

# Comanding with the NE577 and NE578

AN1762

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## INTRODUCTION

This application note is written for the designer who understands the basic functions of companding and wants to use the NE577 or NE578. If a designer is not familiar with the functionality of companders, 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 NE578
- How to power-down the NE578
- How to mute the NE578
- How to use the NE577 and NE578 as a dual expander

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 companders: the NE570, NE571, NE572, and NE575. Each of the four companders has its own 'claim to fame'. The NE570 and NE571 are known to work well in high performance audio applications. The only real difference between the two is that the NE570 has a slight edge in performance. However when separate attack and recovery times are needed, the NE572 is the compandor to choose. The NE575 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 companders to its family, the NE576, NE577 and NE578. These companders 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 NE578 has a power-down mode. In this mode, the chip consumes only 170 $\mu$ A. This power-down mode is useful when the functionality of the chip is not needed at all times. In the power-down mode, the NE578 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 NE578. Having the mute function internal to the NE578 audio section eliminates the need for an external switch. The NE578 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 NE577 and NE578. However, for the NE576, the 0dB level is

specified and set at 100mV<sub>RMS</sub>. The earlier companders also have a set unity gain (0dB) level. The NE570 and NE571 have a set 0dB level at 775mV<sub>RMS</sub>. While the NE572 and the NE575 both have their 0dB levels at 100mV<sub>RMS</sub>. 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 NE577 and NE578, these external op amps are no longer needed. The 0dB level can be programmed from 10mV<sub>RMS</sub> to 1V<sub>RMS</sub> with three external resistors.

Many of the external parts in the previous family of companders are now internal to the device. Additionally, the left side of the chip is configured as an expander, 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 NE576, NE577 and NE578 are easy to implement in any design.

Table 1 shows a brief summary of all the companders. The seven different companders 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 NE570, NE571, and NE572 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 NE575, NE576, NE577, and NE578, 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 NE577 AND NE578

Figure 1 and 2 show block diagrams of the NE577 and NE578 respectively. The only substantial difference between the two is that the NE578 has a power-down capability, mute function and summing capabilities (for signals like DTMF tones). In addition the NE578 summing amplifiers are capable of driving 600 $\Omega$  loads. Listed below are the basic functions of each external component for Figure 1 (NE577).

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Table 1. Comandor Family Overview

	NE570	NE571	NE572	NE575	NE576	NE577	NE578
V <sub>CC</sub>	6–24V	6–18V	6–22V	3–7V	2–7V	2–7V	2–7V
I <sub>CC</sub>	3.2mA	3.2mA	6mA	3–5.5mA*	1–3mA*	1–2mA*	1–2mA*
Number of Pins	16	16	16	20	14	14	16
<b>Packages</b> NE: 0 to +70°C SA: –40 to +85°C N: Plastic DIP D: Plastic SO F: Ceramic DIP DK: SSOP (Shrink Small Outline Package)	NE570F NE570N NE570D	NE571F NE571N NE571D  SA571F SA571N SA571D	NE572N NE572D  SA572F SA572N SA572D	NE575N NE575D NE575DJ  SA575N SA575D SA575DK	NE576N NE576D  SA576N SA576D	NE577N NE577D  SA577N SA577D	NE578N NE578D  SA578N SA578D
<b>ALC (Automatic Level Control)</b>	Both Channels	Both Channels	Both Channels	Right Channel	Right Channel	Right Channel	Right Channel
<b>Reference Voltage</b>	Fixed 1.8V	Fixed 1.8V	Fixed 2.5V	V <sub>CC</sub> / 2	V <sub>CC</sub> / 2	V <sub>CC</sub> / 2	V <sub>CC</sub> / 2
<b>Unity Gain</b>	775mV <sub>RMS</sub>	775mV <sub>RMS</sub>	100mV <sub>RMS</sub>	100mV <sub>RMS</sub>	100mV <sub>RMS</sub>	10mV to 1V <sub>RMS</sub>	10mV to 1V <sub>RMS</sub>
<b>Power-Down</b>	NO	NO	NO	NO	NO	NO	YES (170µA)
<b>Key Features</b>	-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 Uncommitted 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
<b>Applications</b> 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:** NE5750/5751 are also excellent audio processor components for high performance cordless and cellular applications that include the companding function..

\*I<sub>CC</sub> varies with V<sub>CC</sub>.

R1 – Determines the Unity Gain Level for the Expander

R2 – Determines What Value the Reference Current (I<sub>REF</sub>) 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 Expander

C3 – DC Blocking Capacitor

C4 – Used to AC Ground the V<sub>REF</sub> 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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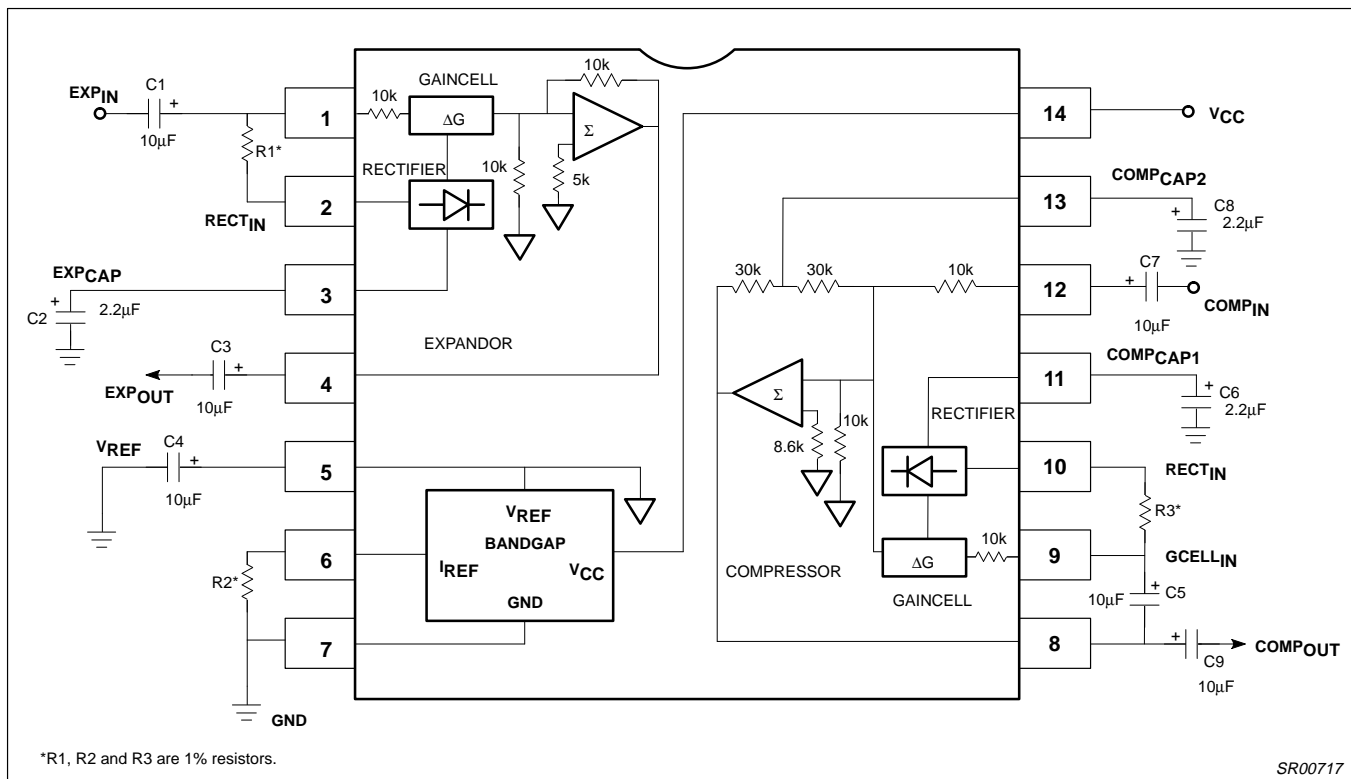


Figure 1 . NE577 Block Diagram

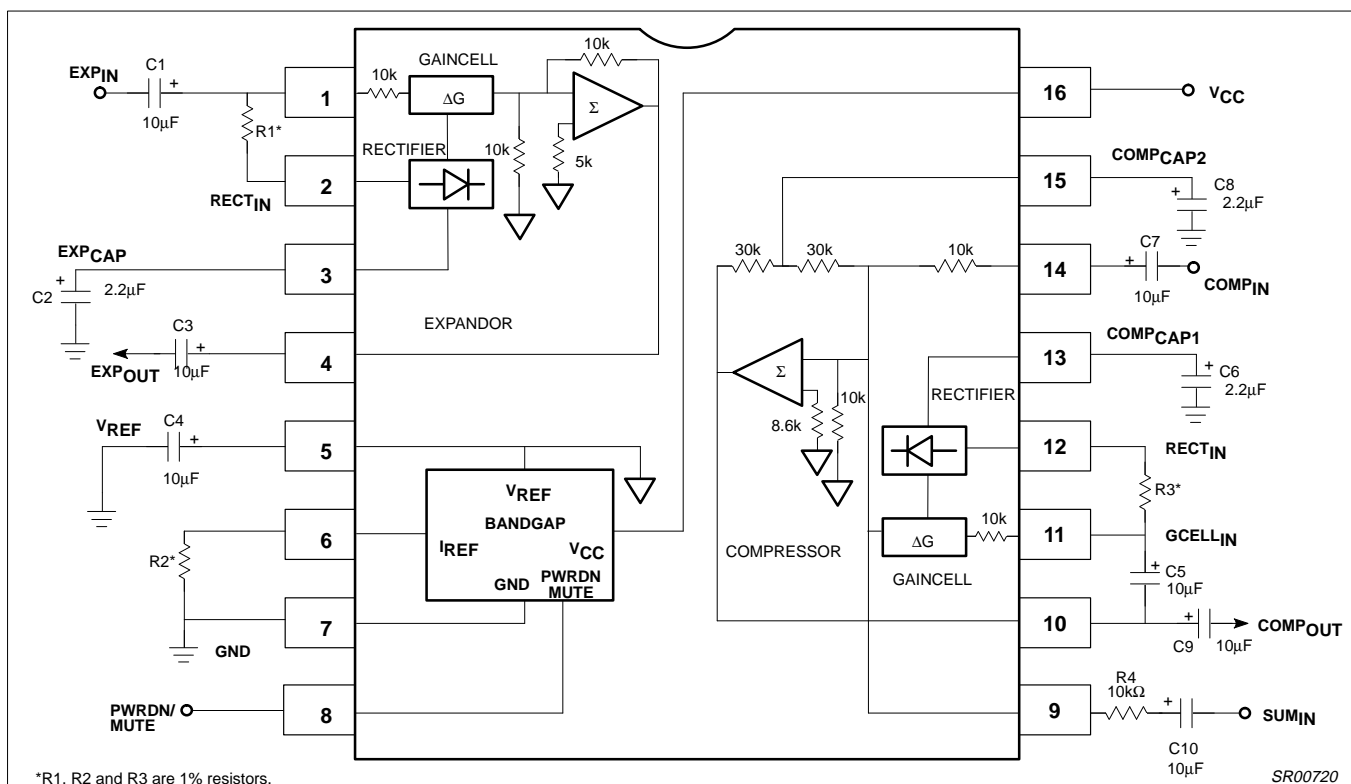


Figure 2 . NE578 Block Diagram

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Listed below are the basic functions of each external component for Figure 2 (NE578).

- R1 – Determines the Unity Gain Level for the Expander
- 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 Expander
- 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 NE577 and the NE578 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 expander 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 expander 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 NE577 or NE578, due to the separate 0dB level programming.

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

$$\text{Formula 1: } R_2 = \frac{V_{BG}}{I_{REF}}$$

where

$V_{BG}$  = Bandgap Voltage

$I_{REF}$  = Reference Current

( $V_{BG}$  is brought out on Pin 6 and R2 determines the  $I_{REF}$  value)

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

where  $V_{IN_{RMS}}$  is the 0dB level

( $R_1 = R_3$  in most cases)

Programming the Unity Gain Level for the NE577 also applies for the NE578.

Example:

Program the NE577 or NE578 for a 0dB Level at  $100mV_{RMS}$

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

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

$$R_2 = 100k$$

Step 2:

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

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

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

Step 3:  $R_1 = R_3 = 7.15k$  (1% value)

$R_2 = 100k$  (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 <sub>2</sub>	R <sub>1</sub> & R <sub>3</sub>
$1.0V_{RMS}$	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 NE577 and NE578, 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 NE577 and NE578 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  $5\mu A$  and  $40\mu A$ .

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  $30\mu A$  is required for approximately 0.1% distortion.

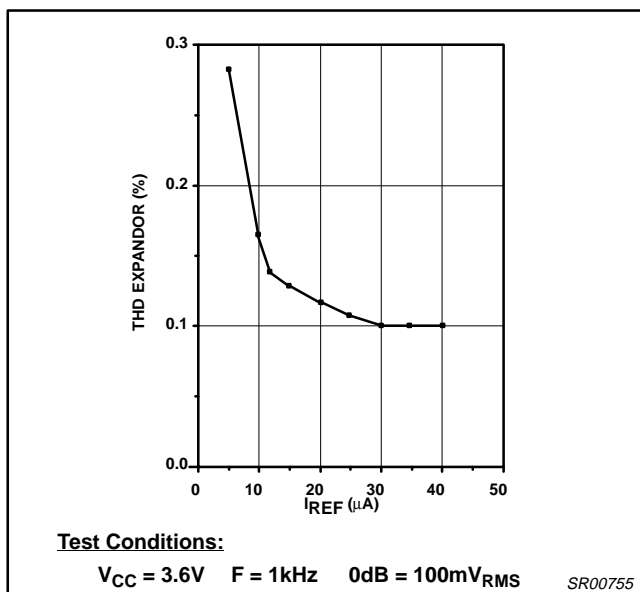


Figure 4 .  $I_{REF}$  vs THD, Expander Side

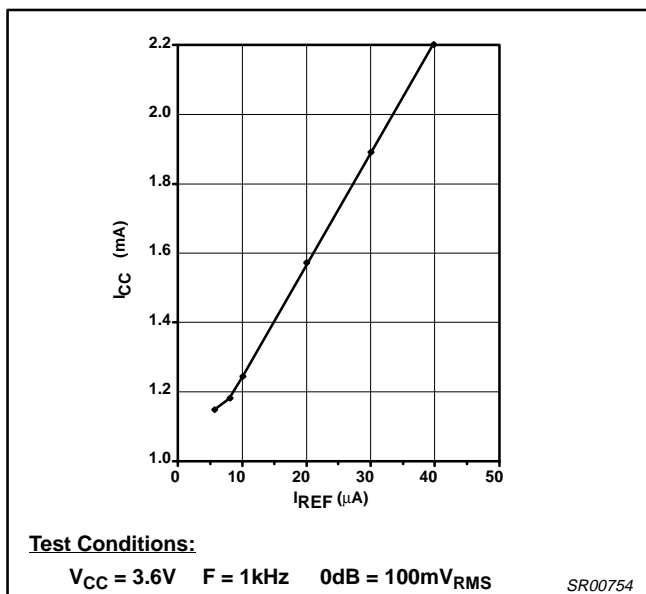


Figure 3 .  $I_{REF}$  vs  $I_{CC}$

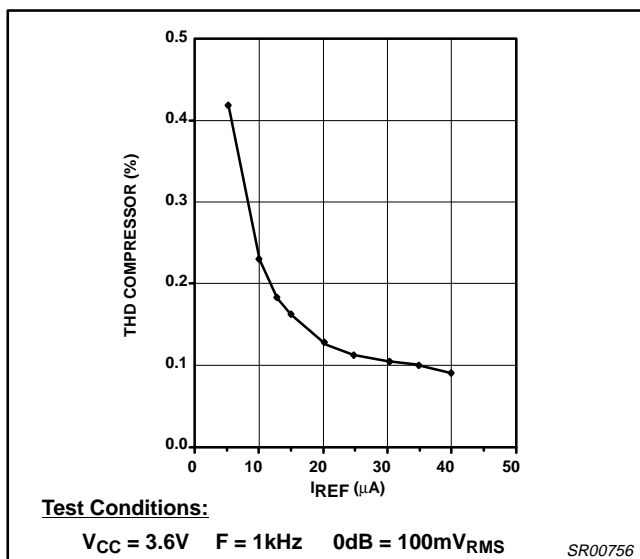
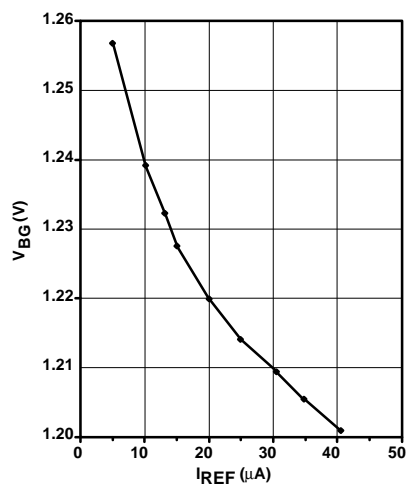


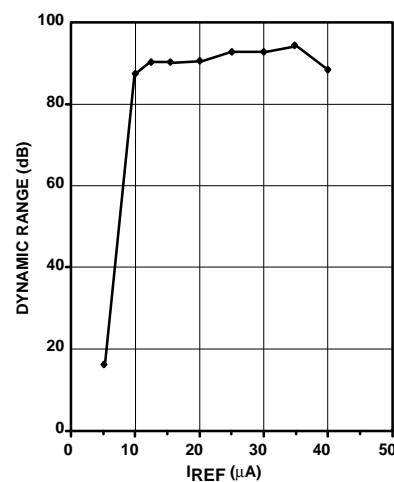
Figure 5 .  $I_{REF}$  vs THD, Compressor Side

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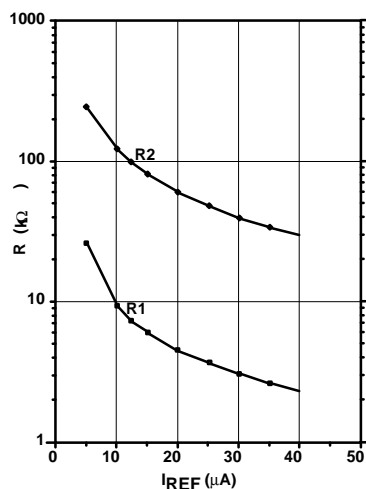
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**Test Conditions:** $V_{CC} = 3.6V$   $F = 1kHz$   $0dB = 100mV_{RMS}$ 

SR00757

Figure 6 .  $I_{REF}$  vs  $V_{BG}$ **Test Conditions:** $V_{CC} = 3.6V$   $F = 1kHz$   $0dB = 100mV_{RMS}$ 

SR00759

Figure 8 .  $I_{REF}$  vs Dynamic Range**Test Conditions:** $V_{CC} = 3.6V$   $F = 1kHz$   $0dB = 100mV_{RMS}$ 

SR00758

Figure 7 .  $I_{REF}$  vs  $R_2$ ,  $R_1$ 

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  $R_1$ ,  $R_2$ , and  $R_3$

**Graphical Method:**

From Figure 7: For  $I_{REF}=30\mu A$  and  $0dB=100mV_{RMS}$   $R_1=R_3=3k$   $R_2=40k$

Actual resistors available:  $R_1=R_3=3.01k$  (1%)  $R_2=40.2k$  (1%)

**Formula Method:**

From Figure 6:  $V_{BG}=1.21V$  for  $I_{REF}=30\mu A$  therefore, using formula 1:

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

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

$$R_2 = 40.33k$$

$$R_2 = 40.2k \text{ (available in 1\%)}$$

Recall from formula 2:

$$R_1 = \frac{0.9V I_{N_{RMS}}}{I_{REF}}$$

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

$$R_1 = 3k$$

$$R_1 = 3.01k \text{ (available in 1\%)}$$

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 (measured 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  $R_1$  and  $R_3$ , the  $0dB$  error can be further reduced to zero.

**BANDWIDTH OF COMPANDOR**

Figure 9 shows the typical bandwidth for the NE577 and NE578. The graphs were taken with a  $V_{CC}$  of 3.6V and a  $0dB$  level of  $100mV_{RMS}$ . The bandwidth of the expander, the compressor, and the compandor (where a signal goes through the compressor and the expander) is shown in this figure. Although the NE577 and NE578 are conservatively specified with a 20kHz bandwidth, Figure 9 reveals that it is actually around 300kHz.

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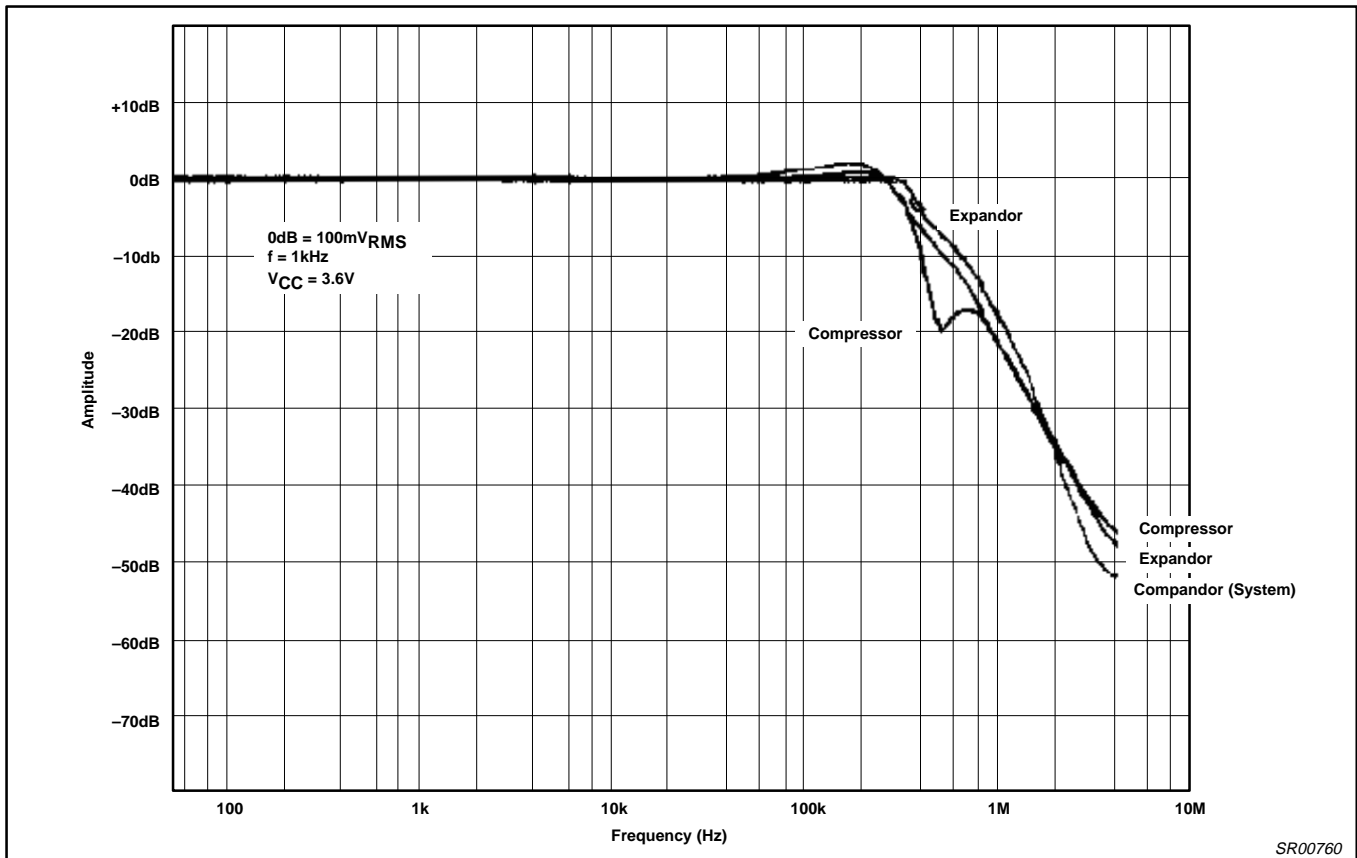


Figure 9 . Bandwidth of NE577 and NE578 Demo Board

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## HOW TO SET THE ATTACK AND RECOVERY TIMES

C2 and C6, from figures 1 and 2, set the attack and recovery times for the NE577 and NE578. 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:

$$\begin{aligned} \text{Attack Time [ms]} &= 10k \cdot C2 \text{ or } C6 \\ \text{Release Time [ms]} &= 4 \cdot \text{Attack Time} \end{aligned}$$

Although a fast attack time is desirable, one must remember that there is a trade-off with low distortion. As a general rule, a  $1\mu\text{F}$  capacitor for C2 will produce 0.2% THD at 1kHz. Since CCITT recommends an RC time constant of 20ms for the attack time, a  $2\mu\text{F}$  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 NE577 and NE578. 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 NE577 and NE578 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 NE577/78 ALC is set up to provide a constant output level of  $100\text{mV}_{\text{RMS}}$  with an input range from  $-34\text{dB}$  to  $+20\text{dB}$  at 1kHz (see Figure 12).

Below are some design equations for the ALC:

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

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

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

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

$$\text{Gain} = \frac{R_3 \cdot R_{2a} \cdot I_{\text{REF}}}{R_{1a} \cdot V_{\text{IN}_{\text{RMS}}}} \quad \text{Eq 3.}$$

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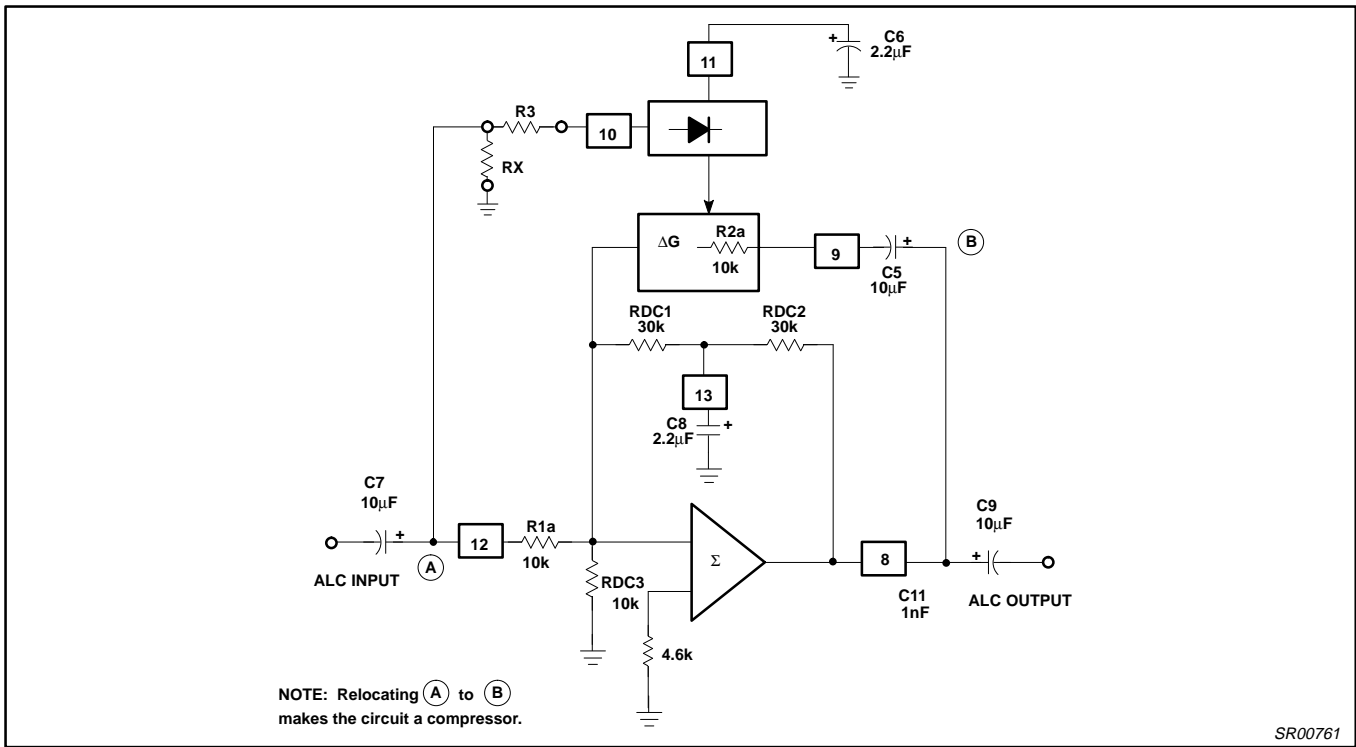


Figure 10 . NE577 ALC Configuration

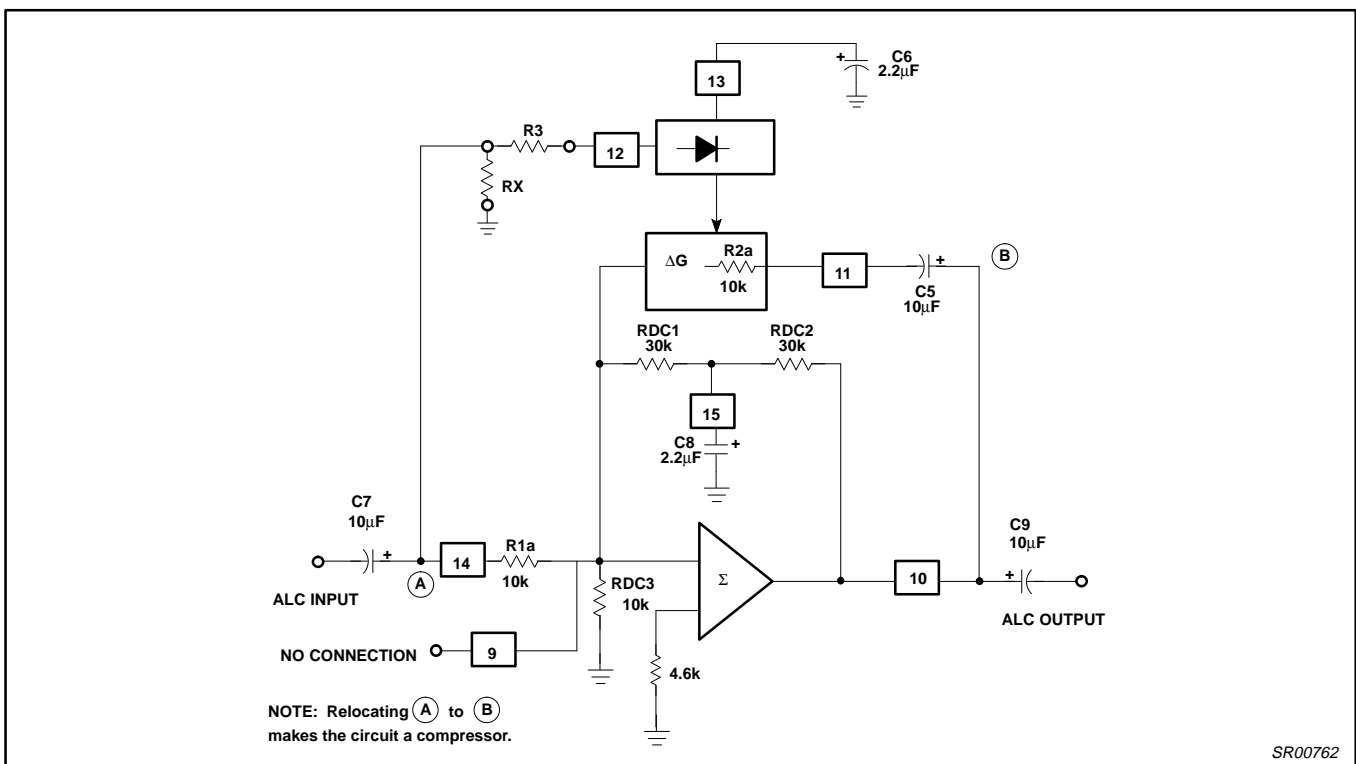


Figure 11 . NE578 ALC Configuration



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## Example:

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

Step 1: From Eq 1

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

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

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

In terms of  $R_3$

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

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

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

$$R_3 = 7.15\text{k}$$

Step 2: From Eq 2

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

In terms of  $R_X$

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

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

$$R_X = 707.1\text{k}$$

$$R_X = 715\text{k} \text{ (available)}$$

Step 3:

- connect resistors to circuit
- measure AC output level and adjust  $R_3$  for best accuracy
- check maximum gain by applying a low input level and adjust  $R_X$  for best results

Figure 12 shows the characteristics of the NE577/578 ALC circuit without  $R_X$ . The output stays at a constant  $100\text{mV}_{\text{RMS}}$  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 NE577 ALC circuit using  $R_X$ . The input range of the ALC is reduced. Instead of a  $2\text{mV}_{\text{RMS}}$  input signal to get  $100\text{mV}_{\text{RMS}}$  on the output, a  $10\text{mV}_{\text{RMS}}$  input signal is now required (for  $R_X=681\text{k}$ ). The purpose of limiting the maximum gain of the circuit is to prevent amplification of background noise. To alleviate this problem,  $R_X$  is used. Since the ALC was designed with a maximum gain of 10, any input signal below  $10\text{mV}$  will not be amplified with a gain greater than 10 ( $100\text{mV}_{\text{RMS}}/10=10\text{mV}_{\text{RMS}}$ ). Using  $R_X$  can be an advantage because the threshold of the ALC can be set.

Figure 14 shows that as  $R_X$  increases so does  $A_V$ . In some applications it might be useful to make  $R_X$  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.  $V_{\text{CC}}$  and  $I_{\text{REF}}$  limit the dynamic range. The upper part of the range can be increased by either increasing  $V_{\text{CC}}$  and/or  $I_{\text{REF}}$ . The lower part of the range can be improved by increasing  $I_{\text{REF}}$ .

## EXTRA FEATURES FOR NE578

The NE578 has three extra functions over the NE577. 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 NE578 only consumes  $170\mu\text{A}$  of current at  $3.6\text{V}$  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 NE578, 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  $R_4$  and  $C_{10}$ . If amplification is not needed, then a  $10\text{k}$  resistor is a recommended value for  $R_4$ . In addition the summing amplifiers are capable of driving  $600\Omega$  loads.

## THE NE577 AND NE578 AS A DUAL EXPANDOR

The compressor side can actually be configured as an expandor for both the NE577 and NE578. Figure 20 shows how this can be done. Because Pin 9 of the NE578 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 NE577 and NE578 can operate at  $1.8\text{V}$ .

## NE577 AND NE578 DEMO BOARDS

Figures 21 shows the DIP package layout for the NE577 and NE578 demo boards, respectively. Figures 22 shows the SO layout for the NE577 and NE578 demo boards, respectively. The layouts are configured such that  $R_1$ ,  $R_2$ ,  $R_3$ , and  $R_X$  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  $R_X$  completely from the socket on the demo boards.  $R_X$  should only be used when the compandor is being used for ALC.

For the NE578 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.

# Companing with the NE577 and NE578

AN1762

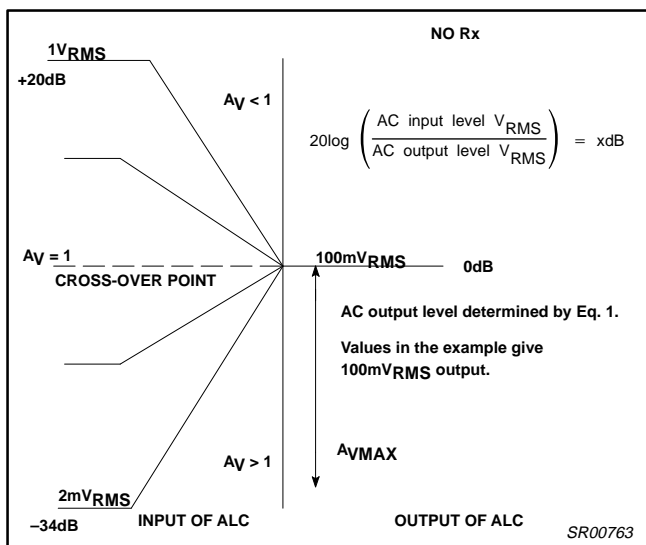


Figure 12 . Dynamic Range of NE577 ALC Demonstration Board Without  $R_x$

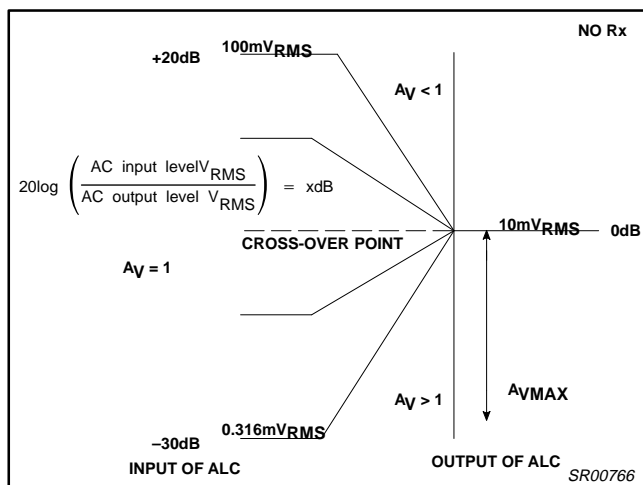


Figure 15 . NE577 ALC: AC Output Level = 10mVRMS

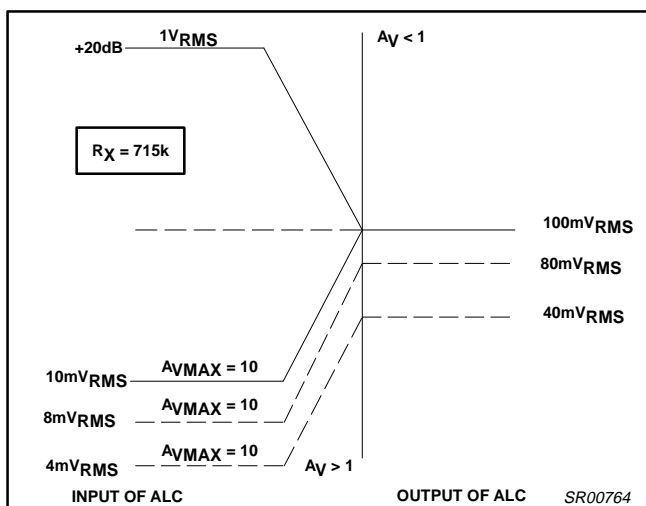


Figure 13 . Dynamic Range of NE577 ALC Demo Board with  $R_x = 715k\Omega$

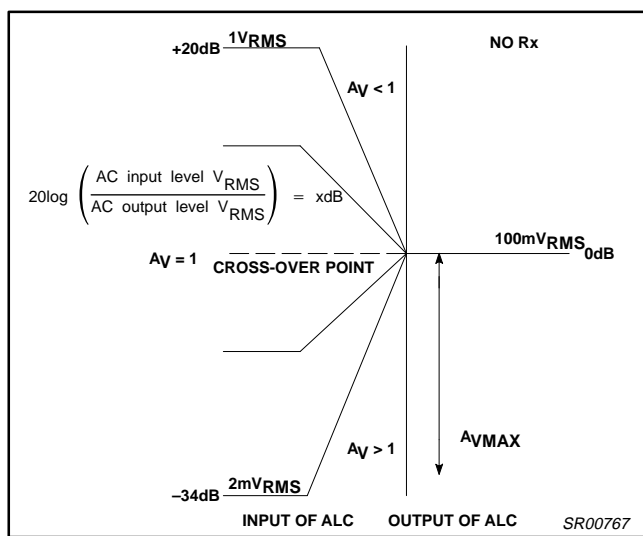


Figure 16 . NE577 ALC: AC Output Level = 100mVRMS

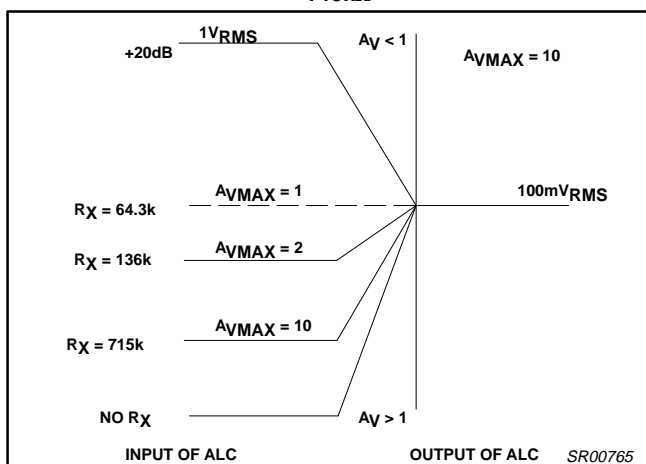


Figure 14 . Dynamic Range of NE577 ALC Demo Board with Different  $R_x$  Values

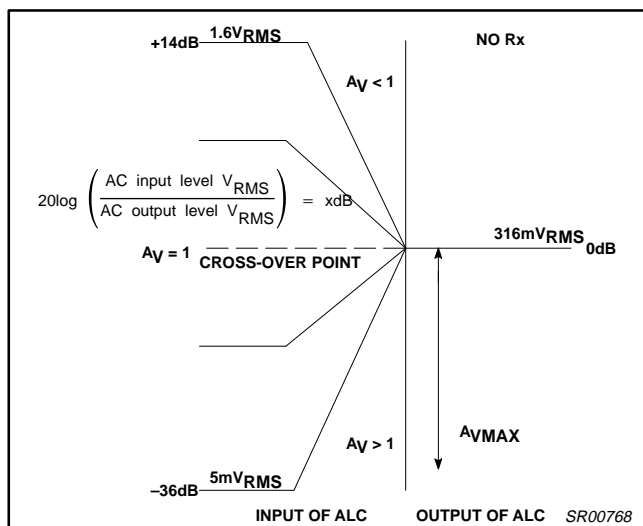


Figure 17 . NE577 ALC: AC Output Level = 316mVRMS

# Companing with the NE577 and NE578

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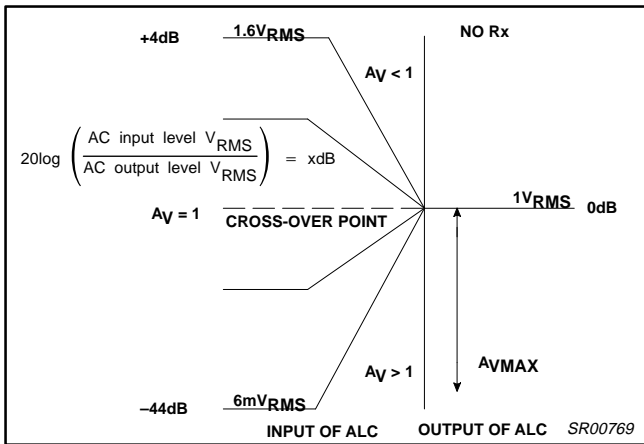


Figure 18 . NE577 ALC: AC Output Level = 1VRMS

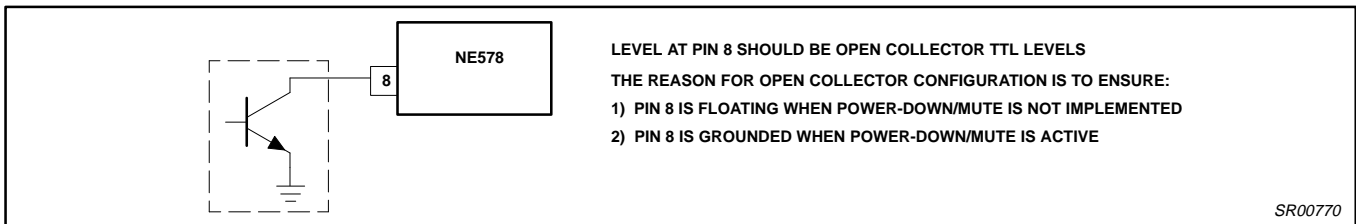
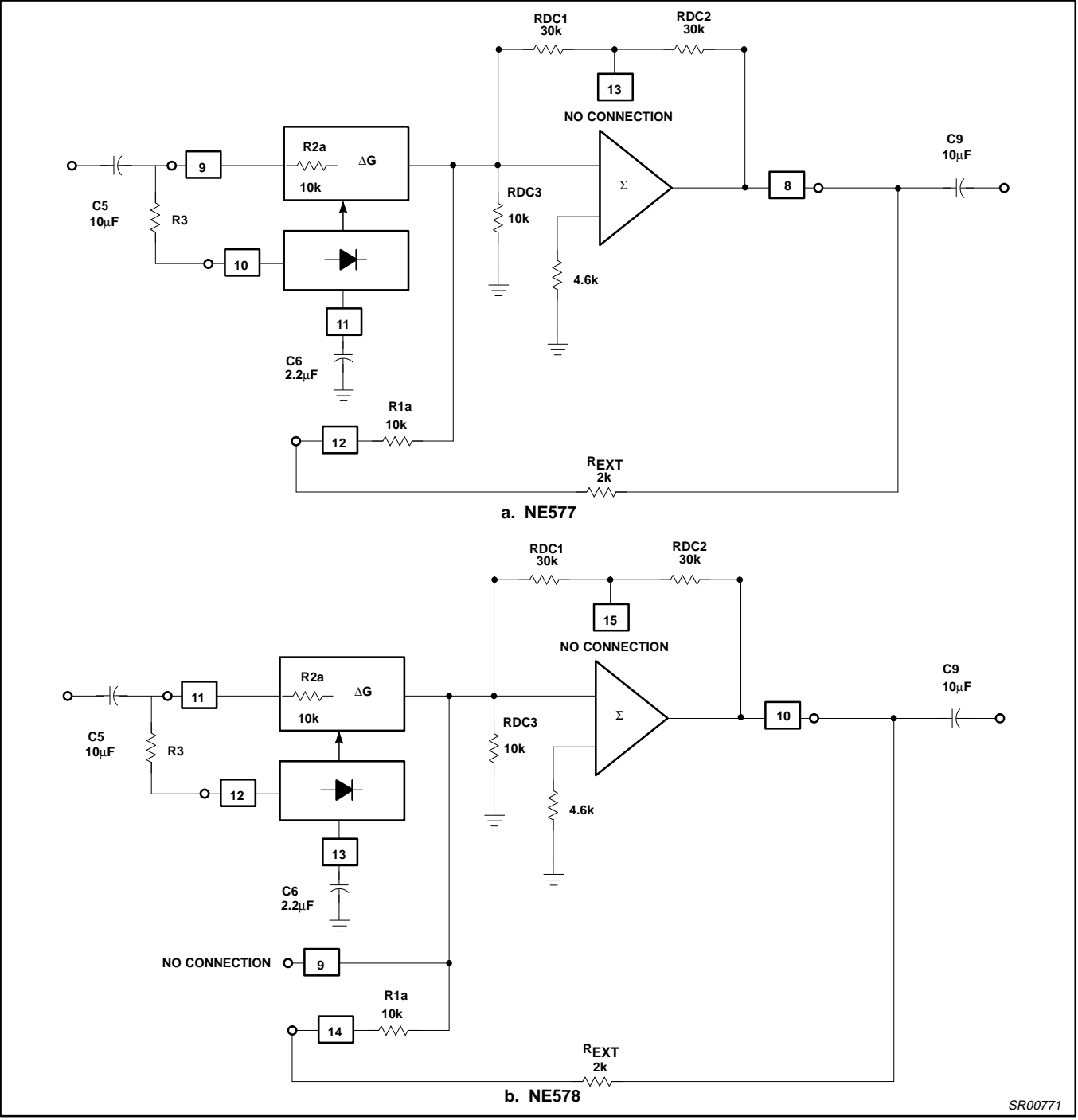


Figure 19 . Proper Use of NE578 Pin 8

# Companing with the NE577 and NE578

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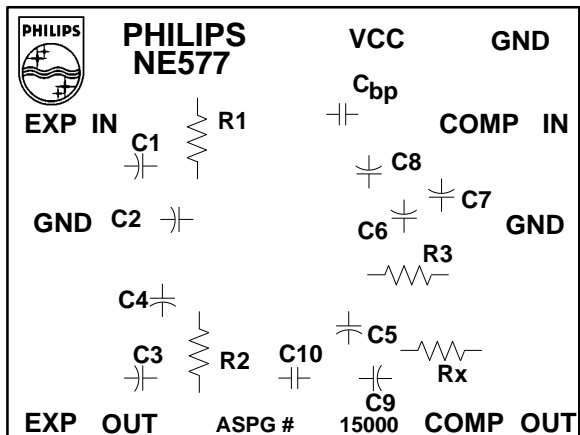


SR00771

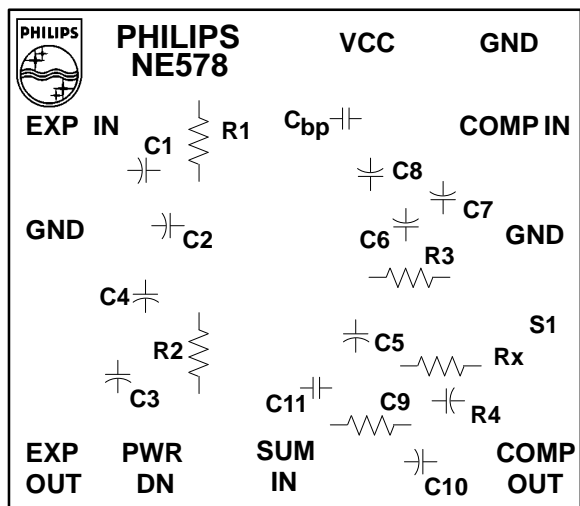
Figure 20 . Expander Configuration for the Compressor Side

# Comanding with the NE577 and NE578

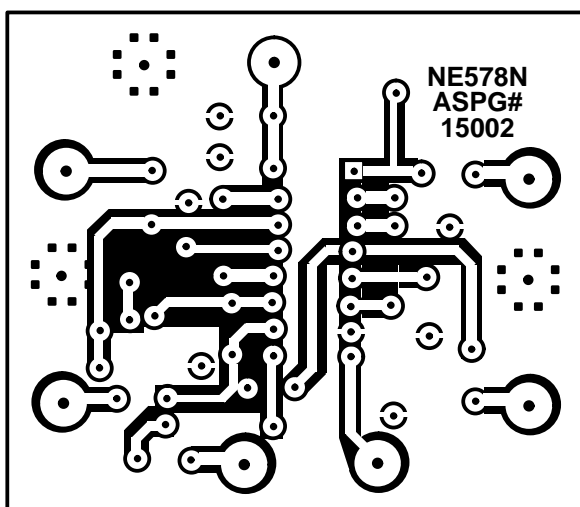
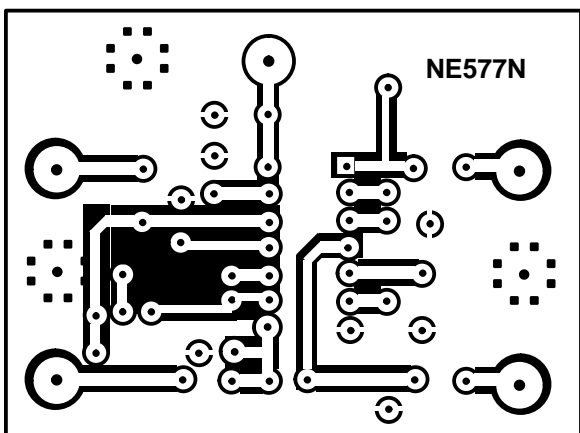
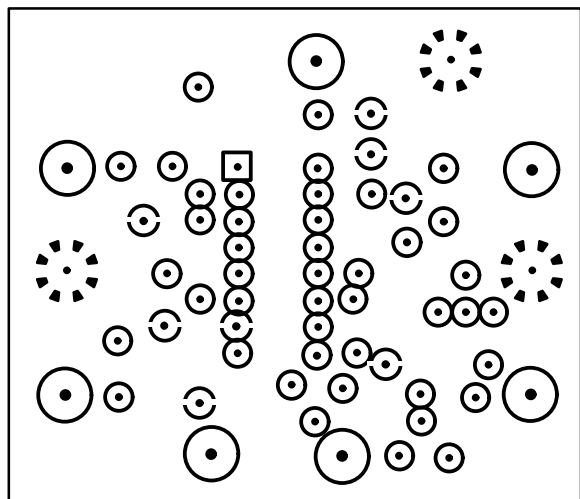
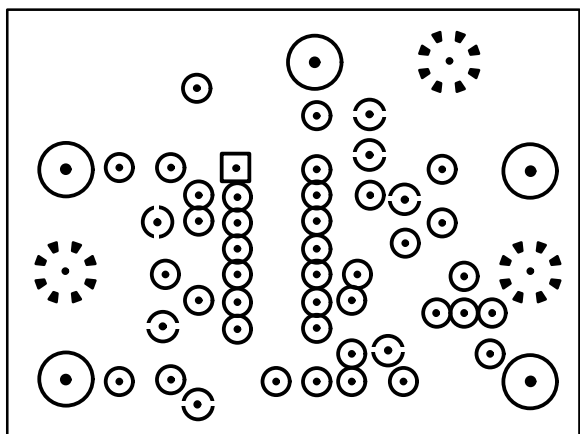
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NE577 DIP Top Silk Screen



NE578 DIP Top Silk Screen



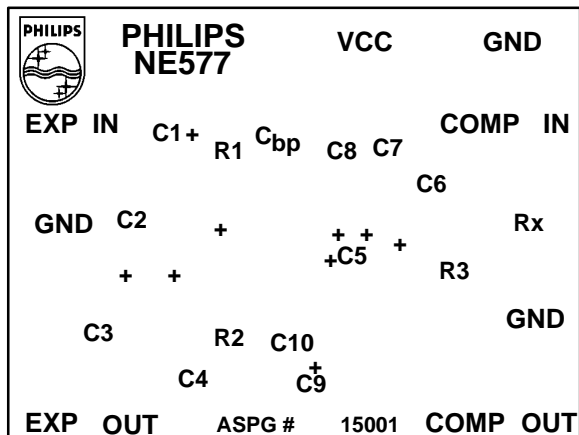
NOTE: C10 eliminated as of 11/30/94.

Figure 21 . NE577 and NE578 DIP Application Board Layout

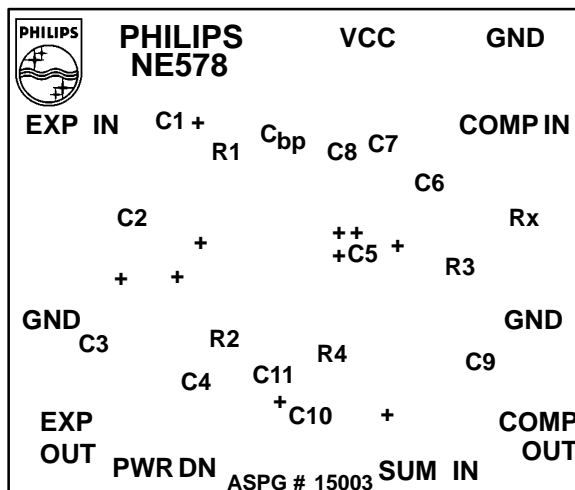
SR00772

# Companding with the NE577 and NE578

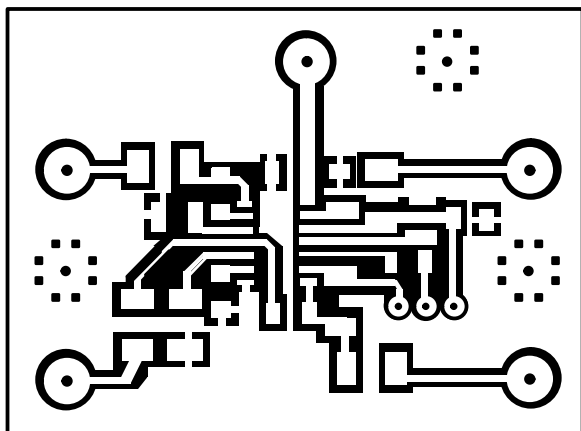
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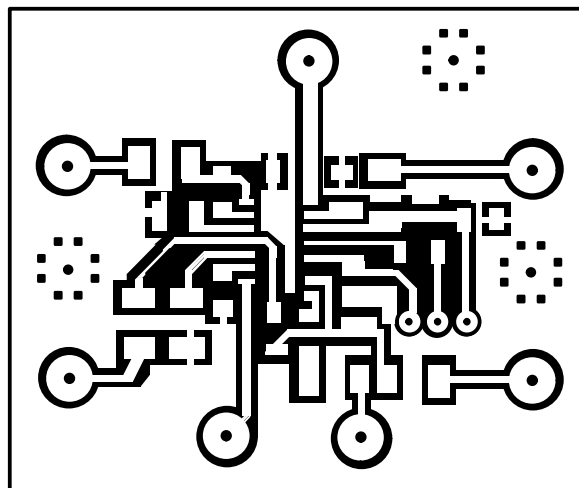
NE577 SO Top Silk Screen



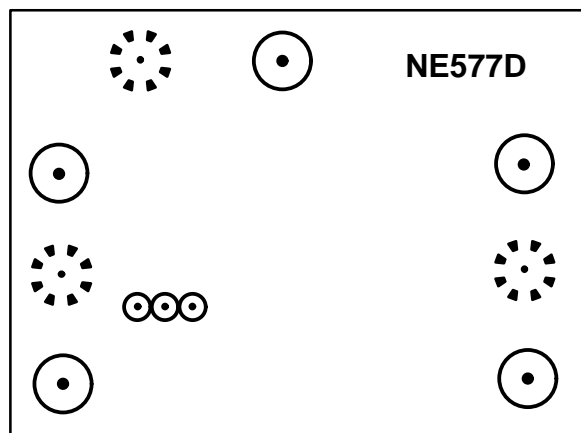
NE578 SO Top Silk Screen



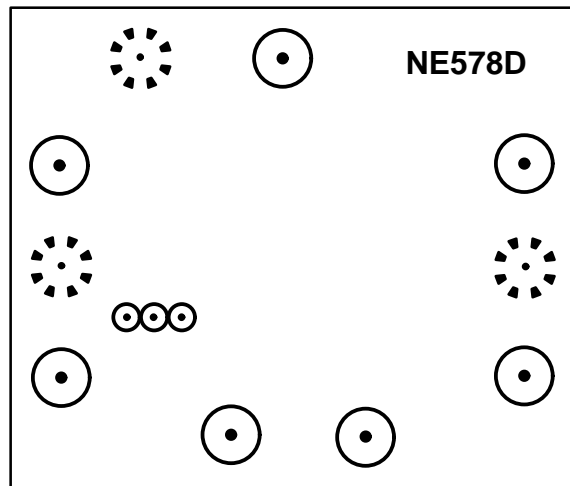
Top View



Top View



Bottom View



Bottom View

NOTE: C11 eliminated as of 11/30/94.

SR00773

Figure 22 . NE577 and NE578 SO Application Board Layout