

KRATOS | **GENERAL MICROWAVE**
Microwave Electronics Division

**VOLTAGE CONTROLLED OSC. (VCO)
DIGITALLY TUNED OSC. (DTO)
SYNTHESIZERS**



FREQUENCY SOURCES

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The information contained in this data sheet is basic marketing information and does not contain any export controlled information.

COMPANY PROFILE



ABOUT KRATOS GENERAL MICROWAVE

KRATOS General Microwave incorporates engineering innovation and excellence with high-quality design and production to deliver special requirements and mission critical needs.

Having built numerous products for the most rigid requirements and demanding environments, KRATOS General Microwave has become a leader in Innovative Microwave Solutions. Whether it is off-the-shelf, or custom made, KRATOS General Microwave designs provide top performance at a competitive price and uncompromised quality, while powering many military, governmental and commercial applications.

For more than 50 years, our multi-disciplinary expertise in RF technology, signal processing, hardware and firmware have been utilized worldwide in state-of-the-art microwave components and subassemblies for a wide range of defense and civil applications.

TYPICAL APPLICATIONS

Military and Defense - Electronic Warfare (EW) Systems, Radars, Missiles, UAVs, Smart Munition/ Precision Guided Munition, GPS Immune/Navigation Warfare, Communications, Homeland Security (HLS), Simulators, Munition Proximity Sensors and Software Defined Radio (SDR).

Commercial - In-Flight Connectivity, Maritime and Train Connectivity, Airborne Weather Radars, IFF, Test Equipment, RF and Fiber Optic Communications, Industry Manufacturing Instrumentation, Research Laboratories and Medical Instruments.

PRODUCT LINES

MICROWAVE PRODUCT SOLUTIONS

Broadband Oscillators and Synthesizers - This product line covers 0.5 to 18 GHz band (and beyond) and includes 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, Ku and Ka-bands for missiles, airborne Radars and HLS radars. Up to 1 KW in VHF for military and non-military applications as well as for Pulse Power Amplifiers for IFF systems and Low Noise Amplifiers.

Data-Links - A variety of customized DATA-LINKS subsystems, from small, simple, low cost and low power to complex, high-end and high-power products that incorporate state-of-the-art microwave technology, mixed signal processing, System on Chip (SoC) devices, high power FPGAs and other Digital technologies.

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-effective product line that includes both Narrowband and Broadband products and covers 0.5 – 18 GHz bands. A perfect fit 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 (IMA) built per specific requirements such as: RF Front-Ends, Complicated Switching Assemblies and Frequency Up and Down Converters.

CONTROL COMPONENTS

Control Components (0.1 – 40 GHz) - Based on PIN diode and proprietary coupler technology, this product line includes low, medium, and high-power switches (SPST up to SP16T), Switched Filter Banks, Attenuators, Limiters, Modulators, Phase Shifters, Frequency Translators. All control components are available with either digital or analog control.

STANDARDS AND CERTIFICATIONS

KRATOS General Microwave Quality Management has been certified to AS9100 and ISO9001. General Microwave Corporation US is certified to ISO 9001:2015. Certain companies within the Microwave Electronics Division are FAA certified to maintain microwave modules for commercial aircraft and is in process of being certified by the European Union Aviation Safety Agency (EASA). KRATOS Microwave Electronics Division shares the concern for a better world for all, and certain companies within the division are certified to ISO 14001. Our products can be ordered to be REACH or RoHS compliant.



Kratos General Microwave detailed product line catalog is available online at www.kratosmed.com/gmcatalog.

FREQUENCY SOURCES GENERAL

Kratos General Microwave has been a leader in the development of microwave frequency sources for more than 30 years. Our microwave frequency sources product line consists of state of the art high performance Synthesizers and Free Running Oscillators.

Kratos General Microwave offers a broad range of microwave frequency sources: Direct Synthesizers, Fast Indirect Synthesizers, Digitally Tuned Oscillators (DTO) and VCOs. In addition to catalog, COTS (Commercial Off The Shelf), MOTS (Modified Off The Shelf) products. Kratos General Microwave is offering a variety of custom frequency sources for demanding requirements and severe environmental conditions such as fighter aircraft and missiles.

Kratos General Microwave frequency sources are used in various applications such as: RF missile seekers, EW, SIGINT, Smart Munitions, Data Links, radar, and simulators.

If your system requirements demand a frequency source which cannot be found in this catalog, please do not hesitate to contact Kratos General Microwave directly.



Frequency Sources Final Testing

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 1 Hz.

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).

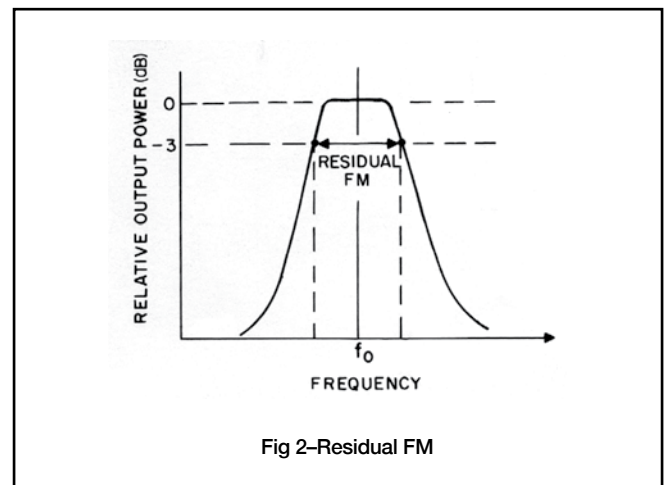
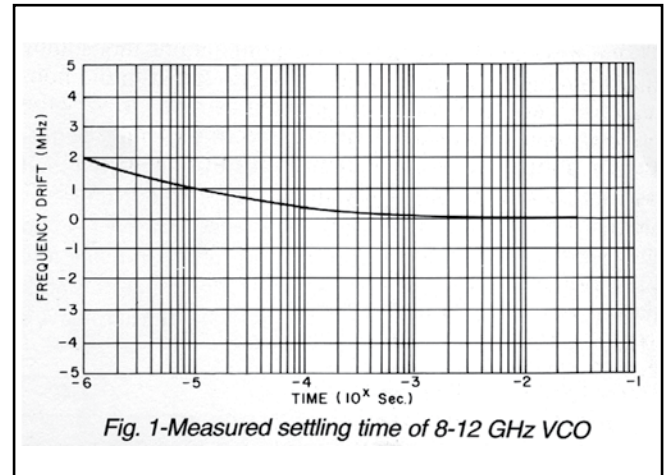
Temperature Stability: The total oscillator frequency variation over the rated operating temperature, usually expressed in ppm/°C.

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:

$$\Delta f_{\text{peak-to-peak}} = \frac{f_o}{2 Q_{\text{EXT}}} (S - 1/S)$$

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.



Microwave Frequency Synthesizers

Kratos General Microwave has developed a broad line of general-purpose synthesizers to be used in various applications. Our synthesizer catalog product line consists of high performance, broadband, and fast indirect synthesizers (FIS). We provide a cost-effective solution to the requirements of a high performance frequency source for various electronic systems.

To provide optimum solutions for diverse requirements, Kratos General Microwave has developed a variety of Fast Indirect Synthesizers (FIS) with different parameter trade-offs: The standard SF series synthesizer product line for fast tuning speed, the SM series synthesizer with frequency modulation capability while in synthesizer mode, and the low cost compact synthesizer SW series.

In addition to the catalog synthesizers product lines, KRATOS General Microwave supports specific customers' requirements, by providing synthesizers built per customer's specifications. Custom synthesizers are provided for missile seekers and EW applications.

FREQUENCY SYNTHESIZERS - SELECTION GUIDE

FREQUENCY RANGE (GHz)							MODEL	PAGE	COMMENTS
0.5	2	4	6	12	18	40			
0.5	—		3				SF6053	7	1 μsec Indirect Synthesizer
2	—				18		SF6218		
2	—				19		SF6219		
2	—				18		SM6218	14	1 μsec Indirect Synthesizer with frequency modulation
6	—				18		SM6618		
2	—				20		SM6220		
0.5	—		8				SW0580	20	Compact Indirect Synthesizers
1.25	—				20		SW0120		
2	—				20		SW0220		
6	—				18		SW0618		
0.5	—				40		FE0P540	24	Frequency Extender
2	—				40		FE0240		
0.5	—				40		FE0P520		
0.25	—				20		FE0P240		
0.25	—				40			28	Custom Direct Synthesizers
								29	Custom Synthesizer
								30	Narrow Band Synthesizers

Series SF60 Fast Indirect Synthesizer

- High Speed: 1 μ sec
- Wide Frequency Range: 0.5 to 19 GHz
- Internal Reference Crystal
- Low Phase Noise
- Small Size
- High Reliability
- Severe Environmental Conditions

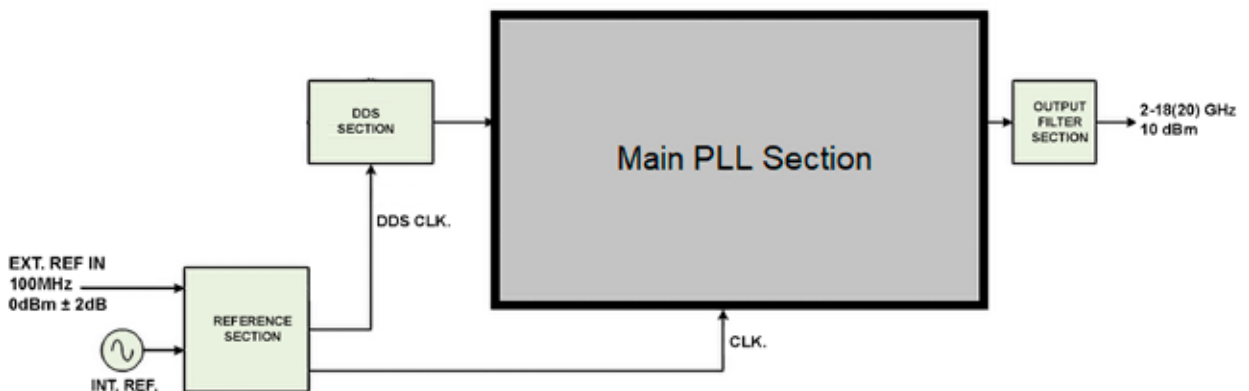


Synthesizer Model SF6218

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.

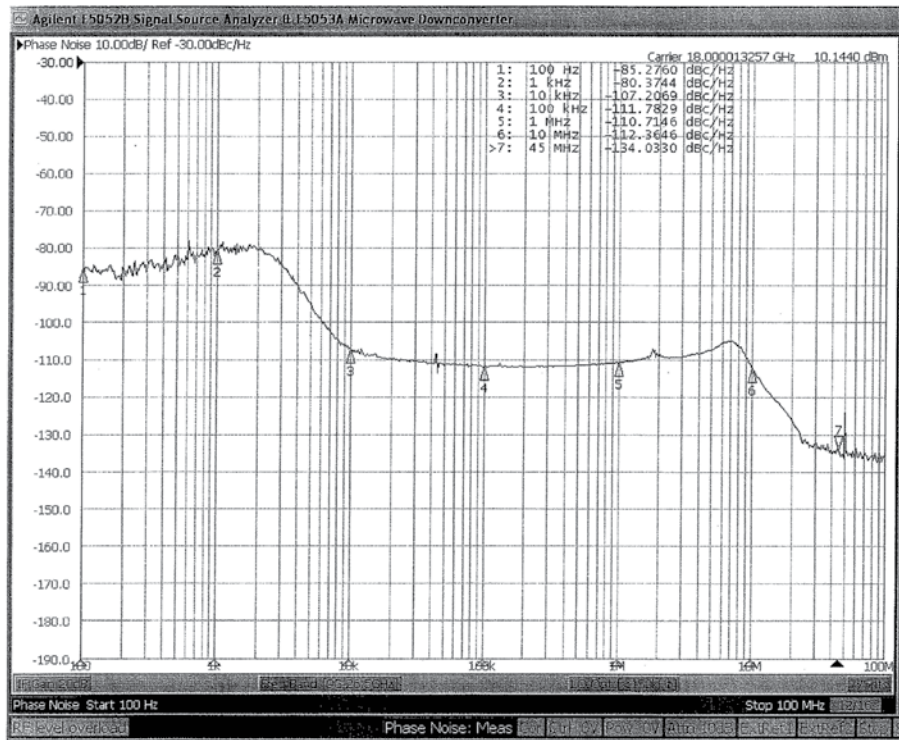
For military applications, this synthesizer requires option G09 to comply with Military Standards. The specific environmental MIL STD requirements as well as the EMI/RFI specifications should be provided by the customer.

Each synthesizer is supplied with an internal reference crystal oscillator. The customer has the option of connecting an external reference crystal oscillator.

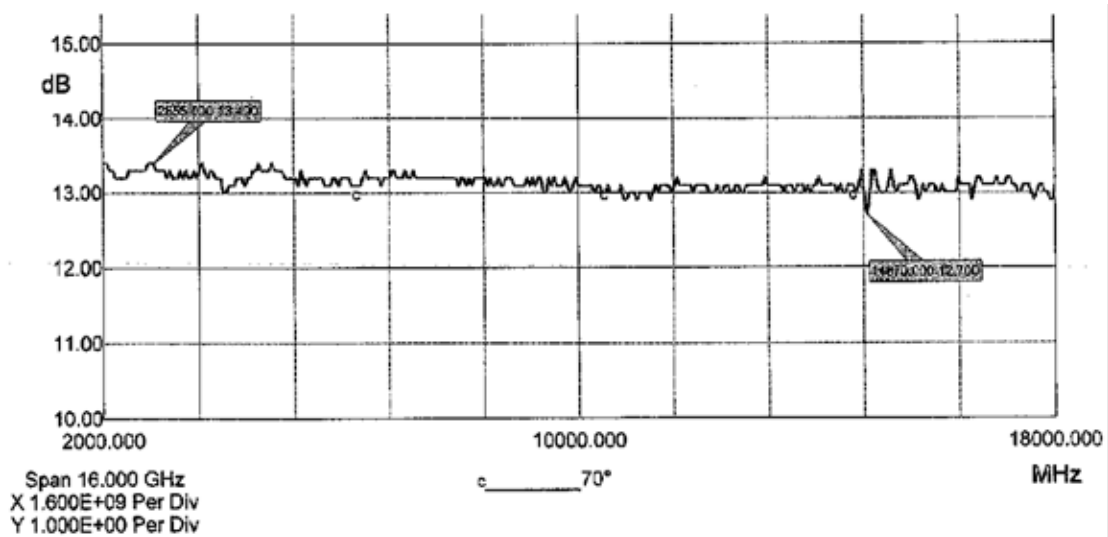


Synthesizer Block Diagram

TYPICAL PERFORMANCE

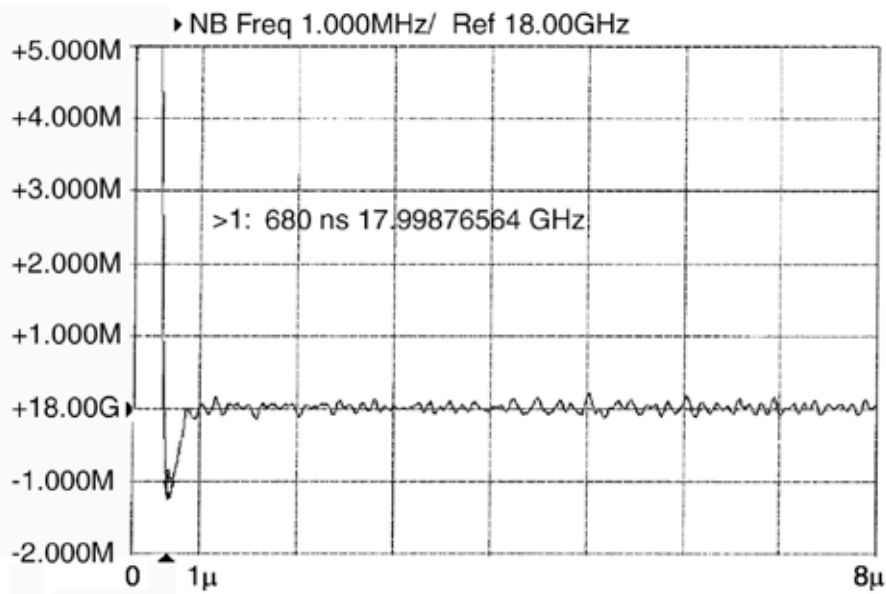


Phase Noise @ 18 GHz

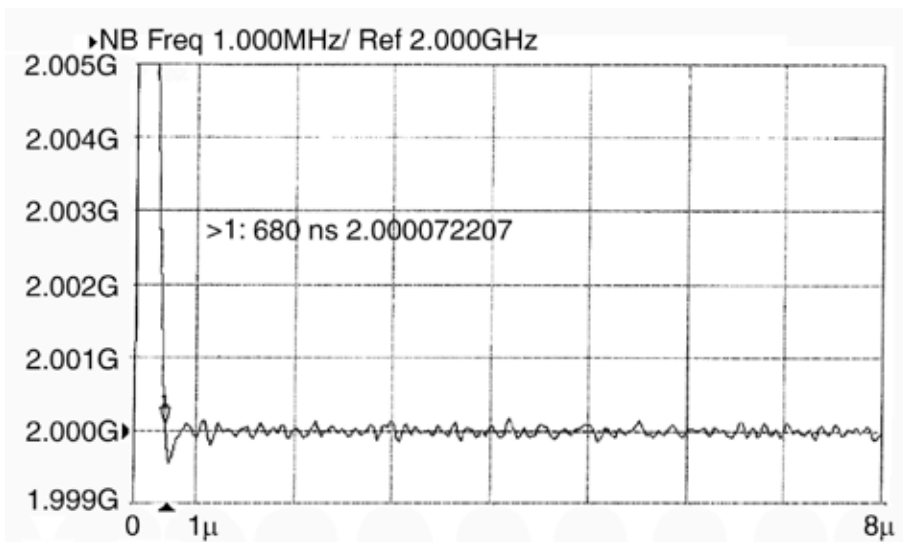


Output Power Flatness @70°

TYPICAL PERFORMANCE



Settling Time 2 to 18 GHz



Settling Time 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	±2		
3	FREQUENCY AGING	±2 First year.	±1 per year, after first year	
4	OUTPUT POWER			
4.1	Min.. (dBm) ⁽¹⁾	10		
4.2	Variation, over freq. and temp., max. (dB)	±2.5		
5	SETTLING TIME ⁽²⁾ , max. (μsec)	1		
6	SSB PHASE NOISE ⁽³⁾ , max (dBc/Hz)			
6.1	@ 100 Hz Offset	-87	-77	
6.2	@ 1 kHz Offset	-100	-90	-90 ⁽³⁾
6.3	@ 10 kHz Offset	-110	-100	-100 ⁽³⁾
6.4	@ 100 kHz Offset	-114	-104	-104 ⁽³⁾
6.5	@ 1 MHz Offset	-114	-104	-104 ⁽³⁾
6.6	@ 10 MHz Offset	-119	-106	-106 ⁽³⁾
7	HARMONICS, max (dBc)	-20		
8	SUB-HARMONICS, max (dBc)	-50		
9	SPURIOUS, max (dBc)	-50	-50	-50 ⁽³⁾
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 ⁽⁴⁾			
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) To within ±1 MHz from final frequency

(3) Degraded by 3 dB @ 18 to 19 GHz

(4) External reference oscillator optional

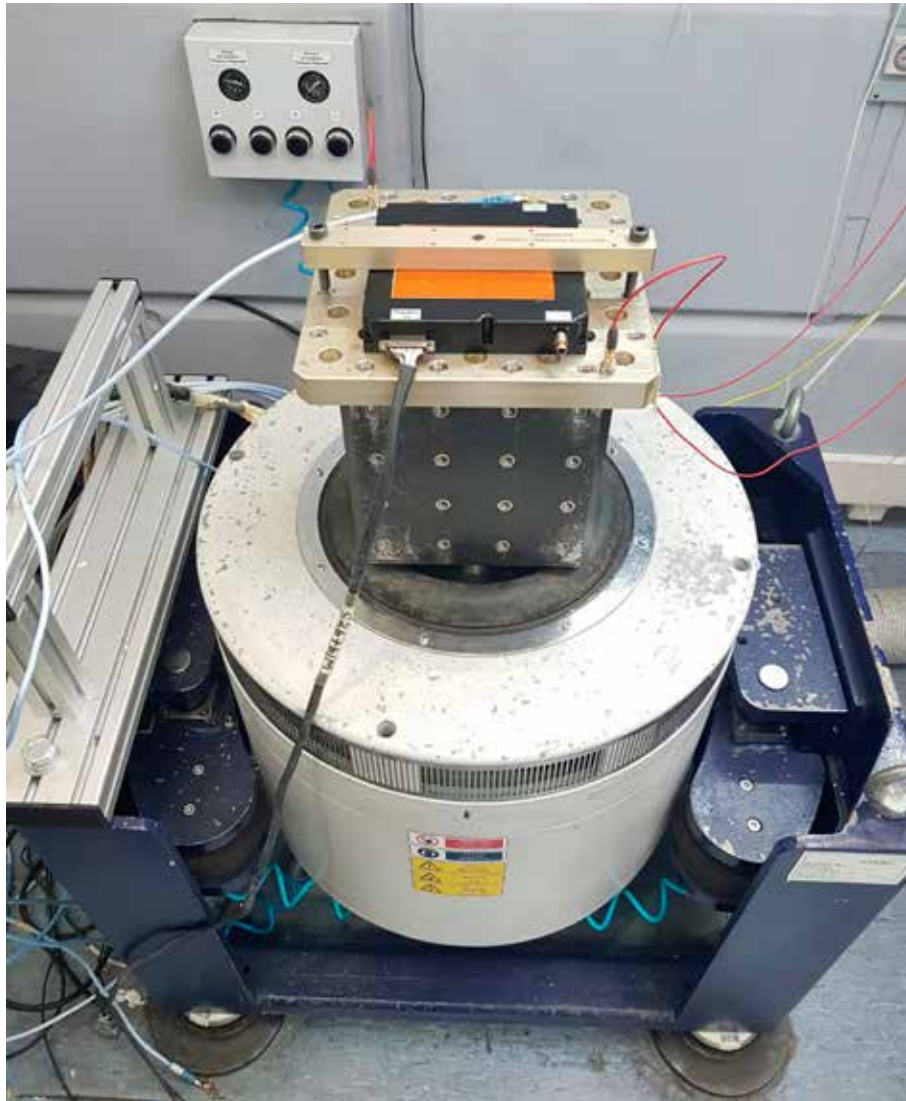
(5) 10 MHz Optional

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.

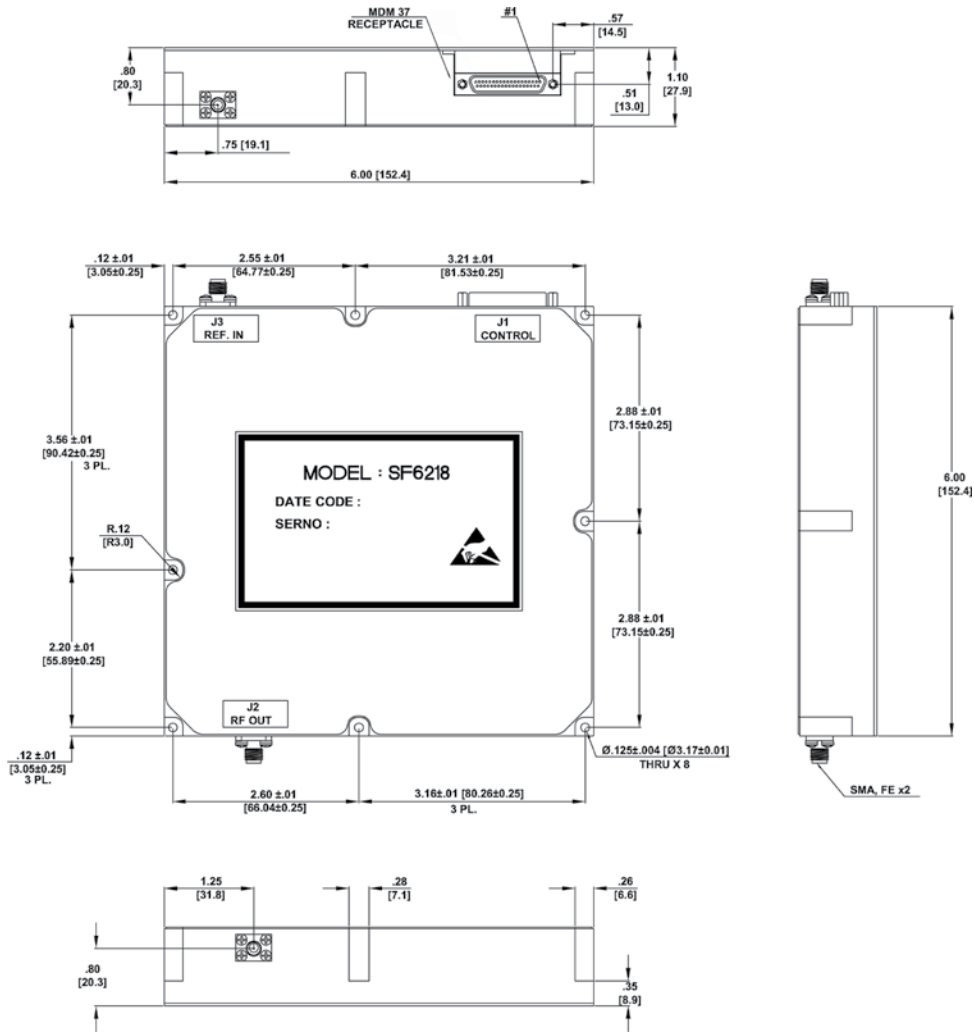
AVAILABLE OPTIONS

Option No.	Description
G02	Operating Temperature -40° to +85°C
G08	10 MHz Reference
G09	Guaranteed to meet Environmental Ratings



VIBRATION TESTING

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

- High Speed: 1 μ sec
- 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 Fast Indirect Synthesizer with Frequency Modulation

KRATOS General Microwave has enhanced 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.

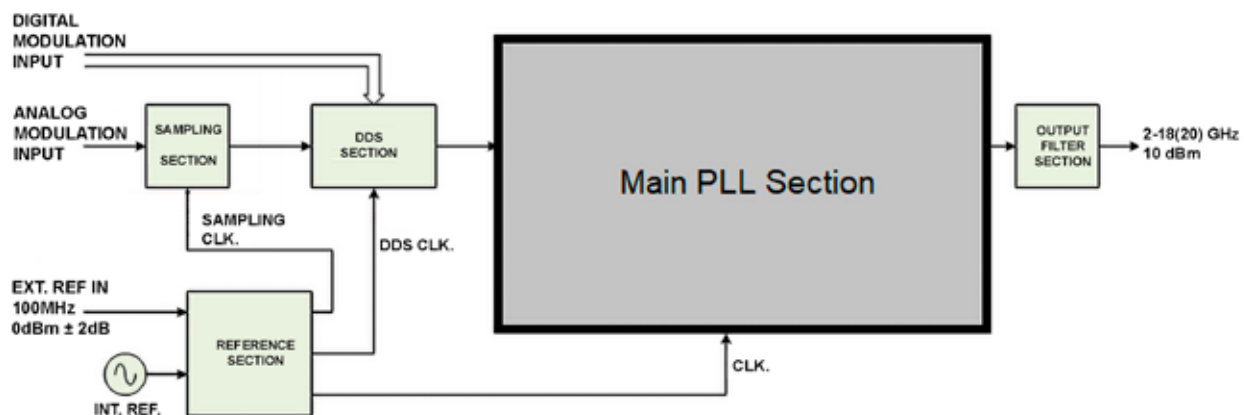
The modulation input can be an analog voltage or a digital signal. This provides the system designer with more flexibility and possibilities in his application for complex modulation options. Fig. 1 is the spectrum of the output signal with a 1 MHz sine-wave modulation input.

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 key 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.

Each synthesizer is supplied with an internal reference crystal oscillator. The customer has the option of connecting an external reference crystal oscillator.

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 a cost effective alternative to signal generators currently used in various applications such as Electronic Warfare (EW), Simulators, and Test Systems that 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.



Synthesizer Block Diagram

MODEL SM6218 – TYPICAL MODULATION SPECTRUMS

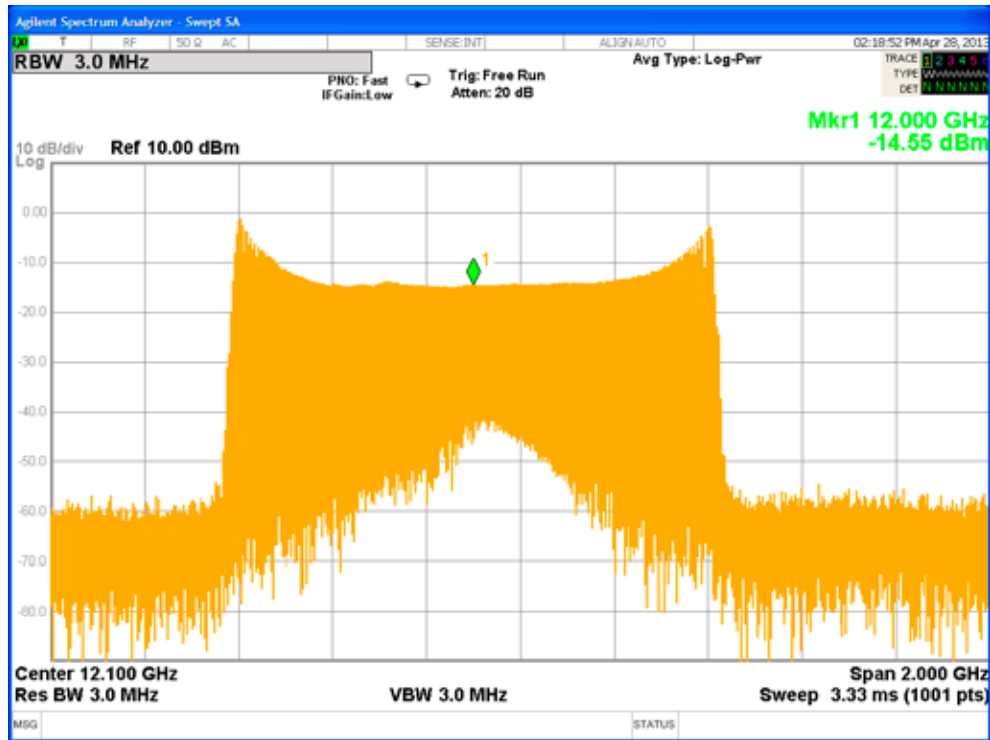


Fig. 1 - 1 GHz Modulation Spectrum using a Sine wave signal

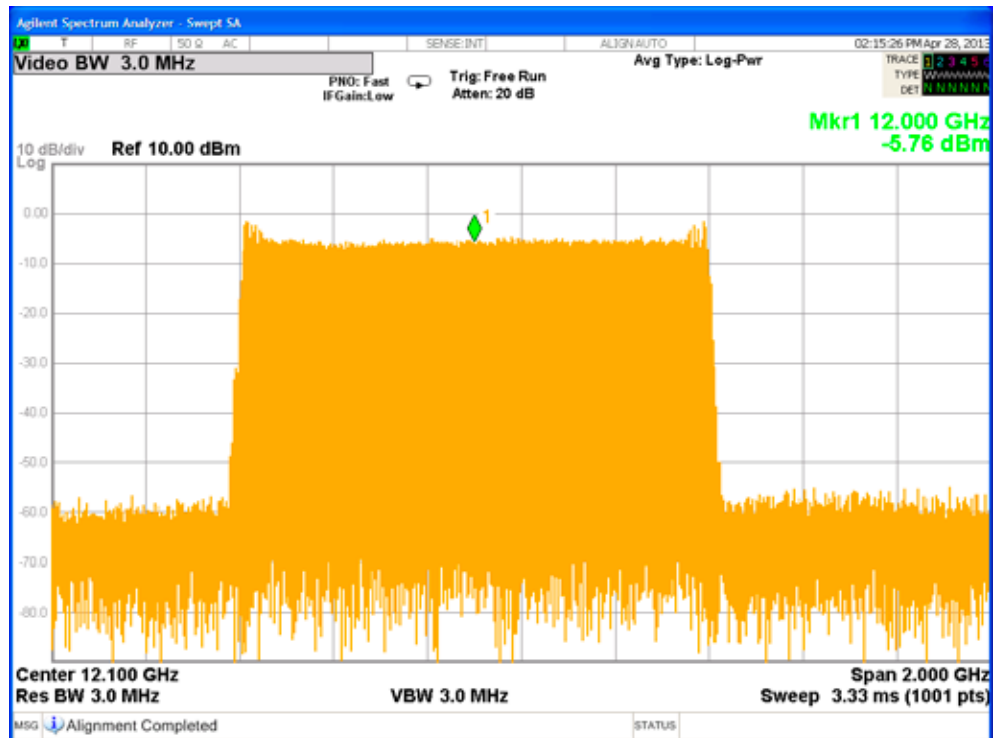


Fig. 2 - 1 GHz Modulation Spectrum using a Triangle signal

SERIES SM60 SYNTHESIZER SPECIFICATIONS

PARAMETER		SPECIFICATION - MODEL		
		SM6218	SM6618	SM6220
1	FREQUENCY RANGE (GHz)	2 to 18 ⁽¹⁾	6 to 18 ⁽¹⁾	2 to 20 ⁽¹⁾
2	ACCURACY (PPM)	±2		
3	FREQUENCY AGING (PPM)	±2 First year. ±1 per year, after first year		
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 ⁽²⁾ , max. (µsec)	1		
6	SSB PHASE NOISE, max (dBc/Hz)			
6.1	@ 100 Hz Offset	-60		-60
6.2	@ 1 kHz Offset	-85		-84
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) ⁽³⁾	-55		-54
10	FREQUENCY CONTROL (PARALLEL)	18 BITS		
11	FREQ. STEP SIZE, nominal LSB (kHz) ⁽¹⁾	100		
12	REFERENCE CRYSTAL OSCILLATOR ⁽⁴⁾			
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)	500, 125, 31.25, Mod. OFF		

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

(2) To within ±1 MHz from the final frequency

(3) Spurious level is guaranteed during modulation at OFF state. When modulation is set to ON, the spurious level is -50 dBc typical.

(4) External reference crystal oscillator- optional

(5) 10 MHz Optional

SERIES SM60 SYNTHESIZER SPECIFICATIONS

PARAMETER		SPECIFICATION - MODEL		
		SM6218	SM6618	SM6220
14	POWER SUPPLY REQUIREMENT, max. (A)			
14.1	+12V to +15V	3.3		
14.2	-12V to -15V	0.45		
14.3	+5V \pm 5%	2.1		
15	OPERATING TEMP. ($^{\circ}$ 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

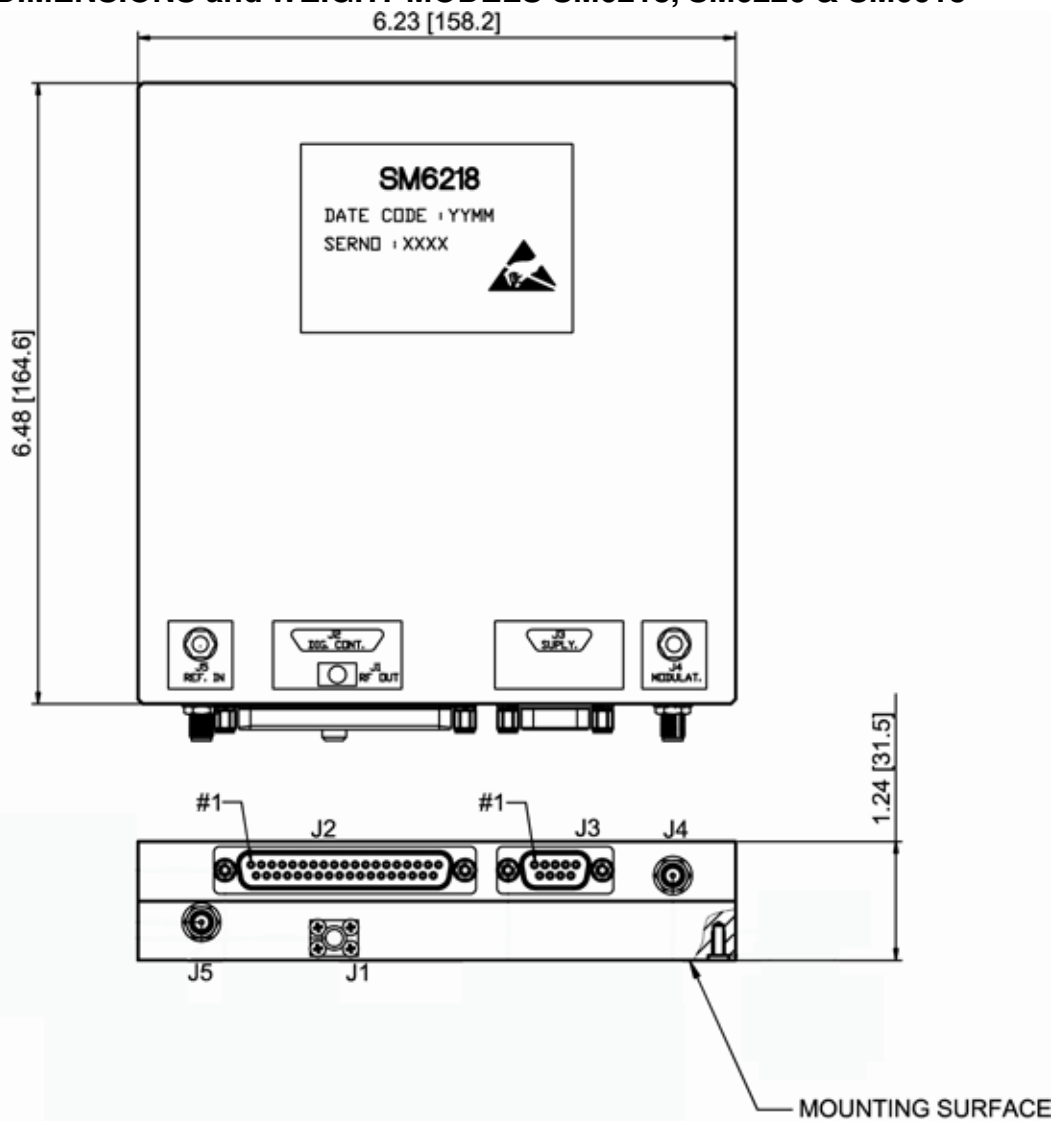
OPTION (G09) ENVIRONMENTAL CONDITIONS

1. Storage Temperature -40^o to +120^oC
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, whichever 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
G02	Operating Temperature -40 ^o to +70 ^o C
G08	10 MHz Reference
G09	Guaranteed to meet Environmental Ratings

DIMENSIONS and WEIGHT MODELS SM6218, SM6220 & SM6618



Weight (Approx.): 1,4 Kg (3.1 Pounds)

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		Control Connector J2	
Pin No.	Function	Pin No.	Function
1.	+5V	1.	A14 Tuning Word
2.	-12V	2.	A12 Tuning Word
3.	+12V	3.	A10 Tuning Word
4.	GND	4.	A8 Tuning Word
5.	+5V	5.	A6 Tuning Word
6.	GND	6.	A4 Tuning Word
7.	GND	7.	A2 Tuning Word
8.	GND	8.	A15 Tuning Word
9.	+12V	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 (0) / External (1)
		37.	A16 Tuning Word

(*) This pin is for factory use only and should be left not connected.

- **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 Low Cost Compact Fast 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.

Each synthesizer is supplied with an internal reference crystal oscillator. The customer has the option of connecting an external reference crystal oscillator.

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 a 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 SYNTHESIZER SPECIFICATIONS

PARAMETER		SPECIFICATION - MODEL			
		SW0580	SW0120	SW0220	SW0618
1	FREQUENCY RANGE (GHz) ⁽²⁾	0.5 to 8 ⁽¹⁾	1.25 to 20	2 to 20	6 to 18
2	ACCURACY at 25°C , (ppm)	±2			
3	FREQUENCY AGING, (ppm/Year)	±2 First year. ±1 per year, after first year			
4	FREQUENCY STABILITY OVER TEMP., ppm	±1			
5	OUTPUT POWER min. , (dBm) ⁽²⁾	(7			
5.1	Peak to Peak Variation Over frequency and temperature (dB)	6			
6	SETTLING TIME , (µsec) ⁽³⁾	120±15			
7	SSB PHASE NOISE , max (dBc/Hz)				
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) ⁽²⁾	0.1			
13	REFERENCE OSCILLATOR ⁽⁴⁾				
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)	-40 to (85			
19	STORAGE TEMPERATURE, (°C)	-65 to + 85			
20	ENVIRONMENTAL CONDITIONS	Airborne and Naval			
21	LOCK DETECT OUTPUT	TTL High			

(1) Special order product

(2) Other Parameters are Optional

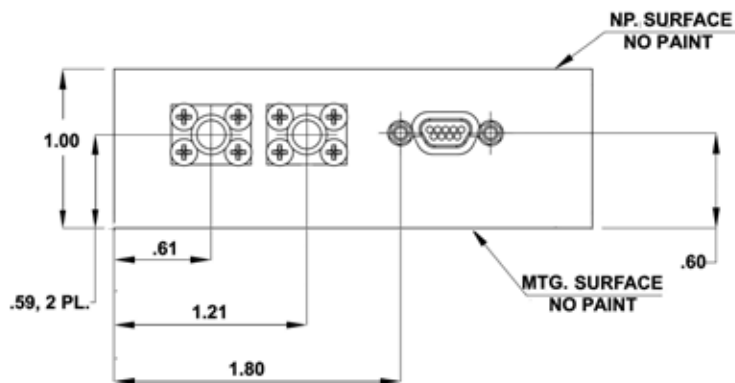
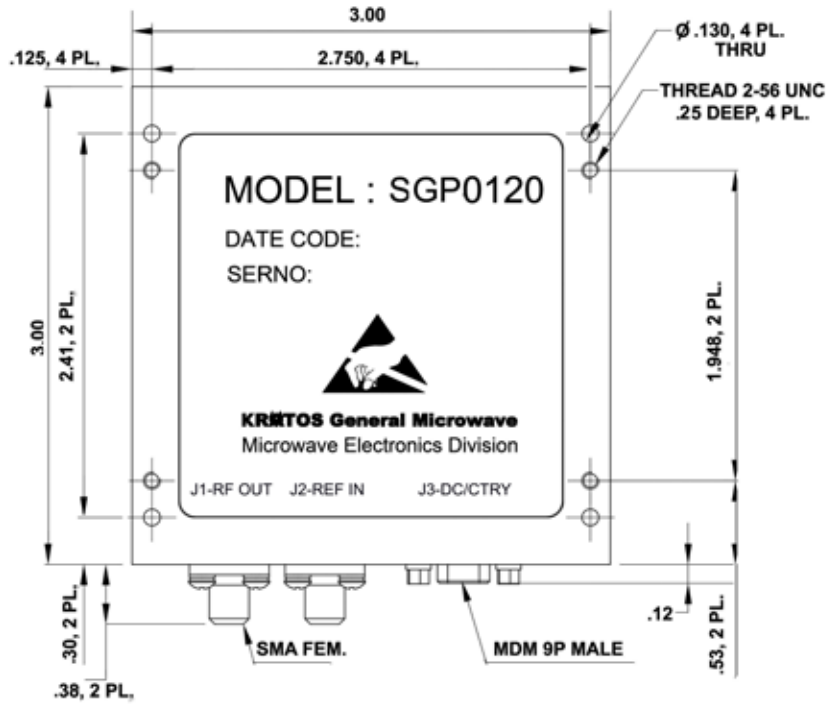
(3) For 50 µsec settling time, order option G17.

(4) Specification is for internal reference. The unit can be configured to work with the internal reference or with an external reference.

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings
G17	50 µsec settling time

DIMENSIONS and WEIGHT



DIMENSIONS IN INCHES (mm)

Dimensional Tolerances, unless otherwise indicated: .XX \pm .02; .XXX \pm .010

J3 - Pin Assignment

PIN No.	FUNCTION
1	VIN positive +12V \pm 10%
2	SDI (Serial Com.)
3	SCLK (Serial Com.)
4	STROBE (Serial Com.)
5	Lock Detect
6	VIN negative -12V \pm 10%
7	For Factory Use - Do not connect
8	For Factory Use - Do not connect
9	GND

Frequency Extender

Kratos General Microwave has introduced 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.

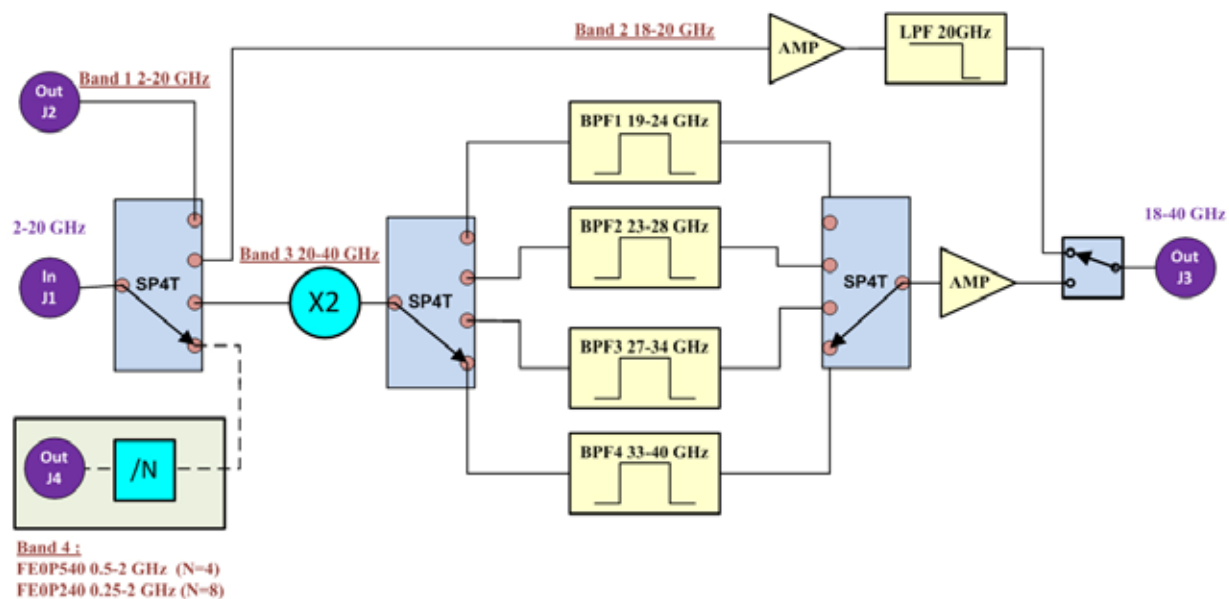
The following frequency synthesizers product lines can be extended by the FE Frequency Extender: SF, SM, SW.

The SM frequency synthesizer is capable of wideband frequency modulation. The FE supports this capability through 40 GHz. The result of combining the SM 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



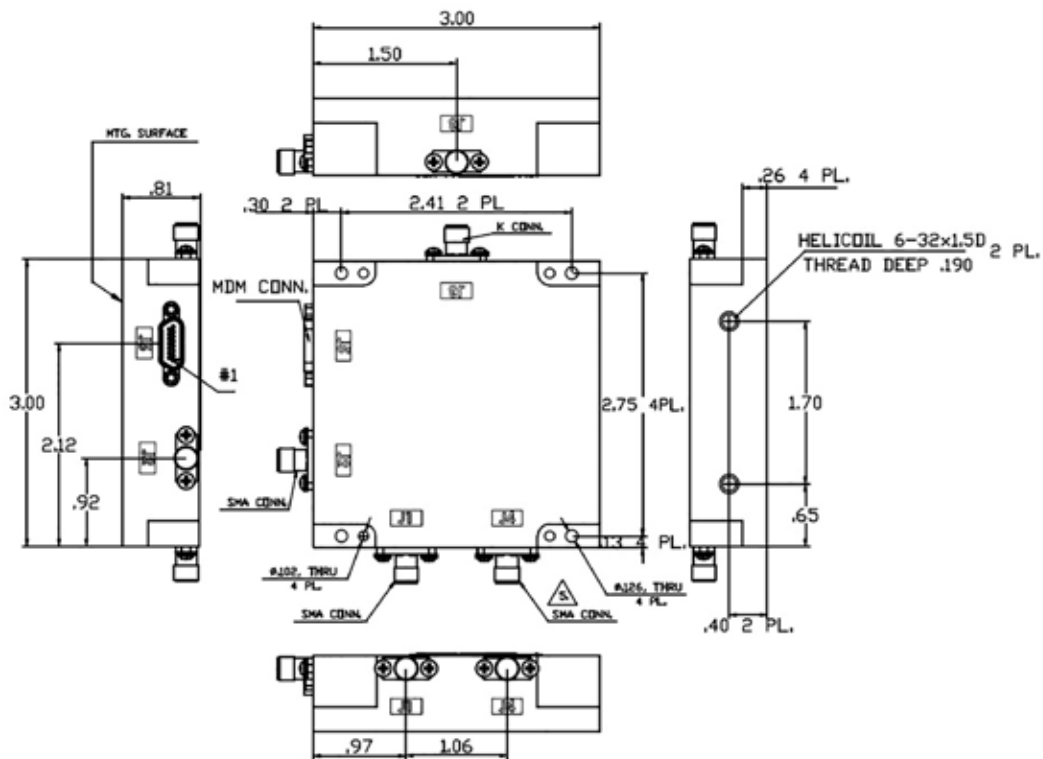
SERIES FE - SPECIFICATIONS

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 POWER (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)

AVAILABLE OPTIONS

Option No.	Description
G09	Guaranteed to meet Environmental Ratings

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

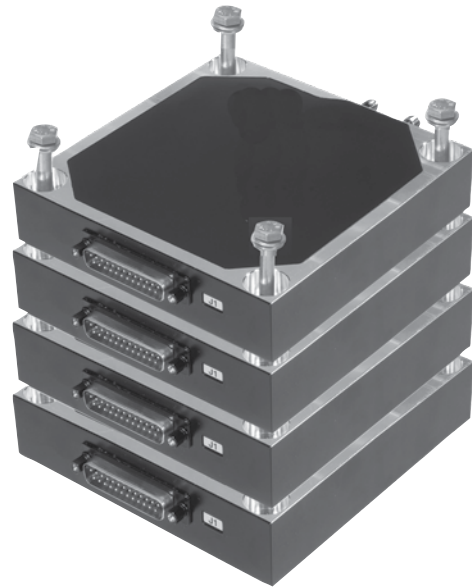
- Switch control logic signals shall be 3 line binary coded TTL logic, as described in the Logic Table.
- Shut-Down Mode – the unit is set to J4 and there is no current to the frequency divider.

CUSTOM FREQUENCY SYNTHESIZERS

Kratos General Microwave is focusing on providing custom Frequency Synthesizers to meet specific customers requirements. Most of these custom synthesizers were designed for missiles and airborne Electronic Warfare systems.

BANK OF SYNTHESIZERS

- Low Spurious
- Wide Frequency Range
- High Reliability



VME CONTROLLED SYNTHESIZER

- Wide Frequency Range
- Fast Settling Time
- Low Power Consumption
- VME mechanical and control Interface



NARROW BAND SYNTHESIZERS

KRATOS General Microwave supplies Narrow Band Synthesizers for operation at fixed frequencies. These are custom designed high performance, low cost alternatives to a fixed frequency sources.

APPLICATIONS

The fixed frequency synthesizers are designed to be used as the L.O. in various up and down frequency converters. They can be used as a replacement of a DRO, in applications that require high frequency stability over temperature while operation under severe vibrations.

- Operating Frequency within 0.5 to 18 GHz
- High Frequency Accuracy
- High Frequency Stability
- Low Cost
- Compact Size
- High Reliability



Synthesizer

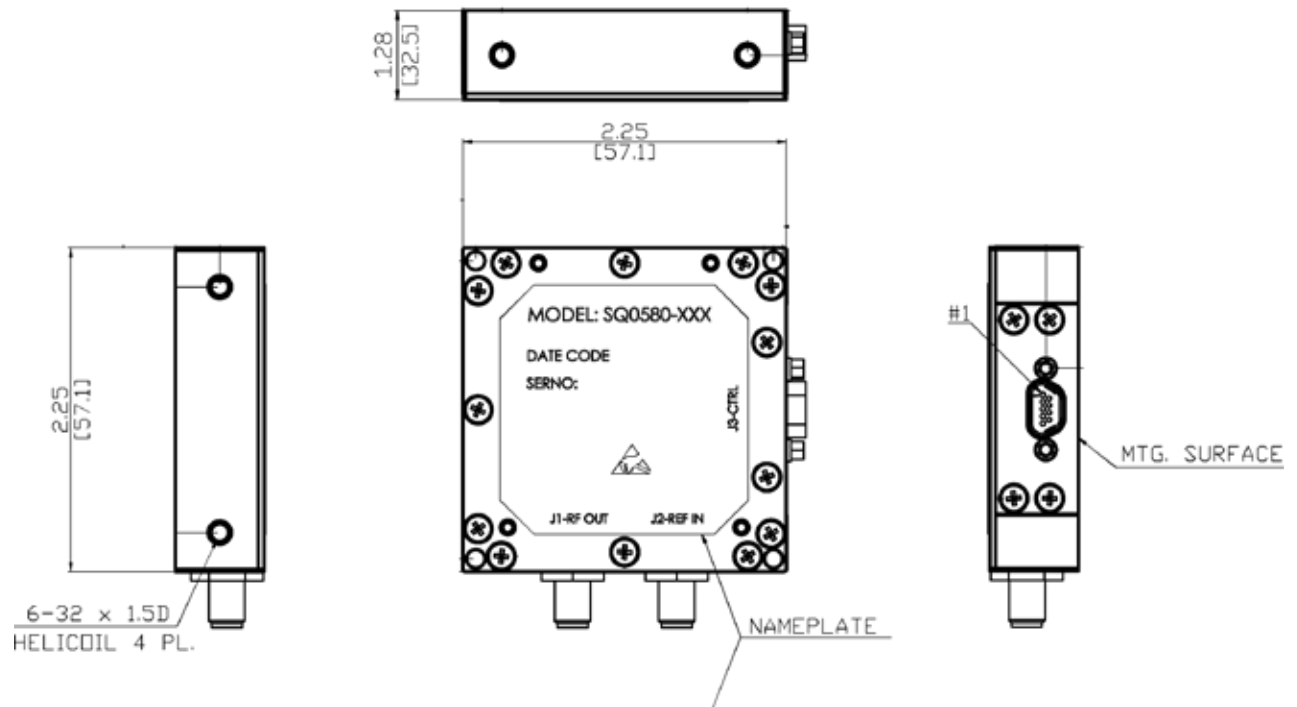
TYPICAL - SPECIFICATIONS

PARAMETER		SPECIFICATION
1	FREQUENCY RANGE (GHz)	7.935
2	ACCURACY, (ppm)	Same as of the ref. crystal
3	FREQUENCY AGING, (ppm)	Same as of the ref. crystal
4	FREQUENCY STABILITY, (ppm)	Same as of the ref. crystal
5	OUTPUT POWER, (dBm)	+10 to +14
6	SSB PHASE NOISE , max (dBc/Hz) ⁽²⁾	@ 8 GHz
6.1	@ 100 Hz Offset	-70
6.2	@ 1 kHz Offset	-90
6.3	@ 10 kHz Offset	-99
6.4	@ 100 kHz Offset	-125
6.5	@ 1 MHz Offset	-142
7	HARMONICS, (dBc) typ	-60
8	SUB-HARMONICS, max (dBc)	-60
9	SPURIOUS, max (dBc)	-80
10	CONTROL	Serial Control
11	EXTERNAL REFERENCE OSCILLATOR	
11.1	INPUT FREQUENCY (MHz)	100
11.2	INPUT POWER (dBm)	0 2
12	SUPPLY VOLTAGE , (VDC)	12 0.4V @ 290 mA
13	DIMENSIONS, Inch (mm)	2.25 (57.2) x 2.25 (57.2) x 1.28 (32.5)
14	RF OUTPUT & REF INPUT CONNECTORS	SMA Female
15	CONTROL CONNECTOR	MDM (9 PINS)
16	OPERATING TEMPERATURE, (C)	-40 to +85
17	STORAGE TEMPERATURE, (C)	-65 to +125
18	ENVIRONMENTAL CONDITIONS	Airborne
19	LOCK DETECT OUTPUT	TTL High

TYPICAL - SPECIFICATIONS

PARAMETER		SPECIFICATION
7	HARMONICS, (dBc) typ	-60
8	SUB-HARMONICS, max (dBc)	-60
9	SPURIOUS, max (dBc)	-80
10	CONTROL	Serial Control
11	EXTERNAL REFERENCE OSCILLATOR	
11.1	INPUT FREQUENCY (MHz)	100
11.2	INPUT POWER (dBm)	0 2
12	SUPPLY VOLTAGE , (VDC)	12 0.4V @ 290 mA
13	DIMENSIONS, Inch (mm)	2.25 (57.2) x 2.25 (57.2) x 1.28 (32.5)
14	RF OUTPUT & REF INPUT CONNECTORS	SMA Female
15	CONTROL CONNECTOR	MDM (9 PINS)
16	OPERATING TEMPERATURE, (C)	-40 to +85
17	STORAGE TEMPERATURE, (C)	-65 to +125
18	ENVIRONMENTAL CONDITIONS	Airborne
19	LOCK DETECT OUTPUT	TTL High

TYPICAL OUTLINE



Weight (Approx.): Gr. (Oz)

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

DIGITALLY TUNED OSCILLATOR

KRATOS General Microwave offers a broad line of DTOs covering the 2 to 18 GHz frequency range based upon its catalog line of broadband VCOs. 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 $\pm 1\%$, 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 $\pm 5\%$ 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.

SELECTION GUIDE DIGITALLY TUNED OSCILLATORS (DTO)

FREQUENCY RANGE (GHz)								MODEL	PAGE	COMMENTS
0.5	2	4	6	8	12	18	19			
1 — 2								D6010C	33	Octave 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	36	Multi-Band Digitally Tuned Oscillators
2 — 6								D6206		
6 — 18								D6618		
2 — 18								D6218		
2 — 6								DC6206 DC6618	41	Compact Airborne DTO
6 — 18										
0.5 — 18								-----	46	Custom Multi-Band Digitally Tuned Oscillators

OCTAVE BAND DTO SPECIFICATIONS

PARAMETER	MODEL					
	D6010C	D6020C	D6026C	D6040C	D6080C	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 (MHz)	0.5			1.0		1.5
MONOTONICITY	Guaranteed					
TURN ON TIME, (minutes) to specified accuracy @ (25Ω	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					

(1) Δ f relative to f after 1 sec.

(2) 50 Ohm input impedance.

(3) 12 Bit TTL input.

(4) Mating connector furnished

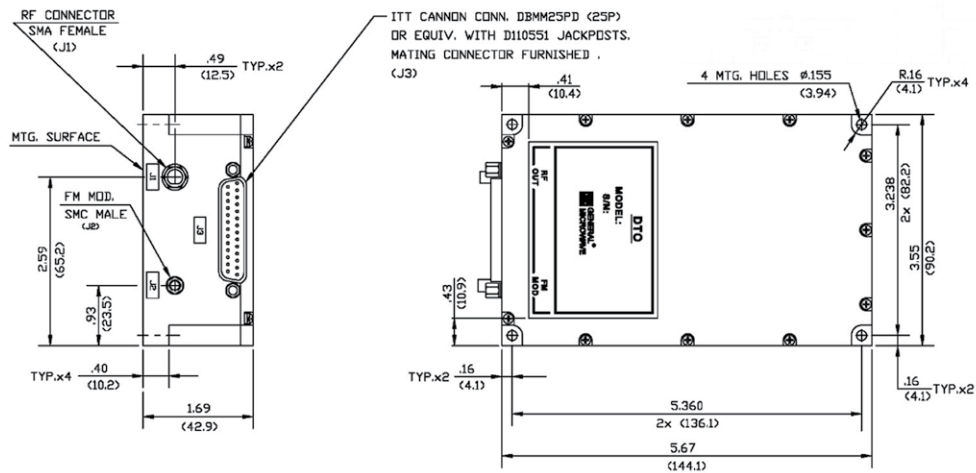
(5) RF section and driver components hermetically sealed

(6) Please consult us for further Modulation Band Width improvement:

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

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 can be 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.

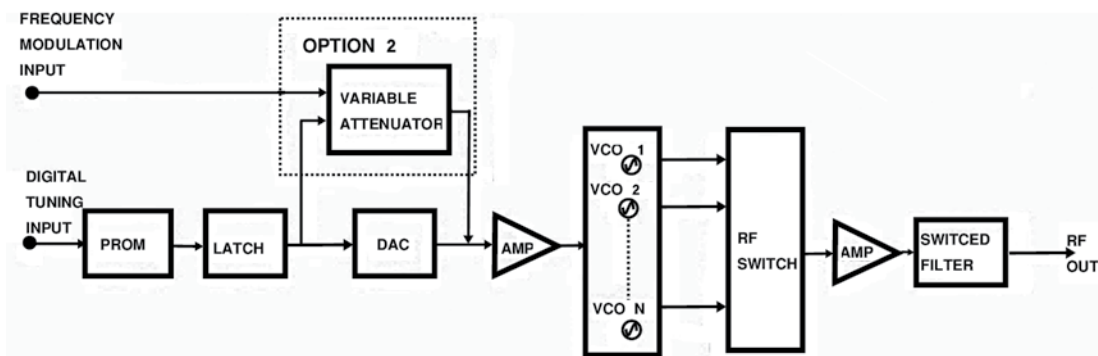


Fig. 1—Multi-Band DTO Block Diagram

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 -15V ± 0.5V (5V ± 0.5V (28V ±2V	450 250 150 1,000	700 250 150 1,000	1,000 300 500 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:

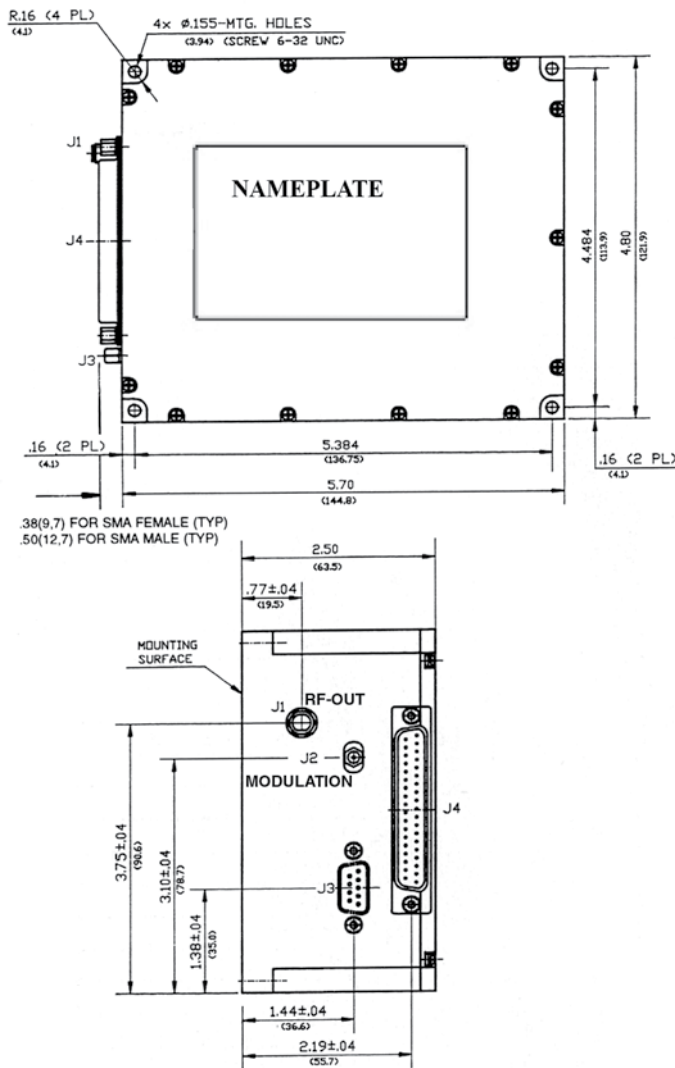
KRATOS | GENERAL MICROWAVE

Microwave Electronics Division

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

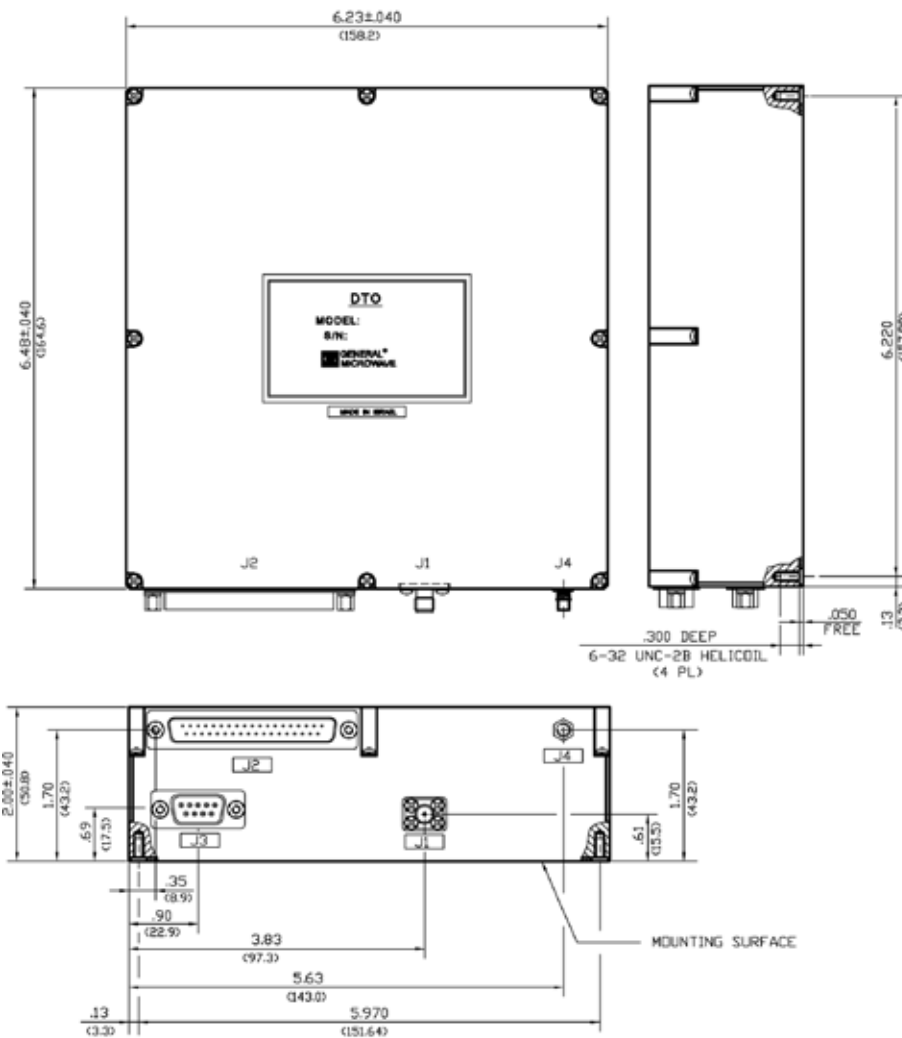
Series D60 Multi Band DTO

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 \pm .02; .XXX \pm .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.

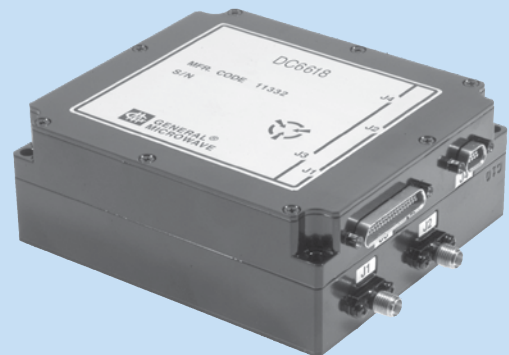
MODELS D6206, D6218 and D6618 Control Connector (J2)	
PIN NO.	FUNCTION
1	A14 Tuning Word (MSB)
2	A12 Tuning Word
3	A10 Tuning Word
4	A8 Tuning Word
5	A6 Tuning Word
6	A4 Tuning Word
7	A2 Tuning Word
8	V0 VCO Control Bit
9	L1 Latch 1 of 3 (Strobe)
10	L3 Latch 3 of 3 (Strobe)
11	OE Memory Output Enable
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 DC Compact DTO

FOR RWR, ESM AND OTHER APPLICATIONS

KRATOS General Microwave offers compact multi-band DTOs for various airborne, naval and ground based 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 enable 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

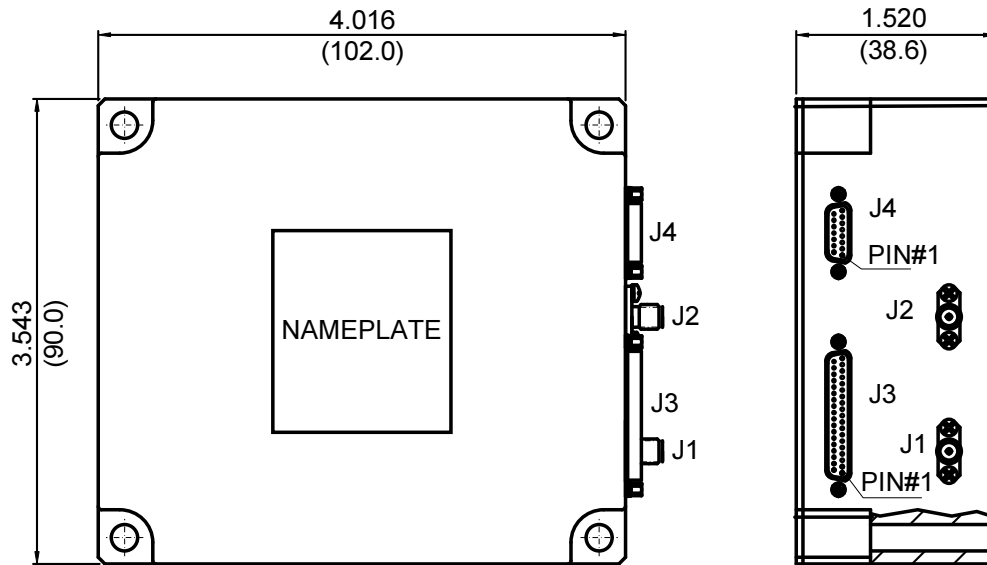
PARAMETER	MODEL	
	DC6206	DC6618
FREQUENCY RANGE (GHz)	2 to 6	6 to 18
ACCURACY @ +25°C, max (MHz)	±2	
FREQUENCY DRIFT, max (MHz/°C)	±0.1	
FREQUENCY SETTling within 1 µsec, max (MHz)	±2	±3
MODULATION ⁽¹⁾ Bandwidth		
min. (MHz)	DC to 15	DC to 10
Sensitivity variation, max	1.1 :1	
Frequency deviation (MHz/V) max	±250 @ 5V PTP	±250 @ 2V PTP
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

Logic Level	Input Level
"0"	-0.3 to 0.8V
"1"	2.0 to 5.0V

COMPACT AIRBORNE DTO DIMENSIONS



CONNECTORS TABLE		
	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).

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 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. 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.

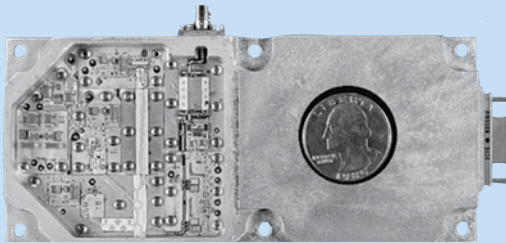


Fig. 1 - Multi-Band DTO (RF side view)

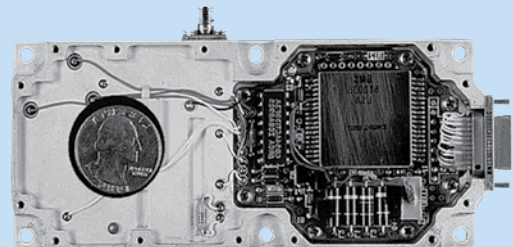


Fig. 2 - Multi-Band DTO (Driver side view)

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 bands DTO (Fig. 4) meets similar requirements

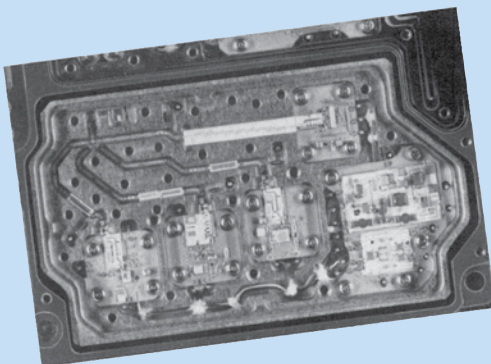


Fig. 3 - C-Ku Band DTO RF Assembly

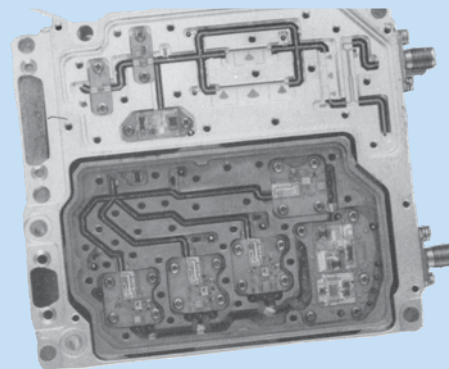


Fig. 4 - S-C Band DTO RF Assembly

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 μ sec 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 μ sec)
- 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)							MODEL	PAGE	COMMENTS
0.5	2	4	6	8	12.0	18.0			
2 ————— 18							FL6218	47	Frequency Locked Oscillator
6 ————— 18							FL6618		

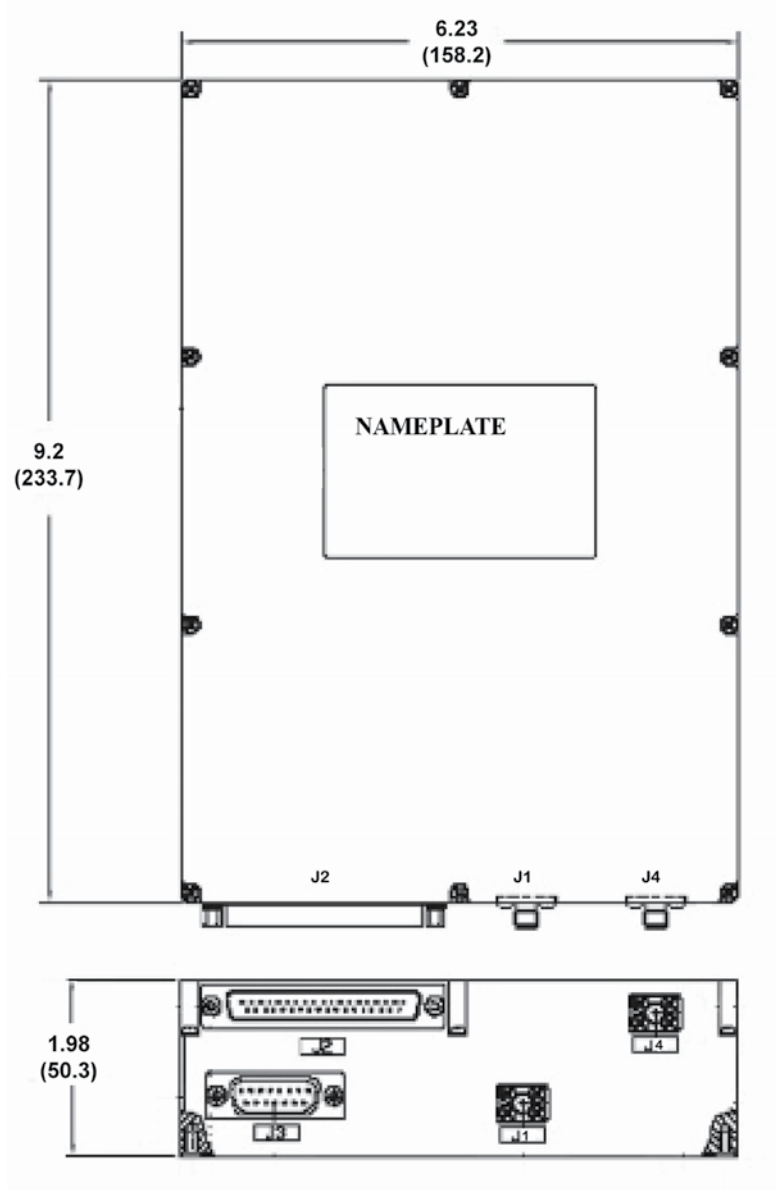
Multi-Band Frequency Locked Oscillator Specifications

PARAMETER		SPECIFICATION	
		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 -15V (5V 28V, start up 28V, steady state @25°C	2,000 580 300 6,500 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

Frequency Locked Oscillator (FLO)

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 Oscillator (VCO)

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 KRATOS 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.)

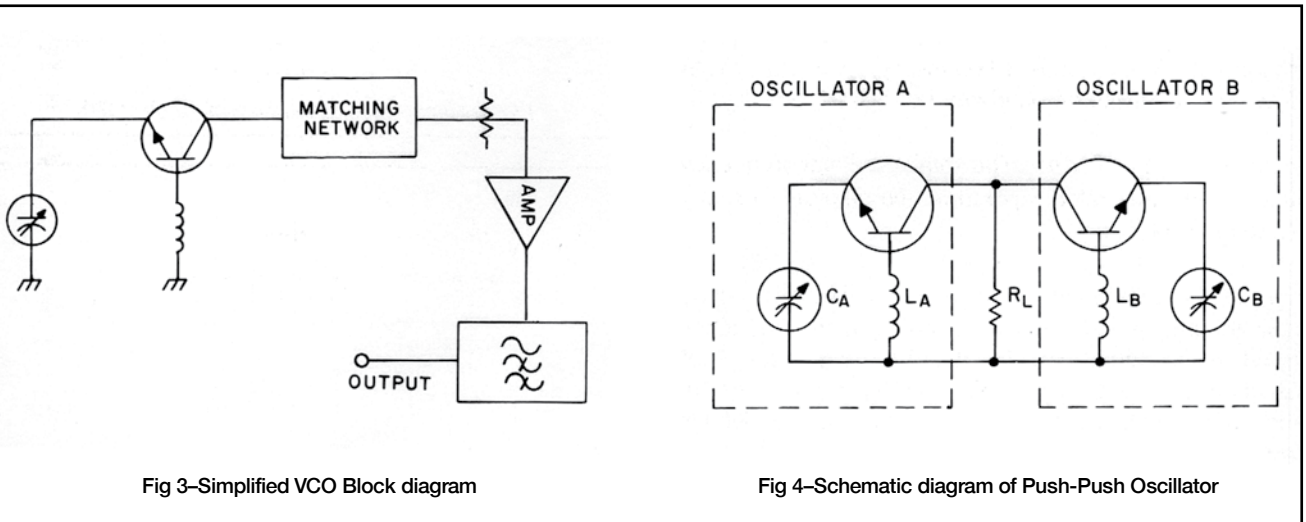
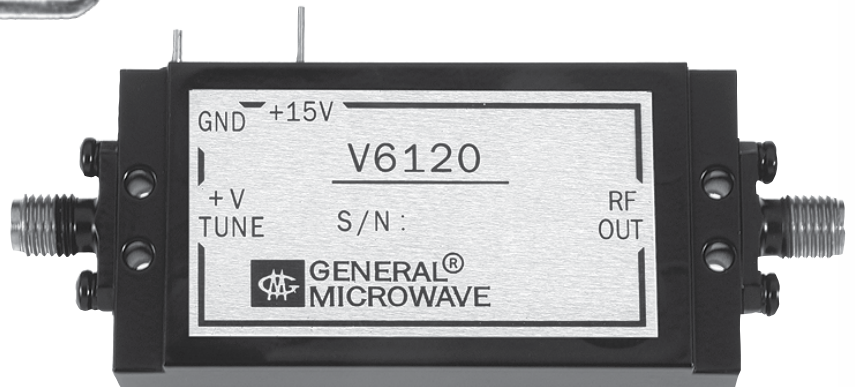


Fig 3-Simplified VCO Block diagram

Fig 4-Schematic diagram of Push-Push Oscillator

VOLTAGE CONTROLLED OSCILLATORS (VCO) SELECTION GUIDE

FREQUENCY RANGE (GHz)							MODEL	PAGE	COMMENTS
0.5	2	4	6	8	12.0	18.0			
2 — 4							V6020	53	Octave Band VCO
2.6 — 5.2							V6026		
4 — 8							V6040		
8 — 12							V6080		
12 — 18							V6120A		
2 — 2.8							V6020-952C	55	Miniaturized Voltage Controlled Oscillators
2.8 — 3.8							V6020-953C		
3.8 — 4.9							V6020-954C		
4.9 — 6.1							V6020-955C		
1 — 18							-----	57	Custom Military and Commercial Voltage Controlled Oscillators



Voltage Controlled Oscillator (VCO)

OCTAVE BAND VCO

PARAMETER	MODEL				
	V6020	V6026	V6040	V6080	V6120A
FREQUENCY RANGE (GHz)	2-4	2.6-5.2	4-8	8-12	12-18
FREQUENCY SETTling ⁽¹⁾ , max (MHz) within 50 nsec, Typical	±8				±10
within 200 nsec, Typical	±3		±4		±5
within 1 µsec	±1.5		±3		±4
MODULATION Bandwidth, min (MHz)	100				
Sensitivity ratio, max	3:1				
RF POWER Output, min (dBm)	(10				
Variation, Incl. temp. and freq. max (dB)	±2.5		±3.0		
PHASE NOISE, max (dBc/Hz) @ 100 kHz offset	-95		-90	-80	-80
HARMONICS, max (dBc) f/2, 3f/2,max (dBc)	-15			-40	-20
	N/A				-20
SPURIOUS, max (dBc)	-60				
TEMPERATURE STABILITY, typ (PPM/°C)	100				
PULLING VSWR 2:1 max (MHz)	1				
PUSHING, max (kHz/V)	250				
CONNECTORS Power supply	Solder terminal				
Tuning voltage	SMA female				
RF output	SMA female				
POWER SUPPLY REQUIREMENT Voltage (VDC)	(15 ±0.5				
Current, max (mA)	150			300	
Tuning voltage (VDC)	0 to (20			0 to (15	
INPUT CAPACITANCE, nominal	25 pF, 10 kΩ				
ENVIRONMENTAL ⁽²⁾ Operating temperature (°C)	-54 to (85				
Storage temperature (°C)	-54 to (125				
MECHANICAL DIMENSIONS Inches	1.79 x 1.10 x 0.45			2.19 x 1.10 x 0.45	
Millimeters	45,5 x 27,9 x 11,4			55,6 x 27,9 x 11,4	

(1) Δf relative to f after 1 sec.

(2) Hermetically sealed.

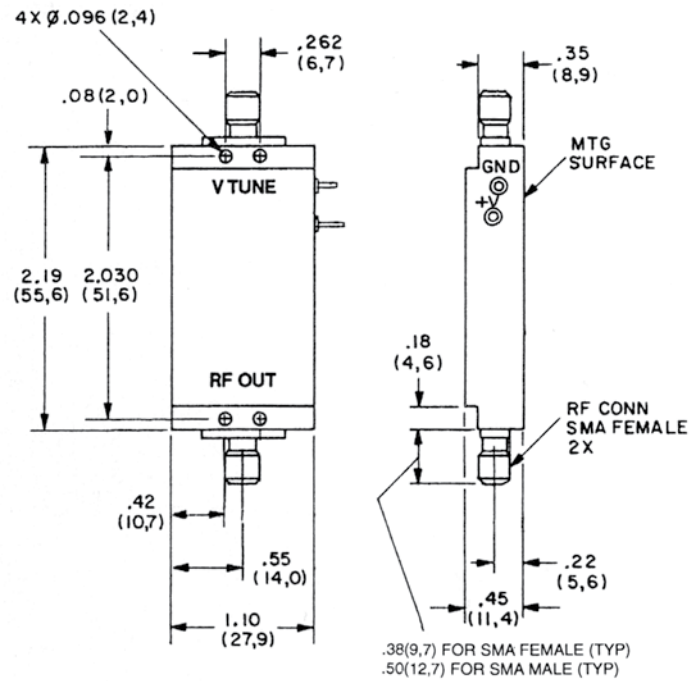
AVAILABLE OPTIONS

Option No.	Description
49	High Rel screening (see Table 1)
G09	Meeting Environmental Ratings

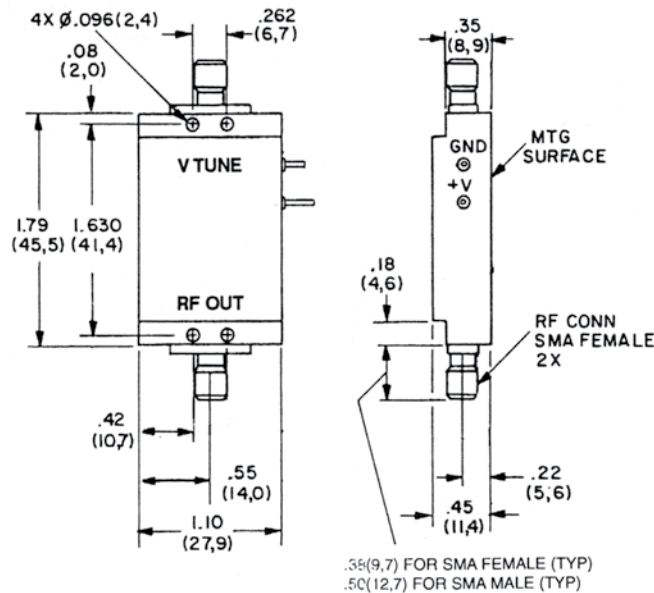
Table 1. Option 49 High Rel Screening

TEST	MIL-STD-883	NOTES
Internal Visual	METHOD-2017	-
Temperature Cycle	METHOD 1010	-55 °C to +95 °C, 10 CYCLES Dwell time at temperature 20 minutes min.. temp. rise time 3°C/MIN
Mechanical Shock	METHOD 2002, COND. B	1,500g 0.5ms
Burn-In	METHOD 1015, COND. B	48 hours, at +110 °C
Leak	METHOD 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 \pm .02; .XXX \pm .008

Voltage Controlled Oscillator (VCO)

MINIATURIZED (VCO)

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

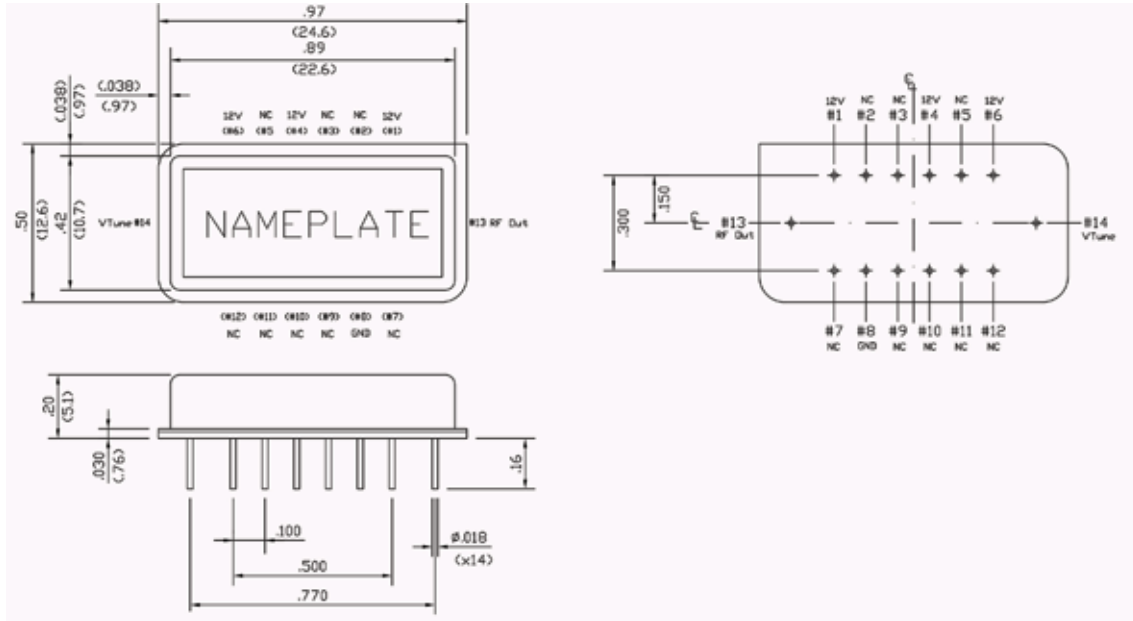
MINIATURIZED VCO SPECIFICATIONS

PARAMETER	MODEL			
	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 μ sec	± 1			
RF POWER	(13			
Output, min. (dBm)				
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	(12 \pm 0.5			
Voltage (VDC)				
Current, max (mA)	125			
Tuning (VDC)	0 to (28			
TUNING PORT CAPACITANCE, max (pF)	50			
ENVIRONMENTAL	0 to (85			
Operating temperature ($^{\circ}$ C)				
Storage temperature ($^{\circ}$ C)	-54 to (125			
MECHANICAL DIMENSIONS	0.97 x 0.50 x 0.20			
Inches				
Millimeters	24,6 x 12,7 x 5,1			

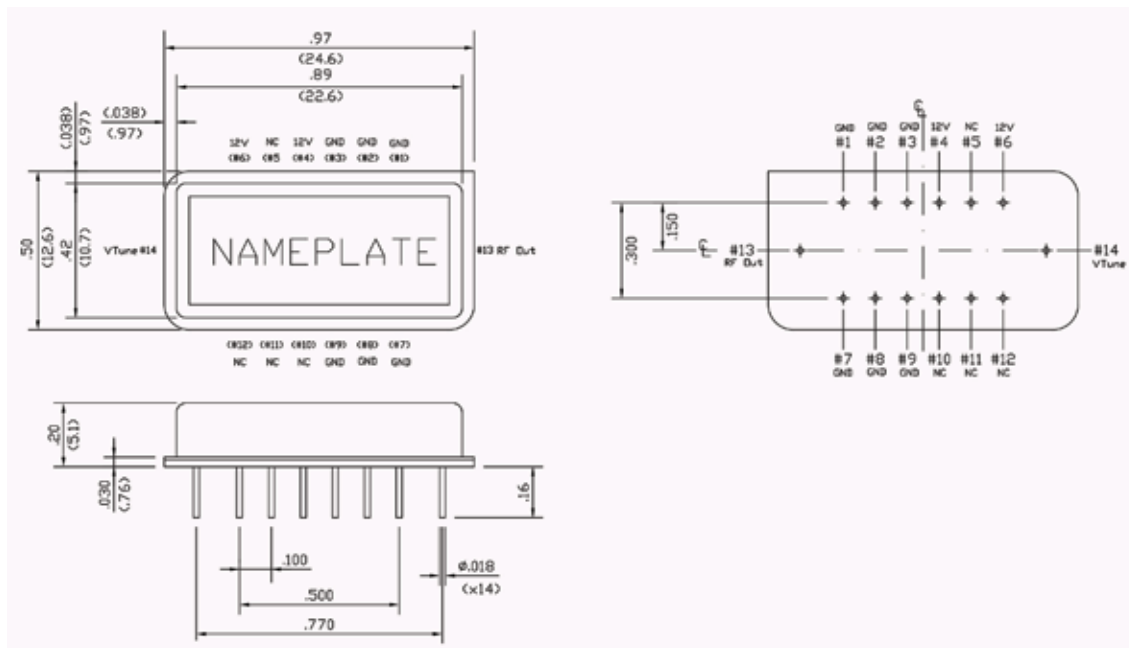
(1) Δf relative to f after 1 millisecond

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.

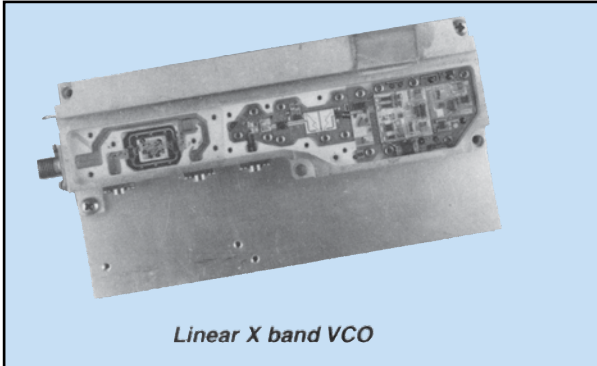
CUSTOM VCOs

Linear VCOs

For narrowband (<5%) applications, KRATOS General Microwave has developed proprietary techniques to achieve a high degree of linearity without the use of external linearizers.

Linear X band

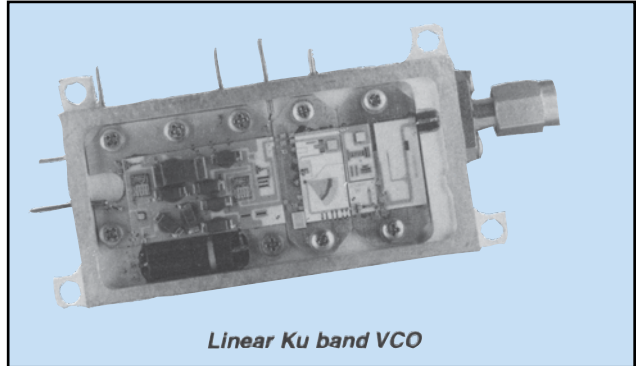
An X-band VCO assembly with linearity of less than $\pm 1\%$ is shown in the photo. The assembly includes two MMIC amplifiers, a medium power MIC amplifier, two filters, a phase shifter and a MMIC SP2T switch. For specific requirements, please consult the factory.



Linear X band VCO

Linear Ku band

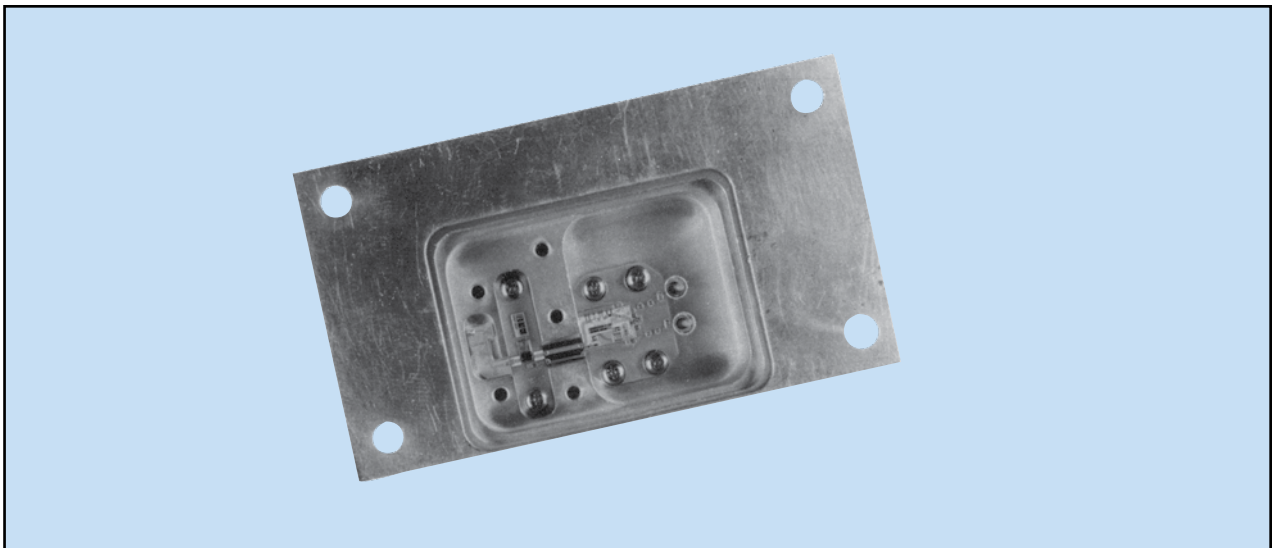
The photo shows a Ku-band VCO with a typical linearity of better than $\pm 5\%$ for an airborne jamming application. The unit is designed for high speed modulation and also includes RFI/EMI filtering.



Linear Ku band VCO

Commercial GaAs FET X band

For X- and Ku-band applications where very low post-tuning drift and phase noise are not required, VCOs based upon GaAs FETs provide a cost-effective solution. In the photo, a GaAs FET X-band VCO, developed for a commercial radar application, is shown.





FREQUENCY SOURCES

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