ANALOG DEVICES
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APPLICATION NOTE
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Low Voltage Amplifier

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BATTERY VOLTAGE DISCHARGE

The AD8517 operates at supply voltages as low as 1.8 V. This amplifier is ideal for battery-powered applications since it can operate at the end of discharge voltage of most popular batteries. Table I lists the Nominal and End of Discharge Voltages of several typical batteries.

Table I. Typical Battery Life Voltage Range

Battery	Nominal Voltage (V)	End-of-Voltage Discharge (V)
Lead-Acid	2	1.8
Lithium-Ion	2.6–3.6	1.7–2.4
NiMH	1.2	1
NiCd	1.2	1
Carbon-Zinc	1.5	1.1

RAIL-TO-RAIL INPUT AND OUTPUT

The AD8517 features an extraordinary rail-to-rail input and output with supply voltages as low as 1.8 V. With the amplifier's supply range set to 1.8 V, the common-mode voltage can be set to 1.8 V p-p, allowing the output to swing to both rails without clipping. Figure 1 shows a scope picture of both input and output taken at unity gain, with a frequency of 22 kHz, at V_S = 1.8 V and V_{IN} = 1.8 V p-p.

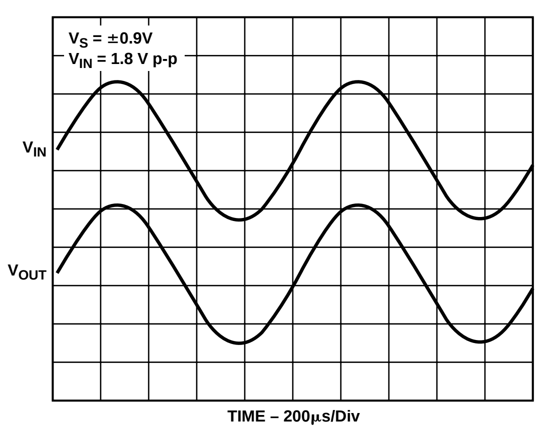

Figure 1. Rail-to-Rail Input Output

The rail-to-rail feature of the AD8517 can be observed over all voltage supply ranges for which the part is being specified, which is from 1.8 V to 5 V.

TOTAL HARMONIC DISTORTION + NOISE

The AD85x7 family offers a low total harmonic distortion, which makes this amplifier ideal for audio applications. Figure 2 shows a graph of THD + N; for a V_S > 3 V, the THD + N is about 0.001% and 0.03% for V_S =1.8 V in a noninverting configuration with a gain of 1. However, with an inverting configuration, the THD + N measures 0.001% for all specified supply voltage ranges.

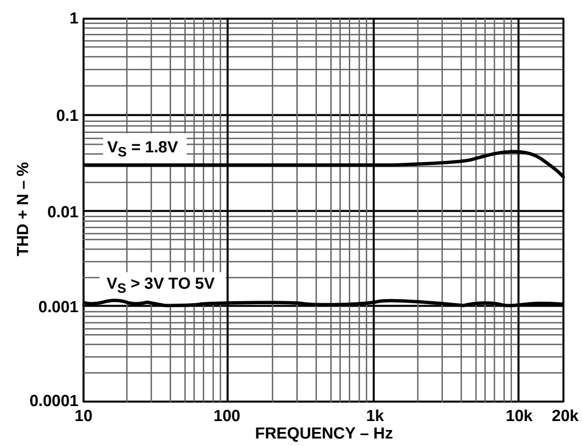

Figure 2. THD + N vs. Frequency Graph

A MICROPOWER REFERENCE VOLTAGE GENERATOR

Many single supply circuits are configured with the circuit biased to one-half of the supply voltage. In these cases, a false-ground reference can be created by using a voltage divider buffered by an amplifier. Figure 3 shows the schematic for such a circuit. The two 1 MΩ resistors generate the reference voltages while drawing only 900 nA of current from a 1.8 V supply. A capacitor connected from the inverting terminal to the output of the op amp provides compensation to allow for a bypass capacitor to be connected at the reference output. This bypass capacitor helps establish an ac ground for the reference output.

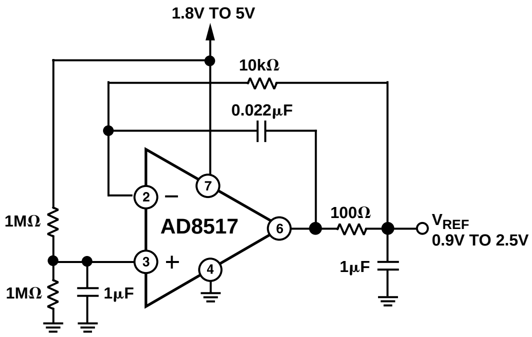

Figure 3. A Micropower Reference Voltage Generator

MICROPHONE PREAMPLIFIER

The AD8517 is ideal to use as a microphone preamplifier. Figure 4 shows this implementation. The gain of the amplifier is set as R3/R2. R1 is used to bias an electret microphone and C1 block dc voltage from the amplifier.

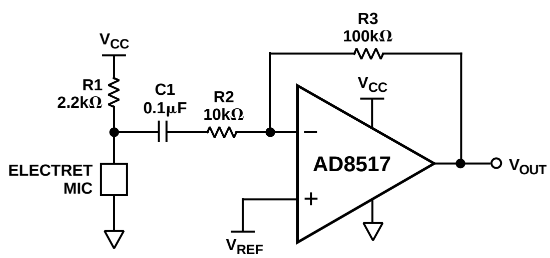

Figure 4. A Microphone Preamplifier

DIRECT ACCESS ARRANGEMENT FOR TELEPHONE LINE INTERFACE

Figure 5 illustrates a 1.8 V transmit/receive telephone line interface for 600 Ω transmission systems. It allows full duplex transmission of signals on a transformer-coupled 600 Ω line in a differential manner. Amplifier A1 provides gain that can be adjusted to meet the modem output drive requirements. Both A1 and A2 are configured to apply the largest possible signal on a single supply to the transformer. Amplifier A3 is configured as a difference amplifier for two reasons: (1) It prevents the transmit signal from interfering with the receive signal and (2) it extracts the receive signal from the transmission line for amplification by A4. A4's gain can be adjusted in the same manner as A1's to meet the modem's input signal requirements. Standard resistor values permit the use of SIP (Single In-line Package) format resistor arrays. Couple this with the AD8517's 5-lead SOT-23 package or the AD8527's 8-lead MSOP, and 8-lead SOIC footprint, and this circuit offers a compact solution.

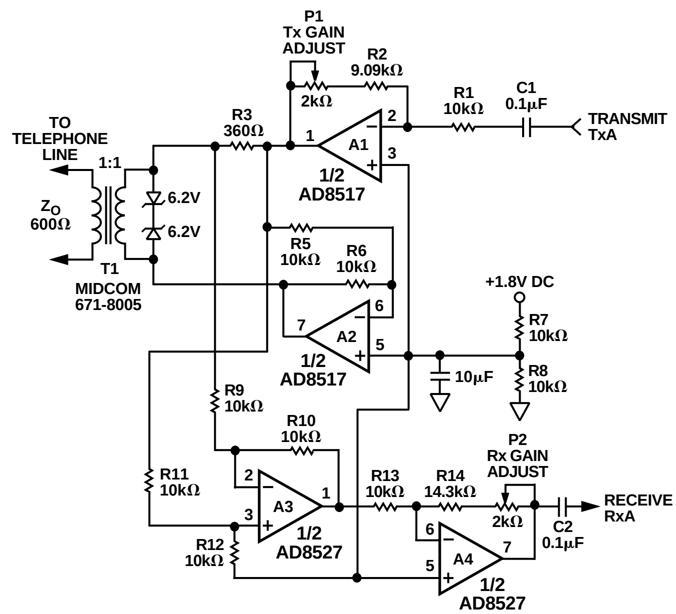

Figure 5. Single-Supply Direct Access Arrangement for Modems

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