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APPLICATION BULLETIN
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SIMPLE CIRCUIT DELIVERS 38Vp-p AT 5A FROM 28V UNIPOLAR SUPPLY

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Since the first analog IC requiring bipolar supplies was developed, people have been trying to operate them from unipolar supplies. Not only do the "headroom" ($V_S - V_{OUTMAX}$) requirements come into play, but with a unipolar supply typically come unipolar outputs. To get bipolar output swings from a unipolar supply, drive the load differentially and create a reference signal which can be used a "pseudo ground" for amplifier and input signal reference. **This circuit topography requires that your signal be elevated to $V_S \div 2$.**

The INA105 is a precision unity gain differential amplifier, and as a low cost monolithic circuit, it offers high reliability and accuracy. With an initial offset voltage of 50µV, gain error of 0.005%, and small signal bandwidth of 1MHz, the INA105 makes an ideal amplifier for creating this pseudo ground. The OPA2541 is a dual power operational amplifier capable of operation from power supplies up to ±40V (or a single, unipolar 80V) at output currents of 5A continuous. With two monolithic power amplifiers in a single package it provides unequaled functional density, and provides the means to deliver differential outputs at high power. By using the INA105 to create the pseudo ground, and the OPA2541 to drive 5A loads differentially, the circuit in Figure 1 can be developed. At 5A output current, the OPA2541 requires a typical headroom of 4.5V, and as configured, output voltage swings of $2V_S - 18V$ (peak-to-peak) can be achieved. The output swing can be calculated by realizing that when one of the amplifiers reaches its positive output limit ($V_S - V_{HEADROOM}$), the other amplifier should reach its negative output limit ($0V + V_{HEADROOM}$). This creates a voltage swing

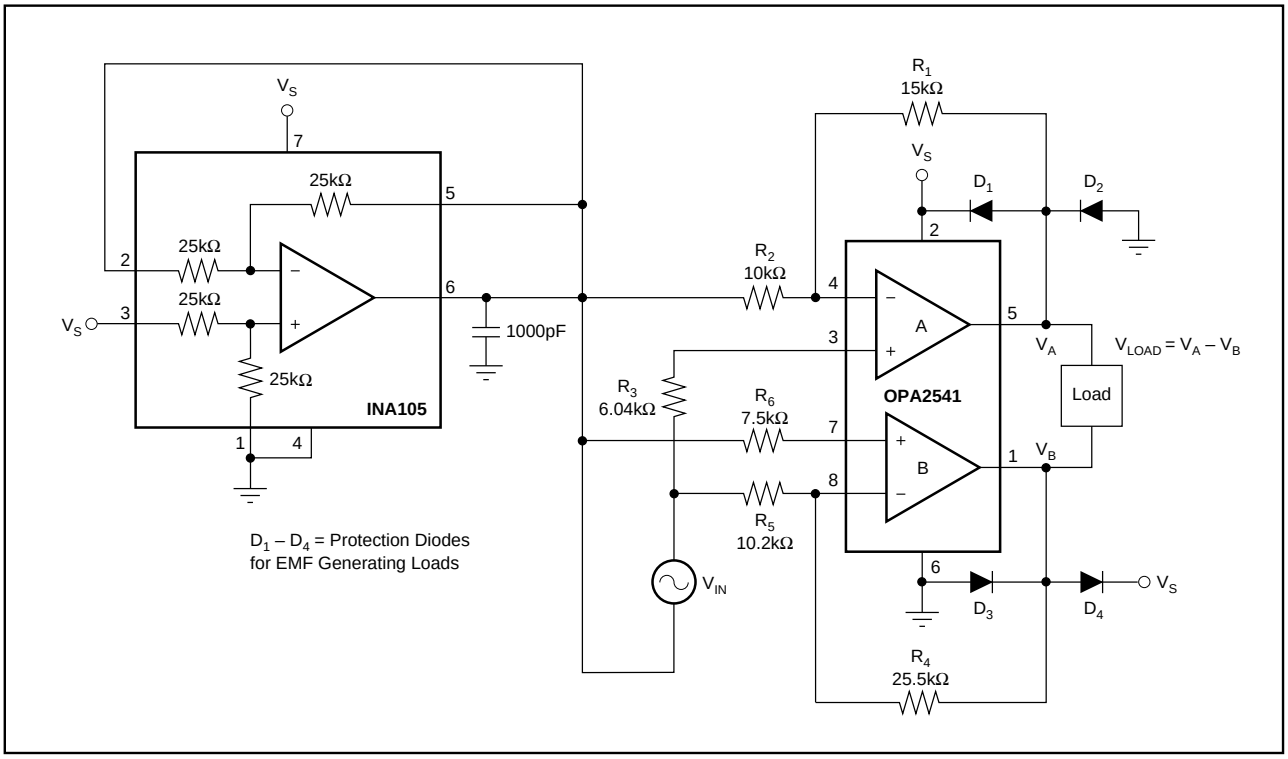

FIGURE 1. Single Supply, Bipolar Output Swing for Floating Signal Source.

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of $V_S - 2V_{HEADROOM}$. This is then multiplied by two, when the input signals reverse polarity so do the output signals which are referenced to the pseudo ground. This causes the peak-to-peak output voltage to be $2V_S - 4V_{HEADROOM}$. For standard 28V systems, this means that you can see output swings of 38Vp-p at 5A (see *Equations for detailed explanation*). When only driving 500mA the headroom is typically only 3.2V, and output swings of $2V_S - 12.8V$ are realizable. This means that from the same 28V supply, the peak-to-peak output is 43.2V. By using the maximum rated supply of 80V, a peak-to-peak output of 142V with load currents of 5A can be realized.

Although the OPA2541 is capable of operating with supply voltages up to 80V, the INA105 is limited to an overall power supply voltage of 36V. If higher supply voltages are required, an amplifier such as the OPA445 and a precision resistor network should be utilized for the pseudo ground.

Equations:

V_G = Pseudo ground voltage
= $V_S/2$

V_{IN}' = $V_G + V_{IN}$

V_{LOAD} = Differential voltage across the load
= $V_A - V_B$

A_V = $1 + (R_1/R_2)$
= R_4/R_5

V_A = $V_{IN}' \{1 + (R_1/R_2)\} - V_G (R_1/R_2)$
= $V_{IN}' (A_V) - V_G (A_V - 1)$
= $V_{IN} (A_V) + V_G$

V_B = $-V_{IN}' (R_4/R_5) + V_G \{1 + (R_4/R_5)\}$
= $-V_{IN}' (A_V) + V_G (A_V + 1)$
= $-V_{IN} (A_V) + V_G$

V_{LOAD} = $V_A - V_B$
= $\{V_{IN} (A_V) + V_G\} - \{-V_{IN}(A_V) + V_G\}$
= $V_{IN} (2A_V)$

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