1-4. ABOUT THE MODEL 4191A.

MULTIPLE PARAMETER FEATURES

The HP Model 4191A RF Impedance Analyzer is a fully automatic, high performance test instrument designed to measure diverse impedance parameter values of electronic devices and materials at extended frequencies ranging from MF to the UHF region. The 4191A measures resistance (R), reactance (X), conductance (G), susceptance (B), inductance (L), capacitance (C), dissipation factor (D), quality factor (Q) and, in addition, the absolute values of impedance (|Z|) and admittance (|Y|), along with phase angle (θ) over wide frequency and measurement ranges at high speed. Furthermore, the 4191A can make reflection parameter measurements (absolute value $|\Gamma|$ with phase angle θ, real Γx and imaginary part Γy) of the sample which is terminated at a single 50Ω test port. These multiple measurement parameters of the 4191A enable straight forward measurement of the desired parameter values obviating the necessity of complex parameter conversion calculations which are usually time-consuming processes in RF vector measurements.

TEST FREQUENCY (1-1000 MHz)

Measurement frequency is keyboard controlled at 100 kHz resolution from 1 MHz to 500 MHz and at 200 kHz resolution for the higher frequencies (to 1000 MHz). Optionally, the frequency is selectable at 100 Hz resolution for the same frequency range (200 Hz resolution for frequencies above 500 MHz). The internal synthesizer test frequency signal is accurate to 3 ppm which satisfies stability and spectral purity requirments for measurement of resonators, high selectivity filtering devices and other components. The built-in test signal source also provides swept frequency measurement convenience (a feature of the 4191A). The 4191A is capable of dual mode digital sweep operations – linear and logarithmic sweep measurements in response to start, stop and step parameters programmed through its control keys. By the use of an external signal source of higher frequency resolution, the test frequency can be exactly tuned to the desired test frequency, for example, the resonance point of a crystal resonator.

WIDE RANGE CAPABILITIES

The measurement ranges were established with respect to acceptable measurement result inaccuracies. The practicable measurement range for impedance and resistance spans 100 mΩ to 20 kΩ, admittance from 100 μS to 10S, conductance from 20 μS to 10S, inductance from 0.1 nH to 5 mH, capacitance from 0.1 pF to 1 μF, all of which are dependent on the test frequency, and reflection coefficient from .0000 to ±1.0000. Either reactance, susceptance, equivalent series resistance, conductance, dissipation factor, quality factor or phase angle can be selected as subordinate choices to the |Z|, |Y|, R, G, L, C or Γ measurement. The practicable range for reactance is from 100 mΩ to 20 kΩ, susceptance and conductance from 20 μS to 10S, equivalent series resistance from 100 mΩ to 20 kΩ, dissipation factor and quality factor from 0.001 to 1000, and phase angle from ±0.01° to ±180.00°.

HIGH SPEED OR AVERAGING

The two measurement display sections provide simultaneous readouts for the selected measurement parameters by 4-1/2 digit numeric segments along with appropriate units. In normal mode operation, the 4191A displays a running average of the five preceding measurements at about an 800 ms measuring rate. A high speed measurement mode implements the instantaneous display of measurement data taken at about 250 ms.

HIGH ACCURACY

The basic accuracy is 1% for measurements of nearly 50Ω impedance elements, and the instrument has an improved accuracy over its full range. The 4191A must be calibrated at the desired frequency range or for the entire frequency range before taking measurements. The calibration is performed under automatic settings of both the test parameter and frequency(ies) using three kinds of reference terminations (supplied accessories). As a result of such automatic calibration, the measurement accuracy is optimized and the frequency of periodic maintenance can be reduced.

OPERABILITY

Microprocessor based design of the hardware pushes this universal impedance analyzer towards simple operation yet adds advanced performance. Desired test parameters are fully programmable through the front panel control keys or by HP-IB control capability furnished in the standard unit. Two delta (Δ) key functions eliminate the inconvenience of deviation measurement calculations. These arithmetic functions make possible the direct readout of the measured values minus a reference value or of the percentage that the measurement deviates from the reference. The reference value can be taken from either the measurement of a reference sample or from program data input. The microprocesser augments the high reliability design of the 4191A. Convenient operational diagnosis is feasible by merely pressing a panel pushbutton. This confirms functional operation of the instrument. Ease of operation is further enhanced by the "save" function for continuous memorization of control settings sustained by battery memory backup capability. A continuous memory also preserves the auto-calibration data and saves calibration time prior to measurements.

INTERNAL BIAS

Internal dc bias up to ±40V by keyboard control action and swept voltage bias provide convenience for bias applications. Precise voltage setting capability enables control of bias voltage in constant 10mV minimum steps (to 40V) with basic voltage accuracy of 0.1%. The programmability and ease of control by keyboard action provide new dc bias operability obviating the need of an external bias supply and a bias controller.

FLEXIBILITY AND EXTENDED USE

The versatility and operability of the 4191A are maximized by the availability of versatile test fixtures. The installation of options which can provide high resolution test frequency and analog recorder output capabilities – both of which can be combined in one unit, augment these capabilities. Test fixtures are designed with careful consideration for enhancing the reliability of measurement across broad frequency and impedance ranges. The high resolution test frequency option multiplies the frequency resolution of the synthesizer test signal source by 1000 times. Analog recorder output permits the graphic recording of measurement data on an X-Y recorder in swept frequency/bias measurements. In reflection parameter measurements (in particular), the recorder output can draw swept parameter data on a Smith Chart.

1-5. SPECIFICATIONS.

1-6. Complete specifications of the Model 4191A Impedance Analyzer are given in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. The test procedures for the specifications are covered in Section IV Performance Tests. Table 1-2 lists supplemental performance characteristics. Supplemental performance characteristics are not specifications but are typical characteristics included as additional information for the operator. When the 4191A RF Impedance Analyzer is shipped from the factory, it meets the specifications listed in Table 1-1.

1-7. SAFETY CONSIDERATIONS.

1-8. The Model 4191A RF Impedance Analyzer has been designed to conform to the safety requirements of an IEC (International Electromechanical Committee) Safety Class I instrument and is shipped from the factory in a safe condition.

1-9. This operating and service manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

1-10. INSTRUMENTS COVERED BY MANUAL.

1-11. Hewlett-Packard uses a two-section nine character serial number which is marked on the serial number plate (Figure 1-2) attached to the instrument rear panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix. The letter placed between the two sections identifies country where instrument was manufactured. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-12. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument may be accompanied by a yellow Manual Changes supplement or have a different manual part number. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-13. In addition to change information, the supplement may contain information for correcting errors (called Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with this manual's print date and part number, both of which appear on the manual's title page. Complementary copies of the supplement are available from Hewlett-Packard. If the serial prefix or number of an instrument is lower than that on the title page of this manual, see Section VII Manual Changes.

1-14. For information concerning a serial number prefix that is not listed on the title page or in the Manual Change supplement, contact your nearest Hewlett-Packard office.

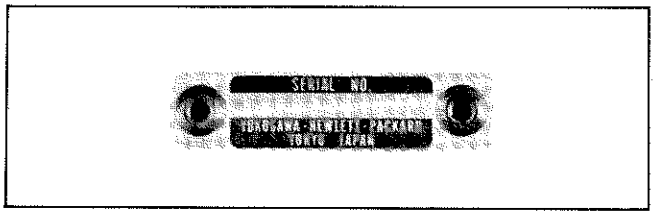


Figure 1-2. Serial Number Plate.

Table 1-1. Specifications (Sheet 1 of 5).

SPECIFICATIONS

Parameters Measured:

Z Y Γ	θ (radian/degree)
R	X
G	B
Γx	Γy
L C	 R , G , D , Q

Δ (unit deviation) and Δ% (percent deviation) for all parameters.

Test Signal (Internal): 1 to 1000 MHz

Characteristics[1]	1–500 MHz	500–1000 MHz
Level (50Ω load)	−20±3 dBm	−20±3 dBm
Frequency Resolution	100 kHz	200 kHz
Frequency Accuracy at 23°C	3 ppm	3 ppm

1. After 40 minute warm-up,
   Temperature: 23°C±5°C.

External Test Signal:

Frequency : 1 MHz to 1000 MHz
Input Level : 0 dBm typ., −3 to +3 dBm.
(Test level: −17 to −23 dBm at 50Ω load)

Sweep Characteristics:

Sweep mode :

Auto: Single sweep from programmed start to stop frequency (or in reverse direction). Sweep pause at desired frequency step is feasible.

Manual: Bidirectional step shift (up-down) of frequency between start and stop frequencies.

Sweep span: Maximum 1 MHz to 1000 MHz, selectable in 100 kHz minimum frequency step intervals.

Frequency step:

Linear sweep: Selectable in 100 kHz minimum step frequency intervals (to 999 MHz).

Logarithmic sweep: A total of 50 step frequencies (51 spot frequencies) automatically selected at logarithmically regular intervals, minimum 100 kHz (rounds off fractional frequency to 100 kHz).

Fast sweep: Manual sweep by 10 times programmed step frequency intervals in linear sweep mode, or by 1/5 of frequency points in logarithmic sweep mode.

Measurement Accuracy and Resolution:
Accuracies apply under the following measurement operating conditions:

1) Specifies reflection coefficient accuracy ($|\Gamma|-\theta$ and Γx − Γy measurement accuracies). Accuracies for other parameter measurements are given as typical values in Supplemental Performance Characteristics.

2) Warm-up time: at least 40 minutes.

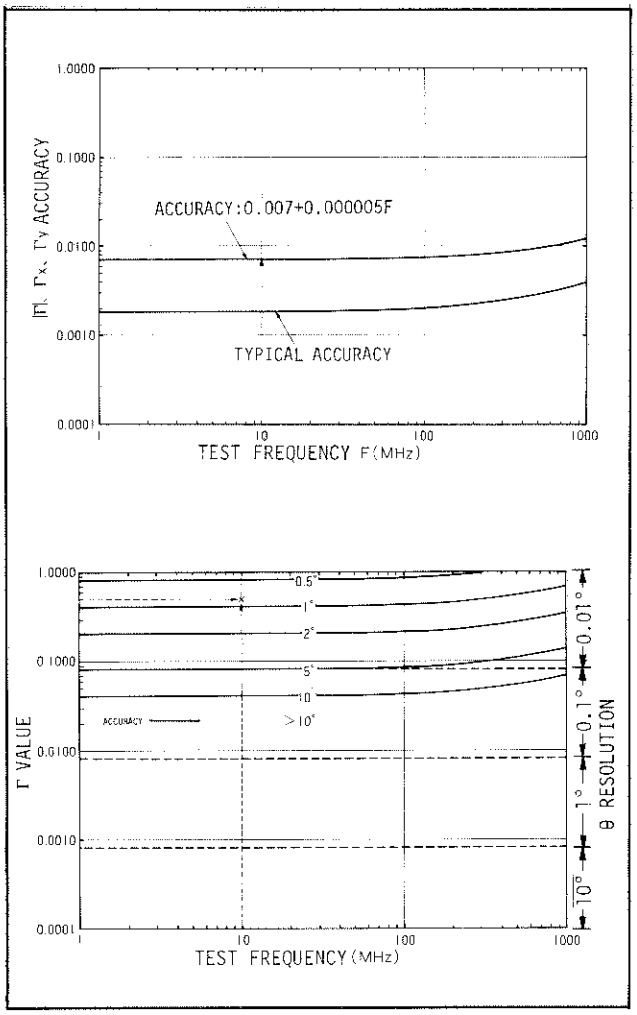
3) Auto-calibration properly completed using standard reference terminations.

4) Measurement frequency identical to auto-calibration frequency points (51 spots).

5) Environmental temperature:
   23°C ± 5°C (allows temperature variation).
   0°C ~ 55°C (at the constant temperature at which auto-calibration is completed).

6) Measurement taken at UNKNOWN connector (without using test port extension).

Table 1-1. Specifications (Sheet 2 of 5).



Measurement Range:

$|\Gamma|$, Γx, Γy : 0.0001 to 1.0000

θ : 0.00 to ±180.00°
(0 to $\pm\pi$ radian)

Display: 4-1/2 digit maximum, simultaneous display of two parameter values, maximum display 19999. (Number of display digits changes depending on measurement frequency and range).

Digit Shift: Number of desired display digits (less than the maximum display digits) is selectable by control key.

Range Modes: Auto and Hold.

Measurement Terminal: Single test port, APC-7 connector terminal.

Deviation Measurement: A measurement display value or a desired value entered by DATA input keys can be stored as a reference value. Next, pressing Δ or Δ% button enables the difference between the referenced value and subsequent result to be displayed. (Deviation spread in counts is -19999 to 19999 or from -1999.9% to 1999.9%).

Electrical Length Correction: The effects in phase of the reflection coefficient particular to the test fixture used can be automatically corrected by entering electrical length number of the test fixture with DATA input keys.
Input data range: 0 to 99.99cm

Automatic Calibration: Memorizes measurement results of reference termination impedances and automatically performs corrections to optimize measurement accuracy in subsequent measurements.

Reference termination impedances: 0Ω, 50Ω and 0S.

Calibration frequency: 51 spot frequencies automatically selected from within the frequency range of 1MHz to 1000MHz or of programmed start to stop frequencies.

Calibration data at frequencies other than the selected calibration frequency points are obtained by using cubic interpolation approximations.

Self Test: Performs cyclic operation of internal function tests and displays diagnostic code sets (when any abnormality is detected).

Internal Bias: Internal dc bias source manually or remotely controllable from 0V to ± 40V in 10mV (minimum) steps.

Bias control range and accuracy (23°C ± 5°C):

Bias Voltage Control Range	Accuracy
-40.00V —— 40.00V	±(0.1% of setting +10mV)*

* ± (0.4% + 20mV) at 0°C to 55°C

Bias output characteristics:
1390Ω ± 10%, 7.2mA max. (±10%).

Table 1-1. Specifications (Sheet 3 of 5).

Control: Manual control by front panel keys or remote control by HP-IB controller. Bias voltage sweep is also feasible.

Sweep characteristics:

Sweep Mode:

Auto: Single sweep from programed start to stop voltages or in reverse direction. Sweep pause at desired voltage step is feasible.

Manual: Bidirectional step shift (up-down) of bias voltage between start and stop bias voltages.

Sweep span: Maxium −40 to +40V (linear sweep). Maximum +0.01 to +40V (logarithmic sweep). Selectable in 0.01V minimum voltage step intervals.

Voltage step:

Linear sweep: Selectable in 0.01V (minimum) step voltage intervals (to ± 40V).

Logarithmic sweep: A total of 50 step voltages (51 spot voltages) automatically selected at logarithmically regular intervals, minimum 0.01V (rounds off fractional voltage to 0.01V).

Fast sweep: Manual sweep at 10 times programmed step voltage intervals in linear sweep mode, or by 1/5 of voltage points in logarithmic sweep mode.

DC bias monitor: Bias voltage monitor output (common to external dc bias input), BNC connector, output impedance 1kΩ ± 10%.

Save Function: Continuous memorization of one or two desired control settings states powered by stand-by battery. Memorized setting data is preserved in event that instrument loses operating power and can be restored as actual control setting anytime by pressing control keys. Memorizes the following data and control settings:

1) Front panel pushbutton control settings (except SELF TEST function).
2) Automatic calibration data (restored just after the instrument is turned on).
3) Reference values in deviation measurement.

External DC Bias: External DC bias input connector on rear panel (common to internal dc bias voltage monitor connector), maximum ± 40V.

Bias input characteristics: 390Ω ± 10%, 100mA max.

Trigger: Internal, external and manual.

HP-IB Compatibility: HP-IB interface capability (data output and remote control per IEEE-STD-488-1975 and ASCI-MC 1.1).

Remotely controllable functions:

1) DISPLAY A functions (|Z|, |Y|, |Γ|, R, G, Γx, L and C).
2) DISPLAY B functions (θ, X, B, Γy, R, G, D and Q).
3) Test signal frequency (SPOT).
4) Frequency sweep functions (START, STOP and STEP frequencies, LOG SWEEP, MANUAL STEP, AUTO START, PAUSE and SWEEP ABORT).
5) Deviation functions (Δ, Δ%, REF A, REF B, and STORE DSPL A/B).
6) High speed.
7) Range hold.
8) Digit shift (DSPL A and DSPL B).
9) Electrical length.
10) Open capacitance.
11) Automatic calibration.
12) Save functions (SAVE 1, SAVE 2, RCL 1 and RCL 2).
13) Self test.
14) Trigger.
15) DC bias voltage (SPOT).
16) Bias voltage sweep functions (START, STOP and STEP voltages, LOG SWEEP, MANUAL STEP, AUTO START, PAUSE and SWEEP ABORT).
17) X-Y recorder control functions (LL, UR and INTRPL) (option 004 only).

Table 1-1. Specifications (Sheet 4 of 5).

Data output:

1) |Z|, |Y| or |Γ| with θ; R with X; G with B; Γx with Γy; L or C with R, G, D or Q.
2) Test frequency in swept frequency measurement.
3) Frequency in automatic calibration.
4) Bias voltage in swept bias voltage measurement.

Internal function allowable subsets:
SH1, AH1, T5, L4, SR1, RL1, DC1 and DT1.

Data output format: Either of two formats may be selected (switchable on rear panel).

Format A.

1. Stationary (fixed) frequency/bias measurement:
   ␣XXX±NNN.NNE±NN,XXX±NNN.NNE±NN CR LF
   1 2 3 4 5 6 7 8 9 10 11
2. Swept frequency/bias measurement or auto-calibration:
   ␣X±NNNN.NNNN,XXX±NNN.NNE±NN,XXX±NNN.NNE±NN CR LF
   1 12 13 6 2 3 4 5 7 8 9 10 11

Format B.

1. Stationary (fixed) frequency/bias measurement:
   ␣XXX±NNN.NNE±NN CR LF
   1 2 3 4 5 11
   XXX±NNN.NNE±NN CR LF
   7 8 9 10 11
2. Swept frequency/bias measurement or auto-calibration:
   ␣X±NNNN.NNNN CR LF
   1 12 13 11
   XXX±NNN.NNE±NN CR LF
   2 3 4 5 11
   XXX±NNN.NNE±NN CR LF
   7 8 9 10 11

(1) Space.
(2) Data status of DISPLAY A.
(3) Function of DISPLAY A or calibration condition.
(4) Deviation measurement mode of DISPLAY A.
(5) Value of DISPLAY A (decimal point position is coincident with display).
(6) Comma (data delimiter).
(7) Data status of DISPLAY B.
(8) Function of DISPLAY B or calibration condition.
(9) Deviation measurement mode of DISPLAY B.
(10) Value of DISPLAY B (decimal point position is coincident with display).
(11) Data terminator.
(12) Sweep parameter.
(13) Measurement frequency or bias voltage (decimal point position is coincident with display).

GENERAL

Operating Temperature and Humidity:
0°C to 55°C at 95% RH (to 40°C).

Power Requirements: 100/120/220V ±10%, 240V -5% +10%, 48-66Hz.

Power Consumption: 150VA max with any option.

Dimensions:
425.5 (W) x 230 (H) x 574 (D) mm
(16-3/4" x 9-1/16" x 22-5/8")

Weight: Approximately 24 kg (Std).

Table 1-1. Specifications (Sheet 5 of 5).

OPTIONS

Option 002: Provides test signal frequencies selectable at 100 Hz resolution to 500 MHz and at 200 Hz resolution to 1000 MHz.

Option 004: Analog voltage outputs for graphically recording sweep measurement data on an X-Y recorder. Three channel BNC output connectors on rear panel.

DISPLAY A connector: Outputs voltage proportional to three lesser significant digit numbers of DISPLAY A display outputs (1 mV/count).

DISPLAY B connector: Outputs voltage proportional to DISPLAY B display outputs in the same manner as that for DISPLAY A connector outputs.

FREQ/BIAS connector: Outputs voltage proportional to test frequency or bias voltage as:
Start frequency/voltage : 0V
Stop frequency/voltage : 1V

Reference recorder voltages:
Lower Left (LL) : 0, 0, 0 V
Upper Right (UR) : +1, +1, +1V

Voltage accuracy: ± (0.5% + 2 mV) at 23°C ± 5°C
± (1% + 5 mV) at 0°C to 55°C

Interpolation function: Smoothing of recorder outputs by arithmetic interpolation of measurement data, selectable by control key.

Option 907: Front handle kit, for front handle installation

Option 908: Rack flange kit, for mounting in IEC standard rack.

Option 909: Rack flange & handle kit, for rack mounting and handle installation.

Option 910: Extra operating manual.

Option 91S: Extra service manual.

ACCESSORIES

Accessories Supplied:

Reference terminations for calibrating the 4191A. Three kinds of terminations are included:

0 Ω reference termination (short), (HP P/N 04191-85300).
50Ω reference termination, (HP P/N 04191-85301).
0S reference termination (open), (HP P/N 04191-85302).

Additionally, accessory box (HP P/N 04191-60200) which accommodates these terminations and all the available test fixtures is furnished.

Operating booklet (HP P/N 04191-90100).

Power Cord (HP P/N 8120-1378).

Accessories Available:

[Accessories, other than primary accessories, are outlined in Table 1-2.]

16091A: Coaxial Fixture set, direct coupled, two types of sample holders, coaxial termination structure, with APC-7 connectors. For mounting cylindrical sample piece in inner cavity chamber. Usable on all 4191A ranges to 1000 MHz.

16092A: Spring Clip Fixture, direct coupled, for holding axial or radial lead components or leadless chip elements. Either slide clip contact or twin clip contacts can be attached on the terminal deck with APC-7 connector. Usable on all ranges at frequencies below 500 MHz.

16093A: Binding Post Fixture, direct coupled, two binding posts on terminal deck with APC-7 connector, for holding axial or radial lead components, 7 mm terminal post interval. Usable on all ranges at frequencies below 250 MHz.

16093B: Binding Post Fixture, direct coupled, three binding posts (including a guard terminal) on terminal deck with APC-7 connector, 18 mm terminal post interval (15 mm to guard). Usable on all ranges at frequencies below 125 MHz.

16094A: Probe fixture, two-needle probe adapter, compatible with APC-7 connector test cable, for in-circuit testing of components, variable needle span (15 mm max.). Useable on all ranges at frequencies below 125 MHz.

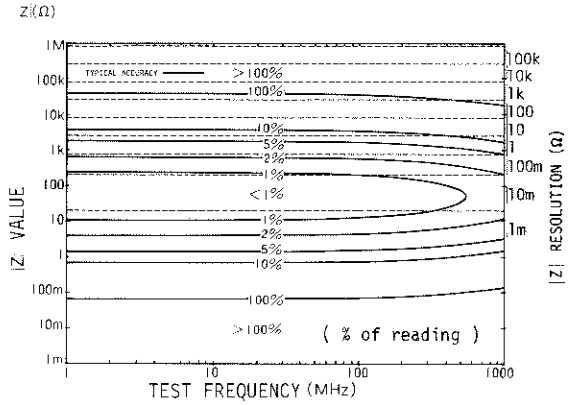
Table 1-2. Supplemental Performance Characteristics (Sheet 1 of 3).

SUPPLEMENTAL PERFORMANCE CHARACTERISTICS

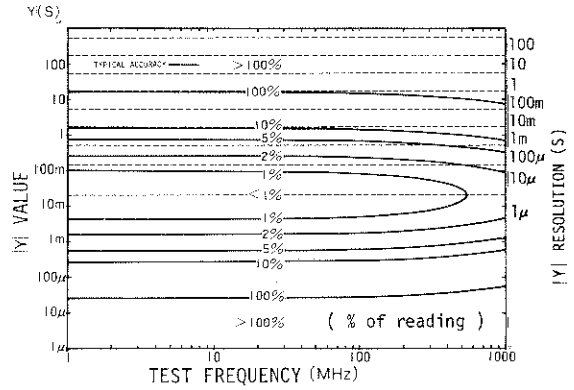
Measurement accuracy:

|Z|-θ, |Y|-θ measurement

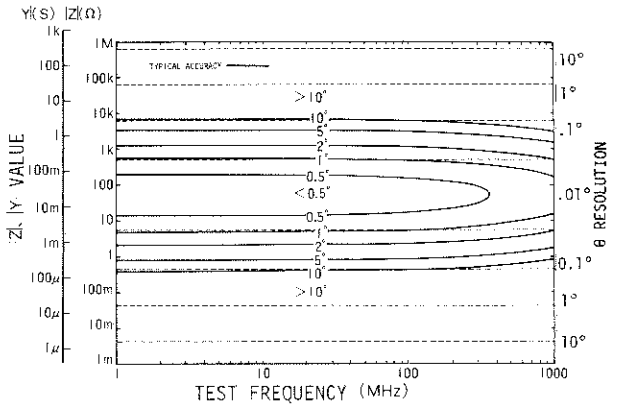
○ |Z| accuracy at θ = 45°:



○ |Y| accuracy at θ = 45°:

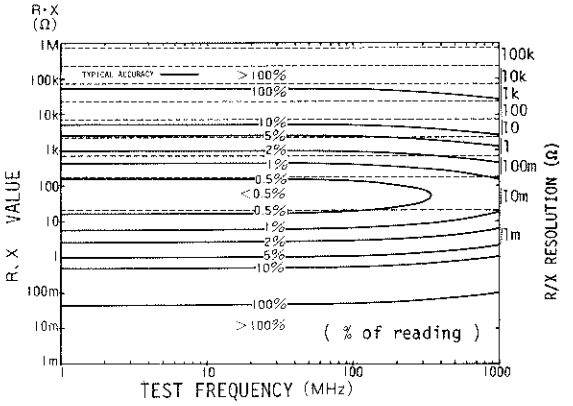


○ θ accuracy at θ = 45°:

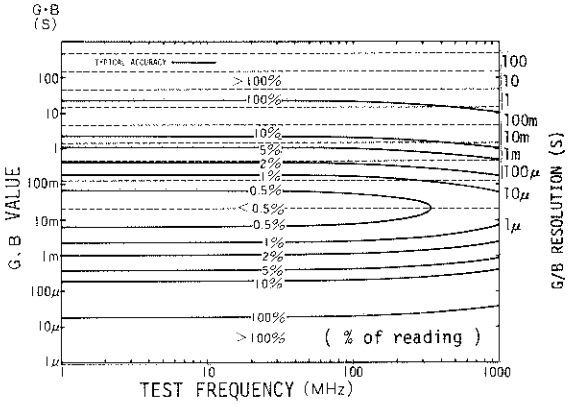


R-X, G-B measurement

○ R-X accuracy at D = 1:



○ G-B accuracy at D = 1:



L-R/G/D/Q, C-R/G/D/Q measurement:

○ L accuracy at D ≤ 0.01:

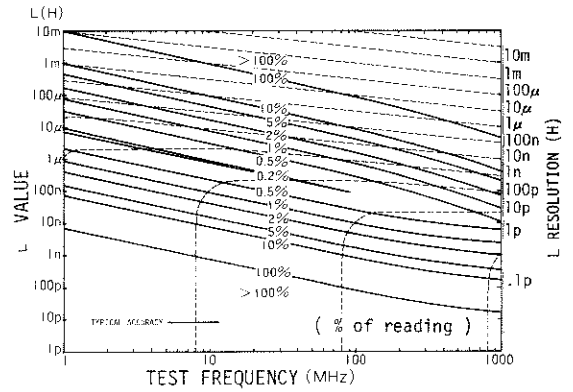
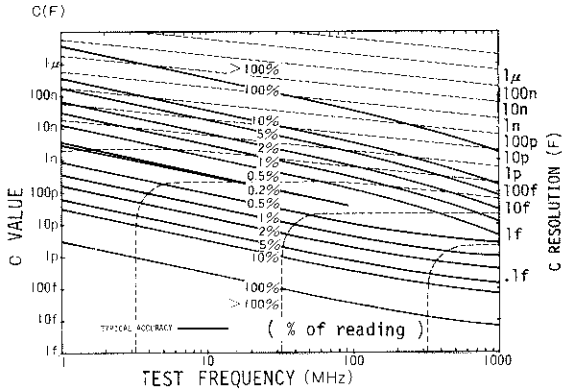


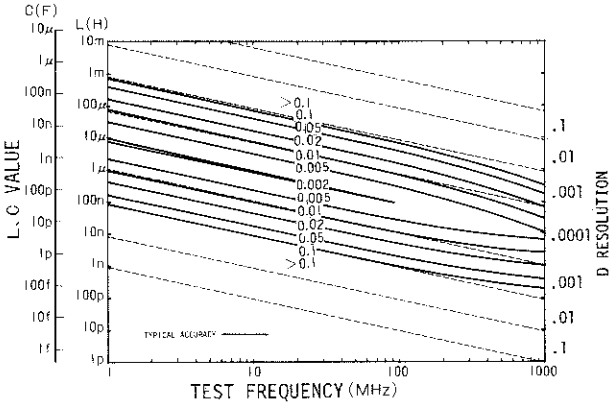
Table 1-2. Supplemental Performance Characteristics (Sheet 2 of 3).

○ C accuracy at D ≤ 0.01:



D (=1/Q) measurement range: 0.0001 to 1000

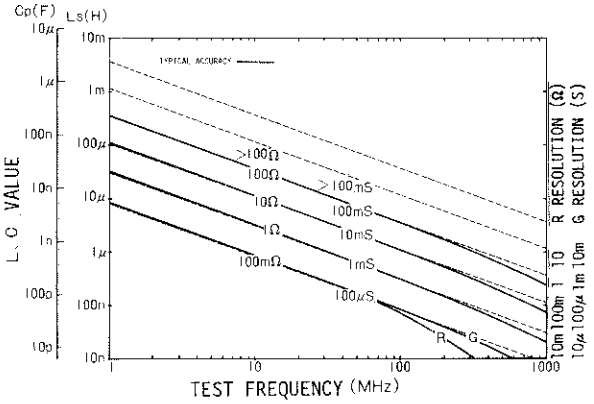
○ D (=1/Q) accuracy at D ≤ 0.01:



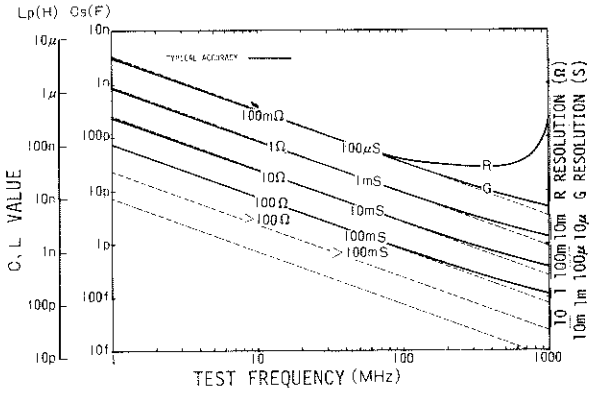
R measurement range: 20mΩ to 100kΩ

G measurement range: 10μS to 50S

○ (L-)R, (C-)G accuracies at D ≤ 0.01:



○ (C-)R, (L-)G accuracies at D ≤ 0.01:



$|\Gamma|-\theta$ and $\Gamma x-\Gamma y$ accuracy temperature coefficient:

$|\Gamma|$, Γx, Γy : 0.0001/°C (23 ± 5°C)

: 0.0004 (1 + 0.01 f)/°C (0 ~ 55°C)

θ : 0.0001/$|\Gamma|$ radian/°C (23 ± 5°C)

: 0.0004 (1 + 0.01f)/$|\Gamma|$ radian/°C (0 ~ 55°C)

(f = measurement frequency in MHz)

Test Signal:

Characteristics[1]	1–500 MHz	500–1000 MHz
Frequency Stability	0.2 ppm/C°	0.2 ppm/C°
Harmonics, THD	<-30 dB[2]	<-30 dB[2]
Residual FM	<30Hz[3,4]	< 60 Hz[3]
Spurious Level	<-30 dB[2]	<-30 dB[2]

1. After 40 minute warm-up,
   Temperature: 23°C ± 5°C
2. Level below fundamental.
3. Averaged rms deviation at 3kHz bandwidth.
4. < 15 Hz at 250MHz and below.

Test signal settling time

Time for test signal to settle when measurement frequency is changed.

Less than 200ms

Sweep time

Frequency sweep:

Linear sweep:

Number of sweep steps x 1.1 seconds (typical).

Logarithmic sweep:

58 seconds for 50 steps (typical).

Table 1-2. Supplemental Performance Characteristics (Sheet 3 of 3).

Bias voltage sweep:
Linear sweep:
Number of sweep steps x 0.84 seconds (typical).
Logarithmic sweep:
44 seconds for 50 steps (typical).

Measurement time
Normal mode: Less than 800ms
(Displays arithmetic running average of five preceding measurement values.)

High speed mode: Less than 250ms
(Displays measured values for each trigger.)

Auto-calibration time
Approximately 48 seconds for each reference termination impedance.

Bias voltage settling time
Internal bias : Less than 100ms
External bias : Less than 10ms

Open capacitance compensation
Typical open stray capacitance (0.082 pF) of *UNKNOWN connector is continuously memorized for subtracting from measured values. The memorized capacitance value can be temporarily changed by concealed controls.
Input capacitance value range: 0 to 1.000 pF

*APC-7 connector

AVAILABLE ACCESSORIES

[Accessories and parts associated with options or which are usable for special applications or as spares. For primary accessories, refer to Table 1-1 Specifications.]

RF connector for external signal source:
HP Part Number 04191-65001

HP-IB Interface Cable: HP 10631A (1m)
HP 10631B (2m)
HP 10631C (4m)
HP 10631D (0.5m)

Front Handle Kit:
Kit Part Number 5061-0091

Rack Flange Kit:
Kit Part Number 5061-0079

Rack Flange Handle Kit:
Kit Part Number 5061-0085

Line Fuse:
HP Part Number 2110-0304 (100/120V)
HP Part Number 2110-0360 (220/240V)

Internal power supply fuses:

HP Part Number	Rating	Use
2110-0003	3A	+ 5V
2110-0055	4A	+ 5V
2110-0094	1.25A	+12V
2110-0094	1.25A	-12V
2110-0004	0.25A	+46V
2110-0004	0.25A	-46V
2110-0513	0.125A	+36V
2110-0513	0.125A	-36V

Protective fuse (for dc bias):
HP Part Number 2110-0011 (0.062A)

Service Parts
APC-7 connector center spring contact:
HP Part Number 1250-0907

Exchange tool : HP Part Number : 8710-0932

1-15. OPTIONS.

1-16. Options are standard modifications to instrument that implement user's special requirements for minor functional changes. A total of seven options for the Model 4191A are available for adding the following capabilities:

Option 002: High Resolution Test Frequency. Test frequency selectable at 100Hz resolution to 500MHz and at 200Hz resolution to 1000MHz.

Option 004: X-Y Recorder Output: Analog output for graphic recording of measurement data (with an X-Y recorder).

Options 907, 908 and 909 are handle or rack mount kits. See paragraph 1-22 for details.

Options 910 and 91S add the following to provide an extra manual or additional information on the 4191A:

Option 910: Extra Operating Manual
Option 91S: Extra Service Manual

Note: Options 002 and 004 can be simultaneously installed in a 4191A unit.

A brief description for each option is given in the paragraphs below.

1-17. OPTION 002.

1-18. The 4191A Option 002 provides test frequency selection capability at the high resolution of 100Hz in frequency range of 1MHz to 500MHz and at 200Hz resolution to 1000MHz frequency instead of standard frequency resolution.

1-19. OPTION 004.

1-20. The 4191A Option 004 provides analog recorder outputs for graphically recording measurement data in swept frequency (or bias voltage) measurements. Two, from among the three output connectors, provide voltages directly proportional to the three lesser significant digit numbers of the respective measurement display outputs (DISPLAY A and DISPLAY B) in the ratio of 1mV to one count. The other output connector affords a voltage of 0 to 1 volt in proportion to the swept frequency (bias voltage) from start to stop frequency (voltage).

1-21. OTHER OPTIONS.

1-22. The following options provide the mechanical parts necessary for rack mounting and hand carrying:

Option 907: Front Handle Kit. Furnishes carrying handles for both ends of front panel.

Option 908: Rack Flange Kit. Furnishes flanges for rack mounting for both ends of front panel.

Option 909: Rack Flange and Front Handle Kit. Furnishes both front handles and rack flanges for instrument.

Installation procedures for these options are detailed in Section II.

1-23. The 4191A Option 910 adds an extra copy of the operating manual and Option 91S provides a service manual.

1-24. ACCESSORIES SUPPLIED.

1-25. Figure 1-1 shows the HP Model 4191A Impedance Analyzer, three reference terminations (HP Part Numbers 04191-85300, -85301 and -85302) with accessory box (HP Part Number 04191-60200), and power cord (HP Part Number 8120-1378). The reference terminations, accessory box and power cord are furnished accessories. Additionally, a fuse (HP Part Number 2110-0304 or 2110-0306) is supplied as a service part.

1-26. ACCESSORIES AVAILABLE.

1-27. For certain measurements and for convenience in connecting sample, four styles of test fixtures are available. Each accessory is designed to meet the various measurement requirements and types of DUT.
All accessories were developed with careful consideration to accuracy, reliability and ease of measurement. Primary accessory model numbers and names are listed in Table 1-1 (other associated accessories are listed in Table 1-2). A brief description for each of these test fixtures is given in Table 1-3.