AN-1828 LMH6514 Digital Controlled Variable Gain Amplifier Evaluation Board

1 General Description

The LMH6514 evaluation board (part # LMH6514SQEVAL) is designed to aid in the characterization of Texas Instruments high speed LMH6514 digital controlled variable gain amplifiers (DVGA).

Use the evaluation board as a guide for high frequency layout and as a tool to aid in device testing and characterization.

2 Basic Operation

The LMH6514 DVGA has differential inputs and differential outputs. The LMH6514 will also support single-ended to differential conversion with no transformer required on the input. To aid evaluation with 50 Ω single-ended test equipment the LMH6514 evaluation board provides for input and output transformers. For driving the evaluation board from a differential source, symmetrical signal paths are provided. Both input and output paths support fully differential signal paths. For component locations refer to the schematic in Figure 1.

The evaluation board uses end mounted SMA connectors. On the IN+ input, resistor R1 provides input termination. The analog supply (V_{CCA}) can be from 4 V to 5.25 V. The capacitor C5 is a supply bypass capacitor and should be low ESR ceramic. Resistors R11 and R12 as well as capacitor C4 should be left empty.

The LMH6514 evaluation board is designed for transformers wtih DC isloation between the primary and secondary windings. If baluns (transmission line transformers with no DC blocking) are used make sure to have DC isolation for all transformer pads.

Transformer T1 can provide both impedance matching as well as single ended to differential conversion. The 2:1 (4:1 impedance) transformer matches 50 Ω equipment with the 200 Ω input impedance of the LMH6514 DVGA and there is an optional capacitor at C3 if additional stability is required. Do not connect the transformer secondary winding directly to ground. The LMH6514 has a self biased input common mode voltage of approximately 1.3 V. The amplifier will bias up to the optimal input common mode point. The resistors R2, R24, and R25 are normally left empty. These resistors can be used to force the LMH6514 input common mode to a value different than it's self biased state. Most applications will not require this function.

If using a transmission line transformer for T1, capacitor C1 is necessary to preserve the proper input common mode voltage. For single-ended inputs to the amplifier, see Figure 7 and Figure 8.

The LMH6514 evaluation board is shipped with a transformer to facilitate testing with single-ended equipment. To drive the LMH6514 evaluation board with a differential signal, transformer T1 must be removed. Then, load capacitor C1 and C16 and cut the trace connecting the capacitor C2. R1 and R5 should be loaded with appropriate valued resistors (normally 50 Ω). The C3 capacitor is not needed for this case and the transformer pads should be shorted with a low inductance wire: pad 6 to pad 1 and pad 4 to pad 3.

On the output side of the board is transformer T2. C11 isolates the output common mode voltage from the output transformer primary windings. The output coupling capacitors C13 and C14 are necessary for Balun transformers that provide no DC isolation between the primary and secondary windings, and are also necessary when driving differential loads.

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For differential output signals remove transformer T2. Capacitor C11 can be left empty. Do not install resistor R4. Using the transformer T2 pads, place coupling capacitors between pads 3 and 4 and between pads 1 and 6 where the transformer would have been. These should be low ESR ceramic capacitors with a value of 1 nF. These output coupling capacitors are necessary to isolate the output common mode voltage of the LMH6514 from the test equipment. The pads for capacitors C13 and C14 can be used as series output matching resistors. There is no copper between transformer pad #6 and C14. A low impedance short will have to be added manually. Resistors R3 and R4 are normally left empty in this configuration.

The evaluation board supports two gain options. As shipped, the evaluation board provides for a low gain, 200 Ω output impedance configuration. In order to use the high gain 400 Ω configuration, the traces from pins 13 and 16 to V_{CCA} can be cut. For a detail of the trace cuts required, see Figure 6.

SW1 is used to set the three gain control bits. When the Latch position of SW1 is in 0 or OFF position, changes in the Gain 2 to Gain 5 bits are processed by the LMH6514 (see the paragraph below). When the latch switch is in 1 or ON position, the last loaded state is held and gain bit switch changes have no effect. Landings for SMA connectors are also provided for high speed triggering of the gain bits.

Since the same PC board is also used for the LMH6515 DVGA, the markings on SW1 are not the same as the pin assignments for the LMH6514. On the SW1, Gain_4 on the board corresponds to Gain_2 on the LMH6514, Gain_3 on the board corresponds to Gain _1 on the LMH6514 and Gain_2 corresponds to Gain_0 on the LMH6514.

The LMH6514 evaluation board is a four layer board; all four layers are detailed in Figure 2 through Figure 5.

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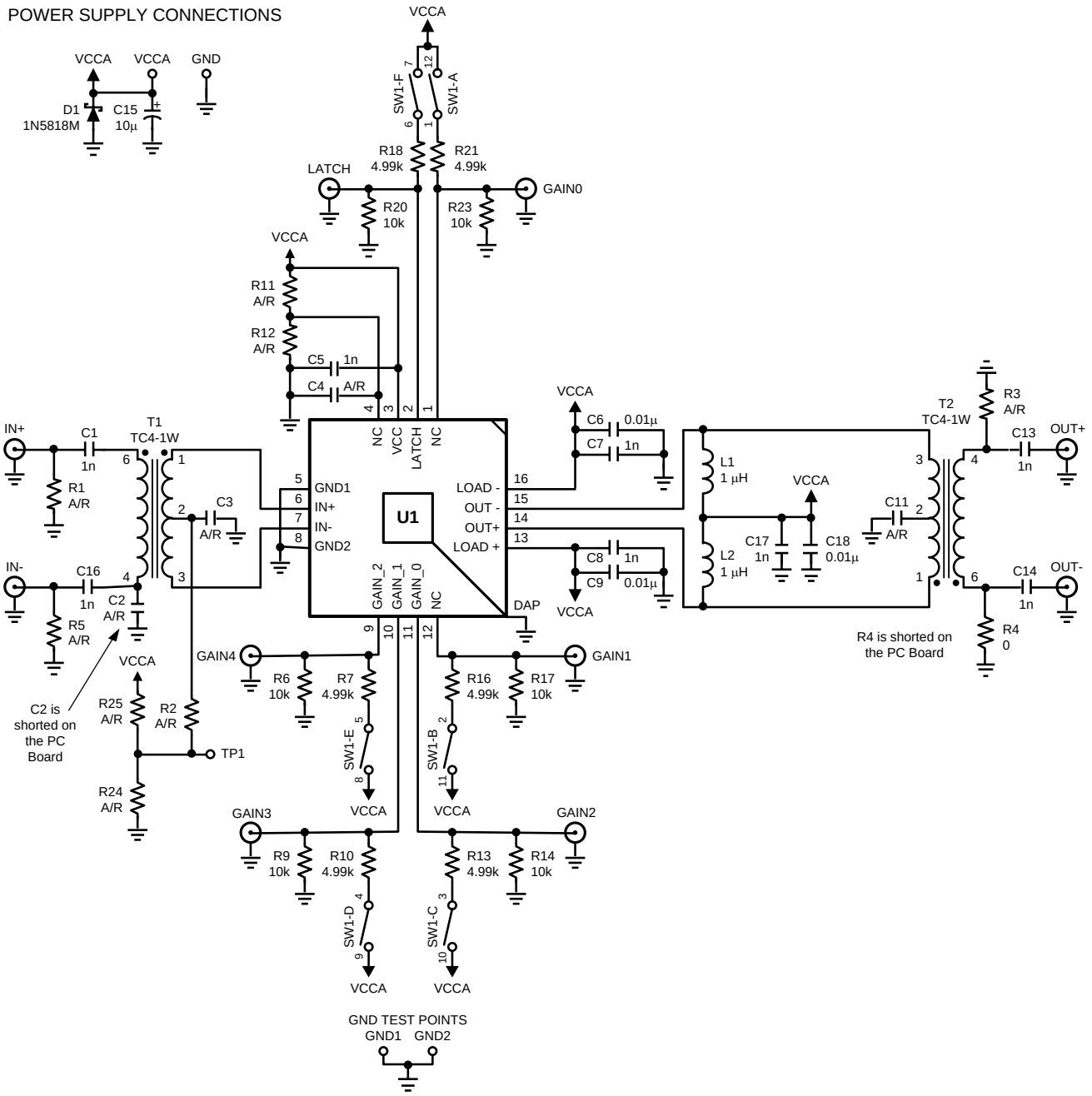


Figure 1. LMH6514 Evaluation Board Schematic

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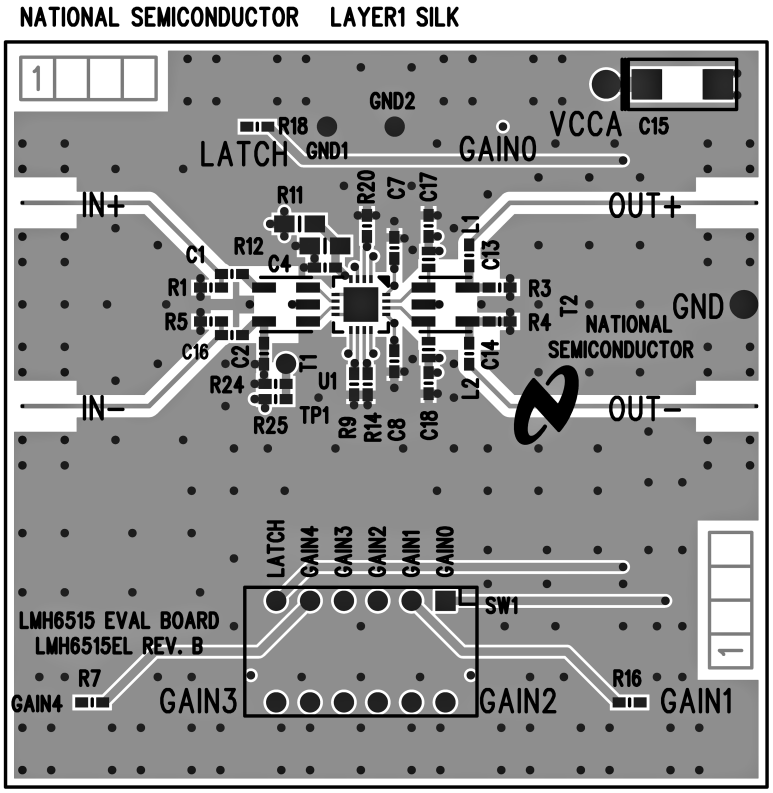


Figure 2. Evaluation Board Top Layer

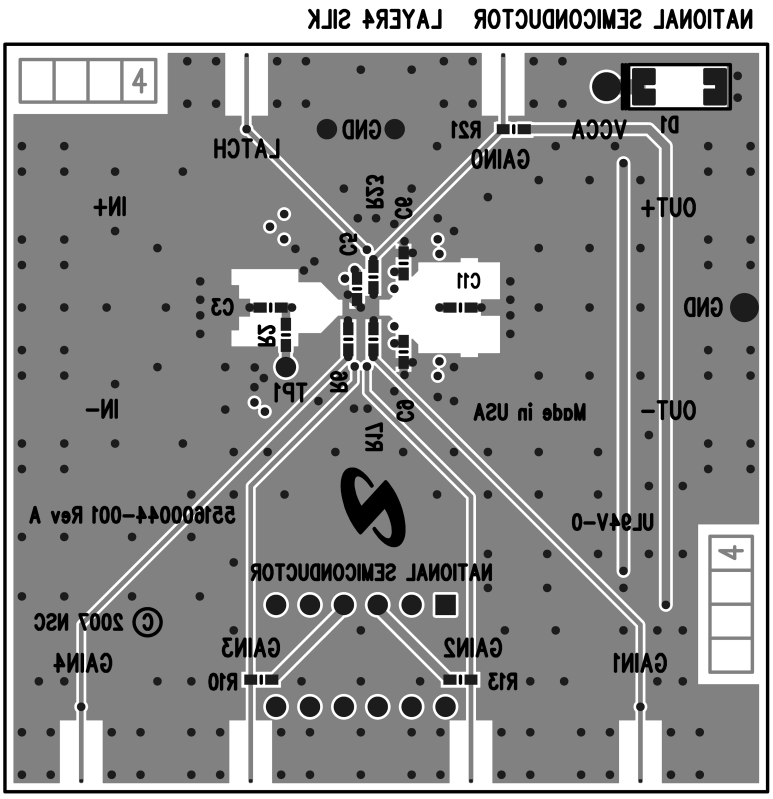


Figure 3. Evaluation Board Bottom Layer

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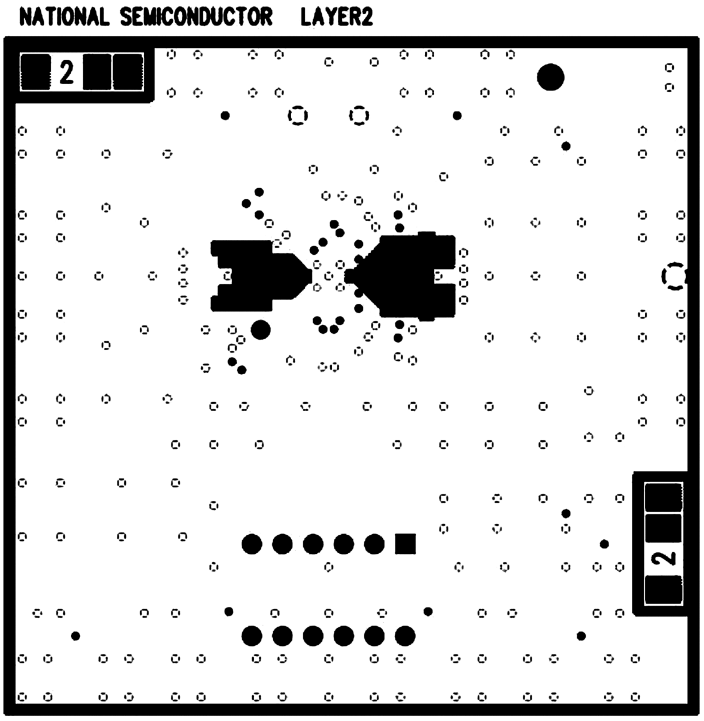


Figure 4. Evaluation Board Layer 2

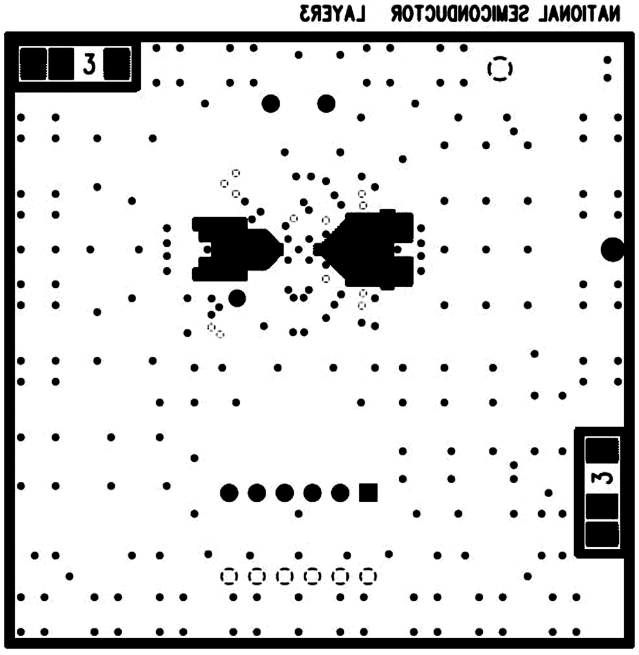


Figure 5. Evaluation Board Layer 3

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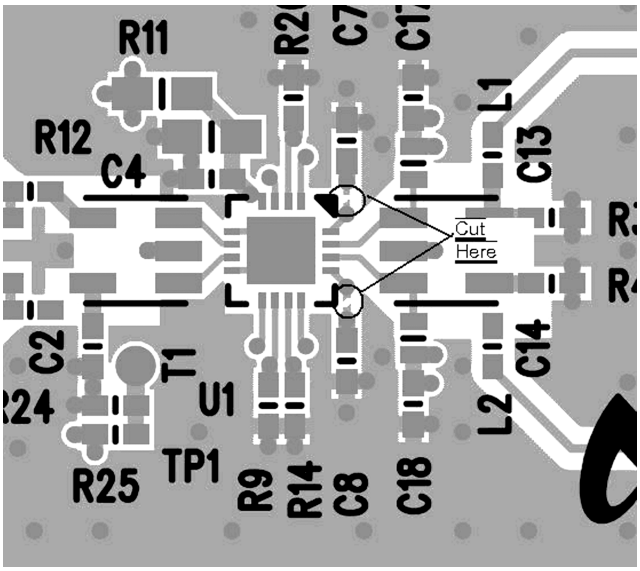


Figure 6. Trace Cuts for High Gain (400 Ω Load) Operation

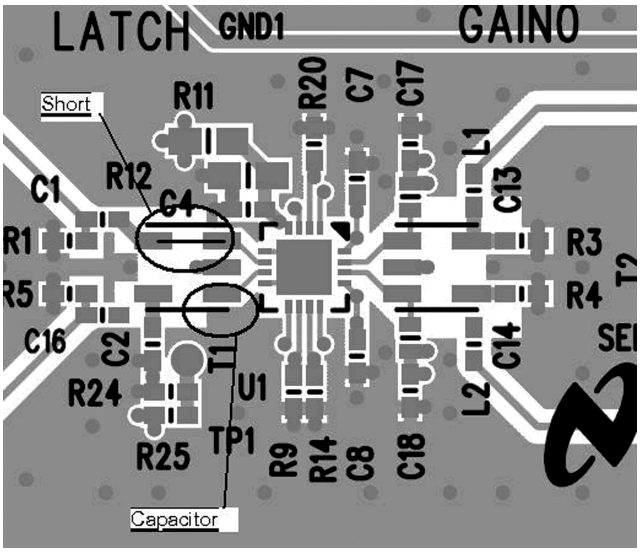


Figure 7. Single-Ended Input – No Transformer

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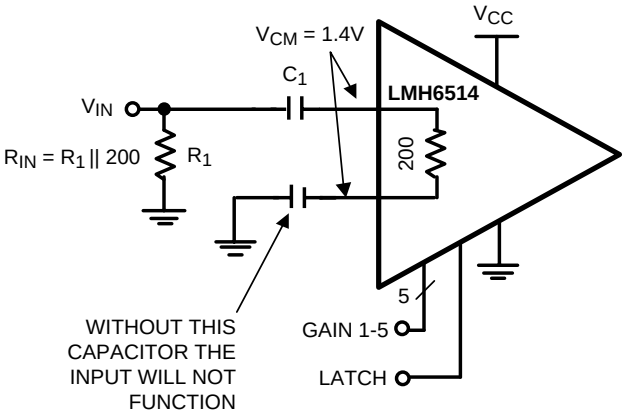


Figure 8. Schematic for Single-Ended Input

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