



USER MANUAL



- Drive 2 WMA-200 high voltage amplifiers to 700Vpp output voltage in bridge mode
- Ultra low noise: with 2 WMA-200 high voltage amplifiers $\sim 105\mu\text{Vrms}$
- Fully differential signal path and connectors + additional BNC input
- DC – 100kHz power bandwidth with two WMA-200 amplifiers
- $\pm 10\text{V}$ maximum differential input and output voltage

About this manual

This user manual is an integral part of the Falco Systems WMA-IB-LN ultra-low noise phase inverter - buffer product. Please read it carefully and pay attention to the recommendations and instructions for safe use.

Operation of the phase inverter

The WMA-IB-LN is an ultra-low noise phase inverter – buffer designed to drive one or two Falco Systems WMA-200 high voltage amplifiers. It can be used:

- To drive two amplifiers in bridge mode by using both the buffered output and the inverting output, or
- As a buffer between a signal source and the amplifier

The BNC and differential input can be used with signals up to $\pm 10\text{V}$ input voltage. The signal on the BNC connector is converted to a differential signal to drive

the high voltage amplifier(s). The differential outputs have a low impedance and are short-circuit protected.

The WMA-IB-LN ships with a customized Mean Well GS25B28-P1J power supply. The power supply connector, 315mA fuse and on-off switch are on the rear panel of the WMA-IB-LN enclosure. A blue led indicates that the WMA-IB-LN is on. The outputs are on the left of the front panel to accommodate neat cabling to high voltage amplifiers that typically have their inputs on the left side too.

Bridge mode

The WMA-IB-LN can be used to double the maximum output voltage driving a load, such as a piezo actuator, EO (electro-optical) modulator, or MEMS (electromechanical systems) device, among many others. This is achieved by driving two high voltage amplifiers both

with the same signal, but with opposite polarity. The outputs of the amplifiers are connected in bridge mode. Fig. 1 shows the concept of the bridge mode circuit.

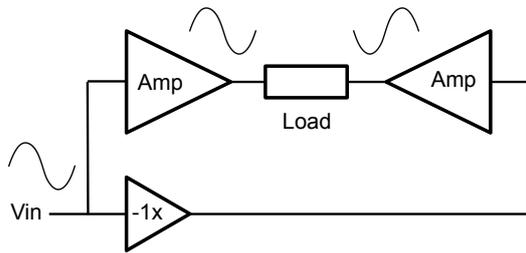


Figure 1. Doubling the maximal output voltage by using 'bridge mode'

The WMA-IB-LN inverts the signal and provides the signal for both amplifiers. The outputs of the two amplifiers are connected to the floating, ungrounded load. The WMA-IB-LN phase inverter - buffer amplifies 1x. If both amplifiers amplify e.g. 20x, the total output voltage across the load will be doubled in bridge mode, i.e. 40x in this case.

Fig. 2 shows an actual setup with the ultra-low noise phase inverter buffer connected to two high voltage amplifiers to drive them in bridge mode.

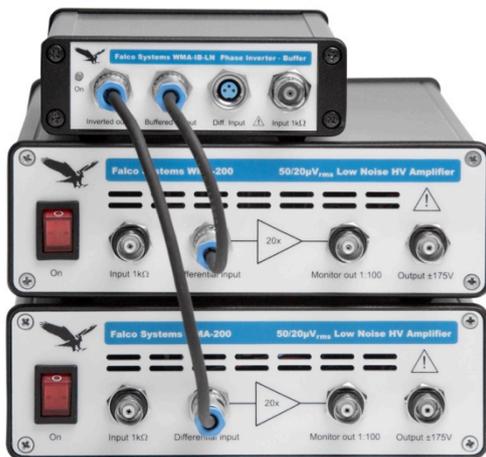


Figure 2. Connecting the high-speed phase inverter buffer and two amplifiers for bridge mode operation

When two amplifiers are driven in bridge mode, the high voltage output signal with twice the amplitude of the individual high voltage amplifiers is available between the inner pins of the two high voltage amplifier BNC outputs and can be connected to the load (Fig 3). Make sure that the load is not grounded to the same ground as the

amplifiers, as this would short-circuit one of the two high voltage amplifiers. This will not damage the amplifier (if it is short-circuit proof) but would reduce the output voltage available to that of a single amplifier only.

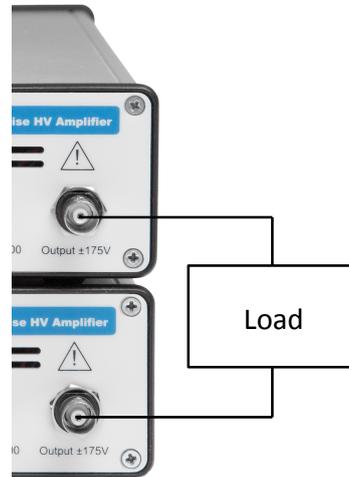


Figure 3. Connecting a load in bridge mode to two WA-200 high voltage amplifiers

Connecting the load

The ultra-low noise phase inverter - buffer in combination with two Falco Systems high voltage amplifiers is capable of both relatively high bandwidth and ultra-low noise performance. This performance can only be obtained with correct shielding of the cables connecting to the load and, if possible, shielding of the load itself. Solid BNC connectors and/or short, high quality BNC cables are recommended.

Some loads, such as certain EO-modulators, have a differential connector available, or two individual connectors, to drive them differentially (Fig. 4).

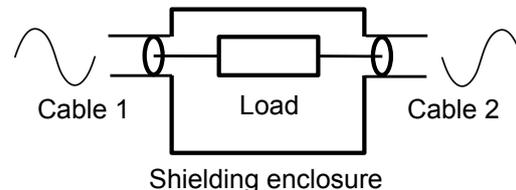


Figure 4. Shielded, differentially driven load for bridge mode operation

The housing of the modulator is connected to the shield of the cables this way, resulting in good interference rejection.

This scheme is also the recommended one if the user has the possibility to design the connections of the load him/herself.

In situations where driving the load differentially with two connectors is impossible, e.g. because the load has a single connector, both amplifier outputs have to be connected together at the load, as depicted in Fig. 5.

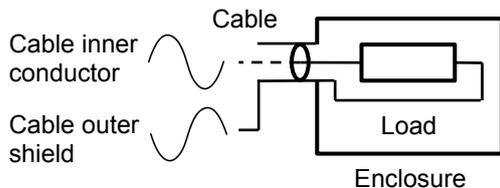


Figure 5. Driving a single-connector load in bridge mode

If one of the two connections of the connector is connected to the (conductive) housing of the load, check that

- *the housing/outside of the load floats with respect to the ground of the amplifiers, i.e. it makes no contact with the electrical circuit to which the amplifiers belong, other than via the output cables, and*
- *the housing/outside of the load and the BNC connector itself cannot be touched, as it carries the full output voltage of one of the high voltage amplifiers. For this*

reason the sign  is present on the type plate of the enclosure of the WMA-IB-LN. The use of an insulated BNC connector is recommended.

To aid in connecting floating loads in bridge mode, Falco Systems offers a special 'bridge mode insulated tee-cable' (Fig. 6). This cable takes the two amplifier cables on BNC connectors, and has a third BNC connector, where the inner conductor of one input cable is connected to the inner pin, and the inner conductor of the other cable to the outer ring, which is normally associated with the 0V shield. This functionality is very different from a normal BNC tee-adapter, which is only used to connect the inner conductor of a BNC cable to two cables, with all inner pins connected together.



Figure 6. A 'bridge mode' tee-cable for connecting the load is available from Falco Systems, and can be purchased on the website www.falco-systems.com

Required amplifier properties

The WMA-IB-LN phase inverter - buffer has been designed for use with the ultra-low noise Falco Systems WMA-200 high voltage amplifiers. Another model, the Falco Systems WMA-IB-HS high speed phase inverter – buffer is a better choice for use with most other high voltage amplifiers due to its larger bandwidth, switchable input impedance, and BNC connectors.

Recommendations and safety

Recommendations:

- Heed the advice in the 'connecting the load' section of the manual. In short: do not short circuit one of the amplifiers by grounding the load, and make sure the voltage-carrying parts of the load cannot be touched during operation
- Never apply more than +10V (or less than -10V) to the phase inverter/buffer input to prevent damage. This is indicated

by the  sign between the two inputs.

- The phase inverter/buffer cannot be damaged by a short-circuit condition or capacitive loading, but two situations should be avoided:

- Connecting a charged capacitor to the input or output.

- Connecting a highly inductive load to the output (such as a coil).

- Do not connect anything to the phase inverter/buffer that can act as an antenna.

- This product should only be cleaned with a soft, slightly moist cloth. Disconnect the phase inverter/buffer from the power supply and all equipment before cleaning.

Safety:

- The Falco Systems WMA-IB-LN ultra-low noise phase inverter - buffer is only suitable for indoor use in a class II environment (domestic, light industrial).
- Use the power supply adapter supplied by Falco Systems only: Mean Well GS25B28-P1J, 100-240V~ 50/60Hz in, 28V 25W DC out, with custom MiniDIN connector
- Only replace fuses with the correct type: 5x20mm 315mA 230V fuse on the rear panel
- This product cannot be powered by non-sinusoidal mains power generators.
- Only replace a damaged power cord with an equivalent type: H03VVH2-F 2X 0,75 mm², with Euro to C7 equipment connector
- The airflow to and from the WMA-IB-LN should not be blocked or impeded, to allow for adequate ventilation

Transmitter mode

This high speed phase inverter - buffer can generate a significant amount of power at frequencies used for radio transmission and reception. It should not be used for telecommunication as described in the R&TTE directive 95/5/EC. Always use shielded cables.

WMA-IB-LN Ultra-Low Noise Phase Inverter - Buffer characteristics

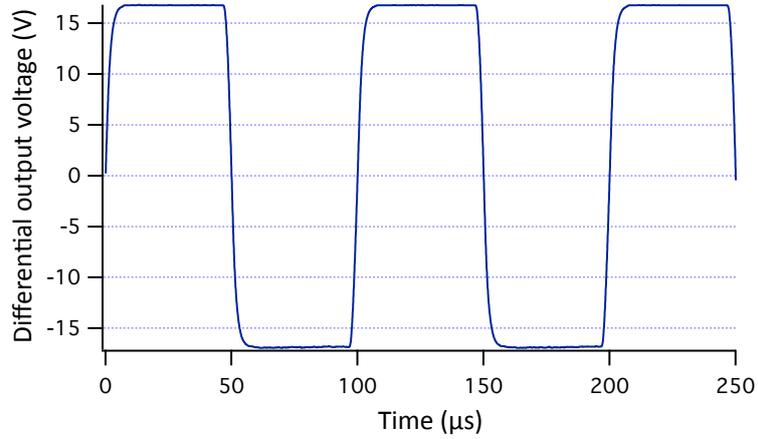


Figure 7. Buffered output signal of the WMA-IB-LN; 10kHz 16Vpp differential square wave signal

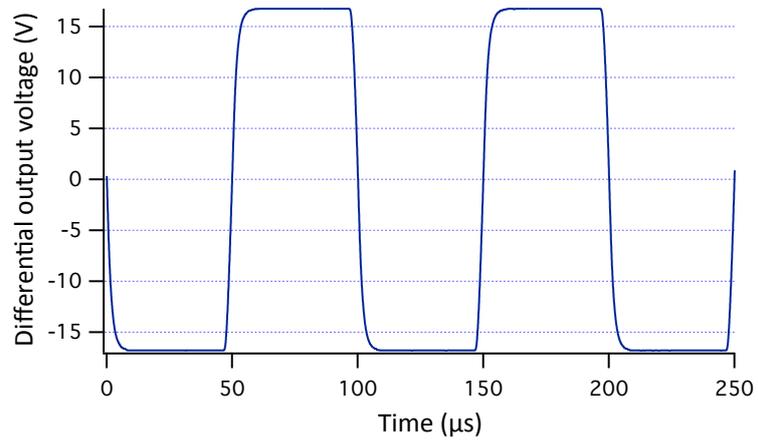


Figure 8. Inverted output signal of the WMA-IB-LN; 10kHz 16Vpp differential square wave signal

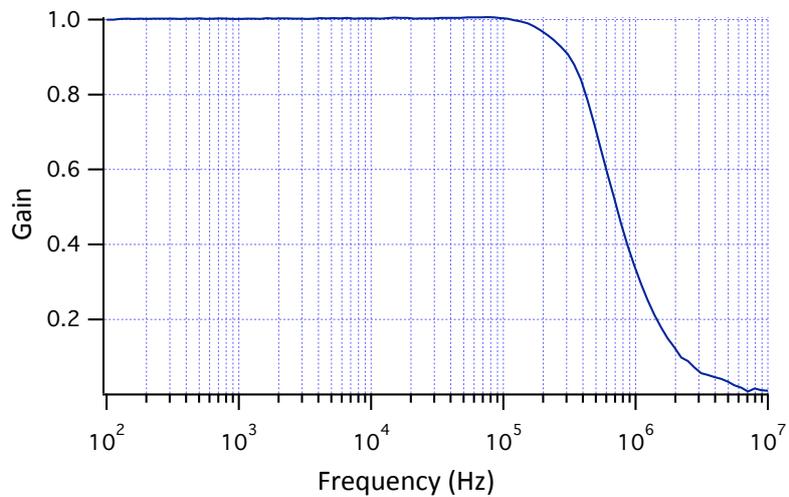


Figure 9. Bandwidth of the WMA-IB-LN from input to output, stand-alone operation

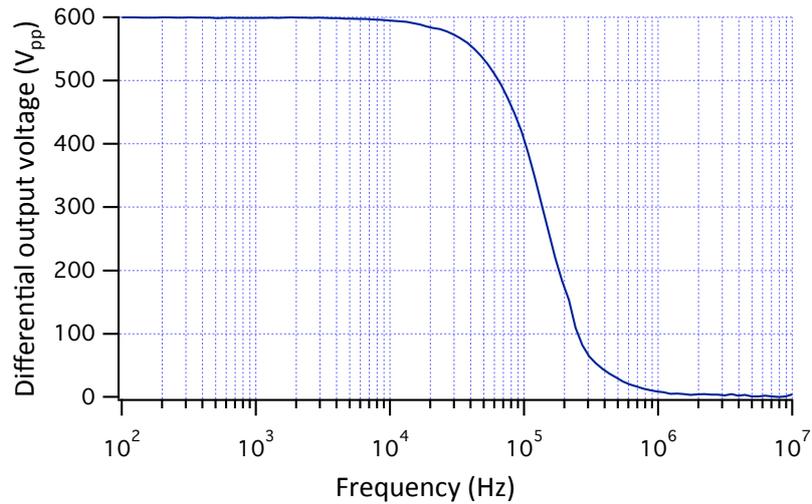


Figure 10. Bandwidth of the WMA-IB-LN when used with two WMA-200 high voltage amplifiers in bridge mode. Shown is the measured bandwidth of a 600Vpp differential sine wave signal between the two WMA-200 high voltage amplifier outputs

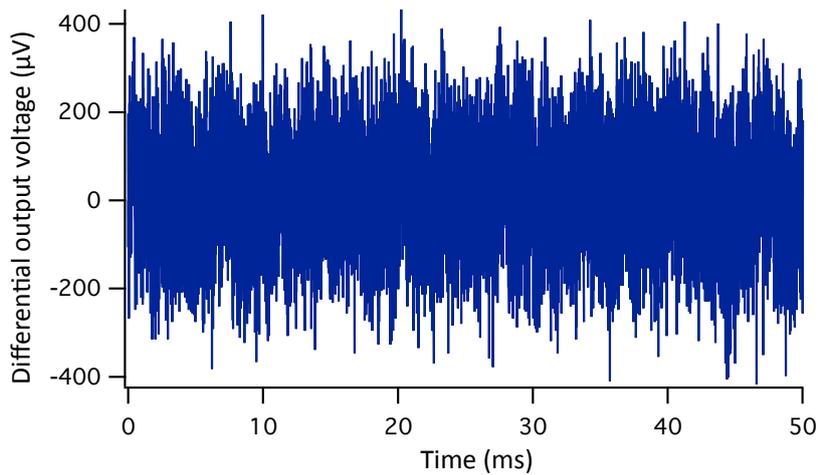


Figure 11. Measured differential output voltage noise between two WMA-200 high voltage amplifier outputs, with short-circuited WMA-IB-LN inputs. The effective differential voltage noise between the two WMA-200 high voltage amplifier outputs is $130\mu V_{rms}$ measured in a bandwidth of DC - 1MHz bandwidth, and $105\mu V_{rms}$ in a bandwidth of DC - 100kHz.

Technical specifications

Inputs: 1k Ω 0.1% input impedance, $\pm 10V$ max input voltage; single-ended BNC and differential connector

Outputs: $\pm 5V$ maximum output voltage (differential $\pm 10V$), short-circuit proof

Gain: buffered out: +1x, inverted out: -1x. The single ended BNC signal will appear buffered and inverted on the two outputs with 0.5x gain each, making a total differential gain of 1x

Bandwidth DC – 100kHz @-3dB typical at the WMA-200 high voltage amplifier outputs

Differential output noise between the WMA-200 high voltage amplifier outputs: $\sim 130\mu V_{rms}$ measured in a bandwidth of DC - 1MHz bandwidth, and $\sim 105\mu V_{rms}$ in a bandwidth of DC - 100kHz

Operating temperature: 15 – 30°C

Storage temperature: 0 – 60°C

Relative humidity: 30 – 70% non-condensing

Maximum usage height: 2000m

Dimensions and weight: 190x106x34mm, 0.4 kg

Power: 28V DC, 200mA maximum, with 315mA 5x20mm 230V fuse and on/off switch on rear panel. Use the power supply adapter supplied by Falco Systems only: Mean Well GS25B28-P1J, 100-240V~ 50/60Hz in, 28V 0.75A DC out, 25W, with custom MiniDIN connector

Country of origin: The Netherlands

Specifications may be subject to change

Harmonized standards

This prototype product complies with the following standards:

Safety: EN61010-1

EMC: EN61326

The **CE** mark is present on the WMA-IB-LN device to indicate compliance of this equipment with the European Union safety and EMC regulations, while the **FC** mark has been added to indicate compliance with the United States FCC regulations.

WEEE and RoHS

Do not dispose of this product as standard waste, but bring it to a WEEE electronic waste collection point. This is indicated by

the  sign on the WMA-IB-LN. The WMA-IB-LN has been built in compliance with the RoHS directive.

Warranty

Falco Systems products are guaranteed against malfunction due to defects in materials or workmanship for a period of 1 year from the date of shipment.

If a malfunction occurs during this period, the product will be repaired or replaced without charge. The product will be returned to the customer prepaid. The warranty does not apply to:

- Exterior finish or appearance
- Malfunction resulting from use or operation of the product in other ways than specified in the user manual
- Malfunctioning due to misuse or abuse of the product
- Malfunctioning occurring after changes or repairs have been made by anyone other than Falco Systems.

To obtain warranty service, the customer has to inform Falco Systems first via info@falco-systems.com to receive further instructions.

Falco Systems will not be liable for any consequential damages, including, without limitation, devices or equipment connected to the product, injury to persons or property or loss of use. See for more details the Falco Systems Standard Terms and Conditions of Sale, which can also be obtained via info@falco-systems.com.

User manual version

User manual version: 1.2

Date: October 29, 2018

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