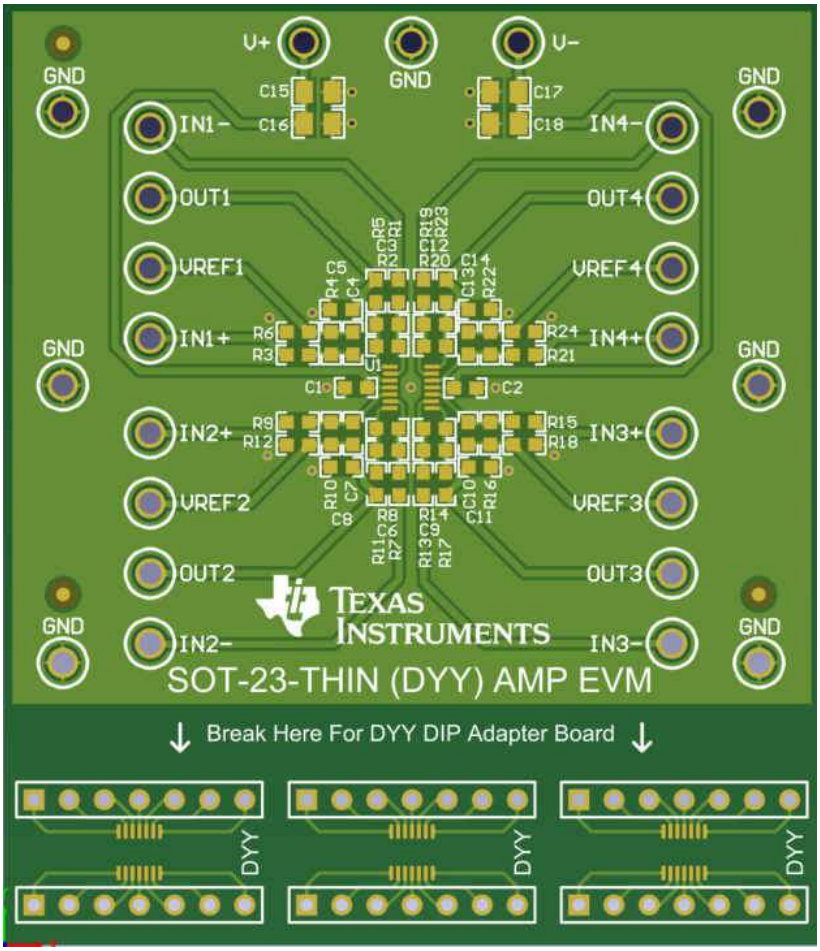
*User's Guide*

# *DYY-AMP Evaluation Module (EVM)*


**ABSTRACT**

This user's guide contains support documentation for the DYY-AMP Evaluation Module (EVM). Included in this document is a description of how to set up and configure the EVM, printed circuit board (PCB) layout, schematic, and bill of materials (BOM) for the DYY-AMP-EVM.

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# 1 Introduction

The DYY-AMP-EVM allows for quick evaluation of design concepts using SOT23-THIN (DYY) package amplifiers. The EVM can be configured into three circuit configurations: difference amplifier, non-inverting amplifier and inverting amplifier by populating different components on board. The EVM also contains removable DYY DIP adapter boards.

# 2 DYY-AMP-EVM Kit Contents

Table 2-1 details the contents included in the DYY-AMP-EVM kit.

**Table 2-1. DYY-AMP-EVM Kit Contents**

| Item | Description | Quantity |
|---|---|---|
| DYY-AMP-EVM | PCB | 1 |
| Header Strip | Header, 2.54 mm, 14× 1, Gold, TH | 3 |

# 3 Circuit Configurations

By populating different components on the PCB, the DYY-AMP-EVM can be configured into three different circuits:

- Difference amplifier
- Non-inverting amplifier
- Inverting amplifier

# 4 Schematic and PCB Layout

This section provides the schematic and PCB layout of the DYY-AMP-EVM. Also included are the schematics for the three DYY-AMP-EVM circuit configuration options.

## 4.1 Schematic

Figure 4-1 displays the DYY-AMP-EVM circuit schematic.

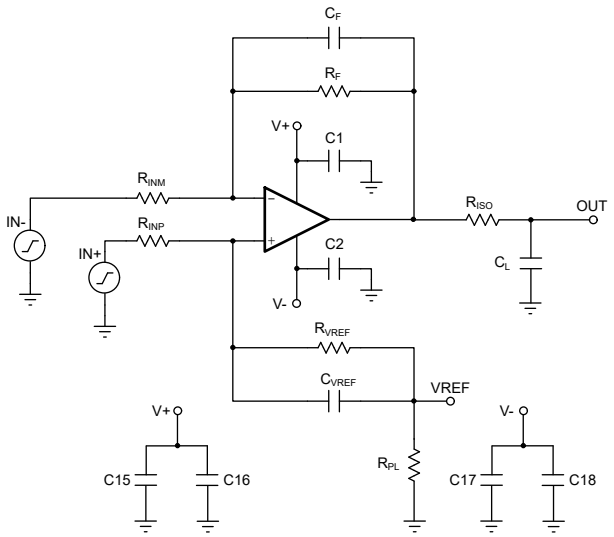


**Figure 4-1. DYY-AMP-EVM Schematic**

**Table 4-1. DYY-AMP-EVM Components**

| CH | $R_{INM}$ | $R_F$ | $C_F$ | $R_{INP}$ | $R_{VREF}$ | $C_{VREF}$ | $R_{PL}$ | $R_{Iso}$ | $C_L$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | R1 | R2 | C3 | R3 | R4 | C4 | R6 | R5 | C5 |
| 2 | R7 | R8 | C6 | R9 | R10 | C7 | R12 | R11 | C8 |
| 3 | R13 | R14 | C9 | R15 | R16 | C10 | R18 | R17 | C11 |
| 4 | R19 | R20 | C12 | R21 | R22 | C13 | R24 | R23 | C14 |

The schematic of the EVM is provided in silk screen located on the back of the PCB for easy reference. Figure 4-2 displays the schematic provided on the back of the PCB.

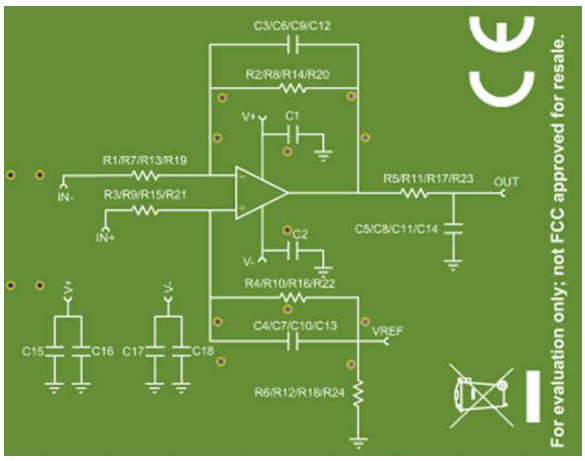


**Figure 4-2. Silkscreen Schematic**

## 4.2 Difference Amplifier

Figure 4-3 displays the schematic for the difference amplifier circuit configuration.

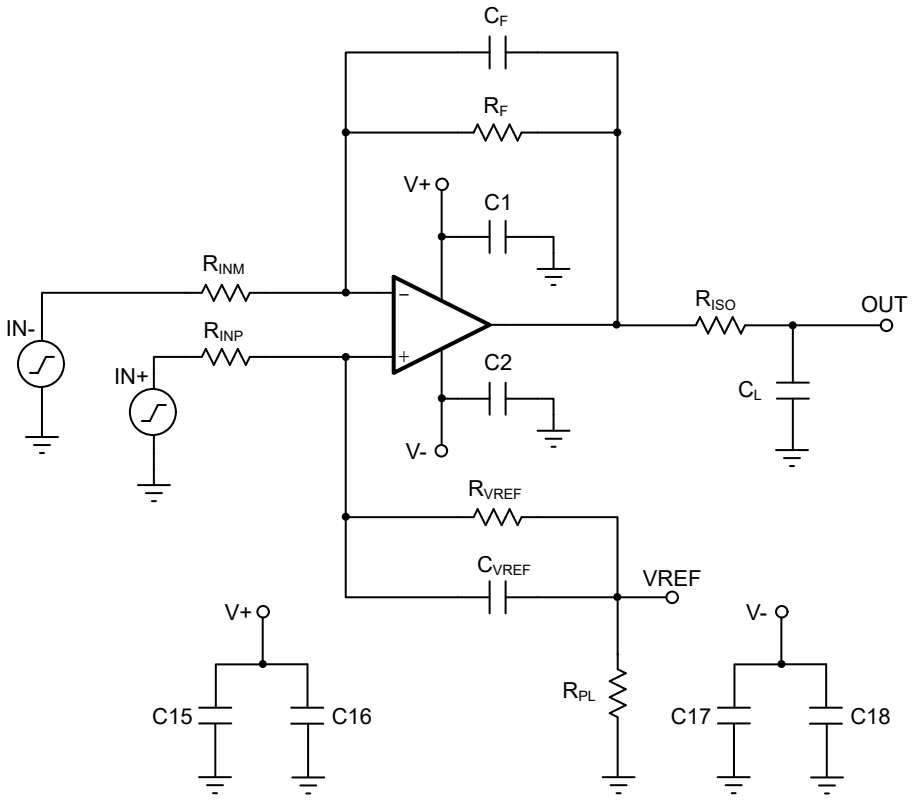


**Figure 4-3. Difference Amplifier Schematic**

**Table 4-2. Difference Amplifier Components**

| CH | $R_{INM}$ | $R_F$ | $C_F$ | $R_{INP}$ | $R_{VREF}$ | $C_{VREF}$ | $R_{PL}$ | $R_{Iso}$ | $C_L$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | R1 | R2 | C3 | R3 | R4 | C4 | R6 | R5 | C5 |
| 2 | R7 | R8 | C6 | R9 | R10 | C7 | R12 | R11 | C8 |
| 3 | R13 | R14 | C9 | R15 | R16 | C10 | R18 | R17 | C11 |
| 4 | R19 | R20 | C12 | R21 | R22 | C13 | R24 | R23 | C14 |

Equation 1 displays the transfer function of the difference amplifier circuit configuration. Note, Input signals IN+ and IN- are altered to $IN_P$ and $IN_M$ respectively in the transfer function for simplicity of the equation.

$$\mathrm{OUT} = \left(\frac{\mathrm{R_{VREF}}}{\mathrm{R_{INP}} + \mathrm{R_{VREF}}}\right) \times \left(1 + \frac{\mathrm{R_F}}{\mathrm{R_{INM}}}\right) \times \mathrm{IN_P} + \left(\frac{\mathrm{R_{INP}}}{\mathrm{R_{INP}} + \mathrm{R_{VREF}}}\right) \times \left(1 + \frac{\mathrm{R_F}}{\mathrm{R_{INM}}}\right) \times \mathrm{Vref} - \frac{\mathrm{R_F}}{\mathrm{R_{INM}}} \times \mathrm{IN_M} \quad (1)$$

If $R_F = R_{VREF}$ and $R_{INM} = R_{INP}$, Equation 1 can simplify to Equation 2.

$$\mathrm{OUT} = \frac{\mathrm{R_F}}{\mathrm{R_{INM}}} \times (\mathrm{IN_P} - \mathrm{IN_M}) + \mathrm{Vref} \quad (2)$$

Capacitors $C_F$ and $C_{VREF}$ provide the option to filter the output of the amplifier. Equation 3 calculates the cutoff frequency, $f_c$, of the filter; where $R_F = R_{VREF}$, $R_{INM} = R_{INP}$, and $C_F = C_{VREF}$.

$$f_c = \frac{1}{2 \times \pi \times \mathrm{R_F} \times \mathrm{C_F}} \quad (3)$$

Resistor $R_{PL}$ can be used to set the Vref pin to GND. A grounded Vref is best used with a split power supply configuration. Do not externally drive the Vref pin if $R_{PL}$ is populated on the PCB.

Resistor $R_{iso}$, and capacitor $C_L$ provide the option to create a RC filter, or test output loads for the amplifier. When not applicable, use a zero ohm resistor for $R_{iso}$ and do not populate $C_L$.

Figure 4-4 displays the DYY-AMP-EVM populated with the required components to configure channel 1 as a difference amplifier with no load and VREF tied to ground.

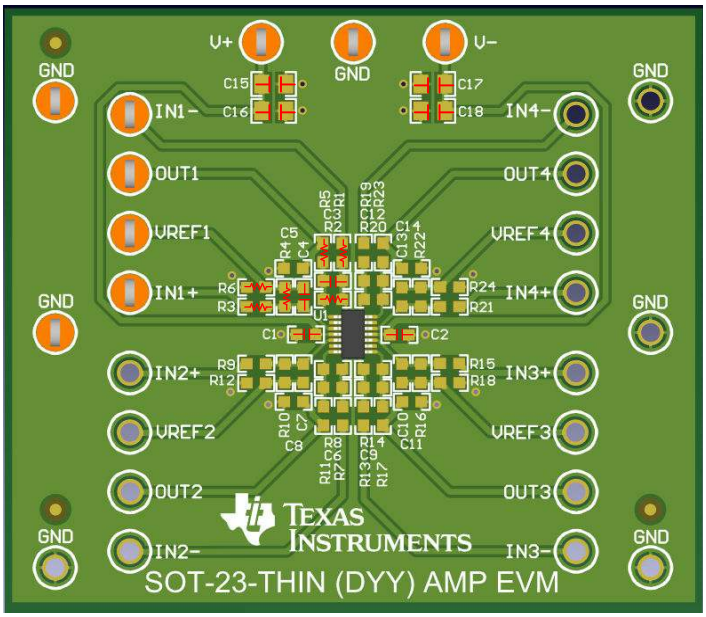


**Figure 4-4. Difference Amplifier Configured on DYY-AMP-EVM, Channel 1**

## 4.3 Non-inverting Amplifier

Figure 4-5 displays the schematic for the non-inverting amplifier circuit configuration. To configure the EVM in a non-inverting configuration short $R_{INP}$ using a 0-Ω resistor or solder bridge, leave $R_{VREF}$ and $C_{VREF}$ unpopulated, and ground the input connection IN–. The input signal is applied directly to the high impedance non-inverting input terminal using the IN+ connection on the EVM.

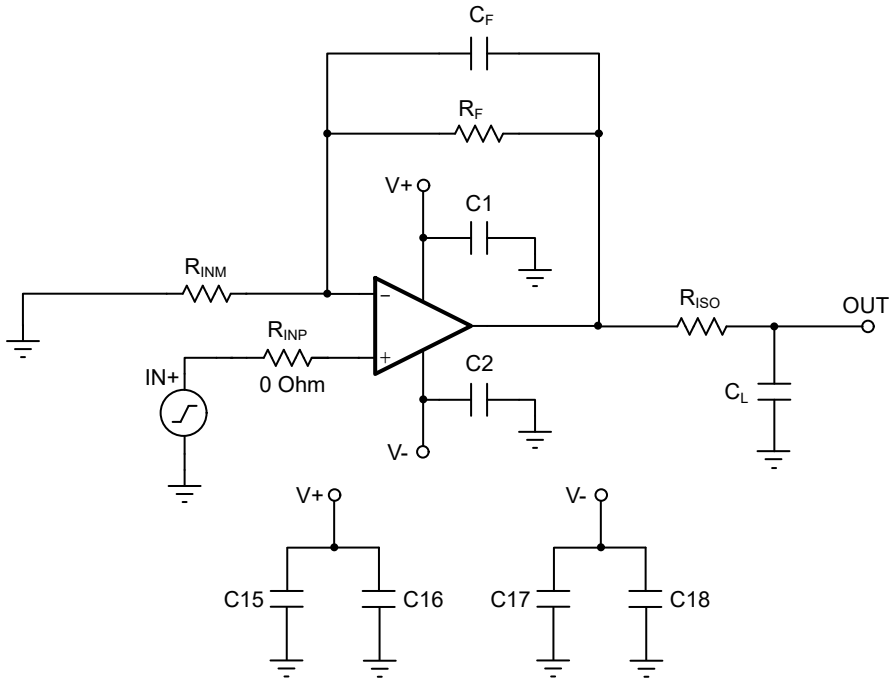


**Figure 4-5. Non-inverting Amplifier Schematic**

**Table 4-3. Non-inverting Amplifier Components**

| CH | $R_{INM}$ | $R_F$ | $C_F$ | $R_{INP}$ | $R_{Iso}$ | $C_L$ |
|---|---|---|---|---|---|---|
| 1 | R1 | R2 | C3 | R3 | R5 | C5 |
| 2 | R7 | R8 | C6 | R9 | R11 | C8 |
| 3 | R13 | R14 | C9 | R15 | R17 | C11 |
| 4 | R19 | R20 | C12 | R21 | R23 | C14 |

Equation 4 displays the DC transfer function of the non-inverting amplifier circuit configuration shown in Figure 4-5. Note, Input signals IN+ and IN- are altered to $IN_P$ and $IN_M$ respectively in the transfer function for simplicity of the equation.

$$OUT = \left(1 + \frac{R_F}{R_{INM}}\right) \times IN_P \quad (4)$$

Capacitor $C_F$ provides the option to filter the output. The cutoff frequency, $f_c$, of the filter can be calculated using Equation 5.

$$f_c = \frac{1}{2 \times \pi \times R_F \times C_F} \quad (5)$$

Resistor $R_{iso}$, and capacitor $C_L$ provide the option to create a RC filter, or test output loads for the amplifier. When not applicable, use a zero ohm resistor for $R_{iso}$ and do not populate $C_L$.

Figure 4-6 displays the DYY-AMP-EVM populated with the required components to configure channel 1 as a non-inverting amplifier with no load.

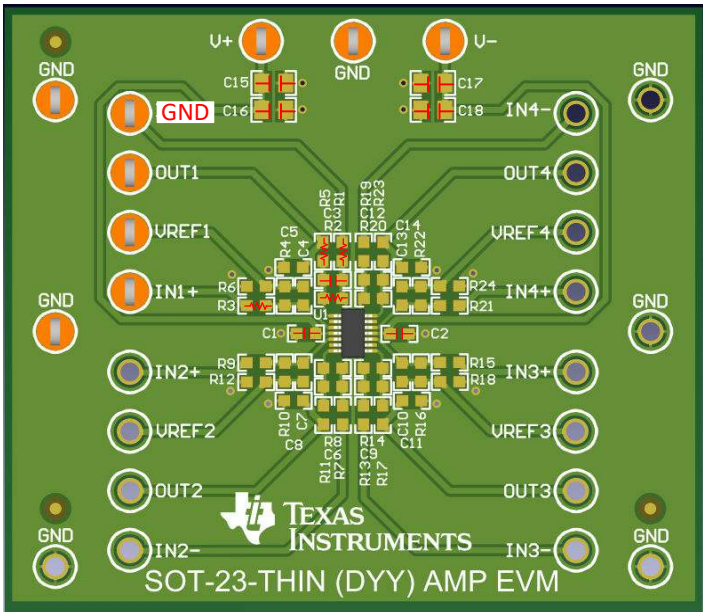


**Figure 4-6. Non-inverting Amplifier Configured on DYY-AMP-EVM, Channel 1**

## 4.4 Inverting Amplifier

Figure 4-7 shows the schematic for the inverting amplifier circuit configuration. To configure the EVM in an inverting configuration short $R_{INP}$ using a 0-Ω resistor or solder bridge, leave $R_{VREF}$ and $C_{VREF}$ unpopulated, and apply the desired common mode voltage(VCM) to the input connection, IN+. The input signal is applied using the input connection IN–.

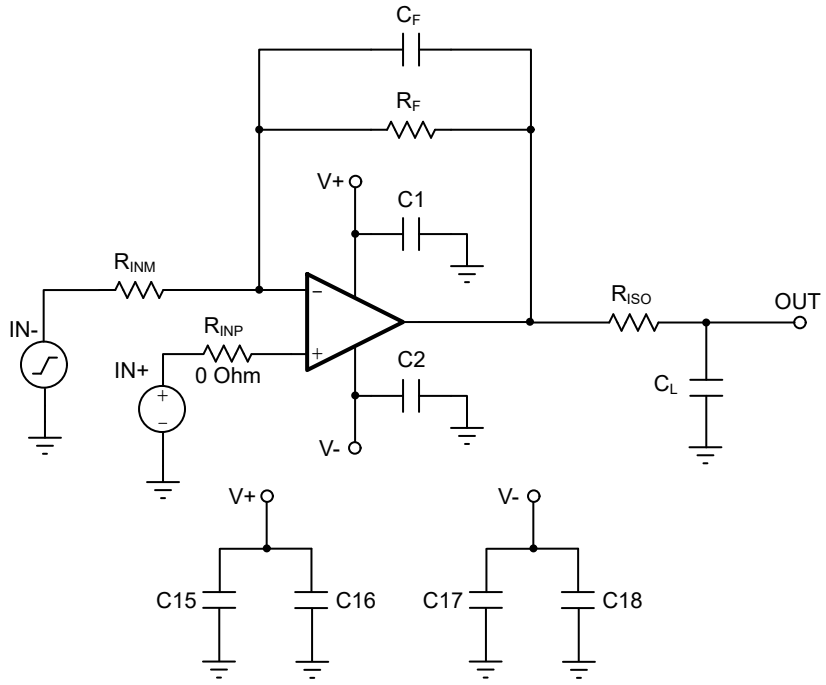


**Figure 4-7. Inverting Amplifier Schematic**

**Table 4-4. Inverting Amplifier Components**

| CH | $R_{INM}$ | $R_F$ | $C_F$ | $R_{INP}$ | $R_{Iso}$ | $C_L$ |
|---|---|---|---|---|---|---|
| 1 | R1 | R2 | C3 | R3 | R5 | C5 |
| 2 | R7 | R8 | C6 | R9 | R11 | C8 |
| 3 | R13 | R14 | C9 | R15 | R17 | C11 |
| 4 | R19 | R20 | C12 | R21 | R23 | C14 |

Equation 6 displays the DC transfer function for channel 1 of the inverting amplifier circuit configuration. Note, Input signals IN+ and IN- are altered to $IN_P$ and $IN_M$ respectively in the transfer function for simplicity of the equation.

$$OUT = -\frac{R_F}{R_{INM}} \times IN_M + \left(1 + \frac{R_F}{R_{INM}}\right) \times IN_P \quad (6)$$

Capacitor $C_F$ provides the option to filter the output. The cutoff frequency, $f_c$, of the filter can be calculated using Equation 7.

$$f_c = \frac{1}{2 \times \pi \times R_F \times C_F} \quad (7)$$

Resistor $R_{iso}$, and capacitor $C_L$ provide the option to create a RC filter, or test output loads for the amplifier. When not applicable, use a zero ohm resistor for $R_{iso}$ and do not populate $C_L$.

Figure 4-8 shows the DYY-AMP-EVM populated with the required components to configure channel 1 as an inverting amplifier with no load.

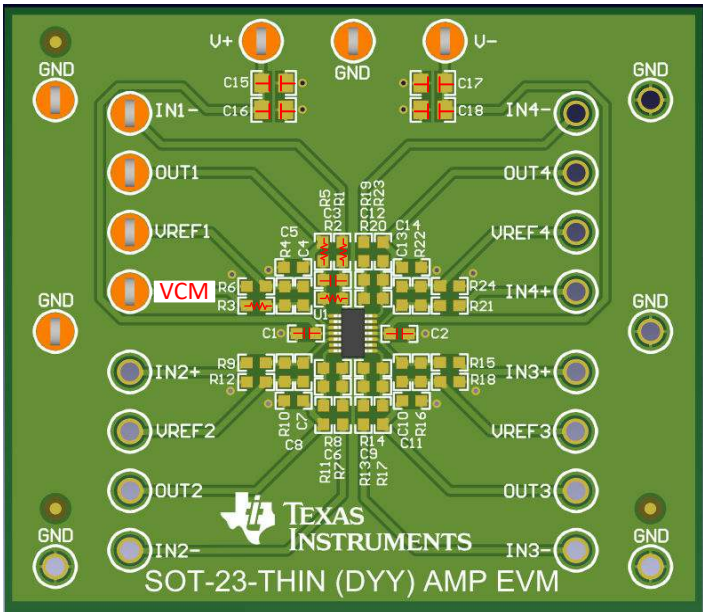


**Figure 4-8. Inverting Amplifier Configured on DYY-AMP-EVM, Channel 1**

## 4.5 PCB Layout

The DYY-AMP-EVM is a two layer board. The PCB layout of the top layer is displayed in Figure 4-9.

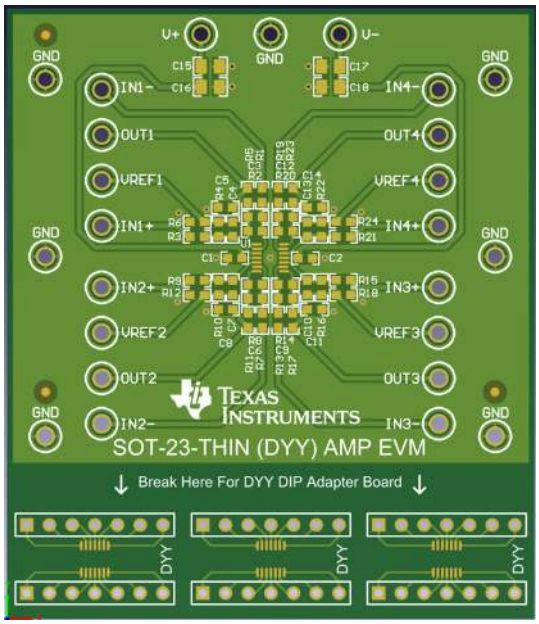


**Figure 4-9. Top Layer PCB Layout**

The PCB layout of the bottom layer is displayed in Figure 4-10.

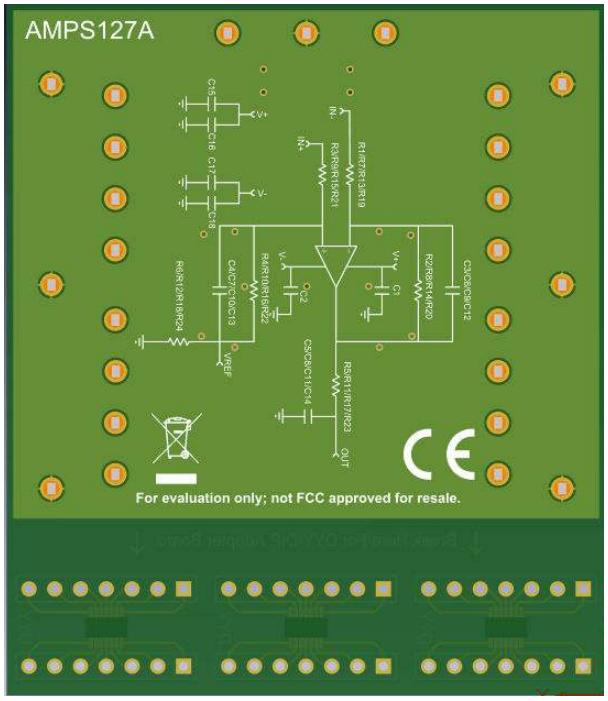


**Figure 4-10. Bottom Layer PCB Layout**

# 5 Connections

This section provides a description for each connection available on the EVM.

## 5.1 Power

The power supply connections for the DYY-AMP-EVM can only be applied using the test points located at the top of the PCB. The positive power supply connection is labeled V+, the negative power supply connection is labeled V–, and the ground connection is labeled GND. For the minimum and maximum supply voltages of the DYY-AMP-EVM, please refer to the relevant device datasheet.

C1 and C2 act as local decoupling capacitors for the amplifier, populate to provide a low impedance return current path for the amplifier. Capacitors C15-C18 are bulk decoupling capacitors for the positive and negative supply rail.

## 5.2 Input Connections

Signals for the input can be applied to the DYY-AMP-EVM through the use of test points. The input connections are labeled as IN+ and IN–, and the number correlates to the specific channel associated with the input.

## 5.3 Output Connections

Output connections are provided through the use of test points labeled as OUT. The following number correlates to the specific channel associated with the output.

## 5.4 Reference Voltage Connections

Signals or DC voltages for the reference voltage can be applied to the DYY-AMP-EVM through the test points labeled VREF. The following number correlates to the specific channel associated with the VREF pin. $R_{PL}$ can be used to set the Vref pin to 0-V without the use of external connections. To set the VREF pin to GND, populate the respective pad with a 0 ohm resistor.

# 6 Bill of Materials (BOM)

**Table 6-1. DYY-AMP-EVM BOM**

| Designator | Quantity | Description | Part Number |
|---|---|---|---|
| PCB | 1 | Printed-Circuit-Board | DYY-AMP-EVM |
| Header Strip | 3 | Header, 2.54 mm, 14× 1, Gold, TH | M22-2011405 |
| R1-R24 | 24 | 0603 package resistor | |
| C1-C14 | 14 | 0603 package capacitor | |
| C15-C18 | 4 | 0805 package capacitor | |

# 7 References

1. Texas Instruments, DIYAMP-EVM evaluation module.
2. Texas Instruments, DUAL-DIYAMP-EVM evaluation module.
3. Texas Instruments, TLV90X1DPW-EVM evaluation module.
4. Texas Instruments, DIP-ADAPTER-EVM evaluation module.
5. Texas Instruments, How to Properly Configure Unused Operational Amplifiers application brief.
6. Texas Instruments, TI Precision Labs Training.

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