KAD/ADC/113

1/4-bridge ADC (current excitation, PT100 temp. sensors, 3kHz b/w) - 16ch at 12ksps

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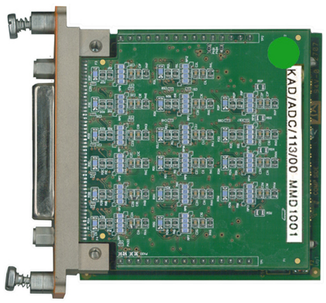

Key Features

- 16 ¼-bridge, 3-wire, input channels for PT100 RTD-type sensors
- Input range of -200°C to 660°C
- High accuracy (0.87°C between -50 and 200°C @ 2mA)
- Programmable constant current excitation per group of four channels
- Short on any channel does not affect others
- 16-bit simultaneous sampling on each channel

Applications

- Temperature measurements with RTD PT100

Overview

The KAD/ADC/113 provides independent excitation for up to 16 channels and is intended for PT100 Resistance Temperature Detector (RTD) type sensors. Each channel has a separate programmable digital filter and A/D converter. At the heart of the KAD/ADC/113 is a hard-wired state-machine that oversamples all channels at a rate between 48ksps and 96ksps 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 8th order Butterworth Infinite-Impulse-Response (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. Therefore, when several channels are sampled at different sampling rates, at the start of an acquisition cycle all channels are aligned. The current through the RTD is programmable from 1mA to 2mA in steps of 0.5µA. The excitation current through the RTD is kept constant. As the resistance changes, the voltage across the RTD (and hence as seen by the amplifier) changes linearly.

A linearization table for each channel can be used to compensate for non-linear sensors or to fine-tune gain and offset.

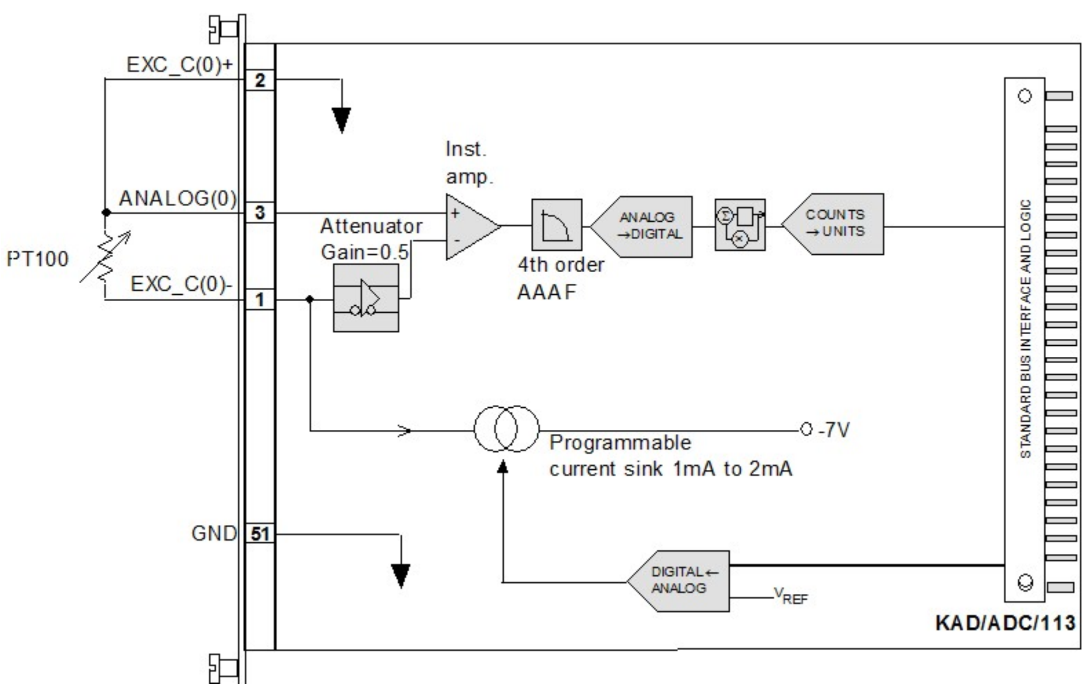

Figure 1: First of 16 channels on the KAD/ADC/113

INFO: CURTISSWRIGHTDS.COM
EMAIL: DS@CURTISSWRIGHT.COM

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					
	–	92	–	g	
	–	3.24	–	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	80	–	120	mA	
+7V	25	–	40	mA	
-7V	30	–	45	mA	Excludes current used by excitation.
±12V	0	–	0	mA	
total power	0.785	–	1.2	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	RTD inputs				
PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITION/DETAILS
Inputs	–	–	16	–	
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(x)	2	–	12,000	sps	
Input temperature					
full scale range	-200	–	660	°C	
DC error					Temperature averaged over 200 measurement points.
for FSR of -200°C to 660°C	–	–	0.27	%FSR	With 1mA excitation current set.
for FSR of -60°C to 250°C	–	–	0.35	%FSR	With 2mA excitation current set.
Effective number of bits	10.5	–	–	bits	$0 \leq f \leq 250$Hz (f: input signal frequency).
Crosstalk	–	–	-72	dB	Between channels on the same module.
Analog filter cutoff					
poles	–	–	4	–	
filter cutoff -3dB	5.7	6	6.3	kHz	
Digital filter					
poles	–	–	8	–	
filter cutoff -3dB	0.25	–	16	f_s	The maximum value is limited to 3kHz. (f_s: sampling frequency)
0.1dB bandwidth	–	0.8	–	f_c	
aliasing to 0.1dB band	–	–	-72	dB	
aliasing to f_c	–	–	-72	dB	
Filter delay	–	0.66	–	ms	At f_c of 3kHz (f_c: filter cutoff frequency). See "Understanding filter delays" on page 5.

TABLE 3	Single ended DC current excitation outputs				
PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITION/DETAILS
Outputs	–	–	16	–	Applied in groups of four channels.
Output current					
operating range	1	–	2	mA	
resolution	–	0.5	–	μA	
compliance	-0.5	–	0	V	
short circuit current	–	–	2	mA	Depends on user setting.
short circuit duration	∞	–	–	s	
DC error					
error	–	–	0.25	%FSR	With a constant 100Ω load. Correction included within channel reading, see DC error in "RTD inputs" on page 3.
noise	–	–	0.5	$°C_{rms}$	Measured as subtraction of rms noise visible on read values with and without excitation used.

Setting up the KAD/ADC/113

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/113/B	KAD/ADC/113/B	The instrument part reference.
SerialNumber	AB1234	AB1234	Unique name for each module.
Channels	-	-	-
Temperature(15:0) Analog Input	-	-	Settings for this channel
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.
Excitation Amplitude	0.001 to 0.00200	0.0016	Required excitation (in A) for the top of the bridge, in 0.51µA steps. Applied to each group of 4 channels.
Linearization Algorithm Reference	Algorithm Reference URL-Defined-Algorithm	MyPT100SensorTypeLookUp	URL algorithm describing a PT100 RTD-type sensor for this channel

Parameter definitions

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

Configurable parameters

Temperature(15:0)

SETUP DATA	CHOICE	DEFAULT	NOTES
Range Maximum	-200 to 660	540	-
Range Minimum	-200 to 660	-200	-

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/113

Lead error compensation

The feedback line ANALOG(x) carries no current. Ideally it should be connected close to the gage to help compensate for lead resistances (assuming that both EXC_C(x)+ and EXC_C(x)- lead resistances are the same). If operating with two wires, and the ANALOG(x) and excitation lines (EXC_C(x)+) are connected close to the module (not the gage), the error introduced is primarily an offset error (because the circuit is linear with respect to resistance) and can be adjusted for.

Use two-wire operation carefully. Estimation of cable resistance should consider temperature drift over the temperature range the cable operates (copper temperature coefficient is approximately 0.4%/°C). Depending on the wire length and diameter, the drift may cause noticeable error of measurement. In general, it may become an issue for thinner and longer cables.

Setting the range and excitation

For any temperature range required, errors can be minimized by using as much as possible of the 0 to 500mV input range of the A/D.

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 diagram shows a delay for an 8th order filter where f_c = 1kHz. 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 (1kHz / f_c). The frequency axis then needs to be rescaled to the new f_c by dividing the frequency values by (1kHz / f_c). For example, an 8th order Butterworth filter with an f_c of 1kHz delays a 1kHz signal by 1ms; a filter with an f_c of 10Hz delays a 10Hz signal by 0.1s. The delay for IIR filters (for example Butterworth) varies with the input frequency.

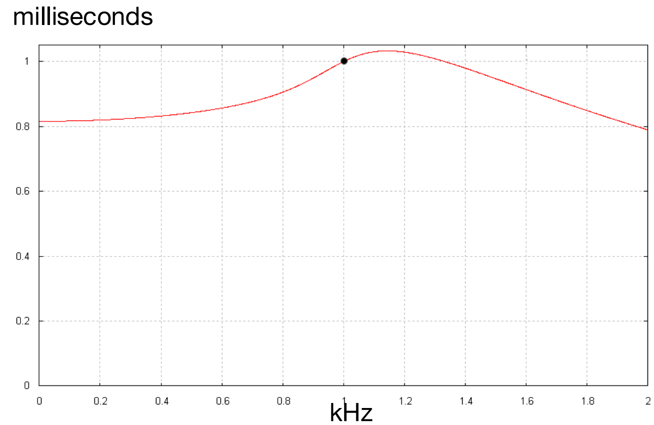

Figure 2: Filter delay for 8th order Butterworth filter where f_c = 1kHz

The filter delay for the KAD/ADC/113 is:

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

T_A (analog filter delay) ≈ 0

T_D is the filter delay

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Connector pinout of the KAD/ADC/113

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

Ordering information

PART NUMBER	DESCRIPTION
KAD/ADC/113/B	1/4-bridge ADC (current excitation, PT100 temp. sensors, 3kHz b/w) - 16ch at 12ksps (with 52-way double-density connector)
KAM/ADC/113/B	1/4-bridge ADC (current excitation, PT100 temp. sensors, 3kHz b/w) - 16ch at 12ksps (with 51-way micro-miniature connector)

By default, the standard mating connector (CON/KAD/002/CP for KAD modules; 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/113 refers to both the KAD and KAM version of the module.

The KAD/ADC/113 uses power from the ±7V power line for excitation and therefore can not be used with KAM/CHS/04L, KAM/CHS/05F or KAM/CHS/03F. If the maximum excitation current is drawn from each channel, then the maximum number of KAD/ADC/113s per chassis is limited to five.

Revision history

REVISION	DIFFERENCES	STATUS
KAD/ADC/113/B	Corrected an issue with signal distortion in slave chassis, or in chassis externally receiving X_Sync signals, or in chassis containing a KAD/BCU/105 receiving IEEE 1588 PTP	Recommended for new programs
KAD/ADC/113	First release	Not recommended for new programs

Supporting software

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

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/016	Power dissipation
TEC/NOT/023	Resistance temperature detectors
TEC/NOT/049	Power estimation

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