APPLICATION NOTES

LINE INTEGRITY MONITORING AND PILOT TONES

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In applications such as voice alarm systems, the integrity of audio signal transmission paths must be constantly monitored to identify faults that could impact the system operation in the event of an emergency. These transmission paths include output loudspeaker lines and circuits, as well as input source connections.

Input Integrity Monitoring

Where input integrity monitoring is necessary, the system should be able to automatically check that an input, be it analogue or digital, is correctly connected to the audio processor/amplifier and does not present any faults. This could be the case, for example, of an alarm message generator or a fire microphone in an emergency evacuation system.

One common way of monitoring the integrity of inputs is by using a high-frequency pilot tone at the source (e.g. 20 kHz), which will then be detected in the amplifier (Figure 1). A pilot tone is a single frequency tone, usually set to a frequency outside of the human audible range.
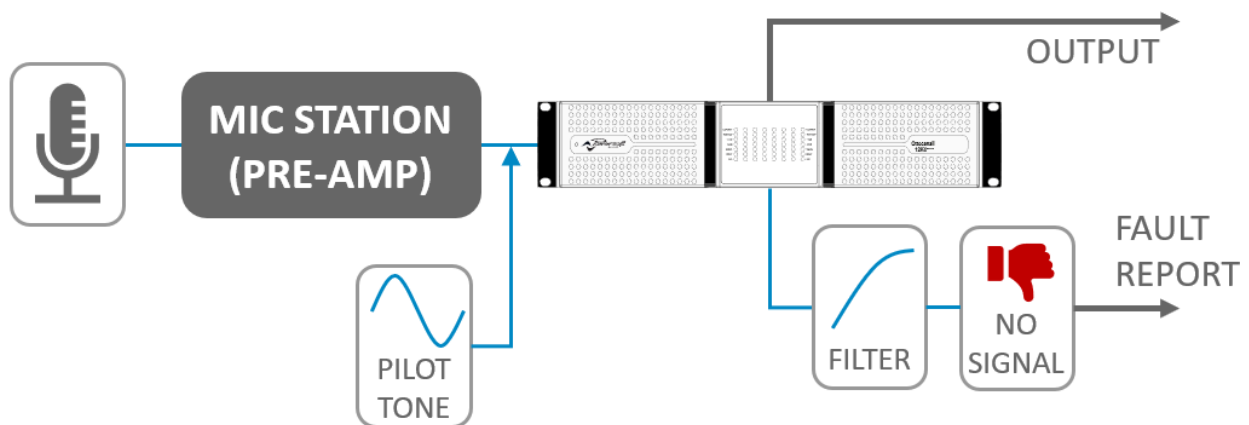

Figure 1 – Example diagram of input monitoring via pilot tone.

In Powersoft amplifiers, input pilot tones can be used for two different purposes:

- Input integrity check and eventual fault notifications.

- Backup Strategy for automatic selection of a backup source when the main one is either disconnected or faulty.

As part of Powersoft amplifiers' internal DSP, each input source channel has a queue with four slots for source selection (Figure 2). Analogue and Dante inputs are available to all source selection queues and can be used in different ones simultaneously. Additionally, Dante patching can be done directly from ArmoníaPlus, including patching with third-party devices found on the network.

The DSP can automatically select an input source based on signal presence or a pilot tone feed. In case of input/source failure, the amplifier will automatically play the next source in the priority queue.

To enable an input Pilot Tone in ArmoníaPlus:

1. Double-click the amplifier in the workspace to access its internal properties.
2. Inside the properties panel, either click on one of the inputs or click the 'Source Selection' icon on the window's left-hand side.
3. Under the 'Source Selection Strategy' in the centre of the screen, select **Pilot Tone** as the 'Backup Mode' (Figure 2).
4. Under 'Source Selection Strategy' it is possible to configure:
   - **TONE Frequency**: the pilot tone frequency between 20 Hz and 22 kHz.
   - **TONE Hi-Threshold**: max input level for the pilot tone to be detected (in dBu).
   - **TONE Lo-Threshold**: minimum input level for the pilot tone to be detected (in dBu).
   - **Trigger GPO**: enables alarm notifications of missing pilot tone inputs via GPO (in amplifiers supporting it).
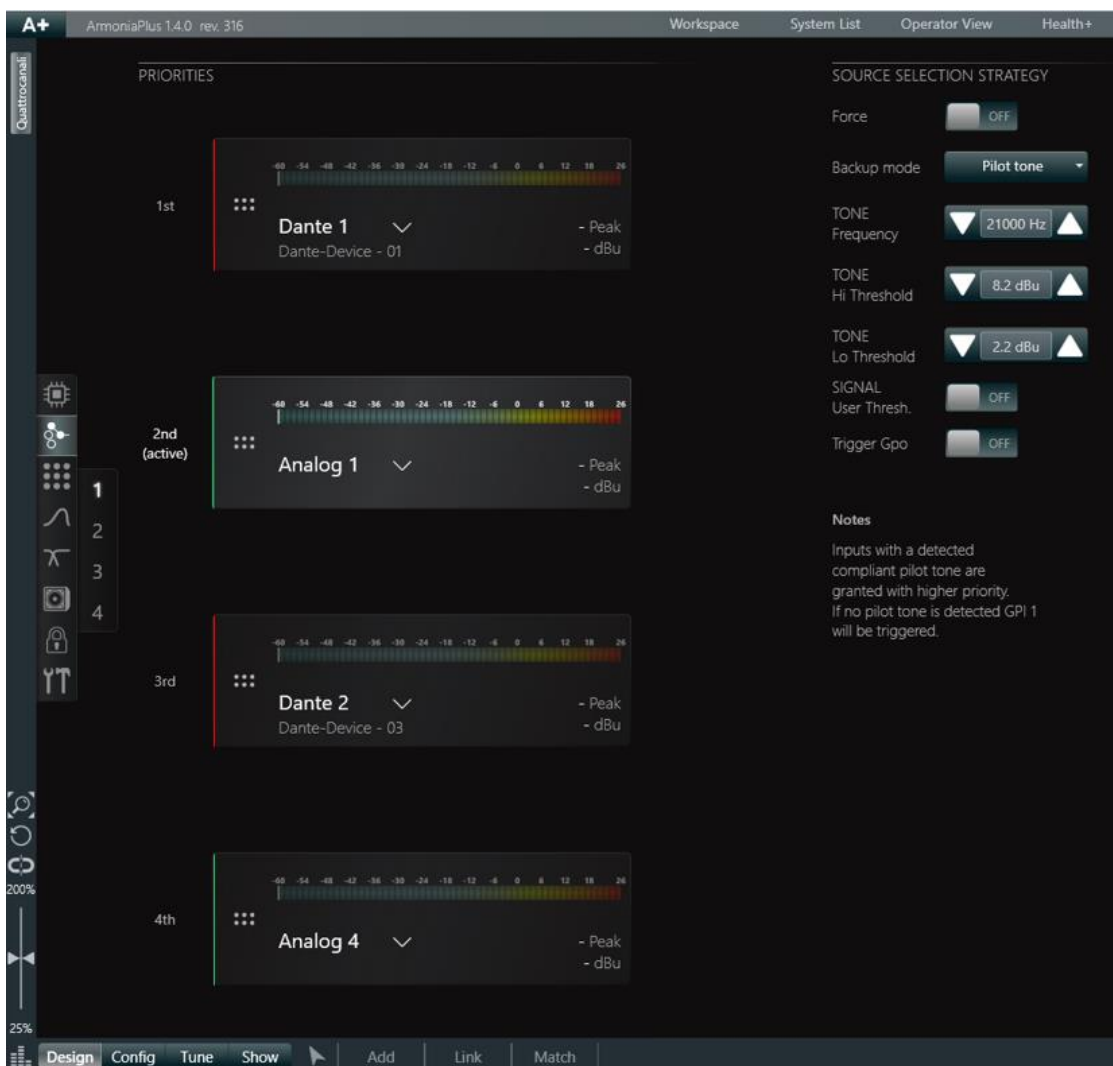

Figure 2 – Source and Priorities Selection page in ArmoníaPlus.

In the example in Figure 2, any input signal containing a pilot tone with a frequency of 21 kHz and a level between 2.2 dBu (approx. 1 V_{RMS}) and 8.2 dBu (approx. 2 V_{RMS}) will be detected. Sources for which a pilot tone has been detected will display a green indicator, as shown in Figure 2. Other input sources without a pilot done, or that contained a pilot tone but have been disconnected or gone into a fault state, will display a red indicator.

Additionally, it can also be seen in Figure 2 that the highest source in the priority queue containing the pilot tone, will be automatically selected as the active source.

Every time a missing or faulty input is detected, it will also be highlighted in Health+ as an alarm notification and is also available in Powersoft's API for third-party monitoring of amplifiers. This alarm notification can also be sent out via GPO, as detailed in the instructions above. GPO alarms are available in all models from the series Duecanali DSP+D, Quattrocanali DSP+D and Ottocanali DSP+D.

Output Monitoring

Output monitoring is also necessary in applications such as voice alarm evacuation systems. In this case, the system should be able to automatically check if the loudspeakers, or the lines connected to the amplifier, present any faults and are ready to play an alarm message in case of an emergency, for example.

This can be done by measuring the impedance of the connected load either via a pilot tone or another type of audio signal (Figure 3). With this method, if the loudspeaker cable is broken or disconnected from the amplifier, a considerably high impedance value would be measured. Conversely, if an impedance close to zero is measured, it is likely that an output short-circuit has occurred. In both cases, a fault alarm should be triggered and clearly indicated.
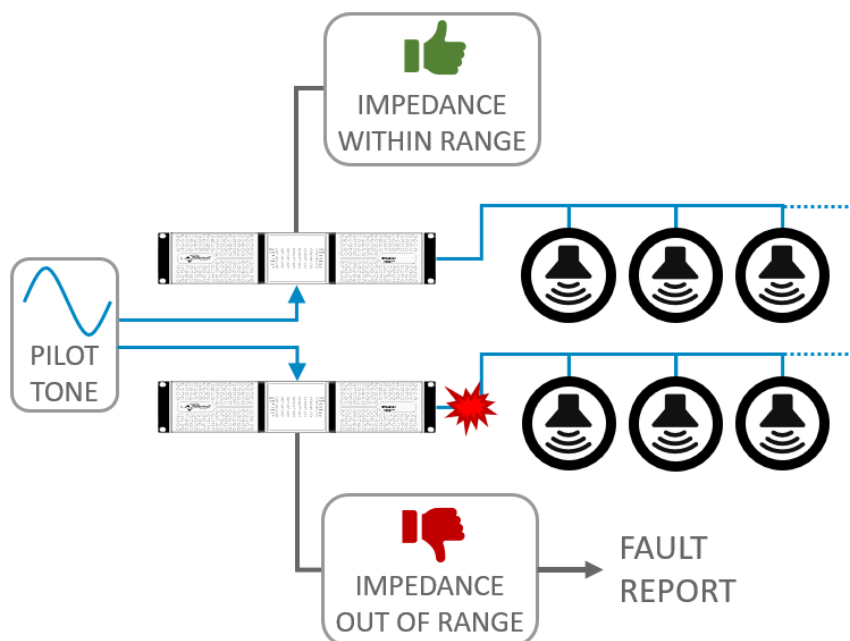

Figure 3 – Example diagram of output impedance monitoring via pilot tone.

With Powersoft amplifiers, it is possible to monitor the integrity of the loudspeaker circuits and lines connected to the outputs and report eventual faults as alarms. This can be done from the 'Diagnostics' page in ArmoníaPlus, in the amplifier's internal configurations.

To access the 'Diagnostics' page in ArmoníaPlus:

1. Double-click the amplifier in the workspace to access its internal properties.
2. Inside the properties panel, either click on one of the 'Ways' outputs or click the 'Ways' icon on the window's left-hand side. 🇽
3. From the page's top bar, select the 'Diagnostic' tab.
4. The diagnostics page should then be displayed (Figure 4), with its different monitoring blocks. Note that the output diagnostics configurations are done individually for each amplifier output channel.
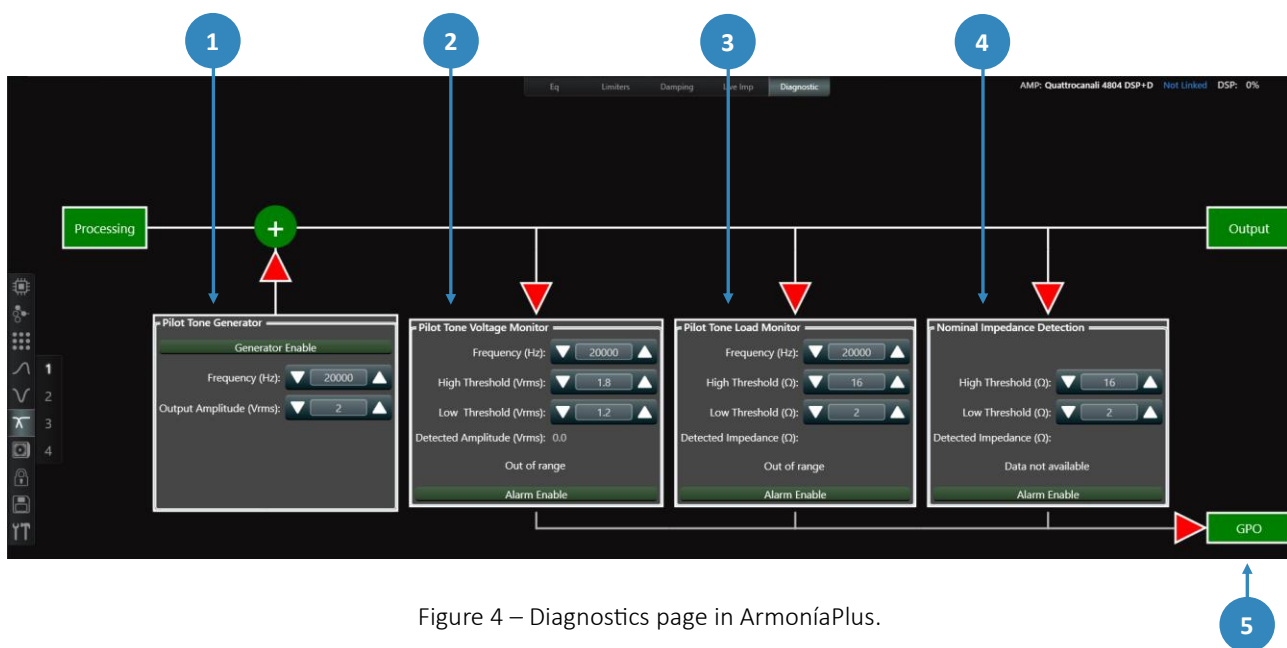

Figure 4 – Diagnostics page in ArmoníaPlus.

1 Pilot Tone Generator – When enabled, it generates and sends a pilot tone, with the defined frequency and signal amplitude, to the channel output. This pilot tone can be used to monitor the impedance of loads connected to the amplifier, so that eventual faults can be identified. It is important to note that the generated pilot tone is sent to the amplifier's output and will be audible if set to a frequency that is within the human hearing range. It is therefore advisable to pay attention to the generator's selected output amplitude, and to set it to low values before enabling the generator.

2 Pilot Tone Voltage Monitor – Allows real-time monitoring of the signal coming from the internal Pilot Tone Generator, or from an external pilot tone[1]. When enabled, it will measure the amplitude of incoming pilot tone signals. If no tone is detected, or if the signal amplitude is outside of the defined high and low threshold limits, an alarm will be triggered (see point 5 below).

3 **Pilot Tone Load Monitor** – Monitors, in real-time, the impedance of any load connected to the channel output, based on internal or external pilot tone signals. When enabled, if the pilot tone is missing, or if the measured impedance is outside of the defined high and low threshold limits, an alarm will be triggered (see point 5 below).

4 **Nominal Impedance Detection** – Measures, in real-time, the nominal impedance of any load connected to the channel, based on any type of output audio signal[1]. When enabled, for example, if music or voice alarm message inputs are sent to the amplifier's output, the nominal impedance of the loudspeaker playing these signals will be measured. If the measured nominal impedance is outside of the high and low threshold limits, an alarm will be triggered (see point 5 below).

5 **GPO and Alarms** – Every time an alarm is triggered by any of the monitoring blocks in the Diagnostics page, this alarm will also be indicated in Health+ and will be available in Powersoft's API for third-party monitoring of amplifiers. It will also be sent out via GPO in amplifiers supporting it. Amplifiers supporting GPO alarms from the Diagnostics page are all models from the series Duecanali DSP+D, Quattrocanali DSP+D and Ottocanali DSP+D.

NOTE:
[1] Diagnostics is an output monitoring tool. External pilot tone signals, and other types of audio signal used for the measurements in the diagnostics block, are always post DSP processing.

Live Impedance Monitoring

Another way of monitoring the integrity of loudspeaker circuits and lines connected to the amplifier outputs is via Powersoft's **Live Impedance** Monitoring, which is available in Duecanali DSP+D, Quattrocanali DSP+D, Ottocanali DSP+D, X Series and T Series.

With Live Impedance monitoring, it is possible to measure, in real-time, the impedance magnitude and phase curves of any load connected to the channel output, based on any type of output audio signal. Additionally, it is possible to store and import existing curves to be used as references.
To access the 'Live Impedance' page in ArmoníaPlus:

1. Double-click the amplifier in the workspace to access its internal properties.
2. Inside the properties panel, either click on one of the 'Ways' outputs or click the 'Ways' icon on the window's left-hand side.
3. From the top bar, select the 'Live Imp' tab to show the Live Impedance page (Figure 5).
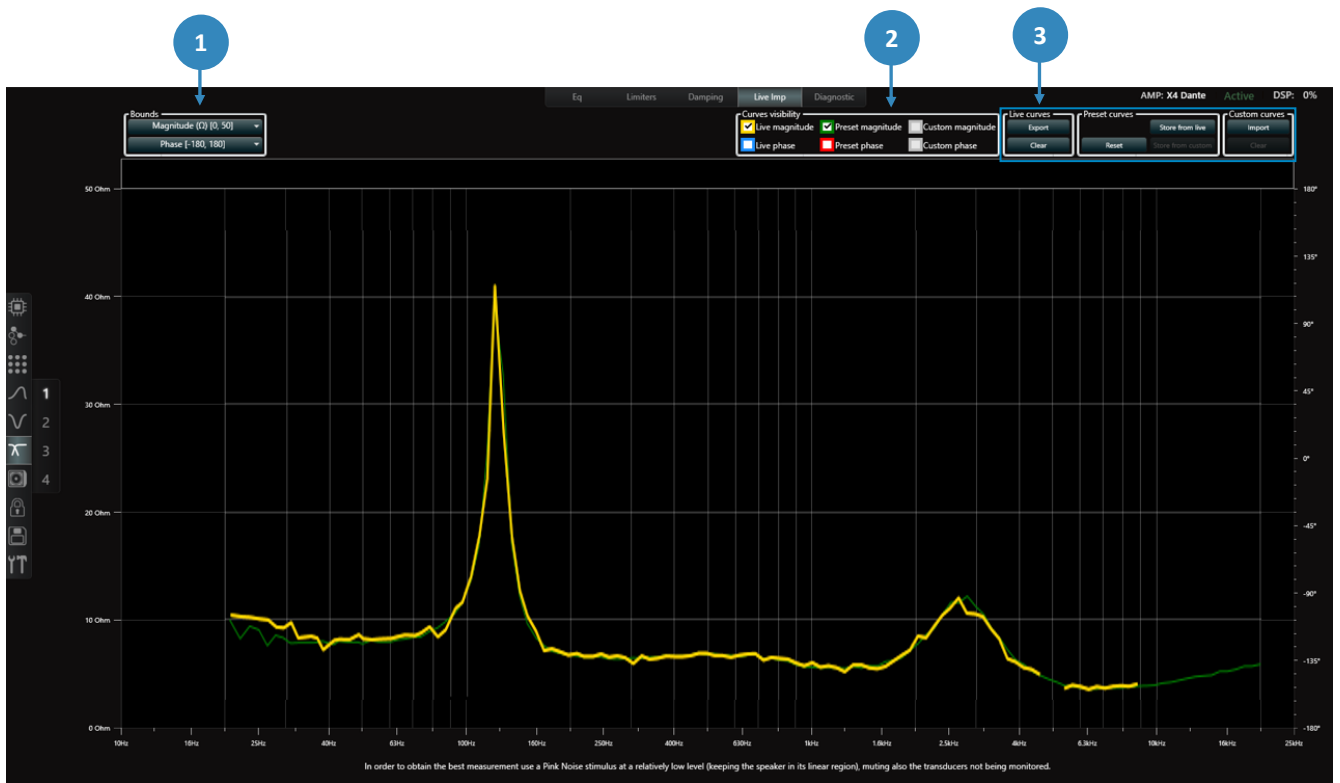
Figure 5 – Live Impedance page in ArmoníaPlus.

1 **Bounds** – For rescaling the magnitude and phase graphs.

2 **Curves Visibility** – Selection of curves to display (Figure 6):
- Live Magnitude and Phase – real-time impedance measurements based on any type of output audio signal.
- Preset Magnitude and Phase – reference curves already saved in the preset loaded to the channel (see point 3 below).
- Custom Magnitude and Phase – user-imported reference curves (see point 3 below).

3 **Additional Curve Options** – for exporting, importing and storing impedance curves (Figure 6):
- Live Curves – export magnitude and phase of real-time curves as a text file.
- Preset Curves – store a reference curve into a preset, from either the live measurement or an imported custom curve.
- Custom Curves – for importing a custom reference curve.

Figure 6 – Live Impedance page in ArmoníaPlus.

Powersoft S.p.A
Via E. Conti, 5- Scandicci (Fi) 50018- Italy
TELEPHONE: +39 055 7350230

General Enquires: info@powersoft.it
Sales: sales@powersoft.it
Application & Technical Support: support.audio@powersoft.it
Service & Maintenance: service@powersoft.it

www.powersoft.com