USB-1616FS

Analog Input and Digital I/O

Specifications

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MEASUREMENT COMPUTING™

USB-1616FS Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.
Specifications in *italic text* are guaranteed by design.

Analog input

Table 1. AI specifications

Parameter	Conditions	Specification
A/D converters		16-bit, SAR type
Number of channels		16 single-ended
Input configuration		Individual A/D per channel
Sampling method		Simultaneous
Absolute maximum input voltage	*CHx IN to GND*	*±15 V max*
Input impedance		100 MΩ, min
Input bandwidth (–3 dB)		50 kHz typ
Input leakage current		±1 µA typ
Input capacitance		*50 pf typ*
Offset temperature drift		15 ppm/°C typ
Gain temperature drift	All ranges	35 ppm/°C typ
Input ranges	Software selectable	±10 V, ±5 V, ±2 V, ±1 V
Sampling rate	Scan to PC memory	0.6 S/s to 50 kS/s, software programmable
	Burst scan to 32 k sample FIFO	20 S/s to 50 kS/s, software programmable
Throughput	Software paced	30 S/s to 500 S/s all channels; throughput is system dependant)
	Scan to PC memory	Refer to the Single Board Throughput and Multiple Board Throughput sections that follow this table.
	Burst scan to 32 k sample FIFO	= (200 kS/s) / (# of channels), max of 50 kS/s for any channel
Gain queue		Software configurable. Sixteen elements, one gain element per channel.
Resolution		16 bits
No missing codes		*15 bits*
Crosstalk	DC – 25 kHz (sine)	–80 dB min
Calibration voltages		0 V, ±0.625 V, ±1.25 V, ±2.5 V, ±5.0 V, software selectable
Calibration voltage accuracy (Note 1)		±0.5% typ, ±1.0% max
Temperature sensor range		0 °C to +70 °C max
Temperature sensor accuracy		±3 °C typ
Trigger source	Software selectable	External digital: TRIG_IN

Note 1: Actual values used for calibration are measured and stored in EEPROM.

Single board throughput

The USB-1616FS has an integral USB hub, which allows up to four USB-1616FS devices to be daisy chained and connected to a single USB 2.0 port on the host computer. The data shown in Table 2 reflects the throughput that can be expected in single board systems. For details on throughput in systems using multiple USB-1616FS devices, refer to Multiple board throughput below.

Table 2. Single board throughput: Scan to PC memory specifications

Number of Input Channels	Per-channel Throughput (kS/s) (Note 2)
1	50000
2	50000
3	36000
4	30000
5	25000
6	22000
7	19000
8	17000
9	15000
10	14000
11	12500
12	12000
13	11250
14	10500
15	10000
16	9500

Note 2: The throughput data in Table 2 applies to a single USB-1616FS installation only. Maximum throughput scanning to PC memory is machine dependent. The rates specified in Table 2 is for Windows XP only.

Multiple board throughput

The USB-1616FS has an integral USB hub, which allows up to four USB-1616FS devices to be daisy chained and connected to a single USB 2.0 port on the host computer. The data shown in Table 2 reflects the throughput that can be expected in single board systems.

The transfer of USB-1616FS data over the USB bus is CPU intensive. The transfer rate using multiple USB-1616FS devices is both CPU intensive and system dependent. This makes it impossible for us to provide a guaranteed multi-board maximum sample rate specification. However, the benchmark performance shown below should serve as a guide for what you may expect.

Multiple board performance is limited by an overall aggregate sample rate. The maximum throughput will be in number of samples taken per second irrespective of the number of channels sampled* or number of devices installed. For example, if the maximum throughput in a system is 150,000 samples per second, you may sample 20 channels at 7.5 kS/s, 30 channels at 5 kS/s, 40 channels at 3.75 kS/s, and so on.

* The maximum sample rate of any one channel is limited to 50 kS/s.

Throughput benchmarks

Table 3. Throughput specifications

Throughput (kS/s)	System
240	2.4 GHz P4 running Win XP, Service Pack 2, using an integrated USB Enhanced Host Controller (EHC) port
240	2.4 GHz P4, Phoenix BIOS, Win XP, Service Pack 2, integrated USB EHC port
130	2 GHz, Xeon, Win XP, Service Pack 2, hyperthreading turned OFF, using an integrated USB EHC port
220	2 GHz, Xeon, Win XP, Service Pack 2, hyperthreading turned ON, using an integrated USB EHC port
260	2.4 GHz, P4 running Win XP, Service Pack 1, using Belkin PCI-bus USB 2.0 card
250	2.4 GHz, P4 running Win XP, Service Pack 1, using StarTec PCI-bus USB 2.0 card

Usage note

The typical limiting factor on throughput is CPU usage. At maximum system throughput, virtually all available CPU power will be consumed by the USB data transfer. This is an important note since running your system close to its maximum throughput will certainly limit the amount of CPU power available for running other concurrent processes (for example, plotting or real-time analysis).

Table 4. Calibrated absolute accuracy specifications

Range	Accuracy (mV)
±10 V	±5.66
±5 V	±2.98
±2 V	±1.31
±1 V	±0.68

Table 5. Accuracy components specifications – all values are (±)

Range	% of Reading	Gain Error at FS (mV)	Offset (mV)
±10 V	0.04	4.00	1.66
±5 V	0.04	2.00	0.98
±2 V	0.04	0.80	0.51
±1 V	0.04	0.40	0.28

Table 6. Noise performance specifications

Range	Typical Counts	LSBrms
±10 V	10	1.52
±5 V	10	1.52
±2 V	11	1.67
±1 V	14	2.12

Noise distribution is determined by gathering 50 k samples with analog inputs tied to ground (AGND) at the user connector. Samples are gathered at the maximum specified sampling rate of 50 kS/s.

Digital input/output

Table 7. Digital I/O specifications

Digital type	CMOS
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output
Pull up/pull-down configuration	All pins pulled up to USB VBUS via 47 kΩ resistors (default). Positions are available for pull-down to ground (GND). Hardware selectable via 0 Ω resistors is available as a factory option.
Digital I/O transfer rate (software paced)	System dependent, 33 port reads to 1000 port reads/writes or single bit reads/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 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 8. External trigger specifications

Parameter	**Conditions**	**Specification**
Trigger source (Note 3)	External digital	TRIG_IN
Trigger mode	Software selectable	Edge Sensitive: user configurable for CMOS compatible rising (default) 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 min
Input leakage current		*±1.0µA*

Note 3: TRIG_IN is a Schmitt trigger input protected with a 1.5 k Ohm series resistor.

External clock input/output

Table 9. External clock I/O specifications

Parameter	**Conditions**	**Specification**
Pin name		SYNC
Pin type		Bidirectional
Software selectable direction	Output	Outputs internal A/D pacer clock.
	Input	Receives A/D pacer clock from external source. Rising edge sensitive.
Input clock rate		50 kHz, max
Clock pulse width	Input	1 µs min
	Output	5 µs min
Input leakage current		*±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 4)	IOH = –2.5 mA	3.3 V min
	No load	3.8 V min
Output low voltage (Note 4)	IOL = 2.5 mA	1.1 V max
	No load	0.6 V max

Note 4: SYNC is a Schmitt trigger input and is over-current protected with a 200 Ω series resistor.

Counter

Table 10. Counter specifications

Pin name	CTR
Counter type	Event counter
Number of channels	1
Input type	TTL, rising edge triggered
Resolution	32 bits
Counter/timer read/write rates; software paced	Counter read: system dependent, 33 reads to 1000 reads per second
	Counter clear: system dependent, 33 reads to 1000 writes per second
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 low voltage	1.0 V min, -0.5 V max
Input high voltage	4.0 V min, 5.5 V max

Memory

Table 11. Memory specifications

Data FIFO	32,768 samples, 65,536 bytes		
EEPROM	1,024 bytes		
EEPROM configuration	**Address range**	**Access**	**Description**
	0x000-0x07F	Reserved	128 bytes system data
	0x080-0x1FF	Read/Write	384 bytes calibration data
	0x200-0x3FF	Read/Write	512 bytes user area

Microcontroller

Table 12. Microcontroller specifications

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

Power

Table 13. Power specifications

Parameter	**Conditions**	**Specification**
Supply current	USB enumeration	<100 mA
Supply current (Note 5)	Continuous mode	350 mA typ
User +5V output voltage range (Note 6)	Available at the 5V screw terminal	4.0 V min, 5.25 V max
User +5V output current (Note 7)	Available at the 5V screw terminal	50 mA max

Note 5: The total current requirement for the USB-1616FS which includes up to 10mA for the status LEDs.

Note 6: Output voltage range assumes input power supply voltage is within specified limits

Note 7: The total amount of current that can be sourced from the 5V screw terminal for general use. This specification includes any additional contribution due to DIO loading.

USB +5V voltage

Table 14. USB voltage specifications

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

External power input

Table 15. External power input specifications

Parameter	Conditions	Specification
External power input		+6.0 VDC to 12.5 VDC (9 VDC power supply included).
Voltage supervisor limits – PWR LED. (Note 8)	6.0 V > Vext or Vext > 12.5 V	PWR LED = Off (power fault)
	6.0 V < Vext < 12.5 V	PWR LED = On
External power adapter (included)	MCC p/n CB-PWR-9V3A	+9 V ±10%, @ 3 A

Note 8: The USB-1616FS monitors the external +9 V power supply voltage with a voltage supervisory circuit. If this power supply exceeds its specified limit, the PWR LED will turn off indicating a power fault condition.

External power output

Table 16. External power output specifications

Parameter	Conditions	Specification
External power output – current range	Note 9	4.0 A max
External power output	Voltage drop between power input and daisy chain power output	0.5 V max
Compatible cable(s) for daisy chain	C-MAPWR-x	X = 2, 3 or 6 feet

Note 9: The daisy chain power output option allows multiple MCC USB Series products to be powered from a single external power source in a daisy chain fashion. The voltage drop between the device power supply input and the daisy chain output is 0.5 V max Users must plan for this drop to assure that the last device in the chain will receive at least 6.0 VDC.

USB specifications

Table 17. USB specifications

USB "B" connector	Input
USB device type	USB 2.0 (full-speed) *Use of multiple USB-1616FS devices requires a USB 2.0 hub*.
Device compatibility	USB 1.1, USB 2.0
USB "A" connector	Downstream hub output port
USB hub type	Supports USB 2.0 high-speed, full-speed, and low-speed operating points
	Self-powered, 100mA max downstream VBUS capability
Compatible products	MCC USB Series devices
USB cable type (upstream and downstream)	*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 (9.84 feet)

Environmental

Table 18. Environmental specifications

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

Mechanical

Table 19. Mechanical specifications

Card dimensions (L × W × H)	203.2 × 121.9 × 20.0 mm (8.0 × 4.8 × 0.8 in.)
Enclosure dimensions (L × W × H)	241.3 × 125.7 × 58.9 mm (9.50 × 4.95 × 2.32 in.)

Screw terminals

Table 20. Screw terminal specifications

Connector type	Screw terminal
Wire gauge range	14 AWG to 30 AWG

Table 21. Screw terminal pinout

Board label		**Signal name**	**Board label**		**Signal name**
DIO	0	DIO 0	GND	0	GND 0
	1	DIO 1		1	GND 1
	2	DIO 2		2	GND 2
	3	DIO 3		3	GND 3
	4	DIO 4		4	GND 4
	5	DIO 5		5	GND 5
	6	DIO 6		6	GND 6
	7	DIO 7		7	GND 7
TRIG IN		TRIG IN	CTR		CTR
5V		5V	SYNC		SYNC
CHANNEL IN	0	CH 0	AGND	0	AGND 0
	1	CH 1		1	AGND 1
	2	CH 2		2	AGND 2
	3	CH 3		3	AGND 3
	4	CH 3		4	AGND 4
	5	CH 4		5	AGND 5
	6	CH 5		6	AGND 6
	7	CH 6		7	AGND 7
	8	CH 8		8	AGND 8
	9	CH 9		9	AGND 9
	10	CH 10		10	AGND 10
	11	CH 11		11	AGND 11
	12	CH 12		12	AGND 12
	13	CH 13		13	AGND 13
	14	CH 14		14	AGND 14
	15	CH 15		15	AGND 15

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