

Feb 10



## **Acousto-Optic Modulator Amplifier**

**Including: Basic Modulator/Q-switch Alignment**

### **Instruction Manual**

### **RFA901-x Series**

#### Models -

|            |                          |
|------------|--------------------------|
| RFA901-0-x | : 30-50MHz, >10W output  |
| RFA901-1-x | : 40-60MHz, >10W output  |
| RFA901-2-x | : 60-100MHz, >10W output |

#### Options -x:

|     |   |
|-----|---|
| - L | : active low digital modulation (gate)<br>no connection RF disabled |
| - V | : 0-5V analog modulation range                                      |
| - A | : analog modulation only. No RF gate                                |
| - F | : fan fitted  |

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1. GENERAL

The RFA901 series are medium power RF amplifiers designed to operate with a range of Isomet acousto-optic modulators and Q-switch devices. The driver accepts two independent digital and analogue modulating signals and provides a double-sideband amplitude modulated RF output to the acousto-optic modulator. A summary of the driver specification is shown in the following table:

|           | <u>Freq' Identifier</u> |          | <u>Option</u> |          |
|-----------|-------------------------|----------|---------------|----------|
| RFA901    | -                       | <b>B</b> | -             | <b>X</b> |
| Range     |                         |          |               |          |
| 30-50MHz  |                         | <b>0</b> |               |          |
| 40-60MHz  |                         | <b>1</b> |               |          |
| 60-100MHz |                         | <b>2</b> |               |          |
|           |                         |          | <b>F</b>      | Fan      |

Figure 2 is a functional block diagram of the amplifier. The input frequency source level should not exceed 3mW. The amplifier gain is approximately 37dB.

**For the RFA901-2, the amplifier broadband response is optimized for an input signal of 200mVpp (50ohm)**

A high-frequency, diode ring modulator is used to amplitude-modulate the RF carrier. The single turn potentiometer provides gain control for adjusting the maximum r-f power at the Driver output.

A solid state switch provides the Digital Modulation or RF Gating function. A TTL high level will gate the RF ON. The MMIC r-f pre-amplifier stage isolates the low level modulation and control circuitry from the power amplifier stage.

The rise and fall times for the amplifier from either modulation input is identical (approx 200nsec and 40nsec resp').

**The video analog input level must not exceed 15 volts**

**The digital input level must not exceed 7 volts**

This amplifier is designed to operate at full rated power into a 50Ω load with 100% duty cycle.

**Forced air cooling is recommended. The heatsink temperature must not exceed 70°C.**



**SERIOUS DAMAGE TO THE AMPLIFIER MAY RESULT IF THE TEMPERATURE EXCEEDS 70°C. SERIOUS DAMAGE TO THE AMPLIFIER MAY ALSO RESULT IF THE RF OUTPUT CONNECTOR IS OPERATED OPEN-CIRCUITED OR SHORT-CIRCUITED.**

A low impedance d-c power source is required. The operating voltage is +24V or +28Vdc at a current drain of approximately 1.5A. The external power source should be regulated to  $\pm 2\%$  and the power supply ripple voltage should be less than 200mV for best results.

The output power level is set by the power adjust potentiometer (PWR ADJ)

**NOTE : Maximum power = fully clockwise**

## 1.1 ANALOG MODULATION

To intensity modulate a laser beam in an acousto-optic modulator requires that the input RF carrier voltage (power) be varied according to the video or baseband information. From the viewpoint of intensity modulation, the deflection efficiency equation is normalized as:

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

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

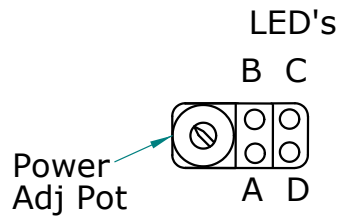
In effect, the acousto-optic interaction demodulates the RF carrier, transforming the modulation envelop (baseband signal) into intensity variation of the first order diffracted laser beam.

Figures 3 and 5 show the main AO modulator parameters

## 2 LED INDICATORS

The front panel LEDs serve to indicate a number of possible operating states.

The LEDs [C] and [D] illuminate when the DC power is applied and the Interlocks are valid.



- [A] Shows GREEN when the RF output is live PROVIDED:
  - a) the modulation duty cycle is more than 20% (approx).
  - b) the RF CW power is > 25% (approx) of the driver maximum power
- [B] Shows RED if the RF output is disabled by the output protection circuitry. (High VSWR)
- [C] shows RED when the DC power is applied
- [D] shows GREEN when the (thermal) Interlocks are enabled

**Caution**, the RF output may be live even if these LED's are not illuminated.

### LEDs Off

The LED [A] will not illuminate if the RF output is low power or low duty cycle

The LEDs [C] and [D] will not illuminate if :

- a) the internal driver thermal interlock switch is open (Over temperature fault)
- b) the AOM thermal interlock switch is open (Over temperature fault)
- c) the AOM thermal interlock is not connected to the driver interlock input
- d) the DC supply is off.



The thermal interlocks will reset once the AO device and / or RF driver are cooled below the switching temperature.

- The driver thermal switch over temperature point is 50deg C
- The AOM thermal switch over temperature point is device dependent.  
(Typical values are 32deg C or 40deg C)

The hysteresis of the thermal switches is in the range of 7-10deg C.

Once in a fault state, it may be necessary to reduce the coolant temperature to reset the thermal switches.

The LED [B] will not illuminate if the RF output is disconnected or connected to an unsuitable load

Once the load fault has been corrected, the driver can be reset by turning the DC supply OFF and ON



### 3. INSTALLATION AND ADJUSTMENT

3.1 Ensure adequate air flow over the heat sink / fan

3.2 With no d-c power applied, connect the + 24V DC in to the center terminal of the feed-thru terminal. DO NOT APPLY POWER.

3.3a Connect the RF output BNC jack to the acousto-optic modulator (or a 50Ω RF load, if it is desired to measure the modulator RF output power).

3.3b Connect the RF input SMA jack to the frequency source (e.g. Isomet iDDS synthesizer). Set the frequency source output level to 200mVpp (into 50ohm)

**3.4** Connect the Interlock of the acousto-optic modulator (SMA, SMC or mini 3pin connector) to the enable inputs on the 9-pin D-type connector of the RFA901. e.g. Connect pin 4 of 'D' to the centre pin of the SMA/SMC and pin 5 of 'D' to the outer ground of the SMA/SMC AO device interlock connector. **(If no interlock connector is fitted to the AO device, link pin 4 and pin 5)**

The interlock connection becomes open circuit disabling the RF output, if the temperature of the modulator exceeds 32°C (device dependent) or the internal driver temperature exceeds 70°C. LED indicator illuminates when the Interlocks are closed and the RF is enabled (see Section 2). In addition, a CMOS 'interlock valid' signal output is provided on pin 1 of the D-type connector for remote monitoring purposes.

3.5 Adjustment of the RF output power is best done with amplifier connected to the acousto-optic modulator and/or RF power meter. The Amplifier maximum output power is factory preset to approx 4W.

**The optimum RF power level required for the modulator to produce maximum first order intensity will be different at various laser wavelengths. Applying RF power in excess of this optimum level will cause a decrease in first order intensity (a false indication of insufficient RF power ) and makes accurate Bragg alignment difficult. It is therefore recommended that initial alignment be performed at a low RF power level.**

3.6 The maximum RF power level is set with PWR ADJ potentiometer on the driver.



- 3.7 With an insulated alignment tool or screwdriver rotate the PWR ADJ potentiometer fully anti-clockwise (CCW) , then clockwise (CW) approx 1/5 turn.
- 3.8 Apply DC to the amplifier.
- 3.9 Apply a 10.0V constant modulation signal to the modulation inputs on the D-type connector. Connect pin 8 of 'D' to the signal and pin 9 of 'D' to the signal return.
- 3.9.1 Apply a constant TTL high level to the digital modulation inputs on the D-type connector. Connect pin 6 of the 'D' to the signal and pin 7 of the 'D' to the signal return.

Input the laser beam toward the centre of either aperture of the AOM/AOQ. For the Quartz AO devices ensure the polarization is vertical with respect to the base and the beam height does not exceed the active aperture height of the AOM/AOQ.

#### AO Modulator/Deflector

Start with the laser beam normal to the input optical face of the AOM and very slowly rotate the AOM (either direction). See Figure 4 below for one possible configuration.

- 3.10 Observe the diffracted first-order output from the acousto-optic modulator and the undeflected zeroth order beam. Adjust the Bragg angle (rotate the modulator) to maximise first order beam intensity.
- 3.11 After Bragg angle has been optimized, slowly increase the RF power (rotate PWR ADJ CW) until the maximum first order intensity is obtained **OR up to the maximum average RF power level recommended for the specific AO Device**. See AO devices data sheet . **BEWARE** not to exceed the AO device maximum RF power rating
- 3.12 The driver is now ready for use for modulation using both the digital and the analog inputs.

AO Q-Switch

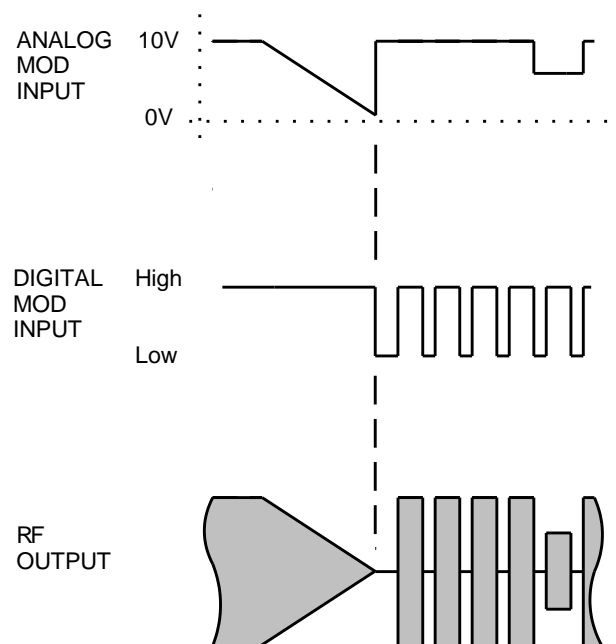
3.10 Observe the CW laser output (= the undeflected zeroth order beam from the AOQ). Adjust the AOQ Bragg angle (rotate the device) to minimize the laser output beam intensity. If no extinction is observed check the RF driver is operating and applying a CW RF signal to the AOQ. If this is OK, increase the RF power a little and repeat the procedure. After the AOQ angle has been optimized, slowly increase the RF power by turning PWR ADJ clockwise until maximum extinction of the laser output is obtained. **BEWARE** not to exceed the AO device maximum RF power rating.

3.11 On the threshold of the optimum RF power, the laser output will flicker On and Off. If possible adjust the beam height relative to the mounting surface in order to optimize efficiency. The goal is to achieve the best hold off and extinction for the least RF drive power.

3.12 Introducing an AOQ into the laser cavity may affect the oscillation properties of the laser. This is due to the refractive index of the AOQ and consequential path length change. It is quite possible that a negative insertion loss is recorded simply by placing the AOQ into the laser cavity !

3.13 After the AOQ is introduced into the cavity, some adjustment of the laser mirror(s) may be required to peak the CW laser power, prior to AOQ operation.

Typical waveforms







#### 4. MAINTENANCE

##### 4.1 Cleaning

It is of utmost importance that the optical apertures of the deflector optical head be kept clean and free of contamination. When the device is not in use, the apertures may be protected by a covering of masking tape. When in use, frequently clean the apertures with a pressurized jet of filtered, dry air.

It will probably be necessary in time to wipe the coated window surfaces of atmospherically deposited films. Although the coatings are hard and durable, care must be taken to avoid gouging of the surface and leaving residues. It is suggested that the coatings be wiped with a soft ball of brushed (short fibres removed) cotton, slightly moistened with clean alcohol. Before the alcohol has had time to dry on the surface, wipe again with dry cotton in a smooth, continuous stroke. Examine the surface for residue and, if necessary, repeat the cleaning.

##### 4.2 Troubleshooting

No troubleshooting procedures are proposed other than a check of alignment and operating procedure. If difficulties arise, take note of the symptoms and contact the manufacturer.

##### 4.3 Repairs

In the event of deflector malfunction, discontinue operation and immediately contact the manufacturer or his representative. Due to the high sensitive of tuning procedures and the possible damage which may result, no user repairs are allowed. Evidence that an attempt has been made to open the optical head will void the manufacturer's warranty.



## RFA 9x0 Standard Version

### Connection Summary

#### 1.0 'D' Type Control Connection

| <u>Signal</u>   | <u>Type</u> | <u>Pin out connection</u>    |
|---|-------------|------------------------------|
| Digital Modulation / GATE<br>TTL high (>2.5V) = ON<br>TTL low (<0.8V)<br>or no connection = Off | Input       | Signal pin 6<br>Return pin 7 |
| Analogue Modulation<br>0.0V(off) to 10.0V(on)   | Input       | Signal pin 8<br>Return pin 9 |
| Interlock<br>(connect to AO<br>modulator 'INT')   | Input       | Signal pin 4<br>Return pin 5 |
| 'Interlock Valid' monitor<br>(CMOS compatible<br>~15V = OK)                                     | Output      | Signal pin 1<br>Return pin 2 |

#### 2.0 Mounting Holes

4 x 4.2mm clearance

#### Notes:

**Both Digital GATE and Analog Modulation signals need to be applied.**

The interlock signal must be connected. Contacts closed for normal operation.

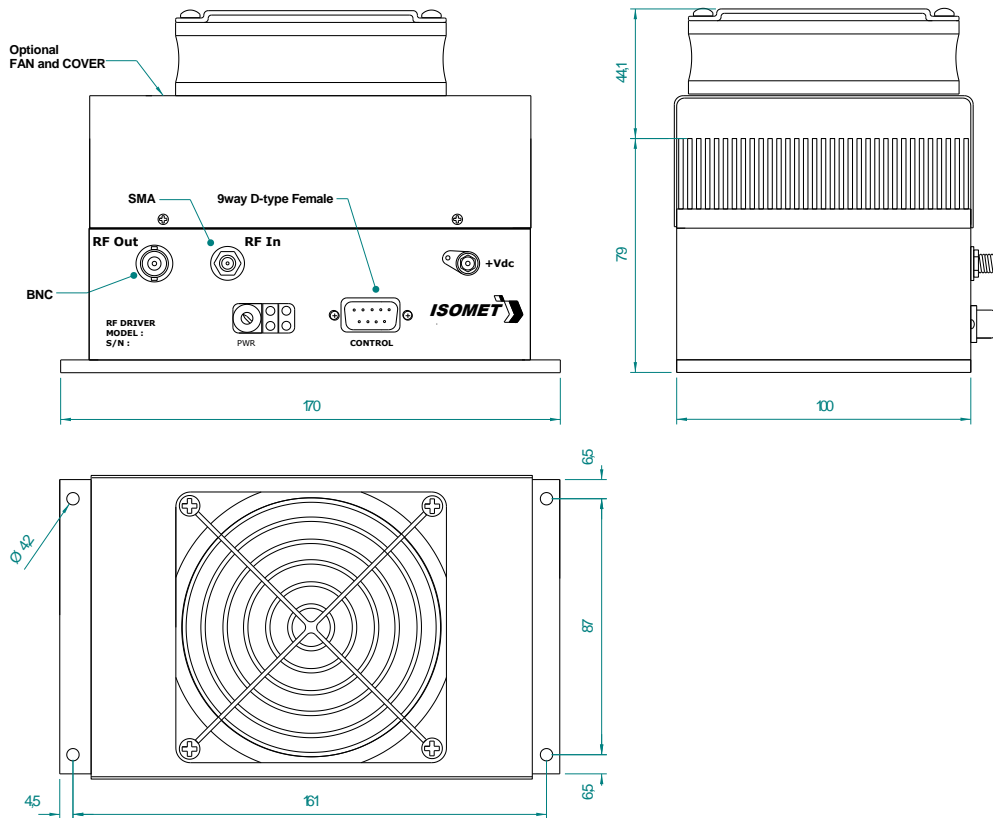


Figure 1: Driver Installation (Driver shown with Fan Option)

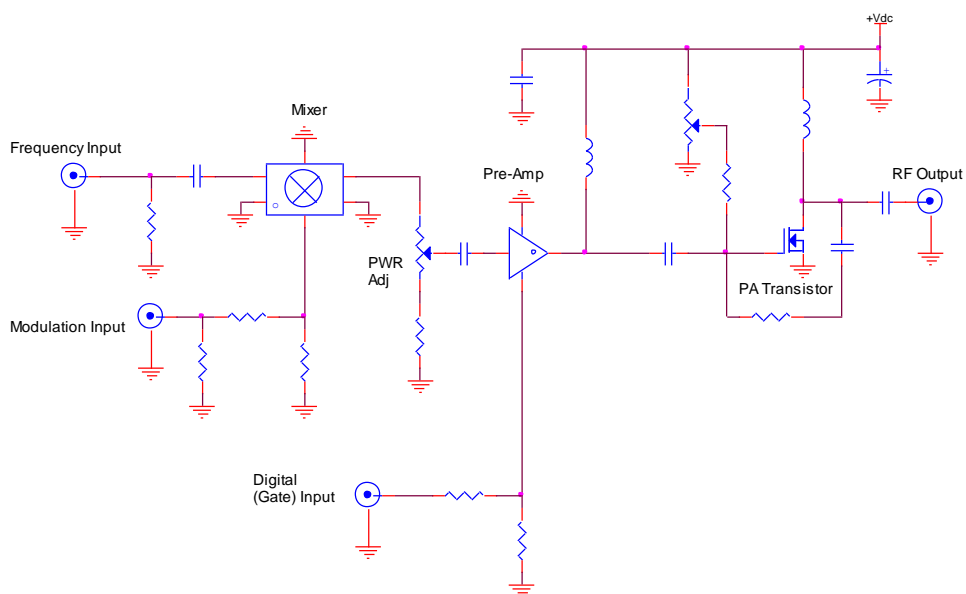
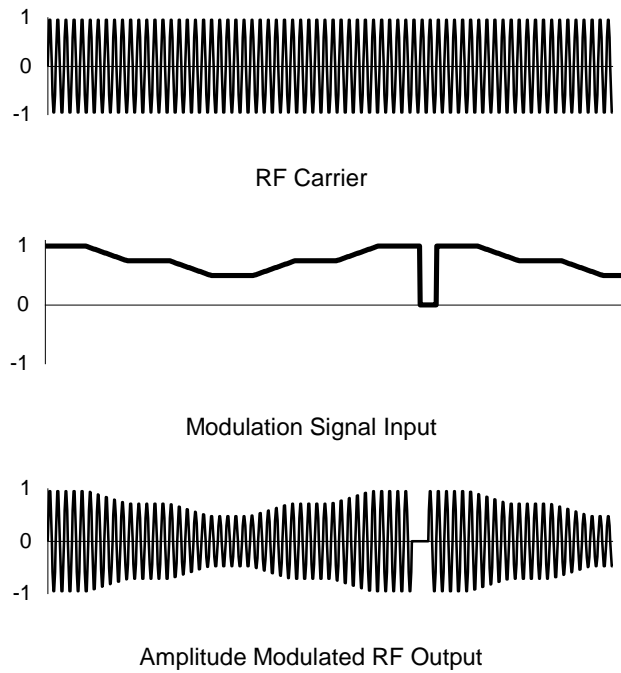


Figure 2: Driver Block Diagram



Typical analog modulation RF waveforms are shown above. For the RFA901 and similar driver/amplifiers, the modulation input is a combination of analog and digital control as illustrated below.

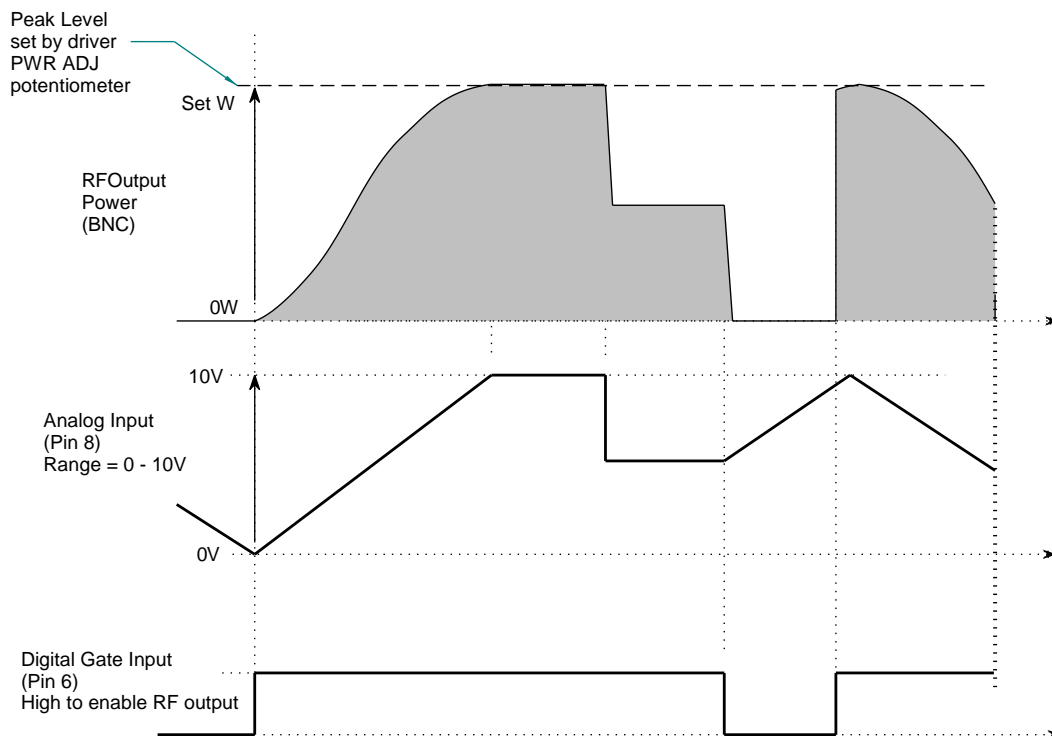


Figure 3: Typical Analog Modulation Waveforms

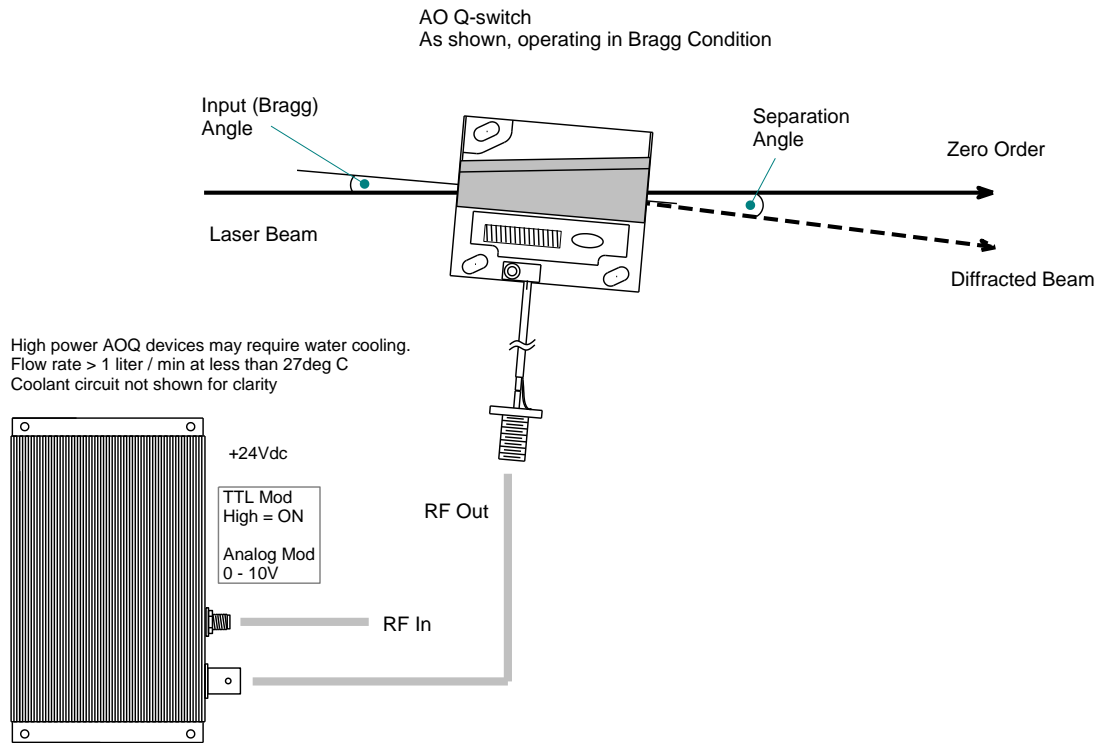
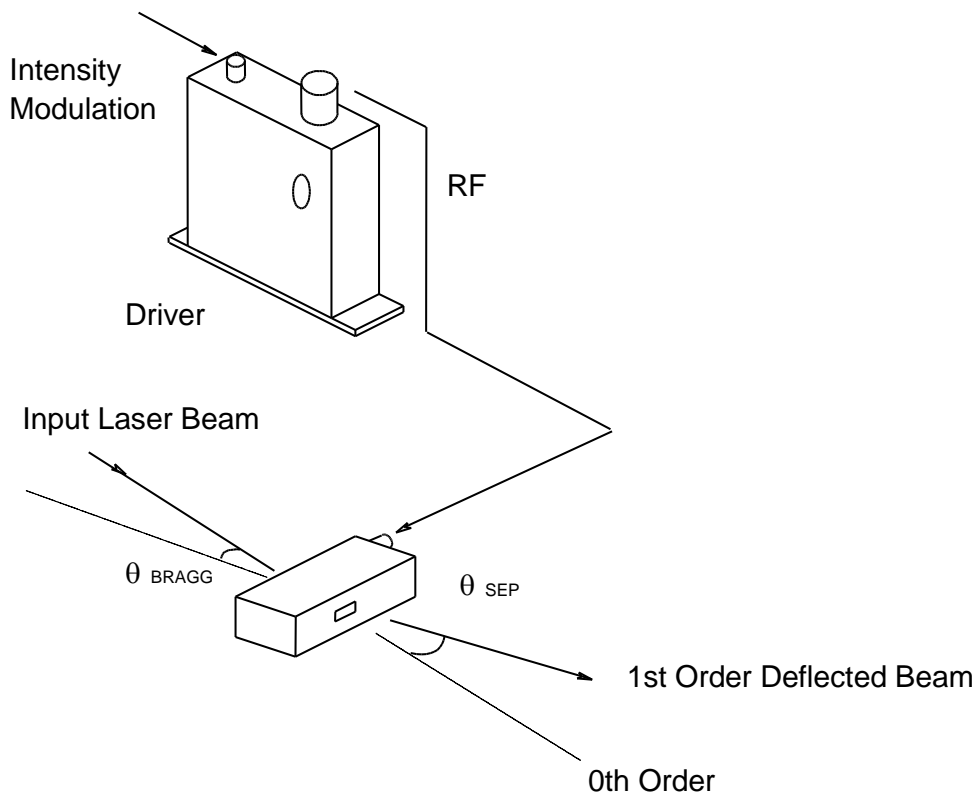


Figure 4: Typical Connection Configuration

### Basic AO Modulator Parameters



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

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

The separation angle between the Zeroth order and the First order is:

$$\theta_{\text{SEP}} = \frac{\lambda \cdot f_c}{v}$$

Optical rise time for a Gaussian input beam is approximately:

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

where:

$\lambda$  = wavelength

$f_c$  = centre frequency = 40.68MHz

$v$  = acoustic velocity of interaction material = 5.7mm/usec (Quartz)

$d = 1/e^2$  beam diameter

Figure 5. Modulation System