KRATOS | GENERAL MICROWAVE

Microwave Electronics Division

FULL LINE CATALOG

Dec. 2019

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KRATOS GENERAL MICROWAVE COMPANY PROFILE

Kratos General Microwave is one of the largest international independent microwave companies with over 30 years of proven experience in the market. Our products are used in a variety of demanding environments including airborne, ground and naval systems.

Kratos General Microwave is a recognized worldwide leader in the design and manufacture of high performance, state-of-the-art Microwave components and subassemblies for the defense as well as non-defense markets. We are supporting a wide range of requirements with catalog and custom Microwave products for applications such as:

For the Defense market: Electronic Warfare (EW) systems, Radars, Missiles, UAV, Smart Munition, GPS Immune, Communications, Data Links, HLS and Simulators

For the Commercial market: In-Flight-Connectivity, IFF, Test Equipment, RF and Fiber Optic Communications, Industry, Research Laboratories and Medical Instruments.

Microwave Product solutions supporting a wide range of applications including:

Broadband Oscillators and Synthesizers (0.5 to 18GHz and beyond)
Fast Indirect Synthesizers with less than 1 microsecond settling time with modulation, Direct Coherent Synthesizers with 40 nanosecond settling time, Digitally Tuned Oscillators (DTOs) Phase Locked Oscillator (PLOs) and Voltage Controlled Oscillators (VCOs).

Solid State Power Amplifiers (SSPAs)
Up to 1KW in X and Ku- bands for missiles, airborne Radars and HLS radars, up to 1 KW in VHF, for military and non-military applications, Pulse Power Amplifiers for IFF systems and Low Noise Amplifiers.

Integrated Microwave Assemblies (IMAs) and Sub-Systems

Beam Forming Modules
A versatile line of complex high-density modules utilizing Surface Mount Technology, for Phase Array Radars.

Transceivers and Receivers.
Superior performance and cost effectiveness. This product line includes both Narrowband and Broadband products, covering 0.5 – 18 GHz, for various applications such as Direction Finder subsystem for ELINT and ESM airborne systems, Data Links for Missiles, Smart Munition, UAVs, Centric Network Warfare, JDAM/BDI and more.

Custom IMAs
Integrated Microwave Assemblies built per specific customer's requirements such as: RF Front Ends, Frequency Converters, and DLVAs.

Control Components (0.1 – 40 GHz)

Based upon PIN diode and proprietary coupler technology. This product line includes Switches (SPST up to SP26T) for low, medium and high power, Switched Filter Banks, Attenuators, Limiters, Modulators, Phase Shifters, Frequency Translators and I/Q Vector Modulators. All these products, with either digital or analog control.

ISO 9001:2008 and AS9100 Rev. C

Kratos General Microwave has been registered to ISO 9001:2008 and AS9100 Rev. C. applicable to the design, manufacture and sales of microwave components, super components and sub systems.

RoHS Compliant™ Available

RoHS Compliance

Kratos General Microwave has a policy of continuous environmental improvement and is committed to working closely with its suppliers and customers to achieve this goal.

The RoHS Directive stands for "the restriction of the use of certain hazardous substances in electrical and electronic equipment". Most of Kratos General Microwave's components are available as RoHS compliant, meeting the requirements of the RoHS Directive when indicted RoHS compliant in our literature and on our web site. If your parts require RoHS compliancy, please indicate as RoHS compliant when you place your order.

Integrated Microwave Assemblies (IMA)

KRATOS General Microwave manufactures both Catalog and Custom Integrated Microwave Assemblies (IMA). This type of multi-function assembly is sometimes identified as a “Supercomponent” or “Microwave Integrated Circuit” with the primary objectives of significantly increasing performance while reducing the size and weight of a system. Applications can range from high environmentally stressed Airborne and Naval Systems to simply size reduction of large Ground Systems and Test Systems.

In addition to designing IMAs which incorporate Microwave Control Components and or Signal Sources, KRATOS General Microwave Engineering has the capability to also include Amplifiers, Filters, Switched Filters, Power Splitters/Couplers, Gain Equalization Circuits depending on individual Customer specification requirements.

KRATOS General Microwave Engineering carefully reviews the specification requirements of each IMA in order to choose the optimum integration technology to provide the Customer with a high performance, high reliability and cost effective solution. These integration technologies can include any one or a combination of the following:

Standard Chip & Wire Technology (MIC)

Surface Mount Technology (SMT)

Integration of Discrete Control Components

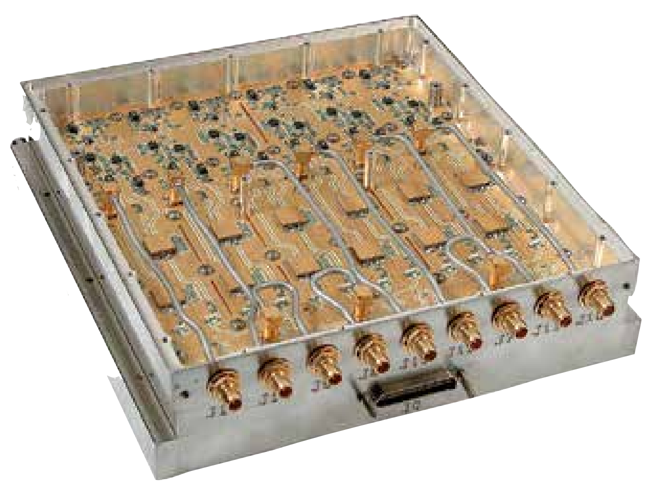
Selection of the appropriate integration technology is typically driven by various factors which can include, Frequency Range, Bandwidth, available volume and number of IMAs required for production.

KRATOS General Microwave has developed many IMAs including Phase & Amplitude Control Modules for Simulators, Beam Forming Networks for Phased Array Radars, Broadband Up & Down Converters, Transmit/Receive Modules and Solid State Power Amplifiers operating in the X to Ku Frequency Ranges. Examples of a few of those IMAs have been provided.

SMT BEAM FORMING NETWORK - FOR PHASED ARRAY RADARS

FEATURES

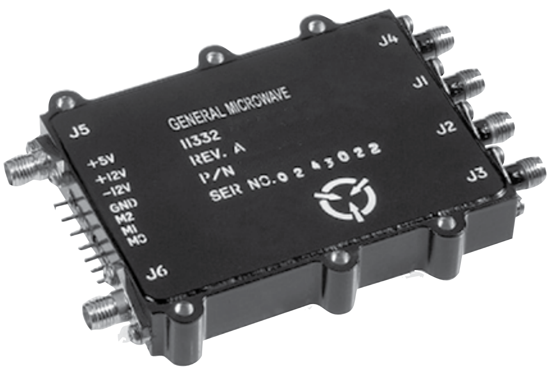
- L and IFF Frequency Bands
- SMT Technology
- Control of Amplitude and Phase



RF FRONT ENDS

FEATURES

- Broadband
- Low Noise Figure
- Wide Dynamic Range



FEATURES

- Wide Frequency Range
- Airborne Application

FEATURES

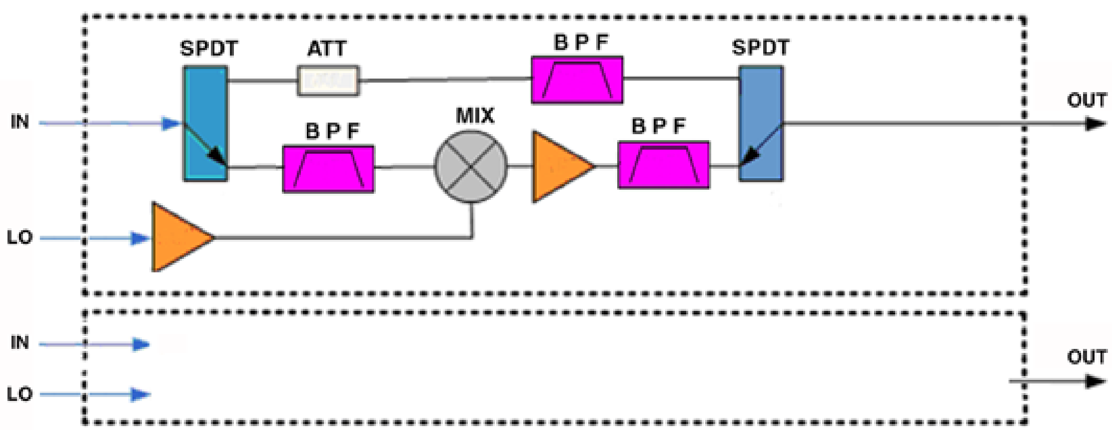
- L to S bands
- Multi Channel
- Airborne Application
- Blind Mating

FREQUENCY CONVERTERS ASSEMBLIES

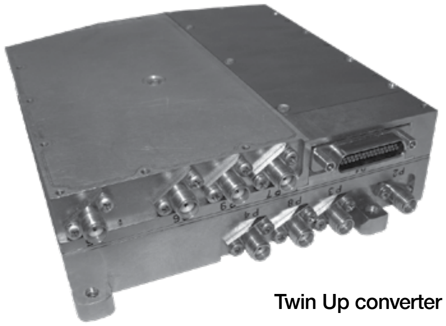
FEATURES

- Frequency Range: 6 to 18 GHz
- High Out of Band Rejection
- High Isolation

Twin Down converter



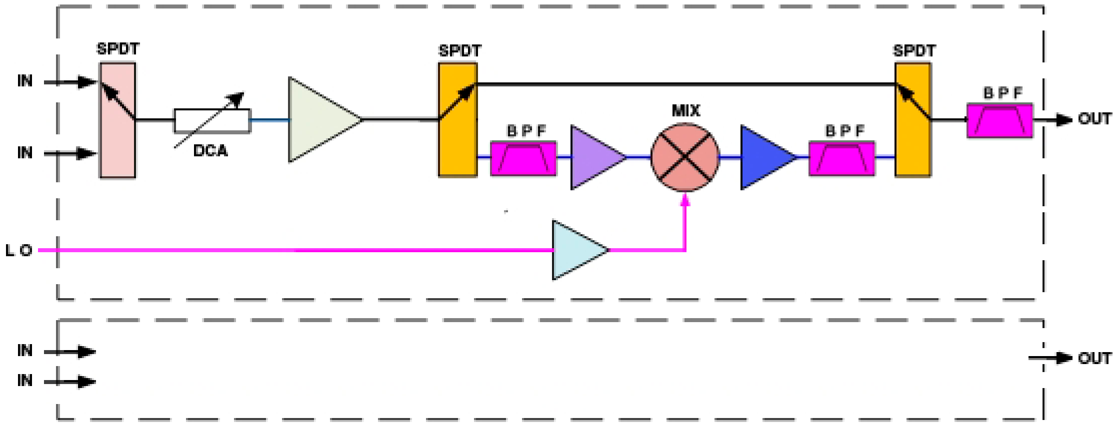
FREQUENCY CONVERTERS ASSEMBLIES



Twin Up converter

FEATURES

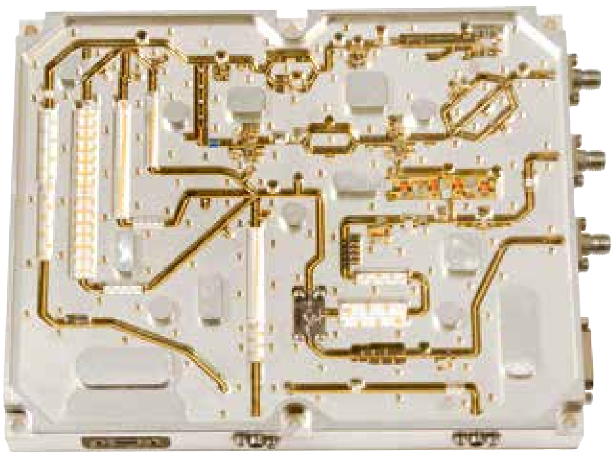
- Frequency Range: 2 to 18 GHz
- High Out of Band Rejection
- High Isolation



FREQUENCY CONVERTERS ASSEMBLIES

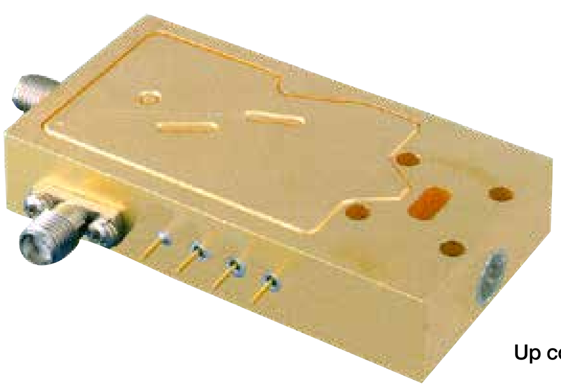
FEATURES

- Frequency Range: 0.5 to 18 GHz
- High image Rejection
- High Performance
- Airborne Applications

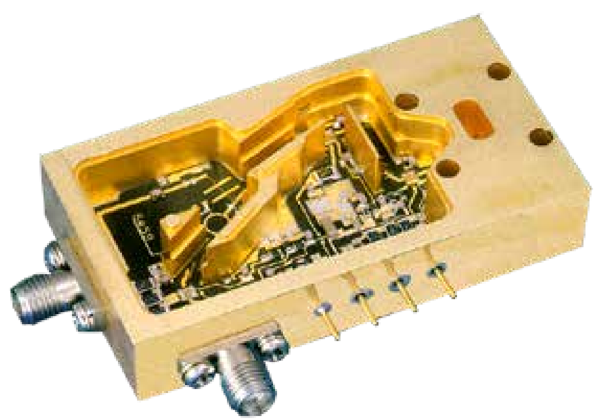


Down converter

Up converter



Up converter



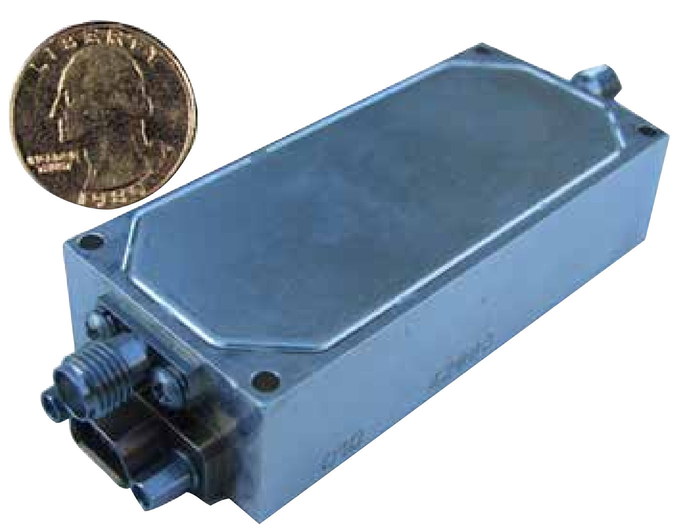
FEATURES

- L Band to Ku Band
- Output Power P1dB: 28dBm
- SMA to WG Connectors

TRANSMIT/RECEIVE MODULES

FEATURES

- Frequency Range: X Band
- Power Output: 10W



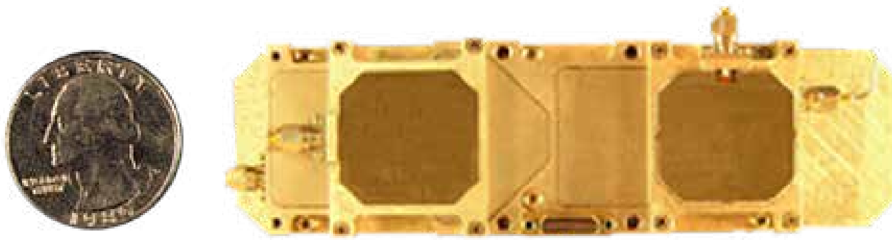
FEATURES

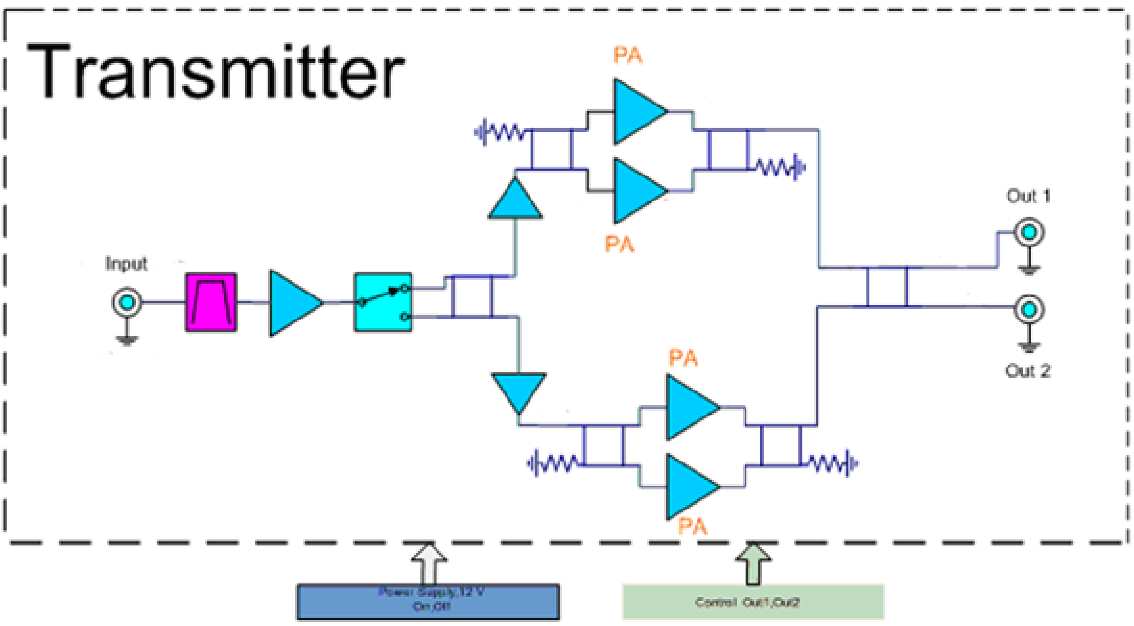
- Frequency Range: 6 to 18 GHz
- Power Output: 2 to 4W
- Noise Figure: < 6.5 dB
- Attenuation Control Range: 15 dB
- Phase Control Range: 180^{o}
- Small Size

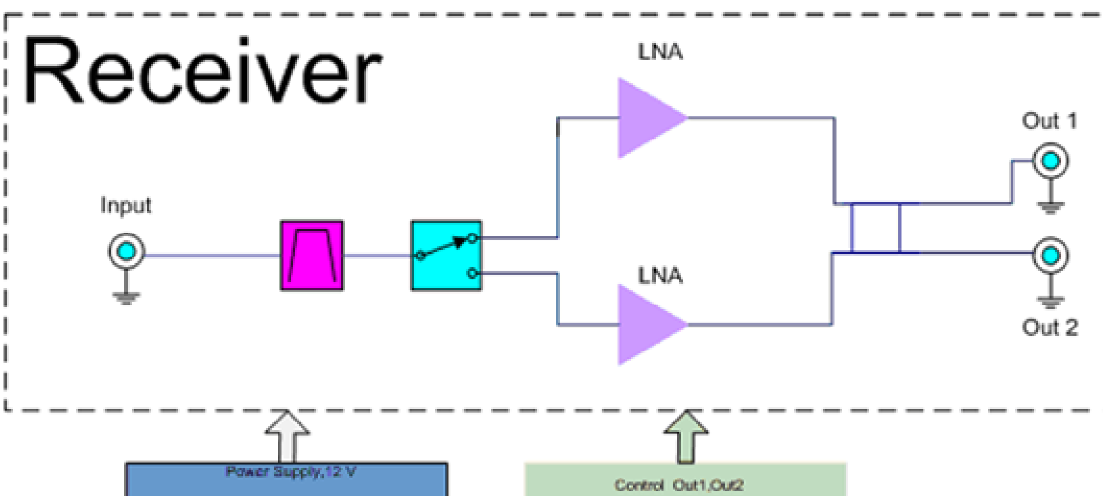
TRANSMIT/RECEIVE MODULES

FEATURES

- Frequency Range: Ku Band
- Power Output: 8W
- Noise Figure: <4 dB
- Small Size





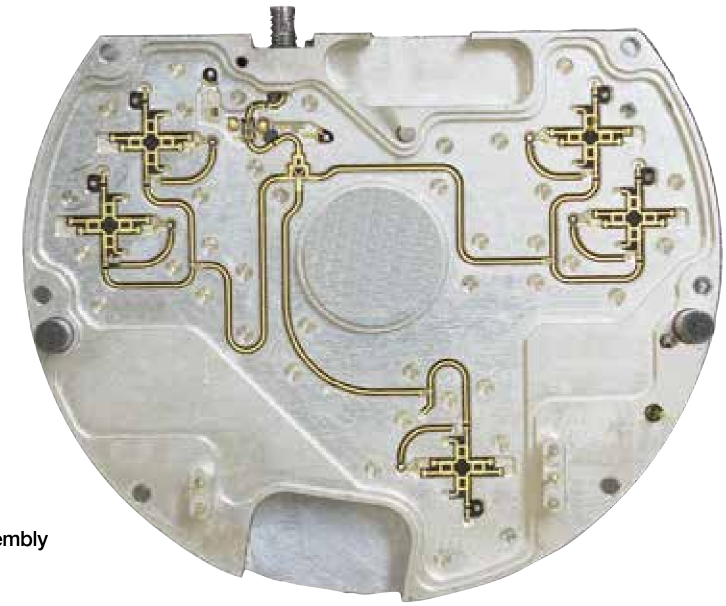


MILLIMETER WAVE TRANSMIT/RECEIVE MODULES

Millimeter Wave Transmitter Sub Assembly

FEATURES

- Operating within Ka Frequency Band
- High Efficiency transmitter
- Five channel receiver



Millimeter Wave Receiver Sub Assembly

TRANSCEIVER FOR DATA-LINKS and SMART MUNITION

KRATOS General Microwave designs and manufactures a variety of customized DATA-LINKS sub-systems, from small, simple, low cost, low power to complex, high-end, high power. Those Data Links are used in various platform and applications such as UAV, mini-UAV, Missiles, Smart/Precision Guided Munition, Network Centric Warfare (NCW) etc. The products combine State Of The Art Microwave technology, mixed signal processing, System On Chip (SoC) devices, high power FPGAs and other Digital technologies.

Kratos General Microwave is offering Data-Links products in two options, based on the customer's preference::

- Hardware only – allowing the customer to incorporate their own IP Firmware / Modem etc.
- Full Data link, including Microwave, Hardware and Firmware.

KRATOS General Microwave has successfully delivered hundreds of Data Links systems to its customers and continues to develop new generations of DATA LINKS with superior capabilities and additional features.

L BAND DATA LINKS

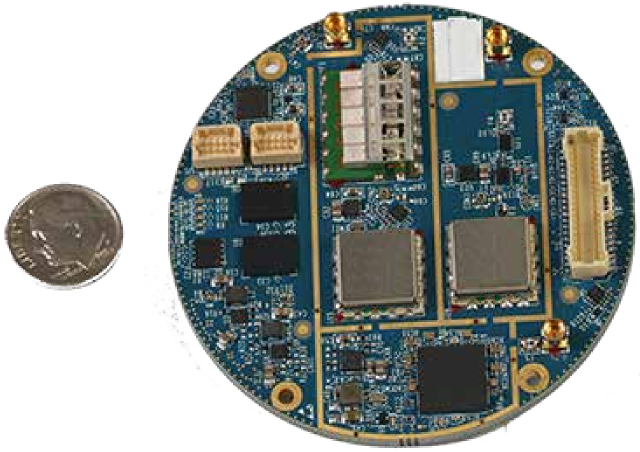
MAIN FEATURES

- TX Power >100W
- Pulse / Half Duplex Mode
- High Altitude >200Kfeet
- High Capacity
- Ground Stations
- High End

COMPACT DATA LINK

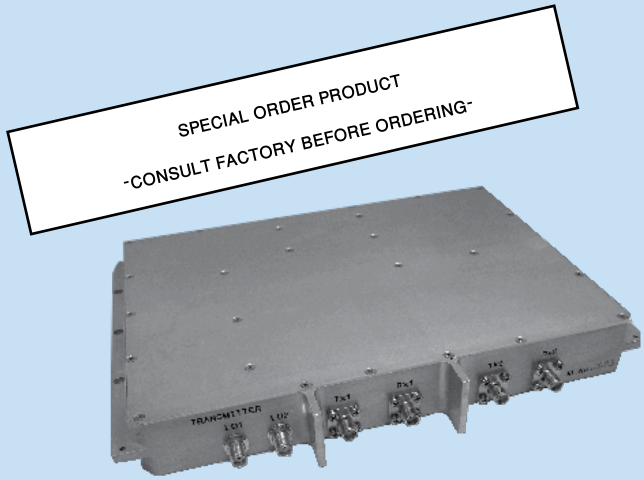
MAIN FEATURES

- TX Power 50W
- Dual Channel Transceiver
- Low Profile
- Smart Ammunition Applications
- SDR
- High Capacity
- Variety of Frequencies
- Low Cost



Model PA4095
IFF Transmitter

- Military & Civilian Modes of Operation
- High Power Output: 600 Watt
- Proven Reliability: LD-MOS Based Design
- High MTBF

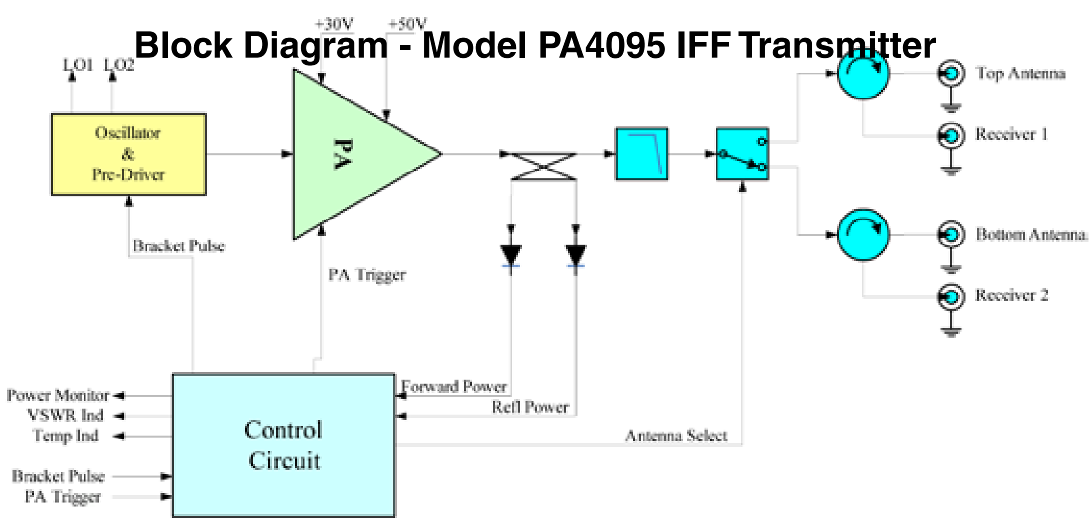


APPLICATIONS

The Model PA4095 was designed to be the transmitter module in an IFF system. It is a state-of-the-art configuration which incorporates all of the RF and Control elements listed below:

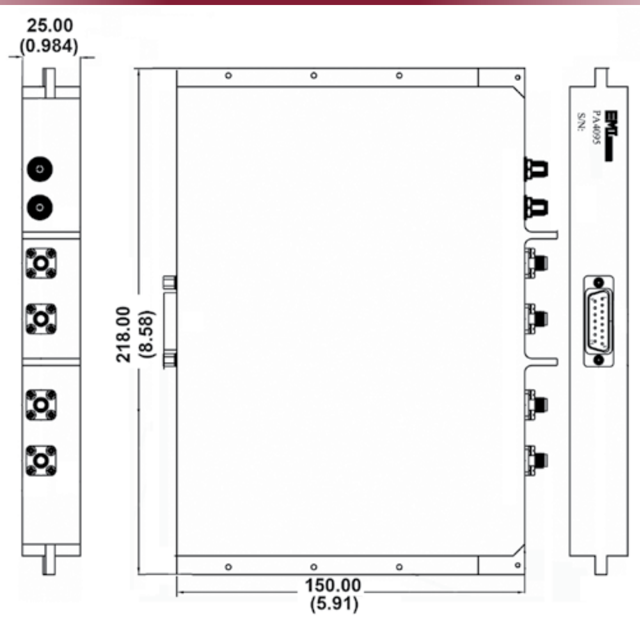
- RF Source at 1090 MHz
- Driver and Modulator
- Power Amplifier
- High Power PIN Switch
- Control and Monitoring

Block Diagram - Model PA4095 IFF Transmitter



	PARAMETERS	SPECIFICATION
1	OUTPUT FREQUENCY, MHz	1,090
2	PEAK POWER OUTPUT, Watts, min.	600
3	OUTPUT PORTS	2 (selectable)
4	SWITCHING TIME, msec, max. (between output ports)	50
5	OUTPUT POWER DIFFERENCE, dB, max. (between first & last pulse)	± 1
6	REPLAY PULSES	60 for 8 Sec. Preamble & 55 Sec. Data Block
		116 for 8 Sec. Preamble & 112 Sec. Data Block
7	DUTY CYCLE, %, max.	2
8	TEMPERATURE RANGE, Degrees C	
	Operating	-40 to +85
	Storage	-55 to +95
9	EMI/EMC	As per MIL-STD-161E
10	ALTITUDE	As per mMIL-E-5000T: 70,000 feet
11	DIMENSIONS	218 x 150 x 25 mm , 8.58 x 5.90 x 0.98”
12	WEIGHT	1,400 grams, 49.38 ounces

Dimensions and Outline



Weight (approx.) 1.4Kg. (49.38 Oz) **Dimensions in mm (Inches)**

Super Heterodyne Wideband Receiver Model WBR-0518-MOD

- Wide Frequency Range: 0.5 to 18 GHz
- Three simultaneous IF outputs
- AM and FM detectors
- Low Phase Noise
- Modes of Operation: Scan Mode or Search Mode
- Built-in test functions
- Low Power Consumption
- Low cost

SPECIAL ORDER PRODUCT

-CONSULT FACTORY BEFORE ORDERING-

Receiver Model WBR-0518-MOD

APPLICATION

The Model WBR-0518-MOD Wideband Receiver utilizes cutting edge technology which provides a high performance and cost effective solution. It has been designed for use as a stand alone receiver or it can be used in more complex receiving systems for ELINT and ESM applications.

Receiver Model WBR-0518-MOD

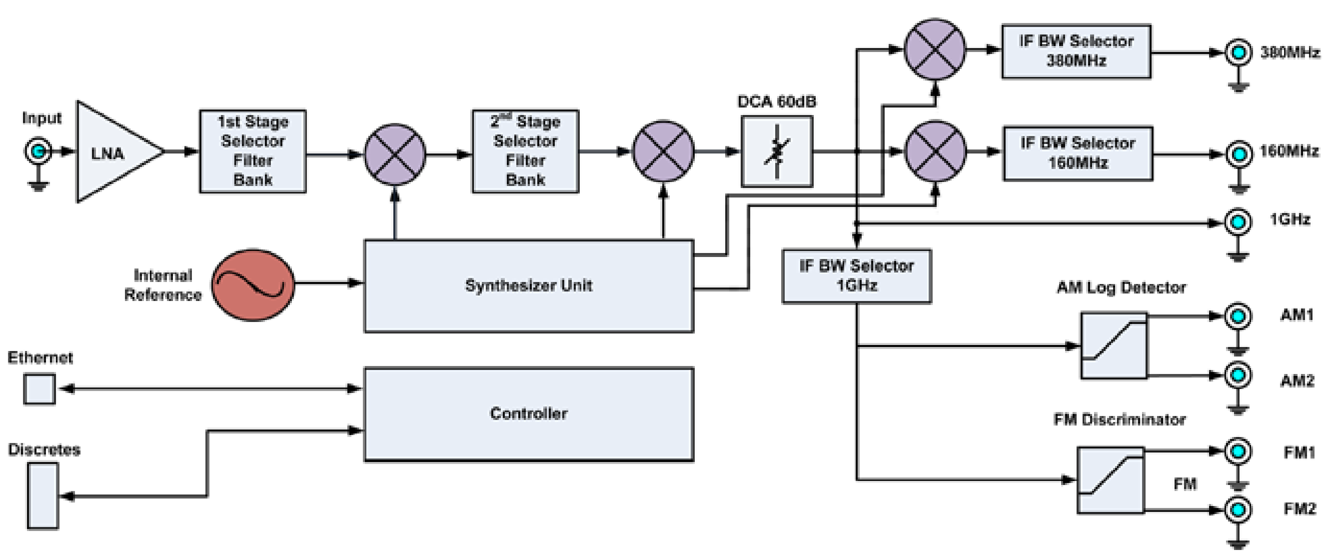
DESCRIPTION

The Model WBR-0518-MOD Super Heterodyne Wideband Receiver was designed to be a low cost, high performance, self contained system capable of advanced detection and processing of communication and non-communication signals. This receiver offers all the features required for high data rate reception while maintaining high pulse fidelity for interception of radar signals. It is ideally suited for today's complex environments.

Signals from the antenna are fed to the WBR receiver input. The input stage consists of a high dynamic range front end which includes a preselector. The dual down converter sections use synthesized LO inputs to convert all incoming signals to 1 GHz signal. This 1 GHz signal is then fed to the IF assembly for further conversion, gain control and filtering to provide simultaneous outputs of 160 MHz and 380 MHz. The 1 GHz signal is also provided as a third and separate IF output. In addition, the 1 GHz signal is fed, in parallel, to the demodulator sections which comprise of AM and FM detectors. These can then extract the respective amplitude and frequency information from the modulated 1 GHz IF signal be it CW or narrow pulse widths of 50 nanoseconds.

The WBR internal control assembly configures all of the receiver sub-assemblies and collects their response to generate a global status report. The internal control assembly also includes a communication link with the external Host computer.

The WBR has built in test (BIT) capability which continuously monitors the operation of the receiver. In the event of a malfunction, it will issue a failure indication alert to the main system.



Receiver Model WBR-0518-MOD

PERFORMANCE CHARACTERISTICS

	PARAMETER	SPECIFICATION
1	Operating Input Frequency, min (GHz)	0.5 to 18
2	Noise Figure, max (dB)	14
3	Sensitivity (dBm) @ 500 MHz and SNR of 15dB	-58
4	DCA Range, min (dB)	0 to 60
5	DCA Resolution, min (dB)	1
6	Measurable Pulse Width	50 ns to CW
7	Input Signal Modulations	Pulse , AM and FM
8	Instantaneous Dynamic Range (dB)	59
9	Number of IF outputs	3
10	IF signal # 1	Centered at 380 MHz with selectable bandwidths of 50, 100, 250, 500 MHz
11	IF signal # 2	Centered at 160 MHz with selectable bandwidths of 1, 10, 20, 50, 100 MHz
12	IF signal # 3	Centered at 1 GHz with bandwidth of 500 MHz
13	Image Rejection, min (dB)	60
14	RF to IF Gain (dB)	5 to 10
15	Input 1dB CP, min (dBm)	+1
16	Input / Output Impedance (Ohms)	50
17	Input / Output VSWR, max	2:1
18	Spurious Level, max (dBm)	-55
19	Survival Input Power, max (dBm)	+20
20	Total Tuning and Settling Speed	Less than 1ms to center frequency
21	Tuning Step Size, min (MHz)	1
22	Integrated Phase Error, max.	0.8^{o} RMS

PERFORMANCE CHARACTERISTICS

	PARAMETER	SPECIFICATION
23	Phase Noise Performance (SSB), max (dBc/Hz)	
24	@ 1kHz offset	- 85
25	@ 10 kHz offset	- 90
26	@ 100 kHz offset	- 100
27	@ 1 MHz offset	- 130
28	Tuner Frequency Stability	Less than 1ppm/year
29	Video Signal Outputs	LOG AM and FM Detectors (at 1 GHz, BW: 100 or 500 MHz)
30	Power Supplies Requirements	
31	5 VDC ± 2.5%	3.2A max
32	-5 VDC ± 2.5%	0.1A max
33	12 VDC ± 5%	3.6A max
34	-12 VDC ± 5%	0.3A max.
35	Receiver Controls	Fast Ethernet (100 Base T)
36	Built In Test (BIT)	
37	On line	Runs in the background
38	Off line	Upon request
39	Operating Temperature Range, min	0°C to + 70° C
40	Dimensions	440 x 220 x 40 mm (17.3” x 8.66” x 1.57 “)
41	Weight	5.8 Kg (13.8 Lb)

Receiver Model WBR-0518-MOD

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range ....0°C to +70°C
Storage Temperature Range ....-40°C to +85°C

Humidity ....95% RH non condensing, @35°C

Shock ....22g, Half sine, 20 msec each axis

Vibration ....Per MIL-STD-167-1A

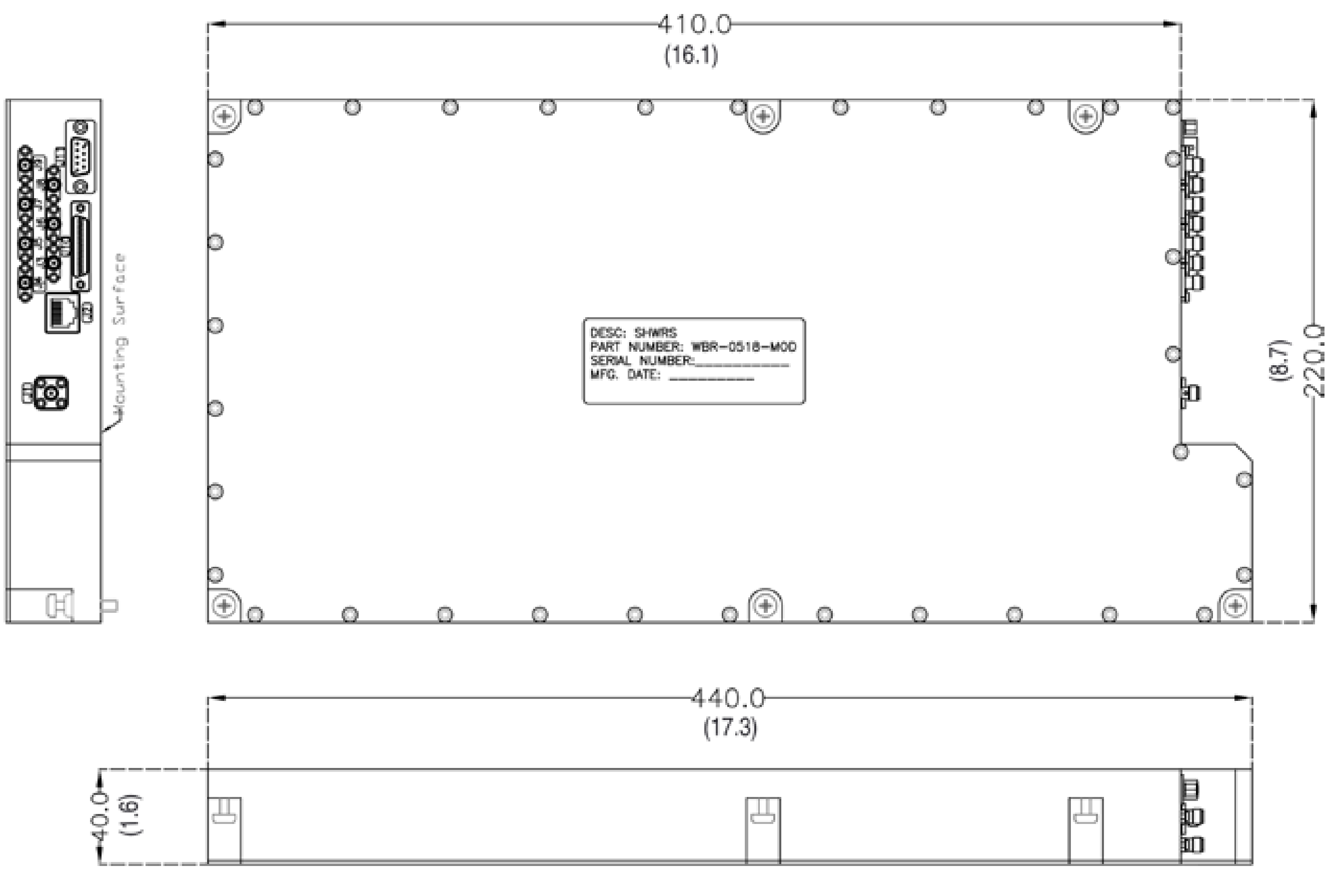
EMI/EMC ....Per MIL 461C

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS AND OUTLINE

The WBR outline shown below can be modified to meet installation requirements of complex receiver systems.

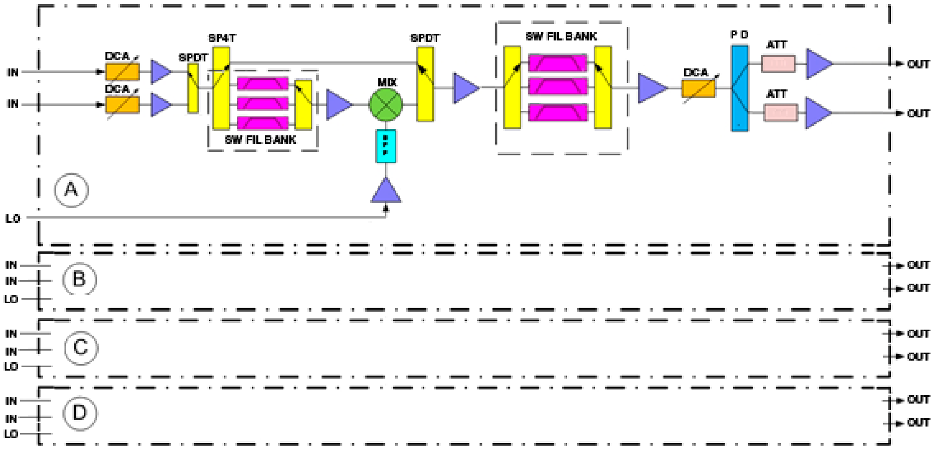


Dimensions in mm (inches)

QUAD RECEIVER CHANNEL (QRC)

FEATURES

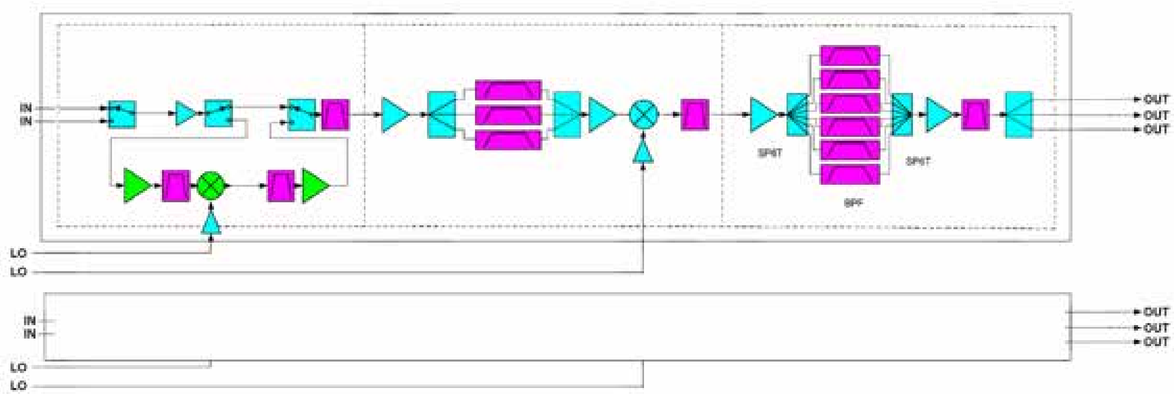
- 0.5 to 18 GHz
- Four Channels
- Airborne Environment



TWIN RECEIVER SUBASSEMBLY (TRS)

FEATURES

- 0.5 to 18 GHz
- Two Channels
- Airborne Environment



SWITCHED FILTER BANKS

KRATOS General microwave is providing various types of Switched Filters banks. These are customized products designed to meet specific customers requirements. The main features of this product line are:

1. Fast Switching
2. Low Loss
3. Temperature Stability

The following filter technologies are being used by us:

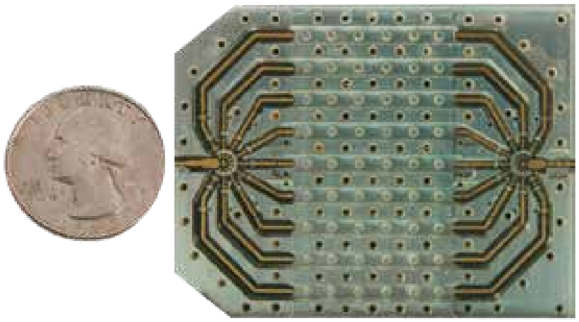
1. Cavity Combline
2. Lumped Elements
3. Printed Filters

The following are samples of switched filter banks supplied by us

SUB-MINIATURE SWITCHED FILTER BANK

FEATURES

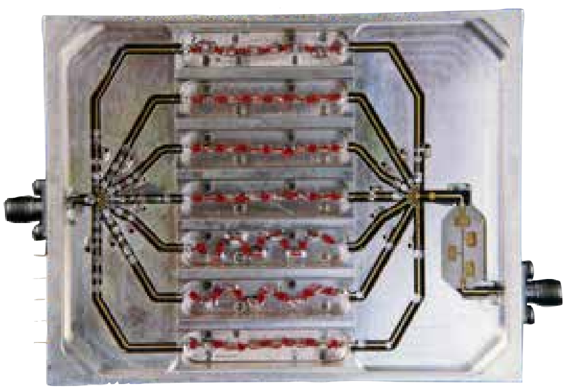
- Miniature Cavity 9 Channel
- Very Thin unit: 9 mm, 0.3"

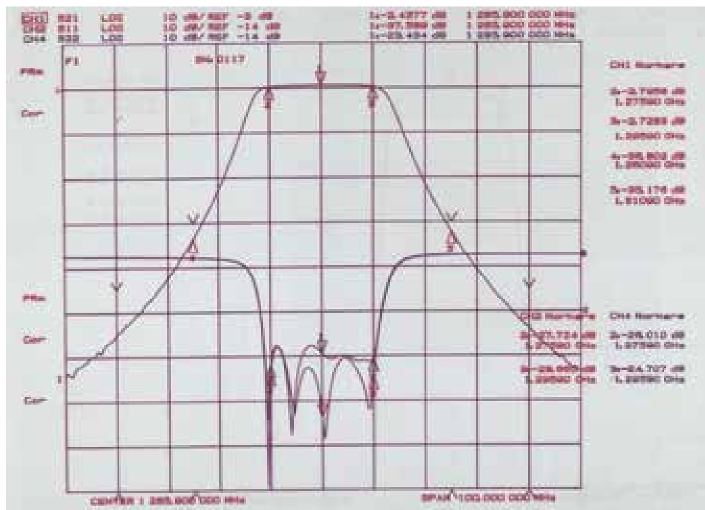


Model SBF-0518-7-LEM
VARIOUS TECHNOLOGIES IMPLEMENTED IN A SWITCHED FILTER BANK

FEATURES

- Filters Implemented by: Lumped Elements and Printed filters
- No. of Channels: 7
- Frequency range: 0.5 to 18 GHz



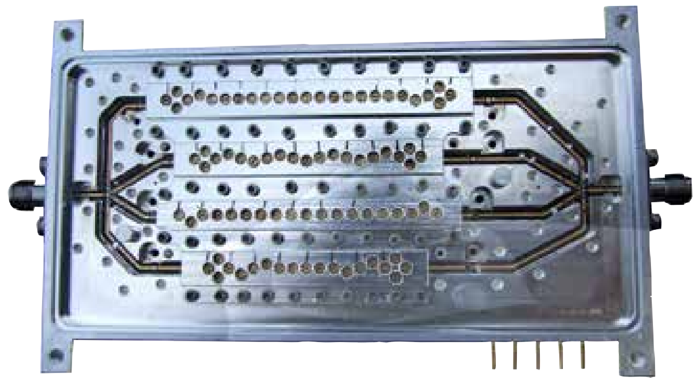


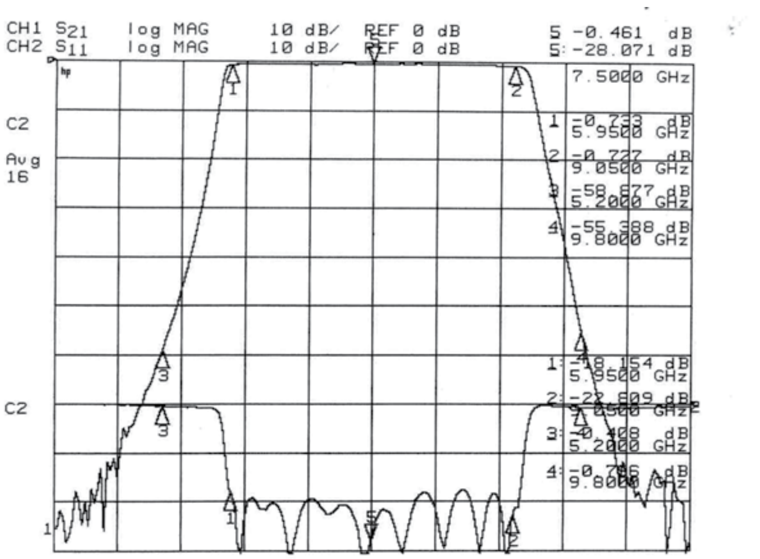
CH	Pass Band (GHz)	Insertion Loss (dB)	Rejection (GHz)			
			30 dB	45 dB	55 dB	60 dB
1	0.472 to 0.808	9.0	14 to 20		1 to 14	DC to 0.22
2	0.728 to 1.320	9.0	14 to 20		1.5 to 14	DC to 0.4
3	1.240 to 2.088	9.0	16 to 20		2.4 to 16	DC to 0.07
4	10.456 to 18.088	9.0		21 to 30	DC to 8.4	
5	2.000 to 3.500	9.0		21 to 30	DC to 1.4	4 to 10
6	3.400 to 6.100	9.0		DC to 2.9		6.8 to 20
7	5.950 to 10.550	9.0			DC to 4.7	12 to 21

Model SBF-620-4-MEC
CAVITY TYPE SWITCHED FILTER BANK

FEATURES

- Filter implemented by: Cavity
- No. of Channels: 4
- Frequency range: 6 to 20.5 GHz



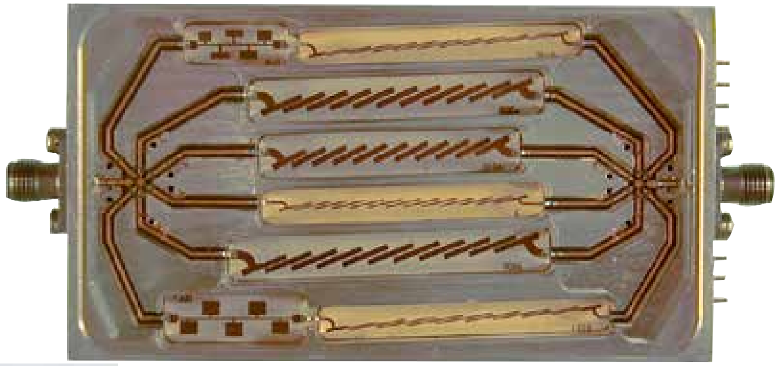


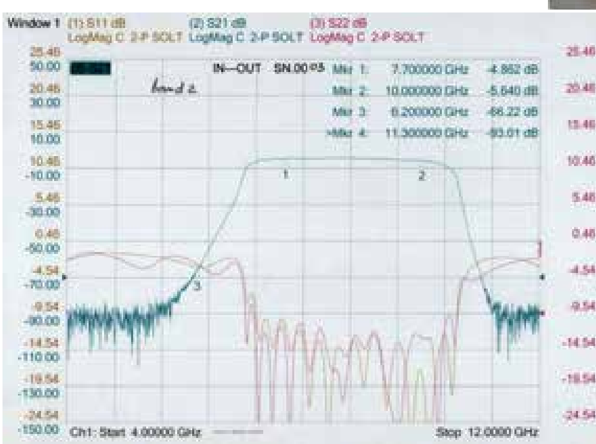
CH	Pass Band (GHz)	Insertion Loss (dB) max.	Min. Rejection (GHz)		
			50 dB	65 dB	50 dB
1	5.95 to 9.05	7.5	2.2 to 5.2	13.4 to 16.4	11.2
2	8.95 to 12.85	7.5	1.6 to 5.4	16.0 to 19.8	14.4
3	12.75 to 16.05	7.5	1.6 to 4.8	6.4 to 9.6	11.2
4	15.95 to 20.05	7.5	1.6 to 3.6	8.8 to 12.8	14.4

Model SBF-618-6-PRT

PRINTED TYPE SWITCHED FILTER BANK

FEATURES
- Filter implemented by: Printed filters
- No. of Channels: 6
- Frequency range: 5.5 to 18 GHz





No.	Freq. Range (GHz)	Ins. Loss (dB)	Stop Band 55 dBc (GHz)	Stop Band 70 dBc (GHz)
1	5.5 to 7.9	6.0	2.0 to 4.3	9.2 to 19.0
2	7.7 to 10.0	6.8	2.0 to 6.2	11.3 to 19.0
3	9.6 to 12.0	6.8	2.0 to 8.2	13.3 to 19.0
4	11.7 to 14.0	6.5	2.0 to 10.5	15.5 to 19.0
5	13.7 to 15.7	6.5	2.0 to 12.0	17.0 to 19.0
6	15.6 to 17.8	6.5	2.0 to 13.5	@ 19.0

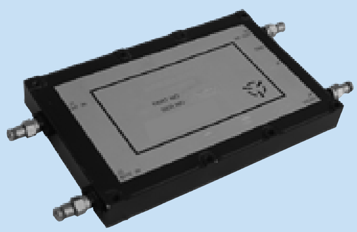
Detector Logarithmic Video Amplifier DLVA DL6 Series

To support customers faced with obsolescence and reliability issues of traditional DLVA suppliers, General Microwave has initially designed and supplied Series DL6 DLVA products as Form, Fit and Function replacements.

Presently, General Microwave offers Series DL6 DLVA as COTS catalog products. In addition to catalog models, custom DLVA units with user specific requirements can be offered.

A broad band logarithmic detector has been developed, capable of detecting CW and pulse signals. This broad band Tunnel Diode Detector has a wide dynamic range, high linearity, high sensitivity and high temperature stability. Special drift compensation circuits have been implemented to ensure a low linearity error over temperature.

- **Wide Frequency Range: 1 to 18 GHz**
- **High Dynamic Range: 70 dB**
- **Fast Rise Time: 25 nSec.**
- **Airborne Application**



DLVA MODEL DL6118

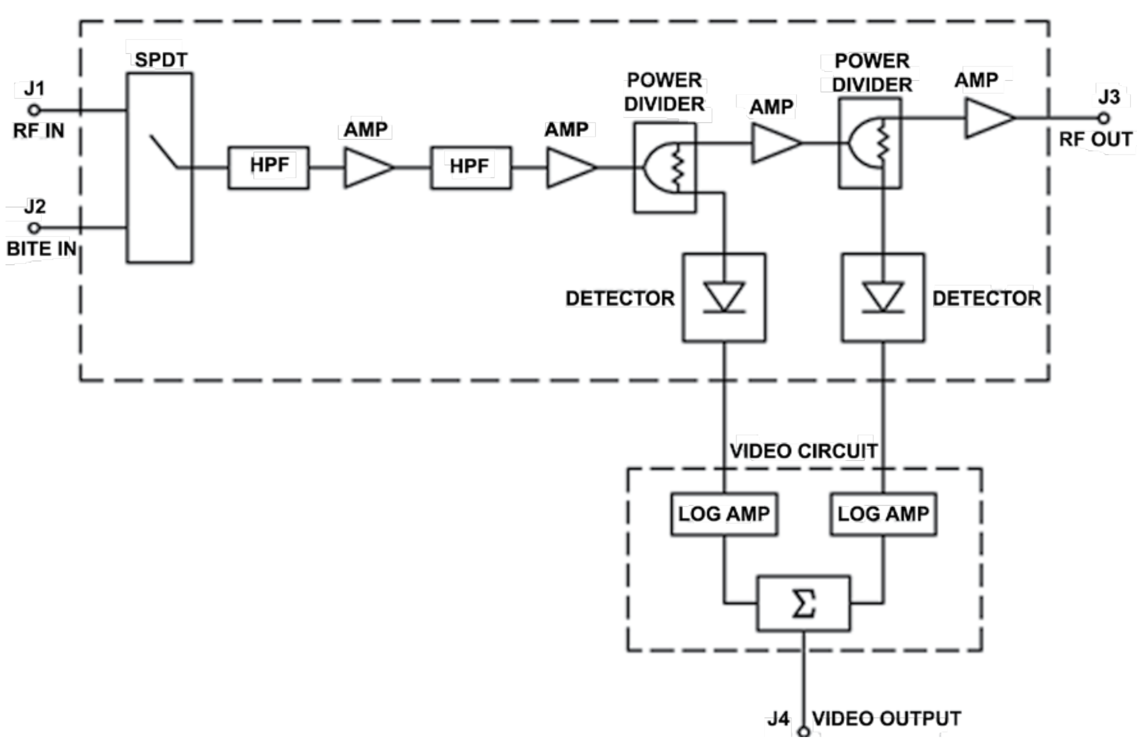
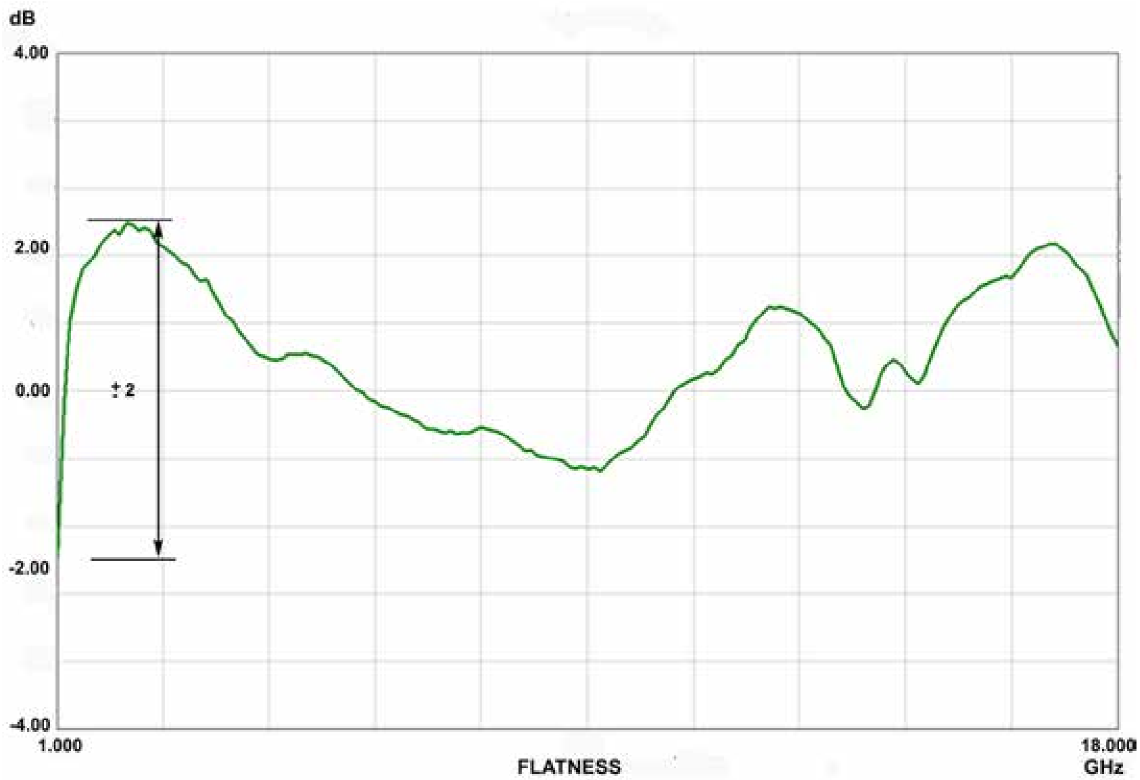
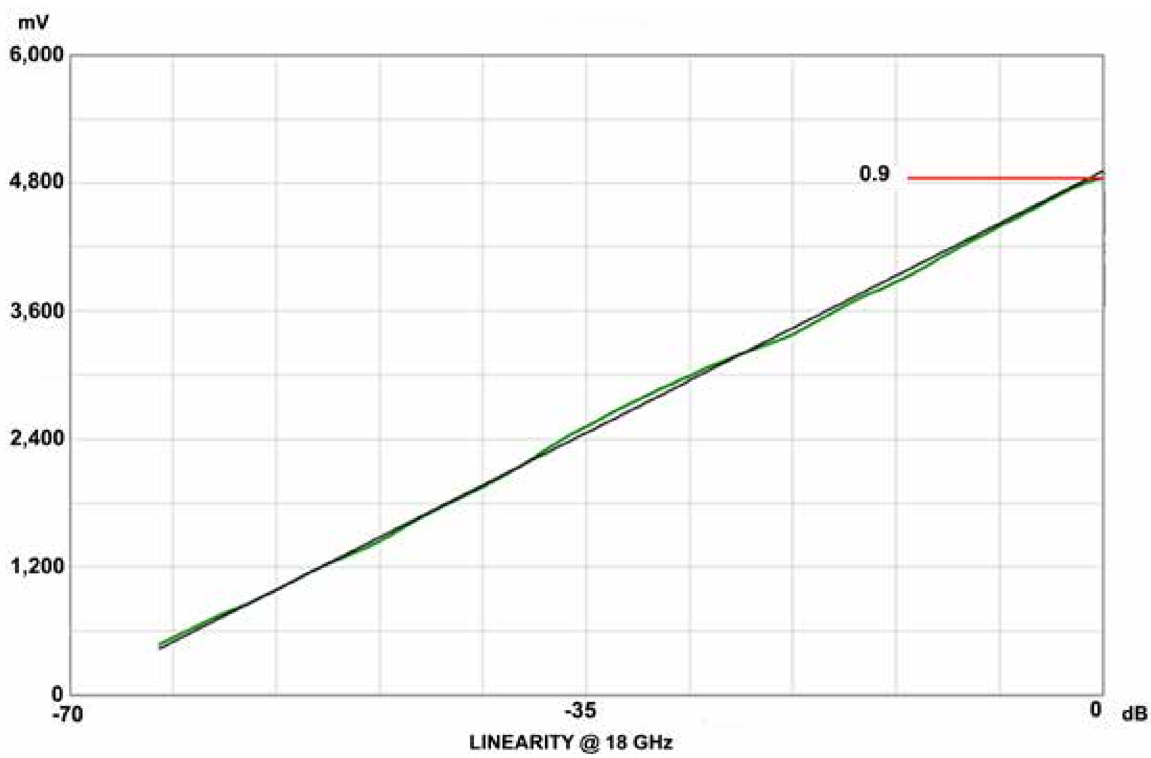


Fig. 1: **DLVA Series DL6 Block Diagram**

TEST DATA


dB
4.00
2.00
0.00
-2.00
-4.00
± 2
1.000
18.000
GHz
FLATNESS


mV
6,000
4,800
3,600
2,400
1,200
0
-70
-35
0
dB
0.9
LINEARITY @ 18 GHz

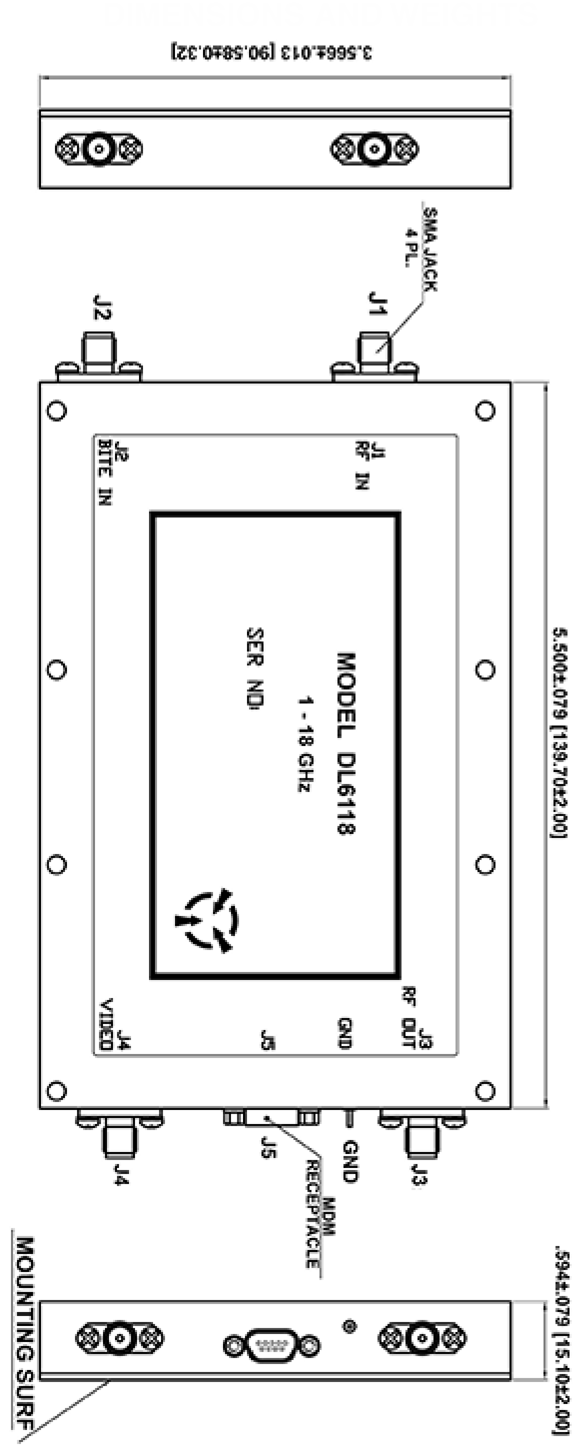
MAIN SPECIFICATIONS

		MODEL DL6118	MODEL DL6218
	PARAMETER	SPECIFICATION	
1	Frequency Range, min. (GHz)	1 to 18	2 to 18
2	CW RF I/P POWER[1] AT J1, max. (W)	2	
3	TSS dBm (20 MHz VIDEO BW), Min. (dBm)	-67	
4	SP2T RF SWITCH ISOLATION, Min. (dB)	60	
5	SWITCHING TIME, Max. (nS)	200 (TURN ON & OFF)	
6	DLVA TYPE	DC COUPLED EXTENDED DYNAMIC RANGE	
7	LOGGING RANGE (dBm)	-66 TO 0	
8	LOG SLOPE (mV/dB)	70	
9	I/P PULSE WIDTH RANGE (mS)	0.050 TO 150	
10	RISE TIME, Max. (nS)	25	
11	SETTLING TIME (FOR 50 nS PULSE), Max. (nS)	35	
12	FILTER REJECTION AT RF & VIDEO O/P PORTS, Min. (dB)	60 @ DC to 850 MHz	60 @ DC to 1,700 MHz
13	DC POWER (PROTECTED FOR REVERSE POLARITY, OVER VOLTAGE UP TO ±20V, SHORT CKT PROTECTION & EMI/EMC)		
	+15 V ± 5%, Max. (A)	1.3	
	-15 V ± 5%, Max. (mA)	300	

(1) Other specifications are available. Please contact Sales.

ENVIRONMENTAL SPECIFICATIONS

1	OPERATING TEMPERATURE RANGE (°C)	-40°C TO +85°C
2	STORAGE TEMPERATURE RANGE	-54°C TO +90°C
3	RANDOM VIBRATION (OPERATIONAL)	0.2 g2/Hz, 20-2000 Hz
4	RELATIVE HUMIDITY	95%
5	ALTITUDE	SEA LEVEL TO 10 Km
6	MECHANICAL SHOCK	75 g, HALF-SINE, 6 mS, 18 SHOCKS
7	EMI/EMC	AS PER MIL-STD-461C
8	ACCELERATION (STRUCTURAL)	10.5 g ON ALL FACES



Model DL6118 and Model DL6218 Wt. 17.6 oz (500gr.) approx.
Dimensional in Inches (mm). Tolerances: unless otherwise indicated: .XX ±.02; .XXX ±.005

Amplitude Control Module Series ACM Specifications

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

The Series ACM Integrated Microwave Assemblies (IMAs) were developed for use in high performance Simulator and ATE Systems. They provide precise control of signal Amplitude and Pulse Modulation over a high dynamic range with very fine resolution and can cover a Frequency Range of 0.5 to 40 GHz in only three modules.

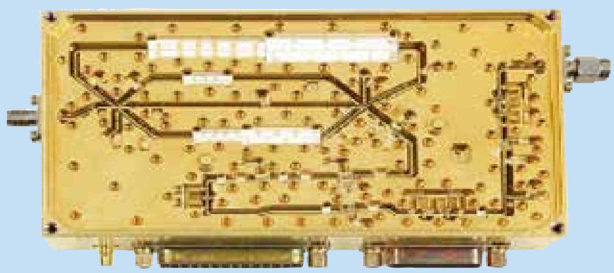
These IMAs were designed using the optimum construction technology to achieve superior products and ease of manufacturing. These include Surface Mount Technology for the 0.5 to 2 GHz module, Chip & Wire (MIC) technology for the broad band 2 to 18 GHz module and Integrated Discrete Components for the much lower volume 18 to 40 GHz module.

OPTION

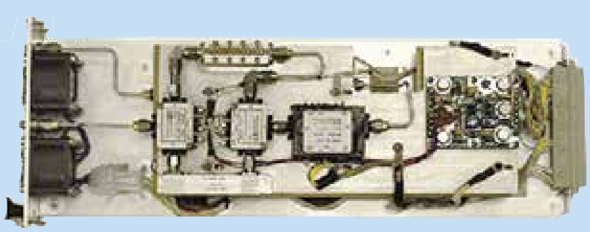
Similar modules, which allow the control of both Phase and Amplitude, are also available. Consult the Factory for details.

- **High Gain**
- **High Dynamic Range: 95 dB**
- **High Resolution: 0.15 dB**
- **Low Harmonics**
- **Pulse Modulation: 90 dB, 25 nsec**
- **Phase Control: Option**
- **Monotonicity: Guaranteed**

Model ACM2052   0.5 to 2 GHz Amplitude Control Module



Model ACM2218   2 to 18 GHz Amplitude Control Module



Model ACM1840   18 to 40 GHz Amplitude Control Module

Amplitude Control Module Series ACM Specifications

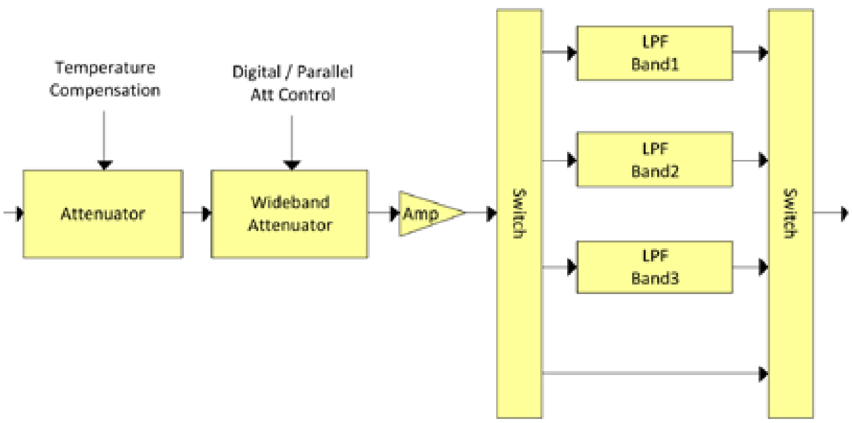


Figure 1: Amplitude Control Module Block Diagram

PERFORMANCE CHARACTERISTICS

PARAMETER	SPECIFICATION		
MODEL NUMBER	ACM2052	ACM2218	ACM1840
FREQUENCY RANGE, min (GHz)	0.5 to 2	2 to 18	18 to 40
OUTPUT POWER, 1 dB compression (dBm)	15	15	6
GAIN, min (dB)	17	@ 2.0 to 3.5 GHz 14 @ 3.5 to 6.0 GHz 16 @ 6.0 to 10.4 GHz 17 @ 10.4 to 18.0 GHz 18	7
HARMONICS, max (dBc)	-60		
INPUT VSWR, max	2.5:1		
OUTPUT VSWR, max	2:1	2.5:1	2.5:1
ATTENUATION			
RANGE, min (dB)	100	100	90
CONTROL	10 BITS TTL		
RESOLUTION, nominal (dB)	0.1	0.1	0.2
MONOTONICITY	GUARANTEED		
SWITCHING SPEED, max (m sec)	1		

PERFORMANCE CHARACTERISTICS (Cont.)

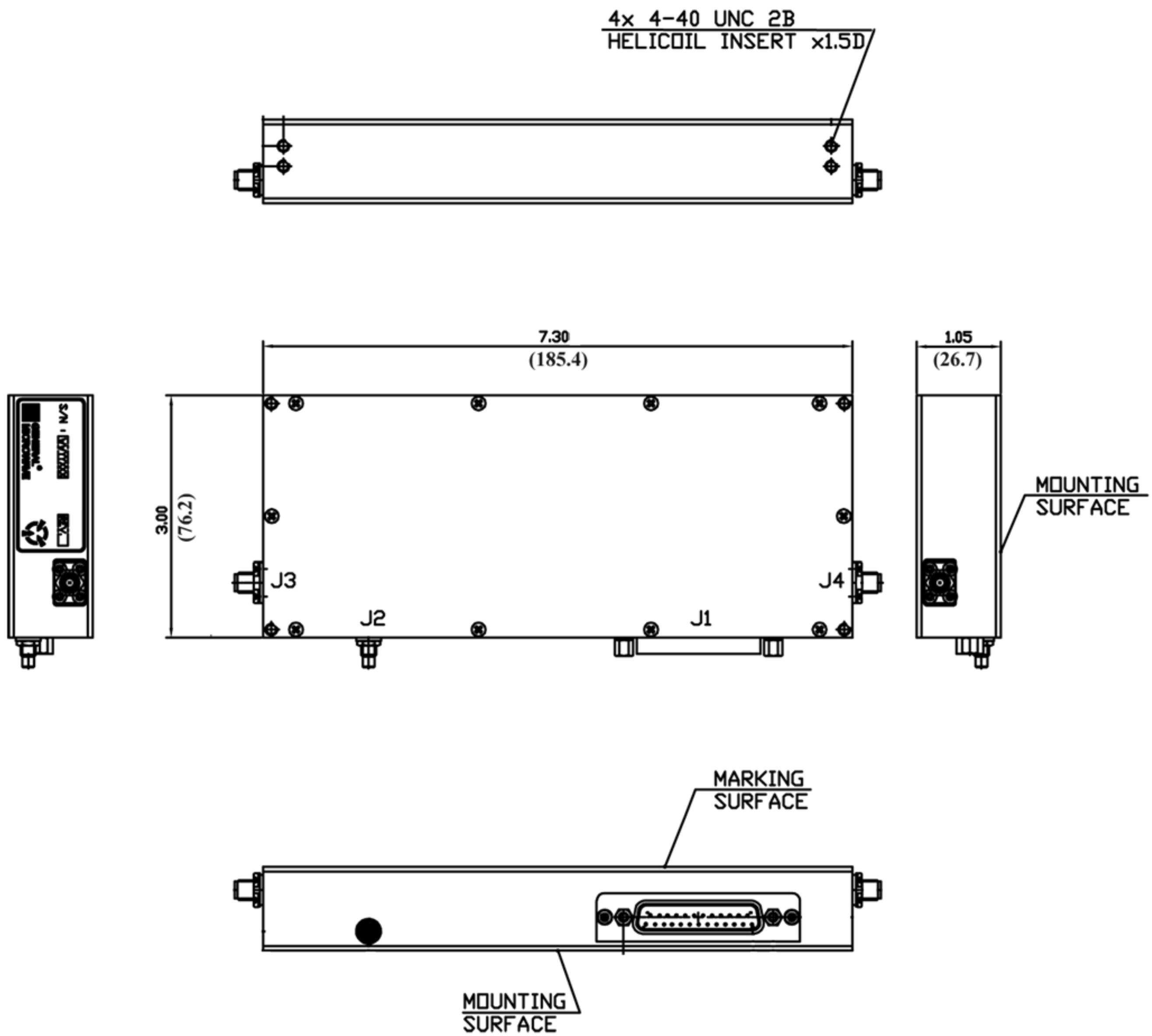
PARAMETER	SPECIFICATION		
MODEL NUMBER	ACM2052	ACM2218	ACM1840
Phase Control (OPTIONAL)	360°	360°	360°
PULSE MODULATION			
ISOLATION, min (dB)	80	90	70
SWITCHING SPEED, max (nsec)	25	25	25
PULSE CONTROL	TTL		
OPERATING TEMPERATURE	+40°C to +50°C		
STORAGE TEMPERATURE	0°C to +50°C		
POWER SUPPLY REQUIREMENT			
+5V DC, max (mA)	500	600	270
+10V DC, max (mA) *	N/A	800	700
+12V DC, max (mA)	750	N/A	N/A
+15V DC, max (mA)	600	400	300
-15V DC, max (mA)	400	400	310

* +10VDC to +15VDC Optional

MODEL ACM2052 (0.5 to 2 GHz) CONNECTORS

CONNECTORS DATA				
PORT	PORT FUNCTION	QTY.	DESCRIPTION	NOTES
J1	CONTROL & SUPPLY	1	DB25 (PLUG)	PER MIL-C-24308
J2	MODULATOR CONTROL	1	SMC MALE	PER MIL-C-39012
J3	RF IN	1	SMA FEMALE	PER MIL-C-39012
J4	RF OUT	1	SMA FEMALE	PER MIL-C-39012

MODEL ACM2052 (0.5 to 2 GHz) DIMENSIONS

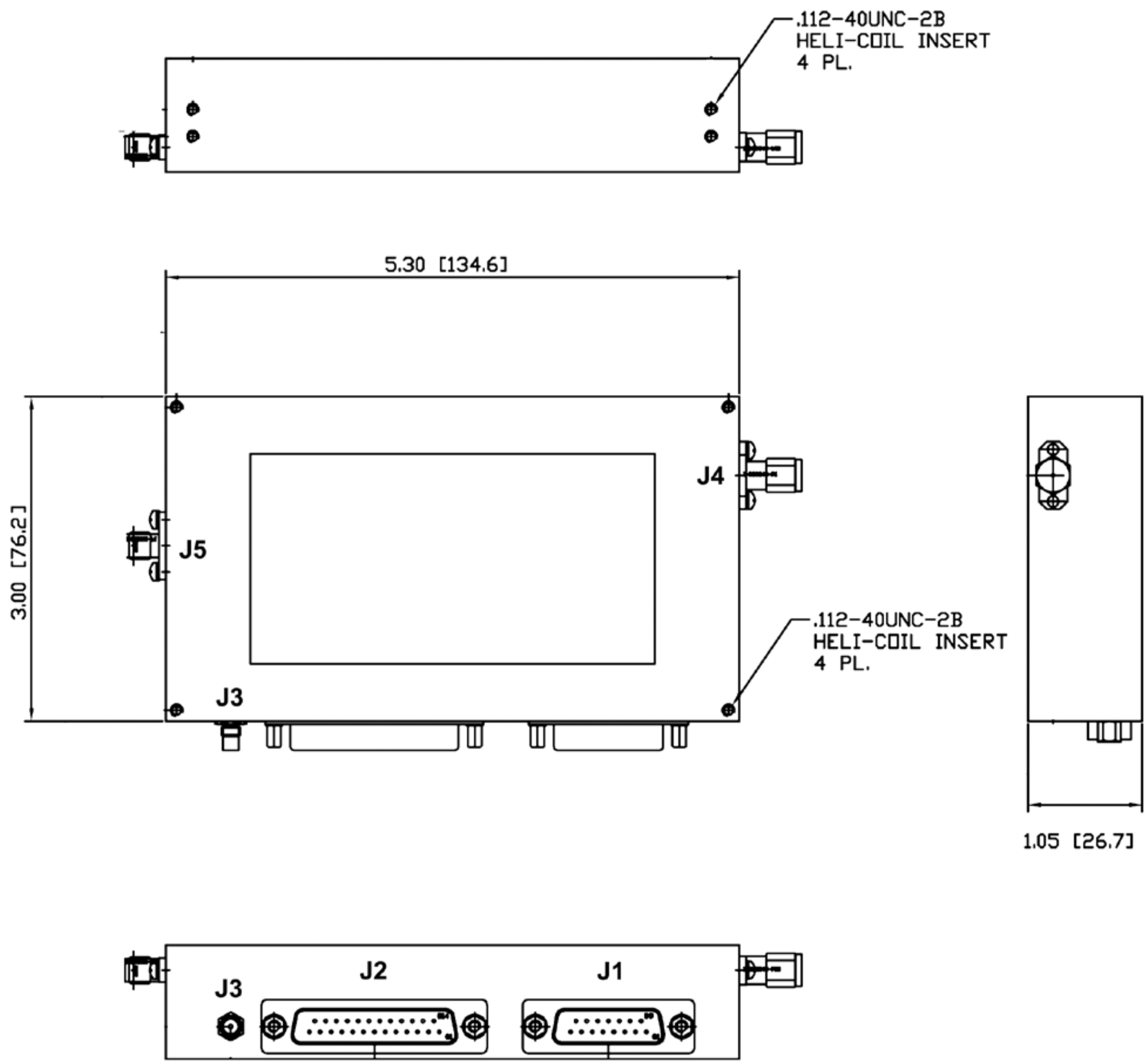


Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

MODEL ACM2052 (0.5 to 2 GHz) CONNECTOR J1 Pinout

PIN #	FUNCTION
1	+15V
2	+15V
3	GND
4	+5V
5	GND
6	-15V
7	GND
8	+12V
9	GND
10	0.5 - 0.8 GHz band CTRL
11	0.8 - 1.3 GHz band CTRL
12	1.3 - 2 GHz band CTRL
13	Output SP4T Termination CTRL
14	Temp GND
15	Temp OUT
16	A1 (Attenuator LSB) 0.1 dB
17	A2 0.2 dB
18	A3 0.4 dB
19	A4 0.8 dB
20	A5 1.6 dB
21	A6 3.2 dB
22	A7 6.4 dB
23	A8 12.8 dB
24	A9 25.6 dB
25	A10 (Attenuator MSB) 51.2 dB

MODEL ACM2218 (2 to 18 GHz) DIMENSIONS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

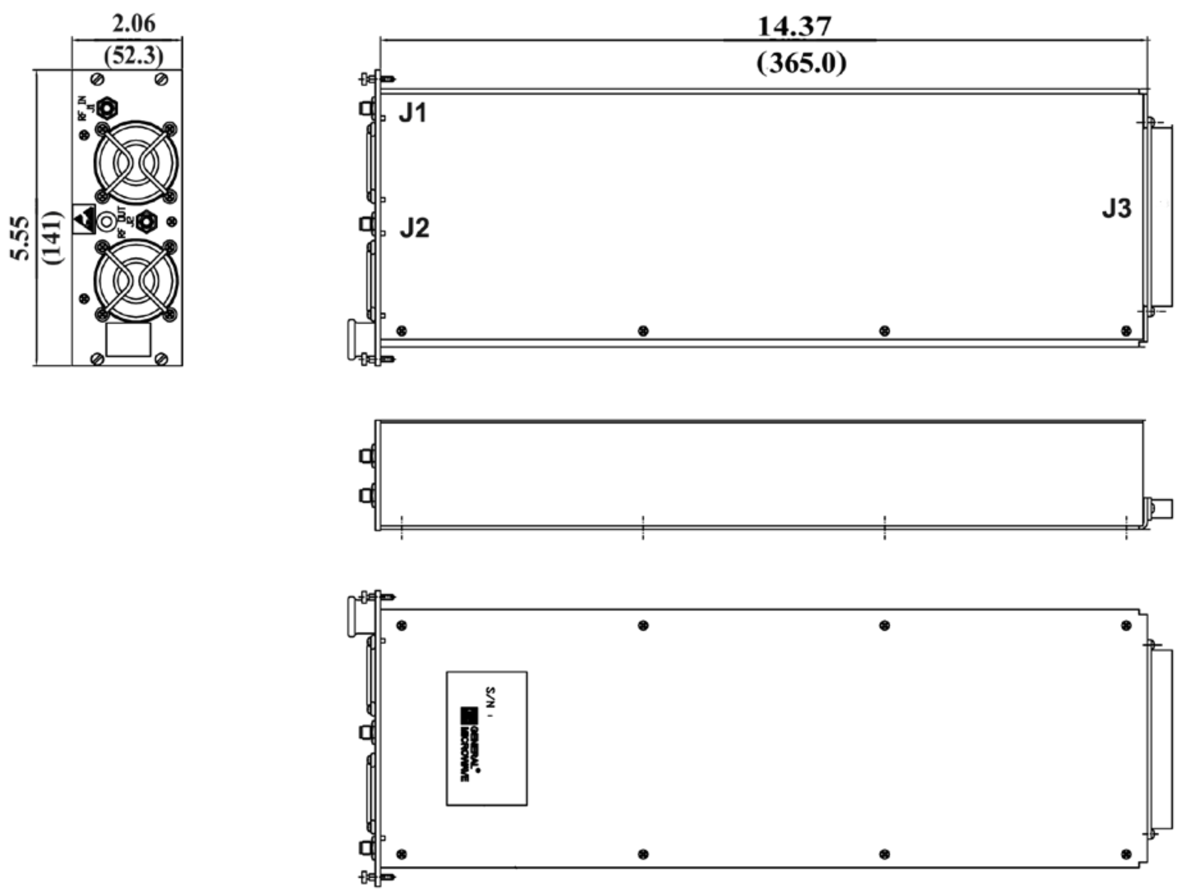
MODEL ACM2218 (2 to 18 GHz) CONNECTORS INFORMATION

CONNECTORS DATA		
	FUNCTION	DESCRIPTION
J1	VVA Control & Supply	Conn D-Type 15P Per MIL-C-24308
J2	MODULE Control & Supply	Conn D-Type 25P Per MIL-C-24308
J3	Pulse Modulation Control	Conn. SMC Male, Per MIL-C-39012/77-0002
J4	RF In	Conn. SMA Male, Per MIL-C-39012
J5	RF Out	Conn. SMA Female, Per MIL-C-39012

J1 PIN FUNCTIONS	
PIN #	FUNCTION
1	.10 dB
2	.20 dB
3	.40 dB
4	.80 dB
5	1.60 dB
6	3.20 dB
7	6.40 dB
8	12.80 dB
9	25.6 dB
10	51.2 dB
11	Strobe
12	Strobe Enable
13	+15 V
14	-15 V
15	GND

J2 PIN FUNCTIONS	
PIN #	FUNCTION
1	2-3.5 Band
2	N/C
3	N/C
4	3.5-6 Band
5	N/C
6	N/C
7	6-10.4 Band
8	N/C
9	N/C
10	10.4-18 Band
11	N/C
12	N/C
13	Park State
14	N/C
15	N/C
16	N/C
17	Temp Monitor
18	+5 V
19	N/C
20	-15 V
21	+10 V
22	+10 V
23	GND
24	GND
25	GND

MODEL ACM1840 (18 to 40 GHz) DIMENSIONS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

CONNECTORS DATA		
SYM	FUNCTION	DESCRIPTION
J1	RF Input	"K" Conn Female
J2	RF Output	"K" Conn Female
J3	Supply & Control	Conn 96 Pin Female (DIN 41612 Type C)

MODEL ACM1840 (18 to 40 GHz) CONNECTOR (J3)

PIN #	ROW A	ROW B	ROW C
1	RF Enable (pulse)	RF Enable screen GND	GND
2	GND	GND	GND
3	+10V	+10V	+10V
4	N.C.	N.C.	N.C.
5	Filter Bit 1 (26.5-40 GHz)	Filter Bit 0 (18-26.5 GHz)	TEMP, MONITOR
6	GND	GND	GND
7	+5V	+5V	+5V
8	-15V	-15V	-15V
9	ATT STROBE LATCH	N.C.	N.C.
10	N.C.	N.C.	A9 (Attenuator MSB) 51.2 dB
11	A8 25.6 dB	A7 12.8 dB	A6 6.4 dB
12	A5 3.2 dB	A4 1.6 dB	A3 0.8 dB
13	A2 0.4 dB	A1 0.2 dB	A0 (Attenuator LSB) 0.1 dB
14	GND	GND	GND
15	N.C.	N.C.	N.C.
16	N.C.	N.C.	N.C.
17	N.C.	N.C.	N.C.
18	N.C.	N.C.	N.C.
19	N.C.	N.C.	N.C.
20	GND	GND	GND
21	-15V	GND	+15V
22	N.C.	GND	+5V
23	N.C.	N.C.	N.C.
24	N.C.	N.C.	N.C.
25	N.C.	N.C.	N.C.
26	N.C.	N.C.	N.C.
27	N.C.	N.C.	N.C.
28	GND	Sense GND	GND
29	LED 1 Power (Green)	Sense	LED 1/2 GND
30	LED 2 Fault (Red)	N.C.	N.C.
31	Fan +24V	N.C.	Fan 0V
32	Fan +24V	N.C.	Fan 0V

POWER AMPLIFIERS

KRATOS General Microwave/Eyal offers a broad range of High Power Amplifiers for both Military and Commercial applications extending over the VHF to Ku Band Frequency Range. The KRATOS Engineering staff is available to design new products to individual specifications, or provide more cost effective customization of existing products, to meet specific Customer requirements. Our Power Amplifiers are typically for used in:

1. RADAR
2. ECM and COMJAM
3. Data-Links for UAVs
4. Test Systems
5. Communication and Cellular Based Stations
6. Special applications

The following is a summary of our capabilities and existing Power Amplifier products

MAIN FEATURES

1. VHF up to Ku bands.
2. Power levels up to 1 Kw, CW or Pulse.
3. Operating in Class A, AB and C.
4. Solid state technology; utilizing transistors such as Bi-Polar, LDMOS and GaAs.
5. Enabling various inputs.
6. Can be integrated as a RF subassembly module, or as 19" Rack mounted.
7. Control:
   a) Remote control optional of RS 232, RS422 or ETHERNET.
   b) Control of Output Power by remote setting and ALC (Automatic Level Control).

PA PROTECTION and MONITORING

Special means and capabilities are implemented to Protect the Power Amplifiers from the following conditions and to monitor them (at the system level):
1. Over Temperature.
2. Forward Power.
3. Reflected Power.
4. Open/Short Load VSWR.

CUSTOM PA AND SSPA PRODUCTS

Examples of KRATOS General Microwave/Eyal Custom PA and Solid State Power Amplifier (SSPA) Products and listed in the following pages and can be found on pages 57 to 62. Consult the Factory with your specific requirements

SOLID STATE POWER AMPLIFIER (SSPA)

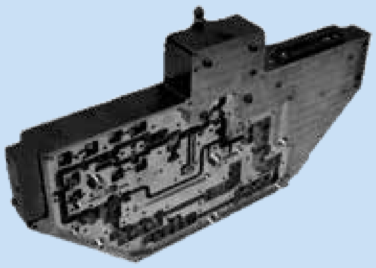
The Solid State Power Amplifier (SSPA) product line was designed for use in the most demanding applications, including Airborne, Missile, Radars and Communications. They are also a practical solution for more benign laboratory or field Test Systems. These diverse applications are made possible by the use of today's cutting edge technologies for design and manufacturing of the SSPAs. As a result, these SSPAs provide high performance, reliability and cost effective alternatives to applications currently using Traveling Wave Tube (TWT) Amplifiers. All SSPAs are designed using the Power Summation concept (Fig1) which provides a graceful degradation capability not found in TWTs and critical to mission completion.

The product line supports both X and Ku Band applications with band width up to 10% and offers peak power outputs up to 400 Watts. Successful SSPA designs have utilized Gallium Arsenide or Gallium Nitride power devices depending upon which was better suited for the application. The flexibility of the SSPA design provides the ability to extend to adjacent frequency bands requiring only a short development time at very low risk.

The RF input to the SSPA (see fig. 2), is pre-amplified and split into several parallel symmetric branches. Each branch includes a power amplifier section (PA). This distributed design of the SSPA results in built in redundancy and graceful degradation of output power should any individual PA section fail. Each branch includes a current sense alarm indication which is monitored and fed to the SSPA controller. The amplified outputs of all the symmetric branches are summed up in a passive combing network which routes the resultant high power to the output of the SSPA.

- **X and Ku Bands**
- **Power Output: up to 400W**
- **High Reliability**
- **For Severe Environmental Applications**
- **Low Life Cycle Cost**


Custom GaAs SSPA


Custom GaN SSPA Assembly

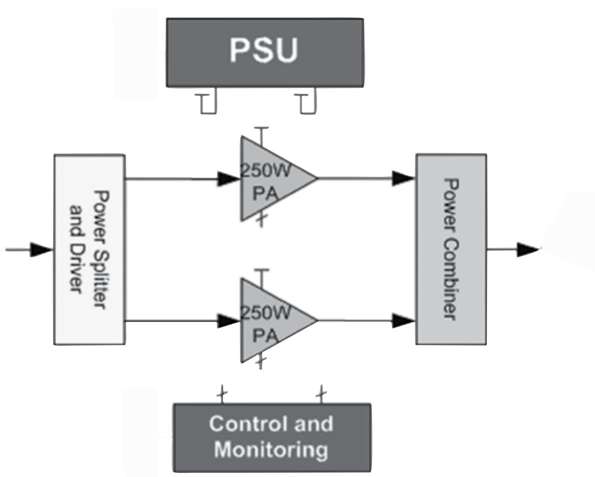


Fig. 2: **SSPA 400W BLOCK DIAGRAM**

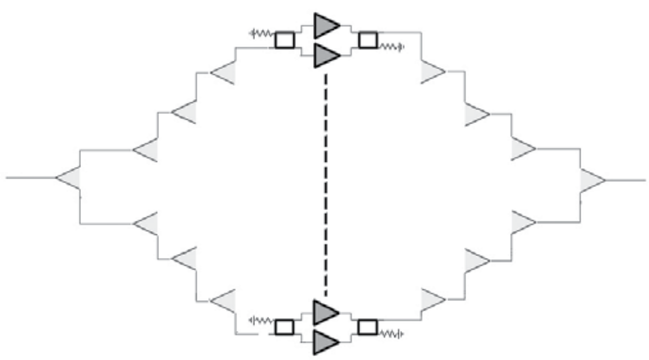


Fig. 1: **POWER SUMMATION**

SSPA - Power Amplifiers

A compact and highly efficient switching Power Supply Unit (PSU) is built into the SSPA. This state-of-the-art PSU design ensures that any contribution of phase noise and spurious signals are significantly reduced at the RF output. The SSPA control section includes a Modulator which switches the DC lines of the individual PA sections On/Off to achieve the required Pulse Width, Pulse Repetition Interval and Duty Cycle. The SSPA Monitoring section includes Built-in-Test capability which receives indications from critical internal subassemblies, including the PA sections, thereby constantly monitoring the condition of the SSPA.

Most all SSPA designs are custom deriving from Customer specifications because of the differing requirements for specific applications such as Airborne Radars and Missile Seekers. There are, however, many applications which can be served by more generic SSPAs as summarized in the below table. They are offered as Special Catalog SSPAs and intended to provide the user with a proven, cost effective solution rather than a new design.

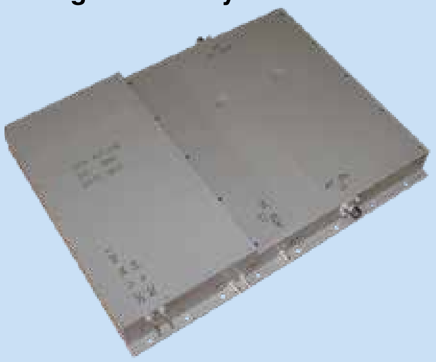
CATALOG SSPA SELECTION GUIDE

MODEL	FREQUENCY BAND	OUTPUT POWER	PAGE	COMMENTS
SGN-K1-7	Ku Band	7W	56	GaN
SPA-X2-100	X BAND	100W	45	GaAs
SPA-X3-200	X BAND	200W	48	GaAs
SGN-X3-400	X BAND	400W	51	GaN
SGN-X4-20	X BAND	20W	54	GaN
SGN-X4-50	X BAND	50W		GaN
CUSTOM SSPA			57	

SSPA Model SPA-X2-100

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

- X Band
- Band Width: 9%
- Output Power: 100W
- Pulse Width: 250 µsec max.
- High Reliability



SSPA MODEL SPA-X2-100

The Model SPA-X2-100 is a Standard Catalog SSPA designed to fulfill various applications including Radar, Communications and Test Systems. It has been designed for optimum operation in the pulse mode and utilizes proven GaAs power devices which provide high performance and reliability at X-Band.

Typical test data are shown below with Fig 1 comparing the command and resultant detected RF pulses and Fig 2 illustrating the minimal droop for a 256 usec pulse at the maximum of 100 Watt RF Power Output.

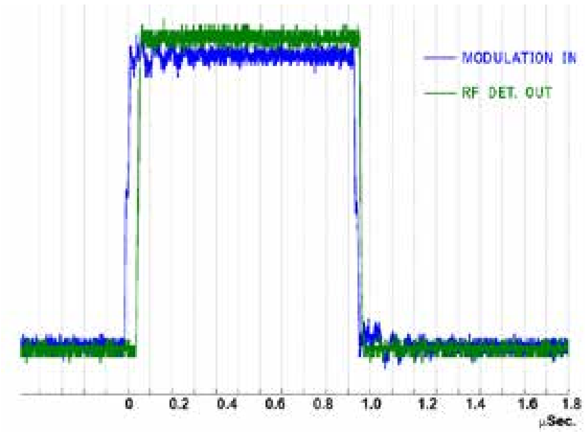


Fig. 1: **PULSE MODULATION**

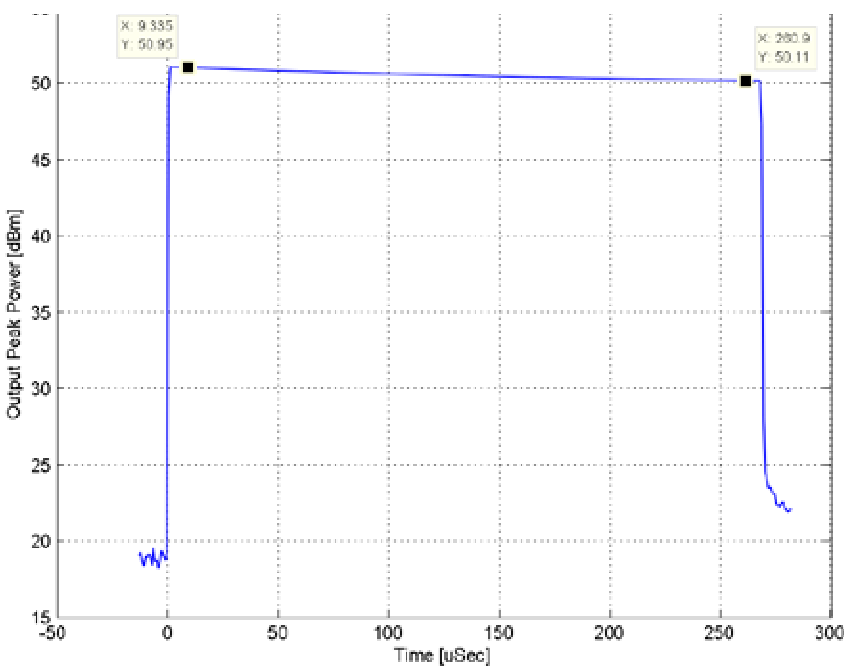


Fig. 2: **PULSE DROOP**

SSPA Model SPA-X2-100

MAIN SPECIFICATIONS

	PARAMETER	SPECIFICATION
	Model	SPA-X2-100
1	Frequency Range, (GHz)	X Band
1.1	Bandwidth, %	9
2	Peak Saturated Output Power, (W) min.	100
2.1	Average Output Power, (W) min.	25
2.2	Amplitude Flatness, (dB) PTP	1.2
2.3	RF Out Amplitude Droop @ Pulse Width of 250 μSec, (dB) max.	1.5
3	Output Load VSWR, max	2:1
4.1	Large Signal Gain, (dB) min. (with 0 dBm, input)	53 (1)
4.2	Input RF Drive, (dBm)	0 to 5 (1)
5	RF Pulse Width, (μSec), max.	250 (1)
6	RF Rise/Fall Time, (nSec.) max.	50nSec
7	Duty Cycle, (%) max.	25
8	PRF, (kHz)	1 – 600 (1)
9	Input Supply Voltage, (V)	+28 (2)
9.1	Average Input Current, (A) max.	7
10	DC Power Consumption, (W) max.	215
11	Switching Power Supply (Provided as part of the SSPA)	Ultra quiet, non-synchronized architecture
12	Spurious Level between PRF Control Lines, (dBc) min.	70
13	Efficiency, (%) min.	15
14	Operating Temperature Range, (°C)	-40 to +85
15	Dimensions L x W x H, (Inch)	9.00 x 7.00 x 1.2
16	Dimensions L x W x H, (mm)	228.6 x 177.8 x 30.5

(1) Other specifications are available. Please contact Sales.

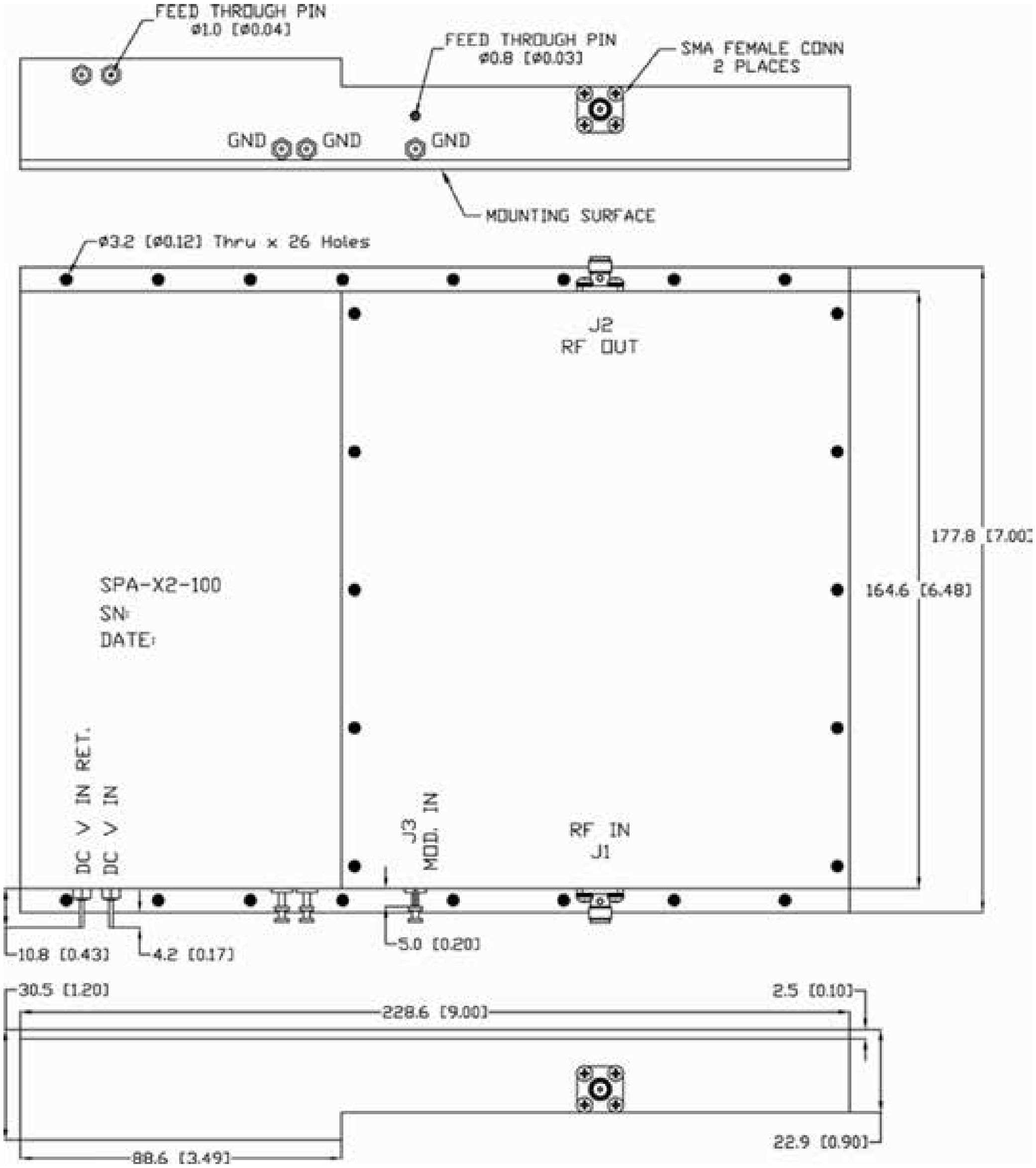
(2) Option 20V to 60V.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

CONNECTOR DESIGNATION	FUNCTION	TYPE	COMMENTS
J1	RF In	SMA F	
J2	RF Out	SMA F	
J3	MODULATION In	Feed Through	Solder Pin 0.8Ø
VDC IN	Input Voltage In	Feed Through	Solder Pin 1.0Ø
VDC IN RET.	Input Voltage Return	Feed Through	Solder Pin 1.0Ø

DIMENSIONS AND WEIGHTS



Dimensions in mm (Inches) Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.005

Wt: 70.5 oz (2Kg.) approx.

SSPA Model SGN-X3-200

SPECIAL ORDER PRODUCT

–CONSULT FACTORY BEFORE ORDERING–

- **GaN Technology**
- **X Band**
- **Band Width: 9%**
- **Output Power: 200W**
- **Pulse Width: 256 μSec. max.**
- **High Efficiency**

SSPA Model SGN-X3-200

Model SGN-X3-200 is part of our Catalog SGN series Solid State Power Amplifiers (SSPA). The SGN SSPA series is based on GaN technology. Utilizing the GaN technology enables us to provide our customers a lower cost SSPA, with high efficiency and higher packaging, while maintaining all of the advantages of the SSPA, such as High Reliability and Power Redundancy.

The SSPA consists of an input section with preamplifier stages and an power amplifier output section. The output section consists of summation of 6 amplifiers. In addition to the microwave section, there is a proprietary designed asynchronous low-noise power supply and pulse-modulator.

The application of this series of GaN based SSPA, is to fulfill various requirements of high reliable products at lower cost. Typical applications of this SSPA are for Radar, Data Links, Communications and Test Systems.

MAIN SPECIFICATION

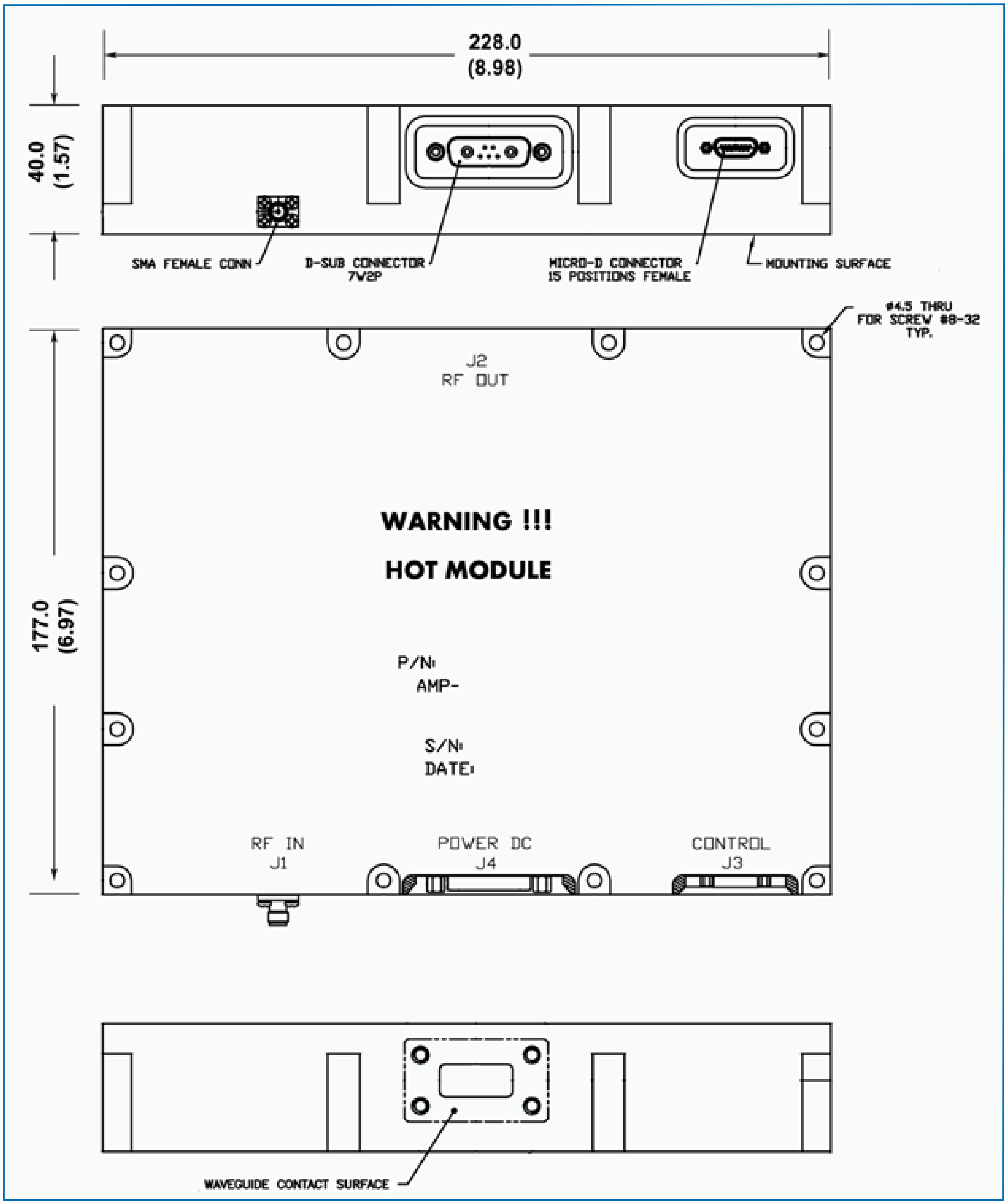
	PARAMETER	SPECIFICATION
	MODEL	SGN-X3-200
1	Frequency Range (GHz)	X band
1.1	Bandwidth %, max.	9
2	Peak Saturated Output Power, min. (W)	250
2.1	Amplitude Flatness, PTP, dB max.	1
2.2	RF Out Amplitude Droop @ Pulse Width of 100 μSec, (dB), max.	1
3	Output Load VSWR	
3.1	For Max. Output Power, max.	1.2:1
3.2	No Damage	2:1
4.1	Large Signal Gain, typ. (dB)	55
4.2	Small Signal Gain, typ. (dB)	70
4.3	Input RF Drive (dBm)	-1 to +5
5	Pulse Width (μs) max.	256
6	Duty Cycle, max (%)	15
7	PRF (kHz), max.	40
8	Input Supply Voltage (V)	22 to 36
8.1	Average Input Current @ 28V, max (A)	10
8.2	Reverse Voltage Protection	Yes
9	DC Power Consumption, typ. (W)	280
10	Efficiency, typ. (%)	20
11	Tx enable external control[1] (TTL)	
11.1	Rise/Fall Time, typ. (nsec.)	50
11.2	Time Delay, typ. (nsec.)	200
12	Operating Temperature Range (°C)	-40 to +70
13	Other Typical Environmental Specifications	Airborne
14	Dimensions L x W x H (in)	9.0 x 7.0 x 1.6
14.1	Dimensions L x W xH (mm)	228.6 x 177.8 x 40.2
15	Weight, max. (Kg.)	3.5
16	Connectors	
16.1	RF In	SMA Female
16.2	RF Out	Waveguide WR90
16.3	Power Supply	D-SUB 7W2
16.4	Control	Micro-D 15 pin female

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

Note
1. Drain switching.

DIMENSIONS AND WEIGHTS

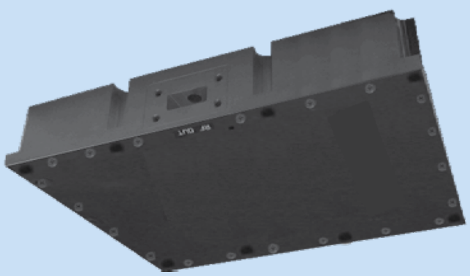


Dimensions in mm (Inches) Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Wt: 7.7 Lb. (3.5Kg.) approx.

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

- **GaN Technology**
- **X Band**
- **Band Width: up to 1.0 GHz**
- **Output Power: 400W**
- **Pulse Width: 0.2 to 150 µSec.**
- **High Efficiency**



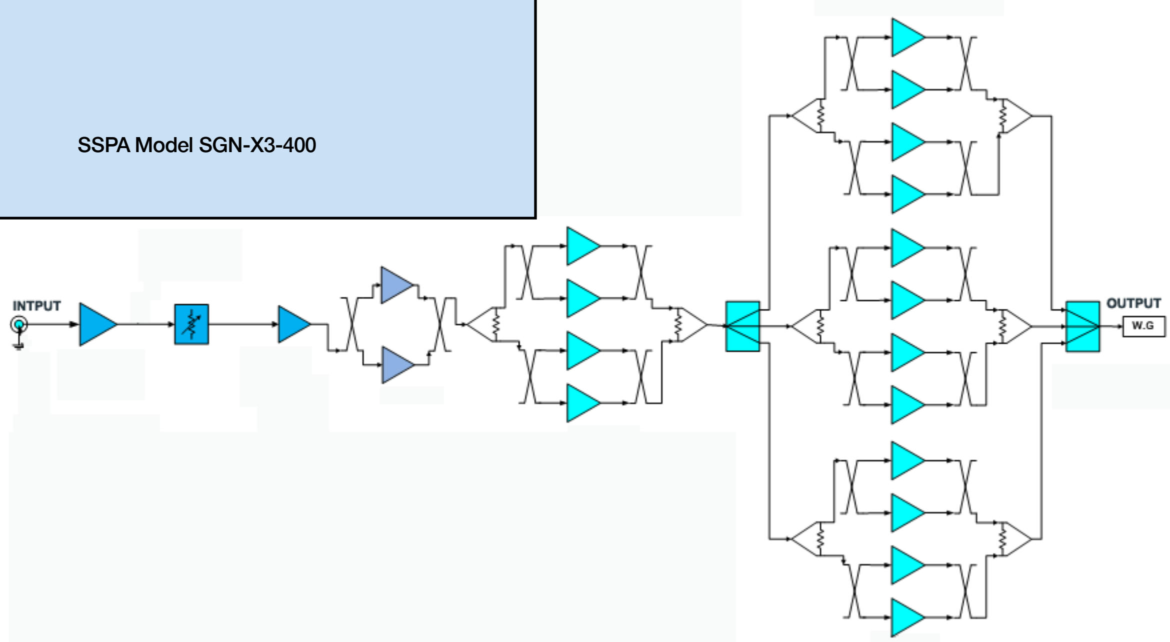
SSPA Model SGN-X3-400

The Model SGN-X3-400 is part of our Catalog SGN series Solid State Power Amplifiers (SSPA). The SGN SSPA series is based on the GaN technology. Utilizing the GaN technology enables us to provide our customers a lower cost SSPA, with high efficiency and higher packaging, while maintaining all of the advantages of the SSPA, such as High Reliability and Power Redundancy.

The application of this series of GaN based SSPA, is to fulfill various requirements of high reliable products at lower cost. Typical applications of this SSPA are for Radar, Data Links, Communications and Test Systems.

Following please find the basic block diagram of the microwave section. It consists of an input section with preamplifier stages and an power amplifier output section. The output section consists of summation of 12 amplifiers.

In addition to the microwave section, there is a proprietary designed asynchronous low-noise power supply and pulse-modulator.



SSPA Model SGN-X3-400 - Microwave Section

SSPA Model SGN-X3-400

MAIN SPECIFICATION

	PARAMETER	SPECIFICATION
	MODEL	SGN-X3-400
1	Frequency Range (GHz)	X band
1.1	Bandwidth %, max.	9
2	Peak Saturated Output Power, min. (W)	400
2.1	Amplitude Flatness, PTP, dB max.	1
2.2	RF Out Amplitude Droop @ Pulse Width of 100 µSec, (dB), max.	1
3	Output Load VSWR	
3.1	For Max. Output Power, max.	1.2:1
3.2	No Damage	2:1
4.1	Large Signal Gain, typ. (dB)	55
4.2	Small Signal Gain, typ. (dB)	70
4.3	Input RF Drive (dBm)	-1 to +5
5	Pulse Width (µs) max.	256
6	Duty Cycle, max (%)	20
7	PRF (kHz), max.	40
8	Input Supply Voltage (V)	22 to 36
8.1	Average Input Current @ 28V, max (A)	15
8.2	Reverse Voltage Protection	Yes
9	DC Power Consumption, typ. (W)	420
10	Efficiency, typ. (%)	20
11	Tx enable external control[1] (TTL)	
11.1	Rise/Fall Time, typ. (nsec.)	50
11.2	Time Delay, typ. (nsec.)	200
12	Operating Temperature Range (°C)	-40 to +70
13	Other Typical Environmental Specifications	Airborne
14	Dimensions L x W x H (in)	9.0 x 7.0 x 1.6
14.1	Dimensions L x W xH (mm)	228.6 x 177.8 x 40.2
15	Weight, max. (Kg.)	3.5
16	Connectors	
16.1	RF In	SMA Female
16.2	RF Out	Waveguide WR90
16.3	Power Supply	D-SUB 7W2
16.4	Control	Micro-D 15 pin female

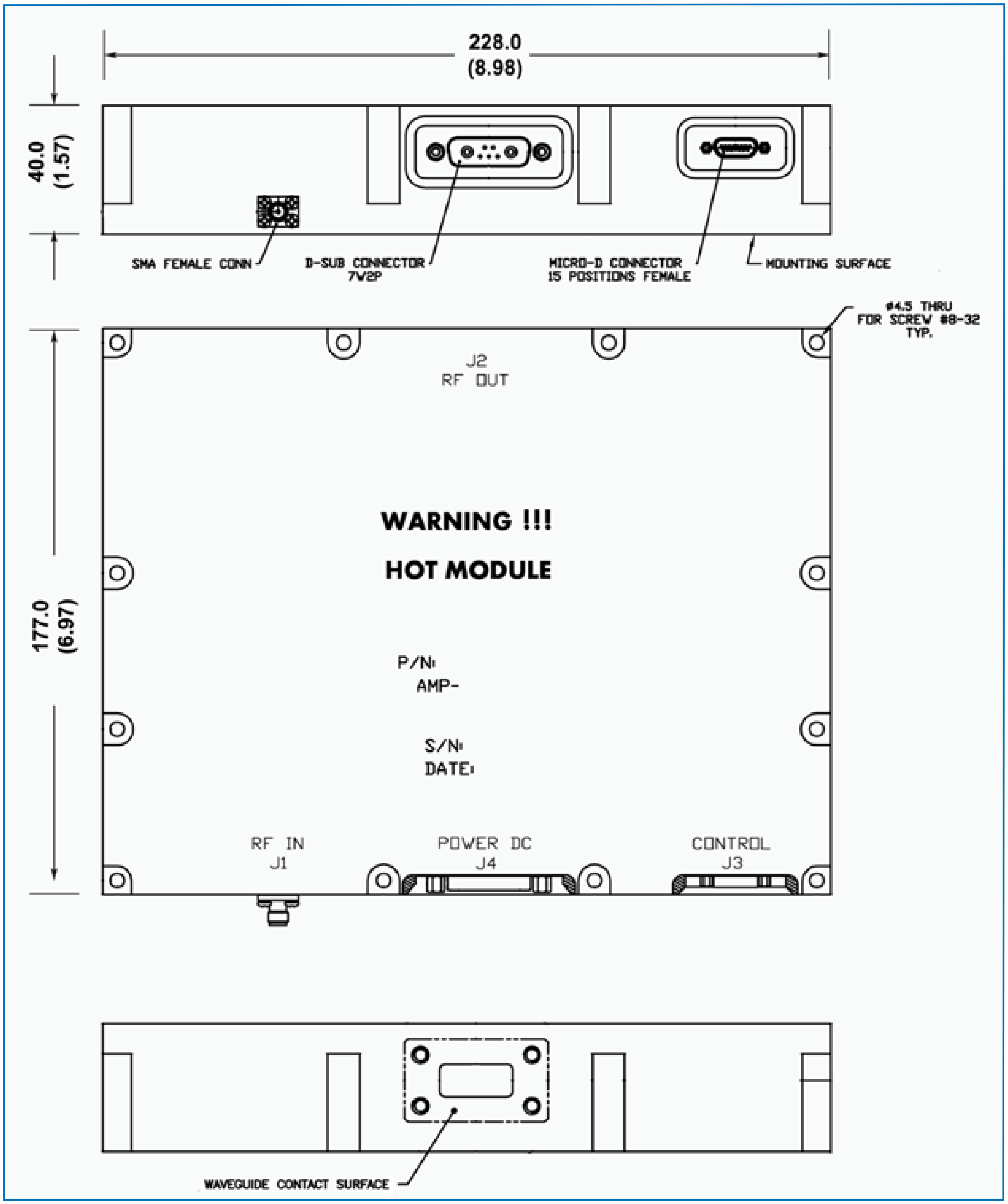
AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

Note

1. Drain switching.

DIMENSIONS AND WEIGHTS



Dimensions in mm (Inches) Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Wt: 7.7 Lb. (3.5Kg.) approx.

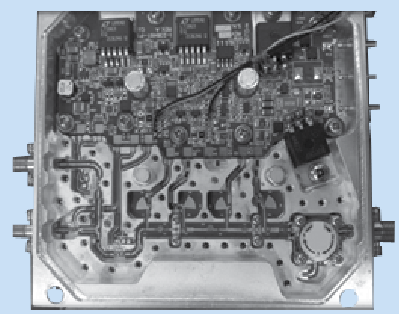
SSPA Model SGN-X4-20/50

The Model SGN-X4-50 is part of our Catalog SGN series Solid State Power Amplifiers (SSPA). The SGN SSPA series is based on the GaN technology. Utilizing the GaN technology enables us to provide our customers a lower cost SSPA, with high efficiency and higher packaging, while maintaining all of the advantages of the SSPA, such as High Reliability and Power Redundancy.

The application of this series of GaN based SSPA, is to fulfill various requirements of high reliable products at lower cost. Typical applications of this SSPA are for Radar, Data Links, Communications and Test Systems.

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

- **GaN Technology**
- **C or X Band**
- **Band Width: up to 1,000 MHz**
- **Output Power: up to 50W, CW**
- **High Efficiency**



SSPA Model SGN-X3-50

MAIN SPECIFICATION

	PARAMETER	SPECIFICATION	
	MODEL	SGN-X4-20	SGN-X4-50*
1	Frequency Range (GHz)	X Band	
2	Bandwidth, (9%),	9	
3	Output Power, (W)		
3.1	Peak Saturated, Typ.	20	50
3.2	Peak Saturated, Min. (W)	16	40
3.3	Average	Same as Peak	
3.4	Amplitude Flatness, PTP, dB typ.	1	
4	Output Load VSWR	Any Load	
5	Large Signal Gain, min. (dB)	46	50
6	Input RF Drive (dBm)	0 to 5	
7	Pulse Width	Up to CW	
8	Input Supply Voltage (V)		
8.1	32V, max (A)	2.5	8.0
8.2	12V, max. (A)	1.0	1.0
9	DC Power Consumption, max (W)	92	268
10	Efficiency, (%) typ.	25	25
11	Operating Temperature Range (°C)	-30 to +70	
12	Dimensions L x W x H (inc)	3.6 X 3.4 X 0.67	7.25 X 4.75 X 1
12.1	Dimensions L x W xH (mm)	91.44 X 86.36 X 17.02	184.15 X 120.65 X 25.4

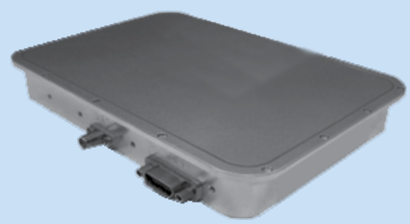
* Special Product, Minimum order applies

SSPA Model SGN-K1-07

Kratos's Ku-band Solid State Power Amplifier (SSPA) is the lightest, most efficient and compact product for embedding into airborne and micro-flyaway SATCOM terminals. The Ku-band SSPA is based on GaN technology to provide high output power efficiency with significant reductions in heat sink and airflow requirements to meet the size, weight and performance requirements for integration into any flyable or mobile SATCOM terminal. The Ku-band SSPA outline can be accommodated to meet customer's specific requirements. Antenna interface is based on a WR62 to minimize transmission loss.

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

- **GaN Technology**
- **Ku Band**
- **Band Width: 500 MHz**
- **Output Power: 7W, CW**
- **High Efficiency**



SSPA Model SGN-K1-07

Most of the Solid State Power Amplifiers (SSPA) supplied by General Microwave have been custom designed to meet specific system requirements. These SSPAs have been fully tested and qualified to meet severe environmental requirements. The following examples represent some of the typical applications of General Microwave's SSPA product line:

a) Airborne RADARS

b) Weather RADARS

c) RADARS for Home Land Security (HLS)

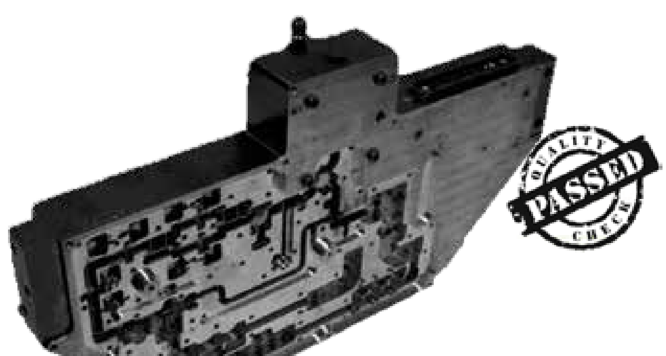
d) Seekers for short range missiles

e) Test Equipment

Certified and fully qualified for airborne application.

Custom SSPA

Certified and fully qualified for
missile application.



Airborne GaN SSPA
TRANSCEIVER

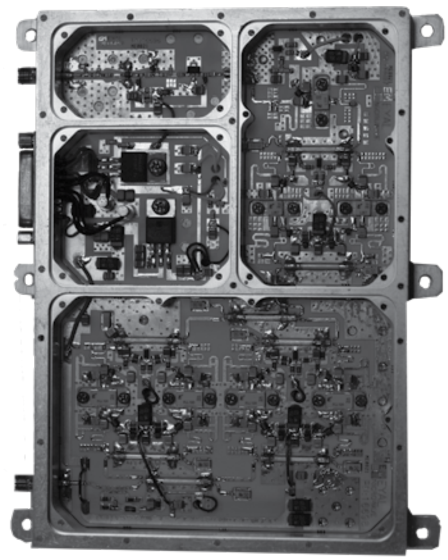
SPECIAL SSPAs

In addition to the Catalog SSPAs, we are offering the following SSPAs as special catalog products.

Model	SPA-X1-400(1)	SPA-KU1-400(1)	SPA-KU2-100(1)
Frequency Range (GHz)	8.5 to 10.9	13.5 to 17.0	13.5 to 17.0
Bandwidth, max (MHz)	400	500	500
Peak Saturated Output Power, min (W)	400	350	100
Average Output Power (W)	100	87.5	25
Pulse Width (µs)	0.2 - 60	0.5 – 250	0.5 – 250
Duty Cycle, max (%)	25	25	25
PRF (kHz)	1 - 600	1 – 600	1 – 600
Input Supply Voltage (V)	22 to 60	22 to 32	22 to 60
Operating Temperature Range (°C)	-40 to +85		
Dimensions, approx. mm (inches)	280 x 140 x75 (11 x 5.5 x 2.9)	280 x 140 x 75 (11 x 5.5 x 2.9)	229 x 178 x 30.5 (9 x 7 x 1.2)

(1) Minimum Order Applies

POWER AMPLIFIER FOR COMMUNICATION



FEATURES

- Radio Telephone Applications
- Band-Width - One Octave
- Class AB (Pulse and Amplitude Linearity)

FEATURES

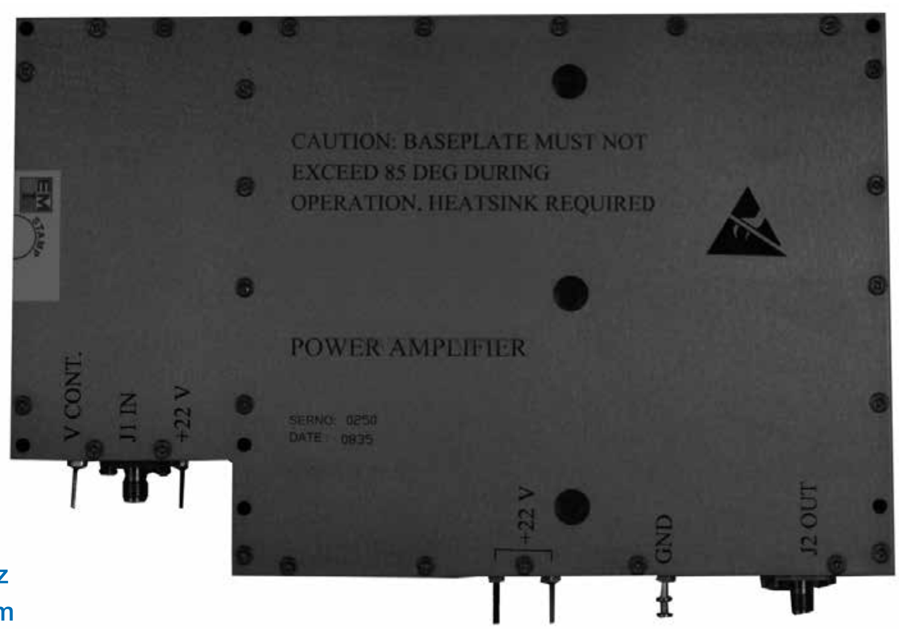
- Frequency Range: 1350-2700 MHz
- Output power at P1dB: 45dBm
- Gain: 44 dB
- DC power Consumption: 110W

POWER AMPLIFIER FOR COMJAM

FEATURES

- Up to 1 kW
- VHF, UHF, L and Cellular frequency bands

POWER AMPLIFIER FOR COMMUNICATION



FEATURES

- Frequency Range: 450-530 MHz
- Output power at P1dB: 48.5dBm
- Gain: 40 dB
- DC power Consumption: 80W

POWER AMPLIFIER FOR UAV DATA-LINK

FEATURES

- VHF, UHF, L and S frequency bands
- Option for Integrated Power Supply (MIL-704 and 461)
- Designed For Frequency Hopping
- Digital Modulation Input
- ALC Power Control
- High Efficiency

(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.

The introduction of the PIN diode more than 45 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.

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_0 as

$$f_0 = \frac{1}{2\pi t},$$

Where t is the minority carrier lifetime, then for frequencies significantly below f_0 the PIN diode will behave as a P-N junction, rectifying the applied a-c signal. For frequencies well above f_0 the diode will behave as a linear resistor. The range of t varies from as low as 10 nsec to as high as 5 µsec, and correspondingly f_0 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 trade-offs 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.

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.

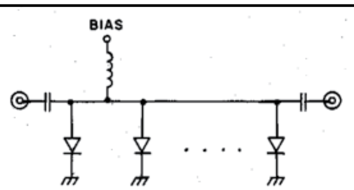


Fig. 1-Shunt mounted reflective attenuator

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 General Microwave covering the frequency range of 0.5 to 40.0 GHz.

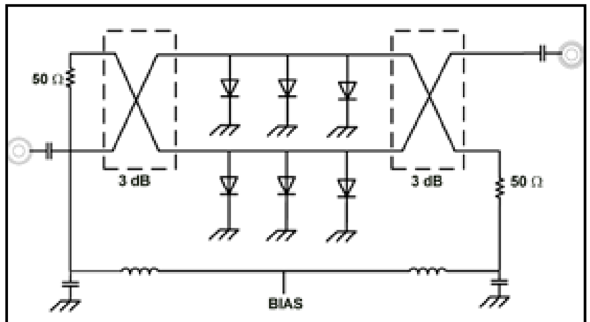


Fig. 2 - Balanced Attenuator

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.

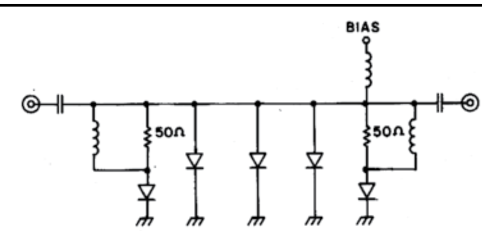


Fig. 3-Array attenuator

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.

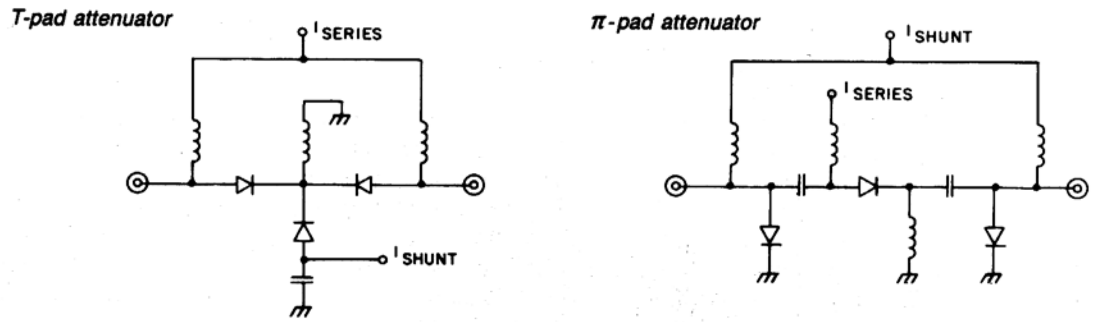


Fig. 4–Attenuator configurations

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.

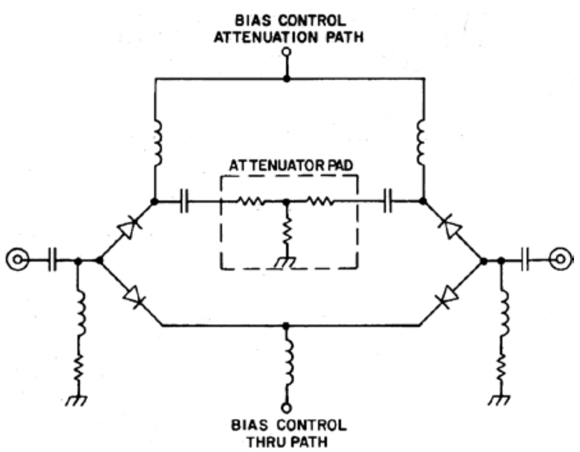


Fig. 5-Switched bit attenuator

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 MTT-S Digest, pp. 673-676.
To obtain a copy of this paper, please write to
SALES, KRATOS GENERAL MICROWAVE

STROBE/LATCH FEATURE - OPTION 4

It is recommended that when operating the Series 349/H Attenuators with the Strobe/Latch Option -4 feature, the digital control inputs should be in place, with the Latch set to a low "(0)" level, before the Attenuator is powered up.

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 monotonic guaranteed.

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

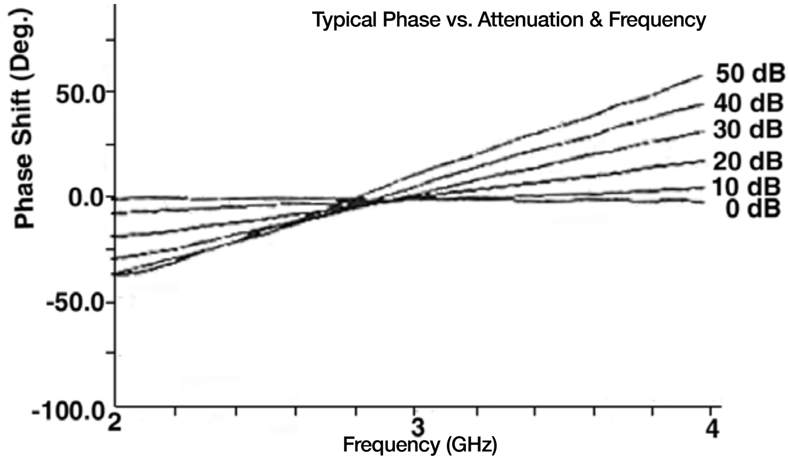
FREQUENCY	2nd ORDER INTERCEPT	3rd ORDER INTERCEPT
2.0 GHz 8.0 GHz	+35 dBm +40 dBm	+30 dBm +35 dBm

POWER HANDLING

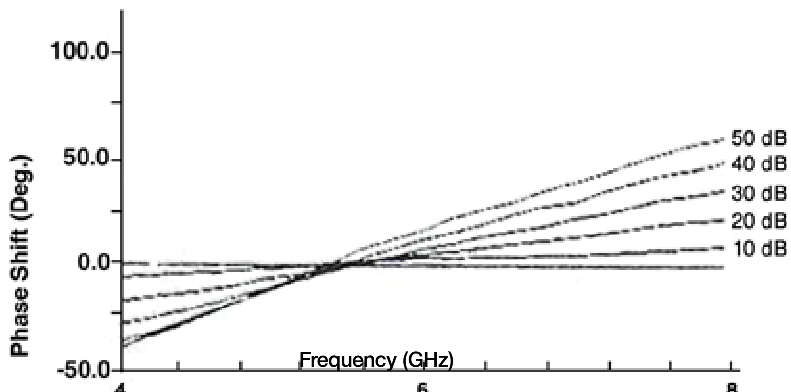
The power handling of a PIN diode attenuator is dependent on its topology, biasing levels, and switching speed. The faster the attenuator, the lower the power handling capability. This catalog specifies both the maximum operating and the maximum survival levels. Maximum operating level is defined as that which will cause 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.

PHASE SHIFT vs. ATTENUATION

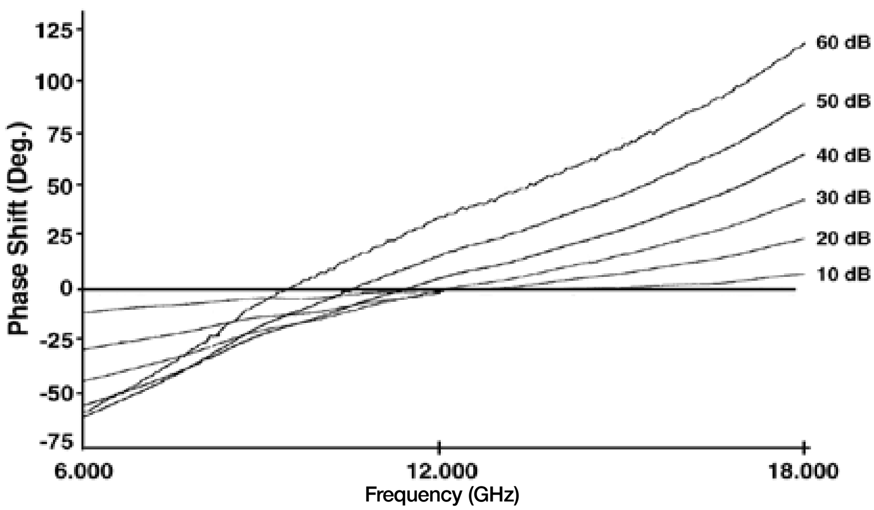
All attenuators exhibit a variation in phase shift with attenuation level (AM/PM modulation). Fig. 6 shows typical phase shift variation as a function of attenuation for a number of GMC attenuator models. The phase shift is attributable to both the stray reactance of the PIN diodes as well as the lengths 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.



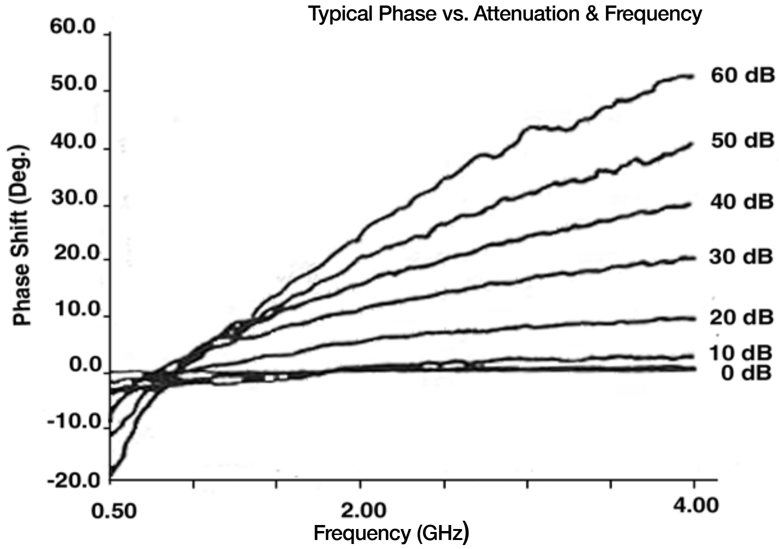
MODELS 1952, D1952 & 3492-64



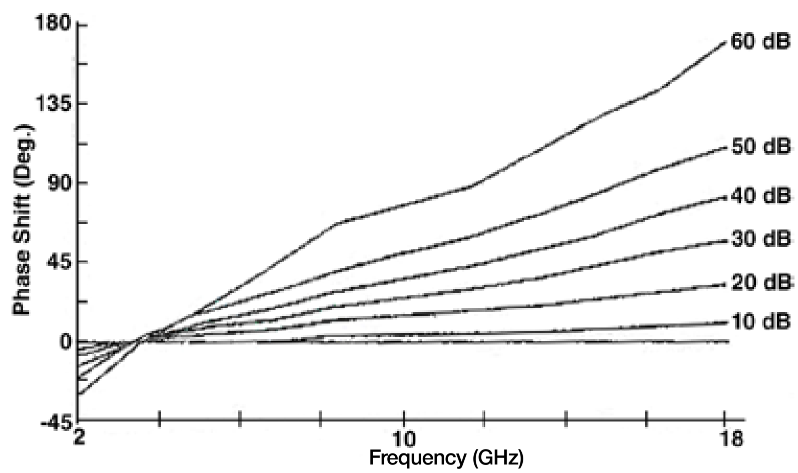
MODELS 1954, D1954 & 3494-64



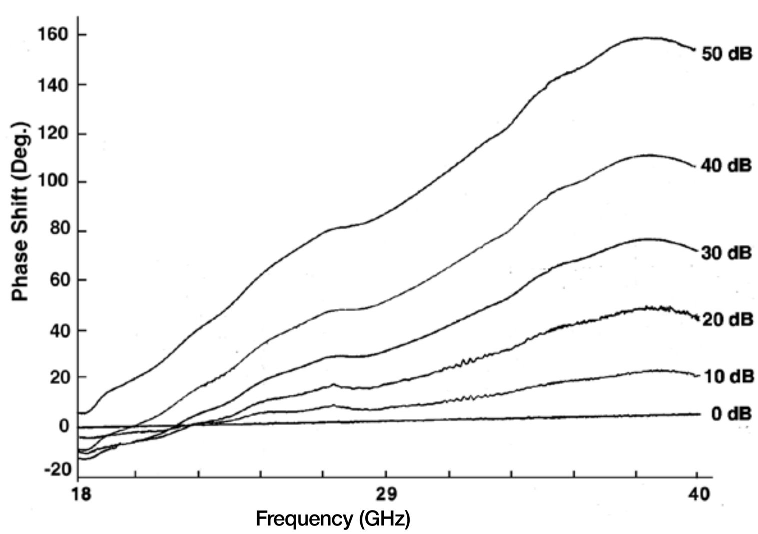
MODELS 1958, D1958 & 3498-64



MODELS D1960 & 3460C

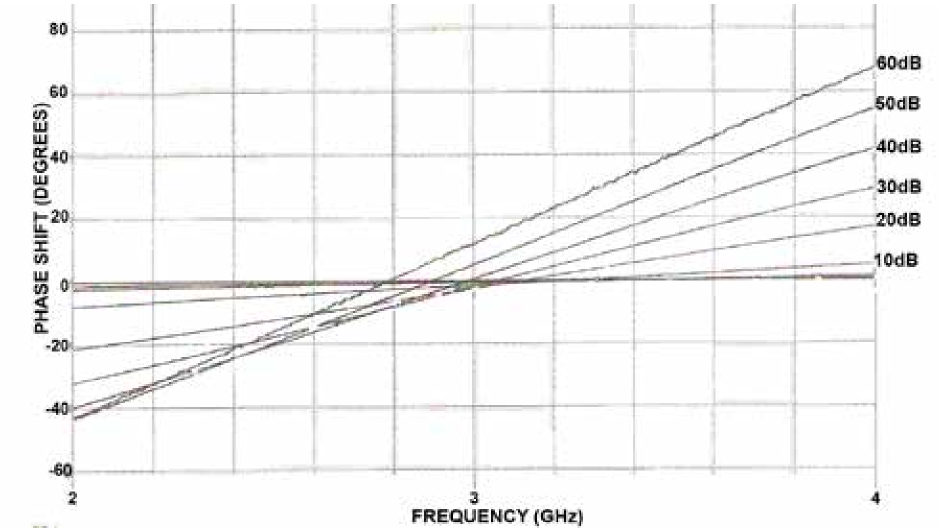


MODELS D1968B, 1761 & 3468C

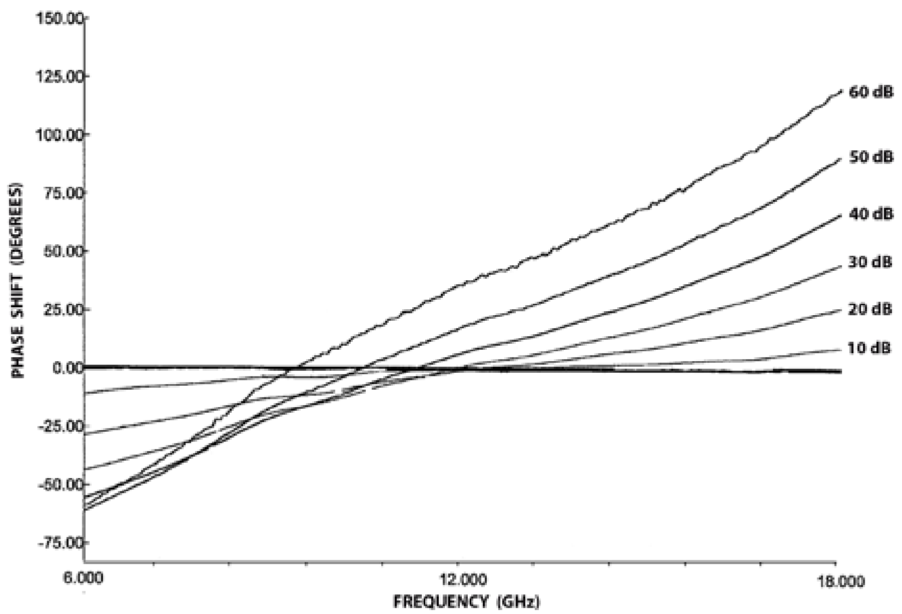


MODELS 1959, D1959 & 3499

Typical Phase vs. Attenuation & Frequency



MODEL 3482



MODEL 3488

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.

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.

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.

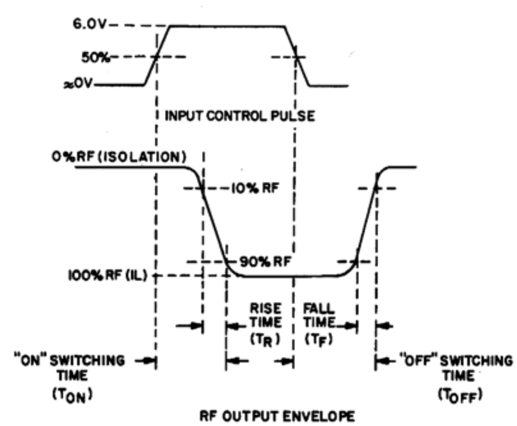


Fig. 8-Switching speed

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

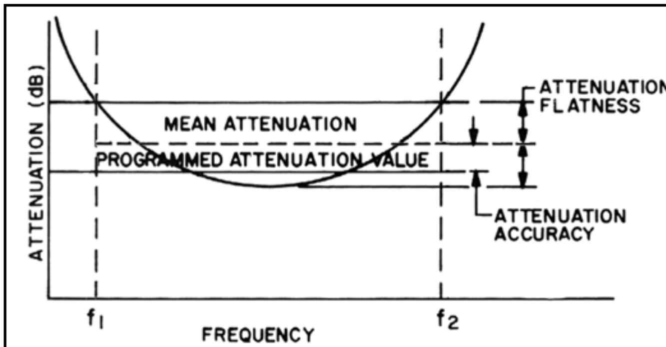


Fig. 7-Total accuracy

ATTENUATORS AND MODULATORS

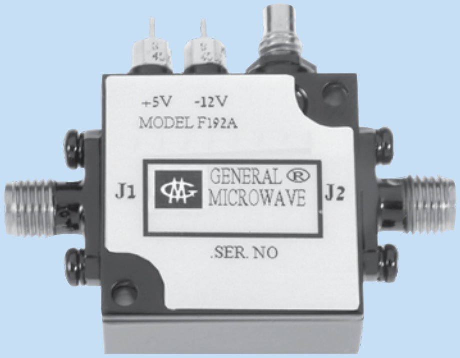
FREQUENCY RANGE (GHz) 0.2 0.5 1.0 2.0 4.0 8.0 12.4 18 40	ATTENUATION RANGE (dB)	MODEL	PAGE	COMMENTS
CONTINUOUSLY VARIABLE, CURRENT CONTROLLED, ABSORPTIVE ATTENUATORS				
0.5 – 1	80	1950A	76	Single control
1 – 2	60	1951		
2 – 4	60	1952		
2.6 – 5.2	60	1953		
4 – 8	60	1954		
5 – 10	60	1955		
6 – 12	60	1956		
8 – 18	60	1958		
18 – 40	50	1959	327	
CONTINUOUSLY VARIABLE, VOLTAGE CONTROLLED, LINEARIZED ABSORPTIVE ATTENUATORS				
0.5 – 4	60	D1960B	84	Integrated driver and RF section
0.5 – 8	60	D1961B		
2 – 8	60	D1962B		
2 – 18	60	D1968B		
0.5 – 1	80	D1950A	80	
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	329	
VOLTAGE CONTROLLED, PHASE INVARIANT, LINEARIZED ATTENUATORS				
2 – 6	32	D1972	87	Integrated driver and RF section
4 – 11	32	D1974		
6 – 18	32	D1978		
HIGH SPEED ABSORPTIVE PULSE MODULATORS				
0.2 – 18	80	F192A	73	Integrated driver and RF section

ATTENUATORS AND MODULATORS (cont.)

FREQUENCY RANGE (GHz) (0.2, 0.5, 1.0, 2.0, 4.0, 8.0, 12.4, 18, 40)	ATTENUATION RANGE (dB)	MIN STEP SIZE (dB)	MODEL	PAGE	COMMENTS
DIGITALLY PROGRAMMABLE ABSORPTIVE ATTENUATORS, ULTRA-BROADBAND					
0.2–18	60	1	3250A	90	Integrated driver and RF section
DIGITALLY PROGRAMMABLE ABSORPTIVE ATTENUATORS, MULTI-OCTAVE BAND					
0.5–4	60	0.06	3460C	93	Integrated driver and RF section
0.5–8	60	0.06	3461C		
2–8	60	0.06	3462C		
2–18	60	0.06	3468C		
DIGITALLY PROGRAMMABLE, PHASE INVARIANT ATTENUATORS, MULTI-OCTAVE BAND					
2–6	32	0.125	3472	96	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	99	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 ATTENUATORS					Integrated driver and RF section
2–18	60	0.5	1761	120	
DIGITALLY PROGRAMMABLE ABSORPTIVE ATTENUATORS, OCTAVE BAND					
1–2	80	0.03	3491, 3491H	104	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	331	

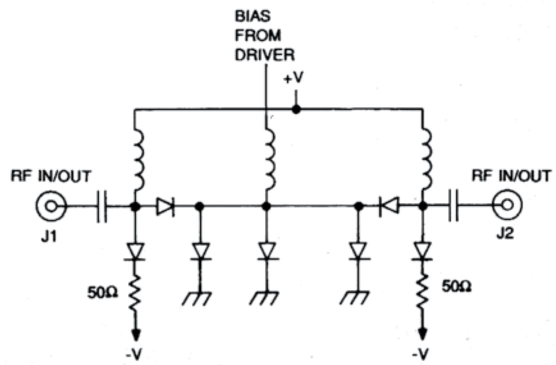
Model F192A Non-Reflective Ultra-Broadband High-Speed Pulse Modulator

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



Pulse Modulator Model F192A

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 20 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.

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range........................–55° 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)

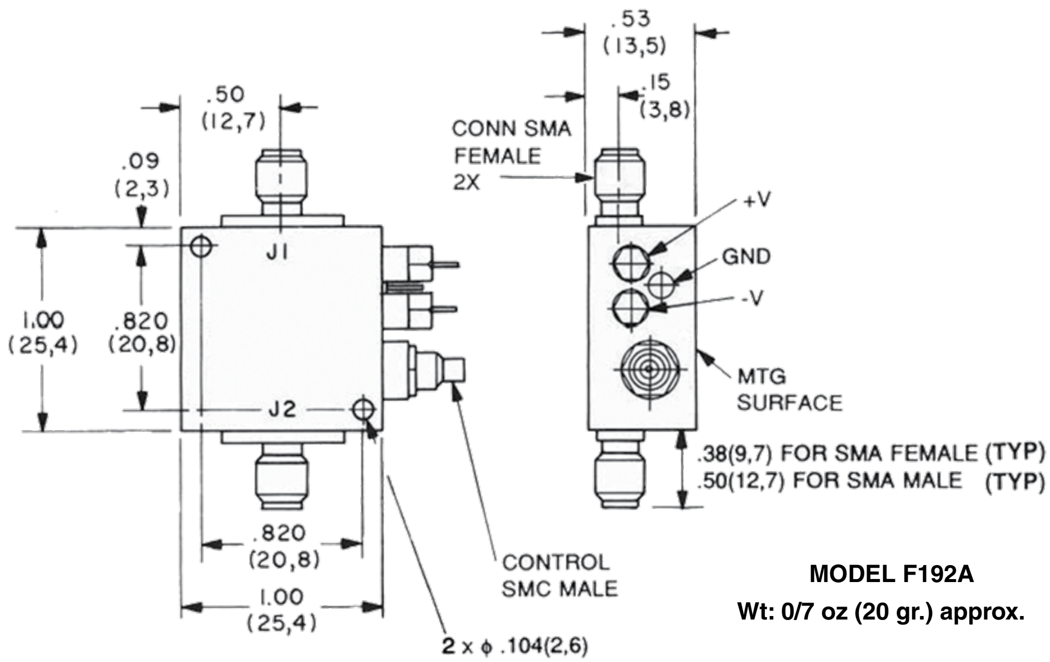
Altitude..........................MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connectors
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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



MODEL F192A
Wt: 0/7 oz (20 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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 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.

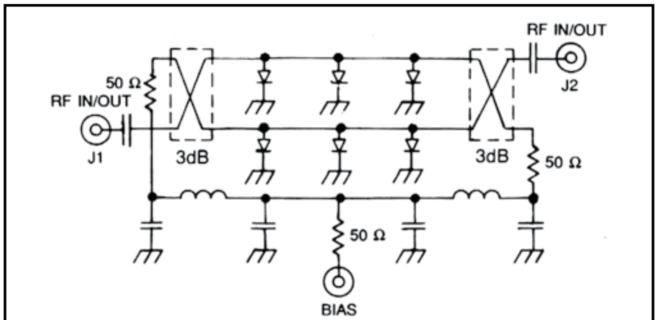


Fig. 1–Models 1951-1958, RF schematic diagram.

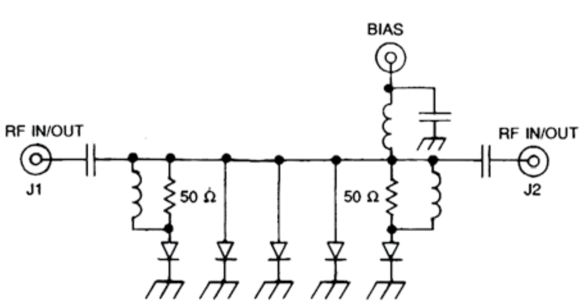
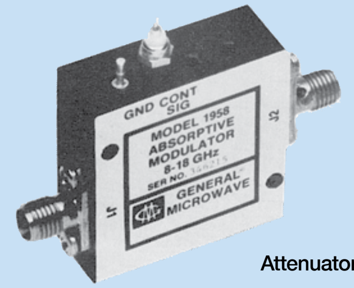
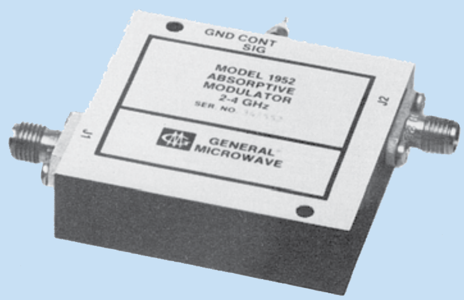


Fig. 2–Model 1950A*, RF schematic diagram.

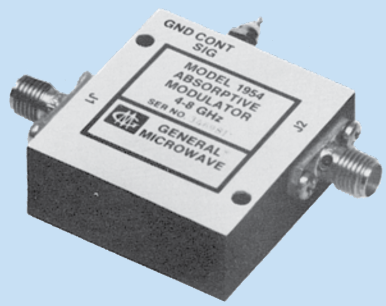
- **Absorptive**
- **Current controlled**
- **0.5 to 18 GHz frequency range**
- **High performance MIC quadrature hybrid design**
- **High speed**



Attenuator Model 1958



Attenuator Model 1952



Attenuator Model 1954

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

Series 195 Specifications

MODEL	FREQUENCY RANGE (GHz)	MAX. INSERTION LOSS (dB)	MAX. VSWR	MAX. 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)	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)	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)	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 (1)	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 (1)	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 (1)	2.4	2.2	0.9	1.5	3.0	3.5	
1958	8.0 – 18.0	2.5(2)	1.8(2)	0.7	1.0	1.5	1.6	
	6.0 – 18.0 (1)	2.5(2)	1.8(2)	0.9	1.5	3.0	3.5	

(1) Specifications for the extended frequency ranges are typical.

(2) Except from 16-18 GHz where insertion loss is 3.5 dB max and VSWR is 2.0 max.

PERFORMANCE CHARACTERISTICS

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

Monotonicity........................ Guaranteed

Phase Shift.......................... See page 67

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° to +125°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(3)
- All other units........... 20 nsec max(3)

Rise Time
- 1950A*...................... 250 nsec max(3)
- All other units........... 125 nsec max(3)

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

(3) For attenuation steps of 10 dB or more.

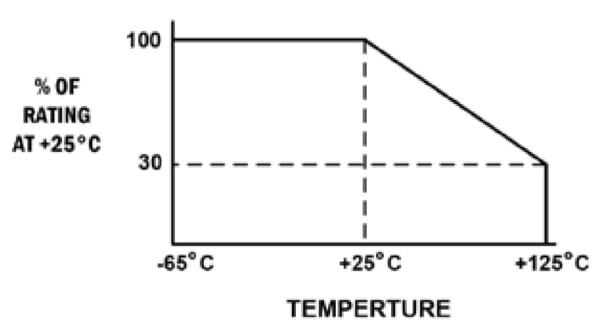


Fig. 4-Series 195 power derating factor

Series 195 Specifications

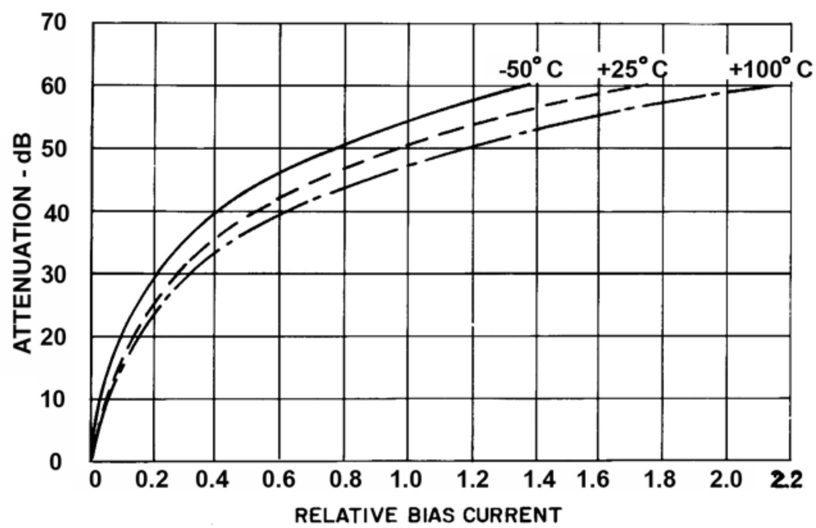


Fig 3–Series 195, typical effects of temperature on attenuation

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range..............................–54°C 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)

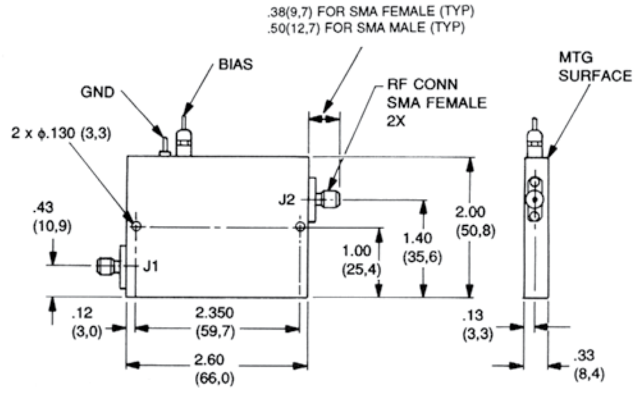
Altitude..................................MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

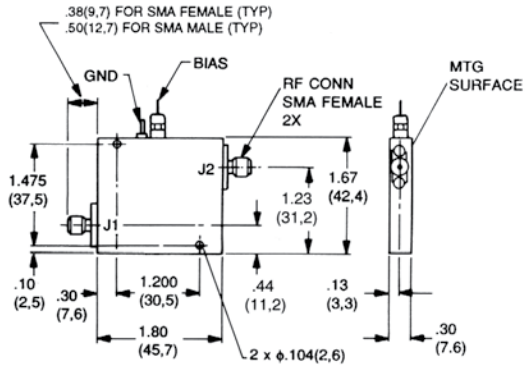
Option No.	Description
3	SMA female bias connector
7	Two SMA male RF connectors
10	One SMA male (J1) and one SMA female (J2) RF connector
64	SMC male bias connector
64A	SMB male bias connector
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHTS

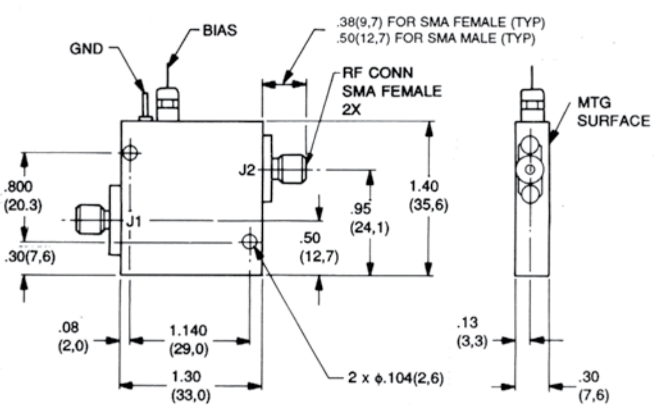


MODELS 1950A*AND 1951
Wt: 3 oz. (85 gr) approx.

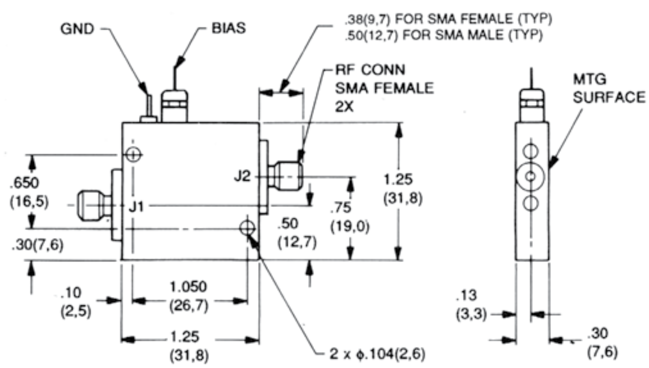
*Model 1950A is a special-order product. Consult factory before ordering.



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



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



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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series D195 Octave-Band PIN Diode Attenuator/Modulators

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.)

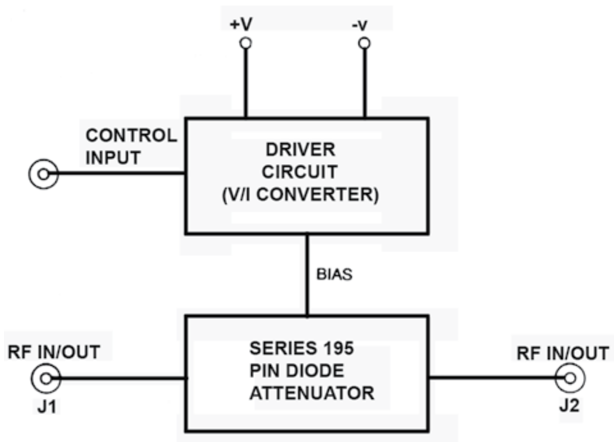


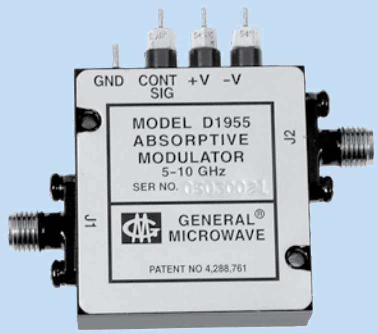
Fig. 1 Series D195, block diagram

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.

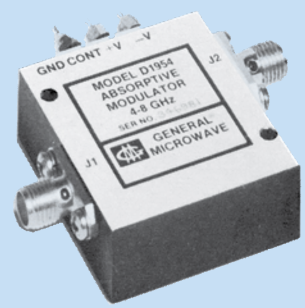
The fall and rise time specifications for the D1950A* are 500 nsec max and 10 μsec max, respectively. Options 58 and 59 are not available for this model.

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

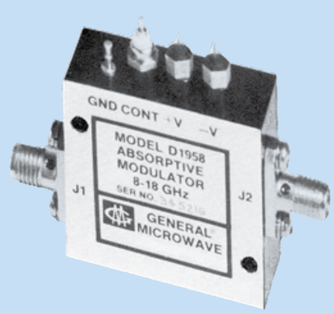
- **Absorptive**
- **Linearized**
- **Frequency range: 0.5 to 18 GHz**
- **High performance MIC quadrature hybrid design**
- **High speed**



Attenuator Model D1955



Attenuator Model D1954



Attenuator Model D1958

ALL UNITS IN THIS SERIES ARE EQUIPPED WITH INTEGRATED DRIVERS

MODEL	FREQUENCY RANGE (GHz)	MAX. INSERTION LOSS (dB)	MAX. VSWR	MAX. FLATNESS (±dB) AT MEAN ATTENUATION LEVELS UP TO				
				10 dB	20 dB	40 dB	60 dB	80 dB
D1950A*	0.5 – 1.0	1.5	2.0	0.3	0.8	1.7	3.0	3.6
D1951	1.0 – 2.0	1.7	1.5	0.3	0.8	1.5	1.6	
	0.75 – 2.25 (1)	1.8	2.0	0.5	1.4	3.0	3.5	
D1952	2.0 – 4.0	2.0	1.5	0.3	0.8	1.5	1.6	
	1.5 – 4.5 (1)	2.1	2.0	0.5	1.4	3.0	3.5	
D1953	2.6 – 5.2	2.2	1.6	0.3	0.8	1.5	1.8	
	1.95 – 5.85 (1)	2.3	2.1	0.5	1.4	3.0	3.5	
D1954	4.0 – 8.0	2.6	1.7	0.3	0.8	1.5	1.6	
	3.0 – 9.0 (1)	2.7	2.2	0.5	1.4	3.0	3.5	
D1955	5.0 – 10.0	2.8	1.7	0.5	0.9	1.5	1.6	
	3.75 – 11.25 (1)	2.9	2.2	0.7	1.4	3.0	3.5	
D1956	6.0 – 12.0	2.9	1.8	0.7	1.0	1.5	1.6	
	4.5 – 13.5 (1)	3.0	2.2	0.9	1.5	3.0	3.5	
D1958	8.0 – 18.0	3.0 (2)	1.8 (2)	0.7	1.0	1.5	1.6	
	6.0 – 18.0 (1)	3.0 (2)	1.8 (2)	0.9	1.5	3.0	3.5	

(1) Specifications for the extended frequency ranges are typical.
(2) Except from 16-18 Ghz where insertion loss is 4.0 dB max and VSWR is 2.0 max.

PERFORMANCE CHARACTERISTICS

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

Accuracy of Attenuation
- 0-30 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 67

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........................... 1W average; 25W 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.................. 30 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 kW

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%, 50 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.

Series D195 Specifications

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range	–54° 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 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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

(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.

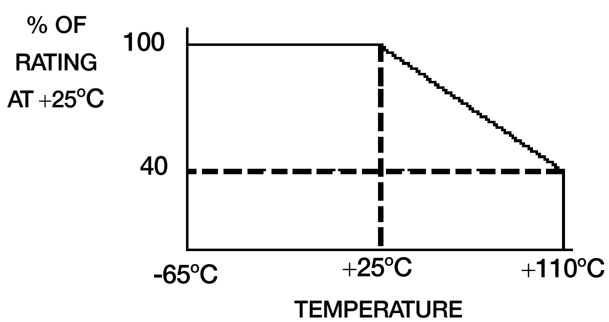
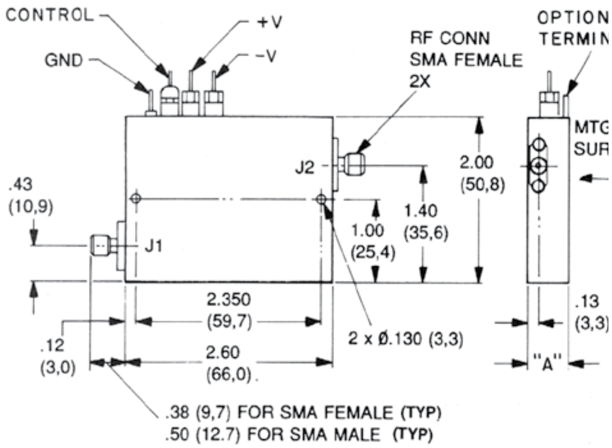


Fig. 2-Series D195, power derating factor

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

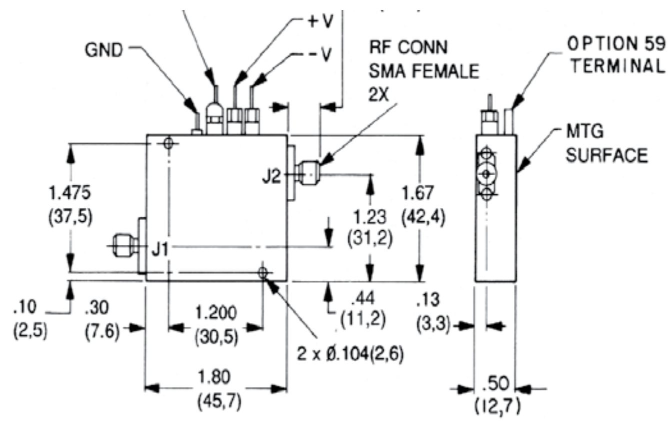
DIMENSIONS AND WEIGHTS



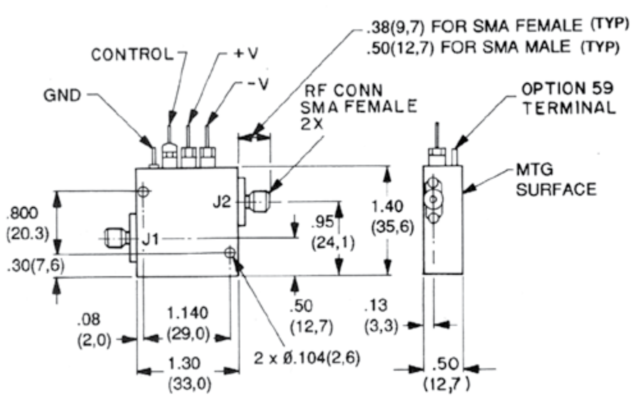
MODEL	DIM "A"
D1950A	.70 (17,8)
D1951	.50 (12,7)

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

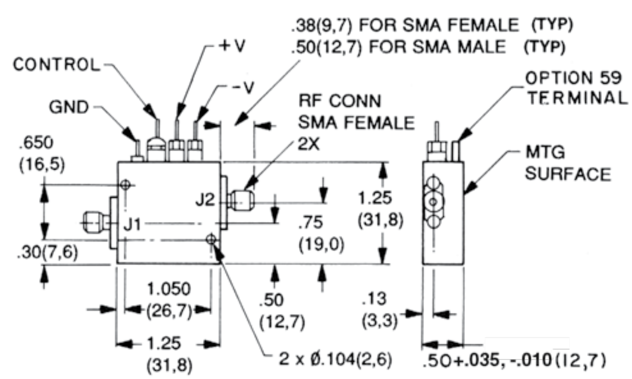
*Model 1950A is a special-order product. Consult factory before ordering.



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



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



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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

D196 Series Multi-Octave PIN Diode Attenuators

The D196 Series is a family of Non-reflective 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.

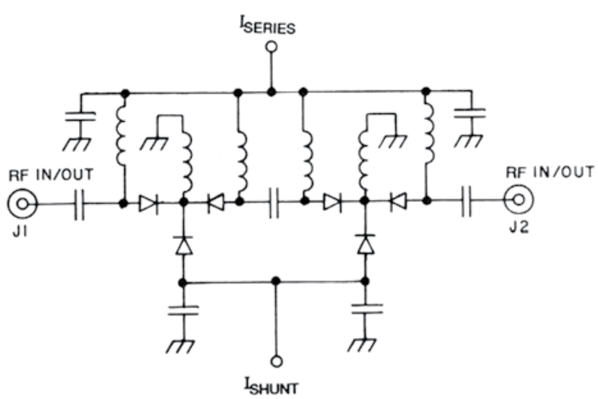


Fig. 1-Series D196, rf schematic diagram

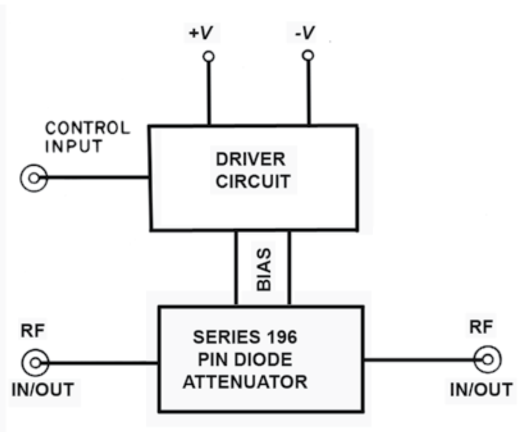


Fig. 2 - Series D196 block diagram

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

Attenuator Model D1968B

All units in this series are equipped with integrated drivers

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)	2.7	2.5 (0.5-4 GHz) 3.2 (4-8 GHz)	3..2	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 to 40 dB .... ±1.5 dB
- 40 to 60 dB .... ±2.0 dB

Monotonicity .... Guaranteed

Phase Shift .... See page 68

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

Power Handling Capability

Without Performance Degradation
- All Units .... Up to 50 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 kW

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

Power Supply
Requirements .... +12V ±5%, 80 mA
–12V ±5%, 50 mA

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

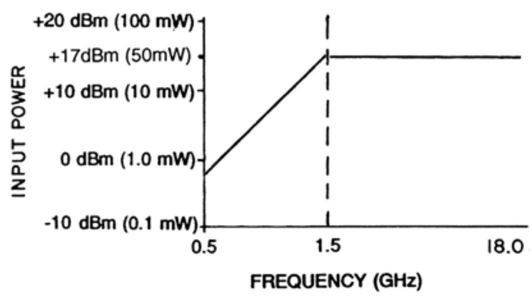


Fig. 3- Series D196, maximum peak and average operating power without performance degradation

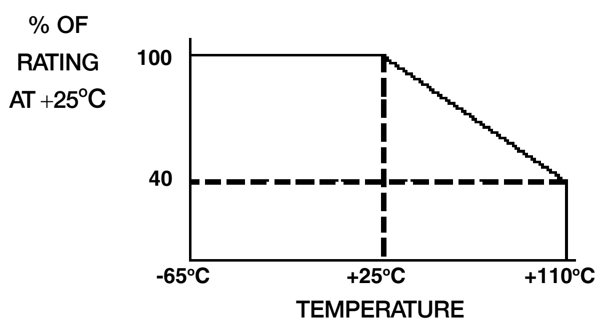


Fig. 4- power derating factor

*Special-order product. Consult factory before ordering.

Series D196 Specifications

OPTION (G09) 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)

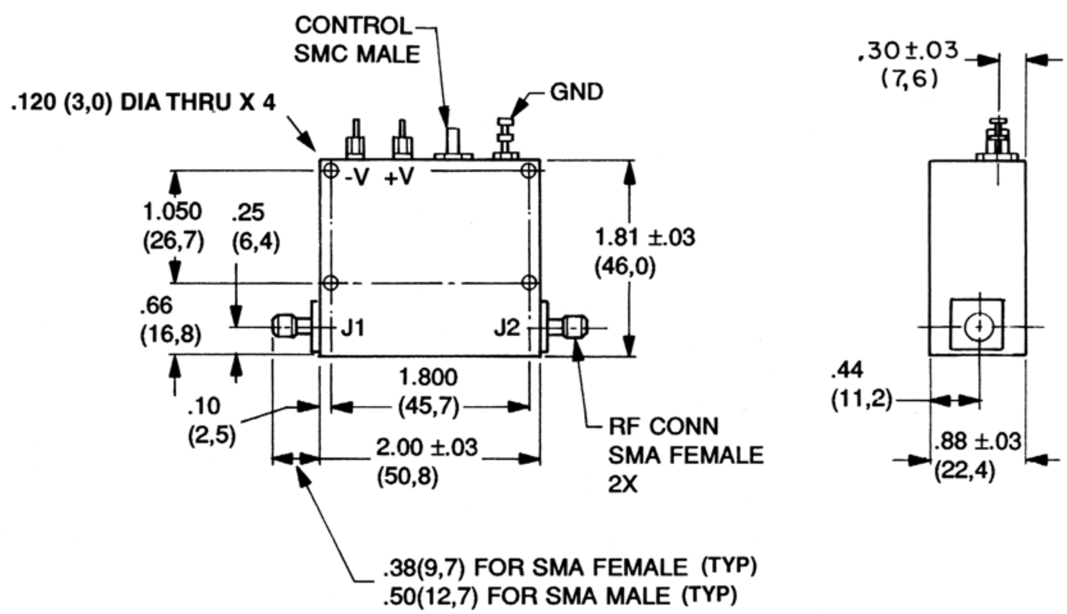
Altitude............................MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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
62	±15V Operation
64A	SMB male control connector
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series D197 Voltage Controlled Phase Invariant Attenuators

- Low phase shift
- Frequency range: 2-18 GHz
- Non-reflective
- Attenuator range: to 45 dB
- Linearized control: 10 dB/V
- High Speed

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

Attenuator Model D1972

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.

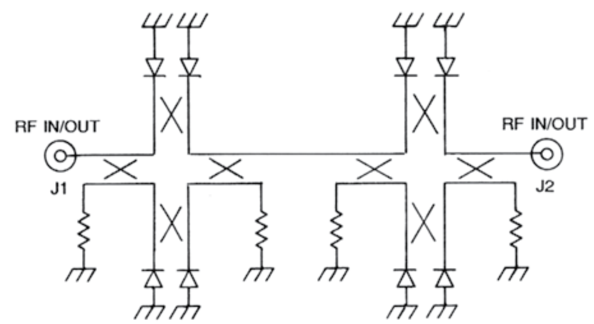
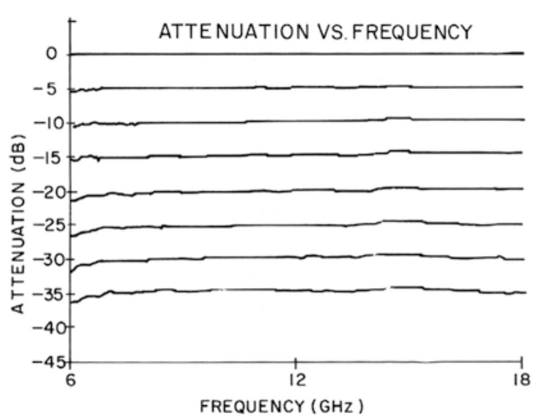
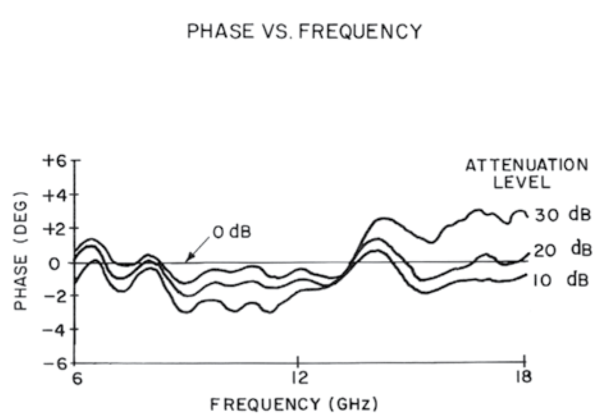


Fig. 1-RF schematic diagram

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	7 dB
VSWR (Max)		2.0		3.0
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°
Control Voltage		0-3.2 V		
Control Input Impedance		10 kW		
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.

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range..........–54° 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)

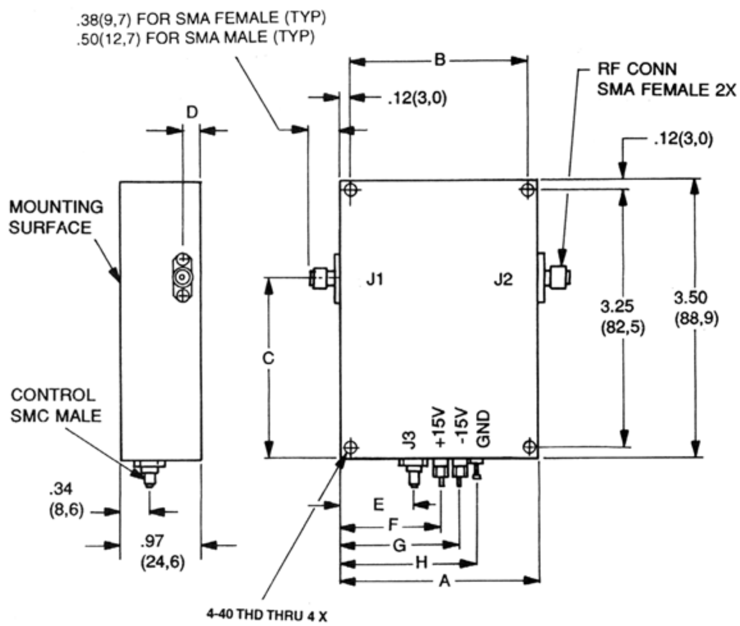
Altitude..........MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



SERIES D197
Wt: 5 oz. (142 gr) 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 ±.008

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

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.

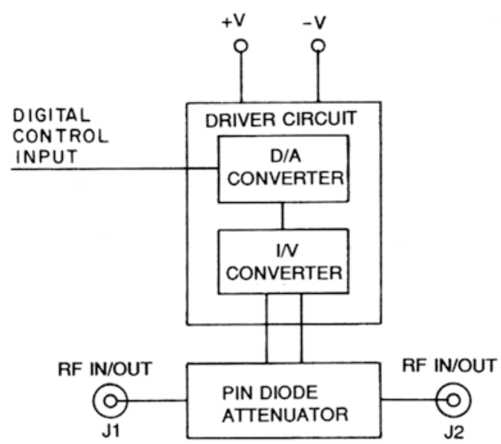


Fig. 1-Model 3250A, block diagram

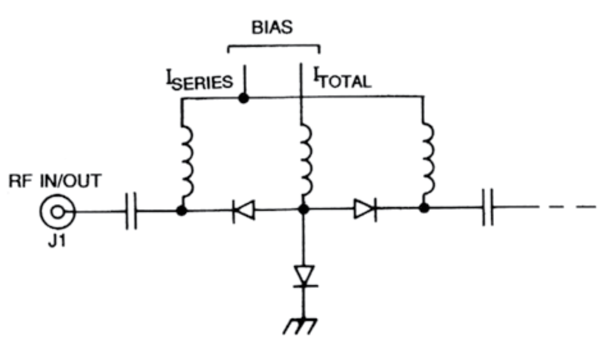
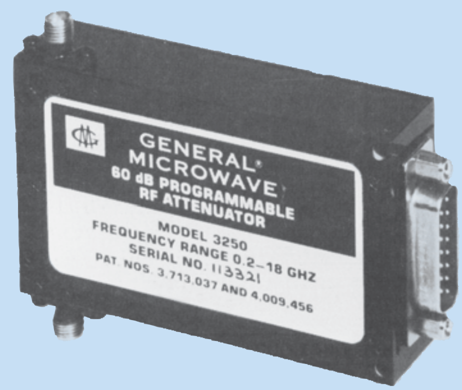


Fig. 2-Model 3250A, RF schematic diagram (unit consists of two such sections)

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



Attenuator Model 3250A

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
>30 to 50 dB .... ±0.75 dB
>50 to 60 dB .... ±1.5 dB

Flatness of Attenuation

0 to 30 dB .... ±1.0 dB
>30 to 40 dB .... ±1.5 dB
>40 to 50 dB .... ±2.0 dB
>50 to 60 dB .... ±3.0 dB

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

Power Handling Capability

Without Performance Degradation .... Up to 50 mW 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

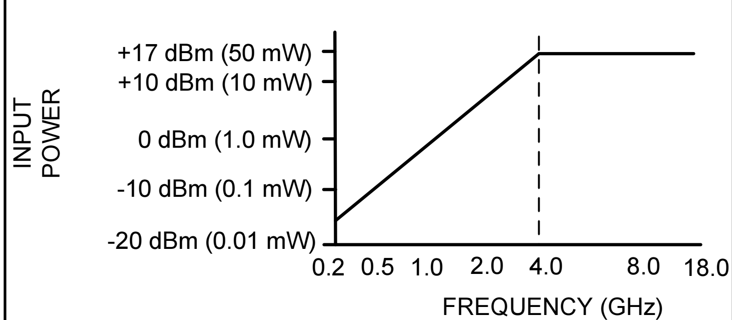


Fig. 3-Model 3250A, maximum peak and average operating power without performance degradation

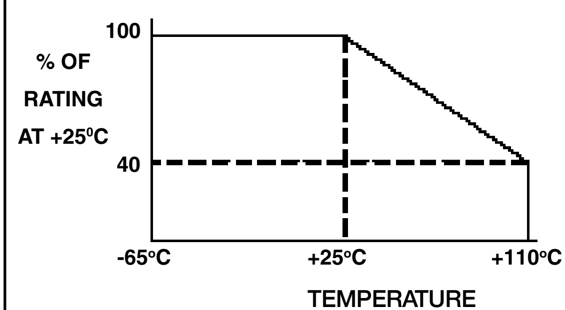


Fig. 4-Model 3250A, survival power derating factor

Model 3250A Specifications

OPTION (G09) 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

ACCESSORY FURNISHED

Mating power/logic connector

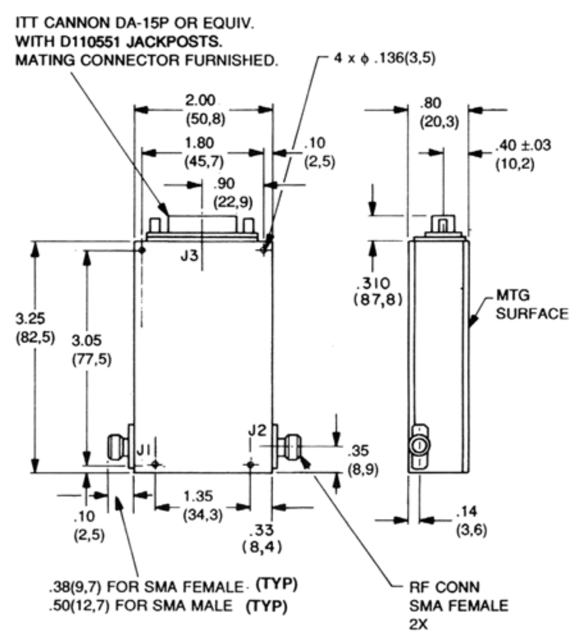
AVAILABLE OPTIONS

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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

*Special order product. Consult factory before ordering. In addition, consult factory for impact on specifications; i.e., VSWR and insertion loss and availability.

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

DIMENSIONS AND WEIGHT

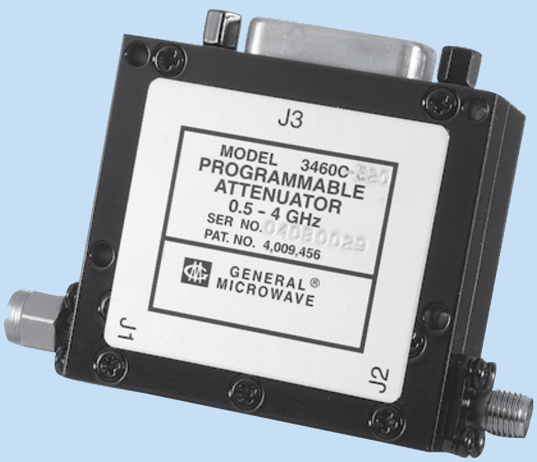


MODEL 3250A
Wt: 4 oz. (113 gr) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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

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



Attenuator Model 3460C

The 346C Series is a family of Non-reflective 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 of 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.

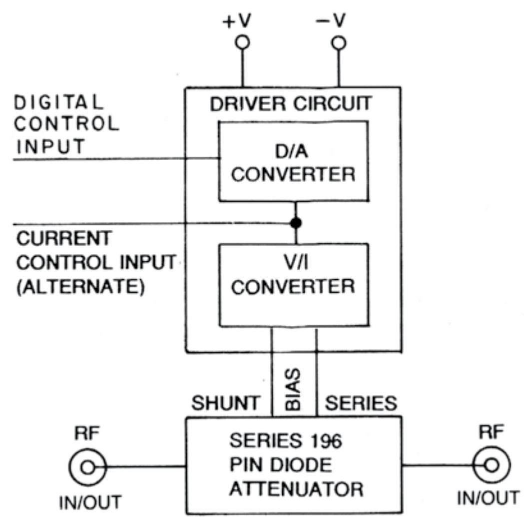


Fig. 1-Series 346C, block diagram

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) 3.2 (4-8 GHz)	3.2	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

*Special-order product. Consult factory before ordering.

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 68

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

Power Handling Capability
- Without Performance Degradation............ Up to 50 mW cw or peak (see figure 3)
- Survival Power............ 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(1)

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

Nominal Control Voltage Characteristics
- Range............ 0 to 3 mA
- Transfer Function............ 20 dB/mA
- Input Impedance .... 3 kW

Power Supply
- **Requirements**............ +12V ±5% , 90 mA; –12V ±5%, 60 mA

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

(1) 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.

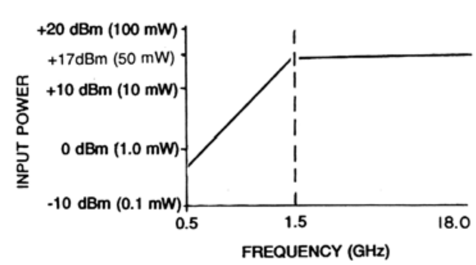


Fig. 2- Series 346C, maximum peak and average operating power without performance degradation

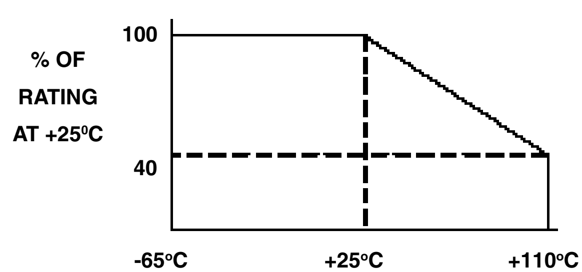


Fig. 3-Model 346C, survival power derating factor

OPTION (G09) 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

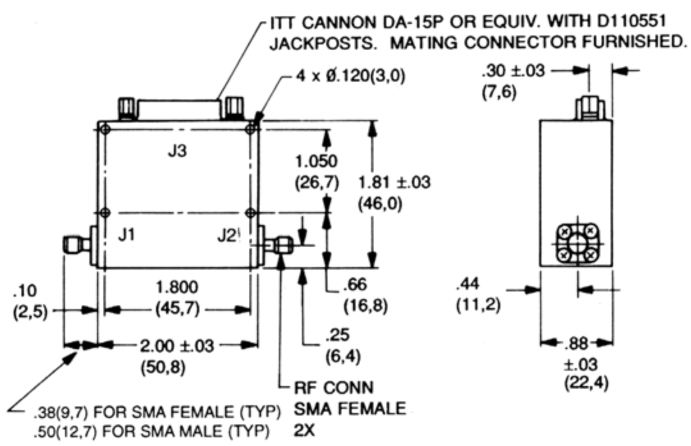
AVAILABLE OPTIONS

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
62	±15 Volt operation
C38	30 dB attenuation range. Consult factory for impact on specifications.
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant
G12	1 to 18 GHz operation. I.L. 4.8 dB max. (model 3468C)

ACCESSORY FURNISHED

Mating power/logic connector

DIMENSIONS AND WEIGHT



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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PIN	J3 PIN FUNCTIONS (1) (4)
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)

(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. If not used as described in (a), (b) or (c), Pin 2 must be open.

(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.

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.

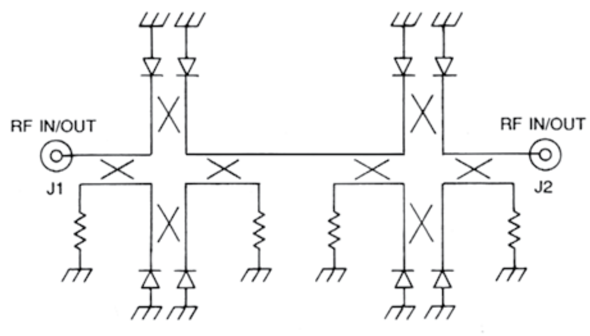


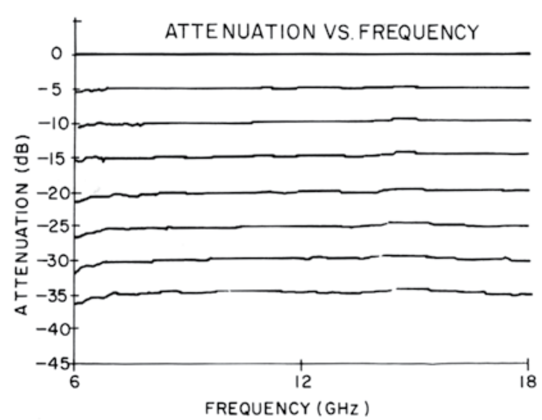
Fig. 1—RF schematic diagram

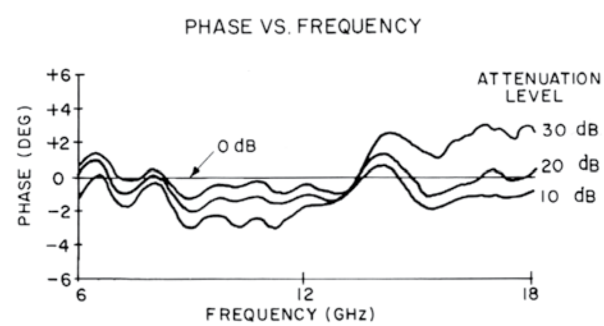
- **Low phase shift**
- **Frequency range: 2-18 GHz**
- **Non-reflective**
- **Attenuator range: to 45 dB**
- **LSB 0.125 dB**
- **High Speed**

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

Attenuator Model 3474

TYPICAL PERFORMANCE





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	7 dB
VSWR (Max)		2.0		3.0
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

OPTION (G09) 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

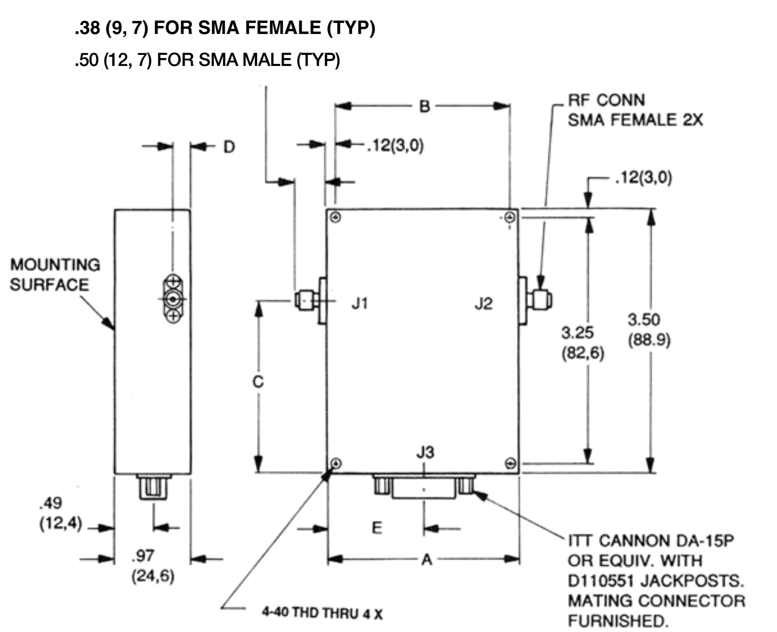
Option No.	Description
7	Two SMA male RF connectors
10	One SMA male (J1) and one SMA female (J2) RF connector
45	Extended attenuation range to 45 dB
65	±12V operation
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

ACCESSORY FURNISHED

Mating power/logic connector

J3 PIN FUNCTIONS		
PIN NO.	BINARY	OPTION 45
1	–15V	–15V
2	+15V	+15V
3	Do Not Connect	Do Not Connect
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 sB	0.35 dB
13	1 dB	1.41 dB
14	NOT USED	NOT USED
15	+5V	+5V

DIMENSIONS AND WEIGHT



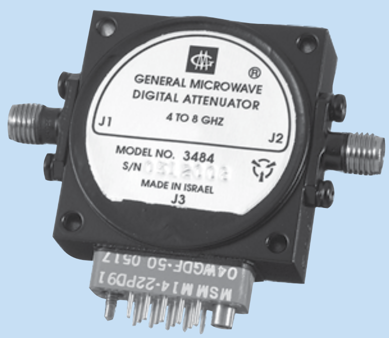
SERIES 347
Wt. 5 oz. (142 gr) approx.

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 ±.008

Series 348 and 348H
8 Bit Digital/Analog Attenuators

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



Attenuator Model 3484

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.

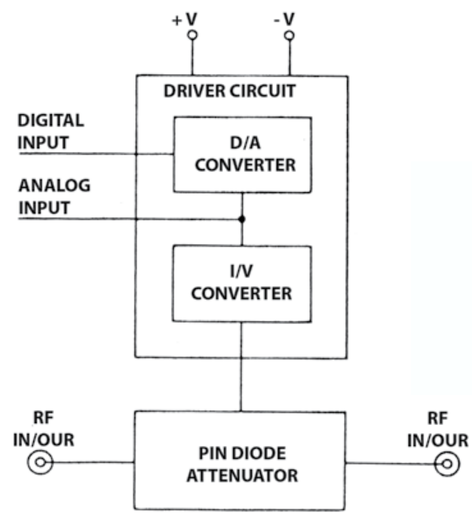
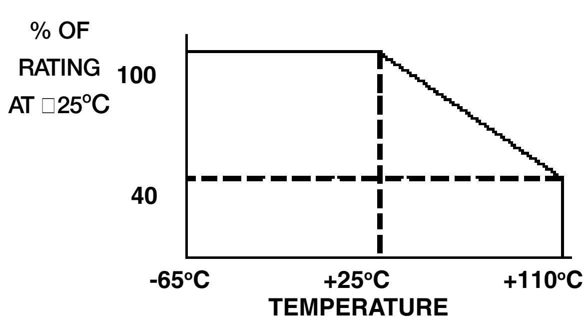


Figure 1
Series 348/H block diagram



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	0.5	1.0	1.5	1.6
	1.5-4.5(1)	1.9	2.0	0.7	1.6	3.0	3.5
3483*/H*	2.6-5.2	2.0	1.6	0.5	1.0	1.5	1.6
	1.95-5.85(1)	2.1	2.1	0.7	1.6	3.0	3.5
3484/H	4.0-8.0	2.4	1.7	0.5	1.0	1.5	1.6
	3.0-9.0(1)	2.5	2.2	0.7	1.6	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(1)	2.8	2.2	0.9	1.6	3.0	3.5
3488/H	8.0-18.0	3.0(2)	1.8(3)	0.7	1.0	1.5	1.6
	6.0-18.0(1)	3.0(2)	1.8(3)	0.9	1.6	3.0	3.5

*Special-order product. Consult factory before ordering.

(1) Specifications for the extended frequency ranges are typical.
(2) For 3488, 4.0 dB from 16-18 GHz. For 3488H, 3.5 dB from 12-16 GHz and 4.0 dB from 16-18 GHz.
(3) VSWR is 2.0 from 16-18 GHz.

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 page 69

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 +0.8 V
- Logic "1" .... +2.0 to +5.0 V
- Logic Input Current .... 10 μA max

Analog Input Characteristics(4)
- **Range**................................ 0 to 6V
- Transfer Function................ 10 dB/V
- Input Resistance .... 6 kW

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

OPTION (G09) ENVIRONMENTAL RATINGS

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

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

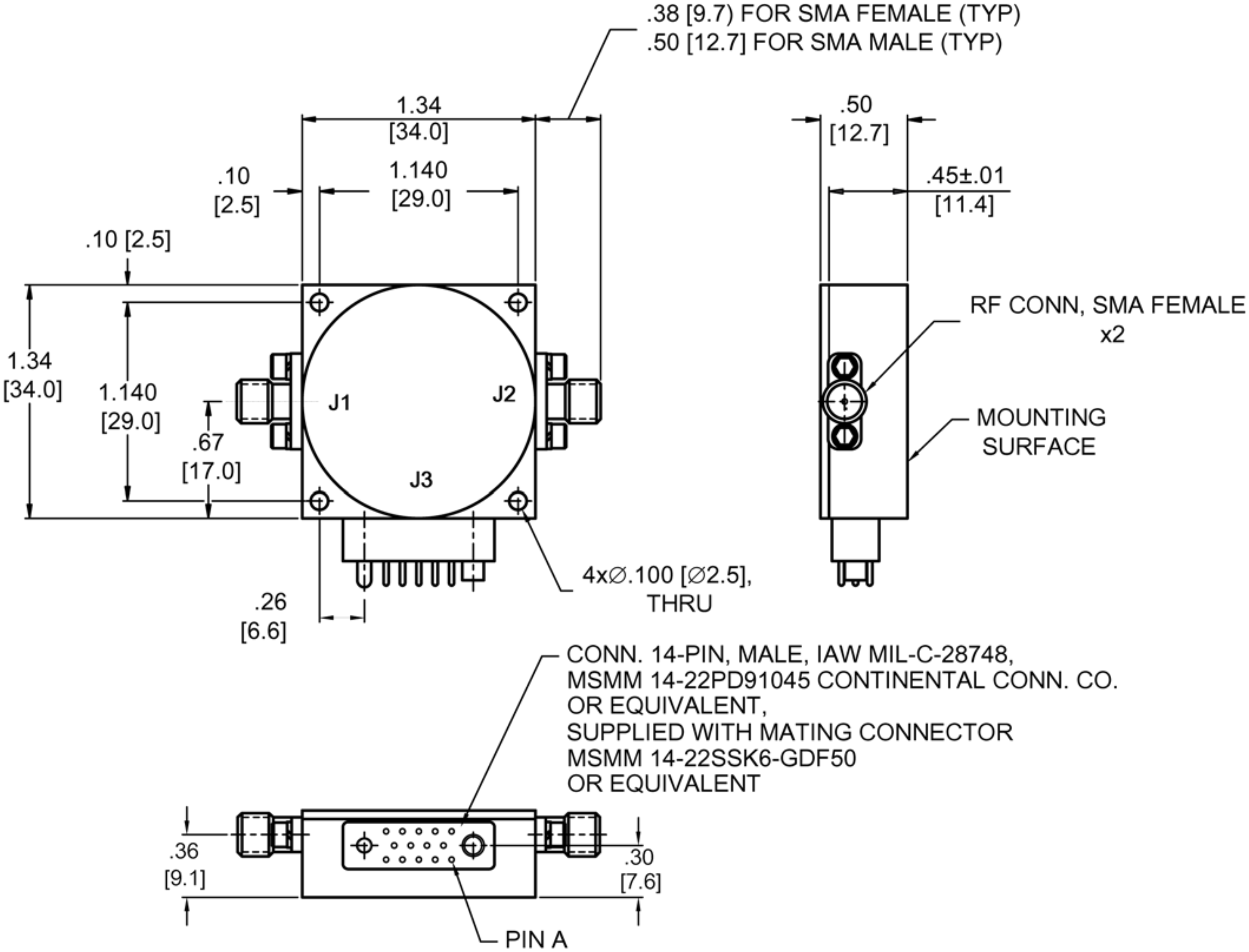
ACCESSORY FURNISHED

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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



SERIES 348/H

wt: 2.4 oz. (68 gr) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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. If Analog input is not to be used, then 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_O) of up to 500 ohms, the attenuation error is approximately $-.0017 \bullet R_O \bullet V_{IN}$ 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.

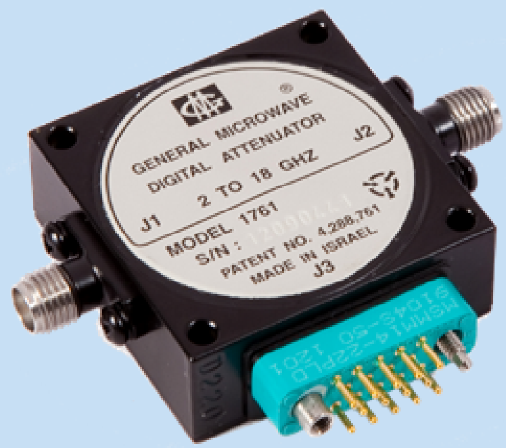
Model 1761 Multi-Octave Digitally Controlled Miniature PIN Diode Attenuator

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.

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



Attenuator Model 1761

PERFORMANCE CHARACTERISTICS

Frequency Range .... 2 to 18 GHz
Mean Attenuation Range ...... 60 dB
Insertion Loss, max. .... 4.5 dB
VSWR, max. 2.0:1
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
Phase Shift.............................. See page 68
Power Handling Capability
Without Performance
Degradation .... Up to 50 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 +0.8 V
Logic “1” (Bit ON)............... +2.0 to +5.0 V
Input Current .... 10 µA 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

OPTION (G09) 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

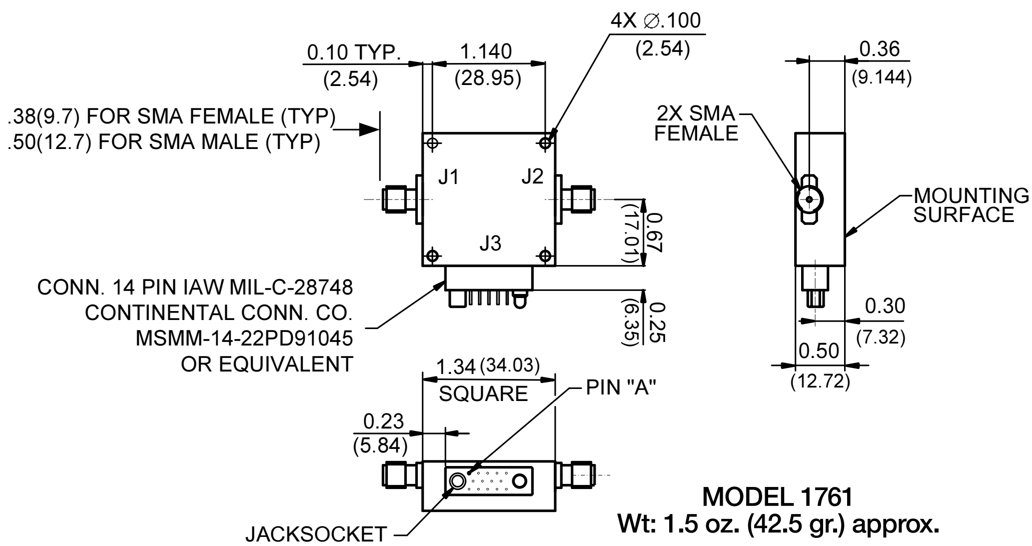
AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

ACCESSORY FURNISHED

Mating power/logic connector

DIMENSIONS AND WEIGHT



MODEL 1761
Wt: 1.5 oz. (42.5 gr.) approx.

PIN Function	
PIN	**FUNCTION**
A	GND
B	LSB 0.5 dB
C	□V
D	N.C.
E	1dB
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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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 less than 300 nsec with essentially the same performance specifications as the 64 dB Series 349 units.

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.

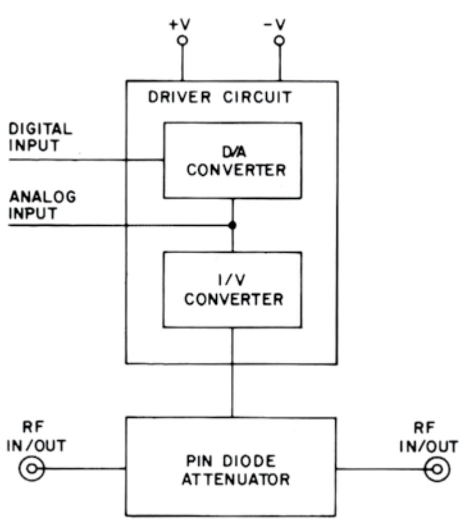
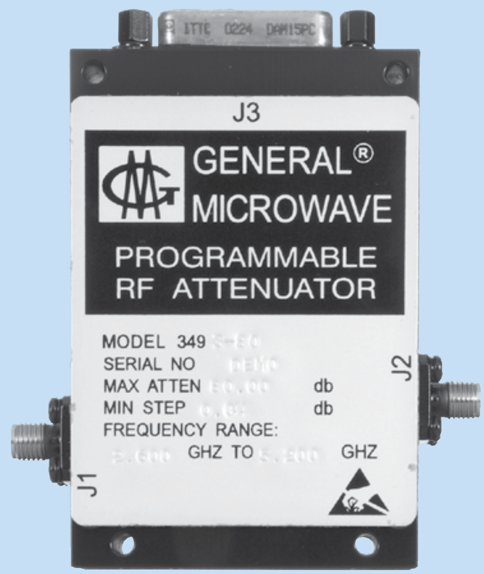


Fig. 1–Series 349 and 349H block diagram

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



Attenuator Model 3498

PERFORMANCE CHARACTERISTICS: SERIES 349

MODEL	FREQUENCY RANGE GHz	MAX. INSERTION LOSS (dB)	MAX. VSWR	MAX. FLATNESS (±dB) AT MEAN ATTENUATION LEVELS UP TO				
				10 dB	20 dB	40 dB	60 dB[4]	80 dB[1]
3491-64 3491-80	1.0-2.0	1.6	1.5	0.3	0.8	1.5	1.6	1.9
	0.75-2.25[2]	1.7	2.0	0.5	1.4	3.0	3.5	3.8
3492-64 3492-80	2.0-4.0	1.8	1.5	0.3	0.8	1.5	1.6	1.9
	1.5-4.5[2]	1.9	2.0	0.5	1.4	3.0	3.5	3.8
3493-64 3493-80	2.6-5.2	2.0	1.6	0.3	0.8	1.5	1.6	1.9
	1.95-5.85[2]	2.1	2.1	0.5	1.4	3.0	3.5	3.8
3494-64 3494-80	4.0-8.0	2.4	1.7	0.3	0.8	1.5	1.6	1.9
	3.0-9.0[2]	2.5	2.2	0.5	1.4	3.0	3.5	3.8
3495-64 3495-80	5.0-10.0	2.6	1.7	0.5	0.9	1.5	1.6	1.9
	3.75-11.25[2]	2.7	2.2	0.7	1.4	3.0	3.5	3.8
3496-64 3496-80	6.0-12.0	2.7	1.8	0.7	1.0	1.5	1.6	1.9
	4.5-13.5[2]	2.8	2.2	0.9	1.5	3.0	3.5	3.8
3498-64	8.0-18.0	3.0[3]	1.8[3]	0.7	1.0	1.5	1.6	—
	6.0-18.0[2]	3.0[3]	1.8[3]	0.9	1.5	3.0	3.5	—

PERFORMANCE CHARACTERISTICS: SERIES 349H

MODEL	FREQUENCY RANGE GHz	MAX. INSERTION LOSS (dB)	MAX. VSWR	MAX. FLATNESS (±dB) AT MEAN ATTENUATION LEVELS UP TO			
				10 dB	20 dB	40 dB	60 dB[4]
3491H-64	1.0-2.0	1.6	1.5	0.5	1.0	1.5	1.6
	0.75-2.25[2]	1.7	2.0	0.7	1.6	3.0	3.5
3492H-64	2.0-4.0	1.8	1.5	0.5	1.0	1.5	1.6
	1.5-4.5[2]	1.9	2.0	0.7	1.6	3.0	3.5
3493H-64	2.6-5.2	2.0	1.6	0.5	1.0	1.5	1.6
	1.95-5.85[2]	2.1	2.1	0.7	1.6	3.0	3.5
3494H-64	4.0-8.0	2.4	1.7	0.5	1.0	1.5	1.6
	3.0-9.0[2]	2.5	2.2	0.7	1.6	3.0	3.5
3495H-64	5.0-10.0	2.6	1.7	0.7	1.0	1.5	1.6
	3.75-11.25[2]	2.7	2.2	0.9	1.6	3.0	3.5
3496H-64	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	1.6	3.0	3.5
3498H-64	8.0-18.0	3.0[3]	1.8[3]	0.7	1.0	1.5	1.6
	6.0-18.0[2]	3.0[3]	1.8[3]	0.9	1.6	3.0	3.5

(1) Applicable only to 80 dB versions.
(2) Specifications for the extended frequency ranges are typical.
(3) Except from 16-18 GHz where insertion loss is 4.2 dB max. and VSWR is 2.2.
(4) Flatness specification at 64 dB level is ±0.2 dB higher than at 60 dB.

Series 349 and 349H Specifications

(5) The Series 349 attenuators are 11-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 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.

(6) Switching speed for analog input is 100 μsec. typical. With Option G06 it is not greater than with digital input.

(7) For average attenuation of 80 dB the analog voltage is in the range of 4 to 8 V.

(8) For average attenuation of 80 dB the analog voltage is in the range of 6 to 10 V.

Mean Attenuation 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

Phase Shift .... See page 67

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

Power Handling Capability

Without Performance Degradation
- 3491, 3492H thru 3498H ...... 10 mW cw or peak
- 3491H .... 1 mW 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 .... 550 nsec max.
- 349(x)-80 .... 2 μsec max

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

Minimum Attenuation Step(5)

Binary Units
- 349(x)-64, 349(x)H-64 .... 0.03 dB
- 349(x)-80 .... 0.04 dB

BCD Units .... 0.10 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 Sink Current .... 0.3 mA max.
- Logic Input Source Current .... 3 μA max.

Analog Input (6)
- 349(x)-64, 349(x)H-64 .... 0 to 6.4 V (7)
- 349(x)-80 .... 0 to 8 V (8)
- Input Resistance .... 10k ±20% W

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

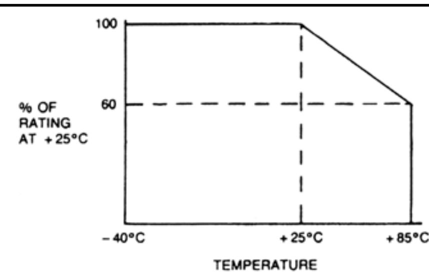


Fig. 2–Series 349 and 349H, power derating factor

OPTION (G09)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

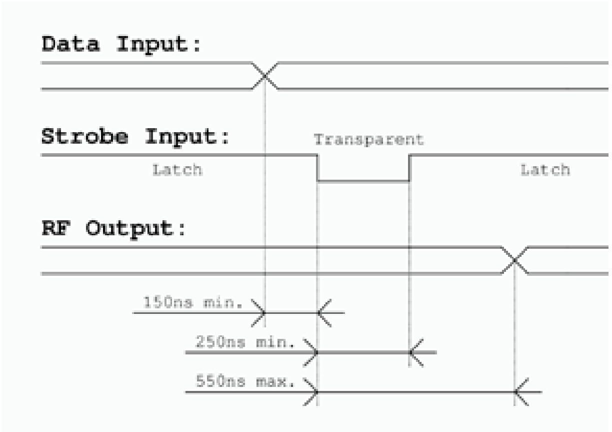


Fig. 3 - Timing Diagram

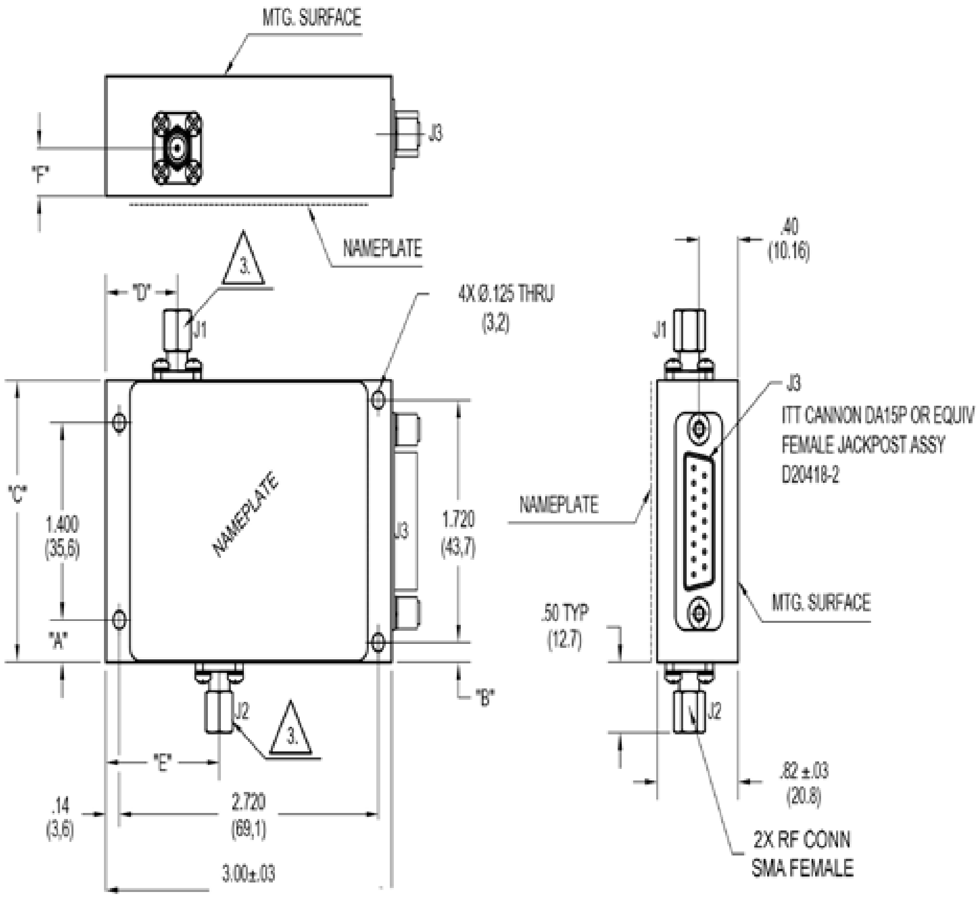
ACCESSORIES FURNISHED

Mating power/logic connector

AVAILABLE OPTIONS

Option No.	Description
1	BDC programming (Binary is standard)
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 - See fig. 3
G06	Switching speed for analog input is no longer than with a digital input.
7	Two SMA male RF connectors
10	One SMA male RF connector (J1) and one SMA female RF connector (J2)
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHTS



MODEL	DIM "A"	DIM "B"	DIM "C"	DIM "D"	DIM "E"	DIM "F"
3491	.58 (14.7)	.42 (10.7)	2.56±.03 (65.0)	.56 (14.2)	1.53 (38.9)	.34 (8.6)
3492,93	.30 (7.6)	.14 (3.6)	2.00±.03 (50.8)	.50 (12.7)	1.29 (32.8)	.34 (8.6)
3494,95,96	.30 (7.6)	.14 (3.6)	2.00±.03 (50.8)	.75 (19.1)	1.19 (30.2)	.34 (8.6)
3498	.30 (7.6)	.14 (3.6)	2.00±.03 (50.8)	.75 (19.1)	1.00 (25.4)	.34 (8.6)

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 +15V		
14	-12 TO -15V		
15	0.03 dB	0.04 dB	0.1 dB

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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)

J3 PIN FUNCTIONS[1]			
PIN	BINARY		BCD
	64 dB	80 dB	
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[2][3][4]		
4	GND		
5	0.25 dB	0.31 dB	0.8 dB
6	0.5dB	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 +15V		
14	–12 to –15V		
15	0.03 dB	0.04 dB	0.1 dB

NOTES

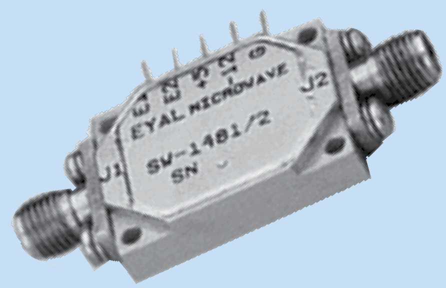
1. The Series 349 attenuators are 11-bit digital attenuators. In order to use this device with a lesser number of bits (lower resolution), the user may simply ground the logic pins for the lowest order unused bits. For example, a Series 349 unit operated as an 8-bit unit would have Pin 15, Pin 1 and Pin 2 connected to ground. All other parameters remain unchanged.
2. 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.
3. Pin 3 is available to apply a current or voltage to control the attenuator in a non-linear fashion.
4. It is recommended that when operating the Series 349/H Attenuators with the Strobe/Latch Option -4 feature, the digital control inputs should be in place, with the Latch set to a low "(0)" level, before the Attenuator is powered up.

Digitally-Controlled Switched-Bit Attenuators

When broadband, ultra-fast-switching performance is needed, the digitally-controlled switched-bit attenuator is the only solution. It excels in attenuation accuracy and flatness over broad frequency ranges, and its switching speed is equivalent to a high-speed PIN diode switch (25 nsec or better). Its only disadvantages are higher insertion loss and higher cost.

As stated earlier, attenuators are designed to match the requirements of specific applications. When the application requires fast switching speed (as in electronic warfare systems, for example), the switched-bit attenuator is the optimum choice (figure 1). It employs one or more pairs of SP2T switches, with a low-loss connection between one pair of outputs, and a fixed attenuator between the other outputs. The diodes are switched between their forward-biased and reverse-biased states, which gives the attenuator higher switching speed..

- 100 Hz to 18 GHz
- Monotonicity Guaranteed
- High Attenuation Range (up to 81 dB)
- High Speed



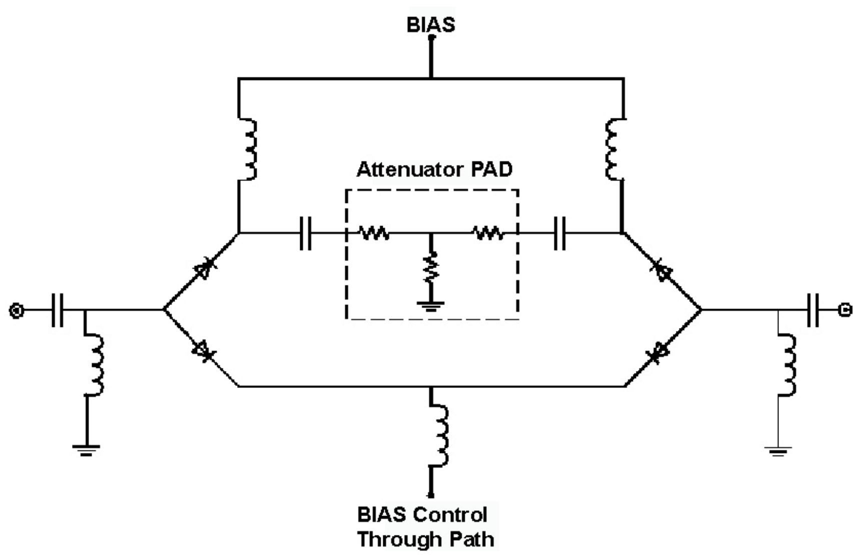


Figure 1
Switch Bit Attenuator

SWITCHED BIT ATTENUATORS

FREQUENCY RANGE (GHz) 0.1 0.5 1.0 2.0 4.0 6.0 8.0 18 40	ATTENUATION RANGE (dB)	MODEL	No. of BITS	PAGE
DIGITALLY CONTROLLED SWITCHED BIT ATTENUATORS				
0.1 — 1	63.5	SA-011-7-05	7	112
0.1 — 1	63.75	SA-011-8-025	8	
2 — 6	25	SA-26-1-25	1	113
2 — 6	15	SA-26-2-5	2	
2 — 6	7	SA-26-3-1	3	
2 — 6	63	SA-26-6-1	6	114
2 — 6	81	SA-26-7-1	7	
2 — 6	6.5	SA-26-8-0.25	8	
6 — 18	63.75	SA-618-2-5	2	115
6 — 18	7.0	SA-618-3-1	3	
6 — 18	63	SA-618-6-1	6	
2 — 18	25	SA-218-1-25	1	116
3 — 3.5	31	SA-335-5-1-60	5	

OPTION G09 - ENVIRONMENTAL CONDITIONS	
Operating Temperature	-54°C to 95°C
Storage Temperature	-65°C to 125°C
Humidity	Per MIL-STD 202F, Method 103B, Cond. B (96 Hours at 95% R.H)
Shock	Per MIL-STD 202F, Method 213B, Cond. C (75g/6mSec)
Altitude	Per MIL-STD 202F, Method 105C, Cond. B (50,000 ft.)
Vibration	Per MIL-STD 202F, Method 204D, Cond. B (06' double amplitude or 15G - which ever is less)
Thermal Shock	Per MIL-STD 202F, Method 107D, Cond. A (5Cycles)

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

Series SA-011 Switched-Bit Attenuators 100-1000 MHz Specifications

PERFORMANCE CHARACTERISTICS

MODEL	SA-011-7- 05	SA-011-8- 025
Frequency Range, min (MHz)	100-1000 (1)	100-1000 (1)
Attenuation Range, min (dB)	63.5 (2)	63.75 (2)
Insertion Loss, max (dB)	6.0	6.0
VSWR, max	1.4:1	1.8:1
Number of Bits	7	8
LSB, max (dB)	0.5	0.25
Monotonicity	Guaranteed	Guaranteed
Accuracy of Attenuation	± 0.125 dB @0.5 dB ± 2% @1 to 63.5 dB	± 0.125 dB @0.5 dB ± 2% @1 to 63.5 dB
Attenuation Flatness, max (dB)	± 1.5	± 1.5
Power Handling, max (dBm)	20	20
Switching Time, max (nsec)	20	500
Switch Rate, max (MHz)	0.5	0.5
Control Logic	'1' = I.Loss '0' = Att.	'1' = I.Loss '0' = Att.
Control Input	TRUE TTL GATE	TRUE TTL GATE
Power Supply Requirements	+5V ±2% @ 400 mA	+5V ±2% @ 450 mA
Environmental Conditions	See page 111	See page 109
Package Type	DC 2-11	DC 18

NOTES

1. Performance can be optimized for a narrower bandwidth
2. Attenuation range can be customized.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

PIN FUNCTIONS		
PIN Designations	SA-011-7- 05	SA-011-8-025
E1	0.5 dB	0.25 dB
E2	1.0 dB	0.5 dB
E3	2.0 dB	1.0 dB
E4	4.0 dB	2.0 dB
E5	8.0 dB	4.0 dB
E6	16.0 dB	8.0 dB
E7	32.0 dB	16.0 dB
E8	-	32.0 dB
+ V	+ 5V	+ 5V
G	GND	GND

Series SA-26 Switched-Bit Attenuators 2-6 GHz Specifications

PERFORMANCE CHARACTERISTICS

MODEL	SA-26-1-25	SA-26-2-5	SA-26-3-1
Frequency Range, min (GHz)	2-6 (1)	2-6 (1)	2-6 (1)
Attenuation Range, min (dB)	25 (2)	15 (2)	7 (2)
Insertion Loss, max (dB)	2.0	2.5	3.2
VSWR, max	1.8:1	1.8:1	1.8:1
Number of Bits	1	2	3
LSB, (dB)	25	5	1
Monotonicity	Guaranteed		
Accuracy of Mean Attenuation, max (dB)	± 0.5	± 3	± 3
Attenuation Flatness, max (dB)	± 1.0 dB	± 0.3 @ 0 dB to 10 dB ± 0.9 @ >10 dB to 15 dB	± 0.3
Power Handling, max (dBm)	+ 23	+ 23	+ 23
Switching Time, max (nsec)	30	30	30
Switch Rate, max (MHz)	4.0	4.0	4.0
Control Logic	'1' = I.Loss '0' = Att.		
Control Input	True TTL Gate		
Power Supply Requirements	+5V ± 2% @ 60 mA -12V ±2% @ 60 mA	+5V ± 2% @ 110 mA -12V ±2% @ 75 mA	+5V ± 2% @ 180 mA -12V ±2% @ 130 mA
Environmental Conditions	See page 111		
Package Type	DC 11	DC 12	DC 13

NOTES
1. Performance can be optimized for a narrower bandwidth
2. Attenuation range can be customized.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

PIN FUNCTIONS			
PIN Designations	SA-26-1-25	SA-26-2-5	SA-26-3-1
E1	25 dB	5 dB	1 dB
E2	-	10 dB	2 dB
E3	-	-	4 dB
E4	-	-	-
E5	-	-	-
E6	-	-	-
E7	-	-	-
E8	-	-	-
+ V	+ 5V	+ 5V	+ 5V
- V	- 12V	- 12V	- 12V
G	GND	GND	GND

Series SA-26 Switched-Bit Attenuators 2-6 GHz Specifications

PERFORMANCE CHARACTERISTICS

MODEL	SA-26-6-1	SA-26-7-1	SA-26-8-0.25
Frequency Range, min (GHz)	2-6 (1)	2-6 (1)	2-6 (1)
Attenuation Range, min (dB)	63 (2)	81 (2)	63.75 (2)
Insertion Loss, max (dB)	5.0	5.5	6.5
VSWR, max	2.0:1	2.0:1	2.0:1
Number of Bits	6	7	8
LSB, max (dB)	1	1	0.25
Monotonicity	Guaranteed		
Accuracy of Mean Attenuation, max (dB)	± 0.5 @ 0dB to 15 dB ± 0.75 @>15dB to 31dB ± 1.0 > 31dB to 63 dB	± 0.5 @ 0dB to 21dB ± 1.0 @ >21dB to 41dB ± 1.5 @ >41dB to 81dB	± 0.5 @ 0dB to 21dB ± 1.0 @ >21dB to 41dB ± 1.5 @ >41 to 63.75dB
Attenuation Flatness, max (dB)	± 0.5 @ 0dB to 15dB ± 0.75 @ >15dB to 32dB ± 1.0 @ >32dB to 63 dB	± 0.5 @ 0dB to 21dB ± 0.75 @ >21dB to 41dB ± 1.25 @ >41dB to 81dB	± 0.5 @ 0dB to 21dB ± 0.75 @ >21dB to 41dB ± 1.25 @ >41 to 63.75dB
Power Handling, max (dBm)	+ 23	+ 23	+ 23
Switching Time, max (nsec)	30	100	100
Switch Rate, max (MHz)	4.0	4.0	4.0
Control Logic	'1' = I.Loss '0' = Att.	'1' = I.Loss '0' = Att.	'1' = I.Loss '0' = Att.
Control Input	TRUE TTL GATE		
Power Supply Requirements	+5V ± 2% @ 300 mA	+5V ± 2% @ 400 mA	+5V ± 2% @ 450 mA
Environmental Conditions	See page 111		
Package Type	DC 2	DC 17	DC 18

NOTES
1. Performance can be optimized for a narrower bandwidth
2. Attenuation range can be customized.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

PIN FUNCTIONS			
PIN Designations	SA-26-6-1	SA-26-7-1	SA-26-8-0.25
E1	1 dB	1 dB	0.25 dB
E2	2 dB	2 dB	0.5 dB
E3	4 dB	4 dB	1.0 dB
E4	8 dB	8 dB	2.0 dB
E5	16 dB	10 dB	4.0 dB
E6	32 dB	20 dB	8.0 dB
E7	-	40 dB	16.0 dB
E8	-	-	32.0 dB
+ V	+ 5V	+ 5V	+ 5V
- V	-	-	-
G	GND	GND	GND

Series SA-618 Switched-Bit Attenuators
6-18 GHz Specification

PERFORMANCE CHARACTERISTICS

MODEL	SA-618-2-5	SA-618-3-1	SA-618-6-1
Frequency Range, min (GHz)	6-18 (1)	6-18 (1)	6-18 (1)
Attenuation Range, min (dB)	15.0 (2)	7.0 (2)	63 (2)
Insertion Loss, max (dB)	4.5	6.5	13
VSWR, max	2.0:1	2.0:1	2.0:1
Number of Bits	2	3	6
LSB, max (dB)	5	1	1
Monotonicity	Guaranteed		
Accuracy of Mean Attenuation, max (dB)	± 1.0	± 0.5	± 0.6 @ 0dB to 15dB ± 1.0 @ >15dB to 32dB ± 1.5 @ >32dB to 63dB
Attenuation Flatness, max (dB)	± 0.6 @ 5 dB ± 1.0 @ 10 dB ± 1.5 @ 15 dB	± 0.75	± 1.5
Power Handling, max (dBm)	+ 23		
Switching Time, max (nsec)	30		
Rise and Fall Time, max (nsec)	20		
Switching Rate, max (MHz)	4.0		
Control Logic	'1' = I.Loss '0' = Att.		
Control Input	True TTL Gate		
Power Supply Requirements	+5V ± 2% @ 110 mA -12V ±2% @ 75 mA	+5V ±2% @ 200 mA -12V ±5% @ 150 mA	+5V ± 2% @ 450 mA -12V ±2% @ 250 mA
Environmental Conditions	See page 111		
Package Type	DC 12	DC 13	DC 22

PIN FUNCTIONS			
PIN Designations	SA-618-2-5	SA-618-3-1	SA-618-6-1
E1	5 dB	1 dB	1 dB
E2	10 dB	2 dB	2 dB
E3	-	4 dB	4 dB
E4	-	-	8 dB
E5	-	-	16 dB
E6	-	-	32 dB
E7	-	-	-
E8	-	-	-
+ V	+ 5V	+ 5V	+ 5V
- V	- 12V	- 12V	- 12V
G	GND	GND	GND

NOTES

1. Performance can be optimized for a narrower bandwidth
2. Attenuation range can be customized.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

Series SA-218 Switched-Bit Attenuators 2-18 GHz Specification

PERFORMANCE CHARACTERISTICS

MODEL	SA-218-1-25
Frequency Range, min (GHz)	2-18 [1]
Attenuation Range, min)dB)	25 [2]
Insertion Loss, max (dB)	2.6
VSWR, max	2.0:1
Number of Bits	1
LSB, max (dB)	25
Monotonicity	Guaranteed
Accuracy of Mean Attenuation, max (dB)	± 0.5
Attenuation Flatness, max (dB)	± 1.5
Power Handling, max (dBm)	+ 23
Switching Time, max (nsec)	30
Rise and Fall Time, max (nsec)	20
Switching Rate, max (MHz)	4.0
Control Logic	'1' = I.Loss '0' = Att.
Control Input	True TTL Gate
Power Supply Requirements	+5V ± 2% @ 60 mA -12V ±2% @ 60 mA
Environmental Conditions	See page 111
Package Type	DC 11

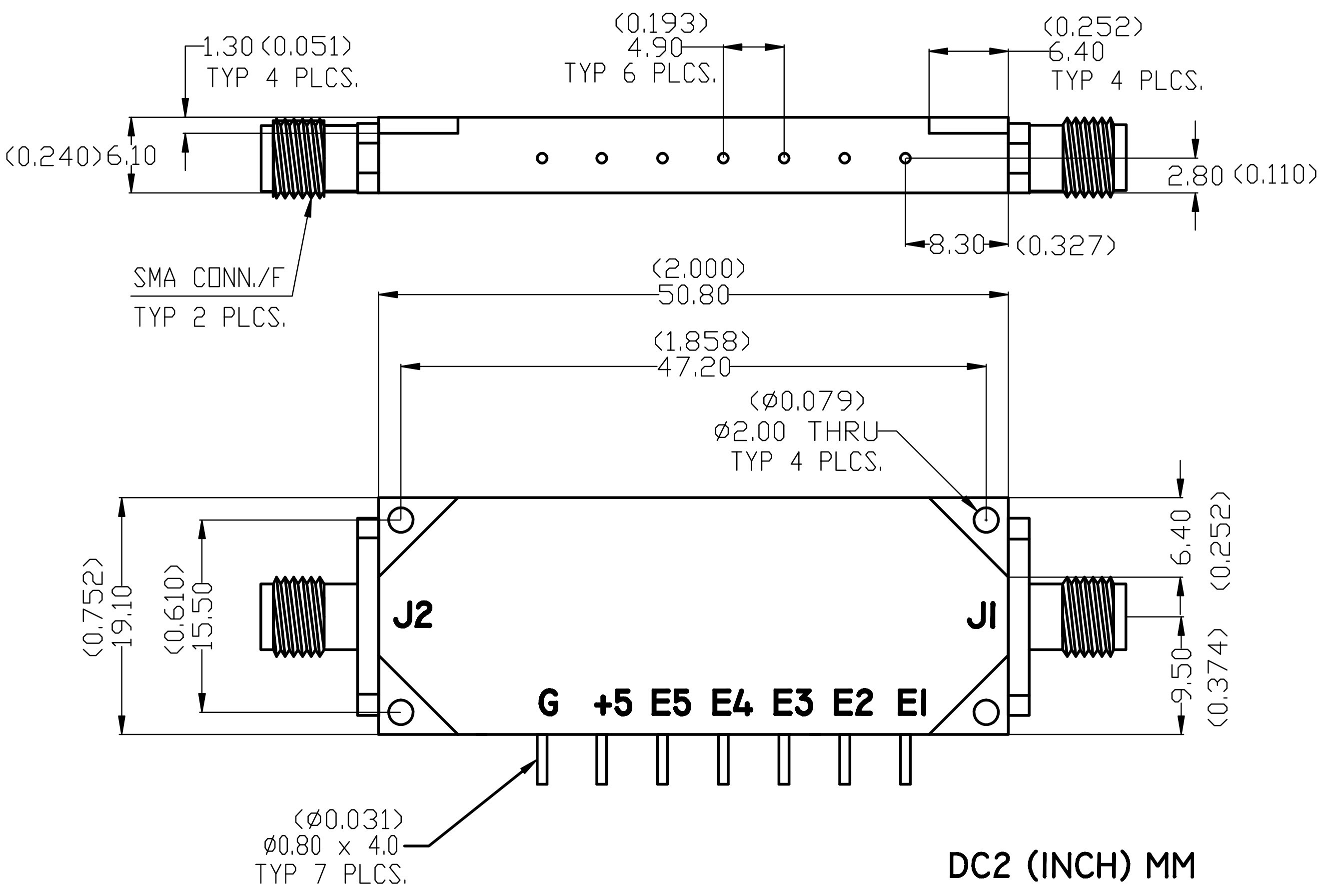
PIN FUNCTIONS	
PIN Designations	
E1	25 dB
E2	-
E3	-
E4	-
E5	-
E6	-
E7	-
E8	-
+ V	+ 5V
- V	- 12V
G	GND

NOTES
1. Performance can be optimized for a narrower bandwidth
2. Attenuation range can be customized.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

PACKAGE TYPE & DIMENSIONS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series SA-335 Switched-Bit Attenuators 3.0-3.5 GHz Specification

PERFORMANCE CHARACTERISTICS

MODEL	SA-335-5-1-60
Frequency Range, min (GHz)	3.0 to 3.5 (1)
Attenuation Range, min)dB)	31 (2)
Insertion Loss, max (dB)	3.8
VSWR, max	2.0:1
Number of Bits	5
LSB, max (dB)	1
Monotonicity	Guaranteed
Accuracy of Mean Attenuation, max (dB)	± 0.3 @0 TO 31 dB
Attenuation Flatness, max (dB)	± 0.5 @0 TO 15 dB ± 0.75 @15 TO 31 dB
Power Handling, max (dBm)	+ 23
Switching Time, max (nsec)	100
Rise and Fall Time, max (nsec)	30
Switching Rate, max (MHz)	2.0
Control Logic	'1' = I.LOSS '0' = ATT.
Control Input	TRUE TTL GATE
Power Supply Requirements	+5V ± 2% @ 300 mA
Environmental Conditions	See page 111
Package Type	DC 2

NOTES
1. Performance can be optimized for a narrower bandwidth
2. Attenuation range can be customized.

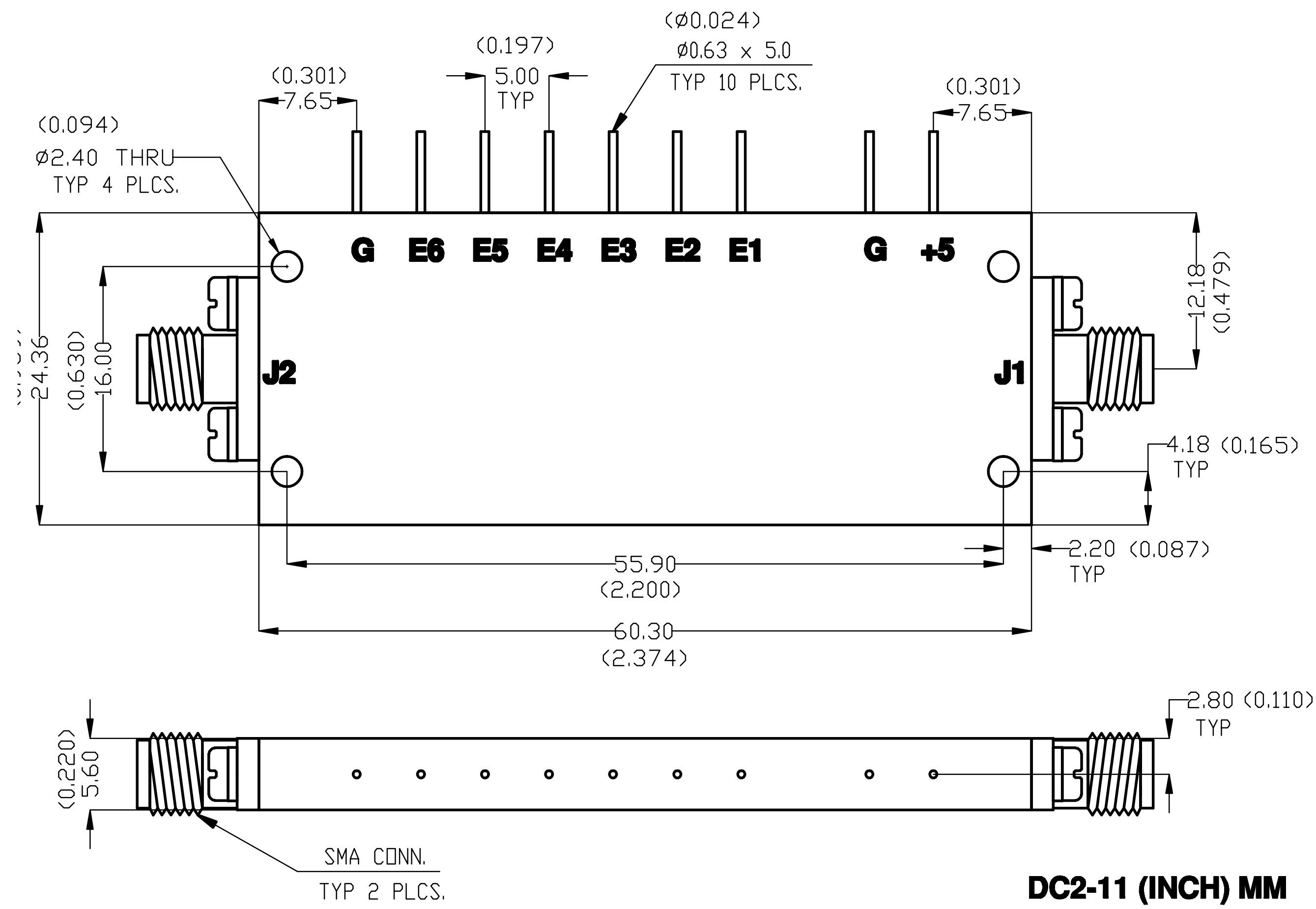
AVAILABLE OPTIONS

Option No. **Description**

G09 Guaranteed to meet Environmental Ratings

PIN FUNCTIONS	
PIN Designations	
E1	1.0 dB
E2	2.0 dB-
E3	4.0 dB-
E4	8.0 dB-
E5	16.0 dB
+ V	+ 5V
- V	- 12V
G	GND

PACKAGE TYPE & DIMENSIONS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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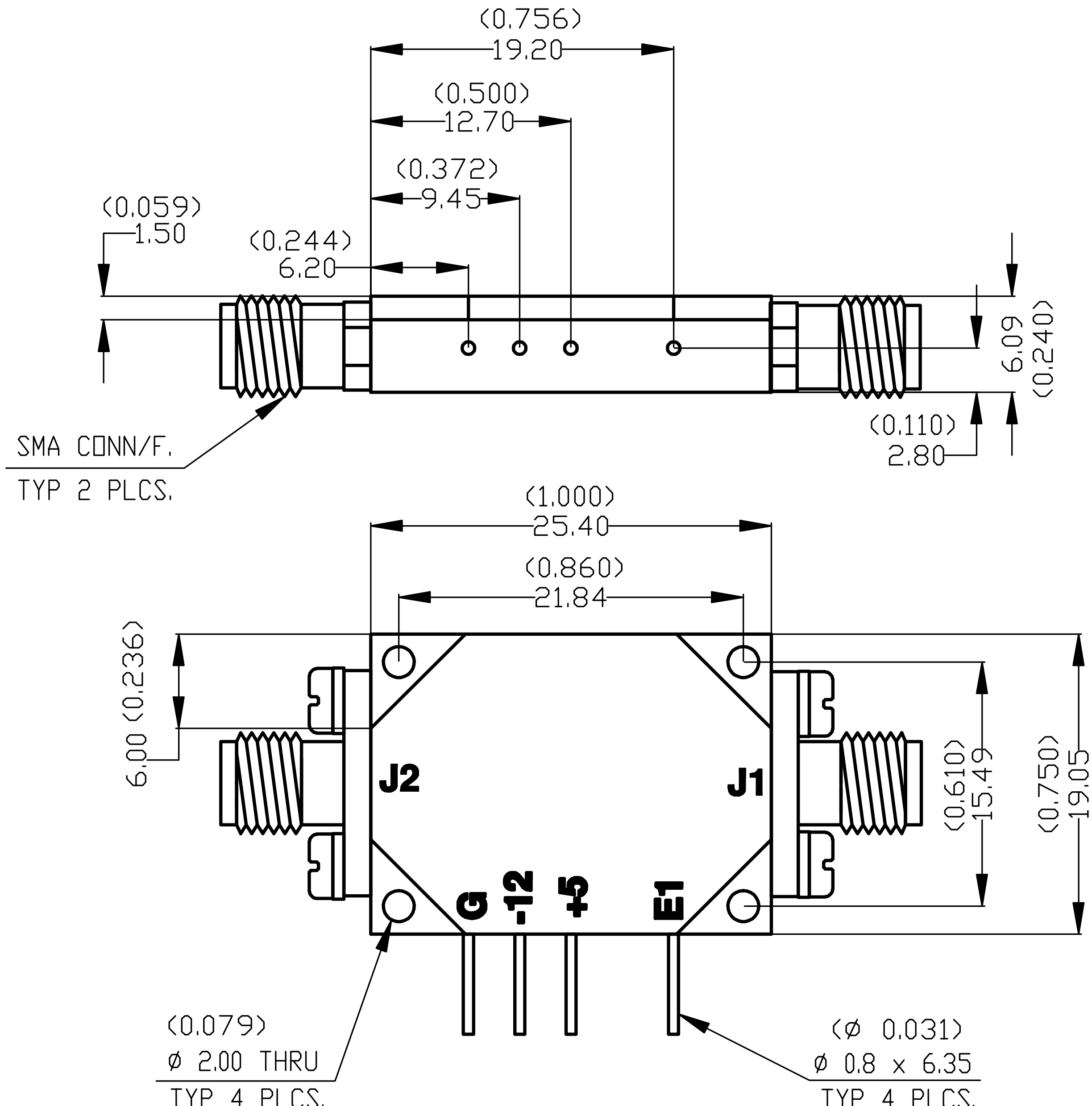
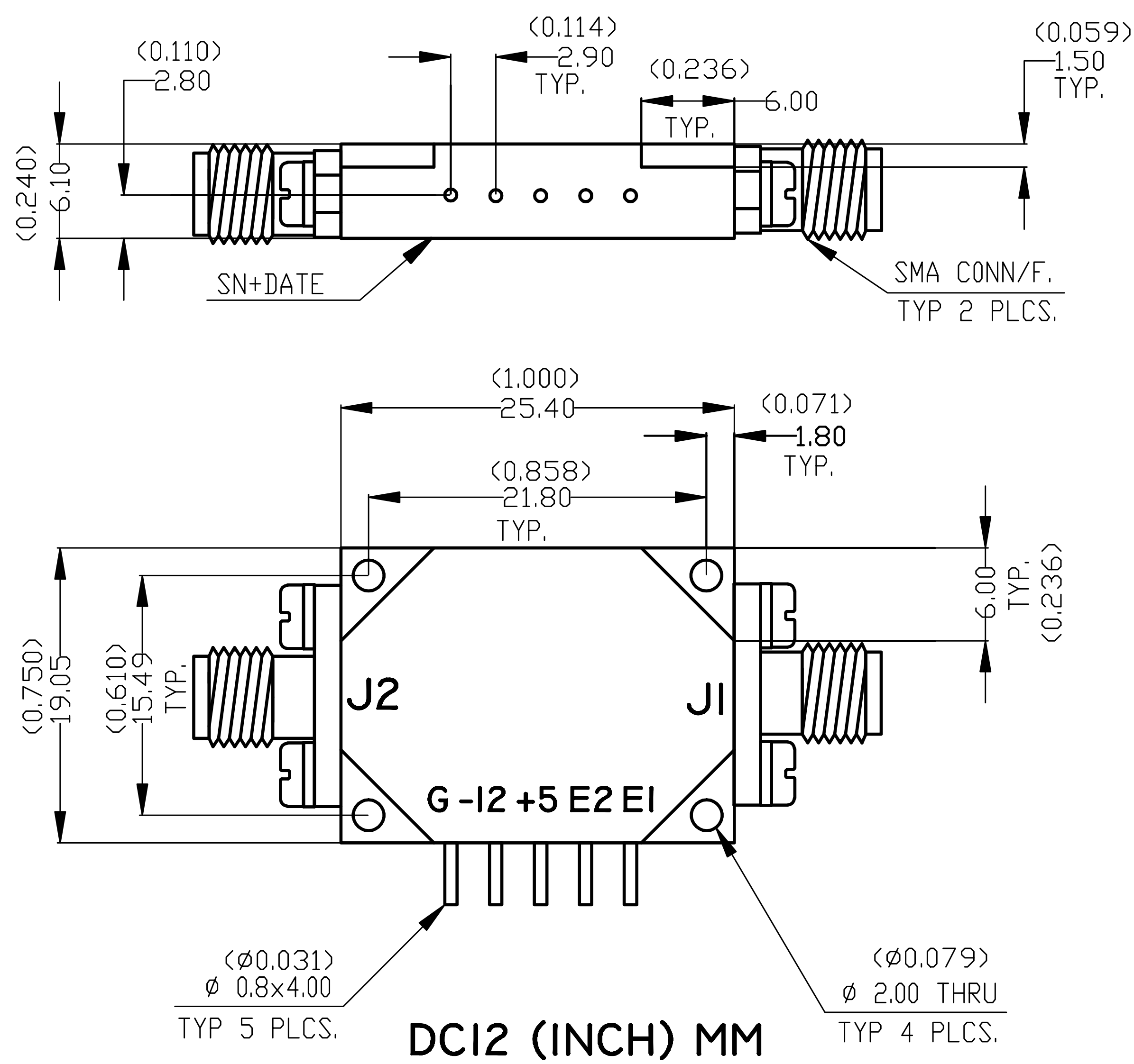


DC11 (INCH) MM

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PACKAGE TYPE & DIMENSIONS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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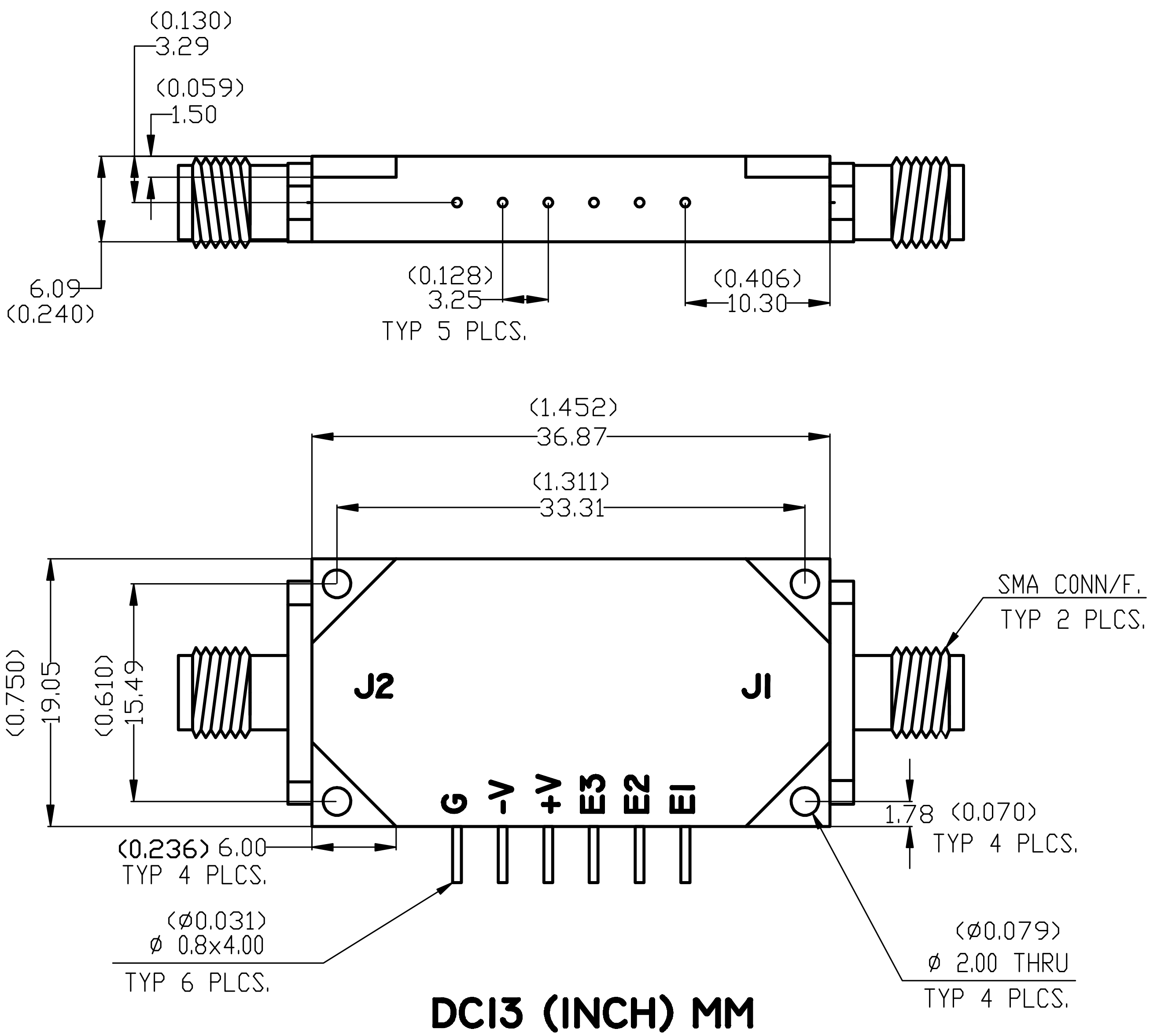
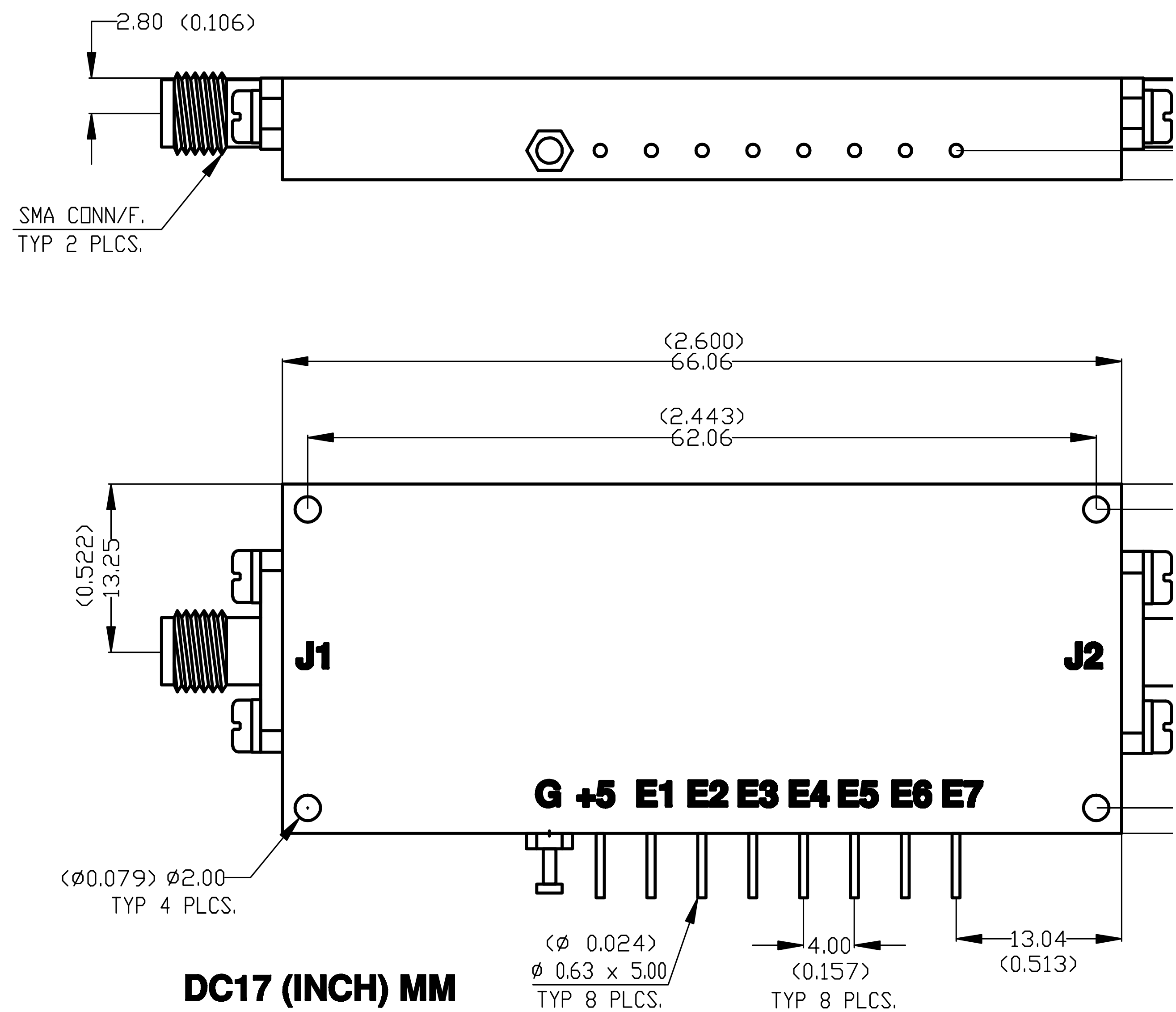


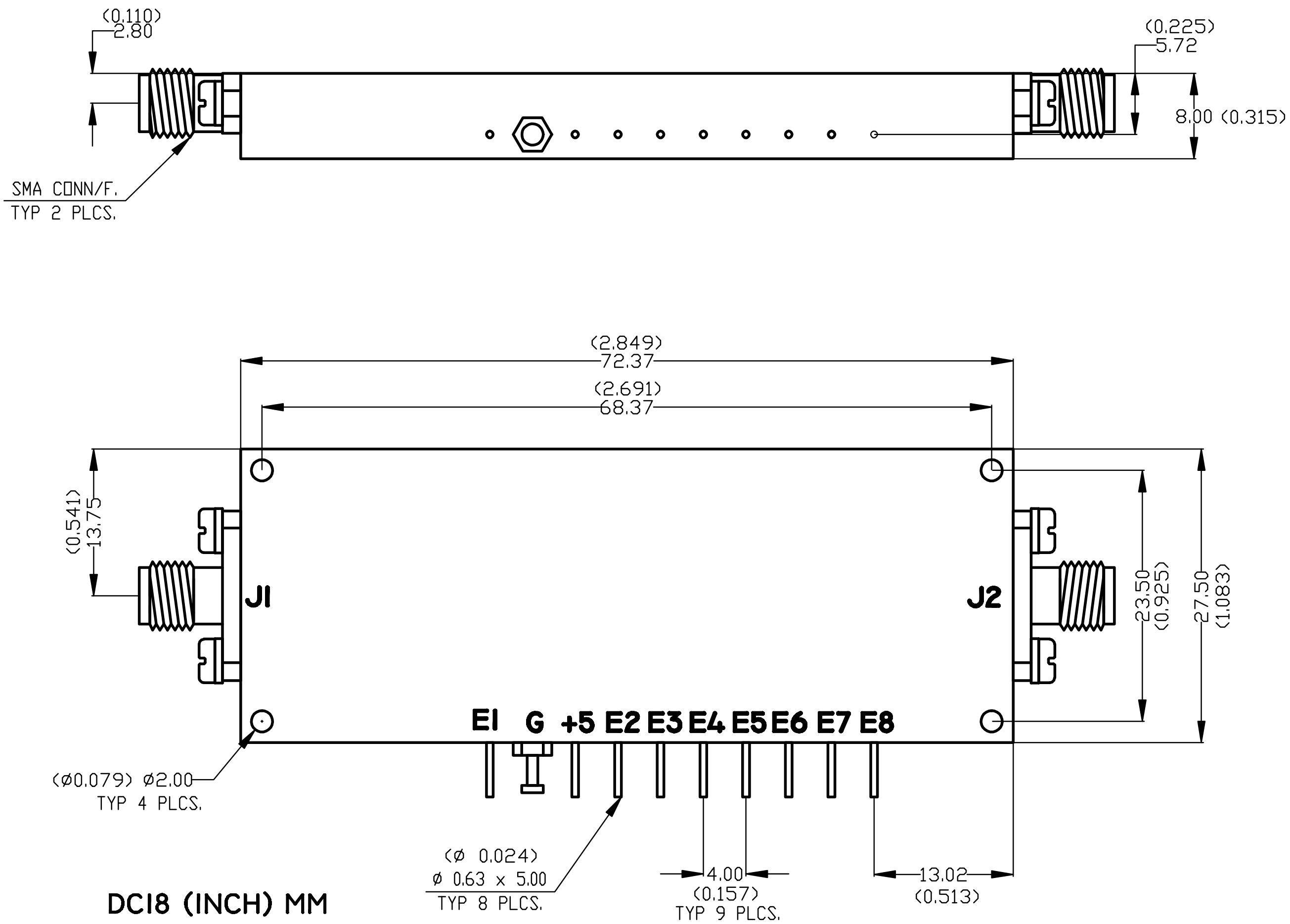
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PACKAGE TYPE & DIMENSIONS



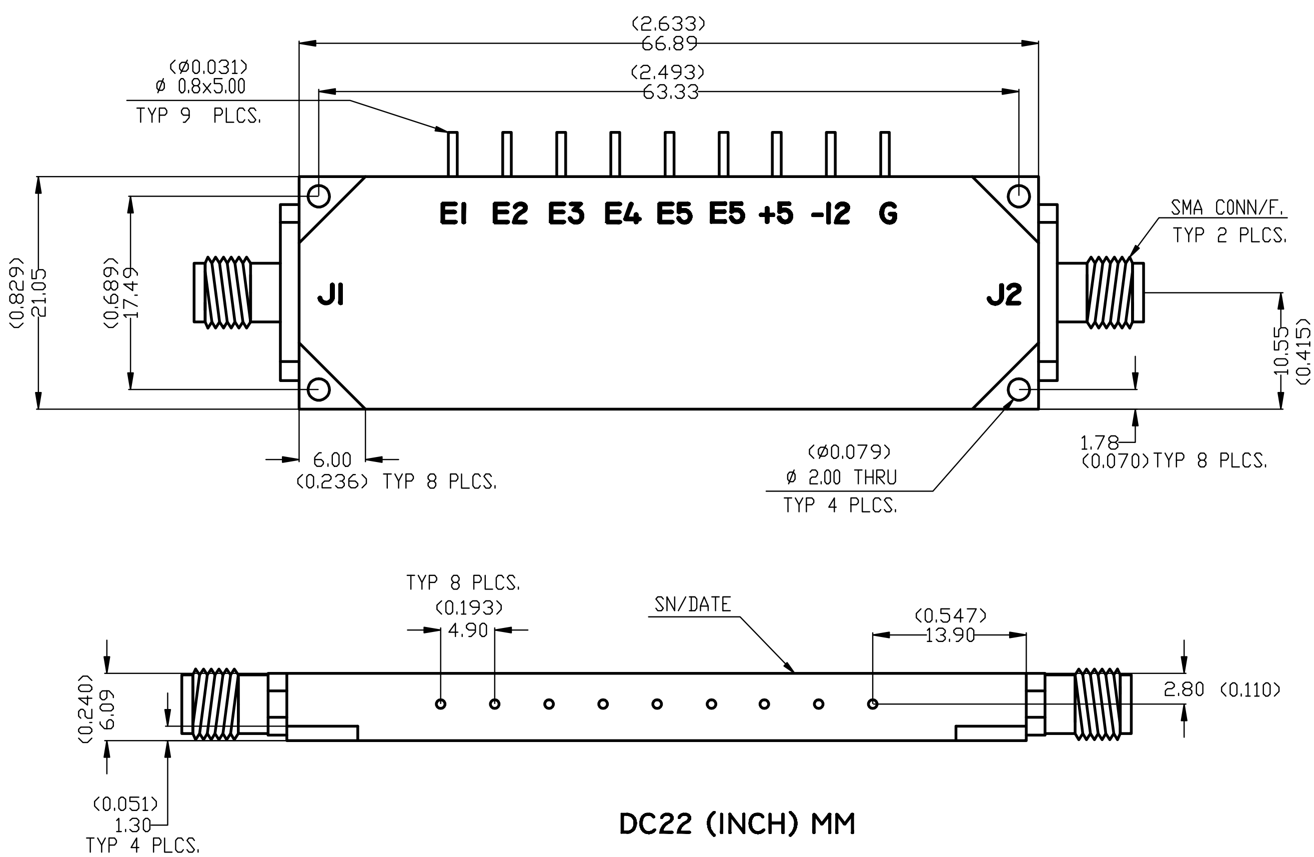
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PACKAGE TYPE & DIMENSIONS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

DIMENSIONS AND WEIGHTS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Phase Shifters Frequency Translators and I-Q Vector Modulators

General Microwave Corporation has been a leader in the field of microwave PIN diode control components for more than 35 years. The design and manufacture of high performance, broadband phase shifters, frequency translators and I-Q Modulators have made General Microwave the undisputed leader for these devices.

Today's more demanding systems require the ability to control the phase and amplitude of RF/microwave signals with a repeatable, high degree of accuracy. General Microwave intends this section to not only inform you of our most popular products but also to provide insight into theory of operation, calibration and practical applications where they can be utilized.

General Microwave offers a complete line of broadband phase shifters and I-Q modulators which span the frequency range from 0.05 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 section describes only our standard line of broadband phase shifter and I-Q modulator models. In addition to these, there are numerous special designs, employing a variety of phase shifter circuits, which General Microwave 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 are not considered here.) Expressing this mathematically, with an input signal $\sin(\omega t)$, the output will be $A(n)*\sin[(\omega t)+\Theta(n)]$, 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.

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 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[(1)] 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.

Analog phase shifters are readily convertible to digital control by the addition of suitable D/A converters and appropriate linearizing circuits.

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

DEFINITION OF PARAMETERS

Phase Shift:

The difference in phase angle of the existing 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.

Accuracy:

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

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/degrees 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.

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°.

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.

Translation Rate:

When the phase shifter is used as a frequency translator, the translation rate is determined by dividing the clock rate by the number of steps. Number of steps is equal to 2^n where n equals number of bits.

TYPICAL PERFORMANCE CHARACTERISTICS

HARMONICS AND INTERMODULATION PRODUCTS

All PIN diode control devices 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 phase shifters 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 a phase shifter or I-Q modulator are greatly dependent upon its design, the operating frequency, attenuation setting and input power level. Typical 2nd and 3rd order intercept performance for a moderately fast phase shifter, i.e. 500 nsec switching speed follows:

TYPICAL INTERCEPT POINTS		
Frequency	2nd Order Intercept	3rd Order Intercept
2.0 GHz	+35 dBm	+30 dBm
8.0 Ghz	+40 dBm	+35 dBm

PHASE NOISE

The phase shifters and I-Q modulators offered by General Microwave minimize the contribution of phase noise to system performance. This is accomplished by utilizing PIN diodes which are less sensitive to high frequency noise than Schottky diodes, limiting the noise bandwidth in driver control elements and the use of low noise buffer amplifiers to drive the PIN diodes.

WHAT IS AN IQ VECTOR MODULATOR?

An IQ Vector Modulator is an RF or microwave circuit which has the ability to control both the amplitude and phase of the transmitted signal simultaneously. Any sinusoidal signal can be expressed as a vector having the properties of both amplitude and phase with respect to a reference signal. If a signal is thought of as a vector in a polar coordinate system with coordinates of amplitude and phase, it can also be defined in a rectangular coordinate system with coordinates of "I" and "Q". The term "IQ" does not represent anything about the intelligence of the design engineer, but rather that the user can control both the "In-Phase" and "Quadrature-Phase" components of the output signal.

WHAT IS A TYPICAL IQ MODULATOR CIRCUIT?

The circuit typically includes an input power divider which splits the incident signal into two paths, an amplitude and/or phase control element in each path, and an output signal summing circuit. In the simplest embodiment, the input signal is divided into two equal signals with a 90° phase difference; controlled by a phase invariant bi-phase attenuator in each path; and combined by an in phase power combiner as shown in figure 1.

WHAT ACTIVE CONTROL COMPONENTS ARE USED IN IQ MODULATORS?

The control components in an IQ vector modulator are circuits that employ PIN diode, Schottky diode or FET devices. The simplest circuit uses a PIN diode attenuator in series with a PIN-diode bi-phase modulator, or a combination of the two devices in a single bi-phase attenuator. This device has the property of providing a continuous function which first attenuates the input signal with no phase shift, then shifts phase 180° at maximum attenuation, and then decreases attenuation while holding a constant 180° phase shift. Balanced or double balanced Schottky diode or FET mixers exhibit a similar function, but are limited in dynamic range of attenuation. PIN diode devices usually exhibit higher power handling, lower insertion loss and higher intercept points than Schottkydiode or FET based devices. Schottky diode or FET devices are preferred for modulation rates higher than a few megahertz.

WHAT ARE SOME OF THE USES OF IQ VECTOR MODULATORS?

- Amplitude and Phase control for RF simulator systems
- Quadrature Amplitude Modulation
- Cancellation of unwanted jamming signals
- Cancellation of crosstalk between co-located communication systems
- Cross-Polarization Cancellation
- Doppler Simulation
- Nulling of antenna reflections in monostatic radar systems
- Complex weights for Phased Array Antennas
- Linear Filter Equalizer

HOW ARE IQ VECTOR MODULATORS CALIBRATED?

Calibration of the IQ vector modulator for controlled amplitude and phase response is often performed by generating a "look-up" table using a vector network analyzer. To obtain the highest degree of accuracy, the calibration should be performed in-situ. A discussion of calibration techniques is provided on page 58. When IQ vector modulators are used in a nulling system an algorithm can readily be developed to adjust the values of I and Q in a closed loop fashion to achieve the desired system performance.

CAN THE I-Q VECTOR MODULATOR BE CUSTOMIZED FOR SPECIAL APPLICATIONS?

General Microwave has customized many variations of the IQ vector modulator for numerous applications ranging from low cost designs to nuclear hardened radar systems. Our sales and engineering staff are available to help you maximize your system performance by incorporating IQ vector modulators to meet challenging system requirements

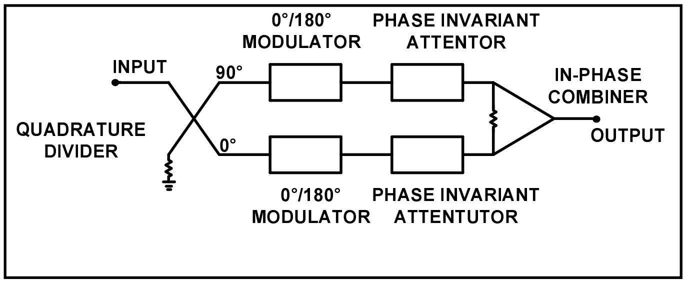


FIGURE 1
I-Q Vector Modulator Block diagram

I-Q VECTOR MODULATOR— THE IDEAL CONTROL COMPONENT!

Microwave control components are used to vary signal amplitude and phase. Typically, they consist of two-port devices including amplifiers, attenuators, phase shifters, and switches. The I-Q vector modulator is a unique combination of active and passive devices that is, in theory, ideally suited for the simultaneous control of amplitude and phase.

THEORY OF OPERATION

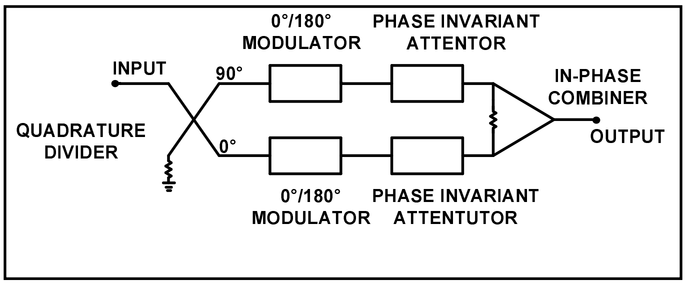


FIGURE 1
I-Q Vector Modulator Block diagram

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 degree phase difference between them. The in-phase or 0 degree channel is designated the I channel and the quadrature or 90 degree channel is designated the Q channel. Each signal passes through a biphase modulator which selects the 0 or 180 degree state for both the I and the Q paths. This defines the quadrant in which the resultant output signal resides (Figure 2). The attenuator in each path then varies the magnitude of each of the signals, which are combined in phase to yield the resultant vector. This vector will lie anywhere within the bounded area shown in Figure 2. Thus, any signal applied to the I-Q vector modulator can be shifted in phase and adjusted in amplitude by assuming the desired attenuation level = x dB and the desired phase shift = Θ degrees. The normalized output voltage magnitude is then given by:

$$R = 10^{-(x/20)}$$

The attenuation values of the I and Q attenuators are then given by:

$$\text{I attenuator (dB)} = 20 \log (R \cos \Theta)$$

$$\text{Q attenuator (dB)} = 20 \log (R \sin \Theta)$$

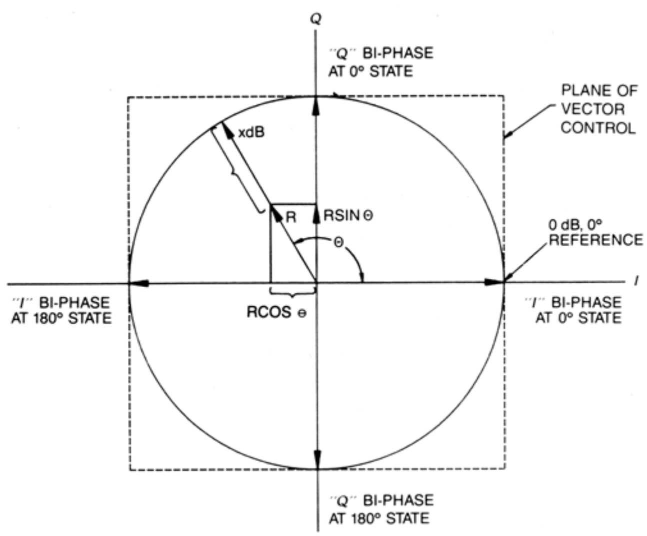


Fig. 2–I-Q Phase Relationship

To achieve the desired phase shift, bi-phase modulator states must also be selected as shown in Table 1. In this way, the phase and amplitude of the output signal can be varied simultaneously in a controlled fashion.

TABLE 1		
Bi-phase Modulator States I	Q	Desired Phase Shift
0°	0°	0°-90°
180°	0°	90°-180°
180°	180°	180°-270°
0°	180°	270°-360°

The theoretical model presupposes perfect amplitude and phase balance in the two signal paths, and ideal quadrature coupling in the 3 dB hybrid. To the extent that the conditions are not met in practice, the performance of the I-Q vector modulator will be limited.

PHASE BALANCE

The key element in determining the useful frequency range of the I-Q vector modulator is the 3 dB quadrature hybrid. Its most important characteristic is very low quadrature phase error (such as small deviation from 90 degree phase shift between outputs). To achieve this over a broad frequency range, we employ the Hopffer quadrature hybrid[2], which exhibits extremely wideband quadrature-phase properties (typically greater than 3 to 1 bandwidth with ±2 degree phase balance).

In addition to using an in-phase Wilkinson combiner (which, with proper design, exhibits excellent phase balance) the transmission-line length for the I and Q paths must also be carefully phase-matched.

(2) S. Hoofer, "A Hybrid Coupler for Microstrip Configuration," IEEE MTT-S International Microwave Symposium Digest, 1979.

AMPLITUDE BALANCE

The amplitude balance of the I and Q paths is a second source of performance limitation. Unequal power levels in these paths also produce errors in both the amplitude and phase of the transmitted signal. To minimize this source of error, the quadrature-hybrid coupling must be adjusted to provide minimum deviation from the nominal 3 dB across the frequency band. For an ideal hybrid, the amplitude unbalance will be ±0.31 dB over an octave band. The effect of amplitude and balance error on phase is shown in Figure 3.

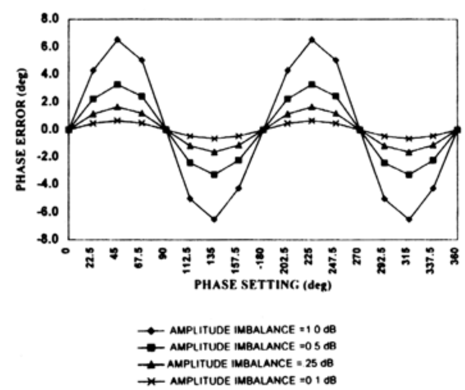


FIGURE 3
Phase Error Due to Amplitude Imbalance

NON-IDEAL BI-PHASE MODULATOR AND ATTENUATOR

Errors in amplitude and phase will occur if the bi-phase modulator deviates from the ideal, eg: changes state from 0 to 180 degrees with constant amplitude or if the attenuator has an associated phase shift as attenuation iis varied. Not only do these components in practice exhibit such deviations, but their interacting reflections may increase the resultant errors significantly. The arrangement in Figure 4 minimizes the errors. As indicated, the tandem combination of a biphase modulator and attenuator in each path is replaced by a doubly-balanced biphase modulator. The doubly-balanced biphase modulator developed by General Microwave[3] has the ability to attenuate a signal by more than 20 dB with constant phase, then change the phase 180 degrees and return to the low-loss state. At insertion loss, it exhibits a maximum phase error of less than ±6 degrees and an amplitude balance of ±0.5 dB over a 3 to 1 bandwidth.

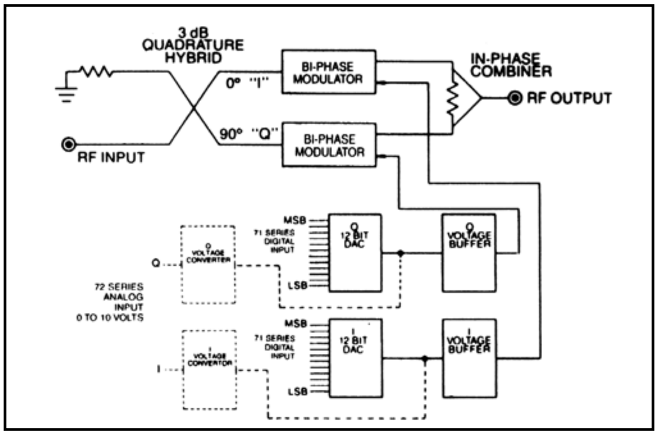


FIGURE 4
Series 71/71 Block Diagram

PRACTICAL APPLICATIONS

PHASE SHIFTERS

If the doubly-balanced biphase-modulator conditions are adjusted so that the magnitude of the resultant vector remains fixed, the I-Q vector modulator can behave as a constant-amplitude phase shifter. The relationships between the desired phase shift and the I and Q attenuation levels are given by:

$$|I|^2 + |Q|^2 = 1$$

$$I = \cos\Theta$$

$$Q = \sin\Theta$$

where I and Q are normalized voltages.

(3) Z. Adler and B. Smilowitz, "Octave-Band High-Precision Balanced Modulator," IEEE MTT-S International Microwave Symposium Digest, 1984.

The relationship between the I and Q drive circuitry can be generated in either analog or digital fashion. The analog circuit employs a broadband quadrature hybrid to generate the drive signals. In the digital drive circuit, PROMS are used to provide the required relationships between I and Q. See the Selection Guide on page 61 for the General Microwave phase shifter model numbers.

FREQUENCY TRANSLATORS

A signal-processing technique using a linear time-varying phase shifter is one method of frequency translation. One principal use is in velocity deception for ECM systems by providing false Doppler radar returns.

In a true Doppler radar situation, the reflected signal is translated in frequency in an amount proportional to the radial velocity of the target. As a rule, there are no harmonics or spurious signals accompanying the reflection. However, if the target is using velocity-deception techniques, spurious signals may be present in the radar return because of the non ideal performance of the frequency translator. The presence of these spurious signals will reveal that the Doppler radar is being jammed. Therefore, it is critical for optimum ECM system performance that the frequency translator suppress the carrier, harmonics and all unwanted sidebands to the greatest extent possible. For the linear phase shifter, the principal factors that contribute to imperfect carrier suppression and sideband generation are:

Symbol

π error

This is the deviation from 360 degrees when maximum phase shift is programmed.

PM/AM error

The amplitude change (AM) is a function of the phase change (PM).

Phase nonlinearity

It is the deviation from linear phase shift vs. time.

Quantization error

This term is usually negligible for phase resolution greater than 6 bits. It arises in a digital phase shifter, which only approximates linear phase shift with discrete phase steps.

Flyback time

This arises from the finite time required by the phase shifter to return from 360 to 0 degrees.

In the I-Q modulator, since the network operates as a constant-velocity rotating vector, the 0 and 360 degree phase states are exactly the same, and the 2π error and flyback error are eliminated. In addition, the General Microwave Series 77 provides 10 bits of digital phase control (sufficient to eliminate the quantization error), while phase linearity is optimized by the use of PROM correction in the drive circuitry. Finally, the PM/AM error is minimized by using matched doubly-balanced biphase modulators, thereby reducing this error essentially to the difference in amplitude of the 3 dB quadrature hybrid output ports. This amplitude imbalance varies with frequency and generates a unique spurious sideband during frequency translation. An additional PROM correction using RF operating frequency information can be employed to reduce this spurious sideband for customer requirements.

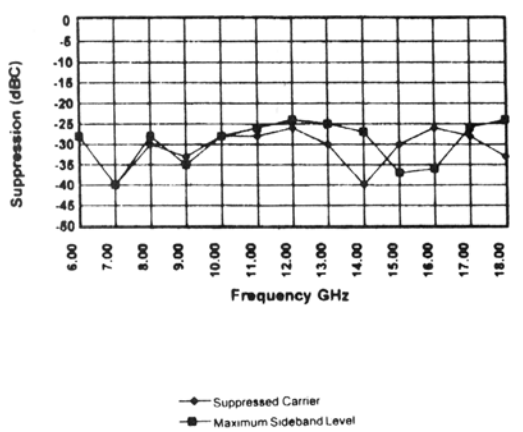


FIGURE 5–Typical Carrier and Sideband Suppression
General Microwave Model 7728A
Frequency Translator

The specifications of the General Microwave Series 77 Digitally Controlled and Series 78 Voltage Controlled Frequency Translators include 25 dB carrier suppression and 20 dB sideband suppression over a three-to-one frequency range. Typical performance data for carrier and sideband suppression, of the 6 to 18 GHz Model 7728A, are shown in Figure 5. Carrier and sideband suppression of greater than 34 dB for a frequency translator covering a 15-percent bandwidth at X band over the operating temperature range of –54°C to +100°C have been achieved in production quantities.

COMPLEX I-Q VECTOR MODULATORS

System requirements often call for a tandem connection of phase shifters and attenuators to provide independent control of magnitude and phase of an RF signal. If tight tolerances are required for the amplitude and phase accuracy, a look-up table is usually incorporated in the system software to calibrate the phase shift and attenuation across the frequency range. This is a tedious job that entails the generation of an extensive amount of error correction data, obtained by alternately varying the phase shifter and attenuator over the dynamic range for each narrow frequency band where optimization is required. The inclusion of an I-Q vector modulator in the system in place of a discrete phase shifter and attenuator offers several distinct advantages. A single RF component replaces two separate units, thus reducing cost and eliminating interacting VSWR. The relationship between the I and Q inputs and the desired amplitude and phase permits a tremendous reduction in the amount of data required for a look-up table. This is because the I and Q inputs are independent variables for the I-Q vector modulator, whereas the tandem connection of attenuator and phase shifter exhibit large AM to PM and PM to AM pushing, creating dependency between the amplitude and phase inputs. Depending on the frequency range and accuracy specifications, the RF circuitry of the I-Q vector modulator can be optimized to eliminate the need for a look-up table entirely.

The I-Q Vector Modulator is ideally suited for use in EW Simulators, Adaptive Equalizers or Automatic Test/Calibration Systems where extremely high accuracy and repeatability are essential.

See the Selection Guide on page 61 for the General Microwave I-Q Vector Modulator model numbers.

WHAT IS FREQUENCY TRANSLATION?

Translation is shifting the frequency of a signal by a user controlled delta. This frequency delta, also known as Translation Rate, is usually notated by “Fm”.

When the user wants to translate the signal by 1 Hz he needs to apply a ramp (counter) that sweeps the phase control of the phase shifter (translator) starting from zero phase shift and ending at 360°. in a cyclic manner.

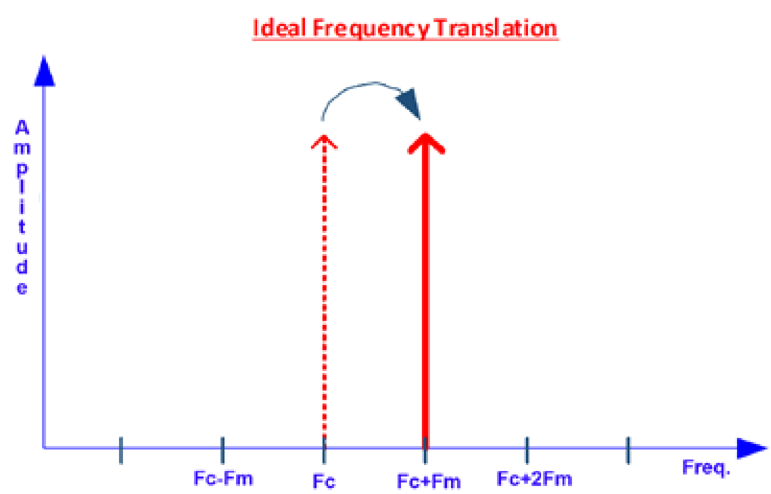
Each cycle should take exactly 1 second in order to achieve a shift of 1 Hz. Using 10 bit counter, the clock of the counter would be 1/1024 Hz. Using only 5 bit counter, the clock of the counter would be 1/32 Hz. So using less bits will enable lower clock rates. However, too low number of bits will cause poor sidebands and carrier suppression.

Let us assume that we have a pure sine-wave signal as a carrier at Fc that appears at the output of the phase shifter with a nominal amplitude of 0 dBm.

Now, when introducing an Fm [Hz] translation (covering the 360° once every 1/Fm [seconds]) using the 5 Most Significant Bits.

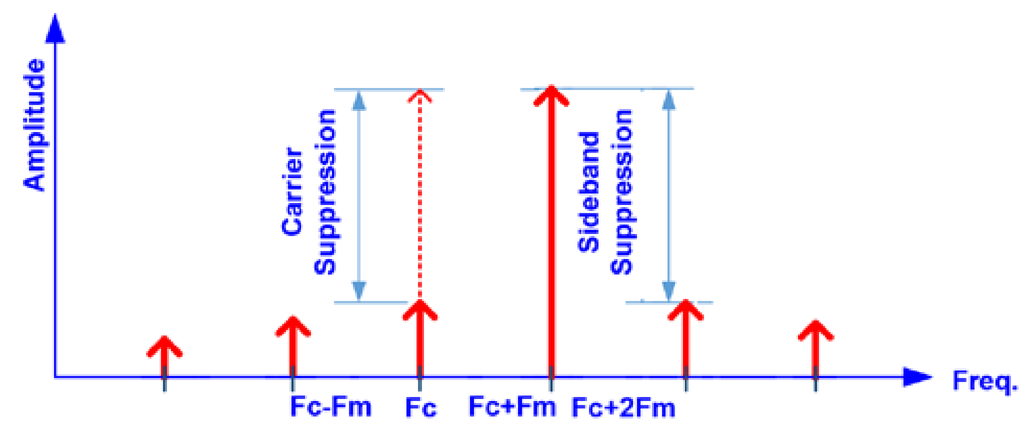
With a perfect phase shifter we expect that the spectrum will look like this:

Ideal Frequency Translation of CW Signal



However, with a practical phase shifter the spectrum will look like this:

Practical Frequency Translation of CW Signal



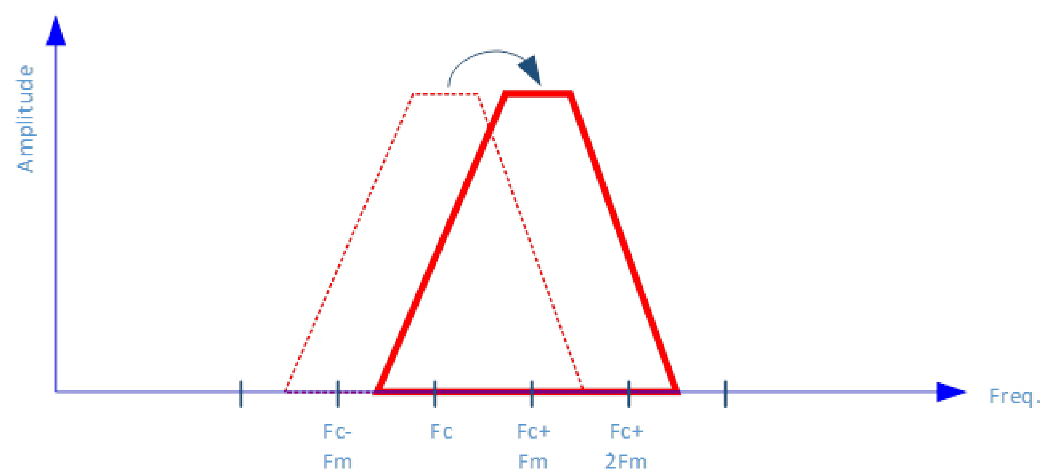
Where:

Carrier Suppression: The amplitude difference between the translated signal and the original carrier.

Sideband Suppression: The amplitude difference between the translated signal and the strongest sideband (could be at Fc-n*Fm or Fc□n*Fm, but usually is the Fc□2*Fm product).

IL Variation: Reduction of the Translated Carrier amplitude relative to an amplitude at low translation rate (50 kHz)."

Ideal Frequency Translation of a Wide-Band Signal



Amplitude and Phase Calibration

General Microwave I-Q Vector modulators can be calibrated to provide precision control on both amplitude and phase over their full rated dynamic range. The calibration is performed using a vector network analyzer and a customer generated test program to achieve the utmost in accuracy. The most frequently used algorithm to accomplish this calibration is described herein. This algorithm involves defining a unity circle and then employing an iterative technique to locate precise calibration values.

Many factors contribute to the overall accuracy that is achievable using any calibration routine for the I-Q vector modulator. It is important that the user fully understand the limitations of measurements in calibrating these units at microwave frequencies. For example, it is imperative that the desired calibration accuracy not exceed the accuracy and repeatability of the microwave test equipment. Another factor which must be included in the overall calibration accuracy is the effects of temperature on the I-Q modulator and the test equipment. Given that the user has a thorough understanding of vector network analyzer measurements, the following will be useful for generating a calibration program for a digitally controlled I-Q vector modulator. (Note that an analog controlled unit can be calibrated in the same fashion using the relationship that 000 hex equals zero volts and FFF hex equals ten volts on the I and Q controls.)

1.0 The calibration routine is performed at discrete frequencies in the band of interest. The calibration will be valid over an interval of frequencies centered at the calibration frequency and will be limited by the amplitude and phase errors that occur as frequency is varied. The highest calibration accuracy will occur with minimum frequency interval size. However this may require an excessive amount of calibration time and data storage. It is recommended that a calibration interval of 100 to 200 MHz be used in the center of the frequency range of the vector modulator and 25 to 50 MHz be used at the band edges. The optimum calibration interval for any user must be determined empirically by insuring that the maximum phase and amplitude error over the frequency calibration interval is within the desired limits.

2.0 Once the calibration interval and the calibration frequency have been chosen, the next step is to define the I and Q axes and the magnitude of the unit circle. For this example, the I axis is defined to be the horizontal axis on the I-Q plane with control word 000 (hex) being equivalent to a vector of approximate magnitude 1.0 at an angle of zero degrees. In the same fashion the Q axis is defined to be the vertical axis on the I-Q plane with control word 000 (hex) equivalent to a vector of approximately magnitude 1.0 at an angle of 90 degrees. Note that for both I and Q, the magnitude zero vector is approximately 7FF (hex) and the magnitude –1.0 vector occurs as FFF (hex). Following this procedure the definition of the I-Q plane is arrived at per the table below:

TABLE 2		
I CONTROL (hex)	**Q CONTROL (hex)**	**APPROX. VECTOR**
000	7FF	1.0 ANG 0°
FFF	7FF	1.0 ANG 180°
7FF	000	1.0 ANG 90°
7FF	FFF	1.0 ANG 270°

3.0 The magnitude of the unit circle is determined by finding the maximum insertion loss at the calibration frequency in each of the four states in table 2 above. Since by nature the I-Q plane is a square and not a circle (see figure 6), the maximum insertion loss will occur at one of these four states. Once the maximum insertion loss is determined, the I or Q values of the other three states in table 2 are adjusted to meet the same maximum insertion loss level. Note that only either I or Q should be adjusted to increase insertion loss at any state, not both. The I or Q value that is initially set to 7FF (which is approximately the center of the IQ plane) is not varied during this part of the calibration since the amplitude of the unit circle is not affected by small changes in the control input.

4.0 Having thus defined the unit circle, the next step is to scale the I and Q axes to allow for computation of I and Q values given the desired amplitude and phase. If the I and Q axes were perfectly linear and each consisted of 4096 equal increments (for a 12 bit control), it would be possible to achieve the desired amplitude and phase shift using only the sine and cosine relationships given in figure 6. In order to approach the ideal case, the I and Q values for each of the four states given in table 2 must be scaled if they differ from 000 or FFF (note that the control input at 7FF is not varied in this step). The scaling entails taking the difference between 2048 digital counts (equal to one half of the 12 bit control) and the number of counts required to equalize the insertion loss of each of the four states required for the unit circle derived from step 3.0. For example, assume that the I value at zero degrees (I=000, Q=7FF), is the maximum insertion loss of the four states and that in order to achieve the same level of insertion loss at 180° (nominal value I=FFF, Q=7FF), I must be lowered by 127 counts such that the new value for 180° on the unity circle is I=F80, Q=7FF. In this case the I axis for I<0 (in the second and third quadrants) is limited to 1921 counts instead of 2048. Thus, when the algorithm is determining the equivalent I value for a desired amplitude and phase occurring in the first or fourth quadrants, the calculated value for I=R*cos Θ is multiplied by 2048 and the result subtracted from 2048 (1=7FF, the origin). When, in the same example, this calculation is done for a vector that occurs in the second or third quadrants, the calculated value for I= R*cos Θ will be multiplied by 1921 and the result added to 2048 (I=7FF) to find the desired I value (reference the I scale at the bottom of figure 6). The scale value will be called SCALE in calculations given in step 5.2. While this scaling is not precise, it is sufficient to enable the algorithm to establish the boundary of the I-Q plane such that any desired amplitude and phase calibration point can be achieved with a minimum of iterations.

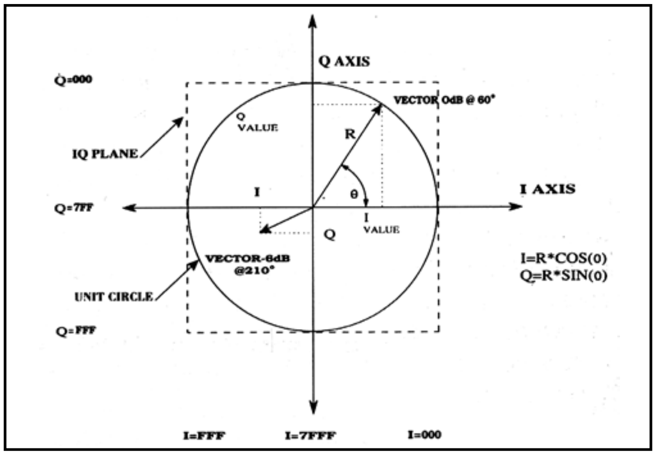


FIGURE 6
I-Q Vector Model

5.0 Once the scaling of the axes has been accomplished, the zero degree point on the unity circle is stored and normalized on the vector analyzer. The control word for this point will be approximately I=000, Q=7FF and all succeeding phase and amplitude values will be referenced to this point. Note that the I control word will differ from 000 if it is not the maximum insertion loss state of the four states listed in table 2. The Q control word will be equal to 7FF. An algorithm to find any desired amplitude and phase with respect to the normalized unit circle zero degree point can be constructed from the following procedure:

5.1 Convert the desired amplitude to a ratio such that the desired amplitude and phase can be expressed as a magnitude (R) and phase (Θ). This is the desired phase and amplitude change with respect to the normalized point obtained in step 5.0.

5.2 Solve for the required values of I and Q and multiply by appropriate scaling factor as outlined in step 4.0. $I = (R*\cos\Theta)*SCALE$, $Q = (R*\sin\Theta)*SCALE$. This process is essentially changing from polar coordinates (amplitude and phase) to rectangular coordinates I and Q.

5.3 Change I-Q modulator control word to the value obtained above and measure the resultant amplitude and phase. Compare the difference between the desired vector (at the calibration frequency) and the measured vector. This difference vector will be adjusted by successive iterations until its amplitude and phase error from the desired value is less than the desired calibration accuracy value. From experience, accuracy values of 0.1 dB and 1 degree are reasonable calibration limits for attenuation levels below 20 dB. However higher accuracy is achievable with careful measurements.

5.4 If the measured vector is within the error limits, store the I-Q value in the calibration table that is being set up. If the error is larger than the limit, calculate the I and Q change that is necessary to reach the desired vector. This is performed by changing both the desired vector and the error vector back into rectangular I-Q coordinates and calculating the difference in I and Q control word required to reach the desired vector. It is recommended that the I-Q steps taken be limited to one half of the calculated value in order to minimize hunting time. Repeat this process until the desired point is reached within the accuracy limits.

6.0 Complete calibration is usually performed by generating sets of constant amplitude circles on the I-Q plane. Data points can readily be interpolated over the plane and therefore only a limited number of actual calibration points are required. Our experience shows that calibration points taken every 22.5 degrees around a constant amplitude circle with a linear interpolation of I and Q values to find intermediate phase angles is sufficient to achieve high accuracy. Constant amplitude circles should be calibrated every 0.5 dB for the first two dB above insertion loss and 1.0 dB increments beyond that level. Interpolation between constant amplitude circles is also useful in minimizing data collection. For applications that require high speed (<1.0 µsec) variations between amplitude and phase states, the entire I-Q plane can be calibrated, interpolated and the results stored for each frequency interval. Where speed is not critical, an interpolation routine can be run in real time and thus the data storage can be minimized. Typical calibrations using this technique should provide amplitude accuracy of ±0.2 dB and phase accuracy of ±2.0 degrees over a 10 dB dynamic range for each frequency calibration interval.

Further improvements in accuracy can be obtained by the following:

- Tightening up the error limits at each calibration point
- Reducing the frequency interval
- Maintaining tight control of temperature (less than ±3 degrees C)

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 24 40	MODEL	PAGE	COMMENTS
0.5 – 2.0	7720A/7820	159	Phase shifter/Frequency translator
2.0 – 6.0	7722A/7822		Phase shifter/Frequency translator,
4.0 – 12.0	7724A/7824		Phase shifter/Frequency translator,
6.0 – 18.0	7728A/7828		Phase shifter/Frequency translator
8.0 – 12.4	7728-NB-0812		Narrow Band Phase Shifter
12 – 14.5	7728-NB-1214		Narrow Band Phase Shifter
6.0 – 18.0	7928A	165	Miniature Phase shifter/Frequency translator
6.0 – 18.0	F1938	140	Bi-Phase modulator
0.5 – 2.0	7120/7220	143	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 – 18.0	7218	148	I.Q. Vector modulator, digitally controlled
2.0 – 6.0	7322/7422	152	I.Q. Vector modulator, High Dynamic Range
6.0 – 18.0	7328/7428		I.Q. Vector modulator, High Dynamic Range
16.0 – 24.0	7329/7429		I.Q. Vector modulator, High Dynamic Range
6.0 – 18.0	7328H	157	I.Q. Vector modulator, High speed High Dynamic Range
18.0 – 40.0	7929	336	MMW Phase Shifter
18.0 – 21.4	7929-NB-1821		Narrow Band Phase Shifter
27.0 – 31.0	7929-NB-2731		Narrow Band Phase Shifter
33.0 – 36.0	7929-NB-3336		Narrow Band Phase Shifter
37.0 – 40.0	7929-NB-3740		Narrow Band Phase Shifter

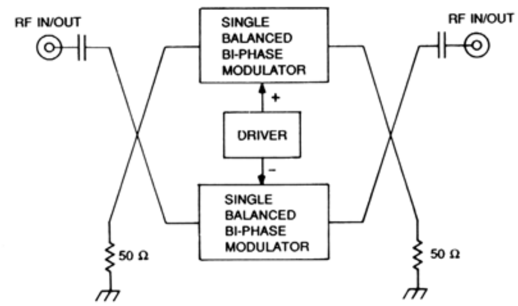
Model F1938
Bi-Phase Modulator

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

Model F1938

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

PERFORMANCE CHARACTERISTICS

Frequency Range .... 6 to 18 GHz

Differential Phase Shift[(1)] .... 180° ±10°

Switching Characteristics[(2)]

- ON Time .... 20 nsec max
- OFF Time .... 20 nsec max
- Rise Time .... 5 nsec max
- Fall Time .... 5 nsec max

Insertion Loss[(1)] .... 6 to 16 GHz, 3 dB max
>16 to 18 GHz, 3.5 dB max

VSWR[(1)] .... 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 (1µsec max pulse width)

Power Supply Requirements .... +5V ±5%, 65mA
–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°.

(1) With Option 85, within Frequency Band of 16 to 18 GHz will be:
   a. Insertion Loss: 4 dB max
   b. Differential Phase Shift: 180° ±15°
   c. VSWR: 2.2:1 max

(2) As measured with a phase bridge.

Model F1938 Specifications

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range .... –55° 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)

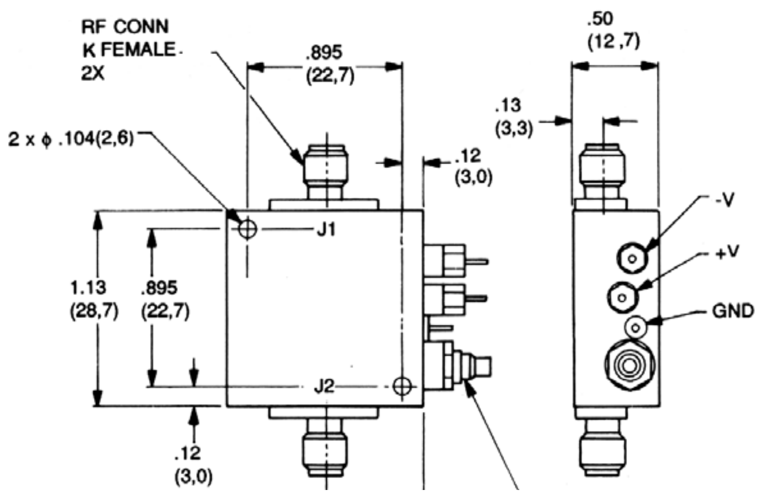
Vibration .... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)

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 K male RF connectors
10	One K (J1) male and one K female (J2) RF connector
33	EMI filter solder-type control terminal
85	SMA RF connectors
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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**

IQ Model 7128

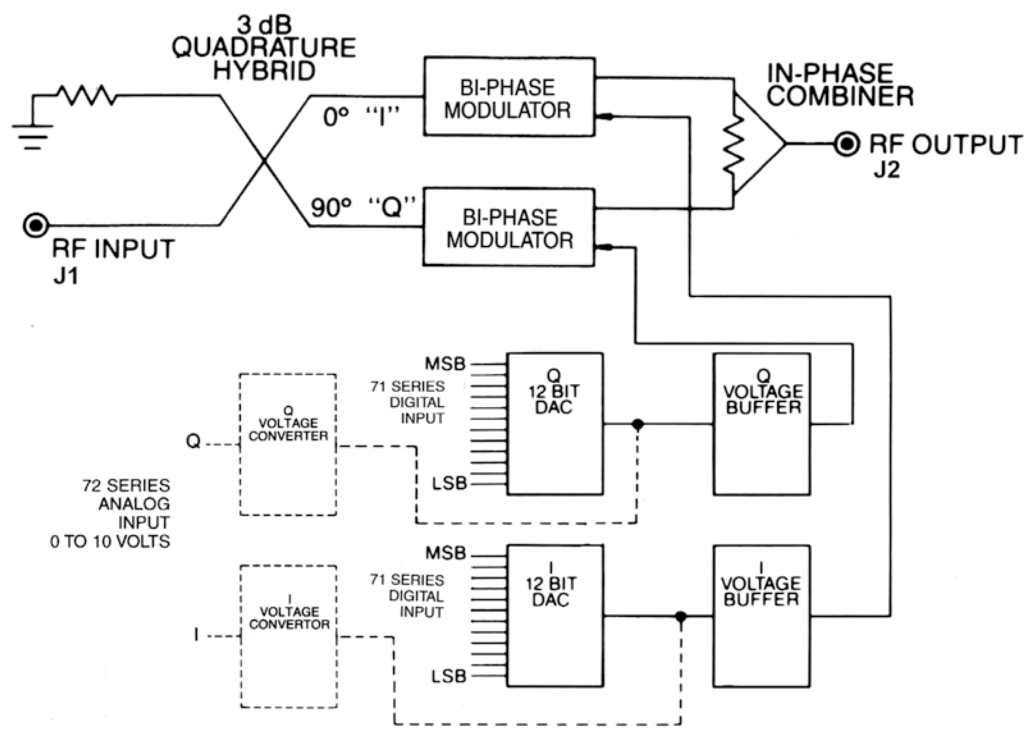


Fig. 1–Series 71, 72 Block Diagram

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

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 biphase 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 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.

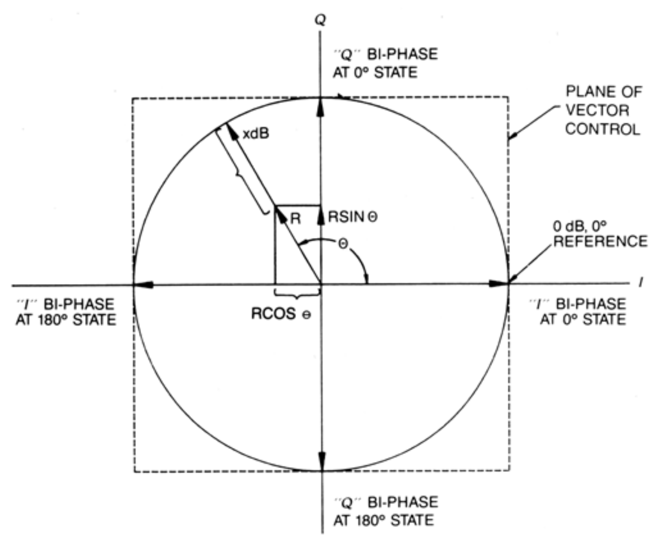


Fig. 2–I-Q Phase Relationship

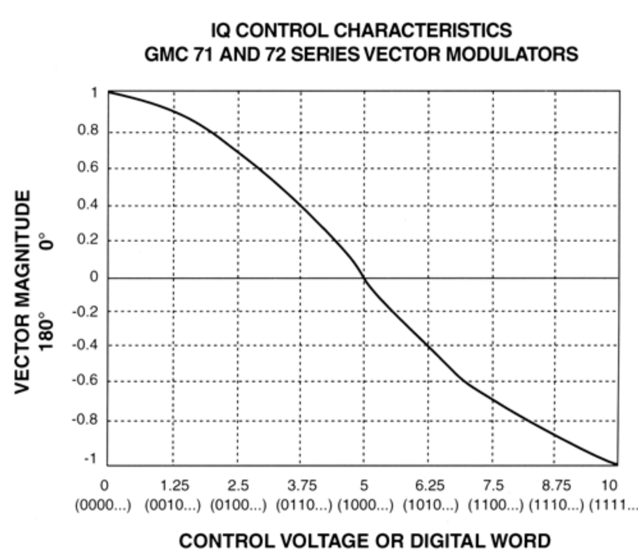


Fig. 3 – I-Q vs. Control Input (Typical)

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°			
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 kw			

OPTION (G09) 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

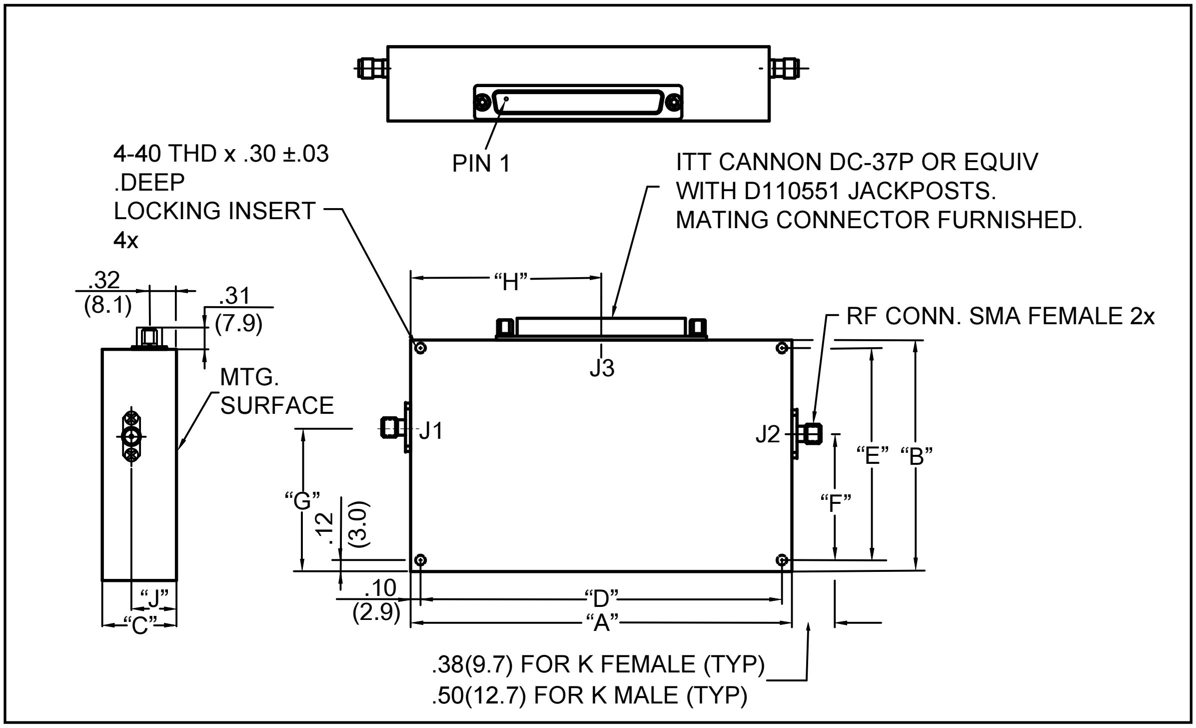
ACCESSORY FURNISHED

Mating power/control connector (Series 71 only)

AVAILABLE OPTIONS

Option No.	Description
7	Two type K male RF connectors
10	One type K male (J2) and one SMA female (J1) RF connector
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHTS SERIES 71



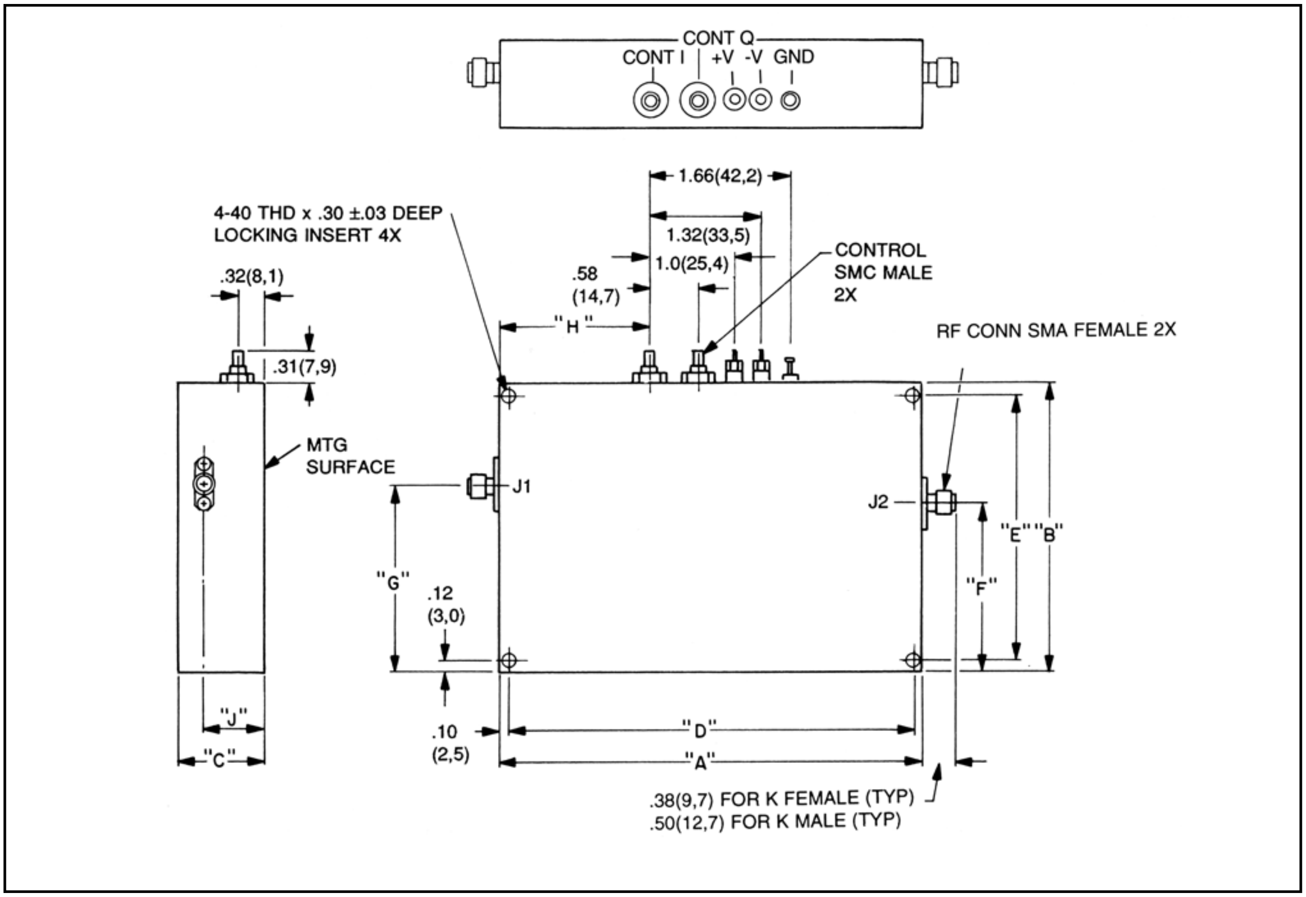
MODEL	A	B	C	D	E	F	G	H	J
7120	4.95±.03 (125,7)	3.38±.03 (85,9)	1.02 (25,9)	4.75±.01 (120,7)	3.12±.01 (79,2)	2.62 (66,5)	1.69 (42,9)	2.47 (62,9)	.73 (18,5)
7122	3.25±.03 (82,6)	3.25±.03 (82,6)	.85 (21,6)	3.05±.01 (77,5)	3.00±.01 (76,2)	1.63 (41,4)	1.99 (50,5)	1.63 (41,4)	.64 (16,3)
7124							1.83 (46,5)		
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 FUNCTION			
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 gr.)
7122	10 oz. (284 gr.)
7124	10 oz. (284 gr.)
7128	9 oz. (255 gr.)

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

DIMENSIONS AND WEIGHTS SERIES 72



<table>
<tr><th>MODEL</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>J</th></tr>
<tr><td>7220</td><td>4.95±.03 (125,7)</td><td>3.38±.03 (85,9)</td><td>1.02 (25,9)</td><td>4.75±.01 (120,6)</td><td>3.12±.01 (79,2)</td><td>1.68 (42,7)</td><td>.75 (19,1)</td><td>1.75 (44,5)</td><td>.73 (18,5)</td></tr>
<tr><td>7222</td><td rowspan="2">3.25±.03 (82,6)</td><td rowspan="2">3.25±.03 (82,6)</td><td rowspan="2">.85 (21,6)</td><td rowspan="2">3.05±.01 (77,5)</td><td rowspan="2">3.00±.01 (76,2)</td><td rowspan="2">1.63 (41,4)</td><td>1.99 (50,5)</td><td rowspan="2">.90 (22,9)</td><td rowspan="2">.64 (16,3)</td></tr>
<tr><td>7224</td><td>1.83 (46,5)</td></tr>
<tr><td>7228</td><td>3.00±.03 (76,2)</td><td>3.00±.03 (76,2)</td><td>.96 (24,4)</td><td>2.80±.01 (71,1)</td><td>2.75±.01 (69,9)</td><td>1.50 (38,1)</td><td>1.63 (41,4)</td><td>.78 (19,8)</td><td>.76 (19,3)</td></tr>
</table>

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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model 7218
Broadband I-Q Vector Modulator

- **Broad Frequency range - 2 to 18 GHz**
- **Simultaneous control of phase and amplitude**
- **Digitally programmable - 12 Bits for both I & Q**
- **High Speed**
- **Guaranteed monotonic**

IQ Model 7218

The Model 7218 is the latest addition to the family of high performance I.Q. Vector Modulators. Its broadband capability is ideally suited for today's more demanding and complex Electronic Warfare systems

The Model 7218 covers a frequency range of 2 to 18 GHz, is capable of a full 360 Degrees phase control and a minimum of 20 dB amplitude control. Response time is 1 microsecond, maximum. Digital control is accomplished by two 12 bit TTL inputs, for I and Q channels, which provide for high precision calibration of phase and amplitude. Operation is guaranteed to be monotonic.

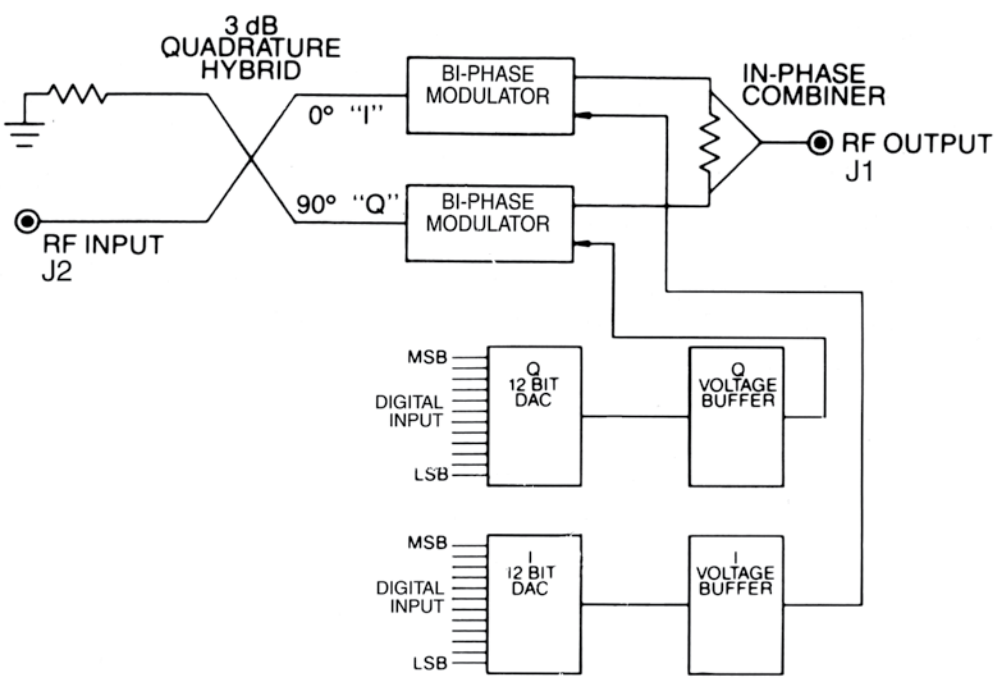


Fig. 1 - Model 7218 Block Diagram

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 biphase 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 = $\theta°$ (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 or analog voltage 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	Digital Units
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.

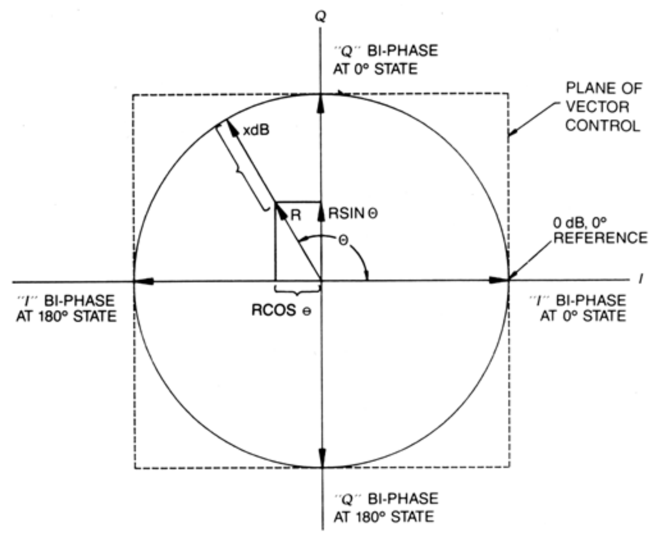


Fig. 2–I-Q Phase Relationship

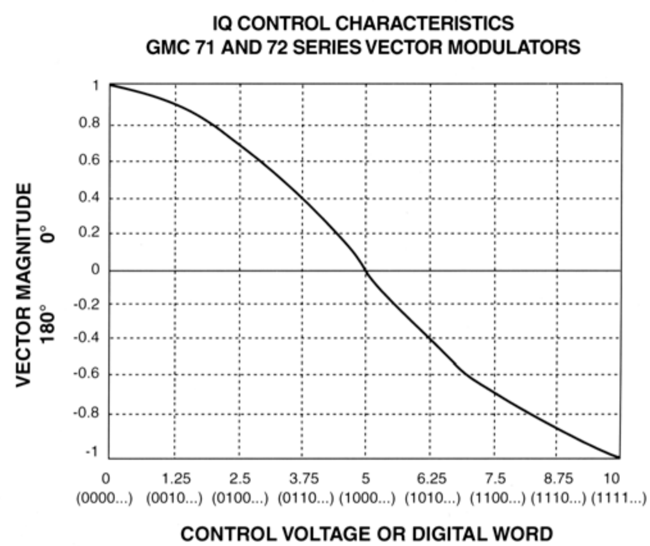


Fig. 3 – I-Q vs. Control Input (Typical)

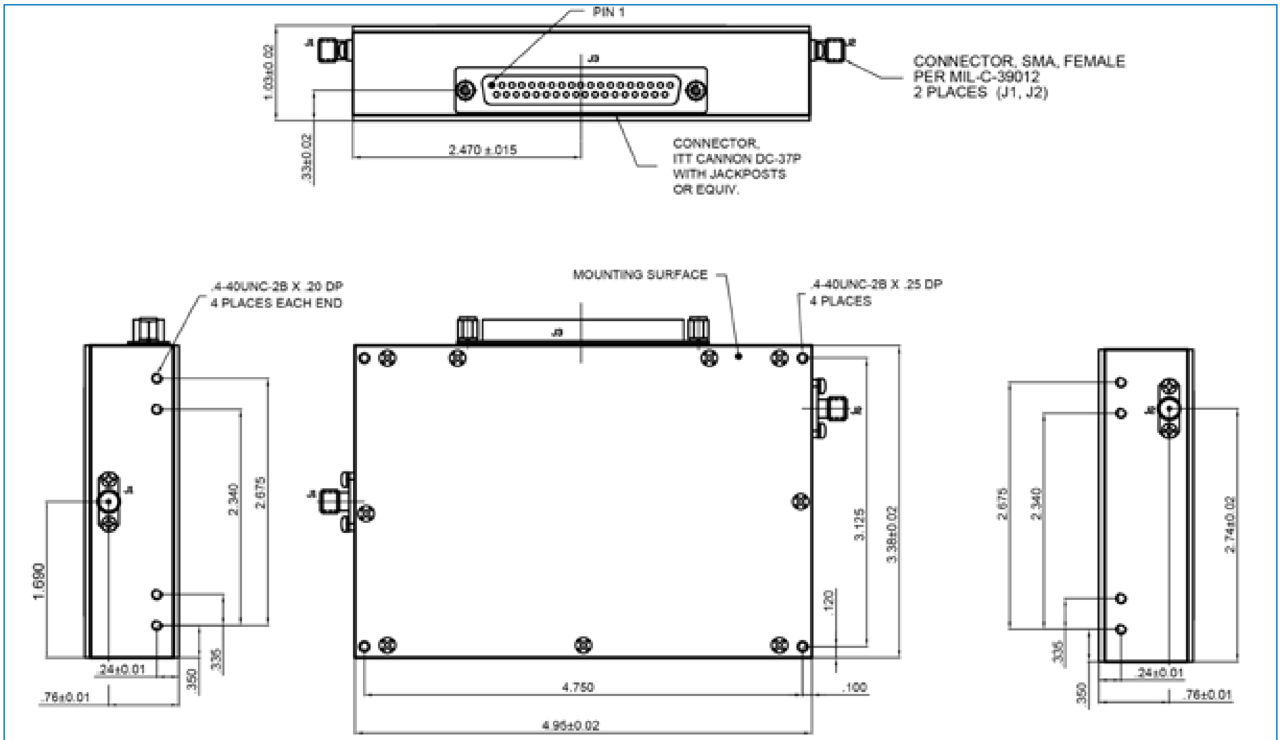
Model 7218 Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER		SPECIFICATION
OPERATING FREQUENCY RANGE		2.0 - 18.0 GHz
	Band 1	2 - 6 GHz
	Band 2	6 - 18 GHz
	Band Switching Speed, max.	250 nanoseconds
INSERTION LOSS (MAX)		16 dB
VSWR (MAX)		2.2 :1
POWER HANDLING CAPABILITY		
	Without performance degradation	+20 dBm
	Survival	1 W
ABSOLUTE INSERTION PHASE ACCURACY VS. FREQUENCY (MAX)		±15° (in each band)
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)		1.0 µsec
POWER SUPPLY		+5 V ±2% @ 200 mA, max. +12 to +15V @ 150 mA, max. -5.2 V ±2% @ 400 mA, max. -12 to -15V @ 150 mA, max
MONOTONICITY		GUARANTEED
CONTROL INPUT		12 BIT TTL FOR BOTH I & Q INPUTS
CONNECTORS		
	RF Input/output	SMA Female, 2X
	Control/Power	Cannon DC-37P or Equivalent
TEMPERATURE RANGE		
	Operating	-55 °C to +85 °C
	Storage	-65 °C to +125 °C

Model 7218 Specifications

DIMENSIONS AND WEIGHT



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

WEIGHT (APPROX) 16oz. (453 gr.)

J3 PIN FUNCTION			
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	BAND 1 (notes1& 2)	26	N/C
8	+12 to +15V	27	+5V ±2%
9	GND	28	GND
10	GND	29	BAND 1 (notes1& 2)
11	–12 to –15V	30	-5.2V ±2%
12	Q-3	31	BAND 2 (notes1& 2)
13	Q-2	32	Q-4
14	Q-1 (LSB)	33	BAND 2 (notes1& 2)
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		

ACCESSORY FURNISHED

Mating power/control connector

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

NOTES:

1. BAND SELECT: Band 1 (2 to 6 GHz) - Apply TTL 0 to Pin 7 or Pin 29
   Band 2 (6 to 18 GHz) - Apply TTL 0 to Pin 31 or Pin 33
2. With no band selected, there will be maximum Isolation between J1 and J2

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

- **Simultaneous control of amplitude and phase over a 50 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**

IQ Model 7328

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.

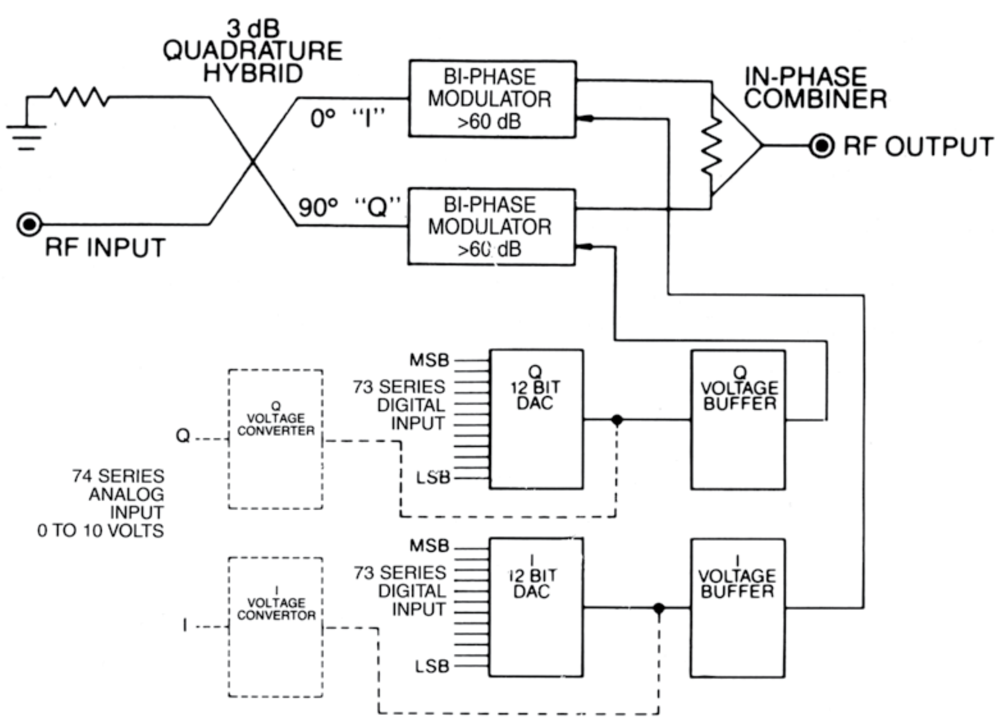


Fig. 1 – Series 73, 74 Block Diagram

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 biphase 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 (73 Series)	Digital Units (74 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.

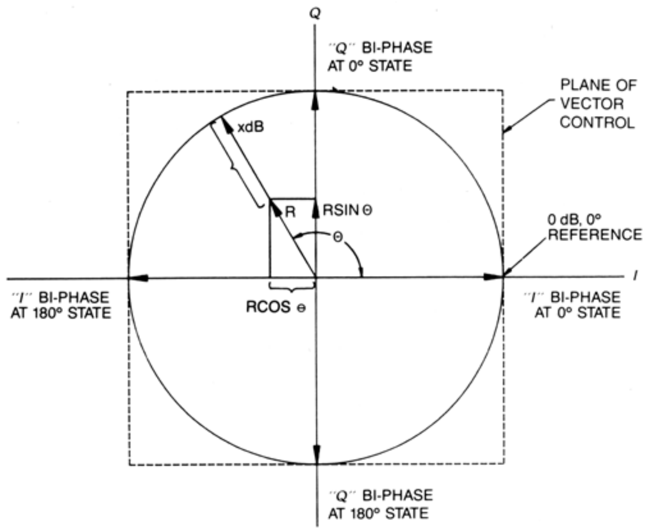


Fig. 2–I-Q Phase Relationship

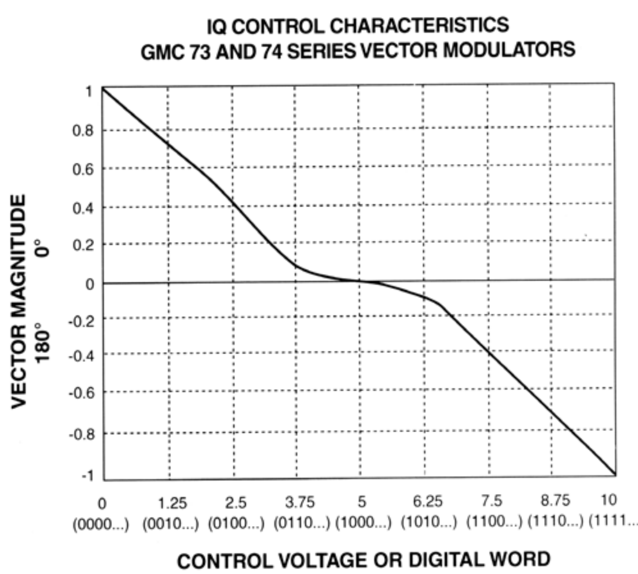


Fig. 3 – I-Q vs. Control Input (Typical)

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	16 dB	6-16 GHz 20 dB >16-18 GHz 23 dB	21 dB
VSWR (MAX)	1.8:1	2.3:1	2.5:1
POWER HANDLING WITHOUT PERFORMANCE DEGRADATION	+20 dBm typical		
SURVIVAL POWER (MAX)	1W		
ABSOLUTE INSERTION PHASE ACCURACY VS. FREQUENCY (MAX)	±25°		±22°
VARIATION OF PHASE VS. TEMPERATURE (MAX)	±0.2 deg./ °C		
ATTENUATION RANGE (MIN)	50 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 kW		

OPTION (G09) 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

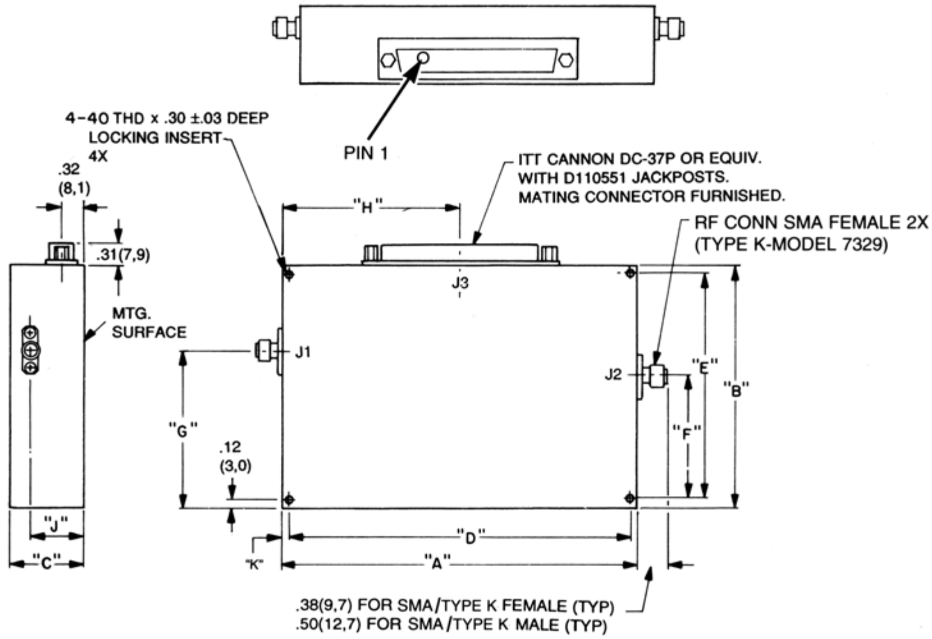
ACCESSORY FURNISHED

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
G09	Meeting the specified Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHTS SERIES 73



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)	1.69 (41,1)	.65 (16,5)	.12 (3,0)

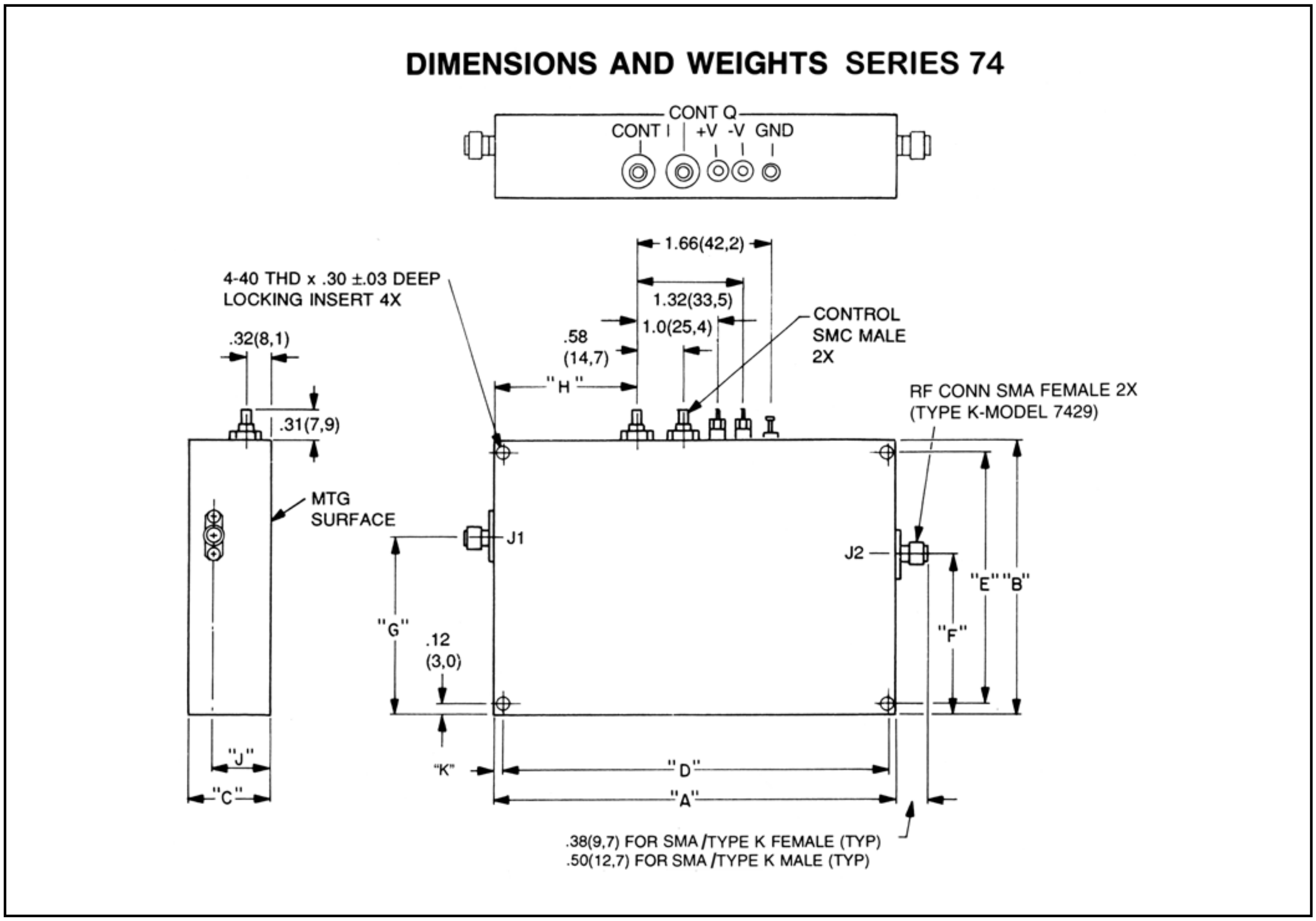
J3 PIN FUNCTION			
PIN	FUNCTION	PIN	FUNCTION
1	I-5	20	I-4
2	I-6	21	I-7
3	I-8	22	I-3
4	I-9	23	I-2
5	I-10	24	I-1 (LSB)
6	I-11	25	I-12 (MSB)
7	N/C	26	N/C
8	+12 to +15V	27	N/C
9	GND	28	GND
10	GND	29	N/C
11	–12 to –15V	30	N/C
12	Q-3	31	N/C
13	Q-2	32	Q-4
14	Q-1 (LSB)	33	N/C
15	Q-5	34	N/C
16	Q-6	35	Q-12 (MSB)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

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

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008



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)	.90 (22,9)	.65 (16,5)	.12 (3,0)

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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model 7328H High Speed, High Dynamic Range I-Q Vector Modulator

The Model 7328H represents the latest advancement to General Microwave's comprehensive product line of PIN diode I-Q Vector Modulators. Its response time has been significantly reduced, resulting in an enhanced modulation rate performance of 50 MHz to better serve today's more demanding system applications.

In addition to the high speed, the Model 7328H incorporates multiple bi-phase modulator sections to provide in excess of 60 dB attenuation through 16 GHz, and is capable of a full 360 degrees of phase shift. Thus, the unit will provide high speed and simultaneous control of amplitude and phase over the full frequency range of 6 to 18 GHz. A simplified block diagram is shown in Fig. 1.

THEORY

The Theory of Operation of the Model 7328H is the same as the Series 73 units. The RF and Driver portions of the IQ Modulator have been modified to enable modulation rates up to 50 MHz.

- **High Speed – Modulation Rate of better than 50 MHz**
- **Wide Frequency Range – 6 to 18 GHz**
- **Simultaneous control of amplitude and phase over a 60 dB dynamic range**
- **Digitally Programmable I&Q – 12 Bit ECL control**
- **Guaranteed monotonicity**

IQ Model 7328H

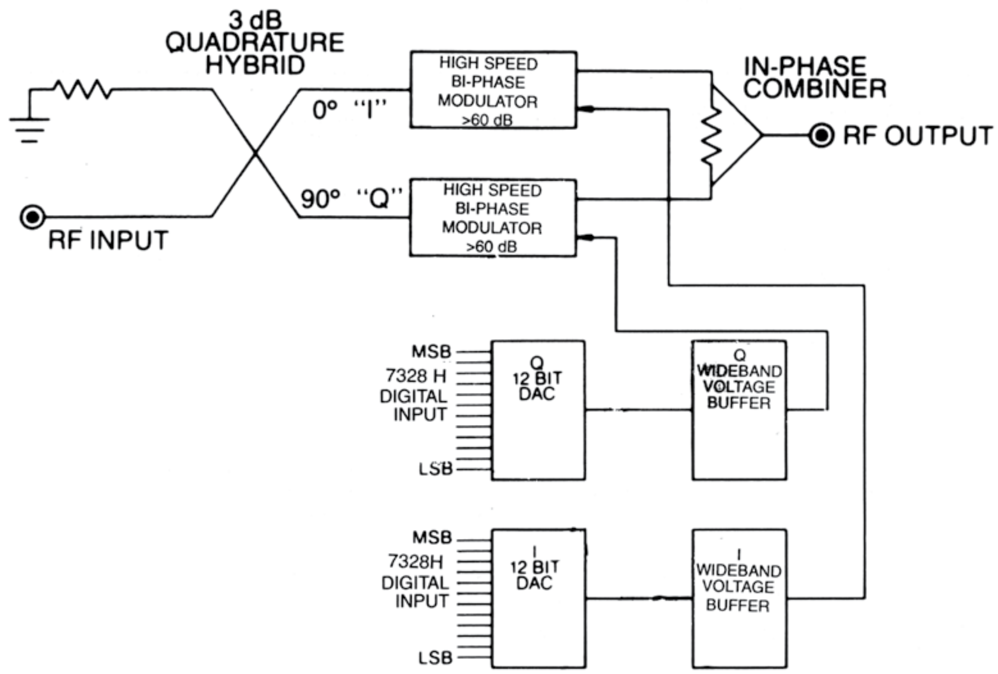


FIG. 1–SERIES 7328H BLOCK DIAGRAM

Model 7328H Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	SPECIFICATION
Frequency Range, min	6.0 to 18.0 GHz
Insertion Loss, max	6 to 10 GHz 18.5 dB 10 to 12 GHz 20 dB 12 to 18 GHz 27 dB
VSWR, max	6 to 10 GHz 2.2:1 10 to 18 GHz 2.6:1
Power Handling, max Without Performance Degradation	–5 dBm Typical
Survival	+27 dBm
Absolute Insertion Phase Accuracy vs Frequency	6 to 12 GHz ±25° 12 to 18 GHz ±35°
Variation of Phase vs Temperature, max	±0.2°/°C
Attenuation range, min 6 to 16 GHz	60dB
>16 to 18 GHz	50dB
Variation of Amplitude vs Temperature, max	0.04 dB/°C
Modulation Rate, min	50 MHz
Control Input	12 Bit ECL for both I&Q
Control Characteristics, I&Q, typ	See Figure 2
Control Input Impedance	100 ohms (to –2V supply)
Power Supply	+12V @ 350 mA –12V @ 130 mA –5.2V @ 340 mA –2V @ 280 mA

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

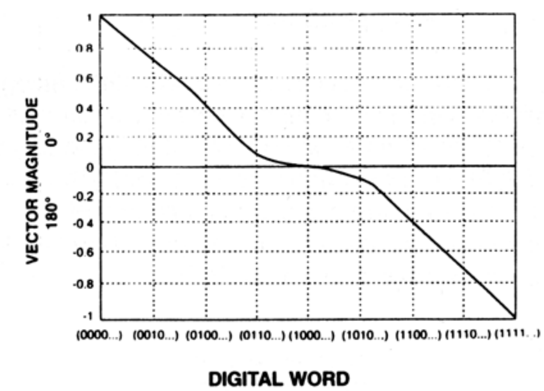
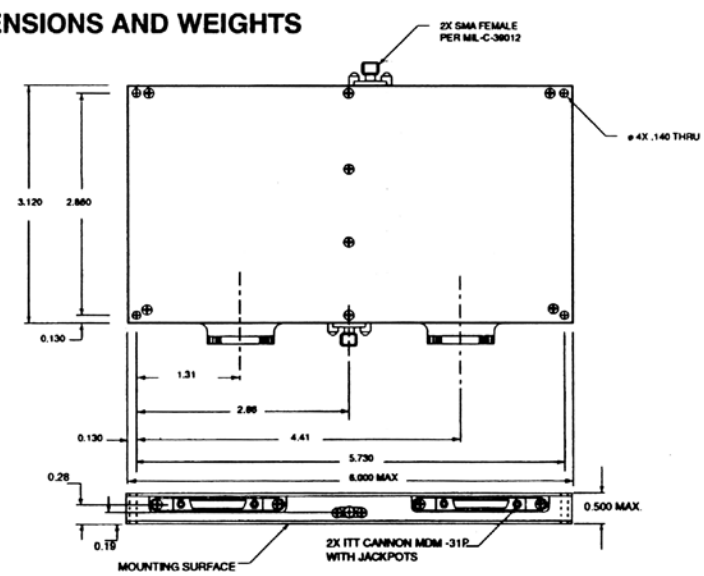


FIG. 2 TYPICAL IQ CONTROL CHARACTERISTICS

PIN DESIGNATIONS– J3(I) AND J4(Q)			
PIN NO.	SIGNAL	PIN NO.	SIGNAL
1	CLK+	17	CLK–
2	D0	18	GND
3	D1	19	GND
4	D2	20	GND
5	D3	21	GND
6	D4	22	GND
7	D5	23	GND
8	D6	24	GND
9	D7	25	GND
10	D8	26	GND
11	D9	27	GND
12	D10	28	GND
13	D11	29	GND
14	GND	30	+12V
15	–5.2V	31	–12V
16	–2V		

DIMENSIONS AND WEIGHTS



Model 7328H weight 8.8 oz. (249 gr.) approximate

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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. 1 B).

The phase in the Series 77 is digitally controlled over a full 360° in 0.35° discrete steps. The voltage converter in the Series 78 consists of a 8 bit A/D converter followed by D/A converter, and converts a continuous analog input voltage into discrete steps of 1.41°.

- **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**

Phase Shifter Model 7728A

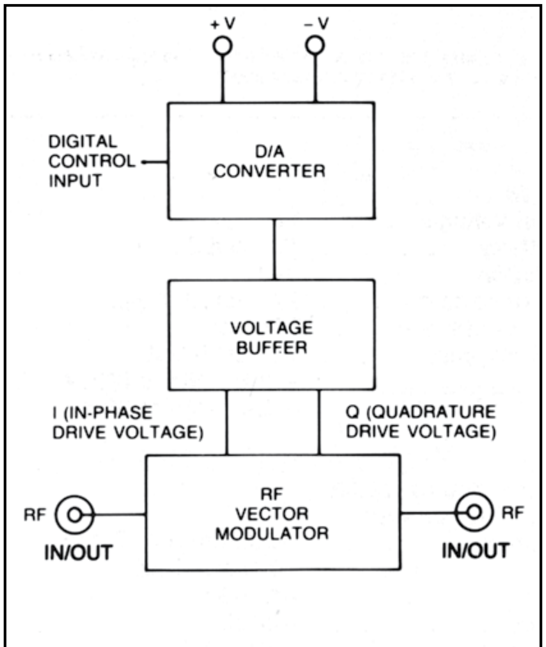


Fig. 1A—Series 77, Block Diagram

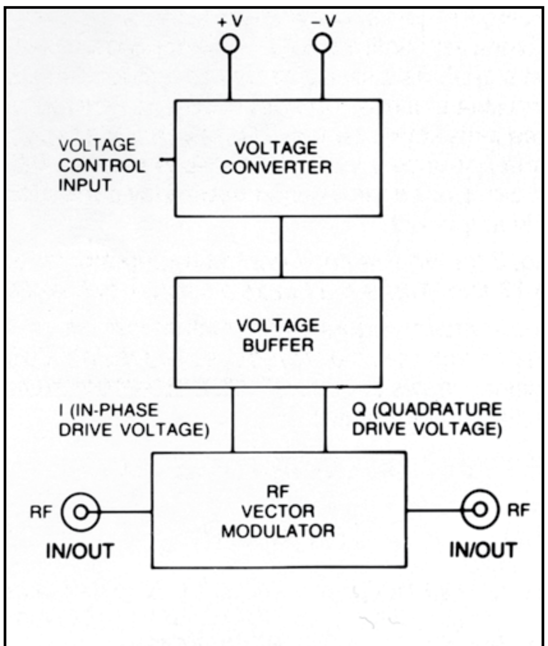


Fig. 1B—Series 78, Block Diagram

Series 77/78 Specifications

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.

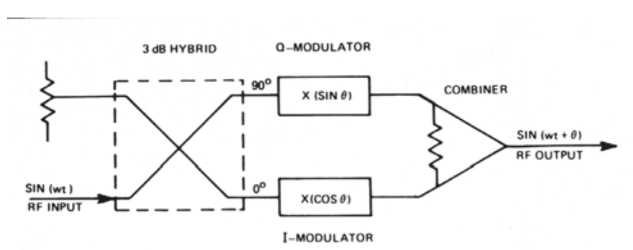


Fig. 2-RF vector modulator

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 CHARACTERISTIC

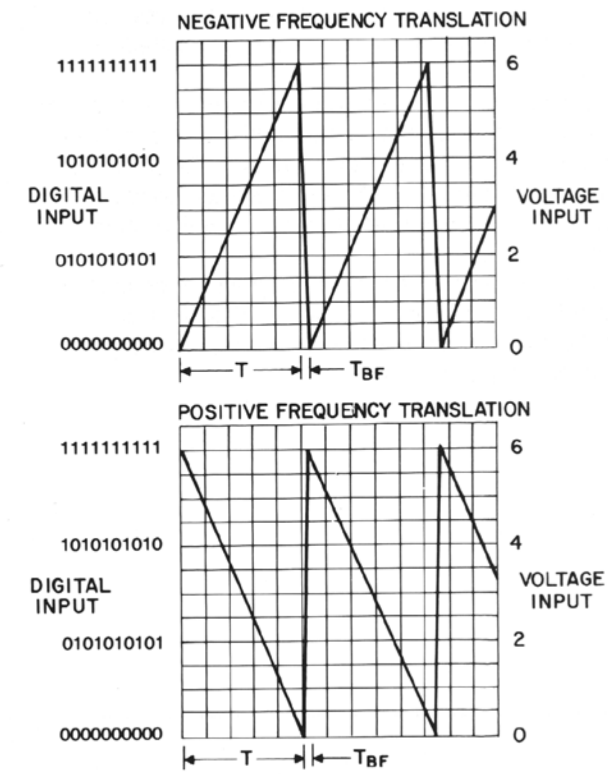
SERIES 77

Control..........................10 bit TTL

Nominal Resolution........ 0.35°

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

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 ....23.4 mV/LSB

Resolution.....................1.41°

Step Uncertainty...........0.7° max, 0.3° typ.

Input Resistance...........2K ohms

POWER SUPPLY REQUIREMENTS

VOLTAGE	SERIES 77	SERIES 78
+5V to +5.5V	100 mA	200 mA
+12V to +15V	100 mA	100 mA
-12V to -15V	90 mA	90 mA

Power Handling Capability
 Without Performance
 Degradation ....+20 dBm (+7 dBm for 7720A, 7820)

Survival..........................+30 dBm

Harmonics.....................–30 dBc

Phase Variation ....0.1°/°C

PHASE SHIFTER SPECIFICATIONS

MODEL NOS.	FREQUENCY RANGE (GHz)	INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY (Max.)	PM/AM (Max.)
7720A & 7820	Main Band (1) 0.7 - 1.9 Stretch Band (2) 0.5 - 2.0 Band Edges (3) 0.5 - 0.7 & 1.9 -2.0	11.5 dB max 13.0 dB typ 13.0 dB max	1.75	±10° max ±15° typ ±10° max	±1.1 dB max ±2.5 dB typ ±1.1 dB max
7722A & 7822	Main Band (1) 2.6 - 5.2 Stretch Band (2) 2.0 - 6.0 Band Edges (3) 2.0 - 2.6 & 5.2 - 6.0	10.0 dB max 11.0 dB typ 11.0 dB max	1.6	±10° max ±15° typ ±10° max	±1.1 dB max ±1.5 dB typ ±1.1 dB max
7724A & 7824	Main Band (1) 4.5-10.5 Stretch Band (2) 4.0-12.0 Band Edges (3) 4.0 - 4.5 & 10.5 - 12.0	10.5 dB max 12.0 dB max 12.0 dB max	1.8	±10° max ±15° typ ±10° max	±1.1 dB max ±2.0 dB typ ±1.1 dB max
7728A & 7828	Main Band (1) 8.0-18.0 Stretch Band (2) 6.0-18.0 Band Edge (3) 6.0 to 8.0	12.0 dB max 12.0 dB typ 12.0 dB max	2.0	±12° max ±15° typ ±12° max	±1.25 dB max ±2.0 dB typ ±1.25 dB max

OTHER SPECIFICATIONS

Switching Speed (50% TTL to within 10^0 of Final Phase Value); 500 nsec Max.

Minimum phase shift range:

Series 77: 360^0 in 1024 Steps (10-bit) Series 78: 360^0 @ 60^0/Volt

FREQUENCY TRANSLATOR SPECIFICATIONS

TRANSLATION RATE (Min.)	CARRIER SUPPRESSION (Min.)	SIDEBAND SUPPRESSION (Min.)	INSERTION LOSS VARIATION (Max.) with translation rate:
0 to 50 kHz(4)	Main Band: 25 dB Stretch Band: 18 dB	Main Band: 20 dB Stretch Band: 15 dB	1 dB
>50 to 500 kHz(4)	Main Band: 20 dB Stretch Band: 15 dB	Main Band: 18 dB Stretch Band: 12 dB	3 dB

NOTES:

BAND SELECTION BY PIN 3 OF J3 LOGIC LEVEL ASSIGNMENT

(1) For **Main Band** optimized operation, apply logic HIGH to pin 3 or leave it floating.

(2) For **Stretch Band** operation, apply logic HIGH to pin 3 or leave it floating. While performance is optimized over the **Main Band**, the reduced performance as stated
in **Stretch Band** specifications apply to band edges..

(3) For **Band Edges** optimized operation, apply logic LOW to pin 3.

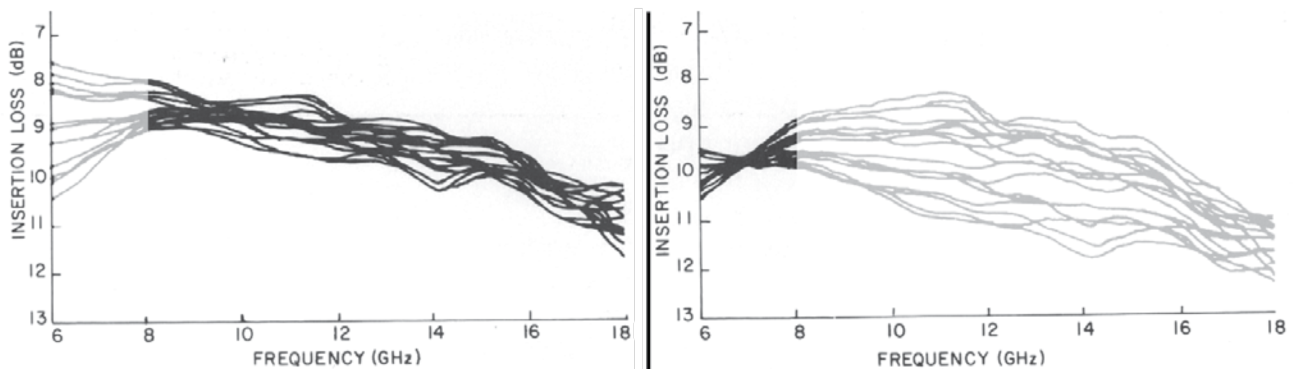
4) All specifications are met using five or more most significant bits for 0 to 50 kHz translation rates.
For 50-500 kHz translation rates, only the four most significant bits are used.

Narrow Band Phase Shifters

In addition to the standard wide band Phase Shifters, KRATOS General Microwave is offering Narrow Band Phase Shifters. These units are available both as standard catalog units and as customized units meeting specific customer's requirements. The narrow band units have better performances and lower prices.

Frequency Range	Model Number	Phase Accuracy	PM/AM	Insertion Loss
8.0 to 12.4 GHz	7728-NB-0812	± 6° (max.)	± 0.6 dB	12.0 dB (max.)
12.0 to 14.5 GHz	7728-NB-1214	± 6° (max.)	± 0.6 dB	12.0 dB (max.)

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

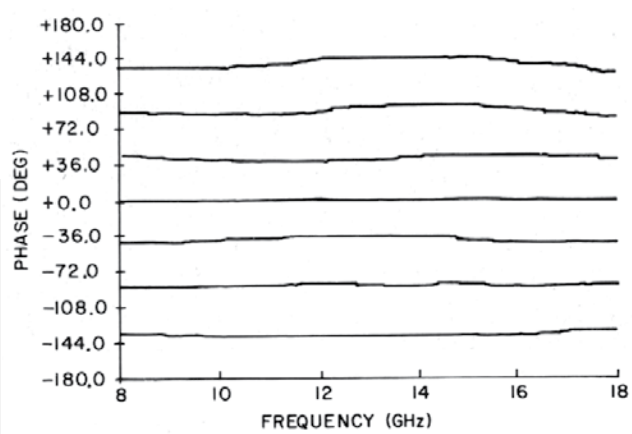


Fig. 5-Model 7728A-Phase accuracy vs. frequency (Logic "1").

OPTION (G09) 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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT

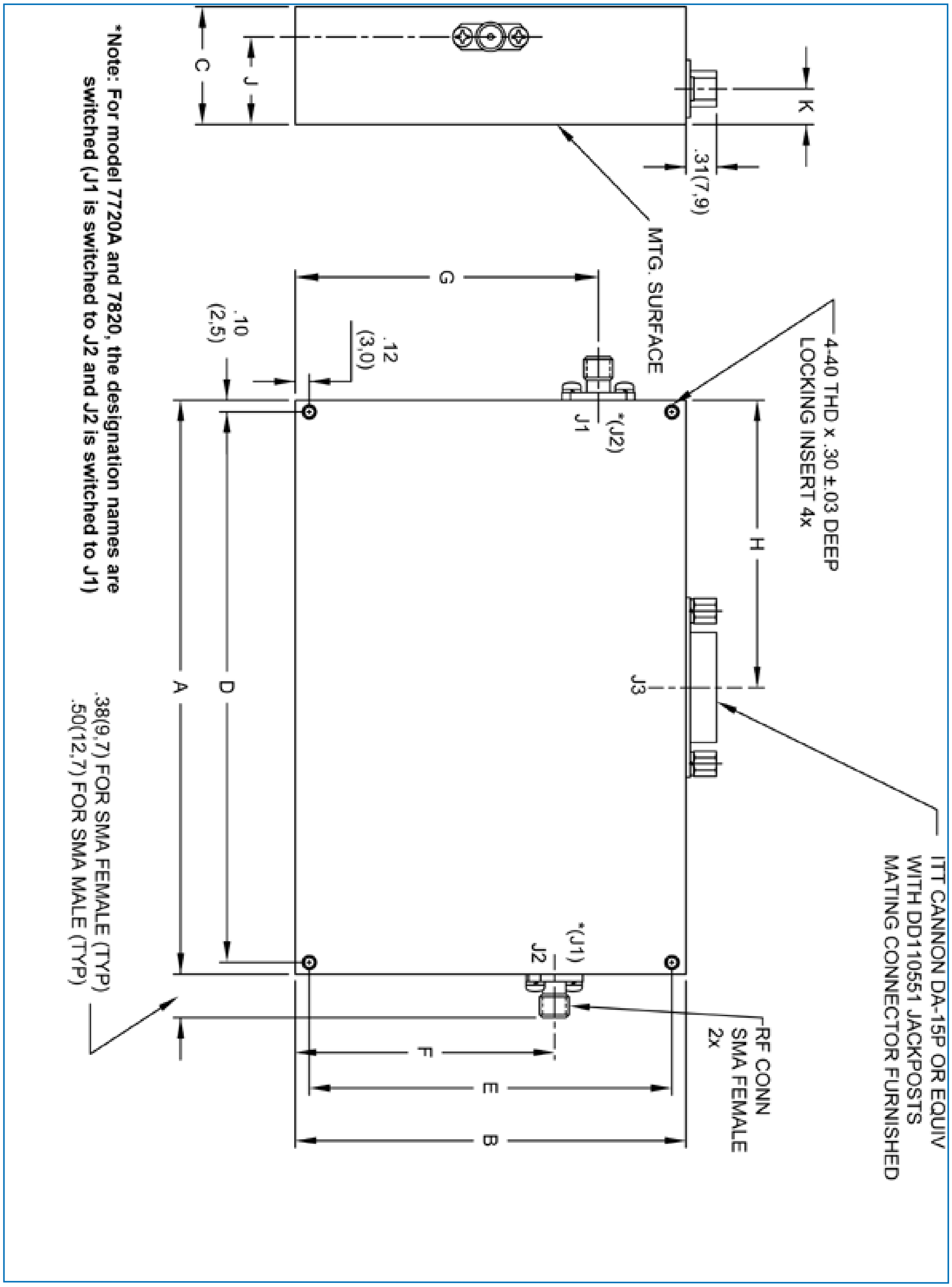
MODEL	A	B	C	D	E	F	G	H	J	K	WEIGHT (APPROX)
7720A	4.95±.03	3.38±.03	1.02 (25,9)	4.75±.01	3.12±.01	2.62	1.69	2.48	.73 (18,5)	.32 (8,1)	13 oz. (369 gr.)
7820	(125,7)	(85,9)	1.48 (37,6)	(120,7)	(79,2)	(66,5)	(42,9)	(62,9)	1.18 (30,0)	.78 (19,8)	15 oz. (425 gr.)
7722A			.84 (21,3)				1.99		.66 (16,8)	.32 (8,1)	9 oz. (255 gr.)
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 gr.)
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 gr.)
7824			1.25 (31,8)				(46,5)		1.07 (27,2)	.72 (18,3)	10 oz. (284 gr.)
7728A	2.50±.03	3.00±.03	.88 (22,4)	2.30±.01	2.75±.01	1.50	1.63	1.25	.71 (18,0)	.39 (9,9)	6 oz. (170 gr.)
7828	(63,5)	(76,2)	1.19 (30,2)	(58,4)	(69,9)	(38,1)	(41,4)	(31,8)	1.02 (25,9)	.69 (17,6)	8 oz. (227 gr.)

J3 PIN FUNCTIONS

Pin No.	Function	
	Series 77[1]	Series 78
1	–12V to –15V	–12V to –15V
2	+12V to +15V	+12V to +15V
3	Freq. Correction Circuit Select[3] "0" = Band Edge	Freq. Correction Circuit Select "0" = Band Edge
4	1.4°[3]	Not Used
5	5.6°[3]	Not Used
6	45.0°[3]	Not Used
7	180.0° (MSB)[3]	Not Used
8	90.0°[3]	Not Used
9	Ground	Ground (Sig)
10	0.7°[3]	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 to +5.5 VDC	+5V to +5.5 VDC

NOTE:
(1) Unused logic bits must be grounded.
(2) Must not exceed □7VDC. See footnote (3) below.
(3) Must not be greater than □0.3 VDC above voltage at pin 15.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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

The Model 7928A 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 7928A 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 40 dB. Consult the factory for such requirements.

- 6 to 18 GHz
- 360° range
- High speed
- Digitally programmable (8 Bits)
- Guaranteed monotonicity
- Hermetically Sealed
- Miniaturized: less than 1.5 in^3

Phase Shifter Model 7928A

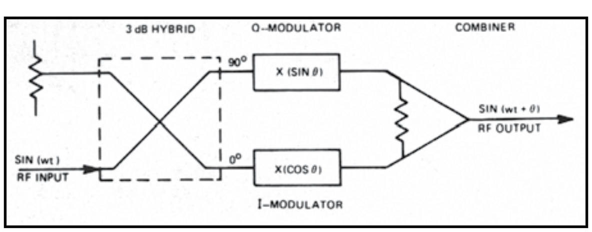


Fig. 2–RF Vector Modulator

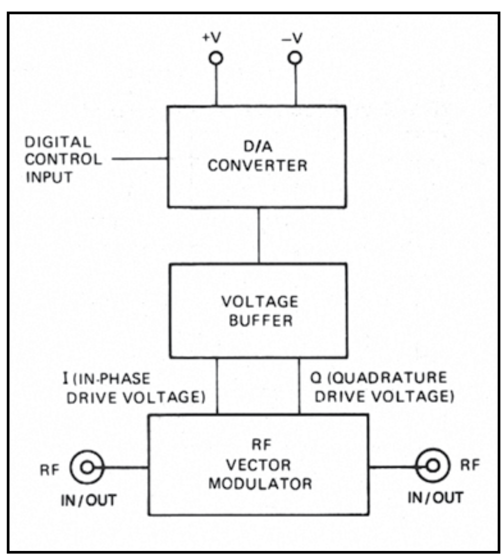


Fig. 1–Model 7928A, block diagram

Model 7928A Specifications

PHASE SHIFTER SPECIFICATIONS

FREQUENCY RANGE (GHz)		INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY[1] (Max.)	PM/AM[1] (Max.)
Main Band Stretch Band [3]	8.0-18.0 6.0-18.0	12.0 dB	2.0:1	±12° ±15°	±1.25 dB ±2.0 dB

FREQUENCY TRANSLATOR SPECIFICATIONS

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

(1) When operating as a Phase Shifter outside the Main Band Frequency Range, a TTL Low (0) applied to the J3 Power/Control Connector Freq. Correction Pin (pin R) will result in Band Edge Frequencies exhibiting enhanced performance characteristics. The resultant Accuracy and PM/AM specifications will be the same as those shown for the Main Band Frequency Range. When using the unit as a Frequency Translator, similar enhanced performance can be achieved for Carrier & Sideband Suppression.

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

(3) Specifications for the Strech Band are typical.

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%, 250 mA max
  +12 to +15V, 50 mA max
  –12 to –15V, 95 mA max

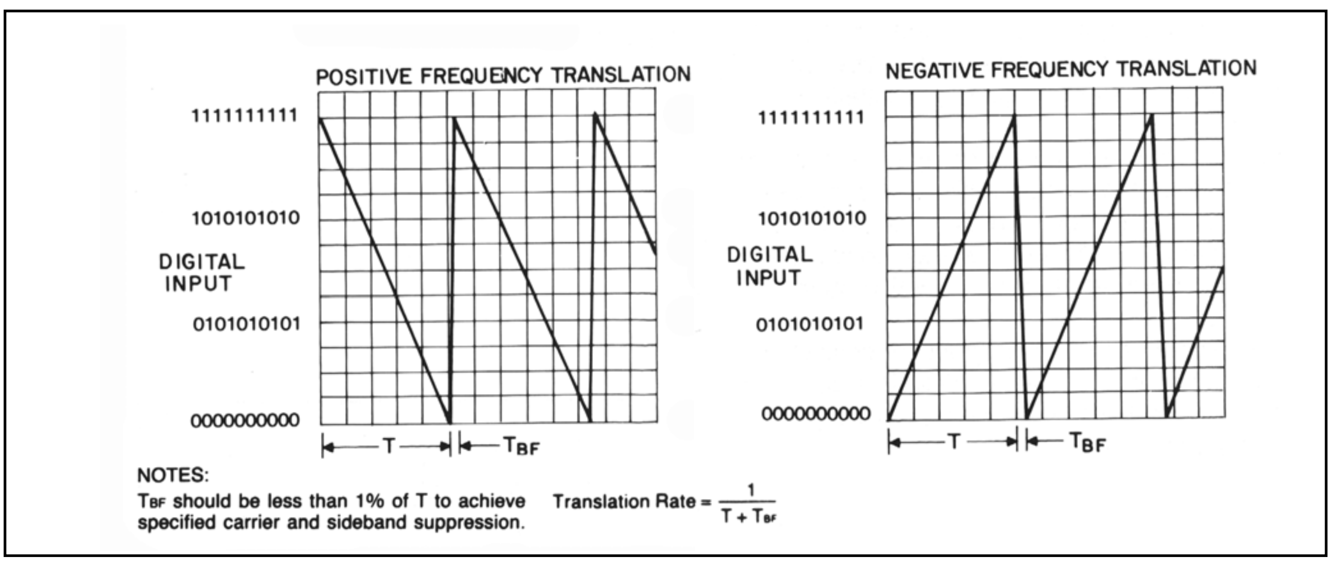


Fig. 3–Model 7928A Control input requirements.

ACCESSORY FURNISHED

Mating power/control connector

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range..............................–54°C to +95°C

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

AVAILABLE OPTIONS

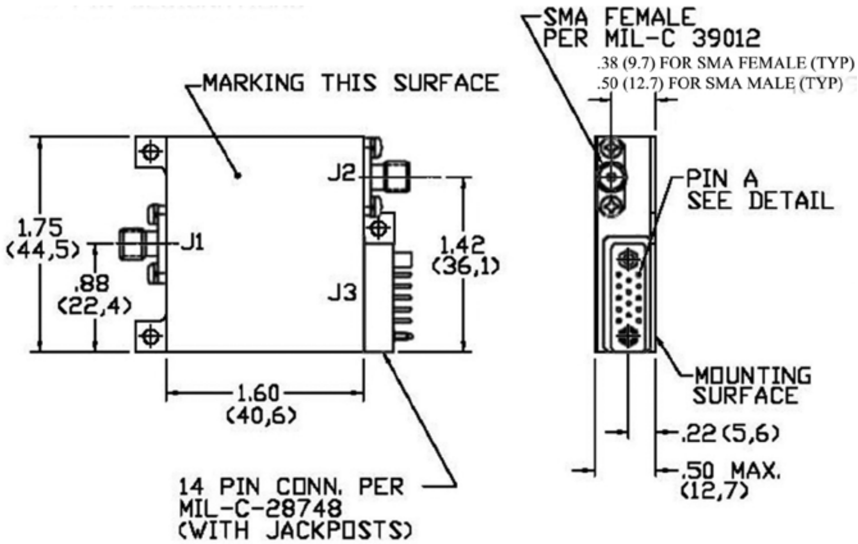
Option No.	Description
7	Two SMA male RF connectors
10	One SMA male (J1), and one SMA female (J2) RF connector
49	High Rel screening
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

NOTE:

To initialized the unit after power up, at least one of the digital bits has to change its TTL level.

DIMENSIONS AND WEIGHT

MODEL 7928A	PIN FUNCTIONS
PIN	**FUNCTIONS**
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 7928A Wt. 4.0 oz (113gr.) approx.

Dimensional Tolerances: unless otherwise indicated: .XX ±.02; .XXX ±.008

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 Non-reflective 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.

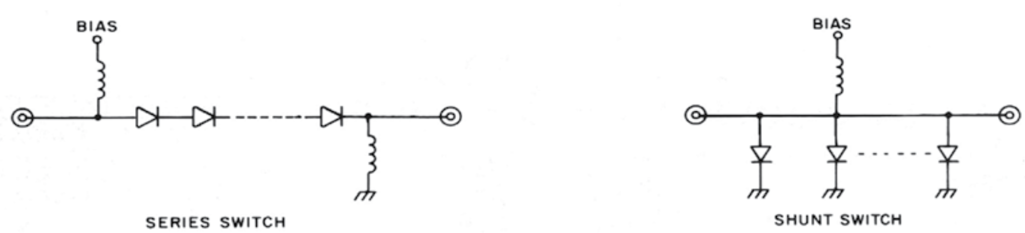


Fig. 1-Reflective SPST switch

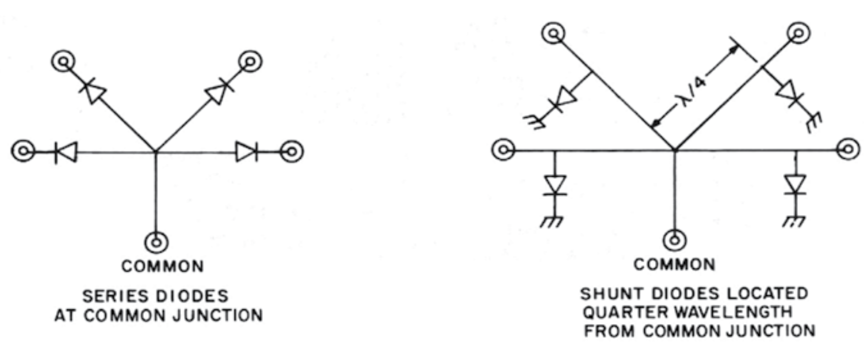


Fig. 2-Schematic diagrams of multi-throw switches

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.

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.

HARMONIC AND INTERMODULATION PRODUCTS

All PIN diode switches generate harmonics and inter-modulation 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.

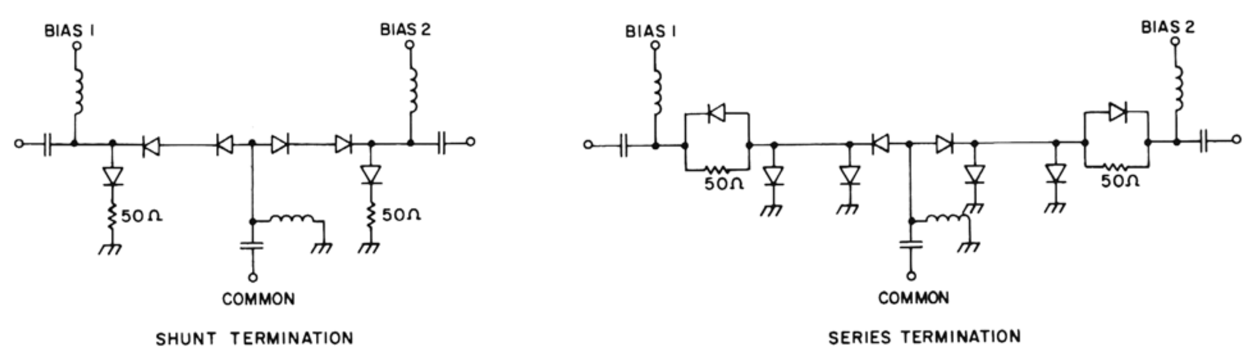


Fig. 3-Schematic diagrams of absorptive switches

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 out of band video leakage can be reduced significantly by the inclusion of high pass or "video filters" (1) in the switch. The General Microwave E-series switches are specially designed for low in-band video leakage, without sacrificing switching speed.

(1) For switches with internal video filters, specify Option 41, Option 42, or Option 43. These filters reduce the leakage as shown in the following chart.

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 LEAKAGE FILTER OPTIONS			
Applicability: F91 and G91 Switch Series			
		Peak (mV)	**Bandwidth (MHz)**
Video Leakage with Video Filter Options:		100 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	1.7:1*
		4-18 GHz	No Change

* As shown for switches whose VSWR specification from 1-4 GHz is less than 1.7.
No change for switches whose VSWR specification from 1-4 GHz is 1.7 or greater.

OPTION 55 – EXTENDED FREQUENCIES
When Option 55 is applicable, a switch in our catalog that covers 1-18 GHz can be modified 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 to 2 GHz specification. VSWR degrades to 2.0:1. 2. Insertion loss in the 12.4 to 18 GHz band increases by 0.3 dB. Consult factory for cost.

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.

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 TF power lrvrl in the on-going port rises to 90% of its final value. See Fig. 4

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

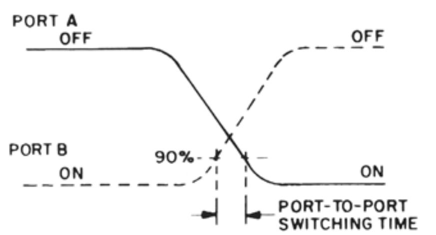


Fig. 4-Port-to-port switching speed definition

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.

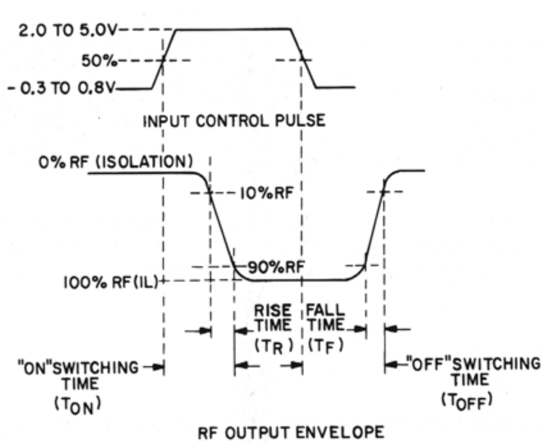


Fig. 5-Switching speed definition

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.

SWITCHES WITH INTEGRATED DRIVERS

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18 40	MODEL OR SERIES	PAGE	COMMENTS
REFLECTIVE SPST SWITCHES			
0.1 — 40-	F9016	180	Wide Frequency Range
1 — 18	F91	182	Miniature broadband
0.2 — 4	F9214A		
1 — 18	E9114H	275	Hermetically sealed,
18 — 40	F90	338	Millimeter Wave
NON-REFLECTIVE SPST SWITCHES			
0.2 — 18	F192A	177	Ultra-broadband
REFLECTIVE SP2T SWITCHES			
0.1 — 40-	F9025	189	Wide Frequency Range
1 — 18	F91, G91	193	Miniature broadband
	F91AH		Miniature broadband, high-speed
0.2 — 4	F92, G92		Miniature broadband
1.5 — 4.5	F892	191	Octave-brand, high-speed
3 — 9			
6 — 18			
1 — 18	E9120H	278	Hermetically sealed,
18 — 40	F90	340	Millimeter Wave
NON-REFLECTIVE SP2T AND TRANSFER SWITCHES			
2 — 21	F9321T	186	Phase and Amplitude matched
1 — 18	F91T, F91W, G91T, G91W	196	Miniature broadband
	F91AHT		Miniature broadband, high-speed
0.2 — 4	F92T, G92T		Miniature broadband
0.5 — 18	F940H	272	Broadband transfer switch
1 — 18	E9120HT	278	Hermetically sealed,
REFLECTIVE SP3T SWITCHES			
1 — 18	F91, G91	202	Miniature broadband
	F91AH		Miniature broadband, high-speed
0.2 — 4	F92, G92		Miniature broadband
1 — 18	E9130H	282	Hermetically sealed, I
NON-REFLECTIVE SP3T SWITCHES			
1 — 18	F91T, F91W, G91T, G92W	202	Miniature broadband
	F91AHT		Miniature broadband, high-speed
0.2 — 4	F92T, G92T		Miniature broadband
1 — 18	E9130HT	282	Hermetically sealed,

SWITCHES WITH INTEGRATED DRIVERS (cont.)

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18 40	MODEL OR SERIES	PAGE	COMMENTS
REFLECTIVE SP4T SWITCHES			
1 – 18	F91, G91	204	Miniature broadband
	F91AH		Miniature broadband, high-speed
0.2 – 4	F92, G92		Miniature broadband
1 – 18	E9140H	286	Hermetically sealed,
NON-REFLECTIVE SP4T SWITCHES			
2 – 21	F9341T	210	Phase and Amplitude matched
1 – 18	F91	206	Miniature broadband
0.2 – 4	F92T, G92T		
1 – 18	E9140HT	286	Hermetically sealed, low video leak-age
6 – 18	2578	213	Low-cost
32 – 36	F9043-C36	342	Output ports all on one side
26 – 40	F9044	344	Miniature broadband
1 – 18	2600	216	Output ports all on one side
REFLECTIVE SP5T SWITCHES			
1 – 18	F91, G91	219	Miniature broadband
0.2 – 4	F92, G92		
0.5 – 18	ER-2260-UK	290	Hermetically Sealed
NON-REFLECTIVE SP5T SWITCHES			
1 – 18	F91T, F91W, G91T, G91W	219	Miniature broadband
0.2 – 4	F92T, G92T		
REFLECTIVE SP6T SWITCHES			
1 – 18	F91, G91	223	Miniature broadband
0.2 – 4	F92, G92		
0.5 – 18	FR-2260-UK	293	Hermetically Sealed
NON-REFLECTIVE SP6T SWITCHES			
2 – 21	F9361T	227	Phase and Amplitude matched
1 – 18	F91T, F91W, G91T, G91W	223	Miniature broadband
0.2 – 4	F92T, G92T		
1 – 18	2629	230	Output ports all on one side
REFLECTIVE SP7T SWITCHES			
1 – 18	F91, G91	234	Miniature broadband
0.2 – 4	F92, G92		

SWITCHES WITH INTEGRATED DRIVERS (cont.)

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18 40	MODEL OR SERIES	PAGE	COMMENTS
NON-REFLECTIVE SP7T SWITCHES			
1 – 18	F91T, F91W, G91T, G91W	234	Miniature broadband
0.2 – 4	F92T, G92T		
REFLECTIVE SP8T SWITCH			
1 – 18	F9180	238	Low-cost broadband
NON-REFLECTIVE SP8T SWITCH			
1 – 18	F9180W	238	Low-cost broadband
1 – 18	2553-B90	241	Phase & Amp. Matched
NON-REFLECTIVE SP9T SWITCH			
8 – 12	IA2470-XO	244	
NON-REFLECTIVE SP10T SWITCH			
6 – 18	2553-B39	247	Phase & Amp. Matched
1 – 18	KA-2970-LK	253	
0.02 – 2	KA-2060-VV	250	
NON-REFLECTIVE SP12T SWITCH			
6 – 18	2553-B48	256	Phase & Amp. Matched
NON-REFLECTIVE SP13T SWITCH			
5.5 – 7.5	NA-2750-CO	259	
NON-REFLECTIVE SP14T SWITCH			
5.5 – 7.5	OA-2750-CO	262	
NON-REFLECTIVE SP15T SWITCH			
5.5 – 7.5	PA-2750-CO	265	
NON-REFLECTIVE SP16T SWITCHES			
0.5 – 6	PA1606	270	Amplitude and Phase Matched
1 – 18	PA1618		
REFLECTIVE SP16T SWITCHES			
2 – 18	1744	268	Broadband

Switch Selection Guide (Cont.)

SWITCHES WITHOUT INTEGRATED DRIVERS

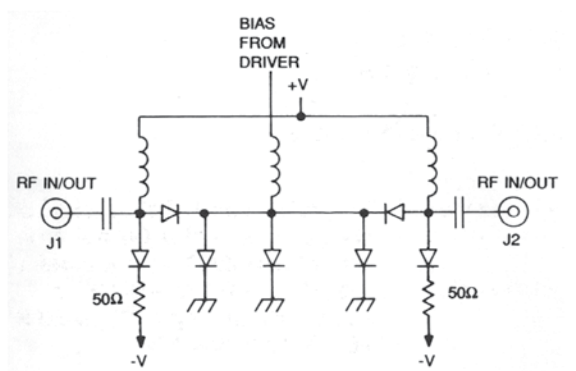
FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18 40	MODEL OR SERIES	PAGE	COMMENTS
REFLECTIVE SPST SWITCHES			
1 – 18	91	182	Miniature broadband
0.2 – 4	9214		
18 – 40	90	338	Millimeter Wave
REFLECTIVE SP2T SWITCHES			
1 – 18	91	195	Miniature broadband
	91AH		Miniature broadband, high-speed
0.2 – 4	92		Miniature broadband
0.1 – 20	2677	200	Wide Band
NON-REFLECTIVE SP2T SWITCHES			
1 – 18	91T, 91W	195	Miniature broadband
	91AHT		Miniature broadband, high-speed
0.2 – 4	92T		Miniature broadband
REFLECTIVE SP3T SWITCHES			
1 – 18	91	202	Miniature broadband
	91AH		Miniature broadband, high-speed
0.2 – 4	92		Miniature broadband
NON-REFLECTIVE SP3T SWITCHES			
1 – 18	91T, 91W	202	Miniature broadband
	91AHT		Miniature broadband, high-speed
0.2 – 4	92T		Miniature broadband
REFLECTIVE SP4T SWITCHES			
1 – 18	91	206	Miniature broadband
	91AH		Miniature broadband, high-speed
0.2 – 4	92		Miniature broadband
NON-REFLECTIVE SP4T SWITCHES			
1 – 18	91T, 91W	206	Miniature broadband
	91AHT		Miniature broadband, high-speed
0.2 – 4	92T		Miniature broadband
REFLECTIVE SP5T SWITCHES			
1 – 18	91	219	Miniature broadband
0.2 – 4	92		
NON-REFLECTIVE SP5T SWITCHES			
1 – 18	91T, 91W	219	Miniature broadband
0.2 – 4	92T		

SWITCHES WITHOUT INTEGRATED DRIVERS (cont.)

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18 40	MODEL OR SERIES	PAGE	COMMENTS
REFLECTIVE SP6T SWITCHES			
1 — 18	91	223	Miniature broadband
0.2 — 4	92		
NON-REFLECTIVE SP6T SWITCHES			
1 — 18	91T, 91W	223	Miniature broadband
0.2 — 4	92T		
REFLECTIVE SP7T SWITCHES			
1 — 18	91	234	Miniature broadband
0.2 — 4	92		
NON-REFLECTIVE SP7T SWITCHES			
1 — 18	91T, 91W	234	Miniature broadband
0.2 — 4	92T		

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

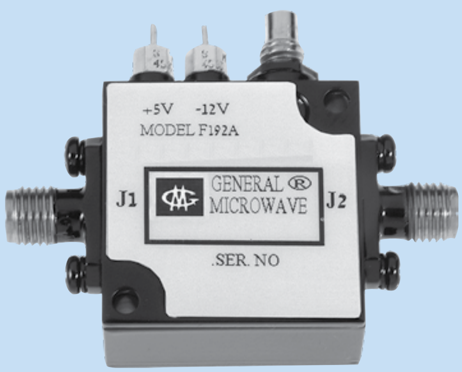
The Model F192A is a high-speed non-reflective PIN diode SPST switch with integrated driver. Operating over the instantaneous frequency range from 0.2 to 18 GHz, it provides a minimum isolation of 80 dB from 0.5 to 18 GHz, and 70 dB below 0.5 GHz. The RF design consists of an arrangement of shunt and 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**
- **Non-reflective**
- **Low VSWR and insertion loss**
- **Small size, light weight**



Switch Model F192A

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 20 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.

OPTION (G09) 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)

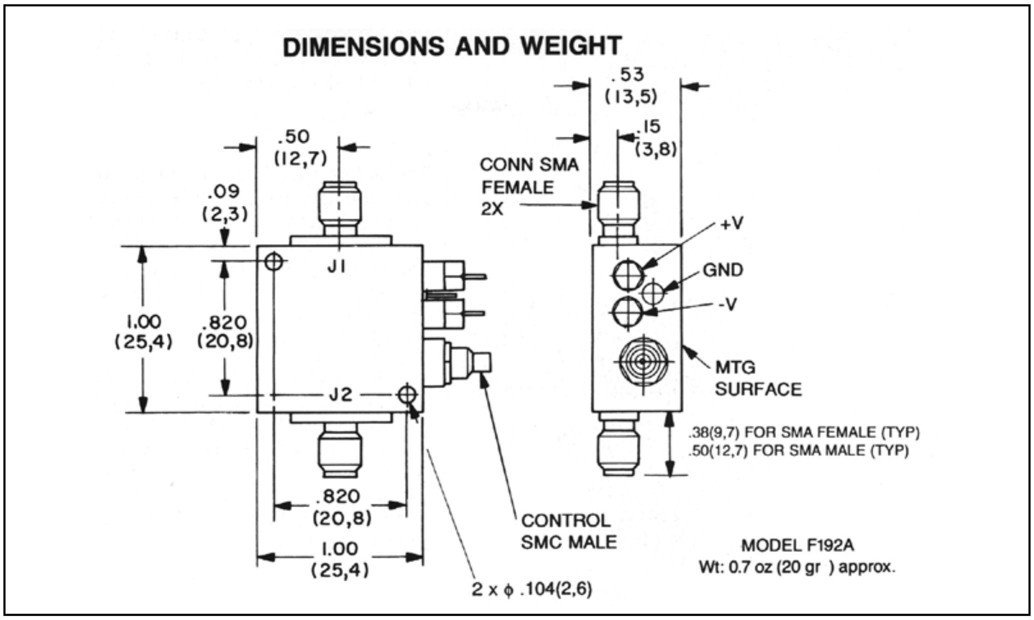
Altitude..........................MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

* Special order products. Consult factory before ordering. In addition, consult factory for full specifications and availability.

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	+5V, –15V operation
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant
5004*	Video Filters. RF operating band restricted to 6-18 GHz. Leakage 50 mV P-P into a 300 MHz bandwidth. Option 5004 includes Options 9 and 33. If Option 5004 is desired and Option 9 and/or 33 are not, consult factory.
893*	Video Filters. RF band 0.5-2 GHz. Leakage 100 mV P-P into 100 MHz bandwidth.
5037*	Video Filters. RF band 2-18 GHz. Leakage 100 mV. P-P into 100 MHz bandwidth.



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model F9016
0.1 to 40 GHz SPST Switch

Model F9016

General Microwave introduces the Model F9016 ultra-broadband, Reflective SPST Switch operating over a frequency range of 100 MHz to 40 GHz.

Applications include ultra-wide band Test, Receiving and EW Systems

- 0.1 to 40 GHz FREQUENCY RANGE
- LOW VSWR and INSERTION LOSS

Model F9016

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 0.1-4	4-18	18-26.5	26.5-40
F9016	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	65 2.3 2.0	65 2.9 2.3	60 3.5 2.5	50 5.0 2.5

SWITCHING CHARACTERISTICS

Switching Time....................250 nsec max.

POWER HANDLING CAPABILITY

Without Performance Degradation .... 200mW cw or peak

POWER SUPPLY REQUIREMENTS

....+5V ±2%, 60 mA max.
–15V ±5%, 50 mA max.

CONTROL CHARACTERISTICS

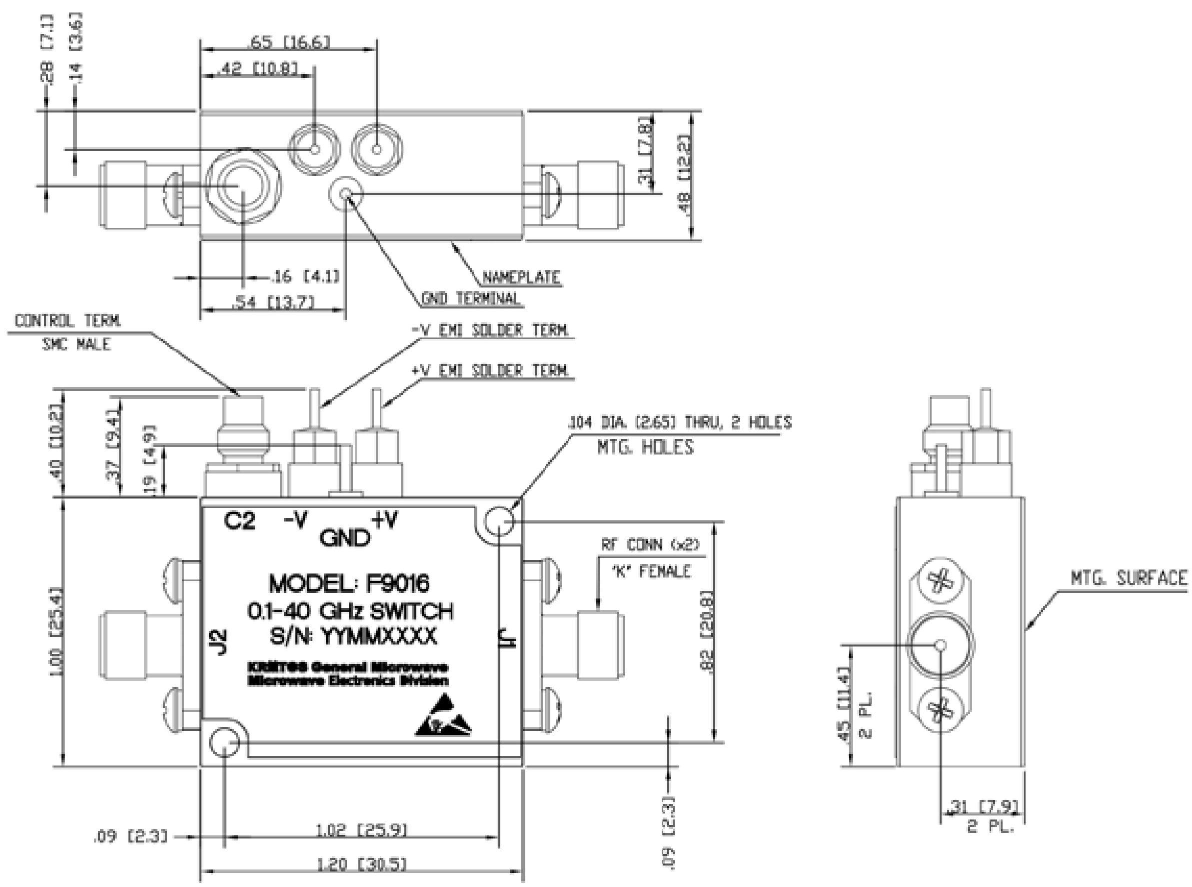
Control Input Impedance.........................TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 µA source current.)

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

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant
G16	RoHS Plus REACH Compliant

DIMENSIONS AND WEIGHT

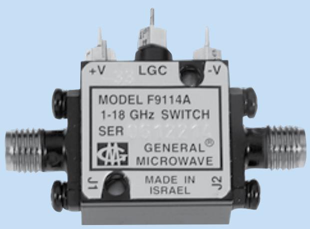


Weight 1.06 oz (30 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

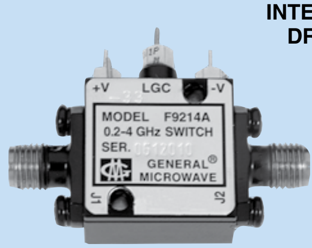
Series 91 and 92
Miniature Broadband SPST Switches

- **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**

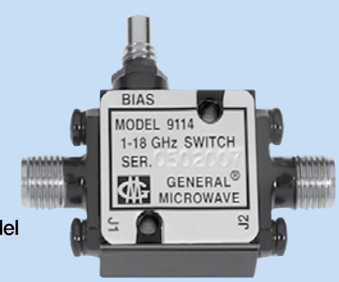


Switch Model
F9114A

UNITS WITH INTEGRATED DRIVERS

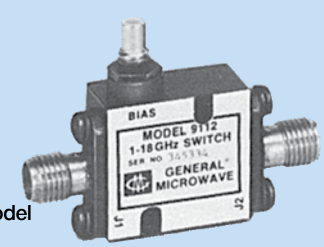


Switch Model
F9214A



Switch Model
9114

DRIVERLESS UNITS

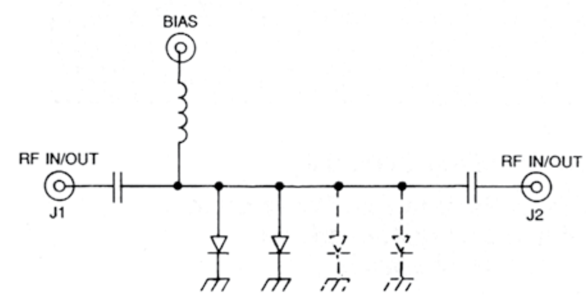


Switch Model
9112

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 x 0.69 x 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 x 0.75 x 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.

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) Max. Insertion Loss (dB) Max. VSWR (ON)	– – –	– – –	36 0.8 1.3	40 0.8 1.3	45 0.9 1.6	45 1.1 1.75	45 1.8 1.75
9114, F9114A	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	– – –	– – –	60 0.9 1.4	74 0.9 1.4	80 1.0 1.75	80 1.6 1.75	80 2.5 2.0
9214*, F9214A	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	40 1.0 1.5	45 1.0 1.5	50 1.0 1.5	50 1.0 1.5	– – –	– – –	– – –

*Special-order product. Consult factory before ordering.

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
Repetition 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
Repetition 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” (–3.0 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

OPTION (G09) 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.)

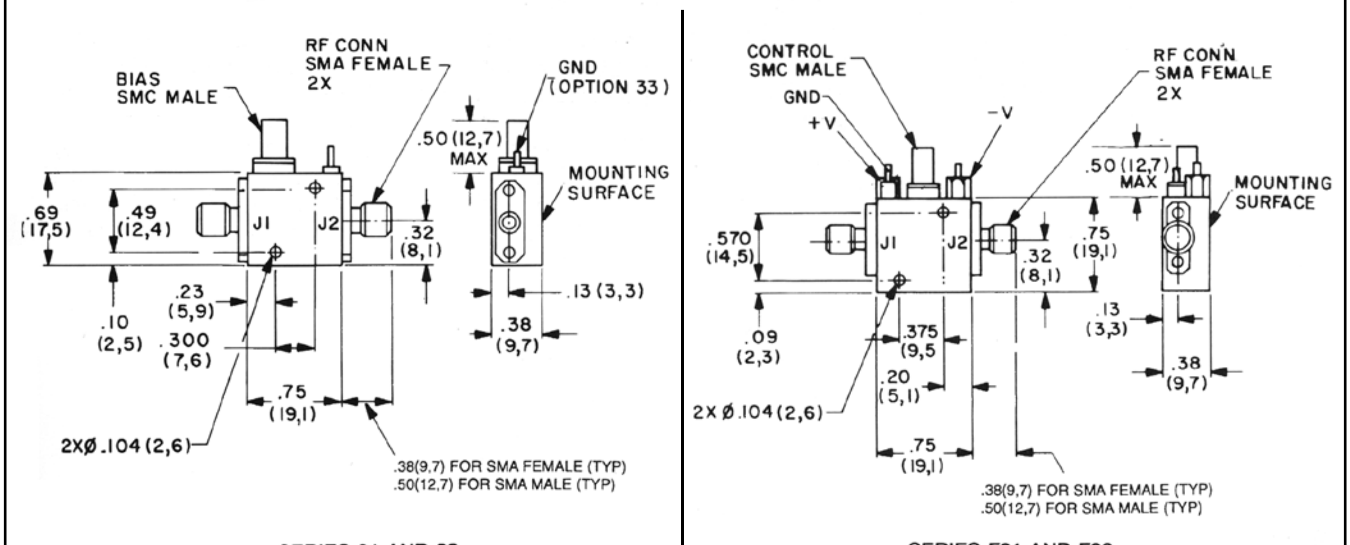
Temp. Cycling...................... MIL-STD-202F, Method 107D, Cond. A, 5 cycles

AVAILABLE OPTIONS

Option No.	Description
3	SMA female 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
55	Frequency range 0.5 to 18 GHz. See page 143.
64A	SMB male bias/control connector
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

* Not applicable to Models 9214 and F9214. See Video Filter Options on page 143.

DIMENSIONS AND WEIGHTS



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

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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model F9321T SPDT
Phase & Amplitude Matched Switch

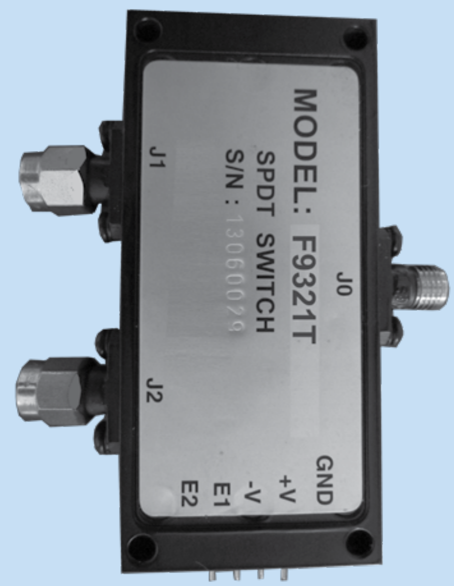
MODEL F9321T

Model F9321T is a low cost high-performance terminated SPDT switch that operates over the full instantaneous bandwidth of 2 to 21 GHz with ON and OFF times of 100 nsec. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line.

The Model F9321T has all of the output ports on one side while maintaining Amplitude and Phase matching between all output ports.

The Model F9321T 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: 2 to 21 GHz**
- **Isolation: 45 dB**
- **In-line outputs**
- **Phase and amplitude matched**
- **Non-reflective**



PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	SPECIFICATION
FREQUENCY RANGE (GHz)	2-21
MIN. ISOLATION (dB)	45
MAX. INSERTION LOSS (dB)	4.0
MAX. VSWR (ON/OFF)	2.5

Phase & Amplitude Matching

Amplitude Matching ....1 dB Typical

Phase Matching ....12 Deg. Typical

Switching Time

ON time..........................500 nsec max.

OFF time........................500 nsec max.

Power Handling Capability

Without Performance Degradation — **OFF port** 100 mW cw or peak; **ON port** 1W cw or peak

Survival Power — **OFF port** 1W average, 10W peak (1 µsec max. pulse width); **ON port** 1W average, 75W peak (1 µsec max. pulse width)

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 +0.8V) for Port “ON”
Logic “1” (+2.0 to +5.0V) for Port “OFF”.

Power Supply Requirements

+5V ±5%, 80 mA max

–12V to -15V 50 mA max

OPTION (G09) 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)

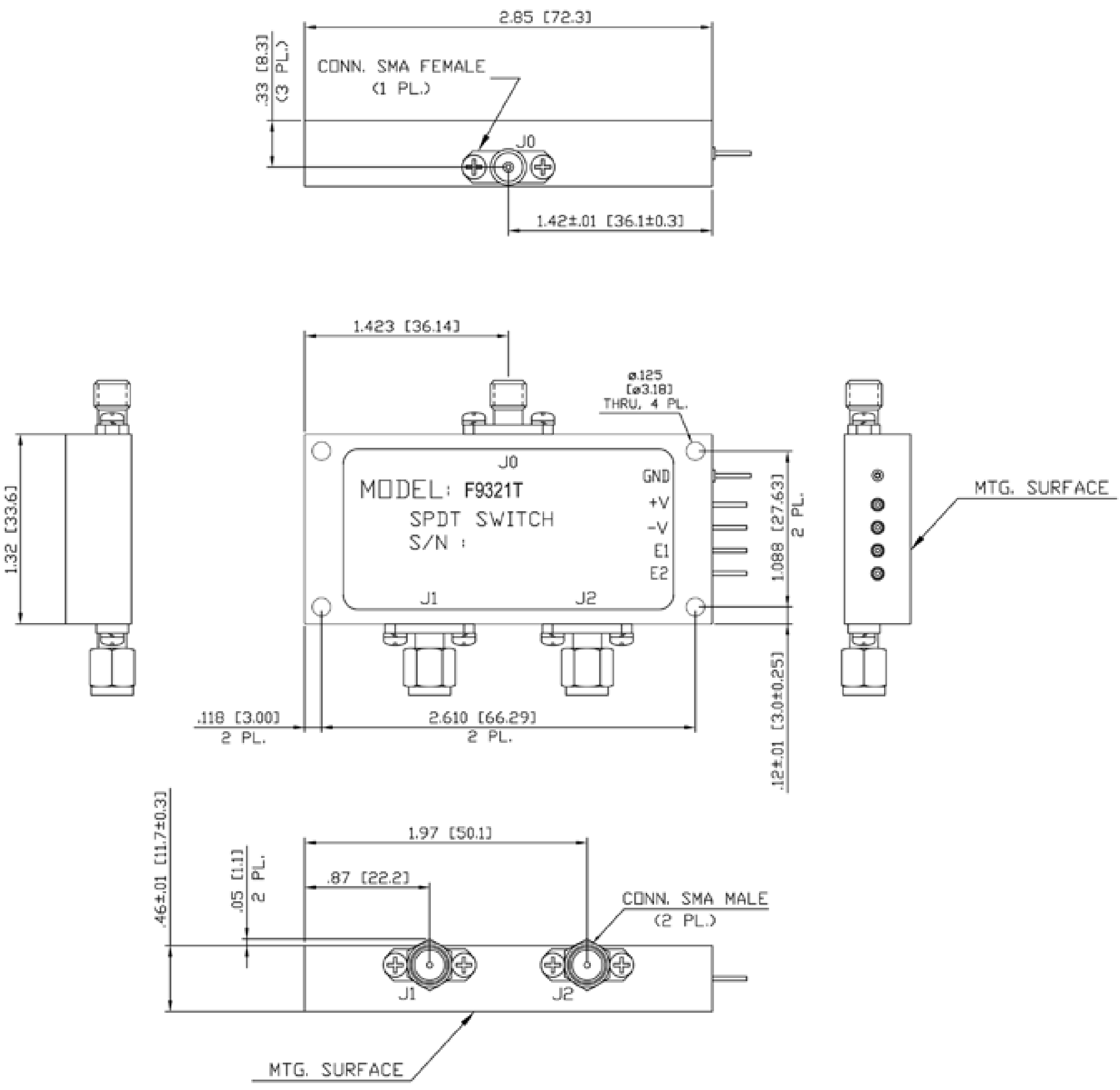
Altitude.. MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
G09	**Guaranteed to meet Environmental Ratings**
G12	RoHS Compliant

DIMENSIONS AND WEIGHTS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model F9025
0.1 to 40 GHz SPDT Switch

Model F9025

General Microwave introduces the Model F9025 ultra-broadband, Reflective SPDT Switch operating over a frequency range of 100 MHz to 40 GHz.

Applications include ultra-wide band Test, Receiving and EW Systems.

- **0.1 to 40 GHz FREQUENCY RANGE**
- **LOW VSWR and INSERTION LOSS**

Model F9025

PERFORMANCE CHARACTERISTICS

		FREQUENCY (GHz)			
MODEL NO.	**CHARACTERISTIC**	**0.1-4**	**4-18**	**18-26.5**	**26.5-40**
F9025	**Min. Isolation (dB)**	**70**	**60**	**55**	**40**
	Max. Insertion Loss (dB)	**2.6**	**3.2**	**3.8**	**5.3**
	Max. VSWR (ON)	**2.0**	**2.3**	**2.5**	**2.5**

SWITCHING CHARACTERISTICS

Switching Time....................250 nsec max.

POWER HANDLING CAPABILITY

Without Performance Degradation .... **200mW cw or peak**

POWER SUPPLY REQUIREMENTS

....+5V ±2%, 75 mA max
–15V ±5%, 50 mA max

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.)

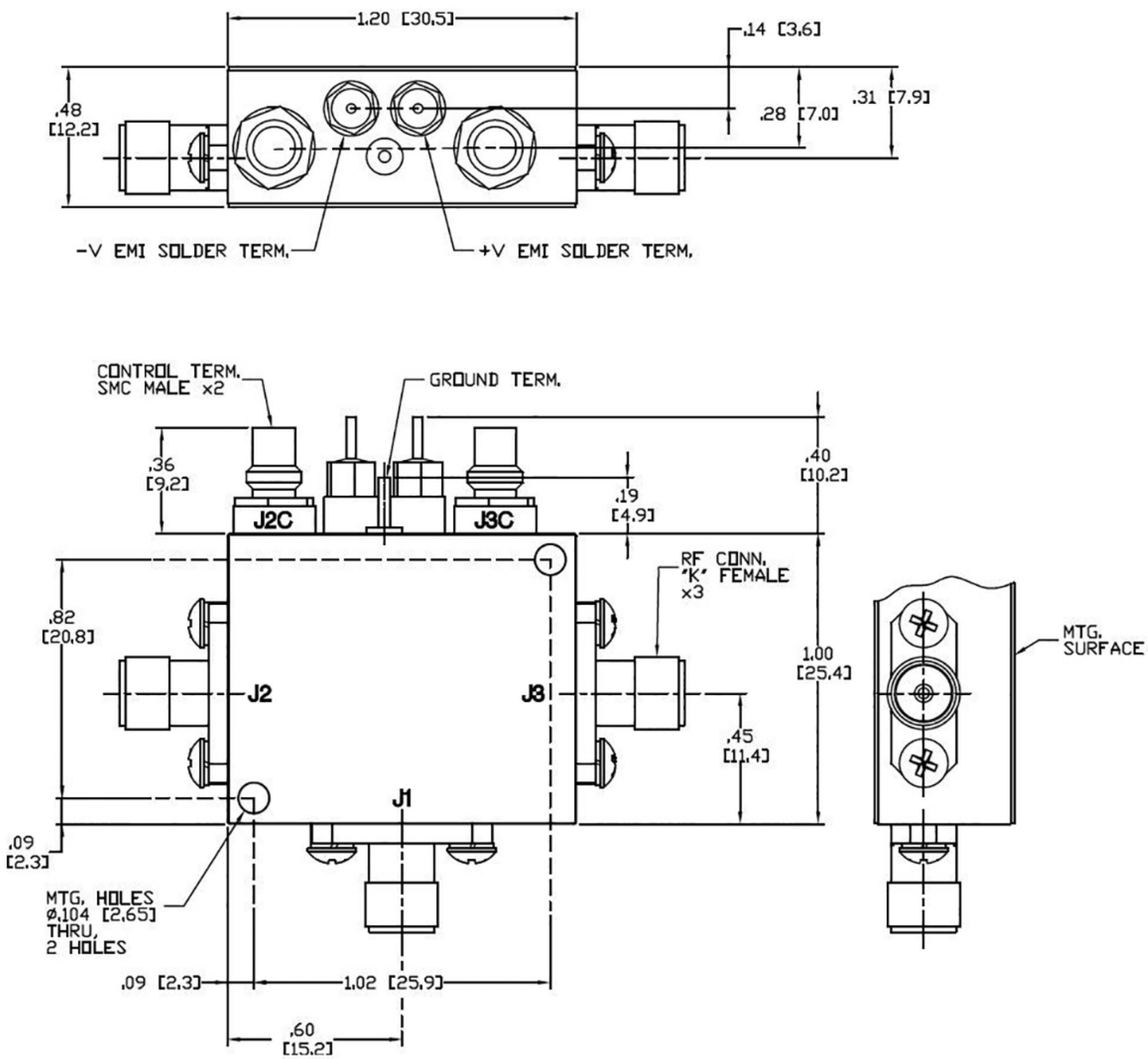
Control Logic........................Logic “0” (–0.3 to +0.8V) for switch ON and Logic “1” (+2.0 to +5.0V) for switch OFF.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

Model F9025
0.1 to 40 GHz SPDT Switch

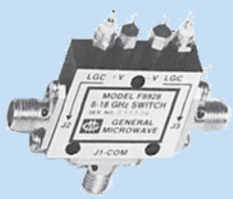
DIMENSIONS AND WEIGHTS



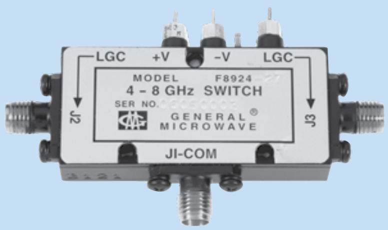
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

High-Speed Octave-Band SP2T Switches

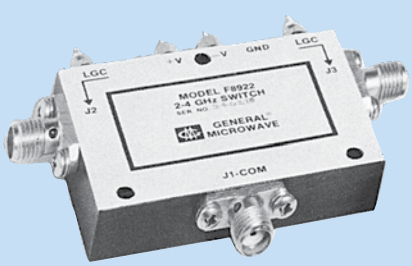
- Low Cost
- S, C and X-U band models
- 10 nsec rise and fall times
- Up to 60 dB isolation
- As low as 1.0 dB insertion loss



Switch Model F8928



Switch Model F8924



Switch Model F8922

THESE THREE UNITS
ARE EQUIPPED WITH
INTEGRATED DRIVERS

SERIES F892

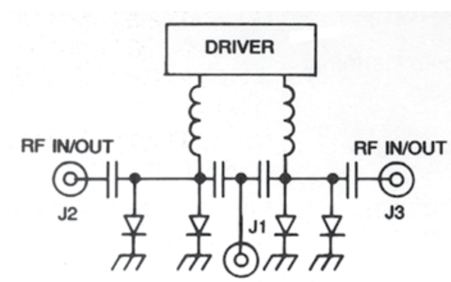
Series F892 high speed switches with integrated drivers are low-cost units that have been engineered to meet the need of microwave system designers for fast switching devices in small packages.

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 102.

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.

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(1)	2.2
	6-18	2.5	45(1)	2.5

*Special-order product. Consult factory before ordering.

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(2)

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(2), 20 mA

(1) Isolation 40 dB above 16 GHz.

(2) With –15V power supply. Reduces to 1.5W with –12V power supply. Units may be operated at higher input power levels some increase in switching time when –30V power supply is used. (consult factory for this optio)

OPTION (G09) 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

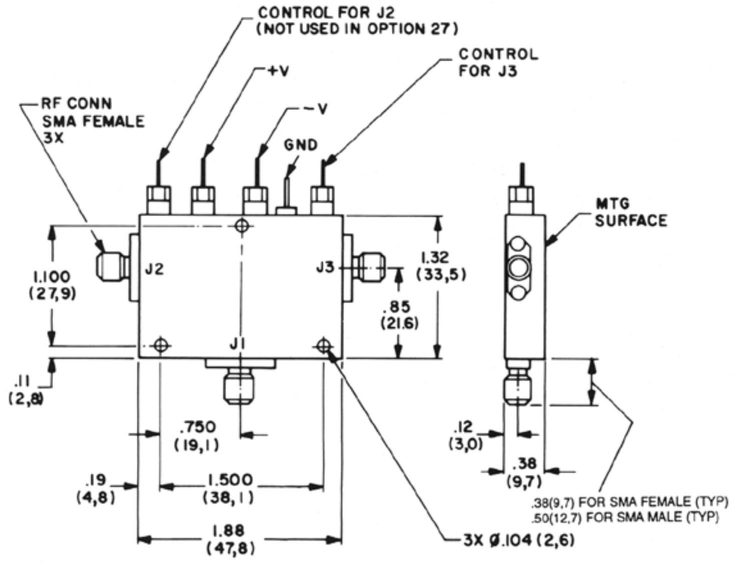
AVAILABLE OPTIONS

Option No.	Description
3	SMA female control connectors
7	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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

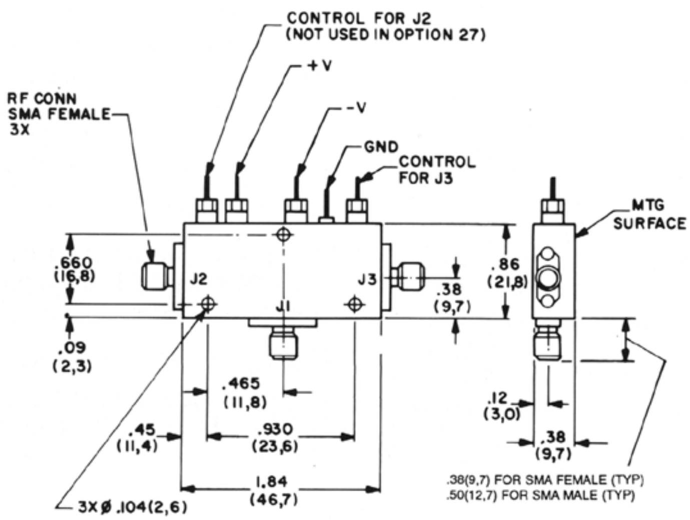
Series F892
SP2T Switches Specifications

DIMENSIONS AND WEIGHTS

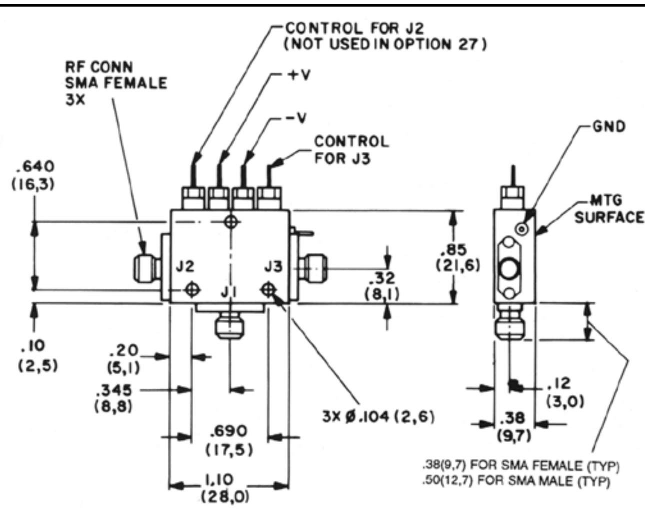
MODEL F8922
Wt: 1.5 oz. (43 gr.) approx.



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



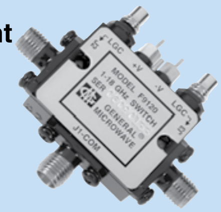
MODEL F8928
Wt: 1 oz. (28 gr.) approx.



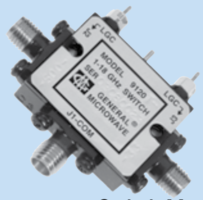
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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 Non-reflective models
- Low VSWR and insertion loss
- Miniature size, light weight



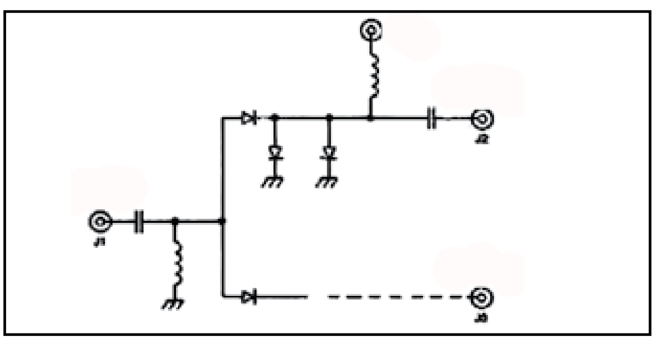
Switch Model
F9120
(WITH INTEGRATED DRIVER)



Switch Model
9120-55-33
(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.



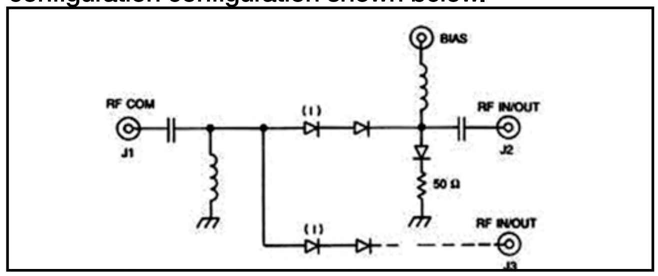
Series 91 and 92 schematic diagram

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 configuration shown below.



(1) SERIES 91W UNITS ARE CONSTRUCTED WITH THREE SERIES DIODES

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.

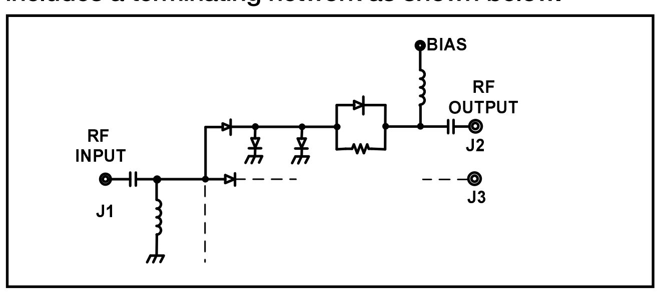
Note that when all output ports are OFF, a high VSWR will be present at the common port.

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

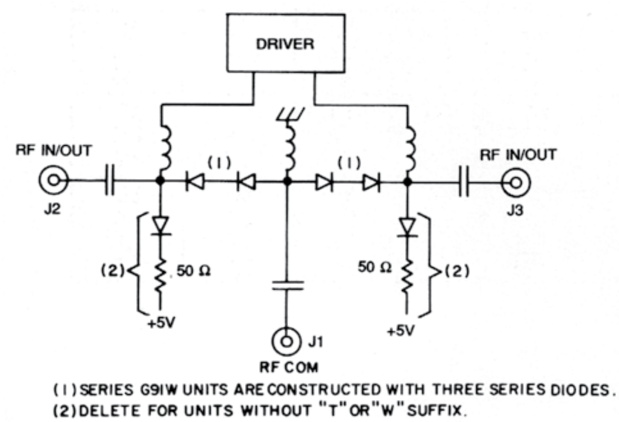
SERIES F91/F92

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 –15V 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.

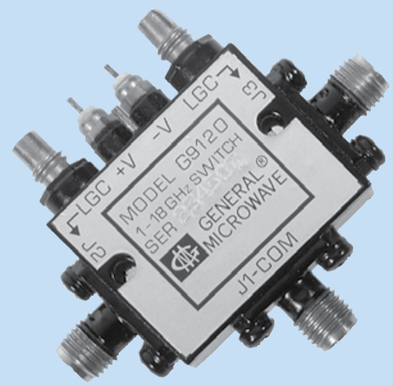


Model G9120( ), rf schematic diagram

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 non-reflective models**
- **Low VSWR and insertion loss**
- **Up to 60 dB isolation**
- **Positive DC supplies only**
- **Miniature size, light weight**



Switch Model G9120

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 1.7	60 2.2 1.7	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 1.7	45 1.5 1.7	40 2.2 2.0
9220T-500* F9220T* G9220T*	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON or OFF)	60 1.3 1.5	60 1.3 1.5	60 1.3 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 1.7	60 1.8 1.7	60 2.2 2.0	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

*Special-order product. Consult factory before ordering.

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/F91/G91

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 92/F92/G92
- ON time .... 500 nsec max.
- OFF time .... 500 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	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

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 +0.8V) 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 +0.8V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

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

ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating	–54°C to +110°C
Non-Operating	–65°C to +125°C

Driverless Units

Operating	–54°C to +110°C
Non-Operating	–65°C to +125°C

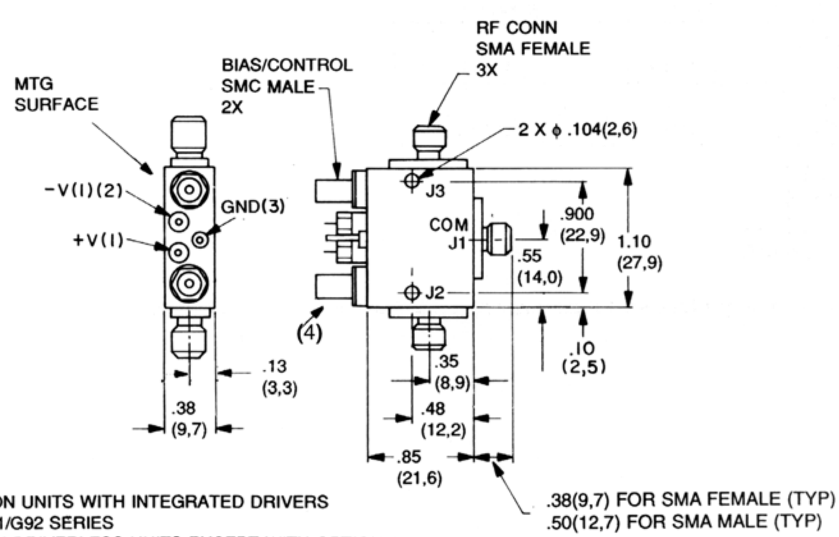
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)
Temp. Cycling	MIL-STD-202F, Method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

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 the Driverless Units, 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
55	Frequency range 0.5 to 18 GHz. See page 139.
64A	SMB male bias/control connectors
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

*Not applicable to Series 92//F92/G92. See Video Filter Options on page 169.

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
(4) NOT USED with Option 27

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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model 2677
Wide Frequency Band SP2T Switch

MODEL 2677

Model 2677 is a wide frequency range, Low Cost, high-performance SPDT switch. It operates over the full instantaneous bandwidth of 0.1 to 20 GHz .

The proper currents required to switch the ports ON or OFF are provided by the user.

- **Frequency range: 0.1 to 20 GHz**
- **Isolation: up to 60 dB**
- **Small Size**

Switch Model 2677

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	FREQUENCY (GHz)			
	0.1-4	4-12	12-18	18-20
MIN. ISOLATION (dB)	60	60	45	45
MAX. INSERTION LOSS (dB)	2	2	3	3.8
MAX. VSWR (ON)	1.8	2.2	3.0	3.5

Switching Time* ....500 nsec max.

*Shaped current pulses must be provided by user.

Power Handling Capability

Without Performance Degradation.................1 W cw or peak

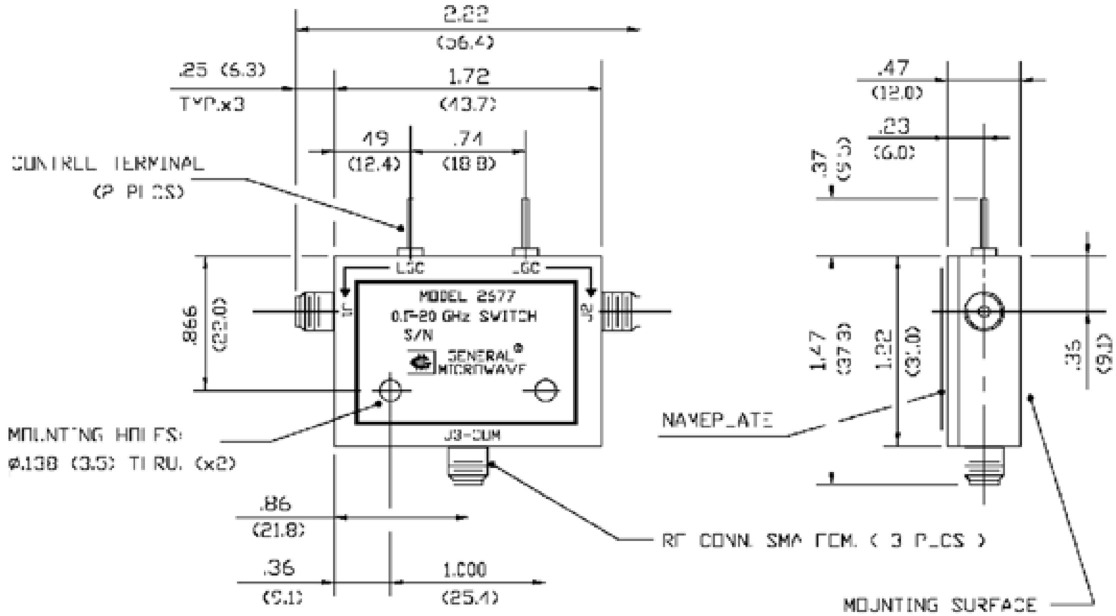
Survival Power ....1 W average, 75 W peak, (1 µsec max. pulse width)

Power Supply Requirements

Port ON ....+7.0 V ±0.5 V, 50 mA max

Port OFF.........- 1.0 V ±0.5 V, 50 mA max

DIMENSIONS AND WEIGHTS



NOTES
1. DIMENSIONS IN ( ), ARE IN MILLIMETERS

MODEL 2677

Wt: 1.7 oz. (47 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series 91 and 92
Miniature Broadband SP3T Switches

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.

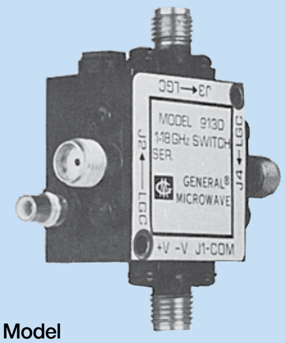
SERIES F91 AND F92

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.

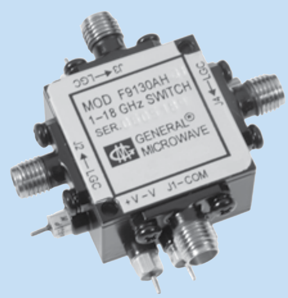
SERIES G91 AND G92

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

- **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 Non-reflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



Switch Model
9130-500 (DRIVERLESS)



Switch Model
F9130 (WITH
INTEGRATED DRIVER)

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 1.5 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 1.7	60 2.0 1.7	60 2.5 2.0	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

*Special-order product. Consult factory before ordering.

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/F91/G91

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 92/F92/G92
- ON time.................................... 500 nsec max.
- OFF time................................... 500 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 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 +0.8V) 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 +0.8V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating	–54°C to +110°C
Non-Operating	–65°C to +125°C

Driverless Units

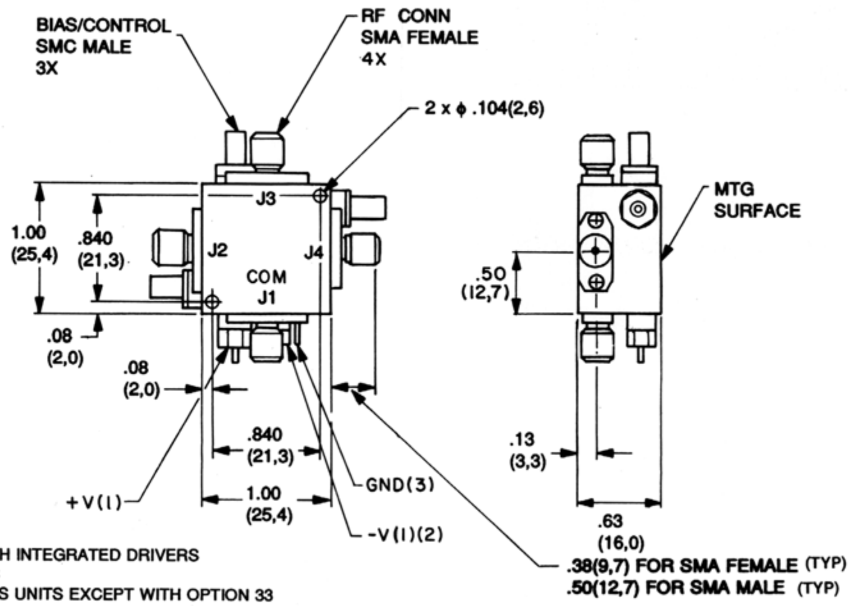
Operating	–54°C to +110°C
Non-Operating	–65°C to +125°C
Humidity	MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock	MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration	MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude	MIL-STD-202F, Method 105C,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

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
55	Frequency range 0.5 to 18 GHz. See page 169.
64A	SMB male bias/control connectors
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

*Not applicable to Series 92//F92/G92. See Video Filter Options on page 169

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 gr) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series 91 and 92
Miniature Broadband SP4T Switches

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 Non-reflective 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.

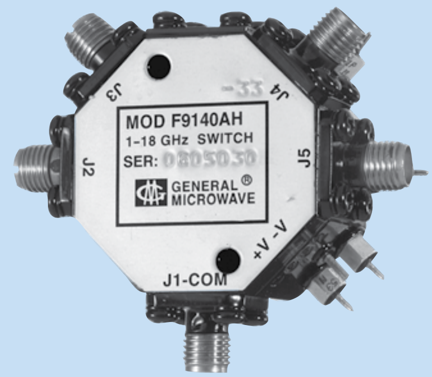
SERIES F91 AND F92

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.

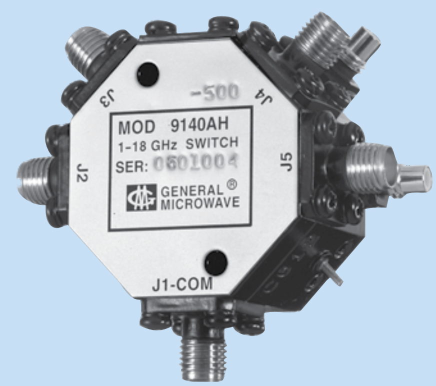
SERIES G91 AND G92

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

- **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 Non-reflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



Switch Model F9140AH
(WITH INTEGRATED DRIVER)



Switch Model 9140AH-500
(DRIVERLESS)

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)	50 1.3 1.5	50 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 1.7	60 2.2 1.7	60 2.7 2.0	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

*Special-order product. Consult factory before ordering.

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/F91/G91

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 92/F92/G92
- ON time .... 500 nsec max.
- OFF time .... 500 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 +0.8V) 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 +0.8V) for port ON and logic "1" (+2.0 to +5.0 V) for port OFF.

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating.................–54°C to +110°C
Non-Operating........–65°C to +125°C

Driverless Units

Operating ....–54°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.)

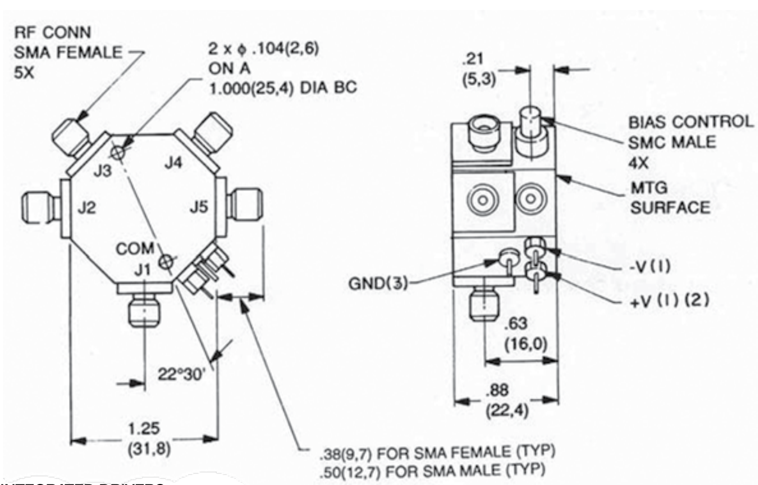
Temp. Cycling.................MIL-STD-202F, Method 107D, Cond. A, 5 cycles

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
55	Frequcy range 0.5 to 18 GHz. See page 169.
64A	SMB male bias/control connectors
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

*Not applicable to Series 92//F92/G92. See Video Filter Options on page 159

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 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model F9341T SP4T Phase & Amplitude Matched Switch

- Frequency range: 2 to 21 GHz
- Isolation: 50 dB
- Phase and amplitude matched
- In-Line Outputs
- Non-reflective
- Decoder (Optional)
- LVDS Interface (Optional)
- RS-422 / RS-485 Interface (Optional)

MODEL F9341T

Model F9341T is a low cost high-performance terminated SP4T switch that operates over the full instantaneous bandwidth of 2 to 21 GHz with ON and OFF times of 500 nsec. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line.

The Model F9341T has all of the output ports on one side while maintaining Amplitude and Phase matching between all output ports.

The Model F9341T 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.

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	SPECIFICATION
Frequency Range (GHz)	2-21
Min. Isolation (dB)	50
Max. Insertion Loss (dB)	5.5
Max. VSWR (ON/OFF)	2.5

Phase & Amplitude Matching
Amplitude Matching ....1 dB Typical
Phase Matching ....12 Deg. Typical

Switching Time
ON time..................................500 nsec max.
OFF time ....500 nsec max.

Power Handling Capability
Power Handling Capability Without Performance Degradation ....**OFF port** 0.1 W cw or peak
ON port 1W CW or Peak

Survival Power ....**OFF port** 1W average, 10W peak (1 µsec max. pulse width)
ON port 1 W average, 75W peak (1 µsec max. pulse width)

Power Supply Requirements
+5V ±5%, 190 mA
–12V ±5%, 60 mA

Control Characteristics

Control Input Impedance...................Schottky TTL, two unit loads. (A unit load is 0.4 mA sink current and 40 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.

OPTION (G09) 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)

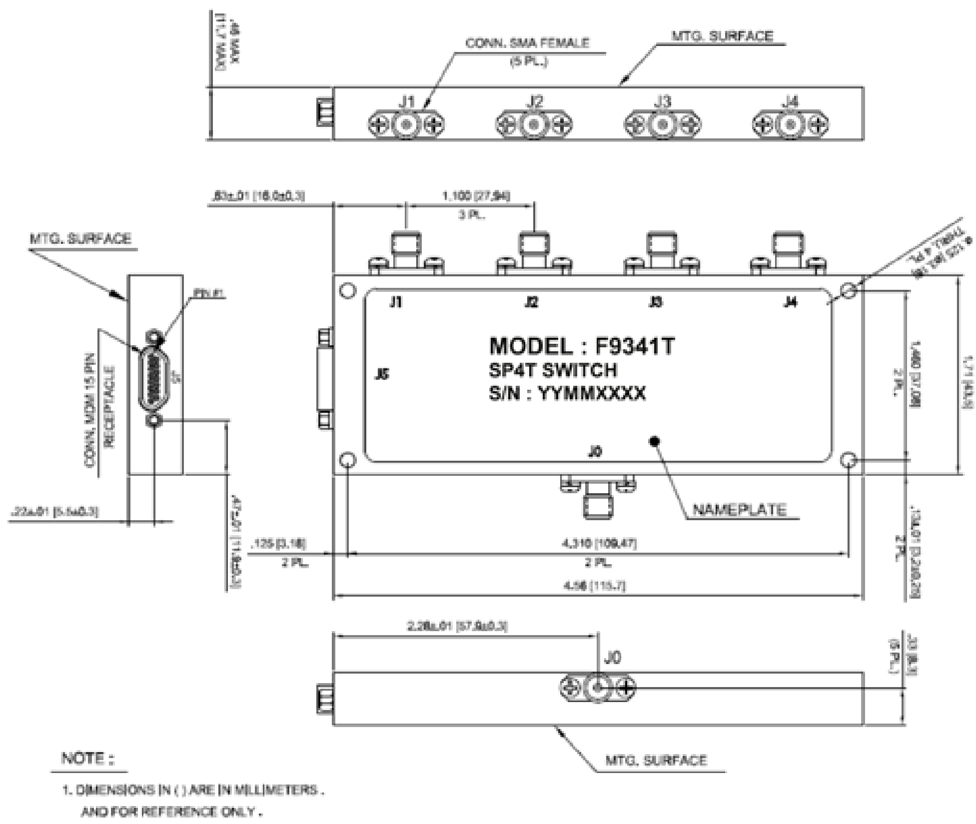
Altitude ....MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G11	-12V & +6 to +15V
G12	RoHS Compliant

MODEL F9341T DIMENSIONS AND WEIGHT



PIN OUT

PIN	FUNCTION
1	+5V
2	N/C
3	J2 CONTROL
4	N/C
5	J4 CONTROL
6	N/C
7	N/C
8	-12V
9	J1 CONTROL
10	N/C
11	J3 CONTROL
12	N/C
13	N/C
14	N/C
15	GND

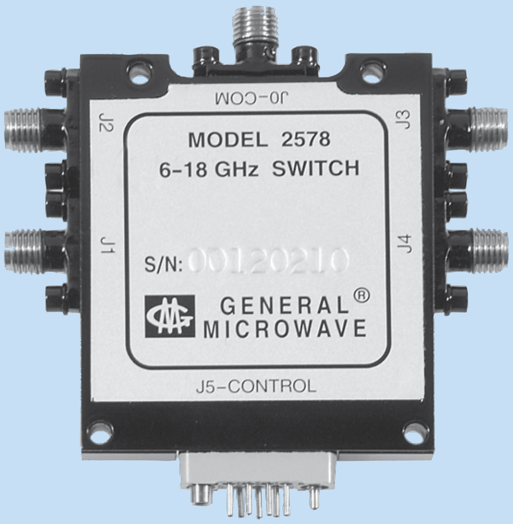
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

MODEL 2578

The Model 2578 is a low cost high-performance terminated SP4T switch that operates over the full instantaneous bandwidth of 6 to 18 GHz with ON and OFF times of 250 nsec. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line.

The Model 2578 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: 6 to 18 GHz**
- **Isolation: up to 55 dB**
- **Phase and amplitude Matched**
- **Non-reflective**



Switch Model 2578

Model 2578 Low Cost SP4T Switch Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	
Frequency Range (GHz)	6-18
Min. Isolation (dB)	55
Max. Insertion Loss (dB)	3.5
Max. VSWR (ON/OFF)	2.0

Switching Time
ON time............................250 nsec max.
OFF time..........................250 nsec max.

Power Handling Capability
Without Performance
Degradation.....................500 mW cw or peak

Survival Power
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)

Power Supply Requirements
+5V ±5%, 135 mA
–12V ±5%, 60 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 "0" (–0.3 to +0.8V) for port ON and logic "1" (+2.0 to +5.0V) for port OFF.

OPTION (G09) 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)

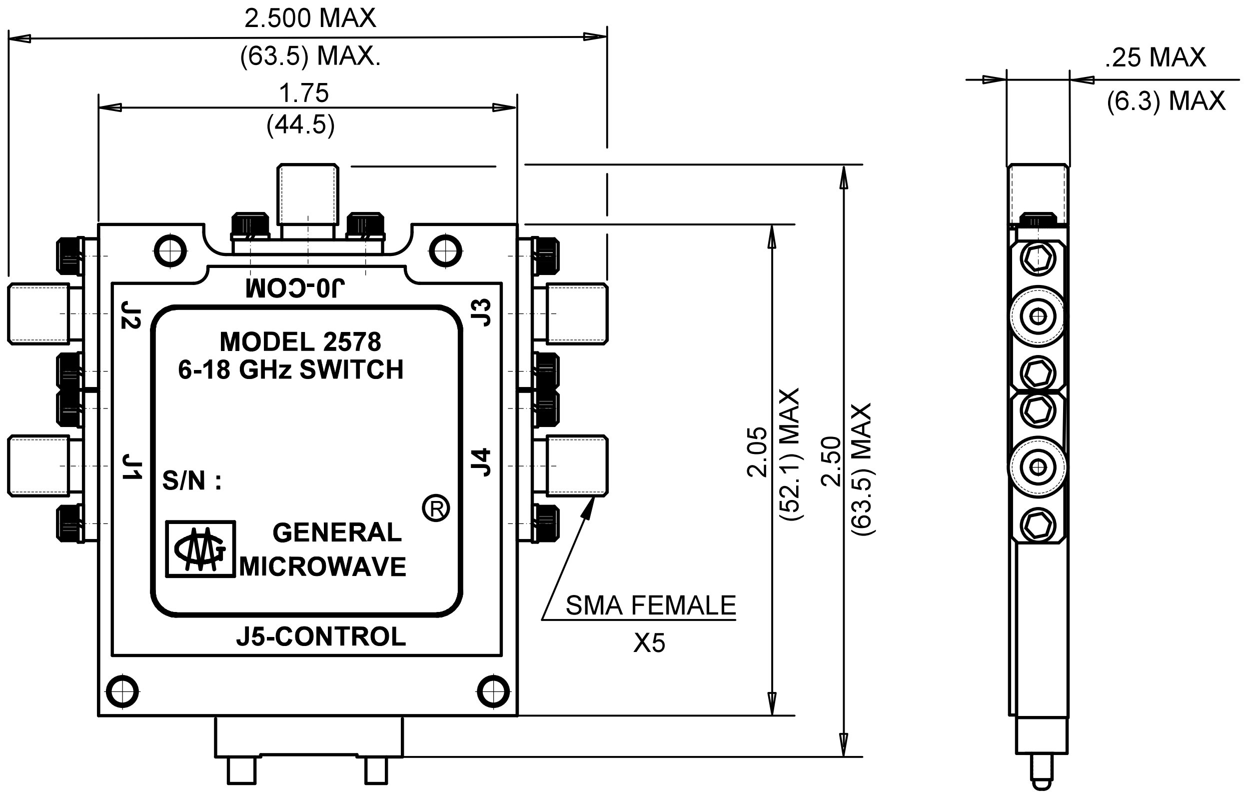
Altitude..............................MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



LOGIC INPUT PIN D	F	H	PORT STATUS J1	J2	J3	J4
0	0	1	X	–	–	–
1	0	1	–	X	–	–
0	1	1	–	–	X	–
1	1	1	–	–	–	X

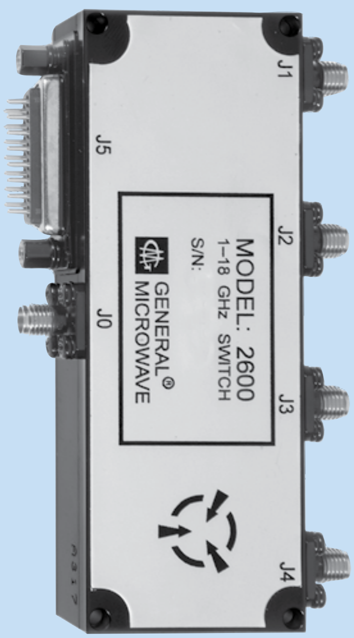
PIN DESIGNATION

A	–12V DC
C	GROUND
B	+5V DC
E	N/C
D	LSB
F	MSB
H	ENABLE

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series 2600 SP4T Amp & Phase Matched Switches

- Frequency range: 1 to 18 GHz
- Isolation: Up to 50 dB
- All in-line outputs
- Phase and amplitude matched
- Non-reflective



Switch Model 2600

MODEL 2600

The Model 2600 is a low cost high-performance terminated SP4T switch that operates over the full instantaneous bandwidth of 1 to 18 GHz with ON and OFF times of 200 nsec. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line.

The Model 2600 has all of the output ports on one side while maintaining Amplitude and Phase matching between all output ports.

The Model 2600 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.

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	Model 2600
Frequency Range (GHz)	**1-18**
Min. Isolation (dB)	**50**
Max. Insertion Loss (dB)	**4.4**
Max. VSWR (ON)	**2.0**
Max. VSWR (OFF)	**2.3**

Amplitude & Phase Matching ......Designed for, not tested

Switching Time
ON time............................500 nsec max.
OFF time ....500 nsec max.

Power Handling Capability
Without Performance Degradation
Input to any OFF port................. 0.1 W 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
Input to any OFF port.................1W average, 10W, (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)

Power Supply Requirements
+5V ±5%, 190 mA
–12V ±5%, 60 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 “0” (–0.3 to +0.8V) for port ON and logic “1” (+2.0 to +5.0V) for port OFF.

OPTION (G09) 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)

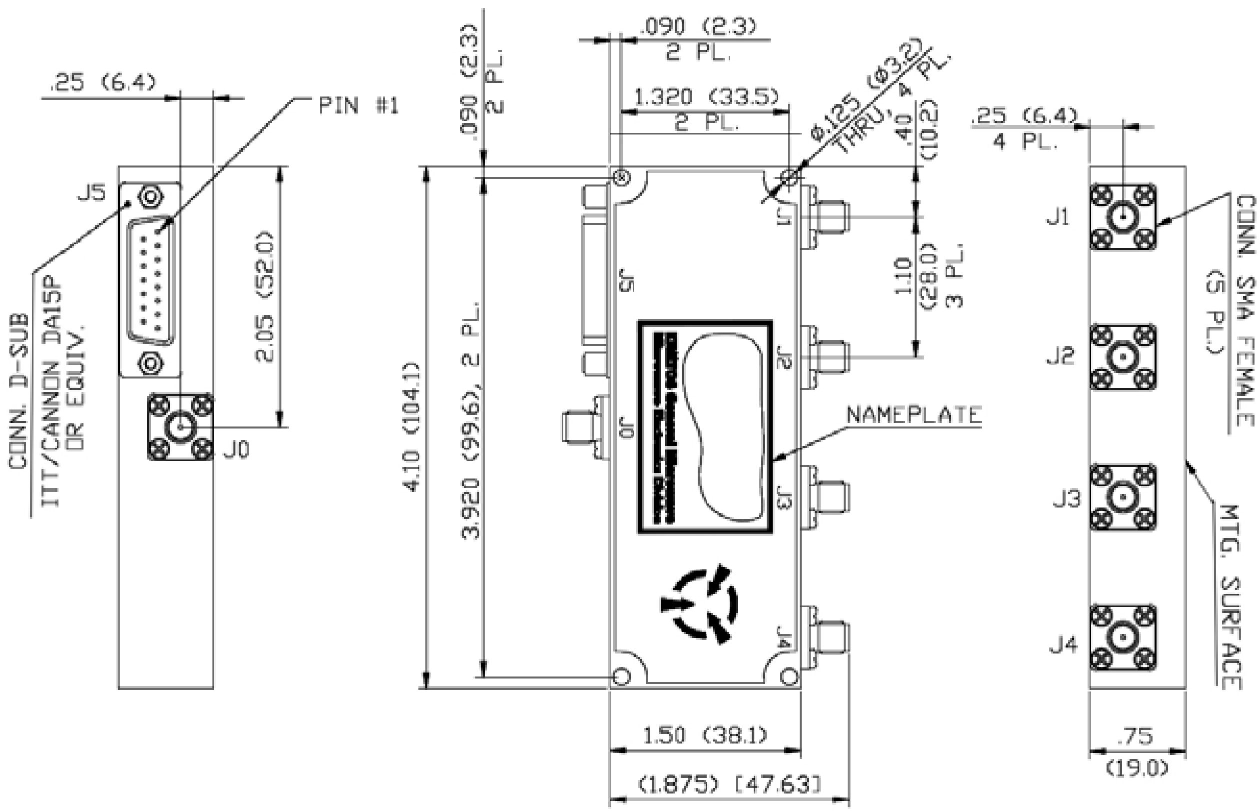
Altitude ....MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

MODEL 2600 DIMENSIONS AND WEIGHT



PIN	FUNCTION
1	J1 CONTROL
2	J3 CONTROL
3	+V
4	GND
5	N/C
6	N/C
7	N/C
8	N/C
9	J2 CONTROL
10	J4 CONTROL
11	N/C
12	N/C
13	N/C
14	–V
15	N/C

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series 91 and 92
Miniature Broadband SP5T Switches

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.

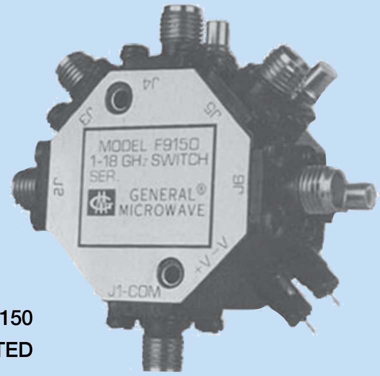
SERIES F91 AND F92

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.

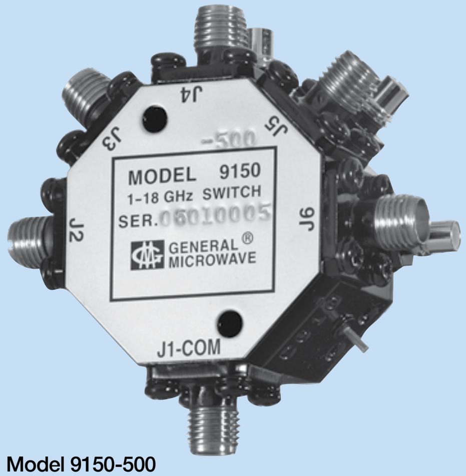
SERIES G91 AND G92

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

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Reflective and Non-reflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



Switch Model F9150
(WITH INTEGRATED DRIVER)



Switch Model 9150-500
(DRIVERLESS)

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 1.7	60 2.4 1.8	60 3.0 2.0	55 3.3 2.2

*Special-order product. Consult factory before ordering.

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/F91/G91

ON time .... 250 nsec max.
OFF time .... 250 nsec max.
With Option C37..................... 100 nsec max.

SERIES 92/F92/G92

ON time .... 500 nsec max.
OFF time .... 500 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.

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, 80 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 “0” (–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 “0” (–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 Video Filter Options on page 169

** Not applicable to series 92/F92/C92. Minimum order buy of 100 switches

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating................–54°C to +110°C
Non-Operating........–65°C to +125°C

Driverless Units

Operating ....–54°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)

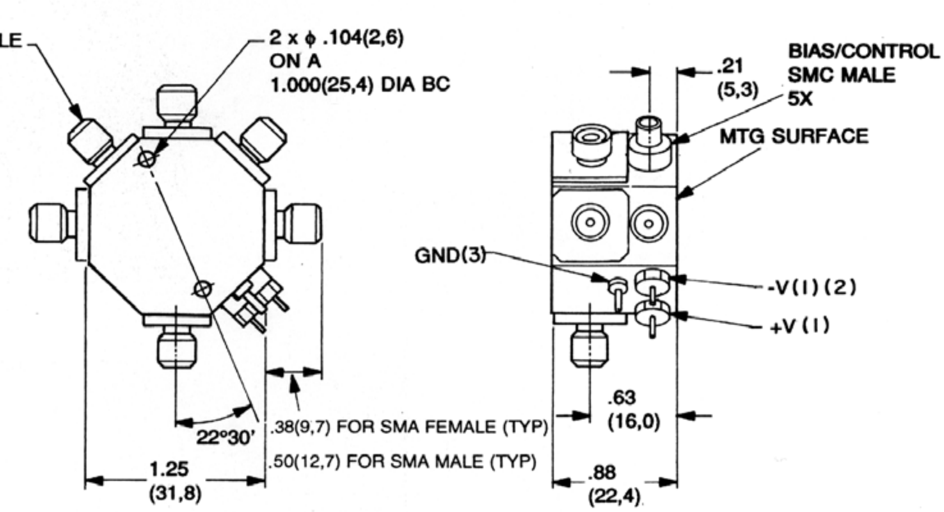
Altitude......................... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

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
55	Frequency range 0.5 to 18 GHz. See page 169
64A	SMB male bias/control connectors
C37**	100 nsec. switching time
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT

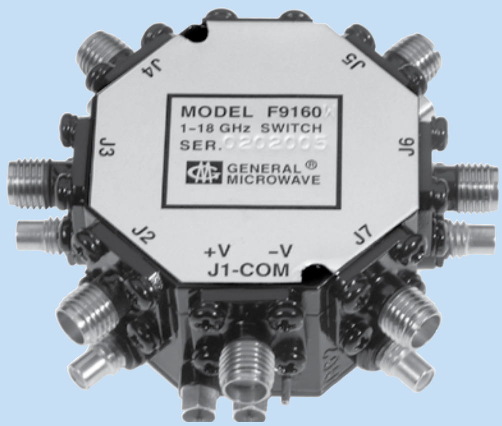


(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS
(2) +15V FOR G91/G92 SERIES
(3) NOT USED ON DRIVERLESS UNITS EXCEPT WITH OPTION 33

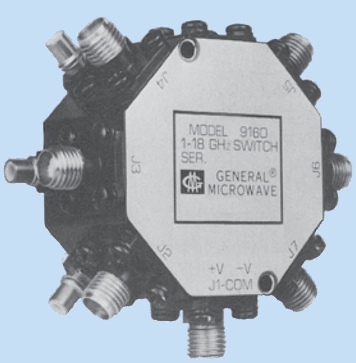
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Miniature Broadband SP6T Switches

- Frequency range (Series 91): 1 to 18 GHz
- Frequency range (Series 92): 0.2 to 4 GHz
- Reflective and non-reflective models
- Low VSWR and insertion loss
- Isolation: up to 60 dB
- Miniature size, light weight



Switch Model F9160
(WITH INTEGRATED DRIVER)



Switch Model 9160-500
(DRIVERLESS)

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.

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 1.7	60 2.2 1.7	60 2.6 2.0	60 3.2 2.2	55 3.5 2.3

*Special-order product. Consult factory before ordering.

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/F91/G91

ON time .... 250 nsec max.
OFF time .... 250 nsec max.
With Option C37...................... 100 nsec max.

SERIES 92/F92/G92

ON time .... 500 nsec max.
OFF time .... 500 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 .... +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 “0” (–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 “0” (–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.)

*Not applicable to Series 92/F92/G92. See Video Filter Options on page 169

** Not applicable to series 92/F92/G92. Minimum order buy of 100 switches.

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range

Units With Integrated Drivers

Operating................–54°C to +110°C
Non-Operating........–65°C to +125°C

Driverless Units

Operating ....–54°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.)

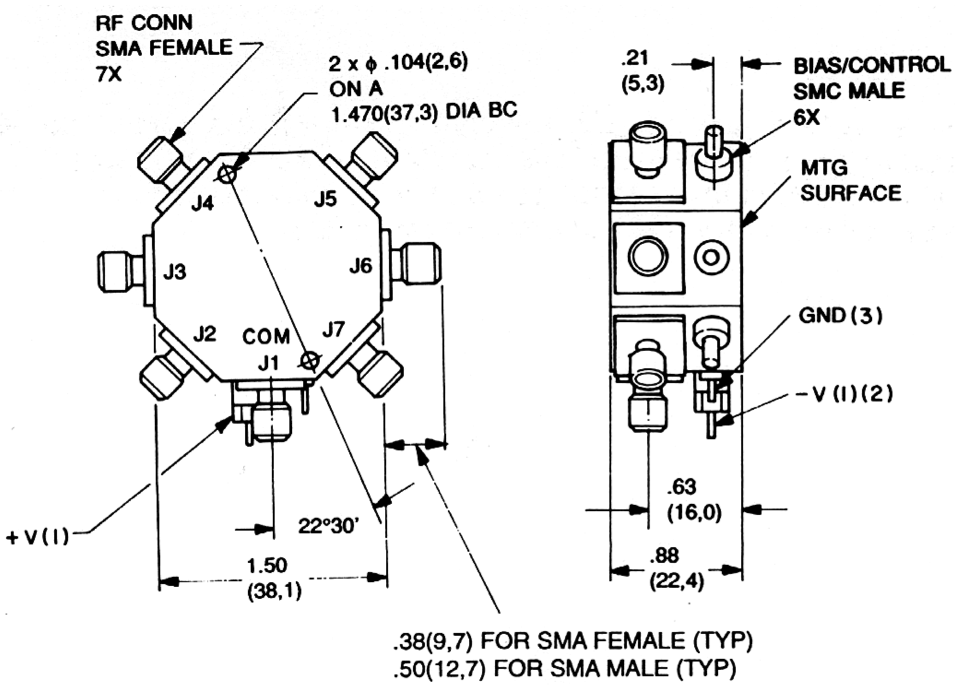
Temp. Cycling.............. MIL-STD-202F, Method 107D, Cond. A, 5 cycles

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
C37**	100 nsec switching time
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

Series 91 and 92 SP6T Switches Specifications

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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model F9361T SP6T Phase & Amplitude Matched Switch

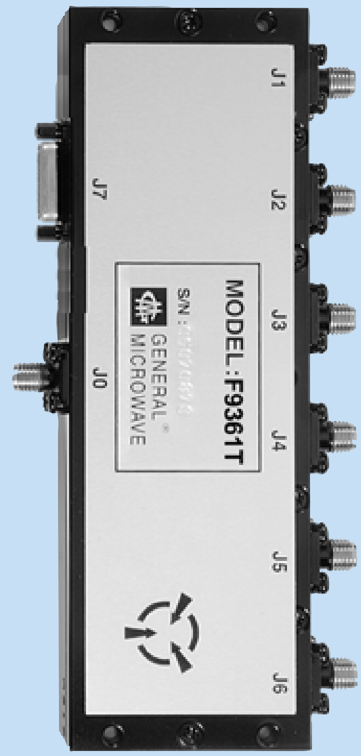
MODEL F9361T

Model F9361T is a low cost high-performance terminated SP6T switch that operates over the full instantaneous bandwidth of 2 to 21 GHz with ON and OFF times of 500 nsec. Design features include an integrated circuit assembly of PIN diodes mounted in a microstrip transmission line.

The Model F9361T has all of the output ports on one side while maintaining Amplitude and Phase matching between all output ports.

The Model F9361T 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: 2 to 21 GHz
- Isolation: 55 dB
- Phase and amplitude matched
- Non-reflective
- In-Line Outputs
- Decoder (Optional)
- LVDS Interface (Optional)
- RS-422 / RS-485 Interface (Optional)



Model F9361T SP6T Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	SPECIFICATION
FREQUENCY RANGE (GHz)	2-21
MIN. ISOLATION (dB)	55
MAX. INSERTION LOSS (dB)	5.5
MAX. VSWR (ON/OFF)	2.5

Phase & Amplitude Matching
Amplitude Matching .....1 dB Typical
Phase Matching ....12 Deg. Typical

Switching Time
ON time............................500 nsec max.
OFF time.........................500 nsec max.

Power Handling Capability Without Performance Degradation ....OFF port 100 mW cw or peak
ON port 1W CW or Peak

Survival Power ....OFF port 1W average,10W peak (1 μsec max. pulse width)
ON port 1W Average, 75W peak (1 μsec max. pulse width)

Power Supply Requirements
+5V ±5%, 250 mA max
–12V ±5%, 100 mA max

Control Characteristics

Control Input Impedance...................Schottky TTL, two unit loads. (A unit load is 0.4 mA sink current and 40 μA source current.)

Control Logic..................Logic “0” (–0.3 to +0.8V) for Port “ON”
Logic “1” (+2.0 to +5.0V) for Port “OFF”.

OPTION (G09) ENVIRONMENTAL RATINGS

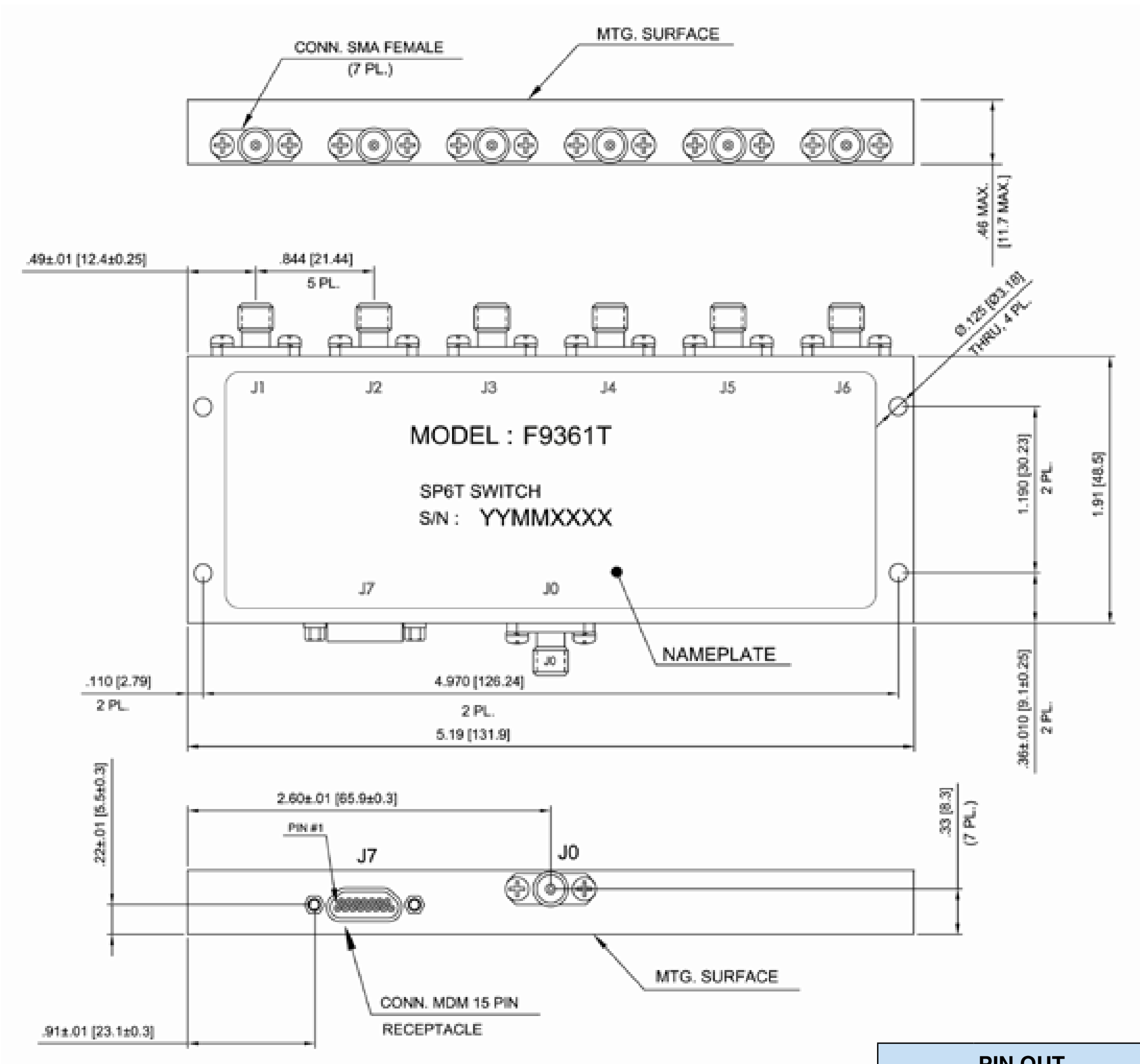
Operating Temperature Range................ –54°C to +110°C
Non-Operating Temperature Range....... –65°C to +125°C
Humidity... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock.. MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude 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
G09	Guaranteed to meet Environmental Ratings
G11	-12V & +6V to +15V
G12	RoHS Compliant

Model F9361T SP6T Specifications

DIMENSIONS AND WEIGHTS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PIN OUT	
PIN	**FUNCTION**
1	+5V
2	N/C
3	J2 CONTROL
4	N/C
5	J4 CONTROL
6	N/C
7	J6 CONTROL
8	–12V
9	J1 CONTROL
10	N/C
11	J3 CONTROL
12	N/C
13	J5 CONTROL
14	N/C
15	GND

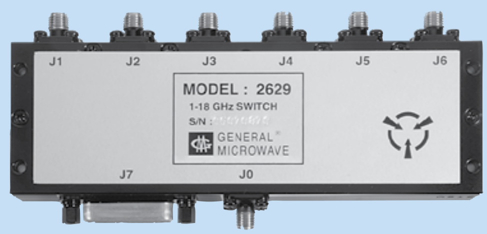
Model 2629
Low Cost SP6T Switches

MODEL 2629

Model 2629 is a Low Cost high-performance terminated SP6T switch that operates over the full instantaneous bandwidth of 1 to 18 GHz with ON and OFF times of 500 nsec.

The Model 2629 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: 1 to 18 GHz**
- **Isolation: up to 55 dB**
- **All in-line outputs**
- **Phase and amplitude matched**
- **Non-reflective**



Switch Model 2629

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	MODEL	
	2629	2626-C99
FREQUENCY RANGE (GHz)	1-18	2-21
MIN. ISOLATION (dB)	55	55
MAX. INSERTION LOSS (dB)	4.8	5.5
MAX. VSWR (ON/OFF)	2.2	2.5
PHASE MATCHING BETWEEN PORTS (deg, max)	±10	±15
AMPLITUDE MATCHING BETWEEN PORTS (dB, max)	±0.6	±1.5
HARMONICS @ +25 dBm (dBc, max)	–35	–35

Switching Time
ON time............................500 nsec max.
OFF time..........................500 nsec max.

Power Handling Capability
Without Performance Degradation: OFF port 100 mW cw or peak; ON port 1W average
Survival Power: OFF port 10W peak, ON port 75W peak (1 μsec max. pulse width)

Power Supply Requirements
+5V ±5%, 250 mA max
–12V ±5%, 100 mA max

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 “0” (–0.3 to +0.8V) for Port “ON”
Logic “1” (+2.0 to +5.0V) for Port “OFF”.

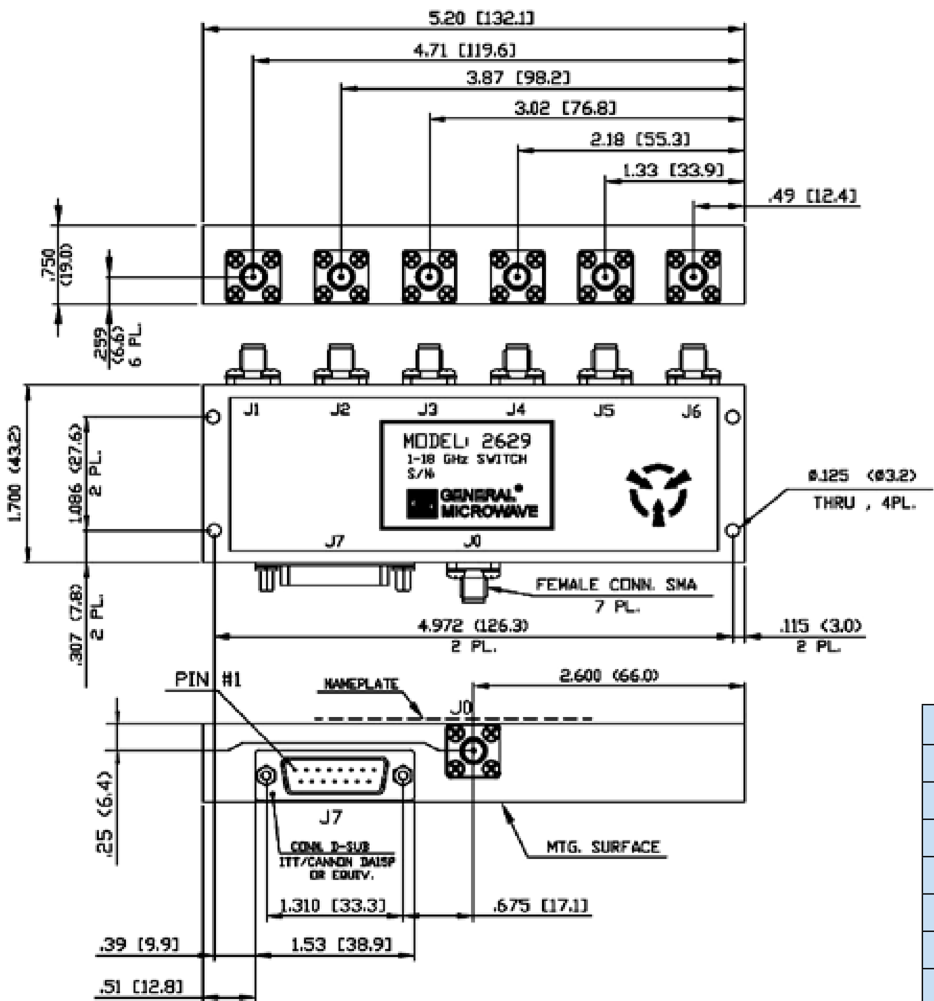
OPTION (G09) ENVIRONMENTAL RATINGS

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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

MODEL 2629 DIMENSIONS AND WEIGHTS



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PIN OUT	
PIN	FUNCTION
1	+5V
2	N/C
3	J2 CONTROL
4	N/C
5	J4 CONTROL
6	N/C
7	J6 CONTROL
8	–12V
9	J1 CONTROL
10	N/C
11	J3 CONTROL
12	N/C
13	J5 CONTROL
14	N/C
15	GND

Series 91 and 92
Miniature Broadband SP7T Switches

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.

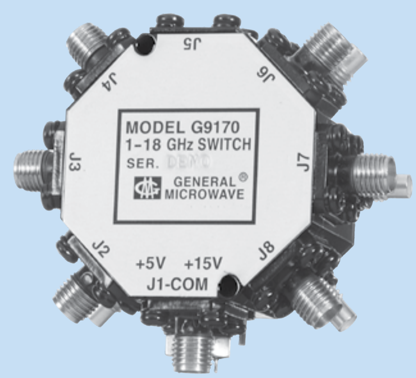
SERIES F91 AND F92

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.

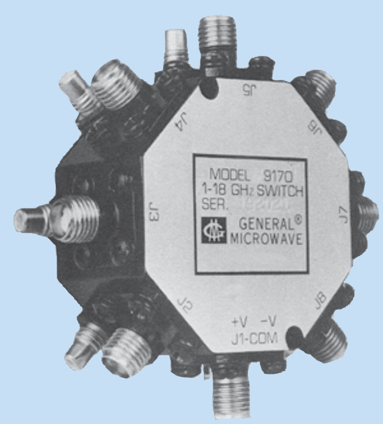
SERIES G91 AND G92

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

- **Frequency range (Series 91): 1 to 18 GHz**
- **Frequency range (Series 92): 0.2 to 4 GHz**
- **Reflective and non-reflective models**
- **Low VSWR and insertion loss**
- **Isolation: up to 60 dB**
- **Miniature size, light weight**



Switch Model F9170
(WITH INTEGRATED
DRIVER)



Switch Model 9170-500
(DRIVERLESS)

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

*Special-order product. Consult factory before ordering.

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/F91/G91

ON time.................................... 250 nsec max.
OFF time .... 250 nsec max.
With Option C37.....................100 nsec max.

SERIES 92/F92/G92

ON time.................................... 500 nsec max.
OFF time .... 500 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 “0” (–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 “0” (–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 Video Filter Options on page 169

** Not applicable to series 92/F92/G92. Minimum order buy of 100 switches

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range
Units With Integrated Drivers
Operating................–54°C to +110°C
Non-Operating........–65°C to +125°C

Driverless Units
Operating ....–54°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.)

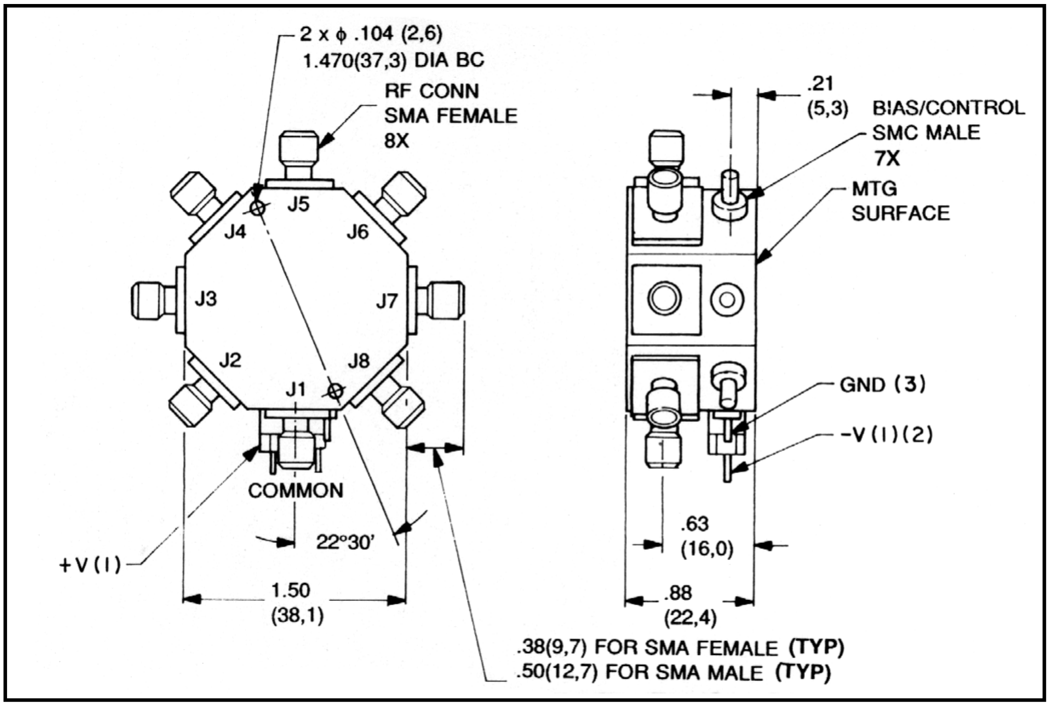
Temp. Cycling............. MIL-STD-202F, Method 107D, Cond. A, 5 cycles

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
55	Frequency range 0.5 to 18 GHz. See page 169
64A	SMB male bias/control connectors
C37**	100 nsec switching time
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT

MODELS 91/92/F91/F92/G91/G92
Wt: 2.9 oz. (82 gr.) approx.

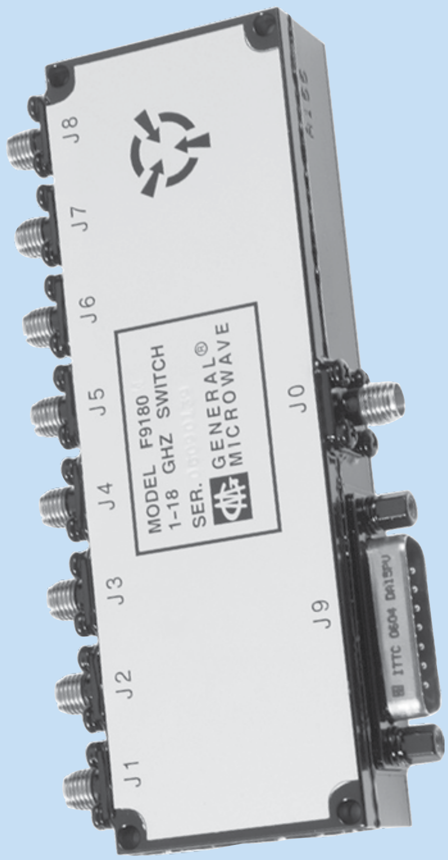


(1) Used only on units with integrated drivers
(2) +15V for G91/G92 Series
(3) Not used on driverless units except with option 33

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Models F9180 and F9180W
Low-Cost Broadband SP8T Switches

- **Frequency range: 1-18 GHz**
- **Reflective and non-reflective models**
- **High isolation, low insertion loss and VSWR**
- **Switching time: 250 nsec**



Switch Model F9180

The Models F9180 and F9180W SP8T switches 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 4.4 dB at 18 GHz. The corresponding values for the Model F9180W, the non-reflective design, are 2.0 dB and 4.8 dB, respectively. Isolation varies from 65 dB at 1 GHz to 55 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 250 nanoseconds. They operate over temperature ranges as wide as –54°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.

MODEL(1) NO.	CHARACTERISTIC	FREQUENCY (GHz) 1–2	2–4	4–8	8–12.4	12.4–18
F9180*	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	65 1.5 1.7	65 2.0 1.7	65 2.4 2.0	65 3.2 2.0	60 4.4 2.0
F9180W	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON or OFF)	65 2.0 1.7	65 2.3 1.7	65 3.2 2.0	60 3.5 2.0	55 4.8 2.0

*Special-order product. Consult factory before ordering.

PERFORMANCE CHARACTERISTICS

Power Handling Capability

Without Performance Degradation

F9180:............................ 0.5W cw or peak

F9180W:

Input to any "OFF" port:............ 100 mW cw or peak

Input to any "ON" port: .... 0.5W cw or peak

Input to common port: .... 0.5W cw or peak

Survival Power

F9180:............................ 1W average, 75W peak (1 μsec max. pulse width)

F9180W:

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

ON Time .... 250 nsec max.

OFF Time .... 250 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.

(1) Models prefixed with "W" are non-reflective except a high VSWR will be presented at the common port if all other ports are OFF.

Models F9180 and F9180W Specifications

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range
- Operating .... –54°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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

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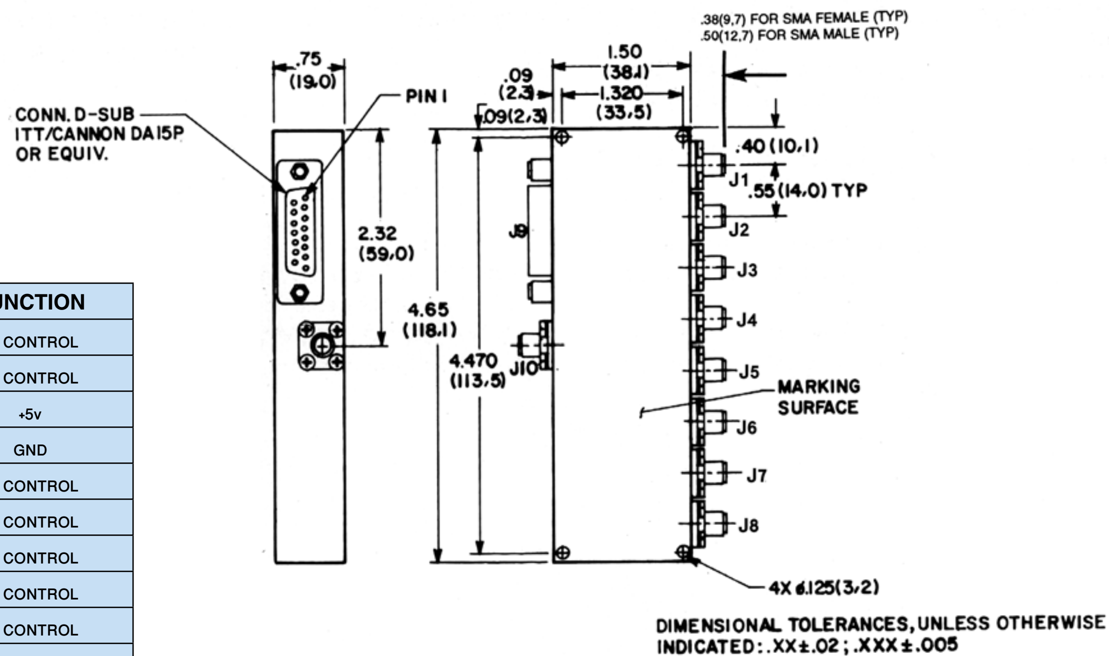
DIMENSIONS AND WEIGHT



PIN	FUNCTION
1	J8 CONTROL
2	J6 CONTROL
3	+5v
4	GND
5	J4 CONTROL
6	J3 CONTROL
7	J2 CONTROL
8	J1 CONTROL
9	J7 CONTROL
10	J5 CONTROL
11	N/C
12	N/C
13	N/C
14	STD Unit: -12v to -15v Opt 11: -5v
15	N/C

MODELS F9180 and F9180W
8.5 oz. (240 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

MODEL 2553 SERIES

Model 2553 series consists of SP8T-SP12T multi throw switches. In this series, all output ports are in-line and the ports are phase and amplitude matched.

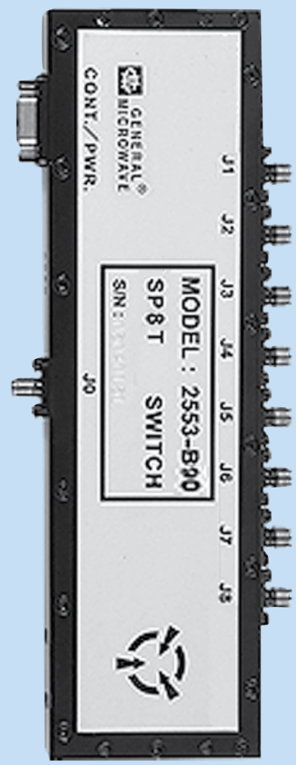
The 2553 series consists of the following multi throw switches:

TYPE	MODEL NO.
SP8T	2553-B90
SP10T	2553-B39
SP12T	2553-B48

The Model 2553 series 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: 1 to 18 GHz**
- **Phase matched**
- **Amplitude matched**
- **All in-line output ports**
- **Non-reflective**

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Switch Model 2553-B90

Model 2553-B90 SP8T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz)
	1.0 to 18.0
Min. Isolation (dB)	55
Max. Insertion Loss (dB)	5.2
Max. VSWR one port ON	2.1 :1
Max. VSWR OFF	2.2 :1

Amplitude Matching
(between any two output ports) ....1.2 dB max.

Phase Matching
(between any two output ports)........... 30° max.

Switching Time
ON Time ....700 nsec max.
OFF Time ....700 nsec max.

Power Handling Capability
Without Performance
Degradation ....600 mW cw or peak
Survival Power..............1.5W cw

Power Supply Requirements

+5V ±5%, 350 mA max
–12V ±5%, 100 mA max

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 “0” (–0.3 to +0.8V) for “ON” state. Logic “1” (+2.0 to +5.0V) for “OFF” state.

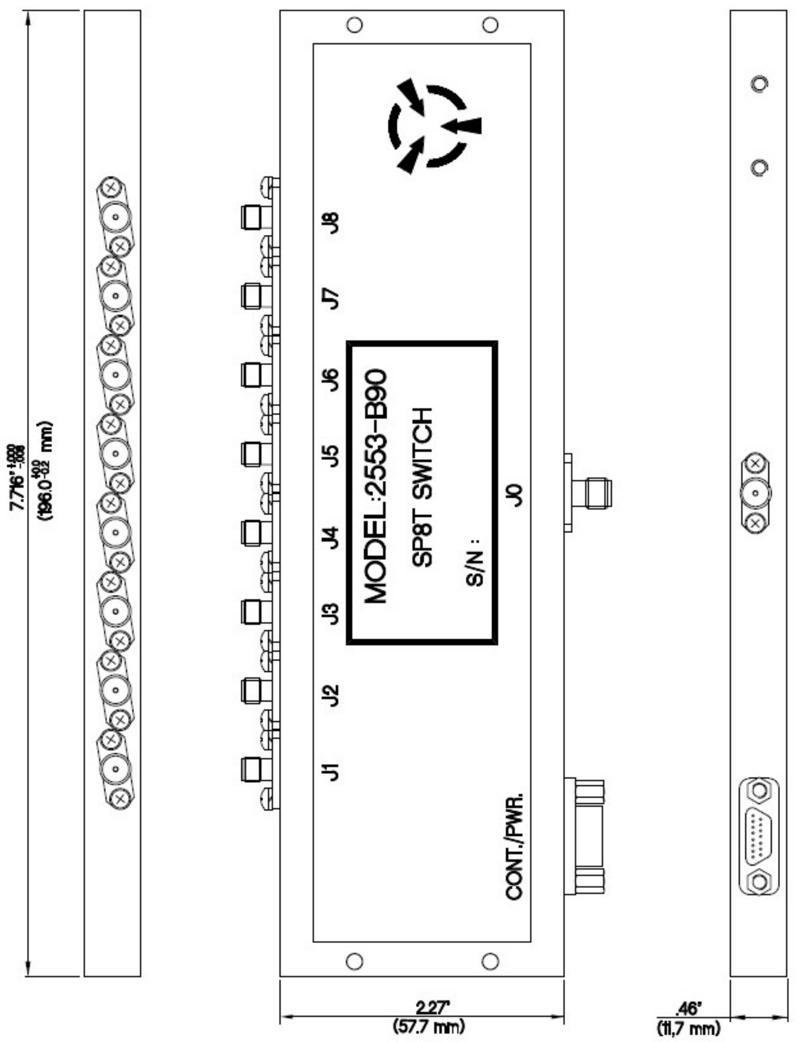
Operating Temperature.........0°C to +70°C
Storage Temperature.........-20°C to +70°C

AVAILABLE OPTIONS

Option No.	Description
G12	RoHS Compliant

Model 2553-B90 SP8T Switch Specifications

DIMENSIONS AND WEIGHT



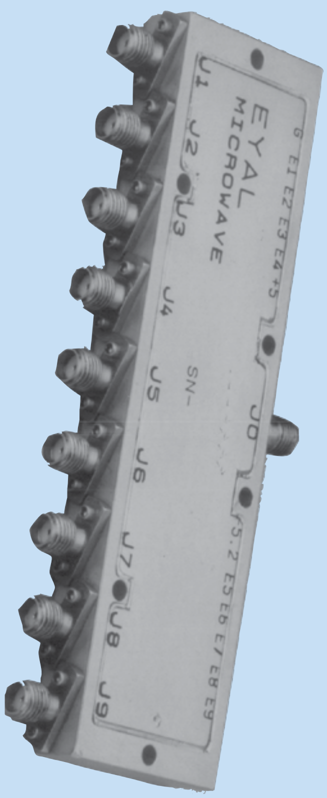
PIN OUT	
PIN	**FUNCTION**
1	+5V
2	J2 CONTROL
3	J4 CONTROL
4	J6 CONTROL
5	J8 CONTROL
6	N.C.
7	N.C.
8	-12v
9	J1 CONTROL
10	J3 CONTROL
11	J5 CONTROL
12	J7 CONTROL
13	N.C.
14	N.C.
15	GND

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model IA-2470-XO
Low Profile Absorptive SP9T Switch

- Frequency range: 8 to 12 GHz
- All in-line output ports
- Non-reflective
- Hermetically Sealed
- Low Profile

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



MODEL IA-2470 SERIES

Model IA-2470-XO SP9T switch, is part of our product line of Low Profile, slim hermetically sealed switches.

The Model IA-2470 series 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.

Model IA-2470-XO SP9T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz) 8.0 to 12.0
Min. Isolation (dB)	70
Max. Insertion Loss (dB)	4.0
Max. VSWR one port ON	2.0 :1
Max. VSWR OFF	2.0 :1

Switching Time
ON Time ....25 nsec max.
OFF Time ....25 nsec max.

Switching Rate................1 MHz max.

Power Handling Capability

Without Performance
Degradation ....100 mW cw or peak

Survival Power..............@25°C 1W cw

Power Supply Requirements

+5V ±2%, 250 mA max
–12V ±2%, 110 mA max

Control Characteristics

TTL Control,

"0" = Insertion Loss, "1" = Isolation

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature
Range...........................-54°C to +85°C

Non-Operating Temperature
Range...........................–55°C to +125°C

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

Shock...............................MIL-STD-202F, Method 213B, Cond. C (100G/ 6 msec)

Vibration..........................MIL-STD-202F, Method 204D, Cond. G (30g PEAK)

Altitude.........................MIL-STD-202F, Method 105C, Cond. C (70,000 ft.)

Temp. Shock...................MIL-STD-202F, Method 107D, Cond. A, (5 cycles) -55°C to +125°C

Seal ....MIL-STD 202F, Method 112C, Cond. C 5x10-7

Salt Spray ....MIL-STD 202F, Method 101D+EST., Cond. B

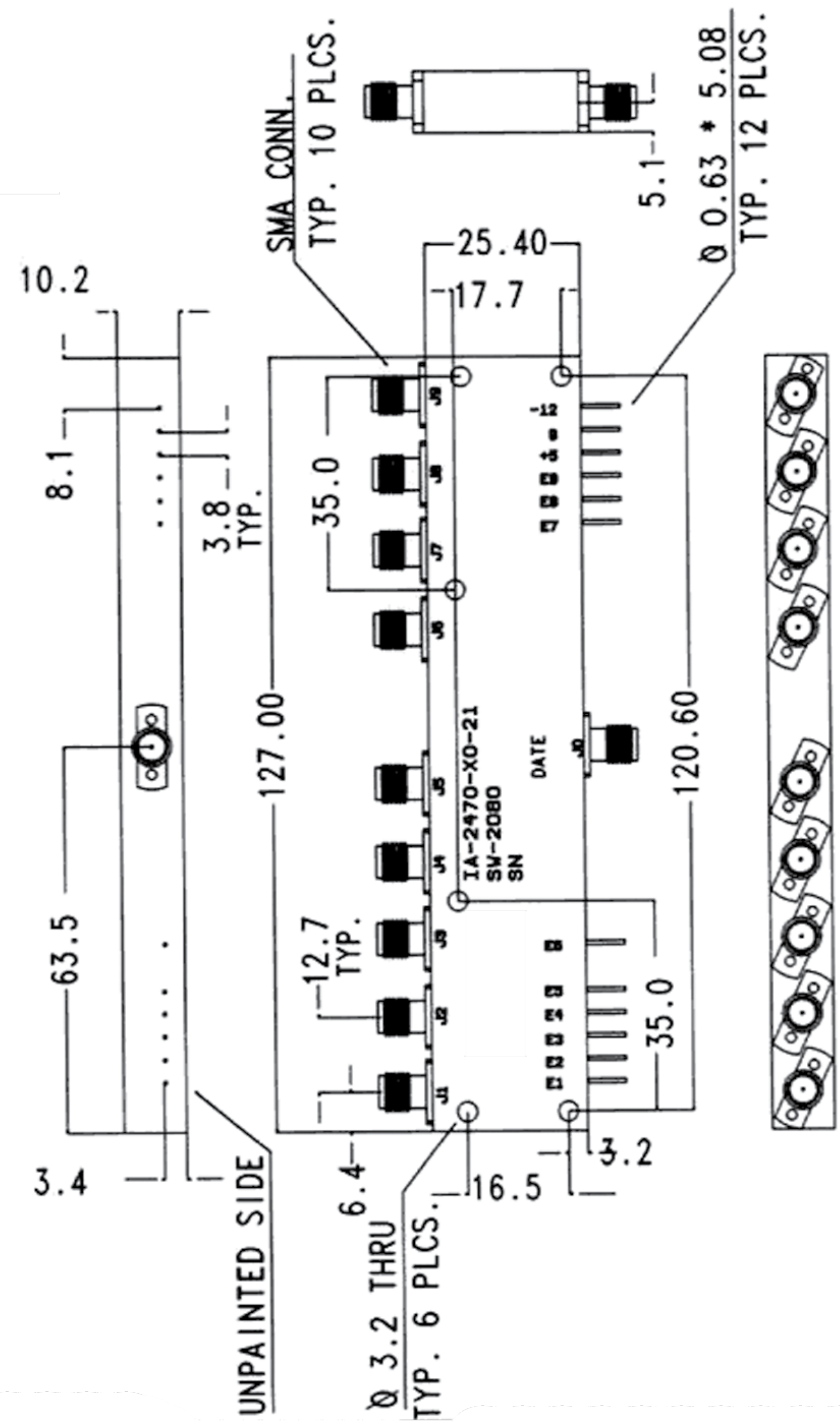
OPTIONS

The switch can be supplied with various options please consult us for more details.

1. **Other Frequency Bands**
2. **Reflective**
3. **Different Outline**
4. **Video Leakage Requirements**
5. **Option G09 - Guaranteed to meet Environmental Ratings**

Model IA-2470-XO SP9T Switch Specifications

DIMENSIONS AND WEIGHT



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

2553 Series Model 2553-B39
SP10T Phase and Amplitude Matched Switch

MODEL 2553 SERIES

Model 2553 series consists of SP8T-SP12T multi throw switches. In this series, all output ports are in-line and the ports are phase and amplitude matched.

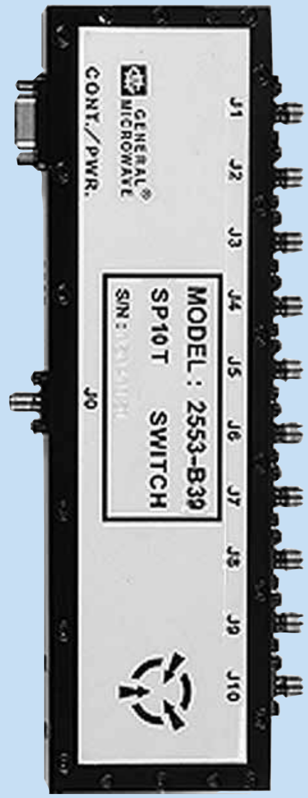
The 2553 series consists of the following multi throw switches:

TYPE	MODEL NO.
SP8T	2553-B90
SP10T	2553-B39
SP12T	2553-B48

The Model 2553 series 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: 6 to 18 GHz
- Phase matched
- Amplitude matched
- All in-line output ports
- Non-reflective

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Switch Model 2553-B39

Model 2553-B39 SP10T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz)	
	6.0 to 12.0	12.0 to 18.0
Min. Isolation (dB)	70	70
Max. Insertion Loss (dB)	4.3	5.6
Max. VSWR one port ON	2.0 :1	2.0 :1
Max. VSWR OFF	2.2 :1	2.2 :1

Amplitude Matching
(between any two output ports) ....1.2 dB max.

Phase Matching
(between any two output ports).......... 30° max.

Switching Time
ON Time ....700 nsec max.
OFF Time ....700 nsec max.

Power Handling Capability
Without Performance
Degradation ....600 mW cw or peak
Survival Power..............1.5W cw

Power Supply Requirements

+5V ±5%, 350 mA max
–12V ±5%, 100 mA max

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 “0” (–0.3 to +0.8V) for “ON” state. Logic “1” (+2.0 to +5.0V) for “OFF” state.

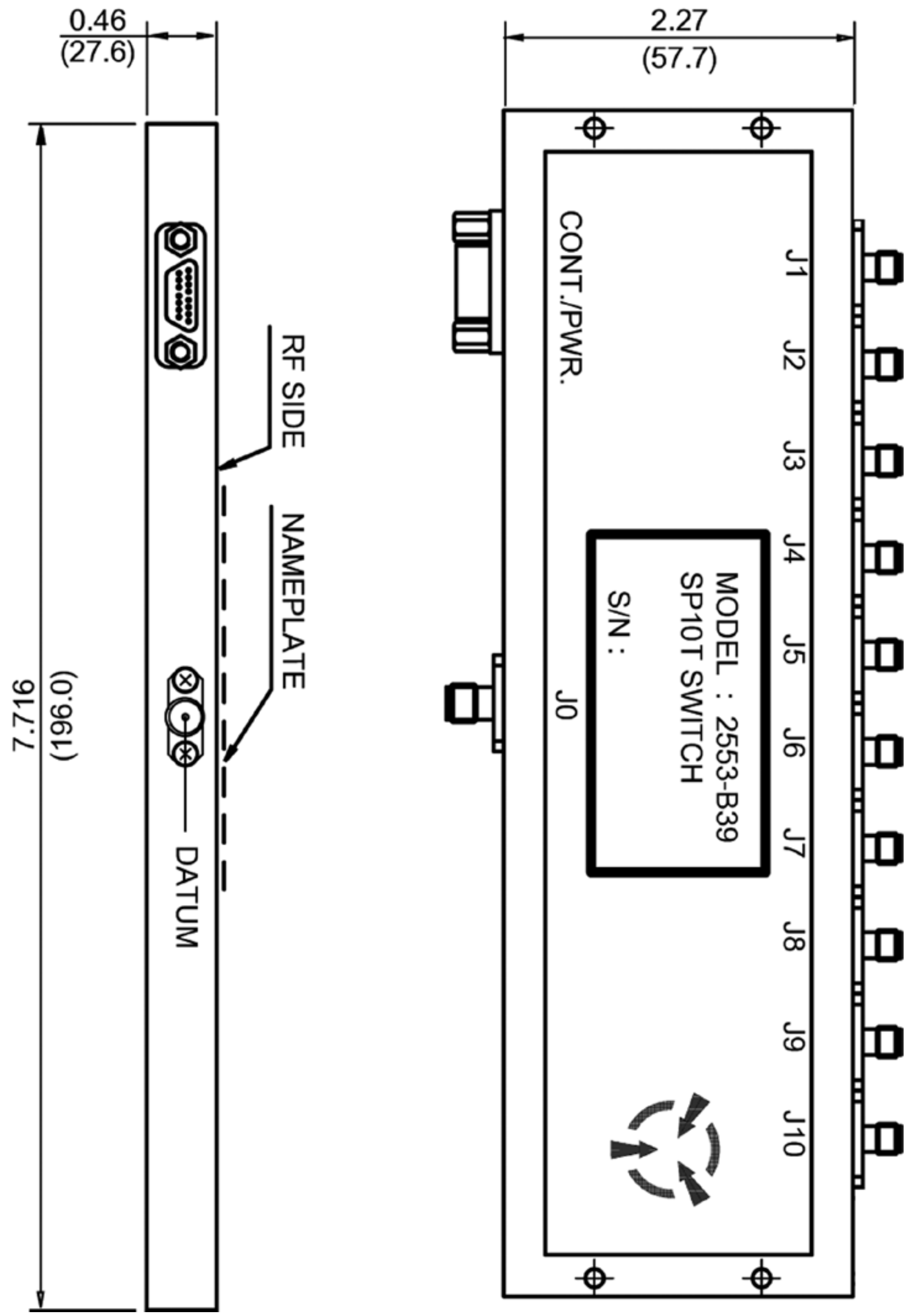
Operating Temperature.........0°C to +70°C

Storage Temperature.........-20°C to +70°C

AVAILABLE OPTIONS

Option No.	Description
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



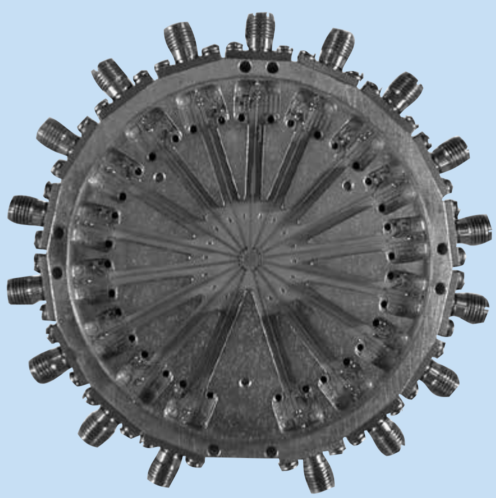
PIN OUT	
PIN	**FUNCTION**
1	+5V
2	J2 CONTROL
3	J4 CONTROL
4	J6 CONTROL
5	J8 CONTROL
6	J10 CONTROL
7	N.U.
8	–12V
9	J1 CONTROL
10	J3 CONTROL
11	J5 CONTROL
12	J7 CONTROL
13	J9 CONTROL
14	N.U.
15	GND

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model KA-2060-VV
Low Frequency Absorptive SP10T Switch

- Frequency range: 20 to 2,000 MHz
- Non-reflective
- Internal Decoder
- Hermetically Sealed
- Low Profile

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



MODEL KA-2060 SERIES

Model KA-2060-LK SP10T switch, is part of our product line of Low Profile, slim hermetically sealed switches. It is a Low Frequency SP10T switch.

The Model KA-2060 series is equipped with an integrated driver that is powered by +5 volt supply. The proper currents required to switch the ports ON or OFF are provided by the driver, which is controlled by external logic signals.

Model KA-2060-VV SP10T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (MHz) 20.0 to 2,000.0
Min. Isolation (dB)	60
Max. Insertion Loss (dB)	6.0
Max. VSWR one port ON	1.7 :1
Max. VSWR OFF	1.7 :1

Switching Time
ON Time ....2 msec max.
OFF Time ....2 msec max.

Switching Rate.................0.1 MHz max.

Power Handling Capability

Without Performance Degradation ....20 mW cw or peak

Survival Power.............@25°C 500 mW cw

Power Supply Requirements

+5V ±2%, 250 mA max

Control Characteristics

4 Bit decoder BCD

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range........................-10°C to +85°C

Non-Operating Temperature Range........................–55°C to +125°C

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

Shock............................MIL-STD-202F, Method 213B, Cond. C (100G/ 6 msec)

Vibration.......................MIL-STD-202F, Method 204D, Cond. G (30g PEAK)

Altitude.........................MIL-STD-202F, Method 105C, Cond. C (70,000 ft.)

Temp. Shock................MIL-STD-202F, Method 107D, Cond. A, (5 cycles) -55°C to +125°C

Seal ....MIL-STD 202F, Method 112C, Cond. C 5x10-7

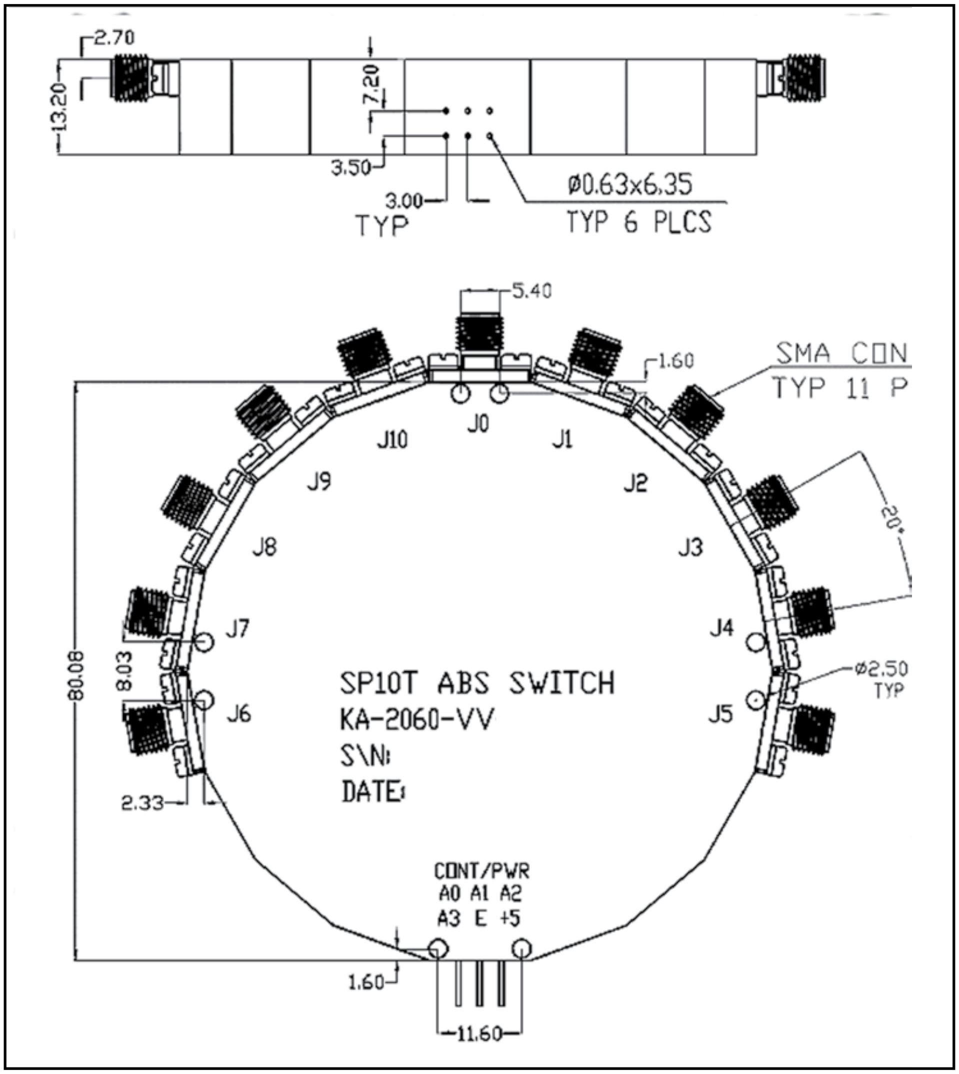
Salt Spray ....MIL-STD 202F, Method 101D EST., Cond. B

OPTIONS

The switch can be supplied with various options please consult us for more details.

1. Other Frequency Bands
2. Reflective
3. Different Outline
4. Video Leakage Requirements
5. Option G09 - Guaranteed to meet Environmental Ratings

Model KA-2060-VV SP10T Switch Specifications



4 BIT DECODER

E	A3	A2	A1	A0	
0	0	0	0	0	J1
	0	0	0	1	J2
	0	0	1	0	J3
	0	0	1	1	J4
	0	1	0	0	J5
	1	0	1	1	J6
	1	1	0	0	J7
	1	1	0	1	J8
	1	1	1	0	J9
	1	1	1	1	J10

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model KA-2970-LK
Low-Profile Absorptive SP10T Switch

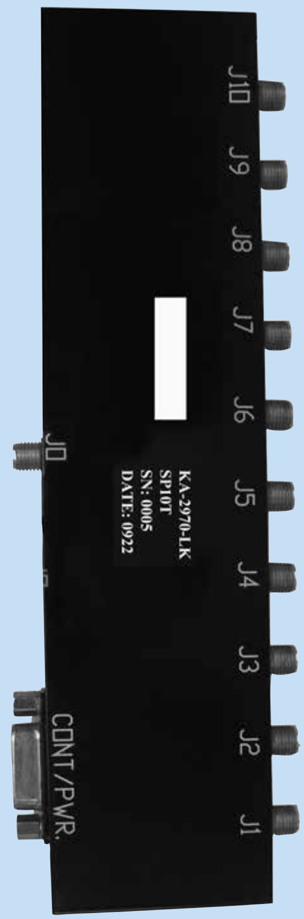
MODEL KA-2970 SERIES

Model KA-2970-LK SP10T switch, is part of our product line of Low Profile, slim hermetically sealed switches.

The Model KA-2970 series 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: 1 to 18 GHz**
- **All in-line output ports**
- **Non-reflective**
- **Internal Decoder**
- **Hermetically Sealed**
- **Low Profile**

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Model KA-2970-LK SP10T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz)	
	1.0 to 10.0	10.0 to 18.0
Min. Isolation (dB)	70	60
Max. Insertion Loss (dB)	4.1	5.6
Max. VSWR one port ON	2.0:1	2.0:1
Max. VSWR OFF	2.2:1	2.2:1

Switching Time
ON Time ....500 nsec max.
OFF Time ....500 nsec max.

Switching Rate.................0.1 MHz max.

Power Handling Capability

Without Performance
Degradation ....500 mW cw or peak

Survival Power..............@25°C 1W cw

Power Supply Requirements

+5V ±2%, 300 mA max
–12V ±2%, 100 mA max

Control Characteristics

4 Bit decoder BCD

OPTION (G09) ENVIRONMENTAL RATINGS

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

Non-Operating Temperature Range........................–55°C to +125°C

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

Shock............................MIL-STD-202F, Method 213B, Cond. C (100G/ 6 msec)

Vibration........................MIL-STD-202F, Method 204D, Cond. G (30g PEAK)

Altitude..........................MIL-STD-202F, Method 105C, Cond. C (70,000 ft.)

Temp. Shock................MIL-STD-202F, Method 107D, Cond. A, (5 cycles) -55°C to +125°C

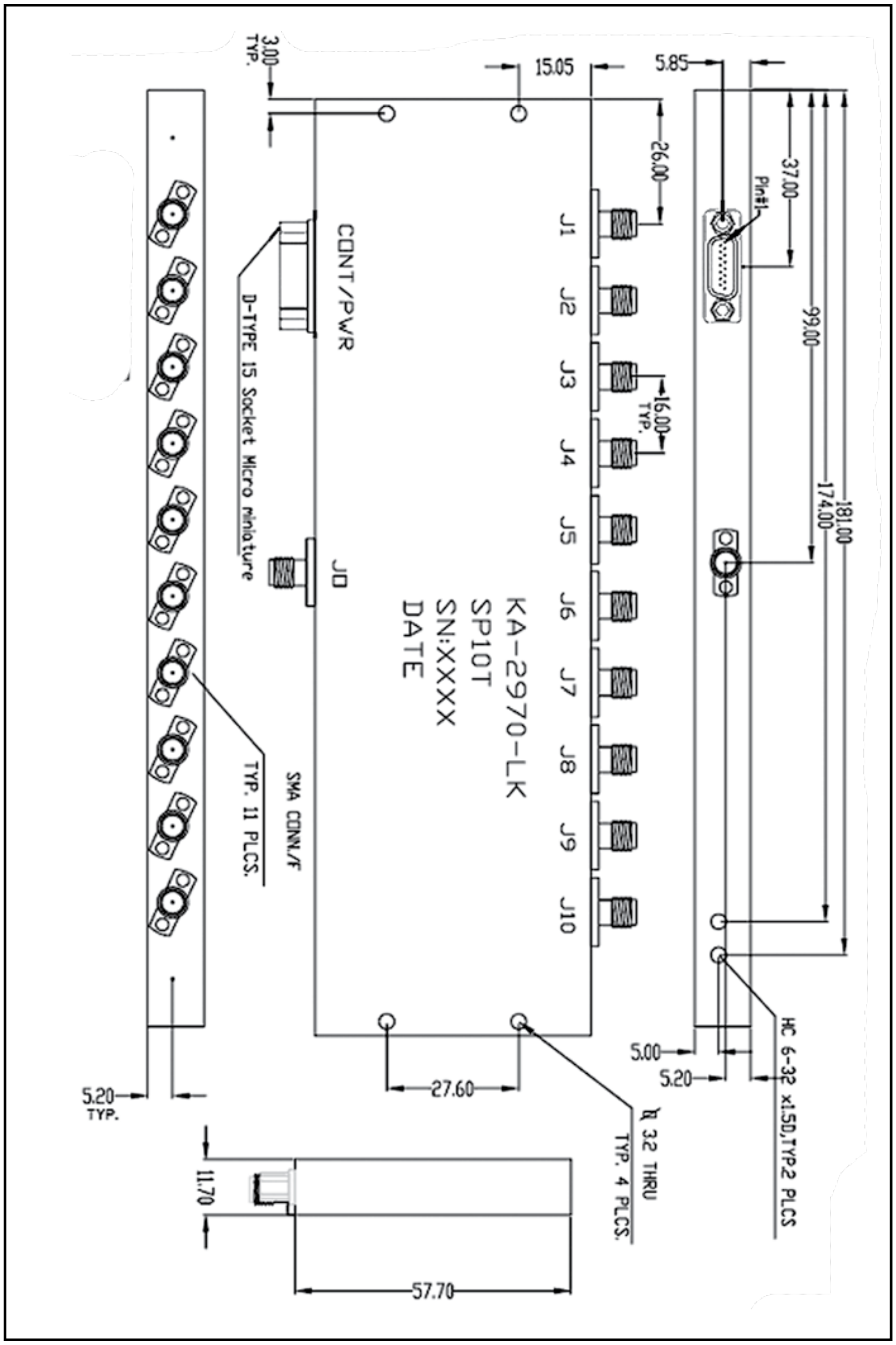
Seal ....MIL-STD 202F, Method 112C, Cond. C 5x10-7

Salt Spray ....MIL-STD 202F, Method 101D+EST., Cond. B

OPTIONS

1. Other Frequency Bands
2. Reflective
3. Different Outline
4. Video Leakage Requirements
5. Option G09 - Guaranteed to meet Environmental Ratings

Model KA-2970-LK SP10T Switch Specifications



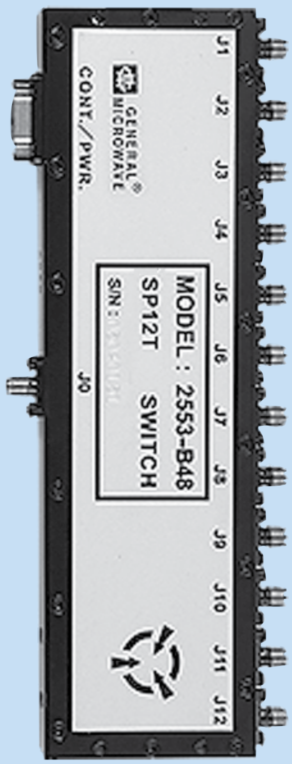
4 BIT DECODER

	E4	E3	E2	E1
J1	0	0	0	1
J2	0	0	1	0
J3	0	0	1	1
J4	0	1	0	0
J5	0	1	0	1
J6	0	1	1	0
J7	0	1	1	1
J8	1	0	0	0
J9	1	0	0	1
10	1	0	1	0
ALL OFF	1	1	1	1

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

2553 Series Model 2553-B48
SP12T Phase and Amplitude Matched Switch

- **Frequency range: 6 to 18 GHz**
- **Phase matched**
- **Amplitude matched**
- **All in-line output ports**
- **Non-reflective**



Switch Model 2553-B48

MODEL 2553 SERIES

Model 2553 series consists of SP8T-SP12T multi throw switches. In this series, all output ports are in-line and the ports are phase and amplitude matched.

The 2553 series consists of the following multi throw switches:

TYPE	MODEL NO.
SP8T	2553-B90
SP10T	2553-B39
SP12T	2553-B48

The Model 2553 series 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.

Model 2553-B48 SP12T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz)	
	6.0 to 12.0	12.0 to 18.0
Min. Isolation (dB)	70	70
Max. Insertion Loss (dB)	4.3	5.6
Max. VSWR one port ON	2.0:1	2.0:1
Max. VSWR OFF	2.2:1	2.2:1

Amplitude Matching
(between any two output ports) ....1.2 dB max.

Phase Matching
(between any two output ports)........... 30° max.

Switching Time
ON Time ....700 nsec max.
OFF Time ....700 nsec max.

Power Handling Capability
Without Performance Degradation ....600 mW cw or peak
Survival Power..............1.5W cw

Power Supply Requirements

+5V ±5%, 350 mA max
–12V ±5%, 100 mA max

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 "0" (–0.3 to +0.8V) for "ON" state. Logic "1" (+2.0 to +5.0V) for "OFF" state.

Operating Temperature.........0°C to +70°C

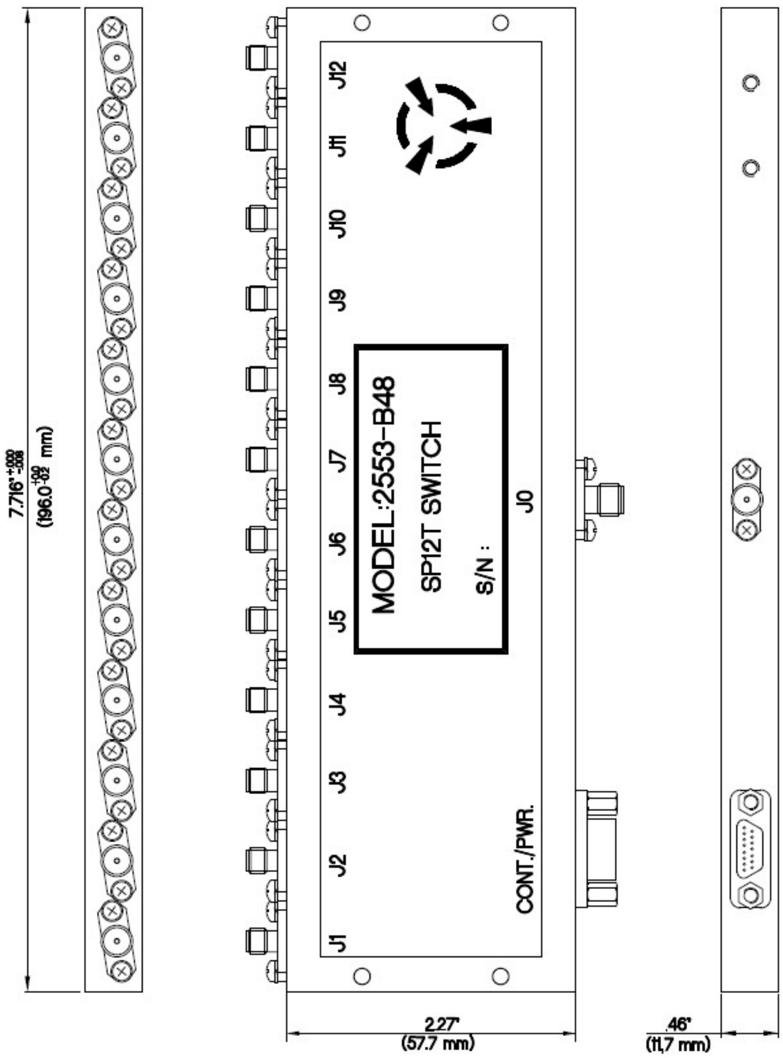
Storage Temperature.........-20°C to +70°C

AVAILABLE OPTIONS

Option No.	Description
G12	RoHS Compliant

Model 2553-B48 SP12T Switch Specifications

DIMENSIONS AND WEIGHT



PIN OUT	
PIN	**FUNCTION**
1	+5V
2	J2 CONTROL
3	J4 CONTROL
4	J6 CONTROL
5	J8 CONTROL
6	J10 CONTROL
7	J12 CONTROL
8	–12V
9	J1 CONTROL
10	J3 CONTROL
11	J5 CONTROL
12	J7 CONTROL
13	J9 CONTROL
14	J11 CONTROL
15	GND

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model NA-2750-CO
Low Profile Absorptive SP13T Switch

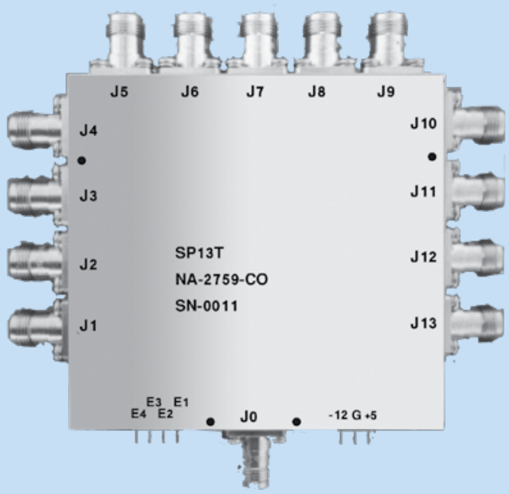
MODEL NA-2750 SERIES

Model NA-2750-CO SP13T switch is part of our product line of Low Profile, slim hermetically sealed switches.

The Model NA-2750 series 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: 5.3 to 7.5 GHz**
- **Non-reflective**
- **Internal Decoder**
- **Hermetically Sealed**
- **Low Profile**
- **Decoder**

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Model NA-2750-CO SP13T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz) 5.3 to 7.5
Min. Isolation (dB)	50
Max. Insertion Loss (dB)	4.5
Max. VSWR one port ON	1.8:1
Max. VSWR OFF	1.8:1

Switching Time
ON Time ....100 nsec max.
OFF Time ....100 nsec max.

Switching Rate.................0.1 MHz max.

Power Handling Capability

Without Performance
Degradation ....200 mW cw or peak

Survival Power..............@25°C 1W cw

Power Supply Requirements

+5V ±2%, 600 mA max

-12V ±2%, 140 mA max

Control Characteristics

4 Bit decoder

Option (G09) ENVIRONMENTAL RATINGS

Operating Temperature
Range........................-20°C to +70°C

Non-Operating Temperature
Range........................–55°C to +125°C

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

Shock............................MIL-STD-202F, Method 213B, Cond. C (100G/ 6 msec)

Vibration........................MIL-STD-202F, Method 204D, Cond. G (30g PEAK)

Altitude.........................MIL-STD-202F, Method 105C, Cond. C (70,000 ft.)

Temp. Shock................MIL-STD-202F, Method 107D, Cond. A, (5 cycles) -55°C to +125°C

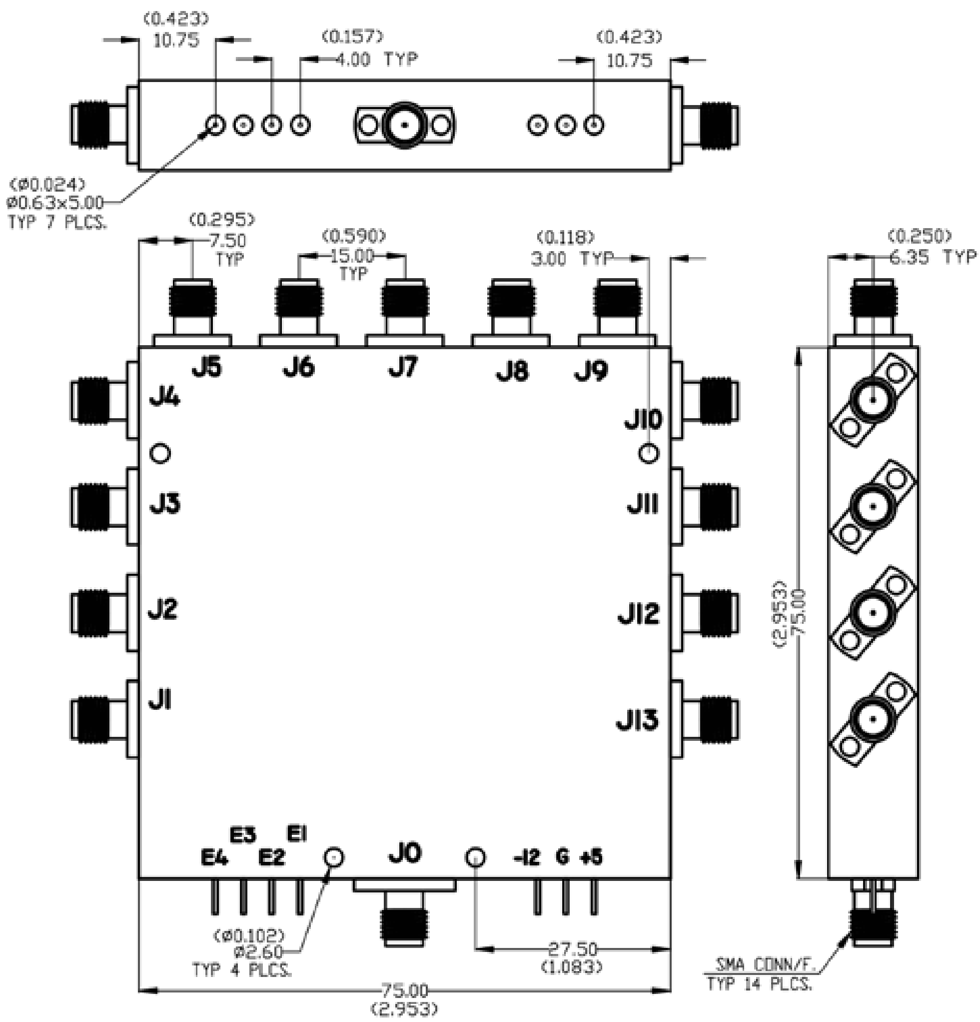
Seal ....MIL-STD 202F, Method 112C, Cond. C 5x10-7

Salt Spray ....MIL-STD 202F, Method 101D+EST., Cond. B

OPTIONS

1. Other Frequency Bands
2. Reflective
3. Different Outline
4. Video Leakage Requirements
5. Option G09 - Guaranteed to meet Environmental Ratings

DIMENSIONS AND WEIGHT



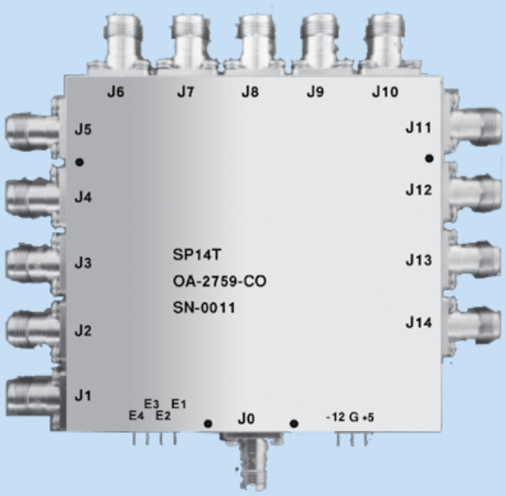
J0 TO....	E4	E3	E2	E1	STATE
J1	0	0	0	0	I. LOSS
J2	0	0	0	1	I. LOSS
J3	0	0	1	0	I. LOSS
J4	0	0	1	1	I. LOSS
J5	0	1	0	0	I. LOSS
J6	0	1	0	1	I. LOSS
J7	0	1	1	0	I. LOSS
J8	0	1	1	1	I. LOSS
J9	1	0	0	0	I. LOSS
J10	1	0	0	1	I. LOSS
J11	1	0	1	0	I. LOSS
J12	1	0	1	1	I. LOSS
J13	1	1	0	0	I. LOSS

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model OA-2750-CO
Low Profile Absorptive SP14T Switch

- Frequency range: 5.3 to 7.5 GHz
- Non-reflective
- Internal Decoder
- Hermetically Sealed
- Low Profile
- Decoder

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



MODEL OA-2750 SERIES

Model OA-2750-CO SP14T switch is part of our product line of Low Profile, slim hermetically sealed switches.

The Model OA-2750 series 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.

Model OA-2750-CO SP14T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz)
	5.3 to 7.5
Min. Isolation (dB)	50
Max. Insertion Loss (dB)	4.5
Max. VSWR one port ON	1.8 :1
Max. VSWR OFF	1.8 :1

Switching Time
- **ON Time** ....100 nsec max.
- **OFF Time** ....100 nsec max.

Switching Rate.................0.1 MHz max.

Power Handling Capability

Without Performance Degradation ....200 mW cw or peak

Survival Power..............@25°C 1W cw

Power Supply Requirements

+5V ±2%, 600 mA max

-12V ±2%, 140 mA max

Control Characteristics

4 Bit TTL

Option (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range...........................-20°C to +70°C

Non-Operating Temperature Range...........................–55°C to +125°C

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

Shock ....MIL-STD-202F, Method 213B, Cond. C (100G/ 6 msec)

Vibration..........................MIL-STD-202F, Method 204D, Cond. G (30g PEAK)

Altitude ....MIL-STD-202F, Method 105C, Cond. C (70,000 ft.)

Temp. Shock...................MIL-STD-202F, Method 107D, Cond. A, (5 cycles) -55°C to +125°C

Seal ....MIL-STD 202F, Method 112C, Cond. C 5x10-7

Salt Spray ....MIL-STD 202F, Method 101D+EST., Cond. B

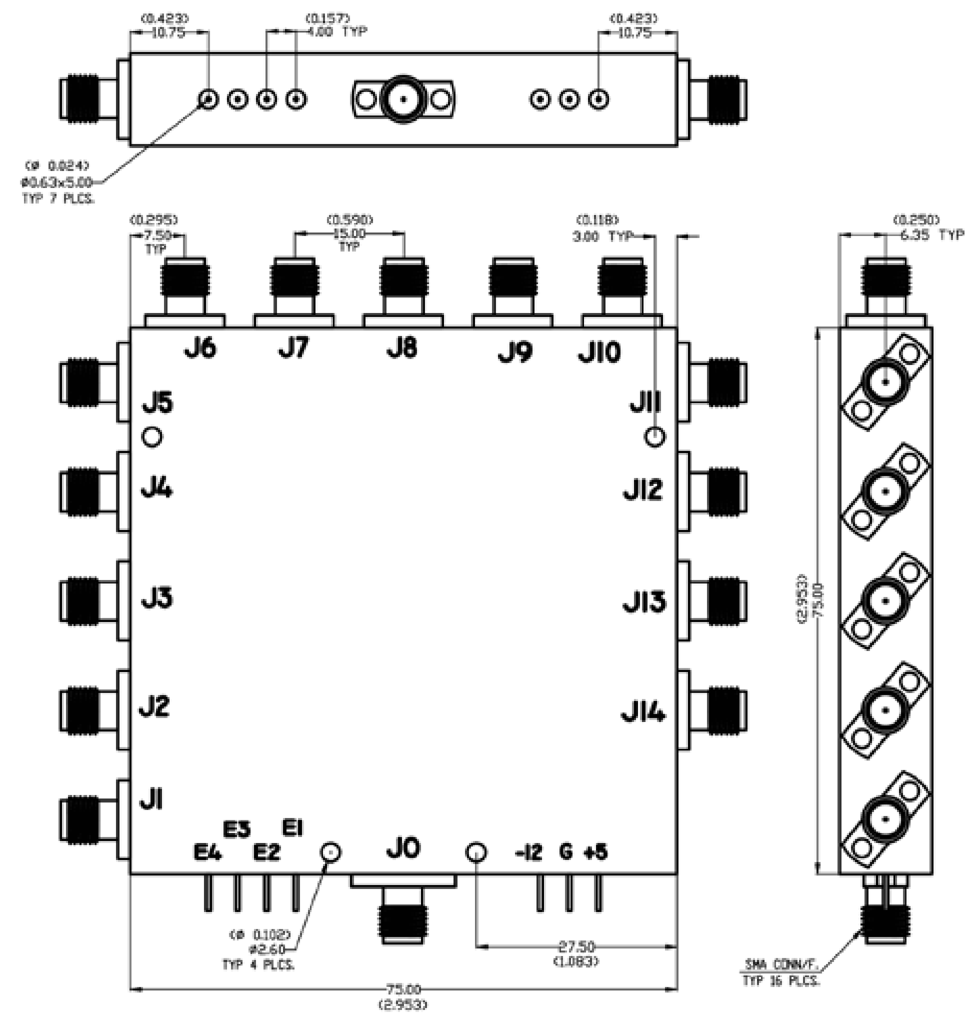
OPTIONS

The switch can be supplied with various options. Please consult us for more details.

1. **Other Frequency Bands**
2. **Reflective**
3. **Different Outline**
4. **Video Leakage Requirements**
5. **Option G09 - Guaranteed to meet Environmental Ratings**

Model OA-2750-CO SP14T Switch Specifications

DIMENSIONS AND WEIGHT



J0 TO....	E4	E3	E2	E1	STATE
J1	0	0	0	0	I. LOSS
J2	0	0	0	1	I. LOSS
J3	0	0	1	0	I. LOSS
J4	0	0	1	1	I. LOSS
J5	0	1	0	0	I. LOSS
J6	0	1	0	1	I. LOSS
J7	0	1	1	0	I. LOSS
J8	0	1	1	1	I. LOSS
J9	1	0	0	0	I. LOSS
J10	1	0	0	1	I. LOSS
J11	1	0	1	0	I. LOSS
J12	1	0	1	1	I. LOSS
J13	1	1	0	0	I. LOSS
J14	1	1	0	1	I. LOSS

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model PA-2750-CO
Low-Profile Absorptive SP15T Switch

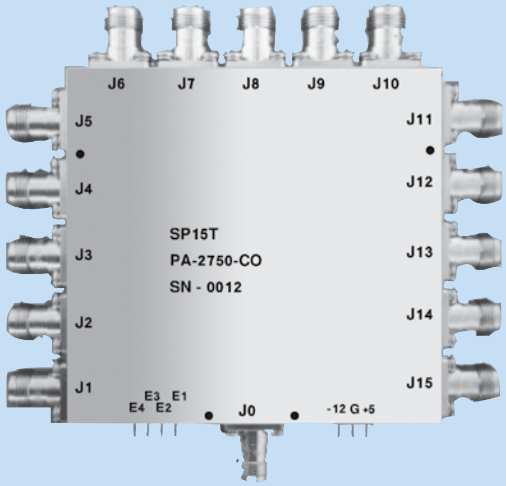
MODEL PA-2750 SERIES

Model PA-2750-CO SP15T switch is part of our product line of Low Profile, slim hermetically sealed switches.

The Model PA-2750 series 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: 5.3 to 7.5 GHz**
- **Non-reflective**
- **Internal Decoder**
- **Hermetically Sealed**
- **Low Profile**
- **Decoder**

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Model PA-2750-CO SP15T Switch Specifications

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	FREQUENCY RANGE (GHz) 5.3 to 7.5
Min. Isolation (dB)	50
Max. Insertion Loss (dB)	4.5
Max. VSWR one port ON	1.8 : 1
Max. VSWR OFF	1.8 : 1

Switching Time

ON Time ....100 nsec max.

OFF Time ....100 nsec max.

Switching Rate................0.1 MHz max.

Power Handling Capability

Without Performance Degradation ....200 mW cw or peak

Survival Power...........@25°C 1W cw

Power Supply Requirements

+5V ±2%, 600 mA max

-12V ±2%, 140 mA max

Control Characteristics

4 Bit decoder

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range...........................-20°C to +70°C

Non-Operating Temperature Range...........................–55°C to +125°C

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

Shock...............................MIL-STD-202F, Method 213B, Cond. C (100G/ 6 msec)

Vibration...........................MIL-STD-202F, Method 204D, Cond. G (30g PEAK)

Altitude.............................MIL-STD-202F, Method 105C, Cond. C (70,000 ft.)

Temp. Shock.....................MIL-STD-202F, Method 107D, Cond. A, (5 cycles) -55°C to +125°C

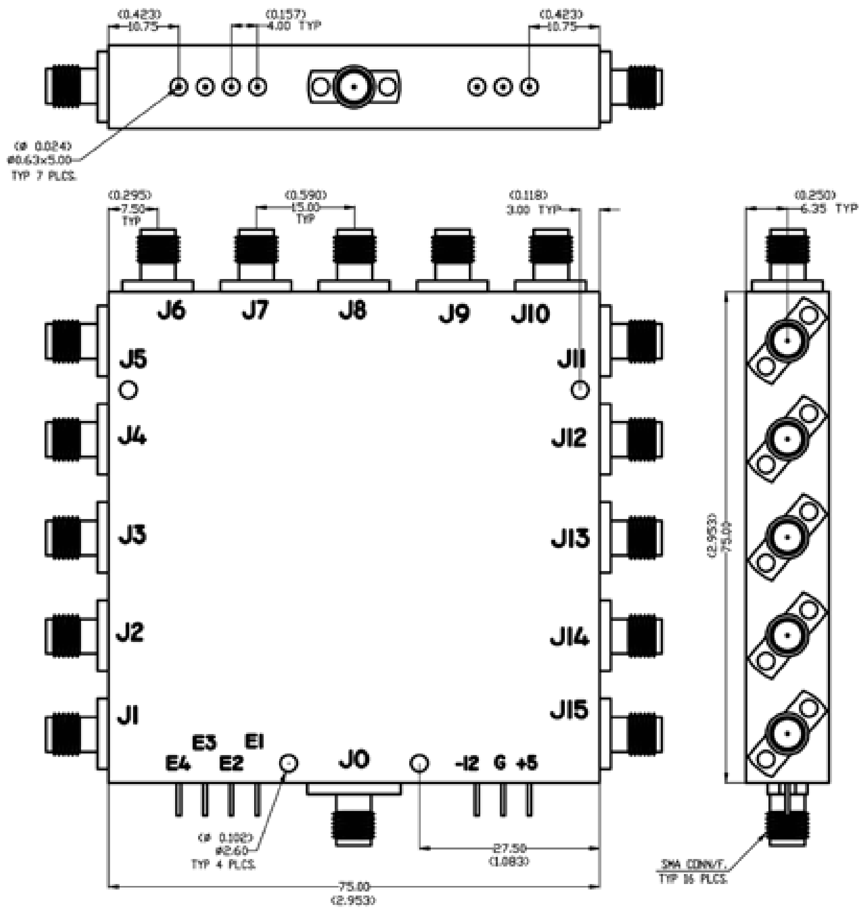
Seal ....MIL-STD 202F, Method 112C, Cond. C 5x10-7

Salt Spray ....MIL-STD 202F, Method 101D+EST., Cond. B

OPTIONS

The switch can be supplied with various options.
Please consult us for more details.

1. Other Frequency Bands
2. Reflective
3. Different Outline
4. Video Leakage Requirements
5. Option G09 - Guaranteed to meet Environmental Ratings



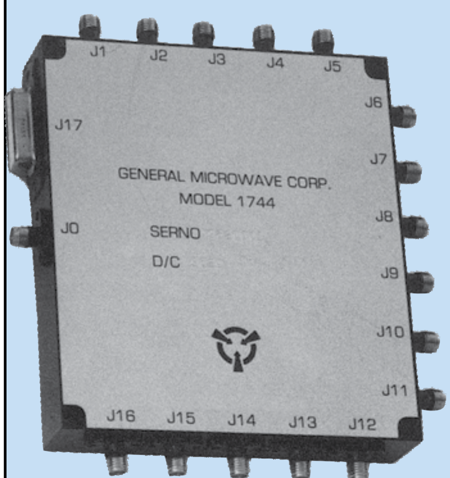
J0 TO....	E4	E3	E2	E1	STATE
J1	0	0	0	0	I. LOSS
J2	0	0	0	1	I. LOSS
J3	0	0	1	0	I. LOSS
J4	0	0	1	1	I. LOSS
J5	0	1	0	0	I. LOSS
J6	0	1	0	1	I. LOSS
J7	0	1	1	0	I. LOSS
J8	0	1	1	1	I. LOSS
J9	1	0	0	0	I. LOSS
J10	1	0	0	1	I. LOSS
J11	1	0	1	0	I. LOSS
J12	1	0	1	1	I. LOSS
J13	1	1	0	0	I. LOSS
J14	1	1	0	1	I. LOSS
J15	1	1	1	0	I. LOSS

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model 1744
SP16T PIN Diode Switch

- **Frequency Range: 2-18 GHz**
- **Non-reflective**
- **High Isolation, Low Insertion Loss and VSWR**
- **Switching Speed: 500 nsec**

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Switch Model 1744

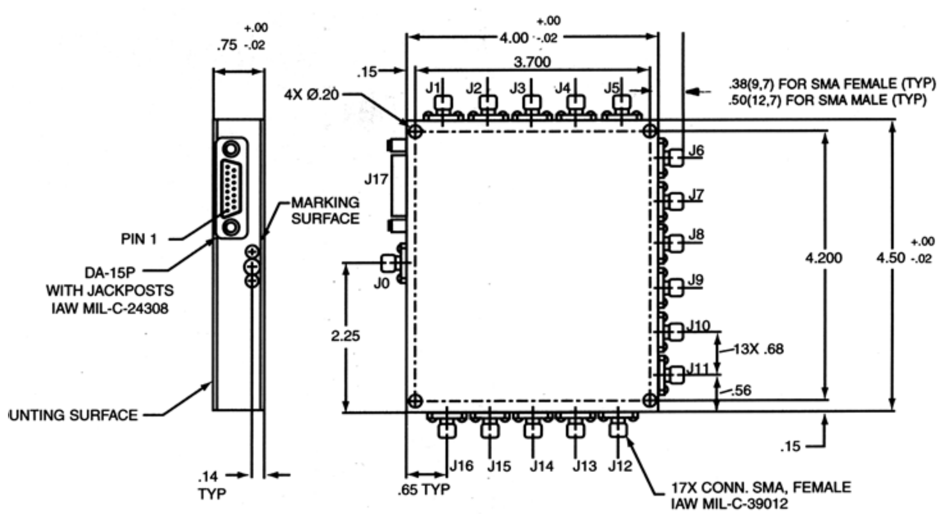
General Microwave Corporation's SP16T PIN Diode Switch, Model 1744, covers the 2 to 18 GHz frequency band. The switch exhibits a maximum insertion loss of 6.0 dB and an isolation of 60 dB to 14 GHz and 50 dB to 18 GHz. The switching speed is 500 nsec maximum. This compact unit measures 4.5 x 4.0 x 0.75". Power supply voltages are +5V 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.

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 ...... 100 mW cw or peak
Input to any ON port .... 1W cw or peak
Input to common port ..... 1W cw or peak
Survival Power
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)

Power Supply .... +5 VDC at 250 mA
+15 VDC at 100 mA
Control Input Impedance .... TTL, two unit load. (A unit load is 0.8 mA sink current and 40 µA 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 ±.008

Series PA16 SP16T Phase and Amplitude Matched Switches

- Frequency range: 0.5 to 18 GHz
- Phase matched
- Amplitude matched
- Non-reflective

Switch Model PA16

Series PA16

The Series PA16 Non-Reflective SP16T Switches have been designed for distribution of wide-band RF/ Microwave signals. Applications include EW Simulators and Test Systems. All output ports are Phase and Amplitude matched to further minimize Simulator calibration and enhance the fidelity of Test Systems

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	MODEL NUMBER	
	PA1606	PA1618
Min. Frequency Range (GHz)	0.5 to 6.0	1.0 to 18
Min. Isolation (dB)	65	60
Max. Insertion Loss (dB)	6.0	6.5
Max. VSWR one port ON	2.0 :1	2.2 :1
Max. VSWR OFF	2.0 :1	2.2 :1

Amplitude Matching
(between any two output ports) ....1.5 dB max.

Phase Matching
(between any two output ports)........... 30° max.

Switching Time
ON Time ....500 nsec max.
OFF Time ....500 nsec max.

Power Supply Requirements
+5V ±5%, 450 mA max
–12V ±5%, 135 mA max

Control Logic 4 Bit TTL Decoded Input

.

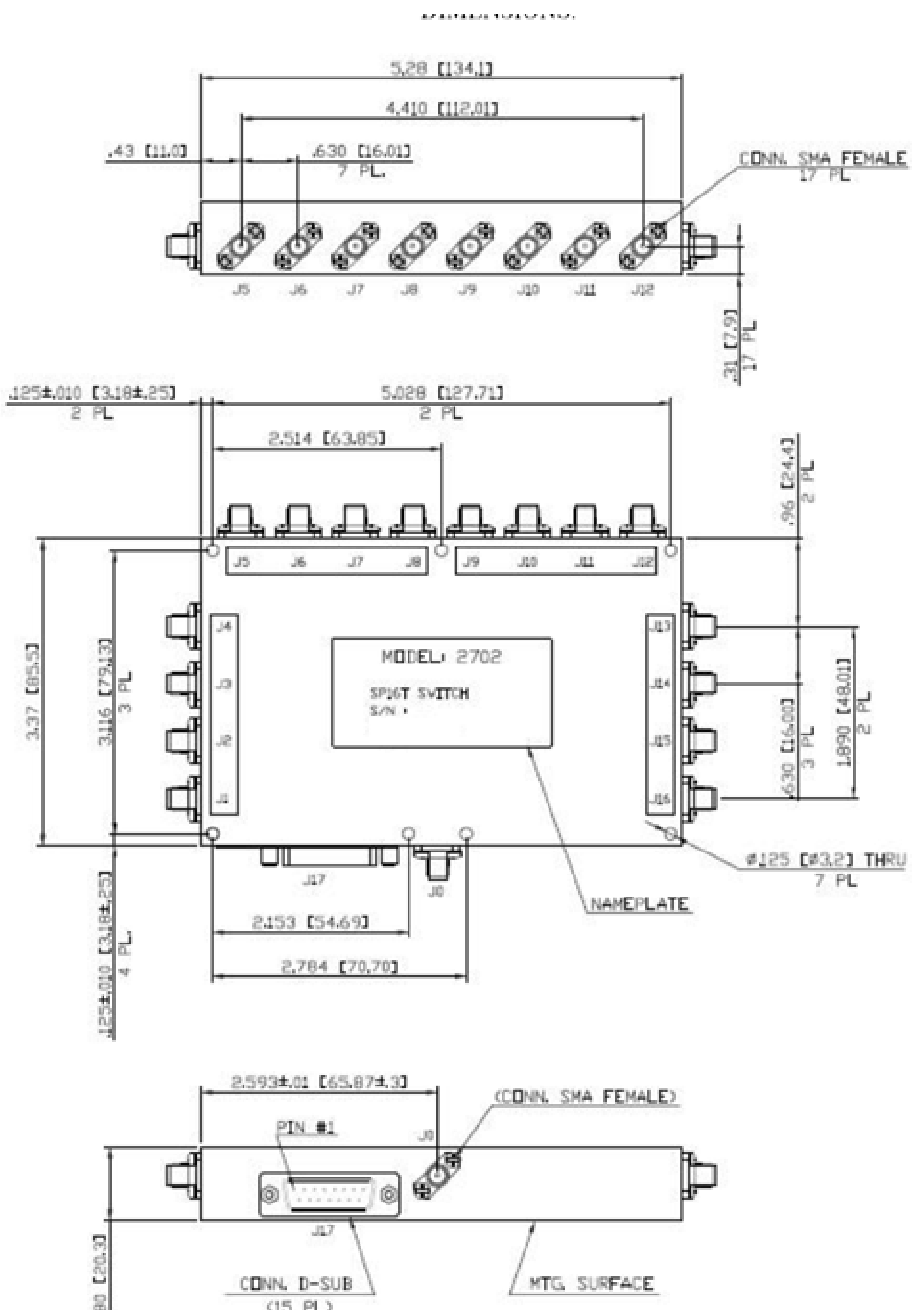
Operating Temperature.....-20°C to +70°C
Storage Temperature.........-20°C to +70°C

Power Handling Capability
Without Performance Degradation
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
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)

AVAILABLE OPTIONS

Option No.	Description
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



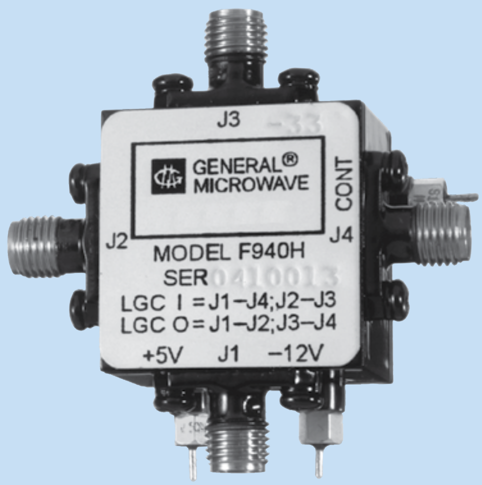
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

4 BIT DECODER					
A3	A2	A1	A0	RF PATH	STATE
0	0	0	0	J0-J1	I.L.
.					
.					
.					
1	1	1	1	J0-J16	I.L.

J17 PIN FUNCTIONS	
PIN NUMBER	FUNCTION
1	+5V
2	N.C.
3	N.C.
4	N.C.
5	N.C.
6	N.C.
7	N.C.
8	-12V
9	A0 (LSB)
10	N.C.
11	A1
12	N.C.
13	A2
14	A3 (MSB)
15	GND

Model F940H
Broadband Transfer Switch

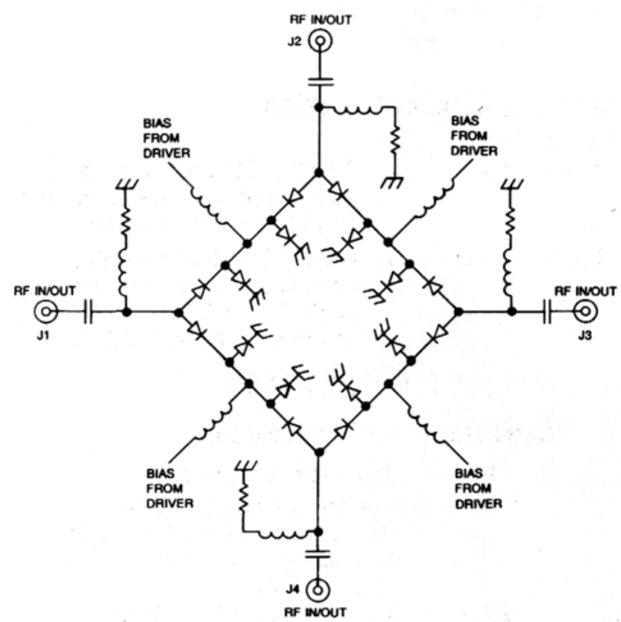
- Frequency range: 0.5 to 18 GHz
- Low VSWR and insertion loss
- Isolation: up to 60 dB
- Small size, light weight



Switch Model F940H

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.

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)

Power Supply Requirements

+5V ±5%, 60 mA
–12V ±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 “0” (–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.

OPTION (G09) 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)

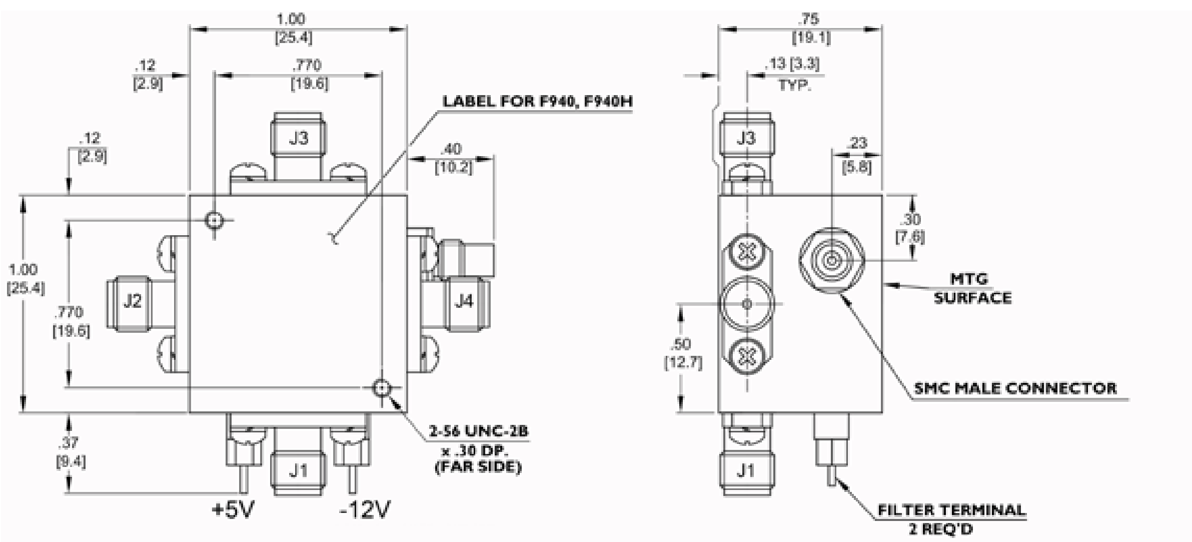
Altitude ....MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

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

AVAILABLE OPTIONS

Option No.	Description
7	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
48	+5V, –15V operation
64A	SMB male control connector
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



Wt: 1.1 oz (31 gr.)

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Hermetically Sealed Low Profile Switches Selection Guide

KRATOS General Microwave is offering a broad range of Hermetically Sealed, Low Profile switches. These are high speed, wide frequency range, high performance switches with low insertion loss and high isolation. They vary from SPST through SP6T, higher Multi-Throw switches are available as specials. The standard thickness of these switches is typically about 0.23” (6.0mm). In some cases, we can provide switches of 0.19” (4.9 mm) too. These switches are meeting sever environmental requirements such as airborne and naval applications.

In addition to the standard configuration as specified in this catalog, they can be supplied with various options such as: Reflective or Non-Reflective (absorptive), low video leakage , various Power Supply Voltages, Over-Voltage Protection and in Drop-In configuration.

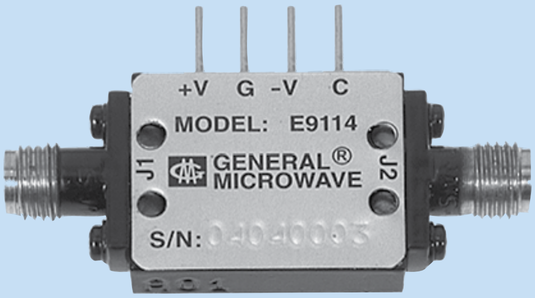
HERMETICALLY SEALED SWITCHES

FREQUENCY RANGE (GHz) 0.1 0.5 1 2 4 8 12.4 18 20	MODEL OR SERIES	PAGE	COMMENTS
SPST SWITCHES			
1 — 18	E9114H	277	
SPDT SWITCHES			
1 — 18	E9120H/HT	280	
SP3T SWITCHES			
1 — 18	E9130H/HT	284	
SP4T SWITCHES			
1 — 18	E9140H/HT	288	
SP5T SWITCHES			
0.5 — 18	ER-2260-UK	292	
SP6T SWITCHES			
0.5 — 18	FR-2260-UK	205	
SP9T SWITCHES			
8 — 12	IA-2470-XO	244	
SP13T SWITCHES			
5.3 — 7.5	NA-2750-CO	259	
SP14T SWITCHES			
5.3 — 7.5	OA-2750-CO	610	
SP15T SWITCHES			
5.3 — 7.5	PA-2750-CO	265	

Model E9114H Hermetically Sealed Low Profile SPST Switch

The Model E9114H is a hermetically sealed, low cost high speed SPST PIN diode switch with integrated driver. The switch can be used as a drop-in module. The switch operates over the instantaneous frequency range of 1 to 18 GHz.

- Low cost
- Frequency range: 1 to 18 GHz
- High speed: 10 nsec rise fall times
- Typical 80 dB isolation
- Low VSWR and insertion loss
- Low in-band video leakage
- Low profile
- Hermetically sealed
- Can be used as drop-in module



Switch Model E9114

Model E9114H
SPST Specifications

PERFORMANCE CHARACTERISTICS

CHARACTERISTIC	FREQUENCY (GHz)				
	1–2	2–4	4–8	8–12.4	12.4–18
Min. Isolation (dB)	60	74	80	80	80
Max. Insertion Loss (dB)	0.9	0.9	1.2	1.6	2.5
VSWR (ON STATE)	1.4	1.4	1.75	1.75	2.0

Power Supply Requirements						
	Standard Switch		With Option 11		With Option 62	
MODEL NO.	+5V ±5%	–12V ±5%	+5V ±5%	–5V ±5%	+5V ±5%	–15V ±5%
E9114H	60 mA max	40 mA max	60 mA max	40 mA max	60 mA max	40 mA max

Switching Characteristics
Rise Time .... 10 nsec max.
Fall Time...................... 10 nsec max.
ON Time .... 25 nsec max.
OFF Time .... 20 nsec max.

Power Handling Capability
Without Performance
Degradation .... 200 mW cw or peak
Survival Power............ 2W average, 75W peak (1 µsec max. pulse width)

Control Characteristics
Control Input
Impedance.............. TTL, 1-unit load
Control Logic
Logic “0” .... (max. VIL = 0.8V) for switch ON
Logic “1” .... (min. VIH = 2V) for switch OFF

AVAILABLE OPTIONS

(Consult factory before ordering)

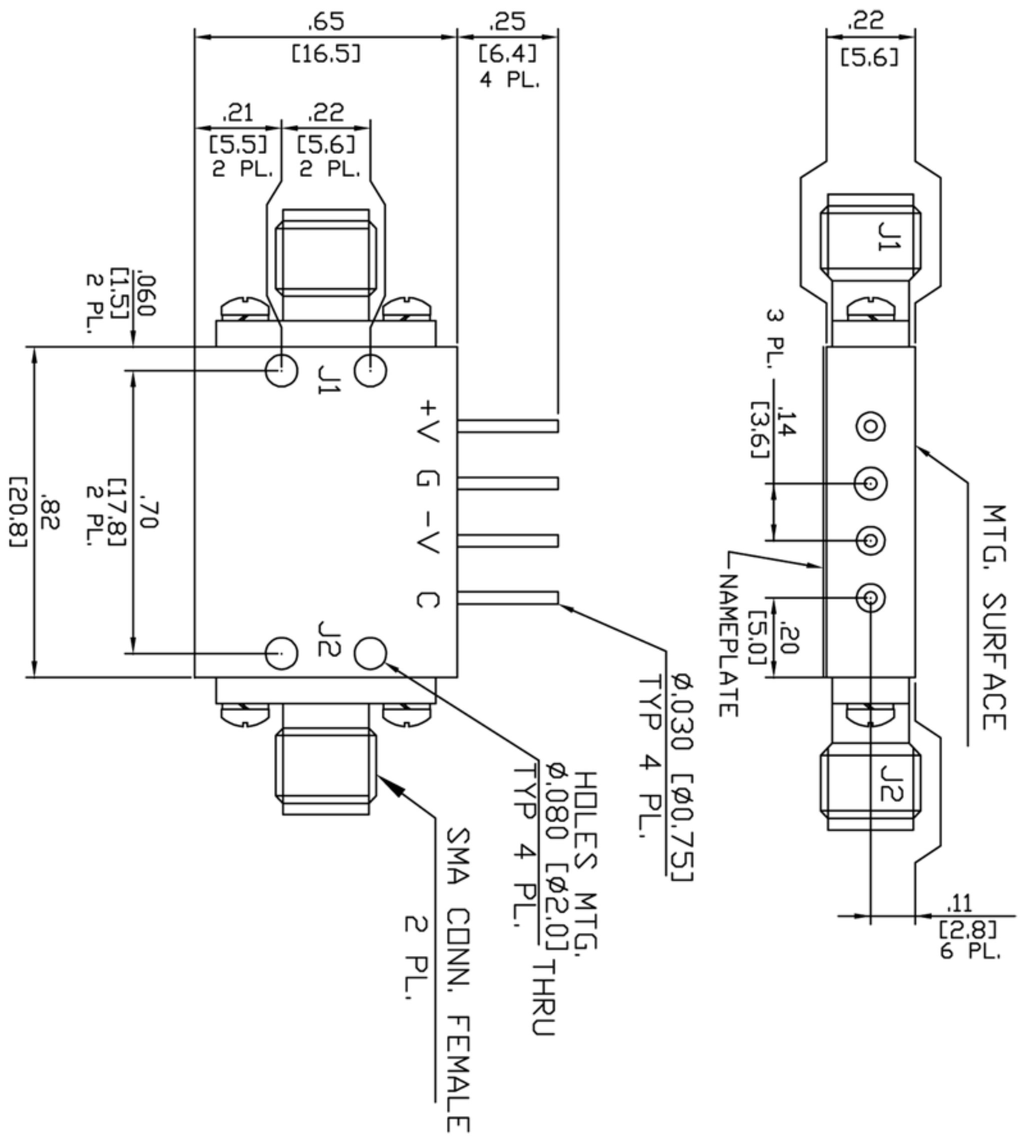
Option No.	Description
7	SMA male RF connectors all ports
9	Inverse control logic; logic “1” for switch ON and logic “0” for switch OFF
11	+5V, –5V operation
43*	Internal video filter, all ports
49	High Reliability Screening
62	+5, –15V operation
G09	Guaranteed to meet Environmental Ratings

*See Video Filter Options on page 169.

OPTION (G09) ENVIRONMENTAL RATING

1 Operating Temperature Range – -54°C to +95°C.
2 Humidity – MIL-STD-202G, Method 103B, Condition B (96 hours at 95%).
3 Shock – MIL-STD-202G, Method 213B, Condition A (50G, 11 msec).
4 Vibration – MIL-STD-202G, Method 204D, Condition B (0.06” double amplitude or 15G,
5 Altitude – MIL-STD-202G, Method 105C, Condition B (50,000 ft.).
6 Temperature Cycling – MIL-STD-202F, Method 107D, Condition A (5 cycles.).

DIMENSIONS AND WEIGHT
Model E9114H



Wt.: 0.28 oz. (8 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Models E9120H and E9120HT Heretically Sealed Low Profile SPDT

- Low cost
- Frequency range: 1 to 18 GHz
- High speed: 10 nsec rise fall times
- Isolation 60 dB
- Reflective and non-reflective models
- Low VSWR and insertion loss
- Low in-band video leakage
- Hermetically sealed
- Low profile
- Can be used as a drop-in module

Switch Model E9120H

The Model E9120H is a hermetically sealed, low cost high speed, SPDT PIN diode switch with integrated driver. The switch can be used as a drop-in module. The switch operates over the instantaneous frequency range of 1 to 18 GHz.

The Model E9120HT is a non-reflective version of this switch.

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 1–4	4–8	8–12.4	12.4–18
E9120H	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	60 1.1 1.75	60 1.4 1.75	60 2.0 1.75	50 2.5 2.0
E9120HT	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

Power Supply Requirements

	Standard Switch		With Option 11		With Option 62	
MODEL NO.	+5V ±5%	–12V ±5%	+5V ±5%	–5V ±5%	+5V ±5%	–15V ±5%
E9120H	95 mA max	70 mA max	95 mA max	70 mA max	95 mA max	70 mA max
E9120HT	95 mA max	70 mA max	95 mA max	70 mA max	95 mA max	70 mA max

Switching Characteristics

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

Power Handling Capability

Without Performance Degradation
- Reflective Switches .... 200 mW cw or peak
- Non-Reflective Switches
  - Input to OFF port: .... 100 mW cw or peak
  - Input to ON port: .... 200 mW cw or peak
  - Input to COMMON port: .... 200 mW cw or peak

Survival Power:
- Reflective Switches .... 1W average, 75W peak (1 μsec max. pulse width)
- Non-Reflective Switches
  - Input to OFF port: .... 1W average, 10W peak (1 μsec max. pulse width)
  - Input to ON port: .... 1W average, 75W peak (1 μsec max. pulse width)
  - Input to COMMON port: .... 1W average, 75W peak (1 μsec max. pulse width)

Control Characteristics

Control Input Impedance .... TTL, 1-unit load

Control Logic
- Logic “0” .... (max. VIL = 0.8V) for switch ON
- Logic “1” .... (min. VIH = 2V) for switch OFF

OPTION (G09) ENVIRONMENTAL RATING

1	Operating Temperature Range – -54°C to +95°C.
2	Humidity – MIL-STD-202G, Method 103B, Condition B (96 hours at 95%).
3	Shock – MIL-STD-202G, Method 213B, Condition A (50G, 11 msec).
4	Vibration – MIL-STD-202G, Method 204D, Condition B (0.06" double amplitude or 15G,
5	Altitude – MIL-STD-202G, Method 105C, Condition B (50,000 ft.).
6	Temperature Cycling – MIL-STD-202F, Method 107D, Condition A (5 cycles.).

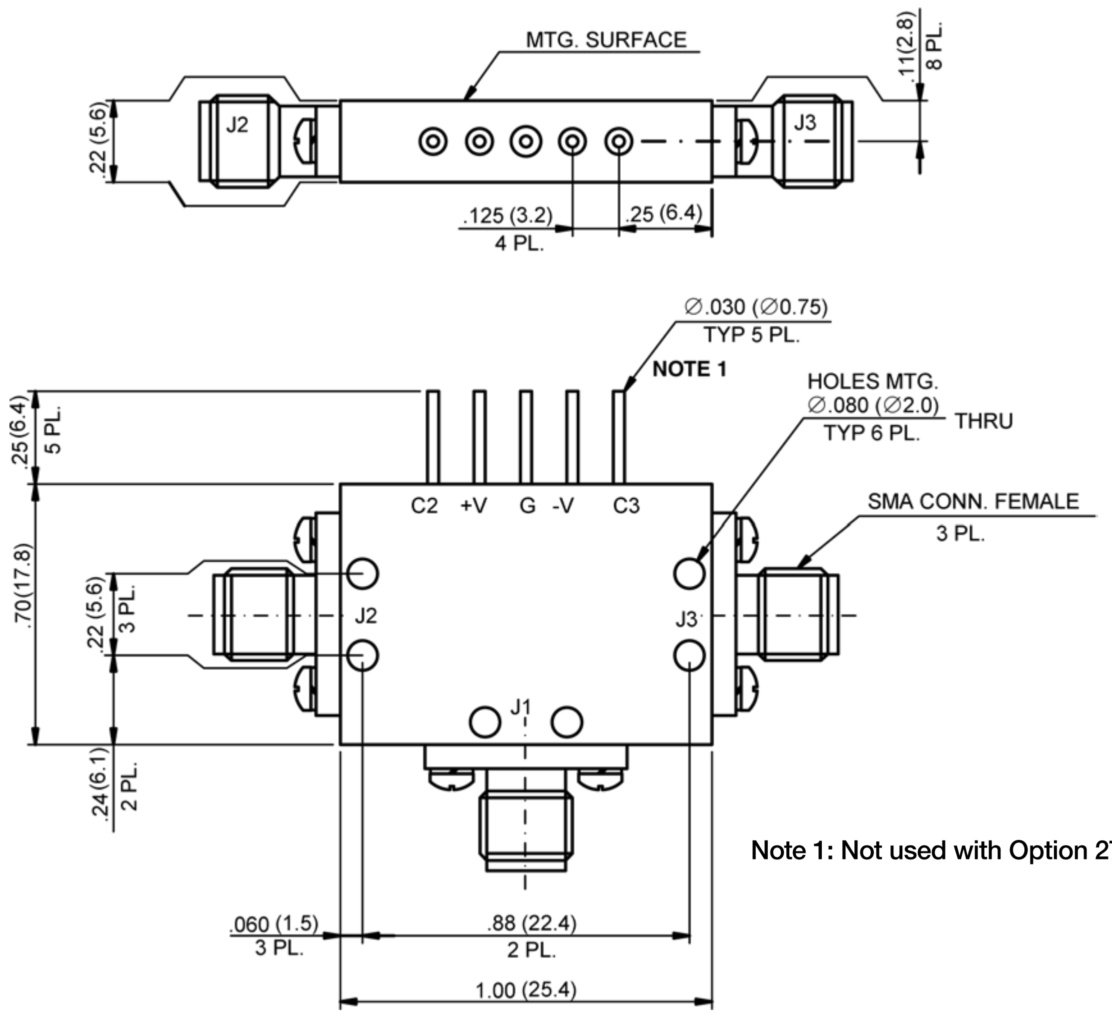
AVAILABLE OPTIONS

(Consult factory before ordering)

Option No.	Description
7	SMA male RF connectors all ports
9	Inverse control logic; logic "1" for switch ON and logic "0" for switch OFF
11	+5V, –5V operation
27	Single-port toggle; logic: Logic "0" connects J1 to J2
43*	Internal video filter, all ports
49	High Reliability Screening
62	+5, –15V operation
G09	Guaranteed to meet Environmental Ratings

*See Video Filter Options on page 169

DIMENSIONS AND WEIGHT
Model E9120H/HT



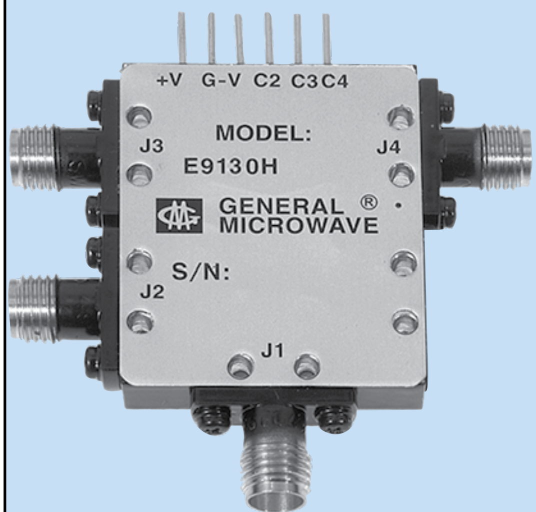
Note 1: Not used with Option 27

Wt.: 0.42 oz. (12 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Models E9130H and E9130HT Hermetically Sealed Low Profile SP3T Switches

- Low cost
- Frequency range: 1 to 18 GHz
- High Speed: 10 nsec rise fall times
- Reflective and non-reflective models
- High Performance
- Improve in-band video leakage
- Hermetically sealed
- Low profile
- Drop-in



Switch Model E9130H

The Model E9130H is a hermetically sealed, low cost high speed, SP3T PIN diode switch with integrated driver. The switch can be used as a drop-in module. The switch operates over the instantaneous frequency range of 1 to 18 GHz.

The Model E9130HT is a non-reflective version of this switch.

Models E9130H and E9130HT SP3T Specifications

PERFORMANCE CHARACTERISTICS

		FREQUENCY (GHz)			
MODEL NO.	**CHARACTERISTIC**	**1–4**	**4–8**	**8–12.4**	**12.4–18**
E9130H	**Min. Isolation (dB)**	**60**	**60**	**60**	**50**
	Max. Insertion Loss (dB)	**1.2**	**1.5**	**2.0**	**2.6**
	VSWR (ON)	**1.75**	**1.75**	**1.75**	**2.0**
E9130HT	**Min. Isolation (dB)**	**60**	**60**	**60**	**50**
	Max. Insertion Loss (dB)	**1.6**	**1.8**	**2.5**	**3.3**
	Max. VSWR Port On	**1.75**	**1.9**	**2.0**	**2.0**
	Max. VSWR Port Off	**1.75**	**2.0**	**2.2**	**2.3**

Power Supply Requirements						
	Standard Switch		**With Option 11**		**With Option 62**	
MODEL NO.	**+5V ±5%**	**–12V ±5%**	**+5V ±5%**	**–5V ±5%**	**+5V ±5%**	**–15V ±5%**
E9130H	110 mA max	65 mA max	110 mA max	65 mA max	110 mA max	65 mA max
E9130HT	110 mA max	65 mA max	110 mA max	65 mA max	110 mA max	65 mA max

Switching Characteristics

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

Power Handling Capability

Without Performance Degradation

- Reflective Switches .... 200 mW cw or peak
- Non-Reflective Switches
  - Input to OFF port: .... 100 mW cw or peak
  - Input to ON port: .... 200 mW cw or peak
  - Input to COMMON port: ...... 200 mW cw or peak

Survival Power:

- Reflective Switches .... 1W average, 75W peak (1 µsec max. pulse width)
- Non-Reflective Switches
  - Input to OFF port: .... 1W average, 10W peak (1 µsec max. pulse width)
  - Input to ON port: .... 1W average, 75W peak (1 µsec max. pulse width)
  - Input to COMMON port: .... 1W average, 75W peak (1 µsec max. pulse width)

Control Characteristics

Control Input Impedance .... TTL, 1-unit load

Control Logic

- Logic “0” .... (max. VIL = 0.8V) for switch ON
- Logic “1” .... (min. VIH = 2V) for switch OFF

Models E9130H and E9130HT SP3T Specifications

AVAILABLE OPTIONS

(Consult factory before ordering)

Option No.	Description
7	SMA male RF connectors all ports
9	Inverse control logic; logic “1” for switch ON and logic “0” for switch OFF
11	–5V, +5V operation
43*	Internal video filter, all ports
49	High Reliability Screening
62	+5, –15V operation
G09	Guaranteed to meet Environmental Ratings

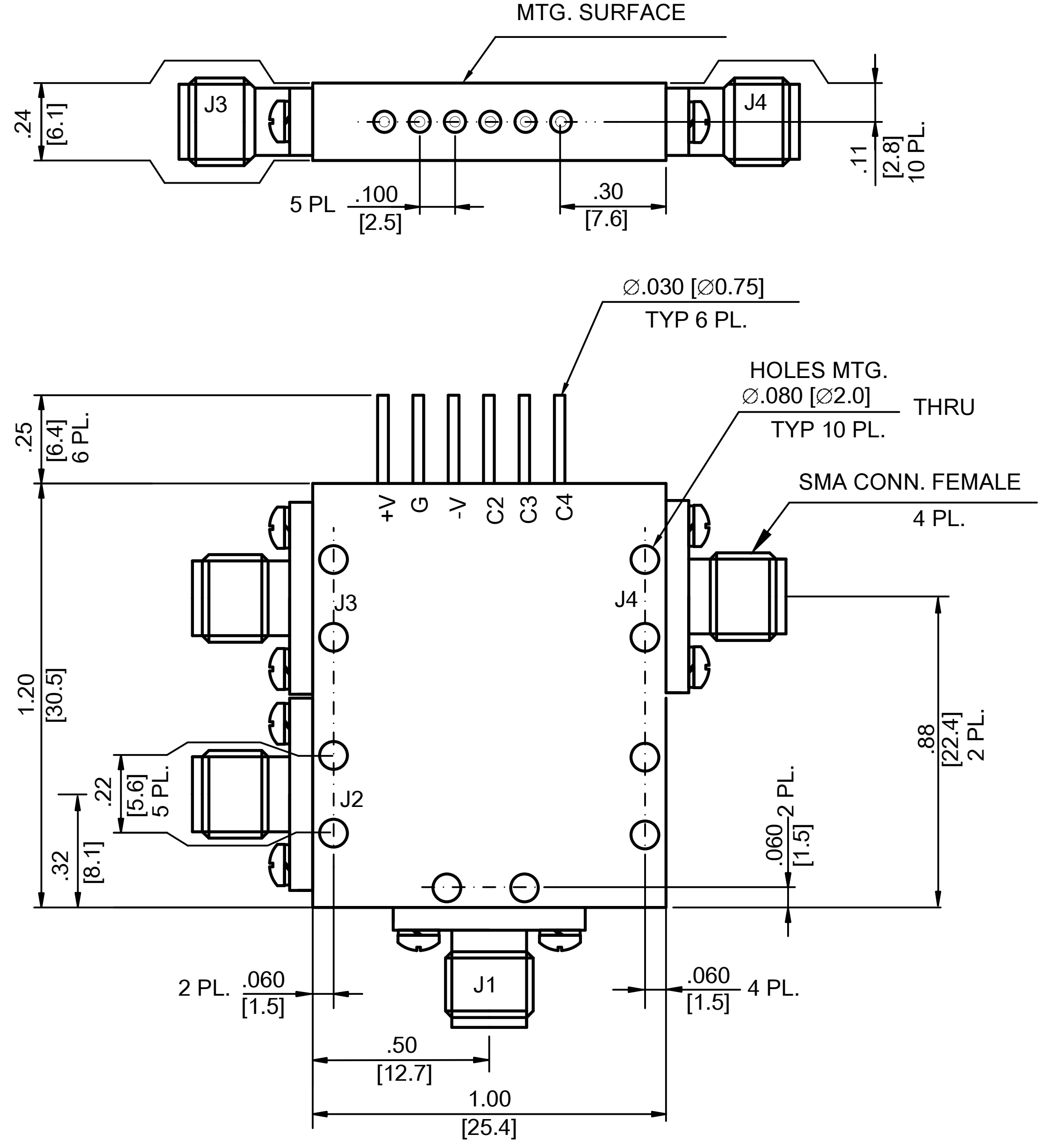
*See Video Filter Options on page 169

OPTION (G09) ENVIRONMENTAL RATING

1	Operating Temperature Range – -54°C to +95°C.
2	Humidity – MIL-STD-202G, Method 103B, Condition B (96 hours at 95%).
3	Shock – MIL-STD-202G, Method 213B, Condition A (50G, 11 msec).
4	Vibration – MIL-STD-202G, Method 204D, Condition B (0.06” double amplitude or 15G,
5	Altitude – MIL-STD-202G, Method 105C, Condition B (50,000 ft.).
6	Temperature Cycling – MIL-STD-202F, Method 107D, Condition A (5 cycles.).

DIMENSIONS AND WEIGHT

Model E9130H/HT



Wt.: 0.70 oz. (20 gr.) approx.

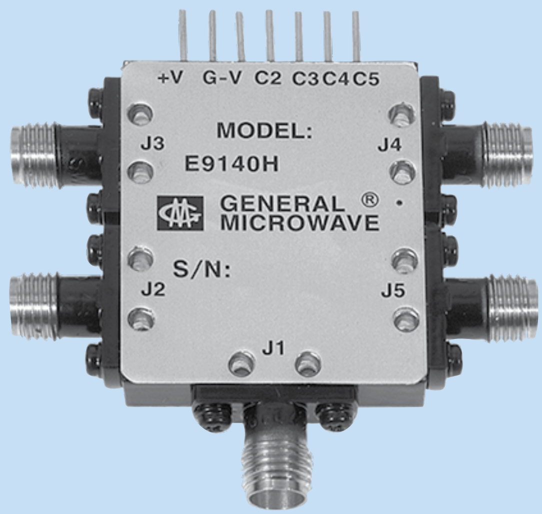
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Models E9140H and E9140HT Hermetically Sealed Low Profile SP4T Switches

The Model E9140H is a hermetically sealed, low cost high speed, SP4T PIN diode switch with integrated driver. The switch can be used as a drop-in module. The switch operates over the instantaneous frequency range of 1 to 18 GHz.

The Model E9140HT is a non-reflective version of this switch.

- **Low cost**
- **Frequency range: 1 to 18 GHz**
- **High Speed: 10 nsec rise fall times**
- **Reflective and non-reflective models**
- **Low insertion loss**
- **Low in-band video leakage**
- **Hermetically sealed**
- **Low profile**
- **Drop-in**



Switch Model E9140H

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 1–4	4–8	8–12.4	12.4–18
E9140H	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	60 1.4 1.75	60 1.5 1.75	60 2.0 1.75	50 2.8 2.0
E9140HT	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

Power Supply Requirements						
	Standard Switch		With Option 11		With Option 62	
MODEL NO.	+5V ±5%	–12V ±5%	+5V ±5%	–5V ±5%	+5V ±5%	–15V ±5%
E9140H	135 mA max	65 mA max	135 mA max	65 mA max	135 mA max	65 mA max
E9140HT	135 mA max	65 mA max	135 mA max	65 mA max	135 mA max	65 mA max

Switching Characteristics

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

Power Handling Capability

Without Performance Degradation
- Reflective Switches .... 200 mW cw or peak
- Non-Reflective Switches
  - Input to OFF port: .... 100 mW cw or peak
  - Input to ON port: .... 200 mW cw or peak
  - Input to COMMON port .... 200 mW cw or peak

Survival Power:
- Reflective Switches .... 1W average, 75W peak (1 µsec max. pulse width)
- Non-Reflective Switches
  - Input to OFF port: .... 1W average, 10W peak (1 µsec max. pulse width)
  - Input to ON port: .... 1W average, 75W peak (1 µsec max. pulse width)
  - Input to COMMON port: .... 1W average, 75W peak (1 µsec max. pulse width)

Control Characteristics

Control Input Impedance .... TTL, 1-unit load

Control Logic
- Logic “0” .... (max. VIL = 0.8V) for switch ON
- Logic “1” .... (min. VIH = 2V) for switch OFF

AVAILABLE OPTIONS

(Consult factory before ordering)

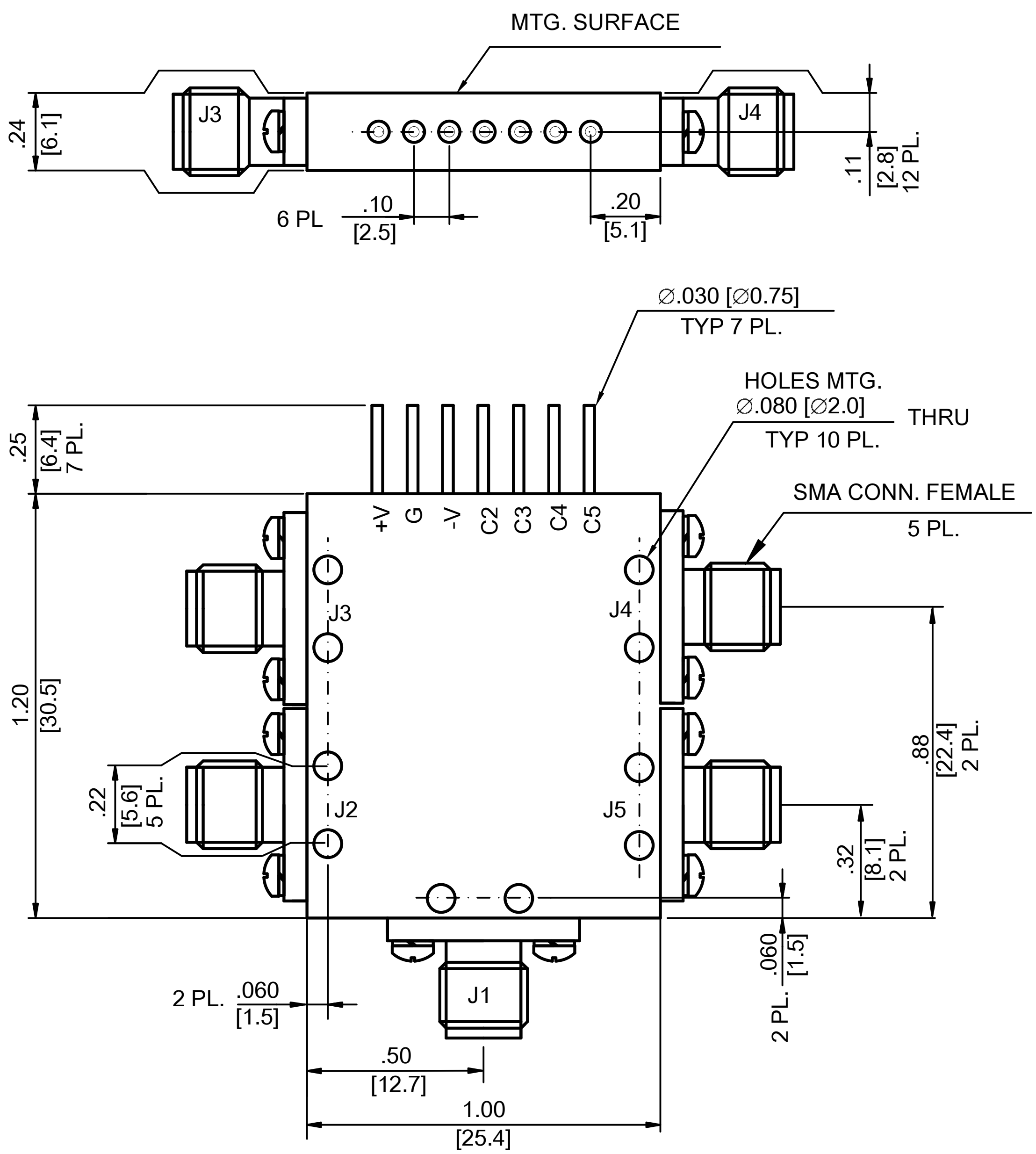
Option No.	Description
7	SMA male RF connectors all ports
9	Inverse control logic; logic “1” for switch ON and logic “0” for switch OFF
11	+5V, –5V operation
43*	Internal video filter, all ports
49	High Reliability Screening
62	–15V operation
G09	Guaranteed to meet Environmental Ratings

*See Video Filter Options on page 169

OPTION (G09) ENVIRONMENTAL RATING

1. Operating Temperature Range – -54°C to +95°C.
2. Humidity – MIL-STD-202G, Method 103B, Condition B (96 hours at 95%).
3. Shock – MIL-STD-202G, Method 213B, Condition A (50G, 11 msec).
4. Vibration – MIL-STD-202G, Method 204D, Condition B (0.06” double amplitude or 15G,
5. Altitude – MIL-STD-202G, Method 105C, Condition B (50,000 ft.).
6. Temperature Cycling – MIL-STD-202F, Method 107D, Condition A (5 cycles.).

DIMENSIONS AND WEIGHT

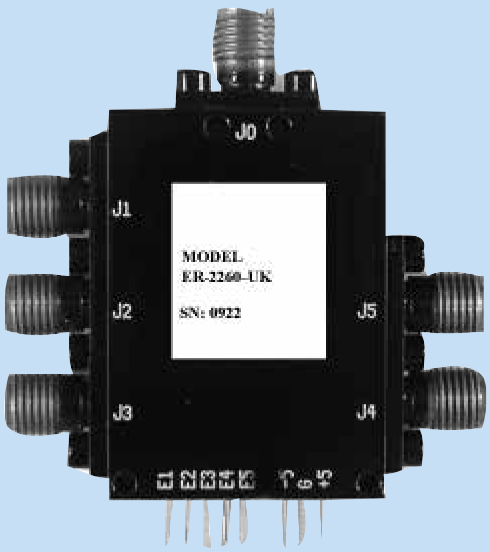


Wt.: 0.74 oz. (21 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model ER-2260-UK Hermetically Sealed Low Profile SP5T Switch

- **Frequency range: 0.5 to 18 GHz**
- **Low VSWR and insertion loss**
- **Isolation: up to 70 dB**
- **Small size, light weight**
- **With Integrated Driver**
- **Low Video Leakage**
- **Removable Connectors**



The Model ER-2260-UK is a hermetically sealed, low cost high speed, SP5T PIN diode switch with integrated driver. The switch operates over the instantaneous frequency range of 0.5 to 18 GHz, with an option of 0.5 to 20 GHz

This switch can be ordered in the basic catalog configuration as specified below, or in a much thinner outline or as a drop-in switch..

Model ER-2260-UK
SP5T Specifications

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz)				
		0.5-2	2-4	4-8	8-12	12-18
ER-2260-UK	Min. Isolation (dB)	70	70	70	65	60
	Max. Insertion Loss (dB)	2.0	2.0	2.5	3.0	3.6
	Max. VSWR (ON)	1.8:1	1.9:1	2.0:1	2.0:1	2.0:1

Switching Time

ON Time ....20 nsec max.
OFF Time ....20 nsec max.

Power Handling Capability

Without Performance Degradation,,,,,,,.......200 mW cw or peak

Survival Power..............1W CW, 20W peak (1 µsec max. pulse width with 5% duty cycle). Derate Linearly to 50% at +95°C

Control logic

..............Logic “0” (0 to +0.8V) = Insertion Loss Logic “1” (+2.0 to +5.5V) = Isolation

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range........................–54°C to +95°C

Humidity.......................MIL-STD-202F, Method 103B, Cond. B

Shock............................MIL-STD-202F, Method 213B, Cond. B

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.)

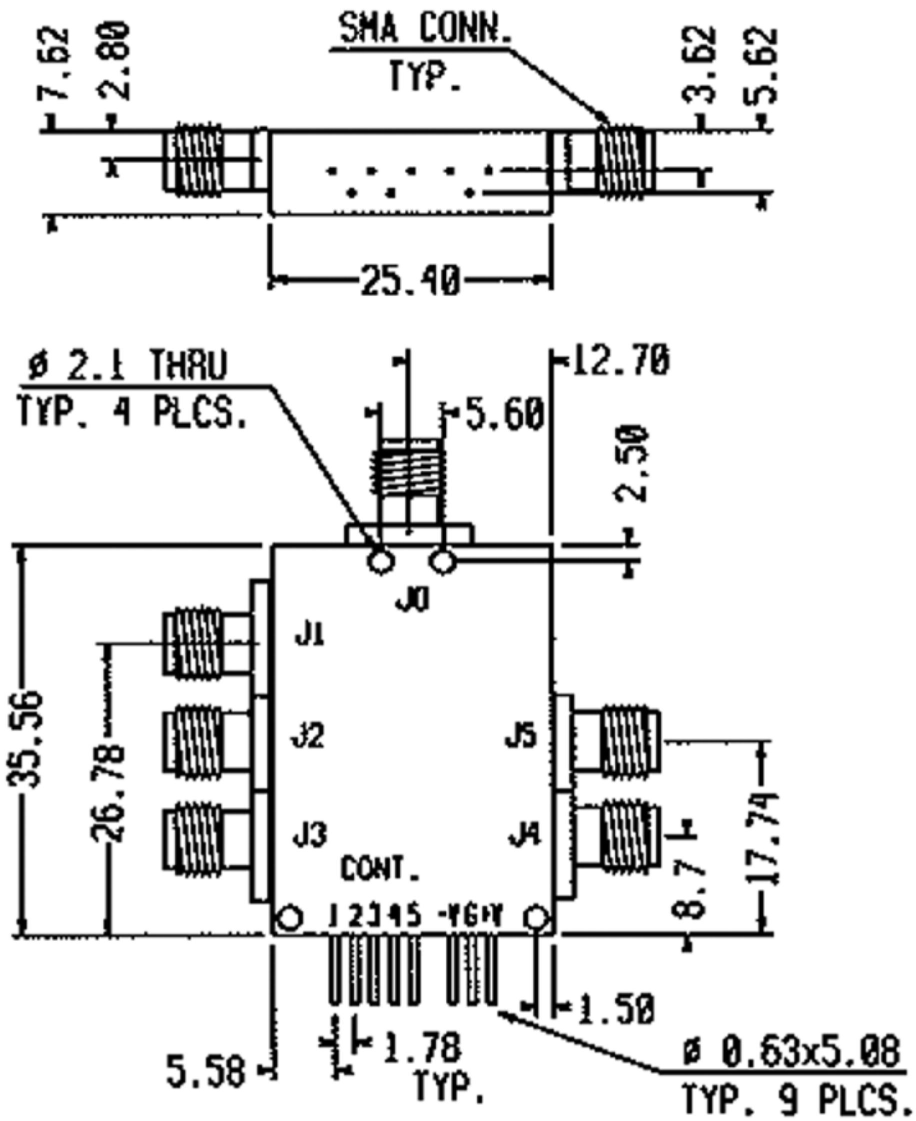
Thermal Shock...........MIL-STD-202F, Method 107D, Cond. A, 5 cycles

Power Supply Requirements	
+5V ±0.5V (mA), max	140
-12V ±10% (mA), max	90

AVAILABLE OPTIONS

- TTL control logic (inverting or non-inverting)
- BCD Decoder driver
- Other DC Voltage supply
- Very Low Video Leakage
- Over Voltage Protection
- Non-Reflective
- Drop-In package
- Extremely Low Profile, thickness of 6.1mm (0.24”)
- Option G09 - Guaranteed to meet Environmental Ratings

Model ER-2260-UK (SP5T)



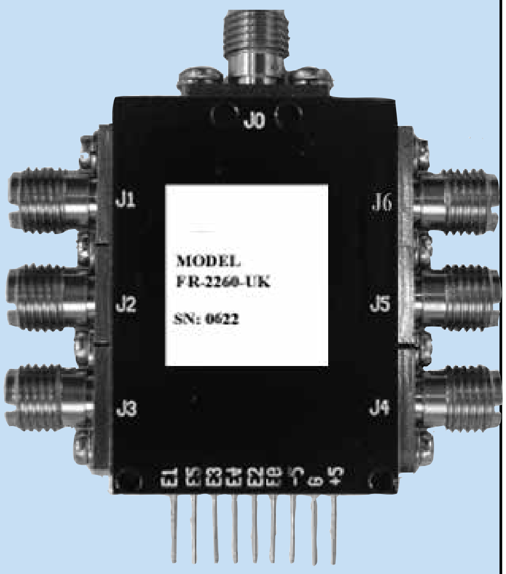
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model FR-2260-UK Hermetically Sealed Low Profile SP6T Switch

The Model FR-2260-UK is a hermetically sealed, low cost high speed, SP6T PIN diode switch with integrated driver. The switch operates over the instantaneous frequency range of 0.5 to 18 GHz, with an option of 1 to 20 GHz

This switch can be ordered in the basic catalog configuration as specified below, or in a much thinner outline or as a drop-in switch..

- **Frequency range: 0.5 to 18 GHz**
- **Low VSWR and insertion loss**
- **Isolation: up to 70 dB**
- **Small size, light weight**
- **With Integrated Driver**
- **Low Video Leakage**
- **Removable Connectors**



Model FR-2260-UK
SP6T Specifications

PERFORMANCE CHARACTERISTICS

	CHARACTERISTIC	FREQUENCY (GHz)				
		0.5-2	2-4	4-8	8-12	12-18
FR-2260-UK	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	70 2.0 1.8:1	75 2.0 1.9:1	70 2.5 2.0:1	65 3.0 2.0:1	60 3.6 2.0:1

Switching Time

ON Time ....20 nsec max.
OFF Time ....20 nsec max.

Power Handling Capability

Without Performance
Degradation,,,,,,,,.......200 mW cw or peak

Survival Power..............1W CW, 20W peak (1 μsec max. pulse width with 5% duty cycle). Derate Linearly to 50% at +95ºC

Control logic
.............Logic “0” (0 to +0.8V) = Insertion Loss Logic “1” (+2.0 to +5.5V) = Isolation

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range........................–54°C to +95°C

Humidity.......................MIL-STD-202F, Method 103B, Cond. B

Shock............................MIL-STD-202F, Method 213B, Cond. B

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.)

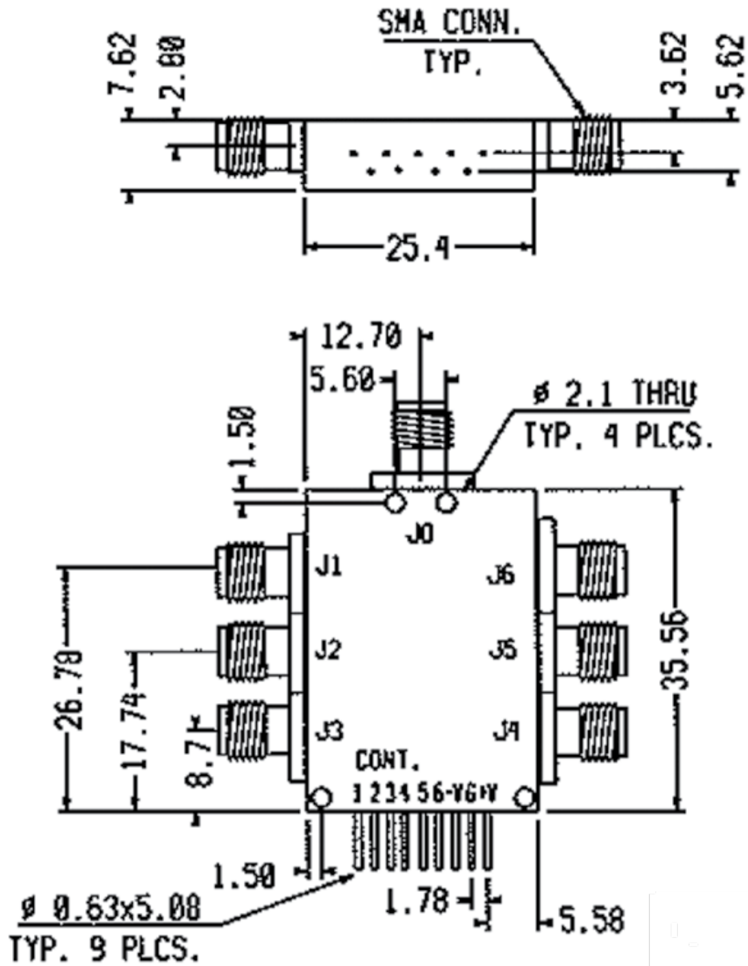
Thermal Shock............MIL-STD-202F, Method 107D, Cond. A, 5 cycles

Power Supply Requirements	
+5V ±0.5V (mA), max	160
-12V ±10% (mA), max	100

AVAILABLE OPTIONS*

- TTL control logic (inverting or non-inverting)
- BCD Decoder driver
- Other DC Voltage supply
- Over Voltage Protection
- Non-Reflective
- Drop-In package
- Extremely Low Profile, thickness of 6.1 mm (0.24”)
- Option G09 - Guaranteed to meet Environmental Ratings

DIMENSIONS AND WEIGHT



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

High Power & Medium Power Switches

HIGH POWER & MEDIUM POWER SWITCHES

KRATOS General Microwave offers wide selection of High and Medium Power PIN Diode Microwave Switches. Current non-reflective and reflective switch designs will support HF, UHF, IFF, L-Band, C-Band and Multi-Band operation with design capabilities up to 18 GHz. These switches are ideal for use in various systems including Communications, IFF, EW, Radar, Test Equipment and other applications demanding high performance, high reliability devices.

The High Power Switches are capable of handling power levels of up to 1K Watts the Medium Power Switches are capable of handling power levels of 30 Watts.

These High and Medium Power Switch designs are accomplished using PIN Diode shunt and shunt-series topology as required by the individual performance characteristics. Special materials are utilized for proper heat dissipation. A proprietary PIN Diode Driver, incorporating TTL control, has been designed for these switches. That driver is capable of supplying reverse bias of up to -100 Volts and forward current up to 150 mA.

Most of the High and Medium Power Switches are custom designs. Therefore, variations of Frequency Range, Switching Time, Operating Temperature are possible for many of the switches shown. Standard component packaging, utilizing SMA or TNC RF connectors are shown but Carrier drop-in configurations are also available is some models.

HIGH POWER & MEDIUM POWER SWITCHES

FREQUENCY RANGE (GHz) 0.1 0.2 0.5 1 2 4 8 12.4 18	MODEL	PAGE	COMMENTS
SPDT SWITCHES			
2.5 — 7.5	HPS-9257	299	200W CW
1.4 — 1.8	SW-2367-01		60W CW
0.25 — 0.8	SW-2746-02	304	100W Peak
4.4 — 5.0	SW-2876-02		20W CW
— 10%	HPS-9201	3002	500W, L Band
SP3T SWITCHES			
— 10%	HPS-9301		350W Peak, IFF Band
— 10%	HPS-9302	311	500W Peak, L Band
— 10%	HPS-9303		1,000W Peak, L Band
0.2 — 0.8	SW-2746-03	308	10W CW
SP4T SWITCHES			
5.0 — 17.0	HPS-9417	316	7W CW
1.0 — 1.3	SW-1193-00	313	65W CW
1.9 — 2.1	SW-1996-00		50W CW
SP6T SWITCHES			
4.4 — 5.0	SW-2876-06	317	5W CW

HIGH POWER SWITCH Model 9257

KRATOS General Microwave has developed model HPS-9257 wide frequency band High Power SP2T switch. This switch operates in the entire frequency range of 2.5 GHz to 7.5 GHz,

This switch can be supplied in a carrier configuration or as a packaged switch.

- Wide Band 2.5 to 7.5 GHz
- Reflective
- Low insertion loss
- Cold Switching
- High Speed

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

Switch Model HPS-9257

Model HPS-9257 SPDT Switch Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	
Power Handling (W)	200 CW
Frequency Range (GHz)	2.5 to 7.5
Min. Isolation (dB)	20
Max. Insertion loss (dB)	1.2
VSWR ON	1.9:1

Switching Characteristics

ON time....................................3.5 μsec max.
OFF time ....3.5 μsec max.

AVAILABLE OPTIONS

1. Carrier drop-in configuration
2. Packaged configuration
G09 Guaranteed to meet Environmental Ratings

Power Supply Requirements

(For one port ON)

MODEL	+5V ±5%	Negative Voltage	
	mA	V	mA
HPS 9257	250	-50	10

Control Characteristics

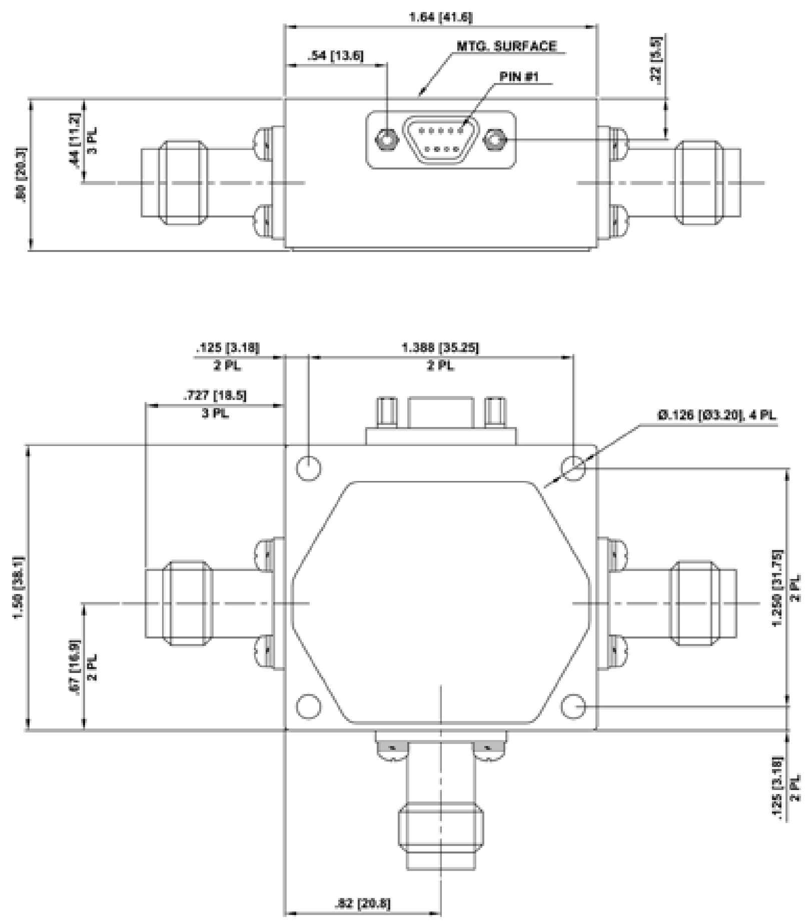
Control Input Impedance TTL, low power Schottky, one unit load. (A unit load is 0.8 mA sink current and 40 μA source current.)

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

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range
Operating ....–40°C to +105°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.)

DIMENSIONS AND WEIGHT - FOR PACKAGED CONFIGURATION



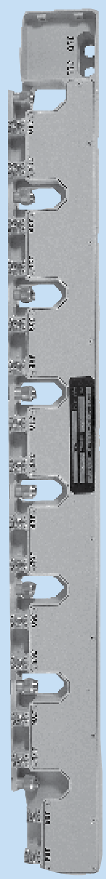
Wt.: 4.06 oz. (115 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

High Power SPDT Switches
Series HPS 9000

- High Power
- Low insertion loss
- High Speed
- Cold Switching
- Non-reflective

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



HIGH POWER SWITCHES SERIES HPS9000

KRATOS General Microwave has developed series HPS900 line of High Power SPDT switches for various applications. These switches operate in the IFF and L bands, providing Power handling capability of up to 1kW in cold switching.

Typically these switches are assembled in a multi-switch assembly. The number of switches in one sub-assembly depends upon the specific architecture of the system. The control and supply voltages to the switch sub-assembly is supplied via a multi-pin connector.

Switch Model HPS-9201
(8 SWITCHES IN A SUB-ASSEMBLY)

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL HPS 9201
Power Handling (W), 100 µsec pulse width, 10% duty cycle	500
Frequency Range	L Band
Frequency Bandwidth	10%
Min. Isolation (dB)	40
Max. Insertion loss (dB)	1.2
VSWR ON and OFF	1.4:1

Switching Characteristics

ON time....................................3.5 µsec max.
OFF time ....3.5 µsec max.

Power Supply Requirements

(For one port ON)

+5V ±5%	-60V
270 mA	40 mA

Control Characteristics

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 “0” (–0.3 to +0.8V) for port ON and logic “1” (+2.0 to +5.0 V) for port OFF.

AVAILABLE OPTIONS*

1. Operating Frequency Range
2. Mechanical Configuration
3. Option - **G09** Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range

Operating ....–40°C to +105°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.)

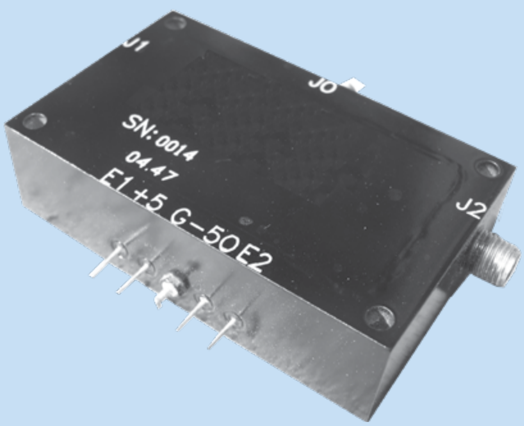
DIMENSIONS AND WEIGHT

These High Power Switches are normally incorporated in systems as a sub-assembly of two or more switches. For this reason specific outline and weight information can be provided per specific requirement.

High and Medium Power SPDT Switches
Series SW-2000-01

- High and Medium Power
- Low insertion loss
- High Isolation
- Reflective and non-reflective models
- Fast Switching Speed

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



HIGH POWER SPDT SWITCH

HIGH AND MEDIUM POWER SWITCHES
Series SW-2000-01

KRATOS General Microwave has developed series SW-2000-01 High and Medium Power SPDT switches for various applications in the frequency range of 30 Hz to 5 GHz in various sub-bands.

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL SW-2367-01	SW-2746-02	SW-2876-02
Frequency Range (GHz) max.	1.4 to 1.8	0.25 to 0.8	4.4 to 5.0
Power Handling			
CW (W) max.	60	N/A	20
Peak-Power (W) max.	N/A	100	N/A
a) Pulse Width (μsec) max.	N/A	50	N/A
b) Duty Cycle %	N/A	20	N/A
Isolation (dB) min.	35	40	60
Insertion loss (dB) max.	1.0	1.0	1.2
VSWR ON	1.6:1	1.5:1	1.5:1
VSWR OFF	N/A	1.6:1	N/A

Power Supply Requirements

(For one port ON)

MODEL	+5V ±5%	Negative Voltage	
	mA	V	mA
SW-2367-01	200	-50	30
SW-2746-02	170	-60	30
SW-2876-02	150	-15	20

Control Characteristics

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 “0” (–0.3 to +0.8V) for port ON and logic “1” (+2.0 to +5.0 V) for port OFF.

Switching Characteristics

Cold Switching

Model SW-2876-02

ON OFF Time ....100 nsec max.

Switching Rate ....1 MHz max.

All Other Models

ON OFF Time...........10 μsec max.

Switching Rate...........500 kHz max.

AVAILABLE OPTIONS

1. Different Operating temperatures
2. Faster Switching Speeds
3. Inverse Control Logic
4. Option G09 - Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

Operating ....–40°C to +105°C

Non Operating..........–65°C to +125°C

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

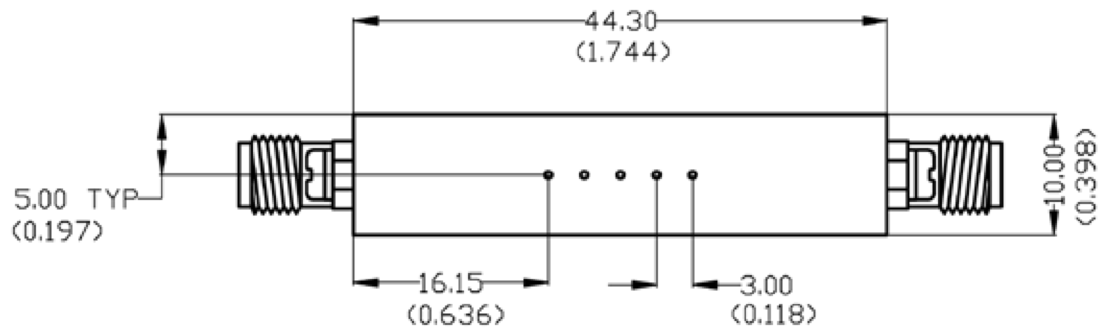
Shock ....MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

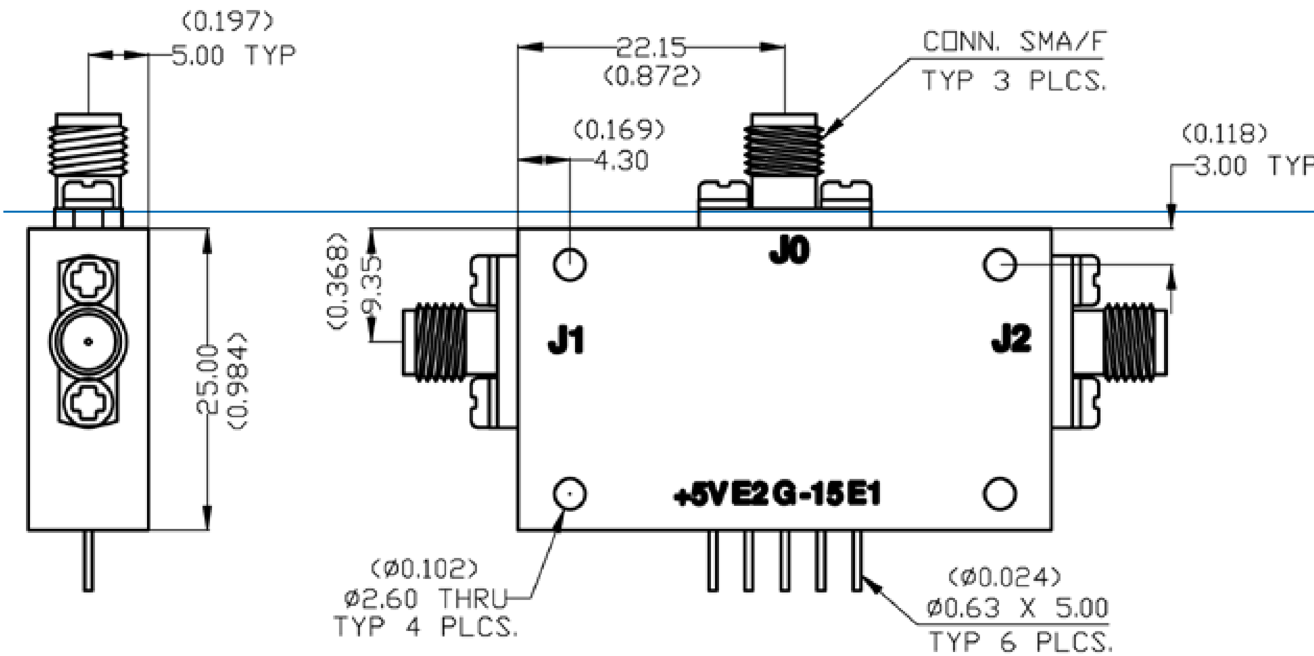
Vibration...........................MIL-STD-202F, Method 204D, Cond. B (.06” double amplitude or 15G, whichever is less)

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

DIMENSIONS AND WEIGHT

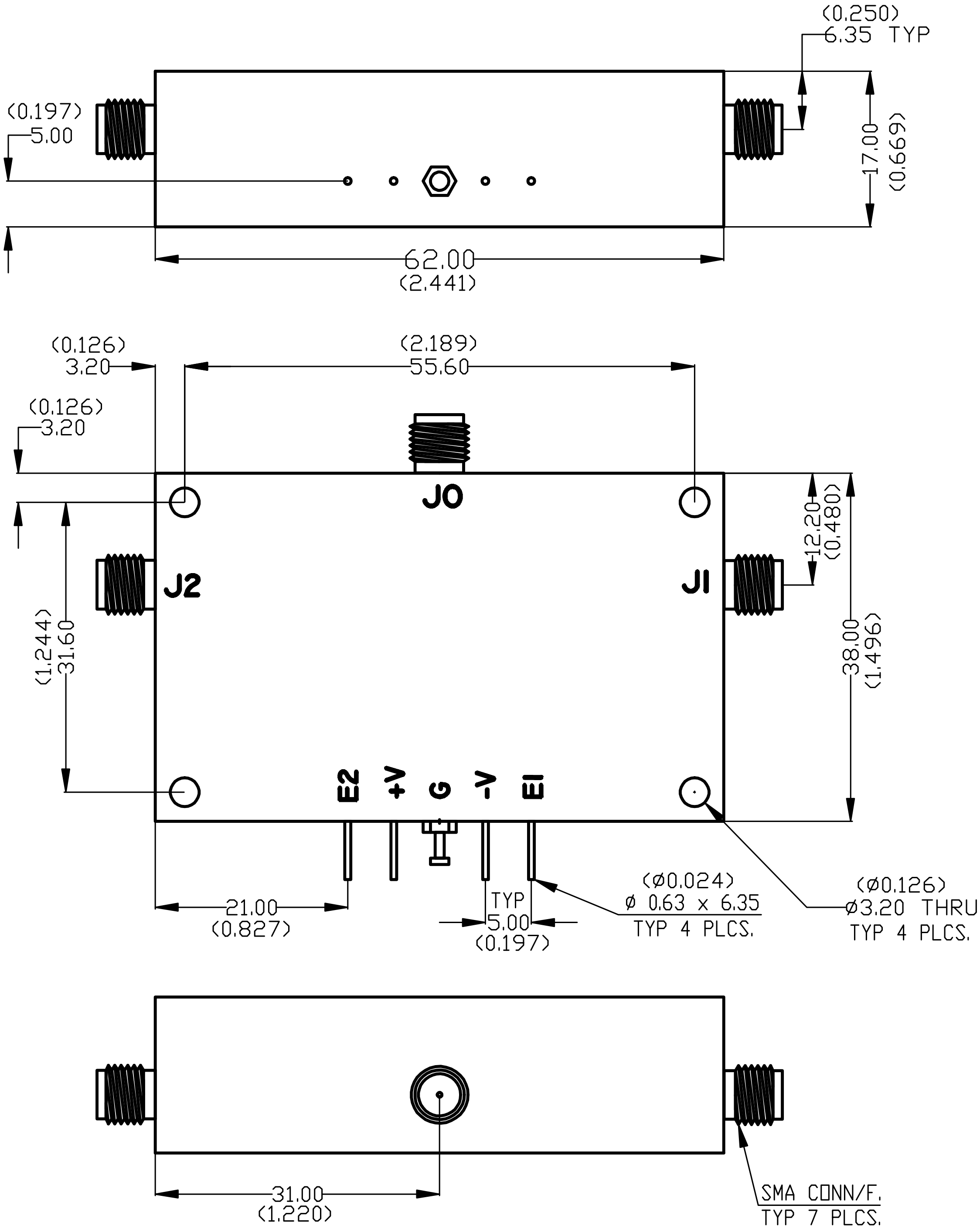
MODEL SW-2876-02





Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

MODEL SW-2367-01 and MODEL SW-2746-02



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

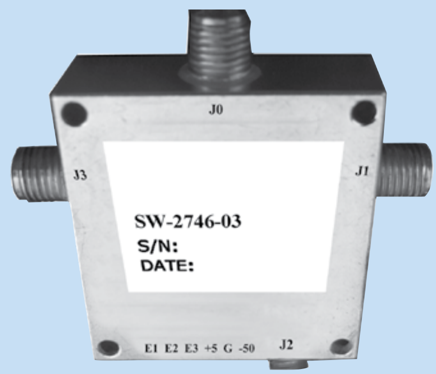
Medium Power SP3T Switch Model SW-2746-03

MEDIUM POWER SP3T SWITCH Model SW-2746-03

KRATOS General Microwave has developed model SW-2746-03 Medium Power SP3T switch, in the frequency range of 200 MHz to 800 MHz, for various applications.

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

- **Medium Power**
- **Low insertion loss**
- **High Isolation**
- **Terminated**



Model SW-2746-03 SP3T Switch Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL SW-2746-03
Frequency Range (MHz) min.	200 to 800
Power Handling	
Peak-Power (W) max.	10
a) Pulse Width (μsec) max.	50
b) Duty Cycle (%)	20
Isolation (dB) min.	50
Insertion loss (dB) max.	0.7
VSWR ON	1.5:1
VSWR OFF	1.6:1

Power Supply Requirements

(For one port ON)

MODEL	+5V ±5%	Negative Voltage	
	mA	V	mA
SW-2746-03	200	-28	30

Control Characteristics

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

Switching Characteristics

Cold Switching

On Off Time....................1 μsec max.

Switching Rate.................0.1 MHz max.

AVAILABLE OPTIONS

1. Different Operating temperatures
2. Different Switching Speeds
3. Inverse Control Logic
4. Option G09 - Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature ..-20°C to +60°C

Storage Temperature .... -30°C to +95°C

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

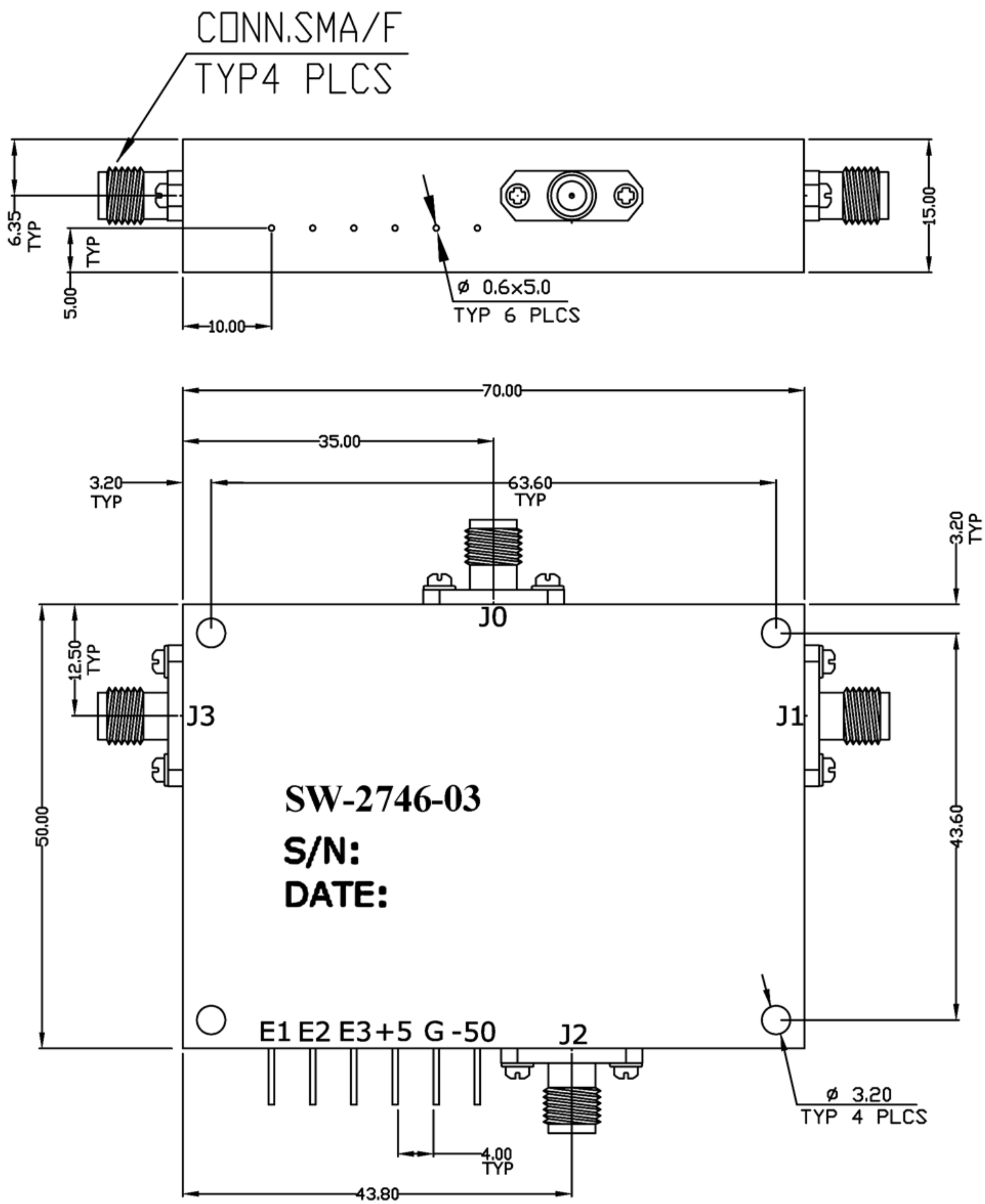
Shock ....MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

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.)

Model SW-2746-03 SP3T Switch Specifications

DIMENSIONS AND WEIGHT

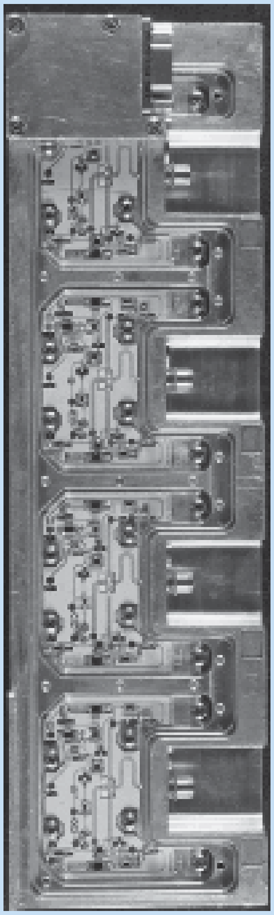


Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

High Power SP3T Switches
Series HPS 9000

- High Power
- Low insertion loss
- High Speed
- Cold Switching
- Non-reflective

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



Switch Model HPS-9302
(4 SWITCHES IN A SUB-ASSEMBLY)

HIGH POWER SWITCHES SERIES HPS 9000

KRATOS General Microwave has developed series HPS900 line of High Power SP3T switches for various applications. These switches operate in the IFF and L bands, providing Power handling capability of up to 1kW in cold switching.

Typically these switches are assembled in a multi-switch assembly. The number of switches in one sub-assembly depends upon the specific architecture of the system. The control and supply voltages to the switch sub-assembly is supplied via a multi-pin connector.

Series HPS 9000 SP3T Switches Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL HPS 9301	HPS 9302	HPS 9303
Power Handling (W), 100 μsec pulse width, 10% duty cycle	350	500	1,000
Frequency Range	IFF	L BAND	L BAND
Frequency Bandwidth	10%	10%	10%
Min. Isolation (dB)	40	30	40
Max. Insertion loss (dB)	1.2	1.2	1.3
VSWR ON and OFF	1.4:1	1.4:1	1.4:1

Switching Characteristics

ON time.................................... 3.5 μsec max.
OFF time .... 3.5 μsec max.

Power Supply Requirements

(For one port ON)

MODEL	+5V ±5%	Negative Voltage	
	mA	V	mA
HPS 9301	400	-60	40
HPS 9302	450	-60	40
HPS 9303	450	-90	40

Control Characteristics

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

AVAILABLE OPTIONS

1. Operating Frequency Range
2. Mechanical Configuration
3. Option **G09 -** Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

Temperature Range

Operating .... –55°C to +70°C
Non Operating.......... –65°C to +125°C

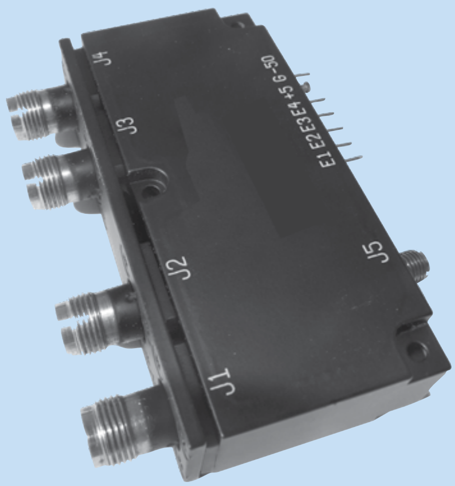
Humidity .... MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock.......................... MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration .... MIL-STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whichever is less)
Altitude .... MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

DIMENSIONS AND WEIGHT

These High Power Switches are normally incorporated in systems as a sub-assembly of two or more switches. For this reason specific outline and weight information can be provided per specific requirement.

- Medium Power
- Low insertion loss
- High Isolation
- Non Reflective

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–



HIGH POWER SP4T SWITCH

MEDIUM POWER SP4T SWITCHES Series SW-1000-00

KRATOS General Microwave has developed series SW-1000-00 Medium Power SP4T switches for various applications in the frequency range of 1.0 GHz to 2.1 GHz in various sub-bands for various applications.

Series SW-1000-00 SP4T Switches Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL SW-1193-00	MODEL SW-1996-00
Frequency Range (GHz) min.	1.0 to 1.3	1.9 to 2.1
Power Handling		
CW (W) max.	65	50
Isolation (dB) min.	30	30
Insertion loss (dB) max.	1.0	1.3
VSWR ON	1.5:1	1.4:1

Power Supply Requirements

(For one port ON)

MODEL	+5V ±5%	Negative Voltage	
	mA	V	mA
SW-1193-00	250	-50	60
SW-1996-00	150	-28	50

Switching Characteristics

Model **SW-1193-00**

Cold Switching
On Off Time ....10 µsec max
Switching Rate.................2 kHz max.

Model SW-1996-00

Cold Switching
On Off Time......................5 µsec max.
Switching Rate.................10 kHz max.

Control Characteristics

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 “0” (–0.3 to +0.8V) for port ON and logic “1” (+2.0 to +5.0 V) for port OFF.

AVAILABLE OPTIONS

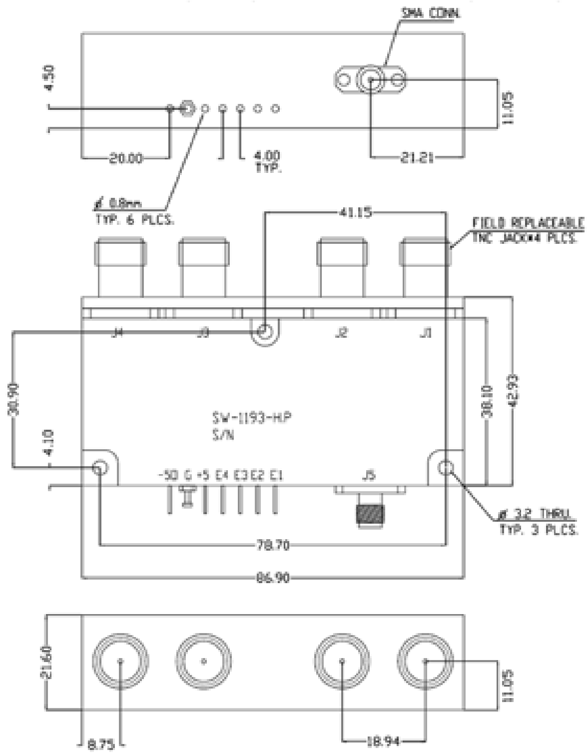
1. Different Operating temperatures
2. Higher Switching Speeds
3. Inverse Control Logic
4. SMC or SMA output Connectors
5. Option G09 - Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

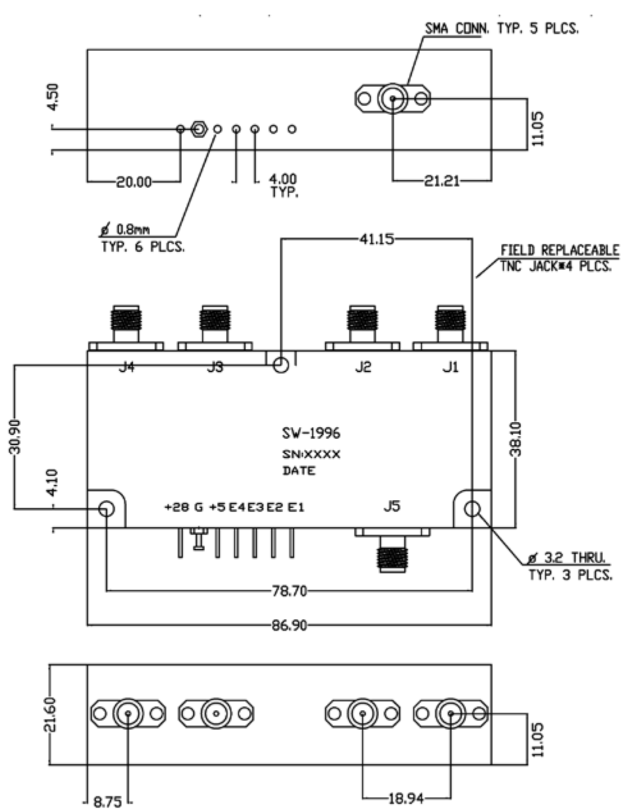
Operating Temperature ..–55°C to +70°C
Non Operating................–65°C to +125°C
Humidity.............................MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)
Shock ....MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)
Vibration............................MIL-STD-202F, Method 204D, Cond. B (.06” double amplitude or 15G, whichever is less)
Altitude ....MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)

DIMENSIONS AND WEIGHT

MODEL SW-1193-00



MODEL SW-1996-00

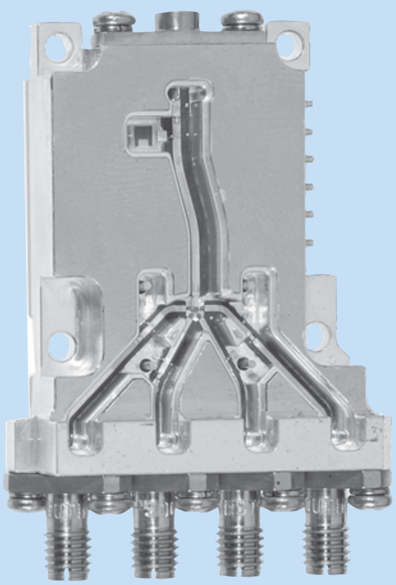


Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Medium Power SP4T Switch
Model HPS-9417

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

- **Medium Power**
- **Low insertion loss**
- **Reflective**



Switch Model HPS-9417

MEDIUM POWER SP4T SWITCH MODEL HPS-9417

KRATOS General Microwave has developed model HPS-9417 Medium Power SP4T switch for various applications in the frequency range of 5 to 17 GHz for various applications.

Model HPS-9417 SP4T Switch Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL HPS-9417	
Frequency Range (GHz) max.	5 to 12	12 to 17
Power Handling, CW (W) max.	7	7
Isolation (dB) min.	20	20
Insertion loss (dB) max.	2.1	2.3
VSWR ON	2:1	2:1

Power Supply Requirements

(For one port ON)

+5V ±5%	-12V ± 0.2
mA	mA
80	80

Control Characteristics

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 “0” (–0.3 to +0.8V) for port ON and logic “1” (+2.0 to +5.0 V) for port OFF.

Switching Characteristics

Cold Switching

ON OFF Time ....100 nsec

AVAILABLE OPTIONS

1. Wider Operating Frequency Range
2. Other Type of Connectors
3. Option **G09 -** Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature ..-30°C to +85°C

Storage Temperature ...... -50°C to +120°C

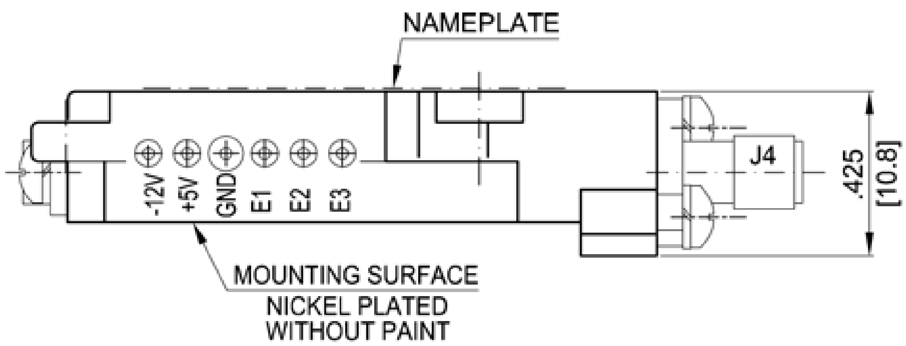
Humidity............................MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

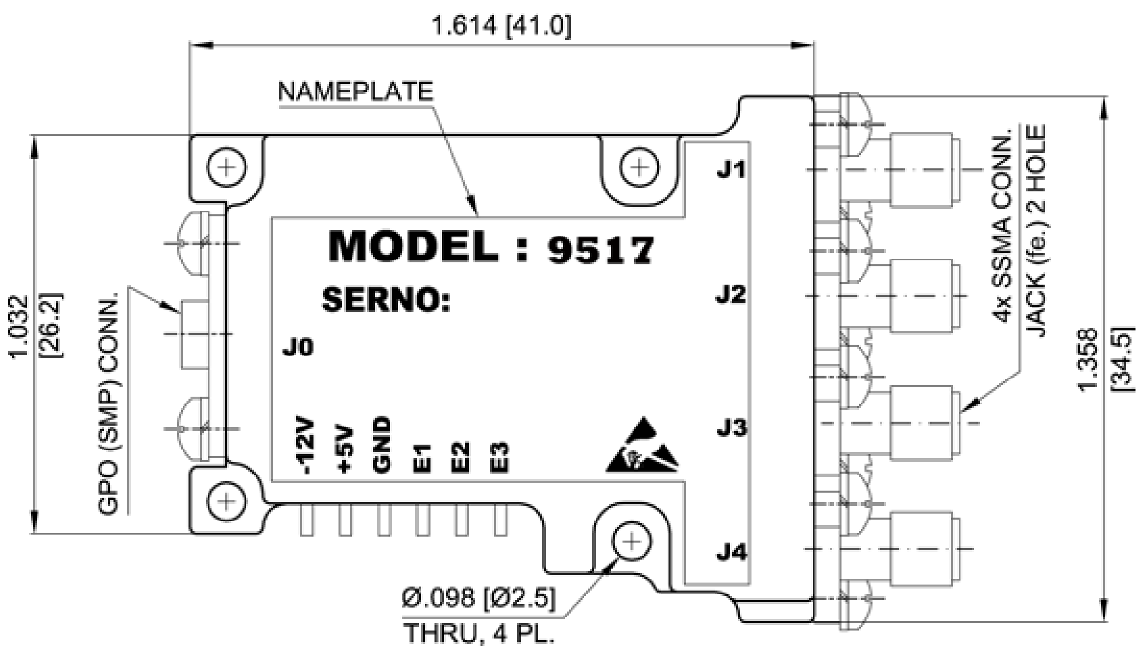
Shock ....MIL-STD-202F, Method 213B, Cond. B (75G, 6 msec)

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.)

DIMENSIONS AND WEIGHT

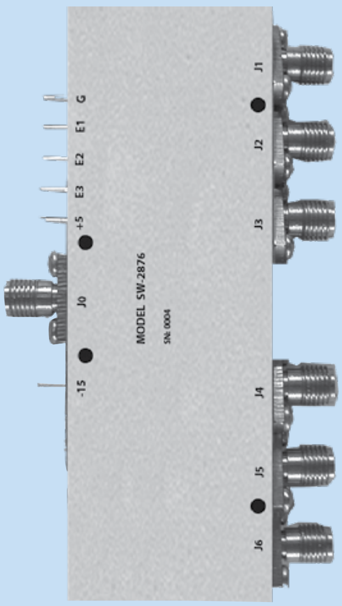




Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Medium Power SP6T Switch
Model SW-2876-06

- Medium Power
- Low insertion loss
- High Isolation
- Reflective
- Fast Switching Speed



MEDIUM POWER SP6T SWITCH Model SW-2876-06

KRATOS General Microwave has developed model SW-2876-06 Medium Power SP6T switch for various applications in the frequency range of 4.4 GHz to 5.0 GHz for various applications.

Model SW-2876-06 SP6T Switch Specifications

PERFORMANCE CHARACTERISTICS

PARAMETER	MODEL SW-2876-06
Frequency Range (GHz) min.	4.4 to 5.0
Power Handling	
CW (W) max.	5
Isolation (dB) min.	55
Insertion loss (dB) max.	1.7
VSWR ON	1.5:1

Power Supply Requirements

(For one port ON)

MODEL	+5V ±5%	Negative Voltage	
	mA	V	mA
SW-2876-06	180	-15	60

Switching Characteristics

Cold Switching

On Off Time....................85 nsec. max.

Switching Rate.................2 MHz max.

Control Characteristics

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

AVAILABLE OPTIONS

1. Different Operating temperatures
2, Inverse Control Logic
3. Option G09 - Guaranteed to meet Environmental Ratings

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature ..-54°C to +85°C

Storage Temperature .... -60°C to +120°C

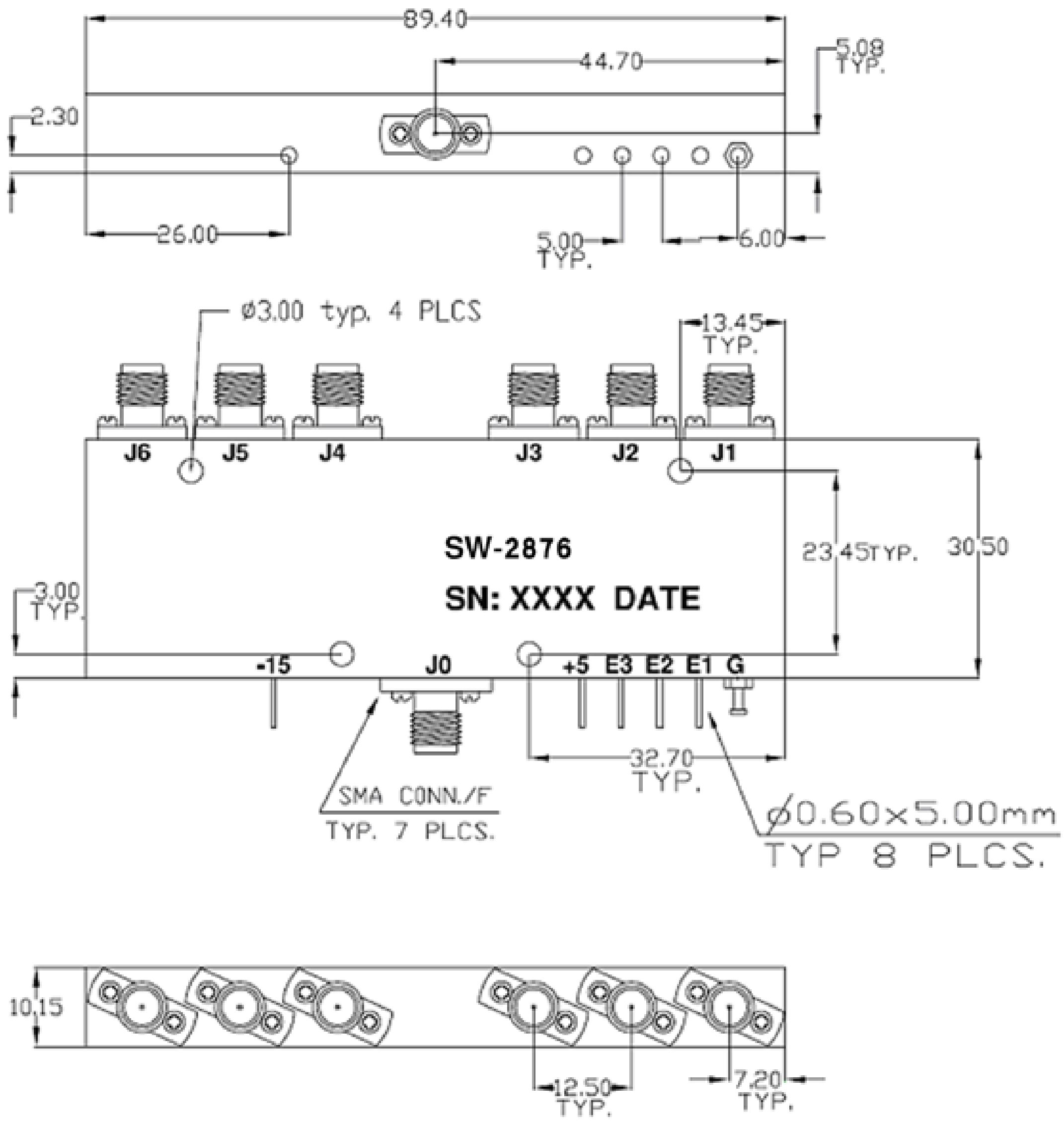
Humidity............................MIL-STD-202F, Method 103B, Cond. B (96 hrs. at 95%)

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.)

DIMENSIONS AND WEIGHT



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Limiters Series LIM

Limiter Products

KRATOS General Microwave offers PIN diode-based limiters, supporting up to 600 watts of pulsed power.

The limiters can be supplied in various configurations: connectorized, drop-in or with field-removable connectors.

The limiters can be supplied as stand alone limiters, or as integrated modules that include the limiter and a control component such as a switch or attenuator as specified in the following:.

SWITCH LIMITERS
A switch module is available before the limiter, handling up to 25-watt CW/ 250-watt Peak power.

LIMITER ATTENUATOR
Provides combined protection and attenuation capabilities (Option).

LIMITER AMPLIFIER
A limiter and an amplifier module that maintains the required power. Signal is amplified if power is not within the specified range (Option).

Low Power Limiters

Support 1GHz – 18GHz, up to 20-Watts Average power and 500-watt Peak power.

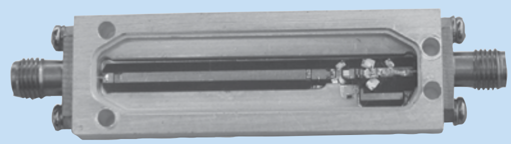
High Power Limiters

Support 1GHz – 12GHz, up to 60-Watts Average power and 600-watt Peak power.

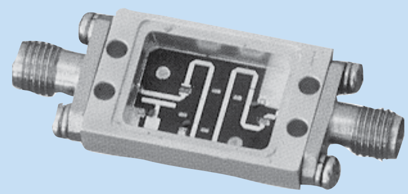
Parameters Trade-off

The main parameters of Limiter specifications are Frequency Band, Input Power and Flat Leakage. Note that there is a trade-off between these parameters.

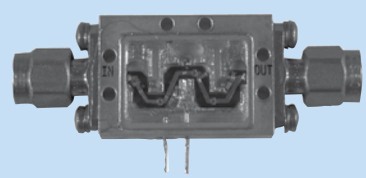
- **Broadband**
- **Coaxial and Drop-In Modules**
- **High-Power Ratings**



Medium Power Limiter



High Power Limiter



Switch Limiter

DEFINITION OF PARAMETERS

Recovery Time:

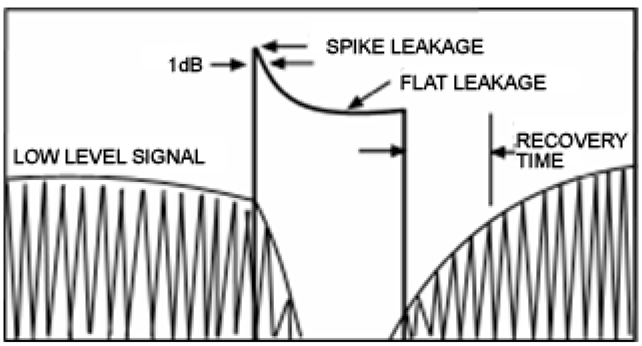
The time period from the end of a high power pulse to the point where the insertion loss value has returned to within 3 dB of the quiescent loss state.

Spike Leakage:

After pulsed high power is applied, the limiter will momentarily pass significantly more power than when it is totally saturated. This power rise is seen as a spike on the leading edge of the leakage pulse. The rise time of the high power pulse and the turn-on time of the diode determine the spike's amplitude. The spike is defined by its energy content, i.e., in ergs. The formula for calculating the spike leakage is as follows:

$$\text{SPIKE LEAKAGE (ERGS)} = t_s \times P_s \times 10^7$$

where t_s equals spike width at the half-power point in seconds, and P_s equals maximum spike amplitude in watts.



Power Handling:

There are two important things to consider when defining the power handling required of a limiter. Two important considerations for defining the required power handling of a limiter are:

- Peak Pulsed Power: for narrow pulses, equated to an equivalent CW power by multiplying the Peak Power by the Duty Cycle. For pulses exceeding 10 microseconds, Peak Power is considered CW
- Source VSWR: When is it fully turned on, the Limiter short circuits across the transmission line, and 90% incident power is reflected back towards the source

Any mismatch at the source reflects power back toward the limiter, resulting in standing waves. In a correct limiter-source phase relationship, the maximum current point occurs at the input diode, causing the diode to dissipate a greater level of power than incident power.

For a source VSWR of up to 2.0:1, an approximate maximum effective power can be achieved by multiplying the source VSWR by the incident power.

The following formula applies for source VSWRs over 2.0:1:

$$PA = \frac{P_S}{[1 \pm (PF_L \; {*}PF_S)]^2}$$

where:

- PA = actual power
- PS = source power
- PFL = load (limiter) power factor 0.96 typical,
- PFS = source power factor.

CONSIDERATIONS IN USING LIMITERS

- The difference between the flat leakage and the 0.1 dB compression point is typically between 10 and 13 dBm, but may vary according to limiter type
- Noise of 10 dBm may be generated following the start of limiter compression. However, limiters can and usually do exhibit signs of limiter compression at 0 dBm
- Limiters dissipate approximately 8% of incident power as heat. Therefore, all limiters should be attached to a heatsink whose temperature does not exceed the maximum rated ambient temperature
- Limiters are inherently broadband components. Band limitation results from DC return are required by some limiter designs. Limiters with bandwidths of up to 10:1 are relatively simple, while those with bandwidths exceeding 10: 1 are progressively more complex and costly.

CAUTION! Limiters are NOT bilateral components! They have a defined input and output. Backwards installation will damage the component.

Limiters Selection Guide

FREQUENCY RANGE (GHz) 1.0 · 2.0 · 4.0 · 6.0 · 10 · 14 · 16 · 18	INPUT POWER	MODEL	PAGE	COMMENTS
1.0 – 18	CW: 2 W Peak: 150 W	LIM-118-L	325	
2.0 – 18	CW: 1 W Peak: 150 W	LIM-218-L		
2.0 – 18	CW: 3 W Peak: 500 W	LIM-218-H		
10 – 15	CW: 20 W Peak: 50 W	LIM-1015-20	326	
1.0 – 2.0	CW: 40 W Peak: 400 W	LIM-12-VHP	327	
1.2 – 1.4	CW: 30 W Peak: 300 W	LIM-1214-VHP		
3.1 – 3.5	CW: 25 W Peak: 250 W	LIM-335-VHP		
8.0 – 12	CW: 5 W Peak: 50 W	LIM-812-50	328	
8.4 – 9.6	CW: 15 W Peak: 315 W	LIM-89-15		
1.28 – 1.4	CW: 30 W Peak: 300 W	LIM-2564-00		

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range................................–30°C to +70°C

Non-Operating Temperature Range.........–55°C to +85°C

Humidity................................RTCA/DO-160D, Category B Sec. 6.3.2). RH Operating 95% @ 60 oC

Shock....................................RTCA/DO-160D Section 7 Category B

Vibration................................RTCV/DO-160D Category R or R2 Sec conde,) Section 8, Par. 8.7.2 Fig. 8-1 & 8-4. Curve C & C1, G rms 4.12 & 5.83.
Random 30 min at performance level and 3 Hrs at endurance level for each axis.

Altitude.................................. (70,000 ft.)

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

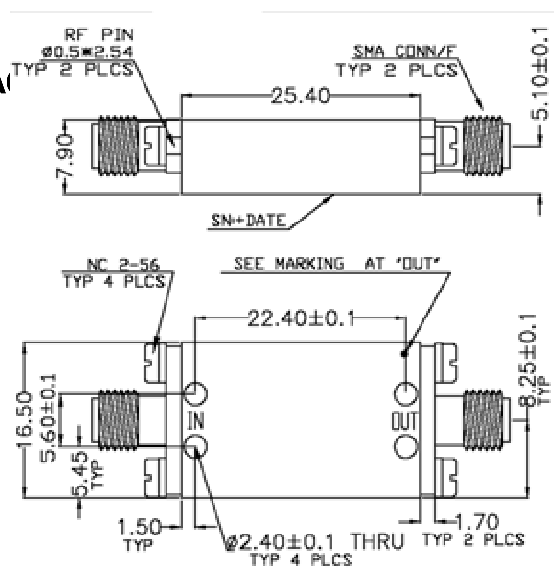
AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

PERFORMANCE CHARACTERISTICS

MODEL		LIM-118-L	LIM-218-L				LIM-218-H			
Frequency Range, (GHz)		1-18	2-18GHz				2-18GHz			
			2-4	4 -8	8-12	12-18	2-4	4 -8	8-12	12-18
Max. Insertion Loss, (dB)		2.5	1.0	1.4	1.8	2.3	1.3	1.8	2.2	2.7
VSWR, max		2.0:1	1.7:1	1.9:1	1.9:1	2.0:1	1.7:1	1.9:1	1.9:1	2.0:1
Input Power, (W)	CW	5	1				3			
	Peak	500	150				500			
Pulse Width, (µSec)		1	1				1			
Duty Cycle, % max.		1	0.1				0.1			
Flat Leakage, (mW)		100	150	130	130	130	150	130	130	130
Recovery Time Max. (nsec)		200	100				200			
Environmental Conditions		See Page 324								
Package Type		200/2-79	200/2-79				200/2-79			
Connectors	Input	SMA (M)	SMA (F)				SMA (F)			
	Output	SMA (F)	SMA (F)				SMA (F)			

PA



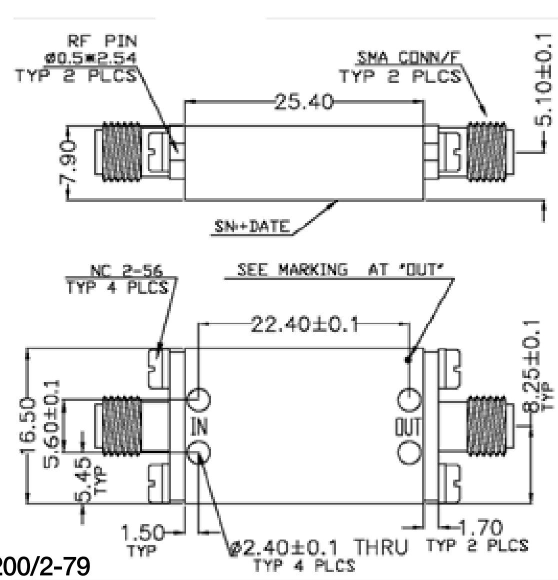
200/2-79

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

PERFORMANCE CHARACTERISTICS

MODEL		LIM-1015-20
Frequency Range, (GHz)		10 - 15
Max. Insertion Loss, (dB)		2.0
VSWR, max.		1.8:1
Input Power, max (W)	CW	20
	Peak	50
Pulse Width, max (μSec)		1
Duty Cycle % max.		0.1
Flat Leakage , (dBm)		15
Recovery Time, max (nsec)		400
Environmental Conditions		See Page 324
Package Type		200/2-79
Connectors:	Input	SMA (F)
	Output	SMA (F)

PACKAGE TYPE & DIMENSIONS



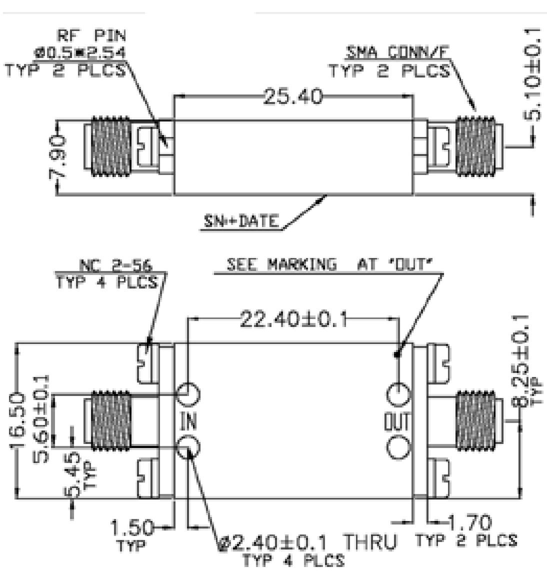
200/2-79

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

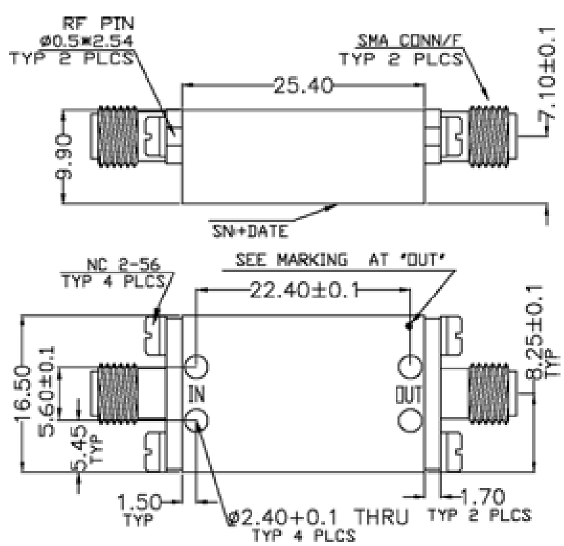
PERFORMANCE CHARACTERISTICS

MODEL		LIM-12-VHP	LIM-1214-VHP	LIM-335-VHP
Frequency Range (GHz)		1.0 - 2.0	1.2 - 1.4	3.1 - 3.5
Insertion Loss, max (dB)		0.8	0.7	1.0
VSWR, max		1.5:1	1.3:1	1.3:1
Input Power, max (W)	CW	40	30	25
	Peak	400	300	250
Pulse Width, max (μSEC)		10	20	50
Duty Cycle % max		10	10	10
Flat Leakage, max (mW)		100	100	32
Recovery Time, max (nsec)		400	400	350
Environmental Conditions		See Page 324		
Package Type		200/2-79	200/2-10	200/2-79
Connectors	Input	SMA (F)	SMA (F)	SMA (F)
	Output	SMA (F)	SMA (F)	SMA (F)

PACKAGE TYPE & DIMENSIONS



200/2-79



200/2-10

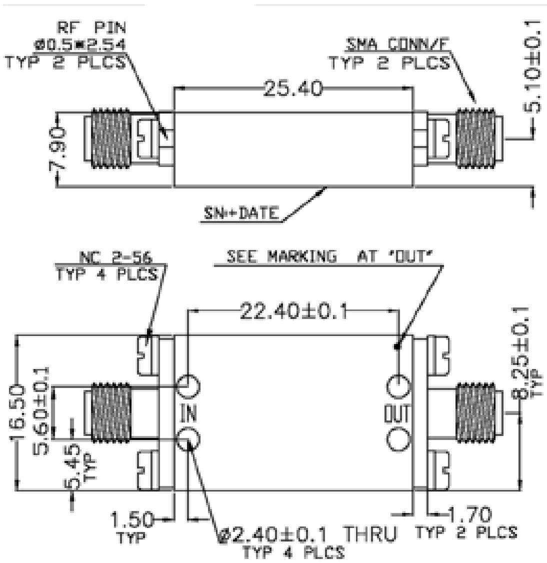
Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Limiters Series LIM Narrowband Specifications

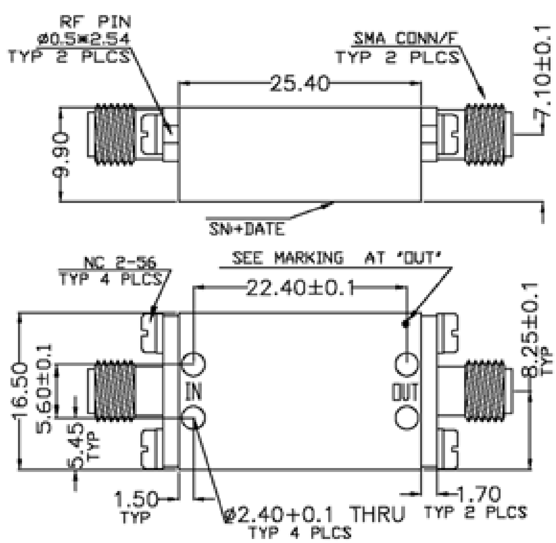
PERFORMANCE CHARACTERISTICS

MODEL		LIM-89-15	LIM-812-50	LIM-2564-00
Frequency Range (GHz)		8.4 - 9.6	8 - 12	1.28 - 1.4
Insertion Loss, max (dB)		2.0	2.2	0.6
VSWR, max		2.0:1	1.8:1	1.5:1
Input Power, max (W)	CW	15	5	30
	Peak	50	50	300
Pulse Width, max (µSec)		20	10	25
Duty Cycle, % max		5.0	10	13
Flat Leakage, max (mW)		64	100	32
Recovery Time, max (nsec)		500	500	200
Environmental Conditions		See Page 324		
Package Type		200/2-79	200/2-79	200-2564
Connectors	Input	SMA (F)	SMA (F)	SMA (F)
	Output	SMA (F)	SMA (F)	SMA (F)

PACKAGE TYPE & DIMENSIONS



200/2-79



200-2564

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Millimeter Wave Components
18-40 GHz

ATTENUATORS: CURRENT, DIGITAL & VOLTAGE CONTROLLED

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 500 nsec.

Each of the three models operates over the full frequency range from 18-40 GHz with a dynamic attenuation range of 50 dB.

See Page 331.

PHASE SHIFTERS

Model 7929 is a MMW Phase Shifter with phase control of 360^0, over the entire frequency range of 10 to 40 GHz.

See page 336

SWITCHES: SPST, SP2T & SP4T

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 nsec

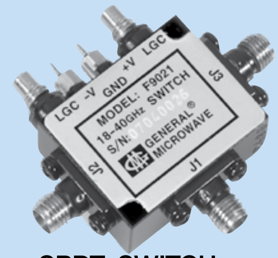
See Page 340.

QUADRATURE COUPLER

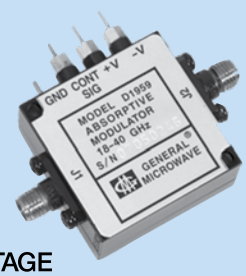
The Model 7050 3-dB Quadrature Coupler is a 4-port single-section Hoppfer coupler which operates over the frequency range from 18-40 GHz. It features low insertion loss, high isolation, and excellent amplitude and phase balance.

See Page 344.

CUSTOM IMA PRODUCTS: See Page 343.



SPDT SWITCH



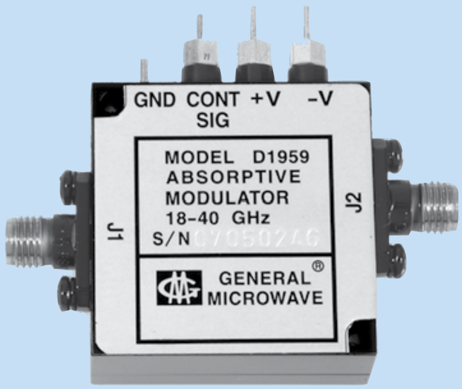
VOLTAGE
CONTROL
ATTENUATOR

DIGITALLY CONTROLLED
ATTENUATOR

PHASE SHIFTER

Models 1959, D1959 Millimeter Wave PIN Diode Attenuator/Modulator

- **Absorptive**
- **Current or voltage controlled**
- **18 to 40 GHz frequency range**
- **High performance MIC quadrature hybrid design**
- **High speed**



Attenuator Model D1959
(WITH INTEGRATED
DRIVER)

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.)

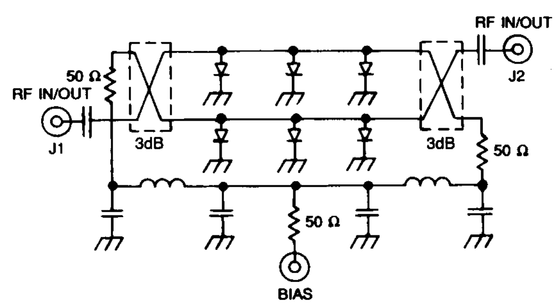


Fig. 1–Model 1959, RF schematic diagram

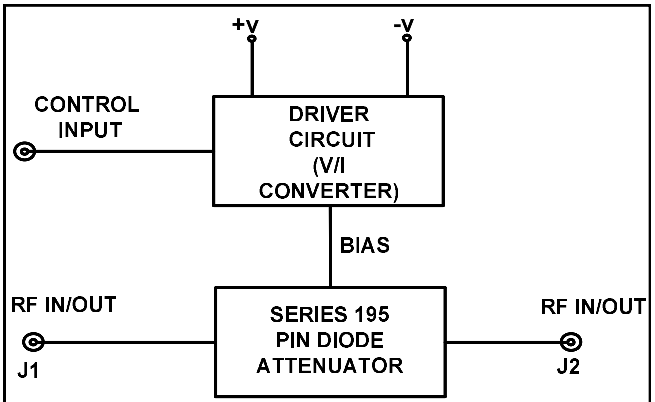


Fig.2-Model D 1959, block diagram

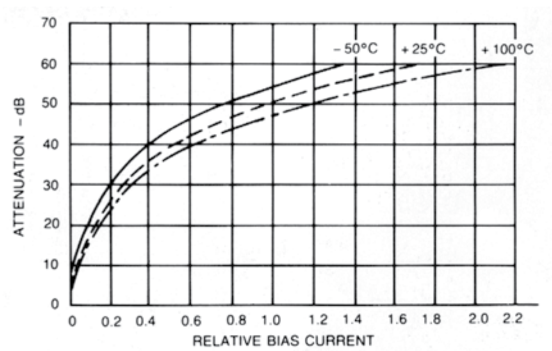


Fig. 3—Model 1959, typical effects of temperature on attenuation.

Models 1959, D1959 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	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					

ENVIRONMENTAL RATINGS AND AVAILABLE OPTIONS

See page 350.

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)

Phase Shift ....see page 66

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 .... 1,600 nsec
OFF Time .... 100 nsec max(1)

Nominal Control Voltage Characteristics
Operating .... 0 to +5V

Transfer Function .... 10 dB/volt

Input Impedance .... 10 kW

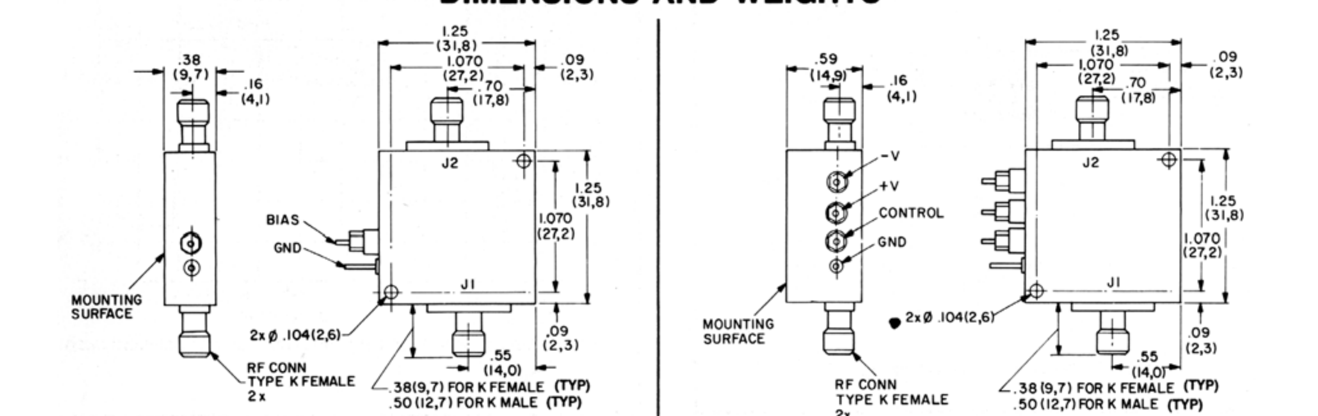
Modulation Bandwidth
Small Signal .... 5 MHz
Large Signal .... 2 MHz

Power Supply
Requirements .... +12V ±5%, 120 mA
–12V ±5%, 50 mA

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

(1) For attenuation steps of 10 dB or more

DIMENSIONS AND WEIGHTS



MODEL 1959
Wt: .8 oz. (23 gr) approx.

MODEL D1959
Wt: 1 oz. (28 gr) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Model 3499 Octave-Band 11 Bit Digital PIN Diode Attenuator

- **Frequency range: 18-40 GHz**
- **50 dB attenuation range**
- **500 nsec switching speed**
- **11 Bit binary programming**
- **Guaranteed monotonicity**
- **Absorptive**

Attenuator Model 3499
(WITH INTEGRATED
DRIVER)

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.

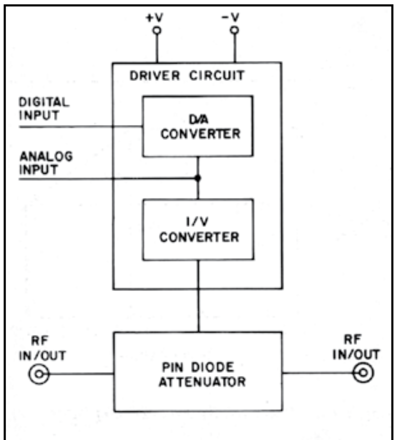


Fig. 1 – Model 3499 block diagram

Model 3499 Specifications

PERFORMANCE CHARACTERISTIC

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	60 dB
3499	18-26.5	4.1	2.2	1.3	2.2	3.4	4.0	N/A
	>26.5-36	4.6						
	>36-40	5.2						
3499-60	18-26.5	4.3	2.2	1.3	2.2	3.4	4.0	5.0
	>26.5-36	4.9						
	>36-40	5.8						

Mean Attenuation Range
Model 3499 ....50 dB
Model 3499-60 ....60 dB

Accuracy of Attenuation
0 to 30 dB .... ±0.5 dB
30 to 50 .... ±1.0 dB
30 to 60 (Model 3499-60)....±1.0 dB

Monotonicity......................... Guaranteed

Temperature Coefficient ..... ±0.03 dB/°C

Phase Shift ....See page 66

Power Handling Capability
Without Performance
Degradation .... 10 mW cw or peak
Survival Power (from –40°C to +25°C; +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[(1)]

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

OPTION (G09) 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

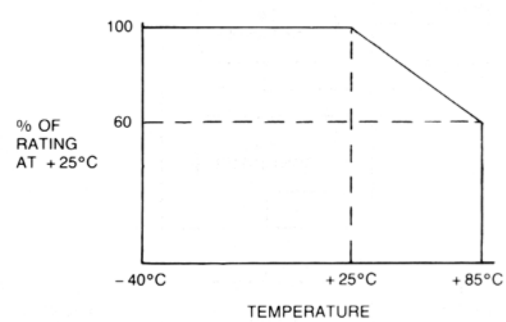
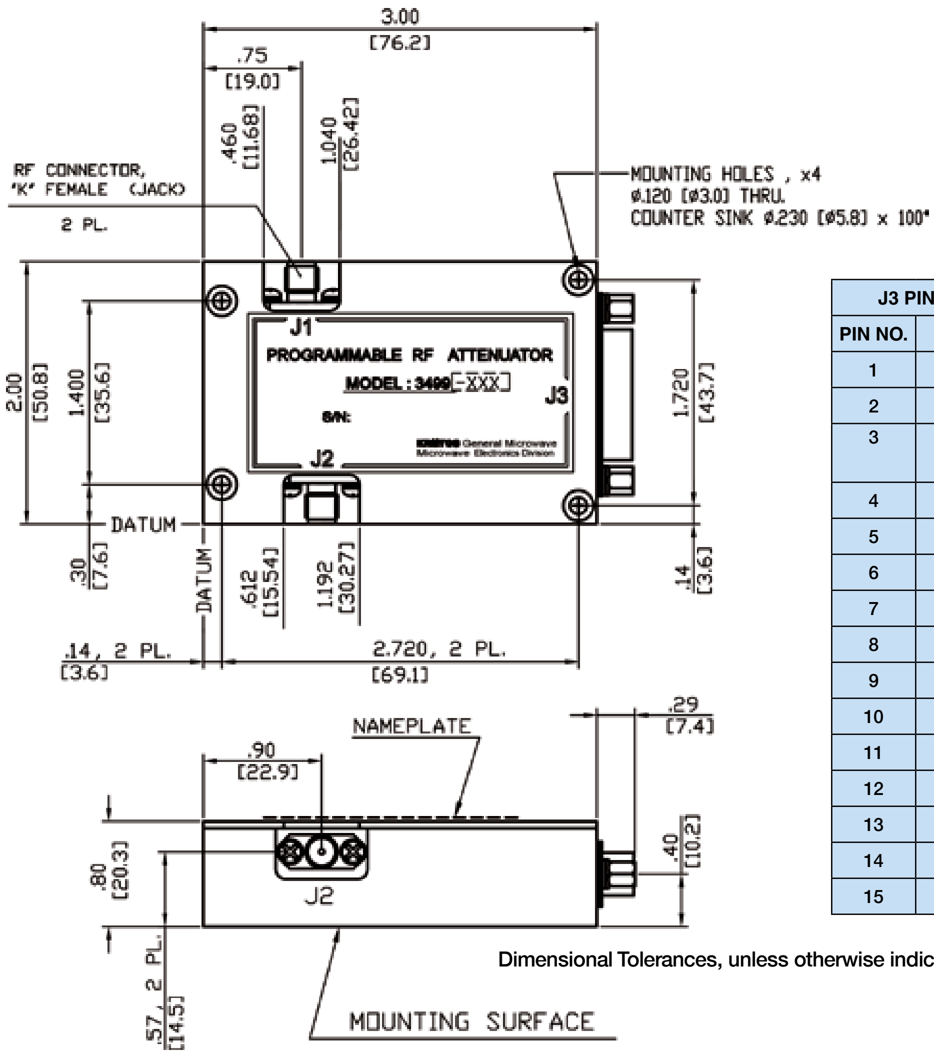


Fig. 2 – Model 3499 power derating factor

DIMENSIONS AND WEIGHTS



J3 PIN FUNCTIONS	
PIN NO.	BINARY
1	0.06 dB(1)
2	0.13 dB
3	Analog Input/ Strobe Latch(2)(3)
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 ±.008

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
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

NOTES:

1. 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.
2. Normally supplied as an Analog input. Optionally available as a strobe latch function for input data.
3. Pin 3 is available to apply a current or voltage to control the attenuator in a non-linear fashion. leave pin as open circuit if not used.

Model 7929 MM Wave 360° Phase Shifter

The Model 7929 is a MMW PIN diode phase shifter covering a frequency range from 18 to 40 GHz providing a full 360° range of variable phase shift.

PHASE SHIFT

Phase shift is achieved by 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 operating band, overall phase accuracy is better than 15°. Switching speed is better than 500 nsec.

- **18 to 40 GHz**
- **360° Range**
- **0.35° Incremental Resolution**
- **High Speed**
- **Digitally Programmable (10 Bits)**
- **Guaranteed Monotonicity**
- **Hermetically Sealed**

Phase Shifter Model 7929

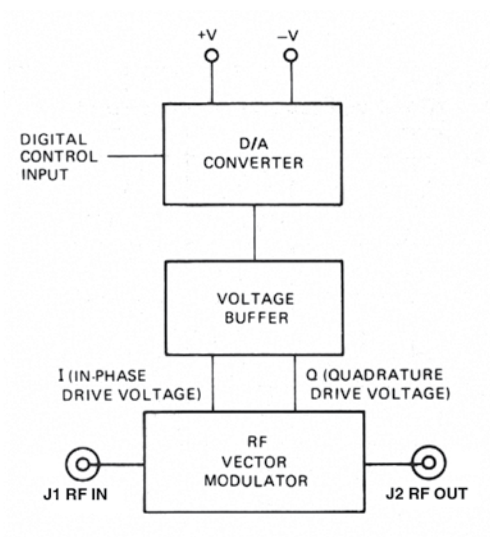


Fig. 1–Model 7929, block diagram

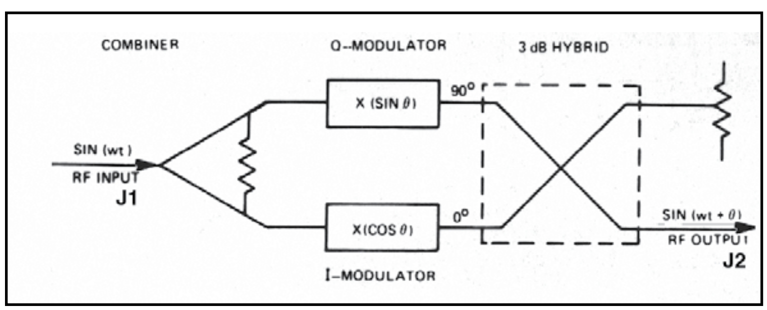


Fig. 2–Model 7929, RF section

PHASE SHIFTER SPECIFICATIONS

FREQUENCY RANGE (GHz)	INSERTION LOSS (Max.)	VSWR (Max.)	ACCURACY (Max.)	PM/AM (Max.)
18.0-40.0	15.0 dB	J1 INPUT: 2.5 :1 J2 OUTPUT: 2.2:1	±15°	±2.0 dB

PERFORMANCE CHARACTERISTICS

Phase Shift
- **Range** .... 360° in 1,024 steps
- **Variation** .... 0.1°/°C

Control Input .... 10 Bit TTL

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

Input IP2 .... +60 dBm typ.

Input IP3.......................................+35 dBm typ.

Power Handling Capability
- **Without Performance Degradation** +20 dBm
- **Survival power** +30 dBm

Power Supply
- **Requirements** +5V ±5%, 125 mA max
  +12 to +15V, 10 mA max
  –12 to –15V, 95 mA max

NOTE:

To initialized the unit after power up, at least one of the digital bits has to change its TTL level.

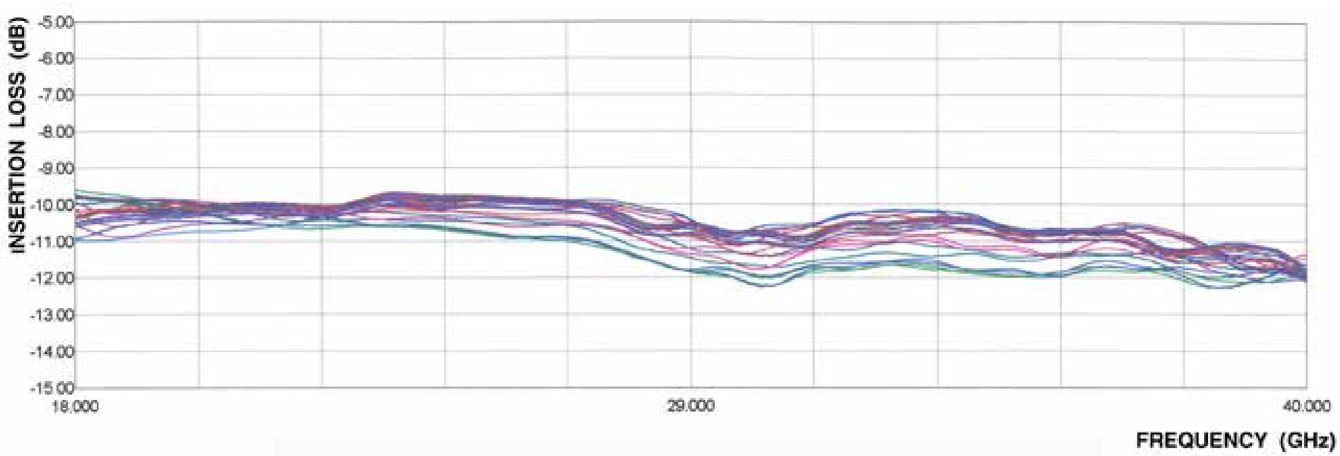


Fig. 3: **MODEL 7929 INSERTION LOSS VS. FREQUENCY (PM/AM)**

Narrow Band Phase Shifters

In addition to the standard wide band Phase Shifters, KRATOS General Microwave is offering Narrow Band Phase Shifters. These units are available both as standard catalog units and as customized units meeting specific customer's requirements. The narrow band units have better performances and lower prices.

Frequency Range	Model Number	Phase Accuracy	PM/AM	Insertion Loss
18.0 to 21.4 GHz	7929-NB-18-21	± 6° (max.)	± 1.0 dB	13.0 dB (max.)
27.0 to 31.0 GHz	7929-NB-27-31	± 6° (max.)	± 1.0 dB	13.0 dB (max.)
33.0 to 36.0 GHz	7929-NB-33-36	± 6° (max.)	± 1.0 dB	13.0 dB (max.)
37.0 to 40.0 GHz	7929-NB-37-40	± 10° (max.)	± 1.0 dB	13.5 dB (max.)

ACCESSORY FURNISHED

Mating power/control connector

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range..............................–54°C to +95°C

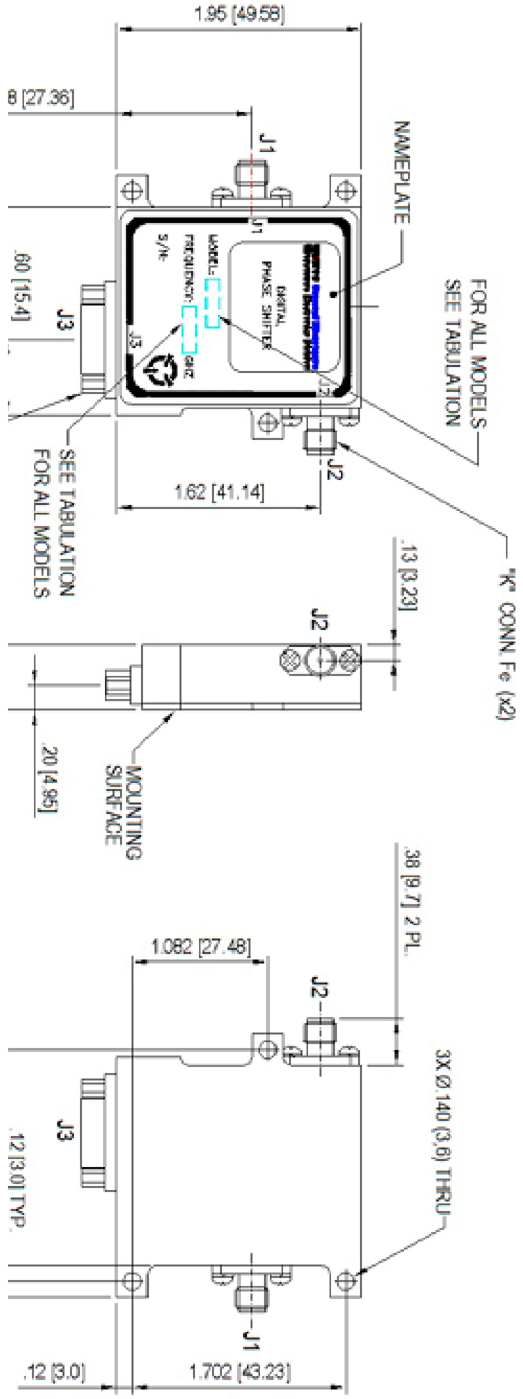
Non-Operating Temperature Range......–65°C to +125°C

AVAILABLE OPTIONS

Option No.	Description
7	Two K male RF connectors
10	One K male (J1), and one K female (J2) RF connector
49	High Rel screening

G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

DIMENSIONS AND WEIGHT



MODEL 7929	PIN FUNCTIONS
PIN	**FUNCTIONS**
1	Ground
2	+5V
3	–12 to –15V
4	1.4°
5	2.8°
6	5.6°
7	22.5°
8	11.3°
9	90°
10	180° (MSB)
11	+12 to +15V
12	45°
13	GND
14	0.7°
15	0.35° (LSB)

Model 7929 Wt. 2.5 oz (71gr.) approx.

Dimensional Tolerances: unless otherwise indicated: .XX ±.02; .XXX ±.008

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.

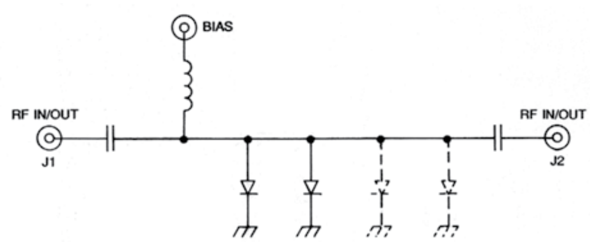


Fig. 1–Series 90 SPST schematic diagram.

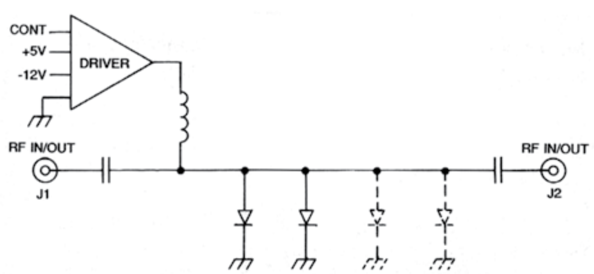


Fig. 2–Series F90 SPST schematic diagram.

- **18 to 40 GHz frequency range**
- **Low VSWR and insertion loss**
- **Up to 75 dB isolation**
- **Less than 10 nsec rise and fall times**

Switch Model 9013
(DRIVERLESS)

PERFORMANCE CHARACTERISTICS

MODEL NO.[1]	CHARACTERISTIC	FREQUENCY (GHz) 18-26.5	FREQUENCY (GHz) 26.5-40
9012, F9012	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	35 2.2 2.0	30 2.7 2.2
9013*, F9013*	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	55 2.5 2.0	50 3.0 2.2
9014, F9014	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	75 2.8 2.2	70 3.5 2.2

*Special-order product. Consult factory before ordering.

SWITCHING CHARACTERISTICS [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.)

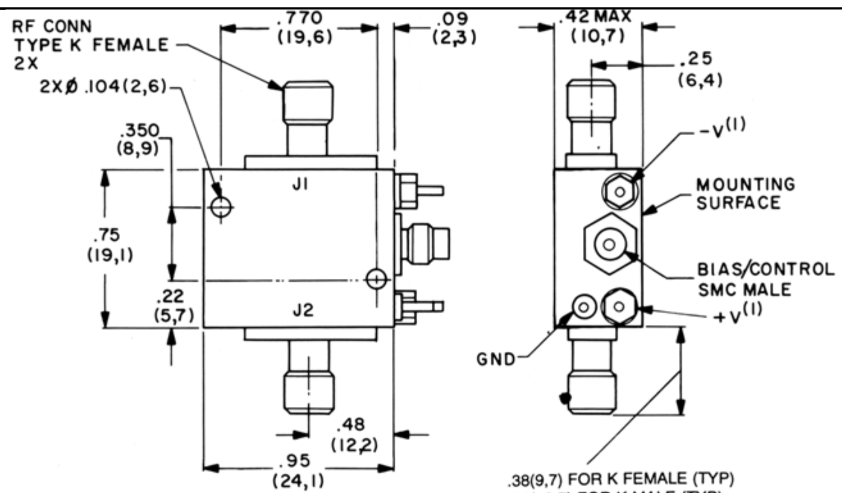
Control Logic........................Logic “0” (–0.3 to +0.8V) for switch ON and Logic “1” (+2.0 to +5.0V) for switch OFF.

ENVIRONMENTAL RATINGS AND AVAILABLE OPTIONS

See page 350

(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 user.

DIMENSIONS AND WEIGHT



Series 90/F90
Wt: .6 oz. (17 gr) approx.

(1) USED ONLY ON UNITS WITH INTEGRATED DRIVERS

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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.

- 18 to 40 GHz frequency range
- Rise and fall times less than 10 nsec
- Low VSWR and insertion loss
- Up to 65 dB isolation

Switch Model F9021
(WITH INTEGRATED
DRIVER)

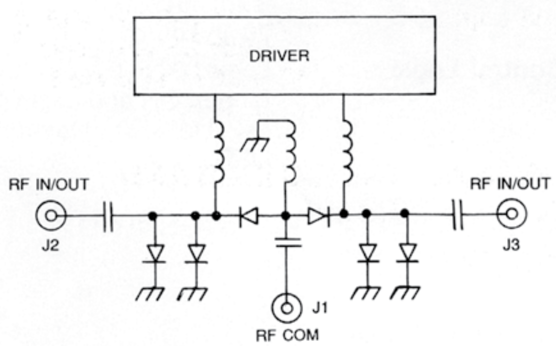


Fig. 1—Series F90 SPDT schematic diagram

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 18-26.5	26.5-40
F9021	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	30 3.0 2.1	20 3.6 2.3
F9022	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	45 3.2 2.2	40 4.0 2.3
F9023	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON)	65 3.5 2.3	55 4.5 2.5

Switching Characteristics

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

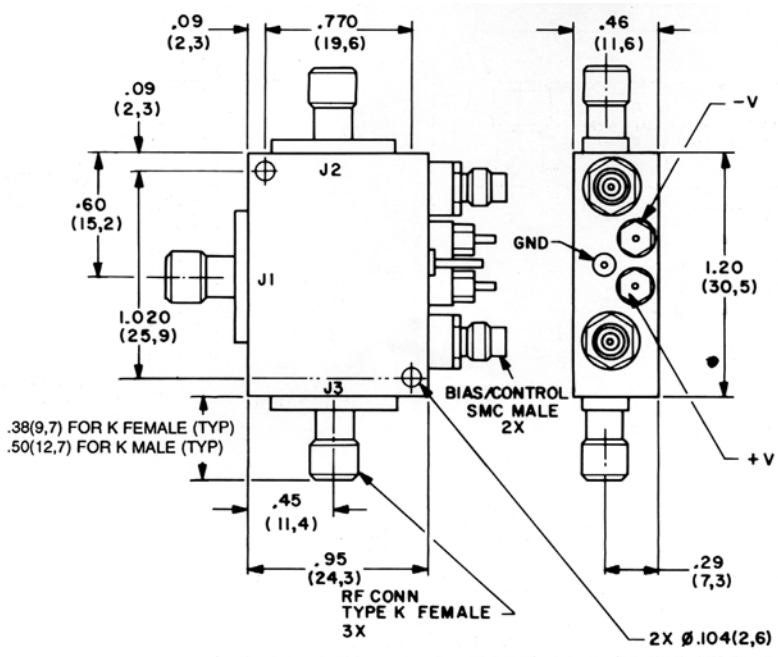
CONTROL CHARACTERISTICS

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 +0.8V) for port ON and Logic “1” (+2.0 to +5.0V) for port OFF.

ENVIRONMENTAL RATINGS AND AVAILABLE OPTIONS

See page 350



SERIES F90
Wt. 1 oz. (28 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

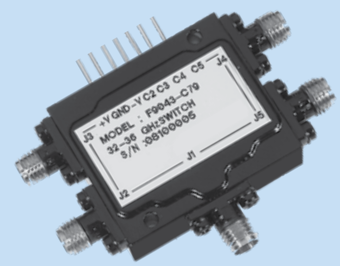
Series 9043
Millimeter Wave SP4T Switches

NON-REFLECTIVE SP4T SWITCHES

Series 90 SP4T switches use an integrated assembly of PIN diodes mounted in a microstrip transmission line in an all shunt arrangement.

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 On/Off times are less than 50 nsec.

- **32 to 36 GHz frequency range**
- **Low VSWR and insertion loss**
- **Non-Reflective**
- **55 dB isolation**



Switch Model F9043-C79
(WITH INTEGRATED
DRIVER)

PERFORMANCE CHARACTERISTICS

MODEL NO.	CHARACTERISTIC	FREQUENCY (GHz) 32-36
F9043-C79	Min. Isolation (dB) Max. Insertion Loss (dB) Max. VSWR (ON/OFF)	55 5.9 2.7:1

Switching Speed
On Off Times........................50 nsec max.

Power Handling Capability
Without Performance Degradation
"On" Port.........................1W cw or peak
Common Port ....1W cw or peak
"Off" Port.........................100 mW cw or peak

Survival Power
"On" Port.............................1W average, 75W peak (1 µsec max. pulse width)
Common Port ....1W average, 75W peak (1 µsec max. pulse width)
"Off" Port.............................200 mW average, 5W peak (1 µsec max. pulse width)

Power Supply Requirements...................+5V ±5%, 120 mA
–12V ±5%, 30 mA

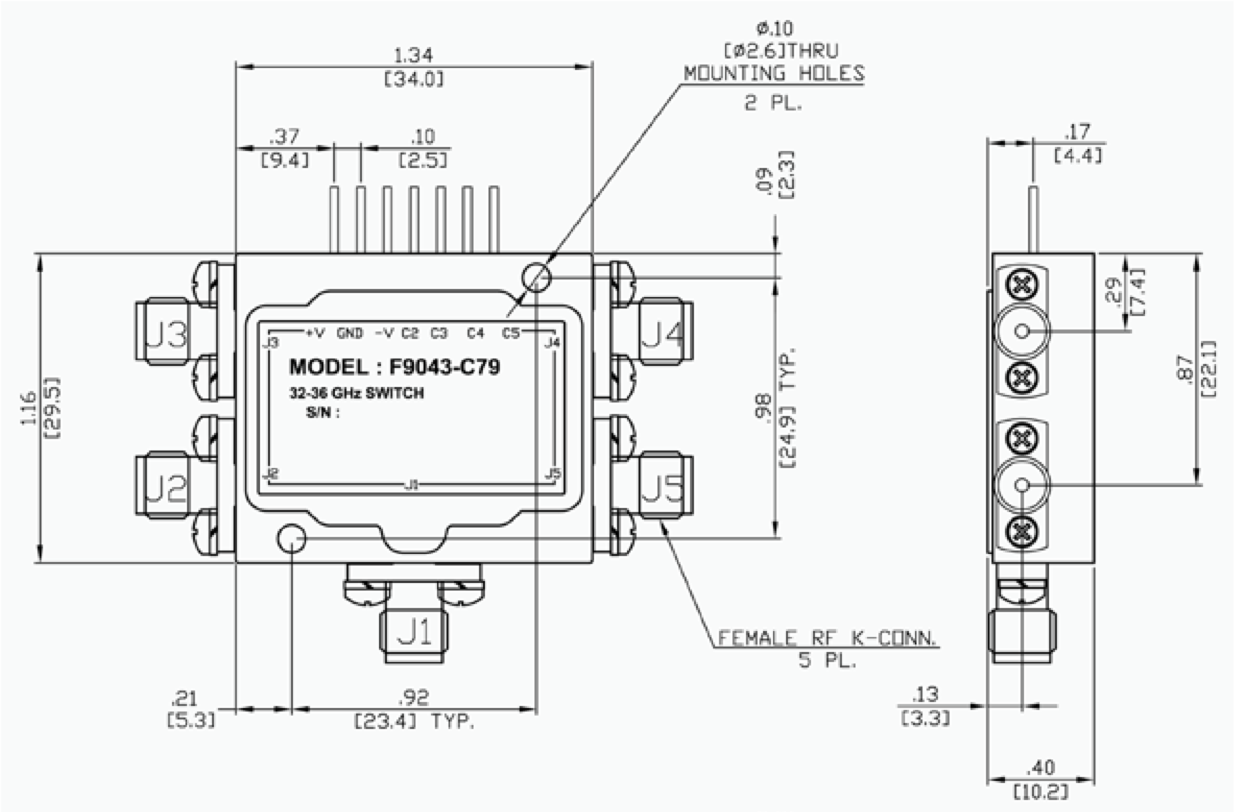
CONTROL CHARACTERISTICS

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 +0.8V) for port ON and Logic "1" (+2.0 to +5.0V) for port OFF.

ENVIRONMENTAL RATINGS

See page 350



Weight 1.16 oz. (33 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series 9044
Millimeter Wave SP4T Switches

NON-REFLECTIVE SP4T SWITCHES

SP4T switch model F9044 use an integrated assembly of PIN diodes mounted in a microstrip transmission line.

F9044 switch is supplied with integrated driver. Standard unit is supplied with logic that turns a port ON with the application of a logic “0” control signal. Maximum On/Off times are less than 50 nsec.

- **26 to 40 GHz frequency range**
- **Low VSWR and insertion loss**
- **Designed for Amplitude & Phase matching**
- **Non-Reflective**
- **55 dB isolation**

PERFORMANCE CHARACTERISTICS

MODEL	CHARACTERISTIC			
F9044	Frequency Range (GHz)	26-33	33-37	37-40
	Min. Isolation (dB)	55	55	55
	Max. Insertion Loss (dB)	6.0	6.5	8.5
	Max. VSWR (ON/OFF)	2.5:1	2.5:1	2.5:1

Switching Speed
On Off Times........................50 nsec max.

Power Handling Capability
Without Performance Degradation
“On” Port.........................1W cw or peak
Common Port ....1W cw or peak
“Off” Port.........................100 mW cw or peak

Survival Power
“On” Port............................1W average, 75W peak (1 µsec max. pulse width)
Common Port ....1W average, 75W peak (1 µsec max. pulse width)
“Off” Port............................200 mW average, 5W peak (1 µsec max. pulse width)

Power Supply
Requirements...................+5V ±5%, 375 mA max.
–12V ±5%, 250 mA max.

CONTROL CHARACTERISTICS

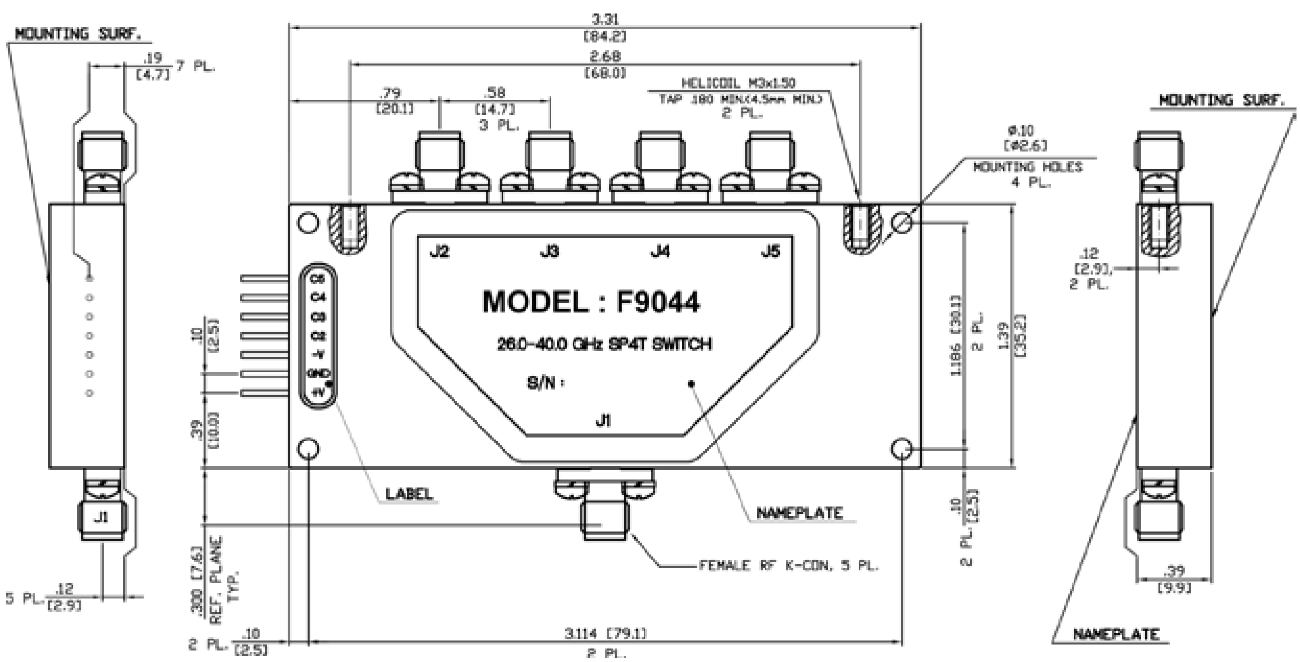
Control Input
Impedance.........................TTL, advanced Schottky, one unit load. (A unit load is 0.6 mA sink current and 20 µA source current.)

Control Logic........................Logic “0” (0 to +0.8V) for port ON and Logic “1” (+2.0 to +5.0V) for switch OFF.

ENVIRONMENTAL RATINGS

See page 350

DIMENSIONS AND WEIGHT



Weight 2.79 oz. (79 gr.) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

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.

- **Frequency range: 18-40 GHz**
- **Low insertion loss**
- **High isolation**
- **Removable connectors**

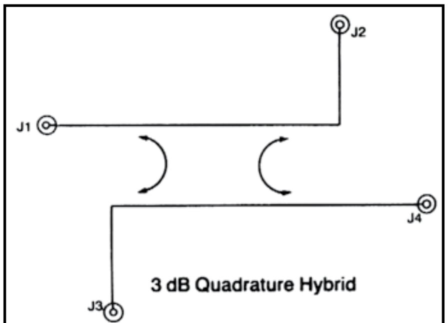
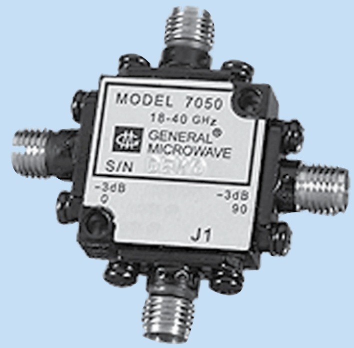


Fig. 1-Model 7050 schematic

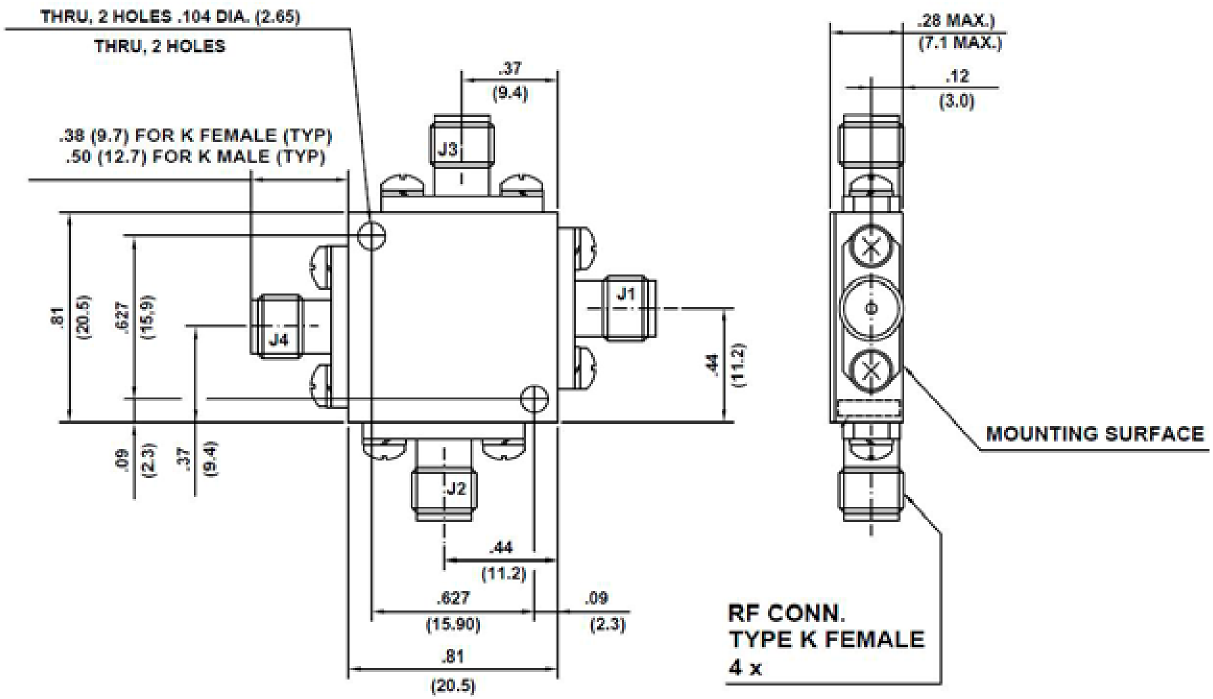


Coupler Model 7050

SPECIFICATIONS	
Frequency (GHz)	18-40
Min. Isolation (dB)	14
Max. Insertion Loss (dB)	1.75
Max. VSWR	1.8
Amplitude Balance (dB)	±2.0
Phase Balance deg.	±10
Power Handling, operating and survival, cw or peak	2W
Environmental Ratings	See page 350

Model 7050 Millimeter Wave 3 dB Quadrature Coupler

DIMENSIONS AND WEIGHT



MODEL 7050
Wt: 1 oz (28gr) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

AVAILABLE OPTIONS

Option No.	Description
G07	2.4 mm Female RF connectors
G09	Guaranteed to meet Environmental Ratings
G12	RoHS Compliant

OPTION (G09) ENVIRONMENTAL RATINGS

Operating Temperature Range

Series 90

With Drivers .... –55°C to +110°C

Without Drivers ...... –55°C to +110°C

Model 1959 .... –54°C to +110°C

Model D1959 .... –54°C to +110°C

Model 7050 .... –55°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

AVAILABLE OPTIONS		MODEL[1]			
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 male; J2 and J3 type K male				✓
9[2]	Inverse control logic; logic “0” for port OFF and logic “1” for port ON			✓	✓
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	✓	✓	✓	✓
G09	Guaranteed to meet Environmental Ratings	✓	✓	✓	✓
G12	RoHS Compliant	✓	✓	✓	✓

(1) See page 329 for Model 3499 digital attenuator.

(2) Not applicable for units without drivers.

CUSTOM MILLIMETER WAVE ASSEMBLIES

KRATOS General Microwave has developed and produced various custom Millimeter Wave Integrated Microwave Assemblies (IMAs). The following are some examples of products we have developed:

1. Attenuator (Fig. 1)
2. One to four Power Divider (Fig. 2)
3. Transmitter Assembly (Fig 3)
4. Receiver Assembly (Fig. 4)

Fig. 1 – Custom Millimeter Wave Attenuator

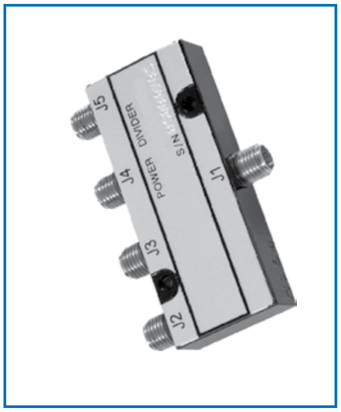


Fig. 2 – Millimeter Wave Power Divider

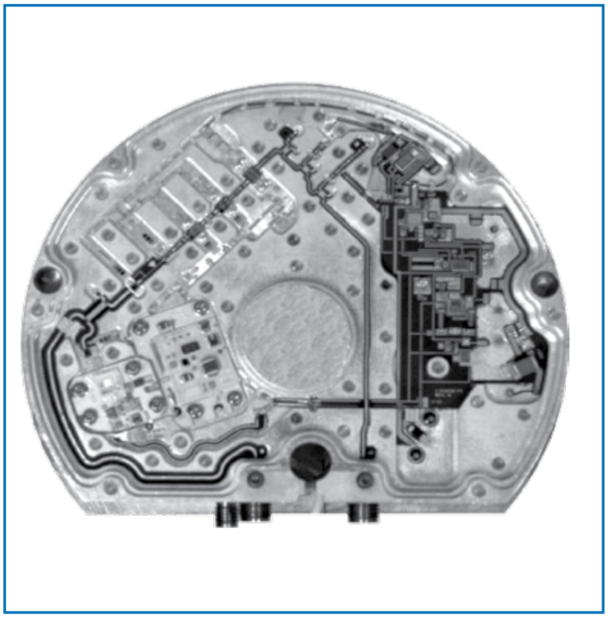


Fig. 3 –Millimeter Wave Transmitter Assembly

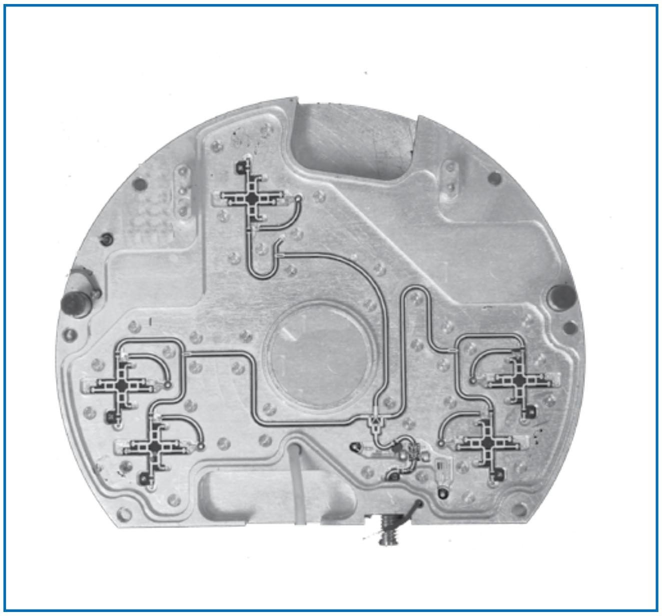


Fig. 4 –Millimeter Wave Receiver Assembly

Microwave Sources

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 (1 PPM/°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.

General Microwave offers a broad line of General Purpose Signal Generators, this includes high-performance voltage-controlled oscillators (VCOs), digitally-tuned oscillators (DTOs), frequency locked oscillators (FLOs) and synthesizers in the microwave frequency range. The VCOs and DTOs feature fast-settling time, low post-tuning drift 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 catalog is proof of General Microwave's success. It includes expanded versions of our general purpose 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.

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.

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 several hundred microseconds, while post-tuning-drift usually refers to the variation from several 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 I Hz. From 10 kHz to 100 kHz, the phase noise of a VCO 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. 2).

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.

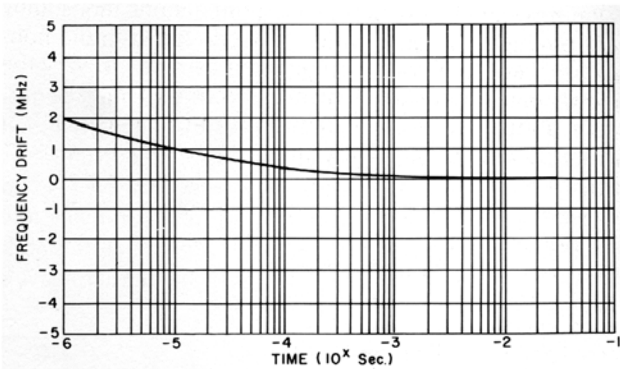


Fig. 1-Measured settling time of 8-12 GHz VCO

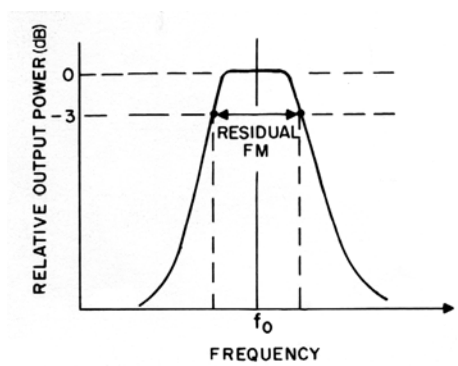


Fig 2–Residual FM

Microwave Synthesizers

KRATOS General Microwave (KGMI) has developed a broad line of General Purpose Synthesizers to be used in various applications. KGMI has developed a line of high performance, broadband Fast Indirect Synthesizers (FIS) to provide a cost-effective solution to the requirements of new systems. Its high speed (as fast as 1 µsec) provides an economical alternative to direct synthesizers for many applications. Because of its low phase noise, it is an excellent alternate to the much slower and generally less reliable YIG based synthesizer.

To provide optimum solutions for different requirements, KRATOS General Microwave has developed a variety of Fast Indirect Synthesizers (FIS) with different parameter trade-offs: The standard FIS line for fastest tuning speed, the low phase noise line for ELINT applications and the compact FIS line for airborne small size applications.

SELECTION GUIDE SYNTHESIZERS

FREQUENCY RANGE (GHz) 0.5 2 4 6 12 18 40	MODEL	PAGE	COMMENTS
0.5 – 3	SF6053	355	1 µsec Indirect Synthesizer
2 – 18	SF6218		
2 – 19	SF6219		
2 – 18	SM6218	359	1 µsec Indirect Synthesizer with frequency modulation
6 – 18	SM6618		
2 – 20	SM6220		
0.5 – 8	SW0580	365	Compact Indirect Synthesizers
1.25 – 20	SW0120		
2 – 20	SW0220		
6 – 18	SW0618		
	SQ0580	372	Narrow Frequency Band Indirect Synthesizer
0.25 – 40	FE0P240	368	Frequency Extender
0.5 – 20	FE0P520		
0.5 – 20		375	Custom Synthesizers

Series SF60 Low Phase Noise 1µsec Fast Indirect Synthesizer

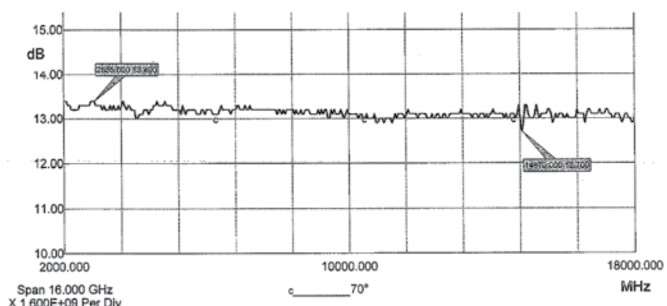
- **High Speed: 1 µsec**
- **Wide Frequency Range: 0.5 to 19 GHz**
- **Low Phase Noise**
- **Small Size**
- **High Reliability**
- **Severe Environmental Conditions**

Synthesizer Model SF6218

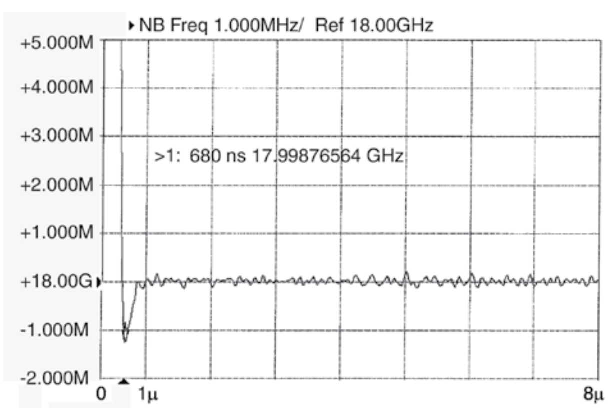
Series SF60 Low Phase Noise Fast Indirect Synthesizer

KRATOS General Microwave has developed the series SF60 fast, broadband, low phase noise and small size synthesizer, to meet the needs of a general purpose fast synthesizer for applications such as Signal Generators and Automatic Test Equipment at an affordable price.

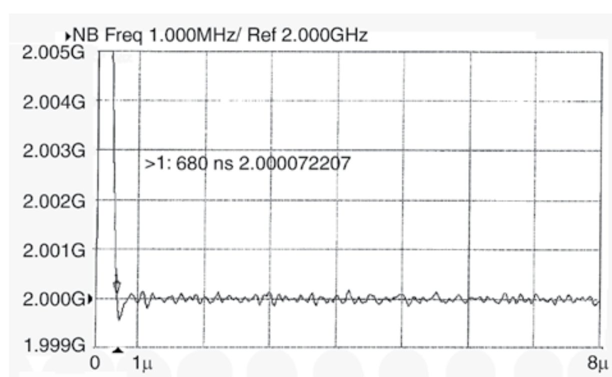
For military applications, this synthesizer requires option G09 to comply with Military Standards. The specific environmental MIL STD requirements as well as the EMI/RFI specifications should be provided by the customer.



OUTPUT POWER



SETTLING TIME
FROM 2 to 18 GHz



SETTLING TIME
FROM 18 to 2 GHz

SERIES SF60 SYNTHESIZER SPECIFICATIONS

	PARAMETER	SPECIFICATION		
		MODEL SF6053	MODEL SF6218	MODEL SF6219
1	FREQUENCY RANGE (GHz)	0.5 to 3 (1)	2 to 18 (1)	2 to 19 (1)
2	ACCURACY	Same (PPM) as of the reference crystal oscillator		
3	FREQUENCY AGING	Same (PPM) as of the reference crystal oscillator		
4	OUTPUT POWER			
4.1	Min. (dBm) (1)	10		
4.2	Variation, over freq. and temp., max. (dB)	±2.5		
5	SETTLING TIME (6) , max. (μsec)	1		
6	SSB PHASE NOISE (2), max (dBc/Hz)			
6.1	@ 100 Hz Offset	–77		
6.2	@ 1 kHz Offset	-90	-90	-90 (4)
6.3	@ 10 kHz Offset	-110	-100	-100 (4)
6.4	@ 100 kHz Offset	-115	-105	-105 (4)
6.5	@ 1 MHz Offset	-115	-105	-105 (4)
6.6	@ 10 MHz Offset	-120	-110	-110 (4)
7	HARMONICS, max (dBc)	–20		
8	SUB-HARMONICS, max (dBc)	–50		
9	SPURIOUS, max (dBc)	–50	–50	–50 (4)
10	PULLING @ VSWR 2:1 max (kHz)	<1		
11	PUSHING, max (kHz/V)	± 1		
12	FREQUENCY CONTROL (PARALLEL)	18 BITS	21 BITS	
13	FREQ. STEP SIZE, nominal LSB (kHz) (1)	10		
14	REFERENCE CRYSTAL OSCILLATOR - EXTERNAL (3)			
14.1	INPUT FREQUENCY, (MHz) (5)	100		
14.2	INPUT POWER, (dBm)	0 ±2		
15	POWER SUPPLY REQUIREMENT, (mA): +12V ±5% –12V ±5% +5V ±5%	1,800 300 1,500		
16	POWER CONSUMPTION, max (W)	30		
17	OPERATING TEMP. (°C) (1)	-20 to +70		
18	OTHER ENVIRONMENTAL PARAMETERS	APPLICABLE FOR AIRBORNE APPLICATIONS		
19	DIMENSIONS, Inches (mm)	6 x 6 x 1.1, (152.4 x 152.4 x 27.9)		

(1) Other values are Optional
(2) With an external reference oscillator with the following phase noise dBc/Hz:
@ 100 Hz Offset: -125
@ 1 kHz Offset: -140
@ 10 kHz Offset: -155
@ >100 kHz Offset: -160
(3) Internal Reference Optional
(4) Degraded by 3 dB @ 18 to 19 GHz
(5) 10 MHz Optional
(6) To within ±1 MHz from final frequency

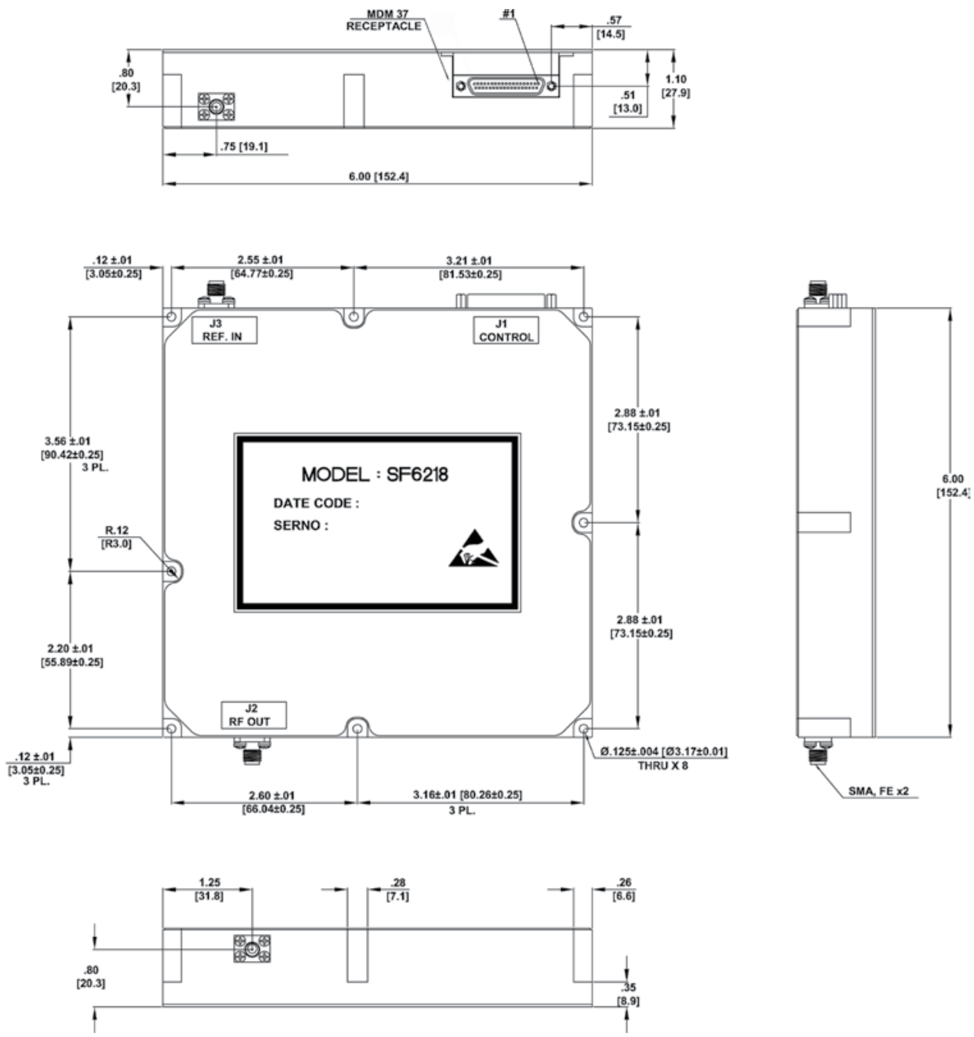
OPTION (G09) ENVIRONMENTAL CONDITIONS

1. **Storage Temperature** -40° to +120°C
2. **Mechanical Shock** MIL-STD-810C, Method 516.2 Procedure I
3. **Random Vibration** MIL-STD-810C, Method 514.2 Figure 514.2-5, Curve AG, 9.3 Grms
4. **Humidity** MIL-STD-810E, Method 507.3 Procedure III
5. **Altitude** 50,000 ft.

AVAILABLE OPTIONS

Option No.	Description
G01	Internal Reference Crystal Oscillator
G02	Operating Temperature -40° to +70°C
G08	10 MHz Reference
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS and WEIGHT



Weight (Approx.): 1,0 Kg (2.2 Pounds)

DIMENSIONS IN INCHES (mm)

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Pin Assignment for Connector J1

Pin Assignment for Connector J1:			
Pin No.	Signal Name	Pin No.	Signal Name
1	Strobe	20	+12V
2	+12V	21	+12V
3	GND	22	GND
4	+5V	23	+5V
5	+5V	24	GND
6	GND	25	-12V
7	-12V	26	Frequency Bit 0
8	Frequency Bit 1	27	Frequency Bit 2
9	Frequency Bit 3	28	Frequency Bit 4
10	Frequency Bit 5	29	Frequency Bit 6
11	Frequency Bit 7	30	Frequency Bit 8
12	Frequency Bit 9	31	Frequency Bit 10
13	Frequency Bit 11	32	Frequency Bit 12
14	Frequency Bit 13	33	Frequency Bit 14
15	Frequency Bit 15	34	Frequency Bit 16
16	Frequency Bit 17	35	Frequency Bit 18 (2)
17	Frequency Bit 19 (2)	36	Frequency Bit 20 (2)
18	N.C. (1)	37	N.C. (1)
19	Lock Indicator		

Note:
(1) For factory use only. All N.C. pins should not be connected
(2) For Model SF6053 - Not Connected

Series SM60 1µsec Fast Indirect Synthesizer With Frequency Modulation

- High Speed: 1 µsec
- Wide Frequency Range: 2 to 18 GHz
- Modulation Span: 1 GHz
- Analog & Digital Modulation Input
- Small Size
- High Reliability
- Severe Environmental Conditions

Synthesizer Model SM6218

Series SM60 Low Phase Noise Fast Indirect Synthesizer

KRATOS General Microwave has enhanced the the series SF60 fast, broadband, indirect synthesizer by adding a modulation function. With this function, the synthesizer is well suited for use in various test systems where the signal output of the signal generator needs to be modulated rather than be just a CW signal.

The modulation input can be an analog voltage or a digital signal. This provides the system designer with more flexibility in his application and possibilities for complex modulation options. Fig. 1 is the spectrum of the output signal with a 1 MHz sine-wave modulation input.

Of special importance is the fact, that this synthesizer remains fully locked even during frequency modulation. As a result of it, the high frequency accuracy and other high performances of the synthesizer are kept all of the time. For this reason, in this synthesizer there isn't the "movement" of the center frequency nor the problem of non linearized modulation.

APPLICATIONS

The Model SM6218 Fast Synthesizer, with Frequency Modulation capability, has been developed as an enhancement to the existing Series SF60 1 usec, CW Synthesizer family. It offers a higher performance and cost effective alternative to signal generators currently used in various applications such as Electronic Warfare (EW), Simulators, Test Systems and especially those which require improved frequency accuracy, phase noise and frequency modulation capabilities. In addition, the Model SM6218 design allows the flexibility to customize .performance to specific application requirements

MODEL SM6218 – TYPICAL MODULATION SPECTRUMS

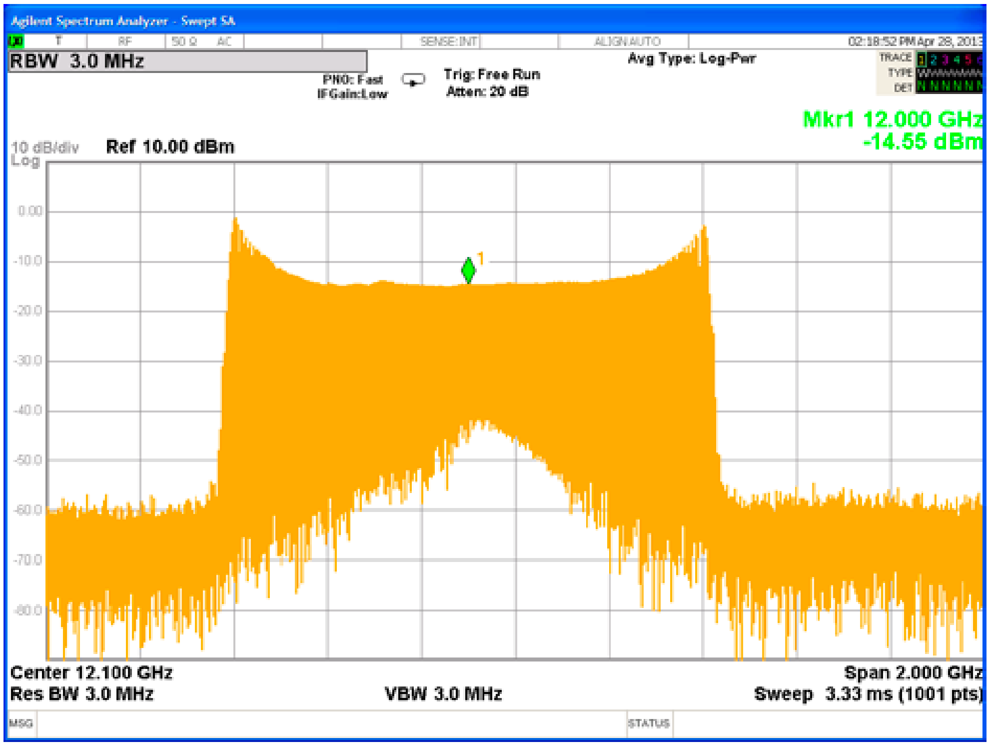


Fig. 1 - 1 GHz Modulation Spectrum using a Sine wave signal

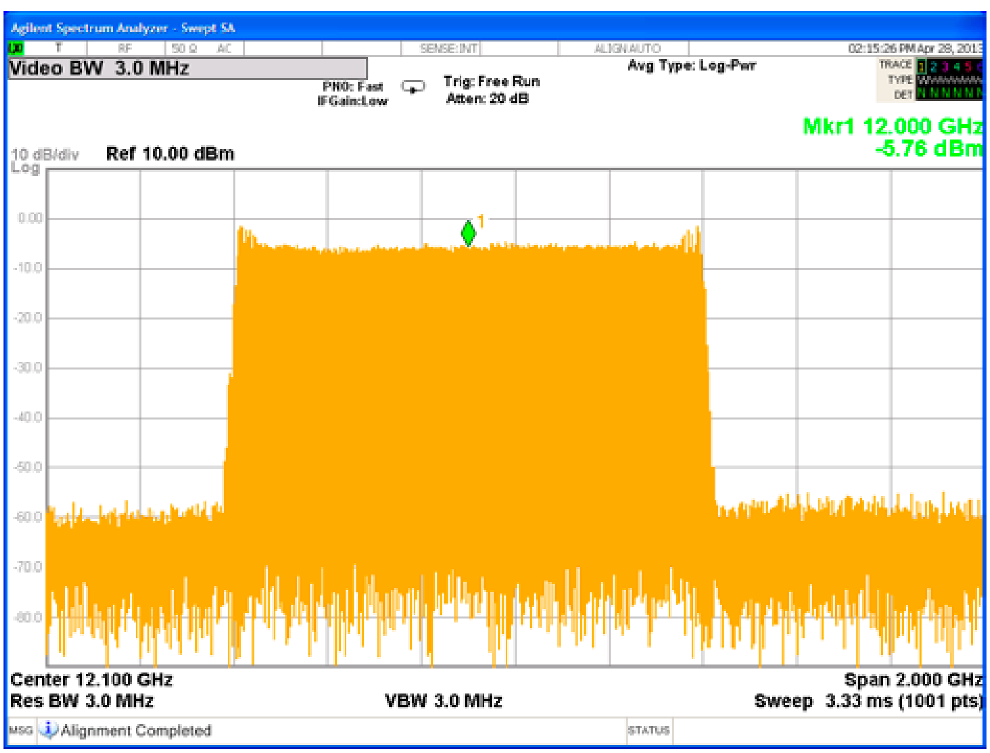


Fig. 2 - 1 GHz Modulation Spectrum using a Triangle signal

SERIES SM60 SYNTHESIZER SPECIFICATIONS

		SPECIFICATION - MODEL		
PARAMETER		SM6218	SM6618	SM6220
1	FREQUENCY RANGE (GHz)	2 to 18 (1)	6 to 18 (1)	2 to 20 (1)
2	ACCURACY	Same (PPM) as of the reference crystal oscillator		
3	FREQUENCY AGING	Same (PPM) as of the reference crystal oscillator		
4	OUTPUT POWER			
4.1	Min. (dBm) (1)	10		
4.2	Variation, over freq. at a given temp., max. (dB)	±1.5		
4.3	Variation, over temperature, max. (dB)	±2.5		
5	SETTLING TIME (6), max. (µsec)	1		
6	SSB PHASE NOISE, max (dBc/Hz) (4)			
6.1	@ 100 Hz Offset	–75		-74
6.2	@ 1 kHz Offset	-90		-89
6.3	@ 10 kHz Offset	-97		-96
6.4	@ 100 kHz Offset	-97		-96
6.5	@ 1 MHz Offset	-97		-96
6.6	@ 10 MHz Offset	-100		-99
7	HARMONICS, max (dBc)	–30 up to 24 GHz -40 from 24 GHz to 40 GHz		
8	SUB-HARMONICS, max (dBc)	NA		
9	SPURIOUS, max (dBc) (2)	–55		-54
10	FREQUENCY CONTROL (PARALLEL)	18 BITS		
11	FREQ. STEP SIZE, nominal LSB (kHz) (1)	100		
12	REFERENCE CRYSTAL OSCILLATOR - EXTERNAL (3)			
12.1	INPUT FREQUENCY, (MHz) (5)	100		
12.2	INPUT POWER, (dBm)	0 ±2		
13	MODULATION			
13.1	Bandwidth, (MHz)	Dc to 10		
13.2	Frequency Deviation, min. (MHz)	± 500		
13.3	Sensitivity control (3 levels plus Mod. OFF)	2 BITS		
13.4	Digital Modulation Control	10 BITS		
13.4	Digital Sensitivity, nominal (MHz/bit)	1, 1/4, 1/16, Mod. OFF		
13.5	Analog Control, (V)	±1		
13.6	Analog Sensitivity, nominal (MHz/V)	512, 128, 32, Mod. OFF		

(1) Other values are available. Please contact Sales.
(2) Spurious level is guaranteed during modulation at OFF state. When modulation is set to ON, the spurious level is -50 dBc typical.
(3) Internal Reference Oscillator is optional
(4) With an external reference oscillator with the following phase noise dBc/Hz
@ 100 Hz Offset: -125
@ 1 kHz Offset: -140
@ 10 kHz Offset: -155
@ >100 kHz Offset: -160
(5) 10 MHz Optiona
(6) To within ±1 MHz from the final frequency

SERIES SF60 SYNTHESIZER SPECIFICATIONS

		SPECIFICATION - MODEL		
PARAMETER		SM6218	SM6618	SM6220
14	POWER SUPPLY REQUIREMENT, max. (A)			
14.1	+12V to +15V	3.2		
14.2	-12V to -15V	0.45		
14.3	+5V ±5%	2.1		
15	OPERATING TEMP. (°C) (1)	-20 to +70		
16	OTHER ENVIRONMENTAL PARAMETERS	APPLICABLE FOR AIRBORNE APPLICATIONS		
17	DIMENSIONS, Inches (mm)	6.48 (164.6) x 6.23 (158.2) x 1.24 (31.5)		

(1) Other Parameters are Optional

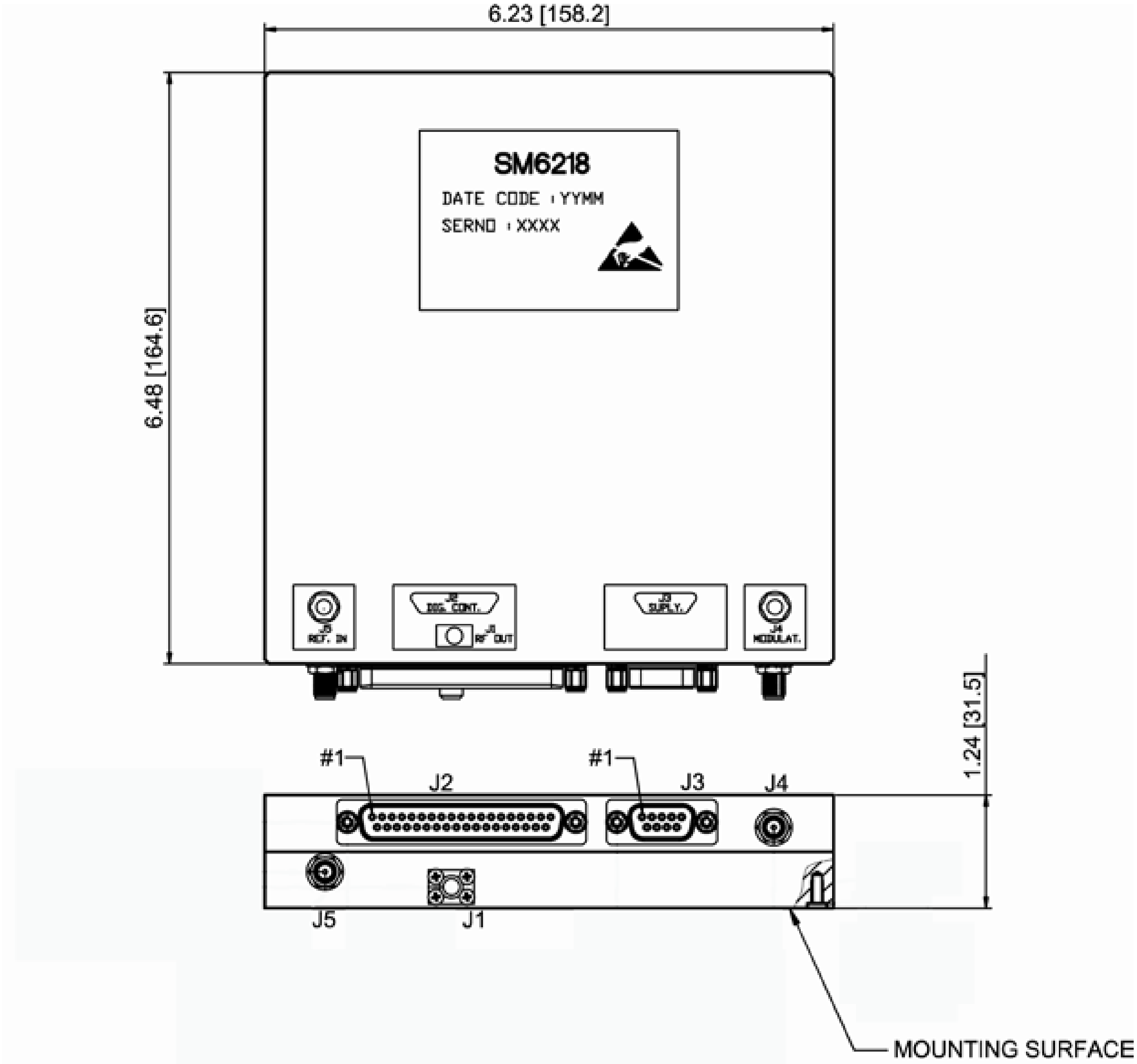
OPTION (G09) ENVIRONMENTAL CONDITIONS

1. **Storage Temperature** **-40^0 to +120^{0}C**
2. **Mechanical Shock** **MIL STD-202F, Method 213B, Cond. B (75G, 6 msec)**
3. **Vibration** **MIL STD-202F, Method 204D, Cond. B (.06" double amplitude or 15G, whitchever is less)**
4. **Humidity** **MIL STD-202F, Method 103B, Cond. B (96 hrs. at 95%)**
5. **Altitude** **MIL-STD-202F, Method 105C, Cond. B (50,000 ft.)**

AVAILABLE OPTIONS

Option No.	Description
G01	Internal Reference Crystal Oscillator
G02	Operating Temperature -40^0 to +70^{0}C
G08	10 MHz Reference
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS and WEIGHT MODELS SM6218, SM6220 & SM6618



DIMENSIONS IN INCHES (mm)

Weight (Approx.): 1,4 Kg (3.1 Poun

CONNECTORS DATA		
SYM	FUNCTION	DESCRIPTION
J1	RF OUTPUT	COAX. CONN. SMA FEMALE
J2	DIGITAL CONTROL	D-TYPE CONN. "DC-37P" (MALE)
J3	SUPPLY	D-TYPE CONN. "DE-9P" (MALE)
J4	MODULATION	COAX. CONN. SMA FEMALE
J5	REF. IN	COAX. CONN. SMA FEMALE

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Pin Assignment - Model SM6218

Power Connector J3

Pin No.	Function
1.	+5V
2.	-12V
3.	+12V
4.	GND
5.	+5V
6.	GND
7.	GND
8.	GND
9.	+12V

Control Connector J2

Pin No.	Function
1.	A14 Tuning Word
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.	A15 Tuning Word
9.	STROBE
10.	M0 Modulation Word (LSB)
11.	GND
12.	M1 Modulation Word
13.	M3 Modulation Word
14.	M5 Modulation Word
15.	M7 Modulation Word
16.	M9 Modulation Word (MSB)
17.	Modulation Analog(1)/Digital(0)
18.	RF on (1) / RF off (0)
19. (*)	Normal (1)/Transparent (0) MODE
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.	A17 Tuning Word (MSB)
29.	M4 Modulation Word
30.	D0 Max Deviation Control
31.	D1 Max Deviation Control
32.	Lock Detect
33.	M6 Modulation Word
34.	M8 Modulation Word
35.	M2 Modulation Word
36.	Internal Ref (1) / External (0)
37.	A16 Tuning Word

(*) This pin is for factory use only and should be left not connected.

Series SW Compact Wide Frequency Band Indirect Synthesizer

- **Small Size: 3 x 3 x 1.28"**
- **Wide Frequency Range: 2 to 20 GHz**
- **High Resolution: 100 Hz**
- **Low Cost**
- **Internal Reference**

Synthesizer Model SW0120

Series SW Compact Wide Frequency Band Indirect Synthesizer

Kratos General Microwave introduces the Synthesizer General Purpose Series SW Compact, Wide Band, Indirect Synthesizers offering exceptionally high performance at a low cost.

APPLICATIONS

The Series SW synthesizer has been designed to be used in applications where small size, low cost and wideband operation are important requirements. It can be used as a Signal Generator in Portable Test Equipment, as microwave source in Built In Test (BIT) subassembly or in a broad frequency range electronic system.

For military applications, this synthesizer requires option G09 to comply with Military Standards. The specific environmental MIL STD requirements as well as the EMI/RFI specifications should be provided by the customer.

Series SW Compact Synthesizer

SERIES SW SYNTHESIZER SPECIFICATIONS

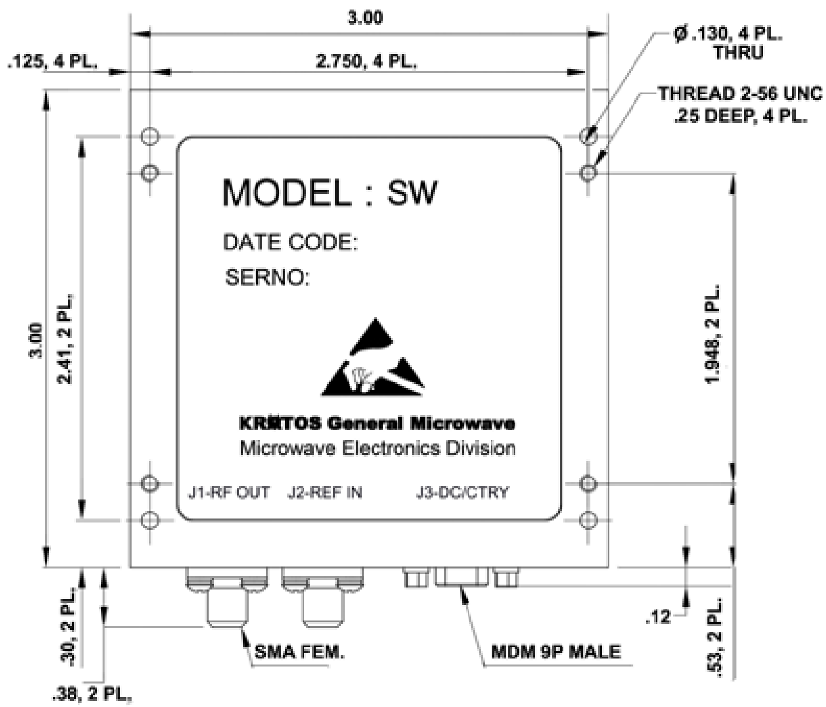
	PARAMETER	SPECIFICATION - MODEL			
		SW0580	SW0120	SW0220	SW0618
1	FREQUENCY RANGE (GHz) (1)	0.5 to 8	1.25 to 20	2 to 20	6 to 18
2	ACCURACY at 25ºC , (ppm) (2)	±1			
3	FREQUENCY AGING, (ppm/Year) (2)	±1			
4	FREQUENCY STABILITY OVER TEMP., ppm (2)	±1			
5.1	OUTPUT POWER min. , (dBm) (1)	+7			
5.2	Peak to Peak Variation Over frequency and temperature (dB)	6			
6	SETTLING TIME , (µsec) (3)	120±15			
7	SSB PHASE NOISE , max (dBc/Hz) (2)				
7.1	@ 100 Hz Offset	–65	–57		-57
7.2	@ 1 kHz Offset	-86	-78		-78
7.3	@ 10 kHz Offset	-93	-87		-87
7.4	@ 100 kHz Offset	-93	-87		-87
7.5	@ 1 MHz Offset	-93	-87		-87
7.6	@ 10 MHz Offset	-130	-125		-125
8	HARMONICS, Typ. (dBc)	–20			
9	LOCK DETECT	TTL High			
10	SPURIOUS, max (dBc)	–65	-60		-60
11	FREQUENCY CONTROL	Serial Control			
12	FREQ. STEP SIZE, nominal LSB (kHz) (1)	0.1			
13	REFERENCE OSCILLATOR, External(2)				
13.1	INPUT FREQUENCY (MHz)	100			
13.2	INPUT POWER (dBm)	0 ±2			
14	SUPPLY VOLTAGE				
14.1	VDC, mA	+12 ±5%, 700			
14.2	VDC, mA	-12 ±5%, 250			
15	DIMENSIONS, Inch (mm)	~ 3 x 3 x 1 (76.2 x 76.2 x 25.4)			
16	RF IN/OUT CONNECTORS	SMA Female			
17	CONTROL CONNECTOR	MDM			
18	OPERATING TEMPERATURE, (°C)	-20 to +70			

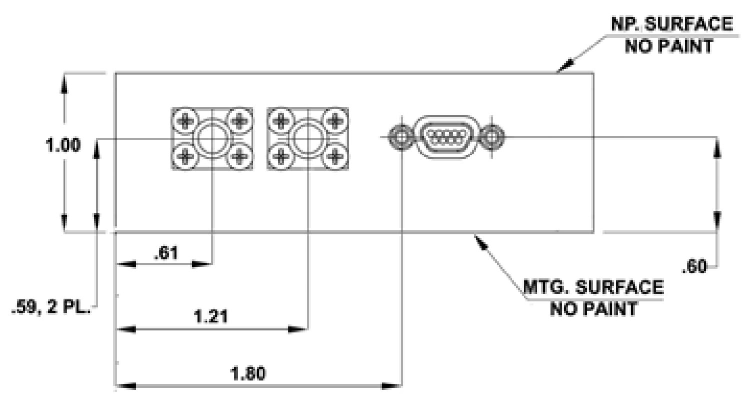
(1) Other Parameters are Optional
(2) Specification is for internal reference. The unit can be configured to work with the internal reference or with an external reference.
(1) For 50 µsec settling time, order option G17.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS and WEIGHT





Weight (Approx.): 250 Gr. (8.8 Oz)

DIMENSIONS IN INCHES (mm)

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.010

J3 - Pin Assignment

PIN No.	FUNCTION
1	VIN positive +12V ±10%
2	SDI (Serial Com.)
3	SCLK (Serial Com.)
4	STROBE (Serial Com.)
5	Lock Detect
6	VIN negative -12V ±10%
7	For Factory Use - Do not connect
8	For Factory Use - Do not connect
9	GND

Frequency Extender Series FE

Series FE Frequency Extender

Kratos General Microwave introduces the series FE Frequency Extender to complement the Fast Indirect Synthesizer product line

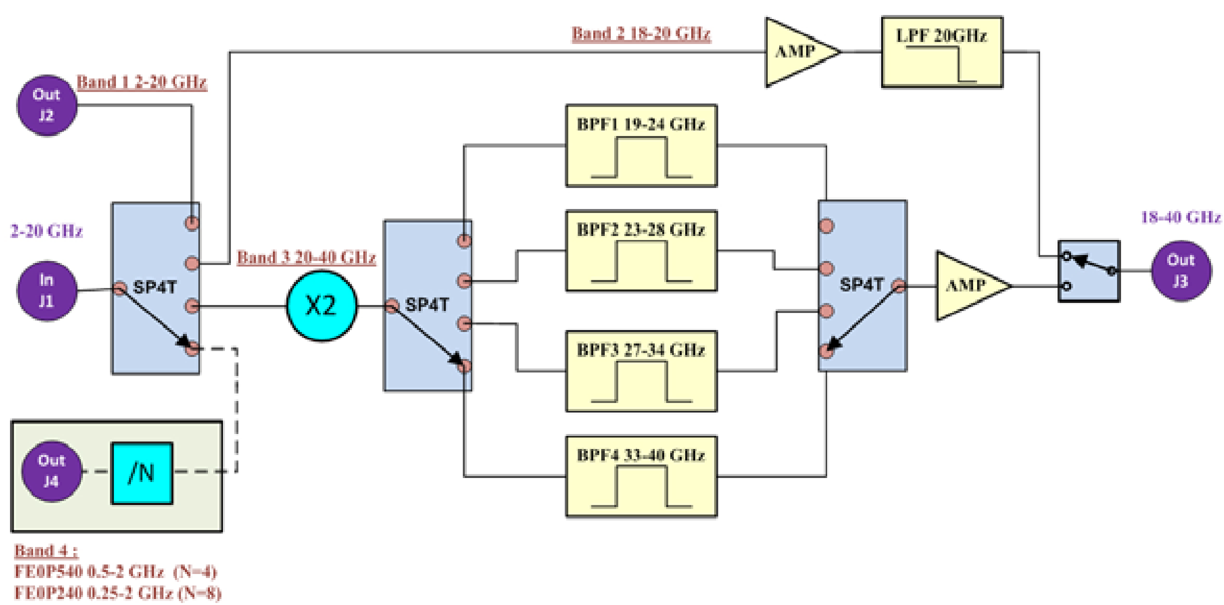
The series FE Frequency Extender has been designed to extend, at a low cost, the frequency range of the high performance Fast Indirect Synthesizers enabling operation from 0.5 to 40 GHz.

The following product families may be used as an input source for the FE Frequency Extender: SW0120, SF6219, SM6220, D6218.

The SM6220 synthesizer is capable of wideband frequency modulation with a span of 1 GHz. The FE is supporting this capability through millimeter wave. The result of combining the SM6220 with the FE is a wideband synthesizer capable of wideband frequency modulation with a span of 1 GHz up to 40 GHz.

- **Input Frequency within 2 to 20 GHz**
- **Output Frequency 2 to 40 GHz**
  Optional 0.5 to 40 GHz
  Optional 0.250 to 40 GHz
- **Compact Size**
- **Airborne**
- **Low Cost**

Frequency Extender
Model FE0P240



Option No.	Description
G09	Guaranteed to meet Environmental Ratings

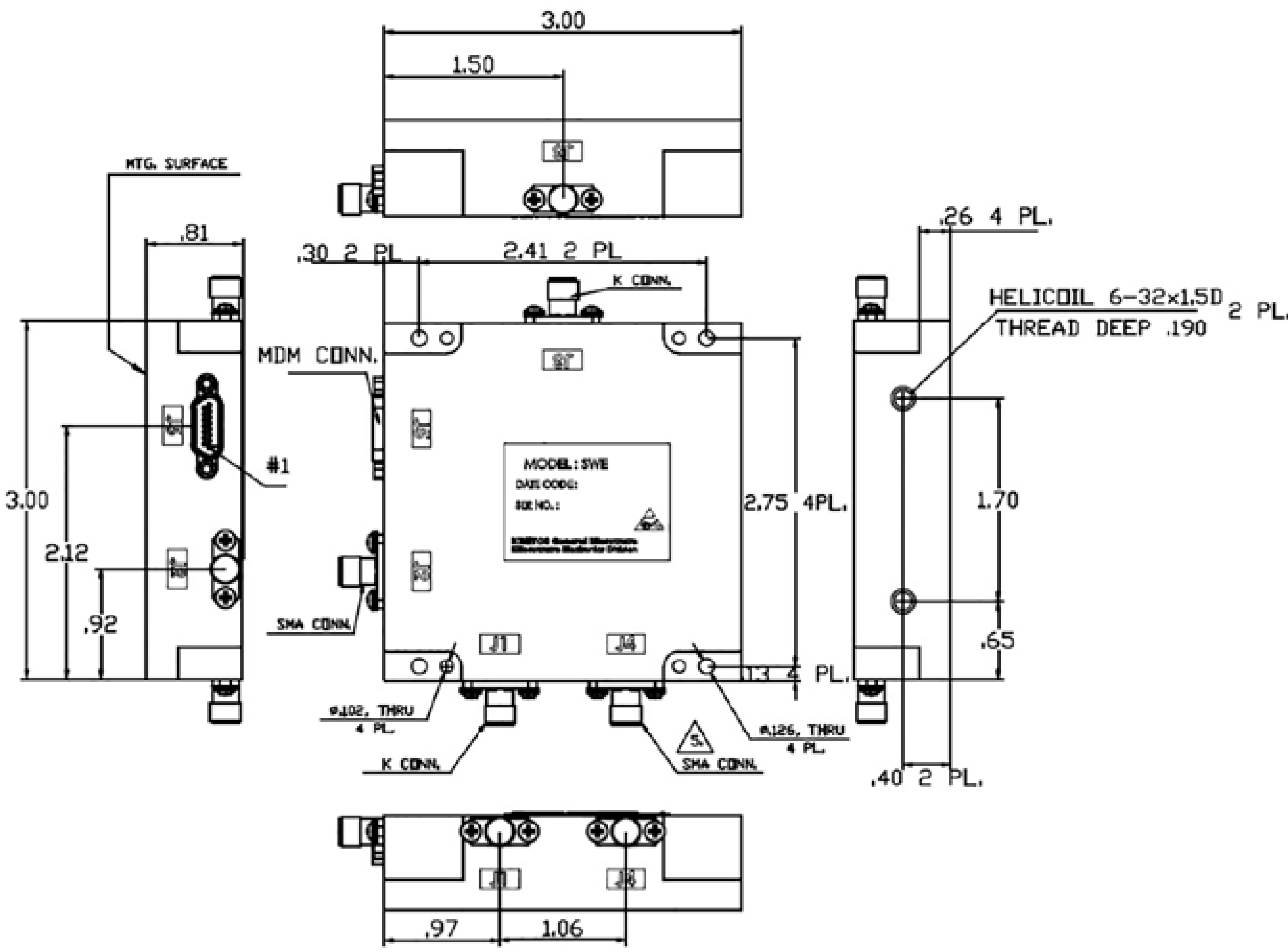
SERIES FE - SPECIFICATIONS

PARAMETER		SPECIFICATION			
Model		FE0P540	FE0240	FE0P520	FE0P240
1	INPUT FREQUENCY RANGE (GHz)	2 to 20	2 to 20	2 to 20	2 to 20
2	OUTPUT FREQUENCY RANGE (GHz)	0.5 to 40	2 to 40	0.5 to 20	0.25 to 40
2.1	J2	2 to 20	2 to 20	2 to 20	2 to 20
2.2	J3	18 to 40	18 to 40	N A	18 to 40
2.3	J4	0.5 to 2	N/A	0.5 to 2	0.25 to 2
3	INPUT POWER (dBm)	+8 to +12	+8 to +12	+8 to +12	+8 to +12
4	OUTPUT POWE (dBm)				
4.1	2 to 20 GHz @ J2 min.	=(Input Power-4dB)			
4.2	18 to 40 GHz @ J3 typ.	+10 to +15	+10 to +15	N A	+10 to +15
4.3	0.5 to 2 GHz @ J4 typ.	0	N/A	0	0
5	INPUT VSWR, max.	2.0:1	2.0:1	2.0:1	2.0:1
6	OUTPUT VSWR				
6.1	0.5 to 2 GHz @J4 max.	2.0:1	N/A	2.0:1	2.0:1
6.2	2 to 18 GHz @J2 max.	2.0:1	2.0:1	2.0:1	2.0:1
6.3	18 to 40 GHz @J3 max.	2.5:1	2.5:1	N A	2.5:1
7	2^{nd} HARMONICS & SPURIOUS (dBc)				
7.1	2.0 to 20 GHz, min.	-50	-50	-50	-50
7.2	18 to 40 GHz, min. (dBc)	-50	-50	N A	-50
8	SWITCHING TIME, max (nSec)	250	250	250	250
9	SUPPLY VOLTAGE (A)				
9.1	12 to 15 VDC (A)	1.5	1.5	0.85	1.5
9.2	-12 to -15 VDC max.	0.25	0.25	0.25	0.25
10	FILTER OVERLAP, min. (GHz)	1	1	N A	1
11	FILTER CONTROL, TTL, Logic 1, BITS	7	7	N A	7
12	OPERATING TEMPERATURE, (°C)	-40 to +85	-40 to +85	-40 to +85	-40 to +85
13	AIRBORNE ENVIRONMENT (Option G09)	YES	YES	YES	YES
14	LASER SEALING	YES	YES	YES	YES
15	RF CONNECTORS				
15.1	J1, J2, J4	SMA FEMALE			
15.2	J3 OUTPUT	K FEMALE		N A	K FEMALE
16	CONTROL CONNECTOR	MDM 15 PINS			
17	DIMENSIONS, (mm)	76.2 x 76.2 x 20.32			
17.1	DIMENSIONS, (Inches)	3.0 x 3.0 x 0.8			

NOTES

1. With Option G09 -40 to □85 °C
2. Requires Option G09

DIMENSIONS and WEIGHT



DIMENSIONS IN INCHES (mm)

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

LOGIC TABLE

	S0	S1	S2
Shunt-Down Mode	0	0	0
2 to 20 GHz (J2)	0	0	1
18 to 20 GHz (J3)	0	1	0
19 to 24 GHz (J3)	0	1	1
23 to 28 GHz (J3)	1	0	0
27 to 34 GHz (J3)	1	0	1
33 to 40 GHz (J3)	1	1	0
0.5 to 2 GHz (J4)	1	1	1

PINOUT TABLE

J5 PIN No.	FUNCTION
1	+12 V
2	+12 V
3	GND
4	S0
5	S1
6	S2
7	N/C
8	GND
9	-12 V
10	GND
11	N/C
12	GND
13	N/C
14	N/C
15	GND

NOTES:

TTL Logic Levels:
“0” - -0.3 to +0.8 V
“1” - +2 to +5 V

CONTROL COMMAND

- Switch control logic signals shall be 3 line binary coded TTL logic, as described in the Logic Table.
- Shut-Down Mode – the unit is set to J4 and there is no current to the frequency divider.

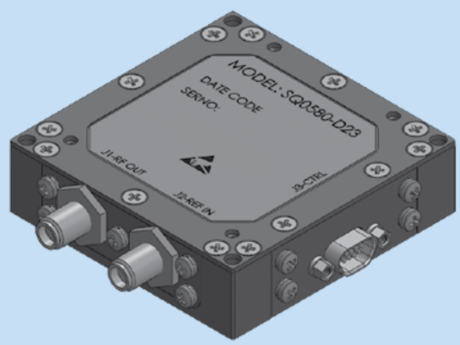
Series SQ0580 Narrow Frequency Band Synthesizer

Series SQ0580 Narrow Frequency Band Synthesizer

Kratos General Microwave introduces the Series SQ Narrow Band Synthesizer as a high performance, low cost alternative to a fixed frequency source.

APPLICATIONS
The Series SQ synthesizer has been designed to be used as the L.O. in various up and down frequency converters. It can be used as a replacement of a DRO, in applications that require high frequency stability over temperature and in operation under vibrations.

- **Operating Frequency within 0.5 to 8 GHz**
- **High Frequency Accuracy**
- **High Frequency Stability**
- **Low Cost**
- **Compact Size**
- **High Reliability**



Synthesizer Model SQ

SERIES SQ - SPECIFICATIONS

		SPECIFICATION
PARAMETER		MODEL SQ0580
1	FREQUENCY RANGE (GHz) (1)	0.5 to 8
2	RF BANDWIDTH, up to (%)	0.3
3	ACCURACY, (ppm)	Same as of the ref. crystal
4	FREQUENCY AGING, (ppm)	Same as of the ref. crystal
5	FREQUENCY STABILITY, (ppm)	Same as of the ref. crystal
6	OUTPUT POWER, (dBm)	+10 to +14
7	SETTLING TIME, max. (μsec)	50
8	SSB PHASE NOISE , max (dBc/Hz) (2)	@ 8 GHz
8.1	@ 100 Hz Offset	-70
8.2	@ 1 kHz Offset	-90
8.3	@ 10 kHz Offset	-99
8.4	@ 100 kHz Offset	-125
8.5	@ 1 MHz Offset	-142

SERIES SQ - SPECIFICATIONS

PARAMETER		SPECIFICATION MODEL SQ0580
9	HARMONICS, (dBc) typ	-60
10	SUB-HARMONICS, max (dBc)	-60
11	SPURIOUS, max (dBc)	-80
12	CONTROL	Serial Control
13	FREQ. STEP SIZE, nominal LSB (Hz) (1)	100
14	EXTERNAL REFERENCE OSCILLATOR (2)	
14.1	INPUT FREQUENCY (MHz)	100
14.2	INPUT POWER (dBm)	0 ± 2
15	SUPPLY VOLTAGE , (VDC)	12 ±0.4V @ 290 mA
16	DIMENSIONS, Inch (mm)	2.25 (57.2) x 2.25 (57.2) x 1.28 (32.5)
17	RF OUTPUT & REF INPUT CONNECTORS	SMA Female
18	CONTROL CONNECTOR	MDM (9 PINS)
19	OPERATING TEMPERATURE, (°C)	-40 to +85
20	STORAGE TEMPERATURE, (°C)	-65 to +125
21	ENVIRONMENTAL CONDITIONS	Airborne
22	LOCK DETECT OUTPUT	TTL High

(1) Other Parameters are Optional

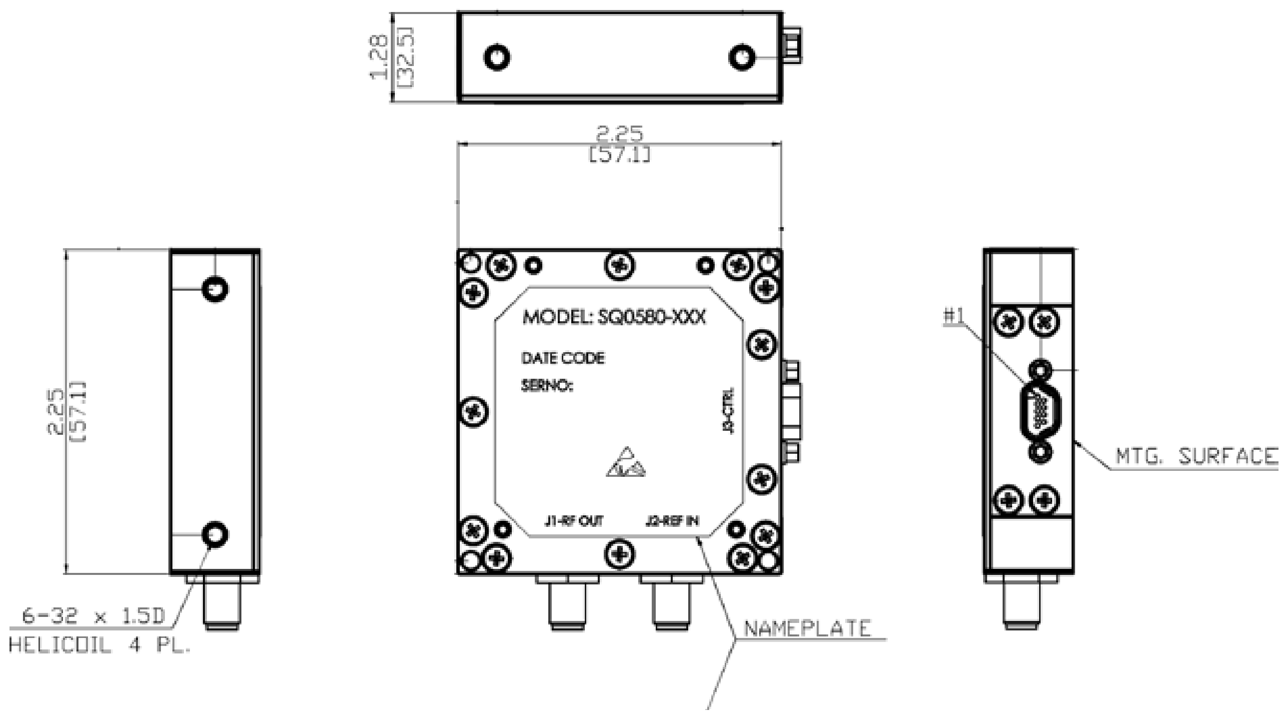
(2) For internal Reference Oscillator (option G01) or external reference oscillator with the following specs (100MHz output):

- 100Hz offset: - 120 dBc/Hz
- 1KHz offset: -137 dBc/Hz
- 10KHz offset: -145 dBc/Hz

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS and WEIGHT



DIMENSIONS IN INCHES (mm)

Weight (Approx.): Gr. (Oz)

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

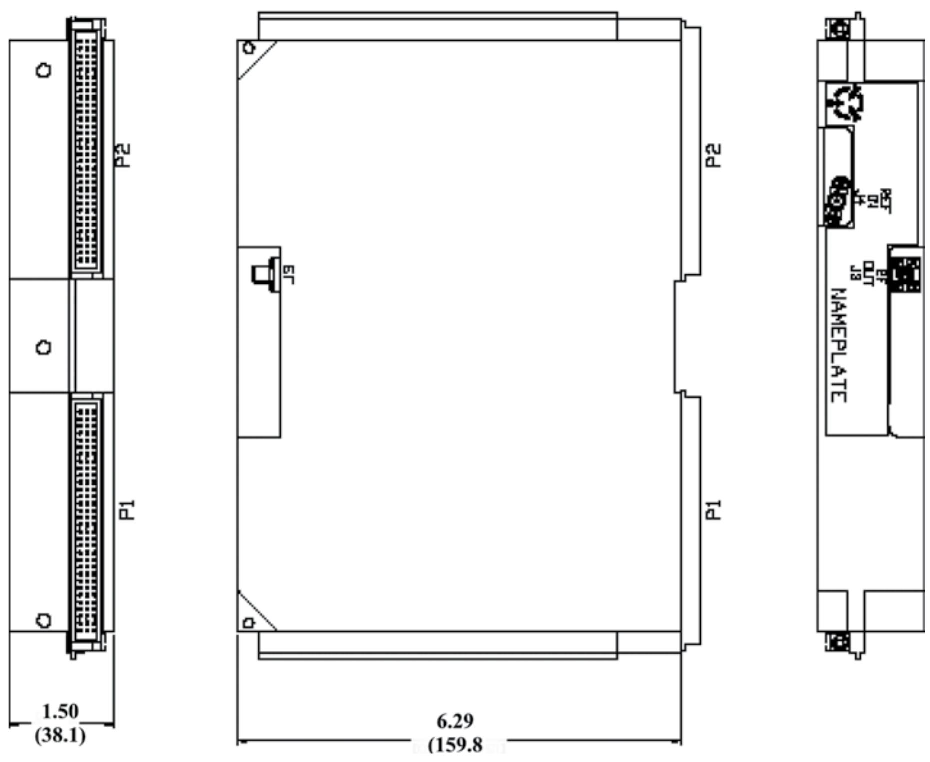
CUSTOM SYNTHESIZERS

Kratos General Microwave has delivered a large number of custom synthesizers for various applications. Most of these custom synthesizers were for airborne Electronic Warfare systems. Following is a sample of custom synthesizers we delivered to our customers.

VME CONTROLLED SYNTHESIZER

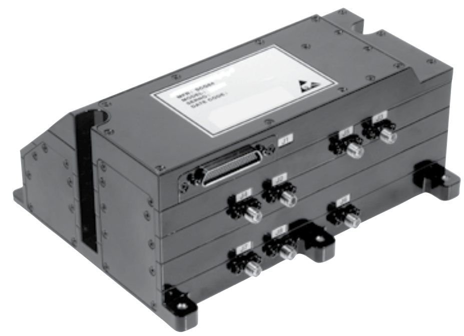
FEATURES

- Wide Frequency Range
- Fast Settling Time
- Low Power Consumption
- VME mechanical and control Interface

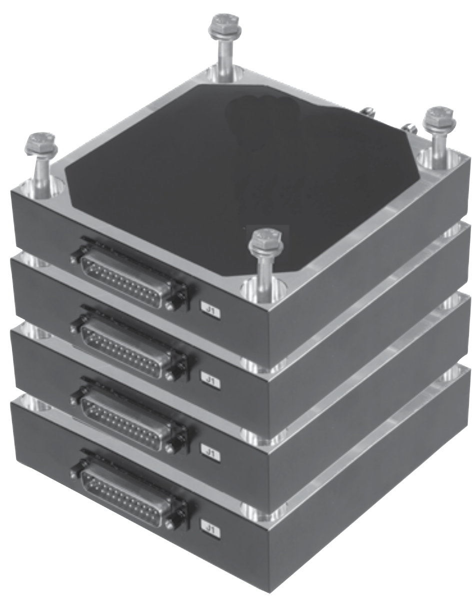


DIRECT SYNTHESIZER

- Broad Frequency Range
- Settling Time: 40 nsec.
- Phase Noise
  @ 1 kHz: -91 dBc/Hz
  @ 100 kHz: -114 dBc/Hz
  @ 1 MHz: -116 dBc/Hz
- Coherency Guaranteed



BANK OF SYNTHESIZERS



FEATURES

- Low Spurious
- Wide Frequency Range
- High Reliability

SYNTHESIZER - FORM FIT REPLACEMENT

- Low Spurious
- Wide Frequency Range
- High Reliability
- Replacement for YIG

Digitally Tuned Oscillators (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. 1. 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, a separate frequency modulation port is provided. Since the slope of the frequency vs. voltage curve of the VCO varies over the frequency 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.

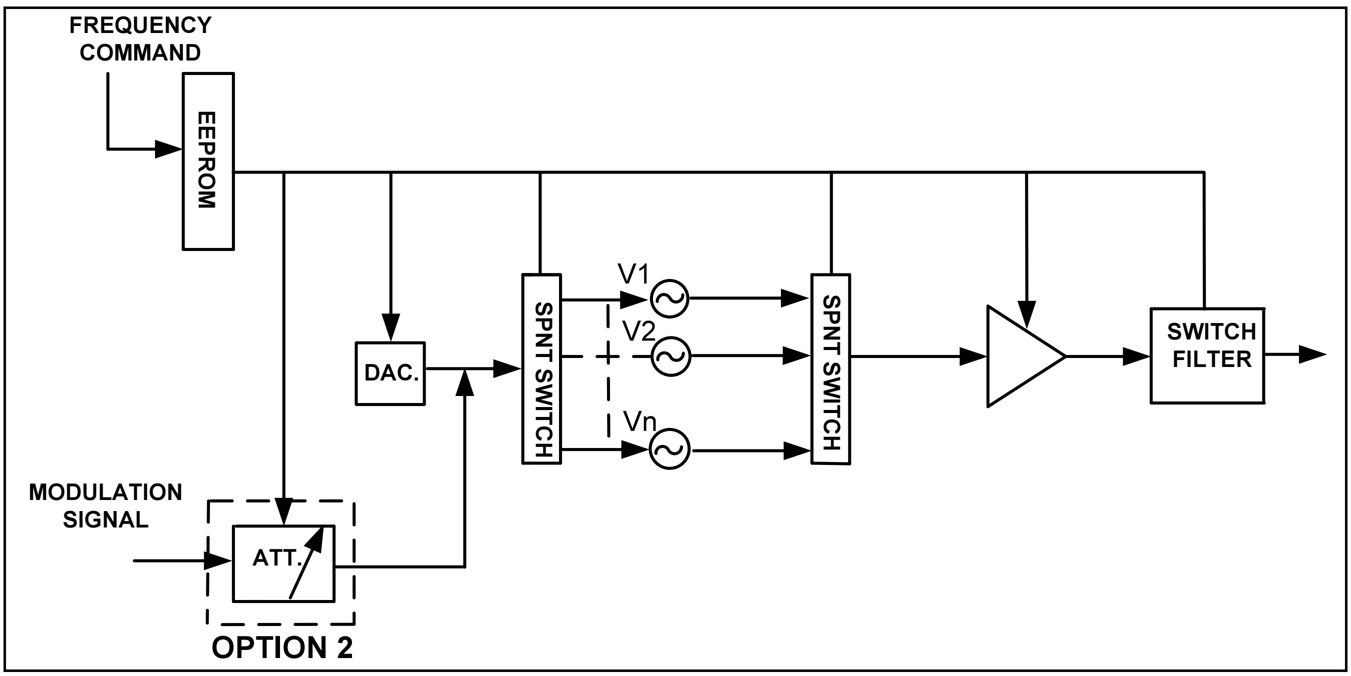


Fig. 1–DTO Block Diagram

SELECTION GUIDE DIGITALLY TUNED OSCILLATORS (DTO)

FREQUENCY RANGE (GHz) 0.5 2 4 6 8 12 18 19	MODEL	PAGE	COMMENTS
1 – 2	D6010C	380	Single Band Digitally Tuned Oscillators
2 – 4	D6020C		
2.6 – 5.2	D6026C		
4 – 8	D6040C		
8 – 12	D6080C		
12 – 18	D6120C		
0.5 – 2	D6052	383	Multi-Band Digitally Tuned Oscillators
2 – 6	D6206		
6 – 18	D6618		
2 – 18	D6218		
2 – 6 6 – 18	DC6206 DC6618	388	Compact Airborne DTO
0.5 – 18	------	393	Custom Multi-Band Digitally Tuned Oscillators

Series D60
Single-Band DTOs

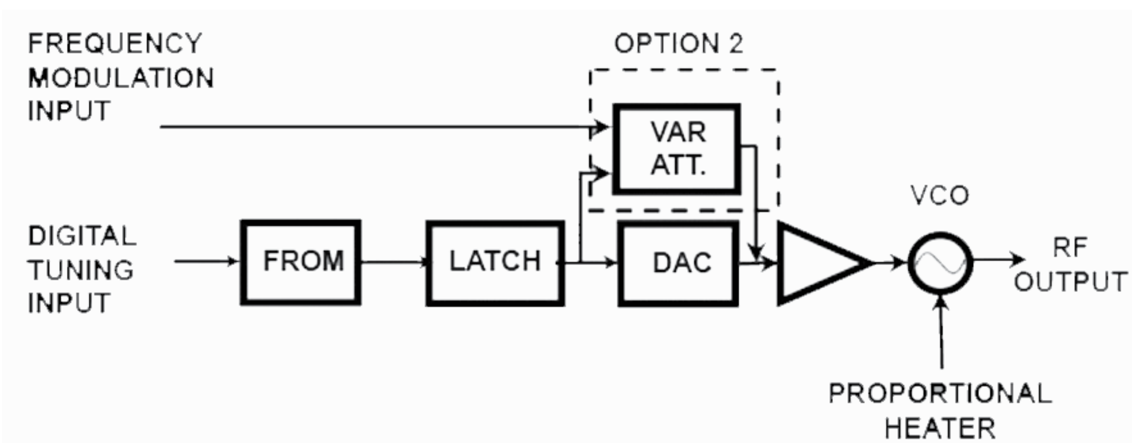
The Series D60 single-band DTO covers the frequency range of 0.5 to 18 GHz in 6 DTOs. Fig. 2 is the basic block diagram of the single band DTO.

When constant deviation bandwidth is required across the entire frequency band of the DTO, Option 2 should be used.

For military applications, these DTOs require option G09 to comply with Military Standards. The specific environmental MIL STD requirements as well as the EMI/RFI specifications should be provided by the customer.

- **1 to 18 GHZ in Various Sub-Band**
- **Fast Settling Time**
- **Modulation Capabilities**
- **High Reliability**

DTO Model D6040C



SINGLE BAND DTO SPECIFICATIONS

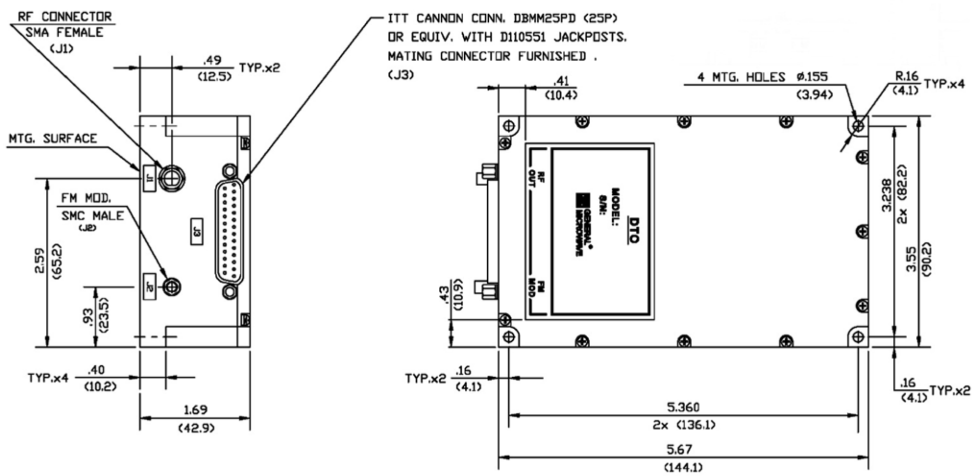
PARAMETER	MODEL D6010C	MODEL D6020C	MODEL D6026C	MODEL D6040C	MODEL D6080C	MODEL D6120C
FREQUENCY RANGE (GHz)	1-2	2-4	2.6-5.2	4-8	8-12	12-18
ACCURACY, Incl. temp. (MHz)	±2	±2	±3	±4		±6
FREQUENCY SETTING (1), **(MHz)** within 1 µsec	±2			±3		±4
MODULATION(2)						
Band Width Standard unit, min (MHz)	DC to 15					
With Option G4(6), min (MHz)	DC to 30					
Sensitivity variation Standard unit, typ	3:1					
With Option 2, max	1.1 :1					
Frequency deviation bandwidth, min @ 2v P-P (MHz)	100	200	260	400		600
RF POWER Output, min (dBm)	+10					
Variation, incl. temp. and freq. max (dB)	±2	±1.5		±2.0		
RESIDUAL FM, P-P @ –3 dBc, typ (kHz)	50		75	100		150
HARMONICS, max (dBc)	–15				–40	–20
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 Sta (MHz)	0.5			1.0		1.5
MONOTONICITY	Guaranteed					
TURN ON TIME, (minutes) to specified accuracy @ +25°	2					
CONNECTORS Control/Power	25 pin, D type male(4)					
RF output	SMA female					
FM input	SMC male					
POWER SUPPLY REQUIREMENT Voltage @ Current	+15V ± 0.5V @ 375 mA max –15V ± 0.5V @ 200 mA max +5V ± 0.5V @ 100 mA max +28V –4V, +2V@ 1,000 mA max					
Turn-On Current @ 28 volts	3 amps max					
ENVIRONMENTAL (5) Operating temperature (°C)	0 to +70					
Storage temperature (°C)	–54 to +100					
MECHANICAL DIMENSIONS Inches	5.67 x 3.55 x 1.69					
Millimeters	144,0 x 90,2 x 42,9					

AVAILABLE OPTIONS

Option No.	Description
2	Reduced Modulation Sensitivity Variation
G4	Modulation Band Width: DC to 30 MHz (6)
G09	Guaranteed to meet Environmental Ratings

(1) Δ f relative to f after 1 sec.
(2) 50 Ohm input impedance.
(3) 12 Bit TTL input.
(4) Mating connector furnished
(5) RF section and driver components hermetically sealed)
(6) Please consult us for further Modulation Band Width improvement:

DIMENSIONS AND WEIGHT



MODELS D6010C, D6020C, D6026C, D6040C, D6080C, D6120C DTOs
Wt. 23.1 oz. (655 gr) approx.

CONTROL/POWER CONNECTOR	
Pin No.	**Function**
1	+28V
2	+28V
3	Temp. monitor thermistor (VCO)
4	Tuning Word Bit 1 (LSB)
5	Tuning Word Bit 3
6	Tuning Word Bit 5
7	Tuning Word Bit 7
8	Tuning Word Bit 9
9	Tuning Word Bit 11
10	Not used
11	+5V (digital)
12	+15V (analog)
13	Analog ground

CONTROL/POWER CONNECTOR	
Pin No.	**Function**
14	+28V (return)
15	+28V (return)
16	Not used
17	Tuning Word Bit 2
18	Tuning Word Bit 4
19	Tuning Word Bit 6
20	Tuning Word Bit 8
21	Tuning Word Bit 10
22	Tuning Word 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.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

MULTI-BAND DTOs

- **0.5 to 18 GHZ in Various Sub-Band**
- **Wide Frequency Range**
- **Fast Settling Time**
- **Wide Modulation Capabilities**
- **High Reliability**

DTO Model D6218

Simulator and other Test Systems Applications

To obtain broadband frequency coverage, as well as to improve settling speed, two or more VCOs are combined, as shown in Fig. 1. 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 specified 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 190. The modular design of the DTOs enables the user to select narrower frequency coverage if desired. Please consult the factory for individual requirements.

For military applications, these DTOs require option G09 to comply with Military Standards. The specific environmental MIL STD requirements as well as the EMI/RFI specifications should be provided by the customer.

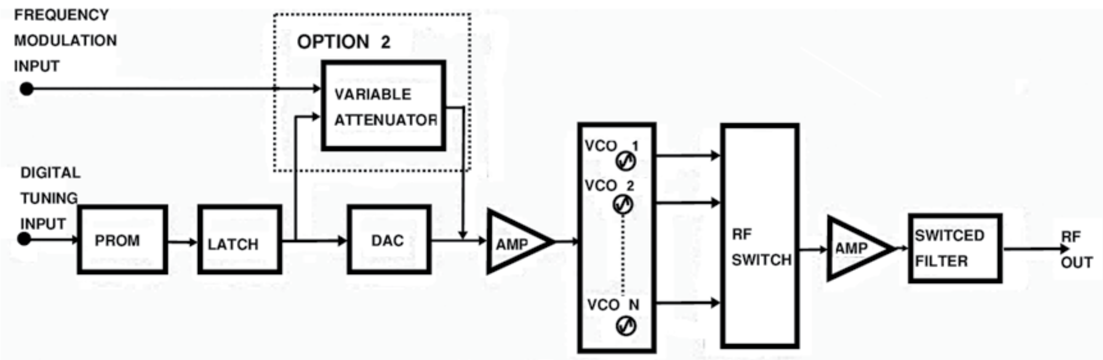


Fig. 1–Multi-Band DTO Block Diagram

Series D60 Multi-Band DTOs Specifications

MULTI-BAND DTO SPECIFICATIONS

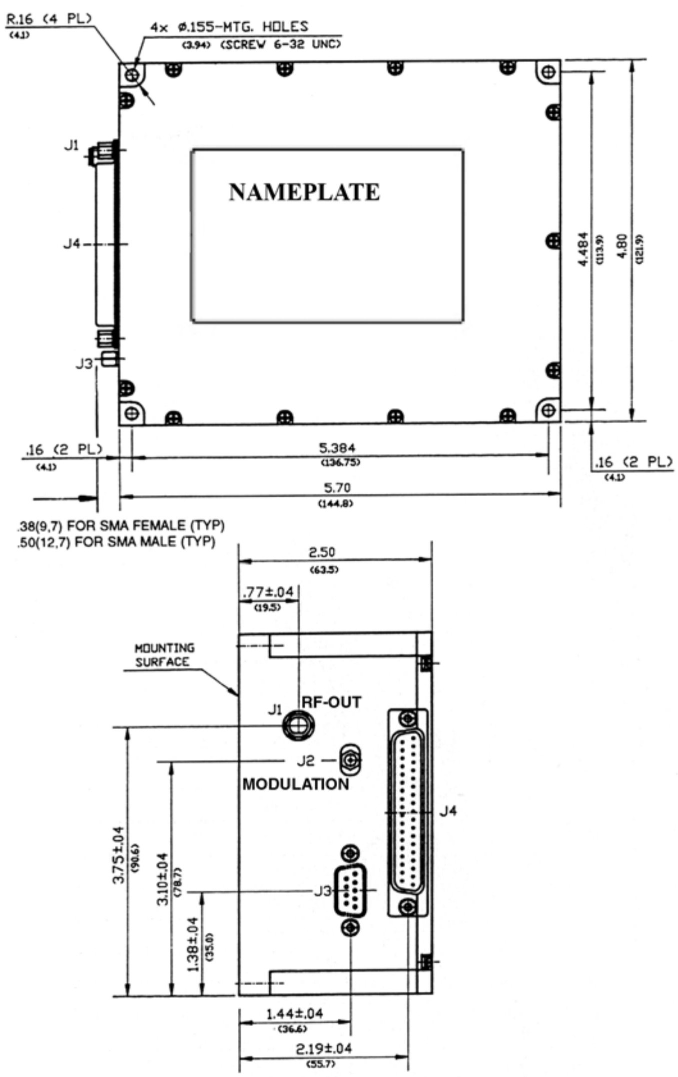
PARAMETER	MODEL D6052	D6206	D6618	D6218
FREQUENCY RANGE (GHz)	0.5-2	2-6	6-18	2-18
ACCURACY @+25°C, max (MHz)	±2			
FREQUENCY DRIFT, max (MHz/°C)	±0.1			
FREQUENCY SETTLING (1), max (MHz) within 1 µsec	±2		±3 (6-12 GHz) ±4 (12-18 GHz)	±2 (2-6 GHz) ±3 (6-12 GHz) ±4 (12-18 GHz)
MODULATION(2)				
Bandwidth				
Standard unit, min (MHz)	DC to 10			
With Option G4 (5), min (MHz)	DC to 30			
Sensitivity variation				
Standard unit, typ	4:1			
Option 2 Unit, max	1.1:1			
Frequency deviation bandwidth, min @ 2v P-P (MHz) – with option 2	100	500		
RF POWER Output, min (dBm)	+10			
Variation, incl. temp. and freq., max (dB)	±2		±2.5	
PHASE NOISE, typ (dBc/Hz) @ 100 kHz offset	–65			
RESIDUAL FM, P-P @ –3 dBc, typ (kHz)	50	75	150	
HARMONICS, max (dBc) Standard Unit	–20			
Option 3 Unit	N/A	-55	–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)	± 125	±250	± 500	
NOMINAL LSB(3) (MHz)	0.5			
MONOTONICITY	Guaranteed			
CONNECTORS Power	9 pin, D type male(4)			
Control	37 pin, D type male(4)			
RF output	SMA female			
Modulation Input	SMC male			
POWER SUPPLY REQUIREMENT Voltage @ Current +15V ± 0.5V	450	700	1,000	1,250
–15V ± 0.5V	250	250	300	300
+5V ± 0.5V	150	150	500	500
+28V ±2V	1,000	1,000	3,000	3,000
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) 50 Ohm input impedance.
(3) 16 Bit TTL input, including VCO control.
(4) Mating connector furnished
(5) Please consult us for further Modulation Band Width improvement:

AVAILABLE OPTIONS

Option No.	Description
2	Reduced Modulation Sensitivity Variation
3	Improved Harmonic Suppression
4	SMA Female Modulation Connector
B09	13 to 20 GHz Operation
B11	Operating Temp. range -5 (□C) to □70 (□C)
B12	With options 2 & 3. Operating Temp. range -10 (□C) to □70 (□C)
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS AND WEIGHT – MODEL D6052



MODELS D6052 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
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

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

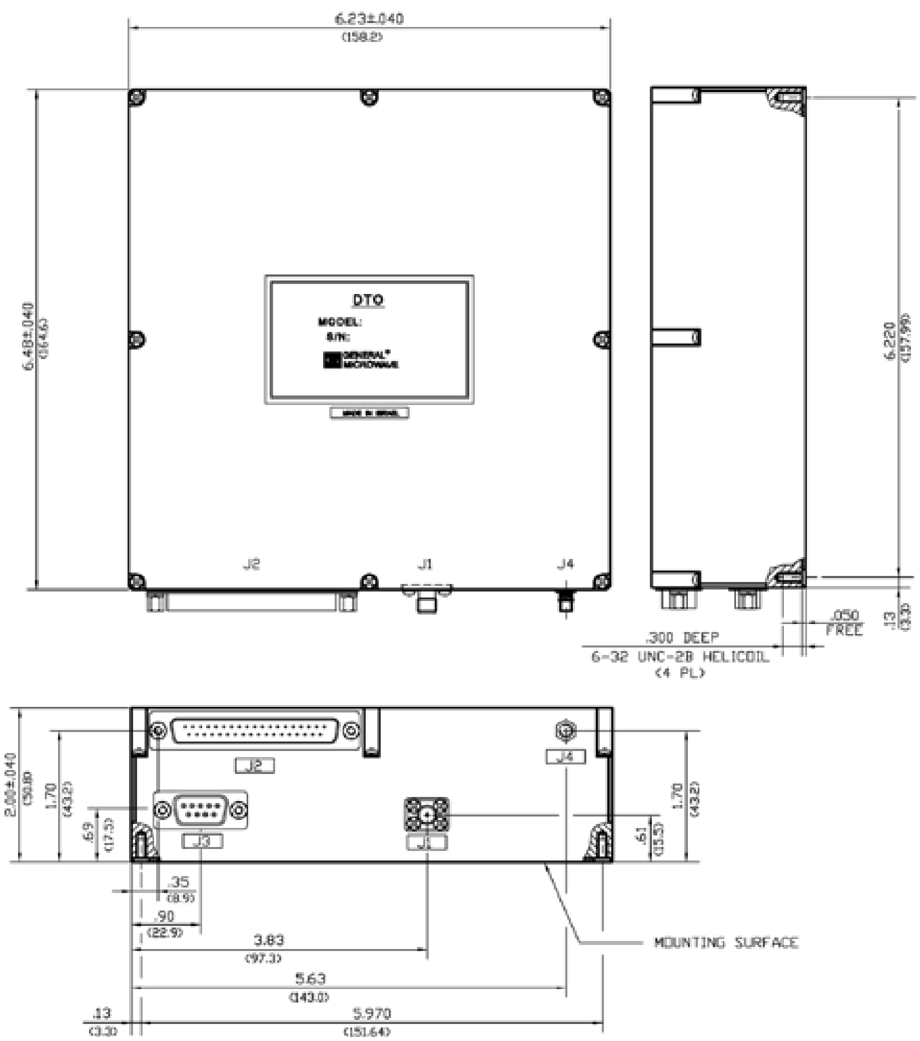
Series D60 Multi-Band DTOs Specifications

MODELS D6052 Power Connector (J3)			
PIN NO.	**FUNCTION**	**PIN NO.**	**FUNCTION**
1	+5V	6	Return for:+5V, -15V, +15V
2	–15V	7	Return for:+5V, -15V, +15V
3	+15V	8	+28V (return)
4	+28V (return)	9	+28V
5	+28V		

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 connected.

DIMENSIONS AND WEIGHT – MODELS D6206, D6218 and D6618



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

MODELS D6206, D6218 and D6618 Power Connector (J3)			
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	+5V	6	Return for:+5V, -15V, +15V
2	–15V	7	Return for:+5V, -15V, +15V
3	+15V	8	+28V (return)
4	+28V (return)	9	+28V
5	+28V		

NOTES: For Normal Operation of the DTO

1) PIN nos. 9, 10 and 28 should be connected together (Latch enable).
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 connected.

MODELS D6206, D6218 and D6618 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	V0	VCO Control Bit
9	L1	Latch 1 of 3 (Strobe)
10	L3	Latch 3 of 3 (Strobe)
11	OE	Memory Output Enable
12	D1	Data Bus
13	D3	Data Bus
14	D5	Data Bus
15	D7	Data Bus
16	W2	Write select 2
17	OET2	Output Enable Transceiver 2
18	GND	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 of 3 (Strobe)
29	G	Ground
30	D0	Data Bus
31	D2	Data Bus
32	D4	Data Bus
33	D6	Data Bus
34	W1	Write select 1
35	OET1	Output Enable Transceiver 1
36	OET3	Output Enable Transceiver 3
37	GND	Ground

Series DC60
Compact Airborne DTOs

FOR RWR, ESM AND OTHER APPLICATIONS

KRATOS General Microwave offers a compact multi-band DTOs for various airborne and other applications, covering the 2-6 and 6-18 GHz frequency ranges. The units feature high speed, high accuracy and low phase noise. The modular design of the DTOs enables the user to select narrower frequency coverage if desired. Please consult the factory for individual requirements.

- **Fast Settling Time**
- **2 to 18 GHz in Various Sub-Bands**
- **Small Size**
- **For Airborne Applications**

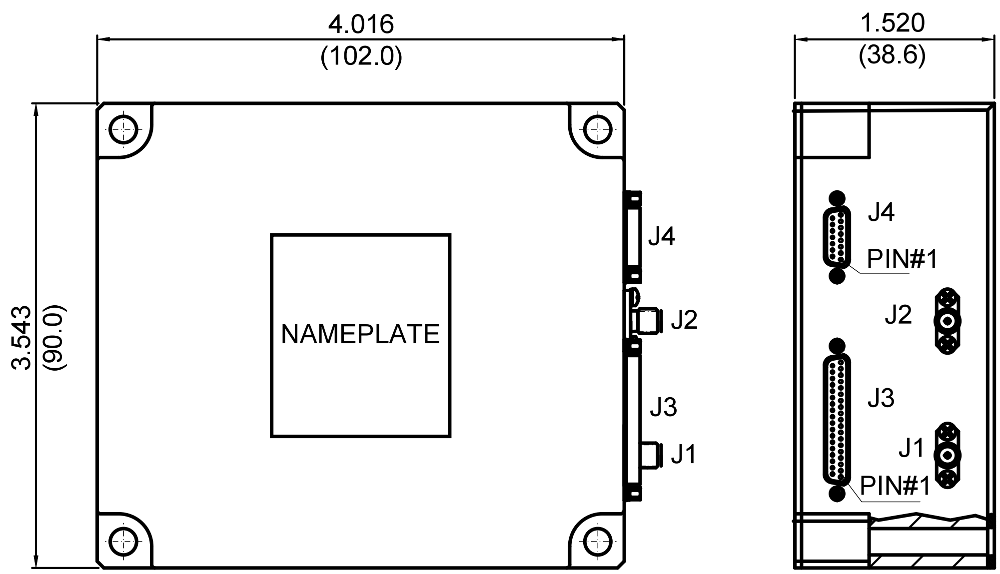
DTO Model DC6618

COMPACT AIRBORNE DTO SPECIFICATIONS

PARAMETER	MODEL DC6206	MODEL DC6618
FREQUENCY RANGE (GHz)	2 to 6	6 to 18
ACCURACY @ +25°C, max (MHz)	±2	
FREQUENCY DRIFT, max (MHz/°C)	±0.1	
FREQUENCY SETTLING within 1 µsec, max (MHz)	±2	±3
MODULATION(1) Bandwidth		
min (MHz)	DC to 15	DC to 10
Sensitivity variation, max	1.1 :1	
Frequency deviation (MHz/V) max	±250 @ 5vPTP	±250 @ 2vPTP
RF POWER Output, min (dBm)	2-8	+10
Variation, incl. temp. and frequency, max (dB)	±2	±2.5
PHASE NOISE, max (dBc/Hz) @ 100 kHz offset	–70	–65
RESIDUAL FM, p-p @ –3 dBc, max (kHz)	200	150
HARMONICS, max (dBc)	–45	–55
SUB-HARMONICS, max (dBc)	–45	–55
SPURIOUS, max (dBc)	–60	
PULLING @ VSWR 2:1, max (MHz)	±2	±1
PUSHING, max (MHz/V)	±2.5	±0.5
FREQUENCY STEP per LSB, (MHz) Nominal	1	0.5
MONOTONICITY	Guaranteed	
OPERATING TEMPERATURE (°C)(2)	0 to +70	
CONNECTORS Power	9 Pin MDM Male	
Control	37 Pin MDM Male	
RF output	SMA female	
Modulation Input	SMA female	
POWER SUPPLY REQUIREMENT (V)	+15, –15, +5 & +28	
MECHANICAL DIMENSIONS Inches	4.0 x 3.5 x 1.5	
Millimeters	102.0 x 90.0 x 38.6	

(1) Option
(2) Other operating temperature option

COMPACT AIRBORNE DTO DIMENSIONS



CONNECTORS TABLE		
Sym	**Description**	**Function**
J1	COAX. CONN., SMA FEMALE	RF OUT
J2	COAX. CONN., SMA FEMALE	MODULATION
J3	"ITT CANNON" CONN. MDM-37SH003P OR EQUIV.	CONTROL
J4	"ITT CANNON" CONN. MDM-9SH003P OR EQUIV.	POWER

MODELS DC6206, DC6618

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

J3 CONTROL CONNECTOR – PIN ASSIGNMENT			
Pin No.	Function		Description
	DC6206	DC6218	
1	N.C.	A14	Tuning Word (MSB)
2	A11	A12	Tuning Word
3	A9	A10	Tuning Word
4	A7	A8	Tuning Word
5	A5	A6	Tuning Word
6	A3	A4	Tuning Word
7	A1	A2	Tuning Word
8	V1	V0	VCO Control Bit
9	LE\	LE\	Latch
10	N.C.	N.C.	N.C.
11	OE\	N.C.	OE
12	N.C.	N.C.	N.C.
13	N.C.	N.C.	N.C.
14	N.C.	N.C.	N.C.
15	N.C.	N.C.	N.C.
16	N.C.	N.C.	N.C.
17	N.C.	N.C.	N.C.
18	GND	N.C.	Ground/N.C.
19	N.C.	GND	Ground
20	A12	A13	Tuning Word
21	A10	A11	Tuning Word
22	A8	A9	Tuning Word
23	A6	A7	Tuning Word
24	A4	A5	Tuning Word
25	A2	A3	Tuning Word
26	A0	A1	Tuning Word
27	V0	A0	VCO Control/Tuning Word (LSB)
28	N.C.	GND	Ground
29	GND	N.C.	Ground/N.C.
30	N.C.	N.C.	N.C.
31	N.C.	N.C.	N.C.
32	N.C.	N.C.	N.C.
33	N.C.	N.C.	N.C.
34	N.C.	N.C.	N.C.
35	N.C.	N.C.	N.C.
36	N.C.	N.C.	N.C.
37	GND	GND	Ground

Notes:

A. For Model DC6218

1. Pins 19, 28 and 37 should be grounded.
2. Pins 10 through 18 and 29 through 36 should not be connected (for factory use only).

B. For Model DC6206

1. Pins 11, 18, 29 and 37 should be grounded.
2. Pins 1, 10, 12 through 17, 19, 28 and 30 through 36 should not be connected (for factory use only).

Logic Level	Input Level
"0"	–0.3 to 0.8V
"1"	2.0 to 5.0V

J4 POWER CONNECTOR – PIN ASSIGNMENT				
Pin No.	**Function**	**Description**	**Notes**	**Max. Current Consumption (mA)**
1	5V	Digital Supply		500
2	–15V	Analog Supply		500
3	+15V	Analog Supply		1,000
4	28V Return	Negative Heater Supply		
5	28V	Positive Heater Supply		
6	Return for:+5V, -15V, +15V	Ground	1	–
7	Return for:+5V, -15V, +15V	Ground	1	–
8	28V Return	Negative Heater Supply		
9	28V	Positive Heater Supply		1,000(2)

Notes:

1. GND is the DTOs analog ground for the +15V, –15V and +5V supplies and not the heater's ground.
2. Warm up 3,000 mA, steady state 1,000 mA max.

CUSTOM MULTI-BAND DTOs

Multi-Band DTO For 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 , as seen in Figs. 1 and 2, 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.

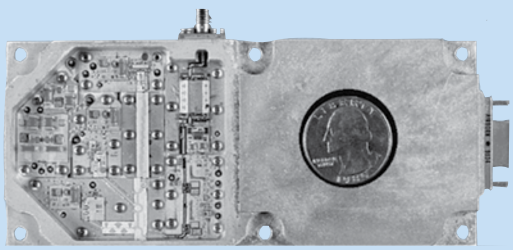


Fig. 1 - Multi-Band DTO (RF side view)

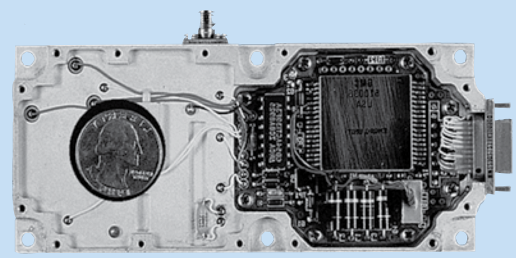


Fig. 2 - Multi-Band DTO (Driver side view)

The C-Ku band DTO (Fig. 3) 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 suppression of the unused VCOs and fast settling tuning. The S-C band DTO (Fig. 4) meets similar requirements

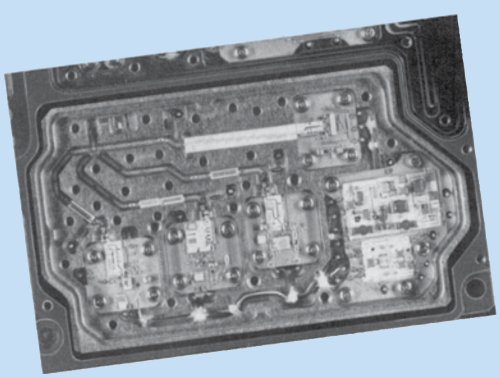


Fig. 3 - C-Ku Band DTO RF Assembly

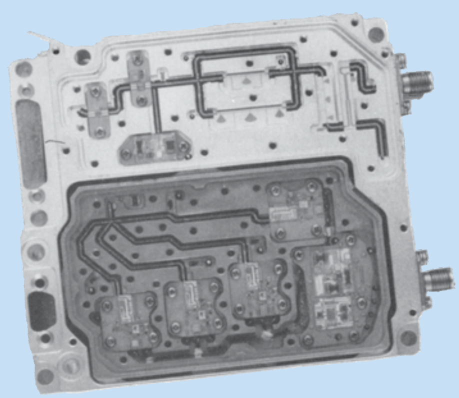


Fig. 4 - S-C Band DTO RF Assembly

Multi-Band Frequency Locked Oscillator (FLO)

MULTI-BAND FREQUENCY LOCKED OSCILLATOR (FLO)

KRATOS General Microwave has developed a new product line of Multi-Band Frequency Locked Oscillators (FLO). This product line is an enhancement to our free running Digitally Tuned Oscillator (DTO) products. This FLO combines the high speed of DTO with the high accuracy and long-term stability of a frequency locked source. The key specification feature of the FLO is a timing speed of less than 1 µsec to settle within 1 MHz of the desired frequency.

SIMULATOR AND TEST SYSTEMS APPLICATIONS

The FLO was specifically designed for test systems and simulator applications. It is a low cost replacement for high cost direct synthesizers, in applications that the frequency setting time of 1 msec is meeting the system requirements.

- **Fast Settling (1MHz in 1 µsec)**
- **Wideband (2-18 GHz)**
- **High Accuracy**
- **Low Phase Noise**

FLO Model FL6618

SPECIAL ORDER PRODUCT
–CONSULT FACTORY BEFORE ORDERING–

SELECTION GUIDE FREQUENCY LOCKED OSCILLATORS

FREQUENCY RANGE (GHz) 0.5 – 2 – 4 – 6 – 8 – 12.0 – 18.0	MODEL	PAGE	COMMENTS
2 — 18	FL6218	394	Frequency Locked Oscillator
6 — 18	FL6618		

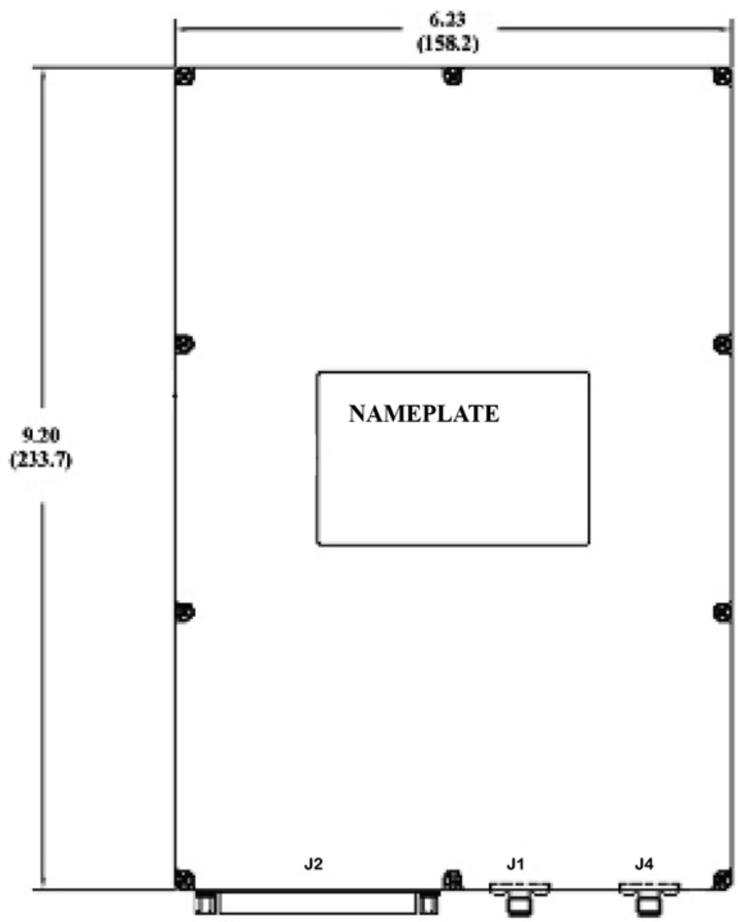
Multi-Band Frequency Locked Oscillator Specifications

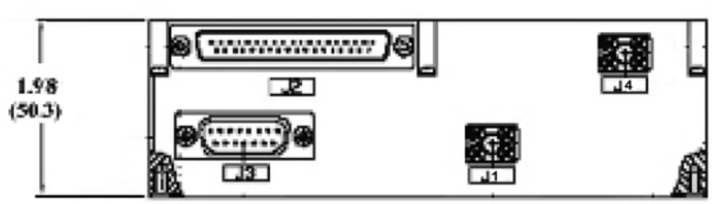
		SPECIFICATION	
PARAMETER		FL6218	FL6618
1	**FREQUENCY RANGE (GHz)**	2 to 18	6 to 18
2	**ACCURACY OVER TEMPERATURE (MHz)**	±1	
3	**SETTLING TIME within 1 μsec (MHz)**	±1	
4	**RESIDUAL FM, max (kHz)**	10	
5	**MODULATION**[1]		
6	**RF POWER**		
6.1	Output, min (dBm)	+10	
6.2	Variation, incl. temp. and freq., max (dB)	±2.5	
7	**PHASE NOISE, max (dBc/Hz) @ 100 kHz offset**	-80	
8	**HARMONICS, max (dBc)**		
8.1	Integer	−55	
8.2	f/2, 3f/2	−55	
9	**SPURIOUS, max (dBc)**	−60	
10	**PULLING, VSWR 2:1, max (MHz)**	± 1	
11	**PUSHING, max (kHz/V)**	± 500	
12	**TUNING CONTROL**		
12.1	Nominal LSB (kHz)	250	
12.2	Tuning (bits)	17	
13	**CONNECTORS**		
13.1	Power	15-Pin, D type	
13.2	Control	37-Pin, D type	
13.3	RF Output, FM Input	SMA female	
14	**POWER SUPPLY REQUIREMENT max (mA):**		
	+15V	2,000	
	−15V	580	
	+5V	300	
	28V, start up	6,500	
	28V, steady state @25°C	2,000	
15	**OPERATING TEMPERATURE** (°C)	0 to +55	
16	**MECHANICAL DIMENSIONS** Inches	9.20 x 6.2 x 2.00	
	Millimeters	234.6 x 158.1 x 51.0	

(1) In DTO mode. Consult factory for specifications

Multi-Band Frequency Locked Oscillator (FLO) Specifications

DIMENSIONS & WEIGHT





Wt. 4.63 lb. (2.1 kg) approx.

CONNECTOR DATA		
SYM	FUNCTION	DESCRIPTION
J1	RF OUTPUT	COAX, CONN, SMA FEMALE
J2	DIGITAL CONTROL	DC-37P
J3	SUPPLY	DA-15P
J4	MODULATION INPUT	SMA FEMALE

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

CONNECTOR J2		
PIN No.	FUNCTION	NOTES
1	A14	
2	A12	
3	A10	
4	A8	
5	A6	
6	A4	
7	A2	
8	V0	
9	LATCH	
10	D2	1
11	GND	
12	D1	1
13	D0	1
14	CL	1
15	FE\	1
16	N.C.	
17	N.C.	
18	A15	
19	N.C.	
20	A13	
21	A11	
22	A9	
23	A7	
24	A5	
25	A3	
26	A1	
27	A0	
28	WR_RD	1
29	GND	
30	TR_REAL	1
31	FL_DTO	1
32	LD_IND	
33	GND	
34	GND	
35	GND	
36	S_H_DIS	
37	GND	

CONNECTOR J3	
PIN No.	FUNCTION
1	+5V
2	–15V
3	+15V
4	N.U.
5	28V
6	28V
7	28V
8	28V
9	GND
10	GND
11	N.U.
12	28V Return
13	28V Return
14	28V Return
15	28V Return

Note:

1. For factory only use, should not be connected.

Voltage Controlled Oscillators (VCOs)

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. 3. 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 nonlinear 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) $f_o/2$ 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. 4, 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 $f_o/2$ and $3f_o/2$ signals, which are filtered to the extent possible. (For the case of a 12 GHz output signal, the undesired $3f_o/2$ signal at 18 GHz cannot be filtered since it is within the 12-18 GHz frequency range of the VCO.)

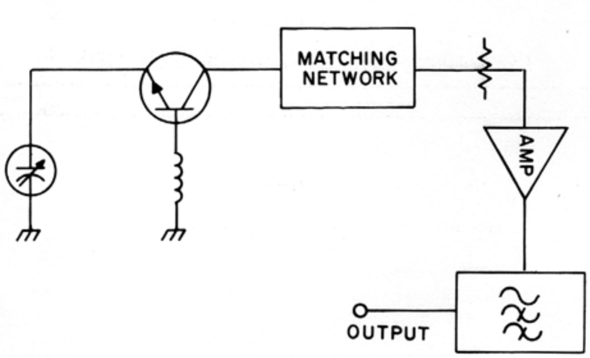


Fig 3–Simplified VCO Block diagram

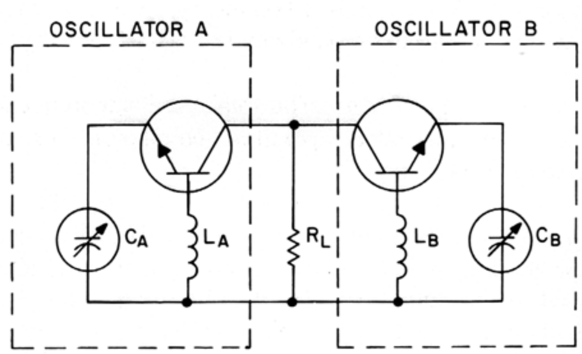


Fig 4–Schematic diagram of Push-Push Oscillator

VOLTAGE CONTROLLED OSCILLATORS (VCO) SELECTION GUIDE

FREQUENCY RANGE (GHz) 0.5 2 4 6 8 12.0 18.0	MODEL	PAGE	COMMENTS
2 — 4	V6020	399	Octave Band Voltage Controlled Oscillators
2.6 — 5.2	V6026		
4 — 8	V6040		
8 — 12	V6080		
12 — 18	V6120A		
2 — 2.8	V6020-952C	302	Miniaturized Voltage Controlled Oscillators
2.8 — 3.8	V6020-953C		
3.8 — 4.9	V6020-954C		
4.9 — 6.1	V6020-955C		
1 — 18	------	397	Custom Military and Commercial Voltage Controlled Oscillators

OCTAVE BAND VCO SPECIFICATIONS

<table>
<tr><th></th><th colspan="5">MODEL</th></tr>
<tr><th>PARAMETER</th><th>V6020</th><th>V6026</th><th>V6040</th><th>V6080</th><th>V6120A</th></tr>
<tr><td>FREQUENCY RANGE (GHz)</td><td>2-4</td><td>2.6-5.2</td><td>4-8</td><td>8-12</td><td>12-18</td></tr>
<tr><td>FREQUENCY SETTLING[(1)], max (MHz)
within 50 nsec , Typical</td><td colspan="4">±8</td><td>±10</td></tr>
<tr><td>within 200 nsec, Typical</td><td colspan="2">±3</td><td colspan="2">±4</td><td>±5</td></tr>
<tr><td>within 1 µsec</td><td colspan="2">±1.5</td><td colspan="2">±3</td><td>±4</td></tr>
<tr><td>MODULATION
Bandwidth, min (MHz)</td><td colspan="5">100</td></tr>
<tr><td>Sensitivity ratio, max</td><td colspan="5">3:1</td></tr>
<tr><td>RF POWER
Output, min (dBm)</td><td colspan="5">+10</td></tr>
<tr><td>Variation, Incl. temp. and freq. max (dB)</td><td colspan="2">±2.5</td><td colspan="3">±3.0</td></tr>
<tr><td>PHASE NOISE, max (dBc/Hz)
@ 100 kHz offset</td><td colspan="2">–95</td><td>–90</td><td>–80</td><td>–80</td></tr>
<tr><td>HARMONICS, max (dBc)</td><td colspan="3">–15</td><td>–40</td><td>–20</td></tr>
<tr><td>f/2, 3f/2,max (dBc)</td><td colspan="4">N/A</td><td>–20</td></tr>
<tr><td>SPURIOUS, max (dBc)</td><td colspan="5">–60</td></tr>
<tr><td>TEMPERATURE STABILITY, typ (PPM/°C)</td><td colspan="5">100</td></tr>
<tr><td>PULLING VSWR 2:1 max (MHz)</td><td colspan="5">1</td></tr>
<tr><td>PUSHING, max (kHz/V)</td><td colspan="5">250</td></tr>
<tr><td>CONNECTORS
Power supply</td><td colspan="5">Solder terminal</td></tr>
<tr><td>Tuning voltage</td><td colspan="5">SMA female</td></tr>
<tr><td>RF output</td><td colspan="5">SMA female</td></tr>
<tr><td>POWER SUPPLY REQUIREMENT
Voltage (VDC)</td><td colspan="5">+15 ±0.5</td></tr>
<tr><td>Current, max (mA)</td><td colspan="4">150</td><td>300</td></tr>
<tr><td>Tuning voltage (VDC)</td><td colspan="3">0 to +20</td><td colspan="2">0 to +15</td></tr>
<tr><td>INPUT CAPACITANCE, nominal</td><td colspan="5">25 pF, 10 kΩ</td></tr>
<tr><td>ENVIRONMENTAL[(2)]
Operating temperature (°C)</td><td colspan="5">–54 to +85</td></tr>
<tr><td>Storage temperature (°C)</td><td colspan="5">–54 to +125</td></tr>
<tr><td>MECHANICAL DIMENSIONS
Inches</td><td colspan="4">1.79 x 1.10 x 0.45</td><td>2.19 x 1.10 x 0.45</td></tr>
<tr><td>Millimeters</td><td colspan="4">45,5 x 27,9 x 11,4</td><td>55,6 x 27,9 x 11,4</td></tr>
</table>

(1) Δf relative to f after 1 sec.
(2) Hermetically sealed.

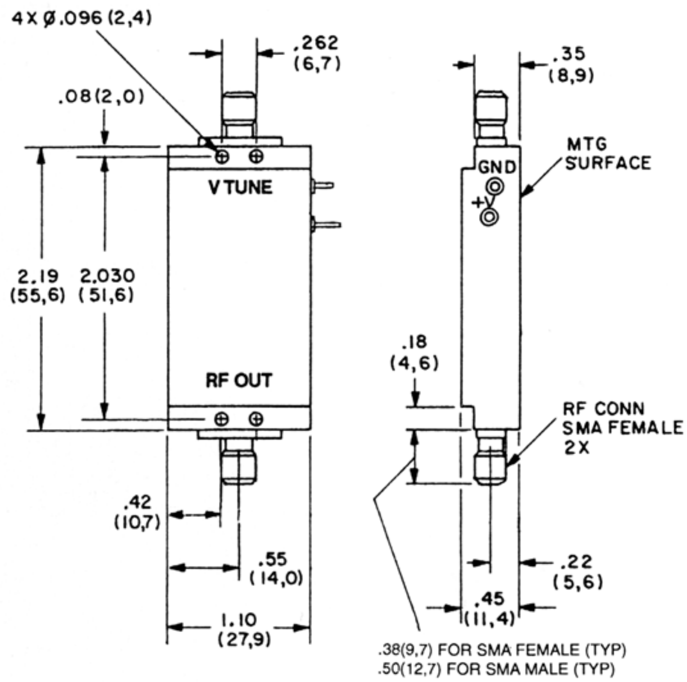
AVAILABLE OPTIONS

Option No.	Description
49	High Rel screening (see Table 1)
G09	Meeting Environmental Ratings

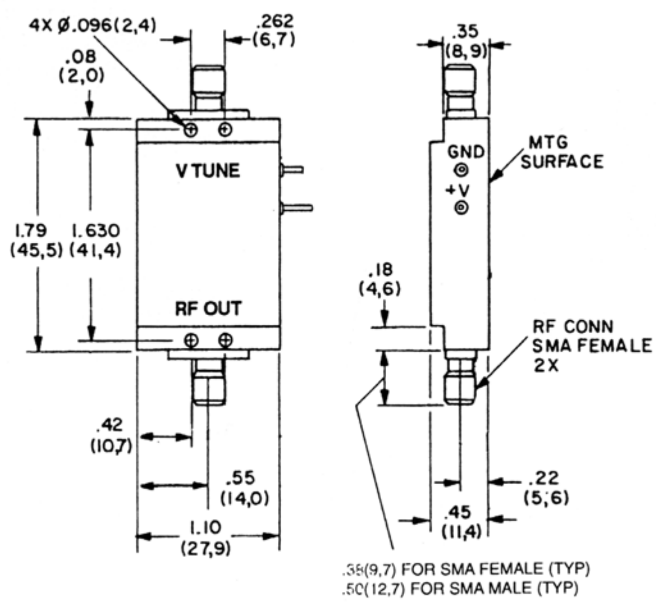
Table 1. Option 49 High Rel Screening

TEST	MIL-STD-883	NOTES
Internal Visual	METHODE2017	–
Temperature Cycle	METHODE 1010	-55 °C to +95 °C, 10 CYCLES Dewll time at temperature 20 minutes min. temp. rise time 3°C/MIN
Mechanical Shock	METHODE 2002, COND. B	1,500g 0.5ms
Burn-In	METHODE 1015, COND. B	48 hours, at +110 °C
Leak	METHODE 1014 COND. A1	$5X10^{-8}$

DIMENSIONS AND WEIGHTS



MODEL V6120A VCO
Wt: 1:94 oz. (55 gr.) approx.



MODELS V6020, V6026, V6040 AND V6080 VCOs
Wt: 1.27 oz. (36 gr) approx.

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

Series V60-95 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

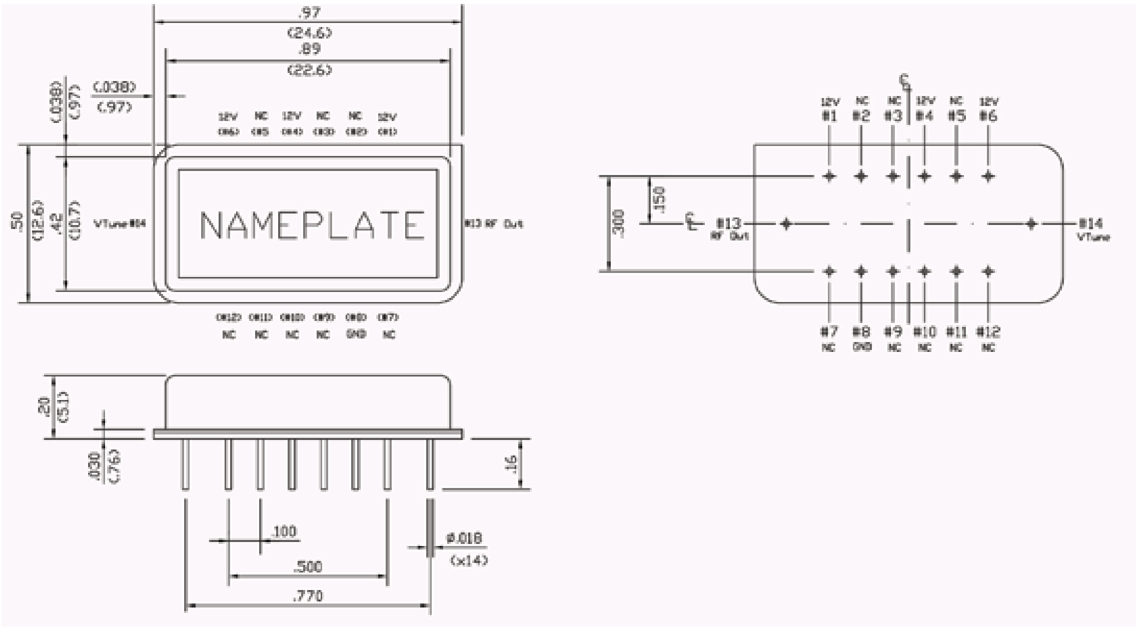
MINIATURIZED VCO SPECIFICATIONS

	MODEL			
PARAMETER	**V6020-952C/J**	**V6020-953C/J**	**V6020-954C/J**	**V6020-955C/J**
FREQUENCY RANGE (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, max (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 ±0.5			
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			

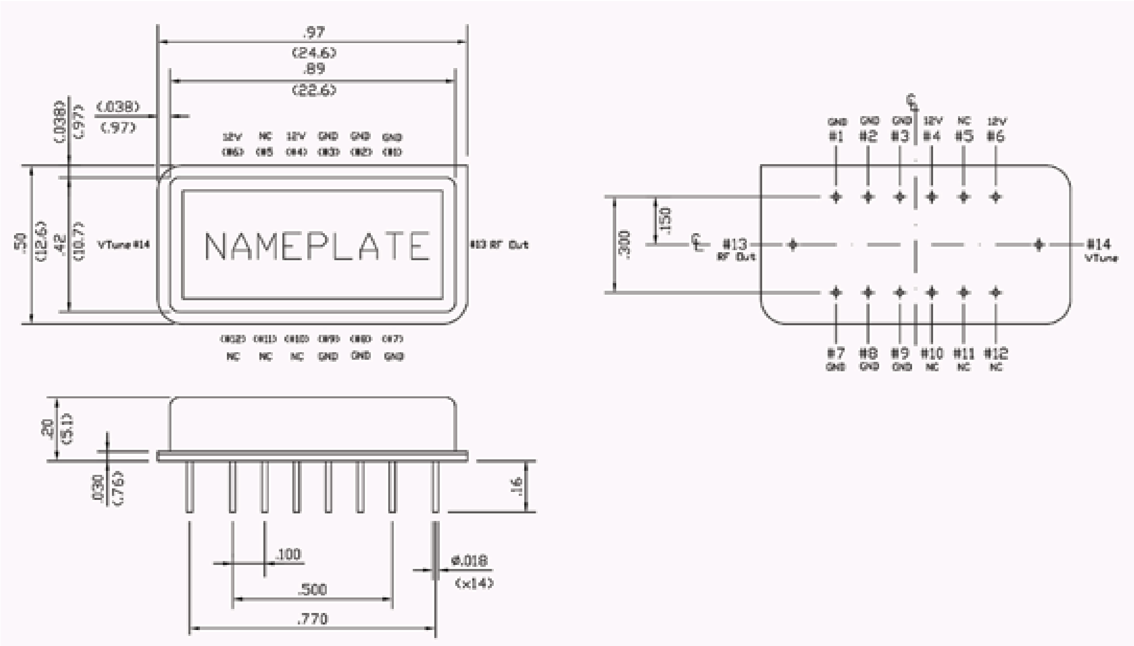
(1) Δf relative to f after 1 millisec

DIMENSIONS and WEIGHTS

Model V6020-95xC



Model V6020-95xJ



Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.008

All Models: 0.15 oz.; (4.34 grams) approx.

CUSTOM VCOs

Linear VCOs

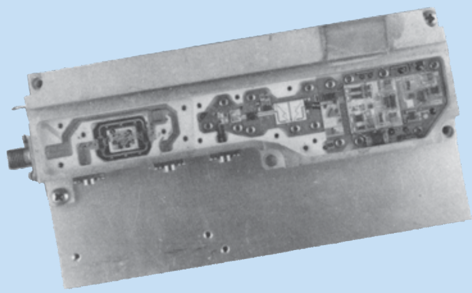
For narrowband (<5%) applications, General Microwave has developed proprietary techniques to achieve a high degree of linearity without the use of external linearizers.

Linear X band

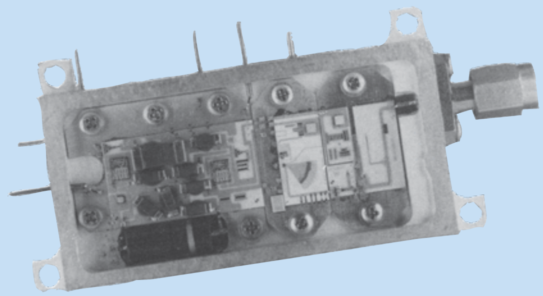
An X-band VCO assembly with linearity of less than ±1% is shown in the photo. The assembly includes two MMIC amplifiers, a medium power MIC amplifier, two filters, a phase shifter and a MMIC SP2T switch. For specific requirements, please consult the factory.

Linear Ku band

The photo shows a Ku-band VCO with a typical linearity of better than ±5% for an airborne jamming application. The unit is designed for high speed modulation and also includes RFI/EMI filtering.



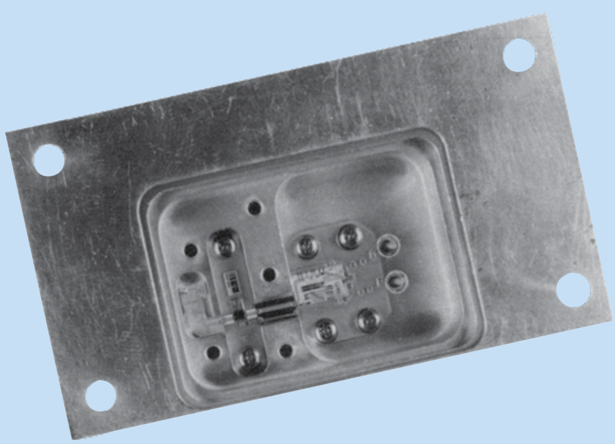
Linear X band VCO



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.



dBm - Volts - Watts Conversion Tables (50 Ohms system)

dBm	V (RMS)	P
+53	100.0	200W
+50	70.7	100W
+49	64.0	80W
+48	58.0	64W
+47	50.0	50W
+46	44.5	40W
+45	40.0	32W
+44	32.5	25W
+43	32.0	20W
+42	26.0	16W
+41	26.2	12.5W
+40	22.5	10W
+39	20.0	8W
+38	18.0	4W
+37	16.0	5W
+36	14.1	4W
+35	12.5	3.2W
+34	11.5	2.5W
+33	10.0	2W
+32	9.0	1.6W
+31	8.0	1.25W
+30	7.10	1.0W
+29	6.40	800mW
+28	5.80	640mW
+27	5.00	500mW
+26	4.45	400mW
+25	4.00	320mW
+24	3.55	250mW
+23	3.20	200mW
+22	2.80	1680mW
+21	2.52	125mW
+20	2.25	100mW

dBm	V (RMS)	P
+19	2.00	80mW
+18	1.80	64mW
+17	1.60	50mW
+16	1.41	40mW
+15	1.25	32mW
+14	1.15	25mW
+13	1.00	20mW
+12	.90	16mW
+11	.80	12.5mW
+10	.71	10mW
+9	.64	8mW
+8	.56	6.4mW
+7	.500	5mW
+6	.445	4mW
+5	.400	3.2mW
+4	.355	2.5mW
+3	.320	2.0mW
+2	.280	1.6mW
+1	.252	1.25mW
0	.225	1.0mW
-1	.200	.80mW
-2	.180	.64mW
-3	.160	.50mW
-4	.141	.40mW
-5	.125	.32mW
-6	.115	.25mW
-7	.100	.20mW
-8	.090	.16mW
-9	.080	.125mW
-10	.071	.10mW
-11	.064	.08mW
-12	.058	.06mW

dBm	mV (RMS)	P
-13	50	
-14	45	
-15	40	
-16	35.5	
-17	31.5	
-18	28.5	
-19	25.1	
-20	22.5	.01mW
-21	20.0	
-22	17.9	
-23	15.9	
-24	14.1	
-25	12.8	
-26	11.5	
-27	10.0	
-28	8.9	
-29	8.0	
-30	7.1	.001mW
-31	6.25	
-32	5.8	
-33	5.0	
-34	4.5	
-35	4.0	
-36	3.5	
-37	3.2	
-38	2.85	
-39	2.5	
-40	2.25	.1µW
-50	0.71	.01µW
-60	0.225	.001µW
-70	71µV	.1nW
-80	22.5µV	.01nW

VSWR Conversion Tables

1) $K = \frac{VSWR-1}{VSWR+1}$ = Reflection Coefficient (r)

2) -K (dB) = 20 LOG_{10} K = Return Loss

3) VSWR (dB) = 20 LOG_{10} VSWR = VSWR in Decibels

4) 1- K^2 =Ratio of Power Transmitted

5). -{1-K^2} (dB) = 10 LOG_{10} {1-K^2} = Loss Due to VSWR)

VSWR	-K (dB)	K	VSWR (dB)	1-K^2	-{1-K^2} (dB)
1.00	∞	.0000	.000	1.00000	.0000
1.01	46.06	.0050	.086	.99998	.0001
1.02	40.09	.0099	.172	.99990	.0004
1.03	36.61	.0148	.257	.99978	.0009
1.04	34.15	.0196	.341	.99962	.0017
1.05	32.26	.0244	.424	.99941	.0026
1.06	30.71	.0291	.506	.99915	.0037
1.07	29.42	.0338	.583	.99886	.0050
1.08	28.30	.0385	.668	.99852	.0064
1.09	27.32	.0431	.749	.99815	.0081
1.10	26.44	.0476	.828	.99773	.0099
1.11	25.66	.0521	.906	.99728	.0118
1.12	24.94	.0566	.984	.99680	.0139
1.13	24.29	.0610	1.062	.99627	.0162
1.14	23.69	.0654	1.138	.99572	.0186
1.15	23.13	.0698	1.214	.99513	.0212
1.16	22.61	.0741	1.289	.99451	.0239
1.17	22.12	.0783	1.364	.99386	.0267
1.18	21.66	.0826	1.438	.99318	.0297
1.19	21.23	.0868	1.511	.99247	.0328
1.20	20.83	.0909	1.584	.99174	.0360
1.21	20.44	.0950	1.656	.99097	.0394
1.22	20.08	.0991	1.727	.99018	.0429
1.23	19.73	.1031	1.798	.98936	.0464
1.24	19.40	.1071	1.868	.98852	.0501

VSWR	-K (dB)	K	VSWR (dB)	1-K^2	{1-k^2} (dB)
1.25	19.08	.1111	1.938	.98765	.0540
1.26	18.78	.1150	2.007	.98676	.0579
1.27	18.49	.1189	2.076	.98585	.0619
1.28	18.22	.1228	2.144	.98492	.0660
1.29	17.95	.1266	2.212	.98396	.0702
1.30	17.69	.1304	2.279	.98299	.0745
1.31	17.45	.1342	2.345	.98199	.0789
1.32	17.21	.1379	2.411	.98098	.0834.
1.33	16.98	.1416	2.477	.97994	.0880
1.34	16.75	.1453	2.542	.97889	.0927
1.35	16.54	.1489	2.607	.97782	.0974
1.36	16.33	.1525	2.671	.97673	.1023
1.37	16.13	.1561	2.734	.97563	.1072
1.38	15.94	1597	2.798	.97451	.1121
1.39	15.75	.1632	2.860	.97337	.1172
1.40	15.56	.1667	2.923	.97222	.1223
1.41	15.38	.1701	2.984	.97106	.1275
1.42	15.21	.1736	3.046	.96988	.1328
1.43	15.04	.1770	3.107	.96869	.1382
1.44	14.88	.1803	3.167	.96748	.1436
1.45	14.72	.1837	3.227	.96626	.1490
1.46	14.56	1870	3.287	.96503	.1546
1.47	14.41	.1903	3.346	.96379	.1602
1.48	14.26	.1935	3.405	.96254	.1658
1.49	14.12	.1968	3.464	.96127	.1715

VSWR Conversion Tables

VSWR	-K (dB)	K	VSWR (dB)	$1-K^2$	$-\{1-K^2\}$ (dB)
1.50	13.98	.2000	3.522	.96000	.1773
1.55	13.32	.2157	3.807	.95348	.2069
1.60	12.74	.2308	4.082	.94675	.2377
1.65	12.21	.2453	4.350	.93984	.2696
1.70	11.73	.2593	4.609	.93278	.3022
1.75	11.29	.2727	4.861	.92562	.3357
1.80	10.88	.2857	5.105	.91837	.3698
1.85	10.51	.2982	5.343	.91105	.4046
1.90	10.16	.3103	5.575	.90369	.4398
1.95	9.84	.3220	5.801	.89629	.4755
2.00	9.54	.3333	6.021	.88889	.5115
2.05	9.26	.3443	6.235	.88148	.5479
2.10	9.00	.3548	6.444	.87409	.5844
2.15	8.75	.3651	6.649	.86672	.6212
2.20	8.52	.3750	6.848	.85938	.6582
2.25	8.30	.3846	7.044	.85207	.6952
2.30	8.09	.3939	7.235	.84481	.7324
2.35	7.89	.4030	7.421	.83760	.7696
2.40	7.71	.4118	7.604	.83045	.8069
2.45	7.53	.4203	7.783	.82336	.8441
2.50	7.36	.4286	7.959	.81633	.8814
2.55	7.20	.4366	8.131	.80936	.9186
2.60	7.04	.4444	8.299	.80247	.9557
2.65	6.90	.4521	8.465	.79565	.9928
2.70	6.76	.4595	8.627	.78890	1.0298
2.75	6.62	.4667	8.787	.78222	1.0667

VSWR	-K (dB)	K	VSWR (dB)	$1-K^2$	$\{1-k^2\}$ (dB)
2.80	6.49	.4737	8.943	.77562	1.1035
2.85	6.37	.4805	9.097	.76910	1.1402
2.90	6.25	.4872	9.248	.76266	1.1767
2.95	6.13	.4937	9.396	.75629	1.2131
3.00	6.02	.5000	9.542	.75000	1.2494
3.05	5.91	.5062	9.686	.74379	1.2855
3.10	5.81	.5122	9.827	.73766	1.3215
3.15	5.71	.5181	9.966	.73160	1.3573
3.20	5.62	.5238	10.103	.72562	1.3929
3.25	5.52	.5294	10.238	.71972	1.4283
3.30	5.43	.5349	10.370	.71390	1.4636
3.35	5.35	.5402	10.501	.70815	1.4987
3.40	5.26	.5455	10.630	.70248	1.5337
3.45	5.18	.5506	10.756	.69688	1.5684
3.50	5.11	.5556	10.881	.69136	1.6030
3.55	5.03	.5604	11.005	.68591	1.6373
3.60	4.96	.5652	11.126	.68053	1.6715
3.65	4.88	.5699	11.246	.67522	1.7055
3.70	4.81	.5745	11.364	.66999	1.7393
3.75	4.75	.5789	11.481	.66482	1.7730
3.80	4.68	.5833	11.596	.65972	1.8064
3.85	4.62	.5876	11.709	.65469	1.8396
3.90	4.56	.5918	11.821	.64973	1.8727
3.95	4.50	.5960	11.932	.64483	1.9055
4.00	4.44	.6000	12.041	.64000	1.9382

1. CONTROLLING PROVISIONS: Seller is the division/subsidiary of KRATOS. that accepts the order of the Buyer. ALL SALES ARE EXPRESSLY LIMITED TO AND THE RIGHTS OF THE PARTIES SHALL BE GOVERNED EXCLUSIVELY BY THE TERMS AND CONDITIONS STATED HEREIN WHETHER THIS CONTRACT, OF WHICH THIS CONDITIONS OF SALE IS A PART, REPRESENTS AN OFFER BY SELLER OR SELLER'S CONDITIONAL ACCEPTANCE OF BUYER'S OFFER. SELLER'S OFFER IS EXPRESSLY CONDITIONED ON BUYER'S ACCEPTANCE OF THE TERMS AND CONDITIONS OF THIS CONTRACT. SELLER'S ACCEPTANCE OF BUYER'S OFFER IS EXPRESSLY CONDITIONED ON BUYER'S ASSENT TO THE TERMS AND CONDITIONS OF THIS CONTRACT No addition to, waiver or modification of these terms and conditions shall be binding on Seller unless expressly agreed to in writing by Seller. All quotations or resulting contracts shall be interpreted under the laws of the State of Delaware and exclude the provisions of the 1980 United Nations Convention on Contracts for the International Sale of Goods and the U. N. Convention on the Limitation Period in the International Sale of Goods, as amended by Protocol. No sale shall be final until acknowledged in writing by Seller. All offers involving the export of goods are contingent upon the ability of Seller to get required export license(s).

2. TERMS, TAXES AND PRICES: (a) Terms of payment are subject to the approval of Seller's credit department. Unless otherwise agreed to in writing by Seller, all payments are due net thirty (30) days from the date of invoice. In the event that the Buyer his failed to pay Seller for products or services ordered under different contracts or under this Contract as required by the terms and conditions of said contracts or Contract Seller, at its option shall have the right to make any delivery under this Contract payable on a cash before shipment basis. In the case of export sales, unless otherwise agreed to in writing by Seller, all payments are to be by means of a confirmed irrevocable letter of credit. (b) In addition to the prices specified in the Contract between the parties, (referred to in this Conditions of Sale as "Contract"), Buyer shall pay Seller the amount of any excise, sales, privilege, use or any other taxes or government charges, local, state or federal, which arise from the sale or delivery of the products, or in lieu thereof, Buyer shall provide Seller with a tax exemption certificate acceptable to the appropriate taxing authorities. (c) Prices and deliveries are F.O.B.. Ex Works Seller's plant. Prices on accepted orders and covering Seller-manufactured products are firm for a period of six months from date of acceptance. Seller reserves the right to increase the prices at the time of shipment to the extent of any increase in cost to it of any item not of Sellers manufacture on which firm prices were not available on the date of acceptance.

3. SHIPMENT: Deliveries are F.O.B. Ex Works Seller's plant. Risk of loss shall pass to the Buyer upon delivery to the carrier. Any claims for damage or loss in shipment are between the carrier and Buyer. Seller shall not be involved in such claims beyond Seller's assistance is processing and securing information pertaining to such damage claims.

4. DELAYS: The delivery date(s) under the Contract is only an estimate and is based upon prompt receipt of all necessary information from Buyer. The delivery date(s) is subject to and shall be extended by delays caused by strikes. fires, accidents, shortages of labor or materials, embargoes. or delays in transportation, compliance with government agency or official requests, or any other similar or dissimilar cause beyond the reasonable control of Seller. FAILURE TO DELIVER WITHIN THE TIME ESTIMATED SHALL: NOT BE A BREACH OF CONTRACT ON SELLER'S PART AND IN NO EVENT WHATSOEVER WILL SELLER BE RESPONSIBLE OR BUYER ENTITLED TO ANY DIRECT OR INDIRECT INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OR OF OR RELATING TO ANY DELAY IN DELIVERY. If Buyer causes Seller to delay shipment or completion of work, Seller shall be entitled to any and all extra cost and expenses resulting from such delay.

5. CANCELLATIONS AND ALTERATIONS: (a) Accepted orders may by cancelled by Buyer only with Seller's express written consent. If cancellation is allowed, Buyer agrees to pay to Seller all expenses incurred and damage sustained by Seller on account of such cancellation, plus a reasonable profit. (b) The delivery date(s) or specifications of accepted orders, whether completed or in process, cannot be altered except by Seller's express written consent and upon terms which will indemnify Seller for all expenses incurred and damages sustained by Seller on account of such alteration, plus a reasonable profit

3. SHIPMENT: Deliveries are F.O.B. Ex Works Seller's plant. Risk of loss shall pass to the Buyer upon delivery to the carrier. Any claims for damage or loss in shipment are between the carrier and Buyer. Seller shall not be involved in such claims beyond Seller's assistance is processing and securing information pertaining to such damage claims.

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6 WARRANTY: Subject to the terms, conditions and limitations hereinafter set forth, Seller warrants, to the original Buyer only, each new product manufactured by seller to be free from defects in material and workmanship. Seller's entire and exclusive obligation and liability, and Buyer's sole and exclusive remedy, under the warranty is limited to repairing or replacing at Sellers option, free of charge; F.O.B. Ex Works Seller's plant, any part proving defective during the duration of this express warranty. The obligations of Seller under this warranty shall not include any transportation cost, labor costs,. installation costs. or other costs or charges associated with the repair or replacement This warranty shall not be enforceable if the Buyer is in default in making any contract payment The duration of this express warranty (a) for new equipment is one year from the date of shipment and (b) for any SELLER replacement part is 90 days after the date of installation, but no more than 6 months after shipment. This warranty does not cover failures caused in whole or in part by (1) improper installation, by other than SELLER, or maintenance; (2) improper use or application; (3) corrosion; (4) normal deterioration; (5) operation beyond rated capacity, (6) the use of replacement parts or lubricants which do not meet or exceed Seller's specifications, or (7) improper repairs. Products furnished, but not manufactured by Seller, are not covered by this warranty, but by only such warranties as are given by the said manufacturers to Seller. To qualify for warranty consideration at the earlier of the Buyer's discovery of the defect or the time at which the Buyer should have discovered the defect; Buyer must immediately notify Seller and must promptly thereafter return to Seller (freight prepaid) all defective parts. THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES INCLUDING WITHOUT LIMITATION ANY WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WHICH ARE HEREBY DISCLAIMED THE OBLIGATION AND LIABILITY OF SELLER UNDER THE EXPRESS WARRANTY STATED SHALL NOT INCLUDE LIABILITY FOR LOSS OF USE, LOSS OF PROFITS OR ANY OTHER DIRECT OR INDIRECT INCIDENTAL OR CONSEQUENTIAL DAMAGES CAUSED BY THE FAILURE OF ITS PRODUCT OR ANY DEFECT IN THAT PRODUCT OR DELAY IN REMEDYING THE SAME.

7. LIABILITY: Seller shall not be liable to Buyer for (a) any losses; (b) any direct or indirect incidental or consequential damages or (c) any delays, caused by the failure of its product or any defect in that product, except to repair or replace defective parts as provided for in the Warranty provision. Seller's warranty runs only to Buyer and does not extend expressly or by implications, to any other person. Buyer agrees that Seller's fulfillment of its obligations under the Warranty provision shall constitute a fulfillment of all Seller's liabilities. whether in contract or in tort, with respect to the Contract. Buyer also agrees that Seller shall not be liable for any damages to Buyer or to a third person arising out of the presence of the installed products on Buyer's or third person's premises or out of the use or operation thereof. In no event whatsoever, shall Seller be held liable to Buyer for any direct or indirect incidental, exemplary, or consequential damages

8. PATENTS: Seller agrees to indemnify. Buyer against all damages and costs recovered in any patent litigation upon Buyer's use of Seller's products in the manner intended by Seller in an amount not exceeding the sum paid for the infringing products provided (a) Buyer immediately notifies the Seller in writing of any such claim of infringement (b) Buyer allows Seller to employ counsel, conduct the defense to a finality and assist Seller with the defense; and (c) Buyer shall have paid for all the products or shall not be in default in any of the required payments. Seller assumes no liability as to possible patent infringement by virtue of the use of its products in combination with other elements or structures or the use of products manufactured to Buyer specifications. If any of its products should be held in any such suit to constitute infringement and its use enjoined Seller shall have the right, at Seller's option, at its own expense, either to procure for Buyer the right to continue such use or to substitute, other non infringing or to remove such infringing products and refund to Buyer all money paid to Seller. Except as herein specifically provided, Seller shall not be liable to Buyer for any patent infringement by said products or any part thereof.

9. EQUIPMENT NOT SPECIFIED: Machinery, equipment, materials and labor services, including engineering or mechanical services. not specified in the Contract, are to be furnished in all cases by Buyer.

10. CHANGES OF CONSTRUCTION AND DESIGN: Seller reserves the right to change or revise the construction and design of the products purchased by Buyer, if in its judgment it is to its own or Buyer's best interest to do so. Buyer agrees to bear the expense of meeting any changes or modifications in regulatory or code requirements which become effective after Seller has accepted Buyer's order.

11. MATERIAL SPECIFIED BY CONTRACT: The Contract specifies the products supplied by Seller. The amount or the kind of such products is not changed nor increased by anything shown upon drawings furnished by Seller which are not a part of the Contract documents.

12. RETURNED PRODUCTS AND RESTOCKING: Including Products covered in paragraph 6, Products may not be returned without the express written consent of Seller and in accordance with shipping instructions from Seller. All transportation charges to and from Seller's factory are to be paid by Buyer. Products made to special order are not returnable. A restocking charge of not less than twenty percent (20%) will apply on standard products accepted by Seller for a return and credit. Seller will not be responsible for the disposition of returned products unless the terms of this provision are complied with.

13. ENTIRE AGREEMENT: The parties agree that there an no agreements or representations express or implied, between the parties other than what is contained in this Contract of which this Conditions of Sale is a part. which represents the entire agreement between Seller and Buyer with the exception of those agreements, if any. expressly agreed to in writing by Seller. No course of prior dealings and no usage of the trade shall be relevant to supplement or explain any terms used in this Contract. The Contract between the parties may be modified or rescinded only by a writing signed by both Seller's contracts representative and Buyer's procurement representative.

14. CHARACTER OF PRODUCT AND SECURITY INTEREST: The products delivered by Seller under the terms of the Contract shall remain personal property and retain its character as such no matter in what manner affixed or attached to any structure or property. Buyer grants Seller a security interest in said products, including any proceeds there from, with remedy of self help until all sums due Seller have bean paid to it in cash.

15. FORCE MAJEURE: Neither party shall be liable in damages or have the right to terminate this Agreement for any delay or default in performing hereunder if such delay or default is caused by conditions beyond its control including, but not limited to Acts of God, Government restrictions (including the denial or cancellation of any export or other necessary license), wars, insurrections and/or any other cause beyond the reasonable control of the party whose performance is affected.

16. INSTALLATION: If installation by the Seller is included within this quotation, Purchaser shall provide all of the following at its own expense and at all times pertinent to the installation :

(a) Free, dry, unrestricted and continuous access to Purchaser's premises.

(b) Proper foundations, lighting, power, water and storage facilities reasonably required.

The information contained in this data sheet is basic marketing information and does not contain any export controlled information.

SWITCHES

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Microwave Electronics Division

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