



# MAX3543 Evaluation Kit

## General Description

The MAX3543 evaluation kit (EV kit) simplifies the testing and evaluation of the MAX3543 hybrid television tuner. The EV kit is fully assembled and tested at the factory. Standard 50Ω SMA connectors are included on the EV kit for the inputs and outputs to allow quick and easy evaluation on the test bench.

This document provides a list of equipment required to evaluate the device, a straightforward test procedure to verify functionality, a description of the EV kit circuit, the circuit schematic, a list of components for the EV kit, and artwork for each layer of the PCB.

## Features

- ◆ Easy Evaluation of the MAX3543
- ◆ 50Ω SMA Connectors
- ◆ All Critical Peripheral Components Included
- ◆ Fully Assembled and Tested
- ◆ PC Control Software

## Ordering Information

| PART          | TYPE   |
|---------------|--------|
| MAX3543EVKIT+ | EV Kit |

+Denotes lead(Pb)-free and RoHS compliant.

## Component List

| DESIGNATION                                                             | QTY | DESCRIPTION                                                  |
|-------------------------------------------------------------------------|-----|--------------------------------------------------------------|
| ATV, DTV, JP3, JP4, JP5, JP7                                            | 6   | Single in-line headers, 100 mil centers<br>Sullins PEC36SAAN |
| C0                                                                      | 1   | 8.2pF ±0.1pF capacitor (0402)<br>Murata GRM1555C1H8R2B       |
| C1                                                                      | 1   | 1μF ±10% capacitor (0402)<br>Murata GRM155R61A105K           |
| C2–C5, C10, C12, C13, C15, C19, C25, C27, C32–C35, C44, C45, C100, C101 | 19  | 1000pF ±10% capacitors (0402)<br>Murata GRM155R71H102K       |
| C6, C8                                                                  | 2   | 39pF ±5% capacitors (0402)<br>Murata GRM1555C1H390J          |
| C7                                                                      | 1   | 2pF ±0.1pF capacitor (0402)<br>Murata GRM1555C1H2R0B         |
| C9                                                                      | 1   | 47μF ±10% capacitor (1210)<br>Murata GRM32CR61A476K          |
| C11                                                                     | 1   | 4.7pF ±0.1pF capacitor (0402)<br>Murata GRM1555C1H4R7B       |
| C14, C23, C29, C31, C36, C60                                            | 0   | Not installed, ceramic capacitors (0402)                     |
| C16                                                                     | 1   | 0.01μF ±10% capacitor (0402)<br>Murata GRM155R71E103K        |

| DESIGNATION   | QTY | DESCRIPTION                                                                         |
|---------------|-----|-------------------------------------------------------------------------------------|
| C17           | 1   | 5.6pF ±0.1 capacitor (0402)<br>Murata GRM1555C1H5R6B                                |
| C18           | 1   | 10μF ±10% tantalum capacitor (2012) (Rcode/case 0805 compatible)<br>AVX TAJR106K006 |
| C20           | 1   | 0.47μF ±10% capacitor (0402)<br>Murata GRM155R61A474K                               |
| C21           | 1   | 1500pF ±10% capacitor (0402)<br>Murata GRM155R71H152K                               |
| C22           | 1   | 33000pF ±10% capacitor (0402)<br>Murata GRM155R71A333K                              |
| C24, C26, C30 | 3   | 22pF ±5% capacitors (0402)<br>Murata GRM1555C1H220J                                 |
| C28           | 0   | Not installed, ceramic capacitor (0603)                                             |
| C37           | 1   | 100pF ±5% capacitor (0402)<br>Murata GRM1555C1H101J                                 |
| C38, C39      | 2   | 47pF ±5% capacitors (0402)<br>Murata GRM1555C1H470J                                 |
| C40           | 1   | 120pF ±5% capacitor (0402)<br>Murata GRM1555C1H121J                                 |
| C41, C42      | 2   | 56pF ±5% capacitors (0402)<br>Murata GRM1555C1H560J                                 |
| C43           | 1   | 180pF ±5% capacitor (0402)<br>Murata GRM1555C1H181J                                 |

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## Component List (continued)

| DESIGNATION        | QTY | DESCRIPTION                                                                   |
|--------------------|-----|-------------------------------------------------------------------------------|
| C61                | 1   | 0.1 $\mu$ F $\pm$ 10% capacitor (0603)<br>Murata GRM188R71E104K               |
| GND, GND1,<br>GND2 | 3   | PC mini (black) test points<br>Keystone 5001                                  |
| IFVGC,<br>RFVGC    | 2   | PC mini (white) test points<br>Keystone 5002                                  |
| J1, J3, J4         | 3   | SMA end-launch jack receptacles,<br>0.062in<br>Emerson (Johnson) 142-0701-801 |
| J2, J5, J6         | 0   | Not installed, SMA end-launch<br>jacks                                        |
| JP2                | 1   | Dual in-line header, 100 mil<br>centers<br>Sullins PEC36DAAN                  |
| JP6, REFOUT        | 0   | Not installed, 2-pin headers                                                  |
| L0, L1             | 2   | 15nH $\pm$ 5% inductors (0603)<br>Murata LQG18HN15J00                         |
| L2                 | 1   | 68nH $\pm$ 5% inductor (0603)<br>Murata LQG18HN68NJ00                         |
| L3                 | 1   | 150nH $\pm$ 5% inductor (0603)<br>TOKO LL1608-FSLR15J                         |
| L4, L7             | 2   | 270nH $\pm$ 5% inductors (0603)<br>TOKO LL1608-FSLR27J                        |
| L5                 | 1   | 12nH $\pm$ 5% inductor (0603)<br>Murata LQG18HN12NJ00                         |
| L6                 | 1   | 18nH $\pm$ 5% inductor (0603)<br>Murata LQG18HN18NJ00                         |
| L8                 | 1   | 47nH $\pm$ 5% inductor (0603)<br>Murata LQG18HN47NJ00                         |
| L9                 | 0   | Not installed, inductor                                                       |
| L12                | 1   | 180nH $\pm$ 5% inductor (0603)<br>TOKO LL1608-FSLR18J                         |
| L13                | 1   | 120nH $\pm$ 5% inductor (0603)<br>TOKO LL1608-FSLR12J                         |
| L14                | 1   | 100nH $\pm$ 5% inductor (0603)<br>TOKO LL1608-FSLR10J                         |
| R0                 | 1   | 560 $\Omega$ $\pm$ 5% resistor (0402)                                         |

| DESIGNATION                                             | QTY | DESCRIPTION                                                               |
|---------------------------------------------------------|-----|---------------------------------------------------------------------------|
| R1, R3, R5,<br>R6, R12,<br>R14–R17,<br>R20, R22         | 0   | Not installed, resistors (0402)                                           |
| R2, R23                                                 | 2   | 390 $\Omega$ $\pm$ 1% resistors (0402)                                    |
| R4, R8                                                  | 2   | 1k $\Omega$ $\pm$ 1% resistors (0402)                                     |
| R7                                                      | 1   | 442 $\Omega$ $\pm$ 1% resistor (0402)                                     |
| R9, R18, R24                                            | 3   | 100 $\Omega$ $\pm$ 5% resistors (0402)                                    |
| R10                                                     | 1   | 86.6 $\Omega$ $\pm$ 1% resistor (0402)                                    |
| R11                                                     | 1   | 43.2 $\Omega$ $\pm$ 1% resistor (0402)                                    |
| R13                                                     | 1   | 499 $\Omega$ $\pm$ 1% resistor (0402)                                     |
| R19, R21, R28,<br>R29, R42, R50,<br>R54–R59,<br>R61–R64 | 16  | 0 $\Omega$ $\pm$ 5% resistors (0402)                                      |
| R25                                                     | 1   | 348 $\Omega$ $\pm$ 1% resistor (0402)                                     |
| R49                                                     | 1   | 910 $\Omega$ $\pm$ 5% resistor (0402)                                     |
| R53                                                     | 1   | 15 $\Omega$ $\pm$ 5% resistor (0402)                                      |
| R60                                                     | 1   | 600 $\Omega$ $\pm$ 25% ferrite bead (0402)<br>Murata BLM15AG601SN1        |
| SCL, SDA,<br>VTUNE                                      | 0   | Not installed, ST single male<br>headers                                  |
| T1                                                      | 1   | Balun (4:1 impedance ratio)<br>TOKO #617PT-1664                           |
| U1                                                      | 1   | Hybrid television tuner<br>(40 TQFN-EP*)<br>Maxim MAX3543CTL+             |
| Y2                                                      | 1   | 16MHz crystal (HC49/U)<br>Suntzu SCX331-16.000MHz                         |
| VCC, VDD                                                | 2   | PC mini (red) test points<br>Keystone 5000                                |
| —                                                       | 2   | 2-position shorting jumpers<br>(JP3, JP5), 0.1in center<br>Kycon SX1100-B |
| —                                                       | 1   | INTF3000+ interface board with<br>ribbon cable                            |
| —                                                       | 1   | PCB: MAX3543 EVALUATION KIT+                                              |

\*EP = Exposed pad.

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## Component Suppliers

| SUPPLIER                               | PHONE        | WEBSITE                     |
|----------------------------------------|--------------|-----------------------------|
| AVX Corporation                        | 843-946-0238 | www.avx.com                 |
| Emerson Network Power                  | 507-833-9922 | www.emersonnetworkpower.com |
| Keystone Electronics Corp.             | 209-796-2032 | www.keyelco.com             |
| Kycon, Inc.                            | 408-494-0330 | www.kycon.com               |
| Murata Electronics North America, Inc. | 770-436-1300 | www.murata-northamerica.com |
| Sullins Electronics Corp.              | 760-744-0125 | www.sullinselectronics.com  |
| Suntsu Frequency Control               | 949-305-0220 | www.suntsuinc.com           |
| TOKO America, Inc.                     | 847-297-0070 | www.tokoam.com              |

**Note:** Indicate that you are using the MAX3543 when contacting these component suppliers.

## Quick Start

The MAX3543 EV kit is fully assembled and factory tested. Follow the steps in the *Connections and Setup* section for proper device evaluation.

### Test Equipment Required

- Power supply capable of supplying at least 300mA, +3.3V
- RF signal generator capable of delivering at least 0dBm of output power at the operating frequency
- RF spectrum analyzer capable of covering the operating frequency range of the device
- 50Ω SMA cables
- User-supplied PC with Windows XP® or later operating system and an available USB port
- USB cable with USB-A male connector on one end and USB-B male connector on the other end
- (Optional) Dual-output power supply capable of supplying up to 3V at < 1mA (to apply gain-control voltages directly).
- (Optional) Ammeter to measure supply current

### Connections and Setup

This section provides a step-by-step guide to testing the basic functionality of the EV kit in DVB-T mode. For user's convenience, Figure 1 illustrates critical connectors on the INTF3000+ USB interface board and the EV kit. **Caution: Do not turn on DC power or RF signal generator until all connections are completed.**

- 1) Connect the provided 20-pin ribbon cable between the INTF3000+ board (J1 labeled as INTF2400) and the EV kit JP2 connector. Make sure that pin 1 of the

INTF3000+ board J1 connector is connected to pin 1 of the EV kit JP2 connector (see the red wire on the 20-pin ribbon cable in Figure 1).

- 2) Make sure that JU1 on the INTF3000+ board is in the "VDEV" position. Verify that the J6 and J7 jumpers are not present.
- 3) Connect the USB cable between the PC's USB port and the INTF3000+ board. The red light on the INTF3000+ board should light once briefly when the board is connected to the PC. It also blinks periodically as the EV kit software communicates with the board.
- 4) Verify that jumpers JP3 and JP5 are installed on the EV kit.
- 5) With its output disabled, set the DC power supply to +3.3V. Connect the power supply to the VCC (through an ammeter if desired) and GND terminals on the EV kit. If available, set the current limit to 300mA.
- 6) With its output disabled, connect the output of the RF signal generator to the SMA connector labeled "RFIN" (J1) on the EV kit.
- 7) Connect the IFOUT\_DTV output (J3) to a spectrum analyzer.
- 8) Turn on the +3.3V power supply. The supply current should read approximately 260mA. If an ammeter is used, be sure to adjust the power supply to account for any voltage drop across the ammeter.
- 9) Install the IC's control software provided by Maxim.

Windows is a registered trademark of Microsoft Corp.

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- 10) Maxim also provides a FactorySettings.ini file that includes predefined MAX3543 register configurations for different TV standards (DVB-T, DVB-C, PAL, SECAM). Manually copy the FactorySettings.ini file into the directory where the IC software is installed. The path should be "C:\Program Files\Max3543\" or similar.
- 11) Launch the IC control software.
- 12) Verify that the I<sup>2</sup>C write address setting in the EV kit software (Options → I<sup>2</sup>C Write Address menu item) matches the EV kit hardware configuration. By default, the EV kit comes with no jumper installed on the JP4 header. This corresponds to the address setting of 0xC2.
- 13) Verify that the software shows "Board/USB-Online" in a green box at the bottom of the window. If the status is "OFFLINE-Click Here," then verify all the connections described above in steps 1 through 8.
- 14) Go to the Options → External IF Bandpass Filter menu item and select the IF bandpass filter used at the IFOUT1 output on the EV kit. Most of the EV kits use a differential LC filter. It is important to select the appropriate mode to ensure that the right IFOUT1 output driver (differential vs. single-ended) is used to drive the bandpass filter.
- 15) Go to the Synth tab and set the REF FREQ to match the crystal frequency (in MHz) on the EV kit. Most of the EV kits use 16MHz crystals.
- 16) Set the IF FREQ to the desired value. Note that the on-chip bandpass filter is centered at 36.15MHz, so the IF FREQ should be set within  $\pm 0.2$ MHz of 36.15MHz.
- 17) Load the predefined factory settings to set the MAX3543 registers to receive the desired TV standard. For instance, to configure the device for reception of DVB-T signals, choose the Factory Settings → DVB-T menu item. Note that Maxim provides predefined configurations for most of the existing TV standards. If custom optimization is desired, use these settings as a starting point.

### Gain Measurement to the IFOUT DTV Port in DVB-T Mode

- 1) Connect the dual-output power-supply outputs to the RFVGC and IFVGC terminals on the EV kit. Adjust voltages at RFVGC and IFVGC to be approximately +3V.
- 2) Load the predefined factory settings for DVB-T mode by selecting the Factory Settings → DVB-T menu item.
- 3) Enter the desired RF frequency (e.g., 666MHz) into the RF FREQ text box in the RF Top tab.

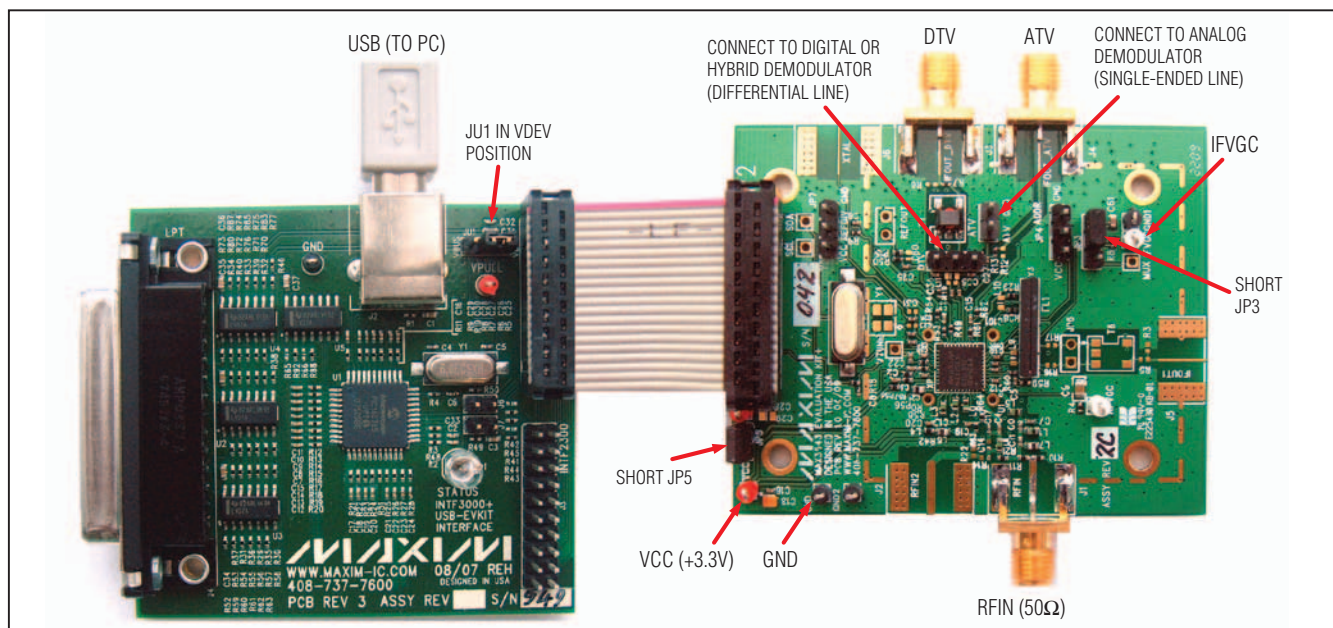


Figure 1. USB Interface Board and MAX3543 EV Kit Connections

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- 4) Verify that the device has locked to the correct frequency by checking the LOCK light in the bottom-right corner of the window. A green light indicates a successful lock.
- 5) Set the RF signal generator to a 666MHz frequency and a -90dBm power level. Enable the RF signal generator's output.
- 6) Set the center frequency of the spectrum analyzer to 36.15MHz and the span to 1MHz. Set the reference level to 0dBm. Increase the input power of the signal generator until the output level reaches -22dBm. This is the output level that corresponds to approximately 1V<sub>P-P</sub> output across the IC's DTVOU<sub>T+</sub> and DTVOU<sub>T-</sub> pins. The voltage gain of the receiver can be calculated by taking the difference in dB between the input and output power and applying correction factors to compensate for the 50Ω-to-75Ω min loss pad at the input (R10 and R11), T1 balun (4:1 impedance ratio), and R7 442Ω series resistor at the output.

Voltage gain can be calculated from:

$$A_V = 3.96\text{dB} + 20 \text{ LOG}(V_{\text{OUT,RMS}}/V_{\text{IN,RMS}}) + 6\text{dB} + 19.86\text{dB}$$

or

$$A_V = (P_{\text{OUT}} - P_{\text{IN}}) + 29.82\text{dB}$$

where:

3.96dB is the voltage loss due to the input min loss pad,

$$V_{\text{IN,RMS}} = \sqrt{50 \times 10 \left( \frac{P_{\text{IN}} (\text{dBm}) - 30}{10} \right)}$$

is the input RMS voltage calculated from the input power P<sub>IN</sub> (i.e., power from the RF signal generator),

$$V_{\text{OUT,RMS}} = \sqrt{50 \times 10 \left( \frac{P_{\text{OUT}} (\text{dBm}) - 30}{10} \right)}$$

is the output RMS voltage calculated from the output power P<sub>OUT</sub> (i.e., power at the spectrum analyzer input),

6dB is the output transformer voltage ratio,

19.86dB (i.e., 20 LOG(492/50)) is the voltage loss due to R7 series resistor.

The calculated voltage gain should be approximately 85dB.

## RF Gain-Control Range (RFVGC)

To measure the gain-control range in the RF stage, follow the steps below:

- 1) Set RFVGC to +3V.
- 2) Set IFVGC to +3V.
- 3) Adjust the RF input power to achieve -22dBm at the IFOUT\_DTV output. Record this as the reference output level.
- 4) Set RFVGC to +0.5V and record the change in the IFOUT\_DTV output level in dB relative to -22dBm. This change in output power is the gain-control range of the RF stage.
- 5) The RF gain-control range should be approximately 53dB.
- 6) Note that it might be necessary to increase the input power level with RFVGC = +0.5V in order to make an accurate level measurement. If this is necessary, calculate the RF gain-control range by first calculating the gain with RFVGC = +3V, then calculate the gain with RFVGC = +0.5V and take the difference between these two gain levels.

## IFVGA Gain-Control Range (IFVGC)

To measure the gain-control range in the IFVGA stage, follow the steps below:

- 1) Set RFVGC to +1V.
- 2) Set IFVGC to +3V.
- 3) Adjust the RF input power to achieve -40dBm at the IFOUT\_DTV output. Record this as the reference output level.
- 4) Set IFVGC to +0.5V and record the change in the IFOUT\_DTV output level in dB relative to -40dBm. This change in output power is the gain-control range of the IFVGA stage.
- 5) The IFVGA gain-control range should be approximately 42dB.
- 6) Note that it might be necessary to increase the input power level with IFVGC = +0.5V in order to make an accurate level measurement. If this is necessary, calculate the IFVGA gain control range by first calculating the gain with IFVGC = +3V, then calculate the gain with IFVGC = +0.5V and take the difference between these two gain levels.

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## Gain Measurement to the IFOUT\_ATV Port in PAL-B/G Mode

- 1) Connect the IFOUT\_ATV output (J4) to a spectrum analyzer.
- 2) Adjust the RFVGC voltage to approximately +3V.
- 3) Load the predefined factory settings for PAL-B/G mode by selecting the Factory Settings → PAL/SECAM B/G/D/K/I (IFOUT2 output) menu item.
- 4) Enter the desired RF frequency (e.g., 506MHz) into the RF FREQ text box in the RF Top tab.
- 5) Set the RF signal generator to the desired RF frequency and a -60dBm power level. Enable the RF signal generator's output.
- 6) Set the center frequency of the spectrum analyzer to 36.15MHz and the span to 1MHz. Set the reference level to 0dBm. Increase the input power of the signal generator until the output level reaches -28dBm. This is the output level that corresponds to approximately 0.5V<sub>P-P</sub> output at the IC's IFOUT2 pin. The voltage gain of the receiver can be calculated by taking the difference in dB between the input and output power and applying correction factors to compensate for the 50Ω-to-75Ω min loss pad at the input (R10 and R11), and R13 500Ω series resistor at the output.

Voltage gain can be calculated from:

$$A_V = 3.96\text{dB} + 20 \text{ LOG}(V_{\text{OUT,RMS}}/V_{\text{IN,RMS}}) + 20.83\text{dB}$$

or

$$A_V = (\text{P}_{\text{OUT}} - \text{P}_{\text{IN}}) + 24.8\text{dB}$$

where:

3.96dB is the voltage loss due to the input min loss pad,

$$V_{\text{IN,RMS}} = \sqrt{50 \times 10 \left( \frac{\text{P}_{\text{IN}} (\text{dBm}) - 30}{10} \right)}$$

is the input RMS voltage calculated from the input power P<sub>IN</sub> (i.e., power from the RF signal generator),

$$V_{\text{OUT,RMS}} = \sqrt{50 \times 10 \left( \frac{\text{P}_{\text{OUT}} (\text{dBm}) - 30}{10} \right)}$$

is the output RMS voltage calculated from the output power P<sub>OUT</sub> (i.e., power at the spectrum analyzer input),

20.83dB (i.e., 20 LOG(550/50)) is the voltage loss due to R13 series resistor.

The calculated voltage gain should be approximately 44dB.

## Connecting the MAX3543 to Digital and Analog Demodulators

The EV kit includes additional input and output connectors to allow for quick and easy evaluation of the IC's performance with digital and analog demodulators. The differential input of the digital (or digital + analog) demodulator can be connected to the DTV 3-pin header on the EV kit. The IFAGC output of the demodulator should be connected to the IFVGC terminal on the EV kit. The IC controls its RF gain autonomously, so the RFVGC terminal on the EV kit should be left unconnected.

Older analog demodulators with single-ended input and built-in IF gain-control stage can be connected using the ATV 2-pin header on the EV kit. The RFVGC terminal on the EV kit should be left unconnected.

The device also provides the buffered reference clock output that can be used by demodulators. Use the REFOUT 2-pin header to connect the clock output to the demodulator reference clock inputs.

## Layout Considerations

Contact Maxim to obtain the MAX3543's reference design layout to use as a starting point for PCB designs. Refer to the *Layout Recommendations* section in the MAX3543 IC data sheet for more information.

## Evaluates: MAX3543



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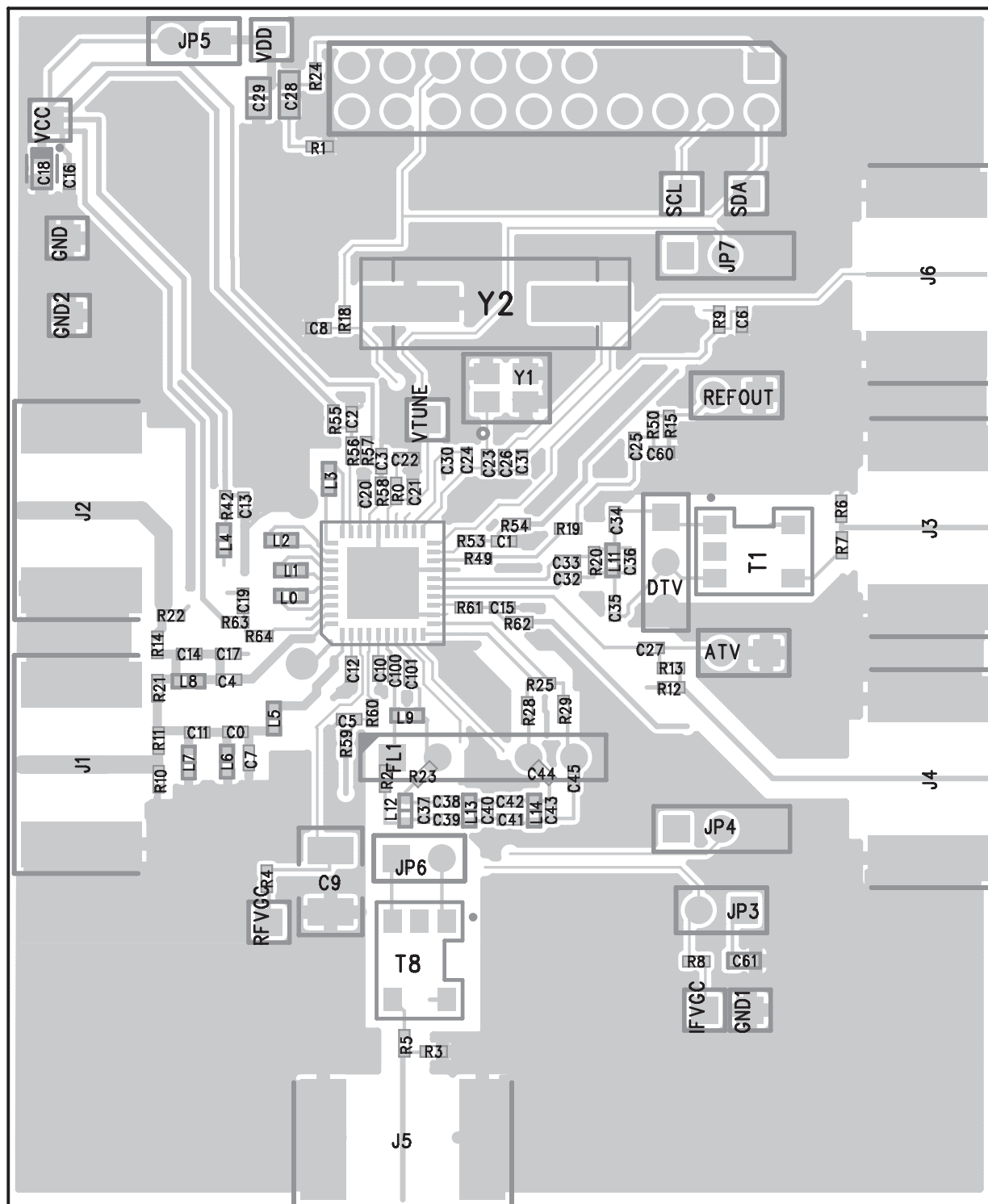


Figure 3. MAX3543 EV Kit PCB Component Placement Guide—Component Side

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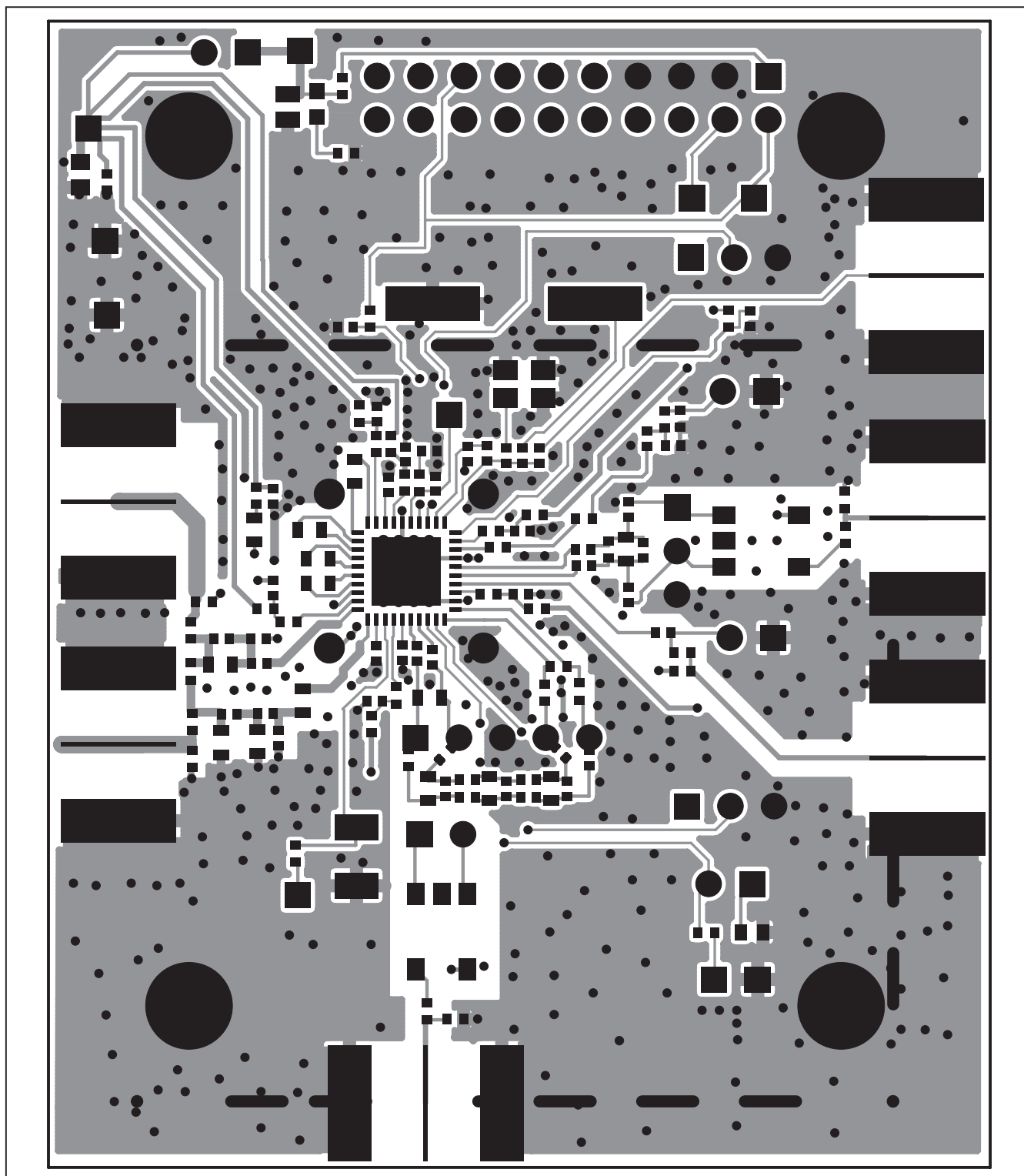


Figure 4. MAX3543 EV Kit PCB Layout—Primary Component Side

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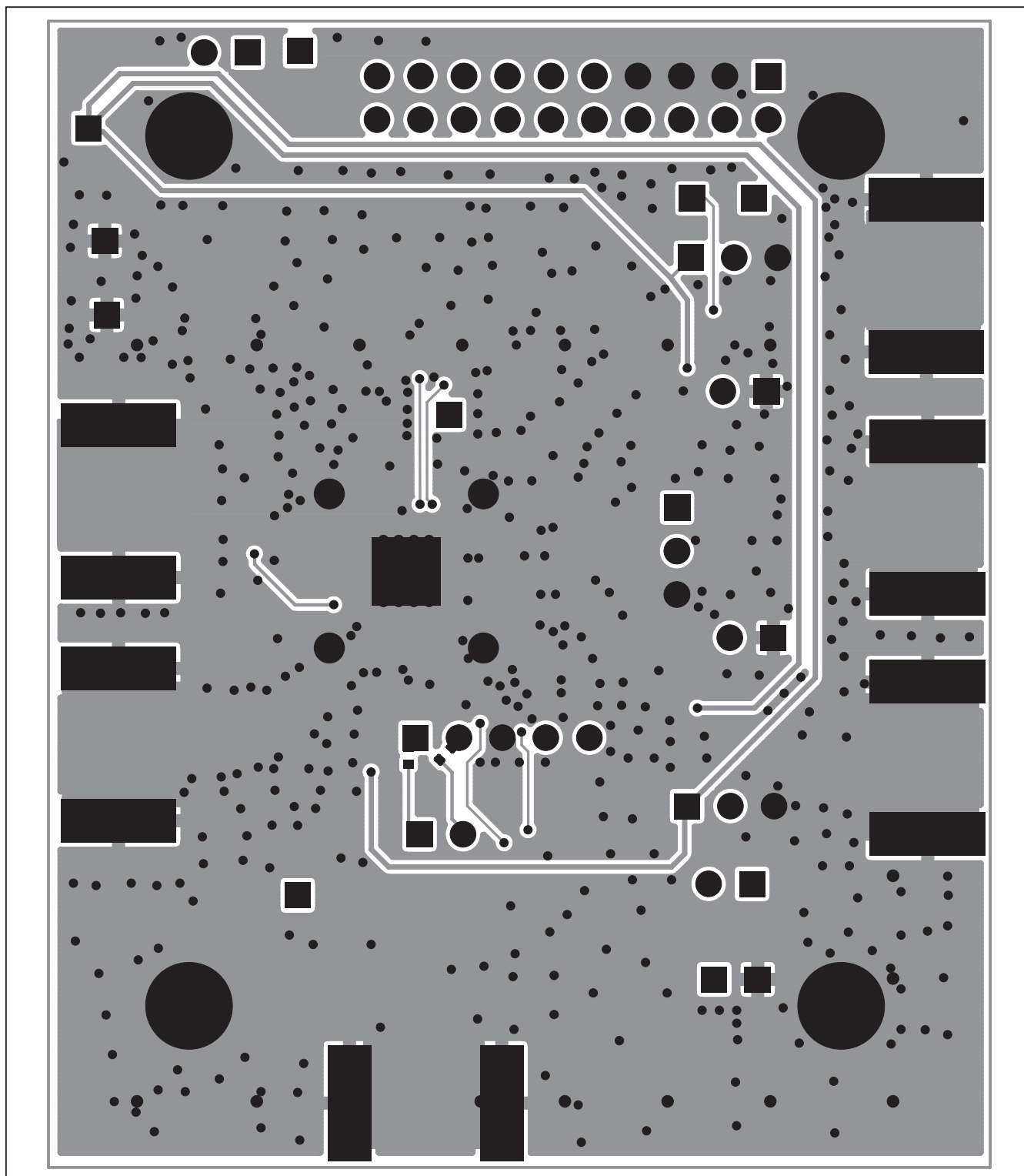


Figure 5. MAX3543 EV Kit PCB Layout—Secondary Component Side

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## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION     | PAGES<br>CHANGED |
|--------------------|------------------|-----------------|------------------|
| 0                  | 5/10             | Initial release | —                |

**Evaluates: MAX3543**

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