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Users Guide

HP 81533B Optical Head Interface Module, HP 81520A, HP 81521B, HP 81524A, and HP 81525A Optical Heads

SERIAL NUMBERS

This manual applies to all instruments listed above, and also to the HP 81533A Optical Head Interface Module.



HP Part No. 81533-90014
Printed in Germany

Fourth Edition
E0597

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Printing History

New editions are complete revisions of the guide reflecting alterations in the functionality of the instrument. Updates are occasionally made to the guide between editions. The date on the title page changes when an updated guide is published. To find out the current revision of the guide, or to purchase an updated guide, contact your Hewlett-Packard representative.

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ISO 9001 Certification

Produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

Control Serial Number: Edition 3 applies directly to all instruments.
Edition 1 : 1st May 1990 : 81533-90011 : E0590 ; 1st December 1990 : 81533-90011 : E1290
Edition 2 : 1st December 1991 : 81533-90012 : E1291
Edition 3 : 1st March 1993 : 81533-90013 : E0393
Edition 4 : 1st May 1994 : 81533-90014 : E0594; 1st December 1994 : 81533-90014 : E1294
1st July 1996 : 81533-90014 : E0796; 1st May 1997 : 81553-90014 : E0597

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Safety Considerations

Before operation, review the instrument and manual, including the red safety page, for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep it until you have checked the contents of the shipment for completeness and verified the module both mechanically and electrically.

The Performance Tests give procedures for checking the operation of the module. If the contents are incomplete, mechanical damage or defect is apparent, or if a module does not pass the operator's checks, notify the nearest Hewlett-Packard office.

Warning



To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

Power Requirements

The HP 81533B operates when installed into the HP 8153A Optical Multimeter mainframe.

Operating Environment

The HP 8153A safety information summarizes the HP 81533B operating environment ranges. In order for the HP 81533B to meet specifications, the operating environment must be within the limits specified in this section.

Input/Output Signals

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Caution A maximum of 15V can be applied as an external voltage to any BNC connectors.



Storage and Shipment

The module can be stored or shipped at temperatures between −40° C and +70° C. Protect the module from temperature extremes that may cause condensation within it.

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C

HP 81533B, HP 81520A, HP 81521B, HP 81524A, and HP 81525A Specifications

Specifications describe the instrument's warranted performance. Supplementary performance characteristics describe the instrument's non-warranted typical performance.

Because of the modular nature of the instrument, these performance specifications apply only to this module. You should insert these pages into the appropriate section of the manual.

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HP 81533B Specifications

	HP 81533B with HP 81520A Optical Head	HP 81533B with HP 81521B Optical Head	HP 81533B with HP 81524A Optical Head	HP 81533B with HP 81525A Optical Head
Sensor Element	Si, 5mm	Ge, 5mm	InGaAs, 5mm	
Wavelength range	450-1020nm	900-1700nm	800-1650nm	
Power range	+10 to -100dBm	+3 to -80dBm	+3 to -90dBm	+27 to -70dBm (1250 to 1650nm) +23 to -70dBm (800 to 1650nm)
Display resolution	0.001dB/dBm (0.0001dB/dBm on printout), 0.01pW tpo 10pW (depending on power range)			
Applicable fiber type	parallel beam, 9/125μm - 100/140μm, NA $\leq$0.3			
Uncertainty (Accuracy) at reference conditions[1]	±2.2% (600-1020nm)	±2.2% (1000-1650nm)	±2.2% (1000-1600nm)	±3% (900-1600nm)
Total Uncertainty[2]	±4%±0.5pW (600-1020nm)	±4%±50pW (1000-1650nm)	±4%±5pW (1000-1600nm)	±5%±500pW (900-1600nm)
Linearity	(+3 to -80dBm)	(0 to -60dBm)	(+3 to -70dBm)	(+10 to -50dBm)[3]
18°C to 28°C const. temp	±0.04dB±0.5pW	±0.04dB±50pW	±0.04dB±5pW	±0.04dB±500pW
Operating temp. range const. temp	±0.15dB±0.5pW	±0.15dB±50pW	±0.15dB±5pW	±0.15dB±500pW
Noise	<0.5pW	<50pW	<5pW	<500pW
peak-peak, avg. time 1sec	(700-900nm)	(1200-1600nm)	(1000-1600nm)	(900-1600nm)
Operating Temperature	0°C to +40°C			0°C to +35°C[4]
Dimensions				
Module	75mm H, 82mm W, 335mm D (2.8"×1.3"×13.2")			
Head	37.5mm Diameter, 140mm Long (1.5"×5.5")			
Weight				
Module	net 0.6kg (1.3lbs), shipping 1kg (2.2lbs)			
Head	net 0.45kg (1lbs), shipping 1kg (2.2lbs)			
Recalibration period	2 years			
Warmup time	20 min.			
The display may vary by ±1 count.				

Information on the traceability of power meters is available on request

[1] at the following reference conditions:

- Power level 10μW (-20dBm), Continuous Wave (CW).
- Parallel beam, 3mm spot diameter on detector.
- Ambient temperature 23°C±5K
- At day of calibration. (add 0.3% for aging over one year, add 0.6% over two years).
- Spectral width of source <10nm

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[2] at the following operating conditions:

- Parallel beam, 3mm spot diameter on detector, or connectorized fiber with NA ≤0.2
- Ambient temperature 0 to 40°C, non-condensating.
- Within 1 year after calibration, add 0.3% for the second year.

[3] Add 0.007dB/dB between 10 and 27dBm.

[4] 30°C for >20dBm input power.

Supplementary Performance Characteristics

Add 1% to total uncertainty for the full wavelength range.

Outside the specified wavelength range, the noise increases by up to 5 times the value shown above.

For fiber applications with NA between 0.2 and 0.3 use specific lenses and add 0.5% total uncertainty for the 850±50nm, 1300±50nm, and 1550±50nm range.

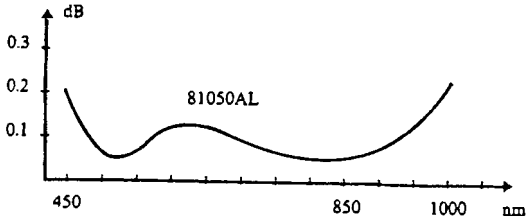
Analog output	
bandwidth	≥DC, ≤300 to 1000Hz
	depending on range and optical head
output voltage	0 to 2V into open
output impedance	600Ω typ.
max. input voltage	±10V

HP 81050AL Lens

Attenuation at 850 nm (AL-type) is printed on each lens. This value must be entered into the power meter using the CAL parameter, for precise measurements.

Typical attenuation over wavelength for the 81050AL, exactly measured at 850 nm:

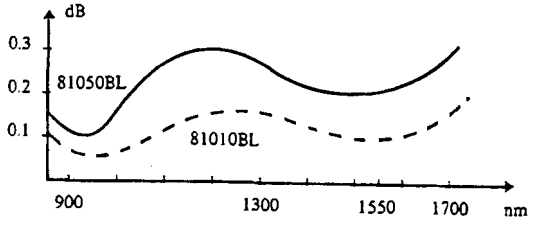
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HP 81010BL and HP 81050BL Lens

Attenuation at 1300/1550 nm (BL-type) is printed on each lens. This value must be entered into the power meter using the CAL parameter, for precise measurements.

Typical attenuation over wavelength for the 81010BL and 81050BL, exactly measured at 1300 nm and 1550 nm:



Optical Connections

For the optical head, various accessories can be ordered that aid measurement, as well as connection to bare or terminated fibers. Depending on which accessories you ordered, Figure C-1 shows the sequence in which you attach them to the HP 81520A. Figure C-2 shows the sequence in which you attach them to the HP 81521B and the HP 81524A.

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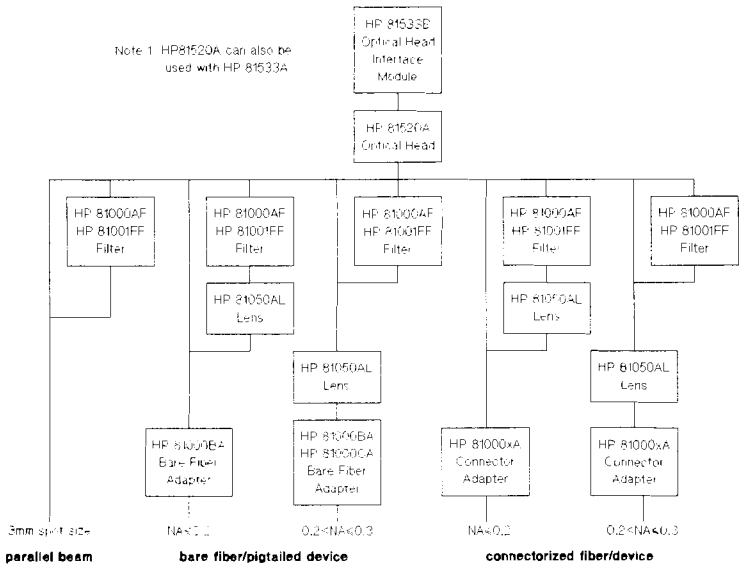


Figure C-1. Optical Connections

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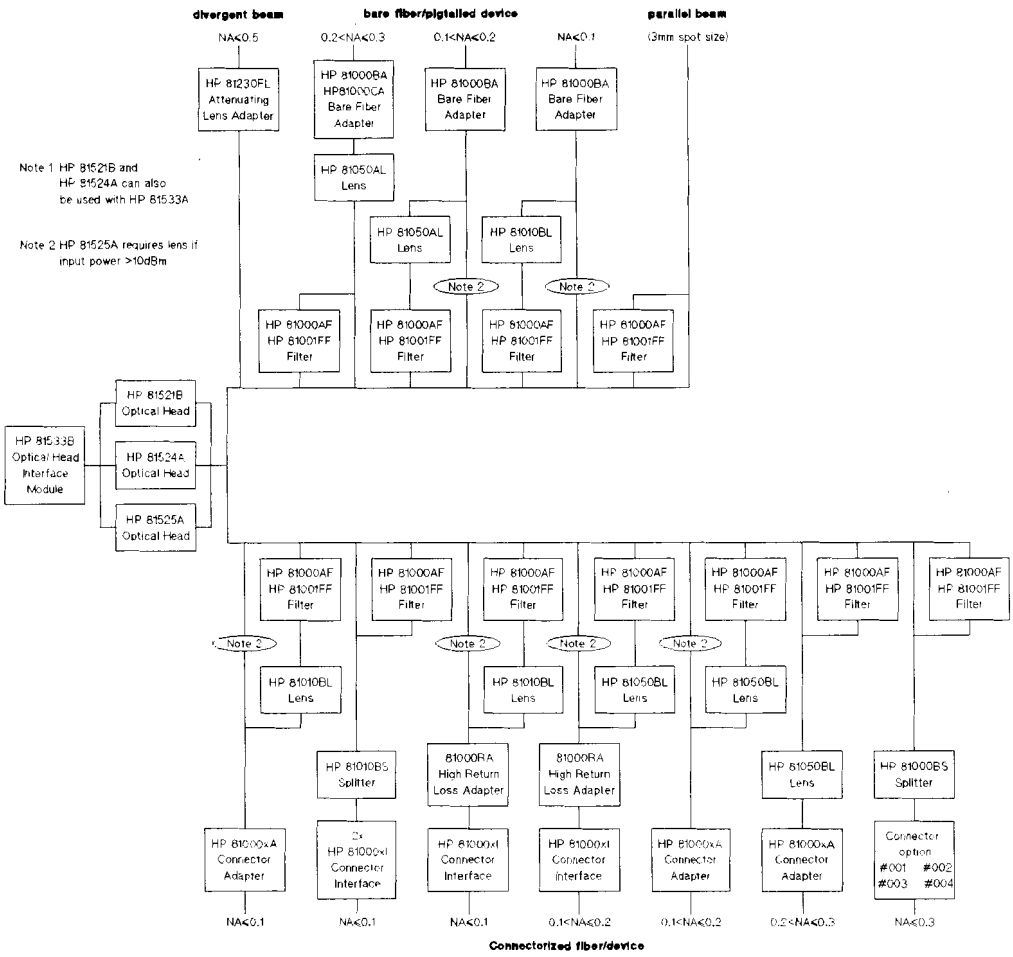


Figure C-2. Optical Connections

Compensating for Lens Loss. If you are using one of the optical heads with a lens, the attenuation loss has been individually measured at the factory. This measured value is marked on the lens casing as a "CAL" factor, for example CAL -.19dB.

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You should enter this CAL factor, together with any other known losses for your measurement system, to compensate for the non-ideal nature of the measuring equipment.

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D

HP 81533B and Optical Heads Performance Tests

Introduction

The procedures in this section test the electrical performance of the instrument. The complete specifications to which the HP 81533B, with an optical head, is tested are given in Appendix C. All tests can be performed without access to the interior of the instrument. The test equipment given corresponds to tests carried out with Diamond HMS-10/HP connectors.

Test Record

Results of the performance test may be tabulated on the Test Record provided after the test procedures. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and setup information are printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are already familiar with the test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Hewlett-Packard.

Test Failure

If the HP 81533B or the optical head fails any performance test, return it to the nearest Hewlett-Packard Sales/Service Office for repair.

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Instrument Specification

Specifications are the performance characteristics of the instrument that are certified. These specifications, listed in Appendix C, are the performance standards or limits against which to test. Appendix C also lists some supplemental characteristics. Supplemental characteristics should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Bureau of Standards, aee covered in a manual change supplement, or revised manual. Such specifications supersede any that were previously published.

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Module Function Tests

Equipment Required

Equipment required for the function test is listed in the table below. Any equipment that satisfies the critical specifications of the equipment given in the table, may be substituted for the recommended models.

Instrument/Accessory	Recommended Model
Multimeter Mainframe	HP 8153A
Optical Head	HP 81520A, HP 81521B, HP 81524A, or HP 81525A
Digital Multimeter	HP 3466A, with test leads.
BNC to BNC cable	HP 10102A
BNC(m) to dual Banana plug	HP 10110B
Test/Cal Box	P/N 08152-63201
Head Recognition Adapter	P/N 08152-63211
Test Cable	P/N 08153-61610
BNC(f) to dual Banana plug	P/N 1251-2277
DC Standard	with adapter cables
Oscilloscope	

Function Test

The function test given in this section is using the HP 8153A with the HP 81533B Optical Head Adapter Module and the 08152- 63201 Test/Cal Box to check voltages and signals to and from the HP 81520A/21B Optical Heads. Perform each step in the tests in the order given, using the corresponding equipment.

Static and Dynamic Tests

1. Insert the HP 81533B into the mainframe channel A position and connect the test/cal box to its input.
2. Make sure that the head recognition adapter is connected to the test/cal box.
3. Turn power on and check that all display segments are lit for approximately 2 seconds and check that the HP 8153A then displays the error message `E3200 HEAD-DAT SELFTEST`.
4. To test the constant voltages:

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a. Using the test cable check the following DC levels at test/cal box receptacles

Receptacle	Expected Value
+15V	+15±0.8V
-15V	-15±0.8V
P.CTRL	0V
STATUS	0V

5. To test the ranging:

   a. The states of RANGE 0 and RANGE 1 depend on the respective HP 8153A range settings.

   b. Press (Auto) to make sure that autoranging is OFF.

   c. Select the following ranges with (Up) and (Down). In each case, check the status of the range selection signal on the RANGE 0 and RANGE 1 receptacle on the test/cal box.

dBm Range	RANGE 0	RANGE 1
0	H	H
-10	H	H
-20	H	L
-30	H	L
-40	H	L
-50	L	L

6. To test the +5V:

   a. Set the oscilloscope as follows:

      Input to 2V/DIV, DC Coupled, 1MΩ.

      Timebase to 0.005s/DIV.

      Sweep mode to AUTO.

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Note

When performing this test and the following tests, each time, after pressing the switch on the head recognition adapter, the message ER 3200 HEAD-DAT appears. To continue the tests or to repeat a test, the error state must be overwritten by pressing any key on the HP 8153A front panel.

b. Use the test cable to connect the +5V receptacle to the oscilloscope.

c. Check that, when you press the switch on the head recognition adapter, the +5V output switches from 0V to +5V and then back to 0V after approximately 2 seconds.

7. To test the data clock (see also the note to step 6):

   a. Use the test cable to connect the CLOCK receptacle to the oscilloscope.

   b. Check that, when you press the switch on the head recognition adapter, the CLOCK outputs clock pulses for approximately 4 seconds, going from +5V to 0V.

8. To test the $\overline{OE}$ (see also the note to step 6):

   a. Use the test cable to connect the $\overline{OE}$ receptacle to the oscilloscope.

   b. Check that, when you press the switch on the head recognition adapter, the $\overline{OE}$ output switches from +5V to 0V and then back to +5V after approximately 2 seconds.

9. To test the ON/OFF (see also the note to step 6):

   a. Use the test cable to connect the ON/OFF receptacle to the oscilloscope.

   b. Check that the ON/OFF output is at +15V while you are pressing the switch on the head recognition adapter, and at +5V when you release the switch.

10. To test the Peltier Control:

    a. Change the input sensitivity of the oscilloscope to 0.05V/DIV and connect the test cable from the P.CTRL receptacle to the oscilloscope.

    b. Watch the DC level displayed on the oscilloscope and connect instead of the head recognition adapter the HP 81520A, HP 81521B, HP 81524A, or HP 81525A Optical Head.

    c. After a few seconds, the P.CTRL voltage should change from approximately 130mV to approximately 30mV (HP 81520A), from

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approximately 150mV to approximately 40mV (HP 81521B)) or from approximately 130mV to approximately 50mV (HP 81524A, or HP 81525A).

Gain/Range Calibration Accuracy Test

Note



These measurements are very dependent on the condition of the test setup. Before beginning these tests, check the equipment for possible ground loops and shielding problems and make sure that the line supply is free of disturbances.

11. To test the gain/range calibration accuracy:
    a. Connect the DC standard to the BNC connector marked "8152A IN" on the test/cal box. Make sure that the DC standard is set to 0 volts.
    b. Make sure the instrument is in MEASure mode, and press (dBm/W) to make sure that the display is in Watts.
    c. Press (Param) to select the CAL parameter. Reset the calibration to 0 by holding (Param) down for 3 seconds.
    d. Press (Zero) to zero the instrument. Select the -20dBm range with (Up) and (Down).
    e. Check that, at the DC standard settings, and Range settings given in the table, you get the readings indicated.

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Range	DC Standard Setting	Reading
-20	0.0000V	0.00μW
-20	+7.6000V	19.000μW(±40 counts)
-20	+0.7600V	1.900μW(±4 counts)
-30	+0.7600V	1900.0nW(±40 counts)
-30	+0.0760V	190.0nW(±4 counts)
-40	+0.0760V	190.00nW(±40 counts)
-40	+0.0076V	19.00nW(±4 counts)

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D

Function Test for the HP 81533B

Test Facility:

_____	Report No.	_____	
_____	Date	_____	
_____	Customer	_____	
_____	Tested By	_____	

Model	HP 81533B Optical Head Interface Module		
Serial No.	_____	Ambient temperature	_____ °C
Options	_____	Relative humidity	_____ %
Firmware Rev.	_____	Line frequency	_____ Hz

Special Notes:

_____

_____

_____

_____

_____

_____

_____

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Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter (Std.)	HP 8153A	_____	_____
2	Opt. Head Interface Module	HP 81533B	_____	_____
3a.	Optical Head 850nm	HP 81520A	_____	_____
3b.	Optical Head 1310, 1550nm	HP 81521B	_____	_____
3c.	Optical Head 1310, 1550nm	HP 81524A	_____	_____
3d.	Optical Head 1310, 1550nm	HP 81525A	_____	_____
4.	BNC to BNC Cable	HP 10102A		
5.	BNC(m) to dual banana plug	HP 10110B		
6.	Test/Cal Box	08152-63201		
7.	Head Recognition Adapter	08152-63211		
8.	Test Cable	08153-61610		
9.	BNC(f) to dual banana plug	1251-2277		
10.	DC Standard with Adapter Cables	_____	_____	_____
11.	Oscilliscope	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____

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Function Test for the HP 81533B

Model HP 81533B Opt. Head Int. Module No. _____ Date _____

Test Description		Pass	Fail
Static and Dynamic Test			
Parameter	Expected Value		
+15V	+15±0.8V	___	___
-15V	-15±0.8V	___	___
P.CTRL	0V	___	___
STATUS	0V	___	___
RANGE 0	High in the 0dBm to -40dBm ranges		
	Low in the -50dBm range	___	___
RANGE 1	High in the 0dBm to -10dBm ranges		
	Low in the -20dBm to -50dBm ranges	___	___
+5V	0V→+5V→0V	___	___
MODE 0	0V→+5V→0V	___	___
MODE 1	0V→+5V→0V	___	___
CLOCK	Pulses from +5V to 0V	___	___
$\overline{OE}$	+5V→0V→+5V	___	___
ON/OFF	+5V→+15V→+5V	___	___
P.CTRL	Peltier Regulation	___	___

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Function Test for the HP 81533B

Model HP 81533B Opt. Head Int. Module No. _____ Date _____

Test Description		Result		
Gain/Range Accuracy Test				
Range	DC Standard Setting	Minimum	Actual	Maximum
-20dBm	0.0000V	0.000μW	_____	0.000μW
-20dBm	+7.6000V	18.960μW	_____	19.040μW
-20dBm	+0.7600V	1.896μW	_____	1.904μW
-30dBm	+0.7600V	1896.0nW	_____	1904.0nW
-30dBm	+0.0760V	189.6nW	_____	190.4nW
-40dBm	+0.0760V	189.60nW	_____	190.40nW
-40dBm	+0.0076V	18.96nW	_____	19.04nW

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HP 81520A, HP 81521B, HP 81524A, and HP 81525A Performance Tests

Equipment Required

Equipment required for the performance test is listed below. Any equipment that satisfies the critical specifications of the equipment given in the table, may be substituted for the recommended models.

HP 81520A

Instrument/Accessory	Rec. Model	Required Characteristic
Power Meter Standard #C01	HP 8153A Lightwave Multimeter Mainframe with HP 81533B Optical Head Interface Module with HP 81520A Optical Head.	Uncertainty ±1.5%
CW Laser Source	HP 8153A Lightwave Multimeter Mainframe with HP 81551MM 850nm Laser Source Module.	Wavelength Uncertainty ±2nm
Optical Attenuator	HP 8158B Option 001/011*	
Lens Adapter	HP 81050AL	
Connector Adapter	HP 81000AA	
Plastic Cap	5040-9361 (×2)	

* or equivalent:

Attenutation range	0 to 30dB
Resolution	0.01dB
Return Loss	>27dB

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HP 81521B

Instrument/Accessory	Rec. Model	Required Characteristic
Power Meter Standard #C01	HP 8153A Lightwave Multimeter Mainframe with HP 81533B Optical Head Interface Module with HP 81521B Optical Head	Uncertainty ±1.5%
CW Laser Source	HP 8153A Lightwave Multimeter Mainframe with HP 81552SM 1310nm Laser Source Module and HP 81553SM 1550nm Laser Source Module	Wavelength Uncertainty ±1.5nm
	OR	
	HP 8153A Lightwave Multimeter Mainframe with HP 81554SM 1310/1550nm Laser Source Module.	Wavelength Uncertainty ±1.5nm
Optical Attenuator	HP 8156A Option 101	
Connector Interface	HP 81000AI (×2)	
Singlemode Fiber	HP 81101AC (×2)	
Lens Adapter	HP 81010BL	
Connector Adapter	HP 81000AA	
Plastic Cap	5040-9361 (×2)	

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HP 81524A or HP 81525A

Instrument/Accessory	Rec. Model	Required Characteristic
Power Meter Standard #C01	HP 8153A Lightwave Multimeter Mainframe with HP 81533B Optical Head Interface Module with HP 81524A Optical Head	Uncertainty ±1.5%
CW Laser Source	HP 8153A Lightwave Multimeter Mainframe with HP 81552SM 1310nm Laser Source Module and HP 81553SM 1550nm Laser Source Module	Wavelength Uncertainty ±1.5nm
	OR	
	HP 8153A Lightwave Multimeter Mainframe with HP 81554SM 1310/1550nm Laser Source Module.	Wavelength Uncertainty ±1.5nm
Optical Attenuator	HP 8156A Option 101	
Connector Interface	HP 81000AI (×2)	
Singlemode Fiber	HP 81101AC (×2)	
Lens Adapter	HP 81010BL	
Connector Adapter	HP 81000AA	
Plastic Cap	5040-9361 (×2)	

Performance Test

The performance tests given in this section are separated into Accuracy Test and Linearity Test. Perform each step in the tests in the order given, using the corresponding test equipment.

Note



Make sure that all optical connections of the test setups given in the procedure are dry and clean. **DO NOT USE INDEX MATCHING OIL** (see cleaning procedure).

The Optical Cables from the Laser Source to and from the HP 8156A Attenuator to the Power Meter must be fixed on the table to ensure minimum cable movement during the tests.

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Accuracy and Linearity Tests

Specifications: HP 81520A

Uncertainty: ±2.5% (600-1020 nm) including aging.
Linearity: ±0.04dB±0.5pW rel. to −20dBm

Specifications: HP 81521B

Uncertainty: ±2.5% (1000-1650 nm) including aging.
Linearity: ±0.04dB±50pW rel. to −20dBm

Specifications: HP 81524A

Uncertainty: ±2.5% (1000-1600 nm) including aging.
Linearity: ±0.04dB±5pW rel. to −20dBm

Specifications: HP 81525A

Uncertainty: ±3.3% (900-1600 nm) including aging.
Linearity: ±0.04dB±500pW rel. to −20dBm

I. Accuracy Test

The following gives the procedure for performing the accuracy test for the HP 81520A, HP 81521B, HP 81524A, or the HP 81525A with the HP 8153A and the HP 81533B:

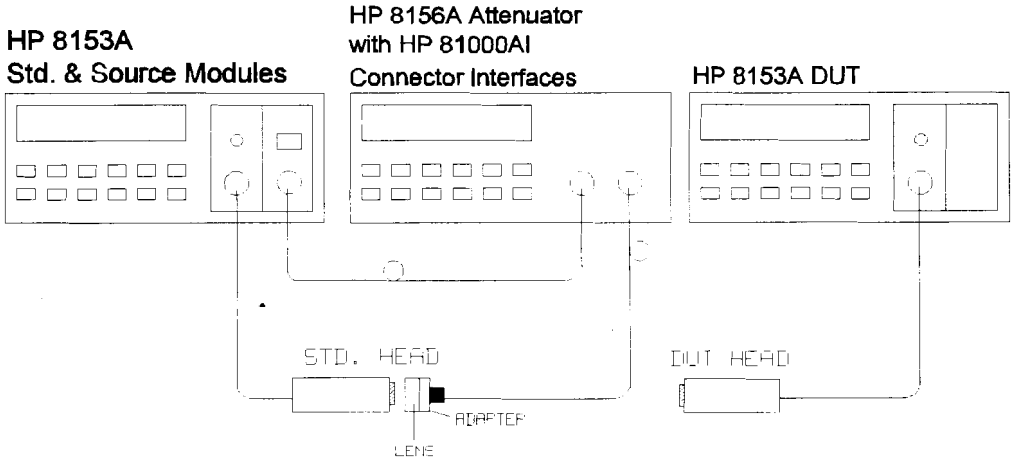


Figure D-1. Accuracy Test Set-Up

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1. Make sure that the cable connectors, lenses and detector windows are clean. Refer to the cleaning procedure.
2. Connect the equipment as shown in Figure D-1. Ensure that the cables to and from the Attenuator are fixed on the table and both optical heads are close together so that minimum cable movement is achieved when connecting the cable to the Standard or to the DUT Head.
3. Turn the instruments on, enable the laser source, and allow the instruments to warm up for at least 20 minutes.
4. ZERO the power meters with the head connector adapters covered with plastic caps (P/N 5040-9361 or 5040-9351).
5. Set the CAL factor of both instruments to zero.
6. Set the WAVELENGTH of both instruments to the actual wavelength of the Laser Source and note the wavelength in the Test Record.
7. Set both instruments to MEASure, (display in μW), switch AUTOrange off and select the -20dBm range.
8. Enable the HP 8156A output, and change the HP 8156A attenuation until the Power Meter Standard displays 10.00 μW.
9. Connect the attenuator output cable, with the same lens and adapter, to the DUT and check that the DUT display is between 9.75 μW and 10.25 μW. Note the result in the Test Record.
10. For the HP 81521B, HP 81524A, or HP 81525A, repeat steps 8 and 9 at the second wavelength.

II. Linearity Test

1. Make sure that the HP 8156A output is disabled. ZERO the DUT.
2. Enable the HP 8156A output.
3. On the DUT, switch off autoranging and select the -20dBm range. Set the display to show results in dBm.
4. Alter the attenuation until the DUT displays -17.4dBm.
5. Press (Disp→Ref), then (dB).
6. Press (Up) to select the -10dBm range.
7. Note the deviation, displayed in dB, as R1 on the test record.

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a. In the -10dBm range. Set the display to show results in dBm.

b. Alter the attenuation until the DUT displays -7.4dBm.

c. Press (Disp→Ref), then (dB).

d. Select the 0dBm range.

e. Note the deviation, displayed in dB, as R2 on the test record.

8. Repeat the steps a to e at the all the range and level settings shown in the test record.

Note

- For the HP 81520A, HP 81524A, or HP 81525A, it might be necessary to use the attenuation of the laser source itself, as well as the attenuator, to set the power to -67.2dBm in the -60dBm range.
- For the HP 81525A in the +10, +20, and +30dBm ranges.

  a. Connect the laser source to the DUT Head as shown in Figure D-2.

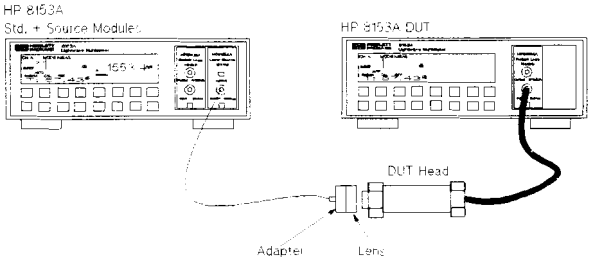


Figure D-2. HP 81525A Linearity Test Test Set-Up

  b. Use the attenuation of the laser source itself to set the power to 0dBm for the 0dBm range before selecting the +10dBm range. You do not need to alter this attenuation of the source before selecting the +20dBm and +30dBm ranges.

---

9. Calculate the non-linearity using the formulae in the test record. An example calculation follows here.

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Example Results for the Linearity test (for an HP 81525A Optical Head)

Test No.	Test Description			Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
II.	**Linearity Test**				dB		
	Range	Power (dBm)					
	-20dBm	-17.4	Disp→Ref				
	-10dBm				0.01 =R1		
	-10dBm	-7.4	Disp→Ref				
	0dBm				-0.02 =R2		
	-20dBm	-27.4	Disp→Ref				
	-30dBm				-0.02 =R3		
	-30dBm	-37.4	Disp→Ref				
	-40dBm				-0.01 =R4		
	0dBm	0	Disp→Ref				
	+10dBm				0.03 =R11		
	0dBm	0	Disp→Ref				
	+20dBm				-0.02 =R21		
	0dBm	0	Disp→Ref				
	+30dBm				0.03 =R31		

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Example Calculated Results for the Linearity Test (for an HP 81525A Optical Head)

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
	Non-Linearity				
	Range Formula				
	+30dBm R1+R2+R31	-0.1dB	0.01dB	+0.01B	[1]
	+20dBm R1+R2+R21	-0.1dB	-0.03dB	+0.1dB	[1]
	+10dBm R1+R2+R11	-0.04dB	0.02dB	+0.04dB	±0.018dB
	0dBm R1+R2	-0.04dB	-0.01dB	+0.04dB	±0.017dB
	-10dBm R1	-0.04dB	0.01dB	+0.04dB	±0.010dB
	-20dBm		0.000dB		±0.000dB
	-30dBm R3	-0.04dB	-0.02dB	+0.04dB	±0.010dB
	-40dBm R3+R4	-0.04dB	-0.03dB	+0.04dB	±0.014dB

[1] Functional test only (insufficient power).

Shown graphically, these results look add as shown in the following figure:

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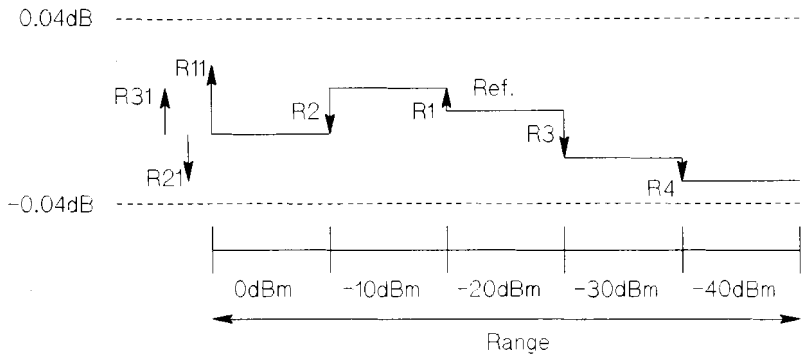


Figure D-3. Addition of results (example)

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Performance Test for the HP 81520A

Test Facility:

_____		Report No.	_____
_____		Date	_____
_____		Customer	_____
_____		Tested By	_____

Model	HP 81520A Optical Head		
Serial No.	_____	Ambient temperature	_____ °C
Options	_____	Relative humidity	_____ %
Firmware Rev.	_____	Line frequency	_____ Hz

Special Notes:

_____

_____

_____

_____

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_____

_____

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Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter (Std.)	HP 8153A	_____	_____
2a.	Opt. Head Interface Module	HP 81533B	_____	_____
2b.	Optical Head 850nm	HP 81520A	_____	_____
3.	Laser Module	HP 81551MM	_____	_____
4.	Lens Adapter	HP 81050AL		
5.	Connector Adapter	HP 81000AA		
6.	Optical Attenuator	HP 8158B Opt.001/011		
7.	Multimode Fiber (×2)	HP 81501AC		
8.	Lightwave Multimeter (DUT)	HP 8153A		
9.	Opt. Head Interface Module (DUT)	HP 81533B		
10.	_____	_____	_____	_____
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____
15.	_____	_____	_____	_____

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Model HP 81520A Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I.	**Accuracy Test**		μW		
	measured at _____nm				
	Output Power	9.75μW	_____	10.25μW	±2.00%
II.	**Linearity Test**		dB		
	Range Power (dBm)				
	-20dBm -17.4 Disp→Ref				
	-10dBm		_____ = R1		
	-10dBm -7.4 Disp→Ref				
	0dBm		_____ = R2		
	-20dBm -27.4 Disp→Ref				
	-30dBm		_____ = R3		
	-30dBm -37.4 Disp→Ref				
	-40dBm		_____ = R4		
	-40dBm -47.4 Disp→Ref				
	-50dBm		_____ = R5		
	-50dBm -57.4 Disp→Ref				
	-60dBm		_____ = R6		

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Performance Test for the HP 81520A

Model HP 81520A Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
	Non-Linearity				
	Range Formula				
	0dBm R1+R2	-0.04dB	_____dB	+0.04dB	±0.017dB
	-10dBm R1	-0.04dB	_____dB	+0.04dB	±0.010dB
	-20dBm		0.000dB		±0.000dB
	-30dBm R3	-0.04dB	_____dB	+0.04dB	±0.010dB
	-40dBm R3+R4	-0.04dB	_____dB	+0.04dB	±0.014dB
	-50dBm R3+R4+R5	-0.04dB	_____dB	+0.04dB	±0.017dB
	-60dBm R3+R4+R5+R6	-0.04dB	_____dB	+0.04dB	±0.022dB

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Performance Test for the HP 81521B

Test Facility:

_____		Report No.	_____
_____		Date	_____
_____		Customer	_____
_____		Tested By	_____

Model	HP 81521B Optical Head		
Serial No.	_____	Ambient temperature	_____ °C
Options	_____	Relative humidity	_____ %
Firmware Rev.	_____	Line frequency	_____ Hz

Special Notes:

_____

_____

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Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter (Std.)	HP 8153A	_____	_____
2a.	Opt. Head Interface Module	HP 81533B	_____	_____
2b.	Optical Head 1310, 1550nm	HP 81521B	_____	_____
3a1.	Laser Module	HP 81552SM	_____	_____
3a2.	Laser Module	HP 81553SM	_____	_____
3b.	Laser Module	HP 81554SM	_____	_____
4.	Lens Adapter	HP 81010BL		
5.	Connector Adapter	HP 81000AA		
6.	Optical Attenuator	HP 8156A Opt.101		
7.	Connector Interface (×2)	HP 81000AI		
8.	Singlemode Fiber (×2)	HP 81101AC		
9.	Lightwave Multimeter (DUT)	HP 8153A		
10.	Opt. Head Interface Module (DUT)	HP 81533B		
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____
14.	_____	_____	_____	_____

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Model HP 81521B Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I.	**Accuracy Test**		μW		
	measured at 13_____nm Output Power	9.75μW	_____	10.25μW	±2.00%
	measured at 15_____nm Output Power	9.75μW	_____	10.25μW	±2.00%
II.	**Linearity Test**		dB		
	Range Power (dBm)				
	-20dBm -17.4 Disp→Ref				
	-10dBm		_____=R1		
	-10dBm -7.4 Disp→Ref				
	0dBm		_____=R2		
	-20dBm -27.4 Disp→Ref				
	-30dBm		_____=R3		
	-30dBm -37.4 Disp→Ref				
	-40dBm		_____=R4		
	-40dBm -47.4 Disp→Ref				
	-50dBm		_____=R5		

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Performance Test for the HP 81521B

Model HP 81521B Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
	Non-Linearity				
	Range Formula				
	0dBm R1+R2	-0.04dB	_____dB	+0.04dB	±0.017dB
	-10dBm R1	-0.04dB	_____dB	+0.04dB	±0.010dB
	-20dBm		0.000dB		±0.000dB
	-30dBm R3	-0.04dB	_____dB	+0.04dB	±0.010dB
	-40dBm R3+R4	-0.04dB	_____dB	+0.04dB	±0.014dB
	-50dBm R3+R4+R5	-0.051dB	_____dB	+0.051dB	±0.017dB

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Performance Test for the HP 81524A

Test Facility:

_____		Report No.	_____
_____		Date	_____
_____		Customer	_____
_____		Tested By	_____

Model	HP 81524A Optical Head		
Serial No.	_____	Ambient temperature	_____ °C
Options	_____	Relative humidity	_____ %
Firmware Rev.	_____	Line frequency	_____ Hz

Special Notes:

_____

_____

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Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter (Std.)	HP 8153A	_____	_____
2a.	Opt. Head Interface Module	HP 81533B	_____	_____
2b.	Optical Head 1310, 1550nm	HP 81524A	_____	_____
3a1.	Laser Module	HP 81552SM	_____	_____
3a2.	Laser Module	HP 81553SM	_____	_____
3b.	Laser Module	HP 81554SM	_____	_____
4.	Lens Adapter	HP 81010BL		
5.	Connector Adapter	HP 81000AA		
6.	Optical Attenuator	HP 8156A Opt.101		
7.	Connector Interface (×2)	HP 81000AI		
8.	Singlemode Fiber (×2)	HP 81101AC		
9.	Lightwave Multimeter (DUT)	HP 8153A		
10.	Opt. Head Interface Module (DUT)	HP 81533B		
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____

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Model HP 81524A Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I.	**Accuracy Test**		μW		
	measured at 13_____nm Output Power	9.75μW	_____	10.25μW	±2.00%
	measured at 15_____nm Output Power	9.75μW	_____	10.25μW	±2.00%
II.	**Linearity Test**		dB		
	Range Power (dBm)				
	-20dBm -17.4 Disp→Ref -10dBm		_____=R1		
	-10dBm -7.4 Disp→Ref 0dBm		_____=R2		
	-20dBm -27.4 Disp→Ref -30dBm		_____=R3		
	-30dBm -37.4 Disp→Ref -40dBm		_____=R4		
	-40dBm -47.4 Disp→Ref -50dBm		_____=R5		
	-50dBm -57.4 Disp→Ref -60dBm		_____=R6		

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Performance Test for the HP 81524A

Model HP 81524A Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
	Non-Linearity				
	Range Formula				
	0dBm R1+R2	-0.04dB	_____dB	+0.04dB	±0.017dB
	-10dBm R1	-0.04dB	_____dB	+0.04dB	±0.010dB
	-20dBm		0.000dB		±0.000dB
	-30dBm R3	-0.04dB	_____dB	+0.04dB	±0.010dB
	-40dBm R3+R4	-0.04dB	_____dB	+0.04dB	±0.014dB
	-50dBm R3+R4+R5	-0.04dB	_____dB	+0.04dB	±0.017dB
	-60dBm R3+R4+R5+R6	-0.04dB	_____dB	+0.04dB	±0.022dB

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Performance Test for the HP 81525A

Test Facility:

_____		Report No.	_____
_____		Date	_____
_____		Customer	_____
_____		Tested By	_____

Model	HP 81525A Optical Head		
Serial No.	_____	Ambient temperature	_____ °C
Options	_____	Relative humidity	_____ %
Firmware Rev.	_____	Line frequency	_____ Hz

Special Notes:

_____

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Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter (Std.)	HP 8153A	_____	_____
2a.	Opt. Head Interface Module	HP 81533B	_____	_____
2b.	Optical Head 1310, 1550nm	HP 81524A	_____	_____
3a1.	Laser Module	HP 81552SM	_____	_____
3a2.	Laser Module	HP 81553SM	_____	_____
3b.	Laser Module	HP 81554SM	_____	_____
4.	Lens Adapter	HP 81010BL		
5.	Connector Adapter	HP 81000AA		
6.	Optical Attenuator	HP 8156A Opt.101		
7.	Connector Interface (×2)	HP 81000AI		
8.	Singlemode Fiber (×2)	HP 81101AC		
9.	Lightwave Multimeter (DUT)	HP 8153A		
10.	Opt. Head Interface Module (DUT)	HP 81533B		
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____

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Model HP 81525A Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
I.	**Accuracy Test**		μW		
	measured at 13_____nm Output Power	9.75μW	_____	10.25μW	±2.00%
	measured at 15_____nm Output Power	9.75μW	_____	10.25μW	±2.00%
II.	**Linearity Test**		dB		
	Range Power (dBm)				
	-20dBm -17.4 Disp→Ref				
	-10dBm		_____=R1		
	-10dBm -7.4 Disp→Ref				
	0dBm		_____=R2		
	-20dBm -27.4 Disp→Ref				
	-30dBm		_____=R3		
	-30dBm -37.4 Disp→Ref				
	-40dBm		_____=R4		
	0dBm 0 Disp→Ref				
	+10dBm		_____=R11		
	0dBm 0 Disp→Ref				
	+20dBm		_____=R21		
	0dBm 0 Disp→Ref				
	+30dBm		_____=R31		

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Performance Test for the HP 81525A

Model HP 81525A Optical Head No. _____ Date _____

Test No.	Test Description	Min. Spec.	Result	Max. Spec.	Measurement Uncertainty
	Non-Linearity Range Formula				
	+30dBm R1+R2+R31	-0.2dB	_____dB	+0.2dB	[1]
	+20dBm R1+R2+R21	-0.2dB	_____dB	+0.2dB	[1]
	+10dBm R1+R2+R11	-0.04dB	_____dB	+0.04dB	0.018dB
	0dBm R1+R2	-0.04dB	_____dB	+0.04dB	±0.017dB
	-10dBm R1	-0.04dB	_____dB	+0.04dB	±0.010dB
	-20dBm		0.000dB		±0.000dB
	-30dBm R3	-0.04dB	_____dB	+0.04dB	±0.010dB
	-40dBm R3+R4	-0.04dB	_____dB	+0.04dB	±0.014dB

[1] Functional test only (insufficient power).

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