# Agilent 4294A
# Precision Impedance Analyzer
Data Sheet

## Specifications
Specifications describe the instrument's warranted performance over the temperature range of 0 °C to 40 °C (except as noted). Supplemental performance characteristics are intended to provide information that is useful in applying the instrument by given non-warranted performance parameters. These are denoted as SPC (supplemental performance characteristics), typical, or nominal. Warm-up time must be greater than or equal to 30 minutes after power on for all specifications.

## Basic Characteristics

### Measurement Parameter

| | |
|---|---|
| Impedance Parameters | \|Z\|-θ, R-X, Ls-Rs, Ls-Q, Cs-Rs, Cs-Q, Cs-D, \|Y\|-θ, G-B, Lp-G, Lp-Q, Cp-G, Cp-Q, Cp-D, Complex Z-Y, \|Z\|-Ls, \|Z\|-Cs, \|Z\|-Lp, \|Z\|-Cp, \|Z\|-Rs, \|Z\|-Q, \|Z\|-D, Lp-Rp, Cp-Rp |

### Measurement Terminal

| | |
|---|---|
| Configuration | Four-terminal pair configuration |
| Connector type | Four BNC (female) connectors. Can be converted to one port terminal using the Agilent 42942A Terminal Adapter (7-mm port) or 42941A Impedance Probe (3.5-mm port). |

### Source Characteristics

#### Frequency

| | |
|---|---|
| Range 40 Hz to 110 MHz | |
| Resolution | 1 MHz |

| | |
|---|---|
| Accuracy | |
| without Option 4294A-1D5 | ±20 ppm (at 23 ±5 °C)<br>±40 ppm (at 0 to 55 °C) |
| with Option 4294A-1D5 | ±0.13 ppm (at 0 to 55 °C) |

**Voltage Signal Level**

| | |
|---|---|
| Range | 5 mVrms to 1 Vrms |
| Resolution | 1 mV |
| Accuracy | |
| at four-terminal pair port of the 4294A or 7-mm port of the 42942A | ±[(10 + 0.05 × *f*)% + 1 mV] (at 23 ±5 °C) |
| at measurement port of the 42941A, 16048G/H | ±[(15 + 0.1 × *f*)% + 1 mV] (at 23 ±5 °C) |

NOTE
*f*: frequency [MHz].
These characteristics apply when OPEN is connected to each port.
Test signal level should be ≤0.5 Vrms when the measured impedance is ≤50 Ω.
Beyond 23 ±5 °C of temperature, test signal level setting accuracy is twice as bad as described.

**Current Signal Level**

| | |
|---|---|
| Range | 200 μArms to 20 mArms |
| Resolution | 20 μA |
| Accuracy | |
| at four-terminal pair port of the 4294A | |
| at ≤15 MHz | +[10% + 50 μA], –[(10 + 0.2 × $f^2$)% + 50 μA]<br>(at 23 ±5 °C, typical) |
| at >15 MHz | ±[(10 + 0.3 × *f*)% + 50 μA]<br>(at 23 ±5 °C, typical) |
| at 7-mm port of the 42942A | |
| at ≤5 MHz | +[10% + 50 μA], –[(10 + 1 × $f^2$)% + 50 μA]<br>(at 23 ± 5 °C, typical) |
| at >5 MHz | ±[(10 + 0.3 × *f*)% + 50 μA]<br>(at 23 ±5 °C, typical) |

| | |
|---|---|
| at measurement port of the 42941A, 16048G/H | |
| at ≤5 MHz | +[10% + 50 μA], –[(15 + 1.5 × $f^2$)% + 50 μA]<br>(at 23 ±5 °C, typical) |
| at >5 MHz | ±[(20 + 0.3 × $f$)% + 50 μA]<br>(at 23 ±5 °C, typical) |

NOTE
*f:* frequency [MHz].
These characteristics apply when SHORT is connected to each port.
Test signal level should be ≤20 mArms when the measured impedance is ≤50 Ω.

**Signal Level Monitor**

| | |
|---|---|
| Voltage range | (Same as the voltage signal level setting range) |
| Voltage monitor accuracy | |
| at four-terminal pair port of the 4294A or 7-mm port of the 42942A | ±(10 + 0.05 × $f$ + 100/$Z_X$)[%]<br>(at 23 ±5 °C, typical) |
| at measurement port of the 42941A, 16048G/H | ±(10 + 0.15 × $f$ + 100/$Z_X$)[%]<br>(at 23 ±5 °C, typical) |
| Current range | (Same as the current signal level setting range) |
| Current monitor accuracy | |
| at four-terminal pair port of the 4294A or 7-mm port of the 42942A | ±(10 + 0.3 × $f$ + $Z_X$/100)[%]<br>(at 23 ±5 °C, typical) |
| at measurement port of the 42941A, 16048G/H | ±(10 + 0.4 × $f$ + $Z_X$/100)[%]<br>(at 23 ±5 °C, typical) |

NOTE
*f:* frequency [MHz], $Z_X$ impedance measurement value [Ω].
Beyond 23 ±5 °C, the test signal level monitor accuracy is twice as bad as described.

**Output Impedance**

| | |
|---|---|
| Output impedance | 25 Ω (nominal) |

**DC Bias Function**

| | |
|---|---|
| DC voltage bias | |
| Range | 0 to ±40 V (see Figure 1) |
| Resolution | 1 mV |
| Accuracy | ±[0.1% + (5 + 30 × \|$I_{mon}$\|) mV] (at 23 ±5 °C)<br>±[0.2% + (10 + 30 × \|$I_{mon}$\|) mV] (beyond 23 ±5 °C) |
| DC current bias | |
| Range | 0 to ±100 mA (see Figure 1) |
| Resolution | 40 μA |
| Accuracy | ±[2% + (0.2 + \|$V_{mon}$\|/20) mA] (at 23 ±5 °C)<br>±[4% + (0.4 + \|$V_{mon}$\|/20) mA] (beyond 23 ±5 °C) |
| DC voltage bias at constant voltage mode | |
| Range | 0 to ±40 V (see Figure 1) |
| Resolution | 1 mV |
| Accuracy | ±[0.5% + (5 + $Z_d$ × \|$I_{mon}$\|) mV] (at 23 ±5 °C, typical)<br>±[1.0% + (10 + $Z_d$ × \|$I_{mon}$\|) mV] (beyond 23 ±5 °C, typical) |
| DC current bias at constant current mode | |
| Range | 0 to ±100 mA (see Figure 1) |
| Resolution | 40 μA |
| Accuracy | ±[1% + (0.5 + \|$V_{mon}$\|/10000) mA] (at 23 ±5 °C, typical)<br>±[2% + (1.0 + \|$V_{mon}$\|/5000) mA] (beyond 23 ±5 °C, typical) |
| DC bias monitor | |
| DC voltage range | (Same as the dc voltage bias setting range) |
| DC voltage accuracy | ±[0.2% + (5 + $Z_d$ × \|$I_{mon}$\|) mV] (at 23 ±5 °C)<br>±[0.4% + (10 + $Z_d$ × \|$I_{mon}$\|) mV] (beyond 23 ±5 °C) |
| DC current range | (Same as the dc current bias setting range) |

| | |
|---|---|
| DC current monitor accuracy | ±[1% + (0.5 + \|$V_{mon}$\|/10000)mA] (at 23 ±5 °C)<br>±[2% + (1.0 + \|$V_{mon}$\|/5000)mA] (beyond 23 ±5 °C) |
| Output impedance | 25 Ω (nominal) |

NOTE
$V_{mon}$: dc voltage bias monitor reading value [mV]
$I_{mon}$ : dc current bias monitor reading value [mA]
$Z_d$ = 0.3 (at four-terminal pair port of the 4294A, adapter setup: NONE)
$Z_d$ = 2.0 (at 3.5 mm port of the 42941A, adapter setup: 42941A Impedance Probe)
$Z_d$ = 0.5 (at 7-mm port of the 42942A, adapter setup: 42942A Terminal Adapter)
$Z_d$ = 1.0 (at measurement port of the 16048G, adapter setup: four-terminal pair 1 m)
$Z_d$ = 1.5 (at measurement port of the 16048H, adapter setup: four-terminal pair 2 m)

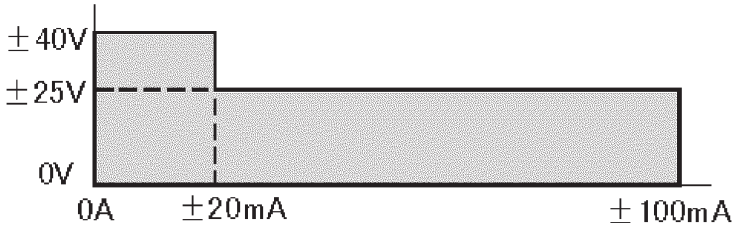



**Figure 1. DC Bias Range (SPC)**

### Sweep Characteristics

| | |
|---|---|
| Available sweep parameters | Frequency, Signal voltage, Signal current, DC bias voltage, DC bias current |
| Sweep type | Linear, Log[1], List[1], Zero-span, Manual |
| Manual sweep | Available for all sweep types |
| Sweep direction | Up sweep, Down sweep |
| Number of measurement points | 2 to 801 points |
| List Sweep | |
| Available setup parameters for each segment | Sweep frequency range, Number of measurement points, Signal level (voltage or current), DC bias (voltage or current), Measurement bandwidth, Point averaging factor |

1. Frequency sweep only.

| | |
|---|---|
| Number of segments | 1 to 18 |
| Sweep span type | Segment span or single span |
| Delay time | |
| Type | Point delay or sweep delay |
| Range | 0 sec to 30 sec |
| Resolution | 1 msec |

**Measurement Time**

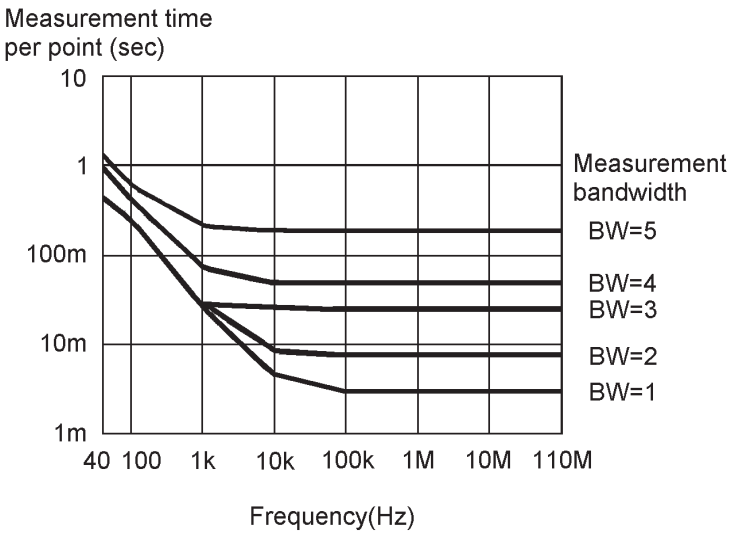



**Figure 2. Measurement Time (SPC)**

NOTE
When the Agilent 42941A Impedance Probe or 42942A Terminal Adapter is used, measurement time is 1.5 times longer than the value in Figure 2.

### Trigger Function

| | |
|---|---|
| Trigger type | Continuous, Single, Number of groups |
| Trigger source | Internal (Free run), External (BNC connector input), GPIB or LAN, Manual (Front key) |
| Trigger event type | Point trigger, Sweep trigger |

### Measurement Bandwidth/Averaging

| | |
|---|---|
| Measurement bandwidth | |
| Range | 1 (Fast) to 5 (Precise), 5 steps |
| Averaging | |
| Type | Sweep-to-sweep averaging, Point averaging |
| Averaging factor | 1 to 256 (integer) |

### Adapter Setup

| | |
|---|---|
| Adapter Selection | |
| NONE | No adapter (the 16047E, etc. direct connection type test fixture is connected) |
| 4TP 1M | Four-terminal pair 1 m (16048G) |
| 4TP 2M | Four-terminal pair 2 m (16048H) |
| 7-mm 42942A | Terminal Adapter (42942A) |
| PROBE 42941A | Impedance Probe (42941A) |

### Calibration

| | |
|---|---|
| Calibration | |
| User calibration | Calibration performed with user-defined calibration kit (OPEN, SHORT, LOAD) |
| Port extension | Compensation performed when the measurement terminal is expanded from the 7-mm connector of the 42942A Terminal Adapter or the 3.5-mm connector of the 42941A Impedance Probe. Enter electrical length or delay time for the extension. |
| Fixture compensation | Compensation performed at the device contacts of the test fixture using OPEN, SHORT, LOAD. |
| Calibration points | Fixed points, or User points determined by sweep setups |

## Measurement Accuracy

**Conditions of Accuracy Specifications**

| | |
|---|---|
| Temperature | |
| Four-terminal pair port of the 4294A's front panel | 23 ±5 °C<br>Beyond 23 ±5 °C, the measurement accuracy is twice as bad as described. |
| 7-mm port of the 42942A Terminal Adapter | Within ±5 °C from the adapter setup temperature. Measurement accuracy applies when the adapter setup is performed at 23 ±5 °C. When the adapter setup is performed beyond 23 ±5 °C, the measurement accuracy is twice as bad as described. |
| 3.5-mm port of the 42941A Impedance Probe | Within ±5 °C from the adapter setup temperature. Measurement accuracy applies when the adapter setup is performed at 23 ±5 °C. When the adapter setup is performed beyond 23 ±5 °C, the measurement accuracy is twice as bad as described. |
| Measurement terminal of the 16048G or 16048H | Within ±5 °C from the adapter setup temperature. Measurement accuracy applies when the adapter setup is performed at 23 ±5 °C. When the adapter setup is performed beyond 23 ±5 °C, the measurement accuracy is twice as bad as described. |
| Measurement bandwidth | 5 |

**Measurement Accuracy**

| | |
|---|---|
| \|Z\|, \|Y\| accuracy | $\pm E$ [%] (see Equation 1 on page 10, Equation 2 on page 12, Equation 3 on page 14) |
| θ accuracy | $\pm E$ /100 [rad] |
| L, C, X, B accuracy | |
| at $D_x \leq 0.1$ | $\pm E$ [%] |
| at $D_x > 0.1$ | $\pm E \times \sqrt{1 + D_x^2}$ [%] |
| R accuracy | |

| | |
|---|---|
| at $D_x \leq 0.1$ ($Q_x \geq 10$) | Rp: $\pm \dfrac{E}{D_x \mp E/100}$ [%]<br>Rs: $\pm E/D_x$ [%] |
| at $0.1 < D_x < 10$<br>($0.1 < Q_x < 10$) | Rp: $\pm E \times \dfrac{\sqrt{1 + D_x^2}}{D_x \mp \dfrac{E}{100} \times \sqrt{1 + D_x^2}}$ [%]<br>Rs: $\pm E \times \dfrac{\sqrt{1 + D_x^2}}{D_x}$ [%] |
| at $D_x \geq 10$ ($Q_x \leq 0.1$) | $\pm E$ [%] |
| D accuracy | |
| at $D_x \leq 0.1$ | $\pm E/100$ |
| at $0.1 < D_x \leq 1$ | $\pm E \times (1 + D_x)/100$ |
| Q accuracy (at $Q_x \times D_a < 1$) | |
| at $Q_x \leq 10$ ($D_x \geq 0.1$) | $\pm \dfrac{Q_x^2 \times E(1 + D_x)/100}{1 \mp Q_x \times E(1 + D_x)/100}$ |
| at $Q_x > 10$ ($D_x < 0.1$) | $\pm \dfrac{Q_x^2 \times E/100}{1 \mp Q_x \times E/100}$ |
| G accuracy | |
| at $D_x > 0.1$ | $\pm E \times \dfrac{\sqrt{1 + D_x^2}}{D_x}$ [%] |
| at $D_x \leq 0.1$ | $\pm E/D_x$ [%] |

NOTE
$D_x$ : measurement value of D.
$Q_x$ : measurement value of Q.
$D_a$ : measurement accuracy of D.

**Impedance Measurement Accuracy at Four-Terminal Pair Port**

Equation 1 shows the impedance measurement accuracy [%] at four-terminal pair port of the Agilent 4294A, or measurement port of the 16048G/16048H.

**Equation 1. Impedance Measurement Accuracy [%] at Four-Terminal Pair Port**

$$E = E_p' + \left( \frac{Z_s'}{|Z_x|} + Y_o' \cdot |Z_x| \right) \times 100$$

Where,

$E_P' = E_{PL} + E_{PBW} + E_{POSC} + E_P$ [%]
$Y_0' = Y_{OL} + K_{BW} \times Ky_{OSC} \times (Y_{ODC} + Y_0)$ [S]
$Z_S' = Z_{SL} + K_{BW} \times Kz_{OSC} \times Z_S$ [Ω]

*$Y_o$, $E_p$, $Z_s$:* See Figure 3 on page 17.

| | |
|---|---|
| $E_{posc}$ [%] = | |
| at oscillator level >500 mV | $0.03 \times \left( \frac{1000}{V_{mV}} - 1 \right) + \frac{f}{100}$ |
| at oscillator level >250 mV, ≤500 mV | $0.03 \times \left( \frac{500}{V_{mV}} - 1 \right)$ |
| at oscillator level >125 mV, ≤250 mV | $0.03 \times \left( \frac{250}{V_{mV}} - 1 \right)$ |
| at oscillator level >64 mV, ≤125 mV | $0.03 \times \left( \frac{125}{V_{mV}} - 1 \right)$ |
| at oscillator level ≤64 mV | $\left( \frac{64}{V_{mV}} - 1 \right) \times (0.03 + E_{PBW})$ |
| $Ky_{osc}$ = | |
| at oscillator level >500 mV | $\frac{1000}{V_{mV}}$ |
| at oscillator level ≤500 mV | $\frac{500}{V_{mV}}$ |
| $Kz_{osc}$ = | |
| at oscillator level >500 mV | 2 |
| at oscillator level >250 mV, ≤500 mV | $\frac{500}{V_{mV}}$ |
| at oscillator level >125 mV, ≤250 mV | $\frac{250}{V_{mV}}$ |
| at oscillator level >64 mV, ≤125 mV | $\frac{125}{V_{mV}}$ |
| at oscillator level ≤64 mV | $\frac{64}{V_{mV}}$ |

| $E_{PBW}$ [%] = | |
|---|---|
| at measurement BW = 5 | 0 |
| at measurement BW = 4 | |
| frequency ≥50 kHz | 0.03 |
| frequency <50 kHz | 0.06 |
| at measurement BW = 3 | |
| frequency ≥50 kHz | 0.1 |
| frequency <50 kHz | 0.2 |
| at measurement BW = 2 | |
| frequency ≥50 kHz | 0.2 |
| frequency <50 kHz | 0.4 |
| at measurement BW = 1 | |
| frequency ≥50 kHz | 0.4 |
| frequency <50 kHz | 0.8 |
| $K_{BW}$ = | |
| at measurement BW = 5 | 1 |
| at measurement BW = 4 | 1 |
| at measurement BW = 3 | |
| frequency ≤1 MHz | 3 |
| frequency >1 MHz | 4 |
| at measurement BW = 2 | |
| frequency ≤1 MHz | 4 |
| frequency >1 MHz | 5 |
| at measurement BW = 1 | |
| frequency ≤1 MHz | 6 |
| frequency >1 MHz | 10 |
| $Y_{ODC}$ = | |
| at dc bias range = 1 mA | 0 [S] |
| at dc bias range = 10 mA | 1 [µS] |
| at dc bias range = 100 mA | 10 [µS] |

$E_{PL}$ [%] =

| | |
|---|---|
| when 16048G is used | $0.02 + 2 \times \frac{f}{100}$ |
| when 16048H is used | $0.02 + 3 \times \frac{f}{100}$ |

$Y_{OL}$ =

| | |
|---|---|
| when 16048G is used | $500 \times \frac{f}{100}$ [nS] |
| when 16048H is used | $1 \times \frac{f}{100}$ [µS] |

$Z_{SL}$ =

| | |
|---|---|
| when 16048G or 16048H is used | |
| frequency ≥500 Hz | 2 [mΩ] |
| frequency <500 Hz | 5 [mΩ] |

NOTE
SPC at frequency >10 MHz.
*f :* frequency in MHz.
$V_{mV}$ *:* oscillator level in mV

**Impedance Measurement Accuracy at 7-mm Port of the Agilent 42942A**
Equation 2 shows the impedance measurement accuracy [%] at 7-mm port of the 42942A Terminal Adapter.

**Equation 2. Impedance Measurement Accuracy [%] at 7-mm Port of the Agilent 42942A**

$$E = E_p' + \left( \frac{Z_s'}{|Z_x|} + Y_o' \cdot |Z_x| \right) \times 100$$

Where,

$E_P' = E_{PBW} + E_{POSC} + E_P$ [%]
$Y_0' = K_{BW} \times Ky_{OSC} \times (Y_{ODC} + Y_0)$ [S]
$Z_S' = K_{BW} \times Kz_{OSC} \times Z_S$ [Ω]

$Y_o$, $E_p$, $Z_s$: See Figure 3 on page 17.

$E_{posc}$ [%] =

| | |
|---|---|
| at oscillator level >500 mV | $\frac{f}{100} \times \left( \frac{V_{mV}}{500} - 1 \right)$ |
| at oscillator level >125 mV, ≤500 mV | 0 |

| | |
|---|---|
| at oscillator level ≤125 mV | $\left(\frac{125}{V_{mV}} - 1\right) \times (0.05 + E_{PBW})$ |
| $Ky_{osc}$ = | |
| at oscillator level ≥500 mV | 1 |
| at oscillator level <500 mV | $\frac{500}{V_{mV}}$ |
| $Kz_{osc}$ = | |
| at oscillator level >500 mV | $2 + \frac{f}{100}$ |
| at oscillator level >250 mV, ≤500 mV | $\frac{500}{V_{mV}}$ |
| at oscillator level ≤250 mV, >125 mV | $\frac{250}{V_{mV}}$ |
| at oscillator level ≤125 mV | $\frac{125}{V_{mV}}$ |
| $E_{PBW}$ [%] = | |
| at measurement BW = 5 | 0 |
| at measurement BW = 4 | |
| frequency ≥50 kHz | 0.03 |
| frequency <50 kHz | 0.06 |
| at measurement BW = 3 | |
| frequency ≥50 kHz | 0.1 |
| frequency <50 kHz | 0.2 |
| at measurement BW = 2 | |
| frequency ≥50 kHz | 0.2 |
| frequency <50 kHz | 0.4 |
| at measurement BW = 1 | |
| frequency ≥50 kHz | 0.4 |
| frequency <50 kHz | 0.8 |
| $K_{BW}$ = | |
| at measurement BW = 5 | 1 |
| at measurement BW = 4 | 1 |

| | |
|---|---|
| at measurement BW = 3 | 3 |
| at measurement BW = 2 | 4 |
| at measurement BW = 1 | 6 |

$Y_{ODC}$ =

| | |
|---|---|
| at dc bias range = 1 mA | 0 [S] |
| at dc bias range = 10 mA | 1 [μS] |
| at dc bias range = 100 mA | 10 [μS] |

NOTE
$f$ : frequency in MHz.
$V_{mV}$ : oscillator level in mV.

**Impedance Measurement Accuracy at 3.5-mm Port of the Agilent 42941A**
Equation 3 shows the impedance measurement accuracy [%] at 3.5-mm port of the 42941A Impedance Probe.

**Equation 3. Impedance Measurement Accuracy [%] at 3.5-mm Port of the Agilent 42941A**

$$E = E_p' + \left( \frac{Z_s'}{|Z_x|} + Y_o' \cdot |Z_x| \right) \times 100$$

Where,

$E_P' = E_{PBW} + E_{POSC} + E_P$ [%]
$Y_0' = K_{BW} \times Ky_{OSC} \times (Y_{ODC} + Y_0)$ [S]
$Z_S' = K_{BW} \times Kz_{OSC} \times Z_S$ [Ω]

$Y_o$, $E_p$, $Z_s$: See Figure 3 on page 17.

$E_{posc}$ [%] =

| | |
|---|---|
| at oscillator level >500 mV | $\frac{f}{100} \times \left( \frac{V_{mV}}{500} - 1 \right)$ |
| at oscillator level >125 mV, ≤500 mV | 0 |
| at oscillator level ≤125 mV | $\left( \frac{125}{V_{mV}} - 1 \right) \times (0.05 + E_{PBW})$ |

$Ky_{osc}$ =

| | |
|---|---|
| at oscillator level ≥500 mV | 1 |
| at oscillator level <500 mV | $\frac{500}{V_{mV}}$ |

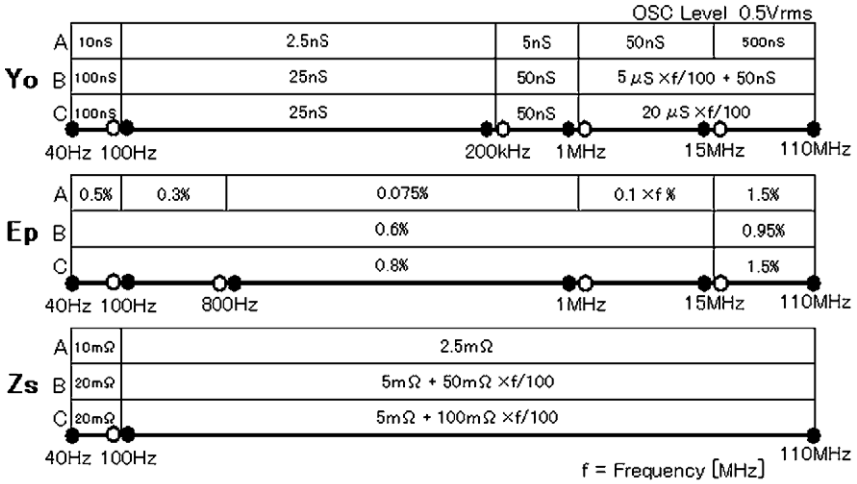
| $Kz_{osc}$ = | |
|---|---|
| at oscillator level >500 mV | $2 + \frac{f}{100}$ |
| at oscillator level >250 mV, ≤500 mV | $\frac{500}{V_{mV}}$ |
| at oscillator level ≤250 mV, >125 mV | $\frac{250}{V_{mV}}$ |
| at oscillator level ≤125 mV | $\frac{125}{V_{mV}}$ |
| $E_{PBW}$ [%] = | |
| at measurement BW = 5 | 0 |
| at measurement BW = 4 | |
| frequency ≥50 kHz | 0.03 |
| frequency <50 kHz | 0.06 |
| at measurement BW = 3 | |
| frequency ≥50 kHz | 0.1 |
| frequency <50 kHz | 0.2 |
| at measurement BW = 2 | |
| frequency ≥50 kHz | 0.2 |
| frequency <50 kHz | 0.4 |
| at measurement BW = 1 | |
| frequency ≥50 kHz | 0.4 |
| frequency <50 kHz | 0.8 |
| $K_{BW}$ = | |
| at measurement BW = 5 | 1 |
| at measurement BW = 4 | 1 |
| at measurement BW = 3 | 3 |
| at measurement BW = 2 | 4 |
| at measurement BW = 1 | 6 |
| $Y_{ODC}$ = | |
| at dc bias range = 1 mA | 0 [S] |
| at dc bias range = 10 mA | 1 [µS] |
| at dc bias range = 100 mA | 10 [µS] |

NOTE
$f$ : frequency in MHz.
$V_{mV}$ : oscillator level in mV.

**Temperature Coefficient of the Agilent 42941A Impedance Probe (SPC)**

| | |
|---|---|
| Proportional part (at 50 Ω measurement) | |
| \|Z\| deviation [ppm/°C] | |
| at frequency ≤1 MHz | <5 |
| at frequency >1 MHz | $20 + 500 \times \frac{f}{100}$ |
| θ deviation [μrad/°C] | |
| at frequency ≤1 MHz | <5 |
| at frequency >1 MHz, ≤5 MHz | $30 \times \frac{f}{5}$ |
| at frequency >5 MHz, ≤30 MHz | $50 + 150 \times \frac{f}{30}$ |
| at frequency >30 MHz | 200 |
| Residual part | |
| Residual impedance | $5 \times \frac{f}{100}$ [mΩ/°C] |
| Residual admittance | $\frac{f}{100}$ [μS/°C] |

NOTE
$f$ : frequency in MHz.
These characteristics apply when the temperature of the probe (tip to 30 cm) is changed.




A = 4294A front panel 4 terminal pair port (no extension),
B = 7-mm one port (with 42942A).
C = Probe 3.5-mm port (with 42941A).
For accuracy at probe tip, add the following error factors (typical):
Yo: + $2\pi f \times 0.1\ \mu S$
Zs: + 20mΩ

**Figure 3. Parameters $Y_o$, $E_p$, and $Z_S$**

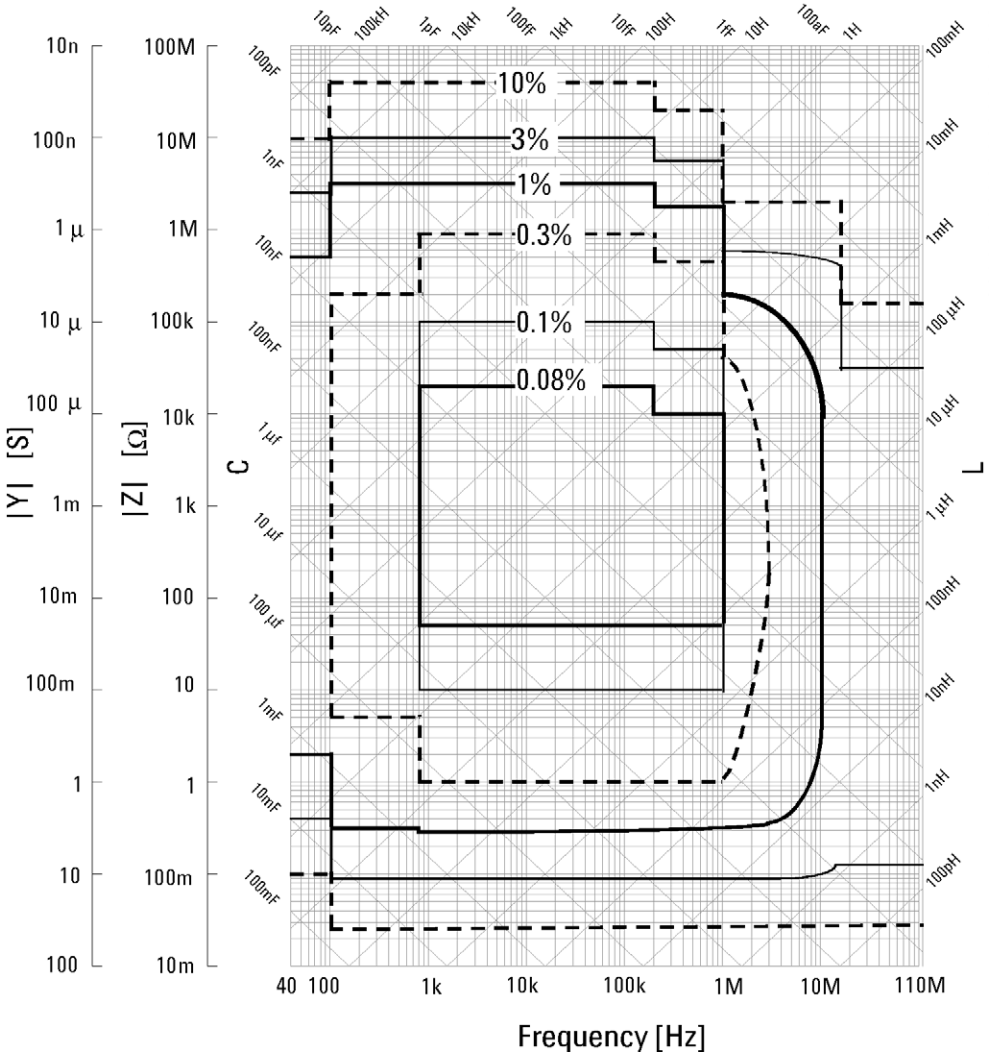



**Figure 4. Examples of Calculated Impedance Measurement Accuracy at Four-Terminal Pair Port of the Agilent 4294A's Front Panel (Oscillator Level = 0.5 Vrms)**

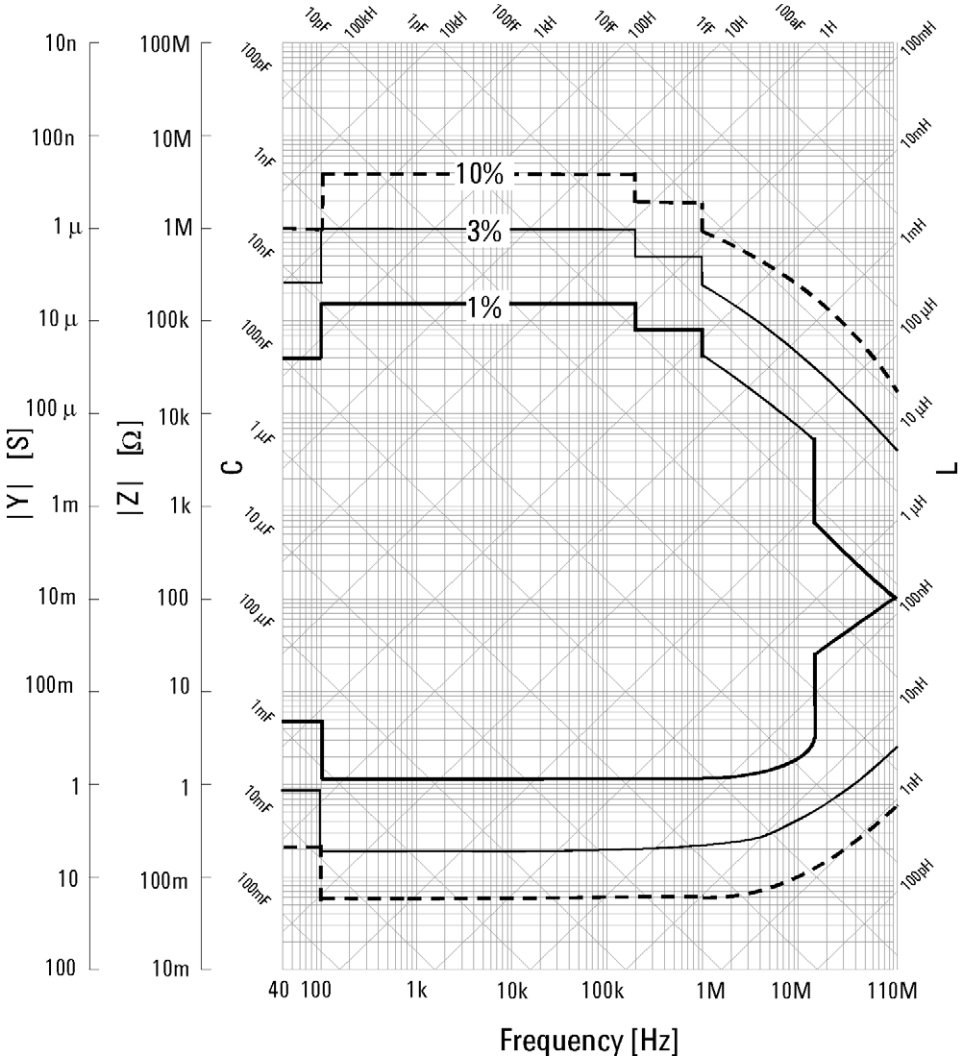



**Figure 5. Impedance Measurement Accuracy at 7-mm Port of the Agilent 42942A Terminal Adapter Connected to the Agilent 4294A (Oscillator Level = 0.5 Vrms)**

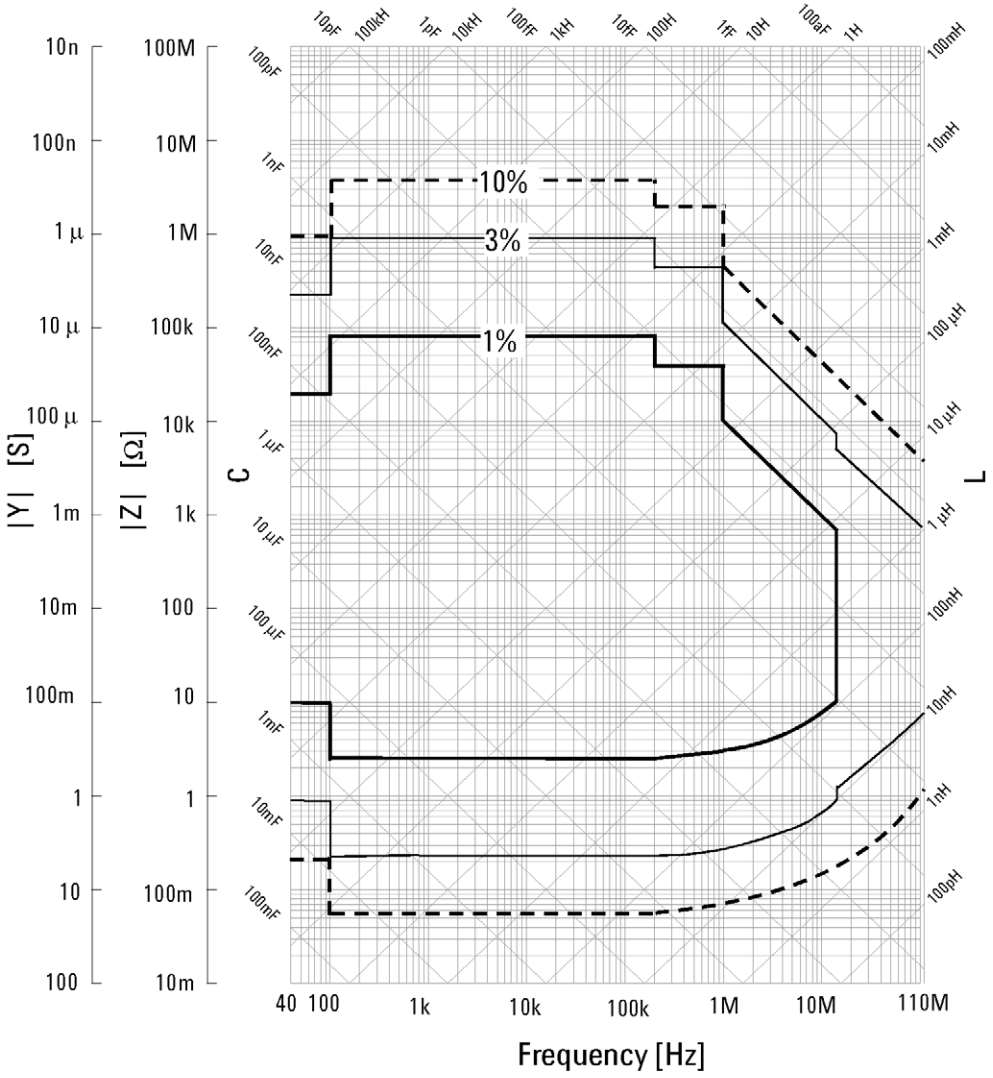



**Figure 6. Impedance Measurement Accuracy at 3.5-mm port of the Agilent 42941A Impedance Probe Connected to the Agilent 4294A (Oscillator Level = 0.5 Vrms)**

**Display Function**

| | |
|---|---|
| Display | |
| Size/Type | 8.4 inch color LCD (TFT) |
| Number or pixels | 640 × 480 (VGA) |
| Scale type | |
| X axis scale | Linear and Log |
| Y axis scale | Linear and Log (depends on the sweep type) |
| Number of traces | |
| Data trace | 2 traces (trace A and trace B) |
| Memory trace | 2 traces (trace A and trace B) |
| Split display | Available (trace A: upper half, trace B: lower half) |
| Instrument/IBASIC display selection | All Instrument, Half Instrument and half IBASIC, all IBASIC, or Instrument and IBASIC status. |
| Other display function | Inactive trace off, Trace accumulation, Phase expansion |
| Data math function | Data—Memory, Data/Memory[1], Delta%[2], Offset |

1. Complex Z-Y measurement only.
2. Except for Complex Z-Y measurement.

**Marker Function**

| | |
|---|---|
| Marker type and number | |
| Main marker | One for each trace (A and B). |
| Sub marker | Seven for each trace (A and B). |
| Δ marker | One for each trace (A and B). |
| Marker search | |
| Search type | Maximum, Minimum, Target, Peak, Trace bandwidth analysis |
| Search track | Performs search by each sweep |
| Marker X-axis display | Sweep parameter value, Sweep elapsed time, or Relaxation time ($1/2\pi f$) |
| Others | Marker continuous mode, Δ marker mode, Marker coupled mode, Marker value substitution (Marker→), Marker zooming, Marker list, Marker statistics, Marker signal/dc bias monitor |

**Equivalent Circuit Analysis**

| | |
|---|---|
| Circuit model | 3 component model (4 models), 4 component model (1 model) |
| Analysis type | Equivalent circuit parameters calculation, Frequency characteristics simulation |

**Limit Line Test**

| | |
|---|---|
| Available setup parameters for each | Sweep start value, sweep stop value, upper limit (middle value) segment and lower limit (delta limit) for sweep start, upper limit (middle value) and lower limit (delta limit) for sweep stop |
| Number of segments | 1 to 18 |
| Other functions | Beep fail, Limit line offset |

**Mass Storage**

| | |
|---|---|
| Flexible disk drive | |
| Type | 3.5 inch, Built-in |
| Size | 1.44 MB |
| Format | DOS |
| Formatting | Available |
| Volatile memory disk | |
| Size | 512 KB |
| Non-volatile memory disk (Flash memory) | |
| Size | 10 MB |
| Stored data | State (binary), Data (binary or ASCII), Display graphics (TIFF) |

**Printer Parallel Port**

| | |
|---|---|
| Interface Standard | IEEE 1284 Centronics |
| Printer control language | HP PCL3 printer control language |
| Connector type | 25 pin D-SUB connector |

### GPIB

| | |
|---|---|
| Standard conformity | IEEE 448.1-1987, IEEE 488.2-1987, IEC 625, JIS C ,1901-1987 |
| Available functions (function code)[1] | SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C4, C11, E2 |
| Numeric data transfer format | ASCII, 32 or 64 bit IEEE 754 floating point format, DOS PC format (32 bit IEEE reversed byte order) |

1. See document of the standard for the meaning of each code.

### Instrument BASIC

| | |
|---|---|
| Keyboard | |
| Type | PS/2 style 101 English |
| Connector Type | Mini-DIN connector |

### 8 Bit I/O Port

| | |
|---|---|
| Connector type | 15 pin D-SUB connector |
| Signal level | TTL |
| Number of I/O bit | 4 bit for input, 8 bit for output |
| Pin assignment | (see Figure 7) |

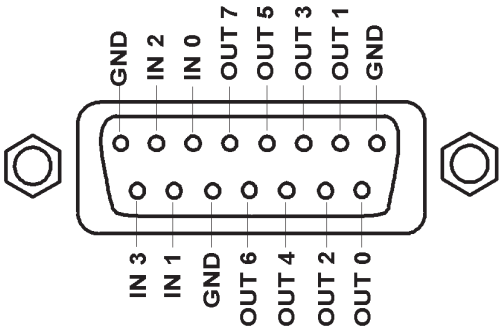



**Figure 7. 8 Bit I/O Port Pin Assignment**

**24 Bit I/O Port (Handler Interface)**

| | |
|---|---|
| Connector type | 36 pin D-SUB connector |
| Signal level | TTL |
| Number of I/O bit | 8 bit for input or output, 16 bit for output |
| Pin Assignment | (see Figure 8 and Table 1) |

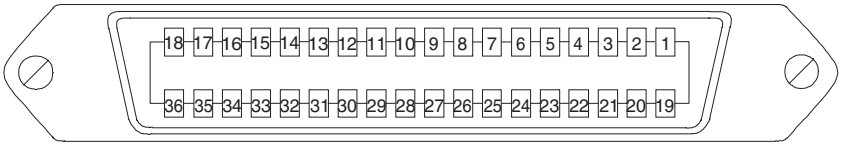



**Figure 8. 24 Bit I/O Port Pin Assignment**

**Table 1. 24 Bit I/O Port Pin Assignment**

| Pin No. | Signal Name | Signal Standard |
|---|---|---|
| 1 | GND | 0 V |
| 2 | INPUT1 | TTL level, pulse input, pulse width: 1 μs or above |
| 3 | OUTPUT1 | TTL level, latch output |
| 4 | OUTPUT2 | TTL level, latch output |
| 5 | Output port A0 | TTL level, latch output |
| 6 | Output port A1 | TTL level, latch output |
| 7 | Output port A2 | TTL level, latch output |
| 8 | Output port A3 | TTL level, latch output |
| 9 | Output port A4 | TTL level, latch output |
| 10 | Output port A5 | TTL level, latch output |
| 11 | Output port A6 | TTL level, latch output |
| 12 | Output port A7 | TTL level, latch output |
| 13 | Output port B0 | TTL level, latch output |
| 14 | Output port B1 | TTL level, latch output |
| 15 | Output port B2 | TTL level, latch output |
| 16 | Output port B3 | TTL level, latch output |

**Table 1. 24 Bit I/0 Port Pin Assignment**

| Pin No. | Signal Name | Signal Standard |
|---|---|---|
| 17 | Output port B4 | TTL level, latch output |
| 18 | Output port B5 | TTL level, latch output |
| 19 | Output port B6 | TTL level, latch output |
| 20 | Output port B7 | TTL level, latch output |
| 21 | Input/Output port C0 | TTL level, latch output |
| 22 | Input/Output port C1 | TTL level, latch output |
| 23 | Input/Output port C2 | TTL level, latch output |
| 24 | Input/Output port C3 | TTL level, latch output |
| 25 | Input/Output port D0 | TTL level, latch output |
| 26 | Input/Output port D1 | TTL level, latch output |
| 27 | Input/Output port D2 | TTL level, latch output |
| 28 | Input/Output port D3 | TTL level, latch output |
| 29 | Port C status | TTL level, input mode; LOW, output mode: HIGH |
| 30 | Port D status | TTL level, input mode; LOW, output mode: HIGH |
| 31 | Write strobe signal | TTL level, active low, pulse output (width: 10 µs, typical) |
| 32 | +5 V pullup | |
| 33 | SWEEP END signal | TTL level, active low, pulse output (width: 20 µs, typical) |
| 34 | +5 V | +5 V, 100 mA MAX |
| 35 | PASS/FAIL signal | TTL level, PASS: HIGH, FAIL; LOW, latch output |
| 36 | PASS/FAIL write strobe signal | TTL level, active low, pulse output (width: 10 µs, typical) |

**LAN Interface**

| | |
|---|---|
| Standard conformity | 10 Base-T Ethertwist, RJ45 connector |
| Protocol | TCP/IP |
| Supported application | Telnet, FTP, FTP with automatic execution |

## General Characteristics

### External Reference Input

| | |
|---|---|
| Frequency | 10 MHz ±10 ppm (typical) |
| Level | – 5 dBm to +5 dBm (typical) |
| Input impedance | 50 Ω (nominal) |
| Connector type | BNC (female) |

### Internal Reference Output

| | |
|---|---|
| Frequency | 10 MHz (nominal) |
| Level | 0 dBm (typical) |
| Output impedance | 50 Ω (nominal) |
| Connector type | BNC (female) |

### High Stability Frequency Reference Output (Option 4294A-1D5)

| | |
|---|---|
| Frequency | 10 MHz (nominal) |
| Level | 0 dBm (typical) |
| Output impedance | 50 Ω (nominal) |
| Connector type | BNC (female) |

### External Trigger Input

| | |
|---|---|
| Level | TTL |
| Pulse width (Tp) | ≥2 µs (typical); see Figure 9 for the definition of Tp. |
| Polarity | Positive or Negative (selective) |
| Connector type | BNC (female) |

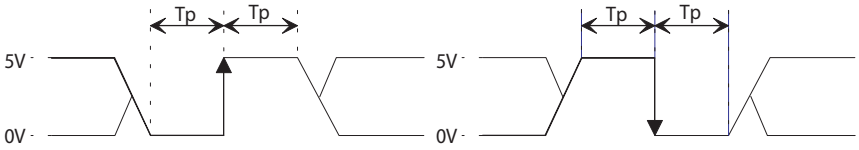



**Figure 9. Required Pulse Width (Tp) for External Trigger Input**

### External Program RUN/CONT Input

| | |
|---|---|
| Level | TTL |
| Connector type | BNC (female) |

### External Monitor Output

| | |
|---|---|
| Connector type | D-SUB, 15 pin HD |
| Display resolution | 640 × 480 (VGA) |

### Operating Conditions

| | |
|---|---|
| Temperature | |
| Disk drive non-operating condition | 0 °C to 40 °C |
| Disk drive operating condition | 10 °C to 40 °C |
| Humidity (at wet bulb temperature ≤29 °C, without condensation) | |
| Disk drive non-operating condition | 15% to 95% RH |
| Disk drive operating condition | 15% to 80% RH |
| Altitude | 0 m to 2,000 m |
| Warm-up time | 30 minutes |

### Non-operating Conditions

| | |
|---|---|
| Temperature | –20 °C to +60 °C |
| Humidity (at wet bulb temperature ≤45 °C, without condensation) | 15% to 95% RH |
| Altitude | 0 m to 4,572 m |

### Others

| | |
|---|---|
| EMC | EN 55011(1991)/CISPR 11(1990) Group 1, Class A<br>EN 50082-1(1992)/IEC 61000-4-2(1995) 4 kV CD, 8 kV AD<br>EN 50082-1(1992)/IEC 61000-4-3(1995) 3 V/m, 27 MHz to 1 GHz<br>EN 50082-1(1992)/IEC 61000-4-4(1995) 0,5 kV Signal Line, 1 kV Power Line<br>EN 61000-3-2(1995)/IEC 61000-3-2(1995)<br>EN 61000-3-3(1995)/IEC 61000-3-3(1994)z |
| Safety | EN 61010-1(1993) +Amd2(1995)/IEC61010-1(1990) +Am1(1992) +Am2(1995)<br>CSA-C22.2 N0.1010.1-92 |
| Power requirement | 90 V to 132 V, or 198 V to 264 V (automatically switched), 47 Hz to 63 Hz, 300 VA max. |
| Weight | 25 kg (SPC) |
| Dimensions | See Figures 10 through 12. |

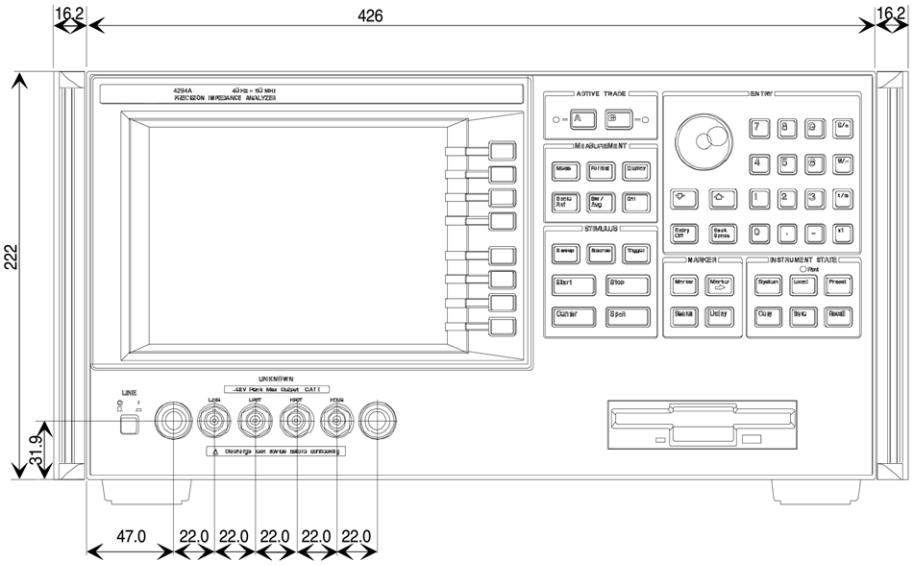



**Figure 10. Agilent 4294A dimensions (front view, with Option 4294A-1CN/4294A-1D5, typical, in millimeters)**

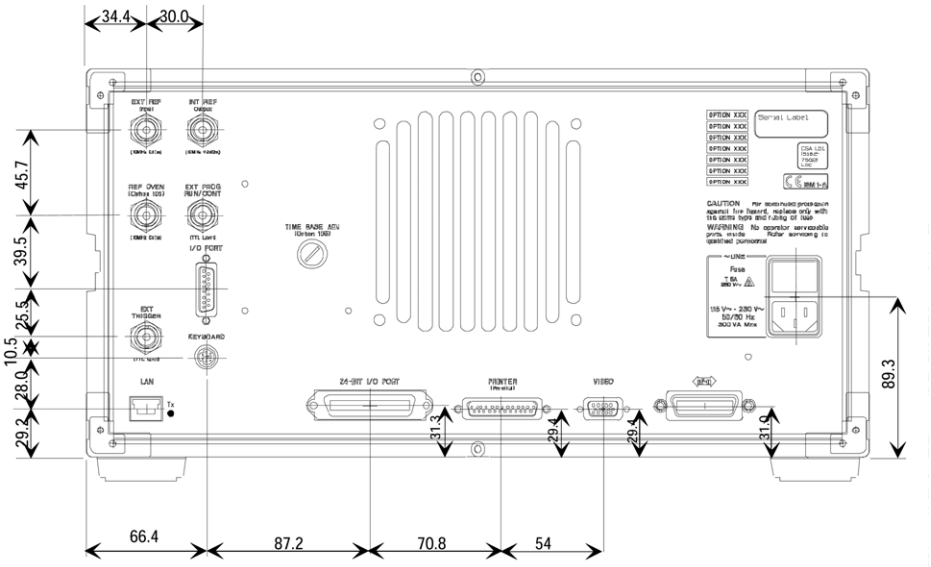



**Figure 11. Agilent 4294A dimensions (rear view, with Option 4294A-1CN/4294A-1D5, typical, in millimeters)**

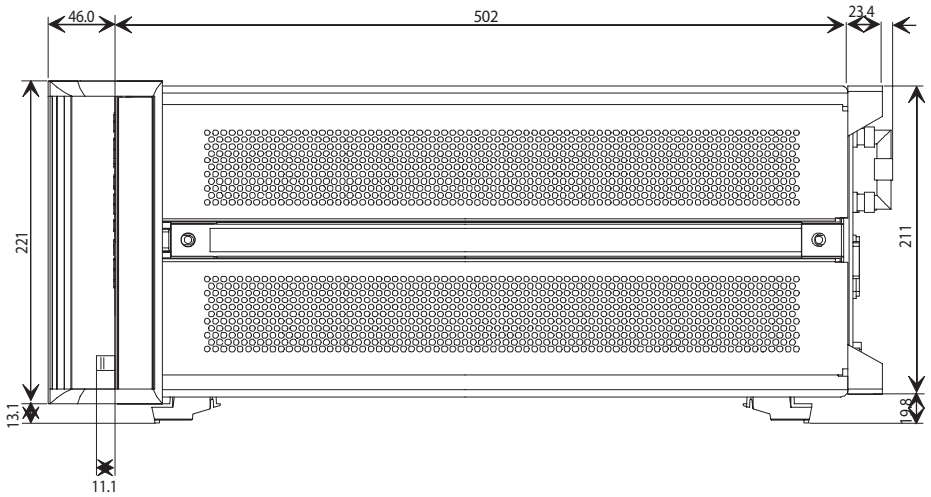



**Figure 12. Agilent 4294A dimensions (side view, with Option 4294A-1CN/4294A-1D5, typical, in millimeters)**

## Furnished Accessories

| Agilent Part Number | Description | Qty |
|---|---|---|
| 04294-90040/04294-97040 | Operation Manual (English/Japanese)[1] | 1 |
| 04294-90041/04294-97031 | Programming Manual (English/Japanese)[1] | 1 |
| E2083-90005 | Instrument BASIC User's Handbook[1] | 1 |
| 04294-90100 | Service Manual[2] | 1 |
| 04294-18000 | Sample Program Disk (3.5 inch)[1] | 1 |
| 04294-61001 | 100 Ω Resister | 1 |
| C3757-60401 | Mini-DIN Keyboard[3] | 1 |
| ——— | Power Cable[4] | 1 |
| 1250-1859 | BNC Adapter[5] | 1 |
| 5062-3991 | Handle Kit[6] | 1 |
| 5062-3979 | Rackmount Kit[7] | 1 |
| 5062-3985 | Rackmount & Handle Kit[8] | 1 |

1. Not furnished if Option 4294A-0B0 (Delete Manual) is designated.
2. Option 4294A-0BW (Add Service Manual) only.
3. Not furnished if Option 4294A-1A2 (Delete Keyboard) is designated.
4. The power cable depends on which country the instrument is used in.
5. Option 4294A-1D5 (High Stability Frequency Reference) only.
6. Option 4294A-1CN (Handle Kit) only.
7. Option 4294A-1CM (Rackmount Kit) only.
8. Option 4294A-1CP (Rackmount & Handle Kit) only.

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