



## USER MANUAL



- High voltage: 20x amplification up to +75V and -75V output voltage
- DC to 20kHz large signal bandwidth and 50k $\Omega$  output resistance
- Power supply 24V DC, battery powered operation possible
- No overshoot with capacitive loads: bandwidth changes automatically to ensure stability
- Short-circuit protected output

### About this manual

This user manual is an integral part of the Falco Systems WMA-005 and WMA-005LF high voltage amplifier products. Please read it carefully and pay attention to the recommendations and instructions for safe use.

### The WMA-005 high voltage amplifier: general description

The Falco Systems WMA-005 and WMA-005LF are high voltage amplifiers that run from an 24V DC power supply and can be battery powered if required, e.g. for use in a Faraday cage. Its internal high voltage generator is inductor-free and hence does not spread magnetic interference in sensitive experimental setups. Its large

voltage range makes it an excellent choice for use with MEMS devices, EO-modulators, piezo actuator positioning systems, beam steering components, and many more.

The amplifiers' full-power frequency response has a -3dB corner frequency at 20kHz. The input impedance is 100k $\Omega$  and the output 50k $\Omega$ .

The output noise of the WMA-005 is <3mVrms. For extremely low noise applications where bandwidth is not an issue, the dedicated WMA-005LF version is available. This amplifier contains an output low pass filter capacitor which reduces the bandwidth to 50Hz, but makes the noise drop to 0.1mVrms. This bandwidth-limited amplifier is ideal for MEMS or piezo positioning with manual voltage adjustment requiring extremely low noise.

The WMA-005 and 005LF amplifiers contain an over-voltage protection for daily use in the laboratory and are long-term short-circuit proof. The input (indicated "Input" on the label), output (indicated "Output") and DC power supply (Indicated "24V DC 180mA") connections are all standard BNC.

The amplification is 20x (fixed). The amplifiers have an output voltage range of -75V to +75V. The 24V DC power supply requirement offers the possibility for battery powered operation. With an output noise below 3mVrms, this amplifier will enable many measurements in different applications.

## Safety

- This product is able to produce over 75V, but the 50k $\Omega$  output impedance limits the current to a rather safe maximum of 2.5mA. This voltage can be painful, but will not be lethal (under normal circumstances). Nevertheless take care. This is a high voltage unit and safety measures should be taken accordingly.
- The internal circuitry of the amplifier operates at high voltage. Only qualified personnel from Falco Systems should service it.
- When the amplifier is turned on or off, a short voltage spike may appear at the output which may damage circuitry already connected to it.
- Replace the fuse with 250V 315mA T 5x20mm rated fuses only.
- This product is only suitable for indoor use in a class II environment (domestic, light industrial).
- The power supply connected to the WMA-005/005LF should be double insulated (class II) or a SELV type (SELV = Safety Extra Low Voltage, typically a battery).
- The WMA-005/005LF is a class III product. Do not connect the amplifier to the mains safety earth. If this is done, the system becomes a class I apparatus with class III isolation, which means that the

protective insulation may be inadequate. Doing so (only under laboratory conditions) is fully at the users' risk. Risk of electric shock!

- The WMA-005/005LF should not be used above 2000m altitude to prevent electrical breakdown.
- This product should only be cleaned with a soft, slightly moist cloth. Unplug the WMA-005/005LF from the DC power before cleaning.

## Input protection

A low-noise amplifier like the WMA-005 or WMA-005LF can never be made fully insensitive to input overload conditions, as this would limit the performance of the amplifier to an unacceptably low level. The absolute maximum input voltage is  $\pm 15V$ . Warning: exceeding this spec may cause permanent malfunction of the amplifier and is not covered by the warranty!

For normal operation, input voltages should remain in the -3.75V to +3.75V range, resulting with an amplification of 20x in an output voltage swing of more than -75V to +75V.

## Output protection

The WMA-005/005LF has been designed to be fully stable with all capacitive loads. It has been optimized for its step-response, but is also a very good linear and sine-wave amplifier. No significant overshoot occurs at any capacitive load.

Overloading or short-circuiting this amplifier will not break down the amplifier, due to the 50k $\Omega$  current limiting resistor that has been employed at the output.

Although the amplifier cannot be damaged by a short-circuit condition or capacitive loading, two situations should be avoided:

- Connecting a charged capacitor.
- Using high inductance values (coils).



Figure 1. The 10x probe connected for monitoring the output signal

## The load

The output impedance of the WMA-005/005LF is 50k $\Omega$ . The amplifier is generally used for high-impedance applications where the load is mainly capacitive. This is the case for MEMS devices, EO-modulators and piezo actuators alike. It should be noted that a coaxial cable also presents a capacitive load of approximately 100pF/m. The cables and capacitance that are connected often limit the maximum usable frequency due to the first order RC filter formed by the output resistance of the amplifier and the connected capacitance.

If output monitoring is required, it is recommended to connect a 10x oscilloscope probe to the output. A special BNC to probe tip connector is usually supplied with the probe (Fig. 1). However, you can choose a different way of connecting the oscilloscope, as long as you mind the high output voltage. Pieces of non-coaxial cable in the connection can cause overshoot in the oscilloscope reading.

The amplifier is capable of amplifying above 9kHz, and should not be used for telecommunication as described in the R&TTE directive 95/5/EC. To prevent unwanted radiation all cables should be kept shorter than 30m.

## Noise and offset

The WMA-005 is a low noise amplifier. The output noise is typically below 3mV rms. If this is not low enough, the dedicated version WMA-005LF is available. It provides less than 0.1mVrms noise: however, the bandwidth is limited to DC – 50Hz (-3dB) instead of DC – 20kHz (-3dB).

## Power supply

Use a 24V DC power supply with a continuous output current capability larger than 200mA. If the power supply has an adjustable current limit, it should be set at 200mA or higher too. Falco Systems offers a suitable 24V power supply, for more details please visit

[www.falco-systems.com/products.html](http://www.falco-systems.com/products.html)

## Amplifier characteristics

In the following pages several amplifier characteristics are shown:

- Frequency response (Fig. 2, 3)
- Square wave response (Fig. 4, 5, 6)
- Influence of a capacitive load on a square wave output (Fig. 7)
- Triangle & sine response (Fig. 8, 9)
- Noise & offset (Fig. 10, 11)

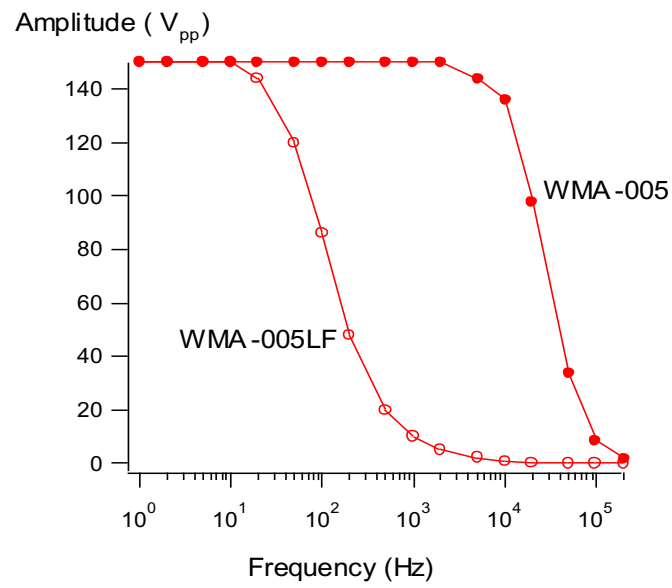


Figure 2. Frequency response at 250Vpp output voltage

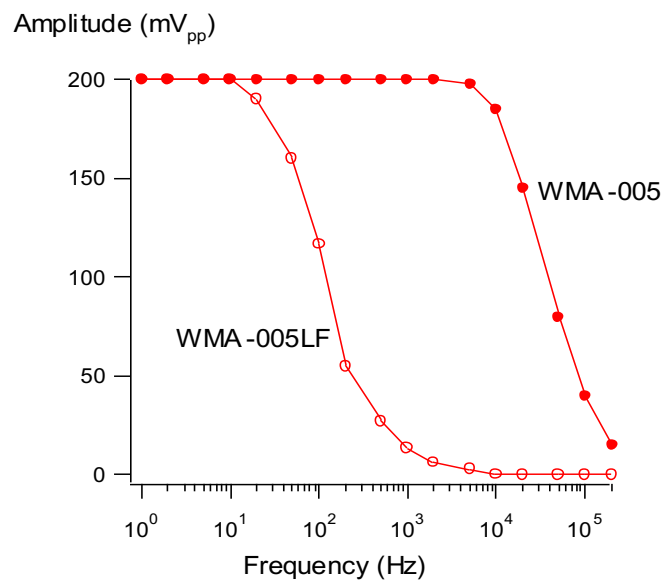


Figure 3. Frequency response at 200mVpp output voltage

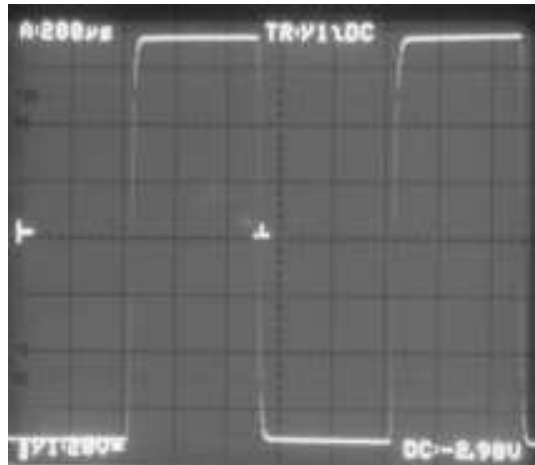


Figure 4. 150V<sub>pp</sub> 1kHz square wave

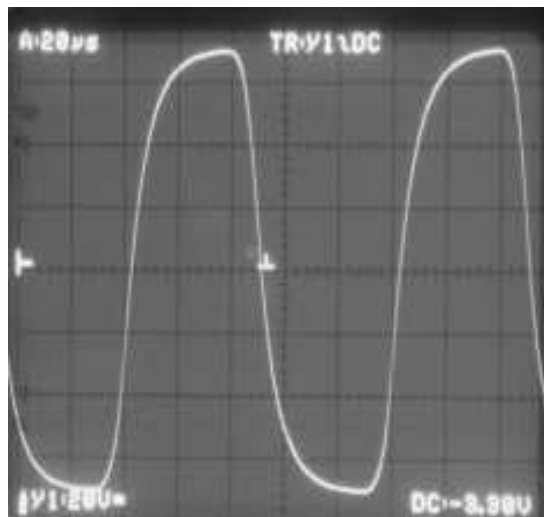


Figure 5. Full scale 10kHz square wave

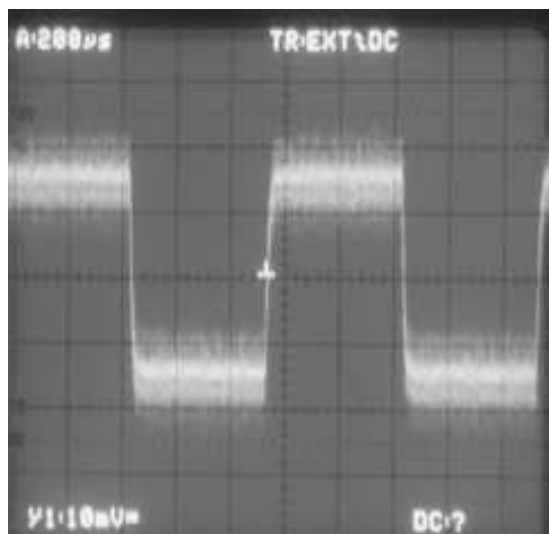
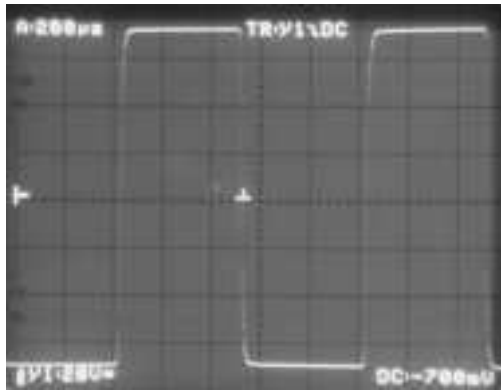
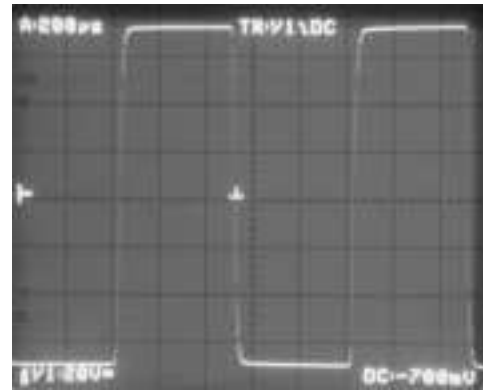


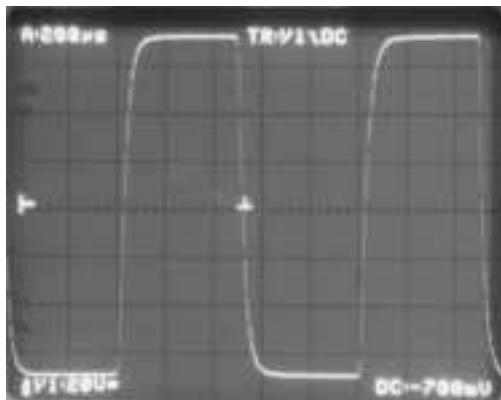
Figure 6. 30mV<sub>pp</sub> 1kHz small square wave output signal



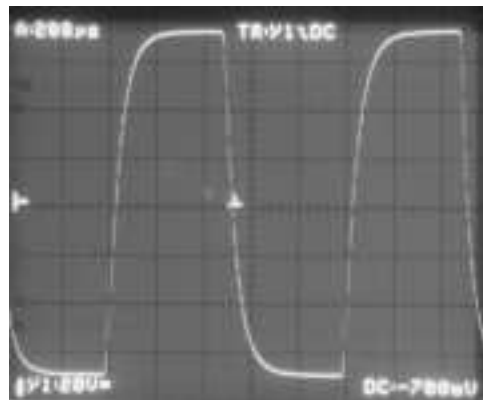
0pF



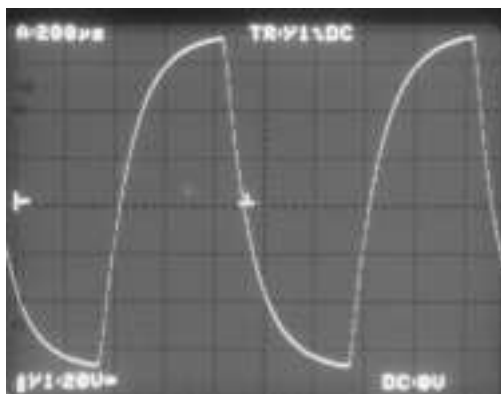
100pF



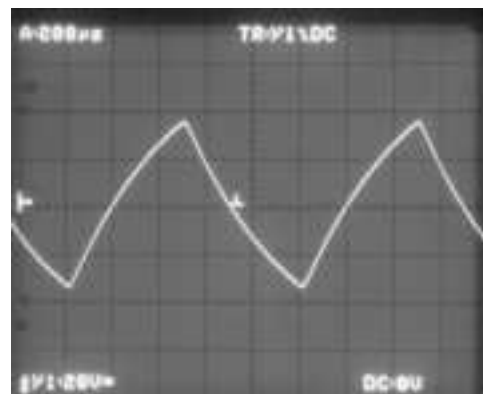
470pF



1nF



2.2n



10nF

Figure 7. Full-power 1kHz square wave response with different capacitive loading conditions. The 50k $\Omega$  output resistor limits the speed at which the capacitor can be charged.

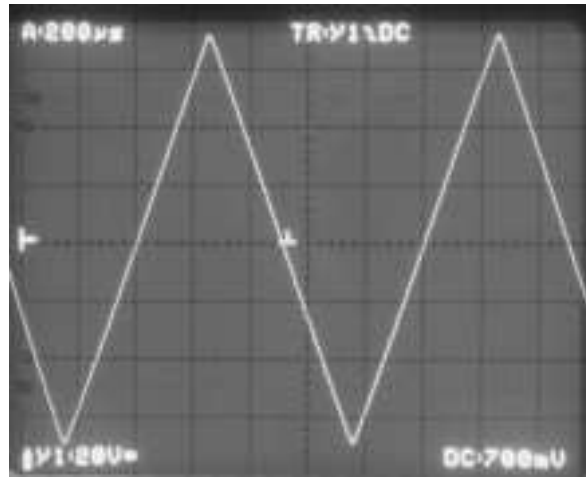


Figure 8. Triangle wave 150V<sub>pp</sub> 1kHz

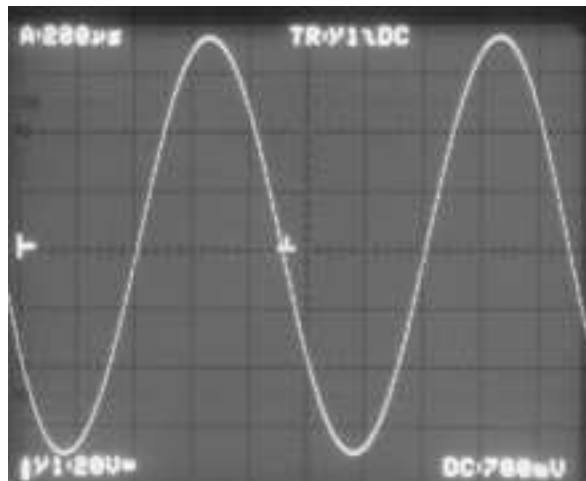


Figure 9. Sine wave 150V<sub>pp</sub> 1kHz

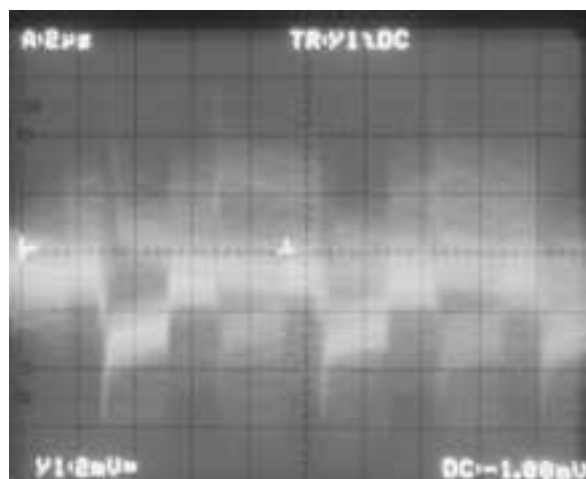


Figure 10. Noise (less than 10mV<sub>pp</sub> or, equivalently, less than 3mV<sub>rms</sub>) and typical DC offset (-1.1mV) for the WMA-005. The high voltage generator frequency (around 150kHz) contributes considerable to the overall noise. This measurement was performed with 1m of coaxial cable connected to the output.

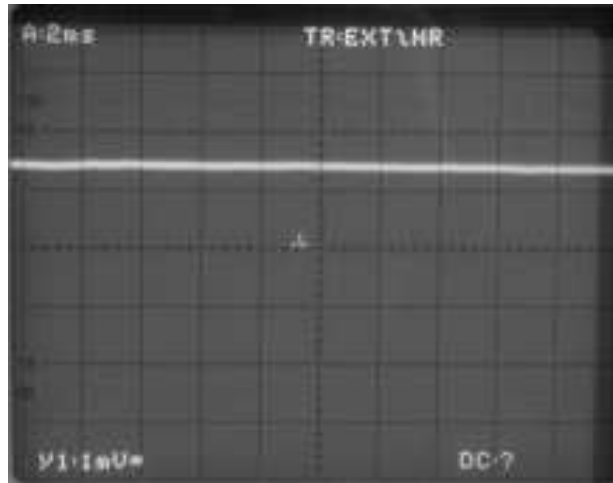


Figure 11. Noise (about  $0.2\text{mV}_{\text{pp}}$  or, equivalently, less than  $0.1\text{mV}_{\text{rms}}$ ) and typical offset ( $+1.5\text{mV}$ ) for the WMA-005LF

## Technical specifications

Amplification: 20x, fixed
Bandwidth: DC – 20kHz @ -3dB large signal bandwidth (DC – 50Hz for the WMA-005LF)
Power supply: 24V DC, 180mA, can be battery powered
Output voltage: -75V to +75V
Noise: $<3\text{mV}_{\text{rms}}$ noise over the full bandwidth typical for the WMA-005; $-1.1\text{mV}$ offset typical
Noise: $<0.1\text{mV}_{\text{rms}}$ noise over the full bandwidth typical for the WMA-005LF, $+1.5\text{mV}$ offset typical
Input impedance: $100\text{k}\Omega$
Output impedance: $50\text{k}\Omega$
Stability: stable with all capacitive and resistive loads, no overshoot $> 5\%$
Fuse: 1x 315mA T 230V
Operating temperature: $10 - 40^{\circ}\text{C}$
Storage temperature: $0 - 60^{\circ}\text{C}$
Relative humidity: 10 – 90% non-condensing
Maximum usage height: 2000m
Dimensions: 50 x 100 x 26mm excl. BNC connectors
Weight: 300g
Country of origin: The Netherlands
HS code: 8543 70 90

Specifications may be subject to change.



## Harmonized standards

This product complies with the following harmonized European standards:

Safety: EN61010-1  
EMC: EN61326



## WEEE and RoHS

Do not dispose of the WMA-005/005LF amplifier as standard waste, but discard it at a WEEE electronic waste collection point. The amplifier 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 on the invoice.

If a malfunction occurs during this period, the product will be repaired or replaced without charge. The product will be returned to the customer free of charge.

The warranty does not apply to:

- Exterior finish or appearance.
- Malfunction of the product resulting from use or operation 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, inform Falco Systems via [info@falco-systems.com](mailto:info@falco-systems.com)

You will receive support and 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. For more details see the Falco Systems Standard Terms and Conditions of Sale, which can also be downloaded on [www.falco-systems.com](http://www.falco-systems.com)

## User manual version

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