C

Performance tests

Introduction

The performance of the HP E1440A can be tested at three levels:

- **Functional Verification Tests** - These check that the instrument functions are working. Use these tests when you want to check that the module is connected properly and responding to commands from the controller. No access to the interior of the module is necessary.
- **Operational Verification Tests** - These check that the instrument meets critical specifications. Use these tests after a repair, or as an aid to troubleshooting. These tests can be carried out *without* a controller.
- **Performance Verification Tests** - These check that the instrument meets all warranted specifications. Use these tests as an instrument calibration check, after repair or as an aid to troubleshooting.

Note

The HP E1440A specifications, given in Chapter 1, are valid after a 30 minute warm up period.

All test equipment used must also be allowed to warm up before testing the HP E1440A. Refer to the equipment specifications to find the warm up time required.

Test Record

You can record the results of the **Performance Verification Tests** using the Test Record provided at the end of this chapter. You can reproduce this Performance Verification Test Record without written permission from Hewlett-Packard.

Recommended Test Equipment

The equipment required for the tests is listed in Table C-1. Any equipment which satisfies the critical specifications given in the table, may be substituted for recommended models.

Table C-1. Recommended Test Equipment for Tests

Instrument	Critical Specifications	Recommended Model	Test[1]
VXI Mainframe (Development)	Must allow access to the Service switch on top of the HP E1440A.	HP E1400T	O[2]
VXI Mainframe		HP E1400B	F O P
Command Module	HP-IB interface	HP E1405A	F O P
Controller	HP BASIC 5.0/5.1	HP 9000 Series 200/300	F O P
Analog Oscilloscope	Vertical Deflection: 0.01 to 5 V/div Horizontal Sweep:10 ns to 0.5 s/div	HP 1722A/25A	P
Electronic Counter	Frequency measurement Time Interval Average A to B Frequency Range: to 100 MHz Resolution: 11 digits	HP 5370B	O P
AC/DC Digital Voltmeter	AC Function (True RMS) Ranges: 10 mV to 1000 V Bandwidth: 1 Hz to 10 MHz Resolution: 4.5 digits minimum DC Functions Ranges: 10 mV to 1000 V	HP 3458A	P
High-speed Digital Voltmeter Trigger Delay:Selectable 1 μs to 10 ms	DC Voltage: 0 to $\pm$10 V External Trigger:Low True	HP 3437A	P
Frequency Synthesizer Source	Frequency: 20 MHz Amplitude: 10 V(p-p) into 50Ω	HP 3324A/3325B	P
Power Meter	Accuracy: $< \pm 0.5\%$	HP 436A	P
Power Sensor	50 Ω, 100 mW (24 dBm)	HP 8482A	P
50Ω Feedthru Termination	Accuracy: $\pm$1% Power Rating: 2 W	HP 10100C	P

1 F = Functional, O = Operational, P = Performance

2 Only required if you are testing *without* a controller.

Table C-1. Recommended Test Equipment for Tests (continued)

Instrument	Critical Specifications	Recommended Model	Test[1]
Spectrum Analyzer	Frequency Range: 20 Hz to 40.1 MHz Spurious Responses: 80 dB below reference	HP 3585B	P
Double Balanced Mixer	Impedance: 50Ω Frequency Range: 1 – 20 MHz	HP 10534A	P
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 – 80 MHz	Model J903, TTE Inc. 2214 S. Benny Ave. Los Angeles, CA 90064	P
15 kHz Filter	Consisting of: Resistor: 10 KΩ 1% Capacitor: 1600 pF 5%		P
Resistors:	20Ω 1/4 W 1% 30Ω 1/4 W 1% 50Ω 1/8 W 1% 475Ω 2 W 1%		P
Capacitor:	300 pF 5%		P
BNC-to-Triax Adapter Cable	Female BNC to Male Triax	HP 1250-0595 0256	P
Adaptors	BNC female to dual banana plug BNC Tee	HP 1251-2277 HP 1250-0781	P P

Functional Verification Tests

The best method of checking that the module is functioning is to:

1. Configure and install the module in a VXI mainframe, as described in Chapter 2.
2. Use the controller to carry out a module self-test and check the results. An example program is given in this section.
3. Check the instrument output with an oscilloscope. An example program is given in this section.

If a controller is not available, carry out the Operational Verification Tests described in the next section. These can be performed with or without a controller, but do not include the instrument self-test.

Note

The HP E1440A has a "Failed" indicator that remains on if the synthesizer is not able to communicate with the controller.

Performing a Self-test

Starting the test

The instrument's self-test routine can be executed by sending it the command: *TST?

Sending the self test command is an easy way to check that you are correctly addressing the synthesizer module, and is also useful in locating intermittent problems which might occur during operation.

The result of the self-test is returned as a number where a value of zero indicates that no errors occurred. If one or more errors occur, they are added to the instrument error queue and a bit is set in the self-test result to indicate the error types:

Table C-2. Self-test result bits

Bit	Meaning	Module
Bit 0 (1)	ROM test failed	A2
Bit 1 (2)	RAM test failed	A2
Bit 2 (4)	Device bus test failed	A2
Bit 3 (8)	Software timer test failed	A2
Bit 4 (16)	Sweep timer test failed	A1
Bit 5 (32)	Amplitude calibration failed	A1 or A2
Bit 6 (64)	Fractional-N IC test failed	A1
Bit 7 (128)	VCO test failed	A1
Bit 8 (256)	Self-test was called when SWEEP or LIST was in progress. No test was carried out.	–

Refer also to the *TST? entry in Chapter 5 Command Reference in the User Manual.

Reading the Error Queue

When errors occur as a result of self-test or during operation, error codes and messages are added to the synthesizer error queue. The error queue can store up to 30 codes and messages on a 'first in first out' (FIFO) basis.

These errors can be read out using the command: SYS:ERR?

A returned value of 0 (zero) means there are no more errors.

Refer to the SYS:ERR? entry in Chapter 5 Command Reference in the User Manual.

Error numbers and messages are listed in Appendix E of the User's Manual.

Example program

The following BASIC 5.0/5.1 program executes a self-test. The program assumes the mainframe is at a primary interface address of 09 and the synthesizer is at a secondary address of 11. The program also assumes that an HP 9000 Series 200/300 computer is used.

```
10  !Send the self-test command to the synthesizer
20  !
30  OUTPUT 70911;"*TST?"
40  !
50  !Enter and display the self test code
60  !
70  ENTER 70911;A
80  PRINT A
90  !
100  !Add code here to interrogate the error queue
110  if A is non-zero.
```

Checking the Instrument Output

After self-test, a simple test with an oscilloscope will check that the module output is functional. Connect an oscilloscope to the output BNC and then send the following short program:

```
10  !Reset the synthesizer
20  !
30  OUTPUT 70911;"*RST"
40  END
50  ! Set frequency value
60  !
70  OUTPUT 70911;"FREQ 1E3"
80  !
90  ! Set function to sinewave
100  OUTPUT 70911;"FUNC SIN"
110  !
120  ! Set output level to 1 V
130  !
140 OUTPUT 70911;"VOLT 1"
150 !
160 Switch on the output
170 !
180 OUTPUT 70911;"OUTP ON"
190 END
```

Operational Verification Tests

Without a Controller

A DIL switch called the **Service Switch**, situated beside the address switch (see Figure C-1 and Figure C-2), can be used to force different startup values for the waveform, frequency and amplitude, as detailed in Table C-3.

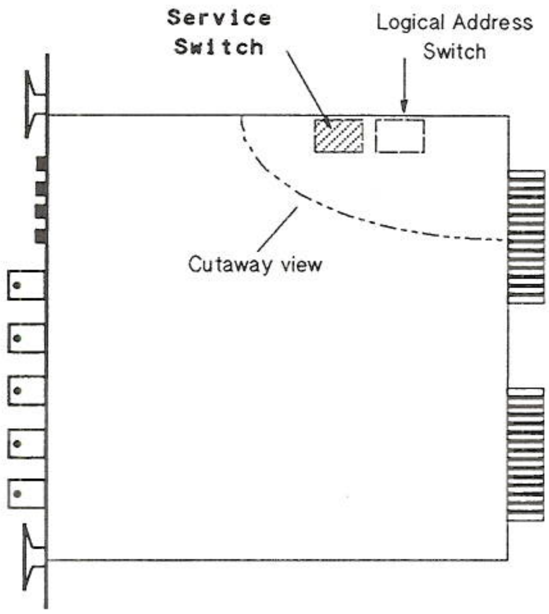

Figure C-1. Service Switch

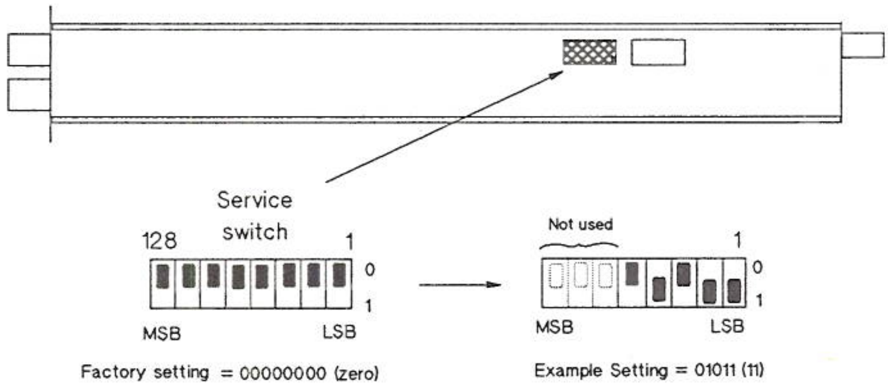

Figure C-2. Example Service Switch Setting

1. Configure and install the module in a VXI mainframe, as described in Chapter 2.
2. For each of the switch settings in Table C-3:
   a. Switch off the mainframe.
   b. Set up the Service Switch.

Caution

If you are not using a Development mainframe, you have to remove the HP E1440A to access the Service Switch. *The mainframe must be switched off when removing or inserting the HP E1440A.*

   c. Switch on the mainframe.
   d. Using a timer and oscilloscope check that the output's frequency and amplitude are as given in Table C-3 and within specification.
3. Set the Service Switch back to 00000.

With a Controller

1. Configure and install the module in a VXI mainframe, as described in Chapter 2.
2. For each of the settings in Table C-3:
   a. Use the controller to set the waveform, frequency and amplitude to the values in the table, for example:

```
OUTPUT 70911; ":FUNC SIN"              Set waveform to sine
OUTPUT 70911; ":FREQ 10 MHZ"           Set frequency to 10 MHz
OUTPUT 70911; ":VOLT:AMPL 10.0 V"      Set amplitude to 10 V
OUTPUT 70911; ":OUTP ON"               Turn on the output
```

   b. Using a timer and oscilloscope check that the output's frequency and amplitude are as given in Table C-3 and within specification.

Table C-3. Service Switch Parameter Settings

Switch	Dec equiv	Waveform	Freq (MHz)	Ampl (V_{pp})	Other
[1]00000	0	sin	0.0	0.001	
00001	1	sin	0.001	10.0	
00010	2	sin	8.0	10.0	
00011	3	sin	10.0	10.0	
00100	4	sin	13.0	10.0	
00101	5	sin	20.0	10.0	
00110	6	sin	21.0	10.0	
00111	7	squ	0.001	10.0	
01000	8	squ	10.0	10.0	
01001	9	squ	11.0	10.0	
01010	10	tri	0.01	10.0	
01011	11	rup	0.01	10.0	
01100	12	ttl	25.0	——	
01101	13	ttl	30.0	——	
01110	14	ttl	35.0	——	
01111	15	ttl	40.0	——	
10000	16	ttl	45.0	——	
10001	17	ttl	50.0	——	
10010	18	ttl	55.0	——	
10011	19	ttl	60.0	——	
10100	20	sin	0.0	10.0	
10101	21	squ	0.0	10.0	
10110	22	tri	0.0	10.0	
10111	23	rup	0.0	10.0	
11000	24	rdow	0.00	10.0	
[2]11001	25	dc	——	——	3V offset

Notes

1 Standard reset values

2 Values over 25 are treated as 25

Performance Verification Tests

Table C-4 groups the Performance Verification Tests according to the warranted specifications in Chapter 1. The tests follow in the order given in the table. All the tests require a controller and a VXI mainframe with the HP E1440A and a command module installed.

Table C-4.

Warranted Specifications (Refer to Chapter 1)	Verification Test(s)
Sinewave Spectral Purity	Harmonic Distortion[1] Spurious Signals Integrated Phase Noise
Frequency	Frequency Accuracy
Phase Offset	Phase Increment Accuracy
Amplitude	Amplitude Accuracy[1]
DC Offset	DC Offset Accuracy[1] DC Offset Accuracy with AC Functions
Triangle/Ramp Characteristics	Triangle Linearity

1 Includes procedure to test High Voltage Output Option 001.

Introduction

Before you start the Performance Verification Tests:

1. Check the HP-IB address of your VXI command module and the secondary address of your HP E1440A module.

   The HP E1440A commands given in the test procedures use the variable **Vxi** to represent the full address of the module. Set this variable to the correct address for your test system.

   For example:

HP-IB interface number:	7
VXI command module address:	16
HP E1440A secondary address:	11

   Set the variable **Vxi**=71611, or replace **Vxi** with the number 71611 every time you use one of the example commands.

2. Reset the HP-IB, HP E1440A and check that you are communicating with the HP E1440A:

   ```
   CLEAR 7
   OUTPUT Vxi;"*RST"
   OUTPUT Vxi;"OUTP ON"
   ```

   The "Output On" LED of the HP E1440A should switch on.

Harmonic Distortion

This procedure tests the harmonic distortion of the HP E1440A sine wave output.

Specifications

Harmonic distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 199 kHz	−60 dBc
200 kHz to 1.99 MHz	−40 dBc
2 MHz to 14.9 MHz	−30 dBc
15 MHz to 20 MHz	−25 dBc

Equipment Required

Spectrum Analyzer
50Ω Feedthru Termination
Resistor 475Ω 2W 1%
Resistor 50Ω 1/8W 1%
Capacitor 300 pF 5%

Procedure

1. Set the HP E1440A output as follows:

High-voltage	Output Off
Function	Sine
Frequency	20 MHz
Amplitude	999 mV(p-p)
DC Offset	0 V

```
OUTPUT Vxi;":FUNC SIN;:FREQ 2E7;        Set up parameters
     :VOLT:AMPL 0.999;:VOLT:OFFS 0;"
OUTPUT Vxi;":OUTP ON"                   Switch on the output
```

2. Connect the signal output to the spectrum analyzer 50Ω input.

3. Set the spectrum analyzer controls to display the fundamental and at least four harmonics. Verify that all harmonics are at least 25 dB below the fundamental.

4. Set the HP E1440A to 15 MHz

   ```
   OUTPUT Vxi;":FREQ 1.5E7"
   ```

   and verify that all harmonics are at least 25 dB below the fundamental.

5. Set the HP E1440A to the following frequencies and verify thet the harmonics are below the specified levels.

Frequency	Command String	Max Level
14.9 MHz	":FREQ 1.49E7"	−30 dBc
2 MHz	":FREQ 2E6"	−30 dBc
1.99 MHz	":FREQ 1.99E6"	−40 dBc
200 kHz	":FREQ 2E5"	−40 dBc

6. Set the HP E1440A frequency to 50 kHz and the amplitude to 9.99 mV(p-p).

```
OUTPUT Vxi;":FREQ 5E4;:VOLT:AMPL 9.99MV"
```

7. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. (It may be necessary to decrease the video bandwidth to separate the harmonics from the noise floor.) Verify that all harmonics are at least 60 dB below the fundamental.

8. Set the HP E1440A to the following frequencies and verify that all harmonics are 60 dB below the fundamental.

Frequency	Command String
10 kHz	":FREQ 1E4"
1 kHz	":FREQ 1E3"
100 Hz	":FREQ ~~1E5~~" 1E2

High-Voltage Output (Option 001)

Continued from the previous procedure.

9. Connect the HP E1440A signal output to the analyzer high-impedance input as shown in Figure C-3.

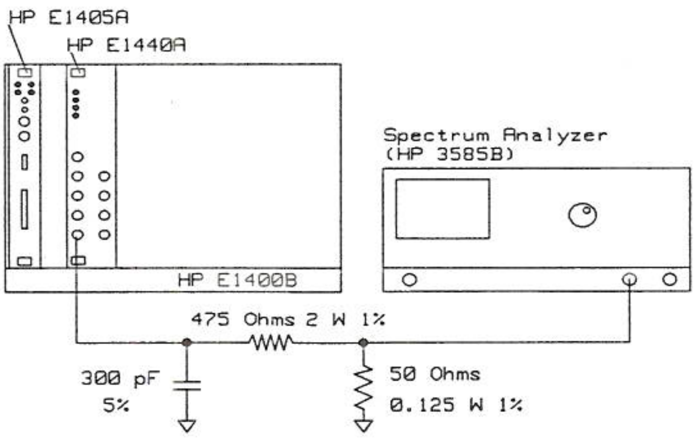

Figure C-3.
Harmonic Distortion Verification Test Set-Up (High-Voltage Output)

10. Select the high-voltage output on the HP E1440A. Set the amplitude to 40 V(p-p) and the frequency to 100 Hz.

```
OUTPUT Vxi;":OUTP:AMPL ON"        Switch on high-voltage output
OUTPUT Vxi;":VOLT:AMPL 40 V"
OUTPUT Vxi;":FREQ 1E2"
```

11. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. Verify that all harmonics are 60 dB below the fundamental.

12. Set the HP E1440A to the following frequencies and verify that the harmonics are below the specified level.

Frequency	Command String	Max Level
10 kHz	":FREQ 1E4"	−60 dBc
100 kHz	":FREQ 1E5"	−60 dBc
200 kHz	":FREQ 2E5"	−40 dBc
1 MHz	":FREQ 1E6"	−40 dBc

13. Turn off the high-voltage output.

```
OUTPUT Vxi;":OUTP:AMPL OFF"
```

Spurious Signal

This procedure tests the HP E1440A sine wave output for spurious signals. Circuits within the HP E1440A may generate repetitive frequencies that are not harmonically related to the fundamental output frequency.

Specifications

All spurious signals must be more than 60 dB below the fundamental signal or less than −85 dBm, whichever is greater.

Equipment Required

Spectrum Analyzer

Mixer Spurious Procedure

1. Connect the HP E1440A signal output to the spectrum analyzer 50Ω (RF) input and the HP E1440A REF INput to the analyzer 10 MHz reference output, as shown in Figure C-4.

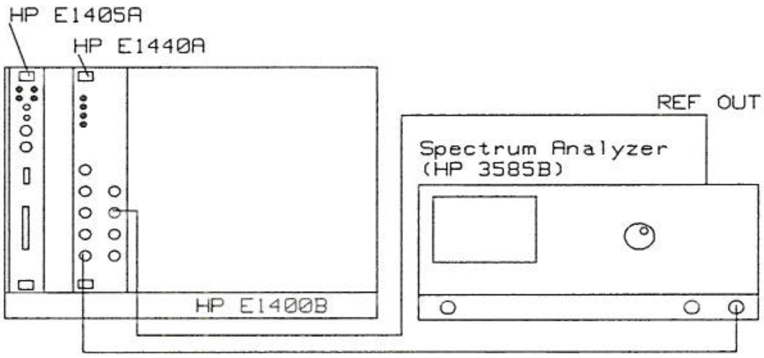

Figure C-4. Mixer Spurious Test Set-Up

2. Set the HP E1440A as follows:

Function	Sine
Frequency	2.001 MHz
Amplitude	63.24 mV(p-p)

```
OUTPUT Vxi;":FUNC SIN;:FREQ 2.001E6;:VOLT:AMPL 63.24MV"
```

3. Set the analyzer controls as follows:

Center Frequency	2.001 MHz
Frequency Span	1 kHz
Video BW	100 Hz
Resolution BW	30 Hz

4. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.
5. Without changing the reference level, change the spectrum analyzer center frequency to 27.999 MHz to display the 2:1

mixer spur. Verify that this spur is at least 60 dB below the fundamental.

6. Change the spectrum analyzer center frequency to 25.998 MHz to display the 3:2 mixer spur. Verify that this spur is at least 60 dB below the fundamental.

7. In the same way, change the HP E1440A frequency and the spectrum analyzer center frequency to the following frequencies. For each setting, verify that all spurious signals are 60 dB below the fundamental.

HP E1440A		Spectrum Analyzer Center Frequency	
Frequency	Command String	2:1 Spur	3:2 Spur
4.100 MHz	":FREQ 4.1E6"	25.9 MHz	21.8 MHz
6.100 MHz	":FREQ 6.1E6"	23.9 MHz	17.8 MHz
8.100 MHz	":FREQ 8.1E6"	21.9 MHz	13.8 MHz
10.100 MHz	":FREQ 10.1E6"	19.9 MHz	9.8 MHz
12.100 MHz	":FREQ 12.1E6"	17.9 MHz	5.8 MHz
14.100 MHz	":FREQ 14.1E6"	15.9 MHz	1.8 MHz
16.100 MHz	":FREQ 16.1E6"	13.9 MHz	2.2 MHz
18.100 MHz	":FREQ 18.1E6"	11.9 MHz	6.2 MHz
20.100 MHz	":FREQ 20.1E6"	9.9 MHz	10.2 MHz

Close-in Spurious (Fractional N Spurs) Procedure

This procedure continues from the previous one.

8. Set the HP E1440A to 5.001 MHz and the amplitude to 448.3 mV(p-p).

```
OUTPUT Vxi;":FREQ 5.001E6;:VOLT:AMPL 448.3MV"
```

9. Set the spectrum analyzer controls as follows:

Center Frequency	5.001 MHz
Frequency Span	1 kHz
Video BW	100 Hz
Resolution BW	30 Hz

10. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.

11. Without changing the reference level, change the spectrum analyzer center frequency to 5.002 MHz to display the API 1 spur. It may be necessary to decrease the video bandwidth to optimize the display resolution.

12. All spurious (non-harmonic) signals should be at least 60 dB below the fundamental.

13. Without changing the reference level, set the HP E1440A frequency and the spectrum analyzer center frequency to the frequencies listed in the following table. For each setting, verify that all spurious signals are at least 60 dB below the fundamental.

HP E1440A		**Spectrum Analyzer**
Frequency	**Command String**	**Center Frequency**
5.0001 MHz	“:FREQ 5.0001E6”	5.0011 MHz
5.00001 MHz	“:FREQ 5.00001E6”	5.00101 MHz
5.000001 MHz	“:FREQ 5.00001E6”	5.001001 MHz
20.001 MHz	“:FREQ 20.001E6”	20.002 MHz
20.001 MHz		20.003 MHz
20.001 MHz		20.004 MHz
20.001 MHz		20.005 MHz

Integrated Phase Noise

This procedure tests the HP E1440A integrated phase noise.

Specifications

−55 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier).

Equipment Required

Frequency Synthesizer
Double Balanced Mixer
50Ω Feedthru Termination
AC/DC Digital Voltmeter
15 kHz Noise Equivalent Filter
1 MHz Low Pass Filter

Procedure

1. Connect the equipment as shown in Figure C-5, connecting the output of the 15 kHz noise equivalent filter to the DVM. Phase lock the HP E1440A and the signal generator together.

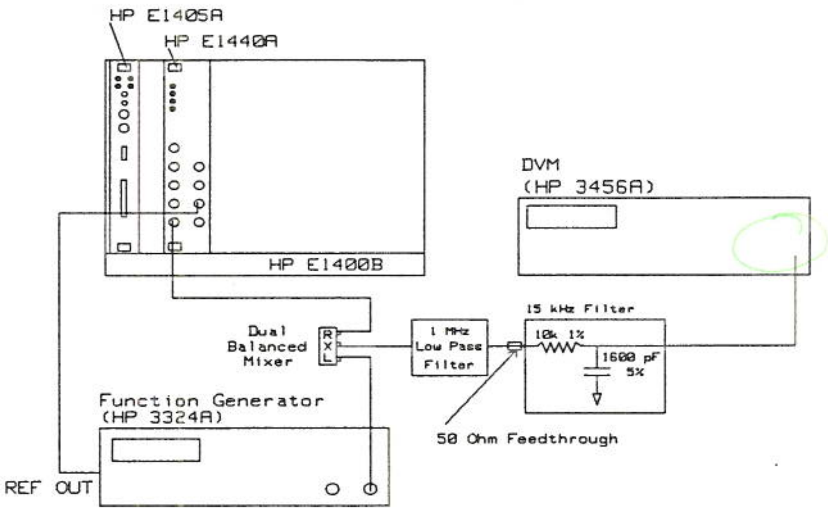

Figure C-5. Integrated Phase Noise Test Set-Up

2. Set the HP E1440A as follows:

Function	Sine
Frequency	19.901 MHz
Amplitude	632 mV(p-p)

```
OUTPUT Vxi;":FUNC SIN;:FREQ 19.901E6;:VOLT:AMPL 632MV"
```

3. Set the synthesizer (reference) as follows:

Frequency	19.9 MHz
Amplitude	1.416 V(p-p)

4. Record the DVM reading as V_{1k}.

5. Change the HP E1440A frequency to 19.9 MHz.

```
OUTPUT Vxi;":FREQ 19.9E6"
```

6. Set the HP E1440A phase reference, and step size to 1 degree.

```
OUTPUT Vxi;":PHAS:REF;:STEP 1 DEG"
```

7. Using the following commands as appropriate, adjust the phase for a minimum reading on the DVM.

`OUTPUT Vxi;":PHAS UP"`	*Increment phase*
`OUTPUT Vxi;":PHAS DOWN"`	*Decrement phase*

8. Record this minimum reading as V_0.
9. Calculate the dB ratio of V_0 to V_{1k} using the following formula:

$$20log_{10}\frac{V_0}{V_{1k}}$$

10. Add -6 dB to the ratio to allow for the folding action of the mixer, and record the result on the Performance Test Record. The specification is -55 dB or lower (-54 dB fails).

Note The frequencies used minimize the phase noise contribution of the frequency synthesizer.

Frequency Accuracy

This procedure compares the accuracy of the HP E1440A output signal to the specification.

Specifications

$\pm 5 \times 10^{-6}$ of selected frequency (20°C to 30°C).

Equipment Required

Electronic counter (calibrated within three months or with an accurate 10 MHz external reference input)

Procedure

1. Connect the HP E1440A signal output to the electronic counter channel A input with a 50Ω feedthru termination. Allow the HP E1440A to warm up for 30 minutes and the counter's frequency reference to warm up for its specified period.
2. Set the HP E1440A output as follows:

High-Voltage Output	Off
Function	Sine
Frequency	20 MHz
Amplitude	0.99 V(p-p)
DC Offset	0 V

```
OUTPUT Vxi;":OUTP:AMPL OFF;
      :FUNC SIN;:FREQ 2E7;
      :VOLT:AMPL 0.99;
      :VOLT:OFFS 0"
```

3. Set the counter's gate time to 0.01 s to measure the frequency of the A input with 0.1 Hz resolution. If necessary adjust the trigger level for stable triggering. The electronic counter should indicate 20,000,000.00 Hz ±100 Hz.
4. Change the HP E1440A frequency 10 MHz. Change the function to a square wave. The electronic counter should indicate 10,000,000.00 Hz ±50 Hz.

OUTPUT Vxi;~~":FREQ 1E7"~~ ":FUNC SQU;:FREQ 1E7"

5. Change the HP E1440A frequency 10 kHz. Change the function to a triangle. Set the counter's gate time to 0.1 s. The electronic counter should indicate 100,000.00 ns ±0.5 ns.

```
OUTPUT Vxi;":FREQ 1E4"
```

6. Change the HP E1440A function to a positive slope ramp. The electronic counter should indicate 100,000.00 ns ±0.5 ns.

```
OUTPUT Vxi;":FUNC RUP"
```

Phase Increment Accuracy

This procedure compares the phase increment accuracy of the HP E1440A to the specification.

Specifications

±0.5°

Equipment Required

Frequency Synthesizer
Electronic Counter

Procedure

1. Connect the equipment as shown in Figure C-6.

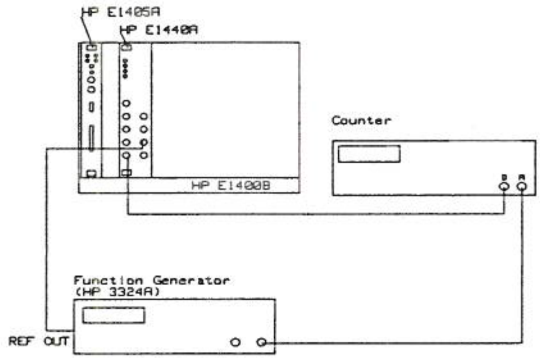

Figure C-6. Phase Increment Accuracy Test Set-Up

2. Set the HP E1440A as follows:

High-Voltage Output	Off
Function	Sine
Frequency	100 kHz
Amplitude	13 dBm

```
OUTPUT Vxi;":OUTP:AMPL OFF;"
OUTPUT Vxi;":FUNC SIN;:FREQ 1E5;"
OUTPUT Vxi;":VOLT:UNIT DBM;OFFS 0"
AMPL 13;
```

3. Set the synthesizer as follows:

Frequency	0.1 MHz
Amplitude	13 dBm

4. Set the counter as follows:

Function	Time Interval ~~Avg A to B~~
~~Frequency~~	
~~Resolution, N~~	~~10^5~~
Inputs	50Ω, separate
Slope A and B	Positive
Sample ~~Rate~~ Size	~~Maximum~~ 10 k

5. Set the phase units to degrees, and assign current signal phase as the 0° phase reference.

```
OUTPUT Vxi;":PHAS:UNIT DEG"
OUTPUT Vxi;":PHAS:REF"
```

6. Set the counter ~~sample~~ display rate close to the "hold" position, then reset the counter. Record the counter reading in nanoseconds (to 2 decimal places) on the Performance Test Record in the space for Zero-Phase Time-Reference.
7. Set the HP E1440A phase to −1°.

```
OUTPUT Vxi;"PHAS -1"
```

8. Reset the counter. Record the counter reading in nanoseconds (to 2 decimal places) in the space for 1° Increment Time Interval.
9. Determine the time difference between the counter readings ,nd the Zero-Phase Time-Reference and record it in the Time Difference column. This difference reperesents 1° at the test frequency.
10. Set the HP E1440A phase to −10°.

```
OUTPUT Vxi;"PHAS -10"
```

11. Reset the counter. Record the counter reading in the space for 10° Increment Time Interval.
12. Enter the time difference between the Zero-Phase Time-Reference and this reading in the Time Difference column. This represents 10° at the test frequency.
13. Set the HP E1440A phase to −100°.

```
OUTPUT Vxi;"PHAS -100"
```

14. Reset the counter. Record the counter reading in the space for 100° Increment Time Interval.
15. Enter the time difference between the Zero-Phase Time-Reference and this reading in the Time Difference column. This represents 100° at the test frequency.

Amplitude Accuracy

This procedure tests the amplitude accuracy of the HP E1440A AC-function output signals.

Specifications

See Chapter 1

Equipment Required

AC/DC Digital Voltmeter
High Speed Digital DC Voltmeter
Analog Oscilloscope
50 Ω Feedthru Termination
Power Meter
Power Sensor
Resistor 500 Ω 2 W 1%
Resistor 475 Ω 2 W 1%
Resistor 50 Ω 1/8 W 1%
Capacitor 300 pF 5%

Note

After each new amplitude setting you must perform an amplitude calibration:

```
OUTPUT Vxi;":CAL?"
```

Amplitude Accuracy at Frequencies upto 100 kHz Procedure

1. **Sine wave Test.** Connect the HP E1440A signal output through a 50Ω feedthru termination to the AC digital voltmeter input.
2. Set the HP E1440A as follows:

High-Voltage Output	Off
Function	Sine
Frequency	100 Hz
Amplitude	3.536 Vrms (10 V(p-p))
DC Offset	0 V

```
OUTPUT Vxi;":OUTP:AMPL OFF;
       :FUNC SIN;:FREQ 1E2;
       :VOLT:AMPL 10;
       :VOLT:OFFS 0;
       :CAL?;"
```

3. Read the AC voltmeter. Change the HP E1440A frequency to 1 kHz and 100 kHz and repeat.

```
OUTPUT Vxi;":FREQ 1E3"
OUTPUT Vxi;":FREQ 1E5"
```

   Verify that all three voltmeter readings are between 3.455 and 3.617 Vrms (±0.2 dB).

4. Change the HP E1440A amplitude to 1.061 Vrms (3 V(p-p)) and take AC voltage readings for 100 Hz, 1 kHz and 100 kHz as above.

```
OUTPUT Vxi;":VOLT:AMPL 3"

OUTPUT Vxi;":FREQ 1E2"
OUTPUT Vxi;":FREQ 1E3"
OUTPUT Vxi;":FREQ 1E5"
```

Verify that all three voltmeter readings are between 1.037 and 1.085 Vrms (±0.2 dB).

5. Change the HP E1440A amplitude to 0.3536 Vrms (1 V(p-p)) and set the DC offset to 1 mV. Set the HP E1440A frequency to 100 Hz, 1 kHz and 100 kHz, and read the AC voltage.

```
OUTPUT Vxi;":VOLT:AMPL 1;
     OFFS 1MV"

OUTPUT Vxi;":FREQ 1E2"
OUTPUT Vxi;":FREQ 1E3"
OUTPUT Vxi;":FREQ 1E5"
```

Verify that all three readings are between 0.3370 and 0.3702 Vrms (±0.4 dB).

6. **Function Test.** Set up the equipment as shown in Figure C-7.

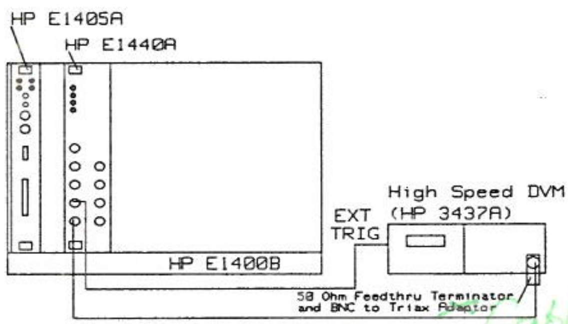

Figure C-7. Function Amplitude Accuracy Test Set-Up

7. Set the HP E1440A as follows:

High-Voltage Option	Off
Function	Square
Frequency	99.9 Hz
Amplitude	10 V(p-p)
DC Offset	0 V

```
OUTPUT Vxi;":OUTP:AMPL OFF;
     :FUNC SQU;:FREQ 9.99E1;
     :VOLT:AMPL 10;
     :VOLT:OFFS 0;
     :CAL?;"
```

8. Set the voltmeter as follows:

Range	10 V
Trigger	Ext
Delay	0 s
Coupling	DC, 1 MΩ

9. For all the E1440A frequency and function settings given in the following table:

   a. Set the voltmeter delay to the **Positive Peak** value given in the table and note the positive peak voltage of the waveform on the voltmeter. If the reading is not stable, press "hold" and "ext" alternately to repeat readings.

   b. Set the voltmeter delay to the **Negative Peak** value given in the table and note the negative peak voltage.

   c. Calculate the peak-to-peak voltage from the two readings and record it on the Test Record. This acceptable limits are given here and on the Test Record.

E1440A		DVM delay (s)		Limits (V_{p-p})	
Frequency E1	**Function**	**Positive Peak**	**Negative Peak**	**Minimum**	**Maximum**
":FREQ 9.99E2"	":FUNC TRI"	0.0075	0.0125	9.85	10.15
	":FUNC RUP"	0.01	0.00001	9.85	10.15
	":FUNC RDOW"	0.005	0.0149	9.85	10.15
":FREQ 1E3"	":FUNC SQU"	0.00075	0.00125	9.85	10.15
":FREQ 2E3"	":FUNC TRI"	0.000375	0.000625	9.85	10.15
":FREQ 5E2"	":FUNC RUP"	0.0020	0.000012	9.85	10.15
	":FUNC RDOW"	0.001	0.00297	9.85	10.15
":FREQ 1.01E5"	":FUNC SQU"	0.0000075	0.0000125	9.50	10.50
":FREQ 1E4"	":FUNC TRI"	0.000075	0.000125	9.50	10.50
	":FUNC RUP"	0.000098	0.000006	9.00	11.00
	":FUNC RDOW"	0.0000525	0.000146	9.00	11.00

10. Change the HP E1440A amplitude to 3 V(p-p), and perform a calibration.

```
OUTPUT Vxi;":VOLT:AMPL 3;
     :CAL?;"
```

11. Repeat steps 9a to 9c for all the E1440A frequency and function settings given in the following table:

E1440A		DVM delay (s)		Limits ($V_{p\text{-}p}$)	
Frequency E1	Function	Positive Peak	Negative Peak	Minimum	Maximum
":FREQ 9.99~~E2~~"	":FUNC SQU"	0.0075	0.0125	2.955	3.045
	":FUNC TRI"	0.0075	0.0125	2.955	3.045
	":FUNC RUP"	0.01	0.00001	2.955	3.045
	":FUNC RDOW"	0.005	0.0149	2.955	3.045
":FREQ 1E3"	":FUNC SQU"	0.00075	0.00125	2.955	3.045
":FREQ 2E3"	":FUNC TRI"	0.000375	0.000625	2.955	3.045
":FREQ 5E2"	":FUNC RUP"	0.0020	0.000012	2.955	3.045
	":FUNC RDOW"	0.001	0.00297	2.955	3.045
":FREQ 1.01E5"	":FUNC SQU"	0.0000075	0.0000125	2.700	3.300
":FREQ 1E4"	":FUNC TRI"	0.000075	0.000125	2.850	3.150
	":FUNC RUP"	0.000098	0.000006	2.700	3.300
	":FUNC RDOW"	0.0000525	0.000146	2.700	3.300

12. Change the HP E1440A amplitude to 1 V(p-p), offset to 1 mV and perform a calibration.

```
OUTPUT Vxi;":VOLT:AMPL 3;
      :VOLT:OFFS 1 MV;
      :CAL?;"
```

13. Repeat steps 9a to 9c for all the E1440A frequency and function settings given in the following table:

E1440A		DVM delay (s)		Limits ($V_{p\text{-}p}$)	
Frequency E1	Function	Positive Peak	Negative Peak	Minimum	Maximum
":FREQ 9.99~~E2~~"	":FUNC SQU"	0.0075	0.0125	0.978	1.022
	":FUNC TRI"	0.0075	0.0125	0.973	1.027
	":FUNC RUP"	0.01	0.00001	0.973	1.027
	":FUNC RDOW"	0.005	0.0149	0.973	1.027
":FREQ 1E3"	":FUNC SQU"	0.00075	0.00125	0.978	1.022
":FREQ 2E3"	":FUNC TRI"	0.000375	0.000625	0.973	1.027
":FREQ 5E2"	":FUNC RUP"	0.0020	0.000012	0.973	1.027
	":FUNC RDOW"	0.001	0.00297	0.973	1.027
":FREQ 1.01E5"	":FUNC SQU"	0.0000075	0.0000125	0.900	1.100
":FREQ 1E4"	":FUNC TRI"	0.000075	0.000125	0.938	1.062
	":FUNC RUP"	0.000098	0.000006	0.888	1.112
	":FUNC RDOW"	0.0000525	0.000146	0.888	1.112

High-Voltage Output (Option 001)

Amplitude Accuracy for Frequencies ≤ 100 kHz

This procedure continues from the previous one.

14. **Sine wave Test.** Connect the HP E1440A signal output to the AC voltmeter as shown in Figure C-8.

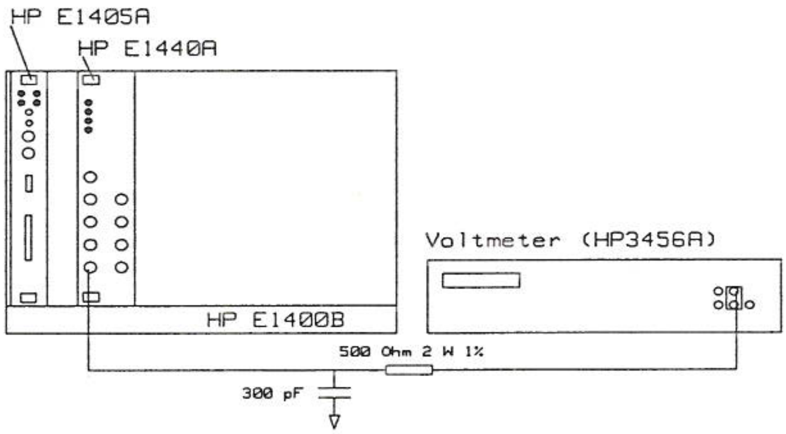

Figure C-8. High voltage sinewave accuracy test set-up.

15. Set up the HP E1440A as follows:

High-Voltage Option	ON
Function	Square
Frequency	2 kHz
Amplitude	40 V(p-p)
DC Offset	0 V

and calibrate.

```
OUTPUT Vxi;":OUTP:AMPL ON;
     :FUNC SIN;:FREQ 2E3;
     :VOLT:AMPL 40;
     :VOLT:OFFS 0;
     :CAL?;"
```

16. Record the voltmeter reading on the Test Record. It should lie between 13.86 and 14.42 Vrms.

17. **High-Voltage Function Test.** Connect the equipment as shown in Figure C-9.

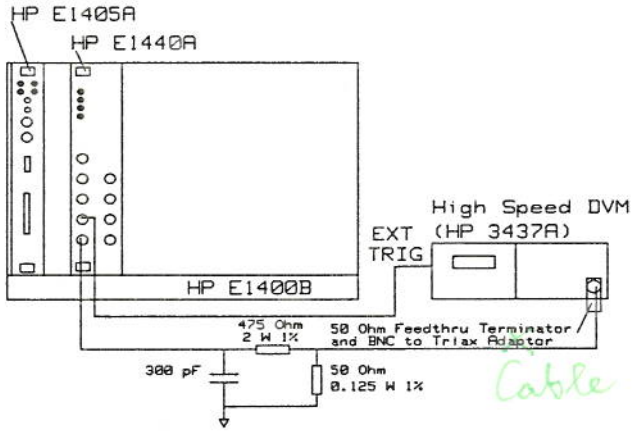

Figure C-9.
Function Amplitude Accuracy Test Set-Up (High-Voltage Output)

18. The voltage divider shown in Figure C-9 is built into a small metal box with 2 BNC connectors. Parts used are:

    R3, 475Ω 2 W 1%
    R4, 50Ω 1/8 W 2%
    C1, 300 pF 5%

19. Set up the HP E1440A as follows:

High-Voltage Option	ON
Function	Square
Frequency	2 kHz
Amplitude	40 V(p-p)
DC Offset	0 V

and calibrate.

```
OUTPUT Vxi;":OUTP:AMPL ON;
      :FUNC SIN;:FREQ 2E3;
      :VOLT:AMPL 40;
      :VOLT:OFFS 0;
      :CAL?;"
```

20. For all the E1440A frequency and function settings given in the following table:

    a. Set the voltmeter delay to the **Positive Peak** value given in the table and note the positive peak voltage of the waveform on the voltmeter. If the reading is not stable, press "hold" and "ext" alternately to repeat readings.
    b. Set the voltmeter delay to the **Negative Peak** value given in the table and note the negative peak voltage.
    c. Calculate the peak-to-peak voltage from the two readings and record it on the Test Record. This acceptable limits are given here and on the Test Record.

E1440A		DVM delay (s)		Limits (V_{p-p})	
Frequency	**Function**	**Positive Peak**	**Negative Peak**	**Minimum**	**Maximum**
":FREQ 2E3"	":FUNC SQU"	0.000375	0.000625	1.96	2.04
	":FUNC TRI"	0.000375	0.000625	1.96	2.04
	":FUNC RUP"	0.000495	0.000508	1.96	2.04
	":FUNC RDOW"	0.000251	0.00074	1.96	2.04

21. Switch off the high-voltage output.

```
OUTPUT Vxi;":OUTP:AMPL OFF;
```

Amplitude Accuracy (Frequencies > 100 kHz)

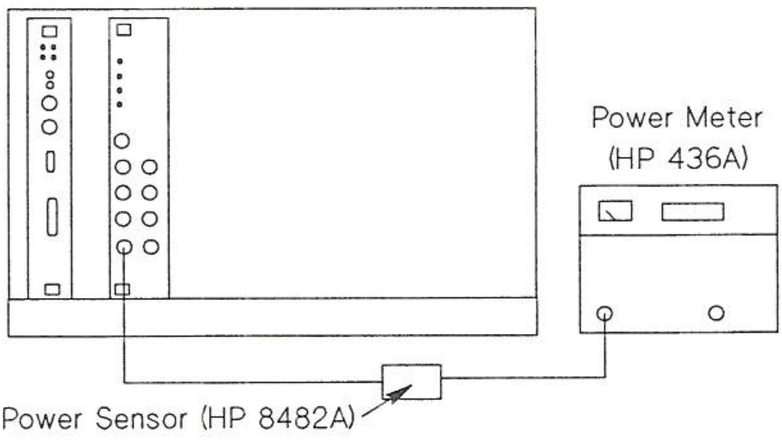

Figure C-10.
Test set-up for Amplitude Accuracy Adjustment (Frequency > 100 kHz)

1. Calibrate the power meter for the sensor using the 50 MHz, 1.00 mW power-reference output on the meter.

2. Set up the HP E1440A as follows:

Function	Sine
Frequency	1 MHz
Amplitude	6 Vp-p (19.54 dBm)
DC Offset	0 V

```
OUTPUT Vxi;" :FUNC SIN;:FREQ 1E6;
      :VOLT:AMPL 6;
      :VOLT:OFFS 0;
      :OUTP ON"
```

3. Connect the output of the HP E1440A to the power meter via the power sensor, as shown in Figure C-10.
4. Switch the power meter to read dBm.
5. Check that the indicated power level is 19.54 dBm ±0.4 dB.
6. For the following frequency settings, check that the indicated power level is 19.54 dBm ±0.4 dB.

   ":FREQ 5E6"
   ":FREQ 1E7"
   ":FREQ 1.5E7"
   ":FREQ 2E7"

7. Set the HP E1440A output amplitude to 2 V (10 dBm).

```
OUTPUT Vxi;":VOLT:AMPL 2"
```

8. For the following frequency settings, check that the indicated power level is 10 dBm ±0.6 dB.

   ":FREQ 1E6"
   ":FREQ 5E6"
   ":FREQ 1E7"
   ":FREQ 1.5E7"
   ":FREQ 2E7"

9. **Square wave accuracy.** Set the HP E1440A as follows:

High-Voltage Output	Off
Function	Square
Frequency	1 kHz
Amplitude	10 V(p-p)
DC Offset	0 V

```
OUTPUT Vxi;":OUTP:AMPL OFF;
      :FUNC SQU;:FREQ 1E3;
      :VOLT:AMPL 10;
      :VOLT:OFFS 0;
```

10. Connect the HP E1440A signal output to an analog oscilloscope using a 50Ω feedthru termination. Set the oscilloscope as follows:

Vertical Sensitivity	2 V/div
Time/div	0.1 ms

11. For each of the following frequency settings from 1 kHz to 10 MHz, verify that the two lines on the oscilloscope are 5 ±0.25 major divisions apart.

    ":FREQ 1E3"
    ":FREQ 2E6"
    ":FREQ 4E6"
    ":FREQ 6E6"
    ":FREQ 1E7"

High-Voltage Output (Option 001)

Amplitude Flatness above 100 kHz

This procedure continues from the previous one.

12. Connect the HP E1440A output to the analog oscilloscope via a 500Ω, 300pF load/voltage divider, as shown in Figure C-11.

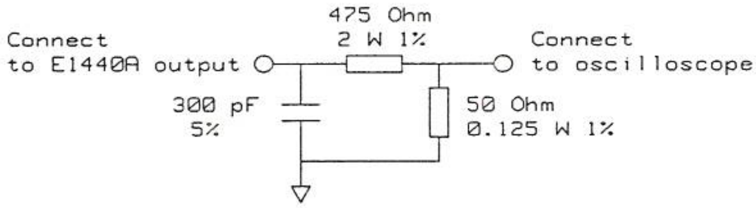

Figure C-11. 500 Ω 300 pF load/Voltage divider

    The cable capacitance (30 pF/foot) must be included in the 300 pF.

13. Set the oscilloscope as follows:

Vertical Sensitivity	1 V/div
Time/div	1 ms
Input Impedance	High

14. Set the HP E1440A to 40 V(p-p) sine wave and 1 kHz and adjust the oscilloscope intensity and focus for a sharp trace.

```
OUTPUT Vxi;":OUTP:AMPL ON;
      :FUNC SIN;:FREQ 1E3;
      :VOLT:AMPL 40;
      :VOLT:OFFS 0"
```

15. For each of the following frequency settings from 1 kHz to 1 MHz, verify that the two lines on the oscilloscope are 4 ±0.4 major divisions apart.

    ":FREQ 1E3"
    ":FREQ 2E5"
    ":FREQ 4E5"
    ":FREQ 6E5"
    ":FREQ 8E5"
    ":FREQ 1E6"

16. Switch off the high voltage output.

```
OUTPUT Vxi;":OUTP:AMPL OFF"
```

DC Offset Accuracy (DC only)

This procedure tests the HP E1440A DC offset accuracy when no AC function output is present.

Specifications

1% of full range ±0.02 mV

Equipment Required

DC Digital Voltmeter
50Ω Feedthru Termination

Procedure

1. Connect the HP E1440A signal output directly to the 50Ω feedthru termination and then with a cable to the DC digital voltmeter input.
2. Set the output so that only the DC output is present.

```
OUTPUT Vxi;":FUNC DC"
```

3. Set the HP E1440A DC offset to 5 V, and calibrate.

```
OUTPUT Vxi;":VOLT:OFFS 5;
      :CAL?"
```

4. The voltmeter reading should be between +4.950 and +5.050 V.
5. Change the HP E1440A DC offset to −5 V.

```
OUTPUT Vxi;":VOLT:OFFS -5;
```

6. The voltmeter reading should be between −4.950 and −5.050 V.

Attenuator Test. This procedure continues from the previous one.

7. Set the DC offset to the positive and negative voltages below. The digital voltmeter reading should be within the tolerances shown for each voltage.

DC Offset	Tolerances
":VOLT:OFFS 1.499"	1.48399 to 1.51401 V
":VOLT:OFFS -1.499"	-1.48399 to -1.51401 V
":VOLT:OFFS 499.9 MV"	0.48488 to 0.50491 V
":VOLT:OFFS -499.9 MV"	-0.48488 to -0.50491 V
":VOLT:OFFS 149.9 MV"	0.14838 to 0.15142 V
":VOLT:OFFS -149.9 MV"	-0.14838 to -0.15142 V
":VOLT:OFFS 49.99 MV"	0.04947 to 0.05051 V
":VOLT:OFFS -49.99 MV"	-0.04947 to -0.05051 V
":VOLT:OFFS 14.99 MV"	0.01482 to 0.01516 V
":VOLT:OFFS -14.99 MV"	-0.01482 to -0.01516 V
":VOLT:OFFS 4.999 MV"	0.004929 to 0.005069 V
":VOLT:OFFS -4.999 MV"	-0.004929 to -0.005069 V
":VOLT:OFFS 1.499 MV"	0.001464 to 0.001534 V
":VOLT:OFFS -1.499 MV"	-0.001464 to -0.001534 V

High-Voltage Output (Option 001)

This procedure continues from the previous one.

8. Remove the 50Ω feedthru termination and connect the HP E1440A output directly to the voltmeter input.
9. Select the high-voltage output on the HP E1440A.

   ```
   OUTPUT Vxi;":OUTP:AMPL ON"
   ```

10. Set the HP E1440A DC offset to 20 V.

    ```
    OUTPUT Vxi;":VOLT:OFFS 20"
    ```

11. The voltmeter reading should be +19.775 to 20.225 V.
12. Switch off the high voltage output.

    ```
    OUTPUT Vxi;":OUTP:AMPL OFF"
    ```

DC Offset Accuracy with AC Functions

This procedure tests the HP E1440A DC offset accuracy when an AC function output is present.

Specifications

DC + AC, up to 1 MHz: 1.2%
For ramps up to 10 kHz: 2.4%
DC + AC, from 1 MHz to 20 MHz: 3%

Equipment Required

DC Digital Voltmeter
50Ω Feedthru Termination

Procedure

1. Connect the equipment as shown in Figure C-12, and set the voltmeter to measure DC voltage.

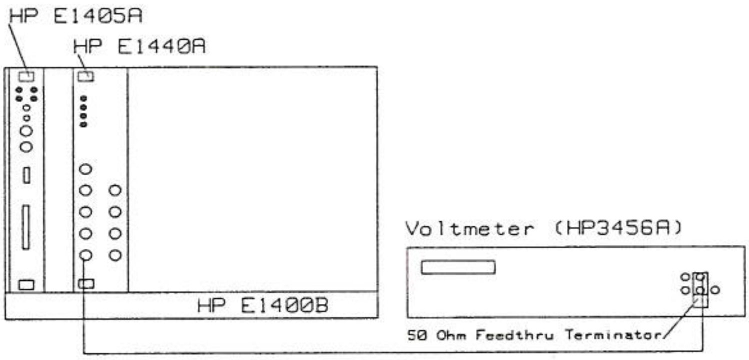

Figure C-12. DC Offset Test Set-Up

2. Set the HP E1440A output as follows, and calibrate:

High-Voltage Output	Off
Function	Sine
Frequency	21 MHz
Amplitude	1 V(p-p)
DC Offset	+4.5 V

```
OUTPUT Vxi;":OUTP:AMPL OFF;
      :FUNC SIN;:FREQ 2.1E7;
      :VOLT:AMPL 1;
      :VOLT:OFFS 4.5;
      :CAL?"
```

3. After amplitude calibration (approximately 2 seconds) the voltmeter reading should be +4.350 to +4.650 Vdc.

4. Change the HP E1440A DC offset to −4.5 V.

```
OUTPUT Vxi;":VOLT:OFFS -4.5"
```

5. The voltmeter reading should be −4.350 to −4.650 Vdc.

6. Change the HP E1440A frequency to 999.9 kHz.

   ```
   OUTPUT Vxi;":FREQ 9.999E5"
   ```

7. The voltmeter reading should be −4.440 to −4.560 Vdc.
8. Change the HP E1440A DC offset to +4.5 V.

   ```
   OUTPUT Vxi;":VOLT:OFFS 4.5"
   ```

9. The voltmeter reading should be +4.440 to +4.560 Vdc.
10. Set the HP E1440A function to square.

    ```
    OUTPUT Vxi;":FUNC SQU"
    ```

11. The voltmeter reading should be +4.440 to +4.560 Vdc.
12. Change the HP E1440A DC offset to −4.5 V.

    ```
    OUTPUT Vxi;":VOLT:OFFS -4.5"
    ```

13. The voltmeter reading should be −4.440 to −4.560 Vdc.
14. Change the HP E1440A frequency to 9.9999 MHz.

    ```
    OUTPUT Vxi;":FREQ 9.9999E6"
    ```

15. The voltmeter reading should be −4.350 to −4.650 Vdc.
16. Set the HP E1440A function to triangle, and frequency to 9.9 kHz.

    ```
    OUTPUT Vxi;":FUNC TRI;
                :FREQ 9.9E3"
    ```

17. The voltmeter reading should be −4.440 to −4.560 Vdc.
18. Set the HP E1440A function to positive ramp.

    ```
    OUTPUT Vxi;":FUNC RUP"
    ```

    The voltmeter reading should be −4.380 to −4.620 V.

Triangle Linearity

This procedure tests the linearity of the HP E1440A triangle wave output. As the triangle and ramp outputs are generated by the same circuits, this procedure also tests the ramp linearity.

Specifications

±0.05% of full output, 10% to 90%, best fit straight line

Equipment Required

High-speed DC Digital Voltmeter
Resistor, 20Ω 1/4 W 1%
Resistor, 30Ω 1/4 W 1%
BNC-to-Triax Adapter

Procedure

1. Connect the HP E1440A and the high-speed voltmeter through the divider as shown in Figure C-13.

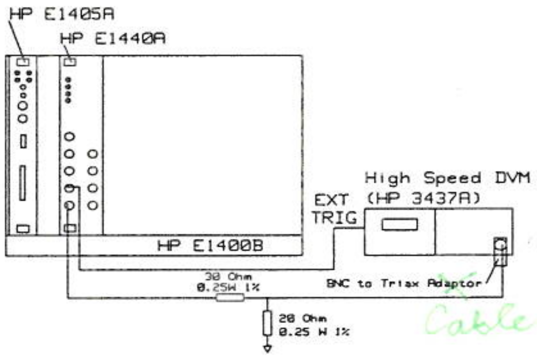

Figure C-13. Triangle Linearity Test Set-Up

2. Set the HP E1440A output as follows:

High-Voltage Output	Off
Function	Triangle
Frequency	10 kHz
Amplitude	10 V(p-p)
DC Offset	0 V

```
OUTPUT Vxi;":OUTP:AMPL OFF;
      :FUNC TRI;:FREQ 1E5;
      :VOLT:AMPL 10;
      :VOLT:OFFS 0"
```

3. Set the voltmeter as follows:

Range	1 V
Number of readings	1
Trigger	External

Note

The HP 3437A triggers on the negative going edge of the HP E1440A sync square wave.

4. Set the voltmeter delay to 0.00003 (seconds). Record the voltmeter reading on the Performance Test Record under *Positive Slope Measurement, (10%)y_1*. This is the 10% point on the positive slope of the triangle.

5. Measure the voltage at each 10% segment point by setting the voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under *Positive Slope Measurement*.

Delay	Percent of Slope
0.000035	20
0.00004	30
0.000045	40
0.00005	50
0.000055	60
0.00006	70
0.000065	80
0.00007	90

6. Algebraically add the voltages recorded in the *Positive Slope Measurement* column and enter the total in the $\sum$y space.

7. Measure the voltage at each 10% segment point on the negative slope by setting the voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under *Negative Slope Measurement*.

Delay	Percent of Slope
0.00008	90
0.000085	80
0.00009	70
0.000095	60
0.0001	50
0.000105	40
0.00011	30
0.000115	20
0.00012	10

8. Algebraically add the voltages recorded in the *Negative Slope Measurement* column and enter the total in the $\sum$y space.

9. For the *Positive Slope Measurement* results, multiply Σy by 45 (which is Σx) and enter the result in theΣ xΣy space.

10. Multiply each y value by the corresponding x value and enter in the x times y column. Total these values and enter in the Σxy space.

11. The equation for determining the best fit straight line specification for each y-value is:

$$y' = a_1 x + a_0$$

where a_1 and a_0 are constants to be calculated from the data taken previously.

Note Calculate the values of a_1 and a_0 to at least five decimal places.

---

12. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

where Σx, Σy, Σxy, $\Sigma x \Sigma y$, Σx^2 , and $(\Sigma x)^2$, are the previously calculated values entered on the Performance Test Record.

where n=9 (the number of points to be calculated).

13. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - \frac{a_1 \Sigma x}{n}$$

14. Calculate the best-fit straight line y' value for each point (y_1 through y_9) using the equation:

$$y' = a_1 x = a_0$$

Enter each result on the Performance Test Record in the *Best-Fit Straight Line* column.

15. For each delay (x), subtract the calculated voltage (y') from the measured voltage (y). Find the largest positive voltage difference ($+V_{max}$) and the largest negative difference ($-V_{max}$). Using the following formula, compute the % linearity.

% linearity = $((|+V_{max}| + |-V_{max}|) \div 8$ volts$) \times 100\%$

16. Add the voltages recorded in the Negative Slope Measurement column algebraically and enter the total in the Σy space.

17. Repeat steps 8 through 14 to determine the best fit straight line values and linearity for the negative slope.

Serial No: ______________________ Report No: ______________________ Date: __________

Test Facility :

____

____

____

____

Test Conditions :

Installed Options : ______________________

Ambient Temperature : ______________________°C

Relative Humidity : ______________________%

Line Frequency : ______________________Hz

Special Notes :

____

____

____

____

____

____

____

Serial No: ____________________________ Report No: ___________________________ Date: ___________

Test Equipment Used :

Description	Model No.	Serial No.	Trace No.	Cal.Due Date
Digital Oscilloscope				
Counter				
Digital Voltmeter				
Spectrum Analyzer				
AC Voltmeter				
Frequency Synthesizer				
High-speed DC Voltmeter				
Power Meter				
Power Sensor				
Controller				
Command Module				
VXI Mainframe				

Harmonic Distortion

Harmonic Distortion Test Pass ▢ Fail ▢

Fundamental Frequency		Specification
20 MHz	____________________	−25 dB
15 MHz	____________________	−25 dB
14.9 MHz	____________________	−30 dB
2 MHz	____________________	−30 dB
1.99 MHz	____________________	−40 dB
200 kHz	____________________	−40 dB
10 kHz	____________________	−60 dB
1 kHz	____________________	−60 dB
100 Hz	____________________	−60 dB

High-Voltage Output (Option 001)

100 Hz	____________________	−60 dB
1 kHz	____________________	−60 dB
10 kHz	____________________	−60 dB
200 kHz	____________________	−40 dB
1 MHz	____________________	−40 dB

Spurious Signals

Spurious Signal Test Pass ☐ Fail ☐

Mixer Spurious

	2:1 spur	3:2 spur	Specification
2.001 MHz	________	________	−60 dBc
4.100 MHz	________	________	−60 dBc
6.100 MHz	________	________	−60 dBc
8.100 MHz	________	________	−60 dBc
10.100 MHz	________	________	−60 dBc
12.100 MHz	________	________	−60 dBc
14.100 MHz	________	________	−60 dBc
16.100 MHz	________	________	−60 dBc
18.100 MHz	________	________	−60 dBc
20.100 MHz	________	________	−60 dBc

Close-in-Spurious

5.001 MHz	________________	−60 dBc
5.0001 MHz	________________	−60 dBc
5.00001 MHz	________________	−60 dBc
5.000001 MHz	________________	−60 dBc
20.001 MHz	________________	−60 dBc
20.001 MHz	________________	−60 dBc
20.001 MHz	________________	−60 dBc
20.001 MHz	________________	−60 dBc

Integrated Phase Noise

Integrated Phase Noise Test — Pass ☐ Fail ☐

1st voltmeter reading V_{1k}	____________________	V
2nd voltmeter reading V_0	____________________	V
$20log_{10}\frac{V_0}{V_{1k}}$	= ____________________	dB
		Specification
Result − 6 dB	= ____________________	−55 dB

Frequency Accuracy

Frequency Accuracy Test — Pass ☐ Fail ☐

Sine, 20 MHz	____________________	±100 Hz
Square, 10 MHz	____________________	±50 Hz
Triangle, 10 kHz (100,000 ns) ok.	____________________	±0.5 ns
Ramp, 10 kHz (100,000 ns)	____________________	±0.5 ns

Phase Increment Accuracy

Phase Increment Accuracy Test — Pass ☐ Fail ☐

	Measured	Minimum	Time Difference	Maximum
Zero-Phase Time-Reference	__________			
1° Increment Time Interval	__________	13.89 ns	__________	41.67 ns
10° Increment Time Interval	__________	263.89 ns	__________	291.67 ns
100° Increment Time Interval	__________	2763.89 ns	__________	2791.67 ns

Amplitude Accuracy

Amplitude Accuracy Test

Pass ☐ Fail ☐

Sine wave Test	Minimum	Measured	Maximum
Amplitude: 3.536 Vrms			
Sine, 100 Hz:	3.455 V	______________	3.617 V
Sine, 1 kHz:	3.455 V	______________	3.617 V
Sine, 100 kHz:	3.455 V	______________	3.617 V
Amplitude: 1.061 Vrms			
Sine, 100 Hz:	1.037 V	______________	1.085 V
Sine, 1 kHz:	1.037 V	______________	1.085 V
Sine, 100 kHz:	1.037 V	______________	1.085 V
Amplitude: 0.3536 Vrms			
DC, 1 mV			
Sine, 100 Hz:	0.3370 V	______________	0.3702 V
Sine, 1 kHz:	0.3370 V	______________	0.3702 V
Sine, 100 kHz:	0.3370 V	______________	0.3702 V

Amplitude Accuracy Test (continued)

Function Test	Minimum	Measured	Maximum
Amplitude: 10 V(p-p)			
Square, 99.9 Hz	9.95 V	______________	10.15 V
Triangle, 99.9 Hz	9.85 V	______________	10.15 V
Pos. Ramp, 99.9 Hz	9.85 V	______________	10.15 V
Neg. Ramp, 99.9 Hz	9.85 V	______________	10.15 V
Square, 1 kHz	9.95 V	______________	10.15 V
Triangle, 2 kHz	9.85 V	______________	10.15 V
Pos. Ramp, 500 Hz	9.85 V	______________	10.15 V
Neg. Ramp, 500 Hz	9.85 V	______________	10.15 V
Square, 101 kHz	9.50 V	______________	10.50 V
Triangle, 10 kHz	9.50 V	______________	10.50 V
Pos. Ramp, 10 kHz	9.00 V	______________	11.00 V
Neg. Ramp, 10 kHz	9.00 V	______________	11.00 V
Amplitude: 3 V(p-p)			
Square, 99.9 Hz	2.955 V	______________	3.045 V
Triangle, 99.9 Hz	2.955 V	______________	3.045 V
Pos. Ramp, 99.9 Hz	2.955 V	______________	3.045 V
Neg. Ramp, 99.9 Hz	2.955 V	______________	3.045 V
Square, 1 kHz	2.955 V	______________	3.045 V
Triangle, 2 kHz	2.955 V	______________	3.045 V
Pos. Ramp, 500 Hz	2.955 V	______________	3.045 V
Neg. Ramp, 500 Hz	2.955 V	______________	3.045 V
Square, 101 kHz	2.700 V	______________	3.300 V
Triangle, 10 kHz	2.850 V	______________	3.150 V
Pos. Ramp, 10 kHz	2.700 V	______________	3.300 V
Neg. Ramp, 10 kHz	2.700 V	______________	3.300 V

Serial No: ________________________ Report No: ________________________ Date: __________

Amplitude Accuracy Test (continued)

Function Test	Minimum	Measured	Maximum
Amplitude: 1 V(p-p)			
DC: 1 mV			
Square, 99.9 Hz	0.978 V	______________	1.022 V
Triangle, 99.9 Hz	0.973 V	______________	1.027 V
Pos. Ramp, 99.9 Hz	0.973 V	______________	1.027 V
Neg. Ramp, 99.9 Hz	0.973 V	______________	1.027 V
Square, 1 kHz	0.978 V	______________	1.022 V
Triangle, 2 kHz	0.973 V	______________	1.027 V
Pos. Ramp, 500 Hz	0.973 V	______________	1.027 V
Neg. Ramp, 500 Hz	0.973 V	______________	1.027 V
Square, 101 kHz	0.900 V	______________	1.100 V
Triangle, 10 kHz	0.938 V	______________	1.062 V
Pos. Ramp, 10 kHz	0.888 V	______________	1.112 V
Neg. Ramp, 10 kHz	0.888 V	______________	1.112 V

High-Voltage Output (Option 001)

Sine wave Test	Minimum	Measured	Maximum
Amplitude: 14.14 Vrms			
Sine, 2 kHz	13.86 V	______________	14.42 V

Function Test	Minimum	Measured	Maximum
Amplitude: 40 V(p-p)			
Square, 2 kHz	3.466 V	______________	3.607 V
Triangle, 2 kHz	3.466 V	______________	3.607 V
Pos. Ramp, 2 kHz	3.466 V	______________	3.607 V
Neg. Ramp, 2 kHz	3.466 V	______________	3.607 V

Amplitude Accuracy Test (> 100 kHz)	Minimum	MEASURED	Maximum
Sine, 19.54 dBm, 1 MHz	19.14 dBm	___________	19.94 dBm
5 MHz	19.14 dBm	___________	19.94 dBm
10 MHz	19.14 dBm	___________	19.94 dBm
15 MHz	19.14 dBm	___________	19.94 dBm
20 MHz	19.14 dBm	___________	19.94 dBm
Sine, 10 dBm, 1 MHz	9.4 dBm		10.6 dBm
5 MHz	9.4 dBm	___________	10.6 dBm
10 MHz	9.4 dBm	___________	10.6 dBm
15 MHz	9.4 dBm	___________	10.6 dBm
20 MHz	9.4 dBm	___________	10.6 dBm

Square, 10 V(p-p) Pass ☐ Fail ☐

High-Voltage Output (Option 001)

Sine, 40 V(p-p) Pass ☐ Fail ☐

DC Offset Accuracy (DC only)

DC Offset Accuracy Test (DC Only) Pass ☐ Fail ☐

	Minimum	Measured	Maximum
5 V	+4.950 V	______________	+5.050 V
−5 V	−4.950 V	______________	−5.050 V
1.499 V	+1.48399 V	______________	+1.51401 V
−1.499 V	−1.48399 V	______________	−1.51401 V
499.9 mV	+0.49488 V	______________	+0.50491 V
−499.9 mV	−0.49488 V	______________	−0.50491 V
149.9 mV	+0.14838 V	______________	+0.15142 V
−149.9 mV	−0.14838 V	______________	−0.15142 V
49.99 mV	+0.04947 V	______________	+0.05051 V
−49.99 mV	−0.04947 V	______________	−0.05051 V
14.99 mV	+0.01482 V	______________	+0.01516 V
−14.99 mV	−0.01482 V	______________	−0.01516 V
4.999 mV	+0.004929 V	______________	+0.005069 V
−4.999 mV	−0.004929 V	______________	−0.005069 V
1.499 ~~1.999~~ mV	+0.001464 V	______________	+0.001534 V
− 1.499 ~~−1.999~~ mV	−0.001464 V	______________	−0.001534 V

High-Voltage Output (Option 001)

	Minimum	Measured	Maximum
20 V	+19.775 V	______________	+20.225 V
−20 V	−19.775 V	______________	−20.225 V

Serial No: ____________________ Report No: ____________________ Date: __________

DC Offset Accuracy with AC Function

DC Offset Accuracy Test with AC Functions Pass ☐ Fail ☐

	Minimum	Measured	Maximum
Sine, 21 MHz			
4.5 V	+4.350 V	______________	+4.650 V
−4.5 V	−4.350 V	______________	−4.650 V
Sine, 999.9 kHz			
4.5 V	+4.440 V	______________	+4.560 V
−4.5 V	−4.440 V	______________	−4.560 V
Square, 999.9 kHz			
4.5 V	+4.440 V	______________	+4.560 V
−4.5 V	−4.440 V	______________	−4.560 V
Square, 9.9999 MHz			
−4.5 V	−4.350 V	______________	−4.650 V
Triangle, 9.9 kHz			
−4.5 V	−4.440 V	______________	−4.560 V
Ramp, 9.9 kHz			
−4.5 V	−4.380 V	______________	−4.620 V

Serial No: ____________________ Report No: ____________________ Date: __________

Triangle Linearity

Triangle Linearity Test (Positive Slope) Pass ▢ Fail ▢

x Values	Positive Slope Measurement y	x times y	Calculated Best-fit Straight Line y'	Difference y' - y
$x_1 = 1$	(10%) y_1______	________	(y'_1)________	________
$x_2 = 2$	(20%) y_2______	________	(y'_2)________	________
$x_3 = 3$	(30%) y_3______	________	(y'_3)________	________
$x_4 = 4$	(40%) y_4______	________	(y'_4)________	________
$x_5 = 5$	(50%) y_5______	________	(y'_5)________	________
$x_6 = 6$	(60%) y_6______	________	(y'_6)________	________
$x_7 = 7$	(70%) y_7______	________	(y'_7)________	________
$x_8 = 8$	(80%) y_8______	________	(y'_8)________	________
$x_9 = 9$	(90%) y_9______	________	(y'_9)________	________
$\Sigma x = 45$	Σy__________	Σxy_____		$+V_{max}$__________
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$________			$-V_{max}$__________
$\Sigma x^2 = 285$				

% Linearity (Positive Slope): ______________

Triangle Linearity Test (Negative Slope) Pass ▢ Fail ▢

x Values	Negative Slope Measurement y	x times y	Calculated Best-fit Straight Line y'	Difference y' - y
$x_1 = 1$	(10%) y_1______	________	(y'_1)________	________
$x_2 = 2$	(20%) y_2______	________	(y'_2)________	________
$x_3 = 3$	(30%) y_3______	________	(y'_3)________	________
$x_4 = 4$	(40%) y_4______	________	(y'_4)________	________
$x_5 = 5$	(50%) y_5______	________	(y'_5)________	________
$x_6 = 6$	(60%) y_6______	________	(y'_6)________	________
$x_7 = 7$	(70%) y_7______	________	(y'_7)________	________
$x_8 = 8$	(80%) y_8______	________	(y'_8)________	________
$x_9 = 9$	(90%) y_9______	________	(y'_9)________	________
$\Sigma x = 45$	Σy__________	Σxy_____		$+V_{max}$__________
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$________			$-V_{max}$__________
$\Sigma x^2 = 285$				

% Linearity (Negative Slope): ______________