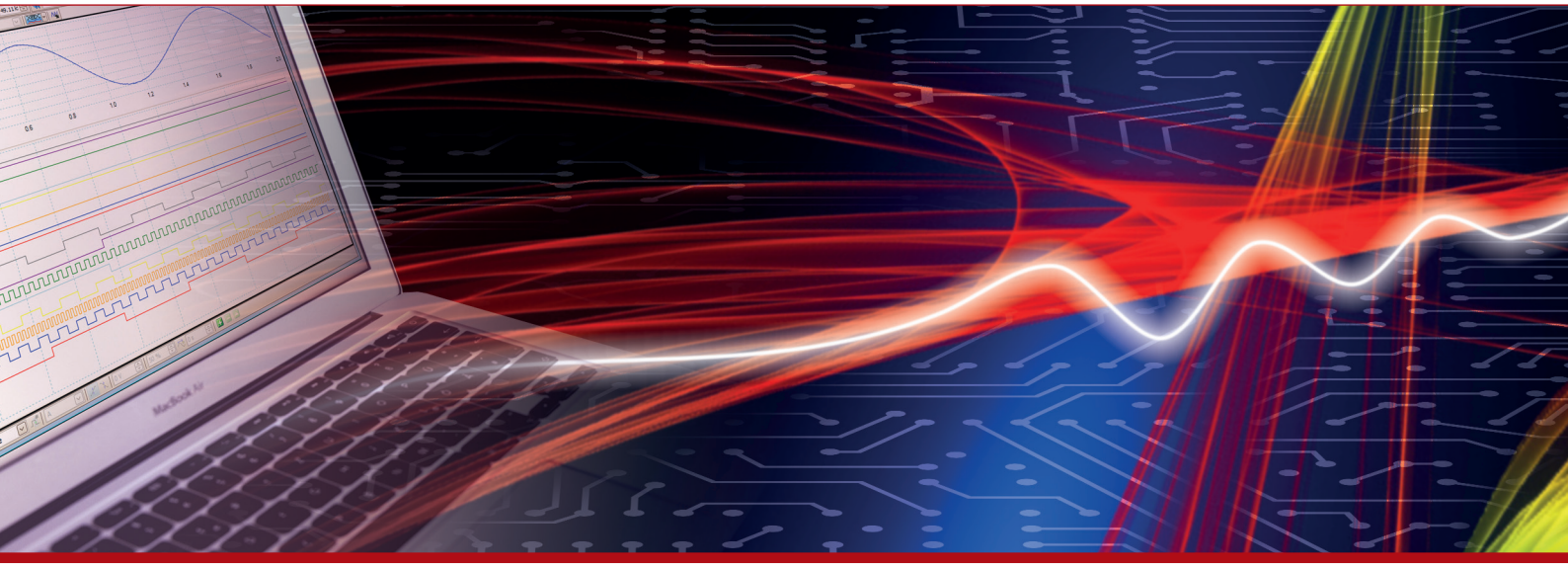
Product Datasheet - Technical Specifications



More information in our Web-Shop at ▸ **www.meilhaus.com** and in our download section.

Your contact

Technical and commercial sales, price information, quotations, demo/test equipment, consulting:

Tel.: **+49 - 81 41 - 52 71-0**

FAX: **+49 - 81 41 - 52 71-129**

E-Mail: **sales@meilhaus.com**

Downloads:
www.meilhaus.com/en/infos/download.htm

Meilhaus Electronic GmbH
Am Sonnenlicht 2
82239 Alling/Germany

Tel. **+49 - 81 41 - 52 71-0**
Fax **+49 - 81 41 - 52 71-129**
E-Mail **sales@meilhaus.com**

www.meilhaus.de

Specifications

All specifications are subject to change without notice.

Typical for 25 °C unless otherwise specified.

All specifications apply to all temperature and voltage input channels unless otherwise specified.

Specifications in *italic* text are guaranteed by design.

Analog input

Table 1. General analog input specifications

Parameter	Conditions	Specification
A/D converter type		ADS1256, 24-bit Sigma Delta
A/D data rates		3750 samples per second (S/s), 2000 S/s, 1000 S/s, 500 S/s, 100 S/s, 60 S/s, 50 S/s, 25 S/s, 10 S/s, 5 S/s, 2.5 S/s
Throughput		▪ Single channel: 2.5 Hz to 1102.94 Hz, software selectable ▪ Multiple channels: 0.16 Hz to 1102.94 Hz, software selectable See Table 18 and Table 19 for details.
Number of channels		Up to 32 channels individually software-configurable as single-ended or differential Thermocouples require differential mode. For each channel configured as differential, you essentially lose one single-ended channel. You can add channels by connecting to an AI-EXP32.
Input isolation		*500 VDC minimum between field wiring and USB interface*
Channel configurations		Temperature sensor input, software programmable to match sensor type
		Voltage input
Input voltage range	Thermocouple mode	±0.078125 V
	Voltage mode (Note 1)	±20 V, ±10 V, ±5 V, ±2.5 V, ±1.25 V, ±0.625 V, ±0.3125 V, ±0.15625 V, ±0.078125 V, software-configurable
Absolute maximum input voltage	*CxH-CxL relative to GND*	▪ *±30 V maximum (power on)* ▪ *±10 V maximum (power off)*
Input impedance		▪ *2 GΩ (power on)* ▪ *390Ω (power off)*
Input leakage current		*±10.6 nA*
	▪ *Input voltage >±30 V (power on/off)*	*±1 µA maximum*
Input capacitance		590 pf
Maximum working voltage (signal + common mode)	Voltage mode: ±20 V range	±20.01 V maximum
	Voltage mode: all other voltage input ranges	±10.25 V maximum
Common mode rejection ratio (Note 1)	*Thermocouple mode, (f_{IN} = 60 Hz)*	*110 dB*
	Voltage mode,(f_{IN} = 60 Hz, all input ranges)	*90 dB*
ADC resolution		24 bits
Crosstalk	Adjacent channels	100 dB
Input coupling		DC
Channel gain queue	Up to 64 elements	Software-configurable channel and range
Warm-up time		45 minutes minimum

Parameter	Conditions	Specification
Open thermocouple detect		Automatically enabled when the channel is configured for a thermocouple sensor.
CJC sensor accuracy	*15 °C to 35 °C*	*±0.15 °C typical*
	0 °C to 55 °C	*±0.5 °C maximum*

Note 1: Placing a notch of the A/D digital filter at 60 Hz (setting A/D data rate = 60 S/s, 10 S/s, 5 S/s or 2.5 S/s) further improves the common mode rejection of this frequency.

Channel configurations

When any item is changed, the firmware stores channel configurations in the EEPROM of the isolated microcontroller. An external application issues commands over the USB to make changes, and the configuration is made non-volatile through the use of the EEPROM.

When connecting differential voltage inputs to a floating voltage source, provide a DC return path from each voltage input to ground. To do this, connect a resistor from each input to a GND pin (pins 18, 36, 39, 42, 44, 46, 66, 81, 84). A value of approximately 100 kΩ can be used for most applications.

Leave unused input channels either floating or tied to GND (pins 18, 36, 39, 42, 44, 46, 66, 81, 84).

Source impedances should be kept as small as possible to avoid settling time and accuracy errors.

For each voltage/thermocouple channel configured as differential, you essentially lose one single-ended channel. You can add channels by connecting to an AI-EXP32.

Table 2. Channel configurations

Channel	Category	Specification
CxH/CxL	Thermocouple	16 differential channels
CxH/CxL	Voltage	32 individually-configurable channels that can be configured as either single-ended or differential.
CxH/CxL	Voltage	

Compatible sensors

Table 3. Compatible sensor type specifications

Parameter	Conditions
Thermocouple	J: -210 °C to 1200 °C
	K: -270 °C to 1372 °C
	R: -50 °C to 1768 °C
	S: -50 °C to 1768 °C
	T: -270 °C to 400 °C
	N: -270 °C to 1300 °C
	E: -270 °C to 1000 °C
	B: 0 °C to 1820 °C

Accuracy

Thermocouple measurement accuracy

Thermocouple measurement accuracy specifications include polynomial linearization error, cold-junction compensation measurement error, and system noise. These specs are for one year, or 3000 operating hours, whichever comes first.

There is a CJC sensor for each terminal block of the module. The accuracy listed below assumes the screw terminals are at the same temperature as the CJC sensor.

The accuracy errors shown do not include the inherent accuracy error of the thermocouple sensor itself. Contact your thermocouple supplier for details on the actual thermocouple sensor accuracy limitations.

Connect thermocouples to the RedLab 2416-4AO such that they are floating with respect to GND (pins 18, 36, 39, 42, 44, 46, 66, 81, 84, 93, and 94).

When configuring thermocouple sensors, keep any stray capacitance relative to GND (pins 18, 36, 39, 42, 44, 46, 66, 81, 84) as small as possible to avoid settling time and accuracy errors.

The RedLab 2416-4AO GND and DGND pins are isolated from earth ground. You can connect thermocouple sensors to voltages referenced to earth ground as long as isolation between the GND/DGND pins and earth ground is maintained.

Table 4. J type thermocouple accuracy specifications, including CJC measurement error. All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-210 °C	2.572 °C	1.416 °C	0.022
	0 °C	0.935 °C	0.469 °C	
	1200 °C	1.869 °C	1.456 °C	
2000 S/s	-210 °C	2.572 °C	1.416 °C	0.022
	0 °C	0.935 °C	0.469 °C	
	1200 °C	1.869 °C	1.456 °C	
1000 S/s	-210 °C	2.572 °C	1.416 °C	0.022
	0 °C	0.935 °C	0.469 °C	
	1200 °C	1.869 °C	1.456 °C	
500 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
100 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
60 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
50 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
25 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
10 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
5 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	
2.5 S/s	-210 °C	2.442 °C	1.334 °C	0.022
	0 °C	0.881 °C	0.415 °C	
	1200 °C	1.821 °C	1.408 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 5. K type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-210 °C	2.917 °C	1.699 °C	0.029
	0 °C	1.017 °C	0.526 °C	
	1372 °C	2.478 °C	2.022 °C	
2000 S/s	-210 °C	2.917 °C	1.699 °C	0.029
	0 °C	1.017 °C	0.526 °C	
	1372 °C	2.478 °C	2.022 °C	
1000 S/s	-210 °C	2.917 °C	1.699 °C	0.029
	0 °C	1.017 °C	0.526 °C	
	1372 °C	2.478 °C	2.022 °C	
500 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
100 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
60 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
50 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
25 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
10 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
5 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	
2.5 S/s	-210 °C	2.735 °C	1.524 °C	0.029
	0 °C	0.948 °C	0.457 °C	
	1372 °C	2.396 °C	1.941 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 6. N type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-200 °C	3.480°C	2.030 °C	0.029
	0 °C	1.201 °C	0.659 °C	
	1300 °C	1.991 °C	1.600 °C	
2000 S/s	-200 °C	3.480°C	2.030 °C	0.029
	0 °C	1.201 °C	0.659 °C	
	1300 °C	1.991 °C	1.600 °C	
1000 S/s	-200 °C	3.480°C	2.030 °C	0.029
	0 °C	1.201 °C	0.659 °C	
	1300 °C	1.991 °C	1.600 °C	
500 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
100 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
60 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
50 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
25 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
10 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
5 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	
2.5 S/s	-200 °C	3.196°C	1.750 °C	0.029
	0 °C	1.096 °C	0.553 °C	
	1300 °C	1.915 °C	1.524 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 7. R type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-50 °C	4.826 °C	3.133 °C	0.082
	250 °C	2.117 °C	1.424 °C	
	1768 °C	2.842 °C	2.347 °C	
2000 S/s	-50 °C	4.826 °C	3.133 °C	0.082
	250 °C	2.117 °C	1.424 °C	
	1768 °C	2.842 °C	2.347 °C	
1000 S/s	-50 °C	4.826 °C	3.133 °C	0.082
	250 °C	2.117 °C	1.424 °C	
	1768 °C	2.842 °C	2.347 °C	
500 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
100 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
60 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
50 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
25 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
10 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
5 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	
2.5 S/s	-50 °C	4.065 °C	2.379 °C	0.082
	250 °C	1.805 °C	1.113 °C	
	1768 °C	2.619 °C	2.123 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 8. S type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-50 °C	4.510 °C	2.930 °C	0.088
	250 °C	2.165 °C	1.468 °C	
	1768 °C	3.187 °C	2.597 °C	
2000 S/s	-50 °C	4.510 °C	2.930 °C	0.088
	250 °C	2.165 °C	1.468 °C	
	1768 °C	3.187 °C	2.597 °C	
1000 S/s	-50 °C	4.510 °C	2.930 °C	0.088
	250 °C	2.165 °C	1.468 °C	
	1768 °C	3.187 °C	2.597 °C	
500 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
100 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
60 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
50 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
25 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
10 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
5 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	
2.5 S/s	-50 °C	3.798 °C	2.226 °C	0.088
	250 °C	1.853 °C	1.156 °C	
	1768 °C	2.922 °C	2.332 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 9. B type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	250 °C	5.489 °C	3.956 °C	0.14
	700 °C	2.283 °C	1.743 °C	
	1820 °C	2.202 °C	1.842 °C	
2000 S/s	250 °C	5.489 °C	3.956 °C	0.14
	700 °C	2.283 °C	1.743 °C	
	1820 °C	2.202 °C	1.842 °C	
1000 S/s	250 °C	5.489 °C	3.956 °C	0.14
	700 °C	2.283 °C	1.743 °C	
	1820 °C	2.202 °C	1.842 °C	
500 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
100 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
60 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
50 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
25 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
10 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
5 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	
2.5 S/s	250 °C	4.387 °C	2.885 °C	0.14
	700 °C	1.879 °C	1.340 °C	
	1820 °C	1.962 °C	1.601 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 10. E type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-200 °C	2.413 °C	1.352 °C	0.017
	0 °C	1.069 °C	0.551 °C	
	1000 °C	1.575 °C	1.211 °C	
2000 S/s	-200 °C	2.413 °C	1.352 °C	0.017
	0 °C	1.069 °C	0.551 °C	
	1000 °C	1.575 °C	1.211 °C	
1000 S/s	-200 °C	2.413 °C	1.352 °C	0.017
	0 °C	1.069 °C	0.551 °C	
	1000 °C	1.575 °C	1.211 °C	
500 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
100 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
60 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
50 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
25 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
10 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
5 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	
2.5 S/s	-200 °C	2.306 °C	1.244 °C	0.017
	0 °C	1.017 °C	0.499 °C	
	1000 °C	1.539 °C	1.175 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Table 11. T type thermocouple accuracy specifications, including CJC measurement error.
All specifications are (±).

A/D data rate	Sensor temperature range	Accuracy error maximum	Accuracy error typical	Tempco (°C/°C)
3750 S/s	-200 °C	2.821 °C	1.676 °C	0.027
	0 °C	1.050 °C	0.558 °C	
	400 °C	0.957 °C	0.595 °C	
2000 S/s	-200 °C	2.821 °C	1.676 °C	0.027
	0 °C	1.050 °C	0.558 °C	
	400 °C	0.957 °C	0.595 °C	
1000 S/s	-200 °C	2.821 °C	1.676 °C	0.027
	0 °C	1.050 °C	0.558 °C	
	400 °C	0.957 °C	0.595 °C	
500 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
100 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
60 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
50 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
25 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
10 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
5 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	
2.5 S/s	-200 °C	2.644 °C	1.505 °C	0.027
	0 °C	0.979 °C	0.487 °C	
	400 °C	0.912 °C	0.551 °C	

To achieve the thermocouple accuracies listed above, the RedLab 2416-4AO should be warmed up for 45 minutes after the initial power on. The accuracies listed above are only guaranteed if the RedLab 2416-4AO is housed in its plastic enclosure.

Analog input DC voltage measurement accuracy

Table 12. DC Accuracy components and specifications. All values are (±)

Range	A/D data rate	Gain error (% of reading)	Offset error	INL error (% of range)	Absolute accuracy	Gain temperature coefficient (% reading/°C)	Offset temperature coefficient (µV/°C)
±20 V	**3750 S/s**	0.003	98 µV	0.0008	857.600 µV	0.0006	3
	2000 S/s	0.003	61 µV	0.0008	821.185 µV	0.0006	3
	1000 S/s	0.003	27 µV	0.0008	787.226 µV	0.0006	3
	500 S/s	0.003	12 µV	0.0008	772.193 µV	0.0006	3
	100 S/s	0.003	11 µV	0.0008	771.014 µV	0.0006	3
	60 S/s	0.003	15 µV	0.0008	774.689 µV	0.0006	3
	50 S/s	0.003	12 µV	0.0008	771.603 µV	0.0006	3
	25 S/s	0.003	12 µV	0.0008	772.070 µV	0.0006	3
	10 S/s	0.003	13 µV	0.0008	773.400 µV	0.0006	3
	5 S/s	0.003	14 µV	0.0008	773.579 µV	0.0006	3
	2.5 S/s	0.003	14 µV	0.0008	773.537 µV	0.0006	3
±10 V	**3750 S/s**	0.003	42 µV	0.0008	421.600 µV	0.0006	3
	2000 S/s	0.003	36 µV	0.0008	416.004 µV	0.0006	3
	1000 S/s	0.003	15 µV	0.0008	395.252 µV	0.0006	3
	500 S/s	0.003	7 µV	0.0008	387.216 µV	0.0006	3
	100 S/s	0.002	8 µV	0.0008	288.470 µV	0.0006	3
	60 S/s	0.002	10 µV	0.0008	290.090 µV	0.0006	3
	50 S/s	0.002	8 µV	0.0008	287.719 µV	0.0006	3
	25 S/s	0.002	6 µV	0.0008	285.672 µV	0.0006	3
	10 S/s	0.002	6 µV	0.0008	285.982 µV	0.0006	3
	5 S/s	0.002	6 µV	0.0008	286.003 µV	0.0006	3
	2.5 S/s	0.002	6 µV	0.0008	286.086 µV	0.0006	3
±5 V	**3750 S/s**	0.003	21 µV	0.0008	210.800 µV	0.0006	2
	2000 S/s	0.003	21 µV	0.0008	210.712 µV	0.0006	2
	1000 S/s	0.003	8 µV	0.0008	198.254 µV	0.0006	2
	500 S/s	0.002	6 µV	0.0008	146.499 µV	0.0006	2
	100 S/s	0.002	7 µV	0.0008	147.285 µV	0.0006	2
	60 S/s	0.002	8 µV	0.0008	148.216 µV	0.0006	2
	50 S/s	0.002	6 µV	0.0008	146.196 µV	0.0006	2
	25 S/s	0.002	6 µV	0.0008	145.996 µV	0.0006	2
	10 S/s	0.002	6 µV	0.0008	145.820 µV	0.0006	2
	5 S/s	0.002	6 µV	0.0008	145.817 µV	0.0006	2
	2.5 S/s	0.002	6 µV	0.0008	145.810 µV	0.0006	2
±2.5 V	**3750 S/s**	0.002	13 µV	0.0008	83.000 µV	0.0006	1
	2000 S/s	0.002	13 µV	0.0008	83.062 µV	0.0006	1
	1000 S/s	0.002	9 µV	0.0008	79.487 µV	0.0006	1
	500 S/s	0.0015	9 µV	0.0008	66.232 µV	0.0006	1
	100 S/s	0.0015	9 µV	0.0008	66.685 µV	0.0006	1
	60 S/s	0.0015	10 µV	0.0008	67.014 µV	0.0006	1
	50 S/s	0.0015	8 µV	0.0008	65.314 µV	0.0006	1
	25 S/s	0.0015	8 µV	0.0008	65.901 µV	0.0006	1
	10 S/s	0.0015	8 µV	0.0008	65.759 µV	0.0006	1
	5 S/s	0.0015	8 µV	0.0008	65.800 µV	0.0006	1
	2.5 S/s	0.0015	8 µV	0.0008	65.769 µV	0.0006	1

Range	A/D data rate	Gain error (% of reading)	Offset error	INL error (% of range)	Absolute accuracy	Gain temperature coefficient (% reading/°C)	Offset temperature coefficient (µV/°C)
±1.25 V	**3750 S/s**	0.0025	7 µV	0.0008	48.050 µV	0.0006	1
	2000 S/s	0.0025	9 µV	0.0008	50.632 µV	0.0006	1
	1000 S/s	0.0025	8 µV	0.0008	49.359 µV	0.0006	1
	500 S/s	0.0025	8 µV	0.0008	49.709 µV	0.0006	1
	100 S/s	0.0025	8 µV	0.0008	49.604 µV	0.0006	1
	60 S/s	0.0025	8 µV	0.0008	49.417 µV	0.0006	1
	50 S/s	0.0025	8 µV	0.0008	49.610 µV	0.0006	1
	25 S/s	0.0025	8 µV	0.0008	49.584 µV	0.0006	1
	10 S/s	0.0025	8 µV	0.0008	49.482 µV	0.0006	1
	5 S/s	0.0025	8 µV	0.0008	49.489 µV	0.0006	1
	2.5 S/s	0.0025	8 µV	0.0008	49.489 µV	0.0006	1
±0.625 V	**3750 S/s**	0.003	7 µV	0.0005	28.775 µV	0.0006	1
	2000 S/s	0.003	7 µV	0.0005	28.679 µV	0.0006	1
	1000 S/s	0.003	6 µV	0.0005	27.762 µV	0.0006	1
	500 S/s	0.003	6 µV	0.0005	28.167 µV	0.0006	1
	100 S/s	0.003	6 µV	0.0005	28.088 µV	0.0006	1
	60 S/s	0.002	6 µV	0.0005	21.709 µV	0.0006	1
	50 S/s	0.002	6 µV	0.0005	21.773 µV	0.0006	1
	25 S/s	0.002	6 µV	0.0005	21.746 µV	0.0006	1
	10 S/s	0.002	6 µV	0.0005	21.927 µV	0.0006	1
	5 S/s	0.002	6 µV	0.0005	21.803 µV	0.0006	1
	2.5 S/s	0.002	6 µV	0.0005	21.784 µV	0.0006	1
±0.3125 V	**3750 S/s**	0.005	7 µV	0.0006	24.500 µV	0.0006	1
	2000 S/s	0.005	6 µV	0.0006	23.443 µV	0.0006	1
	1000 S/s	0.005	6 µV	0.0006	23.086 µV	0.0006	1
	500 S/s	0.005	6 µV	0.0006	23.094 µV	0.0006	1
	100 S/s	0.005	6 µV	0.0006	23.084 µV	0.0006	1
	60 S/s	0.005	6 µV	0.0006	23.288 µV	0.0006	1
	50 S/s	0.005	6 µV	0.0006	23.232 µV	0.0006	1
	25 S/s	0.005	6 µV	0.0006	23.191 µV	0.0006	1
	10 S/s	0.005	6 µV	0.0006	23.125 µV	0.0006	1
	5 S/s	0.005	6 µV	0.0006	23.182 µV	0.0006	1
	2.5 S/s	0.005	6 µV	0.0006	23.127 µV	0.0006	1
±0.15625 V	**3750 S/s**	0.006	6 µV	0.0005	15.856 µV	0.0006	1
	2000 S/s	0.006	6 µV	0.0005	15.793 µV	0.0006	1
	1000 S/s	0.006	6 µV	0.0005	15.902 µV	0.0006	1
	500 S/s	0.006	6 µV	0.0005	16.118 µV	0.0006	1
	100 S/s	0.006	6 µV	0.0005	15.877 µV	0.0006	1
	60 S/s	0.006	6 µV	0.0005	16.014 µV	0.0006	1
	50 S/s	0.006	6 µV	0.0005	16.122 µV	0.0006	1
	25 S/s	0.006	6 µV	0.0005	15.903 µV	0.0006	1
	10 S/s	0.006	6 µV	0.0005	15.927 µV	0.0006	1
	5 S/s	0.006	6 µV	0.0005	15.981 µV	0.0006	1
	2.5 S/s	0.006	6 µV	0.0005	15.979 µV	0.0006	1
±0.078125 V	**3750 S/s**	0.035	6 µV	0.0009	33.547 µV	0.0006	1
	2000 S/s	0.035	6 µV	0.0009	34.252 µV	0.0006	1
	1000 S/s	0.035	6 µV	0.0009	33.696 µV	0.0006	1
	500 S/s	0.035	6 µV	0.0009	34.002 µV	0.0006	1

Range	A/D data rate	Gain error (% of reading)	Offset error	INL error (% of range)	Absolute accuracy	Gain temperature coefficient (% reading/°C)	Offset temperature coefficient (µV/°C)
	100 S/s	0.035	6 µV	0.0009	34.005 µV	0.0006	1
	60 S/s	0.035	6 µV	0.0009	33.866 µV	0.0006	1
	50 S/s	0.035	6 µV	0.0009	34.026 µV	0.0006	1
	25 S/s	0.035	6 µV	0.0009	33.933 µV	0.0006	1
	10 S/s	0.035	6 µV	0.0009	33.937 µV	0.0006	1
	5 S/s	0.035	6 µV	0.0009	33.969 µV	0.0006	1
	2.5 S/s	0.035	6 µV	0.0009	33.934 µV	0.0006	1

Input bandwidth

Table 13. input bandwidth

A/D data rate	-3 db Bandwidth (Hz)
3750 S/s	1615
2000 S/s	878
1000 S/s	441
500 S/s	221
100 S/s	44.2
60 S/s	26.5
50 S/s	22.1
25 S/s	11.1
10 S/s	4.42
5 S/s	2.21
2.5 S/s	1.1

Noise performance

For the peak-to-peak noise distribution test, a differential input channel is connected to GND at the input terminal block, and 50,000 samples are acquired at the maximum rate available at each setting.

Table 14. Peak-to-peak noise performance specifications (µV)

	A/D data rate										
Range	**3750 S/s**	**2000 S/s**	**1000 S/s**	**500 S/s**	**100 S/s**	**60 S/s**	**50 S/s**	**25 S/s**	**10 S/s**	**5 S/s**	**2.5 S/s**
±20 V	230.31	186.92	126.84	100.14	57.22	57.22	49.59	47.58	23.84	23.84	14.31
±10 V	126.84	100.14	71.76	45.06	30.52	30.52	26.70	19.07	11.92	9.54	9.54
±5 V	56.74	47.56	34.21	25.87	16.21	14.31	14.31	14.30	5.96	4.77	4.77
±2.5 V	32.96	28.79	17.94	14.19	7.51	7.09	7.09	5.72	3.81	2.86	2.38
±1.25 V	18.57	17.52	13.83	9.30	5.48	5.48	5.01	3.81	3.34	3.34	2.86
±0.625 V	18.88	16.58	8.45	7.41	5.32	4.80	4.38	3.86	2.50	2.61	1.98
±0.3125 V	15.33	14.76	8.19	6.94	4.75	4.69	4.49	3.70	3.34	2.56	2.45
±0.15625 V	13.28	16.84	7.47	6.61	5.70	4.48	4.48	4.24	2.66	3.07	2.29
±0.078125 V	13.47	15.02	9.17	6.88	4.28	4.16	4.00	3.57	2.28	2.13	2.40

Table 15. RMS noise performance specifications (μVRMS)

	A/D data rate										
Range	**3750 S/s**	**2000 S/s**	**1000 S/s**	**500 S/s**	**100 S/s**	**60 S/s**	**50 S/s**	**25 S/s**	**10 S/s**	**5 S/s**	**2.5 S/s**
±20 V	34.90	28.32	19.22	15.17	8.67	8.67	7.51	7.22	3.61	3.61	2.17
±10 V	19.22	15.17	10.87	6.83	4.62	4.62	4.05	2.89	1.81	1.44	1.44
±5 V	8.60	7.21	5.18	3.92	2.46	2.17	2.17	2.16	0.90	0.72	0.72
±2.5 V	4.99	4.36	2.72	2.15	1.14	1.07	1.07	0.87	0.58	0.43	0.36
±1.25 V	2.81	2.66	2.10	1.41	0.83	0.83	0.76	0.58	0.51	0.51	0.43
±0.625 V	2.86	2.51	1.28	1.12	0.81	0.73	0.66	0.58	0.38	0.40	0.30
±0.3125 V	2.32	2.24	1.24	1.05	0.72	0.71	0.68	0.56	0.51	0.39	0.37
±0.15625 V	2.01	2.55	1.13	1.00	0.86	0.68	0.68	0.64	0.40	0.47	0.35
±0.078125 V	2.04	2.28	1.39	1.04	0.65	0.63	0.60	0.54	0.35	0.32	0.36

Table 16. Noise-free resolution specifications (bits)

	A/D data rate										
Range	**3750 S/s**	**2000 S/s**	**1000 S/s**	**500 S/s**	**100 S/s**	**60 S/s**	**50 S/s**	**25 S/s**	**10 S/s**	**5 S/s**	**2.5 S/s**
±20 V	17.4	17.7	18.2	18.6	19.4	19.4	19.6	19.6	20.6	20.6	21.4
±10 V	17.2	17.6	18.1	18.7	19.3	19.3	19.5	20.0	20.6	21.0	21.0
±5 V	17.4	17.6	18.1	18.5	19.2	19.4	19.4	19.4	20.6	21.0	21.0
±2.5 V	17.2	17.4	18.1	18.4	19.3	19.4	19.4	19.7	20.3	20.7	21.0
±1.25 V	17.0	17.1	17.4	18.0	18.8	18.8	18.9	19.3	19.5	19.5	19.7
±0.625 V	16.0	16.2	17.1	17.3	17.8	18.0	18.1	18.3	18.9	18.8	19.2
±0.3125 V	15.3	15.3	16.2	16.4	17.0	17.0	17.0	17.3	17.5	17.9	17.9
±0.15625 V	14.5	14.1	15.3	15.5	15.7	16.1	16.1	16.1	16.8	16.9	17.1
±0.078125 V	14.5	14.3	15.0	15.4	16.1	16.2	16.2	16.4	17.0	17.1	16.9

Channel switching error

Table 17. Step response accuracy specifications

	Accuracy										
Range	**3750 S/s**	**2000 S/s**	**1000 S/s**	**500 S/s**	**100 S/s**	**60 S/s**	**50 S/s**	**25 S/s**	**10 S/s**	**5 S/s**	**2.5 S/s**
±20 V	0.0011%	0.0006%	0.0004%	0.0003%	0.0002%	0.0002%	0.0002%	0.0002%	0.0001%	0.0001%	0.0001%
±10 V	0.0010%	0.0008%	0.0005%	0.0004%	0.0002%	0.0002%	0.0003%	0.0002%	0.0001%	0.0001%	0.0001%
±5 V	0.0009%	0.0008%	0.0004%	0.0004%	0.0003%	0.0002%	0.0002%	0.0002%	0.0001%	0.0001%	0.0001%
±2.5 V	0.0010%	0.0007%	0.0008%	0.0004%	0.0003%	0.0002%	0.0002%	0.0002%	0.0002%	0.0001%	0.0001%
±1.25 V	0.0013%	0.0009%	0.0008%	0.0007%	0.0004%	0.0004%	0.0003%	0.0003%	0.0003%	0.0003%	0.0003%
±0.625 V	0.0022%	0.0016%	0.0011%	0.0011%	0.0007%	0.0007%	0.0005%	0.0005%	0.0004%	0.0005%	0.0003%
±0.3125 V	0.0031%	0.0031%	0.0020%	0.0017%	0.0015%	0.0012%	0.0010%	0.0010%	0.0012%	0.0009%	0.0009%
±0.15625 V	0.0056%	0.0062%	0.0048%	0.0037%	0.0032%	0.0025%	0.0024%	0.0021%	0.0019%	0.0022%	0.0016%
±0.078125 V	0.0114%	0.0123%	0.0076%	0.0070%	0.0041%	0.0051%	0.0046%	0.0036%	0.0032%	0.0030%	0.0034%

Channel switching error is defined as the accuracy that can be expected after one conversion when switching from a channel with a DC input at one extreme of full scale to another channel with a DC input at the other extreme of full scale, expressed in terms of percentage of full scale value.

Throughput rate

Table 18. Single channel throughput rate specifications

The single channel throughput rate is calculated using this formula:

$$Maximum\ throughput = \frac{1}{\frac{1}{data\ rate} + 640\ \mu s}$$

A/D data rate	Maximum throughput (Hz)
3750 S/s	1102.94
2000 S/s	877.19
1000 S/s	609.76
500 S/s	378.79
100 S/s	93.98
60 S/s	57.78
50 S/s	48.45
25 S/s	24.61
10 S/s	9.94
5 S/s	4.98
2.5 S/s	2.50

The multiple-channel throughput rate is calculated using this formula:

$$Maximum\ throughput = \frac{1}{\sum_{n}\left(\frac{1}{data\ rate} + 640\ \mu s\right)}$$, where n is the number of channels

Table 19. Multiple-channel throughput rate specifications (Hz)

	3750 S/s	2000 S/s	1000 S/s	500 S/s	100 S/s	60 S/s	50 S/s	25 S/s	10 S/s	5 S/s	2.5 S/s
Number of input channels											
1	1102.94	877.19	609.76	378.79	93.98	57.78	48.45	24.61	9.94	4.98	2.50
2	551.47	438.60	304.88	189.39	46.99	28.89	24.22	12.30	4.97	2.49	1.25
3	367.65	292.40	203.25	126.26	31.33	19.26	16.15	8.20	3.31	1.66	0.83
4	275.74	219.30	152.44	94.70	23.50	14.45	12.11	6.15	2.48	1.25	0.62
5	220.59	175.44	121.95	75.76	18.80	11.56	9.69	4.92	1.99	1.00	0.50
6	183.82	146.20	101.63	63.13	15.66	9.63	8.07	4.10	1.66	0.83	0.42
7	157.56	125.31	87.11	54.11	13.43	8.25	6.92	3.52	1.42	0.71	0.36
8	137.87	109.65	76.22	47.35	11.75	7.22	6.06	3.08	1.24	0.62	0.31
9	122.55	97.47	67.75	42.09	10.44	6.42	5.38	2.73	1.10	0.55	0.28
10	110.29	87.72	60.98	37.88	9.40	5.78	4.84	2.46	0.99	0.50	0.25
11	100.27	79.74	55.43	34.44	8.54	5.25	4.40	2.24	0.90	0.45	0.23
12	91.91	73.10	50.81	31.57	7.83	4.82	4.04	2.05	0.83	0.42	0.21
13	84.84	67.48	46.90	29.14	7.23	4.44	3.73	1.89	0.76	0.38	0.19
14	78.78	62.66	43.55	27.06	6.71	4.13	3.46	1.76	0.71	0.36	0.18
15	73.53	58.48	40.65	25.25	6.27	3.85	3.23	1.64	0.66	0.33	0.17
16	68.93	54.82	38.11	23.67	5.87	3.61	3.03	1.54	0.62	0.31	0.16

Analog voltage output

Unused VDACx output channels should be left disconnected.

The RedLab 2416-4AO output voltage level defaults to 0 V whenever the host PC is reset, shut down or suspended, or if a reset command is issued to the device.

The duration of the output transient depends highly on the enumeration process of the host PC. Typically, the output of the RedLab 2416-4AO is stable after two seconds.

Table 20. Analog voltage output specifications

Parameter	Conditions	Specifications
Digital-to-analog converter		DAC8555
Number of channels		4
Resolution		16 bits
Output ranges	Calibrated	±10 V
	Uncalibrated	±10.05 V, software configurable
Output transient	Host PC is reset, powered on, suspended or a reset command is issued to device (Note 6)	Duration: 2 s Amplitude: 2 V p-p
	Initial power on	Duration: 50 ms Amplitude: 5 V peak
Differential non-linearity		±0.25 LSB typical ±1 LSB maximum
Output current	VDACx pins	±3.5 mA maximum
Output short-circuit protection	VDACx connected to AGND	Unlimited duration
Output coupling		DC
VDACx readback		Each VDAC*x* output can be independently measured by the onboard A/D converter. Software selectable
Power on and reset state		DACs cleared to zero-scale: 0 V, ±50 mV
Output noise		30 µVrms
Settling time	*To rated accuracy, 10 V step*	*45 µs*
Slew rate		*1.0 V/µs*
Throughput	Single-channel	1000 S/s maximum, system-dependent
	Multi-channel	1000 S/s / #ch maximum, system-dependent

Table 21. Calibrated absolute accuracy specifications

Range	Accuracy (±LSB)
±10 V	16.0

Table 22. Calibrated absolute accuracy components specifications

Range	% of reading	Offset (±mV)	Temp drift (%/°C)	Absolute accuracy at FS (±mV)
±10 V	±0.0183	1.831	0.00055	3.661

Table 23. Relative accuracy specifications

Range	Relative accuracy (±LSB)
±10 V	4.0 typical

Analog input/output calibration

Table 24. Analog input/output calibration specifications

Parameter	Specifications
Recommended warm-up time	45 minutes minimum
Calibration	Firmware calibration
Calibration interval	1 year
Calibration reference	+10.000 V, ±5 mV maximum. Actual measured values stored in EEPROM
	Tempco: 5 ppm/°C maximum
	Long term stability: 30 ppm/1000 hours

Digital input/output

Table 25. Digital input specifications

Number of I/O	8 channels
Configuration	Each DIO bit can be independently read from (DIN) or written to (DOUT). The DIN bits can be read at any time whether the DOUT is active or tri-stated.
Input voltage range	0 to +15 V
Input type	CMOS (Schmitt trigger)
Input characteristics	47 kΩ pull-up/pull-down resistor, 28 kΩ series resistor
Maximum input voltage range	*0 to +20 V maximum (power on/off, relative to DGND pins 93 and 94)*
Pull-up/pull-down configuration	All pins pulled up to +5 V via individual 47 kΩ resistors (the JP1 shorting block default position is pins 1 and 2). Pull down capability is available by placing the JP1 shorting block across pins 2 and 3.
Transfer rate (software paced)	500 port reads or single bit reads per second typical.
Input high voltage	1.3 V minimum, 2.2 V maximum
Input low voltage	1.5 V maximum, 0.6 V minimum
Schmitt trigger hysteresis	0.4 V minimum, 1.2 V maximum

Note 2: DGND pins (pins 93, 94) are recommended for use with digital input and digital output pins. The DGND and GND pins are common and are isolated from earth ground.

Table 26. Digital output specifications

Number of I/O	8 channels
Configuration	Each DIO bit can be independently read from (DIN) or written to (DOUT). The DIN bits may be read at any time whether the DOUT is active or tri-stated
Output characteristics	47 kΩ pull-up, open drain (DMOS transistor)
Pull-up configuration	All pins pulled up to +5 V via individual 47 kΩ resistors (the JP1 shorting block default position is pins 1 and 2).
Transfer rate (software paced)	Digital output – 500 port writes or single-bit writes per second typical.
Output voltage range	0 to +5 V (no external pull up resistor, internal 47 kΩ pull-up resistors connected to +5 V by default) 0 to +15 V maximum (Note 9)
Drain to source breakdown voltage	+50 V minimum
Off state leakage current (Note 6)	0.1 µA
Sink current capability	▪ 150 mA maximum (continuous) per output pin ▪ 150 mA maximum (continuous) for all eight channels
DMOS transistor on-resistance (drain to source)	4 Ω

Note 3: Each DMOS transistor's source pin is internally connected to GND.

Note 4: DGND pins (pins 93, 94) are recommended for use with digital input and digital output pins. The DGND and GND pins are common and are isolated from earth ground.

Note 5: The external pull-up is connected to the digital output bit through an external pull-up resistor. Adding an external pull-up resistor connects it in parallel with the internal 47 kΩ pull-up resistor of that particular digital input/output bit. Careful consideration should be made when considering the external pull-up resistor value and the resultant pull-up voltage produced at the load.

Note 6: Does not include the additional leakage current contribution that may occur when using an external pull-up resistor.

Counter

Table 27. CTR specifications

Parameter	Conditions	Specification
Pin name		CTR0, CTR1
Number of channels		2 channels
Resolution		32-bits
Counter type		Event counter
Input type		Schmitt trigger, rising edge triggered
Input source		CTR0 (pin 43) CTR1 (pin 45)
Counter read/writes rates (software paced)	Counter read	System dependent, 500 reads per second.
	Counter write	System dependent, 500 writes per second.
Input characteristics	Each CTRx input pin	562 KΩ pull-up resistor to +5 V, 10 kΩ series resistor
Input voltage range		±15 V maximum
Maximum input voltage range	*CTR0,CTR1 relative to GND and DGND (pins 18,36,39,42,44,46,66,81,84,93,94)*	*±20 V maximum (power on/off)*
Input high voltage		1.3 V minimum, 2.2 V maximum
Input low voltage		1.5 V maximum, 0.6 V minimum
Schmitt trigger hysteresis		0.4 V minimum, 1.2 V maximum
Input bandwidth (-3 dB)		1 MHz
Input capacitance		*25 pf*
Input leakage current		*±120 nA*
Input frequency		1 MHz, maximum
High pulse width		*500 ns, minimum*
Low pulse width		*500 ns, minimum*

Note 7: The DGND and GND pins *(pins 18,36,39,42,44,46,66,81,84,93,94)* are common and are isolated from earth ground.

Memory

Table 28. Memory specifications

EEPROM	4096 bytes isolated micro reserved for sensor configuration 256 bytes USB micro for external application use

Microcontroller

Table 29. Microcontroller specifications

Type	One high-performance 8-bit RISC microcontroller with USB interface (non-isolated) One high-performance 16-bit RISC microcontroller for measurements (isolated)

Power

The RedLab 2416-4AO product includes an AC power adapter (MCC part number PS-10W5VEPS).

Table 30. Power specifications

Parameter	Conditions	Specification
Supply current (Note 8)	Quiescent current	340 mA
External power input (Note 9)		+5 V, ±5%
External power supply	MCC p/n PS-5V2AEPS (included)	+5 VDC, 10 W, 5% regulation
Voltage supervisor limits	4.5 V > V_{ext} or V_{ext} > 5.5 V	PWR LED = Off; (power fault)
	4.5 V < V_{ext} < 5.5 V	PWR LED = On
+5 V user output voltage range	Available at terminal block pin 35	4.9 V minimum to 5.1 V maximum
User +5V user output current	Available at terminal block pin 35	10 mA maximum
Isolation	Measurement system to PC	500 VDC minimum

Table 31. AC power requirements

Parameter	Conditions	Specification
Output voltage		+5 V, ±5%
Output wattage		10 watts
Power jack configuration		Two conductor
Power jack barrel diameter		6.3 mm
Power jack pin diameter		2.0 mm
Power jack polarity		Center positive

Note 8: This is the total quiescent current requirement for the RedLab 2416-4AO which includes up to 10 mA for the status LED. This does not include any potential loading of the digital I/O bits, +5V user terminal or the VDACx outputs

Note 9: This specification applies to the actual voltage level at the input to the external power connector of the RedLab 2416-4AO.

USB specifications

Table 32. USB specifications

USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0
USB cable type	*A-B cable, UL type AWM 2527 or equivalent. (minimum 24 AWG VBUS/GND, minimum 28 AWG D+/D–)*
USB cable length	5 meters maximum

Environmental

The environmental specifications listed in Table 33 apply only to the RedLab 2416-4AO and not to the AC power adapter.

Table 33. Environmental specifications

Operating temperature range	0 to 50° C maximum
Storage temperature range	-40 to 85 ° C maximum
Humidity	0 to 90% non-condensing maximum

Mechanical

Table 34. Mechanical specifications

Dimensions	245 mm (L) x 146 mm (W) x 50 mm (H)
User connection length	5 meters maximum

Screw terminal connector type and pin-out

Table 35. Screw terminal connector specifications

Connector type	Detachable screw terminal
Wire gauge range	16 AWG to 30 AWG

Screw terminal pin out

For additional channel configurations when using the optional AI-EXP expansion device, refer to the "

Optional AI-EXP32 expansion module" section below.

Table 36. 16-channel differential mode pin out

Do not connect to terminal block pins labeled "NC."

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	NC	No connect	49	NC	No connect
2	CH0H	Channel 0 HI	50	CH15L	Channel 15 LO
3	CH0L	Channel 0 LO	51	CH15H	Channel 15 HI
4	NC	No connect	52	IC14	No connect
5	IC0	No connect	53	4WC14	No connect
6	CH1H	Channel 1 HI	54	CH14L	Channel 14 LO
7	CH1L	Channel 1 LO	55	CH14H	Channel 14 HI
8	4WC1	No connect	56	IC13	No connect
9	IC1	No connect	57	4WC13	No connect
10	CH2H	Channel 2 HI	58	CH13L	Channel 13 LO
11	CH2L	Channel 2 LO	59	CH13H	Channel 13 HI
12	4WC2	No connect	60	IC12	No connect
13	IC2	No connect	61	4WC12	No connect
14	CH3H	Channel 3 HI	62	CH12L	Channel 12 LO
15	CH3L	Channel 3 LO	63	CH12H	Channel 12 HI
16	4WC3	No connect	64	IC11	No connect
17	IC3	No connect	65	4WC11	No connect
18	GND	Analog ground	66	GND	Analog ground
19	CH4H	Channel 4 HI	67	CH11L	Channel 11 LO
20	CH4L	Channel 4 LO	68	CH11H	Channel 11 HI
21	4WC4	No connect	69	IC10	No connect
22	IC4	No connect	70	4WC10	No connect
23	CH5H	Channel 5 HI	71	CH10L	Channel 10 LO
24	CH5L	Channel 5 LO	72	CH10H	Channel 10 HI
25	4WC5	No connect	73	IC9	No connect
26	IC5	No connect	74	4WC9	No connect
27	CH6H	Channel 6 HI	75	CH9L	Channel 9 LO
28	CH6L	Channel 6 LO	76	CH9H	Channel 9 HI
29	4WC6	No connect	77	IC8	No connect
30	IC6	No connect	78	4WC8	No connect
31	CH7H	Channel 7 HI	79	CH8L	Channel 8 LO
32	CH7L	Channel 7 LO	80	CH8H	Channel 8 HI
33	4WC7	No connect	81	GND	Analog ground
34	IC7	No connect	82	NC	No connect
35	+5V	+5V output	83	NC	No connect
36	GND	Analog ground	84	GND	Analog ground
37	VDAC0	Analog output Ch0	85	DIO7	Digital input/output
38	VDAC1	Analog output Ch1	86	DIO6	Digital input/output
39	GND	Analog ground	87	DIO5	Digital input/output
40	VDAC2	Analog output Ch2	88	DIO4	Digital input/output
41	VDAC3	Analog output Ch3	89	DIO3	Digital input/output
42	GND	Analog ground	90	DIO2	Digital input/output
43	CTR0	Counter input Ch0	91	DIO1	Digital input/output

Pin	Signal name	Pin description	Pin	Signal name	Pin description
44	GND	Analog ground	92	DIO0	Digital input/output
45	CTR1	Counter input Ch1	93	DGND	Digital I/O ground
46	GND	Analog ground	94	DGND	Digital I/O ground
47	NC	No connect	95	NC	No connect
48	NC	No connect	96	NC	No connect

Table 37. 32-channel single-ended mode pin out

Do not connect to terminal block pins labeled "NC."

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	NC	No connect	49	NC	No connect
2	CH0H	Channel 0	50	CH15L	Channel 31
3	CH0L	Channel 16	51	CH15H	Channel 15
4	NC	No connect	52	IC14	No connect
5	IC0	No connect	53	4WC14	No connect
6	CH1H	Channel 1	54	CH14L	Channel 30
7	CH1L	Channel 17	55	CH14H	Channel 14
8	4WC1	No connect	56	IC13	No connect
9	IC1	No connect	57	4WC13	No connect
10	CH2H	Channel 2	58	CH13L	Channel 29
11	CH2L	Channel 18	59	CH13H	Channel 13
12	4WC2	No connect	60	IC12	No connect
13	IC2	No connect	61	4WC12	No connect
14	CH3H	Channel 3	62	CH12L	Channel 28
15	CH3L	Channel 19	63	CH12H	Channel 12
16	4WC3	No connect	64	IC11	No connect
17	IC3	No connect	65	4WC11	No connect
18	GND	Analog ground	66	GND	Analog ground
19	CH4H	Channel 4	67	CH11L	Channel 27
20	CH4L	Channel 20	68	CH11H	Channel 11
21	4WC4	No connect	69	IC10	No connect
22	IC4	No connect	70	4WC10	No connect
23	CH5H	Channel 5	71	CH10L	Channel 26
24	CH5L	Channel 21	72	CH10H	Channel 10
25	4WC5	No connect	73	IC9	No connect
26	IC5	No connect	74	4WC9	No connect
27	CH6H	Channel 6	75	CH9L	Channel 25
28	CH6L	Channel 22	76	CH9H	Channel 9
29	4WC6	No connect	77	IC8	No connect
30	IC6	No connect	78	4WC8	No connect
31	CH7H	Channel 7	79	CH8L	Channel 24
32	CH7L	Channel 23	80	CH8H	Channel 8
33	4WC7	No connect	81	GND	Analog ground
34	IC7	No connect	82	NC	No connect
35	+5V	+5V output	83	NC	No connect
36	GND	Analog ground	84	GND	Analog ground
37	VDAC0	Analog output Ch0	85	DIO7	Digital input/output
38	VDAC1	Analog output Ch1	86	DIO6	Digital input/output
39	GND	Analog ground	87	DIO5	Digital input/output
40	VDAC2	Analog output Ch2	88	DIO4	Digital input/output
41	VDAC3	Analog output Ch3	89	DIO3	Digital input/output
42	GND	Analog ground	90	DIO2	Digital input/output
43	CTR0	Counter input Ch0	91	DIO1	Digital input/output

Pin	Signal name	Pin description	Pin	Signal name	Pin description
44	GND	Analog ground	92	DIO0	Digital input/output
45	CTR1	Counter input Ch1	93	DGND	Digital I/O ground
46	GND	Analog ground	94	DGND	Digital I/O ground
47	NC	No connect	95	NC	No connect
48	NC	No connect	96	NC	No connect

Optional AI-EXP32 expansion module

Use the AI-EXP32 (sold separately) for applications that need additional analog/thermocouple input and digital I/O channels.

The AI-EXP32 expansion port is intended to interface with a RedLab 2416-4AO. Do not try to use any of the expansion port pins for any other purpose.

Table 38. AI-EXP32 37-pin connector pin out

Do not connect to terminal block pins labeled "NC."

Pin	Signal name	Pin description
1	GND	Analog ground
2	NC	No connect
3	GND	Analog ground
4	NC	No connect
5	GND	Analog ground
6	VCC	+12 V power
7	NC	No connect
8	NC	No connect
9	IM_A2	I/O control signal
10	IM_A1	I/O control signal
11	IM_A0	I/O control signal
12	IMEN10	I/O control signal
13	IMEN9	I/O control signal
14	IMEN8	I/O control signal
15	IMEN7	I/O control signal
16	DIO_LOAD2	I/O control signal
17	DIO_LOAD1	I/O control signal
18	NC	No connect
19	NC	No connect
20	+3.3V_ISO	+3.3 V power
21	GND	Analog ground
22	+5 VA	+5 V analog power
23	+20.5V	+20.5 V power
24	GND	Analog ground
25	-20.5V	-20.5 V power
26	VDD_ISO	+5 V digital power
27	EXTDIO_INT	I/O control signal
28	CM_A3	I/O control signal
29	SM_A1	I/O control signal
30	SM_AO	I/O control signal
31	CM_A2	I/O control signal
32	SCL	Serial I/O control signal
33	SDA	Serial I/O control signal
34	MOSI	Serial I/O control signal
35	SCK	Serial I/O control signal
36	NC	No connect
37	NC	No connect

The multiple-channel throughput rate calculation is based on the following formula:

Maximum throughput = $\frac{1}{\sum_n \left(\frac{1}{\text{data rate}} + 640\,\mu s\right)}$, where n is the number of channels

Table 39. Multiple-channel throughput rate specifications (Hz), RedLab 2416-4AO and optional AI-EXP32 expansion module

	3750 S/s	**2000 S/s**	**1000 S/s**	**500 S/s**	**100 S/s**	**60 S/s**	**50 S/s**	**25 S/s**	**10 S/s**	**5 S/s**	**2.5 S/s**
Number of input channels											
1	1102.94	877.19	609.76	378.79	93.98	57.78	48.45	24.61	9.94	4.98	2.50
2	551.47	438.60	304.88	189.39	46.99	28.89	24.22	12.30	4.97	2.49	1.25
3	367.65	292.40	203.25	126.26	31.33	19.26	16.15	8.20	3.31	1.66	0.83
4	275.74	219.30	152.44	94.70	23.50	14.45	12.11	6.15	2.48	1.25	0.62
5	220.59	175.44	121.95	75.76	18.80	11.56	9.69	4.92	1.99	1.00	0.50
6	183.82	146.20	101.63	63.13	15.66	9.63	8.07	4.10	1.66	0.83	0.42
7	157.56	125.31	87.11	54.11	13.43	8.25	6.92	3.52	1.42	0.71	0.36
8	137.87	109.65	76.22	47.35	11.75	7.22	6.06	3.08	1.24	0.62	0.31
9	122.55	97.47	67.75	42.09	10.44	6.42	5.38	2.73	1.10	0.55	0.28
10	110.29	87.72	60.98	37.88	9.40	5.78	4.84	2.46	0.99	0.50	0.25
11	100.27	79.74	55.43	34.44	8.54	5.25	4.40	2.24	0.90	0.45	0.23
12	91.91	73.10	50.81	31.57	7.83	4.82	4.04	2.05	0.83	0.42	0.21
13	84.84	67.48	46.90	29.14	7.23	4.44	3.73	1.89	0.76	0.38	0.19
14	78.78	62.66	43.55	27.06	6.71	4.13	3.46	1.76	0.71	0.36	0.18
15	73.53	58.48	40.65	25.25	6.27	3.85	3.23	1.64	0.66	0.33	0.17
16	68.93	54.82	38.11	23.67	5.87	3.61	3.03	1.54	0.62	0.31	0.16
17	64.88	51.60	35.87	22.28	5.53	3.40	2.85	1.45	0.58	0.29	0.15
18	61.27	48.73	33.88	21.04	5.22	3.21	2.69	1.37	0.55	0.28	0.14
19	58.05	46.17	32.09	19.94	4.95	3.04	2.55	1.30	0.52	0.26	0.13
20	55.15	43.86	30.49	18.94	4.70	2.89	2.42	1.23	0.50	0.25	0.12
21	52.52	41.77	29.04	18.04	4.48	2.75	2.31	1.17	0.47	0.24	0.12
22	50.13	39.87	27.72	17.22	4.27	2.63	2.20	1.12	0.45	0.23	0.11
23	47.95	38.14	26.51	16.47	4.09	2.51	2.11	1.07	0.43	0.22	0.11
24	45.96	36.55	25.41	15.78	3.92	2.41	2.02	1.03	0.41	0.21	0.10
25	44.12	35.09	24.39	15.15	3.76	2.31	1.94	0.98	0.40	0.20	0.10
26	42.42	33.74	23.45	14.57	3.61	2.22	1.86	0.95	0.38	0.19	0.10
27	40.85	32.49	22.58	14.03	3.48	2.14	1.79	0.91	0.37	0.18	0.09
28	39.39	31.33	21.78	13.53	3.36	2.06	1.73	0.88	0.35	0.18	0.09
29	38.03	30.25	21.03	13.06	3.24	1.99	1.67	0.85	0.34	0.17	0.09
30	36.76	29.24	20.33	12.63	3.13	1.93	1.61	0.82	0.33	0.17	0.08
31	35.58	28.30	19.67	12.22	3.03	1.86	1.56	0.79	0.32	0.16	0.08
32	34.47	27.41	19.05	11.84	2.94	1.81	1.51	0.77	0.31	0.16	0.08

AI-EXP32 screw terminal pin out

Table 40. 32-channel differential mode pin out

Do not connect to terminal block pins labeled "NC."

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH16H	Channel 16 HI	49	CH31L	Channel 31 LO
2	CH16L	Channel 16 LO	50	CH31H	Channel 31 HI
3	CH17H	Channel 17 HI	51	CH30L	Channel 30 LO
4	CH17L	Channel 17 LO	52	CH30H	Channel 30 HI
5	CH18H	Channel 18 HI	53	CH29L	Channel 29 LO
6	CH18L	Channel 18 LO	54	CH29H	Channel 29 HI
7	CH19H	Channel 19 HI	55	CH28L	Channel 28 LO
8	CH19L	Channel 19 LO	56	CH28H	Channel 28 HI
9	CH20H	Channel 20 HI	57	CH27L	Channel 27 LO
10	CH20L	Channel 20 LO	58	CH27H	Channel 27 HI
11	CH21H	Channel 21 HI	59	CH26L	Channel 26 LO
12	CH21L	Channel 21 LO	60	CH26H	Channel 26 HI
13	CH22H	Channel 22 HI	61	CH25L	Channel 25 LO
14	CH22L	Channel 22 LO	62	CH25H	Channel 25 HI
15	CH23H	Channel 23 HI	63	CH24L	Channel 24 LO
16	CH23L	Channel 23 LO	64	CH24H	Channel 24 HI
17	GND	Analog ground	65	GND	Analog ground
18	GND	Analog ground	66	GND	Analog ground
19	+5VUSER	+5V output	67	NC	No connect
20	NC	No connect	68	NC	No connect
21	DIO8	Digital input/output	69	DIO23	Digital input/output
22	DIO9	Digital input/output	70	DIO22	Digital input/output
23	DIO10	Digital input/output	71	DIO21	Digital input/output
24	DIO11	Digital input/output	72	DIO20	Digital input/output
25	DIO12	Digital input/output	73	DIO19	Digital input/output
26	DIO13	Digital input/output	74	DIO18	Digital input/output
27	DIO14	Digital input/output	75	DIO17	Digital input/output
28	DIO15	Digital input/output	76	DIO16	Digital input/output
29	DGND	Digital ground	77	DGND	Digital ground
30	DGND	Digital ground	78	DGND	Digital ground
31	NC	No connect	79	NC	No connect
32	NC	No connect	80	NC	No connect

Table 41. 32-channel single-ended mode pin out

Do not connect to terminal block pins labeled "NC."

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH16H	Channel 16	33	CH31L	Channel 63
2	CH16L	Channel 48	34	CH31H	Channel 31
3	CH17H	Channel 17	35	CH30L	Channel 62
4	CH17L	Channel 49	36	CH30H	Channel 30
5	CH18H	Channel 18	37	CH29L	Channel 61
6	CH18L	Channel 50	38	CH29H	Channel 29
7	CH19H	Channel 19	39	CH28L	Channel 60
8	CH19L	Channel 51	40	CH28H	Channel 28
9	CH20H	Channel 20	41	CH27L	Channel 59
10	CH20L	Channel 52	42	CH27H	Channel 27
11	CH21H	Channel 21	43	CH26L	Channel 58
12	CH21L	Channel 53	44	CH26H	Channel 26
13	CH22H	Channel 22	45	CH25L	Channel 57
14	CH22L	Channel 54	46	CH25H	Channel 25
15	CH23H	Channel 23	47	CH24L	Channel 56
16	CH23L	Channel 55	48	CH24H	Channel 24
17	GND	Analog ground	49	GND	Analog ground
18	GND	Analog ground	50	GND	Analog ground
19	+5VUSER	+5V output	51	NC	No connect
20	NC	No connect	52	NC	No connect
21	DIO8	Digital input/output	69	DIO23	Digital input/output
22	DIO9	Digital input/output	70	DIO22	Digital input/output
23	DIO10	Digital input/output	71	DIO21	Digital input/output
24	DIO11	Digital input/output	72	DIO20	Digital input/output
25	DIO12	Digital input/output	73	DIO19	Digital input/output
26	DIO13	Digital input/output	74	DIO18	Digital input/output
27	DIO14	Digital input/output	75	DIO17	Digital input/output
28	DIO15	Digital input/output	76	DIO16	Digital input/output
29	DGND	Digital ground	61	DGND	Digital ground
30	DGND	Digital ground	62	DGND	Digital ground
31	NC	No connect	63	NC	No connect
32	NC	No connect	64	NC	No connect

RedLab 2416-4AO screw terminal pin out (with AI-EXP32 attached)

Table 42. RedLab 2416-4AO single-ended mode pin out with AI-EXP32 connected

Do not connect to terminal block pins labeled "NC."

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	NC	No connect	49	NC	No connect
2	CH0H	Channel 0	50	CH15L	Channel 47
3	CH0L	Channel 32	51	CH15H	Channel 15
4	NC	No connect	52	IC14	No connect
5	IC0	No connect	53	4WC14	No connect
6	CH1H	Channel 1	54	CH14L	Channel 46
7	CH1L	Channel 33	55	CH14H	Channel 14
8	4WC1	No connect	56	IC13	No connect
9	IC1	No connect	57	4WC13	No connect
10	CH2H	Channel 2	58	CH13L	Channel 45
11	CH2L	Channel 34	59	CH13H	Channel 13
12	4WC2	No connect	60	IC12	No connect
13	IC2	No connect	61	4WC12	No connect
14	CH3H	Channel 3	62	CH12L	Channel 44
15	CH3L	Channel 35	63	CH12H	Channel 12
16	4WC3	No connect	64	IC11	No connect
17	IC3	No connect	65	4WC11	No connect
18	GND	Analog ground	66	GND	Analog ground
19	CH4H	Channel 4	67	CH11L	Channel 43
20	CH4L	Channel 36	68	CH11H	Channel 11
21	4WC4	No connect	69	IC10	No connect
22	IC4	No connect	70	4WC10	No connect
23	CH5H	Channel 5	71	CH10L	Channel 42
24	CH5L	Channel 37	72	CH10H	Channel 10
25	4WC5	No connect	73	IC9	No connect
26	IC5	No connect	74	4WC9	No connect
27	CH6H	Channel 6	75	CH9L	Channel 41
28	CH6L	Channel 38	76	CH9H	Channel 9
29	4WC6	No connect	77	IC8	No connect
30	IC6	No connect	78	4WC8	No connect
31	CH7H	Channel 7	79	CH8L	Channel 40
32	CH7L	Channel 39	80	CH8H	Channel 8
33	4WC7	No connect	81	GND	Analog ground
34	IC7	No connect	82	NC	No connect
35	+5V	+5V output	83	NC	No connect
36	GND	Analog ground	84	GND	Analog ground
37	VDAC0	Analog output Ch0	85	DIO7	Digital input/output
38	VDAC1	Analog output Ch1	86	DIO6	Digital input/output
39	GND	Analog ground	87	DIO5	Digital input/output
40	VDAC2	Analog output Ch2	88	DIO4	Digital input/output
41	VDAC3	Analog output Ch3	89	DIO3	Digital input/output

Pin	Signal name	Pin description	Pin	Signal name	Pin description
42	GND	Analog ground	90	DIO2	Digital input/output
43	CTR0	Counter input Ch0	91	DIO1	Digital input/output
44	GND	Analog ground	92	DIO0	Digital input/output
45	CTR1	Counter input Ch1	93	DGND	Digital I/O ground
46	GND	Analog ground	94	DGND	Digital I/O ground
47	NC	No connect	95	NC	No connect
48	NC	No connect	96	NC	No connect