

VOLTAGE CONTROLLED OSCILLATORS

WATKINS-JOHNSON COMPANY



OCTOBER 1975

VCO Selection Guide

Frequency Range

.25 to .5 GHz

.5 to 1

2 to 4

4 to 8

8 to 12.4

12.4 to 18



WJ-2830 series
Militarized Transistor Oscillator

WJ-2832

WJ-2833

WJ-2834

WJ-2835



WJ-2860 series
Militarized GaAs Oscillator

WJ-2860

WJ-2860

WJ-2863



WJ-2800 series
Standard Oscillator

WJ-2811

WJ-2800

WJ-2803

WJ-2804

WJ-2806



WJ-2840 series
Standard Oscillator with Isolator

WJ-2842

WJ-2843

WJ-2844

WJ-2845

INTRODUCTION

Watkins-Johnson Company was formed in December, 1957 to engage in research, development and production of advanced electron devices and electronic systems. Now employing more than 2,000 people, the Company is a diversified electronics firm with manufacturing facilities in the U.S. and overseas.

Stewart Division, located in Scotts Valley, five miles north of Santa Cruz, California, is the site of Watkins-Johnson's voltage controlled oscillator (VCO) design and manufacturing activity. Maintained here is a continuing R&D effort, incorporating innovative designs by the Company's technical staff and guidance provided by the Division's customers worldwide. The application of the latest engineering techniques to W-J's state-of-the-art product line ensures reliability, durability and continued customer satisfaction.

APPLICATIONS

VCO's are employed in a wide variety of applications in both military and commercial markets. In the commercial field, they are used as replacements for backward-wave oscillators in sweeper designs, as sources in frequency synthesizers and as video up- and downconverters for high-data-rate FM communication systems. In the military market, VCO's may be used as local oscillators (L.O.'s) and transmitters in radar applications, as noise sources for active jammers and as L.O.'s for superheterodyne receivers. In general, they are used wherever a wideband oscillator characterized by fast tuning, high power output, small size and light weight is needed.

OPTIONS

Customers find that specifying Watkins-Johnson VCO's is advantageous for several reasons. First, W-J builds its own ferrite isolators, proportionally controlled heaters and high-speed linearizers. This means cost savings because the intricate interface of these components is done by W-J. Second, in-house fabrication of these parts eliminates delivery problems since outside suppliers are not involved.

HEATERS Temperature extremes encountered by today's sophisticated military electronic systems necessitate some provision for temperature control. Watkins-Johnson Company has developed a unique hybrid heater capable of containing critical components within a narrow temperature excursion. Please refer to the inside back cover for a discussion of the W-J heater module.

LINEARIZERS The required equipment for extremely

linear output in many modern systems demands that an optional linearizer circuit be available. W-J's linearizers are discussed on the inside back cover.

HIGH-SPEED MODULATION PORT A high-modulation port SMA jack can be supplied as a linearizer bypass. Typically, this port is capable of providing an rf output spectrum of 200 MHz peak-to-peak deviation at modulation bandwidths ranging from 25 kHz to 10 MHz. Typical input impedances are 50 to 100 ohms. With this modulation port, the linear modulation bandwidth is limited to 10 kHz.

MICROWAVE ISOLATORS W-J VCO's can be mounted with integral isolators. Typically, 20 dB isolators will be supplied for improved performance. Other levels of isolation will be supplied upon request. Frequency pulling due to mismatched loads is reduced by approximately a factor of ten for each isolator junction.

MICROWAVE FILTERS To reduce harmonic content, W-J VCO's can be manufactured with filters tailored to specific customer requirements.

OTHER OPTIONS Other options such as amplifier/oscillator combinations, switches between two oscillators and couplers which allow the user to sample the fundamental frequency may also be specified. Consult the factory or the W-J Field Sales Office in your area for details.

SPECIALS

Minor modifications such as shifts in frequency range and the optimization of performance over narrower frequency or temperature ranges can be easily accomplished. Because of the experience garnered through many years of delivering custom VCO's, many customers find W-J's technical consulting and custom design team to be a very real asset in ordering the precise VCO for the job.

Watkins-Johnson VCO Applications Engineering or any W-J Field Sales Office will expedite special VCO inquiries.

MILITARIZED VERSIONS

W-J militarized VCO's are designed to operate without performance degradation in typical military environments such as those defined by MIL-E-5400, MIL-E-16400 and MIL-T-21200. Details regarding specific methods and conditions are available from VCO Applications Engineering and the W-J Field Sales Offices.

Militarized Transistor Oscillators

APPLICATION

The WJ-2830 series of voltage-controlled oscillators is designed to meet the environmental requirements encountered in both space and military applications. The varactor-tuned oscillator can be used in superheterodyne receivers, frequency agile radar systems, frequency synthesizers, radar correlators, radar simulators, and jammers.

DESCRIPTION OF UNITS

To meet the stability requirements typically found in these applications, all WJ-2830 series oscillators contain a proportionally controlled heater, a voltage regulator, and an isolator. In the frequency range of 1.0 to 4.0 GHz, the oscillators are fundamental sources, while in the 4 to 12 GHz range the units employ a doubling rf circuit.

HEATER All of the components of the oscillator assembly are mounted to a temperature-controlled heater plate. The temperature of this plate is maintained by hybrid, proportionally controlled heater modules. These heaters were developed by

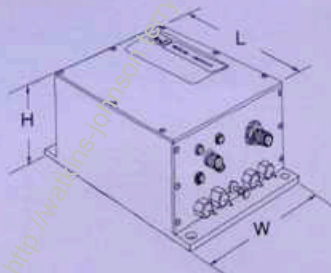
Watkins-Johnson and are able to maintain a preset temperature within 10°C. The heaters have been tested and screened to the requirements of MIL STD 883.

REGULATOR The regulators found in all WJ-2830 series oscillators are monolithic integrated circuits. Their function is to provide a stable reference for the oscillator in an environment of changing external voltages, temperatures, and time.

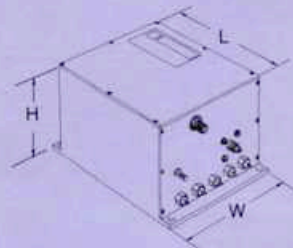
ISOLATOR Most WJ-2830 oscillators contain a minimum of 40 dB isolation. This improves the performance of the frequency pulling into varying mismatches.

OPTIONS

- LINEARIZERS
- MULTISTAGE ISOLATORS
- FILTERS
- AMPLIFIER/OSCILLATOR COMBINATIONS
- SWITCHES
- HI-REL VERSIONS
- ± 15 Vdc BIAS



General outline drawing for militarized, non-linearized voltage-controlled oscillator.



General outline drawing for militarized, linearized voltage-controlled oscillator.

WJ-2830 SERIES

	Frequency Range (GHz)	Output Power (mW)	Input Power ¹	Heater Current Turn On (Amps)	Steady State ² (Amps)	Tuning Voltage Range (Vdc)	Modulation Bandwidth (MHz)	Residual FM (kHz, pk-pk)	Freq. Pulling 2:1 VSWR (MHz)	Freq. Pushing (MHz/V)	Freq. Drift w/Temp (MHz)	Size ³ L x W x H (inches)	Weight (ounces)
WJ-2832-35	1.0-2.0	50	±20±0.5Vdc @ 250mA	3.2	2.5	0 to -60	10	5	16	±1	6	5.06×3.50×2.00	34
WJ-2833-35	2.0-4.0	50	±20±0.5Vdc @ 300mA	3.2	2.5	0 to -60	20	10	4	±2	12	4.25×3.50×2.00	26
WJ-2834-35	4.0-8.0	20	±20±0.5Vdc @ 300mA	3.2	2.5	0 to -60	20	15	4	±4	30	3.31×2.80×1.75	16
WJ-2835-35	8.0-11.0	20	±20±0.5Vdc @ 150mA	2.1	1.5	0 to -40	20	20	4	±5	35	2.88×2.80×1.75	12
WJ-2835-25	8.0-12.0	5	±20±0.5Vdc @ 150mA	2.1	1.5	0 to -60	20	20	4	±5	35	2.88×2.80×1.75	12

All the above units have the following additional specifications:

Harmonic Rejection (n= 1/2, 3/2, 2) ⁴	20 dB
In-Band, Non-Harmonic Rejection	60 dB
Heater Voltage	+28±2 Vdc
RF Output Connector	SMA Jack

Tuning Input Connector	SMA Jack
Bias and Heater Connectors	RFI protected solder terminals
Operating Temperature	-55 to +71°C
Storage Temperature	-62 to +100°C

WJ-2830 SERIES LINEARIZED

	Freq. Range (GHz)	Output Power (mW)	Input Power ¹	Heater Current Turn On (Amps)	Steady State ² (Amps)	Residual FM (kHz, pk-pk)	Freq. Pulling 2:1 VSWR (MHz)	Freq. Pushing (MHz/V)	Size ³ L x W x H (inches)	Weight (ounces)
WJ-2832-36	1.0-2.0	50	±20±0.5 Vdc @ 300mA max	4.2	3.0	30	16	±1	5.06×3.50×2.00	40
WJ-2833-36	2.0-4.0	50	±20±0.5 Vdc @ 350mA	4.2	3.0	50	4	±2	4.25×3.50×2.00	34
WJ-2834-36	4.0-8.0	20	±20±0.5 Vdc @ 350mA	4.2	3.0	50	4	±4	3.31×2.80×1.96	18
WJ-2835-36	8.0-11.0	20	±20±0.5 Vdc @ 200mA	3.2	2.5	50	4	±5	3.31×2.80×1.75	16
WJ-2835-25	8.0-12.0	5	±20±0.5 Vdc @ 200mA	3.2	2.5	50	4	±5	3.31×2.80×1.75	16

All the above units have the following additional specifications:

Harmonic Rejection (n= 1/2, 3/2, 2) ⁴	20 dB
In-band Non-Harmonic Rejection	60 dB
Tuning Non-Linearity	±1%
Modulation bandwidth (small signal, Δf=20MHz)	500 KHz
Modulation bandwidth (full band)	dc to 100 KHz
Input Impedance	10K ohm
Tuning Voltage Range	0 to +10 Vdc

Linearizer Supply	-75±2 Vdc @ 50mA
Heater Voltage	+28±2 Vdc
RF Output Connector	SMA Jack
Tuning Input Connector	SMA Jack
Bias and Heater Connectors	RFI protected solder terminals
Operating Temperature	-55° to +71°C
Storage Temperature	-62° to 100°C

Notes: 1. Protective circuitry guards against damage due to over-voltage (up to 10 percent) and against transient reverse voltages.
2. Steady state current at -55°C mounting plate temperature.

3. Nominal dimensions shown exclude mounting flanges and connectors.
4. WJ-2834 and 2835 oscillators are doubling sources, therefore exhibiting n=1/2 and n=3/2 harmonics.

Militarized GaAs Oscillators

APPLICATIONS

Voltage-controlled bulk-effect oscillators may be used in military or commercial applications as described earlier. These oscillators are extremely useful in applications where small size and light weight are critical. The standard oscillator with isolator, heater, and regulator occupies less than 7½ cubic inches and weighs 9 ounces.

DESCRIPTION OF UNITS

The basic RF circuit for the bulk-effect oscillator is a fundamental series-tuned resonant circuit. The oscillator is integrated with an isolator to maintain a fixed load impedance at the oscillator output. A voltage regulator is incorporated in the standard design to provide the optimum voltage to the GaAs device as a function of temperature, time, and varying voltages. A heater is also part of the standard package.

HEATER All of the components of the oscillator assembly are mounted to a temperature-controlled heater plate. The temperature of this plate is maintained by hybrid, proportionally controlled heater modules. These heaters were developed by Watkins-Johnson and are able to maintain a preset temperature within 10°C. The heaters have been tested and screened to the requirements of MIL STD 883.

REGULATOR The regulators found in all WJ-2860 series oscillators are monolithic integrated circuits. Their function is to provide a stable reference for the oscillator in an environment of changing external voltages, temperatures, and time.

ISOLATOR All WJ-2860 oscillators contain integral isolators to minimize frequency and power pulling in varying load mismatches.

BULK-EFFECT VS. TRANSISTOR OSCILLATORS

From approximately 8 to 12 GHz, it is possible to use either a transistor or bulk-effect oscillator. How, then, does the user choose which device is best for his application? Transistor oscillators exhibit less overall as well as fine grain modulation-sensitivity variation, together with improved post-tuning drift characteristics. Bulk-effect oscillators operate from a single active element and are fundamental devices. As such, they are less costly and smaller in size than the transistor devices.

OPTIONS

- LINEARIZERS
- MULTISTAGE ISOLATORS
- FILTERS
- SWITCHES
- HI-REL VERSIONS



General outline drawing for militarized GaAs oscillator.



General outline drawing for militarized GaAs oscillator with linearizer.

WJ-2860 SERIES with single-stage isolator

	Freq. Range (GHz)	Output Power (mW)	Residual FM (kHz., pk-pk)	Freq. Pulling 1.5:1 VSWR (MHz)	Frequency Drift w/Temp. (MHz)
WJ-2860-4	7.5-10.5	20	60	40	25
WJ-2860-10	8.0-10.0	20	60	40	25
WJ-2860-11	10.0-12.4	20	60	50	32
WJ-2863-5	12.0-15.0	20	100	60	40
WJ-2863-6	15.0-18.0	10	100	72	50

All of the above units have the following additional specifications

Second Harmonic Rejection	20 dB	Heater Current Turn On	3.2 A
In-band Non-Harmonic Rejection	60 dB	Steady State at -55°C	2 A
Modulation Bandwidth	dc to 20 MHz	RF Output Connector	SMA jack
Tuning Voltage Range	0 to -60 Vdc	Tuning Input Connector	SMA jack
Input Power ¹	+15 ±0.5 Volts dc @ 700 mA, max.	Bias and Heater Connectors	RFI protected solder terminals
Threshold Current	1,000 mA, max.	Size LxWxH (inches) ²	1.98x2.86x1.34
Frequency Pushing	±5 MHz/V	Weight (ounces)	9
Heater Voltage	+28 ±2 Vdc	Operating Temperature	-55°C to +71°C
		Storage Temperature	-62°C to +100°C

WJ-2860 SERIES with two-stage isolator

	Freq. Range (GHz)	Output Power (mw)	Residual F.M. (kHz, pk-pk)	Frequency Drift w/Temp. (MHz)
WJ-2860-19	8.0-10.0	20	60	25
WJ-2860-20	10.0-12.4	20	60	32
WJ-2863-21	12.0-15.0	20	100	40
WJ-2863-22	15.0-18.0	10	100	50

All the above units have the following additional specifications:

Second Harmonic Rejection	20 dB	Heater Current Turn On	3.2 A
In-band Non-Harmonic Rejection	60 dB	Steady State at -55°C	2 A
Freq. Pulling (2:1 VSWR)	4 MHz	RF output connector	SMA jack
Modulation Bandwidth	dc to 20 MHz	Tuning Connector	SMA jack
Tuning Voltage Range	0 to -60 Vdc	Bias and Heater Connectors	RFI protected solder terminals
Input Power	+15 VDC ±0.5 @ 700 mA max.	Size LxWxH (inches) ²	2.77x2.25x1.34
Threshold Current	1,000 mA, max.	Weight (ounces)	12
Freq. Pushing	±5 MHz/V	Operating Temperature	-55° to +71°C
Heater Voltage	+28 ±2 Vdc	Storage Temperature	-62° to +100°C

WJ-2860 SERIES LINEARIZED with two-stage isolator

	Frequency Range (GHz)	Output Power (mW)	Residual FM (pk-pk)
WJ-2860-12	8.0-10.0	20	100 kHz
WJ-2860-13	10.0-12.4	20	Input Power ¹
WJ-2863-11	12.0-15.0	20	+15 ±0.5 Vdc @ 800 mA, max
WJ-2863-12	15.0-18.0	10	-15 ±0.5 Vdc @ 100 mA, max
			-75 ±2.0 Vdc @ 50 mA, max
			Tuning Voltage Range
			0 to +10 Vdc
			Freq. Pushing
			±5 MHz/V
			Threshold Current (+15V Supply)
			1,000 mA, max.
			Heater Voltage
			+28 ±2 Vdc
			Heater Current Turn On
			3.2 A
			Steady State at -55°C
			2.5 A
			Tuning Input Connector
			SMA jack
			RF Output Connector
			SMA jack
			Bias and Heater Connectors
			RFI protected solder terminals
			Size LxWxH (inches) ²
			2.88x2.80x1.75
			Weight (ounces)
			16
			Operating Temperature
			-55° to +71°C
			Storage Temperature
			-62° to +100°C

All the above units have the following additional specifications:

Second Harmonic Rejection	20 dB
In-band Non-Harmonic Rejection	60 dB
Freq. Pulling (2:1 VSWR)	4 MHz
Tuning Non-Linearity	±0.0%
Modulation Bandwidth (Small signal, Δf=20 MHz)	500 kHz
Modulation Bandwidth (full band)	dc to 100 kHz
Input Impedance	10K ohm

Notes: 1. Protective circuitry guards against damage due to overvoltage (up to 10 percent) and against transient reverse voltages

2. Nominal dimensions shown exclude mounting flanges and connectors.

VCO's for General Applications

APPLICATIONS

The application and utilization of the standard line of voltage-controlled oscillators is wide and diversified. W-J's solid state VCO's are ideal for applications where small size, low input requirements and high reliability are essential. Currently available in frequency ranges from 195 MHz to more than 10 GHz, these devices find application in commercial sweepers and breadboard designs as well as laboratory signal sources.

DESCRIPTION OF UNITS

VCO's operating in the 250 MHz to 2 GHz range typically provide fundamental microwave power of 100 mW minimum. From 2 to 4 GHz, the fundamental output power may be selected from a range of values up to 100 mW.

Up to 50 mW of power is provided by a VCO in the 4 GHz to 8 GHz range. For these devices, multiple transistors in a push-push configuration provide output power at the second harmonic of the fundamental oscillator frequency. Circuit balancing provides rejection of the fundamental and unwanted harmonics.

Narrowband versions of these devices provide power outputs higher than those normally available. A 5.9 to 6.5 GHz unit, for instance, offers 75 mW minimum. In the 8.5 to 9.6 GHz range, 50 mW is available.

OPTION

- HIGH SPEED TUNING INPUT

WJ-2800 SERIES

	Freq. Range (GHz)	Output Power ¹ (mW)	Harmonic Rejection (dB)	Input Power ²	Tuning Voltage (Vdc. min.) (Vdc. max.)		Residual FM (kHz, pk to pk)	Freq. Pulling (MHz)	Frequency Drift w/temperature (Mhz)	Size ³ L x W x H (inches)	Weight (ounces)
WJ-2800	0.5-1.0	100	15	+24 Vdc @ 200 mA	+1.5	+60	10	1.5:1 VSWR 40	16	2.25x1.38x1.13	6
WJ-2800-12	0.5-1.0	75	15	+24 Vdc @ 200 mA	+1.5	+60	10	1.25:1 VSWR 40	16	2.25x1.38x1.13	4
WJ-2803	1.0-2.0	100	20	+15 Vdc @ 250 mA	+1.5	+60	10	1.5:1 VSWR 80	33	2.25x1.38x1.13	6
WJ-2803-50	1.0-2.0	50	20	+15 Vdc @ 250 mA	+1.5	+60	10	1.5:1 VSWR 80	33	2.26x1.39x1.15	6
WJ-2804-10	2.0-4.0	10	20	+15 Vdc @ 200 mA	+1.0	+60	20	1.25:1 VSWR 160	66	2.26x1.39x1.15	6
WJ-2804-20	2.0-4.0	20	20	+15 Vdc @ 200 mA	+1.0	+60	20	1.25:1 VSWR 160	66	2.26x1.39x1.15	6
WJ-2804-40	2.0-4.0	40	20	+15 Vdc @ 200 mA	+1.0	+60	20	1.25:1 VSWR 160	66	2.26x1.39x1.15	6
WJ-2806-11	3.6-4.3	75	20	+15 Vdc @ 200 mA	+2	+60	40	1.25:1 VSWR 172	70	2.26x1.39x1.13	6
WJ-2806-12	5.9-6.5	75	20	+15 Vdc @ 200 mA	+2	+60	40	1.25:1 VSWR 260	110	2.26x1.39x1.13	6
WJ-2811	0.25-0.5	100	15	+24 Vdc @ 200 mA	+1	+60	10	1.5:1 VSWR 20	8	2.26x1.39x1.15	6
WJ-2811-10	0.195-0.4	50	15	+24 Vdc @ 200 mA	0	+60	10	1.5:1 VSWR 16	7	2.26x1.39x1.15	7
WJ-2811-14	0.25-0.50	75	15	+24 Vdc @ 200 mA	+1	+60	10	1.25:1 VSWR 20	8	2.26x1.38x1.15	8

All the above units have the following specifications:

In-band Non-Harmonic Spurious Rejection	60 dB
RF Output Connector	SMA jack
Bias and Tuning Connectors	RFI protected solder terminals
Operating Temperature Range	0 to 55°C
Storage Temperature	-62 to +100°C

Notes: 1. WJ-2806-11 and 2806-12 contain n=1/2 and n=3/2 harmonically related signals.

2. Protective circuitry guards against damage due to overvoltage (up to 10 percent) and transient reverse voltages.
3. Nominal dimensions shown exclude connectors.

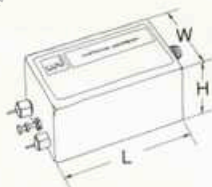
WJ-2840 SERIES with integral isolator

	Frequency Range (GHz)	Output Power (mW)	Input Power ¹	Tuning Voltage		Residual FM (kHz. pk-pk)	Freq. Pulling (MHz)	Frequency Drift w/temp. (MHz)	Size ² L x W x H (Inches)	Weight (ounces)
				Low End (Vdc. min.)	High End (Vdc. max.)					
WJ-2842	1.0-2.0	100	+15 Vdc @ 250 mA max.	+7.5	+60	10	(2:1 VSWR) 20	33	5.1 x 2.8 x 1.3	17
WJ-2842-1	1.0-2.0	50	+15 Vdc @ 200 mA max.	+1.5	+60	10	(2:1 VSWR) 10	33	5.1 x 2.8 x 1.3	24
WJ-2843	2.0-4.0	50	+15 Vdc @ 300 mA max.	+1.5	+60	20	(1.5:1 VSWR) 40	66	4.9 x 2.3 x 1.3	15
WJ-2843-20	2.0-4.0	20	+15 Vdc @ 300 mA max.	+1.5	+60	10	(2:1 VSWR) 40	66	4.85 x 2.1 x 1.25	20
WJ-2843-100	2.0-4.0	100	+15 Vdc @ 300 mA max.	+1.5	+60	10	(2:1 VSWR) 40	66	4.85 x 2.1 x 1.25	15
WJ-2844-7	4.0-8.0	50	-15 Vdc @ 300 mA max.	-9	-70	40	(3:1 VSWR) 80	88	3.0 x 2.6 x 1.8	12
WJ-2844-20	4.0-8.0	20	-15 Vdc @ 300 mA max.	-9	-70	40	(3:1 VSWR) 80	88	3.0 x 2.6 x 1.8	16
WJ-2844-50	4.0-8.0	50	-15 Vdc @ 300 mA max.	-9	-70	40	(2:1 VSWR) 80	88	3.0 x 2.6 x 1.8	16
WJ-2845-1	8.5-9.6	20	-15 Vdc @ 250 mA max.	-5	-50	40	(2:1 VSWR) 96	220	2.3 x 1.39 x 1.13	10
WJ-2845-3	7.5-10.5	20	-15 Vdc @ 250 mA max.	-5	-40	40	(3:1 VSWR) 100	231	2.3 x 1.39 x 1.13	10
WJ-2845-10	7.5-10.5	20	-15 Vdc @ 250 mA max.	-5	-40	40	(3:1 VSWR) 105	225	2.5 x 1.4 x 1.2	12
WJ-2845-50	8.5-9.6	50	-15 Vdc @ 250 mA max.	-5	-40	40	(2:1 VSWR) 96	220	2.3 x 1.39 x 1.13	10

All the above units have the following additional specifications:

Harmonic Rejection (n=1/2, 3/2, 2) ³	20 db
In-band Non-Harmonic Spurious Rejection	dB
RF Output Connector	SMA jack
Bias and Tuning Connectors	RFI protected solder terminals
Storage Temperature	-62 to +100°C
Operating Temperature	0 to 55°C

- Notes: 1. Protective circuitry guards against damage due to overvoltage (up to 10 percent) and transient reverse voltages.
 2. Nominal dimensions shown exclude connectors.
 3. WJ-2844 and 2845 oscillators contain n=1/2 and n=3/2 harmonically related signals.



General outline drawing for standard voltage-controlled transistor oscillator.



General outline drawing for standard voltage-controlled oscillator with isolator.

Definitions

1. Frequency Pulling: The total frequency excursion observed as a load of the specified VSWR varies over 180 electrical degrees.

2. Residual F.M. (peak): The peak-to-peak deviation of the output signal as observed on a spectrum analyzer with a 1kHz IFBW at -3 dB. See Figure 1.

3. Harmonic Rejection: The level of harmonically related signals (nf_0 or $n(f_0/2)$, as applicable) relative to the desired output signal level, measured in dB.

4. Non-Harmonic Spurious Rejection: The level of signals not harmonically related to the output signal, relative to the desired output, measured in dB. Usually, only in-band spurious signals are measured.

5. Frequency Pushing: The incremental change in operating frequency produced by an incremental change in bias voltage (within the specified limits of bias voltage for the unit).

6. Frequency Drift with Temperature: The change in operating frequency produced by a change in operating temperature. The operating temperature is measured on the baseplate.

7. Non-Linearity: Tuning non-linearity is the maximum deviation from linear tuning between the specified tuning voltage extremes and includes the effect of frequency drift over the operating temperature range.

8. Monotonicity: A VCO's tuning characteristic is monotonic if $V_2(f_2) > V_1(f_1)$, where f is frequency and V is

tuning voltage. That is, output frequency is single valued at any voltage and continuously increasing for a continuously increasing tuning voltage. See Figure 2.

9. Power Output Variation: The extremes of output power (min. to max.) measured over the entire frequency range as measured into a specified VSWR (all phases). Temperature effects are not included.

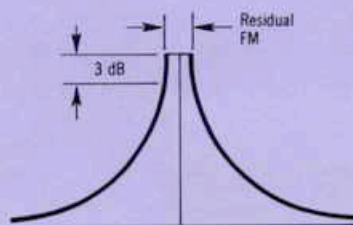
10. Post Tuning Drift: The shift in oscillator frequency output as a function of time after a step change in tuning voltage. The time interval of importance must be specified.

11. Modulation Sensitivity: The reciprocal of the slope of the tuning voltage vs. frequency graph, as measured in MHz/V.

12. Threshold Current: The current at the point that the slope (dI/dV) of the current vs. voltage graph of a bulk effect device is zero. This is the maximum current that occurs before the diode goes into its negative resistance region.

13. Operating Current: The current required by the oscillator during steady state operation.

14. Modulation Bandwidth: With the VCO tuning port modulated sinusoidally by a 50-ohm source, the modulation bandwidth is defined as that modulation frequency at which the frequency deviation decreases to 0.707 of its low-frequency value.



Note: Bias and tuning voltages are to be filtered to eliminate ripple.

Figure 1

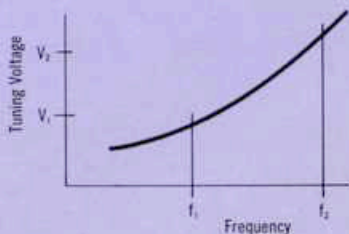


Figure 2

Heaters & Linearizers

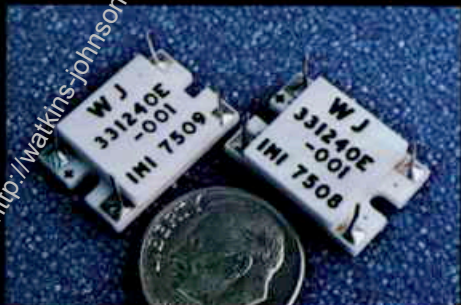
HEATER

The WJ-331240-001 is a proportionally controlled integrated circuit dc heater module employed in Watkins-Johnson's militarized VCO product line. Operating from 28 Vdc, it can dissipate 28 watts and, by means of an external control resistor, can control its mounting surface at any temperature between +60°C and +100°C, within 10°C. The operating temperature range for the heater is -54°C to +100°C. The module features an automatic shutdown temperature of 120°C which operates at any control resistance and any voltage.

Each heater module is subjected to the following reliability screening during manufacture:

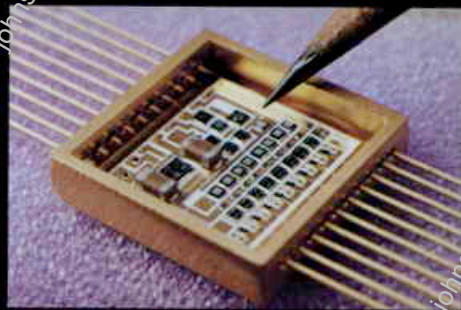
- Precap internal visual per MIL-STD-883, Method 2010, Test Condition B.
- High temperature stabilization bake per MIL-STD-883, Method 1008, Test Condition B, 48 hours.
- Temperature cycling per MIL-STD-883, Method 1010, Test Condition B.
- Constant acceleration per MIL-STD-883, Method 2001, Test Condition B, Y, axis only.

The heater circuit is floating so that currents will not affect system ground voltages. The WJ-331240-001 is protected against reverse voltages up to 50 Vdc and against overvoltages up to 34 Vdc. Heaters may be used either singly or in parallel to control the temperature of items such as critical electronic components, chemicals and mechanical devices. W-J offers the heater as a standard catalog item.



LINEARIZER

Today's ECM system designer frequently requires a VCO which delivers an extremely linear output while maintaining tuning speed. Since tuning voltage vs. frequency curves for VCO's are exponential in nature,



shaping circuit is required to yield a linear tuning voltage vs. frequency curve. Watkins-Johnson employs a modern hybrid integrated circuit linearizer as the interface between the tuning input of the oscillator. Consisting of a variable gain stage and level translator, this device shapes the linear tuning input to match the nonlinear VCO tuning characteristic.

Watkins-Johnson's standard linearizer is capable of 100 kHz large-signal (full band) bandwidth and 500 kHz small-signal (20 MHz deviation) bandwidth. Additionally, the linearizer has a constant input impedance of 10K ohm (9K ohm minimum) and an input voltage range of 0 to +30 Vdc.

W-J's hybrid linearizer has a large degree of adaptability for special customer requirements. In addition to being able to accommodate variations and/or translations of the input tuning voltage range, the standard linearizer can be optimized for such factors as maximum modulation bandwidth and minimum settling time.

- Optimized for maximum modulation bandwidth. Typically, 1.25 MHz large-signal (full band) bandwidth can be achieved.
- Optimized for minimum settling time. The linearized oscillator can be optimized to settle to within 0.1% of final frequency in 2 to 5 μ sec.

The two versions have a 1K ohm input impedance. Newer versions of the hybrid linearizer currently under development have achieved input bandwidths up to 200 MHz and have rise times less than 10 nanoseconds.

This significant linearizer capability allows for custom development when special VCO characteristics are required. All of W-J's militarized oscillators, both bulk effect and transistor, are available with linearizers. Contact VCO Applications Engineering in Scotts Valley for full details on linearized VCO's.

Ordering Information—United States Purchase order for W-J may be placed with Applications Engineering or Customer Services at the Santa Cruz plant location or with any one of the Field Sales Offices.

Watkins-Johnson Company
440 Mt. Hermon Road
Scotts Valley, Calif. 95066
Telephone: (408) 438-2100

Ordering Information—Overseas Watkins-Johnson International, a subsidiary of Watkins-Johnson Company, operates sales offices in Palo Alto, the United Kingdom, Italy and West Germany. There are representatives' offices located throughout Europe, the Mediterranean, Japan, and Canada. The locations of Company Sales Offices are listed below. Orders may be placed with any sales office or the representative office nearest you.

Terms and Conditions All products are shipped F.O.B., Scotts Valley, California. Our customary terms are net 30 days. Watkins-Johnson's standard terms and conditions of sale apply to all quotations.

Warranty The W-J voltage-controlled oscillators (VCO's) covered hereby are warranted against defects

in workmanship and materials for a period of one year from date of shipment.

VCO's which fail during the warranty period as a result of a defect in workmanship or materials will be repaired or replaced at W-J's option, without charge for parts or labor. Repairs or replacements to the defective VCO will carry this warranty for the time remaining on the warranty covering the defective VCO. W-J's sole obligation under this warranty shall be limited to the repair or replacement of the defective VCO, and in no event will W-J be liable for any incidental or consequential charges, nor will it be liable for failure of any VCO attributable to the fault or negligence of any user of the product, or for VCO's received by it in a broken condition or with evidence of tampering or improper operating voltage, current or installation conditions.

Service W-J has a competent, experienced group of Applications Engineers at the Santa Cruz plant as well as local sales offices to assist in answering technical questions about the oscillators and their relation to your particular application. The services of our engineering and technical staff are also readily available as required.



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