DO 9704

INSTRUCTIONS MANUAL

DO 9704

Pressure Datalogger DO 9704
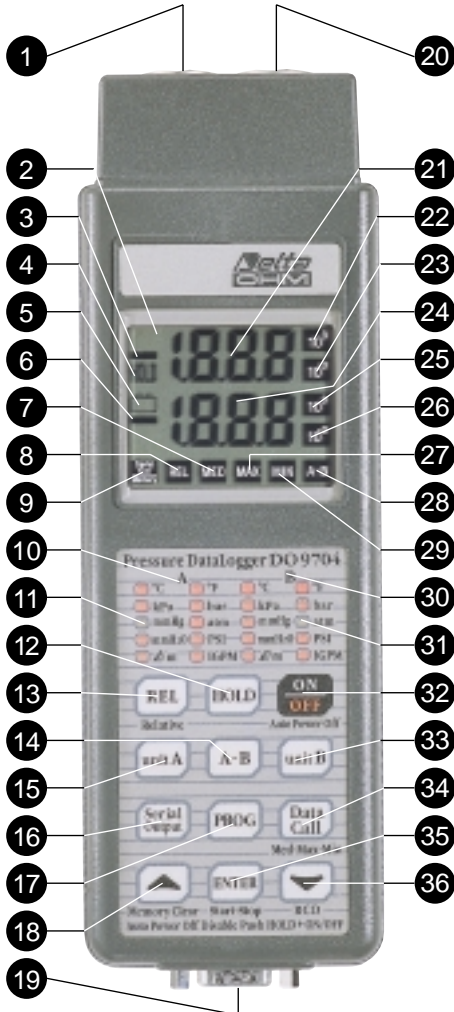
DO 9704

PRESSURE AND TEMPERATURE - DATA-LOGGER

1 Input A, DIN 8-pole connector for pressure, flow rate or temperature.
2 Display.
3 Negative symbol input A.
4 HOLD symbol.
5 ⊟ symbol: flashes during RECORD function, permanently lit if the battery is running low.
6 Negative symbol input B.
7 The display shows the Mean values.
8 REL symbol, indicates that the instrument is making a relative measurement.
9 Memory/Serial Out. Fixed symbol: the instrument is storing. Flashing symbol: serial output is enabled.
10 Measurement units that may be selected at input A.
11 Measurement unit selected at input A.
12 HOLD key for blocking the reading.
13 REL key, the value shown is related to the indication at the moment in which the REL key was pressed.
14 A-B key. The instrument displays the difference between the inputs.
15 Unit A: Key for selecting the measurement unit for input A.
16 Serial Output: enables unloading of data at the RS 232C serial output.
17 Prog: this key is pressed to enter the routine for programming the various functions of the instrument.
18 ▲ key. When enabled, this key increases the displayed parameter.
19 Output for RS 232C (SUB D male 9-pole).
20 Input B, DIN 8-pole connector for pressure, flow rate or temperature.
21 Input A indication.
22 Multiplication channel for channel A 10^3.
23 Multiplication channel for channel A 10^{-3}.
24 Input B indication.
25 Multiplication channel for channel B 10^3.
26 Multiplication channel for channel B 10^{-3}.
27 The display shows the Maximum values.
28 The display shows the difference in value between inputs A or B.
29 The display shows the Minimum values.
30 Measurement units that may be selected at input B.
31 Measurement unit selected at input B.
32 Key for switching the instrument on and off.
33 Unit B. Key for selecting the measurement unit for input B.
34 When pressed in sequence, the display indicates the Maximum peak value, the Minimum value and the Mean value.
35 The key has various functions: it starts and stops storage, confirms the set parameters.
36 ▼ key. When enabled, this key decreases the displayed values, starts and stops the RECORD function.

INTRODUCTION

The **DELTA OHM DO 9704** pressure gauge and data logger has been designed for detecting pressure, flow rate and temperature, physical values which are very important in industrial and chemical processes.

The instrument has two inputs, A and B, and automatically recognises the probes connected, whether they be pressure or temperature probes or turbines for measuring flow rate, and displays the difference between the two inputs.

As the probes are interchangeable, it is possible to choose the most suitable combination for all applications without having to recalibrate the instrument. The operating principle of the pressure sensor is based on the bending of a membrane in a watertight chamber in contact with the flow of which you want to measure the pressure. The flow may be liquid or gas. The flow rate measurement is based on the number of impulses or the frequency of a small fan.

The DO 9704 is able to measure differential or relative pressure for air or non corrosive gases, absolute and relative pressure for measurements in contact with liquids or gases, in 6 different measurement units; temperature (in °C or °F); flow rate in the range for 2 to 2000 litres/minute with a turbine in the measurement units LPM (litres per minute) or IGPM (Imperial Gallons per Minute).

The instrument's Data Logger function enables it to store up to 30,000 readings. The sampling period is variable from 1 second to 12 hours.

The data acquired may later be transferred to a Personal Computer or a printer by means of the opto-insulated serial line RS 232C. For each value stored the date and time of acquisition are indicated; each acquisition block is ended with a report which provides the maximum (peak), minimum and mean values

With the Serial Output function it is possible to obtain the instantaneous values measured by the instrument at the output of the serial line RS 232C, in order to send them to a printer or a computer.

Other functions such as HOLD (which blocks the display), REL (for taking relative measurements) and RECORD (for storing the maximum, minimum and mean values) further enrich the instrument's performance.

Thanks to its versatility and to its storage capacity, the instrument is particularly suitable for pressure measurements in hydraulics, fluidodynamics, in chemical plants and process controls, in pumping plants; it is also useful in particular sectors such as moulding and presses for plastics and thermosetting materials, chimney draught, compressors; it may also be used for flow rate and level measurements.
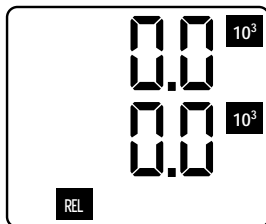
KEYBOARD

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION
ON/OFF ON/OFF	All the symbols are lit for a few seconds after pressing the ON/OFF key. Complete display.	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.
HOLD + ON/OFF HOLD + ON/OFF	The ⊟ symbol flashes to indicate that Auto Power Off is disabled.	HOLD and ON/OFF 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 disactivated. The battery symbol flashes at a frequency of 1 Hz. The instrument can be switched off only by pressing the ON/OFF key.
HOLD HOLD		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.

| KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION
REL REL	0.0 10^3 0.0 10^3 REL	The REL 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. After data has been sent onto the serial line, in immediate or remote mode from the instrument's internal memory, obtained with the REL function active, a report will be provided giving the maximum, minimum and mean relative values and the reference values on which the calculation of the relative values was based.
UNIT A unit A		When the Unit A key is pressed, input A, any of the following measurement units may be chosen: kPa, bar, mmHg, atm, mmH_2O, psi, l/m, IGPM. The led corresponding to the unit chosen lights up. The indication at the top of the display corresponds to input A.
UNIT B unit B		When the Unit B key is pressed, input B, any of the following measurement units may be chosen: kPa, bar, mmHg, atm, mmH_2O, psi, l/m, IGPM. The led corresponding to the unit chosen lights up. The indication at the top of the display corresponds to input B.

KEY	**SIMBOLS LIT BESIDES THE NUMBERS**	**FUNCTION DESCRIPTION**

A-B

A-B

Pressing A-B obtains the difference between the values indicated for input A minus the values of input B. **The full-scale value of the two probes must be the same and they must be operating with the same measurement units, otherwise an ERR message is given.** The value of the difference appears at the bottom of the display.

SERIAL OUTPUT

Serial
Output
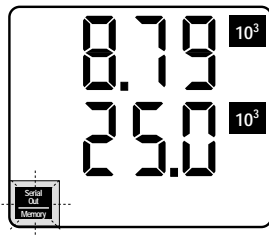
Serial Output key. The Serial Output key sends the data being acquired onto the serial line immediately, according to the set programming parameters. The Serial Out symbol flashes.

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.

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION

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

BAUD RATE	MINIMUM SETTABLE TIME
300 Baud	4 sec.
600 Baud	2 sec.
> 600 Baud	1 sec.

P0+ ENTER

- P0 -
When ENTER is pressed with P0 on the display, the instrument returns to normal operating mode without storing any parameter.
Press the PROG key to move on to step P1.

PROG + ▲
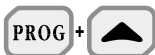
When the ▲ key is pressed with P0 on the channel A display it resets the offset of the connected probe **(only for probes for relative or differential measurements).**
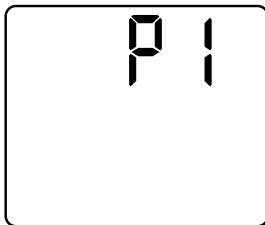
PROG + ▼

When the ▼ key is pressed with P0 on the channel B display it resets the offset of the connected probe **(only for probes for relative or differential measurements).**

| **KEY** | **SIMBOLS LIT BESIDES THE NUMBERS** | **FUNCTION DESCRIPTION** |

P1+ [ENTER] **= data dump**

- P1 -
When ENTER is pressed with P1 on the display, the data stored in the memory of the instrument are unloaded (DUMP); press the PROG key to move on to step P2. During data dumping the message P1 appears on the upper display of the instrument. At the end the instrument automatically returns to normal operating mode.

```
P1
```

The unloading of data from the instrument memory may be momentarily stopped by pressing the ENTER key. Press the ENTER key again to reactivate data unloading.
When the PROG key is pressed, data unloading is finally concluded.
At the end of each block the report is sent with the maximum (peak), minimum and mean values calculated on the block.
During the DUMP phase the instrument does not switch off automatically, all the key functions are disabled except the ENTER, PROG and ON/OFF keys.
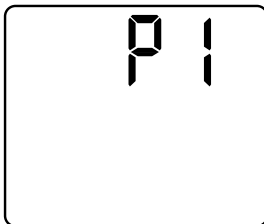
Note:
The block is defined at the moment of storage as a group of consecutive recordings. The first interruption of storage ends and determines the block.

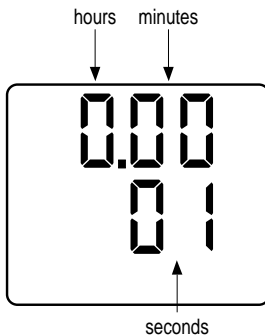| **KEY**	**SIMBOLS LIT BESIDES THE NUMBERS**	**FUNCTION DESCRIPTION**

P1+ ▲ = erase memory

When the ▲ key (MEMORY CLEAR sub-function) is pressed with P1 on the display, all the stored data are erased.
The instrument will display the message P1. At the end the instrument automatically returns to normal operating mode.

P2+ ENTER = storage interval programming

hours   minutes

seconds

- 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 internal memory of the instrument.
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 intervention 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).

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION

After defining the storage 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.
The indicative time taken to fill the memory completely is a function of the recording interval and may be 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 quits storage status. The flashing FUL message appears. The instrument switches off after 8 minutes.

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION

P3+ ENTER **= set Baud Rate**

```
P3
19.2
```
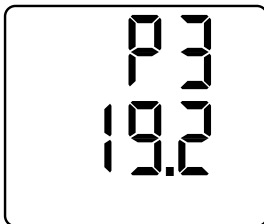
- P3 -
When ENTER is pressed with P3 on the display, the Baud Rate of the RS 232C serial transmission may be modified.
The ▲ and ▼ keys are used to select the desired value.
The possible values are:
19.2 = 19200 Baud
 9.6 = 9600 Baud
 4.8 = 4800 Baud
 2.4 = 2400 Baud
 1.2 = 1200 Baud
 0.6 = 600 Baud
 0.3 = 300 Baud

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

P4+ ENTER **= set year**

```
P4
98
99
00
0.1
...
```
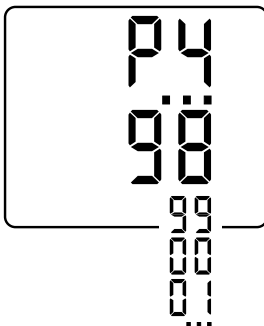
- P4 -
When ENTER is pressed with P4 on the display, the year value may be set or changed.
The ▲ and ▼ keys are used to select the desired year.
Then press PROG to move on to step P5 (the ENTER key is not active).

KEY	**SIMBOLS LIT BESIDES THE NUMBERS**	**FUNCTION DESCRIPTION**

P5+ ENTER = set month

```
P5
0.1
11
12
0.1
```

- 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).

P6+ ENTER = set day

```
P6
28
9
```

- P6 -
When ENTER is pressed with P6 on the display, the day may be set or changed.
The ▲ and ▼ keys are used to select the desired day.
Then press PROG to move on to step P7 (the ENTER key is not active).

| **KEY** | **SIMBOLS LIT BESIDES THE NUMBERS** | **FUNCTION DESCRIPTION** |

P7+ ENTER = set hours

```
P7
08
9
```
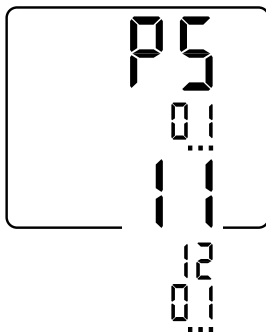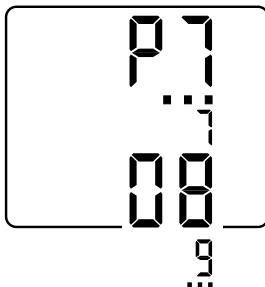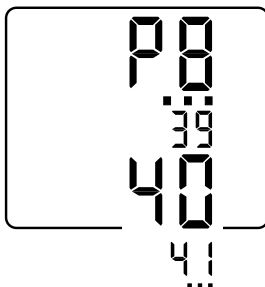
- P7 -
When ENTER is pressed with P7 on the display, the hour may be set or changed.
The ▲ and ▼ keys are used to select the desired hour.
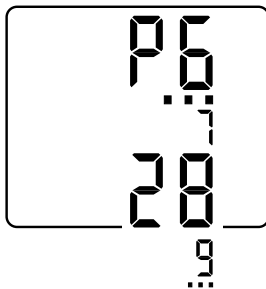Then press PROG to move on to step P8 (the ENTER key is not active).

P8+ ENTER = set minutes

```
P8
39
40
41
```

- P8 -
When ENTER is pressed with P8 on the display, the minutes may 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.

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION

P9+ ENTER = enable/disable self cut-out

```
P9
00
```
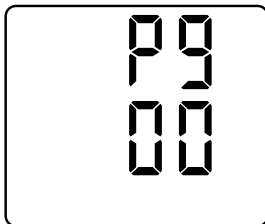
- P9 -
When ENTER is pressed with P9 on the display, the instrument enters the program which enables or disables the self cut-out function when it is in storage mode and with a set storage interval higher than or equal to 1 minute.

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

00 With a set storage interval 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

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION

SIMBOLS LIT BESIDES THE NUMBERS

```
P9
01
```
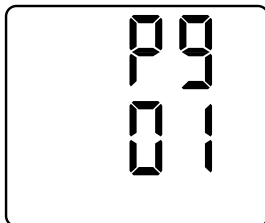
FUNCTION DESCRIPTION

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 ENTER key.

The ENTER key is used to return to normal operating mode, while pressing the PROG key moves on to step P10.

P10+ [ENTER] **= select type of printing**

```
P10
00
0.1
```
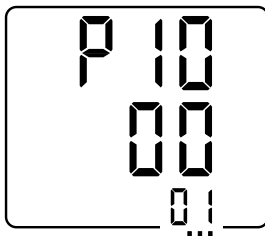
- P10 -
When ENTER is pressed with P10 on the display it is possible to select complete or reduced data printing.

The ▲ and ▼ keys are used to select the desired printing format.
01: complete printing
00: reduced printing
The ENTER key is used to return to normal operating mode, while pressing the PROG key moves on to step P11.

KEY	**SIMBOLS LIT BESIDES THE NUMBERS**	**FUNCTION DESCRIPTION**

P11+ ENTER

- P11 -
When ENTER is pressed with P11 on the display, the instrument enters the program for calibrating the instrument.

DATA CALL
Data Call
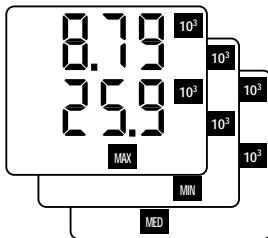
DATA CALL key (Mean - Max - Min).
When the DATA CALL key is pressed repeatedly, the Max (Peak), Min and Mean values measured for both measuring channels are shown on the display.

▲ key. When enabled it increases the values, **in function P0 it resets the probe offset of channel A** (only for relative or differential probes), with P1 it enables the memory clear function.
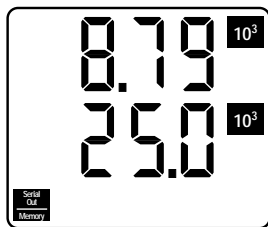
ENTER **+ Start-Stop**

ENTER key (Start-Stop sub-function).
The ENTER key 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.

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION
		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 storage 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 appears to be off, but it is active in operating 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. In this stage the Serial Out and PROG keys are not enabled. When this operative mode is disactivated the Serial Out/Memory symbol is not lit.
		The total memory capacity available is 512 kbyte, with the possibility of storing more than 30,000 readings.

KEY	**SIMBOLS LIT BESIDES THE NUMBERS**	**FUNCTION DESCRIPTION**

ENTER

ENTER

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

▼ with RCD
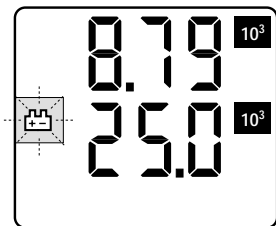
When pressed repeatedly, the ▼ key, sub-function RCD, starts and stops the record function, which calculates and stores the maximum, minimum and mean values.

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 about 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 battery symbol flashes at a frequency of 2 Hz.

Attention:
If the battery symbol does not fla-

KEY	SIMBOLS LIT BESIDES THE NUMBERS	FUNCTION DESCRIPTION
		sh at a frequency of 2 Hz when the RCD key is pressed, it means that the RCD function has stored more than 30,000 acquisitions and cannot continue any further. After having taken note of the max. min. and mean values calculated up till then, reset the RCD function and restart it.
▼		▼ key. During programming or calibration, this key is used to decrease the value of the parameter being considered. **In function P0 it resets the probe offset of channel B** (only for relative or differential probes).

PROBE CONNECTION

One or two pressure probes, one or two temperature probes may be connected to the DO 9704 pressure and temperature gauge - data logger. The pressure probes of the TP 704 series have a 1/4" BSP male threaded coupling and must be screwed into the fitting in which the pressure is to be measured; the probes of the TP 705 series have a $\varnothing$ 5 mm. coupling to which will be connected a suitable tube for taking the desired measurement; **take great care with the pressure seal of the fitting**, if necessary using gaskets and suitable fittings. The threaded coupling is protected by a plastic cap; put the cap back after use, as it protects the pressure cell against foreign bodies. **IT IS VERY IMPORTANT** to ensure that the full scale value of the probe is higher than the pressure that is to be measured. If you do not know the value, start off using probes with high capacities. Using the CPA cable, connect the pressure probe to the instrument and then take the measurement. The same operations are carried out when using two temperature probes at the same time. The temperature probe must be connected to input A or B of the instrument or to both if there are two probes; then measure the temperature with the sensitive part of the probe. Depending on the case, immersion, contact, penetration or air probes will be used.

The same applies to probes for measuring flow rate; in this case ensure that the connection cable is specifically configured for the flow rate or for the number of impulses of the turbine.

HOW TO MEASURE

1. Press the ON/OFF key to switch on the instrument.
  * This operation enables the automatic cut-out timer.
   If you wish power supply without automatic interruption, when switching on, press the HOLD and ON/OFF keys simultaneously and keep the HOLD button held down for the duration of the switching-on routine. The battery symbol flashes at a frequency of 1 Hz, indicating that the Auto Power Off function is disabled.
  * When the instrument is switched on all the numbers and symbols light up for a few moments, allowing you to check that all the display segments are working.
  * After a few moments it moves on to normal operation.

2. Checking display.
  * After all the segments are lit, the instrument is ready to measure in the engineering unit (Pa, bar, psi, atm, mmHg, mH$_2$O) set before the instrument was switched off.
  * If a probe is broken or is not properly connected, the **Err** signal appears. In this case the sensor part and/or the connector must be checked.

3. Selection of the measuring unit.
  * Press the Unit A key repeatedly to show, at the top of the display, the measurement of the probe connected to input A in the desired measuring unit; press the Unit B key repeatedly to show, at the top of the display, the measurement of the probe connected to input B in the desired

measuring unit.
* Press the Unit A or B key to select the temperature measuring unit in °C or °F.

4. Switching off the instrument.
* 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.
* The instrument usually switches off automatically after 8 minutes of inactivity, with the following 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.
In the last three cases the instrument switches off automatically 8 minutes after the low battery warning and interrupts storage and unloading of data.
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 battery 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 battery 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.

5. Various operations.
* For operations such as HOLD display, relative measurements, RCD storage, DATA CALL, Serial Output, storage in the internal memory, unloading of stored data, erasing of the internal memory, setting of the working parameters, see the description of the instrument keyboard.

Attention when using the keyboard
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.

TEMPERATURE MEASUREMENT

Immersion temperature measurements are performed by introducing the 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 of the container holding the liquid or of the duct in which the air to be measured is passing.

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 contact** 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.

METHOD OF USING THE INSTRUMENT AND WARNINGS

1. Do not expose the probes to gases or liquids that could corrode the material of the sensor or the probe; clean the probe carefully after use.
2. Do not bend the connectors applying upward or downward force.
3. Do not bend or force the contacts when inserting the probe connector in the instrument.
4. Do not bend, deform and drop the probes as this could cause irreparable damage.
5. Always use the most suitable probe for the measurement to be taken.
6. Be careful with the range of use of the probe, measurements at limit values are possible only for short periods.
7. 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. Do not let the surfaces of the probe come in contact with sticky surfaces or with substances that can corrode or damage the probe. If the sensor breaks or becomes faulty it must be replaced. In this case the probe must be recalibrated.
8. Above 400°C, avoid violent blows or thermal shock to the Pt100 temperature probes as these could cause irreparable damage.
9. To obtain a reliable temperature measurement, too fast temperature variations must be avoided.
10. 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.
11. Temperature measurements on non-metal surfaces require a great deal of time on account of

their low heat conductivity.

⚠ **12.** The probes are not insulated from their 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.

13. Avoid taking measurements in the presence of high frequency sources, microwaves or large magnetic fields, as the results would not be very reliable

14. Always clean the probes carefully after use.

15. After taking a pressure measurement, clean the probe pressure chamber accurately; do not let the fluid that comes in contact with the membrane leave any deposits or scale, with time these could cause errors in measurement.

16. Avoid inserting sharp points or nails in the pressure chamber; a sudden blow could accidentally break the membrane.

17. To secure the probes use a suitably sized spanner and, if necessary, sealing gaskets.

⚠ **18.** Great care must be taken when installing probes in pressurised containers or in pipes. Take care when choosing the full scale range of the probes. Apart from causing irreparable damage to the probe, an error could cause quite serious physical harm to the operator and to objects in the vicinity. There should always be a stop key upstream from the probe. Ensure that there are no abnormal and sudden variations in the fluid under pressure.

19. 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 instrument must be handled in such a way that water cannot get in through the connector side.

INSTRUMENT SIGNALS AND MALFUNCTIONS

Err	On the upper display indicates: * Error in reading the signal present at input A or B or A-B; * Error when, with A-B, the probes inserted do not have the same full scale value and are not of the same type.
FUL	Memory full.
LOU	When switching on this indicates that the instrument has switched off because the battery voltage was too low when it was in storage or serial output status. Change the battery even if there are no low battery signals.

LOW BATTERY WARNING AND BATTERY REPLACEMENT

When the battery has run down and its voltage has reached the limit value of 7.2 Volts, the symbol ▱ appears permanently on the display and an alarm beep sounds at regular intervals of about 15 seconds. 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 6.5V the instrument is no longer able to ensure correct measurement.

AFTER CHANGING THE BATTERY YOU MUST UPDATE THE CLOCK AND THE SET PARA-METERS.

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 as long as the working routines have been completed.

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 ON USE OF THE BATTERIES

* 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.

STORAGE OF THE INSTRUMENT

Instrument storage conditions:
* Temperature: -10...+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 RS 232C. 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 RS 232C must be turned to COM-PUTER or PRINTER position, depending on the chosen connector (this may not be true on some computers or printers).
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
* N. bit	8
* Stop bit	1
* Protocol	Xon/Xoff

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: 19200, 9600, 4800, 2400, 1200, 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	TYPE	REPLY
AA	Type of terminal	MANOMETER – DL
AG	Firmware Version	Vx Rx
AH	Firmware Date	dd/mm/yy
A*		?
SA	Request	Input A
SB	Request	Input B
SC	Request	Input A-B
SI	Measurement	MANOMETER - DL
S*		NC

It is possible to unload data onto a computer using the Xon/Xoff protocol to control the data flow:
The character Xoff (hex 13) on the serial line stops the data unloading in progress.
The character Xon (hex 11) reactivates the suspended data unloading in progress.

Dumping data from the memory
Press the PROG key twice until P1 appears on the display.
Press the ENTER key.
The instrument continues to show P1 on the display and dumps the data from the instrument's internal memory through the serial line.

At the end of data dumping the instrument returns to normal display.
It is possible to stop and resume data dumping by repeatedly pressing the ENTER key.
Once data dumping has been stopped it may be terminated by pressing the PROG key.

Memory clear
Press the PROG key twice until P1 appears on the display.
Press the ▲ key (memory clear sub-function).
The instrument will erase the internal memory, showing P1 on the display.
At the end of the operation the instrument returns to normal display.
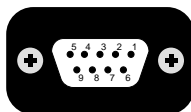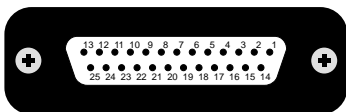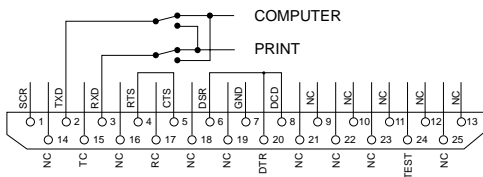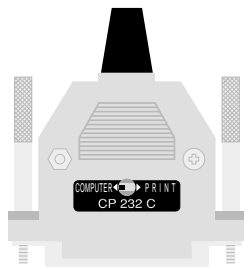
DIAGRAM DO 9704

Probe A Pressure or temperature

Probe B Pressure or temperature

A B

PRINTER WITH SERIAL INPUT

SERIAL/ PARALLEL CONVERTER

PRINTER WITH PARALLEL INPUT
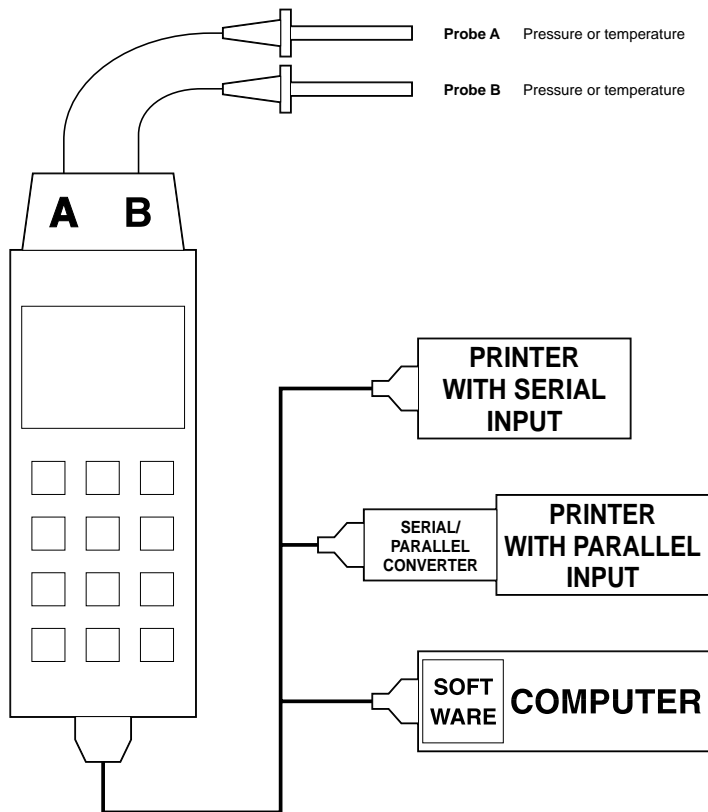
SOFT WARE **COMPUTER**

EXAMPLE OF A REPORT PRINTED BY THE INSTRUMENT

```
MANOMETER   - Data Logger

Immediate serial report

  DATE      TIME       -------- A --------      -------- B --------     ---- A -- B ------

06/09/99 14:35:09      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:11      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:13      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:15      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:17      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:19      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:21      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:23      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
06/09/99 14:35:25      1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
 Continue values report
 Max. Values   :       1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
 Min. Values   :       1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
 Medium Values :       1016 E-3   Bar        1016 E-3   Bar        00 E-3   Bar
 Instrument calibration date : 25-05-99



MANOMETER   - Data Logger

Immediate serial report

  DATE      TIME       -------- A --------      -------- B --------     ---- A -- B ------

06/09/99 14:35:57      762        mmHg       7.25       mmHg       ERR
06/09/99 14:35:58      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:00      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:02      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:04      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:06      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:08      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:10      762        mmHg       7.25       mmHg       ERR
06/09/99 14:36:12      762        mmHg       7.25       mmHg       ERR
 Continue values report
 Max. Values   :       762        mmHg       7.25       mmHg       ERR
 Min. Values   :       762        mmHg       7.25       mmHg       ERR
 Medium Values :       762        mmHg       7.25       mmHg       ERR
 Instrument calibration date : 25-05-99



MANOMETER   - Data Logger

Immediate serial report

  DATE      TIME       -------- A --------      -------- B --------

06/09/99 14:36:45      101.6      kPa        966 E-3    kPa
06/09/99 14:36:47      101.6      kPa        966 E-3    kPa
06/09/99 14:36:49      101.6      kPa        966 E-3    kPa
06/09/99 14:36:51      101.6      kPa        966 E-3    kPa
06/09/99 14:36:53      101.6      kPa        966 E-3    kPa
06/09/99 14:36:55      101.6      kPa        966 E-3    kPa
06/09/99 14:36:57      101.6      kPa        964 E-3    kPa
06/09/99 14:36:59      101.6      kPa        966 E-3    kPa
 Continue values report
 Max. Values   :       101.6      kPa        966 E-3    kPa
 Min. Values   :       101.6      kPa        966 E-3    kPa
 Medium Values :       101.6      kPa        966 E-3    kPa
 Instrument calibration date : 25-05-99
```

```
MANOMETER  - Data Logger

Immediate serial report

   DATE        TIME      ------ A ------       ------ B ------

06/09/99 14:37:29    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:31    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:33    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:35    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:37    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:39    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:41    1003 E-3   atm      98.5      mmH2O
06/09/99 14:37:43    1003 E-3   atm      98.5      mmH2O
 Continue values report
 Max. Values   :    1003 E-3   atm      98.5      mmH2O
 Min. Values   :    1003 E-3   atm      98.3      mmH2O
 Medium Values :    1003 E-3   atm      98.5      mmH2O
 Instrument calibration date : 25-05-99



MANOMETER  - Data Logger

Immediate serial report

   DATE        TIME      ------ A ------       ------ B ------       ----- A - B -----

06/09/99 14:38:12    14.74    PSI     140.1 E-3   PSI      ERR
06/09/99 14:38:13    14.74    PSI     140.1 E-3   PSI      ERR
06/09/99 14:38:15    14.74    PSI     140.1 E-3   PSI      ERR
06/09/99 14:38:17    14.74    PSI     140.1 E-3   PSI      ERR
06/09/99 14:38:19    14.74    PSI     140.1 E-3   PSI      ERR
06/09/99 14:38:21    14.74    PSI     140.1 E-3   PSI      ERR
06/09/99 14:38:23    14.74    PSI     140.1 E-3   PSI      ERR
 Continue values report
 Max. Values   :    14.74    PSI     140.1 E-3   PSI      ERR
 Min. Values   :    14.74    PSI     139.8 E-3   PSI      ERR
 Medium Values :    14.74    PSI     140.1 E-3   PSI      ERR
 Instrument calibration date : 25-05-99



MANOMETER  - Data Logger

Remote memory report

   DATE        TIME      ------ A ------       ------ B ------       ----- A - B -----

06/09/99 14:21:48    37     l/m      64     l/m    ---   27     l/m
06/09/99 14:21:49    37     l/m      64     l/m    ---   27     l/m
06/09/99 14:21:50    37     l/m      64     l/m    ---   27     l/m
06/09/99 14:21:51    37     l/m      64     l/m    ---   27     l/m
06/09/99 14:21:52    37     l/m      64     l/m    ---   27     l/m
06/09/99 14:21:53    37     l/m      64     l/m    ---   27     l/m
06/09/99 14:21:54    37     l/m      64     l/m    ---   27     l/m
 Max. Values   :    37     l/m      64     l/m    ---   27     l/m
 Min. Values   :    37     l/m      64     l/m    ---   27     l/m
 Medium Values :    37     l/m      64     l/m    ---   27     l/m
 Instrument calibration date : 25-05-99


06/09/99 14:21:55    00     l/m      00     l/m          00     l/m
06/09/99 14:21:56    00     l/m      00     l/m          00     l/m
06/09/99 14:21:57    00     l/m      00     l/m          00     l/m
06/09/99 14:21:58    00     l/m      00     l/m          00     l/m
06/09/99 14:21:59    00     l/m      00     l/m          00     l/m
06/09/99 14:22:00    02     l/m      00     l/m          02     l/m
 Max. Values   :    02     l/m      00     l/m          02     l/m
 Min. Values   :    00     l/m      00     l/m          00     l/m
 Medium Values :    00     l/m      00     l/m          00     l/m
 Relative to   :    37     l/m      64     l/m    ---   27     l/m
 Instrument calibration date : 25-05-99
```

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 CP RS 232C cable.

   Note: the CP RS 232C 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 RS 232C cable to COMPUTER position.

Software connection with WINDOWS 3.1:

A) Start WINDOWS

B) Select ACCESSORIES (double click)

C) Select TERMINAL and activate the communications program (double 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 (one click)
   select COMMUNICATIONS from the menu (one 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 (one click)
      DATA BITS: 8 (one click)
      STOP BITS: 1 (one click)
      PARITY: None (one click)
      FLOW CONTROL: Xon/Xoff (one click)
      CONNECTOR: COM1 or COM2 depending on the gate used for connection (one click)
      CHECK PARITY and SHOW CARRIER must remain unmarked
   OK to confirm the setting (one click)
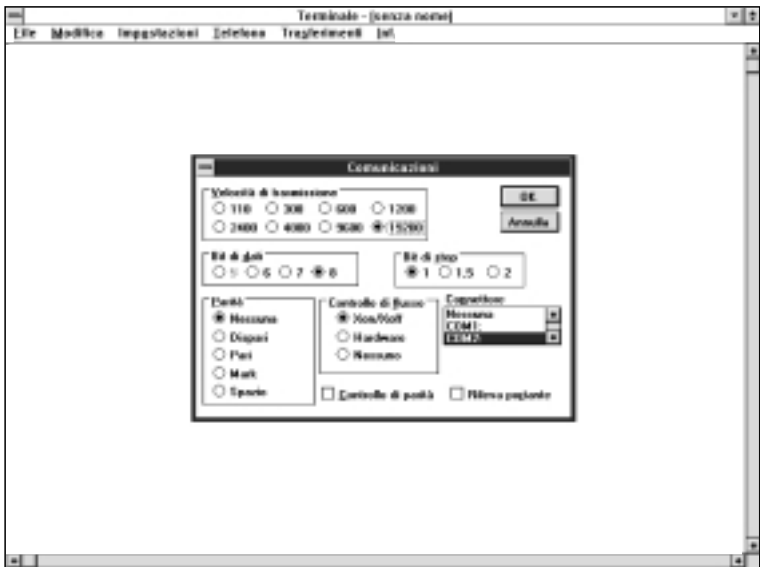
E) To set the correct character type:
    select SETTINGS from the terminal window (one click)
    on the pull-down menu select TERMINAL PREFERENCES... (one click)
    the TERMINAL PREFERENCES window appears on the monitor, set:
        Mark local Echo (one click)
        Character type: Terminal (or equivalent)
        Leave the rest unchanged
    OK to confirm the setting (one click)

F) If you want to save this terminal setting:
    select FILE from the terminal window (one click)
    select SAVE AS from the pull-down menu and the SAVE FILE AS window will appear (one click)
    type the name of the terminal setting file (max. 8 characters) on the line provided
    OK to confirm and save the setting (one click)
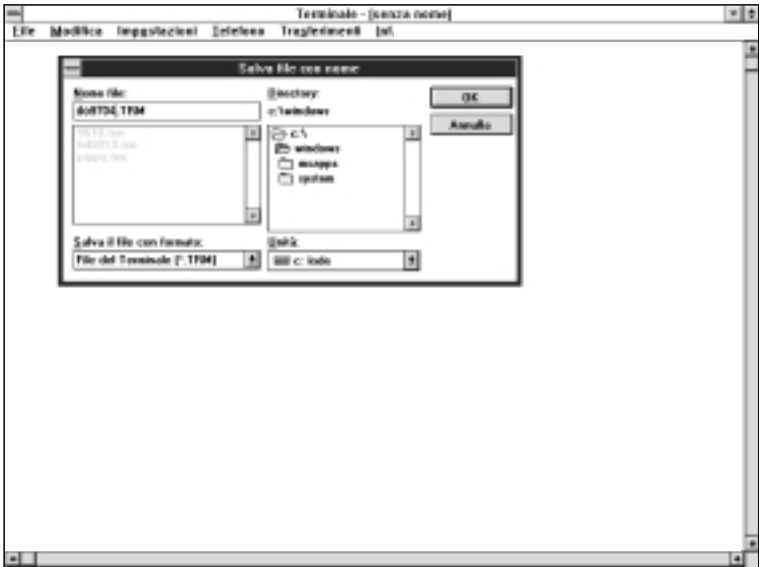
G) To receive and store data from an instrument:

    select TRANSFER from the terminal window (one click)

    select RECEIVE TEXT FILE from the pull-down menu and the window will appear (one 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 (one click)
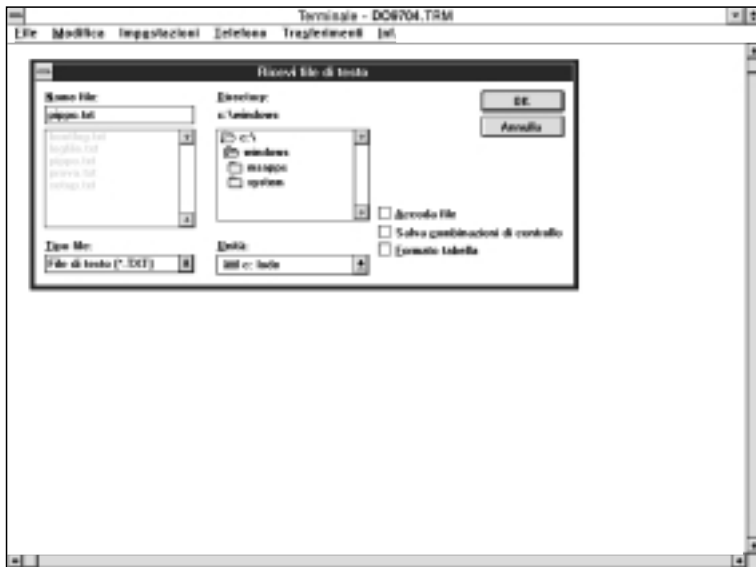
At this point the terminal is ready to receive data from the measuring instrument. Everything sent by the measuring instrument will be stored in the file indicated previously

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.

I) End of storage of the data sent by the instrument
select TRANSFER from the terminal window (one click)
to end storage, select END from the pull-down menu (one click)

The software returns to the terminal window

L) End use of the TERMINAL:
select FILE from the terminal window (one click)
select QUIT from the pull-down menu (one 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 (double 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 to confirm
   Cancel in the next window
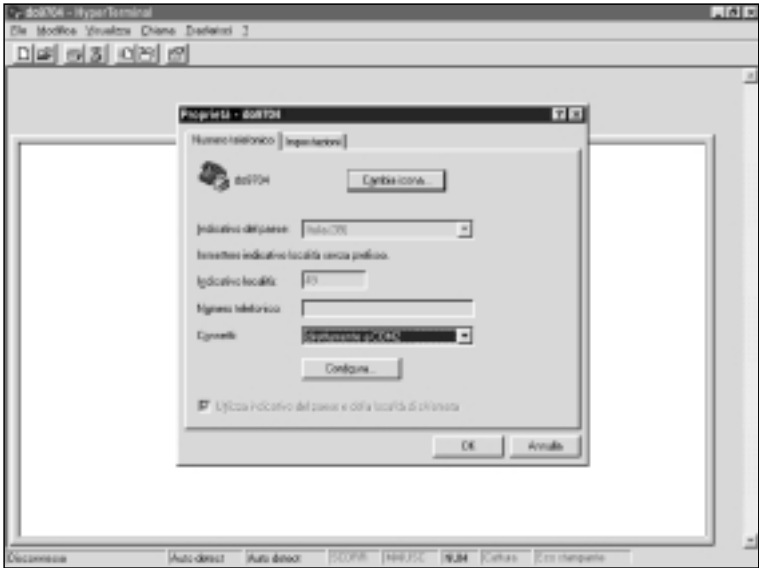
C) Setting communication
- select FILE from the Hyper Terminal window (one click)
- select PROPERTIES from the pull-down menu (one click) and the "Properties" window will appear
- on the "telephone number" card, for the Connect property, choose "directly to COM1" or "COM2", depending on the serial gate that you intend to use for communication with the measuring instrument
- on the "telephone number" card, select CONFIGURE (one 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: 1
  FLOW CONTROL: Xon/Xoff
OK to confirm the gate setting (one click)
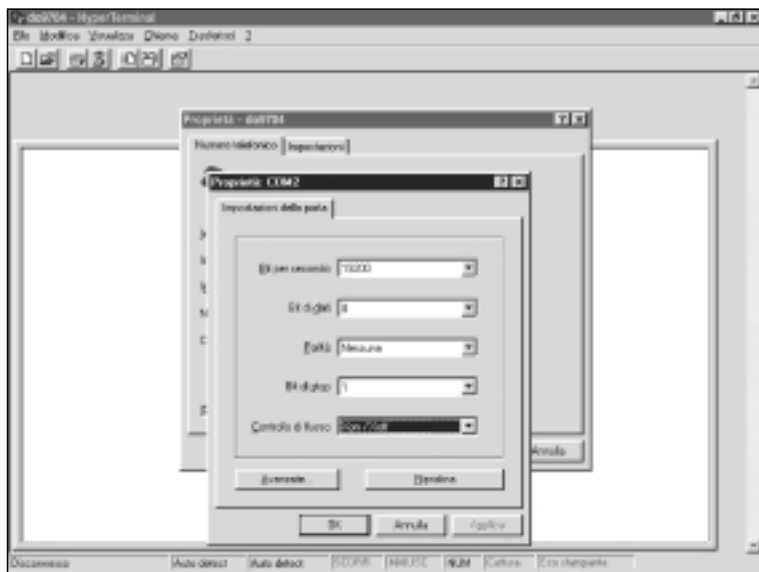
- select SETTINGS to display the "Settings" card
- on the "Settings" card, for the "Emulation" property, select: TTY
- OK to confirm the "Properties" set (one click)
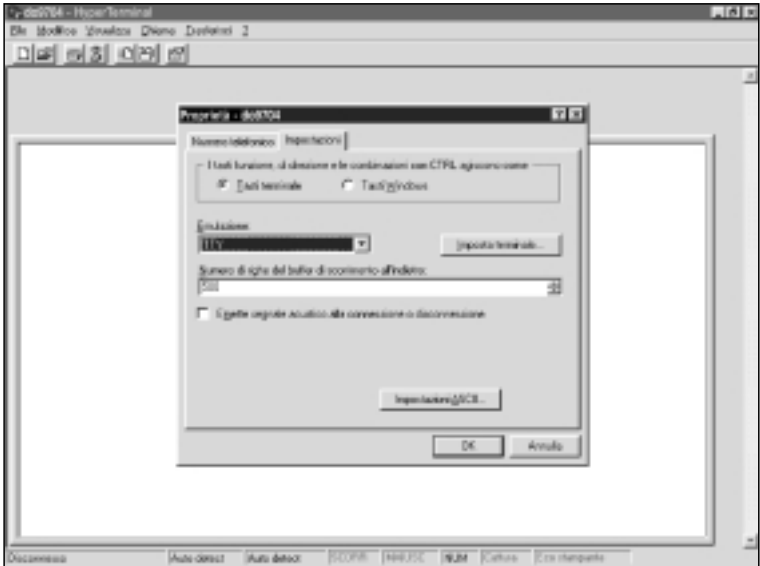
D) To set the correct character type:
- select DISPLAY from the Hyper Terminal window (one click)
- select CHARACTER from the pull-down menu (one click) and the window for selecting the character will appear; set:
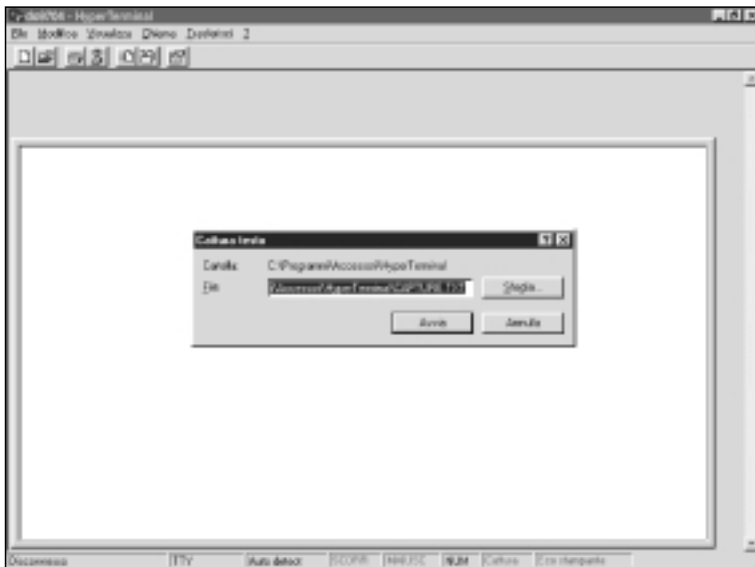- Terminal (or equivalent)
- OK to confirm (one click)
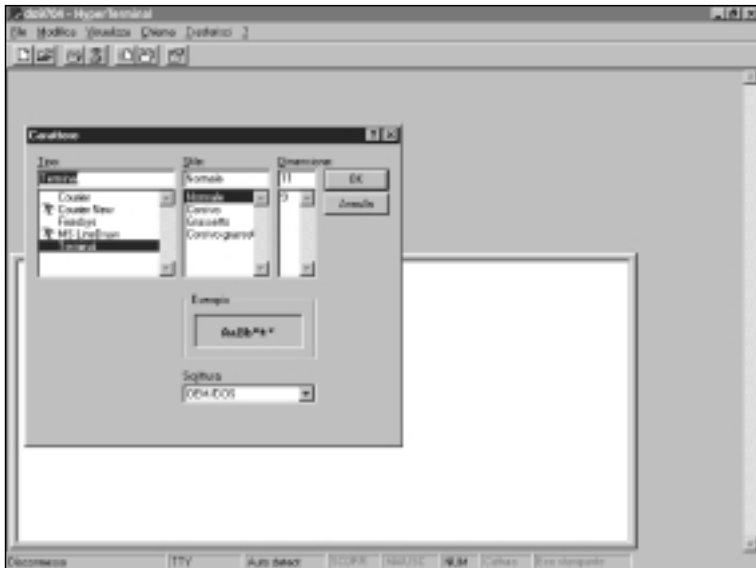
E) To receive and store data from an instrument:
- select CALL from the Hyper Terminal window (one click)
- select CONNECT from the pull-down menu
- In this way it is possible to receive the characters from the instrument on the monitor

F) To receive and store data from an instrument:
   - select TRANSFER from the Hyper Terminal window (one click)
   - select CAPTURE TEXT from the menu (one 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 (one click)

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

G) To end receiving data from an instrument:
  select TRANSFER from the Hyper Terminal window (one click)
  select CAPTURE TEXT from the menu (one click)
 select END from the pull-down sub-menu (one 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.
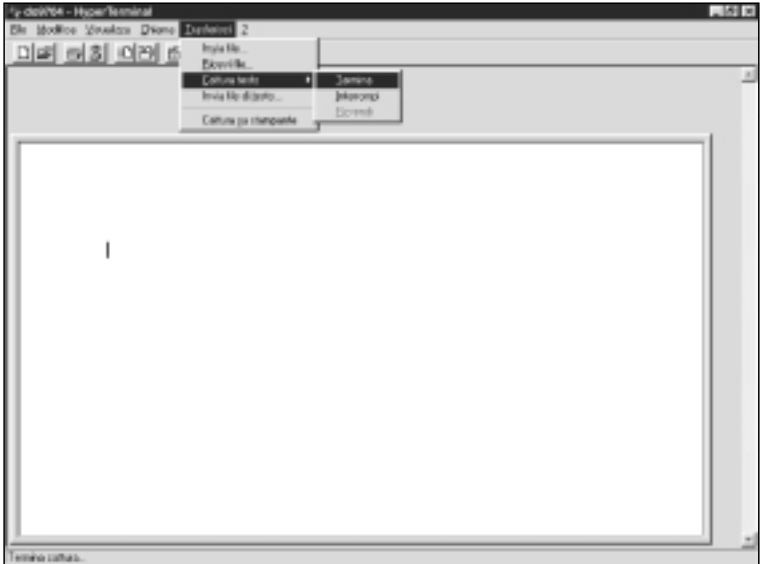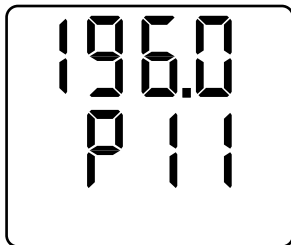

H) To quit running the Hyper Terminal:
  select FILE from the Hyper Terminal window
  select QUIT from the pull-down menu

CALIBRATING THE INSTRUMENT DO 9704

Apply a voltage of 465.5 mVdc between pin 6 (GND) and pin 1 (OUT) of the DIN 8-pole connector at input A.
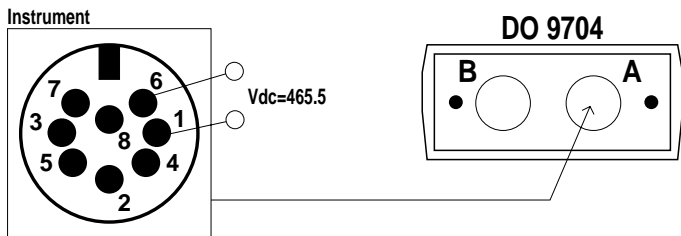
Select step 11 with the PROG key; press the ENTER key, the display shows

Using the ▲ and ▼ keys, make the value shown on the display coincide with 196.0. Confirm by pressing the ENTER key; P11 appears on the display; press PROG: P0 appears; press ENTER: this quits the instrument calibration function.

FLOW RATE MEASUREMENTS

A selection resistance sets the conversion factor of the connected turbine.
The instrument automatically recognises 5 fixed flow rate values plus a sixth which may be configured by the user.

FLOW RATE PROBES				
	Measuring range	**Selection resistance kΩ**	**Output frequency PPL**	**Indication lt/min.**
LT 5	5 l/min.	90.9	5	5
(LT10)* LT20	20 l/min.	95.3	5	20
(LT50)* LT125	125 l/min.	100	0.5	125
(LT250)* (LT300)* LT400	400 l/min.	105	0.1	400
LT500	500 l/min.	110	0.04	500
LT750	750 l/min.	115	0.04	750
LT configurable	2000 l/max	121	configurable	PPL

*The instrument can read a reduced measuring range, it has the same selection resistance.

The connection cable of the configurable turbine will end with a DIN 8-pole connector; connect a 121 kΩ resistance between pin 3 and pin 7.
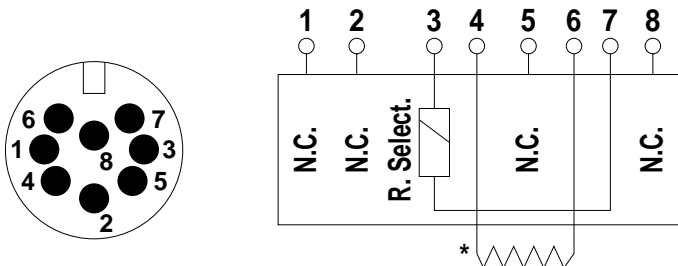
Active probe for measuring flow rate with a turbine 2 to 2000 litres/minute.

*A coil which generates impulses with a minimum of 100 mV p-p is connected to pins 4 and 6.

Connect the probe to the turbine that you want to configure and switch on the instrument; the message PPL will appear on the display corresponding to input A or B.

Press the PROG key, P0 will appear on the display; using the ▲ and ▼ keys, select the input to which the turbine probe is connected; the previously set number of impulses per litre will appear on the display. Using the ▲ and ▼ keys, set the number of impulses per litre corresponding to the number of impulses per litre of the turbine that is being configured. Confirm by pressing the ENTER key; P0 appears on the display. Press ENTER: this quits the procedure for configuring a turbine with any number of impulses per litre.

## CONNECTION OF PROBES TO THE PRESSURE GAUGE DATA LOGGER DO 9704

One or two pressure probes of the series TP 704 or TP 705 may be connected to the instrument, one or two temperature probes of the series TP 870, turbine probes for measuring flow rate or impulse probes for measuring flow rate.
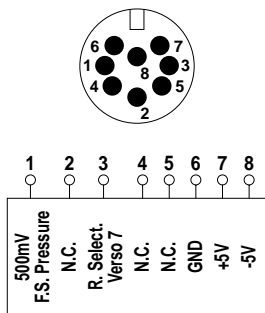
Probe connection diagram

Instrument DO 9704
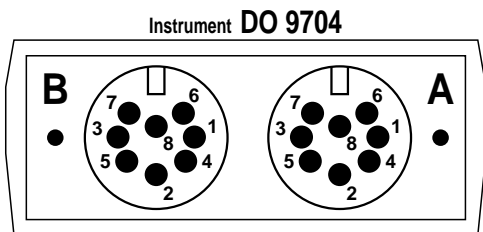
1° 500mV △ F.S.Pressure
2° Reserved
3° JP$_2$ Configuration (Selec. R towards 7)
4° Flow rate input
5° Reserved
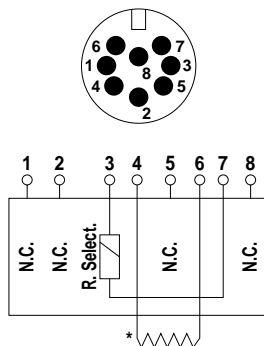6° GND (Ref. Flow rate)
7° +5 Vdc
8° -5 Vdc~

Probe series TP 870

7 6 1 8

+5V | GND | OUT 2.375mV/°C | -5V
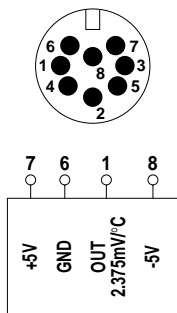
Active probe Pt100 series TP 870

Probe series TP 704, TP 705

1 2 3 4 5 6 7 8

500mV F.S. Pressure | N.C. | R. Select. Verso 7 | N.C. | N.C. | GND | +5V | -5V

Active probe TP 704, TP 705

Turbine probe for measuring flow rate

1 2 3 4 5 6 7 8

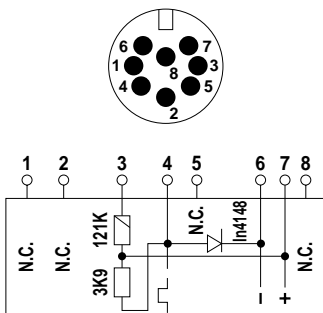N.C. | N.C. | R. Select. | | N.C. | | | N.C.

*\WWW

Active turbine probe for measuring flow rate.
2 to 2000 litres/minute
* A coil which generates impulses with a minimum of 100 mV p-p is connected between 4 and 6.

Probe for measuring flow rate with impulses

1 2 3 4 5 6 7 8

N.C. | N.C. | 121K / 3K9 | N.C. | 1n4148 | I + | | N.C.

Active probe with NPN output for measuring flow rate with impulses

| SEL R.	PPL Turbine (WEBSTER)
90 k9	5
95 k3	5
100 k	0.5
105 k	0.1
110 k	0.04
115 k	0.04

CLASSIFICATION OF PRESSURE MEASUREMENTS

Pressure measurements are relative and therefore refer to a reference pressure. There are four types of pressure measurement which enable the reference pressure to be defined immediately.
- Absolute pressure **(A)** – Pressure with respect to absolute zero, the ideal vacuum reference; the pressure measured is always higher than the reference pressure.
- Gauge **(G)** – Pressure measured with respect to atmospheric pressure, environment pressure is the reference; the pressure measured is always higher than the reference pressure.
- Vacuum **(V)** – Pressure with reference to atmospheric pressure, environment pressure is the reference; the pressure measured is always lower than the reference pressure.
- Differential pressure **(D)** – Pressure measured with respect to any reference pressure; the pressure measured may be higher or lower than the reference pressure.
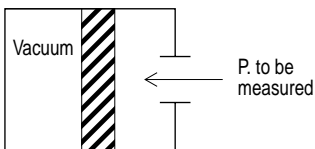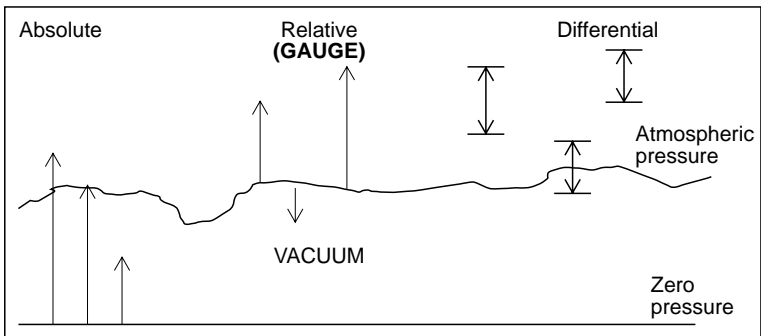
Absolute pressure A
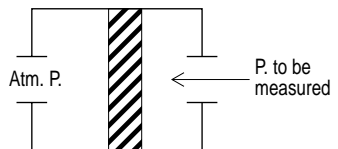
Relative pressure **(gauge)** G
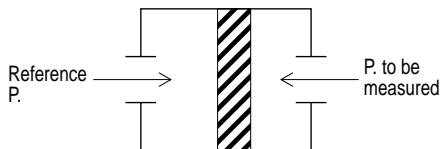
The case G is similar to the case D where the reference P = atmospheric P

Differential pressure D

CONVERSION FACTORS AND TABLES

Temperature: $°C = \dfrac{°F-32}{1.8}$; $°F = (1.8 \times °C) + 32$

Pressure measurement:
mm = 0.03937 in	in = 25.4 mm
cm = 0.3937 in	in = 2.54 cm
m = 39.37 in	in = 2.54 x 10^{-2} m

$$p = \frac{f}{m^2} = \text{pressure} = \frac{\text{force}}{\text{surface}}$$

According to the international system, pressure measurement is expressed in Pascal 1 Pa = 1 N/m^2 = 1 Newton/square metre.
The principal engineering units for measuring pressure are:

Pascal = Pa (N/m^2), kPa = 10^3 Pa, Mpa = 10^6 Pa
Bar = bar, mbar = bar x 10^{-3}
Metres of column of water 4°C = mH_2O, mmH_2O = mH_2O x 10^{-3}
Millimetres of column of mercury 0°C	= mmHg, Torr
Theoretic atmosphere	= at (kp/cm^2)
Physical atmosphere	= atm
Inches of column of water at 4°C	= in H_2O
Inches of column of mercury at 0°C	= in Hg
Micro of column of mercury at 0°C	= μm Hg
Pounds per square inch	= psi

1 bar = 100,000 Pa	Pa	= 10^{-5} x bar
1 bar = 14.5038307 psi	psi	= 0.0689473023 x bar
1 bar = 0.986923 atm	atm	= 1.01325 x bar
1 bar = 755.7299444 mmHg	mmHg	= 0.001323224 x bar
1 bar = 10.19716213 mH_2O	mH_2O	= 0.0980665 x bar

psi = in of H_2O	x (3.6127 x 10^{-2})	in of H_2O	= psi x 27.68
psi = mm of H_2O	x (1.4223 x 10^{-3})	mm of H_2O	= psi x 703.1
psi = cm of H_2O	x (1.4223 x 10^{-3})	cm of H_2O	= psi x 70.3
psi = in of Hg	x 0.49118	in of Hg	= psi x 2.036
psi = mm of Hg	x (1.9339 x 10^{-2})	mm of Hg	= psi x 51.71
psi = Kg/cm^2	x 14.223	Kg/cm^2	= psi x 0.0703
psi = bar	x 14.503	bar	= psi x 0.0689
psi = mbar	x (1.4503 x 10^{-2})	mbar	= psi x 68.95

psi = Pa   x (1.4503×10^{-4}) Pa = psi x 6895
psi = kPa   x (1.4503×10^{-1}) kPa = psi x 6.895

1 atm	$= 1{,}013 \times 10^{5}$ Pa
1 bar	$= 1{,}000 \times 10^{5}$ Pa
1 dyne/cm^2	$= 1{,}000 \times 10^{-1}$ Pa
1 inch of Hg (0°C)	$= 3{,}386 \times 10^{3}$ Pa
1 inch of H$_2$O (4°C)	$= 2{,}491 \times 10^{2}$ Pa
1 Kg/m^2	$= 9{,}806$ Pa
1 pound/inch^2 (psi)	$= 6{,}895 \times 10^{3}$
1 pound/foot^2	$= 4{,}788 \times 10^{1}$
1 Torr (mm de Hg 0°C)	$= 1{,}333 \times 10^{2}$

PA N/m²	kPa	MPa	bar	mbar	mH₂O	mmH₂O	Torr mmHg	at kp/cm²	atm	inch H₂O	inch Hg	Microns	psi lpf/in²
1	10^{-3}	10^{-6}	10^{-5}	10^{-2}	$0.1020 \cdot 10^{-3}$	0.1020	$7.501 \cdot 10^{-3}$	$10.20 \cdot 10^{-6}$	$9.869 \cdot 10^{-6}$	$4.016 \cdot 10^{-3}$	$2.953 \cdot 10^{-4}$	7.501	$45.05 \cdot 10^{-6}$
10^3	1	10^{-3}	10^{-2}	10	0.1020	102.0	7.501	$10.20 \cdot 10^{-3}$	$9.869 \cdot 10^{-3}$	4.016	0.2953	7501	0.14505
10^6	10^3	1	10	10^4	102.0	$102.0 \cdot 10^3$	7501	10.20	9.869	4016	295.3	$7.501 \cdot 10^6$	145.05
10^5	100	0.1	1	10^3	10.20	$10.20 \cdot 10^3$	750.1	1.020	0.9869	401.6	29.53	$750.1 \cdot 10^3$	14.505
100	0.1	10^{-4}	10^{-3}	1	$10.20 \cdot 10^{-3}$	10.20	0.7501	$1.020 \cdot 10^{-3}$	$0.9869 \cdot 10^{-3}$	0.4016	$29.53 \cdot 10^{-3}$	750.1	$14.505 \cdot 10^{-3}$
9807	9.807	$9.807 \cdot 10^{-3}$	$98.07 \cdot 10^{-3}$	98.07	1	10^3	73.56	0.1	$96.78 \cdot 10^{-3}$	39.37	2.896	$73.56 \cdot 10^{-3}$	1.4224
9.807	$9.807 \cdot 10^{-3}$	$9.807 \cdot 10^{-6}$	$98.07 \cdot 10^{-6}$	$98.07 \cdot 10^{-3}$	10^{-3}	1	$73.56 \cdot 10^{-3}$	10^{-4}	$96.78 \cdot 10^{-6}$	0.03937	$2.896 \cdot 10^{-3}$	73.56	$1.4224 \cdot 10^{-3}$
133.32	0.13332	$133.32 \cdot 10^{-6}$	$1.333 \cdot 10^{-3}$	1.333	$13.59 \cdot 10^{-3}$	13.59	1	$1.359 \cdot 10^{-3}$	$1.316 \cdot 10^{-3}$	0.5351	$3.937 \cdot 10^{-2}$	10^3	0.01934
$98.07 \cdot 10^3$	98.07	$98.07 \cdot 10^{-3}$	0.9807	980.7	10	10^4	735.6	1	0.9678	393.7	28.96	$735.6 \cdot 10^3$	14.224
$1.013 \cdot 10^5$	101.3	0.1013	1.013	1013	10.33	$10.33 \cdot 10^3$	760	1.033	1	406.7	29.92	$760 \cdot 10^3$	14.68
249.1	0.2491	$0.2491 \cdot 10^{-3}$	$2.491 \cdot 10^{-3}$	2.491	$25.4 \cdot 10^{-3}$	25.4	1.8684	$2.54 \cdot 10^{-3}$	$2.458 \cdot 10^{-3}$	1	$7.355 \cdot 10^{-2}$	$1.868 \cdot 10^3$	$36.126 \cdot 10^{-3}$
3386	3.386	$3.386 \cdot 10^{-3}$	$3.386 \cdot 10^{-2}$	33.86	0.3453	345.3	25.4	$3.453 \cdot 10^{-6}$	$3.342 \cdot 10^{-2}$	13.60	1	$25.4 \cdot 10^3$	0.4912
0.13332	$133.32 \cdot 10^{-6}$	$0.1333 \cdot 10^{-6}$	$1.333 \cdot 10^{-6}$	$1.333 \cdot 10^{-3}$	$13.59 \cdot 10^{-6}$	$13.59 \cdot 10^{-3}$	10^{-3}	$1.359 \cdot 10^{-6}$	$1.316 \cdot 10^{-6}$	$0.5351 \cdot 10^{-3}$	$3.937 \cdot 10^{-5}$	1	$1.934 \cdot 10^{-5}$
6894.8	6.8948	$6.8948 \cdot 10^{-3}$	$6.8948 \cdot 10^{-2}$	68.948	0.7031	703.1	51.715	$70.31 \cdot 10^{-3}$	$6.8948 \cdot 10^{-3}$	27.68	2.036	51.715	1

INSTRUMENT TECHNICAL DATA

Inputs / type of measurement	2 / pressure, flow rate or temperature
Connector	DIN 45326 8-pole
No. conversions per second	2
Working temperature	-5...+50°C
Working relative humidity	0...90% R.H. (no condensation)
Serial output	RS 232C 300...19200 Baud (galvanically insulated)
Display	Double LCD 12.5 mm
Functions	Auto power off, Autorange, Hold, Record, Peak (5 ms), Minimum, Mean, Relative, A-B (differential)
Memory	512 kB (FLASH) corr. to 30000 measurements
Power supply	9 Vdc alkaline battery
Autonomy	Approx. 50 hours (continuous duty)
Weight / dimensions	320 gr. / 215x73x38 mm

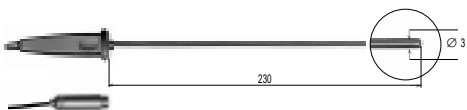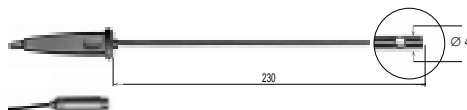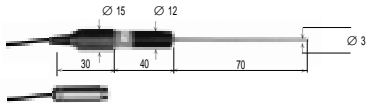| INSTRUMENT PRECISION			
	Amb. T 18 to 25°C	**Amb. T -5...18 or 25...50°C**	**Measure**
Pressure measurements	0.1% FS + 0.1% RDG	0.1% FS + 0.1% RDG +100ppm/°C	RDG=measured value
Flow rate measurements	0.2% FS + 0.5% RDG	0.2% FS + 0.5% RDG + 100ppm/°C	RDG=measured value
Temperature measurements with TP 870	0.4°C 0.2°C 3°C	0.4°C + 0.01°C/°C 0.2°C + 0.01°C/°C 3°C + 0.01°C/°C	(measures −200...-50°C) (measures −50...+200°C) (measures +200...+800°C)

PROBE PRECISION
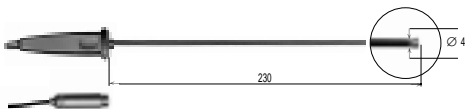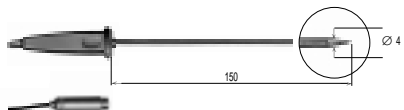
Rated pressure	Maximum over-pressure	DIFFERENTIAL RELATIVE rear of sensor connected to GATE 2	ABSOLUTE ABSOLUTE rear of sensor connected to vacuum	GAUGE RELATIVE rear of sensor connected to ambient INSULATED MEMBRANE	ABSOLUTE ABSOLUTE rear of sensor connected to vacuum INSULATED MEMBRANE	PRECISION 20-25°C	TEMPERATURE DRIFT AT 25°C %FS•1°C	WORKING TEMP.	CONNECTIONS
10.0 mbar	20.0 mbar	TP705-10MBD				0.50% FSO	≤ 0.024	0-60°C	Ø= 5 mm TUBE
20.0 mbar	40.0 mbar	TP705-20MBD				0.50% FSO	≤ 0.024	0-60°C	Ø= 5 mm TUBE
50.0 mbar	100 mbar	TP705-50MBD				0.50% FSO	≤ 0.024	0-60°C	Ø= 5 mm TUBE
100 mbar	200 mbar	TP705-100MBD				0.25% FSO	≤ 0.012	0-60°C	Ø= 5 mm TUBE
200 mbar	400 mbar	TP705-200MBD				0.12% FSO	≤ 0.012	0-60°C	Ø= 5 mm TUBE
				TP704-200MBGI		0.20% FSO	≤ 0.015	0-80°C	1/4 BSP
500 mbar	1000 mbar	TP705-500MBD				0.12% FSO	≤ 0.012	0-60°C	Ø= 5 mm TUBE
				TP704-500MBGI		0.20% FSO	≤ 0.015	0-80°C	1/4 BSP
1.00 bar	2.00 bar	TP705-1BD	TP705BARO			0.20% FSO	≤ 0.012	0-60°C	Ø= 5 mm TUBE
				TP704-1 BGI		0.20% FSO	≤ 0.015	0-80°C	1/4 BSP
2.00 bar	4.00 bar	TP705-2BD				0.12% FSO	≤ 0.012	0-60°C	Ø= 5 mm TUBE
				TP704-2BGI	TP704-2BAI	0.40% FSO	≤ 0.04	0-80°C	1/4 BSP
10.0 bar	20.0 bar			TP704-10BGI	TP704-10BAI	0.40% FSO	≤ 0.04	0-80°C	1/4 BSP
20.0 bar	40.0 bar			TP704-20BGI	TP704-20BAI	0.40% FSO	≤ 0.04	0-80°C	1/4 BSP
50.0 bar	100.0 bar			TP704-50BGI	TP704-50BAI	0.40% FSO	≤ 0.04	0-80°C	1/4 BSP
100 bar	200 bar				TP704-100BAI	0.40% FSO	≤ 0.04	0-80°C	1/4 BSP
200 bar	400 bar				TP704-200BAI	0.40% FSO	≤ 0.04	0-80°C	1/4 BSP
500 bar	750 bar				TP704-500BAI	0.50% FSO	≤ 0.04	0-80°C	1/4 BSP
1000 bar	1100 bar				TP704-1000BAI	0.50% FSO	≤ 0.04	0-80°C	1/4 BSP

N.B.: Differential probes may be used also for relative measurements (use only the socket marked +).
Differential probes may be used also for two-pole measurements (with pressure on the bottom socket marked + and pressure on the socket marked –).
The BAROMETRIC probe may be used also for measurements up to 0 bar (vacuum).

Pt100 SENSOR PROBES

COD.	°C max.	τ ** sec.	DIMENSIONS	USE	
TP 870	-50 +400	3"	230 Ø 3		•
TP 870C	-50 +400	12"	230 Ø 4		HD 9010 HD 8602 HD 8705 HD 8706 HD 8804 HD 8901 HD 9117 HD 9021 DO 9406 DO 9505 DO 9417 DO 9704 DO 9709
TP 870P	-50 +400	3"	150 Ø 4		
TP 870A	-50 +300	3"	230 Ø 4		
TP 871	-50 +200	3"	Ø 15 Ø 12 30 40 70 Ø 3		•

ORDER CODES

DO 9704 K   Pressure gauge - thermometer - data logger kit composed of a diplomatic carrying case, instrument DO 9704, series of fittings, 1 CPA 8-pole din 45326 connecting cable between instrument and probe, manual, 9 Vdc alkaline battery.

NOTE: **The pressure or temperature probes must be ordered separately to suit the customer's requirements.**

TP 870   Immersion temperature probe, Pt100 sensor, diam. 3 x 230 mm, measuring range -50°C...+400°C.
TP 870/C   Contact temperature probe, Pt100 sensor, diam. 4 x 230 mm, measuring range -50°C...+400°C.
TP 870/P   Penetration temperature probe, Pt100 sensor, diam. 4 x 150 mm, measuring range -50°C...+400°C.
TP 870/A   Air temperature probe, Pt100 sensor, diam. 4 x 230 mm, measuring range -50°C...+300°C.

Pressure probes: contact surface with Allumina pressurised fluid, stainless steel body AISI 304, male threaded coupling 1/4" BSP, 8-pole DIN 45326 male connector.
TP 704-200MBGI   Pressure probe, full scale 200 mbar relative.
TP 704-500MBGI   Pressure probe, full scale 500 mbar relative.
TP 704-1BGI   Pressure probe, full scale 1 bar relative.
TP 704-2BGI   Pressure probe, full scale 2 bar relative.
TP 704-10BGI   Pressure probe, full scale 10 bar relative.
TP 704-20BGI   Pressure probe, full scale 20 bar relative.
TP 704-50BGI   Pressure probe, full scale 50 bar relative.
TP 704-2BAI   Pressure probe, full scale 2 bar absolute.
TP 704-10BAI   Pressure probe, full scale 10 bar absolute.
TP 704-20BAI   Pressure probe, full scale 20 bar absolute.
TP 704-50BAI   Pressure probe, full scale 50 bar absolute.
TP 704-100BAI   Pressure probe, full scale 100 bar absolute.
TP 704-200BAI   Pressure probe, full scale 200 bar absolute.
TP 704-500BAI   Pressure probe, full scale 500 bar absolute.
TP 704-1000BAI   Pressure probe, full scale 1000 bar absolute.

The probes in the series TP 705 are suitable for measuring the low pressure of non-corrosive gases and dry air, fitting diam. 5 mm.
TP 705-10MBD   Pressure probe, full scale 10 mbar relative.
TP 705-20MBD   Pressure probe, full scale 20 mbar relative.
TP 705-50MBD   Pressure probe, full scale 50 mbar relative.
TP 705-100MBD   Pressure probe, full scale 100 mbar relative.
TP 705-200MBD   Pressure probe, full scale 200 mbar relative.
TP 705-500MBD   Pressure probe, full scale 500 mbar relative.

TP 705-1BD   Pressure probe, full scale 1 bar relative.
TP 705-2BD   Pressure probe, full scale 2 bar relative.
TP 705-BARO   Pressure probe, full scale 1 bar absolute barometric.

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.
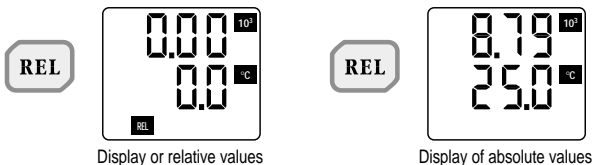
EXAMPLES OF USE OF THE KEYBOARD

1. **ON OFF** Switches the instrument on or off.

2. **HOLD** Blocks or resets updating of the display.
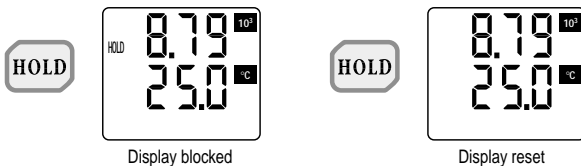
Display blocked

Display reset

3. **REL** Allows the display, storage or sending of the relative values immediately onto the serial line.

Display or relative values

Display of absolute values

4. Data Call   Pressing DATA CALL repeatedly gives:

1. Data Call

$$8.79 \times 10^2$$
$$25.0 \ °C$$
MAX

The Maximum value of the probes connected to the inputs

2. Data Call Call

$$8.79 \times 10^2$$
$$25.0 \ °C$$
MIN

The Minimum value of the probes connected to the inputs

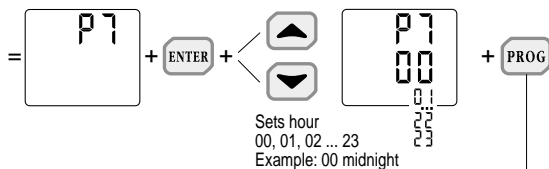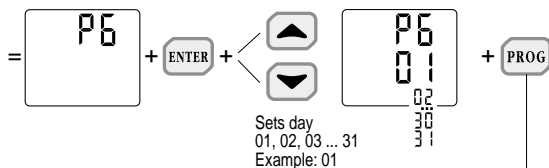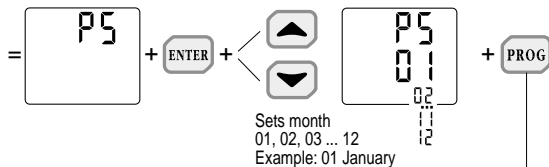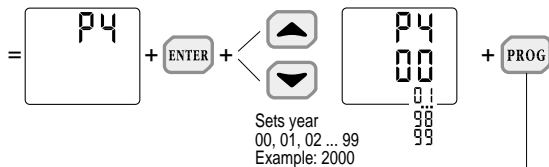3. Data Call Call Call

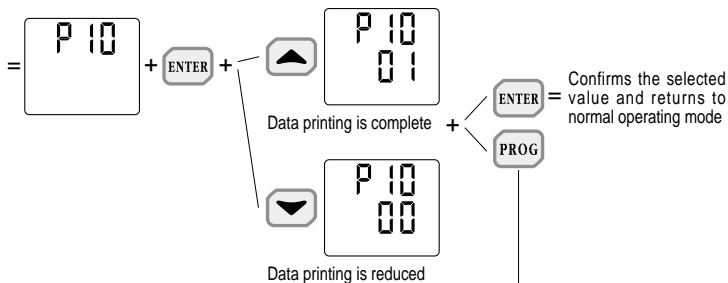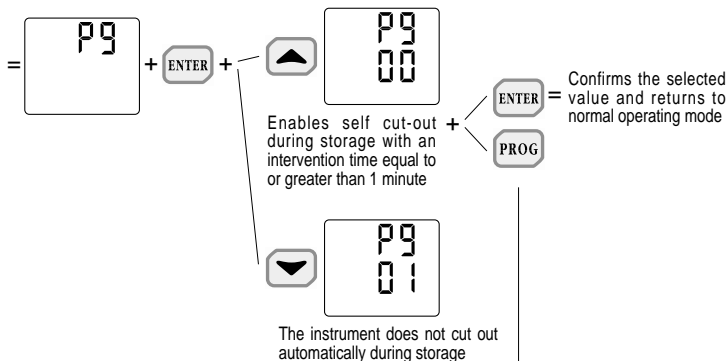$$8.79 \times 10^2$$
$$25.0 \ °C$$
MED
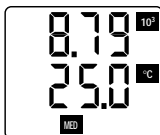
The Mean value of the probes connected to the inputs

4. Data Call Call Call Call

$$8.79 \times 10^2$$
$$25.0 \ °C$$

Returns to normal operating mode

5. `PROG` Instrument programming.

`PROG` = `P0` + `ENTER` = `8.79` `10²` `25.0`

Returns to normal operating mode, without storing the changed values.

`PROG`

`PROG` + `▲` `00.0` `10²` `25.0` + `ENTER`   `PROG` + `▼` `00.0` `10²` `00.0` + `ENTER`

Resets relative probes offset on channel A `PROG`   Resets relative probes offset on channel B `PROG`

`PROG` + `P1` + `ENTER` = Unloads data from the memory Returns to normal operating mode

`▲` = Erases memory (Memory Clear) Returns to normal operating mode

`PROG`

= `P2` + `ENTER` + `▲` `▼` `0.00` `05` + `ENTER` = Confirms the selected value and returns to normal operating mode

`PROG`

Sets reading or storage interval (from 1 sec. to 12 hours)

= `P3` + `ENTER` + `▲` `▼` `P3` `0.3` `0.6` `1.2` `2.4` `4.8` `9.6` `19.2` + `ENTER` = Confirms the selected value and returns to normal operating mode

`PROG`

Sets Baud Rate

= | P4   + ENTER + ▲/▼

Sets year
00, 01, 02 ... 99
Example: 2000

P4
00
01
98
99

+ PROG

= | P5   + ENTER + ▲/▼

Sets month
01, 02, 03 ... 12
Example: 01 January

P5
01
02
11
12

+ PROG

= | P6   + ENTER + ▲/▼

Sets day
01, 02, 03 ... 31
Example: 01

P6
01
02
30
31

+ PROG

= | P7   + ENTER + ▲/▼

Sets hour
00, 01, 02 ... 23
Example: 00 midnight

P7
00
01
22
23

+ PROG

= P8 + ENTER + ▲ / ▼

Sets minutes
00, 01, 02 ... 59
Example: 01 minutes

P8
00
0 1
58
59

+ ENTER / PROG = Confirms the selected value and returns to normal operating mode, storing the set date and time

= P9 + ENTER + ▲

P9
00

Enables self cut-out during storage with an intervention time equal to or greater than 1 minute

+ ▼

P9
0 1

The instrument does not cut out automatically during storage

+ ENTER / PROG = Confirms the selected value and returns to normal operating mode

= P 10 + ENTER + ▲

P 10
0 1

Data printing is complete

+ ▼

P 10
00

Data printing is reduced

+ ENTER / PROG = Confirms the selected value and returns to normal operating mode

= $\boxed{P\ II}$ + PROG = $\boxed{P0}$ + ENTER = Returns to normal operating mode

= $\boxed{P\ II}$ + ENTER = Enters calibration function + ▲ ▼ $\boxed{\begin{array}{c}196.0\\P\ II\end{array}}$ + ENTER / PROG

6. **Serial Output** Activation or disactivation of the serial output.

Serial output active

Serial output ended

7. **▼ RCD** Activation or disactivation of the Record function.

When the key is pressed the instrument gives a beep and starts storing and updating the MAX, MIN and MEAN value

▼ RCD When the key is held down for more than one second, the instrument gives a short beep followed by a long one. The Maximum, Minimum and Mean values have been reset and the instrument starts updating these values again.

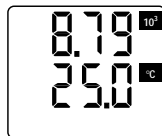**8.** [ENTER] Activation and disactivation of the storage function.
Start-Stop

[ENTER]
Start-Stop

```
 8.79  10³
25.0   ℃
```

Storage phase active

[ENTER]
Start-Stop

```
 8.79  10³
25.0   ℃
```

Storage phase ended

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SIT CALIBRATION
CENTRE N° 124

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