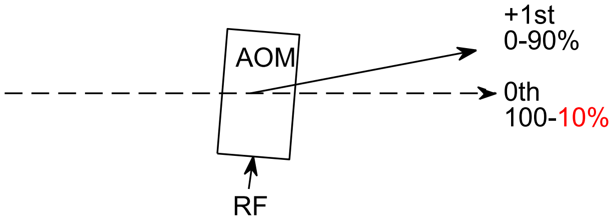
Dual beam / Beam Splitting options using AO

An overview of various AO modulation methods is shown below.

A: Basic Modulator Configuration

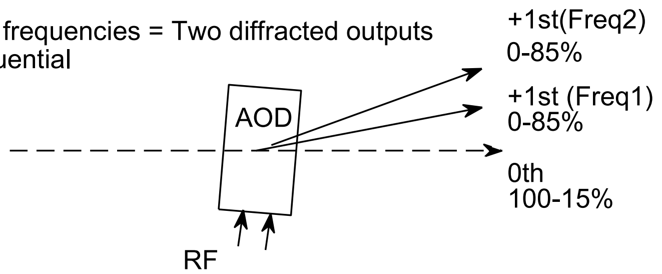
One frequency = One diffracted output
0th order cannot be 0%



0th order + 1st order always = 100%

B: Multispot / Deflector Configuration

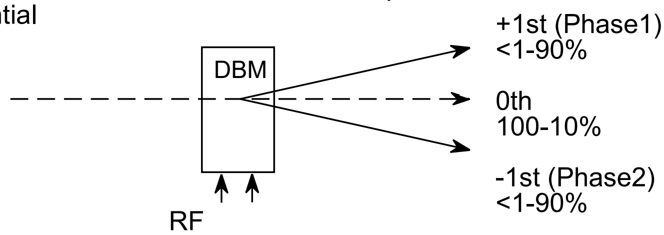
Two frequencies = Two diffracted outputs
Sequential



+1st (Freq1) and +1st (Freq2) powers independent

C: Dual Beam Phase Switching Modulator

One phase reversal = Two diffracted outputs
Sequential



+1st order and -1st order powers independent

Configurations B and C generate multiple diffracted beams from a single laser input.

- Config B is the classical approach using a change in RF drive frequency to create two or more spots. **OFF state beam is < 0.001%** of input power

- Config C is a unique design using a change in phase of the RF drive frequency to create two spots, each one either side of the zero order. **OFF state beam is <1%** of input power

All these methods produce spots that are sequential in time

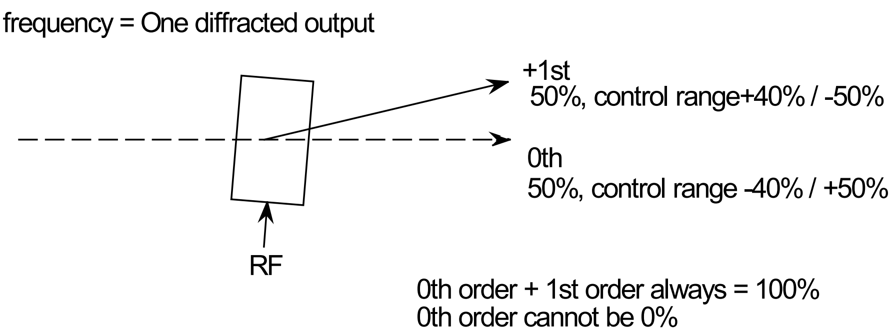
Beam Splitting: Configuration A

A simple AOM can be used as an adjustable beam splitter. Controlling the RF drive power adjusts the beam splitter ratio.

Pros: Both beams output simultaneously.
Simple.

Cons: Power control is not independent. If the 1st order is increased, the zero order will reduce.
The **0^{th} order beam will always have residual light** even at maximum efficiency.
Complete "OFF" modulation is not possible for the 0th beam.

The diagram below shows a nominal 50-50 beam splitter. E.g. RF drive power is adjusted to compensate for imbalances in the remainder of the optical system.



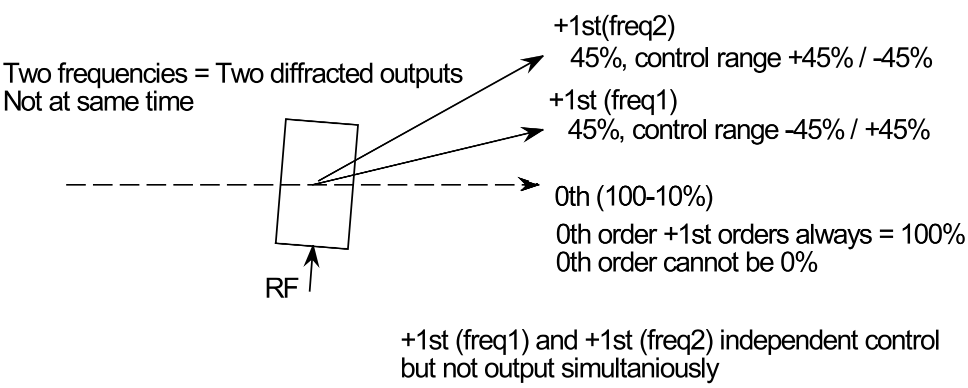
Beam Splitting: Configuration B

An AOD can also be used as an adjustable beam splitter. Controlling the RF drive power at each frequency adjusts the beam splitter ratio of the two (or more) diffracted outputs.

Pros: Independent power control for each 1^{st} order beam
Full ON:OFF modulation is possible for both 1^{st} order diffracted beams

Cons: 1^{st} order beams are NOT output simultaneously

The diagram below shows a nominal 50-50 beam splitter.



(The % figures shown are for the ideal case and ignore losses)

Pulse control: Configuration B

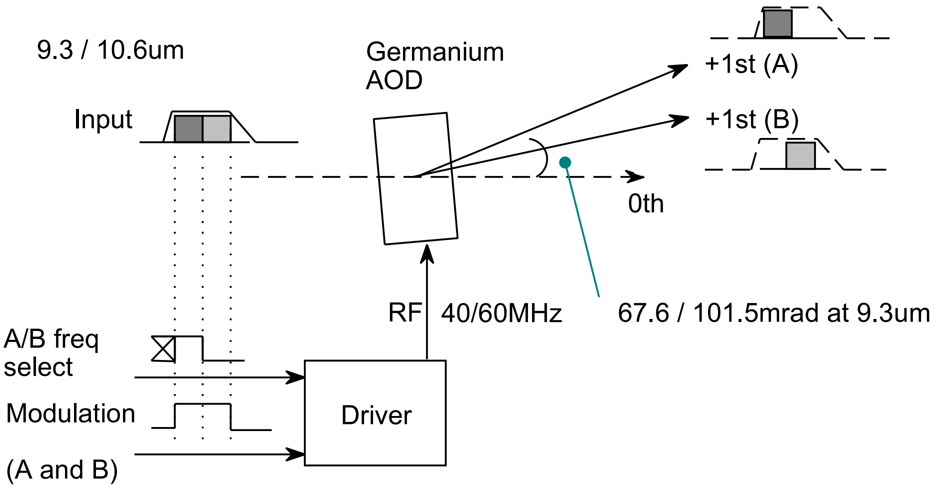
AO deflectors can be used for pulse shaping, modulation and multiple beam generation. The method will depend on the laser pulse width.

Pulse splitting
Long laser pulses can be divided as shown in 'Pulse Division'. This requires the laser pulse width to be longer than the transit time of the acoustic wave across the laser beam.

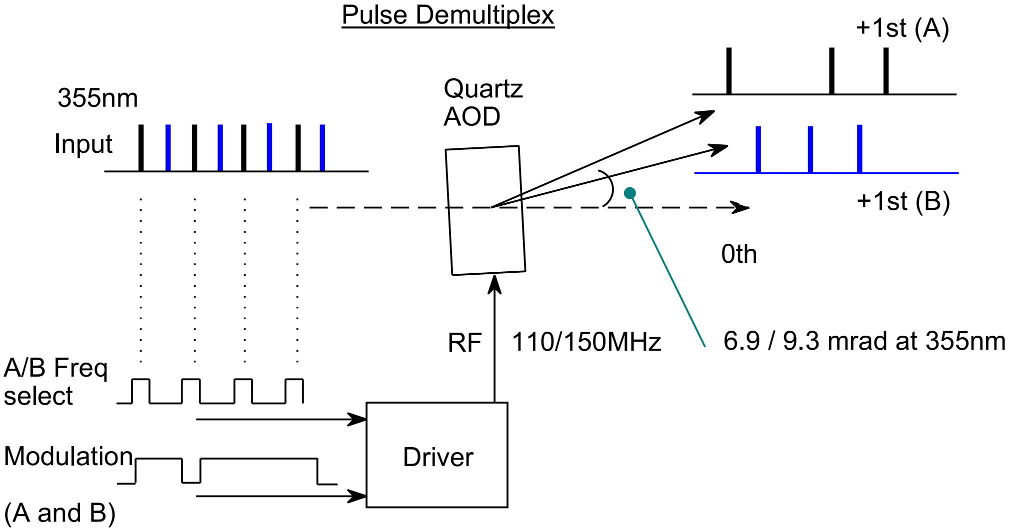
Pulse Demultiplexing
Short laser pulses can be demultiplexed as shown in 'Pulse Demultiplex'
This demultiplexing creates two beams at half (say) the input repetition rate with the benefit of pulse-to-pulse power control.

Multispot / Deflector Configurations

Pulse Division



Pulse Demultiplex



Pulse control: Configuration C

Pulse width considerations also apply to **Dual Beam Phase Switching Modulators**

Long laser pulses can be divided as shown in ‘Pulse Division’. This requires the laser pulse width to be longer than the transit time of the acoustic wave across the laser beam.

Short laser pulses can be demultiplexed as shown in ‘Pulse Demultiplex’
This demultiplexing creates two beams at half the input repetition rate

Caution: Dual Beam Phase Switching Modulators exhibit OFF leakage.
The OFF-condition beam (A or B) will have significant residual laser power. These devices are best suited to applications with high marking thresholds.

Dual Beam Phase Switching Modulator Configurations