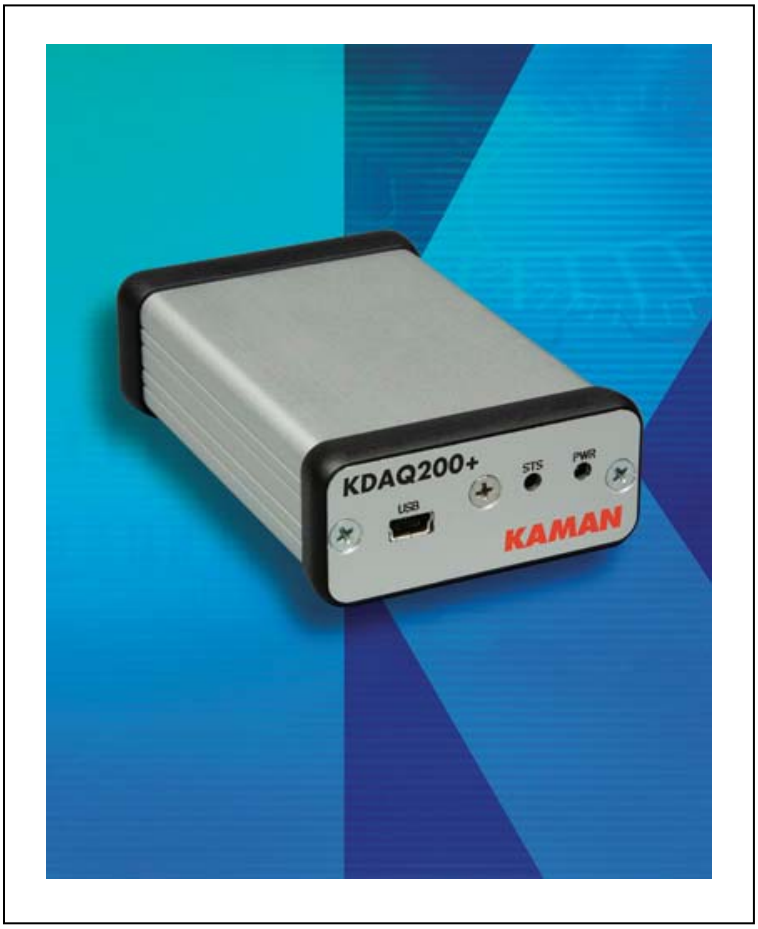
DAQ-JACK™
KDAQ200+

USB Enabled Data Acquisition With Built-In Programmable Power Supply



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Installation

Before attaching the KDAQ200+ to your computer or USB port you must install the software and drivers. Run the program 'Setup.exe' found in the install directory on the DAQ-JACK USB stick provided for you. This installs the data logging and setup software for the KDAQ200+ as well as the generic device drivers required.

Connections and Hardware

USB Connection Side

USB Connection

The USB connection is a standard host connection to USB-mini connector on the KDAQ200+. The KDAQ200+ is completely powered over the USB connection and the power supply output from the KDAQ200+ gets its power from the USB connection as well. Once you have the software installed you can plug into the USB port and run the software. Note when you connect a USB port it may take up to 10 seconds for the PC to recognize the port depending on how long it was disconnected. If you start the software before the PC has recognized the port the software will not recognize the device and exit the program.

LED's

There are two LED's on the USB connector side of the enclosure. The blue 'STS' or status LED flashes to indicate a USB connection and that the unit is functioning. The green 'PWR' LED indicates whether or not the power supply output is active or not.

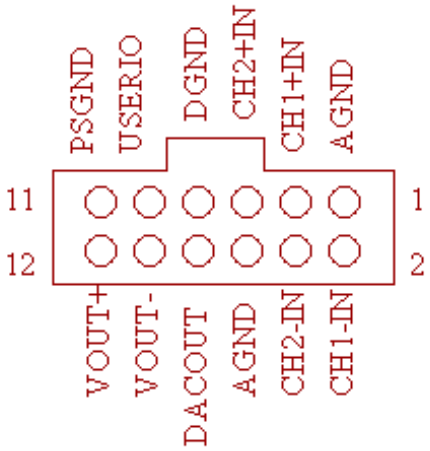
I/O Connections Side

Thermocouple Connection

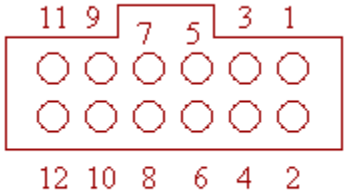
There is a standard 'K' type thermocouple connector on the KDAQ200+. You can plug other thermocouples into the same connector such as a 'J' or 'T' type and select the polynomial to use from the thermocouple setup menu.

I/O Connection

The I/O connector is meant to mate to a 12 pin ribbon cable connector. You can use the 12 pin female connector provided along with the crimp pins for custom setups. Be sure to observe the proper orientation for pin 1 when installing the pins – it is quite easy to mirror image when installing the pins into the connector.



KDAQ200+ Pinout
(Viewed from Back of Connector)



KDAQ200+ Pinout
(Viewed from Back of Connector

Pin	Name	Function
1	AGND	Analog Ground for the Inputs
2	CH1-IN	Channel 1 Negative Input to ADC
3	CH1+IN	Channel 1 Positive Input to ADC
4	CH2-IN	Channel 2 Negative Input to ADC
5	CH2+IN	Channel 2 Positive Input to ADC
6	AGND	Analog Ground for the Inputs
7	DGND	Digital Ground (for I/O)
8	DACOUT	Digital to Analog Converter Output 12 bits @ 0-3.3V
9	USERIO	Configuration User I/O bit (0-3.3V)
10	Vout-	Negative Power Supply Output (-5V to -24V)
11	PSGND	Power Supply Ground
12	Vout+	Positive Power Supply Output (+5 to +24V)

NOTE: All grounds are connected together at the USB Ground

Connector Housing:

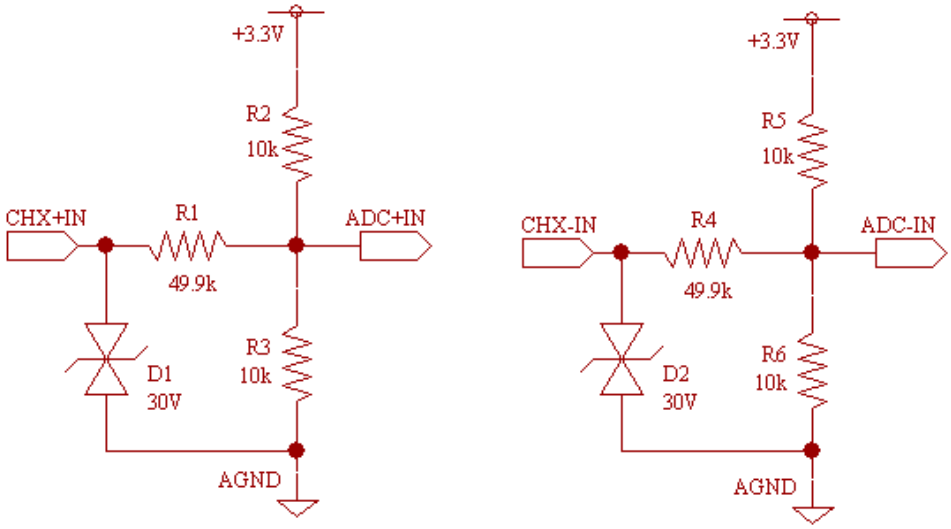
Digikey PN: WM8038-ND
Molex PN: 90142-0012

Connector Pins:

Digikey PN: WM2560-ND
Molex PN: 90119-2120

ADC Inputs

The ADC inputs are fully differential bipolar inputs. The ADC input can take up to ±18V before it starts to saturate the converter at which point the other channels may be affected. It can take ±30V without damage. Whatever drives the input to the ADC must be low impedance able to sink a small amount of current for the inputs to work properly. This is because of the way the input circuit is structured to allow for the negative inputs. Note that the negative and positive inputs to the ADC are configured identically. The input impedance is approximately 50k and the input is divided down and offset by the 3.3V reference to fall within the input range of the AD converter.



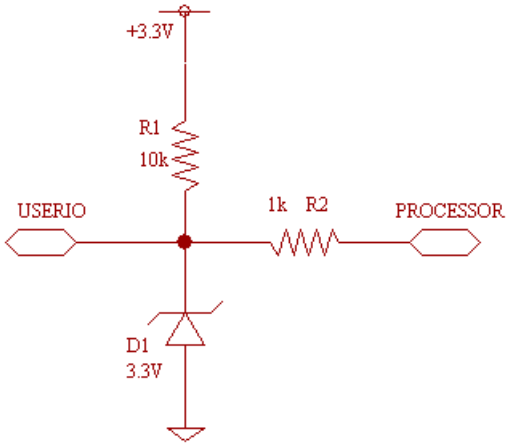
ADC Input Configuration

DAC output

The DAC output is a 3.3V output. The actual range will vary from about 3.2 to 3.4V from unit to unit. The DAC output is 12 bits and is configurable via software. The DAC setting is not retained if the unit loses power.

User I/O

There is one digital bit output that is configurable as either an input or output. Notice that there is a 10k pullup resistor and a 1k input resistor to protect the processor. There is also a 3.3V TVS so if the input is much above 3.3V the TVS will start to conduct and will fail as a short if the system is overvoltaged for too long.



USER INPUT/OUTPUT BIT CONFIGURATION

Power Supply Output

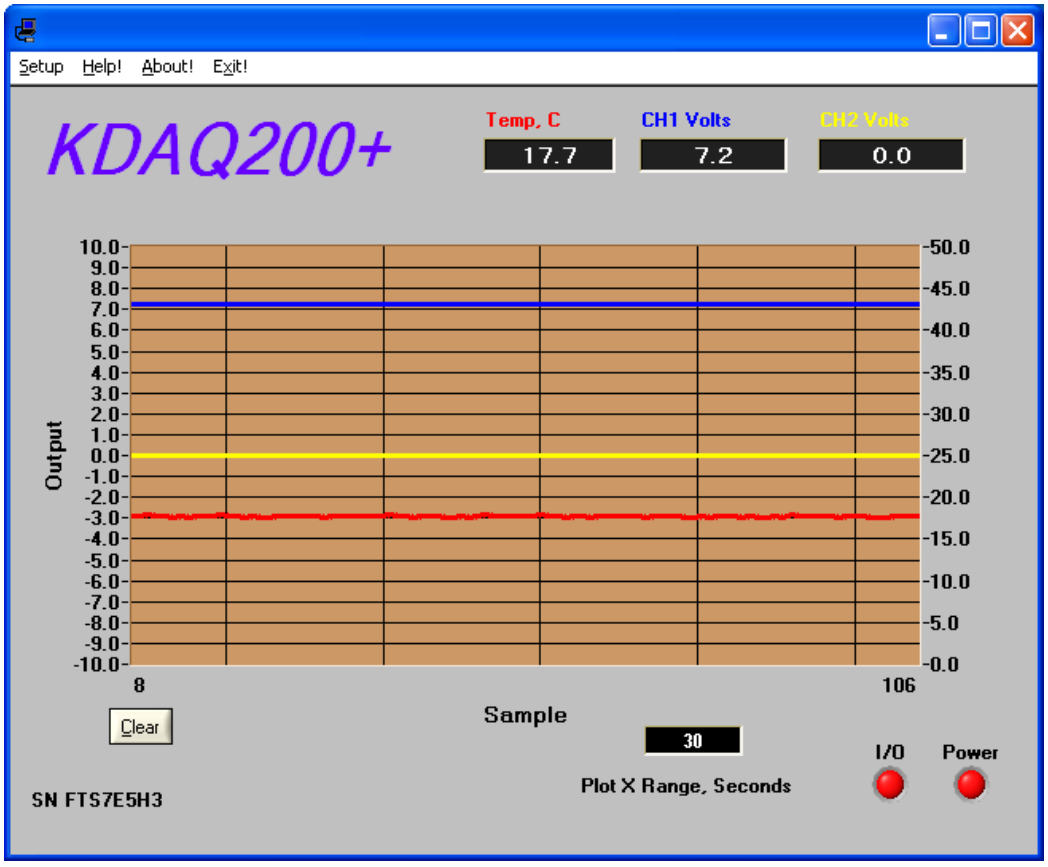
The bipolar power supply output is what makes the KDAQ200+ unique. It is designed to supply power to sensors and other instrumentation. The unit can supply up to 1.5W of *total* power. This means that it can supply 15V@100mA or ±15V@50mA. The supply output is programmable from ±5V to ±24V. The negative supply is always present but does not have to be used. The negative supply is unregulated and depends on the current draw from the positive supply so if it is used you must be drawing current on the positive supply.

Data Logging and Setup Software

The KDAQ200+ comes with easy to use software for configuring and monitoring / data logging.

NOTE: *When you connect a USB port it may take up to 10 seconds for the PC to recognize the port depending on how long it was disconnected. If you start the software before the PC has recognized the port the software will run in demo mode. If it does this inadvertently simply exit the program and restart it.*

Main Screen



Strip Chart

The main feature is the strip chart function. You can change the settings by accessing Setup via the pull down menu. The Y axis for the temperature is on the right if another channel is enabled. Only enabled channels are displayed. You can clear the strip chart by pressing the 'Clear' button near the lower left section of the chart. The number of seconds for the horizontal axis is also shown.

Pull Down Menu

Access the pull down menus for setup Parameters.

Serial Number

In the bottom left corner of the screen the serial number of the unit that the software is connected to shows up. You can connect multiple systems to the USB port but each must run its own instance of the software. You can tell which one is connected to which instance by the serial number.

I/O LED

The I/O LED indicates the state of the User IO bit.

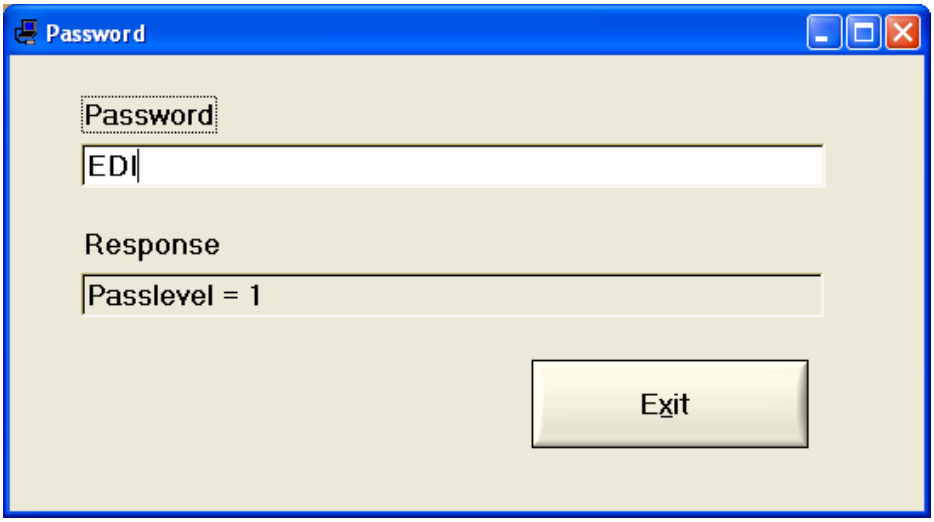
Power LED

The power LED indicates whether or not the power supply output is on.

Main Screen Pull Down Menus

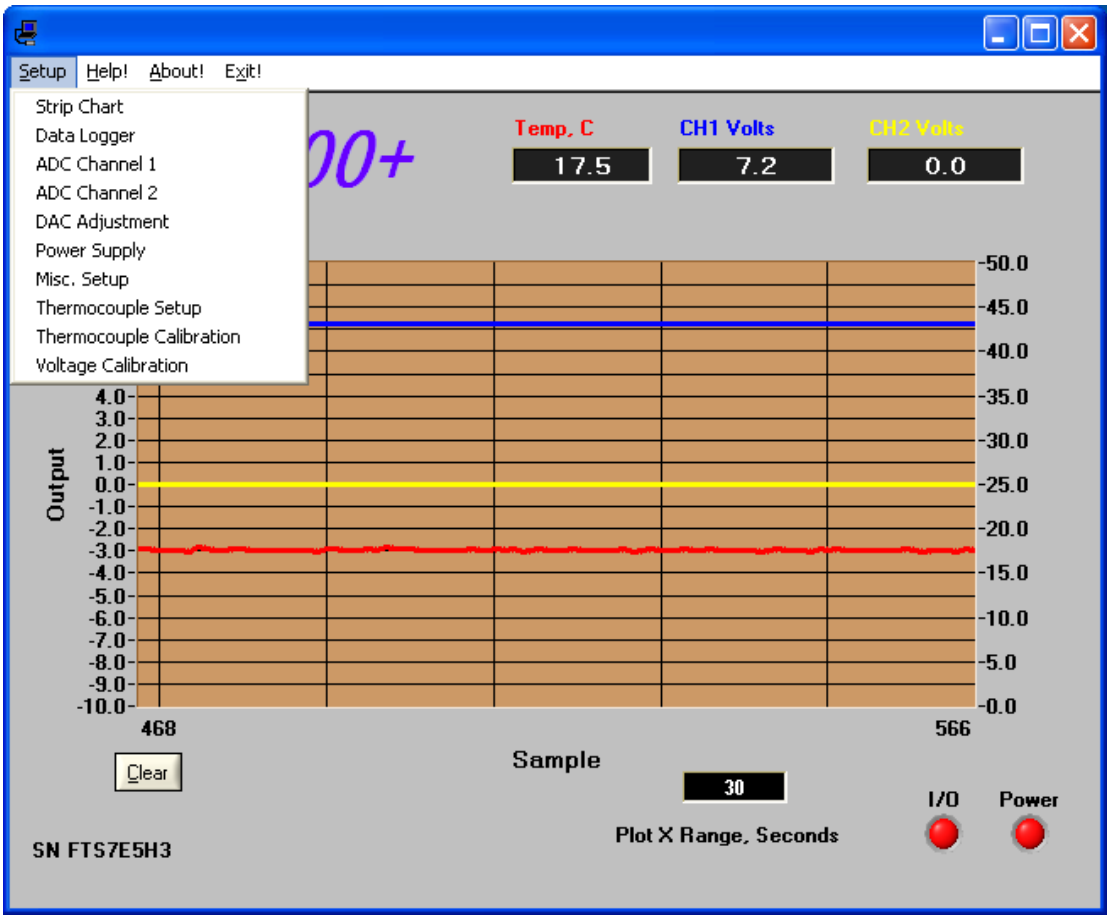
Enter Password

If it is enabled to require a password then the password must be entered before the Setup menu appears. This is enabled via the 'Setup/Misc.' screen. The password to access the 'Setup' menu is 'EDI' – all capitals. It is not a strong password protection but only available so that the user can prevent inadvertent changes. Be sure to press the <enter> key and that you see in the response the Passlevel of 1. If you press the <enter> key with nothing in the Password box or something incorrect you will see a Passlevel of 0.



Setup

The setup menu allows the user to change the configuration of the system, change the parameters on the strip chart, log data, or calibrate the outputs. See the section on the 'Setup Menu' for more information.



Help

Loads this file.

About

Displays the manufacturer information.

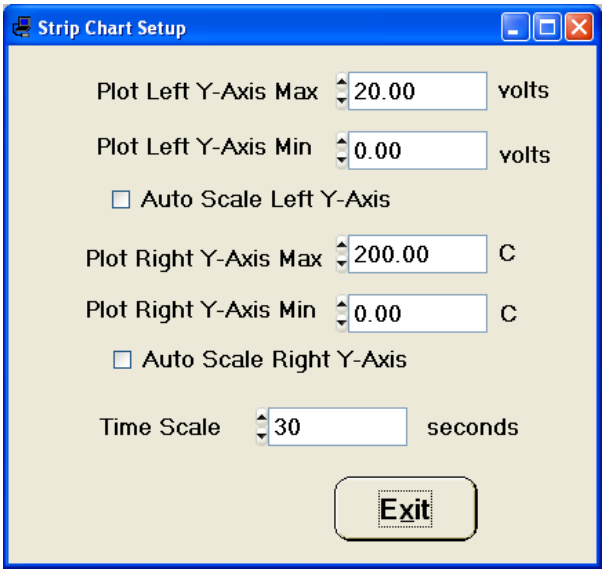
Exit

Exits the application.

Setup Menu

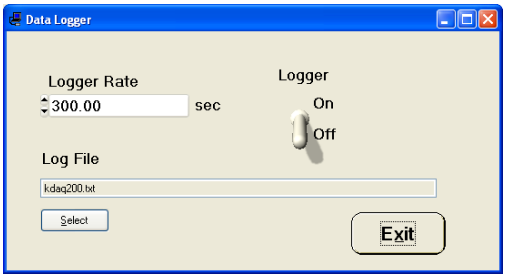
Strip Chart

The strip chart setup allows you to change the plot settings. You can AutoScale the plot axes or you can fix the scaling. You can also change the horizontal time scale.

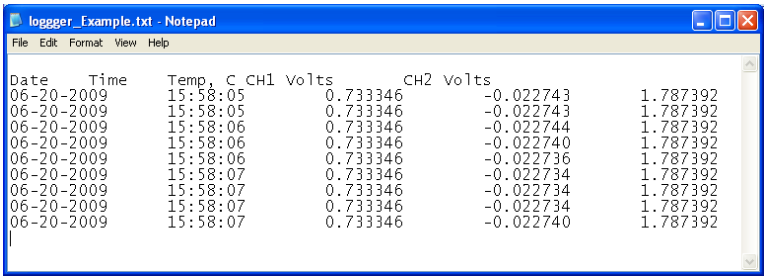


Data Logger

The data logger setup lets you change the logger rate (0.1 seconds minimum increment), enable or disable the logger and select the file to log to. The data is stored in a tab delimited format suitable for direct import into a spreadsheet. Note if there is a file error the logger will be turned off.



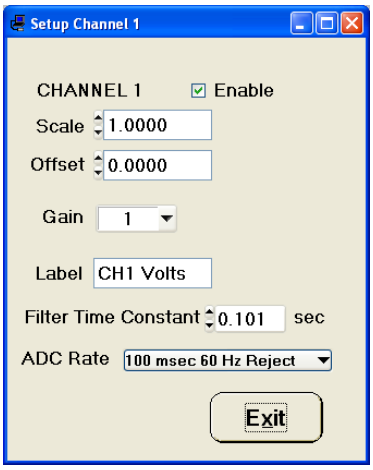
Data Logger Setup



Text File Example of Logger Output

ADC Channel 1 / ADC Channel 2

ADC Channel 1 and Channel 2 setup screens are identical.



Enable

The effective sample rate of the system is decreased by the number of enabled channels and the ADC rate. Also channels that are not enabled won't be displayed on the strip chart.

Scale

This allows the user to change the scale without directly changing the voltage calibration. This way if the user wants to convert units of volts to displacement units he can put in the scale factor as a conversion.

Offset

This allows the user to change the offset without directly changing the voltage calibration. Can be used as a 'Zero' or reference to another value.

Gain

The unit has programmable input gain from 1 to 128. When you change the gain it adjusts the voltage scaling to compensate. The input range will be reduced proportionately when you change the gain. Typically it is best to leave this setting at a gain of 1 as the input noise increases as the gain is changed.

Label

User defined label for the channel that shows up on the main screen and in the log files.

Filter

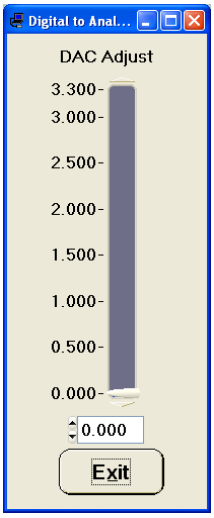
This is for programming the single pole digital IIR filter for the channel. This will change if the ADC rate is changed. The time constant calculation is approximate and only takes into account the channels ADC rate and the time constant setting. If more channels are enabled the time constant will be effectively increased based upon the number of enabled channels (Channel 2 as well as if the Temperature input is enabled) and the ADC rates of those channels, however, this is not reflected in the setting of this value.

ADC Rate

The ADC conversion time is set from 0.004 to 0.48 seconds. The actual sample rate depends on the number of enabled channels and the sample rate of each. The PC can only read back data as fast as 0.1 second for this system but the embedded system would sample in 4 milliseconds if only one channel is enabled at the highest sample rate. Typically a setting of 100 milliseconds is good although sometimes it is advantageous to set the sample rate for a faster setting and digitally filter the result.

DAC Adjustment

The DAC adjustment is a simple slider. The DAC setting is not retained if the USB input loses power.

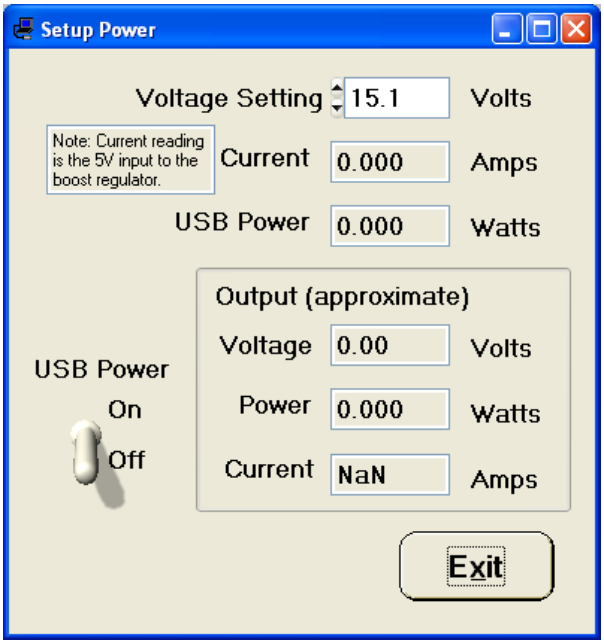


Power Supply

The power supply is a bipolar supply but only the positive side is adjusted. The current measured and approximated on the output is the total current from both supplies. The power supply current is measured on the 5V input from the USB to the boost regulator and the output power is approximated by multiplying the average efficiency of the regulator by the input power. The voltage of the output is measured using a low resolution AD and is displayed on the output. It is useful for detecting whether or not the output is loaded down. The voltage can be set from under 5V to just over 24 volts.

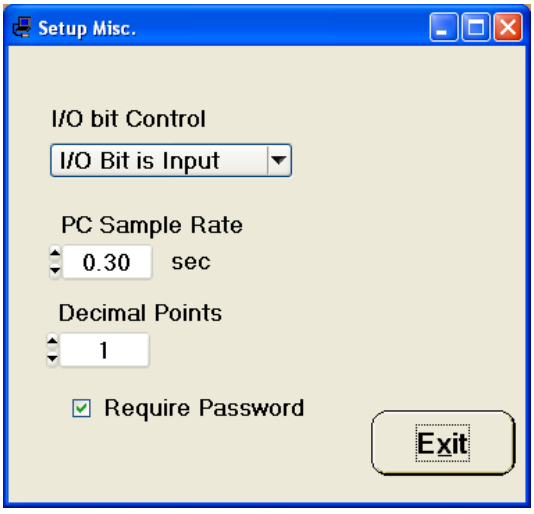
The voltage setting and state of the switch are stored in EEPROM so if the unit is disconnected from the USB and the power is on it will be on the next time the unit is connected to a USB at the same voltage. You want to be careful if you are powering different devices from the same KDAQ to set the voltage before you power it on.

If the power supply is shorted or draws too much current it will shut off and the green LED will go out on the panel (and at the lower right on the screen). Once the condition that caused the overcurrent is corrected simply toggle the power switch to turn it back on.

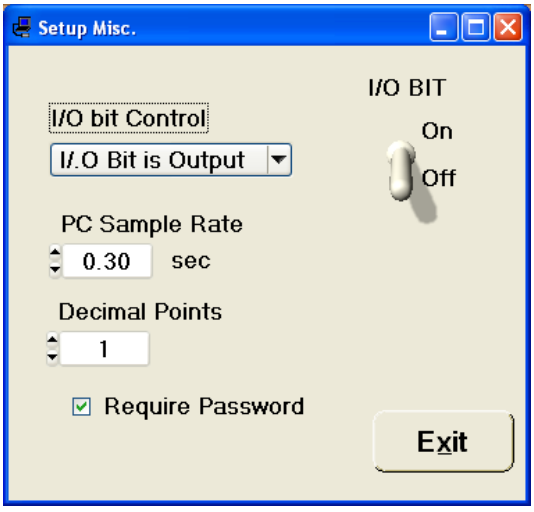


Misc. Setup

This is the catch-all screen where miscellaneous items are setup.



Screen with I/O set as Input



Screen with I/O set as Output

I/O Bit Control

The I/O bit can be configured as an output or an input. If the I/O bit is configured as an output you can toggle the state of the bit with a switch. The state of the bit shows up on the main screen I/O LED. The state of the control mode and the state of the bit (if an output) is stored in EEPROM and so is retained if the power is cycled.

PC Sample Rate

This is the rate at which the PC collects data from the system and displays it. The maximum rate is 0.1 samples per second. At the faster rates it may slow the PC down depending on the grade of the PC. Typically a value of 0.3 seconds is a good compromise.

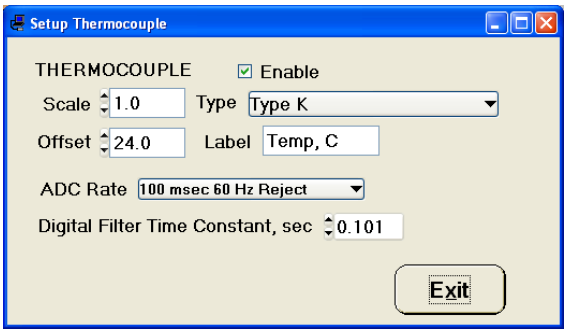
Decimal Points

This is the number of decimal points displayed on the main screen for Channel 1 and Channel 2.

Require Password

If this box is checked the user must enter a password before the Setup menu is displayed. This is only to protect against inadvertent changes.

Thermocouple Setup



Enable
The effective sample rate of the system is decreased by the number of enabled channels and the ADC rate. Also channels that are not enabled won't be displayed on the strip chart.

Scale
This allows the user to change the scale without directly changing the calibration. This way if the user wants to convert to Fahrenheit it can be done by changing the scale (to 1.8) and offset.

Offset
This allows the user to change the offset. This is the value changed when the thermocouple is calibrated to a reference temperature.

Type
Allows the user to change the standard polynomial used to compute the temperature. 'J','K', and 'T' types are standard but other types are available. There is also a user defined option but the polynomial coefficients must be changed via a terminal program.

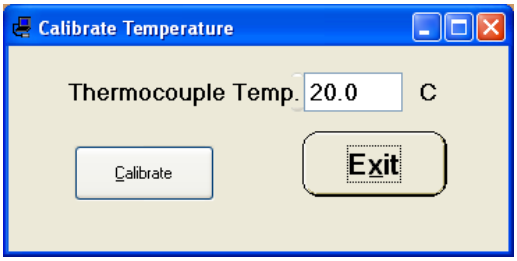
Label
User defined label that shows up on the main screen and in the log files.

Filter
This is for programming the single pole digital IIR filter for the channel. This will change if the ADC rate is changed. The time constant calculation is approximate and only takes into account the channels ADC rate and the time constant setting. If more channels are enabled the time constant will be effectively increased based upon the number of enabled channels (Channel 2 as well as if the Temperature input is enabled) and the ADC rates of those channels, however, this is not reflected in the setting of this value.

ADC Rate
The ADC conversion time is set from 0.004 to 0.48 seconds. The actual sample rate depends on the number of enabled channels and the sample rate of each. The PC can only read back data as fast as 0.1 second for this system but the embedded system would sample in 4 milliseconds if only one channel is enabled at the highest sample rate. Typically a setting of 100 milliseconds is good although sometimes it is advantageous to set the sample rate for a faster setting and digitally filter the result.

Thermocouple Calibration

This allows the user to set the thermocouple reference. Simply type in the current temperature of the thermocouple and push the 'Calibrate' button. This will change the user offset (see the section on Thermocouple Setup) such that the output of the thermocouple matches the temperature. Note that if you scaled up for Fahrenheit you would enter the temperature in Fahrenheit.



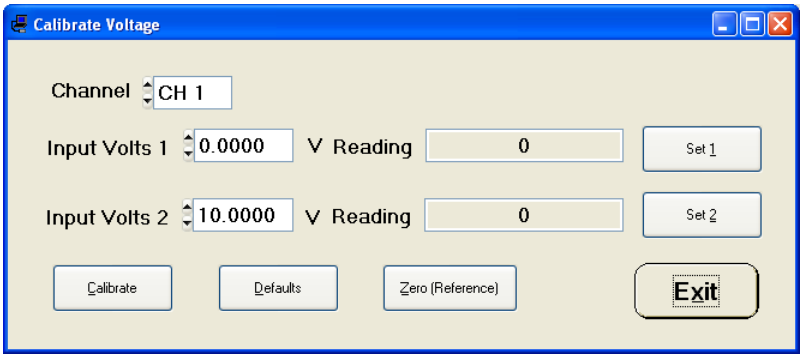
Voltage Calibration

The default calibration is only approximate and is based on the calculated input to the AD based on the nominal resistance and voltage values of the reference. The calibration can be more accurate if desired as long as the user has something to measure the input voltage with that is a calibration reference.

1) Set the channel number you want to calibrate.
2) Connect up a voltage source to the channel you want to calibrate and something to accurately read the input voltage.
3) Simply set the input voltage to a particular value press the 'Set 1' button and the raw ADC reading will show up.
4) Go to a second voltage and press the 'Set 2' button.
5) Press the 'Calibrate' button and the offset and scale of the voltage measurement (not the user offset and scale – these occur after the voltage scaling) will be adjusted.

You can also restore the default values for a channel by pressing the 'Defaults' button.

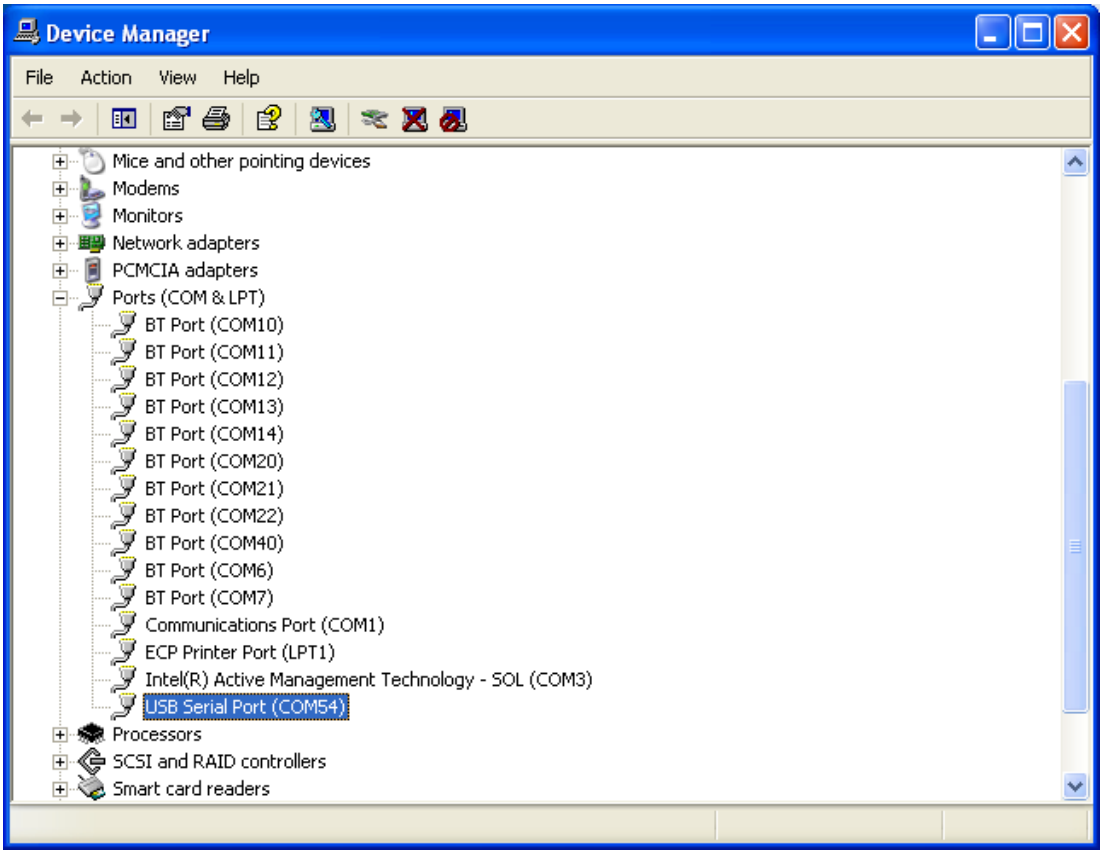
If you simply want to 'Zero' the channels output press the 'Zero' button. This does not change the channels voltage calibration but only adjusts the user offset (see section on ADC Channel 1 / ADC Channel 2 setup) such that the output of the channel is zero. This is useful when you want to see relative changes.



Terminal or User Program Interface

Serial Interface

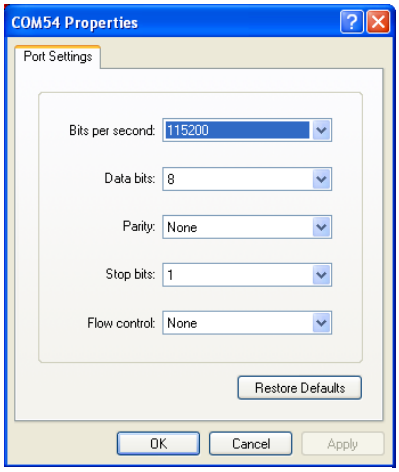
You can communicate with the KDAQ200+ just as you would any other RS232 serial device through a terminal program or through a programming language. The first step is to find out which port has been selected on your computer. In Windows XP go to 'My Computer', right click and select 'Properties'. Select the 'Hardware' tab and then select 'Device Manager'. Click the [+] button by the Ports in Device Manager. Note that in the case below the port is setup as 'COM54'.



In the program you are using to communicate setup 'COM54' to a 115200 Baud Rate, 8 data bits, no parity, 1 stop bit, and no flow control.

The communications interfaces cannot be configured to communicate at a different rate. This is due to the maximum speed at which the system can maintain real time tasks and continue to communicate without interruption.

In the Terminal if you hit <CR> (carriage return) you should see the ready character – '>' repeated every time you hit return.



Comport Settings

Command Protocol

Basic Protocol

Communication with the KDAQ200+ is conducted through the Serial Interface using ASCII command strings. Command strings contain several optional characters in addition to the Command itself. Optional characters are indicated in italics. Required characters are not italicized.

Other considerations when communicating include:

- All responses are terminated with a <CR> carriage return.
- Lower case letters are ignored.
- All numbers entered in command strings may be in floating point format. For example, a number can be entered as 52, 52.1, 52.1E1. The "E" must be upper case.
- Multiple commands may be entered on the same line as long as the maximum number of characters in the string is less than 39 characters. For example, the string "MTT MA0<CR>" will return the thermocouple output followed by the channel 1 output. (See command list).
- Command strings that end with the ")" character will cause the command line to repeat until another command string is entered. For example, entering "MA1)<CR>" will cause the channel 2 output to be repeatedly output from the KDAQ200+ until a new command string is input.

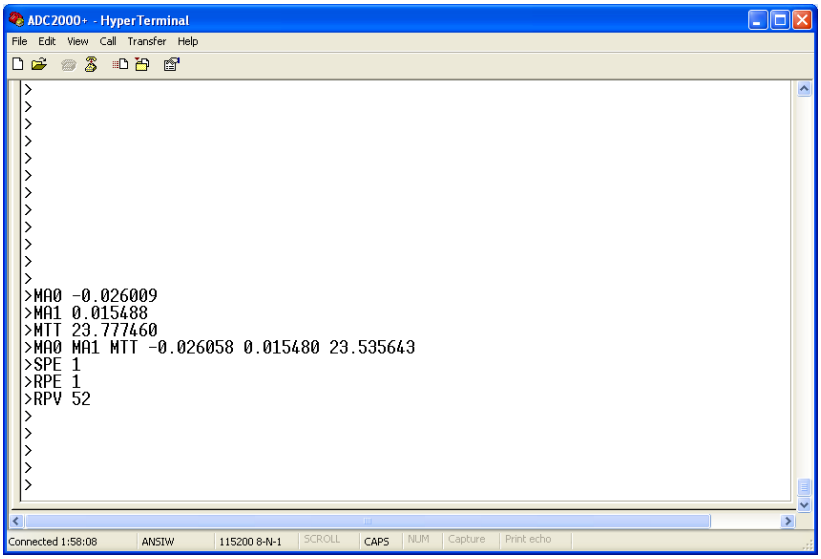
There are several different versions of Command strings that can be used. The protocol of the ASCII command strings are as follows:

$ccc<CR> no verbose
ccc<CR> verbose mode

where:

- **$** is an optional character used to indicate verbose or non-verbose response mode. The **$** character is used to indicate do not return a verbose response. Eliminating the **$** causes all responses to be verbose.

- **ccc** is the actual command itself as listed in the Command Listings later in this chapter. Commands vary in length and consist of the command characters and any associated parameter information that may be included. Parameter information must be separated from the command by a delimiter. Valid delimiters are “space, comma or equal” (“ “ or ”,” or “=”).



Sample Terminal Session

Error Messages

In some cases, when issuing commands, the system will have no way to responds other than with an error message. These error messages are in response to a communications error rather that with an error given by the command itself.

When there is this type of error the system will respond with:

?xx ERRORMESSAGE<CR>

where **xx** is the number of the error message and ERRORMESSAGE is the description of the error. The ERRORMESSAGE will not print when the “**$**” character was used in the original issuing command.

The following table lists the possible error messages:

System Error Messages:

Error Number (xx)	ErrorMessage	Probable Cause
01	Password Protected Command	A command was issued that is password protected and is not directly available to the user.
03	Communication Time out	There is a communication failure of some kind. This is typically a cable or configuration problem.
05	Serial Buffer Overflow	Too many characters in serial buffer before carriage return

Command List

These are the low level commands used if the user wants to program an interface. They can also be used with a dumb terminal such as HyperTerminal. If programming, it is recommended to preface the commands with '$' to get a less verbose response.

Monitor Commands

Command	Passlevel Required	Parameters	Returns	Comments
D xx	any	xx is the delay in tenths of second	none	This is just a software delay useful when monitoring in terminal mode and using the repeat ')' command. Example **MA0 D10)**<ret> repeats reading the ch1 ADC output when using a dumb terminal
MA0	any	none	ADC output from CH1	This is the output after all scaling
MA1	any	none	ADC output from CH2	This is the output after all scaling
MTV	any	none	Thermocouple Voltage output	This is the thermocouple output only after voltage scaling
MTT	any	none	Thermocouple output	This is the thermocouple output after polynomial and user scaling applied
MEA0	any	none	ADC output from channel 1	ADC counts when $ prefaced, ADC counts and voltage based on default scale when no $ used
MEA1	any	none	ADC output from channel 2	ADC counts when $ prefaced, ADC counts and voltage based on default scale when no $ used
MEA2	any	none	ADC output from channel 3	ADC counts when $ prefaced, ADC counts and voltage based on default scale when no $ used – this is the thermocouple ADC
MEA3	any	none	output of the power supply output voltage	This is from a relatively low resolution ADC so it looks noisier
MEA4	any	none	voltage of board temperature IC	Board temperature measurement is from and LM60
MEA5	any	none	voltage of the current measurement	The current into the power supply boost regulator
MI	any	none	status of the I/O bit	1 is high (or 3.3V), 0 is low
MET	any	none	Electronics Temperature	The is the PCB temperature measured from an LM60 on the board
MEP	any	none	power supply output voltage	Positive supply reading from the output supply boost regulator
MEC	any	none	power supply input current	This is the current measured to the input to the boost regulator. The total power into the boost regulator is approximately 5.0V x current reading.

ADC Setup Commands

Command	Passlevel Required	Parameters	Returns	Comments
SAxE y	user	x – 0,1,2 y – 0,1	none	Sets the ADC to be enabled or disable. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y is enable (1) or disable (0)
RAxE	any	x – 0,1,2	status of the enable bit	X is the ADC (0=CH1,1=CH2,2=Thermocouple)
SAxRy	user	x – 0,1,2 y – 1-15	none	Sets the ADC rate. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y values: 1 – 4 msec 2 – 8 msec 3 – 16 msec 4 – 32 msec 5 – 40 msec 6 – 48 msec 7 – 60 msec 8 – 100 msec 60 Hz reject 9 – 120 msec 50 Hz reject 10 – 120 msec 50/60 Hz reject 11 – 160 msec 12 – 200 msec 13 – 240 msec 14 – 320 msec 15 – 480 msec
RAxR	any	x – 0,1,2	rate setting	Returns the rate setting (see SAxR) X is the ADC (0=CH1,1=CH2,2=Thermocouple)
SAxGy	user	x – 0,1,2 y – 0-7	none	Sets the ADC gain. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y : the input gain is 2^y – so 2^0 is a gain of 1, 2^4 is a gain of 16
RAxR	any	x – 0,1,2	gain setting	Returns the gain setting (see SAxG) X is the ADC (0=CH1,1=CH2,2=Thermocouple)
SAxF y	user	x – 0,1,2 y – 0.004 to 10.0	none	Sets the digital filter value. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y : the time constant is approximately the rate in seconds over the filter value
RAxF	any	x – 0,1,2	filter value	Returns the digital filter setting (see SAxG) X is the ADC (0=CH1,1=CH2,2=Thermocouple)

ADC Setup Commands (cont.)

Command	Passlevel Required	Parameters	Returns	Comments
SAxSy	superuser	x – 0,1,2 y – scale	none	Sets the voltage scaling for the ADC. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y : scale
RAxS	any	x – 0,1,2	scale	Returns voltage scaling for the ADC X is the ADC (0=CH1,1=CH2,2=Thermocouple)
SaxO y	superuser	x – 0,1,2 y – scale	none	Sets the voltage offset for the ADC. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y : offset
RAxO	any	x – 0,1,2	offset	Returns voltage offset for the ADC X is the ADC (0=CH1,1=CH2,2=Thermocouple)
SAxMy	user	x – 0,1,2 y – scale	none	Sets the user scaling for the ADC. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y : scale
RAxM	any	x – 0,1,2	scale	Returns user scaling for the ADC X is the ADC (0=CH1,1=CH2,2=Thermocouple)
SaxB y	user	x – 0,1,2 y – scale	none	Sets the user offset for the ADC. X is the ADC (0=CH1,1=CH2,2=Thermocouple) y : offset
RAxB	any	x – 0,1,2	offset	Returns user offset for the ADC X is the ADC (0=CH1,1=CH2,2=Thermocouple)

DAC, I/O bit, and Power Supply Commands

Command	Passlevel Required	Parameters	Returns	Comments
SDV x	any	x – DAC voltage	none	Sets the DAC voltage
RDV	any	none	DAC voltage	Returns the DAC voltage setting
SIT x	any	x – 0,1	none	Sets the I/O bit type – 0 is output, 1 is input
RIT x	any	none	0 or 1	reads the I/O bit type – 0 is output, 1 is input
SIV x	any	x – 0 or 1	none	Sets the I/O bit type if it is an output – 0 is off, 1 is 3.3V
RIV	any	none	0 or 1	Reads the I/O bit value
SPE x	any	x – 0 or 1		x = 1 enables the power supply output x = 0 disables thepower supply
RPE	any	none	0 or 1	Reads the status of the power supply output enable
SPV x	user	x - 27-255		Sets the digital pot controlling the power supply voltage output. The setting (x) is calculated by: x = ((255.0/50000.0)*(1.0/(((voltage/1.255)-1.0)/113000.0))));
RPV	any	none	27-255	Reads the digital pot setting controlling the power supply output voltage. The voltage is approximately: voltage= 1.255*(1+ 113000/(setting*(50000/255)));
SPC x	superuser	x – current limit	none	Sets the current limit setting on the current to the boost supply in amps
RPC	any	none	current limit	Reads the current limit setting on the boost supply in amps

Thermocouple Setup Commands

Command	Passlevel Required	Parameters	Returns	Comments
SLT x	any	x – current temperature	none	Thermocouple calibration. Reads the thermocouple and sets the value of the user offset for the thermocouple such that the thermocouple output matches the temperature input
STT x	user	x – thermocouple type – 0-7	none	Sets the thermocouple type which defines the polynomial used: 0 – User Defined (uses STC x to set coefficients) 1 - TYPE_T 2 - TYPE_J 3 - TYPE_K (default) 4 - TYPE_R 5 - TYPE_E 6 - TYPE_S 7 - TYPE_T2
RTT	any	none	thermocouple type	Reads back the thermocouple type (see STT x command)
STC x y	user	x – 0-9 coefficient y – coefficient value	none	Sets the value of the user coefficient for the thermocouple polynomial. X is the coefficient number in the polynomial and y is the value
RTC x	any	x – 0-9	coefficient value	Reads back the user coefficient for the thermocouple polynomial

Misc. Commands

Command	Passlevel Required	Parameters	Returns	Comments
U	any	none	0	Sets the passlevel to normal (no special privileges)
U EDI	any	none	1	Sets the passlevel to user (some special privileges)
U COLORADO	any	none	2	Sets the passlevel to super user (all privileges)
PK	any	none	passkey	special key used with a factory equation to enter the superuser passlevel
SZI	superuser	none	none	Completely reinitializes the EEPROM in the microcontroller to the default values
SYR	any	none	none	Does a software reboot
WC	any	none	clock output	returns the seconds since turn on (i.e power)
WT	any	none	clock ticks	processor clock ticks

Miscellaneous Topics

Scaling

For the 2 ADC outputs the system output is basically scaled up to a voltage and then a second set of coefficients are allowed for the user to scale it to whatever units are desired. The gain of the ADC is taken into account when it is changed. The output is scaled as follows:

Output = (advalue*voltage_scale + voltage_offset)/gain)*user_scale + user_offset)

For the thermocouple it is a bit different. First the thermocouple voltage is computed then the polynomial is applied. Finally the user scaling and offset are applied.

Voltage = = (advalue*voltage_scale + voltage_offset)/gain;
temperature = thermocouple_polynomial_calculation(voltage);
output = temperature * user_scale+ user_offset;

The user offset is used to offset the temperature reading to calibrate to a known temperature.

Filtering

Actual Filter Values depend on how many channels are enabled and the sample rate setup for each. The filter time constants are based on the channel being the only enabled channel and the embedded system sampling at the ADC rate defined. The digital filter is a simple single pole IIR implementation.

Embedded System Sample Rate

The actual sample rate is based on the conversion time and the number of enabled channels. The thermocouple counts as a channel if it is enabled. If the two AD inputs are both enabled and have a 4 msec ADC rate and the thermocouple is enabled with a 100 msec ADC rate the sample time would be 2 * 4 msec + 100 msec = 108 msec. So if the digital filter time constant setting was 1 second in the ADC channel 1 the real time constant would be 0.108 sec/ (0.004 sec/1 sec) = 27 seconds! So it is best to set all of the channels at a lower, generally equal rate, and filter to get better resolution. If all the channels are set to an equal rate the time constant is just increased by a factor of 3. For example if all the channels are set to a 100 msec ADC rate and the filter is set to 1 second then the real update rate is 0.3 seconds and the time constant would be 0.3 secs / (0.1sec/1sec) = 3 seconds.

PC Sample Rate

The PC sample rate set in the Misc. Setup screen is slower than the embedded sample rate can be. The fastest PC sample rate allowed is 100 milliseconds while a single enabled channel can sample as fast as 4 milliseconds. This is still useful as the digital filtering would be applied to the 4 milliseconds sample rate that the embedded system is running at and the resulting output may be smoother in some cases.

The .ini File parameters

When your run the program the first time a .ini file is created in the directory the program is executed from. The name of the .ini file is based on the serial number. For example if the serial number of the system is 'FTSCGTRP' - the name of the .ini file will be 'KDAQ200_FTSCGTRP.ini'. The KDAQ200_*SN*.ini file is a simple text file and can be edited but the parameters are generally changed via the GUI. This allows multiple instances to have their own displays setup differently.

Running Multiple Instances with Multiple KDAQ200+

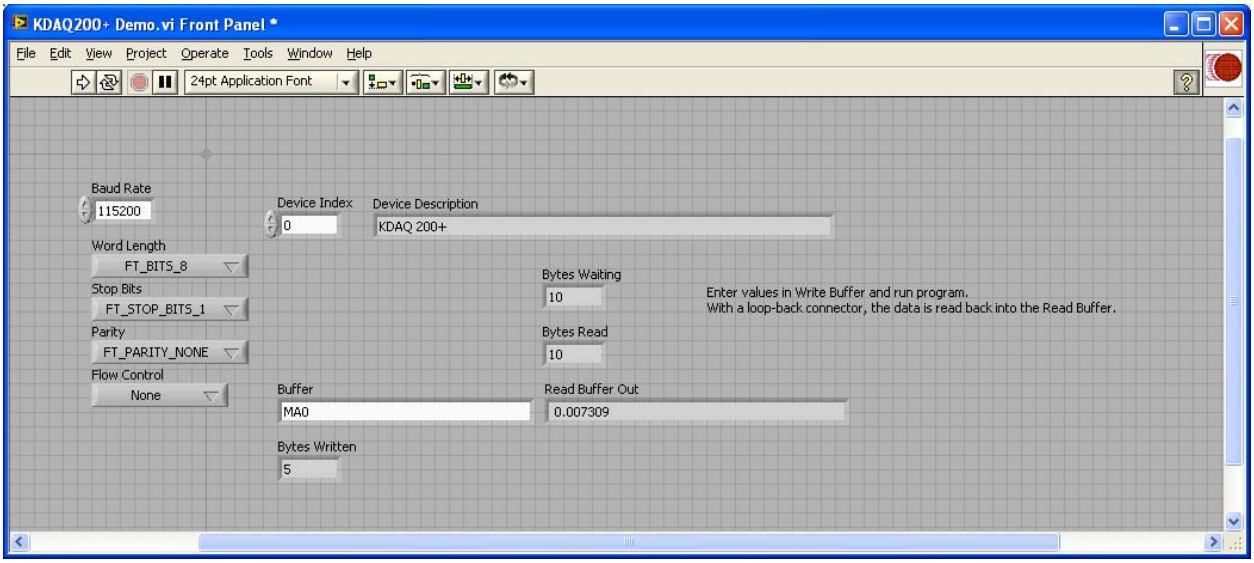
You can run multiple instances of the program. Each instance will try and find a different KDAQ200+ unit. If it does not find one it will want to run in demo mode. If it finds a new unit it will put the serial number of the unit in the lower left corner of the main screen GUI so that you know which KDAQ200+ it is talking to. It may be best to run the instances from different directories otherwise changes in one instance will affect the .ini file and if the GUI is restarted it may affect how the graphs are displayed. Most parameters, other than plotting parameters, logging parameters and decimal points are stored in the KDAQ200+ unit EEPROM and would be unaffected.

LABVIEW Interface

Labview is a popular interface for many laboratories. A Labview interface example is provided. It was saved in Labview 8.0 format as that is the earliest version the 'Save for previous version' function allows as it was originally written in Labview 8.6.

The files are stored in the 'KDAQ200+ LABVIEW INTERFACE' folder on the DAQJACK USB stick. The main VI is the 'KDAQ200+ Demo.vi'. When you run the interface type the command to execute (from the command list) into the write buffer. A typical command would be 'MA0' as in the example below to read the output from the ADC. Press the 'Run' arrow in the upper left menu bar and it should find the KDAQ (you should see KDAQ200+ in the Device Description) and return the read buffer, which in this case will be a number. Note the Baud Rate is set to 115200. The routine appends a '$' to the start of the string and a carriage return to the end of the string so you just type the command in as you would from a terminal program.

NOTE: *You need to have installed the KDAQ 200+ software first so that it installs the proper drivers.*



This serves as the jumping off point for integrating the KDAQ200+ into specialized Labview applications.

KDAQ200+ Specifications

Parameter	Specification	Notes
USB Input	USB 2.0 500mA	Must be powered hub if used
Analog to Digital Converter Inputs	24 bit ADC Differential Inputs	Configurable Gain
Usable Range	±18V	Output can be calibrated for greater accuracy by user
Absolute Maximum Input	±30V	If inputs above 18V readings on other channels become innaccurate
Resolution	<100uV RMS	with 0.1 second ADC sample time – better with additional digital filtering
Input Impedance	50k ohms	Note Input Circuitry for bipolar inputs, output of instrumentation must be able sink a small amount (100uA) of current
Thermocouple Input*	K type standard	Other types can be plugged in with less accuracy – software contains polynomials for J,K, T types
Power Supply Output	Programmable ±5 to ±24V	Negative supply is unregulated and will vary more with no load. Positive supply must have a load.
Power Supply Current	1.5W total Power	1.5W maximum – for example can use only +15V@100mA, or ±15V@50mA
Digital Filter	Single Pole IIR filter	Software Configurable
DAC output	0-3.3 V, 12 bits	Output may not go all the way to 3.3V Typical 3.2V maximum
I/O bit	3.3V	Configurable for input or output
Sample Rate – Embedded	4 milliseconds per enabled channel minimum	overall sample rate depends on number of enabled channels and ADC rates
Sample Rate – PC	0.1 sec	minimum
Software Requirements	Windows 2000 Service Pack 3 or later (XP or Vista)	Comes with driver so that a simple terminal interface can be used

NOTES: *thermocouple not included

Specifications Subject to Change without Notice

Included with KDAQ200+

- 1 meter USB Interface Cable
- K type Thermocouple Connector (not thermocouple wire)
- 12 pin I/O connector with crimp pins
- KDAQ200+ Data Logging and Setup Software

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