INSTRUCTIONS

NOISE AND DISTORTION ANALYZER

HEWLETT hp PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

395 PAGE MILL ROAD • PALO ALTO • CALIFORNIA

600~ — 660 Osc. calibration

SERVICE: NEELY ENTERPRISES
501 LAUREL ST.
SAN CARLOS
LY 1-2626

INSTRUCTIONS FOR MODEL 325B DISTORTION ANALYZER

DESCRIPTION

The Model 325B is designed primarily for making distortion measurements at certain fixed frequencies although provision is made for a limited adjustment of the individual filter frequencies. However, the circuits have been so arranged that the instrument may also be used as a high impedance vacuum tube voltmeter for general audio or intermediate frequency measurements or for making low level noise and hum measurements. It consists of the following units: a high impedance input amplifier with a fixed gain of 20 db, a filter unit consisting of nine bridge "T" networks selected by a rotary switch so that the fundamental of any of nine fixed frequencies may be eliminated, a high impedance multirange vacuum tube voltmeter, a power supply, and a voltage regulator.

In distortion measurements the input is to the amplifier through the filters and thence to the voltmeter. For noise or hum measurements the filters are switched out of the circuit and for straight voltage measurements only the voltmeter is used, a separate set of terminals being provided for this use. Another set of terminals is also provided for connecting an oscilloscope across the output of the voltmeter in order that the wave shape of the measured voltage may be observed. Input impedance of the amplifier is 200000 ohms shunted by approximately 24 mmfd capacity. Input impedance of the voltmeter is not less than 1 megohm shunted by approximately 32 mmfd capacity. Frequency responses of the voltmeter is flat from 10 cps to 100kc. The frequency response of the input amplifier is flat from 20 cps to 100kc.

OPERATION

Initial Adjustments: This instrument has been thoroughly tested before being shipped and should be ready for operation when it is received. The zero reading of the meter may change slightly with changes in line voltage so that a few minutes should be allowed for the instrument to warm up and then with the meter range switch set to 30, the selector switch to METER, and with no voltage applied to the METER terminals, the zero adjustment should be checked.

Distortion Measurements: The voltage wave to be analyzed is connected to the terminals marked INPUT on the left side of the panel. The selector switch below the meter should be set to NOISE. The meter range switch should be set at plus 20 db. The meter should then be adjusted to read 0 db on the scale either by adjusting the level of the incoming voltage or by varying the input control.

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CAUTION Under no circumstances should this initial setting be at a higher voltage on the meter than 10 volts as the amplifier will overload beyond this point and introduce serious distortion.

The selector switch should now be set to DISTORTION, and the frequency selector switch to the desired frequency. The incoming frequency should now be adjusted for minimum deflection of the meter, adjustment of the meter range switch being made to obtain a suitable reading as the minimum is approached. Further reduction may then be obtained by adjusting the balancing control. When as low a reading as possible has been obtained by making these adjustments the distortion in db below the fundamental may be obtained directly from the db scale on the meter. (The initial setting was + 20 db, so for example, if the meter reads -28 db the distortion will be -48 db). The exact frequency to which the filters are tuned may be varied approximately plus or minus one per cent by means of the control to the right of the balancing control. This control may be used to obtain a minimum instead of varying the frequency, provided the frequency lies somewhere within the range of the control, and thus may be used to obtain the distortion of a source remote from the unit. In using this control it will be found that it and the balancing control are interdependent so that it will be necessary to vary them in such a manner as to obtain an absolute minimum. In either method it is the lowest possible obtainable reading that is the correct one for this represents complete balancing out of the fundamental frequency leaving only the distortion products. Impedance at the input terminals is 200000 ohms shunted by approximately 24 mmfd. If a lower input capacity is desired, it may be reduced to approximately 10 mmfd by removal of the input blocking condenser and using an external condenser in such a manner that it will have little capacity to ground.

Noise Measurements: For noise measurements the terminals marked INPUT are used. The selector switch is set to NOISE. The INPUT control should be set at 100. The voltage sensitivity of the meter is now increased by 20 db so the voltage scale readings must be divided by a factor of 10.

CAUTION No attempt should be made to measure voltages greater than 1 volt under the above conditions as overloading of the amplifier will introduce serious errors. See voltage measurement below for this use.

Frequency response using the input amplifier is flat from 20 cps to 100 kc. (See distortion measurements above for input impedance of amplifier.)

Voltage Measurements: For straight voltage measurements the terminals marked METER are used and the selector switch is set to METER. This connects the meter to these terminals and disconnects

all other circuits. The meter then reads directly as indicated on its scale, taking into account the proper multiplying factor indicated by the meter range switch. The input impedance at the METER terminals is not less than 1 megohm shunted by approximately 32 mmfd. Frequency response is flat from 10 cps to 100 kc.

Use of Oscilloscope: The terminals marked OSCILLOSCOPE are connected to the output of the voltmeter amplifier just ahead of the diode portion of the voltmeter circuit. By connecting an oscilloscope at this point the additional gain of this amplifier may be added to that of the oscilloscope, and the wave shape from the output of the voltmeter may be observed. This connection permits observation of the wave shape of the incoming wave after the fundamental has been eliminated and the presence of second or third harmonics may easily be seen. Excessive hum components present in the wave can also be observed as well as any high frequency components such as might be caused by parasitics.

MAINTENANCE

The Model 325B should require no maintenance other than changing tubes occasionally and removing accumulated dust and dirt. Changing tubes will ordinarily affect the meter calibration by less than 1%.

When either of the 6AC7 tubes in the voltmeter amplifier is changed it should be checked for grid current effect. If either of these tubes draws an undue amount of grid current, it will show by a slow drift of the meter needle as the range switch is changed from a higher to a lower range. This may be corrected by a new tube.

The sensitivity of the meter may be adjusted over a small range by turning the screw driver adjustment immediately in front of the first 6AC7. This adjustment should never be made except to make the meter correspond to a standard meter and then care should be taken to avoid wave form errors as the meter reads the approximate average of the applied voltage wave although calibrated in RMS value of a pure sine wave. A poor tube in the amplifier unit may cause distortion in this section. This can be checked by measuring a wave with a distortion known to be more than 60db below the fundamental. No distortion above the 60 db level should be introduced by the amplifier. If distortions no lower than 50 db are to be measured, a 55 db distortion may be tolerated in the amplifier without introducing a serious error.

HEWLETT-PACKARD COMPANY
PALO ALTO, CALIFORNIA

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INSTRUCTIONS FOR USING MODEL 325B DISTORTION ANALYZER FOR MEASURING THE DISTORTION OF A MODULATED R.F. CARRIER

This bulletin has been written in answer to numerous queries as to whether or not a rectifier system can be built into the Model 325B Distortion Analyzer to measure the distortion of the modulated RF carrier from a radio transmitter. Since it is not practical to do this it will be necessary to build a separate rectifier system according to the following instructions.

The rectifier unit requires the following parts:

1--Rectifier, 6H6, 1 V, or 6X5G or equivalent
1--6.3 Volt fil. transformer
2--50 mmfd. mica condensers
2--50,000 ohm 1 watt carbon resistors
1--250,000 ohm 1 watt carbon resistors
1--R.F. coupling coil (adjusted for desired carrier frequency.)

These parts should be assembled in a suitable metal box and wired as shown in the wiring diagram. Connections between the rectifier unit and the Model 325B should be as short and of as low a capacity as possible.

Coupling to the transmitter may be made in any convenient manner and should be adjusted to give between 1 and 5 volts A.C. to the input of the Model 325B when the carrier is modulated 30%. Care should be taken to see that the Model 325B is located sufficiently far from any strong R.F. fields, to prevent any possibility of sufficient R.F. entering the unit to cause spurious readings. If sufficient R.F. voltage is not available it will be necessary to use a tuned circuit at the input to the rectifier.

If the above instructions are followed carefully the rectifier system should not introduce over 1% distortion at 100% modulation. However, a tuned circuit should not be used unless absolutely necessary as it is possible to change the percentage modulation by side band clipping in the tuned circuit if it is too sharply tuned.

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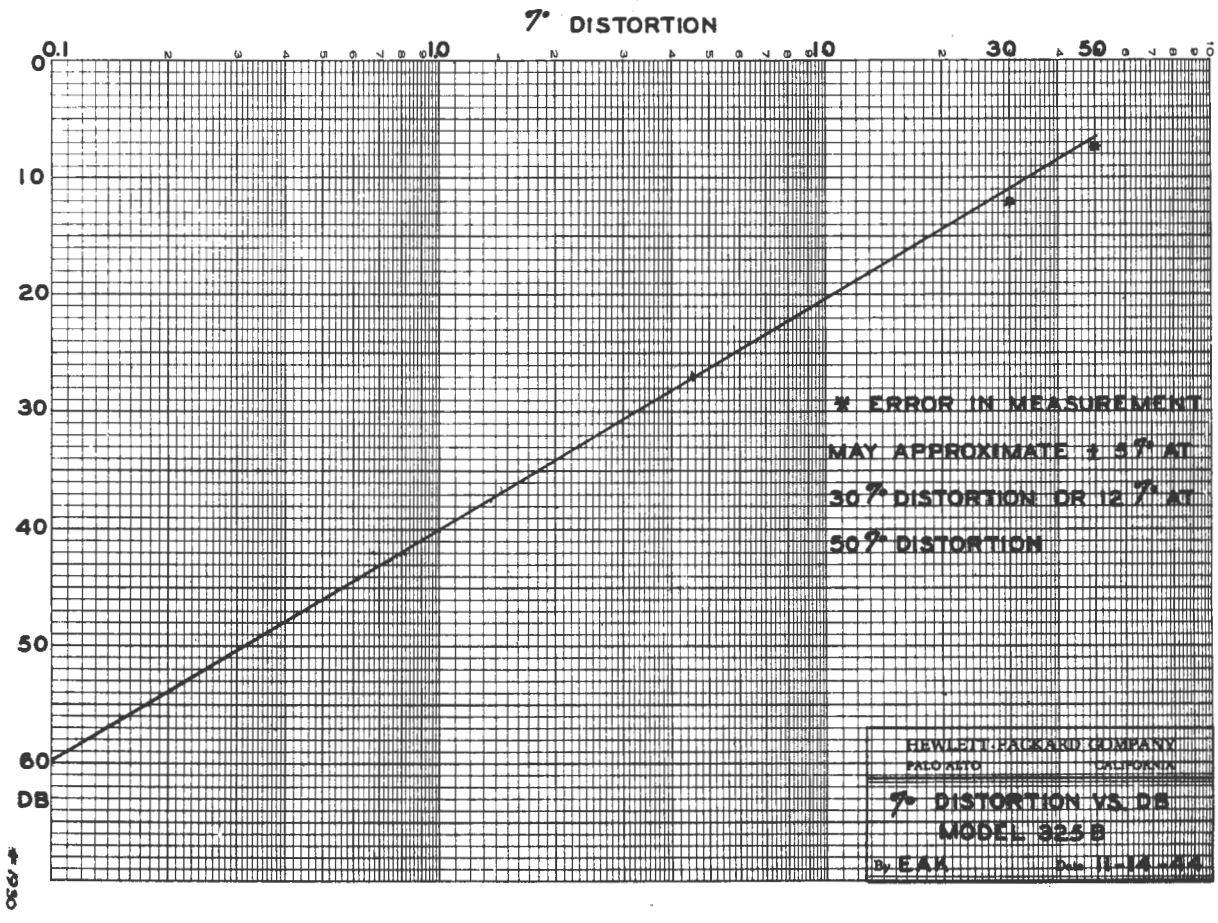

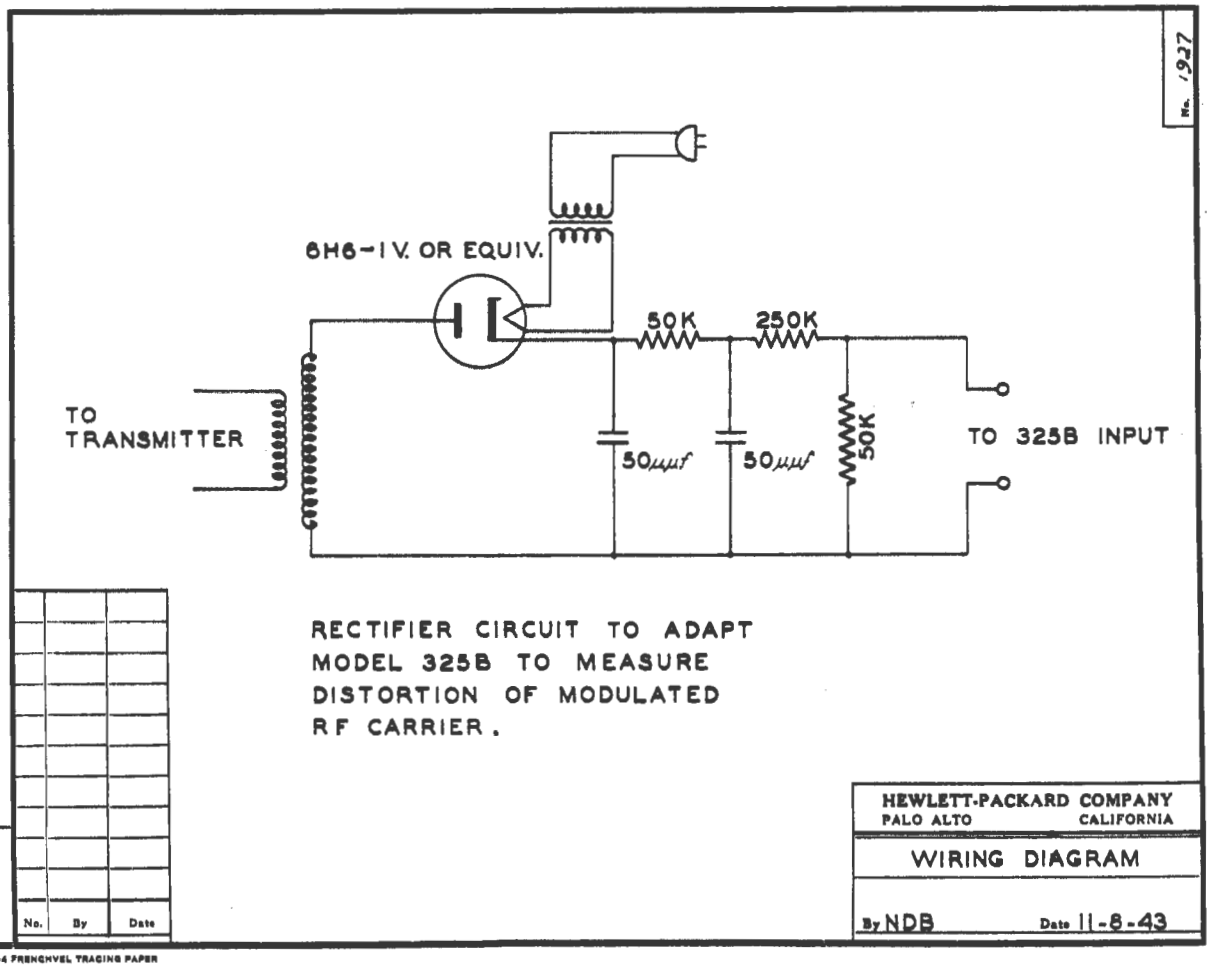

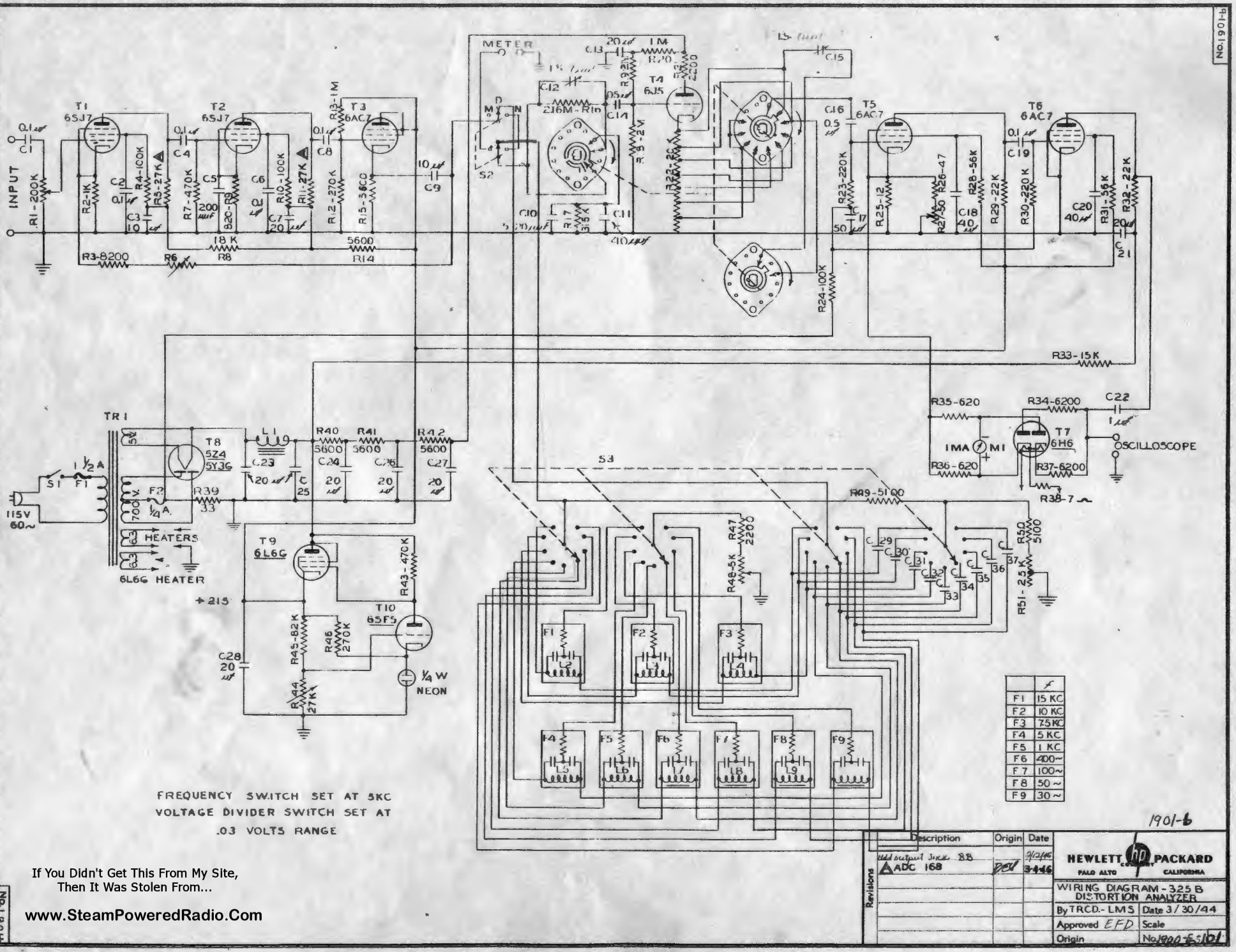

	f
F1	15 KC
F2	10 KC
F3	7.5 KC
F4	5 KC
F5	1 KC
F6	400~
F7	100~
F8	50 ~
F9	30 ~

FREQUENCY SWITCH SET AT 5KC
VOLTAGE DIVIDER SWITCH SET AT
.03 VOLTS RANGE

1901-6

Revisions	Description	Origin	Date
	Add output Jacks J8		2/12/45
	ADC 168	Dev	3-4-46

HEWLETT-PACKARD COMPANY
PALO ALTO CALIFORNIA

WIRING DIAGRAM - 325 B
DISTORTION ANALYZER

By TRCD.- LMS | Date 3/30/44
Approved EFD | Scale
Origin | No. 1900-S101

CIRCUIT CONSTANTS
Model 325-B

R1	200 K	... potentiometer
R2	1 K	1 W composition
R3	8,200 ohms (plus R6)	1 W composition (adjusted at factory)
R4	100 K	1 W composition
R5	27 K	1 W composition
R6	.....	Padding resistor
R7	470 K	1 W composition
R8	18 K	1 W composition
R9	820 ohms	1 W composition
R10	100 K	1 W composition
R11	27 K	1 W composition
R12	270 K	1 W composition
R13	1 megohm	1 W composition
R14	5,600 ohms	1 W composition
R15	5,600 ohms	1 W composition
R16	2.16 megohms	... precision carbon
R17	316 K	... precision carbon
R18	2 megohms	... precision carbon
R19	2 megohms	... precision carbon
R20	1 megohm	1 W composition
R21	2,200 ohms	½ W composition
R22	20 K	(HP)voltage divider
R23	220 K	1 W composition
R24	100 K	1 W composition
R25	12 ohms	(HP)wirewound (adjusted at factory)
R26	50 ohms	½ W composition
R27	50 ohms	... potentiometer
R28	56 K	1 W composition
R29	22 K	2 W composition
R30	220 K	½ W composition
R31	56 K	1 W composition
R32	22 K	2 W composition
R33	15 K	1 W composition
R34	6,200 ohms	1 W composition
R35	620 ohms	1 W composition
R36	620 ohms	1 W composition
R37	6,200 ohms	1 W composition
R38	7 ohms	(HP)wirewound
R39	33 ohms	1 W composition (100 ohms & 50 ohms in parallel)
R40	5,600 ohms	1 W composition
R41	5,600 ohms	1 W composition
R42	5,600 ohms	1 W composition
R43	470 K	1 W composition
R44	27 K	1 W composition
R45	82 K	1 W composition
R46	270 K	(adjusted at factory)
R47	2,200 ohms	1 W composition
R48	5 K	potentiometer
R49	5,100 ohms	1 W composition
R50	5,100 ohms	1 W composition
R51	25 K	... potentiometer

T1	6SJ7
T2	6SJ7
T3	6AC7
T4	6J5
T5	6AC7
T6	6AC7
T7	6H6
T8	5Z4 or 5Y3G
T9	6L6G
T10	6SF5
T11	Neon glow lamp ¼ W

TR1	Power Transformer
L1	Filter choke, 6 henries
M	Meter, 1 M.A.
Fuse 1	1½ amps
Fuse 2	¼ amp

CIRCUIT CONSTANTS
MODEL 325-B

C1	0.1 mfd	600 V, paper
C2	0.1 mfd	600 V, paper
C3	10 mfd	450 V, electrolytic
C4	0.1 mfd	600 V, paper
C5	200 mmfd	..... mica
C6	0.1 mfd	600 V, paper
C7	20 mfd	450 V, electrolytic
C8	0.1 mfd	600 V, paper
C9	10 mfd	450 V, electrolytic
C10	5 - 20 mmfd	..... ceramic trimmer
C11	40 mmfd	..... mica
C12	1.5 - 7 mmfd	..... ceramic trimmer
C13	20 mfd	450 V, electrolytic
C14	.05 mfd	600 V, paper
C15	1.5 - 7 mmfd	..... ceramic trimmer
C16	0.5 mfd	600 V, paper
C17	50 mfd	50 V, electrolytic
C18	40 mfd	450 V, electrolytic
C19	0.1 mfd	600 V, paper
C20	40 mfd	450 V, electrolytic
C21	20 mfd	450 V, electrolytic
C22	1 mfd	600 V, paper
C23	20 mfd	450 V, electrolytic
C24	20 mfd	450 V, electrolytic
C25	20 mfd	450 V, electrolytic
C26	20 mfd	450 V, electrolytic
C27	20 mfd	450 V, electrolytic
C28	20 mfd	450 V, electrolytic
C29) to C37)	.....	adjusted to elimination filter circuit.

F1	15 kc	filter calibrated
F2	10 kc	filter calibrated
F3	7.5 kc	filter calibrated
F4	5 kc	filter calibrated
F5	1 kc	filter calibrated
F6	400 cps	filter calibrated
F7	100 cps	filter calibrated
F8	50 cps	filter calibrated
F9	30 cps	filter calibrated

S1	Power Switch, AC
S2	Noise and Distortion Meter Switch
S3	Frequency Selector Switch, filter section
S4	RMS-db volts Switch, voltmeter section

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof (except tubes, fuses and batteries). This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number, type number and serial number. On receipt of this information, we will give you service instructions or shipping data.

2. On receipt of shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Railway Express. The instruments should be packed in a wooden box and surrounded by two to three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

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LABORATORY INSTRUMENTS OF SPEED AND ACCURACY

Standard -hp- instruments shown here are adaptable for making nearly every electronic measurement in the electronic field. Following is a brief description of a few of these instruments. Complete technical information will be sent—without obligation—on request. In addition, -hp- engineers are at your service to help solve special problems.

VACUUM TUBE VOLTMETER

-hp- Model 400A Vacuum Tube Voltmeter sets a new standard of performance for voltage measurements in the audio, supersonic, and lower radio frequency region. Measurements up to 1 megacycle with this instrument are as simple as measurements with the usual multi-range meter at d-c. Nine ranges give full-scale sensitivities from .030 to 300 volts. Ordinarily no precautions whatsoever are required: turn-over effect and waveform errors are minimized; there are no adjustments to make during operation; a large overload will not damage the instrument. The input impedance is 1 megohm so that most circuits will not be disturbed when their voltage is measured.

H-F VACUUM TUBE VOLTMETER

-hp- 410A High Frequency Vacuum Tube Voltmeter combines in one instrument an ac voltmeter covering frequencies from 20 cps to 700 mc, a dc voltmeter with 100 megohms input impedance, and an ohmeter capable of measuring resistances from .2 ohms to 500 megohms. The special probe places a capacity of 1.3 uufd across the circuit under test. Input resistance for ac measurements is 6 megohms. Six voltage ranges provide full-scale sensitivities from 1 to 300 volts.

WIDE-BAND AMPLIFIER

-hp- 450A Amplifier is a new, versatile, wide-band amplifier designed for general laboratory or production use. It provides exceptional stability at 40 or 20 db gain, and gives new freedom from spurious responses. Low phase shift is assured by a straight-forward, resistance-coupled amplifier design, together with inverse feed back. Frequency response is flat within ½ db between 10 and 1,000,000 cps. Varying tube voltages or aging tubes have no appreciable effect on the gain or other characteristics. When used in conjunction with *-hp-* 400A Vacuum Tube Voltmeter, it increases voltmeter sensitivity 100 times.

AUDIO SIGNAL GENERATORS

-hp- Audio Signal Generators are designed for time-saving performance. They are excellent for general laboratory applications because they supply a known voltage as well as a known frequency at the commonly used impedance levels. They are particularly suitable for gain measurements because no auxiliary apparatus is required. They provide an excellent source of voltage for distortion measurements because their waveform distortion is very small.

RESISTANCE-TUNED AUDIO OSCILLATORS

-hp- Resistance-Tuned Oscillators are suitable for almost every type of work. Their low distortion makes them particularly valuable in making distortion measurements on audio amplifiers, broadcast transmitters and other equipment. They provide an excellent source of voltage for accurate bridge measurements. The output is sufficient to drive signal generators and other equipment requiring considerable power. Their wide frequency range also makes them suitable for work in the supersonic region.

HARMONIC WAVE ANALYZER

-hp- Model 300A Harmonic Wave Analyzer is an excellent instrument for both laboratory and production work where accurate and rapid measurement of individual components of a complex wave is required. The maximum selectivity is sufficient for measurement of harmonics of frequencies as low as 30 cycles and it can be varied over a wide range. With this variable selectivity feature, measurements at higher frequencies can be made more rapidly, yet with no sacrifice in accuracy.

DISTORTION ANALYZER

This Model 330B Distortion Analyzer is *-hp-*'s newest, finest distortion measuring instrument. It is capable of measuring distortion at any frequency between 20 cps and 20,000 cps. It will make noise measurements of voltages as small as 100 microvolts. A linear r-f detector makes it possible to measure these characteristics directly from a modulated r-f carrier. The high sensitivity, stable accuracy and compactness of the 330B make it extremely valuable for broadcast, laboratory and production measurements.

ADDITIONAL INSTRUMENTS ON REVERSE SIDE OF PAGE

LABORATORY INSTRUMENTS OF SPEED AND ACCURACY

SQUARE WAVE GENERATOR

-hp- Model 210 Square Wave Generator provides a new approach to the problem of measuring the characteristics of audio frequency equipment. One or two observations with this generator will check the frequency response of apparatus where heretofore a large number of observations were necessary. It will show up phase shift and transient effects, both of which are rather difficult to study by other methods.

ATTENUATORS AND VOLTAGE DIVIDERS

-hp- Model 350 is a bridged-T attenuator consisting of one 100 db attenuator with 10 db steps and a 10 db attenuator having 1 db steps. Special construction is used to assure high frequency response. Inquiries pertaining to your particular attenuator or voltage divider problems will be given careful attention. The Model 350A operates on a 500-ohm impedance level while the 350B operates at a 600-ohm impedance level.

DISTORTION ANALYZER

-hp- Model 320B Distortion Analyzer is a simple and convenient device for studying and measuring the harmonic distortion in audio frequency apparatus. It measures total harmonic distortion at frequencies of 50 cps, 100 cps, 400 cps, 1 kc, 5 kc, and 7.5 kc. It is excellent for production work because it is easy to operate and provides a rapid and accurate check for normal operation.

BAND SPREAD OSCILLATOR

-hp- Model 200I Band Spread Oscillator is a good example of the newer type of electronic measuring instruments which are built for split-hair accuracy. The main frequency control dial is 6 inches in diameter, calibrated over approximately 300 degrees, and is driven by a smooth friction vernier. A total of more than 750 calibrated points is available to cover the entire frequency range. Each range is provided with an individual frequency adjustment to enable the calibration to be set to a frequency standard such as the *-hp-* Model 100B, where very accurate calibration is required. The frequency range of this instrument is 6 cps to 6000 cps.

Like other *-hp-* oscillators, the Model 200I contains these outstanding advantages: No zero setting required; constant output; wide frequency range; great stability.

POWER SUPPLY UNIT

-hp- Model 710A Power Supply is an excellent source of d-c power for every laboratory and production department use. The power pack is designed for the utmost in flexibility, compactness, portability and economy. Output is continuously variable between 180 and 360 volts. The output voltage varies approximately 1 per cent with changes in load current up to 75 ma and with normal line variations. Noise and hum level is exceptionally low, and output unusually stable over a long period of time. Also contains auxiliary center-tapped 6.3 volt source providing 5 amperes of ac.

SECONDARY FREQUENCY STANDARD

-hp- Model 100 Low Frequency Standard provides a convenient and extremely useful source of four standard frequencies (100 cps, 1 kc, 10 kc, 100 kc) for accurate measurement purposes, for calibrating audio equipment and for various other work where great accuracy is required. It is useful in making accurate interpolation measurements at higher frequencies.

ELECTRONIC FREQUENCY METER

-hp- Model 500A Frequency Meter is designed to measure the frequency of an alternating voltage from 0 to 50 kc. It can be used to measure difference between two h-f signals. It is particularly suited to crystal grinding work where it can be used to measure the frequency deviation from the standard, quickly and accurately.

AUDIO OSCILLATOR

-hp- Model 201B Audio Frequency Oscillator readily meets every requirement for speed, accuracy, and purity of wave form. A large, illuminated, no-parallax tuning dial makes possible accurate frequency selection by use of a direct control tuning knob or an extremely accurate 6-1 ratio vernier control. The dial itself is calibrated over 300 degrees for accurate tuning throughout a range from 20 cps to 20 kc. The 201B's amplifier delivers up to 3 watts of power in a 600-ohm resistance load, with distortion held to 1 per cent or less.

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