GREENRAY

Precision Crystal Oscillators for Industry & Defense

Serving Defense, Aerospace, Communications
& Instrumentation markets since 1961.

Contents

Our Company

In 1961 a young engineer named Ray Green, armed with a knowledge of quartz crystal oscillator design and a fresh order for 100 R-C oscillators he'd built in his basement, founded Greenray Industries.

Early catalogs reflect the company's focus on state-of-the-art oscillator design – and a legacy of innovation and commitment to partnership with our customers.

Today Greenray Industries, Inc. is a leading U.S. manufacturer of precision quartz crystal oscillators. Our oscillators function as stable reference sources for defense, aerospace, communications and a variety of commercial applications.

Our high performance frequency control devices are designed for demanding applications from 1 Hz to 1 GHz. Greenray oscillators serve the needs of the communications industry with frequency control products designed for applications including Stratum III and IIIE for telecommunications, as well as for wireless, SATCOM, and today's emerging technologies. We provide components for use in industrial, instrumentation and GNSS/GPS applications.

For the defense market, we provide high performance oscillators, reference sources for smart munitions, missile guidance, mobile receivers and radar systems.

Greenray Industries is committed to providing high precision quartz crystal oscillators that incorporate cutting edge solutions for next generation programs and that meet or exceed the requirements of our worldwide industrial and defense customers, including RoHS compliancy. In fact, Greenray has manufactured and delivered RoHS compliant products on virtually every product platform we offer.

We are a preferred provider to customers that require reference sources that deliver mission critical performance and reliability. We bring design innovation and engineering expertise in low phase noise, tight temperature stability, high shock and vibration and low g-sensitivity performance to every project.

All product design, assembly, electrical and performance testing is done at our facility in Mechanicsburg, Pennsylvania.

Greenray Industries utilizes the unique expertise of its two sister companies to enhance our capabilities and to help us produce some of the highest performance frequency control components available today.

To learn more about the exceptional capabilities of AdTech Ceramics and Statek Corporation, visit them online at ***www.adtechceramics.com*** and ***www.statek.com***.

AdTech Ceramics STATEK Est. 1970

Our Products

Greenray designs and manufactures high performance frequency control devices including OCXOs, TCXOs VCXOs and clock oscillators. We manufacture SMT, through-hole, hybrid and custom products.

Our TCXO (temperature compensated) crystal oscillators are designed for communications, instrumentation and defense applications and feature temperature stabilities of 1 ppm or less and are available from 20 kHz to 1 GHz in a variety of packages including SMT.

We offer OCXO (oven controlled) oscillators in a wide range of frequencies, from 1 MHz to 200 MHz, and a variety of packages including DIP, SMT and larger, industry-standard sizes to satisfy specific customer requirements. Greenray also offers VCXO and XO products, available in a variety of packages.

Tight stability, low phase noise and vibration, shock and acceleration sensitivity performance are essential considerations for every product we manufacture.

Key product features include:

- Sine Wave, CMOS, ECL, PECL & TTL outputs
- Operating Temp Range of -55 to +125°C
- OCXO Frequency Stability to ± 0.05 ppm
- TCXO Frequency Stability to ± 0.04 ppm
- Up to 100,000g Shock
- g-Sensitivity to <0.05 ppb

Quality Assurance & Testing

Greenray Industries' Quality Management System is certified to the AS9100 standard which incorporates the requirements of ISO 9001:2015 and over 100 additional industry specific requirements for Aerospace. The more stringent AS9100 standard is necessary for the defense and aerospace industries and offers a higher degree of confidence in the quality of the products we design and manufacture.

Greenray in-house electrical and environmental test capabilities include:

- Aging
- Sine Vibration
- Mechanical Shock
- Acceleration
- Temperature Cycle
- Stabilization Bake
- Thermal Shock
- Fine/Gross Leak
- Random Vibration
- Temperature Test
- Resistance to Solvents
- Solderability

Markets We Serve

Greenray Industries has supported ***Defense & Aerospace*** markets with high performance, precision oscillators for over a half century. Our engineering experience and manufacturing expertise have helped established Greenray as a key component supplier for a variety of programs, providing innovative, cost-efficient, solutions and a long-term service commitment.

Today, Greenray oscillators feature various combinations of rugged packaging, ultra-low g-sensitivity and enhanced phase noise performance; many have been engineered to perform reliably in adverse environments, including those of extreme shock, temperature and vibration.

For the ***Military*** market, Greenray supports critical applications including smart munitions, missile guidance, airborne communications, airborne instrumentation, radar, telemetry, portable communications and equipment, satellite communications, GPS, jammers, detection and identification.

Our rugged TCXO and OCXO products withstand the most severe environmental requirements of military applications including MIL-PRF- 55310, MIL-STD-202, MIL-STD-883, MIL-E-5400, and MIL-M-38510.

Greenray Specialized MIL Capabilities include:

- Testing and processing to MIL-PRF-55310
- Screening to MIL-PRF-55310
- Established reliability construction
- IPC-A-610 & J-STD-001 trained operators
- In-house qualification testing
- Reliability calculations per MIL-HBK-217
- Phase Noise vs. Vibration Testing for Random and Sine Vibration
- High Shock test to 50,000g
- Vibration test to >50g RMS

Communications & Instrumentation: We offer specialized products for commercial applications including Stratum3 compliant TCXOs suitable for wireline and wireless comms, small cell, Ethernet and 1588 synchronization requirements.

Our TCXOs feature superior temperature and long-term stability in compact, RoHS compliant packages. We offer ruggedized TCXOs for GNSS/GPS applications that require tight stability, excellent low micro-jump performance and the best performance under shock available today.

Greenray VCXOs feature very low noise for PLL applications to support instrumentation and SATCOM market needs, with phase noise of -170 dBc/Hz and compact, cost-efficient SMD packages.

INTRODUCTION

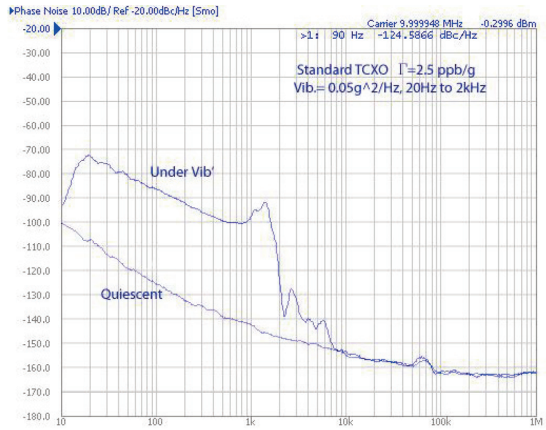
Crystal oscillators provide system designers with frequency sources that give exceptional frequency stability, spectral purity and phase noise performance. One aspect that is sometimes not considered initially is the degradation in the output spectrum that can occur when the oscillator is exposed to vibration in the application environment. Even moderate levels of vibration can significantly affect a low noise signal.

The acceleration sensitivity (also commonly referred to as "g-sensitivity") of a well designed crystal oscillator is primarily due to the crystal resonator itself. All quartz crystals have an intrinsic characteristic that causes small changes in the series resonant frequency when experiencing a change in acceleration. The resultant effect on the frequency of a given crystal is determined by the instantaneous magnitude of the acceleration as well as the direction in which it is applied since the acceleration sensitivity of a quartz crystal is a vector quantity. Therefore, any force that is applied in the plane normal to the vector will have minimal effect on the crystal. The frequency during acceleration can then be written as the product of 2 vectors: $f(\vec{a}) = f_0(1+\vec{\Gamma}\cdot\vec{a})$ where f_0 is the carrier frequency with no acceleration, $\vec{\Gamma}$ is the acceleration sensitivity vector and $\vec{a}$ is the acceleration force vector. (The acceleration sensitivity of a crystal or oscillator is typically denoted by the Greek letter gamma, Γ.)

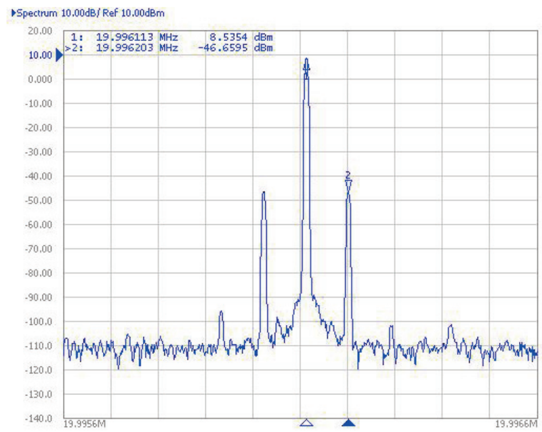
The magnitude of Γ is usually linear vs. the applied force to greater than 50g. The frequency response of Γ is also relatively flat up through vibration frequencies of several kHz although mechanical resonances in the crystal blank and mounting structures may cause peaking in some areas depending on the type of crystal.

CHARACTERIZING YOUR OSCILLATOR

The acceleration sensitivity of an oscillator that will be used in a vibratory environment would typically be measured by applying a known vibration level



and then observing the effect on the output spectrum. When the applied vibration is a single frequency sine wave, a discrete spur will be produced offset from the carrier by the vibration frequency. By measuring the level of this spur relative to the power of the carrier, the amount of frequency devi-



ation may be determined from FM modulation theory. For a crystal oscillator where the fractional frequency shift is very small, Γ is usually expressed in parts per billion per g. (1 ppb/g = 1 x 10^{-9} per g) The level of the sideband that will be produced when the excitation is a single frequency sine wave is closely approximated by: $SB\,Level\,(dBc) = 20\log\left(\frac{\vec{a} \times \vec{\Gamma} \times f_{nom}}{2f_v}\right)$

Solving for $\vec{\Gamma}$ gives $\vec{\Gamma} = \left(\frac{2f_v}{\vec{a} \times f_{nom}}\right) \times 10^{\frac{dBc}{20}}$ where $\vec{a}$ is the peak magnitude of the vibration force in the direction of $\vec{\Gamma}$ being measured, f_v is the frequency of the

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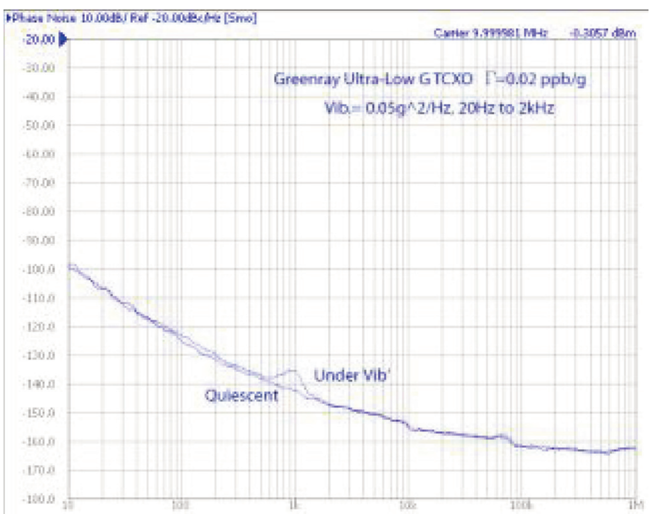
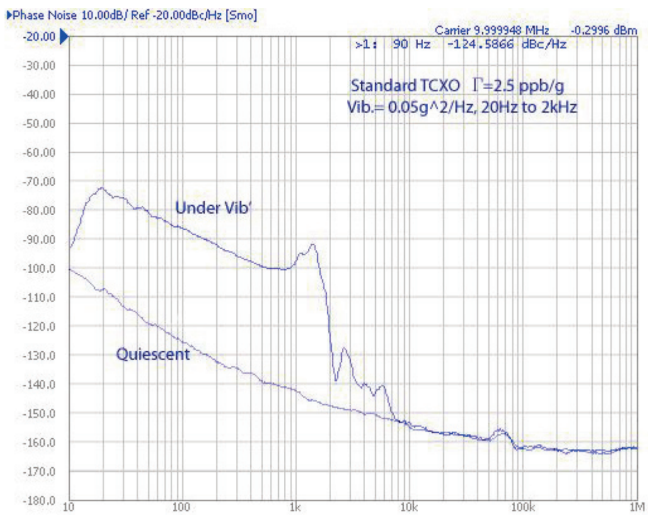
sine vibration and f_{nom} is the nominal carrier frequency at rest. This figure shows the spectrum of a 20 MHz crystal being vibrated with a peak acceleration of g at 90Hz.

In most real world applications however, the vibration energy will be spread across a frequency band producing a random vibration profile. This noise-like random energy is expressed as a power spectral density with units of g^2/Hz. Rather than producing a discrete spur in the spectrum as with sine vibration, random vibration will cause the phase noise floor of the oscillator to rise across the frequency band of vibration as shown in the figure above. The following formula can be used to calculate the single-sideband phase noise of the oscillator under vibration at a specific offset frequency f_V: $\mathcal{L}(f_v) = 20\log\left(\frac{\vec{\Gamma}\cdot f_{nom}\cdot\sqrt{2\cdot PSD}}{2f_v}\right)$ where PSD is the power spectral density of the vibration. The acceleration sensitivity could then be determined by measuring the phase noise of the oscillator while vibrating.

Although the frequency stability of a typical TCXO is more than an order of magnitude worse than a precision OCXO, their acceleration sensitivities may be similar. This means that the dynamic stability and phase noise under vibration will also be similar since the performance under vibration is determined by the Γ characteristic and the applied acceleration level and is largely independent of the static phase noise and frequency stability. Greenray currently produces TCXOs and OCXOs that provide acceleration sensitivity specifications as low as 5×10^{-11} per g.

The graphs below illustrate the comparison of a Greenray g-comp'ed TCXOs vs. a standard TCXO under the same vibration profile.





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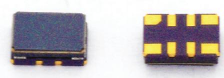
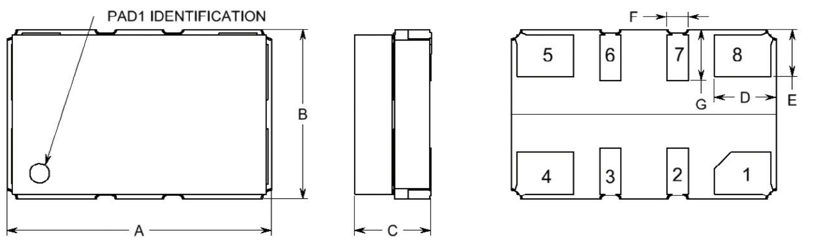
T52

➤ *TIGHT TEMPERATURE STABILITY*
LOW G-SENSITIVITY OPTION
30,000g SHOCK OPTION

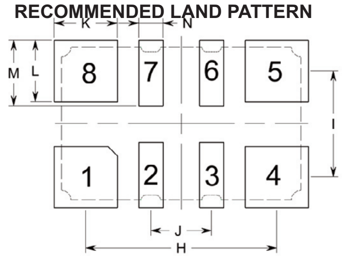


Frequency	10.0 MHz to 52.0 MHz		
Output	CMOS (C option) or Clipped Sine Wave (S option)		
Symmetry	50% ± 10% (CMOS)		
Output Level	Clipped Sine Wave: +0.8 V_{pp} min CMOS (3.3 V): +0.2 V max to +2.8 V min CMOS (5.0 V): +0.2 V max to +4.2 V min		
Output Load	CMOS: 15 pF typ; Clipped Sine: 10 kΩ, 10 pF typ		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 0.1 ppm	N17
	-40°C to +85°C	± 0.5 ppm	T57
	-40°C to +85°C	± 1.0 ppm	T16
Aging	< 1.0 ppm/yr. typ		
Frequency v. Reflow	< 1.0 ppm after 24 hr recovery		
Frequency Adjust	± 8 ppm typ; 0 V to V_{CC} applied to EFC pin, positive slope		
Acceleration Sensitivity	≤ 2 x 10^{-9}/g (Standard "SD"); ≤ 7 x 10^{-10}/g (Low G-Sense "LG")		
Supply Voltage	+3.0 VDC, +3.3 VDC, or +5.0 VDC ± 5%		
Supply Current	< 6 mA for CMOS; < 3 mA for Clipped Sine Wave		
Environmentals	*Vibration* per MIL-STD-202G, Meth 214, Cond I-F *Shock* per MIL-STD-202G, Meth 213, Cond D **Note:** Shock available to 30,000g (specify Model T57)		

For RFQ specify: Model - Stability - Output - Supply Voltage - G-Sens - Frequency
Example: **T52 - N17 - C - 3.3 - LG - 20.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. EFC
2. CS (INTERNAL USE ONLY)
3. ADIO (INTERNAL USE ONLY)
4. GND
5. OUTPUT
6. TRISTATE OR N/C, SEE TABLE 1
7. VC (INTERNAL USE ONLY)
8. SUPPLY

TABLE 1: TRISTATE FUNCTION

PAD 6	Enable/Disable Function
HIGH (Supply)	**Output Enabled**
OPEN (N/C)	**Output Enabled**
LOW (GND)	**High Impedance Disabled**

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.197	5.00	0.207	5.25
B	0.126	3.20	0.136	3.45
C	NA	NA	0.079	2.00
D	0.046	1.17	NA	NA
E	0.035	0.89	NA	NA
F	0.016	0.41	NA	NA
G	0.038	0.97	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
H	0.147	3.73	0.157	3.39
I	0.126	3.20	0.136	3.45
J	0.047	1.19	NA	NA
K	0.049	1.25	NA	NA
L	0.047	1.19	NA	NA
M	0.051	1.30	NA	NA
N	0.019	0.48	NA	NA

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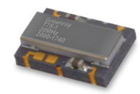
T70

tcxo

➤ *TIGHT TEMPERATURE STABILITY*
RUGGED PACKAGE



Frequency	10.0 MHz to 50.0 MHz
Output	CMOS (C option) or Clipped Sine Wave (S option)
Symmetry	50% ± 10% (CMOS)
Output Level	SINE: +0.8 V_{pp} min CMOS: T70: +0.2 V max to +2.8 V min T71: +0.2 V max to +4.2 V min
Output Load	CMOS: 15 pF typ; Clipped Sine: 10 kΩ, 10 pF typ

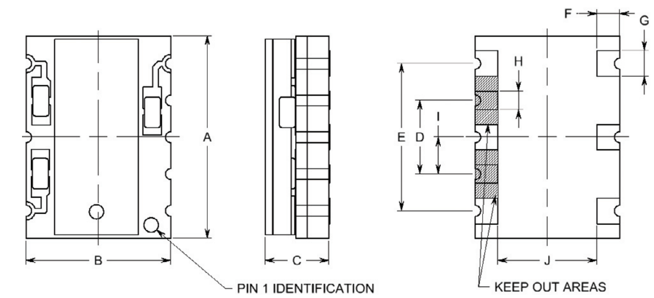
Temp Stability (other stabilities available)

Temp Range	Tolerance	Option
-10°C to +60°C	± 0.1 ppm	G17
-20°C to +70°C	± 0.1 ppm	N17
-40°C to +85°C	± 0.3 ppm	T37
-55°C to +95°C	± 1.0 ppm	V16

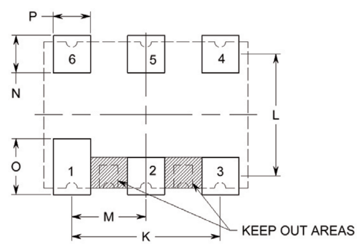
Aging	< 0.5 ppm/yr (10 MHz typ)
Frequency Adjust	± 7 ppm typ; 0 V to V_{CC} applied to EFC pin, positive slope
Acceleration Sensitivity	≤ 2.5 x 10^{-9}/g (Standard "SD"); ≤ 7 x 10^{-10}/g (Low G-Sense "LG")
Supply Voltage	+3.3 VDC ± 5% or +5.0 VDC
Supply Current	< 6 mA for HCMOS; < 3 mA for Clipped Sine Wave
Environmentals	*Vibration* per MIL-STD-202G, Meth 214, Cond I-F *Shock* per MIL-STD-202G, Meth 213, Cond F (Shock level to 50,000 g available)

MODEL	INPUT V	OUTPUT
T70	+3.3 V	CMOS
T71	+5.0 V	CMOS
T72	+3.3 V	Clipped Sine Wave
T73	+5.0 V	Clipped Sine Wave

For RFQ specify: Model - Stability - G-Sens - Frequency
Example: **T72 - T37 - LG - 20.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. EFC or N/C
2. SCLK (INTERNAL USE ONLY)
3. 0V & CASE GND
4. OUTPUT
5. TRISTATE/VREF/UTIL (SEE TABLE 1
6. SUPPLY

A. DIA (INTERNAL USE ONLY)
B. CS (INTERNAL USE ONLY)

TABLE 1: TRISTATE FUNCTION

PAD 5	Enable/Disable Function
HIGH (Supply)	**Output Enabled**
OPEN (N/C)	**Output Enabled**
LOW (GND)	**High Impedance Disabled**

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.275	7.00	0.280	7.11
B	0.197	5.00	0.202	5.13
C	NA	NA	0.100	2.54
D	0.100	2.54	0.105	2.67
E	0.200	5.08	0.205	5.21
F	0.025	0.64	NA	NA
G	0.033	0.84	NA	NA
H	0.035	0.89	NA	NA
I	0.050	1.27	0.055	1.40
J	0.135	3.43	1.40	3.56

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
K	0.200	5.08	0.205	5.21
L	0.164	4.17	0.169	4.29
M	0.100	2.54	0.105	2.68
N	0.050	1.27	NA	NA
O	0.050	1.27	NA	NA
P	0.075	1.91	NA	NA

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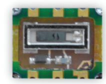
T90

tcxo

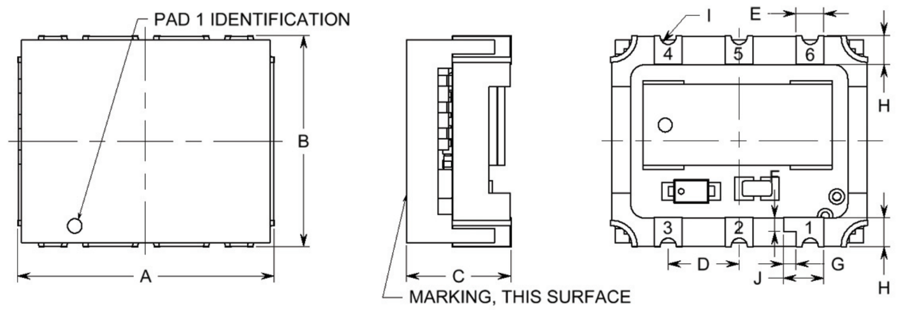
➤ *TIGHT TEMPERATURE STABILITY*
VERY RUGGED, SMT PACKAGE



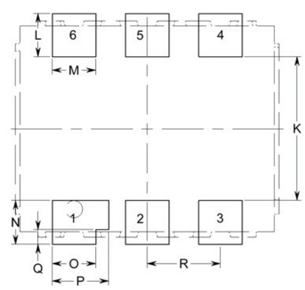
Frequency	10.0 MHz to 50.0 MHz		
Output	CMOS Square Wave		
Symmetry	50% ± 10%		
Output Level	T90: +0.2 V max to +4.1 V min; T91: +0.2 V max to +2.4 V min		
Output Load	15 pF typ		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 0.5 ppm	N57
	-40°C to +85°C	± 1.0 ppm	T16
	-40°C to +85°C	± 0.5 ppm	T57
	-55°C to +95°C	± 2.0 ppm	V26
Aging	< 1 ppm/yr @ 10 MHz typ		
Frequency Adjust	± 5 ppm typ; 0 V to 5 V or 0 V to +3.3 V applied to EFC pin, positive slope		
Supply Voltage	+5.0 VDC ± 5% or +3.3 VDC		
Supply Current	< 20 mA for CMOS		
Environmentals	*Vibration* per MIL-STD-202F, Meth 204, Cond A		
	Shock per MIL-STD-202F, Meth 213, Cond C		

MODEL	INPUT V	OUTPUT
T90	+5.0 V	CMOS
T91	+3.3 V	CMOS

For RFQ specify: Model - Stability - Frequency
Example: **T90- N57 - 20.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. EFC
2. VREF
3. 0V & CASE GND
4. OUTPUT
5. N/C
6. SUPPLY

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.360	9.14	0.375	9.53
B	0.295	7.49	0.310	7.87
C	NA	NA	0.153	3.90
D	0.100	2.54	0.0115	2.92
E	0.040	1.02	NA	NA
F	0.020	0.51	NA	NA
G	0.018	0.46	NA	NA
H	0.040	1.02	NA	NA
I	R0.014	R0.36	NA	NA
J	0.057	1.45	NA	NA

LAND PATTERN DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
R	0.100	2.54	NA	NA
K	0.196	4.98	NA	NA
L	0.060	1.52	NA	NA
M	0.060	1.52	NA	NA
N	0.060	1.52	NA	NA
O	0.060	1.52	NA	NA
P	0.077	1.52	NA	NA
Q	0.020	1.52	NA	NA

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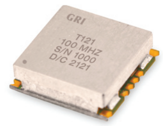
T121

➤ *LOW G-SENSITIVITY, TIGHT STABILITY*
RUGGED PACKAGE

tcxo



Frequency	50.0 MHz to 100.0 MHz		
Output	Sine Wave		
Output Level	+3 dBm ± 2 dBm into 50 Ω load		
Harmonic & Subs	-40 dBc max		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-40°C to +85°C	± 0.5 ppm	T57
	-40°C to +85°C	± 1.0 ppm	T16
	-55°C to +95°C	± 3.0 ppm	V36

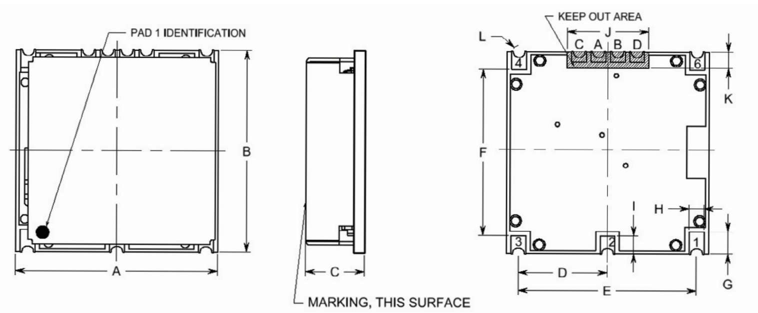
Voltage Stability ± 0.1 ppm for a ± 5% change
Load Stability ± 0.1 ppm for a ± 5% change
Aging < 1.0 ppm/yr @ 50 MHz typ
Total Stability ± 5 ppm max from nominal over 10 years (incl. temp, V, load & aging)

Phase Noise (typ @ 100 MHz)	**Offset**	**Static dBc/Hz**
	10 Hz	-75
	100 Hz	-102
	1 kHz	-125
	10 kHz	-140
	100 kHz	-145

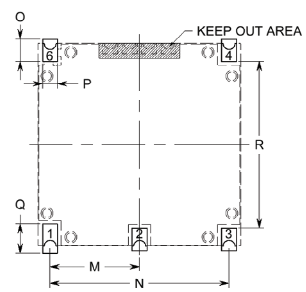
Frequency Adjust ± 7 ppm typ; 0 V to +5.0 V applied to EFC pin, positive slope
Acceleration Sensitivity ≤ 7×10^{-10}/g
Supply Voltage ± 5.0 VDC
Supply Current < 25 mA

Environmentals		
	Vibration	per MIL-STD-202F, Meth 214, Cond II H, 3 min/axis
	Shock	per MIL-STD-202F, Meth 213, 90 g peak, 1⁄2 sine, 5ms
	Storage Temp	-55°C to +105°C

For RFQ specify: Model - Stability - Frequency
Example: **T121 - T57 -70.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1.OUTPUT
2. N/C
3. SUPPLY
4. N/C
6. 0V & CASE GND
A. DIO (Internal Use Only)
B. CS (Internal Use Only)
C. SCLK (Internal Use Only)
D. ENABLE (Internal Use Only)

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.680	17.27	0.690	17.53
B	0.680	17.27	0.690	17.53
C	0.200	5.08	0.210	5.33
D	0.300	7.62	0.310	7.87
E	0.050	15.24	0.610	15.49
F	0.350	14.22	0.570	14.48
G	0.075	1.91	0.085	2.16
H	0.050	1.27	0.060	1.52
I	0.060	1.52	0.070	1.78
J	0.275	6.99	0.285	7.24
K	0.060	1.52	0.070	1.78
L	R0.020	R0.51	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
M	0.300	7.62	NA	NA
N	0.600	15.24	NA	NA
O	0.075	1.91	NA	NA
P	0.050	1.27	NA	NA
Q	0.100	2.54	NA	NA
R	0.560	14.22	NA	NA

AS 9100D

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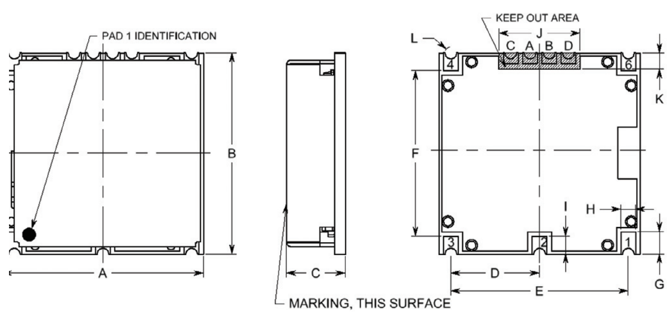
T124

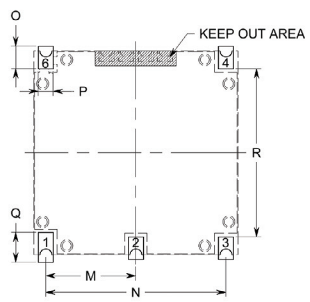
➤ *LOW FREQUENCY TCXO*
TIGHT TEMPERATURE STABILITY

Frequency	650.0 Hz to 5.0 MHz		
Output	CMOS Square Wave		
Symmetry	50/50 ± 5%		
Output Level	+0.2 V max		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 0.3 ppm	N37
	-40°C to +85°C	± 0.5 ppm	T57
	-40°C to +85°C	± 1.0 ppm	T16
Voltage Stability	± 0.3 ppm for a 5% change		
Load Stability	± 0.3 ppm for a 5% change		
Total Stability	± 5 ppm max from nominal over 10 years (incl. temp, V, load & aging)		
Phase Noise	**Offset**	**Static dBc/Hz**	
	10 Hz	-75	
	100 Hz	-102	
	1 kHz	-125	
	10 kHz	-140	
	100 kHz	-145	
Aging	< 0.5 ppm/yr		
Frequency Adjust	± 7 ppm typ; 0 V to +3.0 VDC applied to EFC pin, positive slope		
Supply Voltage	± 3.3 VDC ± 5% or +5.0 VDC		
Supply Current	< 20 mA		
Environmentals	*Vibration*	per MIL-STD-202F, Meth 214, Cond II F	
	Shock	per MIL-STD-202F, Meth 213, 90 g peak, 1⁄2 sine, 5ms	
	Storage Temp	-54°C to +105°C	

For RFQ specify: Model - Stability - Supply Voltage - Frequency
Example: **T124 - T16 - 3.3 - 5.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. OUTPUT
2. N/C
3. SUPPLY
4. EFC
6. 0V & CASE GND
A. N/C (Internal Use Only)
B. N/C (Internal Use Only)
C. N/C (Internal Use Only)
D. N/C (Internal Use Only)

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.680	17.27	0.690	17.53
B	0.680	17.27	0.690	17.53
C	0.200	5.08	0.210	5.33
D	0.300	7.62	0.310	7.87
E	0.050	15.24	0.610	15.49
F	0.350	14.22	0.570	14.48
G	0.075	1.91	0.085	2.16
H	0.050	1.27	0.060	1.52
I	0.060	1.52	0.070	1.78
J	0.275	6.99	0.285	7.24
K	0.060	1.52	0.070	1.78
L	R0.020	R0.51	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
M	0.300	7.62	NA	NA
N	0.600	15.24	NA	NA
O	0.075	1.91	NA	NA
P	0.050	1.27	NA	NA
Q	0.100	2.54	NA	NA
R	0.560	14.22	NA	NA

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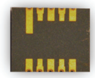
T1215

tcxo

➤ *HERMETIC TCXO*
TIGHT TEMPERATURE STABILITY



Frequency	750.0 KHz to 800.0 MHz		
Output	CMOS (Option C); available 750 kHz to 150 MHz Clipped Sine Wave (Option S); available 10 MHz to 50 MHz LVPECL (Option PE); available 20 MHz to 800 MHz LVDS (Option DS); available 20 MHz to 800 MHz		
Symmetry	50/50 ± 10%		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-40°C to +85°C	± 0.5 ppm	T57
	-40°C to +85°C	± 1.0 ppm	T16
	-55°C to +85°C	± 2.0 ppm	U26
	-55°C to +95°C	± 3.0 ppm	V36

Aging < 1 ppm/yr; < 10 ppm for 20 years

Frequency Adjust ± 7 ppm typ; 0 V to V_{CC} applied to EFC pin, positive slope

Acceleration Sensitivity ≤ 2.5 x 10^{-9}/g (SD option) or ≤ 7 x 10^{-10}/g (LG option)

Supply Voltage +2.7 VDC to +5.0 VDC, ± 5%

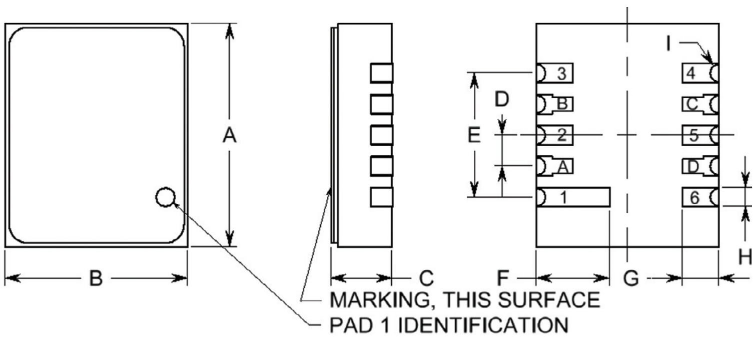
Supply Current < 80 mA max (some options are lower)

Environmentals (Other vibration & shock levels available. Please contact factory.)

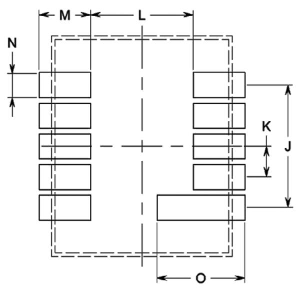
Vibration	per MIL-STD-202F, Meth 214, Cond A
Storage Temp	-55°C to +95°C
Shock	per MIL-STD-202F, Meth 213, Cond C
Fine Leak	MIL-STD-202, Meth 112, Cond C

Screening to MIL-PRF-55310, Class 3 Product Level B: Option B
No screening: Option X

For RFQ specify: Model - Stability - Output - Supply Voltage - Screening - g-Sensitivity - Frequency
Example: **T1215 - T57 - PE - 5.0 - B - LG - 300.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. EFC/N/C
2. Vref/N/C
3. 0V & CASE GND
4. OUTPUT
5. SCLK/N/C (Internal Use Only)
6. SUPPLY
A. CS (Internal Use Only)
B. TRI-STATE/N/C (Internal Use Only)
C. COMP. OUTPUT/N/C (Internal Use Only)
D. DIO (Internal Use Only)

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.360	9.14	0.370	9.40
B	0.295	7.49	0.305	7.75
C	NA	NA	0.115	2.92
D	0.050	1.27	0.060	1.52
E	0.200	5.08	0.210	5.33
F	0.118	3.00	NA	NA
G	0.059	1.50	NA	NA
H	0.031	0.79	NA	NA
I	R0.015	R0.38	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
J	0.200	5.08	NA	NA
K	0.050	1.27	NA	NA
L	0.167	4.24	NA	NA
M	0.084	2.13	NA	NA
N	0.041	1.04	NA	NA
O	0.143	3.63	NA	NA

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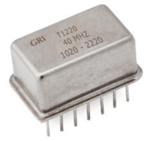
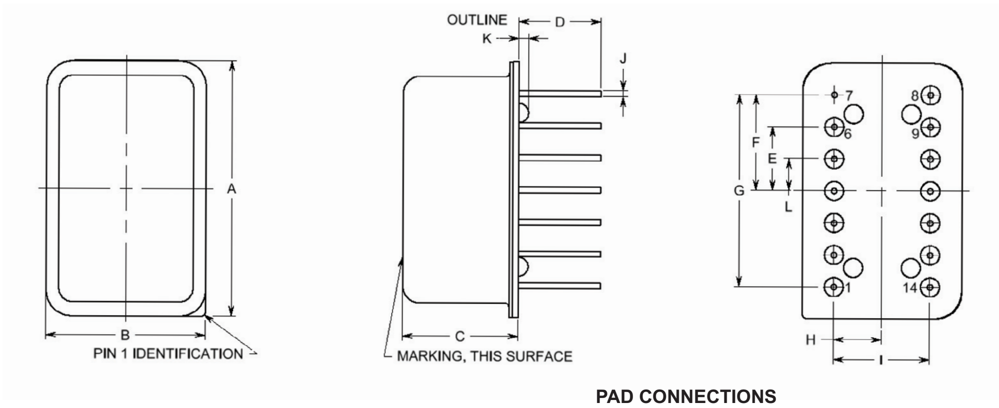
T1220

➤ ***DUAL COMPENSATION***
TIGHT TEMP STABILITY



Frequency	10.0 MHz to 50.0 MHz		
Output	T1220: CMOS Square Wave		
	T1221: Clipped Sine Wave		
Symmetry	50% ± 10% (Square Wave)		
Output Load	CMOS: 15 pF typ; Clipped Sine: 10 kΩ, 10 pF typ		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 0.05 ppm	N58
	-40°C to +85°C	± 0.1 ppm	T17
	$(f_{max}-f_{min})/(2 \times f_{min})$; EFC at center of range		
	Trim effect ≤ ± 0.1 ppm over 0 to V_{supply} EFC and temp.		
	Hysteresis not included.		
Voltage Stability	± 1 x 10^{-7} for a 5% change		
Phase Noise	**Offset**	**Static dBc/Hz**	
(10 MHz CMOS typ)	10 Hz	-90	
	100 Hz	-120	
	1 kHz	-140	
	10 kHz	-150	
	100 kHz	-155	
Aging	< 0.3 ppm/yr. typ, 0.5 ppm/yr max		
Frequency Adjust	± 6.0 ppm typ; positive slope, 0 V to V_{supply} EFC		
Acceleration Sensitivity	≤ 2.5 x 10^{-9}/g (SD option) or ≤ 7 x 10^{-10}/g (LG option)		
Supply Voltage	+3.3 VDC or +5.0 VDC ± 5%		
Supply Current	25 mA max		
Environmentals	*Random Vibration*	per MIL-STD-202, Meth 214, Cond I-J	
	Sine Vibration	per MIL-STD-202, Meth 204, Cond D	
	Shock	per MIL-STD-202, Meth 213, Cond F	
	Storage Temp	-55°C to +95°C	

For RFQ specify: Model - Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1220 - N58 - 3.3 - LG - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.80	20.32	0.82	20.83
B	0.50	12.70	0.52	13.21
C	NA	NA	0.400	10.16
D	NA	NA	0.27	6.86
E	0.200	5.08	0.210	5.33
F	0.300	7.62	0.310	7.87
G	0.600	15.24	0.610	15.49
H	0.150	3.81	0.160	4.06
I	0.300	7.62	0.310	7.87
J	ø0.018	ø0.46	ø0.021	ø0.53
K	NA	NA	0.030	0.76
L	0.100	2.54	0.110	2.79

PAD CONNECTIONS

1. EFC
7. 0V & CASE GND
8. OUTPUT
14. SUPPLY

All other pins are N/C and should be isolated.

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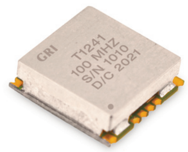
T1241

➤ *LOW PHASE NOISE*
VIBRATION COMPENSATED

tcxo



Frequency	50.0 MHz to 100.0 MHz		
Output	CMOS Square Wave		
Symmetry	50% ± 10%		
Output Load	CMOS: 15 pF typ		
Rise/Fall Time	≤ 10 ns		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 3.0 ppm	N36
	-40°C to +85°C	± 5.0 ppm	T56

Voltage Stability ± 3 x 10^{-7} for a 5% change

Phase Noise (100 MHz typ)

Offset	dBc/Hz
10 Hz	-80
100 Hz	-110
1 kHz	-135
10 kHz	-150
100 kHz	-160

Aging < 1.0 ppm/yr @ 50 MHz typ

Frequency Adjust ± 5.0 ppm typ; positive slope, 0 V to V_{supply} EFC

Acceleration Sensitivity ≤ 8 x 10^{-10}/g (SD option); ≤ 3 x 10^{-10}/g, worst axis (LG option); ≤ 7 x 10^{-11}/g, worst axis (ULG option)

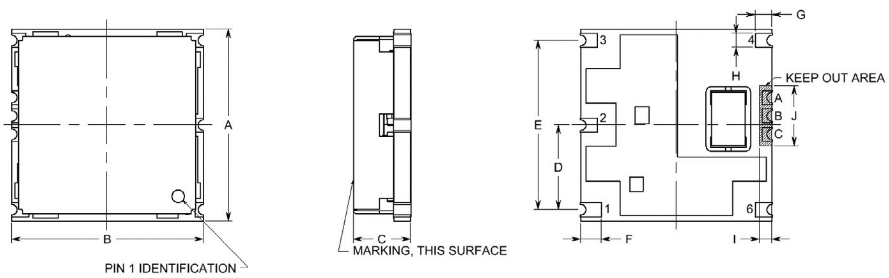
Supply Voltage +3.3 VDC or +5.0 VDC ± 5%

Supply Current 30 mA max

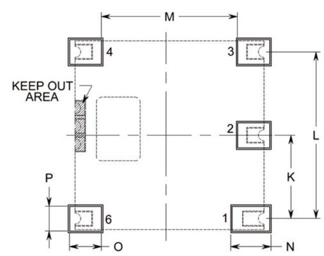
Environmentals

Vibration	per MIL-STD-202, Meth 214, Meth I-F
Shock	per MIL-STD-202, Meth 213, Cond K
Storage Temp	-55°C to +95°C

For RFQ specify: Model - Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1241 - T56 - 3.3 - LG - 100.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. OUTPUT
2. N/C
3. SUPPLY
4. OUTPUT
6. 0V & CASE GND
A. SCLK (Internal Use Only)
B. DIO (Internal Use Only)
C. CS (Internal Use Only)

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.680	17.27	0.695	17.63
B	0.680	17.27	0.695	17.63
C	0.200	5.08	0.215	5.46
D	0.300	7.62	0.315	8.00
E	0.600	15.24	0.615	15.62
F	0.075	1.91	NA	NA
G	0.060	1.52	NA	NA
H	0.050	1.27	NA	NA
I	0.045	1.14	NA	NA
J	0.212	5.38	0.227	5.77

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
K	0.300	5.62	NA	NA
L	0.600	15.24	NA	NA
M	0.490	12.45	NA	NA
N	0.145	3.68	NA	NA
O	0.115	2.92	NA	NA
P	0.090	2.29	NA	NA

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T1243

➤ *ULTRA-LOW ACCELERATION SENSITIVITY*
LOW PHASE NOISE

tcxo

Frequency 10.0 MHz to 50.0 MHz
Output CMOS Square Wave
Symmetry 50% ± 10%
Output Load CMOS: 15 pF typ

Temp Stability (other stabilities available)

Temp Range	Tolerance	Option
-20°C to +70°C	± 1.0 ppm	N16
-40°C to +85°C	± 2.0 ppm	T26

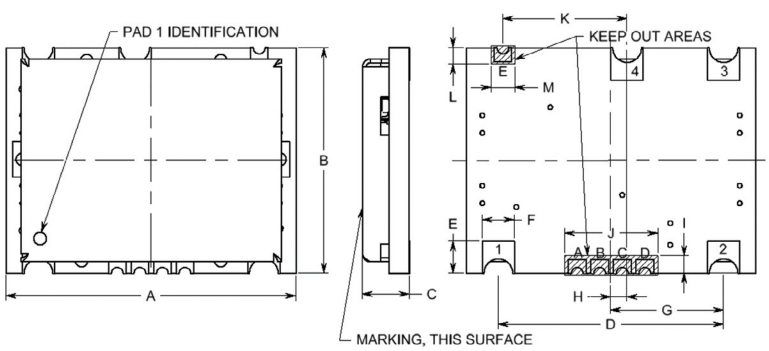
Aging < 1.0 ppm/yr @ 10 MHz typ
Voltage Stability ± 1 x 10^{-6} for a 5% change

Phase Noise (10 MHz typ)

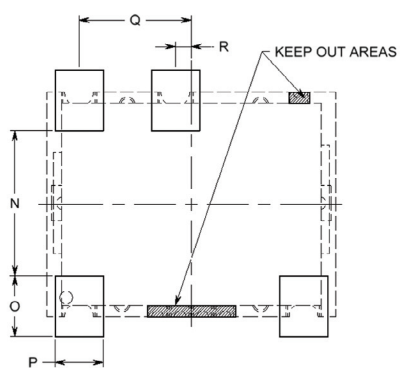
Offset	dBc/Hz
10 Hz	-100
100 Hz	-127
1 kHz	-150
10 kHz	-160
100 kHz	-165
Floor	-168

Frequency Adjust ± 7.0 ppm typ via 0 V to 3.3 VDC
Acceleration Sensitivity ≤ 7 x 10^{-10}/g, worst axis (SD option) or ≤ 7 x 10^{-11}/g, worst axis (LG option)
Supply Voltage +3.3 VDC or +5.0 VDC ± 5%

For RFQ specify: Model - Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1243 - N16 - 3.3 - LG - 50.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. OUTPUT
2. EFC
3. 0V & CASE GND
4. SUPPLY
A. OE (Internal Use Only)
B. SCLK (Internal Use Only)
C. DIO (Internal Use Only)
D. CS (Internal Use Only)
E. PNF (Internal Use Only)

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.900	22.86	0.915	23.24
B	0.700	17.78	0.715	18.16
C	NA	NA	0.250	6.35
D	0.700	17.78	0.715	18.16
E	0.100	2.54	NA	NA
F	0.100	2.54	NA	NA
G	0.350	8.89	0.365	9.27
H	0.050	1.27	NA	NA
I	0.054	1.37	NA	NA
J	0.290	7.38	0.305	7.75
K	0.385	9.78	0.400	10.16
L	0.051	1.30	NA	NA
M	0.074	1.87	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
N	0.452	11.48	0.467	11.86
O	0.200	5.08	0.215	5.46
P	0.150	3.81	0.165	4.19
Q	0.350	8.89	0.365	9.27
R	0.050	1.27	0.065	1.65

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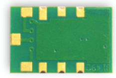
T1244

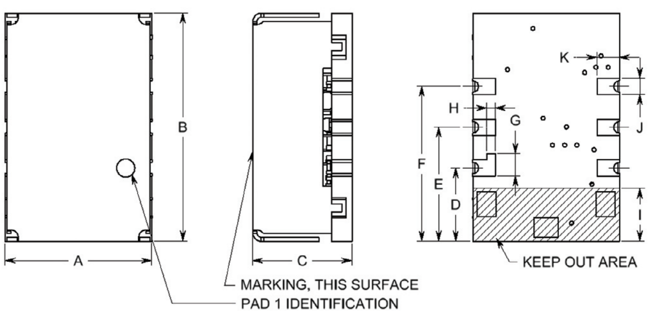
tcxo

➤ *LOW PHASE NOISE*

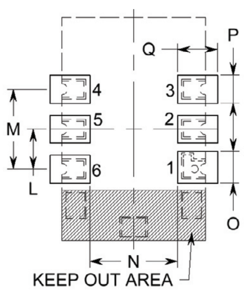


Frequency	50.0 MHz to 150.0 MHz		
Output	LVPECL		
Symmetry	50% ± 10%		
Output Load	50 Ω to V_{CC} -2.0 V		
Rise/Fall Time	≤ 1 ns (20% to 80%)		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-40°C to +85°C	± 1.0 ppm	T16
	-40°C to +85°C	± 2.0 ppm	T26
	-55°C to +85°C	± 2.0 ppm	U26
	-55°C to +95°C	± 3.0 ppm	V36
Reflow Shift	< 1.0 ppm typ after 24 hr settling time		
Aging	≤ ± 1 ppm 1st year; ≤ 5 ppm for 10 years		
Voltage Stability	≤ 0.3 ppm for a 5% change		
Frequency Adjust	± 5 ppm min via 0 V to +3.0 VDC		
Phase Noise	**Offset**	**dBc/Hz**	
(typ @ 100 MHz)	10 Hz	-75	
	100 Hz	-112	
	1 kHz	-140	
	10 kHz	-154	
	100 kHz	-157	
Acceleration Sensitivity	≤ 2.5 x 10^{-9}/g		
Supply Voltage	+3.3 VDC ± 5%		
Supply Current	65 mA max		
Environmentals	*Vibration*	per MIL-STD-202, Meth 201 & 204 10g from 10 to 2000 Hz	
	Shock	per MIL-STD-202, Meth 213, Cond C	
	Storage Temp	-55°C to +95°C	

For RFQ specify: Model - Temp Stability - Frequency
Example: **T1244 - T16 - 100.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. EFC
2. N/C
3. 0V CASE GND
4. OUTPUT
5. OUTPUT (-)
6. V SUPPLY

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.360	9.14	0.375	9.53
B	0.560	14.22	0.575	14.61
C	0.255	6.48	0.270	6.86
D	0.180	4.57	0.195	4.95
E	0.280	7.11	0.295	7.49
F	0.380	9.65	0.395	10.03
G	0.055	1.40	NA	NA
H	0.020	0.508	NA	NA
I	0.130	3.30	0.145	3.68
J	0.040	1.02	NA	NA
K	0.055	1.40	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
L	0.300	5.08	0.215	5.46
M	0.100	2.54	0.115	2.29
N	0.220	5.59	0.235	5.97
O	0.080	2.03	NA	NA
P	0.070	1.78	NA	NA
Q	0.100	2.54	NA	NA

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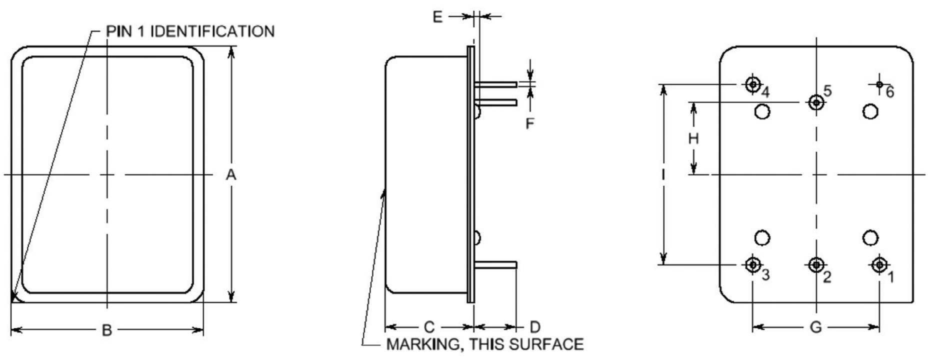
T1247

➤ *DUAL COMPENSATION*
TIGHT STABILITY

tcxo

Frequency	10.0 MHz to 50.0 MHz		
Output	CMOS Square Wave		
Symmetry	50% ± 10% (Square Wave)		
Output Load	15 pF typ		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 0.03 ppm	N38
	-40°C to +85°C	± 0.05 ppm	T58
Aging	±1 ppm 1st year		
Voltage Stability	≤ 0.3 ppm for a 5% change		
Frequency Adjust	± 5 ppm min via 0 to +3.0 VDC		
Phase Noise	**Offset**	**dBc/Hz**	
(10 MHz CMOS typ)	10 Hz	-90	
	100 Hz	-120	
	1 kHz	-140	
	10 kHz	-150	
	100 kHz	-155	
Frequency Adjust	± 7.0 ppm typ via 0 V to V_{supply} EFC; positive slope		
Acceleration Sensitivity	≤ 2.5 x 10^{-9}/g (SD Option) or ≤ 7 x 10^{-10}/g (LG Option)		
Supply Voltage	+3.3 VDC or +5.0 VDC ± 5%		
Supply Current	35 mA max		
Environmentals	*Random Vibration*	per MIL-STD-202, Meth 214, Cond I, J	
	Sine Vibration	per MIL-STD-202, Meth 204, Cond D	
	Shock	per MIL-STD-202, Meth 213, Cond F	
	Storage Temp	-55°C to +95°C	

For RFQ specify: Model - Temp Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1247 - T58 - 3.3 - LG - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	1.420	36.10	1.430	36.32
B	1.060	26.92	1.070	27.18
C	0.490	12.45	0.500	12.70
D	0.230	5.84	0.240	6.10
E	0.026	0.66	0.032	0.81
F	ø0.032	ø0.81	ø0.034	ø0.86
G	0.700	17.78	0.710	18.03
H	0.400	10.16	0.410	10.41
I	1.000	25.40	1.010	25.65

PAD CONNECTIONS

1. EFC (GND thru 10 kΩ resistor when EFC is disabled)
2. EFC ENABLED (See Pin 2 Function, below)
3. SUPPLY
4. OUTPUT
5. N/C 0V (Internal Use Only)
6. 0V & CASE GND

Pin 2 Function: 3 to 4.5V Input - External EFC Enabled;
(Stability will depend on external Ref. or Voltage

0V/GND Input: Compensated/Free Run Mode
Note: Internal Pull Down

AS 9100D

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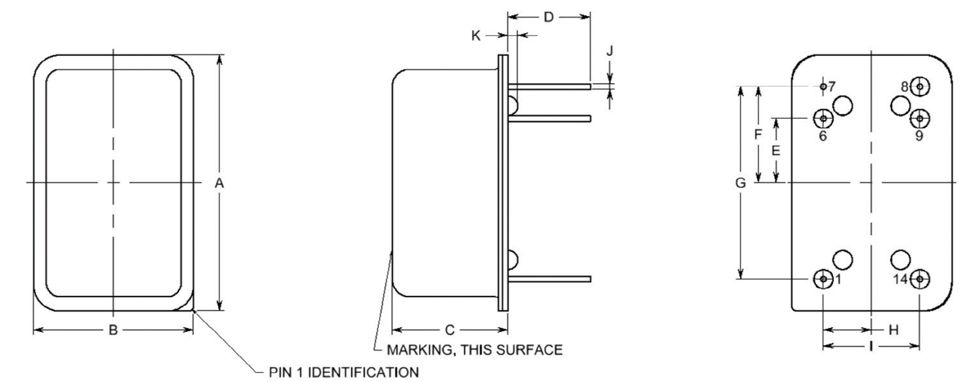
T1254

➤ *RADIATION TOLERANT*
ULTRA-LOW G-SENSITIVITY

tcxo

Frequency	10.0 MHz to 100.0 MHz		
Output	CMOS		
Symmetry	50% ± 10%		
Output Level	+0.2 V max to +4.5 V min		
Output Load	CMOS: 15 pF typ		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 1.0 ppm	N16
	-40°C to +85°C	± 5.0 ppm	T56
	-55°C to +125°C	± 7.0 ppm	X76
Short Term	≤ 1 x 10^{-9} for a 1 sec tau		
Aging	< 1 ppm/yr @10 MHz typ		
Phase Noise	**Offset**	**dBc/Hz**	
(typ @ 10 MHz)	10 Hz	-90	
	100 Hz	-120	
	1 kHz	-145	
	10 kHz	-150	
	100 kHz	-155	
Frequency Adjust	± 7 ppm typ via 0 V to V_{CC} control V, negative slope		
Voltage Stability	± 3 x 10^{-7} max for a 2% change		
Acceleration Sensitivity	≤ 7 x 10^{-10}/g (SD option) or ≤ 7 x 10^{-11}/g (LG option)		
Supply Voltage	+5.0 VDC ± 5% (+3.3 VDC option available)		
Supply Current	< 35 mA max		
Environmentals	*Vibration*	per MIL-STD-883, Meth 2007, Cond A	
	Shock	per MIL-STD-883, Meth 2002, Cond B	
	Operating Temp	-55°C to +125°C	
	Storage Temp	-65°C to +125°C	
	Radiation	Designed to operate during 30kRad (Si) TID	
	Package Finish	Stainless Steel & Nickel-plated Kovar	
	Package Weight	approx. 3 grams	

For RFQ specify: Model - Temp Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1254 - T56 - 3.3 - LG - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.80	20.32	0.82	20.83
B	0.50	12.70	0.52	13.21
C	NA	NA	0.370	9.40
D	0.220	5.59	0.240	6.10
E	0.200	5.08	0.210	5.53
F	0.300	7.62	0.310	7.87
G	0.600	15.24	0.610	15.49
H	0.150	3.81	0.160	4.06
I	0.300	7.62	0.310	7.87
J	ø0.018	ø0.46	ø0.021	ø0.53
K	0.031	0.79	0.041	1.04

PAD CONNECTIONS

1. EFC
6. N/C
7. 0V & CASE GND
8. OUTPUT
9. N/C
14. V SUPPLY

PINS 6 & 9: Internal use only & must be isolated

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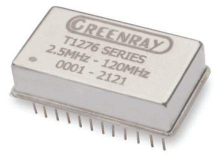
T1276

➤ *RADIATION TOLERANT*
ULTRA-LOW G-SENSITIVITY

tcxo



Frequency 2.5 MHz to 120.0 MHz

Output CMOS Square Wave (C Option)
Sine Wave (S Option)

Symmetry 50% ± 10% (CMOS)

Output Level +3 dBm ±2 dBm into 50 Ω load (Sinewave)
CMOS (@3.3V +0.2 V max to +2.8V min)

Harmonic & Subs -26 dBc max

Output Load CMOS: 15 pF typ; Sinewave: 50 Ω

Temp Stability
(other stabilities available)

Temp Range	Tolerance	Option
-20°C to +70°C	± 1.0 ppm	N16
-40°C to +85°C	± 3.0 ppm	T36
-55°C to +125°C	± 7.0 ppm	X76

Short Term ≤ 1 x 10^{-9} for a 1 sec tau

Aging < ±1 ppm/yr @ 10 MHz typ

Phase Noise
(typ @ 20 MHz)

Offset	dBc/Hz
10 Hz	-90
100 Hz	-120
1 kHz	-140
10 kHz	-150
100 kHz	-155
1 M	-160

Frequency Adjust ± 7 ppm typ via 0 V to V_{CC} control V, negative slope

Voltage Stability ± 3 x 10^{-7} max for a 2% change

Acceleration Sensitivity ≤ 7 x 10^{-10}/g (SD option); ≤ 7 x 10^{-11}/g (ULG option)

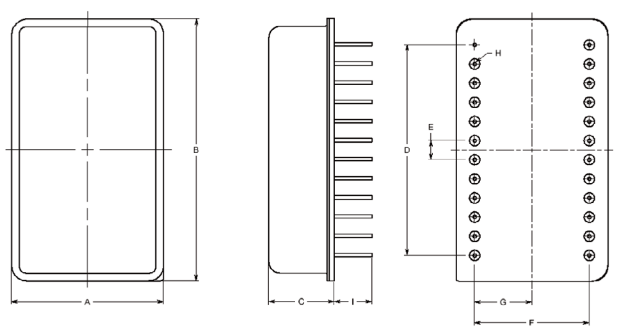
Supply Voltage +5.0 VDC ± 5% (+3.3 VDC option available)

Supply Current < 35 mA max

Environmentals

Vibration	per MIL-STD-883, Meth 2007, Cond A
Shock	per MIL-STD-883, Meth 2002, Cond B
Operating Temp	-55°C to +125°C
Storage Temp	-65°C to +130°C
Radiation	Designed to operate during 200kRad (Si) TID
Package Finish	Stainless Steel & Nickel-plated Kovar
Package Weight	approx. 4 grams

For RFQ specify: Model - Temp Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1276 - T36 - 5.0 - SD - 100.0 MHz**



PAD CONNECTIONS

1. EFC
12. GND
13. OUTPUT
24. V SUPPLY

ALL OTHER PINS N/C

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.795	20.19	0.799	20.30
B	1.370	34.80	1.374	34.90
C	0.343	8.71	0.345	8.76
D	1.100	27.94	1.104	28.04
E	0.100	2.54	NA	NA
F	0.600	15.24	NA	NA
G	0.300	7.62	NA	NA
H	0.018	0.46	0.020	0.50
I	0.197	5.00	0.217	5.50

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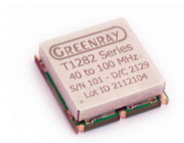
T1282

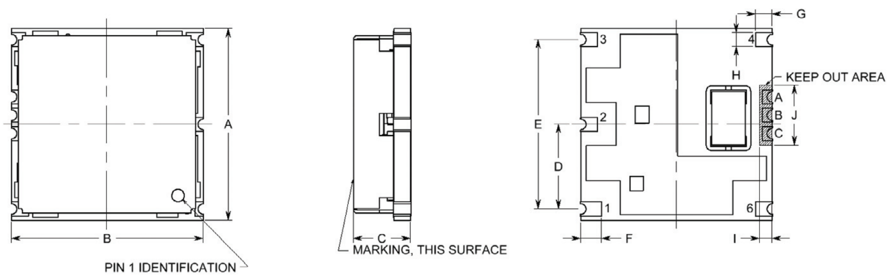
tcxo

➤ *RADIATION TOLERANT*
ULTRA-LOW G-SENSITIVITY

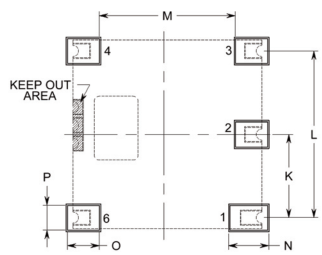


Frequency	40.0 MHz to 100.0 MHz		
Output	CMOS		
Symmetry	50% ± 10%		
Output Level	+0.2 V max to +4.5 V min		
Output Load	CMOS: 15 pF typ		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-20°C to +70°C	± 3.0 ppm	N36
	-40°C to +85°C	± 5.0 ppm	T56
Short Term	≤ 1 x 10^{-9} for a 1 sec tau		
Aging	< ±1 ppm/yr @ 40 MHz typ		
Phase Noise	**Offset**	**dBc/Hz (10 M)**	
(typ @ 10 MHz)	10 Hz	-80	
	100 Hz	-110	
	1 kHz	-135	
	10 kHz	-150	
	100 kHz	-160	
Frequency Adjust	± 7 ppm typ via 0 V to V_{CC} control V, negative slope		
Voltage Stability	± 3 x 10^{-7} max for a 2% change		
Acceleration Sensitivity	≤ 8 x 10^{-10}/g (SD option); ≤ 3 x 10^{-10}/g (LG option) or ≤ 7 x 10^{-11}/g (ULG option)		
Supply Voltage	+5.0 VDC ± 5% (+3.3 VDC option available)		
Supply Current	< 30 mA max		
Environmentals	*Vibration*	per MIL-STD-202F, Meth 214, Cond I.F	
	Shock	per MIL-STD-202F, Meth 213, Cond K	
	Operating Temp	-40°C to +85°C	
	Storage Temp	-55°C to +105°C	
	Radiation	Designed to operate during 50kRad (Si) TID	
	Package Finish	Stainless Steel & Nickel-plated Kovar	
	Package Weight	approx. 3 grams	

For RFQ specify: Model - Temp Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1282 - T56 - 3.3 - LG - 40.0 MHz**



RECOMMENDED LAND PATTERN



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.680	17.27	0.695	17.63
B	0.680	17.27	0.695	17.63
C	0.200	5.08	0.215	5.46
D	0.300	7.62	0.315	8.00
E	0.600	15.24	0.615	15.62
F	0.075	1.91	NA	NA
G	0.060	1.52	NA	NA
H	0.050	1.27	NA	NA
I	0.045	1.14	NA	NA
J	0.212	5.38	0.227	5.77

PAD CONNECTIONS

1. OUTPUT
2. N/C
3. SUPPLY
4. OUTPUT
6. 0V & CASE GND
A. SCLK (Internal Use Only)
B. DIO (Internal Use Only)
C. CS (Internal Use Only)

LAND PATTERN DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
K	0.300	5.62	NA	NA
L	0.600	15.24	NA	NA
M	0.490	12.45	NA	NA
N	0.145	3.68	NA	NA
O	0.115	2.92	NA	NA
P	0.090	2.29	NA	NA

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T1300

➤ *ULTRA-LOW ACCELERATION SENSITIVITY*
LOW PHASE NOISE

Frequency 10.0 MHz to 50.0 MHz

Output CMOS Square Wave

Symmetry 50% ± 10%

Output Load 15 pF typ

Temp Stability
(other stabilities available)

Temp Range	Tolerance	Option
-20°C to +70°C	± 1.0 ppm	N16
-40°C to +85°C	± 2.0 ppm	T26

Voltage Stability ± 1 x 10^{-7} max for a 5% change

Frequency vs. Load < ± 1 x 10^{-9} typ for a 10% change

Short Term 8 x 10^{-10} for a 1 sec tau (10 MHz)

Aging ± 0.5 ppm/yr @ 10 MHz typ after 14 days operation

Warm Up Time to within ± 1 ppm in 10 msec

Phase Noise
(typ @ 10 MHz, +5 V)

Offset	dBc/Hz
10 Hz	-100
100 Hz	-130
1 kHz	-155
10 kHz	-162
100 kHz	-162

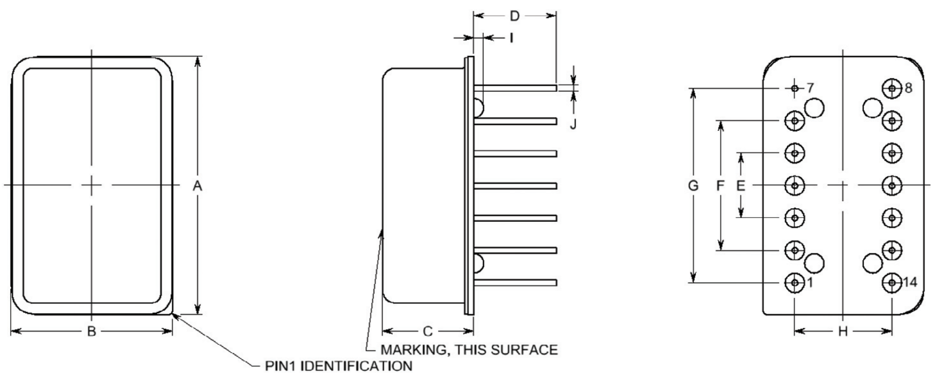
Frequency Adjust ± 6.0 ppm typ, positive slope
0 to V_{CC} EFC, 50k Ω input Z

Acceleration Sensitivity ≤ 7 x 10^{-10}/g (SD option); ≤ 1 x 10^{-10}/g, worst axis (LG option);
≤ 7 x 10^{-11}/g, worst axis (ULG option)

Supply Voltage +5.0 VDC or +3.3 VDC ± 5%

Supply Current 20 mA max

For RFQ specify: Model - Temp Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1300 - T26 - 5.0 - LG - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.800	20.32	0.815	20.70
B	0.500	12.70	0.515	13.08
C	NA	NA	0.370	9.34
D	0.215	5.46	0.230	5.84
E	0.200	5.08	0.210	5.33
F	0.300	7.62	0.310	7.87
G	0.600	15.24	0.610	15.49
H	0.300	7.62	0.310	7.87
I	0.018	0.46	0.024	0.61
J	ø0.018	ø0.46	ø0.021	ø0.53

PAD CONNECTIONS

1. EFC
7. 0V CASE GND
8. OUTPUT
12. EFC FILTER ENABLE (See Note 1)
14. V SUPPLY

NOTES

1. EFC Input is through a Low Pass Filter for phase noise reduction. Filter may be disabled for faster response by grounding Pin 12. Filter is enabled if Pin 12 is floating or at Logic “1” (+5 V).
2. Remaining pins are not connected

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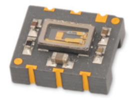
T1307

ULTRA-LOW ACCELERATION SENSITIVITY
MINIATURE SMT PACKAGE

tcxo



Frequency	10.0 MHz to 50.0 MHz
Output	CMOS Square Wave (Option C)
	Clipped Sine Wave (Option S)
Symmetry	50% ± 10% (CMOS)
Output Load	CMOS: 15 pF typ; Clipped Sine: 10 kΩ, 10 pF typ

Temp Stability (other stabilities available)

Temp Range	Tolerance	Option
-20°C to +70°C	± 0.5 ppm	N57
-40°C to +85°C	± 1.0 ppm	T16

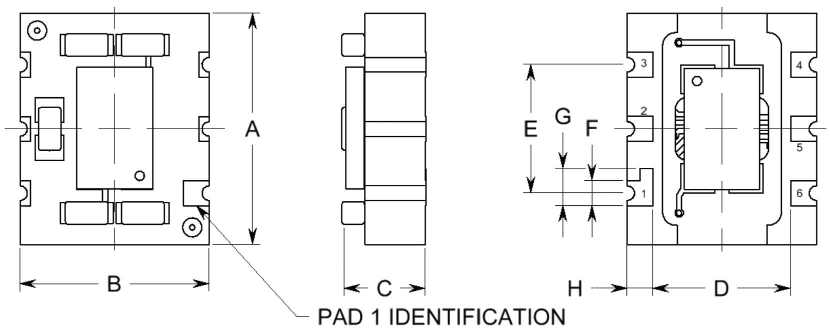
Voltage Stability	± 1 x 10^{-7} max for a 5% change
Frequency vs. Load	± 1 x 10^{-7} for a 10% change
Aging	≤ ± 0.5 ppm/yr @ 10 MHz typ after 14 days operation

Phase Noise (typ @ 10 MHz)

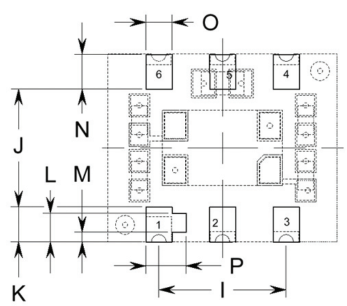
Offset	dBc/Hz
10 Hz	-95
100 Hz	-123
1 kHz	-145
10 kHz	-155
100 kHz	-157

Acceleration Sensitivity	≤ 7 x 10^{-10}/g (SD option); ≤ 1 x 10^{-10}/g, worst axis (LG option); ≤ 7 x 10^{-11}/g, worst axis (ULG option)
Frequency Adjust	± 7.0 ppm typ, positive slope
	0 to V_{CC} EFC, 50 kΩ input Z
Supply Voltage	+5.0 VDC or +3.3 VDC ± 5%
Supply Current	6 mA max
Warm Up Time	to within ± 1 ppm in 10 msec

For RFQ specify: Model - Stability - Output - Supply Voltage - g-Sensitivity - Frequency
Example: **T1307 - N57 - C - 3.3 - SD - 10.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. EFC
2. N/C
3. 0 V & CASE GND
4. OUTPUT
5. N/C
6. V SUPPLY

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.360	9.14	0.370	9.40
B	0.295	7.49	0.305	7.75
C	0.146	3.71	0.157	4.00
D	0.215	5.46	0.225	5.72
E	0.200	5.08	0.210	5.33
F	0.039	1.00	NA	NA
G	0.058	1.46	NA	NA
H	0.040	1.02	NA	NA

LAND PATTERN DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
I	0.200	5.08	0.210	5.33
J	0.185	4.70	0.195	4.95
K	0.055	1.40	NA	NA
L	0.045	1.14	NA	NA
M	0.015	0.38	NA	NA
N	0.055	1.40	NA	NA
O	0.041	1.04	NA	NA
P	0.063	1.60	NA	NA

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T1354

tcxo

➤ RADIATION TOLERANT 100kRad (Si) TID
ULTRA-LOW ACCELERATION SENSITIVITY

Frequency 10.0 MHz to 100.0 MHz
Output Clipped Sine Wave
Output Level +1.5 V_{p-p} min typ, +1.0 V_{p-p} min
Output Load 10 kΩ, 10 pF typ
Temp Stability (other stabilities available)

Temp Range	Tolerance	Option
-20°C to +70°C	± 1.0 ppm	N16
-40°C to +85°C	± 5.0 ppm	T56
-55°C to +125°C	± 7.0 ppm	X76

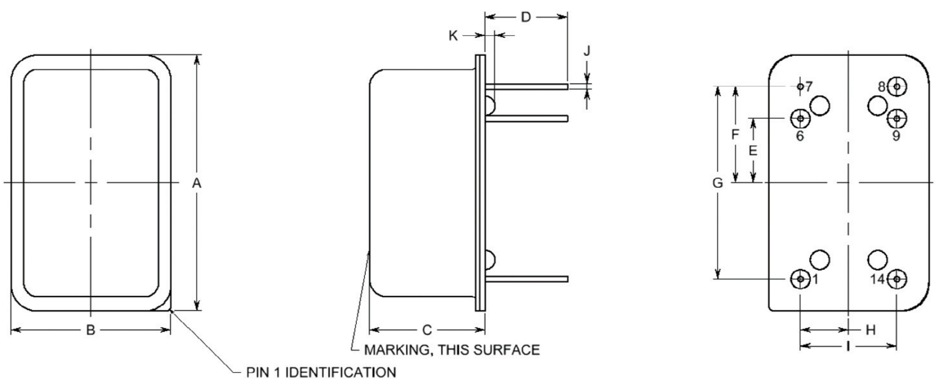
Voltage Stability ± 3 x 10^{-7} max for a 2% change
Frequency vs. Load ± 1 x 10^{-7} for a 10% change
Aging < 1.0 ppm/yr @10 MHz typ
Phase Noise (typ @ 10 MHz)

Offset	dBc/Hz
10 Hz	-90
100 Hz	-120
1 kHz	-145
10 kHz	-150
100 kHz	-155

Acceleration Sensitivity ≤ 7 x 10^{-10}/g (SD option); ≤ 7 x 10^{-11}/g (LG option)
Frequency Adjust ± 7.0 ppm typ, negative slope V_{dd} to 0 V
0 to V_{cc} EFC, 50 kΩ input Z
Supply Voltage +5.0 VDC or +3.3 VDC ± 5%
Supply Current 35 mA
Environmentals

Vibration	per MIL-STD-883, Meth 2007, Cond A
Shock	per MIL-STD-883, Meth 2002, Cond B
Operating Temp	-55°C to +125°C
Storage Temp	-65°C to +125°C
Radiation	Designed to operate during 100kRad (Si) TID
Package Finish	Stainless Steel & Nickel-plated Kovar
Package Weight	approx. 3 grams

For RFQ specify: Model - Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **T1354 - T56 - 3.3 - SD - 100.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.80	20.32	0.82	20.83
B	0.50	12.70	0.52	13.21
C	NA	NA	0.370	9.40
D	0.220	5.59	0.240	6.10
E	0.200	5.08	0.210	5.53
F	0.300	7.62	0.310	7.87
G	0.600	15.24	0.610	15.49
H	0.150	3.81	0.160	4.06
I	0.300	7.62	0.310	7.87
J	ø0.018	ø0.46	ø0.021	ø0.53
K	0.031	0.79	0.041	1.04

PAD CONNECTIONS

1. EFC
6. N/C
7. 0V & CASE GND
8. OUTPUT
9. N/C
14. V SUPPLY

PINS 6 & 9: Internal use only & must be isolated

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ZT600

tcxo

➤ *SMT PACKAGE*
TIGHT TEMPERATURE STABILITY

Frequency 10.0 MHz to 500.0 MHz

Output ZT600: Square Wave, CMOS (10 to 125 MHz only)
ZT601: Sine Wave, 0 dBm min into 50 Ω

Harmonics -20 dBc (Sine Wave)

Symmetry 50% ± 10% (Square Wave)

Output Level +0.2 V max to +4.5 V min

Output Load CMOS: 15 pF typ

Temp Stability (other stabilities available)

Temp Range	Tolerance	Option
-10°C to +60°C	± 0.2 ppm	G27
-20°C to +70°C	± 0.5 ppm	N57
-40°C to +85°C	± 0.5 ppm	T57
-40°C to +85°C	± 1.0 ppm	T16

Aging < ±0.5 ppm/yr @ 10 MHz typ

Phase Noise (typ @ 10 MHz)

Offset	dBc/Hz
10 Hz	-95
100 Hz	-125
1 kHz	-140
10 kHz	-150
100 kHz	-155

Voltage Stability < 0.5 ppm typ for 5% change

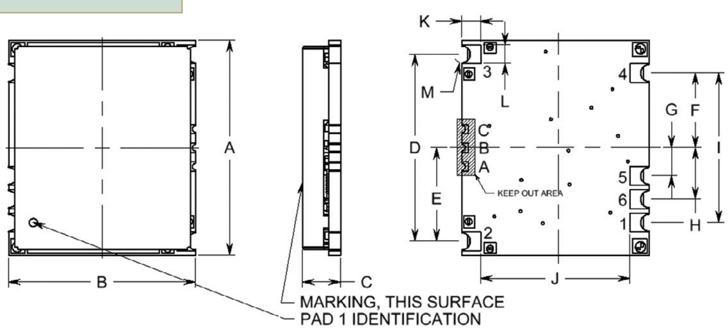
Frequency Adjust ± 7 ppm typ via 0 to V_{CC} control V, positive slope

Supply Voltage +5.0 VDC ± 5% (+3.3 VDC option available)

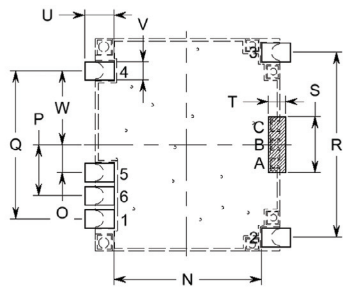
Supply Current < 35 mA max

MODEL	OUTPUT
ZT600	CMOS
ZT601	Sine Wave

For RFQ specify: Model - Temp Stability - Supply Voltage - Frequency
Example: **ZT600 - T16 - 5.0 - 10.0 MHz**



RECOMMENDED LAND PATTERN



PAD CONNECTIONS

1. OUTPUT
2. V SUPPLY
3. 0V & CASE GND
4. EFC
5. 0V & CASE GND
6. 0V & CASE GND
A. SCLK (Internal Use Only)
B. DIO (Internal Use Only)
C. CS (Internal Use Only)

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	1.150	29.21	1.170	29.72
B	1.000	25.40	1.020	25.91
C	0.200	5.08	0.220	5.59
D	1.000	25.40	1.020	25.91
E	0.500	12.70	0.520	13.21
F	0.400	10.16	0.420	10.67
G	0.150	3.81	0.170	4.32
H	0.275	6.99	0.295	7.49
I	0.800	20.32	0.820	20.83
J	0.800	20.32	0.820	20.83
K	0.100	2.54	NA	NA
L	0.100	2.54	NA	NA
M	ø0.090	ø2.29	NA	NA

LAND PATTERN DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
N	0.800	20.32	0.820	20.83
O	0.150	3.81	0.170	4.32
P	0.275	6.99	0.295	7.49
Q	0.050	20.32	0.820	20.83
R	1.000	25.40	1.020	25.91
S	0.303	7.70	0.323	8.20
T	0.091	2.31	0.111	2.82
U	0.158	4.01	0.178	4.52
V	0.100	2.54	0.120	3.05

NOTE:
1. Area which is shaded around Pads A, B and C are N/C and should not have any metalization in this area.
2. Landing Pads should not extend any further underneath PCB than shown.

9100D

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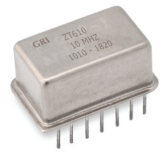
ZT610

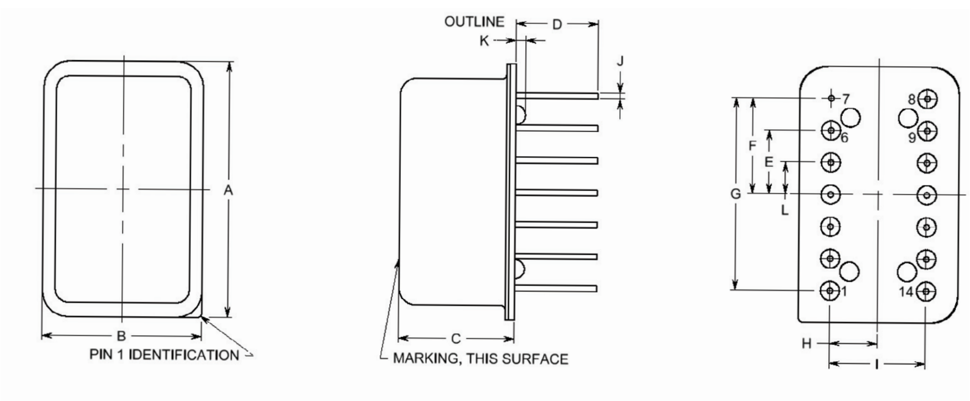
tcxo

➤ *LOW PHASE NOISE*
VERY RUGGED PACKAGE



Frequency	10.0 MHz to 50.0 MHz		
Output	CMOS Square Wave; capable of sink/source to 15 mA		
Load	10 to 15 pF		
Symmetry	50% ± 10%		
Rise/Fall Time	≤ 3 ns		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	0°C to +50°C	± 0.5 ppm	B57
	-20°C to +70°C	± 1.0 ppm	N16
	-40°C to +85°C	± 3.0 ppm	T36
Aging	< 1 ppm/yr; < ± 5.0 ppm for 10 years		
Phase Noise	**Offset**	**dBc/Hz (10 MHz)**	
(typ @ 10 MHz)	10 Hz	-105	
	100 Hz	-135	
	1 kHz	-155	
	10 kHz	-160	
	100 kHz	-163	
Voltage Stability	< 1 ppm for a 5% change		
Frequency Adjust	± 5 ppm typ; positive slope; settable to nominal for 10 years		
EFC Characteristics	+0.5 V to +4.5 V EFC; Input Z: 100 kΩ; Input I: < 50 uA		
Supply Voltage	+5.0 VDC ± 5%		
Supply Current	< 15 mA + output sink/source current (15 pF load)		
Environmentals	*Random Vibration*	per MIL-STD-202, Meth 214, Cond IA	
	Shock	per MIL-STD-202, Meth 213, Cond C	
	Storage Temp	-55°C to +85°C	

For RFQ specify: Model - Temp Stability - Frequency
Example: **ZT610 - N16 - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.80	20.32	0.82	20.83
B	0.50	12.70	0.52	13.21
C	NA	NA	0.37	9.34
D	0.215	5.46	0.230	5.84
E	0.200	5.08	0.210	5.33
F	0.300	7.62	0.310	7.87
G	0.600	15.24	0.610	15.49
H	0.150	3.81	0.160	4.06
I	0.300	7.62	0.310	7.87
J	ø0.018	ø0.46	ø0.021	ø0.53
K	0.018	0.46	0.024	0.61
L	0.100	2.54	0.110	2.79

PAD CONNECTIONS

1. EFC
7. 0V & CASE GND
8. OUTPUT
14. SUPPLY V

All other pins are N/C and should be isolated.

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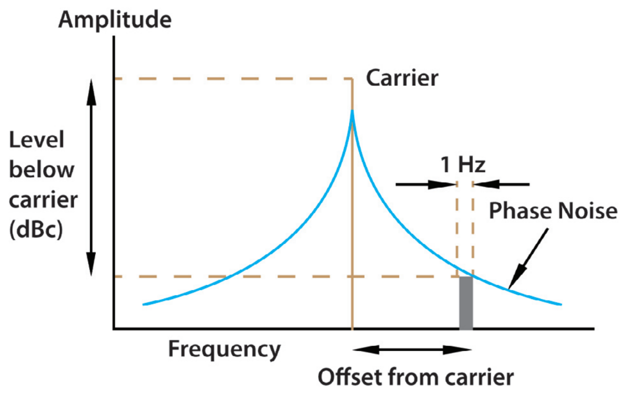
INTRODUCTION

Phase noise is a phenomenon which is present on every oscillator output spectrum. Phase noise can often be the limiting factor that defines the specifications that are achievable in a given system. High phase noise in the local oscillator of a receiver will limit the sensitivity to detect very low power signals. Such as a very weak radio station or a radar return from a distant target. In a phase modulated digital transmission system it will directly affect the achievable Bit Error Rate. If the signal is to be multiplied to a higher frequency it is important to start with phase noise as low as possible since the noise will degrade as 20 times the log of the multiplication factor. It is, therefore, necessary to understand and to quantify phase noise so that its effects on the higher level product are minimized.

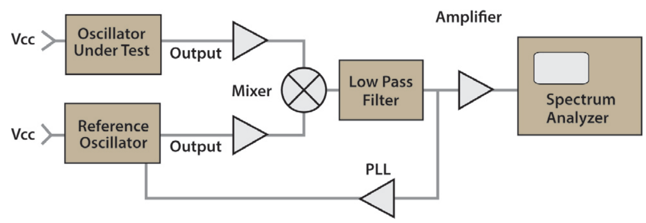
An ideal oscillator would generate a pure noise-free sine wave. In the frequency domain, this would be represented as a single bright line on a spectrum analyzer with all of the carrier signal's power at a single precise frequency. But all real oscillators produce noise due to active devices in the circuit. This noise arises from rapid short term random phase fluctuations that cause time domain instabilities. These instabilities modulate the carrier which then translates them to the frequency domain. These phase noise components spread the power of the carrier signal to adjacent frequencies resulting in noise sidebands.

Phase noise is typically noted as £(f). It is usually given in units of dBc/Hz which represents the noise power relative to the carrier contained in a 1Hz bandwidth centered at certain offsets from the carrier. The phase noise spreads out equally on either side of the carrier but according to IEEE definition, only one side is measured - hence the designation SSB or single sideband phase noise.



MEASURING PHASE NOISE

In some cases, it may be possible to measure phase noise directly with a spectrum analyzer as long as adjustments are made for the measurement bandwidth. But this is only possible if the oscillator under test exhibits a relatively high level of phase noise. With most crystal oscillators and other high stability sources, the phase noise of the unit being measured will be much lower than the noise of the wideband local oscillator in the spectrum analyzer. The noise of the unit under test therefore can't be determined. Special test sets or phase noise analyzers are required.



The classical method for phase noise measurement employs two oscillators of the same frequency which are phase locked in quadrature with a very low bandwidth loop. This nulls out the carrier leaving just the residual phase noise which can be

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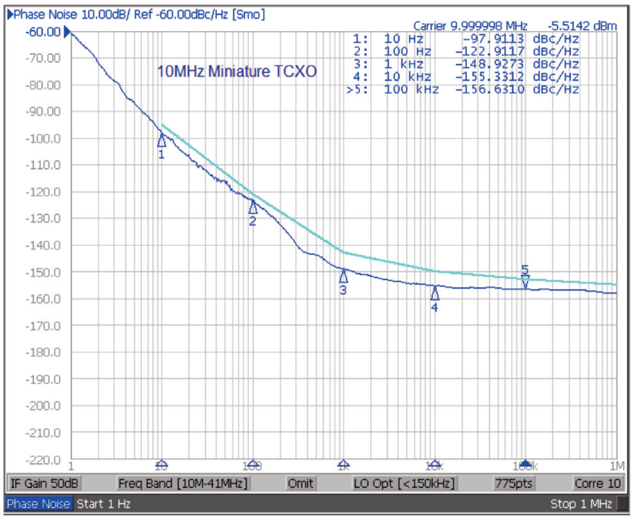
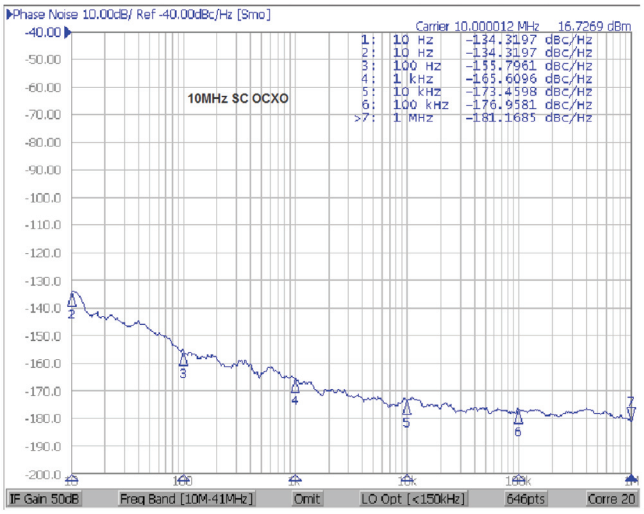
measured with a low frequency analyzer. If two identical units are used, it is assumed that 3dB can be subtracted from the measurement. Or if a reference is used which is known to have much lower noise than the UUT, then the measured noise is primarily just due to the UUT. But very sensitive phase noise analyzers are now available which can take the input directly from a single UUT and with the push of a button accurately characterize the phase noise over a wide frequency range with noise floors lower than -170dBc/Hz.

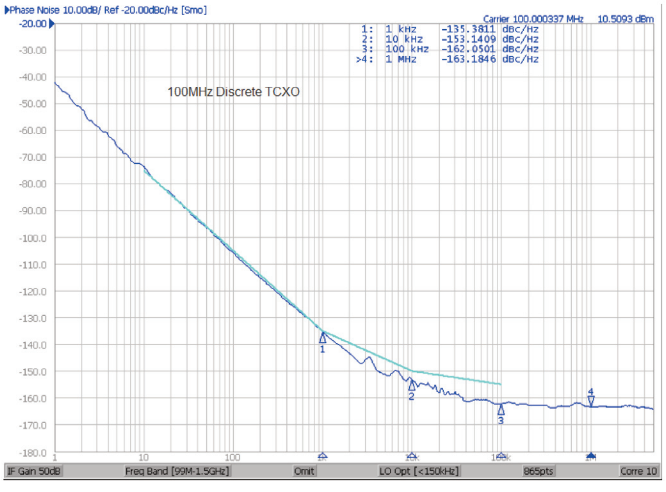
TYPICAL CRYSTAL OSCILLATOR PHASE NOISE

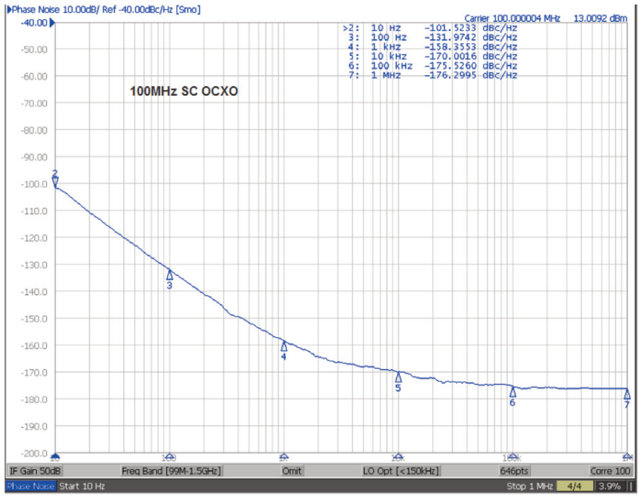
The graphs here show the typical phase noise performance of some common crystal oscillators. The first graph is from a miniature 10 MHz TCXO. This performance is typical for small low-cost units, measuring about -100dBc/Hz at 10 Hz offset from the carrier with a noise floor of -156dBc/Hz. When much lower phase noise is needed, an OCXO is often specified. The second graph shows the noise of a 10 MHz OCXO. These units employ a very high-Q SC cut crystal for much lower noise close to the carrier, achieving -100dBc/Hz only 1 Hz from the carrier. Low noise discrete circuitry then lowers the noise floor to -170dBc/Hz.

As the oscillator frequency increases, the phase noise at a given offset increases proportionally. The graphs at the bottom illustrate the difference between a typical TCXO and OCXO at 100 MHz.









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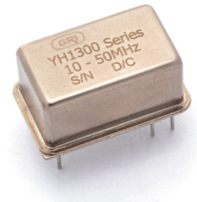
YH1300

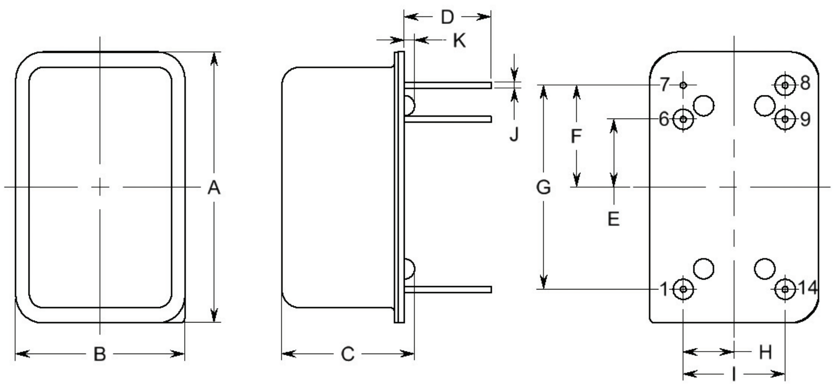
OCXO

➤ *LOW PHASE NOISE*
ULTRA-LOW G-SENSITIVITY



Frequency	10.0 MHz to 50.0 MHz		
Output	CMOS Square Wave (C option) Sine Wave (S option)		
Symmetry	50% ± 10% (Square Wave)		
Output Load	CMOS: 15 pF typ		
Harmonics	-20 dBc (Sine Wave)		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	-10°C to +60°C	± 0.2 ppm	G27
	-20°C to +70°C	± 0.3 ppm	N37
	-40°C to +70°C	± 0.4 ppm	S47
	-40°C to +85°C	± 0.5 ppm	T57
Aging	< 0.5 ppm/yr		
Frequency vs. Supply	± 3 x 10^{-9} for a 5% change		
Frequency Adjust	± 5.0 ppm typ, positive slope; 0 to V_{supply} EFC		
Input Voltage	+5.0 VDC or +3.3 VDC (at turn-on voltage must rise to > 3 V within 15 msec)		
Input Power	Warmup: < 3 W for 5 minutes; Idle: < 1.0 W @ +25°C		
Phase Noise	10 Hz	-97 dBc/Hz	
(typ @ 50 MHz, 5 V)	100 Hz	-125 dBc/Hz	
	1 kHz	-149 dBc/Hz	
	10 kHz	-155 dBc/Hz	
	100 kHz	-158 dBc/Hz	
	1M	-165 dBc/Hz	
Acceleration Sensitivity	< 7 x 10^{-11}/g, worst axis, DC to 2 kHz		

For RFQ specify: Model - Stability - Output - Supply Voltage - Frequency
Example: **YH1300 - N37 - S - 5.0 - 10.0 MHz**



DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	0.800	20.32	0.820	20.83
B	0.50	12.70	0.520	13.21
C	NA	NA	0.358	9.09
D	0.220	5.59	0.240	6.10
E	0.200	5.08	0.210	5.33
F	0.300	7.62	0.310	7.87
G	0.600	15.24	0.610	15.49
H	0.150	3.81	0.160	4.06
I	0.300	7.62	0.310	7.87
J	ø0.018	ø0.46	ø0.021	ø0.53
K	R0.020	R0.51	R0.030	R0.76

PAD CONNECTIONS

1. EFC
7. 0V & CASE GND
8. OUTPUT
14. SUPPLY VOLTAGE

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YH1310

➤ *LOW PHASE NOISE*
COMPACT EURO PACKAGE

OCXO

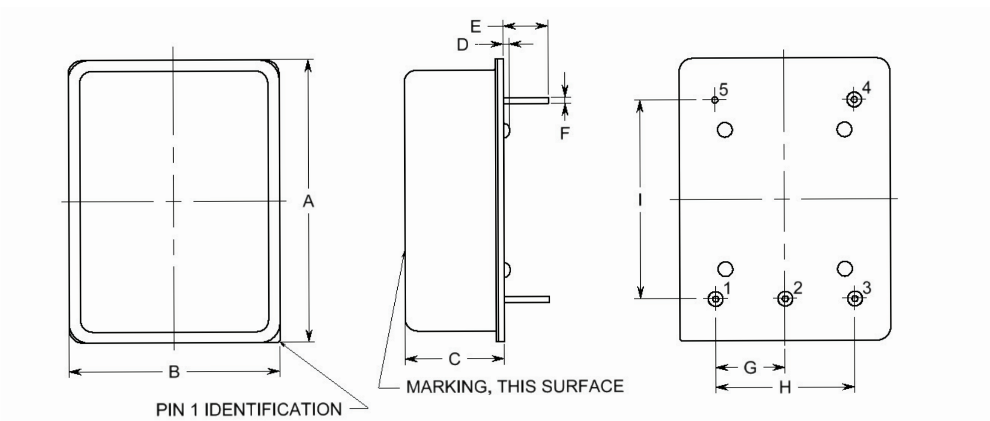
Frequency	10.0 MHz to 100.0 MHz		
Output	Sine Wave (YH1310); CMOS (YH1311)		
Symmetry	50% ± 10%		
Output Load	CMOS: 15 pF typ		
Harmonics	-20 dBc (Sine Wave)		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
(other stabilities available)	0°C to +50°C	± 0.2 ppm	B28
	-20°C to +70°C	± 0.3 ppm	N38
	-40°C to +85°C	± 0.5 ppm	T58
Aging	± 0.1 ppm/yr (10 MHz)		
Frequency vs. Supply	± 5 x 10^{-9} for a 5% change		
Frequency Adjust	± 1.0 ppm typ, positive slope; +0.5 to +4.5 V EFC		
Input Voltage	+5.0 VDC or +12 VDC ± 5%		
Input Power	Warmup: < 6 W for 5 minutes; Idle: < 2.0 W @ +25°C		
Warm-up Time	within ± 5×10^{-8} in 5 minutes, ref to 60 minute frequency @ +25°C		

Phase Noise

	10 MHz
10 Hz	-118 dBc/Hz
100 Hz	-140 dBc/Hz
1 kHz	-150 dBc/Hz
10 kHz	-157 dBc/Hz
100 kHz	-158 dBc/Hz
1M kHz	-160 dBc/Hz

MODEL	OUTPUT
YH1310	Sine Wave
YH1311	Square Wave, CMOS

For RFQ specify: Model - Stability - Supply Voltage - Frequency
Example: **YH1310 - N38 - 5.0 - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	1.420	36.07	1.620	41.15
B	1.060	26.92	1.260	32.00
C	0.516	13.11	0.542	13.77
D	0.026	0.66	0.032	0.81
E	0.230	5.84	0.260	6.60
F	0.032	0.81	0.034	0.86
G	0.350	8.89	0.360	9.14
H	0.700	17.78	0.710	18.03
I	1.000	25.40	1.010	25.65

PAD CONNECTIONS
1. EFC
2. Vref
3. SUPPLY VOLTAGE
4. OUTPUT
5. 0V & CASE GND

AS 9100D

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YH1320

OCXO

➤ *LOW PHASE NOISE*
HCMOS OR SINE WAVE OUTPUT

Frequency	10.0 MHz to 120.0 MHz		
Output	YH1320: Square Wave, CMOS		
	YH1321: Sine Wave; +10 dBm min into 50Ω		
Harmonics	-20 dBc		
Temp Stability (other stabilities available)	**Temp Range**	**10 MHz Tol / Option**	**100 MHz Tol / Option**
	0°C to +50°C	± 0.01 ppm / B18	± 0.05 ppm / B58
	-10°C to +60°C	± 0.015 ppm / G158	± 0.07 ppm / G78
	-20°C to +70°C	± 0.02 ppm / N28	± 0.1 ppm / N17
	-40°C to +85°C	± 0.05 ppm / T58	± 0.3 ppm / T37
Aging	$\pm 1\times10^{-7}$ per year (10 MHz); $\pm 5\times10^{-7}$ per year (100 MHz)		
Frequency vs. Supply	$\pm 5 \times 10^{-9}$ for a 5% change		
Frequency Adjust	± 1.0 ppm typ, positive slope; +0.5 to +5.0 V EFC		
Input Voltage	+15.0 VDC ± 5%, Option C; +12.0 VDC ± 5%, Option D		
Input Power	Warmup: < 6 W for 5 minutes; Idle: < 2.5 W @ +25°C		
Warm-up Time	within $\pm 5\times10^{-8}$ in 5 minutes, ref to 60 minute frequency @ +25°C		

Phase Noise (Sine max)

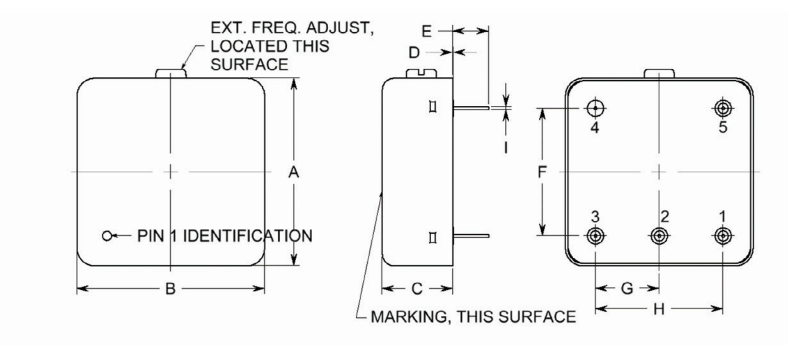
	10 MHz Std	**10 MHz Ultra-Low**	**100 MHz Std**	**100 MHz Ultra-Low**
10 Hz	-125 dBc/Hz	-128 dBc/Hz	-85 dBc/Hz	-90 dBc/Hz
100 Hz	-150 dBc/Hz	-155 dBc/Hz	-115 dBc/Hz	-120 dBc/Hz
1 kHz	-160 dBc/Hz	-163 dBc/Hz	-145 dBc/Hz	-150 dBc/Hz
10 kHz	-165 dBc/Hz	-168 dBc/Hz	-160 dBc/Hz	-165 dBc/Hz
100 kHz	-165 dBc/Hz	-168 dBc/Hz	-165 dBc/Hz	-165 dBc/Hz

Environmentals

Shock	per MIL-STD-202, Meth 213, Cond C
Vibration	per MIL-STD-202, Meth 204, Cond A

MODEL	OUTPUT
YH1320	Square Wave, CMOS
YH1321	Sine Wave (+10 dBm min into 50 ohms)

For RFQ specify: Model - Stability - Phase Noise - Supply Voltage - Frequency
Example: **YH1321 - N28 - UL - D - 10.0 MHz**



PAD CONNECTIONS
1. EFC
2. N/C
3. OUTPUT
4. 0V & CASE GND
5. SUPPLY VOLTAGE

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	2.000	50.80	2.040	51.82
B	2.000	50.80	2.040	51.82
C	0.750	19.05	0.790	20.07
D	NA	NA	0.030	0.76
E	0.240	6.10	0.28	7.11
F	1.360	34.54	1.375	34.93
G	0.680	17.27	0.695	17.65
H	1.360	34.54	1.375	34.93
I	0.030	0.76	0.033	0.84

9100D

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YH1322

OCXO

➤ *LOW PHASE NOISE OPTION*
SMA CONNECTOR

Frequency	10.0 MHz to 120.0 MHz		
Output	Sine Wave; +10 dBm min into 50Ω		
Harmonics	-20 dBc (Sine Wave)		
Temp Stability	**Temp Range**	**10 MHz Tol / Option**	**100 MHz Tol / Option**
(other stabilities available)	0°C to +50°C	± 0.01 ppm / B18	± 0.05 ppm / B58
	-10°C to +60°C	± 0.015 ppm / G158	± 0.07 ppm / G78
	-20°C to +70°C	± 0.02 ppm / N28	± 0.1 ppm / N17
	-40°C to +85°C	± 0.05 ppm / T58	± 0.3 ppm / T37

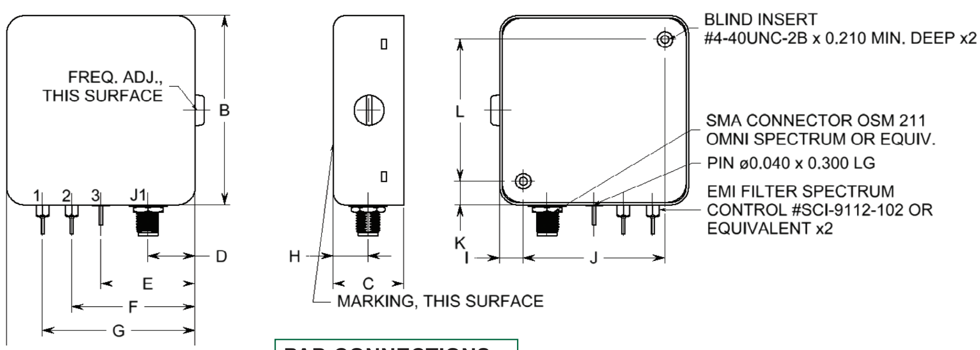
Aging ± 0.1 ppm/yr (10 MHz); ± 0.5 ppm/yr (100 MHz)
Frequency vs. Supply ± 5 x 10^{-9} for a 5% change
Frequency Adjust ± 1.0 ppm typ, positive slope; 0.5 to +5.0 V EFC
Input Voltage +12.0 VDC ± 5%
Input Power Warmup: < 6 W for 5 minutes; Idle: < 2.5 W @ +25°C
Warm-up Time within ± 5x10^{-8} in 5 minutes, ref to 60 minute frequency @ +25°C

Phase Noise (Sine max)

	10 MHz Std	**10 MHz Ultra-Low**	**100 MHz Std**	**100 MHz Ultra-Low**
10 Hz	-125 dBc/Hz	-128 dBc/Hz	-85 dBc/Hz	-90 dBc/Hz
100 Hz	-150 dBc/Hz	-155 dBc/Hz	-115 dBc/Hz	-120 dBc/Hz
1 kHz	-160 dBc/Hz	-163 dBc/Hz	-145 dBc/Hz	-150 dBc/Hz
10 kHz	-165 dBc/Hz	-168 dBc/Hz	-160 dBc/Hz	-165 dBc/Hz
100 kHz	-165 dBc/Hz	-168 dBc/Hz	-165 dBc/Hz	-165 dBc/Hz

Environmentals
Shock (optional) per MIL-STD-202, Meth 213, Cond C
Vibration (optional) per MIL-STD-202, Meth 204, Cond A

For RFQ specify: Model - Stability - Phase Noise - Frequency
Example: **YH1322 - N17 - UL - 100.0 MHz**



PAD CONNECTIONS
1. EFC
2. SUPPLY VOLTAGE
3. 0V & CASE GND
J1. OUTPUT

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	2.000	50.80	2.040	51.82
B	2.000	50.80	2.040	51.82
C	0.750	19.05	0.790	20.07
D	0.500	12.70	0.515	13.08
E	1.000	25.40	1.015	25.78
F	1.310	33.27	1.325	33.66
G	1.620	41.15	1.635	41.53
H	0.370	9.40	0.385	9.78
I	0.250	6.35	0.265	6.73
J	1.500	38.10	1.515	38.48
K	0.250	6.35	0.265	6.73
L	1.500	38.10	1.515	38.48

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YH1420

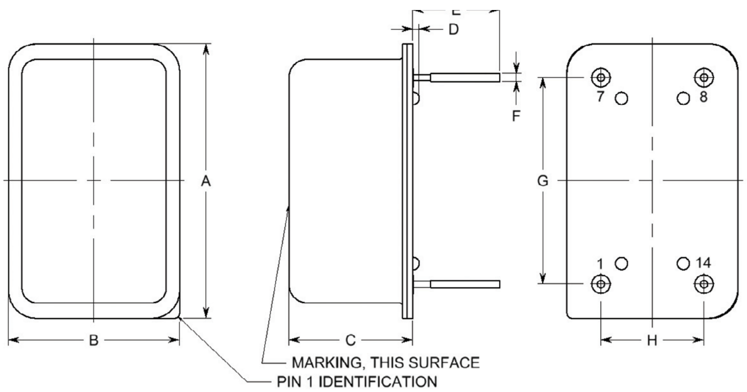
OCXO

➤ *MINIATURE DIP PACKAGE*
GOOD TEMP STABILITY

Frequency	10.0 MHz to 120.0 MHz	
Output	Square Wave, CMOS	
Symmetry	50% ± 10% (Square Wave)	
Harmonics	-20 dBc (Sine Wave)	
Temp Stability	**Temp Range**	**SC Tolerance / Option**
(other stabilities available)	0°C to +60°C	± 0.1 ppm / G17
	-20°C to +70°C	± 0.2 ppm / N27
	-40°C to +85°C	± 0.3 ppm / T37
Aging	< 0.5 ppm/yr	
Frequency vs. Supply	± 3 x 10^{-9} for a 5% change	
Frequency Adjust	± 5.0 ppm typ, positive slope; 0 to V_{supply} EFC	
Input Voltage	+5.0 VDC or +3.3 VDC	
Input Power	Warmup: < 3 W for 5 minutes; Idle: < 1.0 W @ +25°C	
Phase Noise (typ @ 10 MHz)	10 Hz	-110 dBc/Hz
	100 Hz	-135 dBc/Hz
	1 kHz	-155 dBc/Hz
	10 kHz	-158 dBc/Hz
	100 kHz	-158 dBc/Hz

MODEL	OUTPUT
YH1420	Square Wave, CMOS
YH1421	Sine Wave (0 dBm min into 50 Ω)

For RFQ specify: Model - Stability - Supply Voltage - Frequency
Example: **YH1420 - N27 - 5.0 - 100.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.800	20.32	0.820	20.83
B	0.500	12.70	0.520	13.21
C	NA	NA	0.370	9.40
D	0.031	0.79	0.036	0.91
E	0.220	5.59	0.240	6.10
F	ø0.018	ø0.46	ø0.023	ø0.58
G	0.600	15.24	0.605	15.37
H	0.300	7.62	0.305	7.75

PAD CONNECTIONS

1. EFC
7. 0V & CASE GND
8. OUTPUT
14. SUPPLY VOLTAGE

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YH1440

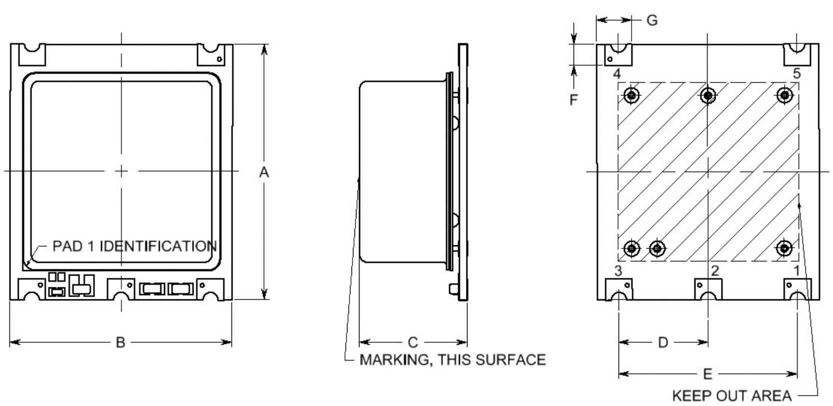
OCXO

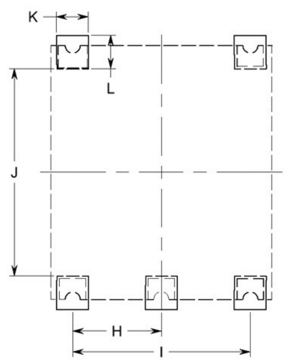
➤ *MINIATURE SMT PACKAGE*
STRATUM 3 COMPLIANT

Frequency	10.0 MHz to 100.0 MHz	
Output	Square Wave, CMOS	
Harmonics	-20 dBc (Sine Wave)	
Temp Stability	**Temp Range**	**SC Tolerance / Option**
(other stabilities available)	0°C to +50°C	± 0.1 ppm / B17
	-10°C to +60°C	± 0.15 ppm / G157
	-20°C to +70°C	± 0.2 ppm / N27
	-40°C to +70°C	± 0.5 ppm / S57
Aging	± 2 x 10^{-9} per day after 30 days (10 MHz typ)	
Frequency vs. Supply	± 3 x 10^{-9} for a 5% change	
Frequency Adjust	± 5.0 ppm typ, positive slope; 0 to +3.3 V or +5.0 V EFC	
Input Voltage	+5.0 VDC, +3.3 VDC, +12.0 VDC and +15.0 VDC	
Input Power	Warmup: < 5 W for 5 minutes; Idle: < 2.0 W max @ +25°C	
Phase Noise		
(typ @ 100 MHz)	10 Hz	-80 dBc/Hz
	100 Hz	-110 dBc/Hz
	1 kHz	-140 dBc/Hz
	10 kHz	-155 dBc/Hz
	100 kHz	-160 dBc/Hz

MODEL	OUTPUT
YH1440	Square Wave, CMOS
YH1441	Sine Wave (0 dBm min into 50 Ω)

For RFQ specify: Model - Stability - Supply Voltage - Frequency
Example: **YH1440 - N27 - 5.0 - 100.0 MHz**





RECOMMENDED LAND PATTERN

PAD CONNECTIONS
1. EFC
2. N/C
3. SUPPLY VOLTAGE
4. OUTPUT
5. 0V & CASE GND

DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
A	1.000	25.40	1.020	25.91
B	0.870	22.10	0.890	22.61
C	NA	NA	0.450	11.40
D	0.350	8.90	0.360	9.14
E	0.700	17.78	0.710	18.03
F	0.082	2.08	NA	NA
G	0.105	2.67	NA	NA

LAND PATTERN DIMENSIONS

	TYP		MAX	
DIM	in.	mm	in.	mm
H	0.350	8.90	NA	NA
I	0.700	17.78	NA	NA
J	0.817	20.75	NA	NA
K	0.126	3.20	NA	NA
L	0.132	3.35	NA	NA

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YH1460

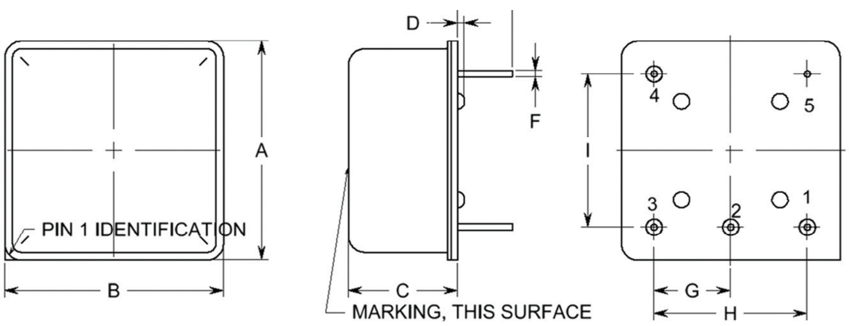
OCXO

➤ *EXCELLENT TEMP STABILITY*
MINIATURE PACKAGE

Frequency	10.0 MHz to 100.0 MHz		
Output	Sine Wave; +7 dBm ±2 dBm into 50 Ω; +4 dBm for a 3.3 V supply		
Harmonics	-20 dBc (Sine Wave)		
Temp Stability	**Temp Range**	**10 MHz Tol / Option**	**100 MHz Tol / Option**
	0°C to +50°C	± 0.01 ppm / B18	± 0.05 ppm / B58
	-10°C to +60°C	± 0.01 ppm / G18	± 0.07 ppm / G78
	-20°C to +70°C	± 0.02 ppm / N28	± 0.1 ppm / N17
	-40°C to +85°C	± 0.02 ppm / T28	± 0.3 ppm / T37
Aging	± 0.1 ppm/yr (10 MHz); ± 0.5 ppm/yr (100 MHz)		
Frequency vs. Supply	± 1 x 10^{-9} for a 5% change		
Frequency Adjust	± 1.0 ppm typ, positive slope; +0.5 to +4.5 V EFC		
Input Voltage	+5.0 VDC, +3.3 VDC, +12.0 VDC and +15.0 VDC Note: specs are degraded for 3.3 V supply; available temp to -20 to +70°C		
Input Power	Warmup: < 5 W for 5 minutes; Idle: < 1.5 W typ @ +25°C		
Warm-up Time	within ± 5 x 10^{-8} in 5 minutes, ref to 60 minute frequency @ +25°C		
Phase Noise		**10 MHz**	**100 MHz**
	10 Hz	-125 dBc/Hz	-90 dBc/Hz
	100 Hz	-145 dBc/Hz	-120 dBc/Hz
	1 kHz	-155 dBc/Hz	-145 dBc/Hz
	10 kHz	-160 dBc/Hz	-155 dBc/Hz
	100 kHz	-160 dBc/Hz	-160 dBc/Hz
Acceleration Sensitivity	≤ 2 x 10^{-9}/g worst axis (SD); ≤ 5 x 10^{-10}/g available with 0.6” high package (LG)		

MODEL	**OUTPUT**
YH1460	Sine Wave
YH1461	Square Wave, CMOS

For RFQ specify: Model - Stability - Supply Voltage - g-Sensitivity - Frequency
Example: **YH1460 - N28 - 5.0 - LG - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	NA	NA	1.030	26.16
B	NA	NA	1.030	26.16
C	NA	NA	0.500	12.70
D	0.026	0.66	NA	NA
E	0.250	6.35	0.270	6.86
F	ø0.030	ø0.76	ø0.032	ø0.81
G	0.350	8.89	0.360	9.14
H	0.700	17.78	0.710	18.03
I	0.700	17.78	0.710	18.03

PAD CONNECTIONS

1. EFC
2. N/C
3. SUPPLY VOLTAGE
4. OUTPUT
5. 0V & CASE GND

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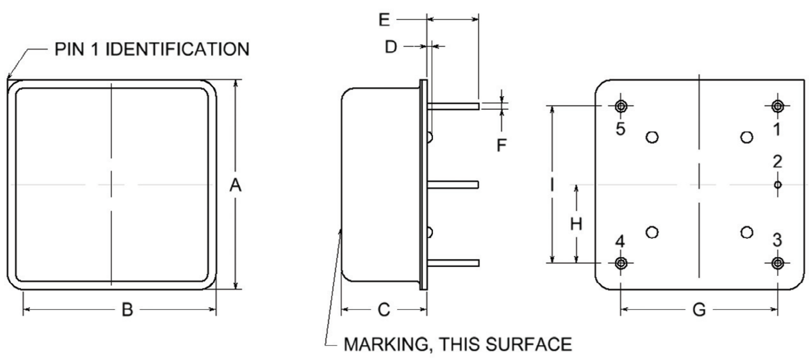
YH1485

OCXO

➤ *ULTRA-LOW PHASE NOISE*
LOW G-SENSITIVITY OPTION

Frequency	10.0 MHz to 100.0 MHz	
Output	Sine Wave; +10 dBm ± 2 dBm into 50 Ω	
Harmonics	-30 dBc	
Spurious	-80 dBc	
Initial Accuracy	within ± 0.25 ppm @ +25°C and +2.5 VDC EFC	
Temp Stability	**Temp Range**	**Tolerance / Option**
	-20°C to +70°C	± 0.05 ppm / N58
	-20°C to +70°C	± 0.1 ppm / N17
	-40°C to +85°C	± 0.1 ppm / T17
	-40°C to +85°C	± 0.3 ppm / T37
Aging	< 0.1 ppm/yr; 0.5 ppm for 10 yrs (10 MHz); < 0.5 ppm/yr (100 MHz)	
Frequency vs. Supply	± 5 x 10^{-9} for a 5% change	
Frequency vs. Load	± 5 x 10^{-9} for a 10% change	
Frequency Adjust	± 0.75 ppm typ, positive slope; 0 to +5 V, center @ +2.5 VDC	
Input Voltage	+5.0 VDC, +3.3 VDC, +12.0 VDC and +15.0 VDC	
Input Power	Warmup: < 5 W for 5 minutes; Idle: < 2.0 W typ @ +25°C	
Warm-up Time	within ± 1 x 10^{-7} in 5 minutes	
Phase Noise	10 Hz	-128 dBc/Hz
(typ @ +25°C, static)	100 Hz	-152 dBc/Hz
	1 kHz	-165 dBc/Hz
	10 kHz	-173 dBc/Hz
	100 kHz	-176 dBc/Hz
	1 MHz	-180 dBc/Hz
Acceleration Sensitivity	< 1 x 10^{-9}/g worst axis (SD), < 5 x 10^{-10}/g (LG)	
Environmentals	*Shock*	per MIL-STD-202, Meth 213, Cond C
	Vibration	per MIL-STD-202, Meth 204, Cond A
		& per MIL-STD-810, Meth 514, Cond A

For RFQ specify: Model - Stability - Supply Voltage - g-Sens - Frequency
Example: **YH1485 - T17 - 12.0 - LG - 100.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.996	25.30	1.000	25.4
B	0.996	25.30	1.000	25.4
C	NA	NA	0.530	13.46
D	0.026	0.65	0.032	0.80
E	0.244	6.20	0.264	6.70
F	NA	NA	ø0.032	ø0.80
G	0.750	19.05	0.758	9.25
H	0.375	9.53	0.382	9.70
I	0.750	19.05	0.758	19.25

PAD CONNECTIONS

1. OUTPUT
2. 0V & CASE GND
3. EFC
4. N/C
5. SUPPLY V

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N623

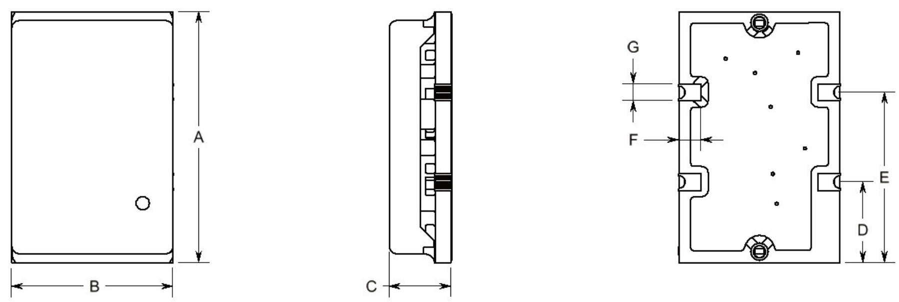
VCXO

➤ *ULTRA-LOW PHASE NOISE*

Frequency	100 MHz (25°C set point)		
Absolute Pull Range	±10 ppM min for all conditions for 10 years		
Frequency vs. Temp	-40°C to +85° ±15 ppM typ		
Frequency vs. Supply	±0.25 V (± 1 ppM typ)		
Aging	<1 ppM/yr typ		
EFC/Frequency Pull	0 V to 5 V @25°C/±30 ppM typ		
EFC Linearity	EFC: 0.5 to 4.5 V; <10% typ		
Output	Sine Wave (50 Ω load typ)		
Power Level	+12 dBm typ; +9.5 dBm min, +14.5 dBm max		
Harmonics	-30 dBc		
Input Voltage	+5.0 VDC typ, ±5%		
Supply Current	30 mA		
Phase Noise		**TYP**	**MAX**
	10 Hz	-85 dBc/Hz	-80 dBc/Hz
	100 Hz	-115 dBc/Hz	-110 dBc/Hz
	1 kHz	-140 dBc/Hz	-135 dBc/Hz
	10 kHz	-162 dBc/Hz	-158 dBc/Hz
	100 kHz	-173 dBc/Hz	-170 dBc/Hz
	1 M	-175dBc/Hz	-173 dBc/Hz

Environmentals	Operating Temp Range	-40 to +85 °C
	Storage Temp Range	-45 to +95 °C
	Random Vibration:	per MIL-STD-202, Meth 214, Cond A
	Mechanical Shock:	per MIL-STD-202, Meth 213, Cond C

For RFQ specify: Model - Frequency
Example: **N623 - 100.0 MHz**



PAD CONNECTIONS

1. EFC
2. GND
3. OUTPUT
4. VDD

DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.560	14.22	0.570	14.47
B	0.360	9.14	0.370	9.39
C	0.136	3.45	0.146	3.70
D	0.180	4.57	0.190	4.82
E	0.380	9.65	0.390	9.90
F	0.050	1.27	NA	NA
G	0.038	0.97	NA	NA

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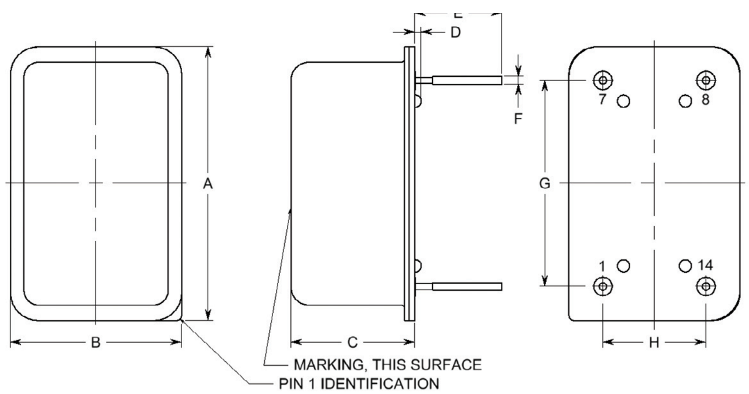
Y1600

XO

➤ *GOOD PHASE NOISE PERFORMANCE*
RUGGED, COMPACT PACKAGE

Frequency	10.0 MHz to 100.0 MHz		
Output	HCMOS		
Load	10 to 15 pF		
Symmetry	50% ± 5%		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
	0°C to +50°C	± 5.0 ppm	B56
	-20°C to +70°C	± 10.0 ppm	N106
	-40°C to +85°C	± 15.0 ppm	T156
Initial Accuracy	within ±3 ppM of nominal @ +2.5 V EFC		
Aging	<±1 ppM 1st year; <3 ppM for 10 yrs (10 MHz)		
Input Voltage	+5.0 VDC ± 5%		
Input Current	< 15 mA (10 MHz)		
Phase Noise (typ @ 10 MHz)	10 Hz	-105 dBc/Hz	
	100 Hz	-135 dBc/Hz	
	1 kHz	-155 dBc/Hz	
	10 kHz	-160 dBc/Hz	
	100 kHz	-162 dBc/Hz	
Frequency Adjust	±10 ppM typ; positive slope 0.5 V to +4.5 V EFC		
Environmentals	*Random Vibration*	per MIL-STD-202, Meth 214, Cond IA	
	Shock	per MIL-STD-202, Meth 213, Cond C	
	Storage Temp	-55°C to +85°C	

For RFQ specify: Model - Temp Stability - Supply Voltage - Frequency
Example: **Y1600 - N106 - 5.0 - 10.0 MHz**



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.800	20.32	0.820	20.83
B	0.500	12.70	0.520	13.21
C	NA	NA	0.370	9.40
D	0.031	0.79	0.036	0.91
E	0.220	5.59	0.240	6.10
F	ø0.018	ø0.46	ø0.023	ø0.58
G	0.600	15.24	0.605	15.37
H	0.300	7.62	0.305	7.75

PAD CONNECTIONS
1. EFC
7. 0V & CASE GND
8. OUTPUT
14. SUPPLY VOLTAGE

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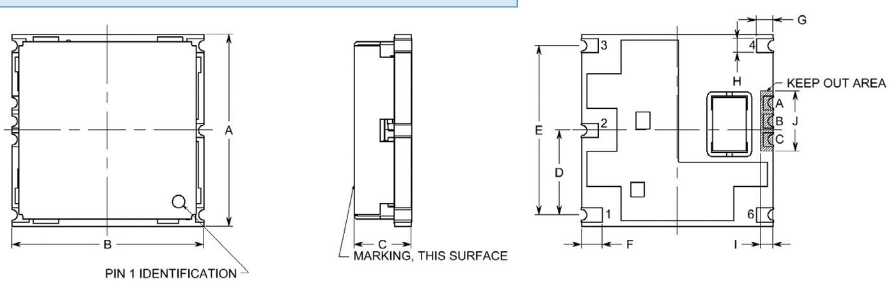
Y1631

➤ *EXCELLENT PHASE NOISE PERFORMANCE*
ULTRA-LOW G-SENSITIVITY

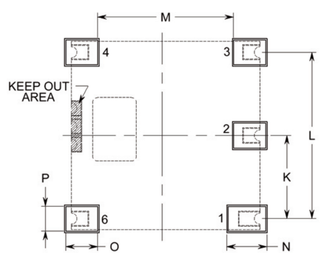
XO

Frequency	60.0 MHz to 130.0 MHz		
Output	Sinewave		
Load	50 Ω typ		
Output Level	+10 dBm min into 50 Ω load		
Harmonic & Subs	-45 dBc max		
Spurious	-90 dBc max		
Temp Stability	**Temp Range**	**Tolerance**	**Option**
	-20°C to +70°C	± 15.0 ppm	N
	-40°C to +85°C	± 20.0 ppm	T
Initial Accuracy	within ±3 ppM of nominal @ +2.5 V EFC		
Aging	<±2 ppM 1st year; <10 ppM for 10 yrs		
Input Voltage	+5.0 VDC ± 5%		
Input Current	30 mA max		
Phase Noise (typ @ 60 MHz)	10 Hz	-83 dBc/Hz	
	100 Hz	-120 dBc/Hz	
	1 kHz	-149 dBc/Hz	
	10 kHz	-160 dBc/Hz	
	100 kHz	-167 dBc/Hz	
	1 kHz	-170 dBc/Hz	
Frequency Adjust	±10 ppM typ; positive slope 0.5 V to +4.5 V EFC		
Environmentals	*Random Vibration*	per MIL-STD-202F, Meth 214, Cond IA (0.3 PSD, 20.7G RMS)	
	Shock	per MIL-STD-202F, Meth 213K, Cond C (30 g peak sawtooth, 11 mS)	
	Storage Temp	-55°C to +105°C	

For RFQ specify: Model - Temp Stability - Frequency
Example: **Y1631 - N - 60.0 MHz**



RECOMMENDED LAND PATTERN



DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
A	0.680	17.27	0.695	17.63
B	0.680	17.27	0.695	17.63
C	0.200	5.08	0.215	5.46
D	0.300	7.62	0.315	8.00
E	0.600	15.24	0.615	15.62
F	0.075	1.91	NA	NA
G	0.060	1.52	NA	NA
H	0.050	1.27	NA	NA
I	0.045	1.14	NA	NA
J	0.212	5.38	0.227	5.77

PAD CONNECTIONS

1. OUTPUT
2. N/C
3. SUPPLY
4. OUTPUT
6. 0V & CASE GND
A. SCLK (Internal Use Only)
B. DIO (Internal Use Only)
C. CS (Internal Use Only)

LAND PATTERN DIMENSIONS

DIM	TYP in.	TYP mm	MAX in.	MAX mm
K	0.300	5.62	NA	NA
L	0.600	15.24	NA	NA
M	0.490	12.45	NA	NA
N	0.145	3.68	NA	NA
O	0.115	2.92	NA	NA
P	0.090	2.29	NA	NA

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