univox
BY EDIN

Univox® TLS-2.2

Loop amplifier for railway use

Technical manual and installation guide

Content

Safety

1. Please read this manual carefully before installing and operating the product
2. This manual shall always be available on-site, along with other technical documentation
3. Do not install the unit near any heat sources such as radiators, heat registers, vents or other apparatus that produce heat
4. Important! The unit must be mounted in such a way that the rear heat-sink overhangs any flat surface onto which the unit is placed
5. Warning! The unit must be properly grounded by connecting the grounding terminal (screw) located on the rear heat-sink to protective earth. The connection should be established before taking the unit into operation
6. Power - There is no power switch on the unit. Isolate power supply externally before removing any connections
7. In case the power to the unit must be interrupted, disconnect the 4-pin WAGO power supply connector in the front panel
8. Do not make any modifications, extensions, or adaptations to the unit
9. All service and maintenance work must be performed by qualified personnel only
10. Never expose the unit to dripping or splashing, nor to liquid or moisture of any kind. IP class 40

Univox TLS-2.2 - Introduction

Univox TLS-2.2 is an audio induction loop driver developed for hearing loop installations in railway and other large vehicle applications. With its rugged and sophisticated design TLS-2.2 ensures efficient and reliable operations in environments completely or partially enclosed by metal, like train cars, trams, subways and ships.

TLS-2.2 provides high output current, up to 30 Arms, enabling compensation for the strong damping effect that conductive materials may have on magnetic transmission. Metal loss correction is also available for high frequency slope corrections.

There are several international standards within the railway industry that must be met when installing electronic devices on-board rolling stock:

- EN 50121-3-2:2016+A1:2019 Railway applications - Electromagnetic compatibility
- EN 50155:2017 Railway applications - Electronic equipment used on rolling stock
- EN 61373:2010 Railway applications. Rolling stock equipment. Shock and vibration tests
- EN 45545-2 Fire protection of railway vehicles - Part 2: Requirement for fire behaviours of materials and components, HL2 (Hazard Level 2)

Univox TLS-2.2 has been tested against and fulfils the requirements in all the above standards.

TLS-2.2 ha also passed the test for the following American standards:

- BSS 7239 - Toxic gas testing
- NFPA 130 - ASTM E162 testing of surface flammability and ASTM E 662 smoke
- FCC Regulations: Title 47, Chapter 1, Part 15 - EMC Emission

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

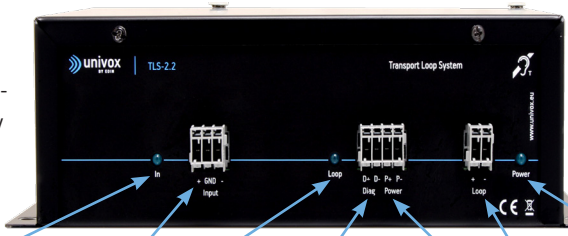
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Univox TLS-2.2 - driver

Weight: 2940g

Front side - overview

Rugged WAGO connectors for railway applications



Input level LED

Input connector

Loop LED

Diagnostic output connector

Power connector

Loop cable connector

Power LED

Rear side - overview

Chassis flanges with screw holes

Large heat sink for effective fan-free cooling

Grounding screw for protective earth connection

Overview of the different connections and connectors

	Connector						Function description
Name	Type	Gender	Pin signal	Pin no.	Voltage	Current	
J1-Loop	WAGO 769662	Male	Loop + Loop -	1 2	<35Vrms	<30Arms	Loop wire connection
J2-Power and Diag.	WAGO 769-664	Male	D +	1	Open collector	20mA	Diagnostic signal
			D -	2	Emitter	20mA	
			P +	3	20-50V	<15ADC 125ms peaks	LVPS +
			P -	4			LVPS -
J3-Audio input and ground	WAGO 769-663	Male	Audio +	1	100mV-5Vrms		Audio input +
			GND	2			Ground
			Audio -	3	100mV-5Vrms		Audio input -

Planning and setup of hearing loop systems on-board a train car

Summary

A successful installation should be planned carefully at an early stage. The challenging installation environment in train cars, with different supply voltages, cramped space for loop driver and loop cable location and ambiguous metal loss, calls for experience when planning, installing and certifying loop systems on-board. Univox has extensive experience since 1995 and our resources include in-house developed loop design software, enabling calculation, 2D and 3D simulation of field strength.

The initial step in the planning process is to create a test loop on-board of the vehicle. Several important factors should be considered: loop figuration, detailed location of the loop cable, cable type and cross-section and location of the loop driver. The information on supplied mains power and signal level from the Passenger Information System (PIS) should also be available.

With the test loop in place, the input sensitivity, loop output level and possible Metal Loss Compensation (MLC) level, can be determined during an on-site measurement of the test loop. If needed, adjustments to the loop figuration, loop cable location, cable type and cross-section and location of the loop driver can be done at this point.

Once the appropriate input, output and MLC settings have been defined, all units intended for the same project/train car type can be supplied with the correct preset levels to facilitate a fast and consistent installation process. A test loop measurement must be performed separately for each train car type.

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General information about loop systems

Current floating in a loop wire creates a directly proportional magnetic field. The magnetic field is picked up by a small copper coil (T-coil) integrated in most listening devices, e.g. hearing aids, allowing the audio source to be transmitted directly to the hearing aid. Magnetic background noise as well as recommended level, dynamic range and frequency response of the field strength (FS), is specified in the IEC 60118-4 standard.

Background noise

At the start of any loop project, the magnetic background noise in the train car must be measured and documented. This is done with a field strength meter (FSM). The background noise level shall be measured at different positions in the train car (at the front, rear and mid sections of the train car as well as in the aisle and at the seats). The background noise levels may differ substantially between a train car standing still without power and the same car moving in traffic, accelerating or braking. The most comprehensive picture of the background noise levels is therefore achieved by measuring in all different operation modes.

The IEC 60118-4 recommends a maximum magnetic background noise level of -22dB(A) for announcements. With a stipulated field strength level of 0dB in the program peaks, this equals a signal-to-noise (S/N) ratio of 22dB(A).

The PA speaker level in trains is normally specified for a S/N ratio of 15dB(A), i.e. the speaker level is 15dB higher compared to the acoustic A-weighted ambient noise. Although the IEC 60118-4 recommends a S/N ratio of 22dB(A) for the hearing loop system, there is a note stating that a lower S/N ratio still might be beneficiary for the hearing aid users in acoustically noisy environments. If the S/N ratio of the hearing loop system is higher than the S/N ratio of the PA-system, the speech intelligibility for the hard of hearing will be increased.

Loop cable and its position

Planning and installation of hearing loops in real environments, particularly in strong metallic environments like trains, trams and boats, puts special focus on the choice of loop cable, its impedance and placement. The chances to succeed in achieving an efficient system is mostly based on extensive experience. Additionally, the chosen loop figuration has a strong influence on both loop impedance and efficiency.

Choice of loop cable and loop load impedance

General: Loop *impedance* (Z), consisting of resistance (R) and reactance (XL) in series, are essential parameters for optimal system performance. The final values depend on several parameters. The goal is to achieve an impedance to match the driver's dynamic large signal behavior along with the speech spectrum . The resistance (R) should be kept as low as possible for the highest efficiency.

The initial design should be based on 4 wires with 2.5-5mm2 cross-section area. Depending on the application, it could be necessary to reduce the number of loop turns, reducing the total impedance, thus making it easier to achieve the desired magnetic field strength level.

The *inductance* (L) is influenced by the cross-section of the wire, its length, the number of turns and the metallic structure of the train car. All parameters can be calculated or estimated, but it is a fairly complicated process for a complete practical design.

Location of loop cable

Metal

The loop wire should be placed as far as practically possible from any metal structures to avoid excessive attenuation of the field strength. Even small variations in distance can influence the performance of the loop substantially. It is recommended to add some distances, whenever possible, to the metal chassis when altering the cable path. Door sections are typical locations where distancing the loop wire could be possible.

Installation level/height

It is vital to achieve a certain difference between the loop level (i.e. the distance from the floor where the loop cable is positioned) and the listening level (i.e. the distance from the floor where the passenger's hearing aids are positioned). For this reason, the loop cable normally must be positioned either at floor level (or close to the floor) or at ceiling level (or close to the ceiling). It should never be positioned too close to the listening level, which is 1.2m from the floor for seated passengers and 1.7m from the floor for standing passengers.

In train cars with many seated passengers (medium- and long-distance train lines) a listening level of 1.2m should be assumed. In these cases, the loop cable can be positioned either at floor or ceiling level.

In train cars with a mix of seated and standing passengers (short-distance train lines, light rail, subway and tram cars) a listening level of 1.45m should be assumed, accommodating for both seated and standing passengers. In these cases, the loop cable must be positioned at ceiling level.

Train car interior

In certain train cars the interior of the car may be used for housing of the loop cable. For example, luggage racks or lighting ducts may be used. If those locations are chosen, a careful study of how the metal in these structures may influence the performance of the loop system.

On-site tests

Establishing the best position of the loop cable is a trial and error process and on-site tests often must be performed. Once determined for a specific train car type, all cars with the same layout should use identical cable paths.

Signal cables

Avoid location of the loop cable closely in parallel to any signal cables to avoid inductive coupling causing interference. This is especially important for analogue signals.

Installation

Location and installation of loop driver

The location of the loop amplifier should allow for easy access to available signal and the power source. The TLS-2.2 driver can be mounted in any position (horizontal/vertical) using the screw holes on the side flanges of the cover.

For the setting of input and output levels, the amplifier's top cover must be removed. A manual screwdriver should be used to avoid damaging the screws. When the installation and setting of the loop system has been completed, the top cover must be refitted.

Note! The unit must be mounted in such a way that the heatsink overhangs the mounting surface and is positioned "in free air", allowing for proper ventilation/air flow. Failure to comply with this requirement may result in unit overheating and shutting down prematurely.

Power connection

Univox TLS-2.2 can be connected to either of two different power sources

- 24VDC direct power source
- A voltage stabilizing device, i.e. DC/DC converter with 24VDC out, that is connected to any other voltage level present on-board (48, 72, 96 or 110VDC)

Since a DC power source may produce temporary voltage fluctuations, a voltage stabilizing device, such as a DC/DC converter between the power source and the loop amplifier, may be used, even when nominal voltage supplied is 24VDC. For any other power source voltages, a DC/DC convertor is a requirement, due to the voltage limitations of the amplifier. Low voltage power supplies (LVPS) need to be fused. Actual fuse specification is highly dependent on the loop figuration. In a suggested figuration we estimate 8A (slow) will be sufficient even for the most demanding loops. Univox TLS-2.2 has a non-retrigger fuse 10A (slow) built into the unit. Quiescent current is approximately 50-100mA.

The cable used for connection to the 24VDC power source must have a cross-section of at least 1mm2.

Note! As the incoming nominal voltage is 24VDC there is no risk of electrical shock if the top cover is removed. Therefore, there is no need to disconnect the power supply before removing the top cover.

Grounding

Signal ground (from PIS) and chassis ground must be kept galvanically separated to avoid floating ground loops. The actual DC shift between the two ground systems needs to be specified before installation, but must never exceed 1500VDC. To avoid any risk of damage due to potential differences between the loop amplifier and other connected units, a floating output DC/DC converter is strongly recommended.

Tools and equipment

For connection of loop cable, signal and power source, and mounting of loop amplifier, the following (common) installation tools are needed:

- Wire stripper
- Cutter
- Screwdrivers
- Screws and fasteners for mounting of the amplifier
- Soldering equipment

Other handy equipment:

- Flashlight
- Insulation tape
- Cable ties

Instruments:

- Multimeter for low resistance measurements
- Inductance meter
- Oscilloscope (normally not needed) with current clamp sensor.

Tools for measurement and listening:

Univox FSM Basic
or equivalent field
strength meter

Univox Listener
or equivalent field
strength meter

Signal source (from train PA system)

The TLS 2.2 input is galvanically isolated, fully balanced and low-pass filtered with common mode transformer, to avoid EMI interference.

Recommended source signal: Low Ohmic (OP amplifier or such), fully balanced with a quality screen.

Recommended input level: 0dBu=0.775Vrms according to audio standard (+4dBu will give another 4dB noise headroom but the advantage is marginal). Default input DIP setting is -16dB and -32dB switches in "ON" position, all remaining switches in "OFF" position.

Note 1: Speakers in high voltage line systems have normally a built-in transformer to tap off the line-level to a low-ohmic speaker which in that case can be connected directly to the TLS 2.2. The wire from the speaker must be screened. The level from a standard low-ohmic speaker is normally less than 0dBu so the input sensitivity of the TLS 2.2 must be adjusted accordingly.

Note 2: Higher voltage input levels, like from 100V speaker line system (not allowed everywhere), can be connected by using a separate tapping transformer. Cable screen should be connected to the chassis. However, if there is a voltage potential difference between signal source screen and hearing loop transmitters screen/chassis, current will float through the screen cable causing interference. In such cases the screen wire must be disconnected at one side, normally at the signal source side.

A direct connection to the on-board speaker system is not possible due to the amplifier's input signal range. Even with a connected signal transformer between the TLS-2.2 unit and the PIS, such a connection is not recommended as the signal is processed for the audio speaker system and will strongly affect the frequency response of the loop system if used.

Input signal adjustment

The input signal level is adjusted at the DIP switch array marked "Input" located on the PCB. It consists of 8 switches, each representing an increasing attenuation of the input signal with a fixed dB value:

0.25dB - 0.5dB - 1dB - 2dB - 4dB - 8dB - 16dB - 32dB

If all DIP switches are set to OFF (left position), no damping of the input signal will result. However if for example the 16dB switch is set to ON, the input signal will be attenuated by 16dB. If two or more DIP switches are set to ON, the combined damping effect of both switches will occur. For example, if the 4dB and 8dB switches are set to ON, the resulting damping effect will be 12dB.

Default settings (adjusted for an input signal level of 600mV):

0.25dB - 8dB = OFF 16 - 32dB = ON

Note! When adjusting the input signal level by setting the DIP switches, the input LED (In) in the front panel will be activated first after a short time period. The input LED will also stay activated a longer time period after deactivation of the input signal to facilitate monitoring of the system. This is intentional and not a fault.

Loop output

The loop output current is adjusted at the other DIP switch array on the PCB marked "Loop". It consists of 8 switches, each representing an increasing attenuation of the output current with a fixed dB value:

0.25dB - 0.5dB - 1dB - 2dB - 4dB - 8dB - 16dB - 32dB

If all DIP switches are set to OFF (left position), no damping of the output loop current will result. However, if for example the 16dB switch is set to ON, the output current will be attenuated by 16dB. If two or more DIP switches are set to ON, the combined damping effect of both switches will occur. For example, if the 4dB and 8dB switches are set to ON, the resulting damping effect will be 12dB.

Default settings (no damping of the output current):

0.25dB - 32dB = OFF

Diagnostic output

TLS-2.2 can be connected to a computer host's diagnostic system through the 20mA current opto-coupler isolated outputs for control of input and/or output signals.

The typical set up for the initial train start-up procedure:

- When booting the on-board computer system an audio test signal activates the 20mA current loop, to verify the function of the hearing loop systems
- The loop amplifier´s opto-coupler indicates if there is any loop output current, i.e. the hearing loop driver transmits
- The opto-coupler's indication is read by the computer and the result can be displayed on the system screen to indicate the proper function of the loop system

The diagnostic output is activated through an isolated opto-coupler. Set the current through the optical transistor to approximately 20mA current loop. The diagnostic output's D+ needs to be terminated by a suitable resistor to achieve the 20mA current loop. If the connected power supply is 24VDC, the suitable resistor is 1.2kOhm (24VDC/20mA = 1.2kOhm).

Note! The diagnostic system does only indicate current floating in the loop, not that this current and the resulting magnetic field strength is according to the IEC standard! This must be ensured by pre-installation testing and setting of the loop systems' input and output level.

Univox setup procedure

The constant current function of TLS 2.2 is active over a wide impedance range, with auto-adjustable gain versus loop load impedance. The loop system uses different levels at different frequencies automatically. Using those facts, it is possible to find the highest efficiency and field strength in the actual car including metal environment attenuation. See the following Step by Step procedure for details.

Contact Univox whenever detailed calculations and further discussions are necessary.

Step by Step procedure

1. Select a suitable place for the loop driver, according to the above recommendations
2. Make sure that the amplifier's ground screw at the heatsink is connected to protective earth before starting the setup procedure
3. Remove the top cover to access the input and output DIP switch arrays on the PCB

4. Plan for the loop layout of the loop cable and its placement, considering all parameters as discussed above and as described above
5. An initial test with a loop wire of 2.5-5mm2 using a 4-turn connection is recommended. Select a cable practical for the installation, such as a flat wire with four conductors or two twin-cables giving four conductors. The 4-turn loop can be considered as a large coil with four turns
6. Connect the three WAGO mating connectors delivered with the driver to the corresponding cables according to the above I/O overview:

   a. 2-pol. WAGO 769-662 to the loop cable
   b. 3-pol. WAGO 769-663 to the audio signal source
   c. 4-pol. WAGO 769-664 to the power source and (if used) the diagnostic signal cable

7. Connect input signal source and loop cable to the loop driver's input and output connector. **Note**: For proper function a loop load must be connected to TLS-2.2
8. Connect the power supply – a standard laboratory DC power supply of 24V/10A is sufficient at the initial test
9. Set all the output DIP switches to "OFF" position
10. Set input DIP switches to: -16dB and -32dB to "ON" position, remaining to "OFF" position
11. Start the speech signal from the PA-system (0dBu) and verify that the input AGC LED indicator is activated within a few seconds by the speech peaks
12. Output loop current LED indicator indicates whenever there is a current floating in the loop wire
13. Note: if the loop wire is open circuit for some reason, the loop current LED indicator and Optical Coupler indicator will not indicate transmission (no current is floating through the loop)
14. Input signal LED-indicator and output loop current LED verifies the basic function of the system
15. Simplest method to find a maximum level at different loop cable connections (cable cross section area and the number of turns) is as follows:

    a. Select a reference place, e.g. an aisle chair in the middle of the car, at approximately 1.2m (sitting) or 1.45m (between sitting and standing) above the floor level
    b. Start with a 4-turn connection and document the highest peak level during a 15 second period. Document Field strength, Resistance (R) and Inductance (L)
    c. Repeat the same procedure for 3-, 2- and 1-turn configuration. Choose the highest number of turns that will generate the highest Field strength level at the reference position

d. If there is no significant level difference when alternating the number of turns, repeat the above installation procedure by using an oscilloscope (current clamp). Set the output level accepting slightly clipping (rounding in current domain) in the high-level speech peaks on each connection. Choose the highest number of turns that will fulfil or give the highest level at the reference position

16. Use the MLC potentiometer to compensate for the metal influence in the high frequency spectrum. If the MLC potentiometer has been used, always make sure that an IEC 60118-4 compliant field strength level can still be achieved
17. The resulting setting of input, output and MLC levels will be used as the default setting for all identical train cars within a project. In this way, no further level trimmings are necessary at the serial installation, thereby securing consistent loop performance and substantially reducing installation time and cost

Trouble shooting

Note: During the troubleshooting it might be necessary to verify signals by using an oscilloscope. Keep in mind that both loop outputs are floating. DO NOT connect the oscilloscope earth to any output as that will short the output to ground. Use the probe tip to look separately at each output. One output has low level (around 50mV) and reflects outgoing current. The other output reflects outgoing voltage (several volts).
Distortion at output voltage is normal for the constant current concept but there should not be any visual distortion for the output current.

Basic trouble shooting scheme
Verify the following:

- Input AGC (Input LED) is activated
- Measure/listening equipment is not input clipping
- Measure/listening reference position and height is representative
- Measure/listening coil is in correct position and direction, considering the listening area
- Verify by listening (for >15 seconds) that the AGC system does not excessively increase the level after an announcement, due to too high input gain setting

Frequency response

1. The frequency response should be measured at approx. -12dB relative 400mA/m (0dBL). Reduce the output current, NOT the input level, to approx. 100mA/m (-12dBL). Readjust the output to the previous level. Proceed with frequency response measurement. After this procedure adjust input sensitivity to the used program material

2. High frequency response could be enhanced by creating a distance between the loop wire and the metallic surface
3. The inductive reactance (XL) increases by the square of the number of turns of the loop. Therefore, it could be necessary to decrease the number of turns to reduce the impedance and thereby increase high frequency gain and reduce the risk of voltage clipping
4. The Australian AS 1428.5-2010 standard is derived from the IEC 60118-4. However, there are some significant differences:
   - for strong metal reinforcement a larger level drop is accepted
   - peak field strength level: -6dB for fast acting AGC
   - field variation: -9dB to +3dB which is 6dB lower than IEC-recommendation (power reduction of factor 4)

General information

Security/Warranty

Basic knowledge in audio installation techniques is required to achieve existing regulations. The installer is responsible for the installation hereby avoiding any risk or cause of fire. Please also note that warranty is not valid for any damage or defects on the product due to incorrect or incautious handling.
Bo Edin AB shall not be held responsible or liable for interference to radio or TV equipment, and/or to any direct, incidental or consequential damages or losses to any person or entity, if the equipment has been installed by unqualified personnel and/or if installation instructions stated in the product Installation Guide have not been strictly followed.

Maintenance and care

The device should be kept clean to prevent excessive dust or other contaminants affecting its operation. Under normal circumstances Univox products do not need any special maintenance. Should the unit become dirty, wipe the unit with a slightly damp cloth. Do not use solvent or heavy cleaning agents.

Service

Should the system still not work after trouble shooting, please contact the local distributor of the product for further instructions. Always enclose a completed Service Form, see www.univox.eu, Support.

Technical data

For additional information, please refer to product data sheet/brochure and CE certificate which can be downloaded from www.univox.eu. If required, spare part lists or other technical documents can be ordered through support@edin.se.

Environment and recycling directives

Please follow existing disposal regulations. Thus, if you respect these instructions you ensure human health and environmental protection.

Notes

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Hearing excellence since 1965

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