



# MAX1011 Evaluation Kit

Evaluates: MAX1011

## General Description

The MAX1011 evaluation kit (EV kit) simplifies evaluation of the 90Msps MAX1011 6-bit analog-to-digital converter (ADC). The kit includes the basic components necessary to operate the on-chip oscillator as a voltage-controlled oscillator (VCO). The board can also be easily modified to accommodate an external clocking source.

Connectors for power supplies, analog inputs, and digital outputs simplify connections to the device. The PC board features an optimized layout to ensure the best possible dynamic performance. The EV kit includes a MAX1011.

## Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3, C5	3	0.01 $\mu$ F, 10V min, 10% ceramic capacitors
C2, C7, C8	3	47pF, 10V min, 5% ceramic capacitors
C4	1	0.22 $\mu$ F, 10V min, 10% ceramic capacitor
C6	1	5pF, 10V min, 10% ceramic capacitor
C9, C10	2	0.1 $\mu$ F, 10V min, 10% ceramic capacitors
C11, C12	2	10 $\mu$ F, 10V min, 20% tantalum caps AVX TAJC106K016
D1	1	Varactor diode M/A-COM MA4ST079CK-287, SOT23
J1	1	14-pin connector
JU1, JU2, JU6	3	0 $\Omega$ resistors
JU3, JU4	2	2-pin headers
JU5	1	3-pin header
L1	1	220nH inductor Coilcraft 1008CS-221XKB
R1	1	10k $\Omega$ , 5% resistor
R2, R3	2	47k $\Omega$ , 5% resistors
R4, R5	2	49.9 $\Omega$ , 1% resistors
U1	1	MAX1011CEG
IN+, IN-	2	BNC connectors
Clock Overdrive	0	Not Supplied
None	1	MAX1011 circuit board
None	1	Shunt for JU5

## Features

- ◆ **5.85 Effective Number of Bits at 20MHz Analog Input Frequency**
- ◆ **Separate Analog and Digital Power and Ground Connections with Optimized PC Board Layout**
- ◆ **Single-Ended or Differential Analog Input**
- ◆ **Square-Pin Header for Easy Connection of Logic Analyzer to Digital Outputs**
- ◆ **User-Selectable ADC Full-Scale Gain Ranges**
- ◆ **Fully Assembled and Tested Surface-Mount Board**

## Ordering Information

PART	TEMP. RANGE	IC PACKAGE
MAX1011EVKIT	0°C to +70°C	24 QSOP

## Component Suppliers

SUPPLIER*	PHONE	FAX
AVX	(803) 946-0690	(803) 626-3123
Coilcraft	(847) 639-6400	(847) 639-1469
M/A-COM	(617) 564-3100	(617) 564-3050
Sprague	(603) 224-1961	(603) 224-1430

\* Please indicate that you are using the MAX1011 when contacting these component suppliers.

## Quick Start

The MAX1011 EV kit is fully assembled and tested. Follow these steps to verify proper board operation. **Do not turn on the power supplies until all connections to the EV kit are completed.**

- 1) Connect a +5V power supply to the pad marked VCC. Connect this supply's ground to the pad marked GND.
- 2) Connect a +3.3V power supply to the pad labeled VCCO. Connect the supply ground to the pad marked OGND.
- 3) Connect a +3.7V power supply to the pad marked VTUNE. Connect the supply ground to the GND pad.
- 4) Remove the shunt from jumper JU5. This sets a 250mVp-p full-scale range.



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- 5) Connect a 250mVp-p, 20MHz sine-wave source to the analog input at BNC J3. The analog input is terminated in 50 $\Omega$  (R4).
- 6) Connect a logic analyzer to connector J1 to monitor the digital outputs.
- 7) Turn on all power supplies and signal sources.
- 8) Observe the digitized analog input signals with the logic analyzer.

## Detailed Description

### EV Kit Jumpers

The MAX1011 EV kit contains several jumpers that control board and part options. The following sections describe the different jumpers and their purposes. Table 1 lists the jumpers on the EV kit and their default positions.

**Table 1. EV Kit Jumpers and Default Positions**

JUMPER(S)	FUNCTION	DEFAULT POSITION
JU1, JU2, JU6	Power-supply current-sense ports	Shorted with 0 $\Omega$ resistors
JU3, JU4	Offset-correction amplifier enabled	Open
JU5	ADC full-scale range selection	Open

### Analog Supply Power Requirements

The MAX1011 requires a +5V at approximately 37mA for the analog VCC supply. 0 $\Omega$  resistors are installed at jumper sites JU1, JU2, and JU6 and can be removed to sense device power-supply currents with an ammeter.




### Digital Outputs Supply

The MAX1011 requires +3.3V for the VCCO supply. The current requirement from the power supply is a function of the sampling clock and analog input frequencies, as well as the capacitive loading on the digital outputs. With 15pF loads and a 20MHz analog input frequency sampled at 90Msps, the current draw is approximately 8.5mA.

### Analog Inputs

The analog inputs to the ADC are provided through BNC connectors IN+, and IN-. The connectors are terminated with 49.9 $\Omega$  to ground and are AC coupled to the converter's analog inputs, which are internally self-biased at 2.35V DC. A typical application circuit drives the IN+ noninverting analog input using AC-coupled signals. The nominal 20k $\Omega$  input resistance of the ana-

**Table 2. Gain-Selection Jumper JU5 Settings**

JU5 SETTING	MAX1011 GAIN CONTROL PIN	ADC GAIN RANGE
	GND	Low-gain, 500mVp-p
	OPEN	Mid-gain, 250mVp-p
	VCC	High-gain, 125mVp-p

**Table 3. Typical Input-Drive Requirements for Mid-Gain**

INPUT DRIVE	IN+	IN-	OUTPUT CODE
Single-Ended Noninverting	+125mV	Open Circuit	111111
	0	Open Circuit	100000
	-125mV	Open Circuit	000000
Single-Ended Inverting	Open Circuit	+125mV	000000
	Open Circuit	0	011111
	Open Circuit	-125mV	111111
Differential	+62.5mV	-62.5mV	111111
	0	0	100000
	-62.5mV	+62.5mV	000000

log inputs, plus the 0.1 $\mu$ F AC-coupling capacitor value, sets the low-frequency corner at approximately 80Hz.

You can drive the analog inputs either single-ended or differentially using AC- or DC-coupled inputs. Either the inverting or the noninverting input can be driven single-ended. If the inverting input is driven, then the digital output codes are inverted (complemented). Refer to the MAX1011 data sheet for typical circuits.

### ADC Gain Selection

The single GAIN-select pin on the MAX1011 controls the full-scale input range. Jumper JU5 is used to manually select the desired gain range as shown in Table 2. The EV kits are shipped with the mid-gain range selected (jumper pins open).

Table 3 lists the possible input-drive combinations for the mid-gain (250mVp-p) full-scale range selection. Drive levels are referenced to the open-circuit, common-mode voltage of the analog inputs (typically

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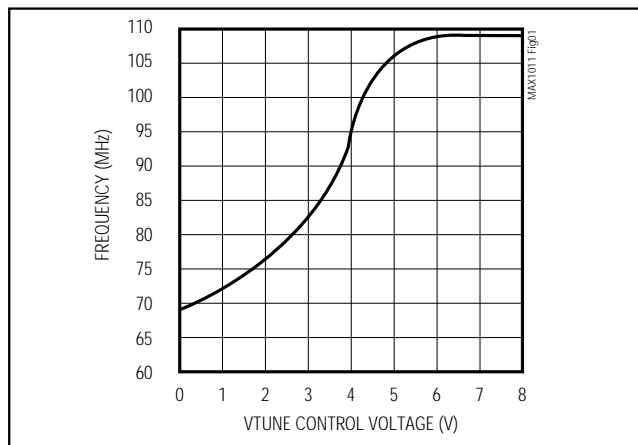


Figure 1. MAX1011 Oscillator Frequency vs. VTUNE Control Voltage

2.35V) if DC coupled, or to ground if AC coupling is used. If the low-gain (500mVp-p) range is selected, the input-drive requirements are twice those listed in Table 3. If the high-gain (125mVp-p) range is selected, the input-drive requirements are half those listed in Table 3.

### Offset-Correction Amplifier

The offset-correction amplifier included on the MAX1011 is usually enabled in a typical AC-coupled application circuit. For DC-coupled applications, the amplifier must be disabled by installing shorting blocks on jumpers JU3 and JU4. These jumpers short device pins OCC+ (pin 2) and OCC- (pin 3) to ground and disable the amplifier. The MAX1011 EV kit is configured with the offset-correction amplifier enabled (jumpers open) and AC-coupled analog inputs.

### Voltage-Controlled-Oscillator Operation

The EV kit includes a voltage-controlled-oscillator (VCO) circuit to set the analog-to-digital converter (ADC) sampling rate using an external resonant tank and a varactor diode. A voltage applied to the VTUNE pad changes the varactor diode's capacitance to adjust the tank's resonant frequency, which sets the oscillator's sampling frequency. VTUNE voltage can be varied from 0V to a maximum of 8V.

The EV kit is designed so that a nominal VTUNE control voltage of about 3.7V sets the ADC sampling rate to 90Msps. The VTUNE control voltage should be well filtered, as any noise on the supply contributes to jitter in the internal oscillator and degrades the converter's dynamic performance. Figure 1 shows the VTUNE control-voltage typical frequency-adjustment range for the MAX1011 EV kit (for VCO mode, refer to schematic in Figure 2).

Table 4. External Clock Source EV Kit Modifications

COMPONENT	DESCRIPTION	MODIFICATION
Clock Overdrive (J2)	Clock input BNC connector	Add
C6	5pF capacitor	Remove
C7, C8	47pF capacitors	Replace with 0.01μF capacitors
L1	220nH inductor	Remove
R1	10kΩ resistor	Remove
R2, R3	47kΩ resistors	Replace with 49.9Ω resistors
D1	Varactor diode	Remove

### External Clock Operation

The MAX1011 EV kit can be converted to drive the ADC from an external clock source. This involves removing the external resonator components from the VCO circuit and adding a few new components. Table 4 lists the EV kit changes required to convert the board to accept an external clock source. The resulting schematic is shown in Figure 3.

The new 49.9Ω value of R3 shown in Figure 3 provides proper termination for a 50Ω external signal generator. AC-coupling capacitor C7 couples the external clock signal to the MAX1011 oscillator circuitry at TNK+ (pin 7). R2 and C8 ensure that the impedance at both ports of the oscillator is balanced. After all modifications are complete, connect an external clock source to the BNC connector on the EV kit marked CLOCK OVERDRIVE (J2). The recommended clock amplitude is 1Vp-p; however, the ADC operates correctly with as little as 300mVp-p or up to 1.25Vp-p on CLOCK OVERDRIVE.

The external clock source should have low-phase noise for best dynamic performance. A low-phase-noise sine-wave oscillator serves this purpose well. A square-wave clock source is not necessary to drive the MAX1011. The device contains sufficient gain to amplify even a low-level-input sine wave to drive the ADC comparators, while ensuring excellent dynamic performance.

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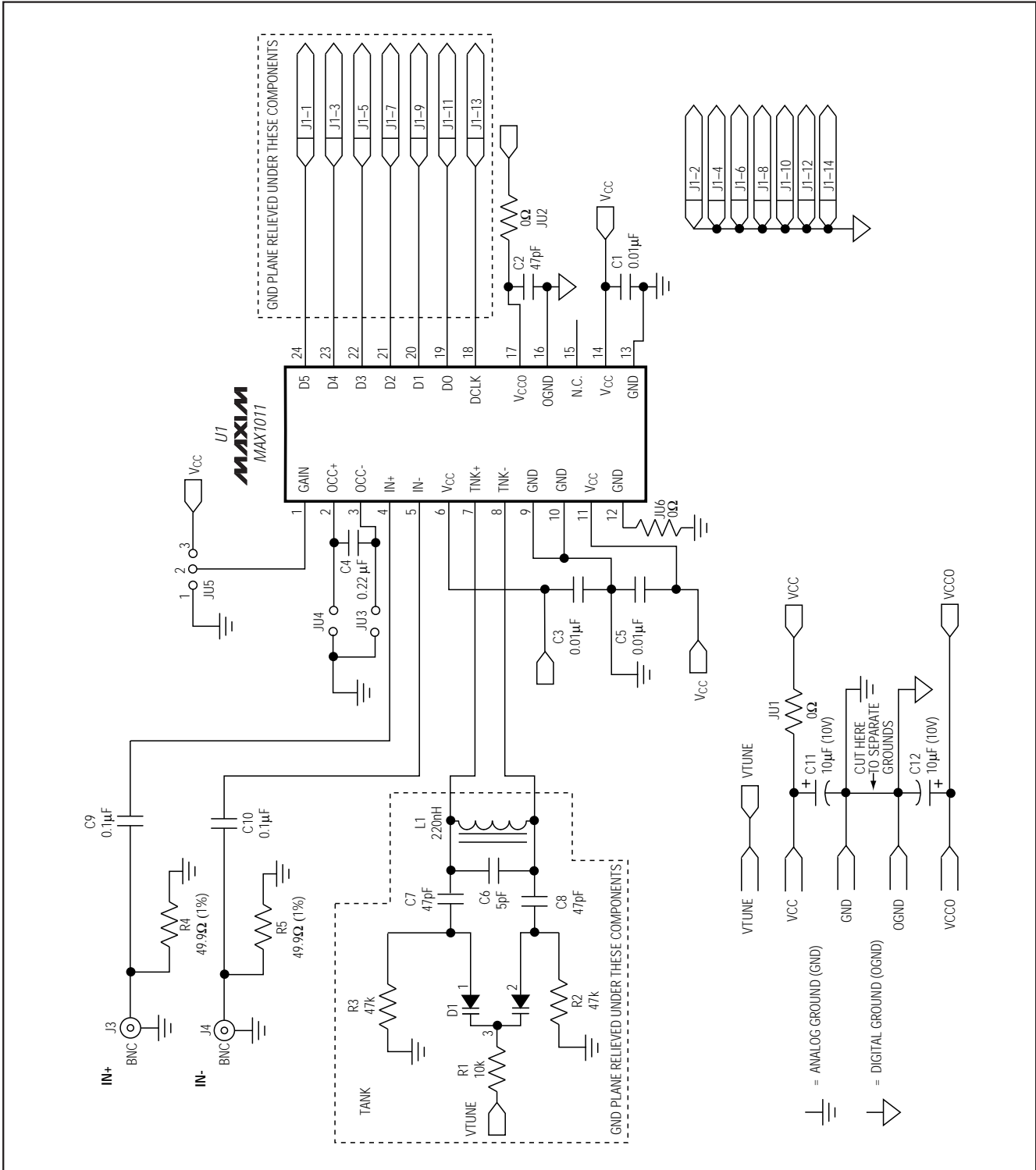


Figure 2. MAX1011 EV Kit Schematic (Voltage-Controlled-Oscillator Mode)

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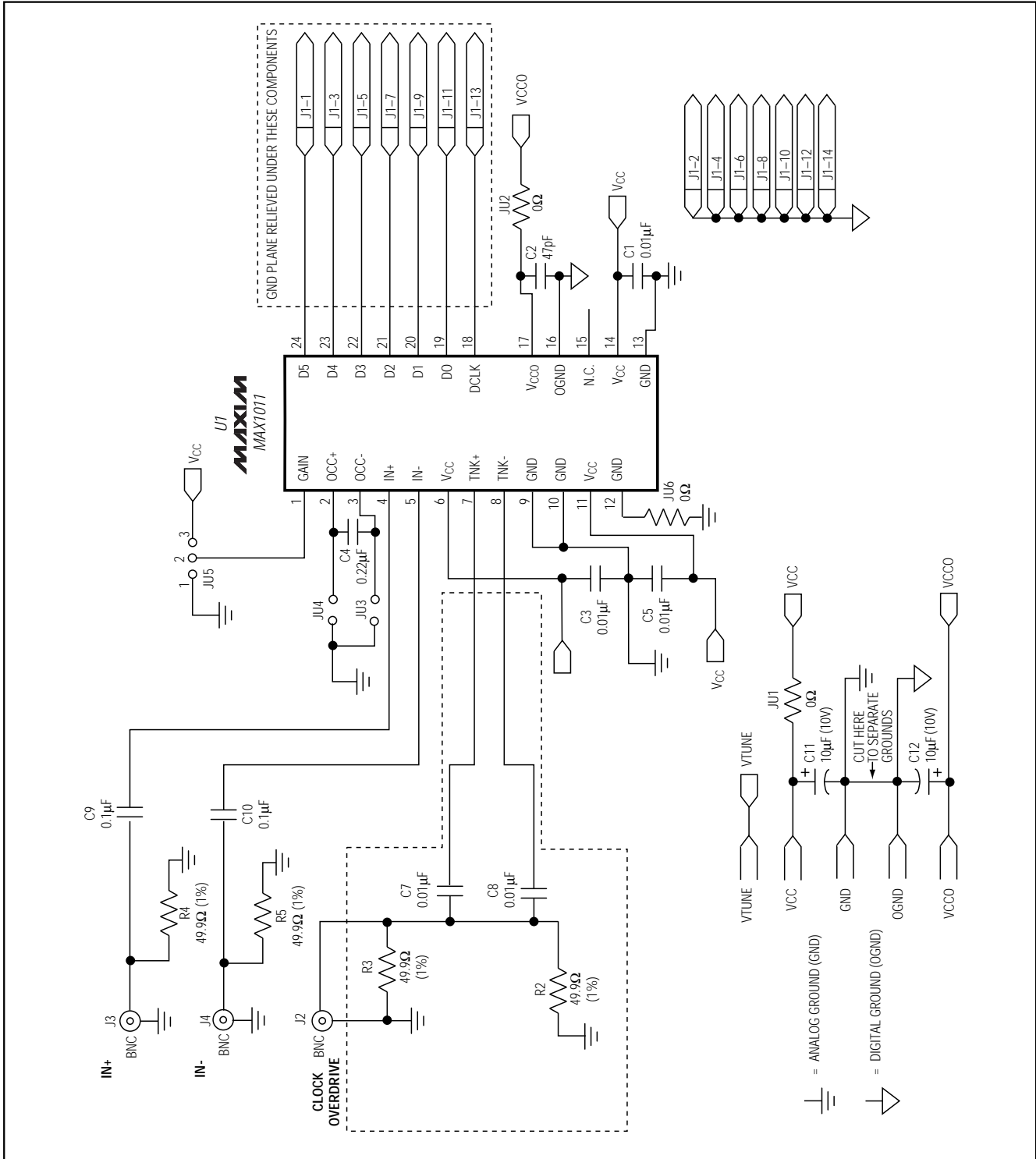


Figure 3. MAX1011 EV Kit Schematic (External Clock Operation)

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## Digital Outputs

The TTL/CMOS-compatible digital outputs are presented in parallel at connector J1. The data format is offset binary with the MSB as D5 and the LSB as D0. The row of pins closest to the board edge is digital output ground (OGND), while the data bits occupy the inside row. Located at the end of the connector is the pin for the output clock labeled DCLK. This signal can be used to latch the parallel-output data for capture into a logic analyzer or external DSP circuitry. The digital output is updated on DCLK's rising edge (see the timing diagram in the MAX1011 data sheet).

## Layout Considerations

The MAX1011 EV kit layout has been optimized for high-speed signals. Careful attention has been given to grounding, power-supply bypassing, and signal-path layout to minimize coupling between the analog and digital sections of the circuit. For example, the ground plane has been removed under the tank circuitry to reduce stray-capacitive loading on the relatively small capacitors required in the resonant tank formed by C6, L1, and D1. Other layout considerations are detailed in the following sections.

## Power Supplies and Grounding

The EV kit features separate analog and digital power supplies and grounds for best dynamic performance. A thin trace located on the backside of the circuit board near the VCC power-supply connector ties the analog and output ground planes together. This trace can be cut if the power-supply grounds are referenced elsewhere.

Referencing analog and digital grounds together at a single point usually avoids ground loops and corruption of sensitive analog circuitry by noise from the digital outputs. If the ground trace on the backside of the board is cut, observe the absolute maximum ratings between the two grounds.

## Bypassing

Proper bypassing is essential to achieve the best dynamic performance from the converter. The MAX1011 EV kit uses 10 $\mu$ F bypass capacitors located close to the power-supply connectors on the board to filter low-frequency supply ripple. High-frequency bypassing is accomplished with ceramic-chip capacitors located very close to the device's supply pins.

As the digital outputs toggle, transient currents in the VCCO supply can couple into sensitive analog circuitry and severely degrade the converter's effective number of bits performance. Of particular concern is effectively bypassing VCCO to OGND. For best results, locate the bypass capacitor on the same side of the board and place it close to the device. This avoids the use of through-holes and results in lower series inductance. The capacitor size chosen for the EV kit (size 0603) keeps the layout compact. Finally, the modest value (47pF) and small size result in a high self-resonant frequency for effective high-frequency bypassing.

## Applications Information

To achieve the full dynamic potential from the converter, minimize the capacitive loading on the digital outputs to reduce the transient currents at VCCO and OGND. The maximum capacitance per output bit should be less than 15pF. For example, the capacitance of the digital-output traces and the J1 connector on the EV kit is about 1.5pF per trace. In an applications circuit, this could be further reduced by locating the digital receiving chip very close to the MAX1011 and removing the ground plane from under the output bit traces.

A logic analyzer can be connected to the J1 connector on the EV kit for evaluation purposes. The analyzer should be directly connected to the EV kit without any additional ribbon cables. Even a short length of ribbon cable can exceed the maximum recommended capacitive loading of the digital outputs. A typical high-speed logic-analyzer probe adds about another 8pF loading per digital bit, which is acceptable for good dynamic performance.

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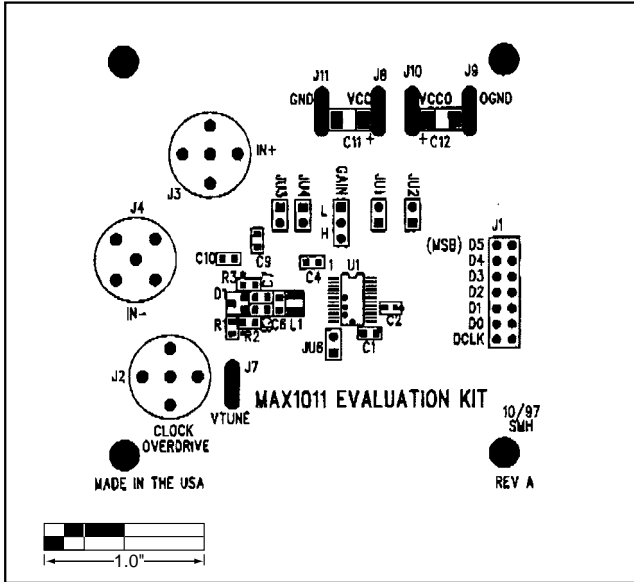


Figure 4. MAX1011 EV Kit Component Placement Guide—Component Side

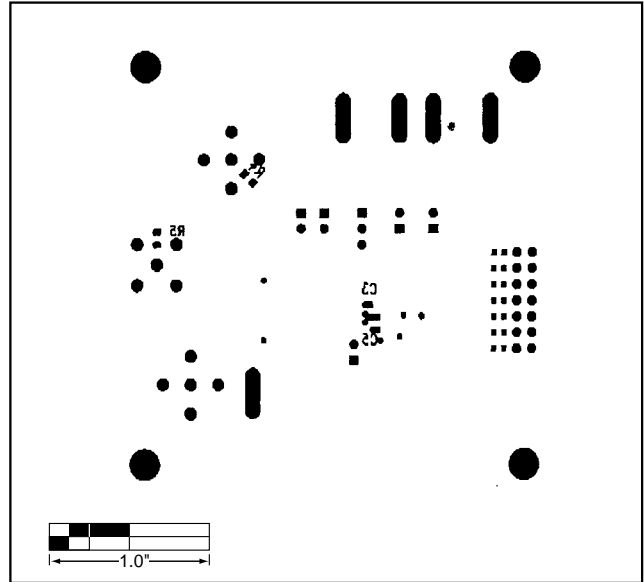


Figure 5. MAX1011 EV Kit Component Placement Guide—Solder Side

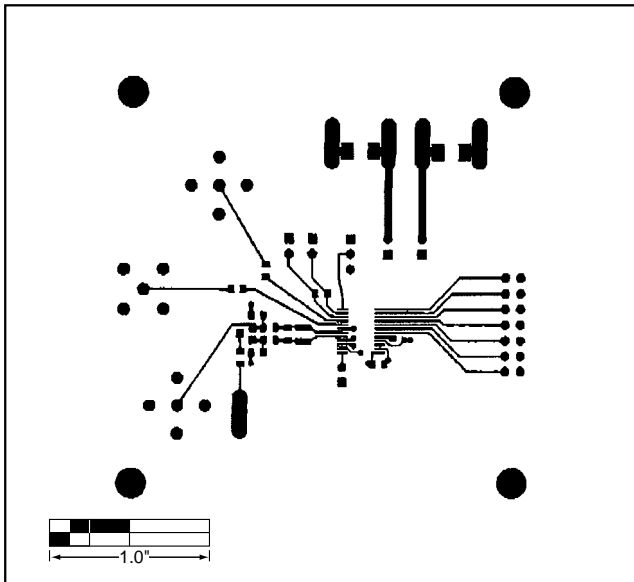


Figure 6. MAX1011 EV Kit PC Board Layout—Component Side

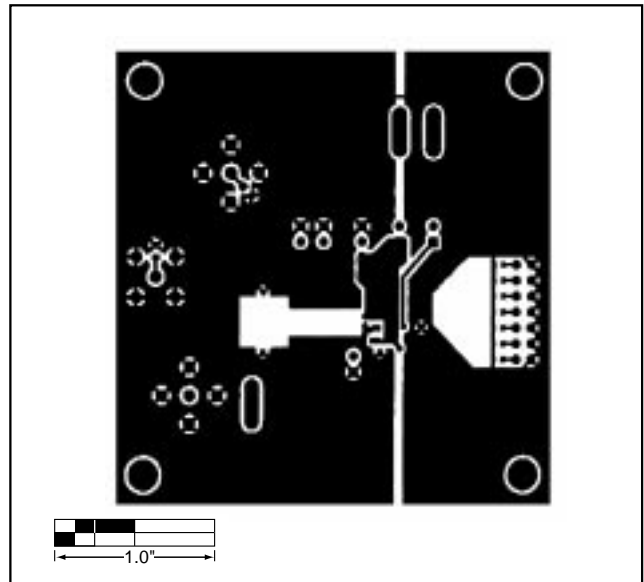


Figure 7. MAX1011 EV Kit PC Board Layout—Solder Side

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## NOTES

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