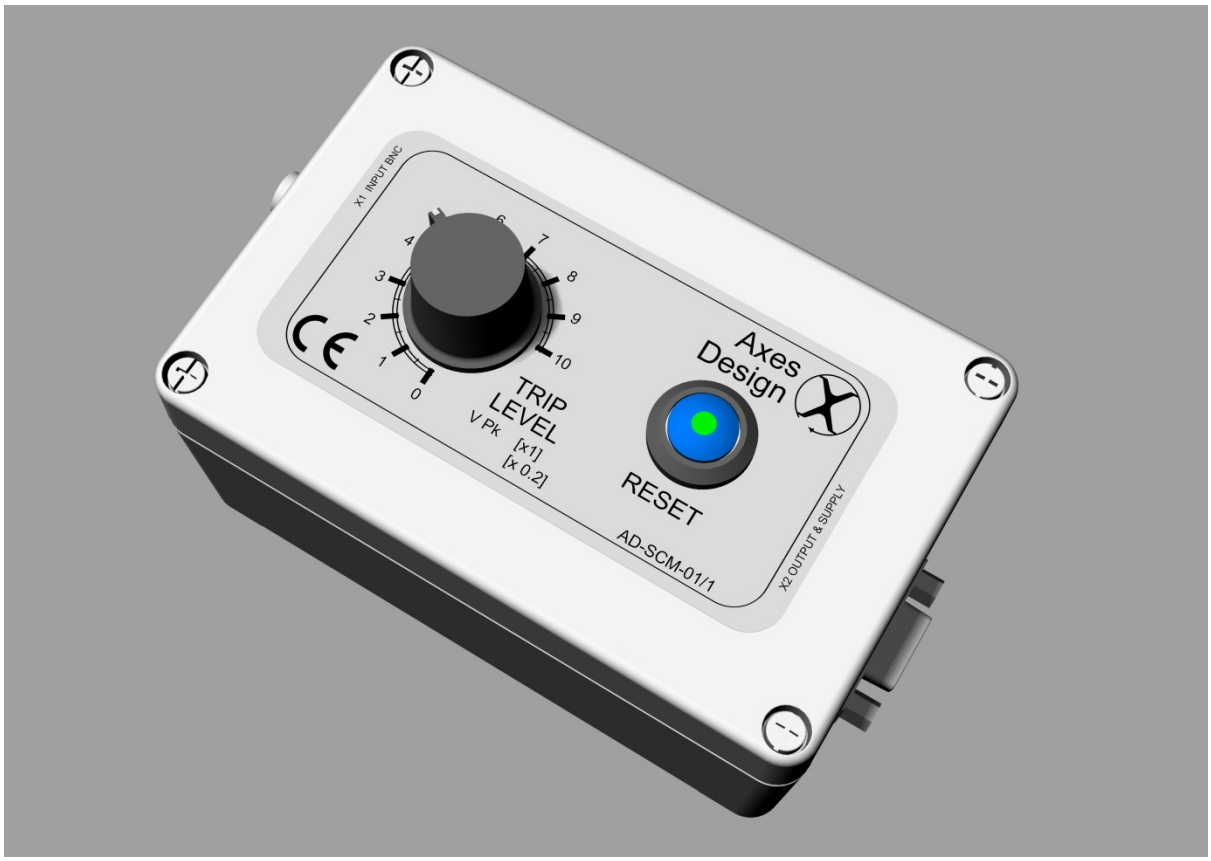
AXES DESIGN

Signal Conditioning Module. SCM-01.1



AC amplitude to DC voltage converter and trip

SHORT MANUAL

Introduction

The module is intended to accept ac signals with or without a DC component. The primary output of the module (AOP2) is a DC voltage proportional to the amplitude of the AC component of the input. The module also provides a volt free contact which will open when the input signal amplitude exceeds a pre-set value. This feature may be used as a trip or peak level detector.

The circuit removes the DC component of the input voltage and converts the residual AC signal to a DC voltage equal to the average of its absolute (rectified) amplitude. The process has high precision and provides a useful measurement of ac amplitude over a dynamic range of > 500:1.

The module is available in a number of build versions depending on the required options, frequency response and gain. (This document refers to the build version and issue shown in the header).

In addition to the primary output, the module also provides an auxiliary monitoring output which can show either the DC or AC coupled input signal after filtering by the module. This AOP1 output is intended as a diagnostic output and has limited current drive capability. A number of link selectable frequency responses are provided for this output.

When fitted with the lid mounted trip option the module is suitable for use indoors in typical test facility conditions and should not be subjected to water spray. A different version of the module is available with environmental sealing to IP65.

Types of waveform measurement

The module supports one type of conversion from an AC waveform conversion (i.e. to average of absolute). For any given waveform shape (sinusoid, triangle wave etc.), the output signal of the circuit and its trip level are proportional to other common measures of waveform (e.g. peak-peak, peak, rms) requiring only a different calibration factor to be applied..

Description

The module is constructed in a grey painted die-cast enclosure. The trip elements are located on the lid of the enclosure. These consist of a momentary reset pushbutton with integral green LED indicator and potentiometer to set the trip level. The LED indicator is lit when the module is reset.

The analogue input to the module is connected via the single BNC connector X1 while all other external connections are made via the 9 way D type socket X2.

Environmental

Dimensions Enclosure	125mm(L) x 80(W) x 57(H)		
Dimensions Overall	144mm(L) x 80(W) x 80(H)		
Connectors c/l	26mm above base		
Weight	0.54 kg		
Mounting	4 x M4 cap screws on 113 x 52 mm rectangle accessed under lid		
Max Ambient *	40	deg C	
Min Ambient	0	deg C	non-condensing

* High temperature options available.

DC Power Supply In

The module requires a safe DC power supply.

Max Volts	36	VDC	max 50mA typical 30mA Max Power = 2W
Min Volts*	9.7	VDC	max 250mA typical 100mA max Power = 2W
Reverse Protected	yes		
Effect of supply voltage	No deviation from specification over min-max range		
Isolation	Module is powered by internal isolated DC-DC converters		
Connector	X 2 - 9 way D type Pin 5: +ve 9: 0V		

* Options to minimum 9V available

Analogue INPUT

Max Volts	+/- 10	V	inclusive of any DC component
Input Connector	Insulated type BNC with centre pin +ve		
Isolation	Differential with limited Common Mode Range and CMMR		
Isolation (Option not in this build)	A high gain instrumentation amplifier with high gain and CMMR is available as an option as well as excitation supplies for transducers.		

Trip

Trip Contacts

Max Switching Current	AC	0.5A @ 120V	DC	1A @ 24V
Max Switching Power	AC	60VA	DC	30W
Contact Material	Gold clad silver			
Relay Type	OMRON G5V-1 Single Pole change Over			
Output Connection	X 2 - 9 way D type Pin 6 - Common/ Pin 7 NC/ Pin 8 NO			
Output Logic	Tripped condition yields Open Circuit Pin 6..Pin 8			

Trip Setting and action

Potentiometer Mechanical range (deg.)	290	+/-5deg
Potentiometer Electrical range (deg.)	270	+/-5deg
Linearity	5	% FS
Accuracy at a scale point	+/-5	% FS
Repeatability	+/- 1	% FS
Zero Setting	+/-2	% FS
Response time (see detail J11/12)	0.1 .. 2 secs	varies with jumper link
Latching	Option Yes and No	Set by jumper link

Analogue OP AOP1

AOP1 supplies a retransmission of the input signal as AC or DC coupled with 3 filter options. The settings of the AOP1 output do not have any effect on any other functions of the module.

Max Volts	+/- 10	V	inclusive of any DC component
Max Drive Current	+/- 10mA		
Overall DC gain	1.0 +/- 0.05		
Output Connector	X 2 - 9 way D type Pin 1 +ve 2 GND		
Maximum Load Capacitance	300pF		
Recommended cable	Co-axial		
Isolation	Common Ground		

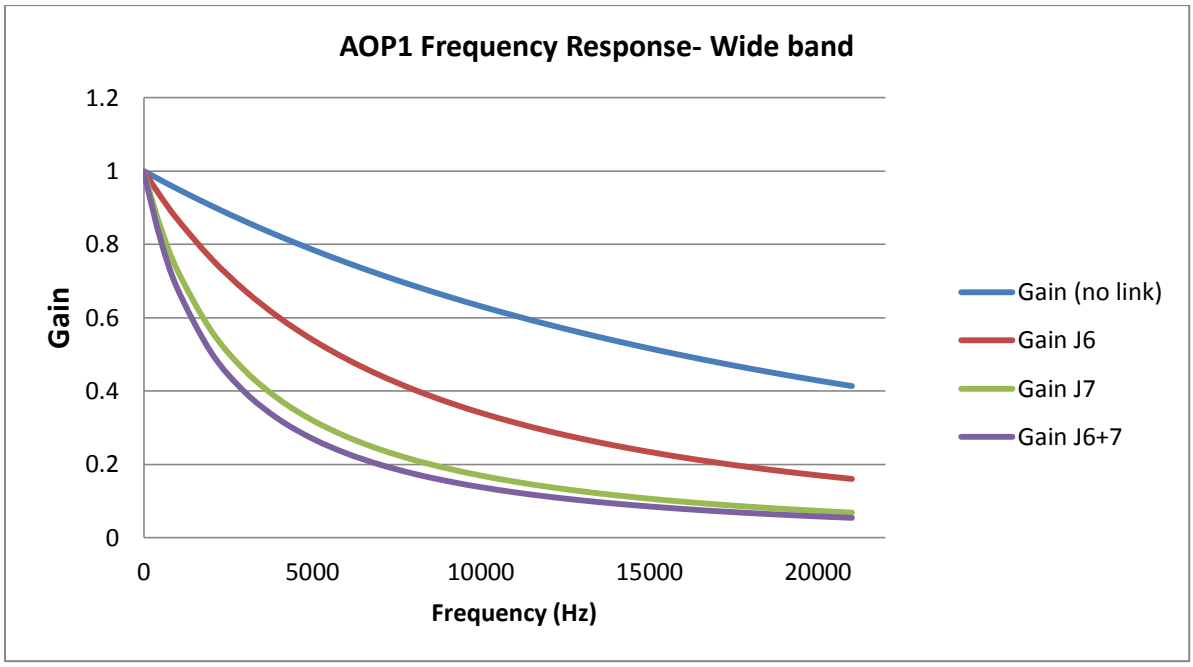
Coupling Option - Only one link to be fitted

J4 Fitted	DC-Coupled	See Figure 1
J5 Fitted	AC Coupled and filtered	See Figure 2

AOP1 Low Pass Frequency Response

JP6	JP7	Output Pole Nominal (kHz)
x	x	70 +/- 10%
Yes	x	9 +/- 10%
x	Yes	3 +/- 10%
Yes	Yes	2.4 +/- 10%

Figure 1a AOP 1 Frequency response J4 fitted.



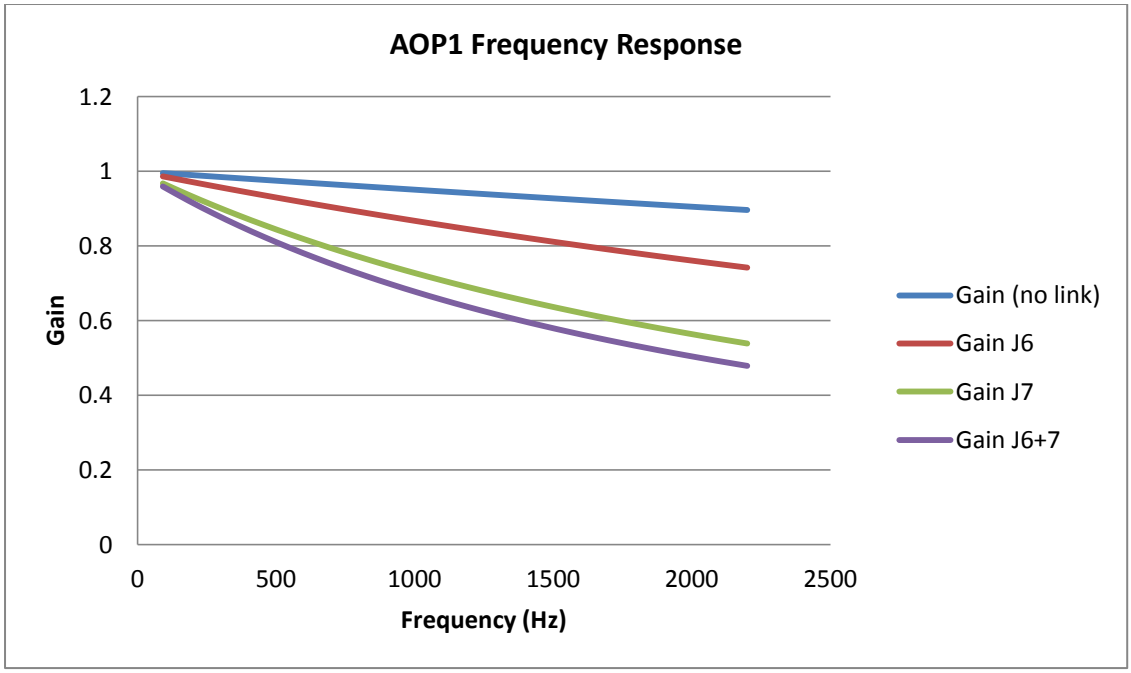
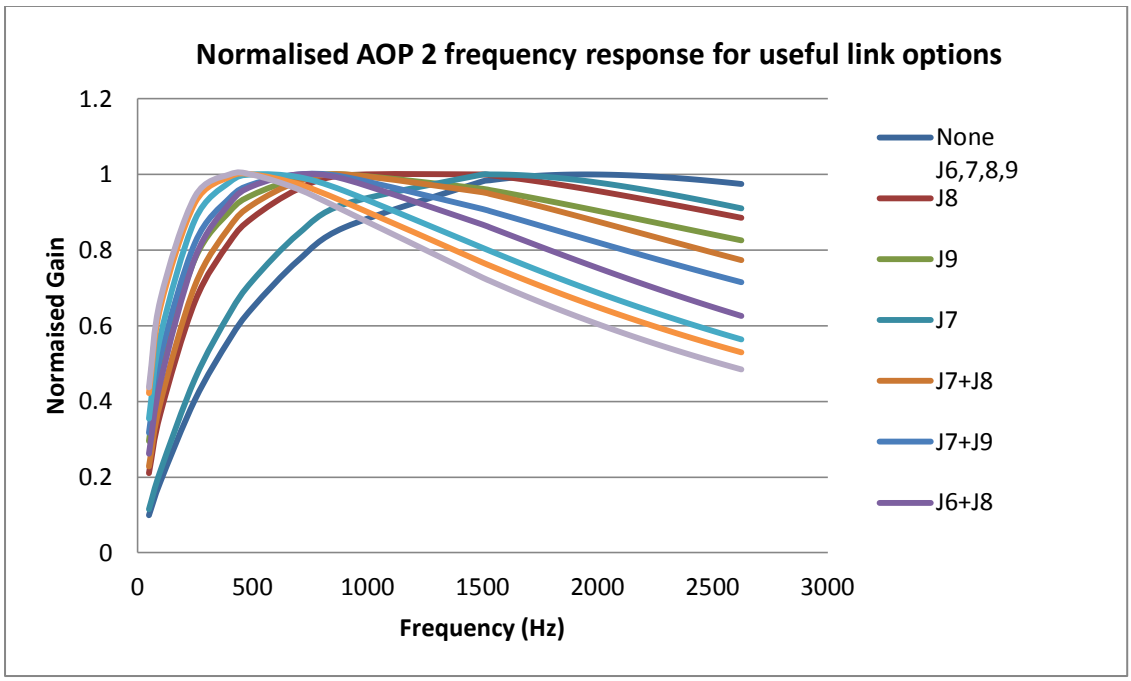


Figure 1b AOP 1 Frequency response J5 fitted.



With J5 fitted AOP1 retransmits the AC component of the input with a number of filter options. The above plot shows a number of the most useful jumper combinations. The gain is normalised to the highest gain in the pass band to assist comparison

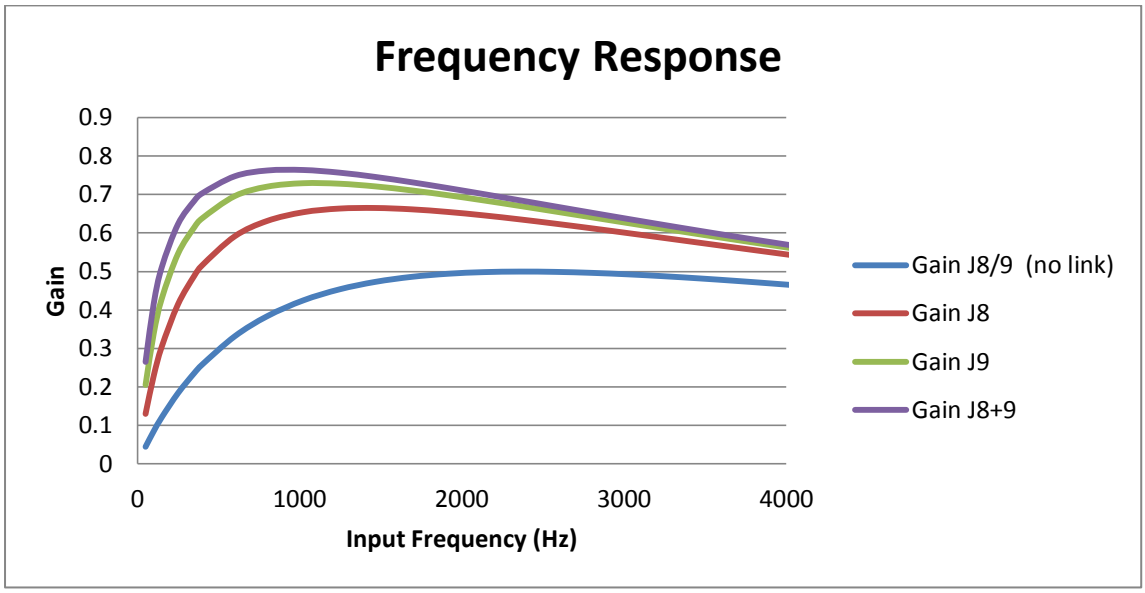
Analogue OP AOP2

AOP2 is the primary output of the system

Specification

Max Volts	+/- 10	V	inclusive of any DC component
Accuracy Gain at 1kHz	Gain = 1 +/- 0.05 i.e. 2V pk-pk at input gives 0.636V +/- 5% at AOP2		
Accuracy Zero	+/- 5mV		
Isolation	Common Ground		
Max Drive Current	+/- 10mA		
Repeatability	+/- 1% of FS over the range 5C to 35C ambient		
Output Connector	X 2 - 9 way D type Pin 1 +ve 2 GND		
Maximum Load Capacitance	300pF		
Recommended cable	Co-axial or multi-pair o/s screen		
Isolation	Common Ground		

Figure 2 The Overall gain response options of the module with frequency prior to conversion to DC.



Gain Option

The Gain link J10 enables an overall gain increase of x5 to be applied (by removal of the link).

When operating at x5 gain the module is able to resolve lower amplitude signals at its input than in x1 setting and it may be used with input signals as low as 2mV pk-pk. (approx. 10mv pk-pk in the x 1 mode) The AOP2 output will remain substantially linear up to 4 pk-pk (dynamic range 2000:1). Higher input levels may be used when accurate measurement (of signals over 4V pk-pk) is not required .

The Absolute Converter

The circuit applies the filtering shown in Figure 2 to the input signal then converts the resultant signal into a DC signal. It also applies one of the selections of smoothing options as set by JP11 and 12 to this DC signal which is output via AOP2.

AOP2 Smoothing Options

JP11	JP12	Time Constant (Sec)
x	x	0.05
Yes	x	0.25
x	Yes	0.5
Yes	Yes	0.75

The Time constant (sec) is the time taken for the AOP2 output to reach 63% of a step change in the input amplitude. It must be understood that the delay in reaching a final value or trip level will be significantly longer than the time constant.

In addition it must also be appreciated that input signals greater than +/- 10V will saturate or clip in the circuitry. Although the average value will continue to rise and a trip set at 10V peak will still activate, it will do so less rapidly than a corresponding step change occurring at a lower voltage.

Choice of smoothing

The smoothing is required to average the AC signal so a time constant must be used which is significantly longer than the period of the lowest frequency of interest. The introduction of further smoothing is then a compromise between the speed with which the AOP2 output and trip respond to a sudden rise in the amplitude of the input signal and the ability of the module to reject unwanted short term noise.

It will be seen from Figure 2 that the bandwidth selection reduces the modules' sensitivity at the low frequency end of the pass band. Operating the module with a wide pass band is recommended when the input signal is sinusoidal and low noise. Where low frequency signals are present , such as low frequency modes of vibration or mains born interference on the sensor signal, it may be helpful to use the J8/9 link options to reduce the low frequency sensitivity of the module. Once all the link options are finalised it will be necessary to calibrate the trip scale by the application of known amplitude AC waveforms.

The AOP2 output of the module is both repeatable and stable with temperature and supply voltage. If the module is used to monitor the amplitude of a signal directly related to a known frequency (such as a first order vibration amplitude of a rotating machine operating at a known speed) the overall function of gain vs frequency of the module may be determined and used to compensate its output for operating speed . Typically this may done within an automation system making it possible to obtain a measurement of the ac signal amplitude to < 0.2% FS at steady speed.

Scale and Range

For this build AOP1 and AOP2 have the same gain as the input. AOP1 is bi-polar while AOP2, being the average of the absolute input, is always positive and in the range 0-6.36V which corresponds to 0-10V peak for a pure sine wave for a pure sinewave.

The trip level is also ranged between 0-6.36V so the scale indicates Pk input volts. Due to the limited precision available with potentiometers it is necessary to calibrate the module trip scale on an individual basis if precision of greater than that provided by the common scale (5% Full scale) is required.

When this x5 gain link is fitted the scale multiplier [x0.2] on the front panel of the module should be identified using an indelible marker pen.

Use with alternative waveforms

The module is designed to be used with sinusoidal waveforms but it may also be applied to non - sinusoidal waveforms providing care is taken to calibrate the module using the required waveform . Square wave inputs have the highest average to peak factor and must be limited in amplitude to +/- 6.36 V to ensure that the trip system and AOP2 output do not saturate.

Wiring Connections - X2

9 way D type pin mating connector required to suit sockets on enclosure.

Pin No	Function	Description
1	AOP1 +	Filtered version of the Input
2	AOP1 -	GND
3	AOP2 +	Peak Absolute Amplitude Volts DC
4	AOP2-	GND
6	Contact 1	Trip Contact NO
7	Contact 2	Trip Contact NC
8	Contact 3	Trip Contact Common
5	PSU +	Power To Module +ve
9	PSU -	Power to Module -ve