

# Spread-Spectrum Crystal Multiplier

DS1080L

## General Description

The DS1080L is a low-jitter, crystal-based clock generator with an integrated phase-locked loop (PLL) to generate spread-spectrum clock outputs from 16MHz to 134MHz. The device is pin-programmable to select the clock multiplier rate as well as the dither magnitude. The DS1080L has a spread-spectrum disable mode and a power-down mode to conserve power.

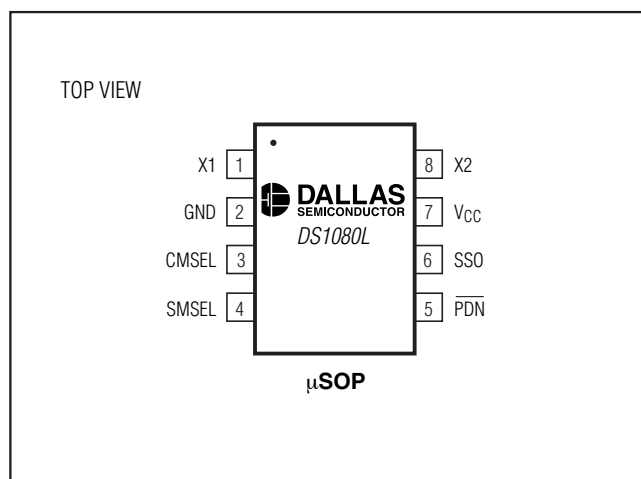
## Applications

Automotive  
Cable Modems  
Cell Phones  
Computer Peripherals  
Copiers  
Infotainment  
PCs  
Printers

## Features

- ◆ Generates Spread-Spectrum Clocks from 16MHz to 134MHz
- ◆ Selectable Clock Multiplier Rates of 1x, 2x, and 4x
- ◆ Center Spread-Spectrum Dithering
- ◆ Selectable Spread-Spectrum Modulation Magnitudes of  $\pm 0.5\%$ ,  $\pm 1.0\%$ , and  $\pm 1.5\%$
- ◆ Spread-Spectrum Disable Mode
- ◆ Low Cycle-to-Cycle Jitter
- ◆ Power-Down Mode with High-Impedance Output
- ◆ Low Cost
- ◆ Low Power Consumption
- ◆ 3.0V to 3.6V Single-Supply Operation
- ◆  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Temperature Operation
- ◆ Small 8-Lead  $\mu\text{SOP}$  Package

## Pin Configuration



## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
DS1080L+	$-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$	8 $\mu\text{SOP}$

+Denotes lead-free package.

# Spread-Spectrum Crystal Multiplier

## ABSOLUTE MAXIMUM RATINGS

Voltage on  $V_{CC}$  Relative to GND ..... -0.5V to +3.63V  
 Voltage on Any Lead Relative  
 to GND ..... -0.5V to ( $V_{CC} + 0.5V$ ), not to exceed +3.63V

Operating Temperature Range ..... -40°C to +125°C  
 Storage Temperature Range ..... -55°C to +125°C  
 Soldering Temperature..... See 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.*

## RECOMMENDED OPERATING CONDITIONS

( $T_A = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ )

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	$V_{CC}$	(Note 1)	3.0		3.6	V
Input Logic 1	$V_{IH}$		0.8 x $V_{CC}$		$V_{CC} + 0.3$	V
Input Logic 0	$V_{IL}$		GND - 0.3		0.2 x $V_{CC}$	V
Input Logic Float	$I_{IF}$	$0V < V_{IN} < V_{CC}$ (Note 2)			$\pm 1$	$\mu\text{A}$
Input Leakage	$I_{IL}$	$0V < V_{IN} < V_{CC}$ (Note 3)			$\pm 80$	$\mu\text{A}$
SSO Load	$C_{SSO}$	SSO < 67MHz			15	pF
		$67\text{MHz} \leq \text{SSO} < 101\text{MHz}$			10	
		$101\text{MHz} \leq \text{SSO} < 134\text{MHz}$			7	
Crystal or Clock Input Frequency	$f_{IN}$		16.0		33.4	MHz
Crystal ESR	$X_{ESR}$				90	$\Omega$
Clock Input Duty Cycle	$F_{INDC}$		40		60	%
Crystal Parallel Load Capacitance	$C_L$	(Note 4)			18	pF

## DC ELECTRICAL CHARACTERISTICS

( $V_{CC} = +3.0V$  to  $+3.6V$ ,  $T_A = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current	$I_{CC1}$	$C_{SSO} = 15\text{pF}$ , SSO = 16MHz			13	mA
Power-Down Current	$I_{CCQ}$	$\overline{PDN} = \text{GND}$ , all input pins floating			200	$\mu\text{A}$
Output Leakage (SSO)	$I_{OZ}$	$\overline{PDN} = \text{GND}$	-1		+1	$\mu\text{A}$
Low-Level Output Voltage (SSO)	$V_{OL}$	$I_{OL} = 4\text{mA}$			0.4	V
High-Level Output Voltage (SSO)	$V_{OH}$	$I_{OH} = -4\text{mA}$	2.4			V
Input Capacitance (X1/X2)	$C_{IN}$	(Note 5)		5		pF

# Spread-Spectrum Crystal Multiplier

## AC ELECTRICAL CHARACTERISTICS

( $V_{CC} = +3.0$  to  $+3.6V$ ,  $T_A = -40^{\circ}C$  to  $+125^{\circ}C$ .)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SSO Duty Cycle	SSODC	Measured at $V_{CC} / 2$		40		60	%
Rise Time	$t_R$	(Note 6)			1.6		ns
Fall Time	$t_F$	(Note 6)			1.6		ns
Peak Cycle-to-Cycle Jitter	$t_J$	$f_{SSO} = 16MHz$ , $T_A = -40$ to $+85^{\circ}C$ , 10,000 cycles (Note 5)			75		ps
Power-Up Time	$t_{POR}$	$\overline{PDN}$ pin (Note 7)	16MHz			20	ms
			33.4MHz			11	
Power-Down Time	$t_{PDN}$	$\overline{PDN}$ pin (Notes 8 and 9)				100	ns
Dither Rate	$f_{DITHER}$				$f_{IN} / 1024$		

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

**Note 2:** Maximum source/sink current applied to input to be considered a float.

**Note 3:** Applicable to pins CMSEL, SMSEL, and  $\overline{PDN}$ .

**Note 4:** See information about  $C_{L1}$  and  $C_{L2}$  in the *Applications Information* section at the end of the data sheet.

**Note 5:** Not production tested.

**Note 6:** For 7pF load.

**Note 7:** Time between  $\overline{PDN}$  deasserted to output active.

**Note 8:** Time between  $\overline{PDN}$  asserted to output high impedance.

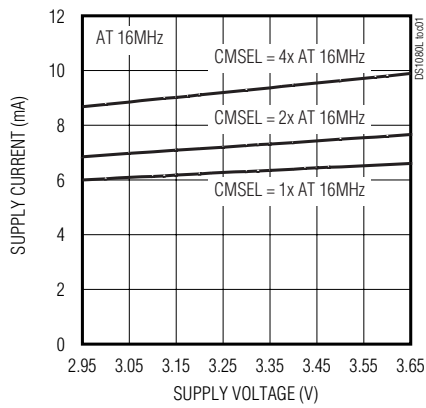
**Note 9:** Guaranteed by design.

# Spread-Spectrum Crystal Multiplier

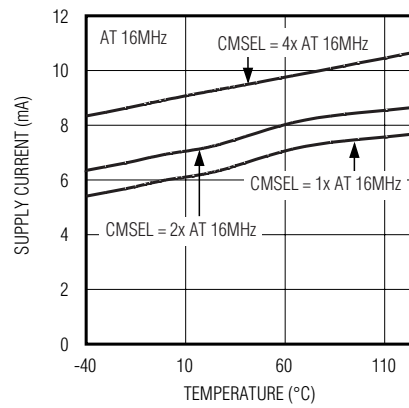
## Typical Operating Characteristics

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

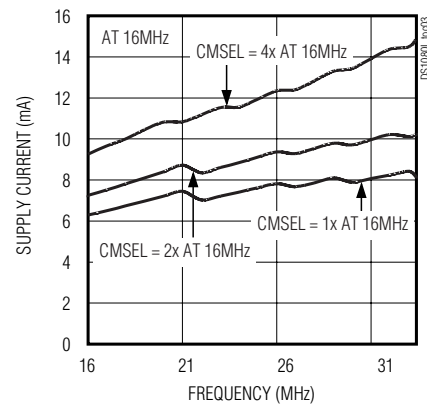
**SUPPLY CURRENT vs. SUPPLY VOLTAGE**



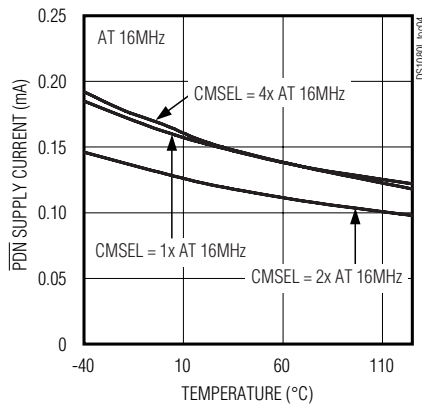
**SUPPLY CURRENT vs. TEMPERATURE**



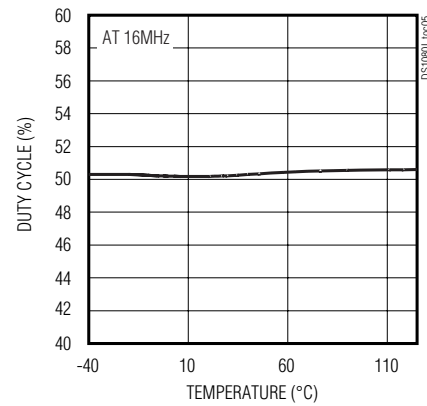
**SUPPLY CURRENT vs. FREQUENCY**



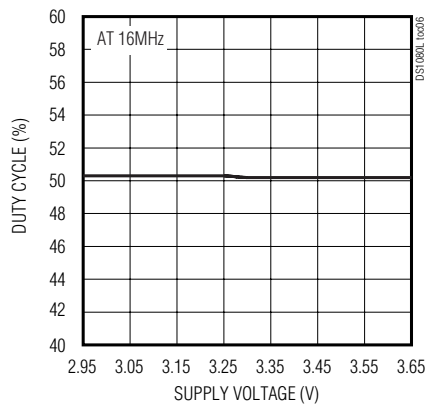
**PDN SUPPLY CURRENT vs. TEMPERATURE**



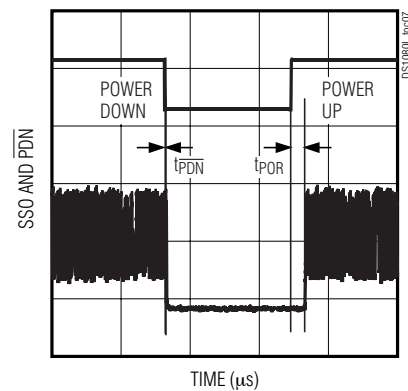
**DUTY CYCLE vs. TEMPERATURE**



**DUTY CYCLE vs. SUPPLY VOLTAGE**



**OUTPUT DURING POWER UP AND POWER DOWN**

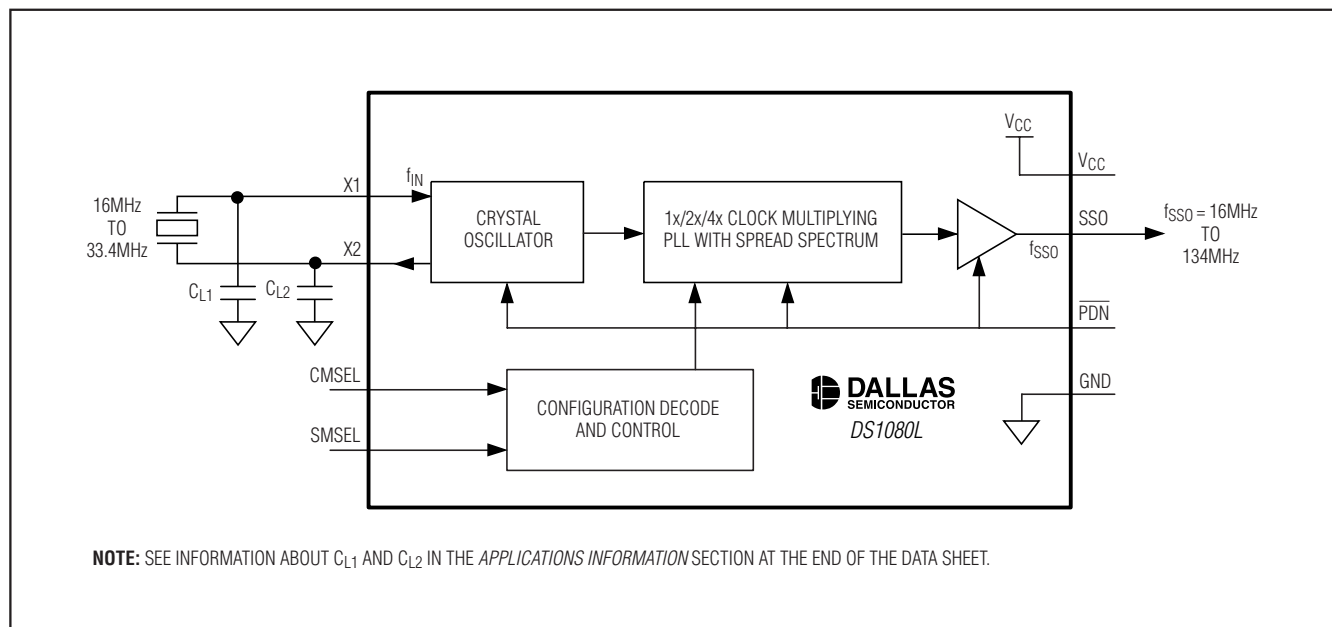


# Spread-Spectrum Crystal Multiplier

## Pin Description

PIN	NAME	FUNCTION
1	X1	Crystal Drive/Clock Input. A crystal with the proper loading capacitors is connected across X1 and X2. Instead of a crystal, a clock can be applied at the X1 input.
2	GND	Signal Ground
3	CMSEL	Clock Multiplier Select. Tri-level digital input. 0 = 1x Float = 2x 1 = 4x
4	SMSEL	Spread-Spectrum Magnitude Select. Tri-level digital input. 0 = $\pm 0.5\%$ Float = $\pm 1.0\%$ 1 = $\pm 1.5\%$
5	$\overline{\text{PDN}}$	Power-Down/Spread-Spectrum Disable. Tri-level digital input. 0 = Power-Down/SSO Tri-Stated Float = Power-Up/Spread Spectrum Disabled 1 = Power-Up/Spread Spectrum Enabled
6	SSO	Spread-Spectrum Clock Multiplier Output. Outputs a 1x, 2x, or 4x spread-spectrum version of the crystal or clock applied at the X1/X2 pins.
7	VCC	Supply Voltage
8	X2	Crystal Drive Output. A crystal with the proper loading capacitors is connected across X1 and X2. If a clock is connected to X1, then X2 should be left open circuit.

## Block Diagram



# Spread-Spectrum Crystal Multiplier

## Detailed Description

The DS1080L is a crystal multiplier with center spread-spectrum capability. A 16MHz to 33.4MHz crystal is connected to the X1 and X2 pins. Alternately, a 16MHz to 33.4MHz clock can be applied to X1 in place of the crystal. In such applications, X2 would be left open circuit. Using the CMSEL input, the user selects whether the attached crystal or input clock is multiplied by 1, 2, or 4. The DS1080L is capable of generating spread-spectrum clocks from 16MHz to 134MHz.

The PLL can dither the output clock about its center frequency at a user-selectable magnitude. Using the SMSEL input, the user selects the dither magnitude. The  $\overline{\text{PDN}}$  input can be used to place the device into a low-power standby mode where the SSO output is tri-stated. If the  $\overline{\text{PDN}}$  pin is floated, the SSO output is active but the spread-spectrum dithering is disabled. The spread-spectrum dither rate is fixed at  $f_{\text{IN}} / 1024$  to keep the dither rate above the audio frequency range. On power-up, the output clock (SSO) remains tri-stated until the PLL reaches a stable frequency ( $f_{\text{SSO}}$ ) and dither ( $f_{\text{DITHER}}$ ).

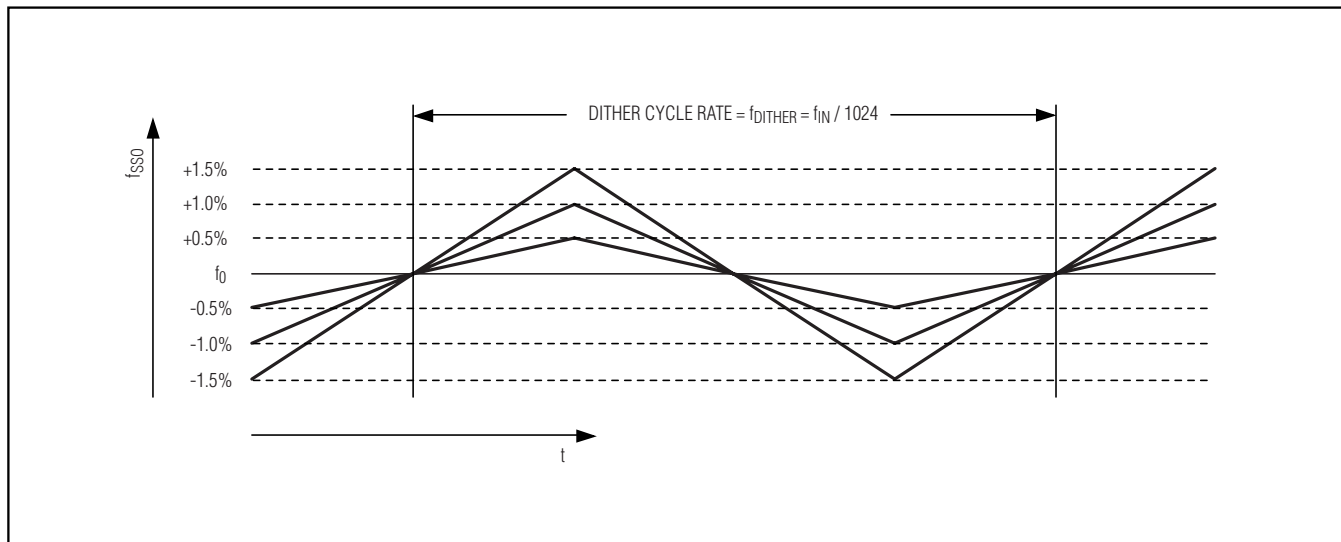
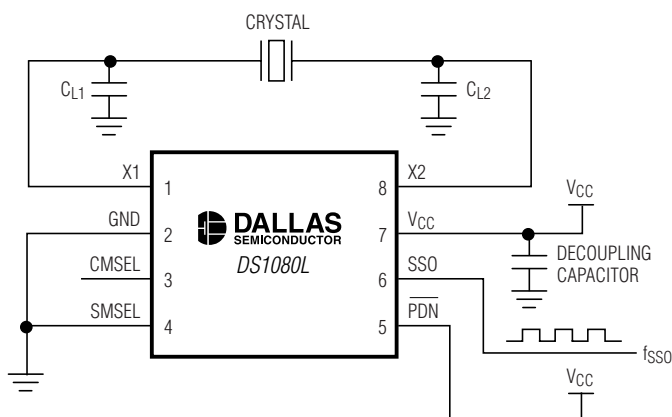


Figure 1. Spread-Spectrum Frequency Modulation

# Spread-Spectrum Crystal Multiplier

## Typical Operating Circuit



**NOTE:** IN THE ABOVE CONFIGURATION WITH  $\overline{\text{PDN}}$  CONNECTED TO  $V_{CC}$ ,  $\text{SMSEL}$  CONNECTED TO GND AND  $\text{CMSEL}$  FLOATING, THE DEVICE IS IN NORMAL OPERATION WITH 2x CLOCK MULTIPLICATION, AND SPREAD-SPECTRUM MAGNITUDE OF  $\pm 0.5\%$ .

## Applications Information

### Crystal Selection

The DS1080L requires a parallel resonating crystal operating in the fundamental mode, with an ESR of less than  $90\Omega$ . The crystal should be placed very close to the device to minimize excessive loading due to parasitic capacitances.

### Oscillator Input

When driving the DS1080L using an external oscillator clock, consider the input (X1) to be high impedance.

### Crystal Capacitor Selection

The load capacitors  $C_{L1}$  and  $C_{L2}$  are selected based on the crystal specifications (from the data sheet of the crystal used). The crystal parallel load capacitance is calculated as follows:

$$C_L = \frac{C_{L1} \times C_{L2}}{C_{L1} + C_{L2}} C_{IN} \quad \text{Equation 1}$$

For the DS1080L use  $C_{L1} = C_{L2} = C_{LX}$ .

In this case, the equation then reduces to:

$$C_L = \frac{C_{LX}}{2} + C_{IN} \quad \text{Equation 2}$$

where  $C_{L1} = C_{L2} = C_{LX}$ .

Equation 2 is used to calculate the values of  $C_{L1}$  and  $C_{L2}$  based on values on  $C_L$  and  $C_{IN}$  noted in the data sheet electrical specifications.

### Power-Supply Decoupling

To achieve best results, it is highly recommended that a decoupling capacitor is used on the IC power-supply pins. Typical values of decoupling capacitors are  $0.001\mu\text{F}$  and  $0.1\mu\text{F}$ . Use a high-quality, ceramic, surface-mount capacitor, and mount it as close as possible to the  $V_{CC}$  and GND pins of the IC to minimize lead inductance.

### Layout Considerations

As noted earlier, the crystal should be placed very close to the device to minimize excessive loading due to parasitic capacitances. Care should also be taken to minimize loading on pins that could be floated as a programming option ( $\text{SMSEL}$  and  $\text{CMSEL}$ ). Coupling on inputs due to clocks should be minimized.

# **Spread-Spectrum Crystal Multiplier**

## **Chip Technology**

TRANSISTOR COUNT: 3951

SUBSTRATE CONNECTED TO GROUND

## **Package Information**

For the latest package outline information, go to

[www.maxim-ic.com/DallasPackInfo](http://www.maxim-ic.com/DallasPackInfo).

*Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.*

**8** **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**

© 2006 Maxim Integrated Products Printed USA **MAXIM** is a registered trademark of Maxim Integrated Products, Inc.

 **DALLAS** SEMICONDUCTOR is a registered trademark of Dallas Semiconductor Corporation.