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APPLICATION BULLETIN
Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (602) 746-1111 • Twx: 910-952-111 • Telex: 066-6491 • FAX (602) 889-1510 • Immediate Product Info: (800) 548-6132

VERY LOW COST ANALOG ISOLATION WITH POWER

By Mark Stitt (602) 746-7445

You can make a low-cost, precision analog isolation amplifier (ISO amp) with power by combining the ISO122 low-cost ISO amp with the HPR117 low-cost DC/DC converter. With isolated signal and isolated power in separate packages, complete application flexibility is assured.

The ISO122 features:

- Unity gain (±10V In to ±10V Out): ±0.05%
- 0.02% max nonlinearity
- 5mA quiescent current
- 140dB isolation mode rejection at 60Hz
- 1500Vrms continuous isolation rating (100% tested)

The HPR117 features:

- $V_{OUT} = V_{IN}$, ±5% (V_{IN} = 13.5V to 16.5V, I_{OUT} = 25mA)
- I_{OUT} = 25mA (750mW) continuous at 85°C
- 8mA quiescent current, no load
- 80% efficiency, full load
- Low output ripple
- 750VDC isolation rating

OUTPUT-SIDE POWERED ISO AMP

The most commonly used ISO amp configuration is shown in Figure 1. Both the ISO amp and the DC/DC converter are powered at the output side of the ISO amp. The HPR117 is connected to +15V and ground. The ISO122 is connected to ±15V and ground. The power-supply connections for the input side of the ISO amp are connected directly to the HPR117 output. No bypass capacitors are needed. The HPR117 has built-in 0.33µF bypass capacitors on both the input and outputs.

The isolated ±15V power output from the HPR117 can also be used for ancillary input-side circuitry such as input amplifiers and references. The ISO122 input section consumes about ±5mA. An additional ±20mA is available for other circuitry.

INPUT-SIDE POWERED ISO AMP

Some applications call for output-side isolation as shown in Figure 2. Isolated ±15V, 20mA auxiliary power is available on the output side for ancillary circuitry.

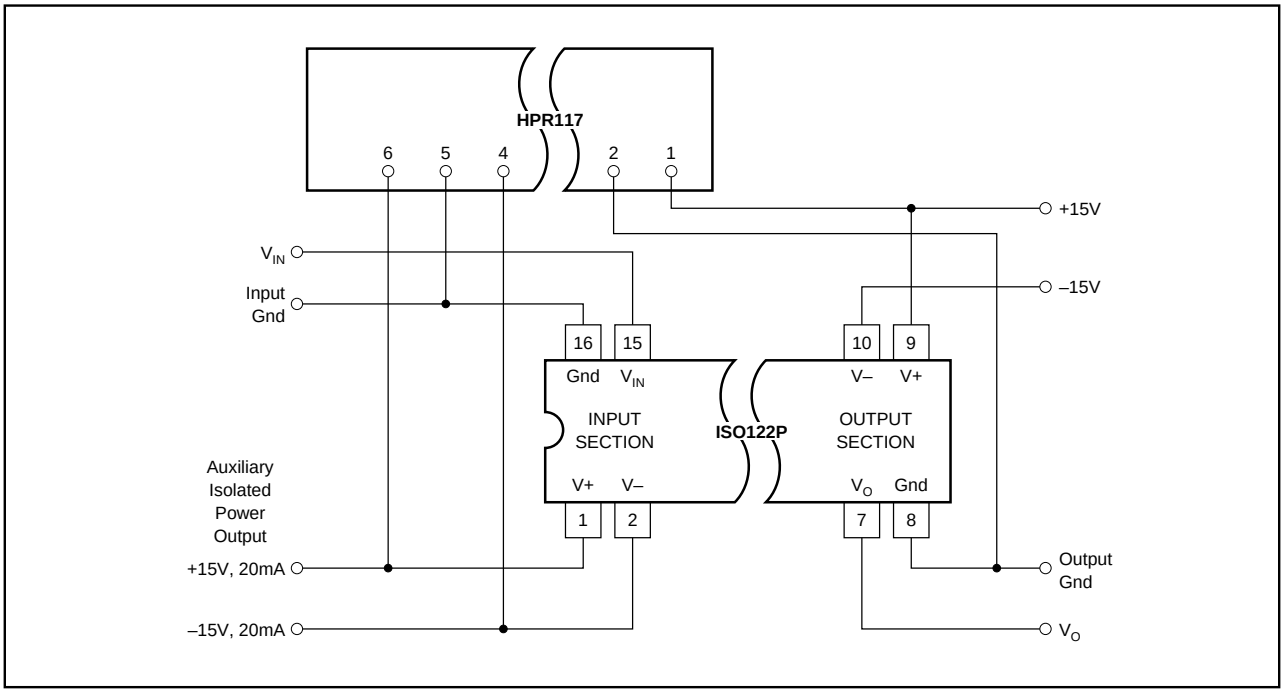

FIGURE 1. Output-Side Powered ISO Amp.

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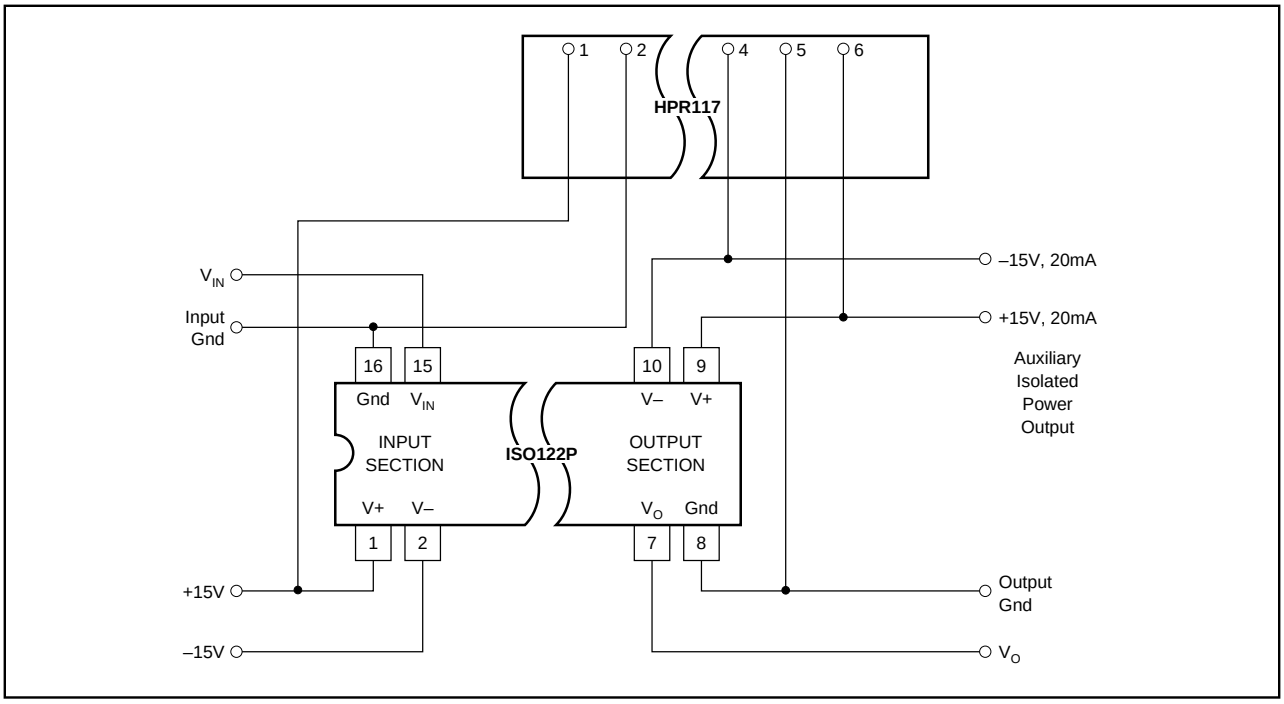

FIGURE 2. Input-Side Powered ISO Amp.

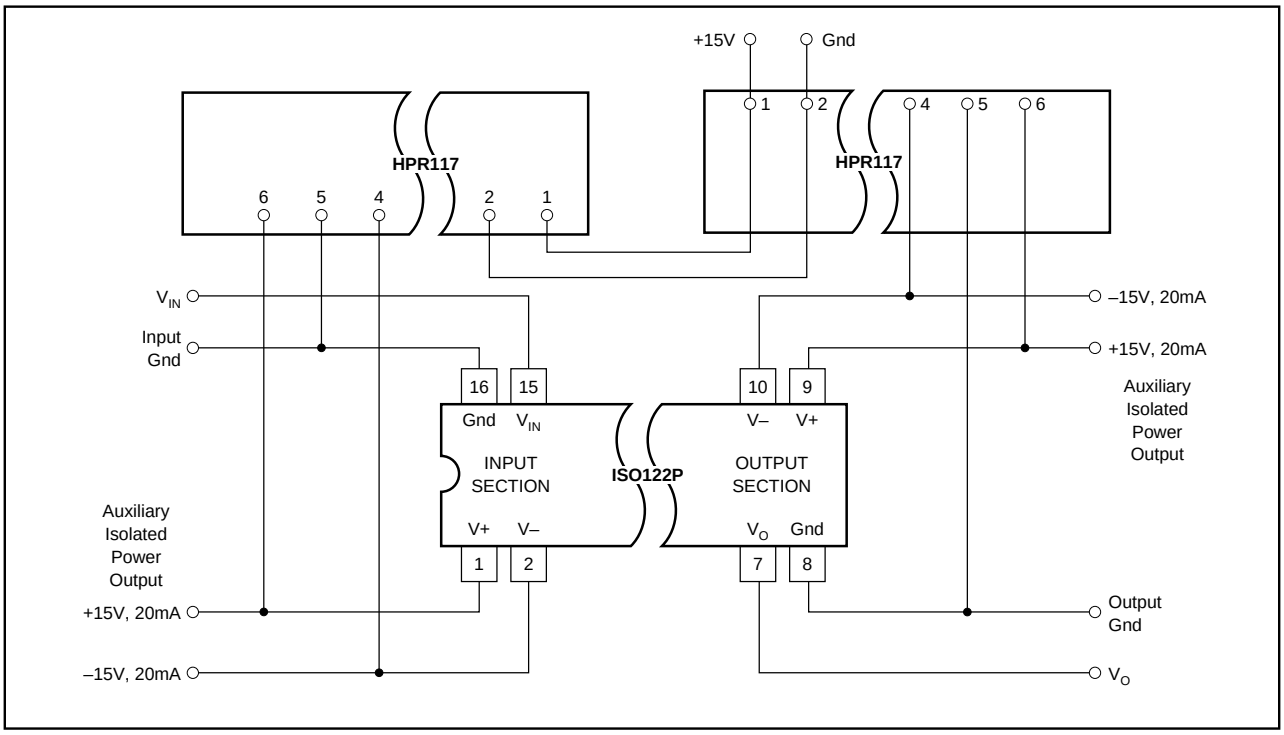

FIGURE 3. Powered ISO Amp with Three-Port Isolation.

THREE PORT ISO AMP

Some applications call for three-port isolation as shown in Figure 3. Both the input and output side of the ISO amp are isolated from the power-supply connection. Isolated ±15V, 20mA auxiliary power is available on both the input and output side of the ISO amp.

ADD RC FILTER TO POWER SUPPLY OUTPUT FOR LOW NOISE

Although performance is good using the ISO122 connected directly to the HPR117, best performance can be achieved with additional filtering. The output ripple of the HPR117 can interact with the ISO122 modulator/demodulator cir-

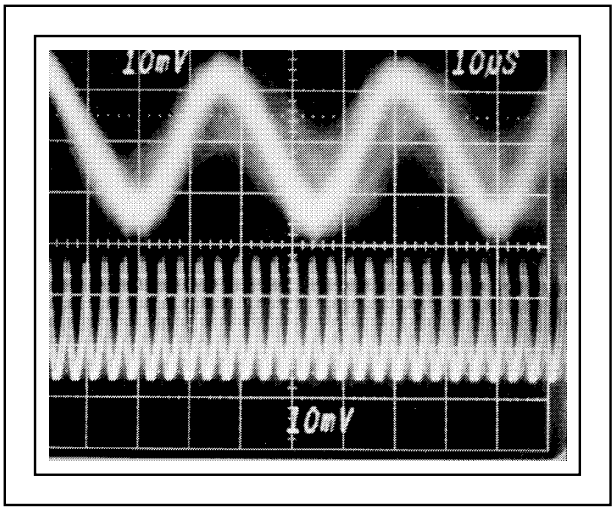

FIGURE 4. Oscilloscope Photograph Showing Typical HPR117 Power Supply Ripple (bottom trace) and Typical 30kHz, 30mVp-p Noise at the ISO122 Output Due to Aliasing of Power Supply Ripple.

cuitry through the power-supply pins resulting in an aliased noise signal within the signal bandwidth of the ISO amp. The 30kHz, 30mVp-p upper trace in Figure 4's scope photo is a typical example. The lower trace in the scope photo is the HPR117 output ripple with the ISO122 plus a 2kΩ load. Adding simple R, C filters in the outputs from the HPR117 as shown in Figure 5 eliminates the problem.

The R,C filter shown in Figure 5 can also be used with either the Figure 1 or Figure 2 circuit. Since the DC/DC converter can induce a substantial amount of ripple on input-side connections, filters may still be needed on both the input-side and output-side power supply connections of the ISO122 to prevent noise due to signal aliasing.

The filter resistors will degrade the load regulation of the DC/DC converters. In addition to the specified HPR117 load regulation, there will be an additional 50mV/mA drop through the 50Ω filter resistors. Although this results in only a 1.25V drop at the full-rated 25mA output, you may want to use smaller value resistors and commensurately larger value filter capacitors if power-supply sensitive ancillary circuitry is needed.

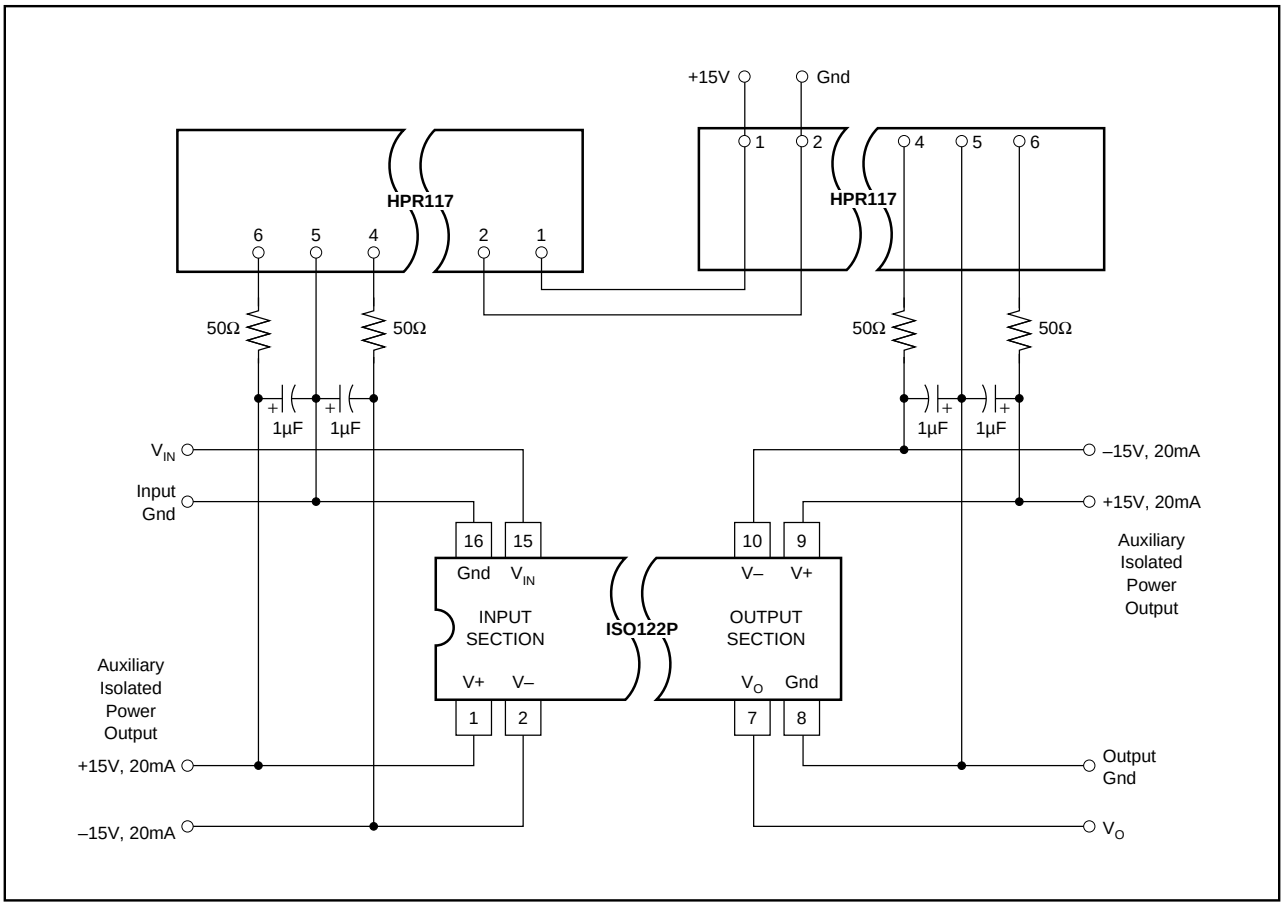

FIGURE 5. Three-Port Isolation Amplifier with R, C Power Supply Filters (eliminates power-supply induced noise).

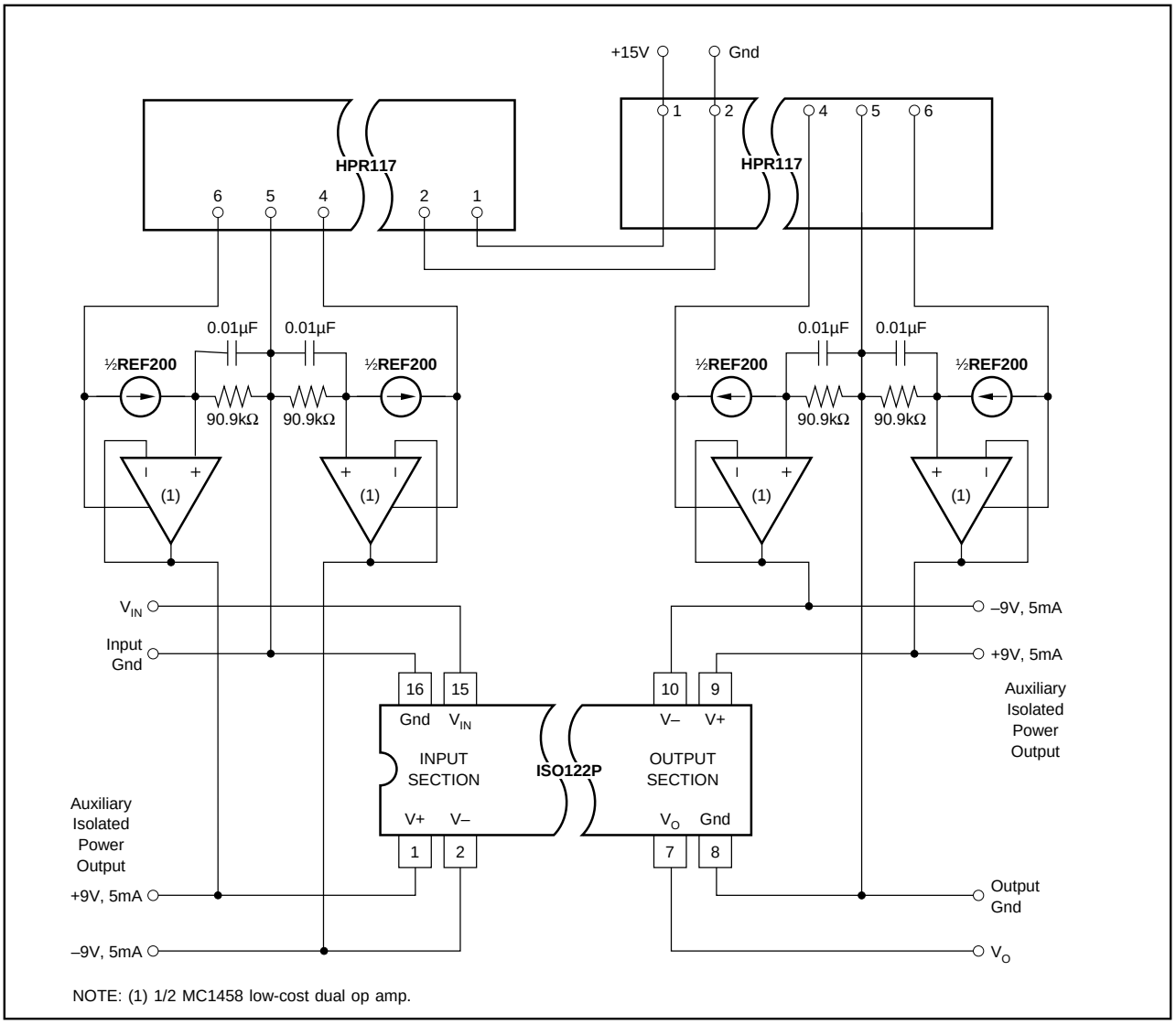

FIGURE 6. Power Supply Regulation in Three-Port Isolation Amplifier (eliminates power-supply induced noise and improves power-supply rejection).

ADD REGULATION FOR IMPROVED POWER-SUPPLY REJECTION

Output ripple can be eliminated and power-supply rejection of the three-port isolation amplifier can be improved as shown in Figure 6. The circuit consists of a dual 100µA current source (the REF200) driving 90.9kΩ resistors to set-up a ±9.09V reference. An inexpensive dual op amp (e.g. Motorola MC1458) is connected as a unity-gain follower to buffer the reference and drive the ISO122. With this circuit, the power-supply rejection is improved from a typical 2mV/V to less than ±1mV for a full 14V to 16.5V input change—(0.4mV/V).

When using the Figure 6 circuit, ISO amp output swing will be reduced. The ISO122 output swing is ±12.5V typ, ±10V min on ±15V supplies. With the ±9V regulated supplies, output swing will be ±6.5V typ, ±4V min.