



European leader in piezoceramic audible components

## Buzzers & Transducers



STANDARD SERIES / SMA-SERIES / SMAT-SERIES / SMB-SERIES

## Alarms & Sirens



SAS-SERIES / SAP-SERIES / SMAC-SERIES / SXL-SERIES / SDS-SERIES

## Piezoceramic Speakers & Amplifiers



SPS-SERIES / SCS-SERIES / PAA-SERIES



REACH



## INTRODUCTION

Our company became the European leader in piezo-ceramic acoustic components. Today we release several new products such as piezo speakers, amplifiers and the first piezo car horn for the automotive industry. We are convinced that these new products will realise a significant contribution in the modern technology evolution and will lead to new applications.

This catalogue describes the three different piezoceramic audible product families.

### **Buzzers & transducers**

They have unlimited applications, and are panel and PCB mountable. The standard series operate in harsh weather conditions and are waterproof, shockproof and gasproof. They are very reliable in critical applications. The SMA series are low cost commercial grade components PCB mountable, available in buzzer and transducer version. Top quality materials and elaborated working principals guarantees high quality products at economic cost.

### **Alarms & sirens**

A range of waterproof and IP67 rating sirens and alarms generates an acoustic warning signal in critical environmental situations. They are especially designed to function from  $-40^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$  offering an high life time in continuous operation. A new series of automotive car horns are available for advanced applications.

### **Speakers and amplifiers**

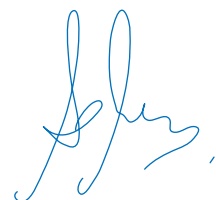
These brand new flat piezo speakers and amplifiers are low weight, solid-state, low distortion with extremely small current drain. This new generation of piezo speakers can be driven by several audio amplifiers recently introduced on the integrated circuits market. Demonstration units are at your disposal for deeper evaluation of this technology in multi media and portable devices. Our on-line support team is assisting you with the design-in of this advanced piezo technology.

We refer to our website: <http://www.sonitron.be>



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Hugo R. Michiels  
President and CEO



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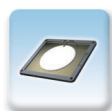
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## COMPANY ORGANISATION

Sonitron manufactures their products in Belgium and sells them through an international network of distributors and representatives.

Our distributors and representatives give excellent sales and technical service.

They provide our customers with price quotations, samples, catalogues, technical assistance,...

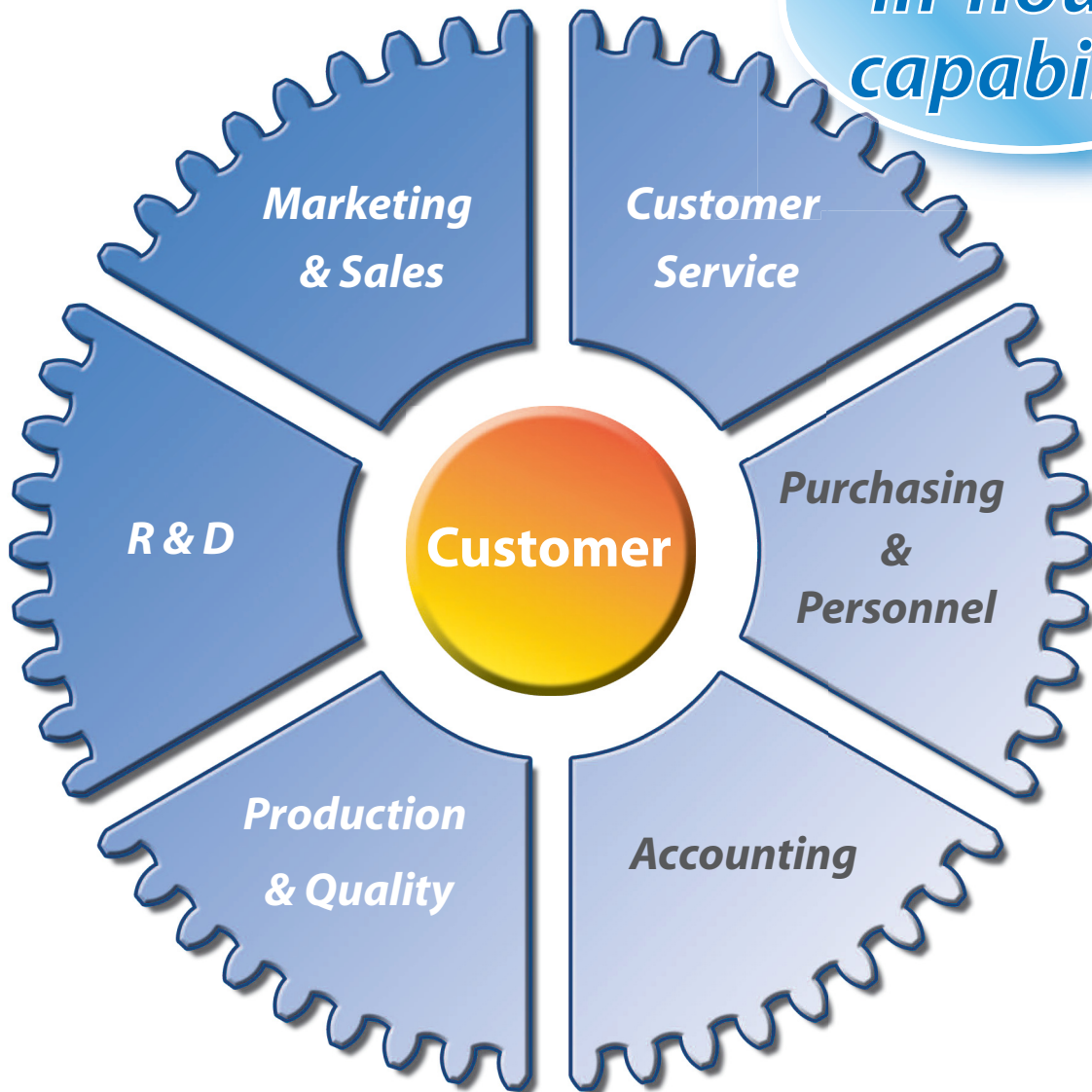
Please check the distributors and representatives list (page 124-126) to look for your nearest contact person or visit our website for updated information about our worldwide distribution network. <http://www.sonitron.be>

However, if there is no distributor or representative in your country or should you require more detailed information, do not hesitate to contact our headquarter in Belgium.

Send your request to [sales@sonitron.be](mailto:sales@sonitron.be) or [info@sonitron.be](mailto:info@sonitron.be) and we will be pleased to help you further !

**Sonitron has the following departments to assist you...**

**Total  
in-house  
capability**





## MODELS ON REQUEST

Continuous research, intensive development and specialist know-how have resulted in a wide range of high quality and reliable products, from the smallest and most cost effective buzzer to highly sophisticated alarms. This allows Sonitron to meet the needs of many different applications within the industrial, consumer, medical and military industry.

Ongoing investments in the in-house disciplines enables Sonitron to maintain their market reputation and being your first choice supplier of audible components and application support in acoustic technology.

Our future activities will be focused not only on research and development of new applications and products, but also on the development of buzzers or speakers for special customer requests. Our engineers will carefully study your application and give their support for the realisation of your audio-project with Sonitron products.

Please send your request to: **Technical support => [support@sonitron.be](mailto:support@sonitron.be)**

We will be pleased to help you !



## **CERTIFICATES**

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The Certification Body  
of TÜV SUD Management Service GmbH

certifies that:

**Sonitron N.V.**  
**Kasteelstraat 93**  
**B - 9100 Sint-Niklaas**



## **CERTIFICATE**



Management Service

Has established and applies  
a Quality Management System for:

**Sales, design and production in Physics and Electronics  
regarding acoustic components**

Management system as per  
ISO 9001 : 2000

Hugo R. Michiels  
President and CEO  
SONITRON N.V.

## **EEx 1**

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### **GAS-EXPLOSIVE CONFORMITY**

Our standard series construction structure has been tested by:

BERGBAU-VERSUCHSSTRECKE  
Postfach 140120  
4600 Dortmund 14  
Date: 28.09.1987

The result was that we obtained the following certificate:

Intrinsically safe (EEx ia I)  IM 1 cert. ISSeP03ATEX099U

Hugo R. Michiels  
President and CEO  
SONITRON N.V.

## **RoHS** (RESTRICTION OF HAZARDOUS SUBSTANCES)

I herewith declare that as from october 1, 2005, all of our products are in compliance with the new directive 2002/95/EC (restricting hazardous materials).

We confirm that none of our buzzers (SMA, SMAT, SMAC, panel/standard series), speakers (SCS and SPS series) or alarms (SAS series) contain any of the following substances:

- mercury (Hg)
- cadmium (Cd)
- hexavalent chromium (Cr (VI))
- polybrominated biphenyls (PBB)
- polybrominated diphenyl ethers (PBDE)
- lead

Sonitron N.V. cannot be held responsible for any deviations in raw materials or components used in their products.

Additional information or reports can be supplied after written and motivated request, provided it does not concern classified unreleased production information and subject to cost calculation when information is requested from third parties.



Hugo R. Michiels  
President and CEO  
SONITRON N.V.

## **REACH Statement.**

REACH



(Registration, Evaluation, Authorization, and restriction of Chemicals).  
(EC 1907/2006)

June 1<sup>st</sup> 2007, REACH, the new European Community Regulation on chemicals and their safe use entered into law. The main objective of REACH is to improve the protection of the environment and human health, by registration and identification of chemicals in products and derivatives.

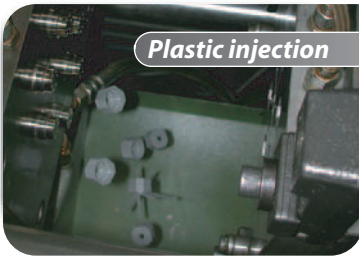
Sonitron NV identified as `Downstream User` will closely monitor the nature of any substance used inside or during the production of our products.

Sonitron NV declares it will notify, and inform its customers and distributors if an article contains more than 0.1% (weight per article) of any substances of the SVHC candidate list.



Hugo R. Michiels  
President and CEO  
SONITRON N.V.

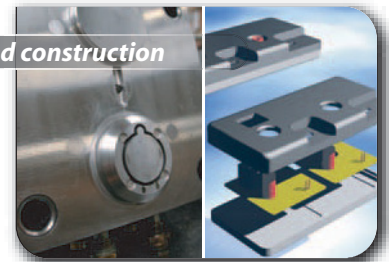
## KNOW-HOW AND EQUIPMENT



**Plastic injection**

Sonitron studied the use of numerous plastic materials for buzzer housings, resulting in the use of the highest quality materials. Sonitron has a fully automated plastic injection department, which guarantees full of all the dimensions and acoustic properties of the housings of our products.

Sonitron develop and produce themselves the mouldings for the plastic housings and pin terminals used in their buzzers. This in-house knowledge and expertise in moulding technology enables Sonitron to manufacture customized products.



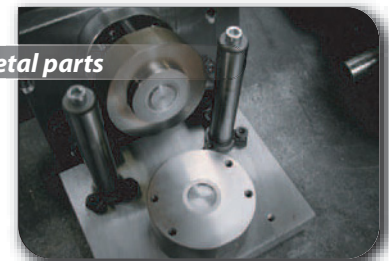
**Mould development and construction**



**CNC milling machine**

The fully automatic Milling Station with 5 axis is used to create new prototypes and plastic injection moulds. A continuous milling productivity is guaranteed due to the 16 load tool exchanger.

Sonitron develop specially shaped and formed membranes for use in their products. These membranes are produced in-house, enabling to maintain the high quality in large quantities, required for mass production of membranes with specific resonant frequencies.



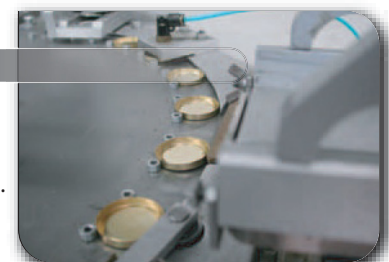
**Pressing and cutting metal parts**



**Pick & place machine**

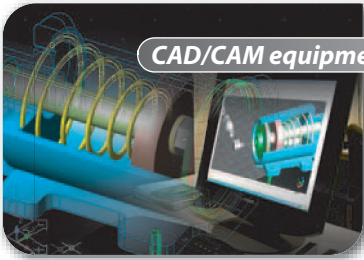
The electronic circuits produced and incorporated in Sonitron's acoustic components are designed in-house and are fully automatically realised with the latest surface mount and soldering equipment.

As the process of gluing the ceramic onto the membrane is of essential importance for the reproduction of the requested frequency, Sonitron developed special gluing equipment. This equipment enables full control of perfect adhesion between the piezo disc and the membrane.



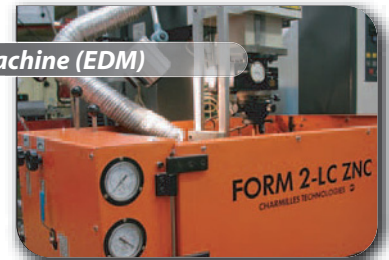
**Automatic gluing**

## KNOW-HOW AND EQUIPMENT



**CAD/CAM equipment**

The latest software programs and computing technologies are used for the in-house 3D-design of PC-boards, metal parts, moulds and automation equipment.



**Electronic discharge machine (EDM)**

The electronic discharge machine makes it possible to create very complex shapes. With this equipment, Sonitron is able to construct the moulds for special designs.



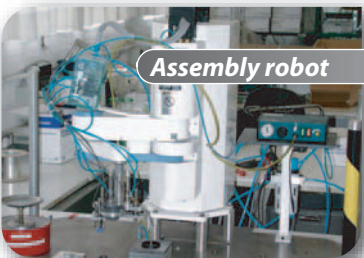
**Test & measurement equipment**

The anechoic room provides acoustic isolation from all background noises. The real time audio analyser can measure each type individually for frequency response, harmonic distortion and phase shift. All parameters such as dB(A), frequency, supply voltage are programmable. A printed copy of specific measurement reports is obtainable upon request.



**Final quality control**

Final testing of Sonitron's products is done in a special pyramid shaped sound absorption environment, avoiding reflection and standing wave patterns. This method guarantees very accurate SPL measurements.



**Assembly robot**

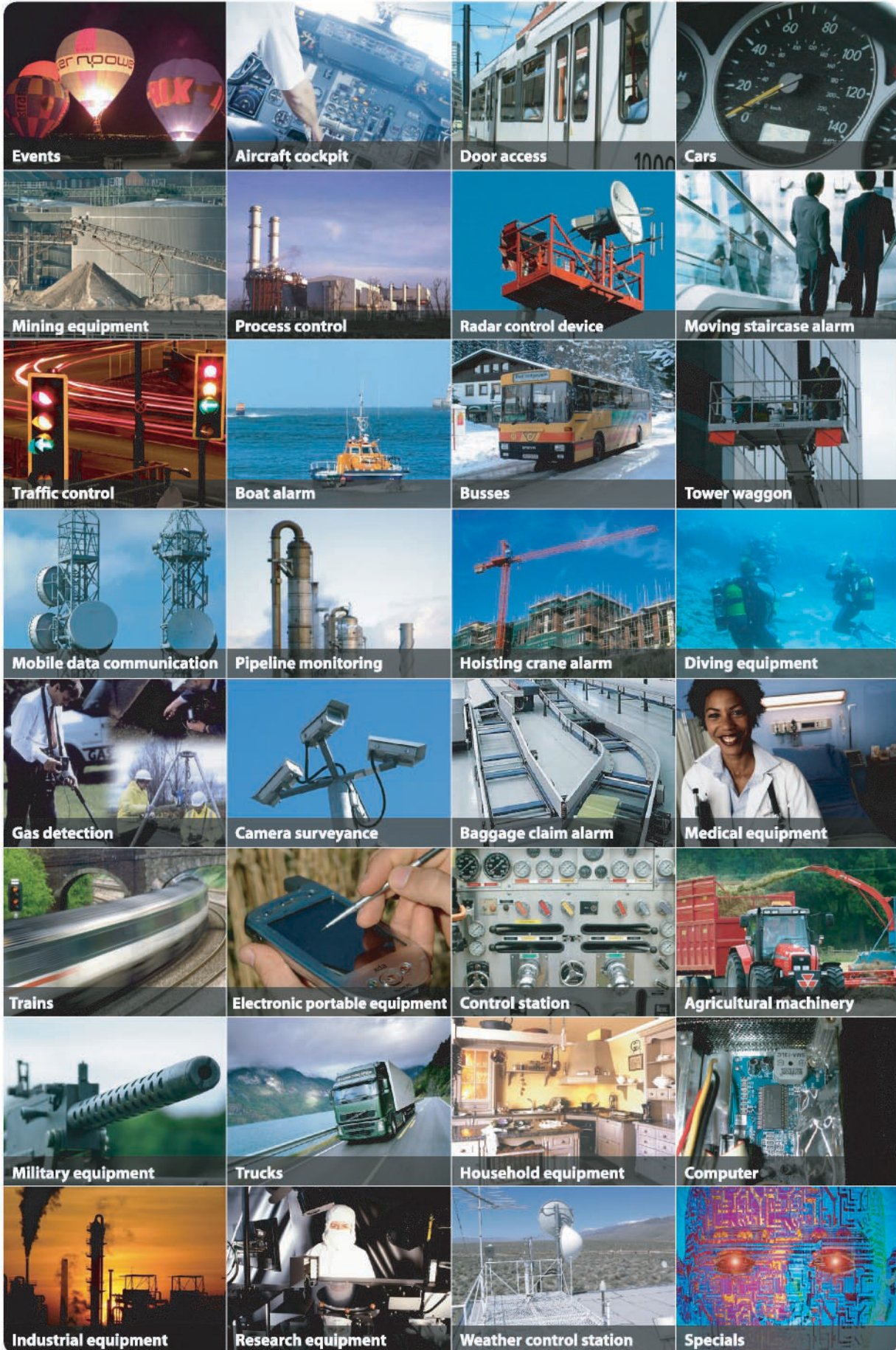
This multifunctional programmable assembling robot is ideal for automation of Sonitron's production.



**Ultrasonic equipment**

This equipment is used for ultrasonic gluing of plastic parts to obtain very strong watertight sealing.

# TYPICAL APPLICATION FIELDS



## APPLICATION FIELDS

ACCESS CONTROL  
 ADVERTISING MESSAGE EQUIPMENT  
 AGRICULTURAL EQUIPMENT  
 AIRCRAFTS  
 ALARMS  
 AMBULANCE SIREN  
 ANSWERING MACHINE  
 ASSEMBLING EQUIPMENT  
 AUTOMATIC DOORS  
 AUTOMATIC GUIDED VEHICLES  
 AUTOMATION EQUIPMENT  
 AUTOMOBILES  
 BAGGAGE CLAIM ALARM  
 BATTERY LOADERS  
 BATTERY OPERATING BUZZERS  
 BICYCLES  
 BIO-FEEDING PUMPS  
 BOAT ENGINE ALARM  
 BOATS  
 BUS  
 CABLE TESTER  
 CAMERA  
 CAMERA SURVEYANCE  
 CAR SPEAKERS  
 CARD READER SYSTEMS  
 CAR-WASH  
 CASH REGISTERS  
 CENTRAL HEATING CONTROL PANELS  
 CLEANING MACHINES  
 CLOCKS  
 COCKPIT ALARM  
 CODIFICATION SYSTEM  
 COIN-TESTER  
 COMMUNICATION EQUIPMENT  
 COMPUTER EQUIPMENT  
 CONSTRUCTION MACHINES  
 CONSUMER ELECTRONICS  
 CONTROL EQUIPMENT  
 CONTROL PANEL  
 CONTROL STATION  
 COOLING MACHINES  
 COPIERS

DASHBOARD  
 DIGITAL SPEECH PROCESSING  
 DIVING EQUIPMENT  
 DOOR ACCESS  
 DOOR LOCK ALARM  
 DOORBELL  
 ELECTRONIC GAMBLING MACHINE  
 ELECTRONIC PORTABLE EQUIPMENT  
 ELECTRONIC TIMERS  
 ELEVATORS  
 EMBARKATION DEVICE  
 EMERGENCY STOP  
 ENTERTAINMENT SYSTEM  
 EVENT ALARM  
 FIRE ALARM  
 FIRE DETECTORS  
 FISH FINDER  
 FORKLIFT  
 GAMES AND TOYS  
 GAS DETECTORS  
 GAS SENSOR  
 GAS STATION  
 GOLF CARTS  
 HAND HELD COMPUTER  
 HEATERS  
 HELMETS  
 HIGH PRESSURE CLEANERS  
 HIGHWAY TOLL CARD SYSTEM  
 HOISTING CRANE ALARM  
 HOME EQUIPMENT & DOMOTICS  
 HOME SPEAKERS  
 HOOTER FOR BLIND PEOPLE  
 HOSPITAL MESSAGE SYSTEM  
 HOUSEHOLD EQUIPMENT  
 INDUSTRIAL EQUIPMENT  
 INDUSTRIAL WASHING MACHINES  
 INSTRUMENTATION  
 INTERCOM SYSTEMS  
 KEYBOARD  
 KEYPAD  
 LANDING GEAR  
 MEASUREMENT EQUIPMENT

## APPLICATION FIELDS

MEDICAL EQUIPMENT  
 MESSAGE RECORDING  
 METAL DETECTOR GATE  
 METAL DETECTORS  
 METRO DOORS  
 MICROPROCESSOR DEVICE  
 MILITARY EQUIPMENT  
 MILITARY RADIO  
 MILITARY VEHICLE  
 MINING EQUIPMENT  
 MOBILE DATA COMMUNICATION  
 MOBILE PHONE  
 MONITORING & TEST EQUIPMENT  
 MOTOR CONTROL  
 MOTORCYCLES  
 MOVING STAIRCASE  
 MOWING-MACHINE  
 MRI DEVICE  
 MULTI-MEDIA EQUIPMENT  
 NAVIGATION SYSTEM  
 NOISE CANCELLATION UNIT  
 NURSE CALL SYSTEM  
 OFFICE EQUIPMENT  
 PASSENGER INFORMATION SYSTEM  
 PC MOTHERBOARD  
 PET PUMP  
 PETROL STATION  
 PIPELINE MONITORING  
 PORTABLE ANALYSERS  
 POWER SUPPLY  
 PRINTERS  
 PROCESS CONTROL  
 PROJECTOR  
 PUBLIC MESSAGE SYSTEMS  
 PUBLIC TELEPHONES  
 PUMP STATIONS  
 PUMP STEERING  
 RADAR CONTROL DEVICE  
 RADIO  
 RAILWAY DOOR SYSTEM  
 REMOTE CONTROL  
 RESEARCH EQUIPMENT

RESPIRATOR  
 RUNWAY LIGHTING  
 SAFETY SYSTEMS  
 SATELLITE SYSTEM  
 SECURITY DEVICES  
 SECURITY GATES (WALK THROUGH)  
 SECURITY SYSTEMS  
 SIGNAL EQUIPMENT  
 SIGNALIZATION & PROCESS CONTROL EQUIPMENT  
 SIGNALIZATION STICK FOR BLIND PEOPLE  
 SOLAR PANELS AND SOLAR TRACKING SYSTEM  
 SOLAR POWERED EMERGENCY PHONE  
 SOLID STATE TIMER  
 SUPERSONIC RECEIVER  
 SURROUND STEREO SPEAKERS  
 SURVEYANCE EQUIPMENT  
 SWITCH BOARD  
 TALKING BUZZER  
 TELECOMMUNICATION  
 TELEMETRY  
 TELEPHONE EQUIPMENT  
 TEST EQUIPMENT  
 TICKET AUTOMAT  
 TIMERS  
 TOWER WAGGON  
 TRACTORS  
 TRAFFIC EQUIPMENT  
 TRAINS  
 TRANSMISSION SYSTEMS  
 TRANSPONDER  
 TRUCKS  
 TV/HIFI MONITOR  
 ULTRASONIC LEVEL DETECTION  
 UNDERGROUND  
 UTILITY METERS  
 VEHICLE ACCESS CONTROL  
 VENDING-MACHINES  
 VENTILATOR  
 VIDEO CONFERENCE SYSTEMS  
 WEATHER CONTROL STATION  
 WEIGHING EQUIPMENT  
 WHEEL LOADER



# sonitron® PRODUCT SELECTION GUIDE

## BUZZERS & TRANSDUCERS

### STANDARD SERIES >



**Dimensions overview**  
(in mm)

- Round  $\phi \times H$   
 $\phi 36.5 \times 26$
- Square  $\nabla$   
 $\nabla 38 \times 26$

### SMA-SERIES >



- SMA-13  $\nabla$   
 $\nabla 14 \times 6.5$
- SMA-17  $\nabla$   
 $\nabla 17.5 \times 8.5$
- SMA-21  $\nabla$   
 $\nabla 21 \times 9.5$
- SMA-24  $\nabla$   
 $\nabla 24 \times 15.5$
- SMA-30  $\nabla$   
 $\nabla 30 \times 10.5$

### SMAT-SERIES >



- SMAT-13  $\nabla$   
 $\nabla 14 \times 6.5$
- SMAT-17  $\nabla$   
 $\nabla 17.5 \times 8.5$
- SMAT-21  $\nabla$   
 $\nabla 21 \times 9.5$
- SMAT-24  $\nabla$   
 $\nabla 24 \times 15.5$
- SMAT-30  $\nabla$   
 $\nabla 30 \times 10.5$

### SMB-SERIES >



- SMB-17  $\nabla$   
 $\nabla 18.6 \times 9.7$
- SMB-32  $\nabla$   
 $\nabla 33.5 \times 9.7$

## ALARMS & SIRENS

### SAP-SERIES

SAP-1302-C



**Dimensions overview**  
(in mm)

- $\phi \times H$   
 $118.5 \times 89$   
 $\times 34.5$

### SAS-SERIES >

SAS-2155



$\phi 54 \times 19.6$

### SMAC-SERIES >



SMAC-25  $\phi 26.5 \times 18$

SMACI-25  $\phi 26.5 \times 18$

### STANDARD XL SERIES >



- Round  $\phi 36.5 \times 26$
- Square  $\nabla 38 \times 26$

SXLC 515 C  
SXLI 515 C1  
SXLW 515 C  
SXLP 515 C

### SDS-SERIES >



## PIEZOCERAMIC SPEAKERS

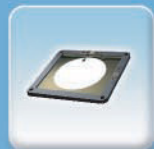
### SCS-SERIES >



**Dimensions overview**  
(in mm)

- $\nabla \times H$
- SCS-17  $\nabla$   
 $\nabla 18.6 \times 9.7$
- SCS-24  $\nabla$   
 $\nabla 25 \times 9.7$
- SCS-32  $\nabla$   
 $\nabla 33.5 \times 9.7$

### SPS-SERIES >



SPS-2220-03  
20x22x1

SPS-3530-03  
43.5x39x2

SPS-4640-03  
50x43.6x2

SPS-6555-03  
65x55x2

SPS-8770-03  
87x70x2

## AMPLIFIERS

### PAA-SERIES >

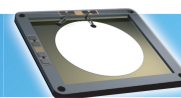


PAA-MAX9788-01  
14x16.5

PAA-LM4960SQ-02  
25x25

PAA-StepUpBTL-01  
40x35

## SPS-SERIES (SONITRON Polymer/metal Speakers)



### INTRODUCTION

Based on the in-house expertise in vibration characteristics of piezoceramic material and micro-acoustics, Sonitron successfully developed the SPS-series piezoceramic speakers for industrial, multimedia and automotive applications. The SPS-series is based on a completely new principle of piezoceramics and a composite polymer/metal membrane. The composite polymer/metal membrane reduces unwanted resonance peaks to provide a more even frequency response than can be achieved with conventional designs. High sound quality and low distortion guarantee perfect reproduction of music and speech.

Piezoceramic speakers offer a faster response than conventional magnet speakers because of their lower mass (no voice coil). Magnet speakers are less efficient than piezo speakers because of the losses via the voice coil. Piezoceramic speakers also feature a low weight and low energy consumption relative to their sound output levels. They do not generate an electromagnetic field, making it easier for designers to ensure that their products meet EMC requirements and regulations.

Sonitron's SPS speakers have a very flat design and are delivered with an open front. They can be used in difficult environmental conditions and applications because of resistance of the front to water, humidity, vibrations and dust.

The described models are released for applications such as mobile phone, PDA, flat LCD computer screens and computer monitors, consumer products, car audio, instrumentation, portable devices, public address systems, paging systems, etc.

*SPS-Series*



## ADVANTAGES & APPLICATIONS

### ADVANTAGES :

- very flat and solid construction
- dust, water- and shockproof
- resistant to temperature variations
- broad frequency range in small size
- combined use as speaker/micro
- no electro-magnetic field (EMC)
- little energy required at low frequencies
- less current consumption needed in the leads to the speaker
- 60% higher acoustic output for smaller speakers compared to electrodynamic speakers
- low weight
- low distortion
- high impedance
- can be driven directly by IC

### APPLICATIONS :

- home equipment & domotics
- communication equipment
- talking buzzer & door bell
- computer equipment
- cars, busses and trains
- vending machines
- multimedia equipment
- industrial equipment
- portable voice recorders
- paging systems
- public address systems
- instrumentation
- mobile phone
- car audio system

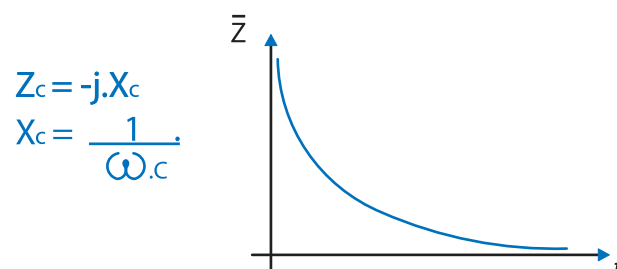
## SPECIFICATIONS

Model	Operating voltage (Vac pp)	Frequency range (Hz)	Max. SPL dB @ 1m, average 4 points	Applications	Capacitive load	Dimensions mm (LxWxH)
SPS-2220-03	1-24	700-20000	85*	GSM, GPS, MP3, camera,...	70nF	22x20x2
SPS-3530-03	5-60	700-20000	81	PDA, GPS, notebooks,...	220nF	43.5x39x2
SPS-4640-03	5-60	400-20000	83	PDA, GPS, notebooks,...	225nF	50x43.6x2
SPS-6555-03	5-60	300-20000	83	Multimedia,...	480nF	65x55x2
SPS-8770-03	5-60	200-20000	84	Computers,...	580nF	87x70x2

\*@10 cm

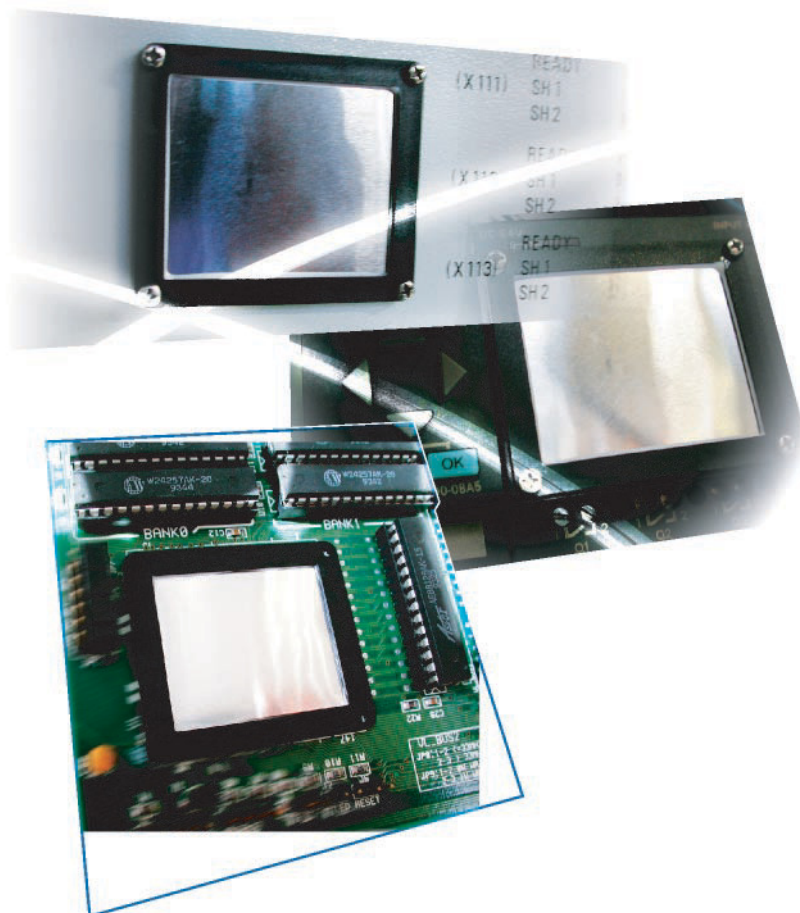
## IMPEDANCE

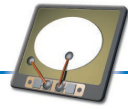
Theoretical the main impedance of the piezo speakers is a capacitive reactance and follows an asymptotic function.



The typical practical impedance values ( $\pm 20\%$ ) for frequencies of 100 Hz up to 20 kHz of our speakers are as follows:

Model	SPS-2220-03	SPS-3530-03	SPS-4640-03	SPS-6555-03	SPS-8770-03
Capacitance ( $\pm 20\%$ )	70 nF	220 nF	225 nF	480 nF	580 nF
Z @ 100 Hz	22360 ohm	5714 ohm	6210 ohm	3845 ohm	2314 ohm
Z @ 1 kHz	2162 ohm	603 ohm	680 ohm	445 ohm	266 ohm
Z @ 2 kHz	1183 ohm	311 ohm	360 ohm	223 ohm	133 ohm
Z @ 5 kHz	497 ohm	127 ohm	143 ohm	92 ohm	54 ohm
Z @ 10 kHz	245 ohm	65 ohm	73 ohm	45 ohm	28 ohm
Z @ 15 kHz	168 ohm	43 ohm	49 ohm	31 ohm	19 ohm
Z @ 20 kHz	125 ohm	32 ohm	37 ohm	23 ohm	14 ohm





## SPS-2220-03



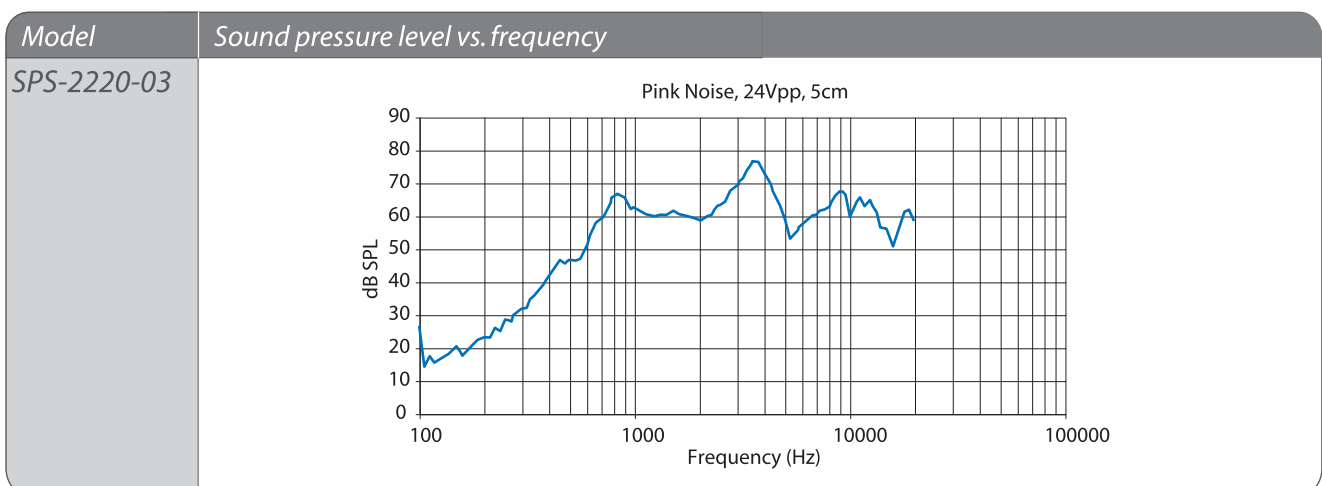
Sonitron's latest slim line profile speaker, the SPS-2220-03, is the result of ten years intensive research and development work. With a thickness of only 1 mm and dimensions of 20x22 mm, this small multifunctional speaker/microphone is ideal for use in GPS, MP3, camera's, mobile phones,... It is distortion free and has excellent sound reproduction. Considering its extremely good voice clarity it definitely is the new speaker generation for the mobile phone industry.

## SPECIFICATIONS

Frequency Range :	700 Hz-20 kHz
Max SPL @ 10 cm, 24Vpp: (average at 4-point)	85 dB
Distortion (%THD): (80dB @ 5 cm, average @ 4-point)	≤1%
Sensitivity: (SPL @ 10cm for 1Vrms, average at 4-point : 800Hz, 1kHz, 1.5kHz, 2kHz)	63 dB
Capacitance (+/- 20%):	70 nF
Impedance @ 1kHz (+/-20%):	2.16 kohm
Operating Voltage:	1Vpp-24Vpp
Weight:	0.4g
Operating Temperature:	-20°C to 60°C
Storage Temperature:	-40°C to 60°C
Case material:	PBT
Standard color:	Black

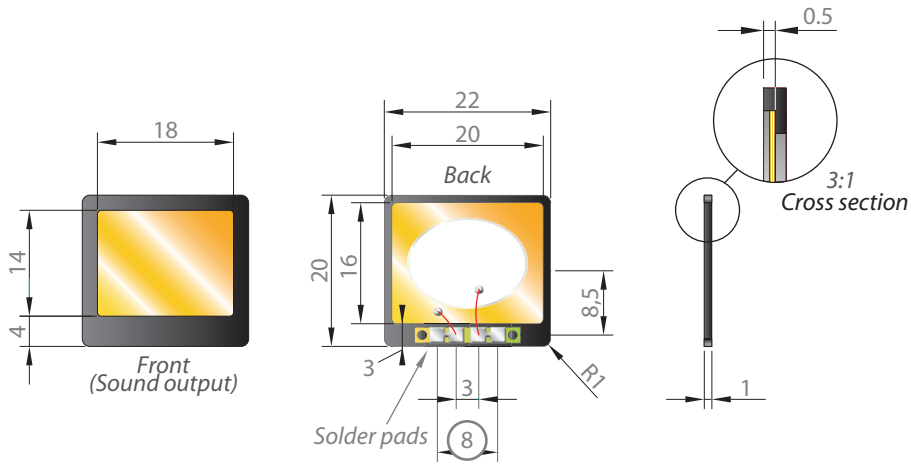
speaker mounted on plexi plate of 5 x 5cm in closed box of 40 x 15 x 5cm

## FREQUENCY RESPONSE



**DIMENSIONS** (all dimensions are in mm)

**SPS-2220-03**



Tolerance: +/- 0.2mm

**Recommended Piezo Audio Amplifiers** (see page 104, 105, 106)

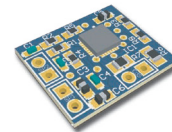
**Integrated Circuits**

**Maxim**  
MAX9788

**Texas Instruments**  
TPA2100P1

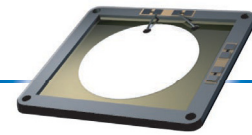
**Linear technology**  
LT3469

**Sonitron production models**



PAA-MAX-9788-01

## SPS-3530-03



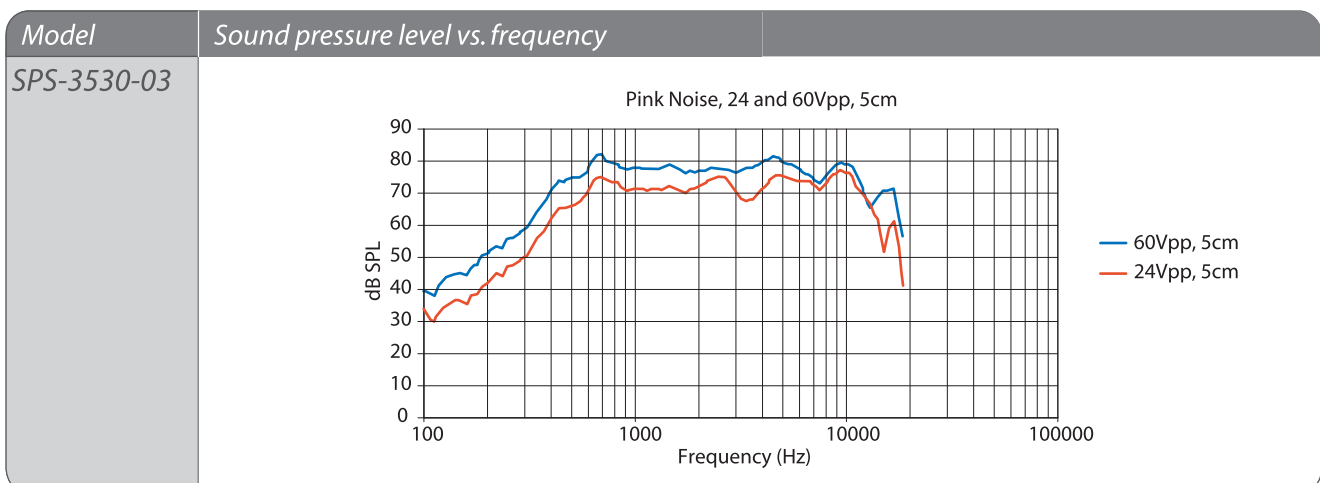
The electronics industry still is a very demanding industry which requires more and more flat and small components. Therefore Sonitron developed this new flat piezoceramic speaker. With a thickness of only 2 mm and dimensions of 39x43.5 mm, this small multifunctional speaker/microphone is ideal for use in portable electronic devices (PDA, GPS, MP3,...), notebooks and consumer products.

## SPECIFICATIONS

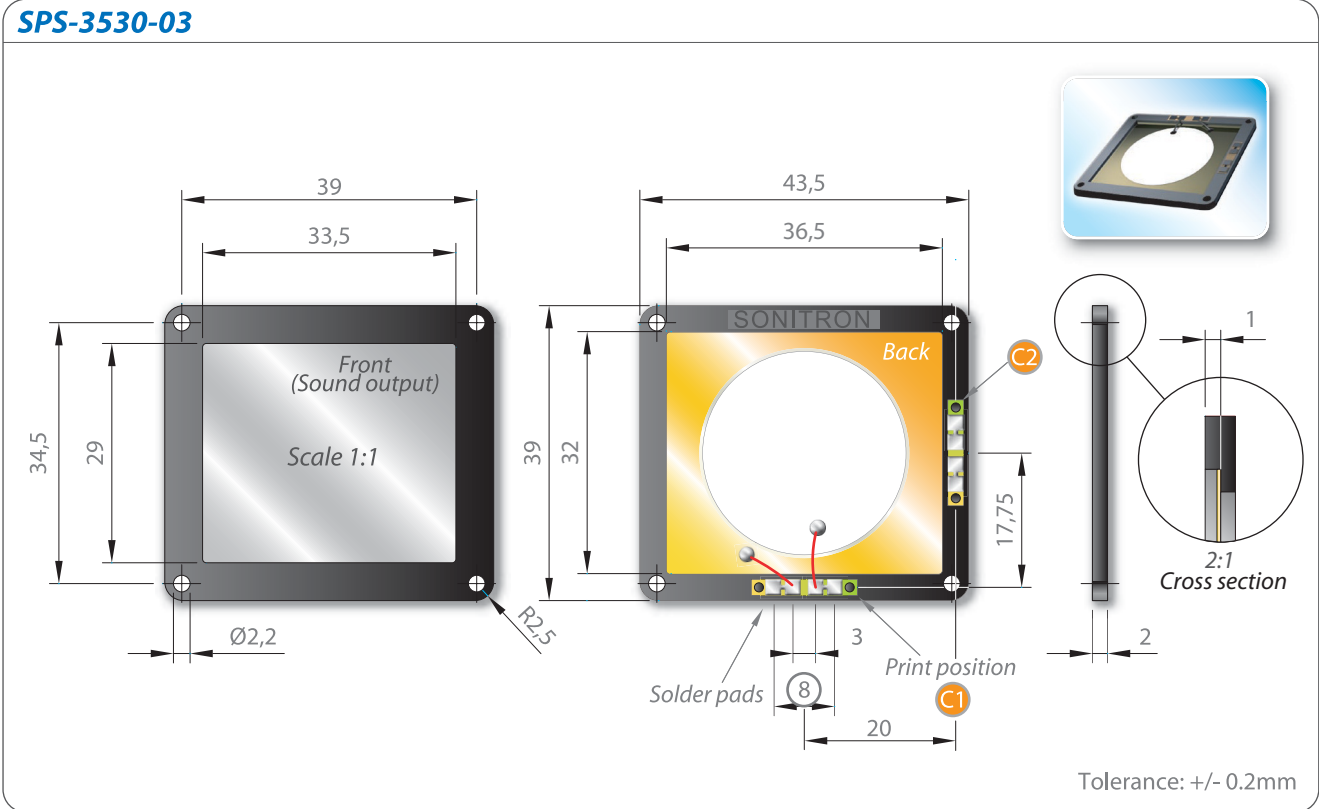
Frequency Range :	700 Hz - 20 kHz
Max SPL @ 1 m, 60 Vpp: (average at 4-point)	81 dB
Distortion (%THD): (80dB @ 5 cm, average @ 4-point)	≤1.5%
Sensitivity: (SPL @ 10cm for 1Vrms, average @ 4-point : 800Hz, 1kHz, 1.5kHz, 2kHz)	73 dB
Capacitance (+/- 20%):	220 nF
Impedance @ 1kHz (+/-20%):	603 ohm
Operating Voltage:	5-60 Vpp
Weight:	2.4g
Operating Temperature:	-20°C to 60°C
Storage Temperature:	-40°C to 60°C
Case material:	PBT
Standard color:	Black

speaker mounted in closed box of 40 x 15 x 5cm

## FREQUENCY RESPONSE



**DIMENSIONS** (all dimensions are in mm)



**Recommended Piezo Audio Amplifiers** (see page 104, 105, 106)

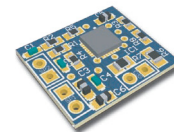
**Integrated Circuits**

**Maxim**  
MAX9788

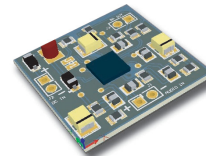
**National semiconductor**  
LM4960

**Texas Instruments**  
TPA2100P1

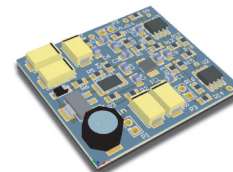
**Sonitron production models**



PAA-MAX-9788-01



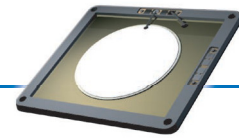
PAA-LM4960SQ-02



PAA-StepUpBTL-01



## SPS-4640-03



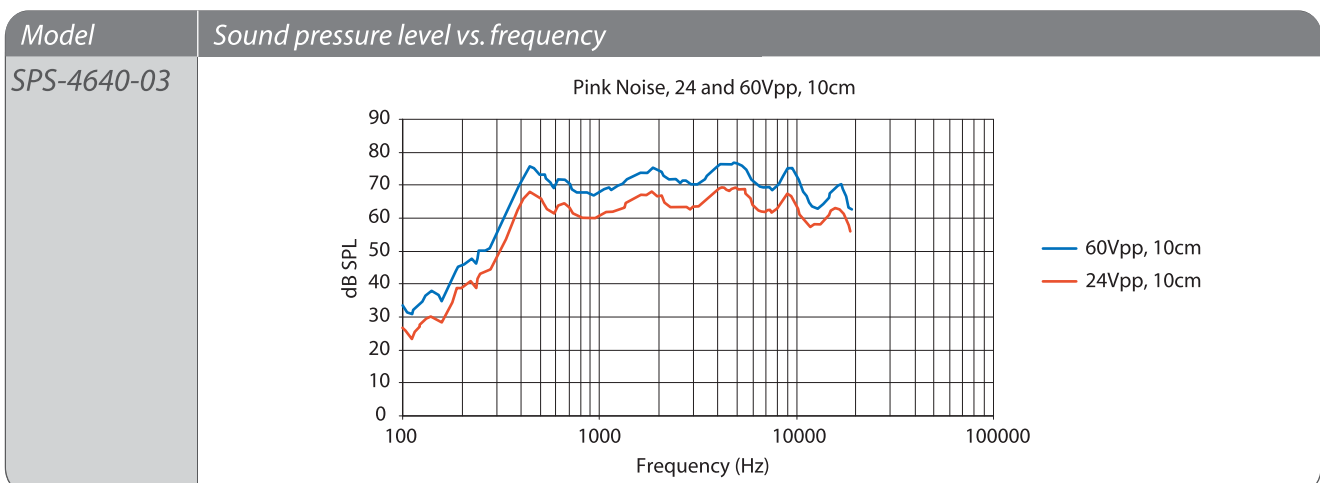
The electronics industry still is a very demanding industry which requires more and more flat and small components. Therefore Sonitron developed this new flat piezoceramic speaker. With a thickness of only 2 mm and dimensions of 43.6x50 mm this small multifunctional speaker/microphone is ideal for use in portable electronic devices (PDA, GPS, MP3,...), notebooks and consumer products.

## SPECIFICATIONS

Frequency Range :	400 Hz - 20 kHz
Max SPL @ 1 m, 60 Vpp: (average @ 4-point)	83 dB
Distortion (%THD): (80dB @ 5 cm, average @ 4-point)	≤1.5%
Sensitivity: (SPL @ 10cm for 1Vrms, average @ 4-point : 800Hz, 1kHz, 1.5kHz, 2kHz)	72 dB
Capacitance (+/- 20%):	225 nF
Impedance @ 1kHz (+/-20%):	680 ohm
Operating Voltage:	5-60 Vpp
Weight:	2.8g
Operating Temperature:	-20°C to 60°C
Storage Temperature:	-40°C to 60°C
Case material:	PBT
Standard color:	Black

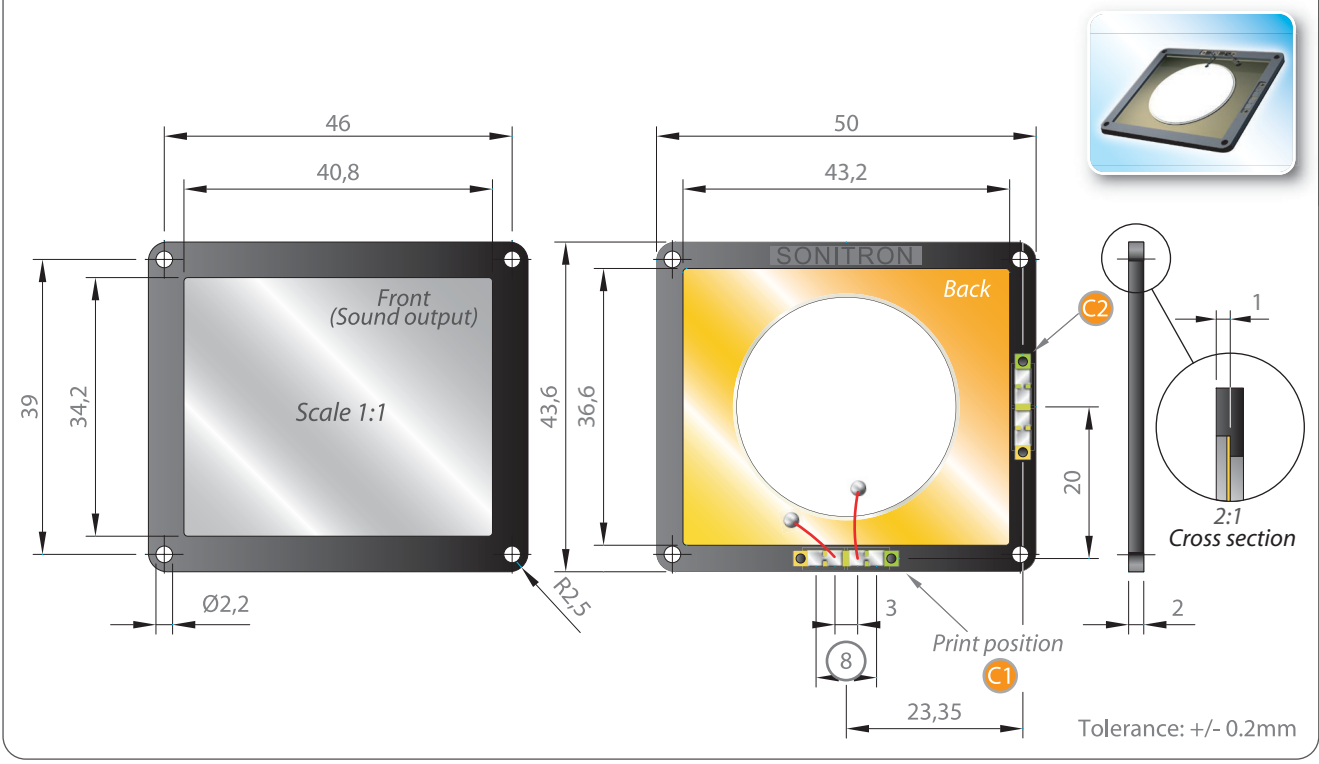
speaker mounted in closed box of 40 x 15 x 5cm

## FREQUENCY RESPONSE



**DIMENSIONS** (all dimensions are in mm)

**SPS-4640-03**



**Recommended Piezo Audio Amplifiers** (see page 104, 105, 106)

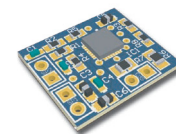
**Integrated Circuits**

**Maxim**  
MAX9788

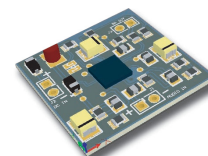
**National semiconductor**  
LM4960

**Texas Instruments**  
TPA2100P1

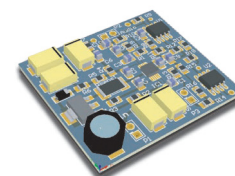
**Sonitron production models**



PAA-MAX-9788-01



PAA-LM4960SQ-02



PAA-StepUpBTL-01

## SPS-6555-03



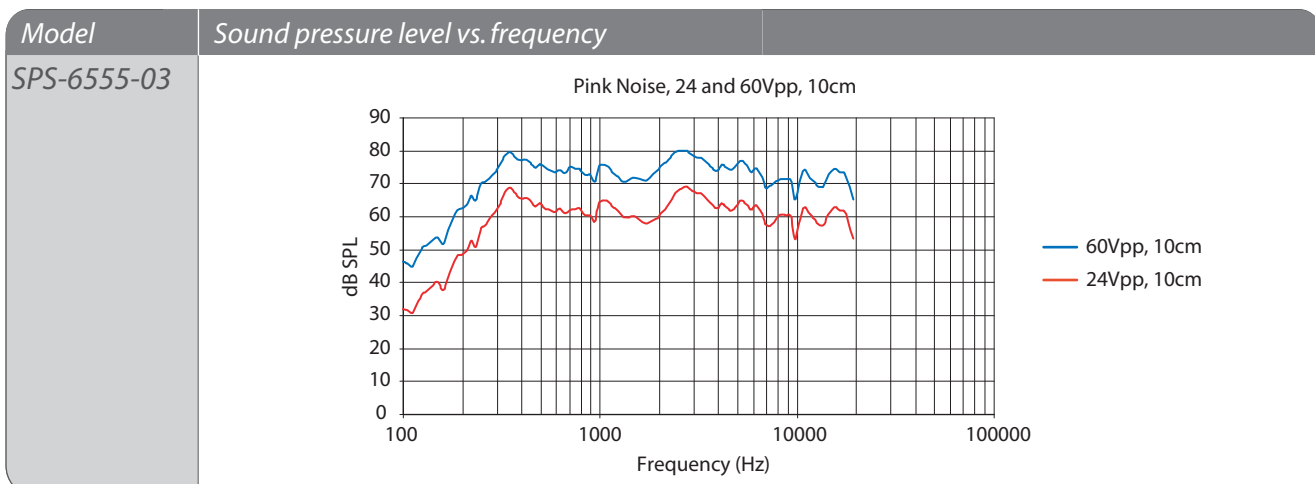
The new SPS-6555-03 is designed for applications where the space is limited and a high sound quality is required. This new speaker model features a broad frequency range combined with small dimensions which makes them ideal for multimedia applications.

### SPECIFICATIONS

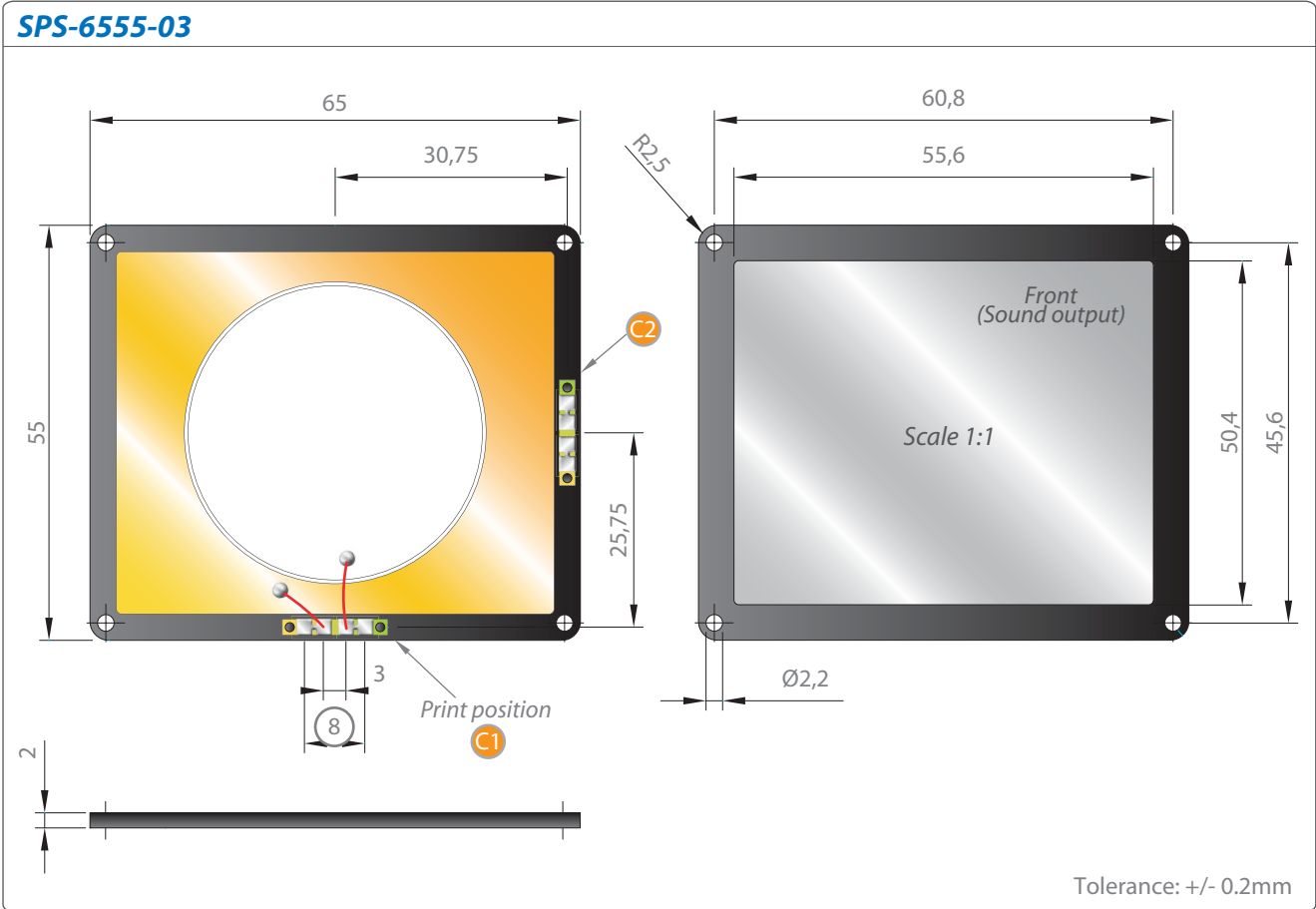
Frequency Range :	300 Hz - 20 kHz
Max SPL @ 1 m, 60 Vpp: (average @ 4-point)	83 dB
Distortion (%THD): (80dB @ 1m, average @ 4-point)	≤1.5%
Sensitivity: (SPL @ 10cm for 1Vrms, average @ 4-point : 800Hz, 1kHz, 1.5kHz, 2kHz)	73 dB
Capacitance (+/- 20%):	480 nF
Impedance @ 1kHz (+/-20%):	333 ohm
Operating Voltage:	5-60 Vpp
Weight:	5g
Operating Temperature:	-20°C to 60°C
Storage Temperature:	-40°C to 60°C
Case material:	PBT
Standard color:	Black

speaker mounted in closed box of 40 x 15 x 5cm

### FREQUENCY RESPONSE



## DIMENSIONS (all dimensions are in mm)



## Recommended Piezo Audio Amplifiers (see page 104, 105, 106)

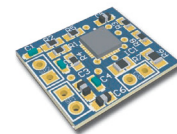
### Integrated Circuits

**Maxim**  
MAX9788

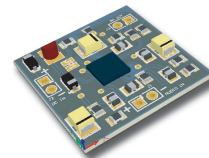
**National semiconductor**  
LM4960

**Texas Instruments**  
TPA2100P1

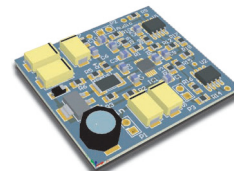
### Sonitron production models



PAA-MAX-9788-01



PAA-LM4960SQ-02



PAA-StepUpBTL-01

## SPS-8770-03



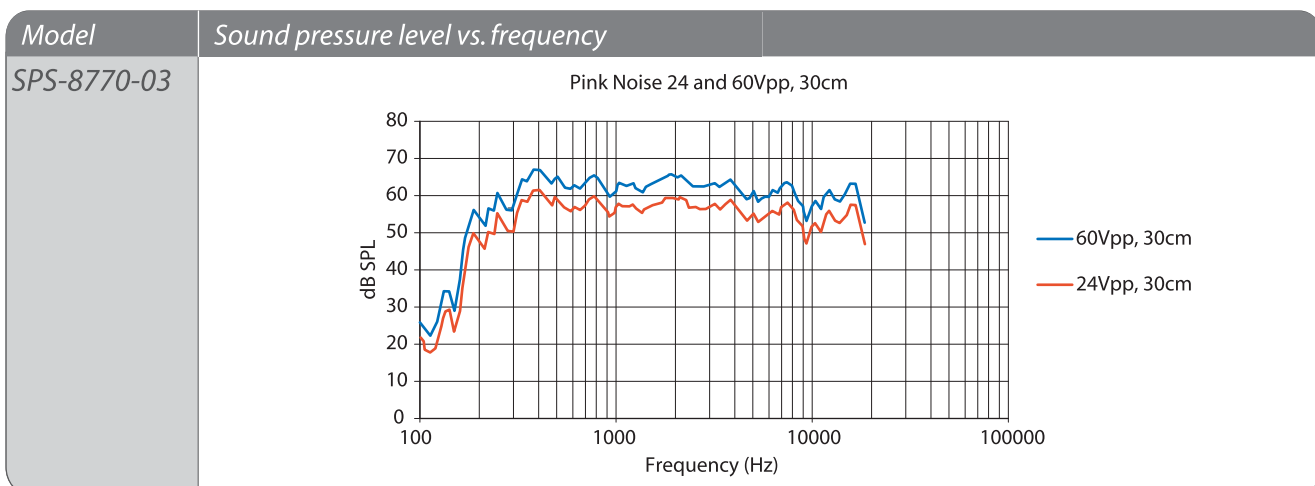
The SPS-8770-03 is the largest version of our piezo speakers, with a thickness of only 2 mm. This model is extremely suitable for flat devices when high sound output and broad frequency range are required. Low weight and easy mounting requirements are the extreme advantages of this speaker. Compared with conventional designs the speaker also has less current consumption.

## SPECIFICATIONS

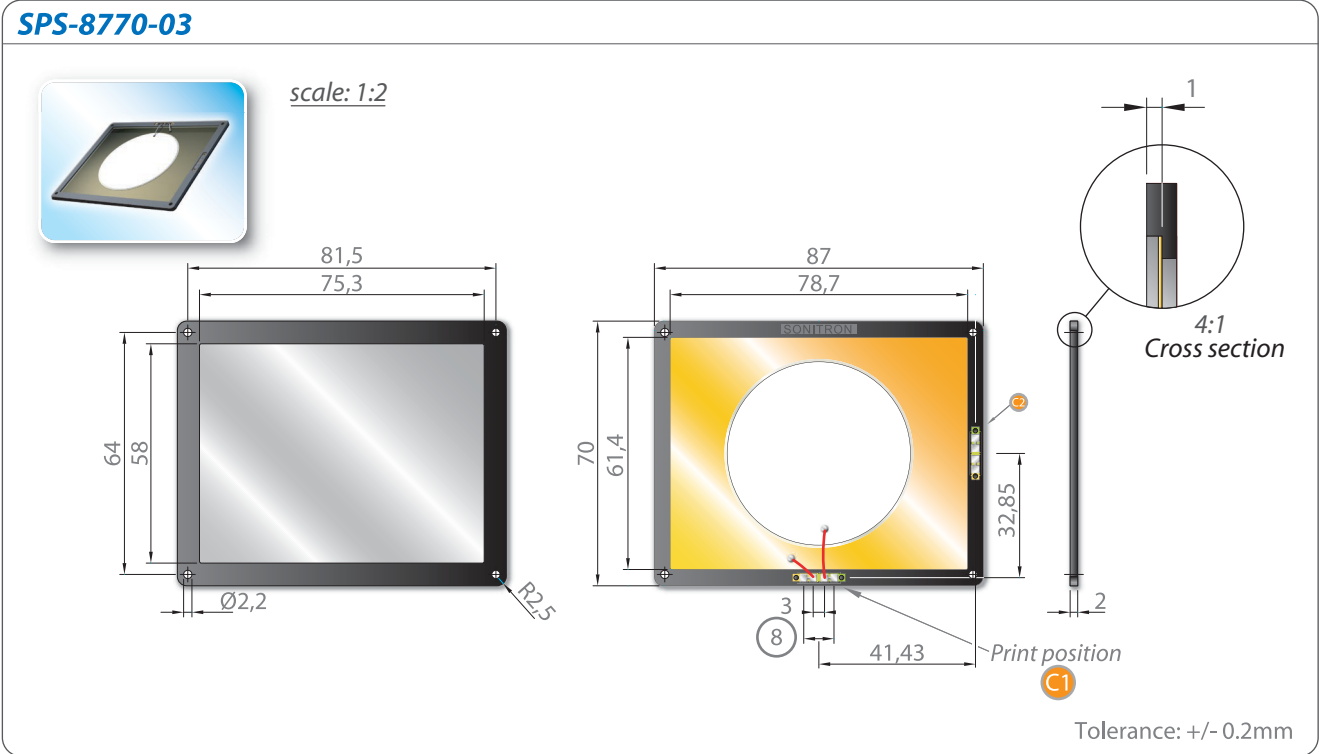
Frequency Range :	200 Hz - 20 kHz
Max SPL @ 1 m, 60 Vpp: (average @ 4-point)	84 dB
Distortion (%THD): (80dB @ 5 cm, average @ 4-point)	≤1.5%
Sensitivity: (SPL @ 10cm for 1Vrms, average @ 4-point : 800Hz, 1kHz, 1.5kHz, 2kHz)	74 dB
Capacitance (+/- 20%):	580 nF
Impedance @ 1kHz (+/-20%):	266 ohm
Operating Voltage:	5-60 Vpp
Weight:	7.3g
Operating Temperature:	-20°C to 60°C
Storage Temperature:	-40°C to 60°C
Case material:	PBT
Standard color:	Black

speaker mounted in closed box of 40 x 15 x 5cm

## FREQUENCY RESPONSE



**DIMENSIONS** (all dimensions are in mm)



**Recommended Piezo Audio Amplifiers** (see page 104, 105, 106)

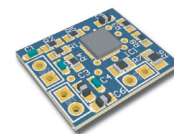
**Integrated Circuits**

**Maxim**  
MAX9788

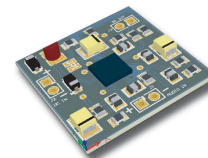
**National semiconductor**  
LM4960

**Texas Instruments**  
TPA2100P1

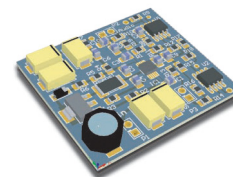
**Sonitron production models**



PAA-MAX-9788-01



PAA-LM4960SQ-02



PAA-StepUpBTL-01

## PRODUCT CODIFICATION

<p>SPS</p> <p>↓</p> <p>Sonitron Polymer/metal Speaker</p>	<p>2220-03 3530-03 4640-03 6555-03 8770-03</p>	<p>C1 or C2</p> <p>↓</p> <p>C1: Position of solder pads C2: Position of solder pads</p>	
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## LIST OF AVAILABLE PRODUCT TYPES

SPS-2220-03	SPS-3530-03-C1 SPS-3530-03-C2	SPS-4640-03-C1 SPS-4640-03-C2	SPS-6555-03-C1 SPS-6555-03-C2	SPS-8770-03-C1 SPS-8770-03-C2
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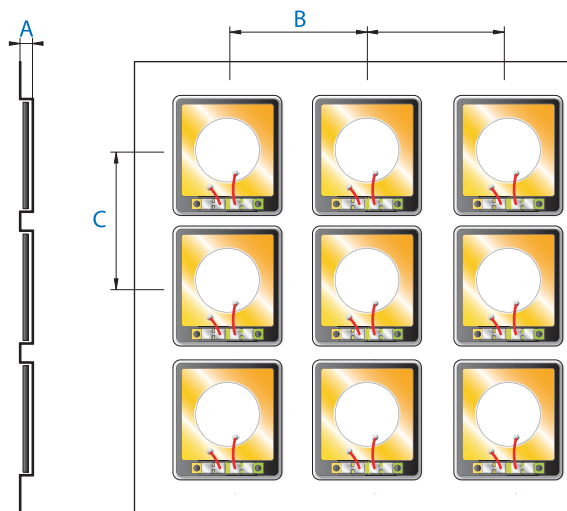
## PACKAGING

The SPS-2220-03/3530-03/4640-03/6555-03/8770-03 are packed in trays (245 L x 245 W) and sold in boxes with dimensions of 250 L x 250 W x 125 H.

Number	SPS-2220-03	SPS-3530-03	SPS-4640-03	SPS-6555-03	SPS-8770-03
per tray	81	25	16	9	6
per box	(81x70) 5670	(25x40) 1000	(16x40) 640	(9x40) 360	(6x40) 240

Dimensions of the tray and position of the SPS-speakers 2022-03/3035-03/4640-03/8770-03/SPS-27-01 are illustrated below:

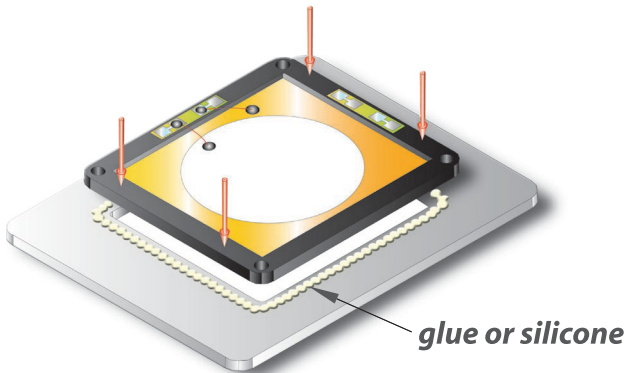
SPS-2220-03	A=1.5 mm B=26 mm C=26 mm
SPS-3530-03	A=3 mm B=47.5 mm C=47.5 mm
SPS-4640-03	A=3 mm B=60 mm C=60 mm
SPS-6555-03	A= 3mm B=68.5mm C=75.5mm
SPS-8770-03	A=3 mm B=78 mm C=120 mm



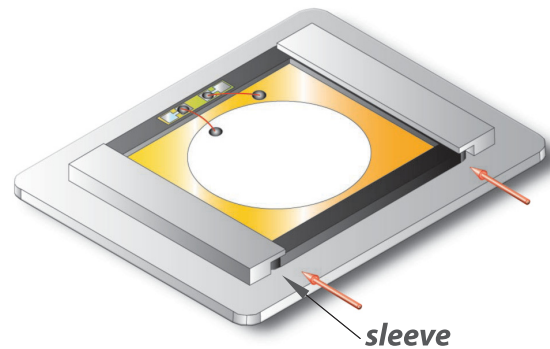
## ACOUSTIC MOUNTING INSTRUCTIONS FOR SPS-SPEAKERS

- Fundamental mounting recommendations see page 102.
- The SPS speakers can be mounted in several different ways. The mounting methods, illustrated below, are recommended to mount all the SPS speaker models. Please keep in mind that not too much mechanical stress is placed on the frame of the piezoceramic speaker after mounting.

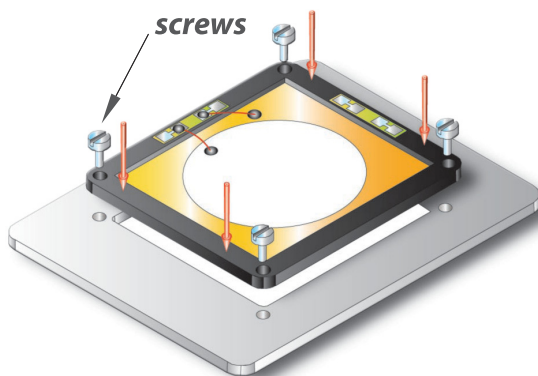
**Mounted with glue or silicone**



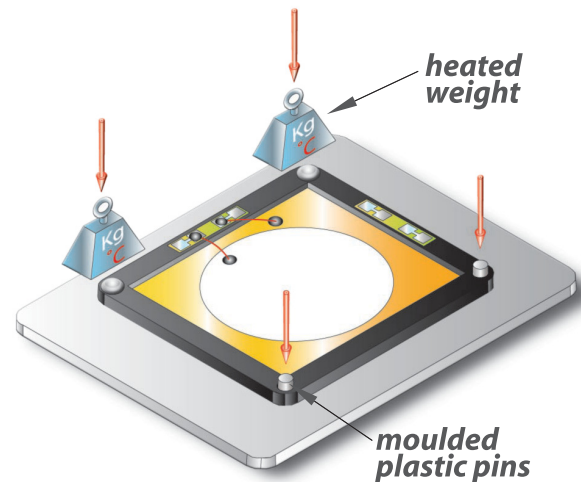
**Mounted with slot groove**



**Mounted with screws**



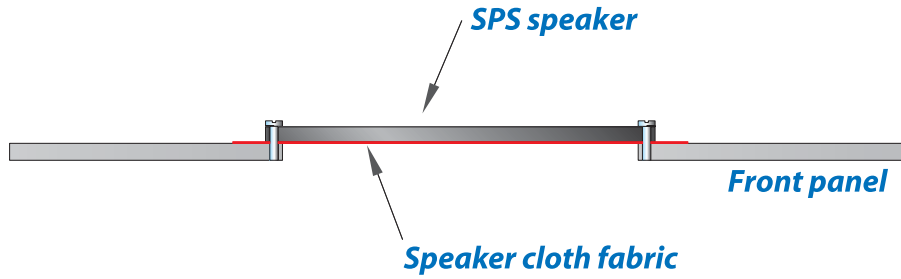
**Plastic deformation method (Ultrasonic)**



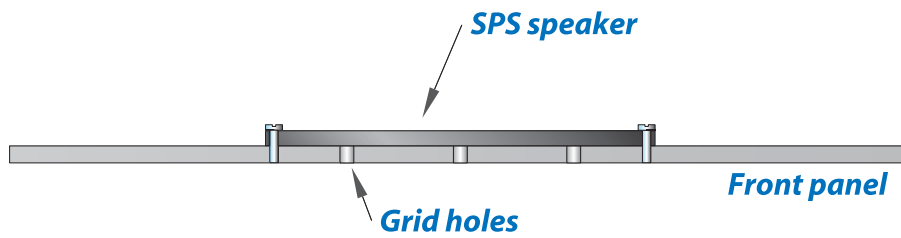
**Other methods...**



**Speaker cloth fabric**

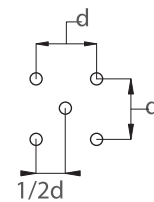


**Front holes**



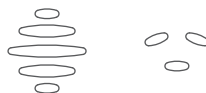
Front holes of            1 mm Ø for model SPS-2220-03  
                                  2 mm Ø for model SPS-3530-03  
                                  2 mm Ø for model SPS-4640-03  
                                  2 mm Ø for model SPS-8770-03

Distance front holes    d=3 mm for model SPS-2220-03  
                                  d=5 mm for model SPS-3530-03  
                                  d=5 mm for model SPS-4640-03  
                                  d=10 mm for model SPS-S8770-03



\*Other designs of the hole pattern (grids) are also suitable. (SPS-2220-03, SPS-3530-03)

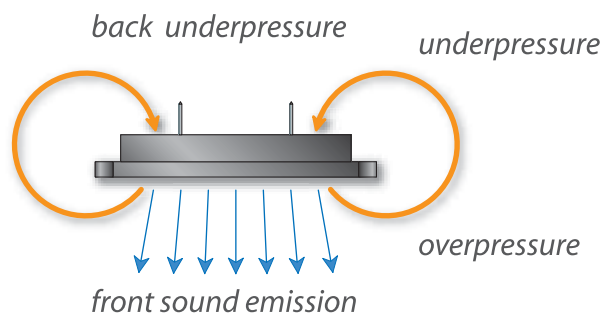
grid examples



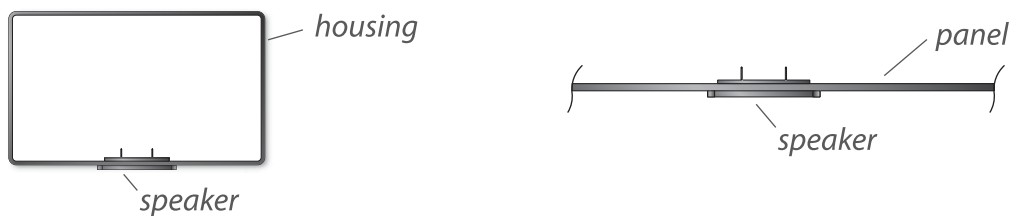
## FUNDAMENTAL ACOUSTIC MOUNTING RECOMMENDATIONS

Important note:

Piezoceramic speakers produce sound by the forward and backward movement of a flat membrane. During this movement the membrane creates an air pressure wave in front and at the backside of the membrane. A forward movement will create a slight overpressure at the frontside and a slight underpressure at the backside and vice versa. It is therefore important that the front and backside are acoustically isolated from each other to avoid air pressure cancellation and consequently a serious reduction of the sound output.

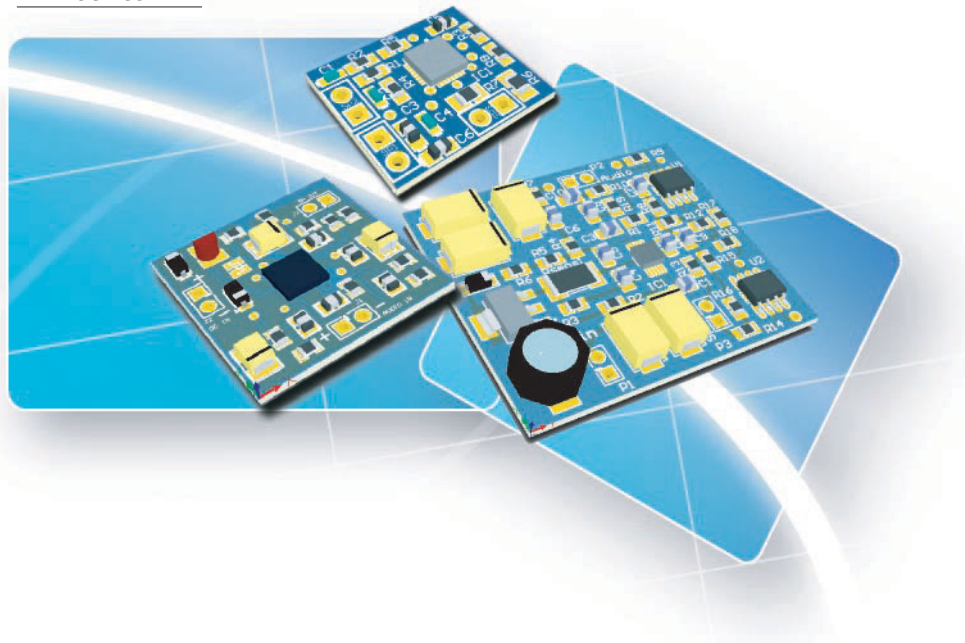


When a speaker is mounted in a panel or in the wall of a housing, the front side is acoustically isolated from the backside.



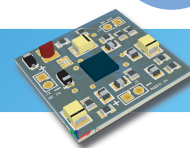
# PIEZO AUDIO AMPLIFIERS

*PAA-series*



*In parallel with the amplifiers developed at Sonitron we refer to various integrated circuits available on the market.*

## PIEZO AUDIO AMPLIFIERS



### INTRODUCTION

The **P**iezo **A**udio **A**mplifiers-series are a total solution to drive piezoceramic sound components. A range of different PCB sizes, amplifier topologies and maximum voltage peak to peak outputs, cover a wide solution to piezo audio amplification.

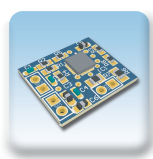
Piezo audio amplifiers are designed to handle capacitive loads and have the possibility to deliver large voltages peak to peak over the complete audio frequency range.

The heart of a piezo audio component is a ceramic piezo stone that interacts when it feels a certain voltage difference. An increase of a voltage peak to peak will have a larger piezo deformation and results in a larger sound output.

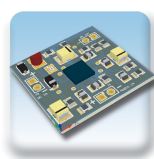
The PAA-series give a quality amplifier solution where a quality sound is needed.

### GENERAL OVERVIEW PAA SERIES

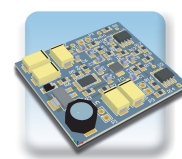
Model	PAA-MAX9788-01	PAA-LM4960-02	PAA-StepUpBTL-01
Measurements PCB(mm)	14x16.5mm	25x25mm	40x35mm
Voltage input (V)	5V	5V	5V-25V
MAX Capacitance Piezo Speaker	1µF	600nF	1µF
Max Voltage Output Vpp	20Vpp	24Vpp	60Vpp
Voltage Topology	Integrated step up converter	Integrated step up converter	Step up converter
Amplifier classification	Class G	Class AB	Class AB
Used amplifier configuration	Fully Differential	Bridge Tied Load	Bridge Tied Load
Average current consumption of speaker and amplifier (mA)	15mA	85mA	40mA-400mA (2 Watt)



**PAA-MAX9788-01**



**PAA-LM4960SQ-02**



**PAA-StepUpBTL-01**

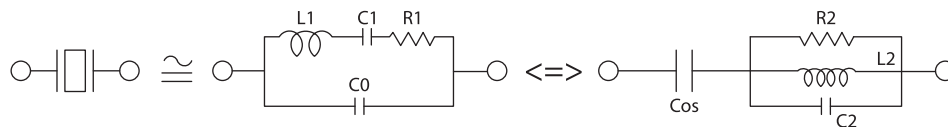
## BASICS OF PIEZO AUDIO AMPLIFIERS

$$PAA = P_{iezo} A_{udio} A_{mplifier}$$

An amplifier for audio signals special designed to drive capacitive loads.

**Max Cap.:** The maximum capacitance the Piezo Audio amplifier can handle.

**-Load Capacitance:** The main impedance of the Piezo Speaker or Piezo vibration element is a capacitance with values mostly between 10nF and 1µF.

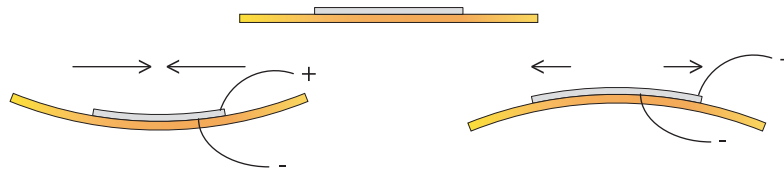


Simple Equivalent electronic circuits of a piezo element:

**Max Vpp:** Maximum voltage peak to peak that an amplifier can deliver at his output channel.

**-Max speaker Vpp:** Maximum voltage swing a piezo speaker can handle to work correctly within the described life time.

**-The heart of a Piezo speaker** is the piezo ceramic stone that interacts with voltage differences. How larger the voltage difference how more intense the amplitude of the sound will be.



## PIEZO AUDIO AMPLIFIER-SERIES

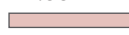
### PAA-MAX9788-01

Designed on a printed circuits board of only 2,31 cm<sup>2</sup>, the “Max9788” piezo audio amplifier of Maxim fulfils the needs of very small designs in portable applications. A maximum output of 20Vpp and very low power consumption makes it even more attractive.

- Integrated charge pump power supply
- Class G Amplifier
- Fully differential inputs and outputs
- Capacitive load up to 1µF
- 15 components

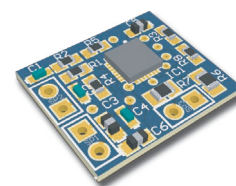
total thickness:

1.88 mm



14x16.5 mm

actual size



Fixed amplification ratio: +/- 80

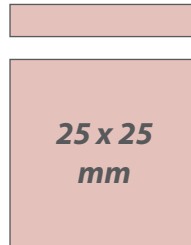
Voltage input: 5 V

## PAA-LM4960SQ-02

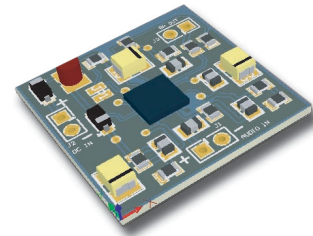
A perfect balance of a bridge tied load and step up converter on a small PCB, the "LM4960" IC of National Semiconductor reaches 24 Vpp for a load of 600nF. Small design and great sound output makes it very understandable.

- Integrated Step Up Converter
- Bridge tied load
- Very small inductor
- Up to 24Vpp
- 22 components

total thickness:  
4.25 mm



actual size



Fixed amplification ratio: +/- 74  
Voltage input: 5 V

## PAA-StepUpBTL-01

To go loud is to amplify the input signal to a large Voltage peak to peak swing of maximum 60Vpp. Tuned on the SPS piezo speakers the "StepUpBTL" piezo audio amplifier is designed for a very loud audio sound in a room.

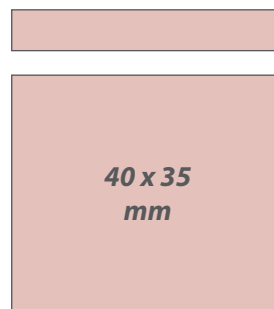
The creation of a 60Vpp swing derives from a stable DC power source of 30 V DC.

The boostconverter circuit is designed to a minimum surface with a maximum variety at the input source. A variation of the input voltage between 5V and 25V gives at the end a stable 30VDC to power the opamps with efficient power consumption.

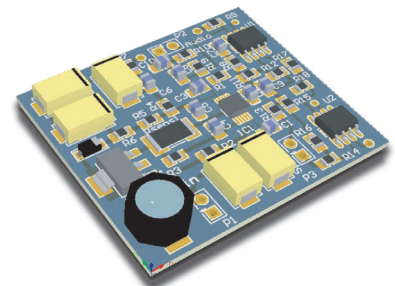
The amplifier circuit is a perfect balance between power consumption and space design. The Bridge Tied Load amplifier topology makes it possible to swing the signal to 60Vpp.

- Input voltage 5V-25V
- Max. output 60Vpp
- Two electronic circuits
- **Ideal: +input: 9Vdc**  
**+output: 40Vpp**

total thickness:  
6 mm



actual size



Fixed amplification ratio: +/- 90  
Voltage input: 5-25 V

### Boost converter + Amplifier

- DC-DC- converter: Max 669  
=> output: 30 Vdc
- Amplifier circuit: OPA 551  
=> "Bridge tied load configuration"

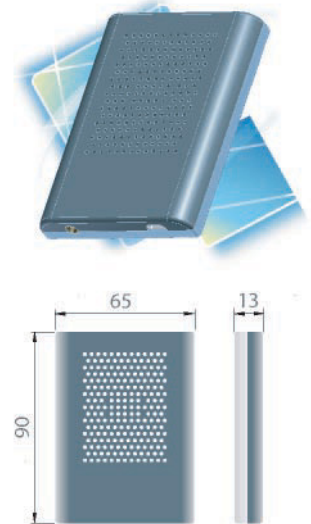
## ADDITIONAL INFORMATION

### DEMONSTRATION UNIT DU6597

The DU6597 is a small speaker demonstration unit that consists of a piezoceramic speaker (SPS6555) and a piezo audio amplifier (PAA-MAX9788).

The **SPS-6555-03** is a polymer/metal speaker with a very flat frequency response. The use of a piezoceramic disc as the heart of the speaker does not generate an electromagnetic field and ensures EMC requirements.

The **PAA-MAX9788** is a fully differential piezo audio amplifier with a class G topology. It is designed for applications where efficiency and small dimensions are a priority and can deliver a signal up to 20Vpp at 5V.



### PRESENTATION EXAMPLES



Presentation with portable PC

The DU6597 is designed for use with MP3-players and the headphone output of a portable PC.

Please note: Other outputs or signals than the music headphone output can damage the amplifier!!

The power source comes from a USB power port and delivers 5V to the piezo audio amplifier. If no USB powerport is available an adapter can be used. In this case we recommend the iPod USB Power Adapter.



Presentation with MP3-player

## Automatic Speaker/Microphone switch + (pre)amplifier

Sonitron's piezoceramic speakers are ideal for use in multifunctional applications (speaker/microphone combination), because of the high sensitivity of the speaker membrane when used as microphone. They can be used in highly integrated equipment, such as GSM, PDA, portable games,... where voice commands could be an added value to meet customer's requirements. The principle starts from an audio detector, which senses if there's an audio input signal present or not. If not, the speaker is used as microphone. If yes, normal speaker operation is automatically selected.

### Absolute Maximum Ratings

- Supply voltage : 20 VDC (applied via Wall Adapter input)
- Max. load capacitance: 800 nF
- Power Dissipation : Internally limited
- Audio Input Voltage : -0.3 V...Vcc + 5.3 V

### Electrical Characteristics

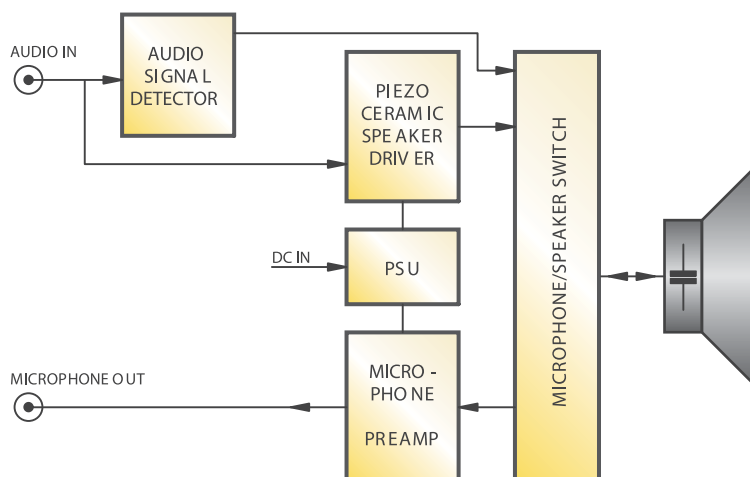
- Supply Voltage : 7...20 VDC (wall adapter input, 12 VDC recommended)
- Speaker drive voltage: 24 Vpp
- Audio input signal : 600 mVpp typical
- Quiescent supply current : 20 mA (microphone), 70 mA (speaker)
- Total harmonic distortion: typical <1%

### Microphone sensitivity of Sonitron's speakers

Model	SPS-2220-03	SPS-3530-03	SPS-4640-03	SPS-6555-03	SPS-8770-03
Sensitivity	6.8 mV/Pa	2.6 mV/Pa	2.8 mV/Pa	2.9 mV/Pa	3.01 mV/Pa

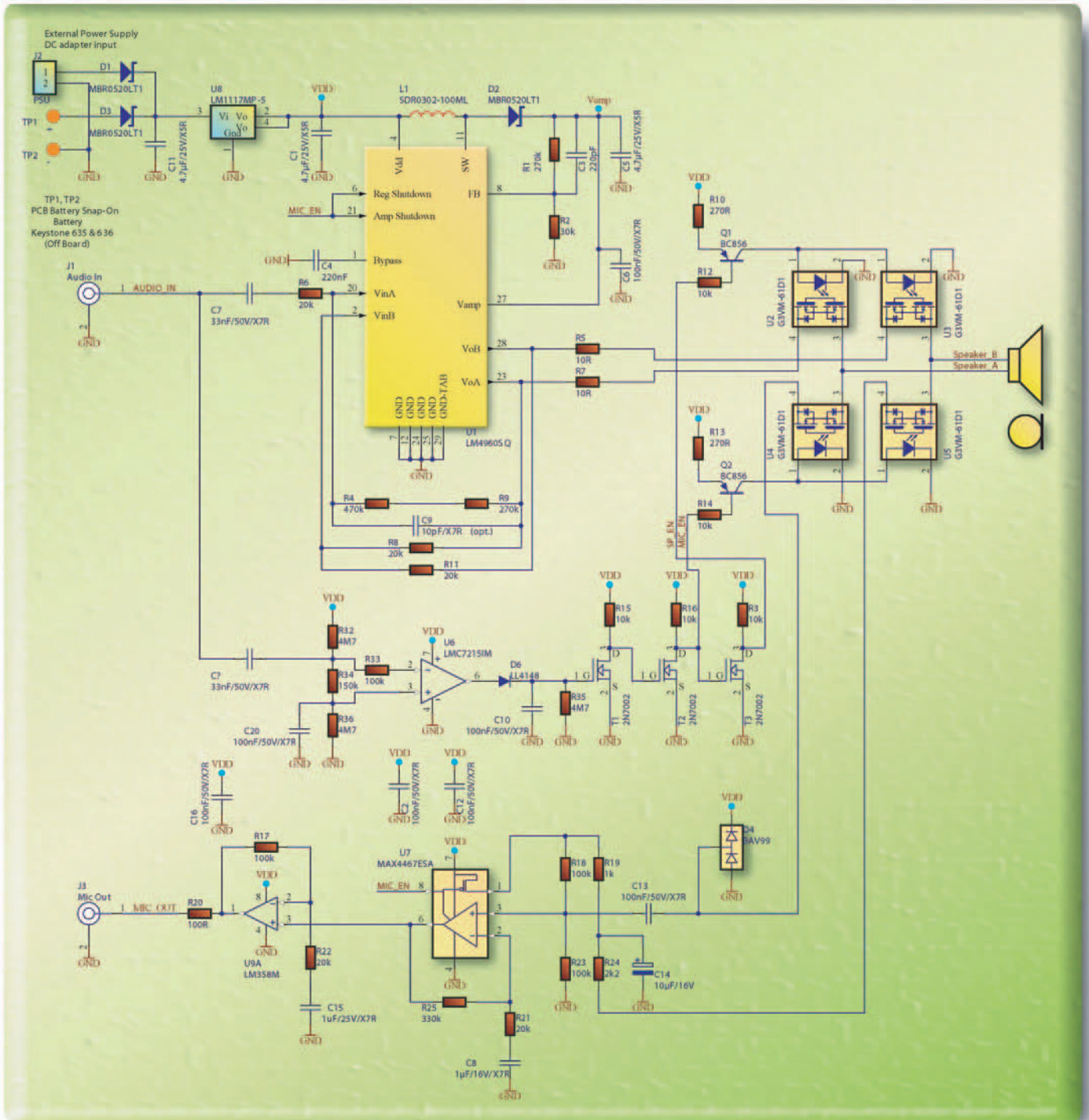
(Measured with a 1kHz/94dB signal)

### SCHEMATICS





**Automatic Speaker/Microphone switch + (pre)amplifier**



## Blind power dissipation in a piezoceramic load (for a sine wave)

The power dissipation in an electro-dynamic speaker depends on the resistance of the drive coil. In our comparison, the power dissipated in an electrodynamic speaker with  $\varnothing$  68 mm and  $16\Omega$  impedance @ 2V is:

$$\frac{V^2}{R} = \frac{4}{16} = 0,25 \text{ W}$$

The power dissipation in a piezo capacitive load, not in resonance, is:

$$P = \frac{c.V^2.\omega.\cos\varphi}{2} + \frac{c.V^2.\omega.D_F}{2} = \frac{c.V^2.\omega}{2} .(\cos\varphi + D_F)$$

capacitive power
power dissipated in ceramic

$D_F$ : Dissipation factor of the ceramic material

$c$ : Capacitance of speaker

$\omega$ :  $2\pi f$

$V$ : Drive voltage

$\cos\varphi$ : The phase angle between current consumption and voltage (in a capacitor is this angle  $90^\circ$  before in phase, thus  $\cos\varphi = 0$ )

In theory, the capacitive power is zero. The power dissipated in the ceramic disc of the speaker depends strongly on the dissipation factor of  $D_F$  of the used ceramic. The  $D_F$  is a measure of the dielectric losses in the material, defined as the tangent of the loss angle or the ratio of parallel resistance to parallel reactance, expressed in percent and measured at 1 kHz. This dissipation factor can vary from 0,4% up to 2% for the most typical ceramics available.

Our speakers are not used at resonance. Consequently the power dissipated mainly depends on the  $D_F$  and is very low or near zero.

The power dissipation of the piezo speaker can be considered as a blind power drain. The amplifier must deliver the total power needed to drive the circuit. Thus the total power drain of the piezo speaker is the drain of the amplifier, needed to deliver the blind power for the speaker, the power dissipated in the ceramics (due to the dissipation factor) and the power dissipated in the isolation resistor  $R_{ISO}$ .

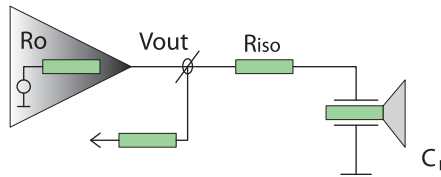
## THE IMPORTANCE OF THE ISOLATION RESISTOR ( $R_{ISO}$ )

Amplifiers feeding capacitive loads can be stabilised in order to avoid oscillation at  $180^\circ$  degrees phase shift at certain feedback conditions.

There are many ways to stabilise an amplifier in combination with a capacitive load, but a small resistor  $R_{ISO}$  is very effective and easy to design-in. By adding an isolation resistor  $R_{ISO}$  in series with the amplifier output and the capacitive load of the speaker  $C_L$ , we improve the gain and phase margin over the entire frequency range.

By adding a  $R_{ISO}$  we create:

1. an extra  $F_{zero}$  (Fz) in the transfer function
2. we reduce the frequency of the pole with an output load in the transfer function



**$F_p$ :** At this frequency, the poles are represented by -45 degrees phase shift with -45 degrees per decade slope, extending this line with 0 degree and -90 degrees horizontal lines.

$$F_p = \frac{1}{2\pi C_L (R_o + R_{ISO})}$$

**$F_z$ :** At this frequency, the phase for zero is represented by a +45 degrees phase shift at the frequency of zero with +45 degrees per decade slope, extending this line with 0 degree and +90 degrees horizontal lines.

$$F_z = \frac{1}{2\pi C_L R_{ISO}}$$

The  $F_z$  in the transfer function is the product of  $R_{ISO}$  and  $C_L$ . The phase improvement is:

$$\Delta\theta: \tan^{-1} (2\pi \cdot UGBW \cdot R_{ISO} \cdot C_L)$$

- $\Delta\theta$  = improvement in phase margin
- UGBW = unity gain bandwidth frequency
- $R_{ISO}$  = isolation resistor
- $C_L$  = capacitive load of the speaker

## ADDENDUM



*Considerations about sound*

*Harmonic*

*Fourier*

*Harmonic content of a square wave*

*RMS and average power*

*Expected life time*

*SMD soldering instructions*

*RMA warranty and critical components*

*Heat protection label and wash tab*

*Cleaning*

*Warranty and delivery conditions*

*Critical components*

*IP ratings*

*Distributors & Representatives*

## CONSIDERATIONS ABOUT SOUND

### Loudness

The loudness of a sound perceived by the human ear at a certain location depends on several factors, such as: distance from the source, frequency of the sound, strength of the source, ear sensitivity, conditions of the air etc.

### Sound pressure level versus distance

In a free progressive spherical sound wave the sound pressure drops by 6 dB each time the measuring distance is doubled. This condition only exists a number of wavelengths away from the source and if the source radiates spherical waves.

$$\Delta\text{SPL} = 20 \cdot \log(r1 / r2)$$

with: **r1 = distance at which the SPL is given**

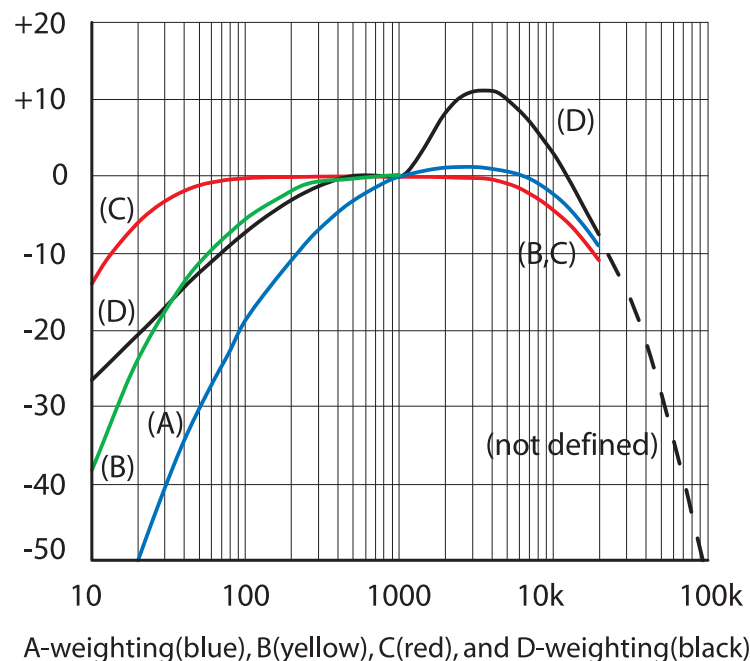
**r2 = distance at which you want to know the SPL**

example: 105 dB(A) @2m    =>@ 1m?  
 => $\Delta\text{SPL} = 20 \log(2/1) = +6$   
 => result: 111 dB(A) @ 1m

### Weighting curve

The human ear is more sensitive to frequencies between 2000 and 5000 Hz. This is why the operating frequency of alerting piezo buzzers is essentially chosen for this range. The human ear has a logarithmically response to sound pressure, of which the unity is expressed in decibels (dB). The sound pressure level is measured with an audiometer; an instrument developed in order to give an objective indication to sound pressure. The frequency response of this instrument is corrected by a weighing curve to match the characteristics of the human ear. The type of the weighing curve is indicated by the symbol (A) that gives the indication dB(A).

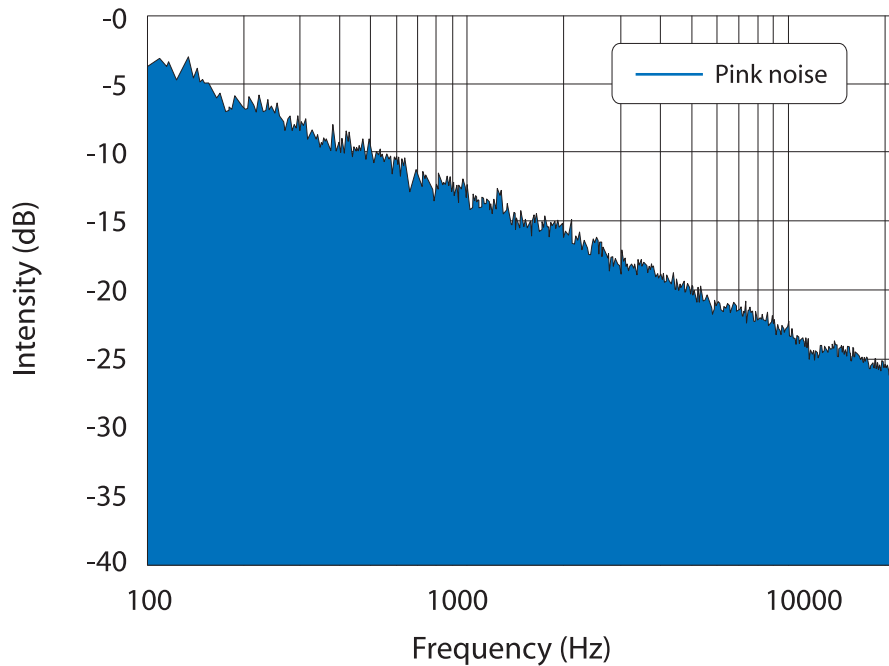
A-weighting curve



## Pink noise

**Pink noise or 1/f noise** is a signal with a frequency spectrum such that the power spectral density is inversely proportional to the frequency. In pink noise, each octave carries an equal amount of noise power. There is equal energy in all octaves (or similar log bundles).

- In terms of power at a constant bandwidth, 1/f noise falls off at 3 dB per octave.
- Pink noise has a tendency to occur in natural physical systems.
- White noise is equal energy per hertz.



## Sound character

The character of a sound is determined by the harmonic content, the amplitude relation between the harmonics for a steady signal when the signal varies the rate of attack and decay, and the presence of resonance.

## Pulsating sounds

The human ear is particularly sensitive to changes in condition. Switching on and off a sound makes it more attention-getting than a continuous sound of the same frequency. Shifting the frequency in a rapid rate produces a similar effect.

## Pulsating frequency

When a pulsed sound source is placed in a reverberant room, reflections tend to fill up the pauses between the pulses. In a large, highly reverberant room, longer pauses are necessary to produce the desired effect: a slow pulsing sound source should be used.

## HARMONIC

In acoustics a harmonic of a wave is a component frequency of the signal that is an integer multiple of the fundamental frequency.

n = 1	n = 2	n = 3	n = 4	...
f1	f2	f3	f4	...
300Hz	600Hz	900Hz	1200Hz	...

## FOURIER

To analyse a certain sound or function it can be decomposed in basic pieces. Mathematical a Fourier series can be used to decompose a periodic function or signal into a sum of simple oscillating functions, namely sines and cosines.

The use of a fourier analyse of a signal into sine waves with a certain amplitude gives the opportunity to study the amplification response of different vibrating systems.

Overview of basic mathematical signals and the corresponding fourier series:

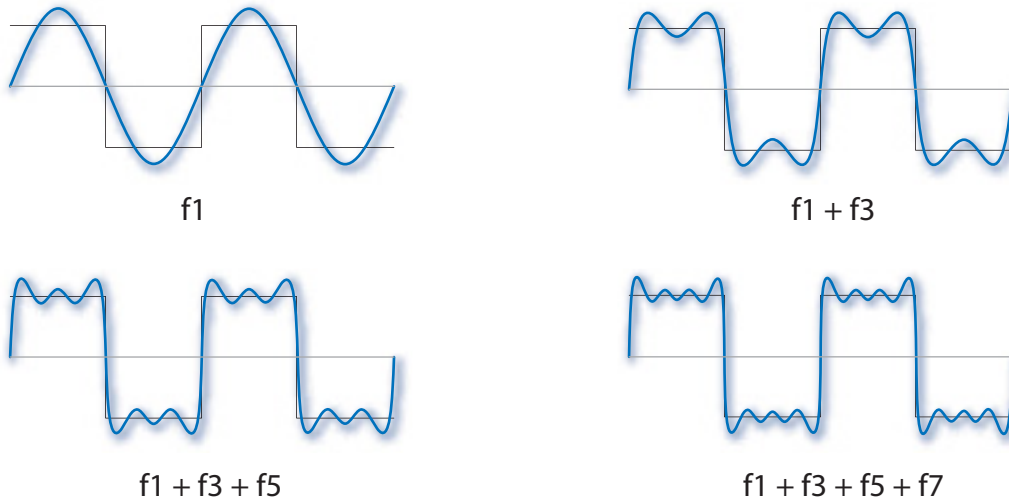
Signal	Time domain	Fourier domain	Frequency domain (log scale)
sine wave		$f_{1\_sine} = \frac{V_{pp}}{2} \cdot f_{1sin}$ $\sin(\omega_0 t)$	
triangle wave		$f_{1\_triangle} = \frac{V_{pp}}{2} \cdot \frac{8}{\pi^2} \cdot \left( \frac{1}{1^2} f_{1sin} + \overset{\pi \text{ phase change}}{(-)} \frac{1}{3^2} f_{3sin} + \frac{1}{5^2} f_{5sin} + \overset{\pi \text{ phase change}}{(-)} \frac{1}{7^2} f_{7sin} + \dots \right)$ $\sum_{n=1, n=odd}^N \left( \frac{1}{n^2} \right) \cdot \sin(n\omega_0 t)$	
square wave		$f_{1\_square} = \frac{V_{pp}}{2} \cdot \frac{4}{\pi} \cdot \left( f_{1sin} + \frac{1}{3} f_{3sin} + \frac{1}{5} f_{5sin} + \frac{1}{7} f_{7sin} + \dots \right)$ $\sum_{n=1, n=odd}^N \left( \frac{1}{n} \right) \cdot \sin(n\omega_0 t)$	

- f1: ground frequency (first harmonic) Vpp= voltage peak to peak
- f2: second harmonic
- f3: thirth harmonic
- fn: "n" th harmonic

## HARMONIC CONTENT OF A SQUARE WAVE

If a square wave is analysed with his fourier series into a sum of sine waves it is notable that it contains a lot of harmonics with a high amplitude.

Or otherwise, a pure square wave can be build as the sum of many  $f(2n-1)$  odd harmonics.



## RMS AND AVERAGE POWER

The average power gives an idea of the power consumption of a device over a certain time period. It can be easily found by multiplying the RMS-voltage and RMS-current .

$$P_{average} = V_{RMS} \cdot I_{RMS}$$

RMS is a mathematical function that reduces a complex function to a single value. It is the "square Root of the Mean of the Square of the function". Mean is the same as average.

$$x_{rms} = \sqrt{\frac{1}{n} \sum_{i=1}^n x_i^2} = \sqrt{\frac{x_1^2 + x_2^2 + \dots + x_n^2}{n}}$$



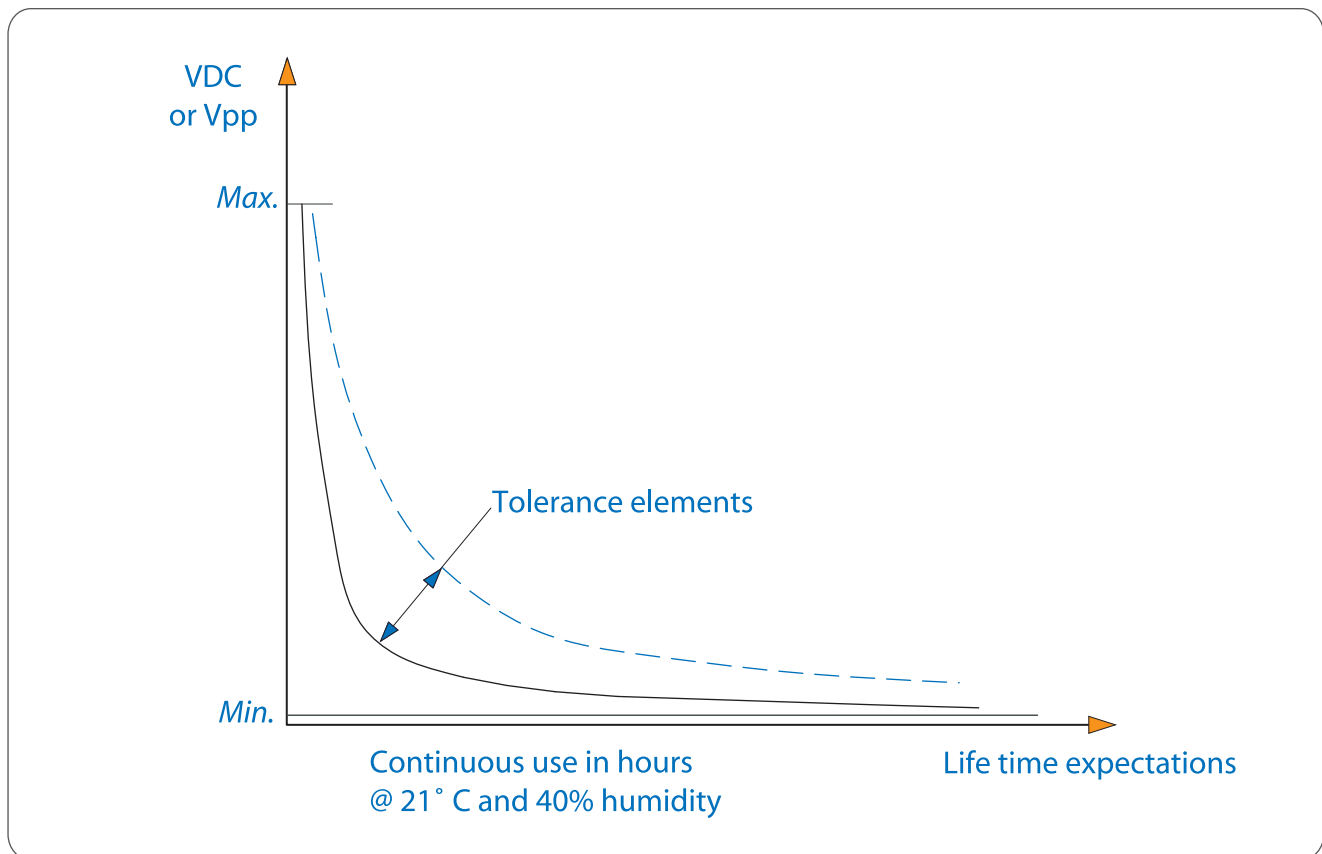
## EXPECTED LIFE TIME

The lifetime of our audible components depends on many different factors and is impossible to determine exactly. We therefore publish the expected minimum lifetime measured under specific circumstances and environmental conditions.

If customers need lifetime expectations under other circumstances, we request them to ask for our instructions before performing their own lifetime tests in order to save time and exclude wrong conclusions.

Claims will only be examined and taken into account on condition that guidelines and instructions below have been strictly applied.

### Working voltage or drive signal versus expected life time:



The relationship between working voltage and expected life time is one of the prime factors on which life time depends. The curve follows an asymptotic function, strongly depending on tolerance elements published by the suppliers of several basic materials and working environmental conditions.

*The expected life time of our different series is defined as follows:*

- **T ambient: 21 °C; humidity: 40%; free air**
- **Voltage : see below**
- **Mounted as described in our catalogue**

#### **Standard series:**

- mounted on panel
- working @ 12 Vdc in continuous use
- life expectations: min. 2000 hours
- The SXLC515C, SXLI515C1, SXLW515C and SXLP515C series have a minimum life time of 9 hours

#### **SMA series:**

- mounted on PCB
- working @ 12 Vdc in continuous use; L-version working @ 6 Vdc
- life expectations: min. 100 hours
- The SMA-21LV (PIN/SMD) working @ 3 Vdc in continuous use: min. 24 hours
- All tests are made @ 20°C

#### **SMAT series**

- mounted on PCB
- working @12 Vpp in continuous use at resonance frequency, tested on maximum sound pressure (eg. SMAT-21 @ 3.75 kHz).
- life expectations: min. 1000 hours

#### **SMAC series**

- mounted on PCB
- working @12 Vdc in continuous use.
- life expectations: min. 1000 hours

#### **Remarks:**

- Please contact our customer service for information and our recommendations before making life time tests at voltages exceeding the above-mentioned levels per series.
- Sonitron reserve the right to make modifications without pre-announcement to their materials, raw materials, specifications, configurations and prices.
- Applications in this catalogue are indicative and it is the responsibility of the customer to make the necessary tests with our products in order to meet the required specifications.
- If you need further information concerning product selection, performances, life time expectations and environmental situations, please contact us.
- The use of Sonitron products, as critical components in life support systems, is not authorised without the explicit written approval by Sonitron.
- If our Products are used as a critical component (final alarms in life support system), we recommend a model especially adapted to the customers' special test requirements.

## SOLDERING INSTRUCTIONS

**WARNING !!!**

### **IMPORTANT REMARK:**

Our products are heat sensitive products. By overheating the air inside the buzzer, silver migration can occur and solder points can be destroyed.

Depolarisation of the membrane might occur if the internal buzzer temperature exceeds 210 °C. To avoid damage to our products, the following instructions and recommendations for maximum time and temperature must be respected during soldering:

### Wave Soldering.

Typical settings:

Preheat temperature: 100 °C

Solder bath temperature 250 (lead)/265 °C (lead-free alloy).

Wave soldering cycle time: 4 sec. (single wave), 6 sec. (dual wave).

Typical settings: Figure 1.

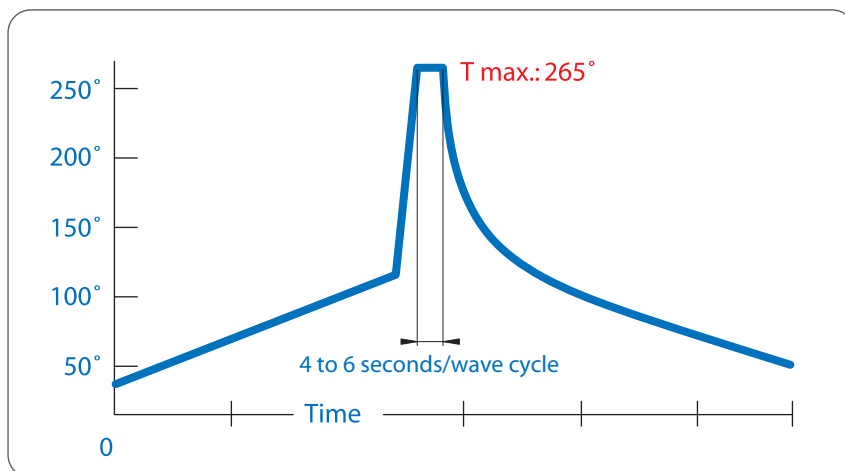


Figure 1.

### Vapor Phase Soldering

Sonitron products are not suitable to be used in a vapour phase soldering process

### Manual Soldering (soldering by hand)

Typical equipment settings:

-270/350 °C (lead(pb) alloys, e.g. Sn60Pb40). 50w Soldering Iron.

-285/380 °C (Lead-free alloys) e.g., SAC305, or 96SC). 80w Soldering Iron.

Note: Temperatures may vary depending on the equipment used.

### Reflow Soldering.

Sonitron SMD buzzers can be used in a Low Temperature surface mount soldering environment with peak reflow soldering conditions below 210°C.

A typical reflow soldering profile is displayed in figure A1.

Note: Settings may vary depending on machine type and materials used.

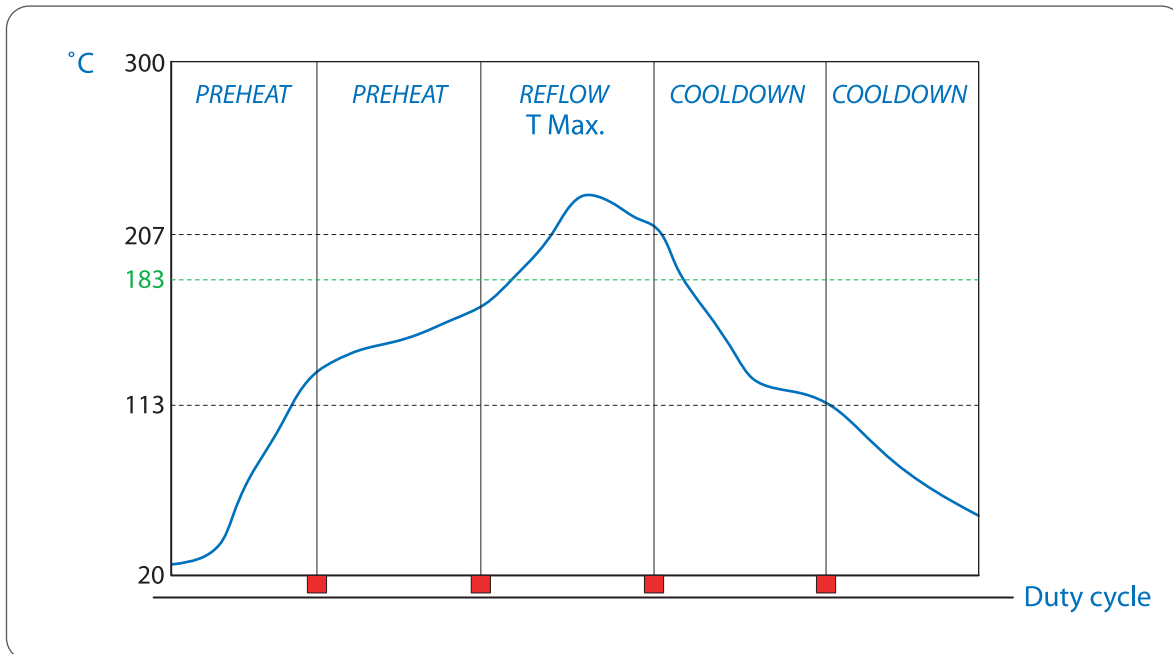


Figure A1

### Infrared soldering method:

Maximum temperature of 175°C during 4 minutes or maximum temperature of **210°C during 30 seconds** may not be exceeded.

### Remark:

1. All our speaker models can be provided with through hole terminals or flat SMD terminals. The SMD models cannot be soldered in a lead-free soldering process. These components must be soldered manually.
2. Buzzers with through hole terminals can only withstand high temperatures (up to 200 °C environmental temperature) when provided with a heat resistant PPS housing. This has to be explicitly mentioned on the order form.

**Lead free solder types:**

Wave Soldering: Typical: SAC305 alloy, SN100C

Reflow Soldering: Typical : Alpha CVP-520 (Low Melting Point No-Clean solder paste),  
or equivalent

Manual Soldering: Most standard lead-free solder wires are suitable.

**Terminal material:**

Tinned brass for both pin terminals and SMD terminals.

**Recommended solder, and solderpaste suppliers:**

Agmet Ltd/ESL-Europe U.K  
[www.electroscience.com](http://www.electroscience.com)

Balver Zinn Josef Jost GmbH  
Germany  
[www.balverzinn.com](http://www.balverzinn.com)

Indium Corporation of Europe  
U.K.  
[www.indium.com](http://www.indium.com)

Cobar Europe.  
[www.cobar.com](http://www.cobar.com)

Cookson Electronics  
[www.cooksonelectronics.com](http://www.cooksonelectronics.com)

Kester lead-free  
[www.kester.com](http://www.kester.com)

Felder lottechnik  
[www.felder.de](http://www.felder.de)

Henkel Technologies  
[www.loctite-europe.com](http://www.loctite-europe.com)

Koki company ltd  
[www.ko-ki.co.jp](http://www.ko-ki.co.jp)

**Useful links:**

[www.leadfree.org](http://www.leadfree.org)

## RMA WARRANTY AND CRITICAL COMPONENTS

### HEAT PROTECTION LABEL AND WASH TAB (SMA series)

A heat protection label in capton material is glued on the SMD model of the SMA buzzer. This enables the user to pick up the buzzer by vacuum.

The heat shield label remains on the buzzer during the reflow solder and must be removed after soldering. These heat protection labels are standard for each SMD buzzer automatically.

If a wash tab model is ordered, the wash tab is glued on the buzzer to protect it from water penetrating into the hole of the cavity. The PCB at the back is also sealed with a silicon film. For ordering these parts, please add Washtab to the model number (see product codification and summary).

### CLEANING

At 21°C, the housing of our buzzers, transducers and speakers is not corroded or affected by oils, fuels, greases, most organic solvents or cleaning agents.

### WARRANTY AND DELIVERY CONDITIONS

Our products are warranted during one year after date of shipment.

In case products are returned for quality control, the products must be sent to the factory with the following information:

- ° Samples of the defective pieces
- ° Name & address of the customer
- ° Application description
- ° Invoice-number
- ° Copy of the inspection sheet delivered in box
- ° Copy of the written complaint from the customer

and accompanied by our QD1 document, which will be sent to you immediately after registration of your complaint. This document should be duly completed, so that we have sufficient details about the problem in order to deal with the matter swiftly.

The products must be used according to the working instructions and conditions specified in this catalogue. Return shipments will only be accepted for quality control, if the products have not been physically changed, damaged or opened. They will only be accepted if all the required information is available.

### CRITICAL COMPONENTS (important note)

We consider critical components these having a final acoustic warning signal in dangerous applications such as: life support systems and equipment used to warn for life danger such as: portable gas detectors, medical monitoring equipment, aircraft cockpit alarm's, car breaking alarm's etc... Components used as an acoustical function in order to indicate continuous supervision of a control function being an audible warning of immediate danger of changes in situations or conditions of environment as life danger or critical function.

In all above described functions, applications and use we recommend our Standard-series and Smac-series. All other models or series can only be used after written approval of the Sonitron application support department or management with test recommendations after receipt of the described application in detail by the customer.

## IP-RATINGS

The IP rating system provides a means of classifying the degrees of protection from dust, water and impact for electrical equipment and enclosures. The system is recognised in most European countries.

The degrees of protection are most commonly expressed as 'IP' followed by two numbers, where the numbers define the degree of protection. The first digit indicates the extent to which the equipment is protected against particles, or to which persons are protected from enclosed hazards. The second digit indicates the extent of protection against water.

DIGIT	FIRST NUMBER-SOLID	SECOND NUMBER-LIQUID
0	Not protected	Not protected
1	Protected against solid objects over 50mm, e.g. Accidental touch by hand	Protected against vertically falling drops of water
2	Protected against solid objects over 12mm diameter, not exceeding 80mm long, e.g. fingers	Protected against direct sprays of water up to 15° from the vertical
3	Protected against solid objects over 2.5mm, e.g. tools and wires	Protected against sprayed water up to 60° from the vertical
4	Protects against solid objects over 1.0mm, e.g. small wires	Protected when sprayed from any direction - limited ingress allowed
5	Protected against dust, limited ingress (no harmful deposit)	Protected against low pressure jets, from all directions - limited ingress allowed
6	Dust tight. Totally protected against dust	Protected against strong jets of water with limited ingress allowed
7	n/a	Protected against temporary immersion between 15cm and 1m for up to 30 minutes
8	n/a	Protected against long periods of immersion under pressure



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