

ACTIVE FILTER AF08

1 Description

The AF08 modules are multi-stage active filters with a Sallen-Key low-pass structure to permit limiting the signal band width. Their main application is as anti-aliasing filters for analogue/digital converters.

In standard design, the modules are laid out as:

- switchable filters with 4 stages 100 - 200 - 500 - 1000 Hz (-3dB),
- with Butterworth characteristic,
- optimised for high output swing and
- equipped with low-power precision operational amplifiers.

There are a number of equipping variants:

- fixed cut-off frequency filter or
- switchable filters in 2 - 3 - 4 stages in the 4th or 8th order in each case, with
- Butterworth or Bessel characteristic,
- optimised for low noise or high output swing.

Because of the low calculation and component selection effort, modules with only one frequency or with a lower order number can be produced at a somewhat lower price than the fully equipped variants.

In the case of the switchable filters, the filter frequency can be switched either via

- the DIP switch on the module or
- remotely via a microcontroller or external mechanical switches (see variants on P.5).

The most practical ratio of frequencies for the switchable filter variants is about 1:10.

In other words, frequencies of between 100Hz and 1kHz or 1kHz and 10kHz can be realised without problem.

Higher ratios can only be realised with certain restrictions in terms of quality, because the same capacitors are used for all stages (see 1st block schematic), and it is only the relevant resistances that are switched via CMOS switches.

It must be ensured thereby that the resistances

- are not too low because of the output load of the internal resistance of the semiconductor switch and
- also not too high because of the increasing noise (and also offset) at high resistance values.

Dimensioning of the filter values is dictated by the application. For maximum output swing, the stage with the highest efficiency is placed at the end of the chain (e.g. at the 8th pole) and for minimum noise at the beginning of the chain (the 1st pole).

Over and above this, correct selection of the operational amplifier makes it possible to optimise the application range of the AF08 module further in terms of

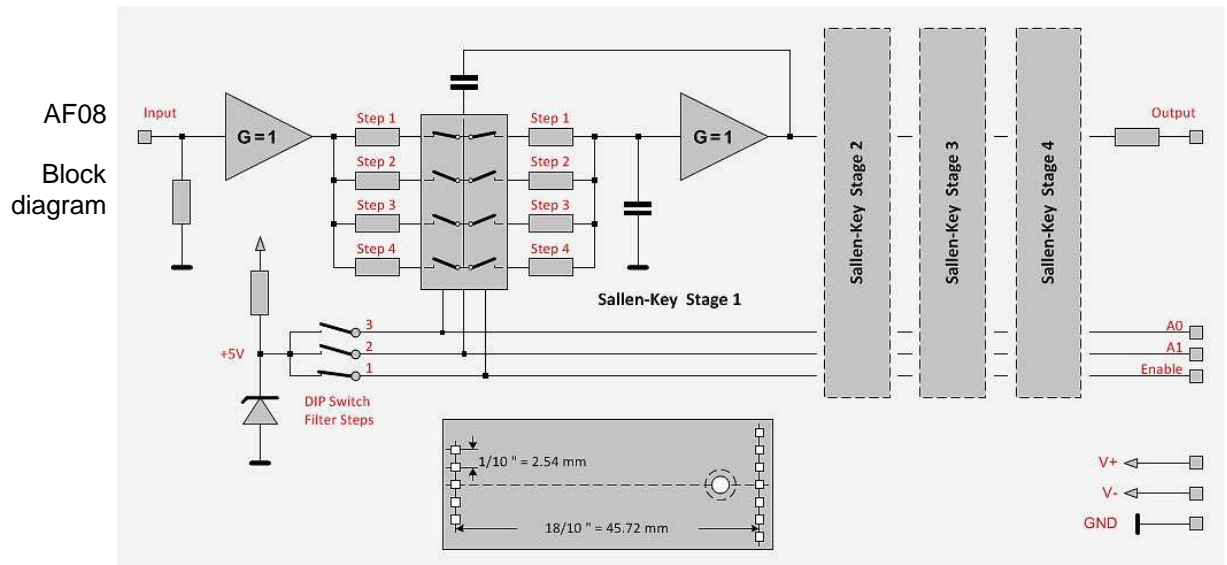
- high AC performance, e.g. for acoustic applications, or
- low power consumption for battery operation, or
- high DC precision for strain gauge amplifiers, etc.

For applications where up to 4 channels (or 8 with two housings flanged together) are sufficient, a mainboard including power supply for 4 modules is available for installation in a housing.

The width of the mainboard corresponds to the standard dimension 100mm (Euro-size board).

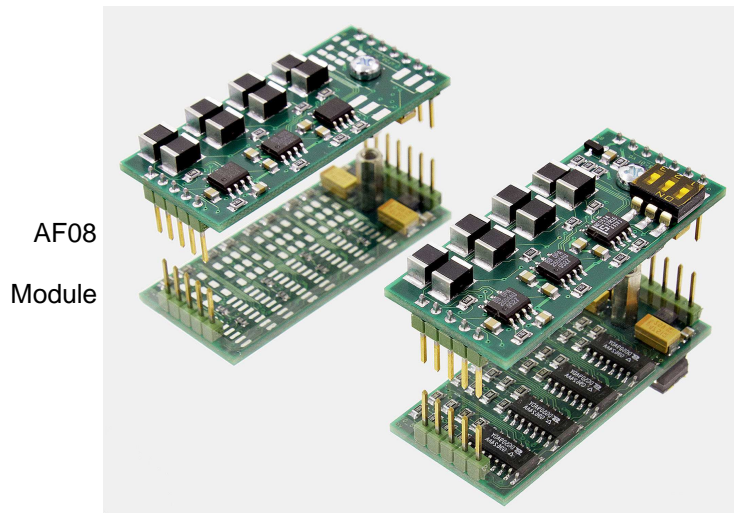
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2 AF08 block diagram with the switchable filter frequencies



Shown here is the first pole of the Sallen-Key filter circuit with the CMOS switch for switching the frequency-determining resistances.

3 Equipping variants: fixed-frequency or switchable filter



a) Fixed-frequency filter

b) Switchable filter

4 Filter frequency set-up:

| DIP switch on module | Switch | 1 | 2 | 3 | F _{Cut-off} [Hz] |
|----------------------|--------|-----|-----|-----|---------------------------|
| | on | on | on | on | 2000 |
| | on | on | on | off | 1000 |
| | on | off | on | on | 500 |
| | on | off | off | off | 200 |
| | off | off | off | off | remote control |

Settings
for
switchable filters

Examples for frequency specs

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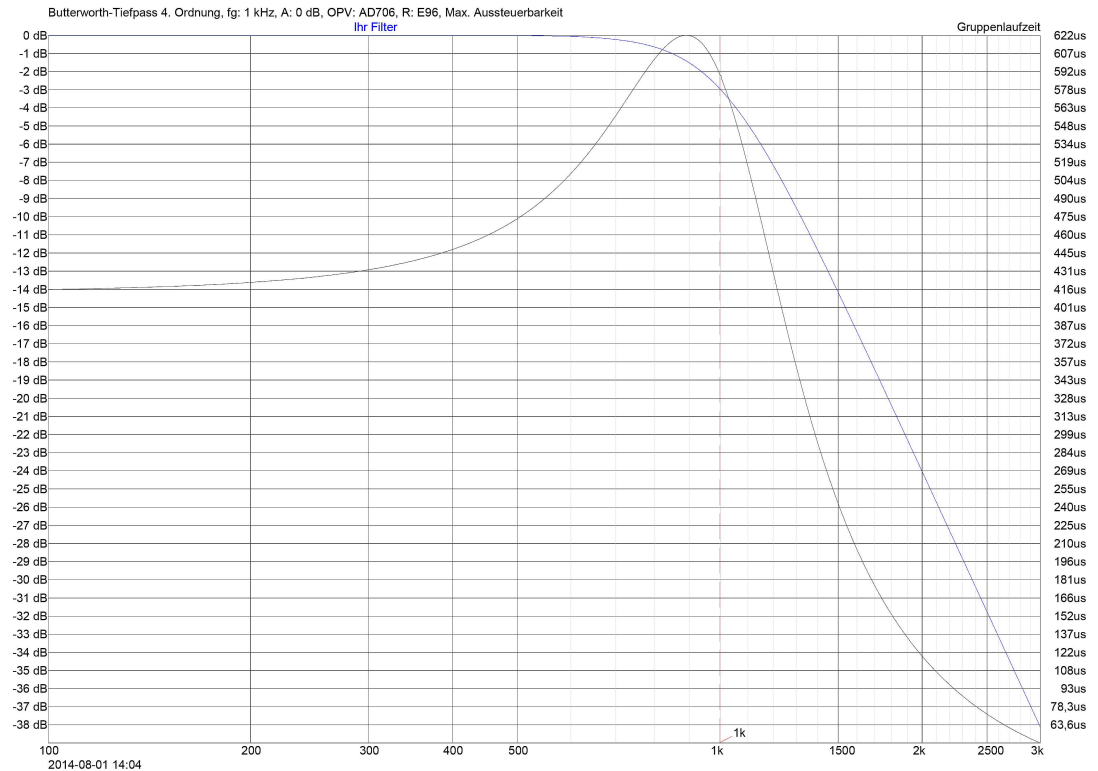
5 Filter curves: cut-off frequencies - group delay times

Blue curve: amplitude gradient plotted over frequency

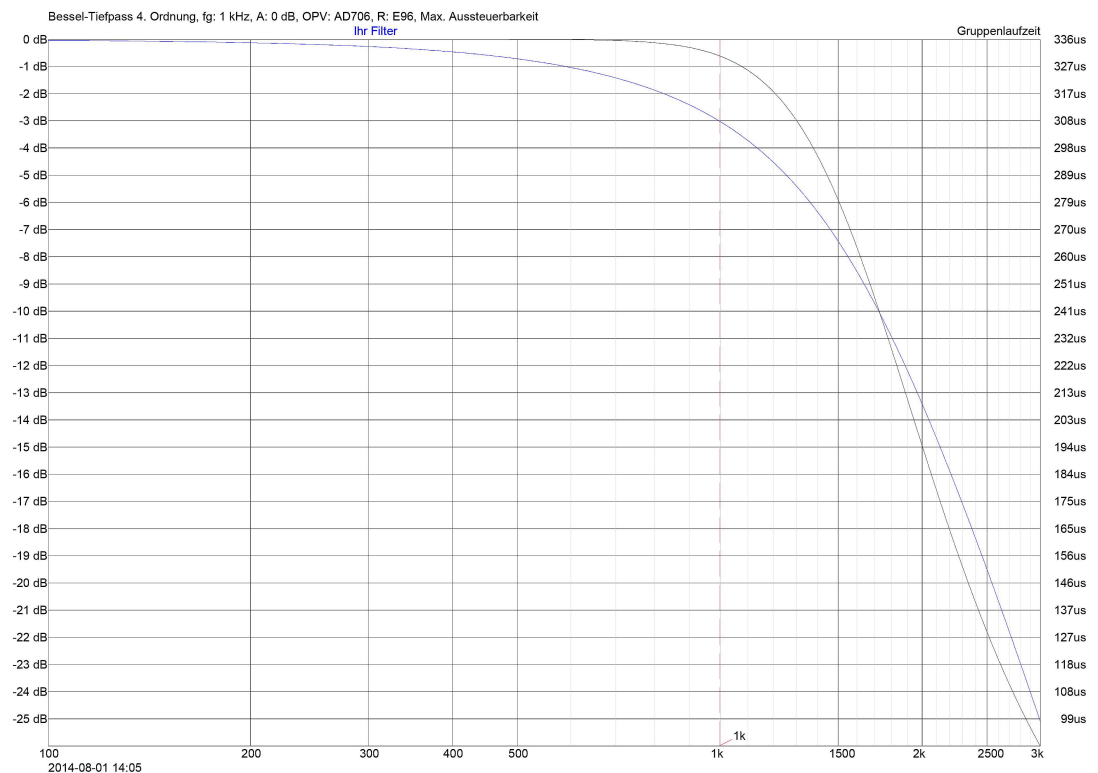
Black curve: group delay time plotted over frequency

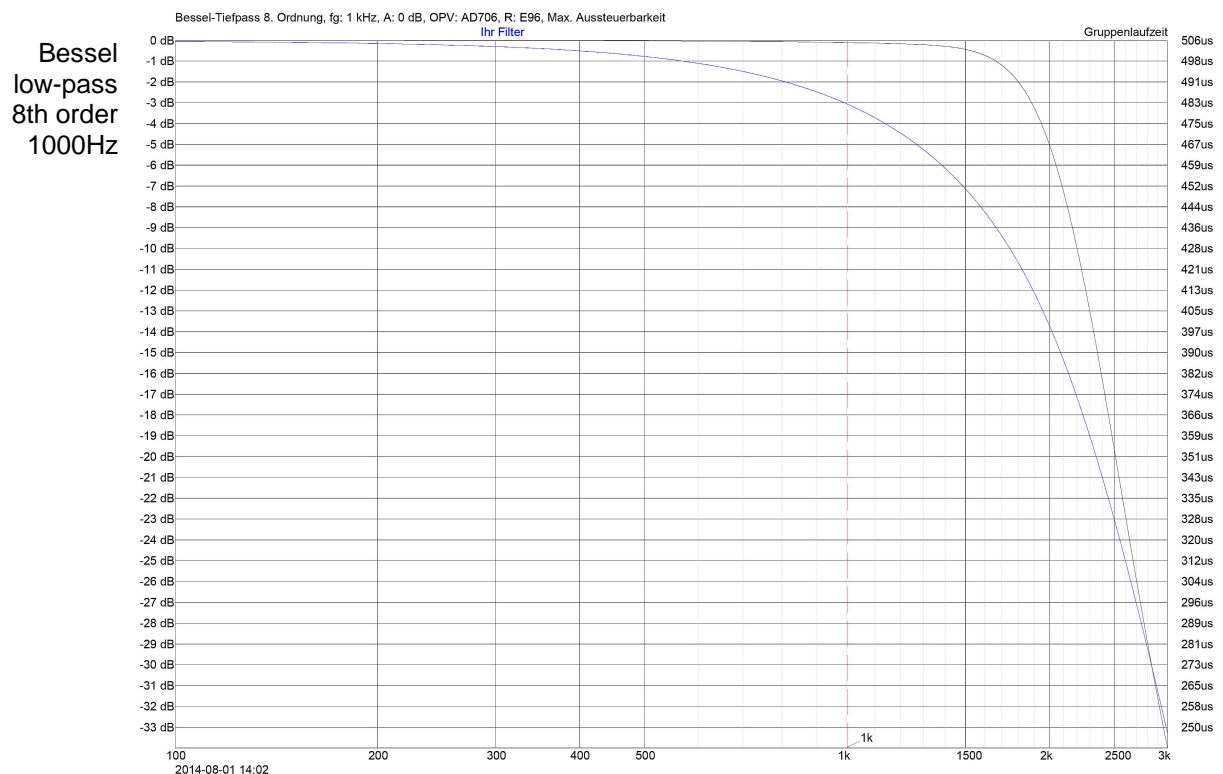
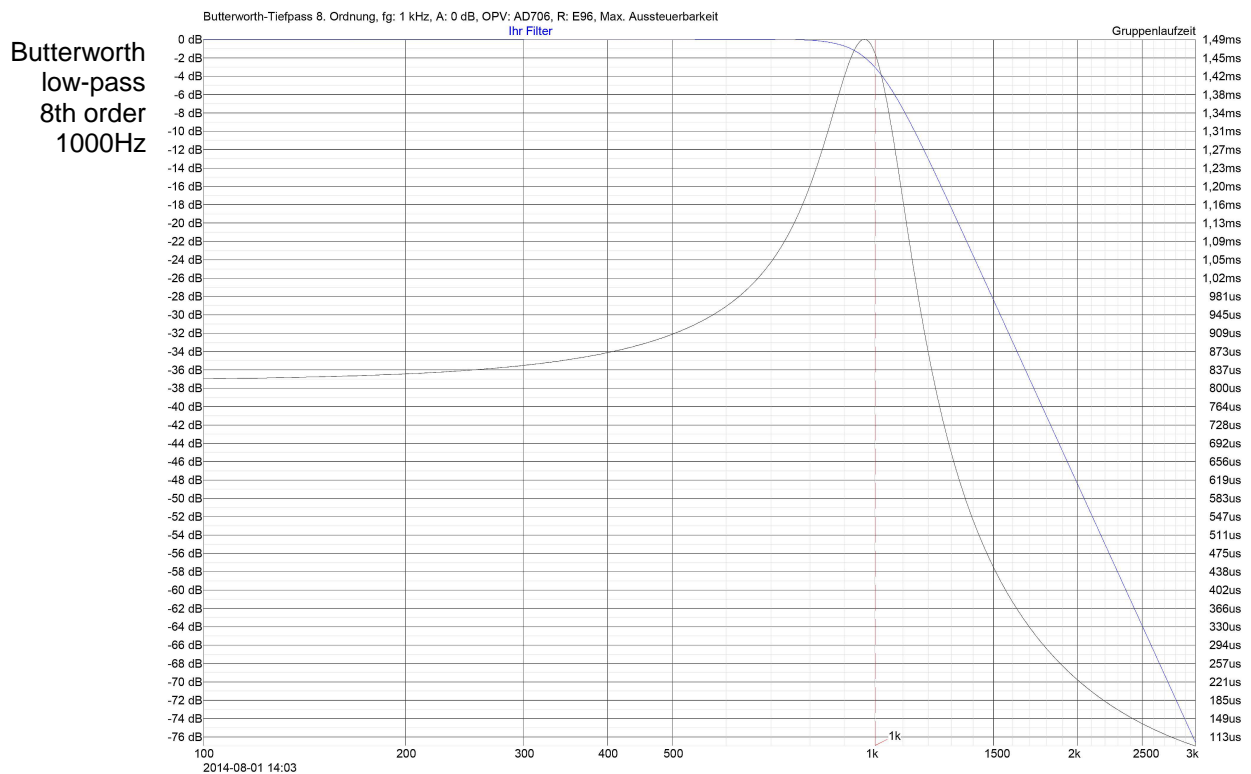
Red line: cut-off frequency (-3dB)

Butterworth
low-pass
4th order
1000Hz



Bessel
low-pass
4th order
1000Hz

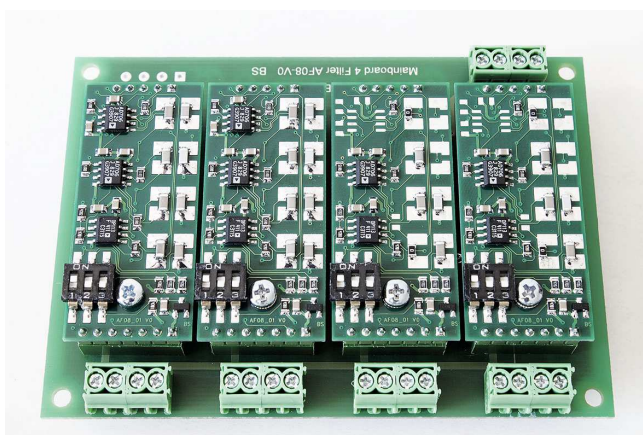


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6 Mainboard and housing

Mainboard
for
4 modules



Mainboard
with
terminals (or solder posts)
for

- Input-Output
- Power Supply
- Power-ON LED
- (optional "Remote Control")

Housing
with terminal
connectors



Housing variants
with / without
mounting plates

Housing
variants



Two housings flanged together for
8 channels

Front variant
with
banana jacks
for
the power supply

Housing
variants



Front variant with rotary switch
for frequency selection
(for 4 modules altogether)
Power supply connector on the back
of the housing

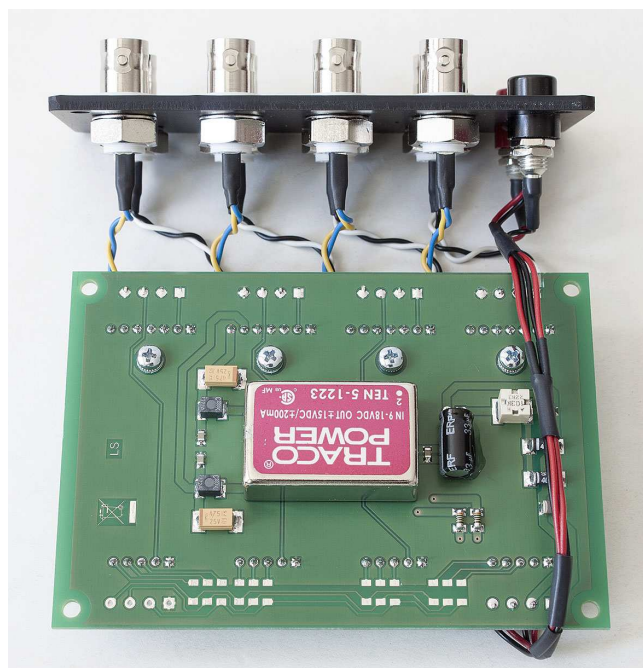
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Mainboard in
housing



Access to the DIP switches
for
frequency settings

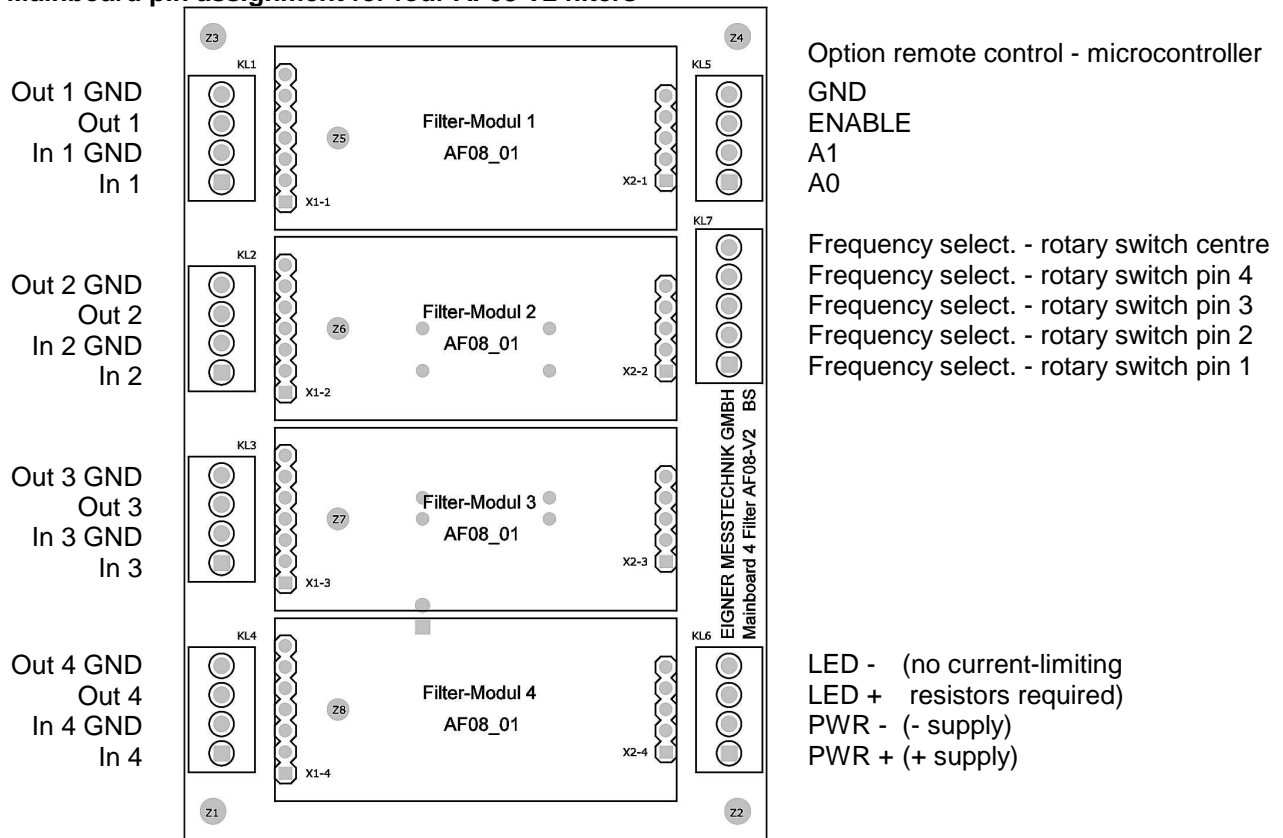
Mainboard in
housing



Rear side of mainboard
with the
power supply components
(w/o remote control option)

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7 Mainboard pin assignment for four AF08 V2 filters



8 Technical specifications of the AF08 module

| | |
|------------------------------------|---|
| Power supply: | ± 12 to 15 VDC |
| Gain: | $G = +1$ |
| R input: | $47 \text{ k}\Omega$ |
| R output: | $51 \text{ }\Omega$ |
| V signal max.: | $\pm 10 \text{ VAC}$ |
| V offset: | $< \pm 2 \text{ mVDC}$ (dependent on the operational amplifier assembly) |
| Remote control: | TTL level (Enable, A0, A1) |
| Operating temperature: | -20 to $+85^\circ\text{C}$ |
| Dimensions: | $48 \times 22 \times 15 \text{ [mm]}$ length x width x height (installation height above mainboard) |
| Pin row raster: | $18/10'' = 45.72 \text{ mm}$, pin spacing $1/10'' = 2.54 \text{ mm}$ |
| Hole dimension for retaining pins: | x-direction 6 mm from 7-pin pin row, y-direction centred for M2.5 screw |
| Height of retaining pins: | 10.5 mm ($10 \text{ mm} + \text{M2.5 washer}$) |

9 Technical specifications of mainboard and housing

| | |
|------------------------------------|--|
| Power supply: | $9\text{-}18\text{VDC}$ or $18\text{-}36\text{VDC}$, or $9\text{-}36\text{VDC}$ via banana jacks (red: +V, black: -V) |
| Power consumption: | approx. 100 mA @ 12 VDC (dependent on the op amp assembly) |
| I/O insulation: | 1500 VDC (onBoard DC/DC converter) |
| Input reverse polarity protection: | $400 \text{ VDC} / 1 \text{ A max.}$ |
| Status display: | LED on $+15\text{V}$ and -15V (series resistors $2 \times 3.3 \text{ k}\Omega$ on mainboard) |
| Plug-in connectors: | Signal input and output per BNC $50 \text{ }\Omega$ (insulated installation) |
| Mainboard dimensions: | $100 \times 70 \times 27 \text{ [mm]}$ length x width x height 4 mounting holes spaced at $93 \times 63 \text{ [mm]}$ for M3 screws |
| Housing dimensions: | $105 \times 108 \times 43 \text{ [mm]}$ length x width x height (without mounting plates, without plug-in connectors) |
| Operating temperature: | -20 to $+85^\circ\text{C}$ |