Specifications

USB-1616FS

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Specifications

Typical for 25 °C unless otherwise specified.

Specifications in *italic text* are guaranteed by design.

Analog input

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 MOhm, 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 – 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 boards to be daisy chained and connected to a single USB 2.0 port on the host computer. The data shown in Table 1 reflects the throughput that can be expected in single board systems. For details on throughput in systems using multiple USB-1616FS boards, please refer to the next section "Multiple board throughput."

Table 1. Single board throughput: Scan to PC memory

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 1 applies to a single USB-1616FS device installation only. Maximum throughput scanning to PC memory is highly machine dependent.

The rates specified in Table 1 is for Windows XP only. The maximum throughput rates on operating systems that predate Windows XP may be less and must be determined through testing on your machine.

Multiple board throughput

The USB-1616FS has an integral USB hub, which allows up to four USB-1616FS boards to be daisy chained and connected to a single USB 2.0 port on the host computer. (The data shown in Table 1 reflects the throughput that can be expected in single board systems.) The transfer of USB-1616FS data over the USB bus is very CPU intensive. The transfer rate using multiple USB-1616FS boards is both CPU intensive and system dependent. This makes it impossible for us to provide a guaranteed spec for multi-board maximum sample rate. 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 boards 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, etc.

*the maximum sample rate of any one channel is limited to 50 KS/s.

Throughput benchmarks

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

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

Table 3. Accuracy components - 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 4. Noise performance

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

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 K resistors (default). Positions available for pull down to ground (GND). Hardware selectable via zero ohm resistors as a factory option.
Digital I/O transfer rate (software paced)	System dependent, 33 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

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

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, maximum
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 Ohm series resistor.

Counter

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 to 1000 reads per second.
	Counter Clear – System-dependent, 33 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

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

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

Power

Parameter	**Conditions**	**Specification**
Supply current	USB enumeration	<100 mA
Supply current (Note 5)	Continuous mode	350 mA typ.
User +5 V output voltage range (Note 6)	Available at terminal block pin 48	4.0 V min. 5.25 V max.
User +5V output current (Note 7)	Available at terminal block pin 48	50 mA max.

Note 5: This is the total current requirement for the USB-1616FS which includes up to 10mA for the status LED's.

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

Note 7: This refers to the total amount of current that can be sourced from the 5 V screw terminal (pin 48) for general use. This spec includes any additional contribution due to DIO loading.

USB +5 V voltage

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

External power input

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

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 module power supply input and the daisy chain output is 0.5 V max. Users must plan for this drop to assure the last module in the chain will receive at least 6.0 VDC

USB specifications

USB "B" connector	Input
USB device type	USB 2.0 (full-speed) *Use of multiple USB-1616FS boards 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, 100 mA 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.

Environmental

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

Mechanical

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

Screw terminal connector

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

Connector pin out

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

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