19-0520; Rev 0; 4/06

MAX6972 Evaluation Kit

Evaluates: MAX6972

General Description

The MAX6972 evaluation kit (EV kit) is an assembled and tested circuit board that demonstrates the MAX6972/MAX6973 precision current-sinking, 16-output PWM LED drivers. The MAX6972/MAX6973 functionality can be evaluated using the MAX6972 EV kit. The MAX6973 has 14-bit individual PWM and 5-bit global PWM, while the MAX6972 has 12-bit individual PWM and 7-bit global PWM. The evaluation kit comes with a MAX6972ATJ+ installed. The Windows® 98/2000/XP software supports only the MAX6972.

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Features

- **Proven PC Board Layout**
- **Complete Evaluation System**
- **Convenient On-Board Test Points**
- **Fully Assembled and Tested**
- **Multiplexed 4 x 8 RGB (96 LEDs Total) 20mA LED Matrix**

Ordering Information

PART	TYPE	INTERFACE REQUIREMENTS
MAX6972EVKIT	EV kit	Windows PC with RS-232 serial port

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	100µF ±20%, 10V X5R capacitor (1812) TDK C4532X5R1A107M
C2	1	100µF ±20%, 6.3V X5R capacitor (1210) TDK C3225X5R0J107M
C3–C6, C30	5	10µF ±10%, 6.3V X5R capacitors (0603) TDK C1608X5R0J106K
C7–C12	6	0.47µF ±10%, 6.3V X5R capacitors (0402) TDK C1005X5R0J474K
C13–C19	7	0.1µF ±10%, 6.3V X5R capacitors (0402) TDK C1005X5R0J104K
C20, C21	2	0.001µF ±10%, 25V X5R capacitors (0402) TDK C1005X5R1E102K
C22–C27	6	120pF ±5%, 25V C0G capacitors (0402) TDK C1005C0G1E121J
C28, C29	2	10pF ±5%, 25V C0G capacitors (0402) TDK C1005C0G1E100J
C31	1	0.01µF ±10%, 6.3V X5R capacitor (0402) TDK C1005X5R1E103K
D1–D32	32	RGB LED modules Stanley URGB1308B
J1	0	Not installed
J2	1	2 x 5 right-angle receptacle (0.1in)
J3	1	2 x 5 right-angle male header (0.1in)
J4	0	Not installed

DESIGNATION	QTY	DESCRIPTION
JU1–JU13, JU22, JU23, JU24	16	2-pin headers
JU14–JU21	8	3-pin headers
P1	1	Female DB9 connector
Q1–Q6	6	pnp transistors Zetex FMMTL717 (SOT23)
R1–R10	10	200Ω ±1% resistors (0603)
R11–R16	6	182Ω ±1% resistors (0603)
R17–R22	6	562Ω ±1% resistors (0603)
R23	1	4.99kΩ ±1% resistor (0402)
R24	1	9.53kΩ ±1% resistor (0402)
R25	1	267kΩ ±1% resistor (0402)
R26	1	249kΩ ±1% resistor (0402)
TP1–TP10	0	Not installed
U1, U2, U3	3	16-output LED drivers Maxim MAX6972ATJ+ (32-pin TQFN, 5mm x 5mm EP)
U4	1	Low-power microcontroller Maxim MAXQ2000-RAX (68-pin QFN, 10mm x 10mm EP)
U5	1	Dual LVDS line driver Maxim MAX9112EKA (8-pin SOT23)

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
U6	1	Dual LVDS line receiver Maxim MAX9113EKA (8-pin SOT23)
U7	1	RS-232 transceiver Maxim MAX3311EUB (10-pin µMAX®)
U8, U9	2	LDO linear regulators Maxim MAX1658ESA (8-pin SO)
U10	1	LDO linear regulator Maxim MAX1659ESA (8-pin SO)

DESIGNATION	QTY	DESCRIPTION
Y1	1	20MHz crystal Citizen HCM49-20.000MABJ
Y2	1	32MHz oscillator ECS ECS-3953M-320-B-TR
—	1	MAX6972 EV kit PC board
—	24	Shunts

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Component Suppliers

SUPPLIER	PHONE	FAX	WEBSITE
TDK	847-803-6100	847-390-4405	www.component.tdk.com
Zetex USA	631-543-7100	631-864-7630	www.zetex.com

Note: *Indicate that you are using the MAX6972 when contacting these component suppliers.*

Quick Start

Required Equipment

Before you begin, you need the following equipment:

- Maxim MAX6972EVKIT
- DC power supply, 5VDC at 1A
- Windows 98/2000/XP-compatible computer with a serial (COM) port
- 9-pin I/O extension cable

Procedure

Do not turn on the power until all connections are complete.

1) Ensure that all jumpers JU1–JU24 are in 1-2 position (see Table 5).
2) Connect a 5VDC power source (7VDC maximum) to the board at the VLED and GND terminals.
3) Connect a cable from the computer's serial port to the EV kit. If using a 9-pin serial port, use a straight-through, 9-pin female-to-male cable. If the only available serial port uses a 25-pin connector, a standard 25-pin-to-9-pin adapter is required.
4) Install the evaluation software on your computer by launching MAX6972.msi. (The latest software can be found on Maxim's website www.maxim-ic.com.) The program files are copied and icons are created for them in the Windows **Start** menu.
5) Turn on the power supply. None of the LEDs light up at this time.
6) Start the MAX6972 program by opening its icon in the **Start** menu.
7) In the **Select Maxim MAX6972 Evaluation Kit Software Mode** window, select **Connect to EVKit on port (Autodetect)**. Click **OK**. See Figure 1. Verify that the blue M test pattern appears (test_0_blue_M.clr).
8) From the **File** menu, select **Load Test Patterns...** and then pick the file **test_01_all_white.clr**. Verify that all 32 RGB LEDs light up in white.
9) In the **LED0 color** grid, double-click one of the large round color dots in the 4 x 8 grid (or select one of the dots and click **OK**). The standard color selector dialog box appears. Select a color and click **OK**. Click **Upload All** to write the 4 x 8 color grid data to the board. Verify that the LEDs light up in colors corresponding to the software color grid settings.
10) Set **Global Intensity** to **5/63** and click **Upload All**. Verify that the LEDs are brighter.

Detailed Description of Software

The MAX6972 EV kit software controls one or more MAX6972 EV kit boards, each of which has three MAX6972s driving a 4 x 8 grid of LEDs.

Universal Options

The **Cascaded Boards** control must be set to the number of boards that are connected.

When **Multiplexing** is disabled, only the left half of the 4 x 8 grid is driven. See the *Detailed Description* of *Hardware* section.

Clicking the **Upload Control Command Only** button writes the control command to all cascaded MAX6972s (see Figure 2). Refer to the MAX6972/MAX6973 data sheet *Commands* section.

Individual Board Options

The **Individual Board Options** controls apply to the three MAX6972s on the selected board. If using a single EV kit board, leave **Select Board** set at 1. See the *Cascading Boards* section.

The **Board Calibration** controls determine the peak LED current for each group of output ports. Because the LEDs used on the EV kit board are only rated for 20mA, setting the calibration controls to a value greater than about 50/255 can exceed the LED's rated drive current, causing permanent damage to the LED.

The 4 x 8 grid of circles inside **Board LED Colors** corresponds to the 4 x 8 grid of LEDs on the EV kit board. These can be individually selected by clicking them with the mouse. The **Change...** button chooses the color of the single selected LED. Clicking the **Change All** button sets all 32 LEDs to a chosen color.

Upload All

Clicking the **Upload All** button writes universal and individual board options to all cascaded MAX6972s.

File-Load Test Patterns

Pressing the key combination Ctrl+T brings up a convenient window containing a list of test pattern files (see Figure 3). All files whose names begin with "test_" and end with ".clr" are listed as test patterns. Click on a filename from the list, and the chroma pattern is immediately loaded. For example, test pattern test_921_ 2boards_all_white.clr loads a master and one slave board with a 4 x 16 pattern where all of the LEDs are on. The test pattern default.clr is loaded at startup.

Disabling LED Multiplexing

As shipped from the factory, the 4 x 8 grid of tricolor LEDs is multiplexed. To disable multiplexing, and drive only the left 4 x 4 half of the grid, two steps are necessary. First, jumpers JU1–JU6 and JU19–JU24 must be reconfigured. See Table 5. Second, the **Multiplexing** must be set to **Disabled** in **Universal Options**.

Cascading Boards

Two or more MAX6972 EV kit boards can be connected together in a master-slave configuration, using the master/slave connectors, J2 and J3.

1) With power off, connect the J3 pins of one board to the J2 socket of the next board.
2) The board on the left is the master. On the master board, set the JU14–JU18 shunts to position 1-2. On all other boards, set the JU14–JU18 shunts to position 2-3.
3) The board on the right is the last slave. On the last slave board, set the JU10–JU13 shunts closed. On all other boards, remove the JU10–JU13 shunts.
4) Connect 5VDC power to the master board, between the VLED and GND pads.
5) Connect a cable from the computer's serial port to the master board. If using a 9-pin serial port, use a straight-through, 9-pin, female-to-male cable.
6) Install the evaluation software on your computer by launching MAX6972.msi. The program files are copied and icons are created for them in the Windows **Start** menu.
7) Turn on the power supply. None of the LEDs light up at this time.
8) Start the MAX6972 program by opening its icon in the Windows **Start** menu.
9) In the **Select Maxim MAX6972 Evaluation Kit Software Mode** window, select **Connect to EVKit on port (Autodetect)**. See Figure 1. Click **OK**.
10) Set the software's **Cascaded Boards** to **2**, **3**, **4**, or **5**, depending on the number of boards used.
11) Set the software's **Select Board** to 1 to work with the master board.
12) In the **Board 1 LED Colors** grid, double-click one of the large round color dots in the 4 x 8 grid (or select one of the dots and click **OK**). The standard color selector dialog box appears. Select a color and click **OK**.
13) Click **Upload All** to write the 4 x 8 color grid data to the board. Verify that the LEDs light up in colors corresponding to the software color grid settings.
14) Set **Board 1 Global Intensity** to **5/63** and click **Upload All**. Verify that the LEDs are brighter.
15) Set the software's **Select Board** to 2 to work with the next board, and repeat the process of setting LED colors, global intensity, and upload all.

Slideshow Demo

The EV kit software can load a sequence of test patterns. From the **Command** menu, select **Slideshow**, then choose a folder containing test pattern files (see Figure 4). The time between patterns can be adjusted between 50ms and 30s.

Detailed Description of Hardware

The MAX6972 precision current-sinking, 16-output PWM LED drivers (U1, U2, and U3) drive a 4 x 8 multiplexed grid of red-green-blue LEDs in the common-anode configuration. Common-emitter pnp BJTs (Q1–Q6) switch the LED supply voltage in the multiplexing configuration. Because the blue LEDs require the closest output-current matching, one device drives all the blue LEDs, and the other devices multiplex between red and green. See Tables 1 and 2.

Table 1. LED Nonmultiplexing

IC/PORT	LED DEVICES DRIVEN	COLORS
U1 port Y	D1 to D8	Red
U1 port Z	D1 to D8	Green
U2 port Y	D9 to D16	Red
U2 port Z	D9 to D16	Green
U3 port Y	D1 to D8	Blue
U3 port Z	D9 to D16	Blue

Table 2. LED Multiplexing

IC/PORT	LED DEVICES DRIVEN	COLORS
U1 port Y	D1 to D8	Red
	D17 to D24	
U1 port Z	D1 to D8	Green
	D17 to D24	
U2 port Y	D9 to D16	Red
	D25 to D32	
U2 port Z	D9 to D16	Green
	D25 to D32	
U3 port Y	D1 to D8	Blue
	D9 to D16	
U3 port Z	D17 to D24	Blue
	D25 to D32	

User-supplied DC power between 5V and 7V, applied between the VLED and GND pads, is regulated by three MAX1658/MAX1659 low-dropout linear regulators (U8, U9, and U10) to produce 5V, 3.3V, and 2.5V supply rails.

The MAXQ2000 microcontroller (U4) drives the MAX9112 LVDS level shifter (U5). When JU14–JU18 are in the 1-2 position, this microcontroller drives the MAX6972 LED display drivers (U1, U2, and U3). A 32MHz crystal oscillator (Y2) is used to demonstrate optimum PWM frequency by driving the LVDS clock signal between command sequences. During command sequences, the MAXQ2000 bit bangs the LVDS clock at 2.8MHz.

When used with the software, the MAX3311 (U7) translates the RS-232 signal levels from the COM port (P1) to logic-level signals. Resistor-dividers R23/R24 convert the 5V logic output into 3.3V logic.

When JU14–JU18 are in the 2-3 position, external LVDS signals must be applied to connector J2. In this slave configuration, the MAXQ2000 (U4), MAX9112 (U5), and MAX3311 (U7) are not used.

LED Power Dissipation

Peak LED current is set by each port's LED current calibration register. This 8-bit DAC allows peak LED current to be reduced to between 20% and 100% of the full-scale rating, 55mA. Setting the current calibration register to a value of 0 limits the peak LED current to 11mA (20% of 55mA). By writing different values to the red, green, and blue ports' current calibration registers, the display's color balance can be adjusted to compensate for LED efficacy variations.

The evaluation kit is shipped from the factory with an LED type (Stanley URGB1308B) that has a maximum rating of 20mA forward current or 84mW power dissipation.

Evaluating the MAX6973

The MAX6972 EV kit's software and firmware are only capable of driving 12-bit PWM values. If the EV kit were used to drive the MAX6973s instead, then the two least significant bits of the individual pixel PWM values are not accessible. See Tables 3 and 4.

Table 3. Device Comparison—Nonmultiplexed Operation

MAX6972	MAX6973	OPERATION
7 bits	5 bits	Global-intensity control PWM resolution
2 (Y, Z)	2 (Y, Z)	Number of LED current calibration registers
8 bits	8 bits	LED current calibration resolution
55mA	55mA	Maximum LED drive current (LED current calibration = 255)
11mA	11mA	LED drive current (LED current calibration = 0)
16	16	Number of pixels
12 bits	14 bits	Individual pixel PWM-intensity-control resolution

Table 4. Device Comparison—Multiplexed Operation

MAX6972	MAX6973	OPERATION
6 bits	4 bits	Global-intensity control PWM resolution
2 (Y, Z)	2 (Y, Z)	Number of LED current calibration registers
8 bits	8 bits	LED current calibration resolution
55mA	55mA	Maximum LED drive current (LED current calibration = 255)
11mA	11mA	LED drive current (LED current calibration = 0)
32	32	Number of pixels
12 bits	14 bits	Individual pixel PWM-intensity-control resolution

Table 5. Jumper Functions Table

JUMPER	PINS	FUNCTION
JU1	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU2	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU3	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU4	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU5	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU6	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU7	Closed*	Normal operation.
	Open	Force LED D1 red open fault condition.
JU8	Closed*	Normal operation.
	Open	Force LED D1 green open fault condition.
JU9	Closed*	Normal operation.
	Open	Force LED D1 blue open fault condition.
JU10	Closed*	Single board mode: R9 terminates CLKO; nothing connects to J3.
	Open	No CLKO termination, allowing slave board to connect to J3.
JU11	Closed*	Single board mode: R9 terminates CLKO; nothing connects to J3.
	Open	No CLKO termination, allowing slave board to connect to J3.

**Default jumper setting.*

Table 5. Jumper Functions Table (continued)

JUMPER	PINS	FUNCTION
JU12	Closed*	Single board mode: R10 terminates DOUT; nothing connects to J3.
	Open	No DOUT termination, allowing slave board to connect to J3.
JU13	Closed*	Single board mode: R10 terminates DOUT; nothing connects to J3.
	Open	No DOUT termination, allowing slave board to connect to J3.
JU14	1-2*	Master mode; nothing connects to J2.
	2-3	Slave mode; driven by another MAX6972 EV kit connected to J2.
	Open	Not valid. Do not use.
JU15	1-2*	Master mode; nothing connects to J2.
	2-3	Slave mode; driven by another MAX6972 EV kit connected to J2.
	Open	Not valid. Do not use.
JU16	1-2*	Master mode; nothing connects to J2.
	2-3	Slave mode; driven by another MAX6972 EV kit connected to J2.
	Open	Not valid. Do not use.
JU17	1-2*	Master mode; nothing connects to J2.
	2-3	Slave mode; driven by another MAX6972 EV kit connected to J2.
	Open	Not valid. Do not use.
JU18	1-2*	Master mode; nothing connects to J2.
	2-3	Slave mode; driven by another MAX6972 EV kit connected to J2.
	Open	Not valid. Do not use.
JU19	1-2*	Enables LED multiplexing.
	2-3	Disables LED multiplexing.
	Open	Not valid. Do not use.
JU20	1-2*	Enables LED multiplexing.
	2-3	Disables LED multiplexing.
	Open	Not valid. Do not use.
JU21	1-2*	Enables LED multiplexing.
	2-3	Disables LED multiplexing.
	Open	Not valid. Do not use.
JU22	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU23	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.
JU24	Closed*	Enables LED multiplexing.
	Open	Disables LED multiplexing.

**Default jumper setting.*

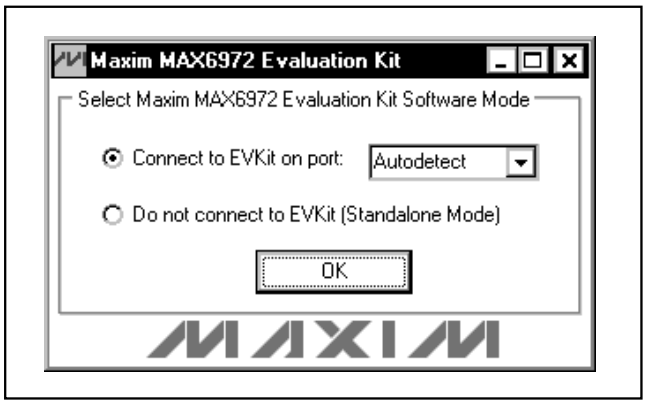

Figure 1. Select Maxim MAX6972 EV Kit Software Mode Screenshot

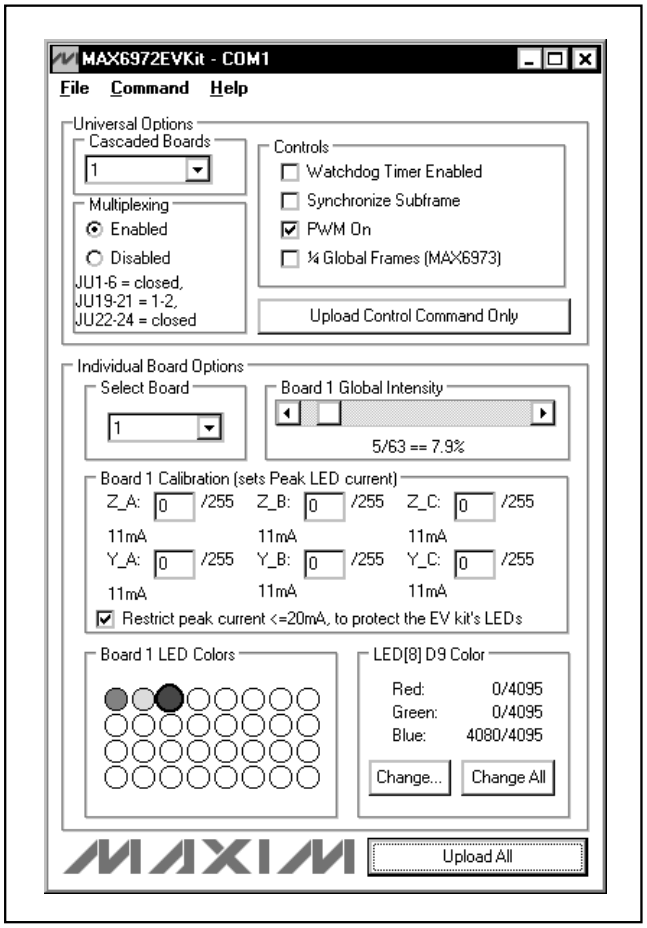

Figure 2. MAX6972 EV Kit—Connected to COM1 Main Window Screenshot

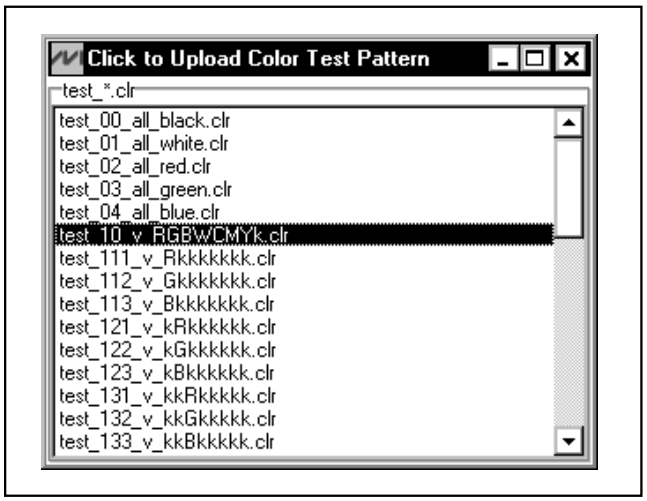

Figure 3. Click to Upload Color Test Pattern Screenshot

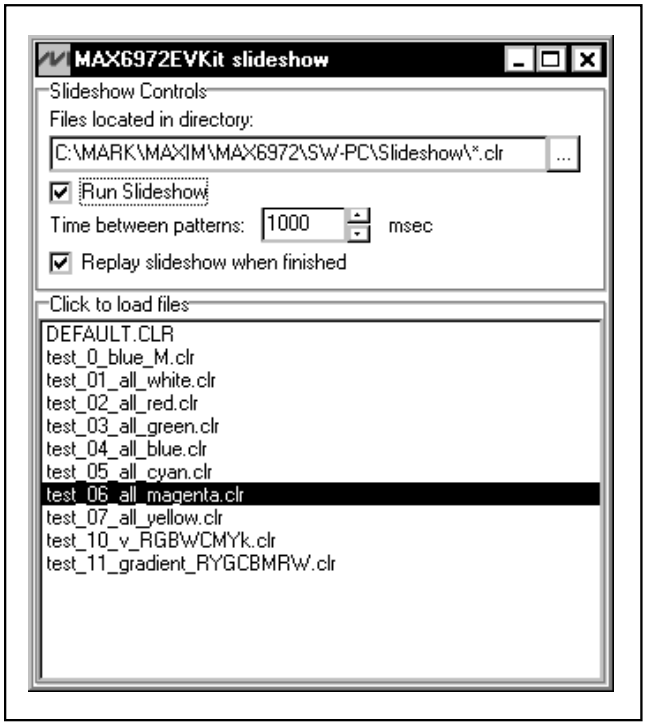

Figure 4. Demo Mode Screenshot

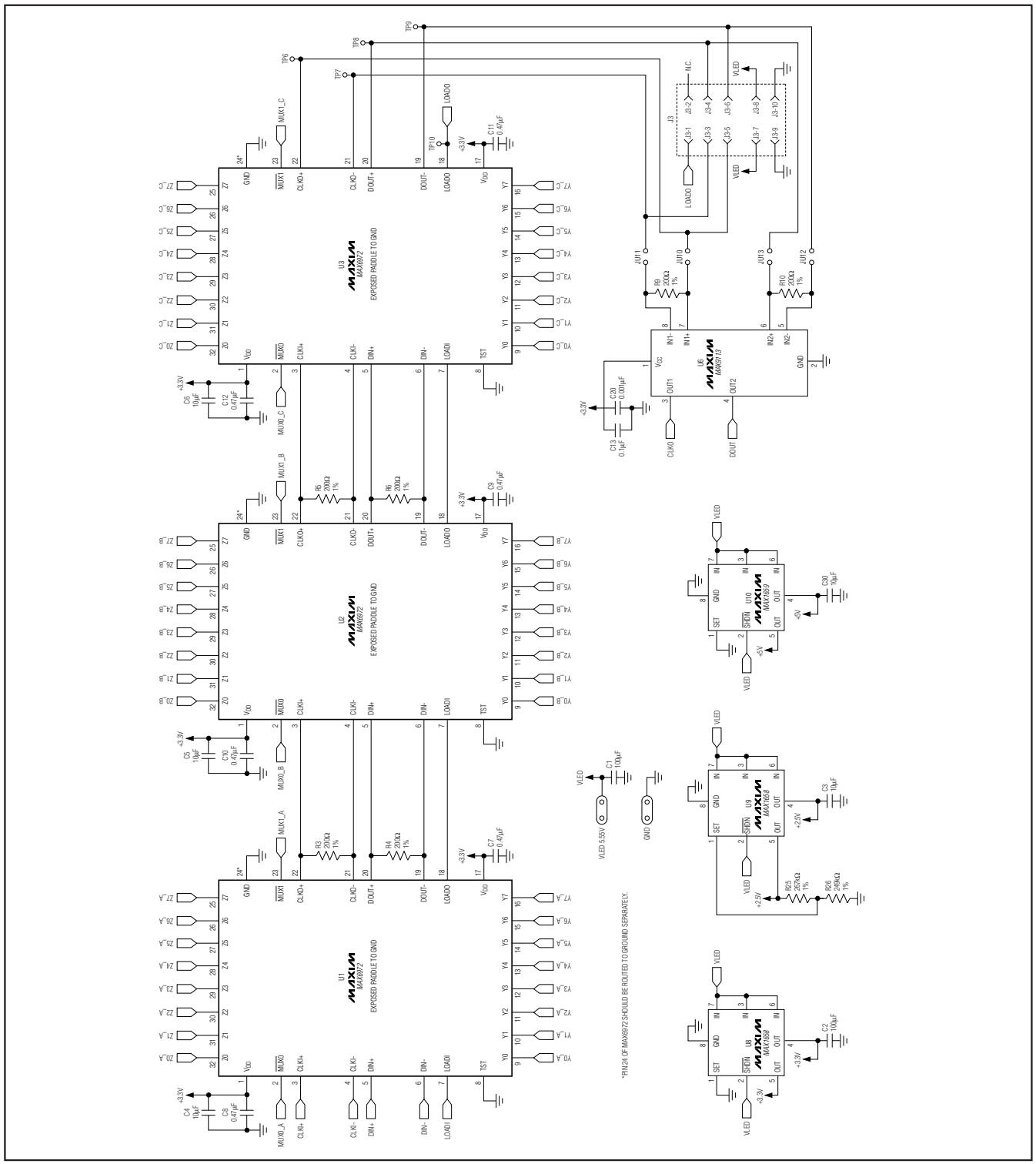

Figure 5. MAX6972 EV Kit Schematic (Sheet 1 of 5)

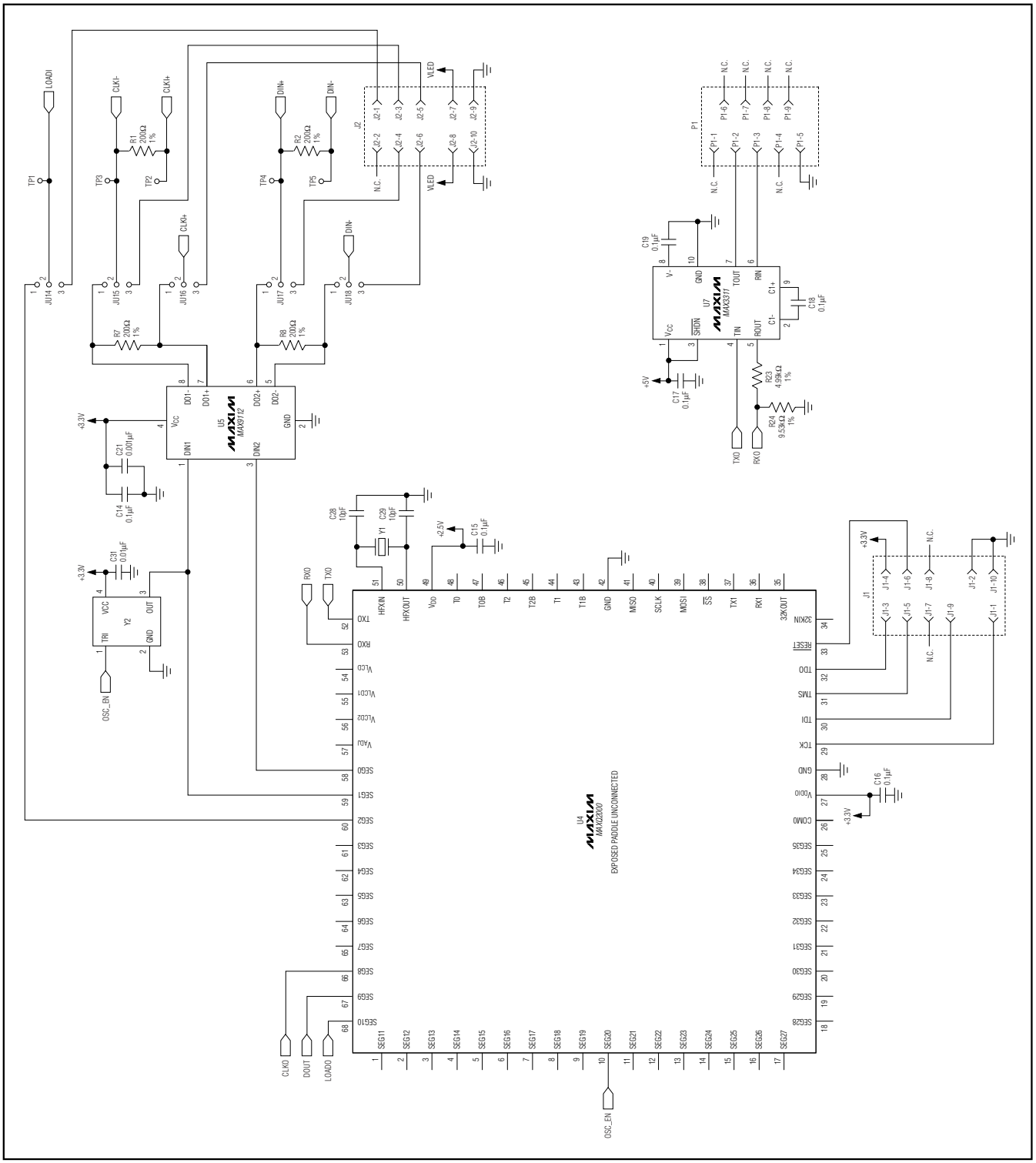

Figure 5. MAX6972 EV Kit Schematic (Sheet 2 of 5)

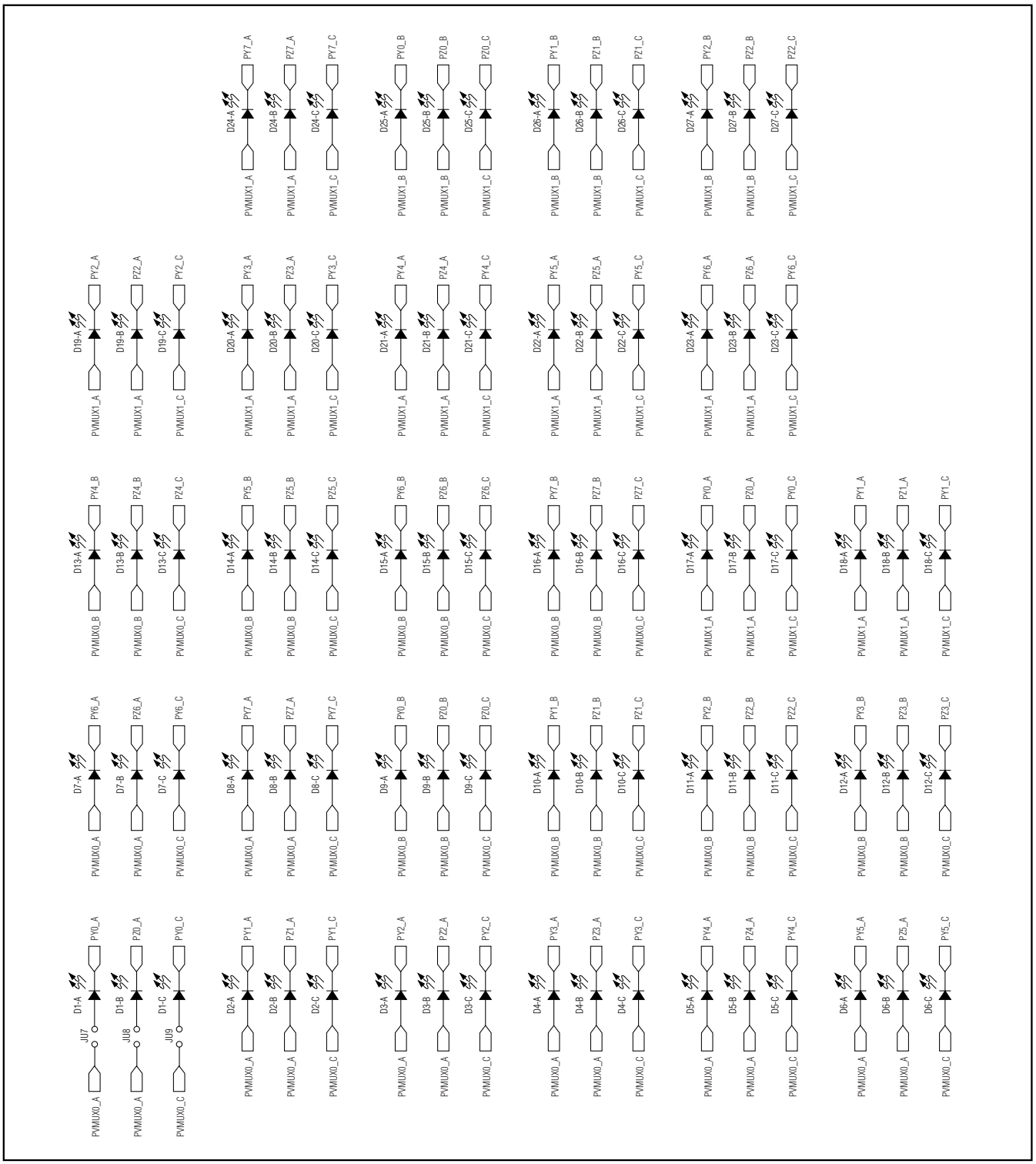

Figure 5. MAX6972 EV Kit Schematic (Sheet 3 of 5)

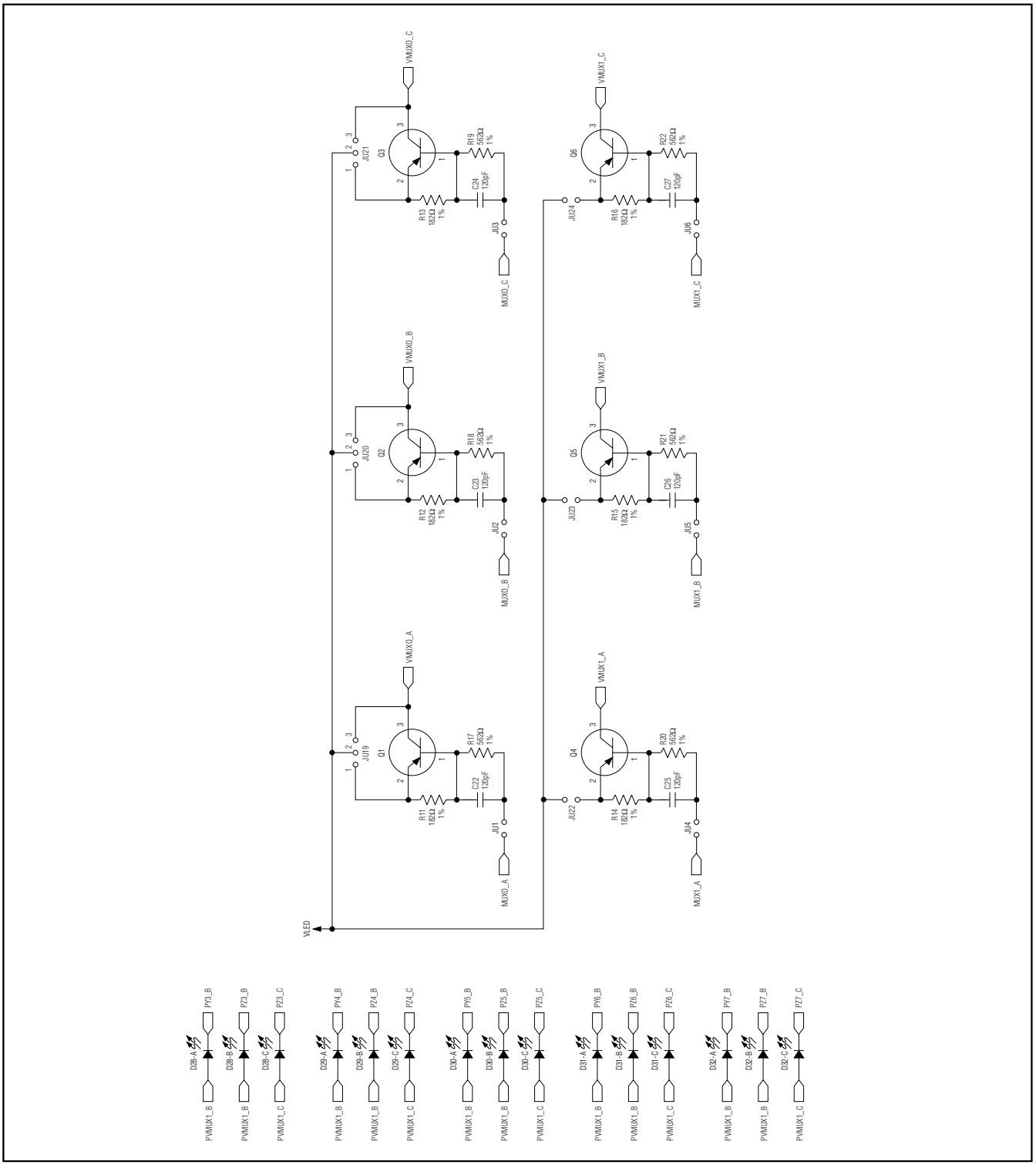

Figure 5. MAX6972 EV Kit Schematic (Sheet 4 of 5)

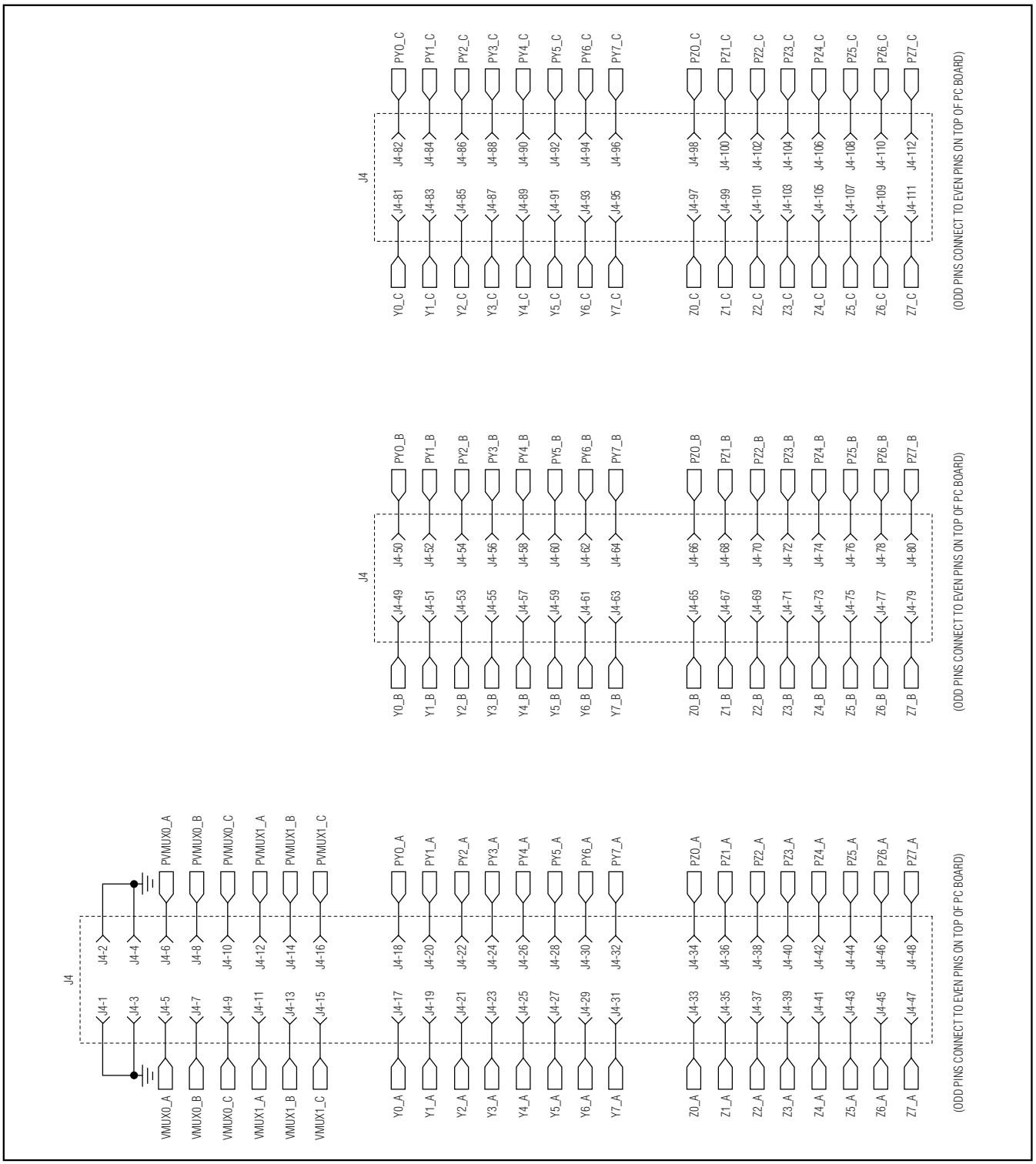

Figure 5. MAX6972 EV Kit Schematic (Sheet 5 of 5)

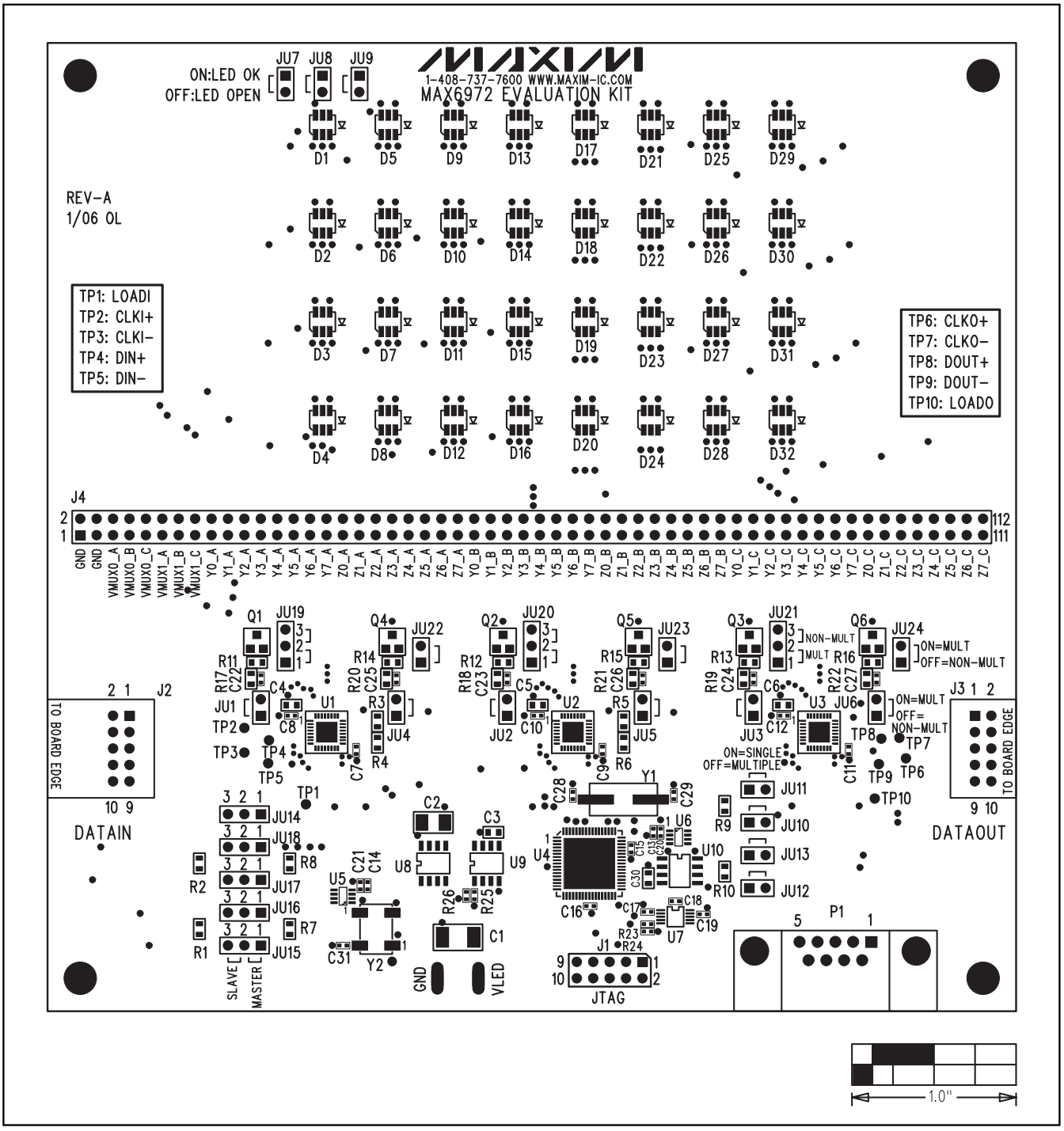

Figure 6. MAX6972 EV Kit Component Placement Guide—Component Side

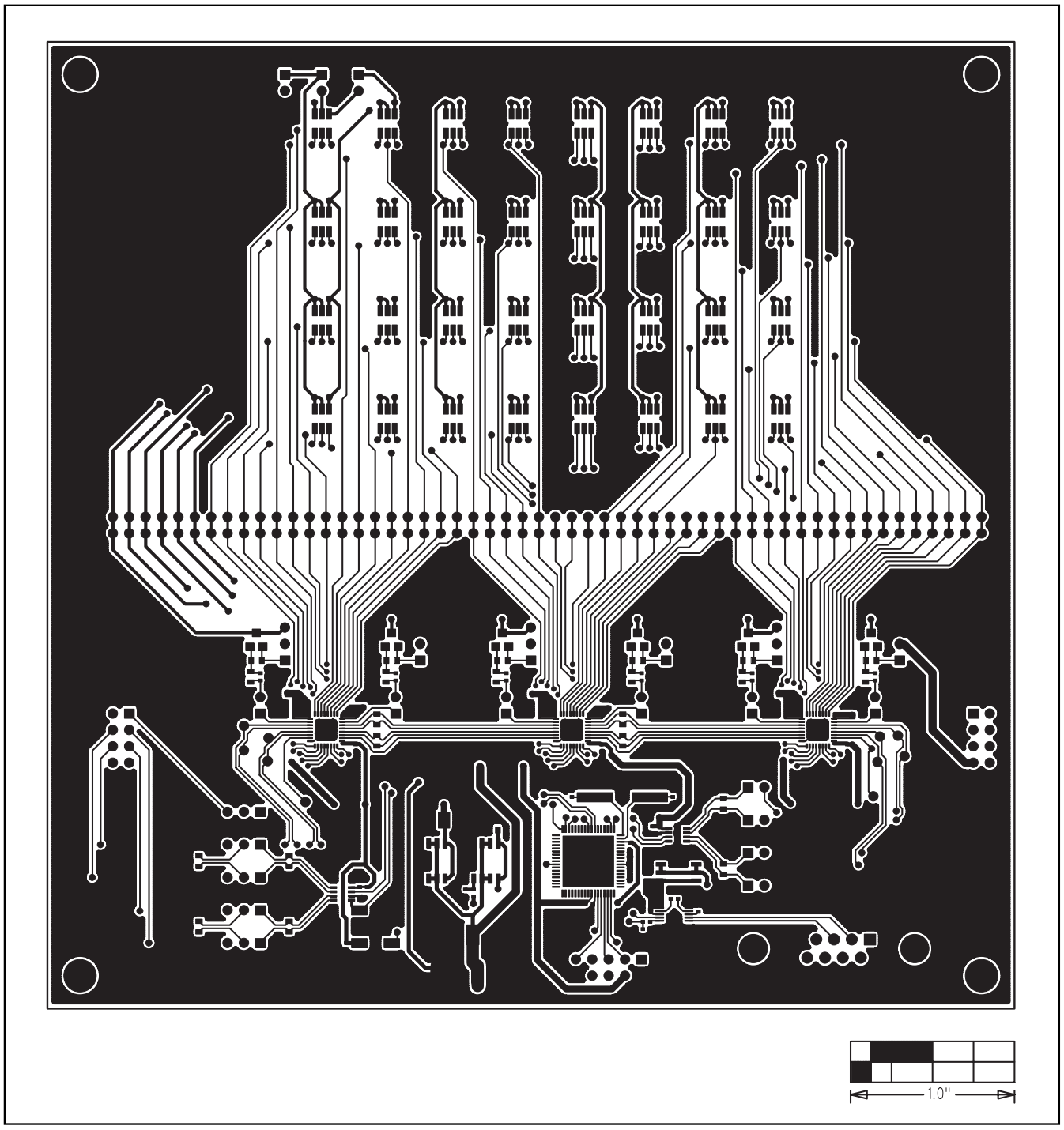

Figure 7. MAX6972 EV Kit PC Board Layout—Component Side

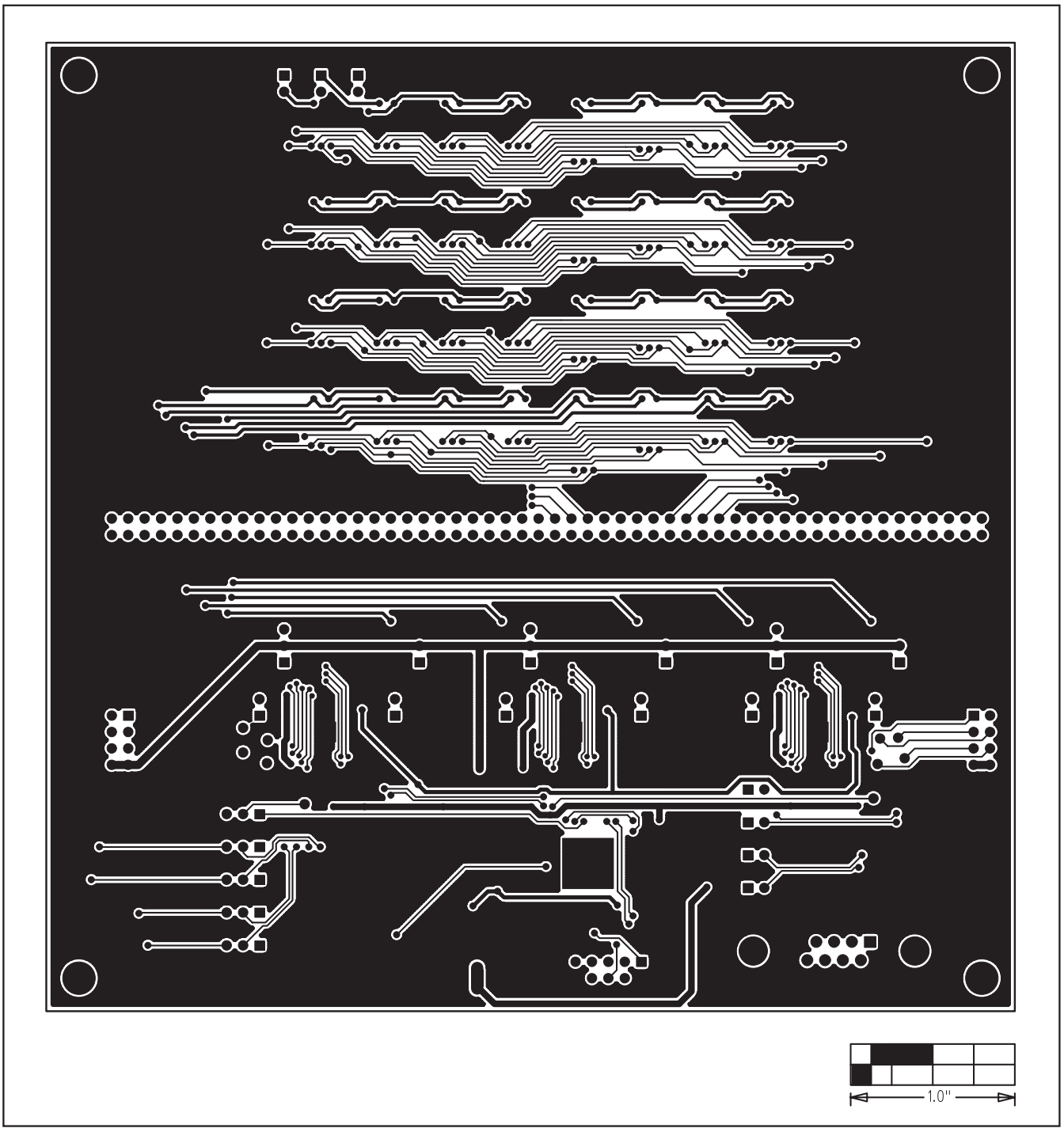

Figure 8. MAX6972 EV Kit PC Board Layout—Solder Side