



AFILS

Induction Loop Systems



Int. Symbol for Induction Loop Systems

This application note describes Inductive Loop Systems and their commissioning and operational verification according the international standards

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1. General



Church with AFILS system installed

Audio-frequency induction loop systems (AFILS) are widely installed and improve the speech intelligibility for hearing aid users. The sounds picked up by a microphone are converted into a magnetic field, which again is transformed by the T-coil – in the hearing aid. This minimizes the listening problems with sound sources at a distance, with persons speaking behind protective windows and in environments with background noise. Vocal communication with a person wearing a hearing aid is often rather poor since acoustical noise and reverberation tend to mask the perceived signal. This is because wearing a hearing aid deprives the person of directional hearing. Communication is much easier when the acoustical distance is small. This is exactly what an inductive loop system provides.

The inductive loop system has to provide a magnetic field, which corresponds to very exact specifications. With the Minilyzer inductive loop menu and a sensor it is possible to measure these magnetic fields very accurately and confirm that the specifications are achieved.



AFILS amplifier

Induction loop systems are widely installed in churches, theatres and cinemas, for the benefit of hearing-impaired people. The use of induction loop systems has been even extended to many further applications, such as ticket offices, bank counters, drive-through services or elevators.

The following method provides repeatable and accurate results for most of the specialized amplification systems on the market. Other methods have been suggested, some using exotic test signals such as artificial speech, but obtaining accurate results has proven difficult.



AFILS main control



Main audio panel

2. Equipment and Set Up

In order to measure inductive loop systems the following equipment is required:

- NTI **Minilyzer M1** audio analyzer with firmware package V3.11 or higher including the **MiniLINK** USB interface. This firmware includes the specialized "Induction Loop Mode" installed. Check the latest firmware version at **www.nti-audio.com**
- NTI **Minirator MR-PRO** signal generator with suitable audio cables for connection to the induction loop system under test.



Minilyzer ML1



Minirator MR-PRO

- Calibrated receiver for inductive loop systems and connecting cable to the Minilyzer. Currently only one calibrated induction loop receiver is available with a flat frequency response, the Ampetronic CMR-3, calibration: 0 dBu RMS = 400 mA/m, for details see **www.ampetronic.co.uk**.
- Induction receivers to listen to the system to detect any artefacts. These receivers are available from various suppliers, e.g. ILR3 of **www.ampetronic.co.uk**.



3. Calibration

Firstly set the induction loop sensitivity for the connected sensor in the Minilyzer calibration menu i.e. 0 dB for the CMR-3. The A weighting filter of the CMR-3 should be switched off. For the previous model CMR-2 the calibration needs to be changed to „0 dBu RMS = 280 mA/m“ or +3dB in the Minilyzer calibration menu.



4. Technical Standards



Measurement in church

The international standard IEC 60118 section 4 (also known as SN, EN or BS 60118-4) specifies the following requirements (all referred to 400 mA/m or 0 dBL (=dB Loop):

- a)** Average Field Strength -12 dBL +/- 3 dB (= 100 mA/m)
- b)** Maximum Field Strength 0 dBL (= 400 mA/m)
- c)** Frequency Response 100 – 5,000 Hz +/- 3 dB
- d)** Background Noise Level -32 dBL, "A" weighted

These specifications relate to the vertical component of the magnetic field. The T-coil in hearing aids is usually mounted vertically. Not all hearing aids comply with this standard which often causes complaints about loop systems. Exceptions must be made in certain situations where the head of the listener is not vertical (places of worship, hospitals and recovery areas as people may be kneel, prone or supine).



Professional Testsystemcase

The average field strength (specification a) is difficult to measure as a long term average must be taken and there is no standardized signal for this measurement. Therefore, it is recommended to always measure the maximum field strength with the Minilyzer "FAST" time weighting. Measuring the average field strength is beyond the scope of this document but a subjective test is suggested at the end.



AFILS main control

When two rooms which are physically close have inductive systems fitted it is possible that there will be interference between these systems. In such cases a specification is required for the maximum allowable crosstalk. This specification is not included in the standard but the following specification has found to be acceptable:

- e) Crosstalk between two Systems -40dB_L @ 1 kHz (in critical cases e.g. cinemas -48dB_L)

The area covered by the induction loop system is defined as the area where all the above specifications are met. All measurements should be repeated at a randomly distributed selection of points. The measurement height should be 1.2 m in seating areas and 1.7 m in standing areas. In special cases it may be necessary to use different heights depending on the listeners. The loop receiver should always be held in order to measure the vertical component of the magnetic field, e.g. with the CMR-2 and CMR-3 receivers the long axis of the device needs to be vertically orientated.



Induction Loop Measurement

5. Measuring the Background Noise Level

The background noise level has to be measured prior to planning the loop system for a room. In rooms with high level of magnetic noise it may not be possible to fit an inductive system. In this case the use of other systems such as FM or Infrared should be discussed with the hearing impaired.

Measurement:

- Switch off the induction loop system.
- Connect the loop receiver to the Minilyzer and select the LVL SLOW function and the A-WTD filter.
- Carry out the measurement at different representative positions, the background noise level shall be not greater than -32 dB_L.



ML1 setting:
LVL Slow & A-WTD



ML1 setting:
1/3 OCT & 5 sec

- Repeat the measurements with any electrical equipment in the room (especially floor heating and lighting in the on and off position. If the lighting can be dimmed, the measurement needs to be repeated with various positions of the dimmer circuits.
- Document the background noise using the 1/3rd OCT menu with time constant (t5.0) for an average spectrum.
- Monitor the background noise by listening to the system with the inductive receiver. If impulsive noise is present this can be observed by switching to shorter time constants in the 1/3rd OCT Menu.
- Repeat this measurement in several positions, the resulting spectra can be stored in the Minilyzer memory and read out using the MiniLINK PC software.

6. Measuring the Field Strength

Measurement:



ML1 setting: Scope



ML1 setting:
LVL FAST & FLAT

- Switch on the induction loop system
- Connect the Minirator to the inductive loop system (use an input with a nominally flat frequency response, such as a line or tape input). Select a 1kHz sine wave. The output level of the Minirator and the induction loop system settings should be adjusted so as to obtain the maximum output without distortion. The output of the induction loop system can be checked with the Minilyzer SCOPE function to ensure that it is not distorted.
- Connect the Minilyzer to the loop receiver and select the LVL FAST function with FLAT filter.
- Carry out the measurement at different representative positions, the maximum field strength shall be 400mA/m (= 0 dBL) and shall not vary by more than ± 3 dB.



ML1 setting:
LVL FAST & HP400

Application hints:

If a high background noise level is detected it may interfere with the maximum field strength measurement. The high-pass filter HP400 can be switched on to reduce the effects of 50/60Hz mains background noise. This will not influence the readings at 1 kHz.

If there are any overheating problems with the induction loop amplifier this measurement should be completed rapidly and the maximum level measurement can be restricted to one position. Reduce the level e.g. by 6 dB, check the other positions and correct the results accordingly.

7. Measuring the Frequency Response

Measurement:



ML1 setting:
1/3 OCT & FLAT

- Connect the Minirator to the inductive loop system and select the pink noise test signal. The level of the input signal should be the same as in the previous section.
- Connect the Minilyzer to the loop receiver and select the 1/3 OCT function with FLAT filter and long time averaging (t5.0)
- Obtain the average spectrum. The frequency response shall be +/- 3 dB when referenced to the level at 1kHz over the range of 100 – 5,000 Hz
- Carry out the measurement at different representative positions. Any differences should be documented.

8. Checking the Noise level with the Loop System

Measurement:

- The measurements of section 5 should be repeated with the induction loop system switched on.
- Set the volume controls to normal operation level. Any microphone inputs should be turned off.
- Carry out the measurement at different representative positions. Any differences should be documented. The background noise level shall be not greater than -32 dBL.
- The results shall be the same or only very slightly higher (not more than 3 dB) than the measurements made in section 5.



ML1 setting:
LVL Slow & A-WTD



ML1 setting:
1/3 OCT & 5 sec

9. Checking Interference from other Loop Systems

At two or more induction loop systems installed close to each other the noise level, caused by the interference from other loop systems, needs to be measured.

Measurement:



ML1 setting:
1/3 OCT & 1 kHz

- Switch off the induction loop system.
- Switch on the loops system in the rooms which may interfere and adjust this systems to obtain the maximum field strength (see pos. 6).
- In the actual room under test, set the Minilyzer cursor in 1/3rd OCT mode to 1 kHz and read out the value
- Carry out the measurement at different representative positions especially near the wall separating the areas. Any differences should be documented. The max. crosstalk between two systems shall be -40dB.

10. System check

For the system check a small number of hearing-aid users should be available. It is important to check these hearing aid users for correct operation of their aids, and to ensure that they actually understand what they are supposed to be listening to.

The system check should include a test with the sound sources (talker, etc.) in their normal positions with respect to the system microphone(s) and with any other sources, such as a CD player.



ML1 setting:
LVL SLOW & FLAT

Measurement:

- Check the average level with a normal talker the using the Mini lyzer LVL SLOW and FLAT settings.
- Observe this average level for several minutes and take an average. This shall be roughly -10 dBL. In the LVL FAST and FLAT positions the maximum level of the speech shall be roughly -3 dB.
- Check the subjective level as perceived by the hearing aid users with the induction loop system on. With the loudspeakers off the perceived level for the hearing aid users should be the same as for unaided speech at a distance of 1m.

11. Information and a List of Possible Problems

The measured results should be recorded or stored on the Mini-lyzer and a report prepared. The AFILS sign shall be placed in a prominent position close to the entrance of the area where an induction loop is installed. The sign shall be of sufficient size to be easily read and constructed of durable material. An example of such a sign is given in Fig. 1. (Some countries may use other signs – contact the local hearing organizations for details).

A plan indicating the specified magnetic field area should be placed beside the above sign or incorporated in it. The results should be analyzed and the areas where all the specifications are obtained should be marked on this plan.

For small area induction loop systems e.g. window counters, a sign shall be placed in a prominent position where the hearing aid user is expected.

The following list includes some possible problems encountered when measuring induction loop systems. A possible source of the problem is given. This list does not cover all problems and their causes, just the most common ones:

PROBLEM	POSSIBLE CAUSE	POSSIBLE REMEDY
Field Strength too low		
In whole area	Incorrect amplifier used	Change
In whole area	Loop positioned too high and height correction factor not taken into consideration.	Change loop position or amplifier
In loop centre	Metal in structure.	Use loop design that compensates the metal loss.
Field Strength too low in system check		
In whole area	AGC not present or incorrectly set up	Check, readjust or replace.
In whole area	Level dependant on position of volume control for the loudspeaker system.	Reconnect the induction loop system to an output which is independent of the volume control.
Field strength irregular		
Low field strength in the centre of the loop	Metal in structure.	Use loop design that compensates the metal loss.
Low field strength in the centre the loop	Loop too wide	Maximum loop width for a vertical of distance of 1.2 m between loop height and receiver height (normal for seated audience and loop laid at floor height) is about 15 m.
Poor frequency response		
Loss of high frequencies	Use of a voltage drive amplifier (possibly in conjunction with a transformer).	Replace with a modern current drive amplifier.
Irregular frequency response	Equalizer used for the sound system affecting the loop response.	Connect loops drive amplifier to a path with no equalizer.
Irregular frequency response	Loop amplifier or electronics of the sound system defect.	Check and replace in necessary.
Loss of high frequencies in centre of the area covered	Metal in structure.	Use a loop design that correctly the compensates for the metal loss in the structure.

PROBLEM**POSSIBLE CAUSE****POSSIBLE REMEDY**

High Noise level (Loop system switched off)

50/60 Hz mains harmonics

Mains interference source.

Check locality for large mains transformers, power lines and so on. If these cannot be moved it may be necessary to consider an alternative to an induction system.

50/60 Hz mains with high level harmonics

Interference from dimmers.

Check dimmers and wiring. Modern dimmers and correct wiring do not produce an interferences.

Interference from other loop systems

Incorrect loop system design

Redesign of loop system(s)

High Noise level (Loop system switched on)

50/60 Hz mains harmonics

Sound system incorrectly installed.

Check grounding, cabling etc. of the sound system.

Wide band noise

Sound system noisy

Check and if necessary replace

**This application note is written by Mr. David Ian Norman, member of IEC committee for the AFILS regulations, see www.david-norman.ch
Many thanks !**