Precision Crystal Oscillators for Industry & Defense

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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.
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
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.


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: \( f(\vec{a}) = f(1, \vec{Γ} \cdot \vec{a}) \) where \( f \) is the carrier frequency with no acceleration, \( Γ \) 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 deviation 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:  
\[
50 \text{ dBc} \left( \frac{\vec{a} \times \vec{Γ} \times f_{\text{os}}}{f_{c}} \right) 
\]

Solving for \( \vec{Γ} \) gives \( \vec{Γ} \left( \frac{\text{50 dBc}}{\vec{a} \times f_{\text{os}}} \right) \times 10^{-9} \frac{\text{ppb}}{\text{g}} \) where \( \vec{a} \) is the peak magnitude of the vibration force in the direction of \( \vec{Γ} \) being measured, \( f_{c} \) is the frequency of the
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 g²/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 $f_v$:

$$L(f_v) \approx 20 \log \left[ \frac{f_{nom}}{f_v} \frac{PSD}{g^2} \right]$$

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 $\Gamma$ 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 $5 \times 10^{-11}$ per g.

The graphs below illustrate the comparison of a Greenray g-comp'ed TCXOs vs. a standard TCXO under the same vibration profile.
**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<sub>pp</sub> 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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.1 ppm</td>
<td>N17</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.5 ppm</td>
<td>T57</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 1.0 ppm</td>
<td>T16</td>
</tr>
</tbody>
</table>

**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<sub>CC</sub> applied to EFC pin, positive slope

**Acceleration Sensitivity**
≤ 2 x 10<sup>-9</sup>/g (Standard “SD”); ≤ 7 x 10<sup>-10</sup>/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

---

**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**

<table>
<thead>
<tr>
<th>PAD 6</th>
<th>Enable/Disable Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>Supply</td>
</tr>
<tr>
<td>OPEN</td>
<td>N/C</td>
</tr>
<tr>
<td>LOW</td>
<td>GND</td>
</tr>
<tr>
<td></td>
<td>Output Enabled</td>
</tr>
<tr>
<td></td>
<td>High Impedance Disabled</td>
</tr>
</tbody>
</table>

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.197</td>
<td>5.00</td>
</tr>
<tr>
<td>B</td>
<td>0.126</td>
<td>3.20</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>0.046</td>
<td>1.17</td>
</tr>
<tr>
<td>E</td>
<td>0.035</td>
<td>0.89</td>
</tr>
<tr>
<td>F</td>
<td>0.016</td>
<td>0.41</td>
</tr>
<tr>
<td>G</td>
<td>0.038</td>
<td>0.97</td>
</tr>
</tbody>
</table>

**LAND PATTERN DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>0.147</td>
<td>3.73</td>
</tr>
<tr>
<td>I</td>
<td>0.126</td>
<td>3.20</td>
</tr>
<tr>
<td>J</td>
<td>0.047</td>
<td>1.19</td>
</tr>
<tr>
<td>K</td>
<td>0.049</td>
<td>1.25</td>
</tr>
<tr>
<td>L</td>
<td>0.047</td>
<td>1.19</td>
</tr>
<tr>
<td>M</td>
<td>0.051</td>
<td>1.30</td>
</tr>
<tr>
<td>N</td>
<td>0.019</td>
<td>0.48</td>
</tr>
</tbody>
</table>

---

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**T70**

**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<sub>pp</sub> 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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10°C to +60°C</td>
<td>± 0.1 ppm</td>
<td>G17</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.1 ppm</td>
<td>N17</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.3 ppm</td>
<td>T37</td>
</tr>
<tr>
<td>-55°C to +95°C</td>
<td>± 1.0 ppm</td>
<td>V16</td>
</tr>
</tbody>
</table>

(Other stabilities available)

**Aging**
< 0.5 ppm/yr (10 MHz typ)

**Frequency Adjust**
± 7 ppm typ; 0 V to V<sub>cc</sub> applied to EFC pin, positive slope

**Acceleration Sensitivity**
≤ 2.5 x 10<sup>-9</sup>/g (Standard “SD”); ≤ 7 x 10<sup>-10</sup>/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

**Environmental**

- **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

---

**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**

<table>
<thead>
<tr>
<th>PAD 5</th>
<th>Enables/Disable Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH (Supply)</td>
<td>Output Enabled</td>
</tr>
<tr>
<td>OPEN (N/C)</td>
<td>Output Enabled</td>
</tr>
<tr>
<td>LOW (GND)</td>
<td>High Impedance Disabled</td>
</tr>
</tbody>
</table>

---

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.275</td>
<td>7.00</td>
</tr>
<tr>
<td>B</td>
<td>0.197</td>
<td>5.00</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>0.100</td>
<td>2.54</td>
</tr>
<tr>
<td>E</td>
<td>0.200</td>
<td>5.08</td>
</tr>
<tr>
<td>F</td>
<td>0.025</td>
<td>0.64</td>
</tr>
<tr>
<td>G</td>
<td>0.033</td>
<td>0.84</td>
</tr>
<tr>
<td>H</td>
<td>0.035</td>
<td>0.89</td>
</tr>
<tr>
<td>I</td>
<td>0.050</td>
<td>1.27</td>
</tr>
<tr>
<td>J</td>
<td>0.135</td>
<td>3.43</td>
</tr>
</tbody>
</table>

---

**RECOMMENDED LAND PATTERN**

---

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

---

**9100D**

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**T90**

**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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.5 ppm</td>
<td>N57</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 1.0 ppm</td>
<td>T16</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.5 ppm</td>
<td>T57</td>
</tr>
<tr>
<td>-55°C to +95°C</td>
<td>± 2.0 ppm</td>
<td>V26</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>INPUT V</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>T90</td>
<td>+5.0 V</td>
<td>CMOS</td>
</tr>
<tr>
<td>T91</td>
<td>+3.3 V</td>
<td>CMOS</td>
</tr>
</tbody>
</table>

**For RFQ specify:**
Model - Stability - Frequency

**Example:**
T90- N57 - 20.0 MHz

---

**PAD CONNECTIONS**

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

---

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.380</td>
<td>9.14</td>
</tr>
<tr>
<td>B</td>
<td>0.295</td>
<td>7.49</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>0.100</td>
<td>2.54</td>
</tr>
<tr>
<td>E</td>
<td>0.040</td>
<td>1.02</td>
</tr>
<tr>
<td>F</td>
<td>0.020</td>
<td>0.51</td>
</tr>
<tr>
<td>G</td>
<td>0.018</td>
<td>0.46</td>
</tr>
<tr>
<td>H</td>
<td>0.040</td>
<td>1.02</td>
</tr>
<tr>
<td>I</td>
<td>0.014</td>
<td>R0.36</td>
</tr>
<tr>
<td>J</td>
<td>0.057</td>
<td>1.45</td>
</tr>
</tbody>
</table>

---

**LAND PATTERN DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.100</td>
<td>2.54</td>
</tr>
<tr>
<td>K</td>
<td>0.196</td>
<td>4.96</td>
</tr>
<tr>
<td>L</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>M</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>N</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>O</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>P</td>
<td>0.077</td>
<td>1.52</td>
</tr>
<tr>
<td>Q</td>
<td>0.020</td>
<td>1.52</td>
</tr>
</tbody>
</table>

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**T121**

**LOW G-SENSITIVITY, TIGHT STABILITY**

**RUGGED PACKAGE**

---

**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: -55°C to +95°C
- Tolerance: ± 3.0 ppm
- Option: 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**
- Offset (typ @ 100 MHz)
  - 10 Hz: -75 dBc/Hz
  - 100 Hz: -102 dBc/Hz
  - 1 kHz: -125 dBc/Hz
  - 10 kHz: -140 dBc/Hz
  - 100 kHz: -145 dBc/Hz

**Frequency Adjust**
- ± 7 ppm typ; 0 V to +5.0 V applied to EFC pin, positive slope

**Acceleration Sensitivity**
- ≤ 7 x 10^{-10}/g

**Supply Voltage**
- ± 5.0 VDC

**Supply Current**
- < 25 mA

**Environmental**
- 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

---

**Dimensions**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.680</td>
<td>0.690</td>
</tr>
<tr>
<td>B</td>
<td>0.680</td>
<td>0.690</td>
</tr>
<tr>
<td>C</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>D</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>E</td>
<td>0.050</td>
<td>0.060</td>
</tr>
<tr>
<td>F</td>
<td>0.350</td>
<td>0.370</td>
</tr>
<tr>
<td>G</td>
<td>0.075</td>
<td>0.085</td>
</tr>
<tr>
<td>H</td>
<td>0.050</td>
<td>0.060</td>
</tr>
<tr>
<td>I</td>
<td>0.060</td>
<td>0.070</td>
</tr>
<tr>
<td>J</td>
<td>0.275</td>
<td>0.285</td>
</tr>
<tr>
<td>K</td>
<td>0.060</td>
<td>0.070</td>
</tr>
<tr>
<td>L</td>
<td>0.020</td>
<td>0.025</td>
</tr>
</tbody>
</table>
**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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.3 ppm</td>
<td>N37</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.5 ppm</td>
<td>T57</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 1.0 ppm</td>
<td>T16</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Offset</th>
<th>Static dBC/Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-75</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-102</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-125</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-140</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-145</td>
</tr>
</tbody>
</table>

**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

**Environmental**

- **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**

<table>
<thead>
<tr>
<th>DIM</th>
<th>in.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.680</td>
<td>17.27</td>
</tr>
<tr>
<td>B</td>
<td>0.680</td>
<td>17.27</td>
</tr>
<tr>
<td>C</td>
<td>0.200</td>
<td>5.08</td>
</tr>
<tr>
<td>D</td>
<td>0.300</td>
<td>7.62</td>
</tr>
<tr>
<td>E</td>
<td>0.050</td>
<td>1.27</td>
</tr>
<tr>
<td>F</td>
<td>0.350</td>
<td>8.90</td>
</tr>
<tr>
<td>G</td>
<td>0.075</td>
<td>1.91</td>
</tr>
<tr>
<td>H</td>
<td>0.050</td>
<td>1.27</td>
</tr>
<tr>
<td>I</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>J</td>
<td>0.275</td>
<td>6.99</td>
</tr>
<tr>
<td>K</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>L</td>
<td>0.020</td>
<td>0.51</td>
</tr>
</tbody>
</table>

---

**LAND PATTERN DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>in.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>0.300</td>
<td>7.62</td>
</tr>
<tr>
<td>N</td>
<td>0.600</td>
<td>15.24</td>
</tr>
<tr>
<td>O</td>
<td>0.075</td>
<td>1.91</td>
</tr>
<tr>
<td>P</td>
<td>0.050</td>
<td>1.27</td>
</tr>
<tr>
<td>Q</td>
<td>0.100</td>
<td>2.54</td>
</tr>
<tr>
<td>R</td>
<td>0.560</td>
<td>14.22</td>
</tr>
</tbody>
</table>
**T1215**

**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**
-40°C to +85°C
-40°C to +85°C
-55°C to +85°C
-55°C to +95°C
-40°C to +85°C
-55°C to +95°C

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

**Frequency Adjust**
± 7 ppm typ; 0 V to Vcc 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**
< 80 mA max (some options are lower)

**Supply Current**
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

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

**For RFQ specify:** Model - Stability - Output - Supply Voltage - Screening - g-Sensitivity - Frequency

**Example:**
T1215 - T57 - PE - 5.0 - B - LG - 300.0 MHz

---

**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**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.360</td>
<td>0.370</td>
</tr>
<tr>
<td>B</td>
<td>0.295</td>
<td>0.305</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>0.115</td>
</tr>
<tr>
<td>D</td>
<td>0.050</td>
<td>0.060</td>
</tr>
<tr>
<td>E</td>
<td>0.200</td>
<td>0.210</td>
</tr>
<tr>
<td>F</td>
<td>0.118</td>
<td>0.300</td>
</tr>
<tr>
<td>G</td>
<td>0.059</td>
<td>0.150</td>
</tr>
<tr>
<td>H</td>
<td>0.031</td>
<td>0.79</td>
</tr>
<tr>
<td>I</td>
<td>R0.015</td>
<td>R0.38</td>
</tr>
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</table>

**LAND PATTERN DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>0.200</td>
<td>0.08</td>
</tr>
<tr>
<td>K</td>
<td>0.050</td>
<td>0.127</td>
</tr>
<tr>
<td>L</td>
<td>0.167</td>
<td>0.424</td>
</tr>
<tr>
<td>M</td>
<td>0.084</td>
<td>0.213</td>
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<tr>
<td>N</td>
<td>0.041</td>
<td>1.04</td>
</tr>
<tr>
<td>O</td>
<td>0.143</td>
<td>3.63</td>
</tr>
</tbody>
</table>

---

840 West Church Road, Mechanicsburg, PA 17055
Telephone: 717-766-0223   Fax: 717-790-9509   e-mail: sales@greenrayindustries.com   www.greenrayindustries.com
**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: -20°C to +70°C ± 0.05 ppm N58
- Temp Range: -40°C to +85°C ± 0.1 ppm T17

\[
\frac{(f_{\text{max}} - f_{\text{min}})}{(2 \times f_{\text{min}})}: \text{EFC at center of range}
\]

Trim effect ≤ ± 0.1 ppm over 0 to V\text{supply} EFC and temp.

Hysteresis not included.

**Voltage Stability**
± 1 x 10^-7 for a 5% change

**Phase Noise**
(10 MHz CMOS typ)

<table>
<thead>
<tr>
<th>Offset</th>
<th>Static dBc/Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-90</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-120</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-140</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-150</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-155</td>
</tr>
</tbody>
</table>

**Aging**
< 0.3 ppm/yr. typ, 0.5 ppm/yr max

**Frequency Adjust**
± 6.0 ppm typ; positive slope, 0 V to V\text{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

**Environments**
- 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

---

**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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840 West Church Road, Mechanicsburg, PA 17055
Telephone: 717-766-0223  Fax: 717-790-9509  e-mail: sales@greenrayindustries.com  www.greenrayindustries.com
**T1241**

**LOW PHASE NOISE**

**VIBRATION COMPENSATED**

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
-20°C to +70°C ± 3.0 ppm N36
-40°C to +85°C ± 5.0 ppm T56
Output Load CMOS: 15 pF typ
Voltage Stability ± 3 x 10^-7 for a 5% change
Phase Noise Offset (100 MHz typ)
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
Environmental 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

---

**PAD CONNECTIONS**
1. OUTPUT
2. N/C
3. SUPPLY
4. OUTPUT
5. 0V & CASE GND
   A. SCLK (Internal Use Only)
   B. DIO (Internal Use Only)
   C. CS (Internal Use Only)

---

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.680</td>
<td>17.27</td>
</tr>
<tr>
<td>B</td>
<td>0.680</td>
<td>17.27</td>
</tr>
<tr>
<td>C</td>
<td>0.200</td>
<td>5.08</td>
</tr>
<tr>
<td>D</td>
<td>0.300</td>
<td>7.62</td>
</tr>
<tr>
<td>E</td>
<td>0.600</td>
<td>15.24</td>
</tr>
<tr>
<td>F</td>
<td>0.075</td>
<td>1.91</td>
</tr>
<tr>
<td>G</td>
<td>0.060</td>
<td>1.52</td>
</tr>
<tr>
<td>H</td>
<td>0.050</td>
<td>1.27</td>
</tr>
<tr>
<td>I</td>
<td>0.045</td>
<td>1.14</td>
</tr>
<tr>
<td>J</td>
<td>0.212</td>
<td>5.38</td>
</tr>
</tbody>
</table>

---

**RECOMMENDED LAND PATTERN**
**T1243**

**ULTRA-LOW ACCELERATION SENSITIVITY**  
**LOW PHASE NOISE**

**Frequency**  
10.0 MHz to 50.0 MHz

**Output**  
CMOS Square Wave

**Symmetry**  
50% ± 10%

**Output Load**  
CMOS: 15 pF typ

**Temp Stability**  
Temp Range:  
-20°C to +70°C, ± 1 ppm  
-40°C to +85°C, ± 2.0 ppm

**Aging**  
< 1.0 ppm/yr @ 10 MHz typ

**Voltage Stability**  
± 1 x 10^-6 for a 5% change

**Phase Noise**  
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**

---

**DIMENSIONS**

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

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**RECOMMENDED LAND PATTERN DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>in.</th>
<th>mm</th>
<th>in.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0.452</td>
<td>11.48</td>
<td>0.467</td>
<td>11.86</td>
</tr>
<tr>
<td>O</td>
<td>0.200</td>
<td>5.08</td>
<td>0.215</td>
<td>5.46</td>
</tr>
<tr>
<td>P</td>
<td>0.150</td>
<td>3.81</td>
<td>0.165</td>
<td>4.19</td>
</tr>
<tr>
<td>Q</td>
<td>0.350</td>
<td>8.89</td>
<td>0.365</td>
<td>9.27</td>
</tr>
<tr>
<td>R</td>
<td>0.050</td>
<td>1.27</td>
<td>0.065</td>
<td>1.65</td>
</tr>
</tbody>
</table>
T1244

LOW PHASE NOISE

Frequency  50.0 MHz to 150.0 MHz
Output  LVPECL
Symmetry  50% ± 10%
Output Load  50 Ω to Vcc, -2.0 V
Rise/Fall Time  ≤ 1 ns (20% to 80%)
Temp Stability
(Other stabilities available)

-40°C to +85°C
-55°C to +85°C
-55°C to +95°C

Option
T16
T26
U26
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 (typ @ 100 MHz)

Offset  dBC/Hz
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
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

LAND PATTERN DIMENSIONS

PAD CONNECTIONS

DIMENSIONS

<table>
<thead>
<tr>
<th>DIM</th>
<th>IN.</th>
<th>MM</th>
<th>IN.</th>
<th>MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.360</td>
<td>9.14</td>
<td>0.375</td>
<td>9.53</td>
</tr>
<tr>
<td>B</td>
<td>0.560</td>
<td>14.22</td>
<td>0.575</td>
<td>14.61</td>
</tr>
<tr>
<td>C</td>
<td>0.255</td>
<td>6.48</td>
<td>0.270</td>
<td>6.86</td>
</tr>
<tr>
<td>D</td>
<td>0.180</td>
<td>4.57</td>
<td>0.195</td>
<td>4.95</td>
</tr>
<tr>
<td>E</td>
<td>0.280</td>
<td>7.11</td>
<td>0.295</td>
<td>7.49</td>
</tr>
<tr>
<td>F</td>
<td>0.380</td>
<td>9.65</td>
<td>0.395</td>
<td>10.03</td>
</tr>
<tr>
<td>G</td>
<td>0.055</td>
<td>1.40</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>H</td>
<td>0.020</td>
<td>0.508</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>I</td>
<td>0.130</td>
<td>3.30</td>
<td>0.145</td>
<td>3.68</td>
</tr>
<tr>
<td>J</td>
<td>0.040</td>
<td>1.02</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>K</td>
<td>0.055</td>
<td>1.40</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

RECOMMENDED LAND PATTERN
T1247

DUAL COMPENSATION
TIGHT STABILITY

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
-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
Environments
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

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

DIMENSIONS

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.420</td>
<td>1.430</td>
</tr>
<tr>
<td>B</td>
<td>1.060</td>
<td>1.070</td>
</tr>
<tr>
<td>C</td>
<td>0.490</td>
<td>0.500</td>
</tr>
<tr>
<td>D</td>
<td>0.230</td>
<td>0.240</td>
</tr>
<tr>
<td>E</td>
<td>0.026</td>
<td>0.032</td>
</tr>
<tr>
<td>F</td>
<td>0.032</td>
<td>0.034</td>
</tr>
<tr>
<td>G</td>
<td>0.700</td>
<td>0.710</td>
</tr>
<tr>
<td>H</td>
<td>0.400</td>
<td>0.410</td>
</tr>
<tr>
<td>I</td>
<td>1.000</td>
<td>1.010</td>
</tr>
</tbody>
</table>

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840 West Church Road, Mechanicsburg, PA 17055
Telephone: 717-766-0223 Fax: 717-790-9509 e-mail: sales@greenrayindustries.com www.greenrayindustries.com
**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**
- (other stabilities available)
  - Temp Range
    - -20°C to +70°C
    - ± 1.0 ppm
    - Tolerance: N16
  - -40°C to +85°C
    - ± 5.0 ppm
    - Tolerance: T56
  - -55°C to +125°C
    - ± 7.0 ppm
    - Tolerance: 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**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.80</td>
<td>0.82</td>
</tr>
<tr>
<td>B</td>
<td>0.50</td>
<td>0.52</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>0.370</td>
</tr>
<tr>
<td>D</td>
<td>0.220</td>
<td>0.240</td>
</tr>
<tr>
<td>E</td>
<td>0.200</td>
<td>0.210</td>
</tr>
<tr>
<td>F</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>G</td>
<td>0.600</td>
<td>0.610</td>
</tr>
<tr>
<td>H</td>
<td>0.150</td>
<td>0.160</td>
</tr>
<tr>
<td>I</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>J</td>
<td>±0.018</td>
<td>±0.018</td>
</tr>
<tr>
<td>K</td>
<td>±0.011</td>
<td>±0.041</td>
</tr>
</tbody>
</table>

**PAD CONNECTIONS**

1. EFC
2. NC
3. 0V & CASE GND
4. OUTPUT
5. 5V SUPPLY
6. NC
7. NC
8. NC
9. NC
10. NC
11. NC
12. NC
13. NC
14. NC

PINS 6 & 9: Internal use only & must be isolated
**T1276**

**RADIATION TOLERANT**

**ULTRA-LOW G-SENSITIVITY**

---

**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 (Sine wave)

CMOS (@3.3V +0.2 V max to +2.8V min)

-26 dBc max

**Harmonic & Subs**

Output Level

CMOS: 15 pF typ; Sinewave: 50 Ω

**Temp Stability**

Temp Range

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Temperature Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20°C to +70°C</td>
<td>± 1.0 ppm</td>
<td>N16</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 3.0 ppm</td>
<td>T36</td>
</tr>
<tr>
<td>-55°C to +125°C</td>
<td>± 7.0 ppm</td>
<td>X76</td>
</tr>
</tbody>
</table>

(Other stabilities available)

**Short Term**

≤ 1 x 10⁻⁹ for a 1 sec τ

**Aging**

< ±1 ppm/yr @ 10 MHz typ

**Phase Noise**

Offset dBc/Hz (typ @ 20 MHz)

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Phase Noise dBc/Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-90</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-120</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-140</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-150</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-155</td>
</tr>
<tr>
<td>1 MHz</td>
<td>-160</td>
</tr>
</tbody>
</table>

**Frequency Adjust**

± 7 ppm typ via 0 V to Vcc control, negative slope

**Voltage Stability**

± 3 x 10⁻⁷ max for a 2% change

**Acceleration Sensitivity**

≤ 7 x 10⁻⁹/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

**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

---

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.795</td>
<td>0.799</td>
</tr>
<tr>
<td>B</td>
<td>1.370</td>
<td>1.374</td>
</tr>
<tr>
<td>C</td>
<td>0.343</td>
<td>0.345</td>
</tr>
<tr>
<td>D</td>
<td>1.100</td>
<td>1.104</td>
</tr>
<tr>
<td>E</td>
<td>0.100</td>
<td>2.54</td>
</tr>
<tr>
<td>F</td>
<td>0.600</td>
<td>15.24</td>
</tr>
<tr>
<td>G</td>
<td>0.300</td>
<td>7.62</td>
</tr>
<tr>
<td>H</td>
<td>0.018</td>
<td>0.46</td>
</tr>
<tr>
<td>I</td>
<td>0.197</td>
<td>5.00</td>
</tr>
</tbody>
</table>

**PAD CONNECTIONS**

1. EFC
2. GND
3. OUTPUT
4. V SUPPLY

ALL OTHER PINS N/C

---

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840 West Church Road, Mechanicsburg, PA 17055

Telephone: 717-766-0223  Fax: 717-790-9509  e-mail: sales@greenrayindustries.com  www.greenrayindustries.com
**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**
(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 τ

**Aging**
< ±1 ppm/yr @ 40 MHz typ

**Phase Noise**
Offset dBc/Hz (10 M)
-10 Hz -80
100 Hz -110
1 kHz -135
10 kHz -150
100 kHz -160

**Frequency Adjust**
± 7 ppm typ via 0 V to Vcc 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

**Environmental**

**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

---

**PAD CONNECTIONS**

**LAND PATTERN DIMENSIONS**

---

**DIMENSIONS**

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

---

**RECOMMENDED LAND PATTERN**
**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.

---

### Frequency

<table>
<thead>
<tr>
<th>Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0 MHz to 50.0 MHz</td>
<td>± 1.0 ppm</td>
<td>N16</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 2.0 ppm</td>
<td>T26</td>
</tr>
</tbody>
</table>

### 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

- Offset dBc/Hz (typ at 10 MHz, +5 V)
  - 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 Vcc EFC, 50kΩ 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

---

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.800</td>
<td>0.815</td>
</tr>
<tr>
<td>B</td>
<td>0.500</td>
<td>0.515</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>0.370</td>
</tr>
<tr>
<td>D</td>
<td>0.215</td>
<td>0.230</td>
</tr>
<tr>
<td>E</td>
<td>0.200</td>
<td>0.210</td>
</tr>
<tr>
<td>F</td>
<td>0.300</td>
<td>0.320</td>
</tr>
<tr>
<td>G</td>
<td>0.600</td>
<td>0.610</td>
</tr>
<tr>
<td>H</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>I</td>
<td>0.018</td>
<td>0.024</td>
</tr>
<tr>
<td>J</td>
<td>±0.018</td>
<td>±0.046</td>
</tr>
</tbody>
</table>

**PAD CONNECTIONS**

1. EFC
2. 0V CASE GND
3. OUTPUT
4. 12 EFC FILTER ENABLE (See Note 1)
5. 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.
RECOMMENDED LAND PATTERN

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

PAD 1 IDENTIFICATION

DIMENSIONS

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.360</td>
<td>9.14</td>
</tr>
<tr>
<td>B</td>
<td>0.295</td>
<td>7.49</td>
</tr>
<tr>
<td>C</td>
<td>0.146</td>
<td>3.71</td>
</tr>
<tr>
<td>D</td>
<td>0.215</td>
<td>5.46</td>
</tr>
<tr>
<td>E</td>
<td>0.200</td>
<td>5.08</td>
</tr>
<tr>
<td>F</td>
<td>0.039</td>
<td>1.00</td>
</tr>
<tr>
<td>G</td>
<td>0.058</td>
<td>1.46</td>
</tr>
<tr>
<td>H</td>
<td>0.040</td>
<td>1.02</td>
</tr>
</tbody>
</table>

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

tcxo
ULTRA-LOW ACCELERATION SENSITIVITY
MINIATURE SMT PACKAGE

840 West Church Road, Mechanicsburg, PA 17055
Telephone: 717-766-0223 Fax: 717-790-9509 e-mail: sales@greenrayindustries.com www.greenrayindustries.com

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**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**
(Temperature Range: -20°C to +70°C, ± 1.0 ppm typ, +1.0 V $p-p$ min)
-40°C to +85°C, ± 5.0 ppm typ
-55°C to +125°C, ± 7.0 ppm typ

**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**

<table>
<thead>
<tr>
<th>Offset (typ @ 10 MHz)</th>
<th>dBC/Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-90</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-120</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-145</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-150</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-155</td>
</tr>
</tbody>
</table>

**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
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.

RECOMMENDED LAND PATTERN

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)

PAD CONNECTIONS

DIMENSIONS

<table>
<thead>
<tr>
<th>LETTER</th>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.150</td>
<td>29.21</td>
<td>1.170</td>
</tr>
<tr>
<td>B</td>
<td>1.000</td>
<td>25.40</td>
<td>1.020</td>
</tr>
<tr>
<td>C</td>
<td>0.200</td>
<td>5.08</td>
<td>0.220</td>
</tr>
<tr>
<td>D</td>
<td>1.000</td>
<td>25.40</td>
<td>1.020</td>
</tr>
<tr>
<td>E</td>
<td>0.500</td>
<td>12.70</td>
<td>0.520</td>
</tr>
<tr>
<td>F</td>
<td>0.400</td>
<td>10.16</td>
<td>0.420</td>
</tr>
<tr>
<td>G</td>
<td>0.150</td>
<td>3.81</td>
<td>0.170</td>
</tr>
<tr>
<td>H</td>
<td>0.275</td>
<td>6.99</td>
<td>0.295</td>
</tr>
<tr>
<td>I</td>
<td>0.800</td>
<td>20.32</td>
<td>0.820</td>
</tr>
<tr>
<td>J</td>
<td>0.800</td>
<td>20.32</td>
<td>0.820</td>
</tr>
<tr>
<td>K</td>
<td>0.100</td>
<td>2.54</td>
<td>NA</td>
</tr>
<tr>
<td>L</td>
<td>0.100</td>
<td>2.54</td>
<td>NA</td>
</tr>
<tr>
<td>M</td>
<td>0.080</td>
<td>2.03</td>
<td>0.090</td>
</tr>
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</table>

LAND PATTERN DIMENSIONS

<table>
<thead>
<tr>
<th>LETTER</th>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0.800</td>
<td>20.32</td>
<td>0.820</td>
</tr>
<tr>
<td>O</td>
<td>0.150</td>
<td>3.81</td>
<td>0.170</td>
</tr>
<tr>
<td>P</td>
<td>0.275</td>
<td>6.99</td>
<td>0.295</td>
</tr>
<tr>
<td>Q</td>
<td>0.050</td>
<td>20.32</td>
<td>0.820</td>
</tr>
<tr>
<td>R</td>
<td>1.000</td>
<td>25.40</td>
<td>1.020</td>
</tr>
<tr>
<td>S</td>
<td>0.303</td>
<td>7.70</td>
<td>0.323</td>
</tr>
<tr>
<td>T</td>
<td>0.091</td>
<td>2.31</td>
<td>0.111</td>
</tr>
<tr>
<td>U</td>
<td>0.158</td>
<td>4.01</td>
<td>0.178</td>
</tr>
<tr>
<td>V</td>
<td>0.100</td>
<td>2.54</td>
<td>0.120</td>
</tr>
</tbody>
</table>

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.

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

Frequency
Output
Harmonics
Symmetry
Output Level
Output Load
Temp Stability
(temp @ 10 MHz)
Phase Noise
(VCR @ 10 MHz)
Voltage Stability
Frequency Adjust
Supply Voltage
Supply Current

MODEL OUTPUT
ZT600 CMOS
ZT601 Sine Wave

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

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

For RFQ specify:
Model - Temp Stability - Supply Voltage - Frequency
Example: ZT600 - T16 - 5.0 - 10.0 MHz
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
(Other stabilities available)
<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to +50°C</td>
<td>± 0.5 ppm</td>
<td>B57</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 1.0 ppm</td>
<td>N16</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 3.0 ppm</td>
<td>T36</td>
</tr>
</tbody>
</table>
Aging < 1 ppm/yr; < ± 5.0 ppm for 10 years
Phase Noise Offset dBC/Hz (10 MHz)
(typ @ 10 MHz)
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-105</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-135</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-155</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-160</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-163</td>
</tr>
</tbody>
</table>
Frequency 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)
Environments 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
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 $\delta(f)$. 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
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.
**YH1300**

**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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10°C to +60°C</td>
<td>± 0.2 ppm</td>
<td>G27</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.3 ppm</td>
<td>N37</td>
</tr>
<tr>
<td>-40°C to +70°C</td>
<td>± 0.4 ppm</td>
<td>S47</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.5 ppm</td>
<td>T57</td>
</tr>
</tbody>
</table>

**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
- 100 Hz: -125 dBc/Hz
- 1 kHz: -149 dBc/Hz
- 10 kHz: -155 dBc/Hz
- 100 kHz: -158 dBc/Hz
- 1 MHz: -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**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.800</td>
<td>0.820</td>
</tr>
<tr>
<td>B</td>
<td>0.500</td>
<td>0.520</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>0.220</td>
<td>0.240</td>
</tr>
<tr>
<td>E</td>
<td>0.200</td>
<td>0.210</td>
</tr>
<tr>
<td>F</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>G</td>
<td>0.600</td>
<td>0.610</td>
</tr>
<tr>
<td>H</td>
<td>0.150</td>
<td>0.160</td>
</tr>
<tr>
<td>I</td>
<td>0.300</td>
<td>0.310</td>
</tr>
<tr>
<td>J</td>
<td>ø0.018</td>
<td>ø0.046</td>
</tr>
<tr>
<td>K</td>
<td>R0.020</td>
<td>R0.030</td>
</tr>
</tbody>
</table>

**PAD CONNECTIONS**

1. EFC
2. 0V & CASE GND
3. OUTPUT 4. SUPPLY VOLTAGE

---

For more information, visit [www.greenrayindustries.com](http://www.greenrayindustries.com)
**YH1310**

**LOW PHASE NOISE COMPACT EURO PACKAGE**

**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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to +50°C</td>
<td>± 0.2 ppm</td>
<td>B28</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.3 ppm</td>
<td>N38</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.5 ppm</td>
<td>T58</td>
</tr>
</tbody>
</table>

**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 x 10^-8 in 5 minutes, ref to 60 minute frequency @ +25°C

**Phase Noise**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Phase Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-118 dBc/Hz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-140 dBc/Hz</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-150 dBc/Hz</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-157 dBc/Hz</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-158 dBc/Hz</td>
</tr>
<tr>
<td>1M kHz</td>
<td>-160 dBc/Hz</td>
</tr>
</tbody>
</table>

**MODEL OUTPUT**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>YH1310</td>
<td>Sine Wave</td>
</tr>
<tr>
<td>YH1311</td>
<td>Square Wave, CMOS</td>
</tr>
</tbody>
</table>

For RFQ specify: Model - Stability - Supply Voltage - Frequency

Example: YH1310 - N38 - 5.0 - 10.0 MHz

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.420</td>
<td>1.620</td>
</tr>
<tr>
<td>B</td>
<td>1.060</td>
<td>1.260</td>
</tr>
<tr>
<td>C</td>
<td>0.516</td>
<td>0.542</td>
</tr>
<tr>
<td>D</td>
<td>0.028</td>
<td>0.032</td>
</tr>
<tr>
<td>E</td>
<td>0.230</td>
<td>0.260</td>
</tr>
<tr>
<td>F</td>
<td>0.032</td>
<td>0.034</td>
</tr>
<tr>
<td>G</td>
<td>0.350</td>
<td>0.360</td>
</tr>
<tr>
<td>H</td>
<td>0.700</td>
<td>0.710</td>
</tr>
<tr>
<td>I</td>
<td>1.000</td>
<td>1.010</td>
</tr>
</tbody>
</table>

**PAD CONNECTIONS**
1. EFC
2. Vref
3. SUPPLY VOLTAGE
4. OUTPUT
5. 0V & CASE GND
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: Temp Range
(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: ± 1x10^-7 per year (10 MHz); ± 5x10^-7 per year (100 MHz)
Frequency vs. Supply: ± 5 x 10^-3 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 ± 5x10^-8 in 5 minutes, ref to 60 minute frequency @ +25°C
Phase Noise:

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>10 MHz Std</th>
<th>10 MHz Ultra-Low</th>
<th>100 MHz Std</th>
<th>100 MHz Ultra-Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-125 dBc/Hz</td>
<td>-128 dBc/Hz</td>
<td>-85 dBc/Hz</td>
<td>-90 dBc/Hz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-150 dBc/Hz</td>
<td>-155 dBc/Hz</td>
<td>-115 dBc/Hz</td>
<td>-120 dBc/Hz</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-160 dBc/Hz</td>
<td>-163 dBc/Hz</td>
<td>-145 dBc/Hz</td>
<td>-150 dBc/Hz</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-165 dBc/Hz</td>
<td>-168 dBc/Hz</td>
<td>-160 dBc/Hz</td>
<td>-165 dBc/Hz</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-165 dBc/Hz</td>
<td>-168 dBc/Hz</td>
<td>-165 dBc/Hz</td>
<td>-165 dBc/Hz</td>
</tr>
</tbody>
</table>

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

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

DIMENSIONS:

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.000</td>
<td>3.040</td>
</tr>
<tr>
<td>B</td>
<td>3.000</td>
<td>3.040</td>
</tr>
<tr>
<td>C</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>D</td>
<td>0.300</td>
<td>0.300</td>
</tr>
<tr>
<td>E</td>
<td>0.250</td>
<td>0.280</td>
</tr>
<tr>
<td>F</td>
<td>1.360</td>
<td>1.375</td>
</tr>
<tr>
<td>G</td>
<td>0.680</td>
<td>0.695</td>
</tr>
<tr>
<td>H</td>
<td>1.360</td>
<td>1.375</td>
</tr>
<tr>
<td>I</td>
<td>0.030</td>
<td>0.033</td>
</tr>
</tbody>
</table>

PAD CONNECTIONS:
1. EFC
2. N/C
3. OUTPUT
4. 0V & CASE GND
5. SUPPLY VOLTAGE
**YH1322**

**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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>10 MHz Tol / Option</th>
<th>100 MHz Tol / Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to +50°C</td>
<td>± 0.01 ppm / B18</td>
<td>± 0.05 ppm / B58</td>
</tr>
<tr>
<td>-10°C to +60°C</td>
<td>± 0.015 ppm / G158</td>
<td>± 0.07 ppm / G78</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.02 ppm / N28</td>
<td>± 0.1 ppm / N17</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.05 ppm / T58</td>
<td>± 0.3 ppm / T37</td>
</tr>
</tbody>
</table>

**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**
+12.0 VDC ± 5%

**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)

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>10 MHz Std</th>
<th>10 MHz Ultra-Low</th>
<th>100 MHz Std</th>
<th>100 MHz Ultra-Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-125 dBc/Hz</td>
<td>-128 dBc/Hz</td>
<td>-85 dBc/Hz</td>
<td>-90 dBc/Hz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-150 dBc/Hz</td>
<td>-155 dBc/Hz</td>
<td>-115 dBc/Hz</td>
<td>-120 dBc/Hz</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-160 dBc/Hz</td>
<td>-163 dBc/Hz</td>
<td>-145 dBc/Hz</td>
<td>-150 dBc/Hz</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-165 dBc/Hz</td>
<td>-168 dBc/Hz</td>
<td>-160 dBc/Hz</td>
<td>-165 dBc/Hz</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-165 dBc/Hz</td>
<td>-168 dBc/Hz</td>
<td>-165 dBc/Hz</td>
<td>-165 dBc/Hz</td>
</tr>
</tbody>
</table>

**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
4. J1, OUTPUT

---

**DIMENSIONS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.000</td>
<td>2.040</td>
</tr>
<tr>
<td>B</td>
<td>2.000</td>
<td>2.040</td>
</tr>
<tr>
<td>C</td>
<td>0.750</td>
<td>0.790</td>
</tr>
<tr>
<td>D</td>
<td>0.500</td>
<td>0.515</td>
</tr>
<tr>
<td>E</td>
<td>1.000</td>
<td>1.015</td>
</tr>
<tr>
<td>F</td>
<td>1.310</td>
<td>1.325</td>
</tr>
<tr>
<td>G</td>
<td>1.620</td>
<td>1.635</td>
</tr>
<tr>
<td>H</td>
<td>0.370</td>
<td>0.385</td>
</tr>
<tr>
<td>I</td>
<td>0.250</td>
<td>0.265</td>
</tr>
<tr>
<td>J</td>
<td>1.500</td>
<td>1.515</td>
</tr>
<tr>
<td>K</td>
<td>0.250</td>
<td>0.265</td>
</tr>
<tr>
<td>L</td>
<td>1.500</td>
<td>1.515</td>
</tr>
</tbody>
</table>
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
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

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

DIMENSIONS
<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.800</td>
<td>0.820</td>
</tr>
<tr>
<td>B</td>
<td>0.500</td>
<td>0.520</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>0.031</td>
<td>0.036</td>
</tr>
<tr>
<td>E</td>
<td>0.220</td>
<td>0.240</td>
</tr>
<tr>
<td>F</td>
<td>±0.018</td>
<td>±0.046</td>
</tr>
<tr>
<td>G</td>
<td>0.600</td>
<td>0.605</td>
</tr>
<tr>
<td>H</td>
<td>0.300</td>
<td>0.305</td>
</tr>
</tbody>
</table>

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**YH1440**

**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**
(Other stabilities available)

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>SC Tolerance / Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to +50°C</td>
<td>± 0.1 ppm / B17</td>
</tr>
<tr>
<td>-10°C to +60°C</td>
<td>± 0.15 ppm / G157</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.2 ppm / N27</td>
</tr>
<tr>
<td>-40°C to +70°C</td>
<td>± 0.5 ppm / S57</td>
</tr>
</tbody>
</table>

**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**
(典型 @ 100 MHz)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Phase Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-80 dBc/Hz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-110 dBc/Hz</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-140 dBc/Hz</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-155 dBc/Hz</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-160 dBc/Hz</td>
</tr>
</tbody>
</table>

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

**DIMENSIONS**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>YH1440</td>
<td>Square Wave, CMOS</td>
</tr>
<tr>
<td>YH1441</td>
<td>Sine Wave (0 dBm min into 50 Ω)</td>
</tr>
</tbody>
</table>

**MODEL OUTPUT**

For RFQ specify: Model - Stability - Supply Voltage - Frequency

Example: YH1440 - N27 - 5.0 - 100.0 MHz

**LAND PATTERN DIMENSIONS**

<table>
<thead>
<tr>
<th>LAND PATTERN DIMENSIONS</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dim</td>
<td>in.</td>
<td>mm</td>
</tr>
<tr>
<td>A</td>
<td>1.000</td>
<td>25.40</td>
</tr>
<tr>
<td>B</td>
<td>0.870</td>
<td>22.10</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>0.350</td>
<td>8.90</td>
</tr>
<tr>
<td>E</td>
<td>0.700</td>
<td>17.78</td>
</tr>
<tr>
<td>F</td>
<td>0.082</td>
<td>2.08</td>
</tr>
<tr>
<td>G</td>
<td>0.105</td>
<td>2.67</td>
</tr>
<tr>
<td>H</td>
<td>0.350</td>
<td>8.90</td>
</tr>
<tr>
<td>I</td>
<td>0.700</td>
<td>17.78</td>
</tr>
<tr>
<td>J</td>
<td>0.817</td>
<td>20.75</td>
</tr>
<tr>
<td>K</td>
<td>0.126</td>
<td>3.20</td>
</tr>
<tr>
<td>L</td>
<td>0.132</td>
<td>3.35</td>
</tr>
</tbody>
</table>

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840 West Church Road, Mechanicsburg, PA 17055
Telephone: 717-766-0223    Fax: 717-790-9509    e-mail: sales@greenrayindustries.com    www.greenrayindustries.com
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

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>10 MHz Tol / Option</th>
<th>100 MHz Tol / Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to +50°C</td>
<td>± 0.01 ppm / B18</td>
<td>± 0.05 ppm / B58</td>
</tr>
<tr>
<td>-10°C to +60°C</td>
<td>± 0.01 ppm / G18</td>
<td>± 0.07 ppm / G78</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.02 ppm / N28</td>
<td>± 0.1 ppm / N17</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.02 ppm / T28</td>
<td>± 0.3 ppm / T37</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>10 MHz</th>
<th>100 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-125 dBc/Hz</td>
<td>-90 dBc/Hz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-145 dBc/Hz</td>
<td>-120 dBc/Hz</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-155 dBc/Hz</td>
<td>-145 dBc/Hz</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-160 dBc/Hz</td>
<td>-155 dBc/Hz</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-160 dBc/Hz</td>
<td>-160 dBc/Hz</td>
</tr>
</tbody>
</table>

Acceleration Sensitivity

≤ 2 x 10^-9/g worst axis (SD);
≤ 5 x 10^-10/g available with 0.6” high package (LG)

Model OUTPUT

<table>
<thead>
<tr>
<th>MODEL</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>YH1460</td>
<td>Sine Wave</td>
</tr>
<tr>
<td>YH1461</td>
<td>Square Wave, CMOS</td>
</tr>
</tbody>
</table>

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

DIMENSIONS

<table>
<thead>
<tr>
<th>DIM</th>
<th>in.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>NA</td>
<td>1.030</td>
</tr>
<tr>
<td>B</td>
<td>NA</td>
<td>1.030</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>0.500</td>
</tr>
<tr>
<td>D</td>
<td>0.026</td>
<td>0.66</td>
</tr>
<tr>
<td>E</td>
<td>0.250</td>
<td>6.35</td>
</tr>
<tr>
<td>F</td>
<td>≤0.030</td>
<td>≤0.076</td>
</tr>
<tr>
<td>G</td>
<td>0.350</td>
<td>8.89</td>
</tr>
<tr>
<td>H</td>
<td>0.700</td>
<td>17.78</td>
</tr>
<tr>
<td>I</td>
<td>0.700</td>
<td>17.78</td>
</tr>
</tbody>
</table>

PAD CONNECTIONS

1. EFC
2. N/C
3. SUPPLY VOLTAGE
4. OUTPUT
5. 0V & CASE GND
YH1485

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
Sporious: -80 dBc
Initial Accuracy: within ± 0.25 ppm @ +25°C and +2.5 VDC EFC

Temp Stability

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance / Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.05 ppm / N58</td>
</tr>
<tr>
<td>-20°C to +70°C</td>
<td>± 0.1 ppm / N17</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.1 ppm / T17</td>
</tr>
<tr>
<td>-40°C to +85°C</td>
<td>± 0.3 ppm / T37</td>
</tr>
</tbody>
</table>

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 (typ @ +25°C, static):
- 10 Hz: -128 dBc/Hz
- 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

<table>
<thead>
<tr>
<th>Shock</th>
<th>Vibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>per MIL-STD-202, Meth 213, Cond C</td>
<td>per MIL-STD-202, Meth 204, Cond A &amp; per MIL-STD-810, Meth 514, Cond A</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hz</td>
<td>-85 dBC/Hz</td>
<td>-80 dBC/Hz</td>
</tr>
<tr>
<td>100 Hz</td>
<td>-115 dBC/Hz</td>
<td>-110 dBC/Hz</td>
</tr>
<tr>
<td>1 kHz</td>
<td>-140 dBC/Hz</td>
<td>-135 dBC/Hz</td>
</tr>
<tr>
<td>10 kHz</td>
<td>-162 dBC/Hz</td>
<td>-158 dBC/Hz</td>
</tr>
<tr>
<td>100 kHz</td>
<td>-173 dBC/Hz</td>
<td>-170 dBC/Hz</td>
</tr>
<tr>
<td>1 M</td>
<td>-175 dBC/Hz</td>
<td>-173 dBC/Hz</td>
</tr>
</tbody>
</table>

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

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

DIMENSIONS

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.560</td>
<td>14.22</td>
</tr>
<tr>
<td>B</td>
<td>0.360</td>
<td>9.14</td>
</tr>
<tr>
<td>C</td>
<td>0.136</td>
<td>3.45</td>
</tr>
<tr>
<td>D</td>
<td>0.180</td>
<td>4.57</td>
</tr>
<tr>
<td>E</td>
<td>0.380</td>
<td>9.65</td>
</tr>
<tr>
<td>F</td>
<td>0.050</td>
<td>1.27</td>
</tr>
<tr>
<td>G</td>
<td>0.038</td>
<td>0.97</td>
</tr>
</tbody>
</table>
Y1600

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
  - 0°C to +50°C ± 5.0 ppm
  - -20°C to +70°C ± 10.0 ppm
  - -40°C to +85°C ± 15.0 ppm
- Option
  - B56
  - N106
  - 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**

<table>
<thead>
<tr>
<th>DIM</th>
<th>TYP (in.)</th>
<th>MAX (mm)</th>
<th>TYP (mm)</th>
<th>MAX (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.800</td>
<td>20.32</td>
<td>0.820</td>
<td>20.83</td>
</tr>
<tr>
<td>B</td>
<td>0.500</td>
<td>12.70</td>
<td>0.520</td>
<td>13.21</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
<td>0.370</td>
<td>9.40</td>
</tr>
<tr>
<td>D</td>
<td>0.031</td>
<td>0.79</td>
<td>0.036</td>
<td>0.91</td>
</tr>
<tr>
<td>E</td>
<td>0.220</td>
<td>5.59</td>
<td>0.240</td>
<td>6.10</td>
</tr>
<tr>
<td>F</td>
<td>a0.016</td>
<td>a0.46</td>
<td>a0.023</td>
<td>a0.58</td>
</tr>
<tr>
<td>G</td>
<td>0.600</td>
<td>15.24</td>
<td>0.605</td>
<td>15.37</td>
</tr>
<tr>
<td>H</td>
<td>0.300</td>
<td>7.62</td>
<td>0.305</td>
<td>7.75</td>
</tr>
</tbody>
</table>

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

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**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**

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Tolerance</th>
<th>Option</th>
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</thead>
<tbody>
<tr>
<td>-20°C to +70°C</td>
<td>± 15.0 ppm</td>
<td>N</td>
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<tr>
<td>-40°C to +85°C</td>
<td>± 20.0 ppm</td>
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**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**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>-83 dBc/Hz</th>
<th>-120 dBc/Hz</th>
<th>-149 dBc/Hz</th>
<th>-160 dBc/Hz</th>
<th>-167 dBc/Hz</th>
<th>-170 dBc/Hz</th>
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<tbody>
<tr>
<td>10 Hz</td>
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<td>100 Hz</td>
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**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