



Acousto-Optic Modulator Driver

Including: Basic M1396 Alignment

Instruction Manual

RVx-3848-1-75

RVxBR-3848-1-75 with Brass Heatsink

Models –

Digital Modulation

RV2-3848-1-75 : 38.4/48MHz, 80W output, dual frequency.
RV2BR-3848-1-75 : with brass heatsink.

Analog Modulation

RV3-3848-1-75 : 38.4/48MHz, 80W output, dual frequency
RV3BR-3848-1-75 : with brass heatsink.

ISOMET CORP, 10342 Battleview Parkway, Manassas, VA 20109, USA.

Tel: (703) 321 8301, Fax: (703) 321 8546, e-mail: isomet@isomet.com

www.ISOMET.com

ISOMET (UK) Ltd, 18 Llantarnam Park, Cwmbran, Torfaen, NP44 3AX, UK.

Tel: +44 1633 872721, Fax: +44 1633 874678, e-mail: sales-uk@isomet.com

1. GENERAL

The RVx(BR)-3848-1-75 series are class-A RF drivers compatible with M1396 / M1208 series of Isomet high power Germanium Acousto-Optic modulator/deflectors, delivering up to 80Watts power at 38.4 and 48MHz. The prime frequency of 38.4MHz provides the active "ON" laser output beam. The dummy frequency of 48.0MHz is applied for the "OFF" condition. Switching between two frequencies provides a constant thermal load to the AOM. The "dummy" output beam needs to be blocked in much the same way as the zero order.

The driver features two main inputs; an amplitude modulation signal to control the intensity of the laser beam and a second input to select the active or dummy drive frequency.

The diagram below illustrates. (In this diagram, active freq = 40MHz, dummy = 50MHz)

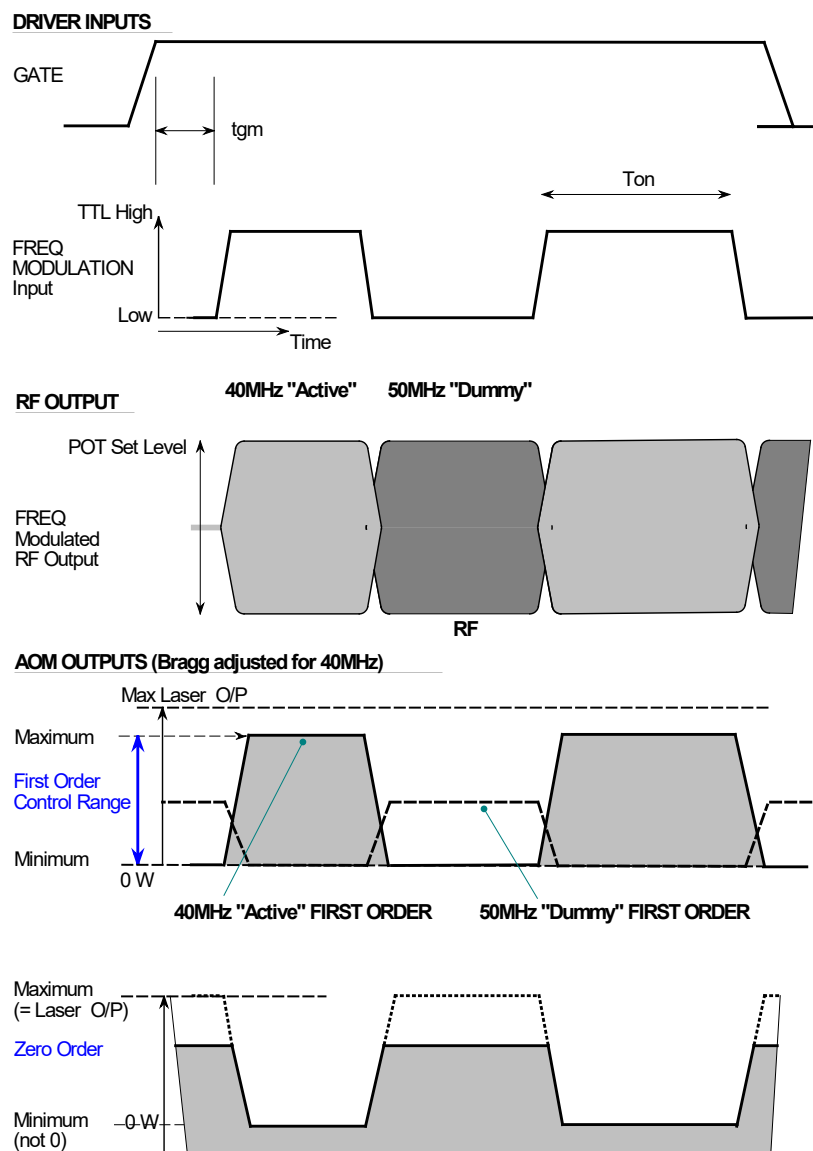


Figure 2 is a conceptual block diagram of the driver. The two center frequencies are determined by free-running quartz-crystal oscillators. The frequency is accurate and stable to within $\pm 25\text{ppm}$. The oscillators are not temperature stabilized.

High-frequency, diode ring mixers are used to amplitude-modulate the RF carriers. Single turn potentiometers provide gain control for adjusting the maximum RF power for both outputs of the driver. One pot for each frequency.

MMIC pre-amplifier stages isolate the modulation and phase control circuitry from the power amplifier stages.

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

There are two control inputs,

- **Fsel:** Frequency select for switching the RF output frequency.

TTL compatible 5V logic.

Note: This input is internally pulled low.

- TTL low level (< 0.8V) will select 48MHz.
- TTL high level (>2.7V) will select 38.4MHz.

- **MOD:** Amplitude Modulation input.

This input controls both RF outputs simultaneously and there are two options depending on the driver model:

RV2-3848-1-, Digital Modulation (Dmod), TTL equivalent ON:OFF control.

Applies to both frequencies.

An input swing of > 2.7V volt (positive with respect to ground) will drive the RF On.

An input voltage of less than 0.8V will drive the RF Off.

RV3-3848-1-, Analog Modulation (Amod), proportional control of RF amplitude.

Applies to both frequencies. The response is pseudo linear.

An input of <0.4V will give minimum RF (OFF).

An input voltage of 10V will give maximum RF output.

The RF switching rise and fall time at full power is approx. 50nsec / 50nsec.

The maximum RF output at each frequency is set by the power adjust potentiometers PWR ADJ1 (38.4MHz) and PWR ADJ2 (48MHz)

NOTE : Maximum RF power = fully clockwise

The digital input levels must not exceed 7 volts

The analog input levels must not exceed 15 volts

Water cooling is mandatory. 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 DC power supply is required. The operating voltage is +24V or +28Vdc at a current drain of approximately 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. Higher RF output power is achieved at 28Vdc.

2.0 MODULATION

The RF POWER ADJUST control sets the peak driver output for the fully ON condition.

RV2-3848-1-, modulation full ON = logic High

RV3-3848-1-, modulation full ON = 10V

Figure 3 illustrate the modulation waveforms.

2.1 LED INDICATORS

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

The LEDs [A] illuminates when the DC power is applied, and the Interlocks are valid.



- [A] shows RED when the (thermal) Interlocks are enabled.
- [B] shows YELLOW when outputs are active.
- [C] shows GREEN when the RF power amplifiers are enabled.

Normal operating condition = all LEDS are ON

LEDs Off

The LED [A] will not illuminate if:

- i. the internal driver thermal interlock switch is open (Over Temperature Fault)
- ii. the AOM thermal interlock switch is open (Over Temperature Fault)
- iii. the AOM thermal interlock is not connected to the driver interlock input.
- iv. the DC supply is off.

The LED [B] may not illuminate or run dim if:

- i. zero or no modulation signal.
- ii. low modulation duty cycle.
- iii. the DC supply is off.

The LED [C] may not illuminate if:

- i. the optional Gate input is set logic high, disabling the amplifier.
- ii. LED [A] is off.
- iii. the DC supply is off.
- iv. high reflected RF power (High Reflected Power fault).

2.2 Resetting over temperature fault (OTF)

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 trip point is 50deg C
- The AOM thermal switch over-temperature trip point is 32deg C

The trip-to-reset hysteresis of the thermal switches is 7-10deg C.

Once in the fault state, the heatsink temperature will need to be reduced to ~22deg C to reset the thermal switches.

See **AN1710** Resetting the AO Thermal Interlock (<https://isomet.com/appnotes.html>)

2.3 Resetting high reflected power (HRP) fault.

Ensure the RF outputs are terminated correctly, and the RF cables are undamaged.

To reset the fault,

- cycle DC power to the RF driver.
- or
- momentarily connect pin 3 to pin 11.

If the fault persists then there may be a fault with the AO device.

3 INSTALLATION AND ADJUSTMENT

Connect cooling water to the driver. Minimum flow rate of 1 litre/minute at <25degC.

For optimum AO performance ensure the flow rate is more than 2 litres/minute at <20degC

Refer to Figure 1. Use of a Corrosion inhibitor is strongly advised.

Connect cooling water to the AO device.

Due to the high RF power dissipated in the AO modulator, it is paramount that the device is operated only when water cooling is circulating.

- 3.1 Connect +24V (or +28V) DC power to the screw terminals as marked. A 10A supply is recommended. DO NOT APPLY POWER.

3.2 Align the AO device to ensure that the incident light beam is centred in the active aperture.

3.3 Connect the RF output BNC jack to the SMA RF input of the acousto-optic device (or a 50-ohm RF load, if it is desired to measure the modulator RF output power

3.4 Connect the Interlock of the acousto-optic device (Binder 719 3-pin snap connector) to the enable inputs on the Interlock connector on the RVx-3848-1-75. Connect pin 1 to pin 1 and pin 2 to pin 2. (See Figure 5)

If the temperature of the modulator exceeds 32°C or the internal driver temperature exceeds 50°C, then the interlock connection becomes open circuit, disabling the RF output. LED indicators illuminate when the Interlocks are closed and the RF is enabled. In addition, a voltage free signals are provided on the D-type connector for remote monitoring purposes.

3.5 Adjustment of the RF output power is best done with driver connected to the acousto-optic device. The driver maximum output power is factory preset to approx' 60W.

The optimum RF power level required for the modulator to produce maximum first order intensity will be different at various laser wavelengths and/or frequencies. 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 relatively low RF power level.

3.6 Locate the two PWR ADJ access holes on the driver end plate.

3.7 If uncertain of the RF power adjustment, start at a moderate power level.
Using an insulated alignment tool or screwdriver, rotate both PWR ADJ1 (38.4MHz) and PWR ADJ2 (48MHz) potentiometers fully anti-clockwise (CCW) i.e. OFF, then increase clockwise (CW) approx. 1/2 turn.

3.8 Apply DC to the driver.

3.9 **RV2-3848 series**, digital modulation:

Apply a TTL high (or 5V) constant modulation signal to the modulation input.

Connect the modulation signal to pin 7 of 'D' type and signal return (0V) to pin 14.

RV3-3848 series, analog modulation:

Apply 10V constant modulation signal to the modulation input on the 15way D-type connector.

Connect the modulation signal to pin 7 of 'D' type and signal return (0V) to pin 14.

3.10 Select then active frequency.

Connect the Freq Select signal to pin 8 of 'D' type and signal return (0V) to pin 15.

- For the 38.4MHz diffracted spot, apply a constant TTL high level (or 5V)

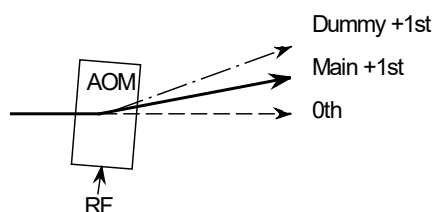
3.11 Alignment (Also refer to Appendix A)

Input the laser beam toward the centre of either aperture of the AO device. Ensure the polarization is horizontal with respect to the base and the beam height does not exceed the active aperture height of the AO device.

Start with the laser beam normal to the input optical face and very slowly rotate the AO device. Direction is related to the RF connection order. See Figures 4 & 5 for possible configurations.

3.12 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.

3.13 After Bragg angle has been optimized for 38.4MHz (Freq Select signal = High), slowly increase the RF power. Rotate PWR ADJ1 for 38.4MHz until the maximum first order intensity is obtained.

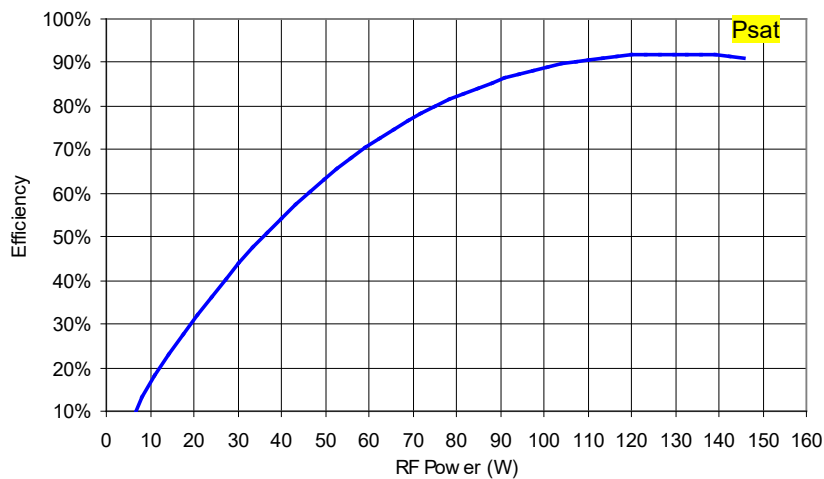


- 3.14 Change the selected Frequency to 48MHz (Freq Select signal = Low).
Increase the RF power for this frequency. Rotate PWR ADJ2 for 48MHz until the same dissipation is obtained at this spot.

To equalise dissipation, alternate between the two frequencies and carefully note the beam shape. Alternatively, compare using an inline RF power meter.

- 3.15 RF power considerations
Refer to the fundamental Efficiency vs. RF power characteristic below.

Typical response



The optimum RF drive power for maximum diffraction efficiency is given by 'Psat' (e.g. at 120W in this plot). This scales with active aperture height and the wavelength²

Due to the \sin^2 response, a ~20% reduction in RF power from the absolute maximum at Psat, results in a ~5% reduction in efficiency. This small sacrifice should be considered to reduce thermal dissipation and minimize undesirable thermal lensing effects.

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 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.

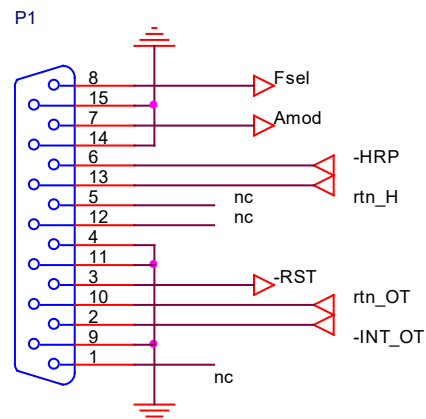
5.0 Connection Summary

15-way male 'D' Type Control Connection

<u>Signal</u>	<u>Type</u>	<u>Pin out connection</u>
Fsel: Frequency Select, TTL. High = 38.4MHz, Low = 48MHz	Input	Signal pin 8 Return pin 15
RV2-3848- Dmod: Digital Modulation TTL * < 0.8V(off), >2.7V(on)	Input	Signal pin 7 Return pin 14
(or)		
RV3-3848- Amod: Analog Modulation. < 0.4V(off), 10.0V(full on)	Input	Signal pin 7 Return pin 14
-INT_OTF: Over Temperature Fault monitor. Open Drain logic, Low = OK Maximum applied voltage (via external pull up resistor) = 5.5V Maximum current = 10mA	Output	Signal pin 2 Return pin 10
-HRP: High reflected power fault monitor. Open Drain logic, Low = OK Maximum applied voltage (via external pull up resistor) = 5.5V Maximum current = 10mA	Output	Signal pin 6 Return pin 13
-RST: Reset high reflected power fault. Internal pull up to 5V via 22Kohm . Momentarily contact to 0V-return to initiate a reset.	Input	Signal pin 3 Return pin11

DO NOT connect:
Pins 1,5,12

Spare 0V (Gnd)
Pins 4,9

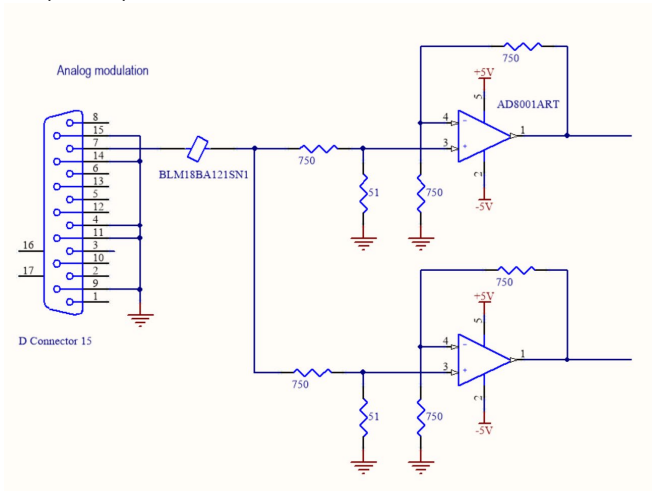


Notes:

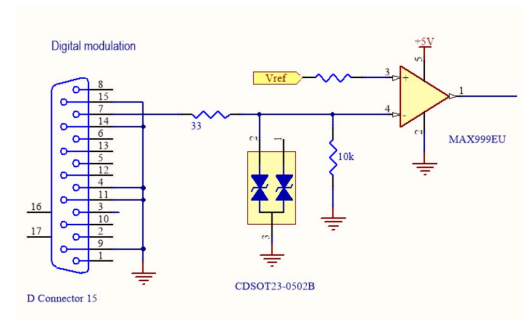
A modulation input signal (pin 7) needs to be applied.
The interlock signal must be connected. Contacts closed for normal operation.

5.2 Internal interface details

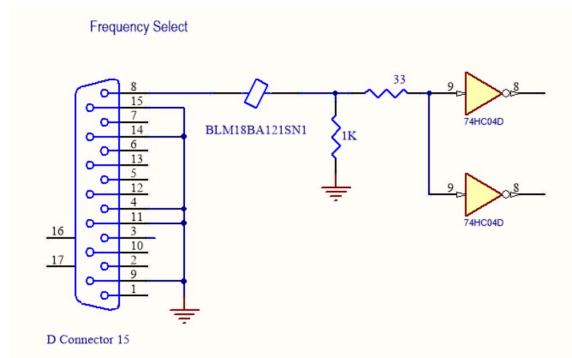
Analog Modulation (Amod) (or)



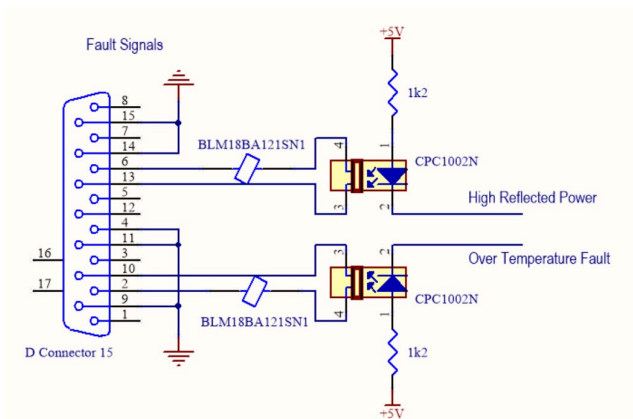
Digital Modulation (Dmod)



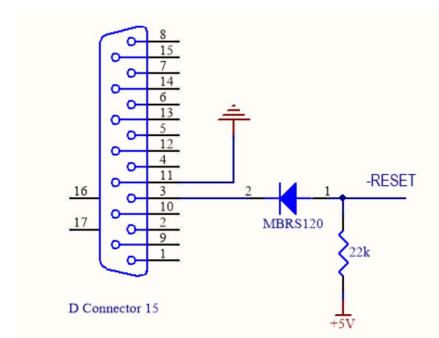
Frequency Select Input, TTL (Fsel)



Fault outputs Solid state relay



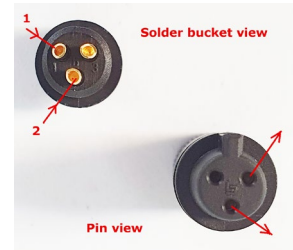
HRP reset



5.3 Interlock Connection (normally closed contact)

Binder 719 connector pin assignment
Isolated thermostatic switch in AO.

Cable Connector Binder719 – 3way		Driver Binder719 – 3way
Pin1	to	Pin1
Pin2	to	Pin2



Binder 719 3-way cable connector (supplied)

5.4 DC Power Connection

Screw Terminals as illustrated below.

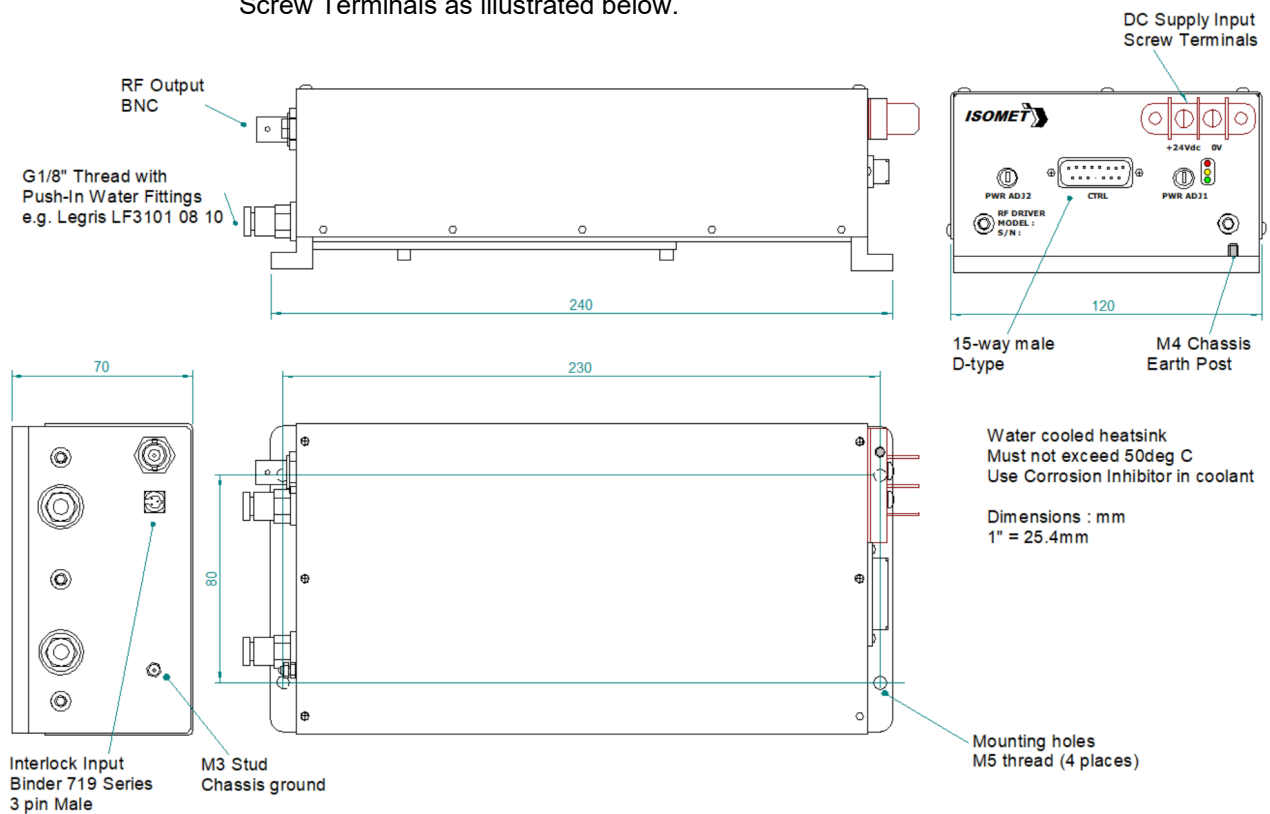


Figure 1: Driver Outline

5.5 RF Power Adjustment: Single turn potentiometers.

- PWR ADJ1 sets the 38.4MHz RF maximum power.
- PWR ADJ2 sets the 48MHz RF maximum power.

5.6 Mounting

Mounting Holes: 4 x M5
Centres spacing: 220mm x 80mm

5.7 Coolant connection

Recommended coolant flow path.

Chillier out > AO > Driver > return

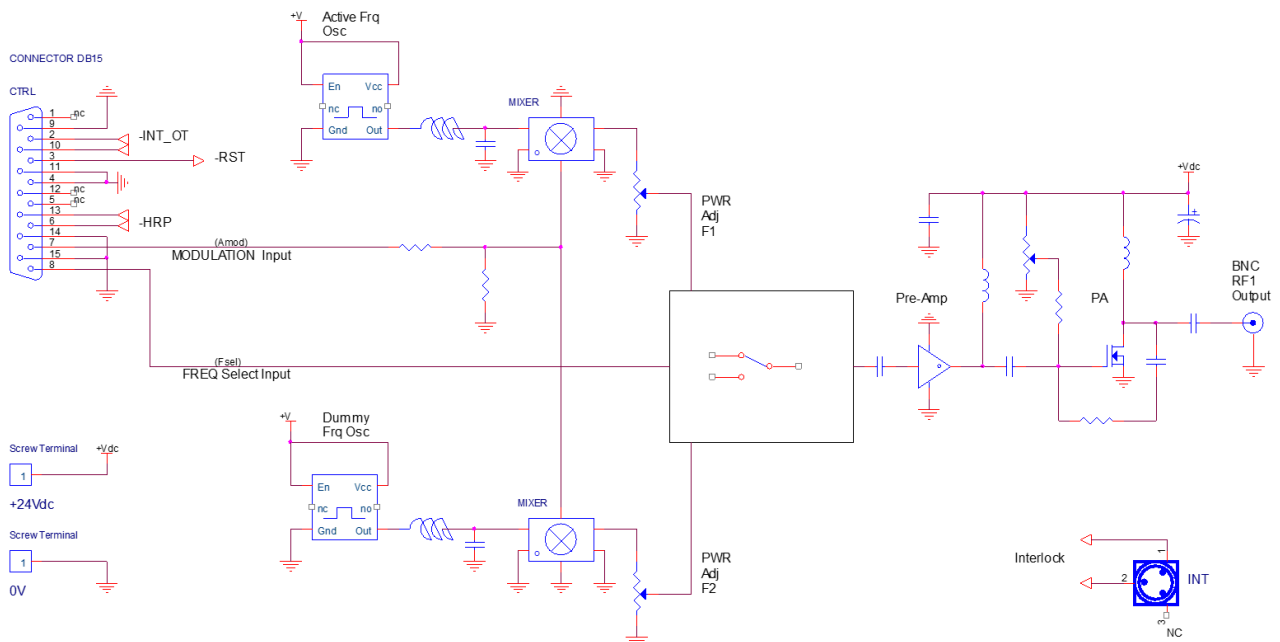
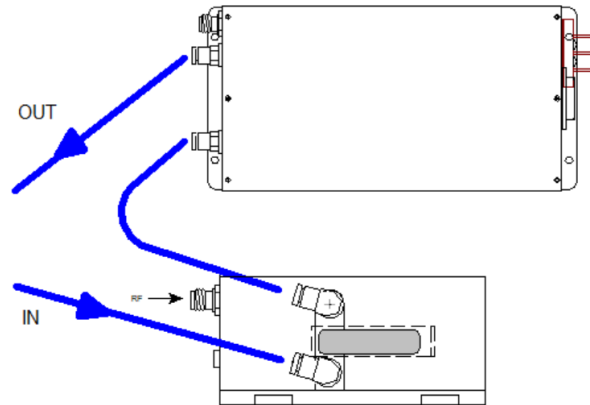
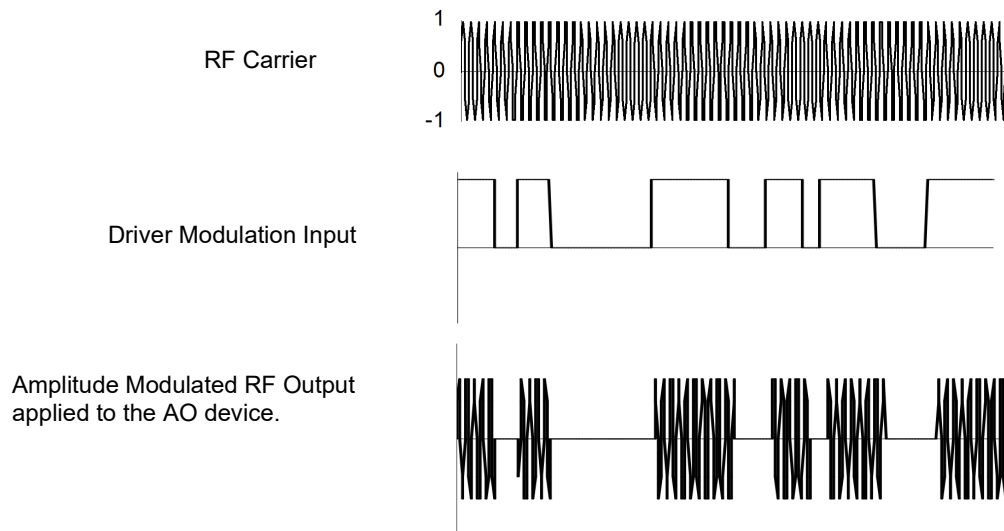


Figure 2: Conceptual Block Diagram

RV2-models: Typical digital modulation RF waveforms.



RV3-models: Typical analog modulation RF waveforms.

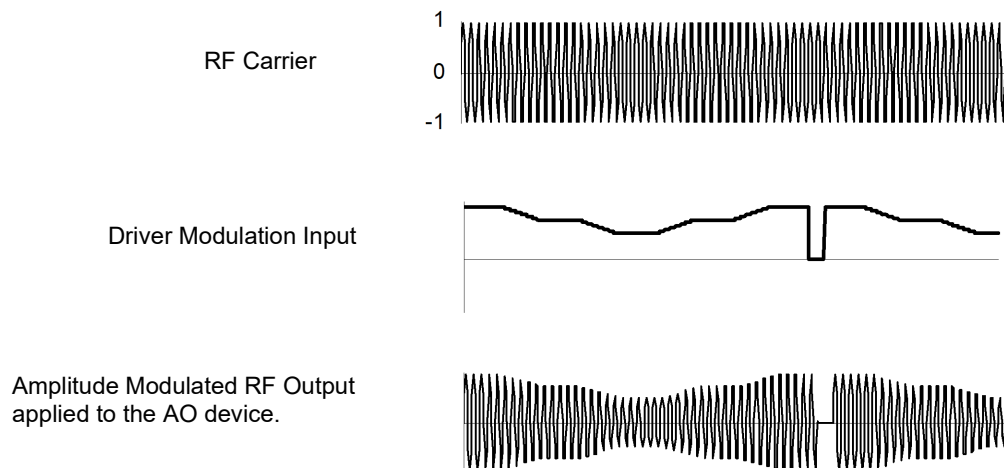


Figure 3: Typical Modulation Waveforms. Modulation impacts both frequencies.

Orientation options

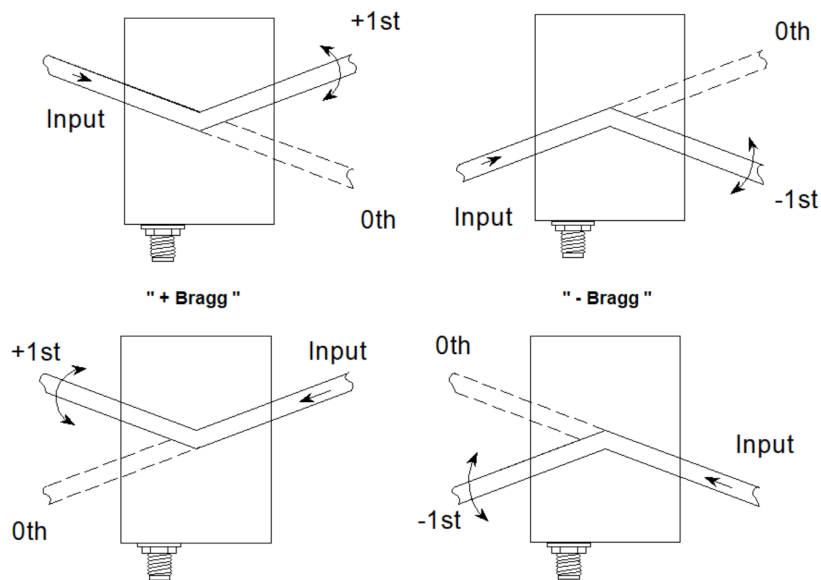


Figure 4: Connection orientations

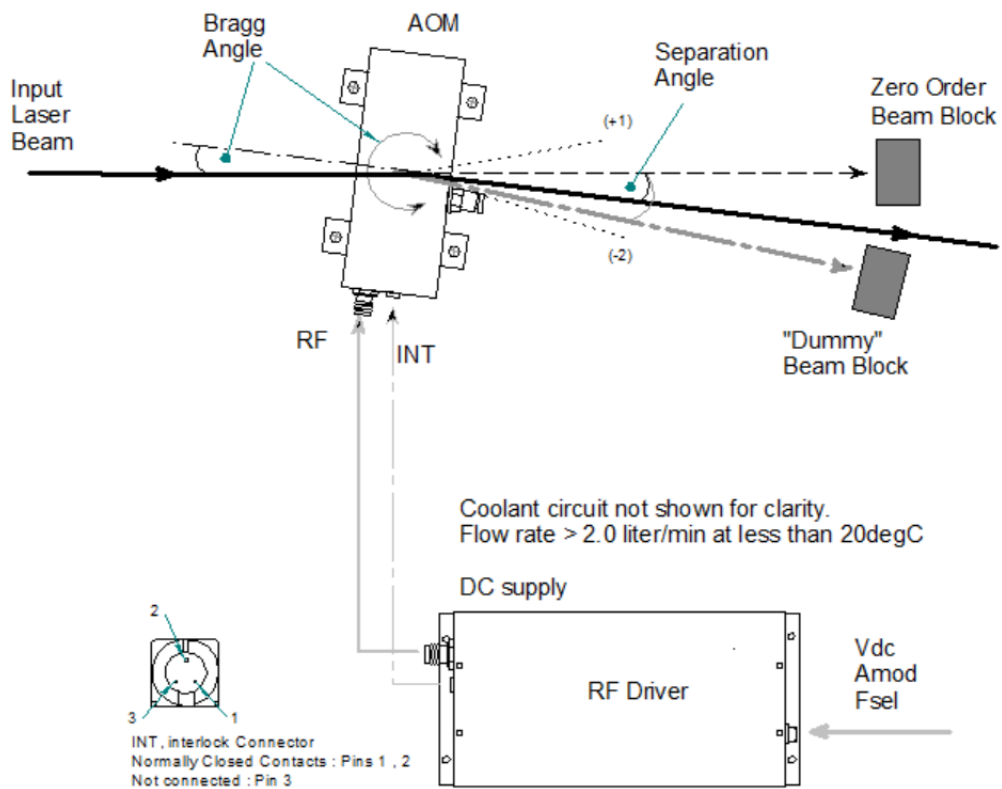
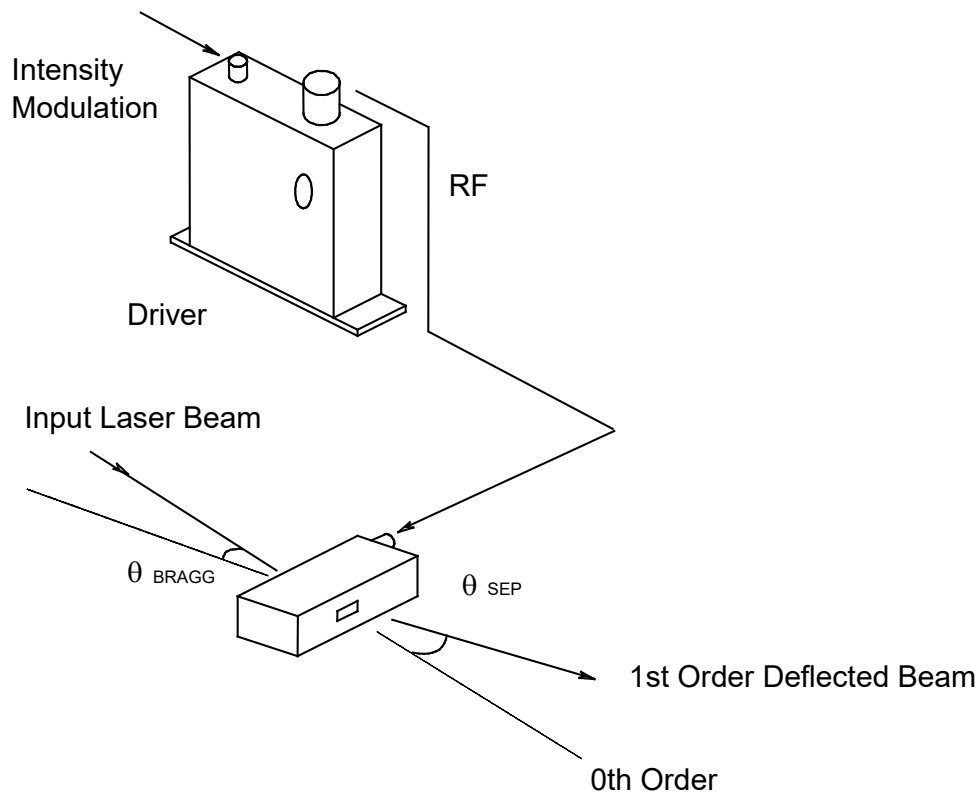


Figure 5: Typical Connection Configuration.

Basic AO Modulator Parameters



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

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

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

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

Optical rise time for a Gaussian input beam is approximately:

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

where:

λ = wavelength

fc = centre frequency = 40MHz / 60MHz

v = acoustic velocity of interaction material = 5.5mm/usec (Ge)

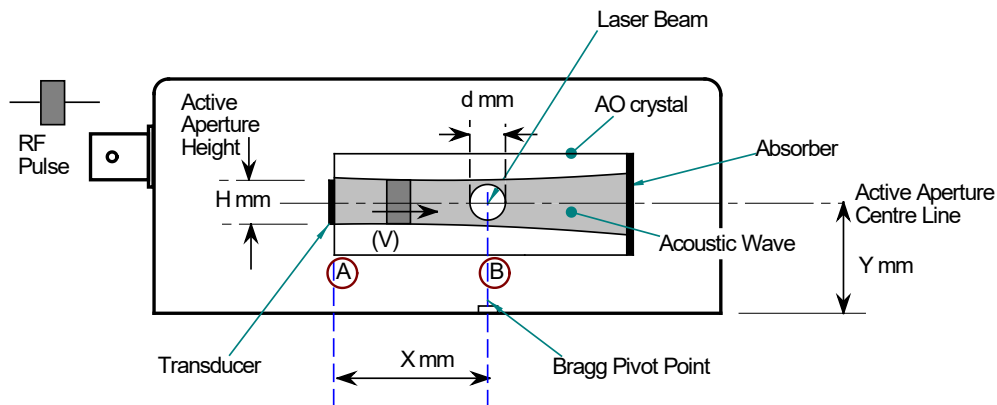
$d = 1/e^2$ beam diameter

Figure 6. Modulation System

Appendix A: Beam Position

Timing Considerations for AO Devices in Pulsed Lasers Applications

When attempting to synchronize a pulsed laser beam with a pulsed RF acoustic wave in an AO device, the designer must consider the transit time of the acoustic wave from the transducer to the laser beam position. This is called the *Pedestal delay*.



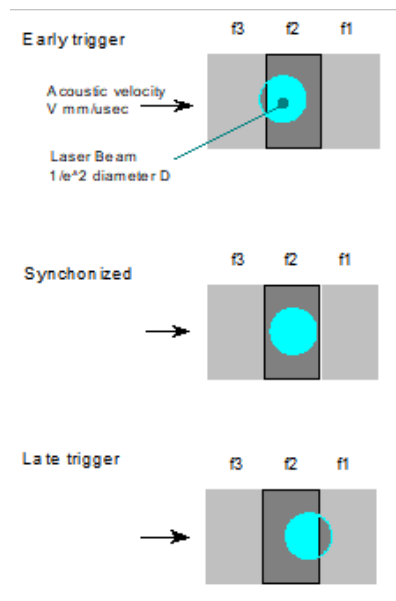
Input Beam Location

Vertical axis: Place the laser beam at the centre of the active aperture at Y mm above the base.
Horizontal (Diffraction) axis: Place beam above the Bragg pivot point.

Timing considerations with respect to the RF modulation signal

An acousto-optic device is characterized by a travelling acoustic wave. This wave is launched from the RF excited transducer and travels at velocity V across the laser beam and into the absorber. It is important to consider this transit period when synchronizing a pulsed laser output with a pulsed AOM/AOD driver signal.

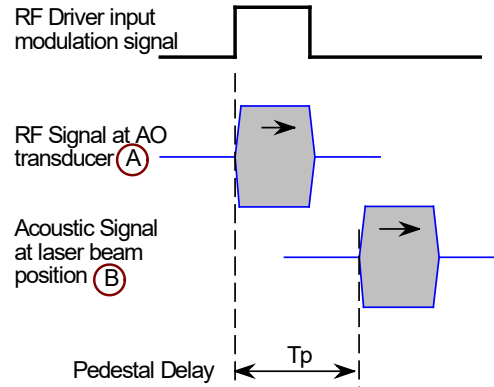
Early/late refers to the laser trigger timing relative to the RF driver modulation signal



Pedestal delay

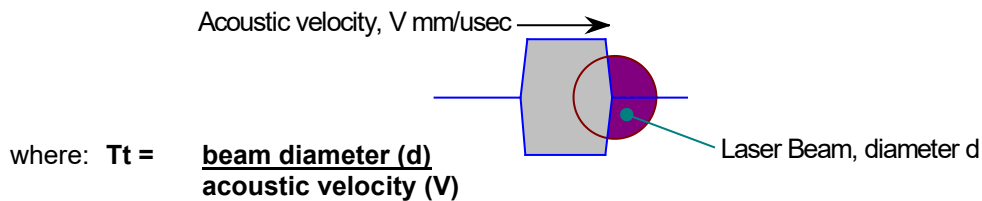
The time taken for the acoustic wavefront to reach the laser beam centre ⁽²⁾.

$$T_p = \frac{\text{beam position from transducer (X)}}{\text{acoustic velocity (V)}}$$



Transit time

The time taken for the acoustic wavefront to cross the entire laser beam diameter.



This equates to the minimum RF pulse width.

Optical rise / fall switching time

For a Gaussian beam is approximately $T_r = 0.65 \times T_t$

Total Sync Time

This represents the total delay time between the electronic modulation signal and the corresponding acoustic signal at the laser beam centred over the Bragg Pivot Point. This is given by:

$$T_{st} = \text{Pedestal delay} + \frac{1}{2} \text{ pulse width duration}$$

The minimum RF pulse width duration will depend on the beam diameter. See 'Transit Time'
In the limiting case, pulse width duration = transit time.

Laser sync output

Please be aware, there may be an additional delay between the laser input trigger signal and the laser output pulse. This delay should also be considered when synchronizing.