

capacitance and noise gain. Table 1 and Figure 3 show the bandwidth and noise performance achieved with several large-area photodiodes (and a small-area SFH213 for comparison). Note that large-area detectors also place extra demands on the gain bandwidth of an amplifier. The final case in Table 1 shows a 1MΩ transimpedance amplifier with 650kHz bandwidth from a 660pF photodiode. Although this may not seem like much bandwidth, it necessitates a gain bandwidth product of at least 1.8GHz in the amplifier.

The task of the LT1793 is to keep the JFET biased at its I_{DSS} current ($V_{GS} = 0V$); it was selected for its low 100pA maximum input offset current over temperature. The LT1793 senses the input voltage at the JFET gate through R1 and nulls this voltage through the LT1806 inverting pin and back around through R4. The time constants formed by R1C1 and R3C3 ensure that the LT1793 noise characteristics do not add to the total noise. C1 shunts the already low LT1793 current noise to ground and R3C3

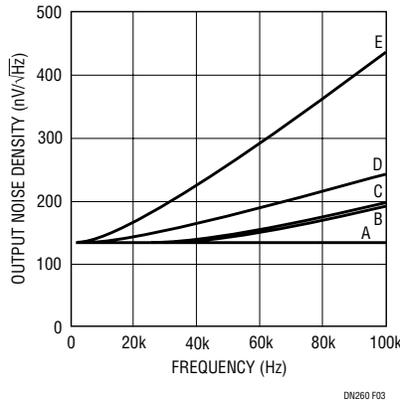


Figure 3. Output Noise Spectra for Various Photodiodes

Table 1. Performance of the Composite Amplifier with Various Photodiodes

	Vendor	Part Number	Optical Character	Typical $V = 0$ Capacitance	Approximate Bandwidth
A	Siemens/Infineon 408-456-4071	SFH213	Fast IR PIN	11pF	250kHz
B	Siemens/Infineon 408-456-4071	BPW34B	Enhanced Blue PIN	72pF	390kHz
C	Opto-Diode 805-499-0335	ODD45W	Narrow IR GaAlAs	170pF	380kHz
D	Fermionics 805-582-0155	FD1500W	Extended IR InGaAs	300pF	500kHz
E	Siemens/Infineon 408-456-4071	BPW21	Visible Spectrum	660pF	650kHz

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keeps the LT1793 and resistor thermal noise away from the LT1806 low noise op amp input. Note that with the JFET gate at 0V, there is no reverse bias across the photodiode, eliminating dark current issues.

At first glance, the circuit does not appear stable, since the JFET circuit puts additional gain into the op amp loop and this is usually a recipe for disaster. The reason the circuit is stable (and with quite a bit of margin) is that the gain is greater than unity at frequencies above a few hundred Hz. Because of the relatively high value of the feedback impedances (1MΩ and 0.5pF) and the 75pF minimum input capacitance of the JFET, the gain of the circuit is 150 minimum above 300kHz. The LT1806 is a 325MHz gain bandwidth, unity-gain-stable op amp, so it is quite comfortable maintaining stability above 300kHz in what it sees as about a gain of 19 (150/8). Note that because the JFET circuit has a gain of 8, the gain bandwidth of the composite amplifier is about 2.4GHz. Also of interest are the open-loop gains of 2.4 million ($8 \cdot 300,000$) in the fast loop and 350 billion ($3.5 \text{ million} \cdot 300,000/3$) in the slow loop. These numbers, along with the gain bandwidth and the 1M feedback resistor, determine the impedance that the photodiode sees looking into the amplifier input.

Conclusion

The LT1806 offers exceptional bandwidth and low noise in a SOT-23 package. The rail-to-rail inputs and outputs make the op amp easy to apply and maximize the available dynamic range. The tiny package makes the op amp a compelling choice where PCB real estate is at a premium. The composite photodiode amplifier shown above is just one example where the LT1806 meets a difficult set of requirements. Let's talk about YOUR difficult set of requirements today.