MAXIM

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 µMAX 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 50Ω) 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 1µA.

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**

♦ **1µA Shutdown Mode**

♦ **+2.7V to +5.5V Supply Voltage Range**

♦ **Miniature 8-Pin µMAX Package**

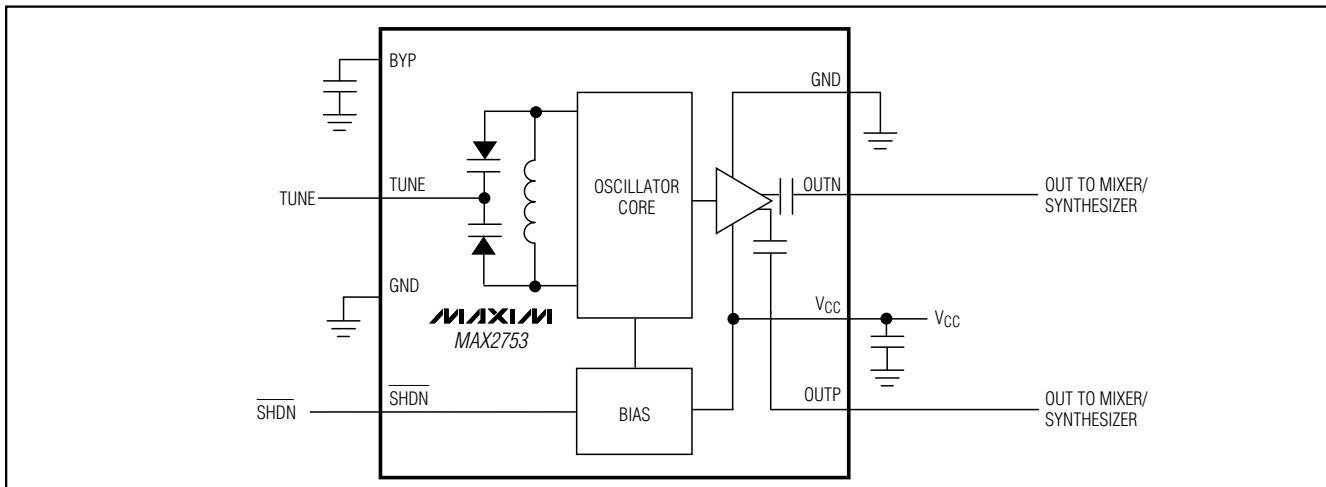## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX2753EUA	-40°C to +85°C	8 µMAX

Pin Configuration

TOP VIEW

BYP	1	8 GND
TUNE	2	7 OUTN
GND	3	6 V_CC
SHDN	4	5 OUTP

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µ**MAX**
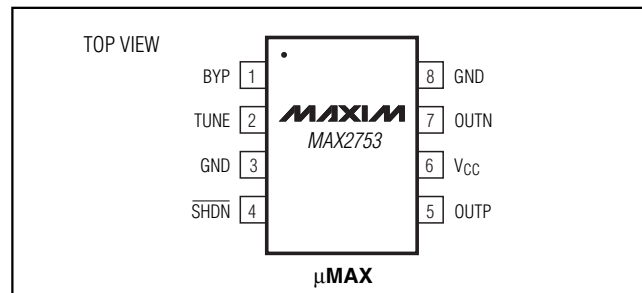
Typical Operating Circuit

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ABSOLUTE MAXIMUM RATINGS

V$_{CC}$ to GND ....-0.3V to +6V
TUNE, $\overline{SHDN}$, BYP,
OUTP, OUTN to GND ....-0.3V to (V$_{CC}$ + 0.3V)
Continuous Power Dissipation (T$_A$ = +70°C)
   8-Pin µMAX (derate 5.7mW/°C above T$_A$ = +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$_{CC}$ = +2.7V to +5.5V, V$_{TUNE}$ = +0.4V to +2.4V, V$\overline{SHDN}$ ≥ +2V, OUTP = OUTN = connected to 50Ω load, T$_A$ = -40°C to +85°C. Typical values are at V$_{CC}$ = +3.0V, T$_A$ = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage		2.7		5.5	V
Supply Current	T$_A$ = +25°C		8.6	13.0	mA
	T$_A$ = -40°C to +85°C			13.5	
Shutdown Supply Current	V$\overline{SHDN}$ ≤ 0.6V		0.2	1	µA
$\overline{SHDN}$ Input Voltage Low				0.6	V
$\overline{SHDN}$ Input Voltage High		2.0			V
$\overline{SHDN}$ Input Current Low	V$\overline{SHDN}$ ≤ 0.6V	-1		1	µA
$\overline{SHDN}$ Input Current High	V$\overline{SHDN}$ ≥ 2.0V	-2		2	µA
TUNE Input Current	0.4V ≤ V$_{TUNE}$ ≤ 2.4V		0.02		nA

AC ELECTRICAL CHARACTERISTICS

(MAX2753 EV kit, V$_{CC}$ = +2.7V to +5.5V, V$_{TUNE}$ = +0.4V to +2.4V, V$\overline{SHDN}$ ≥ +2V, OUTP = OUTN = connected to 50Ω load, T$_A$ = +25°C. Typical values are at V$_{CC}$ = +3.0V, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Oscillator Guaranteed Frequency Limits (Note1)	V$_{TUNE}$ = +0.4V to +2.4V, T$_A$ = -40°C to +85°C	2400		2500	MHz
Phase Noise	f$_{OFFSET}$ = 4MHz		-130		dBc/Hz
	Noise floor		-153		dBm/Hz
Tuning Gain (Note 2)	f$_{OSC}$ = 2400MHz		150		MHz/V
	f$_{OSC}$ = 2500MHz		110		
Differential Output Power			-8		dBm
Return Loss	Pins OUTP or OUTN		11		dB
Harmonics	Differential output		-26		dBc
Load Pulling	VSWR = 2:1, all phases, pins OUTP or OUTN		3.4		MHzp-p
Supply Pushing	V$_{CC}$ stepped: +3.3V to +2.8V		1.1		MHz/V
Oscillator Turn-On Time (Note 3)	Exiting shutdown		10		µs
Oscillator Turn-Off Time (Note 4)	Entering shutdown		8		µs

Note 1: Specifications are production tested at T$_A$ = +25°C. Limits over temperature are guaranteed by design and characterization.
Note 2: Tuning gain is measured at the oscillator's guaranteed frequency limits.
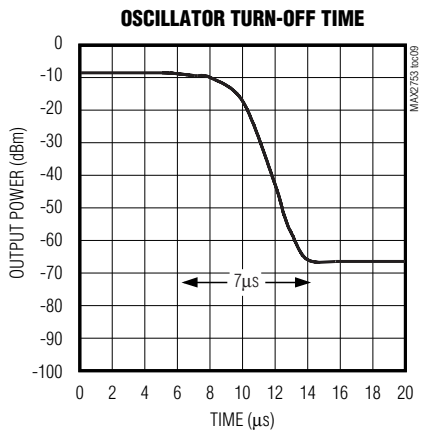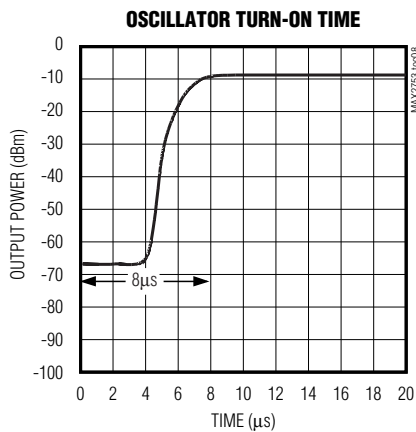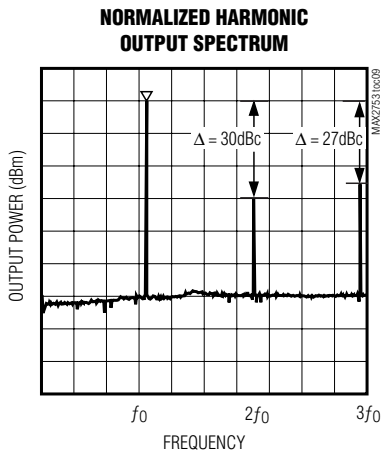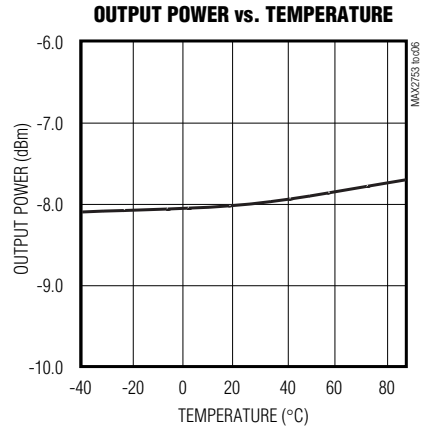**Note 3:** Turn-on time to within 3dB of final output power
Note 4: Turn-off time to output power of -15dBm.

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Typical Operating Characteristics

(MAX2753 EV kit, V_{CC} = +3.0V, V_{TUNE} = +0.4V to +2.4V, $V_{\overline{SHDN}}$ ≥ +2V, T_A = +25°C, unless otherwise noted.)
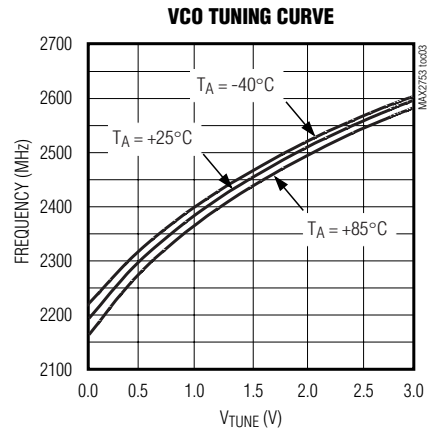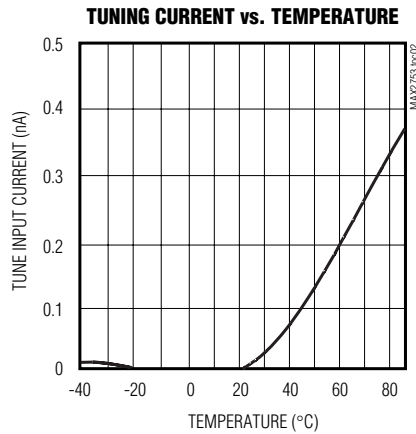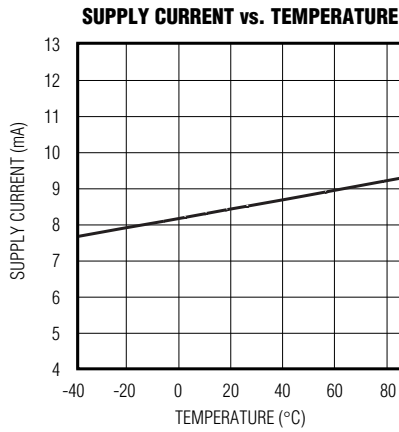
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SUPPLY CURRENT vs. TEMPERATURE

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SUPPLY CURRENT (mA) vs. TEMPERATURE (°C)

TUNING CURRENT vs. TEMPERATURE

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TUNE INPUT CURRENT (nA) vs. TEMPERATURE (°C)

VCO TUNING CURVE

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FREQUENCY (MHz) vs. V_{TUNE} (V)

T_A = -40°C

T_A = +25°C

T_A = +85°C

PHASE NOISE

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PHASE NOISE (dBc/Hz) vs. OFFSET FREQUENCY (MHz)

OUTPUT POWER vs. FREQUENCY

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OUTPUT POWER (dBm) vs. FREQUENCY (MHz)

OUTPUT POWER vs. TEMPERATURE

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OUTPUT POWER (dBm) vs. TEMPERATURE (°C)

NORMALIZED HARMONIC OUTPUT SPECTRUM

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OUTPUT POWER (dBm) vs. FREQUENCY

Δ = 30dBc Δ = 27dBc

f_0 $2f_0$ $3f_0$

OSCILLATOR TURN-ON TIME

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OUTPUT POWER (dBm) vs. TIME (µs)

8µs

OSCILLATOR TURN-OFF TIME

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OUTPUT POWER (dBm) vs. TIME (µs)

7µs

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PIN	NAME	FUNCTION
1	BYP	VCO Bypass. Bypass with a 0.1µF 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	$\overline{SHDN}$	Shutdown Logic Input. A high-impedance input logic level low disables the device and reduces supply current to less than 1.0µA. A logic level high enables the device.
5	OUTP	Positive Buffered Oscillator Output. Incorporates an internal DC blocking capacitor. OUTP is internally matched to 50Ω.
6	V_{CC}	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 50Ω.
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 var-actor. 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 50Ω 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 appropri-ately 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 intro-duced 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 V_{CC} pins as possible; for long V_{CC} lines, it may be nec-essary to add additional decoupling capacitors located further from the device. Always provide a low-induc-tance path to ground, and keep GND vias as close to the device as possible. Thermal reliefs on GND pads are not recommended.

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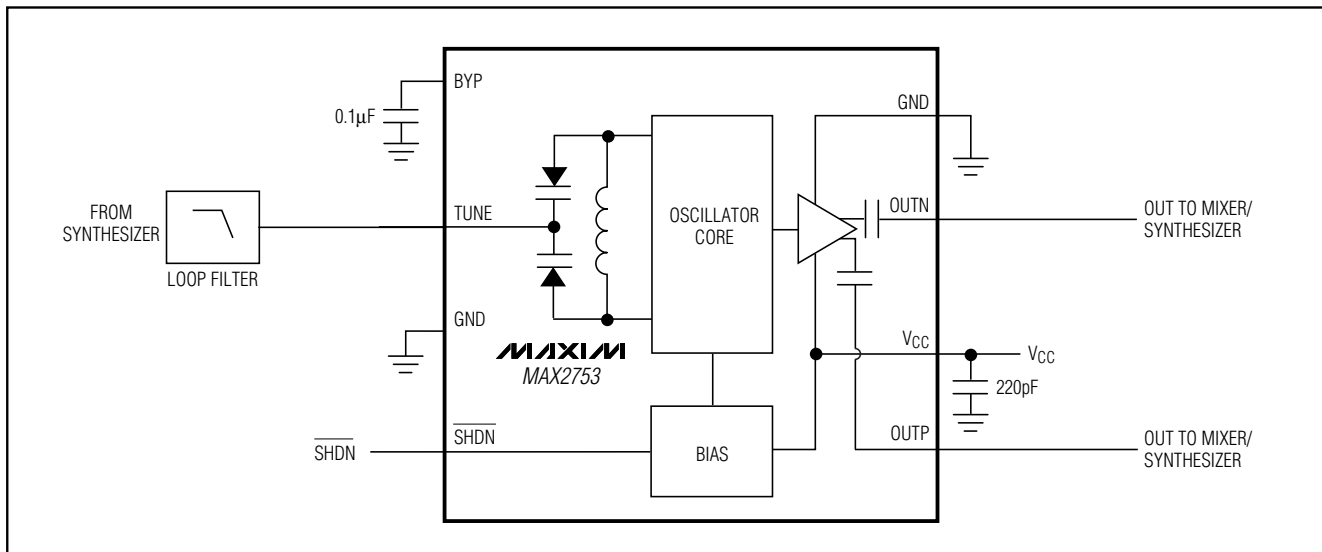# 2.4GHz Monolithic Voltage-Controlled Oscillator with Differential Outputs

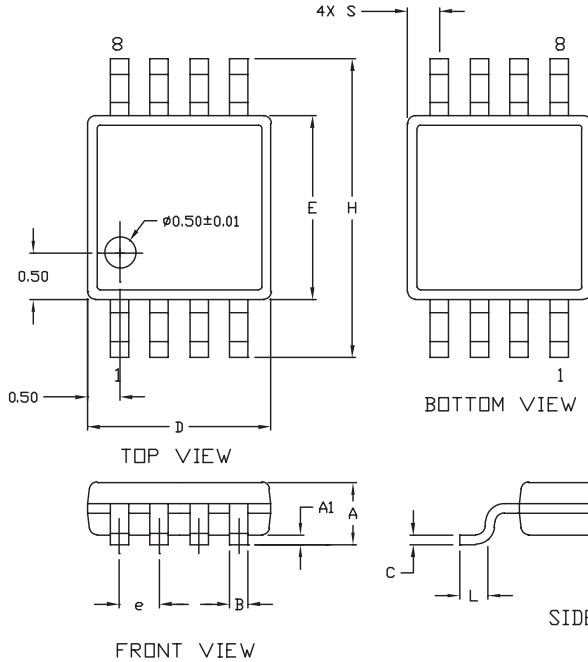*Figure 1. Typical Application Circuit*

Chip Information

TRANSISTOR COUNT: 176
PROCESS: BiPOLAR

MAX2753

Package Information

TOP VIEW

BOTTOM VIEW

FRONT VIEW

SIDE VIEW

8LUMAXD.EPS

| | INCHES | | MILLIMETERS | | JEDEC | | | |
| | | | | | INCHES | | MILLIMETERS | |
	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
α	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.

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PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, 8L uMAX

| APPROVAL | DOCUMENT CONTROL NO. | REV | |
| | 21-0036 | I | 1/1 |

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