



# 100MHz HCSL Clock Oscillator

DS4100H

## General Description

The DS4100H is a low-jitter 100MHz clock oscillator with a high-speed current steering logic (HCSL) output. It combines an AT-cut crystal, an oscillator, and a low-noise phase-locked loop (PLL) in a 5mm by 3.2mm ceramic package. Typical phase jitter is 0.9ps<sub>RMS</sub> from 12kHz to 20MHz. The device operates from a single +3.3V supply.

## Applications

PCI Express®

## Features

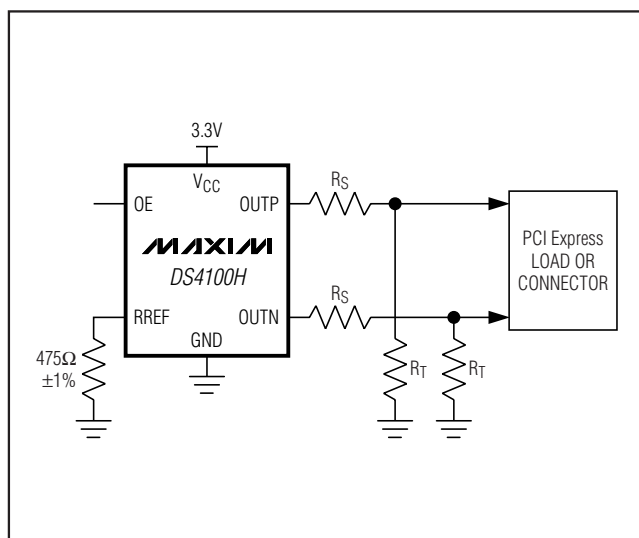
- ◆ 100MHz Output Frequency
- ◆ 3.3V ±5% Operating Voltage
- ◆ HCSL Output
- ◆ Phase Jitter (RMS): 0.9ps Typical
- ◆ ±39ppm Frequency Stability Over Voltage, Temperature, 10 Years of Aging
- ◆ Output-Enable (OE) Control Input
- ◆ 5mm x 3.2mm x 1.49mm Ceramic Package (LCCC)
- ◆ Pb Free/RoHS Compliant

## Ordering Information

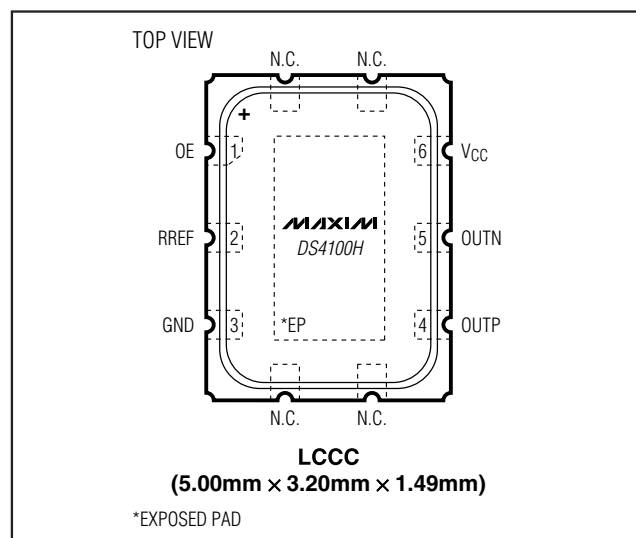
| PART     | TEMP RANGE     | PIN-PACKAGE | TOP MARK |
|----------|----------------|-------------|----------|
| DS4100H+ | -40°C to +85°C | 10 LCCC     | 10H      |

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

## Typical Operating Circuit



## Pin Configuration



PCI Express is a registered trademark of PCI-SIG Corp.



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## ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage ( $V_{CC}$ ) ..... -0.3V, +4V  
 Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ ) ..... 280mW  
 Operating Temperature Range .....  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$   
 Junction Temperature .....  $+150^\circ\text{C}$

Storage Temperature Range .....  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$   
 Soldering Temperature Profile  
 (3 passes max) ..... 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

( $V_{CC} = 3.135\text{V}$  to  $3.465\text{V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ . Typical values are at  $V_{CC} = +3.3\text{V}$  and  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

| PARAMETER                        | SYMBOL      | CONDITIONS                                                                                                                    | MIN   | TYP                         | MAX      | UNITS         |
|----------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------|----------|---------------|
| Supply Voltage                   | $V_{CC}$    | (Note 1)                                                                                                                      | 3.135 | 3.300                       | 3.465    | V             |
| Supply Current                   | $I_{CC}$    | $OE = V_{IH}$ , Figure 2                                                                                                      |       | 71                          | 85       | mA            |
| Input High Voltage (OE)          | $V_{IH}$    | (Note 1)                                                                                                                      | 2.0   |                             | $V_{CC}$ | V             |
| Input Low Voltage (OE)           | $V_{IL}$    | (Note 1)                                                                                                                      | 0     |                             | 0.8      | V             |
| Input Leakage Current (OE)       | $I_{IN}$    | $GND \leq OE \leq V_{CC}$                                                                                                     | -55   |                             | +10      | $\mu\text{A}$ |
| <b>HCSL OUTPUTS (OUTP, OUTN)</b> |             |                                                                                                                               |       |                             |          |               |
| Output High Current              | $I_{OH}$    | 475 $\Omega$ resistor connected between RREF and GND, $V_{OUTN}$ or $V_{OUTP} = 1.2\text{V}$ , $V_{CC} = 3.3\text{V} \pm 5\%$ | 12.25 | 13.92                       | 15.59    | mA            |
| Output High Voltage              | $V_{OH}$    | $R_S = 0\Omega$ , $R_T = 50\Omega$ (Notes 1, 2)                                                                               | 612.5 | 696.0                       | 779.5    | mV            |
| Output Low Voltage               | $V_{OL}$    | $R_S = 0\Omega$ , $R_T = 50\Omega$ (Notes 1, 2)                                                                               |       | 0                           | 50       | mV            |
| Output Leakage High Current      | $I_{LEAKH}$ | $V_{OE} = 0$ ; $V_{OUTN}$ , $V_{OUTP} = V_{CC}$                                                                               | -10   |                             | +10      | $\mu\text{A}$ |
| Output Leakage Low Current       | $I_{LEAKL}$ | $V_{OE} = 0$ ; $V_{OUTN}$ , $V_{OUTP} = 0$                                                                                    | -10   |                             | +10      | $\mu\text{A}$ |
| Output Resistance                | $R_O$       | Measure current out of OUTN pin at $V_{OUTN} = 0.5\text{V}$ and $1.0\text{V}$ ; $R_O = 0.5 / I_{0.5} - I_{1.0}$               | 3000  |                             |          | $\Omega$      |
| Crossover Voltage                | $V_{CROSS}$ | Measure crossing voltage at OUTP and OUTN (Notes 1, 2, and 3)                                                                 |       | (50% x $V_{OH}$ ) $\pm 5\%$ |          | mV            |
| Output Rise Time                 | $t_R$       | 20% to 80%, $CL = 2\text{pF}$                                                                                                 | 175   |                             | 700      | ps            |
| Output Fall Time                 | $t_F$       | 80% to 20%, $CL = 2\text{pF}$                                                                                                 | 175   |                             | 700      | ps            |
| Overshoot                        | $V_{OVER}$  | Measure overshoot voltage at OUTP and OUTN (Notes 1, 2, and 3)                                                                |       | $V_{OH} + 0.2\text{V}$      |          | V             |
| Undershoot                       | $V_{UNDER}$ | Measure undershoot voltage at OUTP and OUTN (Notes 1, 2, and 3)                                                               |       | -0.2                        |          | V             |
| Output-Enable Time to Low Level  | $t_{PZL}$   | Figure 3 (Note 4)                                                                                                             |       |                             | 200      | ns            |
| Output-Enable Time to High Level | $t_{PZH}$   | Figure 3 (Note 5)                                                                                                             |       |                             | 200      | ns            |

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## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = 3.135V$  to  $3.465V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ . Typical values are at  $V_{CC} = +3.3V$  and  $T_A = +25^{\circ}C$ , unless otherwise noted.)

| PARAMETER                                                           | SYMBOL                  | CONDITIONS                                                                 | MIN | TYP      | MAX | UNITS  |
|---------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------|-----|----------|-----|--------|
| Output Disable Time                                                 | $t_{PZ}$                | Figure 3 (Note 6)                                                          |     |          | 10  | ns     |
| <b>CLOCK OUTPUT AS MEASURED AT OUTP WITH RESPECT TO OUTN</b>        |                         |                                                                            |     |          |     |        |
| Clock Output                                                        | $f_{OUT}$               |                                                                            |     | 100      |     | MHz    |
| Frequency Stability Total                                           | $\Delta f / f_0$        | Over temperature range, aging, load, and supply (Note 7)                   | -39 |          | +39 | ppm    |
| Initial Frequency Tolerance                                         | $f_{TOL}$               | $V_{CC} = 3.3V$ , $T_A = +25^{\circ}C$                                     |     | $\pm 15$ |     | ppm    |
| Frequency Stability vs. Temperature                                 | $\Delta f / f_0   T_A$  | $V_{CC} = 3.3V$                                                            | -30 |          | +30 | ppm    |
| Frequency Stability vs. $V_{CC}$                                    | $\Delta f / f_0   V$    | $V_{CC} = 3.3V \pm 5\%$                                                    | -3  |          | +3  | ppm/V  |
| Frequency Stability vs. Load                                        | $\Delta f / f_0   LOAD$ | $\pm 10\%$ variation in termination resistance                             |     | $\pm 1$  |     | ppm    |
| Aging (10 Years)                                                    | $f_{AGING}$             |                                                                            | -7  |          | +7  | ppm    |
| Phase Jitter (RMS)                                                  | $PJ_{RMS}$              | 12kHz to 20MHz                                                             |     | 0.9      |     | ps     |
| Accumulated Deterministic Jitter Due to Power-Supply Noise (Note 8) | $DJ_{PN,P-P}$           | 10kHz                                                                      |     | 3.0      |     | ps     |
|                                                                     |                         | 100kHz                                                                     |     | 27       |     |        |
|                                                                     |                         | 200kHz                                                                     |     | 15       |     |        |
|                                                                     |                         | 1MHz                                                                       |     | 7.0      |     |        |
| Rise and Fall Time Mismatching                                      |                         | 20% to 80%; $CL = 2pF$ ; Figure 2;<br>$2 \times (t_R - t_F) / (t_R + t_F)$ |     | $\pm 20$ |     | %      |
| Duty Cycle                                                          | $t_{DC}$                | Measure at OUTP and OUTN, Figure 2                                         | 45  |          | 55  | %      |
| Oscillation Startup Time                                            |                         | (Note 9)                                                                   |     | 3        |     | ms     |
| Clock Output SSB Phase Noise                                        |                         | 100Hz                                                                      |     | -90.0    |     | dBc/Hz |
|                                                                     |                         | 1kHz                                                                       |     | -112     |     |        |
|                                                                     |                         | 10kHz                                                                      |     | -115     |     |        |
|                                                                     |                         | 100kHz                                                                     |     | -123     |     |        |
|                                                                     |                         | 1MHz                                                                       |     | -142     |     |        |
|                                                                     |                         | 10MHz                                                                      |     | -147     |     |        |

**Note 1:** All voltages are referenced to ground.

**Note 2:** With  $50\Omega$  load to ground on each output pin.

**Note 3:** Guaranteed by design and not production tested.

**Note 4:**  $t_{PZL}$  is defined as the time at which  $VOE = 1.0V$  on the rising edge of OE to the time at which  $V_{OUTP}$  or  $V_{OUTN} = 0.1V_{OH}$  on the falling edge of OUTP or OUTN.

**Note 5:**  $t_{PZH}$  is defined as the time at which the voltage on the rising edge of OE is equal to  $1.0V$  to the time at which  $V_{OUTP}$  or  $V_{OUTN} = 0.9V_{OH}$  on the rising edge of  $V_{OUTP}$  or  $V_{OUTN}$ .

**Note 6:**  $t_{PZ}$  is defined as the time at which  $VOE = 1.0V$  on the falling edge of OE to the time at which both  $V_{OUTP}$  and  $V_{OUTN}$  are less than  $0.1V_{OH}$ .

**Note 7:** Frequency stability is calculated as:  $\Delta f_{TOTAL} = \Delta f_{TEMP} + \Delta f_{VCC} \times 0.165 + \Delta f_{LOAD} + \Delta f_{AGING}$ .

**Note 8:** Measured with  $50mV_{P-P}$  sinusoidal signal on the supply from 10kHz to 1MHz.

**Note 9:** Including oscillator startup time and PLL acquisition time measured after  $V_{CC}$  reaches  $3.0V$  from power-on.

## 100MHz HCSL Clock Oscillator

## Typical Operating Characteristics

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

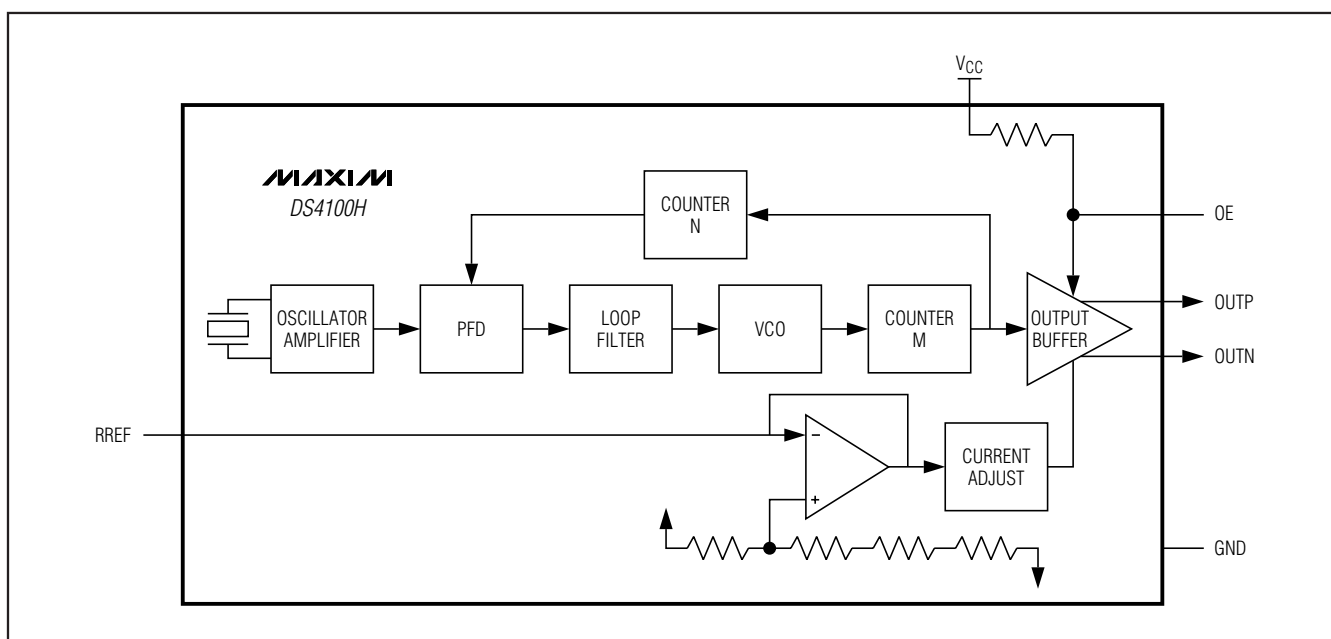
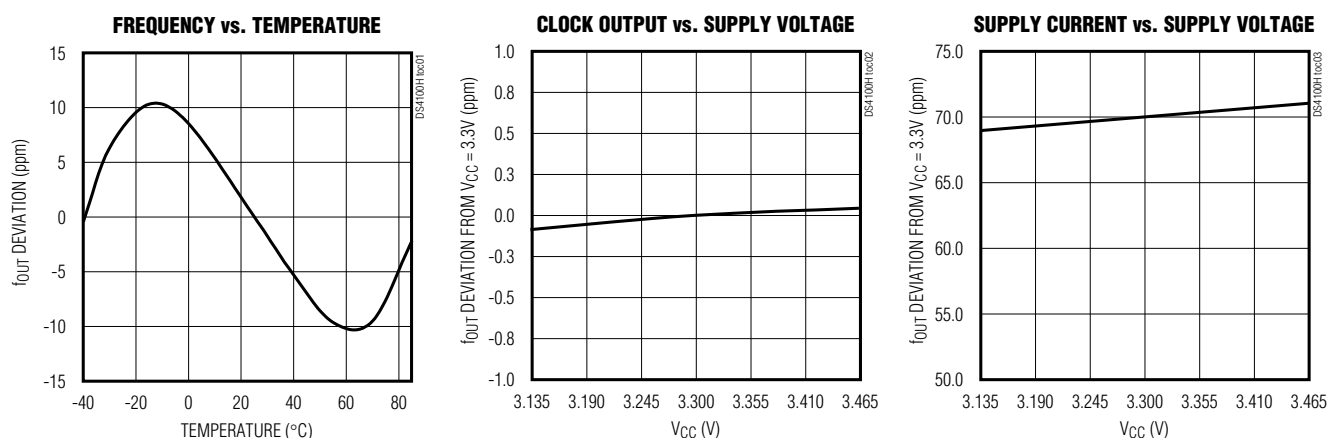


Figure 1. Functional Diagram

# 100MHz HCSL Clock Oscillator

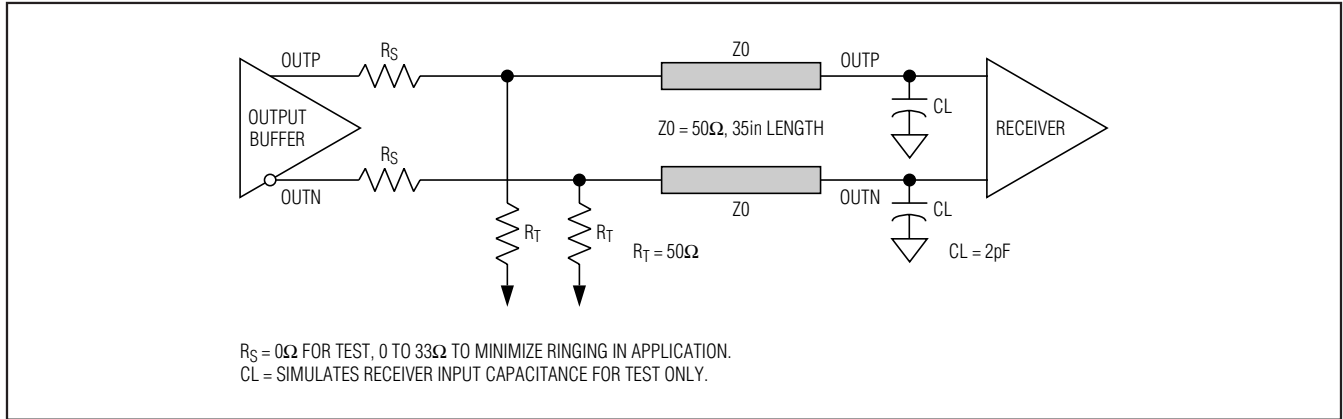


Figure 2. Typical Termination for HCSL Driver and Test Conditions

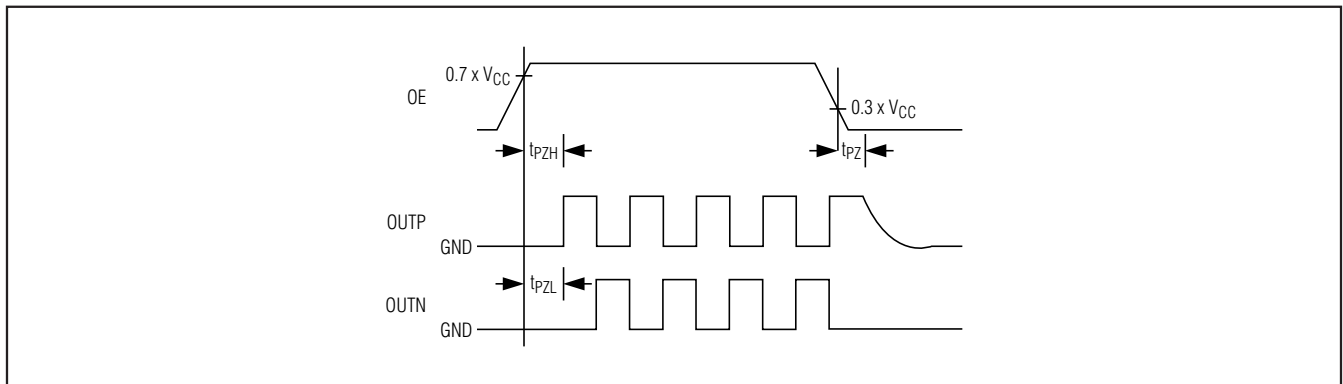


Figure 3. HCSL Output Timing Diagram When OE is Enabled and Disabled

## Pin Description

| PIN  | NAME | FUNCTION                                                                                                                                                             |
|------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | OE   | Output Enable. On-chip pullup resistor. If connected to logic-high or left open, the clock output is enabled. If connected to logic-low, the output is three-stated. |
| 2    | RREF | Connect a $475\Omega \pm 1\%$ resistor from RREF to ground.                                                                                                          |
| 3    | GND  | Ground                                                                                                                                                               |
| 4    | OUTP | Positive Clock Output. Requires a series resistor and a pulldown resistor.                                                                                           |
| 5    | OUTN | Negative Clock Output. Requires a series resistor and a pulldown resistor.                                                                                           |
| 6    | VCC  | +3.3V Supply Input. Device power can range from 3.135V to 3.465V.                                                                                                    |
| 7-10 | N.C. | No Connection                                                                                                                                                        |
| —    | EP   | Exposed Paddle. Do not connect this pad or place exposed metal under the pad.                                                                                        |

# 100MHz HCSL Clock Oscillator

## Detailed Description

The DS4100H is a low-jitter HCSL 100MHz clock oscillator. It combines an AT-cut crystal, an oscillator, and a low-noise PLL in a 5mm by 3.2mm ceramic package. The typical phase jitter is 0.9ps<sub>RMS</sub> from 12kHz to 20MHz. The device operates from a single +3.3V supply.

### PLL

The PLL generates a 1.6GHz high-speed clock signal based on the 25MHz crystal oscillator output. Clock-divider circuit M generates the output clock by scaling the VCO output frequency. Clock-divider circuit N applies a scaled version of the output clock signal to the phase/frequency detector (PFD) circuit.

### Output Drivers

The DS4100H is available with HCSL output buffers. When not needed, the output buffers can be disabled by driving the OE input to a logic-low. OE has an internal pullup resistor so that, if OE is left open, the outputs are enabled by default. When disabled, the output buffer goes to a high-impedance state.

## Chip Information

TRANSISTOR COUNT: 2850

SUBSTRATE CONNECTED TO GROUND

PROCESS: Bipolar SiGe

## Thermal Information

| THETA-JA (°C/W) |
|-----------------|
| 90              |

## Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO.            |
|--------------|--------------|-------------------------|
| 10 LCCC      | L1053+H2     | <a href="#">21-0389</a> |

# 100MHz HCSL Clock Oscillator

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION                                                                                                                                                         | PAGES CHANGED |
|-----------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 0               | 11/07         | Initial release.                                                                                                                                                    | —             |
| 1               | 4/08          | In the Electrical Characteristics table, added the typical supply current value of 71mA; corrected the units for the clock phase noise parameter from ps to dBc/Hz. | 2, 3          |
|                 |               | In the Pin Description, changed the exposed pad description to indicate that it should not be connected and to avoid placing exposed metal under the pad location.  | 5             |

DS4100H

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