# 2.4GHz Monolithic Voltage-Controlled Oscillators

## ABSOLUTE MAXIMUM RATINGS

$V_{CC}$ to GND .....-0.3V to +6V
TUNE, $\overline{SHDN}$, BYP, OUT to GND .....-0.3V to ($V_{CC}$ + 0.3V)
Continuous Power Dissipation ($T_A$ = +70°C)
μMAX (derate 4.8mW/°C above $T_A$ = +70°C).....387.8mW
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
Soldering Temperature (reflow) .....+260°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, $V_{\overline{SHDN}} \le$ +2V, OUT = 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 | MAX2750 | $T_A$ = +25°C | | 11.3 | 14.4 | mA |
| | | $T_A$ = -40°C to +85°C | | 14.1 | 17.0 | |
| | MAX2751 | $T_A$ = +25°C | | 9.7 | 12.1 | |
| | | $T_A$ = -40°C to +85°C | | 12.7 | 15.9 | |
| | MAX2752 | $T_A$ = +25°C | | 10 | 12.1 | |
| | | $T_A$ = -40°C to +85°C | | 12.8 | 15.2 | |
| Shutdown Supply Current | | | | 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 | $V_{\overline{SHDN}} \le$ 0.6V | | -2 | | 2 | μA |
| $\overline{SHDN}$ Input Current High | $V_{\overline{SHDN}} \ge$ 2.0V | | -2 | | 2 | μA |
| TUNE Input Current | 0.4 ≤ $V_{TUNE}$ ≤ 2.4V | | | 0.02 | | nA |

## AC ELECTRICAL CHARACTERISTICS

(MAX2750/MAX2751/MAX2752 EV kit, $V_{CC}$ = +2.7V to +5.5V, $V_{TUNE}$ = +0.4V to +2.4V, $V_{\overline{SHDN}} \le$ +2V, OUT = 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 | MAX2750 | 2400 | | 2500 | MHz |
| | | MAX2751 | 2120 | | 2260 | MHz |
| | | MAX2752 | 2025 | | 2165 | MHz |
| Phase Noise | $f_{OFFSET}$ = 4MHz | | | -125 | | dBc/Hz |
| | Noise floor | | | -151 | | dBm/Hz |
| Tuning Gain (Note 2) | MAX2750 | $f_{OSC}$ = 2400MHz, +3V | | 140 | | MHz/V |
| | | $f_{OSC}$ = 2500MHz, +3V | | 90 | | |
| | MAX2751 | $f_{OSC}$ = 2120MHz, +3V | | 175 | | |
| | | $f_{OSC}$ = 2260MHz, +3V | | 110 | | |
| | MAX2752 | $f_{OSC}$ = 2025MHz, +3V | | 170 | | |
| | | $f_{OSC}$ = 2165MHz, +3V | | 105 | | |
| Output Power | | | | -3 | | dBm |
| Return Loss | | | | 12 | | dB |
| Harmonics | | | | -30 | | dBc |

## AC ELECTRICAL CHARACTERISTICS (continued)

(MAX2750/MAX2751/MAX2752 EV kit, $V_{CC}$ = +2.7V to +5.5V, $V_{TUNE}$ = +0.4V to +2.4V, $V_{\overline{SHDN}} \le$ +2V, OUT = connected to 50Ω load, $T_A$ = +25°C. Typical values are at $V_{CC}$ = +3.0V, unless otherwise noted.)

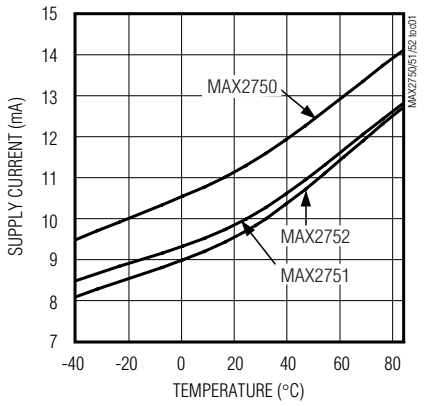
| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| Load Pulling | VSWR = 2:1, all phases | | 4 | | MHzp-p |
| Supply Pushing | $V_{CC}$ stepped: +3.3V to +2.8V | | 1.3 | | MHz/V |
| Oscillator Turn-On Time (Note 3) | Exiting shutdown | | 8 | | µs |
| Oscillator Turn-Off Time (Note 4) | Entering shutdown | | 5 | | 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 -10dBm.

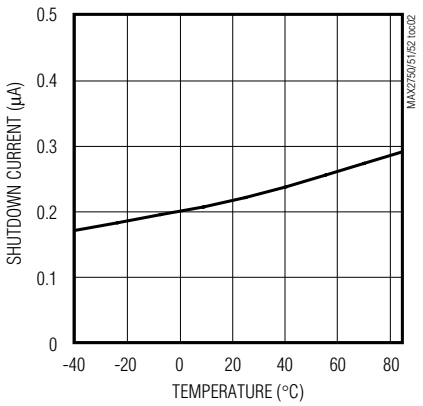
## Typical Operating Characteristics

(Circuit of Figure 1, $V_{CC}$ = +3.0V, $V_{TUNE}$ = +0.4V to +2.4V, $V_{\overline{SHDN}} \le$ 2V, $T_A$ = +25°C, unless otherwise noted.)

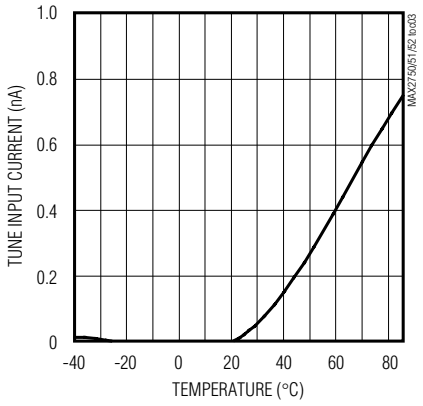
**MAX2750/MAX2751/MAX2752**
**SUPPLY CURRENT vs. TEMPERATURE**



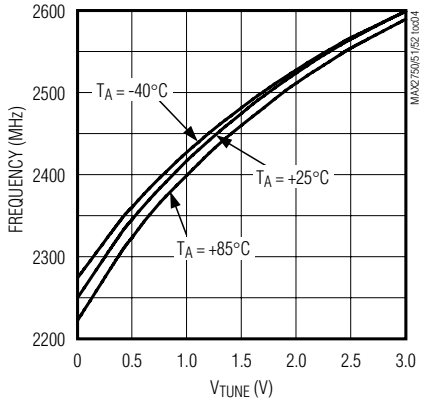

**MAX2750/MAX2751/MAX2752**
**SHUTDOWN CURRENT vs. TEMPERATURE**



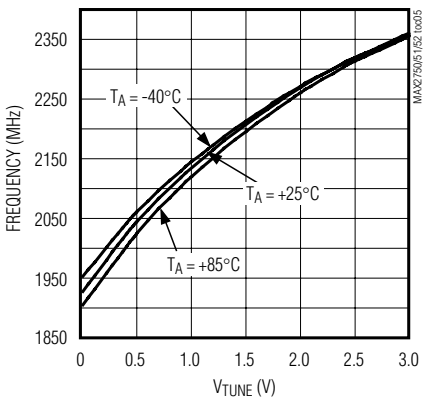

**MAX2750/MAX2751/MAX2752**
**TUNING CURRENT vs. TEMPERATURE**



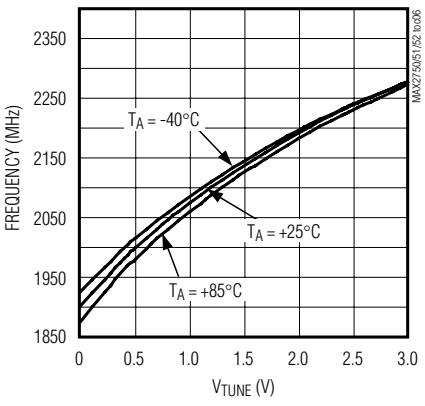

**MAX2750**
**VCO TUNING CURRENT**




**MAX2751**
**VCO TUNING CURRENT**




**MAX2752**
**VCO TUNING CURRENT**

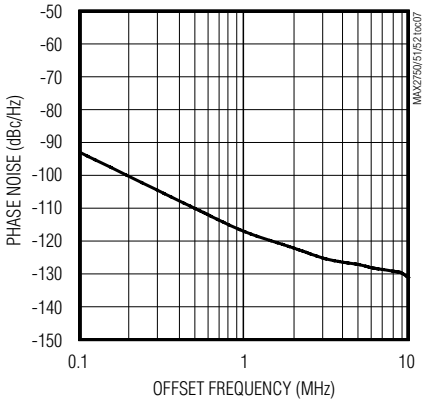


# 2.4GHz Monolithic Voltage-Controlled Oscillators

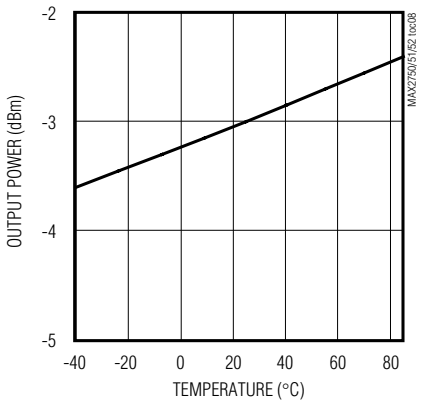
## Typical Operating Characteristics (continued)

(Circuit of Figure 1, $V_{CC}$ = +3.0V, $V_{TUNE}$ = +0.4V to +2.4V, $V_{\overline{SHDN}} \le 2V$, $T_A$ = +25°C, unless otherwise noted.)

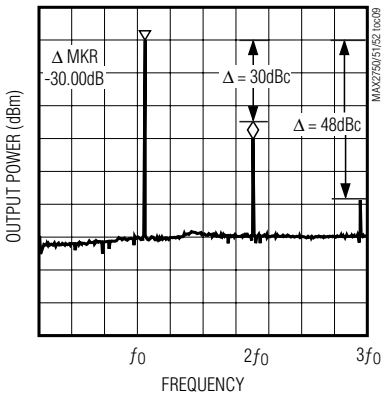
**PHASE NOISE**



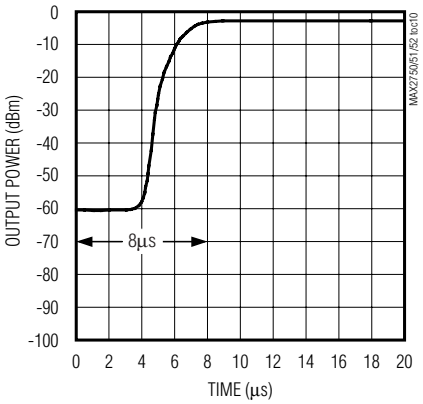

**MAX2751 OUTPUT POWER vs. TEMPERATURE**



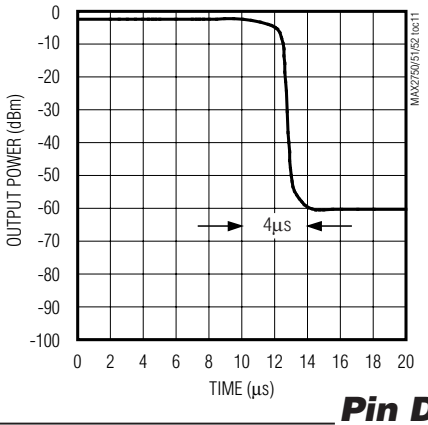

**NORMALIZED HARMONIC OUTPUT SPECTRUM**




**OSCILLATOR TURN-ON TIME**




**OSCILLATOR TURN-OFF TIME**




## Pin Description

| 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 | $V_{CC1}$ | Bias and Oscillator DC Supply Voltage Connection. Bypass separately from PIN6 with a 220pF capacitor to GND for low noise and low spurious content performance from the oscillator. |
| 6 | $V_{CC2}$ | Output Buffer DC Supply Voltage Connection. Bypass separately from PIN5 with a 220pF capacitor to GND for best high frequency performance. |
| 7 | OUT | Buffered Oscillator Output. Incorporates an internal DC blocking capacitor. OUT is internally matched to 50Ω. |
| 8 | GND | Ground Connection for Output Buffer. Requires a low-inductance connection to the circuit board ground plane. |

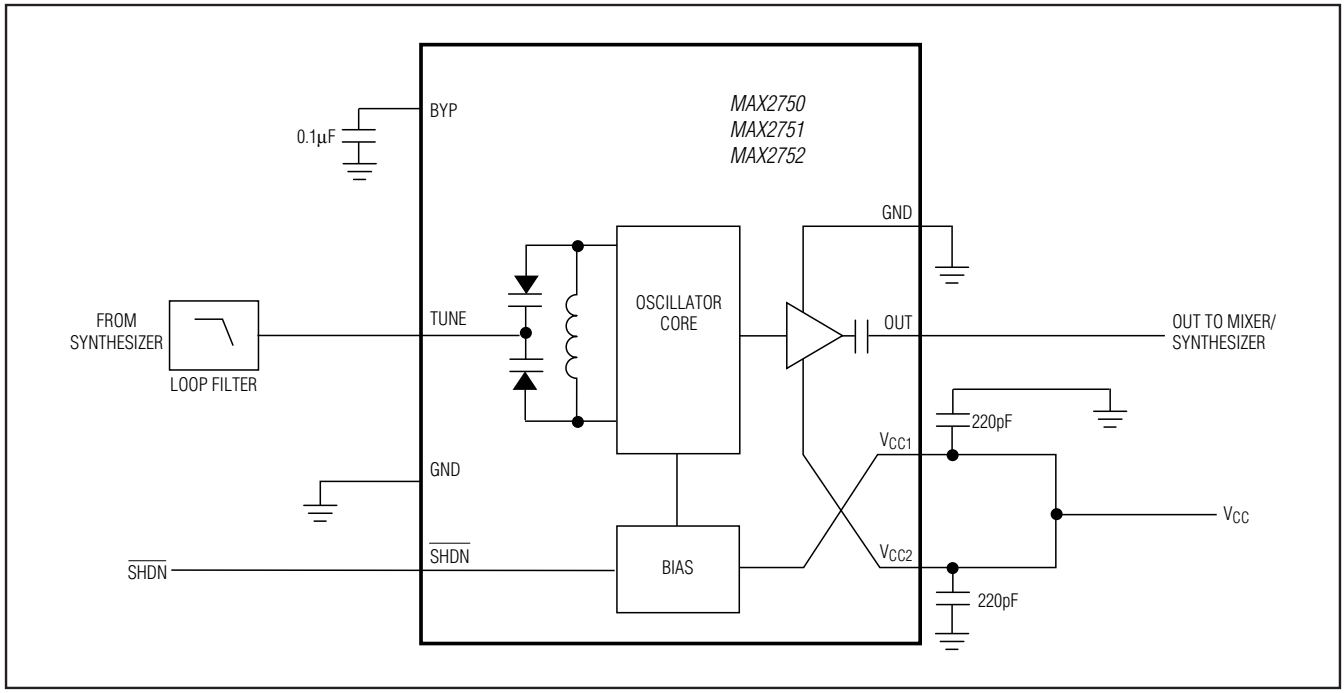



*Figure 1. Typical Application Circuit*

## Detailed Description

### Oscillator

The MAX2750/MAX2751/MAX2752 VCOs are 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 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 an output buffer amplifier. The amplifier 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 output amplifier has its own $V_{CC}$ and GND pins to minimize load-pulling effects. 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 in order 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 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.

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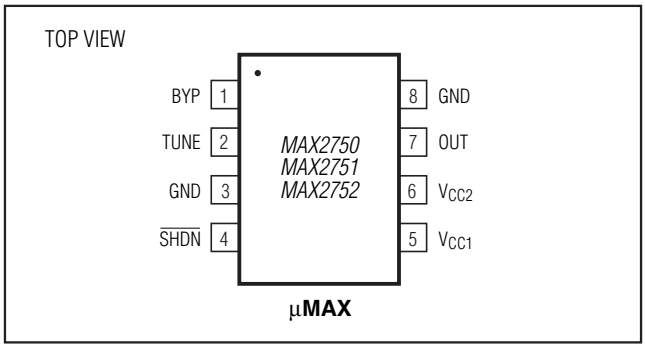
## Pin Configuration




## Chip Information

PROCESS: BiPOLAR

## Package Information

For the latest package outline information and land patterns (footprints), 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 | OUTLINE NO. | LAND PATTERN NO. |
|---|---|---|---|
| 8 µMAX | U8+1 | 21-0036 | 90-0092 |

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 10/00 | Initial release | — |
| 1 | 5/12 | Added information for lead-free compliant options, added *Absolute Maximum Ratings* information, updated TOC 11 | 1, 2, 4 |