USB-5203

Specifications

Document Revision 1.8, June, 2009

Specifications

Typical for 25 °C unless otherwise specified.

Specifications in *italic* text are guaranteed by design.

Analog input section

Table 1. Generic analog input specifications

Parameter	Conditions	Specification
A/D converters		Four dual 24-bit, Sigma-Delta type
Number of channels		8 differential
Input isolation		*500 VDC minimum between field wiring and USB interface*
Channel configuration		Software programmable to match sensor type
Differential input voltage range for the various sensor categories	Thermocouple	±0.080 V
	RTD	0 to 0.5 V
	Thermistor	0 to 2 V
	Semiconductor sensor	0 to 2.5 V
Absolute maximum input voltage	*±C0x through ±C7x relative to GND (pins 9, 19, 28, 38)*	±25 V power on, ±40 V power off.
Input impedance		5 Gigohm, min.
Input leakage current	Open thermocouple detect disabled	30 nA max.
	Open thermocouple detect enabled	105 nA max.
Normal mode rejection ratio	*f_{IN} = 60 Hz*	90 dB min.
Common mode rejection Ratio	*f_{IN}=50 Hz/60 Hz*	100 dB min.
Resolution		24 bits
No missing codes		*24 bits*
Input coupling		DC
Warm-up time		30 minutes min.
Open thermocouple detect		Automatically enabled when the channel pair is configured for thermocouple sensor. The maximum open detection time is 3 seconds.
CJC sensor accuracy	*15 °C to 35 °C*	*±0.25 °C typ.,±0.5 °C max.*
	0 °C to 70 °C	*-1.0 to +0.5 °C max*

Channel configurations

Table 2. Channel configuration specifications

Sensor Category	Conditions	Max number of sensors (all channels configured alike)
Disabled		
Thermocouple	J, K, S, R, B, E, T, or N	8 differential channels
Semiconductor sensor		8 differential channels
RTD and thermistor	2-wire input configuration with a single sensor per channel pair	4 differential channels
	2-wire input configuration with two sensors per channel pair	8 differential channels
	3-wire configuration with a single sensor per channel pair	4 differential channels
	4-wire input configuration with a single sensor per channel pair	4 differential channels
	4-wire input configuration with two sensors per channel pair	8 differential channels

Note 1: Internally, the device has four, dual-channel, fully differential A/Ds providing a total of eight differential channels. The analog input channels are therefore configured in four channel pairs with CH0/CH1 sensor inputs, CH2/CH3 sensor inputs, CH4/CH5 sensor inputs, and CH6/CH7 sensor inputs paired together. This "channel-pairing" requires the analog input channel pairs be configured to monitor the same category of temperature sensor. Mixing different sensor types of the same category (such as a type J thermocouple on channel 0 and a type T thermocouple on channel 1) is valid.

Note 2: Channel configuration information is stored in the EEPROM of the isolated microcontroller by the firmware whenever any item is modified. Modification is performed by commands issued over USB from an external application, and the configuration is made non-volatile through the use of the EEPROM.

Note 3: The factory default configuration is *Disabled*. The Disabled mode will disconnect the analog inputs from the terminal blocks and internally ground all of the A/D inputs. This mode also disables each of the current excitation sources.

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
RTD	100 ohm PT (DIN 43760: 0.00385 ohms/ohm/°C)
	100 ohm PT (SAMA: 0.003911 ohms/ohm/°C)
	100 ohm PT (ITS-90/IEC751:0.0038505 ohms/ohm/°C)
Thermistor	Standard 2,252 ohm through 30,000 ohm
Semiconductor / IC	TMP36 or equivalent

Accuracy

Thermocouple measurement accuracy

Table 4. Thermocouple accuracy specifications, including CJC measurement error

Sensor Type	Maximum error	Typical error	Temperature range
J	±1.499 °C	±0.507 °C	-210 to 0 °C
	±0.643 °C	±0.312 °C	0 to 1200 °C
K	±1.761 °C	±0.538 °C	-210 to 0 °C
	±0.691 °C	±0.345 °C	0 to 1372 °C
S	±2.491 °C	±0.648 °C	-50 to 250 °C
	±1.841 °C	±0.399 °C	250 to 1768.1 °C
R	±2.653 °C	±0.650 °C	-50 to 250 °C
	±1.070 °C	±0.358 °C	250 to 1768.1 °C
B	±1.779 °C	±0.581 °C	250 to 700 °C
	±0.912 °C	±0.369 °C	700 to 1820 °C
E	±1.471 °C	±0.462 °C	-200 to 0 °C
	±0.639 °C	±0.245 °C	0 to 1000 °C
T	±1.717 °C	±0.514 °C	-200 to 0 °C
	±0.713 °C	±0.256 °C	0 to 600 °C
N	±1.969 °C	±0.502 °C	-200 to 0 °C
	±0.769 °C	±0.272 °C	0 to 1300 °C

Note 4: Thermocouple measurement accuracy specifications include linearization, cold-junction compensation and system noise. These specs are for one year, or 3000 operating hours, whichever comes first, and for operation of the device between 15 °C and 35 °C. For measurements outside this range, add ±0.5 degree to the maximum error shown. There are CJC sensors on each side of the module. The accuracy listed above assumes the screw terminals are at the same temperature as the CJC sensor. Errors shown do not include inherent thermocouple error. Please contact your thermocouple supplier for details on the actual thermocouple error.

Note 5: Thermocouples must be connected to the device such that they are floating with respect to GND (pins 9, 19, 28, 38). The device GND pins are isolated from earth ground, so connecting thermocouple sensors to voltages referenced to earth ground is permissible as long as the isolation between the GND pins and earth ground is maintained.

Note 6: When thermocouples are attached to conductive surfaces, the voltage differential between multiple thermocouples must remain within ±1.4 V. For best results we recommend the use of insulated or ungrounded thermocouples when possible.

Semiconductor sensor measurement accuracy

Table 5. Semiconductor sensor accuracy specifications

Sensor Type	Temperature Range (°C)	Maximum Accuracy Error
TMP36 or equivalent	-40 to 150 °C	±0.50 °C

Note 7: Error shown does not include errors of the sensor itself. These specs are for one year while operation of the device is between 15 °C and 35 °C. Please contact your sensor supplier for details on the actual sensor error limitations.

RTD measurement accuracy

Table 6. RTD measurement accuracy specifications

RTD	Sensor Temperature	Maximum Accuracy Error (°C) Ix+ = 210 µA	Typical Accuracy Error (°C) Ix+ = 210 µA
PT100, DIN, US or ITS-90	-200°C to -150°C	±2.85	±2.59
	-150°C to -100°C	±1.24	±0.97
	-100°C to 0°C	±0.58	±0.31
	0°C to 100°C	±0.38	±0.11
	100°C to 300°C	±0.39	±0.12
	300°C to 600°C	±0.40	±0.12

Note 8: Error shown does not include errors of the sensor itself. The sensor linearization is performed using a Callendar-Van Dusen linearization algorithm. These specs are for one year while operation of the device is between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire RTD connections. Please contact your sensor supplier for details on the actual sensor error limitations.

Note 9: Resistance values greater than 660 ohms cannot be measured by the device in the RTD mode. The 660 ohm resistance limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the RTD resistance and the lead resistances.

Note 10: For accurate three wire compensation, the individual lead resistances connected to the ±Ix pins must be of equal value.

Thermistor measurement accuracy

Table 7. Thermistor measurement accuracy specifications

Thermistor	Temperature Range	Maximum Accuracy Error (°C) I_{x+} = 10 µA
2252 Ω	-40 to120 °C	±0.05
3000 Ω	-40 to120 °C	±0.05
5000 Ω	-35 to120 °C	±0.05
10000 Ω	-25 to120 °C	±0.05
30000 Ω	-10 to120 °C	±0.05

Note 11: Error shown does not include errors of the sensor itself. The sensor linearization is performed using a Steinhart-Hart linearization algorithm. These specs are for one year while operation of the device is between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire thermistor connections. Please contact your sensor supplier for details on the actual sensor error limitations. Total thermistor resistance on any given channel pair must not exceed 180 k ohms. Typical resistance values at various temperatures for supported thermistors are shown in Table 8.

Table 8. Typical thermistor resistance specifications

Temp	2252 Ω thermistor	3000 Ω thermistor	5 kΩ thermistor	10 kΩ thermistor	30 kΩ thermistor
-40 °C	76 kΩ	101 kΩ	168 kΩ	240 kΩ (Note 12)	885 kΩ (Note 12)
-35 °C	55 kΩ	73 kΩ	121 kΩ	179 kΩ	649 kΩ (Note 12)
-30 °C	40 kΩ	53 kΩ	88 kΩ	135 kΩ	481 kΩ (Note 12)
-25 °C	29 kΩ	39 kΩ	65 kΩ	103 kΩ	360 kΩ (Note 12)
-20 °C	22 kΩ	29 kΩ	49 kΩ	79 kΩ	271 kΩ (Note 12)
-15 °C	16 kΩ	22 kΩ	36 kΩ	61 kΩ	206 kΩ (Note 12)
-10 °C	12 kΩ	17 kΩ	28 kΩ	48 kΩ	158 kΩ
-5 °C	9.5 kΩ	13 kΩ	21 kΩ	37 kΩ	122 kΩ
0 °C	7.4 kΩ	9.8 kΩ	16 kΩ	29 kΩ	95 kΩ

Note 12: Resistance values greater than 180k ohms cannot be measured by the device in the thermistor mode. The 180 k ohm resistance limit includes the total resistance across the current excitation (±Ix) pins, which is the sum of the thermistor resistance and the lead resistances.

Note 13: For accurate three wire compensation, the individual lead resistances connected to the ±Ix pins must be of equal value.

Throughput rate to PC

Table 9. Throughput rate specifications

Number of Input Channels	Maximum Throughput
1	2 Samples/second
2	2 S/s on each channel, 4 S/s total
3	2 S/s on each channel, 6 S/s total
4	2 S/s on each channel, 8 S/s total
5	2 S/s on each channel, 10 S/s total
6	2 S/s on each channel, 12 S/s total
7	2 S/s on each channel, 14 S/s total
8	2 S/s on each channel, 16 S/s total

Note 14: The analog inputs are configured to run continuously. Each channel is sampled twice per second. The maximum latency between when a sample is acquired and the temperature data is provided by the USB unit is approximately 0.5 seconds. Throughput to CompactFlash memory card is limited to 1 S/s per channel.

Digital input/output

Table 10. Digital input/output specifications

Digital type	CMOS
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output. Power on reset is input mode unless bit is configured for alarm.
Pull up/pull-down configuration	All pins pulled up to +5 V via 47 K resistors (default). Pull down to ground (GND) also available.
Digital I/O transfer rate (software paced)	▪ Digital input – 50 port reads or single bit reads per second typ. ▪ Digital output – 100 port writes or single bit writes per second typ.
Input high voltage	2.0 V min., 5.5 V absolute max.
Input low voltage	0.8 V max., -0.5 V absolute min.
Output low voltage (IOL = 2.5 mA)	0.7 V max
Output high voltage (IOH = -2.5 mA)	3.8 V min.

Note 15: All ground pins on the device (pins 9, 19, 28, 38) are common and are isolated from earth ground. If a connection is made to earth ground when using digital I/O and conductive thermocouples, the thermocouples are no longer isolated. In this case, thermocouples must not be connected to any conductive surfaces that may be referenced to earth ground.

Temperature alarms

Table 11. Temperature alarm specifications

Number of alarms	8 (one per digital I/O line)
Alarm functionality	Each alarm controls its associated digital I/O line as an alarm output. The input to each alarm may be any of the analog temperature input channels. When an alarm is enabled, its associated I/O line is set to output (after the device is reset) and driven to the appropriate state determined by the alarm options and input temperature. The alarm configurations are stored in non-volatile memory and are loaded at power on. Alarms will function both in data logging mode and while attached to USB.
Alarm input modes	▪ Alarm when input temperature > T1 ▪ Alarm when input temperature > T1, reset alarm when input temperature goes below T2 ▪ Alarm when input temperature < T1 ▪ Alarm when input temperature < T1, reset alarm when input temperature goes above T2 ▪ Alarm when input temperature is < T1 or > T2 **Note**: T1 and T2 may be independently set for each alarm.
Alarm output modes	▪ Disabled, digital I/O line may be used for normal operation ▪ Enabled, active high output (digital I/O line goes high when alarm conditions met) ▪ Enabled, active low output (digital I/O line goes low when alarm conditions met)
Alarm update rate	1 second

Memory

Table 12. Memory specifications

EEPROM	1,024 bytes isolated micro reserved for sensor configuration 256 bytes USB micro for external application use 256 bytes USB micro reserved for data logging configuration

Microcontroller

Table 13. Microcontroller specifications

Type	Two high performance 8-bit RISC microcontrollers

Data Logging

Table 14. Data logging specifications

Standalone power supply	USB Power Adapter 2.5 Watt USB Adapter with Interchangeable Plugs (Includes Plug for USA)
Memory card type	CompactFlash
Supplied memory card	512 MB CFCard 512 MB Compact Flash Card for MCC Dataloggers
Memory card host access	USB Mass Storage Device (MSD)
File systems supported	FAT16, FAT32 The device only creates 8.3 file names in the root subdirectory.
Log file format	binary
Logging rate	Min 1 second between entries, max 2^{32} seconds, 1 second granularity
Data items logged	Timestamp, temperature or raw reading from selected channels, state of DIO lines, CJC sensor readings
Logging start methods	Configurable: ▪ Start Logging on Power Up – Logging begins 5 seconds after power on to allow hardware to settle. ▪ Start Logging on Button – Device is idle on power on, press and hold button until LED comes on to begin logging. The first sample will be taken 1 second after LED comes on unless less than 5 seconds have elapsed since power on. ▪ Start Logging at Specified Time – Device is idle until the real time clock indicates the time is equal to or greater than the specified time, at which time the LED will come on. The first sample will be taken 1 second after LED comes on unless less than 5 seconds have elapsed since power on. **Note**: Data logging is not allowed when the device is attached to an active USB bus due to processing limitations. The device must be connected to the standalone power supply to perform data logging.
Logging stop methods	Stop on button press – To stop logging, press and hold button until LED turns off. **Note**: The device caches log data in volatile memory prior to writing to memory card. When logging, always use the button to stop logging and ensure data is written to memory card prior to removing power.
Logging status indication	The LED operations when connected to the AC adapter power supply are different than when connected to USB: Logging modes: ▪ Logging Off mode: the LED is off (disabled). ▪ Start Logging on Power Up mode: the LED is on, with a momentary off flash every time data is captured. ▪ Start Logging on Button mode: the LED is initially off. When the button is pressed and held for approximately 1 second the LED will turn on and act the same as Start Logging on Power Up mode. ▪ Start Logging at Specified Time mode: the LED is off, with a momentary on flash every second until the specified date/time is reached. At that time, the LED will turn on and act the same as Start Logging on Power Up mode. Other indication: ▪ To stop logging and store the remaining data to memory card, press and hold the button until the LED turns off. It is then safe to remove the memory card. ▪ If the memory card becomes full the LED will blink rapidly (250 ms period). ▪ If the memory card is removed while logging is in progress the LED will blink rapidly (250 ms period). Inserting a memory card will stop the blinking.

Real time clock

Table 15. Real time clock specifications

Battery backup	CR-2032 lithium coin cell, replaceable
Accuracy	±1 minute per month

USB +5V voltage

Table 16. USB +5V voltage specifications

Parameter	**Conditions**	**Specification**
USB +5V (VBUS) input voltage range		4.75 V min. to 5.25 V max.

Power

Table 17. Power specifications

Parameter	**Conditions**	**Specification**
Connected to USB		
Supply current	USB enumeration	<100 mA
Supply current (Note 16)	Continuous mode	500 mA max.
User +5V output voltage range (terminal block pin 21 and 47)	Connected to a self-powered hub. (Note 17)	4.75 V min. to 5.25 V max.
User +5V output current (terminal block pin 21 and pin 47)	Connected to a self-powered hub. (Note 17)	10 mA max.
Isolation	Measurement system to PC	500 VDC min.
AC Adapter Power Supply (used for data logging operation)		
Output voltage		5V ±5%
Output wattage		2.5W
Input voltage		100 – 240 VAC 50 – 60 Hz
Input current		0.2A

Note 16: This is the total current requirement for the device which includes up to 10 mA for the status LED.

Note 17: Self-Powered Hub refers to a USB hub with an external power supply. Self-powered hubs allow a connected USB device to draw up to 500 mA. This device may not be used with bus-powered hubs due to the power supply requirements.

Root Port Hubs reside in the PC’s USB Host Controller. The USB port(s) on your PC are root port hubs. All externally powered root port hubs (desktop PC's) provide up to 500 mA of current for a USB device. Battery-powered root port hubs provide 100 mA or 500 mA, depending upon the manufacturer. A laptop PC that is not connected to an external power adapter is an example of a battery-powered root port hub.

USB specifications

Table 18. USB specifications

USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0
	Self-powered, 500 mA consumption max.
USB cable type	*A-B cable, UL type AWM 2527 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D-)*
USB cable length	3 meters max.

Current excitation outputs (Ix+)

Table 19. Current excitation output specifications

Parameter	**Conditions**	**Specification**
Configuration		4 dedicated pairs: ±I1 - CH0/CH1 ±I2 - CH2/CH3 ±I3 - CH4/CH5 ±I4 - CH6/CH7
Current excitation output ranges	Thermistor	10 µA typ.
	RTD	210 µA typ.
Tolerance		±5% typ.
Drift		200 ppm/°C
Line regulation		*2.1 ppm/V max.*
Load regulation		*0.3 ppm/V typ.*
Output compliance voltage (relative to GND pins 9,19,28,38)		3.90 V max. -0.03 V min.

Note 18: The device has four current excitation outputs, with ±I1 dedicated to the CH0/CH1 analog inputs, ±I2 dedicated to CH2/CH3, ±I3 dedicated to CH4/CH5, and ±I4 dedicated to CH6/CH7. The excitation output currents should always be used in this dedicated configuration.

Note 19: The current excitation outputs are automatically configured based on the sensor (thermistor or RTD) selected.

Environmental

Table 20. Environmental specifications

Operating temperature range	0 to 70 ° C
Storage temperature range	-40 to 85 ° C
Humidity	0 to 90% non-condensing

Mechanical

Table 21. Mechanical specifications

Dimensions	127 mm (L) x 88.9 mm (W) x 35.56 (H)
User connection length	3 meters max.

Screw terminal connector type and pin out

Table 22. Screw terminal connector specifications

Connector type	**Screw terminal**
Wire gauge range	16 AWG to 30 AWG

Screw terminal pin out

Table 23. Screw terminal pin out

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	I1+	CH0/CH1 current excitation source	27	I4-	CH6/CH7 current excitation return
2	NC		28	GND	
3	C0H	CH0 sensor input (+)	29	C7L	CH7 sensor input (-)
4	C0L	CH0 sensor input (-)	30	C7H	CH7 sensor input (+)
5	4W01	CH0/CH1 4-wire, 2 sensor common	31	IC67	CH6/CH7 2 sensor common
6	IC01	CH0/CH1 2-sensor common	32	4W67	CH6/CH7 4-wire, 2 sensor common
7	C1H	CH1 sensor input (+)	33	C6L	CH6 sensor input (-)
8	C1L	CH1 sensor input (-)	34	C6H	CH6 sensor input (+)
9	GND		35	NC	
10	I1-	CH0/CH1 current excitation return	36	I4+	CH6/CH7 current excitation source
	CJC sensor			CJC sensor	
11	I2+	CH2/CH3 current excitation source	37	I3-	CH4/CH5 current excitation return
12	NC		38	GND	
13	C2H	CH2 sensor input (+)	39	C5L	CH5 sensor input (-)
14	C2L	CH2 sensor input (-)	40	C5H	CH5 sensor input (+)
15	4W23	CH2/CH3 4-wire, 2 sensor common	41	IC45	CH4/CH5 2 sensor common
16	IC23	CH2/CH3 2 sensor common	42	4W45	CH4/CH5 4-wire, 2 sensor common
17	C3H	CH3 sensor input (+)	43	C4L	CH4 sensor input (-)
18	C3L	CH3 sensor input (-)	44	C4H	CH4 sensor input (+)
19	GND		45	NC	
20	I2-	CH2/CH3 current excitation return	46	I3+	CH4/CH5 current excitation source
21	+5V	+5V output	47	+5V	+5V output
22	GND		48	GND	
23	DIO0	Digital Input/Output	49	DIO7	Digital Input/Output
24	DIO1	Digital Input/Output	50	DIO6	Digital Input/Output
25	DIO2	Digital Input/Output	51	DIO5	Digital Input/Output
26	DIO3	Digital Input/Output	52	DIO4	Digital Input/Output

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