19-5214; Rev 0; 4/10

MAXIM

# Spread-Spectrum Clock Generators

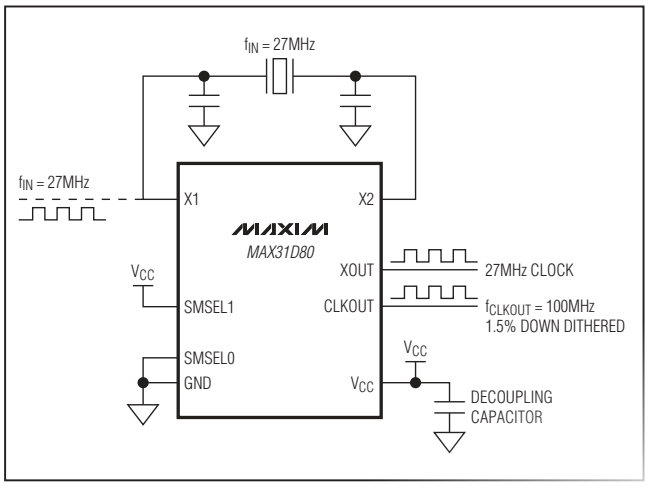


## General Description

The MAX31C80/MAX31D80 are spread-spectrum clock generators that contain a phase-locked loop (PLL) that generates a 2MHz to 134MHz clock from an input clock or crystal. The PLL can provide a spread-spectrum down-dithered (MAX31D80) or center-dithered (MAX31C80) frequency-modulated clock. The devices also buffer the incoming clock and provide this output on a separate pin.

The MAX31C80/MAX31D80 are provided in a 10-pin TDFN package and operate over a full -40°C to +125°C automotive temperature range. Devices can be factory programmed for multiple combinations of input and output frequencies (see the *Ordering Information* table). A low-cost, low-frequency crystal can be used at the input to generate frequencies up to 134MHz.

## Typical Application Circuit




## Features

- **2MHz to 134MHz Spread-Spectrum Clock Generator**
- **Input Can Be Either an 8MHz to 34MHz Crystal or 8MHz to 134MHz Clock**
- **Factory-Programmable Output Frequencies in 2MHz to 134MHz Range**
- **Low-Cost Crystal at Low Frequency Used to Generate High Frequencies**
- **On-Board PLL is Capable of Spread-Spectrum Frequency Modulation**
- **Down- or Center-Dither Spread-Spectrum Frequency Modulation**
- **User-Configurable Spread-Spectrum Dither Magnitude**
- **Low Cycle-to-Cycle Jitter**
- **3.3V Supply Voltage**
- **Temperature Range: -40°C to +125°C**
- **Small Package: 10-Pin TDFN (3mm x 3mm x 0.8mm)**

## Applications

Graphics Cards

Set-Top Boxes

Automotive Infotainment

Printers

## Ordering Information

| PART | TEMP RANGE | DITHER MODE | PIN-PACKAGE |
|---|---|---|---|
| **MAX31C80**T-xxx+ | -40°C to +125°C | Center | 10 TDFN-EP* |
| MAX31C80T-xxx+T | -40°C to +125°C | Center | 10 TDFN-EP* |
| **MAX31D80**T-xxx+ | -40°C to +125°C | Down | 10 TDFN-EP* |
| MAX31D80T-xxx+T | -40°C to +125°C | Down | 10 TDFN-EP* |

*xxx = Factory-programmable output frequency and dither rate (see the Selector Guide table).*
*+Denotes a lead(Pb)-free/RoHS-compliant package.*
*T = Tape and reel.*
**EP = Exposed pad.*

***Selector Guide appears at end of data sheet.***

# Spread-Spectrum Clock Generators

## ABSOLUTE MAXIMUM RATINGS

Voltage Range on $V_{CC}$ Relative to GND.....-0.3V to +4.3V
Voltage Range on Any Other Pin
Relative to GND .....-0.3V to ($V_{CC}$ + 0.3V)*
Continuous Power Dissipation ($T_A$ = +70°C)
10-Pin TDFN (derate 24.4mW/°C above +70°C).....1951.2mW

Storage Temperature Range.....-55°C to +135°C
Lead Temperature (soldering, 10s) .....+300°C
Soldering Temperature (reflow) .....+260°C

**Not to exceed +4.3V.*

*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.*

## RECOMMENDED OPERATING CONDITIONS

($T_A$ = -40°C to +125°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | | 3.0 | 3.3 | 3.6 | V |
| Input Logic 0 (SMSEL0 and SMSEL1) | $V_{IL}$ | | -0.3 | | 0.25 x $V_{CC}$ | V |
| Input Logic 1 (SMSEL0 and SMSEL1) | $V_{IH}$ | | 0.75 x $V_{CC}$ | | $V_{CC}$ + 0.3 | V |
| Input Logic Unconnected (SMSEL0 and SMSEL1) | $V_{IF}$ | Limits are in case user wants to force voltage instead of unconnecting this pin | 0.4 x $V_{CC}$ | | 0.55 x $V_{CC}$ | V |
| Input Logic 0 for X1 | $V_{IL:X1}$ | | -0.3 | | 0.3 x $V_{CC}$ | V |
| Input Logic 1 for X1 | $V_{IH:X1}$ | | 0.7 x $V_{CC}$ | | $V_{CC}$ + 0.3 | V |
| XOUT Load | $C_{L:XOUT}$ | | | | 15 | pF |
| CLKOUT Load | $C_{L:CLKOUT}$ | 2MHz ≤ $f_{CLKOUT}$ < 67MHz | | | 15 | pF |
| | | 67MHz ≤ $f_{CLKOUT}$ < 101MHz | | | 10 | |
| | | 101MHz ≤ $f_{CLKOUT}$ ≤ 134MHz | | | 7 | |
| Crystal Frequency | $f_{IN}$ | | 8 | | 34 | MHz |
| Clock Input Frequency | $f_{IN}$ | | 8 | | 134 | MHz |
| Crystal ESR | $X_{ESR}$ | | | | 90 | Ω |
| Clock Input Duty Cycle | $f_{INDC}$ | | 40 | | 60 | % |
| Crystal Parallel Load Capacitance | $C_{CL}$ | | | | 18 | pF |

## DC ELECTRICAL CHARACTERISTICS

(3.0V ≤ $V_{CC}$ ≤ 3.6V, $T_A$ = -40°C to +125°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Supply Current | $I_{DD}$ | $f_{IN}$ = 27MHz, $f_{CLKOUT}$ = 100MHz, down dithered, $C_L$ = 10pF | | 22 | | mA |
| Input Leakage (SMSEL0 and SMSEL1) | $I_{IL}$ | SMSEL_ = GND or $V_{CC}$ | | | ±15 | µA |
| Low-Level Output Voltage (XOUT and CLKOUT) | $V_{OL}$ | $I_{OL}$ = 10mA | | | 0.2 | V |
| High-Level Output Voltage (XOUT and CLKOUT) | $V_{OH}$ | $I_{OH}$ = -10mA | $V_{CC}$ - 0.2 | | | V |
| Input Capacitance (X1 and X2) | $C_{IN}$ | | | 5 | | pF |

## AC ELECTRICAL CHARACTERISTICS

(3.0V ≤ $V_{CC}$ ≤ 3.6V, $T_A$ = -40°C to +125°C, unless otherwise noted.)

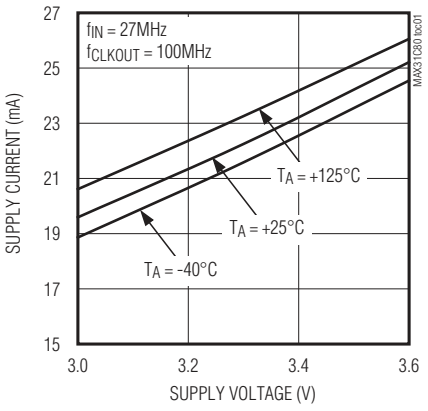
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| CLKOUT Duty Cycle | $f_{CLKOUT:DC}$ | $C_{L:CLKOUT}$ = 7pF | 40 | | 60 | % |
| XOUT Duty Cycle | $f_{XOUT:DC}$ | $C_{L:XOUT}$ = 7pF, $T_A$ = +25°C, $V_{CC}$ = 3.3V | 40 | | 60 | |
| Rise Time | $t_R$ | $C_{L:CLKOUT}$ = 7pF | | 1.6 | | ns |
| Fall Time | $t_F$ | $C_{L:CLKOUT}$ = 7pF | | 1.6 | | ns |
| Dither Rate Range | $f_{DR}$ | Factory programmable | 20 | | 40 | kHz |
| Dither Rate Accuracy | | | -4 | | +4 | % |
| Peak Cycle-to-Cycle Jitter | $t_J$ | CLKOUT = 100MHz, 10,000 cycles, $T_A$ = +25°C | | 75 | | ps |
| Power-Up Time | $t_{PUP}$ | $V_{CC}$ valid to output active, $T_A$ = +25°C, $V_{CC}$ = 3.3V | | 1 | | ms |

# Spread-Spectrum Clock Generators

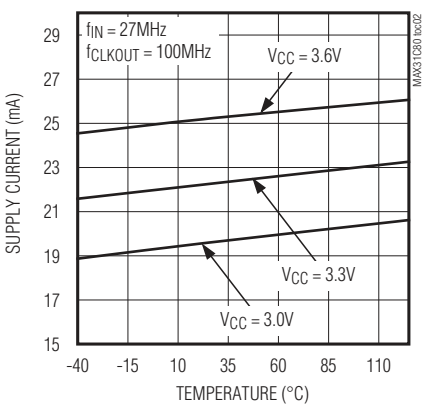
## Typical Operating Characteristics

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

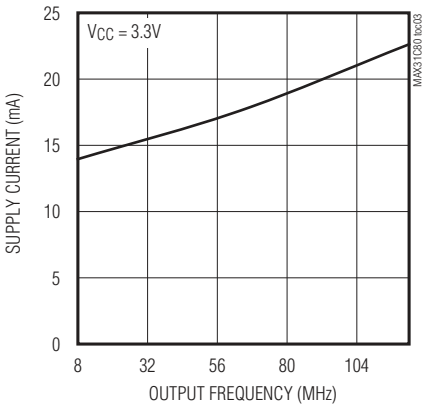
**SUPPLY CURRENT vs. SUPPLY VOLTAGE**



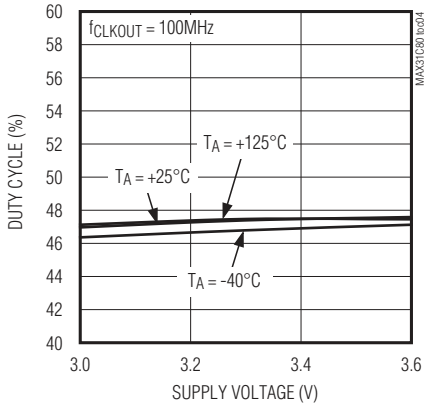

**SUPPLY CURRENT vs. TEMPERATURE**



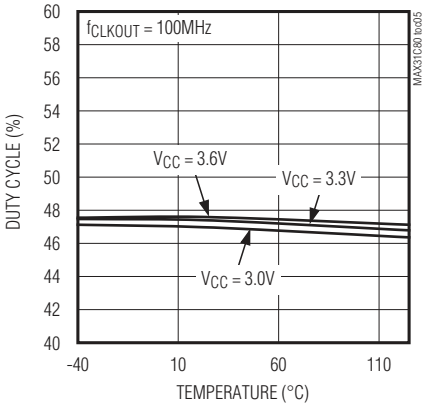

**SUPPLY CURRENT vs. OUTPUT FREQUENCY**



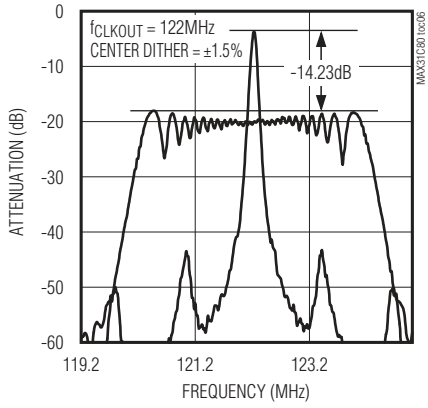

**DUTY CYCLE vs. SUPPLY VOLTAGE**



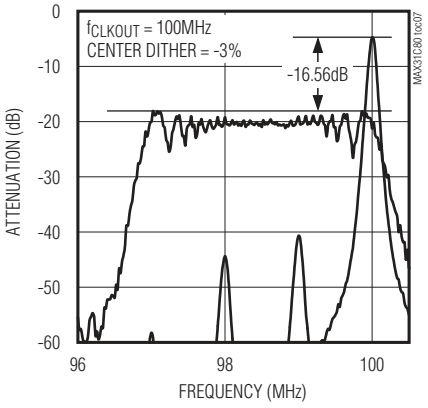

**DUTY CYCLE vs. TEMPERATURE**



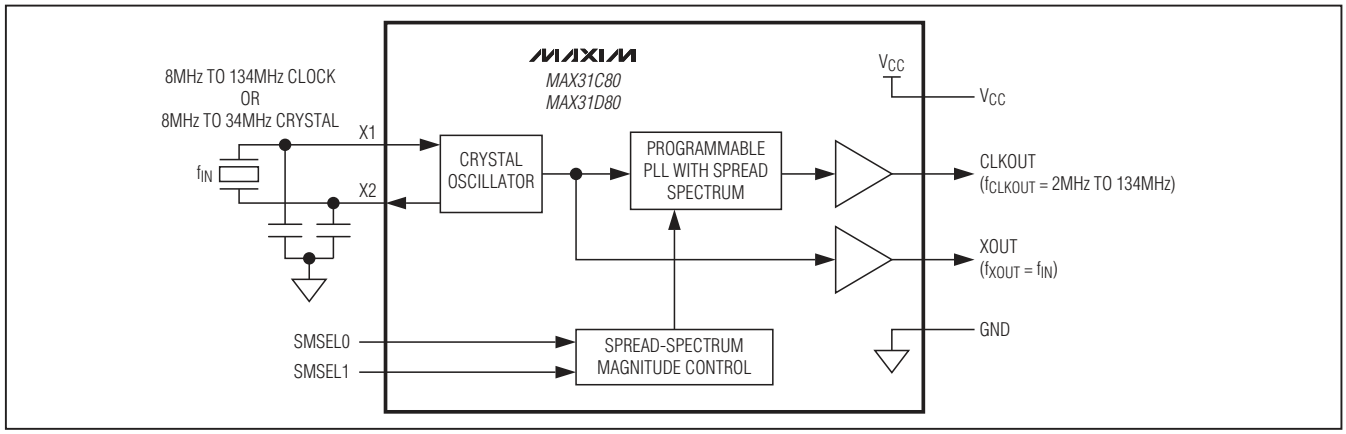

**FREQUENCY SPECTRUM AT 122MHz WITH CENTER SPREAD**



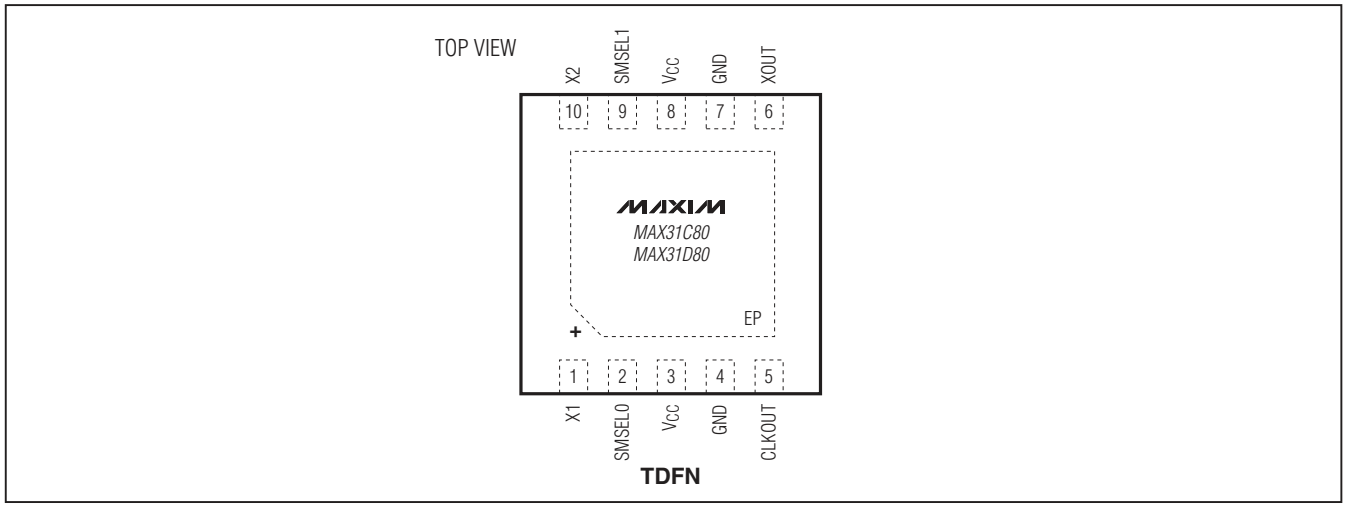

**FREQUENCY SPECTRUM AT 100MHz WITH DOWN DITHER**



## Block Diagram




## Pin Configuration




## Pin Description

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | X1 | Crystal Drive/Clock Input. A crystal with the proper loading is connected across X1 and X2. Instead of a crystal, a clock can be applied at the X1 input. If no clock or crystal is present, then no clock is output at either XOUT or CLKOUT. |
| 2, 9 | SMSEL0, SMSEL1 | Spread-Spectrum Magnitude Select. These are three-state digital inputs to determine the spread-spectrum magnitude. Tables 1 and 2 provide details for configuration of these pins for down and center dither, respectively. |

| PIN | NAME | FUNCTION |
|---|---|---|
| 3, 8 | VCC | Supply Voltage |
| 4, 7 | GND | Ground |
| 5 | CLKOUT | Clock Output. Spread-spectrum-capable digital output clock from the PLL. |
| 6 | XOUT | Crystal Buffered Output. Buffered digital output of the input crystal or clock. |
| 10 | X2 | Crystal Drive Output. A crystal with the proper loading is connected across X1 and X2. If a clock is applied at the X1 input, then X2 should be left open circuit. |
| — | EP | Exposed Pad. Connect to GND. |

# Spread-Spectrum Clock Generators

## Detailed Description

The MAX31C80/MAX31D80 modulate an input clock to generate a center-dithered or down-dithered spread-spectrum output. An 8MHz to 27MHz crystal or 8MHz to 134MHz oscillator input is applied to the device. An internal PLL dithers the output clock at a user-selectable magnitude to produce a down-dithered or center-dithered output clock. The output clock's frequency is programmable from 2MHz to 134MHz. The devices also buffer the incoming clock and provide this output on a separate pin.

### Spread-Spectrum Dither Magnitude

The MAX31D80 can generate down-dithered magnitudes up to -3%. The MAX31C80 can generate center-dithered magnitudes up to ≤ 1.5%. The desired magnitude is selected using the input pins SMSEL1 and SMSEL0 as shown in Tables 1 and 2. A power cycle is required after each change of the dither magnitude for the changes to take effect.

**Table 1. Spread-Spectrum Mode and Magnitude Select (for Down Dither)**

| SMSEL1 | SMSEL0 | SPREAD-SPECTRUM MAGNITUDE SELECTED (%) | SPREAD-SPECTRUM DITHER MODE SELECTED |
|---|---|---|---|
| 0 | 0 | Spread-Spectrum Disabled | |
| 0 | Unconnected | 0 to -0.25 | Down Dither |
| 0 | 1 | 0 to -0.375 | |
| Unconnected | 0 | 0 to -0.5 | |
| Unconnected | Unconnected | 0 to -0.75 | |
| Unconnected | 1 | 0 to -1.0 | |
| 1 | 0 | 0 to -1.5 | |
| 1 | Unconnected | 0 to -2.0 | |
| 1 | 1 | 0 to -3.0 | |

**Table 2. Spread-Spectrum Mode and Magnitude Select (for Center Dither)**

| SMSEL1 | SMSEL0 | SPREAD-SPECTRUM MAGNITUDE SELECTED (%) | SPREAD-SPECTRUM DITHER MODE SELECTED |
|---|---|---|---|
| 0 | 0 | Spread-Spectrum Disabled | |
| 0 | Unconnected | -0.25 to +0.25 | Center Dither |
| 0 | 1 | -0.375 to +0.375 | |
| Unconnected | 0 | -0.5 to +0.5 | |
| Unconnected | Unconnected | -0.75 to +0.75 | |
| Unconnected | 1 | -1.0 to +1.0 | |
| 1 | 0 | -1.5 to +1.5 | |
| 1 | Unconnected | N/A | |
| 1 | 1 | N/A | |

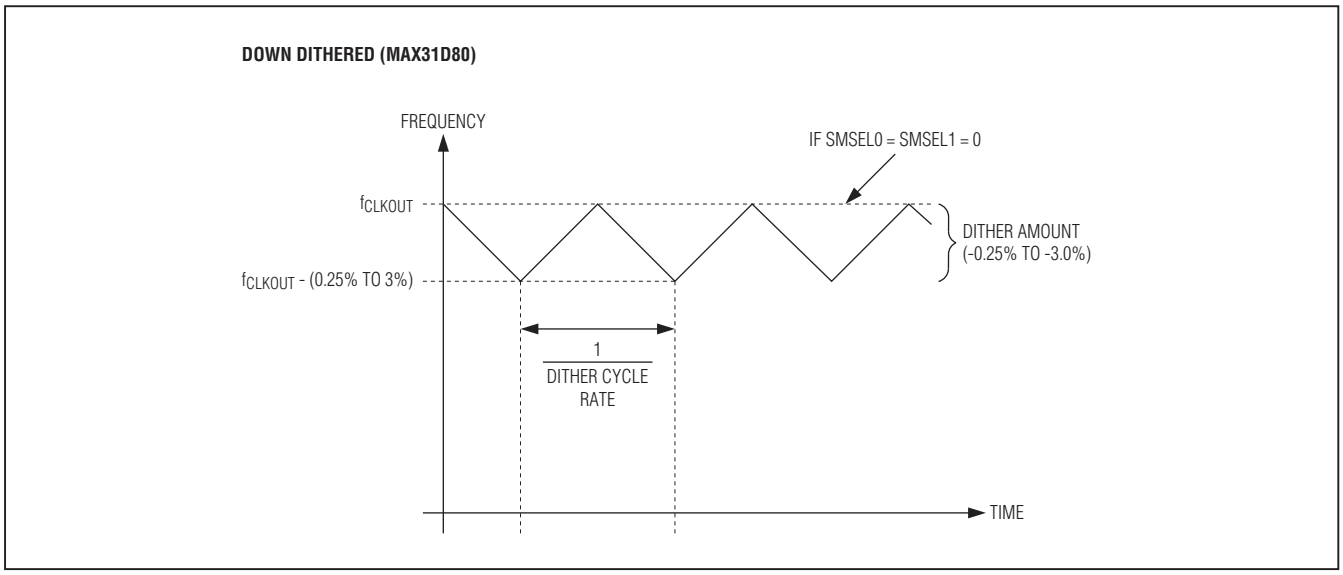



*Figure 1. Spread-Spectrum Frequency Modulation (Down Dithered)*

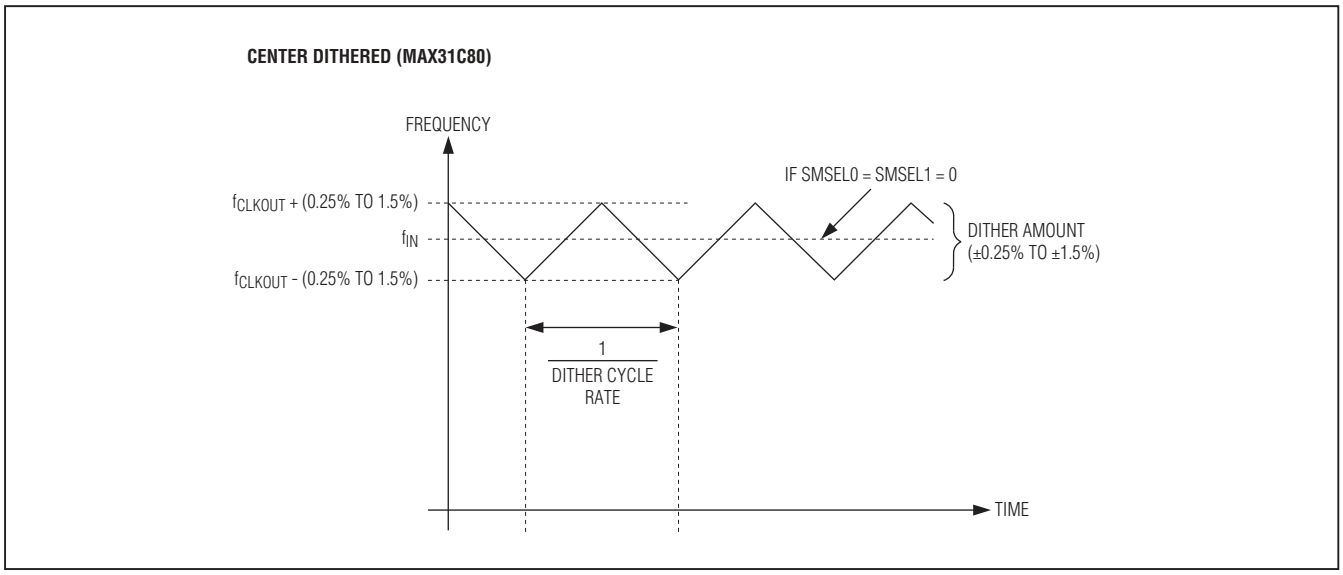



*Figure 2. Spread-Spectrum Frequency Modulation (Center Dithered)*

# Spread-Spectrum Clock Generators

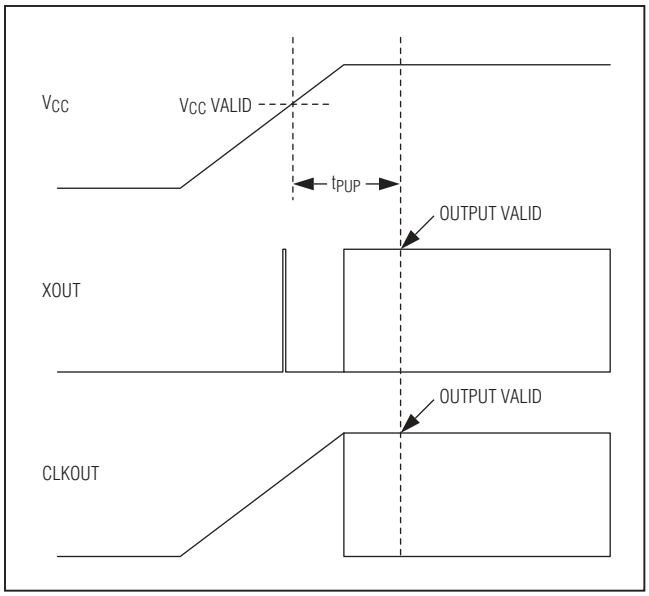



*Figure 3. Power-Up Timing*

### Factory Programmability

The MAX31C80/MAX31D80 can provide a variety of frequencies, which are available to users by ordering the device according to specifications listed in the *Selector Guide* table.

Email the factory at **custom.oscillators@maxim-ic.com** to obtain custom output frequencies for specific input frequencies not mentioned in the *Selector Guide* table.

## Applications Information

### Power-Supply Decoupling

To achieve best results, it is highly recommended that a decoupling capacitor be used on the IC power-supply pins. Typical values of decoupling capacitors are 0.01µF and 0.1µF. Use a high-quality, ceramic, surface-mount capacitor and mount it as close as possible to the VCC pins of the IC to minimize lead inductance.

## Selector Guide

| PART | INPUT FREQUENCY (MHz) | OUTPUT FREQUENCY (MHz) | DITHER RATE (kHz) | DITHER TYPE |
|---|---|---|---|---|
| **MAX31C80**T-UGQ+ | 27 | 100 | 31.25 | Center |
| MAX31C80T-002+ | 25 | 63.05 | 32.05 | Center |
| **MAX31D80**T-UGQ+ | 27 | 100 | 31.25 | Down |
| MAX31D80T-003+ | 12 | 12 | 25 | Down |

*+Denotes a lead(Pb)-free/RoHS-compliant package.*

## Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO. |
|---|---|---|
| 10 TDFN-EP | T1033+1 | 21-0137 |

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 4/10 | Initial release | — |