



# 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

MAX2753

## General Description

The MAX2753 is a self-contained voltage-controlled oscillator (VCO) intended for use in 2.4GHz radios that utilize a low-IF or zero-IF architecture. It combines a fully integrated oscillator and output buffer in a miniature 8-pin  $\mu$ MAX package.

The inductor and varactor elements of the tank are integrated on-chip, greatly simplifying application of the part. The only required external components are a couple of supply bypass capacitors. The MAX2753 provides direct connection to the VCO tuning voltage input and the VCO buffer output. The tuning voltage input range is +0.4V to +2.4V, and the oscillator frequency tuning range is factory adjusted to provide guaranteed limits. The output signal is buffered by an amplifier stage (internally matched to 50 $\Omega$ ) to provide higher output power and isolate the device from load impedance variations. In addition, the MAX2753 provides differential outputs.

The MAX2753 operates over a +2.7V to +5.5V supply voltage range. Internal regulation of the oscillator supply voltage eliminates the need for an external LDO regulator for the VCO. The MAX2753 also provides a digitally controlled shutdown mode to permit implementation of sophisticated power-supply management. In shutdown, the supply current is reduced to less than 1 $\mu$ A.

## Applications

- 802.11 FHSS WLAN
- Home RF
- 2.4GHz Bluetooth ISM Proprietary Radio

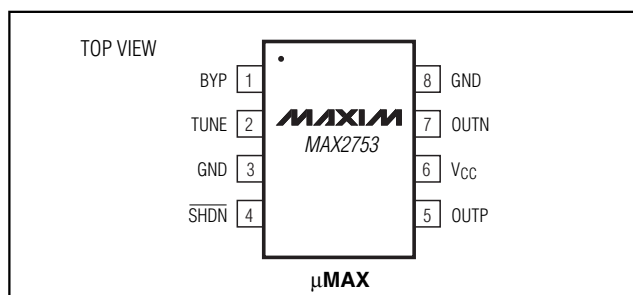
## Features

- ◆ Guaranteed Frequency Tuning Range: 2400MHz to 2500MHz
- ◆ Compatible with Low-IF or Zero-IF Radio Architectures
- ◆ Differential Outputs
- ◆ On-Chip Tank Circuit
- ◆ Internally Matched Output Buffer Amplifier
- ◆ 1 $\mu$ A Shutdown Mode
- ◆ +2.7V to +5.5V Supply Voltage Range
- ◆ Miniature 8-Pin  $\mu$ MAX Package

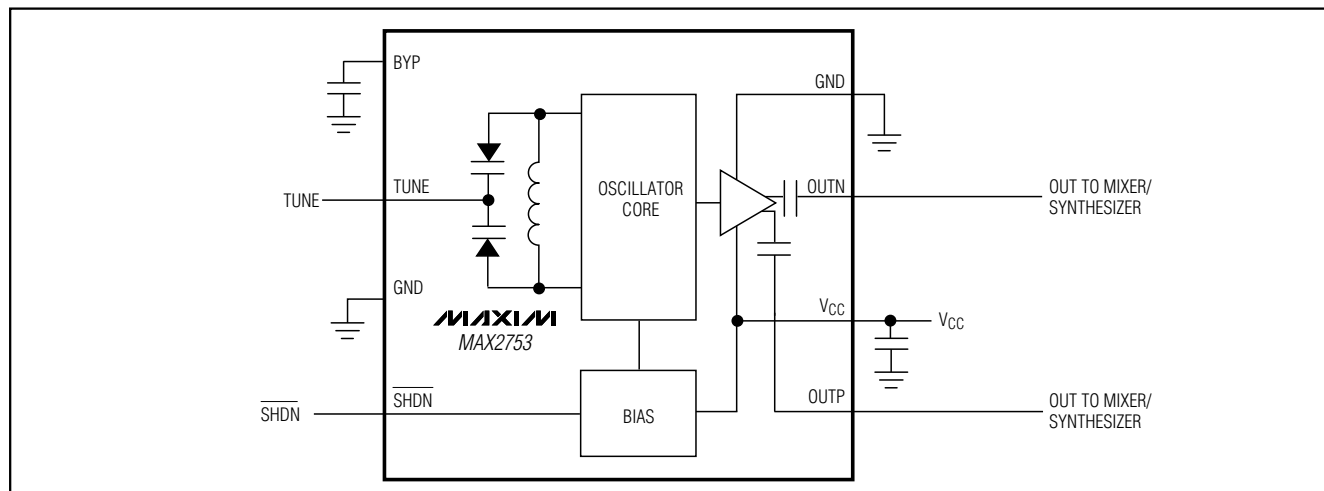
## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX2753EUA	-40°C to +85°C	8 $\mu$ MAX

## Pin Configuration



## Typical Operating Circuit



# 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

## ABSOLUTE MAXIMUM RATINGS

V<sub>CC</sub> to GND .....-0.3V to +6V  
 TUNE,  $\overline{\text{SHDN}}$ , BYP,  
 OUTP, OUTN to GND .....-0.3V to (V<sub>CC</sub> + 0.3V)  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
 8-Pin  $\mu\text{MAX}$  (derate 5.7mW/°C above T<sub>A</sub> = +70°C).....457mW

Operating Temperature Range .....-40°C to +85°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.

## DC ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +2.7V to +5.5V, V<sub>TUNE</sub> = +0.4V to +2.4V, V $\overline{\text{SHDN}}$   $\geq$  +2V, OUTP = OUTN = connected to 50 $\Omega$  load, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>CC</sub> = +3.0V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage		2.7		5.5	V
Supply Current	T <sub>A</sub> = +25°C		8.6	13.0	mA
	T <sub>A</sub> = -40°C to +85°C			13.5	
Shutdown Supply Current	V $\overline{\text{SHDN}}$ $\leq$ 0.6V		0.2	1	$\mu\text{A}$
$\overline{\text{SHDN}}$ Input Voltage Low				0.6	V
$\overline{\text{SHDN}}$ Input Voltage High		2.0			V
$\overline{\text{SHDN}}$ Input Current Low	V $\overline{\text{SHDN}}$ $\leq$ 0.6V	-1		1	$\mu\text{A}$
$\overline{\text{SHDN}}$ Input Current High	V $\overline{\text{SHDN}}$ $\geq$ 2.0V	-2		2	$\mu\text{A}$
TUNE Input Current	0.4V $\leq$ V <sub>TUNE</sub> $\leq$ 2.4V		0.02		nA

## AC ELECTRICAL CHARACTERISTICS

(MAX2753 EV kit, V<sub>CC</sub> = +2.7V to +5.5V, V<sub>TUNE</sub> = +0.4V to +2.4V, V $\overline{\text{SHDN}}$   $\geq$  +2V, OUTP = OUTN = connected to 50 $\Omega$  load, T<sub>A</sub> = +25°C. Typical values are at V<sub>CC</sub> = +3.0V, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Oscillator Guaranteed Frequency Limits (Note 1)	V <sub>TUNE</sub> = +0.4V to +2.4V, T <sub>A</sub> = -40°C to +85°C	2400		2500	MHz
Phase Noise	f <sub>OFFSET</sub> = 4MHz		-130		dBc/Hz
	Noise floor		-153		dBm/Hz
Tuning Gain (Note 2)	f <sub>OSC</sub> = 2400MHz		150		MHz/V
	f <sub>OSC</sub> = 2500MHz		110		
Differential Output Power			-8		dBm
Return Loss	Pins OUTP or OUTN		11		dB
Harmonics	Differential output		-26		dBc
Load Pulling	V <sub>SWR</sub> = 2:1, all phases, pins OUTP or OUTN		3.4		MHzp-p
Supply Pushing	V <sub>CC</sub> stepped: +3.3V to +2.8V		1.1		MHz/V
Oscillator Turn-On Time (Note 3)	Exiting shutdown		10		$\mu\text{s}$
Oscillator Turn-Off Time (Note 4)	Entering shutdown		8		$\mu\text{s}$

**Note 1:** Specifications are production tested at T<sub>A</sub> = +25°C. Limits over temperature are guaranteed by design and characterization.

**Note 2:** Tuning gain is measured at the oscillator's guaranteed frequency limits.

**Note 3:** Turn-on time to within 3dB of final output power

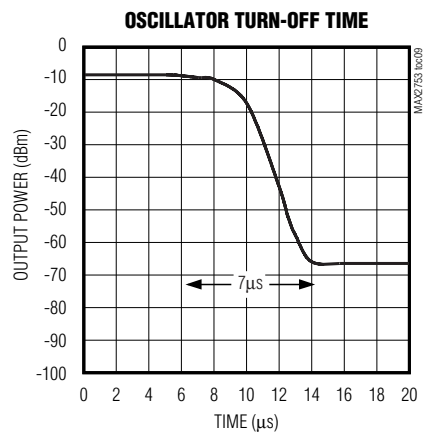
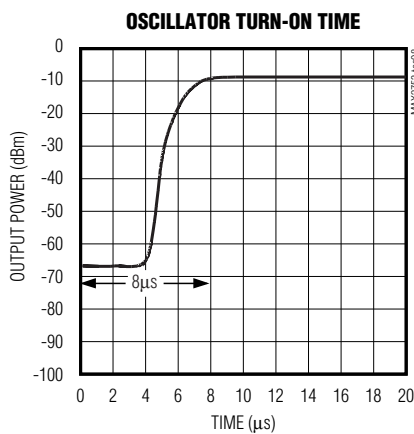
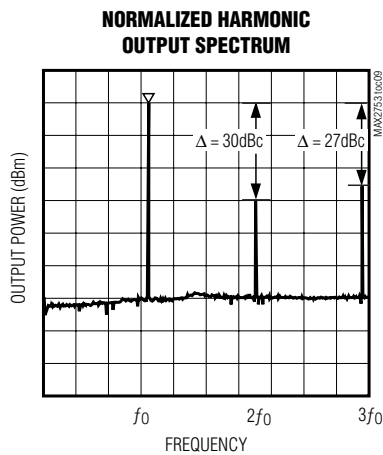
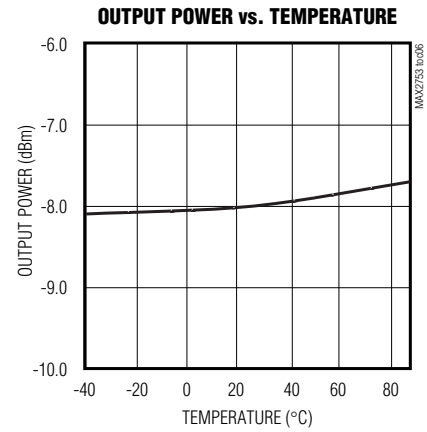
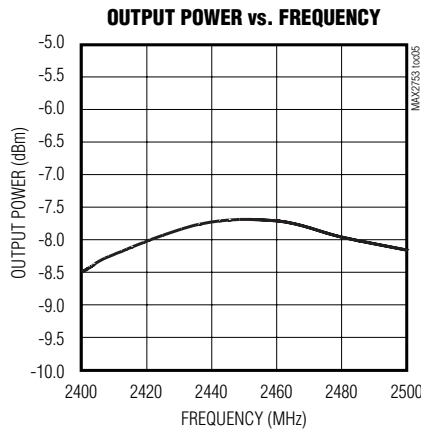
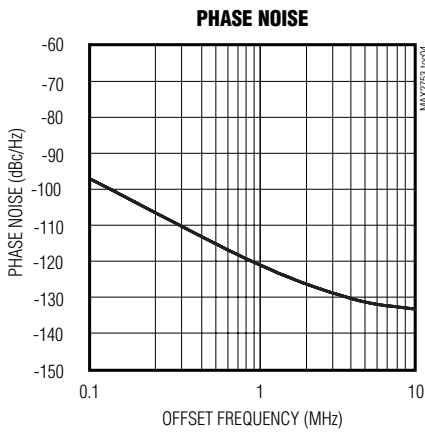
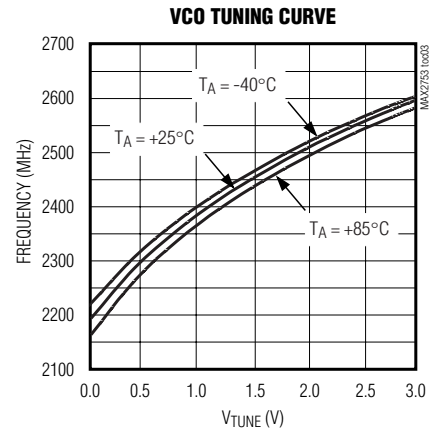
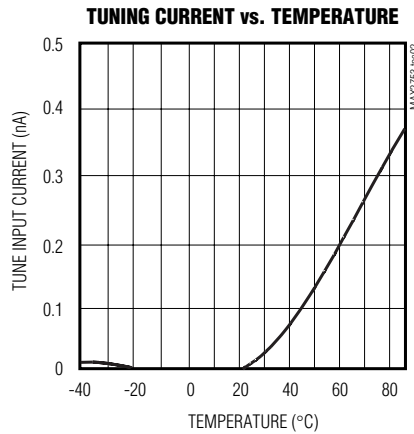
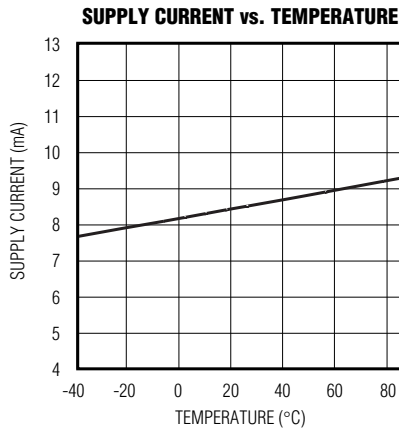
**Note 4:** Turn-off time to output power of -15dBm.

# 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

## Typical Operating Characteristics

(MAX2753 EV kit,  $V_{CC} = +3.0V$ ,  $V_{TUNE} = +0.4V$  to  $+2.4V$ ,  $V_{SHDN} \geq +2V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

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## 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

### Pin Description

PIN	NAME	FUNCTION
1	BYP	VCO Bypass. Bypass with a 0.1 $\mu$ F capacitor to GND.
2	TUNE	Oscillator Frequency Tuning Voltage Input. High-impedance input with a voltage input range of +0.4V (low frequency) to +2.4V (high frequency).
3	GND	Ground Connection for Oscillator and Biasing. Requires a low-inductance connection to the circuit board ground plane.
4	$\overline{\text{SHDN}}$	Shutdown Logic Input. A high-impedance input logic level low disables the device and reduces supply current to less than 1.0 $\mu$ A. A logic level high enables the device.
5	OUTP	Positive Buffered Oscillator Output. Incorporates an internal DC blocking capacitor. OUTP is internally matched to 50 $\Omega$ .
6	VCC	DC Supply Voltage Connection. Bypass with a 220pF capacitor to GND for best high frequency performance.
7	OUTN	Negative Buffered Oscillator Output. Incorporates an internal DC blocking capacitor. OUTN is internally matched to 50 $\Omega$ .
8	GND	Ground Connection for Output Buffer. Requires a low-inductance connection to the circuit board ground plane.

### Detailed Description

#### Oscillator

The MAX2753 VCO is implemented as an LC oscillator topology, integrating all of the tank components on-chip. This fully monolithic approach provides an extremely easy-to-use VCO, equivalent to a VCO module. The frequency is controlled by a voltage applied to the TUNE pin, which is internally connected to the varactor. The VCO core uses a differential topology to provide a stable frequency versus supply voltage and improve the immunity to load variations. In addition, there is a differential buffer amplifier following the oscillator core to provide added isolation from load variations and to boost the output power.

#### Output Buffer

The oscillator signal from the core drives a differential output buffer amplifier. Each of the two amplifier outputs is internally matched to 50 $\Omega$  including an on-chip DC-blocking capacitor. No external DC-blocking capacitor is required, eliminating the need for any external components. The amplifier boosts the oscillator signal to a level suitable for driving most RF mixers.

### Applications Information

#### Tune Input

The tuning input is typically connected to the output of the PLL loop filter. The loop filter provides an appropriately low-impedance source. The input may incorporate an extra RC filter stage to reduce high-frequency noise and spurious signals. Any excess noise on the tuning input is directly translated into FM noise, which can degrade the phase-noise performance of the oscillator. Therefore, it is important to minimize the noise introduced on the tuning input. A simple RC filter with low corner frequency is needed during testing to filter the noise present on the voltage source driving the tuning line.

#### Layout Issues

Always use controlled impedance lines (microstrip, coplanar waveguide, etc.) for high-frequency signals. Always place decoupling capacitors as close to the VCC pins as possible; for long VCC lines, it may be necessary to add additional decoupling capacitors located further from the device. Always provide a low-inductance path to ground, and keep GND vias as close to the device as possible. Thermal reliefs on GND pads are not recommended.

## 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

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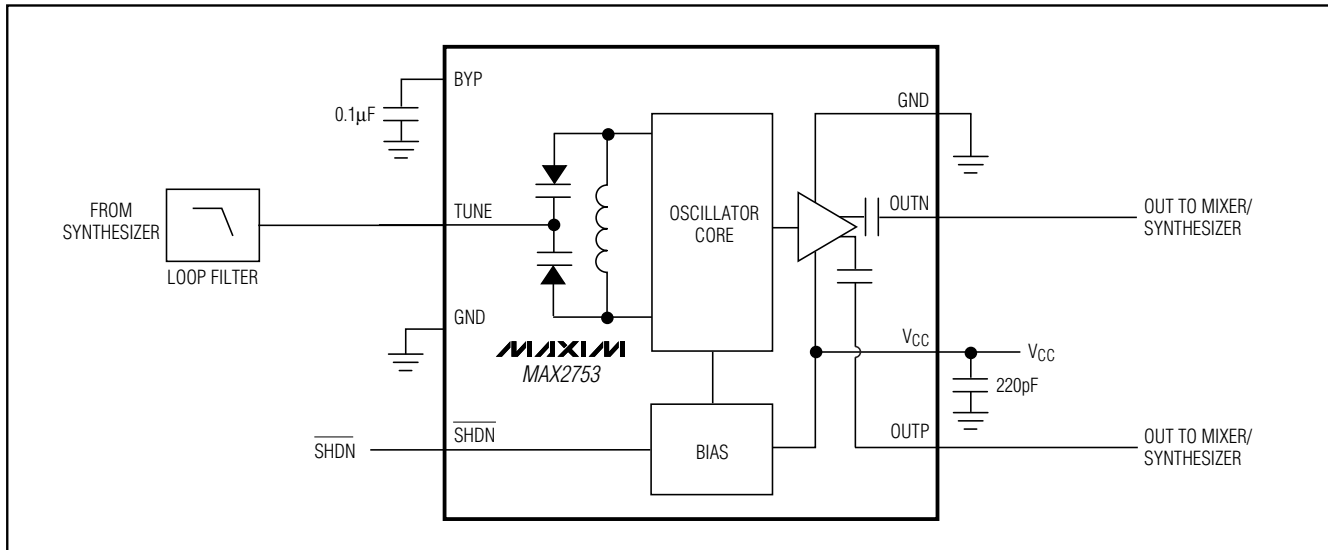


Figure 1. Typical Application Circuit

### Chip Information

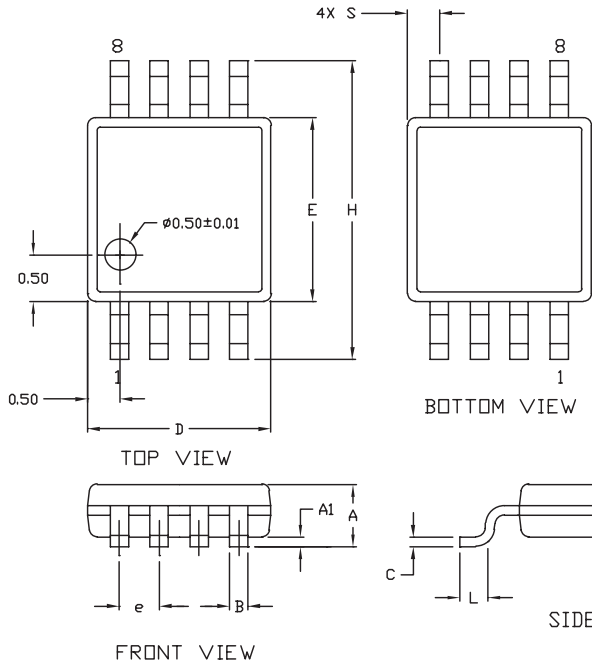
TRANSISTOR COUNT: 176

PROCESS: BIPOlar

# 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

## Package Information

8LUMAXDEFS



	INCHES		MILLIMETERS		JEDEC			
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
$\alpha$	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					

- 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-187.

**MAXIM**  
 PROPRIETARY INFORMATION  
 TITLE:  
 PACKAGE OUTLINE, 8L uMAX  
 APPROVAL: \_\_\_\_\_ DOCUMENT CONTROL NO: 21-0036 REV: I 1/1