Rev 2; 6/08

# DS4-XO Series Crystal Oscillators



## General Description

The DS4125, DS4150, DS4155, DS4156, DS4160, DS4250, DS4300, DS4311, DS4312, DS4622, and DS4776 ceramic surface-mount crystal oscillators are part of Maxim's DS4-XO series of crystal oscillators. These devices offer output frequencies at 125MHz, 155.52MHz, 156.25MHz, 160MHz, 311.04MHz, 312.5MHz, 622.08MHz, and 77.76MHz. The clock oscillators are suited for systems with tight tolerances because of the jitter, phase noise, and stability performance. The small package provides a format made for applications where PCB space is critical.

These clock oscillators are crystal based and use a fundamental crystal with PLL technology to provide the final output frequencies. Each device is offered with LVDS or LVPECL output types. The output enable pin is active-high logic.

These clock oscillators have very low phase jitter and phase noise. Typical phase jitter is < 0.7ps$_{RMS}$ from 12kHz to 20MHz. The devices are designed to operate with a 3.3V ±5% supply voltage, and are available in a 5.0mm x 3.2mm x 1.49mm, 10-pin LCCC surface-mount ceramic package.

## Applications

InfiniBand

BPON/GPON

Ethernet

10GbE

SONET/SDH

***Pin Configuration and Selector Guide appear at end of data sheet.***

## Features

- **< 0.7ps$_{RMS}$ from 12kHz to 20MHz Jitter**
- **LVDS or LVPECL Output Types**
- **3.3V Operating Voltage**
- **5.0mm x 3.2mm x 1.49mm, 10-Pin LCCC Ceramic Package**
- **-40°C to +85°C Operating Temperature Range**
- **Lead-Free/RoHS Compliant**

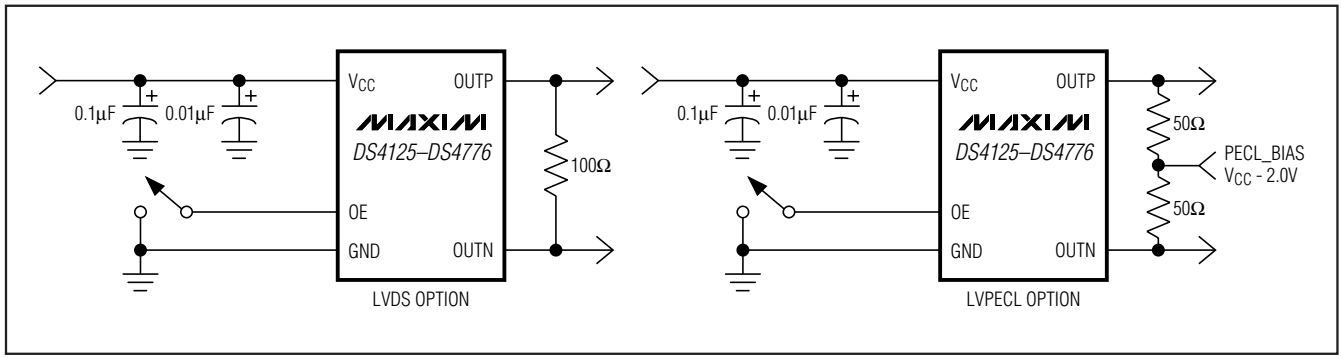
## Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **DS4125**D+ | -40°C to +85°C | 10 LCCC |
| DS4125P+ | -40°C to +85°C | 10 LCCC |
| **DS4150**D+ | -40°C to +85°C | 10 LCCC |
| DS4150P+ | -40°C to +85°C | 10 LCCC |
| **DS4155**D+ | -40°C to +85°C | 10 LCCC |
| DS4155P+ | -40°C to +85°C | 10 LCCC |
| **DS4156**D+ | -40°C to +85°C | 10 LCCC |
| DS4156P+ | -40°C to +85°C | 10 LCCC |
| **DS4160**D+ | -40°C to +85°C | 10 LCCC |
| DS4160P+ | -40°C to +85°C | 10 LCCC |
| **DS4250**D+ | -40°C to +85°C | 10 LCCC |
| DS4250P+ | -40°C to +85°C | 10 LCCC |
| **DS4300**D+ | -40°C to +85°C | 10 LCCC |
| DS4300P+ | -40°C to +85°C | 10 LCCC |

*+Denotes a lead(Pb)-free/RoHS-compliant package. The lead finish is JESD97 category e4 (Au over Ni) and is compatible with both lead-based and lead-free soldering processes.*

***Ordering Information continued at end of data sheet.***

## Typical Operating Circuits






***For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.***

# DS4-XO Series Crystal Oscillators

## ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage ($V_{CC}$) .....-0.3V, +4V
Operating Temperature Range .....-40°C to +85°C
Junction Temperature .....+150°C
Storage Temperature Range .....-55°C to +85°C
Soldering Temperature Profile
(3 passes max of reflow) .....Refer to the IPC/JEDEC J-STD-020 Specification.

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## ELECTRICAL CHARACTERISTICS

($V_{CC}$ = 3.135V to 3.465V, $T_A$ = -40°C to +85°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Operating Voltage Range | $V_{CC}$ | (Note 1) | 3.135 | 3.3 | 3.465 | V |
| Operating Current | $I_{CC_D}$ | LVDS, output loaded or unloaded | | 52 | 75 | mA |
| | $I_{CC_PU}$ | LVPECL, output unloaded | | 49 | 70 | |
| | $I_{CC_PI}$ | LVPECL, output load 50Ω at $V_{CC}$ - 2.0V | | 74 | 100 | |
| Output Frequency | $f_{OUT}$ | | | $f_{NOM}$ | | MHz |
| Oscillator Startup Time | $t_{STARTUP}$ | (Note 2) | | | 50 | ms |
| Frequency Stability | $\Delta f_{TOTAL}$ | Over temperature range, aging, load, supply, and initial tolerance (Note 3) | -50 | $f_{NOM}$ | +50 | ppm |
| Frequency Stability Over Temperature with Initial Tolerance | $\Delta f_{TEMP}$ | $V_{CC}$ = 3.3V | -35 | | +35 | ppm |
| Initial Tolerance | $\Delta f_{INITIAL}$ | $V_{CC}$ = 3.3V, $T_A$ = +25°C | | ±20 | | ppm |
| Frequency Change Due to $\Delta V_{CC}$ | $\Delta f_{VCC}$ | $V_{CC}$ = 3.3V ±5% | -3 | | +3 | ppm/V |
| Frequency Change Due to Load Variation | $\Delta f_{LOAD}$ | ±10% variation in termination resistance | | ±1 | | ppm |
| Aging (15 Years) | $\Delta f_{AGING}$ | | -7 | | +7 | ppm |
| Jitter | $J_{RMS}$ | Integrated phase RMS; 12kHz to 5MHz, $V_{CC}$ = 3.3V, $T_A$ = +25°C | | 0.7 | | ps |
| | | Integrated phase RMS; 12kHz to 20MHz, $V_{CC}$ = 3.3V, $T_A$ = +25°C | | 0.7 | | |
| | | Integrated phase RMS; 12kHz to 80MHz, $V_{CC}$ = 3.3V, $T_A$ = +25°C | | 1.0 | | |
| Input-Voltage High (OE) | $V_{IH}$ | (Note 1) | 0.7 x $V_{CC}$ | | $V_{CC}$ | V |
| Input-Voltage Low (OE) | $V_{IL}$ | (Note 1) | 0 | | 0.3 x $V_{CC}$ | V |
| Input Leakage (OE) | $I_{LEAK}$ | GND ≤ OE ≤ $V_{CC}$ | -50 | | +5.0 | µA |

## ELECTRICAL CHARACTERISTICS (continued)

($V_{CC}$ = 3.135V to 3.465V, $T_A$ = -40°C to +85°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **LVDS** | | | | | | |
| Output High Voltage | $V_{OHLVDSO}$ | 100Ω differential load (Note 1) | | | 1.475 | V |
| Output Low Voltage | $V_{OLLVDSO}$ | 100Ω differential load (Note 1) | 0.925 | | | V |
| Differential Output Voltage | $\|V_{ODLVDSO}\|$ | 100Ω differential load | 250 | | 425 | mV |
| Output Common-Mode Voltage Variation | $V_{LVDSOCOM}$ | 100Ω differential load | | | 150 | mV |
| Change in Differential Magnitude or Complementary Inputs | $\Delta\|V_{ODLVDSO}\|$ | 100Ω differential load | | | 25 | mV |
| Offset Output Voltage | $V_{OFFLVDSO}$ | 100Ω differential load (Note 1) | 1.125 | | 1.275 | V |
| Differential Output Impedance | $R_{OLVDSO}$ | | 80 | | 140 | Ω |
| Output Current | $I_{VSSLVDSO}$ | OUTN or OUTP shorted to ground and measure the current in the shorting path | | | 40 | mA |
| | $I_{LVDSO}$ | OUTN or OUTP shorted together | | 6.5 | | |
| Output Rise Time (Differential) | $t_{RLVDSO}$ | 20% to 80% | | 175 | | ps |
| Output Fall Time (Differential) | $t_{FLVDSO}$ | 80% to 20% | | 175 | | ps |
| Duty Cycle | $D_{CYCLE_LVDS}$ | | 45 | | 55 | % |
| Propagation Delay from OE Going LOW to Logical 1 at OUTP | $t_{PA1}$ | | | | 200 | ns |
| Propagation Delay from OE Going HIGH to Output Active | $t_{P1A}$ | | | | 200 | ns |
| **LVPECL** | | | | | | |
| Output High Voltage | $V_{OH}$ | Output connected to 50Ω at PECL_BIAS at $V_{CC}$ - 2.0V | $V_{CC}$ - 1.085 | | $V_{CC}$ - 0.88 | V |
| Output Low Voltage | $V_{OL}$ | Output connected to 50Ω at PECL_BIAS at $V_{CC}$ - 2.0V | $V_{CC}$ - 1.825 | | $V_{CC}$ - 1.62 | V |
| Differential Voltage | $V_{DIFF_PECL}$ | Output connected to 50Ω at PECL_BIAS at $V_{CC}$ - 2.0V | 0.595 | 0.710 | | V |
| Rise Time | $t_{R\text{-}PECL}$ | | | 200 | | ps |
| Fall Time | $t_{F\text{-}PECL}$ | | | 200 | | ps |
| Duty Cycle | $D_{CYCLE_PECL}$ | | 45 | | 55 | % |
| Propagation Delay from OE Going LOW to Output High Impedance | $t_{PAZ}$ | | | | 200 | ns |
| Propagation Delay from OE Going HIGH to Output Active | $t_{PZA}$ | | | | 200 | ns |

**Note 1:** All voltages referenced to ground.
**Note 2:** AC parameters are guaranteed by design and not production tested.
**Note 3:** Frequency stability is calculated as: $\Delta f_{TOTAL} = \Delta f_{TEMP} + \Delta f_{VCC} \times (3.3 \times 5\%) + \Delta f_{LOAD} + \Delta f_{AGING}$.

# DS4-XO Series Crystal Oscillators

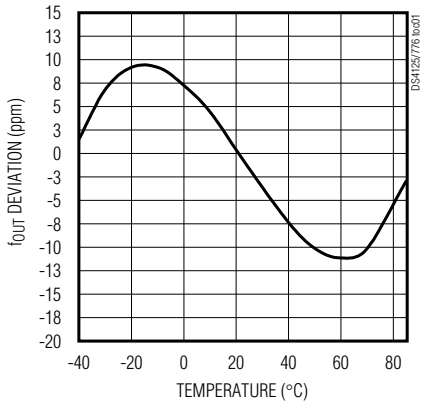
## SINGLE-SIDEBAND PHASE NOISE AT $f_O = f_{NOM}$

| $f_M$ = | SINGLE-SIDEBAND PHASE NOISE AT $f_O = f_{NOM}$ (dBc/Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 77.76MHz | 125.00MHz | 155.52MHz | 156.25MHz | 160.00MHz | 311.04MHz | 312.5MHz | 622.08MHz |
| 10Hz | -60 | -70 | -70 | -70 | -70 | -65 | -65 | -60 |
| 100Hz | -95 | -100 | -100 | -100 | -100 | -95 | -95 | -90 |
| 1kHz | -122 | -120 | -120 | -120 | -120 | -113 | -113 | -107 |
| 10kHz | -126 | -120 | -120 | -120 | -120 | -113 | -113 | -107 |
| 100kHz | -131 | -125 | -125 | -125 | -125 | -118 | -118 | -113 |
| 1MHz | -143 | -142 | -142 | -142 | -142 | -137 | -137 | -131 |
| 10MHz | -149 | -149 | -149 | -149 | -149 | -149 | -149 | -147 |
| 20MHz | -153 | -153 | -153 | -153 | -153 | -153 | -153 | -150 |

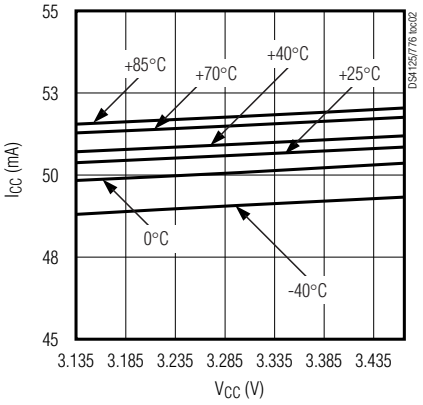
## Typical Operating Characteristics

($V_{CC}$ = +3.3V, $T_A$ = +25°C, unless otherwise noted.)

**FREQUENCY vs. TEMPERATURE**




**OPERATING CURRENT (DS4155) vs. OPERATING VOLTAGE**




## Pin Description

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | OE | Active-High Output Enable. Has an internal pullup 100kΩ resistor. |
| 2, 7–10 | N.C. | No Connection. Must be floated. |
| 3 | GND | Ground |
| 4 | OUTP | Positive Output for LVPECL or LVDS |
| 5 | OUTN | Negative Output for LVPECL or LVDS |
| 6 | $V_{CC}$ | Supply Voltage |
| — | EP | Exposed Paddle. Do not connect this pad or place exposed metal under the pad. |

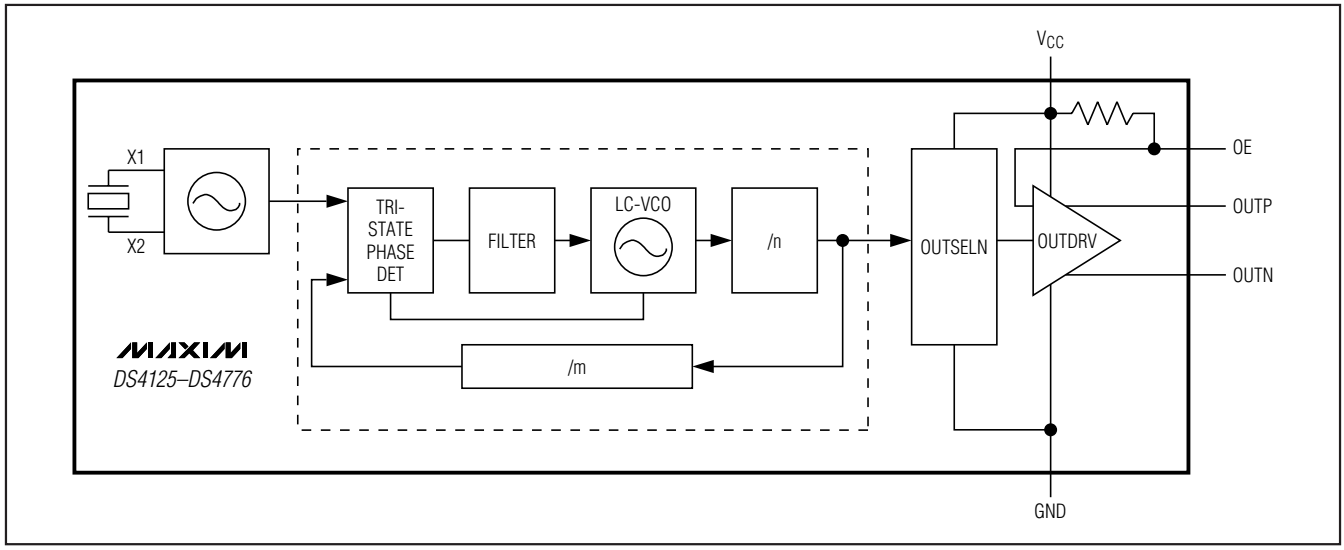



*Figure 1. Functional Diagram*

## Detailed Description

The devices consist of a fundamental-mode, AT-cut crystal and a synthesizer IC that can synthesize any one of these frequencies: 77.76MHz, 125MHz, 150MHz, 155.52MHz, 156.25MHz, 160MHz, 250MHz, 300MHz, 311.04MHz, 312.5MHz, and 622.08MHz.

All devices support two types of differential output drivers: LVDS and LVPECL. When the OE signal is low, LVPECL outputs go to the PECL_BIAS level of $V_{CC}$ - 2.0V, while the LVDS outputs are a logical one. See Figures 2 and 3 for an LVDS and LVPECL output timing diagram.

## Additional Information

For more available frequencies, refer to the DS4106 data sheet at **www.maxim-ic.com/DS4106**.

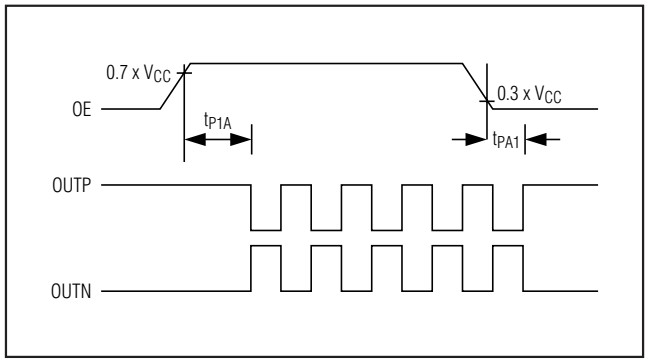



*Figure 2. LVDS Output Timing Diagram When OE Is Enabled and Disabled*

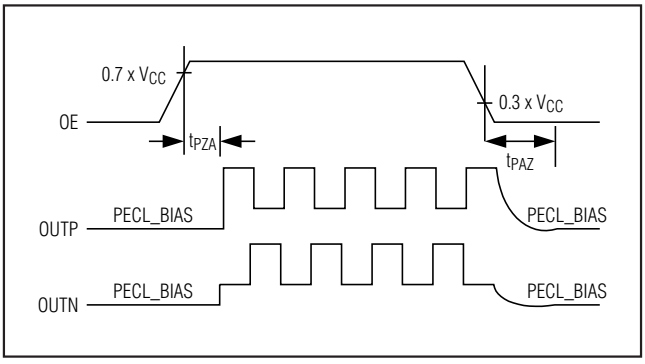



*Figure 3. LVPECL Output Timing Diagram When OE Is Enabled and Disabled*

# DS4-XO Series Crystal Oscillators

## Ordering Information (continued)

| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **DS4311**D+ | -40°C to +85°C | 10 LCCC |
| DS4311P+ | -40°C to +85°C | 10 LCCC |
| **DS4312**D+ | -40°C to +85°C | 10 LCCC |
| DS4312P+ | -40°C to +85°C | 10 LCCC |
| **DS4622**D+ | -40°C to +85°C | 10 LCCC |
| DS4622P+ | -40°C to +85°C | 10 LCCC |
| **DS4776**D+ | -40°C to +85°C | 10 LCCC |
| DS4776P+ | -40°C to +85°C | 10 LCCC |

*+Denotes a lead(Pb)-free/RoHS-compliant package. The lead finish is JESD97 category e4 (Au over Ni) and is compatible with both lead-based and lead-free soldering processes.*

## Chip Information

SUBSTRATE CONNECTED TO GROUND

PROCESS: BiPOLAR SiGe

## Thermal Information

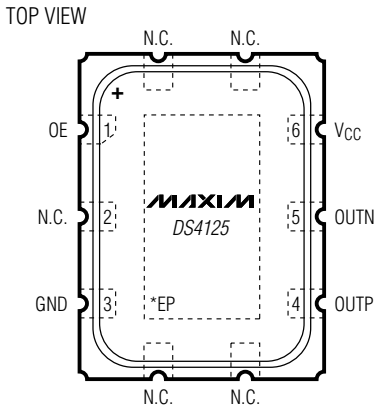
| THETA-JA (°C/W) |
|---|
| 90 |

## Selector Guide

| PART | FREQUENCY (NOM) (MHz) | FREQUENCY STABILITY (ppm) | OUTPUT TYPE | TOP MARK |
|---|---|---|---|---|
| **DS4125**D+ | 125.00 | ±50 | LVDS | 25D |
| DS4125P+ | 125.00 | ±50 | LVPECL | 25P |
| **DS4150**D+ | 150.00 | ±50 | LVDS | 50D |
| DS4150P+ | 150.00 | ±50 | LVPECL | 50P |
| **DS4155**D+ | 155.52 | ±50 | LVDS | 55D |
| DS4155P+ | 155.52 | ±50 | LVPECL | 55P |
| **DS4156**D+ | 156.25 | ±50 | LVDS | 56D |
| DS4156P+ | 156.25 | ±50 | LVPECL | 56P |
| **DS4160**D+ | 160.00 | ±50 | LVDS | 60D |
| DS4160P+ | 160.00 | ±50 | LVPECL | 60P |
| **DS4250**D+ | 250.00 | ±50 | LVDS | T5D |
| DS4250P+ | 250.00 | ±50 | LVPECL | T5P |
| **DS4300**D+ | 300.00 | ±50 | LVDS | 30D |
| DS4300P+ | 300.00 | ±50 | LVPECL | 30P |
| **DS4311**D+ | 311.04 | ±50 | LVDS | 31D |
| DS4311P+ | 311.04 | ±50 | LVPECL | 31P |
| **DS4312**D+ | 312.50 | ±50 | LVDS | 32D |
| DS4312P+ | 312.50 | ±50 | LVPECL | 32P |
| **DS4622**D+ | 622.08 | ±50 | LVDS | 62D |
| DS4622P+ | 622.08 | ±50 | LVPECL | 62P |
| **DS4776**D+ | 77.76 | ±50 | LVDS | 76D |
| DS4776P+ | 77.76 | ±50 | LVPECL | 76P |

*+Denotes a lead(Pb)-free/RoHS-compliant package. The lead finish is JESD97 category e4 (Au over Ni) and is compatible with both lead-based and lead-free soldering processes.*

## Pin Configuration




**LCCC**
**(5.00mm × 3.20mm × 1.49mm)**

*EXPOSED PAD

## Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO. |
|---|---|---|
| 10 LCCC | L1053+H2 | **21-0389** |

# DS4-XO Series Crystal Oscillators

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 7/07 | Initial release. | — |
| 1 | 3/08 | Added DS4150, DS4250, DS4300. | All |
| | | Removed $\Delta f_{INITIAL}$ from the frequency stability calculation in Note 3. | 3 |
| | | In the *Pin Description*, changed the EP description to indicate that it should not be connected and to avoid placing exposed metal under the pad location. | 4 |
| 2 | 6/08 | Removed future status from the DS4150, DS4250, and DS4300. | 1, 6 |

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