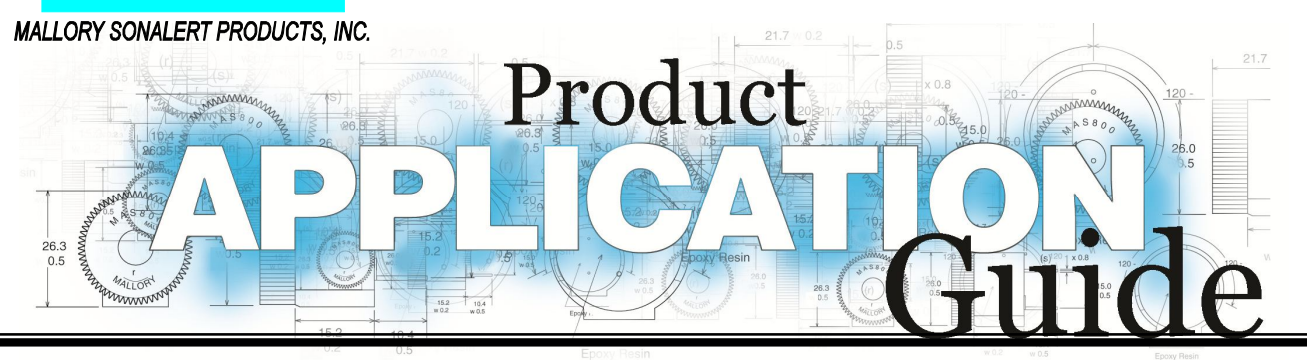


The logo for Mallory, featuring the word "MALLORY" in white, bold, sans-serif capital letters inside a solid blue rectangle.

MALLORY SONALERT PRODUCTS, INC.

The background of the header section features a technical drawing of a mechanical assembly, possibly a gear or a motor component, with various dimensions and labels like "Epoxy Resin" and "MALLORY".

# Product APPLICATION Guide

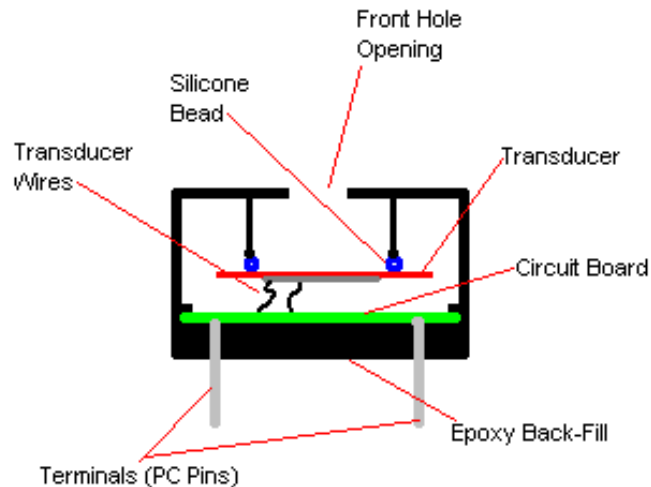
## Product Application Guide- Industrial Alarms

### Part Numbering System SC, LSC, SBM, SNP, & VSB Series

| Part Number Structure                                         |                        |                        | SC                   | 648A | NP | R |
|---------------------------------------------------------------|------------------------|------------------------|----------------------|------|----|---|
| <u>Series</u>                                                 |                        |                        |                      |      |    |   |
| SC = Screw Neck Panel Mount                                   |                        | LSC = LED Alarm        |                      |      |    |   |
| SBM = Large Board Mount                                       |                        | SNP = Snap-in Mount    |                      |      |    |   |
| VSB= Specialty Sound                                          |                        |                        |                      |      |    |   |
| <u>Voltage Range &amp; Type</u>                               |                        |                        |                      |      |    |   |
| 307 = 3 to 7 Vdc                                              | 616 = 6 to 16 Vdc      | 628 = 6 to 28 Vdc      |                      |      |    |   |
| 628A = 6 to 28 Vac/dc                                         | 648 = 10 to 48 Vdc     | 648A = 10 to 48 Vac/dc |                      |      |    |   |
| 110 = 30 to 120 Vac/dc                                        | 250 = 60 to 250 Vac/dc |                        |                      |      |    |   |
| <u>Suffixes</u>                                               |                        |                        |                      |      |    |   |
| CP = Chime                                                    | D = 1900 Hz            | E = Soft / 1900 Hz     | F = Soft             |      |    |   |
| H = 4500 Hz                                                   | J = Slow Pulse         | K = Short Pulse        | L = Lead Wires       |      |    |   |
| M = Military                                                  | N = Loud               | P = Fast Pulse         | PU = Dual Mode       |      |    |   |
| Q = Chirp                                                     | S = Siren              | W = Warble             | WY/WXY = Multi Sound |      |    |   |
| RoHS: R = RoHS Compliant; -BTR = Flat Blades & RoHS Compliant |                        |                        |                      |      |    |   |

## Piezoelectric Electronic Alarm Construction

Piezoelectric Audible Signal Basic Construction



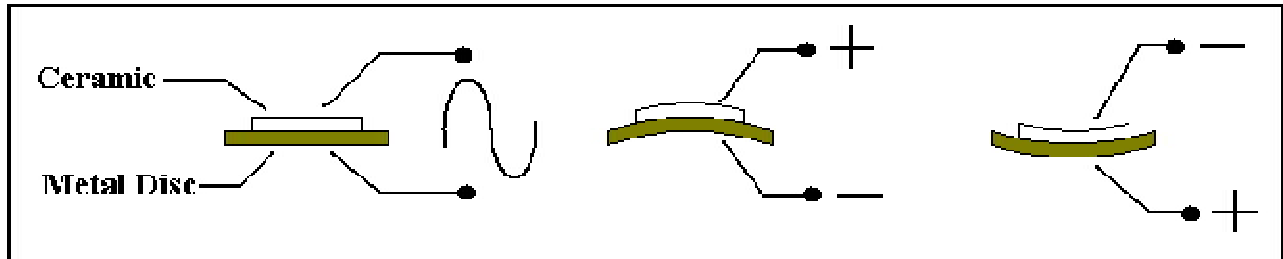
The above cross section picture shows the basic elements used in a piezoelectric audible alarm. The area in front of the transducer element including the front hole opening forms an acoustic cavity that lets the sound radiate out with the most efficiency (i.e. loudest sound level). If the alarm is an indicator that contains a circuit board, the circuit board is attached to the piezoelectric sounder element via soldered wires.

The above picture can be interpreted to represent a board mount package with pc pin terminations, but the same concept is used when building audible alarms in other mounting configurations such as SMT, Flange Mount, and Panel Mount alarms.

If the back of the alarm is sealed with epoxy or other material, the “guts” of the alarm (including the circuit board and components) are protected against fluid intrusion. However, fluid sitting inside the front cavity can obstruct the operation of the device causing the sound level to decrease significantly. If you need to wash the alarms after a soldering operation, it is strongly recommended to use an alarm that comes with a wash label that keeps the washing fluid from getting inside of the front cavity.

## Operation of Piezoelectric Audible Alarms

Piezoelectric electronic audible alarms work by converting the user input voltage to an appropriate oscillating signal that is applied to a sounder element that is mounted in a housing. The piezoelectric sounder element consists of a metal disc that has a special ceramic material bonded to it that physically bends when voltage is applied to it.



The above picture shows a bare piezoelectric sounder element. By applying a sinusoidal wave-form at an appropriate frequency, the transducer will physically deflect in one direction and then in the opposite direction following the shape of the input wave-form. If this oscillation occurs in the audible frequency range (1 Hz to 20 kHz), then air pressure waves are produced that the human ear interprets as an audible sound.

The larger the voltage of the applied wave-form, the larger the amplitude of the air pressure waves resulting in a louder sound level. However, the ceramic portion of the transducer can only bend so far before there is a risk of a catastrophic failure. This maximum voltage is somewhere around 40 to 50 volts. However, it is rare to apply this much voltage to a transducer as you reach a point of diminishing returns for voltages much greater than 32 volts.

By itself, the sound level produced by a transducer element is insignificant. To increase the size of the air pressure waves (and thus the sound level), the transducer element must be mounted inside an acoustic chamber that is optimized for the transducer size and resonant frequency. Every transducer has one frequency where it flexes more efficiently producing the louder sound levels. This frequency where the transducer performs the best is called the resonant frequency.

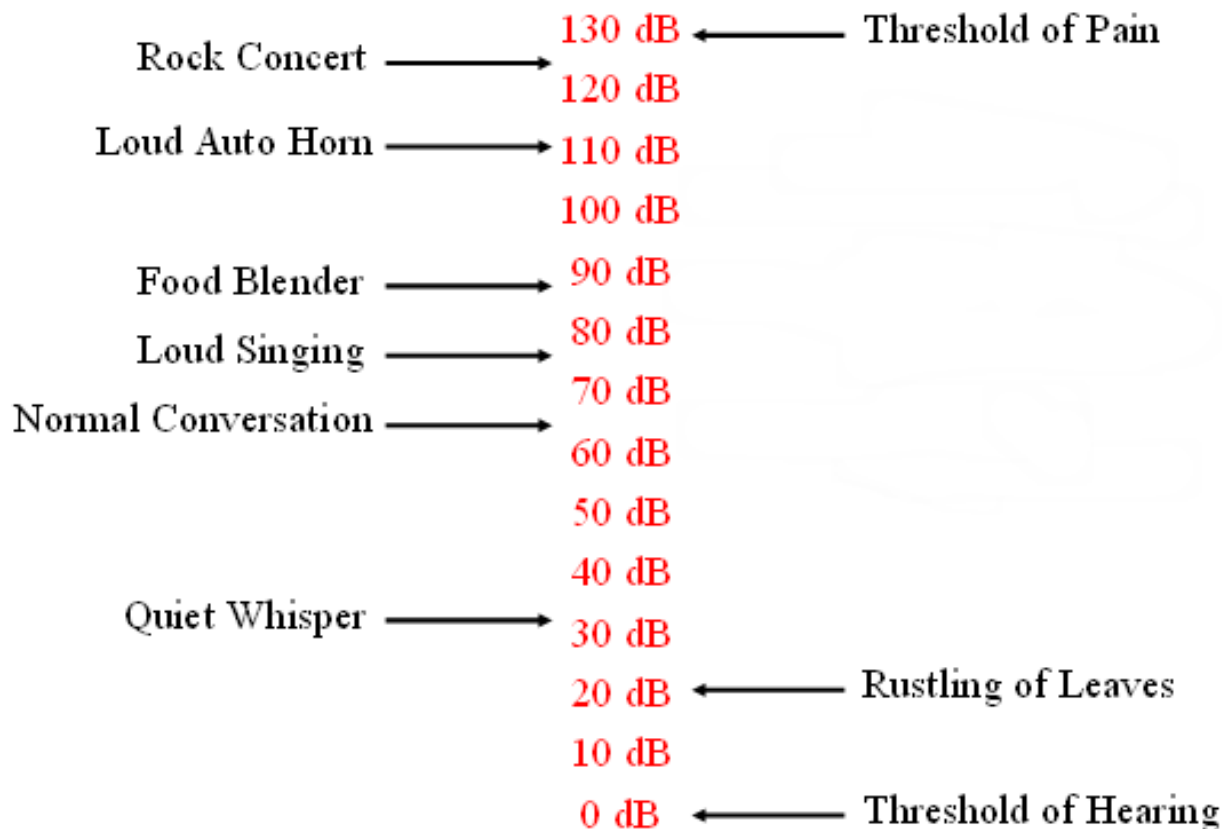
Self-Drive type devices provide a 3<sup>rd</sup> terminal that connects to an isolated portion of the piezoelectric transducer. This third terminal provides a feed-back signal that is 180 degrees out of phase with the drive signal. This signal can be fed back into the circuit to allow the sounder element to self-tune itself to the transducer's resonant frequency.

## Decibel Sound Level Scale

The decibel sound level scale is an arbitrary scale that ranges from 0 dB (threshold of hearing) to 130 dB (threshold of pain). The chart below shows where some common sounds fall on this dB scale. Audible alarms are available that have sound levels as soft as 55 dB at 2 feet and as loud as 110 dB at 2 feet.

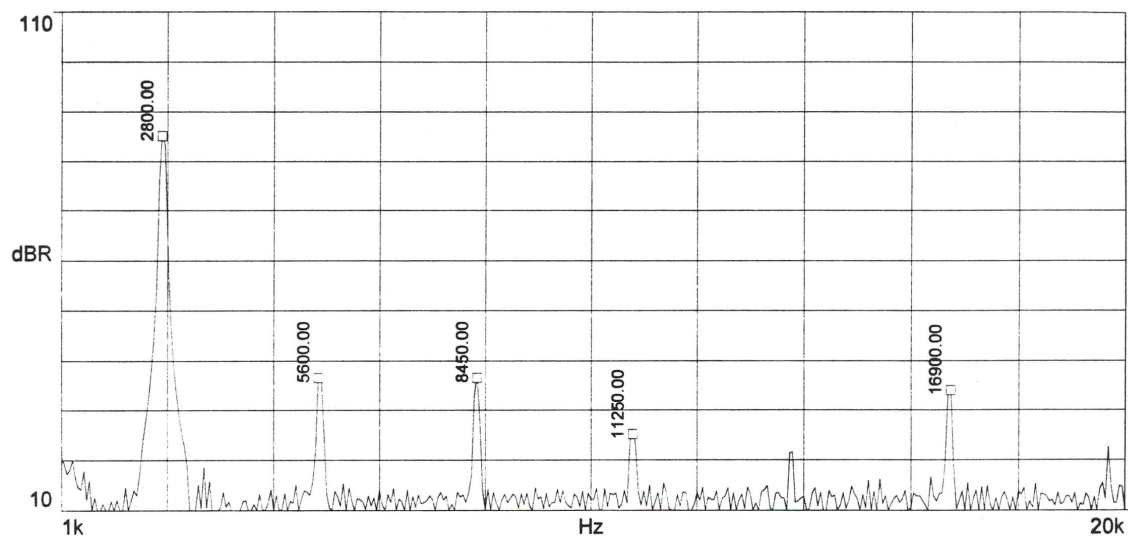
### Reference Sound Levels

(as if you were standing 2 feet from the sound source)



## Fundamental Frequency & Harmonics

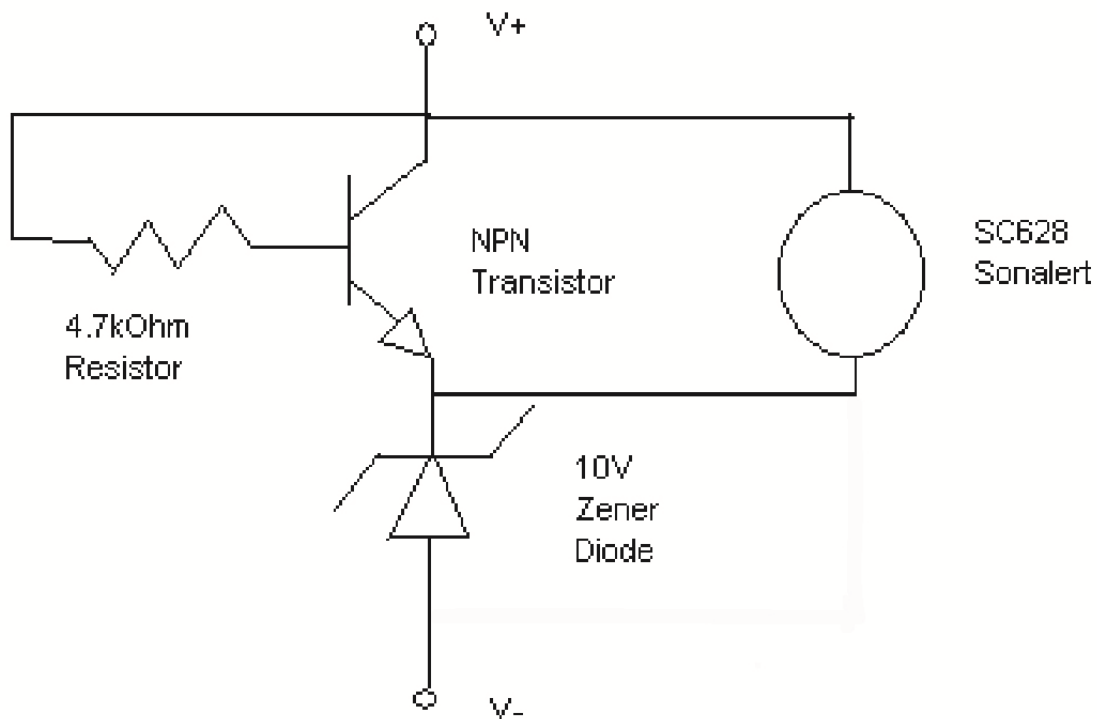
Below is a frequency scan of a piezoelectric audible alarm that has a resonant frequency of 2,800 Hz. As you can see, there is a strong frequency peak at 2.8 kHz and several smaller frequency peaks that follow called harmonic frequencies. The table below the chart shows that the size of the harmonic frequencies are significantly smaller than the fundamental frequency for this particular alarm unit. Because this alarm has a large fundamental frequency and much smaller harmonic frequencies, the sound quality of this part will be very good. When this alarm is activated, the listener will hear one clear frequency (also called sound pitch) from the alarm. Other electronic alarm technologies such as electro-magnetic or electro-mechanical type alarms often have much larger harmonic frequency components resulting in less clear tone.



|               | Frequency  | dB   | % dB of Fundamental |
|---------------|------------|------|---------------------|
| Fundamental:  | 2.800 KHz  | 86.1 | 100.0%              |
| 2nd Harmonic: | 5.600 KHz  | 37.6 | 43.7%               |
| 3rd Harmonic: | 8.450 KHz  | 37.6 | 43.7%               |
| 4th Harmonic: | 11.250 KHz | 26.1 | 30.3%               |

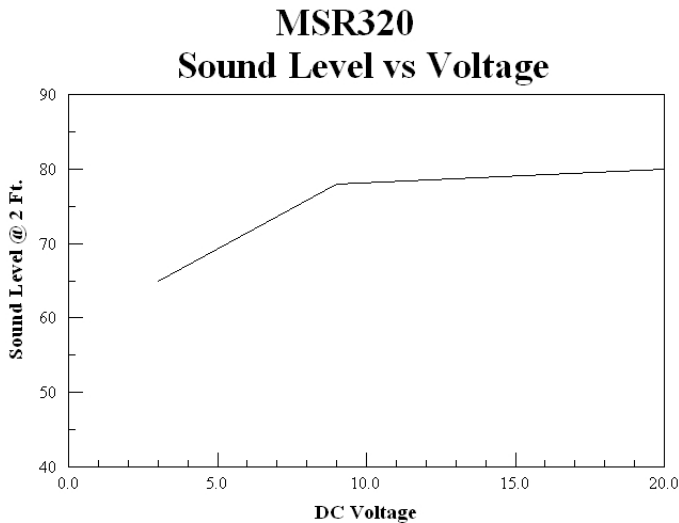
## Circuit to Increase Turn-On Voltage

Below is a circuit that can be used to prevent the alarm from sounding until a certain voltage is reached. This particular circuit has a turn-on voltage around 10 Vdc due to the 10 volt Zener Diode, but you can just substitute other values of Zener Diodes to get the needed turn-on voltage for your circuit.



## Controlling Sound Level- Electronic Method

For piezoelectric type audible alarms, the larger the voltage signal applied to the piezoelectric transducer, the louder the sound level. This property can be used to electronically control the sound level of these devices.



For audible alarm model MSR320R, the sound level will vary from 65 dB at 2 ft. at 3 Vdc up to 80 dB at 2 ft. at 20 Vdc. By varying the voltage from 3 to 20 Vdc, the sound level can be varied by 15 dB. A 10 dB drop in sound level will make the alarm sound half as loud.

There are several ways of electronically controlling the voltage including:

1. Using a manual or digital potentiometer.
2. Using a selector circuit and different values of resistors.
3. Using PWM voltage signals from microcontrollers.

In all cases, care must be taken to make sure that the circuitry and voltage signals used do not interfere with the internal circuitry of the audible alarm. This method of controlling the sound level will probably not work well in the following cases:

1. The sound level of electro-magnetic type alarms do not vary much over the voltage range of these devices, so most electro-magnetic type alarms are not suitable for this method.
2. When you only have a narrow operating voltage range to work with. For example, if you are using the MSR320R at 5 Vdc, the sound level change from 5 Vdc to 3 Vdc is not very much.
3. When the voltage range of the audible alarm is narrow. For example, panel mount model SC307NR only has a voltage range of 3 to 7 Vdc. Over this range, the sound level will vary by only 6 dB. This sound level change is significant, but may not be enough to make a difference in the application.

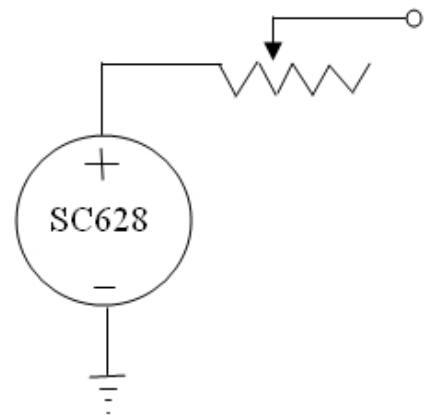
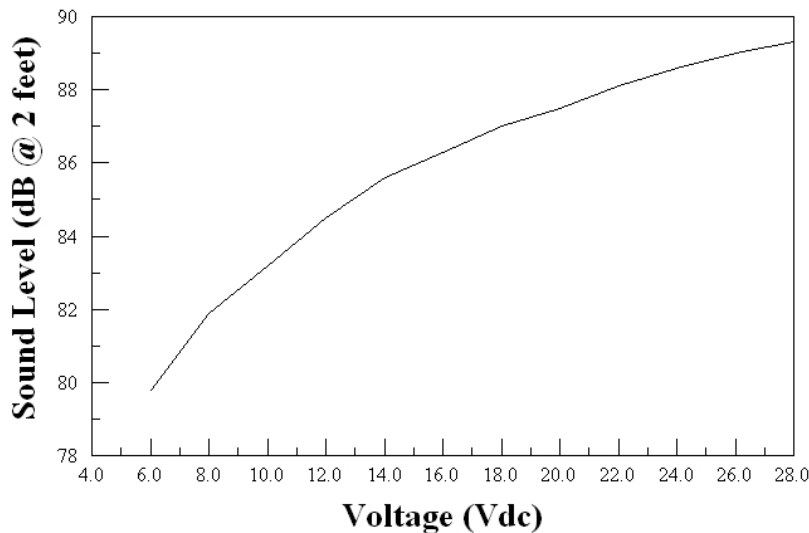
## Controlling Sound Level Using a Potentiometer

A potentiometer can be used on many Mallory Sonalert alarm models to control the sound level. However, there are some alarm models where the use of a potentiometer actually interferes with the operation of the alarm circuitry. The first step to using a potentiometer, therefore, is to verify that it will not affect the operation of the audible alarm.

For panel mount model SC628R, as the left graph below shows, the sound level will change as much as 10 dB over the rated voltage range. By putting a potentiometer in series with the SC628R, we can adjust the voltage to the alarm and thus adjust the alarm sound level.

### Panel Mount Model SC628

#### Sound Level from 6 to 28 Vdc



It was verified that the circuitry of model SC628R is not affected by a potentiometer, so data was gathered to find the value of a potentiometer that gives the greatest range of sound change.

#### Results:

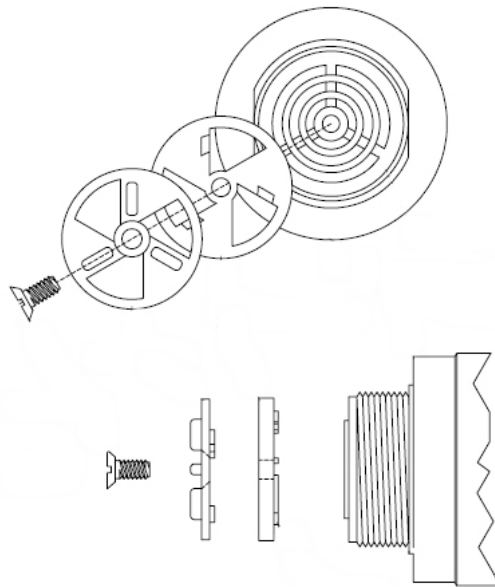
At 12 Vdc, it was found that a 7 kOhm potentiometer in series with the SC628R will give the widest swing of sound level. At 0 Ohm, the sound level is 84 dB, and with the POT turned all the way up to 7 kOhm, the sound level drops to 73 dB. This gives a fairly wide swing of 11 dB.

At 28 Vdc, it was found that a 20 kOhm potentiometer in series with the SC628R works well. At 0 Ohm, the sound level is 89 dB, and with the POT set at 20 kOhm, the sound level drops to 73 dB. This gives an even wider swing of 16 dB.

It should be noted that with the two potentiometers listed above turned all the way up to their maximum value, the voltage across the SC628R is only 3 Vdc. While this is outside the rated voltage range, the alarm will still work at this voltage, so it is okay to drop the voltage this low in order to get a wider swing of sound level as long as this sound level is still adequate for the application.

## Controlling Sound Level- Mechanical Method

There are two ways to control sound level in an electronic audible alarm. One is mechanical and the other is electrical. The mechanical method involves changing the size of the front hole opening of the audible alarm. The open area in the front of the audible alarm including the front hole opening is an acoustically tuned cavity. By partially covering the front hole opening, you are changing the cavity tuning making it less efficient. The more the front hole opening is covered, the more the sound level will decrease.



An example of how to do this is shown above. The picture above shows our manual sound baffle accessory with part number: SCVC being assembled onto the front of a panel mount alarm housing. The SCVC accessory consists of a screw and two pieces of plastic. After the sound baffle is attached to the front of the alarm, the sound level can be changed by manually turning the top piece of plastic. The sound level of the alarm will attenuate anywhere from 10 to 15 dB's making the alarm sound about half as loud as before.

The main disadvantage of this manual method of controlling the sound level is that it is controlled by the operator. In some situations, it is dangerous to let the operator have the ability to decrease the sound level of the alarm. The most obvious potential problem is that the operator could turn the sound level down too much so that the alarm will not easily be heard the next time it is activated.

## Typical Failure Modes of Piezoelectric Audible Alarms

| Component/Subsystem                                                  | Failure Mode                                                                                            | End Result                                                               | Occurrence                     |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------|
| Circuit Components<br>(Resistors, Capacitors,<br>Diodes, IC's, etc.) | Over-voltage by customer's<br>application                                                               | Unit ceases working.                                                     | Vast<br>Majority of<br>Returns |
| Transducer/Wire Solder<br>Operation                                  | Not enough wire strands in<br>solder joint                                                              | Wire breaks after<br>period of time & unit<br>ceases sounding            | Rare                           |
| Physical Assembly                                                    | Transducer wire pinched,<br>adhesive/epoxy run down<br>onto transducer, or RTV<br>adhesive seal failure | Intermittent operation                                                   | Rare                           |
| Soldering Operation                                                  | Incorrect Solder Temperature<br>or Time Causing Cold Solder<br>Joint                                    | Intermittent operation<br>or unit ceases working<br>after period of time | Very Rare                      |
| Circuit Components                                                   | Random Component Failure;<br>Wrong Component Used;<br>Missing Component                                 | Unit ceases working<br>under normal<br>operating conditions              | Very Rare                      |
| Transducer Wire                                                      | Defect in Wire;<br>Wire Strands Damaged in<br>Production                                                | Wire breaks after<br>period of time & unit<br>ceases sounding            | Very Rare                      |
| Piezo Transducer                                                     | Incorrect Polarization by<br>Manufacturer;<br>Glue Bonding Failure                                      | Sound volume level<br>decreases over time.                               | Exceedingly<br>Rare            |

### Notes:

1. Customer returns of Mallory audible alarms for failure to operate are very rare. Of the few parts returned each year, the vast majority of the root cause of failure is an over-voltage or voltage spike condition caused by the customer's application.
2. All Mallory alarms are, at a minimum, function tested 100% during production, and a final audit is performed. Mallory SC/SBM/SBT/SBS/SNP/LSC/VSB/MSR/MSO/ZA series of alarms are audited 100% at final test by checking that sound level, frequency, and current are within specification limits from 2 to 4 different voltage levels.

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