Fibre Coupling Alignment

FOA1065-R

Precautions

EXCEEDING THE MAXIMUM DRIVE POWER INDICATED ON THE AO DATA SHEET COULD DAMAGE THE MODULATOR

NEVER OPERATE THE DRIVER WITHOUT PROPER COOLING. THE MOUNTING FACE TEMPERATURE MUST NOT EXCEED 70*C.

NEVER OPERATE THE DRIVER INTO AN OPEN OR SHORT CIRCUIT LOAD

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1. GENERAL

1.1. Acousto Optic Modulator

When no RF power is applied to an AO device, all of the input laser beam will be seen at the zero order position (less insertion losses).

When RF drive is applied a proportion of the zero order beam is diffracted into the first order. In general, when the input beam of an AO device is adjusted for the correct Bragg angle the diffraction efficiency (DE) can reach a value of 90%. The operating wavelength and AO transducer parameters define the required RF drive power. This value for maximum efficiency is referred to as the saturation power. At NIR wavelengths, the saturation powers can exceed the recommended maximum input power for the AO device and hence the efficiencies will be lower (refer to the AO device data sheet).

At the first order beam position, the static on-off contrast ratio should exceed 30dB.

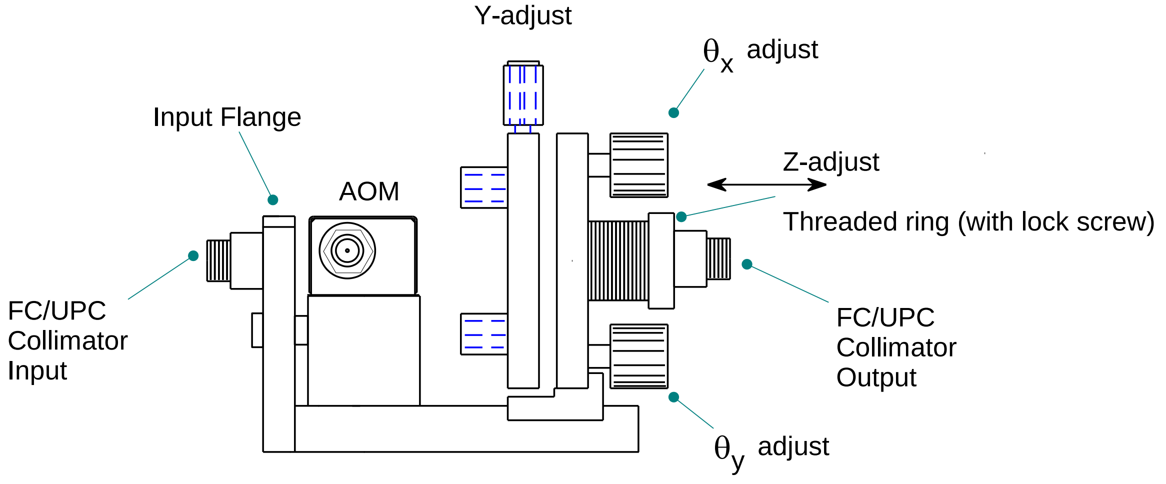
1.2 Fibre Optic

To avoid damage to the end face of the fibre, the following alignment process must only be carried out at a low laser power. Recommended power less than 30 mW c.w.

Great care must be taken at optical powers exceeding 50mW.
Although for a correctly aligned system, the first order beam will be aligned into the fibre, it is possible that the zero order beam could be focussed on the fibre cladding and damage could result at higher optical powers.

Please ensure that adequate laser safety precautions are taken. If in doubt, consult your laser safety officer before proceeding further.

1.3 Basic elements



The output flange features a 4-axis kinematic mount allowing lateral and angular adjustment of the output fibre collimator.

The input flange is fixed. The aperture is designed to be coaxial with the AOM active aperture.

Typically, the AOM and fibre optic components are supplied pre-assembled and aligned. The following describes the full alignment. Not all stages may be required for partial re-alignment.

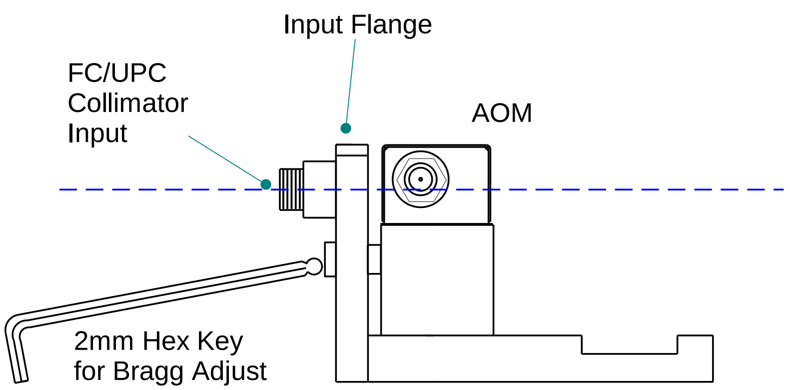
2. ALIGNMENT

To aid alignment, an optical power meter and fluorescent IR viewer card are essential at NIR wavelengths. To get a feel for the system adequate performance can be seen at 635nm. Of course the alignment will not be appropriate for NIR wavelengths but the visible operation will help familiarise you with the adjustments.

2.1 <u>Input fibre alignment.</u>

The input fibre is located nearest to the AOM. Insert the input fibre collimator into the input flange and tighten the collimator locking screw.

At this stage, remove the output plate with collimator by removing the two lock-screws.



Ensure that the AO device is mounted correctly. Even when tight, the Bragg pivot centre point screw (underside) should allow rotation with Bragg adjuster.

2.1.1 Align the AO device so that it is square to the modulator block (i.e. the RF connector face is in line with the edge of the mounting block).

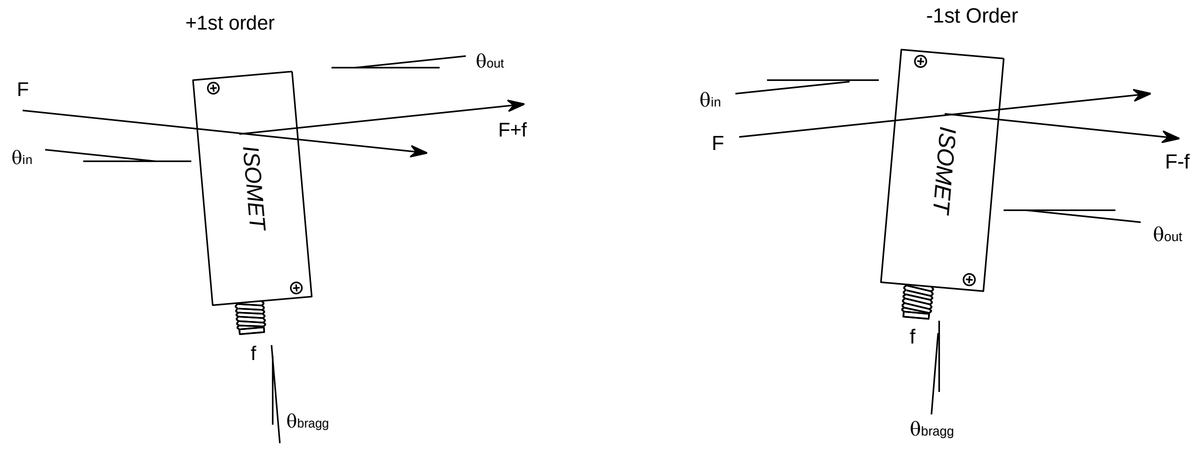
2.1.2 With no RF applied, ensure that all the input optical power (less insertion losses) is seen in the zero order or straight through position.

2.1.3 Insert the input collimator so that zero order beam remains on axis in height and width, in other words the beam passes through the AO device apertures and is flat and square to the base of the AO device. It may be necessary to remove the AOM cover to aid initial alignment.

For increased accuracy, this can be achieved by monitoring the beam path at a number of positions away from the unit and along the axis line of the unit.

2.1.4 Connect the RF driver to the AO device as explained in the driver instruction manual. Apply RF power. (See appendix)

2.1.5 The diagrams below illustrate the relationship between the AO Bragg angle direction, the corresponding +1 or –1 order output and the resultant up or down frequency shift.



ANGLES ARE EXAGGERATED FOR CLARITY.

2.1.6 Slowly and carefully rotate the AO device in the appropriate direction and note any diffracted light. For a poorly adjusted AO device, diffracted beams may be seen at opposite and higher order beam positions e.g. –1, 0, +1, +2 etc.

2.1.7 As described, adjustment of the Bragg angle (θ_{Bragg}) is achieved by rotating the Bragg adjuster using a 2mm Hex Key. Monitor the first order power and making incremental adjustments to the AO device Bragg angle

2.1.8 Maximize the first order output intensity by first optimizing the Bragg angle and then by careful adjustment of the RF input power. .

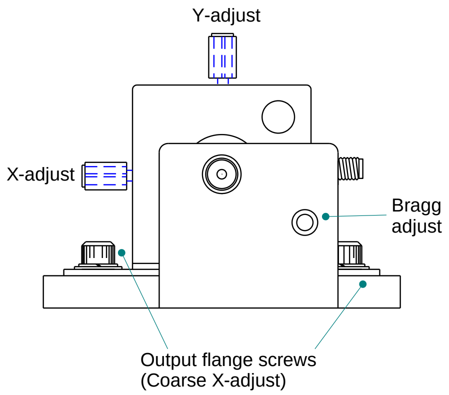
2.1.9 You should be able to achieve at least 50% diffraction efficiency into the selected first order.

2.2 Output fibre alignment

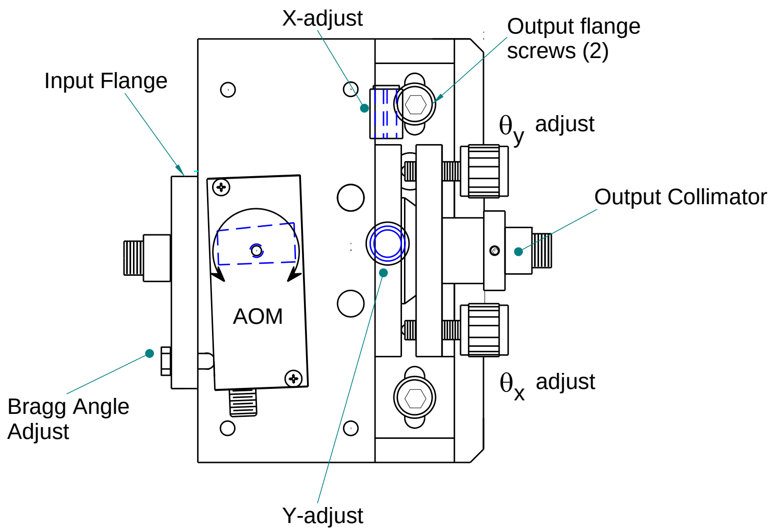
2.2.1 For NIR wavelengths, a fluorescent IR viewer card will assist alignment of the output fibre to the first order beam.

2.2.2 Replace the output flange (without the fibre collimator) onto the base. Tighten the flange mounting screws sufficient to allow the plate to slide along the grove in the base.

2.2.3 Centre the output flange about the 1st order beam. Tighten the flange screws.



2.2.4 Insert the Output fibre collimator into the Output flange and tighten the collimator locking screw.



2.2.5 <u>Slowly</u> turn each of the X, Y, θ_x. θ_y adjusters ½ turn clockwise then back ¼ turn anti-clockwise and monitor the output power from the fibre. This procedure will require care and patience to locate the beam. By taking each adjustment screw in order it is possible to spiral in on the beam position. To ensure you are aligning to the first order beam, disable the RF drive to the AO modulator. The output should fall to zero.

2.2.6 The position of the collimator can be checked by inputting the optical power into the output fibre and viewing where the beam strikes the output face of the AOM. This will gave a good indication of the Output collimator flange angle.

2.2.7 It may be necessary to remove the AO cover to avoid clipping problems. If there is such a problem you can enlarge the aperture holes (with the cover removed !).

2.2.8 The efficiency of the completed F/O coupled unit may need final optimisation by careful adjustment of the Bragg angle.

2.2.9 Tighten all screws and Lock adjusters. Monitor the power continually to ensure alignment is maintained

Appendix

ACOUSTO-OPTIC MODULATOR SET UP

THEORY OF OPERATION

The Acousto-Optic Modulator enables the user to modulate light intensity by means of an RF Signal at a given centre frequency (fc). Either digital (on-off) or analog (proportional) modulation of the first order can be produced, depending on the type of driver selected.

The principle of operation can be briefly described as follows (see Fig 2):
To intensity modulate the input laser beam, the amplitude of the RF drive frequency is varied according to the applied video or modulation signal.
AO modulators are travelling wave devices. The modulation bandwidth depends on the beam diameter in the AO device and the acoustic velocity. The maximum rate is limited to half the device RF bandwidth

From the viewpoint of intensity modulation, the deflection efficiency is given by the general equation:

$$i_1 = \mathrm{Sin}^2\,(kE_{RF})$$

where i_1 is the instantaneous intensity in the first order diffracted beam and E_{RF} is the instantaneous RF envelop voltage applied across the matched transducer at the centre frequency.

When the RF voltage is applied to the piezoelectric transducer, acoustic waves are generated and launched into the crystal interaction medium. Associated with this acoustic wave is a strain induced change of the refractive index in the medium.

Interaction of the light beam with the acoustic wave results in optical beam diffraction. If the incident light beam strikes the acoustic wave front at a specific angle, called the Bragg angle (θ_{BRAGG}), then efficient diffraction of light into the first order occurs. The diffraction efficiency from the zero to first order can be up to 90%. Some diffraction may be seen in the opposite first and high orders. The first order light beam is deflected by twice the Bragg angle ($\theta_{SEP} = 2\theta_{BRAGG}$).

OPERATING PROCUDURE

1. The standard AO Modulator may be mounted in any orientation. Either optical aperture may be used as the entrance aperture. Align the AO Modulator so that the laser beam is normal to the entrance surface with laser polarization parallel to the mounting base.

2. Attach a 50Ω Coax cable from the SMA connector of the AOM to the RF output of the driver (digital or analog). Set the driver RF power level to some nominal value (about 30%) below the saturation level as indicated on the modulator test data sheet.

3. Align the AOM to insure that the incident light beam is centred in the active aperture

4. Rotate the deflector slightly until deflection of the light beam occurs. Diffraction occurs in the horizontal plane. Select the diffraction spot next to the undiffracted “zeroth order” beam and monitor the light intensity by using either a photodetector or a light power meter. Re-adjust the Bragg angle for maximum deflected light intensity into the “First Order” output. Fine tuning of the incident light beam position may be necessary for optimum results.

5. Adjust the RF power level for the desired light intensity. Exceeding the maximum drive power indicated on the data sheet could damage the modulator.

Remember:
Optimize the Bragg angle BEFORE increasing RF power

MAINTENANCE

1. Cleaning

   It is important that the optical surfaces of the modulator be kept clean and free from contamination.

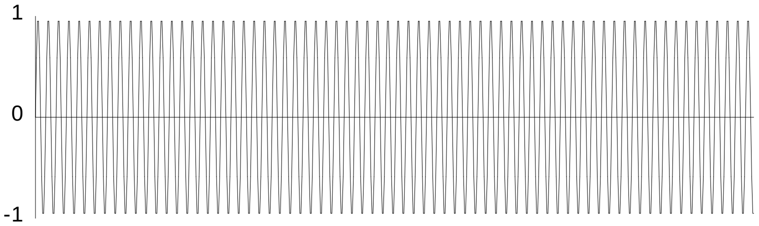
   Prior to assembly into users' equipment, the modulator case apertures should be kept covered.

   Dust or dirt accumulated on the optical surfaces of the crystal may, in many cases be removed by a pressurized jet of filtered dry air.

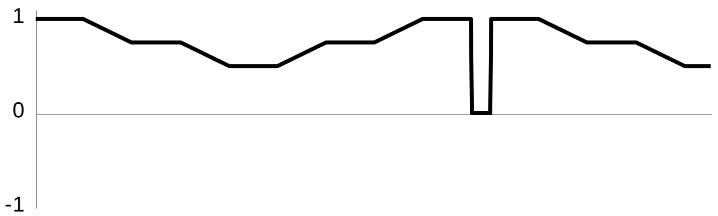
   In time, it may be necessary to remove atmospherically deposited films from the optical surfaces. Although the AR coatings are hard and durable, care must be taken to avoid scratching the surfaces. It is suggested that the coating be wiped with a soft ball of brushed cotton moistened with acetone or alcohol. After wiping, examine the optical surfaces for cleaning solution residue and, if necessary, repeat the above procedure.

2. Troubleshooting

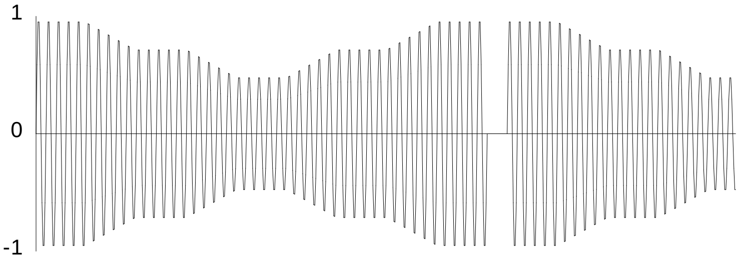
   Troubleshooting should be limited to checking the alignment and operating procedures. If difficulties arise, note the symptoms and contact the manufacturer.



RF Carrier



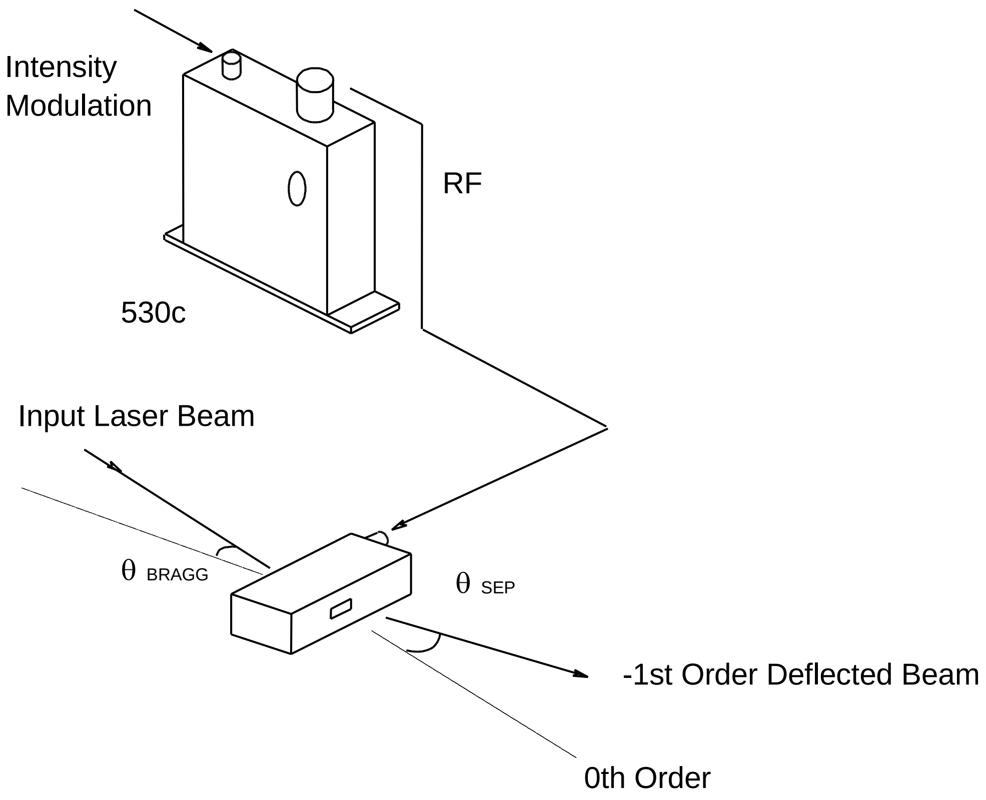
Video Input



Modulated RF

Figure 1: Typical Analog Modulation Waveforms

Schematic for an AO modulator with 530c series analogue driver



The input Bragg angle, relative to a normal to the optical surface and in the plane of deflection is :

$$\theta_{BRAGG} = \frac{\lambda.fc}{2.v}$$

The separation angle between the zeroth order and the first order outputs is :

$$\theta_{SEP} = \frac{\lambda.fc}{v}$$

Optical rise time for a Gaussian input beam is approximated by :

$$t_r = \frac{0.65.d}{v}$$

where : λ = wavelength
fc = centre frequency
v = acoustic velocity of AO interaction material = 4.21mm/usec (TeO_2)
= 3.63mm/usec ($PbMoO_4$)
= 5.96mm/usec (Fused Si)
d = $1/e^2$ beam diameter

Figure 2: Modulation System