19-3493; Rev 2; 4/07

MAXIM

Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

General Description

The MAX7384 dual-speed silicon oscillator replaces ceramic resonators, crystals, and crystal-oscillator modules as the primary and secondary clock source for microcontrollers in 3V, 3.3V, and 5V applications. The MAX7384 features a factory-programmed high-speed oscillator, a 32.768kHz oscillator, a clock enable input, a clock-selector input, and a µP power-on-reset (POR) supervisor. The clock output can be switched at any time between the high-speed clock and the 32.768kHz clock for low-power operation. Switchover is synchronized internally to provide glitch-free clock switching.

Unlike typical crystal and ceramic-resonator oscillator circuits, the MAX7384 is resistant to vibration and EMI. The high-output-drive current and absence of high-impedance nodes makes the oscillator less susceptible to dirty or humid operating conditions. With a wide operating temperature range as the MAX7384 is a good choice for demanding home appliance, industrial, and automotive environments.

The MAX7384 is available with factory-programmed frequencies ranging from 10MHz to 16MHz. See Table 1 for standard frequencies and contact the factory for custom frequencies and POR thresholds.

The MAX7384 is available in an 8-pin µMAX® package. The MAX7384 operating temperature range is -40°C to +125°C.

Applications

White Goods
Automotive
Consumer Products
Appliances and Controls
Handheld Products
Portable Equipment
Microcontroller Systems

µMAX is a registered trademark of Maxim Integrated Products, Inc.

Pin Configuration appears at end of data sheet.

Features

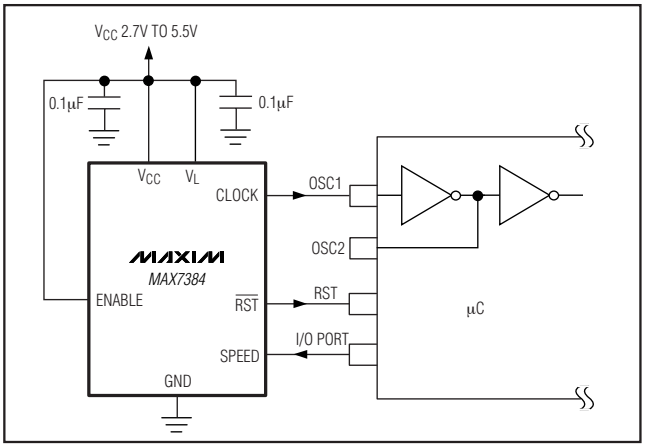
- **2.7V to 5.5V Operation**
- **High-Speed Oscillator from 10MHz to 16MHz**
- **Low-Speed 32.768kHz Oscillator**
- **Glitch-Free Clock-Speed Switching**
- **Integrated POR (Factory Programmable)**
- **±10mA Clock-Output Drive Capability**
- **2.5% Initial Accuracy**
- **Typical 4.5mA Operating Current at 16MHz**
- **Typical 0.5µA Shutdown Supply Current**
- **Typical 13µA Operating Current at 32.768kHz**
- **±100ppm/°C Frequency Drift**
- **Clock Enable Input**
- **50% Duty Cycle**
- **5ns Output Rise and Fall Time**
- **-40°C to +125°C Temperature Range**

Ordering Information

PART*	TEMP RANGE	PIN-PACKAGE	RESET OUTPUT
MAX7384B_ _ _	-40°C to +125°C	8 µMAX	Active low push-pull
MAX7384C_ _ _	**-40°C to +125°C**	**8 µMAX**	**Open drain**

**Standard version is shown in bold. The first letter after the part number designates the reset output option. Insert the letter corresponding to the desired reset threshold level from Table 1 in the next position. Insert the two-letter code from Table 2 in the remaining two positions for the desired frequency range. Table 1 and Table 2 are located at the end of the data sheet.*

Typical Application Circuit



Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND .....-0.3V to +6.0V
All Other Pins to GND .....-0.3V to (V_{CC} + 0.3V)
CLOCK, $\overline{RST}$ Current .....±50mA
Input Current (SPEED, ENABLE) .....±50mA
Continuous Power Dissipation (T_A = +70°C)
8-Pin µMAX (derate 4.5mW/°C above +70°C) ...362mW (U8-1)
Operating Temperature Range .....-40°C to +125°C
Junction Temperature .....+150°C
Storage Temperature Range .....-65°C to +150°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.

ELECTRICAL CHARACTERISTICS

(*Typical Operating Circuit*, V_{CC} = 2.7V to 5.5V, V_L = V_{CC}, T_A = -40°C to +125°C. Typical values are at V_{CC} = 5.0V, T_A = +25°C, unless otherwise noted.) (Notes 1 and 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage	V_{CC}, V_L		2.7		5.5	V
Operating Supply Current	I_{CC} + I_L	f_{CLOCK} = 16MHz, V_{CC} = 5.5V, no load			8.7	mA
		f_{CLOCK} = 14MHz, V_{CC} = 5.5V, no load			8.0	
		f_{CLOCK} = 12MHz, V_{CC} = 5.5V, no load			6.5	
		f_{CLOCK} = 11MHz, V_{CC} = 5.5V, no load			6.0	
		f_{CLOCK} = 10MHz, V_{CC} = 5.5V, no load			5.4	
		f_{CLOCK} = 32.768kHz, V_{CC} = 5.5V, no load		13	25	µA
Shutdown Supply Current	I_{SHDN}	ENABLE = 0V; I_{SHDN} = I_{CC} + I_L		0.5	1	µA
LOGIC INPUTS (SPEED, ENABLE)						
Input High Voltage	V_{IH}		0.7 x V_{CC}			V
Input Low Voltage	V_{IL}				0.3 x V_{CC}	V
Input Current	I_{IN}	V_{CC} = V_{SPEED} = V_{ENABLE} = 5.5V			2	µA
CLOCK OUTPUT						
Output High Voltage	V_{OH}	V_{CC} = 4.5V, I_{SOURCE} = 7.0mA	V_{CC} - 0.4			V
		V_{CC} = 3.0V, I_{SOURCE} = 2.0mA for MAX7384xSxx				
Output Low Voltage	V_{OL}	V_{CC} = 4.5V, I_{SINK} = 20mA			0.4	V
		V_{CC} = 3.0V, I_{SINK} = 10mA				
Fast Clock Frequency Accuracy	f_{CLOCK}	V_{CC} = 5V (for MAX7384xMxx) or V_{CC} = 3.3V (for MAX7384xSxx), T_A = +25°C, deviation from nominal frequency	-2.5		+2.5	%
		V_{CC} = 3.0V to 5.5V, T_A = +25°C, deviation from nominal frequency	-5.0		+3.5	
Fast Clock Temperature Coefficient		(Note 3)		±100	±550	ppm/°C
Slow Clock Frequency	f_{CLOCK}	V_{CC} = 5V (for MAX7384xMxx) or V_{CC} = 3.3V (for MAX7384xSxx), T_A = +25°C	32.268	32.768	33.268	kHz
		V_{CC} = 3.0V to 5.5V, T_A = +25°C	31.768	32.768	33.768	

ELECTRICAL CHARACTERISTICS (continued)

(*Typical Operating Circuit*, V_{CC} = 2.7V to 5.5V, V_L = V_{CC}, T_A = -40°C to +125°C. Typical values are at V_{CC} = 5.0V, T_A = +25°C, unless otherwise noted.) (Notes 1 and 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Slow Clock Temperature Coefficient		(Note 3)			±50	±325	ppm/°C
Duty Cycle		(Note 3)		40	50	60	%
Output Period Jitter	J_P	f_{OUT} = 16MHz; ±6σ period jitter			±240		ps
Output Rise Time	t_R	10% to 90%, C_L = 10pF			5		ns
Output Fall Time	t_F	90% to 10%, C_L = 10pF			5		ns
Power-On-Reset Threshold Accuracy		V_{CC} rising, deviation from nominal threshold (V_{TH}) (Table 1)	T_A = +25°C	-2		+2	%
				-5		+5	
Power-On-Reset Hysteresis		Difference between rising and falling thresholds			1		%
Power-On-Reset Delay	PORdly	V_{CC} rising from 0 to 5V in 1µs at +25°C			122		µs
RESET OUTPUT ($\overline{RST}$)							
Output High Voltage (Note 4)	V_{OH}	V_{CC} = 4.5V, I_{SOURCE} = 7.0mA (MAX7384xMxx)		V_{CC} - 0.4			V
		V_{CC} = 3.0V, I_{SOURCE} = 2.0mA (MAX7384xSxx)					
Output Low Voltage	V_{OL}	V_{CC} = 4.5V, I_{SINK} = 20mA (MAX7384xMxx)				0.4	V
		V_{CC} = 3.0V, I_{SINK} = 10mA (MAX7384xSxx)					

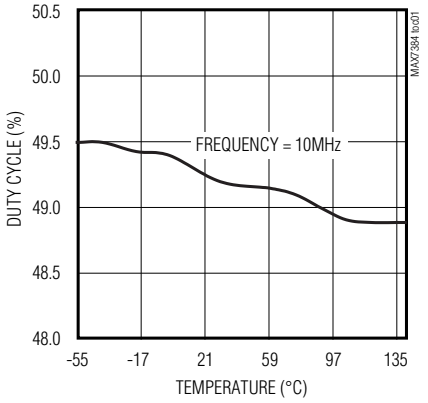
Note 1: All parameters tested at T_A = +25°C. Specifications over temperature are guaranteed by design.
Note 2: Oscillator is enabled when V_{CC} > V_{TH}.
Note 3: Guaranteed by design. Not production tested.
Note 4: For push-pull output only.

Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

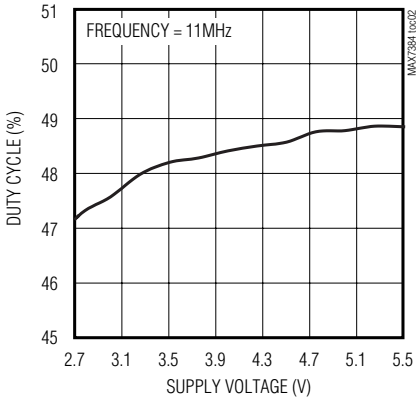
Typical Operating Characteristics

(V_{CC} = V_L = V_{ENABLE} = V_{SPEED} = 5V, T_A = +25°C, frequency = 10MHz, unless otherwise noted.)

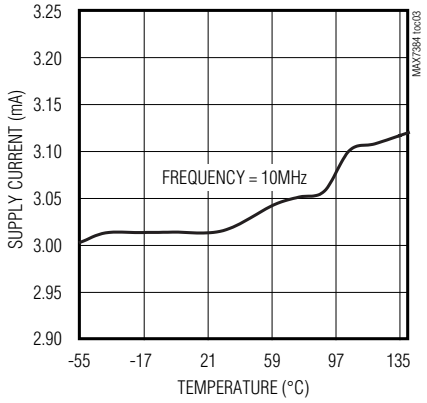
DUTY CYCLE vs. TEMPERATURE



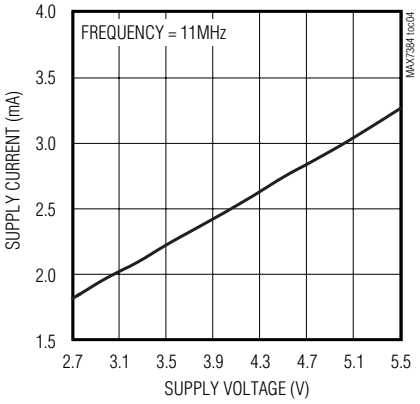
DUTY CYCLE vs. SUPPLY VOLTAGE



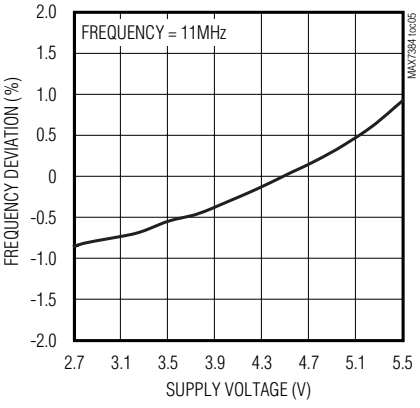
SUPPLY CURRENT vs. TEMPERATURE



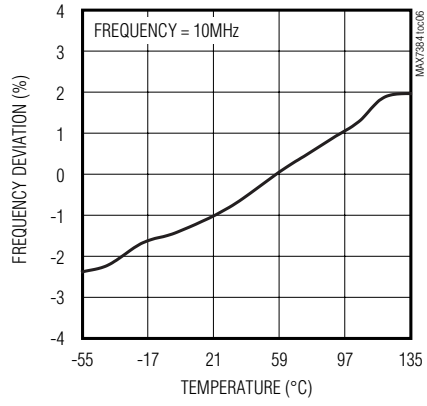
SUPPLY CURRENT vs. SUPPLY VOLTAGE



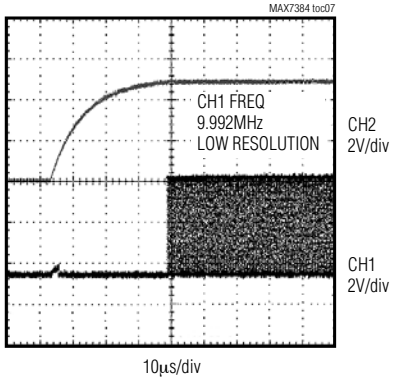
FREQUENCY DEVIATION vs. SUPPLY VOLTAGE



FREQUENCY DEVIATION vs. TEMPERATURE

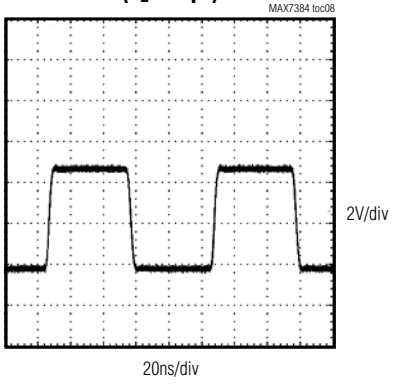


SETTLING TIME FROM START

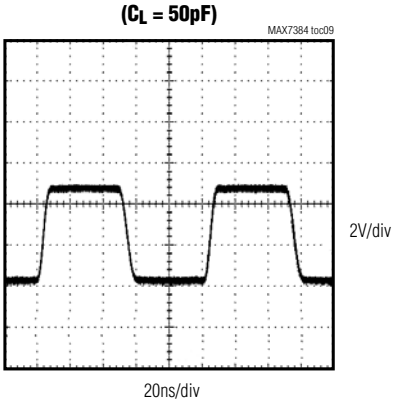


CHANNEL 1 = CLOCK, CHANNEL 2 = V_{CC}

CLOCK OUTPUT WAVEFORM (C_L = 10pF)



CLOCK OUTPUT WAVEFORM (C_L = 50pF)

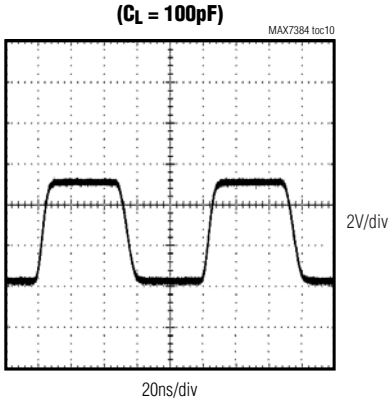


Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

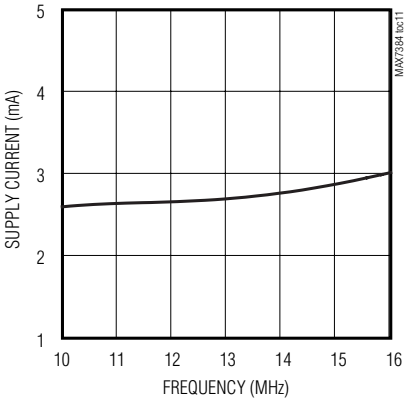
Typical Operating Characteristics (continued)

(V_{CC} = V_L = V_{ENABLE} = V_{SPEED} = 5V, T_A = +25°C, frequency = 10MHz, unless otherwise noted.)

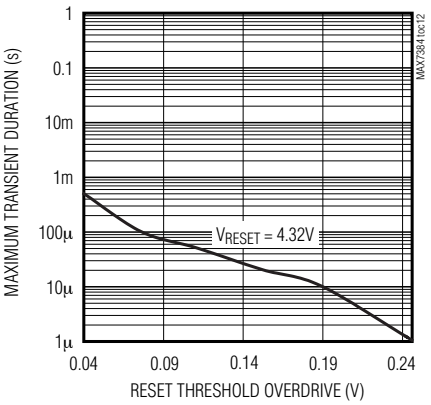
CLOCK OUTPUT WAVEFORM (C_L = 100pF)



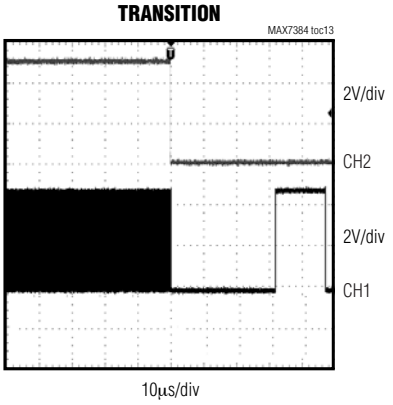
SUPPLY CURRENT vs. FREQUENCY



MAXIMUM TRANSIENT DURATION vs. RESET THRESHOLD OVERDRIVE

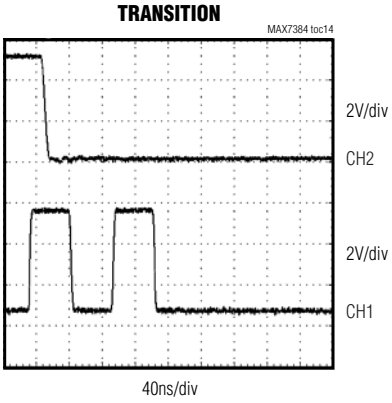


HIGH-SPEED TO LOW-SPEED TRANSITION



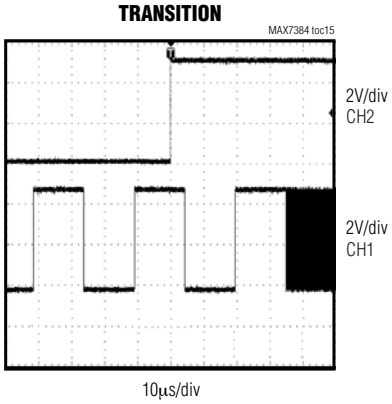
CHANNEL 1 = CLOCK, CHANNEL 2 = SPEED

HIGH-SPEED TO LOW-SPEED TRANSITION



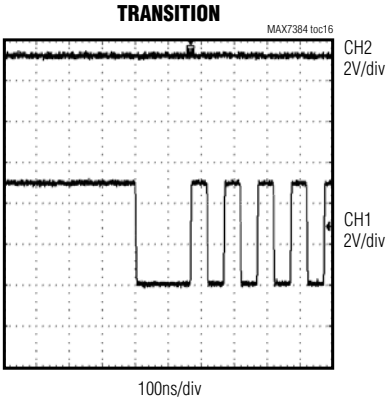
CHANNEL 1 = CLOCK, CHANNEL 2 = SPEED

LOW-SPEED TO HIGH-SPEED TRANSITION



CHANNEL 1 = CLOCK, CHANNEL 2 = SPEED

LOW-SPEED TO HIGH-SPEED TRANSITION



CHANNEL 1 = CLOCK, CHANNEL 2 = SPEED

Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

Pin Description

PIN	NAME	FUNCTION
1	V_{CC}	Positive Supply Voltage. Bypass V_{CC} to GND with a 0.1µF capacitor.
2	V_L	Output Supply Voltage. Bypass V_L to GND with a 0.1µF capacitor. V_L must be connected to V_{CC}.
3	SPEED	Clock-Speed Select Input. Drive SPEED low to select the 32.768kHz fixed frequency. Drive SPEED high to select factory-trimmed frequency.
4	$\overline{RST}$	Reset Output. Open-drain or push-pull output. See the *Ordering Information.*
5	CLOCK	Push-Pull Clock Output
6	GND	Ground
7	ENABLE	Active-High Clock Enable Input. See the *ENABLE Input* section for more details.
8	N.C.	No Connection

Detailed Description

The MAX7384 is a dual-speed clock generator with integrated reset for microcontrollers (µCs) and UARTs in 3V, 3.3V, and 5V applications. The MAX7384 is a replacement for crystal-oscillator modules, crystals, or ceramic resonators and a system reset IC. The high-speed clock frequency and reset threshold voltage are factory programmed to specific values (see Tables 1 and 2). A variety of popular standard frequencies are available. The low-speed clock frequency is fixed at 32.768kHz. No external components are required for setting or adjusting the frequency.

Oscillator

The push-pull clock output is enabled when $V_{CC} > V_{TH}$ (Table 1) and drives a load to within 400mV of either supply rail. The clock output remains stable over the full operating voltage range and does not generate short output cycles during either power-on or changing of the frequency. A typical oscillating startup is shown in the *Typical Operating Characteristics*.

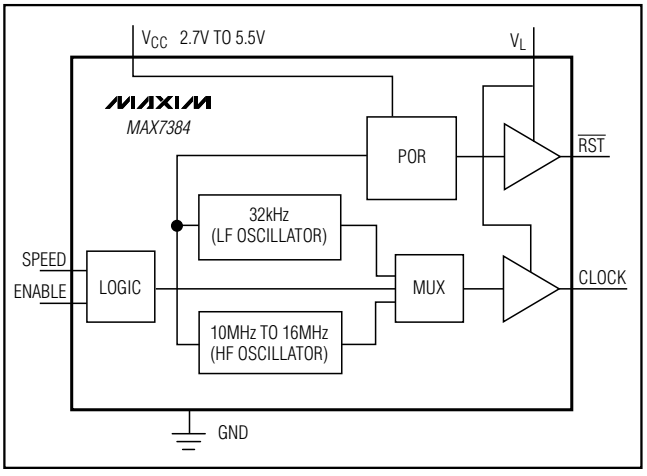


Figure 1. Functional Diagram

ENABLE Input

The MAX7384 has an active-high enable input that controls the clock and reset outputs. The clock output is driven low and $\overline{RST}$ asserts when the device is disabled. Drive ENABLE low to disable the clock output on the next rising edge. Drive ENABLE high to activate the clock output.

Clock-Speed Selection

Drive SPEED low to select slow clock speed (nominally 32.768kHz) or high to select full clock speed. SPEED can be connected to V_{CC} or to GND to select fast or slow clock speed, or connected to a logic output (such as a µP GPIO port) used to change clock speed on the fly. If SPEED is connected to a µP GPIO port, connect a pullup or pulldown resistor to set the clock to the preferred speed on power-up. SPEED input bias current is 2µA (max), so a resistor value as high as 100kΩ can be used.

Applications Information

Interfacing to a Microcontroller Clock Input

The MAX7384 clock output is a push-pull, CMOS, logic output that directly drives a µP or µC clock input. There are no impedance-matching issues when using the MAX7384. Refer to the microcontroller data sheet for clock input compatibility with external clock signals. The MAX7384 requires no biasing components or load capacitance. When using the MAX7384 to retrofit a crystal oscillator, remove all biasing components from the oscillator input.

Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

Reset Output

The MAX7384 is available with two reset output stage options: push-pull active low and open-drain active low. $\overline{RST}$ is asserted when the monitored input (V_{CC}) drops below the internal V_{TH} threshold and remains asserted for 120µs after the monitored input exceeds the internal V_{TH} threshold. The open-drain $\overline{RST}$ output requires an external pullup resistor. Under a reset condition, the oscillator is turned off.

Output Jitter

The MAX7384's jitter performance is given in the *Electrical Characteristics* table as a ±6σ period jitter value. Jitter measurements are approximately proportional to the output period of the device. The jitter performance of all clock sources degrades in the presence of mechanical and electrical interference. The MAX7384 is relatively immune to vibration, shock, and EMI influences and thus provides a considerably more robust clock source than crystal or ceramic resonator-based oscillator circuits.

Initial Power-Up and Operation

An internal power-up reset asserts $\overline{RST}$ until the supply voltage has risen above the power-on-reset threshold (V_{TH}). $\overline{RST}$ holds the microcontroller in a reset condition until 120µs after V_{CC} has risen above V_{TH}. This reset delay ensures that the clock output and the microcontroller's internal clock circuits have stabilized before the system is allowed to start. Typical microcontroller reset delay ranges from 1ms to 250ms to allow a slow crystal oscillator circuit to start up. The MAX7384 has a fast startup, eliminating the need for such a long reset delay.

Power-Supply Considerations

The MAX7384 operates with a 2.7V and 5.5V power-supply voltage. V_{CC} provides power to the the internal circuitry and V_L supplies power to the clock and reset outputs. Good power-supply decoupling is needed to maintain the power-supply rejection performance of the MAX7384. Bypass both V_{CC} and V_L to GND with a 0.1µF surface-mount ceramic capacitor. Mount the bypassing capacitors as close to the device as possible. Use a larger value bypass capacitor if the MAX7384 is to operate with a large capacitive load. Use a bypass capacitor value of at least 1000 times that of the output load capacitance.

Table 1. Standard Reset Threshold Levels

SUFFIX	RESET THRESHOLD (V) (V_{TH})	
S	2.89	Standard value
M	4.38	Standard value

Contact factory for nonstandard reset threshold options of 2.5V < V_{TH} < 4.38V.

Table 2. Standard Frequencies

SUFFIX	STANDARD FREQUENCY (MHz)
UK	10
UT	11
VB	12
VT	14
WB	16

For all other frequency options, contact factory.

Table 3. Standard Part Numbers

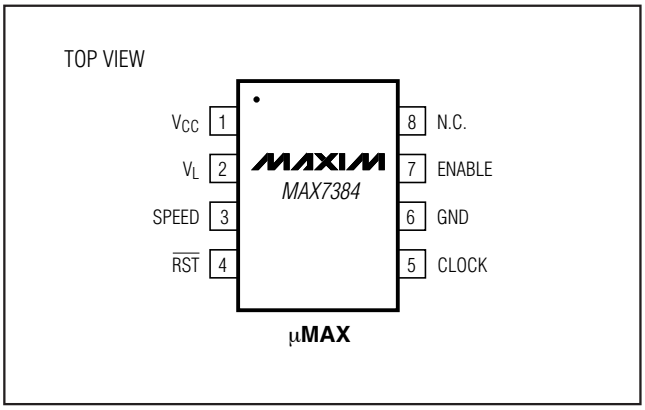
PART	RESET THRESHOLD (V)	FREQUENCY (MHz)
MAX7384CSUK	2.89	10
MAX7384CSUT	2.89	11
MAX7384CSVB	2.89	12
MAX7384CSVT	2.89	14
MAX7384CSWB	2.89	16
MAX7384CMUK	4.38	10
MAX7384CMUT	4.38	11
MAX7384CMVB	4.38	12
MAX7384CMVT	4.38	14
MAX7384CMWB	4.38	16

Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

Chip Information

PROCESS: BiCMOS

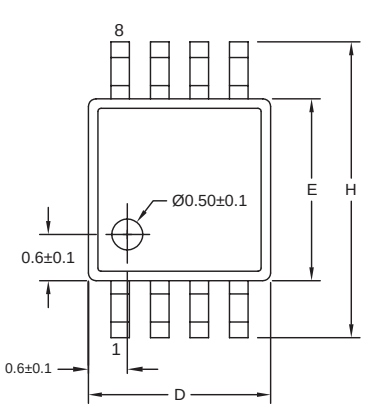
Pin Configuration



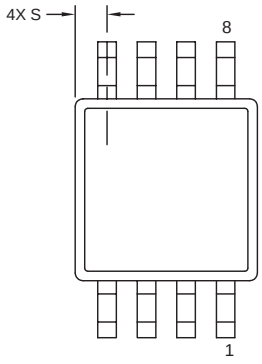
Silicon Oscillator with Low-Power Frequency Select, Reset Output, and Enable

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**.)

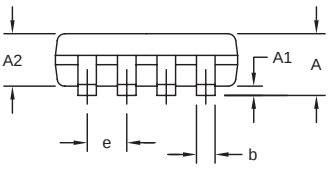


TOP VIEW

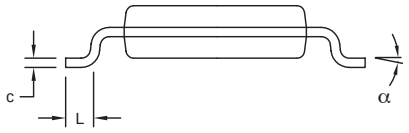


BOTTOM VIEW

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	-	0.043	-	1.10
A1	0.002	0.006	0.05	0.15
A2	0.030	0.037	0.75	0.95
b	0.010	0.014	0.25	0.36
c	0.005	0.007	0.13	0.18
D	0.116	0.120	2.95	3.05
e	0.0256 BSC		0.65 BSC	
E	0.116	0.120	2.95	3.05
H	0.188	0.198	4.78	5.03
L	0.016	0.026	0.41	0.66
α	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC	



FRONT VIEW



SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187C-AA.

8LUMAXD.EPS

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 8L uMAX/uSOP

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0036	J	1/1

Revision History

Pages changed at Rev 2: 1–9