KAD/ADC/115

¼-bridge ADC (current excitation, PT1000 temp. sensors, 6.25kHz b/w) - 16ch at 25ksps

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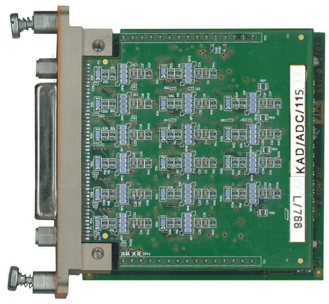

Key Features

- 16 ¼-bridge, 2-wire, input channels for PT1000 RTD-type sensors
- Input range of -200°C to 660°C
- High accuracy (±1.4°C between 0 and 200°C @ 500µA, ±2°C between 0 and 350°C @ 400µA)
- Programmable constant current excitation
- Short on any channel does not affect others
- 16-bit simultaneous sampling on each channel

Applications

- Temperature measurements with RTD PT1000

Overview

The KAD/ADC/115 provides independent excitation for up to 16 channels and is intended for PT1000 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/115 is a hard-wired state-machine that oversamples all channels at a rate between 100ksps and 200ksps and digitally filters any noise above the user-programmable cutoff frequency. This is achieved using cascaded, half-band, finite-impulse-response 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. Thus, when several channels are sampled at different sampling rates, at the start of an acquisition cycle, all channels are aligned.

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.

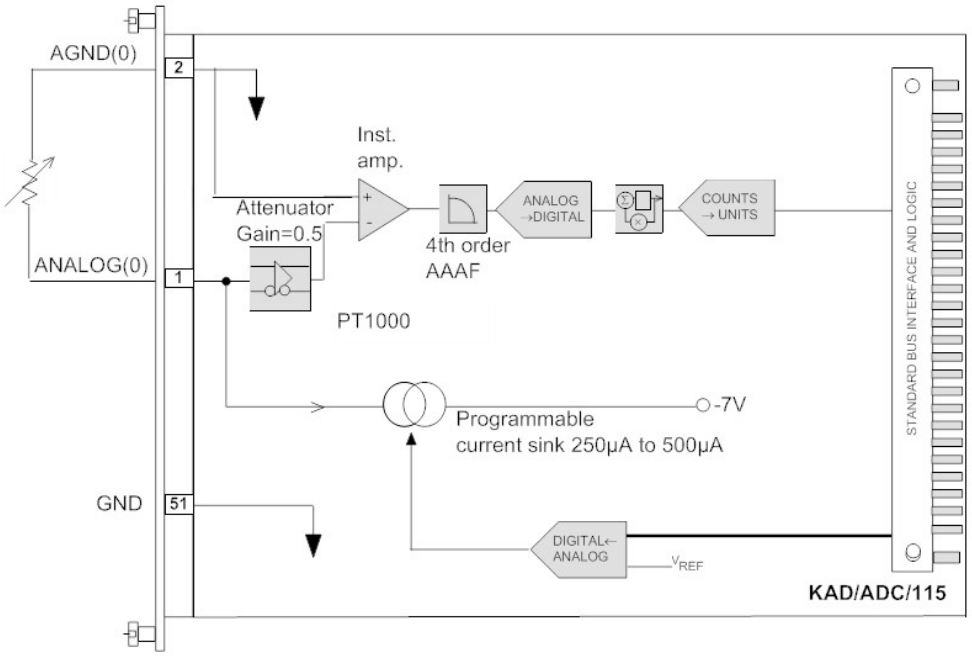

Figure 1: First of 16 channels on the KAD/ADC/115

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					
	–	85	–	g	
	–	2.99	–	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	130	–	150	mA	
+7V	10	–	19	mA	
-7V	50	–	75	mA	Excludes current used by excitation.
+12V	35	–	90	mA	
-12V	30	–	85	mA	
total power	1.85	–	3.51	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	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	250	–	500	µA	
resolution	–	5	–	µA	
compliance	2	–	–	V	The product of the sensor resistance and the excitation current must not exceed this value.
short circuit current	–	–	500	µA	
short circuit duration	∞	–	–	s	
DC error					
error	–	–	0.25	%FSR	With a constant 1,000Ω 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.

TABLE 3	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)	0.5	–	25,000	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	–	–	2.4	°C	When excitation current set to 250µA.
for FSR of 0°C to 350°C	–	–	2	°C	When excitation current set to 400µA.
for FSR of 0°C to 200°C			1.4	°C	When excitation current set to 500µA.
Effective number of bits	12	–	–	bits	$0 \le f \le 0.6f_c$ (f_c: filter cutoff frequency)
Crosstalk	–	–	-72	dB	Between channels on the same module.
Analog filter cutoff					
poles	–	–	4	–	
filter cutoff -3dB	11.9	12.5	13.1	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	–	–	-74	dB	
Filter delay	–	0.66	–	ms	At f_c of 3kHz (See “Understanding filter delays” on page 5).

Setting up the KAD/ADC/115

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

Instrument settings

NAME/DESCRIPTION	BASE UNIT	DATA FORMAT	BITS
Manufacturer	-	-	-
Name	ACRA CONTROL	ACRA CONTROL	Name of manufacturer.
PartReference	KAD/ADC/115	KAD/ADC/115	The instrument part reference.
SerialNumber	AB1234	AB1234	Unique name for each module.
Channels	-	-	-
Temperature(15:0) Analog Input	-	-	1/4-bridge A/D converter with excitation and signal conditioning for PT1000.
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.
Linearization Algorithm Reference	UTF-8 String	.\LookupFiles\RTD\PT1000_385.LU	URL algorithm describing a PT1000 RTD-type sensor for this channel.
Excitation Amplitude	250E-6 to 500E-6	400E-6	Required excitation (in µA) for the top of the bridge, in 5µA steps. Applied to each group of four channels.

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	350	-
Range Minimum	-200 to 660	0	-

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/115

Lead error compensation

The KAD/ADC/115 is configured for two-wire operation where lead resistance needs to be considered primarily as an offset error. Relative to the resistance of a PT1000 sensor, the offset error should be negligible. However estimation of cable resistance should consider temperature drift over the temperature range the cable operates (copper temperature coefficient is approximately 0.4% per °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 excitation current

The KAD/ADC/115 can operate with up to 1V across the PT1000 sensor. However, to achieve the best accuracy, calibration is applied by the Field Programmable Gate Array in the digital domain; cable length IR voltage drops must also be considered. Therefore, we recommend you select an excitation current that does not exceed 0.95V across the PT1000 sensor, for the maximum resistance of the selected temperature range.

The KAD/ADC/115's design has been verified at 500µA between 0 and 200°C, at 400µA between 0 and 350°C, and at 250µA between -200 to 660°C.

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 will always be 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 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.

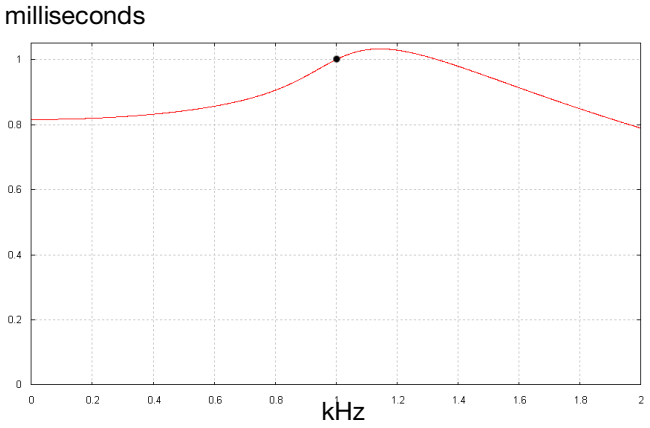

Figure 2: Filter delay for 8th order Butterworth filter where f_c = 1kHz

The filter delay for the KAD/ADC/115 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

Connector pinout of the KAD/ADC/115

PIN	NAME	SEE SPECIFICATIONS TABLE	COMMENT
1	ANALOG(0)	RTD inputs	PT1000 inputs
2	AGND(0)		Analog (0) ground return
3	DNC		Do not connect
4	ANALOG(1)	RTD inputs	PT1000 inputs
5	AGND(1)		Analog (1) ground return
6	DNC		Do not connect
7	ANALOG(2)	RTD inputs	PT1000 inputs
8	AGND(2)		Analog (2) ground return
9	DNC		Do not connect
10	ANALOG(3)	RTD inputs	PT1000 inputs
11	AGND(3)		Analog (3) ground return
12	DNC		Do not connect
13	ANALOG(4)	RTD inputs	PT1000 inputs
14	AGND(4)		Analog (4) ground return
15	DNC		Do not connect
16	ANALOG(5)	RTD inputs	PT1000 inputs
17	AGND(5)		Analog (5) ground return
18	DNC		Do not connect
19	ANALOG(6)	RTD inputs	PT1000 inputs
20	AGND(6)		Analog (6) ground return
21	DNC		Do not connect
22	ANALOG(7)	RTD inputs	PT1000 inputs
23	AGND(7)		Analog (7) ground return
24	DNC		Do not connect
25	ANALOG(8)	RTD inputs	PT1000 inputs
26	AGND(8)		Analog (8) ground return
27	DNC		Do not connect
28	ANALOG(9)	RTD inputs	PT1000 inputs
29	AGND(9)		Analog (9) ground return
30	DNC		Do not connect
31	ANALOG(10)	RTD inputs	PT1000 inputs
32	AGND(10)		Analog (10) ground return
33	DNC		Do not connect
34	ANALOG(11)	RTD inputs	PT1000 inputs
35	AGND(11)		Analog (11) ground return
36	DNC		Do not connect
37	ANALOG(12)	RTD inputs	PT1000 inputs
38	AGND(12)		Analog (12) ground return
39	DNC		Do not connect
40	ANALOG(13)	RTD inputs	PT1000 inputs
41	AGND(13)		Analog (13) ground return
42	DNC		Do not connect
43	ANALOG(14)	RTD inputs	PT1000 inputs
44	AGND(14)		Analog (14) ground return
45	DNC		Do not connect
46	ANALOG(15)	RTD inputs	PT1000 inputs
47	AGND(15)		Analog (15) ground return
48	DNC		Do not connect
49	DNC		Do not connect
50	GND	Internal ground	
51	GND	Internal ground	
52	CHASSIS	Chassis	

Ordering information

PART NUMBER	DESCRIPTION
KAD/ADC/115	¼-bridge ADC (current excitation, PT1000 temp. sensors, 6.25kHz b/w) - 16ch at 25ksps

By default, the standard mating connector, CON/KAD/002/CP, 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).

The KAD/ADC/115 uses power from the ±7V power lines for excitation and therefore can not be used with KAM/CHS/04L, KAM/CHS/05F, KAM/CHS/03F, or KAM/CHS/02F. If the maximum excitation current is drawn from each channel, then the maximum number of KAD/ADC/115s per chassis is limited to five.

Revision history

REVISION	DIFFERENCES	STATUS
KAD/ADC/115	First release	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

Related documentation

DOCUMENT	DETAILS
DOC/DBK/001	Acra KAM-500 Databook
DOC/HBK/002	Environmental Qualification Handbook
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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