Purpose of this guide

This Quick Start Guide will help you get familiar with the AODS Controller and the supplied utilities. You will learn how to use the supplied Windows based AODS Controller application to issue commands to the AODS Controller and interpret the results. This guide explains how to optimize the frequency and power settings for maximum deflection efficiency using the AODS Controller and either of these two environments:

- A spectrum analyzer
- A laser with an AOTF Crystal and optical power sensor

Table of contents

Introduction

This Quick Start Guide is divided into three sections:

- The Overview contains a description of the AODS Controller, including a simplified block diagram and a description of the front panel.
- The Electrical section explains how to configure and manipulate the features of the AOTF Controller and observe the results with a spectrum analyzer.
- The Optical section explains how to optimize the frequency and power settings for maximum deflection efficiency using the AODS Controller and a laser + AOTF Crystal + Optical Power Sensor.

Overview

Software Installation

This release of the AOTF Utilities includes a new setup utility that will easily install and configure the software. To install the software execute the Setup.exe command and follow the instructions. The Setup program will copy the necessary drivers and applications to your local hard disk.

After the AOTF Utilities setup has completed the various components need additional setup and/or installation steps as outlined below.

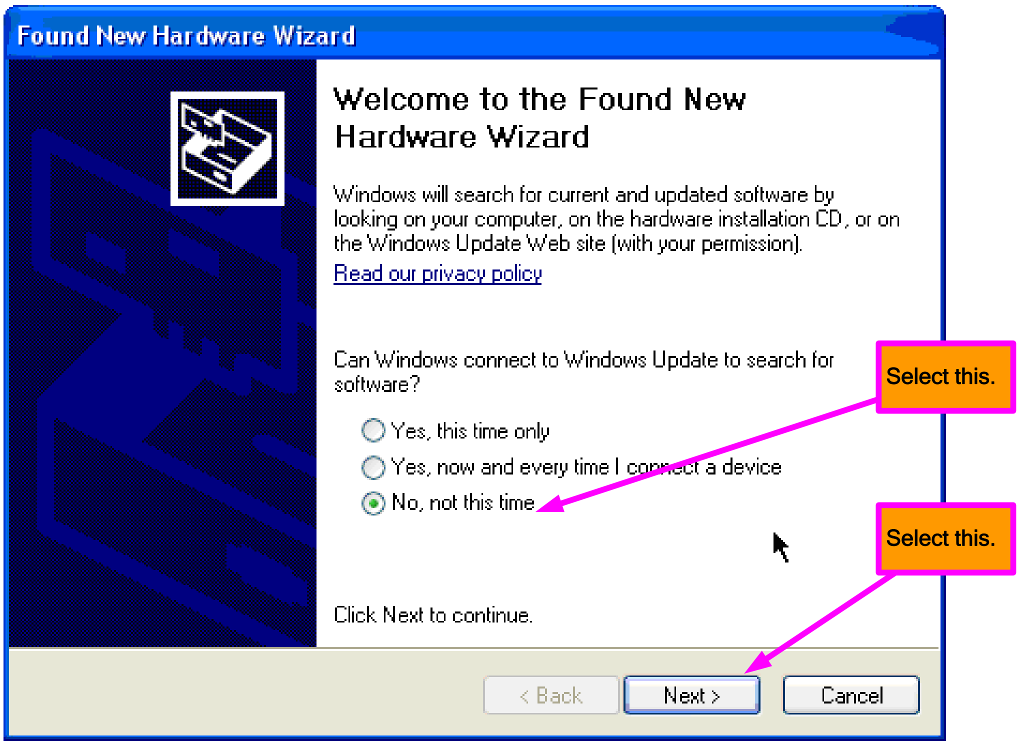
USB Driver Installation

The USB Device Driver functions with all models of AOTF Controllers (Octal, Quad, and Single Channel) and with all models of Modulation Daughter Cards (Analog and Digital).

- Plug the AODS power supply into an outlet with 100-240VAC. Plug the DC connector into+*24 VDC*. – The *Power* LED will light up when powered.
- Plug one end of a USB cable into the USB connector on the front panel of the AODS Controller (see **1** in the figures below) and the other end into a USB connector of your computer. The “Found New Hardware Wizard” will be launched to help you install the driver.

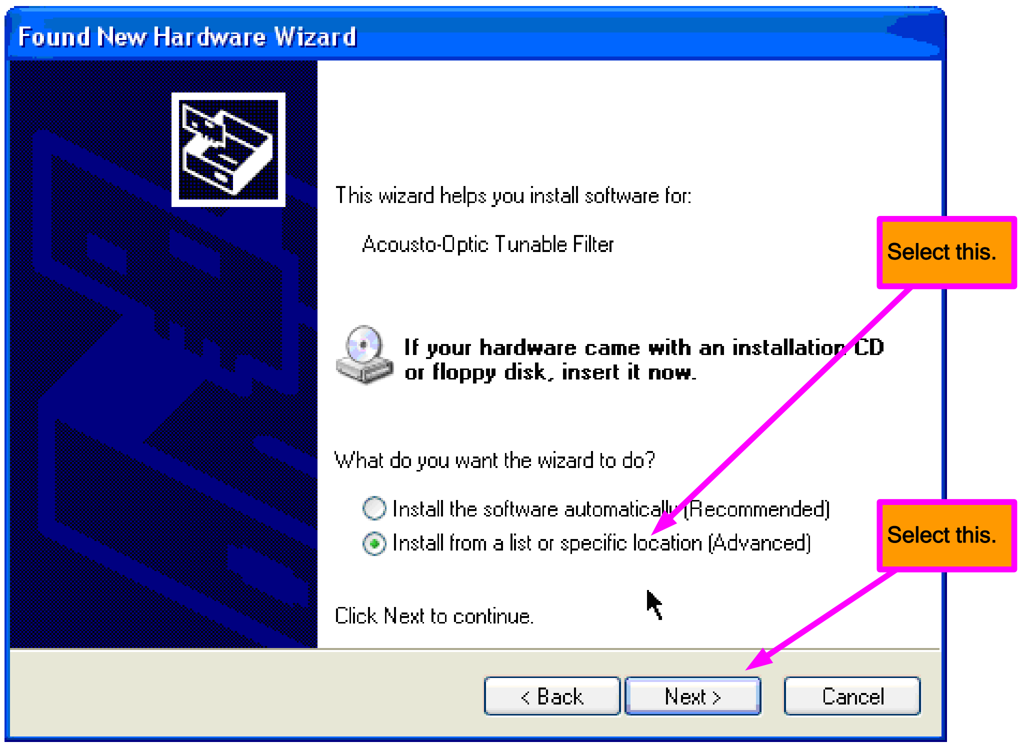
Windows XP, both 32 bit and 64 bit, will invoke the “Found New Hardware Wizard” when the USB cable is connected to the AOTF Controller the first time. Follow these instructions:

- Instead of allowing the “Found New Hardware Wizard” to search for drivers, select “No not at this time” option to navigate to the directory where the INF file for the driver can be located.



- Select the “Next” button.

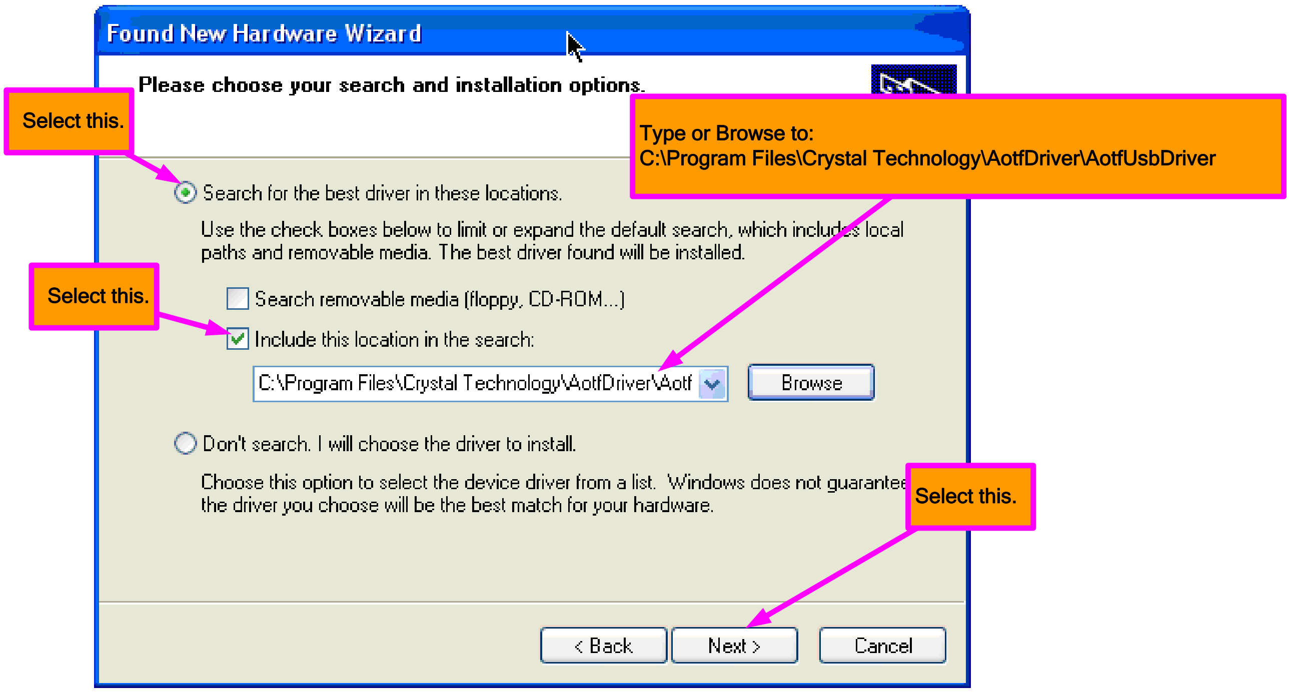
- Select the option “Install from a list or specific location (Advanced)”.



- Select the “Next” button.

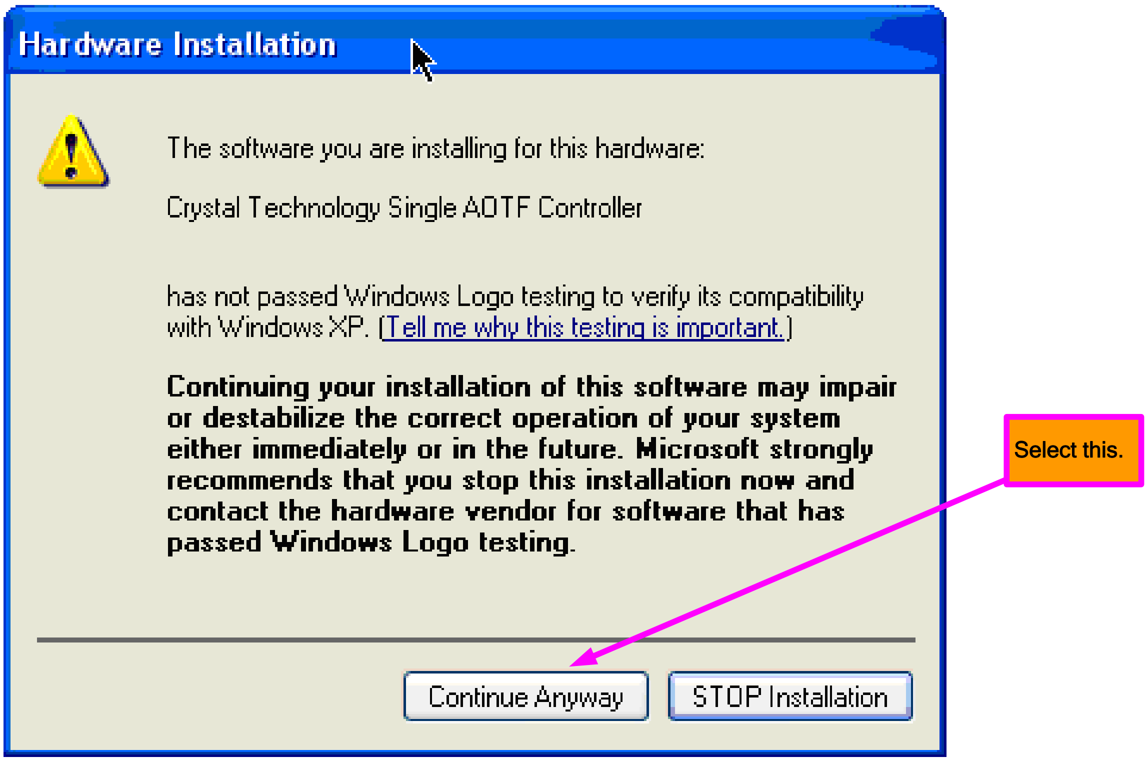
- Select the option “Search for the best driver in these locations” and also make sure the check box for “Include this location in the search” is checked. Select the “Browse” button and navigate to this directory:

  C:\Program Files\Crystal Technology\AotfDriver\AotfUsbDriver

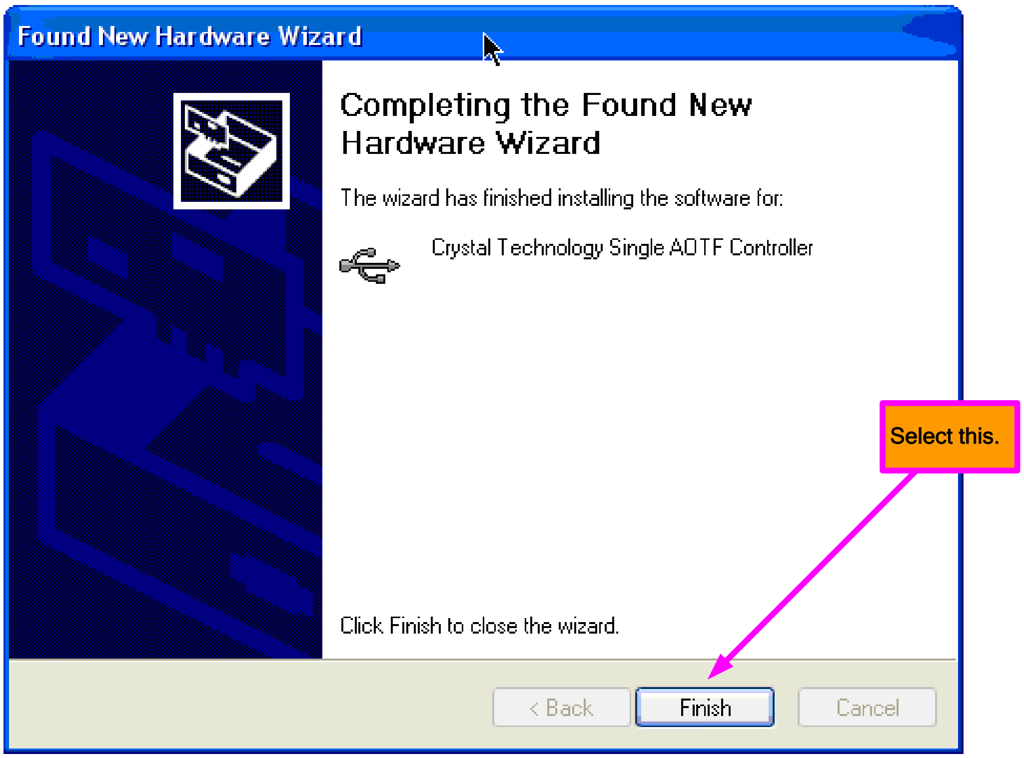


- Select the “Next” button.

- Select the option “Continue Anyway” to install the driver.



- Select the option "Finish" to complete the installation of the driver.



LabView Runtime Installation

AOTF Utilities setup can optionally automatically install the LabView Runtime. If it becomes necessary to re-install or change the configuration of LabView execute the LabView installer:

C:\Program Files\Crystal Technology\LabViewLVRunTimeEng.exe.

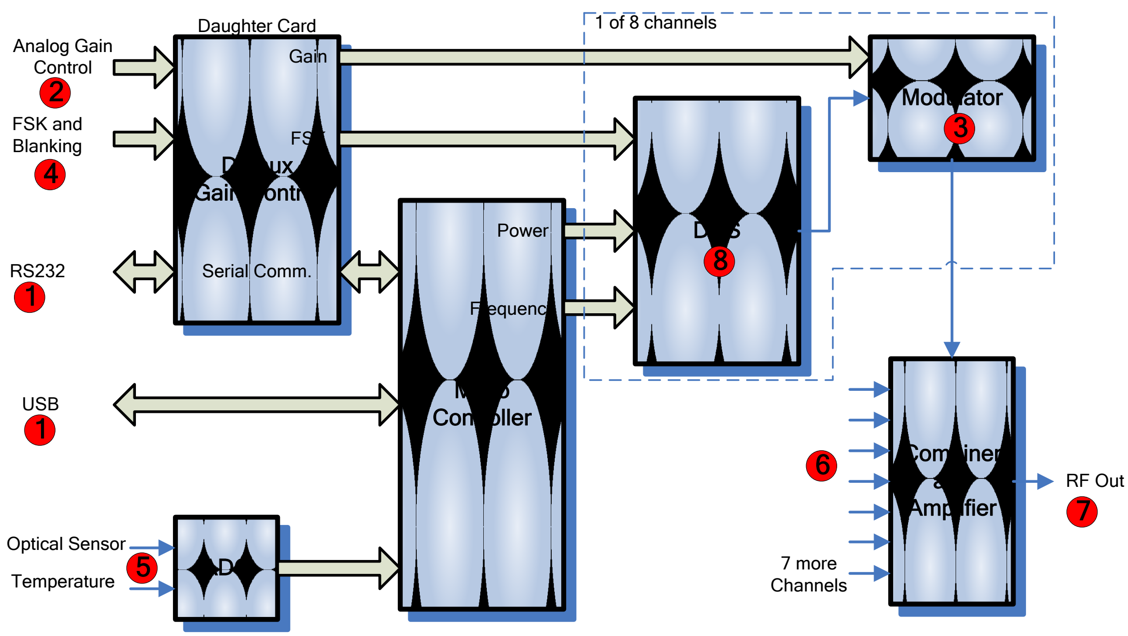
Block Diagram

A block diagram of the AODS Controller is shown below. The numbers in **RED** indicate areas on the block diagram.

The AODS Controller has several host communication options (**1**):

- RS232
- USB
- Bluetooth

For the purpose of this guide, we assume USB communication.



Once the communication channel has been established with the host, commands can be sent to the AODS Controller to set frequencies and power levels of the DDS frequency generator chips (**8**).

The AODS Controller receives modulation information from the host (**2**), which is amplified or attenuated as necessary to create the signal that drives the modulator at the output of the DDS frequency generator (**3**).

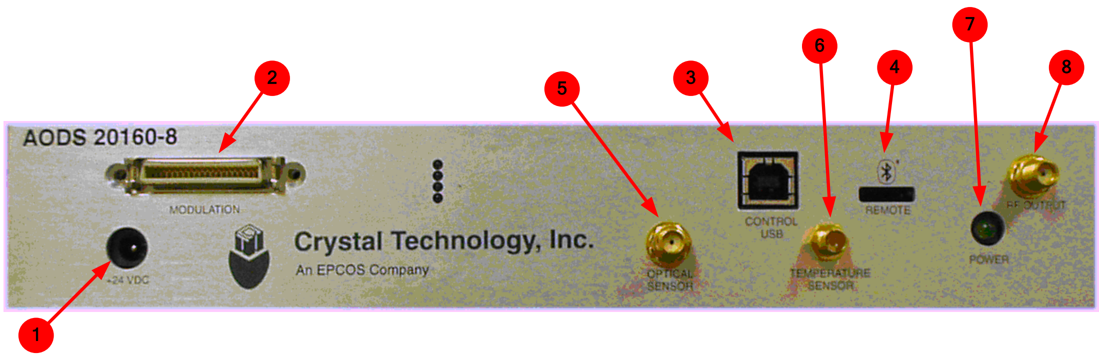
The AODS Controller also receives FSK and BLANK information from the host (**4**), which is used to select profiles (i.e. rapidly change frequencies).

The AODS Controller also monitors the Optical Power Sensor and temperature inputs (**5**). The Optical Power Sensor can be used to maximize deflection efficiency; while the temperature sensor can be used to compensate for changes in AOTF Crystal temperature.

The output from all of the channels (**6**) are combined into a single RF output (**7**) and used to drive the AOTF Crystal.

Front Panel

The front panel of the AODS Controller is shown below.



- +24 VDC: supply voltage for the AODS controller (**1**).
- Modulation: Daughter board interface. Includes RS232 computer interface for host control, analog inputs for fast amplitude modulation, digital inputs for on-off and fast frequency change of individual RF channels (**2**).
- Control USB: USB interface to communicate with host computer (**3**).
- Remote: optional blue-tooth interface for host control (**4**).
- Optical sensor: AODS controller reads signal from connected optical power detector (**5**).
- Temperature sensor: AODS controller reads temperature and other information from AOTF device (**6**).
- Power: Power on indicator (**7**).
- RF output: Output with up to 8 simultaneous frequencies (**8**).

AODS 20160 Controller Application

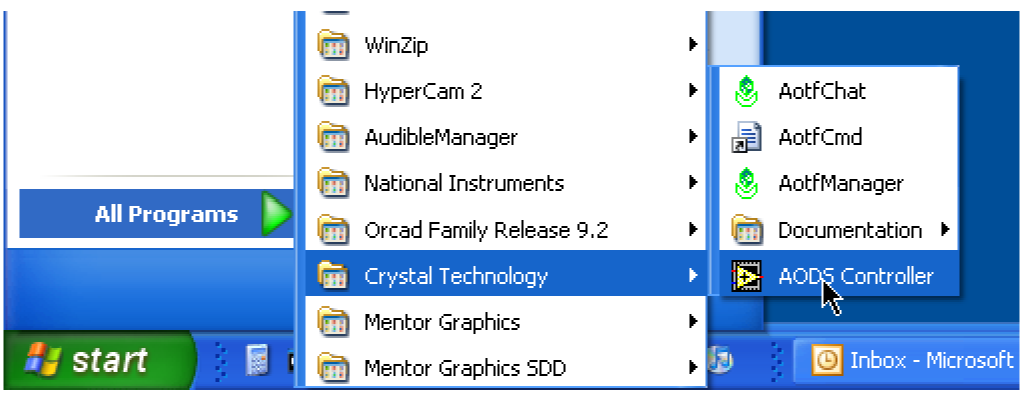
The *AODS 20160 Controller* program provides an easy to use interface through which commands are sent to the AOTF Controller. Commands can be typed into a text window and sent to the AOTF Controller, or they can be issued through buttons and controls in the AODS 20160 Controller application.

The AODS 20160 Controller application functions with all models of AOTF Controllers (Octal, Quad, and Single Channel) and with all models of Modulation Daughter Cards (Analog and Digital).

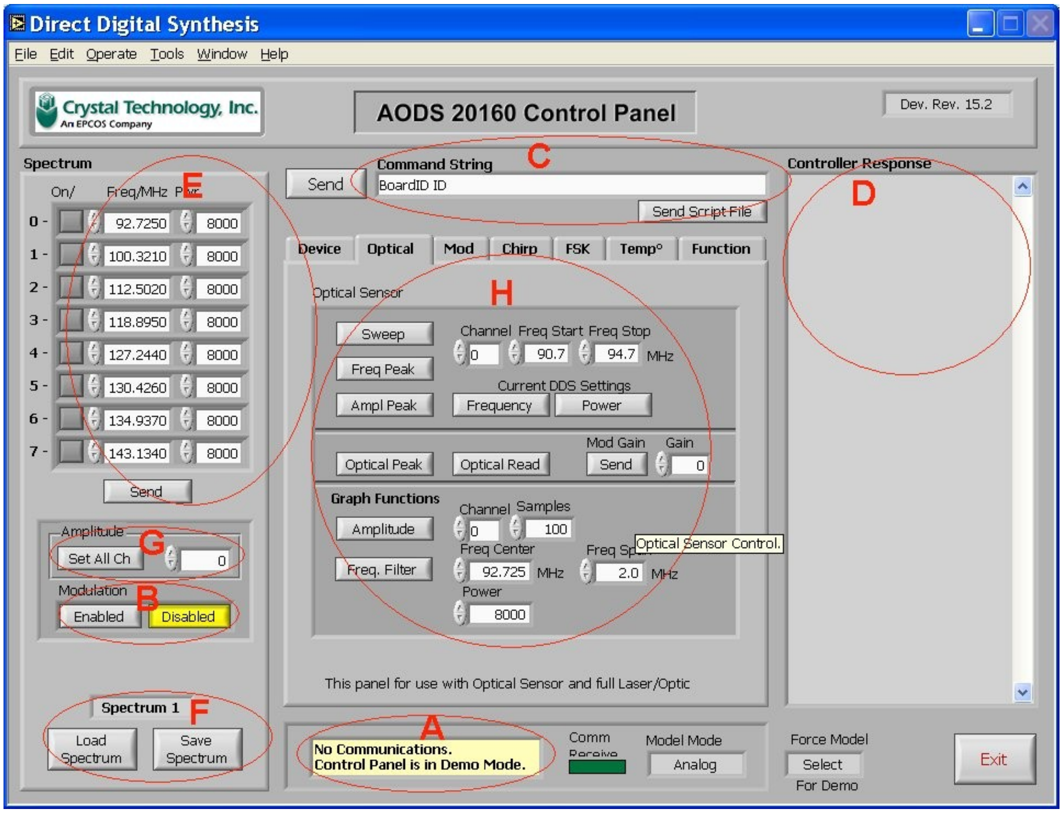
The AODS 20160 Controller application allows the user to manipulate the various features of the AOTF Controllers, including the modulation controls (gain, FSK, and BLANK), frequency controls, and power control. There are many advance algorithms implemented in the firmware of the AOTF Controller that are accessible through the AODS 20160 Controller application, such as frequency sweeping, peak searching, and temperature compensation.

Launch the AODS Controller Application

From the Start menu select “All Programs”, then “Crystal Technology”, and then “AODS Controller” to launch the application.



The main window of the AODS 20160 Controller application should appear.



The controller program window will indicate that the USB connection has been established (**A**).

Enable daughter board and issue sample command

- Activate the modulation by clicking on the button *Enable* (**B**). This allows the microcontroller of the AOTF Controller to control the modulation. When the modulation is *Disabled* (**B**) the host is in control of the modulation.
- Type *Help dds* into the text window (**C**) and click *Send*. The command will be mirrored in the *Controller Response* window (**D**), and the microprocessor of the AOTF Controller will answer with a brief statement on the *dds* family of commands and syntax expectations.

  NOTE: All commands to the controller follow similar syntax. Pressing any of the buttons in **E, G,** and **H** will be interpreted and translated into a series of command lines that are sent to the microcontroller of the AOTF Controller. The *Controller Response* window (**D**) will show the issued commands and responses. This can be a valuable reference tool if you are developing your own software code to command the AOTF Controller.

Electrical

This section explains how to configure and manipulate the features of the AOTF Controller and observe the results with a spectrum analyzer.

Required Equipment

- Computer with Win2000 or XP.
    - USB port
    - 128M Bytes of memory
    - CD drive
- AODS Controller.
- Spectrum analyzer with 150MHz bandwidth or better.

Equipment Setup

- Connect the *RF output* of the AOTF Controller to the spectrum analyzer with a coaxial cable (use SMA- BNC adaptor if necessary). The output impedance is 50Ω.

Operation

- From the "Spectrum" section (**E**), select frequency (from 20MHz to 200MHz) and power level (from 0 to 16383) for one of the eight channels and click on the green On/Off button. A light green color indicates that the particular channel is enabled. Although you may enter a frequency lower than 20 MHz, the "operating frequency" of the AODS starts at 20 MHz.
- Observe the RF power on the spectrum analyzer.
- Enable multiple channels simultaneously. Most commands will be sent when the value changes. To re-send all the settings to the microcontroller, click on *Send*.
- If you want all eight channels at the same power level, type in that level **G** and press *Set ALL CH.* This will update the power in the AODS controller, but will not be reflected in the settings (**G**).
- To store the frequency and power settings for all channels, click on *Save to File* (**F**). The information for settings (**G**) will be stored on the computer's hard disk and can be loaded back into the *spectrum* control by clicking on *Load from File.* The *Save to*, and *Load from File* is a system file and cannot be named or pre-selected at this time.

Optimizing Deflection Efficiency (Optical)

This section explains how to optimize diffraction efficiency using a laser + AOTF Crystal + Optical Power Sensor.

Required Equipment

- Computer with Win2000 or XP.
    - USB port
    - 128M Bytes of memory
    - CD drive
- AODS Controller.
- Laser (HeNe 632.8nm, collimated laser diode or similar).
- AOTF Crystal, CTI part number 97-02838-01 or similar.
- Optical power detector providing a voltage proportional to laser power.

Equipment Setup

Optical setup

- Ensure that the laser has proper polarization for the AOTF Crystal orientation. Use a polarization rotator if necessary.
- Align the AOTF Crystal so that the beam enters the input side of the modulator (the larger opening in the cover) and falls perpendicular onto the AOTF Crystal face. Use the back-reflection to align within 0.5°. Center the beam with respect to the openings so that the transmitted beam (0-order; undiffracted) is not clipped.
- Position the laser power detector to measure the transmitted beam power. Attenuate optical power as necessary to achieve a linear detector response.

Electrical setup

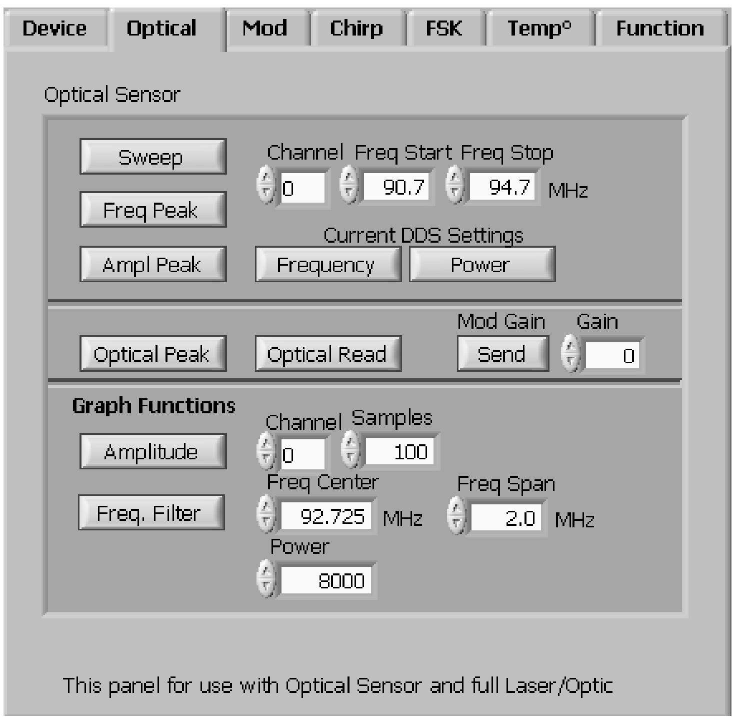
- Connect the *RF output* of the AOTF Controller AOTF Crystal
- Connect the Optical Power Sensor to the Optical Sensor input of the AOTF Controller. The input impedance is 100kΩ. The voltage should be proportional to the detected laser power with a maximal voltage of 3.3V.

Operation

The Optical Power Sensor was aligned above to measure the power of the undiffracted beam. The optical sensor input is assigned to channel 2 of the AOTF Controller's analog to digital converter (ADC). The assignment of all 8 input channels is:

Sensor input channel	**Sensor signal**
0	RF power (internal to AODS controller)
1	AOTF cell temperature (uses *Temperature sensor*)
2	Laser power (uses *optical sensor*)
3-5	Not used, accessible on AODS controller board
6	Oscillator temperature (internal to AODS controller)
7	Amplifier temperature (internal to AODS controller)

- Select the *optical sensor* tab (**H**).



Adjust the Optical Sensor Gain

Be sure that the Optical Power Sensor is in line with the undiffracted beam.

- Click on *Optical Peak.* The AOTF Controller will initiate an algorithm that adjusts the gain of the Optical Sensor so that the undiffracted beam will be around 85% of the ADC conversion range. This provides the AOTF Controller with the proper gain setting for the Optical sensor so that the Optical Power Sensor is above the noise floor, and also doesn't saturate the ADC. The AOTF Controller will adjust the gain from 0 to 255 and determine the best setting that provides an ADC conversion of about 85%. The final setting chosen by the algorithm can be queried with the "*adc gain 2*" command.

- Click on *Optical Read*. The output of the ADC can range from 0 to 4095. If the gain setting for the Optical Sensor is correct, then an 85% reading should be around 3500.

Position the Optical Power Sensor

- Sweep channel 0 to align the detector to the first diffracted order:
  - Click the *On/Off* button to turn it light green for channel 0 (**E**). You will notice the settings on the Optical Tab (**H**) will automatically set itself to the specific channel selection of the Spectrum control (**E**).
  - Set the *Pwr[0…16383]* to 10000.
  - For the *Sweep* settings (**H**), choose *Channel*=0, *Freq Start/Stop* should equal Channel 0 of the Spectrum Control ± 2 MHz… click *sweep*.

    Note: For different AOTF Crystals or laser wavelengths, the frequency range might need to be adjusted accordingly. Please refer to the optical device data sheet if necessary.

  The sweep function will begin sweeping through the spectrum. Each time the sweep crosses the optimum Bragg condition you should be able to observe the first order diffraction.
- Move the Optical Power Sensor to measure the first diffraction order instead of the undiffracted beam.

Optimize the Frequency

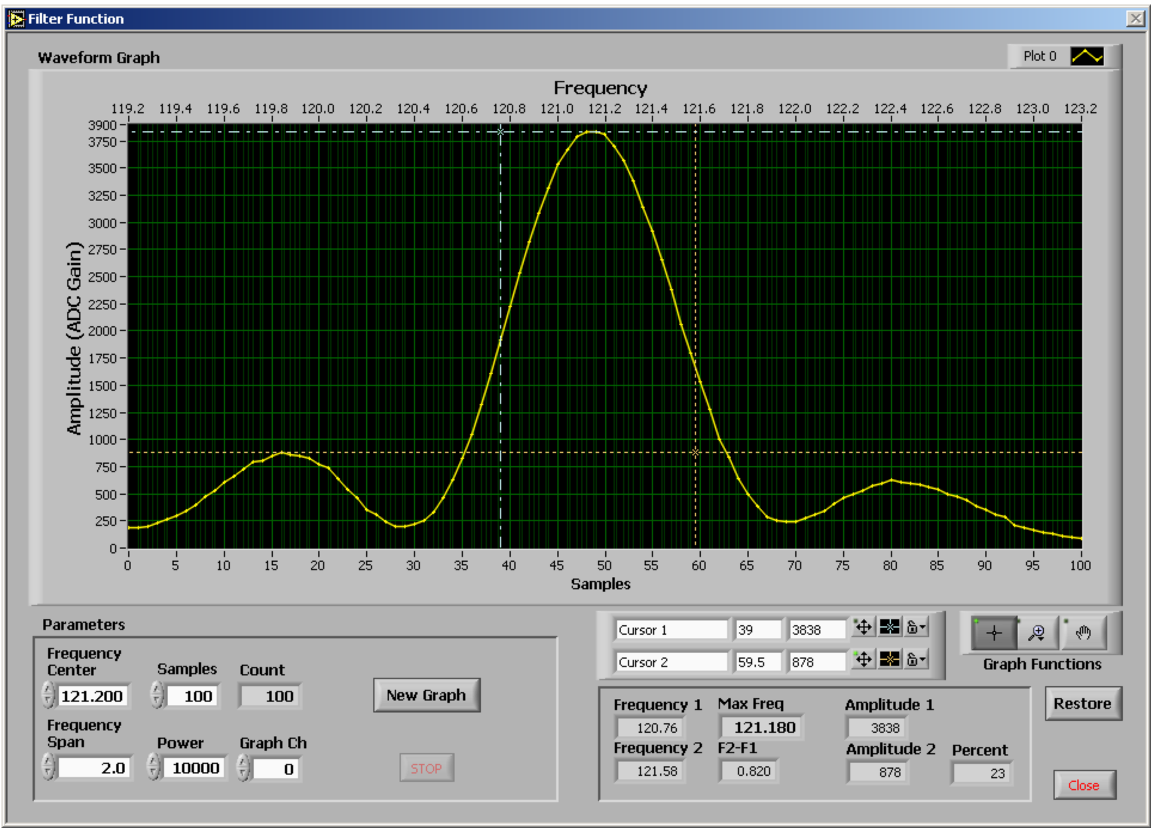
- Stop the sweep function by pressing *Sweep* again.
- Select the same channel and frequency values as and click *Freq Peak*.

  The AOTF Controller will adjust the frequency in consecutively smaller steps to find the frequency that optimizes the diffraction efficiency (maximizes the signal from the Optical Power Sensor). It will report the optimum value in Hz in the controller Response window (**D**). For example, a reported value 9.27250e+07 corresponds to 92.7250 MHz.
- Type this value into the *Freq/MHz* window (**E**) for Channel 0 and turn the LED light green. The first order diffracted power should be clearly visible now.

Graph Efficiency vs. Frequency Response

- For the *Filter* settings (**H**), choose *Channel*=0, *Frequency Center* the optimum determined above, *Frequency Span* 2 MHz default, leave *Samples* =100 and *Amplitude* =10000 and and click *Freq Filter*.

  A new window will open and the computer will instruct the controller to measure the optical diffracted power for a number of frequencies (*Samples)* in a two MHz window around the optimal frequency. After completion, the two cursors will be automatically positioned at the sides of the main peak and the FWHM (Full width at half maximum) frequency range will be displayed as *F2-F1*. The cursor functions will not work properly if the signal is noisy, but may be manually moved to any location on the graph.



Click *EXIT* to close the window.

Notes:

(1) If for any reason the Waveform is clipped at the top, go back to the main window, ake sure that the “Spectrum” Frequency and Power are On and are at their correct values (you may need to re-exercise the Off/On function of the Spectrum window). Now readjust the Optical Sensor gain by exercising the *Optical Peak* features listed in the “Adjust sensor gain” section, and then re-exercise the *Freq Filter* graphing function.

(2) The *Optical Peak* feature attenuates the input from the Optical Power Sensor so the highest input value will be about 85% of the maximum ADC conversion value of 4095. On this graph it peaked at 3838.

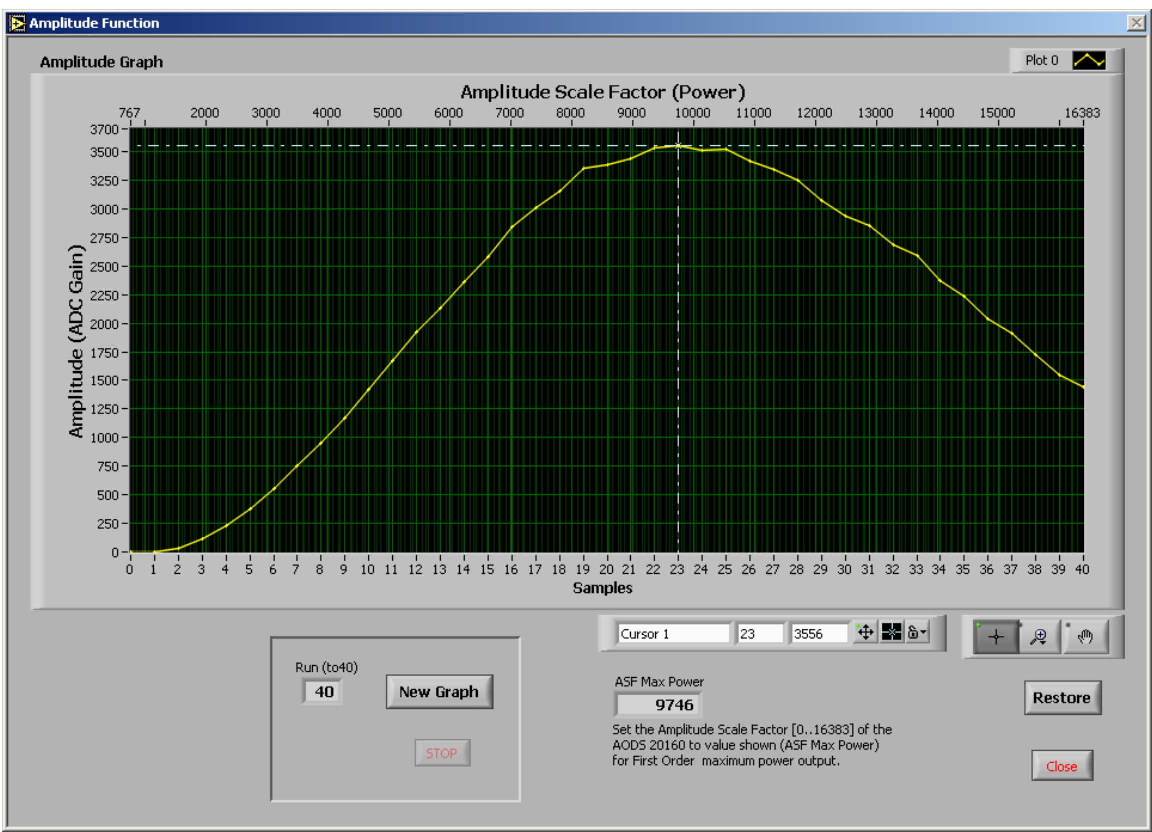
(3) If the graph is not a clean waveform, a noisy laser or Optical Power Sensor may be a cause.

(4) *New Graph* will run a new graph, but *Restore* will reset the same graph (and cursors) to its original position. This is recommended if the Graph Functions (zoom or move) have been exercised and you want to get back to full view.

Optimize RF Power for Maximal Diffraction Efficiency

- Choose *Channel*=0, *Samples* =100 and put in the value determined above for the optimal frequency into *Frequency Center* (**H**), Click *Amplitude*.

  A new window will open and the computer will instruct the controller to measure the optical diffracted power for a number of power settings (40 *Samples)* over the range of available power levels. After completion, the cursor will be positioned at the peak and the optimized power setting for that frequency will be displayed as *ASF Max Power.*



- Click *Close* to close the window, and enter the ASF Max Power value (e.g. 9746) in the *Pwr [0…16383]* window for channel 0 (**E**). The settings are now optimized for maximal diffraction efficiency.

Optimizing Frequency and Power Settings for Other Wavelengths

The example above demonstrated how to set the frequency and power parameters for RF channel 0 such that the diffraction efficiency is optimized. These settings are dependent on beam position and AOTF Crystal tilt with respect to the laser beam. The procedure needs to be repeated when the optical path is re-aligned or the AOTF Crystal is exchanged.

For a multiple line laser or multiple co-propagating laser beams, different channels can be optimized individually to any of the lines. The example above was setting the parameters for RF channel 0. To set other channels for a different color:

1. Switch the previously optimized channels off (*On/Off* is dark green (**E**)).
2. Make sure the diffracted beam is fully captured by the optical detector (diffraction angle is dependent on color/frequency).
3. Adjust the Start and Stop frequencies such that only the desired line is diffracted. Use the *Filter* function above to scan over a wide frequency range

Going further

By now, you will know how to issue commands to the AOTF Controller through a communications interface. This allows you to activate/de-activate channels, and adjust their power and frequency settings.

Many applications will require analog modulation of the RF power, or rapid switching of frequency values. The AOTF controller can accept such signals through the Hot Modulation Interface (*Modulation* connector). These signals do not pass through the microprocessor and will not have software-induced delays. For rapid frequency adjustments, the FSK feature of the AOTF Controller is utilized. It requires that the desired frequencies for each of the channels are programmed ahead of time. This programming is done through issuing *dds* commands.

Please consult the manual for specifications of the connector pin assignments and for a complete list of *dds* and other commands.