# LMH6672,LMP8601

***Application Note 1255 An OrCAD PSPICE Library for the VIP10 High-Speed Op Amp***


Literature Number: SNOA427C

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

National Semiconductor
Application Note 1255
Barry Yuen
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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**. 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*.

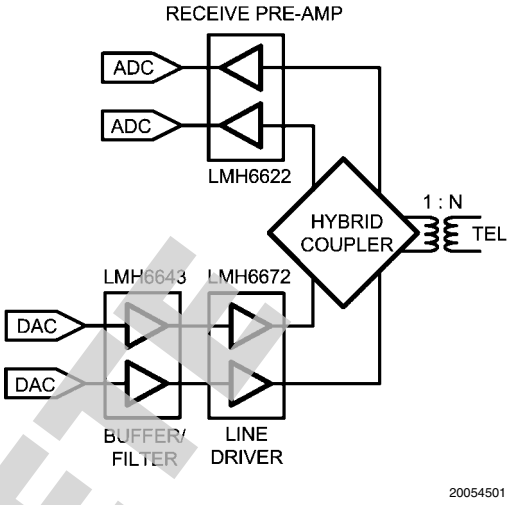


**FIGURE 1. Block Diagram of ADSL CPE Analog Front End**

## 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 simlpy defined as $-R_{B1+}/R_{B2+}$ and $-R_{B1-}/R_{B2-}$











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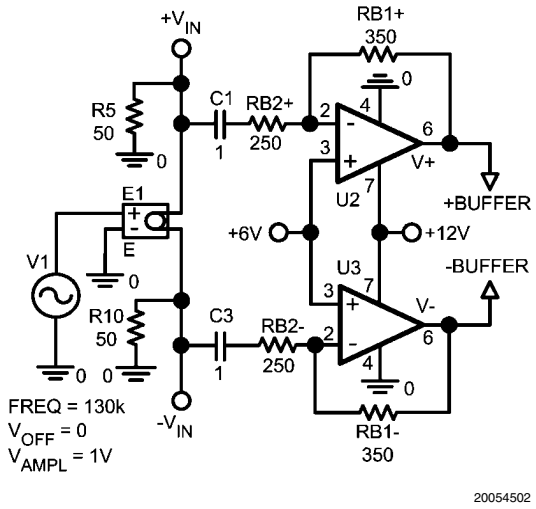


**FIGURE 2. LMH6643 as an ADC Buffer in ADSL CPE Analog Front End**

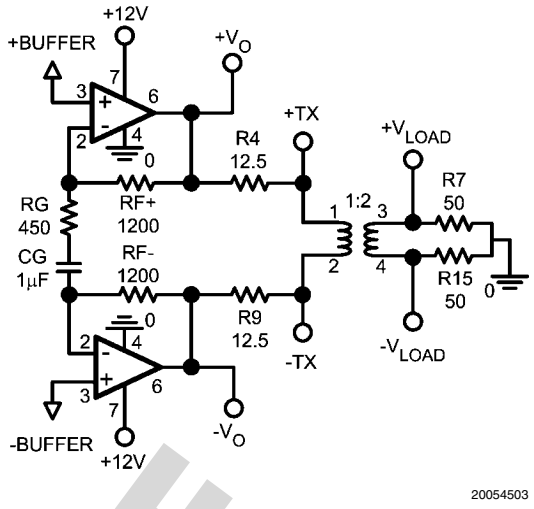


**FIGURE 3. LMH6672 as a Differential Driver to a 50Ω Differential Load**

## 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 $V_{PP}$ 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 $(1+2*R_F+/R_G)$ or $(1+2*R_F-/R_G)$. The capacitor $C_G$ is inserted to set a DC gain of 1 V/V.

## 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, $R_{1+}$ is set to be $2*R_{2+}$ and $R_{1-}$ is set to be $2*R_{2-}$.

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.





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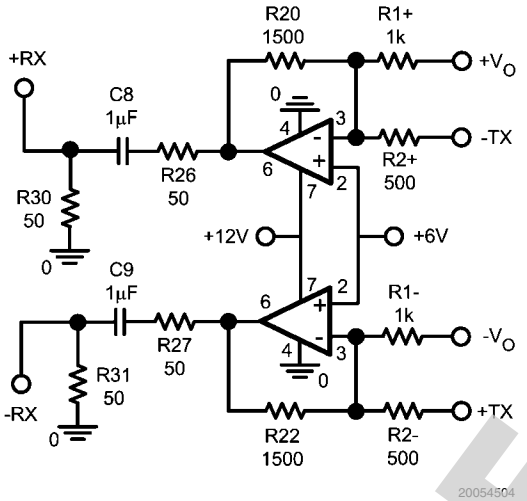


**FIGURE 4. LMH6622 as a Low-noise Pre-amp in the ADSL Downstream**

*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.

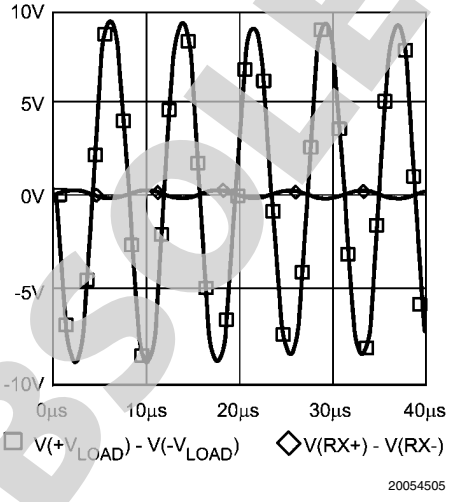


**FIGURE 5. Simulation Results at the Transmission Line and Pre-amp's Output**

In conclusion, PSPICE models and Capture symbols for National's high-speed op amps can be downloaded from **amplifiers.national.com** and used for simulation.

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