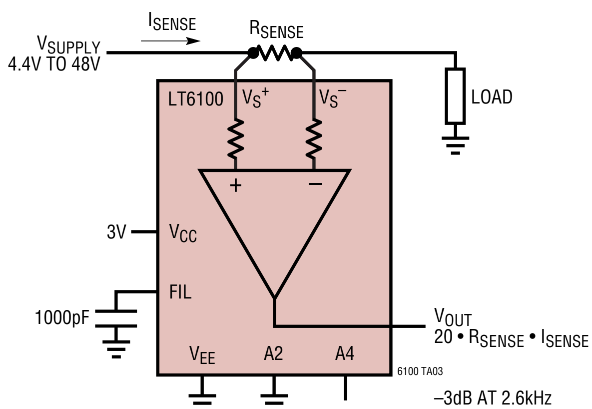
Low Current (Picoamps to Milliamps)

For low current applications the easiest way to sense current is to use a large sense resistor. This however causes larger voltage drops in the line being sensed which may not be acceptable. Using a smaller sense resistor and taking gain in the sense amplifier stage is often a better approach. Low current implies high source impedance measurements which are subject approach. Low current implies high source impedance measurements which are subject to noise pickup and often require filtering of some sort.

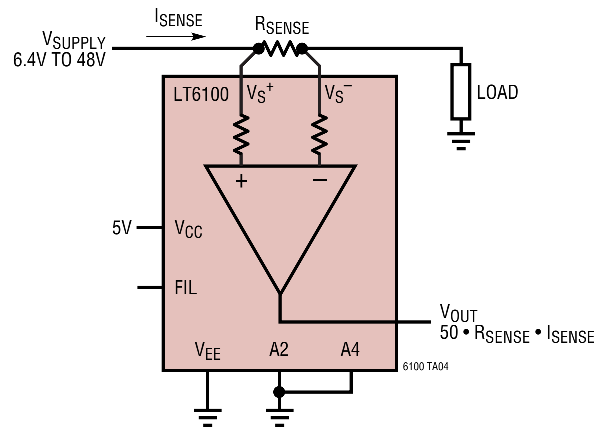
To see other chapters in this Application Note, return to the Introduction.

Filtered Gain of 20 Current Sense



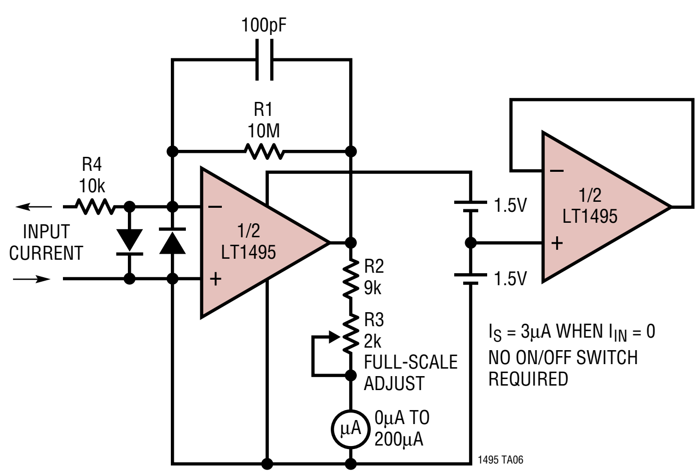
The LT6100 has pin strap connections to establish a variety of accurate gain settings without using external components. For this circuit grounding A2 and leaving A4 open set a gain of 20. Adding one external capacitor to the FIL pin creates a low-pass filter in the signal path. A capacitor of 1000pF as shown sets a filter corner frequency of 2.6KHz.

Gain of 50 Current Sense



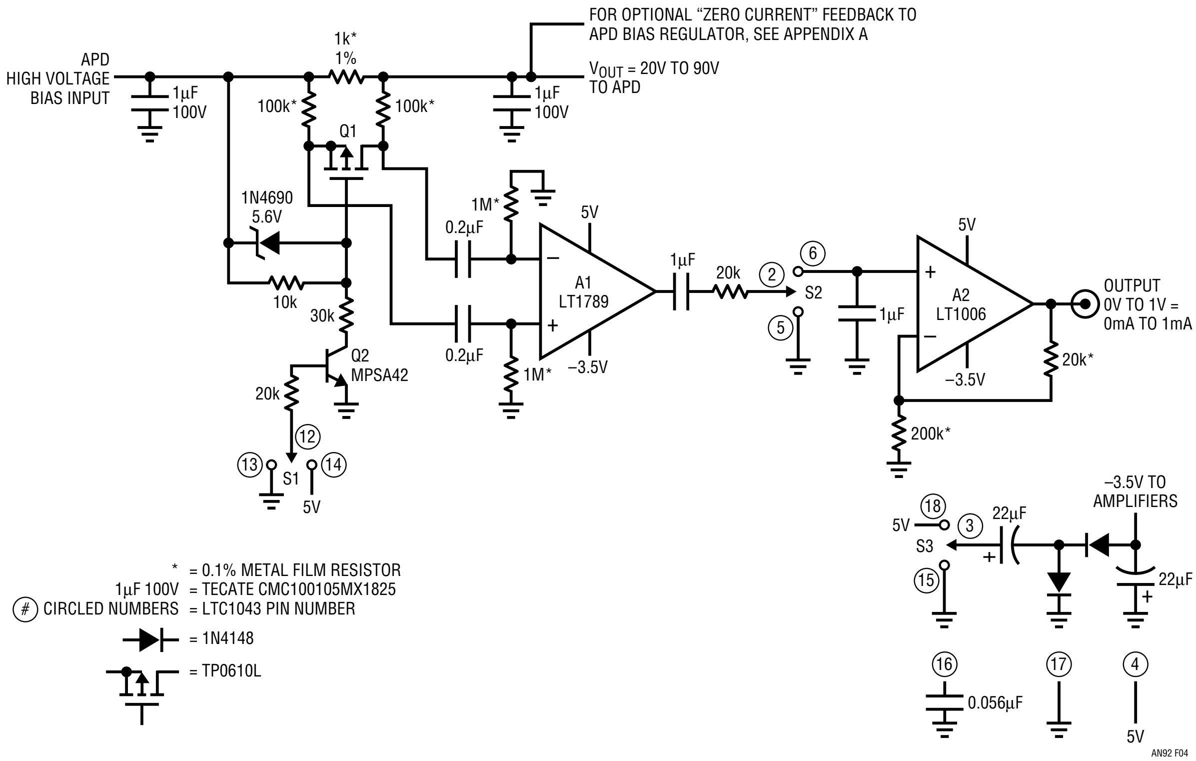
The LT6100 is configured for a gain of 50 by grounding both A2 and A4. This is one of the simplest current sensing amplifier circuits where only a sense resistor is required.

0nA to 200nA Current Meter



A floating amplifier circuit converts a full-scale 200nA flowing in the direction indicated at the inputs to 2V at the output of the LT1495. This voltage is converted to a current to drive a 200µA meter movement. By floating the power to the circuit with batteries, any voltage potential at the inputs are handled. The LT1495 is a micropower op amp so the quiescent current drain from the batteries is very low and thus no on/off switch is required.

Lock-In Amplifier Technique Permits 1% Accurate APD Current Measurement Over 100nA to 1mA Range.



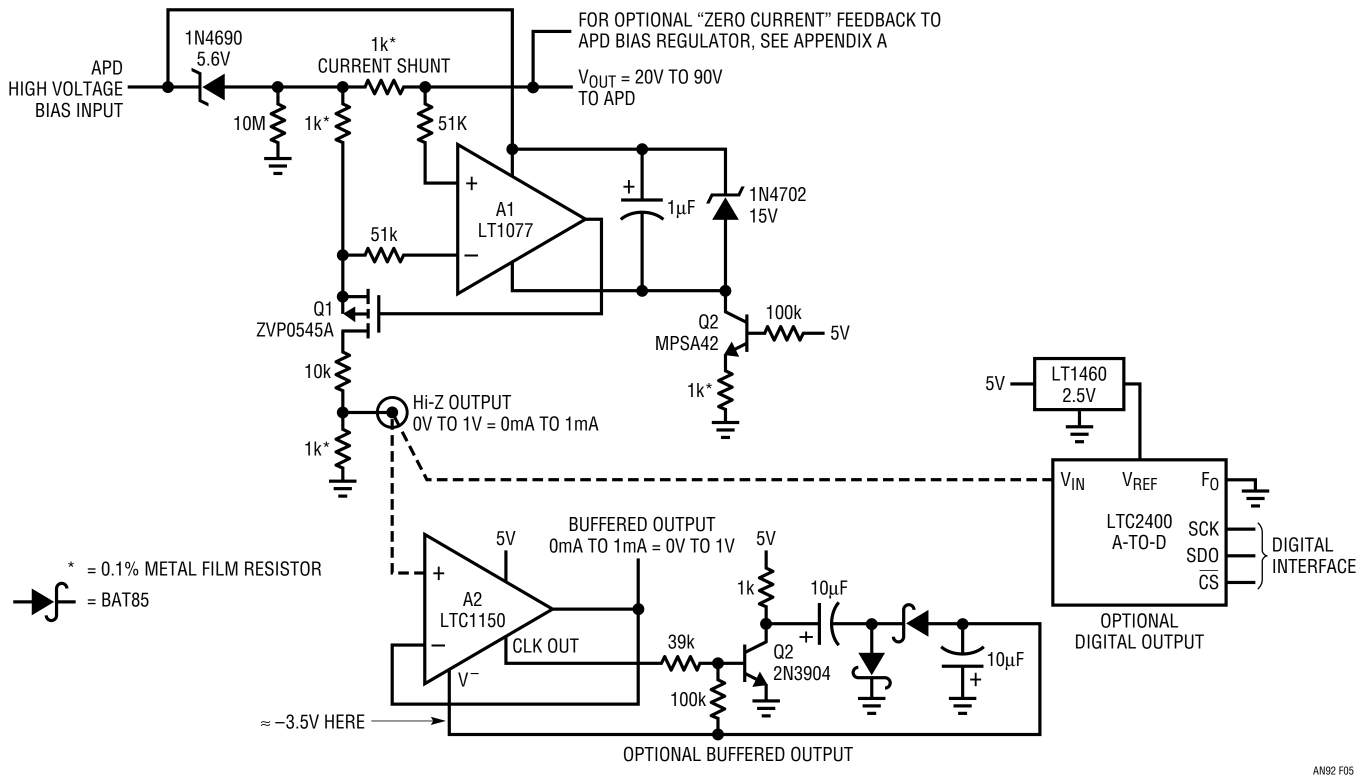
Avalanche Photodiodes, APDs, require a small amount of current from a high voltage supply. The current into the diode is an indication of optical signal strength and must be monitored very accurately. It is desirable to power all of the support circuitry from a single 5V supply.

This circuit utilizes AC carrier modulation techniques to meet APD current monitor requirements. It features 0.4% accuracy over the sensed current range, runs from a 5V supply and has the high noise rejection character stics of carrier based "lock in" measurements.

The LTC1043 switch array is clocked by its internal oscillator. Oscillator frequency, set by the capacitor at Pin 16, is about 150Hz. S1 clocking biases Q1 via level shifter Q2. Q1 chops the DC voltage across the 1k current shunt, modulating it into a differential square wave signal which feeds A1 through 0.2µF AC coupling capacitors. A1's single-ended output biases demodulator S2, which presents a DC output to buffer amplifier A2. A2's output is the circuit output.

Switch S3 clocks a negative output charge pump which supplies the amplifier's V– pins, permitting output swing to (and below) zero volts. The 100k resistors at Q1 minimize its on-resistance error contribution and prevent destructive potentials from reaching A1 (and the 5V rail) if either 0.2µF capacitor fails. A2's gain of 1.1 corrects for the slight attenuation introduced by A1's input resistors. In practice, it may be desirable to derive the APD bias voltage regulator's feedback signal from the indicated point, eliminating the 1kΩshunt resistor's voltage drop. Verifying accuracy involves loading the APD bias line with 100nA to 1mA and noting output agreement.

DC Coupled APD Current Monitor

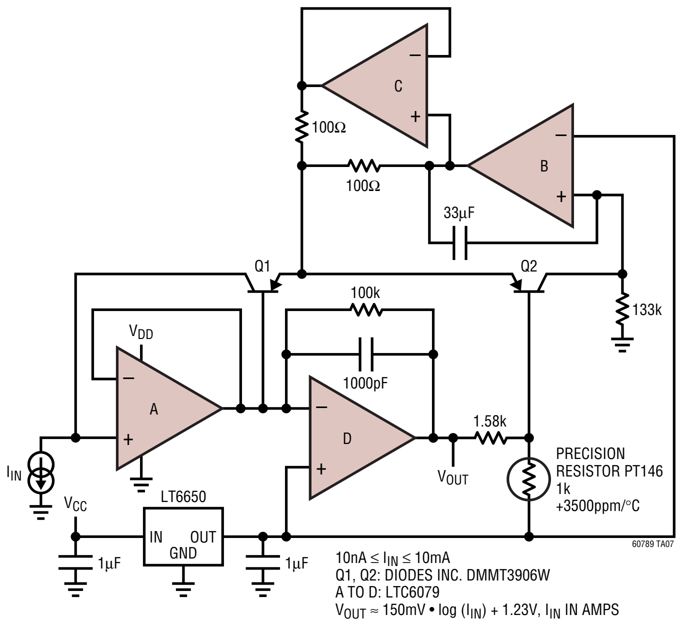


Avalanche Photodiodes, APDs, require a small amount of current from a high voltage supply. The current into the diode is an indication of optical signal strength and must be monitored very accurately. It is desirable to power all of the support circuitry from a single 5V supply.

This circuit's DC coupled current monitor eliminates the previous circuit's trim but pulls more current from the APD bias supply. A1 floats, powered by the APD bias rail. The 15V zener diode and current source Q2 ensure A1 never is exposed to destructive voltages. The 1kΩ current shunt's voltage drop sets A1's positive input potential. A1 balances its inputs by feedback controlling its negative input via Q1. As such, Q1's source voltage equals A1's positive input voltage and its drain current sets the voltage across its source resistor. Q1's drain current produces a voltage drop across the ground referred 1kΩ resistor identical to the drop across the 1kΩ current shunt and, hence, APD current. This relationship holds across the 20V to 90V APD bias voltage range. The 5.6V zener assures A1's inputs are always within their common mode operating range and the 10MΩ resistor maintains adequate zener current when APD current is at very low levels.

Two output options are shown. A2, a chopper stabilized amplifier, provides an analog output. Its output is able to swing to (and below) zero because its V– pin is supplied with a negative voltage. This potential is generated by using A2's internal clock to activate a charge pump which, in turn, biases A2's V– pin.3 A second output option substitutes an A-to-D converter, providing a serial format digital output. No V– supply is required, as the LTC2400 A-to-D will convert inputs to (and slightly below) zero volts.

Six Decade (10nA to 10mA) Current Log Amplifier



Using precision quad amplifiers like the LTC6079, (10µV offset and <1pA bias current) allow for very wide range current sensing. In this circuit a six decade range of current pulled from the circuit input terminal is converted to an output voltage in logarithmic fashion increasing 150mV for every decade of current change.