



# VS-502 Voltage Controlled SAW Oscillator



## Features

- Output frequencies from 300 MHz to 1350 MHz
- Ultra low jitter < 0.05 ps-rms (12 kHz to 20 MHz)  
< 0.05 ps-rms (50 kHz to 80 MHz)
- Low phase noise, -160 dBc/Hz @ 1 MHz offset (1 GHz)
- Small low profile 9.0 \* 14.0 \* 4.5 mm SMT package
- 3.3 V, 5.0 V and 12V Supply Options
- LV-PECL, PECL, or Sinewave (0 to +10 dBm into 50  $\Omega$ )
- Output disable feature (For LVPECL - PECL option)



Product is free of lead and compliant to EC ROHS Directive

## Applications

- Point to Point / Point to Multi Point Radios
- Instrumentation
- PLL Frequency Translation
- Test & Measurement
- Military & Avionics

## Description

The VS-502 is a SAW based voltage controlled oscillator that operates at the fundamental frequency of the internal SAW resonator. This direct approach enables this series to achieve low phase noise and jitter performance at high output frequencies and over wide operating temperature range. The oscillator is housed in a hermetically sealed J-lead surface mount package offered on tape and reel. As an option, it has an output disable to facilitate on-board test

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**Table 1. Electrical Performance**

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
<b>Frequency</b>						
Center Frequency	$F_N$	300		1350	MHz	1,2
Absolute Pull Range	APR	$\pm 50$			ppm	9,2,3
Linearity (+12V Supply)				$\pm 20$	%	4,2,9,3
Linearity (+5V Supply)				$\pm 10$	%	4,2,9,3
Linearity (+3.3V Supply)				$\pm 10$	%	4,2,9,3
Gain Transfer (+12V Supply)			+100		ppm/V	2,8
Gain Transfer (+5V Supply)			+200		ppm/V	2,8
Gain Transfer (+3.3V Supply)			+300		ppm/V	2,8
Temperature Stability (-40°C to +85°C)			$\pm 200$		ppm	6,9
<b>Supply</b>						
Voltage (B)	$V_{CC}$	11.4	12	12.6	V	2,3
Voltage (C)	$V_{CC}$	4.75	5	5.25	V	2,3
Voltage (D) - PECL Output Only	$V_{CC}$	3.135	3.3	3.450	V	2,3
Current (No Load)	$I_{CC}$		55	70	mA	2,3
<b>Output- Sinewave Options</b>						
Sinewave, into 50 $\Omega$ (G)	$P_O$	0			dBm	2,3
Sinewave, into 50 $\Omega$ (H)	$P_O$	+3			dBm	2,3
Sinewave, into 50 $\Omega$ (J)	$P_O$	+7			dBm	2,3
Sinewave, into 50 $\Omega$ (K)	$P_O$	+10			dBm	2,3
Harmonics				-20	dBc	2,3
Jitter @ 622.08 MHz (12 kHz to 20 MHz)			0.035	0.050	ps,rms	7,6
Jitter @ 622.08 MHz (50 kHz to 80 MHz)			0.035	0.050	ps,rms	7,6
<b>Output- PECL Logic Option (F)</b>						
Output Level Low	$V_{OL}$			$V_{CC}-1.525$	V	2,3,5
Output Level High	$V_{OL}$	$V_{CC}-1.125$			V	2,3,5
Rise & Fall Time	$t_R, t_F$		200	350	ps	2,3,5
Symmetry (Duty Cycle)	SYM	45	49/51	55	%	2,3,5
<b>Control Voltage</b>						
Input Impedance	$Z_C$		100		k $\Omega$	6
Modulation BW (Driven from Low Impedance)	BW		100		kHz	6
<b>Operating Temperature</b>						
	$T_{OP}$	See Ordering Table			°C	1,3
<b>Package Size</b>						
		9.0 x 14.0 x 4.5			mm	

**Table Notes:**

1. See Standard Frequencies and Ordering Information
2. Parameters are tested with production test circuit
3. Parameters are tested at ambient temperature with test limits guard-banded for specified operating temperature.
4. Measured as the maximum deviation from the best straight-line fit, per MIL-0-55310.
5. Output levels are standard 100K PECL compatible and measured from 20% to 80% of a full output swing (Fig 1).
6. Not tested in production, guaranteed by design, verified at qualification.
7. Integrated across 12 kHz to 20 MHz, or 50 KHz to 80 MHz per GR-253-CORE Issue3. LVPECL Output
8. Tested with  $V_c = 0.3V$  to 3V for 3.3V supply,  $V_c = 0.5V$  to 4.5 V for 5V supply,  $V_c = 0.5V$  to 11.5V for 12V supply
9. Maximum frequency occurs at room temperature

# VS-502 Voltage Controlled SAW Oscillator

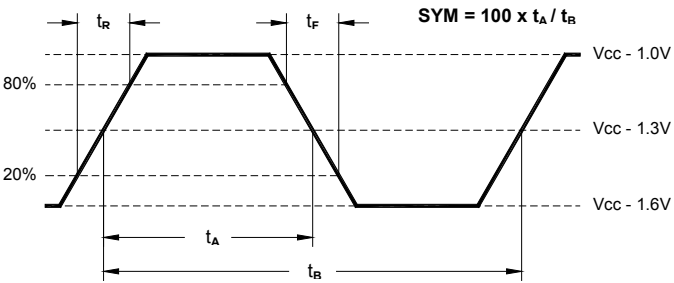
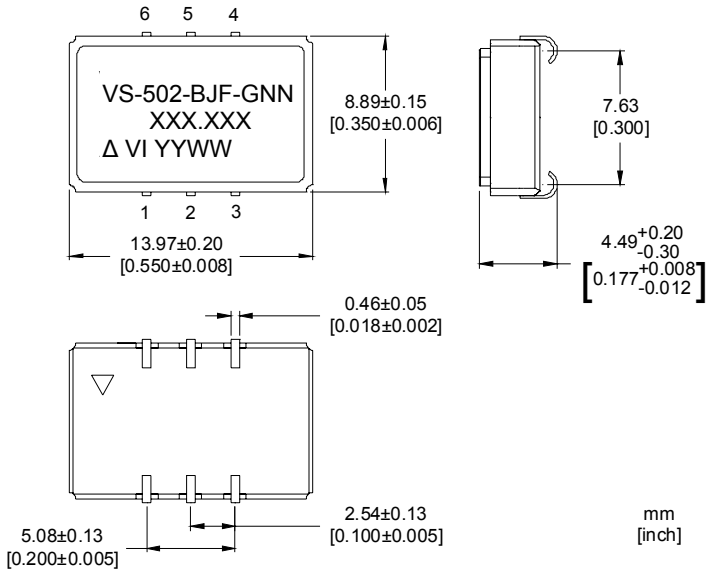
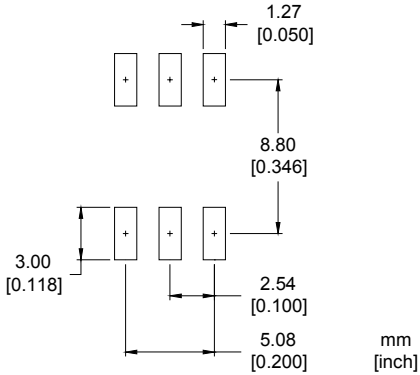


Figure 1. 100K PECL Waveform

## Outline Diagram



## Pad Layout



# VS-502 Voltage Controlled SAW Oscillator

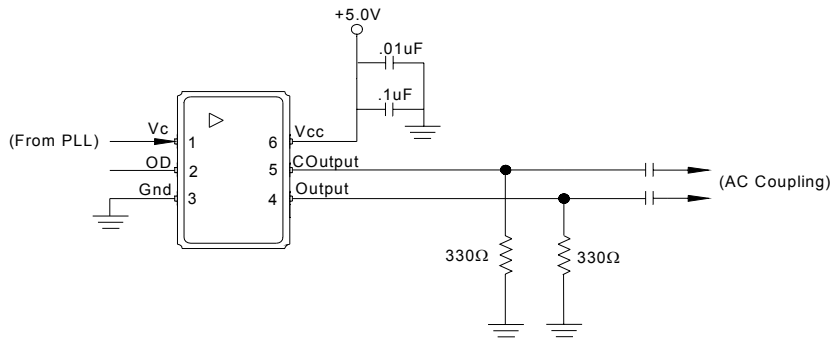
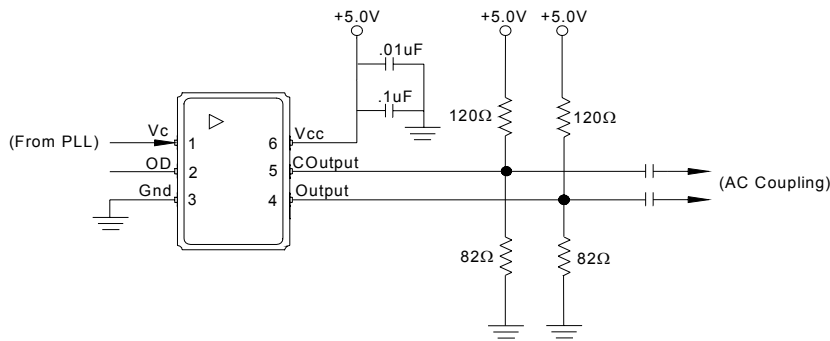
**Table 3. Pin Out – PECL Option**

Pin	Symbol	Function
1	V <sub>c</sub>	VCSO Control Voltage
2	OD	N/C or Output Disable <sup>1</sup>
3	GND	Case and Electrical Ground
4	Output	VCSO Output
5	COutput	VCSO Complementary Output
6	V <sub>cc</sub>	Power Supply Voltage

**Table Notes:**

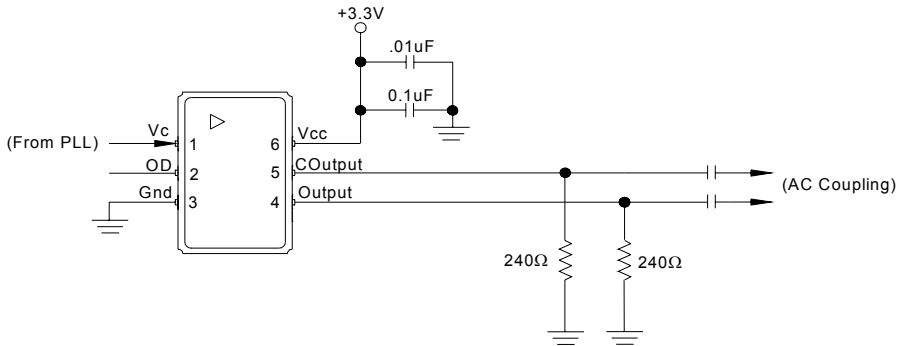
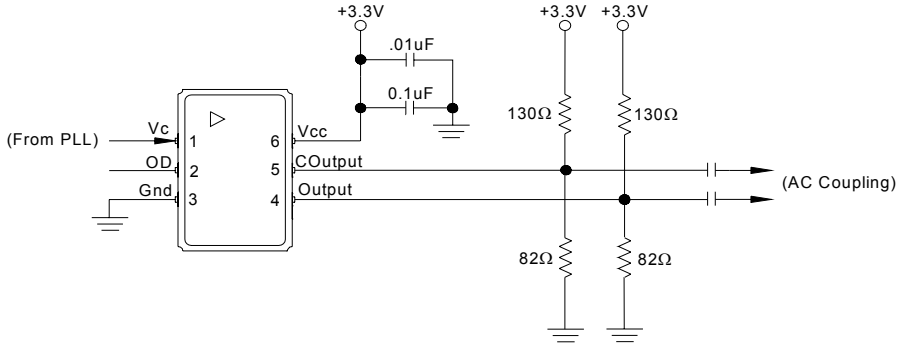
- By setting Output Disable pin high, the RF output is disabled and pin 4 is held high, pin 5 is held low. The threshold for Output Disable is 2.3V above pin 3. Output disable pin can be left floating for normal operation

## Suggested Output Load Configurations – PECL Operation



# VS-502 Voltage Controlled SAW Oscillator

## Suggested Output Load Configurations – LVPECL Operation



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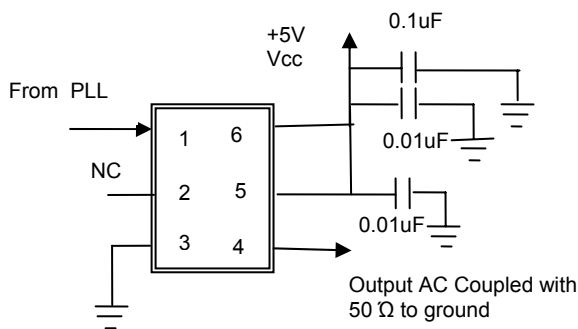
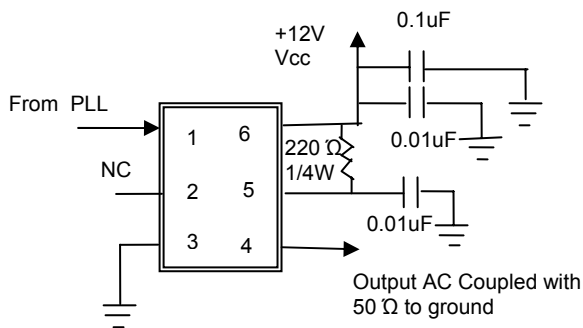
**Table 4. Pin Out – Sinewave Option**

Pin	Symbol	Function
1	$V_C$	VCSO Control Voltage
2	-	N/C
3	$V_{EE}$	Ground
4	Output	VCSO Sinewave Output
5	$V_{CC}$	$V_{CC2}$ <sup>1</sup>
6	$V_{CC}$	$V_{CC1}$

**Table Notes:**

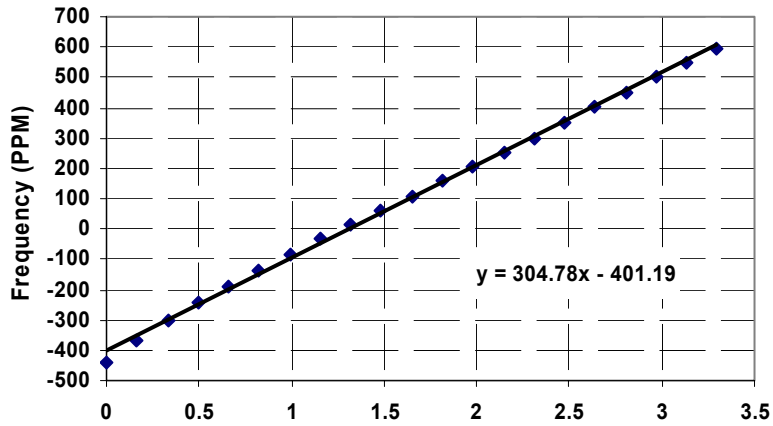
1. If  $V_{CC1}$  is +12V and a separate 5V is not applied to pin 5 then pin 5 must be connected through a 220Ω 1/4W external resistor.

## Suggested Output Load Configurations – SINEWAVE Operation

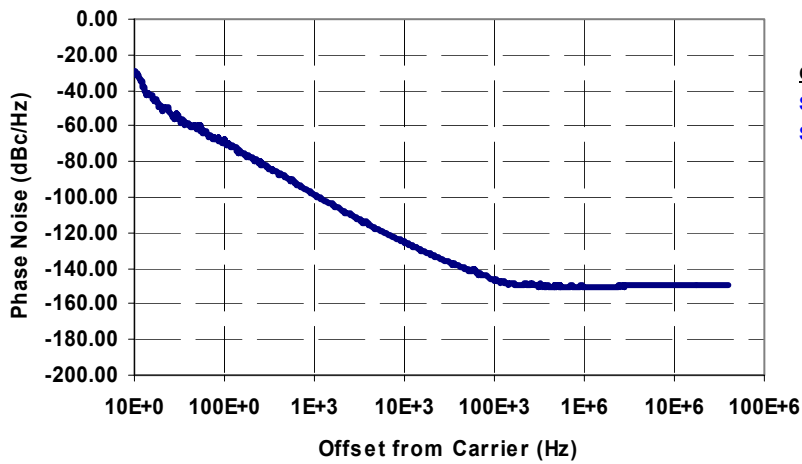


# VS-502 Voltage Controlled SAW Oscillator

## Typical Characteristics (3.3V, LVPECL Operation)



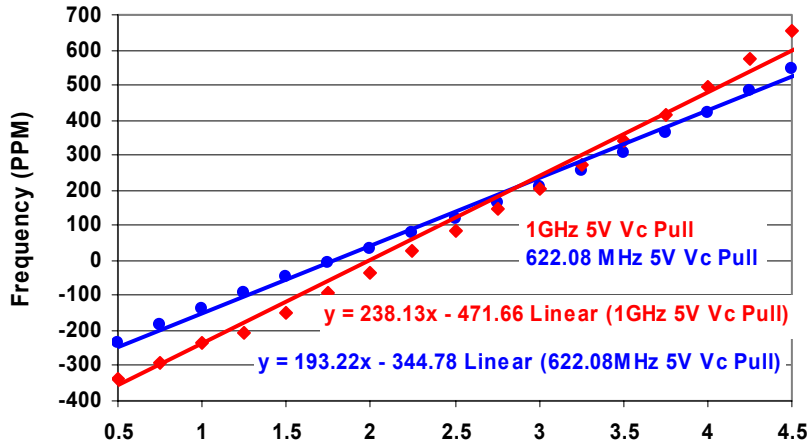
**Vc Pull Characteristics @ 983.04MHz (22.5 °C)**  
Typical Gain Transfer = +300 ppm/V



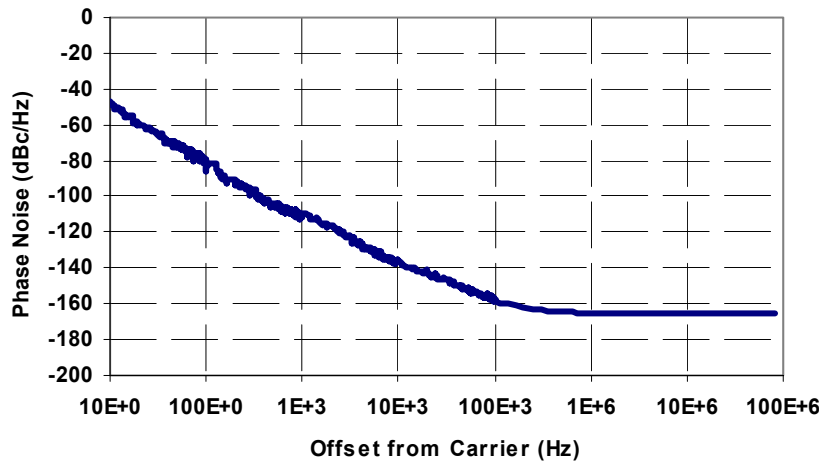
**Calculated Jitter @ 983.04 MHz (22.5 °C)**  
SONET OC-48 (12kHz-20MHz) = 37.04 fs-rms; 259 fs-pp  
SONET OC-192 (50kHz-80MHz) = 36.59 fs-rms; 250 ps-pp

# VS-502 Voltage Controlled SAW Oscillator

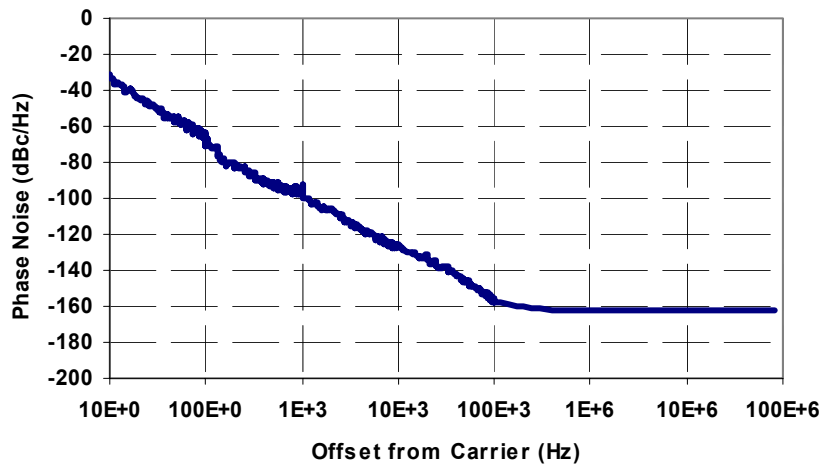
## Typical Characteristics (5V, Sinewave Operation)



**Vc Pull Characteristics (22.5 °C)**  
 Typical Gain Transfer @ 1GHz = +238 ppm/V  
 Typical Gain Transfer @622.08MHz= +193 ppm/V



**Calculated Jitter @ 622.08 MHz (22.5 °C)**  
 SONET OC-48 (12kHz-20MHz) = 9.93 fs-rms; 69.51 fs-pp  
 SONET OC-192 (50kHz-80MHz) = 9.35 fs-rms; 65.49 fs-pp

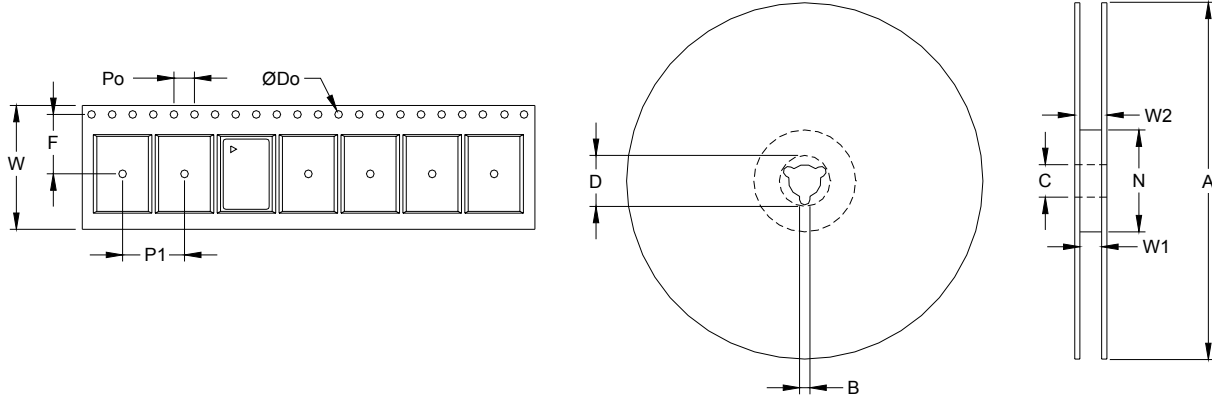


**Calculated Jitter @ 1 GHz (22.5 °C)**  
 SONET OC-48 (12kHz-20MHz) = 11.23 fs-rms; 78.9 fs-pp  
 SONET OC-192 (50kHz-80MHz) = 8.65 fs-rms; 60.58 fs-pp



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## Tape and Reel (EIA-481-2-A)



Tape Dimensions (mm)						Reel Dimensions (mm)							
Dimension	W	F	Do	Po	P1	A	B	C	D	N	W1	W2	# Per Reel
Tolerance	Typ	Typ	Typ	Typ	Typ	Typ	Min	Typ	Min	Min	Typ	Max	
VS-502	24	11.5	1.5	4	12	330	1.5	13	20.2	100	24.4	30.4	200

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
Power Supply	$V_{CC}$	$V_{CC} + 1.0V$	V
Voltage Control Range	$V_C$	-0.5 to $V_{CC} + 0.5V$	V
Storage Temperature	$T_S$	-55 to +125	°C
Soldering Temp/Time	$T_{LS}$	+260/40	°C/sec

Stresses in excess of the absolute maximum ratings can permanently damage the device. Functional operation is not implied at these or any other conditions in excess of conditions represented in the operational sections of this datasheet. Exposure to absolute maximum ratings for extended periods may adversely affect device reliability.

## Reliability

The VS-502 family is capable of meeting the following qualification tests:

## Environmental Compliance

Parameter	Conditions
Mechanical Shock	MIL-STD-883, Method 2002
Mechanical Vibration	MIL-STD-883, Method 2007
Solderability	MIL-STD-883, Method 2003
Gross and Fine Leak	MIL-STD-883, Method 1014
Resistance to Solvents	MIL-STD-883, Method 2016

# VS-502 Voltage Controlled SAW Oscillator

## Handling Precautions

Although ESD protection circuitry has been designed into the VS-502 proper precautions should be taken when handling and mounting. VI employs a human body model (HBM) and a charged-device model (CDM) for ESD susceptibility testing and design protection evaluation. The ESD classification level varies with output waveform type as shown in the table.

## ESD Ratings

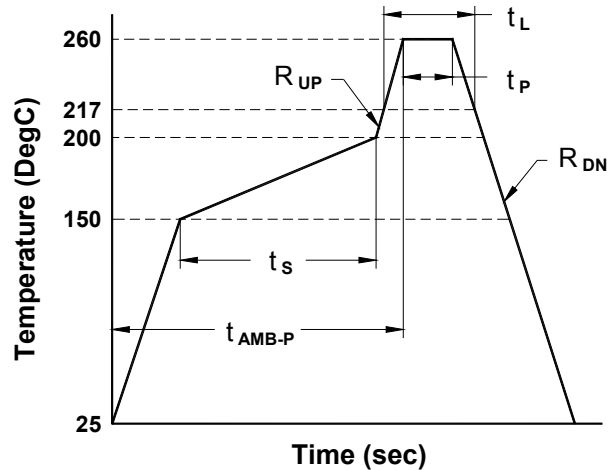
Model	Minimum	Conditions
Human Body Model	1000 V (PECL/LVPECVL)	MIL-STD 883, Method 3015
Human Body Model	700 V (Sine wave)	MIL-STD 883, Method 3015
Charged Device Model	1000 V (PECL/LVPECL)	JESD 22-C101
Charged Device Model	500 V (Sine wave)	JESD 22-C101

## Reflow Profile (IPC/JEDEC J-STD-020)

Parameter	Symbol	Value
Preheat Time	$t_s$	60 sec Min, 180 sec Max
Ramp Up	$R_{UP}$	3 °C/sec Max
Time Above 217 °C	$t_L$	60 sec Min, 150 sec Max
Time To Peak Temperature	$t_{AMB-P}$	480 sec Max
Time At 260 °C	$t_P$	20 sec Min, 40 sec Max
Ramp Down	$R_{DN}$	6 °C/sec Max

The device is designed to meet the JEDEC standard for Pb-Free assembly. The temperatures and time intervals listed are based on the Pb-Free small body requirements. The VS-502 device is hermetically sealed so an aqueous wash is not an issue.

Termination Plating: Electroless Gold Plate over Nickel Plate



# VS-502 Voltage Controlled SAW Oscillator

## Available Standard Frequencies (MHz)

480	622.08	640	672.1627	696.4215	840
930	970	983.04	1000	1200	1330
1344.3200					

Other Frequencies Available Upon Request.

## Ordering Information

### VS – 502 - B J C - G N N – xxxx.xxxx

**Product Family**

VS: VCSO

**Frequency (See Above)**

300 – 1350 MHz

**Package**

502: 9 x 14 x 4.5 mm

**Input**

D: 3.3 V  
C: 5.0 V  
B: 12.0 V

**Output**

F: PECL  
G: Sine  $\geq$  0 dBm  
H: Sine  $\geq$  3 dBm  
J: Sine  $\geq$  7 dBm  
K: Sine  $\geq$  10 dBm

**Operating Temperature**

C: 0°C to +70 °C  
D: -20°C to +70 °C  
F: -40°C to +85 °C

**Other (Future Use)**

N: N/A

**Other (Future Use)**

N: N/A

**Absolute Pull Range**

G:  $\pm$  50 ppm  
F:  $\pm$  32 ppm  
C:  $\pm$  20 ppm

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