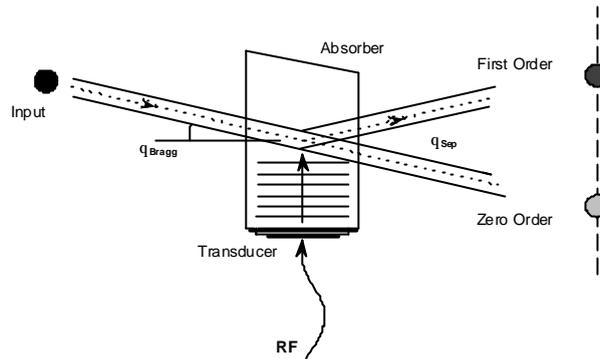


AN1106

Nov11

## Maximizing AO Diffraction efficiency

Efficiency is typically defined as the ratio of the zero and first order output beams:



$$\text{Diffraction Efficiency (DE)} = \frac{\text{First order (RF On)}}{\text{Zero order (RF Off)}}$$

In addition the device exhibits insertion losses due to absorption in the bulk material and losses at the A.R coated surfaces.

$$\text{Transmission (TX)} = \frac{\text{Zero order (RF Off)}}{\text{Input Power}}$$

Or alternatively, the insertion Loss (IL) is specified, where  $IL = (1 - TX) \%$

The total throughput efficiency is a combination of the above:  $TE = DE \times TX \%$

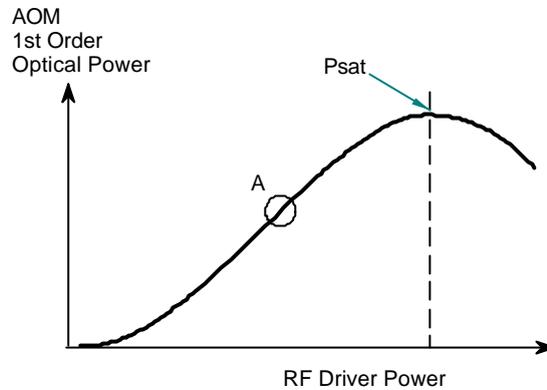
Maximum efficiency is achieved at the when the applied RF power is at the saturation value. This value is given by:

$$P_{\text{sat}} = \frac{k \cdot \lambda^2 \cdot H}{2 \cdot L \cdot M_2}$$

where :

v	= acoustic velocity	L	= interaction length
f <sub>c</sub>	= RF centre frequency	λ	= wavelength
H	= electrode height	L	= electrode length
M <sub>2</sub>	= Figure of Merit	k	= Conversion loss (1.12 typ.)

## Drive Power Characteristic



As can be seen from the curve above, applying RF power in excess of  $P_{sat}$  will cause a decrease in first order intensity (a false indication of insufficient RF power)

**DO NOT operate beyond  $P_{sat}$ . This will cause excessive thermal effects and may damage the AO device**

**It is important to set the input Bragg range and laser beam position correctly BEFORE optimizing the efficiency by adjusting the RF power.**

The correct sequence is:

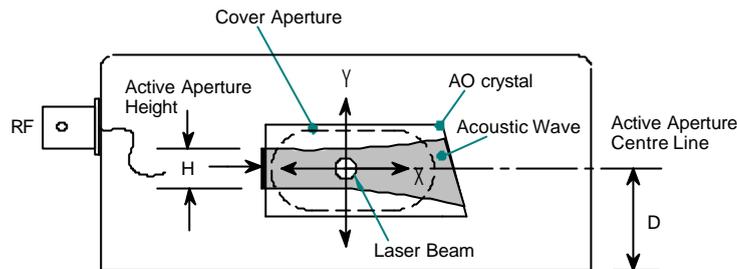
- 1: Set beam height in aperture
- 2: Adjust Bragg Angle at low RF power
- 3: Set RF Power

Specific values for beam height and Bragg angle are given in the appropriate device data sheets.

## 1: Beam Height and Position

Ensure beam is on the acoustic axis and central to the aperture width.

Diagram below shows a generic AO crystal outline and the acoustic column position. Best results are achieved when the laser is placed over the AOM Bragg pivot point (this is usually above a dowel pin hole in the base) and at a height (D) above the base that is on the active aperture center line.



Input Beam Location  
 Y axis : Centre the beam in Active Aperture height H, on centre line D mm above base  
 X axis : Not critical but avoid clipping device cover

(See AO data sheet for dimension D)

## 2 : Bragg Angle adjustment

For accurate Bragg alignment set the initial RF power to a low level, so that the AOM is operating in the linear region ( e.g. Area 'A' in the Drive Power curve above)

As a guide, use approximately half the drive power stated in the AO data sheet.

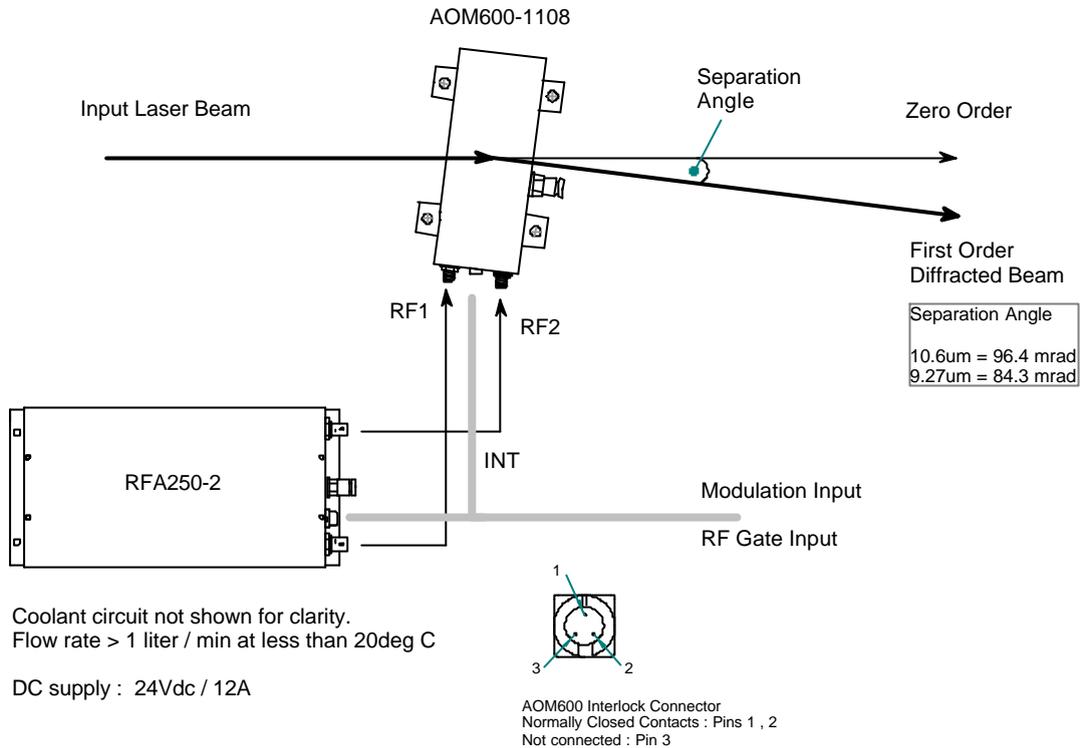
Maximize the efficiency by carefully rotating the AO device with respect to the input laser beam.

The angular adjustment is quite sensitive

The exact Bragg angle is given by:

$$\theta_B = \frac{\lambda f_c}{2.v}$$

Diagram below shows the Bragg angle setting for the AOM600 operating at centre frequency of 50MHz.



### 3: RF power Set

AFTER the beam position and Bragg angle have been optimised, slowly increase the RF power (rotate PWR ADJ CW) until the first order laser intensity stops increasing and reaches the saturation power level; Psat.

[For applications with a diverging or converging input beam in the AOM, the correctly adjusted Bragg angle condition is indicated when the zero order shows a characteristic dark line through the middle of the beam at or near the Psat drive level]

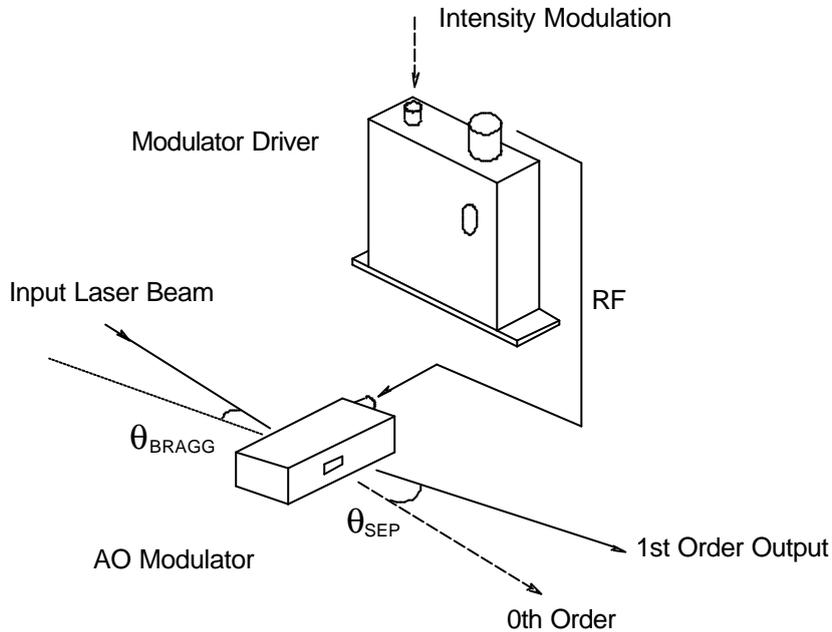
Note:

All AO devices are limited by the total RF power dissipation.

The RF drive power increases with the square of the wavelength.

In some cases the Psat power is higher than the safe operating maximum limit for the AO device. In such cases the diffraction efficiency is limited by the applied drive power rating.

## Schematic of an acousto optic modulator and driver



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

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

The separation angle between the zeroth order first order outputs is given by:

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

Optical rise time for a Gaussian input beam is approximately:

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

where :

$\lambda$	=	wavelength
$fc$	=	centre frequency
$v$	=	acoustic velocity of interaction material
$d$	=	$1/e^2$ beam diameter