HEWLETT hp PACKARD

VHF ATTENUATOR

models
355C
355D

OPERATING NOTE 4 NOV 66

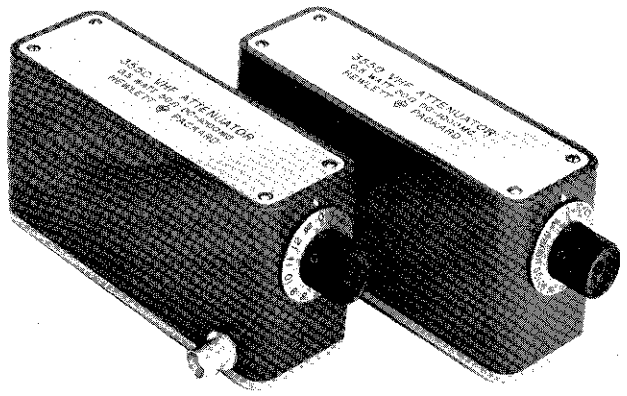

Figure 1. Model 355C and Model 355D VHF Attenuator

SECTION I

GENERAL INFORMATION

1. The Model 355C/D is a direct-reading step attenuator usable from dc to 1000 mc. The Model 355C provides 0- to 12-db attenuation in 1-db steps, and the Model 355D provides 0 to 120 db in 10-db steps. Connected, the Models 355C and D provide a range of attenuation of 0 to 132 db in 1-db steps. SWR, error, and residual attenuation are low at all settings. Input and output connectors are female type BNC. Input and output impedances are 50 ohms, nominal.

2. The unit is compact, rugged, and well-shielded. The design, indicated in Figure 2, has resulted in an accurate and convenient attenuator with excellent electrical characteristics. The drive mechanism, controlled from the front panel, is a single rotary shaft which mounts four cams. The cams drive eight

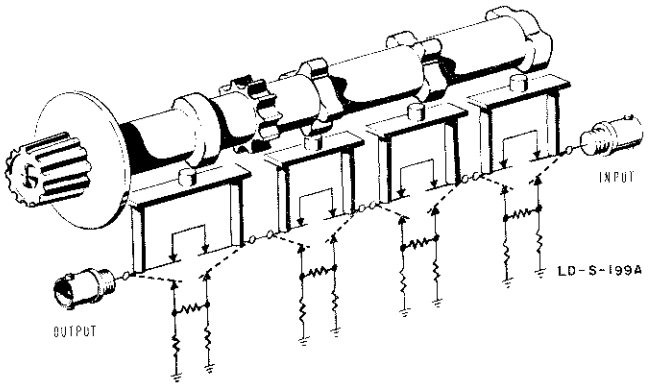

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Figure 2. Arrangement of Model 355C/D Attenuator

Table 1. Specifications

MODEL 355C

Attenuation Range: 0 to 12 dB

Attenuation Steps: 1 dB

Overall Accuracy: 0.1 dB at 1000 cps;
0.25 dB, dc to 500 mc;
0.35 dB, dc to 1000 mc.

MODEL 355D

Attenuation Range: 0 to 120 dB

Attenuation Steps: 10 dB

Overall Accuracy: at 1000 cps; 0 to 120 dB; ±0.3 dB, below 1000 mc; 0 to 90 dB; ±1.5 dB, 90 to 120 dB; ±3 dB.

MODELS 355C and 355D

Frequency Range: dc to 1000 mc

Impedance: 50 ohms (nominal)

Maximum SWR (input and output): 1.2 below 250 mc; 1.3 below 500 mc; 1.5 below 1000 mc,

Maximum Residual Attenuation: Less than 0.25 db to 100 mc; less than 0.75 db to 500 mc; less than 1.5 db to 1000 mc.

Maximum Power Dissipation: 0.5 watt, average

Maximum Pulse Voltage: 350 volts, peak

Connectors: BNC, female

Dimensions: Length: 6 inches (152,4 mm)
Width: 2.8 inches (71,1 mm)
Height: 2.7 inches (68,6 mm)

Weight: Net, 1-1/2 lb (0,67 kg)

Accessories Available:

803A-16E Cable Assembly. Solid shield 50 ohm cable, 15 inches long (381,0 mm) with male BNC connectors.

803A-16D Cable Assembly. RG-55/U cable, 2 feet long, (609,6 mm) with male type N connector on one end, male BNC connector on other end.

00355-90003

1501 Page Mill Road, Palo Alto, California, U.S.A., Cable: "HEWPACK" Tel: (415) 326-7000

Europe: 54 Route Des Acacias, Geneva, Switzerland, Cable: "HEWPACKSA" Tel. (022) 42.81.50

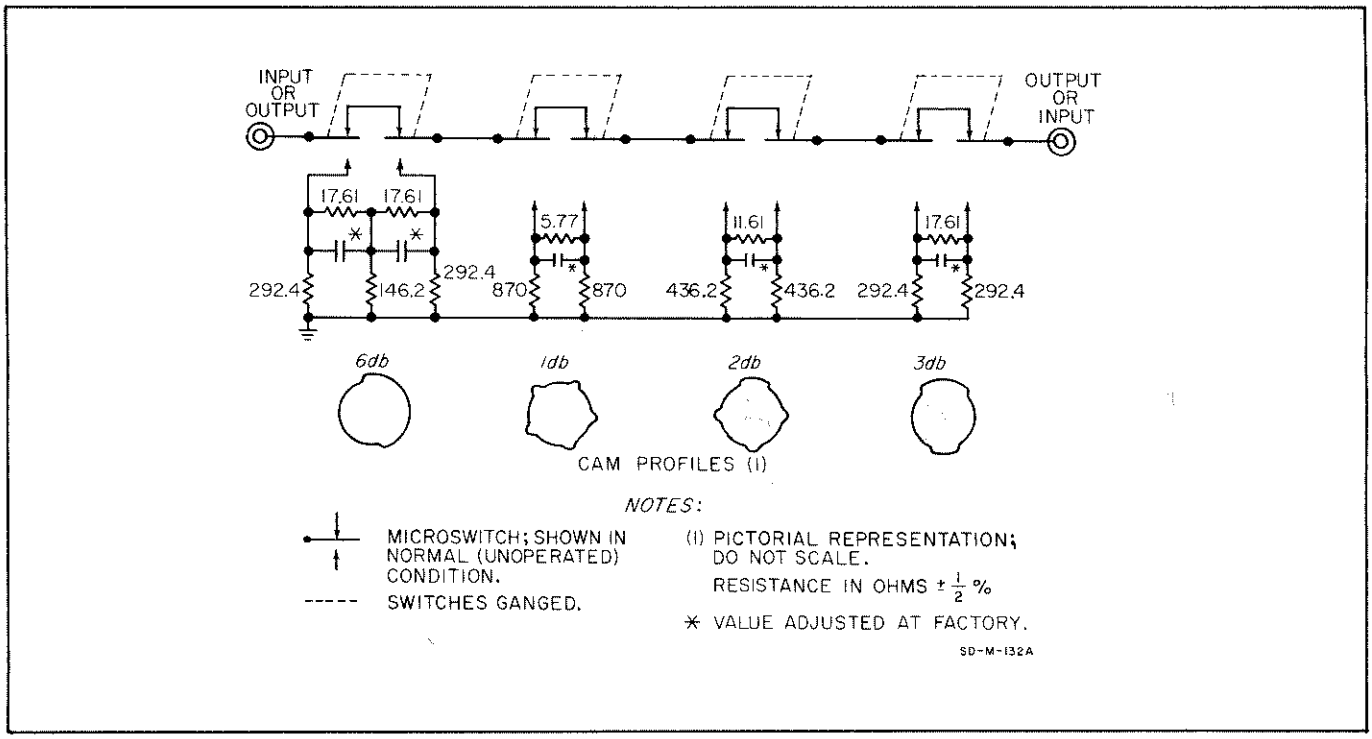


Figure 3. Schematic Diagram and Cam Profiles of Model 355C

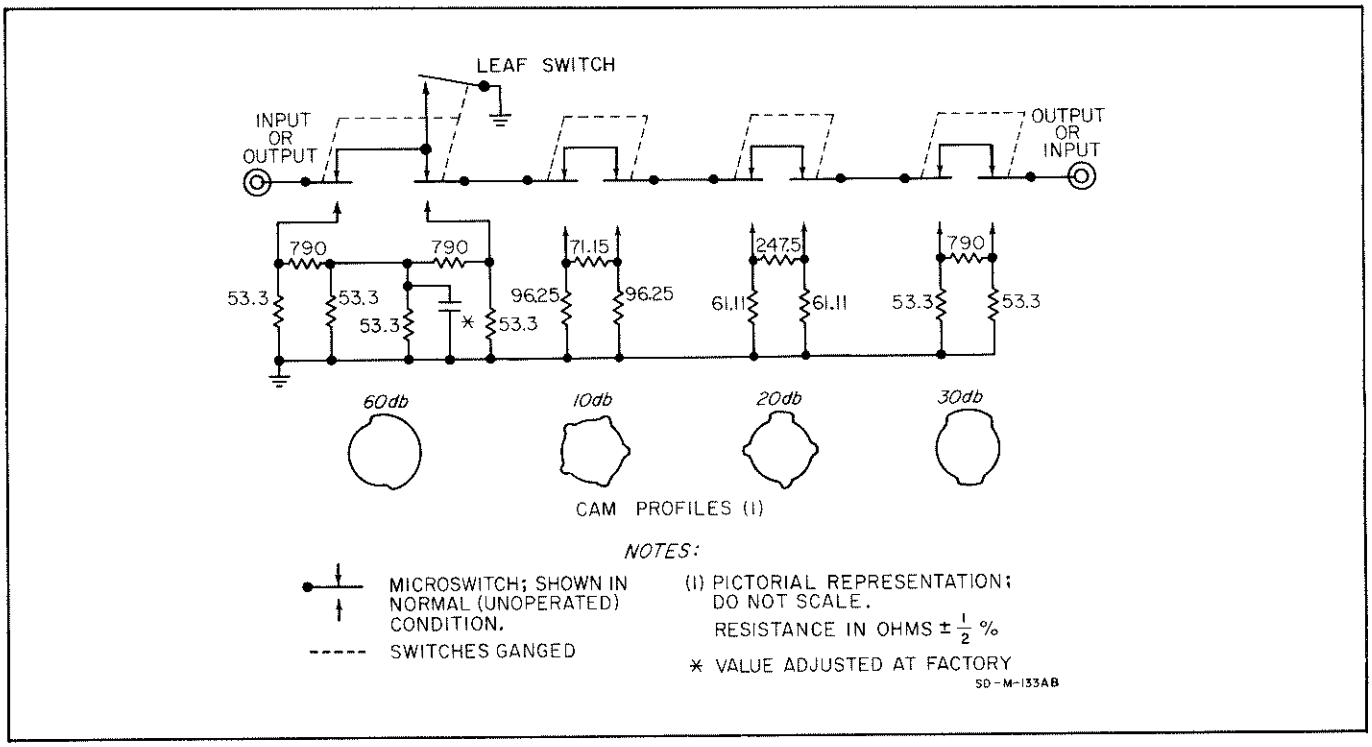


Figure 4. Schematic Diagram and Cam Profiles of Model 355D

microswitches, in pairs. The microswitches set up connections, in the proper sequence to obtain the desired degree of attenuation, to four π-type attenuator pads. The Model 355C has pads of 1, 2, 3, and 6 decibels which allow a range of 0 to 12 db in 1-db steps; the Model 355D has 10-, 20-, 30-, and 60-db pads which allow a range of 0 to 120 db in 10-db steps.

SECTION II

OPERATING INSTRUCTIONS

3. OPERATION.

a. The Model 355C/D is designed to dissipate a maximum average power of 0.5 watt and accommodate pulses up to 350 volts maximum. The attenuator will be damaged if overloaded. (If the Model 355C/D is damaged by overload, see Paragraph 7.)

b. The input may be applied to either connector, and the output taken from the other, except in the case of the 355D driven from a low impedance source. In this one case, the leaf switch (Figure 4) may close before the microswitch opens when the dial is switched from 50 db to 60 db. Should this occur, a momentary short is placed across the connector, inviting damage to either the microswitch or the signal source. If the signal source is capable of delivering more than 10 amperes, use the rear connector for the input. This pads the momentary short with 50 db of isolation.

c. Up to 132 db attenuation in 1-db steps is available by connecting the Model 355C to the Model 355D. The connector location on the 355D is the mirror image of the connector location on the 355C, which permits the two attenuators to be mounted side by side with a short connection between them. A standard UG-491A/U male-to-male BNC adapter or an hp 803A-16E Cable Assembly may be used to connect the two units.

Note

The hp 803A-16E Cable Assembly, a solid (low leakage) coaxial cable, is recommended over flexible coaxial cable.

d. The Model 355C/D may be operated by remote control since it is switched by rotating one shaft.

SECTION III

CIRCUIT

4. The schematic for the Model 355C is shown in Figure 3, and that of the Model 355D in Figure 4.

SECTION IV

MAINTENANCE

5. LUBRICATION.

6. The cam shaft of the Model 355C/D should be lubricated occasionally with a light lubricant such as Lubriplate No. 105V. Lubrication once a year should be sufficient.

7. RESISTANCE MEASUREMENTS.

8. If overload power has been applied and damage to the unit is suspected, make dc resistance measurements as follows. (A Wheatstone bridge or equivalent is necessary for these measurements.)

a. Terminate either connector with 50 ohms ±1%. (The connector thus terminated will be referred to as No. 1, the other as No. 2.)

b. Connect the measuring device to connector No. 2, and measure the dc resistance at each step. Resistance measured should be 50 ohms ±1%.

c. Terminate connector No. 2 with 50 ohms, connect the measuring device to connector No. 1, and again measure the dc resistance at each setting of the dial. Resistance measured should be 50 ohms ±1%.

d. If the reading on any step is not within specified limits, the unit has been damaged.

9. REPAIR.

10. The precision performance of the Model 355C/D is due in part to the fact that the instrument is held to tight electrical and mechanical tolerances during manufacture. To maintain the precision performance of the Model 355C/D it is recommended that it be returned to the factory for repair.

11. PERFORMANCE CHECK.

12. PURPOSE. The procedures of Table 3 check 355C/D performance for incoming inspection, periodic evaluation and calibration. The tests are performed external to the 355C/D. The specifications of Table 1 are the performance standards.

13. TEST EQUIPMENT REQUIRED. The test instruments and accessories required to make the performance checks are listed in Table 2. Test equipment other than the ones listed may be used provided their performance equals the Critical Specifications listed.

CHECK	OPERATION
1	SWR
2	RF Attenuation (355C only)
3	RF Attenuation (355D only)
4	RF Attenuation at 1 Kc
5	Residual Attenuation

Table 2. Test Equipment and Accessories Recommended

Instrument	Critical Specifications	Check	Model or Stock No.
UHF Signal Generator	Frequency Range: 500 to 1000 Mc	1, 2, 3, 5	hp 612A
VHF Signal Generator	Output: 100 Mc	5	hp 608A
Sweep Generator	Frequency Range: 250 to 1000 Mc	1	Jerrold 900A
Oscilloscope	Vertical Deflection: 1 mv/cm Horizontal Deflection: 1 v/cm	1	hp 130C
SWR Meter	Bolometer bias provided ±0.1 db accuracy	2, 3, 4, 5	hp 415D
Oscillator	Frequency: 1 Kc Output Balance: 1%	3, 4	hp 200CD
Microwave Amplifier	Frequency Range: 800 to 1000 Mc Power: 1 watt out for 1 mw in at 800 Mc	3	hp 489A
Leveler Amplifier	Leveled Power Constant: ±.05 db	3	hp H01-8401A
Power Meter	Measurement Capabilities: -5 mw Accepts Coaxial Mount	3	hp 431B
VTVM	Measure: 5 volts RMS	4	hp 400D
Dual Directional Coupler	Range: 250 to 1000 Mc Directivity: 35 db min	1	Narda 3020
Dual Directional Coupler	Range: 450 to 940 Mc (Adequate for detection at 1000 Mc)	3	hp 765D or hp 775D
Bolometer Mount	Input Impedance: 50 ohms Max SWR: 1.25	2, 3, 5	hp 476A
Low Pass Filter	Cut-off Frequency: 1200 Mc Residual Attenuation: Less than 3 db	1, 2, 3, 5	hp 360B
Coaxial Thermistor Mount	Frequency Range: 800 to 1000 Mc SWR: Less than 1.3	3	hp 478A
Coaxial Termination (2 needed)	Input Impedance: 50 ohms SWR: 1.05	1, 3	hp 908A
VHF Attenuator (2 needed)	Calibrated in 10-db steps SWR: 1.5	1, 2, 4, 5 (one only for check No. 1)	hp 355C
VHF Attenuator	Calibrated in 10-db steps SWR:1.5	1, 3	hp 355D
Output Transformer	Impedance Match: 600 ohms to 50 ohms	4	hp 9120-0021

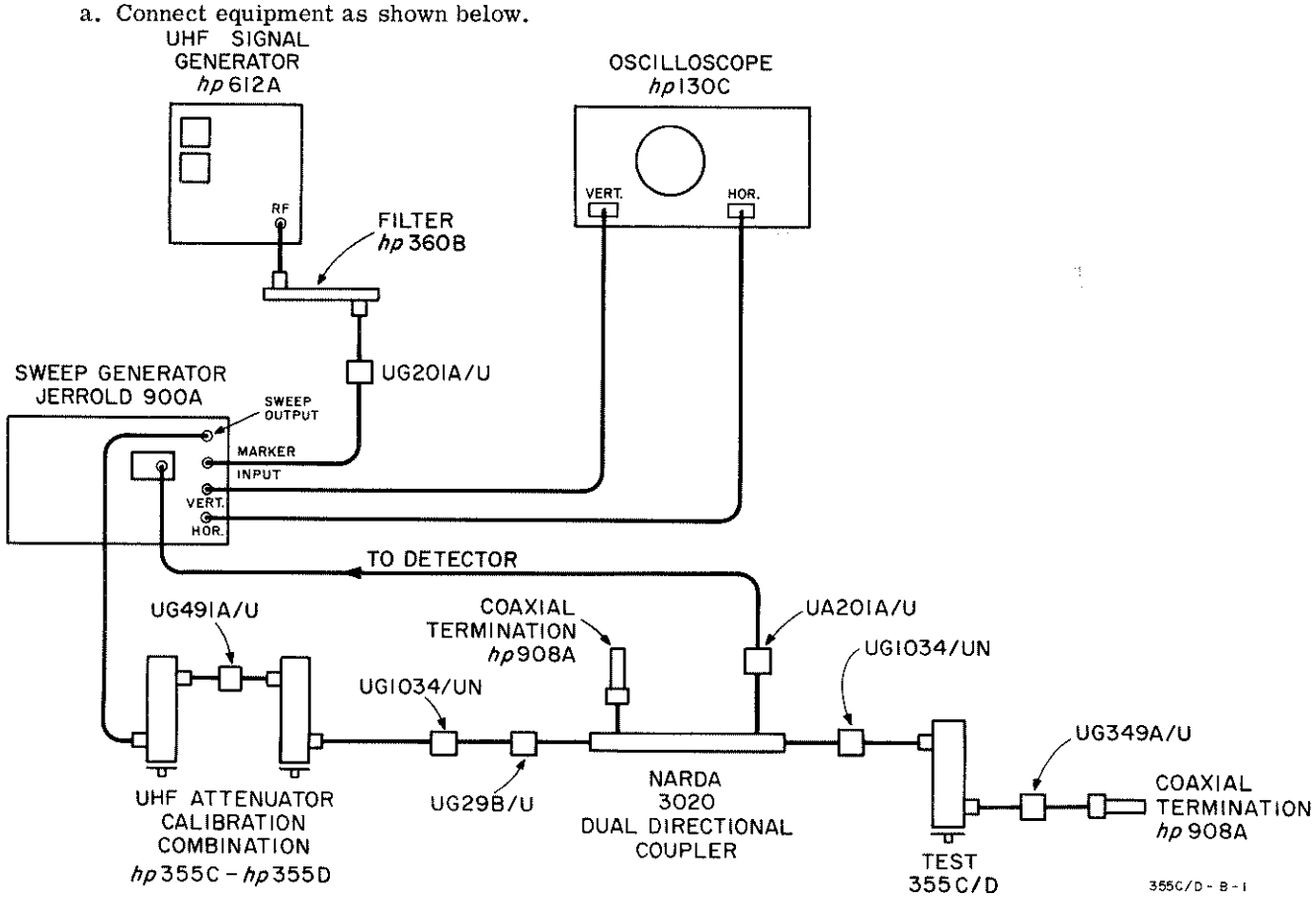
Accessories

No. Required	Description	Type No. or hp Stock No.
2	Adapter - male BNC to male BNC	UG-491A/U
2	Adapter - male N to male BNC	UG-1034/UN
1	Adapter - female N to female N	UG-29B/U
1	Adapter - female N to male BNC	UG-349A/U
2	Adapter - male N to female BNC	UG-201A/U
1	Adapter - male BNC to dual banana post	hp 10110A
1	Resistor	(66.7 ohms) hp 0730-0003

Table 3. Performance Test Procedure

1. SWR (Swept Frequency Method) 1.2 below 250 Mc; 1.3 below 500 Mc; 1.5 below 1000 Mc.

a. Connect equipment as shown below.



b. Begin procedure by selecting the following settings on designated equipment:

Instrument	Control	Setting
Jerrold 900A	BANDWIDTH	1/4 turn (approx) from full cw
	BLANKING	OFF
	MARK GAIN	1/4 turn (approx) from full cw
	UHF-VHF	UHF
	FREQUENCY	800MC
	PHASE REVERSE	Switch to left side (facing rear panel)
Oscilloscope hp 130C	VERTICAL SENS	1 mv/cm
	HORIZ SENS	1 v/cm
	AC-DC Inputs	DC
UHF Signal Generator hp 612A	SELECTOR	cw
	FREQUENCY	1000MC
	ATTENUATION	-15DBM

c. Set 355C to 8DB and 355D to 10DB. This combination equals 18 db, or the return loss equivalent of a 1.5 SWR.

Table 3. Performance Test Procedure (cont'd)

1. SWR (Swept Frequency Method) (cont'd)

d. Adjust Jerrold HOR PHASE so that the two traces displayed superimpose as one, and turn BLANKING ON. Adjust Jerrold FREQUENCY until the 1000 Mc marker from the UHF Signal Generator appears at edge of oscilloscope trace.

e. Reset UHF Signal Generator to 600 Mc and look for a marker at opposite edge of oscilloscope trace. Adjust Jerrold BANDWIDTH as necessary to bring marker into view. Recheck marker at 1000 Mc. When markers are established note exact position of Jerrold frequency dial. Do not readjust Jerrold BANDWIDTH.

f. Adjust Jerrold ALC for about 4 cm vertical deflection on oscilloscope. Short circuit the output of the coupler; then grease pencil base line and average of short circuit and open circuit on oscilloscope face. This average line is the 1.5 SWR test limit. Note: The baseline is used as a reference to reposition trace should drift occur.

g. Set Jerrold FREQUENCY to about 410 Mc. (Sweep range will be about 500 to 250 Mc.) Set 355C to 5DB, and 355D to 20DB. This combination equals 25 db, or the return loss equivalent of a 1.3 SWR. Grease pencil average of open and short circuit traces on oscilloscope face. This average line is the 1.3 SWR test limit.

h. Set Jerrold FREQUENCY to about 325 Mc. (Sweep range will be about 385 to 250 Mc.) Set 355C to 7DB and leave 355D set to 20DB. This combination equals 27 db, or the return loss equivalent of a 1.2 SWR. Grease pencil the average of open and short circuit traces on oscilloscope face. This average line is the 1.2 SWR test limit. Return 355C and 355D CALIBRATION COMBINATION to 0DB.

i. Terminate the 355C/D under test with a 50-ohm Coaxial Termination, and connect as shown. Return Jerrold FREQUENCY to the first position (1000 Mc to 600 Mc) which corresponds to a SWR of 1.5.

j. Rotate the knob of the VHF Attenuator under test throughout its entire range while observing oscilloscope.

TEST LIMIT: The SWR of the unit under test should not exceed 1.5

k. Reverse VHF Attenuator, end for end, and repeat step j.

m. Set Jerrold FREQUENCY to 410MC and repeat steps j and k.

TEST LIMIT: The SWR of the unit under test should not exceed 1.3

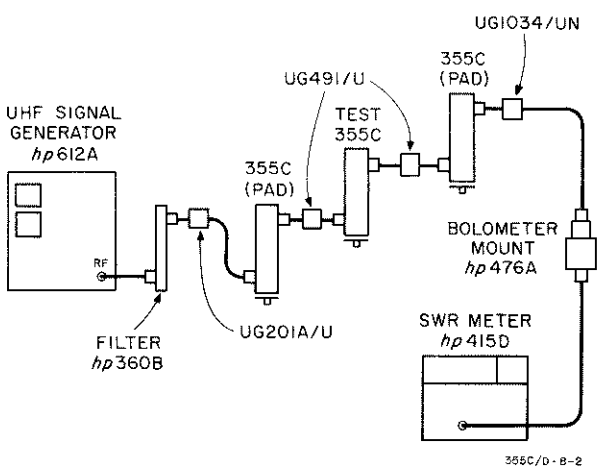
n. Set Jerrold FREQUENCY to 325 MC and repeat steps j and k.

TEST LIMIT: The SWR of the unit under test should not exceed 1.2

2. RF ATTENUATION (355C only) Less than ±.35 db at 1000 Mc; less than ±.25 db at 500 Mc.

PROCEDURE Note: Attenuation, by definition, is a negative quantity. A SWR Meter attenuation reading greater than indicated on 355C is therefore a negative error.

a. Connect equipment as shown below.



b. Set both 355Cs in setup to 6DB.

c. 1000 cps modulate the UHF Signal Generator at at 1000 Mc with maximum output. Set test unit to 0DB, and adjust SWR Meter for a 0.0DB meter reference on 0.0 EXPAND, 40DB RANGE, HIGH BOLO.

d. Set test unit to 1DB and note SWR Meter reading.

e. Increase test unit attenuation to 2 db and note SWR Meter reading.

f. Switch SWR Meter EXPAND to 2.5DB and the test unit to 3DB. Note reading.

g. Continue checking test unit to 12 db, switching the SWR Meter EXPAND switch in turn to 5.0, 7.5, and 0.0, 50DB RANGE.

h. Set UHF Signal Generator to 500 Mc and repeat above procedure.

Table 3. Performance Test Procedure (cont'd)

2. RF ATTENUATION (355C only) Less than ±.35 db at 1000 Mc; less than ±.25 db at 500 Mc. (cont'd)

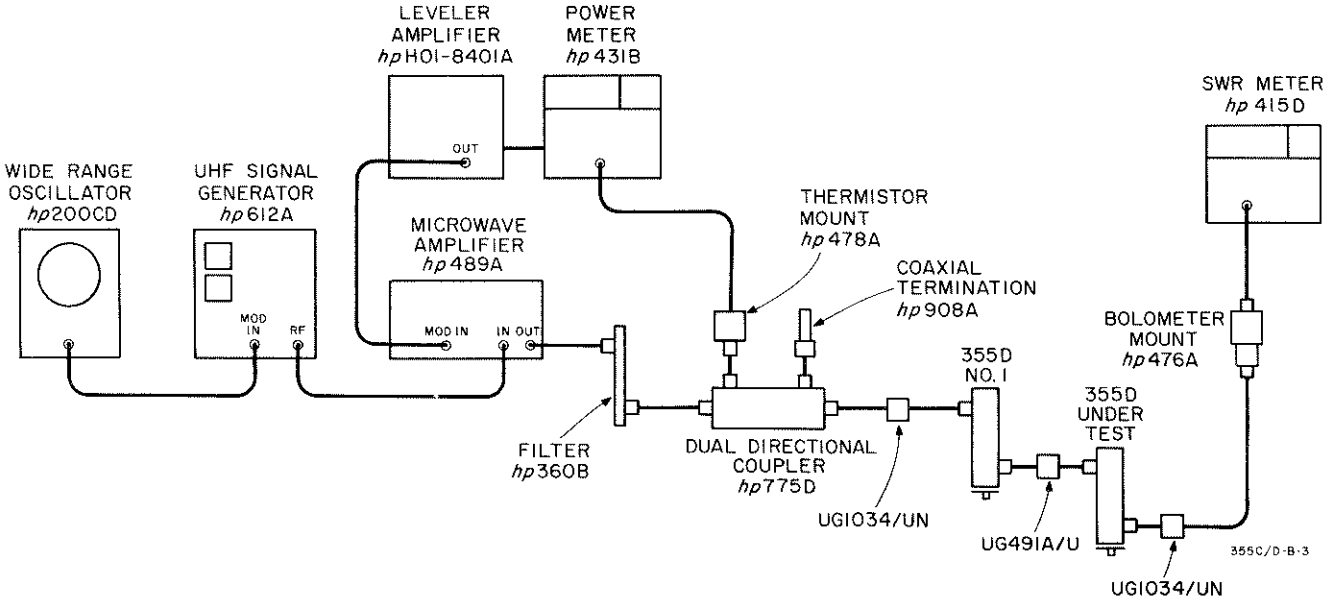
TEST RESULTS

DB	Error at 1000MC (DB)	Error at 500MC (DB)
1	-.35 _____ +.35	-.25 _____ +.25
2	-.35 _____ +.35	-.25 _____ +.25
3	-.35 _____ +.35	-.25 _____ +.25
4	-.35 _____ +.35	-.25 _____ +.25
5	-.35 _____ +.35	-.25 _____ +.25
6	-.35 _____ +.35	-.25 _____ +.25
7	-.35 _____ +.35	-.25 _____ +.25
8	-.35 _____ +.35	-.25 _____ +.25
9	-.35 _____ +.35	-.25 _____ +.25
10	-.35 _____ +.35	-.25 _____ +.25

3. RF ATTENUATION (355D only)
±1.5 db at 1000 Mc and 800 Mc from 10 to 90 db inclusive
±3.0 db at 1000 Mc and 800 Mc from 100 to 120 db inclusive

PROCEDURE

a. Set UHF Signal Generator on desired frequency. Set the Microwave Amplifier GAIN full ccw to avoid bolometer damage, and connect equipment as shown below.



b. Monitor power. With both 355Ds set to at least 40 db set power level to indicate a +5DBM reading on the Power Meter.

c. Observe leveling action by switching 355D #1 from 40 to 0 db. The Power Meter reading should remain constant.

d. Return 355D #1 setting to 40DB and set test unit to 0DB. Measure attenuation accuracy as follows:

Table 3. Performance Test Procedure (cont'd)

3. RF ATTENUATION (355C only) (cont'd)

TEST UNIT (DB)	355D #1 (DB)	SWR METER	MEASUREMENT	ERROR (DB)
0	40	30	Set 3.0DB Reference	
10	40	40	Read error from 3.0 ref	-1.5 _____ +1.5
20	40	50	Read error on SWR Meter	-1.5 _____ +1.5
20	20	30	Adjust SWR Meter GAIN to exactly the same reading as previous measurement	
30	20	40	Read error on SWR Meter	-1.5 _____ +1.5
40	20	50	Read error on SWR Meter	-1.5 _____ +1.5
40	0	30	Adjust GAIN to same previous reading	
50	0	40	Read error on SWR Meter	-1.5 _____ +1.5
60	0	50	Read error on SWR Meter	-1.5 _____ +1.5

TEST LIMITS: 10 to 60DB ±1.5DB

e. The attenuation errors from 70 db to 120 db are calculated by combining the errors of previous readings, as follows:

TEST UNIT (DB)	CALCULATION	ERROR (DB)
70	Add 60DB and 10DB errors	-1.5 _____ +1.5
80	Add 60DB and 20DB errors	-1.5 _____ +1.5
90	Add 60DB and 30DB errors	-3.0 _____ +3.0
100	Add 60DB, 30DB, and 10DB errors	-3.0 _____ +3.0
110	Add 60DB, 30DB, and 20DB errors	-3.0 _____ +3.0
120	Add 60DB, 50DB, and 10DB errors	-3.0 _____ +3.0

4. RF ATTENUATION at 1 KC - Maximum attenuation error
355C: ±0.1 db
355D: ±0.3 db

PROCEDURE

a. Connect 355C equipment as shown on Page 9. Set 355C pads to 6DB each.

b. Adjust Wide Range Oscillator AMPLITUDE for 5 volts on VTVM. Do not exceed this voltage. Adjust Wide Range Oscillator frequency for a maximum SWR Meter reading, 10DB, 0.0 EXPAND RANGE, 200 ohm XTAL INPUT.

c. Set 355C to 0DB and adjust SWR Meter GAIN for 0.0 meter reading. Switch 355C to 1DB. The SWR Meter reading should drop .5DB. Continue checking the 355C attenuator to 120dB, switching the SWR Meter EXPAND switch as necessary to 2.5 and 5.0.

TEST LIMITS: Attenuation indicated by the SWR Meter shall be one-half of the 355C dial reading at each step ±.05 db.

d. The initial procedure is the same for the 355D except that the Wide Range Oscillator FREQUENCY is adjusted for a maximum SWR Meter reading on the 0DB RANGE.

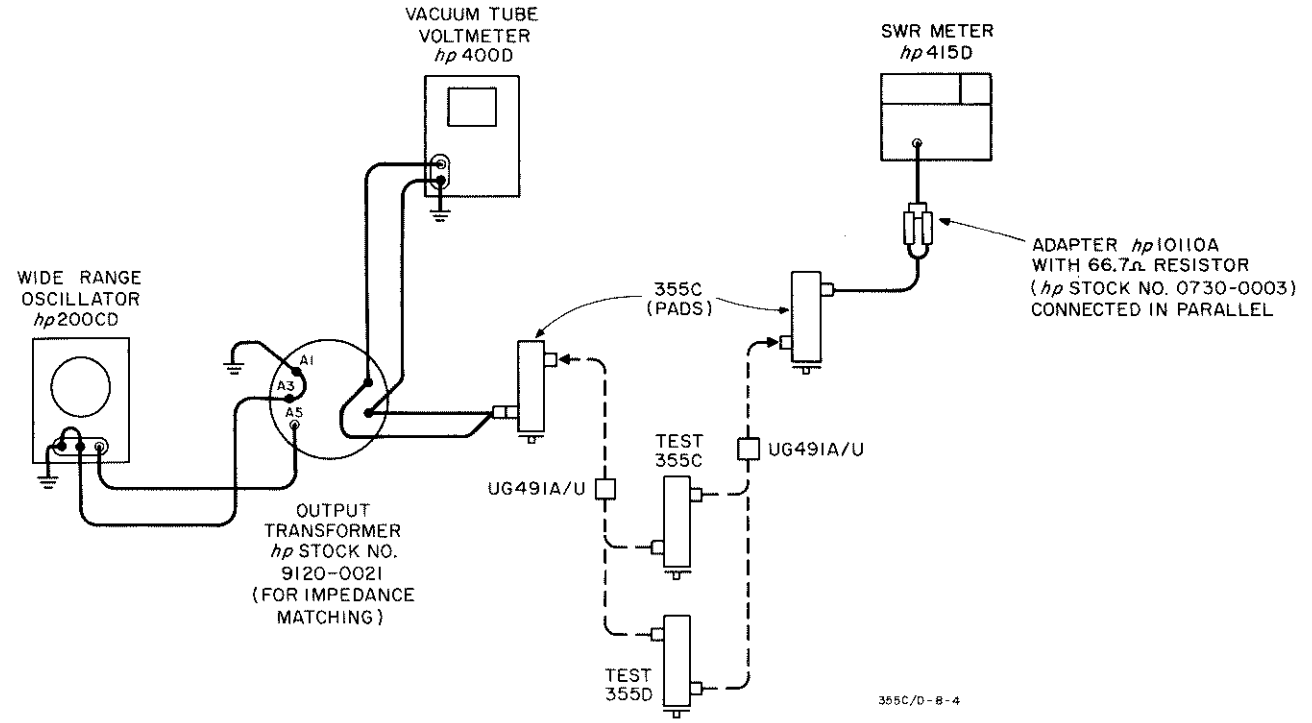
e. Set 355D to 0DB and adjust SWR Meter GAIN for a 1.0DB meter reference. Switch 355D to 10DB, set SWR Meter EXPAND switch to 5.0DB, and read error from 1.0DB reference.

f. Continue checking 355D attenuator to 120DB, switching SWR Meter RANGE and EXPAND as necessary.

TEST LIMITS: Attenuation indicated by the SWR Meter shall be one-half of the 355D dial reading at each step ±.15 db.

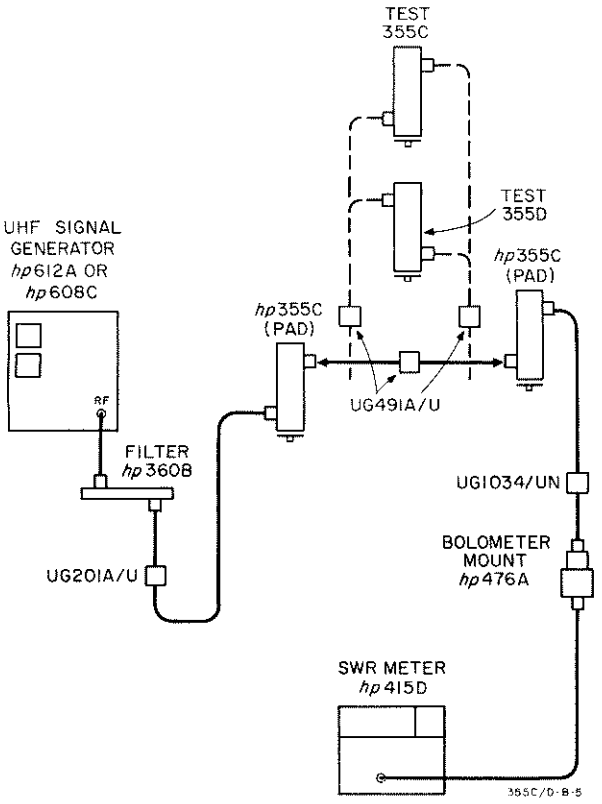
Table 3. Performance Test Procedure (cont'd)

4. RF ATTENUATION at 1 KC (cont'd)



5. RF RESIDUAL ATTENUATION

Maximum residual attenuation 355C/D: Less than 0.25 db to 100 Mc; less than 0.75 db to 500 Mc; less than 1.5 db to 1000 Mc.



a. Connect equipment as shown at left.

b. Set 355Cs #1 and #2 to 6DB each and connect together with UG-491/U adapter.

c. 1000 cps modulate the UHF Signal Generator at 1000 Mc, with maximum output. Adjust SWR Meter GAIN for a 0.0DB meter reference, 0.0 EXPAND, 40DB RANGE.

d. Insert the 355C/D in place of the adapter; set it to 0DB, and measure residual attenuation.

TEST LIMIT: Less than 1.5DB

e. Repeat test at 500Mc.

TEST LIMIT: Less than 0.75DB

f. Substitute 608C VHF Signal Generator for 612A UHF Signal Generator and repeat test at 100Mc.

TEST LIMIT: Less than 0.25DB