KAD/ADC/116

Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w) – 12ch at 12 ksps

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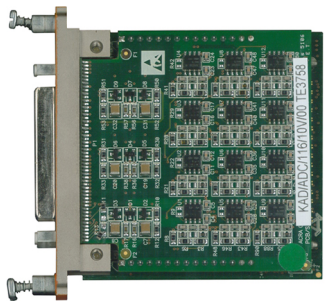

Key Features

- 12 accelerometer input channels with DC-reject
- Ordering Input range (1V, 10V)
- Accuracy 0.4% FSR max. at 10 Hz
- Constant current source excitation on each channel (3.6 mA typical)
- Short on any channel does not affect others
- 16-bit simultaneous sampling on each channel

Applications

- Accelerometer signal conditioning and digitalization
- Suitable for ICP©, Isotron©, and Deltatron© sensors

Overview

The KAD/ADC/116 is used to condition and digitize up to 12 accelerometer-type input channels. Each of these channels has a constant current source and AC coupled (DC-reject) inputs for use with integrated charge-amp piezoelectric accelerometer devices.

At the heart of the KAD/ADC/116 is a hard-wired state-machine that over-samples all channels at a rate between 48 ksps and 96 ksps and digitally filters any noise above the user-programmable cutoff frequency. This is achieved using cascaded, half-band, Finite-Impulse-Response (FIR) filters followed by an 8^{th} order Butterworth IIR filter with a default cutoff point set at one quarter of the sampling frequency ($f_c = f_s / 4$).

All signals are sampled simultaneously. This means that even when several channels are sampled at different sampling rates, the sample at the start of the acquisition is always synchronized.

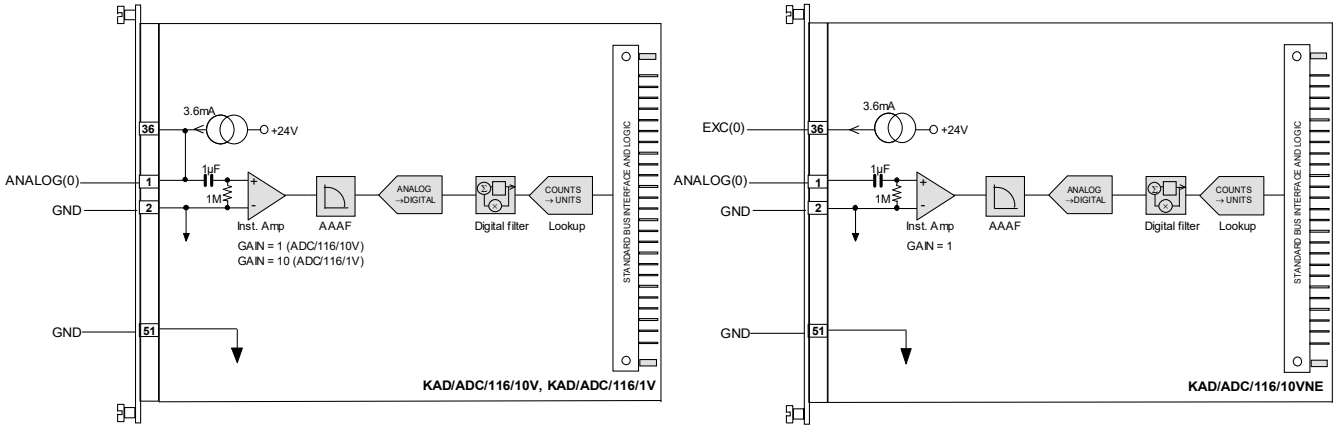

Figure 1: First of 12 accelerometer channels on the KAD/ADC/116/10V, KAD/ADC/116/1V and KAD/ADC/116/10VNE

Specifications

All values provided in the following specification tables are valid within the operating temperature range specified under "Environmental ratings" in the "General specifications" table. Module specifications are met for up to 97% of Full Scale Range (FSR).

TABLE 1	General specifications				
PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITION/DETAILS
Slots	–	–	1	–	Can be placed in any user-slot in any combination.
Mass					
	–	90	–	g	
	–	3.17	–	oz	Design metric is grams.
Height above chassis					For recommended clearance requirements see the *CON/KAD/002/CP* data sheet.
bare connector	–	–	11	mm	
bare connector	–	–	0.43	in.	Design metric is millimeters.
Access rate	–	–	2	Msps	Maximum combined access rate for read and write.
Power consumption					
+5V	100	–	140	mA	
±7V	0	–	0	mA	
±12V	45	–	65	mA	Excludes current used by excitation. As a DC/DC converter is used, multiply excitation current by 1.5 to calculate +12V and -12V line currents.
total power	1.58	–	2.26	W	Particular combinations of chassis and Acra KAM-500 modules may have power or current limitations. For details, see *TEC/NOT/016 - Power dissipation, TEC/NOT/049 - Power estimation*, and the relevant chassis data sheet.
Environmental ratings					See *Environmental Qualification Handbook*.
operating temperature	-40	–	85	°C	Chassis base/side plate temperature.
storage temperature	-55	–	105	°C	

TABLE 2	AC analog inputs (for KAD/ADC/116/10V and KAD/ADC/116/1V shorted internally with DC current excitation outputs)				
PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITION/DETAILS
Inputs	–	–	12	–	
Sampling rate					While the sampling rate can be set individually, each must have a power of two times any other (¼, ½ ...2, 4).
ANALOG[11:0]	2	–	12,000	sps	
Input voltage					
operating range	-10	–	10	V	KAD/ADC/116/10V, KAD/ADC/116/10VNE.
operating range	-1	–	1	V	KAD/ADC/116/1V.
overvoltage protection	-40	–	40	V	Voltages outside of this range can damage input.

TABLE 2	AC analog inputs (for KAD/ADC/116/10V and KAD/ADC/116/1V shorted internally with DC current excitation outputs) (continued)				
PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITION/DETAILS
AC gain error					
gain = 1	–	–	0.4	%FSR	For 10 Hz < f_{in} < 0.6f_c. f_c < 2 kHz.
gain = 2	–	–	0.4	%FSR	For 10 Hz < f_{in} < 0.6f_c. f_c < 2 kHz.
gain = 4	–	–	0.4	%FSR	For 10 Hz < f_{in} < 0.6f_c. f_c < 2 kHz.
gain = 8	–	–	0.4	%FSR	For 10 Hz < f_{in} < 0.6f_c. f_c < 2 kHz.
Effective number of bits	12	–	–	bits	For 10 Hz < f_{in} < 0.6f_c. f_c < 2 kHz.
Crosstalk	–	–	-72	dB	
Analog filters					Analog filters are Butterworth.
High pass filter					
poles	–	–	1	–	
filter cutoff -3 dB	–	0.16	–	Hz	
Anti aliasing filter					
poles	–	–	4	–	
filter cutoff -3 dB	5.7	6	6.3	kHz	
Digital filter					Digital filter is Butterworth.
poles	–	–	8	–	
filter cutoff -3 dB	0.25	–	16	f_s	The maximum value is limited to 3 kHz (f_s : sampling frequency).
0.1 dB bandwidth	–	0.8	–	f_c	
aliasing to 0.1 dB band	–	–	-70	dB	
aliasing to f_c	–	–	-74	dB	
Filter delay	–	0.66	–	ms	Measured for f_{in} = f_c = 3 kHz (f_{in} : input signal frequency; f_c : filter cutoff frequency). See “Understanding filter delays” on page 7.
Input impedance					
each input to GND	20	25	–	kΩ	Module powered off (measured at 3 kHz).
each input to GND	200	250	–	kΩ	Module powered on (measured at 3 kHz).

TABLE 3	Single ended DC current excitation outputs (for KAD/ADC/116/10V and KAD/ADC/116/1V shorted internally with AC analog inputs)				
PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITION/DETAILS
Outputs	–	–	12	–	Applied in groups of four channels.
Output current					
operating range	–	3.6	–	mA	
compliance	–	–	24	V	
short circuit current	–	3.6	4.9	mA	
short circuit duration	∞	–	–	s	
DC error					
error	–	–	1.3	mA	With a constant 2.2k load.
noise	–	3	–	mV_{rms}	As measured on analog input.
Output resistance	–	90	–	kΩ	

Setting up the KAD/ADC/116

All module setup can be defined in XML using XidML® schemas (see http://www.xidml.org).

Instrument settings

SETUP DATA	CHOICE	DEFAULT	NOTES
Manufacturer	-	-	-
Name	ACRA CONTROL	ACRA CONTROL	Name of manufacturer.
PartReference	KAD/ADC/116/10V	KAD/ADC/116/10V	The instrument part reference.
SerialNumber	AB1234	AB1234	Unique name for each module.
Channels	-	-	-
Acceleration(11:0) Analog Input	-	-	-
Settings	-	-	-
Filter Cutoff	0.25 0.5 1 2 4 8 16	0.25	Required cutoff point for the filter is the chosen value multiplied by the user sampling frequency. 0.25 is recommended as any higher may lead to aliasing. 1 is the sampling rate.

Parameter definitions

NAME/DESCRIPTION	BASE UNIT	DATA FORMAT	BITS	REGISTER DEFINITION
Acceleration(11:0) Parameters				
Acceleration Acceleration signal data	Volt	OffsetBinary	16	R[15:0]

Configurable parameters

Acceleration(11:0)

SETUP DATA	CHOICE	DEFAULT	NOTES
Range Maximum	-10 to 10	10	Range maximum for analog channel
Range Minimum	-10 to 10	-10	Range minimum for analog channel

NOTE: It is recommended that names are less than 20 characters, have no white space or contain any of the following five characters "/><\.

Getting the most from the KAD/ADC/116

Signal return path

For channels 0 to 11 each signal is single ended so a return GND for the constant current must be provided. Return path effects are minimized if a GND pin on the module is used. These channels are band-pass filtered (that is, the DC component is also removed) so that when a sensor is first connected or powered it takes about 60 seconds to settle.

Current excitation

The KAD/ADC/116 has three ordering options; the KAD/ADC/116/10V, KAD/ADC/116/1V and KAD/ADC/116/10VNE.

The KAD/ADC/116/10V and KAD/ADC/116/1V have internally connected current excitation to each ANALOG input pin as shown in the following figure. When internally provided current excitations are to be used, the KAD/ADC/116/10V or KAD/ADC/116/1V can reduce the number of wires inside the top-block connector back shell. In that case EXC(x) pins are not connected as they are connected internally.

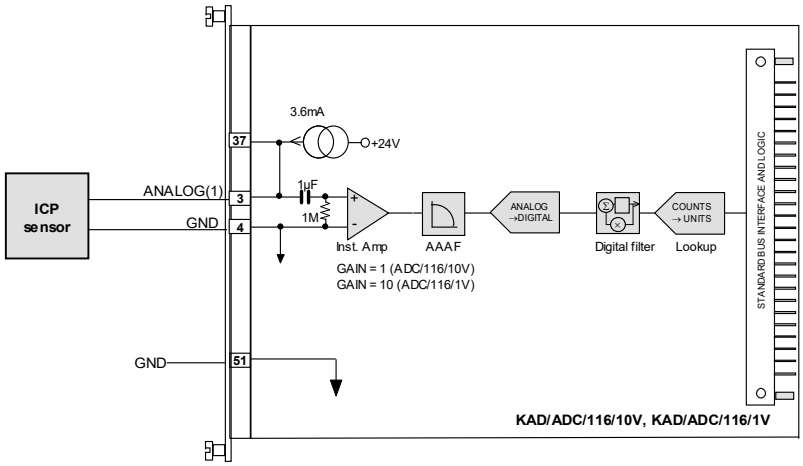

Figure 2: Second of 12 accelerometer channels on the KAD/ADC/116/10V and KAD/ADC/116/1V with ICP sensor connected

The KAD/ADC/116/10VNE provides current excitations, which are not connected internally with ANALOG input pins. This allows the use of external excitations. However, when required, internal excitation EXC(x) are provided on the top-block, and still can be used by connecting them to ANALOG pins as shown in the following figure.

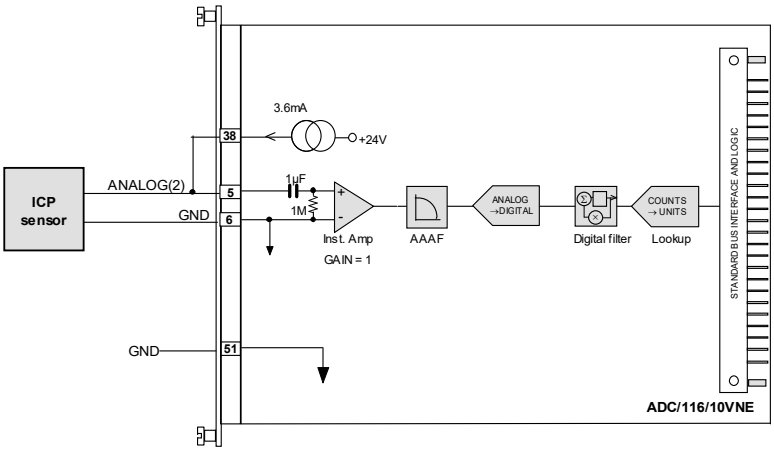

Figure 3: Third of 12 accelerometer channels on the KAD/ADC/116/10VNE with ICP sensor connected using internal current excitation

Understanding filter delays

The Acra KAM-500 uniquely samples all signals at the start of an acquisition cycle and at equal intervals of time thereafter. Signals sampled at the same sample rate are always sampled at the same time independently of how they are stored or transmitted. (This has significant advantages for issues such as time correlation.) However, before signals are sampled they are filtered to remove noise components that might alias. The recommended cutoff point is one quarter the sampling frequency, as this results in the maximum filtering of aliasing frequencies.

The Acra KAM-500 filters signals using over-sampling signal processing techniques. The following figure shows a delay for an 8^{th} order filter where f_c = 1 kHz. All filters cause a delay inversely proportional to the filter cutoff frequency (f_c), so to calculate the delay for other f_c values, multiply the delay by (1 kHz / f_c). The frequency axis then needs to be rescaled to the new f_c by dividing the frequency values by (1 kHz / f_c). For example, an 8^{th} order Butterworth filter with an f_c of 1 kHz delays a 1 kHz signal by 1 ms; a filter with an f_c of 10 Hz delays a 10 Hz signal by 0.1s. The delay for IIR filters (for example Butterworth) varies with the input frequency.

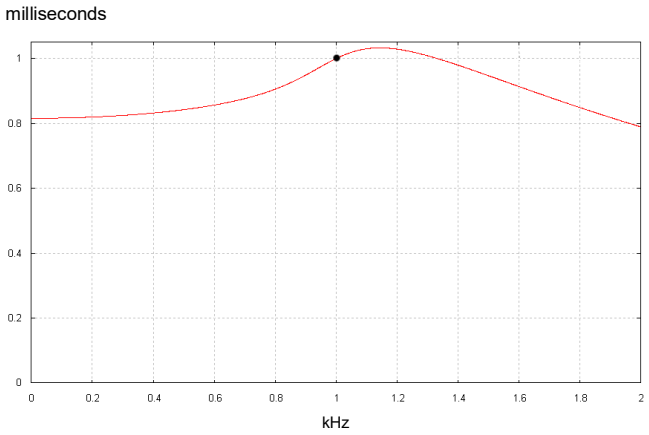

Figure 4: Filter delay for 8^{th} order Butterworth filter where f_c = 1kHz

The filter delay for the KAD/ADC/116 is:

$$T_D \approx T_A + \frac{1}{f_C} + T_{Butterworth8}(f)$$

T_D is the filter delay

T_A (analog filter delay) ≈ 0

Connector pinout of the KAD/ADC/116

PIN	NAME	SEE SPECIFICATIONS TABLE	COMMENT
1	ANALOG(0)	AC analog inputs (connected with EXC(0) internally)	EXC(0) not connected on 10VNE
2	GND	Internal ground	
3	ANALOG(1)	AC analog inputs (connected with EXC(1) internally)	EXC(1) not connected on 10VNE
4	GND	Internal ground	
5	ANALOG(2)	AC analog inputs (connected with EXC(2) internally)	EXC(2) not connected on 10VNE
6	GND	Internal ground	
7	ANALOG(3)	AC analog inputs (connected with EXC(3) internally)	EXC(3) not connected on 10VNE
8	GND	Internal ground	
9	ANALOG(4)	AC analog inputs (connected with EXC(4) internally)	EXC(4) not connected on 10VNE
10	GND	Internal ground	
11	ANALOG(5)	AC analog inputs (connected with EXC(5) internally)	EXC(5) not connected on 10VNE
12	GND	Internal ground	
13	ANALOG(6)	AC analog inputs (connected with EXC(6) internally)	EXC(6) not connected on 10VNE
14	GND	Internal ground	
15	ANALOG(7)	AC analog inputs (connected with EXC(7) internally)	EXC(7) not connected on 10VNE
16	GND	Internal ground	
17	GND	Internal ground	
18	DNC		Do not connect
19	ANALOG(8)	AC analog inputs (connected with EXC(8) internally)	EXC(8) not connected on 10VNE
20	GND	Internal ground	
21	ANALOG(9)	AC analog inputs (connected with EXC(9) internally)	EXC(9) not connected on 10VNE
22	GND	Internal ground	
23	ANALOG(10)	AC analog inputs (connected with EXC(10) internally)	EXC(10) not connected on 10VNE
24	GND	Internal ground	
25	ANALOG(11)	AC analog inputs (connected with EXC(11) internally)	EXC(11) not connected on 10VNE
26	GND	Internal ground	
27	DNC		Do not connect
28	DNC		Do not connect
29	DNC		Do not connect
30	DNC		Do not connect
31	DNC		Do not connect
32	DNC		Do not connect
33	DNC		Do not connect
34	DNC		Do not connect
35	DNC		Do not connect
36	EXC(0)	Single ended DC current excitation outputs	
37	EXC(1)	Single ended DC current excitation outputs	
38	EXC(2)	Single ended DC current excitation outputs	
39	EXC(3)	Single ended DC current excitation outputs	
40	EXC(4)	Single ended DC current excitation outputs	
41	EXC(5)	Single ended DC current excitation outputs	
42	EXC(6)	Single ended DC current excitation outputs	
43	EXC(7)	Single ended DC current excitation outputs	
44	EXC(8)	Single ended DC current excitation outputs	
45	EXC(9)	Single ended DC current excitation outputs	
46	EXC(10)	Single ended DC current excitation outputs	
47	EXC(11)	Single ended DC current excitation outputs	
48	DNC		Do not connect
49	DNC		Do not connect
50	DNC		Do not connect
51	GND	Internal ground	
52	CHASSIS	Chassis	Double-density connector only

Ordering information

PART NUMBER	DESCRIPTION
KAD/ADC/116/10V	Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w, ±10V) – 12ch at 12 ksps (with 52-way double-density top connector); current excitations connected internally to analog inputs
KAD/ADC/116/10VNE	Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w, ±10V) – 12ch at 12 ksps (with 52-way double-density top connector); current excitations not connected internally to analog inputs but provided on top connector as separate pin
KAD/ADC/116/1V	Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w, ±1V) – 12ch at 12 ksps (with 52-way double-density top connector); current excitations connected internally to analog inputs
KAM/ADC/116/10V	Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w, ±10V) – 12ch at 12 ksps (with 51-way micro miniature top connector); current excitations connected internally to analog inputs
KAM/ADC/116/10VNE	Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w, ±10V) – 12ch at 12 ksps (with 51-way micro miniature top connector); current excitations not connected internally to analog inputs but provided on top connector as separate pin
KAM/ADC/116/1V	Accelerometer ADC (current excitation, programmable analog gain, 3 kHz b/w, ±1V) – 12ch at 12 ksps (with 51-way micro miniature top connector); current excitations connected internally to analog inputs

By default, the standard mating connector (CON/KAD/002/CP for KAD modules; or ACC/CON/008/04 for KAM modules) is included with each module in the shipment. Its part number will be added to the Confirmation of Order unless an alternative option is specified (see the *Cables* data sheet). In this data sheet, KAD/ADC/116 refers to both the KAD and KAM version of the module.

Revision history

REVISION	DIFFERENCES	STATUS
KAD/ADC/116	First release	Recommended for new programs

Supporting software

SOFTWARE	DETAILS
KSM-500	This module is supported by the KSM-500 suite of software tools
DAS Studio 3	User interface for setup and management of data acquisition, network switches, recorders and ground stations in an integrated environment

Related documentation

DOCUMENT	DETAILS
DOC/DBK/001	Acra KAM-500 Databook
DOC/HBK/002	Environmental Qualification Handbook
DOC/MAN/018	KSM-500 Databook
DOC/MAN/030	DAS Studio 3 User Manual
TEC/NOT/012	Piezoelectric Effect and Charge Amplifiers
TEC/NOT/016	Power dissipation
TEC/NOT/049	Power estimation

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