

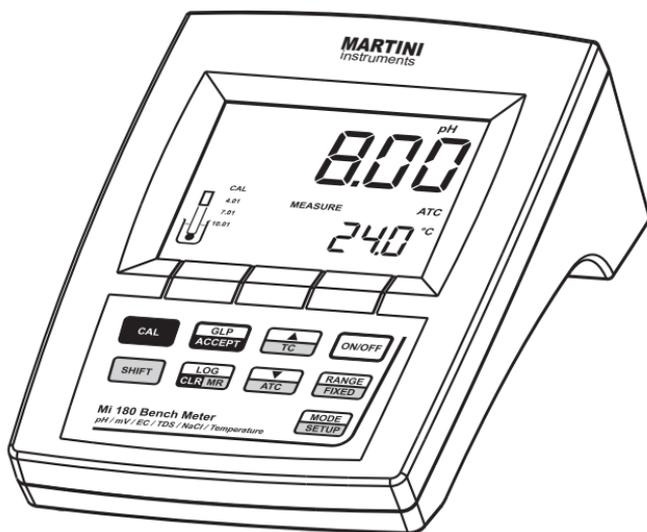
INSTRUCTION MANUAL

Multiparameter Bench Meter



■ Mi 180

pH/mV/EC/TDS/NaCl/Temperature



MARTINI
instruments

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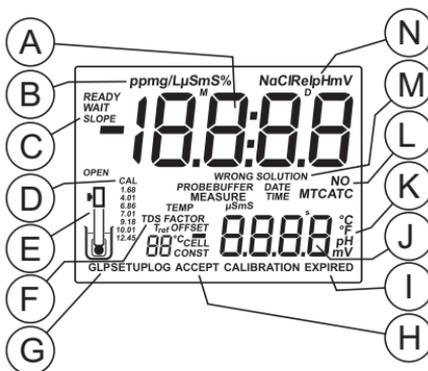
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FUNCTIONAL DESCRIPTION

DISPLAY

- A. PRIMARY DISPLAY
- B. MEASURING UNIT FOR PRIMARY DISPLAY
- C. CALIBRATION MESSAGES
- D. MEMORIZED pH CALIBRATION BUFFERS
- E. CALIBRATION TAGS
- F. GLP TAGS
- G. MODE INDICATORS
- H. REQUIRE USER CONFIRMATION
- I. CALIBRATION REQUESTED
- J. SECONDARY DISPLAY
- K. MEASURING UNIT FOR SECONDARY DISPLAY
- L. TEMPERATURE COMPENSATION MODE INDICATOR
- M. CALIBRATION MESSAGES
- N. MEASURING UNIT FOR PRIMARY DISPLAY



FUNCTIONAL DESCRIPTION

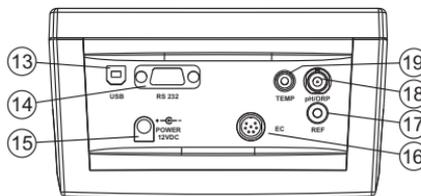
FRONT PANEL

1. Liquid Crystal Display (LCD)
2. CAL key, to enter/exit calibration mode
3. GLP/ACCEPT key, to display GLP data or to confirm value
4. SHIFT key, to select second key function
5. LOG/CLR/MR key, to store reading in memory, to clear calibration or to enter/exit recall mode
6. MODE/SETUP key, to select measurement mode/pH resolution, to enter/exit setup mode or to toggle between delete one or all logged data
7. ▼/ATC key, to manually decrease temperature value or other parameters or to select temperature compensation mode
8. RANGE/FIXED key, to switch measurement unit pH/mV/EC or focused data, or to freeze current reading on the LCD
9. ▲/TC key, to manually increase temperature value or other parameters or to view temperature coefficient value
10. ON/OFF key, to turn the meter ON and OFF
11. Secondary LCD
12. Primary LCD



REAR PANEL

13. USB connector
14. RS232 connector
15. Power supply socket
16. DIN connector for EC probe
17. Reference pH electrode socket
18. BNC pH electrode connector
19. Temperature probe socket



GENERAL DESCRIPTION

Thank you for choosing Martini Instruments. This instruction manual will provide you the necessary information for correct use of the meter.

Mi 180 is a logging microprocessor-based pH, ORP, EC, TDS, NaCl and temperature bench meter. This meter is provided with a series of new diagnostic features which add an entirely new dimension to the measurement of pH/ORP/EC/TDS/NaCl, by allowing the user to dramatically improve the reliability of the measurement:

- 7 memorized buffers (pH 1.68, 4.01, 6.86, 7.01, 9.18, 10.01 and 12.45) for pH calibration
- pH calibration up to 3 points
- Messages on the LCD to make the calibration easy and accurate
- Relative mV feature
- GLP feature, to view last calibration data for pH, EC or NaCl
- User-selectable alarm time out to alert the user that too much time elapsed since the last pH calibration
- Log-on-demand (50 samples for each range: pH, mV/Rel mV, EC, TDS, NaCl)

Moreover, it offers an extended temperature range from -20°C (-4°F) to 120°C (248°F), using **MA 831R** interchangeable temperature probe or the temperature sensor inside the EC probe.

The autoranging feature of the EC and TDS ranges automatically sets the instrument to the scale with the highest possible resolution.

The conductivity measurements are manually or automatically compensated for temperature effect, with the temperature sensor inside the conductivity probe. It is also possible to disable the temperature compensation and measure the actual conductivity. The temperature coefficient is user selectable.

For accurate measurements, use the electrode holder supplied with the meter.

This Bench Meter is supplied with:

- MA 917B/1 pH Electrode
- MA 831R Temperature Probe
- MA 814DB/1 EC/Temperature Probe
- MA 9315 Electrode Holder
- M 10004 pH 4.01 Sachet Buffer Solution
- M 10007 pH 7.01 Sachet Buffer Solution
- M 10010 pH 10.01 Sachet Buffer Solution
- M 10016 Sachet Electrode Cleaning Solution
- M 100 31 1,413 mS/cm Cal Solution Sachet
- M 100 16 Cleaning Solution Sachet
- Mi 5200 Application Software
- MA 9350 RS232 Connector cable (2 meters)
- Graduate Pipet
- 12 VDC Adapter
- Instruction Manual

SPECIFICATIONS

Range	pH	-2.00 to 16.00 pH / -2.000 to 16.000 pH
	mV	±699.9 mV / ±2000 mV
	EC	0.00 to 29.99 $\mu\text{S}/\text{cm}$
		30.0 to 299.9 $\mu\text{S}/\text{cm}$
		300 to 2999 $\mu\text{S}/\text{cm}$
		3.00 to 29.99 mS/cm
		30.0 to 200.0 mS/cm
		up to 500.0 mS/cm (uncompensated EC)*
	TDS	0.00 to 14.99 mg/L (ppm)
		15.0 to 149.9 mg/L (ppm)
		150 to 1499 mg/L (ppm)
		1.50 to 14.99 g/L (ppt)
		15.0 to 100.0 g/L (ppt)
	up to 400.0 g/L (uncompensated TDS)* with 0.80 conversion factor	
NaCl	0.0 to 400.0%	
Temp	-20.0 to 120.0 °C (-4.0 to 248.0 °F)	
Resolution	pH	0.01 pH / 0.001 pH
	mV	0.1 mV / 1 mV
	EC	0.01 $\mu\text{S}/\text{cm}$
		0.1 $\mu\text{S}/\text{cm}$
		1 $\mu\text{S}/\text{cm}$
		0.01 mS/cm
		0.1 mS/cm
	TDS	0.01 mg/L
		0.1 mg/L
		1 mg/L
		0.01 g/L
	0.1 g/L	
NaCl	0.1%	
Temp	0.1 °C (0.1 °F)	

(*) Uncompensated conductivity (or TDS) is the conductivity (or TDS) value without temperature compensation.

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Accuracy	pH	± 0.01 pH / ± 0.002 pH
(@ 20 °C / 68 °F)	mV	± 0.2 mV / ± 1 mV
	EC	$\pm 1\%$ of reading (± 0.05 $\mu\text{S}/\text{cm}$ or 1 digit)
	TDS	$\pm 1\%$ of reading (± 0.03 mg/L or 1 digit)
	NaCl	$\pm 1\%$ of reading
	Temp	± 0.4 °C (± 0.8 °F)
Rel mV offset		± 2000 mV
Calibration	pH	1, 2 or 3 points calibration, with 7 memorized buffers: 1.68, 4.01, 6.86, 7.01, 9.18, 10.01 and 12.45
	EC	1 point slope calibration with 6 memorized solutions available: 84.0 $\mu\text{S}/\text{cm}$, 1413 $\mu\text{S}/\text{cm}$, 5.00 mS/cm, 12.88 mS/cm, 80.0 mS/cm, 111.8 mS/cm; 1 point offset calibration: 0.00 $\mu\text{S}/\text{cm}$
	NaCl	1-point, with MA 9050 calibration solution
	Temp	2-point, at 0 and 50 °C (32 and 122 °F)
Temperature Compensation		Automatic or manual, from -20.0 to 120.0 °C (-4.0 to 248.0 °F)
Temperature Coefficient		Selectable from 0.00 to 6.00%/°C (EC and TDS only)
TDS factor		0.40 to 0.80 (default value is 0.50)
pH Electrode		MA 917B/1 (included)
Temperature Probe		MA 831R (included)
EC Probe		MA 814DB/1 (included)
Input Impedance (pH)		10^{12} ohms
Computer Interface		RS232/USB opto-isolated
Power supply		12 VDC power adapter
Dimensions		230 x 160 x 95 mm (9.0 x 6.3 x 3.7")
Weight		0.9 kg (2.0 lb.)
Environment		0 to 50 °C (32 to 122 °F) ; max RH 95%
Warranty		3 years

This instrument is in compliance with the CE Directives.

OPERATIONAL GUIDE

INITIAL PREPARATION

Plug the 12 VDC adapter to the power supply socket. To prepare the instrument for pH measurements, connect the pH electrode to the BNC connector and the temperature probe to the appropriate socket on the rear panel of the instrument. The temperature probe is used in conjunction with the pH electrode to utilize the instrument's ATC capability, but it can also be used independently to take temperature measurements.

For electrodes with a separate reference, connect the electrode's BNC to the BNC connector and plug the reference electrode to the reference socket.

For temperature measurements and pH automatic temperature compensation connect the temperature probe to the appropriate socket. After taking measurements switch the meter off, clean the electrode and store it with a few drops of **MA 9015** storage solution in the protection cap.

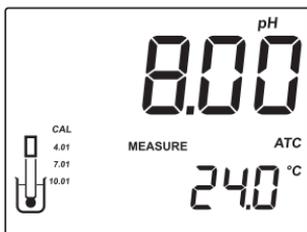
For EC/TDS measurements connect the EC probe to the 7-pin connector. Make sure the probe sleeve is properly inserted and tighten the threaded ring.

The instrument enters the same range and mode as it was at power off. For pH and mV/Rel mV modes, after turning the instrument on, the "OPEN" tag and the "•" and "U" symbols from the electrode blink on the LCD for a few seconds to remind the user to unscrew the electrode refilling cap, and to remove the protective cap before taking measurements.

pH MEASUREMENTS

Make sure the instrument has been calibrated before taking pH measurements.

- If necessary, press the RANGE key until the display changes to pH mode.
- Submerge the tip of the electrode (4cm/1 1/2") and the temperature probe into the sample to be tested and stir gently. Allow for the electrode to stabilize.
- The pH measurement is displayed on the primary LCD and the temperature on the secondary LCD.



- If the reading is out of range, the closest full-scale value will blink on the primary LCD.

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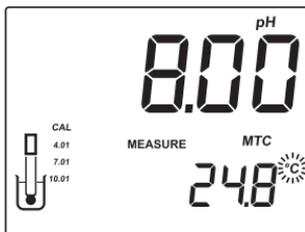
Note: To change pH resolution press the MODE/SETUP key.

If measurements are taken successively in different samples, it is recommended to rinse the electrode thoroughly with deionized water and then with some of the sample to be tested.

The pH reading is affected by temperature. In order to measure the pH accurately, the temperature effect must be compensated. To use the Automatic Temperature Compensation (ATC) feature, connect and submerge the **MA 831R** temperature probe into the sample as close as possible to the electrode and wait for a few seconds. The "ATC" tag will be displayed.

If Manual Temperature Compensation (MTC) is desired, the temperature probe must be disconnected from the instrument.

The display will show the default temperature of 25 °C or the last temperature reading with the "MTC" tag and "°C" (or "°F") tag blinking.



The temperature can now be adjusted with the UP and DOWN arrow keys (from -20.0 °C to 120.0 °C).

mV / REL mV MEASUREMENTS

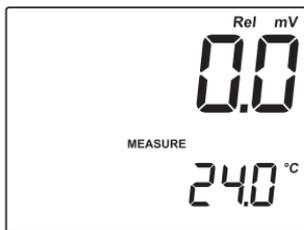
An optional ORP electrode must be used to perform ORP measurements (see "Accessories" section). Oxidation-Reduction Potential (ORP) measurements provide the quantification of the oxidizing or reducing power of the tested sample.

To perform an ORP measurement correctly, the surface of the electrode must be clean and smooth.

- If necessary, press the RANGE/FIXED key until the display changes to mV/Rel mV.
- Submerge the ORP electrode tip (4cm/1 1/2") into the sample to be tested and allow a few seconds for the reading to stabilize.
- The instrument displays the mV reading on the primary LCD or Rel mV reading if a Rel mV calibration has been performed and the temperature on the secondary LCD.



OR

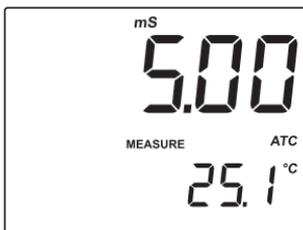
**Notes:**

- When the reading is out of range, the closest full-scale value is displayed blinking.
- If using a pH electrode while in mV mode, the instrument will measure the mV generated by the pH electrode.
- If the instrument displays a Rel mV reading and it is desired to take mV measurements, simply clear the Rel mV calibration (see Rel mV calibration section at page 16).

CONDUCTIVITY MEASUREMENTS

Make sure the instrument has been calibrated before taking conductivity measurements.

- Press the RANGE/FIXED key to enter EC measurement mode.
- Immerse the probe into the solution to be tested. The sleeve holes must be completely submerged. Tap the probe repeatedly to remove any air bubbles that may be trapped inside the sleeve.
- The conductivity value is displayed on the primary LCD and the temperature on the secondary LCD, along with the reference temperature.

**Notes:**

- If the reading is out of range, the closest full-scale value (200.0 mS for MTC/ATC mode or 500.0 mS for uncompensated conductivity) will be displayed blinking.
- If SHIFT&RANGE/FIXED keys are pressed to freeze the LCD range and the reading goes out of range, the full-scale value of the frozen range will be displayed blinking.

The EC reading is affected by temperature. Three options for temperature compensation are available in EC measurement mode.

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Note: The compensation is referenced at the selected reference temperature (see SETUP for details, page 33).

Automatic (ATC): The EC probe has a built-in temperature sensor; the temperature value is used to automatically compensate the EC/TDS reading (from -20.0 – 120.0 °C).

Manual (MTC): The temperature value, shown on the secondary LCD, can be manually set with the UP and DOWN arrow keys. The “°C” tag blinks when this option is active.

No Compensation (NOTC): The temperature value is displayed, but it is not taken into account. The reading displayed on the primary LCD is the uncompensated EC or TDS value. To select the desired option, press the SHIFT&▼/ATC keys until the option is displayed on the LCD.

Notes:

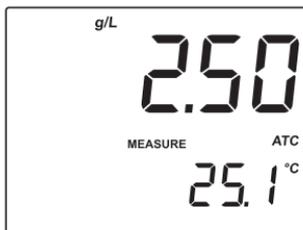
- The default compensation mode is **ATC**.
- If no temperature probe is detected, **ATC** mode can not be selected and the instrument displays “----” on the secondary LCD.

If temperature compensation is active, measurements are compensated using the temperature coefficient (default value 1.90 %/°C). To change the temperature coefficient, enter the setup mode and select the “tc” item (see SETUP for details, page 33). The current temperature coefficient can be quickly viewed by pressing the SHIFT&▲/TC keys. The value is briefly displayed on the secondary LCD.

- If the temperature reading is out of the -20.0 to 120.0 °C (-4.0 to 248.0 °F) interval and **ATC** option is selected, the “°C” tag will blink and the closest interval limit will be displayed.
- By pressing the UP and DOWN arrow keys the displayed temperature value can be changed. This value is used to compensate the EC/TDS reading.

TDS MEASUREMENTS

- Press the MODE/SETUP key while in EC range until the display changes to TDS mode.
- The TDS reading will be displayed on the primary LCD and the temperature reading on the secondary LCD, along with the reference temperature.

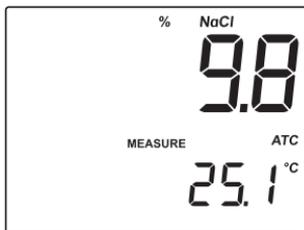


Notes:

- If the reading is out of range, the full-scale value (160.0 g/L for MTC/ATC mode or 400.0 g/L for uncompensated TDS) will be displayed blinking.
- If the SHIFT&RANGE/FIXED keys are pressed to freeze the LCD range and the reading goes out of range, the full-scale value of the frozen range will be displayed blinking.

NaCl MEASUREMENTS

- Press the MODE/SETUP key while in EC range to enter NaCl measurement mode.
- The instrument will display the NaCl reading on the primary LCD and the temperature on the secondary LCD, along with the reference temperature.



AUTORANGING

The EC and TDS scales are autoranging. The meter automatically sets the scale with the highest possible resolution.

By pressing the SHIFT&RANGE/FIXED keys, the autoranging feature is disabled and the current range is frozen on the LCD. The "Auto" "OFF" (autoranging disabled) message will be displayed on the LCD for a few seconds. To restore the autoranging option, press the SHIFT&RANGE/FIXED keys again. The "Auto" "On" (autoranging enabled) message will be displayed on the LCD for a few seconds.

Note: Autoranging is automatically restored if the range is changed, if the setup or calibration modes are entered and if the meter is turned off and back on again.

pH CALIBRATION

It is recommended to calibrate the instrument frequently, especially if high accuracy is required.

The pH calibration is also necessary in the following cases:

- Whenever the pH electrode is replaced.
- At least once a week.
- After testing aggressive chemicals.
- When extreme accuracy is required.
- If "CALIBRATION EXPIRED" tag is blinking during measurement.

Every time you calibrate the instrument use fresh buffers and perform an electrode Cleaning Procedure (see page 41).

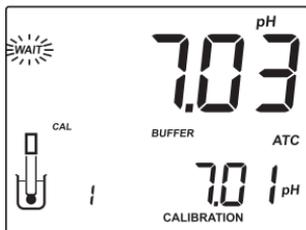
PROCEDURE

One, two or three points calibration can be performed, from the 7 memorized buffers (1.68, 4.01, 6.86, 7.01, 9.18, 10.01 and 12.45 pH).

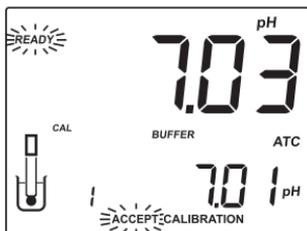
- Pour small quantities of selected buffer solutions into clean beakers. For accurate calibration use two beakers for each buffer solution, the first one to rinse the electrode and the second one for calibration.
- Remove the protective cap and rinse the electrode with some of the buffer solution to be used for the first calibration point.

THREE-POINT CALIBRATION

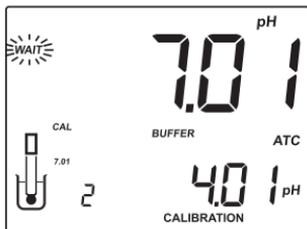
- Immerse the pH electrode and the temperature probe approximately 4 cm (1½") into a buffer solution of your choice (pH 1.68, 4.01, 6.86, 7.01, 9.18, 10.01 or 12.45) and stir gently. The temperature probe should be close to the pH electrode.
- Press the CAL key. The "CAL", "1" and "CALIBRATION" tags will appear and the secondary LCD will display buffer "7.01".



- If necessary, press the UP and DOWN arrow keys to select a different buffer value.
- The “WAIT” tag will blink on the LCD until the reading is stable.
- When the reading is stable and close to the selected buffer, the “READY” and “ACCEPT” tags will blink on the LCD.



- Press the GLP/ACCEPT key to confirm calibration.
- The calibrated value will be displayed on the primary LCD and the second expected buffer value on the secondary LCD, along with the tag of the buffer already calibrated.



- After the first calibration point is accepted, immerse the pH electrode and the temperature probe approximately 4 cm (1½”) into the second buffer solution and stir gently. The temperature probe should be close to the pH electrode.
- If necessary, press the UP and DOWN arrow keys to select a different buffer value.
- The “WAIT” tag will blink on the LCD until the reading is stable.
- When the reading is stable and close to the selected buffer, the “READY” and “ACCEPT” tags will blink on the LCD.
- Press the GLP/ACCEPT key to confirm calibration.
- The calibrated value will be displayed on the primary LCD and the third expected buffer value on the secondary LCD, along with the tags of the buffers already calibrated.

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- After the second calibration point is accepted, immerse the pH electrode and the temperature probe approximately 4 cm (1½") into the third buffer solution and stir gently. The temperature probe should be close to the pH electrode.
- If necessary, press the UP and DOWN arrow keys to select a different buffer value.
- The "WAIT" tag will blink on the LCD until the reading is stable.
- When the reading is stable and close to the selected buffer, the "READY" and "ACCEPT" tags will blink on the LCD.
- Press the GLP/ACCEPT key to confirm calibration.
- The instrument stores the calibration values and returns to normal measurement mode.

Notes:

- The instrument automatically skips the buffers already used for the previous calibration points to avoid erroneous procedure.
- If the value measured by the instrument is not close to the selected buffer, "WRONG BUFFER" and "WRONG PROBE" messages will blink alternately. In this case, check if the correct buffer has been used or regenerate the electrode by following the Cleaning Procedure (see page 40). If necessary, change the buffer or the electrode.
- If "WRONG BUFFER" and "Old" messages on the secondary LCD are displayed blinking, an inconsistency between new and previous (old) calibration is detected. Clear calibration parameters by pressing the LOG/CLR/MR key and proceed with calibration from the current calibration point (the instrument will keep all confirmed values during current calibration).
- The "WRONG BUFFER" message and the temperature value blink if temperature reading is out of the defined temperature range for the buffer. Calibration cannot be confirmed in this situation.
- Press the RANGE/FIXED key to display the temperature reading during calibration.
- To clear a previous calibration and return to the default values, press the LOG/CLR/MR key at any time after entering calibration mode. The LCD will show "CLr CAL" for one second, and then the meter will return to normal measurement mode.



1 OR 2 POINT CALIBRATION

- Proceed as described in “Three-point calibration” section.
- Press the CAL key after the appropriate calibration point is accepted.

The instrument will return to measurement mode, will memorize the calibration data, and the appropriate tags for the calibrated buffers will be displayed on the LCD only if the “disp” option from the SETUP menu is ON (see page 33).

pH BUFFER TEMPERATURE DEPENDENCE

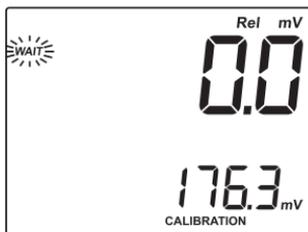
The temperature has an effect on pH. The calibration buffer solutions are affected by temperature changes to a lesser degree than normal solutions. During calibration the instrument will automatically calibrate to the pH value corresponding to the measured or set temperature.

During calibration the instrument will display the pH buffer value at 25 °C.

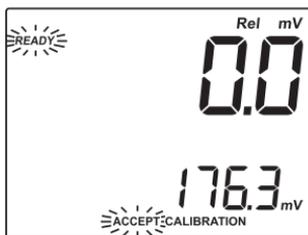
TEMP		pH BUFFERS						
°C	°F	1.68	4.01	6.86	7.01	9.18	10.01	12.45
0	32	1.67	4.01	6.98	7.13	9.46	10.32	13.38
5	41	1.67	4.00	6.95	7.10	9.39	10.24	13.18
10	50	1.67	4.00	6.92	7.07	9.33	10.18	12.99
15	59	1.67	4.00	6.90	7.05	9.27	10.12	12.80
20	68	1.68	4.00	6.88	7.03	9.22	10.06	12.62
25	77	1.68	4.01	6.86	7.01	9.18	10.01	12.45
30	86	1.68	4.02	6.85	7.00	9.14	9.96	12.29
35	95	1.69	4.03	6.84	6.99	9.11	9.92	12.13
40	104	1.69	4.04	6.84	6.98	9.07	9.88	11.98
45	113	1.70	4.05	6.83	6.98	9.04	9.85	11.83
50	122	1.71	4.06	6.83	6.98	9.01	9.82	11.70
55	131	1.72	4.08	6.84	6.98	8.99	9.79	11.57
60	140	1.72	4.09	6.84	6.98	8.97	9.77	11.44
65	149	1.73	4.11	6.84	6.99	8.95	9.76	11.32
70	158	1.74	4.12	6.85	6.99	8.93	9.75	11.21
75	167	1.76	4.14	6.86	7.00	8.91	9.74	11.10
80	176	1.77	4.16	6.87	7.01	8.89	9.74	11.00
85	185	1.78	4.17	6.87	7.02	8.87	9.74	10.91
90	194	1.79	4.19	6.88	7.03	8.85	9.75	10.82
95	203	1.81	4.20	6.89	7.04	8.83	9.76	10.73

RELATIVE mV CALIBRATION

- Press the CAL key when the instrument is in mV / Rel mV measurement mode. The “CALIBRATION” tag will appear on the LCD.
- Relative mV value is displayed on the primary LCD and the absolute mV value on the secondary LCD.



- The “WAIT” tag will blink until the reading is stable.
- When the absolute reading is stable and in measurement range, the “READY” and “ACCEPT” tags blink on the LCD, asking for confirmation.



- If the reading is out of range, the absolute mV value and the “WRONG” tag will blink.
- Press the GLP/ACCEPT key to confirm the calibration. The instrument enters Rel mV measurement mode.

Notes:

- If a Rel mV calibration is performed, the range changes from mV to Rel mV.
- To return to mV measurement mode, clear the Rel mV calibration by pressing LOG/CLR/MR after entering calibration mode. The “CLR CAL” message will appear on the LCD for one second and the instrument will enter mV measurement mode.

EC/TDS CALIBRATION

EC calibration is a one-point procedure. Selectable calibration points are 0.00 μS for offset and 84.0 μS , 1413 μS , 5.00 mS, 12.88 mS, 80.0 mS, 111.8 mS for slope.

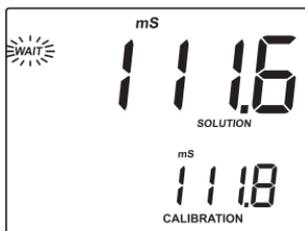
Rinse the probe with calibration solution or deionized water. Immerse the probe into the solution. The sleeve holes must be completely submerged. Tap the probe repeatedly to remove any air bubbles that may be trapped inside the sleeve.

To enter EC calibration, select the EC range and press CAL.

Note: The TDS reading is automatically derived from the EC reading and no specific calibration for TDS is needed. Pressing CAL when TDS range is selected has no effect.

For *zero calibration*, just leave the dry probe in the air. This calibration is performed in order to correct the reading around 0.00 μS . The slope is evaluated when the calibration is performed in any other point.

The primary LCD will display the EC reading and the secondary LCD will display the closest calibration solution, along with "CALIBRATION" tag. The "WAIT" tag will blink until the reading is stable.



When the reading is stable and close to the selected calibration solution, "READY" and "ACCEPT" tags will blink on the LCD.



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Press the GLP/ACCEPT key to confirm calibration.

The instrument stores the calibration value and returns to measurement mode.

Notes:

- If the uncalibrated reading is too far from the expected value, the “WRONG” and “SOLUTION” tags will blink. Calibration can not be confirmed. In this case check if the correct calibration solution has been used.
- If the meter is in **ATC** mode and the solution temperature is out of the 0.0 to 60.0 °C (32.0 to 140.0 °F) interval, the “WRONG” “SOLUTION” “°C” tags and the temperature will be displayed blinking.
- For best results choose an EC calibration solution value close to the sample to be measured.
- It is possible to set the cell constant value directly, without following the calibration procedure. To set the cell constant, enter SETUP mode and select “CELL” (see SETUP for details, page 33).

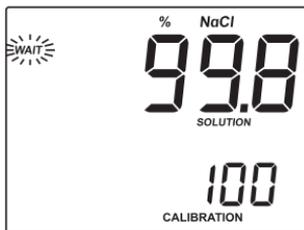
NaCl CALIBRATION

NaCl calibration is a one-point procedure at 100.0% NaCl. Use the MA 9050 calibration solution (sea water solution) as a 100% NaCl standard solution.

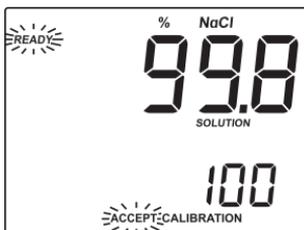
Rinse the probe with some of the calibration solution or deionized water. Immerse the probe into the MA 9050 solution. The sleeve holes must be completely submerged. Tap the probe repeatedly to remove any air bubbles that may be trapped inside the sleeve.

To enter NaCl calibration select the NaCl range and press CAL.

The primary LCD will display the NaCl reading in percentage and the secondary LCD will display “100”, along with “CALIBRATION” tag. The “WAIT” tag will blink until the reading is stable.



When the reading is stable, the “READY” and “ACCEPT” tags will blink on the LCD. Press the GLP/ACCEPT key to confirm calibration. The instrument stores the calibration value and returns to measurement mode.



Notes:

- If the reading is too far from the expected value, the “WRONG” and “SOLUTION” tags will blink. Calibration cannot be confirmed.
- If the temperature of the buffer is out of the 0.0 – 60.0 °C (32.0 – 140.0 °F) temperature interval, the “WRONG” “SOLUTION”, “°C” tags and temperature will be displayed blinking.
- If a new EC calibration is performed, the NaCl calibration is automatically cleared. Thus, a new NaCl calibration is required.

GOOD LABORATORY PRACTICE (GLP)

GLP is a set of functions that allows storage and retrieval of calibration data and electrode status. All data regarding pH, EC and NaCl calibration is stored for the user to review when necessary.

CALIBRATION ALARM TIME-OUT

For pH calibration, **Mi 180** allows the user to set the number of days (1 to 14) before the next required calibration. The default setting is OFF (disabled).

The instrument checks the time-out and if the time elapsed, the “CALIBRATION EXPIRED” message will blink as a reminder.

Note: If the instrument is not calibrated, the “CALIBRATION EXPIRED” message will be displayed even if the calibration time-out feature is disabled in SETUP menu.

LAST pH CALIBRATION DATA

pH calibration data is stored automatically after a successful calibration.

To view the last pH calibration data, press the GLP/ACCEPT key while in pH measurement mode.

The instrument will display the time (hh:mm:ss) of the last calibration.

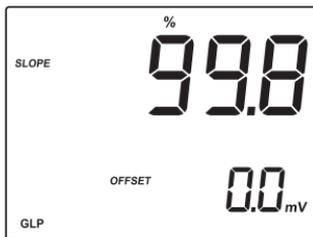


Press the arrow keys and the instrument will display the next calibration parameter (pressing the UP key):

- The date (MM.DD.YYYY).

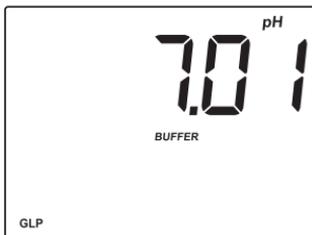


- The pH calibration slope value on the primary LCD and the offset on the secondary LCD.

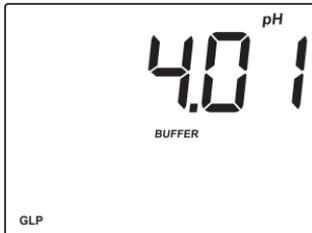


- The pH calibration buffers in calibrating order.

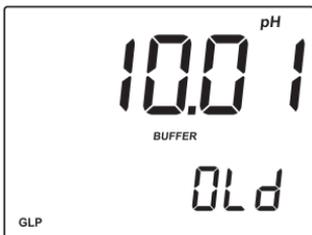
The first pH calibration buffer:



- The second pH calibration buffer:



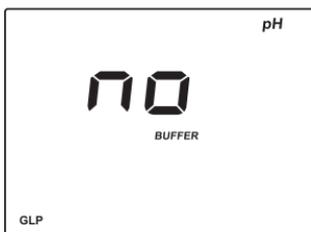
- The third pH calibration buffer:



Notes:

- The "OLD" message displayed under the pH value means that this buffer was not used during last calibration. Press the SHIFT&MODE/SETUP keys if you want to see calibration date (or time if old calibration was performed in the same day with current calibration).

- The “no BUFFER” message means that the instrument was calibrated in less than three points.



- Calibration alarm time-out status. The meter displays “OFF” if the function is disabled,



or the number of days before the calibration alarm will be displayed (e.g. 5 days), or from the time calibration expired (e.g. -3 days).

- Instrument Identification Code. When using several identical meters it may be useful to uniquely identify them by assigning an ID code to each meter.



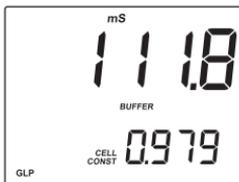
LAST EC CALIBRATION DATA

Last EC calibration data is stored automatically after a successful calibration. To view the EC calibration data, press the GLP/ACCEPT key while in EC measurement mode.

The instrument will display the time (hh:mm:ss) of the last calibration as in pH GLP mode.

Press the arrow UP key and the instrument will display the following calibration parameters:

- The date (MM.DD.YYYY) as in pH GLP mode.
- The EC calibration solution on the primary LCD and the cell constant on the secondary LCD.



- The EC calibration offset on the primary LCD.



- The reference temperature on the primary LCD.



- The temperature coefficient on the primary LCD, along with the temperature compensation mode.



- The instrument Identification Code as in pH GLP mode.

LAST NaCl CALIBRATION DATA

Last NaCl calibration data is stored automatically after a successful calibration. To view the NaCl calibration data, press the GLP/ACCEPT key when the instrument is in NaCl measurement mode. The instrument will display the time (hh:mm:ss) of the last calibration as in pH GLP mode. Press the UP and DOWN arrow keys to view the next logged calibration parameters (pressing the UP key):

- The date (MM.DD.YYYY) as in pH GLP mode.
- The cell constant.



- The salinity coefficient.

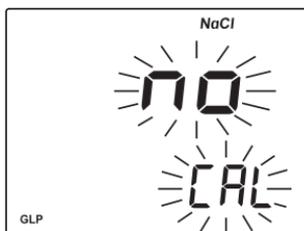


- The temperature coefficient on the primary LCD, along with the temperature compensation mode as in EC GLP mode.
- The reference temperature on the primary LCD as in pH GLP mode.
- The instrument Identification Code as in pH GLP mode.

Notes:

- If a one-point pH calibration is performed after a two-point pH calibration, the instrument will keep the old slope.
- Press the GLP/ACCEPT key at any moment and the instrument will return to measurement mode.

- If calibration has not been performed for the selected range, the instrument displays “no CAL” message blinking.



LOGGING

Up to 50 readings can be stored into memory for each measurement range (pH, mV/Rel mV, EC, TDS and NaCl).

LOGGING THE CURRENT DATA

To store the current reading into memory press the LOG/CLR/MR key while in measurement mode.

The instrument will display the current date (MM.DD) on the primary LCD and the record number on the secondary LCD, along with “LOG” tag (see example below: record No. 25, dated July 28).

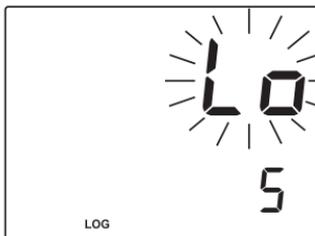


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The instrument then displays the amount of free log space for about one second and returns to normal measurement mode (e.g. 45 records free).



If there are less than 6 memory locations remaining, the record number and "Lo" message will blink to alert the user.



If the log space is full, "FULL LOC" message will be displayed and no more data will be saved.



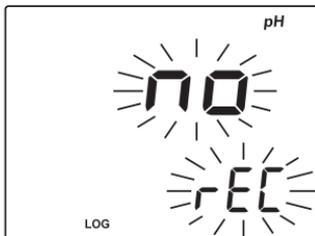
If the LOG/CLR/MR key is pressed while in measurement mode, a complete set of information is stored.

VIEW LOGGED DATA

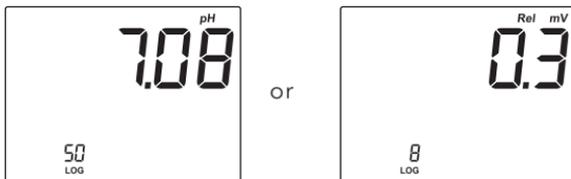
Press the SHIFT&LOG/CLR/MR keys to retrieve the information stored while in measurement mode.

pH, mV/Rel mV RANGE

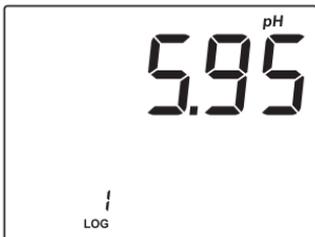
If no data is logged, the instrument displays "no rEC" message for the selected mode.



Otherwise, the instrument will display the **pH** or **Rel mV** value on the primary LCD and the last stored record number along with "LOG" tag.



Pressing the arrow keys, the instrument will display the same parameter but for a different record:



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Press the RANGE/FIXED key and the instrument will display the next logged parameter:

- The mV value on the primary LCD and the temperature on the secondary LCD.



- The date: month and day on the primary LCD and the year on the secondary LCD, along with "DATE" tag.



- The time: hour and minutes on the primary LCD and the seconds on the secondary LCD, along with "TIME" tag.



- The slope on the primary LCD and the offset on the secondary LCD, along with “SLOPE” and “OFFSET” tags.



Note: If in mV/Rel mV RECALL mode, the instrument will display dashes for slope.

- The “dEL” message on the primary LCD and the record number on the secondary LCD, along with “ACCEPT” tag blinking.



Notes:

- If one of the arrow keys is pressed while “dEL” message is displayed, the next/previous record number will be selected.
- If the SHIFT & MODE/SETUP key is pressed, the secondary LCD will toggle between the record number and “ALL” message.

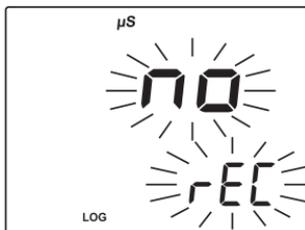


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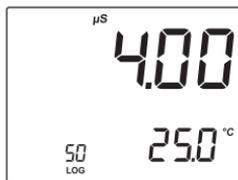
- Press the GLP/ACCEPT key to delete the selected or all records.
- If “dEL ALL” option was selected, all records for the selected range are deleted and the instrument returns to measurement mode.
- After deleting a record, the “noLL” message is displayed on the LCD for the selected record.

EC RANGE

If no data is logged, the instrument displays “no rEC” message for the selected mode.



Otherwise, the instrument will display the **EC**, **TDS** or **NaCl** value on the primary LCD and the last stored record number along with “LOG” tag.



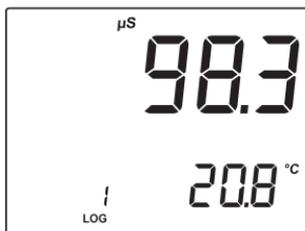
or



or

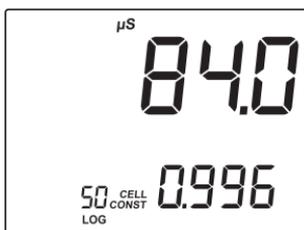


Pressing the arrow keys, the instrument will display the same parameter but for a different record:

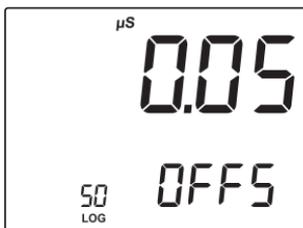


Press the RANGE/FIXED key and the instrument will display the next logged parameter:

- The conductivity value on the primary LCD and the cell constant on the secondary LCD.

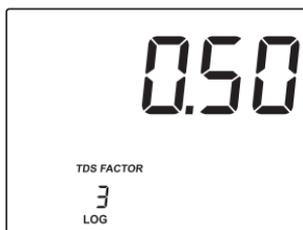


- The date as described in pH range.
- The time as described in pH range.
- For EC mode: the offset on the primary LCD.



or

- For TDS mode: the TDS factor.



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or

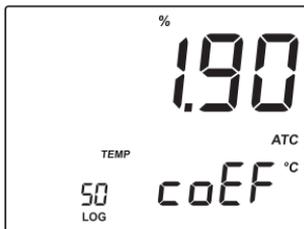
- For NaCl mode: the salinity coefficient.



- The reference temperature.



- The temperature coefficient and compensation mode.



- The "dEL" message as described in pH range.

Press the SHIFT&LOG/CLR/MR keys to leave RECALL mode at any time.

SETUP

Setup mode allows viewing and modifying the following parameters:

- Calibration Alarm Time-Out (pH range only)
- Buffer Display (pH range only)
- Cell Constant (EC range only)
- TDS Factor (EC range only)
- Temperature Coefficient (EC range only)
- Reference Temperature (EC range only)
- Current Time (hh:mm)
- Current Date (MM.DD.YYYY)
- Beep Status
- Baud Rate (serial communication)
- Instrument ID
- Temperature Unit

To enter SETUP mode, press the SHIFT&MODE/SETUP keys while in normal measurement mode.

Select the desired setup parameter using the UP and DOWN arrow keys.

Press the CAL key if you want to change the item value. The selected item (e.g. hour) will start blinking.



Press the arrow keys to change the blinking value.

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If there is another item to be set (e.g. minutes), press the RANGE/FIXED key, and that item will start blinking.



Press the arrow keys to change the blinking value.

Press the GLP/ACCEPT key to accept the value or the CAL key to escape.

Press the arrow keys to select the next/previous parameter.

Press the SHIFT & MODE/SETUP key to exit SETUP menu at any time.

The following table lists the SETUP parameters, their valid values range and the factory settings (default):

Item	Description	Valid values	Default
OFF dAY	Alarm Time Out	OFF or 1 to 14 days	OFF
dISP	Display Cal Buffers	ON/OFF	ON
CELL	Cell Constant	0.500 to 1.700	1.000
tdS	TDS Factor	0.40 to 0.80	0.50
tc	Temperature Coefficient	0.00 to 6.00%/°C	1.90
rEF	Reference Temperature	20.0 or 25.0 °C	25.0
TIME	Time (hh:mm)	00:00 to 23:59	00:00
DATE	Date (MM.DD.YYYY)	01.01.2000-12.31.2099	01.01.2005
bEEP	Beep Status	ON/OFF	OFF
bAud	Baud Rate	600; 1200; 2400; 4800; 9600	2400
In Id	Instrument ID	0000 to 9999	0000
tEMP	Temperature Unit	°C or °F	°C

Note: If “dISP” option is ON, the tags corresponding to the calibrated buffers are displayed on the LCD while in pH measurement mode.

mV CALIBRATION (for technical personnel only)

The **Mi 180** is factory calibrated for mV.

Martini's ORP electrodes are interchangeable and no mV calibration is needed when they are replaced.

If the mV measurements are inaccurate, mV recalibration should be performed.

For an accurate recalibration, contact your dealer or the nearest Martini Customer Service Center, or follow the instructions below.

A two or three-point calibration can be performed at 0.0 mV, 600 mV and 1800 mV.

- Attach to the BNC connector a mV simulator with an accuracy of ± 0.1 mV.
- With the instrument off, press and hold the CAL & SHIFT keys, then power on the instrument. The "CALIBRATION" tag will appear, and the secondary LCD will show 0.0 mV.
- Set 0.0 mV on the simulator.
- When the reading is stable and close to the selected calibration point, the "READY" and "ACCEPT" tags will blink.
- Press the GLP/ACCEPT key to accept the calibration point. The secondary LCD will display 600 mV.
- Set 600 mV on the simulator.
- When the reading is stable and close to the selected calibration point, the "READY" and "ACCEPT" tags will blink.
- Press the GLP/ACCEPT key to accept the calibration point. The secondary LCD will display 1800 mV.
- Set 1800 mV on the simulator.
- When the reading is stable and close to the selected calibration point, the "READY" and "ACCEPT" tags will blink.
- Press the GLP/ACCEPT key to accept the calibration point. The instrument returns to measurement mode.

Notes:

- If the reading is not close to the selected calibration point, "WRONG" tag will blink. Verify calibration condition or contact your vendor if you cannot calibrate.
- To exit the calibration mode press the CAL key in any moment and the instrument will return to measurement mode. If you exit calibration after 600 mV is confirmed, the 600 mV range is calibrated and calibration parameters are memorized.

TEMPERATURE CALIBRATION (for technical personnel only)

The **Mi 180** is factory calibrated for temperature.

Martini's temperature probes are interchangeable and no temperature calibration is needed when they are replaced.

If the temperature measurements are inaccurate, temperature recalibration should be performed on both ranges (pH and EC).

For an accurate recalibration, contact your dealer or the nearest Martini Customer Service Center, or follow the instructions below.

- Prepare a vessel containing ice and water and another one containing hot water (at 50 °C). Place insulation material around the vessels to minimize temperature changes.
- Use a calibrated thermometer with a resolution of 0.1°C.
- With the instrument off, press and hold the GLP/ACCEPT & LOG/CLR/MR keys (pH range) or CAL & LOG/CLR/MR keys (EC range), then power on the instrument. The "CALIBRATION" tag will appear and the secondary LCD will show 0.0 °C.
- Immerse the temperature probe in the vessel with ice and water as near as possible to the reference thermometer. Allow a few seconds for the probe to stabilize.
- Use the UP and DOWN arrow keys to set the reading on the secondary LCD to the one measured by the reference thermometer. When the reading is stable and close to the selected calibration point, the "READY" and "ACCEPT" tags will blink.
- Press the GLP/ACCEPT key to accept the calibration point. The secondary LCD will show 50.0 °C.
- Immerse the temperature probe in the second vessel as near as possible to the reference thermometer. Allow a few seconds for the probe to stabilize.
- Use the UP and DOWN arrow keys to set the reading on the secondary LCD to that of the hot water.
- When the reading is stable and close to the selected calibration point, the "READY" and "ACCEPT" tags will blink.
- Press the GLP/ACCEPT key to accept the calibration point. The instrument returns to measurement mode.

Note: If the reading is not close to the selected calibration point, "WRONG" tag will blink. Change the temperature probe and restart calibration.

EC SOLUTIONS TEMPERATURE DEPENDENCE

The conductivity of an aqueous solution is a measure of its ability to carry an electrical current by means of ionic motion.

The conductivity invariably increases with increasing temperature.

It is affected by the type and number of ions in the solutions and by the viscosity of the solution itself. Both parameters are temperature dependent. The dependency of conductivity on temperature is expressed as a relative change per Celsius degrees at a particular temperature, commonly as %/°C.

The following table lists the temperature dependence of Martini EC calibration solutions.

°C	°F	MA 9060 ($\mu\text{S/cm}$)	MA 9061 ($\mu\text{S/cm}$)	MA 9063 ($\mu\text{S/cm}$)	MA 9064 ($\mu\text{S/cm}$)	MA 9065 ($\mu\text{S/cm}$)	MA 9069 ($\mu\text{S/cm}$)
0	32.0	7150	776	64	48300	65400	2760
5	41.0	8220	896	65	53500	74100	3180
10	50.0	9330	1020	67	59600	83200	3615
15	59.0	10480	1147	68	65400	92500	4063
16	60.8	10720	1173	70	67200	94400	4155
17	62.6	10950	1199	71	68500	96300	4245
18	64.4	11190	1225	73	69800	98200	4337
19	66.2	11430	1251	74	71300	100200	4429
20	68.0	11670	1278	76	72400	102100	4523
21	69.8	11910	1305	78	74000	104000	4617
22	71.6	12150	1332	79	75200	105900	4711
23	73.4	12390	1359	81	76500	107900	4805
24	75.2	12640	1386	82	78300	109800	4902
25	77.0	12880	1413	84	80000	111800	5000
26	78.8	13130	1440	86	81300	113800	5096
27	80.6	13370	1467	87	83000	115700	5190
28	82.4	13620	1494	89	84900	117700	5286
29	84.2	13870	1521	90	86300	119700	5383
30	86.0	14120	1548	92	88200	121800	5479
31	87.8	14370	1575	94	90000	123900	5575

PCINTERFACE

Data transmission from the instrument to the PC can be done with the **Mi 5200** Windows® compatible software, when using the RS232 or USB serial interface. **Mi 5200** also offers graphing and on-line help feature.

Data can be exported to the most popular spreadsheet programs for further analysis.

To connect the instrument to a PC through the RS232 port, use the Martini **MA 9350** cable connector.

To connect the instrument to a PC through the USB port, use a standard USB cable.

Make sure that your instrument is switched off and plug one connector of the cable to the instrument RS232/USB connector and the other to the serial port of your PC.

Notes:

- Other cables than **MA 9350** may use a different configuration. In this case, communication between instrument and PC may not be possible.
- Keep only one cable connected (RS232 or USB) during PC communication to avoid possible errors.
- If you are not using Martini Instruments **Mi 5200** software, please see the following instructions.

SENDING COMMANDS FROM PC

It is also possible to remotely control the instrument with any terminal program. Use **MA 9350** cable to connect the instrument to a PC, start the terminal program and set the communication options as follows: 8, N, 1, no flow control.

COMMAND TYPES

To send a command to the instrument follow the next scheme:

<*> <command> <CR>

where: <*> is the command prefix.

<command> is the command code.

Note: Either small or capital letters can be used.

UNIT CHANGE COMMAND

CHU xx Change the instrument unit according with the parameter value (xx):

- xx=00 pH range/0.001 resolution
- xx=01 pH range/0.01 resolution
- xx=03 mV range
- xx=04 Rel mV range

- xx=06 EC range
- xx=07 TDS range
- xx=08 NaCl range

The instrument will answer for this command with:

<STX> <answer> <ETX>

where: <STX> is 02 ASCII code character (start of text)

<ETX> is 03 ASCII code character (end of text)

<answer>:

<ACK> is sent for a recognized command

<CAN> is sent when the instrument is logging

<Err6>/<Err8> is sent when the command is incorrect or the instrument is not in measurement mode.

COMMANDS REQUIRING AN ANSWER

The instrument will answer for these commands with:

<STX> <answer> <checksum> <ETX>

where the checksum is the bytes sum of the answer string sent as 2 ASCII characters.

All the answer messages are with ASCII characters.

- RPH** Causes the instrument to send a complete set of readings in according with the pH range.
- RMV** Causes the instrument to send a complete set of readings in according with the mV / Rel mV range.
- REC** Causes the instrument to send a complete set of readings in according with the EC range.
- RTD** Causes the instrument to send a complete set of readings in according with the TDS range.
- RNC** Causes the instrument to send a complete set of readings in according with the NaCl range.
- MDL** Requests the instrument model name and firmware code (16 ASCII chars).
- INF** Requests the calibration data and the setup parameters.
- SAM** Requests the number of logged samples (20 chars).
- LDPH** Requests the xxxth pH record logged data.
- LDMV** Requests the xxxth mV/Rel mV record logged data.
- LDEC** Requests the xxxth EC record logged data.
- LDTD** Requests the xxxth TDS record logged data.
- LDNC** Requests the xxxth NaCl record logged data.
- LAPH** Requests all pH Log on demand.

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LAMV Requests all mV/Rel mV Log on demand.

LAEC Requests all EC Log on demand.

LATD Requests all TDS Log on demand.

LANC Requests all NaCl Log on demand.

Notes:

- "Err8" is sent if the instrument is not in measurement mode.
- "Err6" is sent if the requested range is not available.
- "Err4" is sent if the requested set parameter is not available.
- "Err3" is sent if the Log on demand is empty.
- Invalid commands will be ignored.

ELECTRODE CONDITIONING & MAINTENANCE

PREPARATION PROCEDURE

Remove the electrode protective cap.

DO NOT BE ALARMED IF ANY SALT DEPOSITS ARE PRESENT. This is normal with electrodes and they will disappear when rinsed with water.

During transport tiny bubbles of air may have formed inside the glass bulb. The electrode cannot function properly under these conditions. These bubbles can be removed by "shaking down" the electrode as you would do with a glass thermometer.

If the bulb and/or junction are dry, soak the electrode in **MA 9015** storage solution for at least one hour.

For refillable electrodes, if the refill solution (electrolyte) is more than 2½ cm (1") below the fill hole, add the appropriate electrolyte solution.

MEASUREMENT

Rinse the electrode tip with distilled water, immerse it (4 cm / 1½") into the sample and stir gently for a few seconds.

For a faster response and to avoid cross contamination of the samples, rinse the electrode tip with the solution to be tested before taking any measurements.

STORAGE PROCEDURE

To minimize clogging and ensure a quick response time, the glass bulb and the junction should always be kept moist.

When not in use, store it with a few drops of **MA 9015** storage solution in the protective cap.

NEVER STORE THE ELECTRODE IN DISTILLED OR DEIONIZED WATER.

PERIODIC MAINTENANCE

Inspect electrode and cable. The cable used for the connection to the instrument must be intact and there must be no points of broken insulation on the cable or cracks on the electrode stem or bulb. If any scratches or cracks are present, replace the electrode. Rinse off any salt deposits with water.

Connectors must be perfectly clean and dry.

For refillable electrodes:

Refill the electrode with fresh electrolyte (see the electrode's specifications to select the correct refilling solution). Allow the electrode to stand upright for 1 hour. Follow the Storage Procedure above.

pH CLEANING PROCEDURE

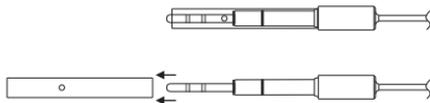
- *General* Soak in **MA 9016** General Cleaning Solution for approx. ½ hour.

IMPORTANT: After performing any of the cleaning procedures, rinse the electrode thoroughly with distilled water and soak it in **MA 9015** storage solution for at least 1 hour before taking measurements.

EC PROBE MAINTENANCE

Rinse the probe with clean water after measurements. If a more thorough cleaning is required, remove the probe sleeve and clean the probe with a cloth or a nonabrasive detergent. Make sure to reinsert the sleeve onto the probe properly and in the right direction. After cleaning the probe, recalibrate the instrument.

Take great care while handling the probe.



TROUBLESHOOTING

SYMPTOMS	PROBLEM	SOLUTION
Slow reponse/excessive drift.	Dirty pH electrode.	Soak the electrode tip in MA9016 for 30 minutes and then follow the Cleaning Procedure.
Reading fluctuates up and down (noise).	Clogged/dirty Junction. Low electrolyte level (refillable electrodes only). EC probe sleeve not properly inserted; air bubbles inside sleeve.	Clean the electrode. Refill with fresh electrolyte MA9012 (refillable electrodes only). Insert the sleeve. Tap the probe to remove air bubbles.
Display shows blinking full scale value	Reading out of range.	Check the sample is within measurable range; Check electrolyte level and general electrode status.
mV scale out of range.	Dry membrane or dry junction.	Soak the electrode in MA9015 storage solution for at least 30 minutes.
Display shows blinking "C°" or "F°" while in pH range.	Out of order temperature probe.	Replace the temperature probe.
Meter does not work with temperature probe.	Broken temperature probe.	Replace the temperature probe.
Meter fails to calibrate or gives faulty readings.	Broken pH electrode.	Replace the electrode
Meter fails to calibrate NaCl.	Incorrect EC calibration.	Recalibrate the meter in EC range. Set cell constant to 1.
At startup the meter displays all LCD tags permanently	One of the keys is blocked.	Check the keyboard or contact your dealer
"Er0, Er1, Er2" message at start up.	Internal error.	Contact your dealer or any Martini Instruments Service Center.

For your Safety don't use or store the instrument in hazardous environments. To avoid damages or burns, do not perform any measurement in microwave ovens.

ACCESSORIES

MA 9001	pH 1.68 Buffer Solution (230 mL bottle)
MA 9004	pH 4.01 Buffer Solution (230 mL bottle)
MA 9006	pH 6.86 Buffer Solution (230 mL bottle)
MA 9007	pH 7.01 Buffer Solution (230 mL bottle)
MA 9009	pH 9.18 Buffer Solution (230 mL bottle)
MA 9010	pH 10.01 Buffer Solution (230 mL bottle)
MA 9112	pH 12.45 Buffer Solution (230 mL bottle)
MA 9012	Refilling Solution for pH electrode (230 mL bottle)
MA 9015	Storage Solution (230 mL bottle)
MA 9016	Electrode Cleaning Solution (230 mL bottle)
MA 9060	12880 $\mu\text{S}/\text{cm}$ Calibration Solution (230 ml bottle)
MA 9061	1413 $\mu\text{S}/\text{cm}$ Calibration Solution (230 ml bottle)
MA 9063	84 $\mu\text{S}/\text{cm}$ Calibration Solution (230 ml bottle)
MA 9065	111.8 mS/cm Calibration Solution (230 ml bottle)
MA 9066	100 % Na Cl Calibration Solution (230 ml bottle)
MA 9069	5000 $\mu\text{S}/\text{cm}$ Calibration Solution (230 ml bottle)
MA 9310	12 VDC Adapter, 220 V
MA 9311	12 VDC Adapter, 110 V
MA 9315	Electrode Holder
MA 917B/1	pH Electrode, glass body, refillable
MA 922B/1	ORP Electrode, glass body, refillable
MA 831R	Temperature Probe
MA 814DB/1	EC/Temperature Probe
MA 9350	RS232 connection cable (2 meters)

WARRANTY

This instrument is warranted against defects in materials and manufacturing for a period of 3 years from the date of purchase. Electrodes and Probes are warranted for 6 months. If during this period the repair or replacement of parts is required, where the damage is not due to negligence or erroneous operation by the user, please return the instrument, electrode and probe to either distributor or our office and the repair will be effected free of charge.

Damage due to accidents, misuse, tampering or lack of prescribed maintenance is not covered by the warranty.

Milwaukee/Martini instruments reserves the right to make improvements in design, construction and appearance of its products without advance notice.

THANK YOU FOR CHOOSING



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