



# Factory-Programmable, Single PLL Clock Generator

## General Description

The MAX9491 multipurpose clock generator is ideal for communication applications. It offers a factory-programmable PLL output that can be set to almost any frequency, ranging from 4MHz to 200MHz. The MAX9491 uses a one-time-programmable (OTP) ROM to program the PLL output. The MAX9491 also features an integrated voltage-controlled crystal oscillator (VCXO) that is tuned by a DC voltage. The VCXO output is used as the PLL input. The VCXO has a wide  $\pm 200$ ppm (typ) tuning range. The OTP on the MAX9491 is factory preset, based upon the customer request. Contact the factory for samples with preferred frequencies.

The device operates from a 3.3V supply and is specified over the  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  extended temperature range. The MAX9491 is available in 14-pin TSSOP and 20-pin TQFN (5mm x 5mm) packages.

## Applications

Telecommunications  
Data Networking Systems  
Home Entertainment Centers  
SOHO

## Features

- ◆ 5MHz to 35MHz for Crystal-Clock Reference
- ◆ 5MHz to 50MHz for a Driver Clock Reference
- ◆ One Fractional-N PLL with Buffered Output
- ◆ 4MHz to 200MHz Output Frequency Range
- ◆ Low RMS Jitter PLL ( $< 13$ ps) at 197 MHz
- ◆ Integrated VCXO with  $\pm 200$ ppm Tuning Range
- ◆ Available in 14-Pin TSSOP and 20-Pin TQFN Packages
- ◆ +3.3V Supply
- ◆  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  Temperature Range

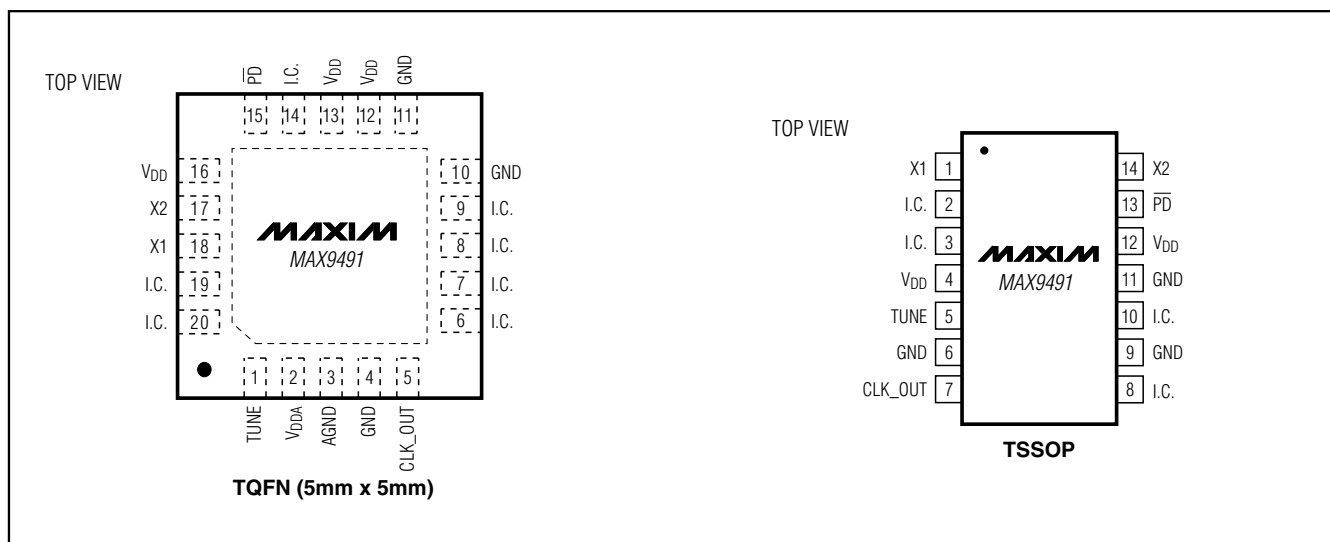
## Ordering Information

| PART        | TEMP RANGE                                     | PIN-PACKAGE  | PKG CODE |
|-------------|------------------------------------------------|--------------|----------|
| MAX9491ETP  | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ | 20 TQFN-EP** | T2055-5  |
| MAX9491EUD* | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ | 14 TSSOP     | U14-2    |

\*Future product—contact factory for availability.

\*\*EP = Exposed pad.

## Pin Configurations



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## ABSOLUTE MAXIMUM RATINGS

V<sub>DD</sub> to GND .....-0.3V to +4.0V  
 V<sub>DDA</sub> to AGND .....-0.3V to +4.0V  
 All Other Pins to GND .....-0.3V to V<sub>DD</sub> + 0.3V  
 Short-Circuit Duration  
   (all LVC MOS outputs).....Continuous  
 ESD Protection (Human Body Model).....±2kV

Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
   20-Lead TQFN (derate 21.3mW/°C above +70°C) ....2758mW  
   14-Pin TSSOP (derate 9.1mW/°C above +70°C) .....796.8mW  
 Storage Temperature Range .....-65°C to +150°C  
 Maximum Junction Temperature .....+150°C  
 Operating Temperature Range .....-40°C to +85°C  
 Lead Temperature (soldering, 10s) .....+300°C

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.

## DC ELECTRICAL CHARACTERISTICS

(V<sub>DD</sub> = V<sub>DDA</sub> = +3.0V to +3.6V and T<sub>A</sub> = -40°C to +85°C. Typical values at V<sub>DD</sub> = V<sub>DDA</sub> = 3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)  
 (Note 1)

| PARAMETER                                                                              | SYMBOL           | CONDITIONS                                                   | MIN                   | TYP | MAX             | UNITS |
|----------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------|-----------------------|-----|-----------------|-------|
| <b>LVC MOS INPUTS (<math>\overline{\text{PD}}</math>, X1 as a reference INPUT CLK)</b> |                  |                                                              |                       |     |                 |       |
| Input High Level                                                                       | V <sub>IH</sub>  |                                                              | 2.0                   |     | V <sub>DD</sub> | V     |
| Input Low Level                                                                        | V <sub>IL</sub>  |                                                              | 0                     |     | 0.8             | V     |
| High-Level Input Current                                                               | I <sub>IH</sub>  | V <sub>IN</sub> = V <sub>DD</sub>                            |                       |     | 20              | μA    |
| Low-Level Input Current                                                                | I <sub>IL</sub>  | V <sub>IN</sub> = 0                                          | -20                   |     |                 | μA    |
| <b>CLOCK OUTPUT (CLK_OUT)</b>                                                          |                  |                                                              |                       |     |                 |       |
| Output High Level                                                                      | V <sub>OH</sub>  | I <sub>OH</sub> = -4mA                                       | V <sub>DD</sub> - 0.6 |     |                 | V     |
| Output Low Level                                                                       | V <sub>OL</sub>  | I <sub>OL</sub> = 4mA                                        |                       |     | 0.4             | V     |
| <b>POWER SUPPLIES</b>                                                                  |                  |                                                              |                       |     |                 |       |
| Digital Power-Supply Voltage                                                           | V <sub>DD</sub>  |                                                              | 3.0                   |     | 3.6             | V     |
| Analog Power-Supply Voltage                                                            | V <sub>DDA</sub> |                                                              | 3.0                   |     | 3.6             | V     |
| Total Current for Digital and Analog Supplies                                          | I <sub>DC</sub>  | f <sub>OUT</sub> = 45MHz, no load<br>f <sub>IN</sub> = 13MHz |                       | 10  |                 | mA    |
| Power-Down Current                                                                     | I <sub>DC2</sub> | $\overline{\text{PD}}$ = low                                 |                       | 60  |                 | μA    |

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## AC ELECTRICAL CHARACTERISTICS

( $V_{DD} = V_{DDA} = +3.0V$  to  $+3.6V$ ,  $C_L = 10pF$  and  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ . Typical values are at  $V_{DD} = V_{DDA} = 3.3V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 2)

| PARAMETER                     | SYMBOL     | CONDITIONS                                                                               | MIN       | TYP       | MAX | UNITS     |
|-------------------------------|------------|------------------------------------------------------------------------------------------|-----------|-----------|-----|-----------|
| <b>OUTPUT CLOCK (CLK_OUT)</b> |            |                                                                                          |           |           |     |           |
| Minimum Frequency Range       | $f_{OUT}$  | $f_{IN} = 5MHz$ to $50MHz$                                                               | 4         |           |     | MHz       |
| Maximum Frequency Range       |            | $C_L < 5pF$                                                                              | 133       | 200       |     |           |
| Clock Rise Time               | $t_R$      | 20% to 80% of $V_{DD}$ , $f_{OUT} = 80MHz$ ,<br>$f_{IN} = 13MHz$                         |           | 1.5       |     | ns        |
| Clock Fall Time               | $t_F$      | 80% to 20% of $V_{DD}$ , $f_{OUT} = 80MHz$ ,<br>$f_{IN} = 13MHz$                         |           | 1.3       |     | ns        |
| Duty Cycle                    |            | $f_{OUT} = 45MHz$ , $f_{IN} = 13MHz$                                                     | 44        | 50        | 56  | %         |
| Output Period Jitter          | $J_P$      | $f_{OUT} = 45MHz$ , $f_{IN} = 13MHz$                                                     |           | 14        |     | ps<br>RMS |
|                               |            | $f_{OUT} = 80MHz$ , $f_{IN} = 13MHz$                                                     |           | 22        |     |           |
|                               |            | $f_{OUT} = 197MHz$ , $f_{IN} = 13MHz$                                                    |           | 13        |     |           |
| Soft Power-On Time            | $t_{PO2}$  | $\overline{PD}$ from low to high, $f_{OUT} = 45MHz$ ,<br>$f_{IN} = 13MHz$ , see Figure 2 |           | 1         |     | ms        |
| Hard Power-On Time            | $t_{PO1}$  | See Figure 2                                                                             |           | 15        |     | ms        |
| <b>VCXO CLOCK</b>             |            |                                                                                          |           |           |     |           |
| Crystal Frequency             | $f_{XTL}$  |                                                                                          |           | 27        |     | MHz       |
| Crystal Accuracy              |            |                                                                                          |           | $\pm 30$  |     | ppm       |
| Tuning Voltage Range          | $V_{TUNE}$ |                                                                                          | 0         |           | 3   | V         |
| VCXO Tuning Range             |            | $V_{TUNE} = 0$ to $3V$ , $C_1 = C_2 = 4pF$                                               | $\pm 150$ | $\pm 200$ |     | ppm       |
| TUNE Input Impedance          | $Z_{TUNE}$ |                                                                                          |           | 95        |     | $k\Omega$ |
| Output CLK Accuracy           |            | $V_{TUNE} = 1.5V$ , $C_1 = C_2 = 4pF$                                                    |           | $\pm 50$  |     | ppm       |

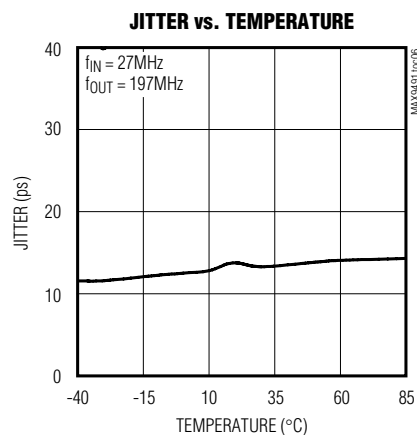
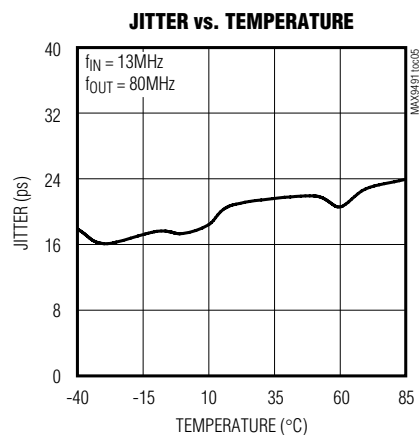
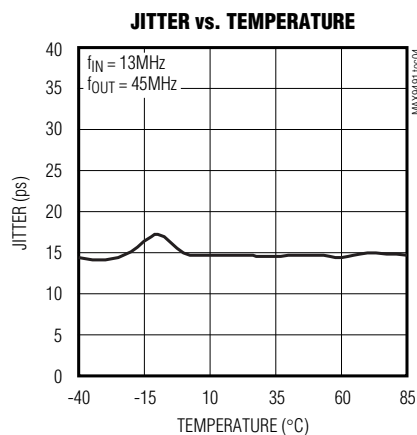
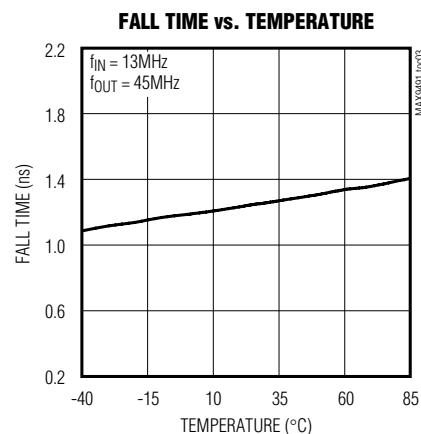
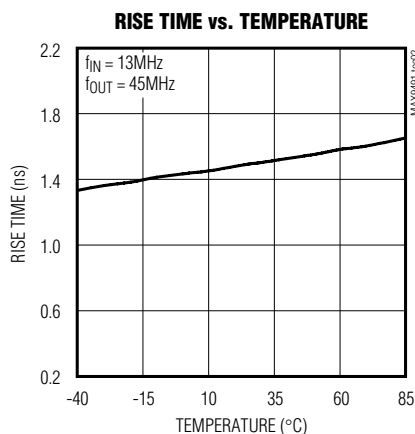
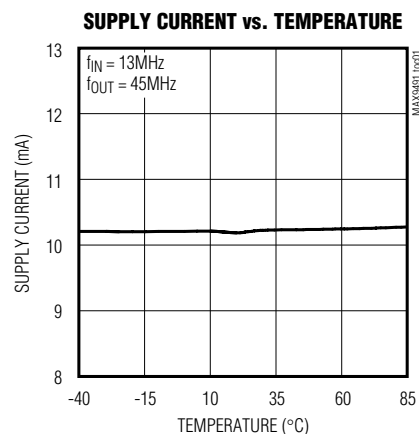
**Note 1:** All parameters are tested at  $T_A = +25^{\circ}C$ . Specifications over temperature are guaranteed by design and characterization.

**Note 2:** Guaranteed by design and characterization; limits are set at  $\pm 6$  sigma.

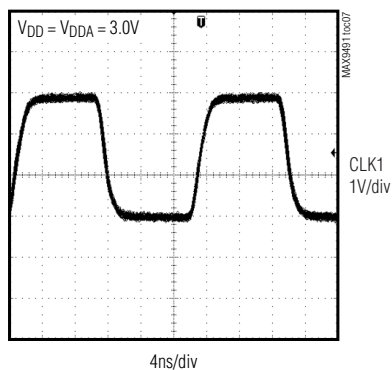
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## Typical Operating Characteristics

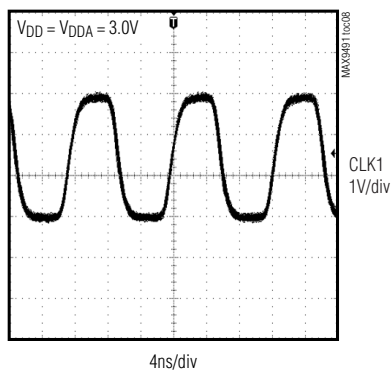
( $V_{DD} = V_{DDA} = +3.3V$ ,  $T_A = +25^\circ C$ ,  $f_{IN} = 13MHz$  clock,  $C_L = 10pF$ , 27MHz, unless otherwise noted.)



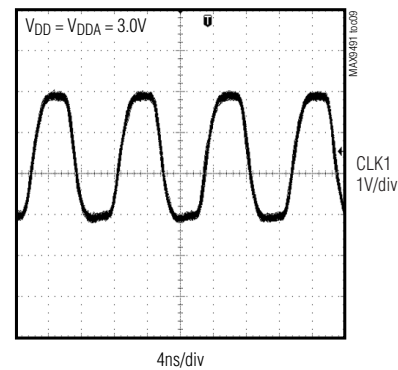
**TYPICAL CLK\_OUT WAVEFORM AT 45MHz**



**TYPICAL CLK\_OUT WAVEFORM AT 80MHz**



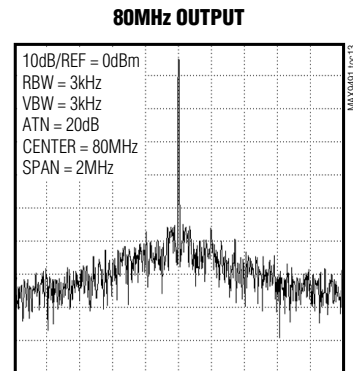
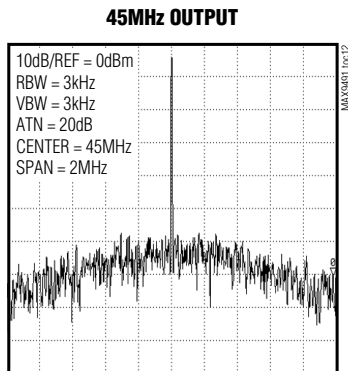
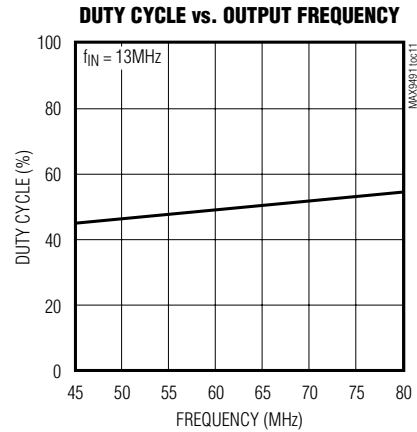
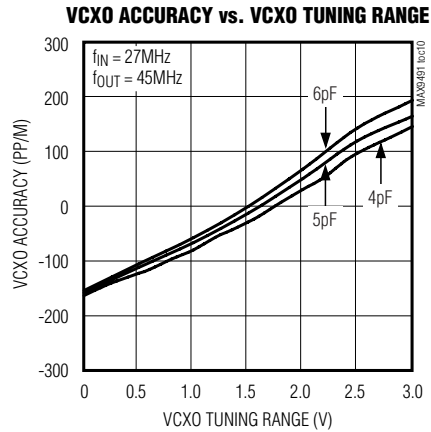
**TYPICAL CLK\_OUT WAVEFORM AT 197MHz**



# Factory Programmable Single PLL Clock Generator

## Typical Operating Characteristics (continued)

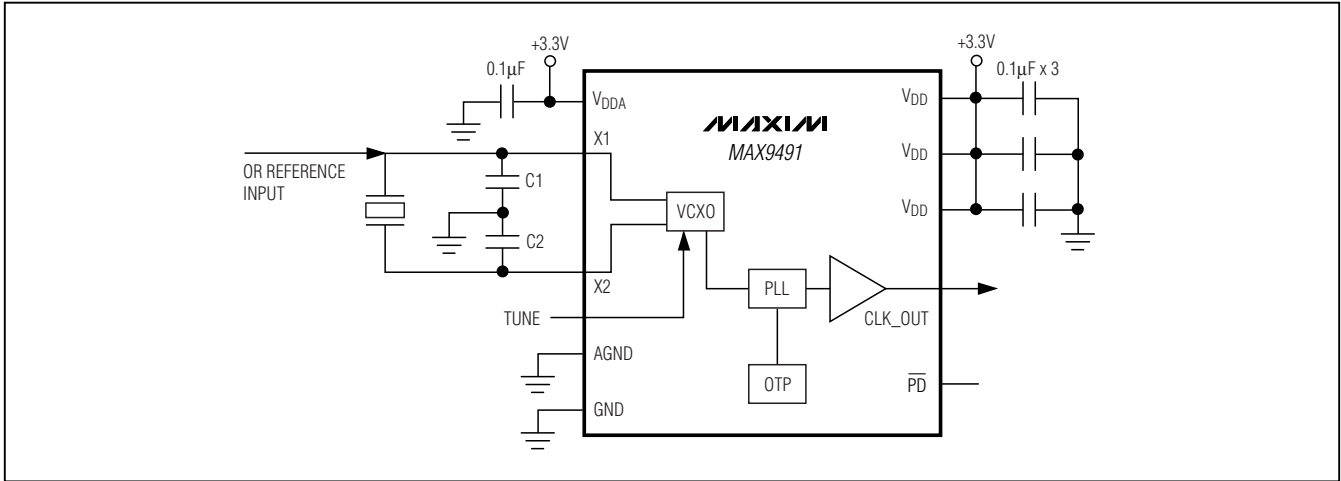
( $V_{DD} = V_{DDA} = +3.3V$ ,  $T_A = +25^\circ C$ ,  $f_{IN} = 13MHz$  clock,  $C_L = 10pF$ , 27MHz, unless otherwise noted.)



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## Typical Operating Circuit/Block Diagram



## Pin Description

| PIN             |             | NAME                   | FUNCTION                                                                                                                                                   |
|-----------------|-------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TQFN            | TSSOP       |                        |                                                                                                                                                            |
| 1               | 5           | TUNE                   | VCXO Tune Voltage Input. If using a reference clock input or VCXO is not used, connect TUNE to V <sub>DD</sub> .                                           |
| 2               | —           | V <sub>DDA</sub>       | Analog Power Supply. Bypass to GND with a 0.1µF capacitor.                                                                                                 |
| 3               | —           | AGND                   | Analog Ground                                                                                                                                              |
| 4, 10, 11       | 6, 9, 11    | GND                    | Ground                                                                                                                                                     |
| 5               | 7           | CLK_OUT                | Output Clock. Internally pulled down.                                                                                                                      |
| 6–9, 14, 19, 20 | 2, 3, 8, 10 | I.C.                   | Internally Connected. Leave unconnected for normal operation.                                                                                              |
| 12, 13, 16      | 4, 12       | V <sub>DD</sub>        | Power Supply. Bypass to GND with a 0.1µF capacitor.                                                                                                        |
| 15              | 13          | $\overline{\text{PD}}$ | Active-Low Power-Down Input. Pull high for normal operation. Drive $\overline{\text{PD}}$ low to place MAX9491 in power-down mode. Internally pulled down. |
| 17              | 14          | X2                     | Crystal Connection 2. Leave unconnected if using a reference clock.                                                                                        |
| 18              | 1           | X1                     | Crystal Connection 1 or Reference Clock Input                                                                                                              |
| EP              | —           | EP                     | Exposed Paddle (TQFN Only). Connect EP to GND or leave unconnected.                                                                                        |

## Detailed Description

The MAX9491 features a programmable fractional-N PLL, so frequencies between 4MHz to 200MHz can be generated. The device provides a buffered PLL clock output. The crystal input frequency can be between 5MHz and 35MHz, and the clock input between 5MHz and 50MHz. The internal VCXO has a fine-tuning range of  $\pm 200\text{ppm}$ .

### Power-Down

Driving  $\overline{\text{PD}}$  low places the MAX9491 in power-down mode.  $\overline{\text{PD}}$  then sets CLK\_OUT to high impedance and

shuts down the PLL. CLK\_OUT has an 80k $\Omega$  (typ) internal pulldown resistor.

### Voltage-Controlled Crystal Oscillator (VCXO)

The MAX9491's internal VCXO produces a reference clock for the PLL used to generate the CLK\_OUT. The oscillator uses a crystal as the base frequency reference and has a voltage-controlled tuning input for micro adjustment in a  $\pm 200\text{ppm}$  range. The tuning voltage, V<sub>TUNE</sub>, can vary from 0 to 3V as shown in Figure 1. The crystal should be AT-cut and oscillate on its fundamental mode with  $\pm 30\text{ppm}$ . The crystal shunt capacitor

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should be less than 10pF, including board parasitic capacitance. To achieve up to  $\pm 200\text{ppm}$  pullability, make sure the crystal-loading capacitance is less than 14pF. The VCXO is a free-running oscillator. It starts oscillating

with an internal POR signal and can be disabled by  $\overline{\text{PD}}$ . When VCXO is not used, connect TUNE to  $V_{\text{DD}}$ .

## Applications Information

### Using an Input Clock as the Reference

When an input clock is used as the reference, connect the input clock to X1, leave X2 unconnected, and connect TUNE to  $V_{\text{DD}}$ .

### Crystal Selection

When using a crystal with the MAX9491's internal oscillator, connect the crystal to X1 and X2. Choose an AT-cut crystal that oscillates on its fundamental mode with  $\pm 30\text{ppm}$  and loading capacitance less than 14pF. To achieve a wide VCXO tuning range, select a crystal with motional capacitance greater than 7fF and connect 6pF or less shunt capacitors at both X1 and X2 to ground. When the VCXO is used as an oscillator, select both shunt capacitors to approximately 13pF. The optimal shunt capacitors for achieving minimum frequency offset can be determined experimentally.

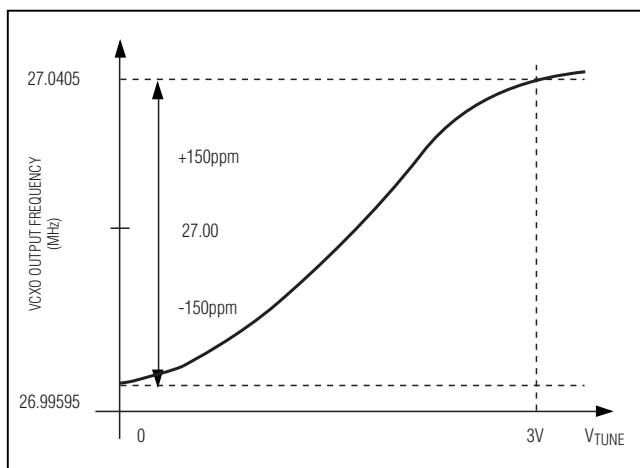


Figure 1. VCXO Tuning Range for a 27MHz Crystal

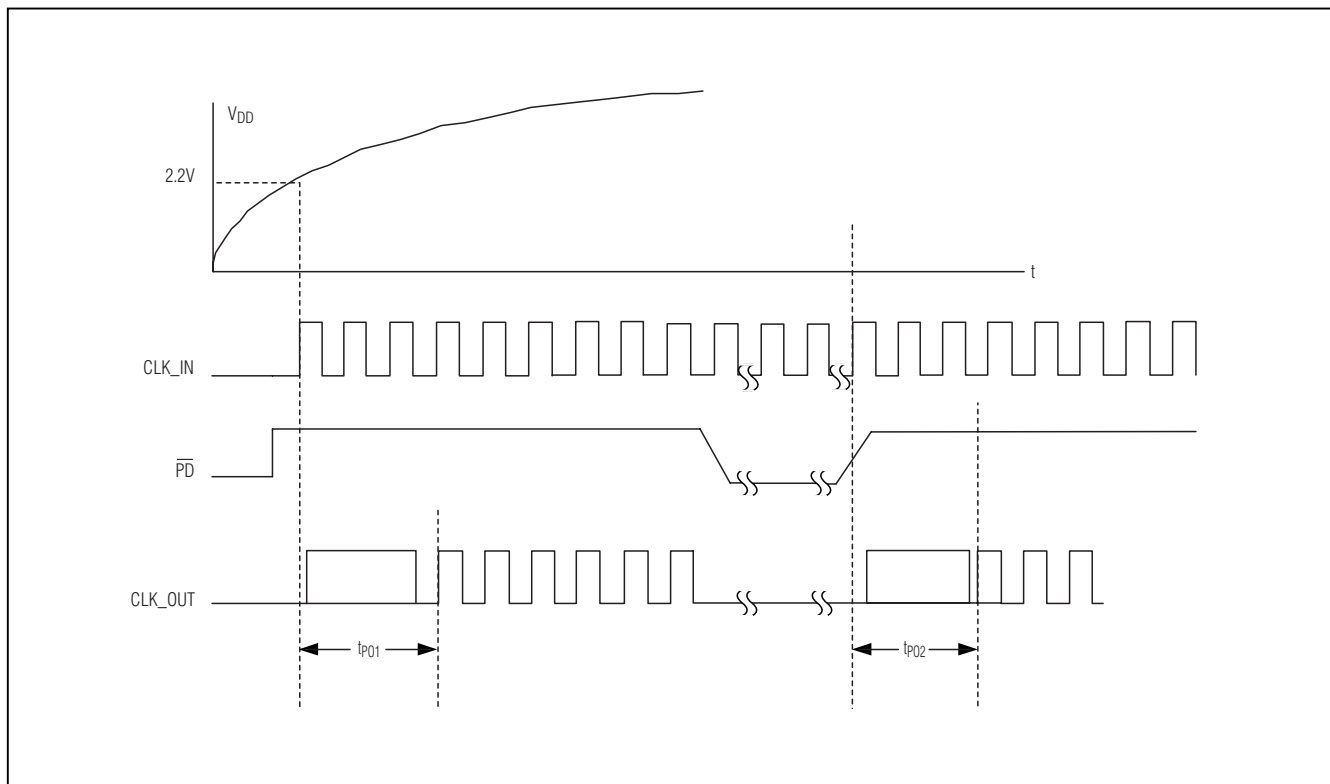


Figure 2. PLL Settling Time

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## **Board Layout Considerations and Bypassing**

The MAX9491's high-frequency oscillator requires proper layout to ensure stability. For best performance, place components as close as possible to the device.

Digital or AC transient signals on GND can create noise at the clock output. Return GND to the highest quality ground available. Bypass each  $V_{DD}$  and  $V_{DDA}$  with a 0.1 $\mu$ F capacitor, placed as close as possible to the device. Careful PC board ground layout minimizes crosstalk between the output and digital inputs.

## **Chip Information**

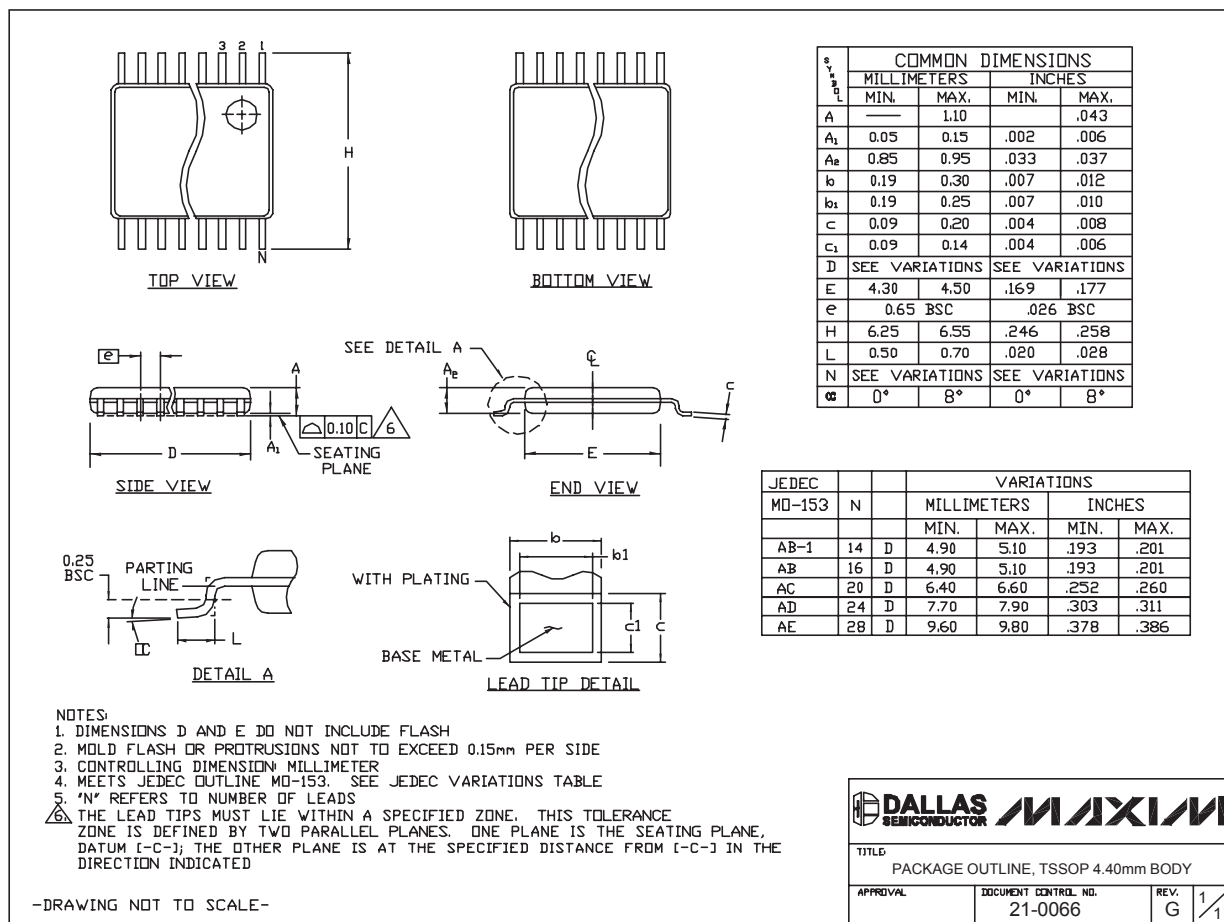
PROCESS: CMOS

# Factory Programmable Single PLL Clock Generator

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

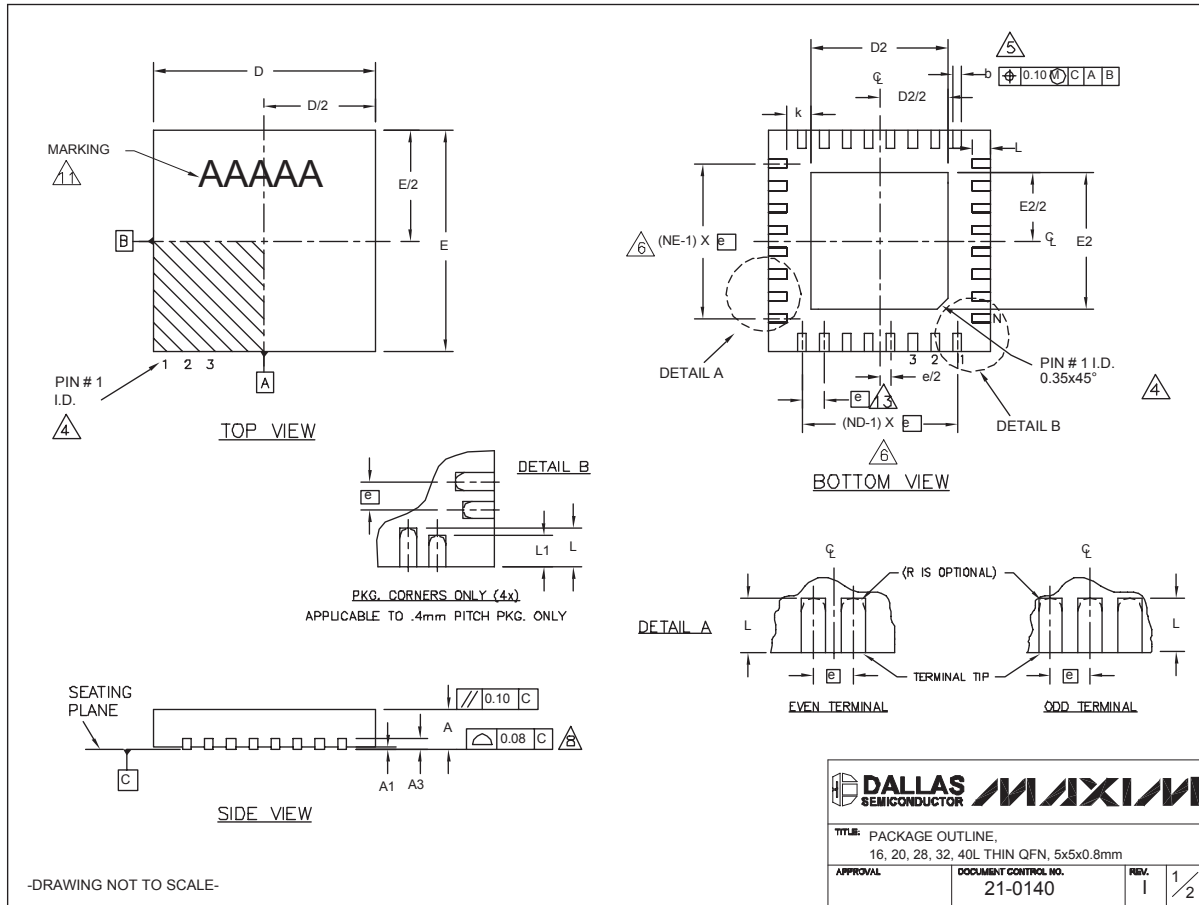
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# Factory Programmable Single PLL Clock Generator

## Package Information (continued)

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# Factory Programmable Single PLL Clock Generator

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

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| COMMON DIMENSIONS |           |      |      |           |      |      |           |      |      |           |      |      |           |      |      |
|-------------------|-----------|------|------|-----------|------|------|-----------|------|------|-----------|------|------|-----------|------|------|
| PKG.              | 16L 5x5   |      |      | 20L 5x5   |      |      | 28L 5x5   |      |      | 32L 5x5   |      |      | 40L 5x5   |      |      |
| SYMBOL            | MIN.      | NOM. | MAX. | MIN.      | NOM. | MAX. | MIN.      | NOM. | MAX. | MIN.      | NOM. | MAX. | MIN.      | NOM. | MAX. |
| A                 | 0.70      | 0.75 | 0.80 | 0.70      | 0.75 | 0.80 | 0.70      | 0.75 | 0.80 | 0.70      | 0.75 | 0.80 | 0.70      | 0.75 | 0.80 |
| A1                | 0         | 0.02 | 0.05 | 0         | 0.02 | 0.05 | 0         | 0.02 | 0.05 | 0         | 0.02 | 0.05 | 0         | 0.02 | 0.05 |
| A3                | 0.20 REF. |      |      | 0.20 REF. |      |      | 0.20 REF. |      |      | 0.20 REF. |      |      | 0.20 REF. |      |      |
| b                 | 0.25      | 0.30 | 0.35 | 0.25      | 0.30 | 0.35 | 0.20      | 0.25 | 0.30 | 0.20      | 0.25 | 0.30 | 0.15      | 0.20 | 0.25 |
| D                 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 |
| E                 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 | 4.90      | 5.00 | 5.10 |
| e                 | 0.80 BSC. |      |      | 0.65 BSC. |      |      | 0.50 BSC. |      |      | 0.50 BSC. |      |      | 0.40 BSC. |      |      |
| k                 | 0.25      | -    | -    | 0.25      | -    | -    | 0.25      | -    | -    | 0.25      | -    | -    | 0.25      | 0.35 | 0.45 |
| L                 | 0.30      | 0.40 | 0.50 | 0.45      | 0.55 | 0.65 | 0.45      | 0.55 | 0.65 | 0.30      | 0.40 | 0.50 | 0.40      | 0.50 | 0.60 |
| L1                | -         | -    | -    | -         | -    | -    | -         | -    | -    | -         | -    | -    | 0.30      | 0.40 | 0.50 |
| N                 | 16        |      |      | 20        |      |      | 28        |      |      | 32        |      |      | 40        |      |      |
| ND                | 4         |      |      | 5         |      |      | 7         |      |      | 8         |      |      | 10        |      |      |
| NE                | 4         |      |      | 5         |      |      | 7         |      |      | 8         |      |      | 10        |      |      |
| JEDEC             | WHHB      |      |      | WHHC      |      |      | WHHD-1    |      |      | WHHD-2    |      |      | ----      |      |      |

### NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JEDEC 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25 mm AND 0.30 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220, EXCEPT EXPOSED PAD DIMENSION FOR T2855-3 AND T2855-6.
10. WARPAGE SHALL NOT EXCEED 0.10 mm.
11. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
12. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
13. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e",  $\pm 0.05$ .

-DRAWING NOT TO SCALE-

| EXPOSED PAD VARIATIONS |      |      |      |      |      |      |                         |                    |  |
|------------------------|------|------|------|------|------|------|-------------------------|--------------------|--|
| PKG. CODES             | D2   |      |      | E2   |      |      | L exceptions $\pm 0.15$ | DOWN BONDS ALLOWED |  |
|                        | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |                         |                    |  |
| T1655-2                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | YES                |  |
| T1655-3                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | NO                 |  |
| T1655N-1               | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | NO                 |  |
| T2055-3                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | YES                |  |
| T2055-4                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | NO                 |  |
| T2055-5                | 3.15 | 3.25 | 3.35 | 3.15 | 3.25 | 3.35 | 0.40                    | YES                |  |
| T2855-3                | 3.15 | 3.25 | 3.35 | 3.15 | 3.25 | 3.35 | **                      | YES                |  |
| T2855-4                | 2.60 | 2.70 | 2.80 | 2.60 | 2.70 | 2.80 | **                      | YES                |  |
| T2855-5                | 2.60 | 2.70 | 2.80 | 2.60 | 2.70 | 2.80 | **                      | NO                 |  |
| T2855-6                | 3.15 | 3.25 | 3.35 | 3.15 | 3.25 | 3.35 | **                      | NO                 |  |
| T2855-7                | 2.60 | 2.70 | 2.80 | 2.60 | 2.70 | 2.80 | **                      | YES                |  |
| T2855-8                | 3.15 | 3.25 | 3.35 | 3.15 | 3.25 | 3.35 | 0.40                    | YES                |  |
| T2855N-1               | 3.15 | 3.25 | 3.35 | 3.15 | 3.25 | 3.35 | **                      | NO                 |  |
| T3255-3                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | YES                |  |
| T3255-4                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | NO                 |  |
| T3255-5                | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | YES                |  |
| T3255N-1               | 3.00 | 3.10 | 3.20 | 3.00 | 3.10 | 3.20 | **                      | NO                 |  |
| T4055-1                | 3.20 | 3.30 | 3.40 | 3.20 | 3.30 | 3.40 | **                      | YES                |  |

\*\*SEE COMMON DIMENSIONS TABLE

|                                                                                                                      |                                 |                                                                                       |     |
|----------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------------------------------------------------------------|-----|
|  <b>DALLAS</b><br>SEMICONDUCTOR |                                 |  |     |
| TITLE: PACKAGE OUTLINE,<br>16, 20, 28, 32, 40L THIN QFN, 5x5x0.8mm                                                   |                                 |                                                                                       |     |
| APPROVAL                                                                                                             | DOCUMENT CONTROL NO.<br>21-0140 | REV.<br>I                                                                             | 2/2 |

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