ActiveGard™

An Introduction to a Unique Safeguard Technology for Headset Users

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Sennheiser Communications A/S
6 Langager, 2680 Solrød Strand, Denmark
Phone: +45 56180000, Fax: +45 56180099
www.sennheisercommunications.com

What is ActiveGard™ ?

ActiveGard™ is a unique sound compression system consisting of sophisticated electrical circuits which is incorporated into telephone headsets manufactured by Sennheiser Communications. The patented system utilizes compression technologies to remove the energy from an excessive incoming signal transmitted through the telephone system and leaves the signal free of distortion.

Who will benefit from ActiveGard™ ?

ActiveGard™ is developed in order to serve as a protective function that any user of a Sennheiser Communications telephone headset will benefit from. The system is, however, of particular interest to contact centre agents, since it is common practice in contact centres to wear a headset continuously for many hours at a time while answering a large number of calls from different sources. Another reason for contact centre agents belonging to a particular risk group is the simple fact that in order to benefit from the many advantages of a headset and having both hands free while working, the headset is worn by means of a headband, an ear-clip or otherwise. When a normal handset of a telephone is held to the ear and a sudden loud noise occurs, a natural reflex will enable the user to move the handset instantly away from the ear and avoid a full exposure to the sound.
For a contact centre agent wearing a headset it is impossible to remove the headset fast enough to avoid the impact of an unexpected intense sound. If the agent furthermore has increased the incoming volume because of the often noisy surroundings in a contact centre the danger is obviously even higher.

What are the sources of these sudden high noise levels?

It is not always possible to define the exact source of a sudden high noise level transmitted through the telephone system. There are nevertheless countless examples, such as: technical malfunctions within the telephone terminal equipment, feedback oscillation howling, modem signals, alarms going off at the other end of the line, misdirected faxes causing a howling tone and many others. These high-level sounds transmitted are in general often described as *acoustic bursts.*

How serious is the problem?

Sudden unexpected noise levels in telephone systems are a growing cause for concern in the contact centre industry world-wide and are today regarded as a highly serious occupational hazard for contact centre agents.

What are the dangers?

Acoustic Shock

An acoustic shock can be described as a temporary or permanent disturbance of the functioning of the hearing by a sudden high-level acoustic burst.
In severe cases reported, contact centre agents have been suffering injuries such as noise induced hearing loss or tinnitus as a result of being exposed to an acoustic shock.
A large number of cases involving contact centre agents experiencing an acoustic shock have been documented since the 1970's.

Which acoustic limiting functions are currently used for headsets?

Many telephone headsets currently available on the market do in fact feature some kind of acoustic limiting function.
This is mainly due to the fact that local legislation in a number of countries dictates a maximum acoustic limit for headsets.

The limiting function is traditionally achieved by using simple diode- or transistor circuits, which enable a peak-clipping function when the headset drive signal reaches a certain voltage. The circuits have been described as a “last line of defence” and as such offer a certain degree of protection for the headset user.

The circuits do, however, at the same time imply some very important disadvantages:

1. The signal is *clipped* diametrically opposed to a *controlled compression*
2. The presence of severe, increasing, and extremely uncomfortable *distortion* during clipping of the signal
3. Most of the *energy in the signal is not removed*
4. As a result, they allow a *very high sound level* to be transmitted via the headset speakers

What distinguishes ActiveGard™ from the traditional limitation methods?

Until the introduction of ActiveGard™ by Sennheiser Communications it has not been possible to incorporate advanced and active signal processing into telephone headsets which obviously do not feature any external power source.

The ActiveGard™ can be compared to an automatic and extremely fast-working “intelligent“ volume control.

If an incoming signal rises to a level which can be harmful to the hearing, it is instantly “turned down” to a considerably lower level. When the sound level returns to normal again, the volume will be “turned back” to the original level after a short period of time as the ActiveGard™ returns to its stand-by surveillance mode.

The significant advantages of the ActiveGard™ are:

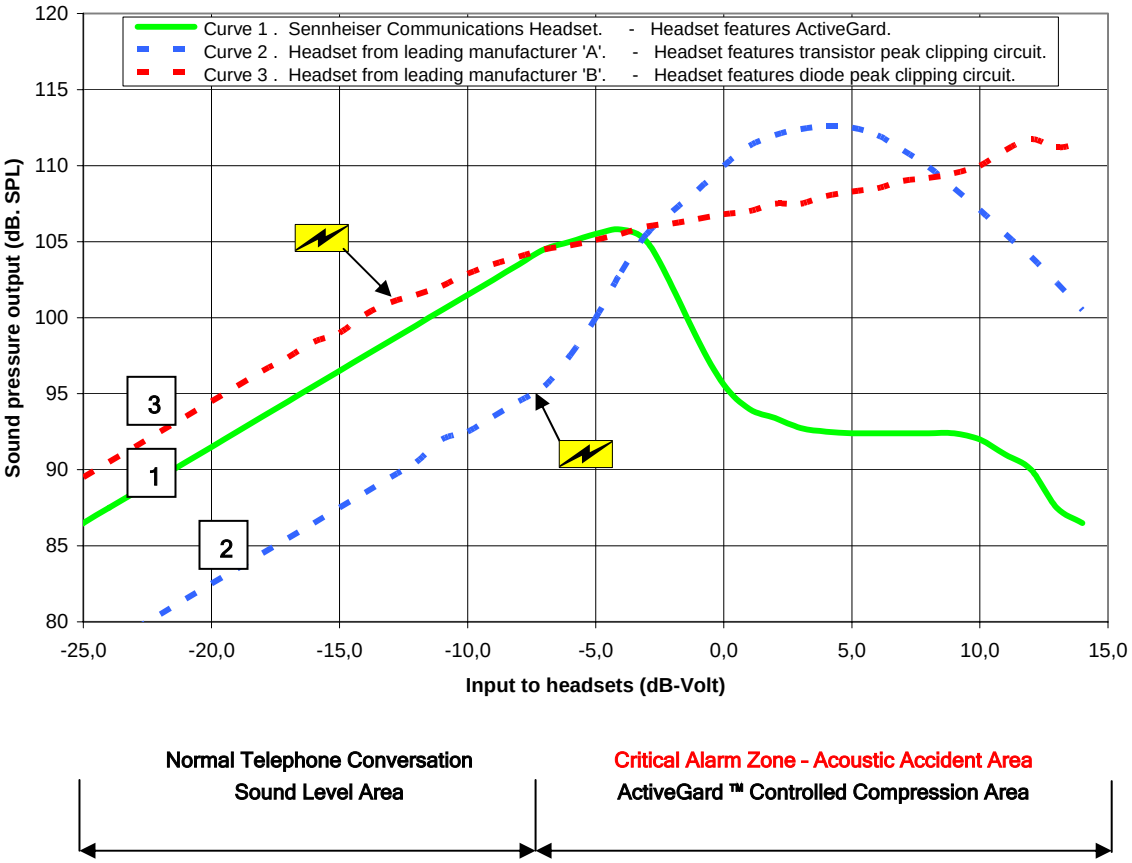
1. The incoming signal is *compressed in one single controlled operation*

   The ActiveGard™ is an *active system* which detects an excessive incoming signal and reacts by initiating a compression process that sets in instantly. The ActiveGard™ reacts in just a few milliseconds, which is much faster than can even be recognized by the human ear
2. Due to the compression method there is virtually *no distortion* of the signal present
3. In contradiction to peak-clipping circuits, the ActiveGard™ *removes the dangerous energy* from the signal by means of the compression technique
4. The *more powerful the incoming signal is*, the more the system *compresses the signal*
5. In contrast to peak-clipping circuits, the ActiveGard™ will *keep the volume at a comfortable level,* even if the incoming signal is an acoustic burst well in excess of the limit which is generally considered to be harmful to the hearing
6. The system does not require any power as it is *driven solely by energy from the incoming signal*

Testing:

Sennheiser Communications has tested various headsets for their sound limiting capabilities.
The example described in the following section shows the Sennheiser Communications headset Type SH330 compared with top range headsets from two of the traditionally leading manufacturers in the field of telephone headsets.

Fig. 1 Headset Speaker Sound Pressure.



= Clipping . Distortion Starting Point

Explanation of the graph Fig. 1:

The horizontal axis shows the level of the signal (voltage) sent to the loudspeaker of the headset *(signal input)*

The vertical axis shows the sound pressure coming out of the headset loudspeaker *(signal output)*

Note: The horizontal axis is logarithmic. -20,0 = 0,1 volt, 0,0 = 1 volt, 20,0=10 volt. The total span represents a 300 times increase of signal input.

The resulting data are illustrated by three curves:

Curve 1 (green curve) : Sennheiser Communications headset, in this case type SH 330, featuring ActiveGard™

Curve 2 (blue curve) : Headset from leading manufacturer ´A´ featuring “transistor type” peak-clipping circuit

Curve 3 (red curve) : Headset from leading manufacturer ´B´ featuring “diode type” peak-clipping circuit

Results:

Curve 1 (green curve)

Curve 1 shows that the headset speaker has a totally straight *linear output* up to around 105 dB Sound Pressure Level (SPL).

This is very important in order to achieve optimal dynamic range at all sound levels.
An optimized dynamic range ensures the best possible speech intelligibility and perceived dynamics of the voice.

When the sound pressure increases above 105 dB, the ActiveGard™ instantly activates and compresses the sound level from the headset speaker down to a much lower and comfortable level of around 92 dB SPL.

Curve 2 (blue curve)

Curve 2 shows that the clipping of the signal already begins to set in at around 95 dB SPL.

The clipping of the signal leads to severe distortion already at around 95 dB SPL and the distortion continues to increase as the input signal increases.

The maximum sound pressure reaches a value of around 112 dB SPL. The curve shows that at this sound pressure and at an input signal as high as +5 dB Volt to the headset, the peak-clipping effect is maximized.

Curve 3 (red curve)

Curve 3 shows that the clipping of the signal begins to set in at around 102 dB SPL.

The clipping of the signal leads to severe distortion at around 102 dB SPL and the distortion continues to increase as the input signal increases.

The sound pressure from the headset, however, continues to increase with increased input signal, just at a flatter rate, and shows a value of around 112 dB SPL at a +14 dB Volt input level to the headset.

Distortion:

Distortion could simplified be defined as being anything in the output signal which differs from, or is not excisting, in the input signal. Peak clipping of a signal will inevitably cause severe distortion.
The ear is particularly sensitive to distorted signals. High-level sounds can by their nature of course be harmful for the hearing; but even regardless of the sound level, it can be extremely uncomfortable to be exposed to a distorted signal and it will also often be percieved as being much louder than a “clean” signal.

The total harmonic distortion (THD) measured at +6 dBV for the Sennheiser Communications Headset is *less than 1 %.*

The total harmonic distortion (THD) measured at +6 dBV for the headset of Manufacturer ‘A’ and ‘B’ is *99,85 % and 37,87 % respectively.*

Total Harmonic Distortion (THD)					
Headset Manufacturer		Measured Sound Pressure at -14 dB Volt (=200 mVolt)	Measured Sound Pressure at +6 dB Volt (=2000 mVolt)	Measured Distortion % at +6 dB Volt (=2000 mVolt)	
		dB SPL	dB SPL	**THD**	
Sennheiser Communications		97,5	92,5	**0,901**	**%**
Manufacturer ‘A’		88,5	112	**99,85**	**%**
Manufacturer ‘B’		100,2	108,5	**37,87**	**%**

Introduction to Sound Recordings:

The sound recordings in the following are meant to further illustrate how effective the ActiveGard™ actually is in comparison to peak-clipping circuits.

All three sound files are calls to an answering machine using a Beocom 2000 HST telephone.
Recording was done via the Brüel & Kjær Type 4158 Head & Torso Artificial Ear which provides a realistic reproduction of the actual acoustic properties.

The normal listening level for the dialling tone at the beginning of the calls is -14 dBV (= 0,2 Volt) (430 Hz Sinus) and the shock signal is a mixed-in signal at a level of +6 dBV (= 2,0 Volt) (1000 Hz Sinus).

The shock signal is 20 dB (equals 10 times) more powerful than the normal listening level.

Description of Sound File 1 . Manufacturer ´A´ . Curve 2 (blue curve) & Sound File 2 . Manufacturer ´B´ . Curve 3 (red curve):

The sound sequences of the two headsets are very alike even though some difference between the sounds heard when the shock signal sets in can be determined.
First a dialling tone followed by dial-up tones is heard. Then the connection to the answering machine is established and the recorded message is played.
After about twenty seconds, a very powerful shock signal occurs.
It applies to both headsets that the sound level of the shock-signal is considerably higher than the spoken signal and that the sound transmitted suddenly gets extremely uncomfortable to listen to.
This is not only caused by the high level of the signal; it is also due to the fact that the shock signal is unclean because of the distortion taking place. (It can furthermore be determined that the recorded message can not be heard).

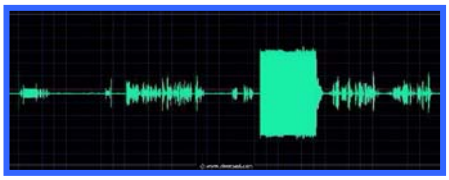
Description of Sound File 3 . Sennheiser Communications SH 330 Headset with ActiveGard™ . Curve 1 (green curve):

Also in this case, first the dialling tone followed by dial-up tones is heard. Then the connection to the answering machine is established and the recorded message is played. After about twenty seconds, an identical powerful shock signal sets in. However, in the case of the Sennheiser Communications headset, the ActiveGard™ reacts instantly by compressing the level of the shock signal to an acceptable listening level and furthermore provides a very clean signal due to the absence of distortion. It can furthermore be observed that it is still possible to hear and understand the weak signal of the recorded message in the background although it is reduced with the same factor size as the shock signal.

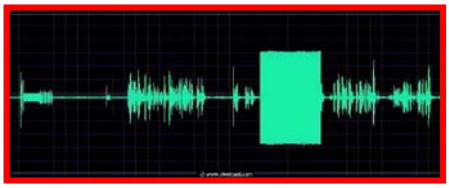
Sound Recordings:

Important: Do under no circumstances listen to Sound File 1 and Sound File 2 while wearing a headset or through any other source held closely to the ear !

(Click inside squares for audio. Note: You may need to download the Apple QuickTime Player or equivalent to play files. The QuickTime Player can be downloaded from the site linked to by right-clicking here and selecting “Open Weblink in Browser”).



⇦ **Sound File 1 . Manufacturer ´A´ . Curve 2 (blue curve)**



⇦ **Sound File 2 . Manufacturer ´B´ . Curve 3 (red curve)**

⇦ **Sound File 3 . Sennheiser Communications SH 330 Headset with ActiveGard™ . Curve 1 (green curve)**

Conclusion:

Sennheiser Communications headsets featuring ActiveGard™ offer, to the best of our knowledge, the optimal protection against the effects of being subjected to an acoustic burst while using a headset.

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Measurement results illustrated in this paper have been verified by testing carried out by the independent telecommunications test institute:

Nemko Comlab AS.

Test report no. 03/566/3.

Comlab is granted accreditation by Norwegian Accreditation under the registration TEST 031.

www.comlab.no

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Disclaimer of Warranty - Limitation of Liability

Although Sennheiser Communications has used and will use its best efforts to ensure that you are protected against the effects of acoustic bursts while using one of our headsets nothing in this information material shall be regarded as a guarantee or representation. Should you be exposed to acoustic bursts, Sennheiser Communications shall not be liable for any loss or injuries.

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