USB-1408FS

Specifications

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Specifications

Typical for 25°C unless otherwise specified.

Specifications in *italic text* are guaranteed by design.

Analog input

Table 1. Analog input specifications

Parameter	Conditions	Specification
A/D converter type		Successive approximation type
Input voltage range for linear operation, single-ended mode	CHx to GND	±10 volts (V) max
Input common-mode voltage range for linear operation, differential mode	CHx to GND	–10 V min, +20 V max
Absolute maximum input voltage	*CHx to GND*	*±28 V max*
Input impedance		*122K Ohms*
Input current (Note 1)	Vin = +10 V	70 microamperes (µA) typ
	Vin = 0 V	–12 µA typ
	Vin = –10 V	–94 µA typ
Number of channels		8 single-ended / 4 differential, software selectable
Input ranges, single-ended mode		±10 V, G=2
Input ranges, differential mode		±20 V, G=1 ±10 V, G=2 ±5 V, G=4 ±4 V, G=5 ±2.5 V, G=8 ±2.0 V, G=10 ±1.25 V, G=16 ±1.0 V, G=20 Software selectable
Throughput (Note 2)	Software paced	250 samples per second (S/s) typ, PC-dependent
	Continuous scan	48 kilosamples per second (kS/s)
Channel gain queue	Up to 16 elements	Software configurable channel, range, and gain.
Resolution (Note 3)	Differential	14-bits, no missing codes
	Single-ended	13-bits
Integral linearity error		±2 least significant bit (LSB) typ
Differential linearity error		±0.5 LSB typ
Absolute accuracy long term drift (Note 4)	±20V range	±3LSB typ. (delta t = 1000 hrs)
	±4V range	±6LSB typ. (delta t = 1000 hrs)
	±1V range	±8LSB typ. (delta t = 1000 hrs)
2.5VREF accuracy (pin 16)		±36.25 mV max.
2.5VREF output current (pin 16)	Source	5 mA max.
	Sink	20 µA min, 100 µA typ
Trigger source	Software selectable	External digital: TRIG_IN

Note 1: Input current is a function of applied voltage on the analog input channels. For a given input voltage, V_{in}, the input leakage is approximately equal to ($8.181*V_{in}$-12) µA.

Note 2: Maximum throughput scanning to PC memory is machine dependent. The rates specified are for Windows XP only. Maximum rates on operating systems that predate XP may be less and must be determined through testing on your machine

Note 3: The ADS7871 converter only returns 13-bits (0 to 8192 codes) in single-ended mode.

Note 4: Extrapolating the long term drift accuracy specifications will provide the approximate long term drift of the USB-1408FS intermediate input ranges.

Table 2. Accuracy, differential mode

Range	Absolute Accuracy 25°C (±mV)	Absolute Accuracy 0 to 50°C (±mV)
±20 V	10.98	49.08
±10 V	7.32	33.42
±5 V	3.66	20.76
±4 V	2.92	19.02
±2.5 V	1.83	14.97
±2 V	1.70	14.29
±1.25 V	1.21	12.18
±1 V	1.09	11.63

Table 3. Accuracy, single-ended mode

Range	Absolute Accuracy 25°C (±mV)	Absolute Accuracy 0 to 50°C (±mV)
±10 V	10.98	49.08

Table 4. Noise performance, differential mode

Range	Typical counts	Least significant bit$_{\text{root mean square}}$ (LSB$_{\text{rms}}$)
±20 V	8	1.21
±10 V	8	1.21
±5 V	9	1.36
±4 V	10	1.51
±2.5 V	12	1.81
±2 V	14	2.12
±1.25 V	18	2.72
±1 V	22	3.33

Table 5. Noise performance, single-ended mode

Range	Typical Counts	LSB$_{\text{rms}}$
±10 V	8.0	1.21

Analog output

Table 6. Analog output specifications

Parameter	Conditions	Specification
Resolution		12-bits, 1 in 4096
Output range		*0 to 4.096 V, 1 mV per LSB.*
Number of channels		2
Throughput (Note 5)	Software paced	250 S/s single channel typical, PC dependent
	Single channel, continuous scan	10 kS/s
	Dual channel, continuous scan, simultaneous update	5 kS/s
Power on and reset voltage		0V, ±20 mV typ. (initializes to 000h code)
Output drive	Each D/A OUT	±15 mA
Slew rate		0.8 V/microsecond (µs) typ

Note 5: Maximum throughput scanning from PC memory is machine dependent. The rates specified are for Windows XP only. Maximum rates on operating systems that predate XP may be less and must be determined through testing on your machine.

Table 7. Analog output accuracy

Range	Accuracy (±LSB)
0 to 4.096 V	4.0 typ, 45.0 max

Table 8. Analog output accuracy components

Range	% of FSR (±)	Gain Error at FS (±mV)	Offset (±mV) (Note 6)	Accuracy at FS (±mV)
0 to 4.096 V	0.1 typ, 0.9 max	4.0 typ, 36.0 max	1.0 typ, 9.0 max	4.0 typ, 45.0 max

Note 6: Zero-scale offsets may result in a fixed zero-scale error producing a "dead-band" digital input code region.. In this case, changes in digital input code at values less than 0x040 may not produce a corresponding change in the output voltage. The USB-1408FS offset error is tested and specified at code 0x040.

Digital input/output

Table 9. Digital I/O specifications

Digital type	CMOS
Number of I/O	16 (Port A0 through A7, Port B0 through B7)
Configuration	2 banks of 8
Pull-up/pull-down configuration	All pins pulled up to Vs via 47 K resistors (default). Positions available for pull-down to ground. Hardware selectable via zero ohm (Ω) resistors as a factory option.
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 high voltage (IOH = –2.5 mA)	3.8 V min
Output low voltage (IOL = 2.5 mA)	0.7 V max
Power on and reset state	Input

External trigger

Table 10. Digital trigger specifications

Parameter	Conditions	Specification
Trigger source (Note 7)	External digital	TRIG_IN
Trigger mode	Software selectable	Edge sensitive: user configurable for CMOS compatible rising or falling edge.
Trigger latency		10 µs max
Trigger pulse width		1 µs min
Input high voltage		4.0 V min, 5.5 V absolute max
Input low voltage		1.0 V max, –0.5 V absolute min
Input leakage current		*±1.0 µA*

Note 7: TRIG_IN is a Schmitt trigger input protected with a 1.5 kilohm (kΩ) series resistor.

External clock input/output

Table 11. External clock I/O specifications

Parameter	Conditions	Specification
Pin name		SYNC
Pin type		Bidirectional
Software selectable direction	Output (default)	Outputs internal A/D pacer clock.
	Input	Receives A/D pacer clock from external source.
Input clock rate		48 KHz, maximum
Clock pulse width	Input mode	1 µs min
	Output mode	5 µs min
Input leakage current	*Input mode*	*±1.0 µA*
Input high voltage		4.0 V min, 5.5 V absolute max
Input low voltage		1.0 V max, –0.5 V absolute min
Output high voltage (Note 8)	IOH = –2.5 mA	3.3 V min
	No load	3.8 V min
Output low voltage (Note 8)	IOL = 2.5 mA	1.1 V max
	No load	0.6 V max

Note 8: SYNC is a Schmitt trigger input and is over-current protected with a 200 Ω series resistor.

Counter section

Table 12. Counter specifications

Pin name (Note 9)	CTR
Counter type	Event counter
Number of channels	1
Input type	TTL, rising edge triggered
Input source	*CTR screw terminal*
Resolution	32 bits
Schmidt trigger hysteresis	*20 mV to 100 mV*
Input leakage current	*±1 µA*
Maximum input frequency	1 MHz
High pulse width	*500 ns min*
Low pulse width	*500 ns min*
Input high voltage	4.0 V min, 5.5 V absolute max
Input low voltage	1.0 V max, –0.5 V absolute min

Note 9: CTR is a Schmitt trigger input protected with a 1.5K Ω series resistor.

Non-volatile memory

Table 13. Non-volatile memory specifications

EEPROM	1,024 bytes		
EEPROM Configuration	**Address Range**	**Access**	**Description**
	0x000-0x1FF	Read/write	512 bytes user area
	0x200-0x3FF	Read/write with unlock	512 bytes calibration data

Microcontroller

Table 14. Microcontroller specifications

Type	*High performance 8-bit RISC microcontroller*
Program memory	*16,384 words*
Data memory	2,048 bytes

Power

Table 15. Power specifications

Parameter	Conditions	Specification
Supply current (Note 10)		80 mA
+5V USB power available (Note 11)	Connected to self-powered hub Connected to externally-powered root port hub	4.5 V min, 5.25 V max
	Connected to bus-powered hub	4.1 V min, 5.25 V max
Output current (Note 12)	Connected to self-powered hub Connected to externally-powered root port hub	420 mA max
	Connected to bus-powered hub	20 mA max

Note 10: This is the total current requirement for the USB-1408FS which includes up to 10 mA for the status LED.

Note 11: *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.

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 PCs) 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.

Bus powered hubs receive power from a self-powered or root port hub. In this case the maximum current available from the USB +5 V is 100 mA. The minimum USB +5 V voltage level can be as low as 4.1 V.

Note 12: Output current refers to the total amount of current that can be sourced from the USB +5 V, analog outputs and digital outputs.

General

Table 16. General specifications

Parameter	Conditions	Specification
Device type		USB 2.0 full speed
Device compatibility		USB 1.1, USB 2.0

Environmental

Table 17. Environmental specifications

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

Mechanical

Table 18. Mechanical specifications

Dimensions	79 millimeters (mm) long x 82 mm wide x 25 mm high
USB cable length	*3 meters max*
User connection length	*3 meters max*

Main connector and pin out

Table 19. Main connector specifications

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

4-channel differential mode

Pin	Signal Name	Pin	Signal Name
1	CH0 IN HI	21	Port A0
2	CH0 IN LO	22	Port A1
3	AGND	23	Port A2
4	CH1 IN HI	24	Port A3
5	CH1 IN LO	25	Port A4
6	AGND	26	Port A5
7	CH2 IN HI	27	Port A6
8	CH2 IN LO	28	Port A7
9	AGND	29	GND
10	CH3 IN HI	30	PC+5V
11	CH3 IN LO	31	GND
12	AGND	32	Port B0
13	D/A OUT 0	33	Port B1
14	D/A OUT 1	34	Port B2
15	AGND	35	Port B3
16	+2.5VREF	36	Port B4
17	GND	37	Port B5
18	TRIG_IN	38	Port B6
19	SYNC	39	Port B7
20	CTR	40	GND

8-channel single-ended mode

Pin	Signal Name	Pin	Signal Name
1	CH0 IN	21	Port A0
2	CH1 IN	22	Port A1
3	AGND	23	Port A2
4	CH2 IN	24	Port A3
5	CH3 IN	25	Port A4
6	AGND	26	Port A5
7	CH4 IN	27	Port A6
8	CH5 IN	28	Port A7
9	AGND	29	GND
10	CH6 IN	30	PC+5V
11	CH7 IN	31	GND
12	AGND	32	Port B0
13	D/A OUT 0	33	Port B1
14	D/A OUT 1	34	Port B2
15	AGND	35	Port B3
16	+2.5VREF	36	Port B4
17	GND	37	Port B5
18	TRIG_IN	38	Port B6
19	SYNC	39	Port B7
20	CTR	40	GND

Measurement Computing Corporation
10 Commerce Way
Suite 1008
Norton, Massachusetts 02766
(508) 946-5100
Fax: (508) 946-9500
E-mail: info@mccdaq.com
www.mccdaq.com