

OKI Semiconductor

ADPCM CODEC Application Notes

GENERAL DESCRIPTION

These notes describe the design of analog interface circuits between ADPCM CODECs and acoustic devices (speakers or microphones). The design method for the interface circuit is shown so that the voice signal level corresponds to the operational characteristics of ADPCM CODEC input or output level.

The interface circuit examples of the ADPCM CODEC are indicated in Fig. 1 and Fig. 2.

Fig. 1 : Applies to Example for MSM7540/7540L/7560/7560L

Fig. 2 : Applies to Example for MSM7570/7570L/7590L

The differences between the groups of devices are as follows:

- (1) The devices in the later group provides an AIN1+ pin for using the first stage amplifier as a differential amplifier.
- (2) The devices in the later group provide the differential output pins (SAO+ and SAO-) for driving a sounder or other acoustic devices other than speakers.
- (3) The devices of the later group have built-in programmable-gain side-tone signal paths.

DESIGN OF CIRCUIT COMPONENTS

This section describes the design approach of circuit components indicated in the analog interface in Fig. 1 and Fig. 2.

RX, RY

These resistance values depends on the power supply voltage and the microphone characteristics (bias current, output impedance, etc.).

CX

This bypass capacitance depends on RX (not includes in Fig. 2).

R1, R2

These resistances set the gain of transmission AMP1. The gain is 10 (+20 dB) when $R1 = 10\text{ k}\Omega$ and $R2 = 100\text{ k}\Omega$. The minimum value of R1 is determined according to the output impedance of the MIC circuit (the gain error increases as the relative value of this impedance to R1 is increased) and the maximum allowable or permissible capacitance of C1 (when the product of C1 and R1 is small, the frequency characteristics are generated within the voice band).

The minimum value of R2 is defined as $20\text{ k}\Omega$. This value corresponds to the case where the signal output amplitude at GSX1 is 2.226 V_{PP} for the MSM7540/7560 (5 V power supply) and where the amplitude at GSX1 is 1.300 V_{PP} for the MSM7540L/7560L/7570L/7590L (3 V power supply).

The value of R2 can be $20\text{ k}\Omega$ or less, because the signal output amplitude at GSX1 will be smaller in the case where the total gain at the transmission side is defined by AMP1 + AMP2.

If the amplitude is half of the level, the value of R2 can be reduced to $10\text{ k}\Omega$.

C1

The minimum value of C1 is determined based on to the value of R1. For example, when $R1 = 10\text{ k}\Omega$, C1 is approximately $0.1\text{ }\mu\text{F}$.

R3, R4

These resistances set the gain of transmission AMP2. For example, the gain is set to 2.75 (+8.8 dB) when $R3 = 12\text{ k}\Omega$ and $R4 = 33\text{ k}\Omega$.

The total gain of AMP1 and AMP2 is 27.5 (+28.8 dB).

The load impedance of AMP1 is about $11\text{ k}\Omega$, as a result of being connected $R1$ and $R2$ in parallel, assuming that $C1$ is negligible. This load impedance of $11\text{ k}\Omega$ does not adversely effect circuit operation, even if the load impedance is less than the $20\text{ k}\Omega$ defined in the specification, since the output impedance at GSX1 is less than half of the maximum of amplitude $2.226V_{PP} / 1.300V_{PP}$ at GSX2.

However, the load impedance of AMP2 is equal to the resistance $R4$, i. e. $33\text{ k}\Omega$, and there is therefore no problem. When the side tone signal path is configured by the external resistor RS in the device interface circuit except for the MSM7570/7570L/7590L, it should be noted that the load impedance of AMP2 is equal to the resistances of $R4$ and RS connected in parallel.

Normally the gains of the transmit amplifiers (AMP1 + AMP2) are set so that the signal level at the CODEC input (GSX2 the this family) becomes -15 dBm_0 when a voice having an average acoustic level is input to the microphone.

Note : The value of 0 dBm_0 is dependent on the power supply voltage (3 V / 5 V) :

3 V power supply ----- -7.7 dBm (0.320 Vrms)

5 V power supply ----- -3 dBm (0.548 Vrms)

C2

The minimum value of $C2$ is determined based on the value of $R3$. The requirements should be considered is the same way as for $C1$.

R5, R6

The receiving gain can be set by these resistances.

Since MSM7570/7570L/7590L contain a programmable gain setting function, the effect of this function must be considered, That is, when the programmable gain is assumed to be set to 0 dB , the internal analog circuit signal reaches the over-loaded level of $+3\text{ dBm}_0$ is inputting to the CODEC. When a peak level signal equal to the full scale of the receive ADPCM data.

The analog signal of non-distortion is assured to be in less than the value of the specification when the analog circuit signal level is $+3\text{ Bm}_0$ or less. The amplifier gain which is configured by AMP2 with $R5$ and $R6$, must be set in less than one ($R5 = R6$) when inputting received data in order for the specified conditions of non-distortion to be satisfied.

When the peak level of receive ADPCM data is a level less than the level equal to the full scale of the data, the gain setting can be more than one, according to the peak level.

RS

An external resistance for configuring the side tone signal path. This resistance is not indicated in Fig. 2, because the MSM7570/7570L/7590L contain built-in side tone signal paths with programmable gains. The side tone signal paths can also be configured from the output GSX1 of first stage transmission amplifier AMP1 via RS.

However, the side tone signal level is determined based on the transmission voice signal level at GSX2(GSX1) and the resistances R6 / RS. Since RS acts as a load of GSX2(GSX1), care should be taken. Refer to the description for R4.

RZ

The value of RZ is determined based on the speaker or sounder characteristics and the analog output signal levels. This signal level is reduced by connecting RZ to the circuit.

A non-distortion amplitude of 1.300 V_{PP} at AOUT+, AOUT-, SAO+*, and SAO-* for the MSM7540L/7560L/7570L/7590L is assured within the voice band (0.3 kHz to 3.0 kHz) under a load of 350 Ω + 120 nF or more. For the MSM7540/7560 with a 5 V power supply, the value of non-distortion amplitude is assured in 2.226 V_{PP} under the same conditions as the device with a 3 V power supply.

The values of non-distortion amplitude and the load condition are interrelated. For example, the non-distortion amplitude becomes small as the load resistance of device becomes another.

The analog output cannot directly drive an acoustic device having a low impedance. In this case, a speaker driving amplifier device such as the MSC1191 or MSC1192 is necessary.

Acoustic components should be selected, and external circuit components should be verified and determined through observing analog output signal waveforms or performing listening tests.

*: These pins are not provided for MSM7540/7540L/7560/7560L.

MSM7540/7540L/7560/7560L

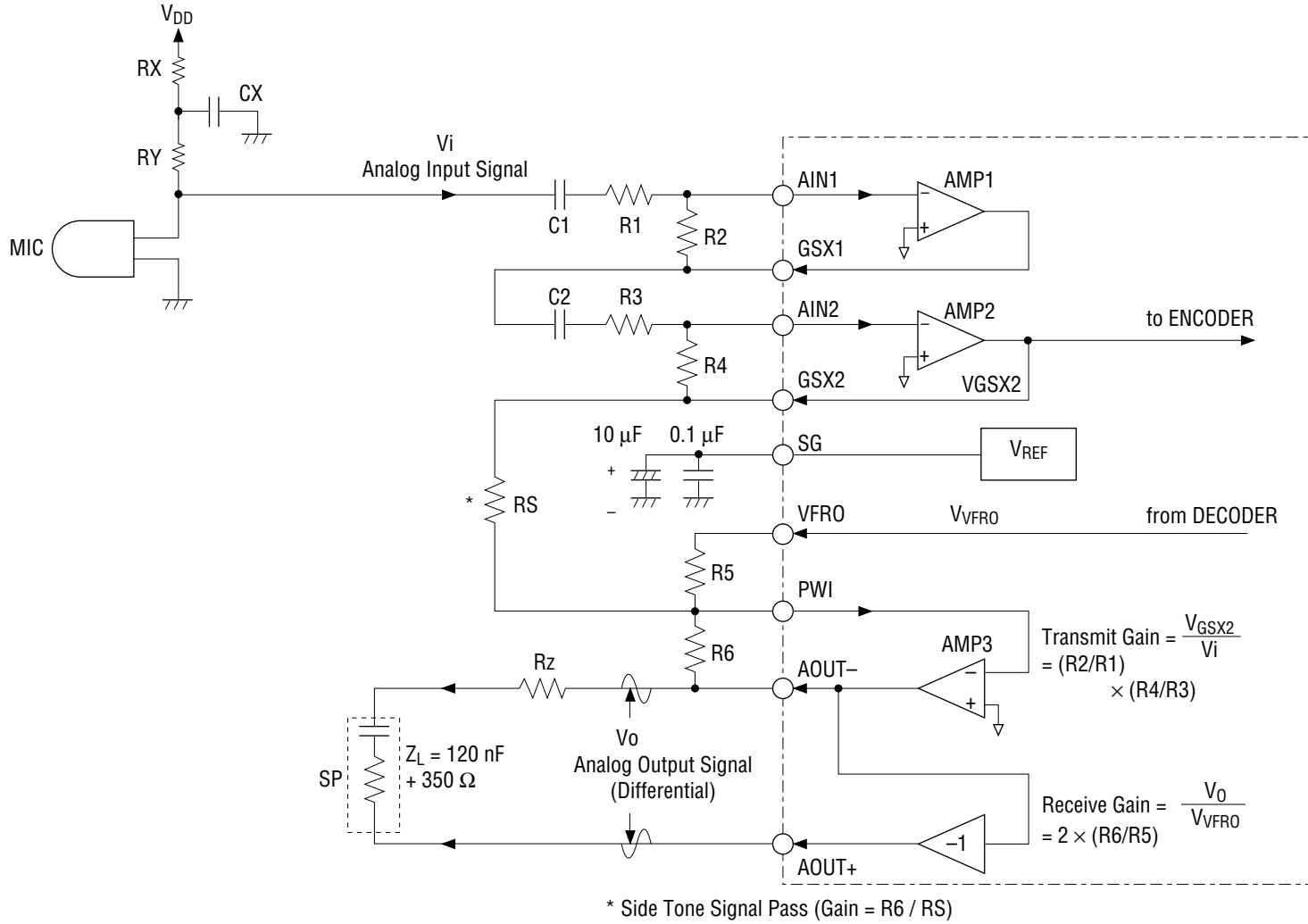


Figure 1 Analog Interface Circuit

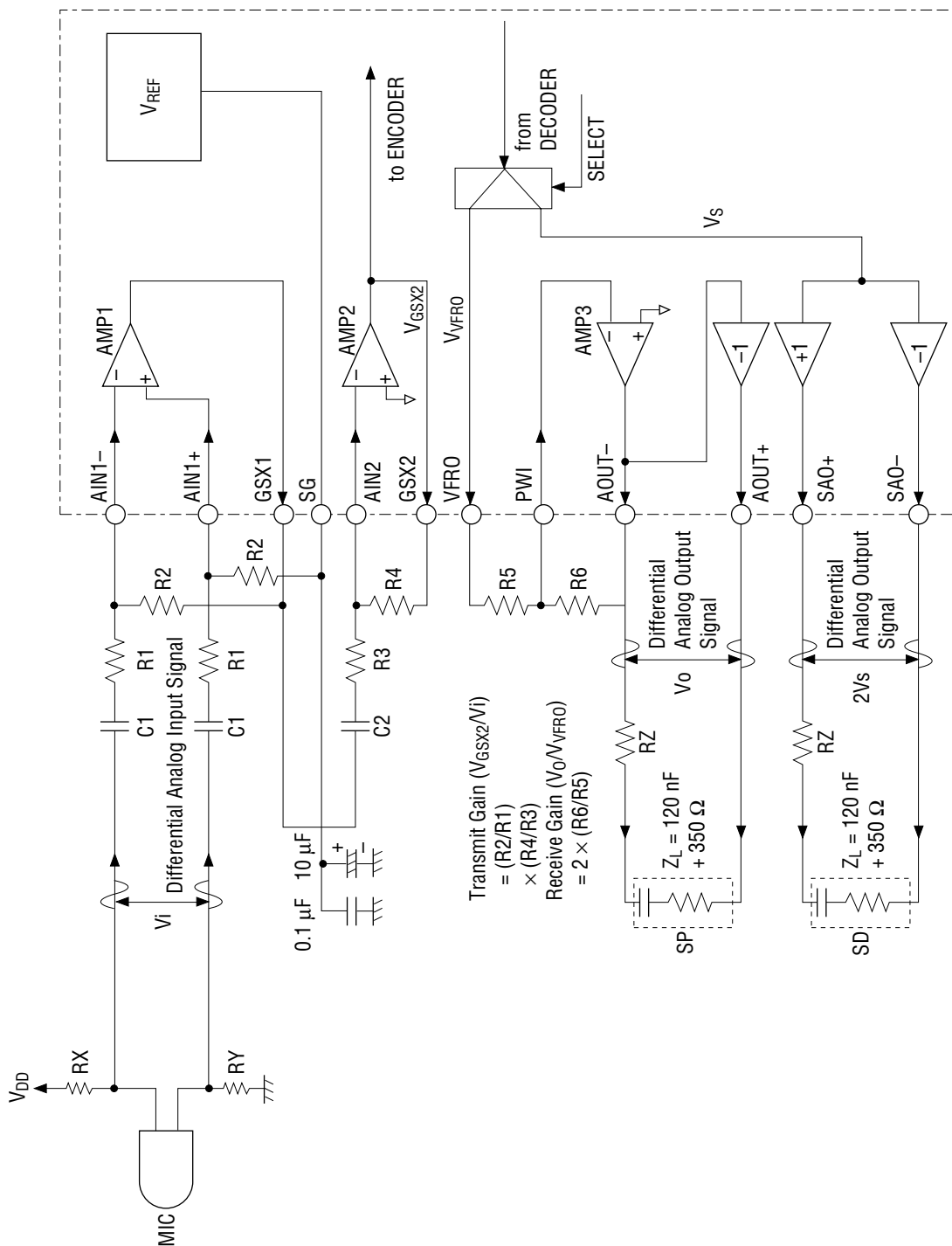
MSM7570/7570L/7590L

Figure 2 Analog Interface Circuit