Guide to commissioning a hearing loop system

AMPETRONIC

Overview

1. This procedure is for checking the performance of an Induction loop system (otherwise known as a hearing loop, T-loop or 'AFILS'). This procedure can be used for both area and counter style loop systems from any manufacturer. You should always read the manufacturer's handbooks in conjunction with this document when testing a system.

Figure 1: Universal Symbol for Hearing Loop Systems

2. The procedure considers how the system is used by the operator. A representative of the client should be present at the time of measurement, and preferably the person who would normally setup / enable the system for use. You will also need access to the induction loop amplifier (Either fixed in the room, within an AV rack, mounted to a desktop counter or a portable unit) to conduct these tests.

3. The loop amplifier must have an indicator which shows when the Automatic Gain Control (AGC) is activated. This indicator may be labelled as 'AGC', 'Compression', 'In' or 'Input' on the amplifier itself.

4. You will need to follow several steps to check the system and write your findings on the Certificate of Test & Conformity which is also available from Ampetronic.

5. For the purposes of this document the reference standard is IEC60118-4:2014, AMD1:2017.

Equipment required

- A field strength meter (Ampetronic FSM or Loopworks R1), or professional audio analyser that reads 0dB at 400mA/m field strength, and headphones to listen to the loop system.
- The appropriate 'Certificate of conformity' to fill in your results (Shown in Fig 2), separate versions are available for counter or area coverage systems.
- An amplifier with built in test tones, or a signal generator / source with adjustable output level capable driving signal into AGC.

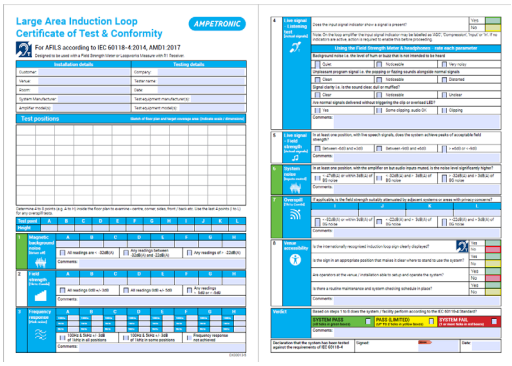


Figure 2: Certificate of conformity-area

- Cable set to connect to the input socket of the induction loop amplifier to be tested. For example:
  - Unbalanced line level input – on 2-pole 3.5mm minijack or twin (stereo) phono/RCA connectors.
  - Balanced line level input – on XLR or 6.3mm (1/4") 3-pole jack connector.
  - Balanced Microphone input - using XLR connector (30dB attenuation).
  - Electret Microphone input - on 3.5mm 2-pole jack connector (30dB attenuation).
  - Bare wires – connection to inputs with screw terminals or phoenix connectors.

Note: Depending on the output range that the signal generator can achieve - cables for lower level inputs such as microphones may require in built attenuation.

Before getting started

- In advance of the commissioning test it should be checked that the loop system is fully working and ready to be setup. If possible, use a multimeter to test the installed loop circuit.

- The circuit should normally have a DC resistance between 0.2Ω and 5Ω, the acceptable range will be specified in the amplifier handbook and the expected resistance may be given on installation design drawings.

- There should be no continuity between the loop circuit and any other circuits, or between the loop and ground.

Turn on the amplifier and make sure it powers on correctly, passing any start-up tests without any errors.
If any faults or errors are seen at this stage, consult the troubleshooting section of the amplifier handbook for further advice

Indicating Test Positions for the System

Before conducting the procedure, it is recommended to establish the positions within the system coverage area to most accurately assess its performance. The recommended positions change depending on the type of system you are looking to test:

Area / Room Scale Type Systems:
Determine 4 to 8 points and positions within the desired coverage to examine, marking them A to H respectively. You may also sketch a floor plan on the test document and indicate dimensions for further accuracy (Fig 3.)

For each position, indicate the height of which you are measuring, normally 1.2m for a seated and 1.7m for standing users. If the space is mixed standing and seating use, you may wish to have pairs of test points in the same position, to check the signal level at the two heights.

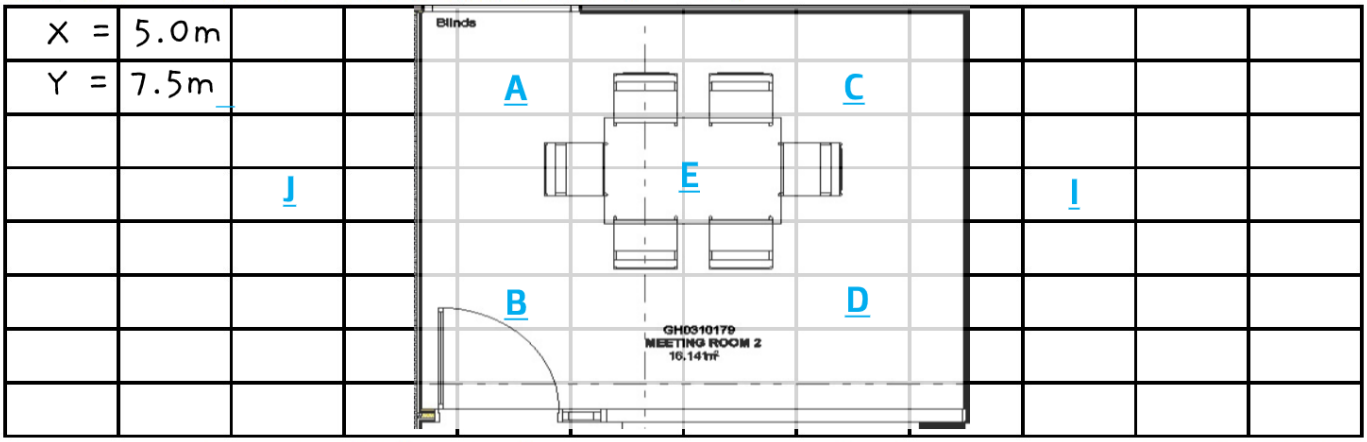
When testing the system's overspill (system signal outside of the coverage area) then you may indicate this using the last four points (I to L).

In larger areas you may wish to record more test positions, for example each seating position within a theatre. In this case these measurements can be documented separately, and a representative selection used in the certificate of conformity.

Counter Loop / Portable Systems:
For counter systems readings should be taken in six positions. Zones A, B and C should be at 1.20m, 1.45m and 1.70m respectively, directly in front of the counter at a point where the user would be expected to stand. Zones D, E and F are positioned horizontally, at 45 degrees from Zones A to C (Fig.4). This allows for some lateral movement by the end user as conversation takes place.

Test positions

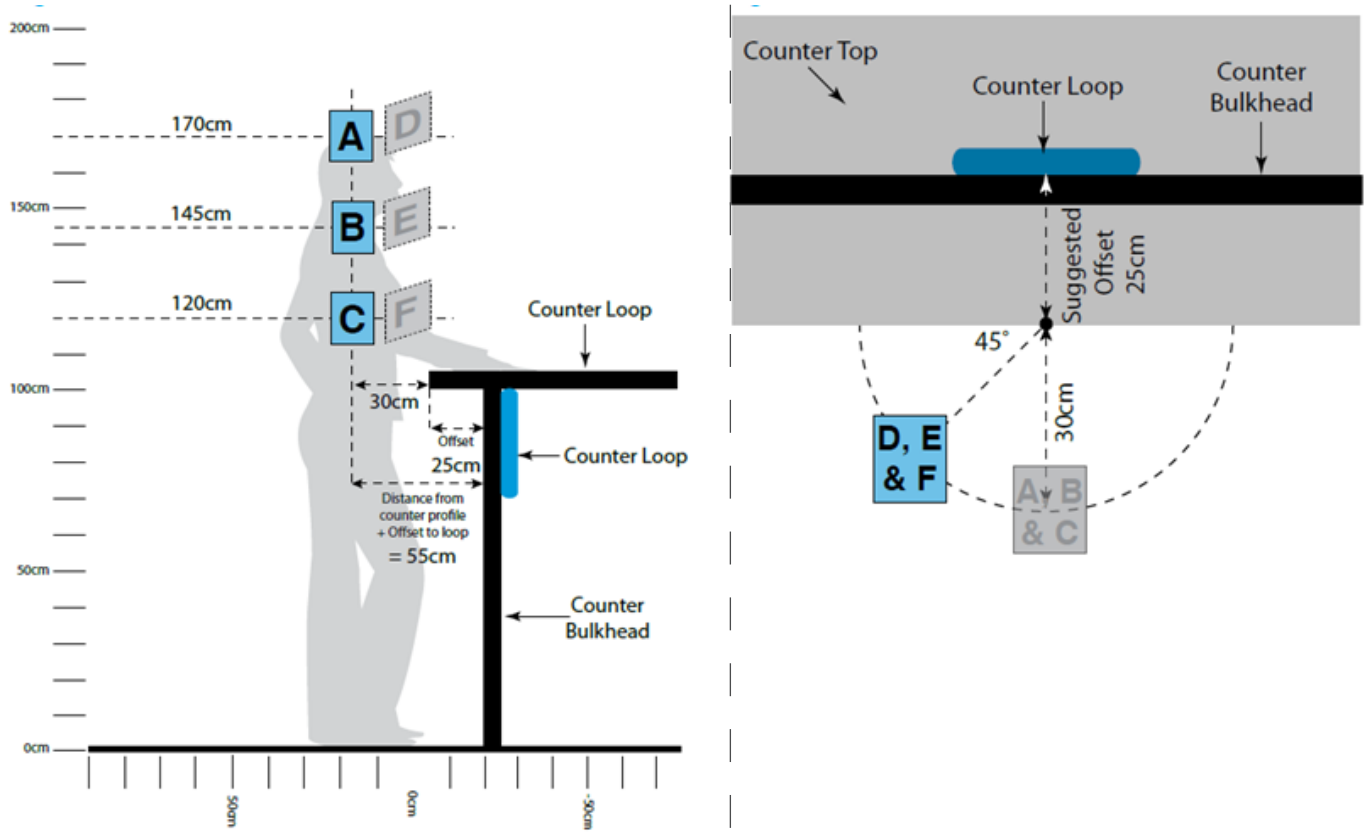
Sketch of floor plan and target coverage area: (indicate scale / dimensions)



Determine 4 to 8 points (e.g. A to H) inside the floor plan to examine - centre, corner, sides, front / back etc. Use the last 4 points (I to L) for any overspill tests.

Test point	A	B	C	D	E	F	G	H	I	J	K	L
Height	1.2	1.2	1.2	1.2	1.2				1.2	1.2		

Figure 3: Example of a completed test position diagram



LEFT - Side View | RIGHT - Top/Plan View

Figure 4: Counter loop test point positions

Test Procedure

- Use the 8 steps in the following procedure to evaluate the system, recording data on the certificate as required.
- When using the field strength meter in Steps 3 to 8, always hold the device vertically at the height determined in the test position section above.
- If using an FSM, the mode should be set between background noise, frequency response and field strength using the middle switch, the test steps are colour coded to match the setting you should use. Using the R1 with Loopworks Measure, simply move between the 3 available meter screens for field strength, frequency response and background noise. See the handbooks for more guidance on using the features of each meter.
- Be sure to adjust the system to achieve the best performance as you go through the procedure before writing down the results. The overall system verdict cannot be better than the result achieved in any step.

Step		Procedure / test	Results	Notes
1	**Magnetic background noise** [Driver off] 	While the system is off, use the meter to take readings of any magnetic Background Noise for each of the test positions and record the results in the respective box. Remember to keep the meter upright to replicate the position of the telecoil within a standing user's hearing aid. An A-Weighting filter is built into the FSM and Loopworks Measure background noise modes, however other meters may require this to be enabled. If present, make notes describing the type of noise heard (e.g. low frequency hum, buzzing)	**All readings are below -32dB:** Rated as a PASS as the noise level will not impact intelligibility of a well setup system. **Any readings between -32dB(A) and -22dB(A):** These may affect both users of the system and the audio quality, this is classified as a QUALIFIED PASS. **Any readings above -22dB(A):** Background noise will be significant, affecting intelligibility and constitutes a FAIL.	High noise levels can interfere with the use of the system. If levels above -32dB are recorded in a significant proportion of the listening area, then the noise should be investigated and marked on a coverage map. Magnetic background noise is often caused by electrical wiring or equipment, it may be possible to identify and correct the cause.

1	**Magnetic background noise** [Driver off] 	A	B	C	D	E	F	G	H
		All readings are < -32dB(A)			Any readings between -32dB(A) and -22dB(A)			Any readings of > -22dB(A)	
		Comments:							

Preparing for Field Strength / Frequency Response Tests

1. Disconnect any existing audio inputs from the loop amplifier, being careful to note how they should be reconnected.

2. Turn the amplifier on and either enable the built-in test signals or setup the external signal source. This should be plugged in to a suitable input and set at a level where at least one LED is illuminated on the AGC meter (this may also be labelled “COMPRESSION”, “SIGNAL INPUT” or “IN”).

System testing signals (1kHz Combi / Pink Noise) can be downloaded via the Ampetronic website at www.ampetronic.co/signals. Ensure that you follow the manufacturer's instructions for your chosen signal source.

Accurate testing is not possible without the above adjustment. Loop signal levels cannot be guaranteed unless the input stages are operated correctly.

Step		Procedure / test	Results	Notes
2	**Field strength** [1kHz Combi]	Select appropriate test signal (usually ‘1kHz Combination’ - a mix of 1kHz Sine / Pink Noise) and set the meter to measure Field Strength. The field strength will go up and down by 6dB as the test signal alternates between pink noise and 1kHz sine, make sure to take readings on the higher 1kHz sine level. Test the dB level of the 1kHz sine wave at each of the measurement positions and record the result. If field strength levels are low overall, try increasing the loop current and retesting. If readings are high try reducing the loop current.	**All readings are 0dB +/- 3dB:** Rated as a PASS **All readings are 0dB +/- 5dB:** If some readings are outside the Pass criteria but all within this slightly wider range the step is rated as a QUALIFIED PASS **Any readings greater than +5dB or less than -5dB:** A measurement within this range is rated as a FAIL	Possible reasons for a FAIL: • System not set up correctly • Incorrect amplifier specification • System cannot compensate for amount of metal content within the proximity of the loop cable If there is more than 6dB variation in level, the system will not be able to reach compliance. Contact your hearing loop system designer for advice. If the overall level is too low following adjustment of the amplifier to maximum current, it may be possible to achieve compliance with a more powerful amplifier.

2	**Field strength** [1kHz Combi]	A	B	C	D	E	F	G	H
		+3dB	0dB	+2dB	0dB	-2dB	+1dB	-3dB	+0.5dB
		✓ All readings 0dB +/- 3dB			All readings 0dB +/- 5dB			Any readings > 5dB or < -5dB	
		Comments:							

Step		Procedure / test	Results	Notes
3	**Frequency response** [Pink noise] 	Select appropriate test signal (Pink Noise) and set the meter to measure **Frequency Response**. For each test point, take readings of the dB level at 1 kHz, 100 Hz and 5kHz. Loopworks Measure will always show a 0dB level at 1kHz. If using an FSM it is often easiest to hold the meter at a height that gives a 0dB 1kHz reading, then check relative levels at 100Hz and 5kHz by adjusting the upper switch. If the high frequencies are too low, try turning the MLC up on the loop amplifier. Some amplifiers have more advanced control to achieve a flat frequency response.	**100Hz & 5kHz +/- 3dB of 1kHz in all positions:** Rated as a PASS **100Hz & 5kHz +/- 3dB of 1kHz in some positions:** If the frequency response passes in some areas but is slightly worse in others this step can be rated as a QUALIFIED PASS. **Frequency response not achieved:** If no readings show an acceptable frequency response this step is rated as a FAIL.	Possible reasons for a FAIL: • System not set up correctly • Incorrect amplifier specification • System cannot compensate for amount of metal content within the proximity of the loop cable If high frequencies are still too low with maximum MLC setting the system will not be able to reach compliance. Contact your hearing loop system designer for advice. If adjusting for high frequencies results in low frequencies becoming non-compliant, use dual slope MLC if available. Prioritise high frequencies if necessary, for best intelligibility.

3	Frequency response [Pink noise] 	A		B		C		D		E		F		G		H	
		100Hz	-2	100Hz	-2.3	100Hz	-1.4	100Hz	-2.5	100Hz	-2.5	100Hz		100Hz		100Hz	
		1kHz	0	1kHz	0	1kHz	0	1kHz	0	1kHz	0	1kHz		1kHz		1kHz	
		5kHz	1.2	5kHz	-0.5	5kHz	0.4	5kHz	0.8	5kHz	1.6	5kHz		5kHz		5kHz	
		✓ 100Hz & 5kHz +/- 3dB of 1kHz in all positions				100Hz & 5kHz +/- 3dB of 1kHz in some positions				Frequency response not achieved							
		Comments:															

Preparing for Live Signal listening / Field Strength Tests

1. Turn the system off and reconnect the intended inputs (e.g. microphone, audio system) to the loop amplifier

Examples of Live signal to provide the amplifier:

- Live speech (ensure the talkers are in typical positions relative to the microphone(s))
- Recorded programme material (e.g. From an MP3 player or online source)
- PA announcement

2. Turn the Loop system back on and adjust the input level on the amplifier until one or two LEDs of AGC are achieved with normal signal levels.
3. Check that the signal is audible on the measurement device (using headphones).

This helps to ensure that the live signal is correctly controlled, and the loop system is left in its original stage once testing has been completed.

Step		Procedure / test	Results	Notes
4	**Live signal - Listening test** [Actual signals] 	Is the AGC/Compression meter being activated with the input signals? Listen to the induction loop on the meter / monitor with headphones at a suitable volume level across the test positions. If using the FSM, you must listen on **Field Strength** mode, if using a listener with an optional low cut filter this should be turned on. Fill in the report form with your subjective assessment of: Background noise e.g. level of hum or buzz that is not intended to be heard? Unpleasant program signal e.g. popping or fizzing sounds alongside normal signals? Signal clarity e.g. is the sound clear or dull and muffled? Are normal signals delivered without triggering the clip or overload LED on the amplifier?	Rate each parameter accordingly and make appropriate notes in the comment section on findings. If there are any concerns, it can be useful to take an audio recording for reference.	An unacceptable result for any of the four main parameters constitutes a FAIL mark. Some of these factors can be addressed by looking at the audio input signal chain, for example ensuring balanced cables are used with good practise for equipment grounding and gain structures. Alternatively, could a better microphone position be used to improve clarity? If there is excessive background noise, try reducing AGC slightly. Poor results in any earlier steps in the test will cause problems at this stage.

Step		Procedure / test	Results	Notes
5	**Live signal - Field strength** [Actual signals] 	Set the meter to measure Field Strength and test the dB level of the live signal in any one test point. If live signal levels are low, ensure AGC is being activated, with one or two LEDs lit during normal signals.	**Level between -6dB and +3dB:** Rated as a PASS **Level between -9dB and +6dB:** If some readings are outside the Pass criteria but all within this slightly wider range the step is rated as a QUALIFIED PASS. **Level above +6dB or below -9dB:** Rated as a FAIL.	Due to the variable nature of live signals, it is important to make sure that the measurement time is long enough to catch the highest peak. A reasonable idea of level is likely to be determined after at least 60 seconds. Try a range of signals that best represent intended use of the system.

Step		Procedure / test	Results	Notes
6	**System noise** [Inputs muted] 	Set the meter to measure **Background Noise** and test dB level of the system with all audio inputs disabled. In at least one position, with the amplifier on but audio inputs muted, is the background noise level increased?	**Level below -47dB or within 3dB of background noise measurement:** Rated as a PASS **Level below -32dB and 3dB above background noise measurement:** These may affect both users of the system and the audio quality, thus is classified as a QUALIFIED PASS. **Level above -32dB and 3dB above background noise measurement:** Rated as a FAIL.	If background noise increases significantly when the system is enabled with no audio transmission, this can negatively affect the performance. Common causes of this would be unbalanced audio cables, poor gain structure or equipment grounding practise. Try to isolate which part of the system is causing the noise by unplugging parts of the audio input chain.

Step		Procedure / test	Results	Notes
7	Overspill [1kHz Combi] 	If the system requires for signal to be controlled outside of the coverage area, an overspill measurement is required. Select appropriate test signal (1kHz Combination) and set the meter to measure **Background Noise.** Test the dB level of the 1kHz sine wave at one or more measurement positions (noted as "I" or "L") in the adjacent areas where overspill is a concern then record the result. These could be in rooms next door, above or below, or on a performance stage for example.	**Level is <-32dB or within 3dB of background noise measurement:** Rated as a PASS **Level is <-22dB and >3dB of background noise:** If some readings are outside the Pass criteria but all within this slightly wider range the step is rated as a QUALIFIED PASS. **Level is > -22dB and > 3dB of background noise:** Rated as a FAIL.	If system overspill is not properly considered at the design stage for the system, hearing aid users will be able to hear the induction loop outside of the intended coverage area. If signal spill is significant, this would indicate that systems are too close to one another / not been designed to compensate for either vertical or horizontal system adjacency. At this stage overspill control can only be improved by adjusting the loop layout, if this may be possible contact your loop system designer for advice. Alternatively, it may be possible to manage which systems are active at any one time or slightly adjust levels to minimise the amount of disruption caused.

Step		Procedure / test	Results	Notes
8	Venue accessibility 	Inspect the area around the system. **Is there appropriate signage to show there is a loop system present?** Note any observations on the signage and staff awareness of the coverage area. If the coverage area is limited, is it clear where to the hearing aid user should expect to be positioned to make use of the system? If applicable, ask the system operator to prepare the system for use and demonstrate the location of the system microphone(s). **Are staff able to set-up / operate the system?** *(This test may not be necessary if the system is permanently enabled)* Ask the staff if there is a procedure in place to routinely check the performance of the loop system. Ask to see their maintenance records and testing equipment to verify this. **Is there any routine maintenance or checking of the system?**	Rate each parameter accordingly and make appropriate notes in the comment section on findings.	An induction loop sign must be displayed. If not, this would count as a FAIL mark against the system. Staff should be aware and able to advice the hearing aid user where there is coverage by the induction loop. If the system requires set-up and the staff are not able to do so, then the system is of no benefit and would count as a FAIL mark. If no routine testing is in place, the system may malfunction or be disabled without the awareness of the venue. **Routine checking is a basic requirement of an induction loop system.** If it is too early in the building schedule to answer these questions, leave them blank with a note that the certification is reliant on these being addressed.

System Verdict and Next Steps

Based on the results of the 8 steps completed above, the system should be judged as follows:

SYSTEM PASS (All ticks in green boxes)

A system should only be passed if there are no failures recorded in any of the steps. i.e. No ticks in any of the red or yellow boxes. The system is properly set up, used and maintained to deliver a consistent performance throughout the required coverage area with no significant noise.
The requirements of IEC60118-4 have been met, and the system is of great benefit to any potential users.

Limited / Qualified PASS (Up to 2 ticks in yellow boxes)

A system should be given a limited / qualified pass if there are only 1 or 2 of the steps which are not passed, but which do not warrant an overall FAIL as detailed below. One or more listeners with hearing aids set to 'T' should assess the severity of any failed steps to determine the extent to which they affect the value of the loop system for the users.

The system can receive a 'PASS with Limitations' where listeners decide:

- That performance is still adequate at the identified points of failure; or
- A hearing aid user could realistically choose to avoid those points of failure; or
- A hearing aid user would have a low probability of experiencing an issue, due to the limited amount of these locations identified.

If a 'PASS with Limitations' is awarded, the nature of the failures identified must be written down and explained to the system operator.
Remedial action is recommended to improve the system if possible, but performance is still good enough for the users to gain a benefit from it.

SYSTEM FAIL (1 or more ticks in red boxes)

A SYSTEM FAIL must be recorded if any of the 8 steps have a tick in the red FAIL box. A SYSTEM FAIL can also be recorded if 3 or more of the steps are not passed, but do not deserve a complete failure as above. Multiple minor issues cause an unsatisfactory experience and render the system short of the demands of IEC60118-4.
Remedial action is urgently recommended to significantly improve the system. A failed system will not provide a genuine benefit to hearing aid users.

Once a system verdict is made, provide the venue with a copy of the commissioning certificate, complete with notes on any action required.

Providing a genuine benefit.

For more information on commissioning hearing loop systems please call +44 (0) 1636 610062
or email us at support@ampetronic.com

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