BTH-1208LS-OEM

Wireless Multifunction DAQ Device

User's Guide

MEASUREMENT COMPUTING™

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About this User's Guide

What you will learn from this user's guide

This user's guide describes the Measurement Computing BTH-1208LS-OEM wireless data acquisition device and lists device specifications.

Conventions in this user's guide

For more information

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.

Bold text is used for the names of objects on a screen, such as buttons, text boxes, and checkboxes.

Italic text is used for the names of manuals and help topic titles, and to emphasize a word or phrase.

Where to find more information

Additional information about the BTH-1208LS-OEM is available on our website at www.mccdaq.com. You can also contact Measurement Computing Corporation with specific questions.

§ Knowledgebase: kb.mccdaq.com
§ Tech support form: www.mccdaq.com/support/support_form.aspx
§ Email: techsupport@mccdaq.com
§ Phone: 508-946-5100 and follow the instructions for reaching Tech Support

For international customers, contact your local distributor. Refer to the International Distributors section on our website at www.mccdaq.com/International.

Introducing the BTH-1208LS-OEM

The BTH-1208LS-OEM is a multifunction data acquisition device that communicates using Bluetooth® wireless technology.

The Bluetooth radio host used with the device must support Bluetooth 2.0 or later. The following Bluetooth stack protocols are supported on Windows:

§   Microsoft Bluetooth stack
§   Broadcom ® Bluetooth stack (not supported by Windows XP)

The device supports USB 2.0 full-speed when connected to a USB port. The device is also compatible with USB 1.1 ports; however, the speed of the device may be limited when using a USB 1.1 port due to the difference in transfer rates on USB 1.1 versions of the protocol (low-speed and full-speed).

The BTH-1208LS-OEM provides the following features:

§   Eight 11-bit single-ended (SE) or four 12-bit differential (DIFF) analog input channels
§   1 kS/s max sample rate in Bluetooth continuous scan mode
§   47 kS/s sample rate in Bluetooth BURSTIO mode and when communicating over USB connection
§   Software-selectable analog input ranges of ±10 V (SE), and ±20 V, ±10 V, ±5 V, ±4 V, ±2.5 V, ±2.0 V, ±1.25 V, and ±1.0 V (DIFF).
§   Two 12-bit analog outputs
§   Eight individually-configurable digital I/O channels
§   One 32-bit event counter
§   One external digital trigger input
§   One external clock input
§   Three header connectors for field wiring
§   Header connectors available for user-supplied power; can also be powered by a USB power supply in Bluetooth mode or from the USB host device in USB mode. Connectors for battery power and battery charging are also included.

Caution!   There are no product safety, electromagnetic compatibility (EMC), or CE marking compliance claims made for the BTH-1208LS-OEM. The BTH-1208LS-OEM is intended for use as a component of a larger system. MCC can help developers meet their compliance requirements. The end product supplier, however, is responsible for conforming to any and all compliance requirements.

Functional block diagram

BTH-1208LS-OEM functions are illustrated in the block diagram shown here.
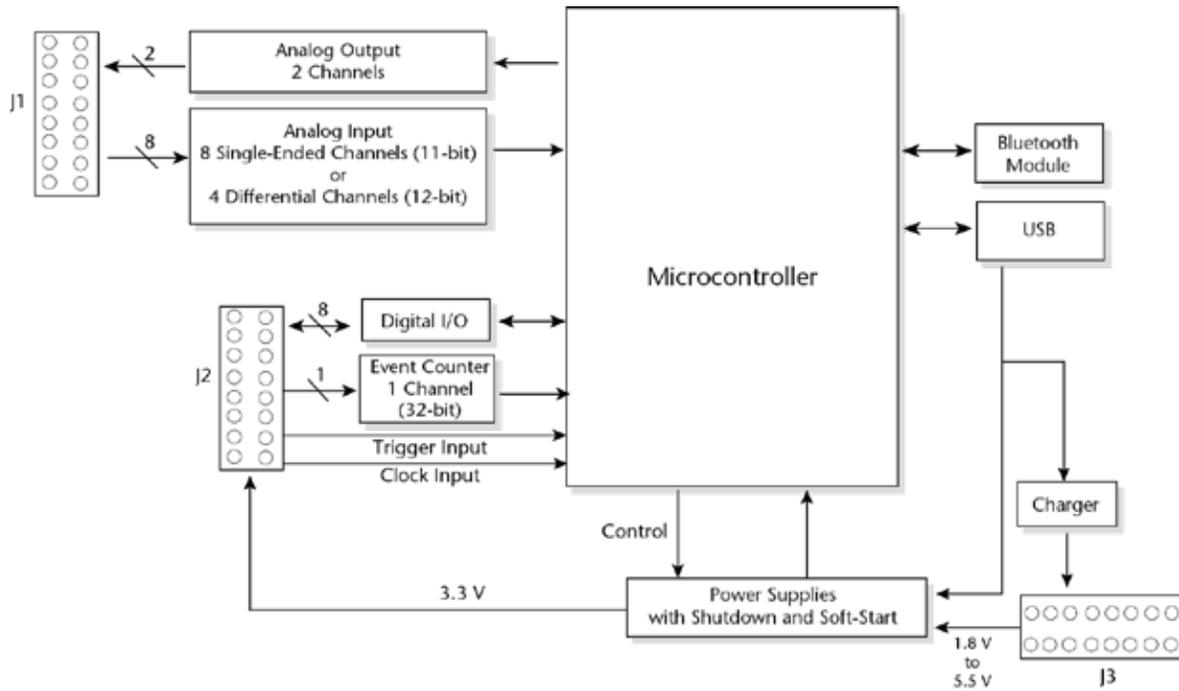
Figure 1. Functional block diagram

Installing a BTH-1208LS-OEM

Unpacking

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the board 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.

Downloading the software

Refer to the BTH-1208LS-OEM product page on our website for information about the supported software you can download.

> **Install the software before you install the hardware**
> The driver needed to run the device is installed when you install the software. Therefore, you need to install the software package you plan to use before you install the hardware.

Pairing with the host device

Pairing creates a bond between a Bluetooth device and a host device. A host device can be either a Windows-based computer or an Android device (tablet, phone, or mini-PC).

The BTH-1208LS-OEM must be paired with the host device before it can establish a wireless connection and transmit acquired data to the device. A BTH-1208LS-OEM only has to be paired once with a particular host device.

The BTH-1208LS-OEM can be paired or connected when powered by:

§   batteries (standard or rechargeable)
§   an external USB power supply

The BTH-1208LS-OEM cannot be paired when powered by a USB host device.

To pair the BTH-1208LS-OEM as a Bluetooth device, make sure the device is not connected to a USB host, and complete the following steps (refer to Figure 2 on page 11 for the location of device components referenced in this section):

1. Make sure the host device is configured to host a Bluetooth device. Refer to host device documentation to learn how to enable Bluetooth and how to search for and pair with Bluetooth devices.

2. If powered by batteries, press and hold the button for at least five seconds to power on the device and put it into pairing mode.

   If powered by a USB power supply, press and hold the button for at least three seconds to put the device into pairing mode.

   When the **Power** and **Status** LEDs blink alternately, the device is in pairing mode and is ready to pair with the host device.

3. Select the Bluetooth device setup in the host device OS software, and then select the BTH-1208LS-OEM when it displays. Refer to the Bluetooth documentation of your host device to learn how to pair it with a Bluetooth device.

   For example, in Windows, select **Bluetooth Device** from the Control Panel, and then double-click on **BTH-1208LS-OEM-xxxx** in the **Add a device** dialog box (**xxxx** are the last four digits of the device serial number. You may need to wait a few seconds for the device to display.

4. If host device requests a passkey, PIN or pairing code, enter the default value for the device (`0000`).

5. Press and hold the power/pairing button for two seconds to remove the device from pairing mode.

Once the BTH-1208LS-OEM is paired to the host device, run an application that communicates with the device (such as InstaCal or a UL for Android example program) to establish a connection. The **Status** LED turns on to indicate a Bluetooth connection is established.

Digital ground to earth ground connection recommended

Measurement Computing recommends that you connect one of the digital grounds (**GND**) to earth ground to reduce the chance of the BTH-1208LS-OEM unexpectedly powering down due to electrostatic discharge.

Installing the hardware in USB mode (Windows only)

The driver needed to run the BTH-1208LS-OEM device is installed when you install the software. Therefore, you need to install the software package you plan to use before you install the hardware. For operation on a Windows operating system, Measurement Computing recommends that you run Windows Update to update your operating system with the latest USB drivers.

Connect the USB cable to an available USB port on the computer or to an external USB hub connected to the computer. Connect the other end of the USB cable to the USB connector on the device. No external power is required.

Configuring Bluetooth settings

All Bluetooth settings except for the pairing code can be changed when the BTH-1208LS-OEM is either physically or wirelessly connected to the host device. The pairing code can only be changed when the BTH-1208LS-OEM is physically connected to the host device.

You can configure the following Bluetooth settings on the BTH-1208LS-OEM through software. For example, if you are using the device in a Windows environment, you can configure these settings with InstaCal.

§ **Pairing code** – Four digit code that identifies the BTH-1208LS-OEM to the host device (default = 0000). The pairing code cannot be changed when the BTH-1208LS-OEM is connected wirelessly to the host device.
§ **Bluetooth connection status notifications** – You can set values that indicate when the device is connected over Bluetooth, and when the Bluetooth connection terminates. Connected and disconnected values can be set for digital outputs, analog output channel 0, and analog input channel 1
§ **Auto shutdown** – When the device is powered by batteries, you can configure the device to power down a specified amount of time after the Bluetooth connection terminates.
§ **Battery charging** – When the device is powered by rechargeable batteries, you can configure the device to recharge batteries from the USB power supply when connected over Bluetooth.

Calibrating the hardware

The Measurement Computing Manufacturing Test department performs the initial factory calibration. Return the device to Measurement Computing Corporation when calibration is required. The recommended calibration interval is one year.

Functional Details

Analog input acquisition modes

The BTH-1208LS-OEM can acquire analog input data in three different modes – software paced, hardware paced, and BURSTIO.

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 repeat this procedure until you have the total number of samples that you want from one channel.

§   When communicating over a Bluetooth connection, the typical throughput sample rate in software paced mode is 10 S/s (system-dependent).

§   When communicating over a USB connection, the typical throughput sample rate in software paced mode is 250 S/s (system-dependent).

Hardware paced mode

In hardware paced mode you can acquire data from up to eight channels. The analog data is acquired and converted to digital values until you stop the scan.

§   When communicating over a Bluetooth connection, the maximum sample rate of 1024 S/s is an aggregate rate. The total acquisition rate for all channels cannot exceed 1024 S/s. The following table lists the sample rates when scanning from one to eight channels in Bluetooth mode.

Maximum per channel sample rate in Bluetooth mode

# channels scanned	Sample rate (S/s)
1	1024
2	512
3	341.33
4	256
5	204.8
6	170.67
7	146.28
8	128

§   When communicating over a USB connection, the maximum sample rate of 47 kS/s is an aggregate rate. The total acquisition rate for all channels cannot exceed 47 kS/s. Data is transferred in blocks of 32 samples from the device to the memory buffer on your computer.

The following table lists the sample rates when scanning from one to eight channels in USB mode.

Maximum per channel sample rate in USB mode

# channels scanned	Sample rate (kS/s)
1	47
2	23.5
3	15.67
4	11.75
5	9.40
6	7.83
7	6.70
8	5.88

In both Bluetooth mode and USB mode, you can start a hardware-paced scan with either a software command or with an external hardware trigger event.

BURSTIO

When using BURSTIO, the BTH-1208LS-OEM can acquire data at the maximum throughput of 47kS/s when connected in Bluetooth mode. BURSTIO doesn't offer any advantage in USB mode, since these rates are supported for BLOCKIO in USB mode.

When BURSTIO is enabled, scans are limited to the depth of the onboard memory (12,288 samples), as the data is acquired at a rate faster than it can be transferred to the computer. Keep in mind that when using Bluetooth the rate of transfer of the acquired data to the host is still limited so the process can take several seconds. Time must be allowed between scans for the acquisition *and* the transfer of the data.

The maximum sample rate is an aggregate rate. The total sample rate using BURSTIO is 47 kS/s per channel for any or all channels. An error occurs if you exceed the FIFO capacity and acquire more than 12,288 samples in BURSTIO mode.

Board components

The BTH-1208LS-OEM has the following components, as shown in Figure 2.
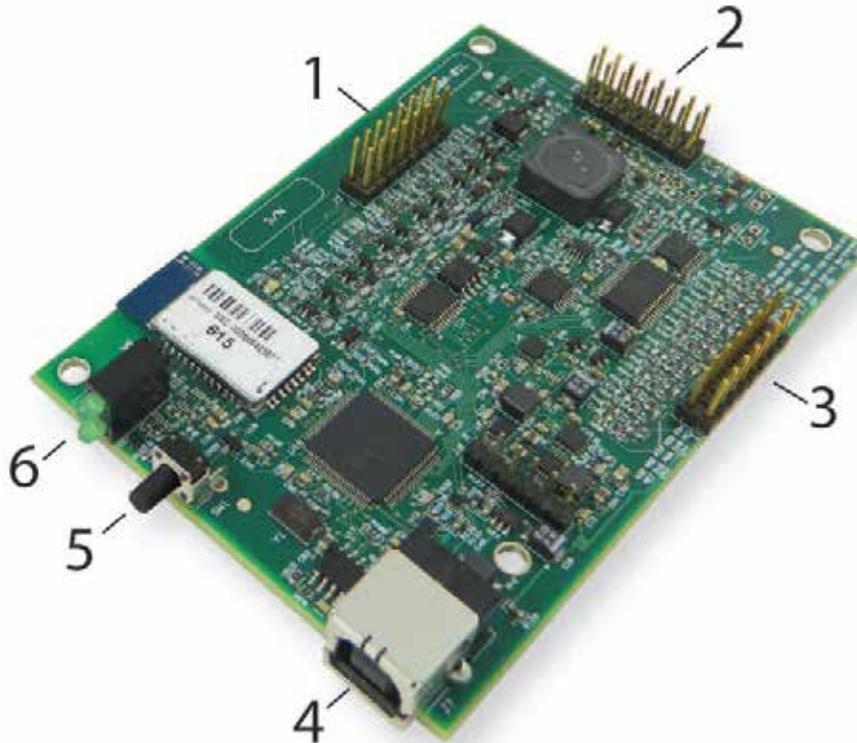
1	Connector J2	4	USB connector
2	Connector J3	5	Power/Pairing Button
3	Connector J1	6	Power LED (top) and Status LED (bottom)

Figure 2. Board components

USB connector

The USB connector provides 5 V power when connected to a USB power supply, and provides both power and communication when the device is connected to a USB port. If rechargeable batteries are powering the device, recharges batteries' when connected to USB host or power supply.

Power/pairing button

The power/pairing button has different functions depending on the power source of the device.

The term pairing refers to one function of the button – to put the device in pairing mode so it can establish an association between the Bluetooth radio on the host device and the BTH-1208LS-OEM radio.

Button functions are listed in the table below.

Power/pairing button functions

Power Status	Button Functions
Battery powered	▪ To power on the device, press and hold the button for 3 seconds. To enter pairing mode, hold the button for an additional 2 seconds. ▪ To remove the device from pairing mode, press and hold the button again for 2 seconds. ▪ To power off the device when not in pairing mode, press and hold the button for 2 seconds
Powered by USB charger/USB power supply	▪ To put the device in pairing mode when it is powered on, press and hold button for 2 seconds. ▪ To remove the device from pairing mode, press and hold the button again for 2 seconds.
Powered by USB host port or hub	The power/pairing button is disabled.

LEDs

The Power LED indicates the power status of the device. The Status LED indicates the communication status of the device.

LEDs cannot be disabled. LED states are listed in the tables below.

Power and Status LED behavior

Power LED	Indication
Steady green	The device is powered by USB and the batteries are sufficiently charged or not installed.
Blinks continuously	▪ Connected to USB port/host: the batteries are recharging (only if rechargeable batteries are installed). ▪ The device is not connected to a USB port: indicates battery power ▪ The Power LED blinks alternately with the Status LED: the device is in pairing mode.
Off	Device is off.
Status LED	**Indication**
Steady green	Bluetooth or USB connection established
Blinks continuously	▪ Communication with host computer over a Bluetooth or USB connection. ▪ The Status LED blinks alternately with the Power LED: the device is in pairing mode.
Off	A Bluetooth or USB connection is not established

Connector J1

Header connector J1 provides connections for the analog inputs, analog outputs, and analog ground reference. Refer to Figure 5 on page 17 for the location and orientation of J1.

Four-channel differential mode

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH0H	Analog input 0 HI	2	AGND	Analog ground
3	CH0L	Analog input 0 LO	4	AGND	Analog ground
5	CH1H	Analog input 1 HI	6	AGND	Analog ground
7	CH1L	Analog input 1 LO	8	AGND	Analog ground
9	CH2H	Analog input 2 HI	10	AGND	Analog ground
11	CH2L	Analog input 2 LO	12	AGND	Analog ground
13	CH3H	Analog input 3 HI	14	AOUT0	Analog output 0
15	CH3L	Analog input 3 LO	16	AOUT1	Analog output 1

Eight-channel single-ended mode

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH0 IN	Analog input 0	2	AGND	Analog ground
3	CH1 IN	Analog input 1	4	AGND	Analog ground
5	CH2 IN	Analog input 2	6	AGND	Analog ground
7	CH3 IN	Analog input 3	8	AGND	Analog ground
9	CH4 IN	Analog input 4	10	AGND	Analog ground
11	CH5 IN	Analog input 5	12	AGND	Analog ground
13	CH6 IN	Analog input 6	14	AOUT0	Analog output 0
15	CH7 IN	Analog input 7	16	AOUT1	Analog output 1

Connector J2

Header connector J2 provides connections for the DIO, external clock input, trigger, counter, power output, and digital ground reference. Refer to Figure 5 on page 17 for the location and orientation of J2.

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	DIO0	Digital input/output 0	2	GND	Digital ground
3	DIO1	Digital input/output 1	4	CTR	Counter input
5	DIO2	Digital input/output 2	6	TRIG_IN	Digital trigger input
7	DIO3	Digital input/output 3	8	AICKI	Pacer input
9	DIO4	Digital input/output 4	10	GND	Digital ground
11	DIO5	Digital input/output 5	12	+VO	3.3V output
13	DIO6	Digital input/output 6	14	GND	Digital ground
15	DIO7	Digital input/output 7	16	GND	Digital ground

Connector J3

Header connector J3 provides connections for bulkhead signals. Refer to Figure 5 on page 17 for the location and orientation of J3.

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	BATT+	Battery input positive (2 AA/AAA cells)	2	BATT–	Battery input negative
3	BATT_MID	Battery center tap	4	GND	Ground
5	THERMISTOR+	10 kΩ thermistor positive (battery temperature sensing)	6	THERMISTOR–	10 kΩ thermistor negative
7	PWR SW+	SPST contact 1 (power switch)	8	PWR SW –	SPST contact 2
9	PAIRING SW+	Momentary contact 1 (pairing / soft power switch)	10	PAIRING SW–	Momentary contact 2
11	LED1+	LED1 anode	12	LED1 –	LED1 cathode
13	LED2+	LED2 anode	14	LED2 –	LED2 cathode
15	Vbus	USB 5V supply (charging LED anode)	16	CHARGE LED –	Charging LED cathode

Signal connections

Analog input

You can connect up to eight single-ended analog input connections (**CH0** to **CH7**) or four differential connections (**CH0H/CH0L** to **CH3H/CH3L**) on connector J1.

Single-ended configuration

When configured for single-ended input mode, eight analog input channels are available. Each analog input has 11-bit resolution (due to restrictions imposed by the A/D converter) and offers a ±10 V analog input range.

The input signal is referenced to signal ground (**AGND**), and is delivered through two wires:

§   Connect the wire carrying the signal to be measured to **CHx**.
§   Connect the second wire to **AGND**.

Single-ended measurements using differential channels

To perform a single-ended measurement using differential channels, connect the signal to the **CHxH** input, and ground the associated **CHxL** input.

Differential configuration

When the analog input channels are configured for differential input mode, four analog input channels are available. A low-noise precision programmable gain amplifier (PGA) is available on differential channels. Each analog input has 12-bit resolution and offers software-selectable analog input ranges of ±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 input signal is measured with respect to the low input. The input signal is delivered through three wires:

§   Connect the wire carrying the signal to be measured to **CHxH**.
§   Connect the wire carrying the reference signal to **CHxL**.
§   Connect the third wire to **AGND**.

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 analog input pair must remain within the selected voltage range.

Channel gain queue

The channel gain queue feature allows you to set up a scan sequence with a unique per-channel gain setting and channel sequence. The gain settings are stored in a channel-gain queue list that is written to local memory on the device.

The channel-gain queue list can contain up to up to 8 elements in single-ended mode or four elements in differential mode. The elements must be unique and listed in ascending order. An example of a three-element list is shown in the table below.

Sample channel gain queue list

Element	Channel	Range
0	CH0	BIP10V
1	CH2	BIP5V
2	CH3	BIP10V

When a scan begins with the gain queue enabled, the BTH-1208LS-OEM 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 acquired.

Carefully match the gain to the expected voltage range on the associated channel or an over range condition may occur. Although this condition does not damage the device, it does produce a useless full-scale reading, and can introduce a long recovery time due to saturation of the input channel.

Analog output

Two 12-bit analog outputs are available at **AOUT0** and **AOUT1** on connector J1.

Each analog output channel has an output range of 0 V to 2.5 V. Throughput is system-dependent. The D/A is software paced.

External clock input

The BTH-1208LS-OEM provides one external clock input for the analog input pacer. You can connect an external clock signal to **AICKI** on connector J2.

Digital I/O

You can connect up to eight digital I/O lines to **DIO0** through **DIO7**. The digital I/O terminals can detect the state of any TTL-level input.

Digital input voltage ranges of up to 0 to 5.5 V are permitted, with thresholds of 0.8 V (low) and 2.0 V (high).

Each DIO channel is an open-drain, which can sink up to 50 mA for direct drive applications when used as an output.

Figure 3 shows an example of a typical DIO connection. The figure represents connections for one channel. The other seven channels are connected in the same manner.

Typical DIO channel
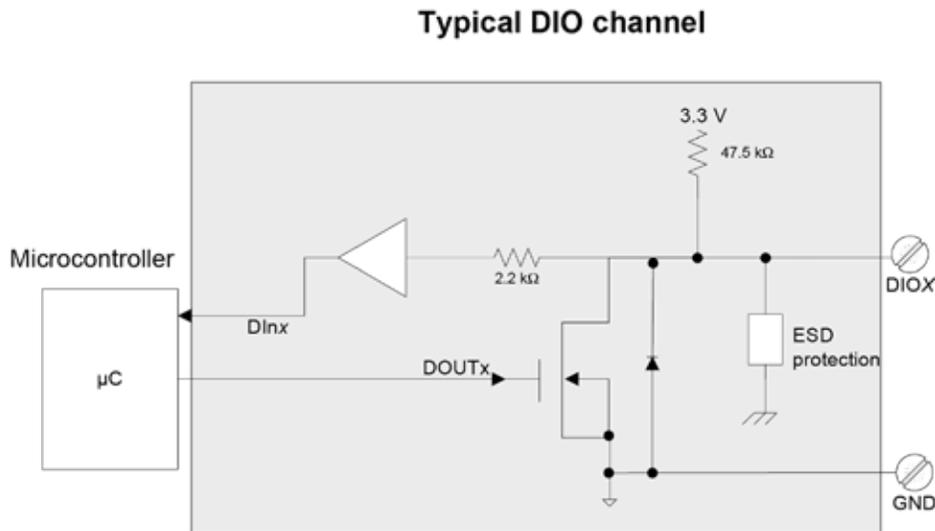
Figure 3. Digital output connection example

External pull-up/pull-down capability

Inputs are pulled high by default to 3.3 V through 47.5 kΩ resistors on the circuit board. The pull-up voltage is common to all 47.5 kΩ resistors.

You can place an external pull-up resistor on any of the DIO bits in order to limit source current to less than 50 mA, which requires a 100 Ω resistor minimum. A 2 kΩ or 5 kΩ resistor would be typically used, allowing for a 1 mA current

You can also use an external pull-up resistor to pull the DIO bit up to a voltage that exceeds the internal 3.3 V pull-up voltage (5.5 V maximum).

When using external pull-up resistors, be aware that the internal resistors cause a slight voltage shift to digital lines in the on state as various lines change between the on/off states.
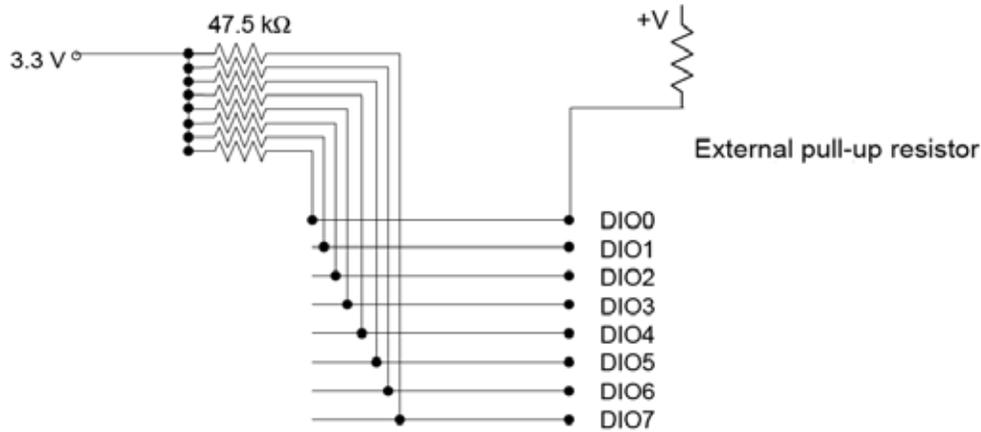
Figure 4. Digital I/O external resistor configuration

Bulkhead signals

The function of the bulkhead pins is explained below.

Battery charging

Use the BATT+, BATT_MID, and BATT– pins to charge two AA or AAA cells used in series, with BATT_MID connected to the midpoint of the series cells. This enables the charger to detect the voltage of the cells independently in order to stop fast charging when either cell reaches full capacity.

Also you must use the THERMISTOR+ and THERMISTOR– pins to connect to a 10 kΩ thermistor in close proximity to the battery cells to monitor battery temperature.

External power supply (battery charging not required)

Use the BATT+ and BATT– pins to supply power to the board when battery charging is not required. Power can be supplied from any DC source in the 1.8 V to 5.5 V range.

Power and pairing control

Use the PWR_SW+ and PWR_SW– pins with an external SPST power switch to turn the board on and off.

Use the PAIRING_SW+ and PAIRING_SW– with a momentary switch to perform the same power and pairing functionality as the onboard button (refer to Power/pairing button on page 12).

LED control

Use the LED1+ and LED1– pins to connect an external power LED. The series resistor is already on the BTH-1208LS-OEM; only a LED is required.

Use the LED2+ and LED2– pins to connect an external status LED. The series resistor is already on the BTH-1208LS-OEM; only a LED is required.

Use the Vbus pin to connect to an external charging LED or to power external circuits from a +5 V supply when a USB host or power supply is present.

Use the CHARGE_LED– pin in combination with the Vbus pin for an external charging LED. The series resistor is already on the BTH-1208LS-OEM; only a LED is required.

Trigger input

The **TRIG_IN** pin on connector J2 is an external digital trigger input that you can configure for either rising/falling edge, or high/low level.

Counter input

The **CTR** pin on connector J2 is a 32-bit event counter that can accept frequency inputs up to 1 MHz. The internal counter increments when the TTL levels transition from low to high.

Ground

The analog ground (**AGND**) pin on connector J1 provide a common ground for all analog channels. The ground (**GND**) pins on connector J2 provide a common ground for the digital, trigger, counter, and power terminals.

Power output

The +**VO** pin on connector J2 is a 3.3 V output that can source up to 50 mA that is supplied by the power source of the device. You can use this terminal to supply power to external devices or circuitry.

Caution!   The +**V0** pin is an output. Do not connect to an external power supply or you may damage the BTH-1208LS-OEM and possibly the computer.

For more information about signal connections

For more information about analog and digital signal connections, refer to the *Guide to DAQ Signal Connections* at www.mccdaq.com/support/DAQ-Signal-Connections.aspx.

Mechanical drawing
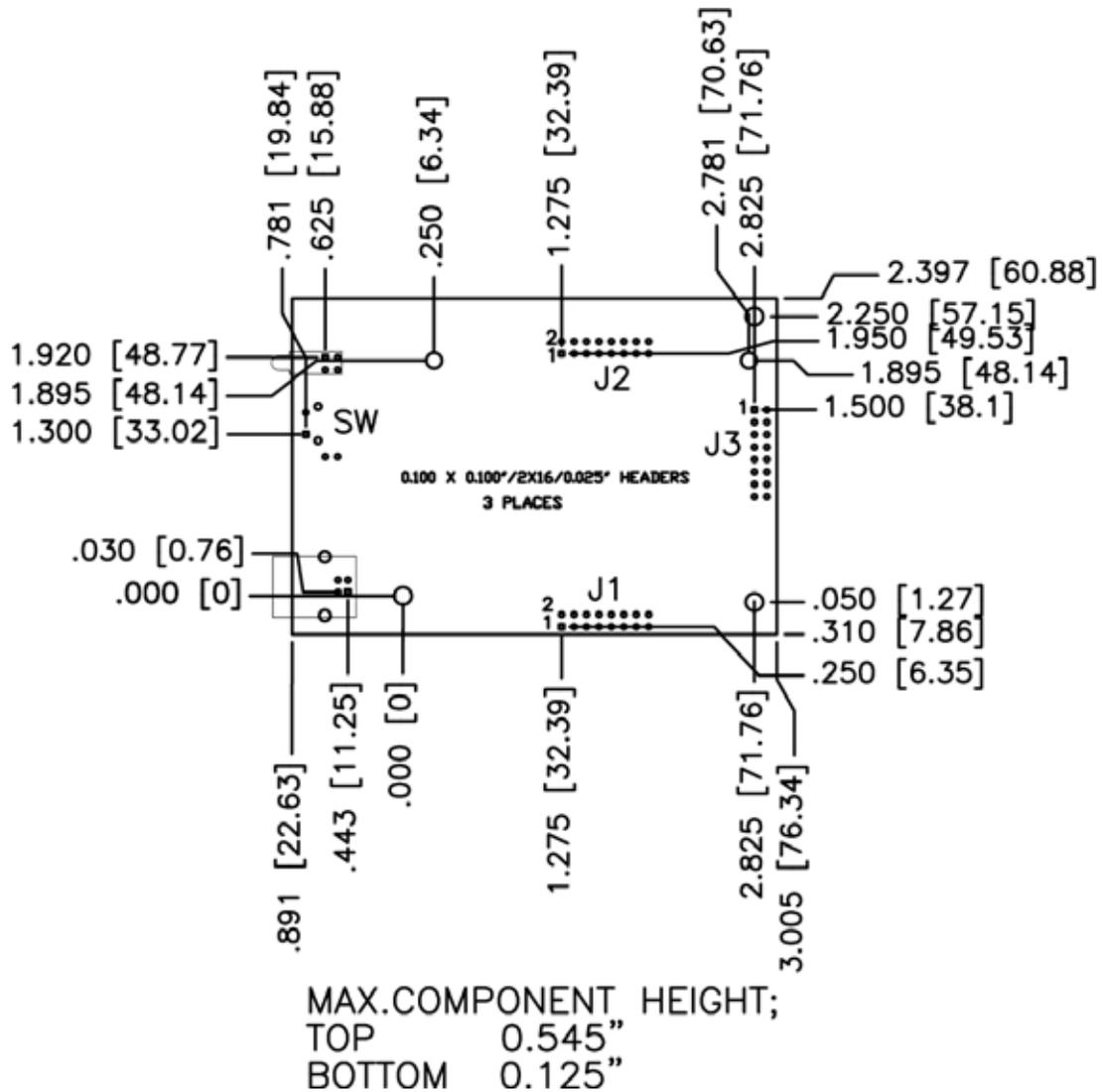
Figure 5. Circuit board dimensions

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. Analog input specifications

Parameter	Condition	Specification
A/D converter type		Successive approximation type
Input voltage range for linear operation	CHx to GND	Single-ended mode: ±10 V max Differential mode: –10 V min, +20 V max
Absolute maximum input voltage	*CHx to GND*	*±25 V max*
Input impedance		*140 kΩ*
Input current (Note 1)	V_{in} = +10 V	70 µA typ
	V_{in} = 0 V	–12 µA typ
	V_{in} = –10 V	–94 µA typ
Number of channels		8 single-ended or 4 differential; software-selectable
Input ranges	Single-ended	±10 V, G=2
	Differential	±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	10 S/s typ, system-dependent (Bluetooth) 250 S/s typ, system-dependent (USB)
	Continuous scan	0.014 S/s to 1024 S/s (Bluetooth) 0.014 S/s to 47 kS/s (USB)
	BURSTIO	0.014 S/s to 47 kS/s to 12K (12,288) sample FIFO Transfer rate to host is limited to 1024 S/s (Bluetooth)
Channel gain queue		Software selectable. 8 elements in SE mode, 4 elements in DIFF mode. One gain element per channel. Elements must be unique and listed in ascending order.
Resolution (Note 3)	Differential	12 bits, no missing codes
	Single-ended	11 bits
Integral linearity error		±1 LSB typ
Differential linearity error		±0.5 LSB typ
Repeatability		±1 LSB typ
Trigger source	Software-selectable	External digital: TRIG Software-selectable
Pacer source	Software-selectable	▪ Internal ▪ External (AICKI), rising edge triggered Software-selectable

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 when scanning is machine dependent.

Note 3:   The AD7870 converter only returns 11 bits (0 to 2,047 codes) in single-ended mode.

Accuracy

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 FS (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

Noise performance

Table 6. Noise performance, differential mode

Range	Typical counts	LSB$_{rms}$
±20 V	3	0.45
±10 V	3	0.45
±5 V	3	0.45
±4 V	4	0.61
±2.5 V	5	0.76
±2 V	7	1.06
±1.25 V	10	1.52
±1 V	12	1.82

Table 7. Noise performance, single-ended mode

Range	Typical counts	LSB$_{rms}$
±10 V	6	0.91

Analog output

Table 8. Analog output specifications

Parameter	Condition	Specification
Resolution		12-bits, 1 in 4,096
Output range		*0 V to 2.5 V*
Number of channels		2
Throughput (Note 2)	Software paced	10 S/s single channel typ, PC dependent
Power on and reset voltage	USB operation	Initializes to 000h code
	Bluetooth operation	The outputs can be individually configured to initialize to 000h or to have user configurable values written to the outputs when the Bluetooth host is connected or disconnected.
Output current drive	Each D/A OUT	5 mA source capability
Slew rate		0.75 V/ µs typ

Table 9. Analog output accuracy, all values are (±), accuracy tested at no load

Range	Accuracy (LSB)
0 V to 2.5 V	8.0 typ, 73.0 max

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

Range	% of FSR	Gain Error at FS (mV)	Offset (mV)	Accuracy at FS (mV)
0 V to 2.5 V	0.16 typ,1.44 max	4.0 typ, 36.0 max	1.0 typ, 9.0 max (Note 4)	5.0 typ, 45.0 max

Note 4: 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 offset error is tested and specified at code 0x040.

Digital input/output

Table 11. Digital I/O specifications

Parameter	Specification
Digital type	3.3 V open drain
Output value mapping	0 written: output drives to DGND 1 written: output is pulled up to 3.3 V via internal resistor
Number of I/O (Note 5)	8
Configuration	Individually configurable
Input voltage range (Note 6)	0 V to 5.5 V
Pull up/pull-down configuration	47.5 kΩ pull-up resistors (to 3.3 V), 2.2 kΩ series resistors
Input high voltage threshold	2.0 V min
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	0.8 V max
Input low voltage limit	–0.5 V absolute min 0 V recommended min
Output voltage range	0 V to 3.3 V (no external pull up resistor) 0 V to 5.5 V max (Note 6)
Output off state leakage current (Note 7)	1.0 µA typ
Sink current capability	50 mA max (continuous) per pin
Transistor on resistance	0.7 Ω max
Power on and reset state	USB operation: All input Bluetooth operation: The digital I/O can either be all input at power on/reset or may be configured to have user-configurable patterns written to the DIO when the Bluetooth host is connected or disconnected.

Note 5:   Each transistor source pin is internally connected to DGND.

Note 6:   The external pull-up is connected to the digital output bit through an external pull-up resistor. Adding an external pull-up resistor connects it in parallel with the internal 47.5 kΩ pull-up resistor of that particular digital input/output bit. Careful consideration should be made when considering the external pull-up resistor value and the resultant pull-up voltage produced at the load.

Note 7:   Does not include the additional leakage current contribution through the internal or any external pull-up resistor.

External trigger

Table 12. Digital trigger specifications

Parameter	Specification
Trigger source	External digital; TRIG terminal
Trigger mode	Software configurable for edge or level sensitive, rising or falling edge, high or low level.
Trigger latency	10 µs max
Trigger pulse width	1 µs min
Input type	Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis	0.76 V typ 0.4 V min 1.2 V max
Input high voltage threshold	1.74 V typ 1.3 V min 2.2 V max
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	0.98 V typ 0.6 V min 1.5 V max
Input low voltage limit	–0.5 V absolute min 0 V recommended min

External clock input

Table 13. External clock input specifications

Parameter	Specification
Terminal name	AICKI
Terminal type	Input
Input clock rate	50 kHz, max
Clock pulse width	1 µs min
Input type	Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis	0.76 V typ 0.4 V min 1.2 V max
Input high voltage threshold	1.74 V typ 1.3 V min 2.2 V max
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	0.98 V typ 0.6 V min 1.5 V max
Input low voltage limit	–0.5 V absolute min 0 V recommended min

Counter

Table 14. Counter specifications

Parameter	Specification
Pin name	CTR
Counter type	Event counter
Number of channels	1
Input type	Schmitt trigger, 47 kΩ pull-down to ground, rising edge triggered
Input source	*CTR screw terminal*
Resolution	32 bits
Maximum input frequency	1 MHz
High pulse width	*500 ns min*
Low pulse width	*500 ns min*
Schmitt trigger hysteresis	0.76 V typ 0.4 V min 1.2 V max
Input high voltage threshold	1.74 V typ 1.3 V min 2.2 V max
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	0.98 V typ 0.6 V min 1.5 V max
Input low voltage limit	–0.5 V absolute min 0 V recommended min

Memory

Table 15. Memory specifications

Parameter	Specification
FIFO	12K (12,288) samples
Non-volatile EEPROM	2,048 bytes (768 bytes calibration, 256 bytes user, 1,024 bytes firmware use)

Microcontroller

Table 16. Microcontroller specifications

Parameter	Specification
Type	*High performance 16-bit RISC microcontroller*

Power

Table 17. Power specifications

Parameter	Condition	Specification
Supply current, USB source	During enumeration	< 100 mA
	After USB enumeration or connected to USB charger / supply	< 500 mA
Battery power (Note 8)		Two AA cells Alkaline and NiMH cells supported
Battery charging		NiMH charging supported. Alkaline cells automatically detected and not charged.
Battery replacement		Replace NiMH cells with Panasonic HHR-10AAB only. Replace Alkaline cells with Energizer E91 or equivalent.
+VO power available	After USB enumeration or Bluetooth connection	3.3 V nominal
+VO output current	After USB enumeration or Bluetooth connection	50 mA max

Note 8: When operating from batteries there is a user configurable power-off timer that will turn the device off when there is no host connection for the specified amount of time. The timer can be disabled or set to a value from 1 to 255 minutes.

Bluetooth

Table 18. Bluetooth specifications

Parameter	Specification
Device type (Note 9)	Bluetooth 2.1
Device compatibility	Backwards compatible with Bluetooth 2.0, 1.2, and 1.1
Bluetooth profile	Serial Port Profile (SPP)
Radio range	Class II, 10 m typ

Note 9: The Bluetooth radio is disabled when the device is connected to a USB host.

USB

Table 19. USB specifications

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

Environmental

Table 20. Environmental specifications

Parameter	Specification
Operating temperature range	0 °C to 50 °C
Storage temperature range	–40 °C to 70 °C
Humidity	0% to 90% non-condensing

Mechanical

Table 21. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	99.06 × 68.58 × 14.61 mm (3.90 × 2.70 × 0.58 in.)
USB cable length	3 m (9.84 ft) max
User connection length	3 m (9.84 ft) max

Signal connectors

Table 22. Header specifications

Parameter	Specification
Connector type	Three 2 × 8 pin, 0.1 in. pitch headers

Analog signals (J1)

Table 23. 4-channel differential mode pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH0H	Analog input 0 HI	2	AGND	Analog ground
3	CH0L	Analog input 0 LO	4	AGND	Analog ground
5	CH1H	Analog input 1 HI	6	AGND	Analog ground
7	CH1L	Analog input 1 LO	8	AGND	Analog ground
9	CH2H	Analog input 2 HI	10	AGND	Analog ground
11	CH2L	Analog input 2 LO	12	AGND	Analog ground
13	CH3H	Analog input 3 HI	14	AOUT0	Analog output 0
15	CH3L	Analog input 3 LO	16	AOUT1	Analog output 1

Table 24. 8-channel single-ended mode pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	CH0 IN	Analog input 0	2	AGND	Analog ground
3	CH1 IN	Analog input 1	4	AGND	Analog ground
5	CH2 IN	Analog input 2	6	AGND	Analog ground
7	CH3 IN	Analog input 3	8	AGND	Analog ground
9	CH4 IN	Analog input 4	10	AGND	Analog ground
11	CH5 IN	Analog input 5	12	AGND	Analog ground
13	CH6 IN	Analog input 6	14	AOUT0	Analog output 0
15	CH7 IN	Analog input 7	16	AOUT1	Analog output 1

Digital signals (J2)

Table 25. Digital I/O signal pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	DIO0	Digital input/output 0	2	GND	Digital ground
3	DIO1	Digital input/output 1	4	CTR	Counter input
5	DIO2	Digital input/output 2	6	TRIG_IN	Digital trigger input
7	DIO3	Digital input/output 3	8	AICKI	Pacer input
9	DIO4	Digital input/output 4	10	GND	Digital ground
11	DIO5	Digital input/output 5	12	+VO	3.3 V output
13	DIO6	Digital input/output 6	14	GND	Digital ground
15	DIO7	Digital input/output 7	16	GND	Digital ground

Bulkhead signals (J3)

Table 26. Bulkhead signal pinout

Pin	Signal name	Pin description	Pin	Signal name	Pin description
1	BATT+	Battery input positive (2 AA/AAA cells)	2	BATT-	Battery input negative
3	BATT_MID	Battery center tap	4	GND	Ground
5	THERMISTOR+	10 kΩ thermistor positive (battery temperature sensing)	6	THERMISTOR-	10 kΩ thermistor negative
7	PWR SW+	SPST contact 1 (power switch)	8	PWR SW-	SPST contact 2
9	PAIRING SW+	Momentary contact 1 (pairing / soft power switch)	10	PAIRING SW-	Momentary contact 2
11	LED1+	LED1 anode	12	LED1-	LED1 cathode
13	LED2+	LED2 anode	14	LED2-	LED2 cathode
15	Vbus	USB 5 V supply (charging LED anode)	16	CHARGE LED-	Charging LED cathode