Electrical Evaluation for LTC6561 Four-Channel Transimpedance Amplifier with Output Multiplexing

DESCRIPTION

Demonstration circuit 2808A features the LTC®6561 four-channel transimpedance amplifier (TIA) with output multiplexing. The DC2808A accepts voltage pulses and converts them to current for the TIA. The board can also be used to measure bandwidth and channel isolation with a network analyzer. The LTC6561, which features 74KΩ transimpedance gain and 30uA linear input current range, is ideal for LIDAR receivers using Avalanche Photodiodes (APD). The LTC6561 operates from 5V single supply and consumes only 220mW. Utilizing the LTC6561's output MUX, multiple LTC6561 devices can combine into a single output. The LTC6561's fast overload recovery makes it well suited for LIDAR receivers. The LTC6561's single-ended output can swing $2V_{P-P}$ into a 100Ω load.

The LTC6561 is packaged in a compact 4mm × 4mm 24-pin leadless QFN package with an exposed pad for thermal management and low inductance.

Design files for this circuit board are available.

BOARD PHOTO

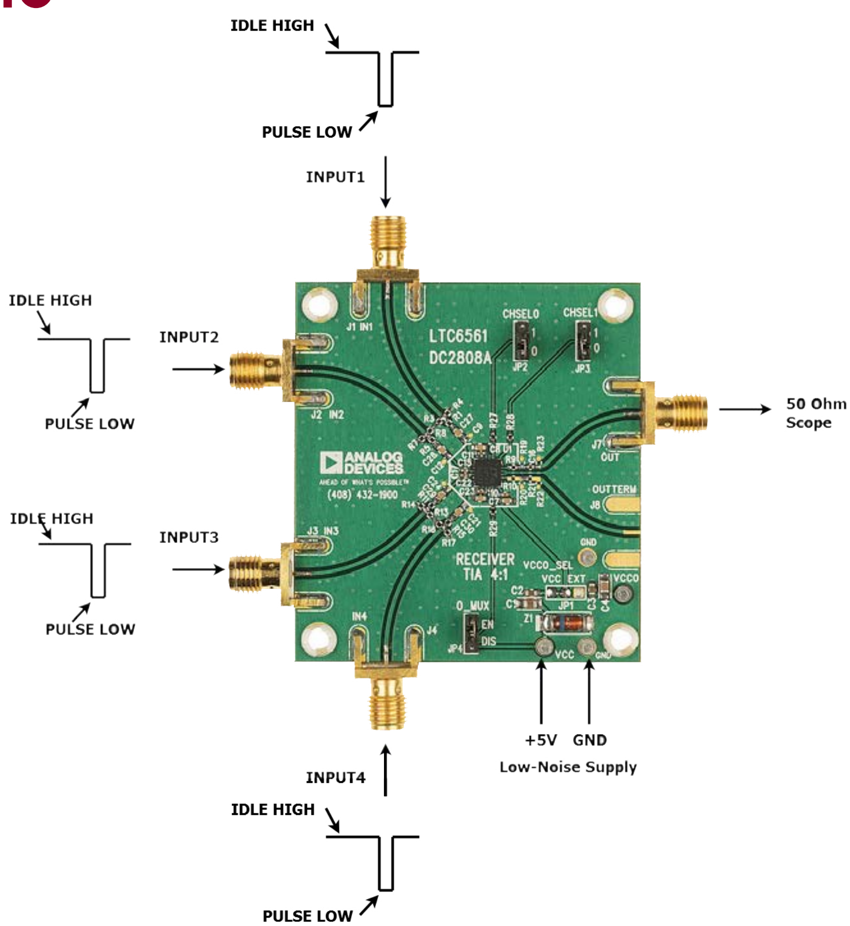


Figure 1. Connection Diagram

QUICK START PROCEDURE

1) Connect a voltage pulse generator to the input to J1, J2, J3, and J4. These inputs are 50Ω terminated to ground, and then AC-coupled. A 2k series resistor converts the voltage to a current. Refer to the input circuit description for details. As an input example, a 25dB attenuator can be used to scale down the pulse generators output that is set to $1V_{P-P}$. This will produce a peak current that is approximately 28uA. The combination of 100pF AC-coupled input and 1000pF AC-coupled output limits the DC2808A repetition rate to less than 100 KHz.
2) Connect J7 to an oscilloscope that is 50Ω terminated or other 50Ω systems. J7 is AC-coupled with a 1000pF capacitor.
3) Connect a 5V low-noise power supply shown in Figure 1. V_{CCO} is hardwired to V_{CC} by default.

INPUT CIRCUIT DESCRIPTION

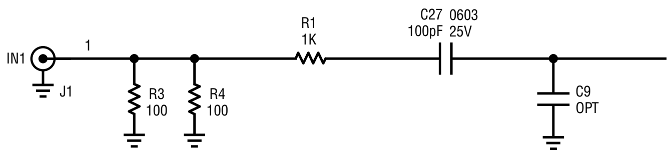


Figure 2. Input Circuit for DC2808A

The input stage, shown in Figure 2, is AC-coupled and 50Ω terminated to allow for interfacing to voltage pulse generators. A series resistor is used to convert the voltage pulse to a current pulse. This allows the use of a pulse generator to inject a current into the TIA. The following equation should be used to calculate the injected current to the LTC6561:

$$I_{LTC6561} = V_{INPP} / 2k\Omega \qquad \text{EQ1}$$

The DC2808A allows insertion of excess capacitance C9, C12, C21, C24 respectively to simulate the effect of sensor (APD) capacitance on rise time and bandwidth.

OUTPUT CIRCUIT DESCRIPTION

For convenience, the LTC6561 offers two outputs: OUTTERM pin has an internal series 50Ω source resistor, and OUT pin has a direct connection. The schematic is shown in Figure 3. Only one output can be used to monitor at a time. The DC2808A output stage is AC-coupled 50Ω source to allow for interfacing to 50Ω systems. J7 is populated by default; this configuration connects to OUT pin on the LTC6561. J8 and its passives can be populated to use the OUTTERM pin. The LTC6561 implements a class B output stage, a 1K pull-down resistor on OUTTERM provide a DC path to ground. This helps the LT6561 output pull to ground when the LTC6561 output is AC-coupled.

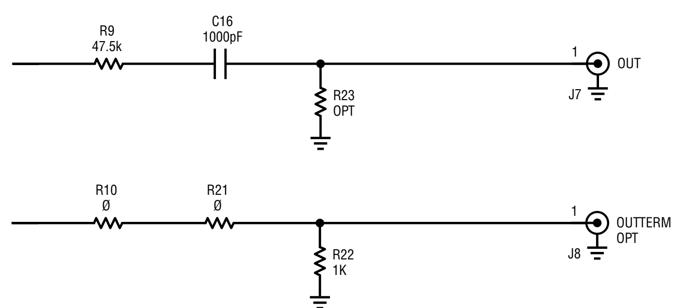


Figure 3. Ouput Circuit for DC2808A

USING THE LTC6561 CHANNEL SELECTS

The LTC6561 multiplexing capability allows compact multichannel designs without external multiplexers. To set the channel on the DC2808A, JP2 and JP3 are used. By placing the jumper in the 1 position, the channel select pin will be tied to VCC. In the 0 position, the channel select pin will float and the internal pull-down resistors pulls the channel to ground. Refer to Table 1 for channel selection.

Table 1. Channel Selection

CHSEL1 (JP3)	CHSEL0 (JP2)	ACTIVE CHANNEL
0	0	1
0	1	2
1	0	3
1	1	4

CONNECTING MULTIPLE LTC6561S FOR OUTPUT MUXING

The outputs of the LTC6561 can be wire OR'd together to combine multiple inputs. When the OMUX pin is high, the LTC6561s output goes to a high impedance state. When the OMUX pin is low, the LTC6561 is enabled. Only one LTC6561 can be enabled at a time. Source resistors are necessary to avoid reflections from the paths that are inactive. Be sure to keep the output lengths as short as possible to mitigate the effects of transmission line stubs. Figure 4 shows how multiple LTC6561 are connected. Both J7 (Out Pin) or J8 (OUTTERM Pin) can be used to implement output MUXing. By replacing C16 or C21 respectively with a 0Ω 0402 resistor, the output can be DC coupled to connect multiple DC2808A boards. A DC block can then be used to interface with 50Ω systems.

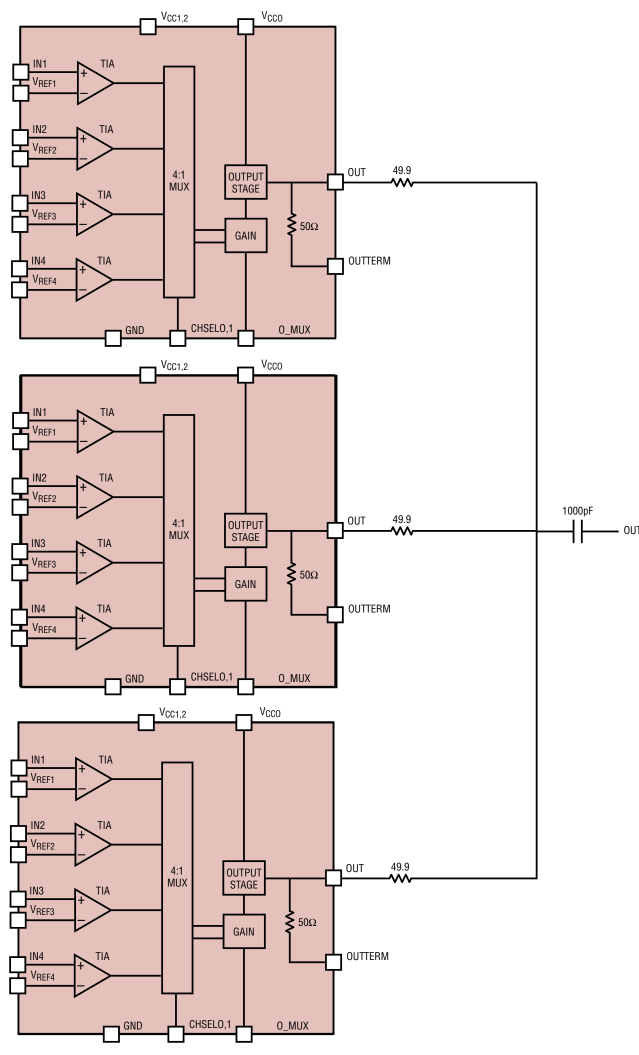
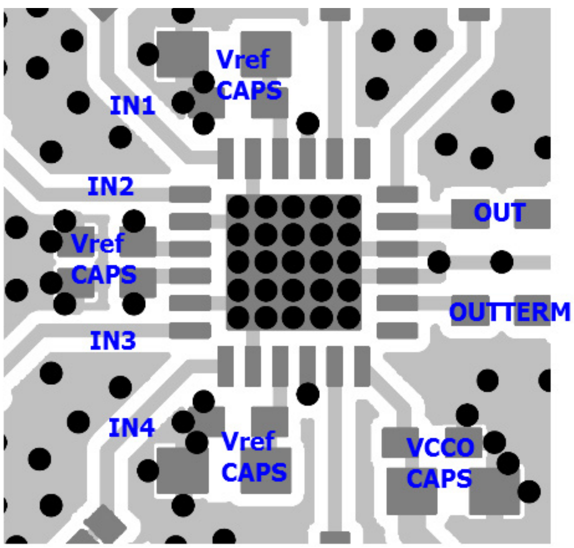


Figure 4. Diagram of Wire OR'd Outputs of Multiple LTC6561's

LAYOUT CONSIDERATIONS

The DC2808A layout is optimized to maximize the LTC6561's performance. The V_{REF} capacitor for IN1 and IN4 should be orthogonal to the input trace. This orientation helps to reduce coupling from the input to V_{REF}. The V_{REF} capacitors for IN2 and IN3 should be placed as close as possible. Local bypass for V_{CCO} and V_{CC} should be as close as possible to the LTC6561. The ground pad in the center of the LTC6561 is important for dissipating the heat from the die and to minimize the ground inductance. Maximizing the number of vias and employing multiple ground plane layers will most effectively heat sink the LTC6561. Figure 5 shows the DC2808A layout.



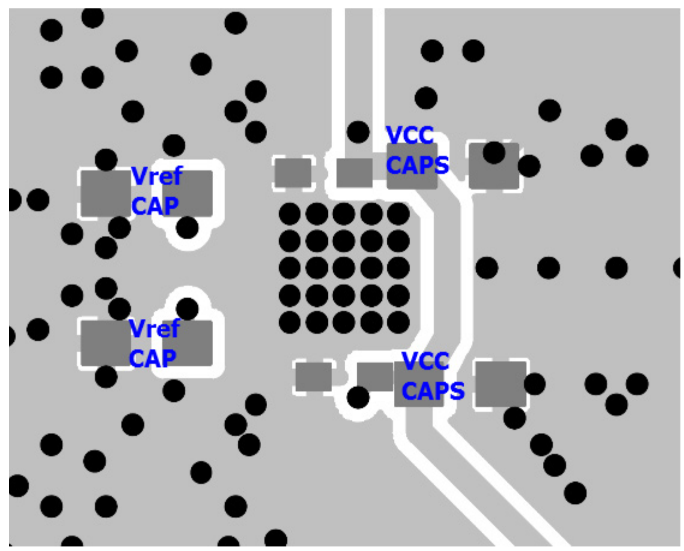


Figure 5. Recomended Layout (Left) Top Layer (Right) Bottom Layer

INPUT AND OUTPUT

The input of the DC2808A is shown in Figure 6 and is attenuated by 25dB. A 25dB reduction of 300mV is 16.9mV. Using Equation 1, the peak current that the TIA sees is 8.4uA. Thus, the output of the DC2808A should be 310 mV since the scope is 50Ω terminated.

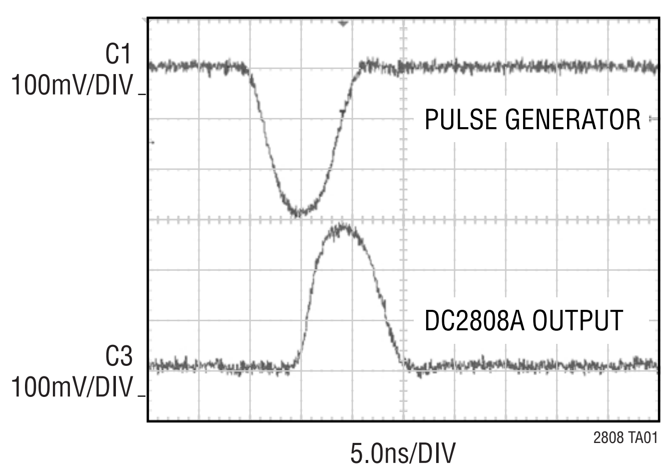


Figure 6. Scope Shoot of DC2808A

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EXTERNAL CONNECTIONS

Connections:

J1, J2, J3, J4: IN1, IN2, IN3, IN4 – The LTC6561's IN1, IN2, IN3, and IN4 channels. The input stage is AC-coupled and then 50Ω terminated to allow for interfacing to voltage pulse generators.

J7: OUT - the analog output of the LTC6561.

J8: OUTTERM - the analog output of the LTC6561 with the internal 50Ω series resistor.

Turrets:

E1: V_{CC} – LTC6561 V_{CC} analog input. The V_{CCO} analog input is connected to this node when JP1 is in the V_{CC} position.

E2: V_{CCO} – LTC6561 V_{CCO} analog input when JP1 is in the external (EXT) position.

E3, E4: GND – the DC2808A ground.

Jumpers:

JP1: V_{CCO_SEL} – selects the input for the LTC6561 V_{CCO} to V_{CC} turret (V_{CC}) or external (EXT) through the V_{CCO} turret. V_{CCO} is hardwired to V_{CC} by default.

JP2: CHSEL0 – The LTC6561 LSB for channel selection.

JP3: CHSEL1 – The LTC6561 MSB for channel selection.

JP4: O_MUX – Enables (EN) or disables (DIS) the LTC6561 output. The output goes high impedance when the LTC6561 O_MUX is disabled. The power of the LTC6561 will not be reduced in either mode.

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.