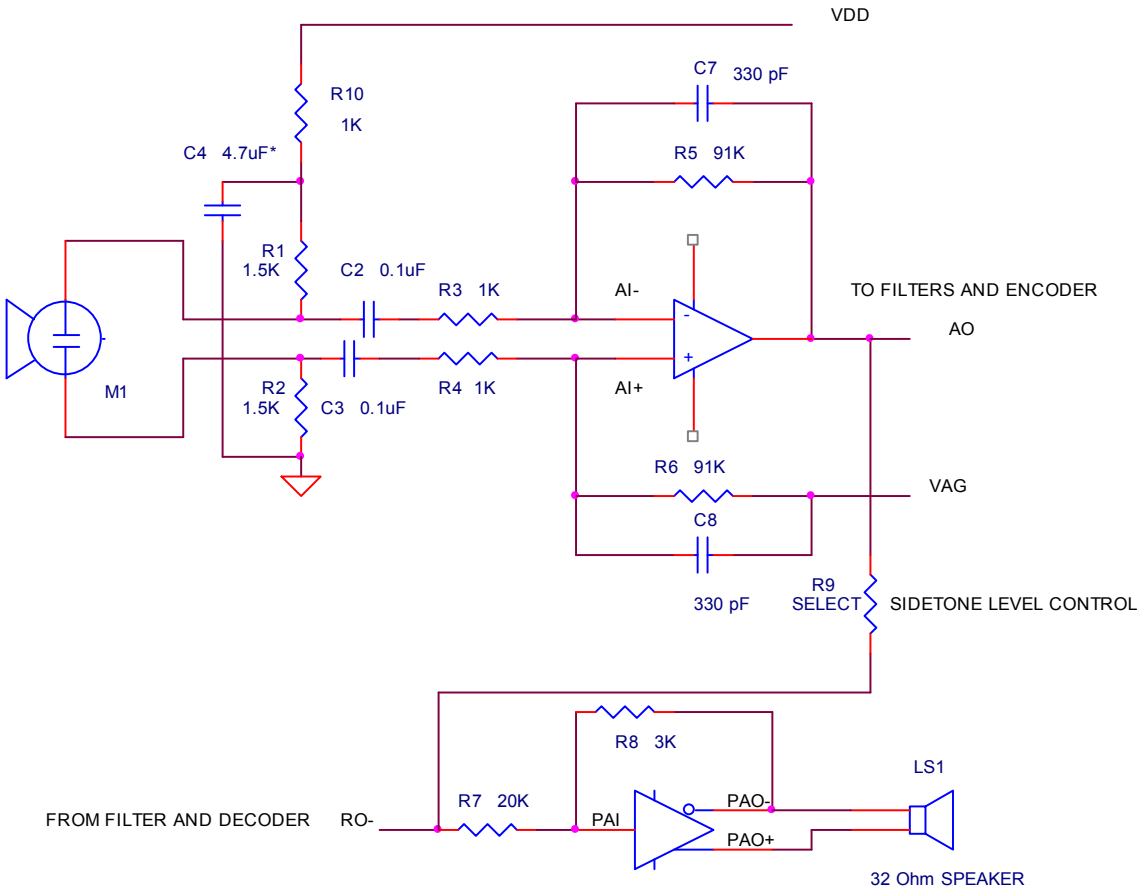
Interfacing CODECs to the Analog World

One of the challenges for a designer working on a new product is how to interface the CODEC (or CODEC/SLIC combination) to the outside analog world. This is “relatively simple” at the central office end of the line. The CO must present a signal of a specific level to the analog 600 ohm subscriber line. Then it must receive back the audio and signaling from the customer equipment and convert to digital for the PCM digital network.

At the customer premise end of the circuit for those who are designing for VoIP and other digital modes, things become a bit more complicated. Here the struggle to maintain adequate SNR in a small package (Handset) is often time consuming. The first problem is capturing the customer’s voice with a microphone and getting it onto the digital line at a suitable level. The second challenge is delivering sufficient analog audio for the customer to hear with as little noise as possible...



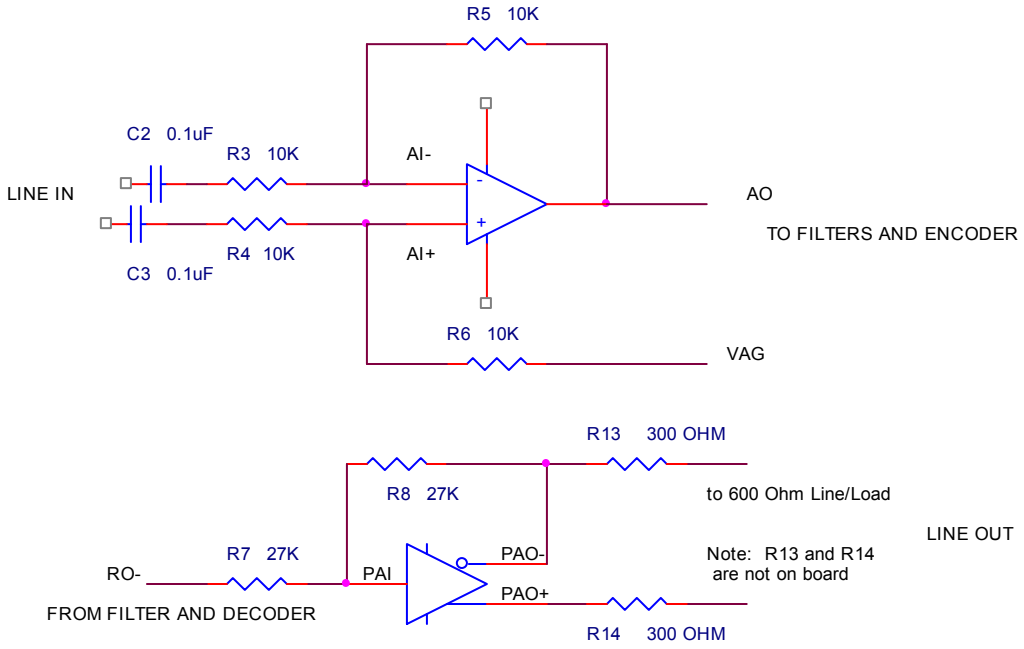
SUGGESTED COMPONENT VALUES BY APPLICATION

SCHEMATIC COMPONENT #	TELEPHONE HANDSET	VoIP PHONE SET (w/boot)	VoIP PHONE SET (no chamber)	600Ω LINE IN/OUT
R3,4	1K	1K	1K	10K
R5,6	27K	75K	91K	10K
C7,8	1200 pF	390 pF	330 pF	N/U
R9	SELECT	SELECT	SELECT	N/U
R7	20K	20K	20K	27k
R8	3K	3K	3K	27k

In the handset application the gain from the handset microphone is set to ~27 for the input amplifier. This is because of the acoustical chamber in the traditional telephone-type handset. This chamber lets the electret microphone provide an output of ~28 mV_{RMS}. The chamber typically has a gain of 3 over a bare microphone (or one placed with only a small opening to the outside world.) Because of the high sensitivity of the earphone (150 Ω impedance) in a typical handset, the output gain from the Power Amp is set to ~0.16 for a satisfactory listening level.

In the VoIP telephone, or small wireless phones, the plastic case is typically too small to provide a reasonable acoustic chamber. Thus the output from the microphone is less than in the previous example. This results in having to set the input gain of the CODEC to ~75 to 90. This increases the signal level to the receive telephone handset. But, because of the increased gain, the Signal-to-Noise Ratio (SNR) has decreased and the signal sounds noisier. By using an appropriate rubber "boot" around the microphone the sensitivity can be improved by several dB. The microphone vendors usually can assist in selecting or designing the boot to best use their microphone. Because of the high gains, the microphone circuits are very susceptible to power supply noise so any passive way to raise the amplitude is preferred. For example, it would be good to ground C4 and R2 at the same point and bring this ground back to the power supply on a trace independent from the other grounds. Good careful layout is very important in these mixed mode designs. And the value of C4 at 4.7 uF is rather small. If there is much noise on the power supply lines this value can be increased to as much as 68 uF for better suppression.

On the receive side, the gain is set as in the previous example. When the Power Amp gain is as low as 0.16, a 32 ohm load can be driven by the W6810, for example. This is sufficient for most receive speakers and transducers.



If the CODEC is used in a telephone Line Card or a VoIP gateway to the external telephone network then it will usually be set for 0TLP in and out. This means that the input gain and output gain will be 1:1 and the values of resistors will be different again. This is dependent upon the expected signal levels. At the CO, after the loss in several kilofeet of twisted pair, the expected receive level may be ~16 dBm. In this case, the input amplifier will need to be set to a gain of ~6 to put a 0 dBm0 signal out onto the digital line. Note that the output of RO- is at 0TLP and going differential will double this level out of the Power Amp. However, R13 and R14 are 300 ohm resistors to match to the 600 ohm line. The resulting voltage presented to the analog line will be 0TLP.

Speaker phones or public address systems require a higher drive level. The CODEC analog output will need to be amplified to achieve the desired drive level. Usually the CODEC outputs will only produce a few milliwatts. For the higher level outputs an external amplifier chip will be needed. Some examples of these are the old LM386 or the more recent amplifier chips by National, Philips, and other manufacturers. It is important to interface the CODEC to the amplifier correctly. Depending upon design philosophy and expense, the desired interface may be single-ended or differential. Some CODECs have single-ended outputs and others have differential outputs. One of the advantages of the differential method is that the noise on the power or ground lines may be cancelled out more easily, providing a better SNR in noisy electrical environment.

Resistor R9 sets the sidetone level (the signal fed back to the ear piece from the microphone so the telephone sounds “live”) to the level desired by the designer. In most 600 ohm audio line applications, this feature is not needed.

In conclusion, a complicated application has been shown to be divided into useful sections. These sections can be designed one step at a time. VoIP and digital telephony analog interface need not be difficult or mysterious.

Important Notice