TANDBERG White Paper on use of Stethoscopes

Using a Medical Stethoscope in TANDBERG Videoconference

System Description:

Stethoscopes are used by every level of healthcare practitioner for the assessment of patient conditions, Generally speaking clinicians will listen for cardiac (heart), respiratory (lung), and gastric (digestive system) sounds.

Traditional stethoscopes are nothing more than hollow tubes (air chambers) that transfer sounds from the chestpiece (touching the patient) to the earpieces (stainless steel tubes inserted into ear canal).

Present day electronic stethoscopes are designed as similar looking devices but are in fact substantially different products. Built into, or sometimes connected just upstream, of the chestpiece is a small low frequency microphone. This pickup device, while specifically designed for low frequency sensitivity, is electronically, simply a room-based microphone. This microphone picks up patient sounds and passes those sounds (electronically) to an amplification circuit (sometimes an external box or built into a one piece stethoscope design), that amplified signal is then presented to a low frequency speaker mounted just before the earpiece(s) for presentation to the clinician. Electronic Stethoscopes designed for Telemedicine have a hardwire output connection (line level) that can be connected as an audio input (Aux. in) to our codec(s) (880,2500,6000).

This audio signal is passed through the videoconferencing systems audio channel (within G.722 + G.728 standards) and can be presented on the “receive side” by using a set of high quality headphones (headphones amplifier will be required). Another option would be to connect this audio out signal to a “receive side” stethoscope to allow the specialist frequency attenuation through a graphic equalizer built into the stethoscope box.

Traditional system configurations for electronic stethoscopes have required an external Analog to Digital converter to transmit the high fidelity/low frequency sounds required by the specialist. This A to D converter will convert the analog sounds from the stethoscope into a digital data stream (typically RS232/ 19.2-38.4KBS) for connection to the vtc data ports. Historically this has been required to overcome some videoconferencing designs that limit quality and fidelity in this environment. The limitations referenced include the ability to pass the low frequency required to insure recognition of abnormal pathology (most VTC audio channels introduce substantial filtration below 50Hz), it is the belief of most cardiologists that they need to resolve down to 20Hz for an accurate assessment. The second (and substantial) limitation is in the audio channel itself, most systems will utilize one audio channel and mix all

audio inputs into that channel, this signal is then sent through echo cancellation and AGC circuitry, both having adverse effects on stethoscope fidelity. This method often introduces tremendous "white" or background noise as the chestpiece is highly amplified (as are the room based mics) to hear these subtle cardiac and respiratory sounds. Additionally these room based mics introduce background sounds (voices and ringing telephones) rendering this method difficult to use (at best) with a considerable amount of background noise.

The Tandberg 6000 codec has some substantial advantages when these products are requested/required.

The ability to pass frequencies required is a significant advantage. We have documented that the Tandberg 6000 codec will pass frequencies down to 20Hz with as little as 3dB loss.

The second advantage is in the design of our audio channels, with the Tandberg 880,2500,6000 we have the ability to Mute the room based mics (simply by pressing the mute key on remote). This will silence all room based microphones while still allowing the Aux. input (elec.steth.) to pass high fidelity sounds with minimal "white" background noise.

This allows Tandberg to deal with these products as they were designed (analog microphones) and simply connect them as an Auxiliary audio source. This eliminates all of the issues with RS232 data transmission in both an IP and multipoint setting (data ports are disabled).

WHEW! Congratulations if you've made it to the end of this document with some reasonable understanding.

PLEASE NOTE that the fidelity out of the system is a direct reflection of what quality is put into the system. There are many manufacturers of electronic stethoscopes, please advise the end user to become comfortable with the electronic stethoscope quality/fidelity in a direct patient contact environment before comparing to remote Telemedicine transmissions. Additionally, most all electronic stethoscopes have the ability (through volume control) to overdrive the speakers into a distortion level so it is important to urge the physician to listen with this tool (adjust volume) to the same (low) level as they would hear from a traditional stethoscope for highest quality.

Using a Medical Stethoscope in TANDBERG Videoconference

Case:

Using a medical stethoscope in TANDBERG Videoconferencing systems, by connecting an electronic stethoscope as an input into the near end conferencing unit and receiving the stethoscope output signals at the far end conferencing unit.

These initial tests shows that the stethoscope signal reproduction through the videoconferencing system is complete both in low- and high frequency band (0-8000Hz). It will be necessary to set a proper level on the audio input where the stethoscope is connected, to make sure the acoustic signal is well hearable at the far end conferencing unit, but never to be overloaded.

Test Procedure:

TANDBERG R&D, Audio, has done some measurements based on the setup as showed in the scheme of figure 1. The stethoscope used is a Meditron electronic with external amplifier for external analysis. The stethoscope is connected to the Audio In 4 (ref. TANDBERG 6000) of the near end conferencing unit. On the far end unit codec the signal is brought to a signal analyzer from the Audio Out 1 connector.

Figure 1 â€“ Stethoscope test configuration in TANDBERG video conferencing.

During the test procedure the Audio Leveling (AGC) and echo canceller of near end and far end conferencing units are turned off. More about these settings in the conclusion below.

Test Results:

When stethoscope is tested on a human body to detect the pulse beats (low frequency signals, about 20-200Hz), the two frequency spectra seen in the analyzer (one spectrum produced directly by stethoscope, and one as output from the far end conferencing unit) looks similar in shape. But the signal level from the far end unit is lower than the level directly from stethoscope, when audio settings are default values. To show the ability of signal reproduction the two signal levels made equal in amplitude. The audio input level at the near end unit is therefore increased from default value of +9dB to +16.5dB.

Now the spectrums overlap exactly all the way down to 20Hz (see figure 2 below), there is a complete signal reproduction, and the signal from the far end conferencing unit is similar to what the operator would hear if the stethoscope output were connected right into the audio amplifier of natural audio module. Below frequencies of 20Hz, there is an amplitude and frequency difference in the two spectra, but these low frequencies are difficult for the human ear to picture, besides that most audio speakers can’t handle such low frequencies. So the user at the far end conferencing unit will not be able to hear these low frequencies anyway.

The +16.5dB input level makes sure a well hearable audio signal from the natural audio module, therefore this level is recommended as a setting on near end unit audio input. By not exceeding this input level, there will be no signal overload when using a stethoscope in TANDBERG equipment.

Figure 2 â€“ Stetoscope audio low frequency signal reproduction through TANDBERG video conferencing units.

When stethoscope is used to transmit high frequency signals (by making noise through the stethoscope), the two frequency spectra from stethoscope and far end conferencing unit is completely overlapping (stethoscope output signal in blue color), like showed in figure 3. The far end audio output reproduce the same signal as output from the stethoscope, for higher frequency bands also.

Figure 3 â€“ Stetoscope output signal, and output signal from far end conferencing unit are overlapping.

**Conclusion, this is what the customer should do to use an electronic stethoscope in TANDBERG video conference:**

**By using an electronic stethoscope with TANDBERG Videoconferencing systems, the stethoscope output signals reproduce completely through the system, both in high frequency and in low frequency band (0-8000Hz).**

**To use the Meditron stethoscope and its external amplifier together with TANDBERG Videoconferencing systems, we suggest to set the Audio In 4 (ref. TANDBERG 6000) to +16.5dB on the near end conferencing unit. This level is chosen to make a well hearable acoustic signal at the far end conference unit. To make sure there will be no signal overload at any time, the audio input level should not exceed the +16.5dB level.**

**The Audio Levelling (AGC) must be turned off for MIC 1-3 / Audio In 4 to make best results. The same is true for the echo canceller on Audio In 4, and Audio Levelling on Audio In 4. All these functions should be turned off during the stethoscope session. Also the audio standard G722 is recommended when using a stethoscope in TANDBERG video conferencing.**

**If the user wants better sound reproduction in the lower frequencies than the TANDBERG Natural Audio Module is capable of (less than 60 Hz), an external speaker should be connected.**