HARDWARE REQUIREMENTS

FOR THE

ADC PROGRAM

by

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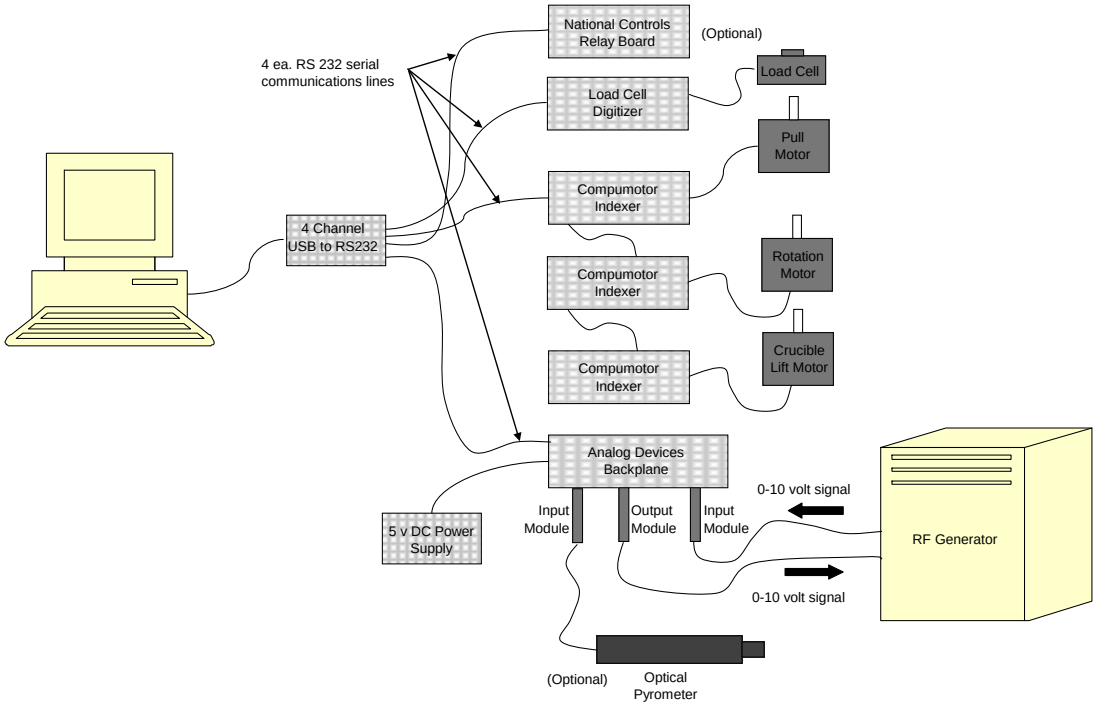
Hardware requirements:

The sketch below shows the recommended hardware layout for the ADC program.



Computer requirements:

The computer should be a standard industrial grade PC running a Windows 98 or newer operating system. COM port communications are achieved using a 4-port, USB to COM port adaptor. The display will be run in the 1024 x 768 pixel resolution. (Note, some newer computers come with display drivers that do not accept this screen resolution, so be careful when ordering.) The computer should have at least one writeable drive such as a floppy disk drive or a CD burner. This is to allow the operator to copy crystal growth run data to a portable medium for analysis on another computer. However, if it has a USB port (fairly standard these days), a memory stick can be used to remove data.

Peripheral hardware:

Communications with all peripheral hardware is through the COM ports configured for RS232 bi-directional communications.

Motors:

The pull motor should be a Compumotor stepper motor connected to a series 6000 Zeta indexer. It is recommended that the same hardware be used for the rotation motor. This lets the computer control the crystal rotation including turning it off during cool-down. The two indexers can be daisy chained together on a single COM port.

Analog I/O:

All analog input and output signals are through Analog Devices series 6B modules. The basic configuration of the software requires one analog input signal in the range of 0 – 10 volts from the RF generator. This signal should be roughly proportional to the power output of the generator. The generator output is controlled using a second Analog Devices module with a 0 – 10 volt or 4 - 20 mA output signal. (Note: the same module can be configured for either output.) Additional analog I/O signals can be accommodated using more Analog Devices modules. The program can be configured to record the output of an optical pyrometer, for example, and/or to monitor the available voltage of a UPS back-up battery stack.

A DC power supply is required to provide current to the analog output module.

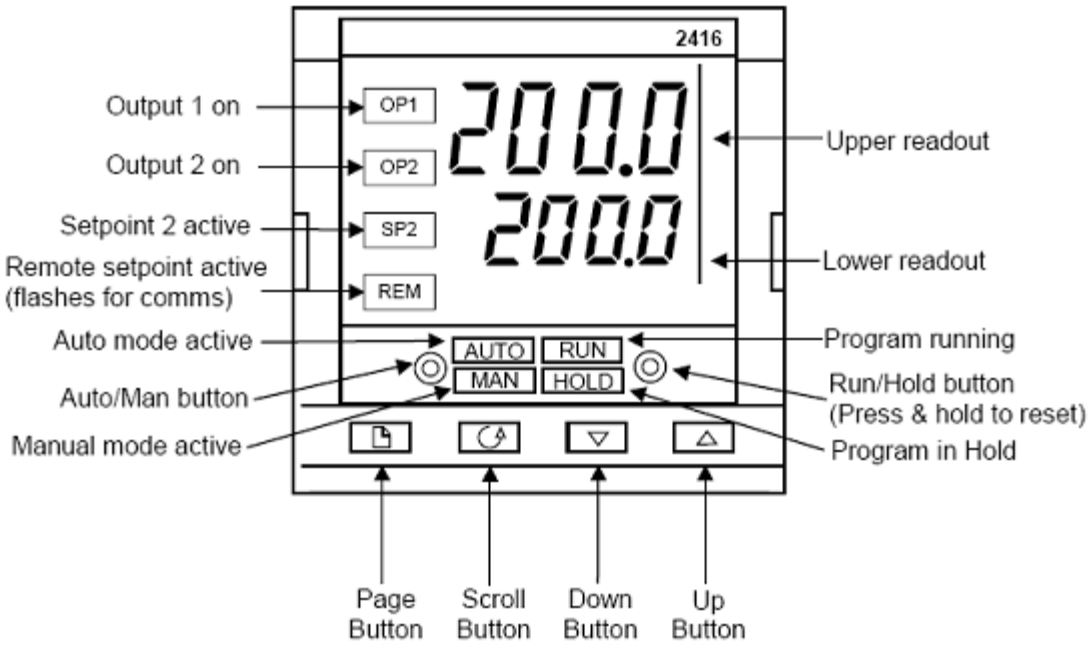
The table below summarizes the analog I/O hardware.

Item	Vendor	Part No.	Qty
Backplane	Analog Devices	6BP04HV-2	1
Input Module	Analog Devices	6B12	1
Output Module	Analog Devices	6B21	1
DC Power Supply	Power One	HA5-1.5/OVP-A	1

Note: Starting with version 7.0, the program will accept a power control loop using a Eurotherm 2416 controller. The Eurotherm accepts the analog signal from the RF generator and provides a control analog signal for feedback. The setpoint of the Eurotherm controller is transmitted to it by the ADC software. Normally, this is a temperature controller designed to accept an input from a thermocouple or a pyrometer. However, there is no reason that it cannot be configured to accept a 0-10 volt input and to output a 0-10 volt or 4-20 mA signal. There are quite a few different models of Eurotherm controllers depending on the application and the sophistication. The 2416 is one of the simplest and cheapest. Note: they do not automatically come with an RS232 interface. That has to be specifically requested as an option.

The Eurotherm substitutes for the Analog Devices I/O modules and backplane. However, if the system has other analog inputs (such as a pyrometer), then additional I/O capability will be needed. Contact the software vendor.

The picture below is a drawing of the front panel of the Eurotherm 2416.



Relay Board:

The program will control the relays on a National Controls type R25 dual SPDT relay board. These relays can be used to switch the generator off at the end of the cool-down cycle or to turn on an alarm.

Load Cell:

The ADC program will accept the input from either of two load cell digitizers: a Hardy Instruments HI2151 WC or an Interface Force Measurements model 9840. The Hardy has a display resolution of 6 digits (0 – 999,999) but an internal resolution of only 60,000 counts. The Interface unit has a claimed internal resolution of 24 bits. The limiting factor in the case of both units is probably the load cell. In other words, despite the claimed resolution of the digitizer, the load cell has a given mV/volt response, and to get a true 6 digit precision requires the measurement of microvolts. It is likely that the noise level in the load cell would swamp such fine measurements.

If the Hardy model is purchased, it should include the Hardy Link option. This allows the unit to be programmed with an address. The address must be 10.

The program will also accept an input from a Sartorius balance. The Sartorius is a true null point instrument and, according to claims by the manufacturer, it has a higher intrinsic resolution than a strain gauge type load cell. The issue becomes one of getting a balance with sufficient range and sufficient resolution in the serial output.

Serial I/O:

The recommended peripheral for serial I/O is a Keyspan 4-port USB to RS232 adaptor. See http://www.tripplite.com/en/products/model.cfm?txtModelID=3916. This allows one USB port to handle all peripheral devices. Note: other models of USB to COM port adaptor have been used with this software and have had problems.

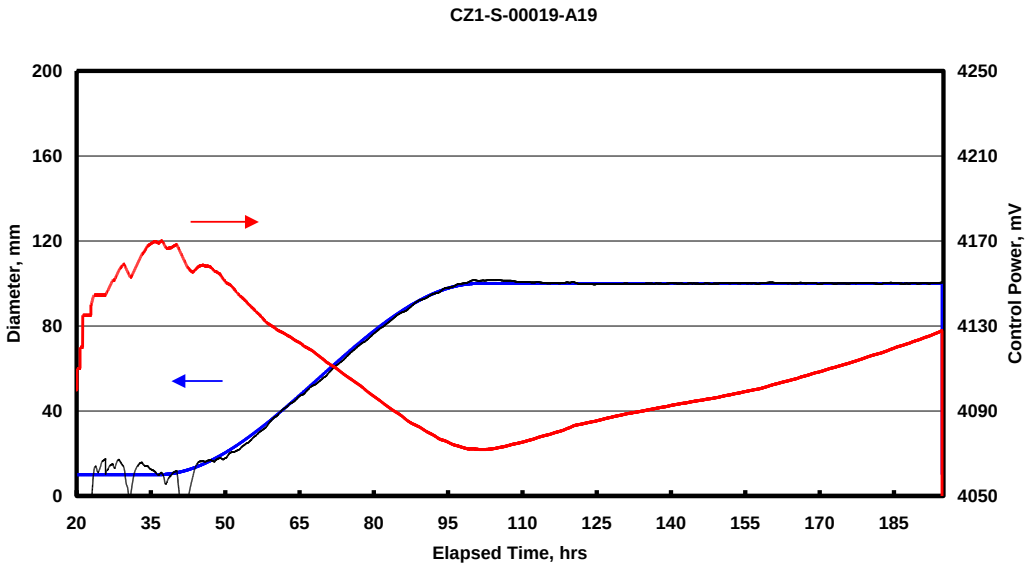
Web Links:

Web links to the various vendors are shown in the following table.

Vendor	Web address
Analog Devices	http://www.analog.com/en/index.html
Compumotor	http://www.compumotor.com/
Hardy Instruments	http://www.hardyinst.com/index.html
Interface Force Measurements	http://www.interface.uk.com/
National Controls	http://www.controlanything.com/
Power One	http://www.power-one.com/

Data Collection and Analysis

One of the key strengths of this software is the large data file that is collected during the crystal growth run. The data file allows the user to graph various parameters versus real time and to observe the performance of the crystal growth process as in the graph below. This graph shows only a small portion of the data collected during a typical growth run.



The crystal corresponding to this data is shown in the photograph on the following page. It is crystal number 19. The photograph also shows the reproducibility of diameter control that this software can achieve from one crystal to the next. Note: the lines in the shoulder growth area are not diameter variations. They are C-plane facets that naturally form on sapphire crystals.