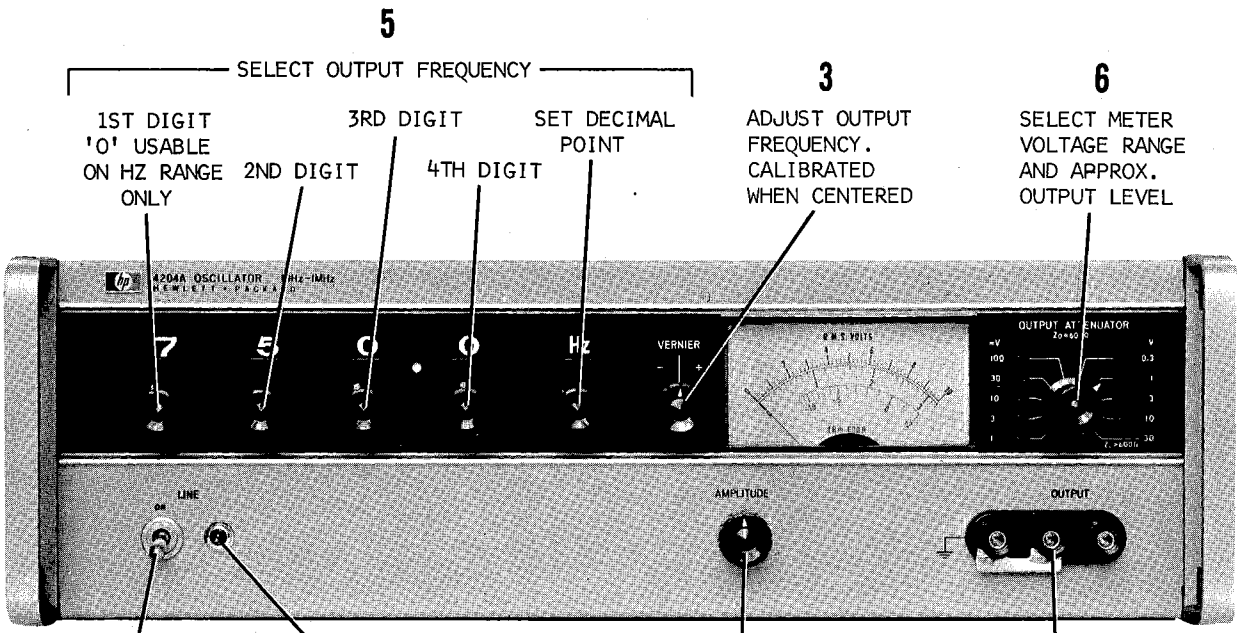
OSCILLATOR

4204A



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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of the Hewlett-Packard Model 4204A Digital Oscillator which is a general purpose, sine-wave signal source providing three and four-place digital frequency selection and a front panel output-level meter. The oscillator is supplied as a "cabinet" model accompanied by the hardware needed for conversion to rack-mounting.

1.2 The instrument being calibrated will be referred to herein as the Test Instrument. The recommended calibration period for the oscillator is 180 days.

Table I. Calibration Description

Test Instrument Characteristics	Performance Specifications	Test Method
Output level & flatness	Output level within ±3% from 10 Hz to 1 MHz; 10 volts into 600 ohms.	Measured on EVM while frequency is switched across range.
Output meter accuracy	±2.0% of full scale	Measured on EVM at selected frequencies.
Output waveform purity	Output distortion less than 0.3% 30 Hz to 100 kHz; 1.0% 10 to 30 Hz and 100 kHz to 1.0 MHz.	Measured on distortion analyzer at five frequencies. See Appendix A for measurement at 1 MHz.
Output frequency range and accuracy	Output frequency within ±0.2% 50 Hz to 1 MHz; ±0.1 Hz, 10 Hz to 50 Hz.	Measured on electronic counter at selected frequencies.
Output frequency stability	< 100 PPM shift in frequency due to ± 10% change in line voltage.	Measured on electronic counter as line voltage is varied.

SECTION 2

EQUIPMENT REQUIREMENTS

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

Item	Minimum Use Specifications	Suggested Mfg. & Model
Load Resistor	600Ω± 1% watt, non-inductive resistor	Electra Mfg. Co. Type MF6C 7-2 HP 0698-6261
Autotransformer	115/230 vac input; 100/200 to 130/260 vac output	Superior Electric #216 Powerstat (115V) General Radio Type W20 HMT3A Variac (230V)
Electronic RMS Voltmeter	0.001 vrms to 30 vrms full scale; ±1% of full scale; 10 Hz to 1 MHz.	Hewlett-Packard Model 3400A or 400F; Voltmeter, Electronic ME-207U or ME-114/FQQ
Frequency Counter	6 Place; frequency and 1, 10, 100-period - average time interval measurements; 1 μsec timing units ±0.001% accuracy; 1 volt input sensitivity.	Hewlett-Packard Models 5233L or 5245L; Electronic Counter CP-798/G or Frequency Meter CP-772U.
Distortion Analyzer	10 Hz to 1 MHz ±1 dB accuracy in distortion measurement; 10 volt input sensitivity.	Hewlett-Packard Model 333A; Indicator Distortion ME-153/U.
Test Leads	Low-capacity coax, terminated in dual-banana plugs.	
Test leads unshielded pair	Terminated in dual-banana plugs.	
Adapter, BNC-to-dual banana		

SECTION 3

PRELIMINARY OPERATIONS

3.1 Verify that all power switches are turned off, then connect all applicable auxiliary equipment to the appropriate power source.

3.2 Adjust the autotransformer for minimum output voltage.

3.3 Connect the Test Instrument power cord to the autotransformer.

3.4 Connect the 600Ω resistor across the red output terminals on the Test Instrument. Unless otherwise specified, the load will be used during calibration. Disconnect the output terminal ground strap.

3.5 Set the Test Instrument controls as follows:

OUTPUT ATTENUATOR	to	10V
AMPLITUDE	to	10
Frequency switches	to	400.0 Hz
Vernier	to	center line

3.6 The 4204A Digital Oscillator is factory calibrated at 115 vac in an ambient temperature of 25°C.

3.7 Turn on power switches for all auziliary equipment and the Test Instrument. Set the autotransformer for 115/230 volts output.

3.8 Verify that each piece of equipment is operating and allow to warm up and stabilize. The required warm-up time for the Test Instrument is five minutes.

SECTION 4

CALIBRATION PROCESS

USE UNSHIELDED LEADS

NOTE: Unless otherwise specified, verify the results of each test and take corrective action (see Appendix B, Table B1) before proceeding.

4.1 OUTPUT LEVEL AND FLATNESS TEST

Complete steps 4.1.4.1 through 4.1.4.4 before taking corrective action. This is to determine if more than one range is out of tolerance.

4.1.4 Set the EVM to the 10 volt range.

4.1.2 Connect the EVM to the Test Instrument output.

4.1.3 Set the Test Instrument controls as follows:

Frequency switches	to	1.000 kHz
OUTPUT ATTENUATOR	to	10 V
AMPLITUDE	for	9.7 volts on EVM

4.1.4 Set the Test Instrument frequency selectors for the following frequencies and record the EVM reading at each frequency. The EVM must read between 9.4 and 10 at each frequency.

4.1.4.1 010.0 Hz and 999.9 Hz

4.1.4.2 1.000 kHz and 9.999 kHz

4.1.4.3 10.00 kHz and 99.99 kHz

4.1.4.4 100.0 kHz and 999.9 kHz

NOTE: If a substitute EVM is used, consider that most EVM's are designed for use above 20 Hz and may read as much as 10% low at 10 Hz.

4.1.5 At the frequency giving the lowest reading in step 4.1.4 turn the AMPLITUDE control maximum clockwise and record the EVM reading; this reading must be between 10.0 vrms and 10.6 vrms.

4.2 METER ACCURACY TEST

4.2.1 Set the EVM to the 10 volt range.

4.2.2 Connect the Test Instrument Output through the unshielded test leads to the EVM.

4.2.3 Set the Test Instrument controls as follows:

Frequency switches	to	010.0 Hz
OUTPUT ATTENUATOR	to	10 V
AMPLITUDE	to	9.8 volts on the Test Instrument Voltmeter

4.2.4 Record the EVM reading; this reading must be between 9.6 and 10.

4.2.5 Set the Test Instrument controls as follows:

Frequency switches	to	1.000 kHz
AMPLITUDE	for	9.8 on the Test Instrument Voltmeter

4.2.6 Record the EVM reading; the EVM reading must be between 9.6 and 10.

4.2.7 Set the Test Instrument controls as follows:

Frequency switches	to	100.0 kHz
AMPLITUDE	for	9.8 on the Test Instrument Voltmeter

4.2.8 Record the EVM reading; the EVM reading must be between 9.6 and 10.

4.2.9 Set the Test Instrument controls as follows:

Frequency switches	to	500.0 kHz
AMPLITUDE	for	9.8 on the Test Instrument Voltmeter

4.2.10 Record the EVM reading; the EVM reading must be between 9.6 and 10.

4.2.11 Set the Test Instrument controls as follows:

Frequency switches	to	999.9 kHz
AMPLITUDE	for	9.8 on the Test Instrument Voltmeter

4.2.12 Record the EVM reading; the EVM reading must be between 9.6 and 10.

4.2.13 Record the maximum difference in readings obtained in steps 4.2.4, 4.2.6, 4.2.8 and 4.2.10; the readings must not differ by more than 0.1v.

4.2.14 Record the difference in readings obtained in steps 4.2.10 and 4.2.12; the readings must not differ by more than 0.2v.

4.2.15 Set the EVM to the 30 volt range.

4.2.16 Disconnect 600Ω load from Test Instrument.

4.2.17 Set the Test Instrument controls as follows:

Frequency switches	to	1.000 kHz
OUTPUT ATTENUATOR	to	30 V
AMPLITUDE	for	20 volts on the EVM

4.2.18 Record the Test Instrument voltmeter reading; the Test Instrument voltmeter must read between 19.4 and 20.6.

4.2.19 Disconnect Test Instrument output terminal ground strap. Connect 600Ω load to output terminals and connect coaxial test leads between output terminals and EVM.

4.2.20 Set the Test Instrument controls as follows:

Frequency switches	to	400.0 Hz
OUTPUT ATTENUATOR	to	+20 dBm
AMPLITUDE	for	0 dBm on the EVM

4.2.21 Set the Test Instrument Output Attenuator and the EVM to the following ranges and record the dbm reading on the EVM for each output level; the EVM must read between -0.5 and +0.5 db at each setting:

+ 10 dBm	-10 dBm	-40 dBm
0 dBm	-20 dBm	-50 dBm
	-30 dBm	-60 dBm

4.2.22 Disconnect the EVM from the Test Instrument.

4.3 DISTORTION TEST

4.3.1 Set the distortion analyzer for measurement of distortion on a 10-volt signal at 10 Hz.

4.3.2 Connect the distortion analyzer input to the Test Instrument output.

4.3.3 Set the Test Instrument controls as follows:

OUTPUT ATTENUATOR	to	10 V
AMPLITUDE	to	10 volts on the Test Instrument Voltmeter

4.3.4 Set the Test Instrument frequency switches for the following frequencies and record the output distortion for each frequency; the distortion analyzer reading must not exceed the percentage given after each frequency setting:

010.0 Hz (1.0%)

030.0 Hz (0.3%)

99.99 kHz (0.3%)

600.0 kHz (1.0%)

4.3.5 Disconnect the distortion analyzer from the Test Instrument.

4.4 FREQUENCY RANGE AND ACCURACY TEST

Complete steps 4.4.4 through 4.4.10 before taking corrective action. This is to determine if more than one range, or more than one digit is out of tolerance.

4.4.1 Connect the frequency counter input to the Test Instrument output.

4.4.2 Set the Test Instrument controls as follows:

OUTPUT ATTENUATOR	to	3V
AMPLITUDE	to	10 on the Output Voltmeter
Vernier	to	center line

4.4.3 Set the counter for frequency measurements with five significant figures for frequencies in step 4.4.4.

4.4.4 Set the Test Instrument frequency switches as follows and record the counter reading for each setting; the counter must read between the figures given after each frequency setting:

100.0 kHz	(99.80 to 100.2 kHz)
999.9 kHz	(998.0 to 1002. kHz)

4.4.5 Set the counter for frequency measurement with five significant figures for frequencies in step 4.4.6.

4.4.6 Set the Test Instrument frequency switches as follows and record the counter reading for each setting; the counter must read between the figures given after each frequency setting:

10.00 kHz	(9.980 to 10.02 kHz)
99.99 kHz	(99.80 to 100.2 kHz)

4.4.7 Set the counter for readings having five significant figures for frequencies in step 4.4.8.

4.4.8 Set the Test Instrument frequency switches as follows and record the counter reading for each setting; the counter must read between the figures given after each frequency setting:

1.100 kHz	(1.098 to 1.102)
2.200 kHz	(2.196 to 2.204)
3.300 kHz	(3.293 to 3.307)
4.400 kHz	(4.391 to 4.409)
5.500 kHz	(5.489 to 5.511)
6.600 kHz	(6.587 to 6.613)
7.700 kHz	(7.685 to 7.715)
8.800 kHz	(8.782 to 8.818)
9.900 kHz	(9.880 to 9.919)
990.0 Hz	(988.0 to 991.9)

4.4.9 Set the counter for period measurement having five significant figures for frequencies in step 4.4.10.

4.4.10 Set the frequency switches as follows and record the period of the output frequency for each setting; the counter must read between the figures given after each frequency setting:

19.9 Hz	(50351 to 50150 μsec)
18.8 Hz	(53304 to 53078 μsec)
17.7 Hz	(56609 to 56384 μsec)
16.6 Hz	(60361 to 60120 μsec)
15.5 Hz	(64645 to 64386 μsec)
14.4 Hz	(69582 to 69305 μsec)
13.3 Hz	(75338 to 75037 μsec)
12.2 Hz	(82130 to 81803 μsec)
11.1 Hz	(90270 to 89909 μsec)
10.0 Hz	(100200 to 99800 μsec)

4.5 FREQUENCY STABILITY TEST

4.5.1 Set the frequency counter for frequency measurement using a 1 second gate time.

4.5.2 Connect the counter input to the Test Instrument Output.

4.5.3 Set the Test Instrument controls as follows:

Frequency switches and Vernier	for	1,000.000 kHz on the counter
OUTPUT ATTENUATOR	to	3V
AMPLITUDE	to	10 on the Output Voltmeter

4.5.4 Adjust the autotransformer output from 115 vac to 105 vac and record the frequency in kHz; the counter must read between 999,900 and 1,000,100.

4.5.5 Adjust the autotransformer output from 105 vac to 125 vac and record the frequency in kHz; the counter must read between 999,900 and 1,000,100.

4.5.6 Disconnect the counter from the Test Instrument.

HEWLETT-PACKARD
CALIBRATION CHECK LIST

TEST INSTRUMENT(S): 4204A OSCILLATOR						
PROCEDURE NUMBER		MFR.		MODEL		SER. NO.
STEP NO.	FUNCTION TESTED	NOMINAL READING	MEASURED VALUES 1ST RUN	MEASURED VALUES 2ND RUN	OUT OF TOL.	CALIBRATION TOLERANCES
	OUTPUT LEVEL FLATNESS	RMS VOLTS				RMS VOLTS
4.1.4.1	at 010.0 Hz	9.7				9.4 to 10.0
	at 999.9 Hz	9.7				9.4 to 10.0
4.1.4.2	at 1.000 kHz	9.7				9.4 to 10.0
	at 9.999 kHz	9.7				9.4 to 10.0
4.1.4.3	at 10.00 kHz	9.7				9.4 to 10.0
	at 99.99 kHz	9.7				9.4 to 10.0
4.1.4.4	at 100.0 kHz	9.7				9.4 to 10.0
	at 999.9 kHz	9.7				9.4 to 10.0
	MAXIMUM OUTPUT LEVEL	RMS VOLTS				RMS VOLTS
4.1.5	AT FREQUENCY GIVING LOWEST OUTPUT LEVEL	10.0				10.0 to 10.6
	OUTPUT METER ACCURACY	RMS VOLTS				RMS VOLTS
4.2.4	at 010.0 Hz	9.8				9.6 to 10.0
4.2.6	at 1.000 kHz	9.8				9.6 to 10.0
4.2.8	at 100.0 kHz	9.8				9.6 to 10.0
4.2.10	at 500.0 kHz	9.8				9.6 to 10.0
4.2.12	at 999.9 kHz	9.8				9.6 to 10.0
4.2.18	at 1.000 kHz	20.0				19.4 to 20.6
	ATTENUATOR ACCURACY	dBm				dBm
4.2.21	at +20 dBm	+20				+19.5 to +20.5
	at +10	+10				+ 9.5 to +10.5
	at 0	0				- 0.5 to + 0.5
	at -10	-10				- 9.5 to -10.5
	at -20	-20				-19.5 to -20.5
	at -30	-30				-29.5 to -30.5
	at -40	-40				-39.5 to -40.5
	at -50	-50				-49.5 to -50.5
	at -60	-60				-59.5 to -60.5
	DISTORTION	PERCENT				PERCENT
4.3.4	at 010.0 Hz	1.0%				1.0% max.
	at 030.0 Hz	0.3%				0.3% max.
	at 99.99 kHz	0.3%				0.3% max.
	at 600.0 kHz	1.0%				1.0% max.

HEWLETT-PACKARD
CALIBRATION CHECK LIST

TEST INSTRUMENT(S): 4204A OSCILLATOR						
PROCEDURE NUMBER		MFR.		MODEL		SER. NO.
STEP NO.	FUNCTION TESTED	NOMINAL READING	MEASURED VALUES 1ST RUN	MEASURED VALUES 2ND RUN	OUT OF TOL.	CALIBRATION TOLERANCES
	FREQUENCY ACCURACY	kHz				kHz
4.4.4	at 100.0 kHz	100.0				99.80 to 100.2
	at 999.9 kHz	999.9				998.0 to 1002.
4.4.6	at 10.00 kHz	10.00				9.980 to 10.02
	at 99.99 kHz	99.99				99.80 to 100.2
4.4.8	at 1.100 kHz	1.100				1.098 to 1.102
	at 2.200 kHz	2.200				2.196 to 2.204
	at 3.300 kHz	3.300				3.293 to 3.307
	at 4.400 kHz	4.400				4.391 to 4.409
	at 5.500 kHz	5.500				5.489 to 5.511
	at 6.600 kHz	6.600				6.587 to 6.613
	at 7.700 kHz	7.700				7.685 to 7.715
	at 8.800 kHz	8.800				8.782 to 8.818
	at 9.900 kHz	9.900				9.880 to 9.919
	at 990.0 Hz	990.0 Hz				999.0 to 991.9 Hz
		μSEC				μSEC
4.4.10	at 019.9 Hz	50251				50351 to 50150
	at 018.8 Hz	53191				53304 to 53078
	at 017.7 Hz	56497				56609 to 56384
	at 016.6 Hz	60241				60361 to 60120
	at 015.5 Hz	64516				64645 to 64386
	at 014.4 Hz	69444				69582 to 69305
	at 013.3 Hz	75188				75338 to 75037
	at 012.2 Hz	81967				82130 to 81803
	at 011.1 Hz	90090				90270 to 89909
	at 010.0 Hz	100000				100200 to 99800
	FREQUENCY STABILITY	Hz				Hz
4.5.4	at 105V/210V	1000000				999900 to 1000100
4.5.5	at 125V/150V	1000000				999900 to 1000100

APPENDIX A TO CALIBRATION PROCEDURE

SECTION A1

INTRODUCTION AND DESCRIPTION

A1.1 This procedure describes a Residual Noise Test and a 999.9 kHz Distortion Test for the HP Model 4204A Oscillator. These tests supplement the Calibration Procedure and require two additional pieces of test equipment. These tests are not intended for routine calibration but for proving the 4204A specifications for residual noise level and distortion at the oscillator output.

SECTION A2

ADDITIONAL EQUIPMENT REQUIREMENTS

ITEM	MINIMUM USE SPECIFICATIONS	SUGGESTED MFR. & MODEL
Oscilloscope	10 MHz Bandwidth 0.005 V/cm sens. 1 μsec/cm sweep	Hewlett-Packard Model 180A or AN/USM-141A
Wave Analyzer	10 MHz Bandwidth	Hewlett-Packard Model 312A

SECTION A3

PRELIMINARY OPERATIONS

A3.1 Perform the preliminary operations in the Calibration Procedure.

A3.2 If the Residual Noise Test is to be performed, remove the 4204A top cover (remove two retaining screws; cover slides off to the rear). Place a clip-on short circuit from the white-yellow lead on the rear of the frequency selector switches to chassis.

SECTION A4

CALIBRATION PROCEDURE

A4.1 RESIDUAL NOISE TEST

A4.1.1 Set Oscilloscope for 0.005 v/cm sensitivity and 5 millisecond/cm sweep and connect to the test instrument output.

A4.1.2 Set the Test Instrument controls as follows; the p-p voltage displayed on the oscilloscope must not exceed 14 millivolts p-p.

Frequency switches	to	000.0 Hz
OUTPUT ATTENUATOR	to	10V
AMPLITUDE	to	Max cw position

A4.1.3 Disconnect oscilloscope from test instrument, remove shorting jumper and replace top cover.

A4.2 DISTORTION TEST

A4.2.1 Remove 600Ω load from Test Instrument OUTPUT Terminals.

A4.2.2 Tune the Wave Analyzer to 1 MHz; set to provide 600Ω load and connect it to the Test Instrument output.

A4.2.3 Set the Test Instrument controls as follows:

Frequency switches	to	999.9 kHz
OUTPUT ATTENUATOR	to	10V
AMPLITUDE	for	10V on Wave Analyzer when tuned to Test Instrument Output Frequency

A4.2.4 Tune Wave Analyzer to 2nd, 3rd and 4th harmonics and note reading in volts for each harmonic.

A4.2.5 Add the squares of the voltage readings and find the square root of the sum. The √sum must not exceed 0.1 volt rms (i.e., at least 40 db below level of fundamental).

A4.2.6 Disconnect Wave Analyzer from Test Instrument.

APPENDIX B TO CALIBRATION PROCEDURE

SECTION B1

INTRODUCTION AND DESCRIPTION

B1.1 This appendix to the calibration procedure lists circuit adjustments on the Test Instrument chassis that may be used to correct inaccuracies in meter calibration, distortion and frequency calibration. It also lists trouble-shooting instructions for each discrepancy found in the calibration procedure.

SECTION B2

EQUIPMENT REQUIREMENTS

B2.1 Equipment required for tests in table B1 is listed in Sections 2 and A2.

SECTION B3

ADJUSTMENTS AND GUIDE TO TROUBLE SHOOTING

Reference	Test	Adjustment or T.S. Reference
4.1.4	Output Flatness	Refer to sheet 5.2A
4.1.5	Maximum Output Level	Overall T.S. Tree
	Meter Accuracy	
4.2.6	10V Range 1.0 KHz	Adjust A3R15
4.2.8	10V Range 100 KHz	Adjust A3R15
4.2.12	10V Range 999 KHz	Adjust A3C7
4.2.18	30V Range 1.0 KHz	Adjust A3R26
4.2.21	Output Attenuation Accuracy	Refer to sheet 6
4.3.4	Distortion	Adjust A2R20; see sheets 4, 6
4.4	Frequency Accuracy	Refer to sheet 5
4.5	Frequency Stability Test	Overall T.S. Tree