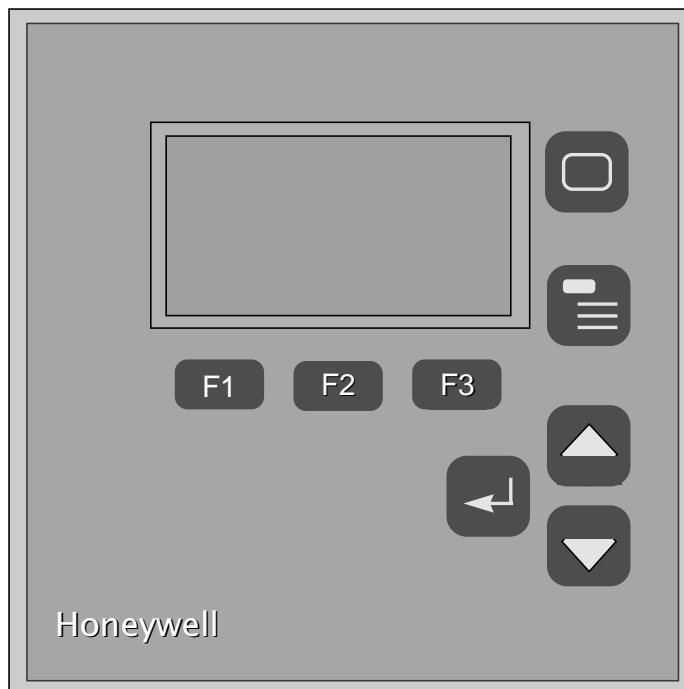# Honeywell

# 9782 Conductivity/ Resistivity Multifunction Analyzer/Controller

# Specification

## Overview

Honeywell's 9782C analyzers measure conductivity, resistivity, Total Dissolved Solids (TDS) or concentration in all conventional process and ultrapure water applications. The 9782C can measure at two locations simultaneously and provide display, alarms, and analog outputs for both. If desired, a comparison of the two measurements can be used for process control, with additional alarms or analog output on the compared value.

The user friendly, menu driven functions and keypad simplify configuration and calibration and reduces installation and wiring time. Relays and isolated output signals can be used for alarm, control, and data acquisition. Internal timers, in coordination with the relays, can be used to perform unattended cell cleaning.



## Description

Honeywell's 9782 Conductivity/Resistivity/TDS Analyzer/Controller is based on over seventy years of conductivity experience. It offers the widest available selection of advanced features in a reliable and economical instrument.

Easy to find and use menus guide the user through instrument and cell set-up, relay, alarm and output configuration, and advanced features, such as computed value and automatic cell cleaning.

The 9782 set-up is fool-proof because the parameters that a user can configure and use are determined by the model number. The model number is configured into the unit at the factory, for new analyzers, or can be changed in the field using a factory supplied password.

The 9782 offers a selection of single parameter displays or multiple parameters on a single display. The front panel has a conveniently grouped keypad that adds to the unit's user friendliness. Alarms and diagnostic messages are displayed in text form on a reverse video line for easy reading.

Using industry-accepted algorithms, the 9782C analyzer accurately compensates for conductivity changes with temperature over wide variations of water quality from ultrapure to industrial water applications.

The 9782C can be calibrated directly from the front panel using known standard solutions and/or by storing the NIST-traceable cell calibration factors in memory. Such a combination permits on-line system calibration to any accepted standard for ultimate system accuracy.

The 9782C is designed for use with the Honeywell proven conductivity cells which assures reliable and accurate analysis and control of your process.

Due to the superior instrument and cell design, a cell can be separated from the analyzer for up to a maximum distance of 1500 ft without loss of cell accuracy.
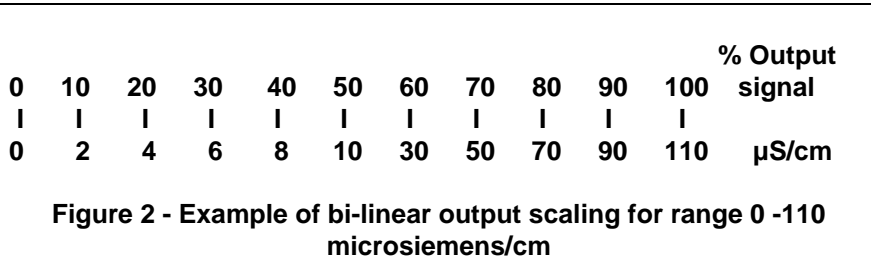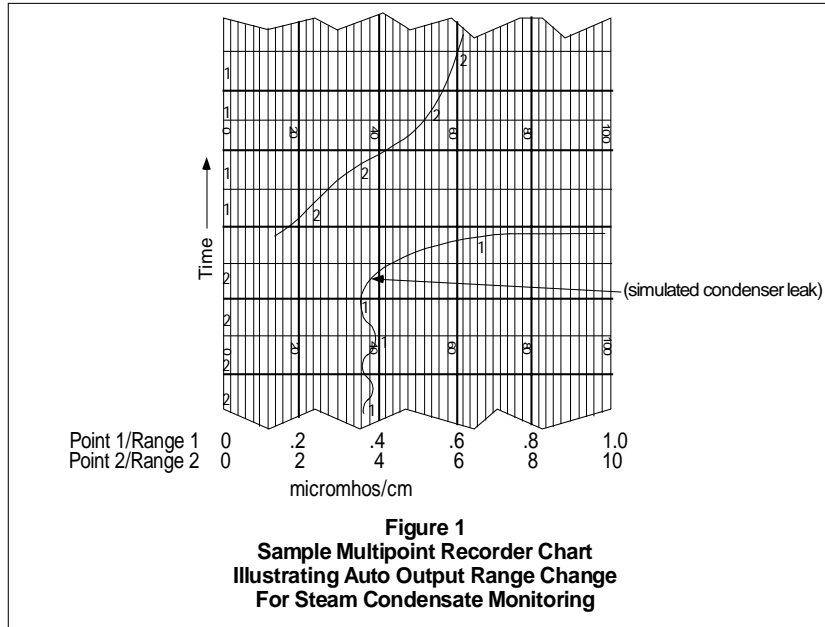
*Alarm/Control relays* have fully adjustable deadbands. The alarms can be dedicated for high or low alarm/control of either or both measurements, temperatures, or calculated values. A process upset delay timer can prevent false alarms by an adjustable delay period. Setpoints are configured from the front panel to any value within the selected range. Relays can also be dedicated to output scaling status, diagnostics and/or automatic cleaning.

*Optional outputs* represent up to three measured values, temperatures, or calculated parameter as 4-20 mA signals isolated from ground for direct connection to programmable logic controllers, data acquisition systems, and recorders.

*Auto Output Scaling Change*, when selected, expands linear scaling by a factor of 10 when the value falls below 10% of the high scaling range limit. The original output scaling is restored when the value exceeds 100% of the low scaling range. One SPDT relay can be dedicated either to indicate the output scaling status or to switch the output between two points of a multipoint recorder for range identification.

Two-decade log and bilinear scaling are also available. See Figure 1 and 2 for examples of their outputs.

Failure would be identified by a text message on the front alarm stripe. Optionally, an alarm relay can be activated by an on-line failure.



**Figure 1**
**Sample Multipoint Recorder Chart**
**Illustrating Auto Output Range Change**
**For Steam Condensate Monitoring**

| % Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | signal |
| I | I | I | I | I | I | I | I | I | I | I | |
| 0 | 2 | 4 | 6 | 8 | 10 | 30 | 50 | 70 | 90 | 110 | µS/cm |

**Figure 2 - Example of bi-linear output scaling for range 0 -110 microsiemens/cm**

*Proportional Control* output options include DAT, duration-adjusting type or time-proportioned; PFT, pulse-frequency type for electronic metering pumps; as well as CAT, current-adjusting type.

*On-line Diagnostics* test the operation of the following: RAM, EPROM memory, A/D converter, cell and temperature signal ranges, and temperature sensors.

*Off-Line Diagnostics* check keypad, display, relays, and output signals for verification of external circuit operation without connecting sensors.

*A Security Password* prevents unauthorized change but allows viewing of online parameters.

*24 Hour Clock* provides a convenient up to the minute "time check" while performing maintenance and calibration functions.

## Features

### Measurement

- Accurate measurements with one or two cells up to 1,000 millisiemens/cm (18.2 megohm-cm), or equivalent total dissolved solids ranges.
- Superior design permits 1000 ft. (305 m) separation of cells and analyzer, achieving rated accuracy without calibration.
- Two cell calibration types for assured accuracy of measurement to any accepted standard.
- Special "Trim" calibration factor for added measurement accuracy.

### Temperature Compensation

- Microprocessor provides true high-purity temperature compensation for all pure water applications.
- Accurate concentration readout with "Full Spectrum Temperature Compensation" for percent sulfuric and hydrochloric acids, sodium hydroxide, sodium chloride, ppm TDS.
- Unique power plant cation/ammonia and morpholine temperature compensation options for highest accuracy.
- Semiconductor "etch-rinse" temperature compensation for highest accuracy rinse and reclaim water monitoring.

### Computational

- Internal calculation of 2-cell ratio, % rejection, % passage, or difference for demineralizer, reverse osmosis, cooling tower, rinse, or other comparison requirements.
- Adjustable TDS conversion factors to match process composition for reverse osmosis, ion exchange, cooling towers, etc.

### Computational …cont,

- Power plant degassed cation conductivity determination of anions and carbon dioxide, using internal ASTM D4519 algorithm.

### Alarm/Control

- Up to four field-allocated SPDT relays for conductivity, resistivity, concentration, TDS, temperature, computed comparison, diagnostics.
- Adjustable alarm delay eliminates false alarms from transient upsets.
- Alarm deadbands are individually adjustable.
- On-off control with internal cycle timer.
- Proportional control with current, time-proportioned, or pulse frequency-type outputs.

### I/O

- Up to three 4-20 mA optional isolated outputs can be field-allocated among two points of conductivity/resistivity/ concentration, temperatures, and computed comparison.
- Alternative option of 0-1 V, 0-10 V, and 4-20 mA isolated outputs representing any single parameter.
- Auto linear output scaling change with SPDT relay indication; logarithmic and bilinear scaling also available.
- Settings protected by security password and $E^2$PROM (no batteries) on loss of power.
- Compatible with future digital communications options.

### Case

- NEMA 4X weatherproof, corrosion-resistant case is RFI-/EMI-shielded from walkie-talkie or other electrical noise.
- 120/240 Vac power operation
- Panel, surface, and pipe mounting available.

### Display

- Single and multiple-parameter display options.
- Menu driven displays.
- Text descriptions for diagnostics and alarms.
- Dynamic function keys
- Conveniently grouped keypad

### Compliances

- Meets CE requirements of EMC and Low Voltage Directives
- Not affected by the Year 2000 rollover

## 9782 Applications

***High Purity Water*** requires special temperature compensation in the range of 0.055 to 5 microsiemens/cm (0.2 to 18.2 Megohms-cm). Traditional compensation techniques used in most analog instruments require temperature compensator selection for a reference conductivity represented by a single curve for a given setting as in the figure. These methods lack the capability to accurately reflect the changing temperature coefficient of water for variations in temperature and conductivity on either side of that reference value.

Advanced high-purity temperature compensation determines the total conductivity at any concentration, the conductivity of water at any temperature and the interaction between the two. It compensates these values to obtain the conductivity referenced to 25°C. Because the temperature coefficients involved are both high and variable, a precise temperature measurement is required to achieve accurate compensation.

To accomplish this the Honeywell 9782 Analyzer first makes precise temperature measurements over a wide range, even with long sensor leads. Second, an accurate conductivity measurement is assured by use of the factory-determined cell calibration factor. Third, internal high-resolution algorithms are used to make exact high-purity water calculations.

This high level of performance in an inexpensive and highly reliable instrument is the result of over seventy years experience in making industrial conductivity measurements.

***Specialized Temperature Compensation*** for applications where acids or bases are the major contaminants rather than salts.
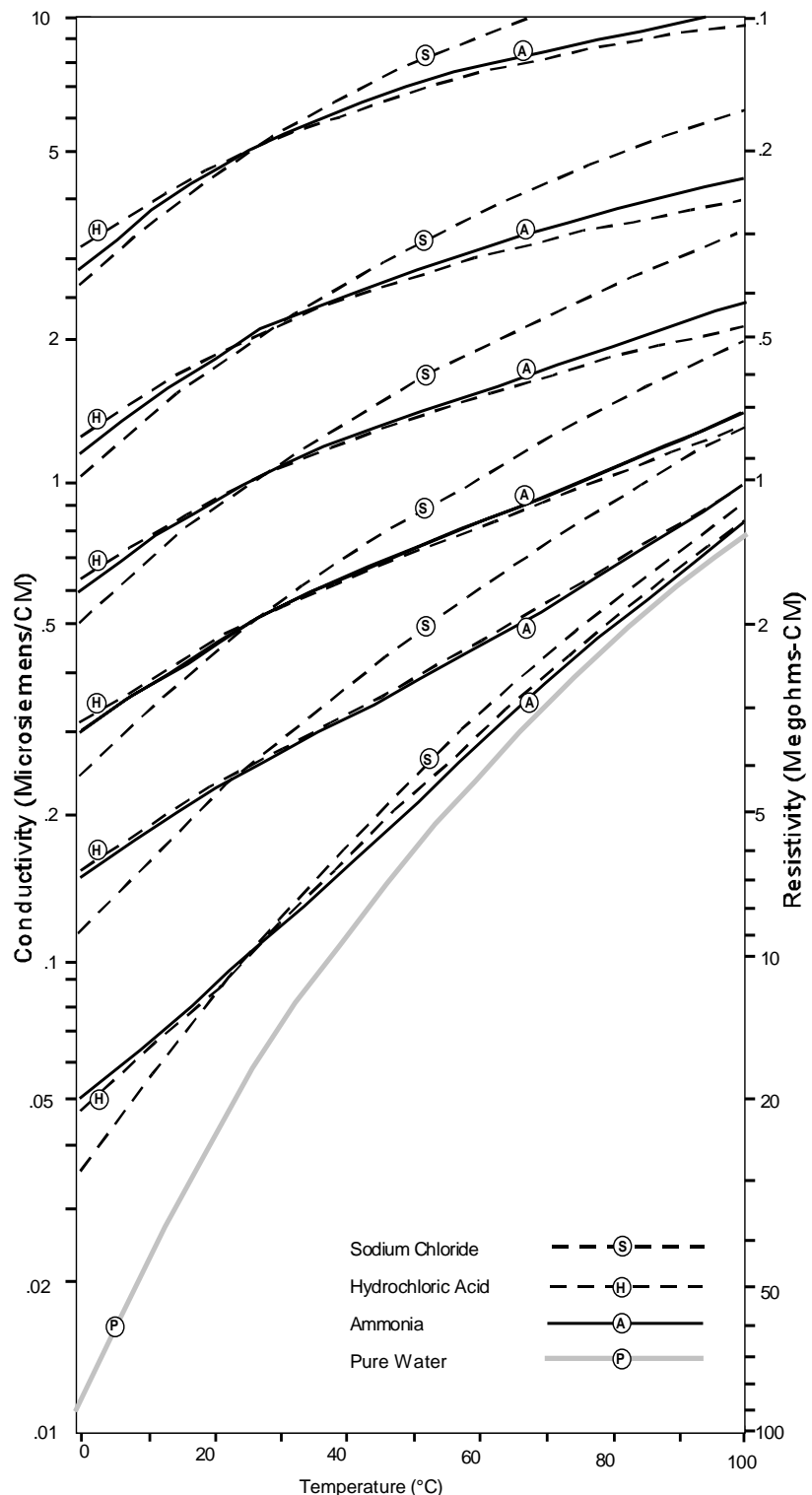


**Figure 3** Temperature effects on high-purity water. Curves represent different levels of water purity: solid curves for ammonia impurities; long/short dashed curves for sodium chloride (neutral salts) and acid impurities; dashed curves for morpholine. The bottom curve represents absolutely pure water.

Unique algorithms can be switch-selected to provide uncompromised temperature compensation accuracy. "Raw" or uncompensated conductivity can also be displayed for verifying compensation performance.

**Power Plant Cation/Ammonia** conductivity temperature compensation provides highest accuracy for measurements of cation exchanger effluent. Specific conductivity measurements of steam and condensate samples containing ammonia are also greatly improved by using this algorithm.

**Power Plant Morpholine** conductivity temperature compensation was developed specifically for this water chemistry. Morpholine has unique temperature characteristics which are available in the 9782.

**Semiconductor Etch Rinse** resistivity temperature compensation provides the most accurate measurements of used rinsewater containing traces of acidic etchants. Rinse quality control and water reclaim monitoring can be made with greater precision when this compensation is used, especially with heated water.

## Two-Cell Applications

**Parts Rinsing** is usually controlled by conductivity to obtain adequate rinsing without wasting excess water, whether a single stage or a counter-current series of tanks. The 2-cell ratio approach can determine whether inadequate rinsing is caused by low flowrate or by poor supply water quality.
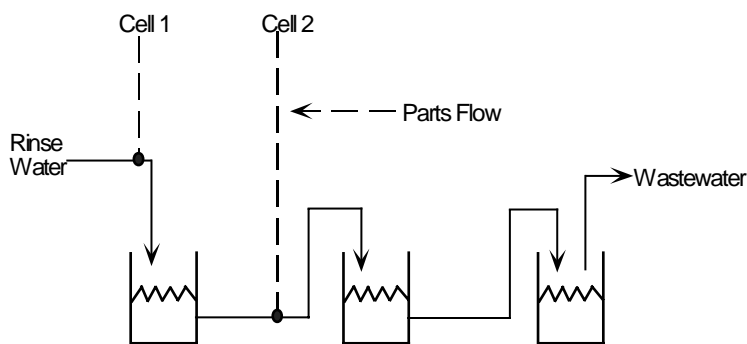


Parts Rinsing

**Reverse Osmosis** efficiency is monitored by comparing inlet and outlet conductivity (or TDS). Automatic calculations of Percent Rejection or Percent Passage are provided. Temperature readout assists with normalized performance comparisons. For seawater desalination, the wide range analyzers are used.
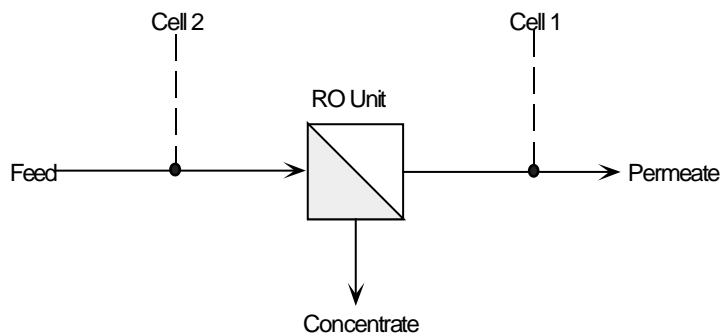


Reverse Osmosis

**Ion Exchange** operations can achieve especially precise control by using the conductivity ratio of two points with each bed. Ratio measurement accounts for feedwater variations when the upstream point is measured at the cation bed inlet. With the upstream point in the bed as shown for the following stages, it can identify exhaustion before breakthrough. Concentration ranges of diluted acid and caustic used for regeneration are also available.
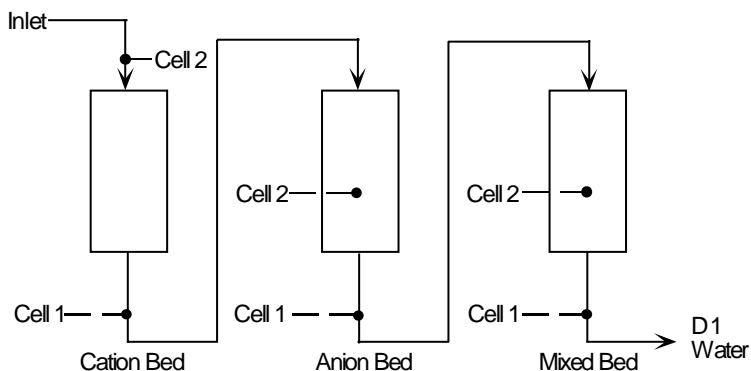


Ion Exchange

**Conductivity/Resistivity/TDS Difference** using redundant cells on critical processes can provide a valuable diagnostic capability. If the difference in measurements exceeds the alarm point, an operator is summoned for corrective action. Monitoring can be switched to the alternate cell during maintenance. A different kind of diagnostic can be provided by a precision check resistor in place of one cell to give continuous analyzer checking at one value.

Another use of conductivity difference in water treatment is to assure chemical delivery. The treatment chemical is injected into the process line between the cells. An increase in conductivity, regardless of background changes, can indicate proper treatment.
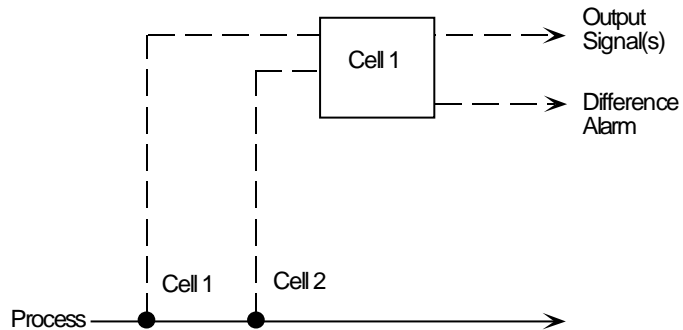


Conductivity/Resistivity/TDS Difference

**Power Plant Conductivity Measurements** relate to water chemistry parameters as follows:
- Specific conductivity—chemical treatment level
- Cation conductivity—total anion contaminants
- Degassed conductivity— non-volatile anion contaminants
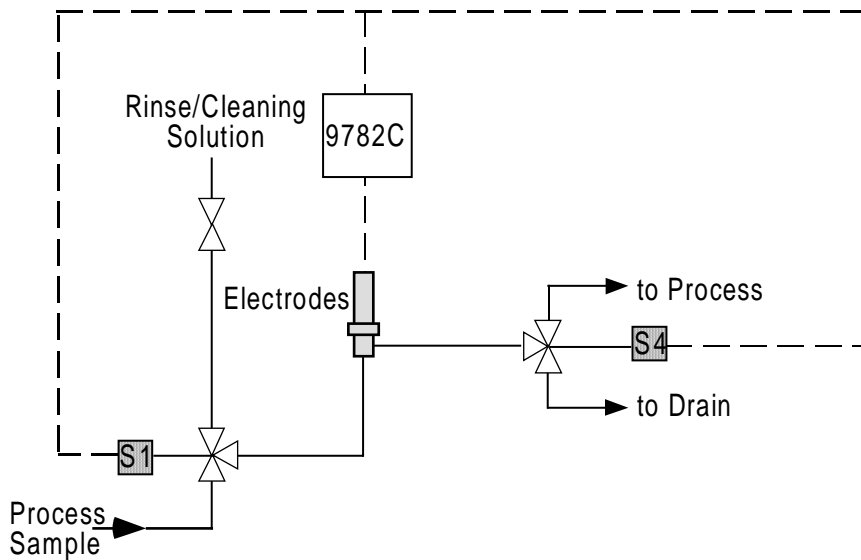- Cation minus degassed conductivities—carbon dioxide
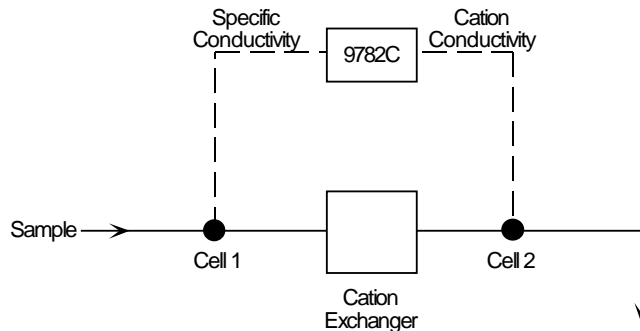


The Honeywell 9782C Two-Cell Conductivity Analyzer includes a complete menu of field-selectable functions for each of these determinations. In addition to specialized high-purity temperature compensation, the 9782 includes reboiler measurement and computation functions to automate ASTM Test Method D4519 for determining anions and carbon dioxide.
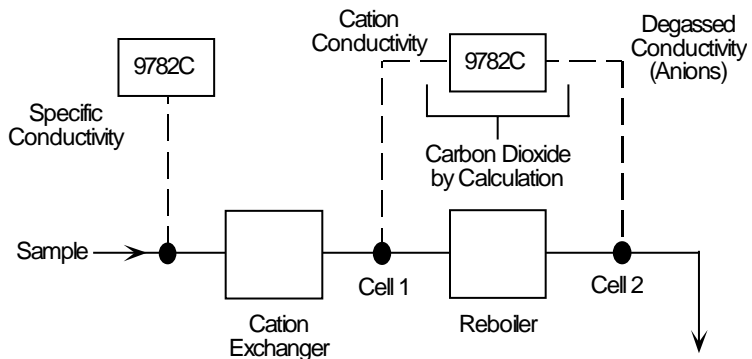
**Softener Monitoring** Softener monitoring by conductivity ratio gives a continuous indication of performance. Sodium is typically more conductive than the hardness minerals it displaces, yielding a higher conductivity at the outlet. A ratio approaching 1 indicates that hardness ions are breaking through and that regeneration is needed. A wide range analyzer can be used to control brine concentration for consistent regeneration.

(Hard) Water Supply

Cell 2

Cell 1

Soft Treated Water
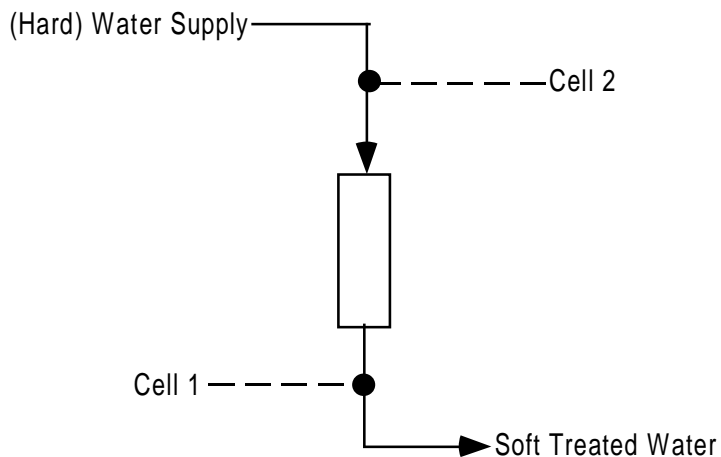
**AutoClean™ automatic cell wash** uses an internal clock to schedule the timing and duration of cleaning solution flow to the cell. Outputs, control action, and alarms are held during the sequence until the measurement has restabilized on the process sample. Solenoid valve S4 is used only if the sample is returned to the process and cleaning solution cannot be tolerated there.

Rinse/Cleaning Solution

9782C

Electrodes

to Process

S4

to Drain

S1

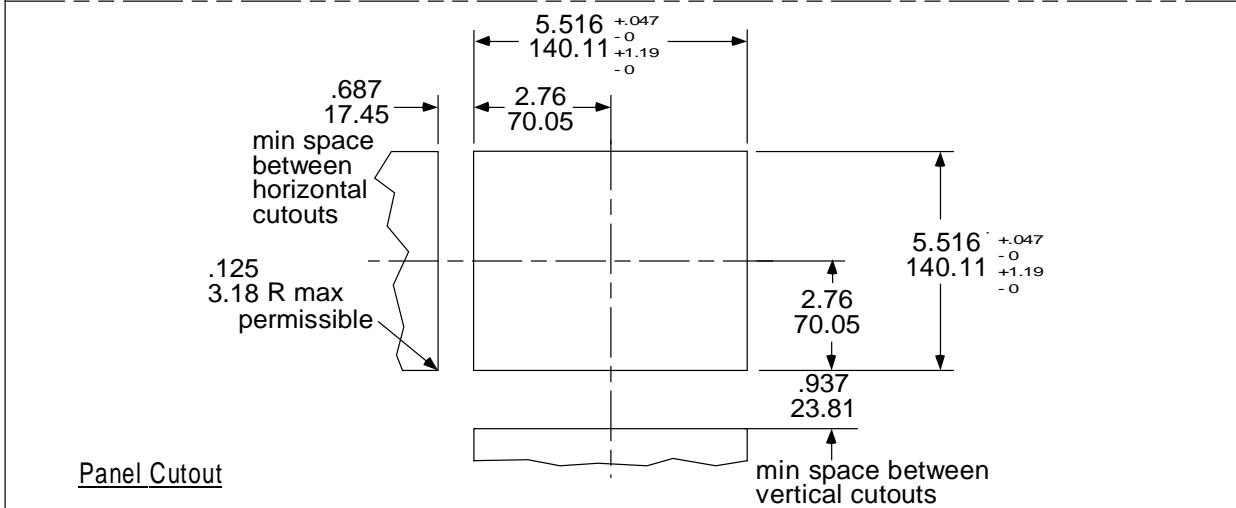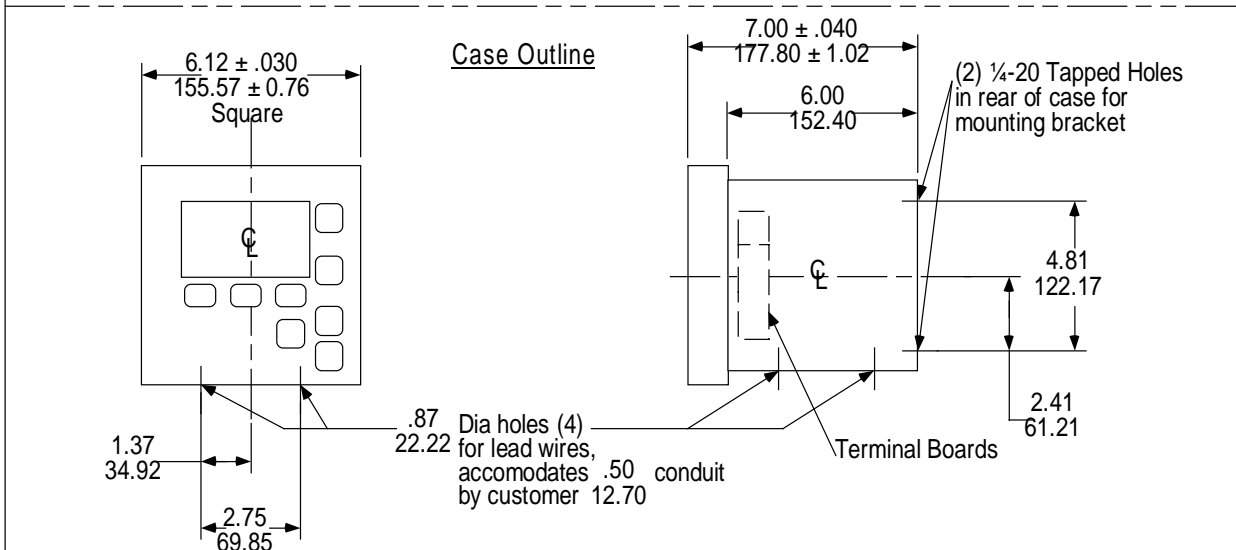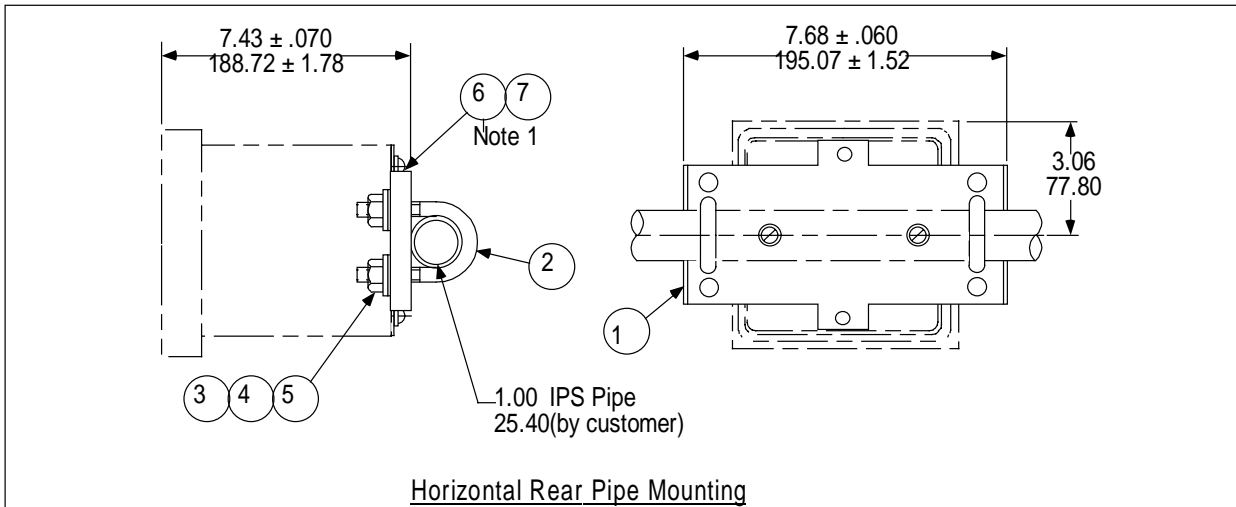Process Sample

## Specifications

| Display | LCD Dot Matrix 128 x 64 dpi Displays conductivity, resistivity, concentration, calculated parameter, temperatures, alarm conditions, alarm setpoints, calibration, output limits, and diagnostics. The display provides autoranging, moving the decimal point to increase resolution in the low end of ranges listed below. |
|---|---|

| Display Ranges | **Standard Range Analyzers:** |
|---|---|

**NOTE: Cell 1 and Cell 2 may have different constants.**

| Conductivity (microsiemens/cm) | TDS* | Resistivity (ohms-cm) | Cell Constant Required (cm$^{-1}$) |
|---|---|---|---|
| 0-1.999** | 0-1999 ppb | 0-19.99 M | 0.01 |
| 0-19.99** | 0-19,990 ppb | 0-1.999 M | 0.1*** |
| 0-199.9** | 0-199.9 ppm | 0-199.9 k | 1.0 |
| 0-1999 | 0-1999 ppm | 0-19.99 k | 10 |
| 0-19,990 | 0-10,000 ppm | 0-1.999 k | 25 or 50 |

**Computed Parameters**

| Ratio: | 0.001-19,990 |
|---|---|
| Difference: | 0 to +/- display range high end |
| Percent Passage or Rejection: | 0-100.0% |
| Carbon Dioxide (ASTM D4519) | 0-19.99 ppm |

\*   For power plant degassed cation conductivity measurements, readout may also be as ppb chloride or sulfate.
\*\*   Equivalent microsiemens/m ranges also available
\*\*\* Recommended constant for most power plant applications.

**Wide range Analyzers:**

| Conductivity | TDS | Cell Constant Required (cm$^{-1}$) |
|---|---|---|
| (microsiemens/cm) | | |
| 100-1999 | 0-1999 ppm | 0.1 |
| 1000-19,990 | 0-19,990 ppm | 1 |
| (millisiemens/cm) | | |
| 10-199.9 | 0-199.9 ppt | 10 |
| 10-500 | - - | 25 |
| 20-1000 | - - | 50 |

**Concentration (by weight)**

| 0-18.00% Hydrochloric Acid[1] | 50[2] |
|---|---|
| 0-19.99% Sulfuric Acid | 50[2] |
| 0-19.99% Sodium Hydroxide[1] | 25[2] or 50 |
| 0-19.99% Sodium Chloride | 25[2] or 50 |

1   Maximum concentrations measurable by conductivity depend on temperature. The maximum for hydrochloride acid is 15.5% above 40°C. The maximum for sodium hydroxide is 10% at 0°C, 13% at 25°C, and 20% at 75°C with linear interpolation between these points.

2   Measurements in the lower half of the concentration ranges and below 50°C can also use the next lower available cell constant:  25 for acids, 10 for sodium hydroxide or sodium chloride.

## **Specifications** (continued)

| | |
|---|---|
| Process Temperature Display | -9.9°C to 100°C, resolution 0.1°C<br>100°C to 140°C, resolution 1°C |
| Keypad | Monoplanar front panel with eight keys for pushbutton entry with tactile feedback. |
| Output Range | May be scaled to any range within the display ranges, such as 0 to 5 microsiemens/cm with 0.1 cell constant. The output may also represent temperature or a computed parameter. Scaling maybe linear, 2 decade log or bi-linear. |
| Output Range Status | An SPDT relay can provide automatic indication of range in use. |
| Performance | Under reference operating conditions.<br>Display accuracy: conductivity/resistivity, ±0.5% of reading<br>Output accuracy, as percent of span: 4-20 mA, ±0.1% or 0.01 mA, whichever is greater; 0-10 V, ±0.4%, 0-1 V, ±0.2%<br>Drift: Negligible<br>Repeatability: ±0.1% of span<br>Reference operating conditions: 25 ±1°C; 10-40% RH; 120 or 240 Vac power; 25.0°C measured process temperature |
| System Performance | Temperature measurement accuracy, without calibration, with up to 305 m (1000') of recommended leadwire: ±0.15°C typical with 4973 cells.<br>Conductivity/resistivity accuracy: ±1.8% RSS, ±1.0% RMS, without calibration; may be improved by using external standards. |
| Operating Influences | Under normal operating conditions. Effect on accuracy (% of span).<br>Temperature: 0.05%/°C<br>RH: <1%<br>Line voltage: <0.1%/volt<br>Power loss: Memory retention by $E^2$PROM, without battery |
| Operating Conditions | Ambient temperature: Normal 0-60°C, Extreme -20 to 60°C<br>Storage: -30 to 70°C<br>Line voltage: Normal 108-132 Vac or 216-264 Vac. Extreme 100-132 Vac or 200-264 Vac, 47-63 Hz.<br>RH: 90% max. noncondensing at 40°C max. |
| Output Signals | Proportional to user-set output range(s) of selected parameters, isolation rating 240 Vac (tested to 1500 V)<br>0-1 Vdc, 200 ohms min.; 0-10 Vdc, 2000 ohms min. and 4-20 mAdc, 600 ohms max., isolated from input and ground, not from each other, all on the same parameter, scaled identically<br>One 4-20 mA dc, 600 ohms max., isolated from inputs, ground, and each other, independently field-assignable to any parameters and ranges.<br>Two 4-20 mA dc, 600 ohms max., isolated from inputs, ground, and each other, independently field-assignable to any parameters and ranges.<br>Three 4-20 mA dc, 600 ohms max., isolated from inputs, ground, and each other, independently field-assignable to any parameters and ranges. |
| Standard Alarm/ Control Relays | Two SPDT, form C general purpose relays rated at 0.6 A @ 120/240 Vac or 110 Vdc, and 2 A @ 30 Vdc. |

## Specifications (continued)

| | |
|---|---|
| Additional, Optional Alarm/Control Relays | Two SPDT, form C, general purpose or hermetically sealed, rated at 3 A, 120 Vac |
| Control Settings | On/off cycle period: 0 to 1000 seconds<br>On/off percent "on" time: 0-100%, 1% resolution<br>Setpoint and proportional band limit ranges: ±100% of display range<br>DAT cycle period: 1 to 200 seconds<br>PFT maximum frequency: 1 to 200 pulse/minute |
| Temperature Compensation | High resolution (0.05°C, typical) temperature compensation by microprocessor calculation for high-purity water as well as routine water measurements. The choice of keyboard-selected temperature compensation algorithms includes high-purity with salt, acid/ammonia, or morpholine. Wide-range analyzers include "Full Spectrum Temperature Compensation," an extensive 2-dimensional data matrix, for each chemical concentration range. |
| Power requirements | 108-132 Vac or 216-264 Vac, 47-63 Hz, 15 VA. Memory retained by $E^2$PROM when power is off. |
| Standards Compliance | In conformance with the following European Council Directives: 89/336/EEC, the Electromagnetic Compatibility Directive and 73/23/EEC, the Low Voltage Directive.<br><br>Not affected by Year 2000 time rollover. |
| Case | Gray Noryl plastic, NEMA 4X, IP65, Rainproof and outdoor. Interior conductive coating to provide effective EMI/RFI shielding. |
| Case Dimensions | 156 mm x 156 mm x 178 mm (61/8" x 61/8" x 7")<br>mounting cutout: 141 mm x 141 mm (5.53" x 5.53") |
| Weight | 1.8 kg (4 lb) |
| Mounting | Panel-mounting hardware supplied. Surface and 1" to 2" pipe-mounting kit available, separately ordered. (Pipe mounting is not recommended if pipe is subject to severe vibration.) |

7.43 ± .070
188.72 ± 1.78

7.68 ± .060
195.07 ± 1.52

⑥ ⑦
Note 1

3.06
77.80

② ①

③ ④ ⑤

1.00 IPS Pipe
25.40(by customer)

Horizontal Rear Pipe Mounting

Case Outline

6.12 ± .030
155.57 ± 0.76
Square

7.00 ± .040
177.80 ± 1.02

6.00
152.40

(2) ¼-20 Tapped Holes
in rear of case for
mounting bracket

C̶L̶

C̶L̶

4.81
122.17

.87
22.22
Dia holes (4)
for lead wires,
accomodates .50 conduit
by customer 12.70

2.41
61.21

1.37
34.92

Terminal Boards

2.75
69.85

5.516 +.047 -0
140.11 +1.19 -0

.687
17.45

2.76
70.05

min space
between
horizontal
cutouts

5.516 +.047 -0
140.11 +1.19 -0

.125
3.18 R max
permissible

2.76
70.05

.937
23.81

Panel Cutout

min space between
vertical cutouts

**Mounting and Dimensions**

Distributor :-