

Test Equipment Solutions Datasheet

Test Equipment Solutions Ltd specialise in the second user sale, rental and distribution of quality test & measurement (T&M) equipment. We stock all major equipment types such as spectrum analyzers, signal generators, oscilloscopes, power meters, logic analysers etc from all the major suppliers such as Agilent, Tektronix, Anritsu and Rohde & Schwarz.

We are focused at the professional end of the marketplace, primarily working with customers for whom high performance, quality and service are key, whilst realising the cost savings that second user equipment offers. As such, we fully test & refurbish equipment in our in-house, traceable Lab. Items are supplied with manuals, accessories and typically a full no-quibble 2 year warranty. Our staff have extensive backgrounds in T&M, totalling over 150 years of combined experience, which enables us to deliver industry-leading service and support. We endeavour to be customer focused in every way right down to the detail, such as offering free delivery on sales, covering the cost of warranty returns BOTH ways (plus supplying a loan unit, if available) and supplying a free business tool with every order.

As well as the headline benefit of cost saving, second user offers shorter lead times, higher reliability and multivendor solutions. Rental, of course, is ideal for shorter term needs and offers fast delivery, flexibility, try-before-you-buy, zero capital expenditure, lower risk and off balance sheet accounting. Both second user and rental improve the key business measure of Return On Capital Employed.

We are based near Heathrow Airport in the UK from where we supply test equipment worldwide. Our facility incorporates Sales, Support, Admin, Logistics and our own in-house Lab.

All products supplied by Test Equipment Solutions include:

- No-quibble parts & labour warranty (we provide transport for UK mainland addresses).
- Free loan equipment during warranty repair, if available.
- Full electrical, mechanical and safety refurbishment in our in-house Lab.
- Certificate of Conformance (calibration available on request).
- Manuals and accessories required for normal operation.
- Free insured delivery to your UK mainland address (sales).
- Support from our team of seasoned Test & Measurement engineers.
- ISO9001 quality assurance.

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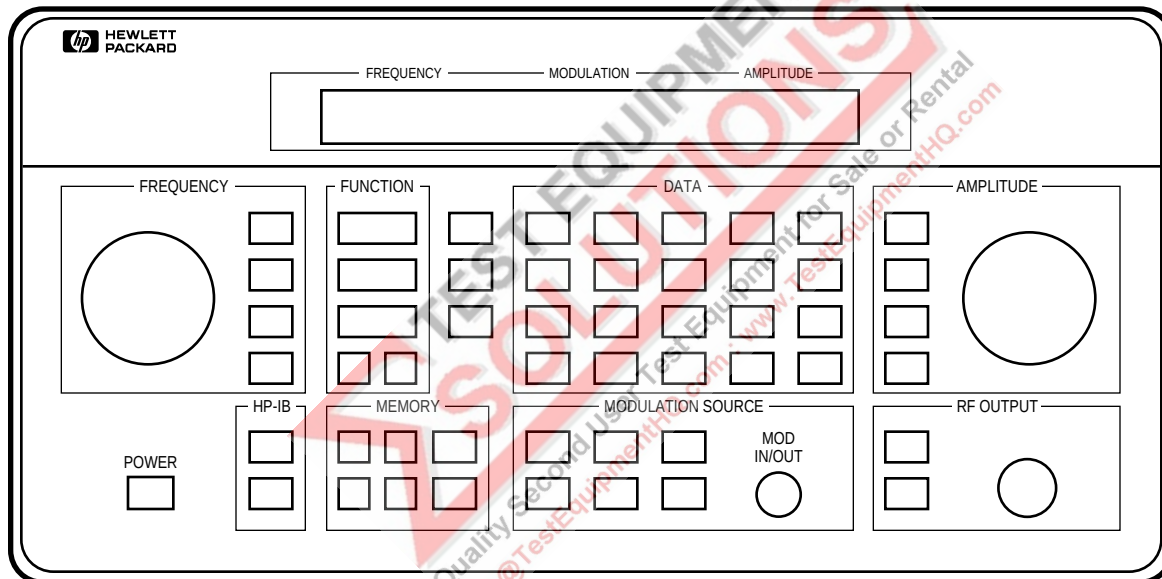
Email: info@TestEquipmentHQ.com
Web: www.TestEquipmentHQ.com



HP 8647A and 8648A/B/C/D Signal Generators

Technical Specifications

HP 8647A, 250 kHz to 1 GHz
HP 8648A, 100 kHz to 1 GHz
HP 8648B, 9 kHz to 2 GHz
HP 8648C, 9 kHz to 3.2 GHz
HP 8648D, 9 kHz to 4 GHz



Specifications describe warranted instrument performance over the 0 to 50°C temperature range and after a 30-minute warm-up, unless otherwise noted. All performance below a carrier frequency of 250 kHz is typical. Supplemental characteristics are intended to provide information useful in estimating instrument capability in your application by describing typical, but non-warranted performance.

Frequency

Range

HP 8647A: 250 kHz to 1000 MHz.
 HP 8648A: 100 kHz to 1000 MHz.
 HP 8648B: 9 kHz to 2000 MHz.
 HP 8648C: 9 kHz to 3200 MHz.
 HP 8648D: 9 kHz to 4000 MHz.

Resolution

Settable

HP 8647A: 1 Hz.
 HP 8648A/B/C/D: 0.001 Hz.

Display

10 Hz.

Accuracy¹

Typically $\pm 3 \times 10^{-6}$ x carrier frequency (Hz),
 $\pm 0.15 \times 10^{-6}$ x carrier frequency (Hz) for Option 1E5.

Switching speed (typical)

HP 8647A

<120 ms.

HP 8648A/B/C/D

<1001 MHz: <75 ms.

≥1001 MHz: <100 ms.

¹After one hour warm-up and within one year of calibration.

Internal Reference Oscillator

Accuracy and stability²

(typical, calibration adjustment dependent)

± Aging rate ± temperature effects ± line voltage effects.

	Standard Timebase (typical)	High Stability Timebase (Opt 1E5)
Aging	<±2 ppm/year	<±0.1 ppm/year ³ <±0.0005 ppm/day ³
Temperature	<±1 ppm	<±0.01 ppm ⁴ (typical)
Line Voltage ⁵	<±0.5 ppm	<±0.1 ppm (typical)

Output

10 MHz, typically >0.5 V_{rms} level into 50Ω.

External reference oscillator input

Accepts 2, 5, 10 MHz ±10 ppm typical (±1 ppm typical with option 1E5) and a level range of 0.5 V to 2 V_{rms} into 50Ω.

Spectral Purity

Harmonics

<-30 dBc (output ≤+4 dBm).

Subharmonics (output ≤+4 dBm)

<1001 MHz: <-60 dBc.

≤3200 MHz: <-50 dBc.

≤4000 MHz: <-40 dBc.

Nonharmonics (≥5 kHz offset, output ≤+4 dBm)

HP 8647A

<-60 dBc⁶.

HP 8648A/B/C/D

<249 MHz: <-55 dBc.

<1001 MHz: <-60 dBc.

<2001 MHz: <-54 dBc.

≤4000 MHz: <-48 dBc.

Residual FM (CCITT, rms)

HP 8647A

<249 MHz: <20 Hz, typically <11 Hz.

<501 MHz: <10 Hz, typically <6 Hz.

≤1000 MHz: <20 Hz, typically <11 Hz.

HP 8648A/B/C/D

<249 MHz: <7 Hz, typically <4 Hz.

<501 MHz: <4 Hz, typically <2 Hz.

<1001 MHz: <7 Hz, typically <4 Hz.

<2001 MHz: <14 Hz, typically <8 Hz.

≤4000 MHz: <28 Hz, typically <12 Hz.

SSB phase noise (at 20 kHz offset, typical)

HP 8647A

at fc 500 MHz: <-110 dBc/Hz.

at fc 1000 MHz: <-106 dBc/Hz.

HP 8648A/B/C/D

at fc 500 MHz: <-120 dBc/Hz.

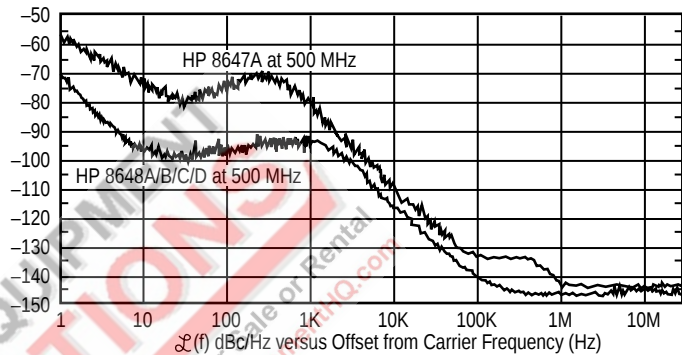
at fc 1000 MHz: <-116 dBc/Hz.

at fc 2000 MHz: <-110 dBc/Hz.

at fc 3000 MHz: <-106 dBc/Hz.

at fc 4000 MHz: <-104 dBc/Hz.

Typical Phase Noise of HP 8647A and 8748A/B/C/D at 500 MHz



Output

Range

HP 8647A and 8648A

+10 to -136 dBm.

HP 8648B/C/D

≤2500 MHz: +13 to -136 dBm.

≤4000 MHz: +10 to -136 dBm.

Maximum Leveled Power (High power option 1EA)

HP8648B/C/D only⁷

≤100 kHz: +17 dBm.

≤1000 MHz: +20 dBm.

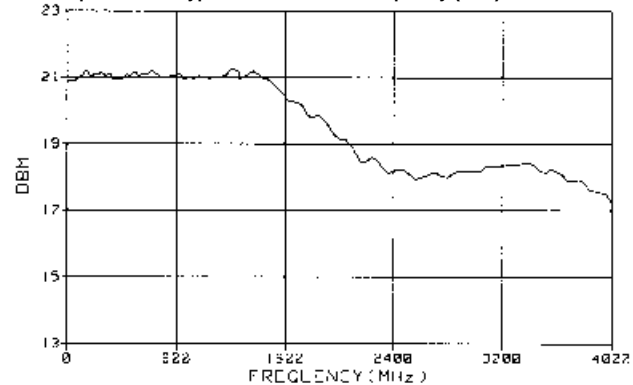
≤1500 MHz: +19 dBm.

≤2100 MHz: +17 dBm.

≤2500 MHz: +15 dBm.

≤4000 MHz: +13 dBm.

Option 1EA—Typical Power versus Frequency (GHz)



Display Resolution

0.1 dB.

Accuracy

HP 8647A⁸

±1.5 dB.

HP 8648A/B/C/D^{8,9,10}

≤2500 MHz: ±1.0 dB.

≤3200 MHz: ±1.5 dB.

≤4000 MHz: ±2.0 dB.

Reverse power protection (watts into 50Ω)

≤2000 MHz: 50 watts.

≤4000 MHz: 25 watts.

SWR (output <−6 dBm, typical)

HP 8647A

<2.0:1.

HP 8648A/B/C/D

<249 kHz: <2.5:1.

<2500 MHz: <1.5:1.

≤4000 MHz: <2.0:1.

Output impedance

Nominally 50 ohms.

Amplitude Modulation ($f_c > 1.5$ MHz)¹¹**Range**

0 to 100% (output ≤+4 dBm).

Resolution

0.1%.

Accuracy¹² (1 kHz rate).

±5% of setting ±1.5%.

Rates

HP 8647A

Internal: 400 Hz or 1 kHz.

External: 20 Hz to 25 kHz (typical, 3 dB BW).

HP 8648A/B/C/D

Internal: 400 Hz or 1 kHz or 10 Hz to 20 kHz with Opt 1E2.

External: DC: dc to 25 kHz (typical, 3 dB BW).

AC: 1 Hz to 25 kHz (typical, 3 dB BW).

Distortion (1 kHz rate, THD+N, 0.3 to 3 kHz BW)

(at 30 % AM): <2%.

HP 8647A and 8648A (at 90% AM): <3%.

HP 8648B/C/D (at 70% AM): <3%.

Frequency Modulation**Peak deviation** (rates >25 Hz ac FM)

HP 8647A

<249 MHz: 0 to 100 kHz.

<501 MHz: 0 to 50 kHz.

≤1000 MHz: 0 to 100 kHz.

HP 8648A/B/C/D

<249 MHz: 0 to 200 kHz.

<501 MHz: 0 to 100 kHz.

<1001 MHz: 0 to 200 kHz.

<2001 MHz: 0 to 400 kHz.

≤4000 MHz: 0 to 800 kHz.

Resolution

For ≤10% peak deviation

<2001 MHz: 10 Hz.

≥2001 MHz: 20 Hz.

For >10% to maximum peak deviation

<2001 MHz: 100 Hz.

≥2001 MHz: 200 Hz.

Deviation accuracy (internal 1 kHz rate)

HP 8647A

±7.5% of FM deviation ±30 Hz.

HP 8648A/B/C/D

<1001 MHz: ±3% of FM deviation ±30 Hz.

<2001 MHz: ±3% of FM deviation ±60 Hz.

≤4000 MHz: ±3% of FM deviation ±120 Hz.

Rates

HP 8647A

Internal: 400 Hz or 1 kHz.

External: DC: dc to 75 kHz (typical, 3 dB BW).

AC: 20 Hz to 75 kHz (typical, 3 dB BW).

HP 8648A/B/C/D

Internal: 400 Hz or 1 kHz or 10 Hz to 20 kHz with Opt 1E2.

External: DC: dc to 150 kHz (typical, 3 dB BW).

AC: 1 Hz to 150 kHz (typical, 3 dB BW).

²After one hour warm-up and within one year of calibration.

³After four days warm-up and within one year of calibration.

⁴Applies over the 25 ±5° C range.

⁵Applies for line voltage change of ±5%.

⁶Non-harmonic spurious are −55 dBc from 220 to 250 MHz.

⁷Combining option 1E6 with 1EA reduces maximum output power by 2 dB above 100 MHz. Below 100 MHz, maximum output is +13 dBm (typically +16 dBm for carrier frequencies between 100 kHz and 100 MHz).

⁸Accuracy is valid from maximum specified output power to −127 dBm. Below −127 dBm, accuracy is typically ±3 dB in the range 100 kHz to 2500 MHz, and is not specified outside this frequency range.

⁹Accuracy applies at 25 ±5°C; and typically degrades up to ±0.5 dB over 0 to 50°C or at output power levels >13 dBm.

¹⁰Accuracy is ±3 dB for power levels between −100 dBm and −127 dBm for frequencies below 100 kHz or above 2500 MHz.

¹¹AM is typical above 1001 MHz.

¹²AM accuracy applies at 25 ±5°C and at <70% depth: it is typically ±7% of setting ±1.5% over 0 to 50°C.

Distortion (1 kHz rate, THD + N, 0.3 to 3 kHz BW)

<1001 MHz: <1% at deviations >4 kHz.

<2001 MHz: <1% at deviations >8 kHz.

≤4000 MHz: <1% at deviations >16 kHz.

(88 to 108 MHz: <0.5% at deviations ≥75 kHz¹³).**Carrier frequency accuracy** (relative to CW in dcFM)¹⁴*HP 8647A*

±500 (typical 200) Hz, deviations <10 kHz.

HP 8648 A/B/C/D

<1001 MHz: ±100 (typical 40) Hz, deviations <10 kHz.

<2001 MHz: ±200 (typical 80) Hz, deviations <20 kHz.

≤4000 MHz: ±400 (typical 160) Hz, deviations <40 kHz.

FM + FM

Internal 1 kHz or 400 Hz source plus external. In internal plus external FM mode, the internal source produces the set level of deviation. The external input should be set to ≤±0.5V peak or 0.5 Vdc (one-half the set deviation).

Phase Modulation**Peak deviation**

<249 MHz: 0 to 10 radians.

<501 MHz: 0 to 5 radians.

<1001 MHz: 0 to 10 radians.

<2001 MHz: 0 to 20 radians.

≤4000 MHz: 0 to 40 radians.

Resolution

<2001 MHz: 0.01 radians.

≥2001 MHz: 0.02 radians.

Deviation accuracy (internal 1 kHz rate, typical)*HP 8647A*

±7.5% of deviation ±0.05 radians.

HP 8648A/B/C/D

<1001 MHz: ±3% of deviation ±0.05 radians.

<2001 MHz: ±3% of deviation ±0.1 radians.

≤4000 MHz: ±3% of deviation ±0.2 radians.

Rates:*Internal*400 Hz or 1 kHz or 10 Hz to 20 kHz with Opt 1E2¹⁵.*External*

20 Hz to 10 kHz (typical, 3 dB BW).

Distortion (1 kHz rate)*HP 8647A*

<2% at deviations ≥3 radians.

HP 8648 A/B/C/D

<1001 MHz: <1% at deviations ≥3 radians.

<2001 MHz: <1% at deviations ≥6 radians.

≤4000 MHz: <1% at deviations ≥12 radians.

Modulation Source**Internal**

400 Hz or 1 kHz, front panel BNC connector provided at nominally 1 Vpk into 600Ω.

External

1 Vpk into 600Ω (nominal) required for full scale modulation. (High/Low indicator provided for external signals ≤10 kHz.)

Modulation Generator (Option 1E2)¹⁵

Adds variable frequency modulation source. Functions also included in Option 1EP Pager encoder/signalling option.

Waveforms

Sine, Square, Triangle, Sawtooth (Ramp).

Frequency range

Sine: 10 Hz to 20 kHz.

Square, Triangle, Sawtooth: 100 Hz to 2 kHz.¹⁶**Frequency accuracy**

±0.01% typical.

Frequency resolution:

1 Hz (3 digits or 10 Hz displayed).

Depth & Deviation Accuracy (1 kHz sine)

Refer to AM, FM, and Phase Modulation Accuracy specs.

Output

Front panel BNC. Nominally 1 Vpk

Pulse Modulation (Option 1E6)*(HP 8648B/C/D only)*

Adds high performance pulse modulation capability.

On/off ratio

<2000 MHz: >80 dB.

≤4000 MHz: >70 dB.

Rise/fall times

<10 ns.

Maximum repetition rate

10 MHz.

Video feedthrough

<30 mV (typical).

Delay

<60 ns (typical).

Pulse input

TTL level (±15V max).

Pager Encoder/Signaling (Option 1EP) (HP 8648A only)

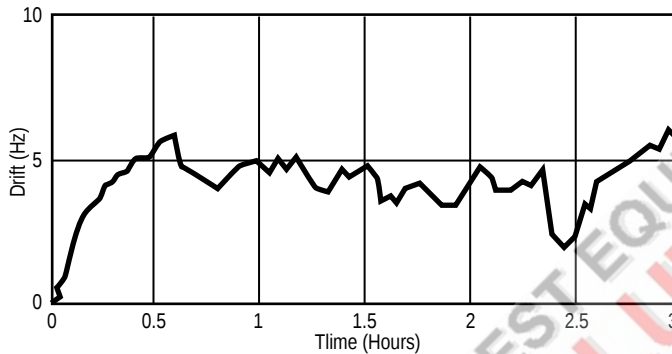
Adds functionality for testing POCSAG, FLEX™¹⁷ and FLEX-TD. Also includes Modulation Generator functions of Option 1E2. Instrument characteristics are the same as the HP 8648A except as noted below.

Frequency

Accuracy with Option 1E5¹⁸: Typically $\pm 0.15 \times 10^{-6}$ x carrier frequency in Hz or 0.092×10^{-6} x carrier frequency in Hz within 90 days of calibration.

Frequency Modulation

FSK Deviation Accuracy with Option 1EP: ± 60 Hz.¹⁹



Pager Signaling

Supported Pager Protocols: POCSAG, FLEX™, and FLEX-TD.

POCSAG

Speed: 512, 1200, and 2400 bps.

Message Format: Tone only, Numeric, Alphanumeric.

FLEX/FLEX-TD

Speed

2 Level FSK: 1600 and 3200 bps.

4 Level FSK: 3200 and 6400 bps.

Message Format: Tone only, Numeric (standard and special), Alphanumeric, HEX/Binary.

Address Type: Short, Long.

Messaging Accessible from Front Panel or HP-IB

Message Types: Five fixed (built-in), one user-defined.

Message Length: 40 characters maximum.

Repetition Modes: Single, Burst, Continuous.

Messaging Accessible only Over HP-IB

Message Type: Arbitrary (user-defined).

Batch Length

FLEX/FLEX-TD: 128 Frames.

POCSAG: 128 Batches.

Repetition Mode: Single only.

Data Rate Accuracy: ± 5 ppm.²⁰

Modulation Source

Internal: 400 Hz or 1 kHz, or audio generator (see Option 1E2 for characteristics), front panel BNC connector provided at nominally 1 Vp into 600 ohms.

General

Storage Registers: 70 storage registers with sequence and register number displayed. Up to 10 sequences are available with 30 registers each.

¹³Only on HP 8648 series.

¹⁴Specifications apply over the $25 \pm 5^\circ\text{C}$ range within one hour of dc FM calibration.

¹⁵Only on HP 8648 series.

¹⁶Useable from 10 Hz to 20 kHz; however, bandwidth limitations may result in waveform degradation. Refer to AM, FM, and Phase Modulation Rate specs (External AC mode).

¹⁷FLEX is a Motorola trademark.

¹⁸After one hour warm-up and within one year of calibration.

¹⁹Specifications apply over the $25 \pm 5^\circ\text{C}$ range, 4.8 kHz deviation.

Meets FLEX requirements at 274 to 288, 322 to 329, 929 to 932 MHz.

²⁰Specifications apply over the $25 \pm 5^\circ\text{C}$ range.

ISO 9002 Compliant

The HP 8647A and HP 8648A/B/C/D signal generators are manufactured in an ISO 9002 registered facility in concurrence with Hewlett-Packard's commitment to quality.

Environmental

Operating temperature range

0° to 50°C.

Shock and vibration

Meets MIL STD 28800E Type III, Class 5.

Leakage

Conducted and radiated interference meets MIL STD 461B RE02 Part 2 and CISPR 11. Leakage is typically <1 μ V (nominally 0.1 μ V with a two-turn loop) at ≤ 1001 MHz, when measured with a resonant dipole antenna one inch from any surface (except the rear panel) with output level <0 dBm (all inputs/outputs properly terminated).

Remote Programming

Interface

HP-IB (IEEE-488.2-1987) with Listen and Talk.

Control languages

SCPI version 1992.0. HP 8656B and 8657 code compatibility on HP 8648A/B/C/D.

Functions controlled

All functions are programmable except the front-panel power key, the knobs, the increment set key, the arrow keys, the reference keys and the rear-panel display contrast control.

IEEE-488 functions

SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2.

General

Power requirements

90 to 264 V; 48 to 440 Hz; 170 VA maximum.

Internal diagnostics

Automatically executes on instrument power-up. Assists user in locating instrument errors and locating faulty module.

Storage registers

300 storage registers with sequence and register number displayed. Up to 10 sequences are available with 30 registers each.

Weight

HP 8647A and HP 8648A

7 kg (15 lb.) net, 9 kg (20 lb.) shipping.

HP 8648B/C/D

8.5 kg (19 lb.) net, 11 kg (24 lb.) shipping.

Dimensions

HP 8647A

165H x 330W x 333D mm (6.5H x 13W x 13.2D inches).

HP 8648A/B/C/D

165H x 330W x 368D mm (6.5H x 13W x 14.6D inches).

Options

1EA: High power (HP 8648B/C/D).

1E2: Modulation generator (HP 8648A/B/C/D).

1E5: High stability timebase.

1E6: Pulse modulation (HP 8648B/C/D).

1EP: Pager encoder/signalling (HP 8648A).

1CM Rack kits

HP 8647A: P/N 08647-61020.

HP 8648A/B/C/D: P/N 08648-60001.

0B0: Delete manual.

0B1: Extra manual (includes service information).

W30: Three year warranty.

Accessories

Transit case

HP 8647A: P/N 5960-2229.

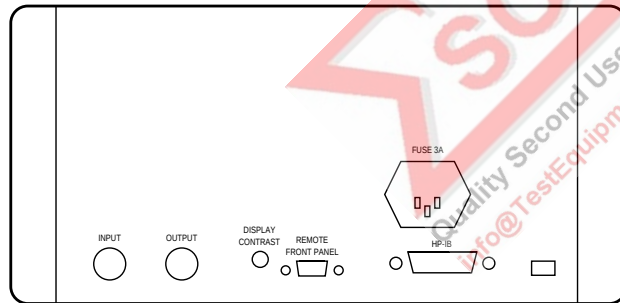
HP 8648A/B/C/D: P/N 5961-4720.

HP 83300A Remote Interface.

HP 83301A Memory Interface.

Translated Operating Manuals

Options	Language	Part Number
HP 8647A		
AB0	Chinese for Taiwan	08647-90010
AB1	Korean	08647-90011
AB2	Chinese for PRC	08647-90012
ABE	Spanish	08647-90013
ABJ	Japanese	08647-90016
HP 8648A/B/C/D		
AB0	Chinese for Taiwan	08648-90002
AB1	Korean	08648-90006
AB2	Chinese for PRC	08648-90004
ABD	German	08648-90019
ABE	Spanish	08648-90003
ABF	French	08648-90020
ABJ	Japanese	08648-90005



HP 8647/8648 rear panel

For more information on Hewlett-Packard Test & Measurement products, applications or services please call your local Hewlett-Packard sales office. A current listing is available via Web through AccessHP at <http://www.hp.com>. If you do not have access to the Internet, please contact one of the HP centers listed below and they will direct you to your nearest HP representative.

United States:

Hewlett-Packard Company
Test and Measurement Organization
5301 Stevens Creek Blvd.
Bldg. 51L-SC
Santa Clara, CA 95052-8059
1 800 452 4844

Canada:

Hewlett-Packard Canada Ltd.
5150 Spectrum Way
Mississauga, Ontario L4W 5G1
(905) 206 4725

Europe:

Hewlett-Packard
European Marketing Centre
P.O. Box 999
1180 AZ Amstelveen
The Netherlands

Japan:

Hewlett-Packard Japan Ltd.
Measurement Assistance Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192, Japan
(81) 426 48 3860

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Latin American Region Headquarters
5200 Blue Lagoon Drive, 9th Floor
Miami, Florida 33126, U.S.A.
(305) 267 4245/4220

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Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130, Australia
131 347 Ext. 2902

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Hewlett-Packard Asia Pacific Ltd.
17-21/F Shell Tower, Time Square,
1 Matheson Street, Causeway Bay,
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