MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MWA310
MWA320
MWA330

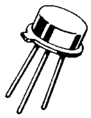
The RF Line

WIDEBAND HYBRID AMPLIFIERS

. . . single stage amplifiers designed for broadband linear applications up to 1000 MHz.

- Low-Cost TO-39 Type Package
- Gain – 8.0 dB Typ MWA310/320
  – 6.2 dB Typ MWA330
- 50 Ω Input and Output Impedance
- Fully Cascadable for Any Gain
- Thin Film Construction
- Hermetic Package
- Guaranteed Performance from -25°C to +80°C

DC-1000 MHz WIDEBAND GENERAL-PURPOSE HYBRID AMPLIFIERS



MAXIMUM RATINGS

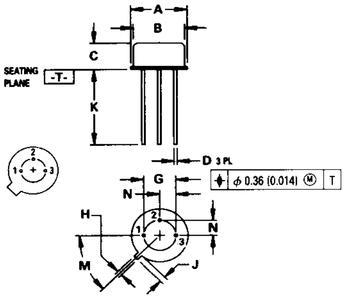
Rating	Symbol	Value			Unit
		MWA310	MWA320	MWA330	
RF Input Power	P_{in}	← 100 →			mW
DC Supply Current	I_D	25	55	100	mA
Maximum Case Temperature	T_C	← 125 →			°C
Storage Temperature Range	T_{stg}	← −65 to +200 →			°C

OPERATING CONDITIONS

Device Voltage	V_D	1.6	2.9	4.0	Vdc
Device Current	I_D	10	25	60	mAdc
Decoupling Impedance	Z_D	620	620	240	Ω

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	110	°C/W



STYLE 2:
PIN 1. INPUT
2. OUTPUT
3. GROUND

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	3.81	4.57	0.165	0.185
D	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	—	0.500	—
M	45° BSC		45° BSC	
N	2.54 BSC		0.100 BSC	

CASE 31A-03

ELECTRICAL CHARACTERISTICS (T_C = -25 to +80°C, 50 Ω system and specified operating conditions)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	0.1	–	1000	MHz
Power Gain	MWA310/320	G_p	7.0	8.0	–	dB
	MWA330		–	6.2	–	
Response Flatness		F	–	0	±1.0	dB
Input VSWR		–	–	–	3:1	–
Output VSWR		–	–	–	3:1	–
Output @ 1 dB Gain Compression						dBm
	MWA310		–	+3.5	–	
	MWA320		–	+11.5	–	
	MWA330		–	+15.2	–	
Noise Figure		NF				dB
	MWA310		–	6.5	–	
	MWA320		–	6.7	–	
	MWA330		–	9.0	–	
Reverse Isolation		P_{RI}				dB
	MWA310		–	10.4	–	
	MWA320		–	10.4	–	
	MWA330		–	9.0	–	
Harmonic Output		d_{so}				dB
	MWA310 (P_{out} = -9 dBm)		–	-30	–	
	MWA320 (P_{out} = 0 dBm)		–	-38	–	
	MWA330 (P_{out} = +10 dBm)		–	-35	–	

FIGURE 1 – DEVICE VOLTAGE versus DEVICE CURRENT

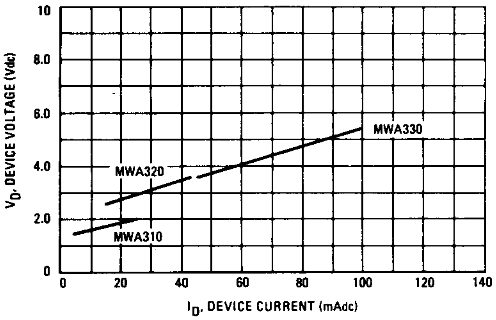


FIGURE 2 – DEVICE CURRENT versus CASE TEMPERATURE

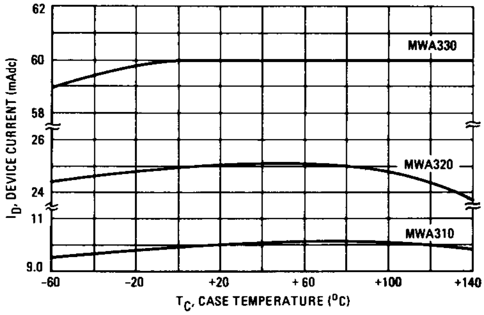


FIGURE 3 – POWER GAIN versus FREQUENCY

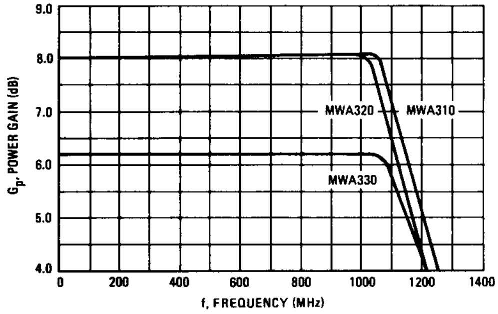


FIGURE 4 – POWER GAIN versus DEVICE CURRENT
f = 1000 MHz

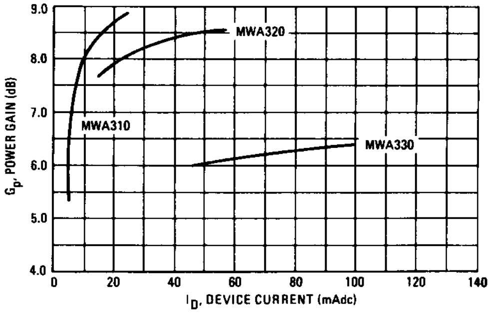


FIGURE 5 — POWER GAIN versus CASE TEMPERATURE
f = 100 MHz

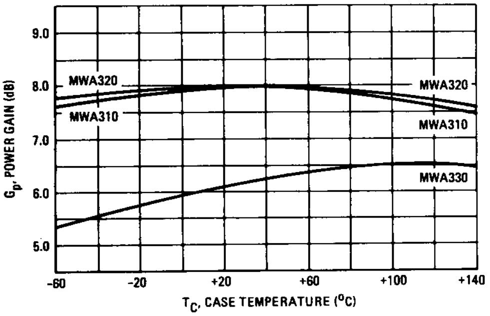


FIGURE 6 — POWER GAIN versus CASE TEMPERATURE
f = 1000 MHz

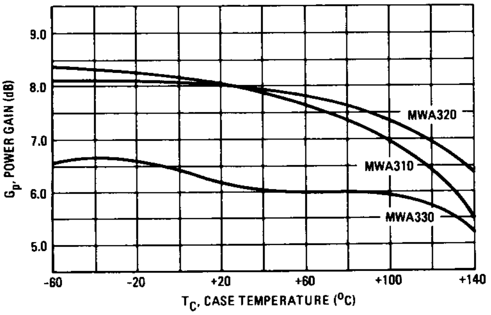


FIGURE 7 — VSWR versus FREQUENCY
MWA310

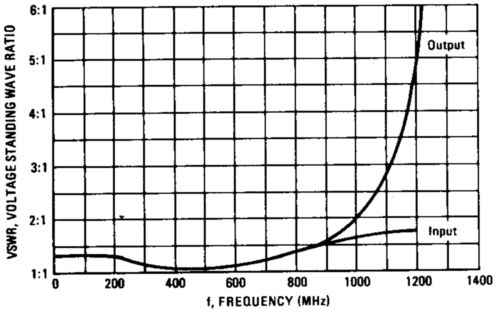


FIGURE 8 — VSWR versus FREQUENCY
MWA320

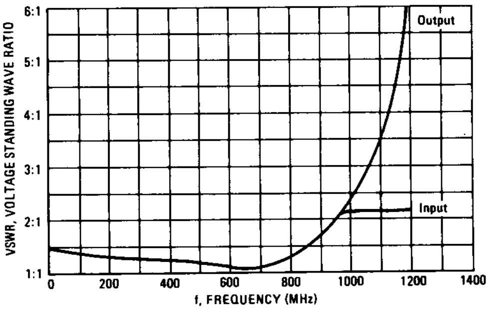


FIGURE 9 — VSWR versus FREQUENCY
MWA330

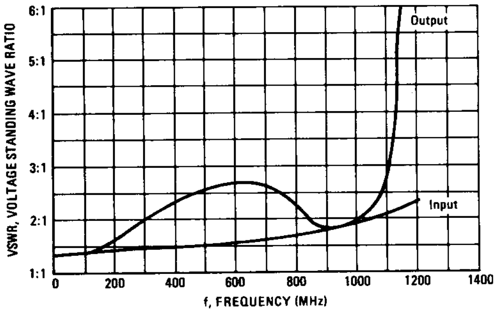
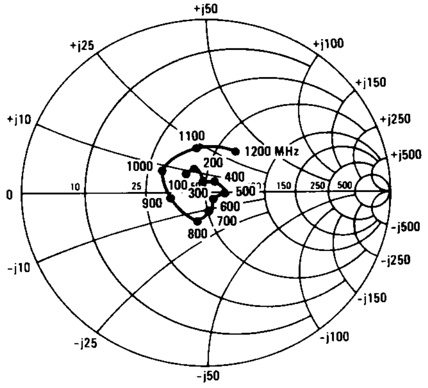


FIGURE 10 — INPUT IMPEDANCE versus FREQUENCY
MWA310



Coordinates in Ohms

FIGURE 11 — OUTPUT IMPEDANCE versus FREQUENCY MWA310

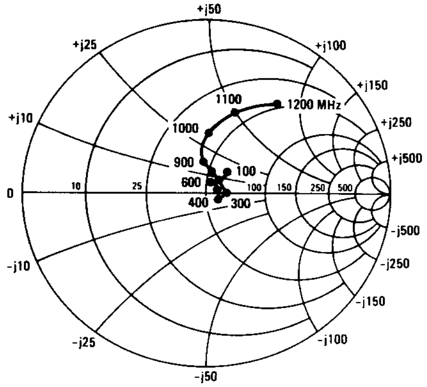
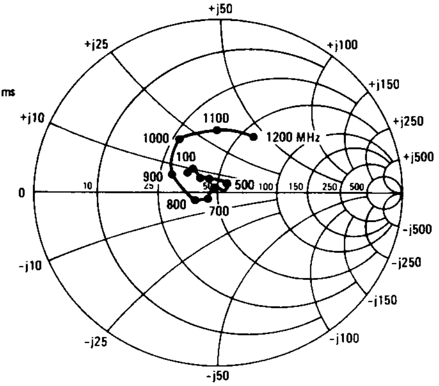


FIGURE 12 — INPUT IMPEDANCE versus FREQUENCY MWA320



Coordinates in Ohms

FIGURE 13 — OUTPUT IMPEDANCE versus FREQUENCY MWA320

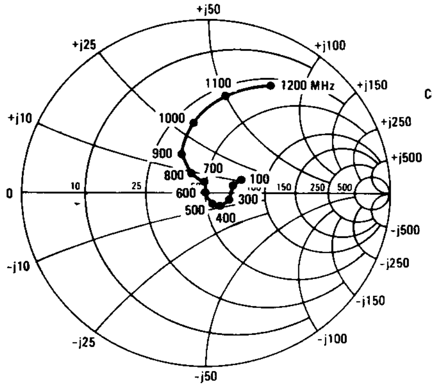
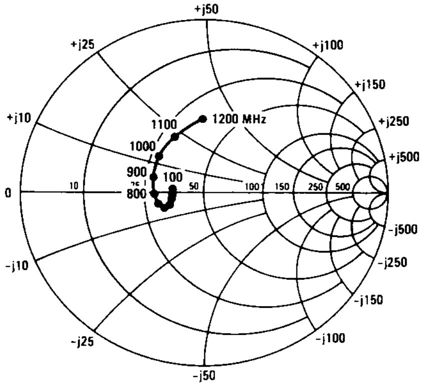
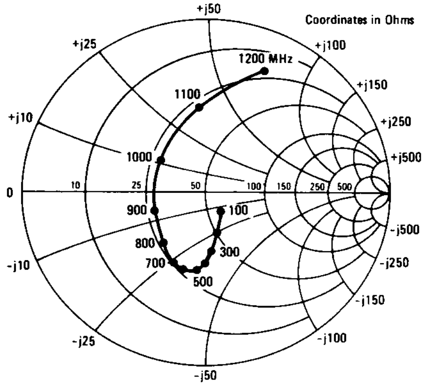


FIGURE 14 — INPUT IMPEDANCE versus FREQUENCY MWA330



Coordinates in Ohms

FIGURE 15 — OUTPUT IMPEDANCE versus FREQUENCY MWA330



Coordinates in Ohms

FIGURE 16 — 1.0 dB GAIN COMPRESSION versus FREQUENCY

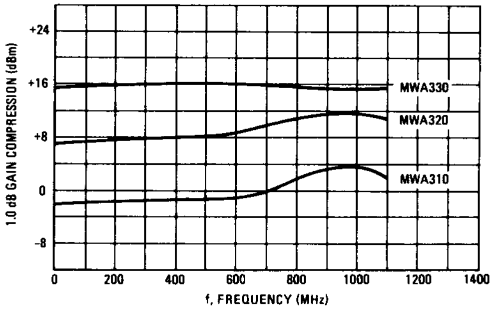


FIGURE 17 — 1.0 dB GAIN COMPRESSION versus DEVICE CURRENT f = 1000 MHz

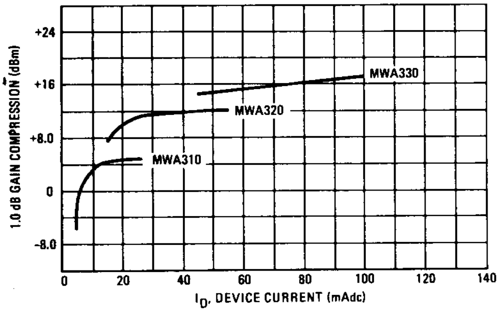


FIGURE 18 — 1.0 dB GAIN COMPRESSION versus CASE TEMPERATURE f = 1000 MHz

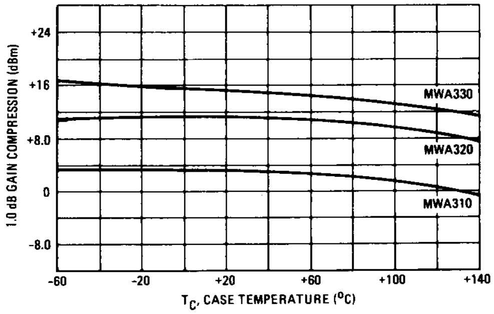


FIGURE 19 — NOISE FIGURE versus FREQUENCY

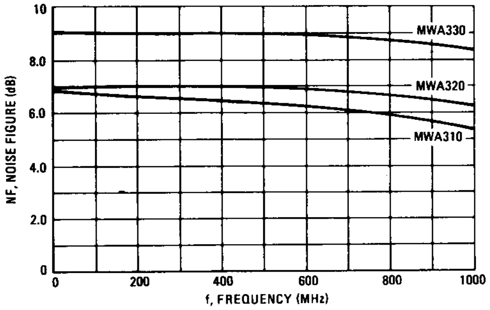


FIGURE 20 — REVERSE ISOLATION versus FREQUENCY

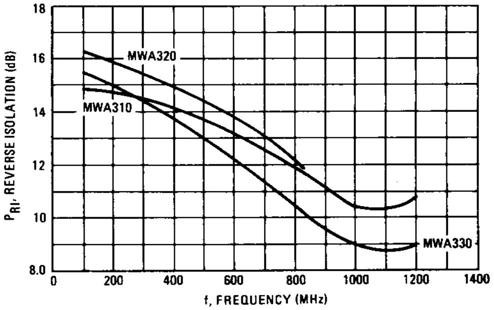


FIGURE 21 — SECOND HARMONIC OUTPUT versus FREQUENCY

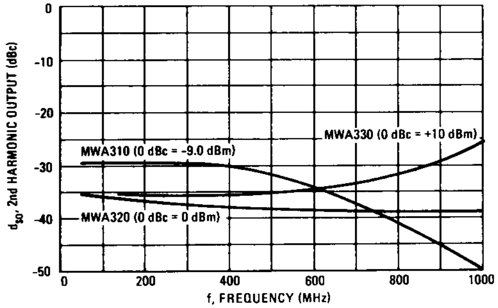


FIGURE 22 — SECOND AND THIRD ORDER INTERCEPT MWA310

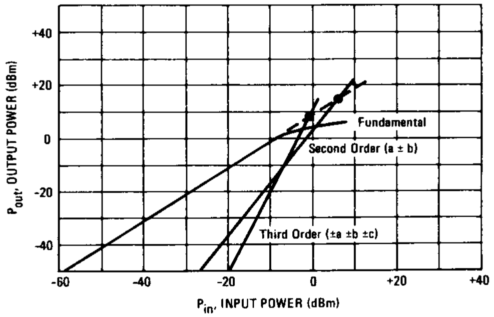


FIGURE 23 – SECOND AND THIRD ORDER INTERCEPT
MWA320

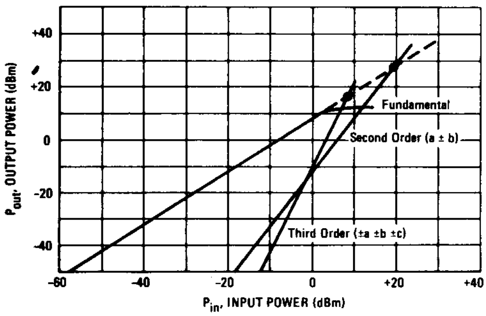


FIGURE 24 – SECOND AND THIRD ORDER INTERCEPT
MWA330

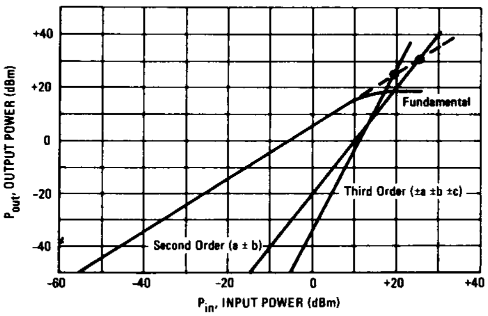


FIGURE 25 – INTERMODULATION DISTORTION
versus POWER OUTPUT
MWA310

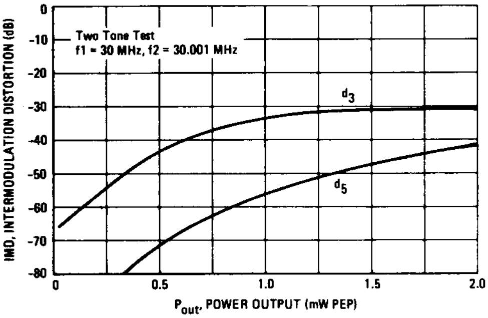


FIGURE 26 – INTERMODULATION DISTORTION
versus POWER OUTPUT
MWA320

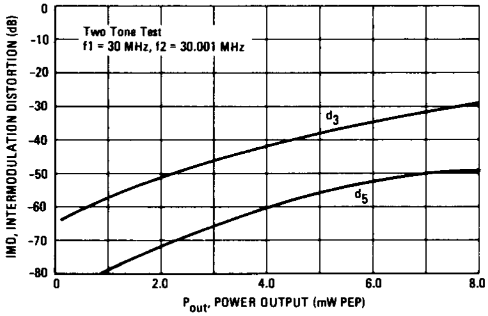


FIGURE 27 – INTERMODULATION DISTORTION
versus POWER OUTPUT
MWA330

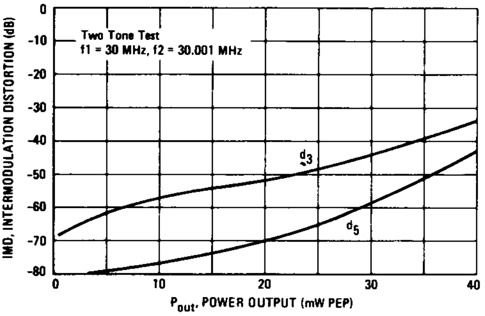
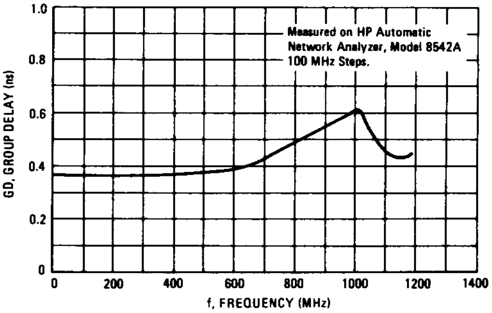


FIGURE 28 – GROUP DELAY versus FREQUENCY
MWA310/MWA320/MWA330



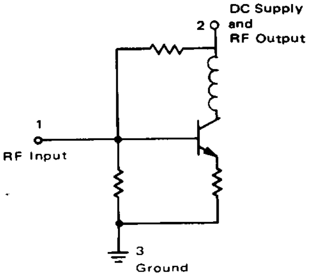
MWA SERIES HYBRID AMPLIFIER APPLICATIONS INFORMATION

The MWA series hybrid amplifiers are designed for wideband general purpose applications in 50 Ω systems. Fully cascadable for any gain combination, operable at voltages as low as 3 Vdc, and external control of the low frequency corner make the MWA amplifiers extremely versatile gain blocks.

Basic Circuit Configuration

Figure 29 shows the basic internal circuit. It is important to note that the specified operating conditions of voltage, current, and external decoupling impedance must be applied to the units in order to achieve the published electrical characteristics.

FIGURE 29 — INTERNAL CIRCUIT



Amplifier Application

The circuit schematic for a simple amplifier design is shown in Figure 30. External to the MWA hybrid amplifier the only components required are:

Decoupling elements — Bypass Capacitor
Decoupling Impedance
(resistor/inductor)
DC Blocking Capacitors at the RF input and output.

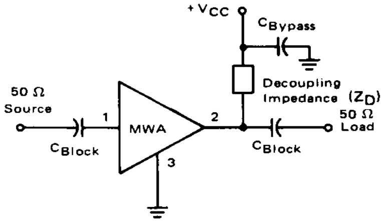
External Decoupling Impedance

In all cases the external bias (decoupling elements) must present an impedance which is large compared to the 50 Ω load impedance to minimize RF gain reduction. The loss in gain due to the decoupling impedance is given by the equation:

$$\text{Loss} = 20 \text{ Log } \frac{Z_D}{Z_D + 25} \text{ dB}$$

where Z_D = decoupling impedance in ohms. For example, if Z_D = 1 kΩ, Loss = 0.214 dB.

FIGURE 30 — AMPLIFIER SCHEMATIC DIAGRAM



Supply Voltage

The value of the external decoupling resistive impedance (R_D) determines the supply voltage ($+V_{CC}$) and is determined by the following equation:

$$V_{CC} = R_D \times I_D + V_D$$

where I_D and V_D are the device current and voltage stated in the data sheet. For example, for MWA110,

$$I_D = 10 \text{ mA}$$
$$V_D = 2.9 \text{ V}$$

and, if R_D = 330 Ω, then

$$V_{CC} = 6.2 \text{ V}$$

More commonly V_{CC} is predetermined and R_D may be calculated from:

$$R_D = \frac{V_{CC} - V_D}{I_D}$$

An RF choke is not recommended for use as a decoupling impedance without also using a resistor having an appropriate value.

Low Frequency Response

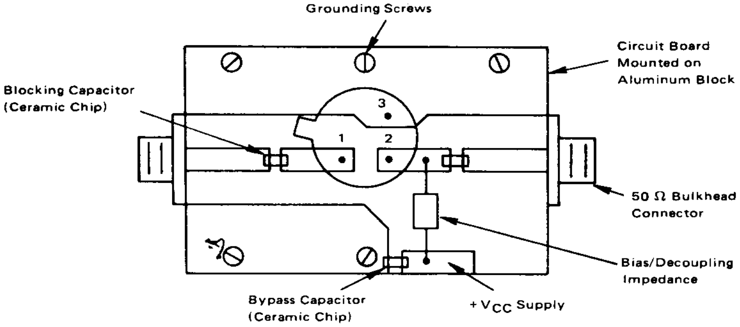
The value of the blocking capacitors determines the low frequency response of the amplifier. The following expression is used to determine the blocking capacitor value to yield a desired 3 dB low frequency corner (f_{LFC}).

$$C_{Block}(\text{Farads}) = \frac{1}{100\,\pi\, f_{LFC}(\text{Hz})}$$

Bypass Capacitor

The reactive impedance of the bypass capacitor should be small compared to the impedance of the decoupling element at the lowest frequency of operation.

FIGURE 31 — TEST FIXTURE



Note: The circuitry indicated is on the underside of the printed circuit board with sockets for the amplifier pins. The case of the amplifier should contact the printed circuit board top surface to ensure effective RF grounding.

Text Fixture

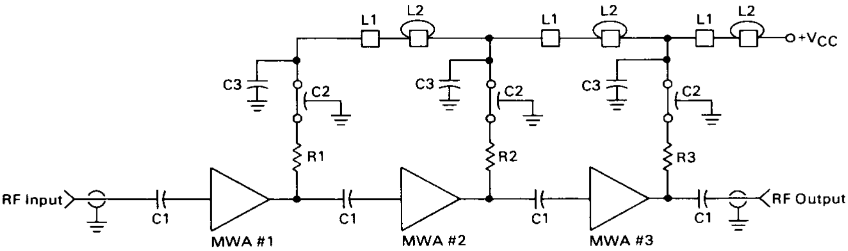
The 50 Ω input/output impedance levels of the MWA hybrids are most easily preserved on a circuit board by using 50 Ω microstrip transmission lines. Figure 31 is an example of a circuit board layout which utilizes microstrip transmission lines in conjunction with other sound RF construction techniques.

The characteristic impedance and corresponding line width of the microstrip are a function of the circuit board dielectric constant and thickness. The table lists appropriate line widths for 50 Ω microstrip lines on commonly used circuit board materials.

MATERIAL TYPE	DIELECTRIC CONSTANT	DIELECTRIC THICKNESS INCHES	LINE WIDTH INCHES
Teflon-Fiberglass	2.5	0.03125 0.0625	0.090 0.180

As in all good RF circuit designs, care should be taken to minimize parasitic lead inductances and to provide adequate grounding.

FIGURE 32 — TYPICAL CASCADE



The dc isolation components shown are critical in maintaining good stability in multi-stage designs. Keep Pin #3 (Ground) as short as possible preferably soldering the case to the ground plane for best gain flatness to 1000 MHz.

C1 — For operation to 400 MHz, 1000 pF, 50 mil Chip Capacitor – ATC 50 mil Case (5.0 MHz L.F.)
C1 — For operation to 1000 MHz, 0.018 mF, Chip Capacitor for 0.25 MHz L.F. Cut-Off
C2 — Feedthru Capacitor Centralab SFT-102, 1000 pF or Metuchen 54-794002-681M, 680 pF
C3 — 0.1 μF Sprague 3CZ5U104X0050C5 – 50 Volt
L1 — Ferroxcube Shielding Bead 56-590-65/4A – Single Wire
L2 — Ferroxcube Shielding Bead 56-590-65/4A – 2 Turns #26 AWG

Cascading

The inherent stability of the MWA hybrid modules makes possible the cascading of two or more units with no oscillatory problems. Figure 32 shows a typical 3 hybrid cascade with measured data for 400 MHz and 1000 MHz hybrids.

	Cascade 1	Cascade 2
Frequency Range	0.25 to 400 MHz	5.0 to 1000 MHz
Gain	43.5 dB	20.5 dB
Gain Flatness	± 1.0 dB	± 0.75 dB
Input VSWR	2.0:1	2.4:1
Output VSWR	1.2:1	2.1:1
V$_{CC}$ Supply	12 Vdc	33 Vdc
I Supply	44 mAdc	150 mAdc
MWA #1	MWA110	MWA320
MWA #2	MWA110	MWA330
MWA #3	MWA120	MWA330
R1	1000 Ω	1000 Ω
R2	1000 Ω	500 Ω
R3	300 Ω	500 Ω