

APPLICATION NOTE 4122

Simple Regulator Provides Constant Voltage for High-Side Current Monitors

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Abstract: In a typical photodiode current-monitoring application, the voltage drop between the current monitor and the avalanche photodiode (APD) varies with the temperature and current flowing through it, thereby changing the overall gain. This application note describes a regulator circuit that solves this problem by maintaining a constant voltage drop across the current monitor and APD.

Overview

The voltage drop between a current monitor and avalanche photodiode (APD) varies with the temperature and current flowing through the photodiode current-monitoring application. Therefore, in applications such as fiber and instrumentation transmission systems, the ability to detect the average photodiode current is essential for efficient system management.

Typical Application Circuit

The [MAX4007/MAX4008](#) are precision, high-side, high-voltage current monitors specifically designed for monitoring photodiode currents. These devices provide a connection point (REF) for the reference current and a monitor output that provides a signal proportional to the reference current. A suitable APD (avalanche photodiode) or PIN (positive-intrinsic-negative) photodiode is connected at the REF pin of the IC as shown in **Figure 1**. The REF pin provides the source current to the cathode of the photodiode.

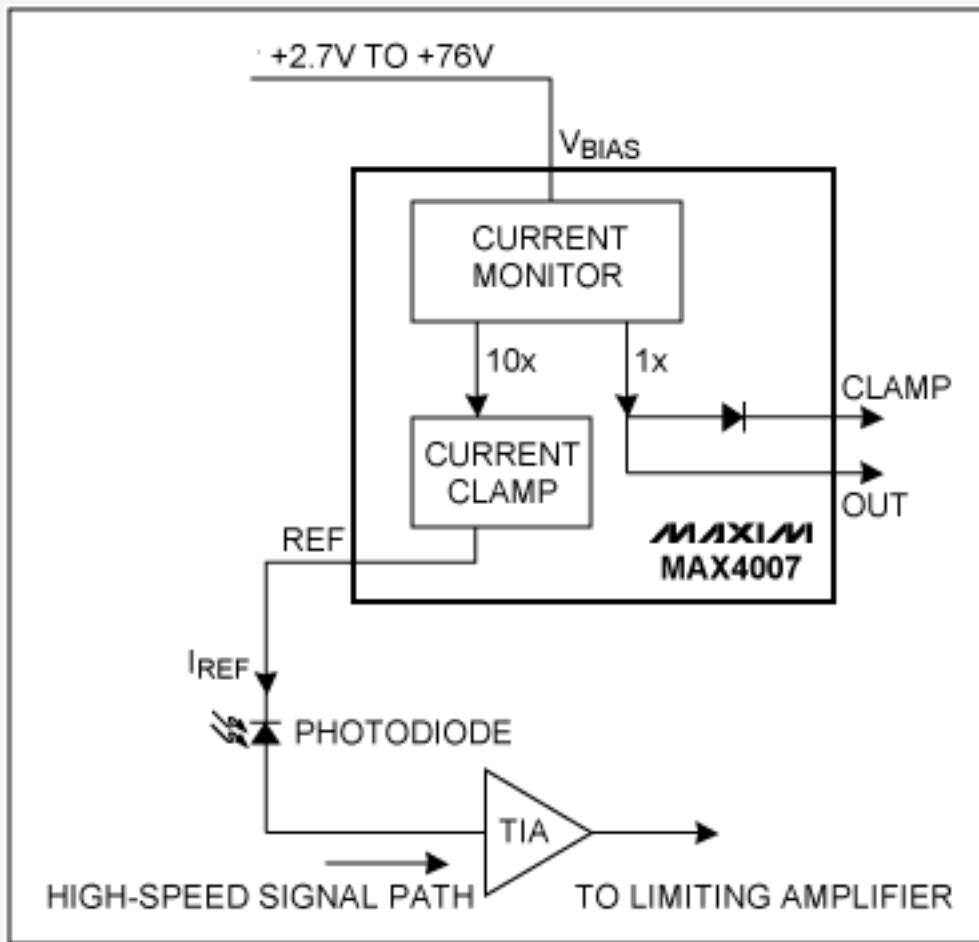


Figure 1. Typical application circuit using the MAX4007 high-side current monitor.

Due to the steep slope of the photodiode's V-I characteristics, a slight change in the voltage across the photodiode causes a significant change in its current, thereby changing the overall gain of the fiber application circuit. The photodiode's voltage drop varies with the temperature and current flowing through it. The typical voltage drop ($V_{BIAS} - V_{REF}$) across the MAX4007 series is 0.8V, with a guaranteed maximum of 1.1V.

Figure 2 shows the variation of the reference voltage with the change in REF current I_{REF} . The plot shows that in the conventional unregulated circuit V_{REF} varies by as much as 0.4V with the 1 μ A to 4mA photodiode-current range. This variation in V_{REF} voltage might be unacceptable in some applications. A major challenge in regulating the REF voltage is that V_{BIAS} can be as high as 76V.

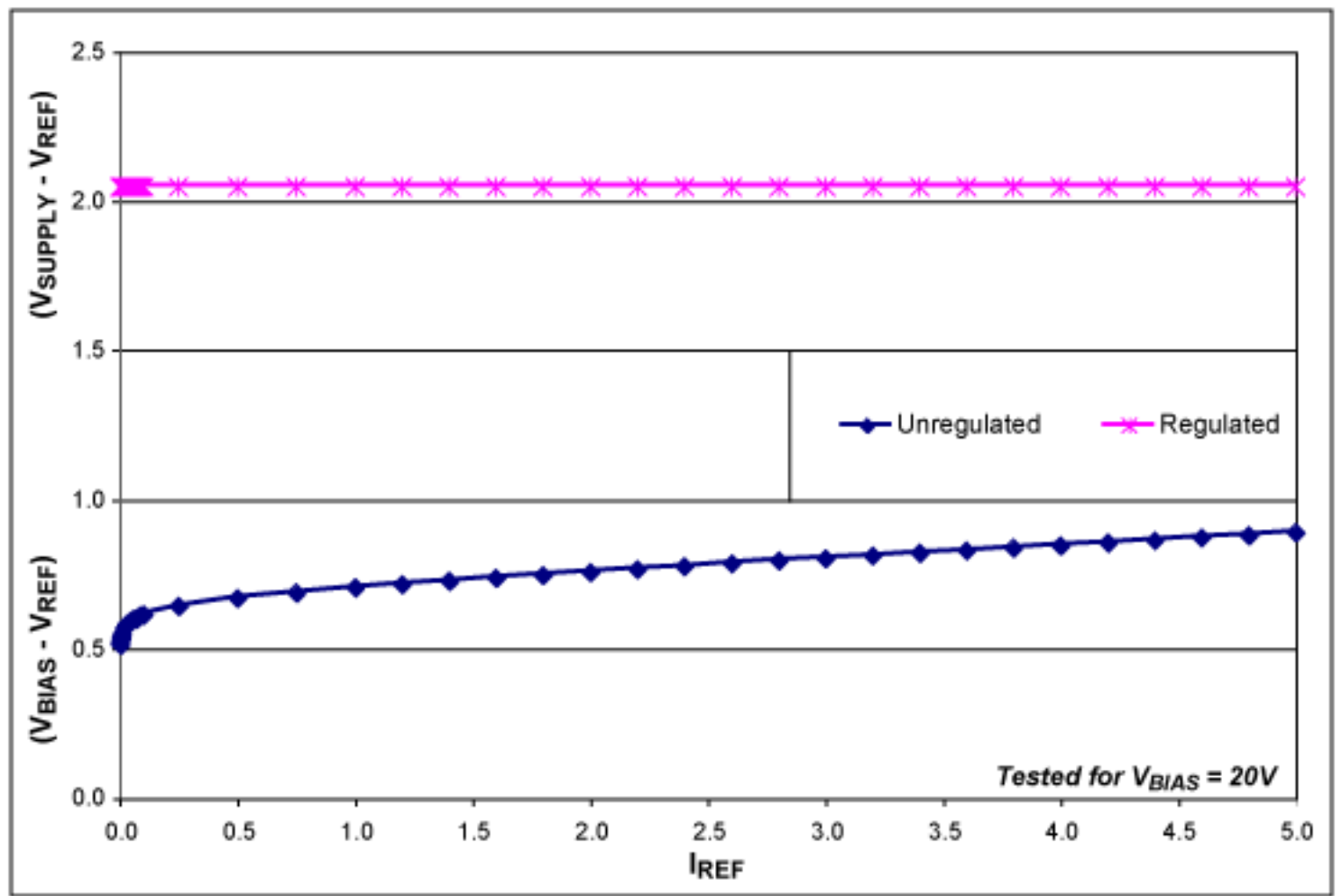


Figure 2. Variation of the reference voltage with I_{REF} .

Regulator Circuit

The regulator circuit shown in **Figure 3** solves both of the above-mentioned problems by maintaining a constant voltage drop from V_{SUPPLY} to V_{REF} . It consists of a 2.048V stable reference (the MAX6007) and a low-bias-current op amp (the MAX4037) with a 1.2V internal buffered reference. Resistor R1 sets the bias current.

The op amp supply will always see a difference across its supply of 3.248V ($2.048V + 1.2V$) over the full 5V to 76V supply-voltage range. The output of the MAX4037 op amp is fed to the BIAS pin of the MAX4007, and its REF pin connects to the inverting input of the op amp. The op amp absorbs any change in the REF voltage by keeping this voltage fixed to the voltage at its noninverting input ($V_{SUPPLY} - 2.048V$). The MAX4037 is able to source currents over the entire 1 μ A to 4mA photodiode-current range.

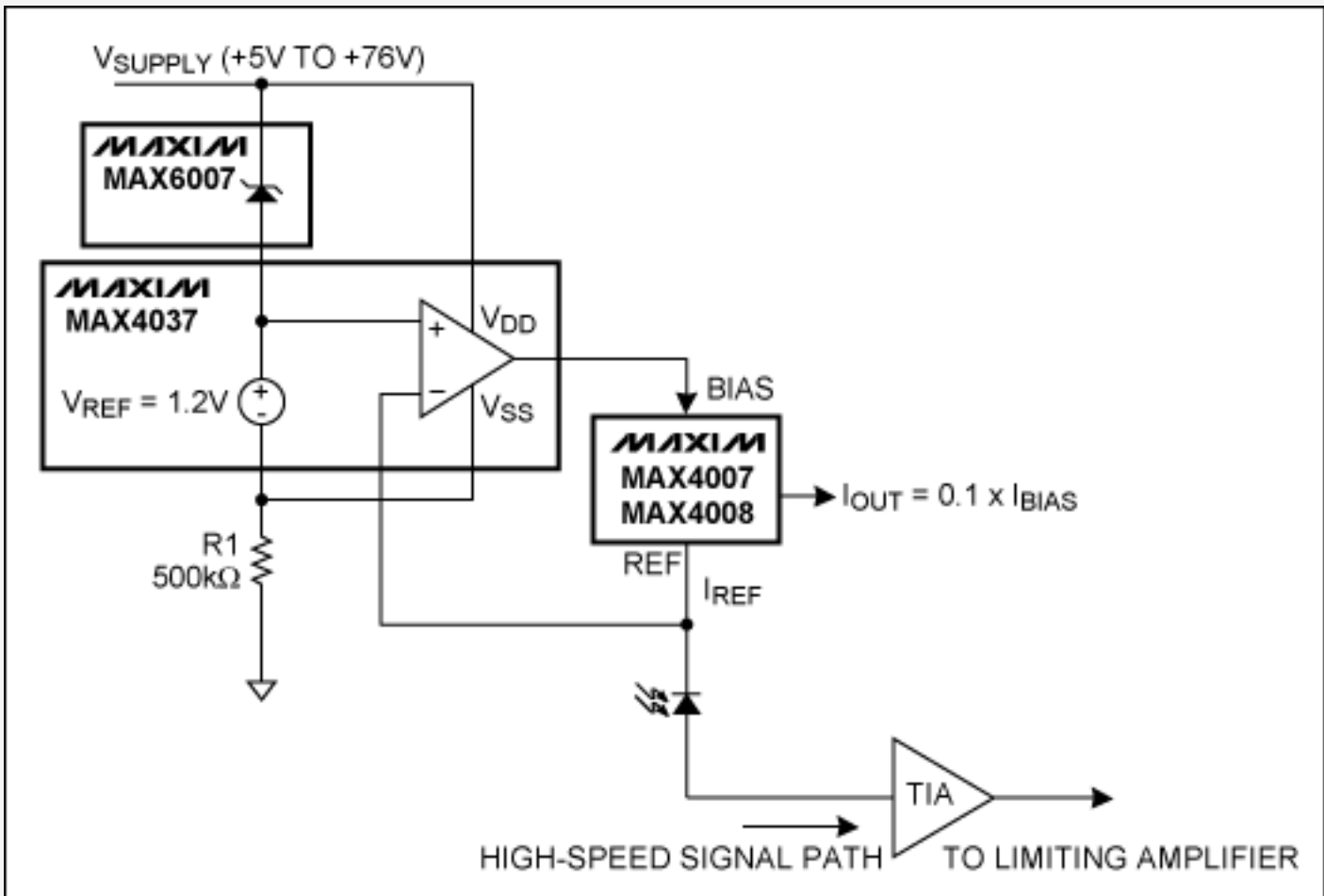


Figure 3. Regulator circuit for the MAX4007/MAX4008 current monitor.

Based on the plot of the regulated output in Figure 2, one can conclude that for the 1 μ A to 4mA photodiode-current variation the REF voltage ($V_{SUPPLY} - V_{REF}$) is constant at 2.047V. **Figure 4** illustrates that this voltage remains constant for supply voltages from 5V to 76V for different reference currents of 1mA, 3mA, and 4mA.

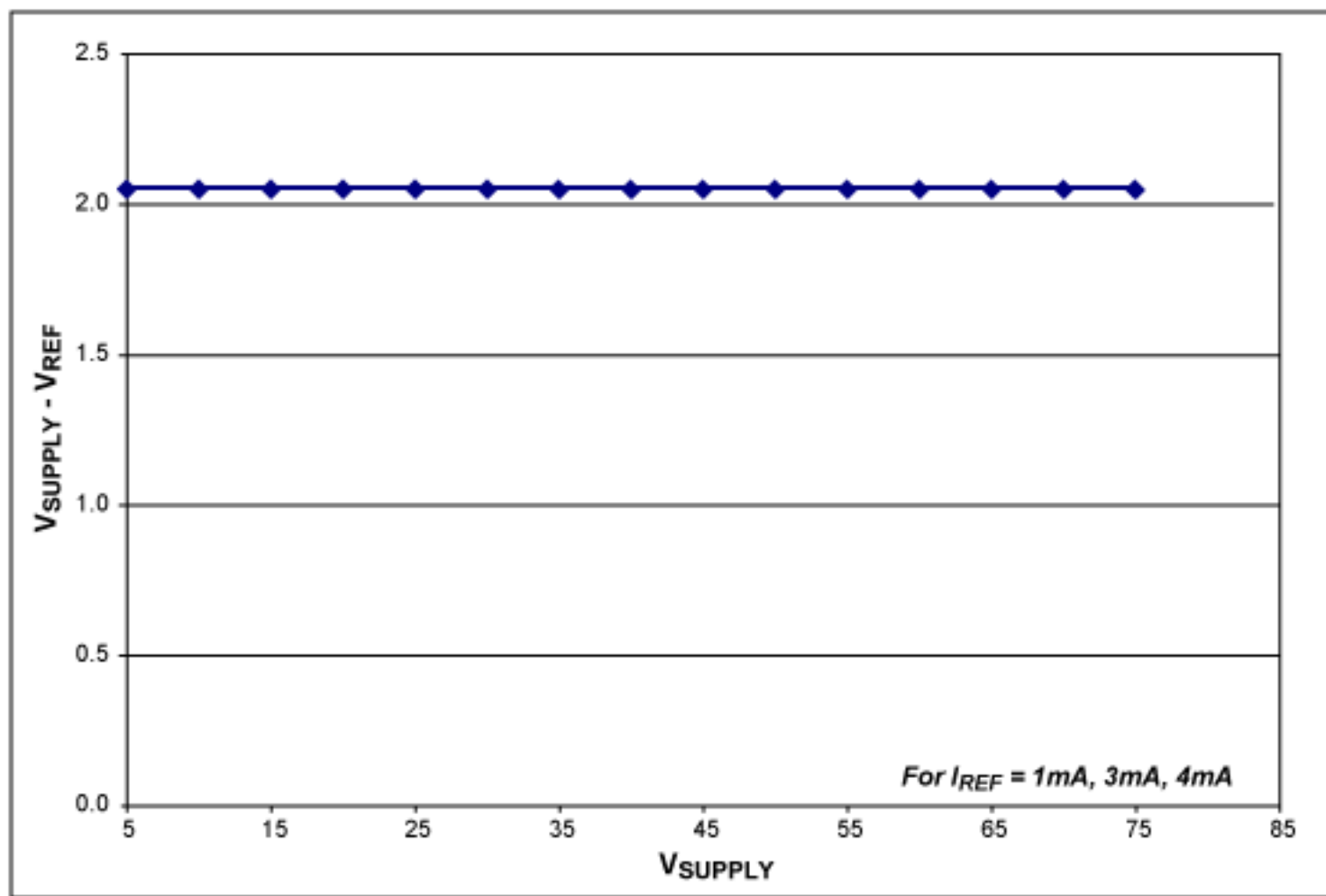


Figure 4. $V_{SUPPLY} - V_{REF}$ vs. V_{SUPPLY} for different values of bias currents.

A slight voltage error is introduced by a couple of error sources. One is the offset voltage of the MAX4037 op amp, but this is very low ($\pm 2.0\text{mV}$) and drifts only by $100\mu\text{V}/^\circ\text{C}$ over temperature. The second one is the breakdown-voltage variation of the MAX6007, which varies by $\pm 1.3\text{mV}$ over the current range and $75\text{ppm}/^\circ\text{C}$ over temperature. Despite these error sources, the proposed regulator circuit represents a significant improvement over the unregulated circuit.

Conclusion

The circuit proposed in this application note nullifies any variation in the voltage drop across the MAX4007/MAX4008 current monitor. Consequently, it provides a stable, known voltage for the photodiode in fiber applications over the full range of load currents and supply voltages.

Application note 4122: www.maxim-ic.com/an4122

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