AAF-2Fe

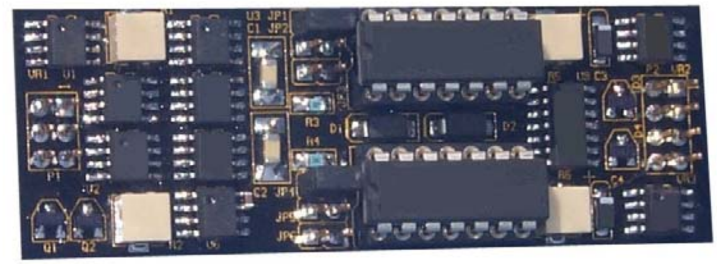
Programmable, 2-Channel Low-Pass Filter Module

Compatible with the AAF-1, AAF-2, AAF-3, AAF-3PCI and OEM Data Acquisition Systems

Features

- Factory configurable gain from 1 to 10000
- Filter types, 8 pole
  - Elliptic (Cauer)
  - Butterworth
  - Bessel (Thomson)
  - Linear phase
  - Hi-speed Linear phase
- ±10V Input and Output optional
- Continuously tunable bandwidths from 0.1Hz to 200kHz
- Differential or Single Ended Instrumentation amplifier input
- Active DC compensation
- DC Offset <1mV
- Gain Accuracy, better than 0.001dB
- Low noise, pre and post filters included

Drive A/D input with output impedance, less than 0.01Ω



Description

The AAF-2Fe may be used with the AAF-3PCI, AAF-3, AAF-2 or AAF-1 filter boards. For all systems, the AAF-2Fe provides flexibility in tunable filter type selections with wide bandwidths making it a perfect choice for a wide variety of filtering applications. AAF-2Fe can be ordered with a factory configured gain from 1 to 10000. The gain option offers exceptional performance for a modest cost.

The AAF-2Fe can be used effectively in time domain as well as frequency domain processing. In the time domain where a small DC offset is critical, the AAF-2Fe filters include Automatic DC offset correction. In both the time and frequency domain, accurate gain can be essential. A factory DC offset adjustment, and a factory gain adjustment provides the AAF-2Fe with one of the best specifications for both DC offset and gain on the market today. The DC offset of the AAF-2Fe is adjusted at the factory for ±0.01mV. Configured with a gain of 1, the AAF-2Fe is factory adjusted @ 1kHz for ±0.001dB gain accuracy.

The AAF-2Fe features connection and operational compatibility with all other previous filter module versions.

Filter Types

A wide variety of filter types are available with the AAF-2Fe. The AAF-2Fe module when combined with the AAF-3PCI, AAF-3, AAF-2 or AAF-1 is suitable for a large range of applications where data is processed in the time domain, frequency domain, or both.

Elliptic (Cauer): The Elliptic filter has ripple in both the pass band and stop band, but provides the fastest transition of any filter type. It has the largest phase non-linearity, especially near cutoff. The step response has the largest overshoot and ringing.

Butterworth: The Butterworth filter has a maximally flat frequency response. The transition is 160dB/decade. This transition is second only to the Elliptic filters. The step response has approximately 15% overshoot, and ringing that lasts for a considerable time. The phase response is non-linear, and has the greatest changes from $0.8f_c$ to $2f_c$.

Bessel (Thomson): The Bessel filter is the time domain equivalent of the Butterworth filter. The Bessel filter exhibits droop in the frequency domain. The droop is predictable and can be compensated in software by adding appropriate gains verses frequency. The Bessel filter has the slowest transition band of any of the filters at 110dB/ Decade The Bessel filter is maximally flat in the time domain, and exhibits less than 1% overshoot. The Bessel filter exhibits linear phase, with constant group delay to about $1.8f_c$.

Linear Phase: The Linear Phase filter approximates a maximally flat frequency response. The Linear Phase filter's transition band is faster that the Bessel. At $2f_c$ the Bessel filter has 12dB of attenuation, while the Linear Phase has 34dB, and at $3f_c$, the Bessel has 30dB, and the Linear Phase 68dB. The Linear Phase filter is optimized for constant group delay out to about $2f_c$. The time domain response has approximately 5% overshoot with no ringing. The Linear Phase filter is a good choice for a compromise filter that works well in both the time domain and frequency domain. One drawback to the Linear Phase filter is at higher cutoff frequencies the filter amplitude response has up to 1dB of gain. To maintain a given distortion level, the input signal level must be reduced at high cutoff frequencies.

Hi-speed Linear Phase: This filter is similar to the Linear Phase filter, but is optimized for speed. The frequency response is maximally flat. The transition band is not as fast as the Linear Phase, but is still better than the Bessel. The step response has approximately 5% overshoot, and no ringing. The phase response is not as accurate as the Linear Phase, and shows some deviation, less than 1% from linear over the band to $2f_c$. This filter exhibits significant gain peaking at higher cutoffs. This gain peaking can be as much as 1dB depending upon temperature, with the greater peaking happening at higher temperatures.

Filter Specifications

	Corner Frequency Range band selectable* jumper selectable low f_c 0.1Hz	Passband Performance	Stopband Rejection	Total Wideband Noise	Phase Match
Bessel	10 Hz – 33 kHz narrow 10 Hz – 67 kHz wide	Group delay ±1% max to f_c, 2dB droop type at 0.75 f_c; low-freq gain –0.5dB +0.15dB max	84 dB Typ.	60µVRMS Typ.	1.2° Typ.
Butterworth	10 Hz – 50 kHz narrow 10 Hz – 100 kHz wide	+0.15dB to -0.5dB max, to 0.85 f_c	90 dB Typ.	80µV RMS Typ.	1.2° Typ.
Cauer	10 Hz – 50 kHz	±0.4dB max, to 0.85 f_c	75 dB Typ.	165µVRMS Typ.	2.5° Typ.
High-Speed Cauer	10 Hz – 50 kHz narrow 10 Hz - 100 kHz wide	Low-freq gain +0.1 dB – 0.5dB max; ripple 0.75dB max to 0.95 f_c	90 dB Typ.	135µVRMS Typ.	1.0° Typ.
Linear Phase	10 Hz – 50 kHz narrow 10 Hz – 100 kHz wide	+.65dB, -.6dB max; -2dB,-.35dB @ .75 f_c +5.75dB, -3.75dB @ f_c narrow band -4.5dB, -2.5dB @ f_c wide band	90 dB Typ.	115µVRMS Typ.	3.0° Typ.
High-Speed Linear Phase	10 Hz – 100 kHz narrow 10 Hz – 200 kHz wide	+.4dB, -.2dB max.85dB at f_c output voltage swing ±3V typ.	90 dB Typ.	175µVRMS Typ.	1.7° Typ.

Input Amplifier

DC offset, Factory Adjusted ..<±.0.01mV
DC offset vs. temperature .....<±20 µV/°C
DC offset, long term drift ....<±5 µV/Month
Common-mode rejection.......gain 1: 80 dB min, 86 dB typ
gain 10: 100 dB min, 106 dB typ
gain 100: 120 dB min, 125 dB typ
gain 1000: 120 dB min, 130 dB typ
Common-mode voltage.........±10 V max
Input voltage ....±5 V max (optional ±10 V max)
Input protection ....±40 V max
Input impedance ....10 MΩ each side to analog ground
Input bias current ....±2 ηA type, ±10 ηA max
Input offset current................±2 ηA type, ±10 ηA max
Amplifier bandwidth...............gain 1: 1.3MHz typ
gain 10: 700kHz typ
gain100: 200kHz typ
gain 1000: 20kHz typ
Amplifier slew rate.................4 V/µsec typ, V_o=±10 V
Noise Voltage, RTI @1kHz...8nV/√Hz

Filter Specifications

DC offset, Automatic ....<±.1.0 mV
Gain ....<±.0.001dB @ 1kHz
Output voltage ....±5 V min (optional ±10 V max)
Load resistance.....................1KΩ min
Output impedance.................<0.01 Ω

Miscellaneous

Power consumption ....75mA at ±12V
Operating temperature..........0°C to 70°C

Ordering Information

Elliptic (Cauer) AAF-2Fe/CE
Butterworth AAF-2Fe/B
Bessel AAF-2Fe/L
Hi-Speed Cauer AAF-2Fe/HC
Linear Phase.........................AAF-2Fe/LP
Hi-Speed Linear Phase.........AAF-2Fe/HLP

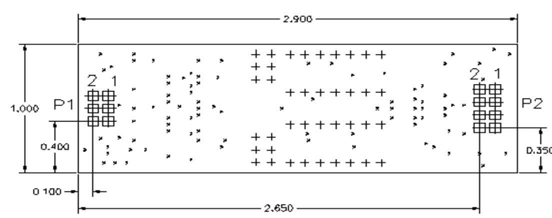
Options*

When the AAF-2Fe is used on an AAF-3PCI or AAF-3 the narrow and wide band select is controlled in software. For wide-band operation on an AAF-1 or AAF-2, the wide-band option is a factory modification.

-001 ....wide-band mode select
-010 ....±10 V max input and output voltage
-400-Y ....Gain modification where Y = gain

These options may be combined e.g. –011 is AAF-1 compatible wide band with a ±10 V max input and output voltage.

Physical Dimensions



Pin Description

Pin #	Input Connector	Output Connector
1	In_A_Hi	Agnd
2	In_A_Lo	Out_A_Hi
3	Agnd	Agnd
4	Mode Selection	Out_B_Hi
5	In_A_Hi	+12V
6	In_A_Lo	-12V
7	N/A	Filter Clock
8	N/A	DGnd