

DO 9416

INSTRUCTIONS MANUAL



DO 9416 - DO 9417



DO 9416 - DO 9417

DO 9416 THERMOCOUPLE THERMOMETER-
DATA-LOGGER

DO 9417 THERMOMETER-Pt100 DATA-LOGGER

ENGLISH

-
1. Input A
 2. HOLD, the symbol indicates that the HOLD key has been pressed
 3. Battery symbol
 4. The display shows the maximum value
 5. The display shows the mean value
 6. The display shows the relative value
 7. Depending on the function chosen, the symbol indicates that the SERIAL OUTPUT function is switched on (flashing symbol) or that the instrument is storing (symbol permanently lit)
 8. Key for selecting temperature measurement in °C or °F
 9. HOLD key for blocking the reading
 10. Key for taking relative measurements
 11. Key for selecting the SERIAL OUTPUT function
 12. Key for selecting the various programs
 13. When enabled, the key increases the values shown on the display
 14. Output for RS-232C (SUB D male 9-pole)
 15. Input B
 16. The temperature measurement shown on the upper display (for input A) is in °C
 17. The temperature measurement shown on the upper display (for input A) is in °F
 18. The temperature measurement shown on the lower display (for input B) is in °C
 19. The temperature measurement shown on the lower display (for input B) is in °F
 20. The temperature measurement shown on the lower display is A-B
 21. The display shows the minimum value
 22. Key for switching the instrument on and off
 23. Key for selecting the A-B function
 24. When pressed in sequence the display indicates the MAX, MIN and MEAN value, normal display
 25. Key for activating and suspending the function that stores the maximum, minimum and mean value or, if held down for more than 2 seconds, for resetting the maximum, minimum and mean values and activating the STORAGE function
 26. When enabled, the key decreases the value shown on the display
 27. The key has various functions: it starts and stops storage, confirms the set parameters
-

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION



All the symbols are lit for a few seconds after pressing the ON/OFF key.


Complete display.

Afterwards the code C01, C02 or C03 is shown, depending on the type of calibration of the instrument chosen for taking the measurement.


ON/OFF key. Press this key repeatedly to switch the instrument on or off.

The instrument has a cut-out system (Auto Power Off) which switches off automatically after about 8 minutes.



The  symbol flashes to indicate that Auto Power Off is disabled.

HOLD key. If this key is pressed and held down together with the ON/OFF key while switching on, for the duration of the switching-on routine, the self cut-out function (Auto Power Off) is deactivated.

The  symbol flashes at a frequency of 1 Hz.

The instrument can be switched off only by pressing the ON/OFF key.



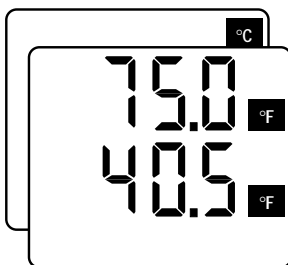
The display shows the code C01, C02, C03 with the letter C flashing, depending on the type of calibration chosen for the measurement.

After the PROG and ON/OFF keys have been pressed together when switching on, holding down PROG for the duration of the switching-on routine, it is possible to select the calibration code C1, C2

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION



or C3 by means of the ▲ and ▼ keys. Then, when the PROG key is pressed, the instrument switches off and stores the calibration code chosen for measurement, which will be shown on the display next time the instrument is switched on with the ON/OFF key.

When this key is pressed during normal operation the value shown on the display is frozen and the HOLD symbol lights up; updating of the internal data continues.

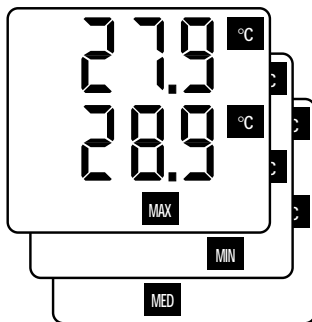
When the key is pressed for the second time the instrument returns to normal operation and the HOLD symbol goes off.

°C/°F key. When the key is pressed the display alternately shows the value of the measurement in °C or °F. The key is active in the RCD, REL, DATA CALL, A-B and HOLD modes.

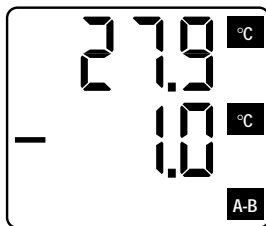
KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION

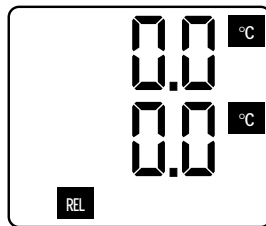


DATA CALL key (Max - Min - Med). When DATA CALL is pressed repeatedly the Max, Min and Med temperature values at input A are shown on the top part of the display; the data for input B appear on the bottom part.



With the A-B key it is possible to show, **on the lower display**, the difference between the temperature values measured at inputs A and B.

If the probe is not connected, or if there is a break in it, the Err signal appears.



The REL (Relative) key allows you to display or store relative values or send them immediately onto the serial line. The values for comparison are stored at the precise moment in which the key is pressed. Data may be stored when the REL button is active.

When unloading relative data (REL function active) immediately onto the serial line, at the end of the data a report will be provided

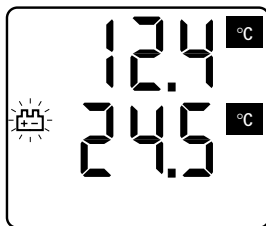
KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION



RCD




giving the maximum, minimum and mean relative values and the reference values on which the calculation of the relative values was based.

The RCD function calculates and stores the maximum, minimum and mean values. When pressed repeatedly the RCD key starts and stops the Record function for calculating the max., min. and mean values.

When the RCD key is held down the instrument emits a short beep followed by a long one. This confirms that the max., min. and mean values stored previously are being erased from the memory and a new series of recordings is started which will be used as the basis on which to calculate and store new max., min. and mean values.

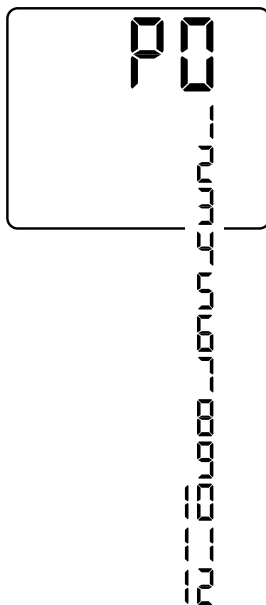
After resetting of the max., min. and mean values, the RCD function has a duration of about 30,000 readings, that is 4 hours. At the end, the RCD function is automatically interrupted and the max. min. and mean values calculated up till then are maintained.


During RCD mode the Auto Power Off function is disabled and the  symbol flashes at a frequency of 2 Hz.

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION

**ATTENTION:**






If the  symbol does not flash at a frequency of 2 Hz when the RCD key is pressed it means that the RCD function has stored more than 30,000 readings and cannot continue any longer.

After having taken note of any max., min. and mean values calculated up till then, proceed to reset the RCD function and restart it.

Programming of the instrument is activated by pressing the PROG key. The message P0 appears at the top of the display indicating that the parameter P0 is being programmed.

By continuing to press the PROG key the messages P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P0, etc. are displayed.

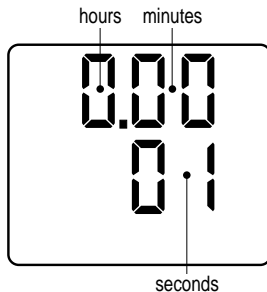
Press the ENTER key on one of the points just described to activate programming of the desired parameter.

KEY	SYMBOLS LIT BESIDES THE NUMBERS	DESCRIPTION
P0+		<p>- P0 -</p> <p>When ENTER is pressed with P0 on the display, the instrument returns to normal operating mode without storing any parameter.</p>
P1+	 = data dump	<p>- P1 -</p> <p>When ENTER is pressed with P1 on the display, the data stored in the memory of the instrument are unloaded.</p>
		<p>The message dUP appears on the upper display of the instrument and the number of the memory unity currently being dumped appears on the lower display. At the end the instrument automatically returns to normal operating mode.</p>
P1+	 = erase memory	<p>When the ▲ key, MEMORY CLEAR sub-command, is pressed with CLr on the display, all the stored data are erased.</p>
		<p>After they have been erased, the instrument will display the number of memory units erased. At the end the instrument automatically returns to normal operating mode.</p>

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

P2+  = storage
interval
programming



DESCRIPTION

- P2 -

When ENTER is pressed with P2 on the display, the storage time parameter may be modified.

This parameter is used for the following two functions:

1. Logging time, or time elapsing between two consecutive data storages in the memory.
2. Data dump interval, or time elapsing between two immediate data dumps on the serial line.

The ▲ and ▼ keys are used to define the desired interval time.

At bottom right of the display the instrument indicates the seconds (1 - 59).

At top right of the display the instrument indicates the minutes (1 - 59).

At top left of the display the instrument indicates the hours (1 - 12).

After defining the time, press ENTER to return to normal operation, or press the PROG key to move on to step P3.

In the storage function the instrument is able to store more than 30,000 acquisitions made at the set interval.

The time taken to fill the memory completely is a function of the recording interval and may be

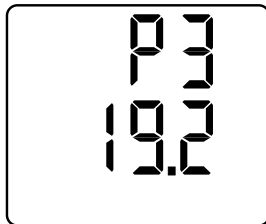
KEY	SYMBOLS LIT BESIDES THE NUMBERS	DESCRIPTION
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obtained from the following table:

RECORDING INTERVAL	TIME TO FILL THE MEMORY
1 sec	8 hours
1 min	20 days
1 hour	1250 days

Once the memory has been filled the instrument automatically stops and leaves storage status. The flashing FUL message appears. The instrument switches off after 8 minutes.

P3+  = set Baud Rate



- P3 -

When ENTER is pressed with P3 on the display, the Baud Rate of the RS-232C serial transmission may be modified.

The ▲ and ▼ keys are used to select the desired value.

The possible values are:

19.2 = 19200 Baud

9.6 = 9600 Baud

4.8 = 4800 Baud

2.4 = 2400 Baud

1.2 = 1200 Baud

0.6 = 600 Baud

0.3 = 300 Baud

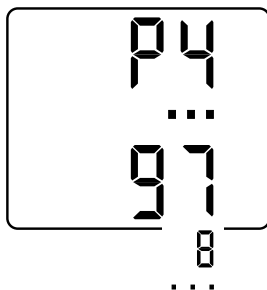
Finally press ENTER to return to normal operation, or press the PROG key to move on to step P4.

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION

P4+  = set year

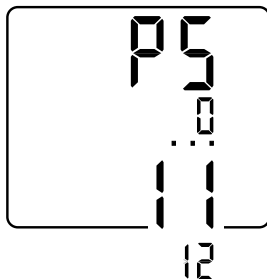
**- P4 -**

When ENTER is pressed with P4 on the display, the year value may be set or changed.

The ▲ and ▼ keys are used to select the desired year.

Then press PROG to move on to step P5 (the ENTER key is not active).


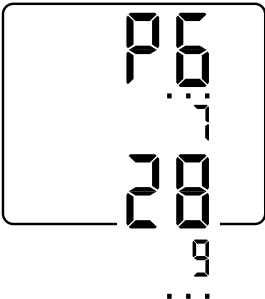

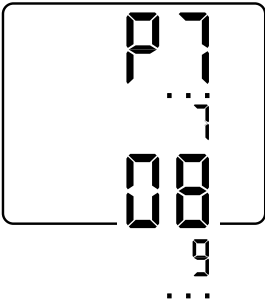

P5+  = set month

**- P5 -**

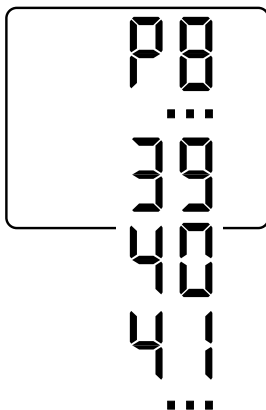
When ENTER is pressed with P5 on the display, the month may be set or changed.

The ▲ and ▼ keys are used to select the desired month.

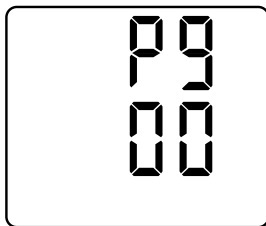
Then press PROG to move on to step P6 (the ENTER key is not active).

KEY	SYMBOLS LIT BESIDES THE NUMBERS	DESCRIPTION
P6+	 = set day	<p>- P6 -</p> <p>When ENTER is pressed with P6 on the display, the day may be set or changed.</p> <p>The ▲ and ▼ keys are used to select the desired day.</p> <p>Then press PROG to move on to step P7 (the ENTER key is not active).</p>
		
P7+	 = set hours	<p>- P7 -</p> <p>When ENTER is pressed with P7 on the display, the hour may be set or changed.</p> <p>The ▲ and ▼ keys are used to select the desired hour.</p> <p>Then press PROG to move on to step P8 (the ENTER key is not active).</p>
		
P8+	 = set minutes	<p>- P8 -</p> <p>When ENTER is pressed with P8 on the display, the minutes may</p>

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

P9+  = enable/disable
self cut-out



DESCRIPTION

be set or changed. The ▲ and ▼ keys are used to select the desired minutes. Then press ENTER to return to normal operating mode or PROG to move on to step P9, without updating the internal clock.

Quitting with the ENTER key updates the internal clock with the date and time just set, setting the seconds at zero at the time of quitting.

- P9 -

When ENTER is pressed with P9 on the display, the instrument enters the program which enables or disables the self cut-out function when it is in storage mode and with a set storage interval higher than or equal to 1 minute.

The ▲ and ▼ keys are used to select the value **00** or **01**.

00 With a set storage interval lower than 1 minute, the instrument does not switch off automatically; it remains always lit.

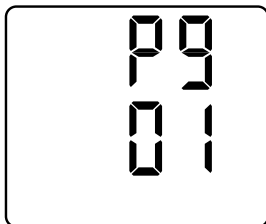
When the ON/OFF key is pressed, storage stops and the instrument switches off.

00 With a set storage interval

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION



higher than 1 minute, the display switches off automatically after about 8 minutes. At each set storage interval there is a beep and the display switches on for a few seconds.

The display can be switched on or off by pressing the ON/OFF key. The instrument keeps on storing if you keep it switched on.

The display switches off automatically after about 8 minutes. To stop storage, press the ON/OFF key (if the instrument is off). Press the ENTER key.

01 With a set storage interval lower than 1 minute, the instrument does not switch off automatically.

When the ON/OFF key is pressed, storage is interrupted and the instrument switches off.

01 With a set storage interval higher than 1 minute, the display does not switch off automatically; it remains always lit and goes on storing. When the ON/OFF key is pressed the display stops till the next acquisition.


Then it switches on again and remains lit.

To stop storage, press the

KEY	SYMBOLS LIT BESIDES THE NUMBERS	DESCRIPTION
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ENTER key.

The ENTER key is used to return to normal operating mode, while pressing the PROG key moves on to step P10 (**P11 for the thermometer DO 9417**).

P10+  = define type of thermocouple
(only found on thermocouple thermometer DO 9416)

- P10 -

When ENTER is pressed with P10 on the display, the instrument enters the program which allows you to choose the type of thermocouple connected to it.

Using the ▲ and ▼ keys you can choose the type of thermocouple to use for the measurements, according to the table given below:

SYMBOL	THERMOCOUPLE
H	NICKEL 10% CHROME - NICKEL 6% ALUMINIUM
J	IRON - COPPER NICKEL
t	NICKEL 10% CHROME - COPPER NICKEL
E	COPPER - COPPER NICKEL
r	PLATINUM 13% RHODIUM - PLATINUM
S	PLATINUM 10% RHODIUM - PLATINUM
b	PLATINUM 30% RHODIUM - PLATINUM 6% RHODIUM

SYMBOLS LIT BESIDES THE NUMBERS

DESCRIPTION



= K



= J



= T



= E



= R



= S



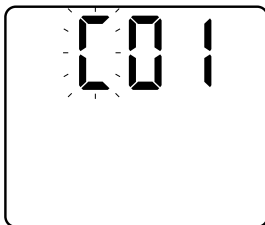
= B

The ENTER key is used to return to normal operating mode, while pressing the PROG key moves on to step P11.

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

P11+  = calibrate probe
in input A



DESCRIPTION

- P11 -

When ENTER is pressed with P11 on the display, the program for calibrating the probe inserted in input A is activated .

The current calibration code is displayed, **C01**, **C02** or **C03**, with the letter C flashing.

The instrument measures the temperature found by the probes inserted in the inputs using three calibration codes:

C01 factory calibration (cannot be changed);

C01 instrument calibration by the user;

C03 calibration of instrument plus probe by the user.

The code **C01** cannot be altered by the user; it is set in the factory when the instrument is tested.

The code **C02** may be altered by the user; it is used to calibrate the instrument with the aid of a thermocouple simulator (for the thermometer DO 9416) or a Pt100 simulator (for the thermometer DO 9417).


The code **C03** may be altered by the user; it is used to calibrate the instrument together with a specific

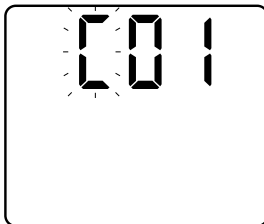
KEY	SYMBOLS LIT BESIDES THE NUMBERS	DESCRIPTION
		<p>probe, with the aid of a calibration oven with which the required temperature is generated.</p>
		<p>First of all, with the ▲ and ▼ keys, choose the calibration code that is to be altered, following the table below:</p>
		<p>C06 alter C02 instrument calibration;</p>
		<p>C08 alter C03 instrument plus probe calibration.</p>
		<p>Then press ENTER to gain access to the program for calibrating the probe inserted in input A, altering the chosen calibration code.</p>
		<p>If the ENTER key is pressed with a value other than C06 or C08, the instrument does not enter the program for calibrating the probe inserted in input A and moves on to normal operation.</p>
		<p>In the program for calibrating the probe inserted in input A, the instrument shows the temperature of the probe inserted in input A at the top of the display and the message CAL at the bottom of the display.</p>
		<p>The calibration instructions are described on page 123 for the</p>

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION

P12+  = calibrate probe
in input B



thermocouple thermometer
DO 9416 and on page 130 for
the Pt100 thermometer DO 9417.

- P12 -

When ENTER is pressed with
P12 on the display, the program
for calibrating the probe inserted
in input B is activated.

The current calibration code is
displayed, **C01**, **C02** or **C03**, with
the letter C flashing.

First of all, with the ▲ and ▼
keys, choose the calibration code
that is to be altered, following the
table below:

C06 alter **C02** instrument calibra-
tion;

C08 alter **C03** instrument plus
probe calibration.

Then press ENTER to gain
access to the program for calibra-
ting the probe inserted in input B,
altering the chosen calibration
code.

If the ENTER key is pressed with
a value other than **C06** or **C08**,
the instrument does not enter the
program for calibrating the probe
inserted in input B and moves on
to normal operation.

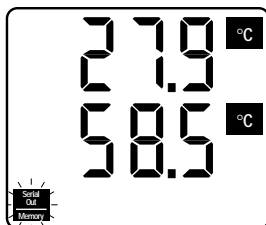
KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION

In the program for calibrating the probe inserted in input B, the instrument shows the temperature of the probe inserted in input B at the top of the display and the message CAL at the bottom of the display.

The calibration instructions are similar to those described for input A.



SERIAL OUTPUT key.

The SERIAL OUTPUT key sends the data being acquired onto the serial line immediately, according to the set programming parameters.

Note: The choice of the Baud Rate influences the speed at which the data are sent onto the serial line.

With a data transmission speed of 300 Baud (the character being composed of 10 bit: 1 start bit +8 character bit +1 stop bit), the time taken to send 80 characters on the serial line is: $80 / (300 / 10) = 2.7$ sec.

There is therefore a limit on the minimum time that may be set as a function of the Baud Rate chosen:

KEY	SYMBOLS LIT BESIDES THE NUMBERS	DESCRIPTION
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BAUD RATE	MINIMUM SETTABLE TIME
300 Baud	4 sec.
600 Baud	2 sec.
> 600 Baud	1 sec.

If a time of less than 4 sec. with a speed of 300 Baud is accidentally set during programming, the time is automatically corrected to 4 sec.

The Serial Out/Memory symbol flashes during the immediate unloading of data onto the serial line. The instrument does not switch off automatically.

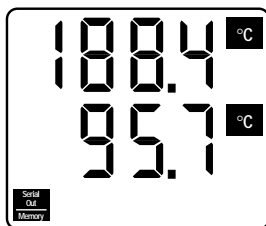
The functions of all the keys are disabled, preventing the performance of all their functions except the SERIAL OUTPUT key and the ON/OFF key.

When pressed again, the SERIAL OUTPUT key ends the unloading of data in progress. A report is issued stating the maximum, minimum and mean values.

▼ key. During programming this key is used to decrease the value of the parameter being considered.



KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION

ENTER key (Start-Stop sub-function).

During programming this key is used both to enter programming and to confirm the value of the parameter considered.

In normal mode the ENTER key as Start-Stop sub-function is used alternatively to start or stop storage of a new block of data to be kept in the memory of the instrument. Data storage is performed at the rate set during programming of step P2. The data stored between one start and the following stop form a block.

Different blocks can thus be formed, all ending (during unloading) with the report giving the maximum, minimum and mean values. The Serial Out/Memory symbol remains lit for the whole period.

The Auto Power Off function is active and the instrument switches itself off after about 8 minutes of inactivity.

It is restarted automatically by the clock interrupt control which reactivates the instrument for only the time needed for all the acquisition and storage operations.

Once this has been done the instrument switches itself off again. During this phase the instrument is apparently off, but it

KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION



is active in operative mode.

If the Serial Out/Memory symbol lights up when switching on the instrument with the ON/OFF key, this means that the instrument was in storage status.

During storage the DO 9406 does not switch off with the ON/OFF button unless a storage time of more than 10 sec. has been set and has been enabled in stage P9 of programming. In this stage the SERIAL OUTPUT and PROG keys are not enabled.

When this operative mode is deactivated the Serial Out/Memory symbol is not lit.

▲ key. During programming this key is used to increase the value of the parameter being considered.

Memory DUMP Function

The DUMP function allows unloading of the data stored in the internal memory of the instrument. The total memory capacity available is 512 kbyte, with the possibility of storing up to 30,000 recordings.

Access to this function is obtained by launching program P1 on the display and pressing the ENTER key. In this way the data are



KEY

SYMBOLS LIT BESIDES
THE NUMBERS

DESCRIPTION



unloaded onto the serial line. The Serial Out/Memory symbol flashes and the message dUP appears at the top of the display throughout the duration of the dumping process while the number of the memory unit currently being dumped appears at the bottom.

When the ENTER key is pressed, data unloading is stopped definitively.

When the ENTER key is pressed again, data dumping is resumed.


When the PROG key is pressed, data dumping is concluded.

At the end of each block a report is issued giving the maximum, minimum and mean values calculated on the block. At the end of Dumping the instrument returns to normal function.

During the DUMP phase the instrument does not switch off automatically, all the key functions are disabled except the ENTER key and the ON/OFF key.

Notes: The block is defined at the time of storage as a group of consecutive recordings. The first interruption in storage ends and determines the block.

HOW TO MEASURE


1. Press the ON/OFF key to switch on the instrument.
 - This operation enables the automatic cutout timer.
 - If you wish power supply without automatic interruption, press the HOLD and ON/OFF keys simultaneously and keep the HOLD button held down for the duration of the switching-on routine. In this case the  symbol flashes. This operation should be carried out before switching the instrument on.
 - When the instrument is switched on all the numbers and symbols light up for a few moments, allowing you to check that all the segments are connected.
 - Immediately afterwards the instrument displays the calibration code set for measurement: C01, C02 or C03. After a few moments it moves on to normal operation.
2. Check display.
 - After the calibration code has been displayed, the temperature measurement of the probe connected to input A will be shown at the top of the display with the measuring unit °C or °F, while the temperature measurement of the probe connected to input B will be shown at the bottom of the display with the measuring unit °C or °F.
 - If there is a break in the probes or if they are not properly connected, the broken probe signal appears (Err). In this case check the sensor part and/or the connector.
3. Selection of the measuring unit.

When the °C/°F key is pressed, the unit for the measurement that is to be taken is selected. Whenever the key is pressed a beep sounds to signal that the command has been accepted.
4. The instrument is switched off by pressing the ON/OFF key.


Because of the Auto Power Off function the instrument may switch itself off during measurements. In this case press the ON/OFF key to switch it on again.
5. Various operations.
 - For operations such as HOLD display, relative measurements, RCD storage, DATA CALL and SERIAL OUTPUT, see the description of the key function.
 - The instrument usually switches off automatically after 8 minutes of inactivity, with the following few exceptions:
 - a) - Instrument in RCD status.
 - b) - Instrument in Auto Power Off Disabled status.In these two cases the instrument switches off only when the ON/OFF key is pressed.
 - c) - Instrument during unloading of stored data.
 - d) - Instrument during SERIAL OUTPUT of immediate data.
 - e) - Instrument in storage function.

The instrument switches off automatically 8 minutes after the low battery warning and interrupts storage.

When it switches on again there are two possibilities:

1. If the battery is definitively low, even when the instrument switches on again LOU appears on the display together with the  symbol.

The PROG key (P1+ENTER) enables the activation of the unloading of stored data even when the battery is low.

2. If the battery has had time to recover and when the instrument switches on its charge seems, even just a little, higher than the minimum value, LOU appears on the display without the  symbol for a short period of time (about 4 seconds), after which the instrument returns to normal operation; this is to remind the user that the instrument was previously in storage function and that this procedure was interrupted by the low battery warning.

- The instrument allows the unloading of the stored data through the program P1+ENTER. The data are transferred directly on the serial line through the CP 2332 C adapter cable.

By using the Xon/Xoff protocol it is possible to unload the data on a computer for the control of data flow:

- The Xoff character (hex 13) on the serial port stops the current unloading of data.
- The Xon character (hex 11) reactivates the current unloading of data which was interrupted.
- The unloading of data may be stopped by pressing the ENTER key on the keyboard. It is possible to quit this status and return to normal operation by pressing the PROG key or to reactivate the unloading of data, which was interrupted, by pressing once again the ENTER key on the keyboard.

- Temperature measurement

Temperature measurements are performed by introducing the immersion probe to a minimum depth of 60 mm into the liquid in which you want to take the measurement; the sensor is housed in the end of the probe. To take measurements in air, the probe must be pointed in a transverse direction to the air flow.

In both cases, to ensure correct measurement avoid contact of the probe with the walls.

When taking penetration measurements the tip of the probe must be inserted at a depth of at least 60 mm; the sensor is housed in the end of the probe.

When taking measurements on frozen blocks it is convenient to use a mechanical tool to make a cavity in which to insert the pointed probe.

To perform a surface measurement correctly the surface must be flat and smooth and the probe must be perpendicular to the measuring plain.

To obtain a correct measurement, the application of a little heat-conductive paste or a drop of oil (water or solvents must absolutely not be used) helps to improve the response time.

ATTENTION:

The use of the keys is relatively simple, but care must be taken to avoid setting it by mistake in an undesired mode. Ensure that HOLD, RCD, REL, MAX, MIN, MED, Serial Out/Memory are not displayed during normal operation.

METHOD OF USE


- If the sensor breaks or becomes faulty it may be replaced. In this case the probe must be recalibrated.
- Do not let the surfaces of the sensor come into contact with sticky surfaces or substances that can corrode or damage the sensor
- Do not use the temperature probes in the presence of corrosive gases or liquids; the container in which the sensor is housed is made of stainless steel AISI 316, while the container for the contact probe is of AISI 316 plus silver and the thermocouple housing is of Inconel.
- Do not bend or force the contacts when inserting the connector.
- Do not bend or deform the probes as this could cause irreparable damage.
- Always use the most suitable probe for the measurement to be taken.
- Be careful with the range of use of the probe, **measurements at limit values are possible only for short periods.**
- Above 400°C, avoid violent blows or thermal shock to the temperature probes as these could cause irreparable damage.
- To obtain a reliable temperature measurement, too fast temperature variations must be avoided.
- Temperature probes for surface measurements must be held in a vertical position with respect to the surface. Apply a drop of oil or heat-conductive paste between the surface and the sensor so as to improve contact and reduce the reading time. Do not use water or solvents to do this.
- Temperature measurements on non-metal surfaces require a great deal of time on account of their low heat conductivity.
- Always clean the probes carefully after use.
- The instrument is resistant to water but it is not watertight and should not therefore be immersed in water. If it should fall into the water, take it out immediately and check that no water has infiltrated.
- The temperature sensor is not insulated from its external casing. Be very careful not to come into contact with live parts (above 48V) as this could be dangerous not only for the instrument but also for the operator, who could suffer an electric shock.
- Avoid taking measurements in the presence of high frequency sources, microwaves or large magnetic fields, as the results would not be very reliable.



ERROR SIGNALS

- Err** (on the upper or lower display) indicates that the probe connected to the respective input A or B is measuring a temperature that exceeds the measuring limits, that the probe is disconnected or broken, or that the battery voltage is too low to take the measurement.
- HI** (only DO 9416) indicates that the instrument is measuring a temperature above the measuring limits.
- LO** (only DO 9416) indicates that the instrument is measuring a temperature below the measuring limits. (Example: with a type B thermocouple at environment temperature, the instrument displays 10).
- E1** Indicates errors in the management of the internal clock and of the display.
- E2** Indicates errors in the management of the internal storage unit.

LOW BATTERY WARNING AND BATTERY REPLACEMENT

If the battery has run down, or if its voltage has reached the limit value of 6.5V, a beep sounds every 10 seconds and the  symbol appears permanently on the display. In these conditions the battery should be replaced as soon as possible. If you continue to use the instrument and the battery voltage falls as low as 5.5V, the instrument is no longer able to ensure correct measurement and two Err codes are shown.





AFTER CHANGING THE BATTERY YOU MUST UPDATE THE CLOCK AND THE PARAMETERS P2, P3 ... AND SO ON.

To change the battery turn the instrument retaining screw in an anti-clockwise direction. After replacing it (with an ordinary 9V alkaline battery) close the instrument, inserting the tag into the slot provided, and turn the screw in a clockwise direction.

The stored data will not be lost even if the instrument remains without batteries.



Ensure that the instrument is switched off before changing the battery.

The  symbol appears fixed to indicate that the battery is low. This indication prevails over all the other signals which make use of the  symbol. In RCD function the  symbol flashes at a frequency of 2 Hz. In Auto Power Off function the  symbol flashes at a frequency of 1 Hz. The flashing of the RCD function prevails over the flashing of Auto Power Off.

FAULTY OPERATION WHEN SWITCHING ON AFTER CHANGING THE BATTERY

Repeat the battery changing procedure, waiting for a few minutes to allow the circuit condenser capacities to be completely discharged, then insert the battery.

WARNING

- If the instrument is not to be used for a long time the battery must be removed.
- If the battery is flat it must be replaced immediately.
- Take steps to avoid leakage of liquid from the battery.
- Use good quality leakproof batteries, alkaline if possible.

MAINTENANCE

Instrument storage conditions:

- * Temperature: -10 to +50°C.
- * Humidity: less than 90% relative humidity, avoid the formation of condensation.
- * Do not store the instrument in places where:
 1. There is a high degree of humidity.
 2. The instrument is exposed to direct sunlight.
 3. The instrument is exposed to a source of high temperature.
 4. There are strong vibrations.
 5. There is steam, salt and/or corrosive gas.

The instrument body is made of ABS plastic so it must not be cleaned with solvents which can spoil plastic.

SERIAL INTERFACE RS-232C

The instrument is equipped with the standard serial interface RS-232C, galvanically insulated; it is supplied with the adapter cable CP 232 C. The following signals are available on the SUB D 9-pin male connector of the instrument.

PIN	SIGNAL	DESCRIPTION
3	TD	Datum transmitted by the instrument
2	RD	Datum received by the instrument
5	GND	Reference logic mass

NOTE: The deflector on the connector of the adapter cable CP 232 C must be turned to COMPUTER or PRINT position, depending on the chosen connector.

The signals present in pins 2 and 3 are at logic levels compatible with the standard RS-232C.

The transmission parameters with which the instrument is supplied are:

- Baud Rate 19200 Baud
- Parity None
- No. bits 8
- Stop bit 1

The data transmission speed may be changed by pressing the PROG key on the instrument to alter the set-up parameter P3. The possible Baud Rates are: 19,200, 9,600, 4,800, 2,400, 1,200, 600, 300. The other transmission parameters are fixed.

All the messages reaching and leaving the instrument must be inserted in a "Communication frame" with the following structure:

Record-cr

where:

- Record- constitutes the message
- cr- Carriage Return (ASCII 0D)

HOST COMMANDS

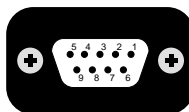
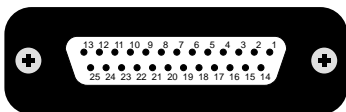
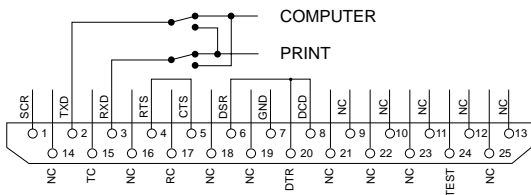
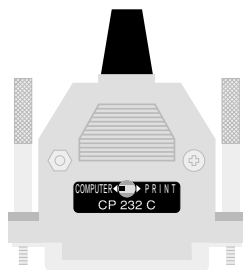
COMMAND

- AA Type of terminal
- AG Firmware Version
- AH Firmware Date

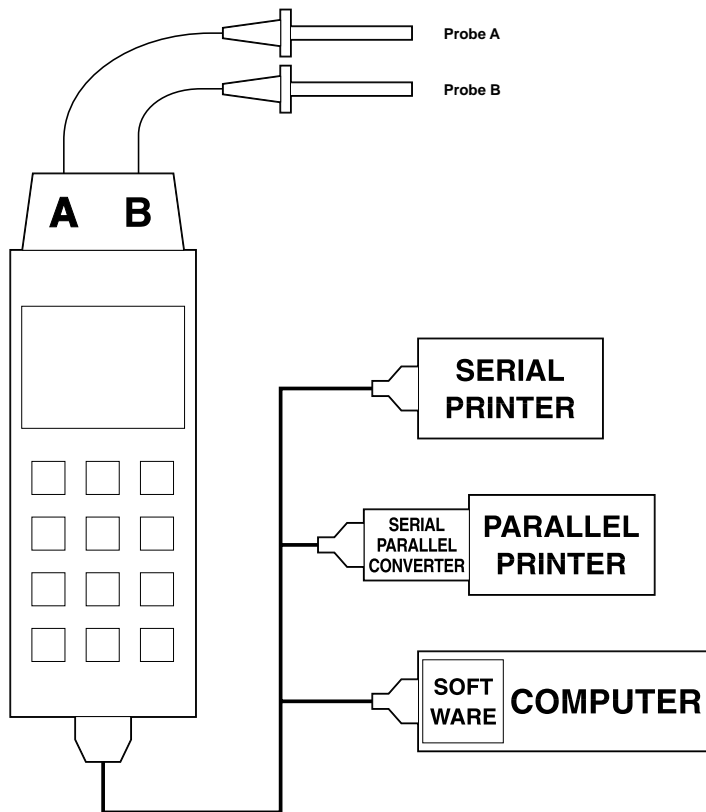
REPLY

- THERMOMETER DL
- V x R x
- dd/mm/yy

SA	Temp. request	t A
SB	Temp. request	t B
SC	Temp. request	t A - t B
SD	Temp. request	t COMPENSATION (only for DO 9416)
SI	Terminal Type	THERMOMETER - Pt100 (for DO 9417)
		THERMOCOUPLE (for DO 9416)
S*		NC
Xoff (Ctr-S)	Stops transmission in progress	
Xon (Ctr-Q)	Resumes transmission in progress	



DO 9416 - DO 9417 DIAGRAM



EXAMPLE OF A REPORT PRINTED BY THE INSTRUMENT**THERMOMETER - Data Logger THERMOCOUPLE**

Immediate serial report

DATE	TIME	--- A ---	--- B ---	--- A-B --
30-09-97	08:01:17	21.4°C	21.9°C	- 0.5°C
30-09-97	08:01:18	21.4°C	21.9°C	- 0.5°C
30-09-97	08:01:19	21.4°C	21.9°C	- 0.5°C
Max. Values	:	21.4°C	21.9°C	- 0.5°C
Min. Values	:	21.4°C	21.9°C	- 0.5°C
Medium Values	:	21.4°C	21.9°C	- 0.5°C

THERMOCOUPLE K

Parameter C01

Input A Calibration date: 27-09-97

Input B Calibration date: 27-09-97

THERMOMETER - Data Logger THERMOCOUPLE

Immediate serial report

DATE	TIME	--- A ---	--- B ---	--- A-B --
30-09-97	08:01:26	0.0°C	0.0°C	0.0°C
30-09-97	08:01:27	0.0°C	0.0°C	0.0°C
30-09-97	08:01:28	0.0°C	0.0°C	0.0°C
Max. Values	:	0.0°C	0.0°C	0.0°C
Min. Values	:	0.0°C	0.0°C	0.0°C
Medium Values	:	0.0°C	0.0°C	0.0°C
Relative to	:	21.4°C	21.9°C	0.5°C

THERMOCOUPLE K

Parameter C01

Input A Calibration date: 27-09-97

Input B Calibration date: 27-09-97

THERMOMETER - Data Logger THERMOCOUPLE

Remote memory report

DATE	TIME	---- A ---	---- B ---	---- A-B --
30-09-97	08:01:53	21.4°C	21.9°C	- 0.5°C
30-09-97	08:01:54	21.4°C	21.9°C	- 0.6°C
30-09-97	08:01:55	21.4°C	21.9°C	- 0.5°C
30-09-97	08:01:56	21.4°C	21.9°C	- 0.5°C
Max. Values	:	21.4°C	21.9°C	- 0.5°C
Min. Values	:	21.4°C	21.9°C	- 0.6°C
Medium Values	:	21.4°C	21.9°C	- 0.5°C

THERMOCOUPLE K

Parameter C01

Input A Calibration date: 27-09-97

Input B Calibration date: 27-09-97

30-09-97	08:01:59	0.0°C	0.0°C	0.0°C
30-09-97	08:02:00	0.0°C	0.0°C	0.0°C
30-09-97	08:02:01	0.0°C	0.0°C	0.0°C
30-09-97	08:02:02	0.0°C	0.0°C	0.0°C
Max. Values	:	0.0°C	0.0°C	0.0°C
Min. Values	:	0.0°C	0.0°C	0.0°C
Medium Values	:	0.0°C	0.0°C	0.0°C
Relative to	:	21.4°C	21.9°C	- 0.5°C

THERMOCOUPLE K

Parameter C01

Input A Calibration date: 27-09-97

Input B Calibration date: 27-09-97

STRUMENTO DO 9417: ESEMPI DI SCARICO DATI**THERMOMETER - Data Logger Pt100**

Immediate serial report

DATE	TIME	--- A ---	--- B ---	--- A-B --
01-10-97	09:59:10	10.0°C	50.1°C	- 40.1°C
01-10-97	09:59:11	10.0°C	50.1°C	- 40.1°C
01-10-97	09:59:12	10.0°C	50.1°C	- 40.1°C
Max. Values	:	10.0°C	50.1°C	- 40.1°C
Min. Values	:	10.0°C	50.1°C	- 40.1°C
Medium Values	:	10.0°C	50.1°C	- 40.1°C

Parameter C01

Input A Calibration date: 28-09-97

Input B Calibration date: 28-09-97

THERMOMETER - Data Logger Pt100

Immediate serial report

DATE	TIME	--- A ---	--- B ---	--- A-B --
01-10-97	09:59:50	0.0°C	0.0°C	0.0°C
01-10-97	09:59:51	0.0°C	0.0°C	0.0°C
01-10-97	09:59:52	0.0°C	0.0°C	0.0°C
01-10-97	09:59:53	0.0°C	0.0°C	0.0°C
Max. Values	:	0.0°C	0.0°C	0.0°C
Min. Values	:	0.0°C	0.0°C	0.0°C
Medium Values	:	0.0°C	0.0°C	0.0°C
Relative to	:	10.0°C	50.1°C	- 40.1°C

Parameter C01

Input A Calibration date: 28-09-97

Input B Calibration date: 28-09-97

THERMOMETER - Data Logger Pt100

Remote memory report

DATE	TIME	---- A ---	---- B ---	---- A-B --
01-10-97	10:00:16	10.0°C	50.1°C	- 40.1°C
01-10-97	10:00:17	10.0°C	50.1°C	- 40.1°C
01-10-97	10:00:18	10.0°C	50.1°C	- 40.1°C
Max. Values	:	10.0°C	50.1°C	- 40.1°C
Min. Values	:	10.0°C	50.1°C	- 40.1°C
Medium Values	:	10.0°C	50.1°C	- 40.1°C

Parameter C01

Input A Calibration date: 28-09-97

Input B Calibration date: 28-09-97

01-10-97	10:00:22	0.0°C	-	0.1°C	0.1°C
01-10-97	10:00:23	0.0°C	-	0.1°C	0.1°C
01-10-97	10:00:24	0.0°C	-	0.1°C	0.1°C
01-10-97	10:00:25	0.0°C	-	0.1°C	0.1°C
Max. Values	:	0.0°C	-	0.1°C	0.1°C
Min. Values	:	0.0°C	-	0.1°C	0.1°C
Medium Values	:	0.0°C	-	0.1°C	0.1°C
Relative to	:	10.0°C		50.1°C	- 40.1°C

Parameter C01

Input A Calibration date: 28-09-97

Input B Calibration date: 28-09-97

INSTRUCTIONS FOR CONNECTING DELTA OHM INSTRUMENTS TO A PC WITH WINDOWS OPERATIVE SYSTEM

Hardware connection

- 1) The measuring instrument must be switched off.
- 2) Connect the serial gate of the measuring instrument to a free serial gate on the PC (COM1/COM2) using the special DELTA OHM RS-232C cable.

Note: the CP 232 C cable ends in a female 25-pin connector; if your PC does not have a compatible connector, use the adapters normally found on the market to make the connection.

- 3) Turn the switch on the CP 232 C cable to COMPUTER position.

Software connection with WINDOWS 3.1

- A) Start WINDOWS
- B) Select ACCESSORIES (2 click)
- C) Select TERMINAL and activate the communications program (2 click)

D) To alter the communication settings of the terminal, in order to make them compatible with those of the measuring instrument used (unless a terminal setting file has already been saved):

select SETTINGS in the terminal window (1 click)

select COMMUNICATIONS from the menu (1 click)

the COMMUNICATIONS window for setting the communication procedures will appear on the screen; set:

TRANSMISSION SPEED: 19200 which must correspond to the speed set on the instrument (1 click)

DATA BITS: 8 (1 click)

STOP BITS: 1 (1 click)

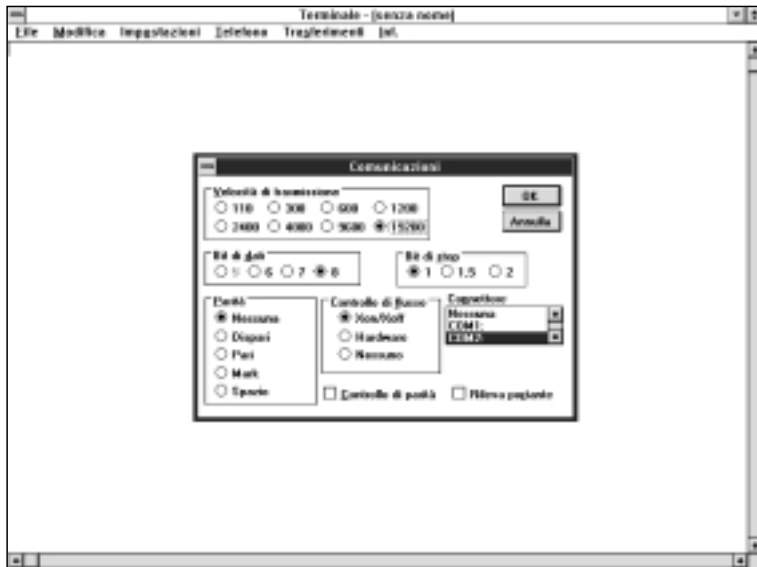
PARITY: None (1 click)

FLOW CONTROL: Xon/Xoff (1 click)

CONNECTOR: COM1 or COM2 depending on the gate used for connection (1 click)

CHECK PARITY and SHOW CARRIER must remain unmarked

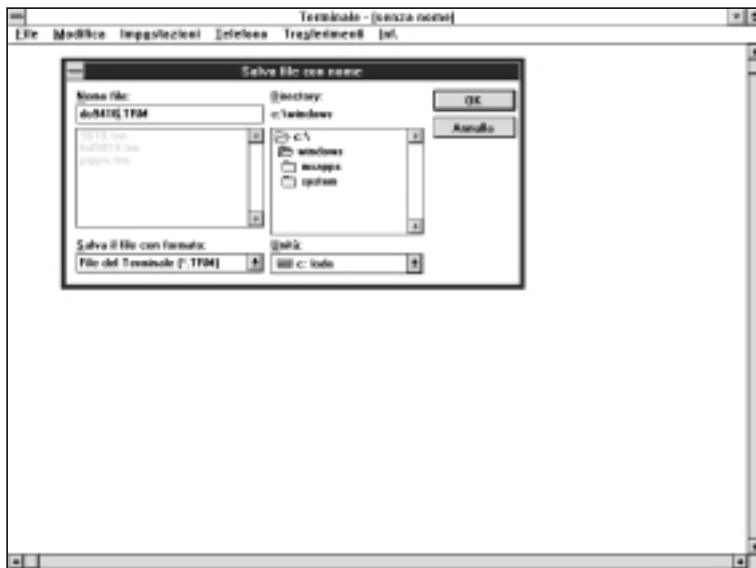
OK to confirm the setting (1 click)



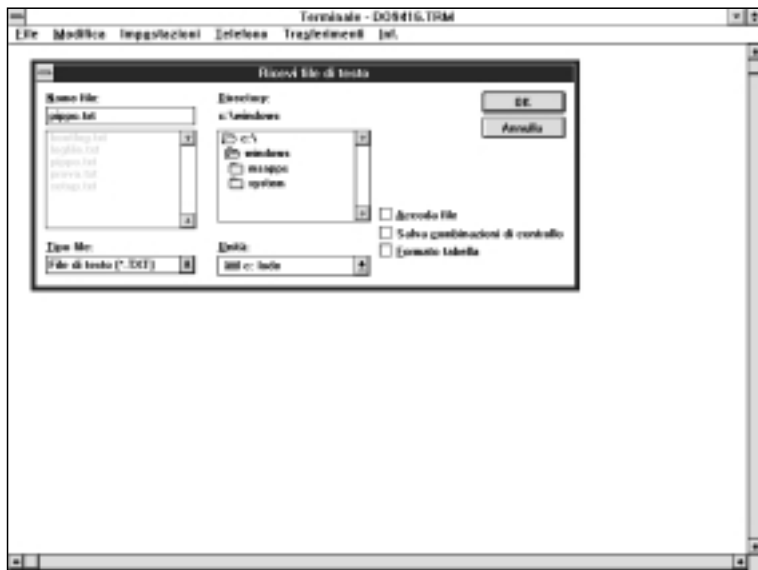
- E) To set the correct character type:
- select SETTINGS in the terminal window (1 click)
 - select TERMINAL PREFERENCES in the pull-down window (1 click)
 - the TERMINAL PREFERENCES window appears on the screen; set:
 - mark local Echo (1 click),
 - Character type: Terminal,
 - Translation: None,
 - leave the rest unchanged.
 - OK to confirm the setting (1 click)



- F) If you want to save this terminal setting:
- select FILE from the terminal window (1 click)
 - select SAVE AS from the menu and the SAVE FILE AS window will appear (1 click)
 - type the name of the terminal setting file (max. 8 characters) on the line provided
 - OK to confirm and save the setting (1 click)



- G) To receive and store data from an instrument:
- select TRANSFER from the terminal window (1 click)
 - select RECEIVE TEXT FILE from the menu and the window will appear (1 click)
 - type the name of the file in which data are to be stored (max. 8 characters) on the line provided
- OK to confirm and start storage (1 click)



At this point the terminal is ready to receive data from the measuring instrument. Everything sent by the measuring instrument will be stored in the file indicated previously.

- H) Switch on the measuring instrument.

When the instrument has completed the switching-on routine, activate the immediate unloading of data at the set rate, pressing the SERIAL OUTPUT button, or activate the unloading of the data stored in the internal memory with the program P1 (press the PROG button twice) and press the ENTER button.

- l) End of storage of the data sent by the instrument
 select TRANSFER from the terminal window (1 click)
 to end storage, select END from the menu (1 click)



- L) End use of the TERMINAL:

- select FILE from the terminal window (1 click)
- select QUIT from the menu (1 click)

The text file, containing the data received from the measuring instrument connected to the PC, is now stored in our computer. To read and process the file obtained we can use any text or table processing program in the Windows environment (WORD, EXCEL, WORKS, etc.).

Software connection with WINDOWS 95

A) After starting WINDOWS 95, select START, PROGRAMS, ACCESSORIES, HYPERTERMINAL.
Run HYPERTRM (2 click).

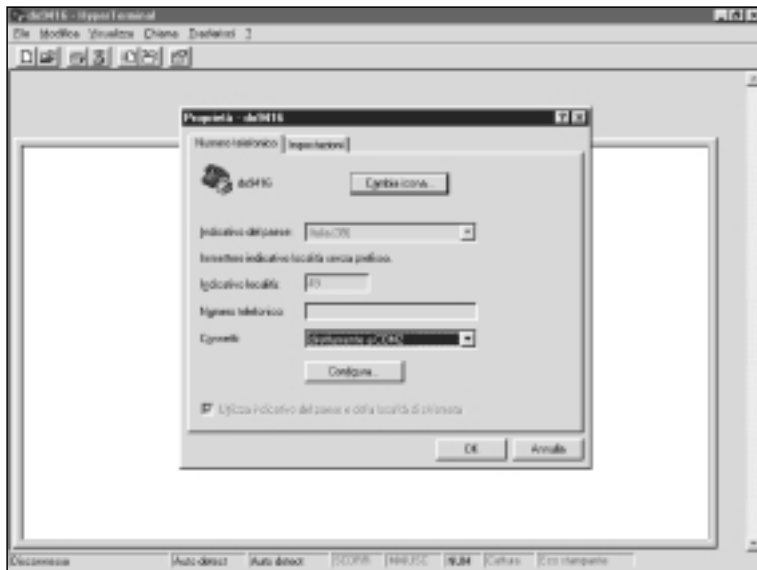
B) Name of the communication.

In the window "Description of connection", give a name to the communication that you want to activate and choose an icon (in subsequent communications it will be possible to activate directly the icon chosen in place of HYPERTRM, automatically recovering all the settings saved with the icon).

OK per confermare

Annulla alla successiva finestra

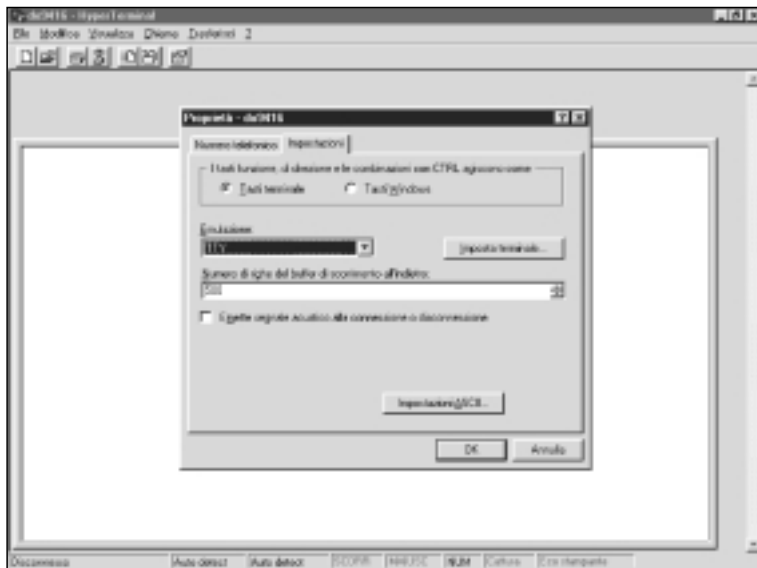




C) Setting communication

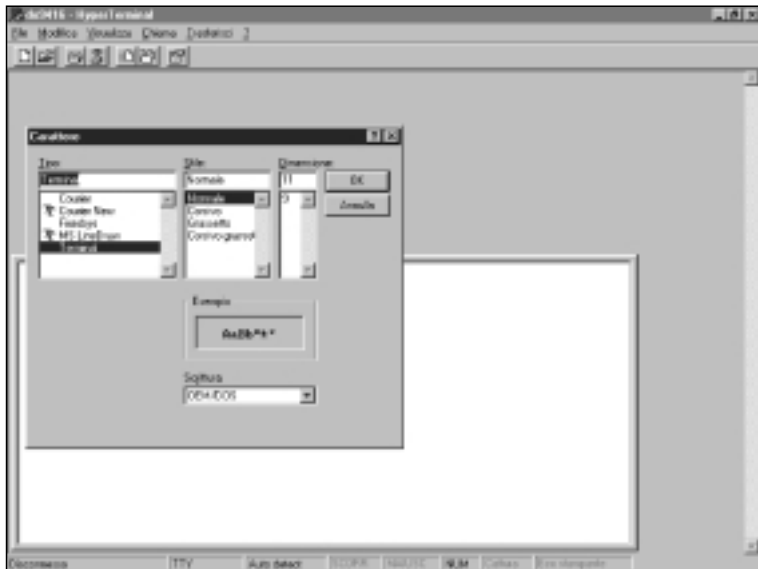
- select FILE from the Hyper Terminal window (1 click)
- select PROPERTIES from the menu (1 click) and the "Properties" window will appear
- on the "telephone number" card, for the Connect property, choose "directly to COM1" or COM2, depending on the serial gate that you intend to use for communication with the measuring instrument.
- on the "telephone number" card, select CONFIGURE (1 click) and the "Gate settings" card will appear.
- on the "Gate settings" card select:
 - BITS PER SECOND: 19200
 - DATA BITS: 8
 - PARITY: None
 - STOP BITS:
 - FLOW CONTROL: Xon/Xoff (1 click)
- OK to confirm the gate setting (1 click)

- select SETTINGS to display the "Settings" card
- on the "Settings" card, for the "Emulation" property, select: TTY
- OK to confirm the "Properties" set (one click)



D) To set the correct type of character:

- select DISPLAY in the Hyper Terminal window (1 click)
- elect CHARACTER in the pull-down window (1 click) and the window for selecting the character appears on the screen; set:
- Terminal.
- OK to confirm (1 click)



E) To receive and store data from an instrument:

- select CALL from the Hyper Terminal window (1 click)
- select CONNECT from the menu

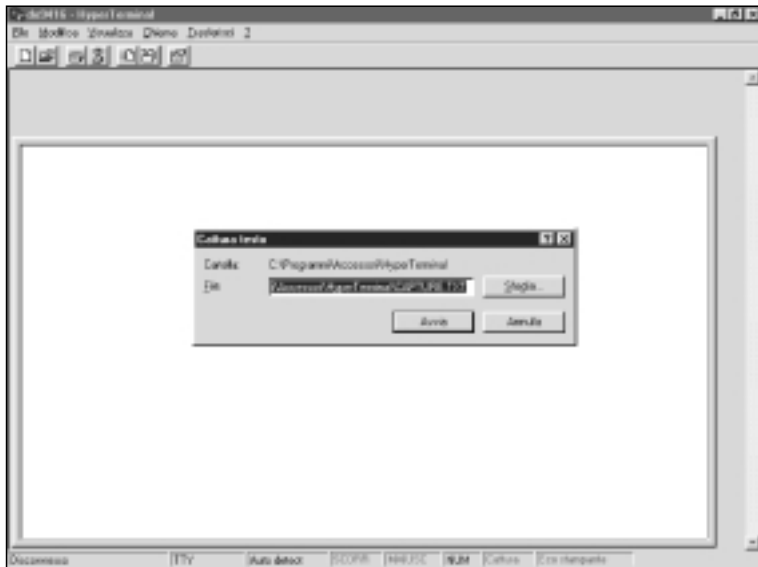
In this way it is possible to see the monitor the characters received from the instrument



At this point the Hyper Terminal software is able to receive data from the measuring instrument and store them in the set file.

To receive and store data from an instrument:

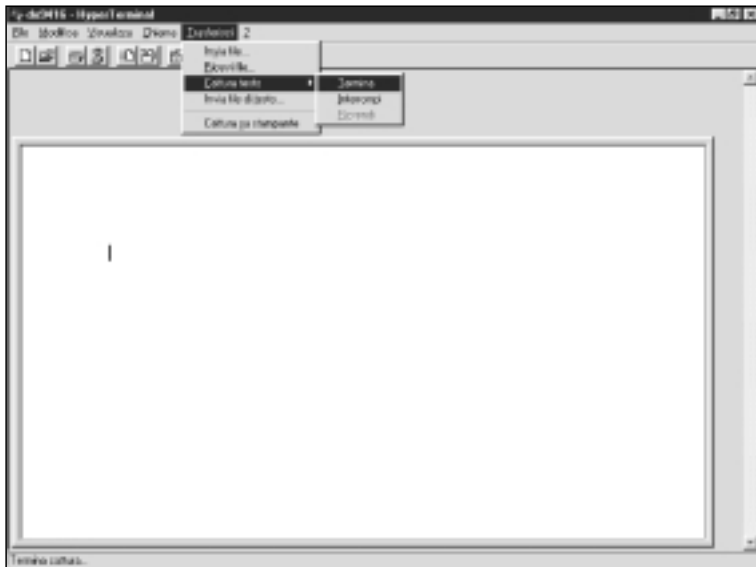
- select TRANSFER from the Hyper Terminal window (1 click)
- select CAPTURE TEXT from the menu (1 click) and the window will appear where you have to set the name of the file in which to store the data received from instrument
- type the name of the file in which data are to be stored on the line provided
- OK to set the name of the receiving file (1 click)



F) To end receiving data from an instrument:

- select TRANSFER from the Hyper Terminal window (1 click)
- select CAPTURE TEXT from the menu (1 click)
- select END from the sub-menu (1 click)

At this point data reception from the instrument is ended and the file stored in the computer can be used with any of the software packages used with WINDOWS 95.



G) To quit running the Hyper Terminal:

- select FILE from the Hyper Terminal window
- select QUIT from the menu
- SI (1 click) se si desidera salvare le impostazioni della comunicazione effettuata.

INSTRUCTIONS FOR CALIBRATING THE THERMOMETER DATA LOGGER DO 9416

Calibration is carried out on two or three values, automatically recognized by the instrument, depending on the type of thermocouple used. To set the type of thermocouple, refer to program P10 on page 88.

Below are given the calibration values depending on the type of thermocouple used (**Tab. 1**):

THERMOCOUPLE	FIRST POINT (°C)	SECOND POINT (°C)	THIRD POINT (°C)
K	0.0	593	1287
J	0.0	443	730
T	0.0	333	not used
E	0.0	336	700
R	484	1343	not used
S	386	1310	not used
B	374	1731	not used

ATTENTION:

- During calibration of the points shown in **Tab. 1**, the instrument does not perform compensation of the cold junction: **the simulated calibration values must be generated without compensation of the cold junction; the calibration values, generated with the calibration oven, must be measured, by the reference thermometer, without compensation of the cold junction, or referred to the environment temperature, that is without compensation of the cold junction.**
- Compensation of the environment temperature is carried out with compensation of the cold junction: the reference thermometer, the probe of which will be immersed in water together with the measuring probe, will measure the temperature of the water at environment temperature, compensating the cold junction.

After having chosen the calibration code to be modified, in program P11 for input A or P12 for input B, the instrument shows on the display the temperature value of the probe inserted in the input that is to be calibrated and the message CAL.

Instrument calibration with code C02.

Instrument calibration comprises:

- compensation of the offset (with the first calibration point),
- compensation of the amplification of the instrument, on the first measuring scale (with the second calibration point),

- only for some types of thermocouple, compensation of the amplification of the instrument, on the second measuring scale (with the third calibration point),
- compensation of the environment temperature.

First calibration point.

With the thermocouple simulator inserted in input A or B, simulate the temperature indicated in **Tab. 1**, in the first point column, depending on the type of thermocouple used.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature indicated in **Tab. 1**, in the first point column, depending on the type of thermocouple used.

Press the PROG key, the °C symbol (or the °F symbol) will stop flashing and the instrument will gradually go to the calibration value.

Second calibration point.

With the thermocouple simulator inserted in input A or B, simulate the temperature indicated in **Tab. 1**, in the second point column, depending on the type of thermocouple used.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature indicated in **Tab. 1**, in the second point column, depending on the type of thermocouple used.

Press the PROG key, the °C symbol (or the °F symbol) will stop flashing and the instrument will gradually go to the calibration value.

Third calibration point (when contemplated for the type of thermocouple used).

With the thermocouple simulator inserted in input A or B, simulate the temperature indicated in **Tab. 1**, in the third point column, depending on the type of thermocouple used.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature indicated in **Tab. 1**, in the third point column, depending on the type of thermocouple used.

Press the PROG key, the °C symbol (or the °F symbol) will stop flashing and the instrument will gradually go to the calibration value.

Compensating the environment temperature.

Insert the probe of the type of thermocouple that you intend to use in input A or B; insert this probe in water, in which there is another probe connected to a reference thermometer.

Press the ▼ button; the water temperature measured by the probe will appear on the bottom display.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the water temperature, measured at that time by the probe.

Using the ▲ and ▼ keys, correct the temperature to make it the same as the one measured by the reference thermometer.

Press the PROG key again, the °C symbol (or the °F symbol) will stop flashing and the instrument will go to the value measured by the reference thermometer.

After compensation of the environment temperature the calibration procedure is complete and the instrument updates the calibration date of input A or B, stated in the report. Switch off the instrument to terminate the calibration operations.

Calibration of the instrument plus probe, code C03.

Calibration of the instrument plus probe comprises:

- compensation of the offset (with the first calibration point),
- compensation of the amplification of the instrument plus probe, on the first measuring scale (with the second calibration point),
- only for some types of thermocouple, compensation of the amplification of the instrument plus probe, on the second measuring scale (with the third calibration point),
- compensation of the environment temperature.

First calibration point.

Bring the calibration oven to the temperature indicated in **Tab. 1**, in the first point column, depending on the type of thermocouple used, and insert the probe that is to be used with the instrument, connecting it to input A or B. When the reading on the instrument to be calibrated has stabilized, move on to the next step.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature indicated in **Tab. 1**, in the first point column, depending on the type of thermocouple used.

Using the ▲ and ▼ keys, correct the temperature value indicated by the instrument being tested to make it the same as the one on the reference instrument inserted in the calibration oven.

Press the PROG button, the °C symbol (or the °F symbol) stop flashing.

Second calibration point.

Bring the calibration oven to the temperature indicated in **Tab. 1**, in the second point column, depending on the type of thermocouple used, and insert the probe that is to be used with the instrument, connecting it to input A or B. When the reading on the instrument to be calibrated has stabilized, move on to the next step.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature indicated in **Tab. 1**, in the second point column, depending on the type of thermocouple used.

Using the ▲ and ▼ keys, correct the temperature value indicated by the instrument being tested to make it the same as the one on the reference instrument inserted in the calibration oven.

Press the PROG button, the °C symbol (or the °F symbol) stop flashing.

Third calibration point (when contemplated for the type of thermocouple used).

Bring the calibration oven to the temperature indicated in **Tab. 1**, in the third point column, depending on the type of thermocouple used, and insert the probe that is to be used with the instrument, connecting it to input A or B. When the reading on the instrument to be calibrated has stabilized, move on to the next step.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature indicated in **Tab. 1**, in the third point column, depending on the type of thermocouple used.

Using the ▲ and ▼ keys, correct the temperature value indicated by the instrument being tested to make it the same as the one on the reference instrument inserted in the calibration oven.

Press the PROG button, the °C symbol (or the °F symbol) stop flashing.

Compensating the environment temperature.

Insert the probe used with the instrument in water, in which there is another probe connected to a reference thermometer.

Press the ▼ button; the water temperature measured by the probe will appear on the bottom display.

Press the PROG key, the °C symbol (or the °F symbol) will flash and the instrument will propose the water temperature, measured at that time by the probe.

Using the ▲ and ▼ keys, correct the temperature to make it the same as the one measured by the reference thermometer.

Press the PROG key again, the °C symbol (or the °F symbol) will stop flashing and the instrument will go to the value measured by the reference thermometer.

After compensation of the environment temperature the calibration procedure is complete and the instrument updates the calibration date of input A or B, stated in the report. Switch off the instrument to terminate the calibration operations.

NOTE: after calibration procedure code C03, for instrument plus probe, to obtain correct measurements the same probe used for calibration must be used.

PROBE CONNECTION TO THE DO 9416

One or two probes may be connected to the DO 9416 thermometer: DELTA OHM thermocouple probes and probes by other manufacturers may be fitted to input A or B as long as they are provided with a standard miniature connector. When connecting the probe, ensure that the connector is polarized.

Thermocouple

Temperature measuring device composed of two homogeneous but dissimilar metal conductors, insulated along their whole length. The two conductors are welded together at one end, called the measuring junction or, hot junction, and are connected to a circuit for measuring the electromotive force (e.m.f.). The connecting area between the thermocouple and the measuring circuit is called the reference junction or, cold junction. When there is a difference in temperature between the measuring junction and the reference junction, the thermocouple generates an e.m.f. that depends on this temperature difference (Seebeck effect).

The most frequently used thermocouples are listed below, with their identification letter:

TYPE OF THERMOCOUPLE	MATERIAL
K	NICKEL 10% CHROME - NICKEL 6% ALUMINIUM
J	IRON - COPPER NICKEL
E	NICKEL 10% CHROME - COPPER NICKEL
T	COPPER - COPPER NICKEL
R	PLATINUM 13% RHODIUM - PLATINUM
S	PLATINUM 10% RHODIUM - PLATINUM
B	PLATINUM 30% RHODIUM - PLATINUM 6% RHODIUM

Measuring junction (hot junction):

This is the end of the thermocouple where the two thermoelements are welded together and is the heat-sensitive part of the thermocouple.

Reference junction (cold junction):

This is the isothermal connection area between the thermocouple and the measurement circuit.

Electromotive force (e.m.f.) of the thermocouple:

This is the difference in electric potential that is measured at the open terminals of the thermocouple when there is a difference in temperature between the measurement junction and the reference junction.

Maximum recommended temperature limits:

The maximum recommended temperature limits for the various types of thermocouple and the respective dimensions of the leads are indicated in the table below.

These limits are indicated for protected thermocouples, that is for thermocouples inserted in cera-

mic insulators, in metal or ceramic protection sheaths closed at one end.

The temperature limits indicated and the respective diameters of the thermoelements are such as to allow a satisfactory life of the thermocouple in continuous duty.

Working temperature limits of thermoelements					
Type of thermocouple	Wire diameter in mm.				
	3.2	1.6	0.8	0.5	0.3
Maximum temperature limit (°C)					
S				1,450	
R				1,450	
B				1,700	
J	750	590	480	370	370
T		400	260	200	200
K	1,250	1,090	980	970	870
E	900	650	540	430	430

Tolerance

The tolerance of a type of thermocouple corresponds to the maximum allowed deviation of the e.m.f. of any thermocouple of that type, with reference junction at 0°C. The tolerance is expressed in degrees Celsius, preceded by the ± sign. The percentage tolerance is given by the ratio between the tolerance expressed in degrees Celsius and the temperature of the measuring junction, multiplied by one hundred. Thermocouples that comply with the standard must respect one of the following two degrees of tolerance, the values of which are shown in the table.

Thermocouple tolerances			
Type of thermocouple	range °C	G I*	G II**
R ed S	0 to 1.450	± 0.6°C or ± 0.1%***	± 1.5°C or ± 0.25 %
B	800 to 1,700	—	± 0.5%
J	0 to 750	± 1.1°C or ± 0.4%	± 2.2°C or ± 0.75 %
T	0 to 400	± 0.5°C or ± 0.4%	± 1 °C or ± 0.75 %
T**	-200 to 0	—	± 1 °C or ± 1.5 %
E	0 to 750	± 1 °C or ± 0.4%	± 1.7°C or ± 1.5 %
E**	-200 to 0	—	± 1.7°C or ± 1.5 %
K	0 to 1,250	± 1.1°C or ± 0.4%	± 2.2°C or ± 0.75 %
K**	-200 to 0	—	± 2.2°C or ± 0.75 %

(* special tolerances) - (** normal tolerances)

The tolerances refer to the working temperature for which the thermocouple is intended, with relation to the diameter of the thermoelements.

TECHNICAL CHARACTERISTICS OF THE DO 9416

- Temperature sensor: thermocouple type K, J, E, T, R, S and B.
- Display: dual LCD with 3¹/₂ digits, height 12.5 mm, and symbols.
- Inputs: n° 2.
Input A and input B for thermocouple temperature probes.
- Instrument measuring range, depending on the thermocouple used and precision:

Type of thermocouple	measuring range °C	resolution °C	precision with instrument temperature from 18 to 25°C	precision with instr. temp. from -10 to 18 and from 25 to 50°C
K	-200 +200	0.1	0.3 °C	0.3°C +0.02°C/°C
	+200 +1,370	1	2 °C	3°C
J	-100 +200	0.1	0.3 °C	0.3°C +0.02°C/°C
	+200 +750	1	2 °C	3°C
E	-200 +200	0.1	0.3 °C	0.3°C +0.02°C/°C
	+200 +750	1	2 °C	3°C
T	-200 +200	0.1	0.3 °C	0.3°C +0.02°C/°C
	+200 +400	1	2 °C	3°C
R	+200 +1,480	1	4 °C	5°C
S	+200 +1,480	1	4 °C	5°C
B	+200 +600	1	5 °C	6°C
	+600 +1,800	1	6 °C	7°C

- Resolution: 0.1°C in the range ±199.9°C; beyond that 1°C.
- Instrument conversion frequency: 2 per second.
- Instrument working temperature: -5°C ... +50°C, 0 ... 90% R.H., no condensation.
- Storage temperature: -20°C ... +60°C.
- Power supply: 9V battery, lifetime with alkaline battery 100 hours.
- Connectors: input A and B have standard miniature connectors, serial gate SUB D male 9-pole.
- Instrument case: ABS.
- Dimensions: instrument alone 210 x 72 x 40 mm
kit 370 x 295 x 85 mm.
- Weight: instrument alone 350 gr.
kit 1600 gr.

ORDER CODE

DO 9416K: Diplomatic carrying case, instrument DO 9416, connecting cable CP 232 C.

PROBES AND CONNECTING CABLES

The probes must be ordered separately. The instrument may be fitted with all DELTA OHM type K thermocouple probes (see page 289) and with probes by other manufacturers as long as they are provided with a standard miniature connector.

CP 232 C Connecting cable from SUB D female 9-pole to SUB D female 25-pole, for serial gate RS-232C.

INSTRUCTIONS FOR CALIBRATING THE INSTRUMENT DO 9417

After the calibration code to be altered has been chosen, in program P11 for input A or P12 for input B, the instrument shows on the display the temperature value of the simulator connected to the input that is to be calibrated and the CAL message.

Instrument calibration with: C02.

Instrument calibration comprises compensation of the offset (first calibration point) and of the amplification of the instrument (second calibration point).

First calibration point 0.0°C (or 32.0°F).

With the Pt100 simulator inserted in input A, simulate a temperature of 0.0°C (32.0°F).

Press the PROG button, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature of 0.0°C (or 32.0°F).

Press the PROG button, the °C symbol (or the °F symbol) stop flashing and the instrument gradually goes to the calibration value of 0.0°C (or 32.0°F).

Second calibration point 197.0°C (or 386°F).

With the Pt100 simulator inserted in input A, simulate a temperature of 197.0°C (386°F).

Press the PROG button, the °C symbol (or the °F symbol) will flash and the instrument will propose the calibration temperature of 197.0°C (or 386°F).

Press the PROG button, the °C symbol (or the °F symbol) stop flashing and the instrument gradually goes to the calibration value of 197.0°C (or 386°F).

After the second calibration point the procedure is complete and the instrument updates the calibration date of input A or B, stated in the report.

Calibration of the instrument plus probe, code C03.

Instrument calibration comprises compensation of the offset (with the first calibration point) and of the amplification of the instrument (with the second calibration point).

First calibration point 0.0°C (or 32.0°F).

Bring the calibration oven to a temperature of 0.0°C (32.0°F) and insert the probe that is to be used with the instrument, connecting it to input A. When the reading on the instrument to be calibrated has stabilized, move on to the next step.

Press the PROG button, the °C symbol (or the °F symbol) will flash and the instrument will propose the reference calibration temperature of 0.0°C (or 32.0°F).

Using the ▲ and ▼ keys, correct the temperature value indicated by the instrument being tested to make it the same as the one on the reference instrument which probe is inserted in the calibration oven.

Press the PROG button, the °C symbol (or the °F symbol) stop flashing.

Second calibration point 197.0°C (or 386°F).

Bring the calibration oven to a temperature of 197.0°C (386°F). When the reading on the instrument to be calibrated has stabilized, move on to the next step.

Press the PROG button, the °C symbol (or the °F symbol) will flash and the instrument will propose the reference calibration temperature of 197.0°C (386°F).

Using the ▲ and ▼ keys, correct the temperature value indicated by the instrument being tested to make it the same as the one on the reference instrument which probe is inserted in the calibration oven.

Press the PROG button, the °C symbol (or the °F symbol) stop flashing and the instrument returns to normal operation, quitting the calibration procedure.

After the second calibration point the procedure is complete and the instrument updates the calibration date of input A or B, stated in the report.

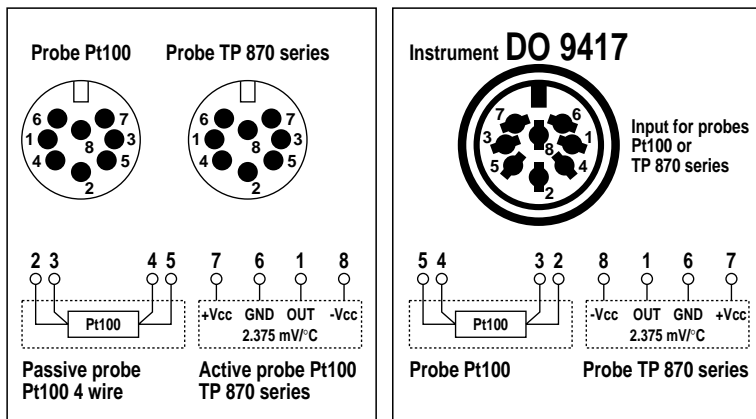
NOTE: after calibration procedure code C03, for instrument plus probe, to obtain correct measurements the same probe used for calibration must be used.

DO 9417 PROBE CONNECTION

One or two probes may be connected to the DO 9417 thermometer: at input A or B, probes of the series TP 870 may be connected, or direct 4-wire probes with a Pt100 sensor.

These probes have a DIN 8-pole male connector.

For the direct input of the 4-wire Pt100 probe, the connection is described in the following diagram:



Platinum thermoresistance

Temperature-sensitive electric resistance, complete with insulation and with connecting leads.

Range of use of platinum thermoresistances

The range of use of platinum thermoresistances is between -200 and 850°C.

If suitably specified, the range of use may be different, as long as it is within the limits stated above.

Tolerance of platinum thermoresistances

Interval, expressed in degrees Celsius (or in Ohm), within which the real characteristic of the resistance thermometer must fall. Two degrees of tolerance are contemplated, A or B, according to standard IEC 751 (1983), and three classes 1/3 DIN, 1/5 DIN and 1/10 DIN, according to standard DIN 43760 (1980).

Tolerances For Platinum Resistance Detectors to IEC 751 (1983) BS 1904 (1984) and DIN 43760 (1980)

Temp °C	Tolerance									
	CLASS B		CLASS A		1/3 DIN		1/5 DIN		1/10 DIN	
	+/- °C	+/- OHMS	+/- °C	+/- OHMS	+/- °C	+/- OHMS	+/- °C	+/- OHMS	+/- °C	+/- OHMS
-200	1.3	0.56	0.55	0.24	0.44	0.19	0.26	0.11	0.13	0.06
-100	0.8	0.32	0.35	0.14	0.27	0.11	0.16	0.06	0.08	0.03
0	0.3	0.12	0.15	0.06	0.1	0.04	0.06	0.02	0.03	0.01
100	0.8	0.3	0.35	0.13	0.27	0.1	0.16	0.05	0.08	0.03
200	1.3	0.48	0.55	0.2	0.44	0.16	0.26	0.1	0.13	0.05
300	1.8	0.64	0.75	0.27	0.6	0.21	0.36	0.13	0.18	0.06
400	2.3	0.79	0.95	0.33	0.77	0.26	0.46	0.16	0.23	0.08
500	2.8	0.93	1.15	0.38	0.94	0.31	0.56	0.19	0.28	0.09
600	3.3	1.06	1.35	0.43	1.1	0.35	0.66	0.21	0.33	0.1
650	3.6	1.13	1.45	0.46	1.2	0.38	0.72	0.23	0.36	0.11

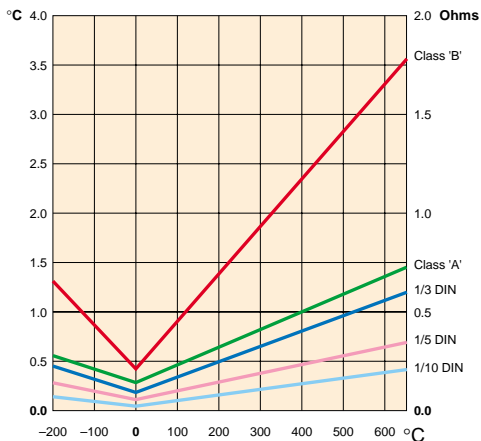


Table of resistances of platinum sensors with regard to temperature (ITS 90).

Industrial Platinum Resistance Thermometer Sensor - R(0) = 100.00Ω

°C ITS 90	0	1	2	3	4	5	6	7	8	9	10	°C ITS 90
-200	18.52											-200
-190	22.83	22.40	21.97	21.54	21.11	20.68	20.25	19.82	19.38	18.95	18.52	-190
-180	27.10	26.67	26.24	25.82	25.39	24.97	24.54	24.11	23.68	23.25	22.83	-180
-170	31.34	30.91	30.49	30.07	29.64	29.22	28.80	28.37	27.95	27.52	27.10	-170
-160	35.54	35.12	34.70	34.28	33.86	33.44	33.02	32.60	32.18	31.76	31.34	-160
-150	39.72	39.31	38.89	38.47	38.05	37.64	37.22	36.80	36.38	35.96	35.54	-150
-140	43.88	43.46	43.05	42.63	42.22	41.80	41.39	40.97	40.56	40.14	39.72	-140
-130	48.00	47.59	47.18	46.77	46.36	45.94	45.53	45.12	44.70	44.29	43.88	-130
-120	52.11	51.70	51.29	50.88	50.47	50.06	49.65	49.24	48.83	48.42	48.00	-120
-110	56.19	55.79	55.38	54.97	54.56	54.15	53.75	53.34	52.93	52.52	52.11	-110
-100	60.26	59.85	59.44	59.04	58.63	58.23	57.82	57.41	57.01	56.60	56.19	-100
-90	64.30	63.90	63.49	63.09	62.68	62.28	61.88	61.47	61.07	60.66	60.26	-90
-80	68.33	67.92	67.52	67.12	66.72	66.31	65.91	65.51	65.11	64.70	64.30	-80
-70	72.33	71.93	71.53	71.13	70.73	70.33	69.93	69.53	69.13	68.73	68.33	-70
-60	76.33	75.93	75.53	75.13	74.73	74.33	73.93	73.53	73.13	72.73	72.33	-60
-50	80.31	79.91	79.51	79.11	78.72	78.32	77.92	77.52	77.12	76.73	76.33	-50
-40	84.27	83.87	83.48	83.08	82.69	82.29	81.89	81.50	81.10	80.70	80.31	-40
-30	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06	84.67	84.27	-30
-20	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01	88.62	88.22	-20
-10	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	92.95	92.55	92.16	-10
0	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87	96.48	96.09	0
10	103.90	103.51	103.12	102.73	102.34	101.95	101.56	101.17	100.78	100.39	100.00	10
20	107.79	107.40	107.01	106.62	106.23	105.84	105.45	105.06	104.67	104.28	103.89	20
30	111.67	111.28	110.89	110.50	110.11	109.72	109.33	108.94	108.55	108.16	107.77	30
40	115.54	115.15	114.76	114.37	113.98	113.59	113.20	112.81	112.42	112.03	111.64	40
50	119.40	119.01	118.62	118.23	117.84	117.45	117.06	116.67	116.28	115.89	115.50	50
60	123.24	122.85	122.46	122.07	121.68	121.29	120.90	120.51	120.12	119.73	119.34	60
70	127.08	126.69	126.30	125.91	125.52	125.13	124.74	124.35	123.96	123.57	123.18	70
80	130.90	130.51	130.12	129.73	129.34	128.95	128.56	128.17	127.78	127.39	127.00	80
90	134.71	134.32	133.93	133.54	133.15	132.76	132.37	131.98	131.59	131.20	130.81	90
100	138.51	138.12	137.73	137.34	136.95	136.56	136.17	135.78	135.39	135.00	134.61	100
110	142.29	141.90	141.51	141.12	140.73	140.34	139.95	139.56	139.17	138.78	138.39	110
120	146.07	145.68	145.29	144.90	144.51	144.12	143.73	143.34	142.95	142.56	142.17	120
130	149.83	149.44	149.05	148.66	148.27	147.88	147.49	147.10	146.71	146.32	145.93	130
140	153.58	153.19	152.80	152.41	152.02	151.63	151.24	150.85	150.46	150.07	149.68	140
150	157.33	156.94	156.55	156.16	155.77	155.38	154.99	154.60	154.21	153.82	153.43	150
160	161.05	160.66	160.27	159.88	159.49	159.10	158.71	158.32	157.93	157.54	157.15	160
170	164.77	164.38	163.99	163.60	163.21	162.82	162.43	162.04	161.65	161.26	160.87	170
180	168.48	168.09	167.70	167.31	166.92	166.53	166.14	165.75	165.36	164.97	164.58	180
190	172.17	171.78	171.39	171.00	170.61	170.22	169.83	169.44	169.05	168.66	168.27	190
200	175.86	175.47	175.08	174.69	174.30	173.91	173.52	173.13	172.74	172.35	171.96	200
210	179.53	179.14	178.75	178.36	177.97	177.58	177.19	176.80	176.41	176.02	175.63	210
220	183.19	182.80	182.41	182.02	181.63	181.24	180.85	180.46	180.07	179.68	179.29	220
230	186.84	186.45	186.06	185.67	185.28	184.89	184.50	184.11	183.72	183.33	182.94	230
240	190.47	190.08	189.69	189.30	188.91	188.52	188.13	187.74	187.35	186.96	186.57	240
250	194.10	193.71	193.32	192.93	192.54	192.15	191.76	191.37	190.98	190.59	190.20	250
260	197.71	197.32	196.93	196.54	196.15	195.76	195.37	194.98	194.59	194.20	193.81	260
270	201.31	200.92	200.53	200.14	199.75	199.36	198.97	198.58	198.19	197.80	197.41	270
280	204.90	204.51	204.12	203.73	203.34	202.95	202.56	202.17	201.78	201.39	201.00	280
290	208.48	208.09	207.70	207.31	206.92	206.53	206.14	205.75	205.36	204.97	204.58	290
300	212.05	211.66	211.27	210.88	210.49	210.10	209.71	209.32	208.93	208.54	208.15	300
310	215.61	215.22	214.83	214.44	214.05	213.66	213.27	212.88	212.49	212.10	211.71	310
320	219.15	218.76	218.37	217.98	217.59	217.20	216.81	216.42	216.03	215.64	215.25	320
330	222.68	222.29	221.90	221.51	221.12	220.73	220.34	219.95	219.56	219.17	218.78	330
340	226.21	225.82	225.43	225.04	224.65	224.26	223.87	223.48	223.09	222.70	222.31	340

°C ITS 90	0	1	2	3	4	5	6	7	8	9	10	°C ITS 90
350	229.72	230.07	230.42	230.77	231.12	231.47	231.82	232.17	232.52	232.87	233.21	350
360	233.21	233.56	233.91	234.26	234.61	234.96	235.31	235.66	236.00	236.35	236.70	360
370	236.70	237.05	237.40	237.74	238.09	238.44	238.79	239.13	239.48	239.83	240.18	370
380	240.18	240.52	240.87	241.22	241.56	241.91	242.26	242.60	242.95	243.29	243.64	380
390	243.64	243.99	244.33	244.68	245.02	245.37	245.71	246.06	246.40	246.75	247.09	390
400	247.09	247.44	247.78	248.13	248.47	248.81	249.16	249.50	249.85	250.19	250.53	400
410	250.53	250.88	251.22	251.56	251.91	252.25	252.59	252.93	253.28	253.62	253.96	410
420	253.96	254.30	254.65	254.99	255.33	255.67	256.01	256.35	256.70	257.04	257.38	420
430	257.38	257.72	258.06	258.40	258.74	259.08	259.42	259.76	260.10	260.44	260.78	430
440	260.78	261.12	261.46	261.80	262.14	262.48	262.82	263.16	263.50	263.84	264.18	440
450	264.18	264.52	264.86	265.20	265.53	265.87	266.21	266.55	266.89	267.22	267.56	450
460	267.56	267.90	268.24	268.58	268.91	269.25	269.59	269.92	270.26	270.60	270.93	460
470	270.93	271.27	271.61	271.94	272.28	272.61	272.95	273.29	273.62	273.96	274.29	470
480	274.29	274.63	274.96	275.30	275.63	275.97	276.30	276.64	276.97	277.31	277.64	480
490	277.64	277.98	278.31	278.64	278.98	279.31	279.64	279.98	280.31	280.64	280.98	490
500	280.98	281.31	281.64	281.98	282.31	282.64	282.97	283.31	283.64	283.97	284.30	500
510	284.30	284.63	284.97	285.30	285.63	285.96	286.29	286.62	286.95	287.29	287.62	510
520	287.62	287.95	288.28	288.61	288.94	289.27	289.60	289.93	290.26	290.59	290.92	520
530	290.92	291.25	291.58	291.91	292.24	292.57	292.89	293.22	293.55	293.88	294.21	530
540	294.21	294.54	294.86	295.19	295.52	295.85	296.18	296.50	296.83	297.16	297.49	540
550	297.49	297.81	298.14	298.47	298.80	299.12	299.45	299.78	300.10	300.43	300.75	550
560	300.75	301.08	301.41	301.73	302.06	302.38	302.71	303.03	303.36	303.69	304.01	560
570	304.01	304.34	304.66	304.98	305.31	305.63	305.96	306.28	306.61	306.93	307.25	570
580	307.25	307.58	307.90	308.23	308.55	308.87	309.20	309.52	309.84	310.16	310.49	580
590	310.49	310.81	311.13	311.45	311.78	312.10	312.42	312.74	313.06	313.39	313.71	590
600	313.71	314.03	314.35	314.67	314.99	315.31	315.64	315.96	316.28	316.60	316.92	600
610	316.92	317.24	317.56	317.88	318.20	318.52	318.84	319.16	319.48	319.80	320.12	610
620	320.12	320.43	320.75	321.07	321.39	321.71	322.03	322.35	322.67	322.99	323.30	620
630	323.30	323.62	323.94	324.26	324.57	324.89	325.21	325.53	325.84	326.16	326.48	630
640	326.48	326.79	327.11	327.43	327.74	328.06	328.38	328.69	329.01	329.32	329.64	640
650	329.64	329.96	330.27	330.59	330.90	331.22	331.53	331.85	332.16	332.48	332.79	650
660	332.79	333.11	333.42	333.74	334.05	334.36	334.68	334.99	335.31	335.62	335.93	660
670	335.93	336.25	336.56	336.87	337.18	337.50	337.81	338.12	338.44	338.75	339.06	670
680	339.06	339.37	339.69	340.00	340.31	340.62	340.93	341.24	341.56	341.87	342.18	680
690	342.18	342.49	342.80	343.11	343.42	343.73	344.04	344.35	344.66	344.97	345.28	690
700	345.28	345.59	345.90	346.21	346.52	346.83	347.14	347.45	347.76	348.07	348.38	700
710	348.38	348.69	348.99	349.30	349.61	349.92	350.23	350.54	350.84	351.15	351.46	710
720	351.46	351.77	352.08	352.38	352.69	353.00	353.30	353.61	353.92	354.22	354.53	720
730	354.53	354.84	355.14	355.45	355.76	356.06	356.37	356.67	356.98	357.28	357.59	730
740	357.59	357.90	358.20	358.51	358.81	359.12	359.42	359.72	360.03	360.33	360.64	740
750	360.64	360.94	361.25	361.55	361.85	362.16	362.46	362.76	363.07	363.37	363.67	750
760	363.67	363.98	364.28	364.58	364.89	365.19	365.49	365.79	366.10	366.40	366.70	760
770	366.70	367.00	367.30	367.60	367.91	368.21	368.51	368.81	369.11	369.41	369.71	770
780	369.71	370.01	370.31	370.61	370.91	371.21	371.51	371.81	372.11	372.41	372.71	780
790	372.71	373.01	373.31	373.61	373.91	374.21	374.51	374.81	375.11	375.41	375.70	790
800	375.70	376.00	376.30	376.60	376.90	377.19	377.49	377.79	378.09	378.39	378.68	800
810	378.68	378.98	379.28	379.57	379.87	380.17	380.46	380.76	381.06	381.35	381.65	810
820	381.65	381.95	382.24	382.54	382.83	383.13	383.42	383.72	384.01	384.31	384.60	820
830	384.60	384.90	385.19	385.49	385.78	386.08	386.37	386.67	386.96	387.25	387.55	830
840	387.55	387.84	388.14	388.43	388.72	389.02	389.31	389.60	389.90	390.19	390.48	840
850	390.48											850

TECHNICAL CHARACTERISTICS OF THE DO 9417

- Temperature sensor: Platinum Pt100 (100 Ω and 0°C).
- Display: dual LCD with 3¹/₂ digits, height 12.5 mm, with symbols.
- Inputs: n° 2.
Input A and input B for temperature probes, series TP 870, TP 870A, TP 870C, TP 870P (Pt100 sensor with amplification and linearization circuit) or 4-wire Pt100 probes with direct input (100 Ω at 0°C).
- Instrument temperature measuring range: -200 ...800°C.
- Instrument precision in temperature measurements:

Type of probe	measuring range °C	resolution °C	precision with instrument temperature from 18 to 25°C	precision with instr. temp. from -10 to 18 and from 25 to 50°C
Instrument alone	-200 -50	0.1	0.4 °C	0.4°C +0.01°C/°C
	-50 +200	0.1	0.2 °C	0.2°C +0.01°C/°C
	+200 +850	1	2 °C	3°C
Instrument with TP 870	-200 -50	0.1	0.6 °C	0.6°C +0.01°C/°C
	-50 +200	0.1	0.4 °C	0.2°C +0.01°C/°C
	+200 +850	1	2 °C	3°C
Instrument with Pt100 classe A	-200 -50	0.1	0.8 °C	0.8°C +0.01°C/°C
	-50 +200	0.1	0.4 °C	0.4°C +0.01°C/°C
	+200 +850	1	3 °C	4°C
Instrument with Pt100 classe B	-200 -50	0.1	1.6 °C	1.6°C +0.01°C/°C
	-50 +200	0.1	1.0 °C	1.0°C +0.01°C/°C
	+200 +850	1	5 °C	6°C
Instrument with Pt100 1/3 DIN	-200 -50	0.1	0.7 °C	0.7°C +0.01°C/°C
	-50 +200	0.1	0.4 °C	0.4°C +0.01°C/°C
	+200 +850	1	3 °C	4°C
Instrument with Pt100 1/5 DIN	-200 -50	0.1	0.6 °C	0.6°C +0.01°C/°C
	-50 +200	0.1	0.3 °C	0.3°C +0.01°C/°C
	+200 +850	1	2 °C	3°C

- Resolution: 0.1°C in the range $\pm 199.9^\circ\text{C}$; beyond that 1°C.
- Instrument conversion frequency: 2 per second.
- Instrument working temperature: -5°C ... +50°C, 0 ... 90% R.H., no condensation.
- Storage temperature: -20°C ... +60°C.
- Power supply: 9V battery, lifetime with alkaline battery ca. 100 hours.
- Connectors: input A and B, DIN 41524 female eight-pole circular connector, serial gate SUB D male 9-pole.

- Instrument case: ABS.
- Dimensions: instrument alone 210 x 72 x 40 mm
kit 370 x 295 x 85 mm.
- Weight: instrument alone 350 gr.
kit 1600 gr.

ORDER CODE

DO 9417K: Diplomatic carrying case, instrument DO 9417, connecting cable CP 232 C.

PROBES AND CONNECTING CABLES

- TP 870:** Immersion temperature probe, diam. 3 x 230 mm.
Measuring range -60...+400°C.
- TP 870P:** Penetration temperature probe, diam. 4 x 150 mm.
Measuring range -60...+400°C.
- TP 870C:** Contact temperature probe, diam. 5 x 230 mm.
Measuring range -60...+400°C.
- TP 870A:** Air temperature probe, diam. 4 x 230 mm.
Measuring range -60...+300°C.
- CP 232 C:** Connecting cable from SUB D female 9-pole to SUB D female 25-pole, for SERIAL OUTPUT RS-232C.


The probes must be ordered separately. The instrument may be fitted with all probes in the TP 870... series (see page 289) or with any type of Pt100 probe by other manufacturers as long as they have 4 wires and comply with the diagram on page 132 of the manual.

GUARANTEE

This instrument is strictly inspected before being sold. However if there should be any defect due to manufacture and/or transport, apply to the dealer from whom you bought the instrument.

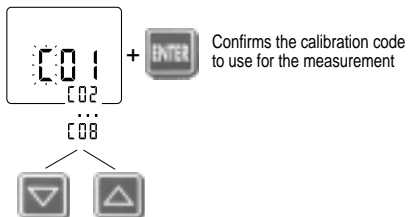
The guarantee period is 2 (two) years from the date of purchase. During this period all defects found by us will be repaired free of charge, excluding those due to incorrect use and careless handling. The probes are not covered by the guarantee, as they can be irreparably damaged after only a few minutes of incorrect use.

EXAMPLES OF USE OF THE KEYBOARD


1.  Switches the instrument on or off.

2.  Blocks or releases updating of the display.

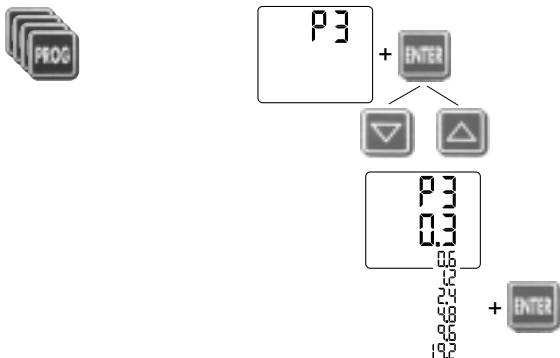
3.  +  Changes the calibration code used.



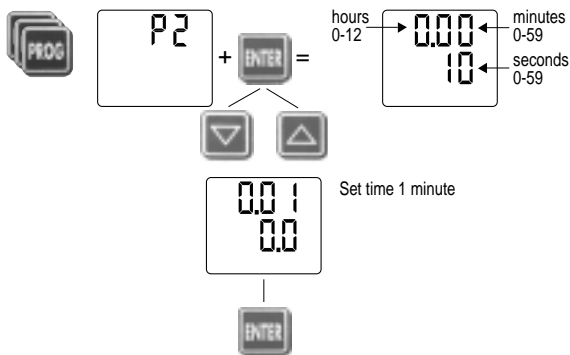
4.  The temperature reading may be in °C or °F.



5.  Before pressing the key the Baud Rate must be set. It must be compatible with the printer or computer to which the instrument is to be connected.


A) Setting the BAUD RATE:




B) Setting the reading or storage interval.

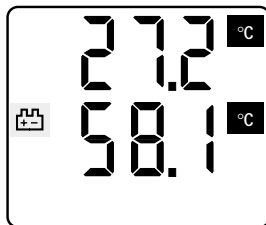


At this point the  key may be pressed. The  symbol flashes.

To quit, press . It will take a few seconds for the Serial Out/Memory symbol to stop flashing because, after the last value has been printed, the final report of the MAX/MIN/MEAN values is printed.

6.  When the key is pressed the instrument starts to store and update the MAX/MIN/MEAN value.

RCD



beep

When it is pressed for a few seconds it emits a beep, clears the Maximum, Minimum and Mean value and starts again, updating the MAX, MIN, MEAN values.



RCD

7. Pressing DATA CALL gives:



1.



The Maximum value of the probes connected to input A and B

2.



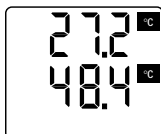
The Minimum value of the probes connected to input A and B

3.



The Mean value of the probes connected to input A and B

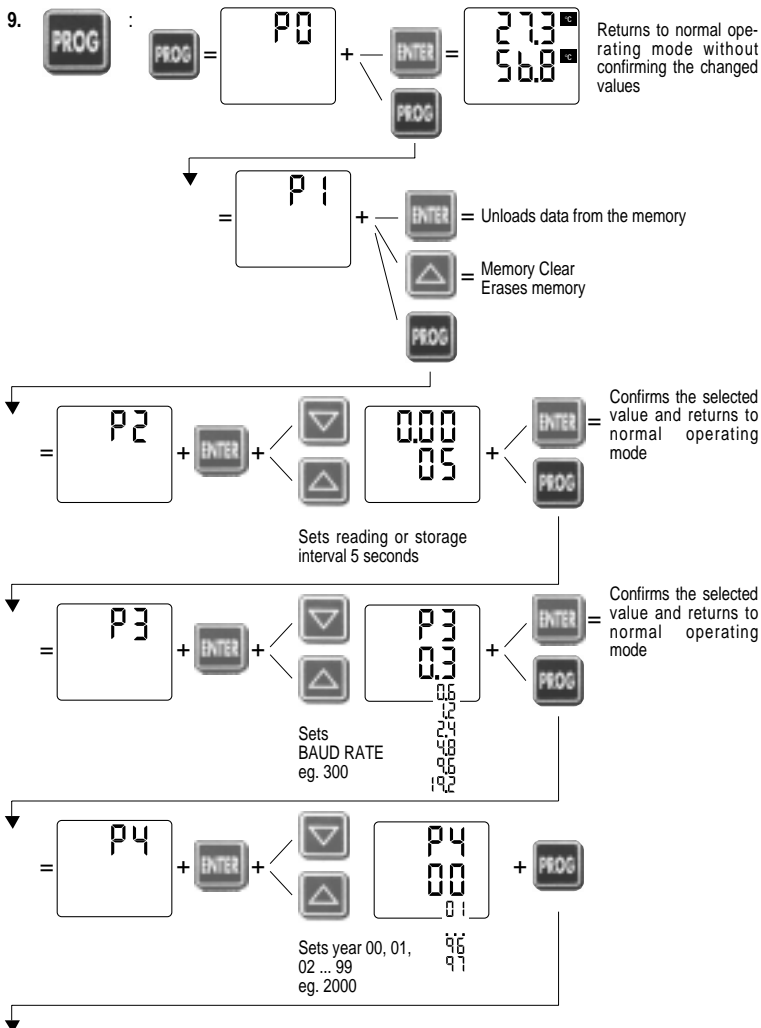
4.

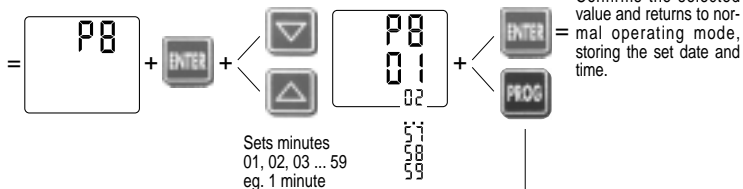
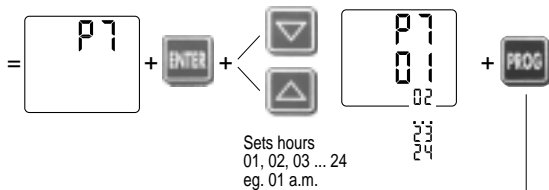
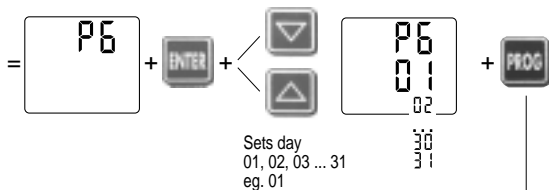
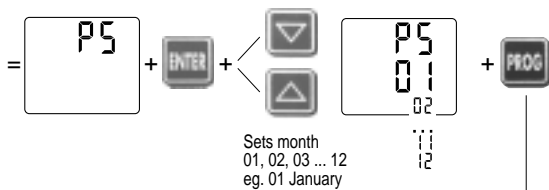


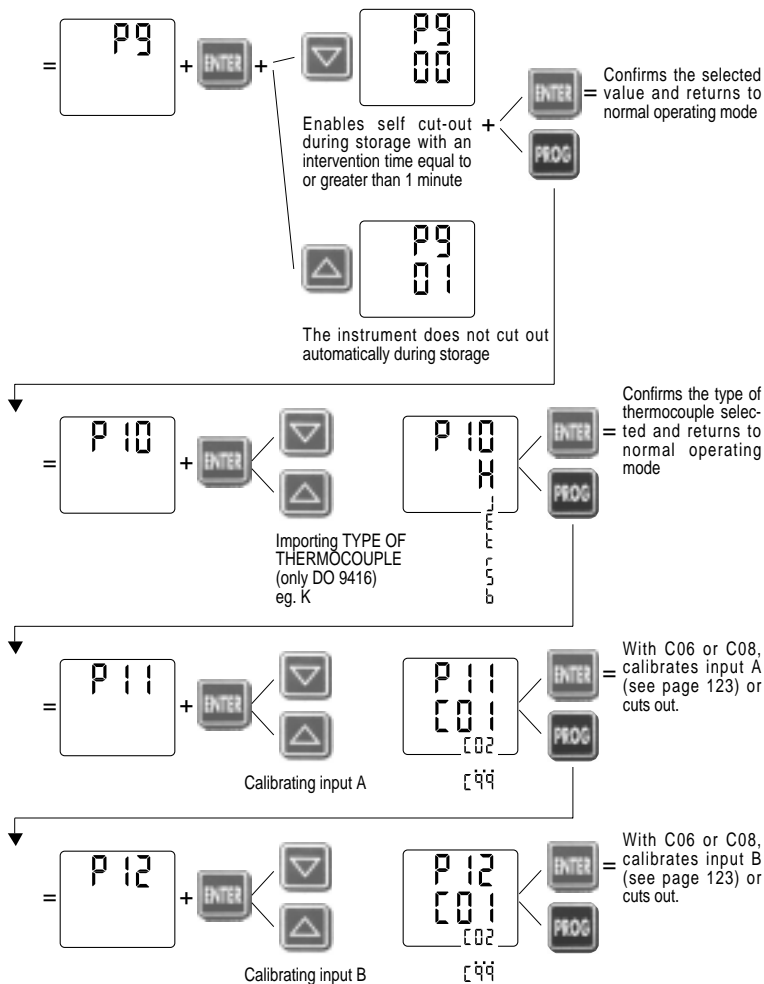
The current value

8. When the key is pressed the instrument starts or stops storage. The Serial Out/Memory symbol appears or disappears.


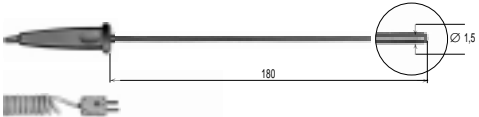


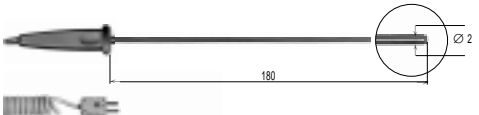
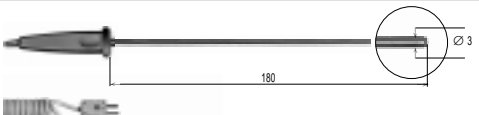
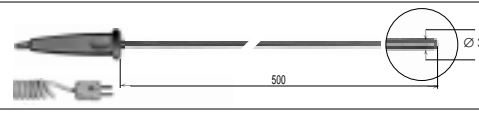



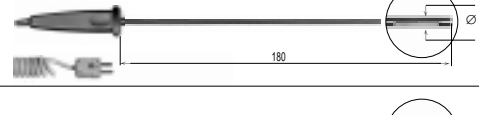












SONDE SENSORE TERMOCOPPIA TIPO "K" (CHROMEL-ALUMEL) - THERMOCOUPLE K TYPE PROBES (CHROMEL-ALUMEL)
 SONDES A THERMOCOUPLE TYPE K (CHROMEL-ALUMEL) - THERMOPAAARFÜHLER TYP K (CHROMEL-ALUMEL) - SONDAS TERMOPARES TIPO K (CHROMEL-ALUMEL)


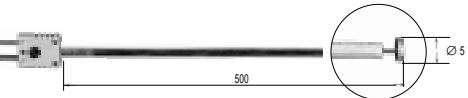


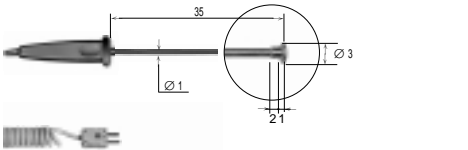
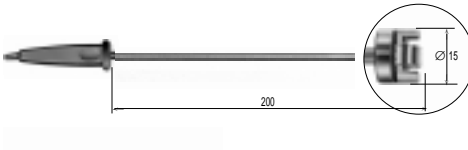
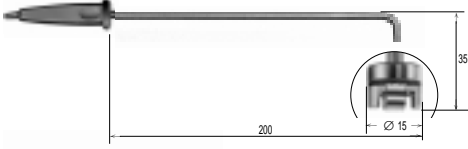
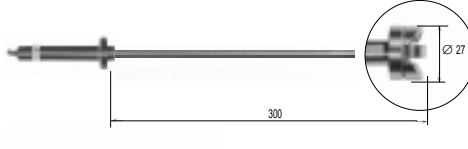
COD.	°C max.	1" sec.	DIMENSIONI	DIMENSIONS	DIMENSIONS	ABMESSUNGEN	DIMENSIONES	IMPIEGO USE UTILISATION GEBRAUCH EMPLOO	
TP 741	800	2"							
TP 742	800	2"							
TP 743	800	3"							
TP 750	800	3"							
TP 651	1200	6"							
TP 652	1200	6"							
TP 744	400	4"							
TP 659	500	3"							

SONDE SENSORE TERMOCOPPIA TIPO "K" (CHROMEL-ALUMEL) - THERMOCOUPLE K TYPE PROBES (CHROMEL-ALUMEL)
 SONDES A THERMOCOUPLE TYPE K (CHROMEL-ALUMEL) - THERMOFAARFUHLER TYP K (CHROMEL-ALUMEL) - SONDAS TERMOPARES TIPO K (CHROMEL-ALUMEL)

COD.	°C max.	1" sec.	DIMENSIONI	DIMENSIONS	DIMENSIONS	ABMESSUNGEN	DIMENSIONES	IMPIEGO USE UTILISATION GEBRAUCH EMPLOO	
TP 660	500	4"							
TP 758	400	4"							
TP 657	200	3"							
TP 657/1	200	5"							
TP 658	200	2"							
TP 647 TP 647/2 TP 647/3 TP 647/5	400 400 400 400	2" 2" 2" 2"							
TP 745	500	3"							
TP 746	250	2"							


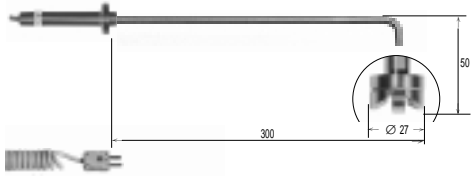
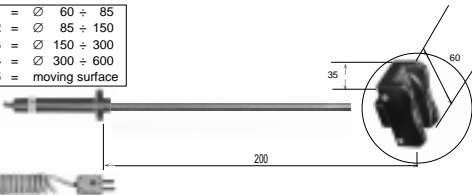




HD 6802
 HD 8704
 HD 9016
 HD 9218
 DO 9416

SONDE SENSORE TERMOCOPPIA TIPO "K" (CHROMEL-ALUMEL) - THERMOCOUPLE K TYPE PROBES (CHROMEL-ALUMEL)
 SONDES A THERMOCOUPLE TYPE K (CHROMEL-ALUMEL) - THERMOPAARFÜHLER TYP K (CHROMEL-ALUMEL) - SONDAS TERMOPARES TIPO K (CHROMEL-ALUMEL)


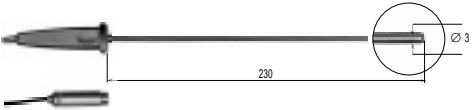


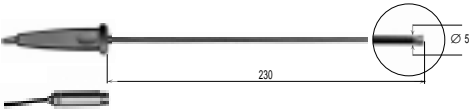

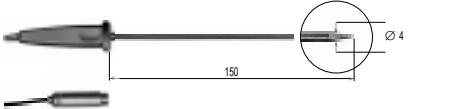

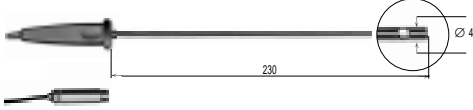

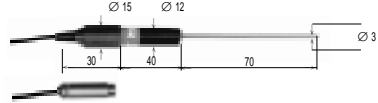


COD.	°C max.	1° sec.	DIMENSIONI	DIMENSIONS	DIMENSIONS	ABMESSUNGEN	DIMENSIONES	IMPIEGO USE UTILISATION GEBRAUCH EMPLEO			
TP 772	400	3"									
TP 777	400	3"									
TP 754	500	2"									
TP 754/9	500	2"									
TP 755	800	2"									

HD 6802
 HD 8704
 HD 9016
 HD 9218
 DO 9416

SONDE SENSORE TERMOCOPPIA TIPO "K" (CHROMEL-ALUMEL) - THERMOCOUPLE K TYPE PROBES (CHROMEL-ALUMEL)
 SONDES A THERMOCOUPLE TYPE K (CHROMEL-ALUMEL) - THERMOPAAARFUEHLER TYP K (CHROMEL-ALUMEL) - SONDAS TERMOPARES TIPO K (CHROMEL-ALUMEL)

COD.	°C max.	↑ sec.	DIMENSIONI	DIMENSIONS	DIMENSIONS	ABMESSUNGEN	DIMENSIONES	IMPIEGO USE UTILISATION GEBRAUCH EMPLEO		
TP 755/9	800	2"								
TP 774	250	2"	<p>1 = \varnothing 60 ÷ 85 2 = \varnothing 85 ÷ 150 3 = \varnothing 150 ÷ 300 4 = \varnothing 300 ÷ 600 5 = moving surface</p>							
TP 655	180	2"							HD 8802 HD 8704 HD 9016 HD 9218 DO 9406	
TP 909										
KCAL TEST	Simula 8 valori fissi della scala della termocoppia K da -100°C a +800°C. Completo di batteria al litio. Indicato per gli strumenti con ingresso a termocoppia K, connettore mignon. 									

SONDE SENSORE P1100 - P1100 SENSOR PROBES - SONDES CAPTEUR P1100 - FÜHLER MIT P1100 SENSOR - SONDAS P1100

COD.	°C max. 1 sec.	DIMENSIONI	DIMENSIONS	DIMENSIONS	ABMESSUNGEN	DIMENSIONES	IMPIEGO USE UTILISATION GEBRAUCH EMPLOO	
TP 870	-60 +400	3"						
TP 870C	-60 +400	5"						
TP 870P	-60 +400	3"						HD 8602 HD 8705 HD 8706 HD 8804 HD 8901 HD 9117 HD 9021 DO 9406 DO 9417
TP 870A	-60 +300	12"						
TP 871	-60 +200	3"						

Type K Thermocouple

Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
-200	-5.891	-5.907	-5.922	-5.936	-5.951	-5.965	-5.980	-5.994	-6.007	-6.021	-6.035
-190	-5.730	-5.747	-5.763	-5.780	-5.797	-5.813	-5.829	-5.845	-5.861	-5.876	-5.891
-180	-5.550	-5.569	-5.588	-5.606	-5.624	-5.642	-5.660	-5.678	-5.695	-5.713	-5.730
-170	-5.354	-5.374	-5.395	-5.415	-5.435	-5.454	-5.474	-5.493	-5.512	-5.531	-5.550
-160	-5.141	-5.163	-5.185	-5.207	-5.228	-5.250	-5.271	-5.292	-5.313	-5.333	-5.354
-150	-4.913	-4.936	-4.960	-4.983	-5.006	-5.029	-5.052	-5.074	-5.097	-5.119	-5.141
-140	-4.669	-4.694	-4.719	-4.744	-4.768	-4.793	-4.817	-4.841	-4.865	-4.889	-4.913
-130	-4.411	-4.437	-4.463	-4.490	-4.516	-4.542	-4.567	-4.593	-4.618	-4.644	-4.669
-120	-4.138	-4.166	-4.194	-4.221	-4.249	-4.276	-4.303	-4.330	-4.357	-4.384	-4.411
-110	-3.852	-3.882	-3.911	-3.939	-3.968	-3.997	-4.025	-4.054	-4.082	-4.110	-4.138
-100	-3.554	-3.584	-3.614	-3.645	-3.675	-3.705	-3.734	-3.764	-3.794	-3.823	-3.852
-90	-3.243	-3.274	-3.306	-3.337	-3.368	-3.400	-3.431	-3.462	-3.492	-3.523	-3.554
-80	-2.920	-2.953	-2.986	-3.018	-3.050	-3.083	-3.115	-3.147	-3.179	-3.211	-3.243
-70	-2.587	-2.620	-2.654	-2.688	-2.721	-2.755	-2.788	-2.821	-2.854	-2.887	-2.920
-60	-2.243	-2.278	-2.312	-2.347	-2.382	-2.416	-2.450	-2.485	-2.519	-2.553	-2.587
-50	-1.889	-1.925	-1.961	-1.996	-2.032	-2.067	-2.103	-2.138	-2.173	-2.208	-2.243
-40	-1.527	-1.564	-1.600	-1.637	-1.673	-1.709	-1.745	-1.782	-1.818	-1.854	-1.889
-30	-1.156	-1.194	-1.231	-1.268	-1.305	-1.343	-1.380	-1.417	-1.455	-1.490	-1.527
-20	-0.778	-0.816	-0.854	-0.892	-0.930	-0.968	-1.006	-1.043	-1.081	-1.119	-1.156
-10	-0.392	-0.431	-0.470	-0.508	-0.547	-0.586	-0.624	-0.663	-0.701	-0.739	-0.778
0	0.000	-0.039	-0.079	-0.118	-0.157	-0.197	-0.236	-0.275	-0.314	-0.353	-0.392
°C	0	1	2	3	4	5	6	7	8	9	10
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.203
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.612
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.023
50	2.023	2.064	2.106	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.436
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.851
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.267
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.682
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.096
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.509
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.920
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.328
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.735
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.138
150	6.138	6.179	6.219	6.259	6.299	6.339	6.380	6.420	6.460	6.500	6.540
160	6.540	6.580	6.620	6.660	6.701	6.741	6.781	6.821	6.861	6.901	6.941
170	6.941	6.981	7.021	7.060	7.100	7.140	7.180	7.220	7.260	7.300	7.340
180	7.340	7.380	7.420	7.460	7.500	7.540	7.579	7.619	7.659	7.699	7.739
190	7.739	7.779	7.819	7.859	7.899	7.939	7.979	8.019	8.059	8.099	8.138
200	8.138	8.178	8.218	8.258	8.298	8.338	8.378	8.418	8.458	8.499	8.539
210	8.539	8.579	8.619	8.659	8.699	8.739	8.779	8.819	8.860	8.900	8.940
220	8.940	8.980	9.020	9.061	9.101	9.141	9.181	9.222	9.262	9.302	9.343
230	9.343	9.383	9.423	9.464	9.504	9.545	9.585	9.626	9.666	9.707	9.747
240	9.747	9.788	9.828	9.869	9.909	9.950	9.991	10.031	10.072	10.113	10.153

Type K Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
250	10.153	10.194	10.235	10.276	10.316	10.357	10.398	10.439	10.480	10.520	10.561
260	10.561	10.602	10.643	10.684	10.725	10.766	10.807	10.848	10.889	10.930	10.971
270	10.971	11.012	11.053	11.094	11.135	11.176	11.217	11.259	11.300	11.341	11.382
280	11.382	11.423	11.465	11.506	11.547	11.588	11.630	11.671	11.712	11.753	11.795
290	11.795	11.836	11.877	11.919	11.960	12.001	12.043	12.084	12.126	12.167	12.209
300	12.209	12.250	12.291	12.333	12.374	12.416	12.457	12.499	12.540	12.582	12.624
310	12.624	12.665	12.707	12.748	12.790	12.831	12.873	12.915	12.956	12.998	13.040
320	13.040	13.081	13.123	13.165	13.206	13.248	13.290	13.331	13.373	13.415	13.457
330	13.457	13.498	13.540	13.582	13.624	13.665	13.707	13.749	13.791	13.833	13.874
340	13.874	13.916	13.958	14.000	14.042	14.084	14.126	14.167	14.209	14.251	14.293
350	14.293	14.335	14.377	14.419	14.461	14.503	14.545	14.587	14.629	14.671	14.713
360	14.713	14.755	14.797	14.839	14.881	14.923	14.965	15.007	15.049	15.091	15.133
370	15.133	15.175	15.217	15.259	15.301	15.343	15.385	15.427	15.469	15.511	15.554
380	15.554	15.596	15.638	15.680	15.722	15.764	15.806	15.849	15.891	15.933	15.975
390	15.975	16.017	16.059	16.102	16.144	16.186	16.228	16.270	16.313	16.355	16.397
400	16.397	16.439	16.482	16.524	16.566	16.608	16.651	16.693	16.735	16.778	16.820
410	16.820	16.862	16.904	16.947	16.989	17.031	17.074	17.116	17.158	17.201	17.243
420	17.243	17.285	17.328	17.370	17.413	17.455	17.497	17.540	17.582	17.624	17.667
430	17.667	17.709	17.752	17.794	17.837	17.879	17.921	17.964	18.006	18.049	18.091
440	18.091	18.134	18.176	18.218	18.261	18.303	18.346	18.388	18.431	18.473	18.516
450	18.516	18.558	18.601	18.643	18.686	18.728	18.771	18.813	18.856	18.898	18.941
460	18.941	18.983	19.026	19.068	19.111	19.154	19.196	19.239	19.281	19.324	19.366
470	19.366	19.409	19.451	19.494	19.537	19.579	19.622	19.664	19.707	19.750	19.792
480	19.792	19.835	19.877	19.920	19.962	20.005	20.048	20.090	20.133	20.175	20.218
490	20.218	20.261	20.303	20.346	20.389	20.431	20.474	20.516	20.559	20.602	20.644
500	20.644	20.687	20.730	20.772	20.815	20.857	20.900	20.943	20.985	21.028	21.071
510	21.071	21.113	21.156	21.199	21.241	21.284	21.326	21.369	21.412	21.454	21.497
520	21.497	21.540	21.582	21.625	21.668	21.710	21.753	21.796	21.838	21.881	21.924
530	21.924	21.966	22.009	22.052	22.094	22.137	22.179	22.222	22.265	22.307	22.350
540	22.350	22.393	22.435	22.478	22.521	22.563	22.606	22.649	22.691	22.734	22.776
550	22.776	22.819	22.862	22.904	22.947	22.990	23.032	23.075	23.117	23.160	23.203
560	23.203	23.245	23.288	23.331	23.373	23.416	23.458	23.501	23.544	23.586	23.629
570	23.629	23.671	23.714	23.757	23.799	23.842	23.884	23.927	23.970	24.012	24.055
580	24.055	24.097	24.140	24.182	24.225	24.267	24.310	24.353	24.395	24.438	24.480
590	24.480	24.523	24.565	24.608	24.650	24.693	24.735	24.778	24.820	24.863	24.905
600	24.905	24.948	24.990	25.033	25.075	25.118	25.160	25.203	25.245	25.288	25.330
610	25.330	25.373	25.415	25.458	25.500	25.543	25.585	25.627	25.670	25.712	25.755
620	25.755	25.797	25.840	25.882	25.924	25.967	26.009	26.052	26.094	26.136	26.179
630	26.179	26.221	26.263	26.306	26.348	26.390	26.433	26.475	26.517	26.560	26.602
640	26.602	26.644	26.687	26.729	26.771	26.814	26.856	26.898	26.940	26.983	27.025
650	27.025	27.067	27.109	27.152	27.194	27.236	27.278	27.320	27.363	27.405	27.447
660	27.447	27.489	27.531	27.574	27.616	27.658	27.700	27.742	27.784	27.826	27.869
670	27.869	27.911	27.953	27.995	28.037	28.079	28.121	28.163	28.205	28.247	28.289
680	28.289	28.332	28.374	28.416	28.458	28.500	28.542	28.584	28.626	28.668	28.710
690	28.710	28.752	28.794	28.836	28.878	28.919	28.961	29.003	29.045	29.087	29.129
700	29.129	29.171	29.213	29.255	29.297	29.338	29.380	29.422	29.464	29.506	29.548
710	29.548	29.589	29.631	29.673	29.715	29.757	29.798	29.840	29.882	29.924	29.965
720	29.965	30.007	30.049	30.090	30.132	30.174	30.216	30.257	30.299	30.341	30.382
730	30.382	30.424	30.466	30.507	30.549	30.590	30.632	30.674	30.715	30.757	30.798
740	30.798	30.840	30.881	30.923	30.964	31.006	31.047	31.089	31.130	31.172	31.213

Type K Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
750	31.213	31.255	31.296	31.338	31.379	31.421	31.462	31.504	31.545	31.586	31.628
760	31.628	31.669	31.710	31.752	31.793	31.834	31.876	31.917	31.958	32.000	32.041
770	32.041	32.082	32.124	32.165	32.206	32.247	32.289	32.330	32.371	32.412	32.453
780	32.453	32.495	32.536	32.577	32.618	32.659	32.700	32.742	32.783	32.824	32.865
790	32.865	32.906	32.947	32.988	33.029	33.070	33.111	33.152	33.193	33.234	33.275
800	33.275	33.316	33.357	33.398	33.439	33.480	33.521	33.562	33.603	33.644	33.685
810	33.685	33.726	33.767	33.808	33.848	33.889	33.930	33.971	34.012	34.053	34.093
820	34.093	34.134	34.175	34.216	34.257	34.297	34.338	34.379	34.420	34.460	34.501
830	34.501	34.542	34.582	34.623	34.664	34.704	34.745	34.786	34.826	34.867	34.908
840	34.908	34.948	34.989	35.029	35.070	35.110	35.151	35.192	35.232	35.273	35.313
850	35.313	35.354	35.394	35.435	35.475	35.516	35.556	35.596	35.637	35.677	35.718
860	35.718	35.758	35.798	35.839	35.879	35.920	35.960	36.000	36.041	36.081	36.121
870	36.121	36.162	36.202	36.242	36.282	36.323	36.363	36.403	36.443	36.484	36.524
880	36.524	36.564	36.604	36.644	36.685	36.725	36.765	36.805	36.845	36.885	36.925
890	36.925	36.965	37.006	37.046	37.086	37.126	37.166	37.206	37.246	37.286	37.326
900	37.326	37.366	37.406	37.446	37.486	37.526	37.566	37.606	37.646	37.686	37.725
910	37.725	37.765	37.805	37.845	37.885	37.925	37.965	38.005	38.044	38.084	38.124
920	38.124	38.164	38.204	38.243	38.283	38.323	38.363	38.402	38.442	38.482	38.522
930	38.522	38.561	38.601	38.641	38.680	38.720	38.760	38.799	38.839	38.878	38.918
940	38.918	38.958	38.997	39.037	39.076	39.116	39.155	39.195	39.235	39.274	39.314
950	39.314	39.353	39.393	39.432	39.471	39.511	39.550	39.590	39.629	39.669	39.708
960	39.708	39.747	39.787	39.826	39.866	39.905	39.944	39.984	40.023	40.062	40.101
970	40.101	40.141	40.180	40.219	40.259	40.298	40.337	40.376	40.415	40.455	40.494
980	40.494	40.533	40.572	40.611	40.651	40.690	40.729	40.768	40.807	40.846	40.885
990	40.885	40.924	40.963	41.002	41.042	41.081	41.120	41.159	41.198	41.237	41.276
1000	41.276	41.315	41.354	41.393	41.431	41.470	41.509	41.548	41.587	41.626	41.665
1010	41.665	41.704	41.743	41.781	41.820	41.859	41.898	41.937	41.976	42.014	42.053
1020	42.053	42.092	42.131	42.169	42.208	42.247	42.286	42.324	42.363	42.402	42.440
1030	42.440	42.479	42.518	42.556	42.595	42.633	42.672	42.711	42.749	42.788	42.826
1040	42.826	42.865	42.903	42.942	42.980	43.019	43.057	43.096	43.134	43.173	43.211
1050	43.211	43.250	43.288	43.327	43.365	43.403	43.442	43.480	43.518	43.557	43.595
1060	43.595	43.633	43.672	43.710	43.748	43.787	43.825	43.863	43.901	43.940	43.978
1070	43.978	44.016	44.054	44.092	44.130	44.169	44.207	44.245	44.283	44.321	44.359
1080	44.359	44.397	44.435	44.473	44.512	44.550	44.588	44.626	44.664	44.702	44.740
1090	44.740	44.778	44.816	44.853	44.891	44.929	44.967	45.005	45.043	45.081	45.119
1100	45.119	45.157	45.194	45.232	45.270	45.308	45.346	45.383	45.421	45.459	45.497
1110	45.497	45.534	45.572	45.610	45.647	45.685	45.723	45.760	45.798	45.836	45.873
1120	45.873	45.911	45.948	45.986	46.024	46.061	46.099	46.136	46.174	46.211	46.249
1130	46.249	46.286	46.324	46.361	46.398	46.436	46.473	46.511	46.548	46.585	46.623
1140	46.623	46.660	46.697	46.735	46.772	46.809	46.847	46.884	46.921	46.958	46.995
1150	46.995	47.033	47.070	47.107	47.144	47.181	47.218	47.256	47.293	47.330	47.367
1160	47.367	47.404	47.441	47.478	47.515	47.552	47.589	47.626	47.663	47.700	47.737
1170	47.737	47.774	47.811	47.848	47.884	47.921	47.958	47.995	48.032	48.069	48.105
1180	48.105	48.142	48.179	48.216	48.252	48.289	48.326	48.363	48.399	48.436	48.473
1190	48.473	48.509	48.546	48.582	48.619	48.656	48.692	48.729	48.765	48.802	48.838
1200	48.838	48.875	48.911	48.948	48.984	49.021	49.057	49.093	49.130	49.166	49.202
1210	49.202	49.239	49.275	49.311	49.348	49.384	49.420	49.456	49.493	49.529	49.565
1220	49.565	49.601	49.637	49.674	49.710	49.746	49.782	49.818	49.854	49.890	49.926
1230	49.926	49.962	49.998	50.034	50.070	50.106	50.142	50.178	50.214	50.250	50.286
1240	50.286	50.322	50.358	50.393	50.429	50.465	50.501	50.537	50.572	50.608	50.644

Type K Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
1250	50.644	50.680	50.715	50.751	50.787	50.822	50.858	50.894	50.929	50.965	51.000
1260	51.000	51.036	51.071	51.107	51.142	51.178	51.213	51.249	51.284	51.320	51.355
1270	51.355	51.391	51.426	51.461	51.497	51.532	51.567	51.603	51.638	51.673	51.708
1280	51.708	51.744	51.779	51.814	51.849	51.885	51.920	51.955	51.990	52.025	52.060
1290	52.060	52.095	52.130	52.165	52.200	52.235	52.270	52.305	52.340	52.375	52.410
1300	52.410	52.445	52.480	52.515	52.550	52.585	52.620	52.654	52.689	52.724	52.759
1310	52.759	52.794	52.828	52.863	52.898	52.932	52.967	53.002	53.037	53.071	53.106
1320	53.106	53.140	53.175	53.210	53.244	53.279	53.313	53.348	53.382	53.417	53.451
1330	53.451	53.486	53.520	53.555	53.589	53.623	53.658	53.692	53.727	53.761	53.795
1340	53.795	53.830	53.864	53.898	53.932	53.967	54.001	54.035	54.069	54.104	54.138
1350	54.138	54.172	54.206	54.240	54.274	54.308	54.343	54.377	54.411	54.445	54.479
1360	54.479	54.513	54.547	54.581	54.615	54.649	54.683	54.717	54.751	54.785	54.819
1370	54.819	54.852	54.885								

Type J Thermocouple Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts Reference Junctions at 0°C

°C	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
-100	-4.633	-4.674	-4.714	-4.755	-4.796	-4.836	-4.877	-4.917	-4.957	-4.997	-5.037
-90	-4.215	-4.257	-4.300	-4.342	-4.384	-4.425	-4.467	-4.509	-4.550	-4.591	-4.633
-80	-3.786	-3.829	-3.872	-3.916	-3.959	-4.002	-4.045	-4.088	-4.130	-4.173	-4.215
-70	-3.344	-3.389	-3.434	-3.478	-3.522	-3.566	-3.610	-3.654	-3.698	-3.742	-3.786
-60	-2.893	-2.938	-2.984	-3.029	-3.075	-3.120	-3.165	-3.210	-3.255	-3.300	-3.344
-50	-2.431	-2.478	-2.524	-2.571	-2.617	-2.663	-2.709	-2.755	-2.801	-2.847	-2.893
-40	-1.961	-2.008	-2.055	-2.103	-2.150	-2.197	-2.244	-2.291	-2.338	-2.385	-2.431
-30	-1.482	-1.530	-1.578	-1.626	-1.674	-1.722	-1.770	-1.818	-1.865	-1.913	-1.961
-20	-0.995	-1.044	-1.093	-1.142	-1.190	-1.239	-1.288	-1.336	-1.385	-1.433	-1.482
-10	-0.501	-0.550	-0.600	-0.650	-0.699	-0.749	-0.798	-0.847	-0.896	-0.946	-0.995
0	0.000	-0.050	-0.101	-0.151	-0.201	-0.251	-0.301	-0.351	-0.401	-0.451	-0.501

°C	0	1	2	3	4	5	6	7	8	9	10
0	0.000	0.050	0.101	0.151	0.202	0.253	0.303	0.354	0.405	0.456	0.507
10	0.507	0.558	0.609	0.660	0.711	0.762	0.814	0.865	0.916	0.968	1.019
20	1.019	1.071	1.122	1.174	1.226	1.277	1.329	1.381	1.433	1.485	1.537
30	1.537	1.589	1.641	1.693	1.745	1.797	1.849	1.902	1.954	2.006	2.059
40	2.059	2.111	2.164	2.216	2.269	2.322	2.374	2.427	2.480	2.532	2.585
50	2.585	2.638	2.691	2.744	2.797	2.850	2.903	2.956	3.009	3.062	3.116
60	3.116	3.169	3.222	3.275	3.329	3.382	3.436	3.489	3.543	3.596	3.650
70	3.650	3.703	3.757	3.810	3.864	3.918	3.971	4.025	4.079	4.133	4.187
80	4.187	4.240	4.294	4.348	4.402	4.456	4.510	4.564	4.618	4.672	4.726
90	4.726	4.781	4.835	4.889	4.943	4.997	5.052	5.106	5.160	5.215	5.269
100	5.269	5.323	5.378	5.432	5.487	5.541	5.595	5.650	5.705	5.759	5.814
110	5.814	5.868	5.923	5.977	6.032	6.087	6.141	6.196	6.251	6.306	6.360
120	6.360	6.415	6.470	6.525	6.579	6.634	6.689	6.744	6.799	6.854	6.909
130	6.909	6.964	7.019	7.074	7.129	7.184	7.239	7.294	7.349	7.404	7.459
140	7.459	7.514	7.569	7.624	7.679	7.734	7.789	7.844	7.900	7.955	8.010
150	8.010	8.065	8.120	8.175	8.231	8.286	8.341	8.396	8.452	8.507	8.562
160	8.562	8.618	8.673	8.728	8.783	8.839	8.894	8.949	9.005	9.060	9.115
170	9.115	9.171	9.226	9.282	9.337	9.392	9.448	9.503	9.559	9.614	9.669
180	9.669	9.725	9.780	9.836	9.891	9.947	10.002	10.057	10.113	10.168	10.224
190	10.224	10.279	10.335	10.390	10.446	10.501	10.557	10.612	10.668	10.723	10.779
200	10.779	10.834	10.890	10.945	11.001	11.056	11.112	11.167	11.223	11.278	11.334
210	11.334	11.389	11.445	11.501	11.556	11.612	11.667	11.723	11.778	11.834	11.889
220	11.889	11.945	12.000	12.056	12.111	12.167	12.222	12.278	12.334	12.389	12.445
230	12.445	12.500	12.556	12.611	12.667	12.722	12.778	12.833	12.889	12.944	13.000
240	13.000	13.056	13.111	13.167	13.222	13.278	13.333	13.389	13.444	13.500	13.555
250	13.555	13.611	13.666	13.722	13.777	13.833	13.888	13.944	13.999	14.055	14.110
260	14.110	14.166	14.221	14.277	14.332	14.388	14.443	14.499	14.554	14.609	14.665
270	14.665	14.720	14.776	14.831	14.887	14.942	14.998	15.053	15.109	15.164	15.219
280	15.219	15.275	15.330	15.386	15.441	15.496	15.552	15.607	15.663	15.718	15.773
290	15.773	15.829	15.884	15.940	15.995	16.050	16.106	16.161	16.216	16.272	16.327
300	16.327	16.383	16.438	16.493	16.549	16.604	16.659	16.715	16.770	16.825	16.881
310	16.881	16.936	16.991	17.046	17.102	17.157	17.212	17.268	17.323	17.378	17.434
320	17.434	17.489	17.544	17.599	17.655	17.710	17.765	17.820	17.876	17.931	17.986
330	17.986	18.041	18.097	18.152	18.207	18.262	18.318	18.373	18.428	18.483	18.538
340	18.538	18.594	18.649	18.704	18.759	18.814	18.870	18.925	18.980	19.035	19.090

Type J Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
350	19.090	19.146	19.201	19.256	19.311	19.366	19.422	19.477	19.532	19.587	19.642
360	19.642	19.697	19.753	19.808	19.863	19.918	19.973	20.028	20.083	20.139	20.194
370	20.194	20.249	20.304	20.359	20.414	20.469	20.525	20.580	20.635	20.690	20.745
380	20.745	20.800	20.855	20.911	20.966	21.021	21.076	21.131	21.186	21.241	21.297
390	21.297	21.352	21.407	21.462	21.517	21.572	21.627	21.683	21.738	21.793	21.848
400	21.848	21.903	21.958	22.014	22.069	22.124	22.179	22.234	22.289	22.345	22.400
410	22.400	22.455	22.510	22.565	22.620	22.676	22.731	22.786	22.841	22.896	22.952
420	22.952	23.007	23.062	23.117	23.172	23.228	23.283	23.338	23.393	23.449	23.504
430	23.504	23.559	23.614	23.670	23.725	23.780	23.835	23.891	23.946	24.001	24.057
440	24.057	24.112	24.167	24.223	24.278	24.333	24.389	24.444	24.499	24.555	24.610
450	24.610	24.665	24.721	24.776	24.832	24.887	24.943	24.998	25.053	25.109	25.164
460	25.164	25.220	25.275	25.331	25.386	25.442	25.497	25.553	25.608	25.664	25.720
470	25.720	25.775	25.831	25.886	25.942	25.998	26.053	26.109	26.165	26.220	26.276
480	26.276	26.332	26.387	26.443	26.499	26.555	26.610	26.666	26.722	26.778	26.834
490	26.834	26.889	26.945	27.001	27.057	27.113	27.169	27.225	27.281	27.337	27.393
500	27.393	27.449	27.505	27.561	27.617	27.673	27.729	27.785	27.841	27.897	27.953
510	27.953	28.010	28.066	28.122	28.178	28.234	28.291	28.347	28.403	28.460	28.516
520	28.516	28.572	28.629	28.685	28.741	28.798	28.854	28.911	28.967	29.024	29.080
530	29.080	29.137	29.194	29.250	29.307	29.363	29.420	29.477	29.534	29.590	29.647
540	29.647	29.704	29.761	29.818	29.874	29.931	29.988	30.045	30.102	30.159	30.216
550	30.216	30.273	30.330	30.387	30.444	30.502	30.559	30.616	30.673	30.730	30.788
560	30.788	30.845	30.902	30.960	31.017	31.074	31.132	31.189	31.247	31.304	31.362
570	31.362	31.419	31.477	31.535	31.592	31.650	31.708	31.766	31.823	31.881	31.939
580	31.939	31.997	32.055	32.113	32.171	32.229	32.287	32.345	32.403	32.461	32.519
590	32.519	32.577	32.636	32.694	32.752	32.810	32.869	32.927	32.985	33.044	33.102
600	33.102	33.161	33.219	33.278	33.337	33.395	33.454	33.513	33.571	33.630	33.689
610	33.689	33.748	33.807	33.866	33.925	33.984	34.043	34.102	34.161	34.220	34.279
620	34.279	34.338	34.397	34.457	34.516	34.575	34.635	34.694	34.754	34.813	34.873
630	34.873	34.932	34.992	35.051	35.111	35.171	35.230	35.290	35.350	35.410	35.470
640	35.470	35.530	35.590	35.650	35.710	35.770	35.830	35.890	35.950	36.010	36.071
650	36.071	36.131	36.191	36.251	36.311	36.373	36.433	36.494	36.554	36.615	36.675
660	36.675	36.736	36.797	36.858	36.918	36.979	37.040	37.101	37.162	37.223	37.284
670	37.284	37.345	37.406	37.467	37.528	37.590	37.651	37.712	37.773	37.835	37.896
680	37.896	37.958	38.019	38.081	38.142	38.204	38.265	38.327	38.389	38.450	38.512
690	38.512	38.574	38.636	38.698	38.760	38.822	38.884	38.946	39.008	39.070	39.132
700	39.132	39.194	39.256	39.318	39.381	39.443	39.505	39.568	39.630	39.693	39.755
710	39.755	39.818	39.880	39.943	40.005	40.068	40.131	40.193	40.256	40.319	40.382
720	40.382	40.445	40.508	40.570	40.633	40.696	40.759	40.822	40.886	40.949	41.012
730	41.012	41.075	41.138	41.201	41.265	41.328	41.391	41.455	41.518	41.581	41.645
740	41.645	41.708	41.772	41.835	41.899	41.962	42.026	42.090	42.153	42.217	42.281
750	42.281	42.344	42.408	42.472	42.536	42.599	42.663	42.727	42.791	42.855	42.919

Type E Thermocouple

Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
-200	-8.825	-8.850	-8.874	-8.899	-8.923	-8.947	-8.971	-8.994	-9.017	-9.040	-9.063
-190	-8.561	-8.588	-8.616	-8.643	-8.669	-8.696	-8.722	-8.748	-8.774	-8.799	-8.825
-180	-8.273	-8.303	-8.333	-8.362	-8.391	-8.420	-8.449	-8.477	-8.505	-8.533	-8.561
-170	-7.963	-7.995	-8.027	-8.059	-8.090	-8.121	-8.152	-8.183	-8.213	-8.243	-8.273
-160	-7.632	-7.666	-7.700	-7.733	-7.767	-7.800	-7.833	-7.866	-7.899	-7.931	-7.963
-150	-7.279	-7.315	-7.351	-7.387	-7.423	-7.458	-7.493	-7.528	-7.563	-7.597	-7.632
-140	-6.907	-6.945	-6.983	-7.021	-7.058	-7.096	-7.133	-7.170	-7.206	-7.243	-7.279
-130	-6.516	-6.556	-6.596	-6.636	-6.675	-6.714	-6.753	-6.792	-6.831	-6.869	-6.907
-120	-6.107	-6.149	-6.191	-6.232	-6.273	-6.314	-6.355	-6.396	-6.436	-6.476	-6.516
-110	-5.681	-5.724	-5.767	-5.810	-5.853	-5.896	-5.939	-5.981	-6.023	-6.065	-6.107
-100	-5.237	-5.282	-5.327	-5.372	-5.417	-5.461	-5.505	-5.549	-5.593	-5.637	-5.681
-90	-4.777	-4.824	-4.871	-4.917	-4.963	-5.009	-5.055	-5.101	-5.147	-5.192	-5.237
-80	-4.302	-4.350	-4.398	-4.446	-4.494	-4.542	-4.589	-4.636	-4.684	-4.731	-4.777
-70	-3.811	-3.861	-3.911	-3.960	-4.009	-4.058	-4.107	-4.156	-4.205	-4.254	-4.302
-60	-3.306	-3.357	-3.408	-3.459	-3.510	-3.561	-3.611	-3.661	-3.711	-3.761	-3.811
-50	-2.787	-2.840	-2.892	-2.944	-2.996	-3.048	-3.100	-3.152	-3.204	-3.255	-3.306
-40	-2.255	-2.309	-2.362	-2.416	-2.469	-2.523	-2.576	-2.629	-2.682	-2.735	-2.787
-30	-1.709	-1.765	-1.820	-1.874	-1.929	-1.984	-2.038	-2.093	-2.147	-2.201	-2.255
-20	-1.152	-1.208	-1.264	-1.320	-1.376	-1.432	-1.488	-1.543	-1.599	-1.654	-1.709
-10	-0.582	-0.639	-0.697	-0.754	-0.811	-0.868	-0.925	-0.982	-1.039	-1.095	-1.152
0	0.000	-0.059	-0.117	-0.176	-0.234	-0.292	-0.350	-0.408	-0.466	-0.524	-0.582
°C	0	1	2	3	4	5	6	7	8	9	10
0	0.000	0.059	0.118	0.176	0.235	0.294	0.354	0.413	0.472	0.532	0.591
10	0.591	0.651	0.711	0.770	0.830	0.890	0.950	1.010	1.071	1.131	1.192
20	1.192	1.252	1.313	1.373	1.434	1.495	1.556	1.617	1.678	1.740	1.801
30	1.801	1.862	1.924	1.986	2.047	2.109	2.171	2.233	2.295	2.357	2.420
40	2.420	2.482	2.545	2.607	2.670	2.733	2.795	2.858	2.921	2.984	3.048
50	3.048	3.111	3.174	3.238	3.301	3.365	3.429	3.492	3.556	3.620	3.685
60	3.685	3.749	3.813	3.877	3.942	4.006	4.071	4.136	4.200	4.265	4.330
70	4.330	4.395	4.460	4.526	4.591	4.656	4.722	4.788	4.853	4.919	4.985
80	4.985	5.051	5.117	5.183	5.249	5.315	5.382	5.448	5.514	5.581	5.648
90	5.648	5.714	5.781	5.848	5.915	5.982	6.049	6.117	6.184	6.251	6.319
100	6.319	6.386	6.454	6.522	6.590	6.658	6.725	6.794	6.862	6.930	6.998
110	6.998	7.066	7.135	7.203	7.272	7.341	7.409	7.478	7.547	7.616	7.685
120	7.685	7.754	7.823	7.892	7.962	8.031	8.101	8.170	8.240	8.309	8.379
130	8.379	8.449	8.519	8.589	8.659	8.729	8.799	8.869	8.940	9.010	9.081
140	9.081	9.151	9.222	9.292	9.363	9.434	9.505	9.576	9.647	9.718	9.789
150	9.789	9.860	9.931	10.003	10.074	10.145	10.217	10.288	10.360	10.432	10.503
160	10.503	10.575	10.647	10.719	10.791	10.863	10.935	11.007	11.080	11.152	11.224
170	11.224	11.297	11.369	11.442	11.514	11.587	11.660	11.733	11.805	11.878	11.951
180	11.951	12.024	12.097	12.170	12.243	12.317	12.390	12.463	12.537	12.610	12.684
190	12.684	12.757	12.831	12.904	12.978	13.052	13.126	13.199	13.273	13.347	13.421
200	13.421	13.495	13.569	13.644	13.718	13.792	13.866	13.941	14.015	14.090	14.164
210	14.164	14.239	14.313	14.388	14.463	14.537	14.612	14.687	14.762	14.837	14.912
220	14.912	14.987	15.062	15.137	15.212	15.287	15.362	15.438	15.513	15.588	15.664
230	15.664	15.739	15.815	15.890	15.966	16.041	16.117	16.193	16.269	16.344	16.420
240	16.420	16.496	16.572	16.648	16.724	16.800	16.876	16.952	17.028	17.104	17.181

Type E Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
250	17.181	17.257	17.333	17.409	17.486	17.562	17.639	17.715	17.792	17.868	17.945
260	17.945	18.021	18.098	18.175	18.252	18.328	18.405	18.482	18.559	18.636	18.713
270	18.713	18.790	18.867	18.944	19.021	19.098	19.175	19.252	19.330	19.407	19.484
280	19.484	19.561	19.639	19.716	19.794	19.871	19.948	20.026	20.103	20.181	20.259
290	20.259	20.336	20.414	20.492	20.569	20.647	20.725	20.803	20.880	20.958	21.036
300	21.036	21.114	21.192	21.270	21.348	21.426	21.504	21.582	21.660	21.739	21.817
310	21.817	21.895	21.973	22.051	22.130	22.208	22.286	22.365	22.443	22.522	22.600
320	22.600	22.678	22.757	22.835	22.914	22.993	23.071	23.150	23.228	23.307	23.386
330	23.386	23.464	23.543	23.622	23.701	23.780	23.858	23.937	24.016	24.095	24.174
340	24.174	24.253	24.332	24.411	24.490	24.569	24.648	24.727	24.806	24.885	24.964
350	24.964	25.044	25.123	25.202	25.281	25.360	25.440	25.519	25.598	25.678	25.757
360	25.757	25.836	25.915	25.995	26.075	26.154	26.233	26.313	26.392	26.472	26.552
370	26.552	26.631	26.711	26.790	26.870	26.950	27.029	27.109	27.189	27.268	27.348
380	27.348	27.428	27.507	27.587	27.667	27.747	27.827	27.907	27.986	28.066	28.146
390	28.146	28.226	28.306	28.386	28.466	28.546	28.626	28.706	28.786	28.866	28.946
400	28.946	29.026	29.106	29.186	29.266	29.346	29.427	29.507	29.587	29.667	29.747
410	29.747	29.827	29.908	29.988	30.068	30.148	30.229	30.309	30.389	30.470	30.550
420	30.550	30.630	30.711	30.791	30.871	30.952	31.032	31.112	31.193	31.273	31.354
430	31.354	31.434	31.515	31.595	31.676	31.756	31.837	31.917	31.998	32.078	32.159
440	32.159	32.239	32.320	32.400	32.481	32.562	32.642	32.723	32.803	32.884	32.965
450	32.965	33.045	33.126	33.207	33.287	33.368	33.449	33.529	33.610	33.691	33.772
460	33.772	33.852	33.933	34.014	34.095	34.176	34.256	34.337	34.418	34.498	34.579
470	34.579	34.660	34.741	34.822	34.902	34.983	35.064	35.145	35.226	35.307	35.387
480	35.387	35.468	35.549	35.630	35.711	35.792	35.873	35.954	36.036	36.116	36.196
490	36.196	36.277	36.358	36.439	36.520	36.601	36.682	36.763	36.844	36.924	37.005
500	37.005	37.086	37.167	37.248	37.329	37.410	37.491	37.572	37.653	37.734	37.815
510	37.815	37.896	37.977	38.058	38.139	38.220	38.300	38.381	38.462	38.543	38.624
520	38.624	38.705	38.786	38.867	38.948	39.029	39.110	39.191	39.272	39.353	39.434
530	39.434	39.515	39.596	39.677	39.758	39.839	39.920	40.001	40.082	40.163	40.244
540	40.244	40.324	40.405	40.486	40.567	40.648	40.729	40.810	40.891	40.972	41.053
550	41.053	41.134	41.215	41.296	41.377	41.457	41.538	41.619	41.700	41.781	41.862
560	41.862	41.943	42.024	42.105	42.185	42.266	42.347	42.428	42.509	42.590	42.671
570	42.671	42.751	42.832	42.913	42.994	43.075	43.156	43.236	43.317	43.398	43.479
580	43.479	43.560	43.640	43.721	43.802	43.883	43.963	44.044	44.125	44.206	44.286
590	44.286	44.367	44.448	44.529	44.609	44.690	44.771	44.851	44.932	45.013	45.093
600	45.093	45.174	45.255	45.335	45.416	45.497	45.577	45.658	45.738	45.819	45.900
610	45.900	45.980	46.061	46.141	46.222	46.302	46.383	46.463	46.544	46.624	46.705
620	46.705	46.785	46.866	46.946	47.027	47.107	47.188	47.268	47.349	47.429	47.509
630	47.509	47.590	47.670	47.751	47.831	47.911	47.992	48.072	48.152	48.233	48.313
640	48.313	48.393	48.474	48.554	48.634	48.715	48.795	48.875	48.955	49.035	49.116
650	49.116	49.196	49.276	49.356	49.436	49.517	49.597	49.677	49.757	49.837	49.917
660	49.917	49.997	50.077	50.157	50.238	50.318	50.398	50.478	50.558	50.638	50.718
670	50.718	50.798	50.878	50.958	51.038	51.118	51.197	51.277	51.357	51.437	51.517
680	51.517	51.597	51.677	51.757	51.837	51.916	51.996	52.076	52.156	52.236	52.315
690	52.315	52.395	52.475	52.555	52.634	52.714	52.794	52.873	52.953	53.033	53.112
700	53.112	53.192	53.272	53.351	53.431	53.510	53.590	53.670	53.749	53.829	53.908
710	53.908	53.988	54.067	54.147	54.226	54.306	54.385	54.465	54.544	54.624	54.703
720	54.703	54.782	54.862	54.941	55.021	55.100	55.179	55.259	55.338	55.417	55.497
730	55.497	55.576	55.655	55.734	55.814	55.893	55.972	56.051	56.131	56.210	56.289
740	56.289	56.368	56.447	56.526	56.606	56.685	56.764	56.843	56.922	57.001	57.080
750	57.080	57.159	57.238	57.317	57.396	57.475	57.554	57.633	57.712	57.791	57.870

Type T Thermocouple Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
-200	-5.603	-5.619	-5.634	-5.650	-5.665	-5.680	-5.695	-5.710	-5.724	-5.739	-5.753
-190	-5.439	-5.456	-5.473	-5.489	-5.506	-5.523	-5.539	-5.555	-5.571	-5.587	-5.603
-180	-5.261	-5.279	-5.297	-5.316	-5.334	-5.351	-5.369	-5.387	-5.404	-5.421	-5.439
-170	-5.070	-5.089	-5.109	-5.128	-5.148	-5.167	-5.186	-5.205	-5.224	-5.242	-5.261
-160	-4.865	-4.886	-4.907	-4.928	-4.949	-4.969	-4.989	-5.010	-5.030	-5.050	-5.070
-150	-4.648	-4.671	-4.693	-4.715	-4.737	-4.759	-4.780	-4.802	-4.823	-4.844	-4.865
-140	-4.419	-4.443	-4.466	-4.489	-4.512	-4.535	-4.558	-4.581	-4.604	-4.626	-4.648
-130	-4.177	-4.202	-4.226	-4.251	-4.275	-4.300	-4.324	-4.348	-4.372	-4.395	-4.419
-120	-3.923	-3.949	-3.975	-4.000	-4.026	-4.052	-4.077	-4.102	-4.127	-4.152	-4.177
-110	-3.657	-3.684	-3.711	-3.738	-3.765	-3.791	-3.818	-3.844	-3.871	-3.897	-3.923
-100	-3.379	-3.407	-3.435	-3.463	-3.491	-3.519	-3.547	-3.574	-3.602	-3.629	-3.657
-90	-3.089	-3.118	-3.148	-3.177	-3.206	-3.235	-3.264	-3.293	-3.322	-3.350	-3.379
-80	-2.788	-2.818	-2.849	-2.879	-2.910	-2.940	-2.970	-3.000	-3.030	-3.059	-3.089
-70	-2.476	-2.507	-2.539	-2.571	-2.602	-2.633	-2.664	-2.695	-2.726	-2.757	-2.788
-60	-2.153	-2.186	-2.218	-2.251	-2.283	-2.316	-2.348	-2.380	-2.412	-2.444	-2.476
-50	-1.819	-1.853	-1.887	-1.920	-1.954	-1.987	-2.021	-2.054	-2.087	-2.120	-2.153
-40	-1.475	-1.510	-1.545	-1.579	-1.614	-1.648	-1.683	-1.717	-1.751	-1.785	-1.819
-30	-1.121	-1.157	-1.192	-1.228	-1.264	-1.299	-1.335	-1.370	-1.405	-1.440	-1.475
-20	-0.757	-0.794	-0.830	-0.867	-0.904	-0.940	-0.976	-1.013	-1.049	-1.085	-1.121
-10	-0.383	-0.421	-0.459	-0.496	-0.534	-0.571	-0.608	-0.646	-0.683	-0.720	-0.757
0	0.000	-0.039	-0.077	-0.116	-0.154	-0.193	-0.231	-0.269	-0.307	-0.345	-0.383
°C	0	1	2	3	4	5	6	7	8	9	10
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.352	0.391
10	0.391	0.431	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749	0.790
20	0.790	0.830	0.870	0.911	0.951	0.992	1.033	1.074	1.114	1.155	1.196
30	1.196	1.238	1.279	1.320	1.362	1.403	1.445	1.486	1.528	1.570	1.612
40	1.612	1.654	1.696	1.738	1.780	1.823	1.865	1.908	1.950	1.993	2.036
50	2.036	2.079	2.122	2.165	2.208	2.251	2.294	2.338	2.381	2.425	2.468
60	2.468	2.512	2.556	2.600	2.643	2.687	2.732	2.776	2.820	2.864	2.909
70	2.909	2.953	2.998	3.043	3.087	3.132	3.177	3.222	3.267	3.312	3.358
80	3.358	3.403	3.448	3.494	3.539	3.585	3.631	3.677	3.722	3.768	3.814
90	3.814	3.860	3.907	3.953	3.999	4.046	4.092	4.138	4.185	4.232	4.279
100	4.279	4.325	4.372	4.419	4.466	4.513	4.561	4.608	4.655	4.702	4.750
110	4.750	4.798	4.845	4.893	4.941	4.988	5.036	5.084	5.132	5.180	5.228
120	5.228	5.277	5.325	5.373	5.422	5.470	5.519	5.567	5.616	5.665	5.714
130	5.714	5.763	5.812	5.861	5.910	5.959	6.008	6.057	6.107	6.156	6.206
140	6.206	6.255	6.305	6.355	6.404	6.454	6.504	6.554	6.604	6.654	6.704
150	6.704	6.754	6.805	6.855	6.905	6.956	7.006	7.057	7.107	7.158	7.209
160	7.209	7.260	7.310	7.361	7.412	7.463	7.515	7.566	7.617	7.668	7.720
170	7.720	7.771	7.823	7.874	7.926	7.977	8.029	8.081	8.133	8.185	8.237
180	8.237	8.289	8.341	8.393	8.445	8.497	8.550	8.602	8.654	8.707	8.759
190	8.759	8.812	8.865	8.917	8.970	9.023	9.076	9.129	9.182	9.235	9.288
200	9.288	9.341	9.395	9.448	9.501	9.555	9.608	9.662	9.715	9.769	9.822
210	9.822	9.876	9.930	9.984	10.038	10.092	10.146	10.200	10.254	10.308	10.362
220	10.362	10.417	10.471	10.525	10.580	10.634	10.689	10.743	10.798	10.853	10.907
230	10.907	10.962	11.017	11.072	11.127	11.182	11.237	11.292	11.347	11.403	11.458
240	11.458	11.513	11.569	11.624	11.680	11.735	11.791	11.846	11.902	11.958	12.013

Type T Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts											Reference Junctions at 0°C
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
250	12.013	12.069	12.125	12.181	12.237	12.293	12.349	12.405	12.461	12.518	12.574
260	12.574	12.630	12.687	12.743	12.799	12.856	12.912	12.969	13.026	13.082	13.139
270	13.139	13.196	13.253	13.310	13.366	13.423	13.480	13.537	13.595	13.652	13.709
280	13.709	13.766	13.823	13.881	13.938	13.995	14.053	14.110	14.168	14.226	14.283
290	14.283	14.341	14.399	14.456	14.514	14.572	14.630	14.688	14.746	14.804	14.862
300	14.862	14.920	14.978	15.036	15.095	15.153	15.211	15.270	15.328	15.386	15.445
310	15.445	15.503	15.562	15.621	15.679	15.738	15.797	15.856	15.914	15.973	16.032
320	16.032	16.091	16.150	16.209	16.268	16.327	16.387	16.446	16.505	16.564	16.624
330	16.624	16.683	16.742	16.802	16.861	16.921	16.980	17.040	17.100	17.159	17.219
340	17.219	17.279	17.339	17.399	17.458	17.518	17.578	17.638	17.698	17.759	17.819
350	17.819	17.879	17.939	17.999	18.060	18.120	18.180	18.241	18.301	18.362	18.422
360	18.422	18.483	18.543	18.604	18.665	18.725	18.786	18.847	18.908	18.969	19.030
370	19.030	19.091	19.152	19.213	19.274	19.335	19.396	19.457	19.518	19.579	19.641
380	19.641	19.702	19.763	19.825	19.886	19.947	20.009	20.070	20.132	20.193	20.255
390	20.255	20.317	20.378	20.440	20.502	20.563	20.625	20.687	20.748	20.810	20.810
400	20.810										

Type R Thermocouple
Temperature in Degrees Celsius (ITS-90)

°C	Reference Junctions at 0°C										
	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
+200	1.469	1.477	1.486	1.495	1.504	1.513	1.522	1.531	1.540	1.549	1.558
210	1.558	1.567	1.575	1.584	1.593	1.602	1.611	1.620	1.629	1.639	1.648
220	1.648	1.657	1.666	1.675	1.684	1.693	1.702	1.711	1.720	1.729	1.739
230	1.739	1.748	1.757	1.766	1.775	1.784	1.794	1.803	1.812	1.821	1.831
240	1.831	1.840	1.849	1.858	1.868	1.877	1.886	1.895	1.905	1.914	1.923
250	1.923	1.933	1.942	1.951	1.961	1.970	1.980	1.989	1.998	2.008	2.017
260	2.017	2.027	2.036	2.046	2.055	2.064	2.074	2.083	2.093	2.102	2.112
270	2.112	2.121	2.131	2.140	2.150	2.159	2.169	2.179	2.188	2.198	2.207
280	2.207	2.217	2.226	2.236	2.246	2.255	2.265	2.275	2.284	2.294	2.304
290	2.304	2.313	2.323	2.333	2.342	2.352	2.362	2.371	2.381	2.391	2.401
300	2.401	2.410	2.420	2.430	2.440	2.449	2.459	2.469	2.479	2.488	2.498
310	2.498	2.508	2.518	2.528	2.538	2.547	2.557	2.567	2.577	2.587	2.597
320	2.597	2.607	2.617	2.626	2.636	2.646	2.656	2.666	2.676	2.686	2.696
330	2.696	2.706	2.716	2.726	2.736	2.746	2.756	2.766	2.776	2.786	2.796
340	2.796	2.806	2.816	2.826	2.836	2.846	2.856	2.866	2.876	2.886	2.896
350	2.896	2.906	2.916	2.926	2.937	2.947	2.957	2.967	2.977	2.987	2.997
360	2.997	3.007	3.018	3.028	3.038	3.048	3.058	3.068	3.079	3.089	3.099
370	3.099	3.109	3.119	3.130	3.140	3.150	3.160	3.171	3.181	3.191	3.201
380	3.201	3.212	3.222	3.232	3.242	3.253	3.263	3.273	3.284	3.294	3.304
390	3.304	3.315	3.325	3.335	3.346	3.356	3.366	3.377	3.387	3.397	3.408
400	3.408	3.418	3.428	3.439	3.449	3.460	3.470	3.480	3.491	3.501	3.512
410	3.512	3.522	3.533	3.543	3.553	3.564	3.574	3.585	3.595	3.606	3.616
420	3.616	3.627	3.637	3.648	3.658	3.669	3.679	3.690	3.700	3.711	3.721
430	3.721	3.732	3.742	3.753	3.764	3.774	3.785	3.795	3.806	3.816	3.827
440	3.827	3.838	3.848	3.859	3.869	3.880	3.891	3.901	3.912	3.922	3.933
450	3.933	3.944	3.954	3.965	3.976	3.986	3.997	4.008	4.018	4.029	4.040
460	4.040	4.050	4.061	4.072	4.083	4.093	4.104	4.115	4.125	4.136	4.147
470	4.147	4.158	4.168	4.179	4.190	4.201	4.211	4.222	4.233	4.244	4.255
480	4.255	4.265	4.276	4.287	4.298	4.309	4.319	4.330	4.341	4.352	4.363
490	4.363	4.373	4.384	4.395	4.406	4.417	4.428	4.439	4.449	4.460	4.471
500	4.471	4.482	4.493	4.504	4.515	4.526	4.537	4.548	4.558	4.569	4.580
510	4.580	4.591	4.602	4.613	4.624	4.635	4.646	4.657	4.668	4.679	4.690
520	4.690	4.701	4.712	4.723	4.734	4.745	4.756	4.767	4.778	4.789	4.800
530	4.800	4.811	4.822	4.833	4.844	4.855	4.866	4.877	4.888	4.899	4.910
540	4.910	4.922	4.933	4.944	4.955	4.966	4.977	4.988	4.999	5.010	5.021
550	5.021	5.033	5.044	5.055	5.066	5.077	5.088	5.099	5.111	5.122	5.133
560	5.133	5.144	5.155	5.166	5.178	5.189	5.200	5.211	5.222	5.234	5.245
570	5.245	5.256	5.267	5.279	5.290	5.301	5.312	5.323	5.335	5.346	5.357
580	5.357	5.369	5.380	5.391	5.402	5.414	5.425	5.436	5.448	5.459	5.470
590	5.470	5.481	5.493	5.504	5.515	5.527	5.538	5.549	5.561	5.572	5.583
600	5.583	5.595	5.606	5.618	5.629	5.640	5.652	5.663	5.674	5.686	5.697
610	5.697	5.709	5.720	5.731	5.743	5.754	5.766	5.777	5.789	5.800	5.812
620	5.812	5.823	5.834	5.846	5.857	5.869	5.880	5.892	5.903	5.915	5.926
630	5.926	5.938	5.949	5.961	5.972	5.984	5.995	6.007	6.018	6.030	6.041
640	6.041	6.053	6.065	6.076	6.088	6.099	6.111	6.122	6.134	6.146	6.157
650	6.157	6.169	6.180	6.192	6.204	6.215	6.227	6.238	6.250	6.262	6.273
660	6.273	6.285	6.297	6.308	6.320	6.332	6.343	6.355	6.367	6.378	6.390
670	6.390	6.402	6.413	6.425	6.437	6.448	6.460	6.472	6.484	6.495	6.507
680	6.507	6.519	6.531	6.542	6.554	6.566	6.578	6.589	6.601	6.613	6.625
690	6.625	6.636	6.648	6.660	6.672	6.684	6.695	6.707	6.719	6.731	6.743

Type R Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
700	6.743	6.755	6.766	6.778	6.790	6.802	6.814	6.826	6.838	6.849	6.861
710	6.861	6.873	6.885	6.897	6.909	6.921	6.933	6.945	6.956	6.968	6.980
720	6.980	6.992	7.004	7.016	7.028	7.040	7.052	7.064	7.076	7.088	7.100
730	7.100	7.112	7.124	7.136	7.148	7.160	7.172	7.184	7.196	7.208	7.220
740	7.220	7.232	7.244	7.256	7.268	7.280	7.292	7.304	7.316	7.328	7.340
750	7.340	7.352	7.364	7.376	7.389	7.401	7.413	7.425	7.437	7.449	7.461
760	7.461	7.473	7.485	7.498	7.510	7.522	7.534	7.546	7.558	7.570	7.583
770	7.583	7.595	7.607	7.619	7.631	7.644	7.656	7.668	7.680	7.692	7.705
780	7.705	7.717	7.729	7.741	7.753	7.766	7.778	7.790	7.802	7.815	7.827
790	7.827	7.839	7.851	7.864	7.876	7.888	7.901	7.913	7.925	7.938	7.950
800	7.950	7.962	7.974	7.987	7.999	8.011	8.024	8.036	8.048	8.061	8.073
810	8.073	8.086	8.098	8.110	8.123	8.135	8.147	8.160	8.172	8.185	8.197
820	8.197	8.209	8.222	8.234	8.247	8.259	8.272	8.284	8.296	8.309	8.321
830	8.321	8.334	8.346	8.359	8.371	8.384	8.396	8.409	8.421	8.434	8.446
840	8.446	8.459	8.471	8.484	8.496	8.509	8.521	8.534	8.546	8.559	8.571
850	8.571	8.584	8.597	8.609	8.622	8.634	8.647	8.659	8.672	8.685	8.697
860	8.697	8.710	8.722	8.735	8.748	8.760	8.773	8.785	8.798	8.811	8.823
870	8.823	8.836	8.849	8.861	8.874	8.887	8.899	8.912	8.925	8.937	8.950
880	8.950	8.963	8.975	8.988	9.001	9.014	9.026	9.039	9.052	9.065	9.077
890	9.077	9.090	9.103	9.115	9.128	9.141	9.154	9.167	9.179	9.192	9.205
900	9.205	9.218	9.230	9.243	9.256	9.269	9.282	9.294	9.307	9.320	9.333
910	9.333	9.346	9.359	9.371	9.384	9.397	9.410	9.423	9.436	9.449	9.461
920	9.461	9.474	9.487	9.500	9.513	9.526	9.539	9.552	9.565	9.578	9.590
930	9.590	9.603	9.616	9.629	9.642	9.655	9.668	9.681	9.694	9.707	9.720
940	9.720	9.733	9.746	9.759	9.772	9.785	9.798	9.811	9.824	9.837	9.850
950	9.850	9.863	9.876	9.889	9.902	9.915	9.928	9.941	9.954	9.967	9.980
960	9.980	9.993	10.006	10.019	10.032	10.046	10.059	10.072	10.085	10.098	10.111
970	10.111	10.124	10.137	10.150	10.163	10.177	10.190	10.203	10.216	10.229	10.242
980	10.242	10.255	10.268	10.282	10.295	10.308	10.321	10.334	10.347	10.361	10.374
990	10.374	10.387	10.400	10.413	10.427	10.440	10.453	10.466	10.480	10.493	10.506
1000	10.506	10.519	10.532	10.546	10.559	10.572	10.585	10.599	10.612	10.625	10.638
1010	10.638	10.652	10.665	10.678	10.692	10.705	10.718	10.731	10.745	10.758	10.771
1020	10.771	10.785	10.798	10.811	10.825	10.838	10.851	10.865	10.878	10.891	10.905
1030	10.905	10.918	10.932	10.945	10.958	10.972	10.985	10.998	11.012	11.025	11.039
1040	11.039	11.052	11.065	11.079	11.092	11.106	11.119	11.132	11.146	11.159	11.173
1050	11.173	11.186	11.200	11.213	11.227	11.240	11.253	11.267	11.280	11.294	11.307
1060	11.307	11.321	11.334	11.348	11.361	11.375	11.388	11.402	11.415	11.429	11.442
1070	11.442	11.456	11.469	11.483	11.496	11.510	11.524	11.537	11.551	11.564	11.578
1080	11.578	11.591	11.605	11.618	11.632	11.646	11.659	11.673	11.686	11.700	11.714
1090	11.714	11.727	11.741	11.754	11.768	11.782	11.795	11.809	11.822	11.836	11.850
1100	11.850	11.863	11.877	11.891	11.904	11.918	11.931	11.945	11.959	11.972	11.986
1110	11.986	12.000	12.013	12.027	12.041	12.054	12.068	12.082	12.096	12.109	12.123
1120	12.123	12.137	12.150	12.164	12.178	12.191	12.205	12.219	12.233	12.246	12.260
1130	12.260	12.274	12.288	12.301	12.315	12.329	12.342	12.356	12.370	12.384	12.397
1140	12.397	12.411	12.425	12.439	12.453	12.466	12.480	12.494	12.508	12.521	12.535
1150	12.535	12.549	12.563	12.577	12.590	12.604	12.618	12.632	12.646	12.659	12.673
1160	12.673	12.687	12.701	12.715	12.729	12.742	12.756	12.770	12.784	12.798	12.812
1170	12.812	12.825	12.839	12.853	12.867	12.881	12.895	12.909	12.922	12.936	12.950
1180	12.950	12.964	12.978	12.992	13.006	13.019	13.033	13.047	13.061	13.075	13.089
1190	13.089	13.103	13.117	13.131	13.145	13.158	13.172	13.186	13.200	13.214	13.228

Type R Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts											Reference Junctions at 0°C
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
1200	13.228	13.242	13.256	13.270	13.284	13.298	13.311	13.325	13.339	13.353	13.367
1210	13.367	13.381	13.395	13.409	13.423	13.437	13.451	13.465	13.479	13.493	13.507
1220	13.507	13.521	13.535	13.549	13.563	13.577	13.590	13.604	13.618	13.632	13.646
1230	13.646	13.660	13.674	13.688	13.702	13.716	13.730	13.744	13.758	13.772	13.786
1240	13.786	13.800	13.814	13.828	13.842	13.856	13.870	13.884	13.898	13.912	13.926
1250	13.926	13.940	13.954	13.968	13.982	13.996	14.010	14.024	14.038	14.052	14.066
1260	14.066	14.081	14.095	14.109	14.123	14.137	14.151	14.165	14.179	14.193	14.207
1270	14.207	14.221	14.235	14.249	14.263	14.277	14.291	14.305	14.319	14.333	14.347
1280	14.347	14.361	14.375	14.390	14.404	14.418	14.432	14.446	14.460	14.474	14.488
1290	14.488	14.502	14.516	14.530	14.544	14.558	14.572	14.586	14.601	14.615	14.629
1300	14.629	14.643	14.657	14.671	14.685	14.699	14.713	14.727	14.741	14.755	14.770
1310	14.770	14.784	14.798	14.812	14.826	14.840	14.854	14.868	14.882	14.896	14.911
1320	14.911	14.925	14.939	14.953	14.967	14.981	14.995	15.009	15.023	15.037	15.052
1330	15.052	15.066	15.080	15.094	15.108	15.122	15.136	15.150	15.164	15.179	15.193
1340	15.193	15.207	15.221	15.235	15.249	15.263	15.277	15.291	15.306	15.320	15.334
1350	15.334	15.348	15.362	15.376	15.390	15.404	15.419	15.433	15.447	15.461	15.475
1360	15.475	15.489	15.503	15.517	15.531	15.546	15.560	15.574	15.588	15.602	15.616
1370	15.616	15.630	15.645	15.659	15.673	15.687	15.701	15.715	15.729	15.743	15.758
1380	15.758	15.772	15.786	15.800	15.814	15.828	15.842	15.856	15.871	15.885	15.899
1390	15.899	15.913	15.927	15.941	15.955	15.969	15.984	15.998	16.012	16.026	16.040
1400	16.040	16.054	16.068	16.082	16.097	16.111	16.125	16.139	16.153	16.167	16.181
1410	16.181	16.196	16.210	16.224	16.238	16.252	16.266	16.280	16.294	16.309	16.323
1420	16.323	16.337	16.351	16.365	16.379	16.393	16.407	16.422	16.436	16.450	16.464
1430	16.464	16.478	16.492	16.506	16.520	16.534	16.549	16.563	16.577	16.591	16.605
1440	16.605	16.619	16.633	16.647	16.662	16.676	16.690	16.704	16.718	16.732	16.746
1450	16.746	16.760	16.774	16.789	16.803	16.817	16.831	16.845	16.859	16.873	16.887
1460	16.887	16.901	16.915	16.930	16.944	16.958	16.972	16.986	17.000	17.014	17.028
1470	17.028	17.042	17.056	17.071	17.085	17.099	17.113	17.127	17.141	17.155	17.169
1480	17.169	17.183	17.197	17.211	17.225	17.240	17.254	17.268	17.282	17.296	17.310

Type S Thermocouple Temperature in Degrees Celsius (ITS-90)

°C	Reference Junctions at 0°C										
	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
+200	1.441	1.449	1.458	1.466	1.475	1.483	1.492	1.500	1.509	1.517	1.526
210	1.526	1.534	1.543	1.551	1.560	1.569	1.577	1.586	1.594	1.603	1.612
220	1.612	1.620	1.629	1.638	1.646	1.655	1.663	1.672	1.681	1.690	1.698
230	1.698	1.707	1.716	1.724	1.733	1.742	1.751	1.759	1.768	1.777	1.786
240	1.786	1.794	1.803	1.812	1.821	1.829	1.838	1.847	1.856	1.865	1.874
250	1.874	1.882	1.891	1.900	1.909	1.918	1.927	1.936	1.944	1.953	1.962
260	1.962	1.971	1.980	1.989	1.998	2.007	2.016	2.025	2.034	2.043	2.052
270	2.052	2.061	2.070	2.078	2.087	2.096	2.105	2.114	2.123	2.132	2.141
280	2.141	2.151	2.160	2.169	2.178	2.187	2.196	2.205	2.214	2.223	2.232
290	2.232	2.241	2.250	2.259	2.268	2.277	2.287	2.296	2.305	2.314	2.323
300	2.323	2.332	2.341	2.350	2.360	2.369	2.378	2.387	2.396	2.405	2.415
310	2.415	2.424	2.433	2.442	2.451	2.461	2.470	2.479	2.488	2.497	2.507
320	2.507	2.516	2.525	2.534	2.544	2.553	2.562	2.571	2.581	2.590	2.599
330	2.599	2.609	2.618	2.627	2.636	2.646	2.655	2.664	2.674	2.683	2.692
340	2.692	2.702	2.711	2.720	2.730	2.739	2.748	2.758	2.767	2.776	2.786
350	2.786	2.795	2.805	2.814	2.823	2.833	2.842	2.851	2.861	2.870	2.880
360	2.880	2.889	2.899	2.908	2.917	2.927	2.936	2.946	2.955	2.965	2.974
370	2.974	2.983	2.993	3.002	3.012	3.021	3.031	3.040	3.050	3.059	3.069
380	3.069	3.078	3.088	3.097	3.107	3.116	3.126	3.135	3.145	3.154	3.164
390	3.164	3.173	3.183	3.192	3.202	3.212	3.221	3.231	3.240	3.250	3.259
400	3.259	3.269	3.279	3.288	3.298	3.307	3.317	3.326	3.336	3.346	3.355
410	3.355	3.365	3.374	3.384	3.394	3.403	3.413	3.423	3.432	3.442	3.451
420	3.451	3.461	3.471	3.480	3.490	3.500	3.509	3.519	3.529	3.538	3.548
430	3.548	3.558	3.567	3.577	3.587	3.596	3.606	3.616	3.626	3.635	3.645
440	3.645	3.655	3.664	3.674	3.684	3.694	3.703	3.713	3.723	3.732	3.742
450	3.742	3.752	3.762	3.771	3.781	3.791	3.801	3.810	3.820	3.830	3.840
460	3.840	3.850	3.859	3.869	3.879	3.889	3.898	3.908	3.918	3.928	3.938
470	3.938	3.947	3.957	3.967	3.977	3.987	3.997	4.006	4.016	4.026	4.036
480	4.036	4.046	4.056	4.065	4.075	4.085	4.095	4.105	4.115	4.125	4.134
490	4.134	4.144	4.154	4.164	4.174	4.184	4.194	4.204	4.213	4.223	4.233
500	4.233	4.243	4.253	4.263	4.273	4.283	4.293	4.303	4.313	4.323	4.332
510	4.332	4.342	4.352	4.362	4.372	4.382	4.392	4.402	4.412	4.422	4.432
520	4.432	4.442	4.452	4.462	4.472	4.482	4.492	4.502	4.512	4.522	4.532
530	4.532	4.542	4.552	4.562	4.572	4.582	4.592	4.602	4.612	4.622	4.632
540	4.632	4.642	4.652	4.662	4.672	4.682	4.692	4.702	4.712	4.722	4.732
550	4.732	4.742	4.752	4.762	4.772	4.782	4.793	4.803	4.813	4.823	4.833
560	4.833	4.843	4.853	4.863	4.873	4.883	4.893	4.904	4.914	4.924	4.934
570	4.934	4.944	4.954	4.964	4.974	4.984	4.995	5.005	5.015	5.025	5.035
580	5.035	5.045	5.055	5.066	5.076	5.086	5.096	5.106	5.116	5.127	5.137
590	5.137	5.147	5.157	5.167	5.178	5.188	5.198	5.208	5.218	5.228	5.239
600	5.239	5.249	5.259	5.269	5.280	5.290	5.300	5.310	5.320	5.331	5.341
610	5.341	5.351	5.361	5.372	5.382	5.392	5.402	5.413	5.423	5.433	5.443
620	5.443	5.454	5.464	5.474	5.485	5.495	5.505	5.515	5.526	5.536	5.546
630	5.546	5.557	5.567	5.577	5.588	5.598	5.608	5.618	5.629	5.639	5.649
640	5.649	5.660	5.670	5.680	5.691	5.701	5.712	5.722	5.732	5.743	5.753
650	5.753	5.763	5.774	5.784	5.794	5.805	5.815	5.826	5.836	5.846	5.857
660	5.857	5.867	5.878	5.888	5.898	5.909	5.919	5.930	5.940	5.950	5.961
670	5.961	5.971	5.982	5.992	6.003	6.013	6.024	6.034	6.044	6.055	6.065
680	6.065	6.076	6.086	6.097	6.107	6.118	6.128	6.139	6.149	6.160	6.170
690	6.170	6.181	6.191	6.202	6.212	6.223	6.233	6.244	6.254	6.265	6.275

Type S Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
700	6.275	6.286	6.296	6.307	6.317	6.328	6.338	6.349	6.360	6.370	6.381
710	6.381	6.391	6.402	6.412	6.423	6.434	6.444	6.455	6.465	6.476	6.486
720	6.486	6.497	6.508	6.518	6.529	6.539	6.550	6.561	6.571	6.582	6.593
730	6.593	6.603	6.614	6.624	6.635	6.646	6.656	6.667	6.678	6.688	6.699
740	6.699	6.710	6.720	6.731	6.742	6.752	6.763	6.774	6.784	6.795	6.806
750	6.806	6.817	6.827	6.838	6.849	6.859	6.870	6.881	6.892	6.902	6.913
760	6.913	6.924	6.934	6.945	6.956	6.967	6.977	6.988	6.999	7.010	7.020
770	7.020	7.031	7.042	7.053	7.064	7.074	7.085	7.096	7.107	7.117	7.128
780	7.128	7.139	7.150	7.161	7.172	7.182	7.193	7.204	7.215	7.226	7.236
790	7.236	7.247	7.258	7.269	7.280	7.291	7.302	7.312	7.323	7.334	7.345
800	7.345	7.356	7.367	7.378	7.388	7.399	7.410	7.421	7.432	7.443	7.454
810	7.454	7.465	7.476	7.487	7.497	7.508	7.519	7.530	7.541	7.552	7.563
820	7.563	7.574	7.585	7.596	7.607	7.618	7.629	7.640	7.651	7.662	7.673
830	7.673	7.684	7.695	7.706	7.717	7.728	7.739	7.750	7.761	7.772	7.783
840	7.783	7.794	7.805	7.816	7.827	7.838	7.849	7.860	7.871	7.882	7.893
850	7.893	7.904	7.915	7.926	7.937	7.948	7.959	7.970	7.981	7.992	8.003
860	8.003	8.014	8.026	8.037	8.048	8.059	8.070	8.081	8.092	8.103	8.114
870	8.114	8.125	8.137	8.148	8.159	8.170	8.181	8.192	8.203	8.214	8.226
880	8.226	8.237	8.248	8.259	8.270	8.281	8.293	8.304	8.315	8.326	8.337
890	8.337	8.348	8.360	8.371	8.382	8.393	8.404	8.416	8.427	8.438	8.449
900	8.449	8.460	8.472	8.483	8.494	8.505	8.517	8.528	8.539	8.550	8.562
910	8.562	8.573	8.584	8.595	8.607	8.618	8.629	8.640	8.652	8.663	8.674
920	8.674	8.685	8.697	8.708	8.719	8.731	8.742	8.753	8.765	8.776	8.787
930	8.787	8.798	8.810	8.821	8.832	8.844	8.855	8.866	8.878	8.889	8.900
940	8.900	8.912	8.923	8.935	8.946	8.957	8.969	8.980	8.991	9.003	9.014
950	9.014	9.025	9.037	9.048	9.060	9.071	9.082	9.094	9.105	9.117	9.128
960	9.128	9.139	9.151	9.162	9.174	9.185	9.197	9.208	9.219	9.231	9.242
970	9.242	9.254	9.265	9.277	9.288	9.300	9.311	9.323	9.334	9.345	9.357
980	9.357	9.368	9.380	9.391	9.403	9.414	9.426	9.437	9.449	9.460	9.472
990	9.472	9.483	9.495	9.506	9.518	9.529	9.541	9.552	9.564	9.576	9.587
1000	9.587	9.599	9.610	9.622	9.633	9.645	9.656	9.668	9.680	9.691	9.703
1010	9.703	9.714	9.726	9.737	9.749	9.761	9.772	9.784	9.795	9.807	9.819
1020	9.819	9.830	9.842	9.853	9.865	9.877	9.888	9.900	9.911	9.923	9.935
1030	9.935	9.946	9.958	9.970	9.981	9.993	10.005	10.016	10.028	10.040	10.051
1040	10.051	10.063	10.075	10.086	10.098	10.110	10.121	10.133	10.145	10.156	10.168
1050	10.168	10.180	10.191	10.203	10.215	10.227	10.238	10.250	10.262	10.273	10.285
1060	10.285	10.297	10.309	10.320	10.332	10.344	10.356	10.367	10.379	10.391	10.403
1070	10.403	10.414	10.426	10.438	10.450	10.461	10.473	10.485	10.497	10.509	10.520
1080	10.520	10.532	10.544	10.556	10.567	10.579	10.591	10.603	10.615	10.626	10.638
1090	10.638	10.650	10.662	10.674	10.686	10.697	10.709	10.721	10.733	10.745	10.757
1100	10.757	10.768	10.780	10.792	10.804	10.816	10.828	10.839	10.851	10.863	10.875
1110	10.875	10.887	10.899	10.911	10.922	10.934	10.946	10.958	10.970	10.982	10.994
1120	10.994	11.006	11.017	11.029	11.041	11.053	11.065	11.077	11.089	11.101	11.113
1130	11.113	11.125	11.136	11.148	11.160	11.172	11.184	11.196	11.208	11.220	11.232
1140	11.232	11.244	11.256	11.268	11.280	11.291	11.303	11.315	11.327	11.339	11.351
1150	11.351	11.363	11.375	11.387	11.399	11.411	11.423	11.435	11.447	11.459	11.471
1160	11.471	11.483	11.495	11.507	11.519	11.531	11.542	11.554	11.566	11.578	11.590
1170	11.590	11.602	11.614	11.626	11.638	11.650	11.662	11.674	11.686	11.698	11.710
1180	11.710	11.722	11.734	11.746	11.758	11.770	11.782	11.794	11.806	11.818	11.830
1190	11.830	11.842	11.854	11.866	11.878	11.890	11.902	11.914	11.926	11.939	11.951

Type S Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
1200	11.951	11.963	11.975	11.987	11.999	12.011	12.023	12.035	12.047	12.059	12.071
1210	12.071	12.083	12.095	12.107	12.119	12.131	12.143	12.155	12.167	12.179	12.191
1220	12.191	12.203	12.216	12.228	12.240	12.252	12.264	12.276	12.288	12.300	12.312
1230	12.312	12.324	12.336	12.348	12.360	12.372	12.384	12.397	12.409	12.421	12.433
1240	12.433	12.445	12.457	12.469	12.481	12.493	12.505	12.517	12.529	12.542	12.554
1250	12.554	12.566	12.578	12.590	12.602	12.614	12.626	12.638	12.650	12.662	12.675
1260	12.675	12.687	12.699	12.711	12.723	12.735	12.747	12.759	12.771	12.783	12.796
1270	12.796	12.808	12.820	12.832	12.844	12.856	12.868	12.880	12.892	12.905	12.917
1280	12.917	12.929	12.941	12.953	12.965	12.977	12.989	13.001	13.014	13.026	13.038
1290	13.038	13.050	13.062	13.074	13.086	13.098	13.111	13.123	13.135	13.147	13.159
1300	13.159	13.171	13.183	13.195	13.208	13.220	13.232	13.244	13.256	13.268	13.280
1310	13.280	13.292	13.305	13.317	13.329	13.341	13.353	13.365	13.377	13.390	13.402
1320	13.402	13.414	13.426	13.438	13.450	13.462	13.474	13.487	13.499	13.511	13.523
1330	13.523	13.535	13.547	13.559	13.572	13.584	13.596	13.608	13.620	13.632	13.644
1340	13.644	13.657	13.669	13.681	13.693	13.705	13.717	13.729	13.742	13.754	13.766
1350	13.766	13.778	13.790	13.802	13.814	13.826	13.839	13.851	13.863	13.875	13.887
1360	13.887	13.899	13.911	13.924	13.936	13.948	13.960	13.972	13.984	13.996	14.009
1370	14.009	14.021	14.033	14.045	14.057	14.069	14.081	14.094	14.106	14.118	14.130
1380	14.130	14.142	14.154	14.166	14.178	14.191	14.203	14.215	14.227	14.239	14.251
1390	14.251	14.263	14.276	14.288	14.300	14.312	14.324	14.336	14.348	14.360	14.373
1400	14.373	14.385	14.397	14.409	14.421	14.433	14.445	14.457	14.470	14.482	14.494
1410	14.494	14.506	14.518	14.530	14.542	14.554	14.567	14.579	14.591	14.603	14.615
1420	14.615	14.627	14.639	14.651	14.664	14.676	14.688	14.700	14.712	14.724	14.736
1430	14.736	14.748	14.760	14.773	14.785	14.797	14.809	14.821	14.833	14.845	14.857
1440	14.857	14.869	14.881	14.894	14.906	14.918	14.930	14.942	14.954	14.966	14.978
1450	14.978	14.990	15.002	15.015	15.027	15.039	15.051	15.063	15.075	15.087	15.099
1460	15.099	15.111	15.123	15.135	15.148	15.160	15.172	15.184	15.196	15.208	15.220
1470	15.220	15.232	15.244	15.256	15.268	15.280	15.292	15.304	15.317	15.329	15.341
1480	15.341	15.353	15.365	15.377	15.389	15.401	15.413	15.425	15.437	15.449	15.461

Type B Thermocouple

Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
+200	0.178	0.180	0.182	0.184	0.186	0.188	0.190	0.192	0.195	0.197	0.199
210	0.199	0.201	0.203	0.205	0.207	0.209	0.212	0.214	0.216	0.218	0.220
220	0.220	0.222	0.225	0.227	0.229	0.231	0.234	0.236	0.238	0.241	0.243
230	0.243	0.245	0.248	0.250	0.252	0.255	0.257	0.259	0.262	0.264	0.267
240	0.267	0.269	0.271	0.274	0.276	0.279	0.281	0.284	0.286	0.289	0.291
250	0.291	0.294	0.296	0.299	0.301	0.304	0.307	0.309	0.312	0.314	0.317
260	0.317	0.320	0.322	0.325	0.328	0.330	0.333	0.336	0.338	0.341	0.344
270	0.344	0.347	0.349	0.352	0.355	0.358	0.360	0.363	0.366	0.369	0.372
280	0.372	0.375	0.377	0.380	0.383	0.386	0.389	0.392	0.395	0.398	0.401
290	0.401	0.404	0.407	0.410	0.413	0.416	0.419	0.422	0.425	0.428	0.431
300	0.431	0.434	0.437	0.440	0.443	0.446	0.449	0.452	0.455	0.458	0.462
310	0.462	0.465	0.468	0.471	0.474	0.478	0.481	0.484	0.487	0.490	0.494
320	0.494	0.497	0.500	0.503	0.507	0.510	0.513	0.517	0.520	0.523	0.527
330	0.527	0.530	0.533	0.537	0.540	0.544	0.547	0.550	0.554	0.557	0.561
340	0.561	0.564	0.568	0.571	0.575	0.578	0.582	0.585	0.589	0.592	0.596
350	0.596	0.599	0.603	0.607	0.610	0.614	0.617	0.621	0.625	0.628	0.632
360	0.632	0.636	0.639	0.643	0.647	0.650	0.654	0.658	0.662	0.665	0.669
370	0.669	0.673	0.677	0.680	0.684	0.688	0.692	0.696	0.700	0.703	0.707
380	0.707	0.711	0.715	0.719	0.723	0.727	0.731	0.735	0.738	0.742	0.746
390	0.746	0.750	0.754	0.758	0.762	0.766	0.770	0.774	0.778	0.782	0.787
400	0.787	0.791	0.795	0.799	0.803	0.807	0.811	0.815	0.819	0.824	0.828
410	0.828	0.832	0.836	0.840	0.844	0.849	0.853	0.857	0.861	0.866	0.870
420	0.870	0.874	0.878	0.883	0.887	0.891	0.896	0.900	0.904	0.909	0.913
430	0.913	0.917	0.922	0.926	0.930	0.935	0.939	0.944	0.948	0.953	0.957
440	0.957	0.961	0.966	0.970	0.975	0.979	0.984	0.988	0.993	0.997	1.002
450	1.002	1.007	1.011	1.016	1.020	1.025	1.030	1.034	1.039	1.043	1.048
460	1.048	1.053	1.057	1.062	1.067	1.071	1.076	1.081	1.086	1.090	1.095
470	1.095	1.100	1.105	1.109	1.114	1.119	1.124	1.129	1.133	1.138	1.143
480	1.143	1.148	1.153	1.158	1.163	1.167	1.172	1.177	1.182	1.187	1.192
490	1.192	1.197	1.202	1.207	1.212	1.217	1.222	1.227	1.232	1.237	1.242
500	1.242	1.247	1.252	1.257	1.262	1.267	1.272	1.277	1.282	1.288	1.293
510	1.293	1.298	1.303	1.308	1.313	1.318	1.324	1.329	1.334	1.339	1.344
520	1.344	1.350	1.355	1.360	1.365	1.371	1.376	1.381	1.387	1.392	1.397
530	1.397	1.402	1.408	1.413	1.418	1.424	1.429	1.435	1.440	1.445	1.451
540	1.451	1.456	1.462	1.467	1.472	1.478	1.483	1.489	1.494	1.500	1.505
550	1.505	1.511	1.516	1.522	1.527	1.533	1.539	1.544	1.550	1.555	1.561
560	1.561	1.566	1.572	1.578	1.583	1.589	1.595	1.600	1.606	1.612	1.617
570	1.617	1.623	1.629	1.634	1.640	1.646	1.652	1.657	1.663	1.669	1.675
580	1.675	1.680	1.686	1.692	1.698	1.704	1.709	1.715	1.721	1.727	1.733
590	1.733	1.739	1.745	1.750	1.756	1.762	1.768	1.774	1.780	1.786	1.792
600	1.792	1.798	1.804	1.810	1.816	1.822	1.828	1.834	1.840	1.846	1.852
610	1.852	1.858	1.864	1.870	1.876	1.882	1.888	1.894	1.901	1.907	1.913
620	1.913	1.919	1.925	1.931	1.937	1.944	1.950	1.956	1.962	1.968	1.975
630	1.975	1.981	1.987	1.993	1.999	2.006	2.012	2.018	2.025	2.031	2.037
640	2.037	2.043	2.050	2.056	2.062	2.069	2.075	2.082	2.088	2.094	2.101
650	2.101	2.107	2.113	2.120	2.126	2.133	2.139	2.146	2.152	2.158	2.165
660	2.165	2.171	2.178	2.184	2.191	2.197	2.204	2.210	2.217	2.224	2.230
670	2.230	2.237	2.243	2.250	2.256	2.263	2.270	2.276	2.283	2.289	2.296
680	2.296	2.303	2.309	2.316	2.323	2.329	2.336	2.343	2.350	2.356	2.363
690	2.363	2.370	2.376	2.383	2.390	2.397	2.403	2.410	2.417	2.424	2.431

Type B Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts	Reference Junctions at 0°C										
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
700	2.431	2.437	2.444	2.451	2.458	2.465	2.472	2.479	2.485	2.492	2.499
710	2.499	2.506	2.513	2.520	2.527	2.534	2.541	2.548	2.555	2.562	2.569
720	2.569	2.576	2.583	2.590	2.597	2.604	2.611	2.618	2.625	2.632	2.639
730	2.639	2.646	2.653	2.660	2.667	2.674	2.681	2.688	2.696	2.703	2.710
740	2.710	2.717	2.724	2.731	2.738	2.746	2.753	2.760	2.767	2.775	2.782
750	2.782	2.789	2.796	2.803	2.811	2.818	2.825	2.833	2.840	2.847	2.854
760	2.854	2.862	2.869	2.876	2.884	2.891	2.898	2.906	2.913	2.921	2.928
770	2.928	2.935	2.943	2.950	2.958	2.965	2.973	2.980	2.987	2.995	3.002
780	3.002	3.010	3.017	3.025	3.032	3.040	3.047	3.055	3.062	3.070	3.078
790	3.078	3.085	3.093	3.100	3.108	3.116	3.123	3.131	3.138	3.146	3.154
800	3.154	3.161	3.169	3.177	3.184	3.192	3.200	3.207	3.215	3.223	3.230
810	3.230	3.238	3.246	3.254	3.261	3.269	3.277	3.285	3.292	3.300	3.308
820	3.308	3.316	3.324	3.331	3.339	3.347	3.355	3.363	3.371	3.379	3.386
830	3.386	3.394	3.402	3.410	3.418	3.426	3.434	3.442	3.450	3.458	3.466
840	3.466	3.474	3.482	3.490	3.498	3.506	3.514	3.522	3.530	3.538	3.546
850	3.546	3.554	3.562	3.570	3.578	3.586	3.594	3.602	3.610	3.618	3.626
860	3.626	3.634	3.643	3.651	3.659	3.667	3.675	3.683	3.692	3.700	3.708
870	3.708	3.716	3.724	3.732	3.741	3.749	3.757	3.765	3.774	3.782	3.790
880	3.790	3.798	3.807	3.815	3.823	3.832	3.840	3.848	3.857	3.865	3.873
890	3.873	3.882	3.890	3.898	3.907	3.915	3.923	3.932	3.940	3.949	3.957
900	3.957	3.965	3.974	3.982	3.991	3.999	4.008	4.016	4.024	4.033	4.041
910	4.041	4.050	4.058	4.067	4.075	4.084	4.093	4.101	4.110	4.118	4.127
920	4.127	4.135	4.144	4.152	4.161	4.170	4.178	4.187	4.195	4.204	4.213
930	4.213	4.221	4.230	4.239	4.247	4.256	4.265	4.273	4.282	4.291	4.299
940	4.299	4.308	4.317	4.326	4.334	4.343	4.352	4.360	4.369	4.378	4.387
950	4.387	4.396	4.404	4.413	4.422	4.431	4.440	4.448	4.457	4.466	4.475
960	4.475	4.484	4.493	4.501	4.510	4.519	4.528	4.537	4.546	4.555	4.564
970	4.564	4.573	4.582	4.591	4.599	4.608	4.617	4.626	4.635	4.644	4.653
980	4.653	4.662	4.671	4.680	4.689	4.698	4.707	4.716	4.725	4.734	4.743
990	4.743	4.753	4.762	4.771	4.780	4.789	4.798	4.807	4.816	4.825	4.834
1000	4.834	4.843	4.853	4.862	4.871	4.880	4.889	4.898	4.908	4.917	4.926
1010	4.926	4.935	4.944	4.954	4.963	4.972	4.981	4.990	5.000	5.009	5.018
1020	5.018	5.027	5.037	5.046	5.055	5.065	5.074	5.083	5.092	5.102	5.111
1030	5.111	5.120	5.130	5.139	5.148	5.158	5.167	5.176	5.186	5.195	5.205
1040	5.205	5.214	5.223	5.233	5.242	5.252	5.261	5.270	5.280	5.289	5.299
1050	5.299	5.308	5.318	5.327	5.337	5.346	5.356	5.365	5.375	5.384	5.394
1060	5.394	5.403	5.413	5.422	5.432	5.441	5.451	5.460	5.470	5.480	5.489
1070	5.489	5.499	5.508	5.518	5.528	5.537	5.547	5.556	5.566	5.576	5.585
1080	5.585	5.595	5.605	5.614	5.624	5.634	5.643	5.653	5.663	5.672	5.682
1090	5.682	5.692	5.702	5.711	5.721	5.731	5.740	5.750	5.760	5.770	5.780
1100	5.780	5.789	5.799	5.809	5.819	5.828	5.838	5.848	5.858	5.868	5.878
1110	5.878	5.887	5.897	5.907	5.917	5.927	5.937	5.947	5.956	5.966	5.976
1120	5.976	5.986	5.996	6.006	6.016	6.026	6.036	6.046	6.055	6.065	6.075
1130	6.075	6.085	6.095	6.105	6.115	6.125	6.135	6.145	6.155	6.165	6.175
1140	6.175	6.185	6.195	6.205	6.215	6.225	6.235	6.245	6.256	6.266	6.276
1150	6.276	6.286	6.296	6.306	6.316	6.326	6.336	6.346	6.356	6.367	6.377
1160	6.377	6.387	6.397	6.407	6.417	6.427	6.438	6.448	6.458	6.468	6.478
1170	6.478	6.488	6.499	6.509	6.519	6.529	6.539	6.550	6.560	6.570	6.580
1180	6.580	6.591	6.601	6.611	6.621	6.632	6.642	6.652	6.663	6.673	6.683
1190	6.683	6.693	6.704	6.714	6.724	6.735	6.745	6.755	6.766	6.776	6.786

Type B Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts		Reference Junctions at 0°C									
°C	0	1	2	3	4	5	6	7	8	9	10
THERMOELECTRIC VOLTAGE IN MILLIVOLTS											
1200	6.786	6.797	6.807	6.818	6.828	6.838	6.849	6.859	6.869	6.880	6.890
1210	6.890	6.901	6.911	6.922	6.932	6.942	6.953	6.963	6.974	6.984	6.995
1220	6.995	7.005	7.016	7.026	7.037	7.047	7.058	7.068	7.079	7.089	7.100
1230	7.100	7.110	7.121	7.131	7.142	7.152	7.163	7.173	7.184	7.194	7.205
1240	7.205	7.216	7.226	7.237	7.247	7.258	7.269	7.279	7.290	7.300	7.311
1250	7.311	7.322	7.332	7.343	7.353	7.364	7.375	7.385	7.396	7.407	7.417
1260	7.417	7.428	7.439	7.449	7.460	7.471	7.482	7.492	7.503	7.514	7.524
1270	7.524	7.535	7.546	7.557	7.567	7.578	7.589	7.600	7.610	7.621	7.632
1280	7.632	7.643	7.653	7.664	7.675	7.686	7.697	7.707	7.718	7.729	7.740
1290	7.740	7.751	7.761	7.772	7.783	7.794	7.805	7.816	7.827	7.837	7.848
1300	7.848	7.859	7.870	7.881	7.892	7.903	7.914	7.924	7.935	7.946	7.957
1310	7.957	7.968	7.979	7.990	8.001	8.012	8.023	8.034	8.045	8.056	8.066
1320	8.066	8.077	8.088	8.099	8.110	8.121	8.132	8.143	8.154	8.165	8.176
1330	8.176	8.187	8.198	8.209	8.220	8.231	8.242	8.253	8.264	8.275	8.286
1340	8.286	8.298	8.309	8.320	8.331	8.342	8.353	8.364	8.375	8.386	8.397
1350	8.397	8.408	8.419	8.430	8.441	8.453	8.464	8.475	8.486	8.497	8.508
1360	8.508	8.519	8.530	8.542	8.553	8.564	8.575	8.586	8.597	8.608	8.620
1370	8.620	8.631	8.642	8.653	8.664	8.675	8.687	8.698	8.709	8.720	8.731
1380	8.731	8.743	8.754	8.765	8.776	8.787	8.799	8.810	8.821	8.832	8.844
1390	8.844	8.855	8.866	8.877	8.889	8.900	8.911	8.922	8.934	8.945	8.956
1400	8.956	8.967	8.979	8.990	9.001	9.013	9.024	9.035	9.047	9.058	9.069
1410	9.069	9.080	9.092	9.103	9.114	9.126	9.137	9.148	9.160	9.171	9.182
1420	9.182	9.194	9.205	9.216	9.228	9.239	9.251	9.262	9.273	9.285	9.296
1430	9.296	9.307	9.319	9.330	9.342	9.353	9.364	9.376	9.387	9.398	9.410
1440	9.410	9.421	9.433	9.444	9.456	9.467	9.478	9.490	9.501	9.513	9.524
1450	9.524	9.536	9.547	9.558	9.570	9.581	9.593	9.604	9.616	9.627	9.639
1460	9.639	9.650	9.662	9.673	9.684	9.696	9.707	9.719	9.730	9.742	9.753
1470	9.753	9.765	9.776	9.788	9.799	9.811	9.822	9.834	9.845	9.857	9.868
1480	9.868	9.880	9.891	9.903	9.914	9.926	9.937	9.949	9.961	9.972	9.984
1490	9.984	9.995	10.007	10.018	10.030	10.041	10.053	10.064	10.076	10.088	10.099
1500	10.099	10.111	10.122	10.134	10.145	10.157	10.168	10.180	10.192	10.203	10.215
1510	10.215	10.226	10.238	10.249	10.261	10.273	10.284	10.296	10.307	10.319	10.331
1520	10.331	10.342	10.354	10.365	10.377	10.389	10.400	10.412	10.423	10.435	10.447
1530	10.447	10.458	10.470	10.482	10.493	10.505	10.516	10.528	10.540	10.551	10.563
1540	10.563	10.575	10.586	10.598	10.609	10.621	10.633	10.644	10.656	10.668	10.679
1550	10.679	10.691	10.703	10.714	10.726	10.738	10.749	10.761	10.773	10.784	10.796
1560	10.796	10.808	10.819	10.831	10.843	10.854	10.866	10.877	10.889	10.901	10.913
1570	10.913	10.924	10.936	10.948	10.959	10.971	10.983	10.994	11.006	11.018	11.029
1580	11.029	11.041	11.053	11.064	11.076	11.088	11.099	11.111	11.123	11.134	11.146
1590	11.146	11.158	11.169	11.181	11.193	11.205	11.216	11.228	11.240	11.251	11.263
1600	11.263	11.275	11.286	11.298	11.310	11.321	11.333	11.345	11.357	11.368	11.380
1610	11.380	11.392	11.403	11.415	11.427	11.438	11.450	11.462	11.474	11.485	11.497
1620	11.497	11.509	11.520	11.532	11.544	11.555	11.567	11.579	11.591	11.602	11.614
1630	11.614	11.626	11.637	11.649	11.661	11.673	11.684	11.696	11.708	11.719	11.731
1640	11.731	11.743	11.754	11.766	11.778	11.790	11.801	11.813	11.825	11.836	11.848
1650	11.848	11.860	11.871	11.883	11.895	11.907	11.918	11.930	11.942	11.953	11.965
1660	11.965	11.977	11.988	12.000	12.012	12.024	12.035	12.047	12.059	12.070	12.082
1670	12.082	12.094	12.105	12.117	12.129	12.141	12.152	12.164	12.176	12.187	12.199
1680	12.199	12.211	12.222	12.234	12.246	12.257	12.269	12.281	12.292	12.304	12.316
1690	12.316	12.327	12.339	12.351	12.363	12.374	12.386	12.398	12.409	12.421	12.433

Type B Thermocouple *Continued*
Temperature in Degrees Celsius (ITS-90)

EMF in Millivolts											Reference Junctions at 0°C											
°C	0	1	2	3	4	5	6	7	8	9	10											
THERMOELECTRIC VOLTAGE IN MILLIVOLTS																						
1700	12.433	12.444	12.456	12.468	12.479	12.491	12.503	12.514	12.526	12.538	12.549											
1710	12.549	12.561	12.572	12.584	12.596	12.607	12.619	12.631	12.642	12.654	12.666											
1720	12.666	12.677	12.689	12.701	12.712	12.724	12.736	12.747	12.759	12.770	12.782											
1730	12.782	12.794	12.805	12.817	12.829	12.840	12.852	12.863	12.875	12.887	12.898											
1740	12.898	12.910	12.921	12.933	12.945	12.956	12.968	12.980	12.991	13.003	13.014											
1750	13.014	13.026	13.037	13.049	13.061	13.072	13.084	13.095	13.107	13.119	13.130											
1760	13.130	13.142	13.153	13.165	13.176	13.188	13.200	13.211	13.223	13.234	13.246											
1770	13.246	13.257	13.269	13.280	13.292	13.304	13.315	13.327	13.338	13.350	13.361											
1780	13.361	13.373	13.384	13.396	13.407	13.419	13.430	13.442	13.453	13.465	13.476											
1790	13.476	13.488	13.499	13.511	13.522	13.534	13.545	13.557	13.568	13.580	13.591											
1800	13.591	13.603	13.614	13.626	13.637	13.649	13.660	13.672	13.683	13.694	13.706											

GUARANTEE CONDITIONS

All our appliances have been subjected to strict tests and are guaranteed for 24 months from date of purchase. The Company undertakes to repair or replace free of charge any parts which it considers to be inefficient within the guarantee period. Complete replacement of the instrument is excluded and no requests for damages are recognized, whatever their origin. Repairs are carried out in our own Technical Service Department. Transport expenses are borne by the buyer. **The guarantee does not include: accidental breakages due to transport, incorrect use or neglect, incorrect connection to voltage different from that contemplated for the instrument, probes, sensors, electrodes and all accessories.** Furthermore the guarantee is not valid if the instrument has been repaired or tampered with by unauthorized third parties, or adjusted for faults or casual checking. The guarantee is valid only if all parts of the guarantee card have been filled in. Any instruments sent for repairs must be accompanied by their guarantee certificate. For all disputes the competent court is the Court of Padua.

CE CONFORMITY	
Safety	EN61000-4-2, EN61010-1 level 3
Electrostatic discharge	EN61000-4-2 level 3
Electric fast transients	EN61000-4-4 level 3
Voltage variations	EN61000-4-11
Electromagnetic interference susceptibility	IEC1000-4-3
Electromagnetic interference emission	EN55020 class B

DO 9417

MANUALE D'ISTRUZIONE - INSTRUCTIONS MANUAL
MANUEL D'INSTRUCTION - GEBRAUCHSANLEITUNG
MANUAL DE INSTRUCCIONES



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