MAX5719 Breakout Board

20-bit, 0.05nV-s DAC

General Description

Digital-to-analog converters (DACs) provide accurate output voltages for actuation and control in many electronic applications such as industrial, medical, and RF systems. The MAX5719 is a highly accurate, 20-bit voltage output DAC featuring low glitch energy of 0.05nV-second. Development with DACs involves expertise in analog systems, power supplies, digital interfaces, and firmware. Now, accelerate the development process using the MAX5719 breakout board.

The MAX5719 breakout board provides for rapid prototyping and development with the MAX5719 (a 20-bit, voltage-output DAC). It interfaces to any Arduino™-compatible or Mbed-compatible platform system with expansion ports configurable for SPI communication. Additionally, the breakout board works with systems that have a Pmod™ connection, a 2x6 right-angle header at board edge (compatible with Digilentinc.com Pmod™ interface spec) Interface type 2A (expanded SPI) on 2x6 header at the board edge. The breakout board also comes with schematics, design files, and firmware for immediate use and forking to future projects.

The board directly interfaces to SPI with logic levels in the range 3.0V to 5.5V. (**Note:** MAX5719 is specified for 4.5V to 5.5V operation).

The board comes installed with MAX5719AGSD+.

Example firmware is provided for Arduino™ and Mbed system boards..

Tested with:

- MAX32625MBED#
  https://os.mbed.com/platforms/MAX32625MBED/
- MAX32600MBED#
  https://os.mbed.com/platforms/MAX32600MBED/
- STM32F446 Nucleo-64
  https://os.mbed.com/platforms/ST-Nucleo-F446RE/
- Arduino UNO (rev 3)
  https://store.arduino.cc/usa/arduino-uno-rev3/
- Adafruit Metro 328 Arduino compatible (USB micro B)
  https://www.adafruit.com/product/50
- Arduino Pro Mini 3.3V/8MHz
  https://store.arduino.cc/usa/arduino-pro-mini/

Ordering Information **appears at end of data sheet.**
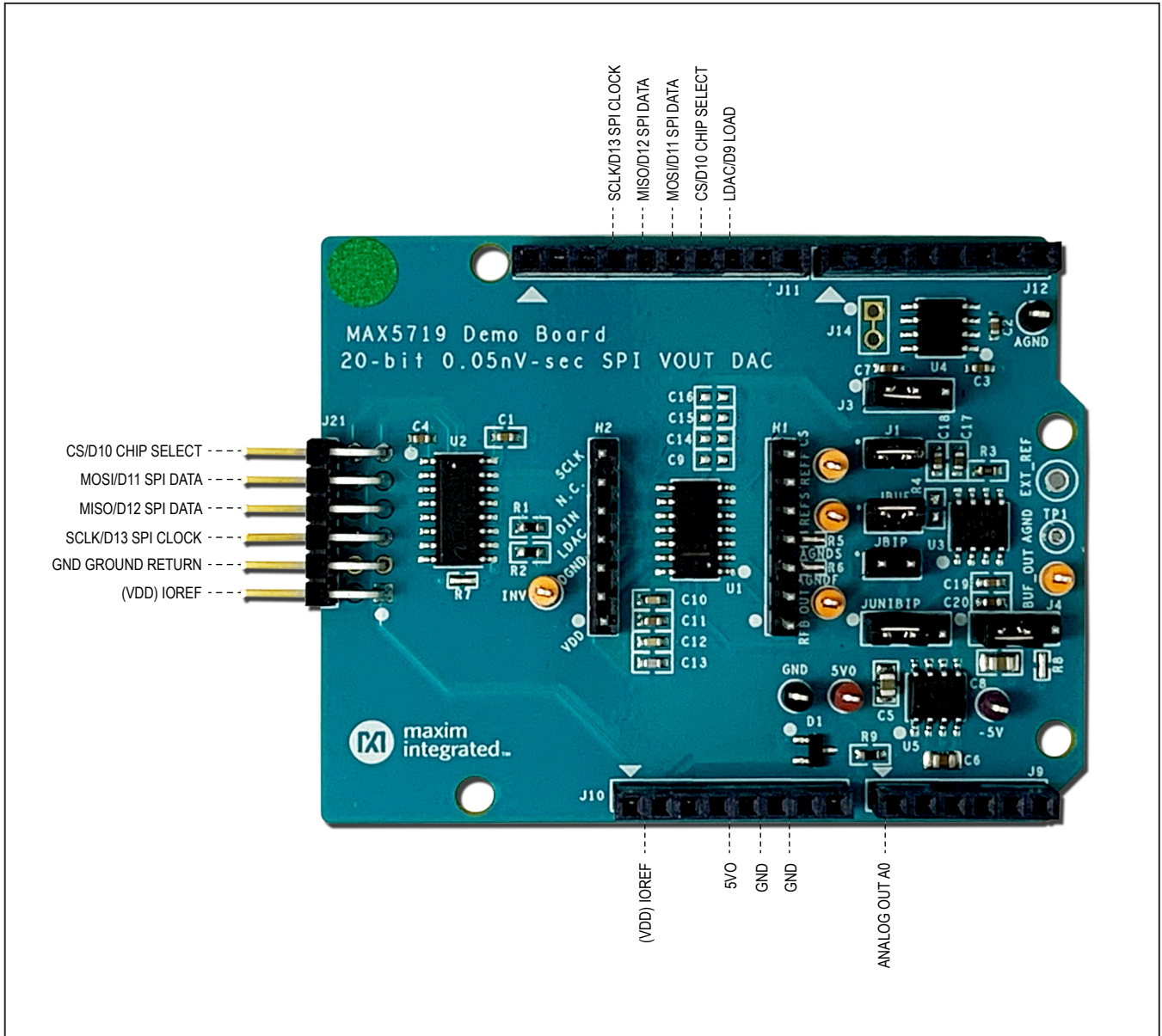
MAX5719 Breakout Board Photo
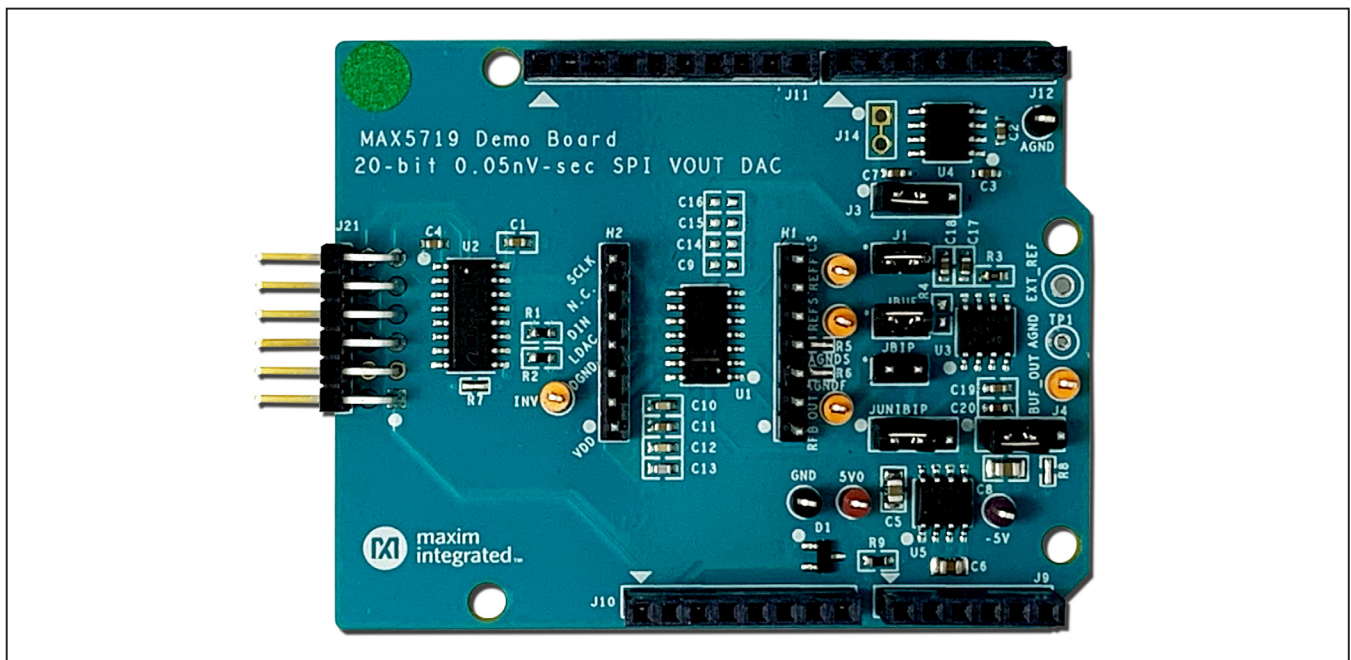
Pmod is a trademark of Digilent, Inc.
Arduino is a trademark of Arduino AG.
Arm is a registered trademark and Mbed is a trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

MAX5719 Breakout Board Pinout

Quick Start

Required Equipment

- MAX5719BOB# breakout board
- Appropriate Mbed or Arduino board
- The following procedures describe the Quick Start process with the MAX32625MBED# and the Arduino UNO.
- Computer with USB and web access
- A serial terminal emulator software such as teraterm, realterm, picocom, minicom, or equivalent

The following procedures describe the Quick Start process with the MAX32625MBED# and the Arduino. The MAX5719 breakout board has been tested on the platform boards listed above.

There are three example programs for each platform:

- The **Simplified Hello World** program is a small example program that can be changed by modifying the Hello_MAX5719.cpp source code and repeating the compile-build-upload cycle, providing straightforward code for easy adoption.
- The **Function Generator** program is a small example program that can be changed by modifying the FunctionGen_MAX5719.cpp source code and repeating the compile-build-upload cycle, providing straightforward code for easy adoption.
- The **Serial Tester** program is an interactive, menu-driven test program that is controlled through a serial communications port, using a terminal emulator, supporting quick discovery and evaluation of device features for testing functionality.

Procedure for Mbed: Simplified Hello World

The **Simplified Hello World** program is a small example program that can be changed by modifying the Hello_MAX5719.cpp source code and repeating the compile-build-upload cycle, providing straightforward code for easy adoption.

The MAX5719 breakout board is fully assembled and tested.

When the board is used for the first time, the breakout board firmware must be loaded into the MAX32625MBED, or equivalent platform board. This firmware is stored on the MAX32625MBED board and remains after the board is powered off.

When the board is plugged into the USB the first time, the computer may need about a minute to install its device drivers.

Follow the steps to verify the board operation:

1) Connect the MAX5719 breakout board to the MAX32625MBED or equivalent Mbed platform board using the standard pinout.

2) Connect a USB cable from the computer to the MAX32625MBED board **HDK** USB port. (Windows® may require some time to install its device driver.) Expect the system to automatically mount the board as a new USB drive named MBED or DAPLINK, or something similar. This is a special-purpose drive: firmware is loaded into the board by copying the compiled binary into the board's drive. Do not write any other files to this drive.

3) Open your board's USB device folder and double click on its MBED.HTML file. On the board page, click **Add** to your Mbed Compiler. This adds your Mbed board to the Online Compiler as a compilation target. See **https://os.mbed.com/docs/mbed-os/v5.13/quick-start/index.html** for more detailed instructions on using the online compiler.

4) In a web browser, navigate to **https://os.mbed.com/teams/MaximIntegrated/code/MAX5719BOB_20bit_DAC/** and click **Import into Compiler**. The Mbed online IDE window opens and prompts to **import** the program. Click the **Import** button to complete the import.

5) Compile the program. When complete, the online Mbed IDE downloads the firmware file to your local **Downloads** folder.

6) Locate the newly built firmware file **MAX5719BOB_20bit_SPI_DAC.MAX32625MBED.bin** and copy the file to the board's Mbed drive. (The names might not match exactly if using a platform other than MAX32625MBED, or if there is already a file with that name.) If a warning dialog appears asking to move this file without its properties, click **Yes**. After file copying is complete, press and release the board's **Reset** button to start the firmware. Use a DVM to measure the voltages on the MAX5719 breakout board.

7) Change the program behavior by modifying the **Hello_MAX5719.cpp** source code and repeating the compile-build-upload cycle from Step 4.

8) Discard local changes and reset to the latest published firmware version as follows: Bring up the project **Revision** tab and right-click on the line that says **default tip**. In the popup context menu, select **Switch working copy to this revision….** A warning indicating that there are uncommitted local changes in the working tree appears. Click **Discard** and all of the local files will be reset to the published version.

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Procedure for Mbed: Function Generator

The **Function Generator** program is a small example program that can be changed by modifying the **FunctionGen_MAX5719.cpp** source code and repeating the compile-build-upload cycle, providing straightforward code for easy adoption.

The MAX5719 breakout board is fully assembled and tested.

When the breakout board is used for the first time, the firmware must be loaded into the MAX32625MBED, or equivalent platform board. This firmware is stored on the MAX32625MBED board and remains after the board is powered off.

When the board is plugged into the USB for the first time, the computer may need about a minute to install its device drivers.

Follow the steps to verify the board operation:

1) Connect the MAX5719 breakout board to the MAX32625MBED or equivalent Mbed platform board using the standard pinout.

2) Connect a USB cable from the computer to the MAX32625MBED board **HDK** USB port. (Windows may require some time to install its device driver.) Expect the system to automatically mount the board as a new USB drive named MBED, or DAPLINK, or something similar. This is a special-purpose drive: firmware is loaded into the board by copying the compiled binary into the board's drive. Don't write any other files to this drive.

3) Open the board's USB device folder and double click on its MBED.HTML file. On the board page, click **Add** to your Mbed Compiler. This adds your Mbed board to the Online Compiler as a compilation target. See **https://os.mbed.com/docs/mbed-os/v5.13/quick-start/index.html** for more detailed instructions on using the online compiler.

4) In a web browser, navigate to **https://os.mbed.com/teams/MaximIntegrated/code/MAX5719BOB_FunctionGen/** and click **Import into Compiler**. The Mbed online IDE window opens and prompts to import the program. Click the **Import** button to complete the import.

5) Compile the program. When complete, the online Mbed IDE downloads the firmware file to your local **Downloads** folder.

Locate the newly built firmware file **MAX5719BOB_FunctionGen.MAX32625MBED.bin** and copy the file to the board's Mbed drive. (The names might not match exactly if using a platform other than MAX-32625MBED, or if there is already a file with that name.) If a warning dialog appears asking to move this file without its properties, click **Yes**. After file copying is complete, press and release the board's **Reset** button to start the firmware. Use an oscilloscope to measure the output waveform of the MAX5719 breakout board.

6) The program behavior can be changed by modifying the **FunctionGen_MAX5719.cpp** source code and repeating the compile-build-upload cycle from step 4.

7) Discard local changes and reset to the latest published firmware version as follows: Bring up the project **Revision** tab and right-click on the line that says **default** tip. In the popup context menu, select **Switch working copy to this revision…**. A warning indicating that there are uncommitted local changes in the working tree appears. Click **Discard** and all of the local files will be reset to the published version.

Procedure for Mbed: Serial Tester

The **Serial Tester** program is an interactive, menu-driven test program that is controlled through a serial communications port, using a terminal emulator, supporting quick discovery and evaluation of device features for testing functionality.

The MAX5719 breakout board is fully assembled and tested.

When the board is used for the first time, the MAX5719 breakout board firmware must be loaded into the MAX32625MBED, or equivalent platform board. This firmware is stored on the MAX32625MBED board and remains after the board is powered off.

The serial tester firmware uses a USB serial port to communicate.

When the board is plugged into the USB the first time, the computer may need about a minute to install its device drivers.

Follow the steps to verify board operation:

1) Connect the MAX5719 breakout board to the MAX32625MBED or equivalent Mbed platform board using the standard pinout.

2) Connect a USB cable from the computer to the MAX32625MBED board **HDK** USB port. (Windows may require some time to install its device driver.) Expect the system to automatically mount the board as a new USB drive named MBED or DAPLINK or something similar. This is a special-purpose drive: firmware will be loaded into the board by copying the

compiled binary into the board's drive. Don't write any other files to this drive.

3) Open your board's USB device folder and double click on its MBED.HTML file. On the board page, click **Add** to your Mbed Compiler. This adds your Mbed board to the Online Compiler as a compilation target. See **https://os.mbed.com/docs/mbed-os/v5.13/quick-start/index.html** for more detailed instructions on using the online compiler.

4) In a web browser, navigate to **https://os.mbed.com/teams/MaximIntegrated/code/MAX5719BOB_Serial_Tester/** and click **Import into Compiler**. The Mbed online IDE window opens, and prompts to import program. Click the **Import** button to complete the import.

5) Compile the program. When complete, the online Mbed IDE downloads the firmware file to your local **Downloads** folder.

6) Locate the newly built firmware file **MAX5719BOB_Serial_Tester.MAX32625MBED.bin** and copy the file to the board's Mbed drive. (The names might not match exactly if using a platform other than MAX-32625MBED, or if there is already a file with that name.) If a warning dialog appears asking to move this file without its properties, click **Yes**.

7) Connect another, or the existing USB cable from the computer to the MAX32625MBED board "DEV" USB port. Expect the LEDs in the lower right corner should flash briefly and then remain lit.

8) Locate the newly arrived USB Serial Device COM port, and use a serial terminal emulator (such as teraterm, realterm, picocom, minicom, or equivalent). Baud rate is 9600.

Procedure for Arduino: Simplified Hello World

The **Simplified Hello World** program is a small example program that can be changed by modifying the **Hello_MAX5719.cpp** source code and repeating the compile-build-upload cycle, providing straightforward code for easy adoption.

The MAX5719 breakout board is fully assembled and tested.

Note: If used with classic Arduino UNO which has a full-sized USB type B connector, ensure that the shield of the USB connector does not contact the underside of the breakout board/Arduino shield.

When the breakout board is used for the first time, the MAX5719 breakout board firmware must be loaded into the Arduino board. This firmware is stored on the Arduino board and remains after the board is powered off.

The firmware uses a USB serial port to communicate.

When the board is plugged into USB the first time, the computer may need about a minute to install its device drivers.

Follow the steps to verify board operation:

1) Connect the MAX5719 breakout board to the Arduino board using the standard pinout.

2) Connect a USB cable from the computer to the Arduino board USB port. (Windows may require some time to install its device driver.)

3) In a web browser, navigate to **https://create.arduino.cc/editor/whismanoid/88c84540-6947-4086-b660-1cf46af6bc3d/preview** and click **Add to my Sketchbook**.

4) Connect the USB cable to the Arduino hardware. If this is the first time using Arduino Create online, you may be prompted to install Arduino Create Agent to connect with the hardware.

Compile the program with the **Upload and Save** button. Use a DVM to measure the voltages on the MAX5719 breakout board.

5) Change the program behavior by modifying the **Hello_MAX5719.cpp** source code and repeating the compile-build-upload cycle.

Procedure for Arduino: Function Generator

The **Function Generator** program is a small example program that can be changed by modifying the **FunctionGen_MAX5719.cpp** source code and repeating the compile-build-upload cycle, providing straightforward code for easy adoption.

The MAX5719 breakout board is fully assembled and tested.

Note: If used with classic Arduino UNO which has a full-sized USB type B connector, ensure that the shield of the USB connector does not contact the underside of the breakout board/Arduino shield.

When the breakout board is used for the first time, the MAX5719 breakout board firmware must be loaded into the Arduino board. This firmware is stored on the Arduino board and remains after the board is powered off.

The firmware uses a USB serial port to communicate.

When the board is plugged into USB the first time, the computer may need about a minute to install its device drivers.

Follow the steps to verify board operation:

1) Connect the MAX5719 breakout board to the Arduino board using the standard pinout.

2) Connect a USB cable from the computer to the Arduino board USB port. (Windows may require some time to install its device driver.)

3) In a web browser, navigate to **https://create.ar-duino.cc/editor/whismanoid/2368936f-e3f9-4d16-b6ba-f2812856bc69/preview** and click **Add to my Sketchbook**.

4) Connect the USB cable to Arduino the hardware. If this is the first time using Arduino Create online, you may be prompted to install Arduino Create Agent to connect with the hardware.

5) Compile the program with the **Upload and Save** button. Use an oscilloscope to measure the output waveform of the MAX5719 breakout board.

6) Change the program behavior by modifying the **FunctionGen_MAX5719.cpp** source code and repeating the compile-build-upload cycle.

Procedure for Arduino: Serial Tester

The **Serial Tester** program is an interactive, menu-driven test program which is controlled through a serial communications port, using a terminal emulator, supporting quick discovery and evaluation of device features for testing functionality.

The MAX5719 breakout board is fully assembled and tested.

Note: If used with classic Arduino UNO which has a full-sized USB type B connector, ensure that the shield of the USB connector does not contact the underside of the breakout board/Arduino shield.

When the breakout board is used for the first time, the MAX5719 breakout board firmware must be loaded into the Arduino board. This firmware is stored on the Arduino board and remains after the board is powered off.

The firmware uses a USB serial port to communicate.

When the board is plugged into USB the first time, the computer may need about a minute to install its device drivers.

Follow the steps to verify board operation:

1) Connect the MAX5719 breakout board to the Arduino board using the standard pinout.

2) Connect a USB cable from the computer to the Arduino board USB port. (Windows may require some time to install its device driver.)

3) In a web browser, navigate to **https://create.ardui-no.cc/editor/whismanoid/07b99e49-e148-4722-b9d2-3281e53b0038/preview** and click **Add to my Sketchbook**.

4) Connect the USB cable to the Arduino hardware. If this is your first time using Arduino Create online, you may be prompted to install Arduino Create Agent to connect with the hardware.

5) Compile the program with the **Upload and Save** button.

6) Locate the newly installed USB Serial Device COM port, and use a serial terminal emulator (such as teraterm, realterm, picocom, minicom, or equivalent). Baud rate is 9600.

Sending Commands with a Serial Console

A serial terminal emulator software (such as teraterm, realterm, putty, picocom, minicom, or equivalent) must be installed to communicate with the example firmware. Various terminal programs connect in various ways and have different user interfaces, but they all share a common set of basic features:

- Connecting to a specific serial port device by name, such as COM4 or /dev/ttyACM0

- Settings such as baud rate 9600, 8 bits/No parity/ 1 Stop bit, no flow control

- Typing at the keyboard transmits to the firmware through the serial port

- Messages received from the firmware are displayed on the screen

- A special keyboard command or menu item exits the terminal program

See **https://os.mbed.com/handbook/Terminals** for more details.

More resources:

- **https://learn.sparkfun.com/tutorials/terminal-basics/tera-term-windows**

- **https://learn.sparkfun.com/tutorials/terminal-basics/real-term-windows**

- **https://learn.sparkfun.com/tutorials/terminal-basics/yat---yet-another-terminal-windows**

- **https://learn.sparkfun.com/tutorials/terminal-basics/coolterm-windows-mac-linux**

- **https://learn.adafruit.com/windows-tools-for-the-electrical-engineer/serial-terminal**

- **https://www.putty.org/**

In Windows, install a terminal emulator such as teraterm, realterm, or putty. Find the serial port name and COM port number in **Control Panel | View devices and printers**. The Mbed board will appear as a **USB Serial Device** or **mbed Serial Port**. Refer to **https://os.mbed.com/handbook/Windows-serial-configuration** and h**ttps://os.mbed.com/docs/mbed-os/v5.11/tutorials/windows-serial-driver.html** for troubleshooting. Start the terminal emulator and use its menu to connect to the serial port that belongs to the board. Pressing **Enter** displays the firmware's banner message. See *Example Session*.

In Linux, install a terminal emulator such as minicom or picocom. For example, under Debian or Ubuntu Linux, use

```
<PRE>
    sudo apt-get install picocom
</PRE>
```

In Linux (Debian), find the serial port name as follows:

```
#<PRE>
    # with the board not connected, get list of tty device names
    ls -1 /dev/tty* >dev_tty_baseline
    # now connect the device to USB and find the new tty device name (such as /dev/ttyACM0)
    ls -1 /dev/tty* | diff dev_tty_baseline -
</PRE>
```

The picocom terminal emulator runs from the tty console. The tty device name must be given on the command line when starting picocom. See man picocom for more details.

```
<PRE>
    picocom /dev/ttyACM0 --baud 9600
</PRE>
```

Pressing **Enter** displays the firmware's banner message (see example session). Pressing **Ctrl+A** and then **Ctrl+X** exits picocom.

Example Serial Console Session

The firmware uses a USB serial port to communicate. Typing **?** prints a menu of supported device commands.

```
<<PRE>
Main menu MAX5719 20-bit 1-ch DAC [serial]
 ? -- help
MAX5719 > ?
Main menu MAX5719 20-bit 1-ch DAC [serial]
 ? -- help
 # -- lines beginning with # are comments
 . -- SelfTest
%Hn {pin: 0 1 2 3 4 5 6 7 8 9 14 15 16 17} -- High Output
%Ln {pin: 0 1 2 3 4 5 6 7 8 9 14 15 16 17} -- Low Output
%?n {pin: 0 1 2 3 4 5 6 7 8 9 14 15 16 17} -- Input
%A -- analogRead
%SC SCLK=12000000=12.000MHz CPOL=0 CPHA=0 -- SPI config
%SD -- SPI diagnostic messages hide
%SW mosi,mosi,...mosi -- SPI write hex bytes
A-Z,a-z,0-9 -- reserved for application use
 ! -- Init
 A code=? -- CODE
 B -- LOAD
 C code=? -- CODE_LOAD
```

```
 @ -- print MAX5719 configuration
 L -- LDACb output LH high LL low
MAX5719 > .
SelfTest()
      VRef = 4.096    MAX5719 20-bit LSB = 0.000004v = 3.90625uV
      Wire MAX5719 OUT to platform AIN0 for analog loopback tests...
+PASS MAX5719.VRef expect 4.096000
      0x000000 = 0.000V
      SPI MOSI-> 0x00 0x00 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =    0.391% = 0.023V   expect 0.000000 +/- 0.050000
      0x01f400 = 0.500V
      SPI MOSI-> 0x1F 0x40 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =    8.016% = 0.481V   expect 0.500000 +/- 0.050000
      0x03e800 = 1.000V
      SPI MOSI-> 0x3E 0x80 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   15.934% = 0.956V   expect 1.000000 +/- 0.050000
      0x05dc00 = 1.500V
      SPI MOSI-> 0x5D 0xC0 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   23.851% = 1.431V   expect 1.500000 +/- 0.075000
      0x07d000 = 2.000V
      SPI MOSI-> 0x7D 0x00 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   31.769% = 1.906V   expect 2.000000 +/- 0.100000
      0x09c400 = 2.500V
      SPI MOSI-> 0x9C 0x40 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   39.687% = 2.381V   expect 2.500000 +/- 0.150000
      0x0bb800 = 3.000V
      SPI MOSI-> 0xBB 0x80 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   47.507% = 2.850V   expect 3.000000 +/- 0.200000
      0x0dac00 = 3.500V
      SPI MOSI-> 0xDA 0xC0 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   55.327% = 3.320V   expect 3.500000 +/- 0.250000
      0x0fa000 = 4.000V
      SPI MOSI-> 0xFA 0x00 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   59.238% = 3.554V   expect 4.000000 +/- 0.500000
      0x0fffff = 4.095V
      SPI MOSI-> 0xFF 0xFF 0xF0 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   59.335% = 3.560V   expect 4.095000 +/- 0.750000
      SPI MOSI-> 0x80 0x00 0x00 MISO<- 0x00 0x00 0x00
+PASS AIN0 =   32.551% = 1.953V   expect 2.048000 +/- 0.200000
      VRef = 4.096    MAX5719 20-bit LSB = 0.000004v = 3.90625uV
      test_voltage_sweep V = 0.000000v to 4.096000v precision 0.100000v step 0.500000v
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(0.5000V) expect 128000
+PASS MAX5719.DACCodeOfVoltage(1.0000V) expect 256000
+PASS MAX5719.DACCodeOfVoltage(1.5000V) expect 384000
+PASS MAX5719.DACCodeOfVoltage(2.0000V) expect 512000
+PASS MAX5719.DACCodeOfVoltage(2.5000V) expect 640000
+PASS MAX5719.DACCodeOfVoltage(3.0000V) expect 768000
```

```
+PASS MAX5719.DACCodeOfVoltage(3.5000V) expect 896000
+PASS MAX5719.DACCodeOfVoltage(4.0000V) expect 1024000
      test_voltage_sweep V = -0.010000v to 0.100000v precision 0.010000v step 0.010000v
+PASS MAX5719.DACCodeOfVoltage(-0.0100V) expect 0
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(0.0100V) expect 2560
+PASS MAX5719.DACCodeOfVoltage(0.0200V) expect 5120
+PASS MAX5719.DACCodeOfVoltage(0.0300V) expect 7680
+PASS MAX5719.DACCodeOfVoltage(0.0400V) expect 10240
+PASS MAX5719.DACCodeOfVoltage(0.0500V) expect 12800
+PASS MAX5719.DACCodeOfVoltage(0.0600V) expect 15360
+PASS MAX5719.DACCodeOfVoltage(0.0700V) expect 17920
+PASS MAX5719.DACCodeOfVoltage(0.0800V) expect 20480
+PASS MAX5719.DACCodeOfVoltage(0.0900V) expect 23040
+PASS MAX5719.DACCodeOfVoltage(0.1000V) expect 25600
      test_voltage_sweep V = 2.047900v to 2.048100v precision 0.000010v step 0.000010v
+PASS MAX5719.DACCodeOfVoltage(2.0479V) expect 524260
+PASS MAX5719.DACCodeOfVoltage(2.0479V) expect 524262
+PASS MAX5719.DACCodeOfVoltage(2.0479V) expect 524265
+PASS MAX5719.DACCodeOfVoltage(2.0479V) expect 524268
+PASS MAX5719.DACCodeOfVoltage(2.0479V) expect 524270
+PASS MAX5719.DACCodeOfVoltage(2.0479V) expect 524273
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524275
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524278
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524280
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524283
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524285
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524288
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524291
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524293
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524296
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524298
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524301
+PASS MAX5719.DACCodeOfVoltage(2.0481V) expect 524303
+PASS MAX5719.DACCodeOfVoltage(2.0481V) expect 524306
+PASS MAX5719.DACCodeOfVoltage(2.0481V) expect 524308
+PASS MAX5719.DACCodeOfVoltage(2.0481V) expect 524311
+PASS MAX5719.DACCodeOfVoltage(2.0481V) expect 524314
      test_voltage_sweep V = 3.996000v to 4.106000v precision 0.010000v step 0.010000v
+PASS MAX5719.DACCodeOfVoltage(3.9900V) expect 1021440
+PASS MAX5719.DACCodeOfVoltage(4.0000V) expect 1024000
+PASS MAX5719.DACCodeOfVoltage(4.0100V) expect 1026560
+PASS MAX5719.DACCodeOfVoltage(4.0200V) expect 1029120
+PASS MAX5719.DACCodeOfVoltage(4.0300V) expect 1031680
+PASS MAX5719.DACCodeOfVoltage(4.0400V) expect 1034240
+PASS MAX5719.DACCodeOfVoltage(4.0500V) expect 1036800
+PASS MAX5719.DACCodeOfVoltage(4.0600V) expect 1039360
+PASS MAX5719.DACCodeOfVoltage(4.0700V) expect 1041920
```

```
+PASS MAX5719.DACCodeOfVoltage(4.0800V) expect 1044480
+PASS MAX5719.DACCodeOfVoltage(4.0900V) expect 1047040
+PASS MAX5719.DACCodeOfVoltage(4.1000V) expect 1048575
      test_lsb_sweep V = 4.096000V LSBradius = 3LSB
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048573
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048573
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048574
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048574
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
+PASS MAX5719.DACCodeOfVoltage(4.0960V) expect 1048575
      test_lsb_sweep V = 3.072000V LSBradius = 3LSB
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786429
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786429
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786430
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786430
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786431
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786431
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786432
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786433
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786433
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786434
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786434
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786435
+PASS MAX5719.DACCodeOfVoltage(3.0720V) expect 786435
      test_lsb_sweep V = 2.048000V LSBradius = 3LSB
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524285
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524285
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524286
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524286
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524287
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524287
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524288
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524289
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524289
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524290
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524290
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524291
+PASS MAX5719.DACCodeOfVoltage(2.0480V) expect 524291
      test_lsb_sweep V = 1.024000V LSBradius = 3LSB
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262141
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262141
```

```
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262142
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262142
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262143
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262143
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262144
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262145
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262145
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262146
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262146
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262147
+PASS MAX5719.DACCodeOfVoltage(1.0240V) expect 262147
      test_lsb_sweep V = 0.000000V LSBradius = 3LSB
+PASS MAX5719.DACCodeOfVoltage(-0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(-0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(-0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(-0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(-0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(-0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 0
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 1
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 1
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 2
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 2
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 3
+PASS MAX5719.DACCodeOfVoltage(0.0000V) expect 3
Summary: 132 PASS 0 FAIL

MAX5719 > C code=0x80000
CODE_LOAD dacCodeLsbs=524288

      SPI MOSI-> 0x80 0x00 0x00 MISO<- 0x00 0x00 0x00  =1

MAX5719 > C code=0x12345
CODE_LOAD dacCodeLsbs=74565

      SPI MOSI-> 0x12 0x34 0x50 MISO<- 0x00 0x00 0x00  =1

MAX5719 > A code=0xfffff
CODE dacCodeLsbs=1048575

      SPI MOSI-> 0xFF 0xFF 0xF0 MISO<- 0x00 0x00 0x00  =1

MAX5719 > B
LOAD =1

MAX5719 > @
VRef = 4.096000
DACCode = 1048575 = 0x000fffff

MAX5719 >
</PRE>
```

Detailed Description of Hardware

The MAX5719 is a 20-bit, voltage-output DAC with SPI Interface. The MAX6126 provides a 4.096V reference voltage. For bipolar operation, the MAX889 charge pump generates a -5V power supply rail to drive the MAX44264 operational amplifier. Jumpers JUNIBIP, JBIP, JBUF, and J4 select unipolar or bipolar output configuration, and jumpers J1 and J3 select on-board 4.096V reference or external reference configuration. When configured for buffered unipolar or bipolar output, the analog output is driven from the BUF_OUT test point. When configured for direct unipolar output, the analog output is driven from the OUT test point. The analog output pin OUT is also connected to the standard Arduino A0 analog pin on the external connector, with Schottky diodes D1 clamping the voltage to avoid exceeding the Arduino or Mbed board's IOREF voltage rail. For more information on these products, please visit:

- **www.maximintegrated.com/max5719**
- **www.maximintegrated.com/max889**
- **www.maximintegrated.com/max44264**
- **www.maximintegrated.com/max6126**
- **www.maximintegrated.com/max14850**

Bipolar (-5V to 5V) Wiring Connection

To drive an output in the range -5V to 5V, put the J4 shunt on pins 1-2, JUNIBIP shunt on 2-3 (BIP), JBUF shunt on 1-2, and JBIP shunt on 1-2. and connect BUF_OUT test point to the positive side of the load. Connect the ground return side of the load to the GND test point.

Unipolar (0 to 5V) Wiring Connection

To drive an output in the range 0 to 5V, put the J4 shunt on pins 2-3 (the MAX889 charge pump and MAX44264 op amp and resistors R3-R4 will not be used). Put the JUNIBIP shunt on 1-2 (UNI), JBUF shunt on 1-2, and no shunt on JBIP. Connect BUF_OUT test point to the positive side of the load. Connect the ground return side of the load to the GND test point.

Minimal Component Count (0 to 4.096VREF) Wiring Connection

To drive an output in the range 0 to 4.096VREF with a minimal component count, remove the shunts from J4, JBUF, JUNIBIP, and JBIP (the MAX889 charge pump and MAX44264 op amp and resistors R1–R4 will not be used). Connect OUT pin of the MAX5719 to the positive side of the load. Connect the ground return side of the load to the GND test point. Leave all other test points unconnected.

Table 1. Jumper Functions

JUMPER	STATE	FUNCTION
J14	1-2*	+4.096VREF reference force/sense connection point
J3	1-2*	+4.096VREF reference drives MAX5719 REFF input
	2-3	External reference EXT_REFIN drives MAX5719 REFF input
J1	1-2*	+4.096VREF reference drives MAX5719 REFS input
	Open	External reference EXT_REFIN drives MAX5719 REFS input
JBUF	1-2*	MAX5719 OUT drives noninverting input of MAX44246 op amp buffer; load is connected to BUF_OUT test point
	Open	MAX44264 op amp is not used; load is connected to OUT test point
JBIP	1-2	Bipolar configuration: RFB input senses BUF_OUT
	Open*	Unipolar configuration: RFB is not connected
JUNIBIP	1-2*	Unipolar configuration: MAX44246 is configured as unity-gain buffer
	2-3	Bipolar configuration: MAX44264 inverting input is driven by INV; use with JBIP = 1-2 so that RFB input senses BUF_OUT
J4	1-2*	Op amp dual supply ±5V using charge pump U5 MAX889
	2-3	Op amp single supply 5V; charge pump is not used

Default position

Ordering Information

| PART	TYPE
MAX5719BOB#	Breakout Board

#Denotes RoHS compliance.

MAX5719 Breakout Board Bill of Materials

| ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
1	-5V	—	1	5119	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; PURPLE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
2	5V0	—	1	5000	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
3	AGND, GND	—	2	5001	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
4	BUF_OUT, INV, OUT, REFF, REFS	—	5	5003	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; ORANGE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
5	C1-C4, C7, C11, C18, C19	—	8	CC0603KRX7R0BB104; GRM188R72A104KA35; HMK107B7104KA; 06031C104KAT2A; GRM188R72A104K	YAGEO;MURATA; TAIYO YUDEN; AVX;MURATA	0.1UF	CAP; SMT (0603); 0.1UF; 10%; 100V; X7R; CERAMIC
6	C5, C8	—	2	GRM21BR61E106K; C2012X5R1E106K085AC125AB; C2012X5R1E106K085AC; TMK212BBJ106KG; CL21A106KAFN3N	MURATA;TDK; TDK;TAIYO YUDEN; SAMSUNG	10UF	CAP; SMT (0805); 10UF; 10%; 25V; X5R; CERAMIC
7	C6	—	1	C0805C225K4RAC; GRM21BR71C225KA12; CGA4J3X7R1C225K125AB	KEMET; MURATA;TDK	2.2UF	CAP; SMT (0805); 2.2UF; 10%; 16V; X7R; CERAMIC;
8	C12	—	1	C0603C102K5RAC; GRM188R71H102KA01; C0603X7R500-102KNE	KEMET; MURATA;VENKEL	1000PF	CAP; SMT (0603); 1000PF; 10%; 50V; X7R; CERAMIC;
9	C13	—	1	C0603C0G500-181JNE; GRM1885C1H181J	VENKEL LTD.; MURATA	180PF	CAP; SMT (0603); 180PF; 5%; 50V; C0G; CERAMIC
10	C10, C14	—	2	CGA3E2X7R2A103K; C0603C103K1RA; GRM188R72A103KA01; C1608X7R2A103K080AA	TDK;KEMET; MURATA;TDK	0.01UF	CAP;SMT(0603);0.01UF;10%;100V;X7R;CERAMIC;
11	C17, C20	—	2	C0603C105K4RAC; C1608X7R1C105K080AC; EMK107B7105KA; CGA3E1X7R1C105K080AC; 0603YC105KAT2A	KEMET;MURATA; TDK;TAIYO YUDEN; TDK;AVX	1UF	CAP; SMT (0603); 1UF; 10%; 16V; X7R; CERAMIC
12	D1	—	1	CMPSH-3S	CENTRAL SEMICONDUCTOR	CMPSH-3S	DIODE; SCH; SMT (SOT-23); PIV=30V; IF=0.1A
13	H1, H2	—	2	PEC07SAAN	SULLINS ELECTRONICS CORP.	PEC07SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 7PINS; -65 DEGC TO +125 DEGC
14	J1, JBIP, JBUF	—	3	PEC02SAAN	SULLINS	PEC02SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 2PINS
15	J3, J4, JUNIBIP	—	3	PEC03SAAN	SULLINS	PEC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS
16	J9	—	1	SSQ-106-03-G-S	SAMTEC	SSQ-106-03-G-S	CONNECTOR; MALE; THROUGH HOLE; THROUGH-HOLE .025 SQ POST SOCKET ; STRAIGHT; 6PINS
17	J10, J12	—	2	SSQ-108-03-G-S	SAMTEC	SSQ-108-03-G-S	CONNECTOR; FEMALE; THROUGH HOLE; .025IN SQ POST SOCKET; STRAIGHT; 8PINS
18	J11	—	1	SSQ-110-03-G-S	SAMTEC	SSQ-110-03-G-S	CONNECTOR; FEMALE; THROUGH HOLE; .025IN SQ POST SOCKET; STRAIGHT; 10PINS

MAX5719 Breakout Board Bill of Materials (continued)

| ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
19	J21	—	1	TSW-106-08-S-D-RA	SAMTEC	TSW-106-08-S-D-RA	CONNECTOR; THROUGH HOLE; DOUBLE ROW; RIGHT ANGLE; 12PINS
20	R1, R2, R9	—	3	CRCW06031K00FK; ERJ-3EKF1001; CR0603AFX-1001ELF	VISHAY; PANASONIC;BOURNS	1K	RES; SMT (0603); 1K; 1%; +/-100PPM/DEGC; 0.1000W
21	R3	—	1	CRCW06030000Z0EAHP	VISHAY DRALORIC	0	RES; SMT (0603); 0; JUMPER; JUMPER; 0.2500W
22	SU1-SU5	—	5	S1100-B;SX1100-B; STC02SYAN	KYCON;KYCON; SULLINS ELECTRONICS CORP.	SX1100-B	TEST POINT; JUMPER; STR; TOTAL LENGTH=0.24IN; BLACK; INSULATION=PBT;PHOSPHOR BRONZE CONTACT=GOLD PLATED
23	U1	—	1	MAX5719AGSD+	MAXIM	MAX5719AGSD+	EVKIT PART - IC; MAX5719AGSD+; PACKAGE OUTLINE DRAWING: 21-0041; PACKAGE LAND PATTERN: 90-0112; PACKAGE CODE: S14+4
24	U2	—	1	MAX14850ASE+	MAXIM	MAX14850ASE+	IC; DISO; SIX CHANNEL DIGITAL ISOLATOR; NSOIC16 150MIL; -40 DEGC TO +125 DEGC
25	U3	—	1	MAX44246ASA+	MAXIM	MAX44246ASA+	IC; OPAMP; 36V; LOW-NOISE; PRECISION; DUAL OP-AMP; NSOIC8 150MIL
26	U4	—	1	MAX6126AASA41+	MAXIM	MAX6126AASA41	IC; VREF; ULTRA-HIGH PRECISION; ULTRA-LOW NOISE; SERIES VOLTAGE REFERENCE; NSOIC8 150MIL; -40 DEGC TO +125 DEGC
27	U5	—	1	MAX889SESA+	MAXIM	MAX889SESA+	IC; VREG; 1MHZ SWITCHING FREQUENCY; HIGH-FREQUENCY; REGULATED; 0.2A; INVERTING CHARGE PUMP; NSOIC8 150MIL
28	PCB	—	1	MAX5719_ARDUINO_DEMO_A	MAXIM	PCB	PCB:MAX5719_ARDUINO_DEMO_A
29	C9	DNP	0	CC0603KRX7R0BB104; GRM188R72A104KA35; HMK107B7104KA; 06031C104KAT2A; GRM188R72A104K	YAGEO;MURATA; TAIYO YUDEN; AVX;MURATA	0.1UF	CAP; SMT (0603); 0.1UF; 10%; 100V; X7R; CERAMIC
30	C15	DNP	0	C0603C102K5RAC; GRM188R71H102KA01; C0603X7R500-102KNE	KEMET;MURATA; VENKEL	1000PF	CAP; SMT (0603); 1000PF; 10%; 50V; X7R; CERAMIC;
31	C16	DNP	0	C0603C0G500-181JNE; GRM1885C1H181J	VENKEL LTD.; MURATA	180PF	CAP; SMT (0603); 180PF; 5%; 50V; C0G; CERAMIC
32	EXT_REF	DNP	0	5007	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.35IN; BOARD HOLE=0.063IN; WHITE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
33	R4	DNP	0	CRCW06030000Z0EAHP	VISHAY DRALORIC	0	RES; SMT (0603); 0; JUMPER; JUMPER; 0.2500W
34	R5, R6-R8	DNP	0	N/A	N/A	SHORT	PACKAGE OUTLINE 0402 RESISTOR
35	TP1	DNP	0	5001	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
TOTAL			55				

MAX5719 Breakout Board Schematic Diagram
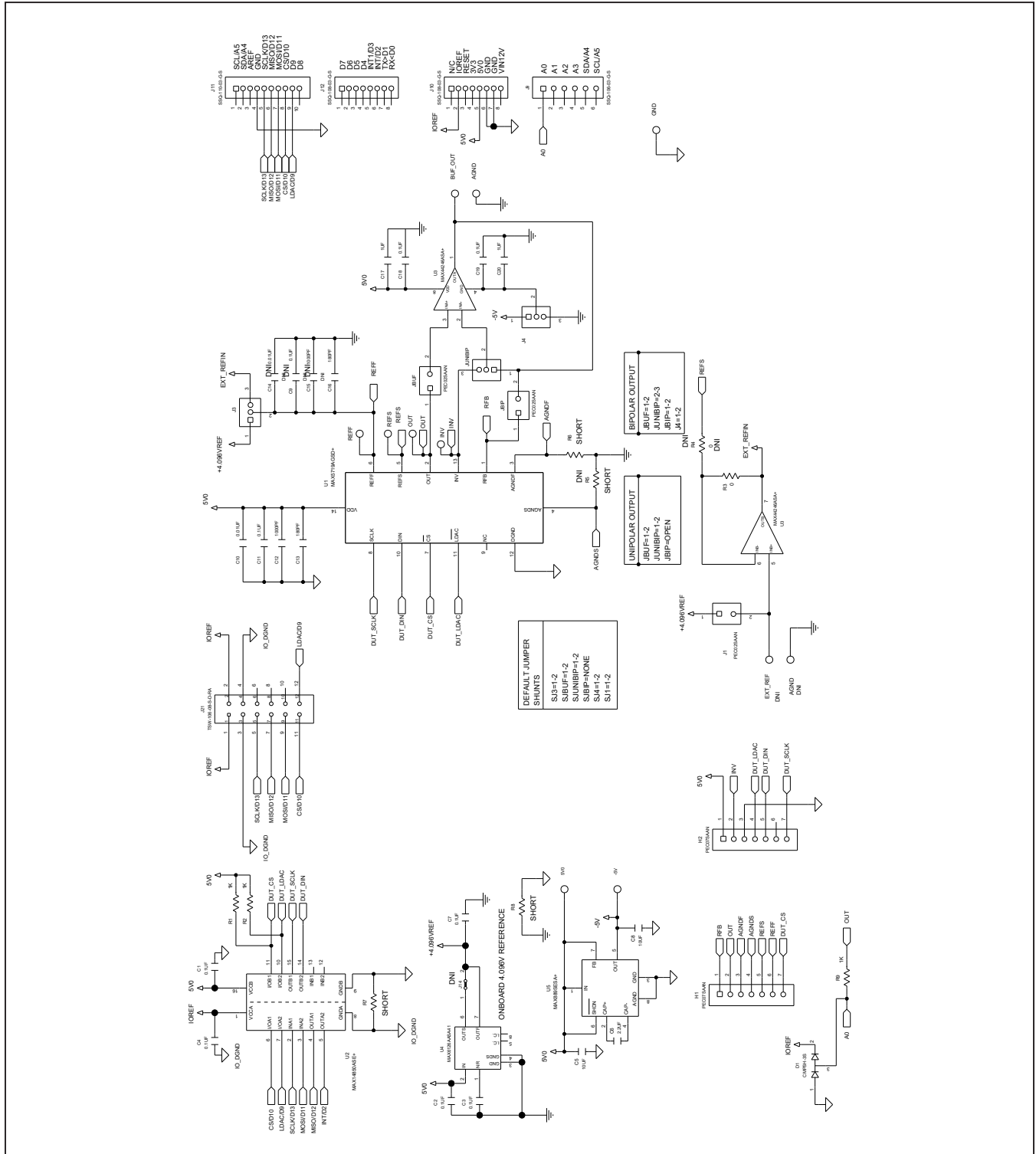
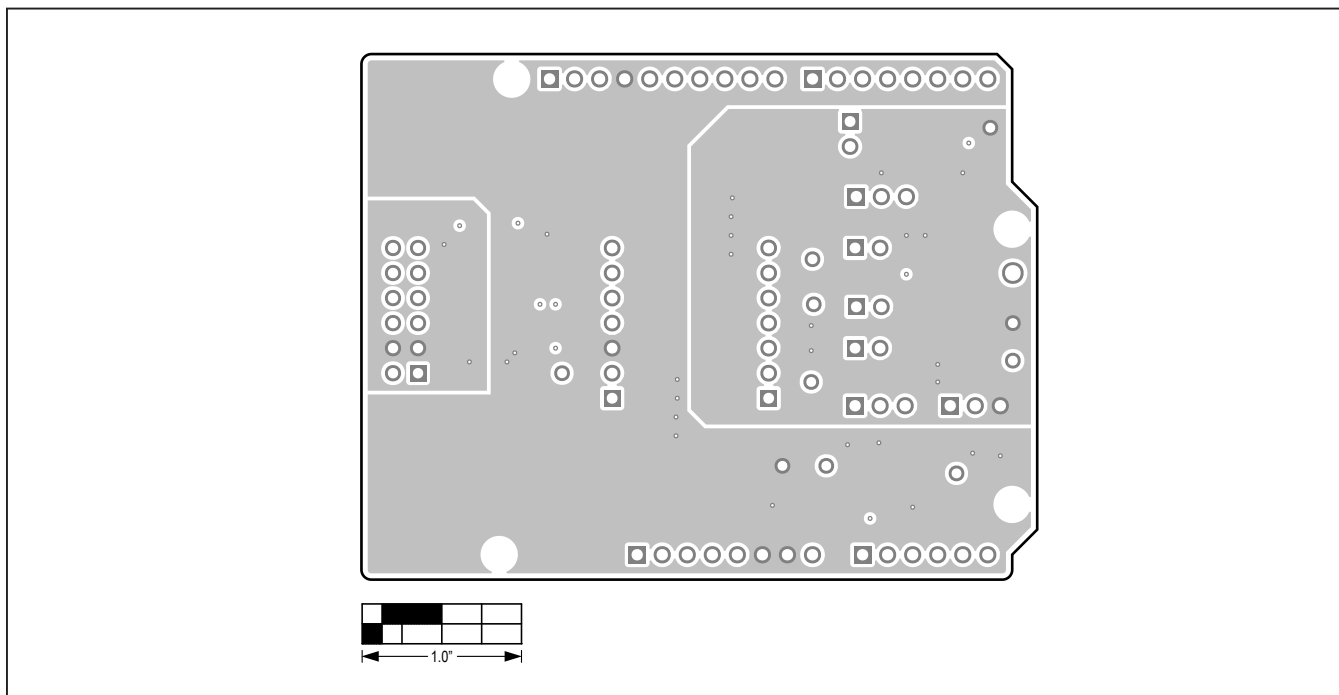## MAX5719 Breakout Board PCB Layout Diagrams
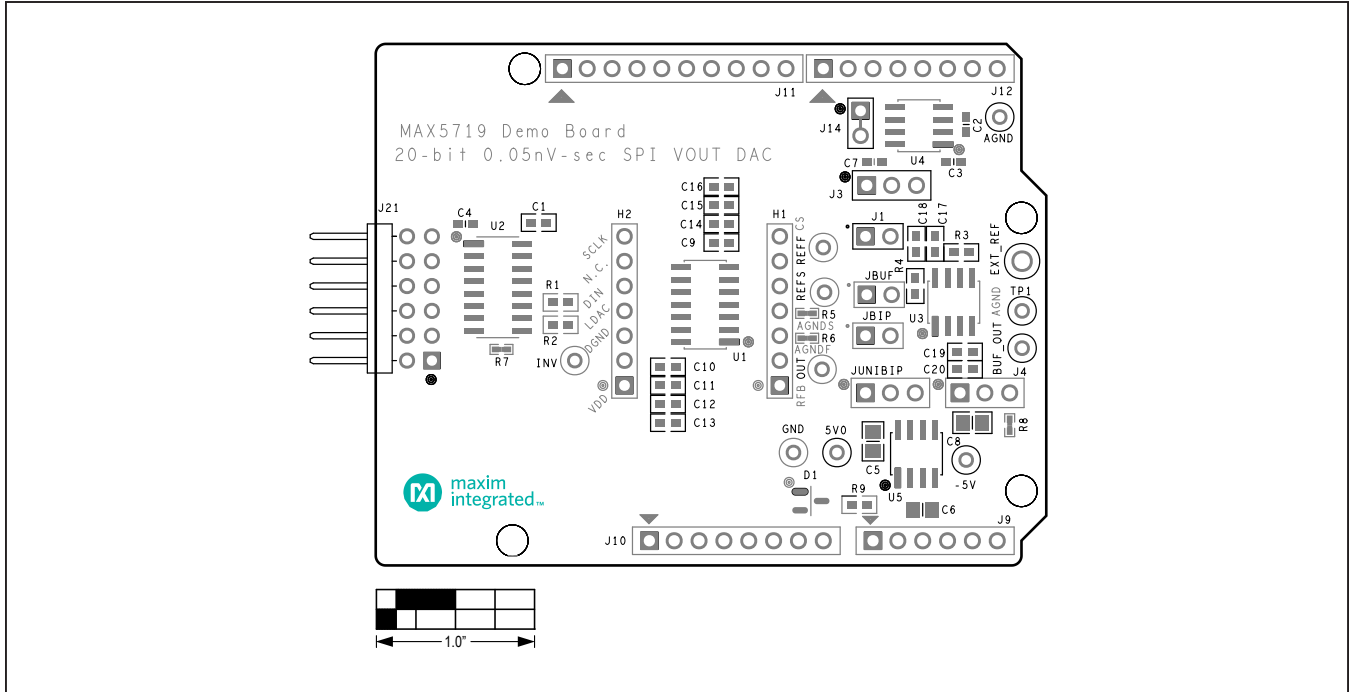
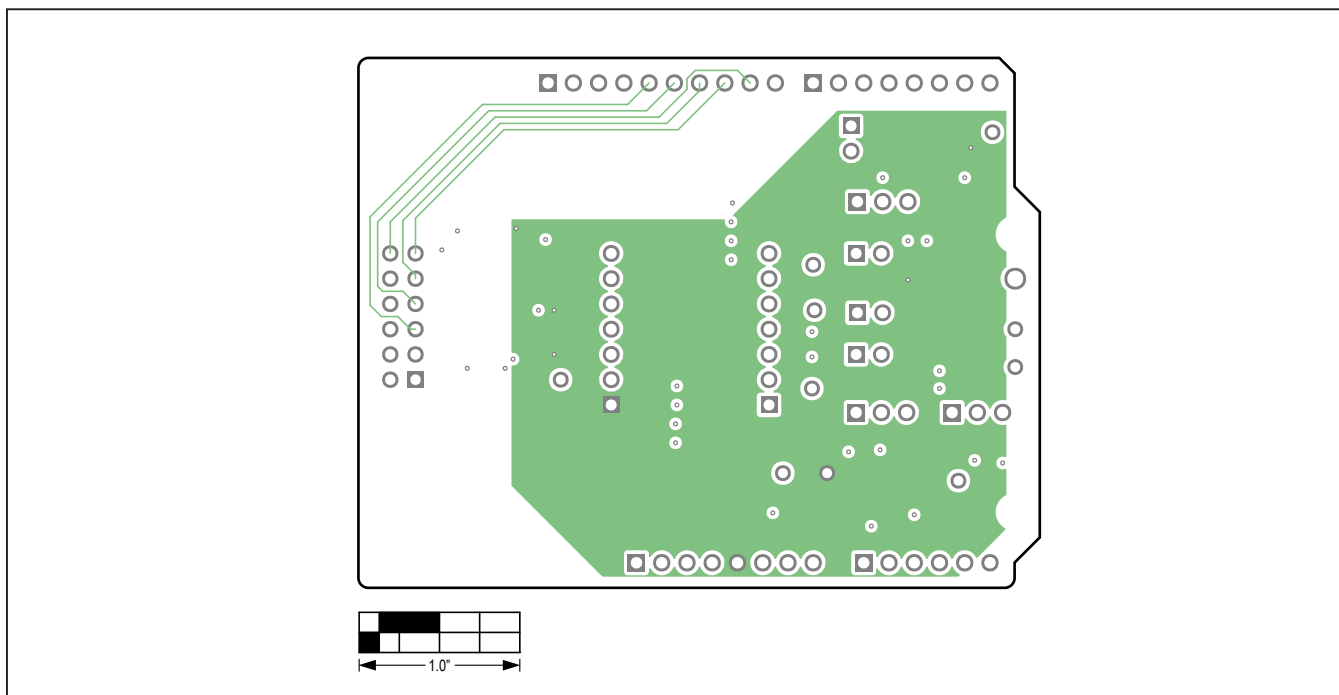*MAX5719 Breakout Board PCB Layout—Top Silkscreen*
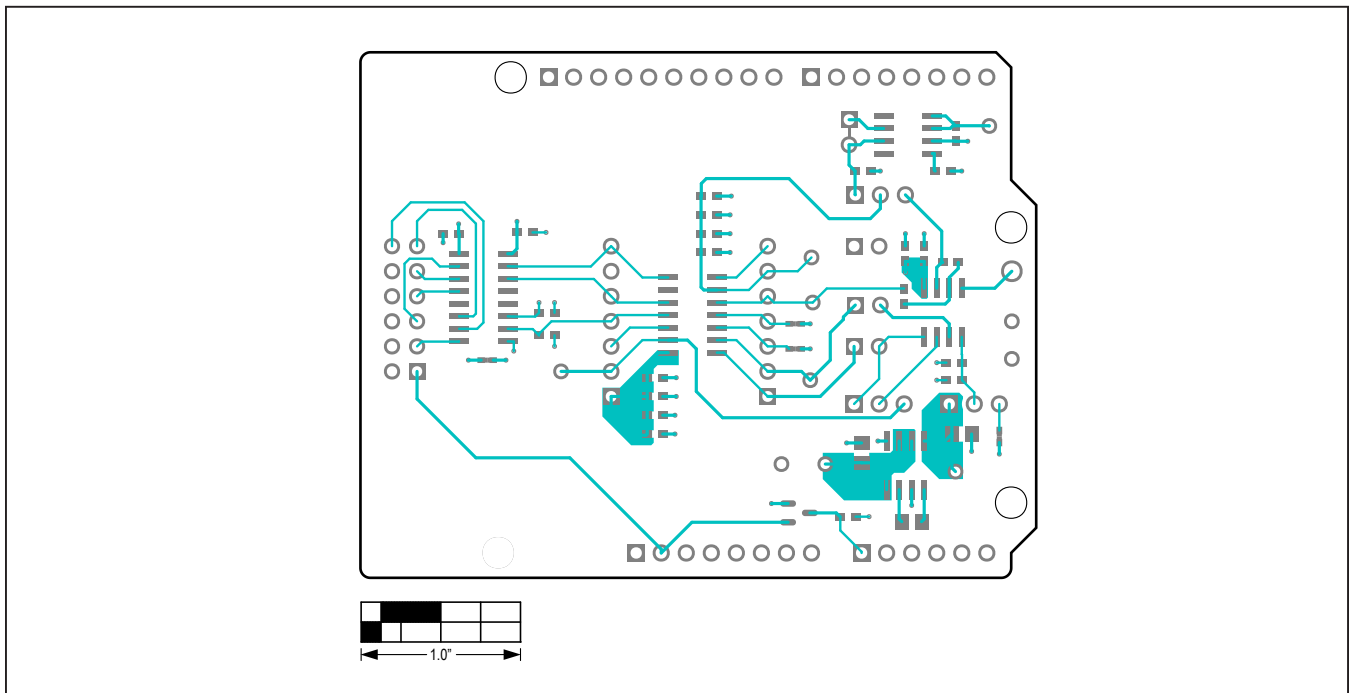
MAX5719 Breakout Board PCB Layout—Top View

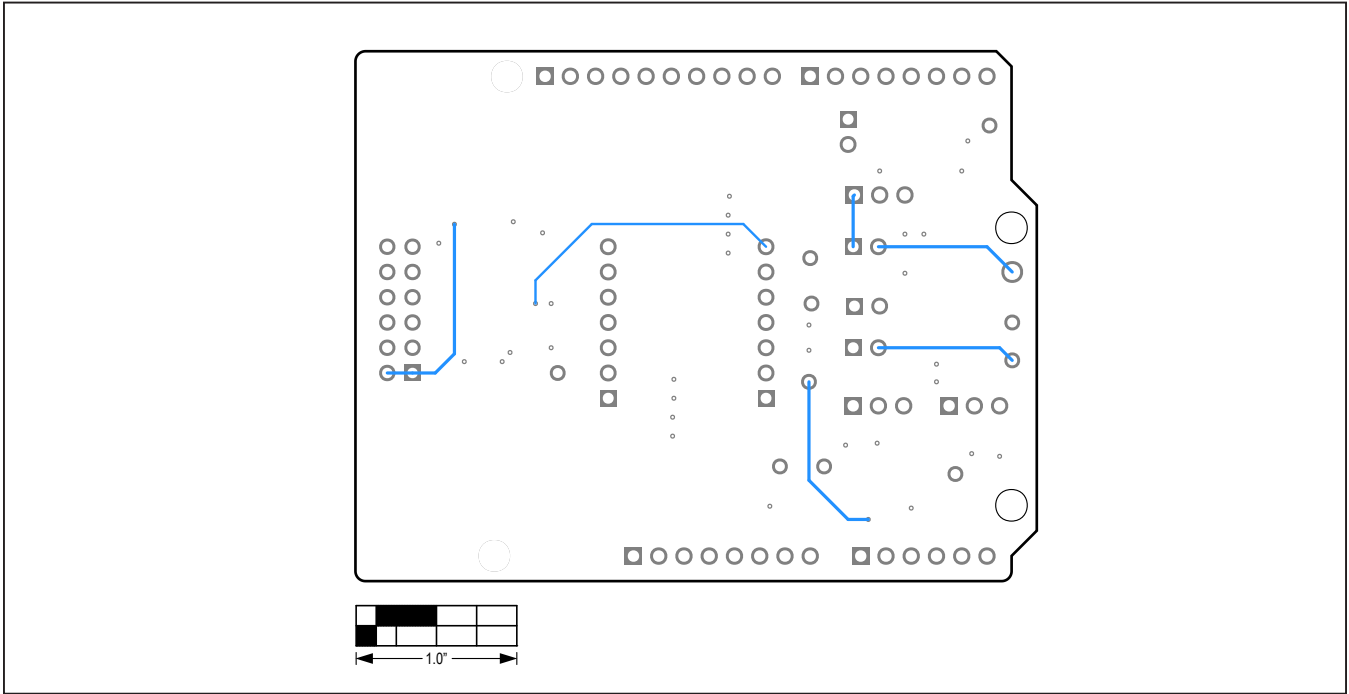## MAX5719 Breakout Board PCB Layout Diagrams (continued)

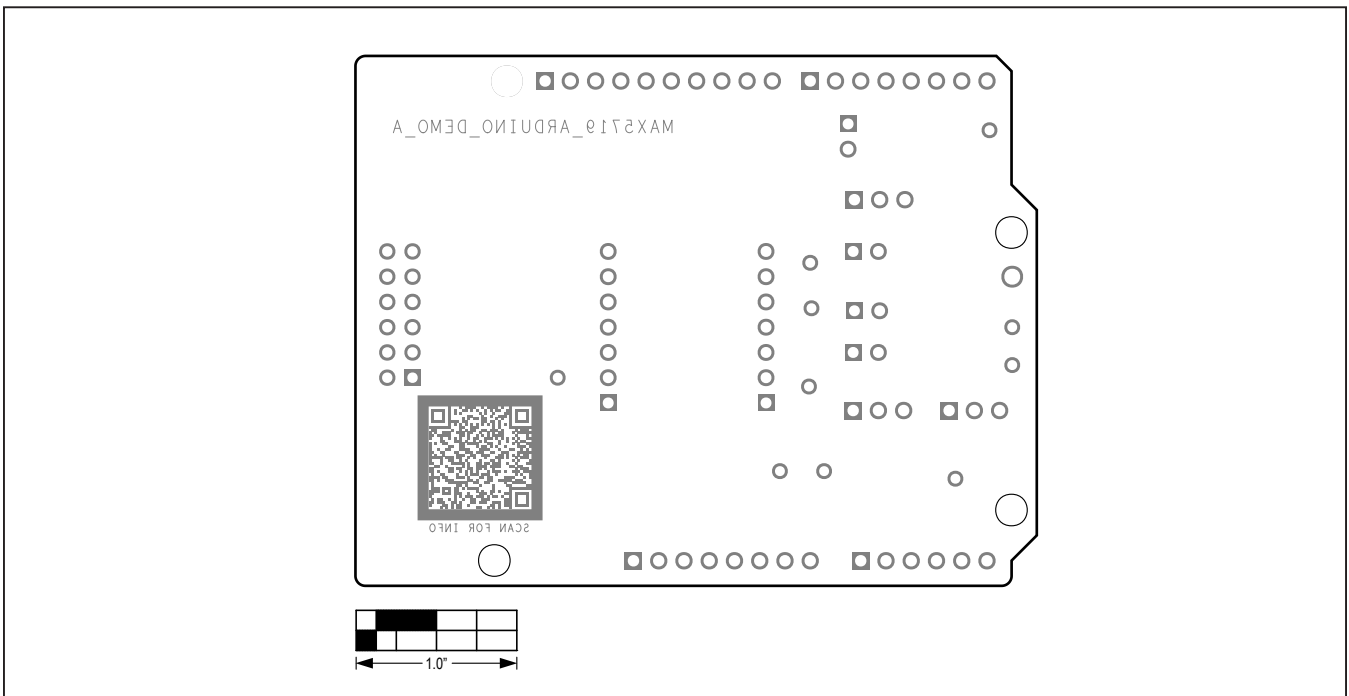*MAX5719 Breakout Board PCB Layout—Internal 2*

MAX5719 Breakout Board PCB Layout—Internal 3

MAX5719 Breakout Board PCB Layout Diagrams (continued)

MAX5719 Breakout Board PCB Layout—Bottom View

MAX5719 Breakout Board PCB Layout—Bottom Silkscreen