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Hewlett Packard
8131A
SPECIFICATIONS

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SPECIFICATIONS

The specifications describe the instrument's warranted performance characteristics unless indicated as being supplemental or typical in nature. The performance tests and recommended test equipment listed in Appendix E can be used to verify the performance characteristics.

Supplemental, Specifications

Supplemental specifications are typical, non-warranted, performance characteristics provided for customer convenience.

Restrictions

The specifications apply to 50 ohm loads unless stated otherwise.

Ambient temperature.

0 to 55 degrees Celcius: The first or only value specified is for this range.

20 to 30 degrees Celcius: The specified values for this range are given in brackets, [], following the 0 to 55 degree Celcius specification.

The instrument warm-up period is 30 minutes.

Period, width, delay, and double pulse are specified at the amplitude 50% points.

Period and width underprogramming is allowed. See Chapters 5 and 7.

Accuracy refers to the programmed values.

WARRANTED SPECIFICATION:

DIFFERENTIAL OUTPUTS

TIMING PARAMETERS

Resolution:	3 digits, best case = 10 ps
Repeatability:	factor of 4 better than accuracy
Jitter(rms)	
10 ns to 100 ns range:	0.05% of programmed value + 15 ps
All other ranges:	0.025% of programmed value + 15 ps
Period	
Range:	2 ns to 99.9 ms
Accuracy:	+/- 5% of programmed value +/- 100 ps
Delay (between trigger output and differential outputs)	
Range:	0 ns to 99.9 ms
Accuracy:	+/- 5% of programmed value +/- 1.5 ns
Fixed Delay:	20 ns (typical)
Double Pulse	
Range:	2 ns to 99.9 ms
Accuracy:	+/- 5% of programmed value +/- 250 ps
Width	
Range:	500 ps to 99.9 ms
Accuracy:	+/- 5% of programmed value +/- 250 ps
Transition Times	
10%-90% of amplitude:	<200 ps, 300 mV to 3V range
20%-80% of amplitude:	<200 ps, 100 mV to 5V range

TABLE A-1. WIDTH AND DELAY: MAXIMUM VALUES

PERiod (ns)	Width	Delay
2.00	500ps or 1ns	0ns
2.01 ... 2.99	50% of PER *	50% of PER - 1ns
3.00 ... 4.99	50% of PER	
5.00 ... 19.99	70% of PER - 1ns	70% of PER - 2ns
≥20.0	90% of PER - 5ns	90% of PER - 6ns

*Width < 1 ns: maximum width is 50% of period - 0.5 ns

TABLE A-2. DOUBLE PULSE: MAXIMUM VALUES

PERiod (ns)	Double Pulse
2.00 ... 4.99	n/a
5.00 ... 9.99	50% of PER **
≥10.0	90% of PER - 4ns

**Period < 5.72 ns: double pulse < 50% of period

LEVEL PARAMETERS

Resolution:	3 digits, best case 10 mV
Accuracy:	+/- 1% of programmed value +/- 3% of amplitude +/- 40 mV
Repeatability:	factor of 4 better than accuracy
High Level:	-4.90 V to +5.00 V
Low Level:	-5.00 V to +4.90 V
Settling Time:	10 ns (typical)

PERFORMANCE PARAMETERS

Overshoot:	< 15% of amplitude +/- 20 mV
Ringing:	< 15% of amplitude +/- 20 mV
Reflections:	< 10% at 1 GHz

SUPPLEMENTAL SPECIFICATIONS

DIFFERENTIAL OUTPUTS

Duty Cycle

Range:	1% to 99%
Resolution:	1

Amplitude:

100 mVpp to 5 Vpp into 50 ohm

The output levels double when the output drives into an open circuit.

The outputs are disabled if the output voltage > +/- 6.5 V

Offset:

-4.95 V to 4.95 V into 50 ohm

Impedance (source):

50 ohm +/- 1%

Skew:

< 100 ps between differential outputs
of same channel

TRIGGER OUTPUT

Levels:	High = 0.0 V; Low = -0.6 V
Impedance:	50 ohm +/- 10%
Fixed Delay:	16 ns (between external input and trigger output)
External Voltage:	+/- 5V maximum

EXTERNAL INPUT

Trigger, gate, burst, and external width operating modes

Input impedance:	50 ohm +/- 5%
Threshold:	-5 V to +5 V
Resolution:	100 mV
Input voltage:	+/- 10 V maximum
Input transitions:	< 50 ns
Input frequency:	dc to 500 MHz
Pulse width:	1 ns minimum
Input sensitivity:	>= 300 mVp-p

Transducer operating mode

Input impedance:	50 ohm +/- 5%
Input transition:	< 50 ns
Input frequency:	10 Mhz to 1 GHz
Input sensitivity:	>= 600 mVp-p

INTERFACE

HP-IB

HP-IB conforms to IEEE Standard 488.1-1987,
Digital Interface for Programmable Information.

Subsets

IEEE Std. 488 interface function subsets:
AH1, SH1, T6, L4, SR1, RL1, PP0, DC1, DT1, CO.

For information regarding interface codes,
formats, protocols, and common commands,
use IEEE Draft Standard 488.2-1987,
Codes, Formats, Protocols, and Common Commands,
as a guide. No claim of conformance is made.

TABLE A-3. PROGRAMMING TIMES

Code 8131A version	Binary				ASCII *		
	upload	download			download of parameters		
	of a complete parameter set				one	two	three
	transfer	transfer	implemen- tation	total	transfer + implementation		
1 channel	110	30	140	170	<60	<90	<110
2 channel	110	30	190	220	-	-	-

Milliseconds (ms) is the base unit for all times listed
in the table above.

*Add 25 ms for "enable output" statements.

BATTERY

Memory is supported for 7 years.

ENVIRONMENTAL

Storage Temperature: -40 to +65 degrees C
Operating Temperature: 0 to 55 degrees C
Humidity: 95% R.H.
(0 to 40 degrees C)

POWER

100/120/220/240 Vrms $\pm 10\%$
250 VA maximum
48-66 Hz
Single phase

WEIGHT

Net: 20 kg (44.4 lb)
Shipping: 28 kg (62.2 lb)

DIMENSIONS

height x width x depth
145 mm x 426 mm x 525 mm
5.7 in x 16.75 in x 20.65 in

**CALIBRATION
PERIOD**

1 year recommended

A069413

1. PERIOD TEST

SPECIFICATIONS

Range: 2 ns to 99.9 ms
 Resolution: 3 digits (best case: 10 ps)
 Accuracy: 5 % of programmed value $\pm$ 100 ps
 rms Jitter: 10 ns to 100 ns range: 0.05 % of progr. value
 + 15 ps
 all other ranges: 0.025 % of programmed value
 + 15 ps
 Repeatability: Factor 4 better than accuracy

EQUIPMENT

1. Counter.
2. Cable, 50 ohm, BNC to BNC, coaxial.

SET-UP

1. Connect the HP 8131A's OUTPUT 1/2 to the Counter's channel A input (HP5335A) / FREQ input (HP5370B).
2. Set the HP 8131A:

MODE	=	AUTO		OPT 020
TIMING	=	PERIOD	: 2.00 ns	
		DEL	: 0 ns	0 ns
		WIDTH	: 1 ns	1 ns
OUTPUT	=	HIGH	: + 1.5 V	+ 1.5 V
		LOW	: - 1.5 V 0 V	- 1.5 V
		ENABLE		DISABLE
4. Set Counter:
 - a. FUNCTION = PERIOD
 - b. CHANNEL A = 50 ohm
 - c. TRIGGER LEVEL = PRESET

PROCEDURE

1. Check the HP 8131A period at the following settings

<u>PERIOD</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
2.00 ns	1.8 ns	2.2 ns	1-1
5.00 ns	4.65 ns	5.35 ns	1-2
10.0 ns	9.4 ns	10.6 ns	1-3
50.0 ns	47.4 ns	52.6 ns	1-4
100 ns	94.9 ns	105.1 ns	1-5
500 ns	474.9 ns	525.1 ns	1-6
1.00 us	949.9 ns	1.05 us	1-7
5.00 us	4.75 us	5.25 us	1-8
10.0 us	9.5 us	10.5 us	1-9
50.0 us	47.5 us	52.5 us	1-10
100 us	95 us	105 us	1-11
500 us	475 us	525 us	1-12
1.00 ms	950 us	1.05 ms	1-13
5.00 ms	4.75 ms	5.25 ms	1-14
10.0 ms	9.5 ms	10.5 ms	1-15
50.0 ms	47.5 ms	52.5 ms	1-16
99.9 ms	94.9 ms	104.9 ms	1-17

2. DELAY TEST

This test consists of two parts:

1. Minimum Delay Test
2. Long Delay Test

NOTES: Repeat the entire delay test procedure for the second channel, if installed.

The specifications and tests are for the 50 % point of amplitude.

SPECIFICATIONS

Range: 0 ns to 99.9 ns
Fixed Delay (Trigger Output to Main Output):
20 ns nominal.
Maximum Delay: Period ≥ 20.0 ns: $0.90 \times \text{Period} - 6.00$ ns
Resolution: 3 digits (best case: 10 ps)
Accuracy: 5 % of programmed value ± 1.5 ns
rms Jitter: 10 ns to 100 ns range: 0.05 % of prog. value +
15 ps
All other ranges: 0.025 % of programmed value
+ 15 ps
Repeatability: Factor 4 better than accuracy

EQUIPMENT

1. HP 54120T Digitizing Oscilloscope with Accessory
2. Pulse Generator
3. Counter
4. Cable, 50 ohm, BNC to BNC, coaxial, 2 each.

PART 1 MINIMUM DELAY TEST

SET-UP

1. Set Pulse Generator:
 - a. PER = 500 ns
 - b. WID = 100 ns
 - c. HIL = 0.5 V LOL = -0.5 V
 - d. Fixed Transition Time
2. Set the HP 8131A:

MODE	= TRIG		OPT 020
	Slope positive		
TIMING	= DEL	: 0 ns	0 ns
	WIDTH	: 100 ns	10 ns
OUTPUT	= HIGH	: 1.5 V	1.5 V
	LOW	: -1.5 V	-1.5 V
	ENABLE		DISABLE
4. Connect the Pulse Generator's Output via a 50 ohm feedthrough to the HP 8131A's EXT INPUT, use a BNC (f) to SMA (m) Adapter.
5. Connect the HP 8131A's TRIG OUTPUT via a Cable assy-coaxial SMA (m-m), and APC 3.5 mm 20dB Attenuator (f-m) to the Input 3 of the HP 54121A.
6. Connect the HP 8131A OUTPUT 1/2 via a same second accessory assembly to the Input 4 of the HP 54121A.
7. Connect the Pulse Generator's Trigger Output via a BNC (f) to SMA (m) Adapter and an APC 3.5 mm 20 dB Attenuator (f-m) to the TRIG input of the HP 54121A.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - set TIME/DIV = 20 ns/div
 - select the Display menu and set the Screen function to Single
 - set the Number of Averages to 64
 - select the Delta V menu and turn the voltage markers On and assign marker 1 to channel 3 and marker 2 to channel 4
 - set Preset Levels = 50-50% and press Auto Level Set
 - select the Delta t menu and turn the time markers On
 - set START ON EDGE = POSI and STOP ON EDGE = POSI
 - Press Precise Edge Find
2. Press the Precise Edge Find key for each new Delay setting.
3. Check the HP 8131A delay at the following settings:

	<u>DELAY</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTR</u>
1.	0.00 ns	*Fixed Delay		2-1
2.	10.0 ns	8.0 ns	12.0 ns	2-2
3.	20.0 ns	17.5 ns	22.5 ns	2-3
4.	50.0 ns	46.0 ns	54.0 ns	2-4
5.	80.0 ns	74.5 ns	85.5 ns	2-5
6.	99.9 ns	93.4 ns	106.4 ns	2-6

* Record the value of the fixed Delay, and subtract it from the other readings.

4. Step with the Vernier up keys from:

0 ps	to	100 ps	in	10 ps steps
100 ps	to	1 ns	in	100 ps steps
1 ns	to	10 ns	in	1 ns steps

Check the function/variation on scope.

PART 2 MAXIMUM DELAY TEST

SET-UP

1. Set the HP 8131A:

MODE	=	AUTO		OPT 020
TIMING	=	PERIOD	: 95 us	
		DEL	: 100 ns	0 ns
		WIDTH	: 100 ns	1 ns
OUTPUT	=	HIGH	: + 1.5 V	+ 1.5 V
		LOW	: - 1.5 V 0 V	- 1.5 V
		ENABLE		DISABLE

2. Set the Counter:

- a. FUNCTION = TI A to B
- b. START = 50 ohm, POS (+) slope, DC, X1
- c. STOP = 50 ohm, POS (+) slope, DC, X1
- d. Gate Time = as necessary
- e. INPUT MODE = SEP (SEPARATE)
- f. START/STOP trigger levels = preset

3. Connect the HP 8131A TRIG OUTPUT to the Counter's START input.

4. Connect the HP 8131A OUTPUT 1/2 to the Counter's STOP input.

PROCEDURE

1. Check the HP 8131A delay at the following Period and Delay settings:

<u>PERIOD</u>	<u>DELAY</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
*95 us	100 ns	93.5 ns	106.5 ns	2-7
*95 us	500 ns	473.5 ns	526.5 ns	2-8
*95 us	999 ns	947.55 ns	1.051 us	2-9
99.9 ms	100 us	95 us	105 us	2-10
99.9 ms	1 ms	950 us	1.05 ms	2-11
99.9 ms	80 ms	76 ms	84 ms	2-12

- * Take the fixed delay into account.

3. DOUBLE PULSE TEST

This test consists of two parts:

1. Minimum Double Pulse Test
2. Long Double Pulse Test

NOTES: Repeat the entire double pulse test procedure for the second channel, if installed.

The specifications and tests are for the 50 % point of amplitude.

SPECIFICATIONS

Range: 2 ns to 99.9 ns
Maximum
Double Pulse: Period ≥ 10.0 ns: $0.9 \times \text{Period} - 4.00$ ns
Resolution: 3 digits (best case: 10 ps)
Accuracy: 5 % of programmed value ± 250 ps
rms Jitter: 10 ns to 100 ns range: 0.05 % of prog. value
+ 15 ps ns
All other ranges: 0.025 % of programmed value
+ 15 ps
Repeatability: Factor 4 better than accuracy

EQUIPMENT

1. HP 54120T Digitizing Oscilloscope with Accessory
2. Counter
3. Cable, 50 ohm, BNC to BNC, coaxial, 2 each.

PART 1 MINIMUM DOUBLE PULSE TEST

SET-UP

1. Set the HP 8131A:

MODE	=	AUTO		OPT 020
TIMING	=	PERIOD	: 200 ns	
		DOUB	: 20 ns	2 ns
		WIDTH	: 10 ns	1 ns
OUTPUT	=	HIGH	: + 1.5 V	+ 1.5 V
		LOW	: - 1.5 V 0 V	- 1.5 V
		ENABLE		DISABLE

2. Connect the HP 8131A's TRIG OUTPUT via a Cable assy-coaxial SMA (m-m), and APC 3.5 mm 20dB Attenuator (f-m) to the TRIG Input of the HP 54121A.
3. Connect the HP 8131A OUTPUT 1/2 via a same second accessory assebley to the Input 4 of the HP 54121A.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - select the Display menu and set the Number of Averages to 64
 - select the Delta V menu and turn the voltage markers On
 - set Preset Levels = 50-50% and press Auto Level Set
 - select the Delta t menu and turn the time markers On
 - set START ON EDGE = POS1 and STOP ON EDGE = POS2
2. Press the Precise Edge Find key for each new Double setting.
3. Check the HP 8131A double pulse delay at the following settings:

<u>DOUBLE</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
20.0 ns	18.75 ns	21.25 ns	3-1
50.0 ns	47.25 ns	52.75 ns	3-2
80.0 ns	75.75 ns	84.25 ns	3-3
99.9 ns	94.65 ns	105.15 ns	3-4

4. Change the HP 8131A Width to 1 ns, and Double to 2 ns.
5. Check the HP 8131A double pulse delay at the following settings:

<u>DOUBLE</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
2.00 ns	1.65 ns	2.35 ns	3-5
5.00 ns	4.5 ns	5.5 ns	3-6
10.0 ns	9.25 ns	10.75 ns	3-7

PART 2 MAXIMUM DOUBLE PULSE TEST SET-UP

1. Set the HP 8131A:

MODE = AUTO
TIMING = PERIOD : 95 μ s
DOUB : 200 ns
WIDTH : 100 ns
OUTPUT = HIGH : + 1.5 V
LOW : - 1.5 V
ENABLE

OPT 020

2 ns
1 ns
+ 1.5 V
- 1.5 V
DISABLE

2. Set the Counter:

a. FUNCTION = TI A to B
b. START = 50 ohm, POS (+) slope, DC, XI
c. STOP = 50 ohm, POS (+) slope, DC, XI
d. Gate Time = as necessary
e. INPUT MODE = COM
f. START/STOP trigger levels = Preset

3. Connect the HP 8131A OUTPUT 1/2 to the Counter's START input.

PROCEDURE

1. Check the HP 8131A double pulse delay at the following Period and Double settings:

<u>PERIOD</u>	<u>DOUBLE</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
95 μ s	200 ns	189.75 ns	210.25 ns	3-8
95 μ s	1 μ s	950 ns	1.05 μ s	3-9
95 μ s	10 μ s	9.5 μ s	10.5 μ s	3-10
99.9 ms	100 μ s	95 μ s	105 μ s	3-11
99.9 ms	1 ms	950 μ s	1.05 ms	3-12
99.9 ms	10 ms	9.5 ms	10.5 ms	3-13
99.9 ms	80 ms	76 ms	84 ms	3-14

4. WIDTH TEST

This test consists of two parts.

1. Minimum Width Test
2. Long Width Test

NOTES: Repeat the entire width test procedure for the second channel, if installed.

The specifications and tests are for the 50 % point of amplitude.

SPECIFICATIONS

Range: 500 ps to 99.9 ns
Maximum Width: Period ≥ 20.0 ns; $0.9 \times \text{Period} - 5.00$ ns
Resolution: 3 digits (best case: 10 ps)
Accuracy: 5 % of programmed value ± 250 ps
rms Jitter: 10 ns to 100 ns range: 0.05 % of prog. value
+ 15 ps
All other ranges: 0.025 % of programmed value
+ 15 ps
Repeatability: Factor 4 better than accuracy

EQUIPMENT

1. HP 54120T Digitizing Oscilloscope with Accessory
2. Counter
3. Cable, 50 ohm, BNC to BNC, coaxial, 2 each.

PART 1 MINIMUM WIDTH TEST

SET-UP

1. Set the HP 8131A:

MODE	=	AUTO		OPT 020
TIMING	=	PERIOD	: 200 ns	
		DEL	: 0 ns	0 ns
		WIDTH	: 10 ns	1 ns
OUTPUT	=	HIGH	: +1.5 V	+1.5 V
		LOW	: -1.5 V 0 V	-1.5 V
		ENABLE		DISABLE

3. Connect the HP 8131A's TRIG OUTPUT via a Cable assy-coaxial SMA (m-m), and APC 3.5 mm 20dB Attenuator (f-m) to the TRIG Input of the HP 54121A.
4. Connect the HP 8131A OUTPUT 1/2 via a same second accessory asseblly to the Input 4 of the HP 54121A.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - select the Display menu and set the Number of Averages to 64
 - select the Delta V menu and turn the voltage markers On
 - set Preset Levels = 50-50% and press Auto Level Set
 - select the Delta t menu and turn the time markers On
 - set START ON EDGE = POS1 and STOP ON EDGE = NEG1
2. Change the scope timebase to 500 ps/div.
Change the HP 8131A Width to 500 ps.
3. Press the Precise Edge Find key for each new Width setting.
4. Check the HP 8131A pulse width at the following settings:

<u>WIDTH</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTR</u>
500 ps	225 ps	775 ps	4-1
800 ps	510 ps	1.09 ns	4-2
2.00 ns	1.65 ns	2.35 ns	4-3
5.00 ns	4.5 ns	5.5 ns	4-4
10.0 ns	9.25 ns	10.75 ns	4-5
20.0 ns	18.75 ns	21.25 ns	4-6
50.0 ns	47.25 ns	52.75 ns	4-7
80.0 ns	75.75 ns	84.25 ns	4-8
99.9 ns	94.65 ns	105.15 ns	4-9

5. Step with the Vernier up keys from:

500 ps	to	600 ps	in	10 ps steps
600 ps	to	1 ns	in	100 ps steps
1 ns	to	10 ns	in	1 ns steps

Check the function/variation on scope.

PART 2 MAXIMUM WIDTH TESTS

SET-UP

1. Set the HP 8131A:

MODE	=	AUTO		OPT 020
TIMING	=	PERIOD	: 95 us	
		DEL	: 0 ns	0 ns
		WIDTH	: 500 ns	1 ns
OUTPUT	=	HIGH	: + 1.5 V	+ 1.5 V
		LOW	: - 1.5 V0 V	- 1.5 V
		ENABLE		DISABLE
2. Set the Counter:
 - a. FUNCTION = TI A to B
 - b. START = 50 ohm, POS (+) slope, DC, X1
 - c. STOP = 50 ohm, NEG (-) slope, DC, X1
 - d. Gate Time = as necessary
 - e. INPUT MODE = COM
 - f. START/STOP trigger levels = Preset
3. Connect the HP 8131A OUTPUT 1/2 to the Counter's START input.

PROCEDURE

1. Check the HP 8131A pulse width at the following Period and Width settings:

<u>PERIOD</u>	<u>WIDTH</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
95 us	500 ns	474.75 ns	525.25 ns	4-10
95 us	999 ns	948.8 ns	1.049 us	4-11
95 us	10 us	9.5 us	10.5 us	4-12
99.9 ms	100 us	95 us	105 us	4-13
99.9 ms	1 ms	950 us	1.05 ms	4-14
99.9 ms	80 ms	76 ms	84 ms	4-15

5. JITTER TESTS

This test consists of three parts: Period Jitter, Delay Jitter, and Width Jitter.

Repeat the tests for the second channel, if installed.

SPECIFICATIONS

rms Jitter: 10 ns to 100 ns range: 0.05 % of programmed value
+ 15 ps
All other ranges: 0.025% of programmed value
+ 15 ps

EQUIPMENT

1. HP 54120T Digitizing Oscilloscope with Accessory

PART 1 PERIOD JITTER TEST

SET-UP

1. Set the HP 8131A:

MODE	=	AUTO		OPT 020
TIMING	=	PERIOD	: 50 ns	
		DEL	: 0 ns	0 ns
		WIDTH	: 25 ns	500 ps
OUTPUT	=	HIGH	: + 1.0 V	+ 1.0 V
		LOW	: - 0.0 V0 V	- 0.0 V
		ENABLE		DISABLE

2. Connect an APC 3.5 mm 20dB Attenuator (f-m) to the TRIG Input of the HP 54121A.
3. Connect one output, APC 3.5 mm (f), of the Power Splitter HP 11667B via a SMA (m-m) Adapter to the 20dB Attenuator at the TRIG Input of the 54121A.
4. Connect to the other output of the Power Splitter a SMA (m) - BNC (f) Adapter and connect 4 BNC (m-m) cables (61 cm) together to this adapter (use BNC Adapters (f-f), 3 each).
5. Connect this cable assembly via a BNC (f) - SMA (m) Adapter to the Input 3 of the 54121A.
6. Connect the 8115A OUTPUT 1/2 via a Cable assy-coaxial SMA (m-m) to the Input of the Power Splitter.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - select the Display menu and set the Number of Averages to 128
 - select the Timebase menu and set the TIME/DIV to 10 ps/div
 - center the first positive going edge of the signal (approx. Delay = 17.8 ns)
 - select the Channel menu and set the Atten factor to 1 (Channel 3)
 - set the VOLT/DIV to 10 mV/div
 - select the Delta V menu and turn the V Markers On
 - set the Marker 1 Position to 240 mV and the Marker 2 Position to 245 mV
 - select the Delta t menu and turn the T Markers On
 - set START ON EDGE = POS1 and STOP ON EDGE = POS1
 - press the Precise Edge Find key
2. RECORD the delta t! It is the risetime of the ref. signal within a 1% amplitude window of the signal connected to Input 3. This value is needed later to calculate the correct jitter.

3. Select the scopes Timebase menu and center the second positive going edge of the signal (actual Delay + 50.x ns = approx. Delay 66.x ns)
4. Press More and Histogram.
5. Select the Window submenu and set:
Source is Channel 3
choose the time Histogram
press WINDOW MARKER 1 and set it to 240 mV
press WINDOW MARKER 2 and set it to 245 mV
6. Select the Acquire submenu and set the Number of Samples to 1000.
Press Start Acquiring.
7. After the data for the time histogram is acquired (#Samples = 100%), select the Result submenu.
8. Press Mean and Sigma. Notice the value of Sigma!
9. The rms jitter has to be calculated as follows:

$$\frac{(\text{Sigma} \times 6) - \text{delta } t \text{ of ref. signal}}{6}$$

10. Maximum rms jitter (period = 50 ns) is 40 ps

TR ENTRY 5-1

11. Set the HP 8131A: PER 500 ns

12. Repeat steps 3 to 9.

NOTE: Time/Div 100 ps/div Delay approx.

51x.x ns

Maximum rms jitter (period = 500 ns) is 140 ps

TR ENTRY 5-2

PART 2 WIDTH JITTER TEST

SET-UP

1. Same set-up as before.
2. Set the HP 8131A:
TIMING = PER : 1 μ s
WIDTH : 1 ns | 500 ps

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press the More key
 - select the Display menu and set the #Aves = 256
 - select the Timebase menu and center the first negative going edge of the signal (Time/Div 10 ps/div, approx. Delay = 17.x ns)
 - select the Delta V menu and set the Marker 1 Position to 260 mV and the Marker 2 Position to 255 mV
 - select the Delta t menu and set START ON EDGE = NEG1 and STOP ON EDGE = NEG1
 - press the Precise Edge Find key
2. Notice the delta t! It is the falltime of the signal within a 1% amplitude window of the signal connected to Input 3. This value is needed later to calculate the correct jitter.
3. Set the HP 8131A: WID 50 ns
4. Select the scopes Timebase menu and center the first neg. going edge of the signal (Time/Div 20 ps/div, Delay approx. 66.x ns).
3. Press More = Histogram.
4. Select the Window submenu and
press WINDOW MARKER 1 and set it to 260 mV
press WINDOW MARKER 2 and set it to 255 mV
5. Select the Acquire submenu and press Start Acquiring.

6. After the data for the time histogram is acquired (#Samples = 100%), select the Result submenu.
7. Press Mean and Sigma. Notice the value of Sigma!
8. The rms jitter has to be calculated as follows:

$$\frac{(\text{Sigma} \times 6) - \text{delta } t \text{ of signal}}{6}$$

9. Maximum rms jitter (width = 50 ns) is 40 ps
10. Set the HP 8131A: WID 500 ns
11. Repeat steps 4 to 8.
NOTE: Time/Div 100 ps/div, Delay 51xx ns
Maximum rms jitter (width 500 ns) is 140 ps.
12. DISABLE THE HP 8131A OUTPUTS!

TR ENTRY 5-3

TR ENTRY 5-4

PART 3 DELAY JITTER TEST

SET-UP

1. Set the HP 8131A:

MODE	= AUTO		OPT 020
TIMING	= PERIOD	: 500 ns	
	DEL	: 250 ns	0 ps
	WIDTH	: 50 ns	500 ps
OUTPUT	= HIGH	: + 5 V	+ 5 V
	LOW	: 0.0 V	0.0 V
	DISABLE		DISABLE
2. Connect the HP 8131A's TRIG OUTPUT via a Cable assy-coaxial SMA (m-m), and APC 3.5 mm 20dB Attenuator (f-m) to the TRIG Input of the HP 54121A.
3. Connect the HP 8131A OUTPUT 1/2 via a Cable assy-coaxial SMA (m-m), and APC 3.5 mm 20 dB Attenuator (f-m) to the Input 3 of the HP 54121A.
4. ENABLE the output.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - select the Display menu and set the #Aves = 128
 - select the Timebase menu and set the TIME/DIV = 50 ps/div
 - center the first positive going edge of the signal (approx. Delay = 26x.x ns)
 - select the Channel menu and set the VOLT/DIV = 10 mV/div
2. Press More = Histogram.
3. Select the Window submenu and
 - press WINDOW MARKER 1 and set it to 240 mV
 - press WINDOW MARKER 2 and set it to 245 mV
4. Select the Acquire submenu and press Start Acquiring.
5. After the data for the time histogram is acquired (#Samples = 100%), select the Result submenu.
6. Press Mean and Sigma. Notice the value of Sigma!
7. The rms jitter has to be calculated as follows:
$$\frac{(\text{Sigma} \times 6) - \text{delta } t \text{ of ref. signal}}{6}$$
8. Max. rms jitter (delay = 250 ns) is 67.5 ps

TR ENTRY 5-5

6. HIGH LEVEL AND LOW LEVEL TESTS

Repeat the high level and low level tests for the second channel, if installed.

SPECIFICATIONS

NOTE: This specification applies to 50 ohm sources and 50 ohm loads.

High Level: -4.90 V to 5.00 V.
Low Level: -5.00 V to 4.90 V.
Resolution: 3 digits (best case: 10.0 mV).
Level Accuracy: 1% of programmed value $\pm$ 3% of pulse
amplitude, $\pm$ 40 mV.
Repeatability: Factor 4 better than accuracy.
Settling time: 10 ns + transition time.

EQUIPMENT

1. Multimeter
2. 50 ohm feedthrough termination, 0.1%, 10 W
3. Adapter, BNC to dual banana plug
4. Cables, BNC to BNC, two each.
5. Pulse Generator with a 50 ohm feedthrough termination

SET-UP

1. Set the HP 8131A:

MODE	= AUTO	
TIMING	= PERIOD	: 99.9 ms
	DEL	: 30 us
	WIDTH	: 50 ms
OUTPUT	= HIGH	: + 5 V
	LOW	: 0.0 V
	ENABLE	

OPT 020
0 ps
500 ps
+ 5 V
0.0 V
DISABLE
2. Set the Multimeter (HP 3478).
 - a. SGL TRIG = Single Trigger
 - b. Blue/AUTO ZERO = Auto Zero off
 - c. BLUE/4 = 4 digits
3. Set the Pulse Generator:
 - a. Mode: Trigger
 - b. Trigger slope positive
 - c. Width: 500 ns
 - d. HIL: 2.0 V
4. Connect the HP 8131A OUTPUT 1/2 via a SMA (m) to BNC (f) Adapter, a 50 ohm feedthrough (0.1%, 10 W), BNC (m-m) cable, and a BNC to dual banana plug adapter to the Multimeters Input.
5. Connect the HP 8131A TRIG OUTPUT via a SMA (m) to BNC (f) to the Pulse Generators External Input.
6. Connect the Pulse Generators Output via a 50 ohm feedthrough terminator to the Multimeters Trigger Input.

PROCEDURE

HIGH LEVEL TEST

1. Check the HP 8131A high level at the following HIGH settings with the low level set to 0.00 V.

<u>HIGH LEVEL</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
5.0 V	4.76 V	5.24 V	6-1
3.0 V	2.84 V	3.16 V	6-2
1.0 V	920 mV	1.08 V	6-3
0.5 V	440 mV	560 mV	6-4
0.1 V	56 mV	144 mV	6-5

The low level 0.0 V may vary within $\pm 3\%$ of pulse amplitude, ± 40 mV.

LOW LEVEL TEST

SET-UP

1. Set the HP 8131A:

MODE = AUTO
TIMING = PERIOD : 99.9 ms
DEL : 30 ms
WIDTH : 50 ms
OUTPUT = HIGH : 0.0 V
LOW : -0.1 V
ENABLE

OPT 020

0 ps

500 ps

0.0 V

-0.1 V

DISABLE

2. Check the HP 8131A low level at the following LOW settings with the high level set to 0.00 V.

<u>LOW LEVEL</u>	<u>ACCEPTABLE RANGE</u>		<u>TR ENTRY</u>
- 0.1 V	56 mV	144 mV	6-6
- 0.5 V	440 mV	560 mV	6-7
- 1.0 V	920 mV	1.08 V	6-8
- 3.0 V	2.84 V	3.16 V	6-9
- 5.0 V	4.76 V	5.24 V	6-10

The high level 0.0 V may vary within $\pm 3\%$ of pulse amplitude, ± 40 mV.

7. TRANSITION TIME TEST

Repeat the entire transition time test procedure for the second channel.

SPECIFICATIONS

10% - 90% of amplitude: < 200 ps, 300 mV to 3 V range
20% - 80% of amplitude: < 200 ps, 100 mV to 5 V range

EQUIPMENT

1. HP 54120T Digitizing Oscilloscope with Accessory

SET-UP

1. Set the HP 8131A:

MODE	= AUTO		OPT 020
TIMING	= PERIOD	: 500 us	
	DEL	: 10 ns	0 ps
	DCYC	: 50 %	50 %
OUTPUT	= HIGH	: + 5 V	+ 5 V
	LOW	: 0.0 V	0.0 V
	ENABLE		DISABLE
2. Connect the HP 8131A's TRIG OUTPUT via a Cable assy-coaxial SMA (m-m), and APC 3.5 mm 20dB Attenuator (f-m) to the TRIG Input of the HP 54121A.
3. Connect the HP 8131A OUTPUT 1/2 via a same second accessory asseby to the Input 4 of the HP 54121A.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - center one pulse horizontal and vertical on screen
(for example, TIME/DIV = 50 us/div, DELAY = 375 us,
VOLT/DIV = 800 mV/div, Offset = 2.5 V).
 - select the Display menu and set the Number of Averages to 64
 - select the Channel menu and set the Atten factor to 10
 - select the Delta V menu and turn the voltage markers On
 - set Preset Levels = 20-80% and press Auto Level Set
 - select the Timebase menu and
set TIME/DIV = 20 ns, DELAY = 16 ns
 - select the Delta t menu and turn the time markers On
 - set START ON EDGE = POS1 and STOP ON EDGE = POS1
2. Set HP 8131A: Period: 250 ns
3. While the Oscilloscope is in the Delta t menu, press the Precise Edge Find Key.
4. Check for Risettime < 200 ps. **TR ENTRY 7-1**
5. Select the scopes Delta t menu and set START ON EDGE = NEG1 and STOP ON
EDGE = NEG1.
6. Press the Precise Edge Find key.
7. Check for Falltime < 200 ps. **TR ENTRY 7-2**
8. Repeat steps 1 to 8.
Set HP 8131A: HIGH = 3.0 V **TR ENTRY 7-3**
TR ENTRY 7-4

NOTES: Set the Voltage Marker in the Delta V menu
to the 10-90% Levels.

Take the scopes trace flatness error (GaAs input circuit)
into account.

8. PULSE ABERRATION TEST

Repeat this test for the second channel, if installed.

SPECIFICATIONS

Overshoot and Ringing: $\leq 15\%$ of the pulse amplitude ± 20 mV.

EQUIPMENT

1. HP 54120T Digitizing Oscilloscope with Accessory

SET-UP

1. Set the HP 8131A:

MODE	= AUTO		OPT 020
TIMING	= PERIOD	: 500 μ s	
	DEL	: 5 ns	0 ps
	DCYC	: 50 %	50 %
OUTPUT	= HIGH	: +5 V	+5 V
	LOW	: 0.0 V	0.0 V
	ENABLE		DISABLE

2. Connect the HP 8131A's TRIG OUTPUT via a Cable assy-coaxial SMA (m-m), an APC 3.5 mm 20dB Attenuator (f-m) to the TRIG Input of the HP 54121A.
3. Connect the HP 8131A OUTPUT 1/2 via a same second accessory assembly to the Inp 4 of the HP 54121A.

PROCEDURE

1. Setup HP 54120T Oscilloscope:
 - press AUTOSCALE
 - center one pulse horizontal and vertical on screen (e.g. TIME/DIV = 50 us/div, DELAY = 350 us, VOLT/DIV = 800 mV/div)
 - select the Display menu and set the Number of Averages to 64
 - select the Channel menu and set the Atten factor to 10
 - select the Delta V menu and turn the voltage markers On
 - set the VARIABLE LEVELS = 85-115% and press Auto Level Set
 - select the Channel menu and center vertical the pulse top (Offset = 5 V)
 - set the VOLTS/DIV to 500 mV/div
 - select the Timebase menu and set TIME/DIV = 500 ps, DELAY = 17.x ns
2. Set HP 8131A: Period: 500 ns
3. Check the Overshoot and Ringing for $\leq 15\% \pm 20$ mV TR ENTRY 8-1
(Take the scopes trace flatness error (GaAs input circuit) into account.)
4. Repeat steps 1 to 3. TR ENTRY 8-2
Set HP 8131A; HIGH = 500 mV

TABLE E-1. RECOMMENDED TEST EQUIPMENT

Other equipment can be used provided it meets the specifications of this equipment.

<u>TYPE (QUANTITY)</u>	<u>MODEL</u>	<u>SPECIFICATIONS</u>
1:1 Probe (1)	HP 10026A	100 V max., 1:1, 50 ohm.
10:1 Probe (1)	HP 10017A	300 V max., 10:1, 1 M ohm, 8 pF.
50 ohm feedthrough (1) termination	HP 10100C	50 ohm, 2W, 1%.
50 ohm feedthrough (1) termination	See Figure 11-1.	50 ohm, 10 W, 0.1 %.
Adapter, (1) BNC to Banana	HP 1251-2277	BNC(f) to dual banana plug, 50 ohm.
Cable Assembly (5)	HP 8120-1839	50 ohm, 24 inches, coax, 2 BNC (m).

<u>TYPE (QUANTITY)</u>	<u>MODEL</u>	<u>SPECIFICATIONS</u>
Counter (1)	HP 5335A/ HP 5370B	50 uHz to 50 MHz; 8 digit display; INPUT: 50 ohm/1M ohm, X1/X10, AC/DC, seperate/common; variable trigger level; TI/PERIOD/FREQUENCY.
Isolation Transformer (1)		Suitable for use with the variac.
Multimeter (1)	HP 3478A/ HP 3456A	4 1/2 digit display; VDC: 30 mV to 300 V; 30 to 35 readings/second; external trigger; input resistance: >10 M ohm.
Oscilloscope (1) (Realtime)	HP 1725A	275 MHz bandwidth; external trigger; 50 ohm/1 M ohm inputs; 0.1 to 5 V.
Oscilloscope (1) (Sampling)	HP 54120T	20 GHz
Smpling Scope Accessories		
Attenuator (3)	33340C	APC 3.5 mm (f-m), 20 dB
Adapter (2)	1250-1200	SMA (m) to BNC (f)
Cable (3)	8120-4948	SMA (m-m) coaxial
Adapter (1)	1250-1159	SMA (m-m)
Adapter (2)	1250-1700	SMA (f) to BNC (m)
Power Splitter (1)	11667B	APC 3.5 mm
Variac (1) (Variable AC Power Supply)		>= 5 A, 0-300 VAC

HP 8131-Test Equipment