

# MAXIM

## MAX101A Evaluation Kit

### General Description

The MAX101A evaluation kit (EV kit) was developed to assist in the initial evaluation of the MAX101A high-speed analog-to-digital converters (ADCs). The EV kit is a two-board set comprised of a main board and a termination board.

The main board contains all the circuitry needed to evaluate the initial performance of this flash converter, which combines high-speed analog and digital circuitry and requires special attention to circuit layout. In conjunction with the MAX101A, the main board allows digitizing of analog signals at up to 500MSPS. It has provisions for an external clock source, which is supplied through an SMA connector. The analog inputs to the converter are through two SMA connectors (AIN+ and AIN-). There are 16 data outputs (two 8-bit words) plus the data clock output.

A separate termination board with 50Ω ECL pull-down resistors is provided with the kit and is connected to the main board with a 3x32 pin EURO-card connector. It provides access to the converter output data, as well as proper ECL termination. The termination board also has two ranks of square pins, each providing eight data outputs, plus data clock outputs. Either AData or BData can be observed with a high-speed logic analyzer.

Standard power supplies of +5V and -5.2V are needed to operate the MAX101A main board. Power can be supplied through the 3x32 EURO-card connector or through the pads on the edge of the board. Nominal power dissipation for both boards is 17W. The board set comes fully assembled and tested, with the MAX101A installed.

The MAX101A EV kit comes with a MAX101A installed on the board, but it can also be used to evaluate the MAX101. Refer to instructions for setting references and input conditions for the appropriate device version throughout this document.

### Features

- ♦ 7.0 Effective Bits at 250MHz
- ♦ On-Board Reference Generator/Buffer
- ♦ 50Ω Input through SMA Coaxial Connectors
- ♦ Dual Differential-Output Data Paths
- ♦ ±270mV Input Signal Range (MAX101)  
±250mV Input Signal Range (MAX101A)
- ♦ Buffered Differential 100k ECL Outputs
- ♦ 3x32 Pin EURO-Card Connector

### Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX101AEVKIT-CFR	0°C to +70°C	Surface Mount

### Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2, C4, C6, C7, C9, C10, C12, C14, C15, C18, C20, C23, C26, C27, C29, C31, C32, C34, C36, C38, C40, C42	23	0.01μF capacitors
C3, C5, C11, C13	4	0.22μF capacitors
C8, C16, C30, C33, C35, C37, C39, C41, C43	9	100pF capacitors
C17, C21, C24	3	0.1μF capacitors
C19, C22, C25	3	10μF capacitors, AVX "D" tantalum
D1-D4	4	100mA Schottky diodes, Central Semiconductor CMPSH-3
DIV 10	1	3-pin jumper block
J1, J2, J3	3	Female SMA connectors
J5	1	96-pin EURO-style plug
L1, L2	2	Ferrite beads
R1, R12	2	180Ω, 1% resistors
R2, R13, R23	3	121Ω, 1% resistors
R3, R4, R14, R15	4	100Ω trim pots
R5, R16, R38, R39	4	51Ω, 5% resistors

Component List continued on next page.

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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R6, R7, R17, R18	4	20 $\Omega$ , 5% resistors
R8, R9, R19, R20	4	12.1k $\Omega$ , 1% resistors
R10, R11, R21, R22	4	27.4 $\Omega$ , 1% resistors
R24, R34, R36	3	82.5 $\Omega$ , 1% resistors
R25	1	1k $\Omega$ , 1% resistor
R26	1	2k $\Omega$ trim pot
R27	1	3.16k $\Omega$ , 1% resistor
R28, R29, R40–R55	18	100 $\Omega$ , 5% resistors
R35, R37	2	221 $\Omega$ , 1% resistors
U1	1	Maxim MAX101ACFR
U2, U4	2	Maxim MAX412CPA high-speed dual op amps
U3, U5	2	Maxim MX580KH 2.5V references
U6	1	LM337T negative voltage regulator
U8, U21–U24	5	MC100E116 quintuple line receivers

## Quick Start

- 1) Plug the termination board into the 96-pin connector of the MAX101A main board.
- 2) Use a fan to provide at least 200 lineal feet/min airflow to the heatsink of the MAX101A.
- 3) Connect the power supplies. The power-supply input pads are in the lower right-hand corner of the MAX101A main board. The board requires a 20W power supply that provides +5V and -5.2V with a common ground.
- 4) Turn on the -5.2V power supply first, followed by the +5V power supply. The -5.2V power supply should be the first supply turned on and the last supply turned off.
- 5) Connect a low-phase-jitter RF source with a level range of -4dBm to +10dBm to the clock input.
- 6) Connect a test signal to the analog inputs. Use IN+ and IN- if the signal is differential, or IN+ if the signal is single-ended ( $\pm 270$ mV (MAX101),  $\pm 250$ mV (MAX101A) differential; see the MAX101 or MAX101A data sheet).
- 7) Observe the digitized results on the termination board pins by using a logic analyzer, such as the HP16500 series or an equivalent data-acquisition system. The outputs are 100k ECL compatible.

## Detailed Description

### Board Set

The MAX101A EV kit is a two-board set. The main board contains ECL-interface circuitry and the MAX101A ADC. The termination board provides high-speed signal termination and access to the digital data. For further signal processing, the main board can be plugged into a larger system board via the provided EURO-card connector.

### Clock Input

The external clock input is capacitively coupled to an on-board bias network. Take care to ensure that the pulse width is within the specified requirements: clock input levels should be -4dBm to +10dBm, and clock frequency can range from 250MHz to 500MHz. Figure 1 in the MAX101A data sheet shows the necessary timing requirements for the clock input, as well as the expected output clock waveforms. The clock input should be driven by a low-jitter RF signal source. Refer to Figures 1, 2, and 3 of the MAX101A data sheet for more information.

### Analog Input

Analog input to the MAX101A is made through one or both of the two SMA coaxial connectors provided (AIN+ and AIN- inputs). Each input is a direct connection to the ADC, with internal 50 $\Omega$  terminations provided by the MAX101A.

### Outputs

The MAX101A main board has two 8-bit-wide digital outputs that are 100k ECL compatible. Each data output is buffered by 100E116 line receivers. There is also a data clock output (DCLK) provided for timing. All 17 outputs provided to the EURO-card connector are differential and unterminated.

The termination board provides a termination for each data line, through 50 $\Omega$  to -2V.

### ADC Reference Resistor String

An on-board reference supply and op-amp circuit drive the ADC reference resistor string. The reference supplies can be adjusted using the four potentiometers on the board (see the *Calibration Procedure*). It is important to ensure that a reverse bias condition never occurs on the reference inputs. Schottky diode clamps on the reference amp outputs help protect the MAX101A.

### DIV 10

The jumper DIV 10 selects the operating mode of the MAX101A, which can output data either at full speed or at 1/10 the clock rate. This feature is valuable during initial testing. DIV 10 is usually left open for normal (full-

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speed) operation.

### Power Supplies

The following supplies are required for normal operation of the main board:

$$V_{CC} = +5V \text{ at } 0.8A$$

$$V_{EE} \text{ and } V_{AA} = -5.2V \text{ at } 2.5A$$

These voltages should be supplied to the connector pins for  $V_{CC}$ ,  $V_{EE}$ , and  $V_{AA}$ , respectively.  $V_{EE}$  and  $V_{AA}$  are connected on the board with a ferrite bead. If system noise must be reduced, you may remove this bead and then provide the analog supply,  $V_{AA}$ , separately from the digital supply,  $V_{EE}$ . The -5.2V power supply should be the first supply turned on and the last supply turned off.

### Board Layout

The MAX101A requires proper PC board layout for device operation. This section explains the layout requirements and demonstrates how the EV kit achieves these goals.

Use power and ground planes to deliver power to the device, keeping the digital planes separate from the analog planes. The EV kit uses layers 3, 4, and 5 for power and ground planes. Tie digital ground and analog ground to a single point, as close to the power supply as possible. On the EV kit, digital ground ties to analog ground at ferrite bead L1. Likewise, tie digital power ( $V_{EE}$ ) and analog power ( $V_{AA}$ ) to a single point, as close to the power supply as possible. On the EV kit, digital power ties to analog -5.2V power at ferrite bead L2.

Use transmission lines for the analog input, clocks, and high-speed digital outputs. The MAX101A EV kit uses microstrip lines of two different impedances. The MAX101A data outputs drive differential line drivers through 100Ω microstrip lines. The 50Ω microstrip lines occupy layers 1 and 2. The 100Ω microstrip lines occupy layers 1 and 3, with layer 2 void. The kit uses FR4 epoxy dielectric material, whose relative dielectric constant is between 4.1 and 4.9. The nominal design is 0.0014 inch (0.0355mm) foil thickness for each copper layer, and 0.011 inch (0.28mm) dielectric thickness between layers. The 50Ω microstrip lines have a signal trace width of 0.020 inch (0.50mm), and the 100Ω

microstrip lines have a signal trace width of 0.010 inch (0.25mm). Refer to Motorola's MECL or ECLinPS data book for an introduction to interconnect design.

Due to the high-speed nature of this part, the propagation delay of the PC board traces becomes a significant design consideration. For the EV kit design, the propagation delay is approximately 145ps per inch (5.7ps/mm). For best results, try to match the lengths of the data traces to within 0.5 inch (12mm). The clock signal must be routed on one layer only, without using any through-hole vias. The MAX101A EV kit is a controlled impedance board (50Ω and 100Ω) and has a total board thickness of 0.062 inches (1.57mm) using six copper layers (see Figure 1, the Layer Profile).

### Evaluating the MAX101

The MAX101A EV kit also can be used to evaluate the MAX101.

To use the MAX101, refer to specific instructions in the *Quick Start*, *Applications Information*, and *Calibration Procedure* sections.

Copper Layer 1	Copper thickness = 0.0007" (1/2 oz copper) (microstrip signals)
Epoxy FR4	Dielectric layer thickness = 0.011"
Copper Layer 2	Copper thickness = 0.0014" (1 oz copper) (50Ω microstrip return; ground plane)
Epoxy FR4	Dielectric layer thickness = 0.011"
Copper Layer 3	Copper thickness = 0.0014" (1 oz copper) (100Ω microstrip return; ground plane)
Epoxy FR4	Dielectric layer thickness = 0.011"
Copper Layer 4	Copper thickness = 0.0014" (1 oz copper) ( $V_{CC}/V_{TT}$ power plane)
Epoxy FR4	Dielectric layer thickness = 0.011"
Copper Layer 5	Copper thickness = 0.0014" (1 oz copper) ( $V_{EE}/V_{AA}$ power plane)
Epoxy FR4	Dielectric layer thickness = 0.011"
Copper Layer 6	Copper thickness = 0.0014" (1 oz copper) (DC signal layer)

Figure 1. MAX101A Evaluation Board Layer Thickness Profile

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## Applications Information

### Analog Input

The main board digitizes single-ended signals by choosing either input and leaving the other input either open or terminated in the system characteristic impedance. In this mode the unused input can provide a DC offset to the incoming signal. (See the *Electrical Characteristics* in the MAX101A data sheet for this DC voltage range.)

To obtain a digital output of all ones (11...1) with differential input drive for the MAX101, 270mV must be applied between AIN+ and AIN-. That is, AIN+ = +135mV and AIN- = -135mV (when no DC offset is applied). Mid-scale digital output code occurs when there is no voltage difference across the analog inputs. Zero-scale digital output code, with differential drive for the MAX101, occurs when AIN+ = -135mV and AIN- = +135mV. The output of the converter stays at all ones (full scale) or all zeros (zero scale) when overranged or underranged, respectively. Tables 1a and 1b show these relationships for both the MAX101 and the MAX101A.

### Digital Outputs

Data from the ADC is interleaved and is output on alternate clock phases. One 8-bit word is output during one clock phase and the other is output on the alternate clock

**Table 1a. MAX101 Input Voltage Range**

INPUT	AIN+*	AIN-*	OUTPUT CODE	MSB TO LSB
Differential	+135mV	-135mV	11111111	full scale
	0	0	10000000	mid scale
	-135mV	+135mV	00000000	zero scale
Single Ended	+270mV	0	11111111	full scale
	0	0	10000000	mid scale
	-270mV	0	00000000	zero scale

**Table 1b. MAX101A Input Voltage Range**

INPUT	AIN+*	AIN-*	OUTPUT CODE	MSB TO LSB
Differential	+125mV	-125mV	11111111	full scale
	0	0	10000000	mid scale
	-125mV	+125mV	00000000	zero scale
Single Ended	+250mV	0	11111111	full scale
	0	0	10000000	mid scale
	-250mV	0	00000000	zero scale

\*An offset  $V_{IO}$ , as specified in the *DC Electrical Characteristics*, will be present at the input. Compensate for this offset by either adjusting the reference voltages  $V_{ART}$ ,  $V_{ARB}$ ,  $V_{BRT}$ ,  $V_{BRB}$ , or introduce an offset voltage in one of the input terminals, AIN+ or AIN-.

phase. The two 8-bit-wide data paths are buffered by 100E116 line receivers, which provide a differential output, available at the connector. If the termination board is not used, the user must provide proper ECL termination at the EURO-card connector.

### Input Reference-Resistor Strings

Operational amplifiers are used to drive the top and bottom inputs of each of the ADC reference resistor chains. A 2.5V reference is resistor-divided down and buffered through two MAX412CPA op amps. (The relatively low input impedance of each string, 120 $\Omega$ , will draw approximately 17mA.) The reference voltage is set at the factory for either the MAX101 or MAX101A. This reference controls the comparator input windows, and can be adjusted between  $\pm 1.20V$  to accommodate input requirements. (Accuracy specifications are guaranteed with a reference of  $\pm 1.02V$  (MAX101) or  $\pm 0.95V$  (MAX101A).)

### Testing

We recommend that a digital acquisition instrument like the HP16500 series of logic analyzers be used to acquire and process the output data. At Maxim, the data acquired from the converter is evaluated in an effective-bits software program developed in-house. The effective-bits measurement is a good tool to determine and compare ADC accuracy. See the MAX101A data sheet for more details on effective-bits testing.

### Calibration Procedure

The MAX101 EV kit comes calibrated and ready to operate from the factory. If other MAX101A devices are to be used in the same fixture, the EV kit should be recalibrated according to the following procedure:

- 1) With the ADC removed, adjust the +5V and -5.2V power supplies.
- 2) Adjust the PHASE potentiometer (R26) to a nominal voltage of 0V. A test point (TP1) for this voltage measurement is located near the potentiometer.
- 3) With the power off, insert the MAX101A into the board. The device's heatsink fits down through the board, and its leads rest on top of the board. Take care to place the part in the board with Pin 1 in the correct location. Pin 1 is indicated by a small dot near the U1 device designation.
- 4) Turn the power on, observing proper sequencing, and let the part warm up for several minutes. Use a fan to ensure 200 lineal feet/min airflow. Repeat Step 2.

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- 5) After the part has warmed up for several minutes, adjust the reference voltages to the values shown in Tables 2a and 2b. These tables list the reference voltages, the trim pots that control the reference voltages, and the measurement points.
- 6) Adjust the A converter mid-code level. With no analog input ( $A_{IN+} - A_{IN-} = 0V$ ), the output code should match that specified in Table 1. If there is an offset, adjust either the positive or negative reference (R3 or R4) until the expected code of 10 00 00 00 (MSB to LSB) is achieved. After adjusting to the proper level, the references need to be balanced to the proper values shown in Tables 2a and 2b, around any offset that was introduced. (If the negative reference was moved by +32mV, the positive reference must be moved by that same amount to ensure the correct LSB size.) It may be necessary to repeat the reference offset adjustment again after the correct differential reference voltage is re-established around a common-mode offset.
- 7) Repeat Step 6 for the B converter reference voltages. (The adjustment pots of the B converter are R14 and R15.)
- 8) Adjust the phase potentiometer (R26) for best effective bits performance (optional). While digitizing a pure sine-wave input, compute the effective-bits performance of the interleaved output data. Good performance can be achieved with the PHADJ voltage set to 0V (Step 2); however, maximum performance can be achieved by adjusting the sampling delay with R26 as required.

**Table 2a. MAX101 Reference Adjustments**

REFERENCE VOLTAGE	CONVERTER	TRIM POT	MEASURE AT DEVICE SIDE OF:
+1.02V	A	R3	R5
-1.02V	A	R4	R8
+1.02V	B	R14	R16
-1.02V	B	R15	R19

**Table 2b. MAX101A Reference Adjustments**

REFERENCE VOLTAGE	CONVERTER	TRIM POT	MEASURE AT DEVICE SIDE OF:
+0.95V	A	R3	R5
-0.95V	A	R4	R8
+0.95V	B	R14	R16
-0.95V	B	R15	R19

Evaluates: MAX101/MAX101A

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Evaluates: MAX101/MAX101A

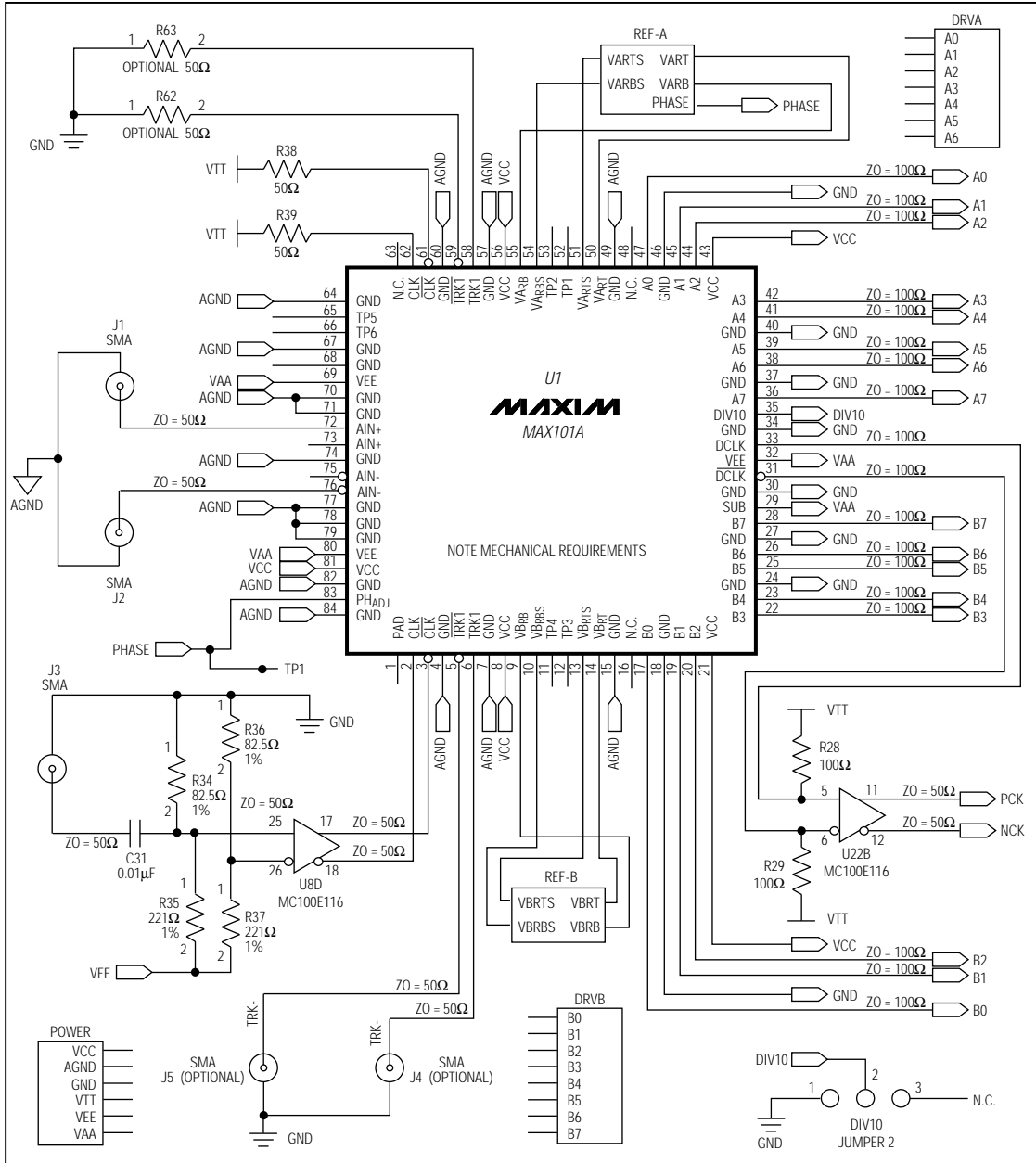


Figure 2. MAX101A EV Kit Schematic

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

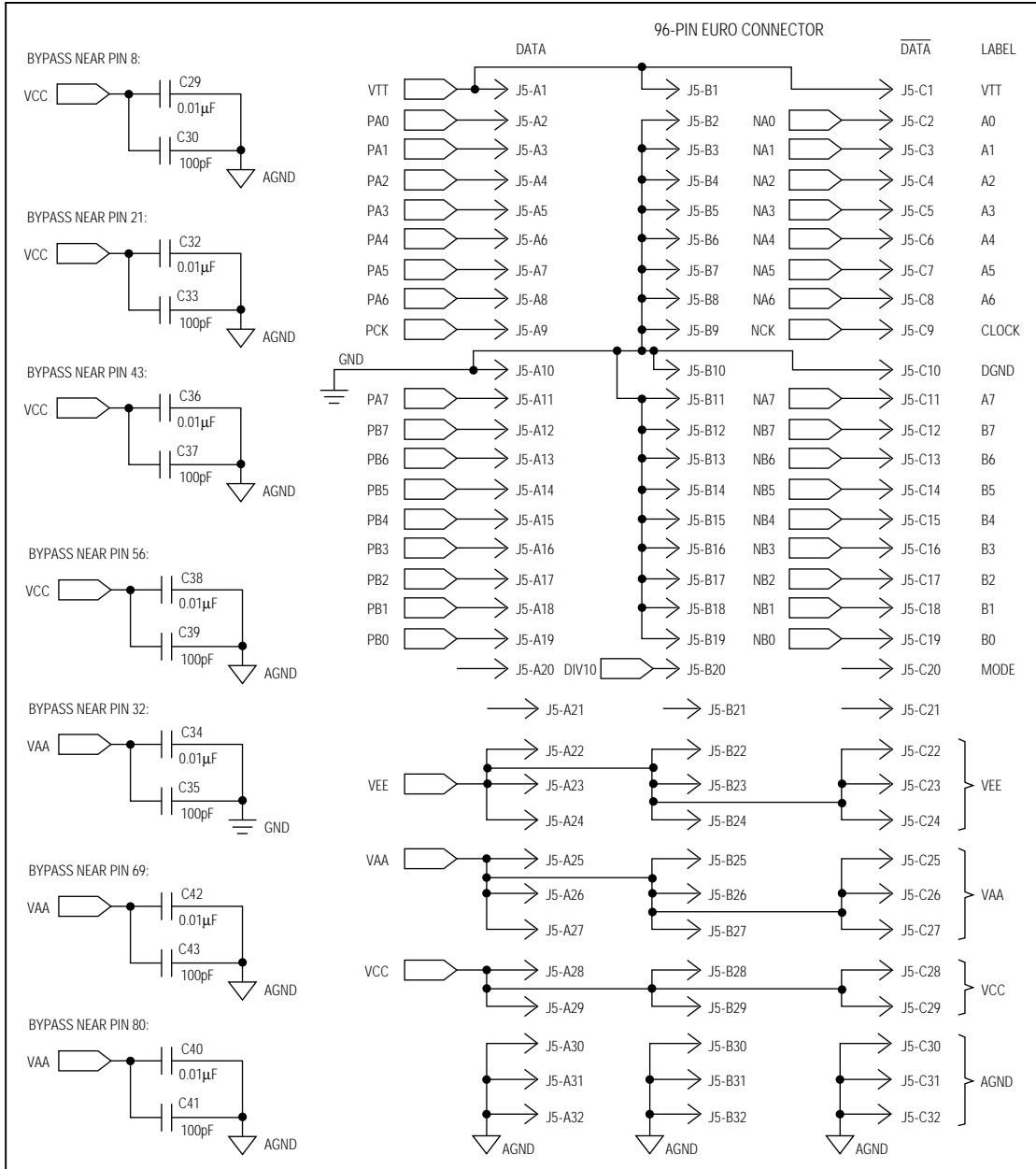


Figure 2. MAX101A EV Kit Schematic (continued)

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

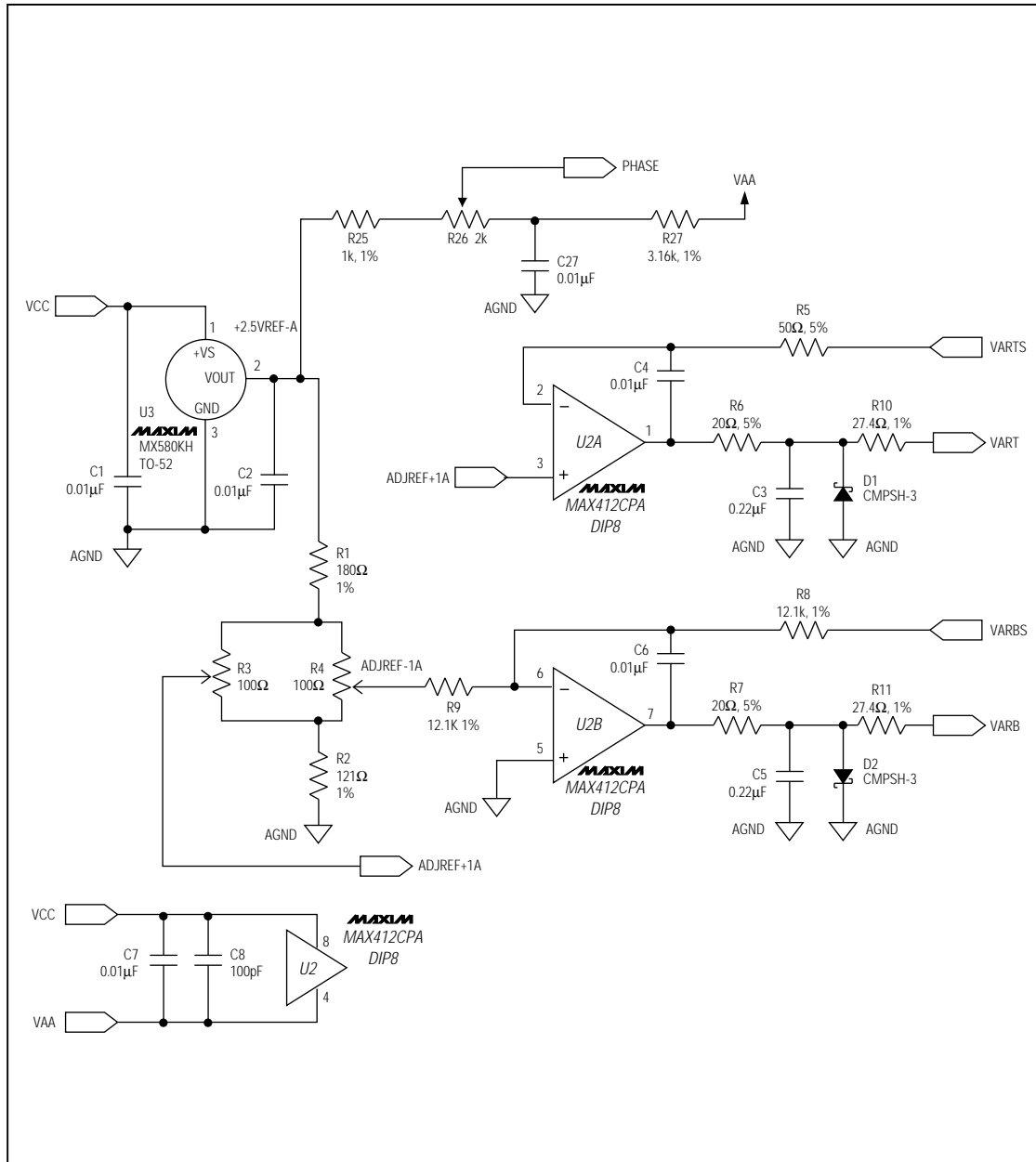


Figure 2. MAX101A EV Kit Schematic (continued)



# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

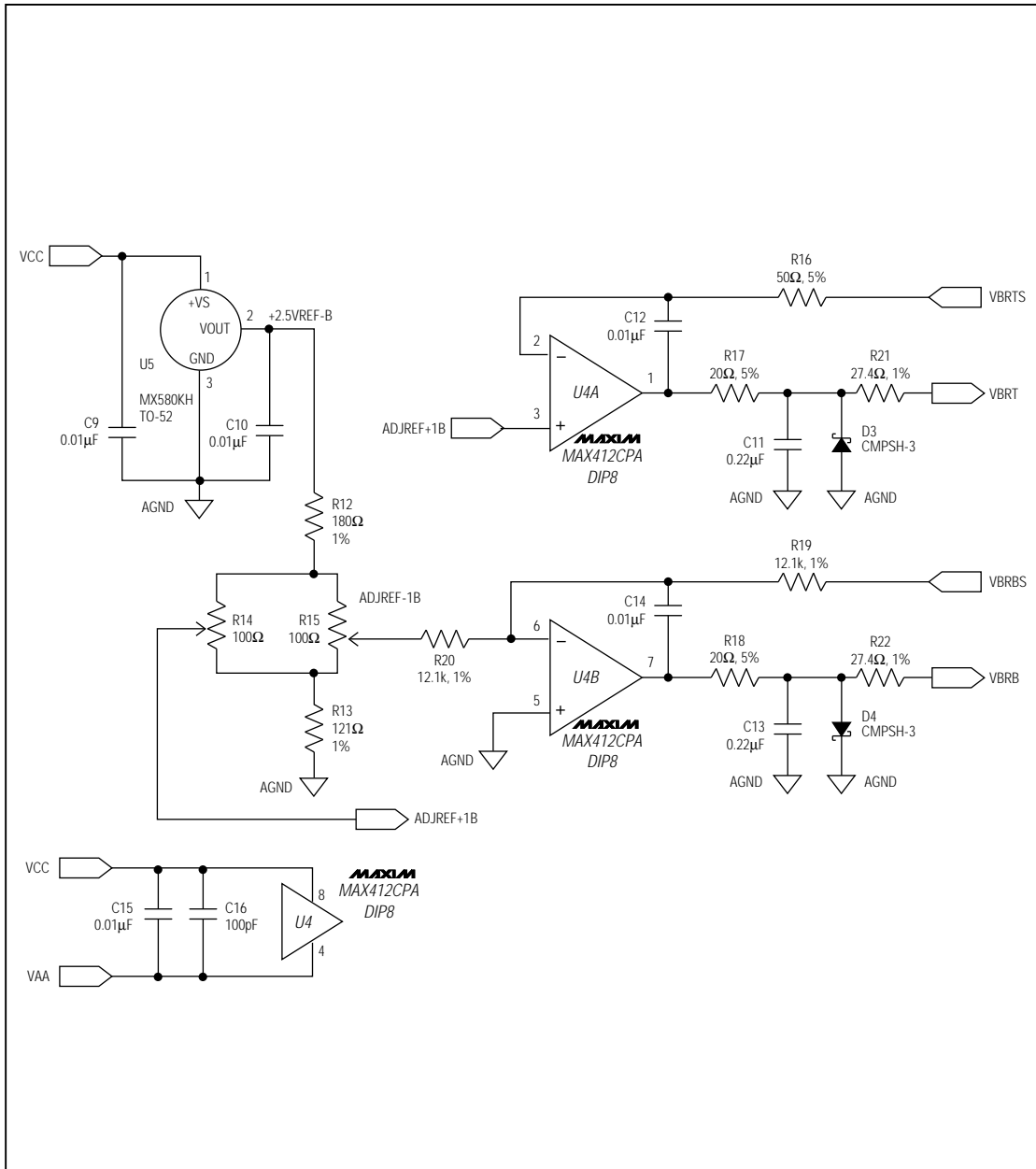


Figure 2. MAX101A EV Kit Schematic (continued)

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

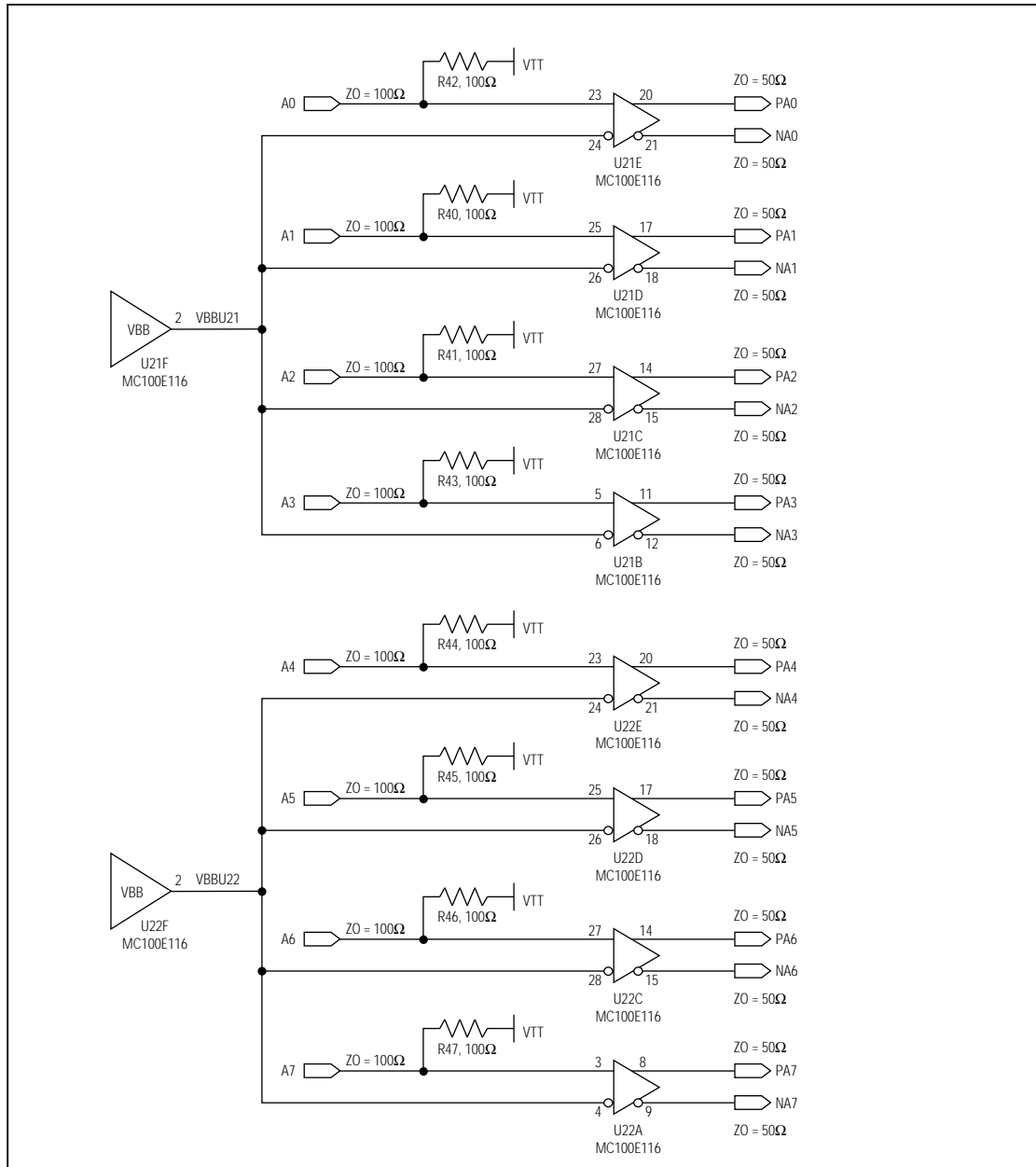


Figure 2. MAX101A EV Kit Schematic (continued)

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

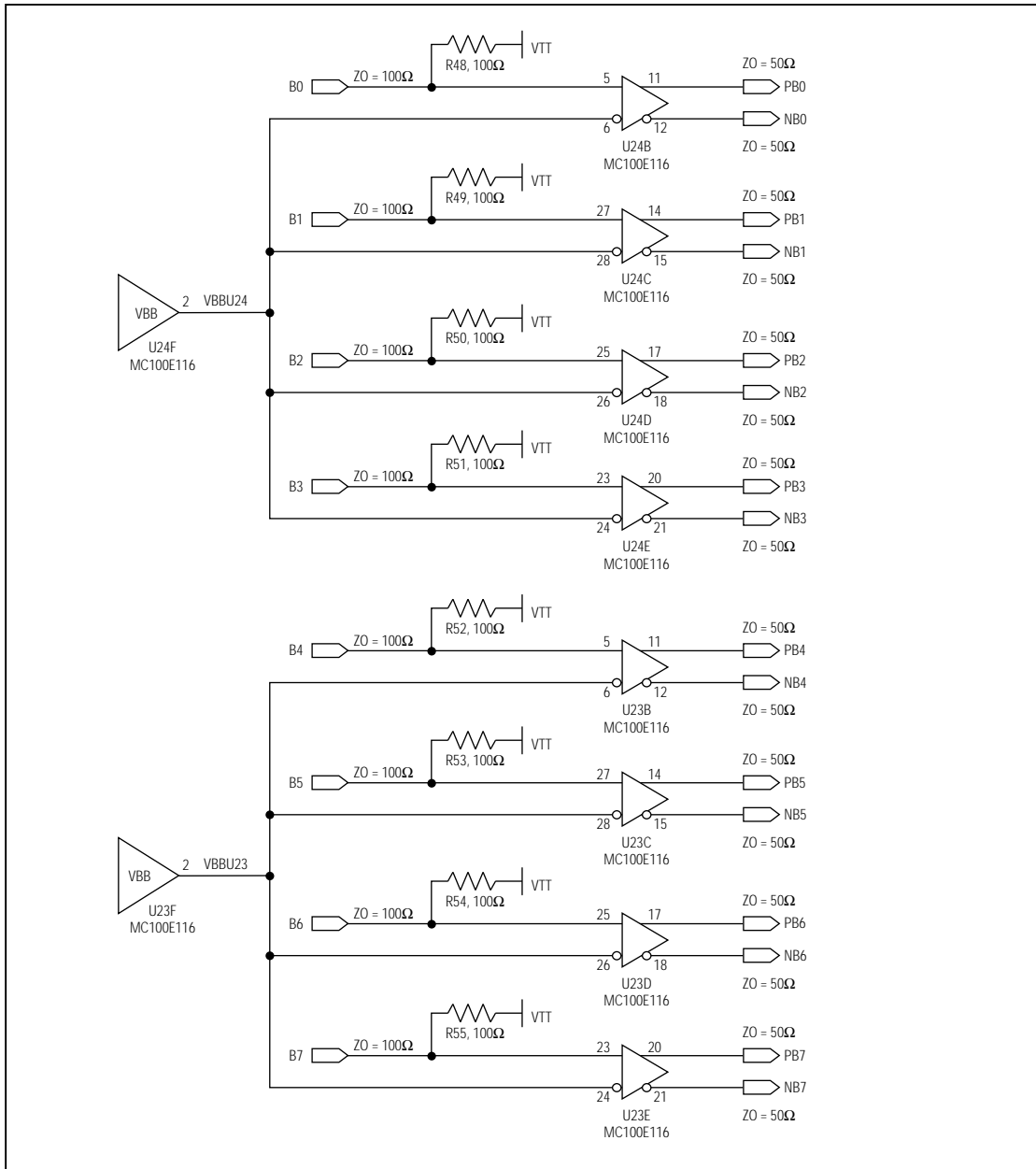


Figure 2. MAX101A EV Kit Schematic (continued)

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

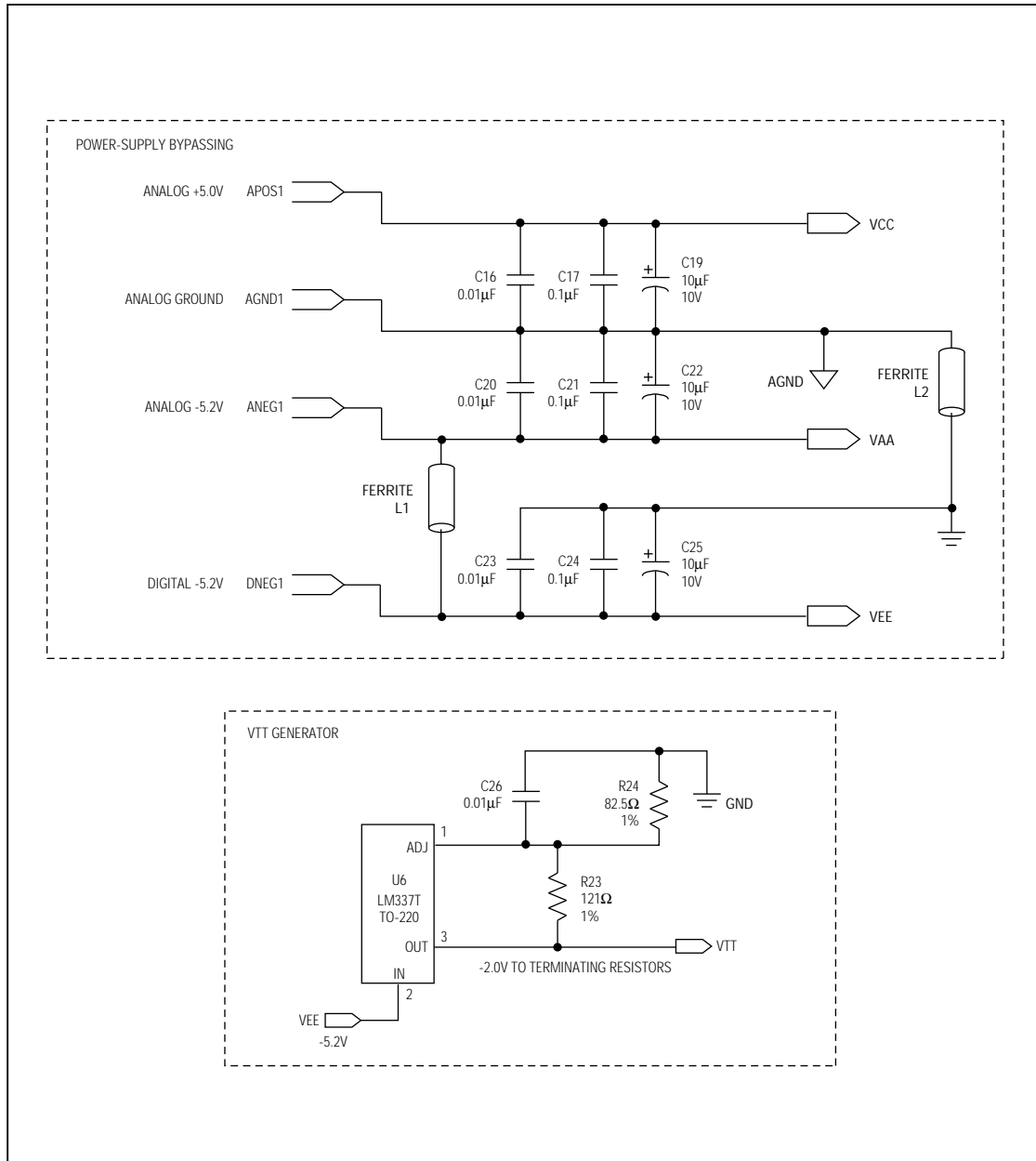


Figure 2. MAX101A EV Kit Schematic (continued)

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

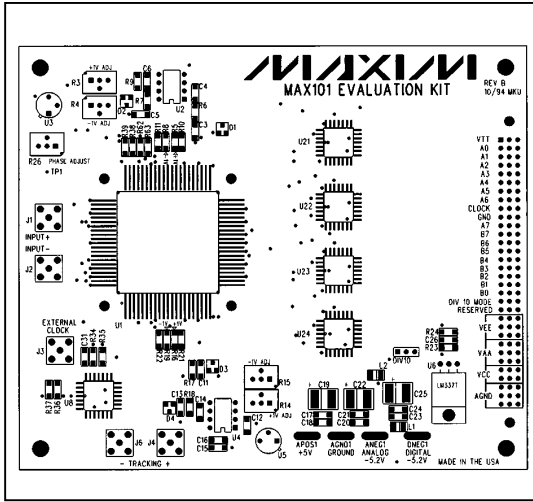


Figure 3. MAX101A EV Kit Main Board Component Placement Guide—Component Side

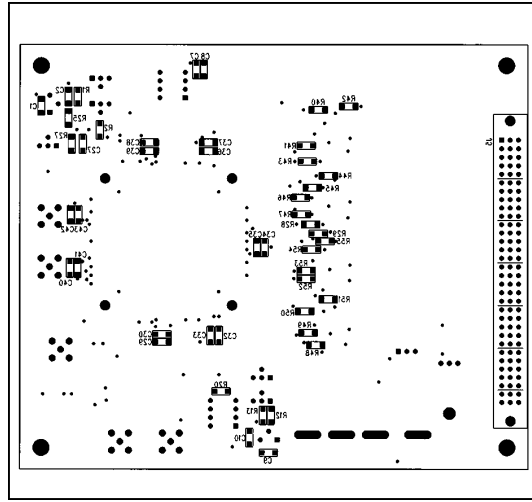


Figure 4. MAX101A EV Kit Main Board Component Placement Guide—Solder Side

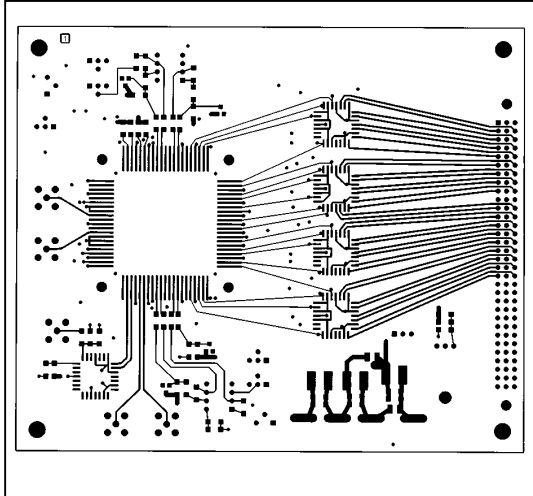


Figure 5. MAX101A EV Kit Main Board Layout—Layer 1

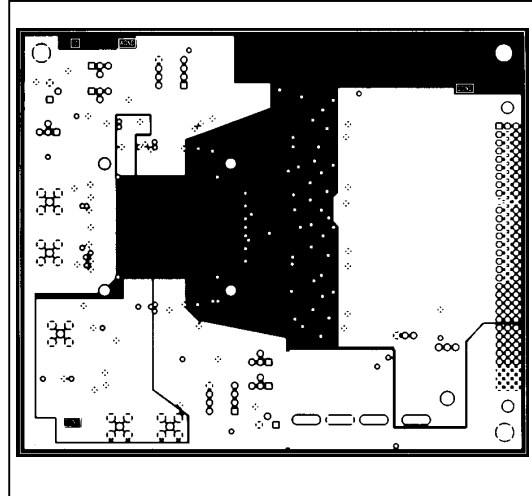


Figure 6. MAX101A EV Kit Main Board Layout—Layer 2 (Negative Image)

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

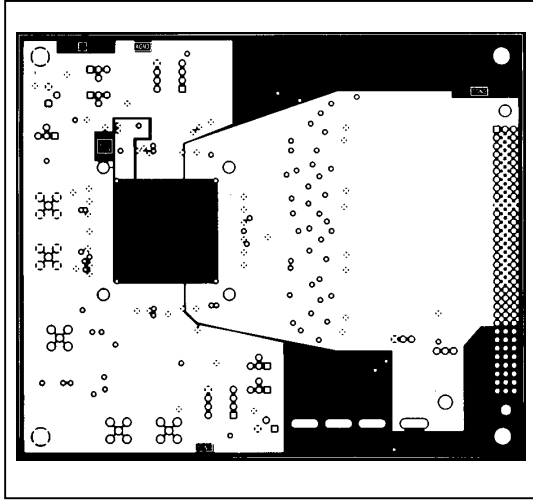


Figure 7. MAX101A EV Kit Main Board Layout—Layer 3 (Negative Image)

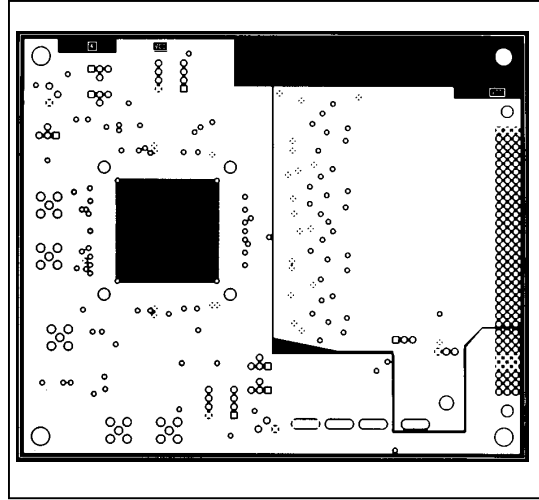


Figure 8. MAX101A EV Kit Main Board Layout—Layer 4 (Negative Image)

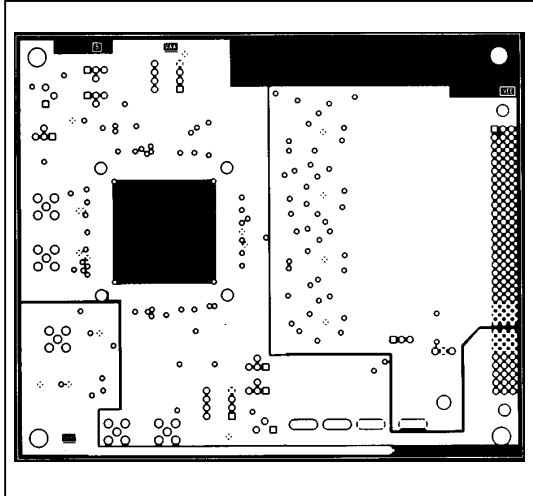


Figure 9. MAX101A EV Kit Main Board Layout—Layer 5 (Negative Image)

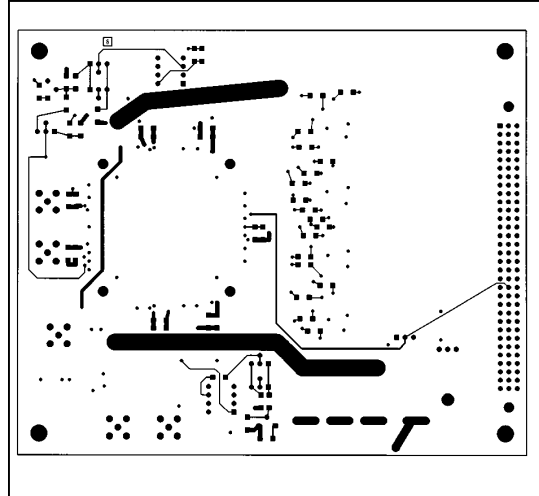


Figure 10. MAX101A EV Kit Main Board Layout—Layer 6

# MAX101A Evaluation Kit

Evaluates: MAX101/MAX101A

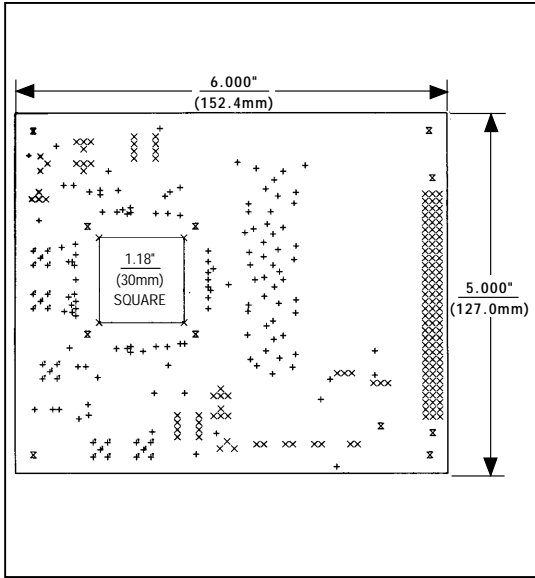


Figure 11. MAX101A EV Kit Main Board Mechanical Guide

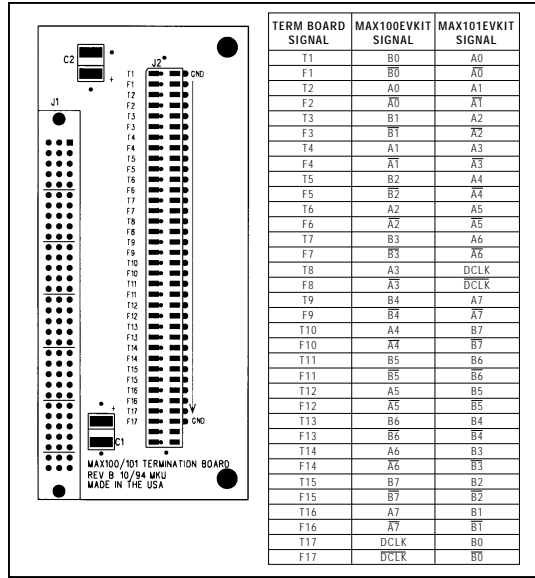


Figure 12. MAX101A EV Kit Termination Board Component Placement Guide—Component Side

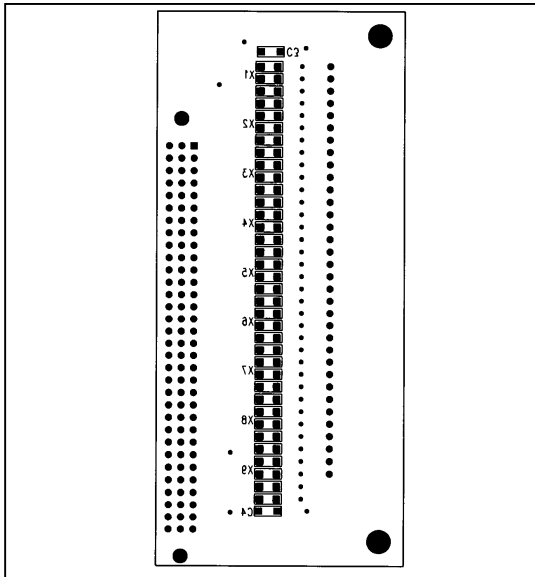


Figure 13. MAX101A EV Kit Termination Board Component Placement Guide—Solder Side

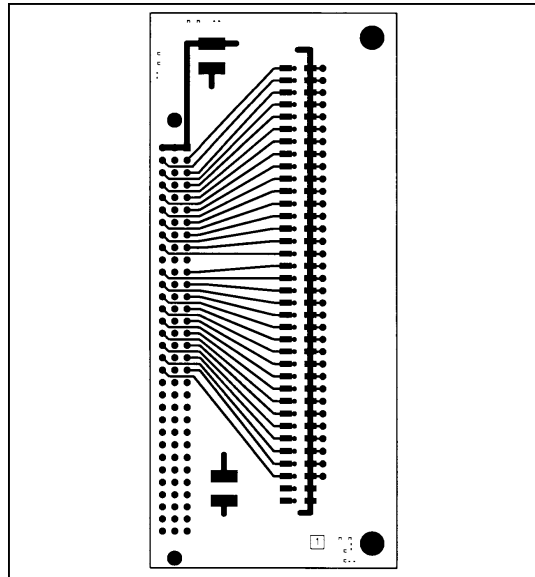


Figure 14. MAX101A EV Kit Termination Board Layout—Layer 1

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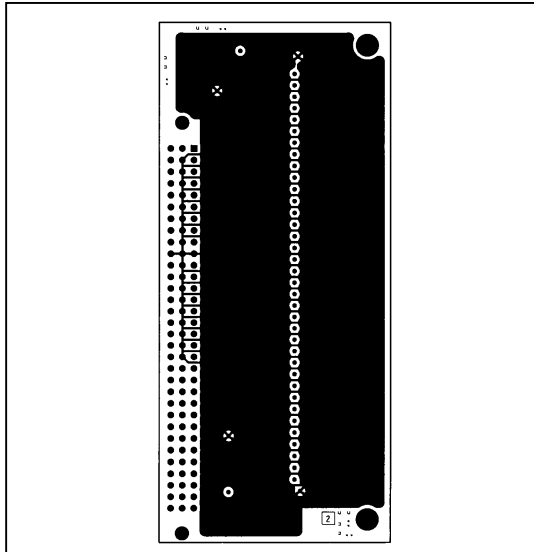


Figure 15. MAX101A EV Kit Termination Board Layout—Layer 2

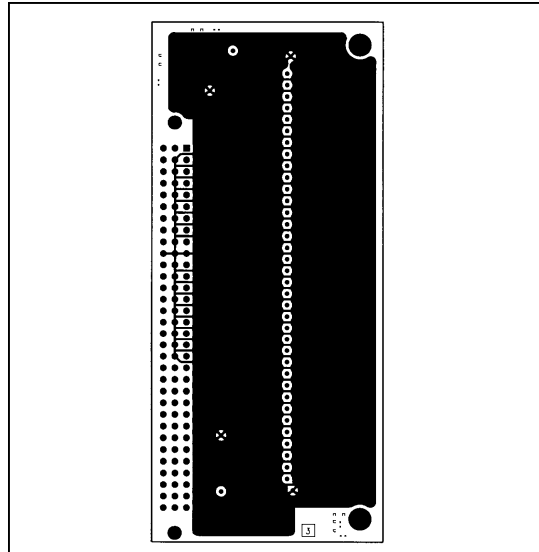


Figure 16. MAX101A EV Kit Termination Board Layout—Layer 3

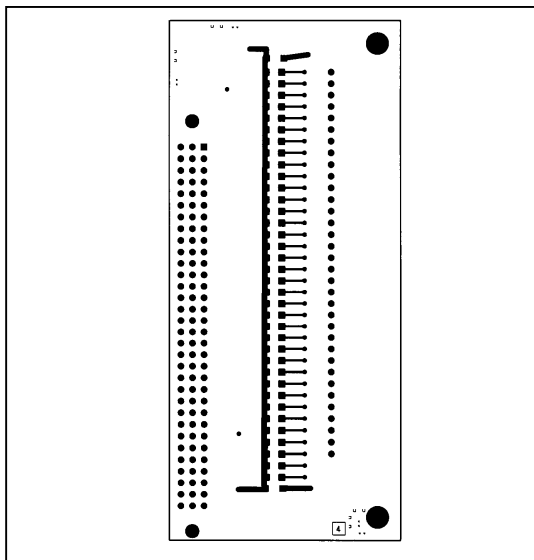


Figure 17. MAX101A EV Kit Termination Board Layout—Layer 4

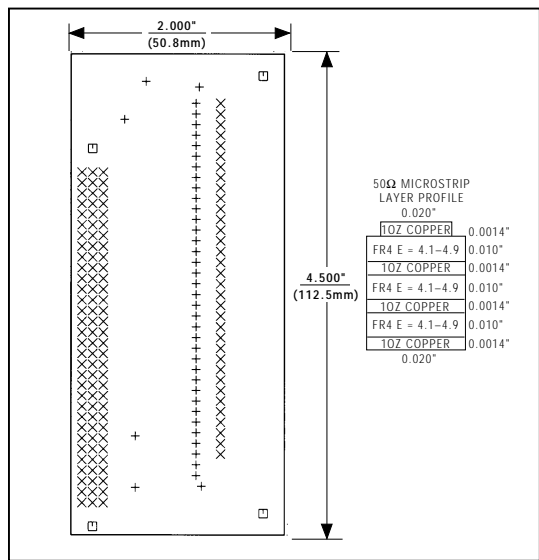


Figure 18. MAX101A EV Kit Termination Board Mechanical Guide

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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