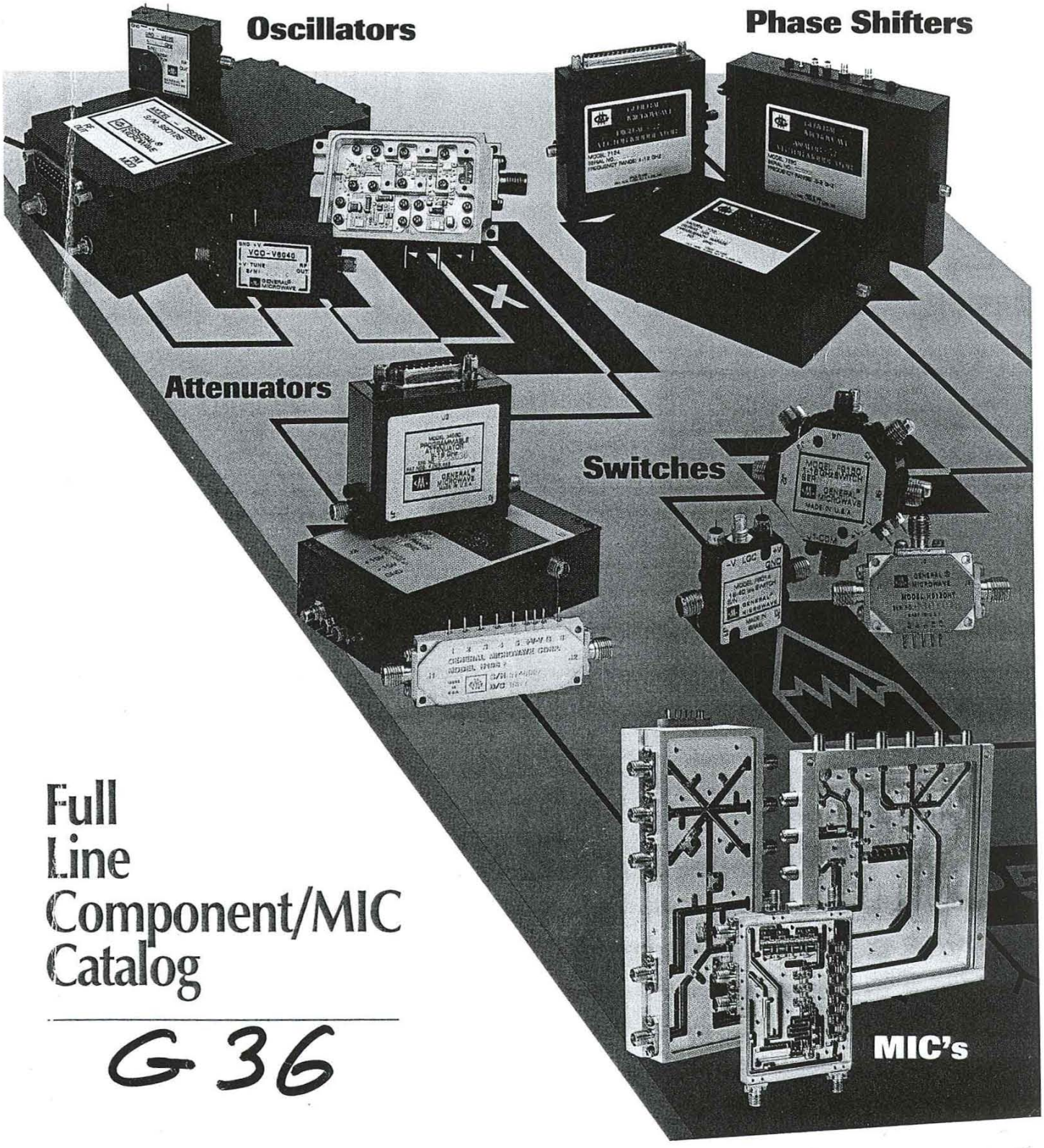
GENERAL MICROWAVE



Full Line Component/MIC Catalog

G 36

Ordering Information

1. Please order by model number, option number (where applicable), and product name.

   Telephone orders for standard catalog products will be accepted and processed immediately. However, shipment cannot be made until a confirming written order is received, either by means of a standard purchase order form or a FAX containing the following information as a minimum.

   Purchase order number.
   Ship to and bill to addresses.
   Description, model number and unit price.
   Name of authorized representative of purchasing department.
   Method of shipment.
   Amount of insurance on shipment.
   Sales/Use tax status of order.

   An order for special or modified catalog products cannot be processed prior to receipt of written authorization.

2. Address all purchase orders to:

   General Microwave Corporation (GMC)
   5500 New Horizons Blvd.
   Amityville, N.Y. 11701-1156

   or in care of our Engineering-Sales Representative in your area. Determination of prices, terms and conditions of sale, and final acceptance of orders are made only at the GMC factory.

3. Terms of payment for domestic orders are Net 30 days, subject to approval of credit. If credit has not been established, please provide payment in full or authorization to ship C.O.D. (certified or bank check only). All prices are FOB Amityville, New York and include packing to good commercial practice. If desired, payment can be made using a VISA or MasterCard credit card. Please advise credit card number and expiration date when placing order. The credit card voucher will not be processed until shipment is made.

   NOTE: Title and risk of loss and damage pass to the purchaser when the shipment is accepted by a common carrier.

4. Our export terms are prepayment or irrevocable sight letter of credit confirmed, engaged and accepted by Key Bank of New York, 1377 Motor Parkway, Islandia, N.Y. 11788.

5. The right to discontinue any item and to change specifications or prices at any time without notice is reserved.

6. The minimum order is $100, unless prepayment is received. The minimum line item charge is $10.

7. Unless specific instructions accompany the order, shipment is made via uninsured UPS or Parcel Post. Air freight shipments will be made FOB origin, freight charges collect.

8. Unless otherwise specified on the face of the order, overseas shipment will be made via air freight using a freight forwarder selected by GMC, with all charges, including forwarder, inland freight, air freight, insurance, consular and banking fees charged to the buyer's account.

9. Units returned for repair must be returned freight prepaid, FOB GMC factory. If warranty repair is applicable, the unit will be repaired and returned freight prepaid. If warranty repair is not applicable, the customer will be advised of the repair charges and his authorization to proceed awaited before any costs are incurred. Non-warranty repairs will be returned FOB Amityville, N.Y.

   Returns from outside the United States must be made Free House/Free Domicile. Note that except where prior authorization has been received from the GMC factory, collect shipments will not be accepted by our receiving department.

10. GMC is obligated to process all orders based on their relative Defense Department priorities. Accordingly, all DO or DX ratings, as well as applicable government contract number(s), should be included on advance and confirming purchase orders.

11. Standard instruments or components returned for credit in a new and unused condition within 60 days after shipment will be accepted subject to a restocking charge of 15% of the selling price ($350 minimum).

12. Deliveries quoted are subject to prior sale.

13. Prices quoted are based on inspection at destination. If source inspection is desired, add $500/inspection day or 3% of the hardware price, whichever is greater.

14. Each unit will be accompanied by one copy of our standard operating instructions and will be tested in accordance with GMC's standard acceptance test procedure for the particular item. Unless specified in the schedule of items or services, no other data or special testing will be provided.

15. Quoted price is based on production and shipment in accord with GMC's most economical rate including accelerated and/or earlier delivery. GMC reserves the right to make partial shipments on a line item or quantity basis.

16. GMC will make its best efforts to ship on/before the promised delivery date. However, failure to do so will not be considered cause for cancellation or for claims arising therefrom.

17. Many of the products manufactured by General Microwave require U.S. Government Export Licenses prior to shipment abroad. Therefore, if the products are to be exported from the U.S. by purchaser or purchaser's agent, or if purchaser transfers title to anyone else who will export the products from the U.S. purchaser is hereby advised that a U.S. Government Export License may be required prior to shipment. All sales by General Microwave assume that the proper licenses are obtained by purchaser, purchaser's agent or transferee before the products are exported.

18. GMC is only authorized to collect taxes for the States of California and New York, and will automatically add the appropriate sales/use taxes to our invoices unless advised to the contrary. In all other states, it is understood that the buyer will pay any applicable taxes directly from his facility.

19. All inventions conceived or first reduced to practice during the course of any contract or order placed with General Microwave are the property of General Microwave, and no rights by way of license or otherwise to such inventions are granted by General Microwave, notwithstanding any clauses to the contrary included or referred to in the solicitation, contract or order.

20. The following warranty applies:

EQUIPMENT WARRANTY

General Microwave Corporation warranties all parts of equipment of its manufacture to be free from defects caused by faulty material or poor workmanship. This warranty excludes electronic tubes, batteries, natural rubber and material normally consumed in operation unless such excepted items fail as a result of improper application by General Microwave.

Liability under this warranty is limited to the obligation to repair, or, at General Microwave's sole option, to replace without charge, FOB General Microwave's Plant, any part found to be defective under normal use and service within the time periods shown below, provided:

(1) General Microwave Corporation is promptly notified within the warranty period in writing upon discovery of such defects;

(2) The original parts or equipment are returned to General Microwave Corporation, transportation charges prepaid;

(3) General Microwave Corporation's examination shall disclose to its satisfaction that such defects have not been caused by abuse after delivery.

Warranties shall not apply to items which have been repaired or altered by others than General Microwave Corporation or its authorized agency.

The period of warranty is one year after delivery of the instrument or component to the original purchaser.

The warranty period shall not include any period of time the unit or part fails to perform satisfactorily due to such defect, and any unit, part or component repaired or replaced by General Microwave pursuant to this warranty shall itself be guaranteed as specified above.

Specification Update (cont'd)

Page 109: In the Option 27 entry in the AVAILABLE OPTIONS table, change "(Not applicable to Series 91/92)" to "(Not applicable to the Driverless Units, Series 91/92)".

Page 109: The ".55 (14,0)" dimension shown to the right of connector J1 is incorrectly shown as extending to the center of the mounting hole. It should extend to the side of the unit on which connector J2 is mounted.

Page 109: The ".13 (3, 3)" dimension shown to the left is incorrectly shown as extending to the mounting surface. It should extend to the surface closest to the ground pin.

Page 111: In the Power Supply Requirements section, change "-12 to ±5%" to "-12 V ±5%".

In the Available Options section, add "Option 48 +5V, -15V Operation".

Page 130: Change the Insertion loss specification in the 12.4 - 18 GHz column to the following:

F9180	From 3.8 to 4.0 dB
F9180W	From 4.2 to 4.4 dB

Page 138: In footnote (1), change "see page 86" to "see page 142".

Pages 155-171: Replace with the attached 20 page document.

Page 158:

TEST	METHOD	CONDITION
Internal Visual	2017.3	-
Temperature Cycle	1010.5	B
Mechanical Shock	2002.3	A
Burn-In *	1015.4	-
Leak	1014.2/.9	A1 & A2

* Burn-in temperature is + 110°C.

GENERAL MICROWAVE
5500 New Horizons Blvd., Amityville, NY 11701
TEL: 516-226-8900 • FAX: 516-226-8966

Specification Update

Please annotate your copy of General Microwave's Catalog G36 in some convenient manner to reflect the following:

Page 0: Replace with the attached version.

Page 16 and all pages containing outline drawings:

Add "TYPICAL" next to SMA Connector protrusion dimensions.

Page 22: In the D1950A Flatness tabulation, change "2.2" to "2.5".

Page 22: In the Power Supply Requirement specification, change -12 V current from "25mA" to "50mA".

Page 27: Add the following to one of the four mounting holes in the outline drawing:

.120 (3,0) DIA THRU X 4

Page 30: In the outline drawing, change the thickness from ".24 (6,1)" to ".27 (6, 9)".

Page 30: Change Table 1 to the following:

TEST	METHOD	CONDITION
Internal Visual	2017.3	-
Temperature Cycle	1010.5	B
Mechanical Shock	2002.3	B
Burn-In *	1015.4	-
Leak	1014.2/.9	A1 & A2

* Burn-in temperature is + 110°C.

Pages 33 and 44: In the outline drawings, change "4 X .120 (3,0)" to "4-40 THD THRU 4 X".

Page 38: In the AVAILABLE OPTIONS table, add * after the Option 5002 description and add the following:

* Consult factory for impact on other specifications, i.e., VSWR and Insertion loss.

Specification Update

Rf RADIATION HAZARD METERS BROCHURE UPDATE

Please annotate your copy of General Microwave's 36 page RAHAM brochure in some convenient manner to reflect the following:

Page 23, SPECIFICATIONS Table

CHARACTERISTIC	SPECIFICATIONS
Frequency Sensitivity	Change "±1 dB 10 to 800 MHz"
	To "±1 dB 3 to 800 MHz"
	Change "±2 dB 10 to 1000 MHz"
	To "±2 dB 3 to 1000 MHz"
Calibration Frequencies	Add 700 and 800 MHz
Isotropy	Change "±2 dB 10 to 1000 MHz"
	To "±2 dB 3 to 1000 MHz"

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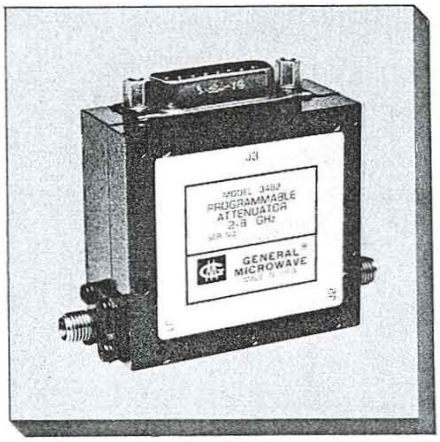
Contents

New Products

0.05 - 18 GHz 10 Bit Digital PIN Diode Attenuators

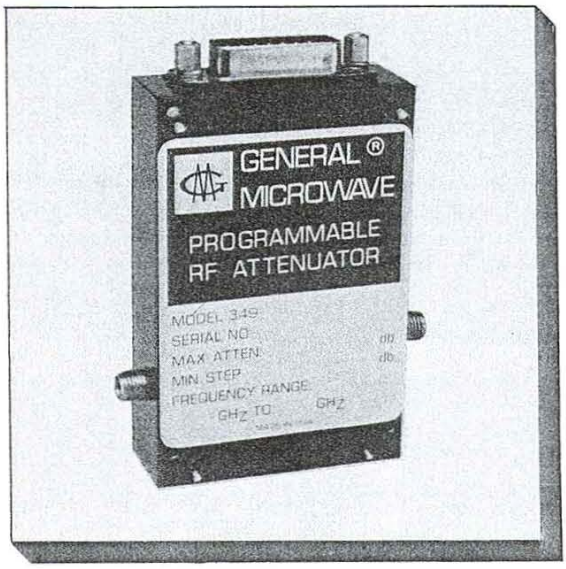


Series 346C
(see page 39)

2 - 18 GHz 8 Bit Digital/ Analog Attenuators

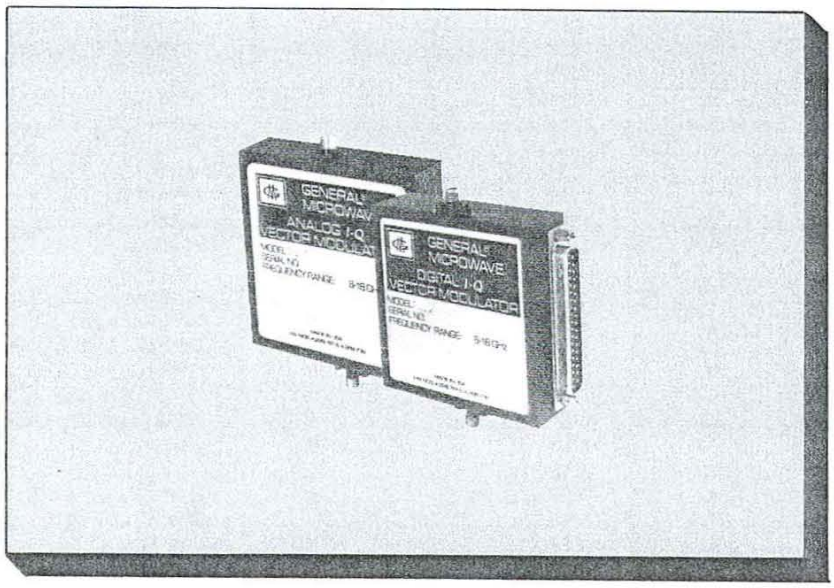
Series 348 and 348H
(see page 45)

0.75 - 18 GHz 11 Bit Digital/Analog Attenuators



Series 349/349H
(see page 50)

2 - 24 GHz
Digital and Analog
I/Q Vector Modulators



Series 73 & 74
(see page 65)

0.5 - 18 GHz
10 Bit Digital and Analog
360° Phase Shifter &
Frequency Translators

Series 77 & 78
(see page 76)

Model Number Index

Model Number Index (Cont)

Product Index

Solid State Control Components

The introduction of the PIN diode more than 35 years ago has led to the development of a large family of rf and microwave control components, including switches, attenuators, modulators, and phase shifters that have become essential elements of most modern microwave systems. Today, the types of PIN diodes available to the component designer is quite extensive and permits a choice of electrical characteristics such as junction capacitance, minority carrier lifetime, reverse voltage breakdown, saturation resistance and resistance vs. current law as well as mechanical format when selecting a diode for a particular application. While a complete treatment of the PIN diode will not be presented here, some of the more important relationships in diode characteristics are described below.[1]

The unique property of the PIN diode that makes it particularly suitable for control component use is that, in its useful operating frequency range, it behaves as a current variable resistor in its forward biased state. Depending upon the diode construction, this resistance can vary from as low as a few tenths of an ohm when the diode is fully ON to as high as 10,000 ohms with zero bias current applied. The PIN diode displays this behavior because, unlike P-N junction diodes, a thin layer of Intrinsic material is inserted between heavily doped layers of P and N material. When dc current flows through the diode, a stored charge is created in the I layer which establishes the conductance of the diode. The charge is in the form of holes and electrons which have a finite recombination time. As long as the period of any time-varying current is sufficiently short compared to this recombination time, there is effectively no modulation of the diode conductance and, ignoring parasitic reactances, the diode behaves as a pure resistor.

If we define a transition frequency f_o as

$$f_o = \frac{1}{2\pi\tau},$$

where τ is the minority carrier lifetime,

then for frequencies significantly below f_o, the PIN diode will behave as a P-N junction, rectifying the applied a-c signal. For frequencies well above f_o, the diode will behave as a linear resistor. The range of τ varies from as low as 10 nsec to as high as 5 μsec, and correspondingly f_o varies from about 16 MHz to 32 kHz.

The degree to which the PIN diode will rectify the a-c signal and thereby generate harmonic power depends not only on the minority carrier lifetime but upon the ratio of the a-c current to the applied d-c current. In general, as the applied signal power rises and the operating frequency decreases, diodes with long minority carrier lifetimes and high bias current are required for satisfactory operation. Unfortunately, such diodes exhibit relatively long switching time and low modulation rates.

When one uses a PIN diode in the microwave frequency range, parasitic reactances will have first order effects. The most important of these is the diode junction capacitance which limits the diode impedance in its back biased state. For low frequency diodes in chip format, employing relatively large junction areas, the junction capacitance is of the order of 0.2 to 1.0 pf. At the other extreme, beam lead diodes exhibit the lowest available junction capacity, ranging from 0.02 to 0.08 pf. For high frequency multi-throw switches, beam lead diodes are frequently employed at the common junction because of their small physical size and low junction capacity. Even with a capacitance as low as 0.02 pf, at a frequency of 18 GHz, the diode will have an impedance of only about 450 ohms in its back biased state due to this reactance. In similar manner, the intrinsic diode inductance as well as that of the connecting ribbons have a significant effect upon the frequency related behavior of the PIN diode.

The diode saturation resistance presents a loss mechanism in the rf and microwave circuit. This resistance can vary from a few tenths of an ohm in a chip diode, to as high as 5 ohms in a low-capacity beam lead diode. In general, there is an inverse relationship between diode junction capacity and saturation resistance. Therefore, in high frequency applications, where low capacity is generally required for best isolation and/or impedance match, higher insertion loss generally arises due to the loss attributed to the diodes.

In the sections that follow more detailed discussions are presented of the circuit topologies, design tradeoffs and performance characteristics of GMC's families of control components. GMC's large number of custom designs, which have evolved from these products, have not been included because of space limitations. Consultation with the factory is recommended for such requirements.

(1) *The reader interested in more information on this subject should consult one or more of the following references:*
"Microwave Semiconductor Engineering", J.F. White, Van Nostrand Reinhold Company, 1982.
"Microwave Semiconductor Control Devices", K.E. Mortenson, Microwave Journal, May 1964, pp 49-57.
"Fundamental Limitations in RF Switching and Phase Shifting Using Semiconductor Diodes", M.E. Hines," Proceedings of the IEEE, vol. 52, pp 697-708.
"Biasing and Driving Considerations for PIN Diode RF Switches and Modulators" Hewlett-Packard Applications Note 914, Jan. 1967.

Attenuators

General Microwave PIN diode attenuators cover the frequency range from 200 MHz to 40 GHz and are available in numerous configurations to permit the user to optimize system performance. Most designs are available with either analog or digital control, operating over octave or multi-octave bands with high or moderate switching speed characteristics.

ATTENUATOR TOPOLOGY

GMC PIN diode attenuators are designed with several different topologies, each of which has been selected to optimize certain performance characteristics. A brief discussion of these various topologies is presented below including a treatment of performance trade-offs.

SHUNT-MOUNTED REFLECTIVE ATTENUATOR

The simplest version of a PIN diode attenuator consists of one or more PIN diodes in shunt with a transmission line as shown in Fig. 1. This design provides a broadband reflective attenuator that can reach very high levels of attenuation, depending upon the number and electrical spacing of the diodes. While it generally has very low insertion loss and can operate at high switching rates, its usefulness is limited by the very large mismatch it presents in the attenuation state.

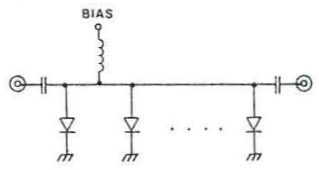


Fig. 1-Shunt mounted reflective attenuator

BALANCED ATTENUATOR

By placing identical shunt-mounted reflective attenuators between an appropriately connected pair of 3 dB quadrature hybrid couplers, a balanced attenuator is realized (see Fig. 2). The balanced attenuator has all the simplicity of the shunt-mounted reflective attenuator with the added feature of providing low VSWR under all conditions of attenuation. In addition, power handling is improved by 3 dB due to the power split of the input hybrid. This style of PIN diode attenuator offers simplicity, up to 3 to 1 bandwidth, moderately fast speed, and excellent linearity. Balanced attenuators are available from GMC covering the frequency range of 0.5 to 40.0 GHz.

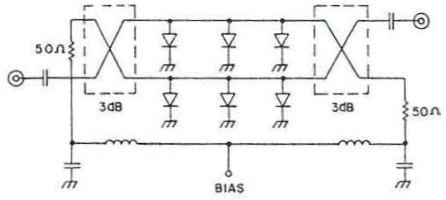


Fig. 2-Balanced attenuator

ARRAY ATTENUATOR

With the addition of terminating diode elements to the shunt-mounted reflective attenuators of Fig. 1, an attenuator can be realized with low VSWR that can operate over an octave band (see Fig. 3). By tapering the diode and transmission line impedance and adding multiple transformer sections it is possible to obtain good VSWR and attenuation characteristics over several octaves.

GMC employs array attenuators in a number of custom designs.

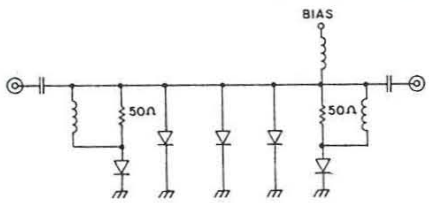


Fig. 3-Array attenuator

T-PAD AND π-PAD ATTENUATORS

The broadest frequency coverage available is obtained with some form of T-pad or π-pad attenuator. These are lumped element circuits which function in the microwave frequency range in essentially the same manner as they do at DC. Attenuation variation is obtained by simultaneously changing the bias current of the series and shunt diodes comprising the pads in a manner that assures constant impedance at all levels. Fig. 4 shows the basic configurations of both circuits. Only the T-pad configuration is used by GMC due to the difficulties in realizing sufficiently low stray reactances and short transmission line lengths in π-pad circuits for operation at higher microwave frequencies. Models of these attenuators cover the full frequency range from 0.2 to 18.0 GHz with excellent attenuation flatness and moderate switching speed.

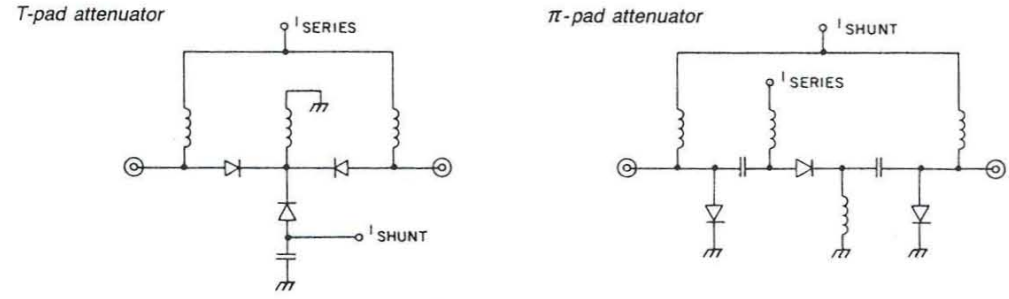


Fig. 4--Attenuator configurations

SWITCHED BIT ATTENUATORS

When an attenuator with a fast switching speed and high power handling capacity is required, the only option is to utilize a switched-bit attenuator. This attenuator combines one or more tandem pairs of SP2T switches with a zero loss connection between one pair of outputs and a fixed attenuator inserted in the other (see Fig. 5). In this configuration the PIN diodes are not used as variable resistors, but are switched between their forward and reversed biased states. This allows for much faster switching speed since high speed PIN diodes and drive circuitry can be used. In addition, it offers higher power handling capacity since the RF power is absorbed in the fixed attenuator(s), and not in the PIN diodes.

There are some disadvantages to this approach that may limit its usefulness. First, the minimum practical attenuation step size at microwave frequencies is about 0.5 dB due to interacting VSWR's as the bits are switched. These interactions may lead to a non-monotonic response as the attenuation is changed in increments of one LSB, i.e., the attenuation level may actually decrease when an increasing attenuation step is called for. Second, because of the RF circuit complexity, the cost of this attenuator is usually higher than other approaches. Finally, the incorporation of high speed switches may lead to excess video leakage.

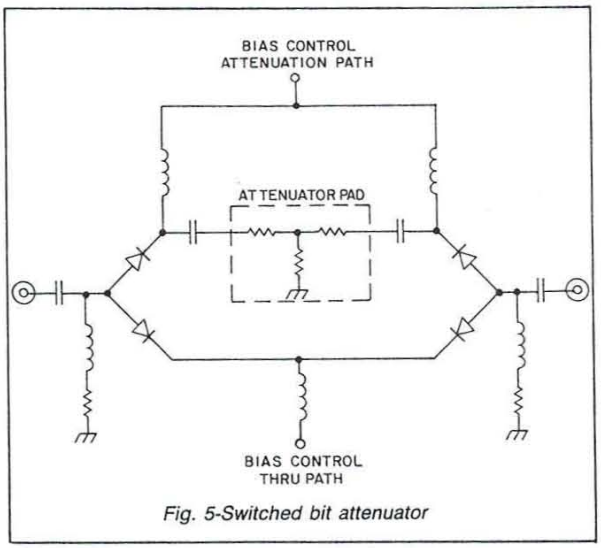


Fig. 5-Switched bit attenuator

PHASE INVARIANT ATTENUATORS

This specialized class of attenuators has the property that the insertion phase variation is minimized as the attenuation level is changed. A unique topology is employed by GMC to obtain this performance which is described in detail in a separate technical paper.[1] In all other respects they perform in a manner similar to the balanced attenuators described above.

DRIVER CONSIDERATIONS

All attenuators except for the switched bit variety are available with linearizing driver circuits with either analog or digital control inputs. In addition, many attenuators are available without the driver for those who choose to provide their own. Most digital attenuators are available with eight-bit TTL control which, for an attenuator with a nominal attenuation range of 60 dB, will provide a resolution of 0.25 dB. Some attenuators are available with a resolution of as low as 0.05 dB. Except for switched-bit designs, all PIN diode attenuators are analog in nature and thus their resolution is essentially limited by the DAC used in the driver circuit.

The driver circuit includes compensating elements to minimize the variation of attenuator with temperature. It also provides the proper source impedance and switching waveforms to optimize switching speed.

(1) *"Broadband Phase Invariant Attenuator", D. Adler and P. Maritato; 1988 IEEE MTTS Digest, pp 673-676. To obtain a copy of this paper, please write to Dept. C., General Microwave Corporation, 5500 New Horizons Blvd., Amityville, NY 11701.*

Attenuators

MONOTONICITY

In most applications it is imperative that the attenuator displays monotonic behavior as a function of the control input. Non-monotonic performance can occur in switched bit attenuators when interacting VSWR's are not properly compensated, or in digitally controlled analog attenuators when a non-monotonic condition exists in the MSB of the DAC. All GMC's attenuators are guaranteed monotonic.

PHASE SHIFT vs. ATTENUATION

All attenuators exhibit a variation in phase shift with attenuation level (AM/PM modulation). Fig. 6 shows typical phase shift variation as a function of attenuation for a number of GMC attenuator models. The phase shift is attributable to both the stray reactance of the PIN diodes as well as the lengths of transmission line interconnecting the diodes. While it is possible to minimize the AM/PM by careful design, it is not possible to eliminate it entirely. Where minimum change of phase with attenuation is a critical parameter, the use of GMC's line of Phase Invariant Attenuators described above should be considered.

HARMONICS AND INTERMODULATION PRODUCTS

All PIN diode control devices (i.e. attenuators, switches and phase shifters) will generate harmonics and intermodulation products to some degree since PIN diodes are non-linear devices. When compared to digital switched-bit designs, analog PIN diode attenuators are more prone to generate spurious signals since the diodes function as current variable resistors and are typically operated at resistance levels where significant RF power is absorbed by the diode.

The levels of harmonic and intermodulation products generated by an attenuator are greatly dependent upon its design, the operating frequency, attenuation setting and input power level. Typical performance for a moderately fast attenuator i.e. 500 nsec switching speed, follows:

TYPICAL ATTENUATOR INTERCEPT POINTS

FREQUENCY	2nd ORDER INTERCEPT	3rd ORDER INTERCEPT
2.0 GHz	+35 dBm	+30 dBm
8.0 GHz	+40 dBm	+35 dBm

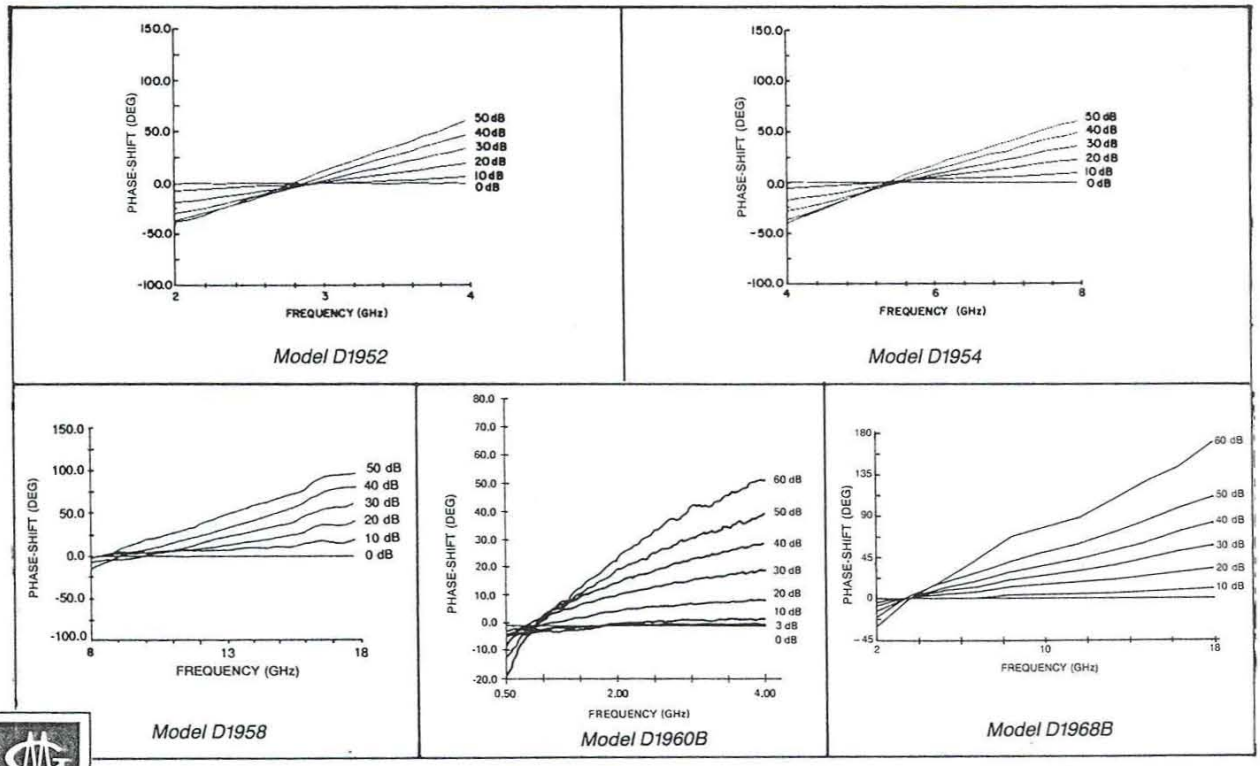


Fig. 6 Typical Phase vs. Attenuation

POWER HANDLING

The power handling of a PIN diode attenuator is dependent on its topology, biasing levels, and switching speed. The faster the attenuator, the lower the power handling capability. This catalog specifies both the maximum operating and the maximum survival levels. Maximum operating level is defined as that which will cause either a one dB compression of attenuation level or an out of specification condition. The survival levels are generally dependent on the maximum ratings of the semiconductors in the attenuator. Please consult the factory for special applications requiring higher operational power levels than those listed in this catalog.

DEFINITION OF PARAMETERS

MEAN ATTENUATION is the average of the maximum and minimum values of the attenuation over the specified frequency range for a given control signal.

ATTENUATION FLATNESS is the variation from the mean attenuation level over the specified frequency range. This is usually a function of the attenuation level, and is expressed in ± dB.

ATTENUATION ACCURACY is the maximum deviation of the mean attenuation from the programmed attenuation value expressed in dB when measured at +23 ±5°C.

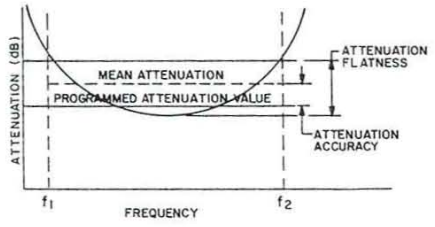


Fig. 7-Total accuracy

TOTAL ACCURACY is the sum of all the effects which contribute to the deviation from the programmed attenuation value. It includes the effects of attenuation accuracy, frequency variation and temperature, as shown in Fig. 7.

SWITCHING SPEED[2]

The following are the standard definitions of switching speed, as shown in Fig 8:

Rise Time is the transition time between the 10% and 90% points of the square-law detected RF power when the unit is switched from full OFF to full ON.

Fall Time is the transition between the 90% and 10% points of the square-law detected RF power when the unit is switched from full ON to full OFF.

(2) *For units without integrated drivers, the specifications apply to conditions when the attenuator is driven by an appropriately shaped switching waveform.*

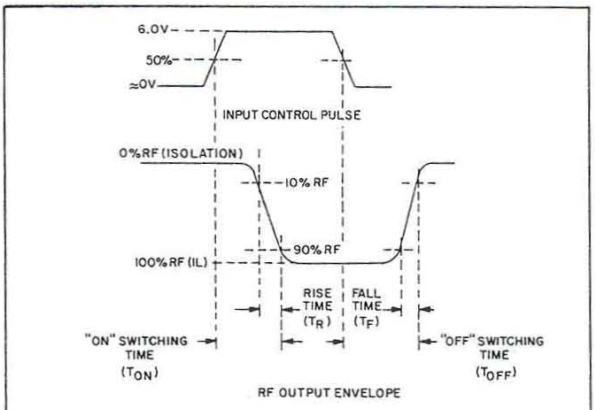


Fig. 8-Switching speed

On Time is the transition time between 50% of the input control signal to the 90% point of the square-law detected RF power when the unit is switched from full OFF to full ON.

Off Time is the transition time between 50% of the input control signal to the 10% point of the square-law detected RF power when the unit is switched from full ON to full OFF.

Note: Depending on the attenuator topology, there are differences in the behavior of the switching characteristics that may affect system performance. Switching speed is only specified to the 90% or 10% points of the detected RF signal, but the time the attenuator takes to reach final attenuation value or switch between different attenuation levels may be significantly longer.

MODULATION BANDWIDTH

Small Signal Bandwidth: With reference to a modulation frequency of 100 Hz and a modulation depth of ±3 dB at a quiescent level of −6 dB, the frequency at which the modulation depth decreases by 50% as measured with a square-law detector.

Large Signal Bandwidth: With reference to a modulation frequency of 100 Hz and a 100% modulation depth at a quiescent level of −6 dB, the frequency at which the modulation depth decreases by 50% as measured with a square-law detector.

TEMPERATURE COEFFICIENT is defined as the average rate of change of attenuation over the full operating temperature range of the unit under fixed bias conditions. It is expressed in dB/°C. Note that the attenuator temperature coefficient may vary with both temperature and programmed attenuation level.

Attenuator Selection Guide

ATTENUATORS AND MODULATORS

FREQUENCY RANGE (GHz) 0.2 0.5 1.0 2.0 4.0 8.0 12.4 18.0	ATTENUATION RANGE (dB)	MODEL	PAGE	COMMENTS
CONTINUOUSLY VARIABLE, CURRENT CONTROLLED, ABSORPTIVE ATTENUATORS				
0.5 — 1	80	1950A	17	Single control
1 — 2	60	1951		
2 — 4	60	1952		
2.6 — 5.2	60	1953		
4 — 8	60	1954		
5 — 10	60	1955		
6 — 12	60	1956		
8 — 18	60	1958		
18 — 40	50	1959	144	
CONTINUOUSLY VARIABLE, VOLTAGE CONTROLLED, LINEARIZED ABSORPTIVE ATTENUATORS				
0.5 — 4	60	D1960B	25	Integrated driver and rf section
0.5 — 8	60	D1961B		
2 — 8	60	D1962B		
2 — 18	60	D1968B		
0.5 — 1	80	D1950A	21	
1 — 2	60	D1951		
2 — 4	60	D1952		
2.6 — 5.2	60	D1953		
4 — 8	60	D1954		
5 — 10	60	D1955		
6 — 12	60	D1956		
8 — 18	60	D1958		
18 — 40	50	D1959	144	
VOLTAGE CONTROLLED, HERMETICALLY SEALED, LINEARIZED ABSORPTIVE ATTENUATOR				
2 — 18	60	H1968	28	Integrated driver and rf section
VOLTAGE CONTROLLED, PHASE INVARIANT, LINEARIZED ATTENUATORS				
2 — 6	32	D1972	31	Integrated driver and rf section
4 — 11	32	D1974		
6 — 18	32	D1978		
HIGH SPEED ABSORPTIVE PULSE MODULATORS				
0.2 — 18	80	F192A	14	Integrated driver and rf section
0.2 — 18	80	HM192	136	Integrated driver and rf section, miniaturized, hermetically sealed

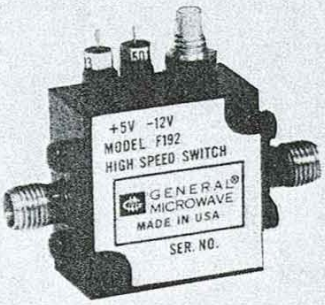
Attenuator Selection Guide (Con't)

ATTENUATORS AND MODULATORS (con't)

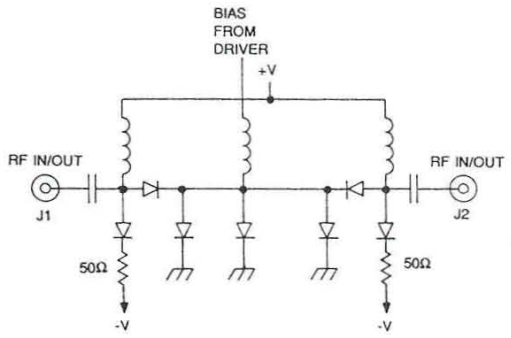
FREQUENCY RANGE (GHz) 0.2 0.5 1.0 2.0 4.0 8.0 12.4 18.0	ATTENUATION RANGE (dB)	MIN STEP SIZE (dB)	MODEL	PAGE	COMMENTS
DIGITALLY PROGRAMMABLE, HERMETICALLY SEALED, ABSORPTIVE ATTENUATORS					
0.5 — 6	63	1.0	H1980	34	Integrated driver and rf section
2 — 6	63	1.0	H1982		
DIGITALLY PROGRAMMABLE ABSORPTIVE ATTENUATORS, ULTRA-BROADBAND					
0.2 — 18	60	1	3250A	36	Integrated driver and rf section
DIGITALLY PROGRAMMABLE ABSORPTIVE ATTENUATORS, MULTI-OCTAVE BAND					
0.5 — 4	60	0.06 dB	3460C	39	Integrated driver and rf section
0.5 — 8	60	0.06 dB	3461C		
2 — 8	60	0.06 dB	3462C		
2 — 18	60	0.06 dB	3468C		
DIGITALLY PROGRAMMABLE, PHASE INVARIANT ATTENUATORS, MULTI-OCTAVE BAND					
2 — 6	32	0.125	3472	42	Integrated driver and rf section
4 — 11	32	0.125	3474		
6 — 18	32	0.125	3478		
DIGITALLY PROGRAMMABLE, MINIATURIZED, ABSORPTIVE ATTENUATORS, OCTAVE BAND					
2 — 4	60	0.25	3482, 3482H	45	Integrated driver and rf section
2.6 — 5.2	60	0.25	3483, 3483H		
4 — 8	60	0.25	3484, 3484H		
6 — 12	60	0.25	3486, 3486H		
8 — 18	60	0.25	3488, 3488H		
MINIATURE, DIGITALLY CONTROLLED, PIN DIODE ATTENUATOR					Integrated driver and rf section
2 — 18	60	0.5	1761	48	
DIGITALLY PROGRAMMABLE ABSORPTIVE ATTENUATORS, OCTAVE BAND					
1 — 2	80	0.03	3491, 3491H	50	Integrated driver and rf section
2 — 4	80	0.03	3492, 3492H		
2.6 — 5.2	80	0.03	3493, 3493H		
4 — 8	80	0.03	3494, 3494H		
5 — 10	80	0.03	3495, 3495H		
6 — 12	80	0.03	3496, 3496H		
8 — 18	64	0.03	3498, 3498H		
18 — 40	50	0.03	3499	146	

Model F192A Non-Reflective Ultra-Broadband High-Speed Pulse Modulator

- **High speed**
- **0.2 to 18 GHz frequency range**
- **80 dB isolation**
- **Low VSWR and insertion loss**
- **Small size, light weight**



The Model F192A is a high-speed non-reflective PIN diode pulse modulator with integrated driver. Operating over the instantaneous frequency range from 0.2 to 18 GHz, it provides a minimum isolation of 80 dB from 0.5 to 18 GHz, and 70 dB below 0.5 GHz. The rf design consists of an arrangement of shunt and series diodes in a microstrip integrated circuit transmission line as shown in the schematic diagram below.



Model F192A RF Schematic Diagram

The currents required to switch the unit ON or OFF and simultaneously maintain a bilateral 50-ohm impedance match in both states are provided by the integrated driver, which is controlled by an external logic signal.

Model F192A Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	FREQUENCY (GHz)				
	0.2 to 0.5	0.5 to 2.0	2.0 to 8.0	8.0 to 12.4	12.4 to 18.0
Min Isolation (dB)	70	80	80	80	80
Max Insertion Loss (dB)	2.0	2.0	2.5	3.0	3.5
VSWR (ON and OFF)	1.5	1.5	1.75	2.0	2.0

Switching Speed

Rise Time . . . . . 10 nsec. max.
Fall Time . . . . . 10 nsec. max.
ON Time . . . . . 30 nsec. max.
OFF Time . . . . . 15 nsec. max.

Power Handling Capability

Without Performance Degradation . . . . . 500 mW cw or peak
Survival Power . . . . . 1W average, 10W peak (1 μsec max. pulse width)

Power Supply Requirements

+5V ±5%, 90 mA
−12V ±5%, 75 mA

Control Characteristics

Control Input Impedance . . . . TTL, advanced Schottky, one-unit load. (A unit load is 0.6 mA sink current and 20μA source current.)
Control Logic . . . . Logic "0" (−0.3 to +0.8V) for switch ON and logic "1" (+2.0 to +5.0V) for switch OFF.

Model F192A Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −65°C to +110°C

Non-Operating Temperature Range ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

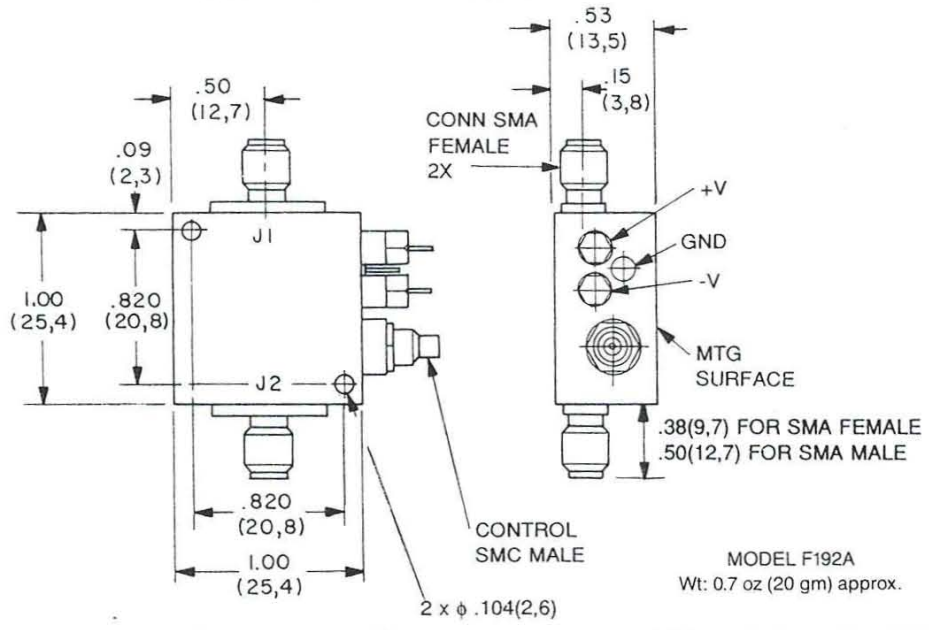
Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connector
7	Two SMA male rf connectors
9	Inverse control logic; logic "1" for switch ON and logic "0" for switch OFF
10	One SMA male (J1) and one SMA female (J2) rf connector
33	EMI filter solder-type control terminal
48	+5, −15V operation
64A	SMB male control connector

DIMENSIONS AND WEIGHT



MODEL F192A
Wt: 0.7 oz (20 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02: .XXX ± .005

Series 195 Octave-Band PIN Diode Attenuator/Modulators

SERIES 195

Series 195 current-controlled attenuator/modulators provide small size with greater than octave-bandwidth performance at low cost. All models except the 1950A* provide a minimum of 60 dB of attenuation with fall times of 20 nsec max, and rise times ranging from 25 nsec max for the 1951 and 1952 to 125 nsec max for the 1956 and 1958. The 1950A* provides a minimum of 80 dB of attenuation with a fall time of 50 nsec max and a rise time of 250 nsec max. These characteristics make this series suitable for a wide range of applications including level setting, complex amplitude modulation, pulse modulation and high-speed switching. The eight models in the Series 195 encompass a frequency range from 0.5 to 18 GHz. All models except the 1950A* are capable of extended bandwidth operation, typically 3:1, with only moderate degradation in performance at the band edges.

As shown in figures 1 and 2 below, the rf circuit employed in all models except the Model 1950A* uses two shunt arrays of PIN diodes and two quadrature hybrid couplers. The quadrature hybrids are of a unique GMC microstrip design which are integrated with the diode arrays to yield a minimal package size. The rf circuit employed in the Model 1950A* uses one shunt array of PIN diodes with input and output impedance matching circuits.

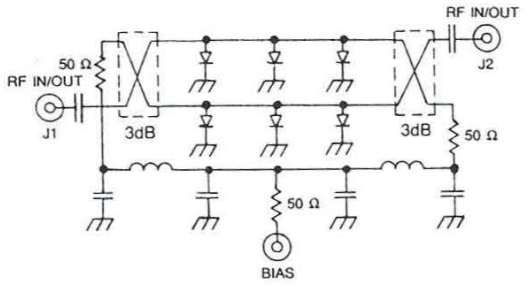


Fig. 1-Models 1951-1958, rf schematic diagram

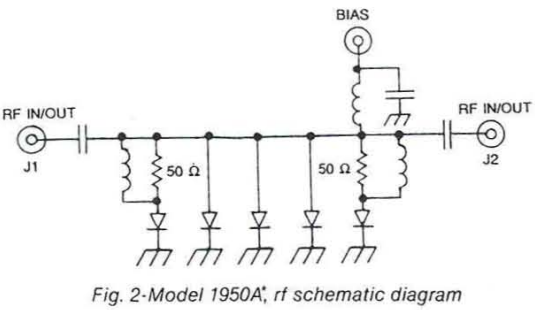
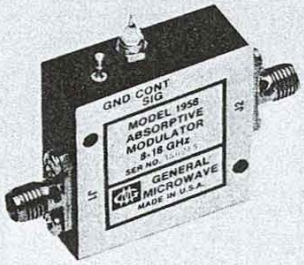
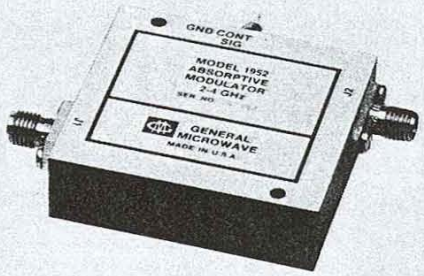


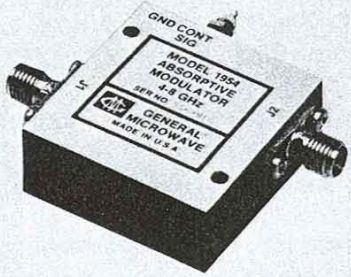
Fig. 2-Model 1950A, rf schematic diagram*

*Model 1950A is a special-order product. Consult factory before ordering.

- **Absorptive**
- **Current controlled**
- **0.5 to 18 GHz frequency range**
- **High performance MIC quadrature hybrid design**
- **High speed**







Series 195 Specifications

MODEL	FREQUENCY RANGE (GHz)	MAX. INSERTION LOSS (dB)	MAX. VSWR	FLATNESS (±dB) AT MEAN ATTENUATION LEVELS UP TO				
				10 dB	20 dB	40 dB	60 dB	80 dB
1950A*	0.5 – 1.0	1.4	2.0	0.3	0.8	1.7	2.2	3.2
1951	1.0 – 2.0	1.3	1.5	0.3	0.8	1.5	1.6	
	0.75–2.25	1.4	2.0	0.5	1.4	3.0	3.5	
1952	2.0–4.0	1.5	1.5	0.3	0.8	1.5	1.6	
	1.5 – 4.5	1.6	2.0	0.5	1.4	3.0	3.5	
1953	2.6 – 5.2	1.7	1.6	0.3	0.8	1.5	1.6	
	1.95–5.85	1.8	2.1	0.5	1.4	3.0	3.5	
1954	4.0 – 8.0	2.0	1.7	0.3	0.8	1.5	1.6	
	3.0 – 9.0	2.1	2.2	0.5	1.4	3.0	3.5	
1955	5.0 –10.0	2.2	1.7	0.5	0.9	1.5	1.6	
	3.75 –11.25	2.3	2.2	0.7	1.4	3.0	3.5	
1956	6.0 – 12.0	2.3	1.8	0.7	1.0	1.5	1.6	
	4.5 – 13.5	2.4	2.2	0.9	1.5	3.0	3.5	
1958	8.0 – 18.0	2.5(1)	1.8(1)	0.7	1.0	1.5	1.6	
	6.0 – 18.0	2.5(1)	1.8(1)	0.9	1.5	3.0	3.5	

Note: Specifications for the extended frequency ranges are typical.

PERFORMANCE CHARACTERISTICS

Mean Attenuation Range
- 1950A* . . . . . 80 dB
- All other units . . . . . 60 dB

Monotonicity . . . . . Guaranteed

Phase Shift . . . . . See page 10

Temperature Effects . . . . . See Fig. 3

Power Handling Capability

Without Performance Degradation
- 1950A*, 1951 . . . . . 10 mW cw or peak
- All other units . . . . . 100 mW cw or peak

Survival Power (from −65°C to +25°C; see Fig. 4 for higher temperatures)
- All units . . . . . 1 W average
  25W peak (1 μsec max pulse width)

*Model 1950A is a special-order product. Consult factory before ordering.

Switching Speed

Fall Time
- 1950A* . . . . . 50 nsec max(2)
- All other units . . . . . 20 nsec max(2)

Rise Time
- 1950A* . . . . . 250 nsec max
- All other units . . . . . 125 nsec max

Bias Current for Maximum Attenuation
- 1950A* . . . . . 5 to 35 mA
- All other units . . . . . 15 to 70 mA

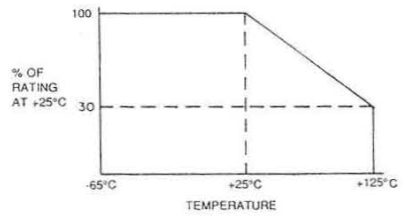


Fig. 4-Series 195 power derating factor

(1) *Except from 16 - 18 GHz where insertion loss is 3.5 dB max and VSWR is 2.0 max.*
(2) *For attenuation steps of 10 dB or more.*

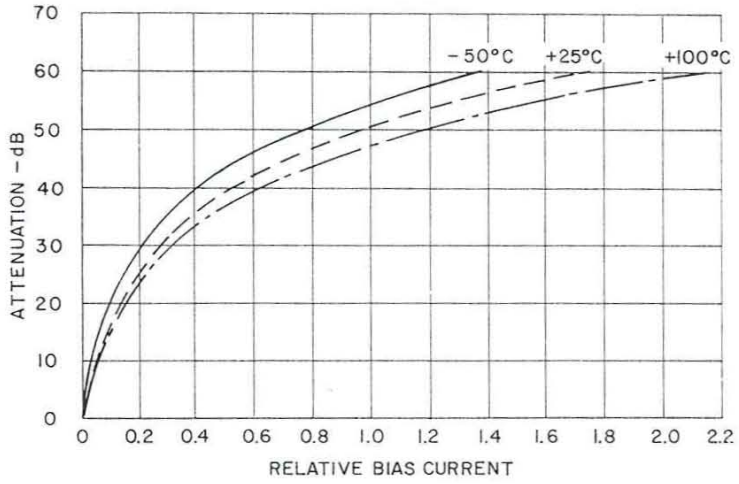


Fig. 3-Series 195, typical effects of temperature on attenuation

ENVIRONMENTAL RATINGS

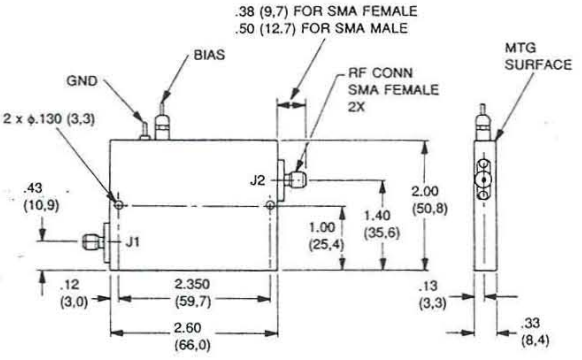
Operating Temperature Range	– 54 °C to + 125 °C
Non-Operating Temperature Range	– 65 °C to + 125 °C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias connector
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
64	SMC male bias connector
64A	SMB male bias connector

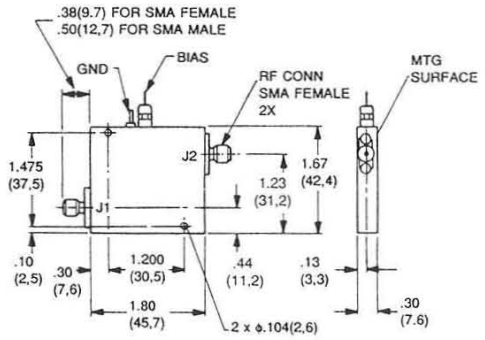
Series 195 Specifications

DIMENSIONS AND WEIGHTS

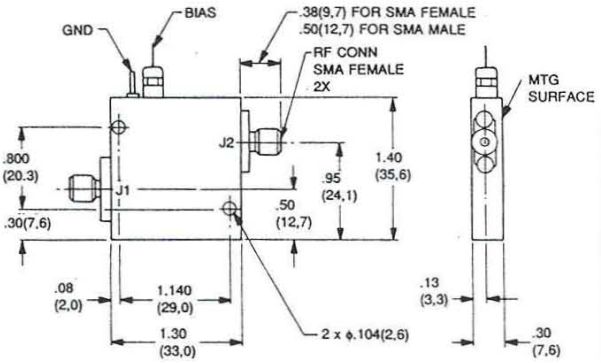


MODELS 1950A* AND 1951
Wt: 3 oz. (85 gm) approx.

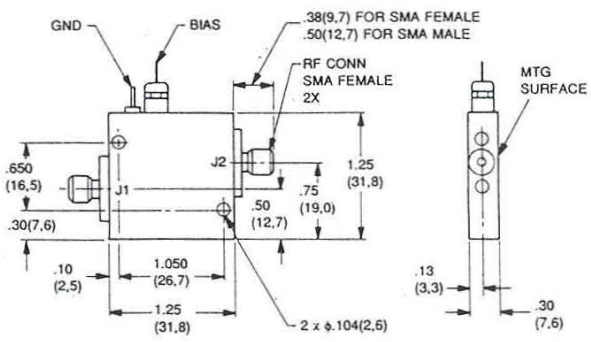
*Model 1950A is a special-order product. Consult factory before ordering.



MODELS 1952 AND 1953
Wt: 2 oz. (57 gm) approx.



MODELS 1954, 1955 AND 1956
Wt: 1 oz. (28 gm) approx.



MODEL 1958
Wt: 1 oz. (28 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series D195 Octave-Band PIN Diode Attenuator/Modulators

With Integrated Drivers

SERIES D195

The Series D195 voltage-controlled linearized attenuator/modulators are integrated assemblies consisting of a Series 195 unit and a hybridized driver circuit which provides a nominal transfer function of 10 dB per volt. (See figure 1 below.)

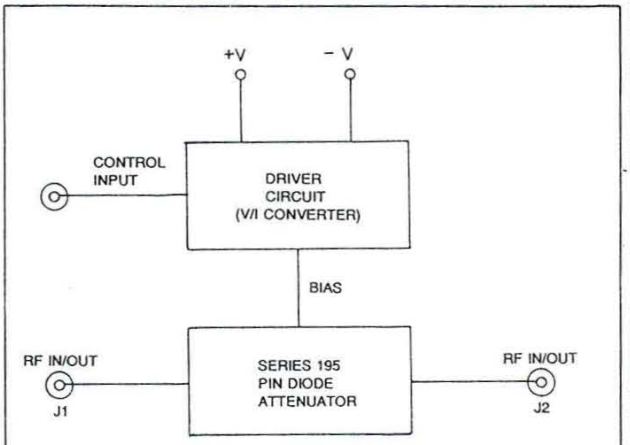
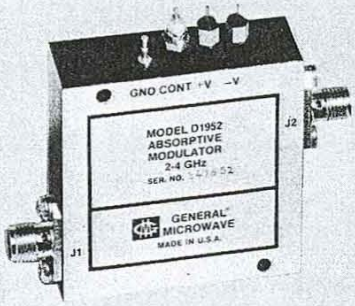


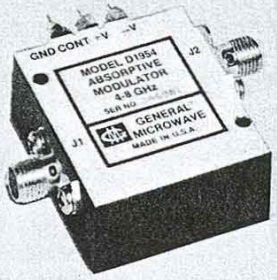
Fig. 1-Series D195, block diagram

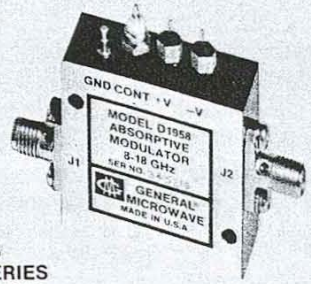
All of the Series D195 units except the D1950A* exhibit fall times of 20 nsec max and rise times of 1.5 μsec max for attenuation steps of 10 dB or more. For smaller excursions, the fall times can increase to several hundred nsec, while the rise times remain essentially unchanged. In applications where a rapid return to insertion loss from any level of attenuation is required, Option 59 is available. With this option, an external pulse is applied to trigger a high-speed reset circuit, and recovery times of 200 nsec max are obtained. Where use of an external reset pulse as described above is not feasible, an internal reset option (Option 58) is available which will automatically reset the unit to insertion loss within 200 nsec for a step of 50 dB or more.

The fall and rise time specifications for the D1950A* are 500 nsec max and 10 μsec max, respectively. Options 58 and 59 are not available for this model.

- **Absorptive**
- **Linearized**
- **Frequency range: 0.5 to 18 GHz**
- **High performance MIC quadrature hybrid design**
- **High speed**







ALL UNITS IN THIS SERIES ARE EQUIPPED WITH INTEGRATED DRIVERS

*Model D1950A is a special-order product. Consult factory before ordering.

Series D195 Specifications

MODEL	FREQUENCY RANGE (GHz)	MAX. INSERTION LOSS (dB)	MAX. VSWR	FLATNESS (± dB) AT MEAN ATTENUATION LEVELS UP TO				
				10 dB	20 dB	40 dB	60 dB	80 dB
D1950A*	0.5 – 1.0	1.4	2.0	0.3	0.8	1.7	2.2	3.2
D1951	1.0 – 2.0	1.6	1.5	0.3	0.8	1.5	1.6	
	0.75–2.25	1.7	2.0	0.5	1.4	3.0	3.5	
D1952	2.0 – 4.0	1.8	1.5	0.3	0.8	1.5	1.6	
	1.5 – 4.5	1.9	2.0	0.5	1.4	3.0	3.5	
D1953	2.6 – 5.2	2.0	1.6	0.3	0.8	1.5	1.6	
	1.95–5.85	2.1	2.1	0.5	1.4	3.0	3.5	
D1954	4.0 – 8.0	2.4	1.7	0.3	0.8	1.5	1.6	
	3.0 – 9.0	2.5	2.2	0.5	1.4	3.0	3.5	
D1955	5.0 – 10.0	2.6	1.7	0.5	0.9	1.5	1.6	
	3.75 –11.25	2.7	2.2	0.7	1.4	3.0	3.5	
D1956	6.0 – 12.0	2.7	1.8	0.7	1.0	1.5	1.6	
	4.5 – 13.5	2.8	2.2	0.9	1.5	3.0	3.5	
D1958	8.0 – 18.0	3.0(1)	1.8(1)	0.7	1.0	1.5	1.6	
	6.0 – 18.0	3.0(1)	1.8(1)	0.9	1.5	3.0	3.5	

Note: Specifications for the extended frequency ranges are typical.

PERFORMANCE CHARACTERISTICS

Mean Attenuation Range
D1950A* . . . . . 80 dB
All other units . . . . . 60 dB

Accuracy of Attenuation
0 to 30 dB . . . . . ± 0.5 dB
> 30 to 50 dB . . . . . ± 1.0 dB
> 50 to 60 dB . . . . . ± 1.5 dB
> 60 to 80 dB . . . . . ± 2.0 dB (D1950A* only)

Monotonicity . . . . . Guaranteed

Phase Shift . . . . . See page 10

Temperature Coefficient . . . . . ± 0.025 dB/°C

Power Handling Capability
Without Performance Degradation
D1950A*, D1951 . . . . . 10 mW cw or peak
All other units . . . . . 100 mW cw or peak
Survival Power (from −65°C to +25°C; see figure 2 for higher temperatures)
All units . . . . . 1 W average
25 W peak (1 μsec max pulse width)

Switching Characteristics
Off Time
D1950A* . . . . . 600 nsec max
All other units . . . . . 100 nsec max
On Time
D1950A* . . . . . 10 μsec max
All other units . . . . . 1.6 μsec max
Fall Time
D1950A* . . . . . 500 nsec max
All other units . . . . . 20 nsec max
Rise Time
D1950A* . . . . . 10 μsec max
All other units . . . . . 1.5 μsec max

Nominal Control Voltage Characteristics

Range	Operating	Maximum
D1950A*	0 to +8V	± 15V
All other units	0 to +6V	± 15V

Transfer Function . . . . 10 dB/volt
Input Impedance . . . . 10 Kohms
Modulation Bandwidth
Small Signal
D1950A* . . . . . 25 kHz
All other units . . . . 500 kHz
Large Signal
D1950A* . . . . . 5 kHz
All Other Units . . . 50 kHz

Power Supply Requirements . . . . . +12V ± 5%, 100 mA
−12V ± 5%, 25 mA

Power Supply Rejection . . . . . Less than 0.1 dB/volt change in either supply

*Model 1950A is a special-order product. Consult factory before ordering.

(1) *Except from 16 - 18 GHz where insertion loss is 4.0 dB max and VSWR is 2.0 max.*

ENVIRONMENTAL RATINGS

Operating Temperature Range	−54°C to +110°C
Non-Operating Temperature Range	−65°C to +125°C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connector
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
58	Internally-generated reset to insertion loss (not available on D1950A)(1)
59	Externally-triggered reset to insertion loss (not available on D1950A*)(2) (3)
61	20 dB/volt transfer function with 0 to +3V control signal input (+4V for the D1950A*)
62	± 15 volt operation
64	SMC male control connector
64A	SMB male control connector

(1) *Where use of an Option 59 external reset pulse (see note 2 below) is not feasible, this option is available which will automatically sense the slope and magnitude of the control signal and reset the unit to the insertion loss state within 200 nsec for a step of 50 dB or more.*

(2) *An external terminal is provided for the user to apply a fast (10 nsec max rise time) positive-going 3-volt pulse at least 0.5 μsec wide to accelerate the return of the attenuator to the insertion loss state with the simultaneous lowering of the control signal to the zero voltage level. This reset can be accomplished within 200 nsec.*

(3) *The input impedance of units equipped with Option 59 is a circuit equivalent to approximately 50 pF in series with a parallel combination of 100 pF and 1000 ohms.*

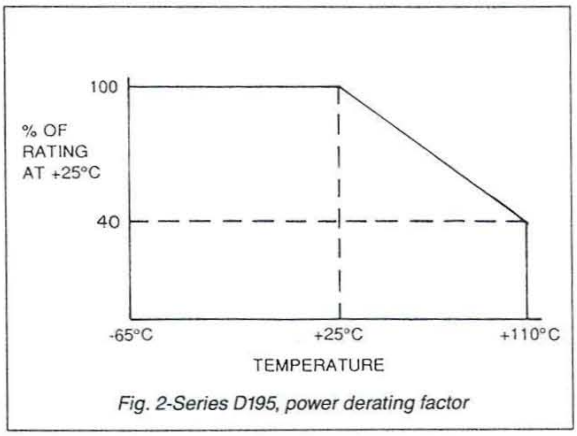
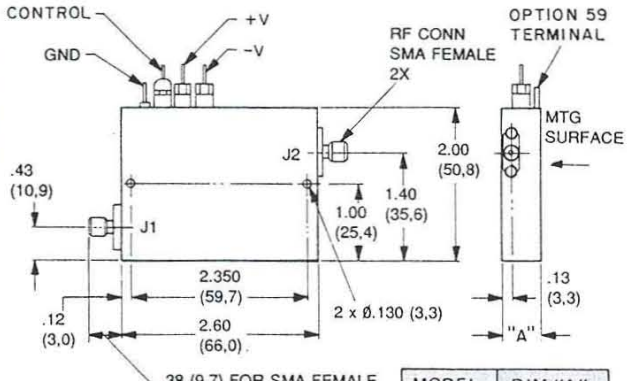


Fig. 2-Series D195, power derating factor

*Model D1950A is a special-order product. Consult factory before ordering.

Series D195 Specifications

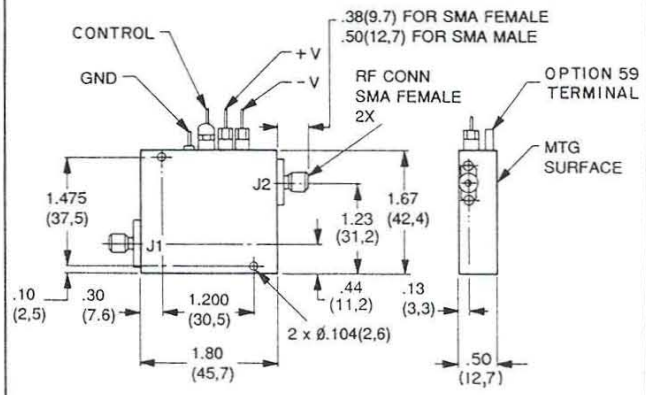
DIMENSIONS AND WEIGHTS



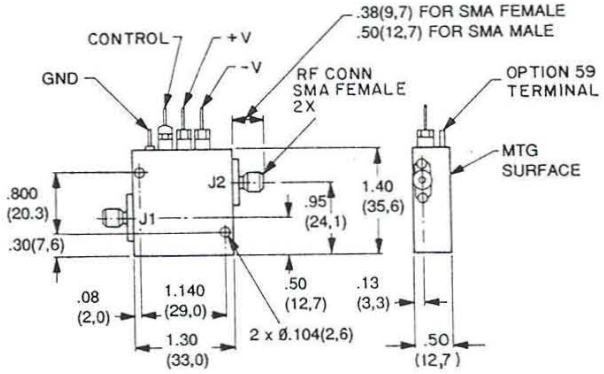
MODEL	DIM "A"
D1950A	.70 (17,8)
D1951	.50 (12,7)

MODELS D1950A* AND D1951
Wt: 3 oz. (85 gm) approx.

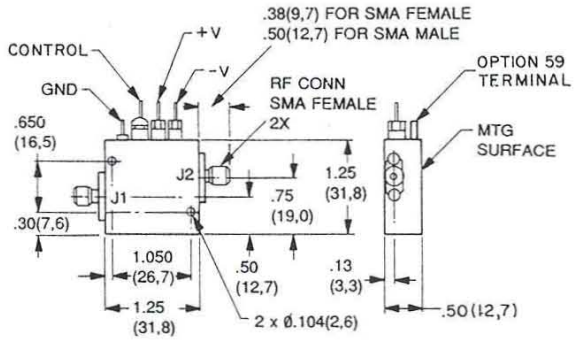
*Model 1950A is a special-order product. Consult factory before ordering.



MODELS D1952 AND D1953
Wt: 2 oz. (57 gm) approx.



MODELS D1954, D1955 AND D1956
Wt: 1 oz. (28 gm) approx.



MODEL D1958
Wt: 1 oz. (28 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

D196 Series Multi-Octave PIN Diode Attenuators

With Integrated Drivers (0.5-18 GHz)

The D196 Series is a family of nonreflective voltage variable 60 dB PIN Diode Attenuators covering the frequency range from 0.5 GHz to 18 GHz in four overlapping multi-octave bands.

Each model in the Series is equipped with an integrated driver which controls the attenuation level at the rate of 10 dB/volt.

The RF circuit consists of two wide-band, T-pad attenuator sections connected in tandem. The driver circuit, which consists of a voltage-to-current converter and linearizing network, furnishes the proper series and shunt currents to control the attenuation value at the specified rate while simultaneously maintaining a bilateral match. See figs. 1 and 2.

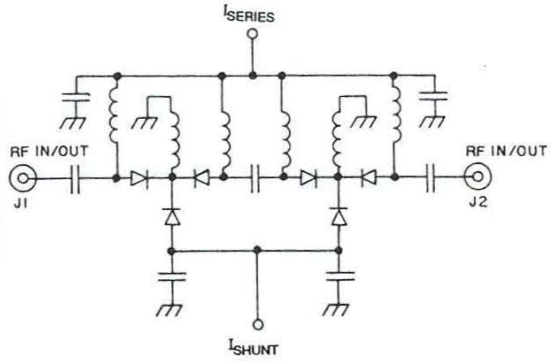


Fig. 1-Series D196, rf schematic diagram

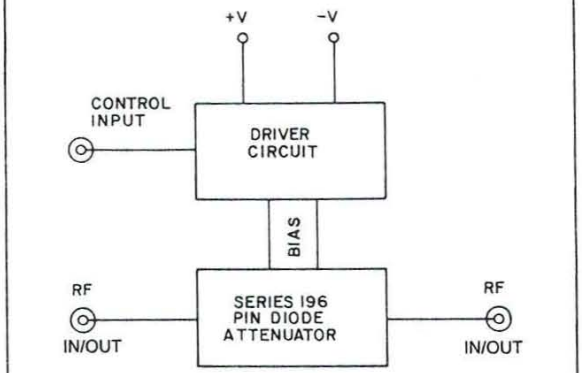
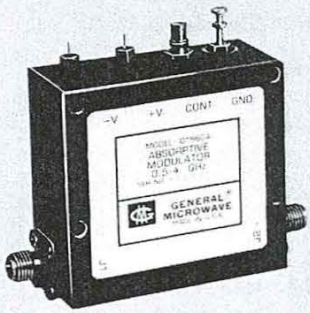


Fig. 2–Series D196 block diagram

- **Frequency range: 0.5 GHz-18 GHz in four overlapping bands**
- **Attenuation range: 60 dB**
- **Linear control: 10 dB/volt**
- **Low insertion loss**
- **Nonreflective**



All units in this series are equipped with integrated drivers

D196 Series Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	MODEL D1960B	MODEL D1961B	MODEL D1962B	MODEL D1968B
Frequency Range (GHz)	0.5-4	0.5-8	2-8	2-18
Mean Attenuation Range (dB)	60	60	60	60
Insertion Loss (dB) (max)	2.5	2.5 (0.5-4 GHz) 3.0 (4-8 GHz)	3.0	4.5
VSWR (max)	1.8	1.8	1.8	2.0
Flatness up to 20 dB **40 dB** **60 dB**	±0.5 dB ±0.75 dB ±1.0 dB	±0.75 dB ±1.0 dB ±1.5 dB	±0.75 dB ±1.0 dB ±1.5 dB	±1.0 dB ±1.25 dB ±3.0 dB

Mean Attenuation Range 60 dB

Accuracy of Attenuation
0-20 dB . . . . . ±1.0 dB
20-40 dB . . . . . ±1.5 dB
40-60 dB . . . . . ±2.0 dB

Monotonicity . . . . . Guaranteed
Phase Shift . . . . . See page 10

Temperature Coefficient . ±0.02 dB/°C

Power Handling Capability
Without Performance Degradation:
All Units . . . . . Up to 100 mW cw or peak (see Fig 3).
Survival Power
All Units . . . . . 2 W average or peak, from −65°C to +25°C (see Fig. 4 for higher temperatures).

Switching Characteristics
ON Time . . . . . 1.0 μsec max.
OFF Time . . . . . 0.5 μsec max.

Nominal Control Voltage Characteristics

Range
Operating . . . . . 0 to +6V
Maximum . . . . . ±15V

Transfer Function . . . . 10 dB/volt

Input Impedance . . . . . 10 kohms

Modulation Bandwidth
Small Signal . . . . . 20 kHz
Large Signal . . . . . 5 kHz

Power Supply Requirements . . . . . +12V to +15V, 70 mA
−12V to −15V, 50 mA

Power Supply Rejection . . . . . Less than 0.1 dB/volt change in either supply

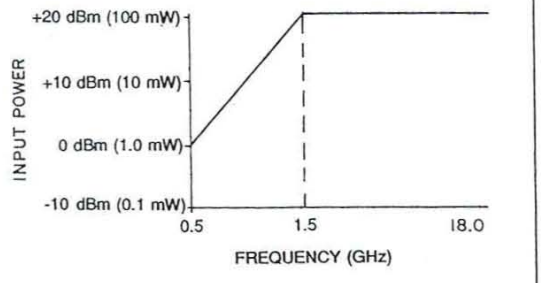


Fig. 3-Series D196, maximum peak and average operating power without performance degradation

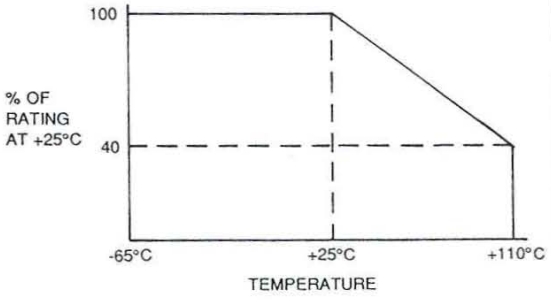


Fig. 4-Power derating factor

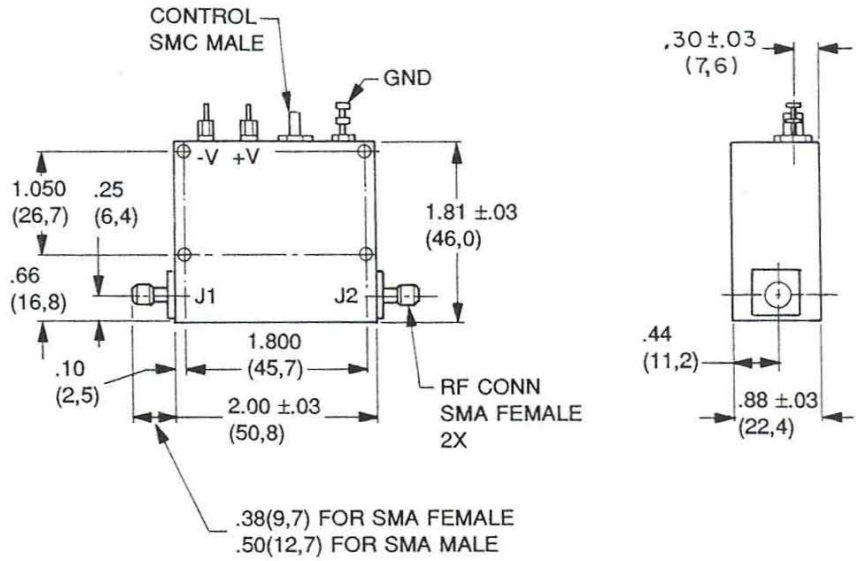
ENVIRONMENTAL RATINGS

Operating Temperature Range	−54°C to +110°C
Non-Operating Temperature Range	−65°C to +125°C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connectors
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
33	EMI filter solder-type control terminal
61	20 dB/volt transfer function with 0 to +3V control signal input
64A	SMB male control connector

DIMENSIONS AND WEIGHT

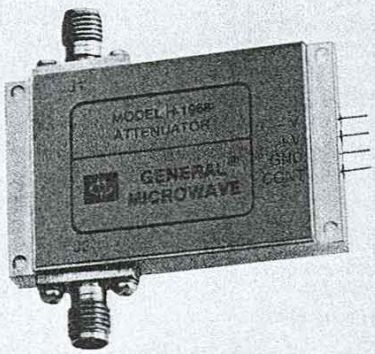


SERIES D196
Wt: 3 oz. (85 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.005

Model H1968B
Hermetic PIN Diode Attenuator (2 to 18 GHz)

- **High reliability: hermetically-sealed**
- **Frequency range: 2-18 GHz**
- **Attenuation range: 60 dB**
- **Linear control: 10 dB/Volt**
- **Removeable SMA connectors: can be used as a drop-in module**



H1968B is a 2 to 18 GHz voltage-controlled PIN diode attenuator, with an attenuation range of 60 dB, in a 0.24" thick hermetically-sealed configuration.

The RF circuit consists of two wide-band PIN diode T-pad attenuator sections connected in tandem. The integrated driver circuit provides the proper series and shunt currents to control the attenuation level at the rate of 10 dB/volt while simultaneously maintaining a bilateral match. See Fig. 1.

HERMETIC SEALING

The H1968B sealed assembly meets a 1×10^{-7} atm cc/sec He leak rate specification.

The RF connectors may be replaced without compromising the integrity of the seal or removed to use the attenuator as a drop-in module.

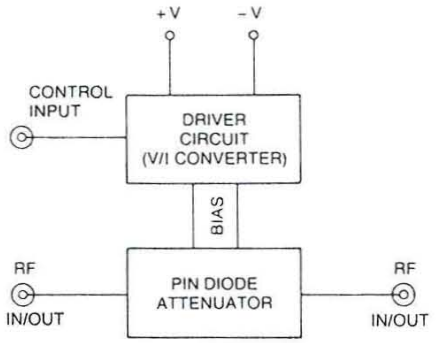


Fig. 1–Model H1968B block diagram.

PERFORMANCE CHARACTERISTICS

Specifications	
Frequency Range (GHz)	2 to 18
Insertion Loss (dB) (max)	4.5
VSWR (max)	2.0
Flatness Up to 20 dB Up to 40 dB Up to 60 dB	 ±1.0 dB ±1.25 dB ±3.0 dB

Mean Attenuation Range . 60 dB

Accuracy of Attenuation
0-20 dB . . . . . ±1.0 dB
20-40 dB . . . . . ±1.5 dB
40-60 dB . . . . . ±2.0 dB

Monotonicity . . . . . Guaranteed

Phase Shift . . . . . See page 10

Temperature Coefficient . ±0.02 dB/°C

Power Handling Capability
Without Performance Degradation . . . . . 100 mW cw or peak

Survival Power . . . . . 2W average or peak (1 μsec max pulse width) from –65°C to +25°C (see Fig. 2 for higher temperatures)

Switching Time
On Time . . . . . 1.0 μsec
Off Time . . . . . 0.5 μsec

Nominal Control Voltage Characteristic Range
Operating . . . . . 0 to +6V
Maximum . . . . . ±15V

Transfer Function . . . . . 10 dB/volt

Input Impedance . . . . . 10 kohms

Power Supply Requirements . . . . . +12V ±5% @ 70 mA
–12V ±5% @ 50 mA

Power Supply Rejection . . . . . Less than 0.1 dB/volt change in either supply.

ENVIRONMENTAL RATINGS

Temperature Range
Operating . . . . . –65°C to +110°C

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J2) and one SMA female rf connector
49	High rel screening (See Table 1 on page 30)
62	±15V operation

AVAILABLE ACCESSORIES

Model	Spacer Plates
H1968B	19177-P3

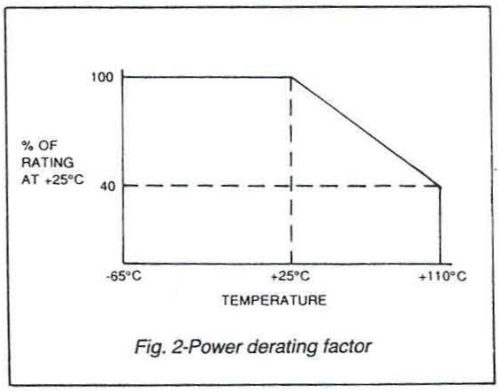


Fig. 2-Power derating factor

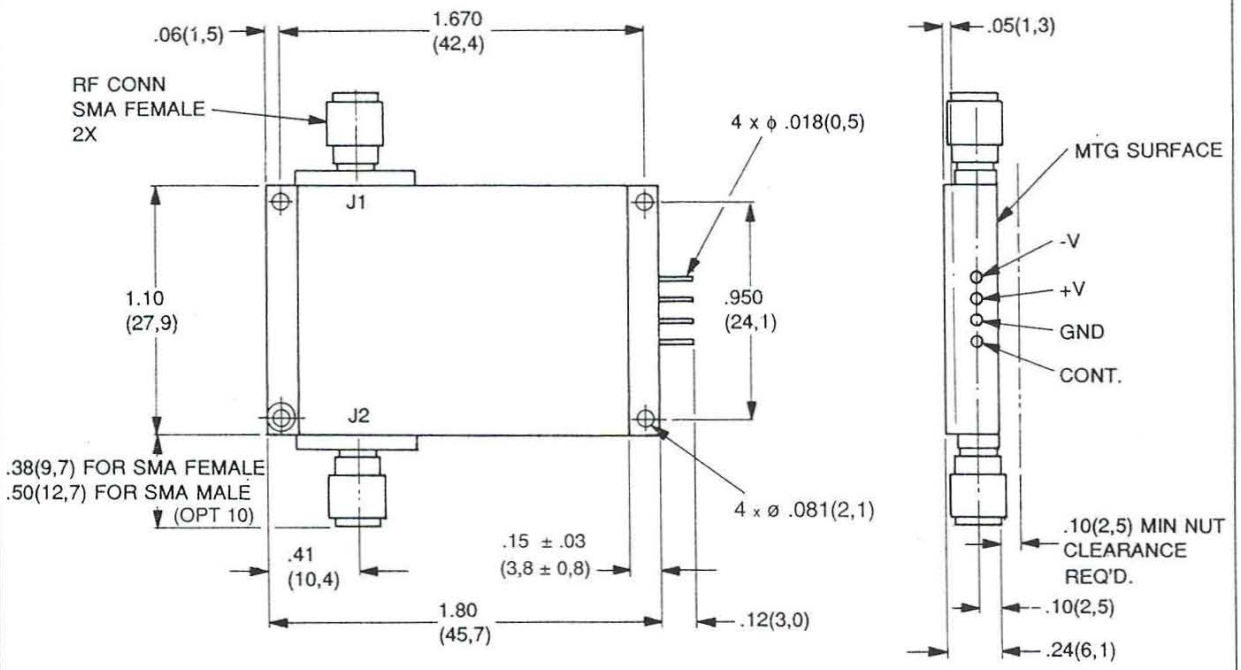
H1968B
Specifications

TABLE 1: OPTION 49 HIGH REL SCREENING

General Microwave's hermetically-sealed components utilize rugged construction techniques and hermetic sealing to meet stringent military requirements for shock, vibration, temperature, altitude, humidity, and salt atmosphere. All hermetically-sealed parts may be ordered, if desired, with 100% screening in accord with the following:

Test	Method	Condition
Internal Visual	2017.3	—
Stabilization Bake	1008.2	C
Temperature Cycle	1010.5	C
Mechanical Shock	2002.3	B
Burn-In	1015.4	—
Leak	1014.2/.9	A1 & A2

DIMENSIONS AND WEIGHT



Weight: 3.5 oz. (99 gm) approx.

Dimensional tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Series D197 Voltage Controlled Phase Invariant Attenuators

The Series D197 voltage controlled PIN diode attenuators offer essentially phase free operation over a wide dynamic range in multi-octave frequency bands between 2 and 18 GHz. The attenuators utilize a unique double balanced arrangement of diodes and quadrature couplers to achieve the phase independent attenuation characteristic. Excellent temperature stability is maintained by employing a self-compensating biasing scheme. See Fig. 1.

- **Low phase shift**
- **Frequency range: 2-18 GHz**
- **Nonreflective**
- **Attenuator range: to 45 dB**
- **Linearized control: 10 dB/V**
- **High speed**

SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

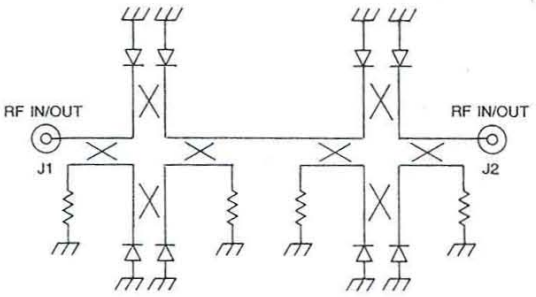
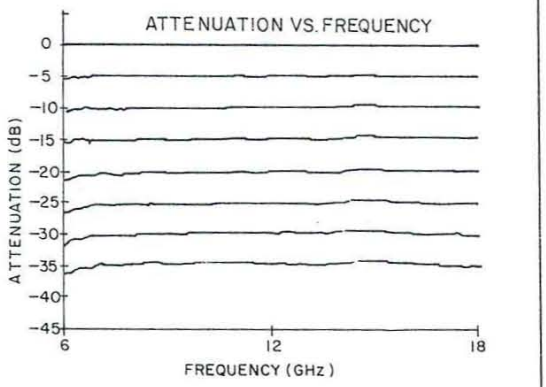
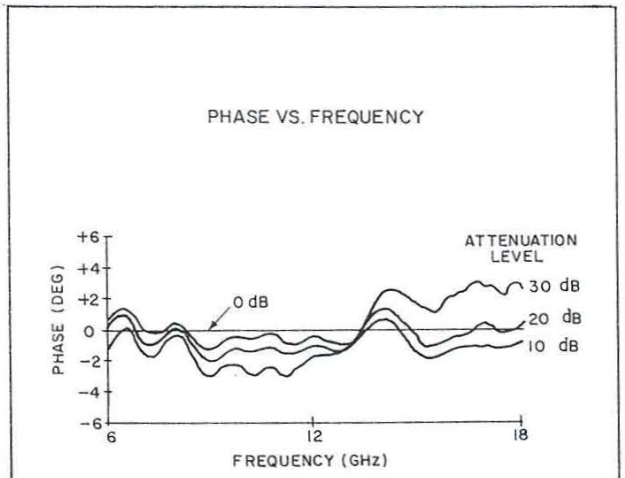


Fig. 1-RF schematic diagram

TYPICAL PERFORMANCE





Series D197 Specifications

PERFORMANCE CHARACTERISTICS

MODEL	D1972	D1974	D1978
Frequency Range (GHz)	2-6	4-11	6-18
Mean Attenuation Range	32 dB		
Insertion Loss (Max)	4 dB	5 dB	5.5 dB
VSWR (Max)	2.0		
Accuracy of Attenuation 0 to 20 dB **> 20 to 32 dB**	± 1.0 dB ± 2.0 dB		
Amplitude Flatness 0 to 20 dB **> 20 to 32 dB**	± 0.4 dB ± 0.6 dB	± 0.4 dB ± 0.8 dB	± 0.8 dB(1) ± 1.3 dB(1)
Monotonicity	Guaranteed		
Phase Shift 0 to 20 dB **> 20 to 32 dB**	± 4° ± 8°	± 4° ± 8°	± 5° ± 10°
Control Voltage	0-3.2 V		
Control Input Impedance	10 kohms		
Transfer Function	10 dB/V		
On Time, Off Time	250 nsec		
Temperature Coefficient 0-20 dB **> 20-32 dB**	.01 dB/°C .03 dB/°C		
Max. RF Power Input (Operating)	100 mW		
Max. RF Power Input (Survival)	0.5 W		
Harmonic Distortion @ Pin = +10 dBm	−40 dBc	−50 dBc	−50 dBc
Power Supply Requirements	+15V ± 5% @ 200 mA −15V ± 5% @ 120 mA		

SPECIFICATIONS WITH EXTENDED RANGE OPTION (OPTION 45)

Mean Attenuation Range	45 dB		
Accuracy of Attenuation 0-20 dB **> 20-32 dB** **> 32 dB**	± 1.0 dB ± 2.0 dB ± 3.5 dB		
Amplitude Flatness 0 to 20 dB **> 20 to 32 dB** **> 32 dB**	± 0.4 dB ± 0.6 dB ± 1.5 dB	± 0.4 dB ± 0.8 dB ± 1.5 dB	± 0.8 dB(1) ± 1.3 dB(1) ± 2.0 dB
Phase Variation 0 to 20 dB **> 20 to 32 dB** **> 32 dB**	± 4° ± 8° ± 15°	± 4° ± 8° ± 20°	± 5° ± 10° ± 30°

(1) *Except from 8-18 GHz, flatness is ± 0.5 dB up to 20 dB, ± 1.0 dB up to 32 dB.*

Series D197 Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −54°C to +110°C

Non-Operating Temperature Range..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)

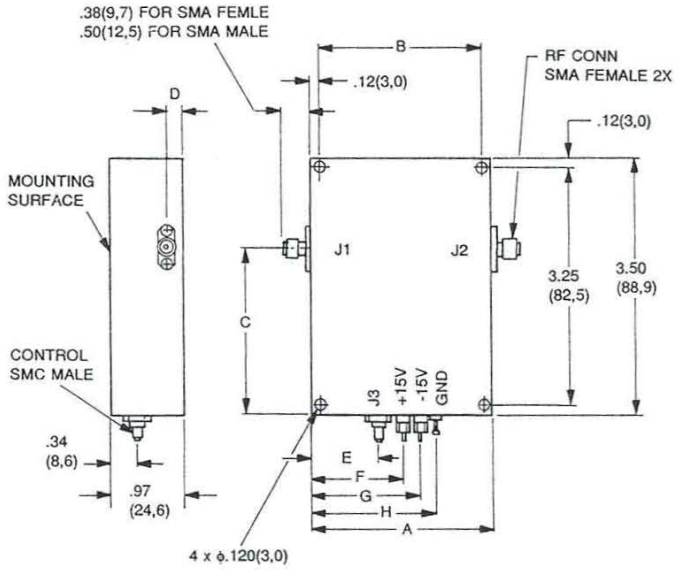
Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
45	Extended attenuation range to 45dB
65	±12V operation

DIMENSIONS AND WEIGHT



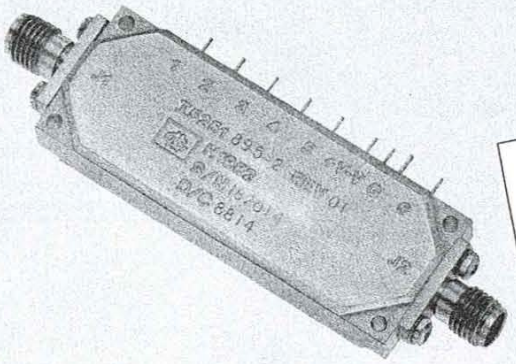
SERIES D197
Wt: 5 oz. (142 gm) approx.

MODEL	A	B	C	D	E	F	G	H
D1972	2.5 (63,5)	2.26 (57,4)	2.28 (57,9)	0.22 (5,6)	0.91 (23,1)	1.25 (31,7)	1.5 (38,1)	1.7 (43,2)
D1974	2.0 (50,8)	1.76 (44,7)	2.43 (61,7)	0.18 (4,6)	0.66 (16,8)	1.0 (25,4)	1.25 (31,7)	1.45 (36,8)
D1978	2.0 (50,8)	1.76 (44,7)	2.58 (65,5)	0.18 (4,6)	0.66 (16,8)	1.0 (25,4)	1.25 (31,7)	1.50 (38,1)

Dimensional Tolerances, unless otherwise indicated: .xx ±.02; .xxx ±.005

Series H198
6 Bit High Speed Digital Attenuators, 0.5-6 GHz

- **30 nSec switching time**
- **Up to 63 dB attenuation**
- **Hermetically-sealed; 0.24″ thick**
- **Guaranteed monotonic**



The Series H198 are hermetically sealed, high speed, digitally controlled switched bit attenuators. Attenuation changes are guaranteed to be monotonic over the entire frequency band and operating temperature range. Employing removable rf connectors, their small size and construction make these attenuators suitable for use as drop-in components for system integration or as conventional connectorized components.

Attenuation level is selected via six FAST TTL input control pins. The attenuators are protected against inadvertent power supply voltage reversals. See Fig. 1.

SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

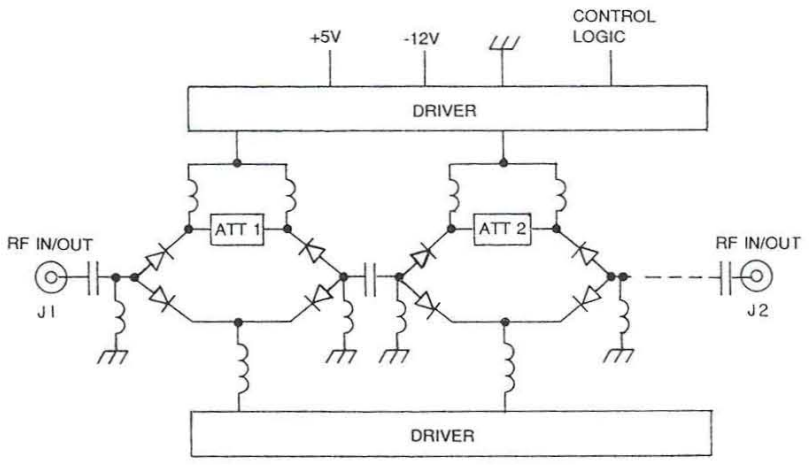


Fig. 1-Series H198 schematic diagram

Series H198 Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	H1980	H1982
Frequency Range (GHz)	0.5-6.0	2.0-6.0
Attenuation Range	63 dB	
Insertion Loss (Max)	5.0 dB	4.0 dB
VSWR (Max)	2.0:1	
Number of Bits	6	
Montonicity	Guaranteed	
Accuracy of Mean Attenuation	±0.5 dB: 0 to 31 dB ±1.0 dB: >31 to 63 dB	
Attenuation Flatness	±0.5 dB; 0 to 14 dB ±0.75 dB: >14 to 32 dB ±1.0 dB >32 to 63 dB	
Power Handling	+23 dBm cw	
Switching Time	30 nsec. (50% TTL to 1 dB of final value)	
Rise and Fall Time	<10 nsec	
Switch Rate	10 MHz (1)	
Control Logic	Logic "O" = Bit Off Logic "1" = Bit On	
Control Input	At Logic "O": −0.3 to +0.8V @ 1.2 mA At Logic "1": +2.0 to +5.0V @40 µA	
Power Supply	+5V ±5% @ 175 mA(2) −12V ±5% @ 150 mA	

(1) *Above 1 MHz, switching time will increase linearly to 35 nsec at 10 MHz.*

(2) *Above 1 MHz, current will increase to +5V @ 300 mA, −12V @ 250 mA at 10 MHz.*

ENVIRONMENTAL RATINGS

Temperature Range

Operating . . . . . −65°C to +110°C

AVAILABLE OPTIONS

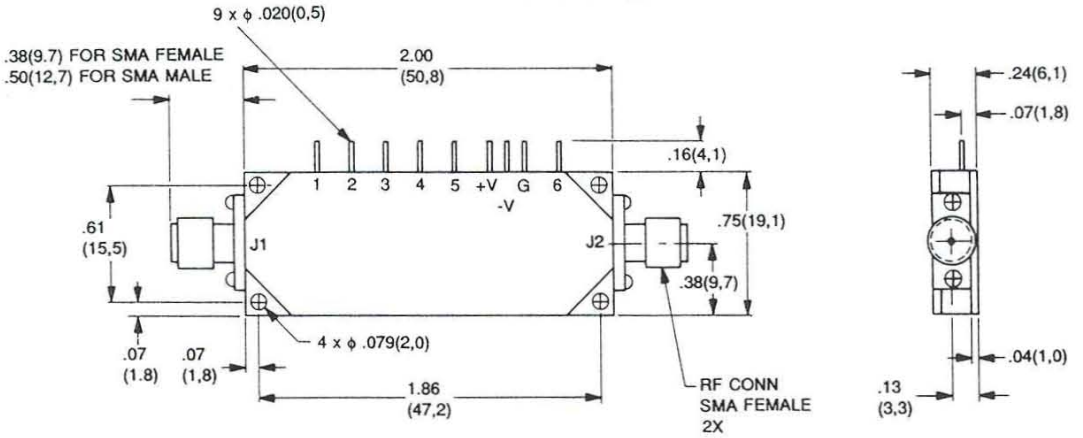
Option No.	Description
6A	31.5 dB range, 0.5 dB LSB (H1982 only)
7	Two SMA male rf Connectors
9	Inverse Control Logic
10	One SMA male and one SMA female rf connector
49	High Rel screening (see Table 1, page 30)

AVAILABLE ACCESSORIES

Model	Spacer Plates
H1980	19177-P2
H1982	19177-P2

PIN DESIGNATIONS	
PIN	FUNCTION
1	16 dB
2	8 dB
3	2 dB
4	4 dB
5	1 dB
6	32 dB
+V	+5V
−V	−12V
G	Ground

DIMENSIONS AND WEIGHT



SERIES H198
Wt: 0.8 oz (23 gm) approx

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Model 3250A Ultra-Broadband 6 Bit Digital PIN Diode Attenuator

- **Frequency range: 0.2 to 18 GHz**
- **Attenuation range: Up to 60 dB**
- **6 Bit Binary or BCD programming**
- **Absorptive**
- **Guaranteed Monotonicity**

The Model 3250A digitally programmable attenuator provides excellent performance characteristics over the frequency range of 0.2 to 18 GHz. Attenuation levels up to 60 dB are programmable in increments of 1 dB.

The unit is an integrated assembly of a dual T-pad PIN diode attenuator and a driver consisting of a D/A and an I/V Converter. See figures 1 and 2.

The Model 3250A operates as a bilaterally-matched device at all attenuation levels. It is supplied in a compact rugged package well-suited to military applications.

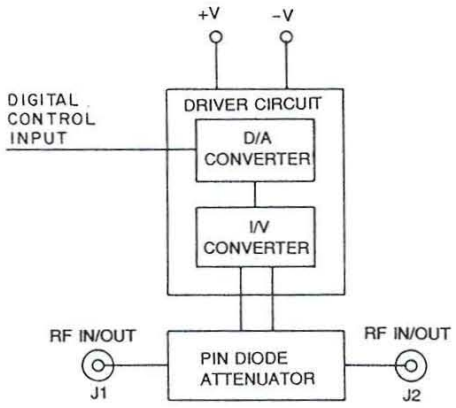


Fig. 1-Model 3250A, block diagram

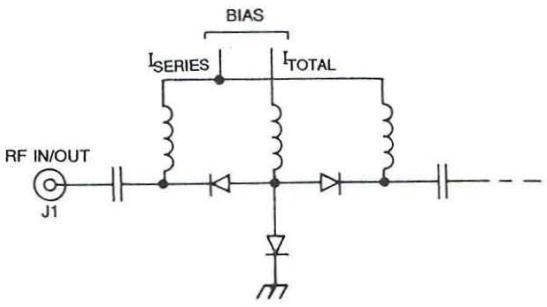


Fig. 2-Model 3250A, rf schematic diagram (unit consists of two such sections)

Model 3250A Specifications

PERFORMANCE CHARACTERISTICS

Frequency Range . . . . . 0.2 to 18 GHz

Mean Attenuation Range
0.2 to 18 GHz . . . . . 60 dB

Insertion Loss (max.)
0.2 to 8 GHz . . . . . 3.5 dB
8 to 12.4 GHz . . . . . 4.0 dB
12.4 to 18 GHz . . . . . 5.0 dB

VSWR (max.)
0.2 to 8 GHz 1.75
8 to 18 GHz 2.0

Accuracy of Attenuation
0 to 30 dB . . . . . ± 0.5 dB
31 to 50 dB . . . . . ± 0.75 dB
51 to 60 dB . . . . . ± 1.5 dB

Flatness of Attenuation
0 to 30 dB . . . . . ± 1.0 dB
31 to 40 dB . . . . . ±1.5 dB
41 to 50 dB . . . . . ±2.0 dB
51 to 60 dB . . . . . ±3.0 dB

Temperature Coefficient . . . . . 0.02 dB/°C max

Power Handling Capability
Without Performance Degradation . . . . . Up to 100mW cw or peak (see Figure 3)
Survival Power . . . . . 2W average or peak (from −65°C to +25°C; see Figure 4 for higher temperatures)

Switching Time . . . . . 2 μsec max.

Programming . . . . . Positive true binary standard or BCD (Option 1). For complementary code, specify Option 2.

Minimum Attenuation Step 1.0 dB

Logic Input
Logic "0" (Bit Off) . . . . . −0.3 to +0.8 V@500 μA max
Logic "1" (Bit On) . . . . . +2.0 to +5.0 V@100 μA max

Power Supply
Requirements . . . . . +5V ±5%, 250 mA
+15V ±5%, 75 mA
−15V, ±5%, 75 mA

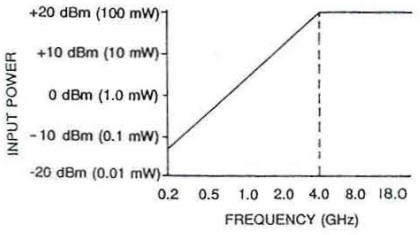


Fig. 3-Model 3250A, maximum peak and average operating power without performance degradation.

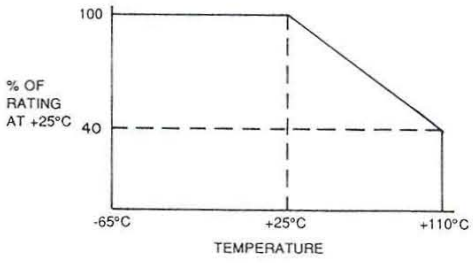


Fig. 4-Model 3250A survival power derating factor.

Model 3250A Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . −54°C to 110°C

Non-Operating Temperature Range . . . . . −65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)

Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

PIN FUNCTIONS		
PIN NO.	**BINARY**	**BCD (Opt. 1)**
1	SPARE	SPARE
2	SPARE	SPARE
3	+5V	+5V
4	DIGITAL & POWER GND	DIGITAL & POWER GND
5	GND	1 dB
6	GND	2 dB
7	1 dB	4 dB
8	2 dB	8 dB
9	4 dB	10 dB
10	8 dB	20 dB
11	16 dB	40 dB
12	32 dB	OPEN (NO CONNECTION)
13	+15V	+15V
14	−15V	−15V
15	SPARE	SPARE

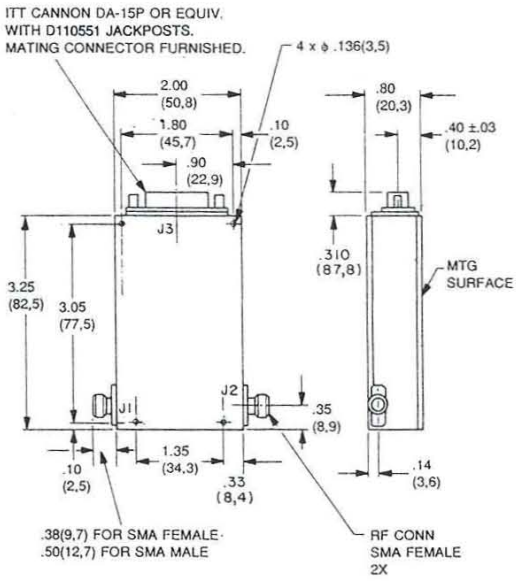
AVAILABLE OPTIONS

Option No.	Description
1	BDC programming (Binary is standard)
2	Complementary programming (positive true is standard)
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
5002	8-Bit Resolution, 1 µsec switching time

ACCESSORY FURNISHED

Mating power/logic connector

DIMENSIONS AND WEIGHT



MODEL 3250A
Wt: 4 oz. (113 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ±.005

346C Series Multi-Octave 10 Bit Digital PIN Diode Attenuators

(0.5-18 GHz)

The 346C Series is a family of nonreflective PIN diode attenuators, each programmable to 60 dB in attenuation steps as low as 0.06 dB, and covering the frequency range from 0.5 GHz to 18 GHz in four overlapping multi-octave bands.

Each model in the Series comprises an integrated assembly of a dual (current-controlled) PIN diode attenuator, and a driver circuit consisting of a D/A converter and a voltage-to-current converter (see Figure 1 below).

The RF circuit consists of two wide-band, T-pad attenuator sections in tandem. The levels of series and shunt currents required to maintain a bilateral match at all attenuation levels are provided by the driver.

This arrangement assures monotonicity over the operating band at all levels of attenuation and for any programmed attenuation step.

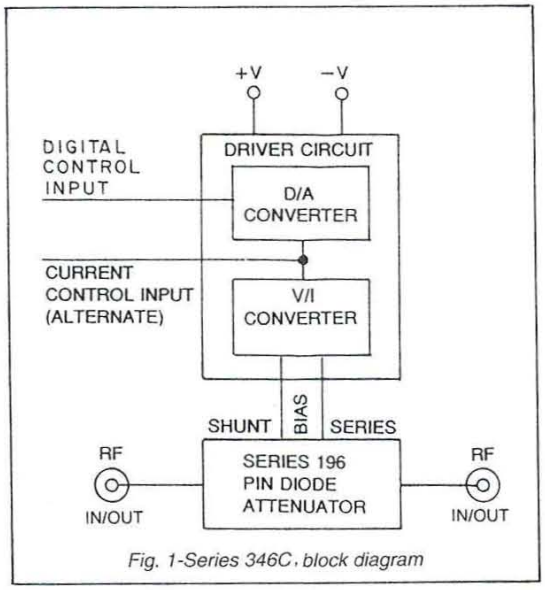
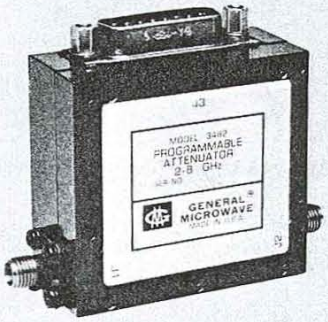


Fig. 1-Series 346C, block diagram

- **Frequency range: 0.5 GHz-18GHz in four overlapping ranges**
- **Attenuation range: 60 dB**
- **Programming: 10-Bit binary**
- **LSB: 0.06 dB**
- **Monotonicity: guaranteed**



Series 346C Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	MODEL 3460C	MODEL 3461C	MODEL 3462C	MODEL 3468C
Frequency Range (GHz)	0.5-4	0.5-8	2-8	2-18
Mean Attenuation Range (dB)	60	60	60	60
Insertion Loss (dB) (max)	2.5	2.5 (0.5-4 GHz) 3.0 (4-8 GHz)	3.0	4.5
VSWR (max)	1.8	1.8	1.8	2.0
Flatness up to 20 dB **40 dB** **60 dB**	±0.5 dB ±0.75 dB ±1.0 dB	±0.75 dB ±1.0 dB ±1.5 dB	±0.75 dB ±1.0 dB ±1.5 dB	±1.0 dB ±1.25 dB ±3.0 dB

Accuracy of Attenuation
0-20 dB . . . . . ±1.0 dB
20-40 dB . . . . . ±1.5 dB
40-60 dB . . . . . ±2.0 dB

Monotonicity . . . . . Guaranteed

Phase Shift . . . . . See figure 2.

Temperature Coefficient . ±0.02 dB/°C

Power Handling Capability
Without Performance Degradation
All Units . . . . . Up to 100 mW cw or peak (see figure 3).
Survival Power
All Units . . . . . 2 W average or peak, from −65°C to +25°C (see figure 4 for higher temperatures).

Switching Time
ON Time . . . . . 1.0 μsec. max.
OFF Time . . . . . 0.5 μsec. max.

Programming . . . . . Positive true binary. For complementary code, specify Option 2. To interface with other logic families, please contact factory.

Minimum Attenuation Step . . . . . 0.06 dB

Logic Input
Logic "0" (Bit off) . . . −0.3 to +0.8V
Logic "1" (Bit on) . . . +2.0 to +5.0V
Input Current . . . . . 10 μA max.

Nominal Control Voltage Characteristics

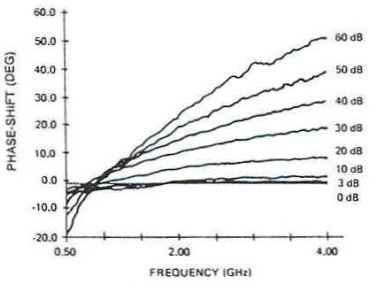
Range . . . . . 0 to 2 mA

Transfer Function . . 30 dB/mA

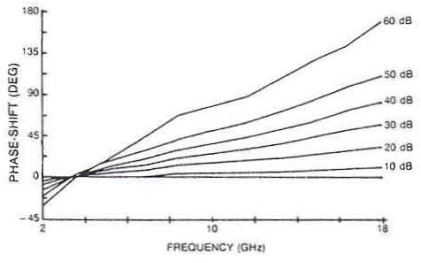
Input Impedance . . . 3 kohms

Power Supply Requirements . . . . . +12V to +15V, 80 mA
−12V to -15V, 60 mA

Power Supply Rejection . . . . . Less than 0.1 dB/volt change in either supply



Model 3460C



Model 3468C

Fig. 2-Series 346C, typical phase shift variation as a function of attenuation

Series 346C Specifications

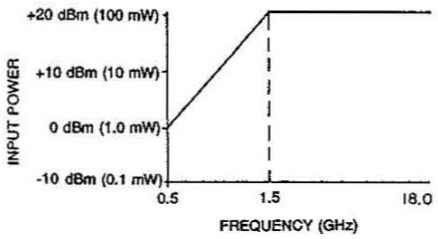


Fig. 3-Series 346C, maximum peak and average operating power without performance degradation

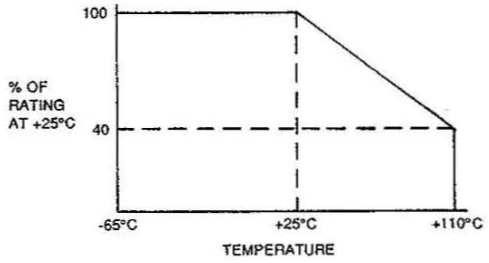


Fig. 4-Series 346C, survival power derating factor

ENVIRONMENTAL RATINGS

Operating Temperature Range	−54°C to +110°C
Non-Operating Temperature Range	−65°C to +125°C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

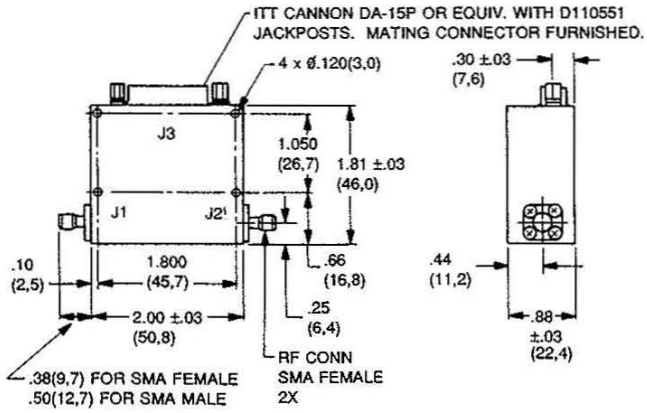
Option No.	Description
2	Complementary programming (logic "0" is bit on)
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector

ACCESSORY FURNISHED

Mating power/logic connector

PIN NO.	J3 PIN FUNCTIONS
1	GND (Note 2)
2	ANALOG INPUT (Note 3)
3	0.13 dB
4	GND
5	0.25 dB
6	0.5 dB
7	1 dB
8	2 dB
9	4 dB
10	8 dB
11	16 dB
12	32 dB(MSB)
13	+V
14	-V
15	0.06 dB(LSB)

DIMENSIONS AND WEIGHT



SERIES 346C
Wt: 3 oz. (85 gm) approx.

(1) *All unused logic inputs must be grounded.*

(2) *For normal programming control Pin 1 must be grounded or at logic "0". Application of logic "1" to Pin 1 overrides the digital input and sets the unit to insertion loss. For units with complementary programming (Option 2), the application of a logic "1" to Pin 1 sets the unit to high isolation (60 dB or greater).*

(3) *Pin 2 is available to (a) monitor the D/A converter output, (b) apply a modulation signal from a current source, or (c) apply an independent analog signal for turn-on, turn-off or vernier attenuation levels.*

(4) *The Series 346C attenuators are 10-bit digital attenuators. In order to use this device with a lesser number of bits (lower resolution), the user may simply ground the logic pins for the lowest order unused bits. For example, a Series 346C unit operated as an 8-bit unit would have Pin 15 and Pin 3 connected to ground. All other parameters remain unchanged.*

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 347, 8 Bit Digital Phase Invariant Attenuators

The Series 347 digitally controlled PIN diode attenuators offer essentially phase free operation over a wide dynamic range in multi-octave frequency bands between 2 and 18 GHz. The attenuators utilize a unique double balanced arrangement of diodes and quadrature couplers to achieve the phase independent attenuation characteristic. Excellent temperature stability is maintained by employing a self-compensating biasing scheme. See Fig. 1.

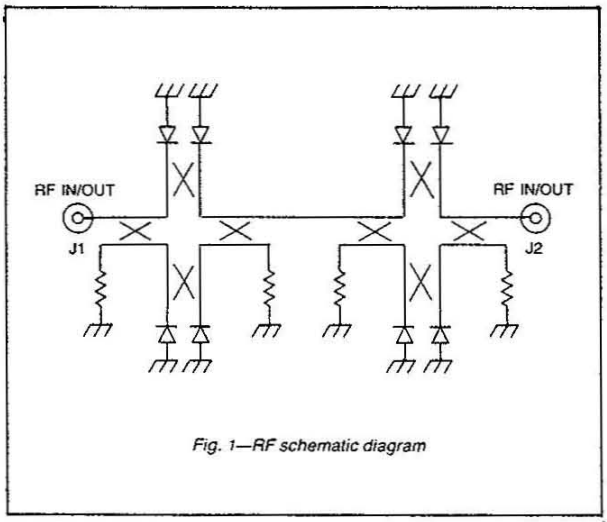
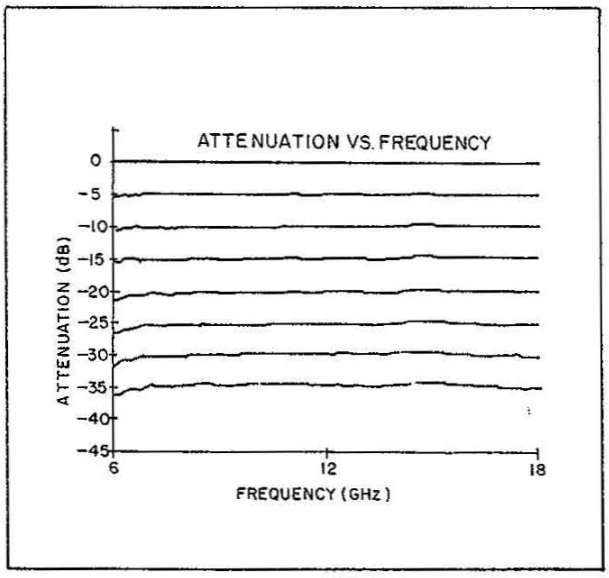
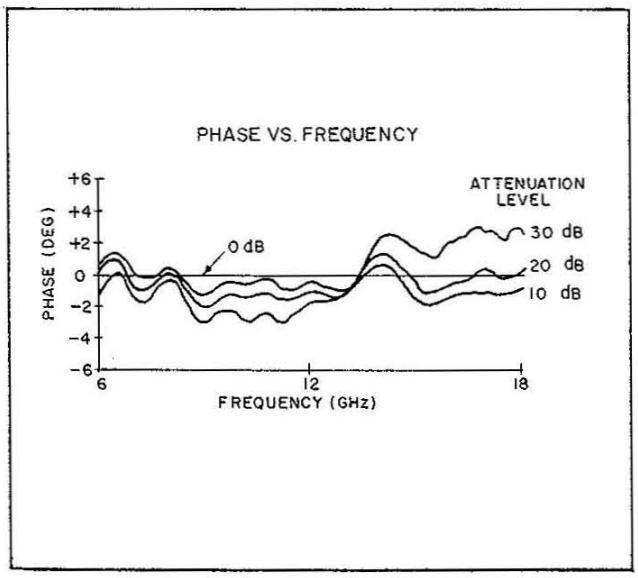


Fig. 1—RF schematic diagram

TYPICAL PERFORMANCE





Series 347 Specifications

PERFORMANCE CHARACTERISTICS

MODEL	3472	3474	3478
Frequency Range (GHz)	2-6	4-11	6-18
Mean Attenuation Range	32 dB		
Insertion Loss (Max)	4 dB	5 dB	5.5 dB
VSWR (Max)	2.0		
Accuracy of Attenuation	±0.5 dB		
Amplitude Flatness 0 to 20 dB > 20 to 32 dB	±0.4 dB ±0.6 dB	±0.4 dB ±0.8 dB	±0.8 dB(1) ±1.3 dB(1)
Monotonicity	Guaranteed		
Phase Shift 0 to 20 dB > 20 to 32 dB	±4° ±8°	±4° ±8°	±5° ±10°
On Time, Off Time	350 nsec		
Temperature Coefficient	.02 dB/°C		
Max. RF Power Input (Operating)	100 mW		
Max. RF Power Input (Survival)	0.5 W		
Harmonic Distortion @ Pin = +10 dBm	−40 dBc	−50 dBc	−50 dBc
Control	8 bit TTL, 0.125 dB LSB		
Control Input Impedance	@ Logic "0" (−0.3 to +0.8 V), 500 μA max. @ Logic "1" (+2.0 to +5.0 V), 100 μA max.		
Logic Input	Logic "0" = Bit OFF; Logic "1" = Bit ON		
Power Supply Requirements	+5V ±5% @ 325 mA +15V ±5% @ 15 mA −15V ±5% @ 70 mA		

SPECIFICATIONS WITH EXTENDED RANGE OPTION (OPTION 45)

Mean Attenuation Range	45 dB		
Accuracy of Attenuation	±1.0 dB		
Amplitude Flatness 0 to 20 dB > 20 to 32 dB > 32 dB	±0.4 dB ±0.6 dB ±1.5 dB	±0.4 dB ±0.8 dB ±1.5 dB	±0.8 dB(1) ±1.3 dB(1) ±2.0 dB
Phase Variation 0 to 20 dB > 20 to 32 dB > 32 dB	±4° ±8° ±15°	±4° ±8° ±20°	±5° ±10° ±30°
Control	8 bit TTL, 0.176 dB LSB		

(1) *Except from 8-18 GHz, flatness is ± 0.5 dB up to 20 dB, ± 1.0 dB up to 32 dB.*

Series 347 Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −54°C to +110°C

Non-Operating Temperature Range ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

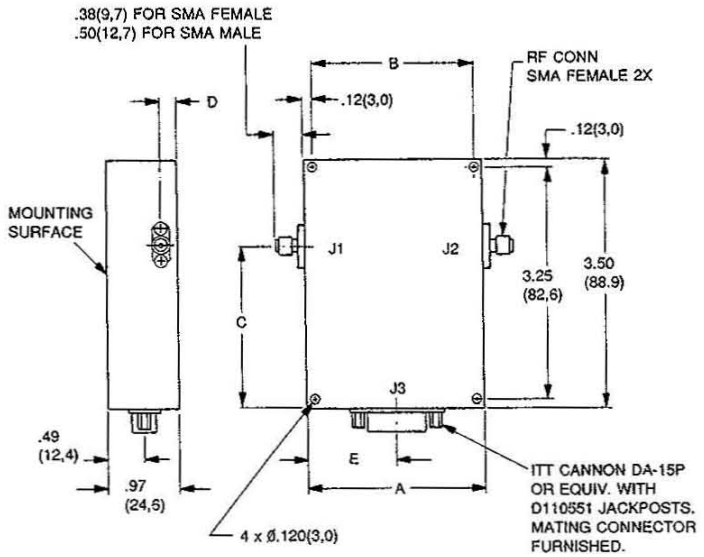
Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
45	Extended attenuation range to 45 dB
65	±12V operation

ACCESSORY FURNISHED

Mating power/logic connector

DIMENSIONS AND WEIGHT

J3 PIN FUNCTIONS		
PIN NO.	BINARY	OPTION 45
1	-15V	-15V
2	+15V	+15V
3	Internal Conn.	Internal Conn.
4	0.125 dB (LSB)	0.18 dB
5	0.5 dB	0.70 dB
6	4 dB	5.62 dB
7	16 dB (MSB)	22.5 dB
8	8 dB	11.25 dB
9	GROUND	GROUND
10	NOT USED	NOT USED
11	2 dB	2.81 dB
12	0.25 dB	0.35 dB
13	1 dB	1.41 dB
14	NOT USED	NOT USED
15	+5V	+5V



SERIES 347
Wt. 5 oz. (142 gm) approx.

MODEL	A	B	C	D	E
3472	2.5 (63,5)	2.26 (57,4)	2.28 (57,9)	0.22 (5,6)	1.25 (31,7)
3474	2.0 (50,8)	1.76 (44,7)	2.43 (61.7)	0.18 (4,6)	1.0 (25,4)
3478	2.0 (50,8)	1.76 (44,7)	2.58 (65,5)	0.18 (4,6)	1.0 (25,4)

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Series 348 and 348H
8 Bit Digital/Analog Attenuators

SERIES 348 AND 348H

The Series 348 and 348H Digitally Programmable Attenuators provide greater than octave band performance in small hermetic packages ideally suited for high reliability applications. The Series 348 offers moderate power handling capability (100 mW) at switching speeds less than 500 nsec while the 348H Series offers 200 nsec switching speed at lower power. Attenuation of all units is 60 dB with monotonic 0.25 dB step resolution.

The attenuator is an integrated assembly of a sealed RF Microwave Integrated Circuit assembly and a sealed hybrid driver. Attenuation is controlled via a miniature 14 pin connector. See Fig. 1.

Although these units are primarily intended for use as digital attenuators, they can also be used as analog (voltage driven) attenuators or as combination analog/digital attenuators. (See note 4 on page 47.)

- **2 to 18 GHz**
- **Digital/Analog**
- **8 Bit TTL**
- **Hermetically sealed**
- **Miniature**

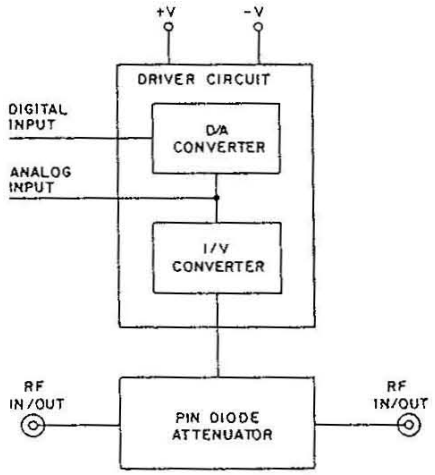


Figure 1
Series 348/H block diagram

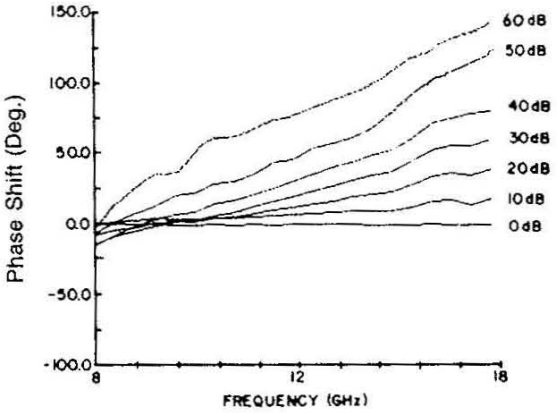


Figure 2
Model 3488
Typical phase vs. attenuation

Series 348 and 348H Specifications

PERFORMANCE CHARACTERISTICS

MODEL	FREQUENCY RANGE (GHz)	MAX. INSERTION LOSS (dB)	MAX VSWR	FLATNESS (±dB) AT MEAN ATTENUATION LEVELS UP TO			
				10 dB	20 dB	40 dB	60 dB
3482/H	2.0-4.0	1.8	1.5	0.3	0.8	1.5	1.6
	1.5-4.5(2)	1.9	2.0	0.5	1.4	3.0	3.5
3483/H	2.6-5.2	2.0	1.6	0.3	0.8	1.5	1.6
	1.95-5.85(2)	2.1	2.1	0.5	1.4	3.0	3.5
3484/H	4.0-8.0	2.4	1.7	0.3	0.8	1.5	1.6
	3.0-9.0(2)	2.5	2.2	0.5	1.4	3.0	3.5
3486/H	6.0-12.0	2.7	1.8	0.7	1.0	1.5	1.6
	4.5-13.5(2)	2.8	2.2	0.9	1.5	3.0	3.5
3488/H	8.0-18.0	3.0(1)	1.8(1)	0.7	1.0	1.5	1.6
	6.0-18.0(2)	3.0(1)	1.8(1)	0.9	1.5	3.0	3.5

(1) For 3488H only: Except from 12-16 GHz where insertion loss is 3.5 dB max. and from 16-18 GHz where insertion loss is 4.0 dB max. and VSWR is 2.0 max.
(2) Specifications for the extended frequency ranges are typical.

Mean Attenuation Range . . 60 dB

Accuracy of Attenuation . . 0-30 dB ±0.5 dB
> 30-50 dB ±1.0 dB
> 50-60 dB ±1.5 dB

Monotonicity . . . . . Guaranteed

Phase Shift . . . . . See Fig. 2

Temperature Coefficient . . ±0.02 dB/°C

Power Handling Capability Without Performance Degradation . . . . . 348 100 mW cw or peak
348H 10 mW cw or peak

Survival Power (from −65°C to +25°C. See Figure 3 for Higher Temperatures) . . . . . 1W average, 25W peak

Switching Time . . . . . (348) 500 nsec max
(348H) 200 nsec max

Programming: 8 Bit TTL . . Positive true binary

Minimum Attenuation Step 0.25 dB

Logic Input . . . . . Logic "0": −0.3 to +0.8V
Logic "1": +2.0 to +5.0V
Logic Input Current: 10 μA max

Analog Input Characteristics
Range . . . . . 0 to 6V
Transfer Function . . . . . 10 dB/V
Input Resistance . . . . . 6 kohms

Power Supply Requirements . . . . . +12 to +15V, 120 mA
−12 to −15V, 50 mA

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . −54°C to +110°C

Non-Operating Temperature Range . . . . . −65°C to +125°C

ACCESSORY FURNISHED

Mating power/logic connector

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J1) and one SMA female (J2) rf connector
49	High Rel screening (see Table 1, page 30)

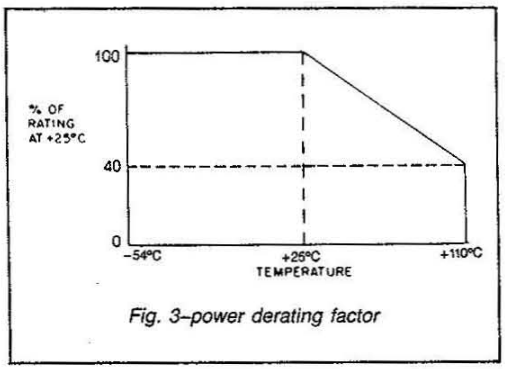
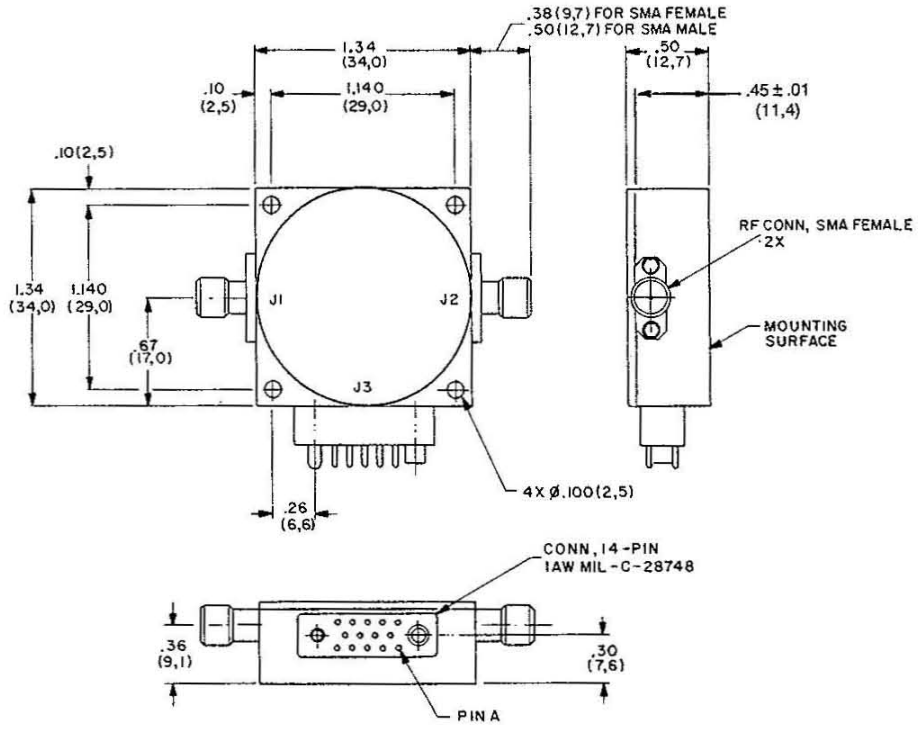


Fig. 3–power derating factor

DIMENSIONS AND WEIGHT



SERIES 348/H
Wt: 2.4 oz. (68 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

J3 POWER/LOGIC CONNECTIONS	
PIN	**FUNCTIONS**
A	Digital/Power GND
B	Logic Control (Note 2)
C	−12 to −15V
D	0.25 dB (LSB)
E	0.5 dB
F	1 dB
H	4 dB
J	2 dB
K	16 dB
L	32 dB (MSB)
M	+12 to +15V
N	8 dB
P	GND
R	Analog Input (Notes 3&4)

NOTES:

1. All unused logic inputs must be grounded.
2. For normal TTL programming control, PIN B must be grounded or at Logic 0. Application of Logic 1 to PIN B overrides the digital input and sets the unit to insertion loss. To interface with other logic families (e.g., CMOS, MTL , NMOS, etc...) contact factory.
3. For digital operation only, connect PIN R to PIN P.
4. To use the unit as a voltage controlled attenuator, apply a control voltage of 0 to +6V at PIN R. The slope of attenuation will be nominally 10 dB/V. For a non-zero source resistance (R_0) of up to 500 ohms, the attenuation error is approximately $-.0017 \cdot R_0 \cdot V_{IN}$ dB and the slope will decrease by approximately 0.17 dB/V per 100 ohms of source resistance.

   Using the 348/H Series attenuator as both a digital and analog control attenuator, the total attenuation ATT = 10 $\bullet V_{IN}$ + programmed digital attenuation. The maximum attainable mean attenuation is 60 dB.

Model 1761 Multi-Octave Digitally Controlled Miniature PIN Diode Attenuator

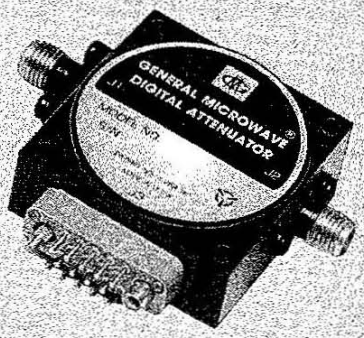
Model 1761 is a miniaturized, digitally controlled PIN diode attenuator covering the instantaneous frequency range of 2 GHz to 18 GHz. This model, measuring only 1.34" square and 0.5" thick, provides a monotonic attenuation range of 60 dB with 7-bit (0.5 dB LSB) resolution and 1 microsecond switching speed.

The Model 1761 is an integrated assembly of a dual PIN diode attenuator and a driver circuit consisting of a D/A converter and voltage-to-current converter. The unit is fully temperature compensated. The RF circuit consists of two wide band, T-pad attenuator sections in tandem. The levels of series and shunt currents required to maintain bilateral match at all frequencies is provided by the driver. This arrangement assures monotonicity over the full 2 to 18 GHz operating band at all levels of attenuation and for any programmed attenuation step.

The Model 1761 weighs approximately 1.5 oz. It is configured with SMA female RF connectors and a multipin connector for logic and power. The unit is powered by ±12 to 15V DC and the logic input is TTL compatible.

SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

- **Miniature**
- **2 to 18 GHz**
- **7 Bit TTL**



Model 1761 Specifications

PERFORMANCE CHARACTERISTICS

Frequency Range . . . . . 2 to 18 GHz
Attenuation Range . . . . . 60 dB min
Insertion Loss, max. . . . . . 4.5 dB

Flatness
Up to 20 dB . . . . . ±1.0 dB
Up to 40 dB . . . . . ±1.25 dB
Up to 60 dB . . . . . ±3.0 dB

Accuracy of Attenuation
0 to 20 dB . . . . . ±1.0 dB
20 to 40 dB . . . . . ±1.5 dB
40 to 60 dB . . . . . ±2.0 dB

Monotonicity . . . . . Guaranteed

Temperature Coefficient . . . . . ±0.02 dB/°C

Power Handling Capability
Without Performance Degradation . . . . . Up to 100 mW cw or peak
Survival Power . . . . . 2 W average or peak from -65°C to +25°C; derate linearly to 800 mW at 110°C

Switching Speed
50% TTL to 90% RF . . . . . 1.0 µsec

Programming . . . . . 7-Bit TTL Binary

Minimum Attenuation Step . . . . . 0.5 dB

Logic Input
Logic "0" (Bit OFF) . . . . . -0.3 to +0.8V
Logic"1" (Bit ON) . . . . . +2.0 to +5.0V
Input Current . . . . . 10µA max.

Power Supply Requirements . . . . . +12 to +15V, 100 mA
-12 to -15V, 100 mA

Power Supply Rejection . . . . . Less than 0.1 dB/volt change in either supply

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . -54°C to +110°C

Non-Operating Temperature Range . . . . . -65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (0.6" double amplitude or 15G, whichever is less)

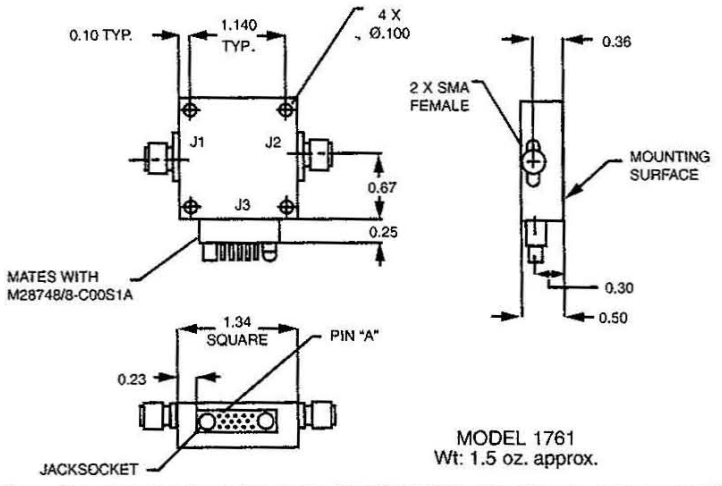
Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

ACCESSORY FURNISHED

Mating power/logic connector

DIMENSIONS AND WEIGHT



PIN FUNCTIONS	
PIN	FUNCTION
A	GND
B	LSB 0.5 dB
C	+V
D	N.C.
E	1 dB
F	-V
H	N.C.
J	4 dB
K	2 dB
L	N.C.
M	16 dB
N	8 dB
P	GND
R	32 dB

MODEL 1761
Wt: 1.5 oz. approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 349 and 349H Octave-Band 11 Bit Digital PIN Diode Attenuators

The Series 349 and 349H programmable attenuators provide greater than octave-band performance and wide programming flexibility in compact rugged packages. Attenuation ranges up to 80 dB are available with attenuation increments as low as 0.03 dB.

Each Series 349 and 349H unit is an integrated assembly of a balanced PIN diode attenuator and a driver circuit consisting of a PROM, a D/A converter and a current-to-voltage converter. See Figure 1. This arrangement provides a high degree of accuracy and repeatability and preserves the inherent monotonicity of the attenuator.

SERIES 349

The maximum programmable attenuation range in every band except the 8.0 - 18.0 GHz frequency range is 80 dB. Attenuators limited in range to 64 dB exhibit switching times less than 500 nsec while the 80 dB units switch in less than 2 µsec.

SERIES 349H

If even faster switching of 64 dB units is required, GMC offers its Series 349H attenuators. These units switch in 300 nsec with the same performance specifications as the 64 dB Series 349 units, albeit at somewhat higher cost.

All the attenuators are available with either a strobe/latch or a non-linear current or voltage controlled attenuation capability. Refer to the Available Options table and the Notes following the Pin Functions table.

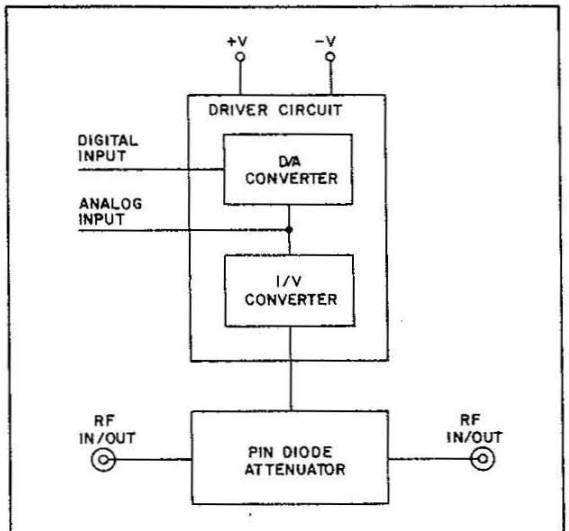


Fig. 1–Series 349 and 349H block diagram

- **Absorptive**
- **64 or 80 dB range**
- **.03 dB resolution**
- **Binary or BCD programming**
- **Guaranteed monotonicity**
- **Frequency range: 0.75 to 18 GHz**

Series 349 and 349H Specifications

PERFORMANCE CHARACTERISTICS

MODEL	FREQUENCY RANGE GHz	MAX. INSERTION LOSS (dB)	MAX. VSWR	FLATNESS (±dB) AT MEAN ATTENUATION LEVELS UP TO				
				10 dB	20 dB	40 dB	60 dB	80 dB (2)
3491-64 3491H-64 3491-80	1.0-2.0	1.6	1.5	0.3	0.8	1.5	1.6	1.7
	0.75-2.25*	1.7	2.0	0.5	1.4	3.0	3.5	3.6
3492-64 3492H-64 3492-80	2.0-4.0	1.8	1.5	0.3	0.8	1.5	1.6	1.7
	1.5-4.5*	1.9	2.0	0.5	1.4	3.0	3.5	3.6
3493-64 3493H-64 3493-80	2.6-5.2	2.0	1.6	0.3	0.8	1.5	1.6	1.7
	1.95-5.85*	2.1	2.1	0.5	1.4	3.0	3.5	3.6
3494-64 3494H-64 3494-80	4.0-8.0	2.4	1.7	0.3	0.8	1.5	1.6	1.7
	3.0-9.0*	2.5	2.2	0.5	1.4	3.0	3.5	3.6
3495-64 3495H-64 3495-80	5.0-10.0	2.6	1.7	0.5	0.9	1.5	1.6	1.7
	3.75-11.25*	2.7	2.2	0.7	1.4	3.0	3.5	3.6
3496-64 3496H-64 3496-80	6.0-12.0	2.7	1.8	0.7	1.0	1.5	1.6	1.7
	4.5-13.5*	2.8	2.2	0.9	1.5	3.0	3.5	3.6
3498-64 3498H-64	8.0-18.0	3.0(1)	1.8(1)	0.7	1.0	1.5	1.6	—
	6.0-18.0*	3.0(1)	1.8(1)	0.9	1.5	3.0	3.5	—

***NOTE:** Specifications for the extended frequency ranges are typical.
(1) Except from 16-18 GHz where insertion loss is 4.2 dB max. and VSWR is 2.2.
(2) Applicable only to 80 dB versions.

Series 349 and 349H Specifications

Mean Attentuation Range
349(x)-64, 349(x)H-64. .....64 dB
349(x)-80 .....80 dB

Accuracy of Attenuation
0-30 dB .....± 0.5 dB
>30-50 dB.....± 1.0 dB
>50-64 dB.....± 1.5 dB
>64-80 dB.....± 2.0 dB

Monotonicity .....Guaranteed

Temperature Coefficient .....± 0.025 dB/°C

Power Handling Capability
Without Performance Degradation
3491 .....10 mW cw or peak
3491H .....1mW cw or peak
All other units .....100 mW cw or peak

Survival Power (from –40°C to +25°C; see figure 2 for higher temperatures)
All units.....1 W average
25 W peak (1 µsec max. pulse width)

Switching Time
349(x)H-64.....300 nsec max.
349(x)-64 .....500 nsec max.
349(x)-80 .....2 µsec max.

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... –40°C to +85°C

Non-Operating Temperature Range .. –54°C to +100°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles.

ACCESSORIES FURNISHED

Mating power/logic connector

Programming.....Positive true binary (standard) or BCD (Option 1). For complementary code, specify Option 2.

Minimum Attenuation Step
Binary Units
349(x)-64, 349(x)H-64..... .03 dB
349(x)-80..... .04 dB
BCD Units ..... .10 dB

Logic Input
Logic "0" (Bit Off).....–0.3 to +0.8 V
Logic "1" (Bit On).....+2.0 to +5.0 V
Logic Input Current .....1 µA max.

Analog Input
349(x)-64, 349(x)H-64.....0 to 6.4 V
349(x)-80.....0 to 8 V
Input Resistance .....10 K ohms

Power Supply Requirements.....+ 12 to +15V, 120 mA
– 12 to –15V, 50 mA

Power Supply Rejection.....Less than 0.1 dB/volt change in either supply

AVAILABLE OPTIONS

Option No.	Description
1	BCD programming (Binary is standard
2	Complementary programming (logic "0" is Bit On)
4	Strobe latch for date input. Attenuator responds to data input when logic "0" is applied. Attenuator latched to data input when logic "1" is applied.
7	Two SMA male rf connectors
10	One SMA male rf connector (J1) and one SMA female rf connector (J2).

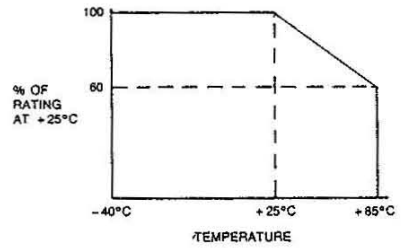
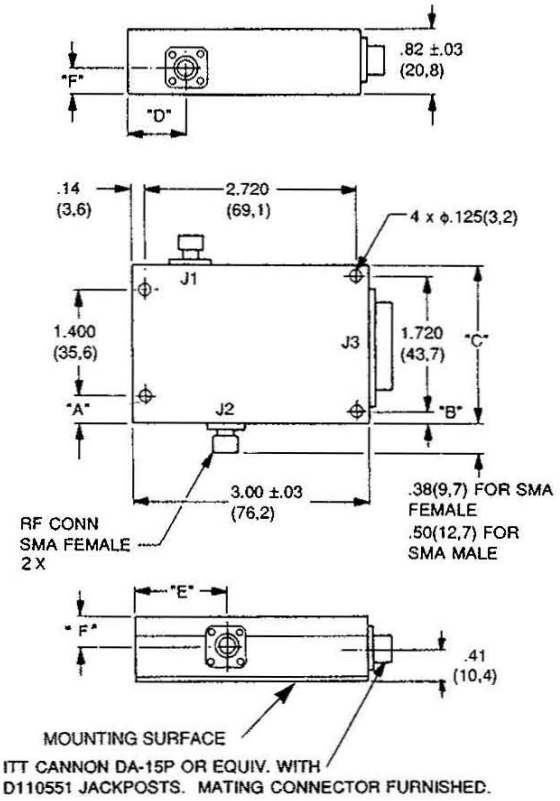


Fig. 2–Series 349 and 349H, power derating factor

DIMENSIONS AND WEIGHTS



J3 PIN FUNCTIONS			
	BINARY		
PIN	64 dB	80 dB	BCD
1	0.06 dB	0.08 dB	0.2 dB
2	0.13 dB	0.16 dB	0.4 dB
3	Analog Input / Strobe Latch[1][2]		
4	GND		
5	0.25 dB	0.31 dB	0.8 dB
6	0.5 dB	0.63 dB	1 dB
7	1 dB	1.25 dB	2 dB
8	2 dB	2.5 dB	4 dB
9	4 dB	5 dB	8 dB
10	8 dB	10 dB	10 dB
11	16 dB	20 dB	20 dB
12	32 dB	40 dB	40 dB
13	+12 to +15 V		
14	−12 to −15 V		
15	0.03 dB	0.04 dB	0.1 dB

Series 349, 349H
Wt: 5.5 oz. (156 gm) approx.

MODEL	DIM "A"	DIM "B"	DIM "C"	DIM "D"	DIM "E"	DIM "F"
3491, 3491H	.58 (14,7)	.42 (10,7)	2.56±.03 (65,0)	.56 (14,2)	1.53 (38,9)	.34 (8,6)
3492,93, 3492H,93H	.30 (7,6)	.14 (3,6)	2.00±.03 (50,8)	.50 (12,7)	1.29 (32,8)	.34 (8,6)
3494,95,96, 3494H,95H,96H	.30 (7,6)	.14 (3,6)	2.00±.03 (50,8)	.75 (19,1)	1.19 (30,2)	.34 (8,6)
3498, 3498H	.30 (7,6)	.14 (3,6)	2.00±.03 (50,8)	.75 (19,1)	1.00 (25,4)	.34 (8,6)

NOTES

1. Normally supplied as an Analog input. Leave pin open if analog input is not used. Optionally available as a strobe latch function for input data.
2. Pin 3 is available to apply a current or voltage to control the attenuator in a non-linear fashion.
3. The Series 349 attenuators are 11-bit digital attentuators. In order to use this device with a lesser number of bits (lower resolution), the user may simply ground the logic pins for the lowest order unused bits. For example, a Series 349 unit operated as an 8-bit unit would have Pin 15, Pin 1 and Pin 2 connected to ground. All other parameters remain unchanged.

Dimensional Tolerances, unless otherwise indicated: .xx ±.02; .xxx ±.005

Phase Shifters and I-Q Modulators

General Microwave offers a complete line of broadband phase shifters and I-Q modulators which span the frequency range from 0.5 to 24.0 GHz. These devices are available in several different topologies that allow the designer to choose among various performance characteristics that best suit his system needs. This catalog describes only our standard line of broadband phase shifter models. In addition to these, there are numerous special designs, employing a variety of phase shifter circuits, which GMC has utilized in custom applications.

PHASE SHIFTER FUNDAMENTALS

A variable phase shifter can be characterized as a linear two port device which alters the phase of its output signal in response to an external electrical command. (Mechanical phase shifters such as line stretchers or rotary waveguide phase shifters are not considered here.) Expressing this mathematically, with an input signal $\sin(\omega t)$, the output will be $A(n)\sin(\omega t + \Phi(n))$, where n is the programmed phase and A(n) is the insertion loss. The difference between the input phase and the output phase is the sum of the phase shift due to the propagation through the phase shifter plus the programmed phase shift.

The relative simplicity of the idea that any reactance placed in series or shunt with a transmission line will produce a phase shift has given rise to many different circuits over the years for use as phase shifters at microwave frequencies. Usually, for high speed applications, the controlling elements have been semiconductor devices such as PIN, Schottky and varactor diodes, whereas for high power requirements, when slower switching speed can be tolerated, ferrites are frequently employed. The final choice of a phase shifter network and control element will depend on the required bandwidth, insertion loss, switching speed, power handling, accuracy and resolution. In addition, a choice between analog and digital control must also be made.

A brief description of several of the more widely used phase shifter circuits follows.

SWITCHED BIT PHASE SHIFTERS

As the name implies, switched bit phase shifters are digitally controlled components. They are generally used where there are requirements for very high switching speed and moderate to high power handling capability. These attributes derive from the use of PIN diodes as switching elements which, for each bit, are used to select between one of two fixed networks which differ in phase shift by a predetermined amount. Typically an *n*-bit phase shifter will consist of *n* such elements in a tandem array, with the specific topology of each bit selected for optimum performance for its phase magnitude.

All switched bit phase shifters suffer from a common problem, i.e. varying VSWR interaction between the bits as the phase shift states are changed. These mismatch effects limit the phase resolution and accuracy of the phase shifter since they give rise to non-monotonic performance as the bit size begins to approach the interaction phase error. This problem becomes significantly more difficult for wide band and high frequency designs and usually limits practical phase shifters to a maximum of four bits.

General Microwave has produced a number of custom narrow and broadband switched bit phase shifters. Recently it has introduced the Model H752 series, a broadband, high speed switched bit phase shifter which utilizes a proprietary "All-Pass" circuit as phase shift elements. A complete description of this design is available in a separate technical paper.[1] This topology achieves relatively constant phase shift performance over octave and greater bandwidths in a very compact format, especially as compared to the distributed transmission line approaches. As a result, the H752 series offers low insertion loss and high speed performance in a low profile, hermetic housing which makes it especially suitable for rugged military applications.

(1) *"Broadband Switched-Bit Phase Shifter Using All-Pass Networks", D. Adler and R. Popovich, 1991 IEEE MTT-S Digest, pp 265-268. To obtain a copy of this paper, please write to Dept. C., General Microwave Corporation, 5500 New Horizons Boulevard, Amityville, N.Y. 11701.*

ANALOG PHASE SHIFTERS

Analog phase shifters are devices whose phase shift changes continuously as the control input is varied and therefore offer almost unlimited resolution with monotonic performance. The most commonly used semiconductor control devices used in analog microwave phase shifters are varactor diodes, which act as voltage controlled variable capacitors, and PIN diodes, which act as current controlled variable resistors. Schottky diodes and ferrite devices are also used as variable elements in analog phase shifters but the former suffer from limited power handling capability and matching difficulty in broadband networks whereas the latter are generally larger, require more bias power, and are relatively slow compared to semiconductor designs.

Among the more useful topologies for analog phase shifters are the loaded line design using lumped or distributed elements and the reflective design employing quadrature hybrids. One of the variants of the reflective phase shifter is the vector modulator, which in the particular embodiment used by General Microwave shows excellent performance over 3:1 bandwidths. This capability is especially useful in the design of frequency translators[2] and high resolution phase shifters for EW systems as well as in broadband simulators as I-Q modulators, where separate control of the quadrature components of the signal allow for independent adjustment of both phase and amplitude. General Microwave's Series 72 and 78 phase control components employ this design.

Analog phase shifters are readily convertible to digital control by the addition of suitable D/A converters and appropriate linearizing circuits. The Series 71, 77 and 79 digital phase shifters use this approach.

DEFINITION OF PARAMETERS

Phase Shift: The difference in phase angle of the exiting rf signal at a given frequency and phase shift setting referenced to the exiting signal at the same frequency with the phase shifter set to zero degree phase shift.

Temperature Coefficient: The average rate of change in phase shift, as referenced to the zero degree phase state, over the full operating temperature range of the unit. Expressed in degrees phase shift/°C.

PM/AM: The maximum peak-to-peak change in insertion loss of the phase shifter at any phase state over the full 360° phase range.

Accuracy: The maximum deviation in phase shift from the programmed phase shift over the operating frequency range when measured at room temperature.

Carrier Suppression: When the phase shifter is operated as a frequency translator, the minimum ratio of carrier output power to the translated carrier output power.

Sideband Suppression: When the phase shifter is operated as a frequency translator, the minimum ratio of any sideband output power to the translated carrier output power.

Switching Speed: The time interval from the 50% point of the TTL control signal to within 10° of final phase shift. This applies to a change in either direction between any two phase states which differ by more than 22.5°.

(2) Phase shifters can be used to translate the frequency of an rf carrier by subjecting it to a linear time varying phase shift.

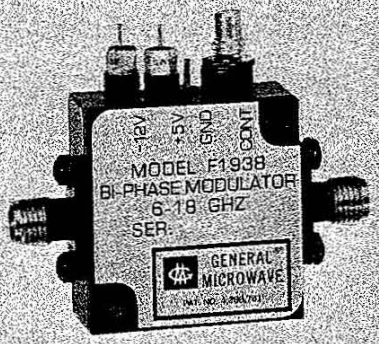
Phase Shifters and I-Q Modulators Selection Guide

PHASE SHIFTERS/FREQUENCY TRANSLATORS
BI-PHASE MODULATORS
I.Q. VECTOR MODULATORS

FREQUENCY RANGE (GHz) 0.5 2.0 4.0 6.0 8.0 12.0 18.0	MODEL	PAGE	COMMENTS
0.5 — 2.0	7720A/7820	76	Phase shifter/Frequency translator, digital/analog
2.0 — 6.0	7722A/7822		Phase shifter/Frequency translator, digital/analog
4.0 — 12.0	7724A/7824		Phase shifter/Frequency translator, digital/analog
6.0 — 18.0	7728A/7828		Phase shifter/Frequency translator, digital/analog
6.0 — 18.0	7928	80	Miniature Phase shifter/Frequency translator, Hermetically sealed, digital
2.0 — 4.0	H7522	70	Phase shifter/Frequency translator, Hermetically sealed, digital
4.0 — 8.0	H7524	73	
6.0 — 18.0	F1938	57	Bi-Phase modulator
0.5 — 2.0	7120/7220	60	I.Q. Vector modulator, digital/analog
2.0 — 6.0	7122/7222		I.Q. Vector modulator, digital/analog
4.0 — 12.0	7124/7224		I.Q. Vector modulator, digital/analog
6.0 — 18.0	7128/7228		I.Q. Vector modulator, digital/analog
2.0 — 6.0	7322/7422	65	I.Q. Vector modulator, digital/analog. High Dynamic Range
6.0 — 18.0	7328/7428		I.Q. Vector modulator, digital/analog. High Dynamic Range
16.0 — 24.0	7329/7429		I.Q. Vector modulator, digital/analog. High Dynamic Range

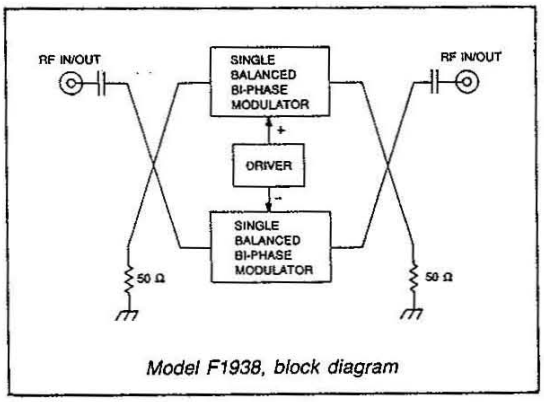
Model F1938
Bi-Phase Modulator
With Integrated Driver

- **Frequency range: 6-18 GHz**
- **Differental phase shift: 180° ± 10°**
- **High speed: 5 nsec (10-90% rf)**
- **Low VSWR and insertion loss**
- **Small size, light weight**



The Model F1938 is a high-speed 0° or 180° phase shifter that operates over the 6 to 18 GHz frequency range. It features a double-balanced design that provides excellent phase accuracy over its entire frequency range.

The rf design is shown below. The currents required to switch the unit between states are provided by the integrated driver, which is controlled by an external logic signal.



Model F1938, block diagram

Model F1938 Specifications

PERFORMANCE CHARACTERISTICS

Frequency Range . . . . . 6 to 18 GHz
Differential Phase Shift . . . . . 180° ± 10°
Switching Characteristics (1)
ON Time . . . . . 20 nsec. max.
OFF Time . . . . . 20 nsec max.
Rise Time . . . . . 5 nsec. max.
Fall Time . . . . . 5 nsec. max.
Insertion Loss . . . . . 3.0 dB max.
VSWR . . . . . 2.0 max.
Change of Insertion Loss With Phase Shift . . . . . 1.0 dB max.
Carrier Suppression . . . . . 20 dB min.
Modulation Rate . . . . . 10 MHz max.
Power Handling Capability
Without Performance Degradation . . . . . 1W cw or peak
Survival Power . . . . . 2W average, 25W peak (1 μsec max. pulse width)

(1) *As measured with a phase bridge.*

Power Supply Requirements . . . . . +5V ± 5%, 65 mA
−12 to −15V, 20 mA

Control Characteristics

Control Input Impedance . . . . . Schottky TTL, two-unit load. (A unit load is 2 mA sink current and 50 μA source current.)

Control Logic . . . . . Alternate applications of logic "0" (−0.3 to +0.8V) and logic "1" (+2.0 to +5.0V) switches phase by 180°.

Model F1938 Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −65° to +110°C

Non-Operating Temperature Range ..... −65° to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

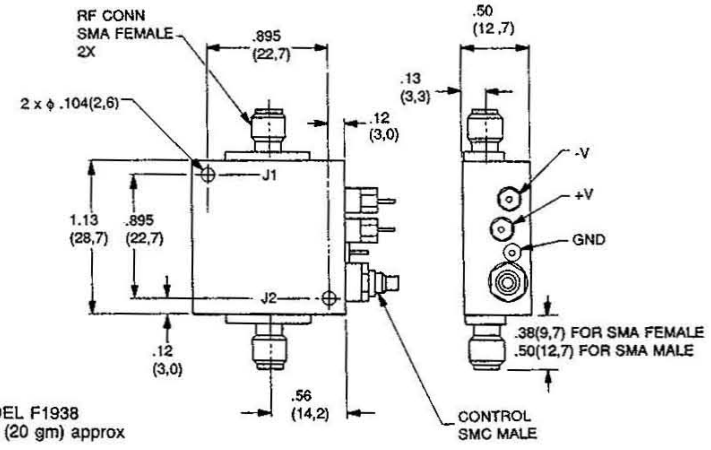
Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connector
7	Two SMA male rf connectors
10	One SMA (J1) male and one SMA female (J2) rf connector
33	EMI filter solder-type control terminal
64A	SMB male control connector

DIMENSIONS AND WEIGHT



MODEL F1938
Wt: 0.7 oz (20 gm) approx

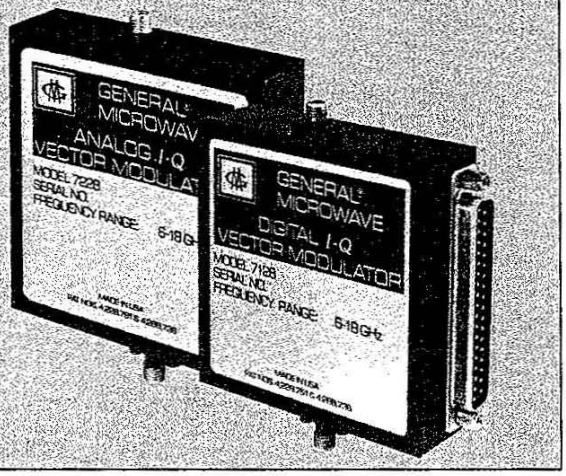
Dimensional tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 71, 12 Bit Digital and Series 72 Analog I-Q Vector Modulators

Both Series comprise a family of four solid-state PIN diode I-Q Vector Modulators covering the frequency range from 0.5 to 18 GHz in four bands; 0.5 to 2 GHz, 2 to 6 GHz, 4 to 12 GHz and 6 to 18 GHz. See Fig. 1.

All models provide a full 360° range of phase shift and a minimum of 20 dB attenuation range at any frequency.

- **Simultaneous control of amplitude and phase**
- **0.5 to 18 GHz in four bands: 0.5 to 2 GHz; 2 to 6 GHz; 4 to 12 GHz; 6 to 18 GHz**
- **12 Bit digitally programmable (Series 71)**
- **Analog control (Series 72)**
- **High speed**
- **Guaranteed monotonicity**



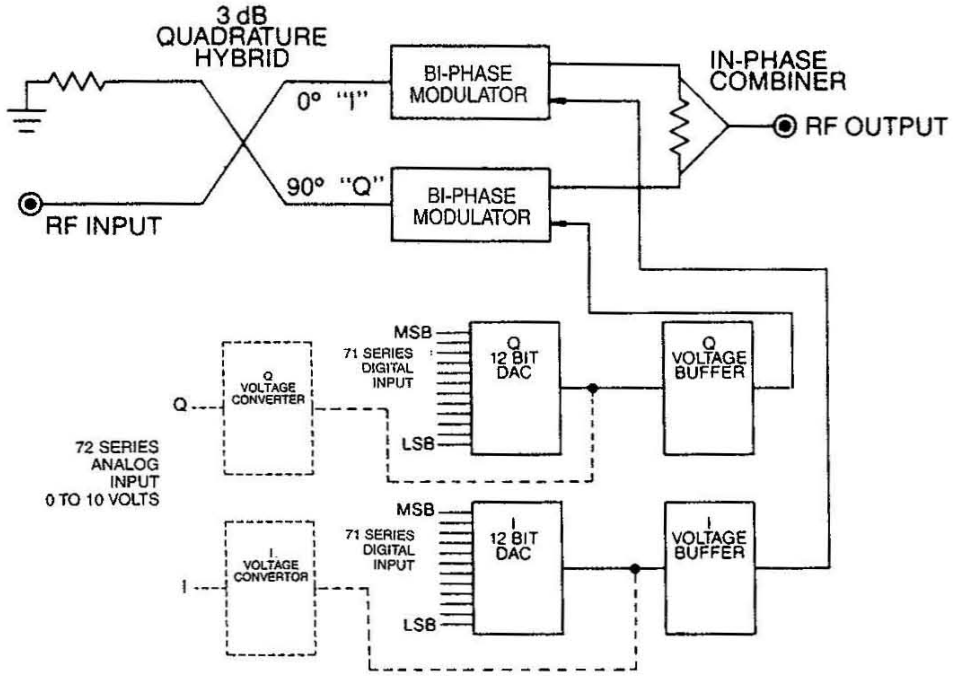


Fig. 1–Series 71, 72 Block Diagram

Series 71, 12 Bit Digital and Series 72 Analog I-Q Vector Modulators

THEORY OF OPERATION

The block diagram of the I-Q Vector Modulator is shown in Figure 1. An RF signal incident on a 3 dB quadrature hybrid is divided into two equal outputs, with a 90° phase difference between them. The in-phase, or 0°, channel is designated the I channel and the Quadrature, or 90°, channel is designated the Q channel. Each signal passes through a bi-phase modulator which sets the 0° or 180° state and the attenuation level for both the I and Q paths. The outputs of the I and Q path are combined to yield the resultant vector which may fall anywhere within the bounded area shown in Figure 2. Any signal applied to the I-Q Vector Modulator can be shifted in phase and adjusted in amplitude by applying the following relationships:

1. Let the desired attenuation level = X dB and the desired phase shift = θ° (with respect to 0 dB and O° reference states).
2. The normalized output voltage magnitude is given by: $|V| = 10^{-(x/20)}$.
3. The values of the I and Q attenuator control inputs are then expressed as:

$$I = V \cos \theta$$

and

$$Q = V \sin \theta.$$

Figure 3 shows the nominal value of I and Q vs. either digital word (Series 71) or analog voltage (Series 72). Thus, to achieve an attenuation level of 3 dB with a phase offset of 112.5° (with respect to 0 dB and 0° reference states) the values of I and Q can be calculated as follows:

$$V = 10^{-(3/20)} = 0.707$$
$$I = 0.707 \cos (112.5°) = -.027$$
$$Q = 0.707 \sin (112.5°) = +0.65$$

From Figure 3, the control inputs to yield the desired amplitude and phase are approximately:

Analog Units (72 Series)	Digital Units (71 Series)
I = 5.78 volts	100101000000
Q = 2.84 volts	010010001011

While these values for I and Q will yield an output signal whose amplitude and phase are close to the nominal values over the entire operating frequency range of the vector modulator, the use of an iterative measurement procedure will determine the I and Q inputs which exactly define the desired parameter at any selected frequency.

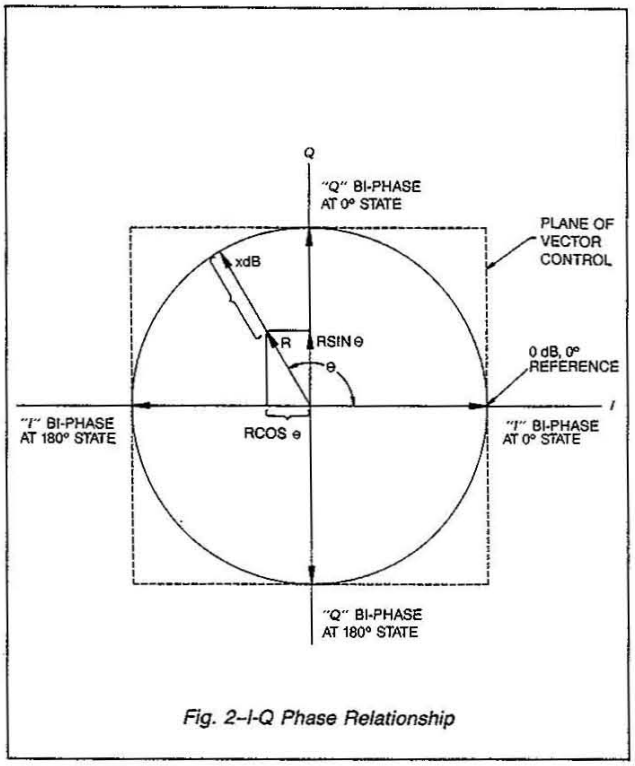


Fig. 2–I-Q Phase Relationship

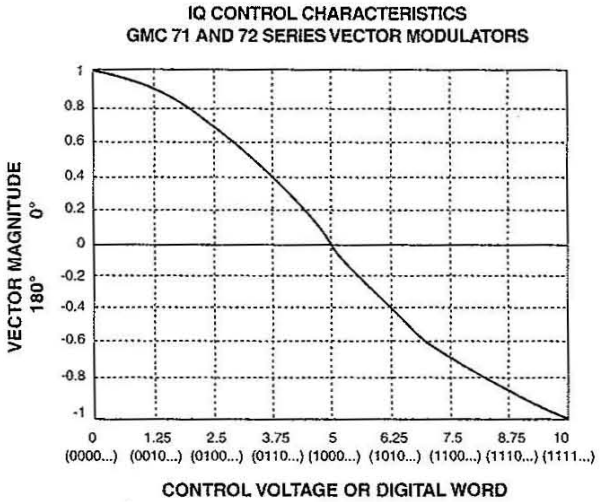


Fig. 3 – I-Q vs. Control Input (Typical)

Series 71/72 Specifications

PERFORMANCE CHARACTERISTICS

MODEL	7120/7220	7122/7222	7124/7224	7128/7228
FREQUENCY	0.5-2.0 GHz	2.0-6.0 GHz	4.0-12.0 GHz	6.0-18.0 GHz
INSERTION LOSS	13 dB	11 dB	12 dB	12 dB
VSWR (MAX)	1.6:1	1.8:1	1.8:1	2.0:1
POWER HANDLING WITHOUT PERFORMANCE DEGRADATION	+7 dBm	+20 dBm	+20 dBm	+20 dBm
SURVIVAL POWER (MAX)	1W			
ABSOLUTE INSERTION PHASE ACCURACY VS. FREQUENCY (MAX)	±15°			
FINE GRAIN PHASE RIPPLE (50 MHz) (MAX)	2° pk-pk			
VARIATION OF PHASE VS. TEMPERATURE (MAX)	±0.1 deg./ °C			
ATTENUATION RANGE (MIN)	20 dB			
VARIATION OF AMPLITUDE VS. TEMPERATURE (MAX)	0.02 dB/ °C			
RESPONSE TIME (MAX)	0.5 µsec			
POWER SUPPLY	-12 to -15V @ 70 mA +12 to +15V @ 70 mA			
CONTROL INPUT 71 SERIES 72 SERIES	12 bit TTL for both I and Q inputs 0 to +10V dc for both I and Q inputs			
CONTROL INPUT IMPEDANCE 71 SERIES 72 SERIES	40 µA max 10 K ohms			

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −54°C to +100°C

Non-Operating Temperature Range ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B. Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C. Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

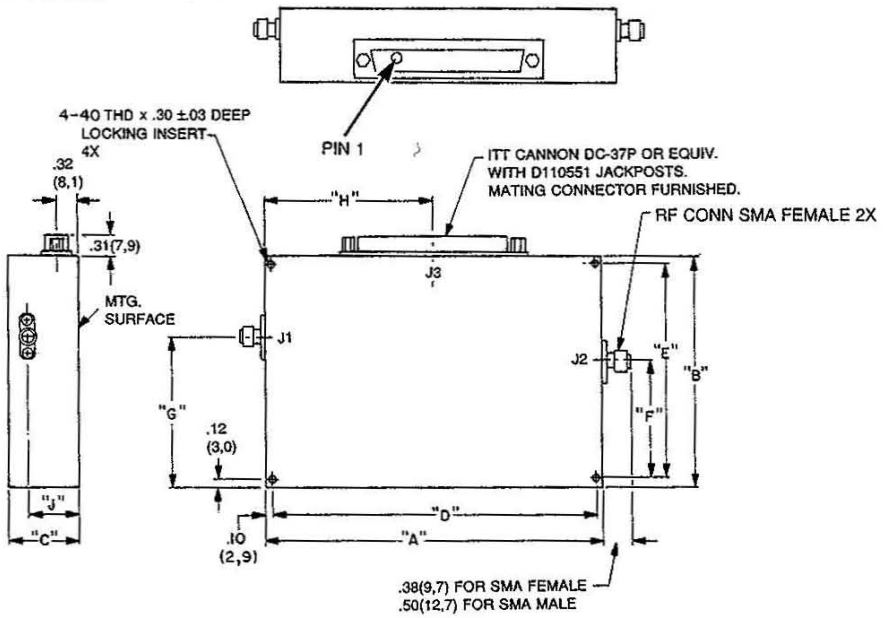
ACCESSORY FURNISHED

Mating power/control connector (Series 71 only)

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J2) and one SMA female (J1) rf connector

DIMENSIONS AND WEIGHTS



MODEL	A	B	C	D	E	F	G	H	J
7120	4.95±.03 (125,7)	3.38±.03 (85,9)	1.02 (25,9)	4.75±.01 (120,7)	3.12±.01 (79.2)	1.68 (42,7)	.75 (19,1)	2.48 (62,9)	.73 (18,5)
7122	3.25±.03 (82,6)	3.25±.03 (82,6)	.85 (21.6)	3.05±.01 (77,5)	3.00±.01 (76,2)	1.63 (41,4)	1.99 (50,5)	1.63 (41,4)	.64 (16,3)
7124							1.83 (46,5)		
7128	3.00±.03 (76,2)	3.00±.03 (76,2)	.96 (24,4)	2.80±.01 (71,1)	2.75±.01 (69,9)	1.50 (38,1)	1.63 (41,4)	1.50 (38,1)	.76 (19,3)

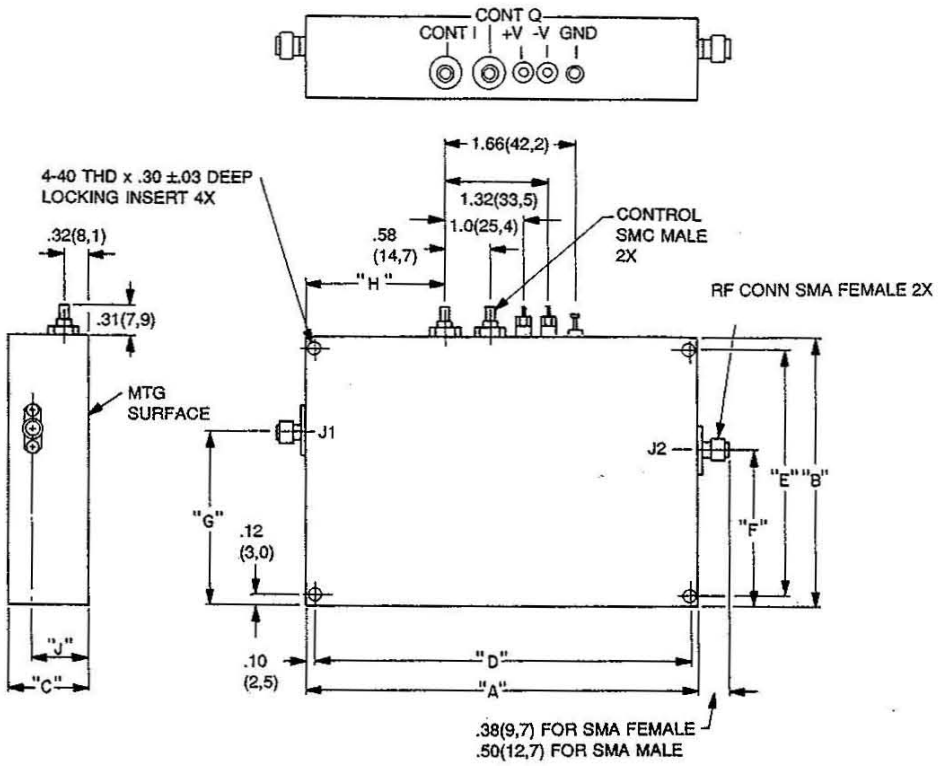
J3 PIN FUNCTIONS			
PIN	FUNCTION	PIN	FUNCTION
1	I-5	20	I-4
2	I-6	21	I-7
3	I-8	22	I-3
4	I-9	23	I-2
5	I-10	24	I-1 (LSB)
6	I-11	25	I-12 (MSB)
7	N/C	26	N/C
8	+12 to +15V	27	N/C
9	GND	28	GND
10	GND	29	N/C
11	-12 to -15V	30	N/C
12	Q-3	31	N/C
13	Q-2	32	Q-4
14	Q-1 (LSB)	33	N/C
15	Q-5	34	N/C
16	Q-6	35	Q-12 (MSB)
17	Q-7	36	Q-11
18	Q-8	37	Q-10
19	Q-9		

MODEL	WEIGHT (APPROX)
7120	13 oz. (369 gm)
7122	10 oz. (284 gm)
7124	10 oz. (284 gm)
7128	9 oz. (255 gm)

Dimensional tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 71/72 Specifications

DIMENSIONS AND WEIGHTS



MODEL	A	B	C	D	E	F	G	H	J
7220	4.95±.03 (125,7)	3.38±.03 (85,9)	1.02 (25,9)	4.75±.01 (120,6)	3.12±.01 (79.2)	1.68 (42,7)	.75 (19,1)	1.75 (44,5)	.73 (18,5)
7222	3.25±.03 (82,6)	3.25±.03 (82,6)	.85 (21.6)	3.05±.01 (77,5)	3.00±.01 (76,2)	1.63 (41,4)	1.99 (50,5)	.90 (22,9)	.64 (16,3)
7224							1.83 (46,5)		
7228	3.00±.03 (76,2)	3.00±.03 (76,2)	.96 (24,4)	2.80±.01 (71,1)	2.75±.01 (69,9)	1.50 (38,1)	1.63 (41,4)	.78 (19,8)	.76 (19,3)

MODEL	WEIGHT (APPROX)
7220	13 oz. (369 gm)
7222	10 oz. (284 gm)
7224	10 oz. (284 gm)
7228	9 oz. (255 gm)

Dimensional tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 73 12 Bit Digital and Series 74 Analog High Dynamic Range I-Q Vector Modulators

The new Series 73/74 represents the latest addition to General Microwave's existing line of PIN Diode I.Q. Vector Modulators. Their performance has been enhanced to provide a higher dynamic range of attenuation for today's more demanding system applications.

All models incorporate multiple bi-phase modulator sections to provide in excess of 60 dB attenuation range at any frequency. All models are also capable of a full 360° range of phase shift. The series covers a frequency range of 2 GHz to 24 GHz in three bands; 2 GHz to 6 GHz, 6 GHz to 18 GHz, and 16 GHz to 24 GHz. A simplified block diagram is shown in Fig. 1.

- **Simultaneous control of amplitude and phase over a 60 dB dynamic range**
- **2 to 24 GHz in three bands: 2 to 6 GHz; 6 to 18 GHz; 16 to 24 GHz**
- **12 Bit digitally programmable (Series 73)**
- **Analog control (Series 74)**
- **High speed**
- **Guaranteed monotonicity**

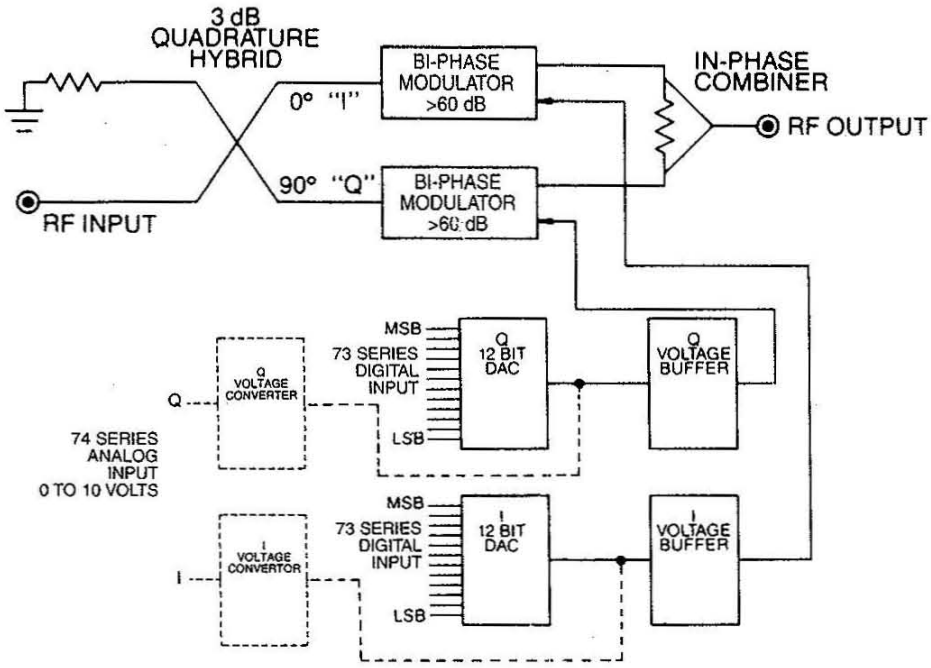


Fig. 1 – Series 73, 74 Block Diagram

Series 73 12 Bit Digital and Series 74 Analog High Dynamic Range I-Q Vector Modulators

THEORY OF OPERATION

The block diagram of the I-Q Vector Modulator is shown in Figure 1. An RF signal incident on a 3 dB quadrature hybrid is divided into two equal outputs, with a 90° phase difference between them. The in-phase, or 0°, channel is designated the I channel and the Quadrature, or 90°, channel is designated the Q channel. Each signal passes through a bi-phase modulator which sets the 0° or 180° state and the attenuation level for both the I and Q paths. The outputs of the I and Q path are combined to yield the resultant vector which may fall anywhere within the bounded area shown in Figure 2. Any signal applied to the I-Q Vector Modulator can be shifted in phase and adjusted in amplitude by applying the following relationships:

1. Let the desired attenuation level = X dB and the desired phase shift = θ° (with respect to 0 dB and 0° reference states).
2. The normalized output voltage magnitude is given by: $|V| = 10^{-(x/20)}$.
3. The values of the I and Q attenuator control inputs are then expressed as:

$$I = V \cos \theta$$

and

$$Q = V \sin \theta.$$

Figure 3 shows the nominal value of I and Q vs. either digital word (Series 73) or analog voltage (Series 74). Thus, to achieve an attenuation level of 3 dB with a phase offset of 112.5° (with respect to 0 dB and 0° reference states) the values of I and Q can be calculated as follows:

$$V = 10^{-(3/20)} = 0.707$$
$$I = 0.707 \cos (112.5°) = -.027$$
$$Q = 0.707 \sin (112.5°) = +0.65$$

From Figure 3, the control inputs to yield the desired amplitude and phase are approximately:

Analog Units (74 Series)	Digital Units (73 Series)
I = 7.81 volts	110010000000
Q = 1.50 volts	001010000000

While these values for I and Q will yield an output signal whose amplitude and phase are close to the nominal values over the entire operating frequency range of the vector modulator, the use of an iterative measurement procedure will determine the I and Q inputs which exactly define the desired parameter at any selected frequency.

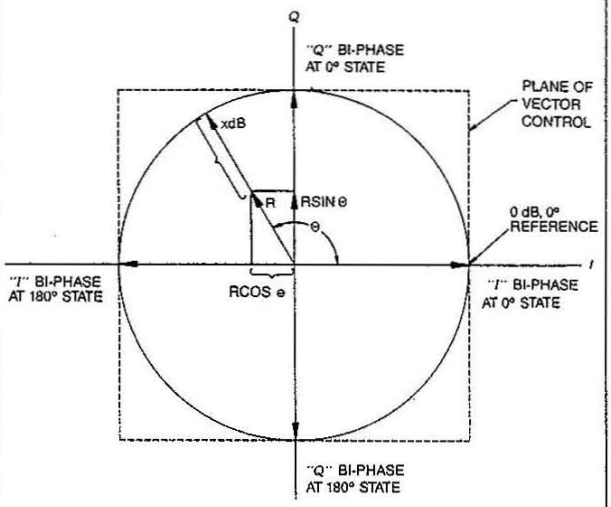


Fig. 2–I-Q Phase Relationship

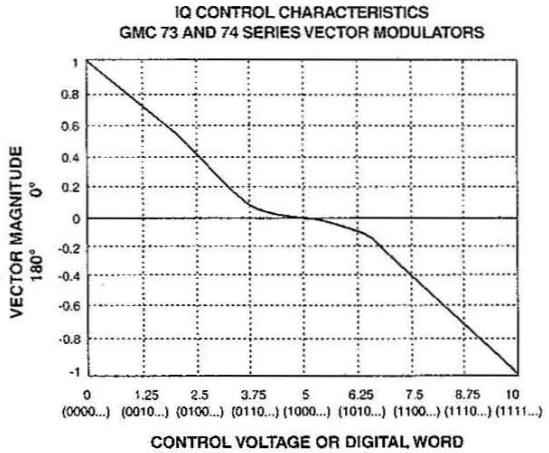


Fig. 3 – I-Q vs. Control Input (Typical)

Series 73/74 Specifications

PERFORMANCE CHARACTERISTICS

MODEL	7322/7422	7328/7428	7329/7429
FREQUENCY	2.0-6.0 GHz	6.0-18.0 GHz	16.0-24.0 GHz
INSERTION LOSS (MAX)	14 dB	15 dB 6-16 GHz 16.5 dB >16-18 GHz	16 dB 16-22 GHz 18 dB >22-24 GHz
VSWR (MAX)	1.8:1	2.0:1	2.0:1 16-22 GHz 2.2:1 >22-24 GHz
POWER HANDLING WITHOUT PERFORMANCE DEGRADATION	+20 dBm		
SURVIVAL POWER (MAX)	1W		
ABSOLUTE INSERTION PHASE ACCURACY VS. FREQUENCY (MAX)	±15°		±15° 16-22 GHz ±20° > 22-24 GHz
FINE GRAIN PHASE RIPPLE (50 MHz) (MAX)	2° pk-pk		
VARIATION OF PHASE VS. TEMPERATURE (MAX)	±0.2 deg./ °C		
ATTENUATION RANGE (MIN)	60 dB		
VARIATION OF AMPLITUDE VS. TEMPERATURE (MAX)	0.04 dB/ °C		
RESPONSE TIME (MAX)	1.0 µsec		
POWER SUPPLY	-12 to -15V @ 100 mA +12 to +15V @ 100 mA		
CONTROL INPUT 73 SERIES 74 SERIES	12 bit TTL for both I and Q inputs 0 to +10V dc for both I and Q inputs		
CONTROL INPUT IMPEDANCE 73 SERIES 74 SERIES	40 µA max 10 K ohms		

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −54°C to +100°C

Non-Operating Temperature Range ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B. Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C. Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

ACCESSORY FURNISHED

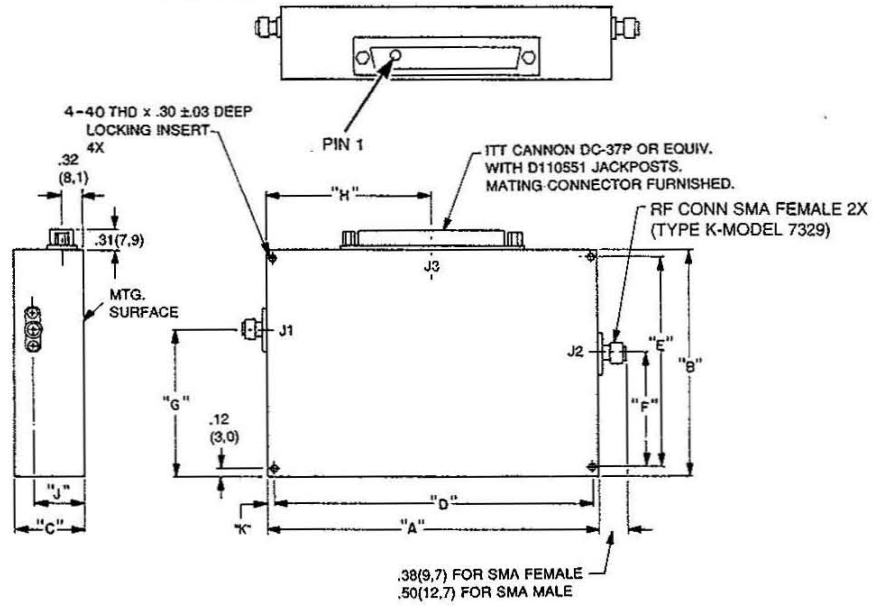
Mating power/control connector (Series 73 only)

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA (Type K-Model 7X29) male rf connectors
10	One SMA (Type K-Model 7X29) male (J2) and one SMA (Type K-Model 7X29) female (J1) rf connector

Series 73/74 Specifications

DIMENSIONS AND WEIGHTS



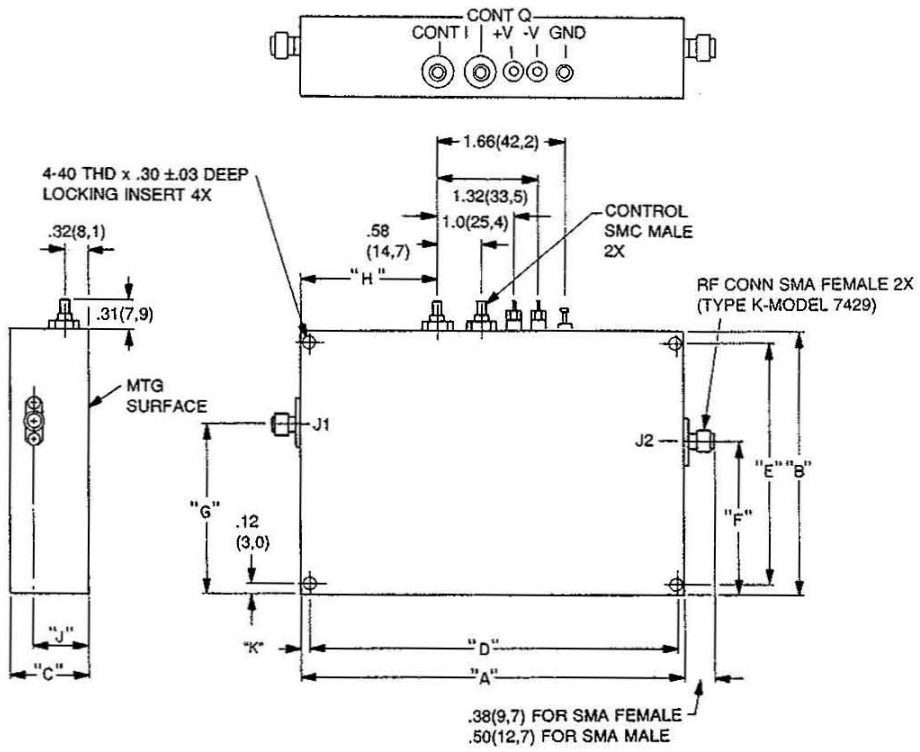
MODEL	A	B	C	D	E	F	G	H	J	K
7322	4.00 ± .03 (101, 6)	3.00 ± .03 (76, 2)	.88 (22, 4)	3.80 ± .01 (96, 5)	2.75 ± .01 (69, 9)	1.50 (38, 1)	1.90 (48, 3)	2.00 (50, 8)	.68 (17, 3)	.10 (2, 9)
7328	3.12 ± .03 (79, 2)	3.00 ± .03 (76, 2)	.88 (22, 4)	2.92 ± .01 (74, 2)	2.75 ± .01 (69, 9)	1.50 (38, 1)	1.82 (46, 2)	1.56 (39, 6)	.68 (17, 3)	.10 (2, 9)
7329	3.25 ± .03 (82, 6)	3.00 ± .03 (76, 2)	.82 (20, 8)	3.00 ± .01 (76, 2)	2.75 ± .01 (69, 9)	1.50 (38, 1)	1.69 (42, 9)	1.62 (41, 1)	.65 (16, 5)	.12 (3, 0)

J3 PIN FUNCTIONS			
PIN	FUNCTION	PIN	FUNCTION
1	I-5	20	I-4
2	I-6	21	I-7
3	I-8	22	I-3
4	I-9	23	I-2
5	I-10	24	I-1 (LSB)
6	I-11	25	I-12 (MSB)
7	N/C	26	N/C
8	+12 to +15V	27	N/C
9	GND	28	GND
10	GND	29	N/C
11	-12 to -15V	30	N/C
12	Q-3	31	N/C
13	Q-2	32	Q-4
14	Q-1 (LSB)	33	N/C
15	Q-5	34	N/C
16	Q-6	35	Q-12 (MSB)
17	Q-7	36	Q-11
18	Q-8	37	Q-10
19	Q-9		

MODEL	WEIGHT (APPROX)
7322	12 oz. (341 gm)
7328	11 oz. (312 gm)
7329	11 oz. (312 gm)

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

DIMENSIONS AND WEIGHTS



MODEL	A	B	C	D	E	F	G	H	J	K
7422	4.00 ± .03 (101, 6)	3.00 ± .03 (76, 2)	.88 (22, 4)	3.80 ± .01 (96, 5)	2.75 ± .01 (69, 9)	1.50 (38, 1)	1.90 (48, 3)	1.28 (32, 5)	.68 (17, 3)	.10 (2, 9)
7428	3.12 ± .03 (79, 2)	3.00 ± .03 (76, 2)	.88 (22, 4)	2.92 ± .01 (74, 2)	2.75 ± .01 (69, 9)	1.50 (38, 1)	1.82 (46, 2)	.83 (21, 1)	.68 (17, 3)	.10 (2, 9)
7429	3.25 ± .03 (82, 6)	3.00 ± .03 (76, 2)	.82 (20, 8)	3.00 ± .01 (76, 2)	2.75 ± .01 (69, 9)	1.50 (38, 1)	1.69 (42, 9)	0.90 (22, 9)	.65 (16, 5)	.12 (3, 0)

MODEL	WEIGHT (APPROX)
7422	12 oz. (341 gm)
7428	11 oz. (312 gm)
7429	11 oz. (312 gm)

Dimensional tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Model H7522 High Speed, 4 Bit Phase Shifter/Frequency Translator

The Model H7522 is a hermetically sealed, high speed, digitally controlled switched bit phase shifter. Broadband, constant, differential phase shift is obtained by switching between two unbalanced all-pass filter networks. See Figs. 1, 2 and 3.

Phase shift changes are guaranteed to be monotonic over the entire frequency band and operating temperature range. Employing removable rf connectors, the small size and construction of the Model H7522 make it suitable for use as a drop-in component for system integration or as a conventional connectorized component.

Phase shift is selected via four FAST TTL input control pins. The unit is protected against inadvertent power supply voltage reversals.

- **2-4 GHz**
- **25 nsec switching speed**
- **4-Bit, 0-337.5° phase shift range**
- **0.27" thick**
- **Hermetically sealed**
- **Guaranteed monotonicity**

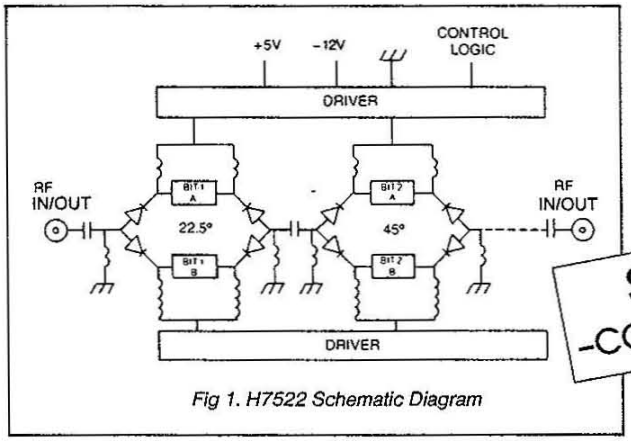


Fig 1. H7522 Schematic Diagram

SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

Model H7522 Specifications

PHASE SHIFTER SPECIFICATIONS

FREQUENCY RANGE (GHz)[3]	INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY (Max.)	PM/AM (Max.)
2 to 4	6 dB	2.0:1	± 15° PEAK, ± 8° RMS	± 0.75 dB

FREQUENCY TRANSLATOR (SERRODYNING) SPECIFICATIONS

TRANSLATION RATE	CARRIER SUPPRESSION (Min.)	SIDEBAND[1] SUPPRESSION (Min.)	CONVERSION LOSS (Max.)
0 to 2 MHz	25 dB	25 dB	6.0 dB

PERFORMANCE CHARACTERISTICS

Phase Shift:
Range . . . . . 0° to 337.5°

Control Input . . . . . 4 Bit TTL
Bit Weights . . . . . 22.5°, 45°, 90° & 180°
Logic "0" . . . . . Insertion Phase (−0.3 to +0.8V@1.2 mA)
Logic "1" . . . . . Positive Phase Shift (+2.0 to +5.0V@40 μA)

Switching Time . . . . . 25 nsec (max)

Harmonics . . . . . −45 dBc

Power Handling Capability (CW) . . . . . +23 dBm

Power Supply[2] . . . . . +5V ±5%, 170 mA
−12V ±5%, 130 mA

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . −54°C to +110°C

Non-Operating Temperature Range . . . . . −65°C to +125°C

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
9	Inverse logic
10	One SMA (J1) male and one SMA (J2) female rf connector
49	High Rel screening (See table 1, page 30)

AVAILABLE ACCESSORY

Model	Spacer Plates
H7522	19177-P3

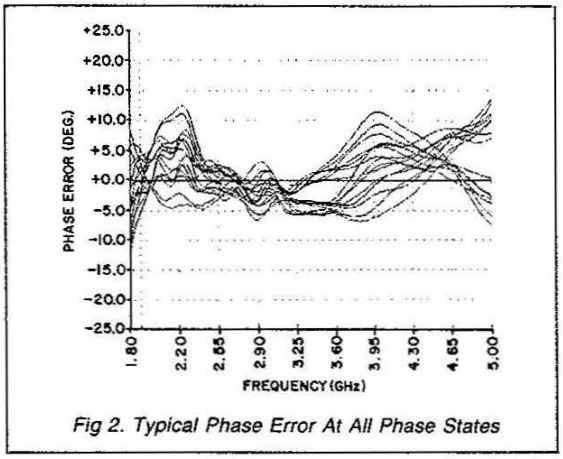


Fig 2. Typical Phase Error At All Phase States

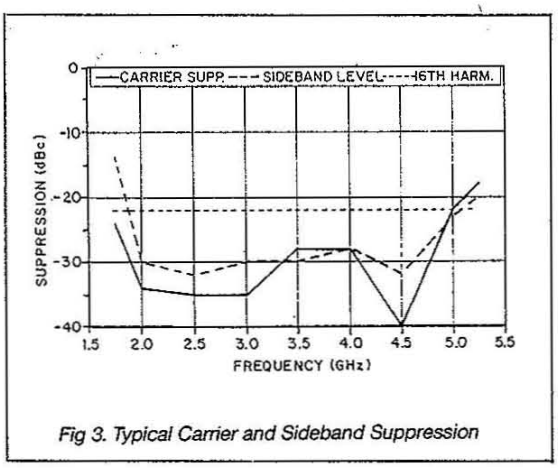
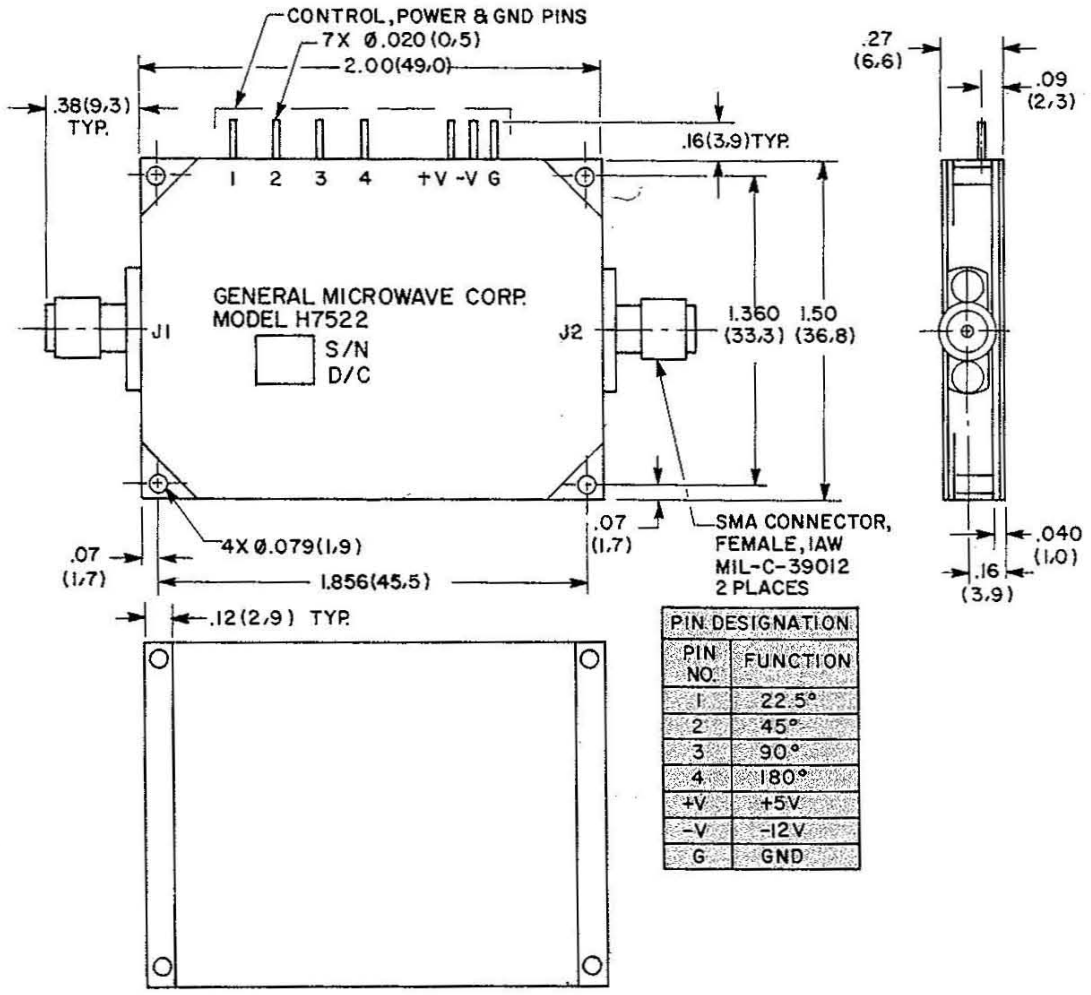


Fig 3. Typical Carrier and Sideband Suppression

(1) *Except 22 dBc for the 16th harmonic*
(2) *Above 1 MHz translation rate (LSB @ 16 MHz rep rate) the power supply current will increase to +5.0V at 325mA, −12V at 275mA, at 2 MHz.*
(3) *The unit will operate over the frequency range of 1.8 to 5.0 GHz with slight performance degradation. See figure 2.*

Model H7522
Specifications

DIMENSIONS AND WEIGHT



PIN DESIGNATION	
PIN NO.	FUNCTION
1	22.5°
2	45°
3	90°
4	180°
+V	+5V
-V	-12V
G	GND

MODEL H7522
Wt: 1.6 oz (46 gm) approx.

Dimensional Tolerances: unless otherwise indicated: .xx ± .02; .xxx ± .005

Model H7524 High Speed, 4 Bit Phase Shifter/Frequency Translator

- **4-8 GHz**
- **25 nsec switching speed**
- **4-Bit, 0-337.5° phase shift range**
- **0.24" thick**
- **Hermetically sealed**
- **Guaranteed monotonicity**

SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

The Model H7524 is a hermetically sealed, high speed, digitally controlled switched bit phase shifter. Broadband, constant, differential phase shift is obtained by switching between two unbalanced all-pass filter networks. See Figs. 1, 2 and 3.

Phase shift changes are guaranteed to be monotonic over the entire frequency band and operating temperature range. Employing removable rf connectors, the small size and contruction of the Model H7524 make it suitable for use as a drop-in component for system integration or as a conventional connectorized component.

Phase shift is selected via four FAST TTL input control pins. The unit is protected against inadvertent power supply voltage reversals.

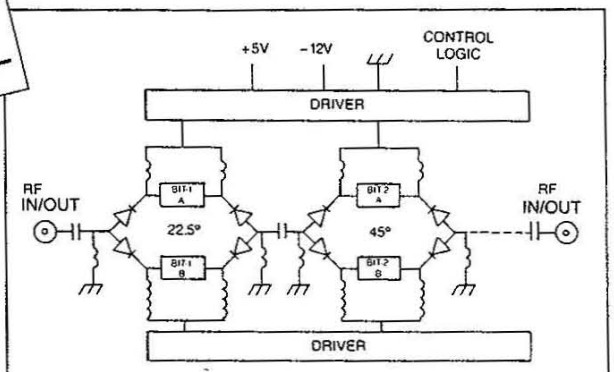


Fig 1. H7524 Schematic Diagram

Model H7524 Specifications

PHASE SHIFTER SPECIFICATIONS

FREQUENCY RANGE (GHz)	INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY (Max.)	PM/AM (Max.)
4 to 8	7 dB	2.0:1	±18° PEAK ±8° RMS	±1.0 dB

FREQUENCY TRANSLATOR (SERRODYNING) SPECIFICATIONS

TRANSLATION RATE	CARRIER SUPPRESSION (Min.)	SIDEBAND[1] SUPPRESSION (Min.)	CONVERSION LOSS (Max.)
0 to 2 MHz	25 dB	25 dB	6.0 dB

PERFORMANCE CHARACTERISTICS

Phase Shift:
Range ..... 0° to 337.5°

Control Input ..... 4 Bit TTL
Bit Weights ..... 22.5°, 45°, 90° & 180°
Logic "0" ..... Insertion Phase (−0.3 to +0.8V@1.2 mA)
Logic "1" ..... Positive Phase Shift (+2.0 to +5.0V@40 μA)

Switching Time ..... 25 nsec (max)

Harmonics ..... −30 dBc

Power Handling Capability (CW) ..... +23 dBm

Power Supply[2] ..... +5V ±5%, 170 mA
−12V ±5%, 130 mA

ENVIRONMENTAL RATINGS

Operating Temperature
Range ..... −54°C to +110°C

Non-Operating Temperature
Range ..... −65°C to +125°C

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
9	Inverse logic
10	One SMA (J1) male and one SMA (J2) female rf connector
49	High Rel screening (See table 1, page 30)

AVAILABLE ACCESSORY

Model	Spacer Plates
H7524	19177-P2

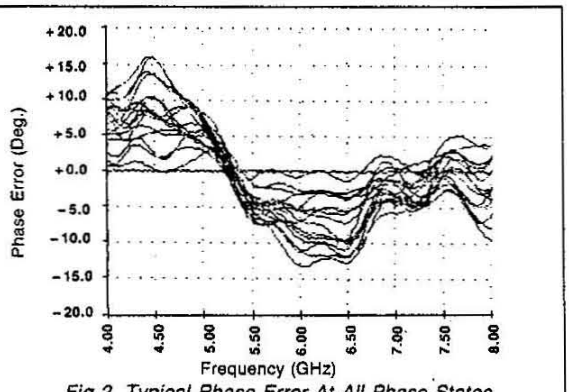


Fig 2. Typical Phase Error At All Phase States

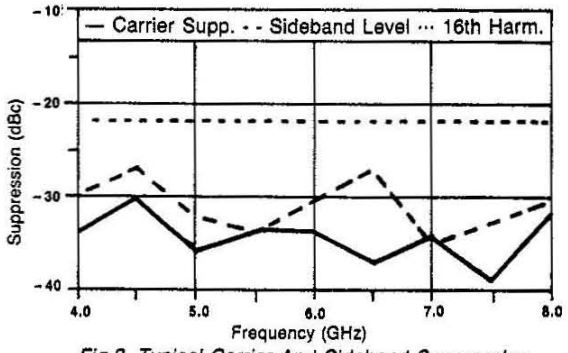
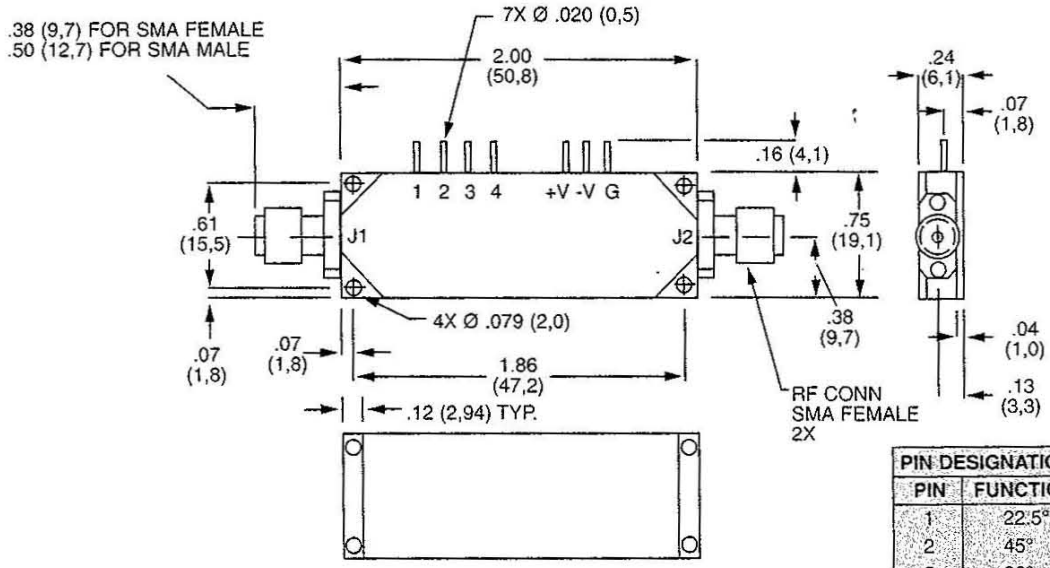


Fig 3. Typical Carrier And Sideband Suppression

(1) *Except 22 dBc for the 16th harmonic*
(2) *Above 1 MHz translation rate (LSB @ 16 MHz rep rate) the power supply current will increase to +5.0V at 325mA, −12V at 275mA, at 2 MHz.*

DIMENSIONS AND WEIGHT



PIN DESIGNATION	
PIN	FUNCTION
1	22.5°
2	45°
3	90°
4	180°
+V	+5V
-V	-12V
G	GND

MODEL H7524
Wt: 0.8 oz (23gm) approx.

Dimensional Tolerances: unless otherwise indicated: .xx ± .02; .xxx ± .005

Series 77, 10 Bit Digital and Series 78 Analog 360° Phase Shifters & Frequency Translators

Both Series, 77 and 78, comprise a family of eight solid-state PIN diode phase shifters covering the frequency range from 0.5 to 18 GHz in four bands; 0.5 to 2 GHz, 2 to 6 GHz, 4 to 12 GHz and 6 to 18 GHz. All models provide a full 360° range of phase shift and may also be used for frequency translation applications.

Each unit is an integrated assembly of an rf vector modulator and a driver circuit, consisting of a 10-bit D/A converter and a voltage buffer in the Series 77 digital units (see Fig. 1A) and a voltage converter and buffer in the Series 78 analog configuration (see Fig. 1B).

The voltage converter in the Series 78 consists of an A/D converter followed by an 10-bit D/A converter, and converts a continuous analog input voltage into discrete steps of 0.35°.

- **0.5 to 18 GHz in four bands: 0.5 to 2 GHz; 2 to 6 GHz; 4 to 12 GHz; 6 to 18 GHz**
- **10 Bit digitally programmable (Series 77)**
- **Analog control (Series 78)**
- **High speed**
- **Guaranteed monotonicity**

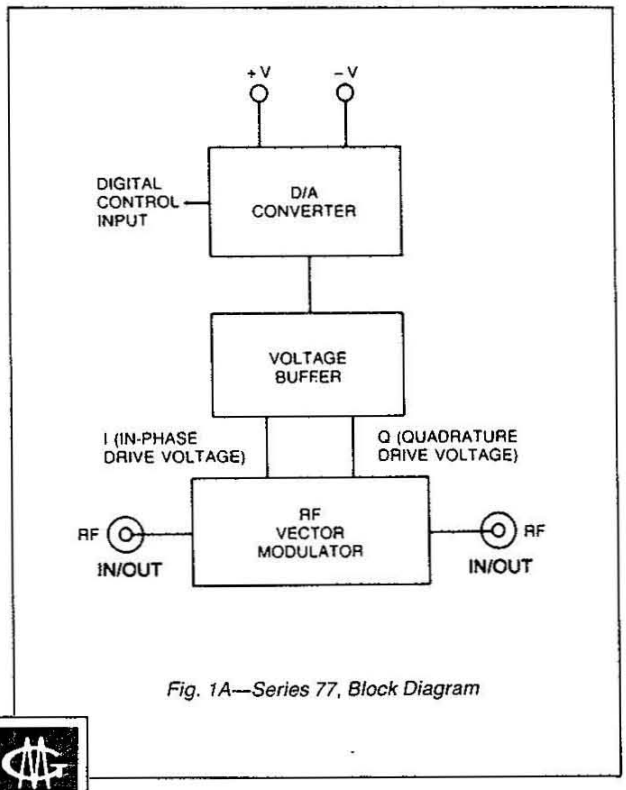


Fig. 1A—Series 77, Block Diagram

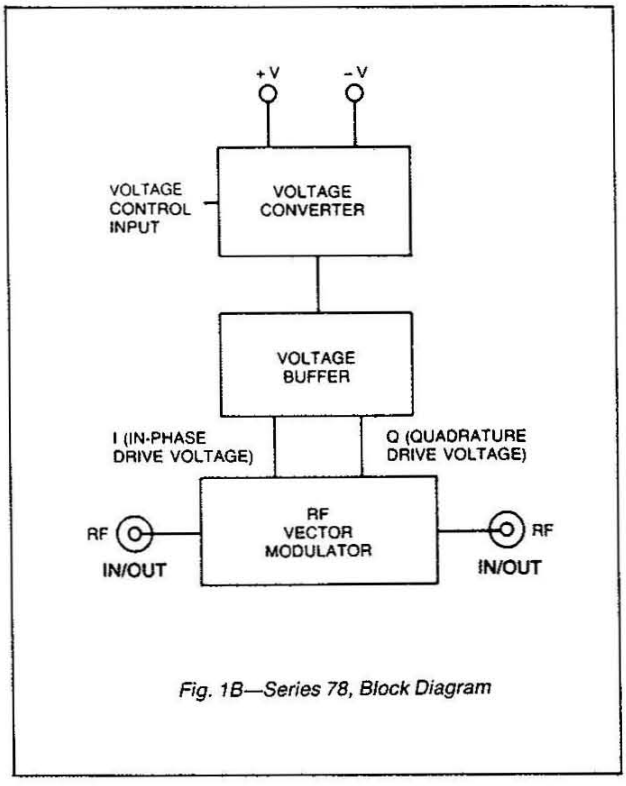


Fig. 1B—Series 78, Block Diagram

Phase Shift
Phase shift is achieved utilizing the rf vector modulator approach shown in Fig. 2. The 3 dB hybrid coupler divides the rf signal into two quadrature components which are then modulated in proportion to the sine and cosine of the desired phase shift. The signals are then combined in-phase to yield the phase-shifted output.

Excellent phase accuracy and PM/AM performance (see Figs. 4 and 5) are achieved by using linearized double balanced modulators. In their main operating bands, phase accuracy is better than ± 10° up to 10 GHz and ± 12° to 18 GHz. This phase accuracy can be extended to cover the band edges by using a built-in frequency correction circuit. Switching speed is better than 500 nsec.

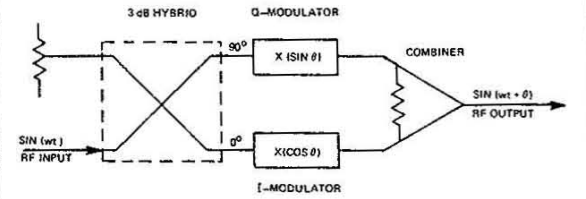


Fig. 2-RF vector modulator

Frequency Translation (Serrodyning)
Special attention in the design of the units has been paid to those characteristics which affect their performance as frequency translators. These include minimizing PM-to-AM conversion, use of high slew rate drivers, and optimizing phase shift linearity with applied signal. As a result, carrier and sideband suppression levels of over 25 and 20 dB, respectively, are obtained in the main bands. The same carrier and sideband performance can be realized over the full stretch band when the internal frequency correction circuit is employed.

See Fig. 3 for input voltage control requirements for Series 77 and 78 when used as a frequency translator.

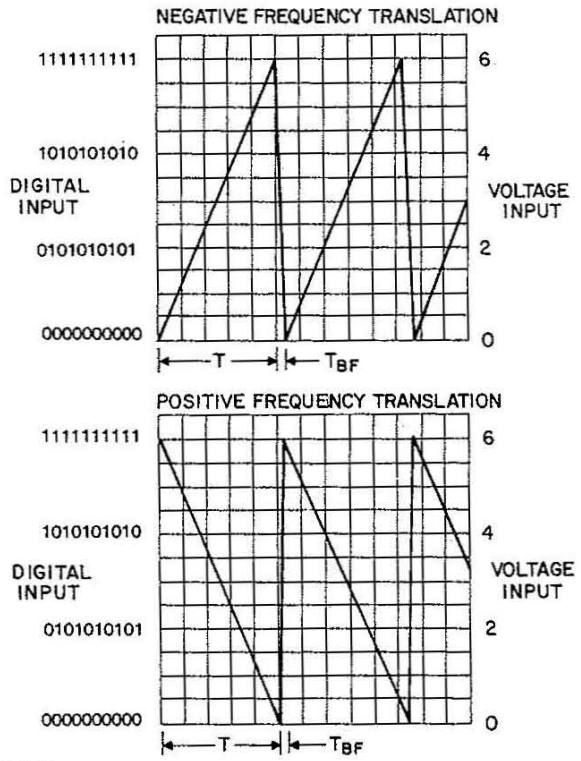
On special order, frequency translators can be provided for operation over reduced bandwidths with suppression levels of up to 35 dB. Consult the factory for special requirements.

PERFORMANCE CHARACTERISTICS

SERIES 77

Control	10 bit TTL
Logic Input	
Logic "0" (Bit OFF)	−0.3 to +0.8V @ 500 μA max
Logic "1" (Bit ON)	+2.0 to +5.0V @ 100 μA max
Power Supply	+5V at 200mA
	+12 to +15V @ 100mA max
	−12 to −15V @ 90mA max

Fig. 3-Series 77 and Series 78 input requirements



NOTES:
T_{BF} should be less than 1% of T to achieve specified carrier and sideband suppression.

Translation Rate = $\frac{1}{T + T_{BF}}$

SERIES 78

Control Voltage	0 to +6V
Sensitivity	5.9 mV/LSB
Resolution	0.35°
Step Uncertainty	0.7° max, 0.3° typ.
Input Resistance	2K ohms
Power Supply	+5V at 300mA
	+12 to +15V at 125mA
	−12 to −15V at 50 mA

COMMON TO BOTH SERIES 77 & 78

Power Handling Capability Without Performance Degradation	+20 dBm (+7 dBm for 7720A, 7820)
Survival	+30 dBm
Harmonics	−30 dBc
Phase Variation	0.1°/°C

Series 77/78 Specifications

PHASE SHIFTER SPECIFICATIONS

MODEL NOS.	FREQUENCY RANGE (GHz)	INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY[1] (Max.)	PM/AM (Max.)
7720A & 7820	Main Band 0.7-1.85 Stretch Band 0.5-2.0	11.5 dB 13.0 dB	1.75	±10° ±15°	±1.1 dB ±2.5 dB
7722A & 7822	Main Band 2.6-5.2 Stretch Band 2.0-6.0	10.0 dB 11.0 dB	1.6	±10° ±15°	±1.1 dB ±1.5 dB
7724A & 7824	Main Band 4.5-10.5 Stretch Band 4.0-12.0	10.5 dB 12.0 dB	1.8	±10° ±15°	±1.1 dB ±2.0 dB
7728A & 7828	Main Band 8.0-18.0 Stretch Band 6.0-18.0	12.0 dB	2.0	±12° ±15°	±1.1 dB ±2.0 dB

OTHER SPECIFICATIONS

Switching Speed (50% TTL to within 10° of Final Phase Value): 500 nsec Max.
Minimum phase shift range:
Series 77: 360° in 1024 Steps (10-bit) Series 78: 360° @ 60°/Volt

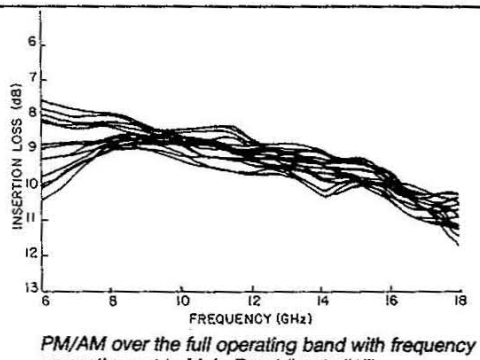
FREQUENCY TRANSLATOR SPECIFICATIONS

TRANSLATION RATE (Min.)	CARRIER[1] SUPPRESSION (Min.)	SIDE BAND[1] SUPPRESSION (Min.)	INSERTION LOSS VARIATION (Max.) with translation rate:
0 to 500 kHz[2]	Main Band: 25 dB Stretch Band: 18 dB	Main Band: 20 dB Stretch Band: 15 dB	200 kHz: 1 dB 500 kHz: 3 dB

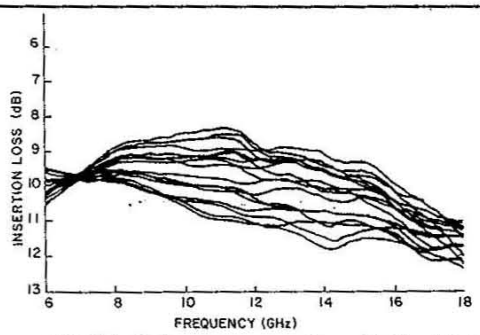
NOTES:

(1) *Main band specifications apply if 1 bit TTL logic signal is provided indicating whether input rf signal is in main-band or band-edge.*
(2) *All specifications are met using five or more most significant bits for 0 to 200 kHz translation rates. For 201-500 kHz translation rates, only the four most significant bits are used.*

TYPICAL PERFORMANCE



PM/AM over the full operating band with frequency correction set to Main Band (Logic "1").



PM/AM with frequency correction set to Band Edge (Logic "0").

Figure 4

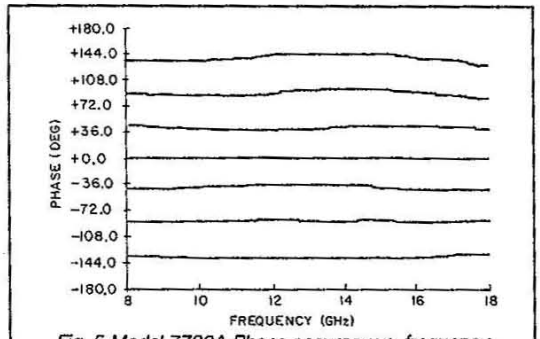


Fig. 5-Model 7728A-Phase accuracy vs. frequency.

Series 77/78 Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range ..... −54°C to +100°C

Non-Operating Temperature Range ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B. Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C. Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

ACCESSORY FURNISHED

Mating power/control connector

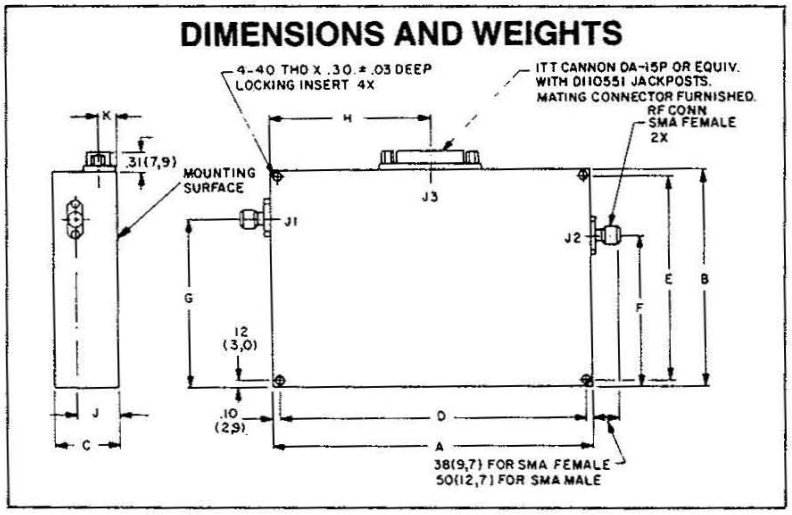
AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J2) and one SMA female (J1) rf connector

J3 PIN FUNCTIONS

Pin No.	Function: Series 77 (1)	Function: Series 78
1	−12V to −15V	−12V to −15V
2	+12V to +15V	+12V to +15V
3	Freq. Correction Circuit Select "0" = Band Edge	Freq. Correction Circuit Select "0" = Band Edge
4	1.4°	Not Used
5	5.6°	Not Used
6	45.0°	Not Used
7	180.0° (MSB)	Not Used
8	90.0°	Not Used
9	Ground	Ground (Sig)
10	0.7°	Ground (Pwr)
11	22.5°	Not Used
12	2.8°	Not Used
13	11.3°	Not Used
14	0.35° (LSB)	Control Voltage
15	+5V	+5V

DIMENSIONS AND WEIGHTS



NOTE:
(1) *Unused logic bits must be grounded.*

MODEL	A	B	C	D	E	F	G	H	J	K	WEIGHT (APPROX)
7720A	4.95 ± .03	3.38 ± .03	1.02 (25,9)	4.75 ± .01	3.12 ± .01	2.62	1.69	2.48	.73 (18,5)	.32 (8,1)	13 oz. (369 gm)
7820	(125,7)	(85,9)	1.48 (37,6)	(120,7)	(79,2)	(66,5)	(42,9)	(62,9)	1.18 (30,0)	.78 (19,8)	15 oz. (425 gm)
7722A			.84 (21,3)				1.99		.66 (16,8)	.32 (8,1)	9 oz. (255gm)
7822	3.25 ± .03	3.25 ± .03	1.25 (31,8)	3.05 ± .01	3.00 ± .01	1.63	(50,5)	1.63	1.07 (27,2)	.72 (18,3)	10 oz. (284 gm)
7724A	(82,6)	(82,6)	.84 (21,3)	(77,5)	(76,2)	(41,4)	1.83	(41,4)	.66 (16,8)	.32 (8,1)	9 oz. (255 gm)
7824			1.25 (31,8)				(46,5)		1.07 (27,2)	.72 (18,3)	10 oz. (284 gm)
7728A	2.50 ± .03	3.00 ± .03	.86 (22,4)	2.30 ± .01	2.75 ± .01	1.50	1.63	1.25	.71 (18,0)	.39 (9,9)	6 oz. (170 gm)
7828	(63,5)	(75,2)	1.19 (30,2)	(58,4)	(69,9)	(38,1)	(41,4)	(31,8)	1.02 (25,9)	.69 (17,6)	8 oz. (227 gm)

Dimensional tolerances, unless otherwise indicated: .xx ± .02, xxx± .005

Model 7928 Miniaturized 8 Bit 360° Phase Shifter/Frequency Translator

- 6 to 18 GHz
- 360° range
- High speed
- Digitally programmable (8 Bits)
- Guaranteed monotonicity
- Hermetically Sealed
- Miniaturized: less than 1.5 in³

The Model 7928 is a miniaturized, hermetically sealed PIN diode phase shifter covering the frequency range from 6 to 18 GHz providing a full 360° range of variable phase shift. It can also be used to perform frequency translation.

The unit is an integrated assembly of an rf vector modulator and a driver circuit consisting of an 8-bit D/A converter and a voltage buffer. See Figure 1.

PHASE SHIFT

Phase shifting is achieved utilizing the rf vector modulator approach shown in Figure 2. The 3-dB hybrid coupler divides the rf signal into two quadrature components which are then biased in proportion to the sine and cosine of the desired phase shift. The signals are then combined in-phase to yield desired output.

ACCURACY

Improved phase accuracy and PM/AM performance are achieved by using double-balanced bi-phase linear amplitude modulators. In the main operating band, overall phase accuracy is better than 12°. The same phase accuracy can be achieved at the band edges by using a built-in frequency correction circuit.

Switching speed is better than 500 nsec.

FREQUENCY TRANSLATION (SERRODYNING)

In the design of the Model 7928 special attention has been paid to those characteristics which affect its performance as a frequency translator. These include minimizing PM-to-AM conversion, use of high slew rate drivers, and optimizing phase shift linearity with applied signal. As a result, carrier and sideband suppression levels of over 25 and 20 dB, respectively, are obtained in the main band. The same carrier and sideband performance can be realized over the full stretch band when the internal frequency correction circuit is employed. See Fig. 3 for input control requirements.

On special order, frequency translators can be provided for operation over reduced bandwidths with suppression levels of up to 40dB. Consult the factory for such requirements.

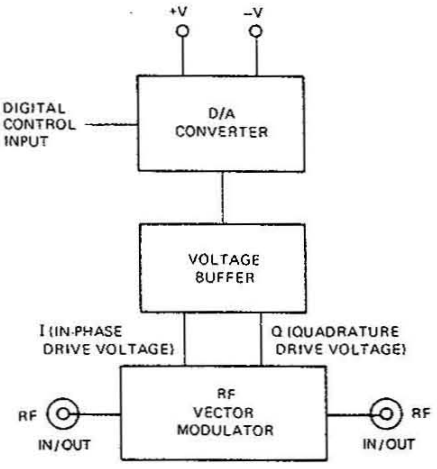


Fig. 1–Model 7928, block diagram

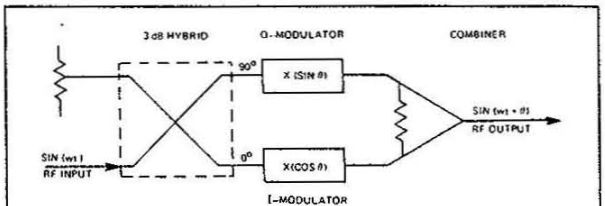


Figure 2. Rf Vector Modulator

Model 7928 Specifications

PHASE SHIFTER SPECIFICATIONS

FREQUENCY RANGE (GHz)	INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY[1] (Max.)	PM/AM (Max.)
Main Band 8.0-18.0 Stretch Band 6.0-18.0	12.0 dB	2.0:1	±12° ±15°	±1.1dB ±2.0dB

FREQUENCY TRANSLATOR SPECIFICATIONS

TRANSLATION RATE (Min.)	CARRIER[1] SUPPRESSION (Min.)	SIDE BAND SUPPRESSION (Min.)	INSERTION LOSS VARIATION (Max.) with translation rate:
0 to 500 kHz[2]	Main Band: 25 dB Stretch Band 18 dB	Main Band: 20 dB Stretch Band: 15 dB	200 kHz: 1 dB 500 kHz: 3 dB

(1) *Main band specifications apply if 1 bit TTL logic signal is provided indicating whether input rf signal is in main band or band edge.*

(2) *All specifications are met using only the five most significant bits for translation rates of 0 to 200kHz. For translation rates of 201 to 500 kHz, only 4 most significant bits are used.*

PERFORMANCE CHARACTERISTICS

Phase Shift

Range ..... 360° in 256 steps
Variation ..... 0.1°/°C

Control Input ..... 8 Bit TTL

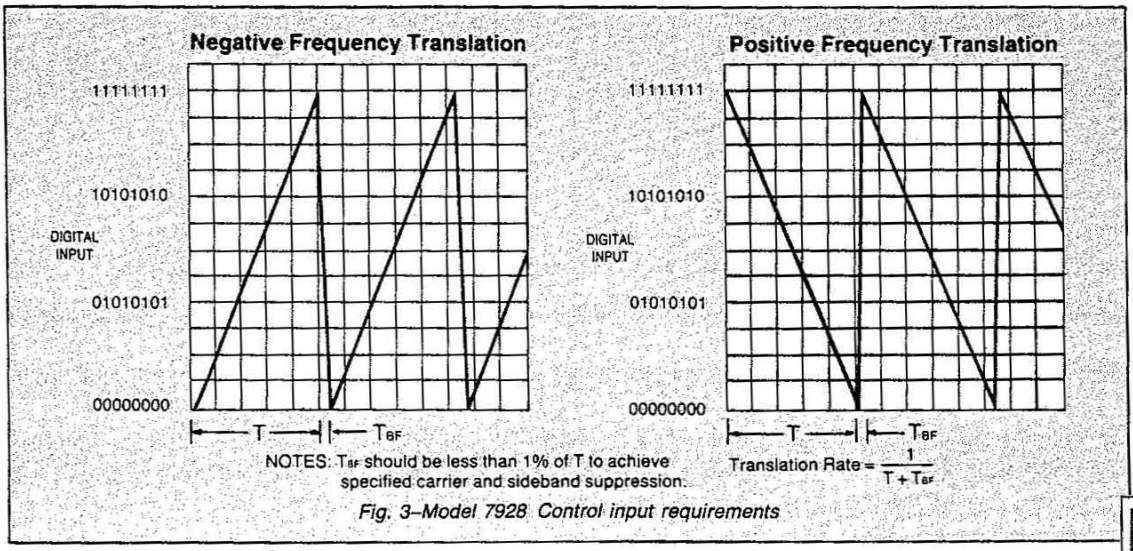
Switching Speed
(50% TTL to within 10° of Final Phase Value) ..... 500 nsec max

Harmonics ..... −30 dBc

Power Handling Capability

Without Performance Degradation ..... +20 dBm
Survival Power ..... +30 dBm

Power Supply Requirements ..... +5V ±5%, 250mA
+12 to +15V, 50mA
−12 to −15V, 35mA



NOTES: T_{BF} should be less than 1% of T to achieve specified carrier and sideband suppression.

Translation Rate = $\frac{1}{T + T_{BF}}$

Fig. 3–Model 7928 Control input requirements

Model 7928
Specifications

ACCESSORY FURNISHED

Mating power/logic connector

ENVIRONMENTAL RATINGS

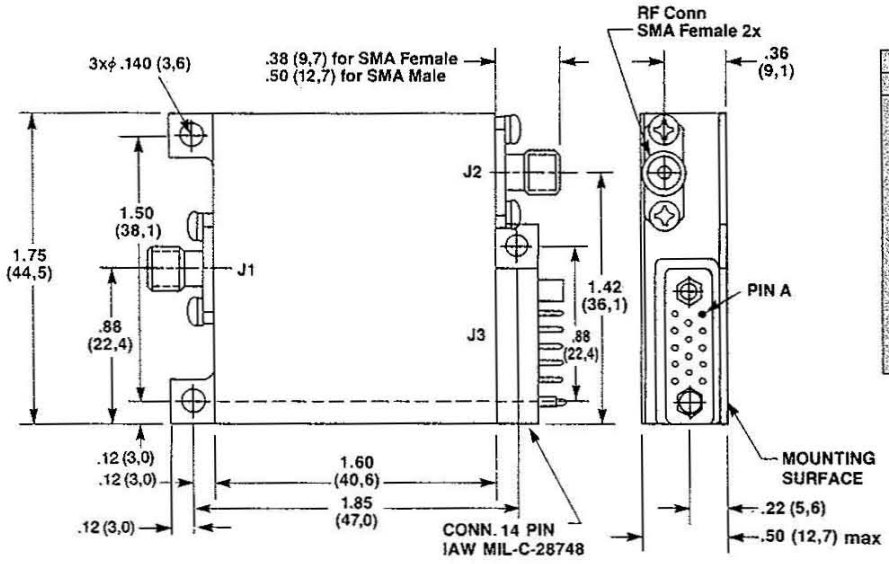
Operating Temperature Range ..... −54°C to +110°C

Non-Operating Temperature Range ..... −65°C to +125°C

AVAILABLE OPTIONS

Option No.	Description
7	Two SMA male rf connectors
10	One SMA male (J1), and one SMA female (J2) rf connector
49	High Rel screening (see Table 1, page 30)

DIMENSIONS AND WEIGHT



MODEL 7928	PIN FUNCTIONS
PIN	FUNCTION
A	Ground
B	+5V
C	−12 to −15V
D	1.4° (LSB)
E	2.8°
F	5.6°
H	22.5°
J	11.3°
K	90°
L	180° (MSB)
M	+12 to +15V
N	45°
P	GND
R	Freq. Correction Circuit Select "0" = Band Edge

Model 7928 Wt. 3.0 oz (85g) approx.
Dimensional Tolerances: unless otherwise indicated: xx ±.02; .xxx ±.005

General Microwave switches cover the frequency range from 100 MHz to 40 GHz and are available in various topologies ranging from single-pole single-throw (SPST) to single-pole eight-throw (SP8T) in both reflective and non-reflective configurations, and a nonreflective SP16T unit.

SWITCH TOPOLOGY

There are two fundamental methods of connecting PIN diodes to a transmission line to provide a switching function: in series with the transmission line so that RF power is conducted when the PIN diode is forward biased and reflected when reverse biased; or in shunt with the transmission line so that the RF power is conducted when the diode is reverse biased and reflected when forward biased. A simple reflective SPST switch can be designed utilizing one or more PIN diodes in either configuration as shown in Fig. 1.

A multi-throw switch essentially consists of a combination of SPST switches connected to a common junction and biased so that each switch port can be enabled individually. The common junction of the switch must be designed to minimize the resistive and reactive loading presented by the OFF ports in order to obtain low insertion loss and VSWR for the ON port. There are two basic methods of realizing a multi-throw switch common junction for optimum performance over a broad frequency range. The first employs series mounted PIN diodes connected to the common junction. A path is selected by forward biasing its series diode and simultaneously reverse biasing all the other diodes. This provides the desired low-loss path for the ON port with a minimum of loading from the OFF ports. The second method utilizes shunt mounted PIN diodes located a quarter wavelength from the junction. The diode(s) of the selected ON port is reverse biased while the OFF ports are forward biased to create a short circuit across the transmission line. As a result of the quarter wavelength spacing, the short circuits are transformed to open circuits at the junction. By proper choice of transmission line impedances and minimization of stray reactance it is possible to construct a switch of this type with low insertion loss and VSWR over a three to one bandwidth. The schematic diagrams for both switches are shown in Fig. 2.

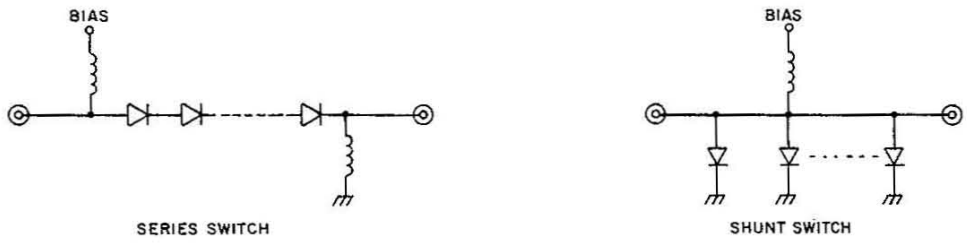


Fig. 1-Reflective SPST switch

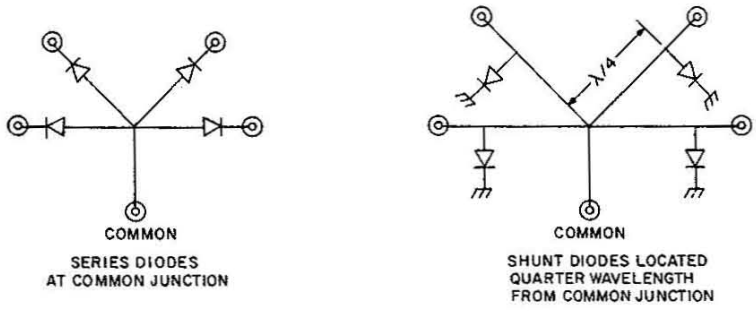


Fig. 2-Schematic diagrams of multi-throw switches

ABSORPTIVE SWITCHES

It is often desirable to have a PIN diode switch present a low VSWR in its OFF position as well as in its ON state in order to maintain desired system performance. General Microwave offers a complete line of single and multi-throw absorptive switches which incorporate 50Ω terminations in each of the output ports. Fig. 3 shows the schematic diagrams of the two versions of absorptive (also known as non-reflective or terminated) switches employed by GMC. The shunt termination is used in GMC's "all-series" configured absorptive switches which have a suffix ending in "T" or "W". This style of absorptive switch offers the minimum penalty in insertion loss due to the addition of the terminating elements. The series termination is used in GMC's high speed "series-shunt" configured absorptive switches since it provides the optimum in switching performance.

The common port of the standard absorptive multi-throw switches in the GMC catalog will be reflective in the special circumstance when all ports are turned OFF. If there is a need for this port to remain matched under these conditions, this can be realized either by employing an additional port to which an external termination is connected or, in a custom design, by providing automatic connection of an internal termination to the common port.

DEFINITION OF PARAMETERS

INSERTION LOSS is the maximum loss measured in a 50 ohm system when only a single port of the switch is in the ON state.

ISOLATION is the ratio of the power level when the switch port is ON to the power level measured when the switch port is OFF. In a multi-throw switch the isolation is measured with one of the other ports turned ON and terminated in 50 ohms.

VSWR is defined for the input and output ports of the selected ON path. For those switches with a "T", "W", or "HT" suffix, the VSWR is also defined for the OFF state.

VIDEO LEAKAGE

Video leakage refers to the spurious signals present at the RF ports of the switch when it is switched without an RF signal present. These signals arise from the waveforms generated by the switch driver and, in particular, from the leading edge voltage spike required for high speed switching of PIN diodes. When measured in a 50 ohm system, the magnitude of the video leakage can be as much as several volts. The frequency content is concentrated in the band below 200 MHz although measurable levels for high speed switches are observed as high as 6.0 GHz. The magnitude of the video leakage can be reduced significantly by the inclusion of high pass or "video filters"(1) in the switch, but the high frequency energy which falls within the passband of the switch can be eliminated only by using a slower speed switch.

HARMONIC AND INTERMODULATION PRODUCTS

All PIN diode switches generate harmonics and intermodulation products since the PIN diodes are fundamentally non-linear devices. The magnitude of these spurious signals is typically small in a switch since the diodes are usually either in their saturated forward biased state or in their reversed biased state. The physics of the PIN diode cause a cut-off frequency phenomena such that the level of harmonics and intermods greatly increase at low frequencies. These levels will vary with the minority carrier lifetime of the diode. Thus, a high speed switch operating below 500 MHz may have a second order intercept point of 35 dBm, while a slow switch operating at 8 GHz will have a second order intercept point of 70 dBm. Typical performance is as follows:

TYPICAL SWITCH INTERCEPT POINTS

SWITCH	FREQUENCY	2nd ORDER INTERCEPT	3rd ORDER INTERCEPT
HIGH SPEED	2.0 GHz	+50 dBm	+40 dBm
LOW SPEED	2.0 GHz	+65 dBm	+50 dBm

Since these levels vary significantly with frequency, switching speed, and RF topology, please consult the factory for specific needs in this area.

(1) *For switches with internal video filters, specify Option 41, Option 42, or Option 43. These filters reduce the leakage as shown in the chart following the power handling discussion on page 86.*

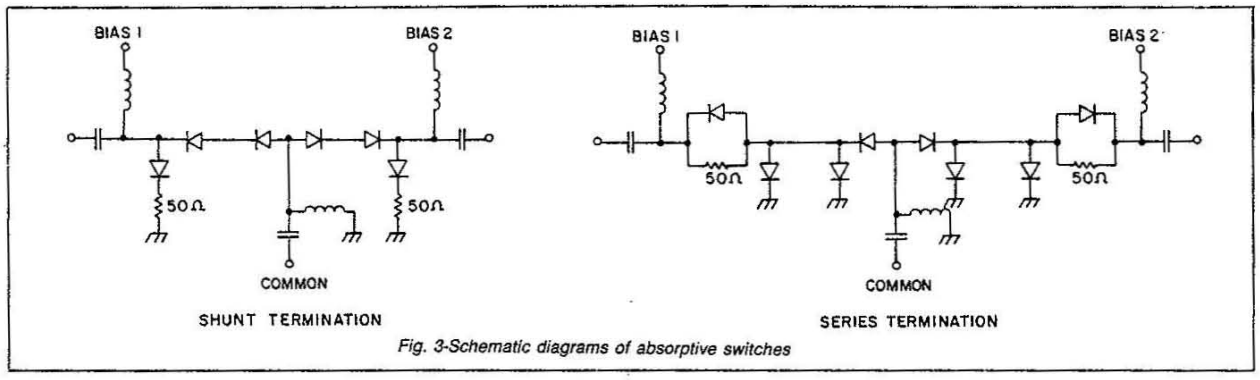


Fig. 3-Schematic diagrams of absorptive switches

SWITCHING SPEED[2]

Port-To-Port Switching is the interval from the time the RF power level at the off-going port drops to 90% of its original value to the time the RF power level in the on-going port rises to 90% of its final value. See Fig. 4.

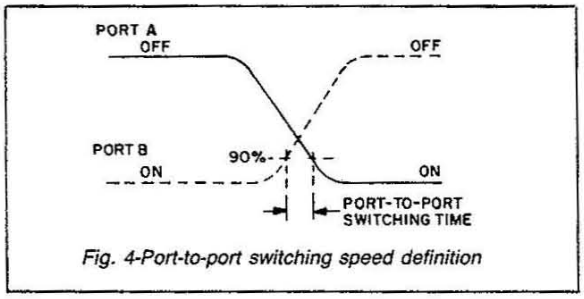


Fig. 4-Port-to-port switching speed definition

Rise Time is measured between the 10% and 90% points of the square-law detected RF power when the unit is switched from full OFF to full ON. See Fig. 5.

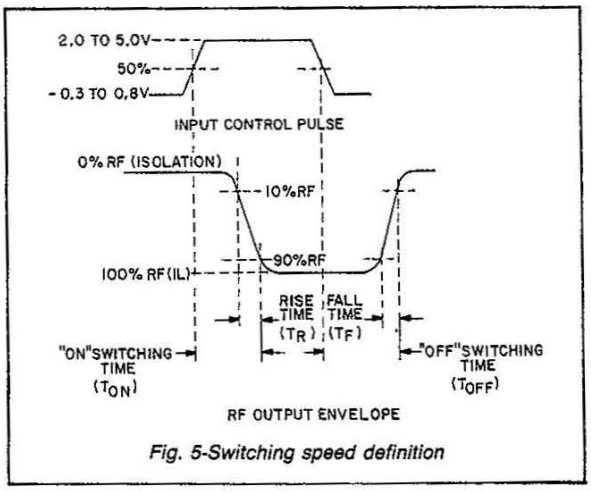


Fig. 5-Switching speed definition

Fall Time is the time between the 90% and 10% points of the square-law detected RF power when the unit is switched from full ON to full OFF.

On Time is measured from the 50% level of the input control signal to the 90% point of the square-law detected RF power when the unit is switched from full OFF to full ON.

Off Time is measured from the 50% level of the input control signal to the 10% point of the square-law detected RF power when the unit is switched from full ON to full OFF.

In addition to the above definitions, the following information about switching performance may be useful to the system designer.

Switching To Isolation - Although catalog switching speed specifications are usually defined to the 10% level of detected RF (equivalent to 10 dB isolation), the user of a switch may be more interested in the time the switch requires to reach rated isolation. This latter time is strongly dependent on the topology of the switch. For all-shunt mounted or combination series and shunt mounted topologies, the time to reach final isolation is usually less than twice the fall time. For an all-series topology, the time to reach final isolation may be as much as ten times the fall time.

Switching To Insertion Loss - For multi-throw switches, the ON time depends on whether the switch is being operated in a commutating or single port mode. In the former mode, switching speed is slower than in the latter due to the loading effect at the junction of the port turning OFF. All switching speed measurements at GMC are performed in the commutating mode.

(2) *For a unit without an integrated driver, the specifications apply to conditions when it is driven by an appropriately shaped switching waveform.*

PHASE AND AMPLITUDE MATCHING

Switches are available on a custom basis with phase and/or amplitude matching. Matching can be either between ports of a switch, between like ports on different switches, or a combination of the two. The uniformity of broadband catalog switches is quite good and is usually better than ±0.75 dB and ±15 degrees over the entire operating frequency of the switch. Please consult the factory for special requirements.

POWER HANDLING

The power handling of PIN diode switches is dependent on the RF topology, forward and reverse biasing levels, and speed of the switch. This catalog addresses both the maximum operating power levels and the survival limits of the components. Maximum operating limits are usually set at the power level which will cause the reversed biased diodes to begin conduction and thereby degrade the insertion loss, VSWR, or isolation of the switch. The survival power limits are based on the maximum ratings of the semiconductors in the switch. For special applications, significantly higher operational power levels can be provided, particularly for narrow band requirements. Please consult the factory for specific applications.

VIDEO FILTER OPTIONS

Applicability: F91, G91, H91 and HM91 Switch Series

Video Leakage with Video Filter Options:	Peak to Peak (mV)	Bandwidth (MHz)
	50 max	100

INSERTION LOSS DEGRADATION

Option	Affected Ports	Frequency	Additional IL
41	Common Port Only	1-12.4 GHz	0.1 dB
		12.4-18 GHz	0.2 dB
42	Output Ports Only	1-12.4 GHz	0.1 dB
		12.4-18 GHz	0.2 dB
43	All Ports	1-12.4 GHz	0.2 dB
		12.4-18 GHz	0.4 dB

VSWR DEGRADATION

Option	Affected Ports	Frequency	VSWR
41, 42, 43	All Ports	1-4 GHz:	1.5:1
		4-18 GHz	No Change

EXTENDED FREQUENCIES

Any switch in our catalog that covers 1-18 GHz can be stretched to cover 0.5 to 18 GHz with following specification changes:

1- Specification for insertion loss and isolation from 0.5 to 1.0 GHz is the same as the 1-2 GHz specification. VSWR degrades to 2.0:1.
2- Insertion loss in the 12.4-18 GHz band increases by 0.3 dB. Consult factory for cost.

Switch Selection Guide

SWITCHES WITH INTEGRATED DRIVERS

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18	MODEL OR SERIES	PAGE	COMMENTS
REFLECTIVE SPST SWITCHES*			
0.1 — 18	DM86, FM86	93	Ultra-broadband, low insertion loss
0.1 — 18	DM86H, FM86H		Ultra-broadband, high-speed
1 — 18	F91	96	Miniature broadband
0.2 — 4	F9214A		
1 — 18	H9114	138	Hermetically sealed, low profile
1 — 18	HM9114		Hermetically sealed, drop-in module
NON-REFLECTIVE SPST SWITCHES			
0.2 — 18	HM192	136	Hermetically sealed, ultra-broadband
0.2 — 18	F192A	90	Ultra-broadband
REFLECTIVE SP2T SWITCHES*			
0.2 — 18	DM870	99	Ultra-broadband
1 — 18	F91, G91	106	Miniature broadband
1 — 18	F91H		Miniature broadband, high-speed
0.2 — 4	F92, G92		Miniature broadband
1.5 — 4.5	F892	102	Octave-brand, high-speed
3 — 9			
6 — 18			
1 — 18	H9120H	139	Hermetically sealed, low profile
1 — 18	HM9120H		Hermetically sealed, drop-in module
NON-REFLECTIVE SP2T AND TRANSFER SWITCHES			
1 — 18	F91T, F91W, G91T, G91W	106	Miniature broadband
1 — 18	F91HT		Miniature broadband, high-speed
0.2 — 4	F92T, G92T		Miniature broadband
0.5 — 18	F940H	110	Broadband transfer switch
1 — 18	H9120HT	139	Hermetically sealed, low profile
1 — 18	HM9120HT		Hermetically sealed, drop-in module
REFLECTIVE SP3T SWITCHES			
1 — 18	F91, G91,	112	Miniature broadband
1 — 18	F91H		Miniature broadband, high-speed
0.2 — 4	F92, G92		Miniature broadband
1 — 18	H9130H	140	Hermetically sealed, low profile
1 — 18	HM9130H		Hermetically sealed, drop-in module
NON-REFLECTIVE SP3T SWITCHES			
1 — 18	F91T, F91W, G91T, G92W	112	Miniature broadband
1 — 18	F91HT		Miniature broadband, high-speed
0.2 — 4	F92T, G92T		Miniature broadband
1 — 18	H9130HT	140	Hermetically sealed, low profile
1 — 18	HM9130HT		Hermetically sealed, drop-in module
REFLECTIVE SP4T SWITCHES			
1 — 18	F91, G91,	116	Miniature broadband
1 — 18	F91H		Miniature broadband, high-speed
0.2 — 4	F92, G92		Miniature broadband
1 — 18	H9140H	141	Hermetically sealed, low profile
1 — 18	HM9140H		Hermetically sealed, drop-in module

*See page 143 for General Microwave's Millimeter Wave Switches.

Switch Selection Guide (Cont.)

SWITCHES WITH INTEGRATED DRIVERS (con't)

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18	MODEL OR SERIES	PAGE	COMMENTS
NON-REFLECTIVE SP4T SWITCHES			
1 — 18	F91T, F91W, G91T, G91W	116	Miniature broadband
1 — 18	F91HT	116	Miniature broadband, high-speed
0.2 — 4	F92T, G92T	116	Miniature broadband
1 — 18	H9140HT	141	Hermetically sealed, low profile
1 — 18	HM9140HT	141	Hermetically sealed, drop-in module
REFLECTIVE SP5T SWITCHES			
1 — 18	F91, G91,	120	Miniature broadband
0.2 — 4	F92, G92	120	Miniature broadband
NON-REFLECTIVE SP5T SWITCHES			
1 — 18	F91T, F91W, G91T, G91W	120	Miniature broadband
0.2 — 4	F92T, G92T	120	Miniature broadband
REFLECTIVE SP6T SWITCHES			
1 — 18	F91, G91,	123	Miniature broadband
0.2 — 4	F92, G92	123	Miniature broadband
NON-REFLECTIVE SP6T SWITCHES			
1 — 18	F91T, F91W, G91T, G91W	123	Miniature broadband
0.2 — 4	F92T, G92T	123	Miniature broadband
REFLECTIVE SP7T SWITCHES			
1 — 18	F91, G91,	126	Miniature broadband
0.2 — 4	F92, G92	126	Miniature broadband
NON-REFLECTIVE SP7T SWITCHES			
1 — 18	F91T, F91W, G91T, G91W	126	Miniature broadband
0.2 — 4	F92T, G92T	126	Miniature broadband
REFLECTIVE SP8T SWITCH			
1 — 18	F9180	129	Low-cost broadband
NON-REFLECTIVE SP8T SWITCH			
1 — 18	F9180W	129	Low-cost broadband
NON-REFLECTIVE SP16T SWITCH			
2 — 18	1744	132	Broadband

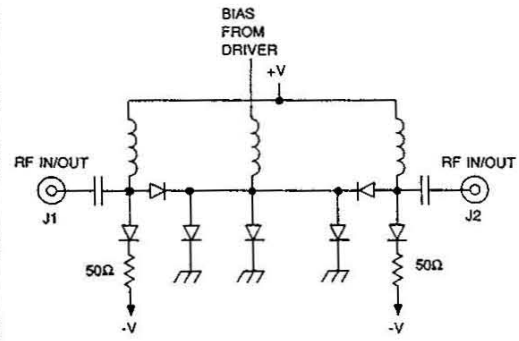
Switch Selection Guide (Cont.)

SWITCHES WITHOUT INTEGRATED DRIVERS

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18	MODEL OR SERIES	PAGE	COMMENTS
REFLECTIVE SPST SWITCHES			
0.1 — 18	M86	93	Ultra-broadband, low insertion loss
	M86H		Ultra-broadband, high-speed
1 — 18	91	96	Minature broadband
0.2 — 4	9214		
REFLECTIVE SP2T SWITCHES			
0.2 — 18	M870	99	Ultra-broadband
1 — 18	91	106	Miniature broadband
	91H		Miniature broadband, high-speed
0.2 — 4	92		Miniature broadband
NON-REFLECTIVE SP2T SWITCHES			
1 — 18	91T, 91W	106	Miniature broadband
	91HT		Miniature broadband, high-speed
0.2 — 4	92T		Miniature broadband
REFLECTIVE SP3T SWITCHES			
1 — 18	91	112	Miniature broadband
	91H		Miniature broadband, high-speed
0.2 — 4	92		Miniature broadband
NON-REFLECTIVE SP3T SWITCHES			
1 — 18	91T, 91W	112	Miniature broadband
	91HT		Miniature broadband, high-speed
0.2 — 4	92T		Miniature broadband
REFLECTIVE SP4T SWITCHES			
1 — 18	91	116	Miniature broadband
	91H		Miniature broadband, high-speed
0.2 — 4	92		Miniature broadband
NON-REFLECTIVE SP4T SWITCHES			
1 — 18	91T, 91W	116	Miniature broadband
	91HT		Miniature broadband, high-speed
0.2 — 4	92T		Miniature broadband
REFLECTIVE SP5T SWITCHES			
1 — 18	91	120	Minature broadband
0.2 — 4	92		
NON-REFLECTIVE SP5T SWITCHES			
1 — 18	91T, 91W	120	Minature broadband
0.2 — 4	92T		
REFLECTIVE SP6T SWITCHES			
1 — 18	91	123	Minature broadband
0.2 — 4	92		
NON-REFLECTIVE SP6T SWITCHES			
1 — 18	91T, 91W	123	Minature broadband
0.2 — 4	92T		
REFLECTIVE SP7T SWITCHES			
1 — 18	91	126	Minature broadband
0.2 — 4	92		
NON-REFLECTIVE SP7T SWITCHES			
1 — 18	91T, 91W	126	Minature broadband
0.2 — 4	92T		

Model F192A Non-Reflective Ultra-Broadband High-Speed SPST Switch

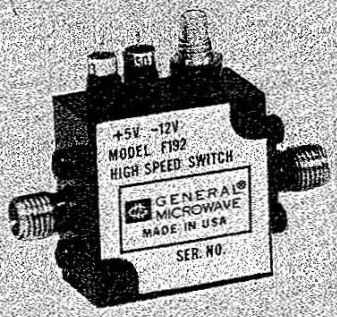
The Model F192A is a high-speed non-reflective PIN diode SPST switch with integrated driver. Operating over the instantaneous frequency range from 0.2 to 18 GHz, it provides a minimum isolation of 80 dB from 0.5 to 18 GHz, and 70 dB below 0.5 GHz. The rf design consists of an arrangement of shunt and series diodes in a microstrip integrated circuit transmission line as shown in the schematic diagram below.



Model F192A RF Schematic Diagram

The currents required to switch the unit ON or OFF and simultaneously maintain a bilateral 50-ohm impedance match in both states are provided by the integrated driver, which is controlled by an external logic signal.

- **High speed**
- **0.2 to 18 GHz frequency range**
- **80 dB isolation**
- **Low VSWR and insertion loss**
- **Small size, light weight**



Model F192A Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	FREQUENCY (GHz)				
	0.2 to 0.5	0.5 to 2.0	2.0 to 8.0	8.0 to 12.4	12.4 to 18.0
Min Isolation (dB)	70	80	80	80	80
Max Insertion Loss (dB)	2.0	2.0	2.5	3.0	3.5
VSWR (ON and OFF)	1.5	1.5	1.75	2.0	2.0

Switching Speed

Rise Time . . . . . 10 nsec. max.
Fall Time . . . . . 10 nsec. max.
ON Time . . . . . 30 nsec. max.
OFF Time . . . . . 15 nsec. max.

Power Handling Capability

Without Performance Degradation . . . . . 500 mW cw or peak
Survival Power . . . . . 1W average, 10W peak (1 μsec max. pulse width)

Power Supply Requirements

+5V ±5%, 90 mA
−12V ±5%, 75 mA

Control Characteristics

Control Input Impedance . . . . TTL, advanced Schottky, one-unit load. (A unit load is 0.6 mA sink current and 20μA source current.)
Control Logic . . . . Logic "0" (−0.3 to +0.8V) for switch ON and logic "1" (+2.0 to +5.0V) for switch OFF.

Model F192A Specifications

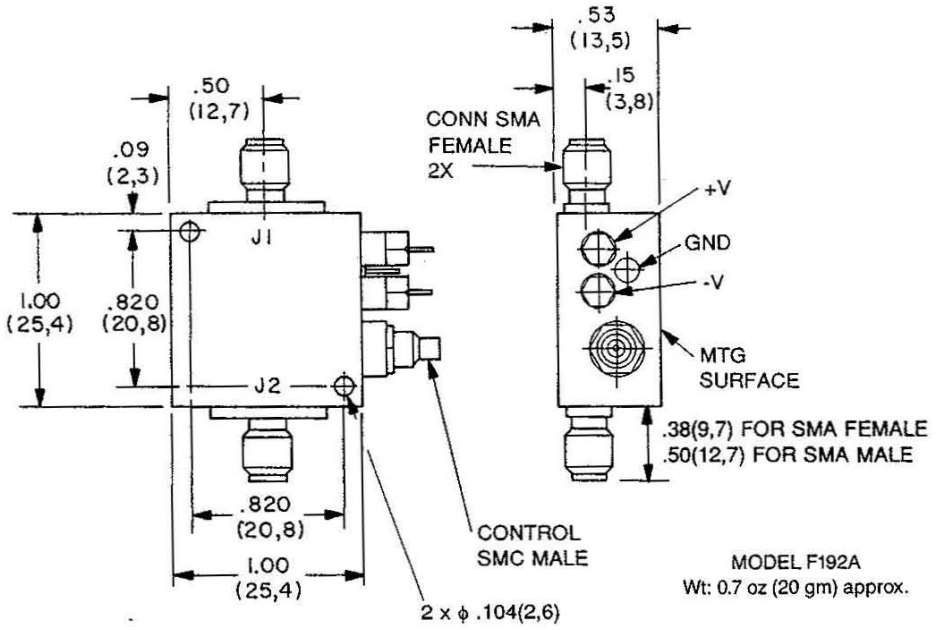
ENVIRONMENTAL RATINGS

Operating Temperature Range	−65°C to +110°C
Non-Operating Temperature Range	−65°C to +125°C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connector
7	Two SMA male rf connectors
9	Inverse control logic; logic "1" for switch ON and logic "0" for switch OFF
10	One SMA male (J1) and one SMA female (J2) rf connector
33	EMI filter solder-type control terminal
5004	Video Filters. RF operating band restricted to 6-18 GHz. Leakage 50 mV P-P into a 300 MHz bandwidth.
893	Video Filters. RF band 2-18 GHz. Leakage 50 mV P-P into 100 MHz bandwidth.
5037	Video Filters. RF band 0.5-2 GHz. Leakage 100 mV P-P into 100 MHz bandwidth.

DIMENSIONS AND WEIGHT



MODEL F192A
Wt: 0.7 oz (20 gm) approx.

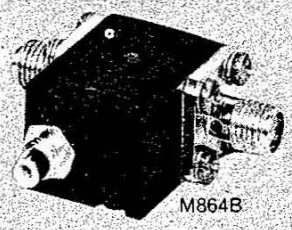
Dimensional Tolerances, unless otherwise indicated: .XX ± .02: .XXX ± .005

Series 86
Ultra-Broadband SPST Switches

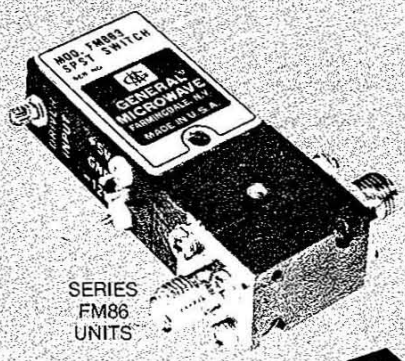
- **Frequency range: 0.1 to 18 GHz**
- **Low VSWR and insertion loss**
- **Up to 80 dB isolation**
- **As fast as 10 nsec rise and fall times**
- **Small size, light weight**

DRIVERLESS UNITS

M862B



M864B



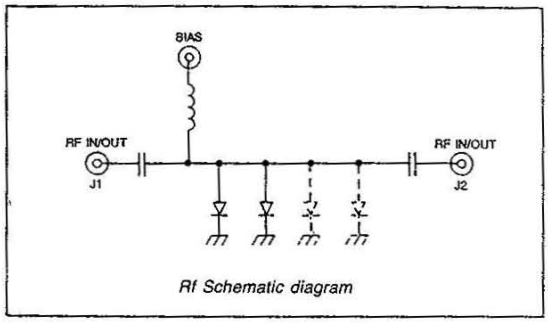
SERIES FM86 UNITS

UNITS WITH INTEGRATED DRIVERS

SERIES DM86 UNITS

SERIES M86

The Series M86 is a diverse group of high performance broadband SPST switches. Included are two low insertion loss models and four high speed models, all of which operate up to 18 GHz. Each model features an integrated circuit assembly of up to four PIN diodes mounted in a microstrip transmission line as well as a resistive bias line that contributes to the broadband low-loss performance. The circuit configuration is shown below. By applying positive current to the bias terminal, the diodes are biased to low resistances and the switch is OFF. With zero or negative voltage at the bias terminal, the diodes are biased to high resistances and the switch is ON.



Rf Schematic diagram

Low Insertion Loss Models

Models M862B and M864B operate over the frequency range from 0.1 to 18 GHz. They exhibit nominal isolation characteristics of 45 and 80 dB at 18 GHz, respectively, with maximum rise and fall times of 50 nanoseconds.

High Speed Models

For higher speed requirements, Models M862BH and M864BH are available. These operate from 0.5 to 18 GHz and feature maximum rise and fall times of 10 nanoseconds. Optional Models M862BH-25 and M864BH-25 operate from 0.1 to 18 GHz with maximum rise and fall times of 20 nanoseconds.

SERIES DM86 AND FM86

The Series DM86 and FM86 switches are the same as the corresponding Series M86 models except the units are equipped with integrated drivers. DM86 switches are powered by ± 15 volt supplies; FM86 units are powered by +5 and −12 to −15 volt supplies. The proper current required to switch the unit ON or OFF is provided by the driver, which is controlled by an external logic signal.

Series 86 Specifications

MODEL NO.[3]		CHARACTERISTIC	FREQUENCY (GHz)					
			0.1 to 1.0	1.0 to 2.0	2.0 to 4.0	4.0 to 8.0	8.0 to 12.4	12.4 to 18.0
LOW INSERTION LOSS MODELS	M862B DM862C FM862C	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	30 1.0 1.3	36 1.0 1.3	40 1.0 1.3	45 1.0 1.6	45 1.5 1.75	45 2.0 1.75
	M864B DM864C FM864C	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	37 1.0 1.4	60 1.0 1.4	74 1.0 1.4	80 1.3 1.7	80 1.8 1.75	80 2.5 2.2
HIGH SPEED MODELS[1]	M862BH DM862CH FM862CH	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	30 1.0 1.3	36 1.0 1.3	40 1.0 1.5	45 1.0 1.7	45 1.5 2.0	45 2.3 2.2
	M864BH DM864CH FM864CH	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	37 1.0 1.4	60 1.0 1.4	74 1.0 1.5	80 1.3 1.7	80 1.8 2.0	80 2.8 2.2

PERFORMANCE CHARACTERISTICS

Switching Characteristics[2]

	High Speed Models	Low Loss Models
Rise Time	10 nsec max.	20 nsec max.
Fall Time	10 nsec max.	20 nsec max.
ON Time[5]	30 nsec max.	50 nsec max.
OFF Time[5]	30 nsec max.	40 nsec max.
Repetition Rate[5]	20 MHz max.	10 MHz max.

Power Handling Capability

Without Performance Degradation

Without Integrated Drivers . . . . . 1W cw or peak[4]

With Integrated Drivers . . . . . 1W cw or peak

Survival Power . . . . . 2W average, 75W peak (1 μsec max pulse width)

(1) *Models shown operate from 0.5 to 18 GHz. The addition of Option 25 to these models permits operation from 0.1 to 18 GHz, with max. rise and fall times of 20 nanoseconds.*

(2) *For driverless units, shaped current pulses must be provided by the user.*

(3) *Models prefixed with "DM" or "FM" are equipped with integrated TTL-compatible drivers; models prefixed with "M" only are current-controlled units and are furnished without drivers.*

(4) *5W cw or peak with −20V back bias.*

(5) *On and Off time and repetition rate specifications are only applicable to Series DM86 and FM86 units.*

Power Supply Requirements

Driverless Units

For rated isolation: +35 mA
For rated insertion loss: −10V

Units With Integrated Drivers

All DM86 Units: +15V ±2%, 70 mA
−15V ±5%, 20 mA
All FM86 Units: +5VDC ±2%, 65 mA
−12 to −15V, 20 mA

Control Characteristics

Units With Integrated Drivers

Control Input
Impedance . . . . . TTL, two-unit load. (A unit load is 1.6 mA sink current and 40 µA source current.)

Control Logic
Series DM86 . . . . . Logic "0" (-0.3 to +0.7V) for switch OFF and logic "1" (+2.5 to +5.0V) for switch ON.
Series FM86 . . . . . Logic "0" (-0.3 to +0.7V) for switch ON and logic "1" (+2.5 to +5.0V) for switch OFF.

ENVIRONMENTAL RATINGS

Operating Temperature Range:
Series M86 . . . . . −65°C to +125°C
Series DM86 . . . . . −65°C to +85°C
Series FM86 . . . . . −65°C to +110°C

ENVIRONMENTAL RATINGS (Con't)

Non-Operating Temperature Range: . . . . . −65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

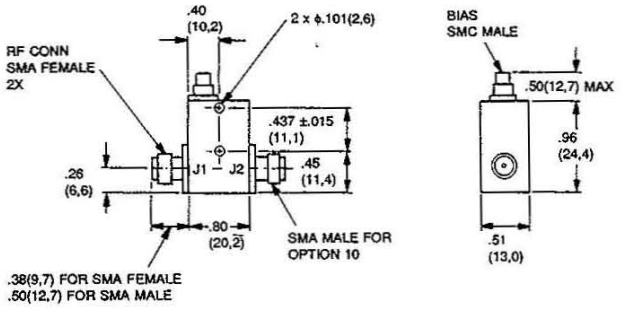
Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

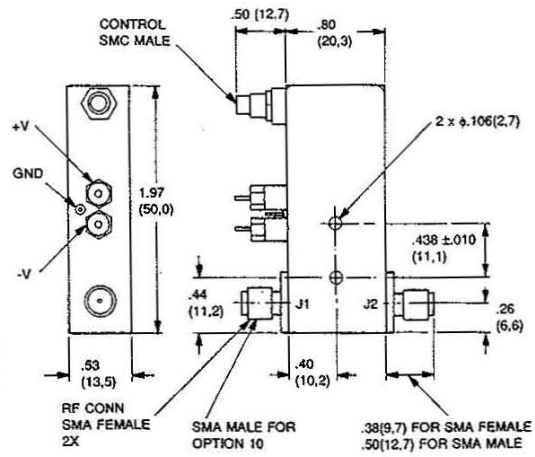
Option No.	Description
3	SMA female bias/control connector
7	Two SMA male rf connectors
9	Inverse control logic (Not applicable to Series M86)
10	One SMA male and one SMA female rf connector
20*	One unit load control input impedance
25	0.1 to 18 GHz range, 20 nsec rise and fall times (available only on high-speed models)
33	EMI filter solder-type bias/control terminal
64A	SMB male bias/control connector

**Not applicable to Series M86; standard in Series FM86 (need not be specified when ordering); all Series DM86 units are furnished with this option unless otherwise specified by customer. Other options, such as 50 ohms to ground, are available on special order.*

DIMENSIONS AND WEIGHTS



SERIES M86
Wt: 1 oz. (28 gm) approx.



SERIES DM86 AND FM86
Wt: 2 oz. (57 gm) approx.

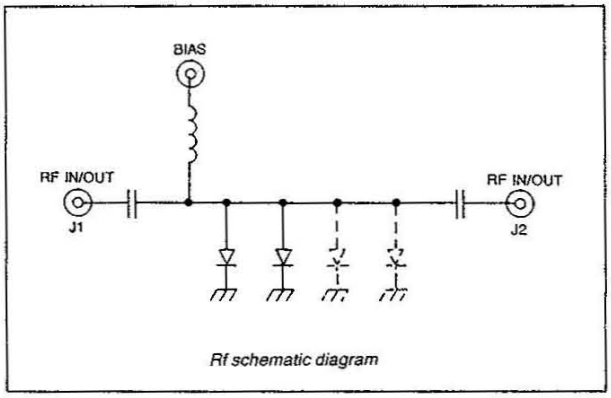
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.005

Series 91 and 92
Miniature Broadband SPST Switches

SERIES 91 AND 92

Series 91 and 92 switches provide high performance characteristics over a multi-octave range. Series 91 models cover the frequency range of 1 to 18 GHz, while Series 92 models cover the range from 0.2 to 4.0 GHz. These miniature switches measure only 0.75 × 0.69 × 0.38 inches.

Both series use an integrated circuit assembly of up to four PIN diodes mounted in a microstrip transmission line. The circuit configuration is shown below.



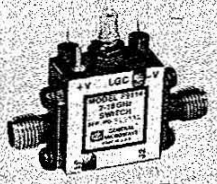
Rf schematic diagram

Application of a positive current to the bias terminal switches the unit OFF since the diodes are biased to a low resistance value. With zero or negative voltage at the bias terminal, the diodes are biased to high resistances and the unit is switched ON. Maximum rise and fall times are less than 10 nsec.

SERIES F91 AND F92

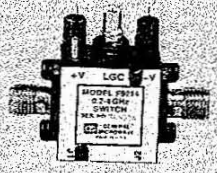
The Series F91 and F92 switches are the same as the corresponding Series 91 and 92 models except the units are equipped with integrated drivers, and the dimensions of the units are 0.75 × 0.75 × 0.38 inches. The proper current required to switch the unit ON or OFF is provided by the integral driver which requires +5 and −12 to −15 volt power supplies and is controlled by an external logic signal.

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Low VSWR and insertion loss**
- **Up to 80 dB isolation**
- **Less than 10 nsec rise and fall time**
- **Miniature size, light weight**

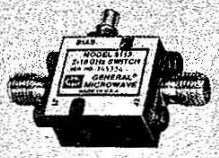


F9114A

UNITS WITH INTEGRATED DRIVERS

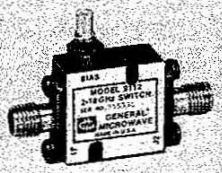


F9214A



9112

DRIVERLESS UNITS



9212

Series 91 and 92 SPST Switches Specifications

PERFORMANCE CHARACTERISTICS

MODEL NO.[1]	CHARACTERISTIC	FREQUENCY (GHz) 0.2 to 0.5	0.5 to 1.0	1.0 to 2.0	2.0 to 4.0	4.0 to 8.0	8.0 to 12.4	12.4 to 18.0
9112, F9112A	Min Isolation (dB)	—	—	36	40	45	45	45
	Max Insertion Loss (dB)	—	—	0.8	0.8	0.9	1.1	1.8
	Max VSWR (ON)	—	—	1.3	1.3	1.6	1.75	1.75
9114, F9114A	Min Isolation (dB)	—	—	60	74	80	80	80
	Max Insertion Loss (dB)	—	—	0.9	0.9	1.0	1.6	2.5
	Max VSWR (ON)	—	—	1.4	1.4	1.75	1.75	2.0
9214, F9214A	Min Isolation (dB)	40	45	50	50	—	—	—
	Max Insertion Loss (dB)	1.0	1.0	1.0	1.0	—	—	—
	Max VSWR (ON)	1.5	1.5	1.5	1.5	—	—	—

9112, F9112A
9114, F9114A

Switching Speed[2]

Rise Time.....10 nsec max
Fall Time.....10 nsec max
On Time[4].....20 nsec max
Off Time[4].....20 nsec max
Repitition Rate[4].....20 MHz max

9214,F9214A

Switching Speed[2]

Rise Time.....10 nsec max
Fall Time.....10 nsec max
On Time[4].....40 nsec max
Off Time[4].....40 nsec max
Repitition Rate[4].....10 MHz max

Power Supply Requirements

Driverless Units
For rated isolation: +35 mA
For rated insertion loss: −10V

Units With Integrated Drivers
+5V ±5%, 65 mA
−12 to −15V, 20 mA

Power Handling Capability

Without Performance Degradation
Without integrated drivers
1W cw or peak[3]

With integrated drivers
1W cw or peak

Survival Power..... 2W average, 75W peak (1 μsec max. pulse width)

Control Characteristics

Control Input Impedance ..... TTL, two-unit load. (A unit load is 1.6 mA sink current and 40 μA source current.)

Control Logic..... Logic "0" (−0.3 to +0.8V) for switch ON and logic "1" (+2.0 to +5.0V) for switch OFF.

(1) Models prefixed with "F" are equipped with integrated TTL-compatible drivers; models without the "F" prefix are current-controlled units and are furnished without drivers.
(2) For driverless units, shaped current pulses must be provided by the user.
(3) 2W cw or peak with −20V back bias.
(4) On and Off time and repetition rate specifications are only applicable to Series F91 and F92 units.

Series 91 and 92 SPST Switches Specifications

ENVIRONMENTAL RATINGS

Operating Temperature Range:
Series 91 and 92 . . . −65°C to +125°C
Series F91 and F92. −65°C to +110°C

Non-Operating Temperature Range . . . . . −65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

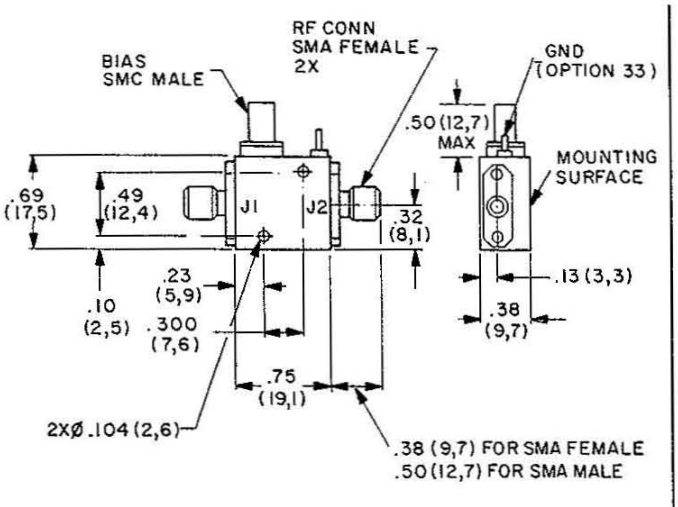
Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

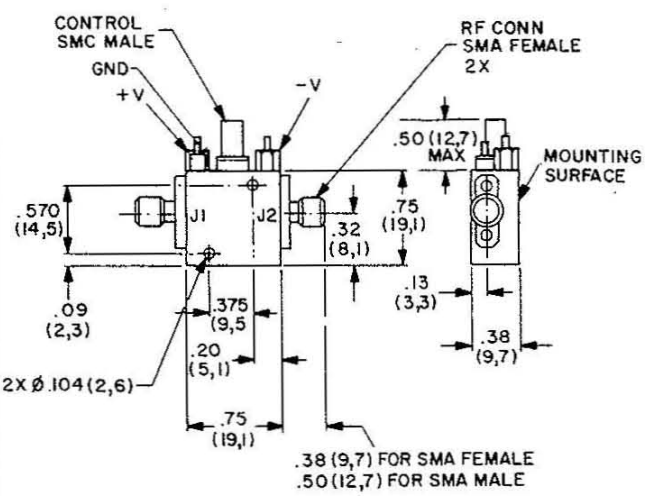
Option No.	Description
3	SMA female bias/control connector
7	Two SMA male rf connectors
9	Inverse control logic; logic "0" for switch OFF, logic "1" for switch ON (Not applicable to Series 91/92)
10	One SMA male (J1) and one SMA female (J2) rf connector
33	EMI filter solder-type bias/control terminal
41*	Internal video filter, port J1 only
42*	Internal video filter, port J2 only
43*	Internal video filter, both ports
64A	SMB male bias/control connector

Not applicable to Models 9214 and F9214. See chart following the power handling discussion on page 86.

DIMENSIONS AND WEIGHTS



SERIES 91 AND 92
Wt: .39 oz. (11 gm) approx.

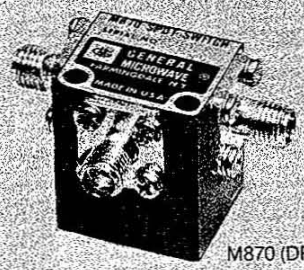


SERIES F91 AND F92
Wt: .43 oz. (12 gm) approx.

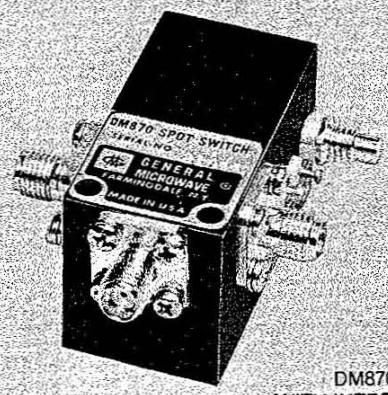
Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Models M870 and DM870
Ultra-Broadband SP2T Switches

- **Frequency range: 0.2 to 18 GHz**
- **Low VSWR and insertion loss**
- **Up to 60 dB isolation**
- **Small size, light weight**



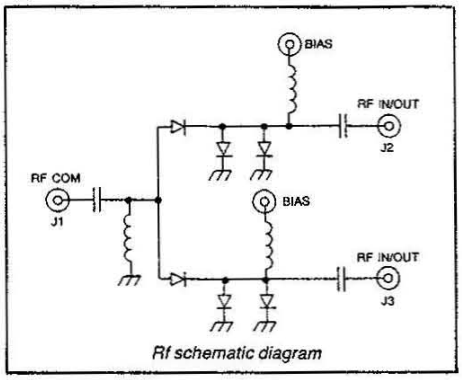
M870 (DRIVERLESS)



DM870
(WITH INTEGRATED
DRIVER)

MODEL M870

Model M870 is a high-performance broadband single-pole two-throw switch that operates over the full instantaneous bandwidth of 0.2 to 18 GHz. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line as well as a resistive bias line that contributes to the broadband low-loss performance. The circuit configuration of the Model M870 is shown below.



Rf schematic diagram

By applying positive current to a bias terminal, the associated port is OFF since the corresponding shunt diodes are biased to a low resistance and the series diode to a high resistance. With negative current at the bias terminal, the converse conditions are established and the port is ON. Since bias terminals are individually available for both ports, the user has the option of operating with either or both ports ON or OFF.

MODEL DM870

The Model DM870 is the same as the Model M870 except it is equipped with an integrated driver that is powered by +15 and −12 to −15 volt supplies. The proper currents required to switch the ports ON or OFF are provided by the driver, which is controlled by external logic signals. Standard units are wired so that one port is biased ON and the other OFF at all times. See AVAILABLE OPTIONS for independent port control.

Models M870 and DM870 Specifications

MODEL NO. (2)	CHARACTERISTIC	FREQUENCY (GHz) 0.2 to 4.0	4.0 to 8.0	8.0 to 12.4	12.4 to 18.0
M870 DM870	Min Isolation (dB)	60	55	55	55
	Max Insertion Loss (dB)	1.5	1.5	1.75	2.2
	Max VSWR (ON)	1.5	1.75	1.75	2.0

PERFORMANCE CHARACTERISTICS

Switching Speed (port to port) ..... 2 μsec max.(1)

Power Handling Capability

Without Performance Degradation .. 1W cw or peak

Survival Power ..... 1W average, 75W peak (1 μsec max. pulse width)

Power Supply Requirements

MODEL M870

Bias current required at each port for rated isolation and insertion loss(3)

Port OFF..... +30 mA

Port ON..... −30 mA

MODEL DM870 (For one port ON)

+15V ±2%, 65 mA

−12 to −15V, 65 mA

Control Characteristics

MODEL DM870

Control Input Impedance..TTL, low power Schottky, two unit load. (A unit load is 0.8 mA sink current and 40 μA source current.)

Control Logic.....One port ON and one port OFF. Logic "0" (−0.3 to +0.8V) connects J1 to J3. Logic "1" (+2.0 to +5.0V) connects J1 to J2.

(1) *Switching speed, defined as the interval between the instant the rf power level in the port switched OFF drops to 90% of its original value and the instant the rf power level in the port switched ON rises to 90% of its final value, is rated for ports driven by shaped current pulses. For the Model DM870, the pulses are provided by the integrated driver. For the Model M870, the pulses must be provided by the user.*

(2) *DM870 is equipped with an integrated TTL compatible driver; M870 is a current-controlled unit that is furnished without a driver.*

(3) *For operation of Models M870 with more than one port ON, total negative current must be limited to −40 mA. Do not apply more than 75 mA to any OFF port or more than −40 mA to any ON port.*

Models M870 and DM870 Specifications

ENVIRONMENTAL RATINGS

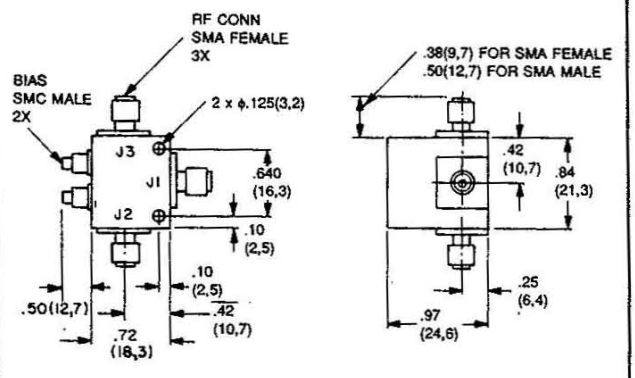
Operating Temperature Range	
Model M870	−65 °C to +125 °C
Model DM870	−65 °C to +110 °C
Non-Operating Temperature Range	−65 °C to +125 °C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

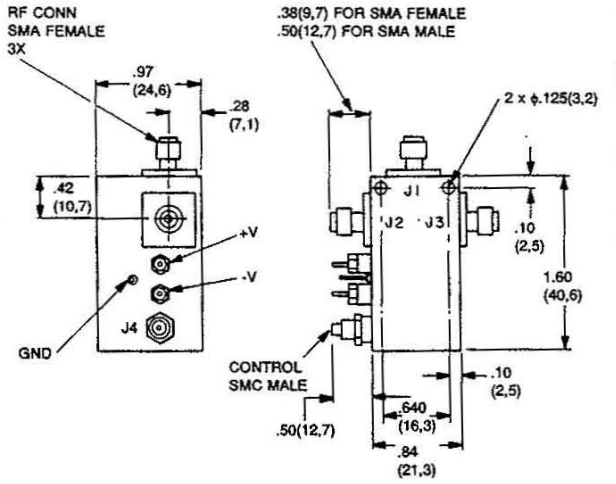
Option No.	Description
7	SMA male rf connectors
7A	J1 SMA male; J2 and J3 SMA female
7B	J1 SMA female; J2 and J3 SMA male
9	Inverse control logic; logic "0" for port ON and logic "1" for port OFF (available only in conjunction with Option 22)
20[1]	Two unit load control input impedance
22	Individual port control (DM 870 only — one unit load); logic "0" for port OFF and logic "1" for port ON. Also available with logic "0" for port ON and logic "1" for port OFF (Specify Option 9)
33	EMI Filter solder-type bias/control terminal
64A	SMB male bias/control connector

(1) *Not applicable to Model M870. All Models DM870 are furnished with this option unless otherwise specified by customer. Other options, such as 50 ohms to ground, are available on special order.*

DIMENSIONS AND WEIGHTS



MODEL M870
Wt: 1.5 oz. (43 gm) approx.



MODEL DM870
Wt: 2.5 oz (71 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series F892
High-Speed Octave-Band SP2T Switches

SERIES F892

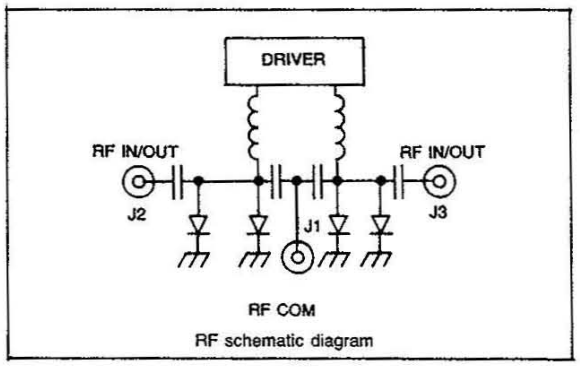
Series F892 high speed switches with integrated drivers are low-cost units that have been engineered to meet the need of microwave system designers for fast switching devices in small packages.

2 To 18 GHz Frequency Range

Frequency coverage from 2 to 18 GHz is provided by the three models in the Series: Model F8922 (2-4 GHz), Model F8924 (4-8 GHz) and Model F8928 (8-18 GHz). Each model is capable of extended bandwidth operation, typically 3:1, with only moderate degradation in performance at the band edges, as shown in the specifications on page 103.

Fast Switching Shunt Design

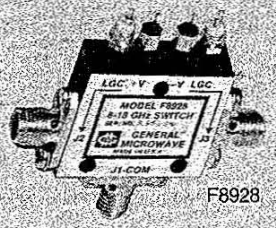
All models are optimally designed, with respect to their size, for low VSWR and insertion loss. As shown in the schematic below, a pure shunt design is used for the most practical realization of fast switching action. Although the use of a pure shunt mode imposes certain bandwidth limitations, frequency coverage in excess of octave bands has been maintained.



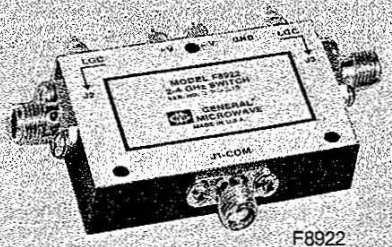
RF schematic diagram

The proper currents required to switch ports ON or OFF are provided by the integrated drivers which are controlled by external logic signals.

- Low Cost
- S, C and X-U band models
- 10 nsec rise and fall times
- Up to 60 dB isolation
- As low as 1.0 dB insertion loss


F8928


F8924


F8922

THE THREE UNITS IN THIS SERIES ARE EQUIPPED WITH INTEGRATED DRIVERS

Series F892 Specifications

PERFORMANCE CHARACTERISTICS

MODEL NO.	FREQUENCY RANGE (GHz)	INSERTION LOSS, MAX. (dB)	ISOLATION MIN. (dB)	VSWR MAX. (ON)
F8922	2-4	1.0	60	1.5
	1.5-4.5	2.0	55	2.0
F8924	4-8	1.4	50	1.5
	3-9	2.3	45	2.2
F8928	8-18	2.3	45(2)	2.2
	6-18	2.5	45(2)	2.5

Switching Characteristics

Rise Time . . . . . 10 nsec max.
Fall Time . . . . . 10 nsec max.

ON Time . . . . . 35 nsec max.
OFF Time . . . . . 30 nsec max.

Repetition rate . . . . . 10 MHz max.

Power Handling Capability

Without Performance Degradation . . . . . 2W cw or peak(1)

Survival Power . . . . . 2W average, 75W peak (1 μsec max pulse width)

Control Characteristics

Control Input Impedance . . . . . Schottky TTL, one-unit load. (A unit load is 2.0 mA sink current and 50 μA source current.)

Control Logic . . . . . Logic "0" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF

Power Supply Requirements

(For one port ON) . . . +5V ±5%, 65 mA
−12 to −15V(1), 2 mA

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . −65°C to +110°C

Non-Operating Temperature Range . . . . . −65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

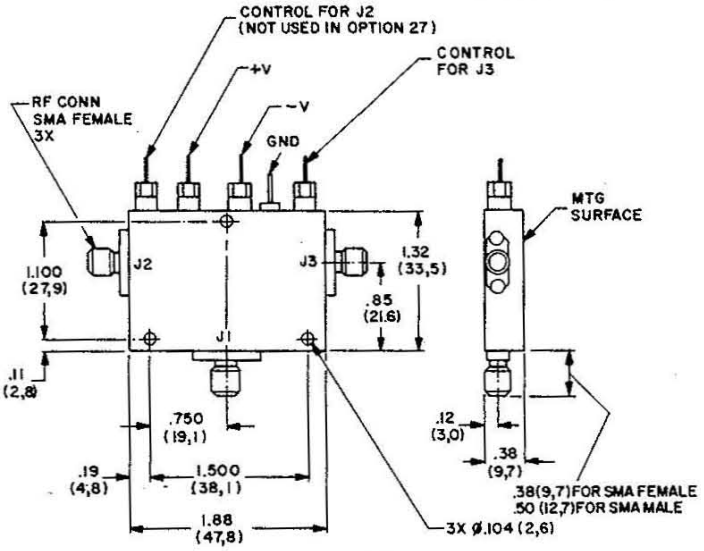
Option No.	Description
3	SMA female control connectors
7	SMA male rf connectors
7A	J1 SMA male; J2 and J3 SMA female
7B	J1 SMA female; J2 and J3 SMA male
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON
27	Single-port toggle control; logic "0" connects J1 to J2
62	±15V operation
64	SMC male control connectors
64A	SMB male control connectors
65	±12V operation

(1) With −15V power supply. Reduces to 1.5W with −12V power supply. Units can be operated at higher input power levels some increase in switching time when −30V power supply is used.
(2) Isolation 40 dB above 16 GHz.

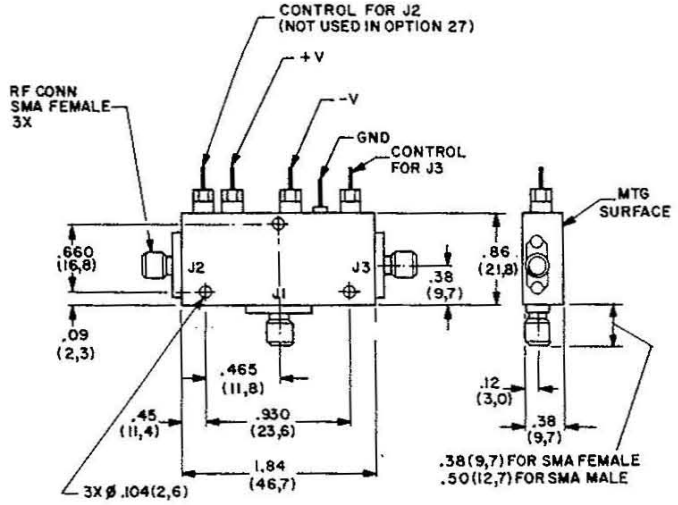
Series F892
Specifications

DIMENSIONS AND WEIGHTS

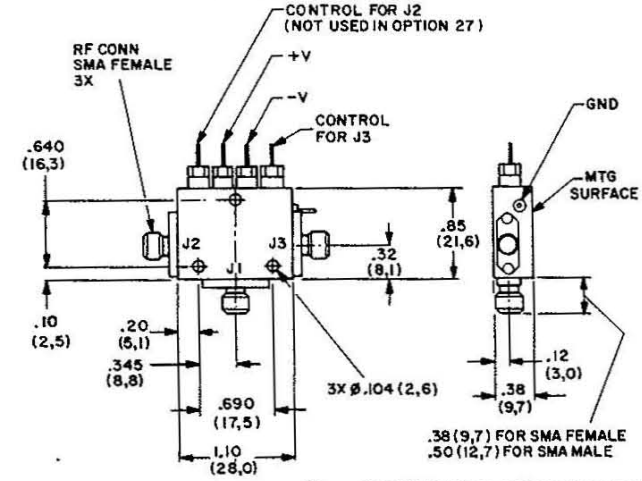
MODEL F8922
Wt: 1.5 oz. (43 gm) approx.



MODEL F8924
Wt: 1 oz. (28 gm) approx.



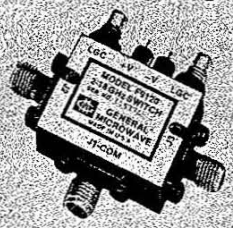
MODEL F8928
Wt: 1 oz. (28 gm) approx.



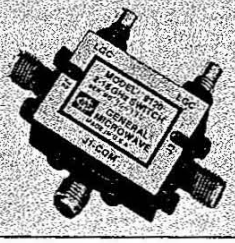
Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Series 91 and 92
Miniature Broadband SP2T Switches

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Rise and fall times as fast as 10 nsec**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Miniature size, light weight**



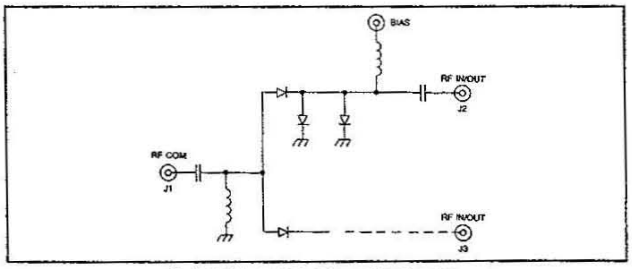
F9120
(WITH INTEGRATED DRIVER)



9120-500
(DRIVERLESS)

MODELS 9120-500 AND 9220-500

These switches provide high-performance characteristics over a multi-octave frequency range. Model 9120-500 covers the frequency range of 1 to 18 GHz; Model 9220-500 covers the frequency range of 0.2 to 4 GHz. Both models use an integrated circuit assembly of a series-shunt configuration of PIN diodes mounted in a microstrip transmission line as shown below.



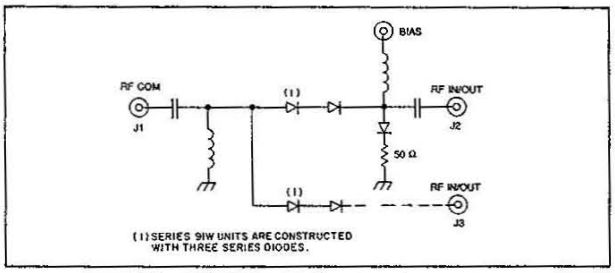
Series 91 and 92 schematic diagram

Port Control

By applying positive current to a bias terminal, the associated port is OFF since the corresponding shunt diodes are biased to a low resistance and the series diode to a high resistance. With negative current at the bias terminal, the converse conditions are established and the port is ON. Since bias terminals are individually available for both ports, the user has the option of any combination of ports ON or OFF.

MODELS 9120T-500, 9120W-500 AND 9220T-500

These switches are non-reflective versions of the switches described above. They are constructed in the configuration shown below.



Series 91T, 92T and 91W schematic diagram

When positive current is applied, the port is OFF since the associated series diodes are back-biased to a high resistance. At the same time, the corresponding shunt diode is biased to a low resistance, and the impedance at the port is then effectively that of the 50 ohm resistor in series with the shunt diode.

When applying negative current, the converse conditions are established and the port is ON.

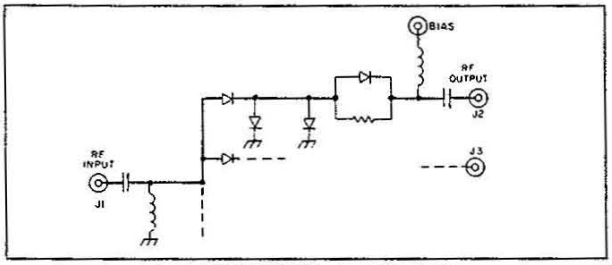
Note that when all output ports are OFF, a high VSWR will be present at the common port.

MODEL 9120AH-500

This switch has the same circuit topology as the 9120-500 except it is equipped with high-speed diodes to achieve rise and fall times of 10 nsec.

MODEL 9120AHT-500

This switch is similar to the 9120AH-500 except it includes a terminating network as shown below.



Model 9120AHT-500 schematic diagram

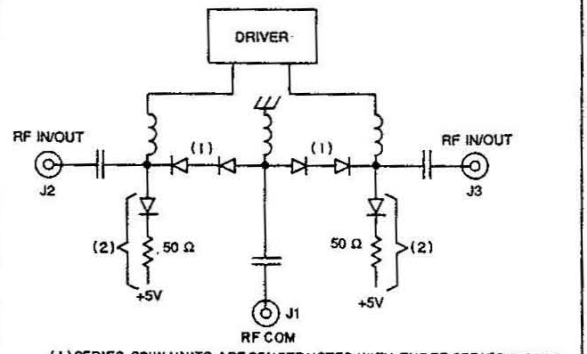
SERIES F91/F92

The Series F91/F92 units are the same as the Series 91/92 units except they are equipped with integrated drivers that are powered by +5 and −12 to −15 V supplies. The proper currents required to switch the ports ON or OFF are provided by the drivers, which are controlled by external control signals. Standard units are wired so that a port is ON with the application of a logic "0" control signal.

Series 91 and 92
Miniature Broadband SP2T Switches

SERIES G91 and G92

Operating from +5 and +15V power supplies only, the G-series switches provide high performance characteristics at relatively high speeds over multi-octave frequency ranges. The series includes low insertion loss and high isolation models in both reflective and non-reflective configurations. Series G91 units cover the frequency range of 1 to 18 GHz; Series G92 units cover the frequency range of 0.2 to 4 GHz. The design is based on an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line as shown below. The currents required to switch the ports ON or OFF are provided by the integrated driver, which is controlled by external TTL logic signals.



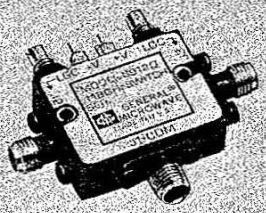
(1) SERIES G91W UNITS ARE CONSTRUCTED WITH THREE SERIES DIODES.
(2) DELETE FOR UNITS WITHOUT "T" OR "W" SUFFIX.

Model G9120( ), rf schematic diagram

SERIES G91T/G92T and G91W

These switches are non-reflective versions of the switches described above.

- **Frequency range (Series G91): 1 to 18 GHz**
- **Frequency range (Series G92): 0.2 to 4 GHz**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Up to 60 dB isolation**
- **Positive dc supplies only**
- **Miniature size, light weight**



MODEL G9120

Series 91 and 92 SP2T Switches Specifications

MODEL NO. (1)	CHARACTERISTIC	FREQUENCY (GHz)					
		0.2-1	1-2	2-4	4-8	8-12.4	12.4-18
9120-500 F9120	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.1 1.75	60 1.1 1.75	60 1.4 1.75	60 2.0 1.75	50 2.5 2.0
G9120	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.8 1.5	60 1.8 1.5	60 1.8 1.5	60 2.2 1.5	50 2.5 2.0
9220-500 F9220	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.5 1.5	60 1.5 1.5	60 1.5 1.5	– – –	– – –	– – –
G9220	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.8 1.5	60 1.8 1.5	60 1.8 1.5	– – –	– – –	– – –
9120T-500 F9120T G9120T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	50 1.2 1.5	50 1.2 1.5	50 1.5 1.5	45 1.5 1.5	40 2.2 2.0
9220T-500 F9220T G9220T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	60 1.2 1.5	60 1.2 1.5	60 1.2 1.5	– – –	– – –	– – –
9120W-500 F9120W G9120W	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	60 1.8 1.5	60 1.8 1.5	60 1.8 1.5	60 2.2 1.5	55 2.5 2.0
9120AH-500 F9120AH	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.1 1.75	60 1.1 1.75	60 1.4 1.75	60 2.0 1.75	50 2.5 2.0
9120AHT-500 F9120AHT	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON) Max VSWR (OFF)	– – – –	60 1.3 1.75 1.75	60 1.3 1.75 1.75	60 1.7 1.9 2.0	60 2.5 2.0 2.2	50 3.0 2.0 2.3

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation
- Units without "T" or "W" suffix: 1W cw or peak
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 100 mW cw or peak
  - Input to any "ON" port: 1W cw or peak
  - Input to common port: 1W cw or peak

Survival Power
- Units without "T" or "W" suffix: 1W average, 75W peak (1 μsec max. pulse width)
- Units with "T" or "W" suffix
  - Input to any "OFF" port : 1W average, 10W peak (1 μsec max. pulse width)
  - Input to any "ON" port: 1W average, 75W peak (1 μsec max. pulse width)
  - Input to common port: 1W average, 75W peak (1 μsec max. pulse width)

(1) *Models prefixed with "F" or "G" are equipped with integrated TTL-compatible drivers; models without the "F" or "G" prefix are current-controlled units and are furnished without drivers; models suffixed with "T" or "W" are non-reflective except a high VSWR will be present at the common port if all other ports are OFF; models suffixed with "H" are high-speed units.*

Series 91 and 92 SP2T Switches Specifications

Switching Characteristics(1)

SERIES 91/92/F91/F92

Units without "H" suffix
- ON time . . . . . 250 nsec max.
- OFF time . . . . . 250 nsec max.

Units with "H" suffix
- Rise time . . . . . 10 nsec max.
- Fall time . . . . . 10 nsec max.
- ON time . . . . . 25 nsec max.
- OFF time . . . . . 20 nsec max.
- Repetition rate . . . . . 20 MHz max.

SERIES G91/G92

- ON time . . . . . 250 nsec max.
- OFF time . . . . . 250 nsec max.

Power Supply Requirements

SERIES 91/92/F91/F92

Driverless Units

Bias current required at each port for rated isolation and insertion loss

PORT OFF
- Units without "H" suffix . . . +50mA
- Units with "H" suffix . . . . . +30mA

PORT ON
- Units without "H" suffix . . . −50mA
- Units with "H" suffix . . . . . −35mA

Units With Integrated Drivers

(For one port ON)	+5V ±5%	−12 to −15V
Units Without "H" Suffix	65 mA	65 mA
Units With "H" Suffix	60 mA	50 mA
Units With "HT" Suffix	80 mA	50 mA

SERIES G91/G92

(For one Port ON)
- +5V ±5%, 100 mA
- +15V ±5%, 30 mA

(1) *For driverless units, shaped current pulses must be provided by user.*

Control Characteristics

SERIES 91/92/F91/F92

Units With Integrated Drivers

Control Input Impedance

Units without "H" suffix . . . TTL, low power Schottky, one unit load. (A unit load is 0.8 mA sink current and 40 μA source current.)

Units with "H" suffix . . . . . TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 μA source current.)

Control Logic . . . . . Logic "0" (−0.3 to +0.8 V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

SERIES G91/G92

Control Input Impedance . . Schottky TTL, one unit load. (A unit load is 2.0 mA sink current and 50 μA source current.)

Control Logic . . . . . Logic "0" (−0.3 to +0.8 V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

Series 91 and 92 SP2T Switches Specifications

ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating ..... −65°C to +110°C

Non-Operating ..... −65°C to +125°C

Driverless Units

Operating and Non-Operating ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

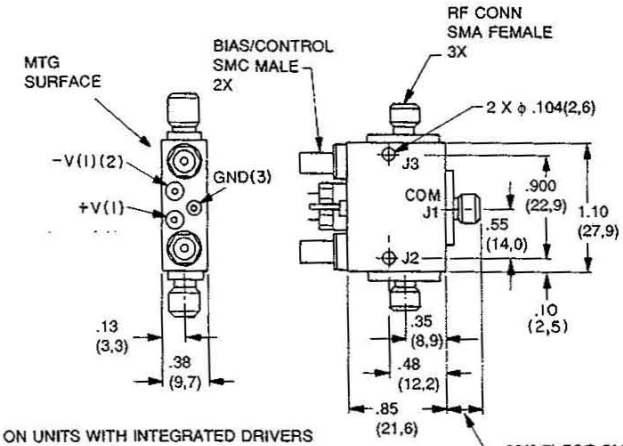
Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias/control connectors
7	J1, J2 and J3 SMA male
7A	J1 SMA male; J2 and J3 SMA female
7B	J1 SMA female; J2 and J3 SMA male
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON (Not applicable to Series 91/92)
27	Single-port toggle control; logic "0" connects J1 to J2 (Not applicable to Series 91/92)
33	EMI filter solder-type bias/control terminals
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
64A	SMB male bias/control connectors

Not applicable to Series 92/F92/G92. See chart following the power handling discussion on page 86.

DIMENSIONS AND WEIGHT



(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS
(2) +15V FOR G91/G92 SERIES
(3) NOT USED ON DRIVERLESS UNITS EXCEPT WITH OPTION 33

SERIES 91/92/F91/F92/G91/G92
Wt: .75 oz. (21 gm) approx.

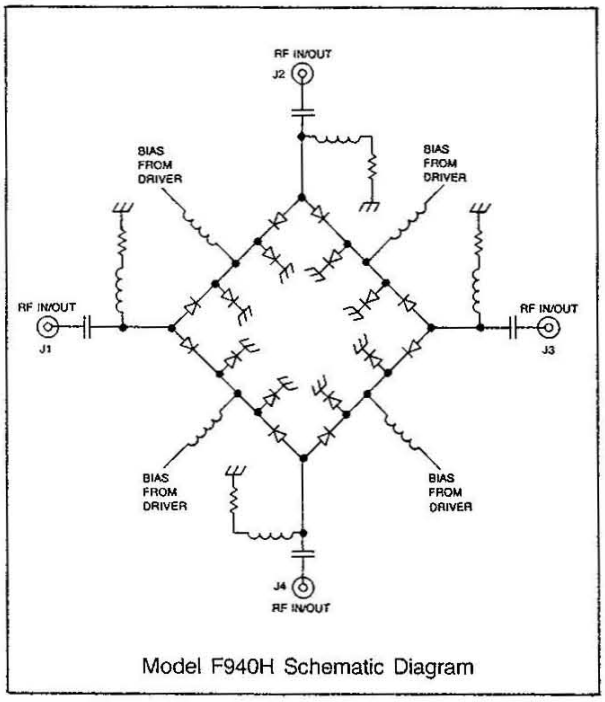
Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Model F940H
Broadband Transfer Switch

With Integrated Driver

MODEL F940H

Model F940H is a high-performance broadband transfer switch that operates over the full instantaneous bandwidth of 0.5 to 18 GHz with ON and OFF times of 30 nsec. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line as well as a resistive bias line that contributes to the broadband low-loss performance. The circuit configuration of the Model F940H is shown below.



Model F940H Schematic Diagram

The Model F940H is equipped with an integrated driver that is powered by +5 and −12 volt supplies. The proper currents required to switch the ports ON or OFF are provided by the driver, which is controlled by external logic signals.

- **Frequency range: 0.5 to 18 GHz**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Small size, light weight**

Model F940H Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	FREQUENCY (GHz)		
	0.5 to 8.0	8.0 to 12.4	12.4 to 18.0
Min Isolation (dB)	60	55	50
Max Insertion Loss (dB)	2.0	2.5	3.5
Max VSWR	1.75	1.75	2.0

Switching Time
ON Time . . . . . 30 nsec max
OFF Time . . . . . 30 nsec max

Power Handling Capability
Without Performance Degradation . . . . . 500 mW cw or peak
Survival Power . . . . . 1W average, 75W peak (1 μsec max pulse width)

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . −65°C to +110°C
Non-Operating Temperature Range . . . . . −65°C to +125°C
Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

Power Supply Requirements

+5V ±5%, 60 mA
-12 to ±5%, 75 mA

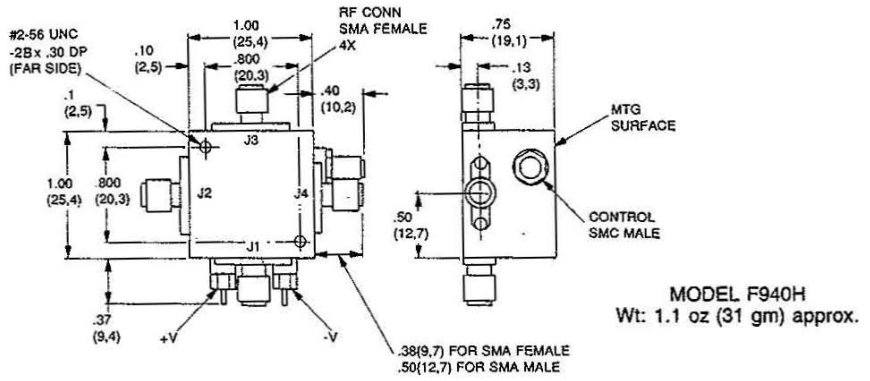
Control Characteristics

Control Input Impedance . . . . . Schottky TTL, two unit loads. (A unit load is 2 mA sink current and 50 μA source current.)
Control Logic . . . . . Logic "O" (−0.3 to +0.8V) connects J1 to J2 and J3 to J4. Logic "1" (+2.0 to +5.0V) connects J1 to J4 and J2 to J3.

AVAILABLE OPTIONS

Option No.	Description
7	SMA male rf connectors
9	Inverse control logic; logic "0" connects J1 to J4 and J2 to J3, and logic "1" connects J1 to J2 and J3 to J4
33	EMI filter solder-type control terminal
64A	SMB male control connector

DIMENSIONS AND WEIGHT

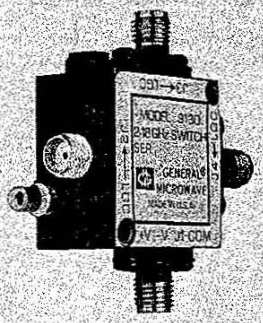


MODEL F940H
Wt: 1.1 oz (31 gm) approx.

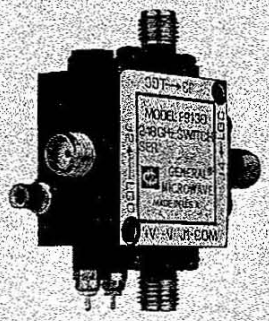
Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Series 91 and 92
Miniature Broadband SP3T Switches

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Rise and fall times as fast as 10 nsec**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



9130-500 (DRIVERLESS)



F9130
(WITH INTEGRATED
DRIVER)

MODELS 9130-500 AND 9230-500

These switches provide high-performance characteristics over a multi-octave frequency range. The Model 9130-500 covers the 1 to 18 GHz frequency range while the Model 9230-500 covers the 0.2 to 4 GHz range. This description and operation are the same as that for the Models 9120-500 and 9220-500 SP2T switches.

MODELS 9130T-500, 9130W-500 AND 9230T-500

These switches are non-reflective versions of the switches described above.

MODELS 9130AH-500 AND 9130AHT-500

These switches are the same as the 9120AH-500 and 9120AHT-500 except for the number of ports.

SERIES F91 AND F92

The Series F91 and F92 switches are the same as the corresponding Series 91 and 92 models, except the units are equipped with integrated drivers.

SERIES G91 AND G92

These switches are the same as the Series G91 and G92 SP2T switches except for the number of ports.

Series 91 and 92 SP3T Switches Specifications

MODEL NO. (1)	CHARACTERISTIC	FREQUENCY (GHz)					
		0.2-1	1-2	2-4	4-8	8-12.4	12.4-18
9130-500 F9130	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.5 1.75	60 1.5 1.75	60 1.5 1.75	60 2.0 1.75	50 2.5 2.0
G9130	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.8 1.5	60 1.8 1.5	60 2.0 1.7	60 2.5 1.7	50 2.8 2.0
9230-500 F9230	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.5 1.5	60 1.5 1.5	60 1.5 1.5	– – –	– – –	– – –
G9230	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.8 1.5	60 1.8 1.5	60 1.8 1.5	– – –	– – –	– – –
9130T-500 F9130T G9130T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	50 1.4 1.5	50 1.4 1.5	45 1.6 1.7	40 1.8 1.7	40 2.5 2.0
9230T-500 F9230T G9230T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	60 1.2 1.5	60 1.2 1.5	50 1.4 1.5	– – –	– – –	– – –
9130W-500 F9130W G9130W	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	60 1.8 1.5	60 1.8 1.5	60 2.0 1.7	60 2.5 1.7	55 2.8 2.0
9130AH-500 F9130AH	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.2 1.75	60 1.2 1.75	60 1.5 1.75	60 2.0 1.75	50 2.6 2.0
9130AHT-500 F9130AHT	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON) Max VSWR (OFF)	– – – –	60 1.6 1.75 1.75	60 1.6 1.75 1.75	60 1.8 1.9 2.0	60 2.5 2.0 2.2	50 3.3 2.0 2.3

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation
- Units without "T" or "W" suffix: 1W cw or peak
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 100 mW cw or peak
  - Input to any "ON" port: 1W cw or peak
  - Input to common port: 1W cw or peak

Survival Power
- Units without "T" or "W" suffix: 1W average, 75W peak (1 μsec max. pulse width)
- Units with "T" or "W" suffix
  - Input to any "OFF" port : 1W average, 10W peak (1 μsec max. pulse width)
  - Input to any "ON" port: 1W average, 75W peak (1 μsec max. pulse width)
  - Input to common port: 1W average, 75W peak (1 μsec max. pulse width)

(1) *Models prefixed with "F" or "G" are equipped with integrated TTL-compatible drivers; models without the "F" or "G" prefix are current-controlled units and are furnished without drivers; models suffixed with "T" or "W" are non-reflective except a high VSWR will be present at the common port if all other ports are OFF; models suffixed with "H" are high-speed units.*

Series 91 and 92 SP3T Switches Specifications

Switching Characteristics[1]

SERIES 91/92/F91/F92

Units without "H" suffix

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

Units with "H" suffix

Rise time..... 10 nsec max.
Fall time..... 10 nsec max.
ON time..... 25 nsec max.
OFF time..... 20 nsec max.
Repetition rate..... 20 MHz max.

SERIES G91/G92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

Power Supply Requirements

SERIES 91/92/F91/F92

Driverless Units

Bias current required at each port for rated isolation and insertion loss

Port OFF
- Units without "H" suffix..... +50 mA
- Units with "H" suffix..... +30 mA

Port ON
- Units without "H" suffix..... −50 mA
- Units with "H" suffix..... −35 mA

Units With Integrated Drivers

(For one port ON)

	+5V ±5%	−12 to −15V
Units Without "H" Suffix	130 mA	60 mA
Units With "H" Suffix	75 mA	55 mA
Units With "HT" Suffix	105 mA	55 mA

SERIES G91/G92
(For one port ON)
+5V ±5%, 100 mA
+15V ±5%, 40 mA

(1) *For driverless units, shaped current pulses must be provided by user.*

Control Characteristics

SERIES 91/92/F91/F92

Units With Integrated Drivers

Control Input Impedance

Units without "H" suffix... TTL, low power Schottky, one unit load. (A unit load is 0.8 mA sink current and 40 uA source current.)

Units with "H" suffix..... TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 μA source current.)

Control Logic..... Logic "0" (−0.3 to +0.8 V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

SERIES G91/G92

Control Input Impedance.. Schottky TTL, one unit load. (A unit load is 2.0 mA sink current and 50 μA source current.)

Control Logic..... Logic "0" (−0.3 to +0.8 V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

Series 91 and 92 SP3T Switches Specifications

ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating	−65°C to +110°C
Non-Operating	−65°C to +125°C

Driverless Units

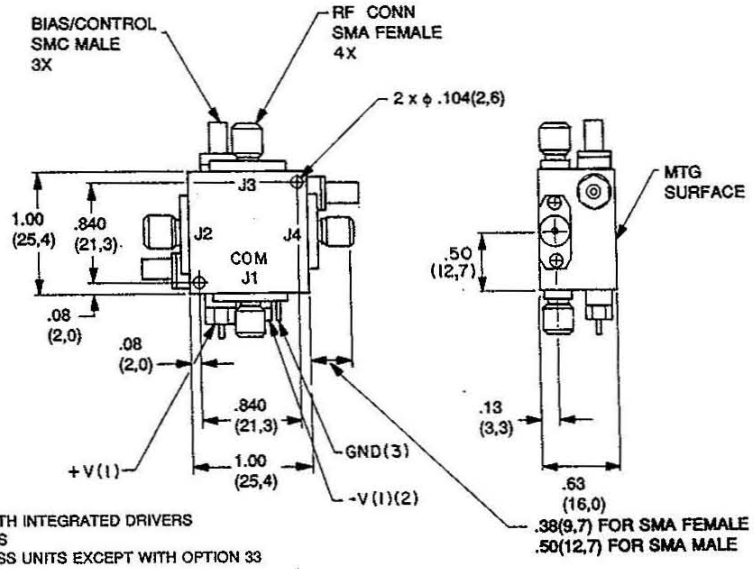
Operating and Non-Operating	−65°C to +125°C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias/control connectors
7	SMA male rf connectors
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON (Not applicable to Series 91/92)
33	EMI-filter solder-type bias/control terminals
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
64A	SMB male bias/control connectors

Not applicable to Series 92/F92/G92. See chart following the power handling discussion on page 86.

DIMENSIONS AND WEIGHT



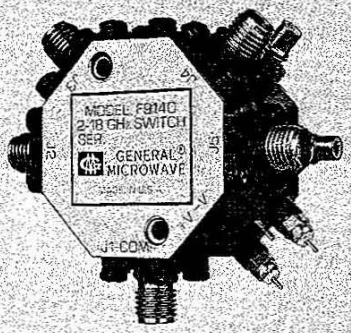
(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS
(2) +15V FOR G91/G92 SERIES
(3) NOT USED ON DRIVERLESS UNITS EXCEPT WITH OPTION 33

MODELS 91/92/F91/F92/G91/G92
Wt: 1.1 oz. (31 gm) approx.

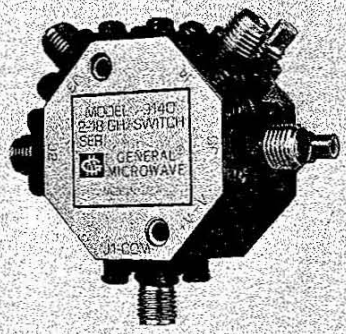
Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 91 and 92
Miniature Broadband SP4T Switches

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Rise and fall times as fast as 10 nsec**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



F9140
(WITH INTEGRATED DRIVER)



9140-500
(DRIVERLESS)

MODELS 9140-500 AND 9240-500

These switches provide high-performance characteristics over a multi-octave frequency range. Model 9140-500 covers the 1 to 18 GHz frequency range while the Model 9240-500 covers the 0.2 to 4 GHz range. Their description and operation are the same as that for the Models 9120-500 and 9220-500 SP2T switches.

MODELS 9140T-500, 9140W-500 AND 9240T-500

These switches are nonreflective versions of the switches described above.

MODELS 9140AH-500 AND 9140AHT-500

These switches are the same as the 9120AH-500 and the 9120AHT-500 except for the number of ports.

SERIES F91 AND F92

The Series F91 and F92 switches are the same as the corresponding Series 91 and 92 models except the units are equipped with integrated drivers.

SERIES G91 AND G92

These switches are the same as the Series G91 and G92 SP2T switches except for the number of ports.

Series 91 and 92 SP4T Switches Specifications

MODEL NO. (1)	CHARACTERISTIC	FREQUENCY (GHz)					
		0.2-1	1-2	2-4	4-8	8-12.4	12.4-18
9140-500 F9140	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.4 1.75	60 1.4 1.75	60 1.5 1.75	60 2.0 1.75	50 2.8 2.0
G9140	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 2.0 1.5	60 2.0 1.5	60 2.2 1.7	60 2.7 1.7	50 3.0 2.0
9240-500 F9240	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.5 1.6	60 1.5 1.6	60 1.5 1.6	– – –	– – –	– – –
G9240	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 2.0 1.5	60 2.0 1.5	60 2.0 1.5	– – –	– – –	– – –
9140T-500 F9140T G9140T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	50 1.5 1.5	50 1.5 1.5	45 1.7 1.7	40 2.0 1.7	40 2.5 2.0
9240T-500 F9240T G9240T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	60 1.3 1.5	60 1.3 1.5	50 1.5 1.5	– – –	– – –	– – –
9140W-500 F9140W G9140W	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	60 2.0 1.5	60 2.0 1.5	60 2.2 1.7	60 2.7 1.7	55 3.0 2.0
9140AH-500 F9140AH	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.4 1.75	60 1.4 1.75	60 1.5 1.75	60 2.0 2.0	50 2.8 2.0
9140AHT-500 F9140AHT	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON) Max VSWR (OFF)	– – – –	60 1.6 1.75 1.75	60 1.6 1.75 1.75	60 1.8 1.9 2.0	60 2.5 2.0 2.2	50 3.3 2.0 2.3

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation
- Units without "T" or "W" suffix: 1W cw or peak
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 100 mW cw or peak
  - Input to any "ON" port: 1W cw or peak
  - Input to common port: 1W cw or peak

Survival Power
- Units without "T" or "W" suffix: 1W average, 75W peak (1 μsec max. pulse width)
- Units with "T" or "W" suffix
  - Input to any "OFF" port : 1W average, 10W peak (1 μsec max. pulse width)
  - Input to any "ON" port: 1W average, 75W peak (1 μsec max. pulse width)
  - Input to common port: 1W average, 75W peak (1 μsec max. pulse width)

(1) *Models prefixed with "F" or "G" are equipped with integrated TTL-compatible drivers; models without the "F" or "G" prefix are current-controlled units and are furnished without drivers; models suffixed with "T" or "W" are non-reflective except a high VSWR will be present at the common port if all other ports are OFF; models suffixed with "H" are high-speed units.*

Series 91 and 92 SP4T Switches Specifications

Switching Characteristics[1]

SERIES 91/92/F91/F92

Units without "H" suffix

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

Units with "H" suffix

Rise time..... 10 nsec max.
Fall time..... 10 nsec max.
ON time..... 25 nsec max.
OFF time..... 20 nsec max.

SERIES G91/G92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

Power Supply Requirements

SERIES 91/92/F91/F92

Driverless Units

Bias current required at each port for rated isolation and insertion loss

Port OFF
- Units without "H" suffix..... +50 mA
- Units with "H" suffix..... +30 mA

Port ON
- Units without "H" suffix..... −50 mA
- Units with "H" suffix..... −35 mA

Units With Integrated Drivers

(For one port ON)

	+5V ±5%	−12 to −15V
Units Without "H" Suffix	190 mA	60 mA
Units With "H" Suffix	95 mA	60 mA
Units With "HT" Suffix	135 mA	60 mA

SERIES G91/G92

(For one port ON)

+5V ±5%, 150 mA
+15V ±5%, 50 mA

(1) *For driverless units, spiked current pulses must be provided by user.*

Control Characteristics

SERIES 91/92/F91/F92

Units With Integrated Drivers

Control Input Impedance

Units without "H" suffix... TTL, low power Schottky, one unit load. (A unit load is 0.8 mA sink current and 40 μA source current.)

Units with "H" suffix..... TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 μA source current.)

Control Logic..... Logic "0" (−0.3 to +0.8 V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

SERIES G91/G92

Control Input Impedance.. Schottky TTL, one unit load. (A unit load is 2.0 mA sink current and 50 μA source current.)

Control Logic..... Logic "0" (−0.3 to +0.8 V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

Series 91 and 92 SP4T Switches Specifications

ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating ..... −65°C to +110°C

Non-Operating ..... −65°C to +125°C

Driverless Units

Operating and Non-Operating ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

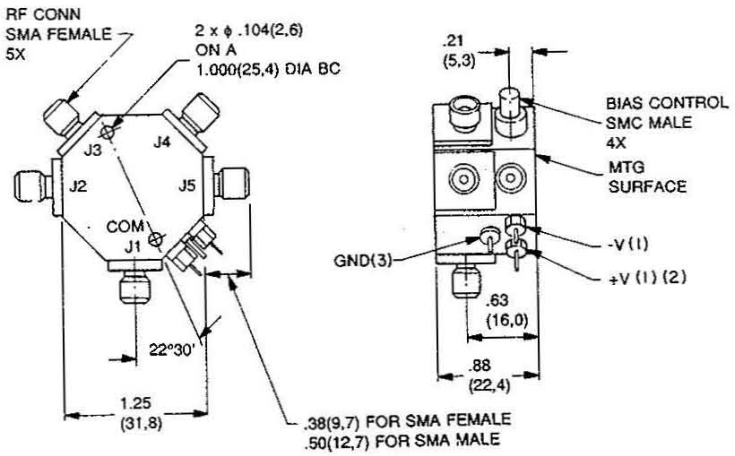
Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias/control connectors
7	SMA male rf connectors
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON (Not applicable to Series 91, 92)
33	EMI-filter solder-type bias/control terminals
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
64A	SMB male bias/control connectors

*Not applicable to Series 92/F92/G92. See chart following the power handling discussion on page 86.

DIMENSIONS AND WEIGHT



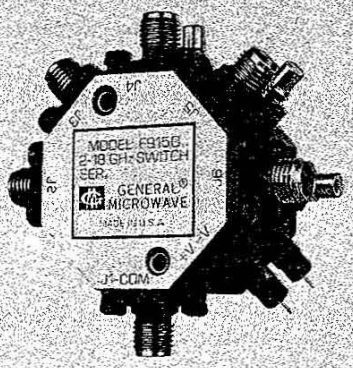
(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS
(2) +15V FOR G91/G92 SERIES
(3) NOT USED ON DRIVERLESS UNITS EXCEPT WITH OPTION 33

MODELS 91/92/F91/F92/G91/G92
Wt. 2 oz. (57 gm) approx.

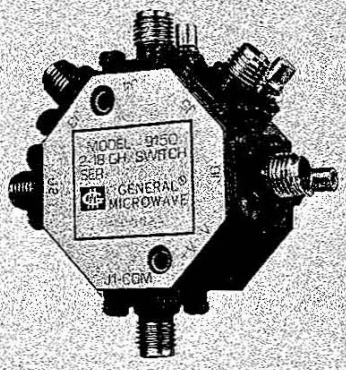
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.005

Series 91 and 92
Miniature Broadband SP5T Switches

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



F9150
(WITH INTEGRATED
DRIVER)



9150-500 (DRIVERLESS)

MODELS 9150-500 AND 9250-500

These switches provide high-performance characteristics over a multi-octave frequency range. The Model 9150-500 covers the 1 to 18 GHz frequency range while the Model 9250-500 covers the 0.2 to 4 GHz range. This description and operation are the same as that for the Models 9120-500 and 9220-500 SP2T switches.

MODELS 9150T-500, 9150W-500 AND 9250T-500

These switches are non-reflective versions of the switches described above.

SERIES F91 AND F92

The Series F91 and F92 switches are the same as the corresponding Series 91 and 92 models, except the units are equipped with integrated drivers.

SERIES G91 AND G92

These switches are the same as the Series G91 and G92 SP2T switches except for the number of ports.

Series 91 and 92 SP5T Switches Specifications

MODEL NO. (1)	CHARACTERISTIC	FREQUENCY (GHz)					
		0.2-1	1-2	2-4	4-8	8-12.4	12.4-18
9150-500 F9150	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.5 1.5	60 1.5 1.5	55 1.5 1.75	50 2.0 1.75	50 3.0 2.0
G9150	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 2.2 1.5	60 2.2 1.5	60 2.4 1.8	60 3.0 2.0	50 3.3 2.2
9250-500 F9250	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.5 1.6	60 1.5 1.6	60 1.5 1.6	– – –	– – –	– – –
G9250	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 2.2 1.5	60 2.2 1.5	60 2.2 1.5	– – –	– – –	– – –
9150T-500 F9150T G9150T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	50 1.5 1.5	50 1.5 1.5	45 2.0 1.7	40 2.5 2.0	40 3.0 2.2
9250T-500 F9250T G9250T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	60 1.4 1.5	60 1.4 1.5	50 1.5 1.5	– – –	– – –	– – –
9150W-500 F9150W G9150W	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	60 2.2 1.5	60 2.2 1.5	60 2.4 1.8	60 3.0 2.0	55 3.3 2.2

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation
- Units without "T" or "W" suffix: 1W cw or peak
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 100 mW cw or peak
  - Input to any "ON" port: 1W cw or peak
  - Input to common port: 1W cw or peak

Survival Power
- Units without "T" or "W" suffix: 1W average, 75W peak (1 μsec max. pulse width)
- Units with "T" or "W" suffix
  - Input to any "OFF" port : 1W average, 10W peak (1 μsec max. pulse width)
  - Input to any "ON" port: 1W average, 75W peak (1 μsec max. pulse width)
  - Input to common port: 1W average, 75W peak (1 μsec max. pulse width)

Switching Time(2)

SERIES 91/92/F91/F92

ON time..... 250 nsec max.
OFF time..... 250 nsec. max.

SERIES G91/G92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

(1) *Models prefixed with "F" or "G" are equipped with integrated TTL-compatible drivers; models without the "F" or "G" prefix are current-controlled units and are furnished without drivers; models suffixed with "T" or "W" are non-reflective except a high VSWR will be present at the common port if all other ports are OFF.*

(2) *For driverless units, shaped current pulses must be provided by the user.*

Series 91 and 92 SP5T Switches Specifications

Power Supply Requirements

SERIES 91/92/F91/F92
Driverless Units

Bias current required at each port for rated isolation and insertion loss

Port OFF . . . . . +50 mA
Port ON . . . . . −50 mA

Units With Integrated Drivers

(For one port ON) . . . . . +5V ±5%, 250 mA
−12 to −15V, 60 mA

SERIES G91/G92

(For one port ON) . . . . . +5V ±5%, 150 mA
+15V ±5%, 60 mA

Control Characteristics

SERIES 91/92/F91/F92
Units With Integrated Drivers

Control Input Impedance . . TTL, low power Schottky, one unit load. (A unit load is 0.8 mA sink current and 40 μA source current.)

Control Logic . . . . . Logic "O" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

SERIES G91/G92

Control Input Impedance . . Schottky TTL, one unit load. (A unit load is 2.0 mA sink current and 50 μA source current.)

Control Logic . . . . . Logic "O" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

**Not applicable to Series 92/F92/G92. See chart following the power handling discussion on page 86.*

ENVIRONMENTAL RATINGS

Temperature Range
Units With Integrated Drivers
Operating . . . . . −65°C to +110°C
Non-Operating . . . . . −65°C to +125°C
Driverless Units
Operating and Non-Operating . . . . . −65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)

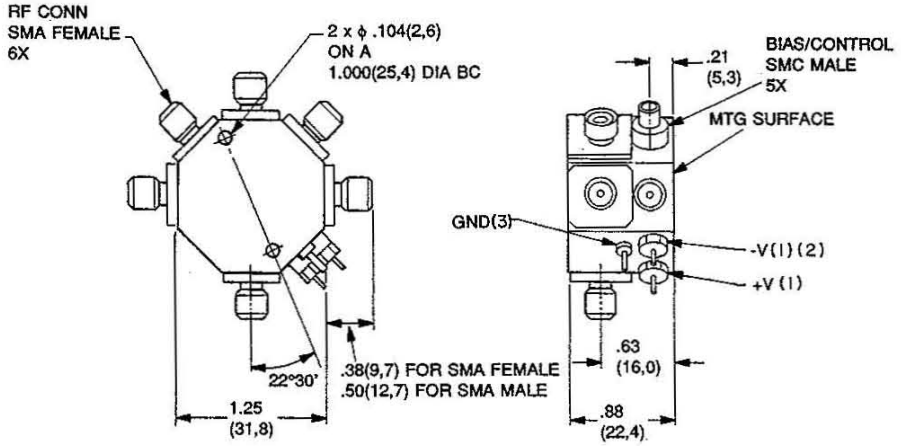
Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias/control connectors
7	SMA male rf connectors
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON (Not applicable to Series 91, 92)
33	EMI filter solder-type bias/control terminals
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
64A	SMB male bias/control connectors

DIMENSIONS AND WEIGHT



(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS
(2) +15V FOR G91/G92 SERIES
(3) NOT USED ON DRIVERLESS UNITS EXCEPT WITH OPTION 33

MODELS 91/92/F91/F92/G91/G92
Wt: 2 oz. (57 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 91 and 92
Miniature Broadband SP6T Switches

MODELS 9160-500 AND 9260-500

These switches provide high-performance characteristics over a multi-octave frequency range. Model 9160-500 covers the 1 to 18 GHz frequency range while the Model 9260-500 covers the 0.2 to 4 GHz range. Their description and operation are the same as that for the Models 9120-500 and 9220-500 SP2T switches.

MODELS 9160T-500, 9160W-500 AND 9260T-500

These switches are non-reflective versions of the switches described above.

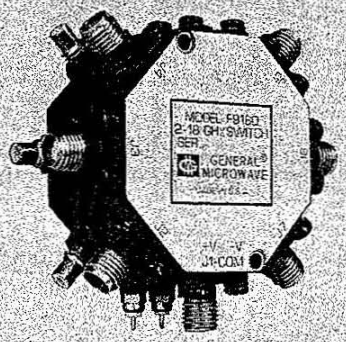
SERIES F91 AND F92

The Series F91 and F92 switches are the same as the corresponding Series 91 and 92 models, except the units are equipped with integrated drivers.

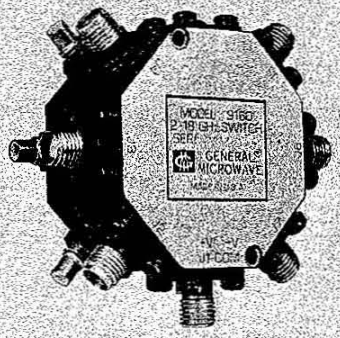
SERIES G91 AND G92

These switches are the same as the Series G91 and G92 SP2T switches except for the number of ports.

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



F9160
(WITH INTEGRATED DRIVER)



9160-500 (DRIVERLESS)

Series 91 and 92 SP6T Switches Specifications

MODEL NO. (1)	CHARACTERISTIC	FREQUENCY (GHz)					
		0.2-1	1-2	2-4	4-8	8-12.4	12.4-18
9160-500 F9160	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.6 1.6	60 1.6 1.6	55 1.8 1.9	50 2.2 2.0	50 3.4 2.2
G9160	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 2.2 1.6	60 2.2 1.6	60 2.6 2.0	60 3.2 2.2	50 3.5 2.3
9260-500 F9260	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.5 1.6	60 1.5 1.6	60 1.5 1.6	– – –	– – –	– – –
G9260	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 2.2 1.6	60 2.2 1.6	60 2.2 1.6	– – –	– – –	– – –
9160T-500 F9160T G9160T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	50 1.5 1.6	50 1.5 1.6	45 2.2 1.8	40 2.7 2.0	40 3.2 2.2
9260T-500 F9260T G9260T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	60 1.5 1.5	60 1.5 1.5	50 1.5 1.6	– – –	– – –	– – –
9160W-500 F9160W G9160W	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	60 2.2 1.6	60 2.2 1.6	60 2.6 2.0	60 3.2 2.2	55 3.5 2.3

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation
- Units without "T" or "W" suffix: 1W cw or peak
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 100 mW cw or peak
  - Input to any "ON" port: 1W cw or peak
  - Input to common port: 1W cw or peak

Survival Power
- Units without "T" or "W" suffix: 1W average, 75W peak (1 μsec max. pulse width)
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 1W average, 10W peak (1 μsec max. pulse width)
  - Input to any "ON" port: 1W average, 75W peak (1 μsec max. pulse width)
  - Input to common port: 1W average, 75W peak (1 μsec pulse width)

Switching Time(2)

SERIES 91/92/F91/F92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

SERIES G91/G92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

(1) *Models prefixed with "F" or "G" are equipped with integrated TTL-compatible drivers; models without the "F" or "G" prefix are current-controlled units and are furnished without drivers; models suffixed with "T" or "W" are non-reflective except a high VSWR will be present at the common port if all other ports are OFF.*

(2) *For driverless units, shaped current pulses must be provided by the user.*

Series 91 and 92 SP6T Switches Specifications

Power Supply Requirements

SERIES 91/92/F91/F92
Driverless Units
Bias current required at each port for rated isolation and insertion loss
Port OFF . . . . . , +50 mA
Port ON . . . . . −50 mA

Units With Integrated Drivers
(For one port ON) . . . . . +5V ±5%, 315 mA
−12 to −15V, 60 mA

SERIES G91/G92
(For one port ON) . . . . . +5V ±5%, 150 mA
+15V ±5%, 70 mA

Control Characteristics

Series 91/92/F91/F92
Units With Integrated Drivers

Control Logic . . . . . Logic "O" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

Control Input Impedance . . . . . TTL, low power Schottky one unit load. (A unit load is 0.8 mA sink current and 40 μA source current).

Series G91/G92

Control Logic . . . . . Logic "O" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

Control Input Impedance . . . . . Schottky TTL, one unit load (A unit load is 2.0 mA sink current and 50 μA source current).

ENVIRONMENTAL RATINGS

Temperature Range
Units With Integrated Drivers
Operating . . . . . −65°C to +110°C
Non-Operating . . . . . −65°C to +125°C
Driverless Units
Operating and Non-Operating . . . . . −65°C to +125°C

Humidity . . . . . MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock . . . . . MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration . . . . . MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude . . . . . MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

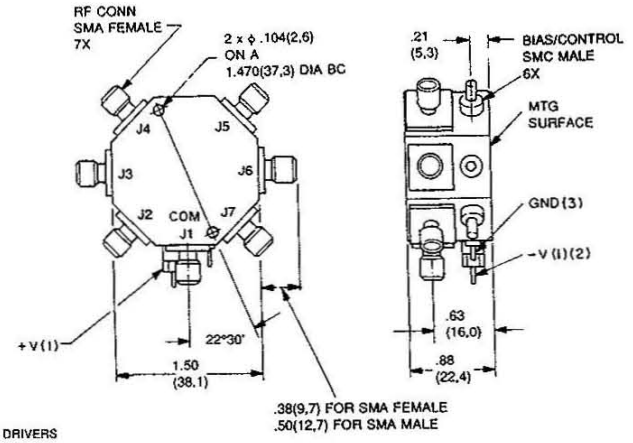
Temp. Cycling . . . . . MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias/control connectors
7	SMA male rf connectors
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON (Not applicable to Series 91/92)
33	EMI filter solder-type bias/control terminals
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
64A	SMB male bias/control connectors

Not applicable to Series 92/F92/G92. See chart following the power handling discussion on page 86.

DIMENSIONS AND WEIGHT



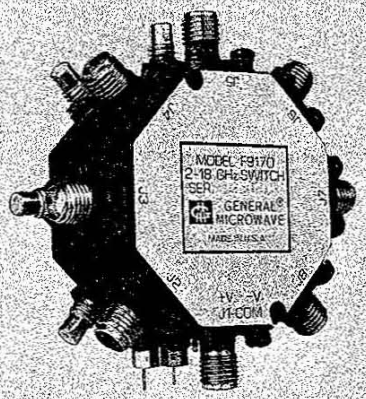
(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS
(2) +15V FOR G91/G92 SERIES
(3) NOT USED ON DRIVERLESS UNITS EXCEPT WITH OPTION 33

MODELS 91/92/F91/F92/G91/G92
Wt: 2.9 oz. (82 gm) approx.

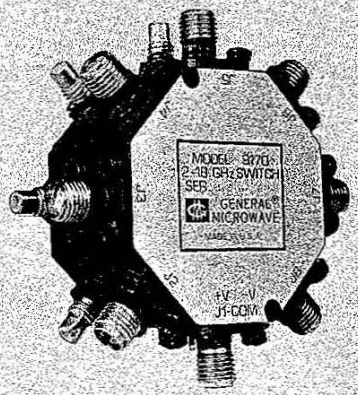
Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Series 91 and 92
Miniature Broadband SP7T Switches

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Reflective and nonreflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



F9170
(WITH INTEGRATED
DRIVER)



9170-500 (DRIVERLESS)

MODELS 9170-500 AND 9270-500

These switches provide high-performance characteristics over a multi-octave frequency range. Model 9170-500 covers the 1 to 18 GHz frequency range while the Model 9270-500 covers the 0.2 to 4 GHz range. Their description and operation are the same as that for the Models 9120-500 and 9220-500 SP2T switches.

MODELS 9170T-500, 9170W-500 AND 9270T-500

These switches are non-reflective versions of the switches described above.

SERIES F91 AND F92

The Series F91 and F92 switches are the same as the corresponding Series 91 and 92 models, except the units are equipped with integrated drivers.

SERIES G91 AND G92

These switches are the same as the Series G91 and G92 SP2T switches except for the number of ports.

Series 91 and 92 SP7T Switches Specifications

MODEL NO.[1]	CHARACTERISTIC	FREQUENCY (GHz)					
		0.2-1	1-2	2-4	4-8	8-12.4	12.4-18
9170-500 F9170	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 1.75 1.75	60 1.75 1.75	55 2.0 2.0	50 2.6 2.2	50 3.8 2.4
G9170	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	– – –	60 2.2 1.7	60 2.2 1.7	60 2.8 2.2	60 3.5 2.2	50 3.8 2.4
9270-500 F9270	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 1.5 1.6	60 1.5 1.6	60 1.5 1.6	– – –	– – –	– – –
G9270	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON)	60 2.2 1.7	60 2.2 1.7	60 2.2 1.7	– – –	– – –	– – –
9170T-500 F9170T G9170T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	50 1.5 1.7	50 1.5 1.7	45 2.4 2.0	40 3.0 2.2	40 3.5 2.4
9270T-500 F9270T G9270T	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	60 1.5 1.5	60 1.5 1.5	50 1.5 1.7	– – –	– – –	– – –
9170W-500 F9170W G9170W	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR (ON or OFF)	– – –	60 2.2 1.7	60 2.2 1.7	60 2.8 2.2	60 3.5 2.2	55 3.8 2.4

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation
- Units without "T" or "W" suffix: 1W cw or peak
- Units with "T" or "W" suffix
  - Input to any "OFF" port: 100 mW cw or peak
  - Input to any "ON" port: 1W cw or peak
  - Input to common port: 1W cw or peak

Survival Power
- Units without "T" or "W" suffix: 1W average, 75W peak (1 μsec max. pulse width)
- Units with "T" or "W" suffix
  - Input to any "OFF" port : 1W average, 10W peak (1 μsec max. pulse width)
  - Input to any "ON" port: 1W average, 75W peak (1 μsec max. pulse width)
  - Input to common port: 1W average, 75W peak (1 μsec max. pulse width)

Switching Time[2]

SERIES 91/92/F91/F92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

SERIES G91/G92

ON time..... 250 nsec max.
OFF time..... 250 nsec max.

(1) *Models prefixed with "F" or "G" are equipped with integrated TTL-compatible drivers; models without the "F" or "G" prefix are current-controlled units and are furnished without drivers; models suffixed with "T" or "W" are non-reflective except a high VSWR will be present at the common port if all other ports are OFF.*

(2) *For driverless units, shaped current pulses must be provided by the user.*

Series 91 and 92 SP7T Switches Specifications

Power Supply Requirements

SERIES 91/92/F91/F92

Driverless Units

Bias current required at each port for rated isolation and insertion loss

Port OFF ..... +50 mA
Port ON ..... −50 mA

Units With Integrated Drivers

(For one port ON)..... +5V ±5%, 375 mA
−12 to −15V, 60 mA

SERIES G91/G92

(For one port ON)..... +5V ±5%, 190 mA
+15V ±5%, 70 mA

Control Characteristics

SERIES 91/92/F91/F92

Units With Integrated Drivers

Control Input Impedance.. TTL, low power Schottky, one unit load. (A unit load is 0.8 mA sink current and 40 μA source current.)

Control Logic..... Logic "O" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

SERIES G91/G92

Control Input Impedance.. Schottky TTL, one unit load. (A unit load is 2.0 mA sink current and 50 μA source current.)

Control Logic..... Logic "O" (−0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating ..... −65°C to +110°C
Non-Operating ..... −65°C to +125°C

Driverless Units

Operating and Non-Operating ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

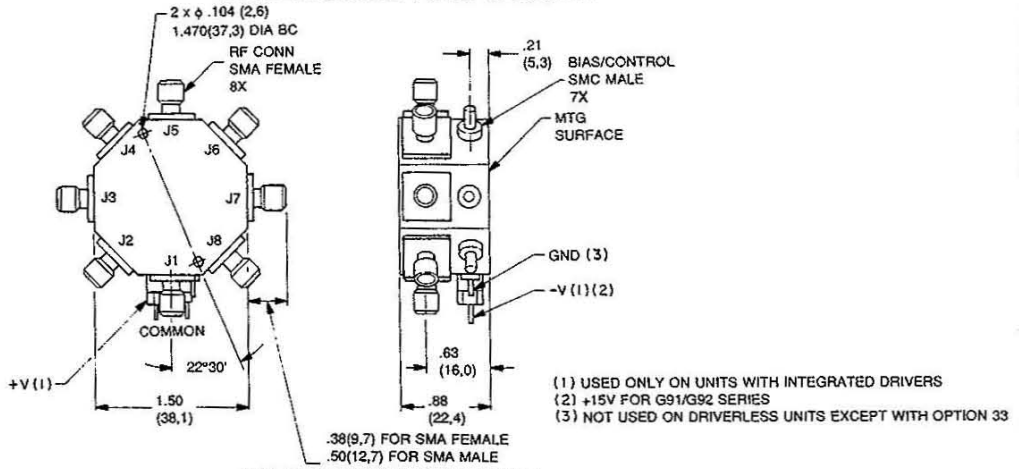
Temp. Cycling..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female bias/control connectors
7	SMA male rf connectors
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON (Not applicable to Series 91, 92)
33	EMI filter solder-type bias/control terminals
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
64A	SMB male bias/control connectors

Not applicable to Series 92/F92/G92. See chart following the power handling discussion on page 86.

DIMENSIONS AND WEIGHT



MODELS 91/92/F91/F92/G91/G92
Wt: 2.9 oz. (82 gm) approx.

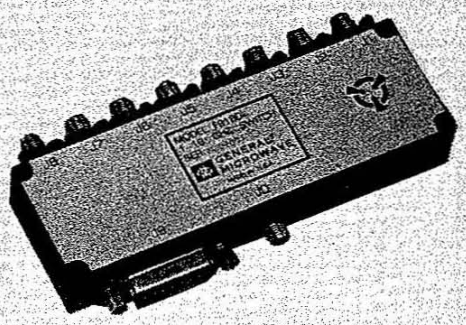
Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

Models F9180 and F9180W
Low-Cost Broadband SP8T Switches

General Microwave's latest addition to its extensive line of PIN diode switches, the Models F9180 and F9180W, operate over a frequency range of 1 to 18 GHz. They are low-cost state-of-the-art, high isolation, low insertion loss units. For the Model F9180, the reflective design, insertion loss varies from 1.5 dB at 1 GHz to 3.8 dB at 18 GHz. The corresponding values for the Model F9180W, the non-reflective design, are 2.0 dB and 4.2 dB, respectively. Isolation varies from 60 dB at 1 GHz to 50 dB at 18 GHz. The VSWR limit for both designs ranges from 1.7 to 2.0, depending on frequency. These units switch in under 200 nanoseconds. They operate over temperature ranges as wide as –55°C to +110 °C and withstand RF power levels as high as 75 watts peak, 1 watt average.

Each model weighs 8.5 ounces and measures 4.65 x 1.5 x 0.75". They are powered by +5V DC and –12 to –15V DC (standard) or by ±5V DC (Option 11). Individual port TTL logic control and power supply connections are made by means of a DA15P connector.

- **Frequency range: 1-18 GHz**
- **Reflective and non-reflective models**
- **High isolation, low insertion loss and VSWR**
- **Switching time: 200 nsec**



Models F9180 and F9180W Specifications

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 1–2	2–4	4–8	8–12.4	12.4–18
F9180	Min. Isolation (dB)	65	65	65	65	60
	Max. Insertion Loss (dB)	1.5	1.7	2.2	2.7	3.8
	Max. VSWR (ON)	1.7	1.7	2.0	2.0	2.0
F9180W	Min. Isolation (dB)	65	65	65	60	55
	Max. Insertion Loss (dB)	2.0	2.0	2.9	3.2	4.2
	Max. VSWR (ON or OFF)	1.7	1.7	2.0	2.0	2.0

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation

F9180: .....0.5 W CW or peak

F9180W:

Input to any "OFF" port: .....100 mW CW or peak

Input to any "ON" port: .....0.5 W CW or peak

Input to common port: .....0.5 W CW or peak

Survival Power

F9180: .....1 W Average, 75 W peak (1 µsec max. pulse width)

F9180W:

Input to any "OFF" port: .....1 W Average, 10 W peak (1 µsec max. pulse width)

Input to any "ON" port: .....1 W Average, 75 peak (1 µsec max. pulse width)

Input to common port: .....1 W Average, 75 W peak (1 µsec max. pulse width)

Switching Time *

ON Time .....200 nsec max.

OFF Time .....200 nsec max.

Power Supply Requirements .....+5V±5% @ 100 mA

–12 to –15V @ 50 mA

CONTROL CHARACTERISTICS

CONTROL LOGIC

Logic "0" (–0.3 to +0.8V) for port ON

Logic "1" (+2.0 to +5.0V) for port OFF

CONTROL INPUT IMPEDANCE

0.5 mA sink current, max.

* See page 85 for definition.

Models F9180 and F9180W Specifications

ENVIRONMENTAL RATINGS

TEMPERATURE RANGE
Operating.....–55°C to +110°C
Non-Operating.....–65°C to +125°C

HUMIDITY.....MIL-STD-202F, Method 103B, Cond. B (96 Hrs. at 95%)

SHOCK.....MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

VIBRATION.....MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less).

ALTITUDE.....MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

TEMP. CYCLING.....MIL-STD-202F, Method 107D, Cond. A, 5 cycles

ACCESSORIES FURNISHED

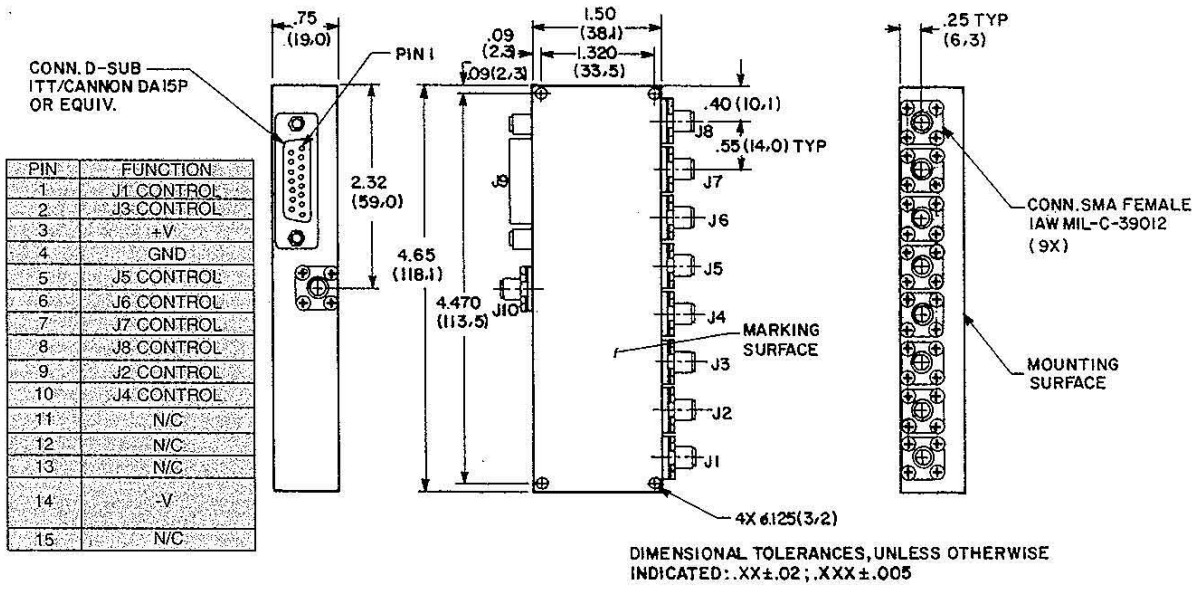
Mating power/logic connector

AVAILABLE OPTIONS

Option No.	Description
7	SMA Male RF Connectors
9	Inverse Control logic; logic "0" for port OFF and logic "1" for port ON
11	±5V Operation
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports

*See Chart following the Power Handling Discussion on page 86.

DIMENSIONS AND WEIGHT



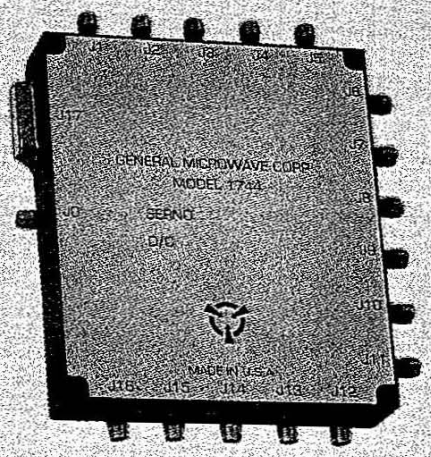
PIN	FUNCTION
1	J1 CONTROL
2	J3 CONTROL
3	+V
4	GND
5	J5 CONTROL
6	J6 CONTROL
7	J7 CONTROL
8	J8 CONTROL
9	J2 CONTROL
10	J4 CONTROL
11	N/C
12	N/C
13	N/C
14	-V
15	N/C

MODELS F9180 and F9180W
8.5 oz. (240 gm) approx.

Dimension tolerances, unless otherwise indicated: .xx ± .02; xxx ± .005

Model 1744
SP16T PIN Diode Switch

General Microwave Corporation's SP16T PIN Diode Switch, Model 1744, covers the 2 to 18 GHz frequency band. The switch exhibits a maximum insertion loss of 6.0 dB and an isolation of 60 dB to 14 GHz and 50 dB to 18 GHz. The switching speed is 500 nsec maximum. This compact unit measures 4.5 x 4.0 x 0.75". Power supply voltages are +5 V and +15 VDC, and it is controlled by 7-bit TTL binary logic. The switch operates over the temperature range of -40°C to +85°C.



SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

- **Frequency Range: 2-18 GHz**
- **Non-reflective**
- **High Isolation, Low Insertion Loss and VSWR**
- **Switching Speed: 500 nsec**

Model 1744 Specifications

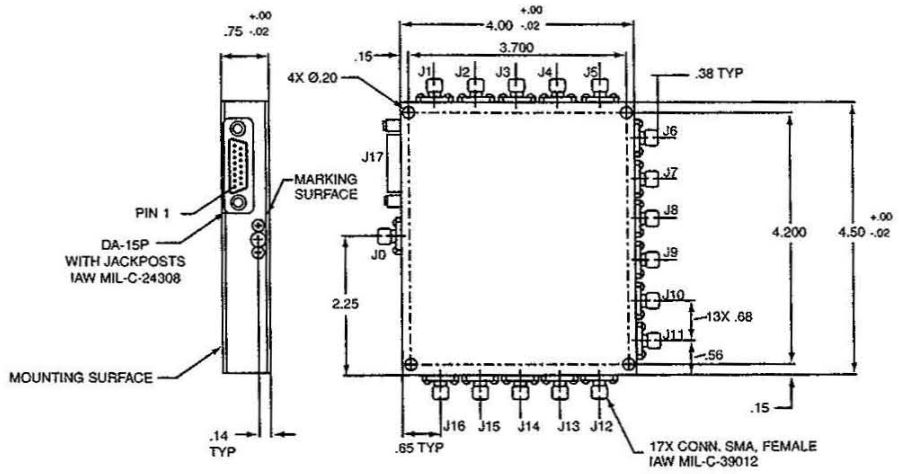
PERFORMANCE CHARACTERISTICS

Frequency . . . . . 2.0 to 18.0 GHz
Insertion Loss . . . . . 6.0 dB max
VSWR (on or off) . . . . . 2.0:1 max
Isolation . . . . . 60 dB min to 14 GHz,
50 dB min to 18 GHz
Switching Speed . . . . . .500 nsec max
Power Handling Capability

Without Performance Degradation
Input to any OFF port . . . . . .100mW cw or peak
Input to any ON port . . . . . .1 W cw or peak
Input to common port . . . . . .1 W cw or peak
Survival Power
Input to any OFF port . . . . . .1 W average, 10 W peak (1 usec max pulse width)
Input to any ON port . . . . . .1 W average, 75 W peak (1 usec max pulse width)
Input to common port . . . . . .1 W average, 75 W peak (1 usec max pulse width)

Power Supply . . . . . .+5 VDC at 250 mA and +15 VDC at 100 mA
Control Input Impedance . . . . . .TTL, two unit load. (A unit load is 0.8 mA sink current and 40 uA source current.)
Control Logic . . . . . .5-bit TTL (Decoded Input)
Connector . . . . . .DA-15P Multipin
Operating Temperature . . . . . .0° to +70° C

DIMENSIONS AND WEIGHT



J17 PIN FUNCTIONS	
PIN	FUNCTION
1	NOT USED
2	+15V
3	NOT USED
4	NOT USED
5	NOT USED
6	CTL-3 (MSB-2)
7	CTL-5 (MSB)
8	CTL-6 (MSB-1)
9	GND
10	GND
11	CTL-2 (LSB+1)
12	NOT USED
13	CTL-1 (LSB)
14	NOT USED
15	+5V

MODEL 1744
Wt. 15 oz. (426 gm.)

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

H91 Series, HM91 Series Hermetically-Sealed SPST Thru SP4T Switches

Both H91 and HM91 Series consist of a family of high-speed high-isolation hermetically sealed switches with integrated drivers that operate over the frequency range from 1 to 18 GHz.

These switches employ sealed glass-to-metal feed-thrus and are designed to meet stringent environmental conditions.

The H Series switches are equipped with removeable SMA female RF connectors permitting field replaceability or integration as drop-in modules. Package area and volume are minimized and overall thickness, with the built-in driver, is only 0.24".

The HM Series switches are supplied without connectors and are primarily intended for use as system drop-in modules. Additional mounting holes around each RF connector ensure optimum RF performance over the entire operating frequency range.

The H91 and HM91 family consists of a reflective SPST and SP2T, SP3T, SP4T switches in both reflective and nonreflective configurations.

On all switches, the dc and control ports are located in line on one wall of the module above the RF connection level. This makes the switches ideally suitable for printed-circuit type mounting.

SPST SWITCH

The models H9114 and HM9114 SPST switch consists of a shunt array of four PIN diodes in a microstrip transmission line (See Fig. 1).

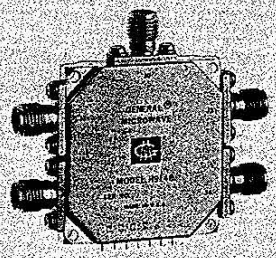
Application of a positive current (by the driver) biases the diodes to a low resistance value, and switches the unit OFF. When the diodes are reverse biased to a high resistance, the unit is switched ON.

REFLECTIVE MULTI-THROW SWITCHES

All models in this group use an integrated assembly of PIN diodes mounted in a microstrip transmission line in a series-shunt arrangement as shown in Fig. 2.

When positive current is applied by the driver, the associated port is OFF since the corresponding shunt diodes are biased to a low resistance and the series diode to a high resistance. With negative current, the converse conditions are established and the port is ON.

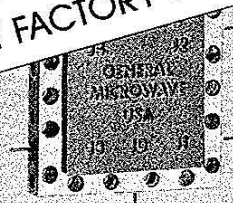
- **Replaceable SMA Connectors**
- **Low Profile: 0.24" thickness with integrated TTL-compatible driver**
- **High Speed, High Isolation**
- **Low VSWR, Low Insertion Loss**
- **Nonreflective and Reflective Models**



H91 — LOW PROFILE CONNECTORIZED SWITCHES

- **TTL-Compatible Driver: Built-in**
- **Effective Mounting Thickness 0.16"**
- **High Speed, High Isolation**
- **Nonreflective and Reflective Models**
- **Low Insertion Loss, Low VSWR**

ALL "HM" UNITS ARE SPECIAL ORDER PRODUCTS -CONSULT FACTORY BEFORE ORDERING-



HM91 — DROP-IN SWITCH MODULES

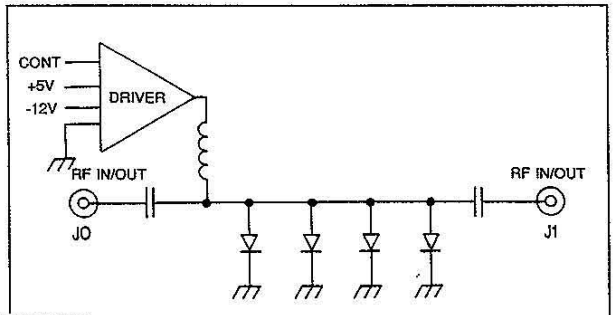


Fig. 1-Single throw switch schematic diagram.

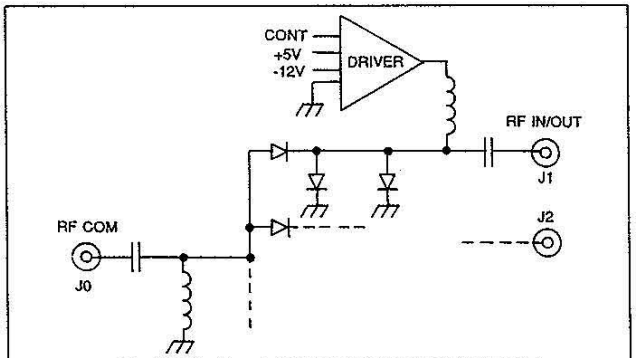


Fig. 2-Reflective multi-throw switch schematic diagram.

H91 Series, HM91 Series Hermetically-Sealed SPST Thru SP4T Switches

NON REFLECTIVE MULTI-THROW SWITCHES

The circuit arrangement for this series is shown in Figure 3.

When positive current is applied the port is turned OFF. All the series diodes in that port are reverse-biased and the impedance at the output of the port is then effectively that of the 50-ohm resistor.

SWITCHING SPEED

All models exhibit transition times of less than 10 nanoseconds between 10% and 90% or 90% and 10% of the RF power.

ON time, the time from 50% point of the TTL command to the 90% level of the detected RF, is less than 25 nanoseconds for all models; OFF time, from the 50% point of the TTL command to the 10% level of the detected RF, is less than 20 nanoseconds.

HERMETIC SEALING

All switches are housed in enclosures using sealed glass-to-metal "feedthru" connectors for true hermeticity.

Covers are welded to the main block in an inert atmosphere, and the final assembly will not leak at a rate in excess of 1 x 10^{-7} atm cc/sec He.

MOUNTING

To facilitate mounting the H Series switches on a flat surface, 0.060" spacers are available to provide clearance for the SMA coupling nut.

Connector kits enabling the user to mount SMA female connectors on the HM Series switches for use in that configuration, or to verify performance, are available as optional accessories.

Each kit also includes an appropriate mounting spacer which permits the switch module to be mounted on a flat surface, while providing proper clearance for mating SMA male connectors.

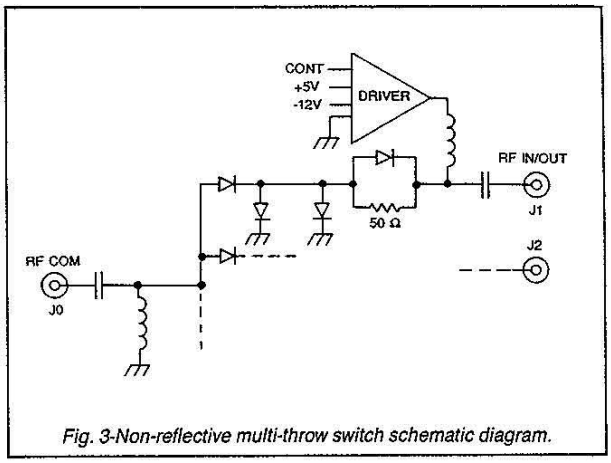


Fig. 3-Non-reflective multi-throw switch schematic diagram.

UNIQUE CONFIGURATION

The HM91 Switch Module Series offers several unique constructional features.

0.16" EFFECTIVE MOUNTING THICKNESS: While the overall thickness of the modules is 0.24", the thickness where the mounting holes are located is only 0.16", minimizing mounting hardware protrusion.

EXTRA MOUNTING HOLES: All switch modules are designed with mounting holes on both sides of each RF port to assure good ground continuity. In addition, four extra mounting holes are provided so that the module can be mounted when used with connectors.

RF AND CONTROL PORTS: The SP3T configurations (HM9130H and HM9130HT), offer the user the added flexibility of being able to specify the positions of three output ports.

Model HM192 Non-Reflective Ultra-Broadband High-Speed SPST Switch Module

The Model HM192 is a hermetically sealed, high speed, non-reflective SPST PIN diode switch with integrated driver. The switch is designed for use as a drop-in module but can be used as a conventional connectorized component when equipped with removable SMA connectors. Operating over the instantaneous frequency range from 0.2 to 18 GHz, it provides a minimum isolation of 80 dB from 0.5 to 18 GHz. The switch consists of an internal driver and an arrangement of shunt and series diodes in a microstrip integrated circuit transmission line as shown in Fig. 1.

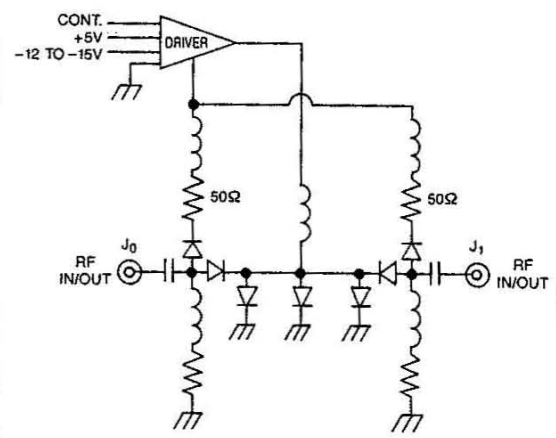
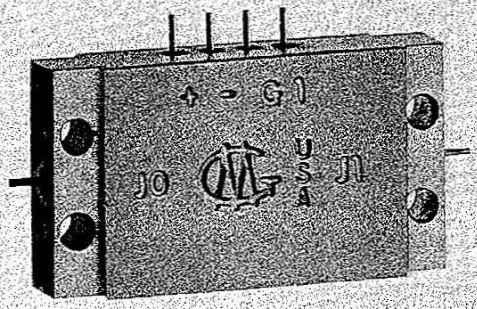


Fig. 1 — Model HM192 Schematic Diagram

- **High speed; 10 nsec**
- **Frequency range: 0.2 to 18 GHz**
- **80 dB isolation**
- **Low VSWR and insertion loss**
- **0.24 inch thick**
- **Hermetically sealed**



SPECIAL ORDER PRODUCT
-CONSULT FACTORY BEFORE ORDERING-

Model HM192 Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	FREQUENCY (GHz)				
	0.2 to 0.5	0.5 to 2.0	2.0 to 8.0	8.0 to 12.4	12.4 to 18.0
Min Isolation (dB)	35	80	80	80	80
Max Insertion Loss (dB)	2.0	2.0	2.5	3.0	3.5
VSWR (ON and OFF)	1.5	1.5	1.75	2.0	2.0

Switching Characteristics

Rise Time . . . . . 10 nsec. max
Fall Time . . . . . 10 nsec. max
ON Time . . . . . 30 nsec. max
OFF Time . . . . . 15 nsec. max

Power Handling Capability

Without Performance Degradation . . . . . 500 mW cw or peak

Survival Power . . . . . 1 W average, 10 W peak (1 μsec max pulse width)

Control Characteristics

Control Input Impedance . . . . . TTL, Advanced Schottky, Two-unit load. (A unit load is 0.6 mA sink current and 20 μA source current)

Control Logic
Logic "O" . . . . . (−0.3 to +0.8V) for switch ON
Logic "1" . . . . . (+2.0 to +5.0V) for switch OFF.

Power Supply Requirements(1) . . . . . +5V ±5%, 50 mA
−12 to −15V
±5%, 50 mA

ENVIRONMENTAL RATINGS

Operating Temperature Range . . . . . −65°C to +125°C

AVAILABLE OPTIONS

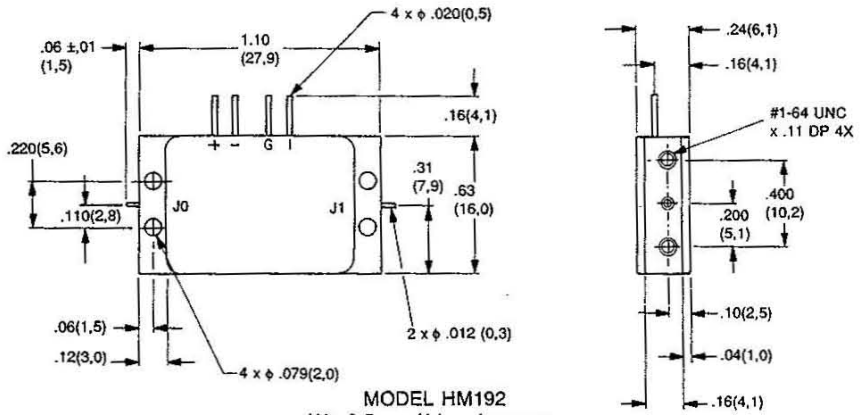
Option No.	Description
9	Inverse control logic; logic "1" for switch ON and logic "O" for switch OFF.
49	High Rel screening (see Table 1 page 30)

AVAILABLE ACCESSORIES

CK-1 Connector Kit:
Two female connectors, spacers and mounting hardware.

(1) *Up to 1 MHz switching rate. At 10 MHz, +V and −V @ 125 mA each.*

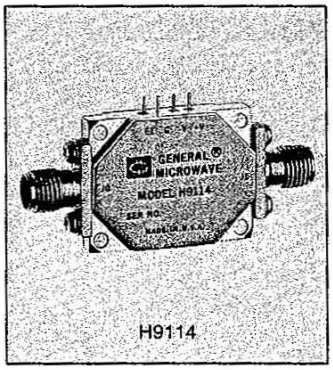
DIMENSIONS AND WEIGHT



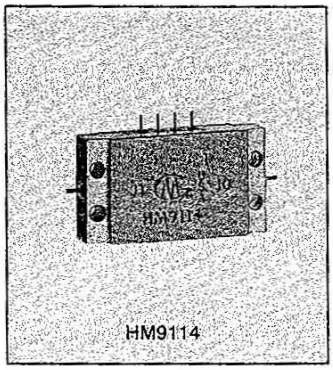
MODEL HM192
Wt: 0.5 oz. (14 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Models H9114, HM9114[2]
Hermetically Sealed SPST Switches



H9114

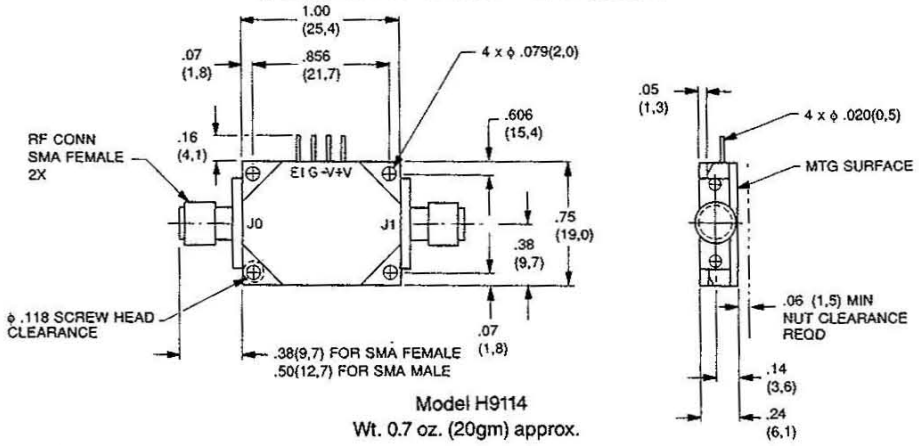

HM9114

PERFORMANCE CHARACTERISTICS[1]

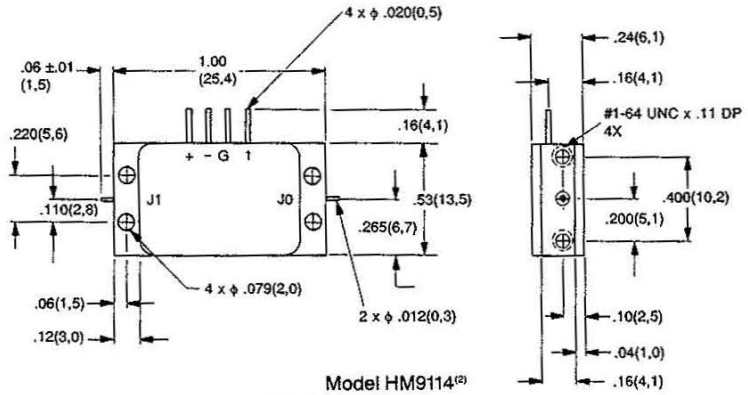
MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz)				
		1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.4	12.4-18.0
H9114 **HM9114**	Min Isolation (dB)	60	74	80	80	80
	Max Insertion Loss (dB)	0.9	0.9	1.2	1.6	2.5
	Max VSWR: (On position)	1.4	1.4	1.75	1.75	2.0

(1) *For Switching Speed, Power Handling and other specifications, see page 86.*
(2) *HM9114 is a special order product; consult factory before ordering.*

DIMENSIONS AND WEIGHTS



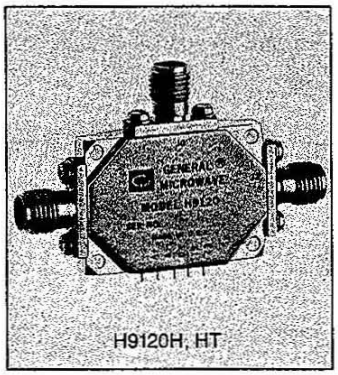
Model H9114
Wt. 0.7 oz. (20gm) approx.

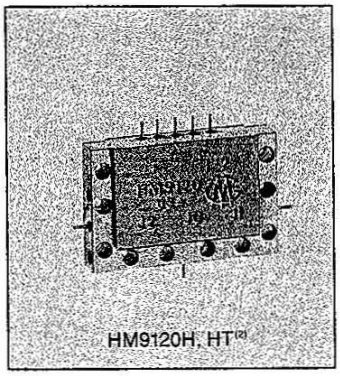


Model HM9114[2]
Wt. 0.4 oz. (11gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Models H9120H, HM9120H[2], H9120HT, HM9120HT[2]
Hermetically Sealed SP2T Switches


H9120H, HT

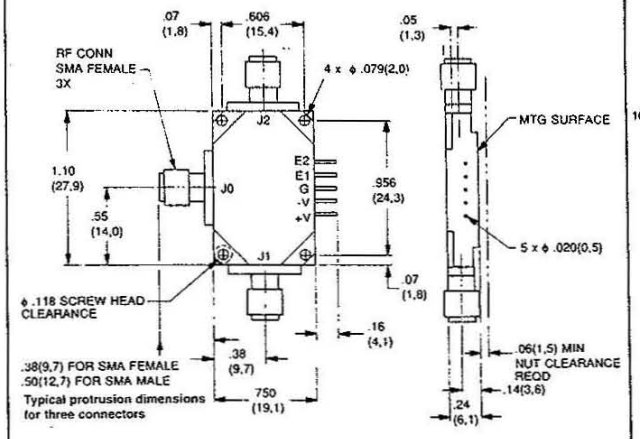

HM9120H, HT[2]

PERFORMANCE CHARACTERISTICS[1]

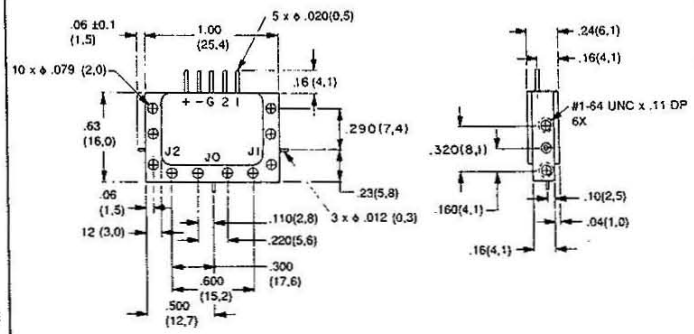
MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz)			
		1-4	4-8	8-12.4	12.4-18
H9120H **HM9120H**[2]	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR: (On position)	60 1.1 1.75	60 1.4 1.75	60 2.0 1.75	50 2.5 2.0
H9120HT **HM9120HT**[2] **(NONREFLECTIVE)**	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR: Port ON Max VSWR: Port OFF	60 1.3 1.75 1.75	60 1.7 1.9 2.0	60 2.5 2.0 2.2	50 3.0 2.0 2.3

(1) *For Switching Speed, Power Handling and other specifications, see page 142.*
(2) *HM Switches are special order products; consult factory before ordering.*

DIMENSIONS AND WEIGHTS



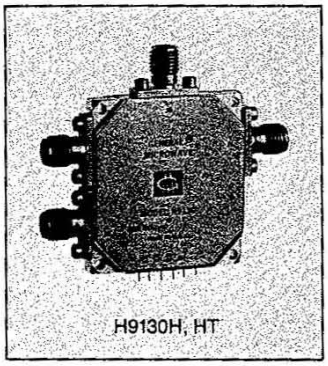
Model H9120H, HT
Wt. 0.8 oz. (23gm) approx.



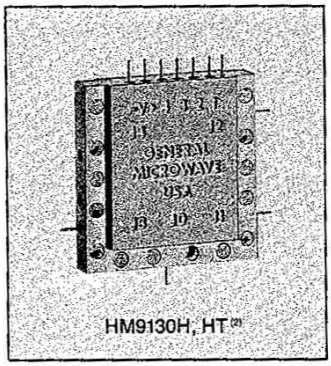
Model HM9120H, HT[2]
Wt. 0.4 oz. (11gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Models H9130H, HM9130H[2], H9130HT, HM9130HT[2] Hermetically Sealed SP3T Switches



H9130H, HT



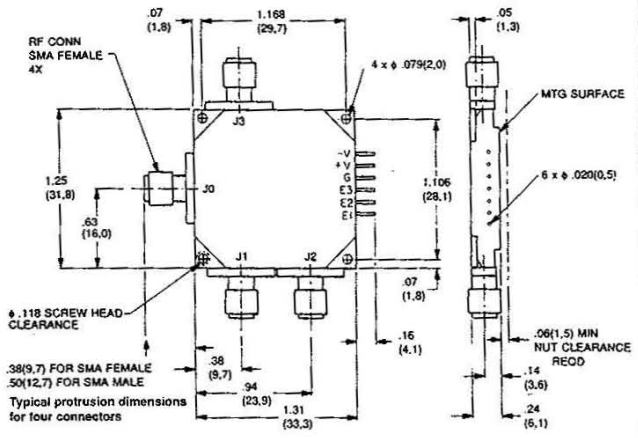
HM9130H, HT[2]

PERFORMANCE CHARACTERISTICS[1]

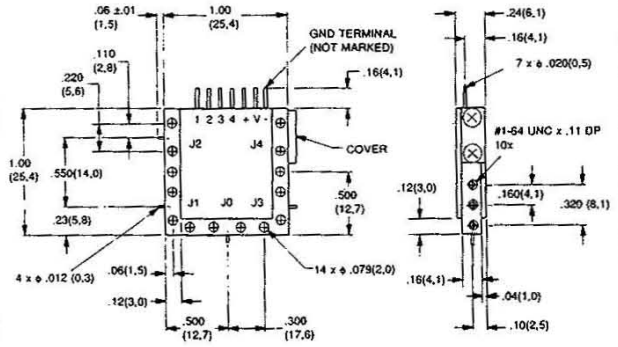
MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz)			
		1-4	4-8	8-12.4	12.4-18
H9130H **HM9130H[2]**	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR: (On position)	60 1.2 1.75	60 1.5 1.75	60 2.0 1.75	50 2.6 2.0
H9130HT **HM9130HT[2]** **(NONREFLECTIVE)**	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR: Port ON Max VSWR: Port OFF	60 1.4 1.75 1.75	60 1.8 1.9 2.0	60 2.5 2.0 2.2	50 3.3 2.0 2.3

(1) *For Switching Speed, Power Handling and other specifications, see page 142.*
(2) *HM Switches are special order products; consult factory before ordering.*

DIMENSIONS AND WEIGHTS



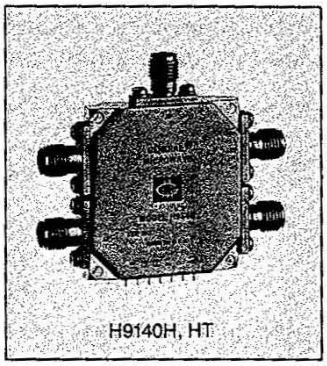
Model H9130H, HT
Wt. 1.4 oz. (40gm) approx.



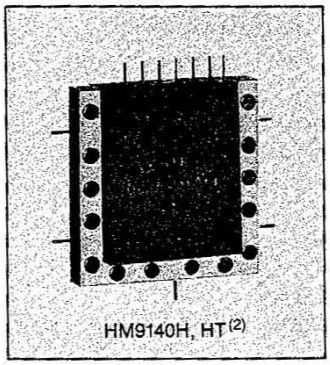
Model HM9130H, HT[2]
Wt. 0.65 oz. (18gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ±02; .xxx ±.005

Models H9140H, HM9140H[2], H9140HT, HM9140HT[2]
Hermetically Sealed SP4T Switches



H9140H, HT



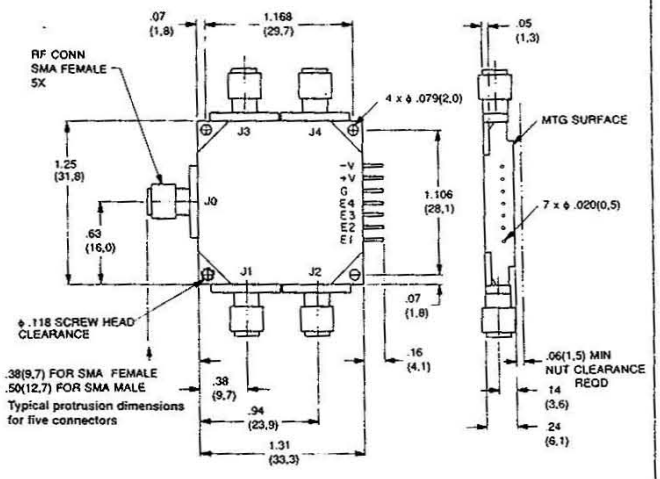
HM9140H, HT[2]

PERFORMANCE CHARACTERISTICS[1]

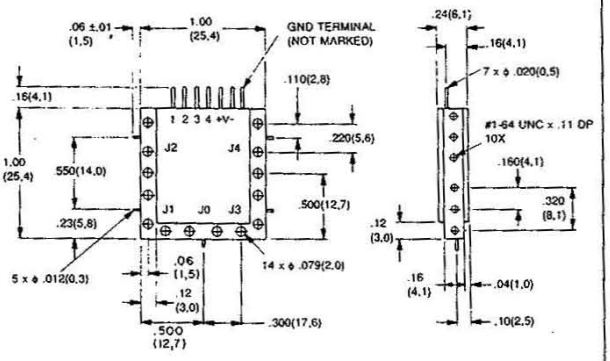
MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz)			
		1-4	4-8	8-12.4	12.4-18
H9140H **HM9140H[2]**	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR: (On position)	60 1.4 1.75	60 1.5 1.75	60 2.0 1.75	50 2.8 2.0
H9140HT **HM9140HT[2]** **(NONREFLECTIVE)**	Min Isolation (dB) Max Insertion Loss (dB) Max VSWR: Port ON Max VSWR: Port OFF	60 1.6 1.75 1.75	60 1.8 1.9 2.0	60 2.5 2.0 2.2	50 3.3 2.0 2.3

(1) *For Switching Speed, Power Handling and other specifications, see page 142.*
(2) *HM Switches are special order products; consult factory before ordering.*

DIMENSIONS AND WEIGHTS



Model H9140H, HT
Wt. 1.5 oz. (43gm) approx.



Model HM9140H, HT[2]
Wt. 0.65 oz. (18gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ±.02; .xxx ±.005

H91/HM91 Series Specifications

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation

All Reflective Switches ..... 1W cw or peak

All Non Reflective Switches

Input to any "OFF" port: 100 mW cw or peak
Input to any "ON" port: 1W cw or peak
Input to common port: 1W cw or peak

Survival Power

SPST Switches .... 2W average, 75W peak (1μsec max pulse width)

Reflective Multi-Throw Switches ..... 1W average, 75W peak (1μsec max. pulse width)

Non Reflective Multi-Throw Switches

Input to any "OFF" port: 1W average, 10W peak (1 μsec max pulse width)
Input to any "ON" port; 1W average 75W peak (1μsec max pulse width)
Input to common port: 1W average 75W peak (1μsec max pulse width)

Switching Speed (All Models)

Rise time ..... 10 nsec max
Fall time ..... 10 nsec max
ON time ..... 25 nsec max
Except SPST Switch .. 20 nsec max
OFF time ..... 20 nsec max
Max Repetition Rate is 20 MHz.

Power Supply Requirements

MODEL	+5V ±5%	−12 to −15V
H9114 HM9114	65 mA	20 mA
FOR ONE PORT ON		
H9120H HM9120H	60 mA	50 mA
H9120HT HM9120HT	80 mA	50 mA
H9130H HM9130H	75 mA	55 mA
H9130HT HM9130HT	105 mA	55 mA
H9140H HM9140H	95 mA	60 mA
H9140HT HM9140HT	135 mA	60 mA

CONTROL CHARACTERISTICS

Units With Integrated Drivers

Control Input Impedance

TTL, advanced Schottky, one unit load.
(A unit load is 0.6 mA sink current and 20 μA source current).

Control Logic

Logic "0" (−0.3 to +0.8 V) for port ON.
Logic "1" (+2.0 to +5.0 V) for port OFF.

ENVIRONMENTAL RATINGS

Temperature Range

Operating ..... −65°C to +125°C

AVAILABLE OPTIONS

Option No.	Description
7	SMA male rf connectors (H series only)
7A	J1 SMA male; J2 and J3 SMA female
7B	J1 SMA female; J2 and J3 SMA male
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON.
10	One SMA male (J0) and one SMA female (J1) rf connector. (H9114 only)
27	Single-port toggle control. Logic "0" connects J0 to J1. Control can be applied to either terminal 1 or 2. (SP2T models only)
41*	Internal video filter, common port only
42*	Internal video filter, output ports only
43*	Internal video filter, all ports
49	High Rel screening (see Table 1, page 30)

AVAILABLE ACCESSORIES

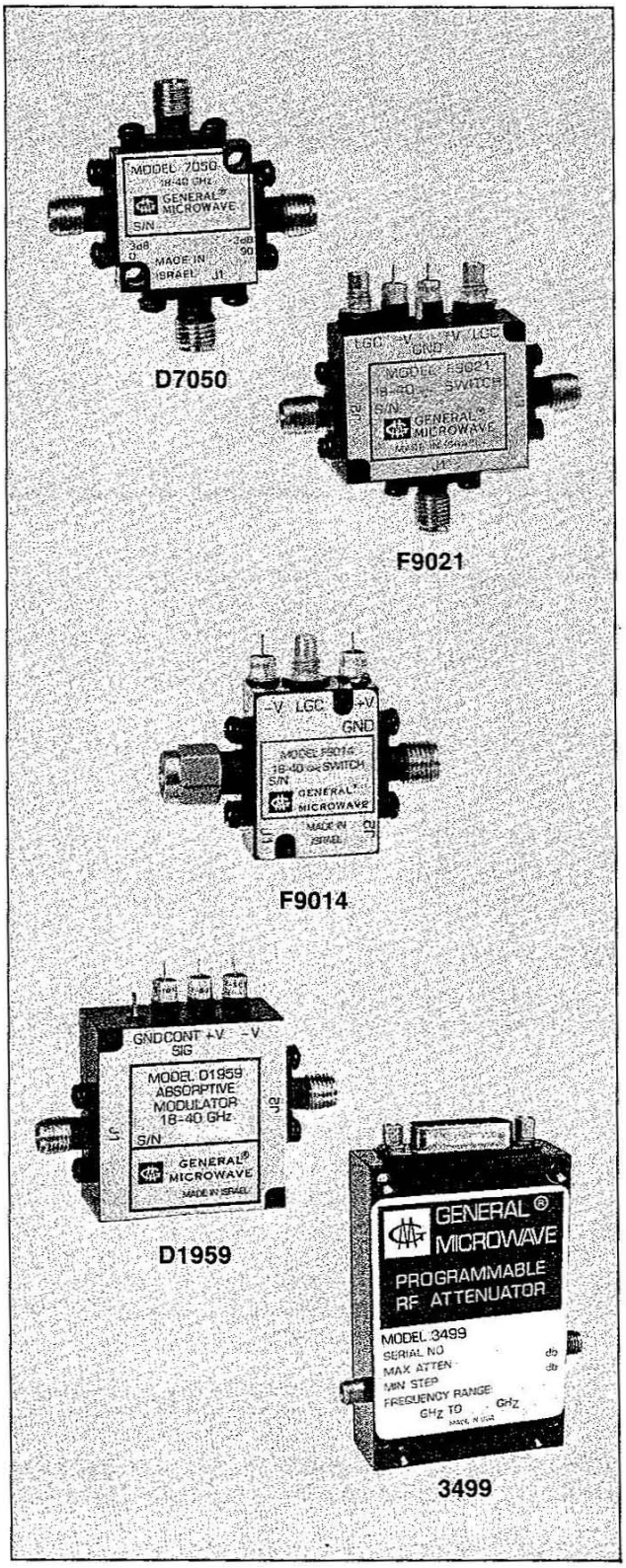
Model	Spacer Plates
H9114	17244-P1
H9120H, HT	17244-P1
H9130H, HT	17244-P3
H9140H, HT	17244-P3

Model	Model[1]
HM9114	CK-1
HM9120H, HT	CK-2
HM9130H, HT	CK-3
HM9140H, HT	CK-4

[1] Each kit includes a set of mounting spacers, one female connector for each RF port and mounting hardware.

* See chart following the power handling discussion on page 86.

Millimeter Wave Components, 18-40 GHz



SPST & SP2T F90 SERIES SWITCHES

General Microwave millimeter wave switches are available in SPST and SP2T models in a variety of topologies and configurations, e.g., with current-controlled switching, or with integrated TTL-compatible voltage drivers, and in both low insertion loss and high isolation models.

All switch models in the series operate over the frequency range from 18-40 GHz; each is capable of handling cw or peak powers up to 1W without performance degradation, and features rise and fall times of less than 10 ns.

CURRENT, DIGITAL & VOLTAGE-CONTROLLED ATTENUATORS

General Microwave wideband millimeter-wave attenuators are available in three configurations.

Model 1959 is current-controlled, while the Model D1959, which incorporates a hybrid driver, is voltage-controlled with a linearized transfer function of 10 dB per volt.

The digitally-controlled Model 3499 provides 0.03 dB resolution (11 bits) and switching speed of less than 500nsec.

Each of the three models operates over the full frequency range from 18-40 GHz with a dynamic attenuation range of 50 dB.

QUADRATURE COUPLER

The Model 7050 3-dB Quadrature Coupler is a 4-port single-section Hopfer coupler which operates over the frequency range from 18-40 GHz. It features low insertion loss, high isolation, and excellent amplitude and phase balance.

Models 1959, D1959
Millimeter Wave PIN Diode Attenuator/Modulator

MODEL 1959

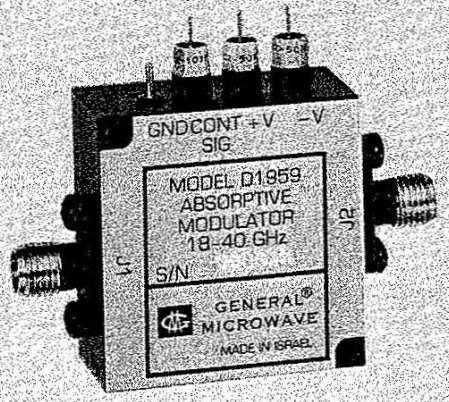
The Model 1959 is a current-controlled attenuator/modulator that provides a minimum of 50 dB of attenuation over the frequency range of 18 to 40 GHz.

As shown in figure 1 below, the rf circuit uses two shunt arrays of PIN diodes and two quadrature hybrid couplers. The quadrature hybrids are of a unique GMC microstrip design which are integrated with the diode arrays to yield a minimal package size.

MODEL D1959

The Model D1959 voltage-controlled linearized attenuator/modulator is an integrated assembly of a Model 1959 and a hybridized driver circuit which provides a nominal transfer function of 10 dB per volt. (See figure 2 below.)

- **Absorptive**
- **Current or voltage controlled**
- **18 to 40 GHz frequency range**
- **High performance MIC quadrature hybrid design**
- **High speed**



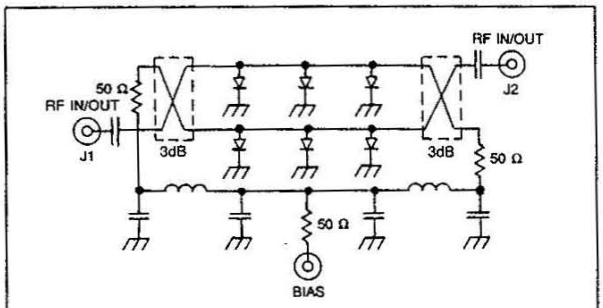


Fig. 1—Model 1959, rf schematic diagram

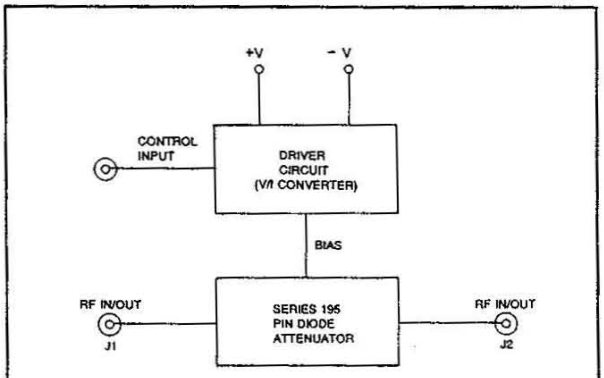


Fig. 2—Model D1959, block diagram

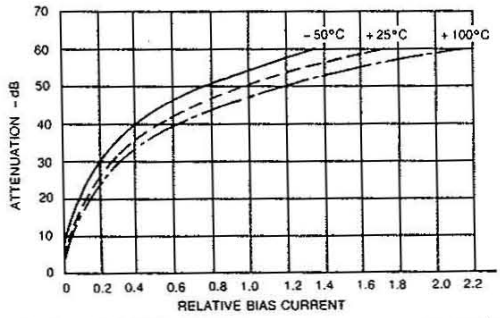


Fig. 3—Model 1959, typical effects of temperature on attenuation.

Models 1959, D1959 Specifications

PERFORMANCE CHARACTERISTICS

MODEL	FREQUENCY RANGE (GHz)	MAX INSERTION LOSS (dB)	MAX VSWR	FLATNESS (± dB) AT MEAN ATTENUATION LEVELS UP TO			
				10 dB	20 dB	40 dB	50 dB
1959	18-26.5	3.6	2.2	1.3	2.2	3.4	4.0
	26.5-36	4.1					
	36-40	4.7					
D1959	18-26.5	4.1	2.2				
	26.5-36	4.6					
	36-40	5.2					

COMMON TO BOTH MODELS 1959 and D1959

Mean Attenuation
Range . . . . . 50 dB
Monotonicity . . . . . Guaranteed
Power Handling
Capability
Without Performance
Degradation . . . . . 10 mW cw or peak
Survival Power . . . . . 0.2W average, 5W peak
(1 μsec max pulse width)

MODEL 1959

Rise and Fall Times
Rise Time . . . . . 75 nsec max
Fall Time . . . . . 20 nsec max (1)
Bias Current for Maximum
Attenuation . . . . . 15 to 70 mA
Temperature Effects . . . See figure 3

MODEL D1959

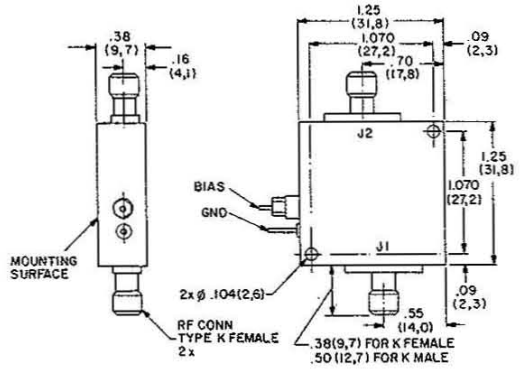
Accuracy of Attenuation
0 to 30 dB . . . . . ±0.5 dB
30 to 50 dB . . . . . ±1.0 dB
Temperature
Coefficient . . . . . ±0.025 dB/°C
Switching Characteristics
On Time . . . . . 300 nsec
Off Time . . . . . 30 nsec max(1)
Nominal Control Voltage Characteristics
Operating . . . . . 0 to +5V
Transfer Function . . . . . 10 dB/volt
Input Impedance . . . . . 10 Kohms
Modulation Bandwidth
Small Signal . . . . . 5 MHz
Large Signal . . . . . 2 MHz
Power Supply
Requirements . . . . . +12V ±5%, 100 mA
−12V ±5%, 20 mA
Power Supply
Rejection . . . . . Less than 0.1 dB/Volt change in either supply

ENVIRONMENTAL RATINGS AND AVAILABLE OPTIONS

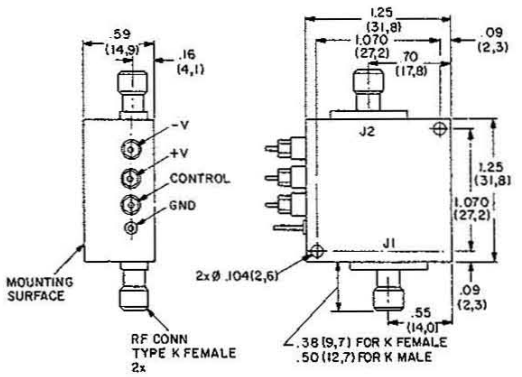
See page 154.

(1) *For attenuation steps of 10 dB or more*

DIMENSIONS AND WEIGHTS



MODEL 1959
Wt: .8 oz. (23 gm) approx.



MODEL D1959
Wt: 1 oz. (28 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ±.02; .xxx ±.005

Model 3499 Octave-Band 11 Bit Digital PIN Diode Attenuator

The Model 3499 Millimeter Wave Digitally Controlled Attenuator provides greater than octave-band performance and wide programming flexibility in a compact rugged package.

The Model 3499 is an integrated assembly of a balanced PIN diode attenuator and a driver circuit consisting of a PROM, a D/A converter and a current-to-voltage converter, as shown in Figure 1. This arrangement provides a high degree of accuracy and repeatability and also preserves the inherent monotonicity of the attenuator.

The Model 3499 offers a 50 dB attenuation range, 0.03 dB resolution and switching speed of no more than 500 nanoseconds. It is available with either a strobe/latch or a non-linear current or voltage controlled attenuation capability. Refer to the Available Options and the Notes on page 148.

- **Frequency range: 18-40 GHz**
- **50 dB attenuation range**
- **500 nsecond switching speed**
- **11 Bit binary programming**
- **Guaranteed monotonicity**
- **Absorptive**

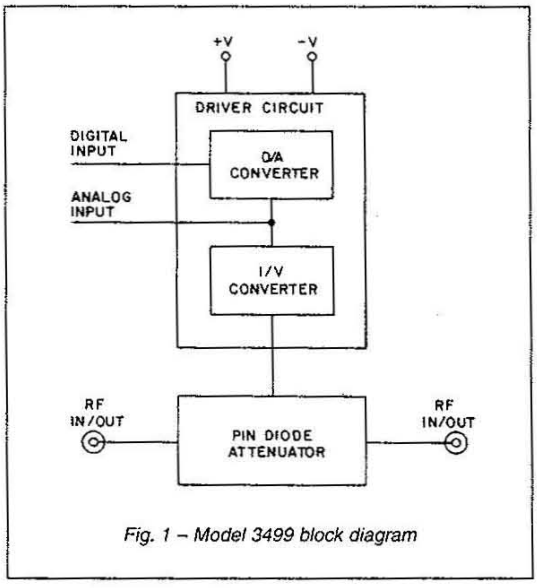


Fig. 1 – Model 3499 block diagram

Model 3499 Specifications

PERFORMANCE CHARACTERISTICS

MODEL	FREQUENCY RANGE (GHz)	MAX INSERTION LOSS (dB)	MAX VSWR	FLATNESS (± dB) AT MEAN ATTENUATION LEVELS UP TO			
				10 dB	20 dB	40 dB	50 dB
3499	18 - 26.5	4.1	2.2	1.3	2.2	3.4	4.0
	>26.5 - 36	4.6					
	>36 - 40	5.2					

Mean Attenuation Range ..... 50 dB

Accuracy of Attenuation
0 to 30 dB ..... ±0.5 dB
30 to 50 dB ..... ±1.0 dB

Monotonicity ..... Guaranteed

Temperature Coefficient ..... ±0.03 dB/°C

Power Handling Capability
Without Performance Degradation ..... 10 mW cw or peak
Survival Power (from -40°C to +25°C; see Figure 2 for higher temperatures) .. 0.2W average, 5W peak (1 µsec max pulse width)

Switching Time ..... 0.5 µsec max

Programming ..... Positive true binary. For complementary code, specify Option '2. To interface with other logic families, please contact factory.

Minimum Attenuation Step ..... 0.03 dB

Logic Input
Logic "0" (Bit Off) ..... -0.3 to +0.8V
Logic "1" (Bit On) ..... +2.0 to +5.0V
Logic Input Current ..... 1 µA max

Analog Input ..... 0 to 6.4V

Power Supply Requirements .... +12V to +15V, 120 mA
-12V to -15V, 50 mA

Power Supply Rejection ..... Less than 0.1 dB/volt change in either supply

ENVIRONMENTAL RATINGS

Operating Temperature Range .... -40°C to +85°C

Non-Operating Temperature Range ..... -54°C to +100°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

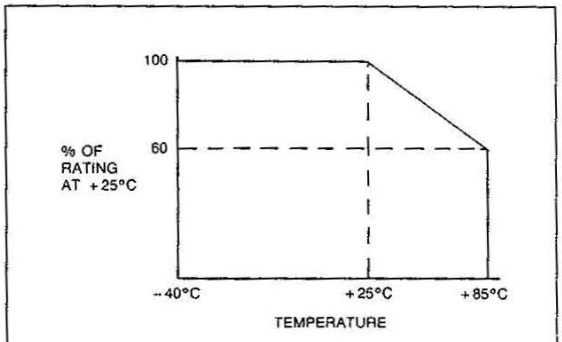
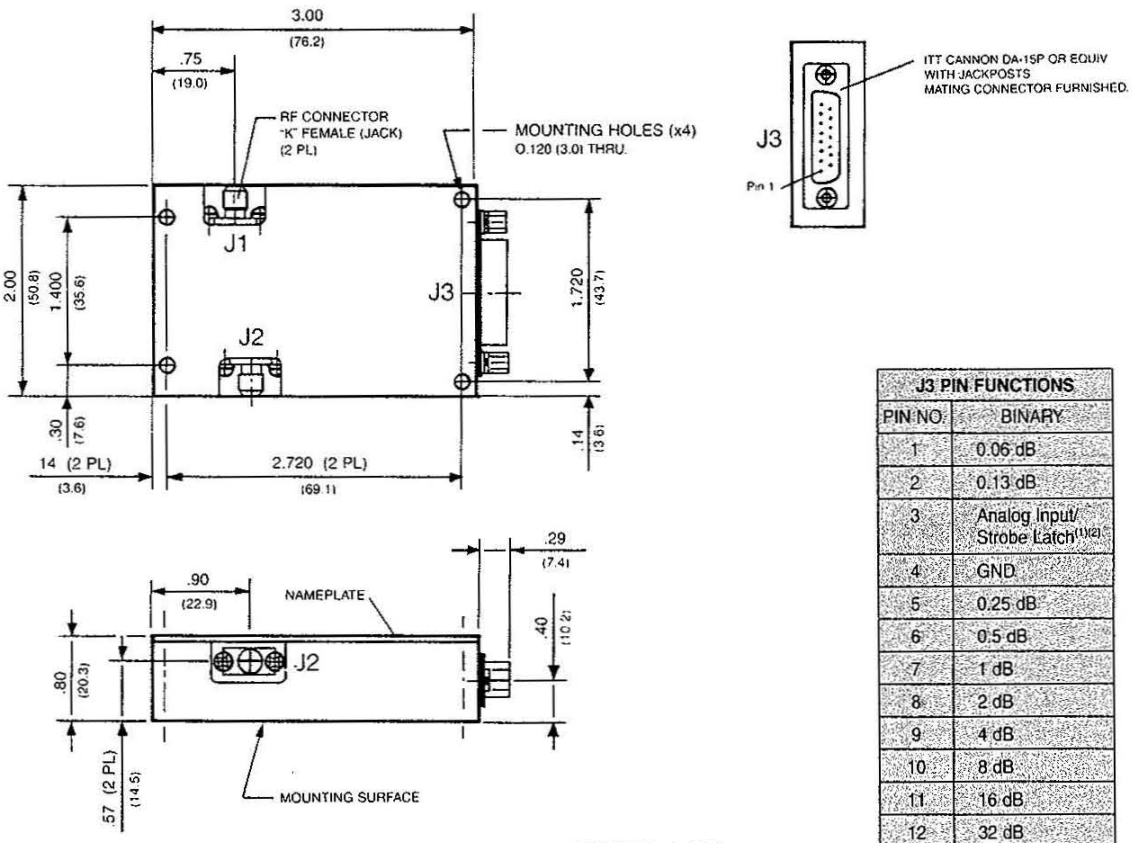


Fig. 2 – Model 3499 power derating factor

Model 3499
Specifications

DIMENSIONS AND WEIGHTS



MODEL 3499
WT: 5 oz. (142 gm) approx.

J3 PIN FUNCTIONS	
PIN NO.	BINARY
1	0.06 dB
2	0.13 dB
3	Analog Input/ Strobe Latch[1][2]
4	GND
5	0.25 dB
6	0.5 dB
7	1 dB
8	2 dB
9	4 dB
10	8 dB
11	16 dB
12	32 dB
13	+12 to +15V
14	-12 to -15V
15	0.03 dB

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

ACCESSORY FURNISHED

Mating power/logic connector

AVAILABLE OPTIONS

Option No.	Description
2	Complementary programming (logic "0" is Bit On)
4	Strobe latch for data input. Attenuator responds to data input when logic "0" is applied. Attenuator latched to data input when logic "1" is applied.
7	Two type K male rf connectors
10	One type K male (J1) and one type K female (J2) rf connector

NOTES:

1. Normally supplied as an Analog input. Optionally available as a strobe latch function for input data.
2. Pin 3 is available to apply a current or voltage to control the attenuator in a non-linear fashion. Leave pin open circuited if not using.
3. The Model 3499 attenuator is an 11-bit digital attenuator. In order to use this device with a lesser number of bits (lower resolution), the user may simply ground the logic pins for the lowest order unused bits. For example, when operated as an 8-bit unit, the Model 3499 would have Pin 15, Pin 1 and Pin 2 connected to ground. All other parameters remain unchanged.

Series 90
Millimeter Wave SPST Switches

SERIES 90

Series 90 switches provide high performance characteristics over the frequency range of 18 to 40 GHz. These miniature switches measure only .75″ x .95″ x .42″.

The series uses an integrated circuit assembly of up to four PIN diodes mounted in a microstrip transmission line. The circuit configuration is shown in Fig. 1, below.

Application of a positive current to the bias terminal switches the unit OFF since the diodes are biased to a low resistance value. With zero or negative voltage at the bias terminal, the diodes are biased to a high resistance and the unit is switched ON.

SERIES F90

The Series F90 switches are the same as the corresponding Series 90 models except the units are equipped with integrated drivers as shown in Fig. 2.

The proper current required to switch the unit ON or OFF is provided by the integral driver which is controlled by an external logic signal. Maximum rise and fall times are less than 10 nsec.

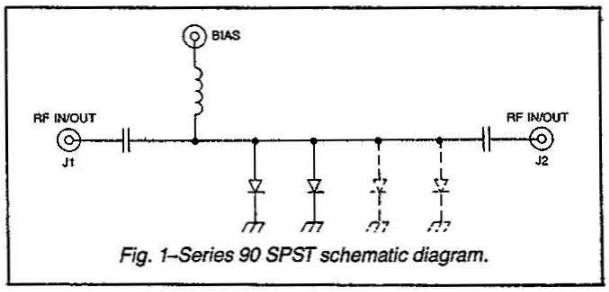


Fig. 1–Series 90 SPST schematic diagram.

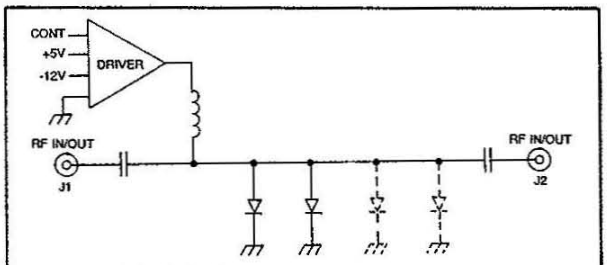
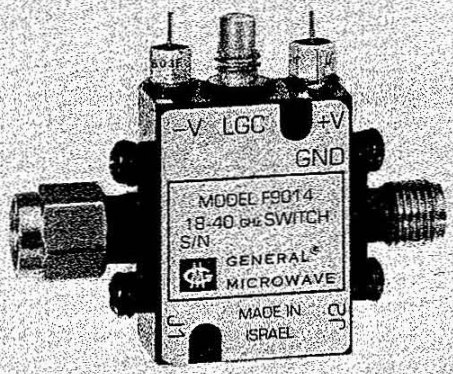


Fig. 2–Series F90 SPST schematic diagram.

- **18 to 40 GHz frequency range**
- **Low VSWR and insertion loss**
- **Up to 75 dB isolation**
- **Less than 10 nsec rise and fall times**



Series 90 SPST Switches Specifications

PERFORMANCE CHARACTERISTICS

MODEL NO.(1)	CHARACTERISTIC	FREQUENCY (GHz) 18-26.5	26.5-40
9012, F9012	Min Isolation (dB)	35	30
	Max Insertion Loss (dB)	2.2	2.7
	Max VSWR (ON)	2.0	2.2
9013, F9013	Min Isolation (dB)	55	50
	Max Insertion Loss (dB)	2.5	3.0
	Max VSWR (ON)	2.0	2.2
9014, F9014	Min Isolation (dB)	75	70
	Max Insertion Loss (dB)	2.8	3.5
	Max VSWR (ON)	2.2	2.2

Rise and Fall Times . . . . . 10 nsec max
Switching Time . . . . . 20 nsec max
Repetition Rate . . . . . 20 MHz max

Power Handling Capability
Without Performance Degradation . . . . . 1W cw or peak
Survival Power . . . . . 2W average, 75W peak (1 μsec max pulse width)

POWER SUPPLY REQUIREMENTS

Driverless Units
For rated isolation . . . . . +35 mA
For rated insertion loss . −10V

Units With Integrated Drivers . . . . . +5V ±2%, 65 mA
−12 to −15V, 20 mA

CONTROL CHARACTERISTICS

Control Input Impedance . . . . . TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 μA source current.)

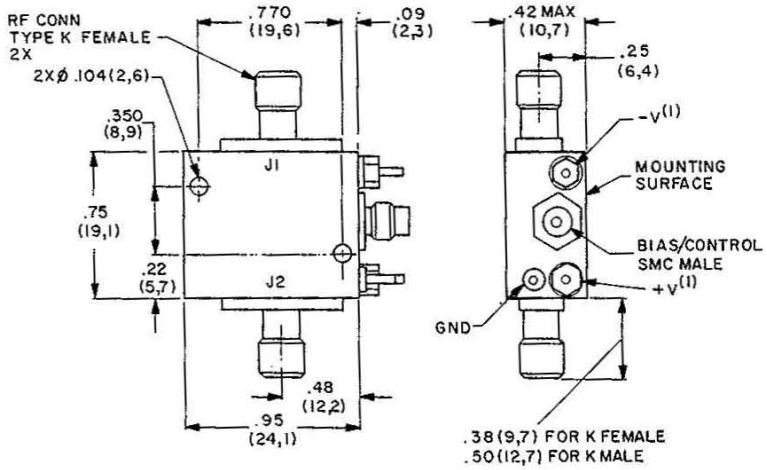
Control Logic . . . . . Logic "0" (−0.3 to +0.8 V) for switch ON and Logic "1" (+2.0 to +5.0 V) for switch OFF.

ENVIRONMENTAL RATINGS AND AVAILABLE OPTIONS

See page 154

(1)*Models prefixed with "F" are equipped with integrated TTL-compatible drivers; models without the "F" prefix are current-controlled units and are furnished without drivers.*

DIMENSIONS & WEIGHT



(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS

Series 90/F90
Wt: .6 oz. (17 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ±.02; .xxx ±.005

Series 90
Millimeter Wave SP2T Switches

REFLECTIVE SP2T SWITCHES

Series 90 SP2T switches use an integrated assembly of PIN diodes mounted in a microstrip transmission line in a series-shunt arrangement as shown in Figure 1.

When applying positive current (by the driver), the associated port is OFF since the corresponding shunt diodes are biased to a low resistance and the series diode to a high resistance. With negative current at the bias terminal converse conditions are established and the port is ON. All models are supplied with integrated drivers. Standard units are supplied with logic that turns a port ON with the application of a logic "0" control signal. Maximum rise and fall times are less than 10 nsec.

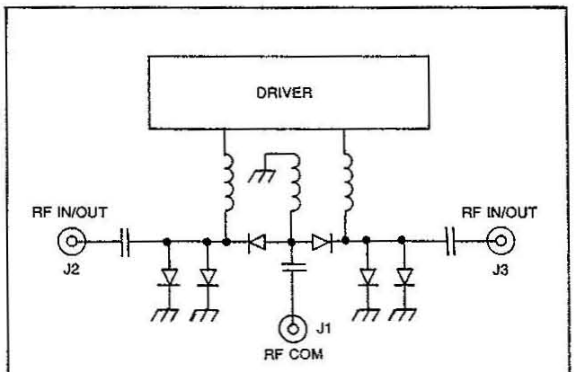
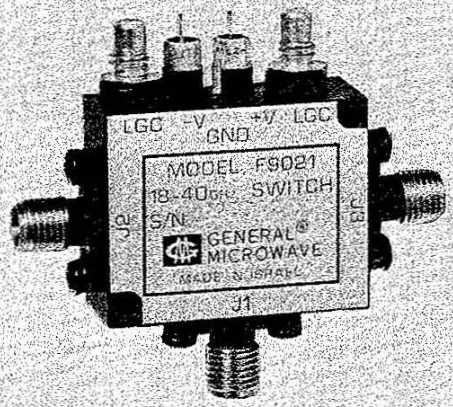


Fig. 1—Series F90 SPDT schematic diagram

- **18 to 40 GHz frequency range**
- **Rise and fall times less than 10 nsec**
- **Low VSWR and insertion loss**
- **Up to 65 dB isolation**



Series 90 SP2T Switches Specifications

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 18 - 26.5	26.5 - 40
F9021	Min Isolation (dB)	30	20
	Max Insertion Loss (dB)	3.0	3.6
	Max VSWR (ON)	2.1	2.3
F9022	Min Isolation (dB)	45	40
	Max Insertion Loss (dB)	3.2	4.0
	Max VSWR (ON)	2.2	2.3
F9023	Min Isolation (dB)	65	55
	Max Insertion Loss (dB)	3.5	4.5
	Max VSWR (ON)	2.3	2.5

Rise and Fall Times . . . . . 10 nsec max
Switching Time . . . . . 25 nsec max
Repetition Rate . . . . . 20 MHz max

Power Handling Capability
Without Performance
Degradation . . . . . 1W cw or peak
Survival Power . . . . . 1W average, 75W peak
(1 μsec max pulse width)

Power Supply Requirements . . . . . +5V ±2%, 75 mA
−12 to −15V, 50 mA

CONTROL CHARACTERISTICS

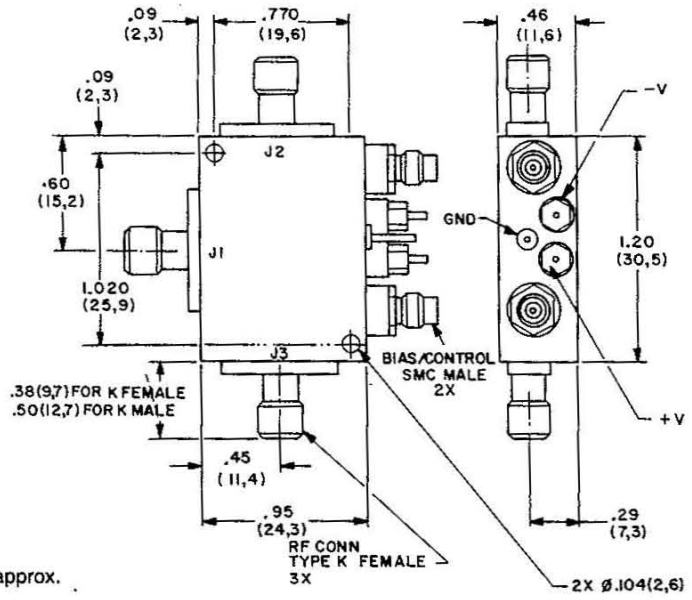
Control Input Impedance . . . . . TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 μA source current.)

Control Logic . . . . . Logic "0" (−0.3 to +0.8 V) for port ON and Logic "1" (+2.0 to +5.0 V) for port OFF.

ENVIRONMENTAL RATINGS AND AVAILABLE OPTIONS

See page 154

DIMENSIONS AND WEIGHT



SERIES F90
Wt: 1 oz. (28 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Model 7050 Millimeter Wave 3 dB Quadrature Coupler

The 3 dB Quadrature Coupler is a four port device covering the frequency range of 18 to 40 GHz. The coupler design is a single section Hopfer coupler which has been optimized to perform in the millimeter frequency range. See Fig. 1. It offers excellent amplitude and phase balance as well as low loss and high isolation. The 3 dB Quadrature Coupler utilizes removable connectors for easy integration into coaxial millimeter wave systems.

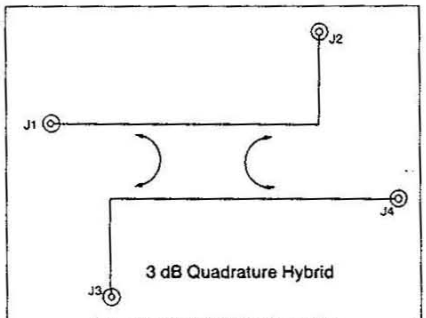
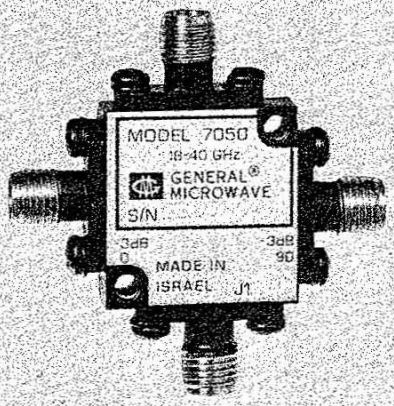


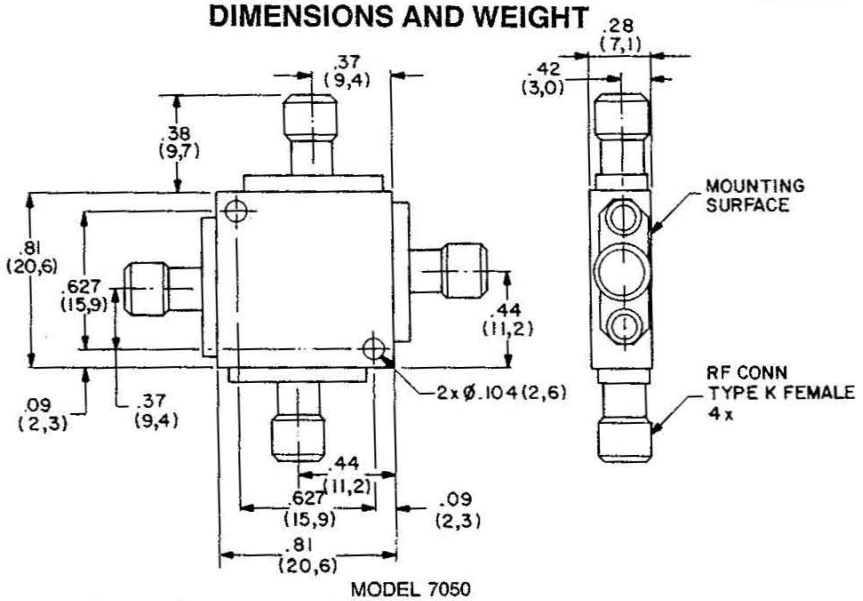
Fig. 1-Model 7050 schematic

- **Frequency range: 18-40 GHz**
- **Low insertion loss**
- **High isolation**
- **Removable connectors**



SPECIFICATIONS	
Frequency (GHz)	18-40
Min Isolation (dB)	14
Max Insertion Loss (dB)	1.5
Max VSWR	1.8
Amplitude Balance (dB)	±1.7
Phase Balance (deg)	±10
Power Handling, operating and survival, cw or peak	2W

DIMENSIONS AND WEIGHT



MODEL 7050
Wt: 1 oz (28gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ±.02; .xxx ±.005

Millimeter Wave Component Specifications

ENVIRONMENTAL AND OPTIONS

ENVIRONMENTAL RATINGS

Operating Temperature Range
- **Series 90**
  - With Drivers ..... −65°C to +110°C
  - Without Drivers .... −65°C to +125°C
- **Model 1959** ..... −54°C to +125°C
- **Model D1959** ..... −54°C to +110°C
- **Model 7050** ..... −65°C to +125°C

Non-Operating Temperature Range ..... −65°C to +125°C

Humidity ..... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06″ double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS		MODEL[2]			
Option No.	Description	1959 Current-Controlled Attenuator	D1959 Voltage-Controlled Attenuator	9012, 9013, 9014 F9012, F9013, F9014 SPST Switches	F9021, F9022, F9023 SP2T Switches
3	SMA female bias/control connectors	✓	✓	✓	✓
7	Type K male rf connectors	✓	✓	✓	✓
7A	J1 type K male; J2 and J3 type K female				✓
7B	J1 type K female; J2 and J3 type K male				✓
9	Inverse control logic; logic "0" for port OFF and logic "1" for port ON[1]			✓	✓
10	One type K male (J1) and one type K female (J2) rf connector	✓	✓	✓	
27	Single-port toggle control; logic "0" connects J1 to J2				✓
33	EMI filter solder-type bias/control terminals			✓	✓
61	20 dB/volt transfer function with 0 to +3V control signal input		✓		
62	± 15 volts operation		✓		
64	SMC male bias/control connectors	✓	✓		
64A	SMB male bias/control connectors	✓	✓	✓	✓

(1) *Not applicable for units without drivers.*
(2) *See page 147 for Model 3499 digital attenuator.*

Introduction: Microwave Oscillators

General Microwave Corporation has been a leader in the field of microwave PIN diode control components for more than 30 years. A natural extension to its product line, microwave oscillators, was launched in 1989. It began with the introduction of an extremely stable (1PPM/°C) free running Dielectric Resonator Oscillator and has subsequently expanded to high performance Voltage Controlled and Digitally Tuned Oscillators. In this relatively short time, General Microwave has once again established itself as an industry leader. Its oscillator engineering staff has been recognized as a dynamic, innovative force who is willing and quite able to take on and solve today's most demanding problems.

Modern microwave oscillators utilize a solid state device, such as a transistor or diode, together with a resonant circuit and matching network, to convert dc power to microwave power at a specified frequency. By appropriate choice of these elements, oscillators may be designed for an extremely wide range of applications. In addition, low frequency digital and analog control circuitry may be incorporated to provide further flexibility.

General Microwave offers a broad line of high-performance voltage-controlled oscillators (VCOs), digitally-tuned oscillators (DTOs), and dielectric resonator oscillators (DROs) in the microwave frequency range. The VCOs and DTOs feature fast-settling time, low post-tuning drift and low phase noise. The DROs feature excellent temperature stability and low phase noise. In addition to General Microwave's standard catalog products, a wide variety of custom oscillators have been developed for demanding airborne receiver, jamming and simulator applications.

This section of the catalog is proof of General Microwave's success. It includes expanded versions of catalog oscillator products and highlights many of the custom oscillators, both military and commercial, that have been successfully developed and manufactured. If your system requirements demand a device which cannot be found in this catalog, do not hesitate to contact General Microwave directly. A sales engineer will be happy to discuss your specific needs.

SELECTION GUIDE

FREQUENCY RANGE (GHz) 0.5 2.0 4.0 6.0 8.0 12.0 18.0	MODEL	PAGE	COMMENTS
2.0----4.0 2.6-----5.2 4.0----------8.0 8.0---12.0 12.0---18.0	V6020 V6026 V6040 V6080 V6120	157-159	Octave Band Voltage Controlled Oscillators
2.0-2.8 2.8-3.8 3.8--4.9 4.9---6.1	V6020-952C V6020-953C V6020-954C V6020-955C	160	Miniaturized Voltage Controlled Oscillators
1.0----------18.0	-------	161	Custom Military and Commercial Voltage Controlled Oscillators
2.0----4.0 2.6-----5.2 4.0----------8.0 8.0---12.0 12.0----18.0	D6020 D6026 D6040 D6080 D6120	162-163	Single Band Digitally Tuned Oscillators
0.5---2.0 2.0----------6.0 6.0----------18.0 2.0----------18.0	D6052 D6206 D6618 D6218	164-167	Multi-Band Digitally Tuned Oscillators
2.0----------18.0	-------	168	Custom Multi-Band Digitally Tuned Oscillators
5.0----------18.0	-------	169	Dielectric Resonator Oscillators
5.0--------8.0 5.0--------8.0 8.0----12.0 8.0----12.0 12.0----18.0 12.0----18.0	F5080 M5080 F5120 M5120 F5180 M5180	169-171	Fixed Tuned (F) and Mechanically Tuned (M) Dielectric Resonator Oscillators

Definition Of Parameters

Frequency Settling/Post-Tuning Drift: The maximum deviation in frequency at a given time, following a change in tuning command, relative to the frequency one second after the change in tuning command. The worst-case condition usually occurs for frequency steps from one end of the band to the other. (Results of a typical measurement are shown in Fig. 1.) Settling time usually refers to the response up to serveral hundred micoseconds, while post-tuning-drift usually refers to the variation from serveral hundred microseconds to as long as several hours.

Modulation Sensitivity Ratio: The ratio between the maximum and minimum slopes of the frequency vs. voltage tuning curve of a VCO over its frequency band. (For a DTO, this is defined at the FM modulation port.)

Frequency Deviation Bandwidth: The peak-to-peak frequency deviation obtained for a given peak-to-peak voltage swing at the modulation port of a VCO or DTO.

Modulation Bandwidth: The modulation frequency at which the frequency deviation bandwidth of a VCO or DTO decreases by 3 dB relative to the deviation bandwidth at low frequencies.

Phase Noise: The sideband noise level at a given deviation, f_m, from the oscillator frequency, relative to the carrier power level and normalized to a bandwidth of 1 Hz. Typical measured DRO phase noise versus frequency deviation is shown in Fig. 2. From 10 kHz to 100 kHz, the phase noise of a VCO or DRO has a nominal $1/f_m^3$ dependence. Thus, as shown in the figure, the phase noise at 100 kHz is approximately 30 dB lower than that at 10 kHz.

Residual FM: The peak-to-peak frequency deviation of an oscillator at its -3 dBc points, when measured on a spectrum analyzer with a resolution bandwidth of 1 kHz. (See Fig. 3.)

Temperature Stability: The total oscillator frequency variation over the rated operating temperature, usually expressed in ppm/°C.

Pulling: The maximum variation in oscillator frequency relative to its frequency when operating with a matched load, when the output load is rotated through a full 360° phase change. The peak-to-peak variation in oscillator frequency is approximately twice the pulling figure defined above.

By using the following approximate formula, the pulling figure may be scaled as a function of the VSWR:

$$\Delta f \text{ peak-to-peak} = \frac{f_o}{2\,Q_{EXT}}(S - 1/S)$$

where f_o is the oscillator frequency, Q_{EXT} is the external Q of the circuit, and S is the load VSWR.

Pushing: The incremental change in oscillator frequency that results from an incremental change in power supply voltage.

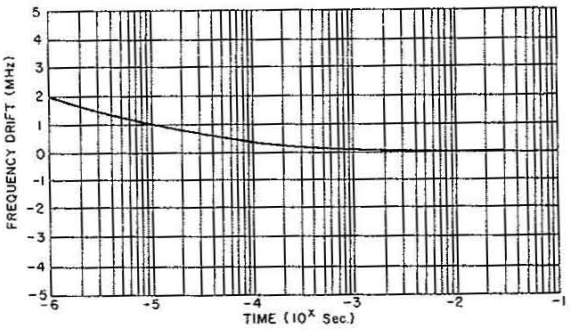


Fig. 1-Measured settling time of 8-12 GHz VCO

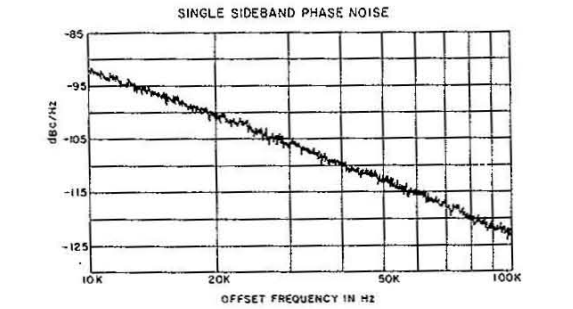


Fig. 2-Measured phase noise of 12 GHz DRO

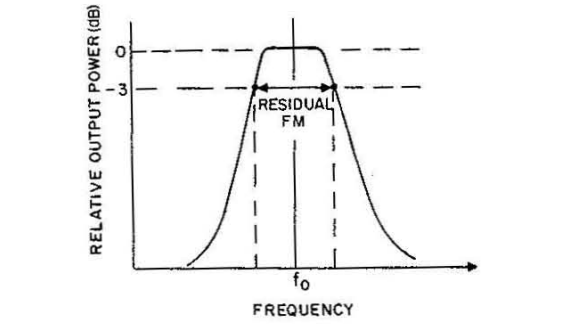


Fig. 3-Residual FM

Broadband VCOs

General Microwave's catalog line of broadband VCOs covers the 2-18 GHz frequency range in octave (2-4, 2.6-5.2 and 4-8 GHz) and half-octave (8-12 and 12-18) GHz bands. The major features of the VCOs are fast settling time, low phase noise and excellent frequency stability.

A simplified block diagram is shown in Fig. 4. For optimum performance, the active element used is a silicon bipolar transistor. (This is in lieu of GaAs FETs which typically exhibit 10-20 dB poorer phase noise performance. Although GaAs FETs have extremely low noise in amplifier applications, they suffer from high 1/f noise, which is upconverted in the non-linear oscillator to phase noise near the carrier.) To vary the frequency of the oscillator, a high-Q silicon hyperabrupt varactor is utilized. The capacitance-voltage characteristic is specified to provide as nearly linear frequency vs. voltage tuning curve as possible. In practice, good linearity can only be realized over a small portion of the tuning range because of parasitic reactances present in the physical circuit and the bipolar transistor. Typical ratios of maximum to minimum frequency vs. voltage sensitivity for an octave band are 2:1, and are specified at 3:1. GaAs varactors, although having higher Q's than silicon varactors, suffer from long-term charging effects as well as relatively poor thermal conductivity. Silicon varactors are therefore mandatory in high-speed applications requiring settling times of the order of several hundred nanoseconds and low post-tuning-drift.

To minimize pulling effects on the oscillator frequency due to variations in the external load, attenuator pads followed by buffer amplifiers are incorporated at the oscillator output. Voltage regulators are also included to minimize the effect of variations in the power supply voltage on both oscillator frequency and power level. Finally, filtering is provided to reduce the harmonic content of the output signal.

Of particular note is General Microwave's 8-12 GHz VCO, which utilizes a high performance transistor operating in the fundamental, rather than the doubling push-push mode. This mode of operation eliminates all (2n + 1) fo/2 frequencies in the output spectrum. The second harmonic signal is specified at -40 dBc maximum but is typically less than -50 dBc.

Because fundamental mode oscillation is not currently achievable with available silicon devices in the 12-18 GHz band, the doubling push-push approach, shown schematically in Fig. 5, is used. Thus, for example, for a 12 GHz output frequency, each oscillator is designed to operate at 6 GHz. If the structure were perfectly symmetrical, all odd harmonics of 6 GHz would be suppressed, and only even harmonics would be present in the output spectrum. By suitable filtering, an essentially pure 12 GHz output signal could be obtained. In practice, imperfect symmetry results in fo/2 and 3fo/2 signals, which are filtered to the extent possible. (For the case of a 12 GHz output signal, the undesired 3fo/2 signal at 18 GHz cannot be filtered since it is within the 12-18 GHz frequency range of the VCO.)

Detailed specifications are provided on Page 158.

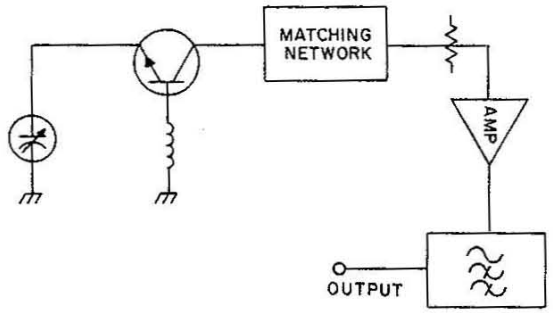


Fig. 4-Simplified VCO Block diagram

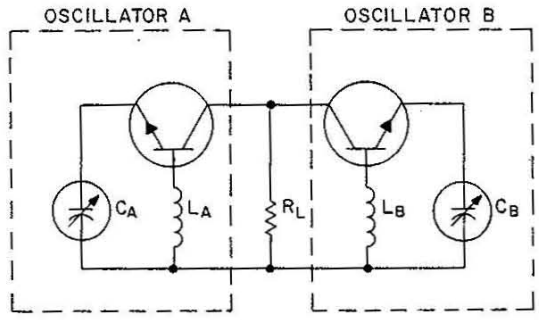


Fig. 5-Schematic diagram of Push-Push Oscillator

BROADBAND VCO SPECIFICATIONS

PARAMETER	MODEL V6020	V6026	V6040	V6080	V6120
FREQUENCY RANGE (GHz)	2-4	2.6-5.2	4-8	8-12	12-18
FREQUENCY SETTLING[1], max (MHz) within 50 nsec			±8		±10
within 200 nsec		±3		±4	±5
within 1μsec		±1		±2	±3
MODULATION Bandwidth, min (MHz)			100		
Sensitivity ratio, max			3:1		
RF POWER Output, min (dBm)			+10		
Variation, Incl. temp. and freq. max (dB)		±2.5		±3.0	
PHASE NOISE, max (dBc/Hz) @ 100 kHz offset		−95		−90	−85
HARMONICS, max (dBc)		−15		−40	−30
f/2, 3f/2, max (dBc)			N/A		−20
SPURIOUS, max (dBc)			−60		
TEMPERATURE STABILITY, typ (PPM/°C)			100		
PULLING, VSWR 2:1 max (MHz)			1		
PUSHING, max (kHz/V)			250		
CONNECTORS Power supply			Solder terminal		
Tuning voltage			SMA female		
RF output			SMA female		
POWER SUPPLY REQUIREMENT Voltage (Vdc)			+15 ± 0.5		
Current, max (mA)			150		250
Tuning voltage (Vdc)		0 to +20		0 to +15	
INPUT CAPACITANCE, nominal (pF)			30		
ENVIRONMENTAL[2] Operating temperature (°C)			−54 to +85		
Storage temperature (°C)			−54 to +125		
MECHANICAL DIMENSIONS Inches			1.79×1.10×0.45		2.19×1.10×0.45
Millimeters			45,5×27,9×11,4		55,6×27,9×11,4

(1) *Δf relative to f after 1 sec.*
(2) *Hermetically sealed.*

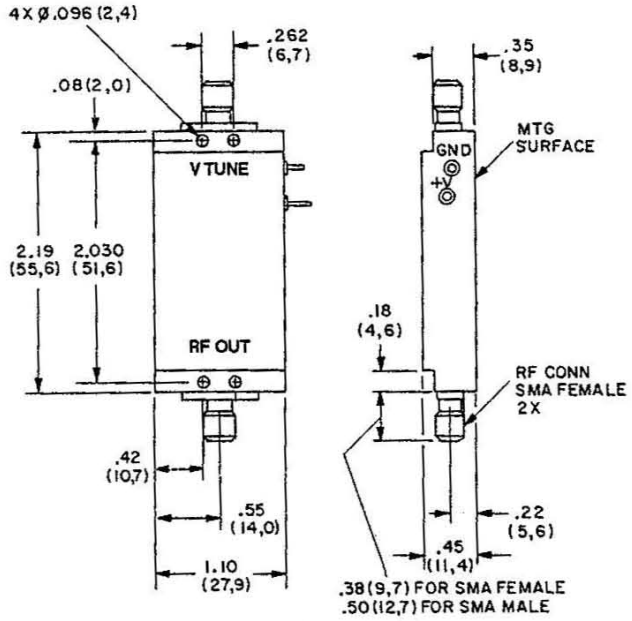
Option No.	Description
49A	High Rel screening (see Table 1 to the right)

Table 1. Option 49A High Rel Screening

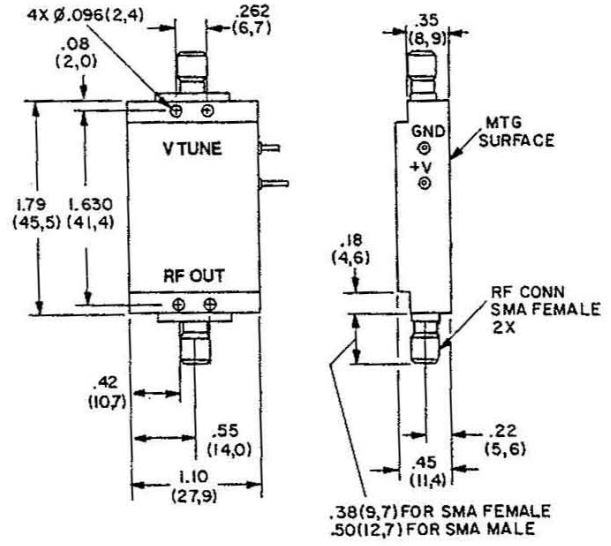
General Microwave's hermetically-sealed oscillators utilize rugged construction techniques and hermetic sealing to meet stringent military requirements for shock, vibration, temperature, altitude, humidity, and salt atmosphere. All hermetically-sealed parts may be ordered, if desired, with 100% screening in accord with the following:

TEST	METHOD	CONDITION
Internal Visual	2017.3	—
Stabilization Bake	1008.2	C
Temperature Cycle	1010.5	B
Mechanical Shock	2002.3	A
Burn-In	1015.4	—
Leak	1014.2/.9	A1 & A2

DIMENSIONS AND WEIGHTS



MODEL V6120 VCO
Wt: 1.94 oz. (55 gm) approx.

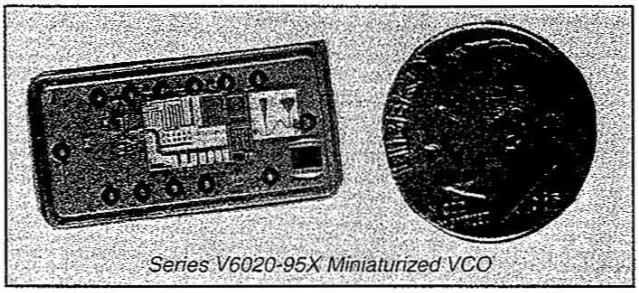


MODELS V6020, V6026, V6040 AND V6080 VCOs
Wt: 1.27 oz. (36 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

Miniaturized VCOs

General Microwave has developed a family of high-speed, miniaturized VCOs covering the 2-6 GHz frequency range. These VCOs have been utilized in airborne EW applications, as well as in ground-based simulators. The specifications are summarized below.



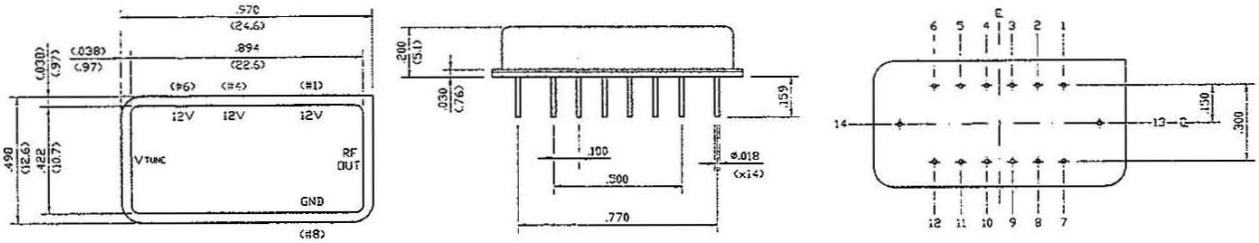
Series V6020-95X Miniaturized VCO

MINIATURIZED VCO SPECIFICATIONS

	MODEL			
PARAMETER	V6020-952C	V6020-953C	V6020-954C	V6020-955C
FREQUENCY RANGE, min (GHz)	2.0-2.8	2.8-3.8	3.8-4.9	4.9-6.1
FREQUENCY SETTLING[1], max (MHz) within 1 µsec	±1			
RF POWER Output, min (dBm)	+13			
Variation, max (dB)	±2			
PHASE NOISE, typ (dBc/Hz) @ 100 kHz offset	-105		-100	
HARMONICS, max (dBc)	-20			
SPURIOUS, max (dBc)	-60			
TEMPERATURE STABILITY, typ (MHz/°C)	-0.6		-1.0	
PULLING, VSWR 3:1, typ (MHz)	2		3	5
PUSHING, typ (MHz/V)	6		10	
POWER SUPPLY REQUIREMENT Voltage (Vdc)	+12			
Current, max (mA)	125			
Tuning (Vdc)	0 to +28			
TUNING PORT CAPACITANCE, max (pF)	50			
ENVIRONMENTAL Operating Temperature (°C)	0 to +85			
Storage Temperature (°C)	-54 to +125			
MECHANICAL DIMENSIONS Inches	0.97 x 0.50 x 0.20			
Millimeters	24,6 x 12,7 x 5,1			

(1) Δf relative to f after 1 millisec

DIMENSIONS AND WEIGHTS



All Models: 0.15 oz; (4.34 gms) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

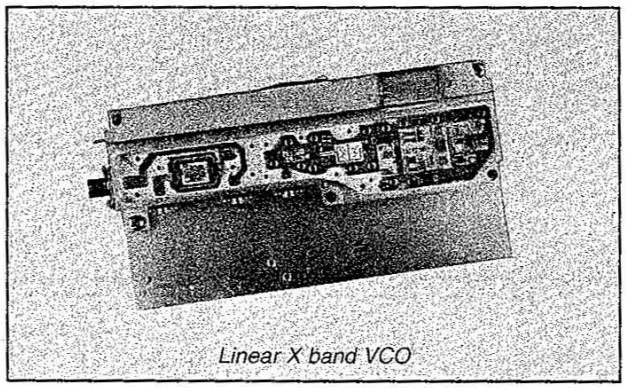
Custom VCOs

Linear VCOs

For narrowband (<5%) applications, General Microwave has developed proprietary techniques to achieve a high degree of linearity without the use of external linearizers.

Linear X band

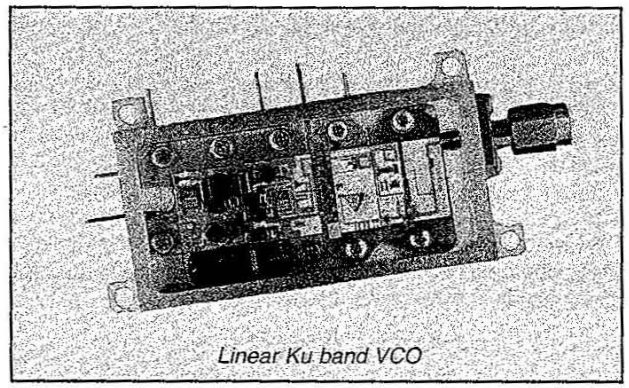
An X-band VCO assembly with linearity of less than ±1% is shown in the photo. The assembly includes two MMIC amplifiers, a medium power MIC amplifier, two filters, a phase shifter and a MMIC SP2T switch. For specific requirements, please consult the factory.



Linear X band VCO

Linear Ku band

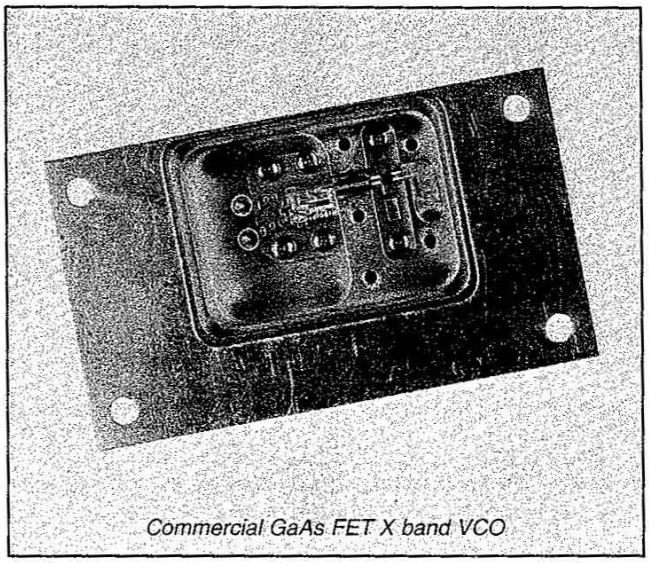
The photo shows a Ku-band VCO with a typical linearity of less than ±5% for an airborne jamming application. The unit is designed for high speed modulation and also includes RFI/EMI filtering.



Linear Ku band VCO

Commercial GaAs FET X band

For X- and Ku-band applications where very low post-tuning drift and phase noise are not required, VCOs based upon GaAs FETs provide a cost-effective solution. In the photo, a GaAs FET X-band VCO, developed for a commercial radar application, is shown.



Commercial GaAs FET X band VCO

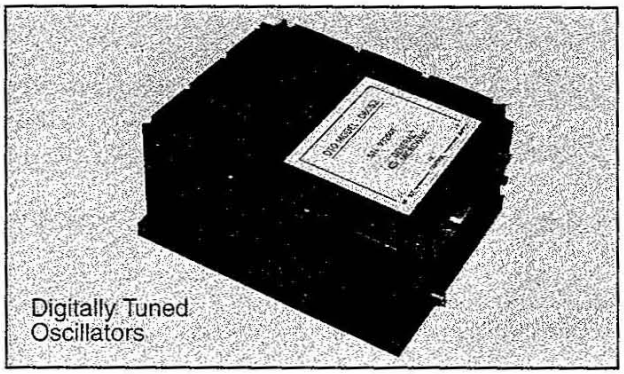
DTOs

Single-Band DTOs

General Microwave offers a line of DTOs covering the 2-18 GHz frequency range based upon its catalog line of broadband VCOs. The DTO provides the desired output frequency in response to a digital control signal. A block diagram of the DTO is shown in Fig. 6. By appropriate design of the electronic circuitry, settling times of less than 300 nanoseconds are achieved. To obtain a frequency accuracy of the order of ±1%, including the effects of temperature, a proportionally-controlled heater is required for the VCO and the electronic circuitry is temperature-compensated. A latch mode is provided as a standard feature.

To enable analog frequency modulation of the DTO for jamming and other applications, a separate frequency modulation port is provided. Since the slope of the frequency vs. voltage curve of the VCO varies over the band, compensation is required to obtain a relatively constant deviation bandwidth. Compensation to within ±5% is achieved (Option 2) by utilizing a PROM to vary the attenuation applied to the modulating signal. The DTO may be frequency modulated at rates of greater than 15 MHz.

These units are designed primarily for simulator applications, although fully militarized units are available, as well. The specifications are summarized on page 163.



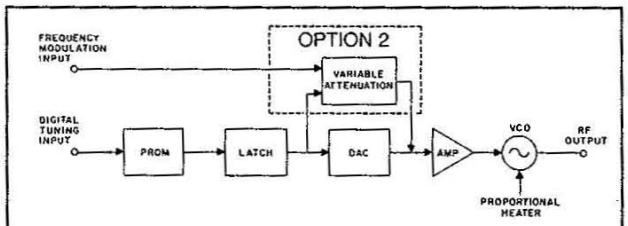
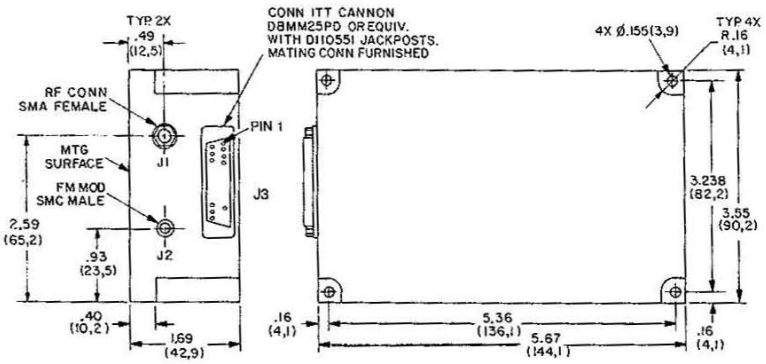


Fig. 6-Single Band DTO Block diagram

DIMENSIONS AND WEIGHT



CONTROL/POWER CONNECTOR	
Pin No.	Function
1	+28 V
2	+28 V
3	Temp. monitor thermistor (VCO)
4	Tuning word Bit 1 (LSB)
5	" " Bit 3
6	" " Bit 5
7	" " Bit 7
8	" " Bit 9
9	" " Bit 11
10	Not used
11	+5V (digital)
12	+15V (analog)
13	Analog ground

CONTROL/POWER CONNECTOR	
Pin No.	Function
14	+28 V (return)
15	+28 V (return)
16	Not used
17	Tuning word Bit 2
18	" " Bit 4
19	" " Bit 6
20	" " Bit 8
21	" " Bit 10
22	" " Bit 12 (MSB)
23	Latch[1]
24	Digital ground
25	−15V (analog)

(1) *Logic "0" to latch input word.*
Logic "1" to unlatch input word.

MODELS D6020C, D6026C, D6040C, D6080C, D6120C DTOs
Wt: 23.1 oz. (655 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

SINGLE BAND DTO SPECIFICATIONS

PARAMETER	MODEL				
	D6020C	D6026C	D6040C	D6080C	D6120C
FREQUENCY RANGE (GHz)	2-4	2.6-5.2	4-8	8-12	12-18
ACCURACY, Incl. temp. (MHz)	±2	±3	±4		±6
FREQUENCY SETTLING[1], (MHz) within 1µsec	±1		±2		±3
MODULATION[5]					
Bandwidth, min (MHz)	DC to 15				
Sensitivity variation					
Standard unit, typ	3:1				
Option 2 unit, max	1.1:1				
Frequency deviation bandwidth, min @ 2V P-P (MHz)	200	260	400		600
RF POWER					
Output, min (dBm)	+10				
Variation, incl. temp. and freq. max (dB)	±1.5		±2.0		
RESIDUAL FM, P-P @ -3 dBc, max (kHz)	50	75	100		150
HARMONICS, max (dBc)	-15			40	-30
f/2, 3f/2, max (dBc)	N/A				-20
SPURIOUS, max (dBc)	-60				
PULLING, VSWR 2:1 max (MHz)	1				
PUSHING, max (kHz/V)	250				
NOMINAL LSB[4] (MHz)	0.5	1.0			1.5
MONOTONICTY	Guaranteed				
TURN ON TIME, (minutes) to specified accuracy @ +25°C	2				
CONNECTORS					
Control/Power	25 pin, D type male[2]				
RF Output	SMA female				
FM Input	SMC male				
POWER SUPPLY REQUIREMENT					
Voltage @ Current	+15V ± 0.5V @ 300 mA max -15V ± 0.5V @ 200 mA max +5V ± 0.5V @ 100 mA max +28V -4V, +2V @ 1000 mA max				
Turn-On Current @ 28 volts	3 amps max				
ENVIRONMENTAL[3]					
Operating Temperature (°C)	0 to +70				
Storage Temperature (°C)	-20 to +100				
MECHANICAL DIMENSIONS					
Inches	5.67 x 3.55 x 1.69				
Millimeters	144,0 x 90,2 x 42,9				

(1) *Δf relative to f after 1 sec.*
(2) *Mating connector furnished*
(3) *RF section and driver components hermetically sealed.*
(4) *12 Bit TTL input*
(5) *50 Ohm input impedance.*

AVAILABLE OPTIONS

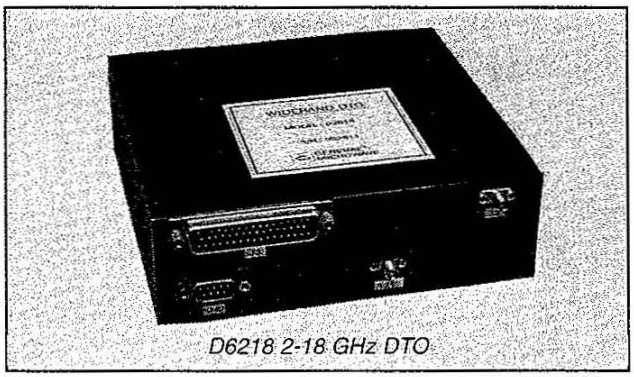
Option No.	Description
2	Reduced Modulation Sensitivity Variation

MULTI-BAND DTOs

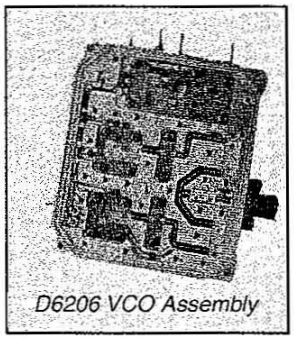
Simulator Applications

To obtain broadband frequency coverage, as well as to improve settling speed, two or more VCOs are combined, as shown in Fig. 7. A high-isolation RF switch is required to suppress all but the desired VCO. A switched lowpass filter is included in the output to reduce harmonic levels. The harmonic level for catalog units is specific at -20 dBc. However, -55 dBc suppression is available as an option.

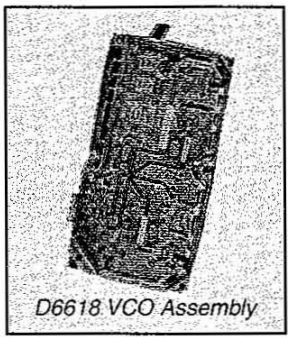
General Microwave offers multi-band DTOs covering the 0.5-2, 2-6, 6-18 and 2 -18 GHz frequency ranges. The units feature high speed, high accuracy and low phase noise. The specifications are summarized on page 165. The modular design of the DTOs enables the user to select narrower frequency coverage if desired. Please consult the factory for individual requirements.



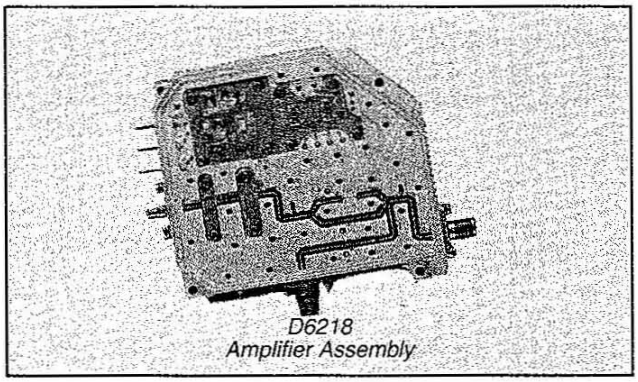
D6218 2-18 GHz DTO



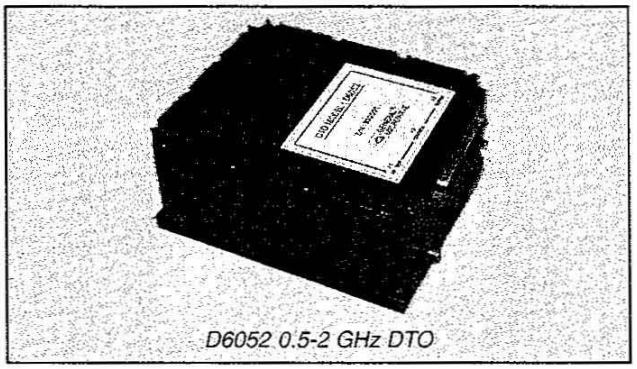
D6206 VCO Assembly



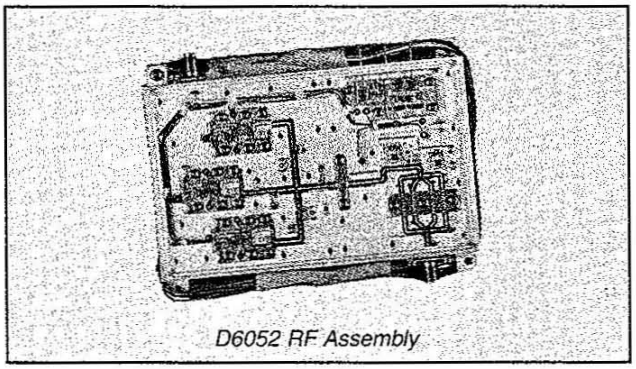
D6618 VCO Assembly



D6218 Amplifier Assembly



D6052 0.5-2 GHz DTO



D6052 RF Assembly

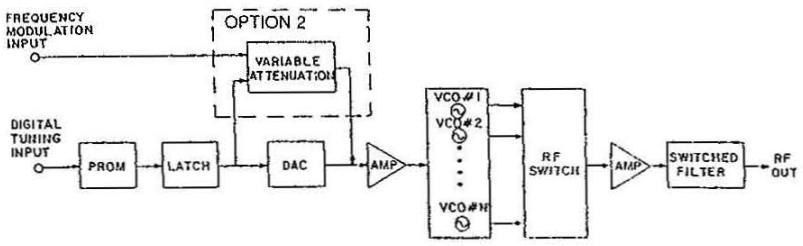


Fig. 7-Multi-Band DTO Block Diagram

MULTI-BAND DTO SPECIFICATIONS

PARAMETER	MODEL D6052	D6206	D6618	D6218
FREQUENCY RANGE (GHz)	0.5-2	2-6	6-18	2-18
ACCURACY @ +25°C, max (MHz)	±1			
FREQUENCY DRIFT, max (MHz/°C)	±0.1			
FREQUENCY SETTLING[1], max (MHz) within 1 µsec				
Standard Unit	±1.5		±2 (6-12 GHz) ±3 (12-18 GHz)	±1.5 (2-6 GHz) ±2 (6-12 GHz) ±3 (12-18 GHz)
Option 1 Unit	±1			
MODULATION[4]				
Bandwidth, min (MHz)	DC to 10			
Sensitivity Variation				
Standard Unit, typ	4:1			
Option 2 Unit, max	1.1:1			
Frequency Deviation Bandwidth, min @ 2V P-P (MHz)	100	200	500	
RF POWER				
Output, min (dBm)	+10			
Variation, incl. temp. and freq., max (dB)	±2		±2.5	
PHASE NOISE, max. (dBc/Hz) @ 100 kHz offset	-65			
RESIDUAL FM, P-P @ -3 dBc, max (kHz)	50	75	150	
HARMONICS, max (dBc)				
Standard Unit	-20			
Option 3 Unit	N/A		-55	
$f/2$, $3f/2$, max (dBc)	N/A		-55	
SPURIOUS, max (dBc)	-60			
PULLING, VSWR 2:1, max (MHz)	1			
PUSHING, max (kHz/V)	250		500	
NOMINAL LSB[3] (MHz)	0.5			
MONOTONICITY	Guaranteed			
CONNECTORS				
Power	9 Pin, D Type Male[2]			
Control	37 Pin, D Type Male[2]			
RF Output	SMA female			
Modulation Input	SMC male			
POWER SUPPLY REQUIREMENT				
Voltage @ Current	+15V ±0.5V @ 350 mA max -15V ±0.5V @ 250 mA max +5V ±0.5V @ 150 mA max +28V ±2V @ 1000 mA max		+15V ±0.5V @ 1000 mA max -15V ±0.5 @ 300 mA max +5V ±0.5V @ 500 mA max +28V ±2V @ 3000 mA max	
Turn-ON Current @ 28 volts	3 amps max		6 amps max	
ENVIRONMENTAL				
Operating Temperature (°C)	0 to +70			
Storage Temperature (°C)	-20 to +100			
MECHANICAL DIMENSIONS				
Inches	5.70 x 4.80 x 2.50		6.48 x 6.23 x 2.00	
Millimeters	144,8 x 121,9 x 63,5		164,6 x 158,2 x 50,8	

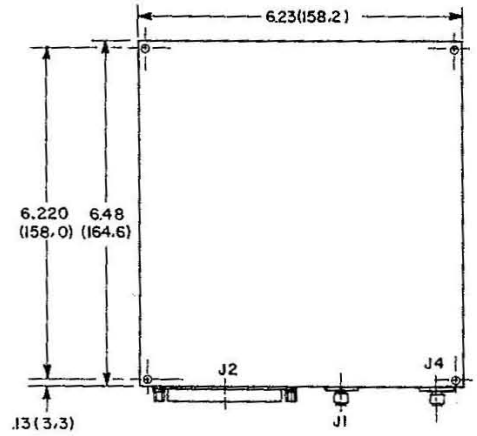
(1) Δf *relative to f after 1 sec.*
(2) *Mating connectors furnished*
(3) *16 Bit TTL input, including VCO control.*
See page 166 and 167.
(4) *50 Ohm input impedance*

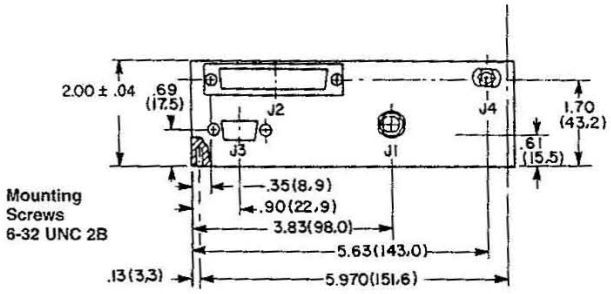
AVAILABLE OPTIONS

Option No.	Description
1	Fast Frequency Settling
2	Reduced Modulation Sensitivity Variation
3	Improved Harmonic Suppression

MULTI-BAND DTOs

DIMENSIONS AND WEIGHT





MODELS D6618 and D6218 Power Connector (J3)			
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	+5V	6	+5V (return)
2	-15V	7	+15V (return)
3	+15V	8	+28V (return)
4	+28V (return)	9	+28V
5	+28V		-----

MODELS D6618 and D6218 Control Connector (J2)	
PIN NO.	FUNCTION
1	A14 Tuning Word (MSB)
2	A12 Tuning Word
3	A10 Tuning Word
4	A8 Tuning Word
5	A6 Tuning Word
6	A4 Tuning Word
7	A2 Tuning Word
8	Vo VCO Control Bit
9	L1 Batch 1 (Strobe)
10	L3 Latch 3
11	OE Memory Output Enable
12	D1 Data Bus
13	D3 Data Bus
14	D5 Data Bus
15	D7 Data Bus
16	W2 Write 2
17	OET2 Output Enable Transceiver 2
18	G Ground
19	WE Write Enable
20	A13 Tuning Word
21	A11 Tuning Word
22	A9 Tuning Word
23	A7 Tuning Word
24	A5 Tuning Word
25	A3 Tuning Word
26	A1 Tuning Word
27	A0 Tuning Word (LSB)
28	L2 Latch 2
29	G Ground
30	DO Data Bus
31	D2 Data Bus
32	D4 Data Bus
33	D6 Data Bus
34	W1 Write 1
35	OET1 Output Enable Transceiver 1
36	OET3 Output Enable Transceiver 3
37	G Ground

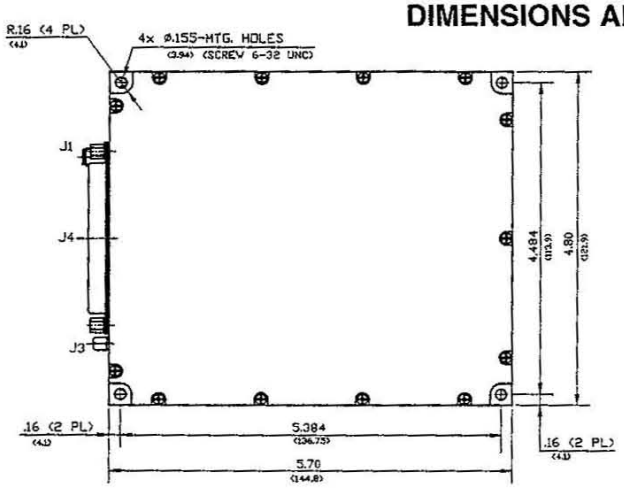
NOTES: For Normal Operation of the DTO

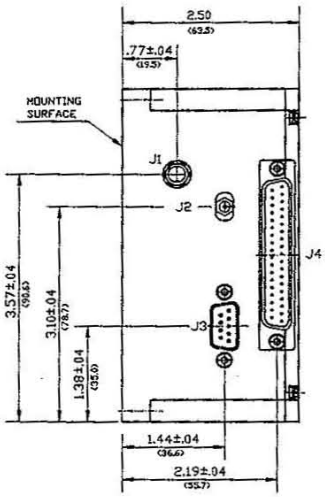
1) PIN nos. 9,10 and 28 should be connected together.
2) PIN no. 11 should be grounded.
3) PIN nos. 12, 13, 14, 15, 16, 17, 19, 30, 31, 32, 33, 34, 35 and 36 are for *FACTORY PROGRAMMING ONLY* and should not be used.

Model D6218 and D6618 Wt: 3.35 lbs (1.52 kg) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

DIMENSIONS AND WEIGHTS





MODELS D6052 and D6206 Power Connector (J3)			
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	+5V	6	+5V (return)
2	-15V	7	+15V (return)
3	+15V	8	+28V (return)
4	+28V (return)	9	+28V
5	+28V		-----

MODELS D6052 and D6206 Control Connector (J4)		
PIN NO.	FUNCTION	
1	A13	Tuning Word (MSB)
2	A11	Tuning Word
3	A9	Tuning Word
4	A7	Tuning Word
5	A5	Tuning Word
6	A3	Tuning Word
7	A1	Tuning Word
8	V1	VCO Control (MSB)
9	L1	Latch 1 (Strobe)
10	L3	Latch 3
11	OE	Memory Output Enable
12	D1	Data Bus
13	D3	Data Bus
14	D5	Data Bus
15	D7	Data Bus
16	W2	Write 2
17	OET2	Output Enable Transceiver 2
18	G	Ground
19	WE	Write Enable
20	A12	Tuning Word
21	A10	Tuning Word
22	A8	Tuning Word
23	A6	Tuning Word
24	A4	Tuning Word
25	A2	Tuning Word
26	A0	Tuning Word (LSB)
27	V0	VCO Control (LSB)
28	L2	Latch 2
29	G	Ground
30	D0	Data Bus
31	D2	Data Bus
32	D4	Data Bus
33	D6	Data Bus
34	W1	Write 1
35	OET1	Output Enable Transceiver 1
36	OET3	Output Enable Transceiver 3
37	G	Ground

NOTES: For Normal Operation of the DTO

1) PIN nos. 9,10 and 28 should be connected together.
2) PIN no. 11 should be grounded.
3) PIN nos. 12, 13, 14, 15, 16, 17, 19, 30, 31, 32, 33, 34, 35 and 36 are for *FACTORY PROGRAMMING ONLY* and should not be used.

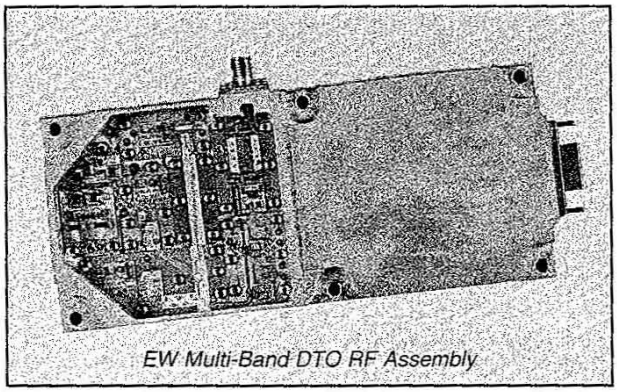
Model D6052 & D6206 Weight: 2.18lbs (990 grams) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ± .005

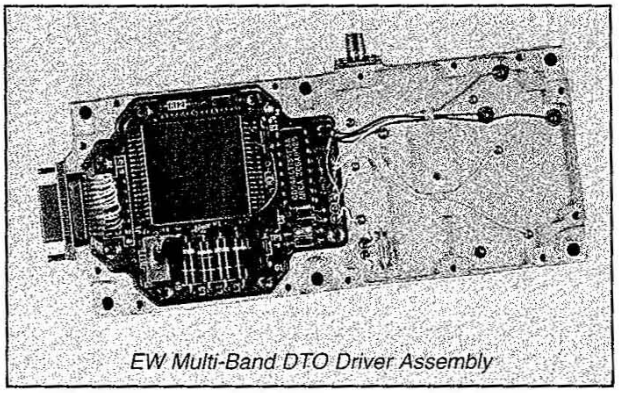
CUSTOM MULTI-BAND DTOS

EW and ESM Applications

General Microwave has developed numerous multi-band DTOs for demanding EW and ESM high-reliability applications, as shown in the photographs. The key requirements for the EW Multi-Band DTO shown are compact size, low spurious and harmonic levels, and 45g rms endurance vibration levels. The unit includes 3 VCOs, 3 MMIC amplifiers, a switched lowpass filter, a custom hybrid electronic circuit, and RFI/EMI filtering.

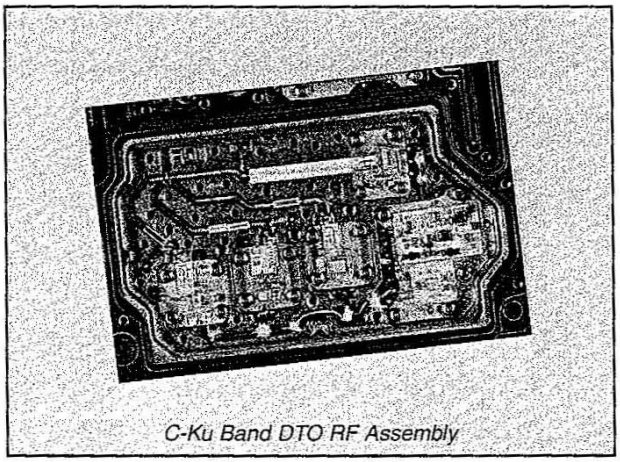


EW Multi-Band DTO RF Assembly

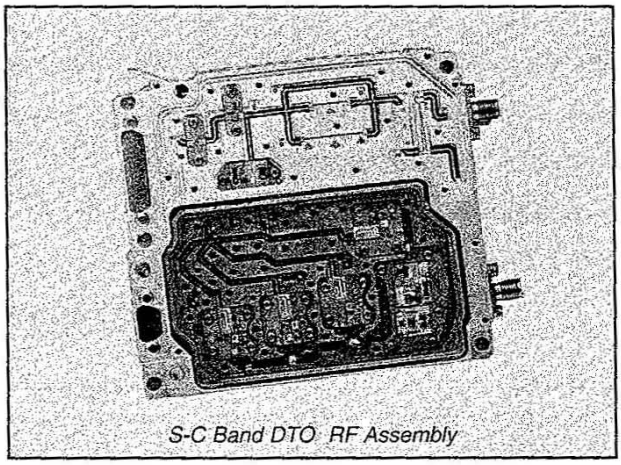


EW Multi-Band DTO Driver Assembly

The C-Ku band DTO shown includes 3 fundamental mode VCOs and 1 push-push VCO, 4 MMIC amplifiers, a SP4T switch, a switched lowpass filter, and associated electronic circuitry. The key requirements are supression of the unused VCOs and fast settling tuning. The S-C band DTO shown meets similar requirements.



C-Ku Band DTO RF Assembly

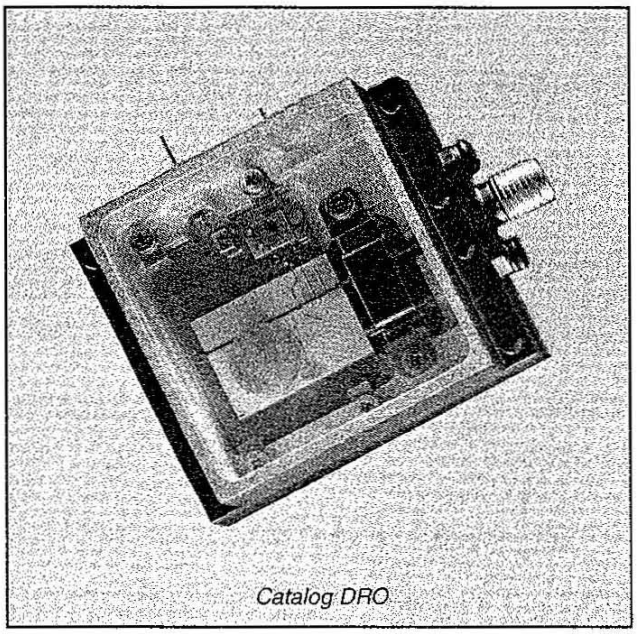


S-C Band DTO RF Assembly

Catalog DROs

Over the past decade, the DRO has become the oscillator of choice for fixed-frequency applications requiring high stability and low phase noise. General Microwave offers a high-performance line of DROs in the 5-18 GHz frequency range featuring 1ppm/°C frequency stability over a wide temperature range. A high-Q temperature-stable dielectric resonator is used as the key element in the passive resonant circuit.

The dielectric resonator is weakly coupled to maximize the loaded Q of the circuit, thereby minimizing the frequency variation over temperature, phase noise, and frequency pulling and pushing. A series feedback topology is chosen for best overall performance, as shown in Fig. 8. GaAs FETs are used as the active device in the 8-18 GHz range, and silicon bipolar transistors in the 5-8 GHz range. Buffer amplifiers and voltage regulators are included as standard features to further reduce the frequency variations due to variations in the load and supply voltages, respectively. General Microwave's "M" series of DROs includes a mechanical tuning element which permits the user to vary the frequency of the DRO over a narrow band. Complete specifications are provided on page 170.



Catalog DRO

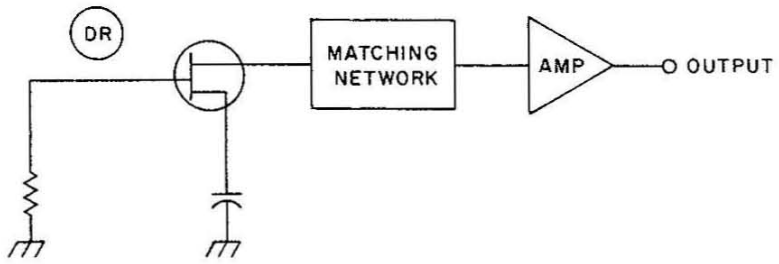
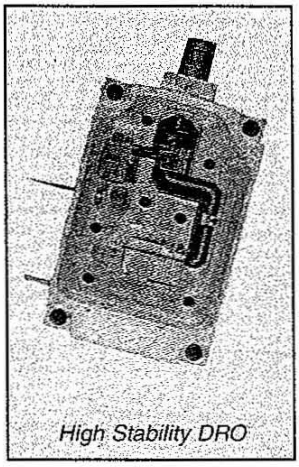


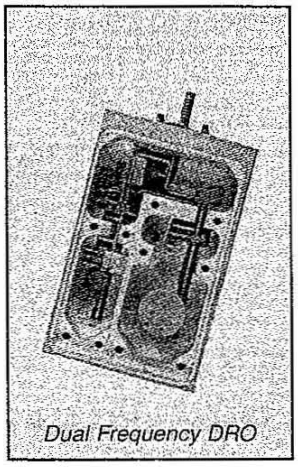
Fig. 8-Schematic diagram of DRO

Custom DROs

Based on General Microwave's catalog line, custom DROs have been developed for a variety of customers. A highly stable DRO which exhibits very little degradation in phase noise under vibration and a dual frequency DRO are shown in photos to the right. Electronically tunable DROs for X and Ku Band applications have also been developed. Please consult the factory for individual requirements.



High Stability DRO



Dual Frequency DRO

CATALOG DRO SPECIFICATIONS

PARAMETER	MODEL					
	F5080	M5080	F5120	M5120	F5180	M5180
TYPE	Fixed Tuned	Mechanically Tuned	Fixed Tuned	Mechanically Tuned	Fixed Tuned	Mechanically Tuned
FREQUENCY RANGE (GHz)	5.000-7.999		8.000-11.999		12.000-18.000	
MECHANICALLY TUNING RANGE, min (MHz)	None	±5	None	±10	None	±15
RF POWER OUTPUT, min (dBm)	+13					
Variation, incl. temp. and freq. max(dB)	±1.0	±1.5	±1.0	±1.5	±1.0	±1.5
PHASE NOISE (dBc/Hz)						
@ 10 kHz offset typ	-105		-90		-85	
@ 100 kHz offset typ	-130		-120		-115	
2nd HARMONIC, max (dBc)	-25		-25		-25	
SPURIOUS, max (dBc)	-70		-70		-70	
TEMPERATURE STABILITY, max (PPm/°C)	1	2	1	2	1	2
PULLING, VSWR 1.5:1 typ (MHz)	0.05	0.075	0.1	0.15	0.15	0.2
PUSHING, max (kHz/V)	2				4	
CONNECTORS						
Power Supply	Solder terminal					
RF Output	SMA female					
POWER SUPPLY REQUIREMENT						
Voltage (Vdc)	+15 to +18		+12 to +18			
Current, max (mA)	150		125			
ENVIRONMENTAL[1]						
Operating Temperature (°C)	-54 to +85					
Storage Temperature (°C)	-54 to +125					
MECHANICAL DIMENSIONS						
Inches	2.09x1.54x0.97	2.09x1.54x1.13	1.77x1.40x0.75	1.77x1.40x0.91	1.54x1.18x0.62	1.54x1.18x0.77
Millimeters	53,1x39,1x24,6	53,1x39,1x28,7	45,0x35,6x19,1	45,0x35,6x23,1	39,1x30,0x15,7	39,1x30,0x19,6

(1) Hermetically sealed.

HOW TO SPECIFY

a. Select mechanically tuned (M) or fixed tuned (F) DRO
b. Specify Model, i.e., F5080 is a FIXED TUNED DRO
c. Specify desired operating frequency (can be specified to a resolution of 1 MHz, i.e., 6038 MHz)

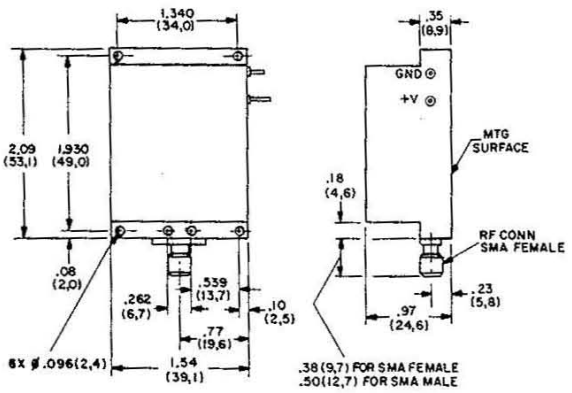
**Note that minimum order quanities may be applicable to these products. Consult factory before ordering.*

AVAILABLE OPTIONS

Option No.	Description
49A	High Rel screening (See Table 1, page 158)

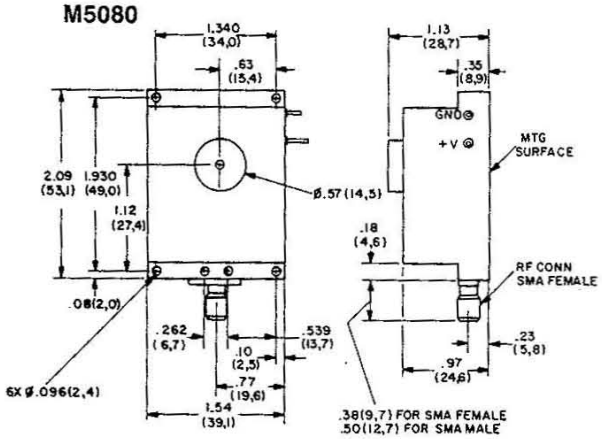
DIMENSIONS AND WEIGHTS

F5080



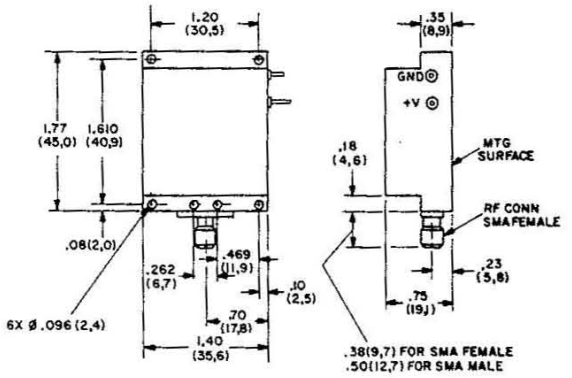
Wt: 2.75 oz. (78 gm) approx.

M5080



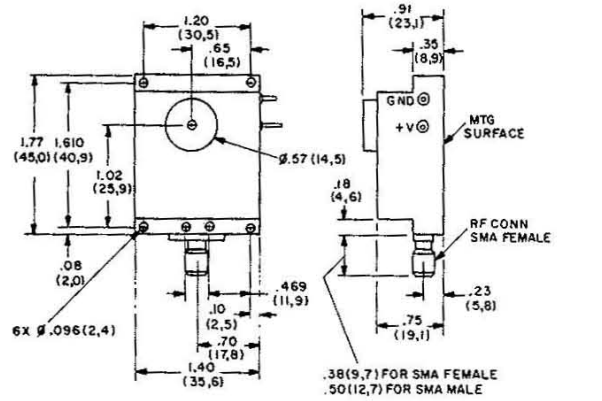
Wt: 2.93 oz. (83 gm) approx.

F5120



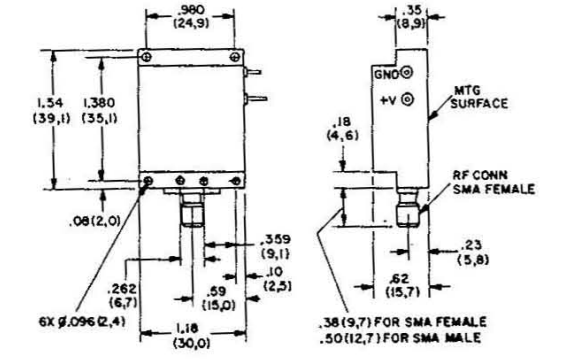
Wt: 1.94 oz. (55 gm) approx.

M5120



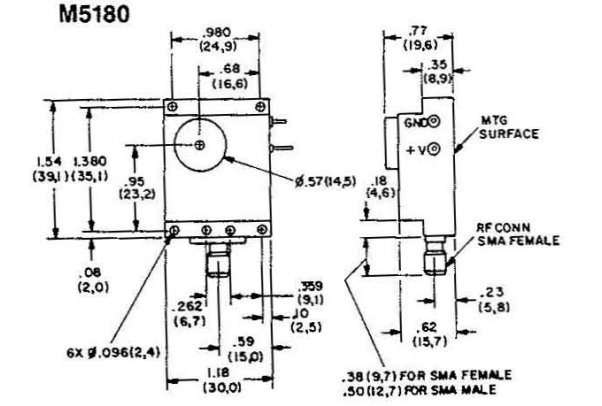
Wt. 2.12 oz. (60 gm) approx.

F5180



Wt: 1.3 oz. (37 gm) approx.

M5180



Wt: 1.48 oz. (42 gm) approx.

Dimensional Tolerances, unless otherwise indicated: .xx ± .02; .xxx ±.0005

Power Measuring Instruments

General Microwave has an extensive product line of power measuring instruments including thermoelectric average power monitors covering the frequency range of 10 MHz to 40 GHz, in both coaxial and waveguide configurations. Consult factory for other available power measuring instruments.

POWER MONITORS

Power Monitors are typically employed in fixed installations for the continuous measurement of system power. Incorporating both the rf detector and an instrumentation amplifier, they offer cost-effective flexible solutions to high accuracy and wide dynamic range power measurements in reliable efficient packages.

The power head design uses thin-film metallic loads to absorb incident rf power. By constructing the rf load as a bi-metallic element, vacuum-deposited on a thin dielectric substrate, pairs of thermoelectric junctions are created. Half of the junctions are thermally "sinked" to the transmission line conductors, while the others are located within the air space between. These latter junctions constitute almost the entire calorimetric mass, enabling high sensitivity and fast response time.

The absorption of rf power by the load creates a temperature difference between the hot and cold junctions that gives rise to a thermoelectric emf. By keeping this temperature differential small, the load acts as a true square-law (rms) device, producing a dc output voltage directly proportional to the absorbed power. This voltage is applied to the monitor amplifier which provides a user-selectable current or voltage output in three remotely selectable 10 dB ranges for a total 30 dB dynamic range.

The Models N425D, N426D, and N427D Power Monitors cover the frequency range of 0.01 to 12.4 GHz with full scale powers of 10,100 and 1 mW respectively. The Models N445B and N446B units cover the range of 0.01 to 18 GHz with full scale powers of 10 and 100 mW respectively. Power monitors in waveguide configurations covering the X, U, K and A waveguide bands are also available.

ERRORS AND WHAT TO DO ABOUT THEM

The numerous sources of errors present in the measurement of microwave power can make an accurate measurement a somewhat daunting task. The errors associated with a power measuring device include its frequency response, mismatch, linearity, square-law response and noise and drift. With respect to the former, each GMC power monitor is furnished with calibration data defining its CAL FACTOR (1) as a function of frequency. (CAL FACTOR is the normalized response of the power monitor relative to its performance at 1 GHz and includes the effects of detector inefficiency as well as the mismatch loss when operating with a matched source.) For GMC power monitors CAL FACTORS typically run about 93% at 12 GHz and 91% at 18 GHz. Errors due to linearity and square-law response for GMC power monitors are usually less than 1% for the former and negligible for the latter.

Another major contributor to the measurement uncertainty is the mismatch error. As stated above, the CAL FACTOR is a correction to be applied when measuring a matched source. If the source is mismatched, inter-reflections between the source and the power monitor produce an additional error whose magnitude is a function of the complex impedance of both the source and load. Because these data vary with frequency and are usually not available, one usually assumes the worst case condition which can be obtained from commonly available mismatch charts or tables.

The contribution of noise and drift to the measurement accuracy is obviously a function of the power level being measured. For GMC Power Monitors, noise and drift are rated from 0.02% to 0.035% and 0.025%/°C to 0.035%/°C of full scale, respectively, on the least sensitive range, increasing proportionally on the more sensitive ranges. For most practical purposes, these effects can be ignored for measurements made over the upper 10dB of the monitor's range.

POWER MONITORS

MODEL	FREQ. RANGE GHz	POWER RANGE dBm	POWER RANGE mW	ACCURACY	PAGE
N425D	0.01-12.4	-20 to +10	0.01 to 10	±1%	173
N426D	0.01-12.4	-10 to +20	0.1 to 100	±1%	
N427D	0.01-12.4	-30 to 0	0.001 to 1	±1%	
N445B	0.01-18.0	-20 to +10	0.01 to 10	±1%	
N446B	0.01-18.0	-10 to +20	0.1 to 100	±1%	

(1) *Cal factor, or calibration factor is the ratio of the substitution audio power to the total incident rf power required to produce equal dc output voltages from the tft power head.*

Models N445B, N446B, N425D, N426D, N427D Integrated Thermoelectric Power Monitors

These power monitors are compact, integrated assemblies of thermoelectric power sensors and dc amplifiers specially designed for system power monitoring at local or remote locations. Small size and light weight make them ideal for difficult systems packaging requirements, and choice of readout type and location is flexible—all this is accomplished without sacrificing high accuracy, excellent stability or economy.

Modulated, pulsed, or cw signals from 0.01 to 18 GHz are measured over a 30 dB dynamic range covered in three convenient decade steps. Power levels as low as −30 dBm (1μW) and as high as +20 dBm (100 mW) can be measured. Provisions for remote range selection and zero setting are included.

The monitor output is a dc analog signal which may be connected to readouts in either a constant current or constant voltage mode, directly scaleable in milliwatts. The constant current output is 1 milliampere full scale, and the constant voltage output is adjustable up to −10 volts full scale. For remote readout distances up to many hundreds of feet, the constant current connection provides a stable reading free from errors caused by long wire resistance values. Where the readout device is a voltmeter, or for such applications as sweep generator leveling, the constant voltage mode of operation is available.

The carefully designed amplifier section, when combined with the excellent stability of the thermoelectric power sensor, assures exceptionally low noise and drift. A wide operating temperature range of −55°C to +85°C is also featured.

The Type N rf connector conforms to MIL-C-39012, and the dc and signal output connector mates with a furnished MS3116E plug connector. Rugged construction is featured throughout.

- **Amplifier and power sensor in a single, compact package**
- **0.01 to 18 GHz frequency range**
- **30 dB dynamic power range**
- **±1% accuracy**
- **−55°C to +85°C temperature range**
- **0.02% F.S. (p-p) noise**
- **0.005% F.S./°C drift**

Models N445B, N446B: 0.01 to 18 GHz
Models N425D, N426D, N427D: 0.01 to 12.4 GHz

Models N445B, N446B, N425D, N426D, N427D Specifications

MODEL	N445B		N446B		N425D		N426D		N427D	
Frequency Range	0.01 to 18 GHz				0.01 to 12.4 GHz					
Full Scale Ranges:	dBm	mW	dBm	mW	dBm	mW	dBm	mW	dBm	mW
Range 1	+10	10	+20	100	+10	10	+20	100	0	1
Range 2	0	1	+10	10	0	1	+10	10	−10	0.1
Range 3	−10	0.1	0	1	−10	0.1	0	1	−20	0.01
Input Impedance	50 ohms									
Max. VSWR	1.35[1] to 10 GHz; 1.6 from 10 GHz to 18 GHz				1.5[2]					
Accuracy[3]	± 1% of full scale									
Operating Temperature Range	−54°C to +85°C[7]		−54°C to +85°C[8]		−54°C to +85°C[7]		−54°C to +85°C[8]		−54°C to +85°C[9]	
Zero Drift[4]	0.005% F.S./°C								0.01% F.S./°C	
Noise[4]	0.02% F.S. (p-p)								0.035% F.S. (p-p)	
Element Temperature Sensitivity	0.1%/°C									
Field-Replaceable Elements	TL-4A		TL-5		TL-0B		TL-1B		TL-2B	
CW Overload Rating[6]	300%		200%		300%					
Max. Pulse Energy at +25°C (Wμsec)	5		30		15		150		1.5	
Max. Pulse Power at +25°C (W)	1		15		3		30		0.3	
Max. Pulse Duration at +25°C (μsec)[5]	5		2		5					
Max. dc Voltage (volts)	10		30		10		30		3	
Output: Current Mode	1 mA full scale, each range									
Voltage Mode	−10 volts full scale (maximum), each range									
Power Supply Requirements	±6V to ±18V, 10mA, 1.0% regulation									
Weight	8 oz. (227 gm.)									

ENVIRONMENTAL RATINGS

Shock ..... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

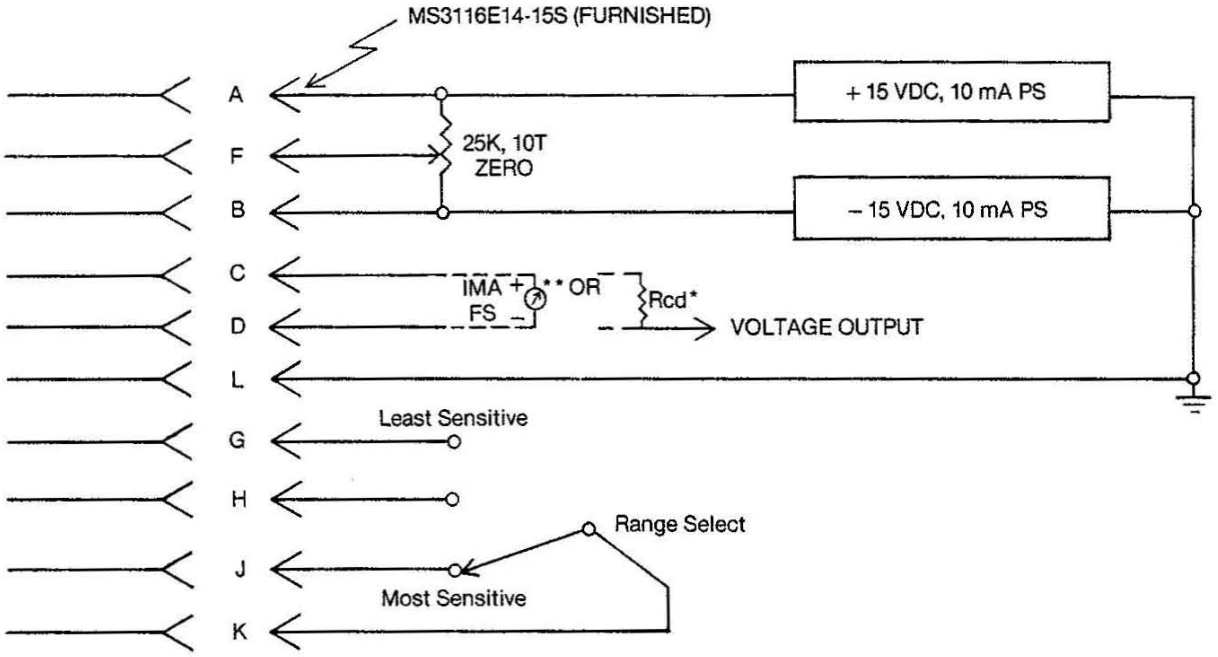
Vibration ..... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

Altitude ..... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

Temp. Cycling ..... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

(1) *Except in the range from 0.010 to 0.015 GHz, where VSWR may rise to 1.5.*
(2) *Except in the range from 0.010 to 0.015 GHz, where VSWR may rise to 1.75.*
(3) *Excluding RF calibration error.*
(4) *On least sensitive range. Proportionately more on lower power ranges.*
(5) *At maximum pulse power.*
(6) *While the units will take overloads for short periods of time, extended periods of operation at overload levels may result in permanent change in the element characteristics or even burnout. Maximum care should be exercised to avoid such an occurrence.*
(7) *Derate at 0.2 mW/°C from +60°C to +85°C.*
(8) *Derate at 1.4 mW/°C from +50°C to +85°C.*
(9) *Derate at 0.02 mW/°C from +60°C to +85°C.*

Models N445B, N446B, N425D, N426D, N427D Specifications



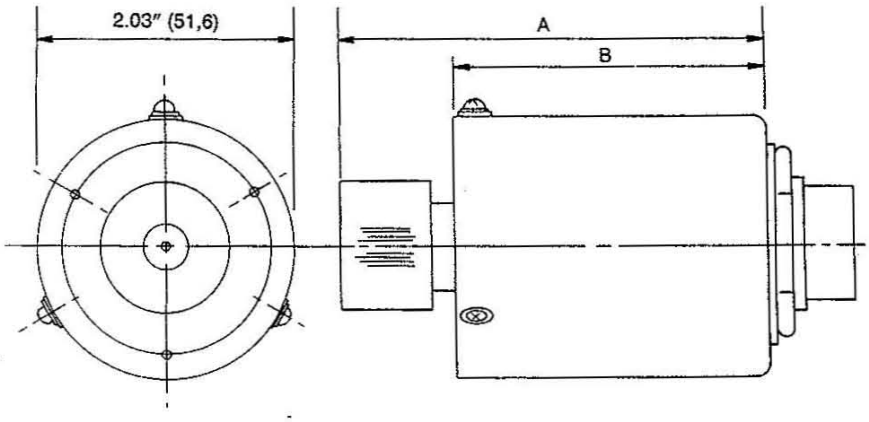
PIN	N445B, N425D	N446B, N426D	N427D
G	+10 dBm	+20 dBm	0 dBm
H	0 dBm	+10 dBm	–10 dBm
J	–10 dBm	0 dBm	–20 dBm

* When voltage output is used, connect resistor (Rcd) between pins C and D. Output between pins D and L will be –1 Volt per 1000 ohms of resistance of Rcd with a maximum value of –10V (i.e. –10,000 ohms). Simultaneous use of voltage and current modes is also possible.

** Any number of 1 mA meters may be connected in series provided total pins C-D loop resistance does not exceed 10,000 ohms.

TYPICAL SET-UP FOR OPERATION

DIMENSIONS



Unit	Dimensions	
	A	B
N445B, N446B	3.60" (91,4)	2.60" (66,0)
N425D, N426D, N427D	4.34" (110,2)	3.10" (78,7)

Dimensional Tolerances, unless otherwise indicated: .XX ± .02; .XXX ± .005

BE ON THE SAFE SIDE!

Protect yourself with the RF BADGE™ ... measure radiation from RF/Microwave sources including Cellular, Satellite and Radar.

The RF Badge offers outstanding personal protection, sounding a warning and visually indicating when non-ionizing radiation exceeds the alarm level. You can also survey your entire workplace to identify hazardous non-ionizing radiation levels with General Microwave's RAHAM® Radiation Hazard Measuring System.

NEW MAGNETIC FIELD PROBES, 10-1000 MHz

RF BADGE - PERSONAL MONITORS		
MODEL	FREQ. RANGE	ALARM LEVEL
		USER ADJUSTABLE
H600	50-2500 MHz	0.2-20 mW/cm²
60	1-40 GHz*	0.2-20 mW/cm²
		FACTORY PRESET
65-1	1-40 GHz*	1 mW/cm²
65-5	1-40 GHz*	5 mW/cm²

*1-18 GHz standard, to 40 GHz optional

RAHAM - SURVEY INSTRUMENTS		
MODEL	FREQ. RANGE	POWER RANGE
30	300 MHz-18 GHz	0.2-200 mW/cm²
40	200 kHz-40 GHz	0.002-20 mW/cm²
H500	10 MHz-1 GHz	0.02-200 mW/cm²

Send For A Free Copy Of Our Pocket Guide

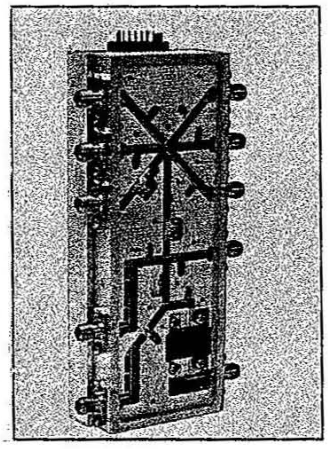
PLEASE REQUEST OUR RAHAM PRODUCTS CATALOG FOR DETAILED INFORMATION ON OUR EXTENSIVE PRODUCT LINE

About General Microwave

Since its inception in 1960, General Microwave Corporation has been dedicated to the principle of designing and producing high quality products that utilize and advance the state of the art. A heavy emphasis on internal Research and Development throughout its history has led to the creation of a broad line of catalog products that include instrumentation such as power and radiation meters and solid state components such as control devices, phase shifters and oscillators. Among the numerous innovative products it has brought to market are: the first commercially available, broadband, thin film thermoelectric power meter; the first broadband microwave radiation hazard meters; the first broadband coaxial solid state microwave attenuator; the first digital peak power meter; and the first broadband solid state vector modulators/phase shifters.

TODAY GENERAL MICROWAVE'S CORE TECHNOLOGY REVOLVES AROUND COMPLEX INTEGRATED MICROWAVE ASSEMBLIES FOR BOTH MILITARY AND COMMERCIAL APPLICATIONS. GENERAL MICROWAVE WORKS WITH YOU AND SUPPORTS YOU WITH COST EFFECTIVE SOLUTIONS THROUGHOUT THE LIFETIME OF YOUR PROJECT. GENERAL MICROWAVE HAS RECEIVED BOTH SBA AND CUSTOMER AWARDS FOR ON TIME DELIVERY, QUALITY AND PERFORMANCE.

INTEGRATED MICROWAVE ASSEMBLIES FOR EW SYSTEMS



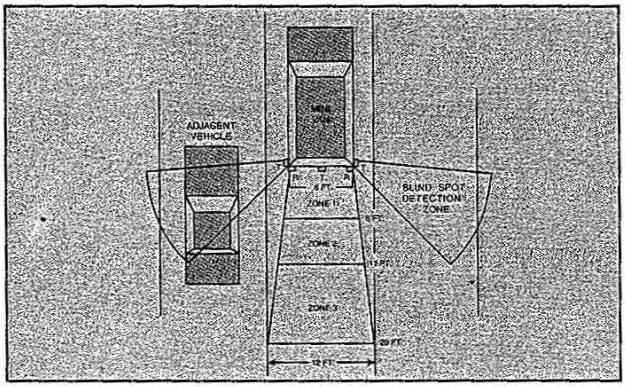
RADIATION HAZARD METERS

Commercial Applications

Although the markets General Microwave has served over most of its history have been defense related, during the past several years it has increasingly devoted a large share of its R&D and marketing efforts to commercial applications of microwave technology. One of the results of this diversification program has been the development of a high precision short range radar which has found applications in both commercial and military systems. Among the former are obstacle detection systems for automotive and other vehicular equipment and gauging equipment for the petroleum and process control industries. For the latter, a terrain mapping system is under development for a mine clearing combat vehicle and an ice thickness measuring system has been developed for the U.S. Army Cold Regions Laboratory.

Another unique equipment that has been developed in our microwave laboratories is a system capable of on-line measurement of the concentration of water in oil. Such measurements are needed both at the well-head as well as at refineries. The technique is also suitable for the measurement of fluid concentrations and mixtures in other industrial processes.

VEHICULAR OBSTACLE DETECTION AND WARNING SYSTEM (AERIAL VIEW)



Facilities

General Microwave's corporate headquarters is located on a 10 acre site in Amityville, NY. General Microwave has a fully owned subsidiary in Jerusalem, Israel, operating as General Microwave Israel Corporation and a subsidiary in Billerica, MA, operating as General Microcircuits Corporation, which manufactures thin film hybrid circuits in a MIL-STD-1772 certified facility.

Our Fourth Decade of Excellence

GENERAL MICROWAVE CORPORATION

5500 New Horizons Boulevard, Amityville, New York 11701
TEL: 516-226-8900 • FAX: 516-226-8966

Specifications subject to change without notice

Litho in U.S.A.