APPLICATION NOTE

AN1762
Companding with the NE577 and NE578

Alvin K. Wong   1997 Oct 23

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Companding with the SA577 and SA578

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Author: Alvin K. Wong

INTRODUCTION

This application note is written for the designer who understands the basic functions of companding and wants to use the SA577 or SA578. If a designer is not familiar with the functionality of compandors, a good discussion can be found in the earlier Philips Semiconductors compandor data sheets and applications notes.

Key topics discussed in this paper are:
- How to program the unity gain level (0dB)
- How to implement an automatic level control
- How to get the best companding performance under strict design requirements
- How to set the attack and recovery time
- How to operate at 1.8V
- How to sum external signals using the SA578
- How to power-down the SA578
- How to mute the SA578
- How to use the SA577 and SA578 as a dual expandor

But before reviewing these areas, a summary of Philips Semiconductors compandor family will be presented. A system designer can then determine which compandor is best for the design.

SUMMARY OF COMPANDOR FAMILY

In the past, Philips Semiconductors offered four different types of compandors: the SA570, SA571, SA572, and SA575. Each of the four compandors has its own 'claim to fame'. The SA570 and SA571 are known to work well in high performance audio applications. The only real difference between the two is that the SA570 has a slight edge in performance. However when separate attack and recovery times are needed, the SA572 is the compandor to choose. The SA575 becomes useful when there are low voltage requirements.

With the increasing demand for low current consumption, good flexibility, and ease of use in semiconductors, Philips Semiconductors is offering three additional compandors to its family, the SA576, SA577 and SA578. These compandors typically require an I_{CC} of 1.4mA at a V_{CC} of 3.6V, but Philips Semiconductors has demonstrated that these new chips are functional down to 1.8V.

In addition to having low power consumption, the SA578 has a power-down mode. In this mode, the chip consumes only 170µA. This power-down mode is useful when the functionality of the chip is not needed at all times. In the power-down mode , the SA578 maintains all of its pin voltages at all their normal DC operating voltages. Because all of the capacitors remain charged in this mode, the power-up state will occur quickly. Powering down automatically mutes the SA578. Having the mute function internal to the SA578 audio section eliminates the need for an external switch. The SA578 is the only compandor in the family that has power-down and mute functions.

To allow for greater flexibility, the 0dB level is now programmable for the SA577 and SA578. However, for the SA576, the 0dB level is specified and set at 100mV$_{RMS}$. The earlier compandors also have a set unity gain (0dB) level. The SA570 and SA571 have a set 0dB level at 775mV$_{RMS}$. While the SA572 and the SA575 both have their 0dB levels at 100mV$_{RMS}$. If a designer wanted a different 0dB level, two op amps would have to be implemented in the design. One of the op amps would connect to the input of the compandor, while the other op amp would connect to the output. But with the SA577 and SA578, these external op amps are no longer needed. The 0dB level can be programmed from 10mV$_{RMS}$ to 1V$_{RMS}$ with three external resistors.

Many of the external parts in the previous family of compandors are now internal to the device. Additionally, the left side of the chip is configured as an expandor, and the right side is configured as a compressor. This allows for minimum part count and fewer variations in systems design. The external capacitors are also reduced in value which saves board space and cost. The only trade-off with using smaller capacitors is that there is less filtering. Because of this new approach, the SA576, SA577 and SA578 are easy to implement in any design.

Table 1 shows a brief summary of all the compandors. The seven different compandors offer a wide range of flexibility: different types of packages, power-down capability, programmable or fixed unity gain, different reference voltages, a wide range of operating voltages and currents, different pin outs, etc. From this information, a designer can quickly choose a compandor which best meets the design requirements. After a compandor is chosen from the table, a designer can find additional help from data sheets and application notes.

Since power consumption is important in most designs, it is important to discuss them in this application note. The SA570, SA571, and SA572 have built in voltage regulators, therefore, the current consumption remains roughly the same over the specified supply voltages. This can be especially useful when the power supply is not regulated very well. However with the SA575, SA576, SA577, and SA578, the current consumption will drop as the supply voltage decreases. For this, the power consumption will drop also. This means one can operate the part at a very low power level. This is a good feature for any design having strict power consumption guidelines.

INTRODUCING SA577 AND SA578

Figure 1 and 2 show block diagrams of the SA577 and SA578 respectively. The only substantial difference between the two is that the SA578 has a power-down capability, mute function and summing capabilities (for signals like DTMF tones). In addition the SA578 summing amplifiers are capable of driving 600Ω loads. Listed below are the basic functions of each external component for Figure 1 (SA577).

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Table 1. Compandor Family Overview

	SA570	SA571	SA572	SA575	SA576	SA577	SA578
V_{CC}	6–24V	6–18V	6–22V	3–7V	2–7V	2–7V	2–7V
I_{CC}	3.2mA	3.2mA	6mA	3–5.5mA*	1–3mA*	1–2mA*	1–2mA*
Number of Pins	16	16	16	20	14	14	16
Packages SA: 0 to +70°C SA: −40 to +85°C N: Plastic DIP D: Plastic SO F: Ceramic DIP DK: SSOP (Shrink Small Outline Package)	SA570F SA570N SA570D	SA571F SA571N SA571D SA571F SA571N SA571D	SA572N SA572D SA572F SA572N SA572D	SA575N SA575D SA575DJ SA575N SA575D SA575DK	SA576N SA576D SA576N SA576D	SA577N SA577D SA577N SA577D	SA578N SA578D SA578N SA578D
ALC (Automatic Level Control)	Both Channels	Both Channels	Both Channels	Right Channel	Right Channel	Right Channel	Right Channel
Reference Voltage	Fixed 1.8V	Fixed 1.8V	Fixed 2.5V	V_{CC} / 2	V_{CC} / 2	V_{CC} / 2	V_{CC} / 2
Unity Gain	775mV$_{RMS}$	775mV$_{RMS}$	100mV$_{RMS}$	100mV$_{RMS}$	100mV$_{RMS}$	10mV to 1V$_{RMS}$	10mV to 1V$_{RMS}$
Power-Down	NO	NO	NO	NO	NO	NO	YES (170µA)
Key Features	-Excellent Unity Gain Tracking Error -Excellent THD	-Excellent Unity Gain Tracking Error -Excellent THD	-Independent Attack & Recovery Time -Good THD -Needs ext. summing op amp	-2 Uncommited on-chip op amps available -Low voltage	-Low power -Low external component count	-Low power -Programmable unity gain	-Low power -Programmable unity gain -Power down -Mute function -Summing capability (DTMF) -600Ω drive capability
Applications Cordless Phones Cellular Phones Wireless Mics Modems Consumer Audio Two-way Communications	High performance audio circuits "Hi–Fi Commercial Quality"	High performance audio circuits "Hi–Fi Commercial Quality"	High performance audio circuits "Hi–Fi Studio Quality"	Consumer audio circuits "Commercial Quality"	Battery powered systems "Commercial Quality"	Battery powered systems "Commercial Quality"	Battery powered systems "Commercial Quality"

NOTES: SA5750/5751 are also excellent audio processor components for high performance cordless and cellular applications that include the companding function..

*I_{CC} varies with V_{CC}.

R1 – Determines the Unity Gain Level for the Expandor

R2 – Determines What Value the Reference Current (I_{REF}) will be for the Part (Also Affects Unity Gain Level)

R3 – Determines the Unity Gain Level for the Compressor

C1 – DC Blocking Capacitor

C2 – Determines the Attack and Recovery Time for the Expandor

C3 – DC Blocking Capacitor

C4 – Used to AC Ground the V_{REF} Pin

C5 – Provides AC Path from Gain Cell to Output of Summing Amp

C6 – Determines the Attack and Recovery Time for the Compressor

C7 – DC Blocking Capacitor

C8 – Provides AC Ground for the DC Feedback Path

C9 – DC Blocking Capacitor
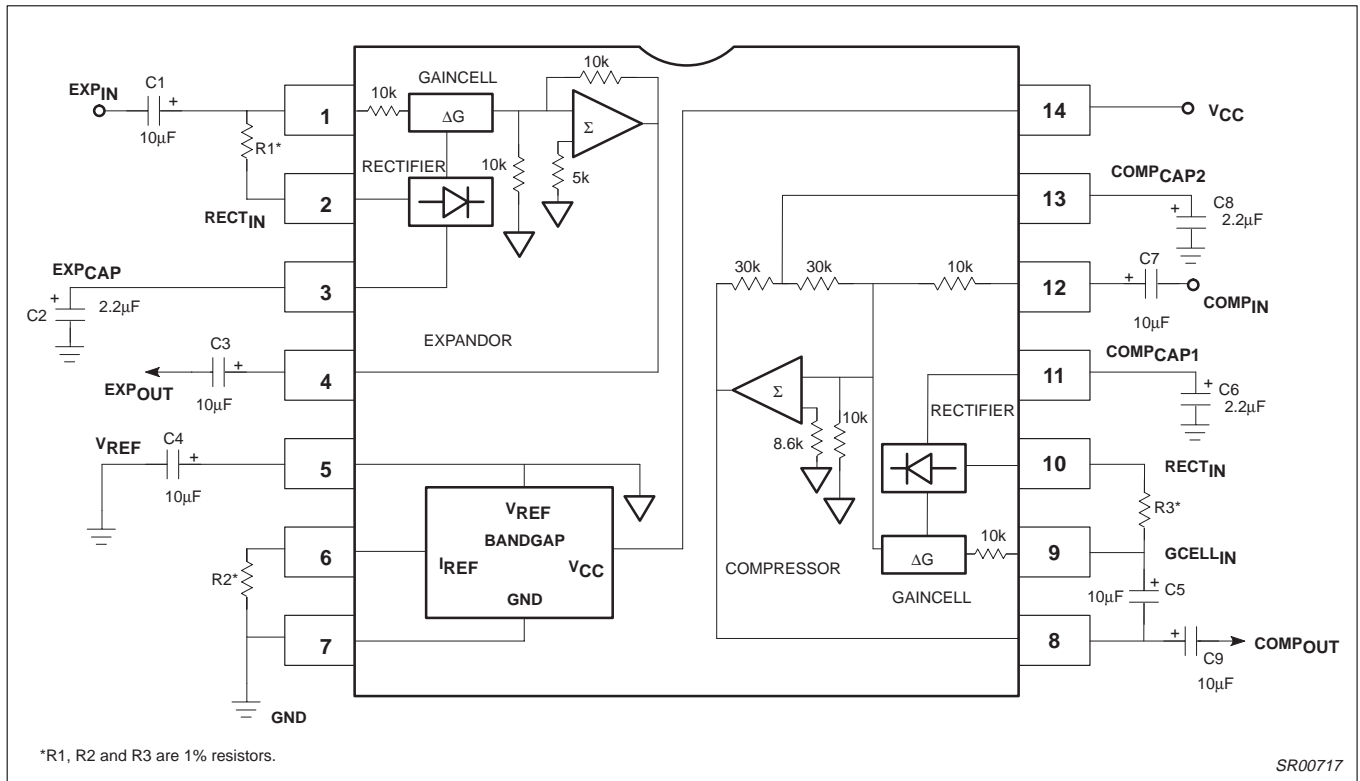
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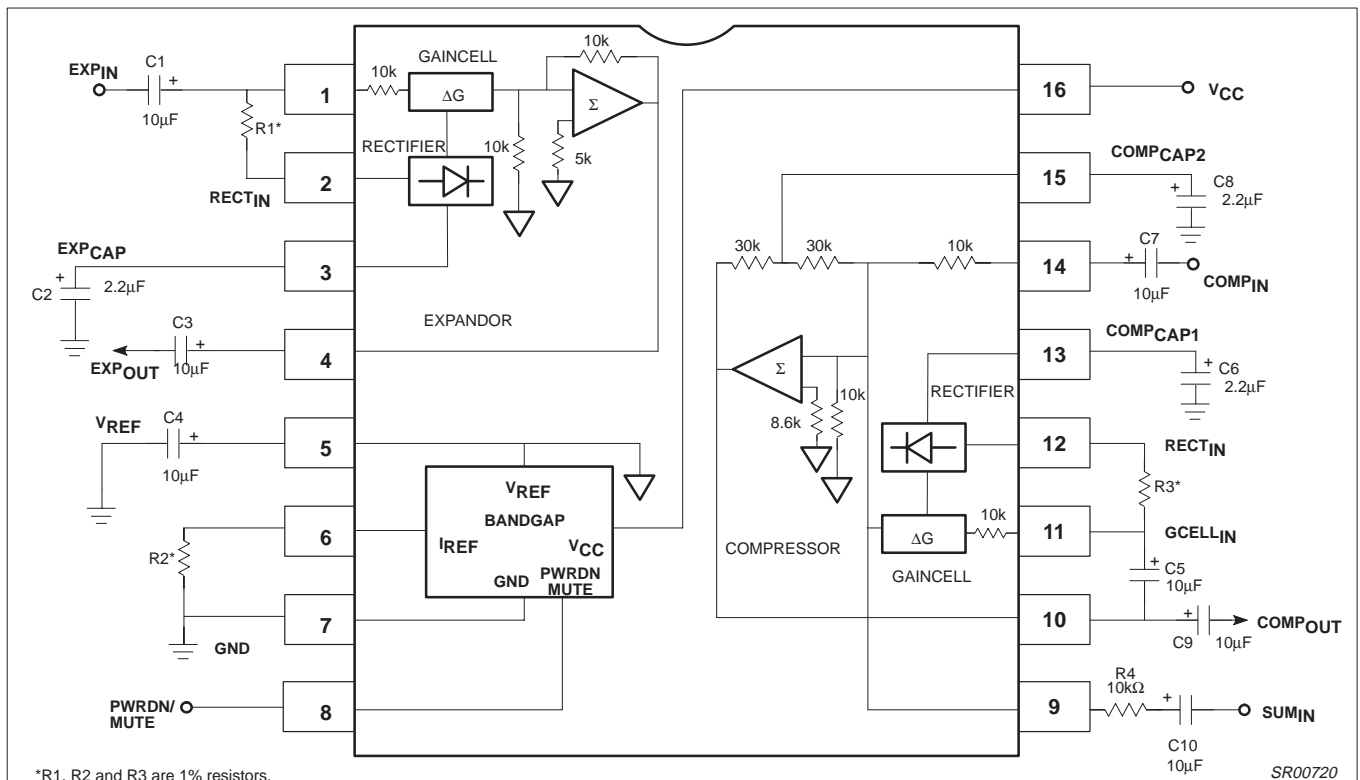
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Figure 1 . SA577 Block Diagram

Figure 2 . SA578 Block Diagram

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Listed below are the basic functions of each external component for Figure 2 (SA578).

R1 – Determines the Unity Gain Level for the Expandor

R2 – Determines What Value the Reference Current (I_{REF}) will be for the Part (Also Affects Unity Gain Level)

R3 – Determines the Unity Gain Level for the Compressor

R4 – Used to Set the Gain of an External Signal like DTMF Tones and Sum them with the Companded Signal

C1 – DC Blocking Capacitor

C2 – Determines the Attack and Recovery Time for the Expandor

C3 – DC Blocking Capacitor

C4 – Used to AC Ground the V_{REF} Pin

C5 – Provides AC Path from Gain Cell to Output of Summing Amp

C6 – Determines the Attack and Recovery Time for the Compressor

C7 – DC Blocking Capacitor

C8 – Provides AC Ground for the DC Feedback Path

C9 – DC Blocking Capacitor

C10 – DC Blocking Capacitor

HOW TO PROGRAM THE UNITY GAIN LEVEL (0dB)

Three external resistors R1, R2, and R3 define the unity gain level. Both the SA577 and the SA578 0dB levels can vary from 10mV$_{RMS}$ to 1.0V$_{RMS}$. These limits are used in product characterization, but these parts can function over a wider 0dB level range.

In most applications the 0dB level is equal for both the compressor and expandor side. Therefore, R1 and R3 are equal in value. R3 sets the 0dB level for the compressor side, and R1 sets the 0dB level for the expandor side. However, there could be a situation where a design requires different 0dB levels for compression and expansion. This will not be a problem with the SA577 or SA578, due to the separate 0dB level programming.

Using the formulas below, a designer can calculate the resistor values for a desired unity gain level.

Formula 1: $\quad R_2 = \dfrac{V_{BG}}{I_{REF}}$

where

V_{BG} = Bandgap Voltage
$\quad I_{REF}$ = Reference Current
(V_{BG} is brought out on Pin 6 and R2 determines the I_{REF} value)

Formula 2: $\quad R_1 = \dfrac{0.9 \cdot V_{IN_{RMS}}}{I_{REF}}$

where $V_{IN_{RMS}}$ is the 0dB level
($R_1 = R_3$ in most cases)

Programming the Unity Gain Level for the SA577 also applies for the SA578.

Example:

Program the SA577 or SA578 for a 0dB Level at 100mV$_{RMS}$

Step 1: V_{BG}=1.26V.......Typically
$\quad I_{REF}$=12.6µA.....Good Starting Point

$$R_2 = \frac{1.26V}{12.6}\,\mu A$$

$\quad R_2 = 100k$

Step 2:

$$R_1 = R_3 = \frac{0.9V_{IN_{RMS}}}{I_{REF}}$$

$$R_1 = R_3 = \frac{(0.9V)\,(100mV_{RMS})}{12.6\mu A}$$

$\quad \backslash\, R_1 = R_3 = 7.15k$

Step 3: $\quad R_1 = R_3 = 7.15k$ (1% value)
$\qquad R_2 = 100k$ (1% value)

Step 4: Plug in these resistor values and measure for unity gain. Adjust accordingly for accuracy.

NOTE: Rough Limits for Resistors:
$1k \leq R1 \leq 100k$ (1% values)
$20k \leq R2 \leq 200k$ (1% values)
$1k \leq R3 \leq 100k$ (1% values)

Rough Limits for I_{REF}
$6.3\mu A \leq I_{REF} \leq 63\mu A$

The example above gives pretty close results. A designer should use 1% resistors to get the best performance. Below in Table 2 are some recommended values to get started:

Table 2. Recommended Resistor Values for Different 0dB Levels

0dB Level	dBv	R_2	R_1 & R_3
1.0V$_{RMS}$	0	24.3k	18.7k
316.2mV$_{RMS}$	−10	100k	22.6k
100mV$_{RMS}$	−20	100k	7.15k
10mV$_{RMS}$	−40	200k	1.33k

PARAMETERS THAT LIMIT THE DYNAMIC RANGE

The above example is a good place to start, but to get the optimum performance from the SA577 and SA578, a designer needs to understand certain key parameters. I_{REF} is important because it determines the values for all three resistors (R1, R2, and R3). Since I_{REF} is directly related to I_{CC} (see Figure 3), one should be careful in choosing a value. If one chooses a high I_{REF} current, power consumption goes up. However the output signal will have excellent low level distortion (see Figures 4 and 5). If one chooses a low I_{REF} value, distortion at the output will increase slightly. Conversely, the power consumption is reduced, which might be worth the trade-off in battery operated designs.

The dynamic range of the SA577 and SA578 is determined by supply voltage (V_{CC}) and reference current (I_{REF}). I_{REF} determines how well the compandor will perform with low level input signals. The supply voltage determines how high (in level) an input signal can be before clipping appears on the output (in some cases increasing I_{REF} also helps). A designer needs to estimate the input

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range going into the compandor so that an appropriate V_{CC} and I_{REF} can be chosen.

The bandgap voltage (V_{BG}) slightly varies over a wide range of I_{REF} currents (Figure 6). Figure 7 shows how I_{REF} varies with R2. The higher R2 is, the lower I_{REF} is. Figure 8 shows how the dynamic range varies over different values of I_{REF} (the higher the supply voltage the better the dynamic range). The graphs in Figures 3 - 8 were taken at V_{CC}=3.6V, F=1kHz and 0dB level=100mV$_{RMS}$. The I_{REF} current was limited between 5µA and 40µA.

It can be seen that I_{REF} plays an important role in current consumption, THD, and dynamic range. With the aid of these figures, one can determine an I_{REF} which meets the design goals.

Example:
Making use of the graphs in Figures 3 - 8 and formulas 1 and 2, design a compandor with a 0dB level of 100mV$_{RMS}$. Try to achieve a THD of 0.1 on the compressor side with wide dynamic range. Operate at a supply voltage of 3.6V but with the lowest possible current consumption.

Step 1: According to Figure 5, an I_{REF} of 30µA is required for approximately 0.1% distortion.

Test Conditions:

$V_{CC} = 3.6V$ F = 1kHz   0dB = 100mV$_{RMS}$ SR00755
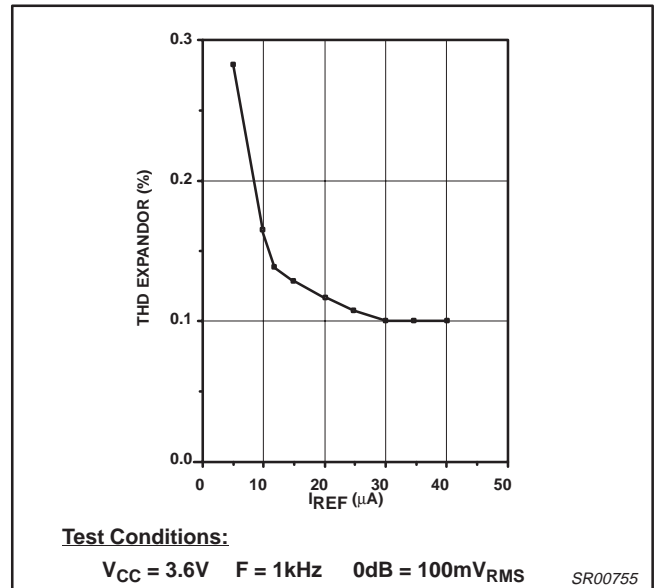
Figure 4 . I_{REF} vs THD, Expandor Side

Test Conditions:

$V_{CC} = 3.6V$ F = 1kHz   0dB = 100mV$_{RMS}$ SR00754

Figure 3 . I_{REF} vs I_{CC}

Test Conditions:

$V_{CC} = 3.6V$ F = 1kHz   0dB = 100mV$_{RMS}$ SR00756
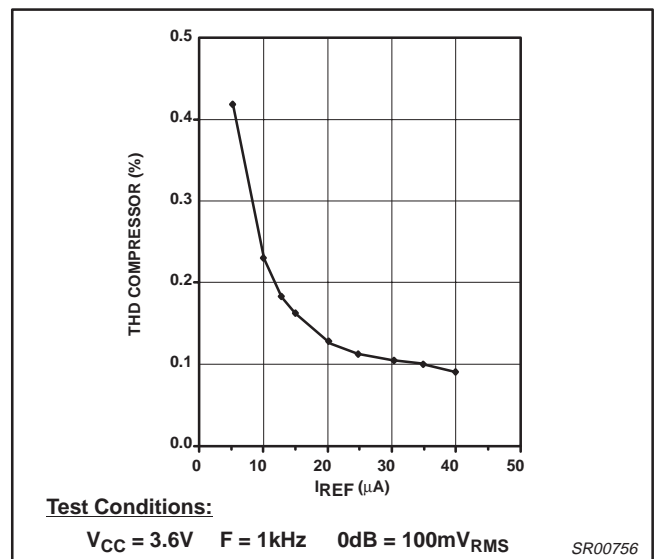
Figure 5 . I_{REF} vs THD, Compressor Side

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Test Conditions:

V_{CC} = 3.6V   F = 1kHz   0dB = 100mV_{RMS}

SR00757
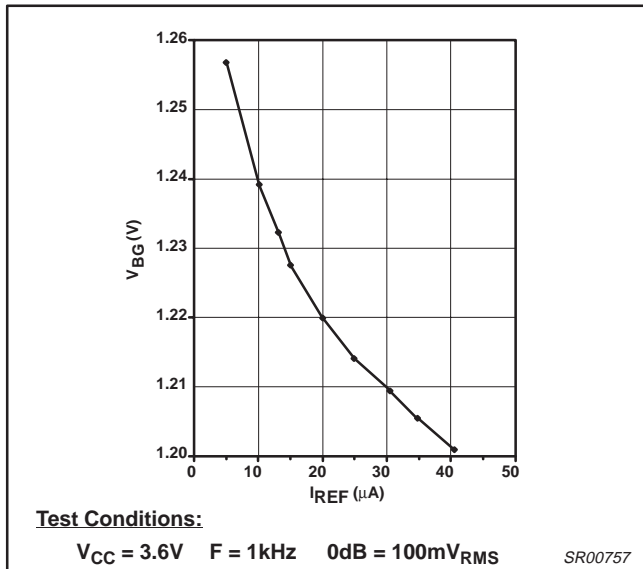
Figure 6 . I_{REF} vs V_{BG}

Test Conditions:

V_{CC} = 3.6V   F = 1kHz   0dB = 100mV_{RMS}
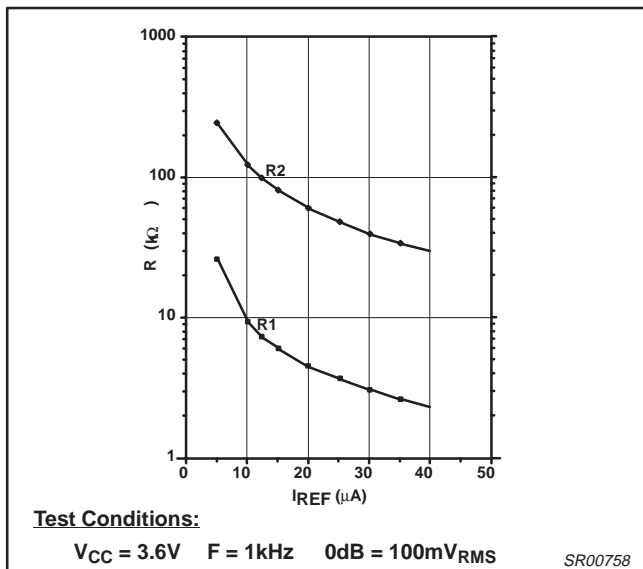
SR00758

Figure 7 . I_{REF} vs R2, R1

Step 2: From Figure 8, the dynamic range is approximately 92dB. So far the requirements have been met.

Step 3: Figure 3 shows us that I_{CC} is at 1.9mA with no input signal (that's not bad at all!).

Step 4: Calculating R1, R2, and R3

Graphical Method:
From Figure 7: For I_{REF}=30μA and 0dB=100mV_{RMS} R1=R3=3k R2=40k

Actual resistors available: R1=R3=3.01k (1%) R2=40.2k (1%)

Test Conditions:

V_{CC} = 3.6V   F = 1kHz   0dB = 100mV_{RMS}

SR00759

Figure 8 . I_{REF} vs Dynamic Range

Formula Method:
From Figure 6: V_{BG}=1.21V for I_{REF}=30μA therefore, using formula 1:

$$R_2 = \frac{V_{BG}}{I_{REF}}$$

$$R_2 = \frac{1.21V}{30\mu A}$$

$R_2 = 40.33k$
$R_2 = 40.2k$ (available in 1%)

Recall from formula 2:

$$R_1 = \frac{0.9V_{IN_{RMS}}}{I_{REF}}$$

$$R_1 = \frac{(0.9V)\,(100mV_{RMS})}{30\mu A}$$

$R_1 = 3k$
$R_1 = 3.01k$ (available in 1%)

Connect these external resistors with the determined values and adjust for optimum performance.

Bench results:
After completing the exercise above, the resistors were connected and the results are given below.

I_{CC} = 1.89mA (with no input signal)
THD = 0.1 (meausured on spectrum analyzer)
0dB = 109mV_{RMS} (off by 0.8dB...good!) Dynamic Range = 92dB

These results are very close to what was predicted and by tweaking R1 and R3, the 0dB error can be further reduced to zero.

BANDWIDTH OF COMPANDOR

Figure 9 shows the typical bandwidth for the SA577 and SA578. The graphs were taken with a V_{CC} of 3.6V and a 0dB level of 100mV_{RMS}. The bandwidth of the expandor, the compressor, and the compandor (where a signal goes through the compressor and the expandor) is shown in this figure. Although the SA577 and SA578 are conservatively specified with a 20kHz bandwidth, Figure 9 reveals that it is actually around 300kHz.

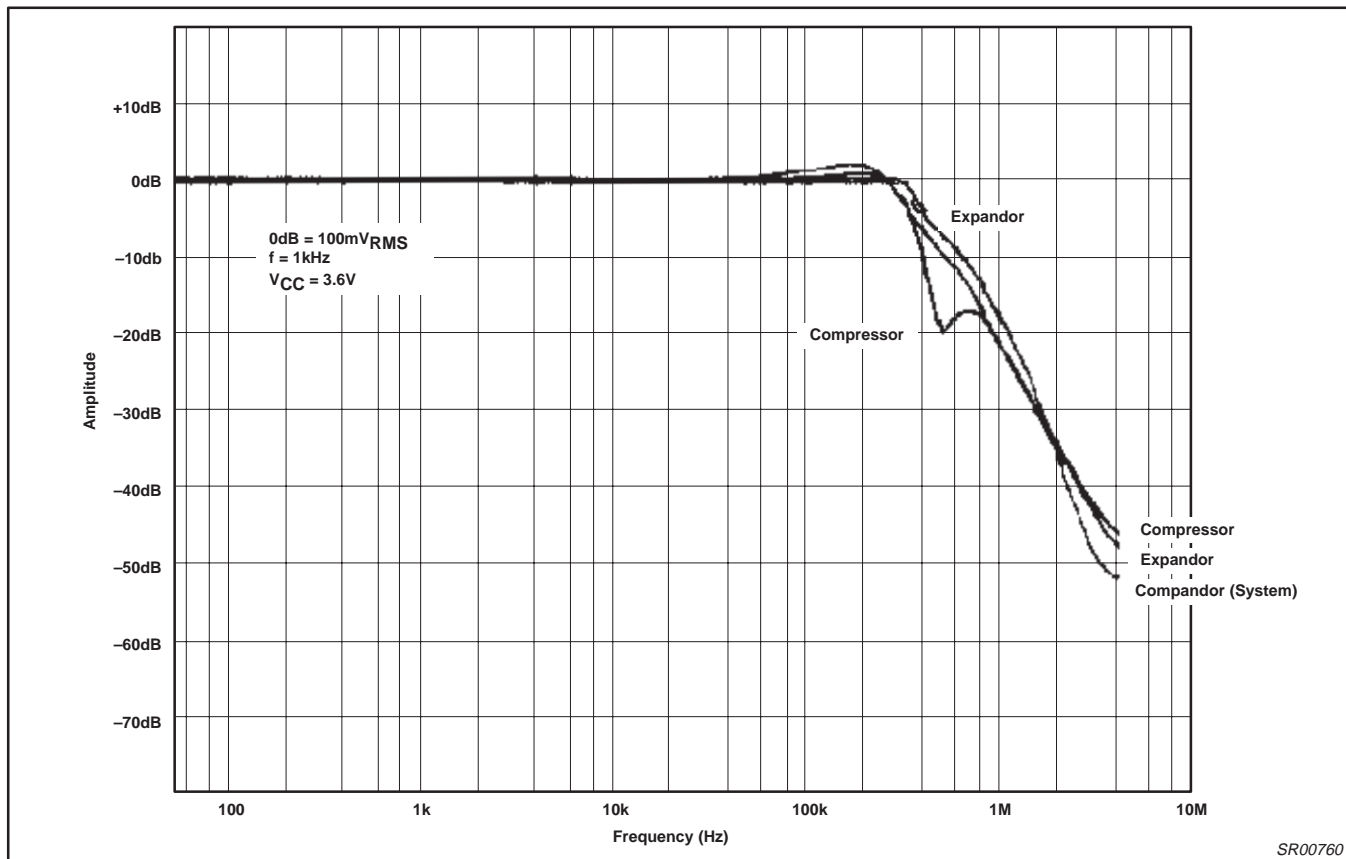# Companding with the SA577 and SA578

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Figure 9 . Bandwidth of SA577 and SA578 Demo Board

HOW TO SET THE ATTACK AND RECOVERY TIMES

C2 and C6, from figures 1 and 2, set the attack and recovery times for the SA577 and SA578. Application Note 174 (AN174) defines A and R times and also describes how they are measured on the bench. Formula 3 shows how the A and R time can be calculated.

Formula 3:

Attack Time [ms] = 10k * C2 or C6
Release Time [ms] = 4 * Attack Time

Although a fast attack time is desirable, one must remember that there is a trade-off with low distortion. As a general rule, a 1µF capacitor for C2 will produce 0.2% THD at 1kHz. Since CCITT recommends an RC time constant of 20ms for the attack time, a 2µF capacitor is recommended for telephony applications because it has only 0.1% THD at 1kHz and 0.33% at 800Hz.

Note: AN174 can be found in the 1989 Linear Data Manual, Volume 1, or the RF Handbook.

IMPLEMENTING A PROGRAMMABLE AUTOMATIC LEVEL CONTROL

The function of an automatic level control (ALC) is to take a given range of input signals and provide a constant AC output level. This type of function is useful in many audio applications. One such application can be found in tape recorders. When a tape recorder with ALC is recording a conversation, a soft spoken person will be heard just as well as a loud spoken person during play back.

Another useful application for ALC could be with telephony. A person who has difficulty hearing, will not have to ask the other party to speak up. If the phone already has a volume control, the user has to adjust the volume for different parties. But with the ALC, the volume only has to be set once.

Different constant AC output levels of an ALC can be 'programmed' with the SA577 and SA578. This allows the designer to choose the output level that is needed in the design, and eliminates the need for an external op amp.

The compressor side of the SA577 and SA578 can be configured to function as an automatic level control (ALC). Figure 10 and 11 show how this can be done. The circuit shown for the SA577/78 ALC is set up to provide a constant output level of 100mV$_{RMS}$ with an input range from –34dB to +20dB at 1kHz (see Figure 12).

Below are some design equations for the ALC:

$$\text{AC output level}(V_{RMS}) = \left[\frac{R_3 \cdot R_{2_a} \cdot I_{REF}}{R_{1_a}} \right] \cdot 1.11 \qquad \text{Eq 1.}$$

where $R_{1_a} = R_{2_a} = 10k$ (internal)

$$I_{REF} = \frac{V_{BG}}{R_2}$$

$$\text{Maximum Gain} = \frac{4(R_3 + R_X) \cdot R_{2_a} \cdot I_{REF}}{R_{1_a} \cdot V_{CC}} \qquad \text{Eq 2.}$$

$$\text{Gain} = \frac{R_3 \cdot R_{2_a} \cdot I_{REF}}{R_{1_a} \cdot V_{IN_{RMS}}} \qquad \text{Eq 3.}$$
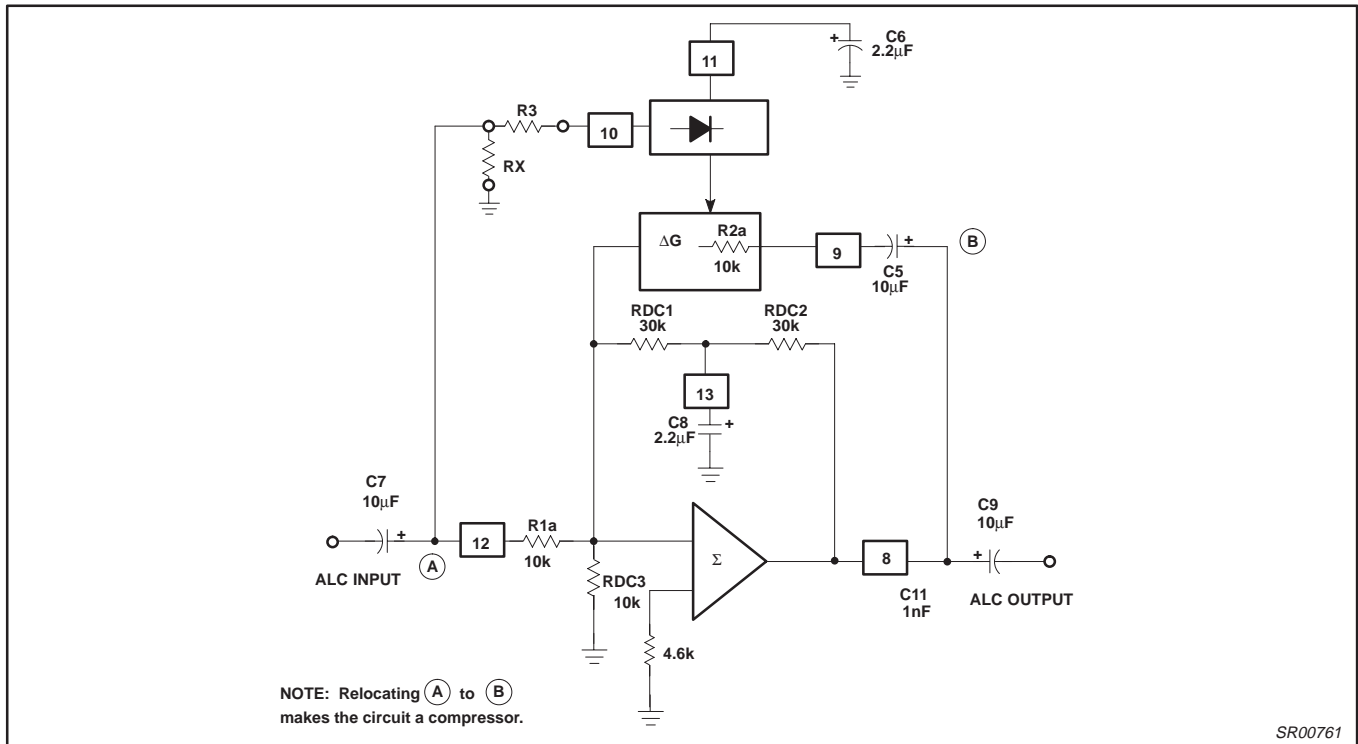
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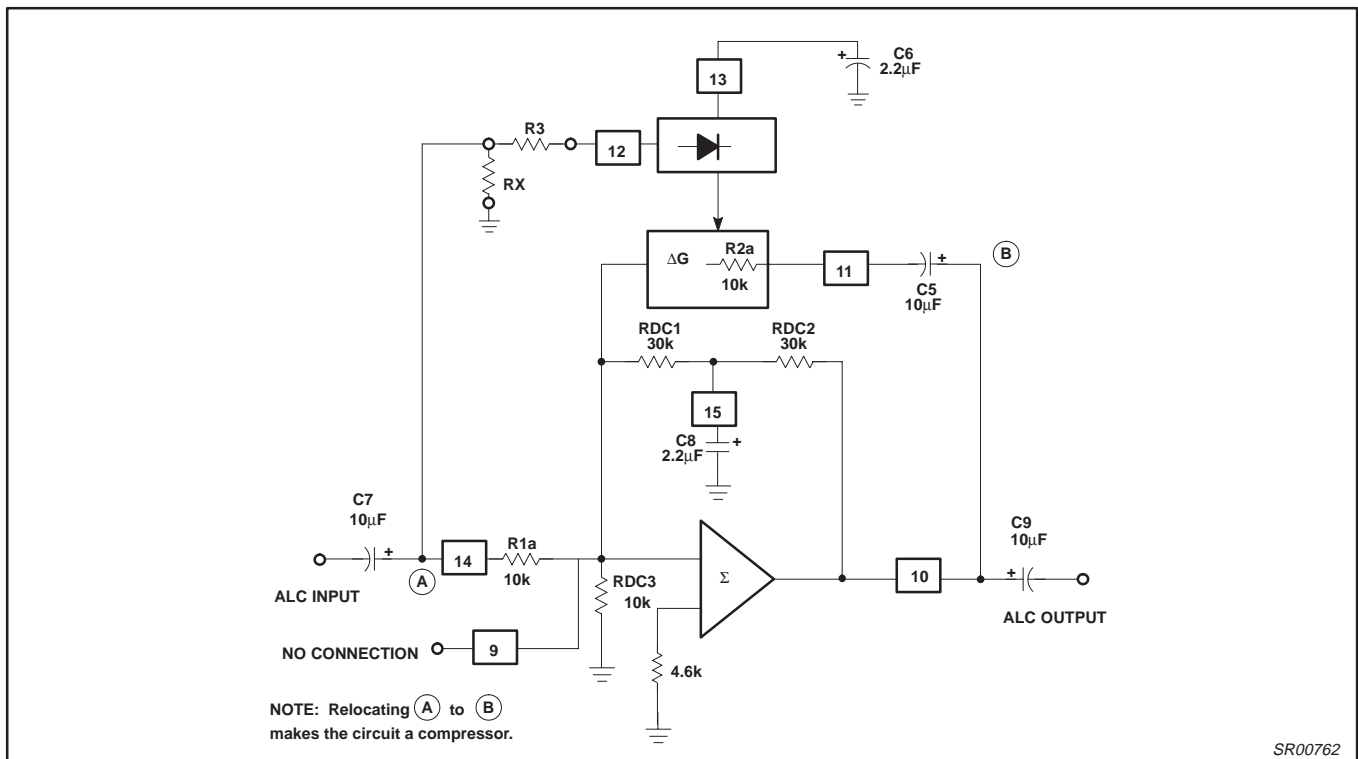

Figure 10 . SA577 ALC Configuration

Figure 11 . SA578 ALC Configuration

Example:
Design an ALC with a constant output level of 100mV$_{RMS}$ with a maximum gain of 10.

Step 1: From Eq 1

$$AC \ output \ level(V_{RMS}) \ = \ \left[\frac{R_3 \cdot R_{2_a} \cdot I_{REF}}{R_{1_a}} \right] \cdot 1.11$$

where $R_{1_a} \ = \ R_{2_a} \ = \ 10k \ (internal)$

$$I_{REF} \ = \ \frac{V_{BG}}{R_2}$$

In terms of R_3

$$R_3 \ = \ \frac{\left[AC \ output \ level(V_{RMS}) \right] \ R_{1_a}}{(1.11) \ (R_{2_a}) \ I_{REF}}$$

assuming R_2 = 100k and V_{BG} = 1.26V.

$$R_3 \ = \ \frac{100mV_{RMS} \cdot 10k}{1.11 \cdot 10k \cdot 12.6\mu A}$$

$$R_3 \ = \ 7.15k$$

Step 2: From Eq 2

$$Maximum \ Gain \ = \ \frac{4(R_3 + R_X) \cdot R_{2_a} \cdot I_{REF}}{R_{1_a} \cdot V_{CC}}$$

In terms of R_X

$$R_X \ = \ \frac{(Max. \ Gain) \ (V_{CC}) \ (R_{1_a})}{4R_{2_a} \cdot I_{REF}} \ - R_3$$

$$R_X \ = \ \frac{(10) \ (3.6V) \ (10k)}{4 \ (10k) \ 12.6\mu A} \ - 7.15k$$

$$R_X \ = \ 707.1k$$
$$R_X \ = \ 715k \ (available)$$

Step 3:
   –connect resistors to circuit
   –measure AC output level and adjust R3 for best accuracy
   –check maximum gain by applying a low input level and adjust Rx for best results

Figure 12 shows the characteristics of the SA577/578 ALC circuit without Rx. The output stays at a constant 100mV$_{RMS}$ level for a wide range of different input AC voltages. Any AC input signal above the cross-over point (unity gain level) is attenuated while any signal below the cross-over point is amplified. The cross-over point is where the input signal is equal to the output signal, where A_V=1.

Figure 13 reveals the dynamic range of the SA577 ALC circuit using Rx. The input range of the ALC is reduced. Instead of a 2mV$_{RMS}$ input signal to get 100mV$_{RMS}$ on the output, a 10mV$_{RMS}$ input signal is now required (for Rx=681k). The purpose of limiting the maximum gain of the circuit is to prevent amplification of background noise. To alleviate this problem, Rx is used. Since the ALC was designed with a maximum gain of 10, any input signal below 10mV will not be amplified with a gain greater than 10 (100mv$_{RMS}$/10=10mv$_{RMS}$). Using Rx can be an advantage because the threshold of the ALC can be set.

Figure 14 shows that as Rx increases so does A$_V$. In some applications it might be useful to make Rx a potentiometer. This will allow the user to adjust the threshold for different environmental conditions.

Figures 15-18 show the results of using the ALC for different constant output levels. V$_{CC}$ and I$_{REF}$ limit the dynamic range. The upper part of the range can be increased by either increasing V$_{CC}$ and/or I$_{REF}$. The lower part of the range can be improved by increasing I$_{REF}$.

EXTRA FEATURES FOR SA578
The SA578 has three extra functions over the SA577. These are power-down, mute and summing capabilities. To implement the power-down/mute mode, Pin 8 should be active low (open collector configuration, see Figure 19). If the power-down/mute feature is not used, Pin 8 should be left open. The SA578 only consumes 170µA of current at 3.6V when Pin 8 is activated. The power-down/mute mode is useful in designs when the function of the chip is not utilized at all times. This feature is a necessity where power conservation is critical.

In cellular and cordless applications, it is common to mix DTMF tones with the audio signal. This usually requires another op amp in which to mix the signals. With the SA578, however, the DTMF tones can be mixed internally on the compressor side. The DTMF signal is also compressed with the audio signal and ready for data transmission. Figure 2 shows that the summing of signals can be done at Pin 9 with R4 and C10. If amplification is not needed, then a 10k resistor is a recommended value for R4. In addition the summing amplifiers are capable of driving 600Ω loads.

THE SA577 AND SA578 AS A DUAL EXPANDOR
The compressor side can actually be configured as an expandor for both the SA577 and SA578. Figure 20 shows how this can be done. Because Pin 9 of the SA578 is available to the designer, the compressor side can not only be configured as an expandor, but as an expandor with summing capabilities.

OPERATING AT 1.8V
The SA577 and SA578 can operate at 1.8V.

SA577 AND SA578 DEMO BOARDS
Figures 21 shows the DIP package layout for the SA577 and SA578 demo boards, respectively. Figures 22 shows the SO layout for the SA577 and SA578 demo boards, respectively. The layouts are configured such that R1, R2, R3, and Rx can be removed and replaced easily. A switch is also available to change the operating mode of the compressor to an ALC configuration and vice versa (position the switch to the right for ALC mode).

When the compressor side is being evaluated, disconnect Rx completely from the socket on the demo boards. Rx should only be used when the compandor is being used for ALC.

For the SA578 demo board, two extra post are available. One is for power-down; the other is for summing external signals. To power-down, simply ground this post. To sum signals, connect the external signal to the proper post.

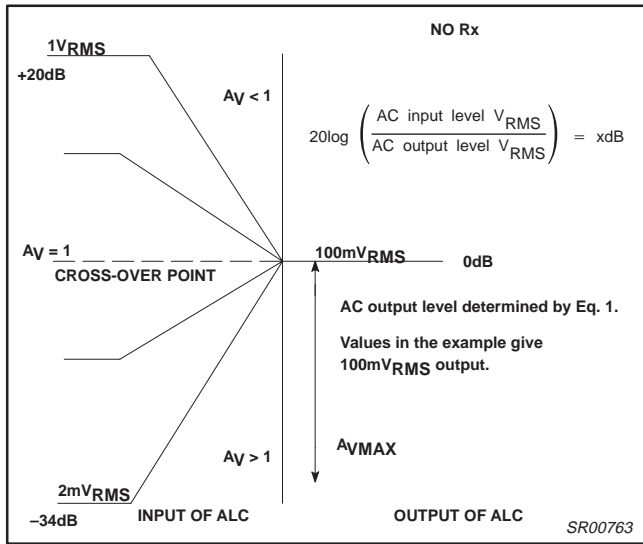# Companding with the SA577 and SA578

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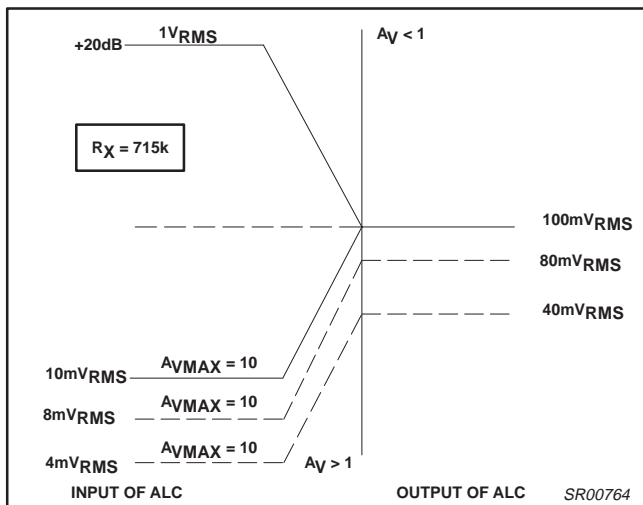**Figure 12 . Dynamic Range of SA577 ALC Demonstration Board Without R$_X$**

The equation shown in Figure 12:

$$20\log\left(\frac{\text{AC input level V}_{RMS}}{\text{AC output level V}_{RMS}}\right) = x\text{dB}$$

AC output level determined by Eq. 1.

Values in the example give 100mV$_{RMS}$ output.

Figure 13 . Dynamic Range of SA577 ALC Demo Board with R$_X$ = 715kΩ
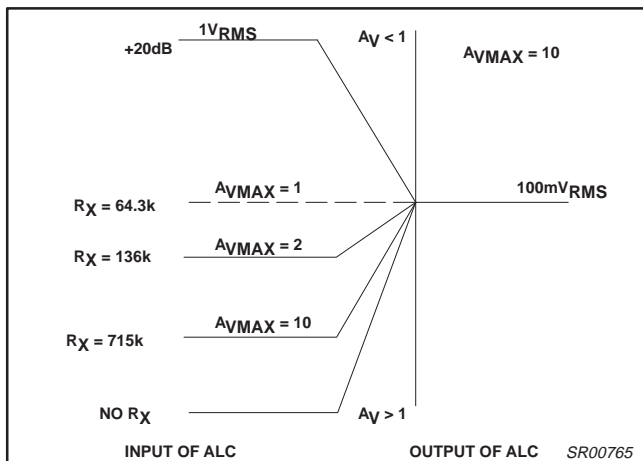
Figure 14 . Dynamic Range of SA577 ALC Demo Board with Different R$_X$ Values
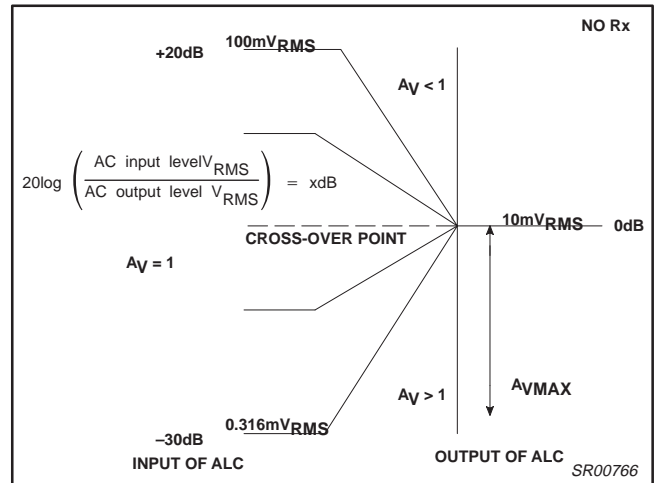
Figure 15 . SA577 ALC: AC Output Level = 10mV$_{RMS}$
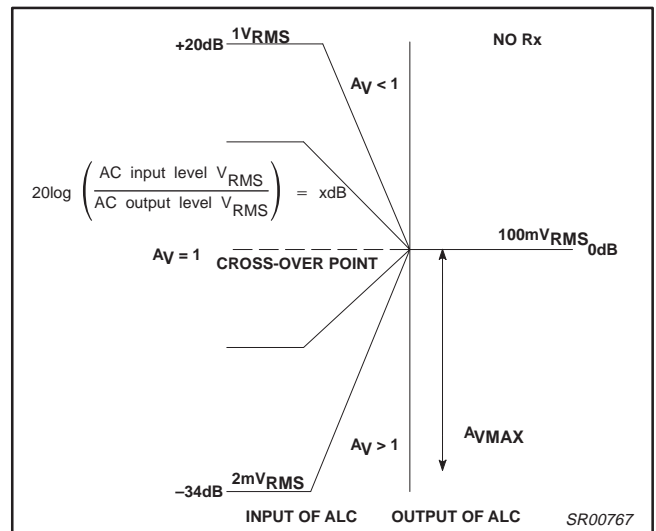
Figure 16 . SA577 ALC: AC Output Level = 100mV$_{RMS}$
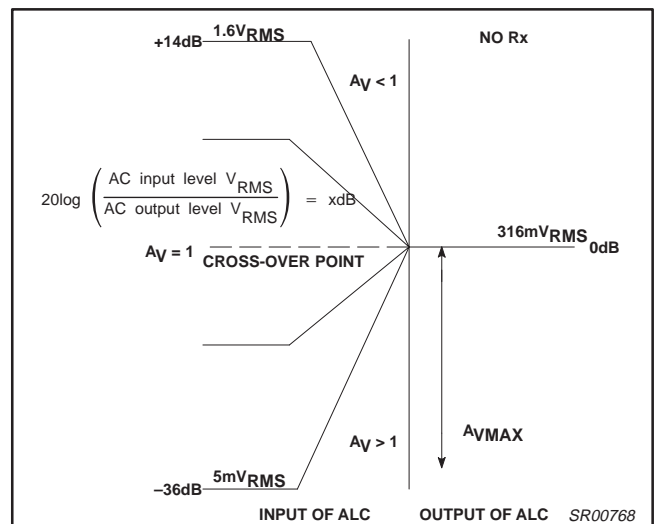
Figure 17 . SA577 ALC: AC Output Level = 316mV$_{RMS}$
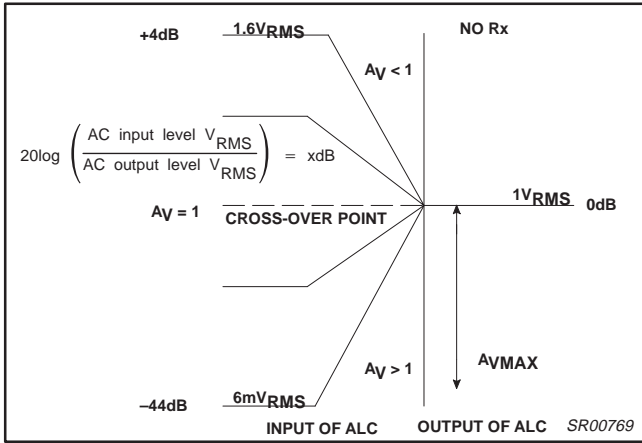
Figure 18 . SA577 ALC: AC Output Level = $1V_{RMS}$

LEVEL AT PIN 8 SHOULD BE OPEN COLLECTOR TTL LEVELS

THE REASON FOR OPEN COLLECTOR CONFIGURATION IS TO ENSURE:

1) PIN 8 IS FLOATING WHEN POWER-DOWN/MUTE IS NOT IMPLEMENTED

2) PIN 8 IS GROUNDED WHEN POWER-DOWN/MUTE IS ACTIVE
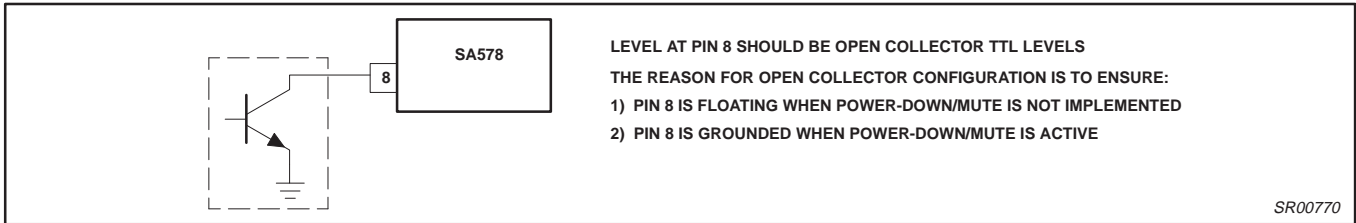
SR00770

Figure 19 . Proper Use of SA578 Pin 8
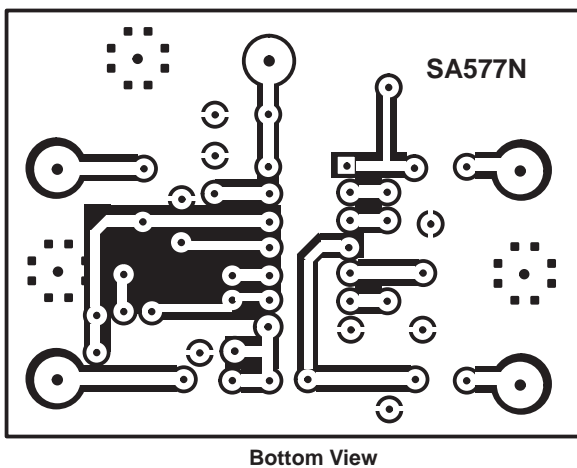
Companding with the SA577 and SA578
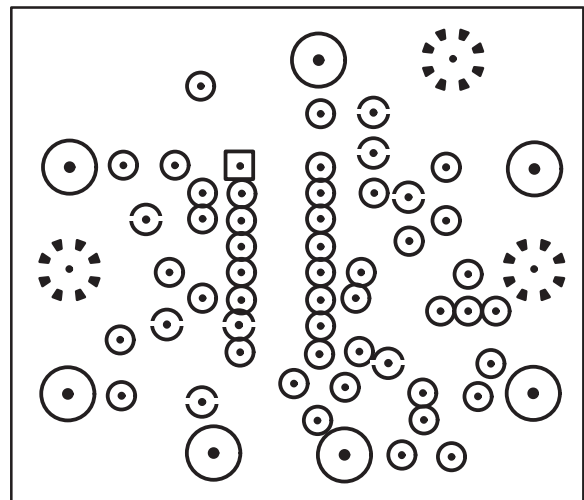
AN1762

a. SA577
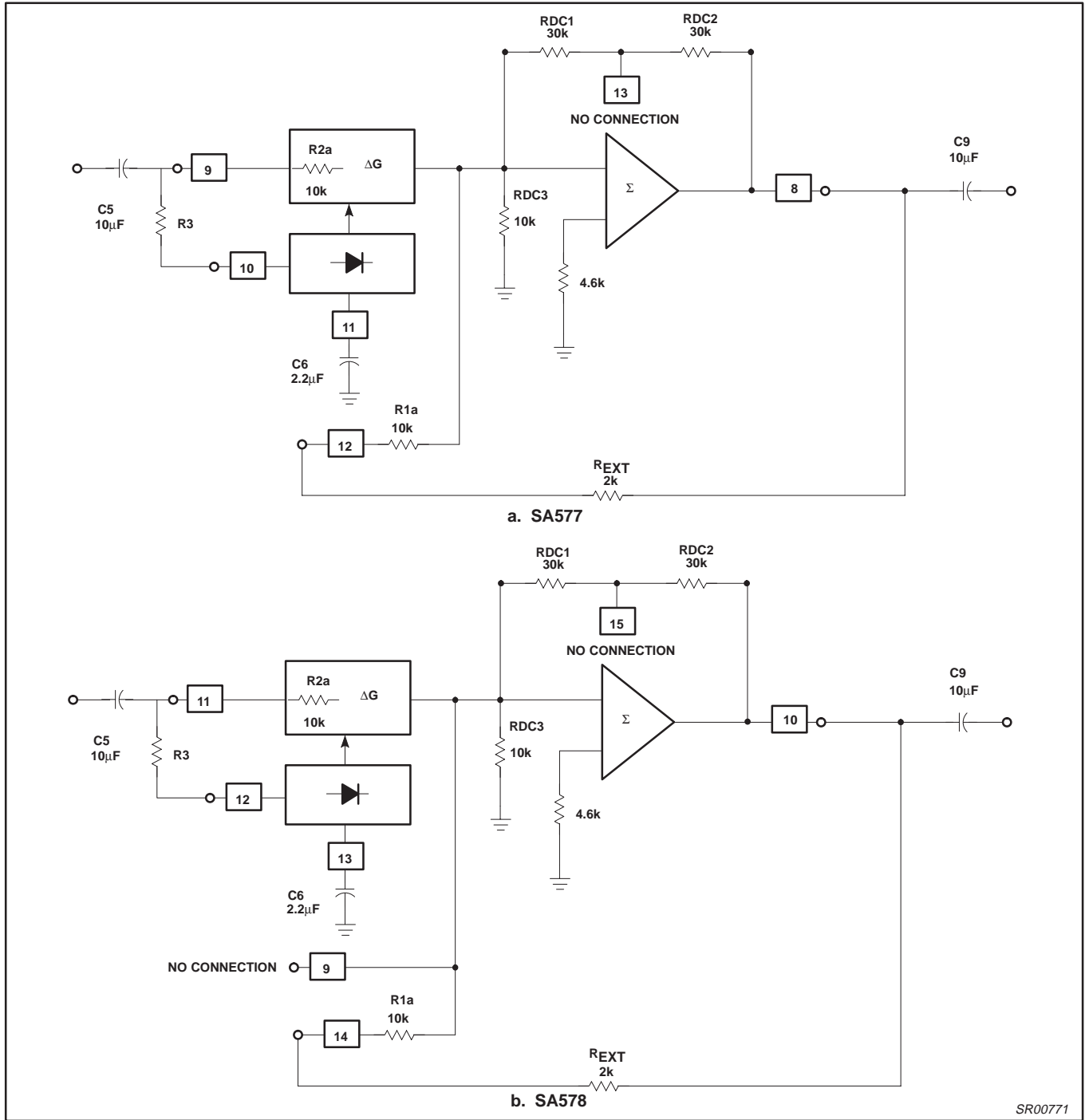
b. SA578

SR00771

Figure 20 . Expandor Configuration for the Compressor Side

Companding with the SA577 and SA578

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Figure 21 . SA577 and SA578 DIP Application Board Layout
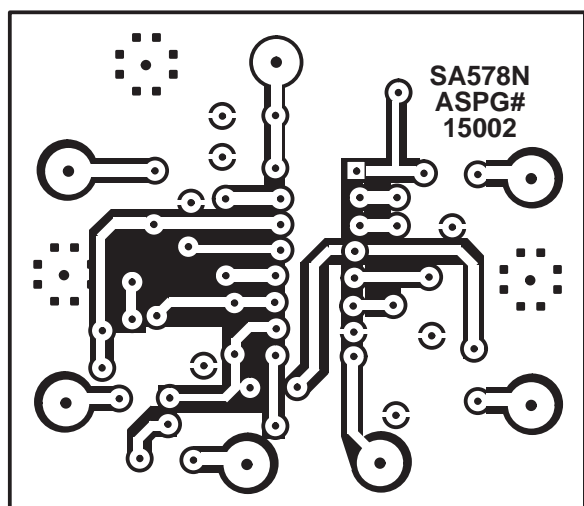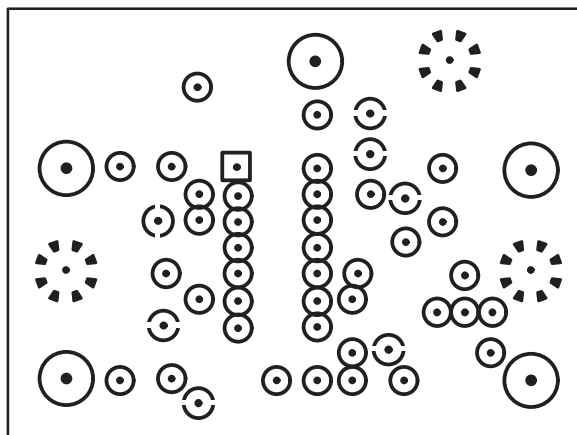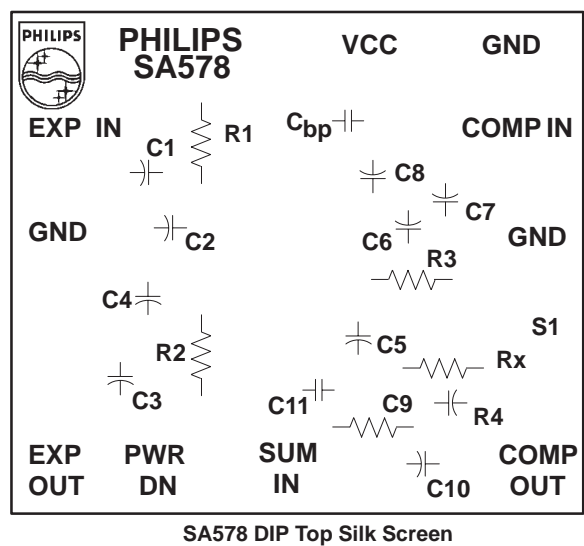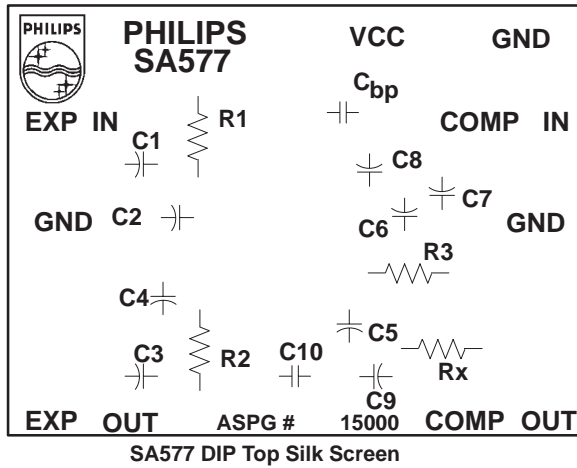
NOTE: C10 eliminated as of 11/30/94.
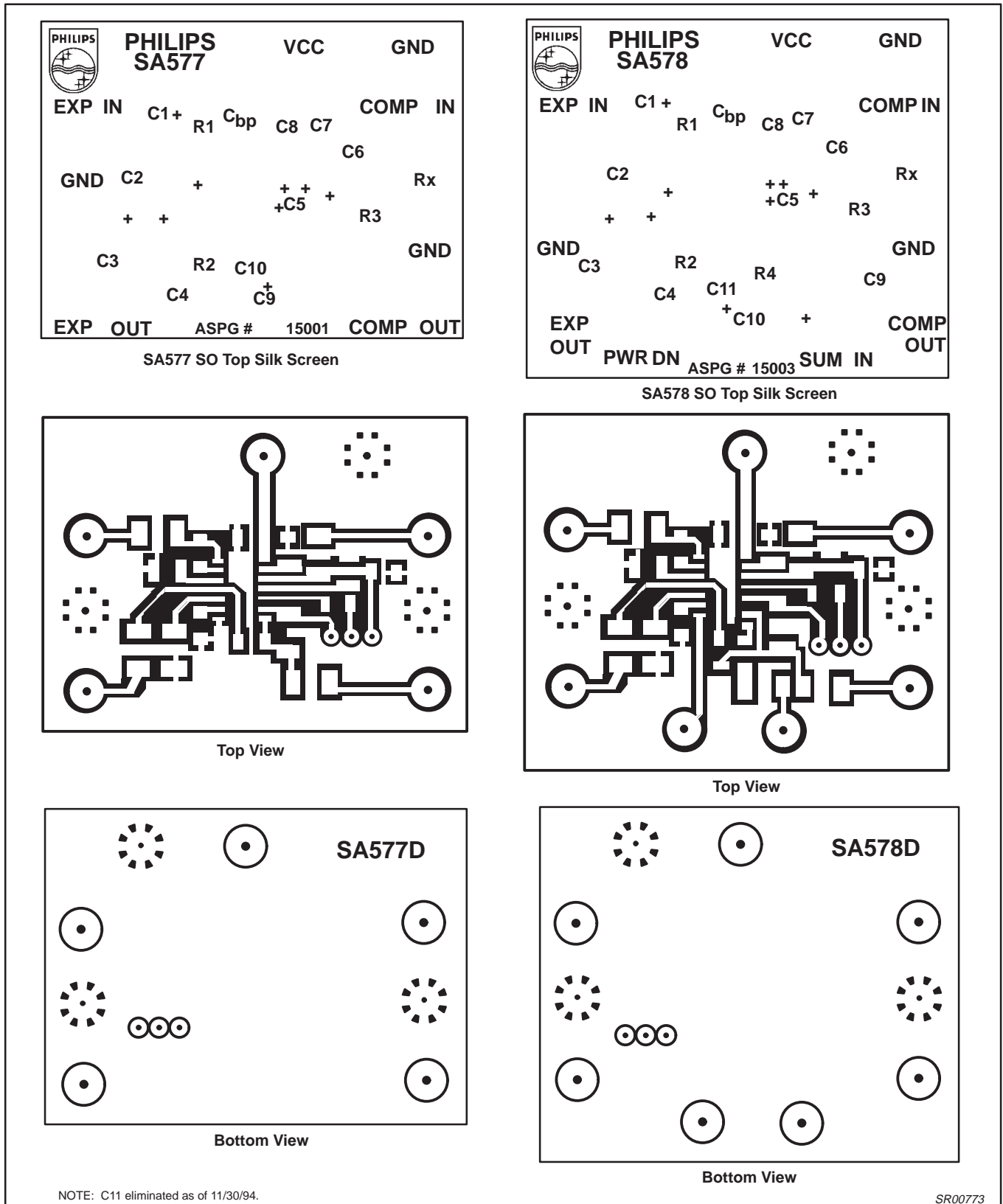
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NOTE: C11 eliminated as of 11/30/94.

SR00773

Figure 22 . SA577 and SA578 SO Application Board Layout