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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China





# MAX6974 Evaluation Kit

## General Description

The MAX6974 evaluation kit (EV kit) is an assembled and tested printed circuit board (PCB) that demonstrates the MAX6974/ MAX6975 precision current-sinking, 24-output PWM LED drivers. The MAX6974/MAX6975 functionality can be evaluated using the MAX6974 EV kit. The MAX6975 has 14-bit individual PWM and 5-bit global PWM, while the MAX6974 has 12-bit individual PWM and 7-bit global PWM. The evaluation kit comes with a MAX6974ATL+ installed. The Windows® 98/2000/XP software supports only the MAX6974.

Windows is a registered trademark of Microsoft Corp.

## Features

- ◆ Proven PCB 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             |
|---------------|--------|------------------------------------|
| MAX6974EVKIT+ | EV kit | Windows PC with RS-232 serial port |

+Denotes a lead-free and RoHS-compliant EV kit.

## Component List

| DESIGNATION | QTY | DESCRIPTION  |
|-------------|-----|--|
| C1          | 1   | 100 $\mu$ F $\pm$ 20%, 10V X5R capacitor (1812)<br>TDK C4532X5R1A107M    |
| C2, C3      | 2   | 100 $\mu$ F $\pm$ 20%, 6.3V X5R capacitors (1210)<br>TDK C3225X5R0J107M  |
| C4, C5, C25 | 3   | 10 $\mu$ F $\pm$ 10%, 6.3V X5R capacitors (0603)<br>TDK C1608X5R0J106K   |
| C6–C9       | 4   | 0.47 $\mu$ F $\pm$ 10%, 6.3V X5R capacitors (0402)<br>TDK C1005X5R0J474K |
| C10–C16     | 7   | 0.1 $\mu$ F $\pm$ 10%, 6.3V X5R capacitors (0402)<br>TDK C1005X5R0J104K  |
| C17, C18    | 2   | 0.001 $\mu$ F $\pm$ 10%, 25V X5R capacitors (0402)<br>TDK C1005X5R1E102K |
| C19–C22     | 4   | 120pF $\pm$ 5%, 25V C0G capacitors (0402)<br>TDK C1005C0G1E121J          |
| C23, C24    | 2   | 10pF $\pm$ 5%, 25V C0G capacitors (0402)<br>TDK C1005C0G1E100J           |
| C26         | 1   | 0.01 $\mu$ F $\pm$ 10%, 6.3V X5R capacitor (0402)<br>TDK C1005X5R1E103K  |
| D1–D32      | 32  | RGB LED modules<br>Stanley URGB1308B-10-TF                               |
| 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    | 13  | 2-pin headers  |
| JU14–JU20   | 7   | 3-pin headers  |
| P1          | 1   | Female DB9 connector   |
| Q1–Q4       | 4   | npn transistors<br>Zetex FMRTL717TA (SOT23)                                      |
| R1–R8       | 8   | 200 $\Omega$ $\pm$ 1% resistors (0603)   |
| R9–R12      | 4   | 182 $\Omega$ $\pm$ 1% resistors (0603)   |
| R13–R16     | 4   | 562 $\Omega$ $\pm$ 1% resistors (0603)   |
| R17         | 1   | 4.99k $\Omega$ $\pm$ 1% resistor (0402)  |
| R18         | 1   | 9.53k $\Omega$ $\pm$ 1% resistor (0402)  |
| R19         | 1   | 249k $\Omega$ $\pm$ 1% resistor (0402)   |
| R20         | 1   | 267k $\Omega$ $\pm$ 1% resistor (0402)   |
| TP1–TP10    | 0   | Not installed  |
| U1, U2      | 2   | 24-output LED drivers<br>Maxim MAX6974ATL+<br>(40-pin TQFN, 6mm x 6mm EP)        |
| U3          | 1   | Low-power microcontroller<br>Maxim MAXQ2000-RAX+<br>(68-pin QFN, 10mm x 10mm EP) |
| U4          | 1   | Dual LVDS line driver<br>Maxim MAX9112EKA+ (8-pin SOT23)                         |
| U5          | 1   | Dual LVDS line receiver<br>Maxim MAX9113EKA+ (8-pin SOT23)                       |

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## Component List (continued)

| DESIGNATION | QTY | DESCRIPTION  |
|-------------|-----|--|
| U6          | 1   | RS-232 transceiver<br>Maxim MAX3311EUB+ (10-pin $\mu$ MAX <sup>®</sup> ) |
| U7, U8      | 2   | LDO linear regulators<br>Maxim MAX1658ESA+ (8-pin SO)                    |
| U9          | 1   | LDO linear regulator<br>Maxim MAX1659ESA+ (8-pin SO)                     |

| DESIGNATION | QTY | DESCRIPTION                                  |
|-------------|-----|--|
| Y1          | 1   | 20MHz crystal<br>Citizen HCM49-20.000MABJ-UT |
| Y2          | 1   | 32MHz oscillator<br>ECS ECS-3953M-320-B-TR   |
| —           | 1   | PCB: MAX6974 evaluation kit+                 |
| —           | 20  | Shunts                                       |

$\mu$ MAX is a registered trademark of Maxim Integrated Products, Inc.

## Component Suppliers

| SUPPLIER  | PHONE        | FAX          | WEBSITE               |
|-----------|--------------|--------------|-----------------------|
| TDK Corp. | 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 MAX6974 when contacting these component suppliers.

## Quick Start

### Required Equipment

Before you begin, you need the following equipment:

- Maxim MAX6974EVKIT
- 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–JU20 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 MAX6974.msi. (The latest software can be found on Maxim's website [www.maxim-ic.com](http://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 MAX6974 program by opening its icon in the **Start** menu.
- 7) In the **Select Maxim MAX6974 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 MAX6974 EV kit software controls one or more MAX6974 EV kit boards, each of which has two MAX6974s driving a 4 x 8 grid of LEDs.

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## 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 MAX6974s (see Figure 2). Refer to the MAX6974/MAX6975 data sheet *Commands* section, Table 15.

## Individual Board Options

The **Individual Board Options** controls apply to the two MAX6974s 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 MAX6974s.

## 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 and JU20 must be reconfigured. See Table 5. Second, the **Multiplexing** must be set to **Disabled** in **Universal Options**.

## Cascading Boards

Two or more MAX6974 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 MAX6974.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 MAX6974 program by opening its icon in the Windows **Start** menu.
- 9) In the **Select Maxim MAX6974 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.

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## 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 MAX6974 precision current-sinking, 24-output PWM LED drivers (U1, U2) drive a 4 x 8 multiplexed grid of red-green-blue LEDs in the common-anode configuration. Common-emitter pnp BJTs (Q1–Q4) switch the LED supply voltage in the multiplexing configuration. See Tables 1 and 2.

**Table 1. LED Nonmultiplexing**

| IC/PORT   | LED DEVICES DRIVEN | COLORS |
|-----------|--------------------|--------|
| U1 port R | D1 to D8           | Red    |
| U1 port G | D1 to D8           | Green  |
| U2 port R | D9 to D16          | Red    |
| U2 port G | D9 to D16          | Green  |
| U1 port B | D1 to D8           | Blue   |
| U2 port B | D9 to D16          | Blue   |

**Table 2. LED Multiplexing**

| IC/PORT   | LED DEVICES DRIVEN | COLORS |
|-----------|--------------------|--------|
| U1 port R | D1 to D8           | Red    |
|           | D17 to D24         |        |
| U1 port G | D1 to D8           | Green  |
|           | D17 to D24         |        |
| U2 port R | D9 to D16          | Red    |
|           | D25 to D32         |        |
| U2 port G | D9 to D16          | Green  |
|           | D25 to D32         |        |
| U1 port B | D1 to D8           | Blue   |
|           | D9 to D16          |        |
| U2 port B | 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 (U7, U8, and U9) to produce 5V, 3.3V, and 2.5V supply rails.

The MAXQ2000 microcontroller (U3) drives the MAX9112 LVDS level shifter (U4). When JU14–JU18 are in the 1-2 position, this microcontroller drives the

MAX6974 LED display drivers (U1, U2). 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 (U6) translates the RS-232 signal levels from the COM port (P1) to logic-level signals. Resistor-dividers R17/R18 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 (U3), MAX9112 (U4), and MAX3311 (U6) 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, 30mA. Setting the current calibration register to a value of 0 limits the peak LED current to 6mA (20% of 30mA). 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 MAX6975

The MAX6974 EV kit's software and firmware are only capable of driving 12-bit PWM values. If the EV kit were used to drive the MAX6975s 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**

| MAX6974     | MAX6975     | OPERATION   |
|-------------|-------------|---|
| 7 bits      | 5 bits      | Global-intensity control PWM resolution                   |
| 3 (R, G, B) | 3 (R, G, B) | Number of LED current calibration registers               |
| 8 bits      | 8 bits      | LED current calibration resolution                        |
| 30mA        | 30mA        | Maximum LED drive current (LED current calibration = 255) |
| 6mA         | 6mA         | LED drive current (LED current calibration = 0)           |
| 24          | 24          | Number of pixels  |
| 12 bits     | 14 bits     | Individual pixel PWM-intensity-control resolution         |

# MAX6974 Evaluation Kit

Evaluates: MAX6974

**Table 4. Device Comparison—  
Multiplexed Operation**

| MAX6974     | MAX6975     | OPERATION   |
|-------------|-------------|---|
| 6 bits      | 4 bits      | Global-intensity control PWM resolution                   |
| 3 (R, G, B) | 3 (R, G, B) | Number of LED current calibration registers               |
| 8 bits      | 8 bits      | LED current calibration resolution                        |
| 30mA        | 30mA        | Maximum LED drive current (LED current calibration = 255) |
| 6mA         | 6mA         | LED drive current (LED current calibration = 0)           |
| 48          | 48          | 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.  |

\*Default jumper setting.

# MAX6974 Evaluation Kit

**Evaluates: MAX6974**

**Table 5. Jumper Functions Table (continued)**

| JUMPER | PINS    | FUNCTION  |
|--------|---------|---|
| JU10   | Closed* | Single board mode: R9 terminates CLK0; nothing connects to J3.  |
|        | Open    | No CLK0 termination, allowing slave board to connect to J3.     |
| JU11   | Closed* | Single board mode: R9 terminates CLK0; nothing connects to J3.  |
|        | Open    | No CLK0 termination, allowing slave board to connect to J3.     |
| 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 MAX6974 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 MAX6974 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 MAX6974 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 MAX6974 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 MAX6974 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.  |

\*Default jumper setting.

# MAX6974 Evaluation Kit

Evaluates: MAX6974

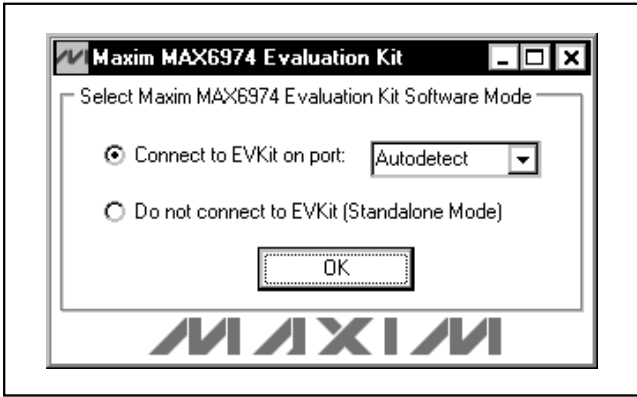


Figure 1. Select Maxim MAX6974 EV Kit Software Mode Screenshot

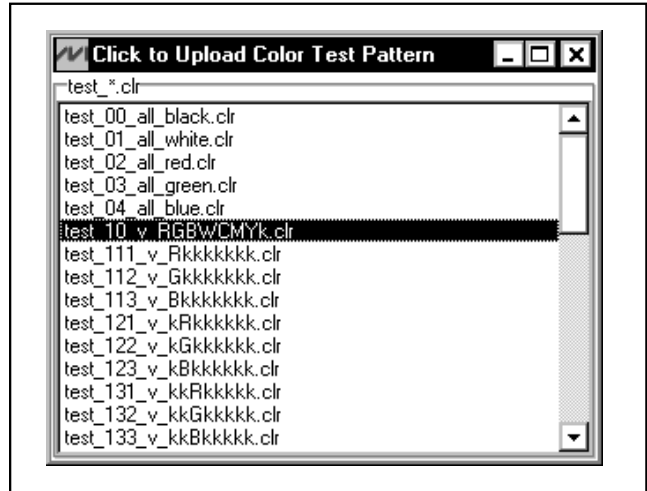


Figure 3. Click to Upload Color Test Pattern Screenshot

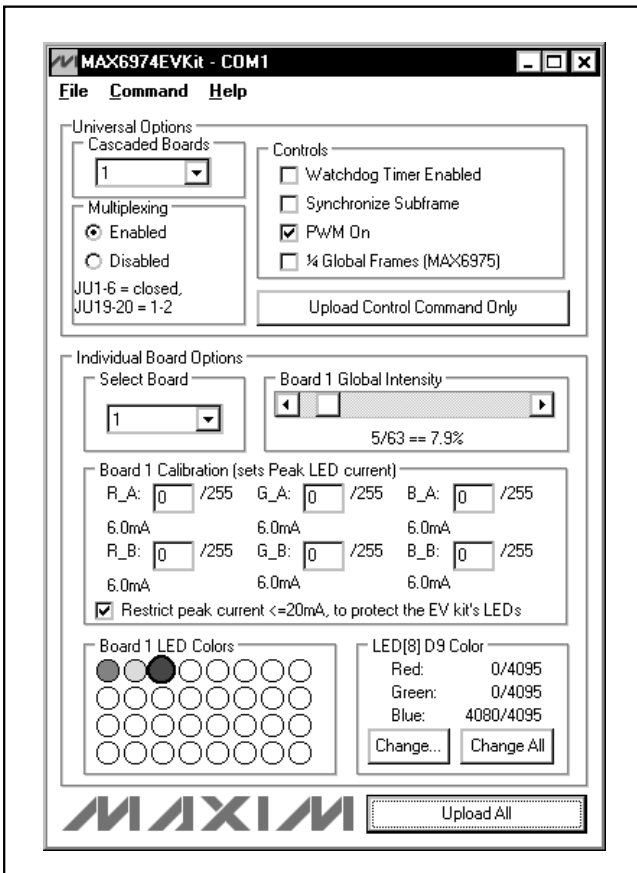


Figure 2. MAX6974 EV Kit—Connected to COM1 Main Window Screenshot

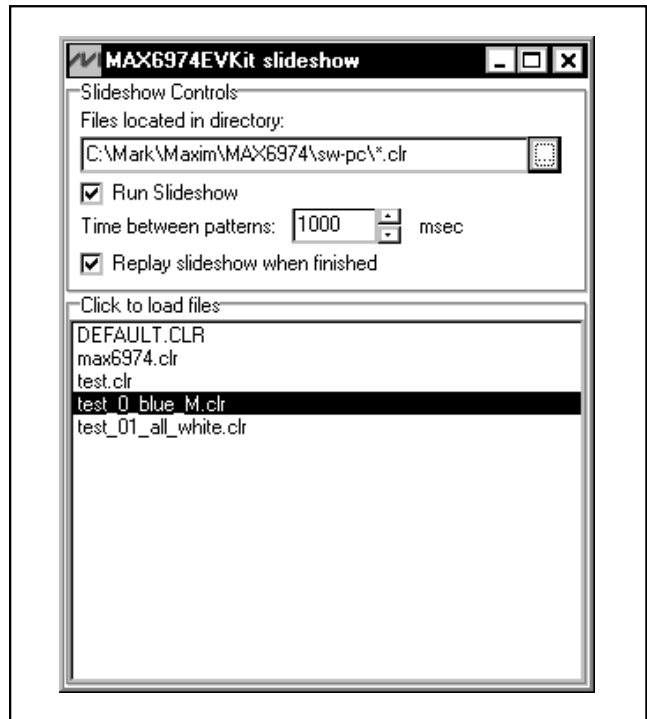
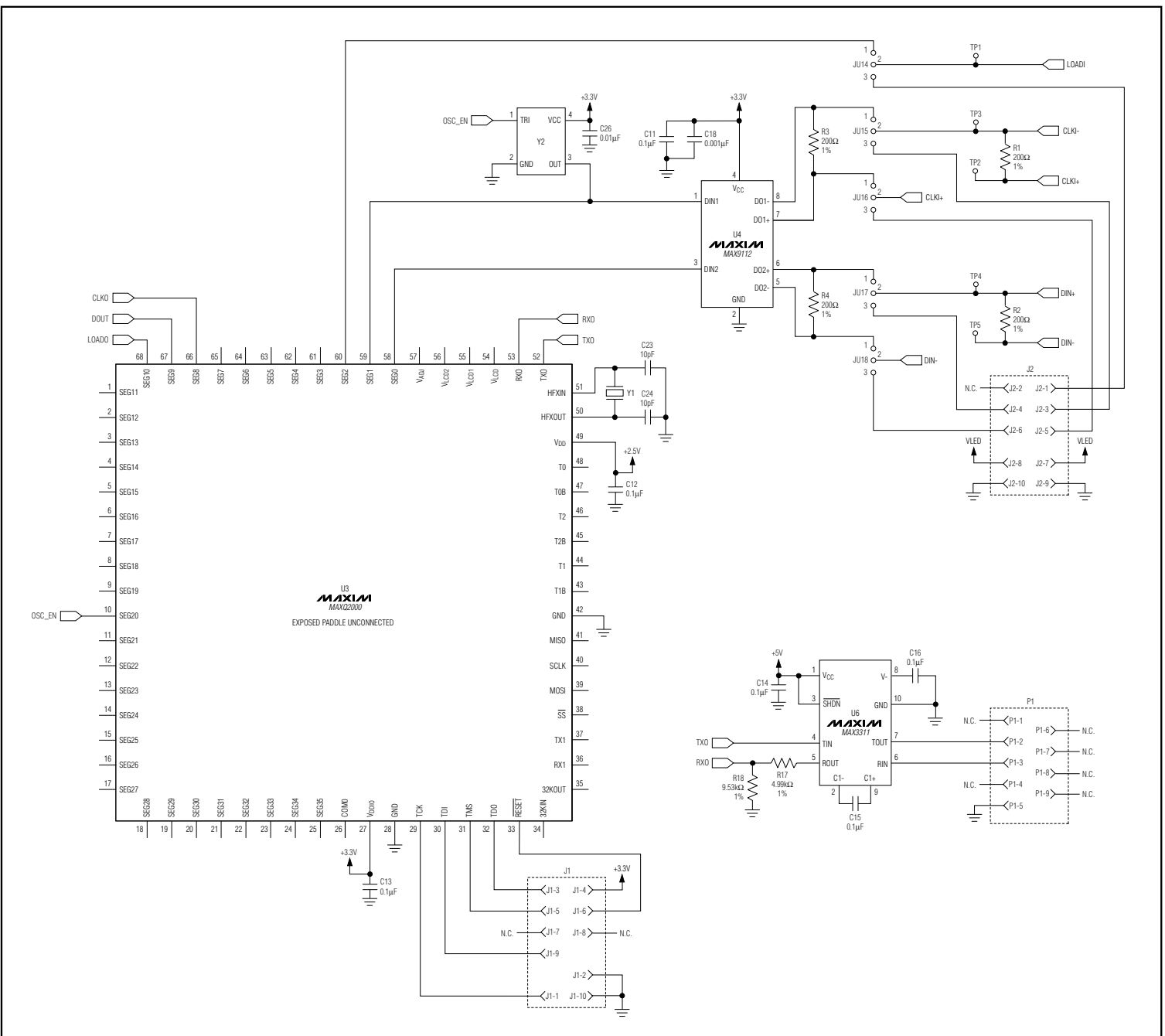


Figure 4. Slideshow Screenshot





# MAX6974 Evaluation Kit



Evaluates: MAX6974

Figure 5b. MAX6974 EV Kit Schematic (Sheet 2 of 5)



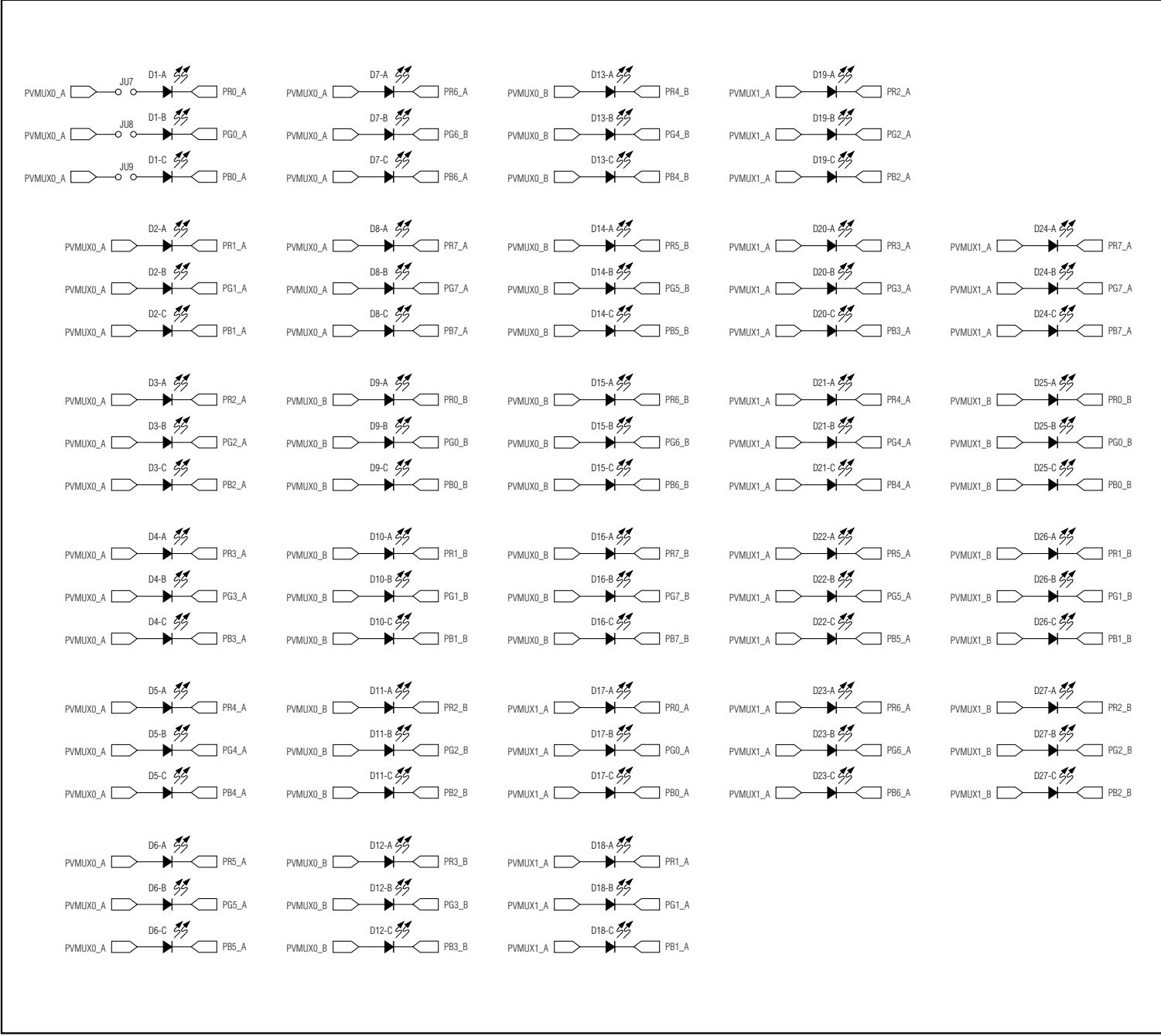


Figure 5c. MAX6974 EV Kit Schematic (Sheet 3 of 5)

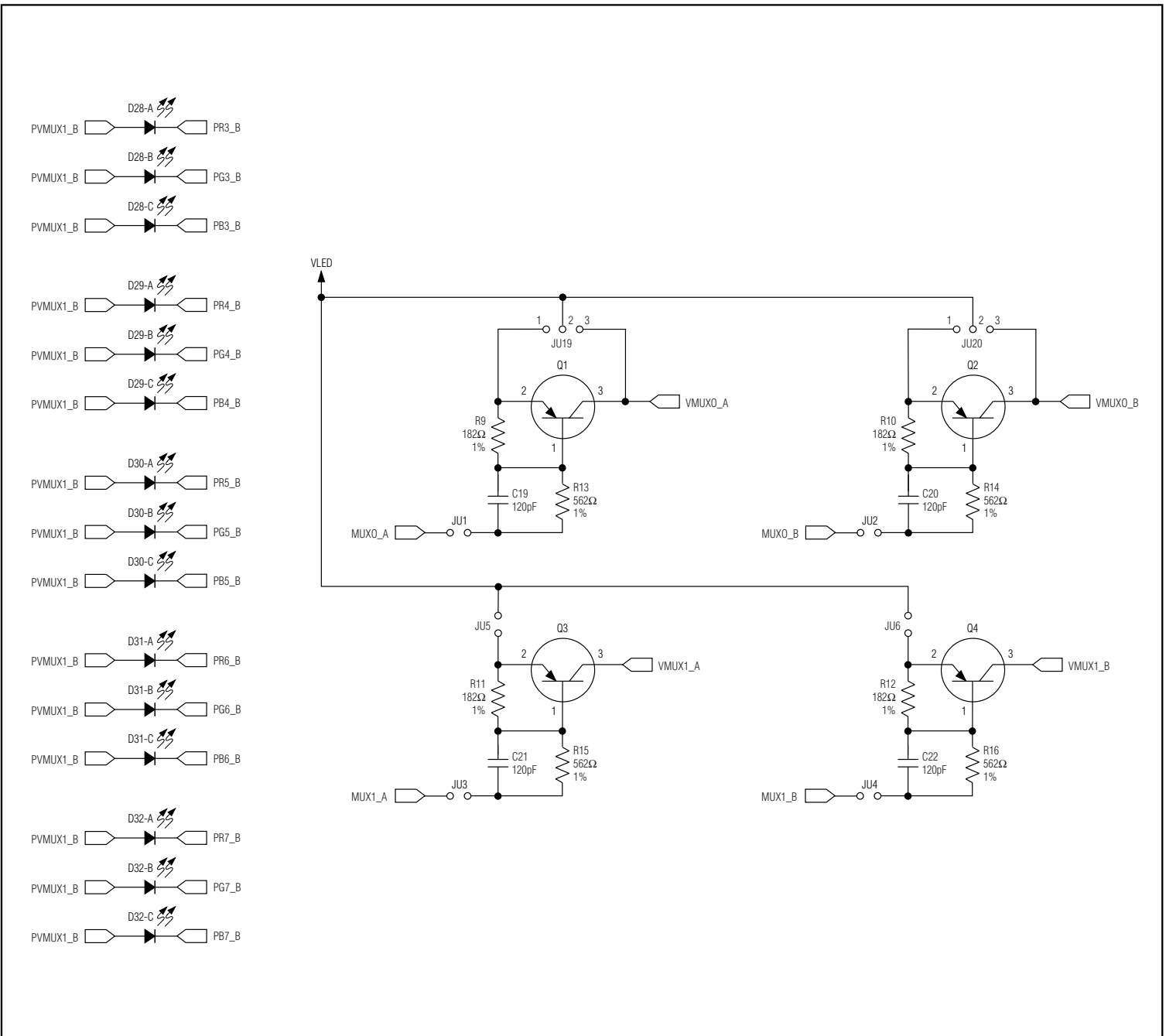


Figure 5d. MAX6974 EV Kit Schematic (Sheet 4 of 5)

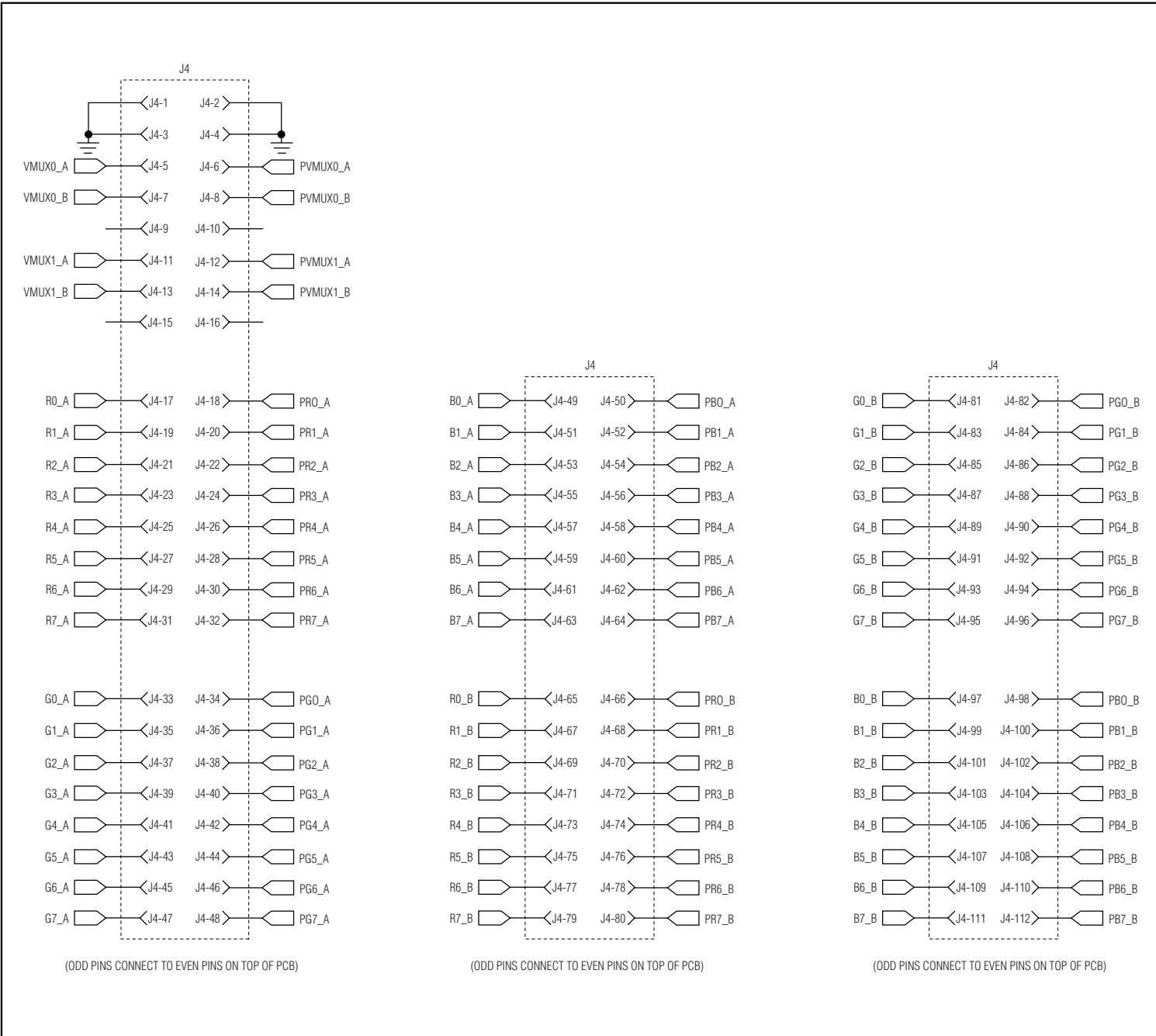


Figure 5e. MAX6974 EV Kit Schematic (Sheet 5 of 5)

# MAX6974 Evaluation Kit

Evaluates: MAX6974

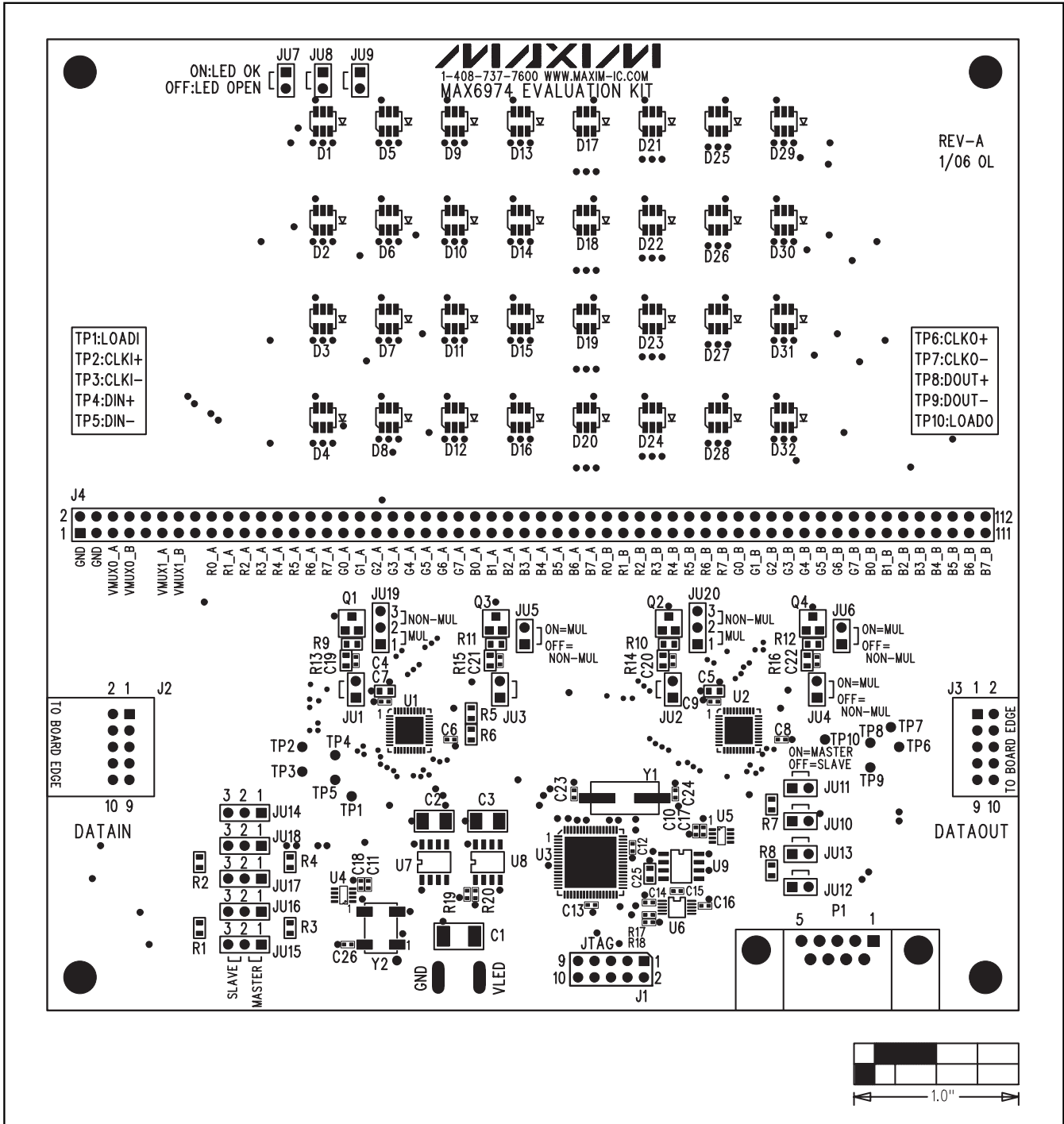


Figure 6. MAX6974 EV Kit Component Placement Guide—Component Side

# MAX6974 Evaluation Kit

Evaluates: MAX6974

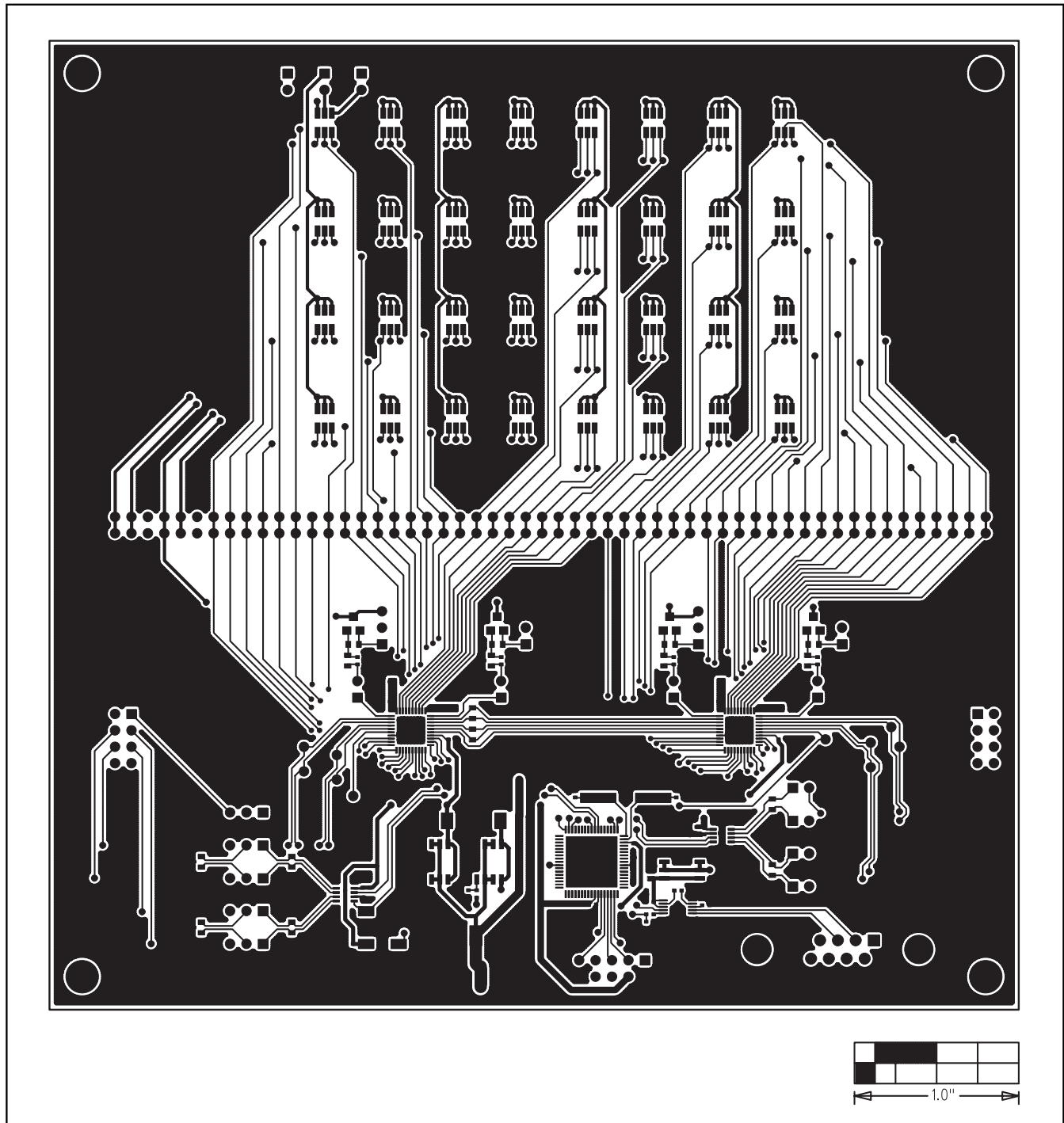


Figure 7. MAX6974 EV Kit PCB Layout—Component Side

# MAX6974 Evaluation Kit

Evaluates: MAX6974

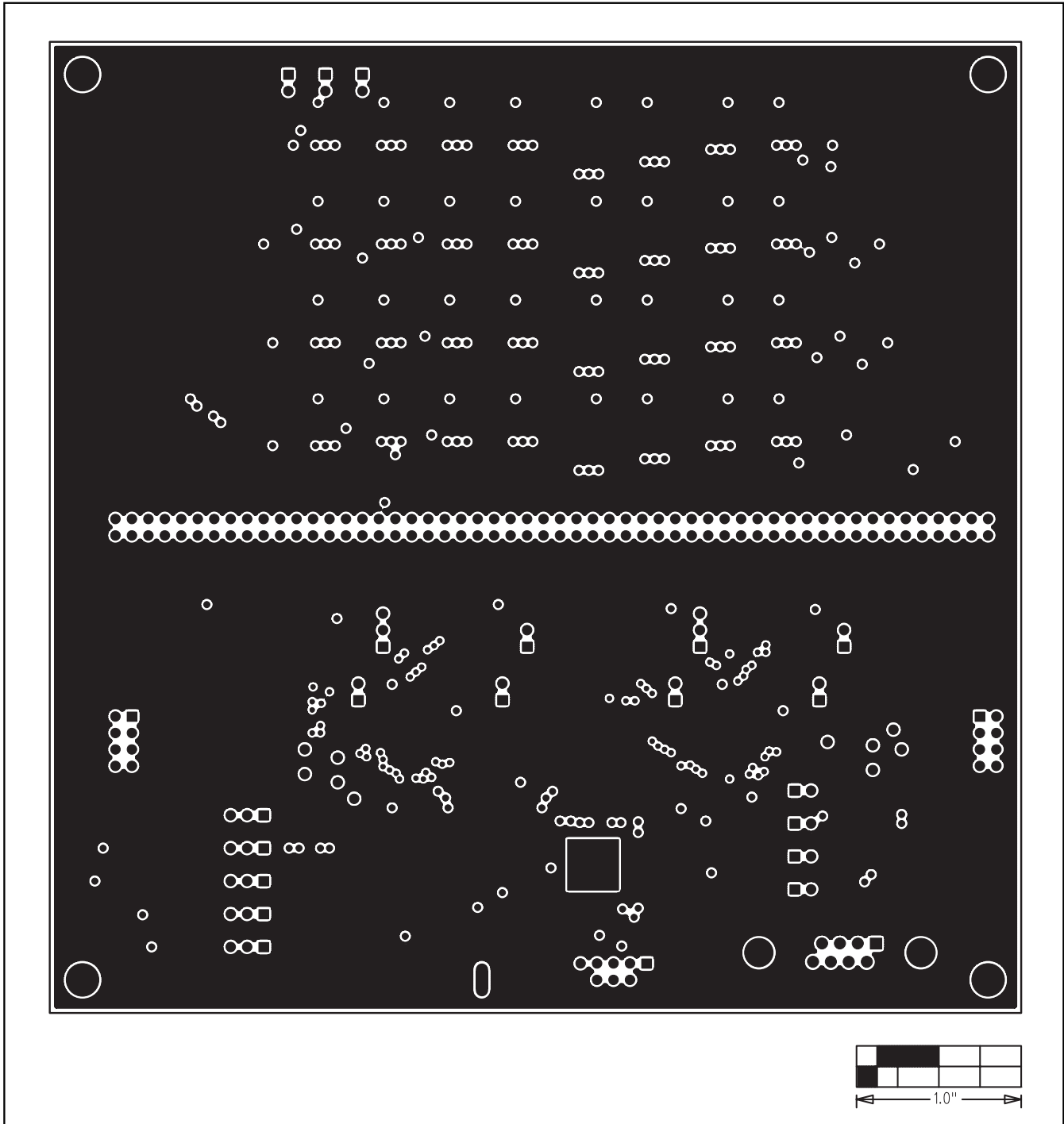


Figure 8. MAX6974 EV Kit PCB Layout—Ground Layer 2



# MAX6974 Evaluation Kit

Evaluates: MAX6974

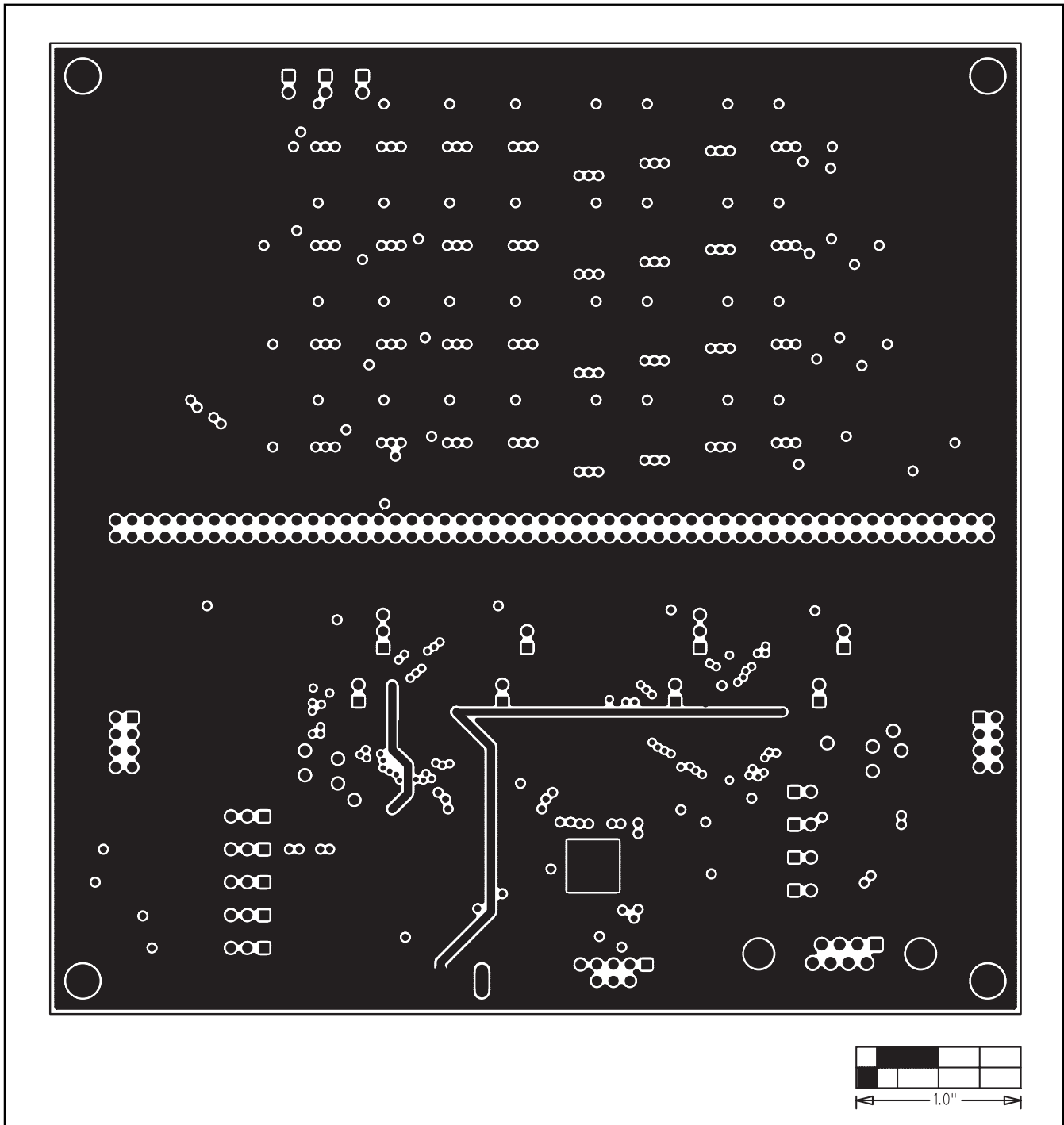


Figure 9. MAX6974 EV Kit PCB Layout—Signal Layer 3

# MAX6974 Evaluation Kit

Evaluates: MAX6974

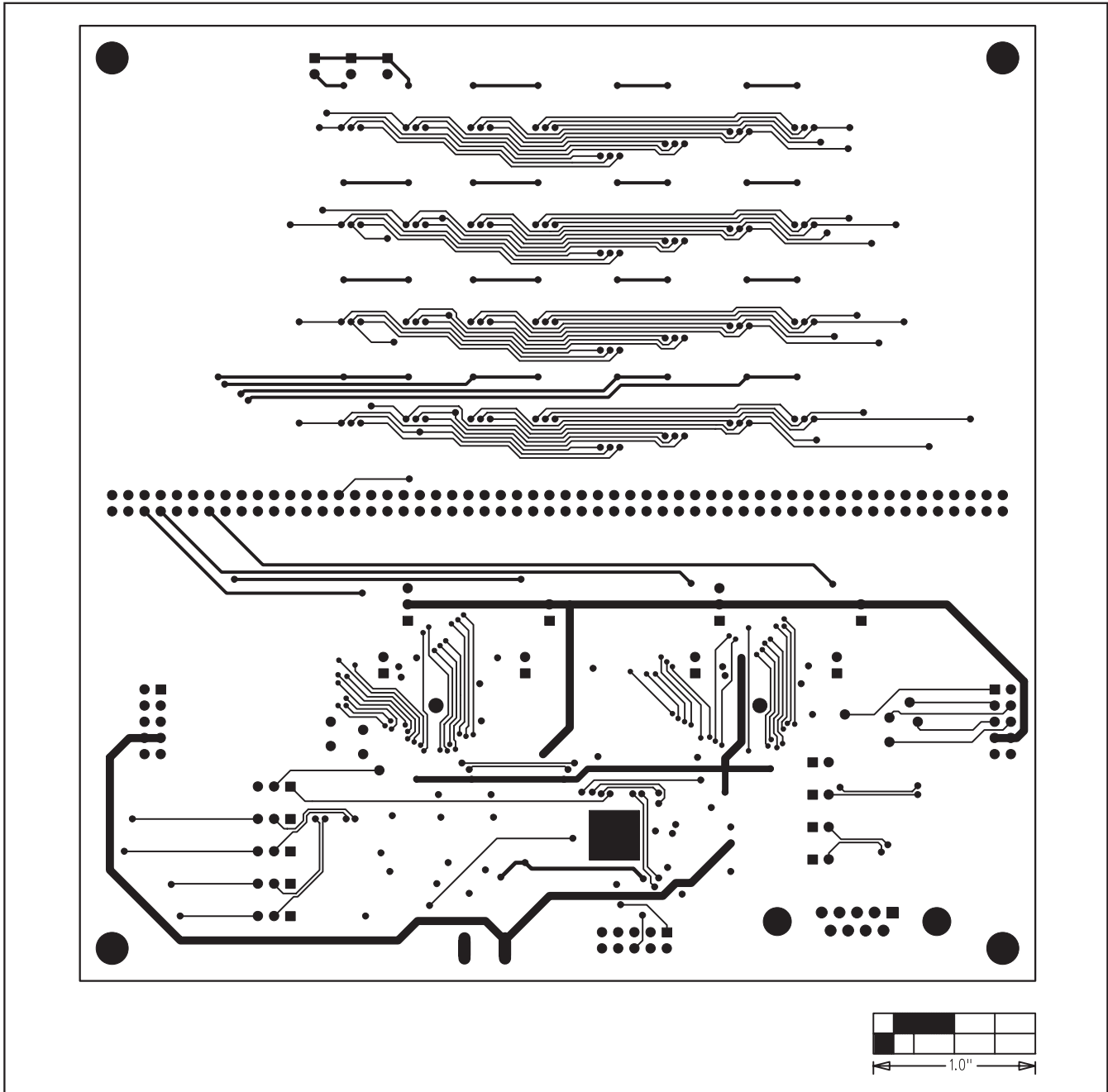


Figure 10. MAX6974 EV Kit PCB Layout—Solder Side

## Revision History

Pages changed at Rev 1: 1, 2, 8–12, 14–17

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