

USER MANUAL

- 150V to +150V output
- 300 μ V_{rms} output noise
- 2mV output offset voltage
- \pm 300mA Output current limit
- DC to 100kHz at -3dB full power bandwidth
- Short-circuit protected output
- For precise positioning of MEMS devices, for EO-modulators, driver for PZT (piezo) positioning, beam steering, ultrasonics, ...



About this manual

This user manual is an integral part of the Falco Systems WMA-280 amplifier product. Please read it carefully and pay attention to the recommendations and the instructions for safe use.

General description

The Falco Systems WMA-280 is an ultra-low noise, high-voltage linear laboratory amplifier for demanding applications. Its extreme voltage precision (2mV output offset voltage), ultra-low output noise (300 μ V_{rms}) and large voltage range (-150 to +150V) make it an excellent choice for measurements where high precision is important. The bandwidth is DC - 100kHz. It can be used for precise positioning of MEMS devices (micromachines), with EO-modulators, PZT (piezo) driver positioning systems, beam steering components, ultrasonics, and many more. Through the extensive use of computer modelling and state-of-the-art design concepts, this amplifier can be used in many applications, including those where conventional amplifiers are difficult to apply. It is designed to be absolutely stable and free of spurious signals with any capacitive load.

The amplification is 20x \pm 0.1% (fixed). A fast current limit of \pm 300mA (typical) and a fast short-circuit protection make this amplifier suitable for both the normal daily

laboratory use (and abuse), and automated measurement systems.

Safety

- This product is able to produce over 150V at more than 300mA at its output, which is a dangerously high level (risk of electric shock). Safety measures should be taken accordingly.
- Only use this appliance with a mains connection with protective earth
- The internal circuitry of the amplifier operates at high voltage. Only qualified personnel from Falco Systems should service this amplifier.
- 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 fuses with 250V 630mA 5x20mm slow blow rated fuses only.
- The Falco Systems WMA-280 is only suitable for indoor use in a class II environment (domestic, light industrial).
- This product should only be cleaned with a soft, slightly moist cloth. Unplug the WMA-280 from the mains power before cleaning.

The inputs: connectors, noise and offset

The WMA-280 has been equipped with both a standard BNC input connector and a differential Thomas & Betts multi-pole connector. The latter is to be used when lowest noise and interference performance is required (see below). The amplifier comes with a spare contra-connector for easy interfacing to other equipment. When using the differential connector (with a differential signal), keep in mind that the WMA-280 output ground and housing are internally connected to the mains earth for safety.

Both inputs of the WMA-280 are grounded with $1\text{k}\Omega$, 0.1% resistors, in parallel with 100pF to prevent ESD (electrostatic discharge) input damage. These resistors add some noise to the output voltage unless they are bypassed by using a low-impedance source connected to the inputs. With a finite-resistance source (e.g. 50Ω), the input resistance also forms a resistive voltage divider, which may influence the exact 20.0x amplification factor. This deviation is well-known from the voltage divider equation however, and can be easily compensated for in the input signal if required. When the BNC connector is used, the negative input of the differential input amplifier is unused and sees the internal $1\text{k}\Omega$ as a small noise source.

The $1\text{k}\Omega$ resistors also add to the offset voltage because the input offset current of the input amplifiers generates a voltage over these resistors. This output offset voltage may become as large as 3mV if both inputs are unconnected. By using the differential inputs or grounding the unused input on the differential connector when using the BNC connector, the offset is reduced to less than 2mV .

Input protection

An ultra-low noise amplifier like the WMA-280 can never be made fully insensitive to input overload conditions, as this would limit the noise performance of the amplifier to an unacceptably low level. Resistors in the input lines limit the input current to a safe value as long as the input voltage is not above $\pm 15\text{V}$.

For normal operation, input voltages should remain in the -7.5V to $+7.5\text{V}$ range, resulting with an amplification of 20x in an output voltage swing of -150V to $+150\text{V}$.

Above 15V (-15V) at the input, the amplifier may be permanently damaged if the current of the source is not limited.

Never apply more than $+15\text{V}$ (-15V) to the amplifier input!

Output protection

The WMA-280 has been designed to be fully stable with all capacitive loads. Instability under capacitive loading conditions is a common problem of high-speed negative feedback amplifiers on the market, often resulting in unwanted overshoot voltages, and, in extreme cases, oscillations (check the respective manuals and datasheets for details). In the WMA-280, this problem has been solved

by a clever feedback system. Although overshoot may occur at certain capacitive loads the amplifier will never oscillate.

Overloading or short-circuiting this amplifier will not break down the amplifier, due to the extremely fast current limiting circuit that has been employed.

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)*

The load

The output impedance of the WMA-280 is in the milliohms range. The amplifier is generally used for high-impedance applications where the load is mainly capacitive. This is true for MEMS devices, EO-modulators and PZT's (piezo's) alike. Resistive loads can be used as well. The amplifier behaves neatly with capacitances up to 10nF , but may show significant offset voltages if the capacitive load is higher and high frequency signals are amplified.

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, the user can choose a different way of connecting the oscilloscope, as long as care is taken with the high output voltage. Pieces of non-coaxial cable in the connection can cause overshoot in the oscilloscope reading.

The amplifier should not be used for telecommunication as described in the R&TTE directive 95/5/EC.

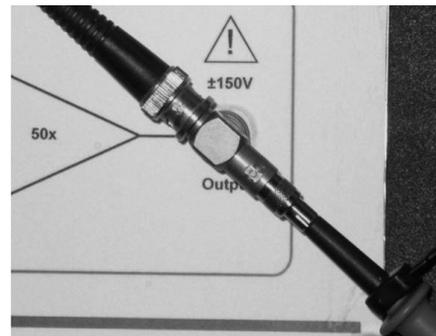


Figure 1. The 10x probe connected for monitoring the output signal

Amplifier characteristics

In the following pages, several amplifier characteristics are shown:

- Frequency response (Fig. 2, 3)
- Noise and offset (Figure 4)
- Integrated output noise spectrum (Figure 5)
- Square wave response (Fig. 6, 7)
- Slew rate (Fig. 8)
- Triangle and sine response (Fig. 9, 10)
- Capacitive load dependency of square wave output (Fig. 11)

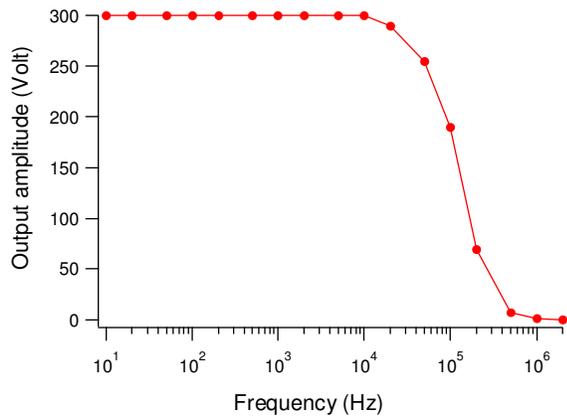


Figure 2. Frequency response at 300Vpp output voltage

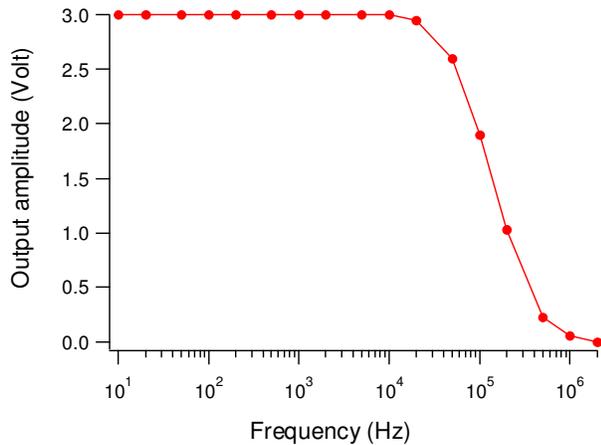


Figure 3. Frequency response at 3Vpp output voltage

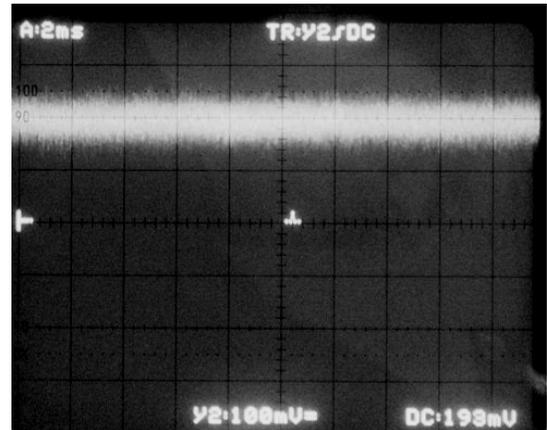


Figure 4. Noise and offset

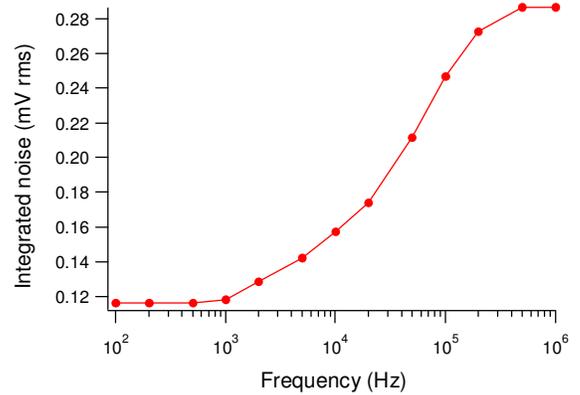


Figure 5. Integrated output noise spectrum

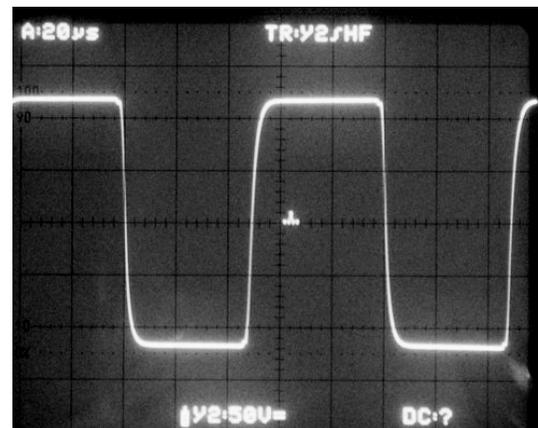


Figure 6. 240V_{pp} 10kHz square wave

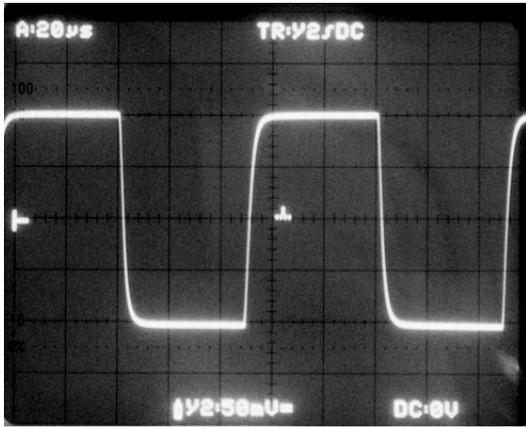


Figure 7. 30mV_{pp} small signal 10kHz square wave

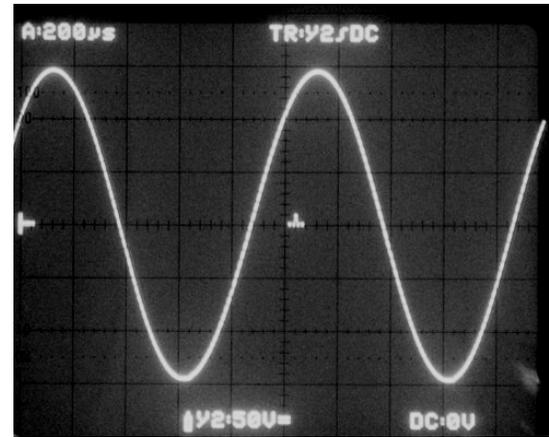
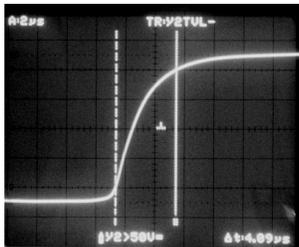
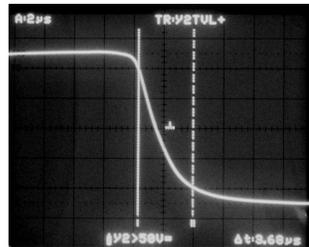


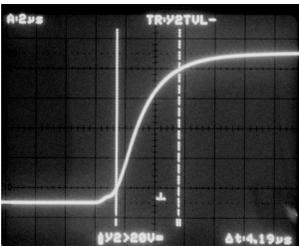
Figure 10. Sine wave 300V_{pp} 1kHz



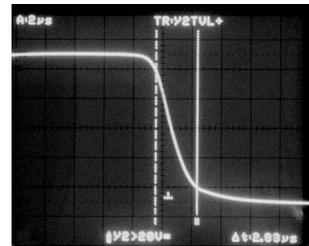
300V_{pp} step up in 4.09µs



300V_{pp} step down in 3.68µs



0V to 150V in 4.19µs



150V to 0V in 2.83µs

Figure 8. Slow rate (definition: step response from 10% to 90% signal). 240V in 4µs ≈ 60V/µs

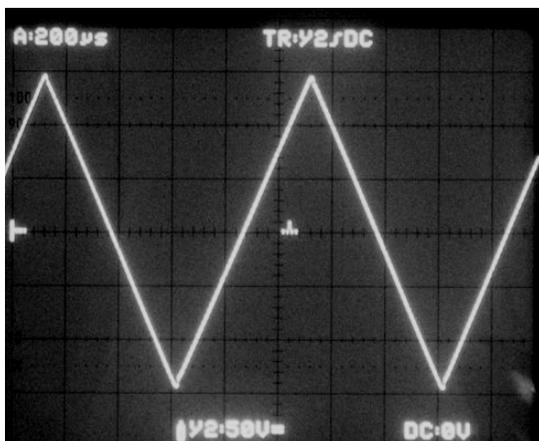
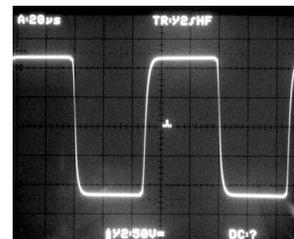
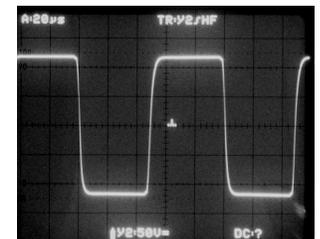


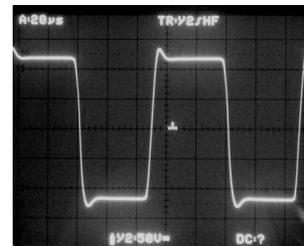
Figure 9. Triangle wave 300V_{pp} 1kHz



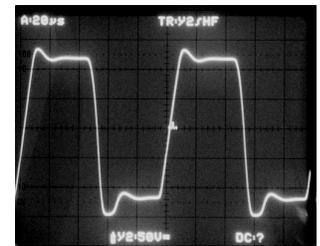
0pF



150pF



1.5nF



4.7nF

Figure 11. 10kHz square wave response with different capacitive loading conditions. The 300mA current limit limits the speed at which the capacitor can be charged and some overshoot occurs with large capacitors.

Technical specifications

Amplification: 20x 0.1%, fixed

Bandwidth: DC – 100kHz @ -3dB

Output voltage: -150V to +150V

Current: 300mA typical with limiter

Output noise: 300µV_{rms} typical

Output offset voltage: 2mV typical

Maximum input voltage: ±15V

Input impedance: 1kΩ 0.1% // 100pF

Output impedance: $\pm 0.1\Omega$

Stability: stable with all capacitive and resistive loads

Power: 230V 50Hz AC, 120W

Mains fuse: 2x 0.63A 230V slow blow

Class 1 safety product: requires mains power supply connector with earth

Do not use: non-sinusoidal power generators, indoor use only

Operating temperature: 15 – 30°C

Storage temperature: 0 – 50°C

Relative humidity: 30 – 70% non-condensing

Dimensions: 280 x 280 x 160 mm

Weight: 6,8kg

Warranty: 1 year

Country of origin: The Netherlands

Specifications are subject to change

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 such a malfunction occurs during this period, the product will be repaired or replaced (at our option) 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 other than as specified in the user manual
- Malfunctioning due to misuse or abuse of the product
- Malfunctioning occurring any time after changes or repairs have been made to the product by anyone other than Falco Systems.

To obtain warranty service, the customer must inform Falco Systems first, and then send the product, prepaid, to Falco Systems together with a proof of purchase of the product in the form of a bill of sale or receipted invoice.

This warranty explicitly only covers the product itself. The repair or replacement including return to the customer are the only services provided to the customer in this respect. 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.

User manual version

User manual version: 1.1

Date: December 9, 2016

Harmonized standards

This product complies with the following harmonized European standards:

Safety: EN61010-1
EMC: EN61326



WEEE

Do not dispose of the WMA-280 as standard waste, but bring it to a WEEE electronic waste collection point.

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