

# ***ADS5440/44/63/74 EVM***

## *User's Guide*



# Contents

|          |                                         |           |
|----------|-----------------------------------------|-----------|
| <b>1</b> | <b>Overview.....</b>                    | <b>5</b>  |
| 1.1      | Purpose.....                            | 5         |
| 1.2      | EVM Basic Functions.....                | 5         |
| 1.3      | Power Requirements .....                | 5         |
| 1.4      | ADS5463 EVM Operational Procedure ..... | 5         |
| <b>2</b> | <b>Circuit Description .....</b>        | <b>7</b>  |
| 2.1      | Schematic Diagram .....                 | 7         |
| 2.2      | Circuit Function.....                   | 7         |
| 2.3      | Test Points.....                        | 10        |
| 2.4      | ADC Options .....                       | 10        |
| <b>3</b> | <b>Physical Description.....</b>        | <b>11</b> |
| 3.1      | PCB Layout.....                         | 11        |
| 3.2      | Bill of Materials.....                  | 18        |
| 3.3      | PCB Schematics.....                     | 19        |
|          | <b>Important Notices .....</b>          | <b>23</b> |

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## List of Figures

|    |                                                |    |
|----|------------------------------------------------|----|
| 1  | Smith Chart .....                              | 8  |
| 2  | THS9001 + ADS5463 FFT Plot .....               | 9  |
| 3  | Top Silkscreen .....                           | 11 |
| 4  | Component Side.....                            | 12 |
| 5  | Ground Plane 1 .....                           | 13 |
| 6  | Power Plane 1 .....                            | 14 |
| 7  | Power Plane 2 .....                            | 15 |
| 8  | Ground Plane 2.....                            | 16 |
| 9  | Bottom Side .....                              | 17 |
| 10 | EVM Schematics .....                           | 19 |
| 11 | EVM Schematics .....                           | 20 |
| 12 | EVM Schematics .....                           | 21 |
| 13 | EVM Schematics .....                           | 21 |
| 14 | Touchless Probe Breakout Board Schematic ..... | 22 |

## List of Tables

|   |                                |    |
|---|--------------------------------|----|
| 1 | Three-Pin Jumper List.....     | 6  |
| 2 | EVM Power Supply Options ..... | 7  |
| 3 | Output Connector J5.....       | 10 |
| 4 | Bill of Materials .....        | 18 |

## **ADS5440/44/63/74 EVM**

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### **1 Overview**

This user's guide gives a general overview of the ADS5440/44/63/74 evaluation module (EVM) and provides a general description of the features and functions to be considered while using this module.

#### **1.1 Purpose**

The EVM provides a platform for evaluating the analog-to-digital converter (ADC) under various signal, reference, and supply conditions. This document should be used in combination with the EVM schematic diagram supplied.

#### **1.2 EVM Basic Functions**

Two analog inputs to the ADC are provided via external SMA connectors. One input path uses a pair of THS9001 amplifiers, while the other input is ac-coupled. In both cases, the user supplies a single-ended input, which is converted into a differential signal.

The EVM provides an external SMA connector for input of the ADC clock. The single-ended input is converted into a differential signal at the input of the device.

Digital output from the EVM is via a high-speed, high-density Samtec output header. A breakout board is provided for high-speed logic analyzer touchless probing solutions from both Agilent and Tektronix. Both the Agilent E5405A and Tektronix P6980 probes are supported.

Power connections to the EVM are via banana jack sockets. Separate sockets are provided for the ADC analog and digital supplies and for the differential amplifier supply.

#### **1.3 Power Requirements**

The EVM can be powered directly with only three supplies: a 3.3-V supply for both ADC analog and digital driver supply, and 5 V for the ADC analog supply.

#### **CAUTION**

**Voltage Limits:** Exceeding the maximum input voltages can damage EVM components. Undervoltage may cause improper operation of some or all of the EVM components.

#### **1.4 ADS5463 EVM Operational Procedure**

The ADS5463 EVM provides a flexible means of evaluating the ADS5463 in a number of modes of operation. A basic setup procedure that can be used as a board confidence check is as follows:

1. Verify all jumper settings against the schematic jumper list in [Table 1](#).

**Table 1. Three-Pin Jumper List**

| JUMPER | FUNCTION                        | LOCATION: PINS 1-2                          | LOCATION: PINS 2-3      | DEFAULT |
|--------|---------------------------------|---------------------------------------------|-------------------------|---------|
| JP3    | Provides AIN+ source to ADS5463 | Source provided from differential amplifier | Source provided from T2 | 2-3     |
| JP4    | Provides AIN- source to ADS5463 | Source provided from differential amplifier | Source provided from T2 | 2-3     |
| J20    | ADC                             | ADS5440/44                                  | ADS5463/74              | 2-3     |
| J21    | ADS5474 Power Down              | ADS5474 Normal Operation                    | ADS5474 Power Down      | 1-2     |

2. Connect supplies to the EVM as follows:

- 5 V (4.75 V–5.25 V) ADC analog supply to J12 and return to J9
- 3.3 V (3 V–3.6 V) ADC analog supply to J14 and return to J9
- 3.3 V (3 V–3.6V) ADC digital buffer supply to J7 and return to J8

3. Switch power supplies on.

4. Using a function generator with 50- $\Omega$  output, generate a 0-V offset, 1.5-V<sub>pp</sub> sine-wave clock into J17. The frequency of the clock must be within the specification for the device speed grade.

5. Use a frequency generator with a 50- $\Omega$  output to provide a 15.5-MHz, 0-V offset, –1-dBFS-amplitude sine-wave signal into J11. This provides a transformer-coupled differential input signal to the ADC.

6. The digital pattern on output connector J5 should now represent a sine wave and can be monitored using the supplied logic analyzer breakout board.

## 2 Circuit Description

### 2.1 Schematic Diagram

The schematic diagram for the EVM is attached to the end of this document.

### 2.2 Circuit Function

The following sections describe the function of individual circuits. Refer to the relevant data sheet for device operating characteristics.

#### 2.2.1 Power

Power is supplied to the EVM via banana jack sockets. The EVM offers the capability to supply 5 V, 3.3 V analog, and digital 3.3 V independently. The heat slug is tied to AGND with multiple vias to provide for thermal dissipation. [Table 2](#) offers a snapshot of the power-supply options. All supplies are required for default operation, except J18 and J19.

**Table 2. EVM Power Supply Options**

| EVM Banana Jack | DESCRIPTION                  |
|-----------------|------------------------------|
| J7              | ADS5463 3.3-V digital supply |
| J8              | AGND                         |
| J9              | AGND                         |
| J12             | ADS5463 5-V analog supply    |
| J14             | ADS5463 3.3-V analog supply  |
| J18             | THS9001 5-V supply           |
| J19             | AGND                         |

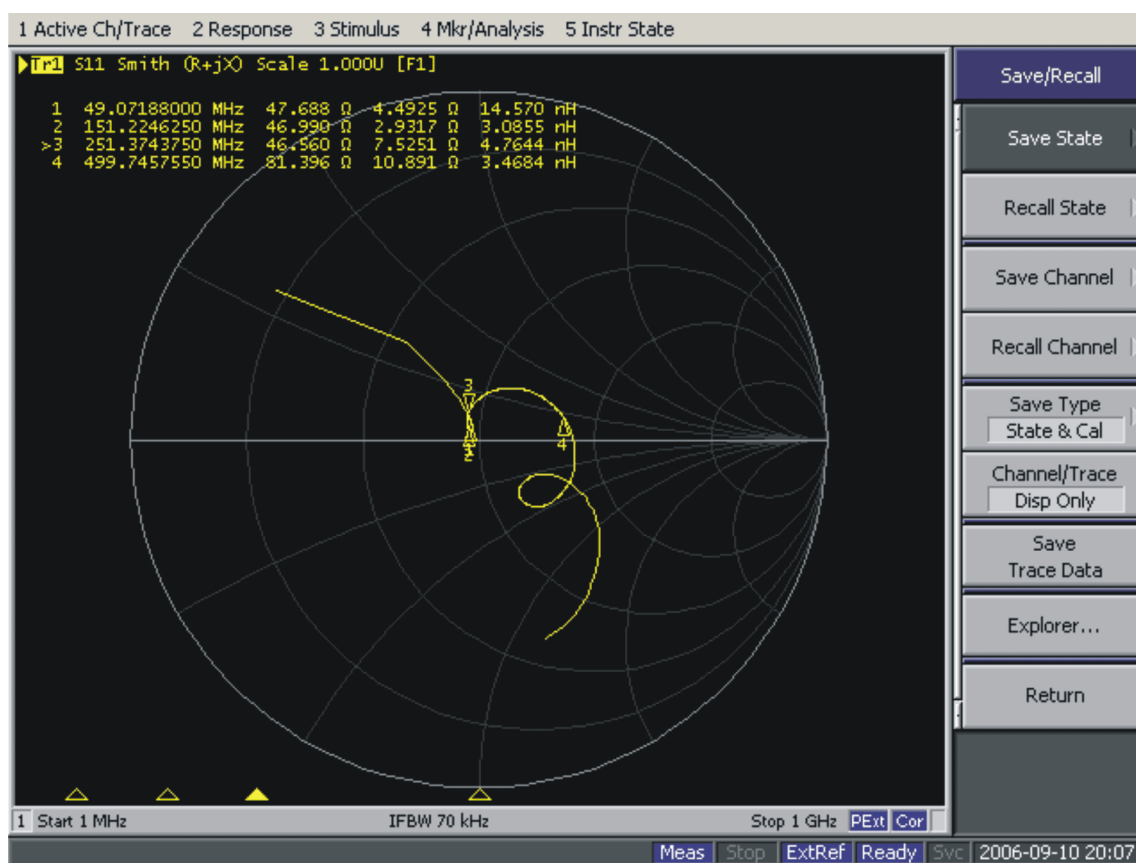
#### 2.2.2 Clock Input

A single-ended square or sinusoidal clock input should be applied to J17. The clock frequency should not exceed 500 MHz. The clock input is converted to differential signal by a Coilcraft WBC4-1W, which has an impedance ratio of 4. It is important to note that voltage applied to J17 is stepped up by a factor of two.

### 2.2.3 Analog Inputs

The EVM can be configured to use either a balun-coupled input or a TI 9001 amplifier input, both from a single-ended source. The inputs are provided via SMA connectors J11 for a balun coupled input and J10 for the amplifier input. To set up for one of these options, the EVM must be configured as follows:

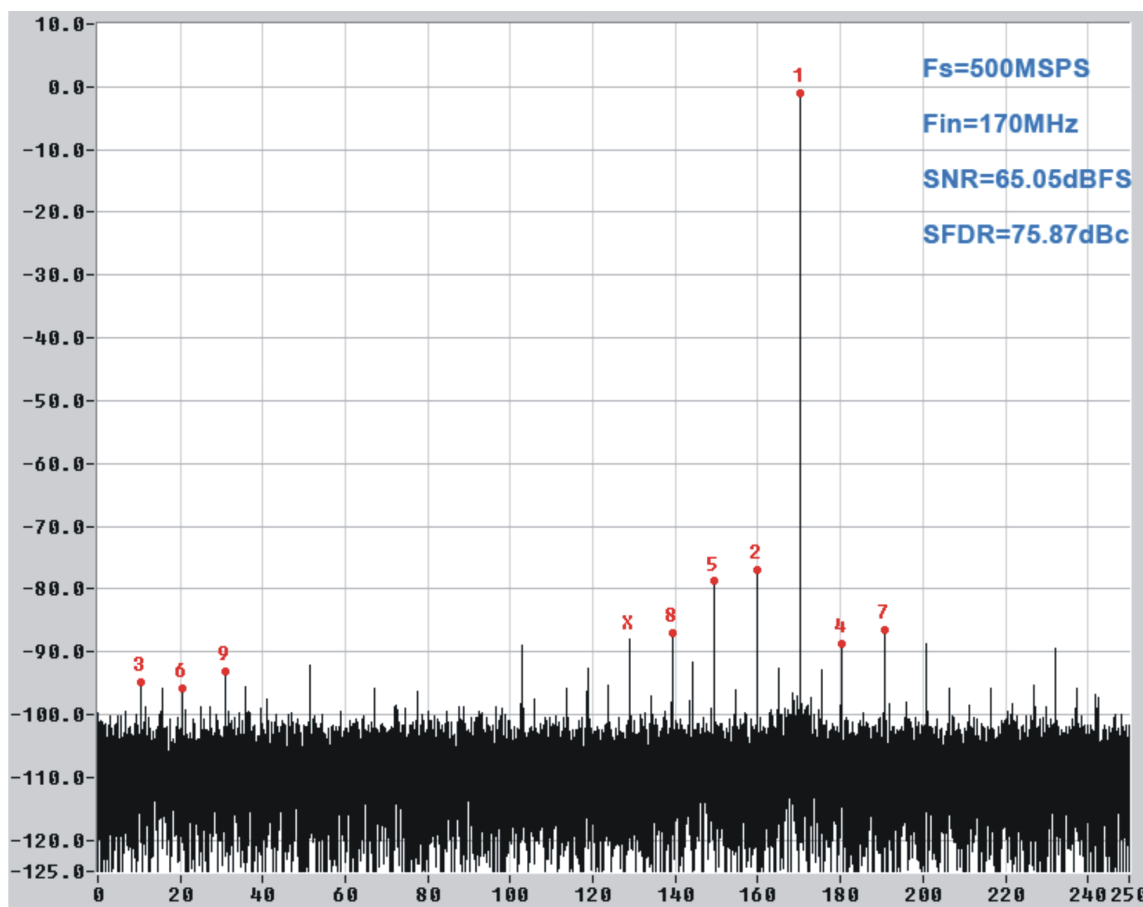
1. For a 1:1 transformer-coupled input to the ADC, a single-ended source is connected to J11. JP3 has pins 1 and 2 shorted, and JP4 has pins 2 and 3 shorted. This is the default configuration for the EVM. The MACOM ETC1-1-13 forms an inherent band-pass filter with a pass band from 4 MHz to 1 GHz, with no more than 1dB insertion loss. A dual balun configuration has been provided which can improve harmonic distortion performance at higher input frequencies (100 MHz+). It should be noted that excellent results have also been obtained using a single Mini-Circuits JTX4-10T transformer. Transformers can be used in place of the baluns, in which case C58 and C77 can be replaced with 0- $\Omega$  resistors, as the ADC features a self-biased input. When choosing a balun or transformer, it is important to take careful consideration of its amplitude and phase performance. Circuit placeholders L7, C88, and C68 are provided if impedance matching is needed at a specific frequency. By default, these are not populated. The termination resistors have been tuned to represent a broadband 50- $\Omega$  impedance over the first two Nyquist zones. [Figure 1](#) shows the Smith chart of the input impedance over four Nyquist zones.



C001

Figure 1. Smith Chart

- One can use two TI THS9001 IF amplifiers to drive the ADC by applying an input to J10. Reconfigure JP3 and JP4, such that both have pins 1 and 2 shorted. To provide power to the amplifiers, connect 5 Vdc to J18 and connect the ground return to J19. The EVM is configured by default with a 170-MHz band-pass filter. Users can adjust this by tuning L12 and C75. Figure 2 shows the performance of the EVM when using the THS9001 amplifier path.



C002

Figure 2. THS9001 + ADS5463 FFT Plot

## 2.2.4 Digital Outputs

The LVDS digital outputs can be accessed through the J5 output connector. A parallel 100- $\Omega$  termination resistor must be placed at the receiver to properly terminate each LVDS data pair. The supplied logic analyzer breakout board includes the 100- $\Omega$  terminations at the logic analyzer probe point. If using the logic analyzer breakout board, [Table 3](#) use for configuration details. When using a logic analyzer, the ADC DRY clock used to latch in the data must be configured in the DDR mode.

**Table 3. Output Connector J5**

| EVM Net Description       | Breakout Board Schematic Net Name | Logic Analyzer Default Assignments using Breakout Board |
|---------------------------|-----------------------------------|---------------------------------------------------------|
| No Connect                | D0                                | D[0] - Ignore                                           |
| OVR                       | D1                                | D[1] - Ignore                                           |
| MSB                       | D2                                | D[2] - MSB                                              |
| MSB-1                     | D3                                | D[3]                                                    |
| MSB-2                     | D4                                | D[4]                                                    |
| MSB-3                     | D5                                | D[5]                                                    |
| MSB-4                     | D6                                | D[6]                                                    |
| MSB-5                     | D7                                | D[7]                                                    |
| MSB-6                     | D8                                | D[8]                                                    |
| MSB-7                     | D9                                | D[9]                                                    |
| MSB-8                     | D10                               | D[10]                                                   |
| MSB-9                     | D11                               | D[11]                                                   |
| MSB-10                    | D12                               | D[12]                                                   |
| MSB-11 (LSB - ADS5463)    | D13                               | D[13]                                                   |
| MSB-12 (LSB - ADS5440/44) | D14                               | D[14]                                                   |
| MSB-13 (LSB - ADS5474)    | D15                               | D[15]                                                   |

## 2.3 Test Points

The EVM provides several different access points to monitor ADC voltages.

- TP1 provides access to the ADC VREF voltage.
- TP2 (ADS5474 only) provides access to the ADS5474 VCM.

## 2.4 ADC Options

The EVM layout has been designed to showcase the family migration ability. Customers can easily design one layout to accommodate both the ADS5463/74 and the ADS5440/44 family of ADCs.

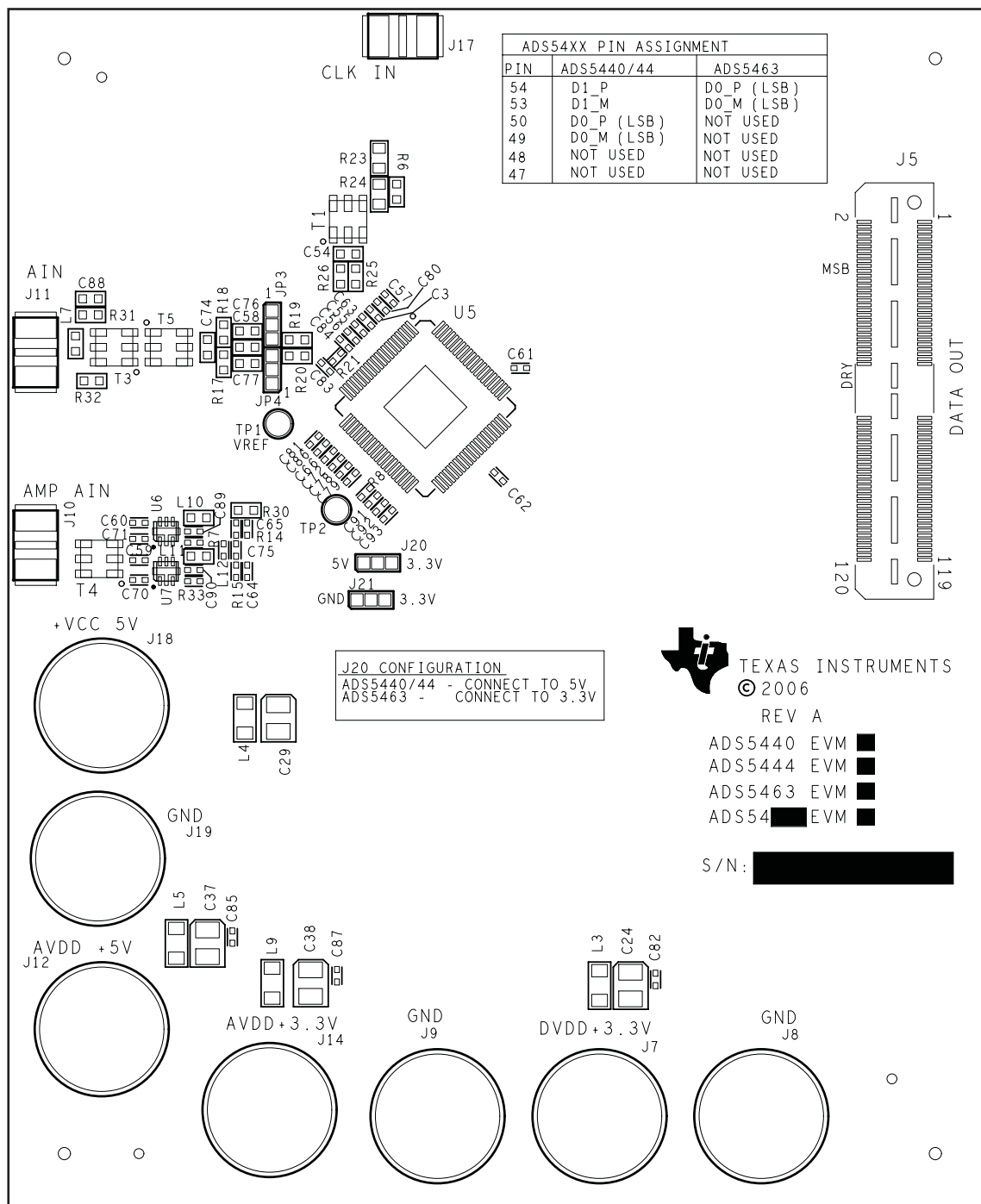
- To use the ADS5440/44 device on this EVM, one must set jumper J20 to short pins 1–2, which connects 5 V to the digital output buffer of the device. To use the ADS5463/74 connect jumper J20 to short pins 2–3.
- The ADS5474 has several modes the ADS5440/44/63 ADCs do not have. Pin 29 becomes a VCM and pin 33 becomes a power down when asserted high. In the case of the ADS5440/44/63 these pins can be left unconnected or grounded.

### 3 Physical Description

This chapter describes the physical characteristics and PCB layout of the EVM.

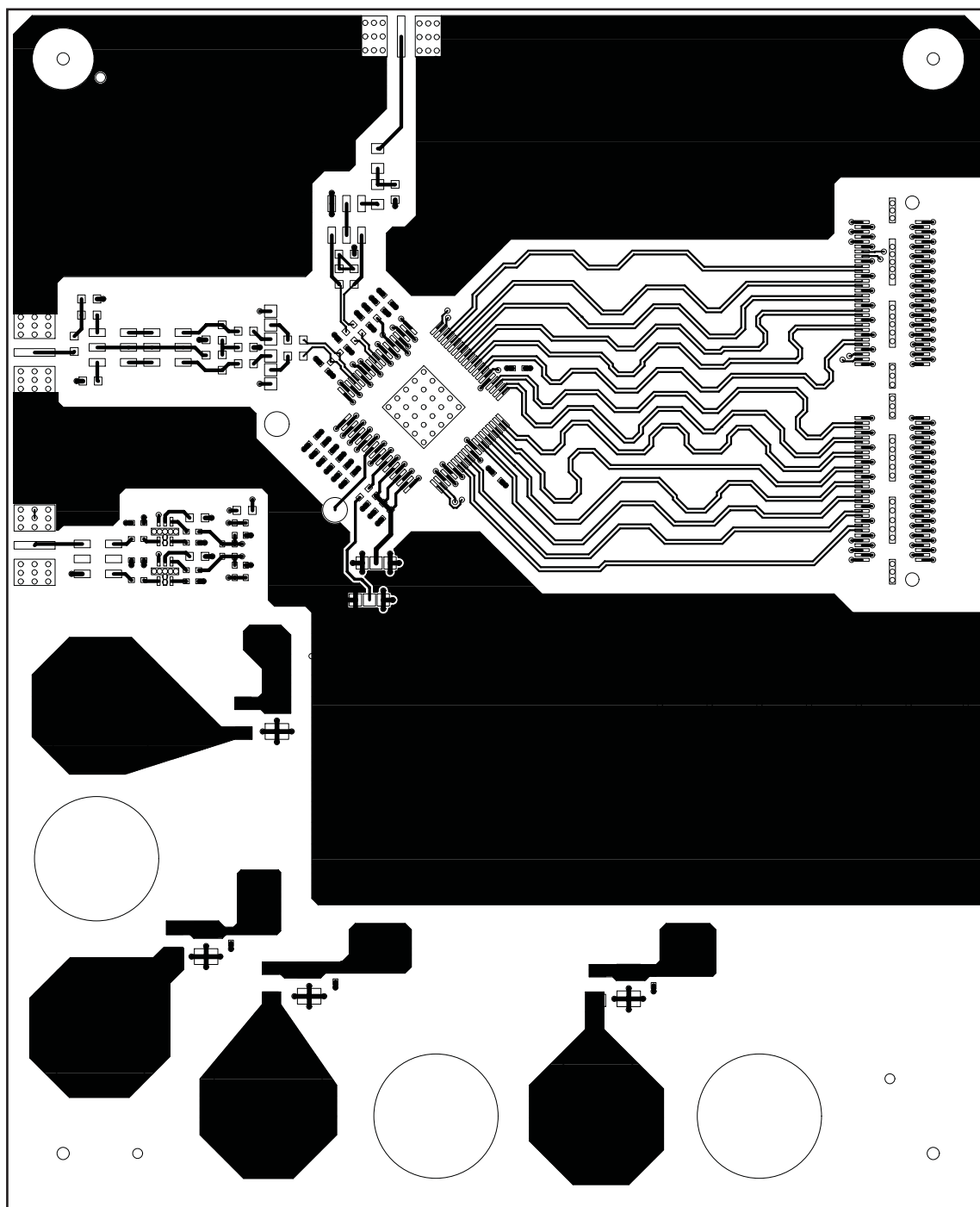
#### 3.1 PCB Layout

The EVM is constructed on a 6-layer, 0.062-inch thick PCB using FR-4 material. The individual layers are shown in Figure 3 through Figure 9. The layout features a common ground plane; however, similar performance can be had with careful layout using a split ground plane.



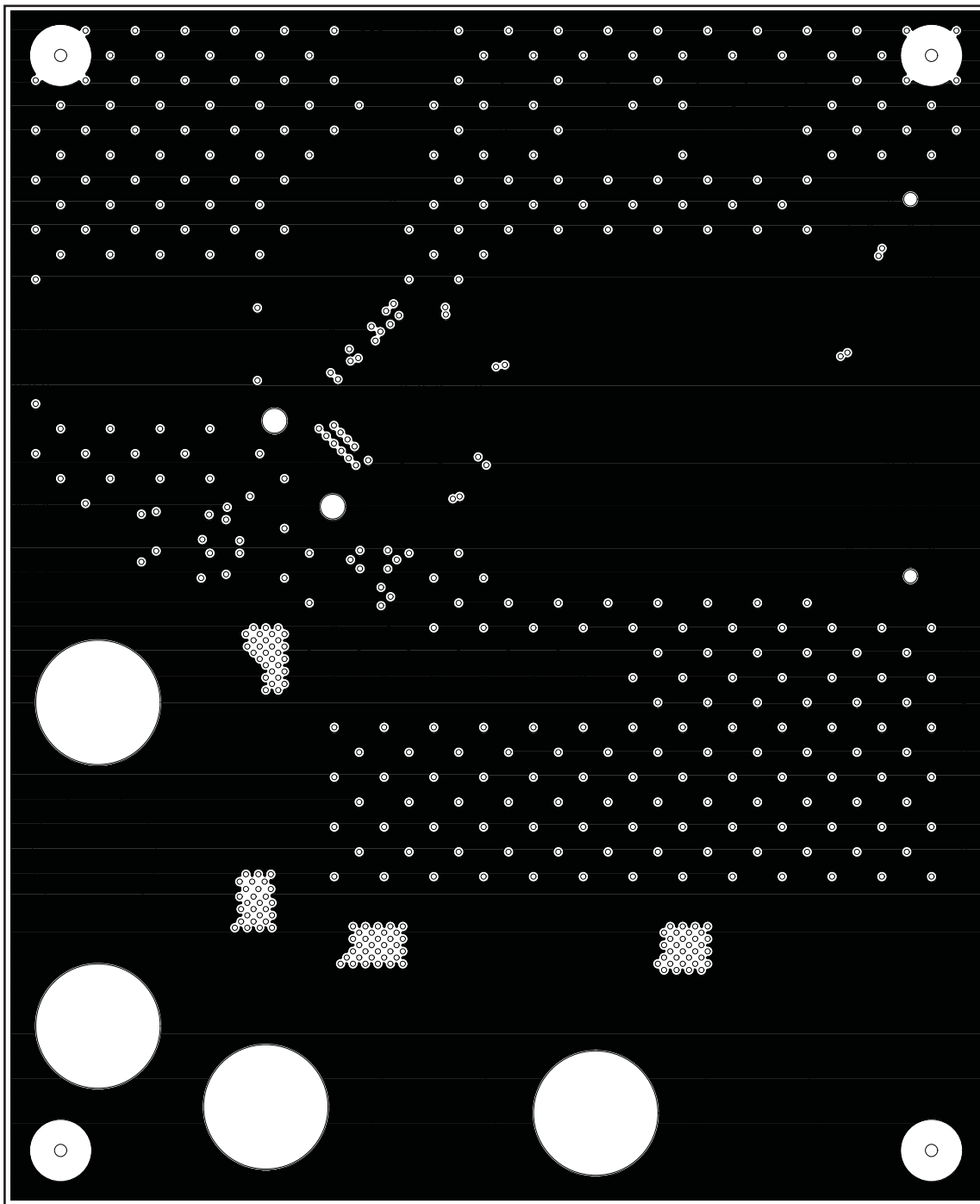
K001

Figure 3. Top Silkscreen



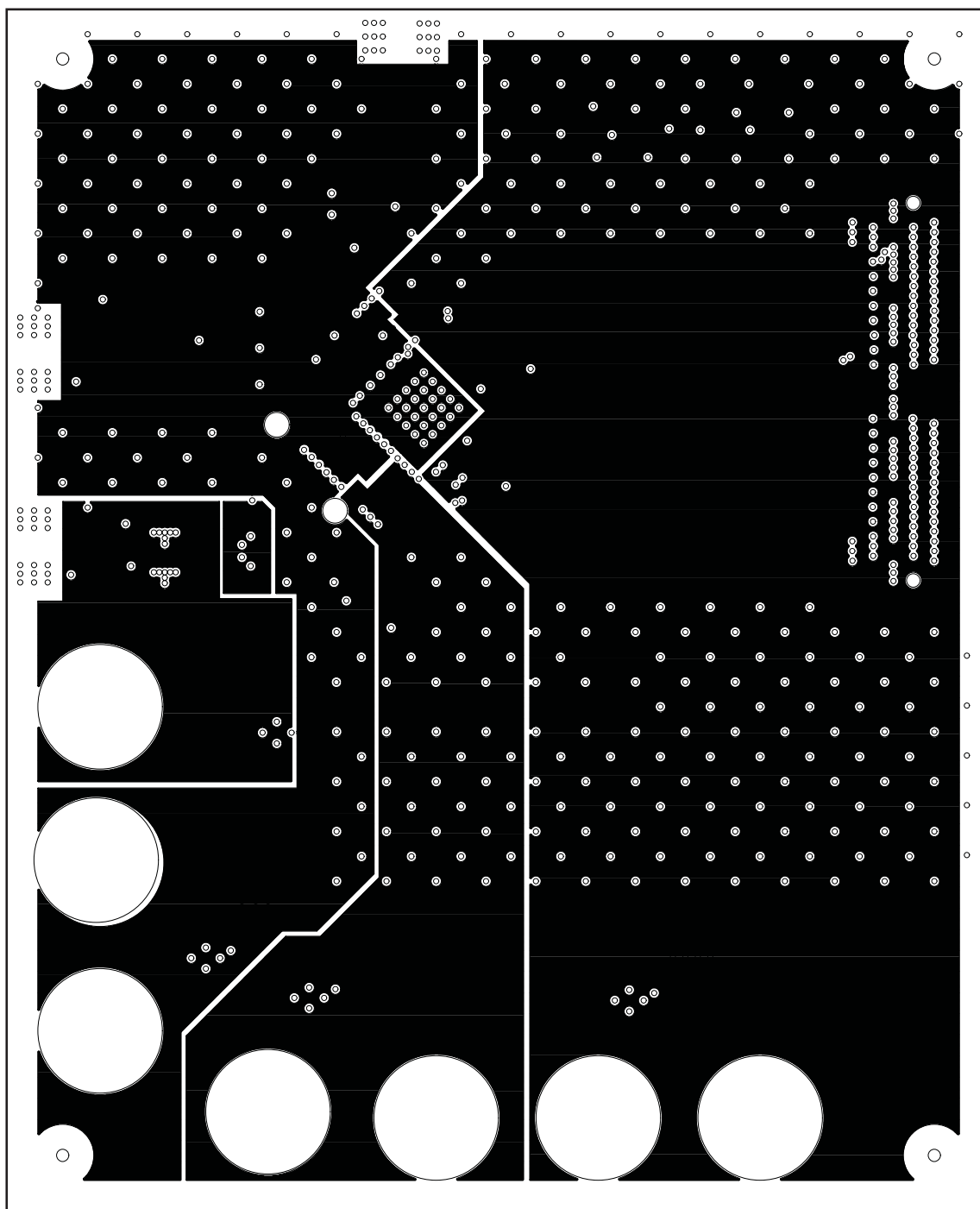
K002

**Figure 4. Component Side**



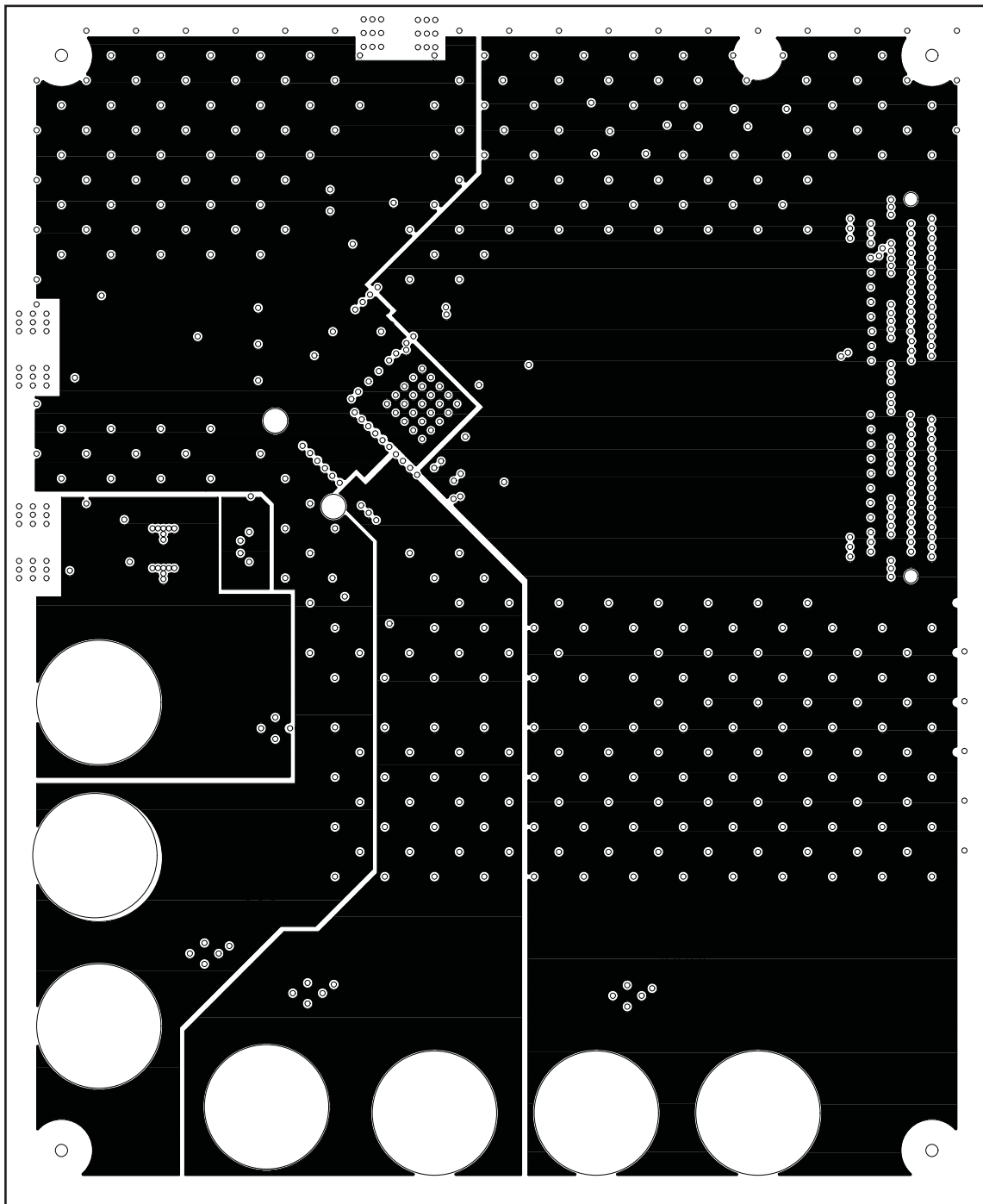
K003

**Figure 5. Ground Plane 1**



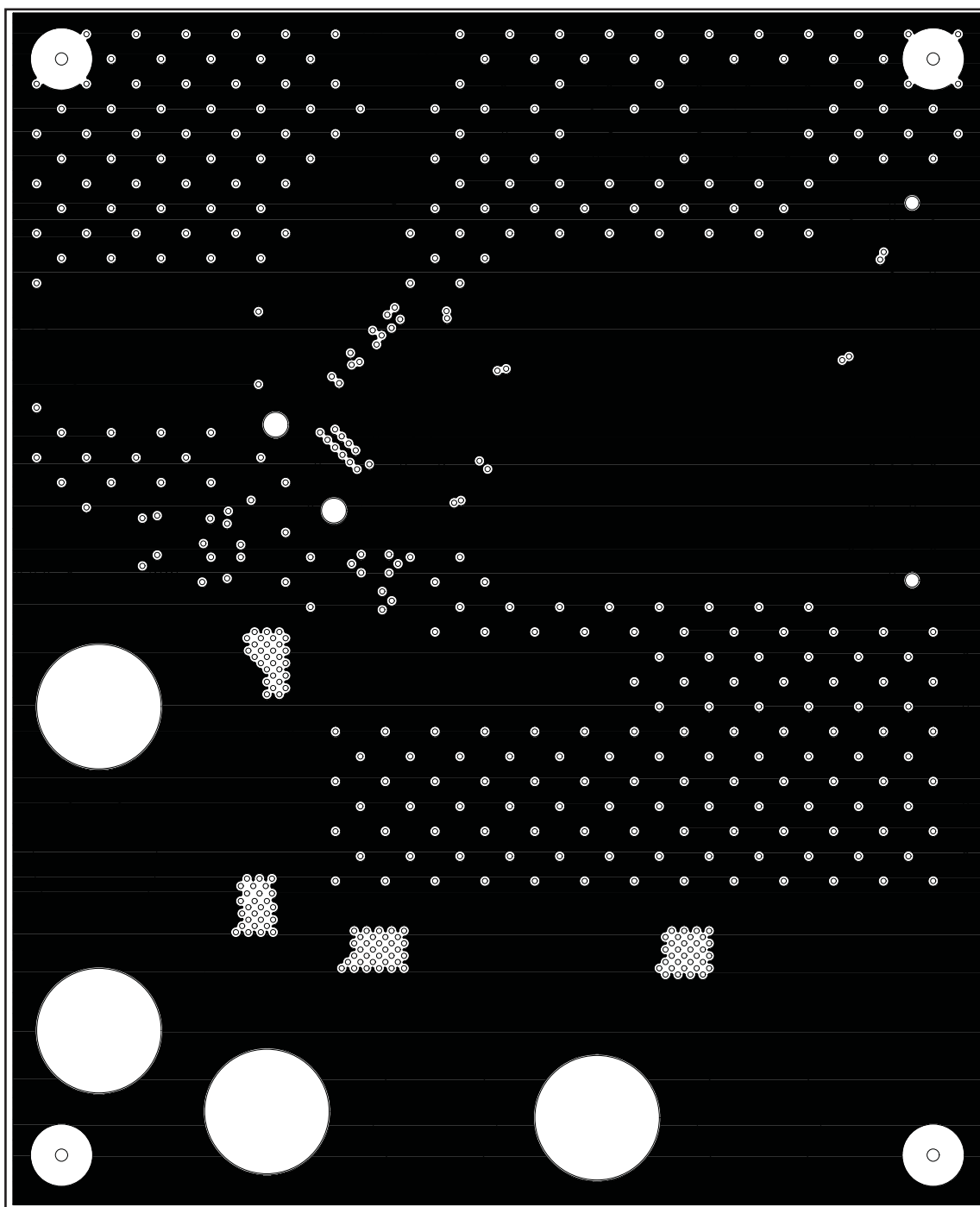
K004

**Figure 6. Power Plane 1**



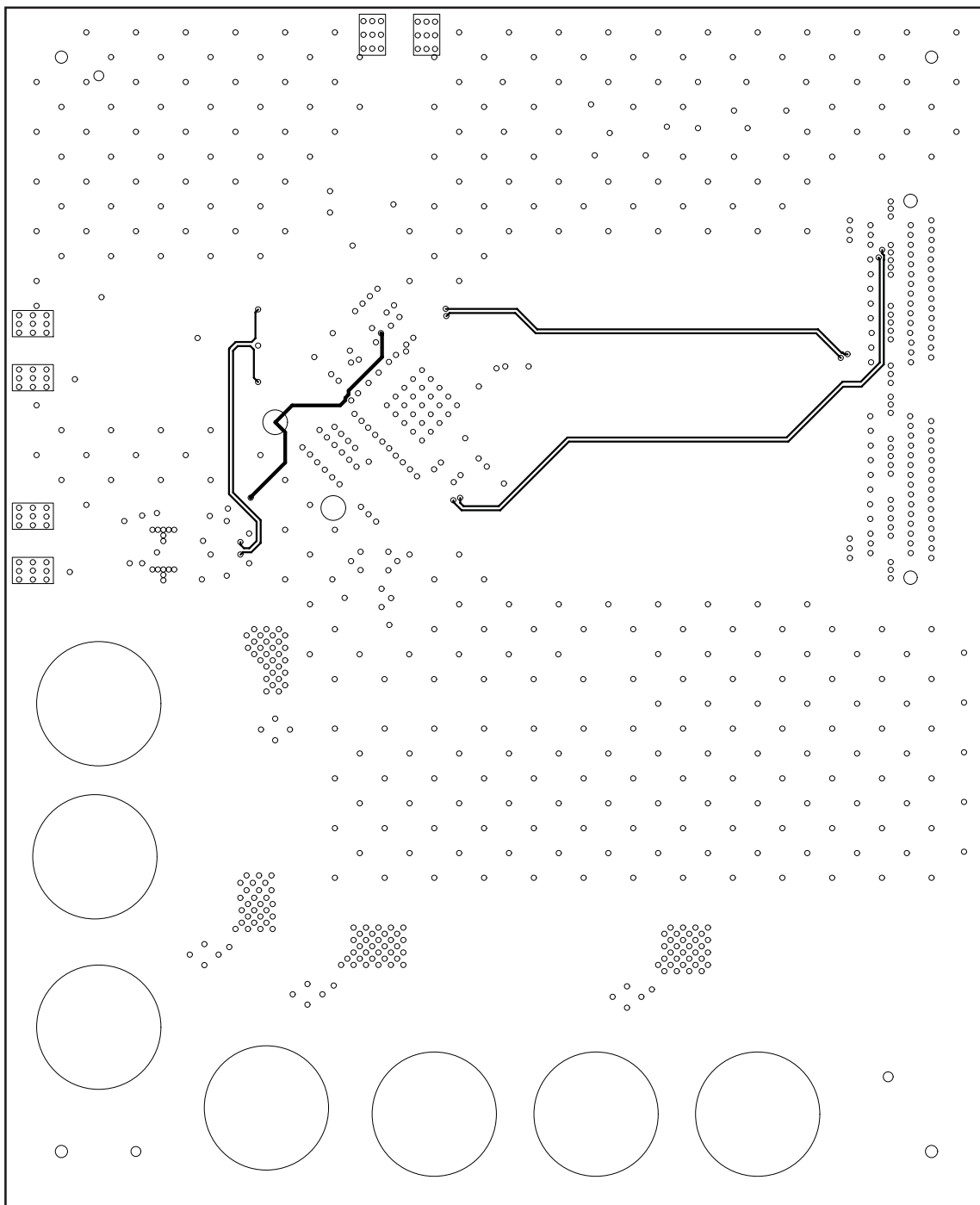
K005

**Figure 7. Power Plane 2**



K006

**Figure 8. Ground Plane 2**



K007

**Figure 9. Bottom Side**

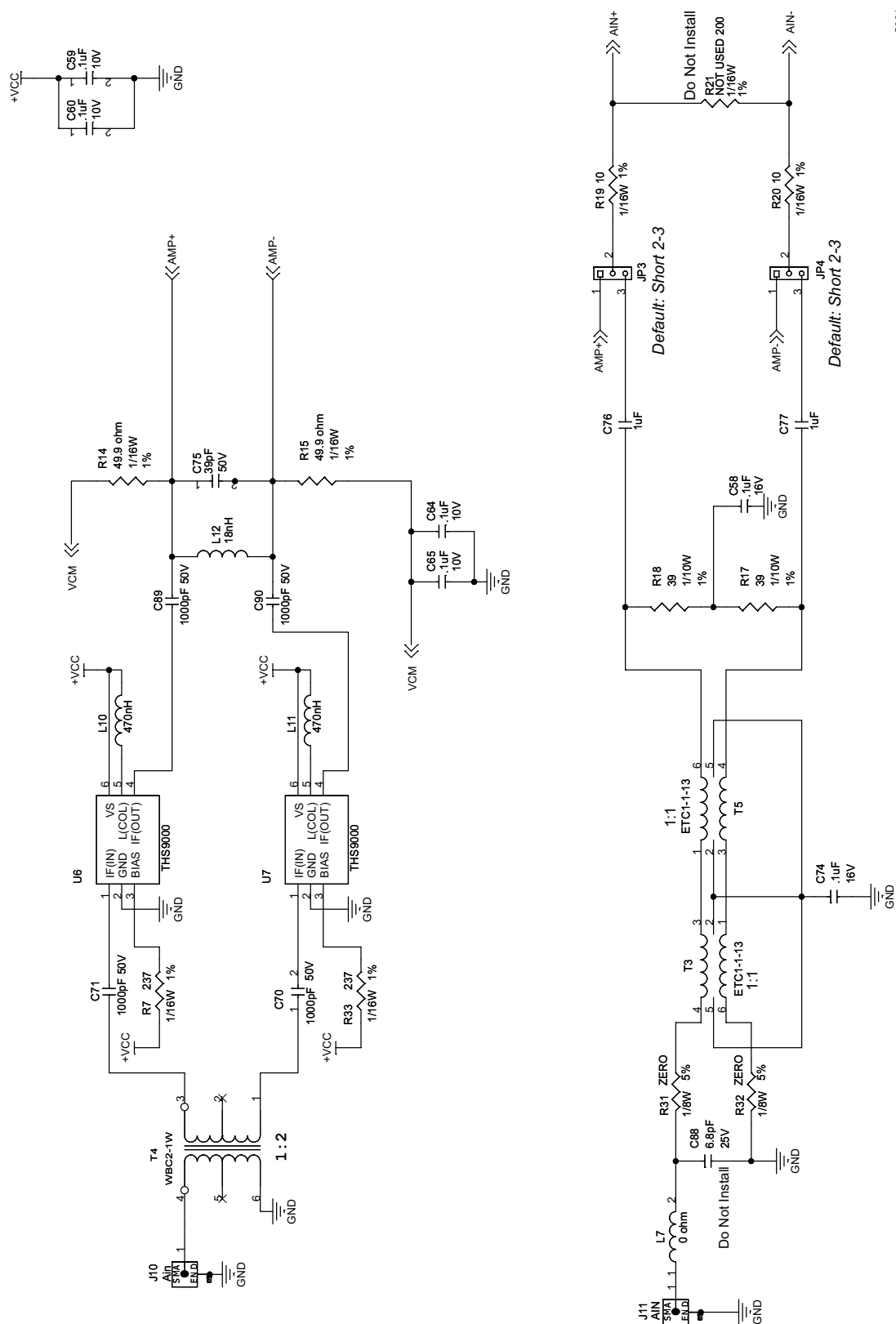
## 3.2 Bill of Materials

**Table 4. Bill of Materials**

| QTY | PART REFERENCE                                                                                                   | VALUE                 | PCB FOOTPRINT | MFR NAME           | MFR PART NUMBER | NOTE               |
|-----|------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|--------------------|-----------------|--------------------|
| 23  | C3, C55, C56, C57, C59, C60, C61, C62, C63, C64, C65, C66, C72, C78, C79, C80, C81, C83, C84, C86, C91, C92, C93 | 0.1 $\mu$ F           | 0402          | Panasonic          | ECJ-0EB1A104K   |                    |
| 4   | C24, C29, C37, C38                                                                                               | 33 $\mu$ F            | TANT_B        | EPCOS, Inc.        | B45196H2336M209 |                    |
| 1   | C54                                                                                                              | 0.1 $\mu$ F           | 0603          | Panasonic          | ECJ-0EB1A104K   |                    |
| 2   | C58, C74                                                                                                         | 0.1 $\mu$ F           | 0603          | Panasonic          | ECJ-1VB1C104K   |                    |
| 4   | C70, C71, C89, C90                                                                                               | 1000 pF               | 0402          | Panasonic          | ECJ-0EB1H102K   |                    |
| 1   | C75                                                                                                              | 39 pF                 | 0603          | Panasonic          | ECJ-0EC1H390J   |                    |
| 2   | C76, C77                                                                                                         | 1 $\mu$ F             | 0603          | Panasonic          | ECJ-1VB1A105K   |                    |
| 2   | C82, C85, C87                                                                                                    | 1 $\mu$ F             | 0402          | Panasonic          | ECJ-0EB1A105M   |                    |
| 0   | C88                                                                                                              | 6.8 pF                | 0603          | Panasonic          | ECD-G0E6R8C     | Do not install     |
| 2   | JP3, JP4                                                                                                         | Jumper_1x3_SMT        |               |                    | NO PART         |                    |
| 1   | J5                                                                                                               | CONN_QTH_30X2-D-A     |               |                    | QTH-60-02-F-D-A |                    |
| 4   | J7, J12, J14, J18                                                                                                | RED                   |               | Allied Electronics | ST-351A         |                    |
| 3   | J8, J9, J19                                                                                                      | BLK                   |               | Allied Electronics | ST-351B         |                    |
| 3   | J10, J11, J17                                                                                                    | SMA_END_RND           |               | Johnson Components | 142-0711-821    |                    |
| 1   | J20                                                                                                              | HEADER 3              |               |                    | NO PART         |                    |
| 1   | J21                                                                                                              | HEADER 3              |               |                    | NO PART         |                    |
| 4   | L3, L4, L5, L9                                                                                                   | 68 $\Omega$ @ 100 MHz | 1206          | Panasonic          | EXC-ML32A680U   |                    |
| 1   | L7                                                                                                               | 0 $\Omega$            | 0603          | Panasonic          | ERJ-8GEY0R00V   |                    |
| 2   | L10, L11                                                                                                         | 470 nH                | 0603          | Murata             | LQW18ANR47J00D  |                    |
| 1   | L12                                                                                                              | 18 nH                 | 0402          | Murata             | LQW15AN18NJ00D  |                    |
| 1   | R6                                                                                                               | 49.9 $\Omega$         | 0603          | Panasonic          | ERJ-3EKF49R9V   |                    |
| 2   | R7, R33                                                                                                          | 237 $\Omega$          | 0402          | Panasonic          | ERJ-2RKF2370X   |                    |
| 1   | R8                                                                                                               | 10 k $\Omega$         | 0402          | Panasonic          | ERJ-2RKF1002X   |                    |
| 2   | R14, R15                                                                                                         | 49.9 $\Omega$         | 0402          | Panasonic          | ERJ-2RKF49R9X   |                    |
| 2   | R17, R18                                                                                                         | 39 $\Omega$           | 0603          | Panasonic          | RC0603FR-0739RL |                    |
| 2   | R19, R20                                                                                                         | 10 $\Omega$           | 0603          | Panasonic          | ERJ-3EKF10R0V   |                    |
| 0   | R21                                                                                                              | 200 $\Omega$          | 0402          | Panasonic          | ERJ-2RKF2000X   | Do not install     |
| 2   | R23, R24                                                                                                         | 0 $\Omega$            | 0805          | Panasonic          | ERJ-6GEY0R00V   |                    |
| 0   | R25, R26                                                                                                         | 121 $\Omega$          | 0603          | Panasonic          | ERJ-3EKF1210V   | Do not install     |
| 0   | R30, R31, R32                                                                                                    | 0 $\Omega$            | 0603          | Panasonic          | ERJ-3GEY0R00V   | Do not install     |
| 1   | T1                                                                                                               | WBC4-1W               |               | Coilcraft          | WBC4-1W         |                    |
| 1   | T4                                                                                                               | WBC2-1W               |               | Coilcraft          | WBC2-1W         |                    |
| 2   | T3, T5                                                                                                           | ETC1-1-13             |               | Macom              | ETC1-1-13       |                    |
| 1   | TP1                                                                                                              | BLK                   |               | Keystone           | 5001K           |                    |
| 1   | U6, U7                                                                                                           | THS9001               |               | TI                 | THS9001         |                    |
| 1   | U5                                                                                                               | ADS5463               |               | TI                 | ADS5463         | See <sup>(1)</sup> |

<sup>(1)</sup> Populate with ADS5440, ADS5444, ADS5463 depending on build.

### 3.3 PCB Schematics



### Figure 10. EVM Schematics

# Physical Description

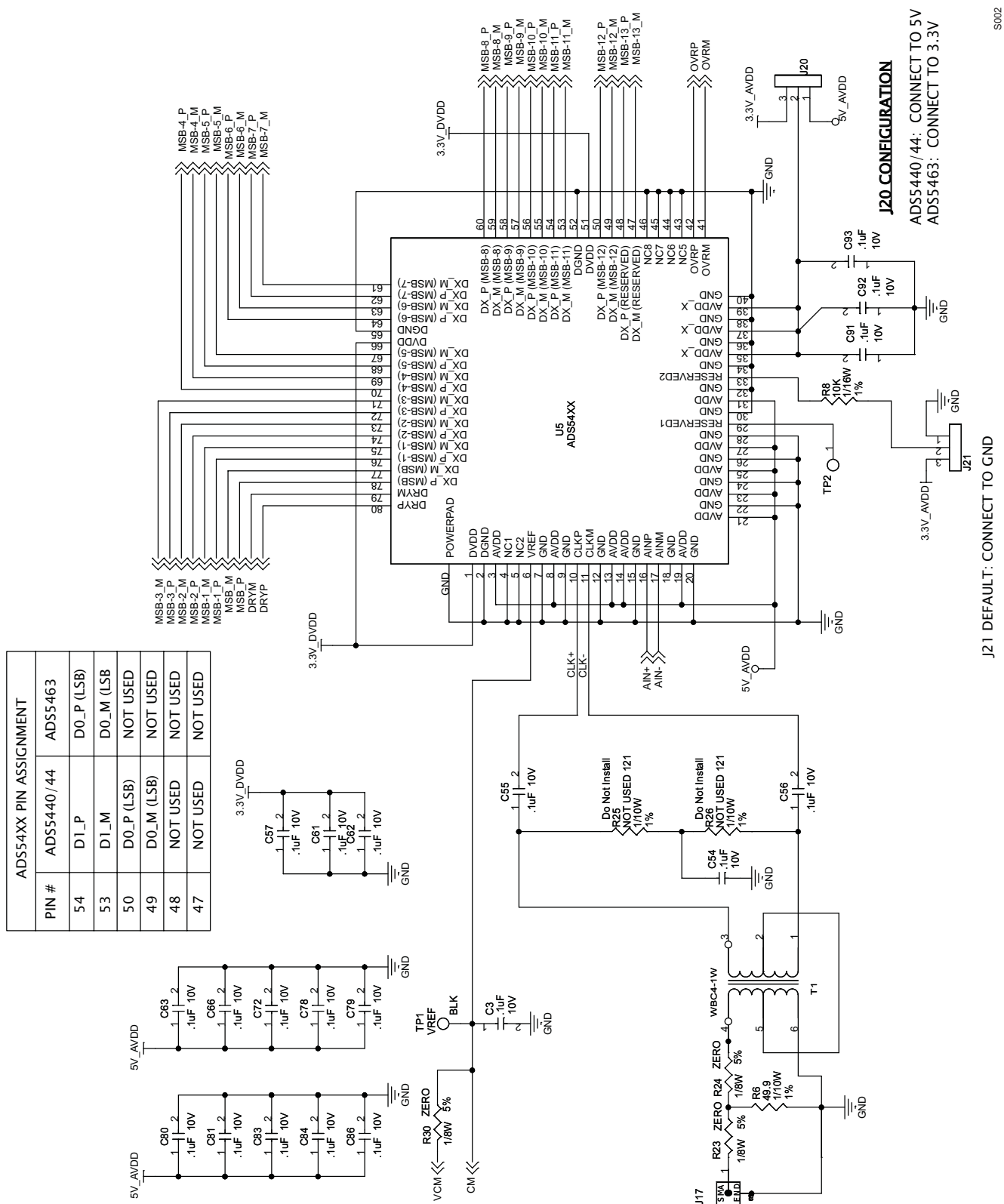
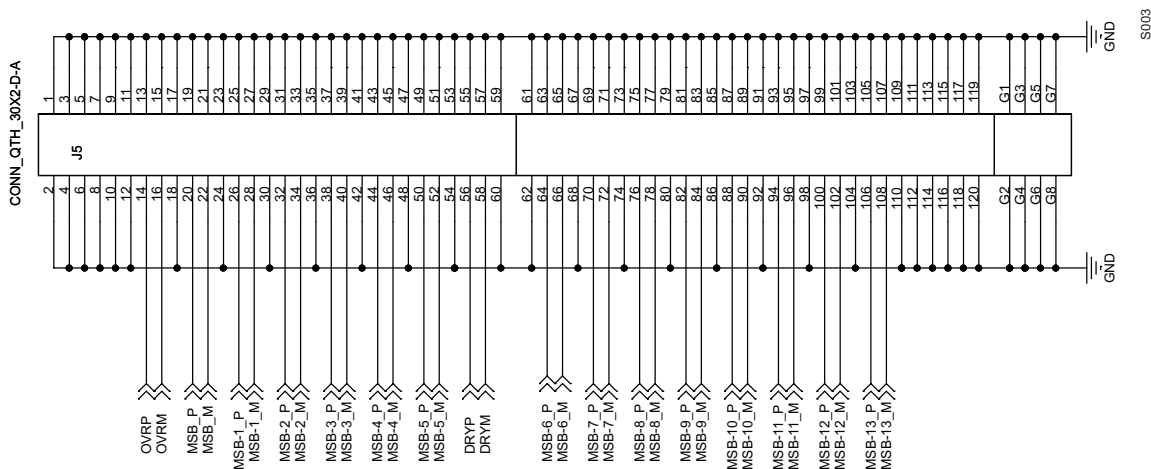
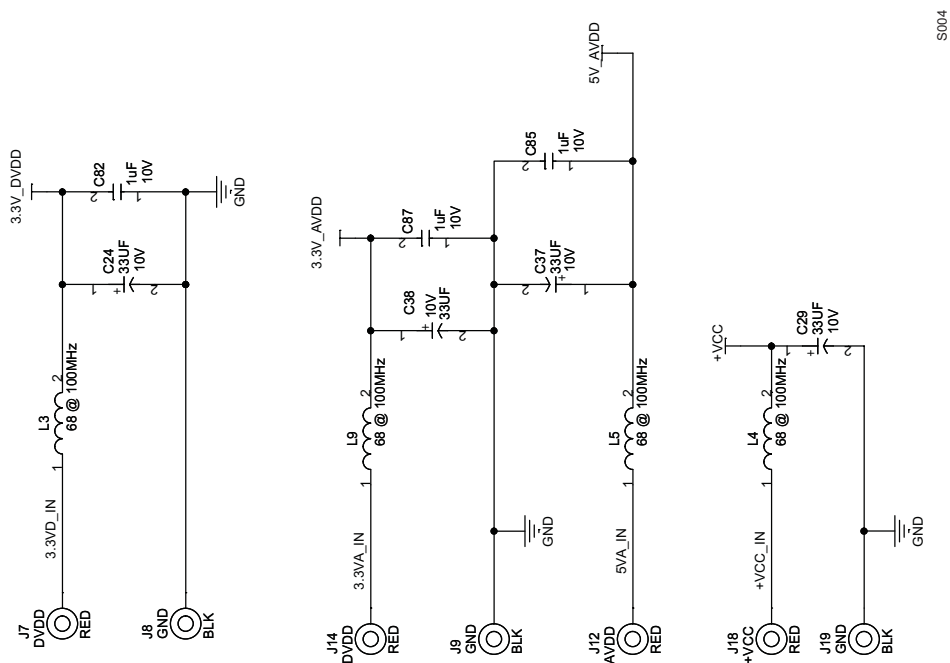


Figure 11. EVM Schematics

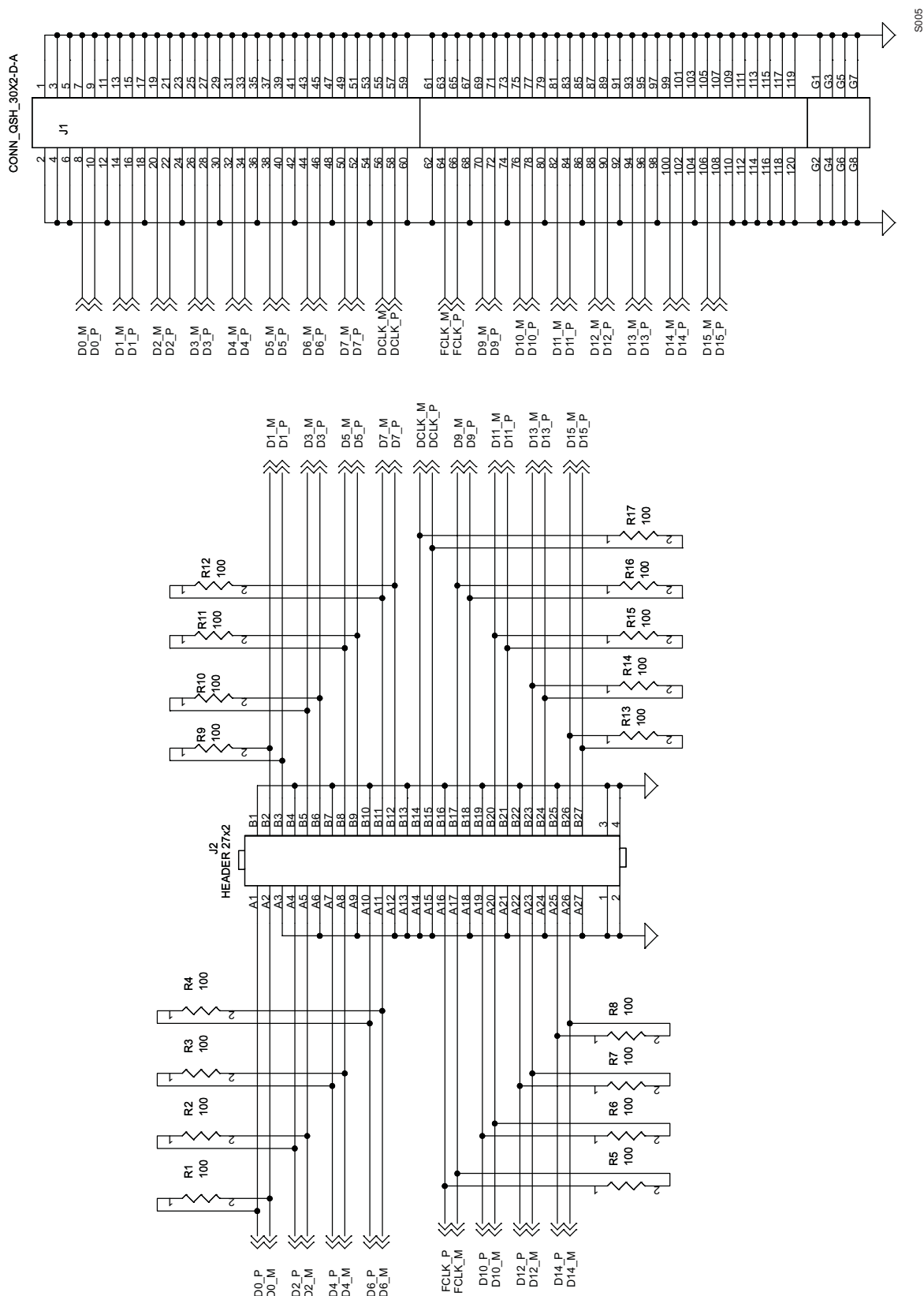


### Figure 12. EVM Schematics



### Figure 13. EVM Schematics

## Physical Description



**Figure 14. Touchless Probe Breakout Board Schematic**

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### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of  $-0.3\text{V}$  to  $+3.6\text{V}$  and the output voltage range of  $-0.3\text{V}$  to  $+3.6\text{V}$ .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than  $+25^{\circ}\text{C}$ . The EVM is designed to operate properly with certain components above  $+50^{\circ}\text{C}$  as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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