

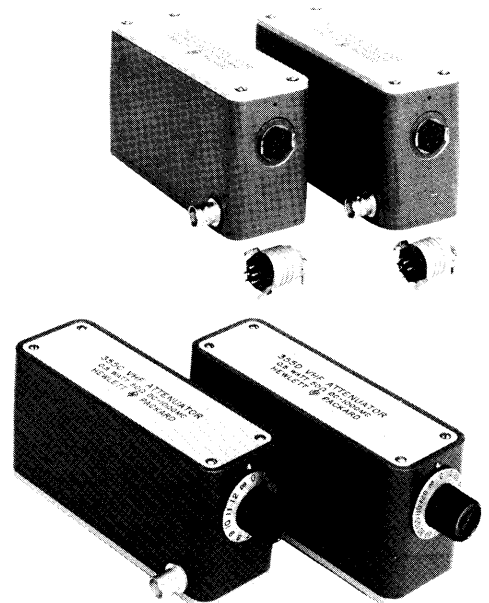
VHF ATTENUATORS

355C

355D

355E

355F



NOVEMBER 1972

HEWLETT  PACKARD

GENERAL INFORMATION

The Model 355C/D/E/F is a direct-reading step attenuator usable from dc to 1000 MHz. The Model 355C/E provides 0 to 12 dB attenuation in 1 dB steps, and the Model 355D/F provides 0 to 120 dB in 10 dB steps. Connected, the Models 355C/E and D/F 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.

Specification 355E/F (Figure 2) is a standard HP Model 355C/D in which the standard shaft with cams which normally activate the microswitches has been replaced by four solenoids to allow remote programmable operation. The solenoids operate the microswitches to proper combinations to obtain the desired degree of attenuation. The solenoids are push type, continuous duty and each solenoid draws approximately 1/10 amp at 15 volts dc.

Programming is achieved through a connector in the housing.

Figure 3 shows the wiring schematic of the solenoids, Table 3 indicates the program of attenuation versus solenoid actuation. The elimination of the dial and knob has decreased the overall length of the instrument by 9/16 inch, while a special cover plate has resulted in a 1/8 inch increase in height.

The 355C/D is compact, rugged, and well-shielded. The design, indicated in Figure 1, has resulted in an

accurate and convenient attenuator with excellent electrical characteristics.

The 355C/D drive mechanism, controlled from the front panel, is a single rotary shaft which mounts four cams. The cams drive eight 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/E 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/F has 10, 20, 30 and 60 dB pads which allow a range of 0 to 120 dB in 10 dB steps.

OPTIONS

Table 2 lists the options available for the Model 355 C/D/E/F.

OPERATION

The Model 355C/D/E/F 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. A dc resistance list for overload damages is given under MAINTENANCE.

The input may be applied to either connector, and the output taken from the other, except in the case of the 355D/F driven from a low impedance source. In this one case, the leaf switch (Figures 1 and 2) may be closed before the micro-switch opens when the dial is switched from 50 dB to 60 dB. Should this occur, a momentary

Table 1. Specifications

| | |
|--|---|
| <p>MODEL 355C/E</p> <p>Attenuation Range: 0 to 12 dB. Attenuation Steps: 1 dB. Overall Accuracy: 0.1 dB at 1000 Hz. 0.25 dB, dc to 500 MHz. 0.35 dB, dc to 1000 MHz.</p> <p>MODEL 355D/F</p> <p>Attenuation Range: 0 to 120 dB. Attenuation Steps: 10 dB. Overall Accuracy: at 1000 Hz, 0 to 120 dB, ± 0.3 dB; below 1000 MHz, 0 to 90 dB, ± 1.5 dB; 90 to 120 dB, ± 3 dB.</p> <p>MODELS 355C/E and 355D/F</p> <p>Frequency Range: dc to 1000 MHz. Impedance: 50 ohms (nominal).</p> | <p>Maximum SWR (input and output): 1.2 below 250 MHz; 1.3 below 500 MHz, 1.5 below 1000 MHz. Maximum Residual Attenuation: Less than 0.25 dB to 100 MHz; less than 0.75 dB to 500 MHz, less than 1.5 dB to 1000 MHz. Maximum Power Dissipation: 0.5 watt, average. Maximum Pulse Voltage: 350 volts, peak. Connectors: BNC, female. Dimensions: I (355C/D): 152 mm long, 97 mm wide, 68 mm high (6 in x 2-13/16 in x 2-11/16 in) I (355E/F): 139 mm long, 97 mm wide, 97 mm high Weight: 1-1/2 lb (0,67 kg) (5-7/16 in x 2-13/16 in x 2-13/16 in) 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.</p> |
|--|---|

Table 2. Model 355C/D/E/F Options

Model 355C/D

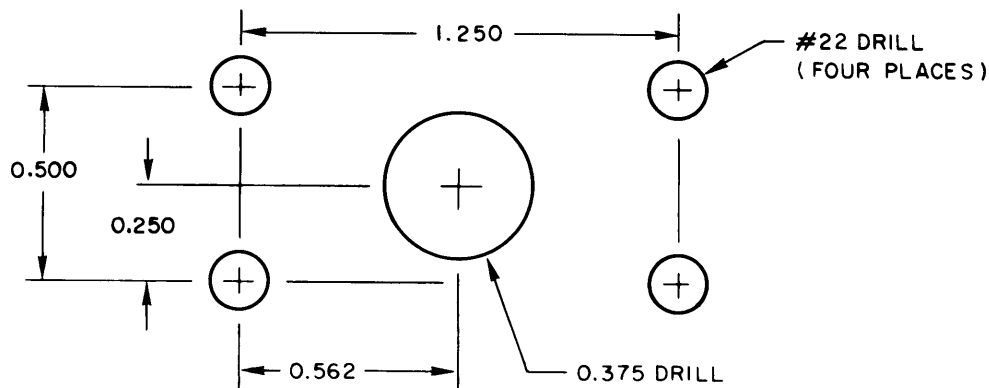
Option 001 - Type "N" input and output connectors.

Option 003 - Modifies the 355C/D to provide panel mounting capability by incorporating the following changes:

1. The attenuator shaft is 3/16" longer, thereby allowing the instrument shaft to protrude through a 3/16" panel.
2. Four 6-32 holes are drilled and tapped in the instrument casting to allow the instrument to be mounted to a panel.
3. A 1 3/4" dial is added.

NOTE

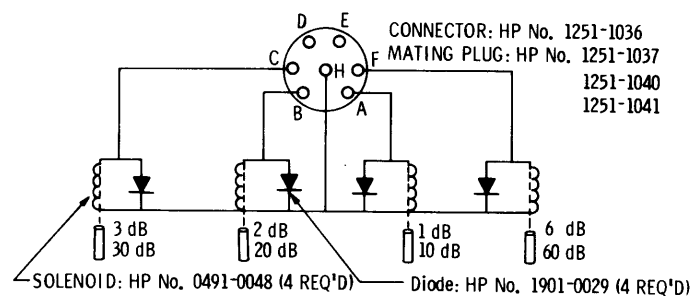
Panel drilling detail for mounting Option 003 is as follows:



Option 005 - Type TNC input and output connectors.

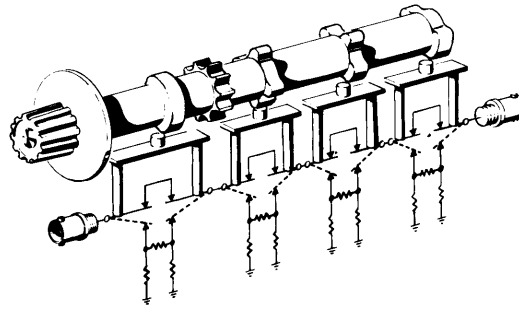
Model 355E/F

Option 007 - Adds transistor driver protection circuitry as follows:

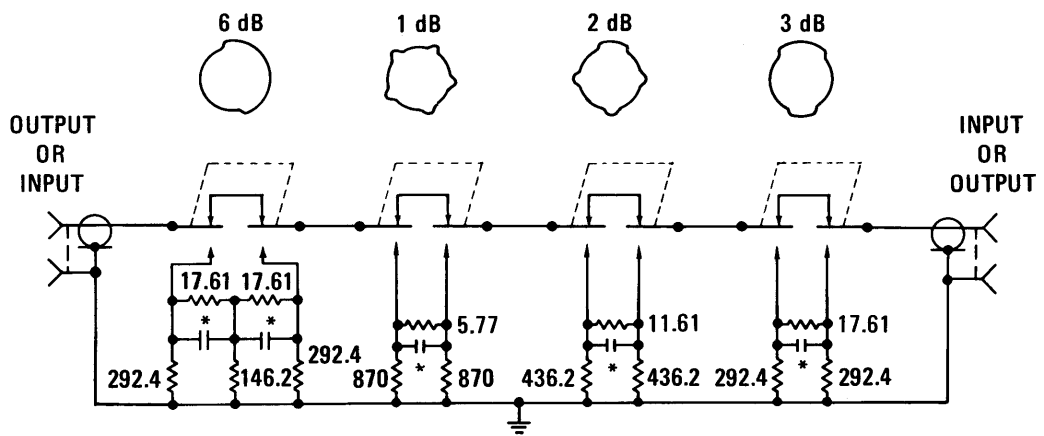
**NOTE**

Pin H must be positive with respect to the other pins.

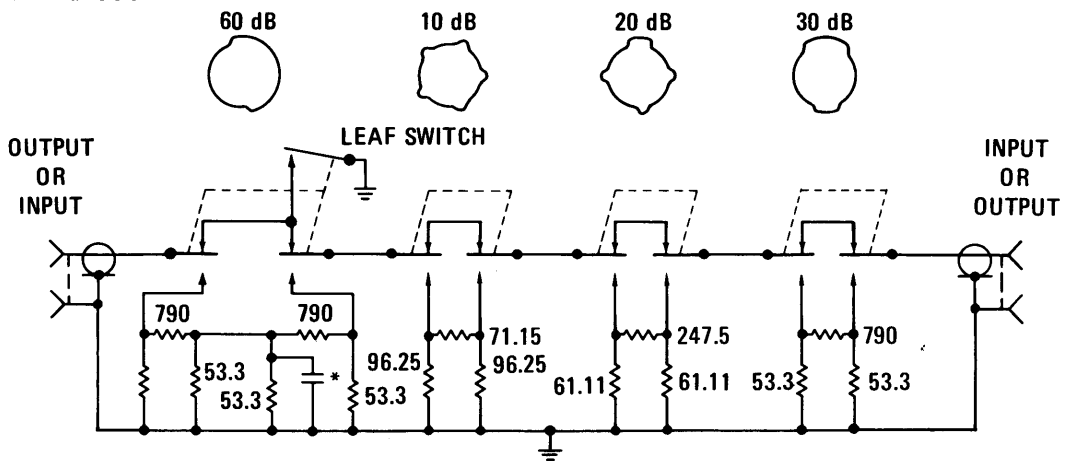
MODELS 355C AND 355D



MODEL 355C



MODEL 355D

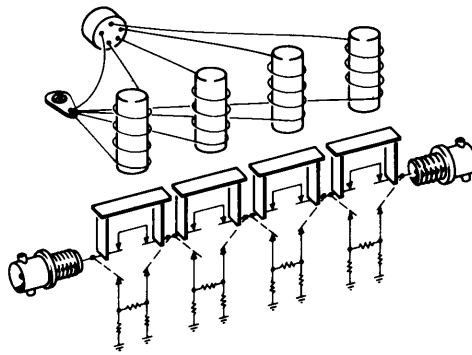


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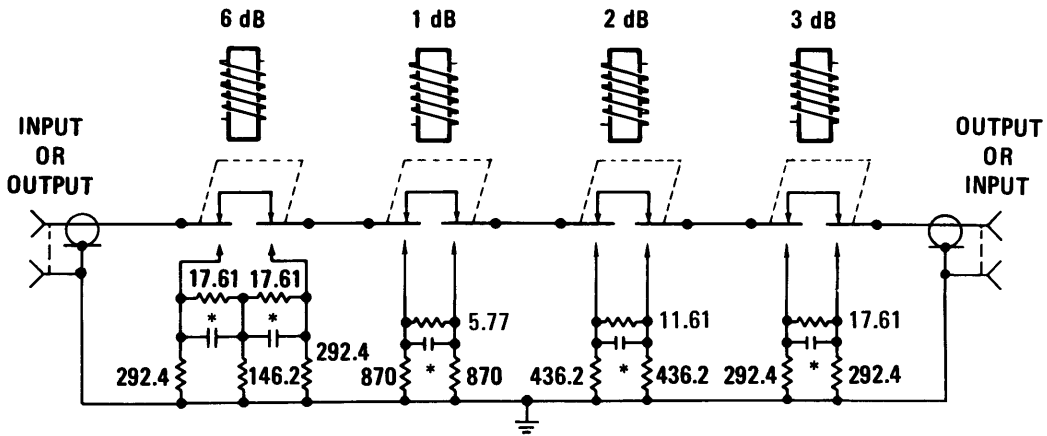
1. Microswitches shown in 0 dB position.
2. Resistances in ohms ($\pm 1/2\%$).
3. Capacitance values factory-adjusted.
4. *Asterisk denotes factory selected value.

Figure 1. Schematic Diagrams, Models 355C and 355D

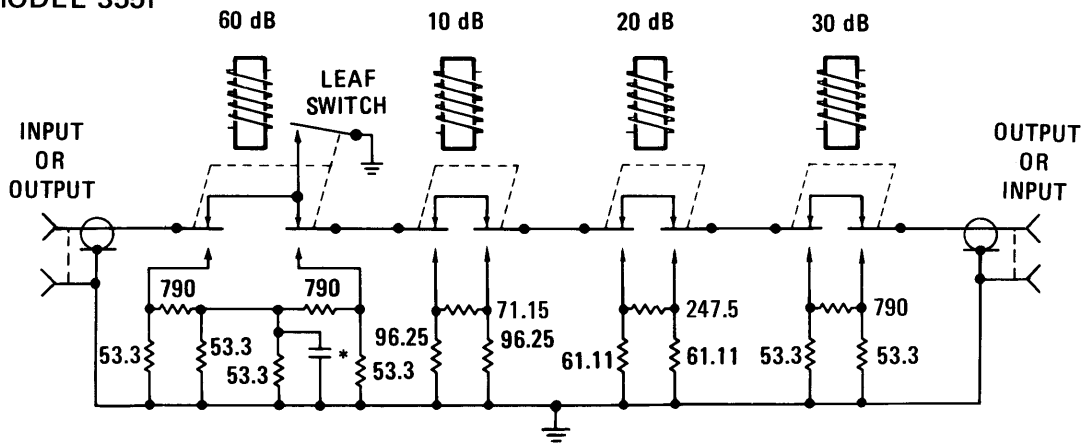
MODELS 355E AND 355F



MODEL 355E



MODEL 355F



NOTES

1. Microswitches shown in 0 dB position.
2. Resistances in ohms ($\pm 1/2\%$).
3. Capacitance values factory-adjusted.
4. *Asterisk denotes factory selected value.

Figure 2. Schematic Diagrams, Models 355E and 355F

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.

Up to 132 dB attenuation in 1 dB steps is available by connecting the Model 355C/E to the Model 355D/F. The connector location on the 355D/F is the mirror image of the connector location on the 355C/E, 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.

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

CIRCUIT

The schematic for the Model 355C/D is shown in Figure 1 and that of the Model 355E/F in Figure 2. With the exception of the solenoids, the Model 355E/F is electrically identical to the Model 355C/D.

CAUTION

The solenoids in the 355E/F have been precisely adjusted at the factory. No attempt should be made to replace them except by factory approved service representatives. The operation of the attenuators will be unreliable if plungers are not kept with their proper solenoids. Do not interchange or "swap" them.

Lubrication

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. The Model 355E/F requires no lubrication.

Resistance Measurements

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

- a. Terminate either connector with 50 ohms \pm 1%.
- b. Connect the measuring device to the other connector and measure the dc resistance at each step. Resistance measured should be close to 50 ohms.
- c. Reverse the connections to the attenuator and again measure the dc resistance at each setting of the dial. Resistance measured should be close to 50 ohms.
- d. If the reading on any step is not near 50 ohms the unit has been damaged.

Repair

CAUTION

The Model 355C/D/E/F attenuators are calibrated with the top and bottom covers installed. Removing either cover destroys the calibration and voids the instrument warranty.

The precision performance of the Model 355C/D/E/F 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/E/F it is recommended that it be returned to your nearest Hewlett-Packard Sales and Service Office for repair.

The following parts, however, are replaceable without removing any cover.

Replacing these parts is recommended if necessary. **355C**

- Glide (feet) 4 each HP 0403-0026
- Dial Assembly HP 355A-40G
- Dial Assembly (Option 003) HP 00355-00001

355D

- Glide (feet) 4 each HP 0403-0026
- Dial Assembly HP 355A-40H
- Dial Assembly (Option 003) HP 00355-00002

355E/F

- Glide (feet) 4 each HP 0403-0026
- Connector, 7 pin (male) HP 1251-1037

| Test | Operation |
|------|------------------------------|
| 1 | SWR |
| 2 | RF Attenuation (355C/E only) |
| 3 | RF Attenuation (355D/F only) |
| 4 | RF Attenuation at 1 kHz |
| 5 | Residual Attenuation |

Table 4. Test Equipment and Accessories Recommended

| Instrument | Critical Specifications | Test | Model or Part No. |
|--------------------------------------|--|------------|-----------------------|
| UHF Signal Generator | Frequency Range: 500 to 1000 MHz | 1, 2, 3, 5 | HP 612A |
| VHF Signal Generator | Output: 100 MHz | 5 | HP 608E/F |
| Sweep Generator | Frequency Range: 250 to 1000 MHz | 1 | HP 8690B/ 8699B |
| 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 415E |
| Oscillator | Frequency: 1 kHz Output Balance: 1% | 3, 4 | HP 200CD |
| Microwave Amplifier | Frequency Range: 800 to 1000 MHz Power: 1 watt out for 1 mW in at 800 MHz | 3 | HP 489A |
| Leveler Amplifier | Leveled Power Constant: ± 0.05 dB | 3 | HP 8404A |
| Power Meter | Measurement Capabilities: -5 mW Accepts Coaxial Mount | 3 | HP 432A |
| AC Voltmeter | Measure: 5 volts rms | 4 | HP 400E |
| Dual Directional Coupler | Range: 250 to 1000 MHz Directivity: 35 dB | 1 | HP 778D |
| Dual Directional Coupler | Range: 450 to 940 MHz (Adequate for detection at 1000 MHz) | 3 | HP 765D or HP 755D |
| Bolometer Mount | Input Impedance: 50 ohms Maximum SWR: 1.25 | 2, 3, 5 | HP 476A |
| Low Pass Filter | Cut-off Frequency: 1200 MHz Residual Attenuation: Less than 3 dB | 1, 2, 3, 5 | HP 360B |
| Coaxial Thermistor Mount | Frequency Range: 800 to 1000 MHz SWR: Less than 1.3 | 3 | HP 478A |
| Coaxial Termination Mount (2 needed) | Input Impedance: 50 ohms SWR: 1.5 | 1, 3 | HP 908A |

Table 4. Test Equipment and Accessories Recommended (Cont)

| Instrument | Critical Specifications | Test | Model or Part No. |
|-----------------------------|--|---------------------------------------|-------------------|
| 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 |
| Crystal Detector (2 needed) | 0.01 to 12.4 GHz | 1 | HP 423A |
| Power Supply | Output Voltage: 0 to 25 Vdc Output Current: 0 to 400 mA | 1 | HP 6216A |
| Accessories | | | |
| Number Required | Description | Type No. or HP Part No. | |
| 2 | Adapter — male BNC to male BNC | UG-491A/U | |
| 2 | Adapter — male N to male BNC | UG-1034U/N | |
| 1 | Adapter — female N to female N | UG-29B/U | |
| 1 | Adapter — female N to male BNC | UG-348A/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 0730-003 | |

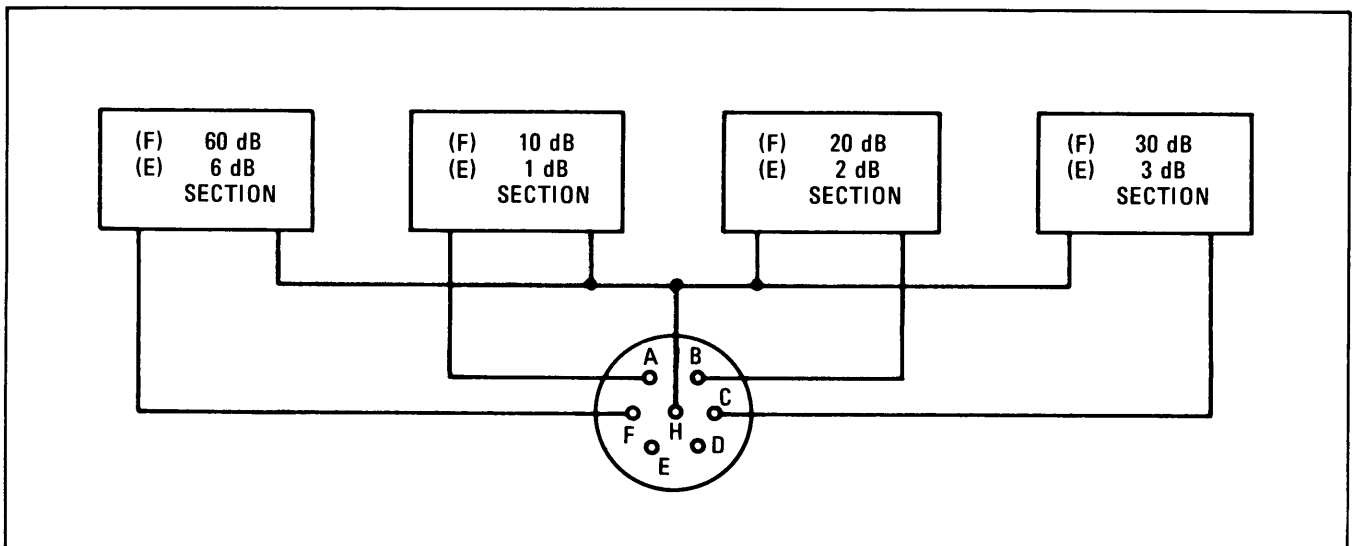


Figure 3. 355E/F Solenoid and Connector Wiring

Table 5. 355E/F Attenuation Program

| To obtain attenuation settings given below, apply 18 volts dc between Pin H (common) and Pins: | | | | | | |
|--|-------|------|--|-------|--------|------------|
| 355E | 355F | Pins | | 355E | 355F | Pins |
| 1 dB | 10 dB | A | | 7 dB | 70 dB | F, A |
| 2 dB | 20 dB | B | | 8 dB | 80 dB | F, B |
| 3 dB | 30 dB | C | | 9 dB | 90 dB | F, C |
| 4 dB | 40 dB | C, A | | 10 dB | 100 dB | F, C, A |
| 5 dB | 50 dB | C, B | | 11 dB | 110 dB | F, C, B |
| 6 dB | 60 dB | F | | 12 dB | 120 dB | F, C, B, A |

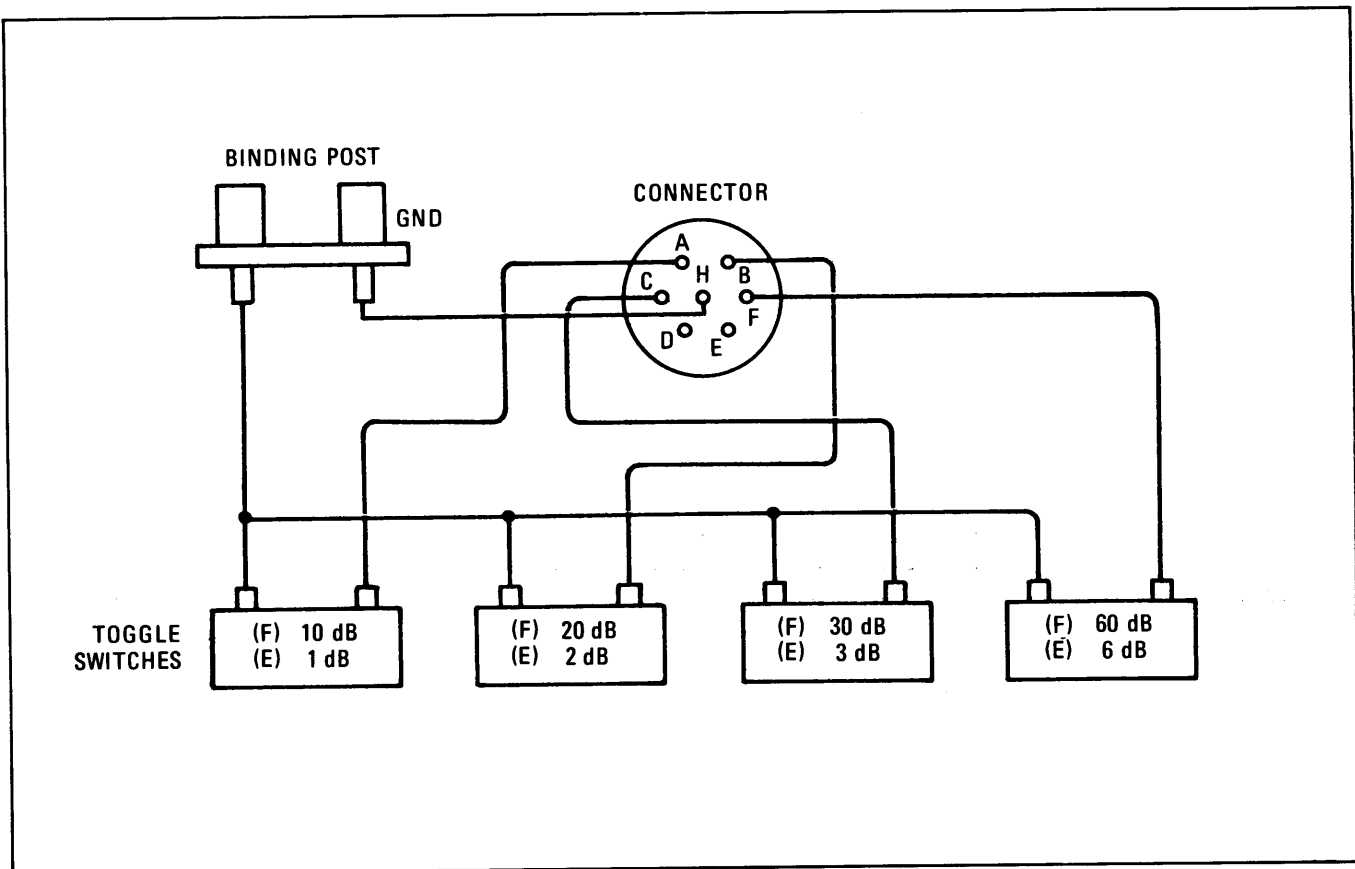


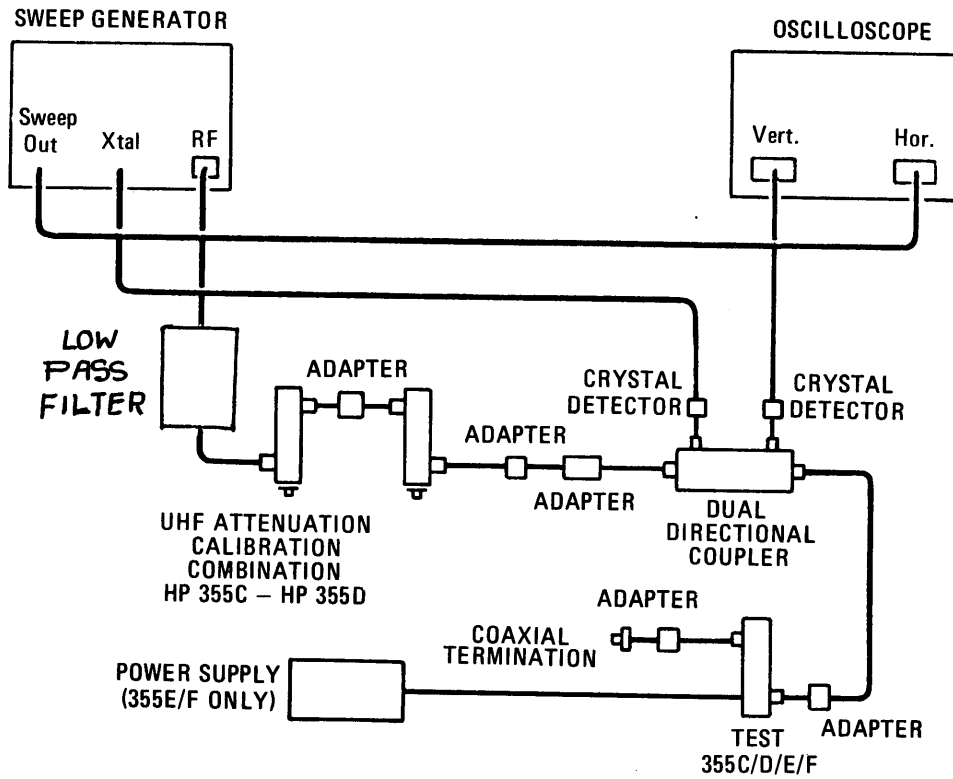
Figure 4. Model 355E/F Programming Switch Test Setup

PERFORMANCE TESTS

1. 355C/D/E/F SWR Procedure (Swept Frequency Method)

Specification:

1.2 below 250 MHz; 1.3 below 500 MHz; 1.5 below 1000 MHz.



Equipment :-

Figure 5. 355C/D/E/F SWR Test Setup

| | | |
|-------------------------------|-------|----------------|
| Low Pass Filter | ..... | H.P.360B |
| V.H.F. Attenuator | ..... | H.P.355C |
| V.H.F. Attenuator | ..... | H.P.355D |
| Sweep Generator | ..... | HP 8690B/8699B |
| Oscilloscope | ..... | HP 130C |
| Adapter, Male BNC to Male BNC | ..... | UG-491A/U |
| Crystal Detectors | ..... | HP 423A |
| Adapter, Male N to Male BNC | ..... | UG-1034U/N |
| Adapter, Female N to Female N | ..... | UG-29B/U |
| Dual Directional Coupler | ..... | HP 778D |
| Adapter, Female N to Male BNC | ..... | UG-348A/U |
| Coaxial Termination | ..... | HP 908A |
| Power Supply | ..... | HP 6216A |

Procedure:

1. Connect the equipment as shown in Figure 5, omitting the 355 under test and the 50 ohm termination.

PERFORMANCE TESTS

2. Set Controls on oscilloscope as follows:

| | |
|----------------------------------|---------|
| VERTICAL SENSITIVITY | 1 mV/cm |
| HORIZONTAL SENSITIVITY | 1 V/cm |
| AC — DC INPUTS | DC |

3. Set the 355C to 4 dB and the 355D to 10 dB. This combination equals 14 dB, or the return loss equivalent of a 1.5 SWR.
4. Set the sweep oscillator to sweep from 500 MHz to 1 GHz.
5. Short the output of the dual directional coupler.
6. With a grease pencil, trace over the pattern on the oscilloscope face.
7. Set the 355C to 8 dB and the 355D to 10 dB. This combination equals 18 dB, or the return loss equivalent of a 1.3 SWR.
8. Set the sweep oscillator to sweep from 250 MHz to 500 MHz.
9. With a grease pencil, trace over the pattern on the oscilloscope face.
10. Set the 355C to 1 dB and the 355D to 20 dB. This combination equals 21 dB, or the return loss equivalent of a 1.2 SWR.
11. Set the sweep oscillator to sweep from 100 MHz to 250 MHz.
12. With a grease pencil, trace over the pattern on the oscilloscope face.
13. Remove short from output and connect unit under test to the dual directional coupler, and terminate the output with 50 ohms. *Set both the 355C and 355D to 0dB.*
14. Repeat steps 3 through 12. The pattern should not cross the grease pencil lines drawn on the oscilloscope. SWR should be less than 1.5 below 1 GHz, less than 1.3 below 500 MHz, and less than 1.2 below 250 MHz.
15. Reverse connections to 355C/D/E/F under test and repeat procedure.
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PERFORMANCE TESTS

2. RF Attenuation (355C and 355E only)

Specification:

Less than $\pm .35$ dB at 1000 MHz; less than $\pm .25$ dB at 500 MHz.

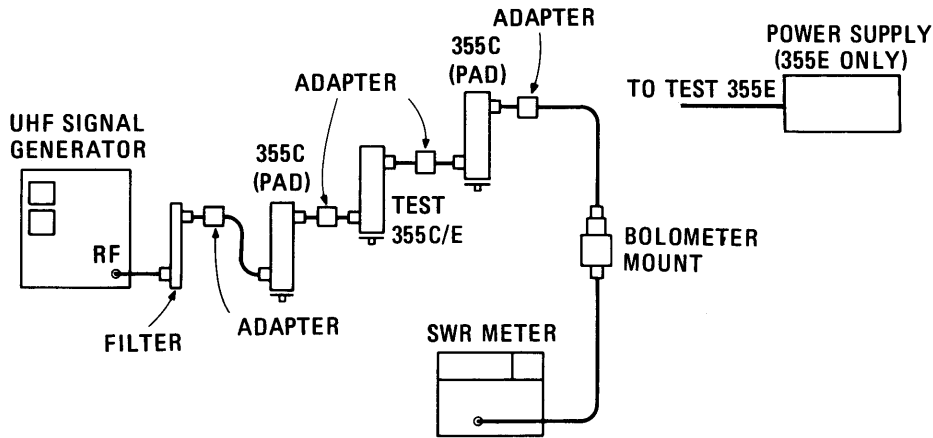


Figure 6. 355C/E RF Attenuation Test Setup

Equipment:

| | |
|-------------------------------|------------|
| UHF Signal Generator | HP 612A |
| Low Pass Filter | HP 360B |
| VHF Attenuator | HP 355C/E |
| Adapter, Male BNC to Male BNC | UG-491A/U |
| Adapter, Male N to Male BNC | UG-1034U/N |
| Bolometer Mount | HP 476A |
| SWR Meter | HP 415E |
| Power Supply | HP 6216A |

Procedure:

Note

Attenuation, by definition, is a negative quantity. A SWR Meter attenuation reading greater than indicated on HP 355C/E is therefore a negative error.

1. Connect equipment as shown in Figure 6.
2. Set both 355C pads in setup to 6 dB.
3. 1000 Hz modulate the UHF Signal Generator at 1000 MHz with maximum output. Set test unit to 0 dB and adjust SWR Meter to 0.0 dB meter reference on 0.0 EXPAND, 40 dB RANGE, HIGH BOLO.

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4. Set test unit to 1 dB and record SWR Meter reading in Table 6.
5. Increase test unit attenuation to 2 dB and record SWR Meter reading.
6. Switch SWR Meter EXPAND to 2.5 dB and the test unit to 3 dB. Record reading.
7. Continue checking test unit to 12 dB, switching the SWR Meter EXPAND switch in turn to 5.0, 7.5, and 0.00, 50 dB RANGE, and record results.
8. Set UHF Signal Generator to 500 MHz, repeat above procedure, and record results.

Table 6. 1 - 10 dB RF Attenuation Test Results (355C/E)

| Test Unit Setting (dB) | Results (dB) at 1000 MHz | | | Results (dB) at 500 MHz | | |
|------------------------|--------------------------|--------|-------|-------------------------|--------|-------|
| | Min | Actual | Max | Min | Actual | Max |
| 1 | 0.65 | _____ | 1.35 | 0.75 | _____ | 1.25 |
| 2 | 1.65 | _____ | 2.35 | 1.75 | _____ | 2.25 |
| 3 | 2.65 | _____ | 3.35 | 2.75 | _____ | 3.25 |
| 4 | 3.65 | _____ | 4.35 | 3.75 | _____ | 4.25 |
| 5 | 4.65 | _____ | 5.35 | 4.75 | _____ | 5.25 |
| 6 | 5.65 | _____ | 6.35 | 5.75 | _____ | 6.25 |
| 7 | 6.65 | _____ | 7.35 | 6.75 | _____ | 7.25 |
| 8 | 7.65 | _____ | 8.35 | 7.75 | _____ | 8.25 |
| 9 | 8.65 | _____ | 9.35 | 8.75 | _____ | 9.25 |
| 10 | 9.65 | _____ | 10.35 | 9.75 | _____ | 10.25 |

PERFORMANCE TESTS

3. RF Attenuation (355D and 355F only)

Specification:

- ±1.5 dB at 1000 MHz and 800 MHz from 0 to 90 dB inclusive.
- ±3.0 dB at 1000 MHz and 800 MHz from 100 to 120 dB inclusive.

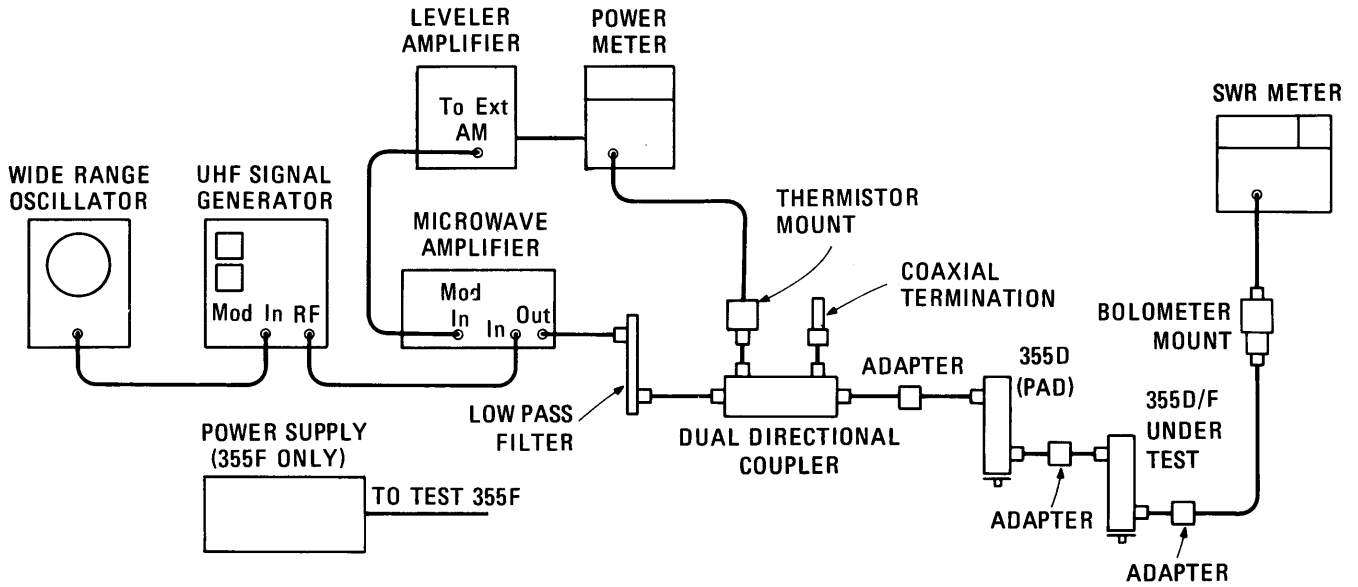


Figure 7. 355D/F RF Attenuation Test Setup

Equipment:

| | |
|--|------------|
| Wide Range Oscillator | HP 200CD |
| UHF Signal Generator | HP 612A |
| Microwave Amplifier | HP 489A |
| Leveler Amplifier | HP 8404A |
| Power Meter | HP 432A |
| Thermistor Mount | HP 478A |
| Coaxial Termination | HP 908A |
| SWR Meter | HP 415E |
| Bolometer Mount | HP 476A |
| Low Pass Filter | HP 360B |
| Dual Directional Coupler | HP 775D |
| Power Supply | HP 6216A |
| Adapters, Male N to Male BNC | UG-1034U/N |
| Adapters, Male BNC to Male BNC | UG-491A/U |

Procedure:

1. Set UHF Signal Generator to 1000 MHz. Set the Microwave Amplifier GAIN full ccw to avoid bolometer damage and connect the equipment as shown in Figure 7.

PERFORMANCE TESTS

2. Set Leveler Amplifier GAIN 1/4 turn from full cw, and POWER LEVEL full ccw. Set Power Meter RANGE switch to +10 dBm and correct mount resistance. Null and zero set the Power Meter.
3. Externally modulate the UHF Signal Generator with a 1000 Hz signal. Set the UHF Signal Generator OUTPUT LEVEL control for a Set Level indication on the generator output meter and set the MOD LEVEL control for maximum percentage of modulation.
4. Set the Microwave Amplifier GAIN control to full cw. Set both 355D or F Attenuators for 40 dB attenuation each. Rotate Leveler Amplifier POWER LEVEL control cw and UHF Signal Generator output attenuator, as required, to establish a +5 dBm indication on the external Power Meter.
5. Observe leveling action by switching 355D (Pad) from 40 to 0 dB. The Power Meter indication should remain constant.
6. Return 355D (Pad) setting to 40 dB and set test unit to 0 dB. Measure attenuation accuracy at 1000 MHz as follows:

Table 7. 0 - 60 dB Attenuation Accuracy Procedure and Test Results (355D/F)

| Test Unit (dB) | 355D (Pad) (dB) | SWR Meter Range (dB) | Procedure | Results (dB) at 1000 MHz | | |
|----------------|-----------------|----------------------|--|--------------------------|--------|------|
| | | | | Min | Actual | Max |
| 0 | 40 | 30 | Set 3.0 reference on SWR Meter | | | |
| 10 | 40 | 40 | Read error from 3.0 reference | 8.5 | _____ | 11.5 |
| 20 | 40 | 50 | Read error on SWR Meter | 18.5 | _____ | 21.5 |
| 20 | 20 | 30 | Adjust SWR Meter GAIN to exactly the same reading as previous measurement. | | | |
| 30 | 20 | 40 | Read error on SWR Meter | 28.5 | _____ | 31.5 |
| 40 | 20 | 50 | Read error on SWR Meter | 38.5 | _____ | 41.5 |
| 40 | 0 | 30 | Adjust SWR Meter GAIN to same reading as obtained in fourth step above (both 355's at 20 dB) | | | |
| 50 | 0 | 40 | Read error on SWR Meter | 48.5 | _____ | 51.5 |
| 60 | 0 | 50 | Read error on SWR Meter | 58.5 | _____ | 61.5 |

PERFORMANCE TESTS

7. The attenuation errors from 70 dB to 120 dB are calculated by combining the errors or previous readings as follows:

Table 8. 70 - 120 dB RF Attenuation Accuracy Calculation and Test Results (355D/F)

| Test Unit (dB) | Calculation | Results (dB) at 1000 MHz | | |
|----------------|------------------------------------|--------------------------|--------|------|
| | | Min | Actual | Max |
| 70 | Add 60 dB and 10 dB errors | 68.5 | _____ | 71.5 |
| 80 | Add 60 dB and 20 dB errors | 78.5 | _____ | 81.5 |
| 90 | Add 60 dB and 30 dB errors | 88.5 | _____ | 91.5 |
| 100 | Add 60 dB, 30 dB, and 10 dB errors | 97 | _____ | 103 |
| 110 | Add 60 dB, 30 dB, and 20 dB errors | 107 | _____ | 113 |
| 120 | Add 60 dB, 50 dB, and 10 dB errors | 117 | _____ | 123 |

8. Set the UHF Signal Generator output frequency to 800 MHz. Repeat steps 4 through 6 and measure the attenuation accuracy at 800 MHz as follows:

Table 9. 0 - 60 dB Attenuation Accuracy Procedure and Test Results (355D/F)

| Test Unit (dB) | 355D (Pad) (dB) | SWR Meter Range (dB) | Procedure | Results (dB) at 800 MHz | | |
|----------------|-----------------|----------------------|--|-------------------------|--------|------|
| | | | | Min | Actual | Max |
| 0 | 40 | 30 | Set 3.0 reference on SWR Meter | | | |
| 10 | 40 | 40 | Read error from 3.0 reference | 8.5 | _____ | 11.5 |
| 20 | 40 | 50 | Read error on SWR Meter | 18.5 | _____ | 21.5 |
| 20 | 20 | 30 | Adjust SWR Meter GAIN to exactly the same reading as previous measurement. | | | |
| 30 | 20 | 40 | Read error on SWR Meter | 28.5 | _____ | 31.5 |
| 40 | 20 | 50 | Read error on SWR Meter | 38.5 | _____ | 41.5 |
| 40 | 0 | 30 | Adjust SWR Meter GAIN to same reading as obtained in fourth step above (both 355's at 20 dB) | | | |
| 50 | 0 | 40 | Read error on SWR Meter | 48.5 | _____ | 51.5 |
| 60 | 0 | 50 | Read error on SWR Meter | 58.5 | _____ | 61.5 |

PERFORMANCE TESTS

9. The attenuation errors from 70 dB to 120 dB are calculated by combining the errors or previous readings as follows:

Table 10. 70 - 120 dB RF Attenuation Accuracy and Calculation Test Results (355D/F)

| Test Unit (dB) | Calculation | Results (dB) at 800 MHz | | |
|-------------------|------------------------------------|-------------------------|--------|------|
| | | Min | Actual | Max |
| 70 | Add 60 dB and 10 dB errors | 68.5 | _____ | 71.5 |
| 80 | Add 60 dB and 20 dB errors | 78.5 | _____ | 81.5 |
| 90 | Add 60 dB and 30 dB errors | 88.5 | _____ | 91.5 |
| 100 | Add 60 dB, 30 dB, and 10 dB errors | 97 | _____ | 103 |
| 110 | Add 60 dB, 30 dB, and 20 dB errors | 107 | _____ | 113 |
| 120 | Add 60 dB, 50 dB, and 10 dB errors | 117 | _____ | 123 |

PERFORMANCE TESTS

4. RF Attenuation at 1 kHz

Specification:

Maximum attenuation error:

355C/E: ±0.1 dB

355D/F: ±0.3 dB

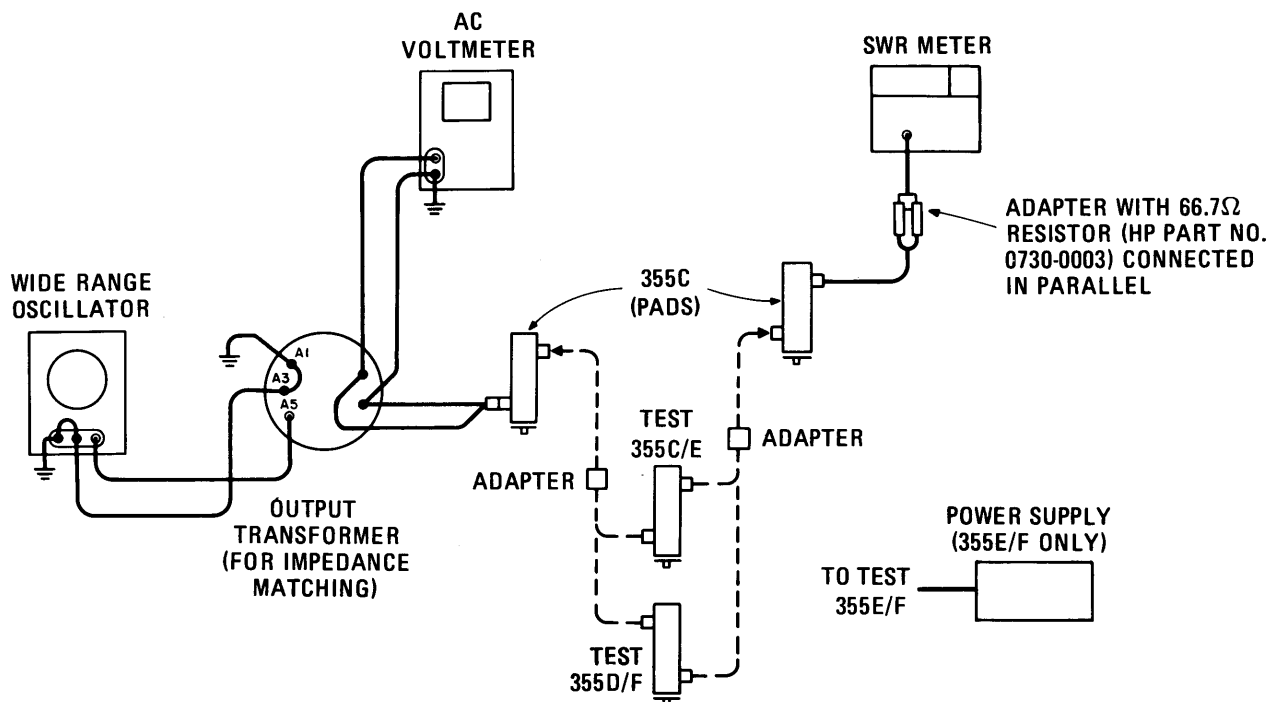


Figure 8. RF Attenuation at 1 kHz Test Setup

Equipment:

| | |
|---------------------------------------|--------------|
| Wide Range Oscillator | HP 200CD |
| Power Supply | HP 6216A |
| Output Transformer | HP 9120-0021 |
| AC Voltmeter | HP 400E |
| SWR Meter | HP 415E |
| Adapter, Male BNC to Male BNC | UG-491A/U |
| Adapter, Male BNC to Dual Banana Post | HP 10110A |

Procedure:

1. Connect equipment as shown in Figure 8. Set 355C pads to 6 dB each.
2. 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, 10 dB, 0.0 EXPAND RANGE, 200 ohm XTAL INPUT.

PERFORMANCE TESTS

3. Set test 355C/E to 0 dB and adjust SWR Meter GAIN for 0.0 meter reading. Switch Test 355C/E to 1 dB. The SWR Meter reading should drop .5 dB. Continue checking the test 355C/E attenuator to 12 dB, switching the SWR Meter EXPAND switch as necessary to 2.5 and 5.0.

Error Limits: Attenuation indicated by the SWR Meter shall be one-half of the test 355C/E dial reading at each step $\pm .05$ dB.

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

5. Set test 355D/F to 0 dB and adjust SWR Meter GAIN for a 1.0 dB meter reference. Switch test 355D/F to 10 dB, set SWR Meter EXPAND switch to 5.0 dB and read error from 1.0 dB reference.

6. Continue checking test 355D/F attenuator to 120 dB, switch SWR Meter RANGE and EXPAND as necessary.

Error Limits: Attenuation indicated by the SWR Meter shall be one-half of the test 355D/F dial reading at each step $\pm .15$ dB.

PERFORMANCE TESTS

Table 11. Test Results, RF Attenuation Accuracy at 1000 Hz (355C/E)

| Test Unit Setting (dB) | Results (dB) | | |
|------------------------|--------------|-----------|------|
| | Min | Actual | Max |
| 0 | 0 | Reference | 0 |
| 1 | 0.45 | _____ | 0.55 |
| 2 | 0.95 | _____ | 1.05 |
| 3 | 1.45 | _____ | 1.55 |
| 4 | 1.95 | _____ | 2.05 |
| 5 | 2.45 | _____ | 2.55 |
| 6 | 2.95 | _____ | 3.05 |
| 7 | 3.45 | _____ | 3.55 |
| 8 | 3.95 | _____ | 4.05 |
| 9 | 4.45 | _____ | 4.55 |
| 10 | 4.95 | _____ | 5.05 |
| 11 | 5.45 | _____ | 5.55 |
| 12 | 5.95 | _____ | 6.05 |

Table 12. Test Results, RF Attenuation Accuracy at 1000 Hz (355D/F)

| Test Unit Setting (dB) | Results (dB) | | |
|------------------------|--------------|-----------|-------|
| | Min | Actual | Max |
| 0 | 0 | Reference | 0 |
| 10 | 4.85 | _____ | 5.15 |
| 20 | 9.85 | _____ | 10.15 |
| 30 | 14.85 | _____ | 15.15 |
| 40 | 19.85 | _____ | 20.15 |
| 50 | 24.85 | _____ | 25.15 |
| 60 | 29.85 | _____ | 30.15 |
| 70 | 34.85 | _____ | 35.15 |
| 80 | 39.85 | _____ | 40.15 |
| 90 | 44.85 | _____ | 45.15 |
| 100 | 49.85 | _____ | 50.15 |
| 110 | 54.85 | _____ | 55.15 |
| 120 | 59.85 | _____ | 60.15 |

PERFORMANCE TESTS

5. RF Residual Attenuation

Specification:

Maximum residual attenuation 355C/D/E/F: Less than 0.25 dB to 100 MHz; less than 0.75 dB to 500 MHz; less than 1.5 dB to 1000 MHz.

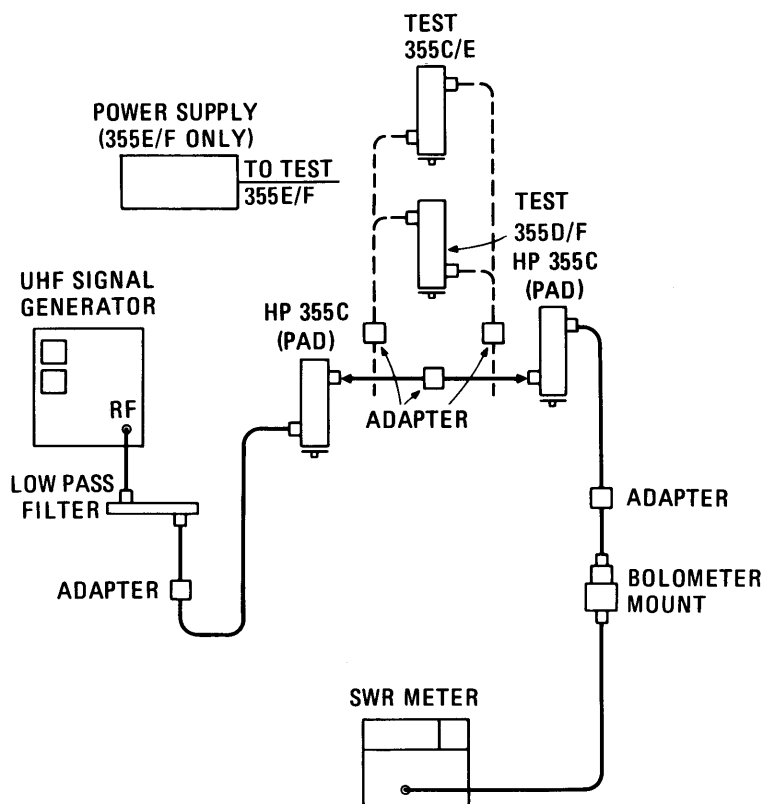


Figure 9. RF Residual Attenuation Test Setup

Equipment:

| | |
|-------------------------------|-------------------|
| UHF Signal Generator | HP 612A or 606E/F |
| Power Supply | HP 6216A |
| Low Pass Filter | HP 360B |
| Adapter, Male N to Female BNC | UG-201A/U |
| Adapter, Male BNC to Male BNC | UG-491A/U |
| Adapter, Male N to Male BNC | UG-1023U/N |
| Bolometer Mount | HP 476A |
| SWR Meter | HP 415E |

PERFORMANCE TESTS

Procedure:

1. Connect equipment as shown in Figure 9.
2. Set 355C pads to 6 dB each and connect together with UG-491A/U Adapter.
3. 1000 Hz modulate the UHF Signal Generator at 1000 MHz with maximum output. Adjust SWR Meter GAIN for a 0.0 dB meter reference, 0.0 EXPAND, 40 dB RANGE.
4. Insert the test 355C/D/E/F in place of the adapter; set it to 0 dB and measure residual attenuation.

Error Limit: Less than 1.5 dB Measured _____ dB

5. Repeat test at 500 MHz.

Error Limit: Less than 9.75 dB Measured _____ dB

6. Substitute 608E/F VHF Signal Generator for 612A UHF Signal Generator and repeat test at 100 MHz.

Error Limit: Less than 0.25 dB. Measured _____ dB

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

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