18200-10

Low-cost, USB-based module with 8 channels, 12-bit input

Operating Manual

Cole-Parmer®

Operating Manual

USB-based
Analog and Digital I/O Module

MODEL NO. 18200-10

The 18200-10 is a USB 2.0 full-speed device designed for USB 1.1 ports, and tested for full compatibility with both USB 1.1 and USB 2.0 ports.

The 18200-10 features eight analog inputs, two 12-bit analog outputs, 16 digital I/O connections, and one 32-bit external event counter. The 18200-10 is powered by the +5 volt USB supply from your computer. No external power is required.

The 18200-10 analog inputs are software configurable for either eight 11-bit single-ended inputs, or four 12-bit differential inputs. Sixteen digital I/O lines are independently selectable as input or output in two 8-bit ports.

A 32-bit counter can count TTL pulses. The counter increments when the TTL levels transition from low to high (rising-edge).

A SYNC (synchronization) input / output line allows you to pace the analog input acquisition of one USB module from the clock output of another.

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Document Revision 1, May, 2006

Table of Contents

About this Operating Manual

What you will learn from this manual

This manual explains how to install, configure, and use the 18200-10 so that you get the most out of its USB data acquisition features.

This manual also refers you to related documents available on our web site, and to technical support resources.

For more information on …
Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

<#:#> Angle brackets that enclose numbers separated by a colon signify a range of numbers, such as those assigned to registers, bit settings, etc.

bold text **Bold** text is used for the names of objects on the screen, such as buttons, text boxes, and check boxes. For example:
1. Insert the disk or CD and click the **OK** button.

italic text *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase. For example:
The *Insta*Cal® installation procedure is explained in the *Quick Start Guide*.
Never touch the exposed pins or circuit connections on the board

Where to find more information

The following electronic documents provide information relevant to the operation of the 18200-10.

- Cole-Parmer's *Specifications: 18200-10* (the PDF version of the Electrical Specification Chapter in this guide) is available on our web site at www.coleparmer.com/catalog/MoreInfo/18200-10-spec.pdf.
- Cole-Parmer's *Quick Start Guide* is available on our web site at www.coleparmer.com/catalog/MoreInfo/CP-Quick-Start.pdf.
- Cole-Parmer's *Guide to Signal Connections* is available on our web site at www.coleparmer.com/catalog/MoreInfo/CPsignals.pdf.
- Cole-Parmer's *Universal Library User's Guide* is available on our web site at www.coleparmer.com/catalog/MoreInfo/sm-ul-user-guide.pdf.
- Cole-Parmer's *Universal Library Function Reference* is available on our web site at www.coleparmer.com/catalog/MoreInfo/sm-ul-functions.pdf.
- Cole-Parmer's *Universal Library for LabVIEW™ User's Guide* is available on our web site at www.coleparmer.com/catalog/MoreInfo/SM-UL-LabVIEW.pdf.

18200-10 Operating Manual (this document) is also available on our web site at www.coleparmer.com/cpusbdaq1/18200-10.pdf.

Introducing the 18200-10

This manual contains all of the information you need to connect the 18200-10 to your computer and to the signals you want to measure. The 18200-10 is part of the Cole-Parmer brand of USB-based data acquisition products.

The 18200-10 is a USB 2.0 full-speed device supported under popular Microsoft® Windows® operating systems. It is designed for USB 1.1 ports, and was tested for full compatibility with both USB 1.1 and USB 2.0 ports.

Refer to the "Be sure you are using the latest system software" note in Chapter 2, "Installing the 18200-10," to make sure you are using the latest USB drivers.

The 18200-10 features eight analog inputs, two 12-bit analog outputs, 16 digital I/O connections, and one 32-bit external event counter. The 18200-10 is powered by the +5 volt USB supply from your computer. No external power is required.

The 18200-10 analog inputs are software configurable for either eight 11-bit single-ended inputs, or four 12-bit differential inputs. Sixteen digital I/O lines are independently selectable as input or output in two 8-bit ports.

A 32-bit counter can count TTL pulses. The counter increments when the TTL levels transition from low to high (rising-edge).

A SYNC (synchronization) input / output line allows you to pace the analog input acquisition of one USB module from the clock output of another.

The 18200-10 is shown in Figure 1-1. I/O connections are made to the screw terminals located along each side of the 18200-10.

Figure 1-1. 18200-10

18200-10 block diagram

18200-10 functions are illustrated in the block diagram shown here.

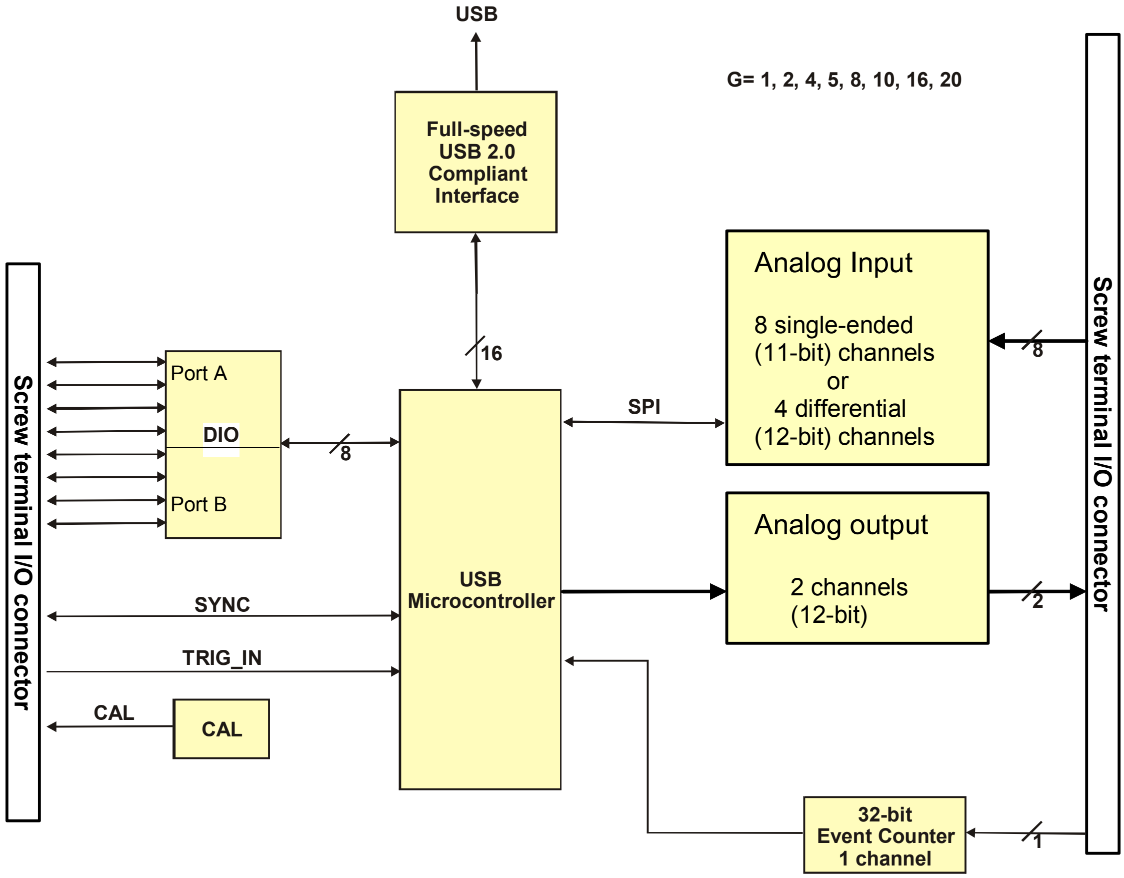


Figure 1-2. 18200-10 functional block diagram

Software features

For information on the features of *Insta*Cal and the other software included with your 18200-10, refer to the *Quick Start Guide* that shipped with your device. The *Quick Start Guide* is also available in PDF at www.coleparmer.com/catalog/MoreInfo/CP-Quick-Start.pdf.

Connecting a 18200-10 to your computer is easy

Installing a data acquisition device has never been easier.

- The 18200-10 relies upon the Microsoft Human Interface Device (HID) class drivers. The HID class drivers ship with every copy of Windows that is designed to work with USB ports. We use the Microsoft HID because it is a standard, and its performance delivers full control and maximizes data transfer rates for your 18200-10. No third-party device driver is required.
- The 18200-10 is plug-and-play. There are no jumpers to position, DIP switches to set, or interrupts to configure.
- You can connect the 18200-10 before or after you install the software, and without powering down your computer first. When you connect an HID to your system, your computer automatically detects it and configures the necessary software. You can connect and power multiple HID peripherals to your system using a USB hub.
- You can connect your system to various devices using a standard four-wire cable. The USB connector replaces the serial and parallel port connectors with one standardized plug and port combination.
- You do not need a separate power supply module. The USB automatically delivers the electrical power required by each peripheral connected to your system.
- Data can flow two ways between a computer and peripheral over USB connections.

Installing the 18200-10

What comes with your 18200-10 shipment?

As you unpack your 18200-10, verify that the following components are included.

Hardware

- 18200-10

- USB cable (2 meter length)

Additional documentation

In addition to this hardware manual, you should also receive the *Quick Start Guide* (available in PDF at www.coleparmer.com/catalog/MoreInfo/CP-Quick-Start.pdf.). This booklet supplies a brief description of the software you received with your 18200-10 and information regarding installation of that software. Please read this booklet completely before installing any software or hardware.

Unpacking the 18200-10

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the 18200-10 from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If your 18200-10 is damaged, notify Cole-Parmer immediately by phone, fax, or email:

- Phone: 800-323-4340.
- Fax: 847-247-2929
- Email: techinfo@coleparmer.com

Installing the software

Refer to the *Quick Start Guide* for instructions on installing the software on the *C-P Data Acquisition Software CD*. This booklet is available in PDF at www.coleparmer.com/catalog/MoreInfo/CP-Quick-Start.pdf.

Installing the hardware

Be sure you are using the latest system software

Before you connect the 18200-10, make sure that you are using the latest versions of the USB drivers.

Before installing the 18200-10, download and install the latest Microsoft Windows updates. In particular, when using Windows XP, make sure you have XP Hotfix KB822603 installed. This update is intended to address a serious error in Usbport.sys when you operate a USB device. You can run Windows Update or download the update from www.microsoft.com/downloads/details.aspx?familyid=733dd867-56a0-4956-b7fe-e85b688b7f86&displaylang=en. For more information, refer to the Microsoft Knowledge Base article "*Availability of the Windows XP SP1 USB 1.1 and 2.0 update.*" This article is available at support.microsoft.com/?kbid=822603.

To connect the 18200-10 to your system, turn your computer on, and connect the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. The USB cable provides power and communication to the 18200-10.

When you connect the 18200-10 for the first time, a series of **Found New Hardware** popup balloons (Windows XP) or dialogs (other Windows versions) opens as the 18200-10 is detected by your computer.

It is normal for multiple dialogs to open when you connect the 18200-10 for the first time. For additional information, refer to the "*Notes on installing and using the 18200-10*" that was shipped with the 18200-10.

The last popup balloon or dialog states "Your new hardware is installed and ready to use," and the LED on the 18200-10 should flash and then remain lit. This indicates that communication is established between the 18200-10 and your computer.

On most computers, you can install up to two 18200-10 units. If you need to connect more than two 18200-10 units to your computer, contact Tech Support:

- Phone: 800-323-4340.
- Fax: 847-247-2929
- Email: techinfo@coleparmer.com

Caution! Do not disconnect **any** device from the USB bus while the computer is communicating with the 18200-10, or you may lose data and/or your ability to communicate with the 18200-10.

If the LED turns off

If the LED is illuminated but then turns off, the computer has lost communication with the 18200-10. To restore communication, disconnect the USB cable from the computer, and then reconnect it. This should restore communication, and the LED should turn back *on*.

Functional Details

Theory of operation - analog input acquisition modes

The 18200-10 can acquire analog input data in two different modes–software paced and continuous scan.

Software paced mode

In software paced mode, you can acquire one analog sample at a time. You initiate the A/D conversion by calling a software command. The analog value is converted to digital and returned to the computer. You can repeat this procedure until you have the total number of samples that you want from one channel.

The maximum throughput sample rate in software paced mode is system-dependent.

Continuous scan mode

In continuous scan mode, you can acquire data from up to eight channels. The analog data is continuously acquired, converted to digital values, and written to an on-board FIFO buffer until you stop the scan. The FIFO buffer is serviced in blocks as the data is transferred from the 18200-10 to the memory buffer on your computer.

The maximum continuous scan rate of 50 kS/s is an aggregate rate. The total acquisition rate for all channels cannot exceed 50 kS/s. You can acquire data from one channel at 50 kS/s, two channels at 25 kS/s, and four channels at 12.5 kS/s. You can start a continuous scan with either a software command or with an external hardware trigger event.

External components

The 18200-10 has the following external components, as shown in Figure 3-1.

- USB connector
- LED
- Screw terminal banks (2)

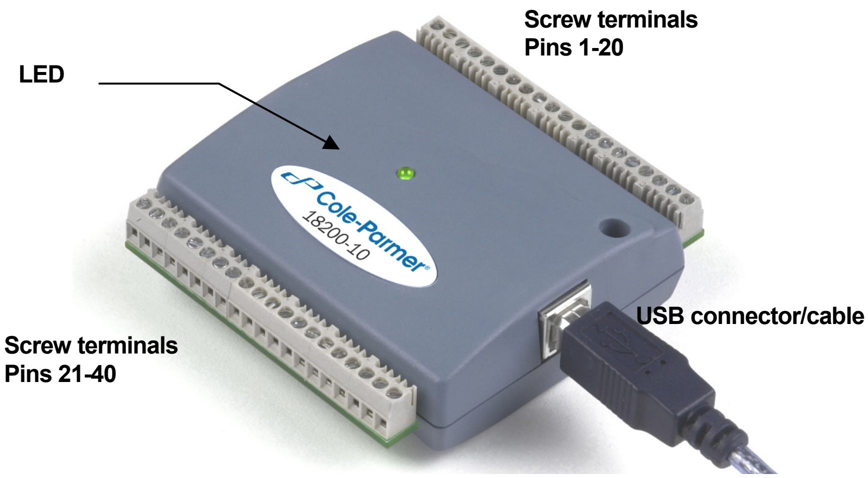


Figure 3-1. 18200-10 external components

USB connector

The USB connector is on the right side of the 18200-10. This connector provides +5 V power and communication. The voltage supplied through the USB connector is system-dependent, and may be less than 5 V. No external power supply is required.

LED

The LED on the front of the housing indicates the communication status of the 18200-10. It uses up to 5 mA of current and cannot be disabled. Table 3-1 defines the function of the 18200-10 LED.

Table 3-1. LED Illumination

LED Illumination	Indication
Steady green	The 18200-10 is connected to a computer or external USB hub.
Blinks continuously	Data is being transferred.

Screw terminal wiring

The 18200-10 has two rows of screw terminals—one row on the top edge of the housing, and one row on the bottom edge. Each row has 20 connections. Pin numbers are identified in Figure 3-2.

Figure 3-2. 18200-10 Screw terminal pin numbers

Screw terminal – pins 1-20

The screw terminals on the top edge of the 18200-10 (pins 1 to 20) provide the following connections:

- Eight analog input connections (**CH0 IN** to **CH7 IN**)
- Two analog output connections (**D/A OUT 0** to **D/A OUT 1**)
- One external trigger source (**TRIG_IN**)
- One SYNC terminal for external clocking and multi-unit synchronization (**SYNC**)
- One calibration terminal (**CAL**)
- Five analog ground connections (**AGND**)
- One ground connection (**GND**)
- One external event counter connection (**CTR**)

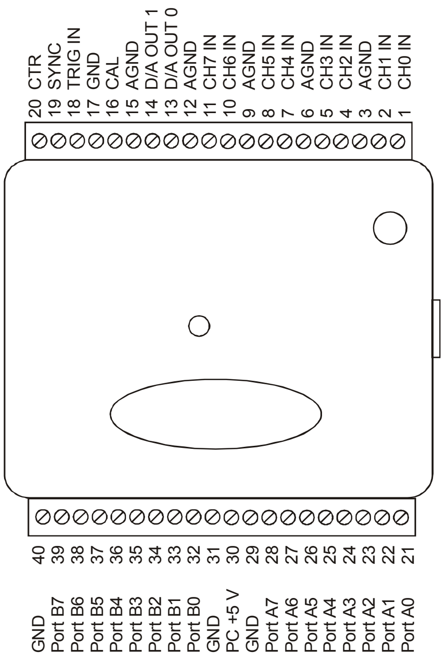
Screw terminal – pins 21-40

The screw terminals on the bottom edge of the (pins 21 to 40) provide the following connections:

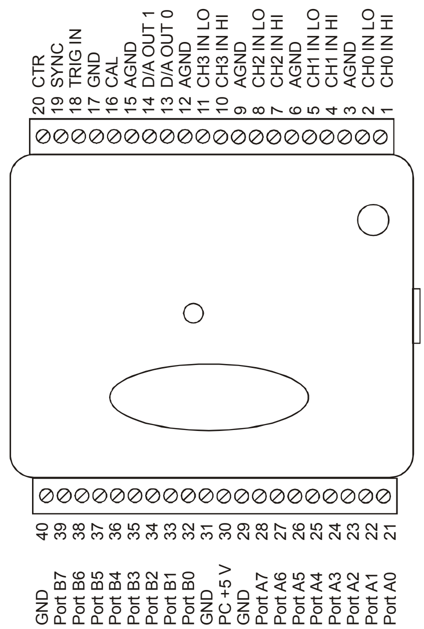
- 16 digital I/O connections (**PortA0** to **Port A7**, and **Port B0** to **Port B7**)
- One power connection (**PC+5 V**)
- Three ground connections (**GND**)

Main connector and pin out

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



8-channel single-ended mode pin out



4-channel differential mode pin out

Analog input terminals (CH0 IN - CH7 IN)

You can connect up to eight analog input connections to the screw terminal containing pins 1 to 20 (**CH0 IN** through **CH7 IN**.) Refer to the pinout diagrams above for the location of these pins.

You can configure the analog input channels as eight single-ended channels or four differential channels. When configured for differential mode, each analog input has 12-bit resolution. When configured for single-ended mode, each analog input has 11-bit resolution, due to restrictions imposed by the A/D converter.

Single-ended configuration

When all of the analog input channels are configured for single-ended input mode, eight analog channels are available. The input signal is referenced to signal ground (**GND**), and delivered through two wires:

- The wire carrying the signal to be measured connects to CH# IN.
- The second wire connects to AGND.

The input range for single-ended mode is ±10 V. No other ranges are supported in single-ended mode. Figure 3-3 illustrates a typical single-ended measurement connection.

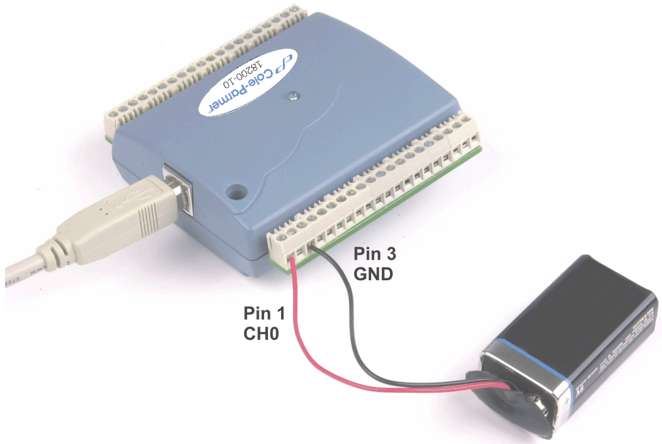


Figure 3-3. Single-ended measurement connection

Single-ended measurements using differential channels

To perform a single-ended measurement using differential channels, connect the signal to "CHn IN HI" input, and ground the associated "CHn IN LO" input.

Differential configuration

When all of the analog input channels are configured for differential input mode, four analog channels are available. In differential mode, the input signal is measured with respect to the low input.

The input signal is delivered through three wires:

- The wire carrying the signal to be measured connects to CH0 IN HI, CH1 IN HI, CH2 IN HI, or CH3 IN HI.
- The wire carrying the reference signal connects to CH0 IN LO, CH1 IN LO, CH2 IN LO, or CH3 IN LO.
- The third wire connects to GND.

A low-noise precision programmable gain amplifier (PGA) is available on differential channels to provide gains of up to 20 and a dynamic range of up to 12-bits. Differential mode input voltage ranges are ±20 V, ±10 V, ±5 V, ±4 V, ±2.5 V, ±2.0 V, 1.25 V, and ±1.0 V.

In differential mode, the following two requirements must be met for linear operation:

- Any analog input must remain in the −10 V to +20 V range with respect to ground at all times.
- The maximum differential voltage on any given analog input pair must remain within the selected voltage range.

The input [*common-mode voltage* + *signal*] of the differential channel must be in the −10 V to +20 V range in order to yield a useful result. For example, you input a 4 V pp sine wave to CHHI, and apply the same sine wave 180° out of phase to CHLO. The common mode voltage is 0 V. The differential input voltage swings from 4 V-(-4 V) = 8 V to -4 V-4 V = -8V. Both inputs satisfy the -10 V to +20 V input range requirement, and the differential voltage is suited for the ±10 V input range (see Figure 3-4).

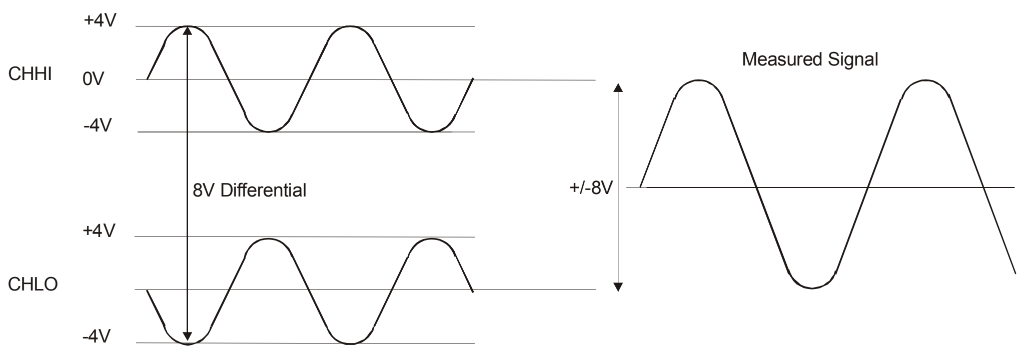


Figure 3-4. Differential voltage example: common mode voltage of 0 V

If you increase the common mode voltage to 11 V, the differential remains at ±8 V. Although the [*common-mode voltage* + *signal*] on each input now has a range of +7 V to +15 V, both inputs still satisfy the -10 V to +20 V input requirement (see Figure 3-5).

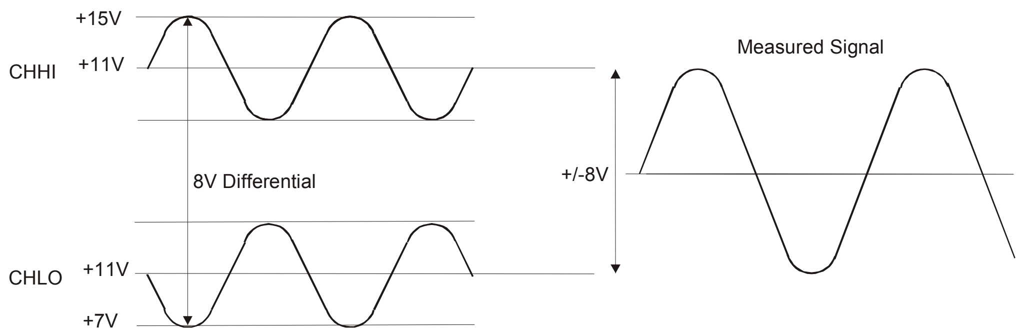


Figure 3-5. Differential voltage example: common mode voltage of 11 V

If you decrease the common-mode voltage to -7 V, the differential stays at ±8 V. However, the solution now violates the input range condition of -10 V to +20 V. The voltage on each analog input now swings from -3V to -11V. Voltages between -10 V and -3 V are resolved, but those below -10 V are clipped (see Figure 3-6).

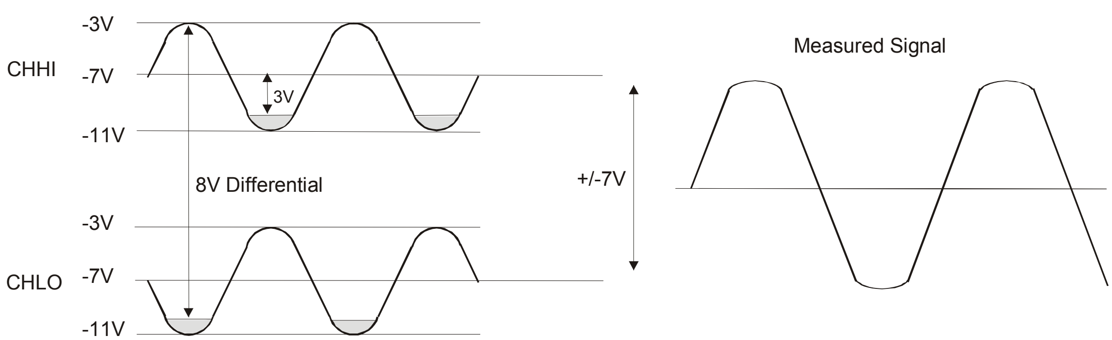


Figure 3-6. Differential voltage example: common mode voltage of -7 V

Since the analog inputs are restricted to a −10 V to +20 V signal swing with respect to ground, all ranges *except* ±20V can realize a linear output for any differential signal with zero common mode voltage and full scale signal inputs. The ±20 V range is the exception. You cannot put −20 V on CHHI and 0 V on CHLO since this violates the input range criteria.

Table 3-2 shows some possible inputs and the expected results.

Table 3-2. Sample inputs and differential results

CHHI	CHLO	Result
-20 V	0 V	In Valid
-15 V	+5 V	In Valid
-10 V	0 V	-10 V
-10 V	+10 V	-20 V
0 V	+10 V	-10 V
0 V	+20 V	-20 V
+10 V	-10 V	+20 V
+10 V	0 V	+10 V
+15 V	-5 V	+20 V
+20 V	0	+20 V

For more information on analog signal connections

For more information on single-ended and differential inputs, refer to the *Guide to Signal Connections* (this document is available on our web site at www.coleparmer.com/catalog/MoreInfo/CPsignals.pdf.)

Analog output terminals (D/A OUT 0 and D/A OUT 1)

You can connect up to two analog output connections to the screw terminal pins 13 and 14 (**D/A OUT 0** and **D/A OUT 1**). Refer to the pinout diagrams on page 13 for the location of these pins.

Each channel can be paced individually at rates up to 10,000 updates per second. Both channels can be paced simultaneously using the same time base at 5000 updates per channel. The 0-4.096 V output range provides a convenient 1 mV per LSB when setting the output voltage levels.

Digital I/O terminals (Port A0 to A7, and Port B0 to B7)

You can connect up to 16 digital I/O lines to the screw terminal containing pins 21 to 40 (**Port A0** to **Port A7**, and **Port B0** to **Port B7**.) Refer to the pinout diagrams on page 13 for the location of these pins. You can configure each digital port for either input or output.

When you configure the digital bits for input, you can use the digital I/O terminals to detect the state of any TTL level input. Refer to the switch shown in Figure 3-7 and the schematic shown in Figure 3-8. If the switch is set to the +5 V input, Port A0 reads *TRUE* (1). If you move the switch to GND, Port A0 reads *FALSE*.

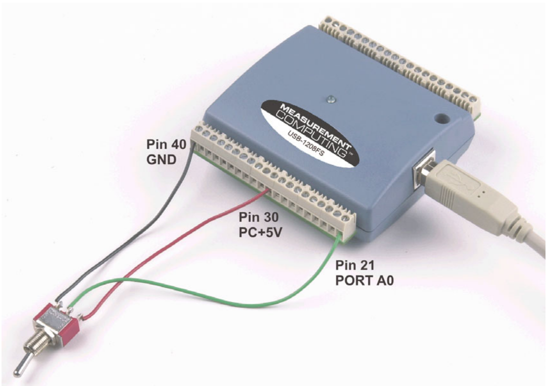


Figure 3-7. Digital connection Port A0 detecting the state of a switch

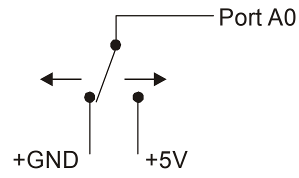


Figure 3-8. Schematic showing switch detection by digital channel Port A0

For more information on digital signal connections

For more information on digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our web site at www.coleparmer.com/catalog/MoreInfo/CPsignals.pdf.)

Power terminals

The **PC +5V** connection (pin 30) is on the bottom screw terminal of the 18200-10. Refer to the pinout diagrams on page 13 for the location of this pin. This terminal draws power from the USB connector. The +5 V screw terminal is a 5 volt output that is supplied by the host computer.

Caution! The +5 V terminal is an output. Do not connect to an external power supply or you may damage the 18200-10 and possibly the computer.

The maximum total output current that can be drawn from all 18200-10 connections (power, analog and digital outputs) is 420 mA. This maximum applies to most personal computers and self-powered USB hubs. Bus-powered hubs and notebook computers may limit the maximum available output current to 100 mA.

Just connecting the 18200-10 to your computer draws 80 mA of current from the USB +5 V supply. Once you start running applications with the 18200-10, each DIO bit can draw up to 2.5 mA, and each analog output can draw 15 mA. The maximum amount of +5 V current available for experimental use, over and above that required by the 18200-10, is the difference between the *total current requirement* of the USB (based on the application), and the *allowed current draw* of the PC platform (500 mA for desktop PCs and self-powered hubs, or 100 mA for bus-powered hubs and notebook computers).

With all outputs at their maximum output current, you can calculate the total current requirement of the 18200-10 USB +5 V as follows:

(18200-10 @ 80 mA) + (16 DIO @ 2.5 mA ea) + (2 AO @ 15 mA ea) = 150 mA

For an application running on a PC or powered hub, the maximum available excess current is 500 mA−150 mA = 350 mA. This number is the total maximum available current at the PC +5 V screw terminals. Measurement Computing highly recommends that you figure in a safety factor of 20% below this maximum current loading for your applications. A conservative, safe user maximum in this case would be in the 350-380 mA range.

Since laptop computers typically allow up to 100 mA, the 18200-10 in a fully-loaded configuration may be above that allowed by the computer. In this case, you must determine the per-pin loading in the application to ensure that the maximum loading criteria is met. The per-pin loading is calculated by simply dividing the +5 V by the load impedance of the pin in question.

Calibration terminal

The **CAL** connection (pin 16) is an output you should use only to calibrate the 18200-10. Refer to the pinout diagrams on page 13 for the location of this pin. Calibration of the 18200-10 is software-controlled via *Insta*Cal.

Ground terminals

The four analog ground connections (**AGND**) provide a common ground for all 18200-10 input channels. Four ground (GND) connections provide a common ground for the **DIO**, **TRIG_IN**, **CTR**, **SYNC** and **PC +5V** connections. Refer to the pinout diagrams on page 13 for the location of the **AGND** and **GND** terminal pins.

External trigger terminal

The **TRIG_IN** connection (pin 18) can be configured for either rising or falling edge. Refer to the pinout diagrams on page 13 for the location of the **TRIG_IN** terminal pin.

SYNC terminal

The **SYNC** connection (pin 19) is a bidirectional I/O signal. You can use it for two purposes:

- Configure as an external clock input to externally source the A/D conversions. The SYNC terminal supports TTL-level input signals of up to 50 kHz.
- Configure as an output to synchronize with a second USB unit and acquire data from 16 channels.

Refer to the pinout diagrams on page 13 for the location of this pin. For more information on synchronizing multiple units, refer to page 21.

Counter terminal

The **CTR** connection (pin 20) is input to the 32-bit external event. Refer to the pinout diagrams on page 13 for the location of this pin. The internal counter increments when the TTL levels transition from low to high. The counter can count frequencies of up to 1 MHz.

Accuracy

The overall accuracy of any instrument is limited by the error components within the system. Quite often, resolution is incorrectly used to quantify the performance of a measurement product. While "12-bits" or "1 part in 4096" does indicate what can be resolved, it provides little insight into the quality of an absolute measurement. Accuracy specifications describe the actual results that can be realized with a measurement device.

There are three types of errors which affect the accuracy of a measurement system:

- offset
- gain
- nonlinearity.

The primary error sources in the 18200-10 are offset and gain. Nonlinearity is small in the 18200-10, and is not significant as an error source with respect to offset and gain.

Figure 3-9 shows an ideal, error-free, 18200-10 transfer function. The typical calibrated accuracy of the 18200-10 is range-dependent, as explained in the "Specifications" chapter of this document. We use a ±10 V range here as an example of what you can expect when performing a measurement in this range.

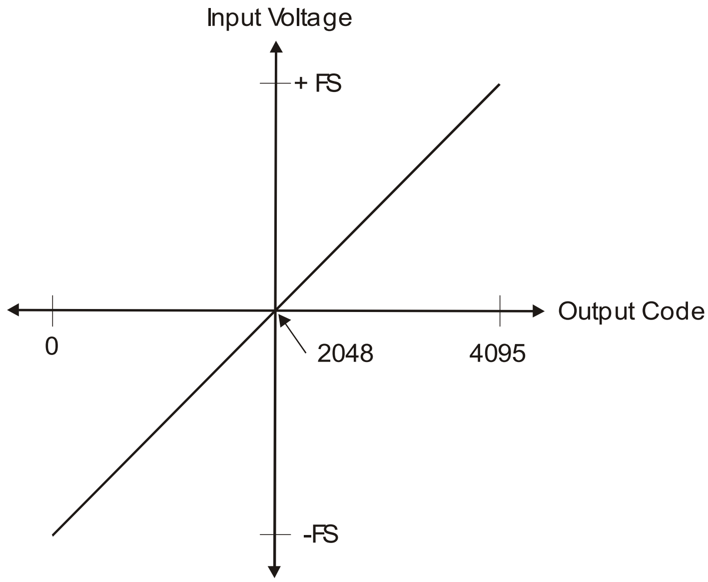


Figure 3-9. Ideal ADC transfer function

The 18200-10 offset error is measured at mid-scale. Ideally, a zero volt input should produce an output code of 2048. Any deviation from this is an offset error. Figure 3-10 shows the 18200-10 transfer function with an offset error. The typical offset error specification on the ±10 V range is ±9.77 mV. Offset error affects all codes equally by shifting the entire transfer function up or down along the input voltage axis.

The accuracy plots in Figure 3-10 are drawn for clarity and are not drawn to scale.

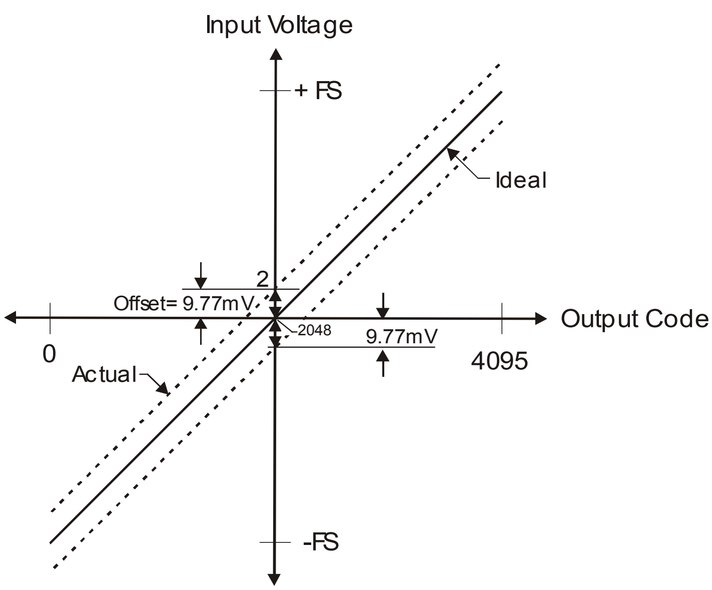


Figure 3-10. ADC transfer function with offset error

Gain error is a change in the slope of the transfer function from the ideal, and is typically expressed as a percentage of full-scale. Figure 3-11 shows the 18200-10 transfer function with gain error. Gain error is easily converted to voltage by multiplying the full-scale (**FS**) input by the error.

The accuracy plots in Figure 3-11 are drawn for clarity and are not drawn to scale.

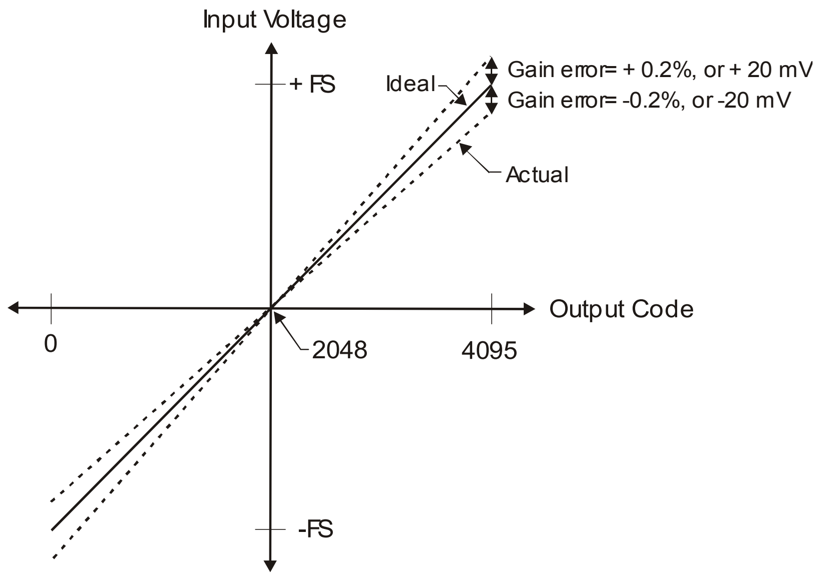


Figure 3-11. ADC Transfer function with gain error

For example, the 18200-10 exhibits a typical calibrated gain error of ±0.2% on all ranges. For the ±10 V range, this would yield 10 V × ±0.002 = ±20 mV. This means that at full scale, neglecting the effect of offset for the moment, the measurement would be within 20 mV of the actual value. Note that gain error is expressed as a ratio. Values near ±FS are more affected from an absolute voltage standpoint than are values near mid-scale, which see little or no voltage error.

Combining these two error sources in Figure 3-12, we have a plot of the error band of the 18200-10 for the ±10 V range. This is a graphical version of the typical accuracy specification of the product.

The accuracy plots in Figure 3-12 are drawn for clarity and are not drawn to scale

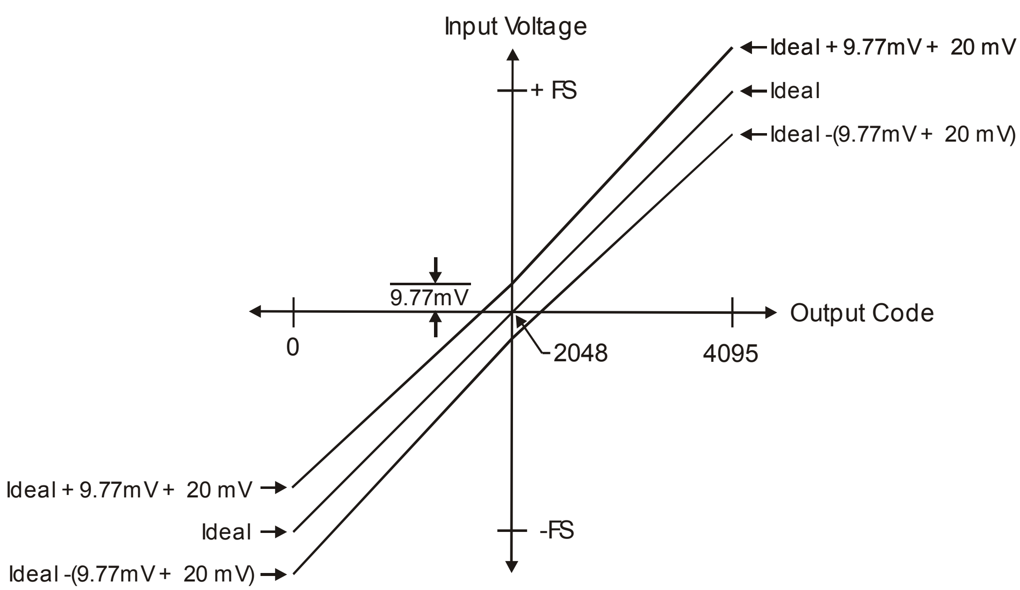


Figure 3-12. Error band plot

18200-10 channel gain queue feature

The 18200-10's channel gain queue feature allows you to set up a scan sequence with a unique per-channel gain setting and channel sequence.

The channel gain queue feature removes the restriction of using an ascending channel sequence at a fixed gain. This feature creates a channel list which is written to local memory on the 18200-10. The channel list is made up of a channel number and range setting. An example of a four-element list is shown in Table 3-3.

Table 3-3. Sample channel gain queue list

Element	Channel	Range
0	CH0	BIP10V
1	CH0	BIP5V
2	CH7	BIP10V
3	CH2	BIP1V

When a scan begins with the gain queue enabled, the 18200-10 reads the first element, sets the appropriate channel number and range, and then acquires a sample. The properties of the next element are then retrieved, and another sample is acquired. This sequence continues until all elements in the gain queue have been selected. When the end of the channel list is detected, the sequence returns to the first element in the list.

This sequence repeats until the specified number of samples is gathered. You must carefully match the gain to the expected voltage range on the associated channel—otherwise, an over range condition can occur. Although this condition does not damage the 18200-10, it does produce a useless full-scale reading. It can also introduce a long recovery time from saturation, which can affect the next measurement in the queue.

Synchronizing multiple units

You can connect the SYNC pin of two 18200-10 units together in a master/slave configuration and acquire data from the analog inputs of both devices using one clock. When the SYNC pin is configured as an output, the internal A/D pacer clock is sent to the screw terminal. You can use this signal as a clock input to a second USB by connecting it to the SYNC pin of the second USB.

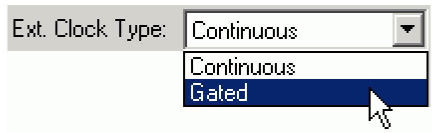
When used as a clock input, the SYNC pin operates in one of two modes – *Continuous* or *Gated*.

In the default *Continuous* mode, a 18200-10 ignores the first clock pulse in order to ensure adequate setup time. Use this mode if the unit is being paced from a continuous clock source, such as a generator.

In the *Gated* mode, it is assumed that the clock signal will be held off for an adequate amount of time for setup to occur. No clock pulses are ignored. Use this mode if the 18200-10 is set up as a slave and the source of the external clock is another USB.

The SYNC pin (pin 19) is set for pacer output by default. To synchronize a master 18200-10 with a slave 18200-10 and acquire data, follow the steps below.

1. Connect the SYNC pin of the master 18200-10 to the SYNC pin of the slave 18200-10.
2. Run *Insta*Cal.
3. From the **PC Board List** on the **InstaCal** main form, double-click on the 18200-10 you want to use as a slave. The **Board Configuration** dialog opens.
4. Select *Gated* from the **Ext. Clock Type** drop-down list.



5. Set the Universal Library `EXTCLOCK` option with `cbAInScan()/AInScan` for the slave 18200-10 to enable pacing from the master USB device.

This *Insta*Cal option does not affect internally paced acquisition. It only affects scans that use the `EXTCLOCK` option.

An example of a master/slave configuration is shown below.

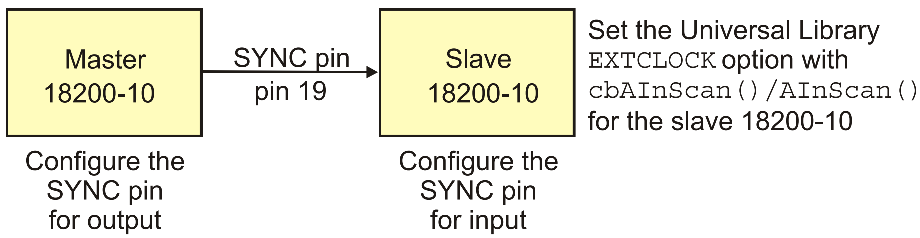


Figure 3-13. Configuring for synchronous data acquisition

When you are operating one 18200-10, do not set the `EXTCLOCK` option unless you are using an external clock for A/D pacing.

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		*122KOhm*
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	50 kilosamples per second (kS/s)
Channel gain queue	Up to 16 elements	Software configurable channel, range, and gain.
Resolution (Note 3)	Differential	12 bits, no missing codes
	Single-ended	11 bits
CAL accuracy	CAL = 2.5 V	±36.25 mV max
Integral linearity error		±1 least significant bit (LSB) typ
Differential linearity error		±0.5 LSB typ
Repeatability		±1 LSB typ
CAL current	Source	5 milliamperes (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 AD7870 converter only returns 11-bits (0-2047 codes) in single-ended mode.

Table 2. Accuracy, differential mode

Range	Accuracy (LSB)
±20 V	5.1
±10 V	6.1
±5 V	8.1
±4 V	9.1
±2.5 V	12.1
±2 V	14.1
±1.25 V	20.1
±1 V	24.1

Table 3. Accuracy, single-ended mode

Range	Accuracy (LSB)
±10 V	4.0

Table 4. Accuracy components, differential mode - All values are (±)

Range	% of Reading	Gain Error at full scale (FS) (millivolts (mV))	Offset (mV)	Accuracy at FS (mV)
±20 V	0.2	40	9.766	49.766
±10 V	0.2	20	9.766	29.766
±5 V	0.2	10	9.766	19.766
±4 V	0.2	8	9.766	17.766
±2.5 V	0.2	5	9.766	14.766
±2 V	0.2	4	9.766	13.766
±1.25 V	0.2	2.5	9.766	12.266
±1 V	0.2	2	9.766	11.766

Table 5. Accuracy components, single-ended mode - All values are (±)

Range	% of Reading	Gain Error at FS (mV)	Offset (mV)	Accuracy at FS (mV)
±10 V	0.2	20	19.531	39.531

Table 6. Noise performance, differential mode

Range	Typical counts	Least significant bit$_{\text{root mean square}}$ (LSB$_{\text{rms}}$)
±20 V	2	0.30
±10 V	2	0.30
±5 V	3	0.45
±4 V	3	0.45
±2.5 V	4	0.61
±2 V	5	0.76
±1.25 V	7	1.06
±1 V	8	1.21

Table 7. Noise performance, single-ended mode

Range	Typical Counts	LSB_{rms}
±10 V	2	0.30

Analog output

Table 8. Analog output specifications

Parameter	Conditions	Specification
Resolution		12-bits, 1 in 4096
Output range		*0 – 4.096 V, 1 mV per LSB.*
Number of channels		2
Throughput (Note 4)	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		Initializes to 000h code
Output drive	Each D/A OUT	15 mA
Slew rate		0.8V/microsecond (µs) typ

Note 4: 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.

Table 9. Analog output accuracy, all values are (±)

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

Table 10. Analog output accuracy components, all values are (±)

Range	% of FSR	Gain Error at FS (mV)	Offset (mV) (Note 5)	Accuracy at FS (mV)
0-4.096 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 5: Negative offsets will result in a fixed zero-scale error or “dead band.” At the maximum offset of -9 mV, any input code of less than 0x009 will not produce a response in the output.

Digital input/output

Table 11. 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 47K 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 12. Digital trigger specifications

Parameter	Conditions	Specification
Trigger source (Note 6)	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 6: TRIG_IN is a Schmitt trigger input protected with a 1.5 kilohm (kΩ) series resistor.

External clock input/output

Table 13. 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		50 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 7)	IOH = -2.5 mA	3.3 V min
	No load	3.8 V min
Output low voltage (Note 7)	IOL = 2.5 mA	1.1 V max
	No load	0.6 V max

Note 7: SYNC is a Schmitt trigger input and is over-current protected with a 200 Ω series resistor.

Counter

Table 14. Counter specifications

Pin name (Note 8)	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 8: CTR is a Schmitt trigger input protected with a 1.5K Ω series resistor.

Non-volatile memory

Table 15. Non-volatile memory specifications

EEPROM	1,024 bytes		
EEPROM Configuration	**Address Range**	**Access**	**Description**
	0x000-0x07F	Reserved	128 bytes system data
	0x080-0x1FF	Read/write	384 bytes cal data
	0x200-0x3FF	Read/write	512 bytes user area

Microcontroller

Table 16. Microcontroller specifications

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

Power

Table 17. Power specifications

Parameter	Conditions	Specification
Supply current (Note 9)		80 mA
+5V USB power available (Note 10)	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 11)	Connected to self-powered hub Connected to externally-powered root port hub	420 mA max
	Connected to bus-powered hub	20 mA max

Note 9: This is the total current requirement for the 18200-10 which includes up to 10 mA for the status LED.

Note 10: *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 11: This refers to the total amount of current that can be sourced from the USB +5 V, analog outputs and digital outputs.

General

Table 18. General specifications

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

Environmental

Table 19. Environmental specifications

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

Mechanical

Table 20. 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 21. 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	CAL	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	CAL	36	Port B4
17	GND	37	Port B5
18	TRIG_IN	38	Port B6
19	SYNC	39	Port B7
20	CTR	40	GND

Declaration of Conformity

Manufacturer:	Measurement Computing Corporation
Address:	10 Commerce Way Suite 1008 Norton, MA 02766 USA

Category: Electrical equipment for measurement, control and laboratory use.

Measurement Computing Corporation declares under sole responsibility that the product

18200-10

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

EU EMC Directive 89/336/EEC: Electromagnetic Compatibility, EN 61326 (1997) Amendment 1 (1998)

Emissions: Group 1, Class A

- EN 55011 (1990)/CISPR 11: Radiated and Conducted emissions.

Immunity: EN61326, Annex A

- IEC 1000-4-2 (1995): Electrostatic Discharge immunity, Criteria C.
- IEC 1000-4-3 (1995): Radiated Electromagnetic Field immunity Criteria A.
- IEC 1000-4-4 (1995): Electric Fast Transient Burst immunity Criteria C.
- IEC 1000-4-5 (1995): Surge immunity Criteria A.
- IEC 1000-4-6 (1996): Radio Frequency Common Mode immunity Criteria A.
- IEC 1000-4-8 (1994): Magnetic Field immunity Criteria A.
- IEC 1000-4-11 (1994): Voltage Dip and Interrupt immunity Criteria A.

IEC 1000-4-4 not required for 18200-10. Device is DC powered by a cable less than three meters long.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in August, 2004. Test records are outlined in Chomerics Test Report #EMI3948.04.

We hereby declare that the equipment specified conforms to the above Directives and Standards.

Carl Haapaoja

Carl Haapaoja, Director of Quality Assurance

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