LT1222 and LT1793 Low Noise Transimpedance Amplifier

DESCRIPTION

Demonstration circuit 1416 is a low noise transimpedance amplifier. It utilizes the low voltage noise LT®1222 op amp, and the low current noise LT1793 op amp, along with the discrete NXP JFET BF862[1] or equivalent, allowing the user to take advantage of each component's particular optimization. These components are arranged with jumpers allowing various composite configurations. A socketed photodiode, OSRAM SFH213, is also provided.

Design files for this circuit board are available at http://www.linear.com/demo/DC1416

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, V_S = ±12V

SYMBOL	PARAMETER	CONDITIONS	TYP	UNITS
V_S	Supply Voltage		±12	V
A_Z	TIA Gain		1M	Ω
V_{OS}	Input Offset Voltage	LT1793 (V_{OS} + I_{BIAS} • 10M)	300	µV
dV_{OS} /dT	Input Offset Voltage Drift	LT1793 (dV_{OS}/dT +dI_{BIAS}/dT • 10M)	10	µV/C
I_{BIAS}	Input Bias Current	LT1793 + BF862[1]	6	pA
en	Input Voltage Noise Density	f = 100kHz, JFET In Gain Configuration	1	nV/√Hz
en	Input Voltage Noise Density	f = 100kHz, Source Follower Configuration	3	nV/√Hz
C_{IN}	Input Capacitance	f = 10kHz, Source Follower Configuration	2	pF
GBW	Gain Bandwidth Product	JP In (C_{COMP} = 49pF)	70	MHz
GBW	Gain Bandwidth Product	JP Out (C_{COMP} = 10pF)	190	MHz
GBW	Gain Bandwidth Product	JP Out, C7 Removed (C_{COMP} = 0pF)	500	MHz
BW	–3dB Bandwidth	With SFH213, 1MΩ Gain, JP7 Out	2	MHz
V_{OUT}	Output Voltage Swing	Cathode Input, Integrator In	0 to 10	V
V_{OUT}	Output Voltage Swing	Cathode Input, Integrator Out	–0.4 to –10	V
V_{OUT}	Output Voltage Swing	Anode Input, Integrator In	0 to –10	V
V_{OUT}	Output Voltage Swing	Anode Input, Integrator Out	–0.4 to –10	V
I_{CC}	Supply Current	V_S = ±12V	17	mA
I_{BIAS}	Input Bias Current	LT1793 + BF862[1]	6	pA
PSRR	Power Supply Rejection Ratio	±5V to ±15V, Integrator In	95	dB

Note 1) BF862 has been obsoleted as of 2017. On-Semi 2SK932-22 has been substituted, with practically identical performance.

OPERATING PRINCIPLES

Composite amplifiers using single JFET inputs can be classified into two groups: common drain (or "source follower") and common source (or "JFET in gain"). The standard jumper configuration of this board, as shipped and as indicated on the silkscreen, has the JFET as a source follower.

Another classification is DC accuracy. The LT1793 has been provided on board as an integrator to provide DC accuracy, overriding the high 400mV or so V_{GS} of the JFET. The standard jumper configuration is "Integrator In", so the TIA will be DC accurate to within the V_{OS} of the LT1793 (900µV max). With the integrator removed from the circuit, the DC error rises to 400mV or so.

The feedback resistor, which sets the TIA gain, is 1MΩ. So the output will respond at 1V per microamp of photocurrent.

QUICK START PROCEDURE

Demonstration circuit 1416 is shipped with the jumpers set for source follower operation with the integrator in. If the jumpers have been changed, restore them to the positions shown in the schematic. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. With power off, connect the +12V, –12V, and Com leads from the power supply to the V^+, $V^–$, and GND terminals of the demo circuit, as shown in Figure 1.
2. With power off, connect the V_{OUT} of the demo circuit to an oscilloscope or DMM. You can use either the gold SMA connector or the turrets provided on board, or both. Set a high range such as 2V/DIV on the oscilloscope, or V_{DC} on the DMM.
3. Turn on the power supply.
4. You should now be able to wave your hand over the clear photodiode provided on the board (upper left of Figure 1) and see the effect in both DC signal and noise. With the photodiode in darkness, or removed from its socket, the output should sit near ground.
5. You can now connect an optical source to excite the photodiode in a more controlled manner. The easiest way is to drive an LED directly from a function generator, with the function generator's internal 50Ω source impedance as a current limiter. Any standard color or IR LED can be used, as the photodiode provided has a wide sensitivity. Be careful not to overdrive sensitive devices such as small lasers.
6. You can now decide whether to play with other configurations (JFET in gain, integrator out, more compensation, etc), or to replace the provided photodiode with the one you intend to use.

QUICK START PROCEDURE

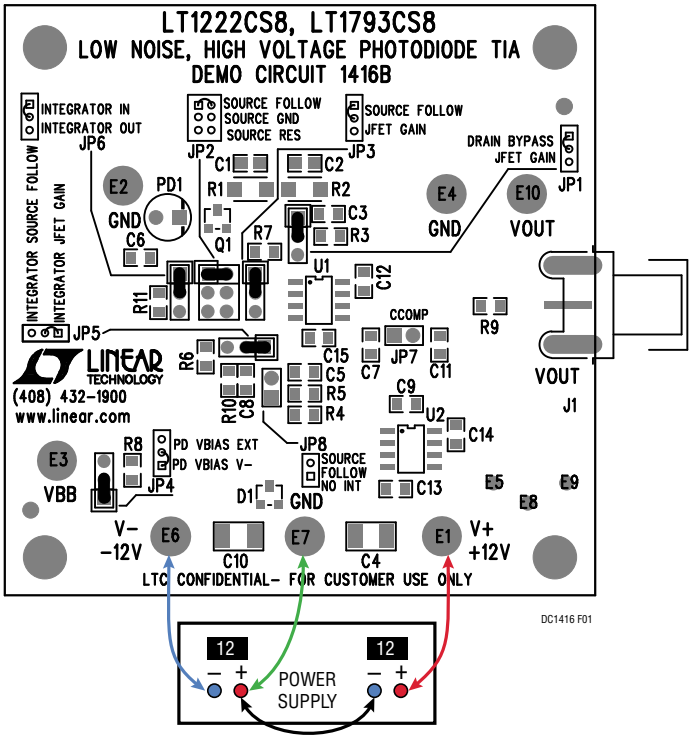

Figure 1. Proper Supply Connections. Board Is Shown for Source Follower with Integrator In (JP1 through JP6 Have Shunt in Position 1. JP7 and JP8 Are Open.)

Table 1. Jumper Settings for Various Configurations. Refer to Figures 2 and 3 for Qualitative Descriptions of the Configurations and to Figure 4 for the Complete Schematic.

JUMPER	TYPE	CIRCUIT	SOURCE FOLLOWER INTEGRATOR IN	SOURCE FOLLOWER INTEGRATOR OUT	JFET IN GAIN INTEGRATOR IN	JFET IN GAIN INTEGRATOR OUT
JP1	1x3	JFET Drain	1, 2	1, 2	2, 3	2, 3
JP2	2x3	JFET Source	1, 2	1, 2	5, 6	3, 4
JP3	1x3	LT1222 –Input	1, 2	1, 2	2, 3	2, 3
JP4	1x3	Photodiode Bias	1, 2	1, 2	1, 2	1, 2
JP5	1x3	Integrator Output	1, 2	Out	2, 3	Out
JP6	1x3	Integrator Input	1, 2	2, 3	1, 2	2, 3
JP7	1x2	LT1222 Compensation	Out	Out	In	In
JP8	1x2	LT1222 +Input	Out	In	Out	Out

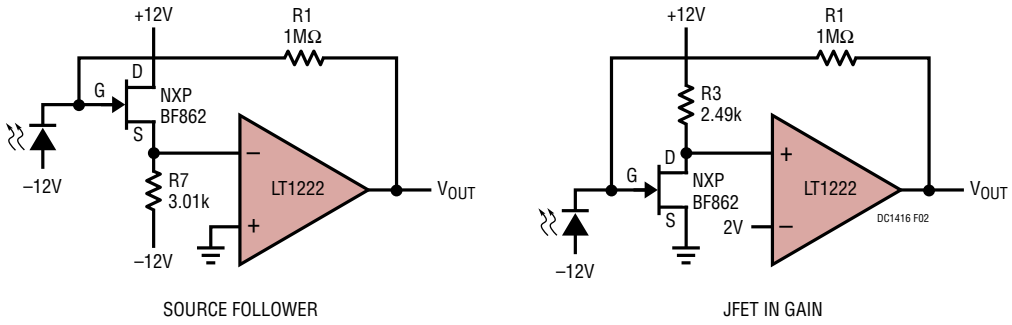

Figure 2. The Two Basic Types of JFET Configuration. The Left Shows the JFET as a Source Follower, Simply Buffering the Feedback Resistor to the Op Amp's Inverting Input. The Right Shows the JFET In Gain, with Source Grounded. Because the JFET Inverts, the Feedback Is Now Applied to the Op Amp's Non-Inverting Input. In Both Cases, the Effective Input Offset Voltage Is One JFET V_{GS} (About –400mV). The Source Follower Configuration Is the Simplest and Most Versatile, but the JFET In Gain Configuration Offers the Highest Achievable Gain-Bandwidth Product and the Lowest Voltage Noise. Output Noise at Low and Medium Frequencies (10kHz to 100kHz) Is 130nV/√Hz, Dominated Entirely by the Feedback Resistor

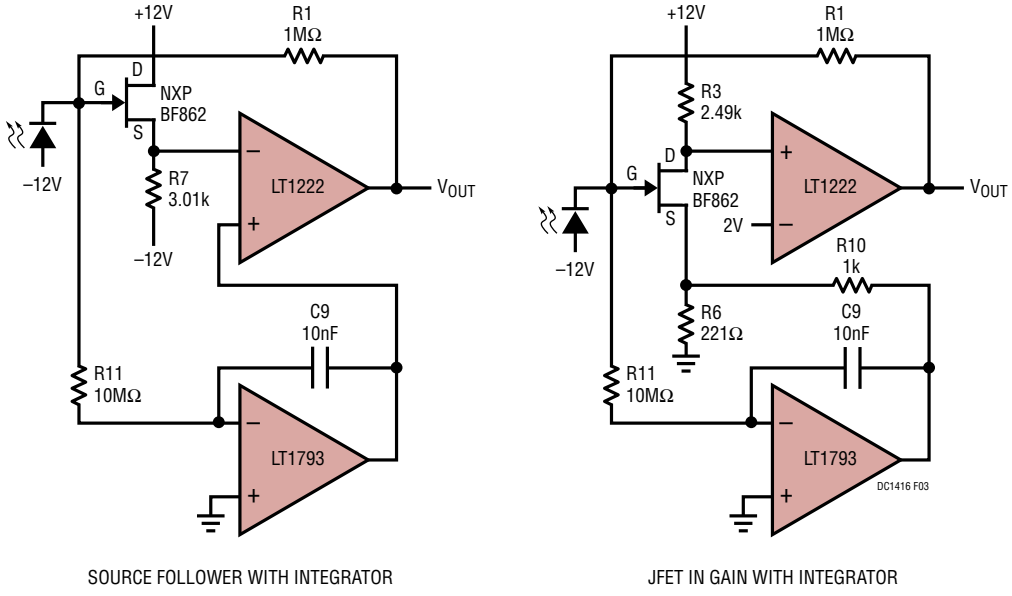

Figure 3. The Two Basic Types of JFET Configuration Again, but Shown with LT1793 Integrators which Zero Out the Overall Input Offset Voltage. On the Left, the JFET V_{GS} Is Forced to the LT1793 Non-Inverting Input. On the Right, the Integrator Puts JFET V_{GS} at the Source Directly. In both Cases, the 10M Sensing Resistor R11 Injects 40fA/√Hz of Current Noise, which Is Discernible but Relatively Small Compared to the 130fA/√Hz of the 1M Feedback Resistor. The Output Noise at Low to Medium Frequencies Is about 136nV/√Hz

SCHEMATIC DIAGRAM

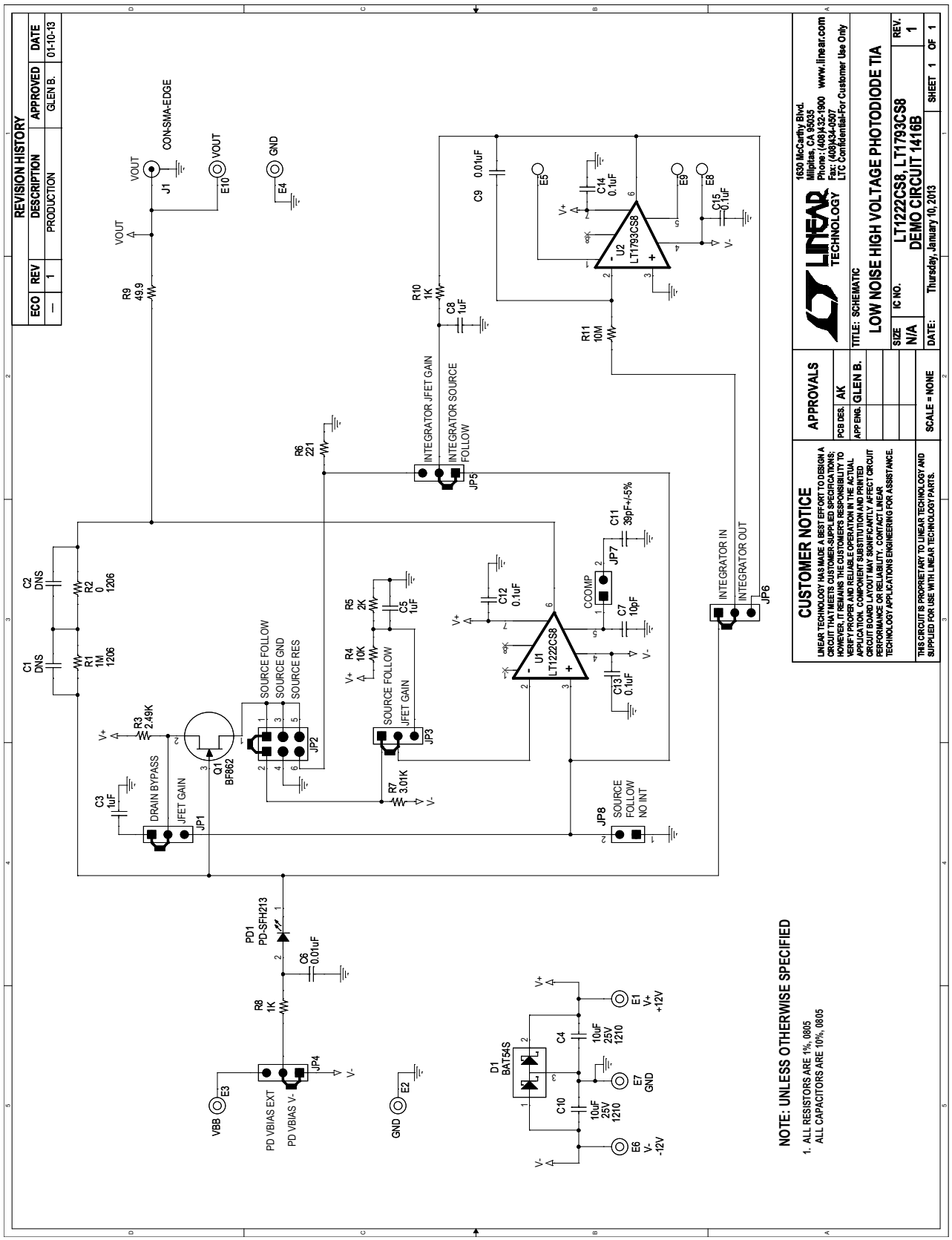

Figure 4. DC1416 Demo Circuit Schematic

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.

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