

# An OrCAD PSPICE Library for the VIP10 High-Speed Op Amp

National Semiconductor  
Application Note 1255  
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Creating the op amp SPICE model from ground-up for simulation is esoteric and often time consuming.

National Semiconductor Corporation has an OrCAD Capture library (**nationalhighspeed.olb**) and PSPICE (**nationalhighspeed.lib**) model library for the industry-leading VIP10 process high-speed operational amplifiers. These libraries contain behavior models of the LMH series high-speed operational amplifiers and the schematic symbols of op amp. These libraries are available for download from [www.national.com/amplifiers](http://www.national.com/amplifiers). Libraries are created from OrCAD PSPICE A/D version 9.1 and have been verified to match the performance in the datasheet.

The VIP10 is a high-speed, dielectrically-isolated, complementary bipolar IC process that utilizes deep trench technology on a bonded wafer for complete dielectric isolation and optimal high-speed amplifier performance. Trench technology with bonded wafers helps minimize parasitic capacitance for optimal power-to-bandwidth performance, lower distortion and decreased die size.

When doing the simulation, the path of **nationalhighspeed.lib** needs to be added under either the "Include Files" option or the "Libraries" option in the "Simulation Profile".

## The ADSL Analog Front End for Customer Premises Equipment

One of the very popular applications for LMH high-speed operational amplifiers is the DSL analog front end in the customer premises equipment side. The new LMH6643 rail-to-rail output, LMH6672 line driver, and LMH6622 low-noise op amps form a robust chipset solution that maximizes the ADSL baseband DSP performance as shown in Figure 1.

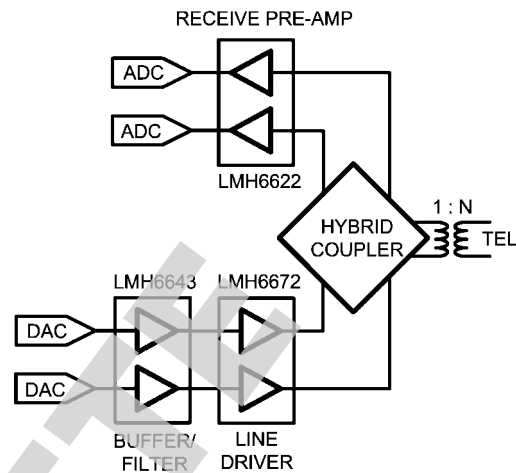
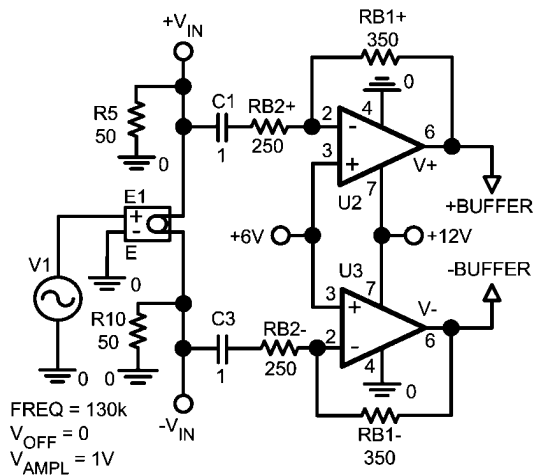


FIGURE 1. Block Diagram of ADSL CPE Analog Front End

## The LMH6643 as a Buffer Amplifier for the D/A Converter

A pair of LMH6643 is used as a differential buffer amplifier at the outputs of digital-to-analog converter for providing impedance matching, isolation, and driving capability to an optional low pass filter between the LMH6643 and the LMH6672. Figure 2 shows the OrCAD schematic to demonstrate the use of SPICE model. The voltage gain of this inverting buffer amplifier is simply defined as  $-R_{B1+}/R_{B2+}$  and  $-R_{B1-}/R_{B2-}$ .

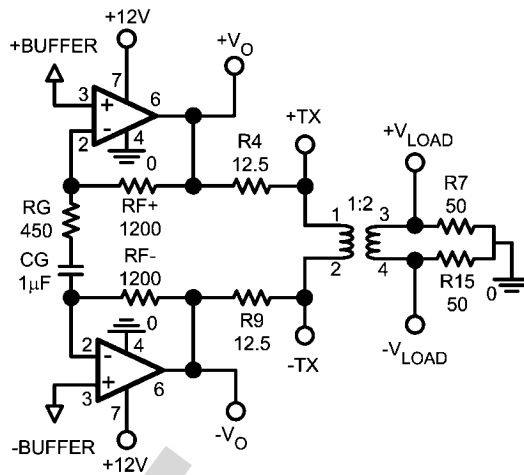


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FIGURE 2. LMH6643 as an ADC Buffer in ADSL CPE Analog Front End

## The LMH6672 as an Upstream Line Driver

The LMH6672 is used as an upstream DSL line driver because of its high-output drive with low distortion and single supply features. When connected as a differential output driver, the LMH6672 can drive a 50Ω load to 16.8 V<sub>PP</sub> swing with only -93 dBc distortion and fully supports the peak upstream power levels for full-rate ADSL. Figure 3 is a typical line driver circuit driving the 100Ω twisted-pair transmission line through a 1:2 transformer. The voltage gain of this non-inverting driver amplifier is simply defined as  $(1+2 \cdot R_F+ / R_G)$  or  $(1+2 \cdot R_F- / R_G)$ . The capacitor C<sub>G</sub> is inserted to set a DC gain of 1 V/V.



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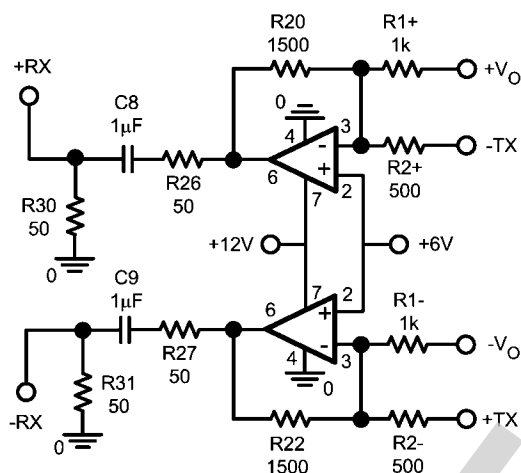
FIGURE 3. LMH6672 as a Differential Driver to a 50Ω Differential Load

## The LMH6622 as a Downstream Low-Noise Pre-Amp

The LMH6622 is used as a low-noise pre-amp in the downstream link because of its low noise and low-distortion performance. This twin personality ensures the receiving path has high dynamic range to meet the stringent linearity and noise requirements of the ADSL standard.

In Figure 4, the LMH6622 is used as an inverting summing amplifier to provide both receive pre-amp channel gain and driver echo signal cancellation. In order to cancel the unwanted driver echo signal in the receive path, R<sub>1+</sub> is set to be 2·R<sub>2+</sub> and R<sub>1-</sub> is set to be 2·R<sub>2-</sub>.

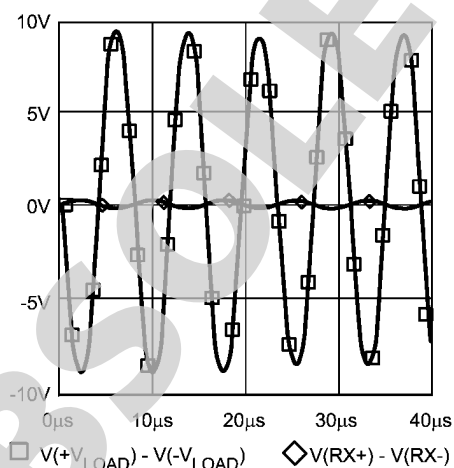
In reality, the hybrid rejection is about 12 dB due to imperfect matching. The resistors values in the simulation can be adjusted to experience the real performance of the receive circuit.



**FIGURE 4. LMH6622 as a Low-noise Pre-amp in the ADSL Downstream**

Figure 5 shows the differential output voltage across the twisted-pair-transmission line and the unwanted echo signal at the

pre-amp's outputs. Perfect cancellation of the unwanted echo signal is possible only if perfect matching is achieved.



**FIGURE 5. Simulation Results at the Transmission Line and Pre-amp's Output**

In conclusion, PSPICE models and Capture symbols for National's high-speed op amps can be downloaded from [amplifiers.national.com](http://amplifiers.national.com) and used for simulation.

## Notes

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Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
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