Gooch & Housego
ENABLING PHOTONIC TECHNOLOGIES

User Manual
HP041-125ADG-A10
I-M041-XXXC11XXX-P5-GH77

Instructions for the set-up and use of a GH77 Germanium AOM and RF Driver

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Table of Contents

1.0 Safety

While the Acousto-Optic Modulator (AOM) itself does not present the user with any specific safety hazards, it's intended use within the optical path of a high power (NIR) laser system can lead to hazardous situations. Therefore, the user should ensure that they are protected from any hazards that the laser system may present during the installation and set-up process of the AOM. Reference to the user manual of the laser with which the AOM will be used and you're companies Laser Safety Officer (LSO) and/or safety manual is recommended before commencing any set-up of the AOM and its associated driver

1.1 Optical Radiation Hazards

Setting up the AOM will require the user to work within the optical path of a CO_2 laser. Exposure to radiation from these lasers warrants the use of protective equipment. Unless the laser's optical path is enclosed, the user should be protected against accidental exposure. Exposure to personnel other than the user must also be considered. Hazards include direct beam exposure and reflected radiation. When working with an unenclosed beam path, it is advisable to do so while the laser is powered down or at reduced power levels.

2.0 Introduction

2.1 RF Driver

HP041-125ADG-A10 is a RF signal generator designed to drive the G&H Germanium Acousto-Optic Modulators with up to 125 W of RF power at 40.68 MHz drive frequency.

The output RF signal amplitude can be modulated by digital and/or analogue input signals.

2.1 AOM

I-M041-XXXC11XXX-P5-GH77 designates a range of acousto-optic modulators designed to operate with high power 9.4 µm and 10.6 µm CO_2 lasers.

3.0 Installation

3.1 Water cooling

The RF driver and the modulator need to be supplied with sufficient coolant flow rate within the specified temperature range in order to obtain optimum performance and prevent possible damage. The use of a closed circuit refrigeration system is recommended to reduce contamination of the cooling circuits and maintain a constant operating temperature.

WARNING: Do not use de-ionised water as it may corrode the copper cooling circuits in both the driver and the AOM.

For optimum modulator performance the coolant flow rate should be >1 litre/minute at a temperature of 20ºC ± 5ºC. The RF driver requires >2.0 litre/minute at temperature of 25ºC ± 10ºC. The maximum coolant pressure applied to the devices should not exceed 80 psi and it is recommended to set the coolant flow level with an appropriate safety margin.

It is mandatory that the modulator and the driver are operated only when the coolant is circulating. Due to the high RF powers and incident laser powers involved operation without sufficient cooling may result in permanent damage to the devices. Discrete over temperature safety cut-outs are installed in both devices however the addition of a coolant flow sensor in series with the AOM temperature sensor (Interlock circuit, see Figure 4) is highly recommended.

WARNING: Do not operate the AOM or RF driver without coolant flow.

To avoid any water condensing on the optical faces of the cooled AOM it should be mounted and operated in an environment where the coolant temperature is above the local dew point.

EXAMPLE: If the air temperature is 29˚C and the relative humidity is 60% then the dew point temperature is 21˚C, therefore to prevent condensation the coolant temperature should be maintained at 22˚C

If this is not possible then consideration should be given to enclosing the unit and laser beams within a sealed/purged tube configuration. To further reduce the possibility of condensation forming always stop the flow of coolant to the AOM and Driver when not in use.

3.2 Mounting procedure

3.2.1 Driver Module

Mount and secure the RF driver using the 4 x M8 holes in a suitable position, see Fig 1. For the mechanical outline drawings. For the initial set-up procedure you may wish to temporarily position the Driver module close to the AOM.

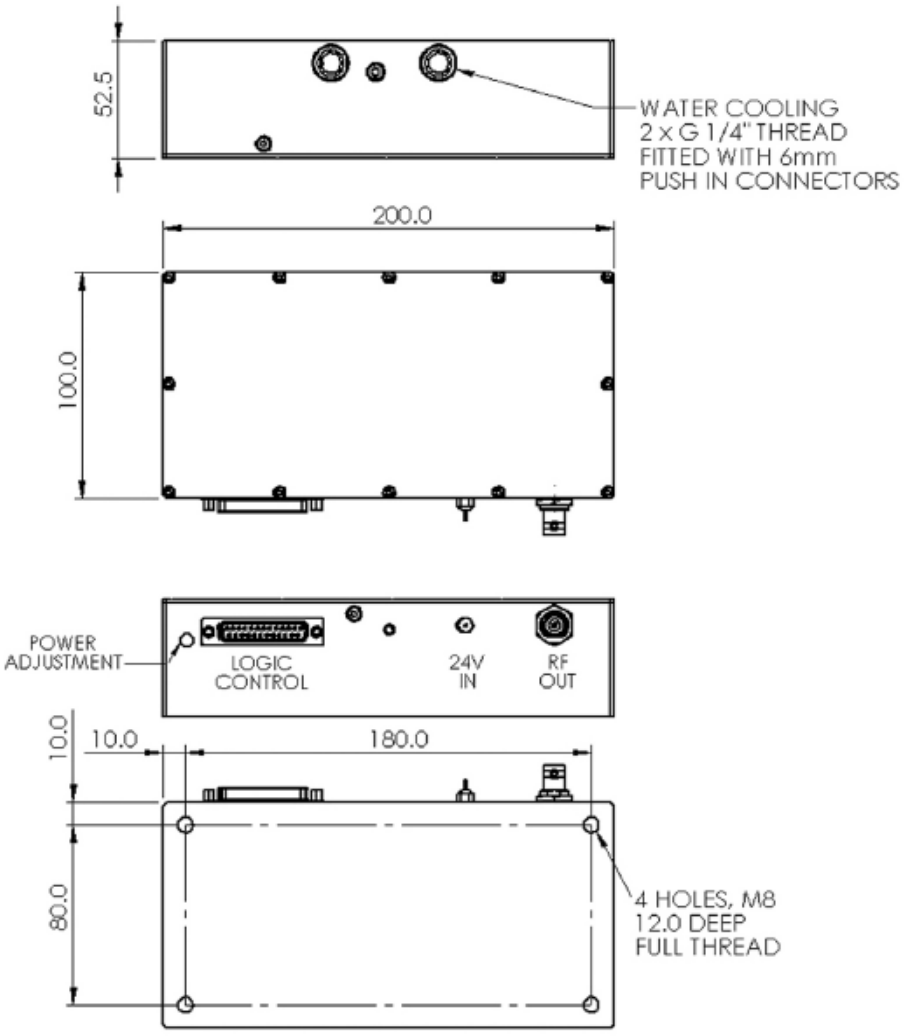


Figure 1. - Outline drawing of the RF driver

The driver module should be positioned such that there is good access to the front panel for making connections and adjusting the RF power during setup. As the unit is water cooled there is no specific requirement to have the unit in a specific ventilated enclosure.

3.2.2 AOM Module

Mount the AOM such that the laser beam will pass through the Optical centre point of the AOM and ensure that it is oriented correctly with the lasers linear polarization (refer to your laser manual). The base of the AOM has a pivot hole which is aligned with the devices optical centre and should be used as the rotation point for the device.

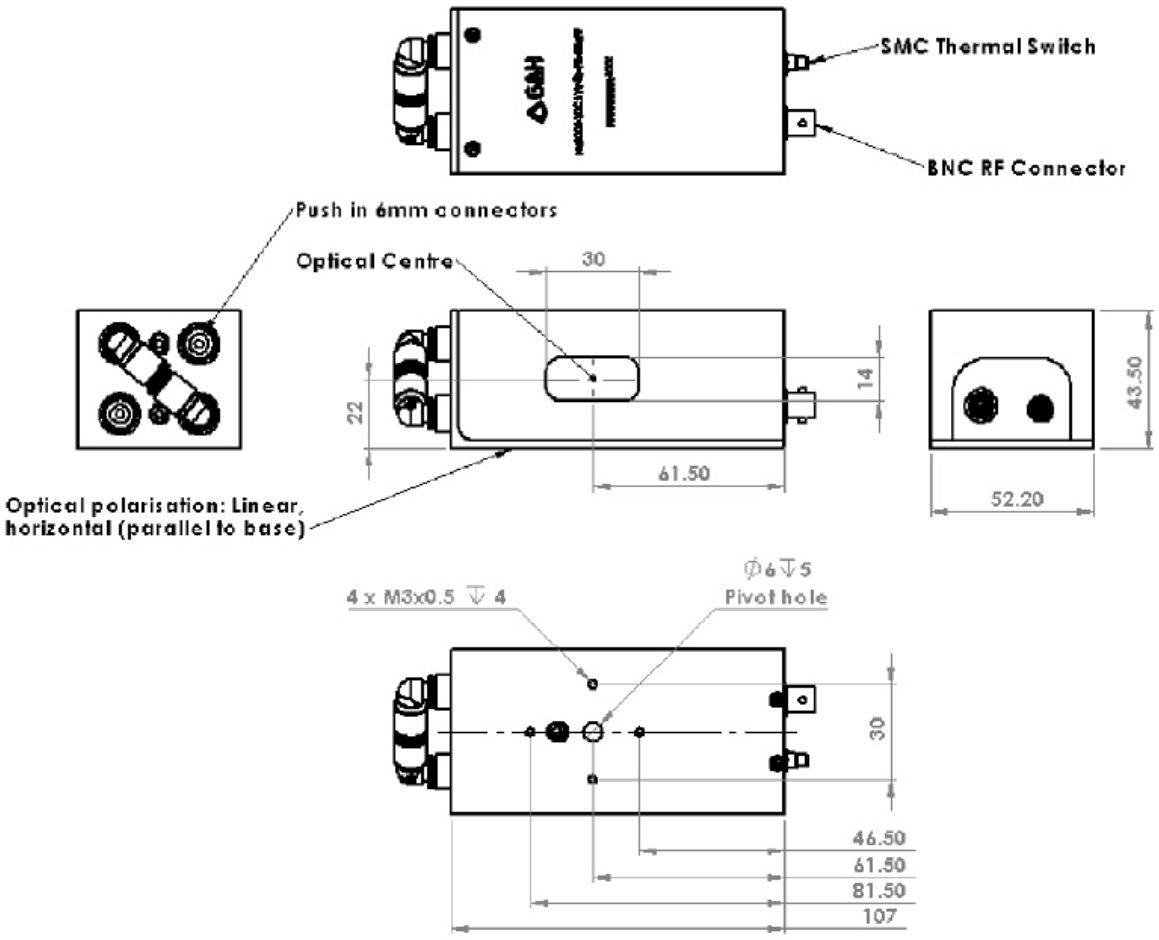


Figure 2. - Outline drawing of the AOM

Once the device is correctly aligned it can be secured using any or all of the 4 M3 x 0.5 holes on the base, this will require access to the underside of the unit.

It is also possible to pre-mount the device onto a larger base plate maintaining the pivot point and arranging for securing holes/slots to be accessible from above.

3.3 Connection procedure

3.3.1 Cooling

Connect cooling pipes (6mm OD flexible tubing) to the RF driver and the AOM. Ensure that cooling parameters are within specified range. Preference is given to running AOM and Driver cooling circuits in parallel rather than in series, if running in series then ensure the AOM is the first device in circuit.

3.3.2 DC Power

Connect positive output of the 24V power supply to the solder feed thru connector and the negative output to the adjacent M4 tag (GND). (Power supply output current rated at a minimum 13 A)

NOTE: Do not apply the power at this time.

3.3.3 RF Connections

WARNING: Serious damage to the Driver module may result if power is applied with the RF output connector in either an open-circuit or short circuited state.

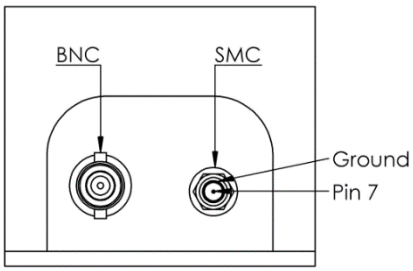
Connect the Driver BNC RF output to the modulator BNC input.

NOTE: For optimum performance the RF cable must have a 50 Ω characteristic impedance. RG58 coaxial cable is recommended.

The RF driver output power is factory pre-set to approximately 65W per channel. The RF power level can be adjusted by means of the potentiometer on the front panel of the driver (see Fig 1). The potentiometer can be rotated clockwise to increase and anticlockwise to decrease the RF power.

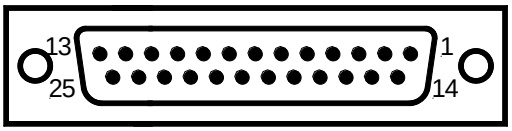
3.3.4 System Interlocks

Connect the interlock of the modulator (SMC plug to bare end cable) to the interlock input of the RF driver (pin 7 and any chassis ground pin of the 15-pin 'D' control input connector). The operating (open circuit) temperature for the AOM's interlock is 55°C. Refer to section 3.3.5 and Figure 4 for further information.



3.3.5 Control Signals (I/O)

D-Sub 25-pole, female (required mating connector is male)



Pin assignments
Any signals refer to chassis ground (CGND) unless denoted differently.

Output signals internal resistance : 1kΩ.

Pin 1 RF ON status (out)

Pin 2 SWR fault indication (out)

Pin 3 Driver temperature fault indication (out)

Pin 4 Reset SWR fault / Init (in)

Pin 5 Interlock 2 fault indication (out)

Pin 6 Interlock 2 (in)

Pin 7 Interlock 1 (in)

Pin 8 Interlock 1 fault indication (out)

Pin 9 Driver temperature monitor (out)

Pin 10 Modulation Ground (MGND)

Pin 11 Analogue modulation 2 (ref. MGND)

Pin 12 Analogue modulation 1 (ref. MGND)

Pin 13 Power Level Select (ref. MGND)
LOW → select Analogue Mod. 1
HIGH → select Analogue Mod. 2

Pins 14 ...22
Chassis ground (CGND)

Pins 10, 23, 24
Modulation Ground (MGND)

Pin 25 not connected

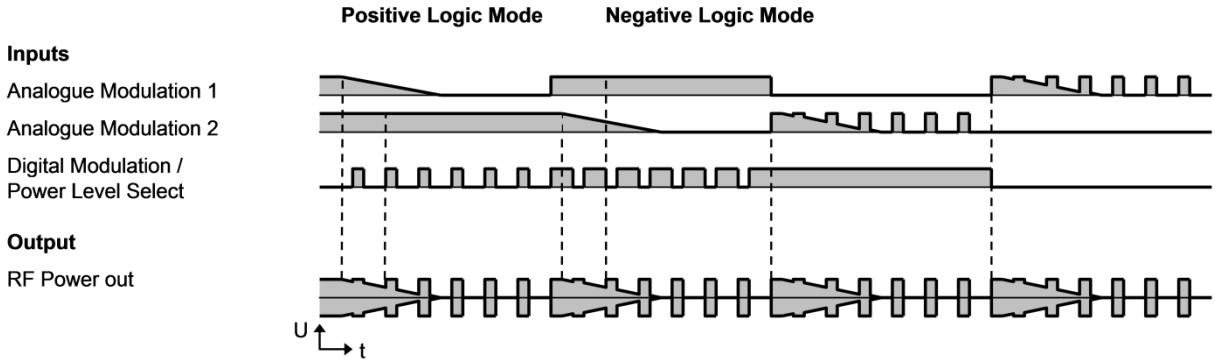


Figure 3 Operation scheme of analogue and digital modulation.

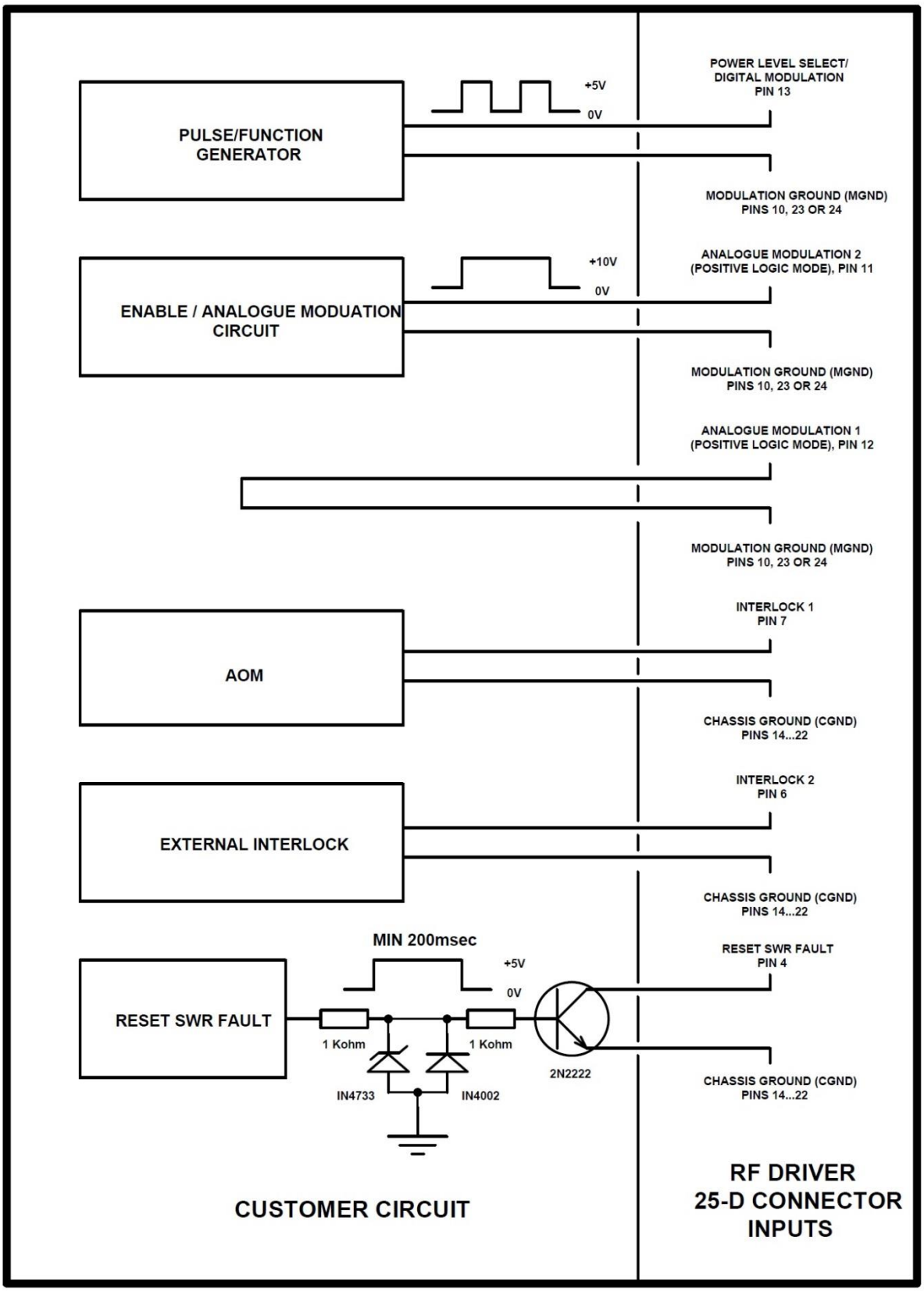


Figure 4 Example of input configuration for the Driver

3.3.6 Signal connection notes

RF ON status – The status of RF signal can be monitored using pin 1 of the D-Sub 25-pole connector where: High = RF output power ON and Low = no RF output power

SWR protection – The driver has integrated high SWR protection circuit which disables the RF signal in case of any external fault. The SWR fault status can be monitored using pin 2 of the D-Sub 25-pole connector where: High = no SWR fault and Low = SWR fault

In case of a fault the protection circuit can be reset by grounding pin 4 for a minimum of 200 msec.

Interlock fault indication – The status of the interlocks can be monitored using pin 5 for interlock 2 and pin 8 for interlock 1 of the D-Sub 25-pole connector where: High = no Interlock fault and Low = Interlock fault

Over temperature protection – The driver has integrated over temperature protection circuit which is responsible for safety shutdown at around 55°C. The driver's temperature can be monitored using pin 9 of the D-Sub 25-pole connector where: 0V≈30°C and 5V≈58°C

Interlock 2 - Connect the second interlock output of the driver (pin 6 of the D-Sub connector) through the external interlock to the ground (pins 14…22 of the D-Sub connector). In case of absence of an external interlock, pin 6 has to be grounded (pins 14…22 of the D-Sub connector).

4.0 Optical alignment procedure

4.1 Minimum equipment required for alignment process

- Optical Power Meter or Joule Stick
- Thermal alignment or ceramic paper
- Various Beam dumps
- Insulated Trim tool
- Optional: RF power meter

4.2 Pre Alignment checks

1. Ensure the laser beam is incident with the centre of the AOM aperture. If the CO_2 laser to be modulated has a co-axial visible pointer beam then use this to align the output beam to the centre point of the AOM aperture.

2. Ensure the laser beam polarization (check laser manual) is horizontal with respect to the base of AOM and the beam diameter does not exceed the active aperture height of the AOM.

3. Ensure suitable beam stops and/or power meter heads are positioned to capture the '0' order beam and the 1st order diffracted beam. Also be aware that other low power beams are generated and must be captured (these will become significant once the AOM incident power is increased) this includes -1 and secondary order beams.

4. Exceeding the optimum RF power results in a decrease of diffraction efficiency and makes accurate Bragg angle alignment difficult. Hence, it is recommended to perform initial alignment at a relatively low RF power level. Using an insulated trim tool turn the RF adjustment potentiometer anti clockwise by 2 full turns.

5. Ensure laser is set to output a power not in excess of 10 W for the initial alignment process.

4.3 Optical Alignment process

1. Position the optical power meter such that it is coincident with the '0' order beam and measure the power output, for the alignment process this should be approximately 10 W.
2. Apply a TTL high constant modulation signal to the Digital modulation input (Pin 13 on the D-sub connector) and constant 10V to the Analogue Modulation 2 input (Pin 11 on the D-sub connector).
3. Position a beam dump to capture the '0' order beam and place the optical power meter such that it will capture the 1st order diffracted beam (diffraction angle is 69.5 mrad for 9.4 µm and 78.4 mrad for 10.6 µm).
4. Start the alignment process with the laser beam normal to the optical face of the AOM.
5. **WARNING: Keep hands/fingers away from the laser beam during the alignment of the AOM**
6. With an active beam slowly rotate the AOM. Direction of the rotation has to be in line with Figure 5 – (Approximation of angle from normal is 2.5°)
7. Monitor the power of the 1st diffracted order from the AOM. Adjust the Bragg angle to maximise the beam intensity, secure the AOM once maximum beam intensity is achieved.
8. After the Bragg angle has been optimized, slowly increase the RF power (turn RF potentiometer clockwise) to maximise the beam intensity.
9. Note all the power results and calculate the diffraction efficiency, check that it is greater than or equal to the reported value on the test sheet shipped with the AOM device. The AOM should now be aligned and ready for use.
10. If a high diffraction efficiency (>85%) cannot be achieved, there is a high chance that either the RF connections between the AOM and the RF driver are incorrect or the AOM angle is wrong.

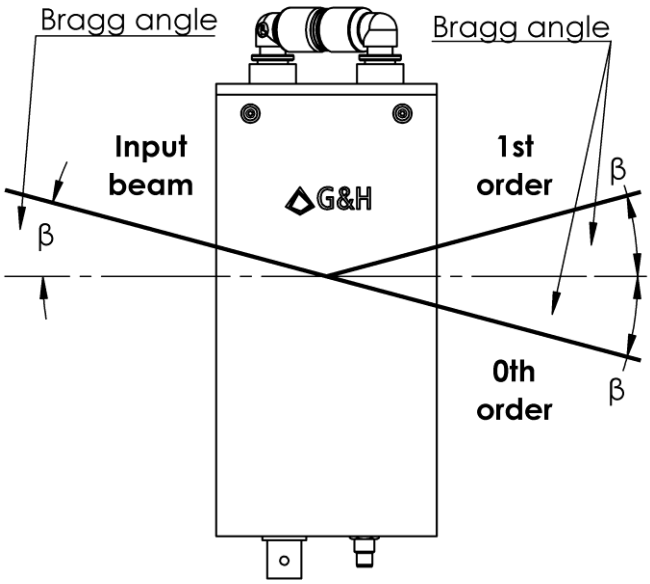


Figure 5 Schematic view on the light beam propagation and diffraction in the modulator.

5.0 Maintenance

5.1 Cleaning

NOTE: Any cleaning is carried out at the customers own risk, G&H is not liable for any damage caused by the customer cleaning the device themselves even if the following procedure is followed.

When the device is not in use the optical surfaces should be protected by covering the beam input and output apertures. If the device operates in dusty environment it may be necessary to frequently clean the optical faces with an air bulb (puffer). The use of pressurized air such as canned air is **not** recommended due to the possible damage to wire bonds internal to the device.

If the contamination cannot be removed with the use of air then it will become necessary to utilise solvents. It is important to note that the removal of debris or contamination by physical rubbing is not feasible and will result in damage to the optical coatings. Cleaning is therefore reliant on a given solvent dissolving the contamination, allowing the resulting solution to be soaked up and removed by the swab.

WARNING: Before using any cleaning agents, read their Material Data Sheets (MDS) and observe all necessary precautions.

The use of powder free finger cots or gloves (latex, nitrile or vinyl) to prevent any further contamination of the optics by dirt and skin oils is recommended.

Depending on the location and accessibility of the AOM this process may require its removal from the system. If so then place the AOM on a suitably clean surface, never place optical components on hard or rough surfaces. Use of clean room grade wipes is recommended.

If the use of a puff of air will not remove all the contamination it is recommended to clean the optics with a fresh lint-free swab or a cotton ball dampened with acetone or isopropyl alcohol. The optical face should be wiped gently (do not apply any pressure the weight of the swab and solvent is sufficient) with the swab, in one direction, slow enough such that the liquid evaporates as the swab passes and leaves no streaks. If necessary repeat the process with as fresh swab and solvent. Reagent grade acetone and isopropyl alcohol are recommended and will dissolve most contamination.

NOTE: The top lid of the device (2 x T6 screws) may be removed to gain better access for cleaning the optical faces, however extreme care should be taken so as not to damage or move other parts of the device that will now be exposed. (I.e. gold wire bonds and impedance matching coils).

5.2 Troubleshooting

Currently no specific troubleshooting process has been formulated other than to check the optical alignment of the AOM with respect to the laser beam and to check any interlocks and the user drive signals.

5.3 Repairs

No user serviceable parts are contained within the AOM or Driver assemblies, in the event of malfunction discontinue operation and immediately contact G&H or their local representative. Evidence that any attempt to access tamper sealed areas of the AOM or Driver will void the manufactures warranty.