Jan 2010

Acousto-Optic Modulator / Deflector Driver

Including: Basic AOM650-9 Alignment

Instruction Manual

RFA4556-2

Models -

RFA4556-2 : 40.0 / 46.7 / 53.3 / 60.0 MHz, 110W output, quad frequency,
Phase controlled
Digital Modulation

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1. GENERAL

The Model RFA4556-2 is a class A amplifier designed to drive the AOM650 series of Isomet High Power Germanium Acousto-Optic Deflectors with four sequential frequencies and up to 120Watts total RF power. The RFA4556-2 exhibits phase shifting between the two RF output channels. Phase shifting forms the basis of the beam-steering technique used in Isomet wideband AO deflectors and ensures optimum efficiency across the bandwidth of the deflector.

A summary of the driver specification is shown in the following table:

Model	Use With	Center Frequency	Total Output Power
RFA4556-2	AOM650 series for Quad spot Modulation	Selectable. 40.0 / 46.7 / 53.3 / 60 MHz (Not simultaneously)	> 110.0 Watt

Figure 2 is a block diagram of the driver. The key areas are summarized below.

Frequency Source

The four output frequencies are determined by free-running quartz-crystal oscillators. The frequency is accurate to within ± 0.005% and the stability is better than ± 0.003%; the oscillators are not temperature stabilized.

Two logic inputs control the output frequency:

	Frequency Select Input	
Frequency	Bit2	Bit1
40.00 MHz	0	0
46.66r MHz	0	1
53.33r MHz	1	1
60.00 MHz	1	0

High-frequency, diode ring modulators are used to amplitude-modulate and power adjust the RF carriers.

Amplitude Modulation

A single digital input is applied to modulate both RF outputs simultaneously. This modulation input is independent of the frequency selection. An input swing of greater than 2.0V volt (positive with respect to ground) will drive the RF On. An input voltage of less than 1.0V will drive the RF Off.

RF Power Control

The RF output power for each frequency is set independently and according to one of two power control methods; manual adjustment or non-volatile digital potentiometers.

Each output frequency has an associated manual and digital pot.

Phase Control

A switched delay unit generates the correct phase control between the outputs depending on the selected spot frequency (i.e. 40, 46.7, 53.3 or 60 MHz). MMIC r-f pre-amplifier stages isolate the low level modulation and phase control circuitry from the power amplifier stages.

Power Amplifiers

The two Class A power amplifier stages function in parallel and are designed to operate at full rated power into a 50Ω load with 100% duty cycle.

DC Input

A low impedance d-c power source is required. The operating voltage is +24V (+28Vdc MAXIMUM) at a current drain of approximately 13A. The external power source should be regulated to ± 2% and the power supply ripple voltage should be less than 200mV for best results.

Higher RF output power is achieved at 28Vdc.

PRECAUTIONS

- **Maximum RF power = fully clockwise**
- **Direct digital input levels must not exceed 7 volts**
- **Opto-Isolated digital input levels must not exceed 24 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.

2.0 DIGITAL MODULATION

The RF POWER ADJUST control sets the peak driver output for the ON condition (TTL=1).
A low level input (TTL=0) will turn the RF output OFF.

Figure 3 illustrate the modulation waveforms

2.1 POWER ADJUSTMENT

A logic input to 25way D type determines the active method.

2.2 Manual: High logic level or Open circuit on ***DP / Manual Sel*** input pin7 (20)
Multi-turn potentiometers control the maximum RF power for both outputs of the Driver at each frequency.

Frequency	Potentiometer
40.00 MHz	F4
46.66r MHz	F3
53.33r MHz	F1
60.00 MHz	F2

2.3 Remote: Low level logic or closed circuit on ***DP / Manual Sel*** input pin7 (20)
Digitally controlled 100 step solid-state potentiometers determine the maximum RF output power.

All inputs to the digital potentiometers (DP) are opto-isolated.
An additional 24Vdc / 100mA DC supply is required for the opto-isolated interface.
This must be provided and applied to pin 9 of the 25 way D-type.

The signal functions are shown in the tables below.

Pin numbers in (brackets) are the signal returns. For the isolated signals these are pins 16, 17, 18, 19, 20 which are connected internally to the isolated ground.

[Note, pins 14, 22, 23, 24, 25 are connected internally to the driver chassis (non-isolated) or 0V ground]

25way D type +sig (-rtn)			
Pin 8 (21)	Pin 6 (19)	Pin 5 (18)	
DP -Write En	***DP Inc***	***DP UP/-DWN***	Mode
L	↓	H	Increase Power
L	↓	L	Decrease Power
↑	H	X	Store DP position
H	X	X	Standby
↑	L	X	No Store, Return to Standby

25way D type +sig (-rtn)				
Pin 8 (21)	Pin 7 (20)	Pin 4 (17)	Pin 3 (16)	
DP -Write En	***DP/Manual Pot Select***	***DP Adjust Bit 2***	***DP Adjust Bit 1***	Frequency selected for DP power adjustment
L	L	L	L	40.00 MHz
L	L	L	H	46.67 MHz
L	L	H	H	53.33 MHz
L	L	H	L	60.00 MHz
H	L	X	X	No Frequency Selected
X	H	X	X	DP disabled, power Control by Manual Pots

High to low transitions on ***DP Inc*** will increment / decrement the RF power depending on the state of the ***DP UP/-DWN*** input.

The power values will be stored in non-volatile memory on a low to high transition of ***DP -Write En*** while the ***DP Inc*** input is also HIGH.

DO NOT change the state of the Frequency select inputs ***DP Adjust Bits 1 and 2*** during the power adjustment and store procedures.

2.4 LED INDICATORS

An array of LED indicator serves to indicate the operating state of the driver.
These are labelled A, B, C, D on the driver front panel.
The LEDs will illuminate RED or GREEN, when the DC power is applied and the Interlocks are valid.
One or both RF outputs may be live if any LED is illuminated.

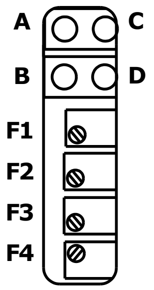
LED A
Illuminates when RF power is live on RF1 output
May not illuminate when the modulation duty cycle is less than 20% (approx).

LED B
Illuminates when DC power is applied.

LED C
Illuminates when RF power is live on RF2 output
May not illuminate when the modulation duty cycle is less than 20% (approx).

LED D
Illuminates when BOTH the AOM and internal driver thermal interlocks switches are in the Closed (no fault) state.

This LED will not illuminate if either the AOM or internal driver thermal interlocks switches are in the open (fault) state or the DC supply is off.



3 INSTALLATION AND ADJUSTMENT

3.1 Connect cooling water to the RFA4556-2 at a flow not less than 0.5 litre / minute at < 25deg.C. Refer to Figure 1.

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.

For optimum AO performance ensure the flow rate is more than 1 litre / minute at < 20 deg.C

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

3.3 Align the deflector head to insure that the incident light beam is centred in the active aperture of the deflector.

3.4 Connect the (2) RF output BNC jacks to the (2) SMA RF inputs of the acousto-optic deflector (or a 50 ohm RF load, if it is desired to measure the modulator RF output power). The order of connection is important. This depends on the Bragg orientation. Figure 4 illustrates the options.

The deflector will not be damaged if the order is incorrect but the amplifier outputs must be terminated. If the RF cable connections are incorrect, it will not be possible to achieve high efficiency at all frequencies / spot positions.

The coax cable from the amplifier to the two RF connections of the deflector should be of equal length

3.5 Connect the Interlock of the acousto-optic modulator (mini 3-pin snap connector) to the enable inputs on the 25-pin D-type connector of the RFA4556-2. Connect pin 1 of 'D' to the centre pin 1 and pin 14 of 'D' to the outer pin 2. (See Figure 5)

If the temperature of the modulator exceeds 32ºC or the internal driver temperature exceeds 70ºC, then the interlock connection becomes open circuit, disabling the RF output. An LED indicator illuminates when the Interlocks are closed and the RF is enabled. In addition, an open drain 'interlock valid' signal output is provided on pin 2 / pin 15 of the D-type connector for remote monitoring purposes.

3.6 Adjustment of the RF output power is best done with amplifier connected to the acousto-optic modulator. The Amplifier maximum output power is factory preset to approx 40W per output (80W total).

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 It is recommended that initial alignment be made using the manual RF power adjustment. Ensure the input to pin7, ***DP/MANUAL Pot Select*** is open (HIGH)

3.7 If the setting of the RF manual potentiometers is unknown, it will be necessary to set the power to a safe starting level of approximately 1/3 to 1/2 maximum. To achieve this without an RF power meter, the following procedure is recommended. With an insulated alignment tool or screwdriver rotate all four power adjustment potentiometers F1, F2, F3, and F4 potentiometers fully OFF, (at least 20 turns anticlockwise / CCW). Then rotate approx 10 turn clockwise.

3.8 Apply DC to the amplifier.

3.9 Apply a TTL High (or 5.0V) constant modulation signal to the Modulation input on the 25way D-type connector of the RFA4556-2.
Connect the modulation signal to pin 11 of ‘D’ type and signal return to pin 23.

3.9.1 Select the “mid” frequency of 46.67MHz.
Connect the TTL compatible Freq Select signals to pin 12 and pin 13 of ‘D’ type and signal returns to pin 24 and 25.

See table below for appropriate signal levels.

:

	Frequency Select Input	
Frequency	Bit2, pin 12	Bit1, pin13
40.00 MHz	0	0
46.66r MHz	0	1
53.33r MHz	1	1
60.00 MHz	1	0

Alignment

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

Start with the laser beam normal to the input optical face of the AOM and very slowly rotate the AOM (direction related to the RF connection order). See Figure 5 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 for 46.67MHz, slowly increase the RF power. Rotate F3 until the maximum first order intensity is obtained.

3.12 Selected each of the other Frequencies in turn.
Increase the RF power for each frequency.
Rotate the corresponding Power adjustment pot until the maximum first order intensity is obtained at each spot.

Frequency	Potentiometer
40.00 MHz	F4
46.66r MHz	F3
53.33r MHz	**F1**
60.00 MHz	F2

To equalise deflection efficiency, alternate between the frequencies and carefully RF powers to give the same efficiency for all four. (Note: the power meter may require repositioning for the four different angles.) It may be necessary to readjust Bragg angle. See 3:14

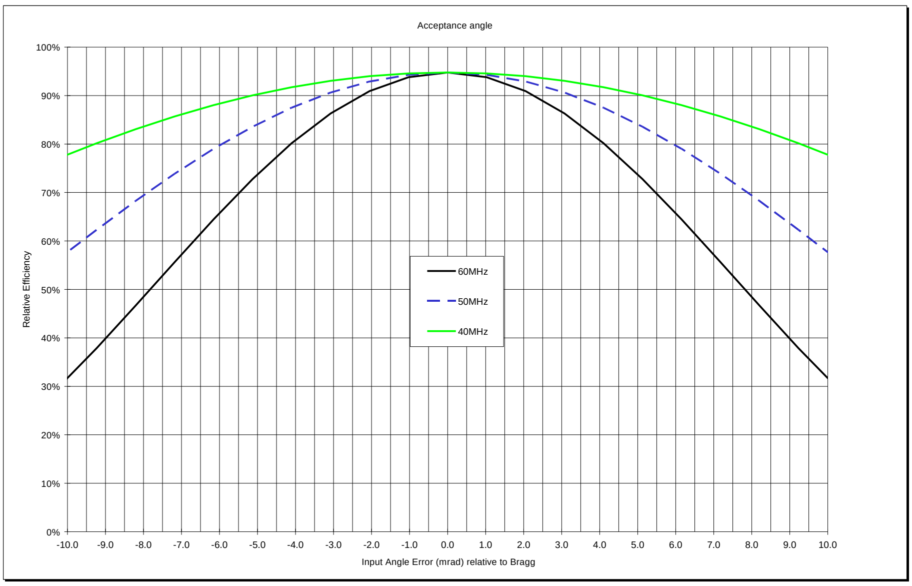
PLEASE NOTE

3.13 If high efficiency cannot be achieved at both frequencies, it is probable that the RF connections to the AOM are incorrect. In this case the phase delayed output of the RFA4556-2 is connected to the incorrect input of the AO deflector. See Fig 4 for guidance.

Turn off the DC power to the RFA4556-2 and exchange RF connections at the Driver. Repeat the above alignment procedure.

3.14 Bragg angle sensitivity increases with frequency, therefore it may be necessary to make a small Bragg angle re-adjustment at 60MHz. See figure below. This graph shows the AOM600 sensitivity to Bragg angle error.

This plot also gives an indication of the reduction in efficiency due to Input Beam Divergence or Convergence.



3:15 A similar procedure can be repeated using the digital potentiometers.
In this case ensure the input to pin7; ***DP/MANUAL Pot Select*** is closed (LOW)

The adjustment method is described in Section 2.1

The adjustment range for the DP's is approximately 15W Minimum to 60W Maximum per output.

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.

RFA 4556-2 Standard Version

Connection Summary

1.0 25 way 'D' Type Control Connection

Signal	Type	Pin out connection
Frequency Select, TTL	Input	---
Bit 1		+Sig pin 13, -Rtn pin 25
Bit 2		+Sig pin 12, -Rtn pin 24
Digital Modulation TTL 0.8V(off) , >2.7V(on)	Input	+Sig pin 11, -Rtn pin 23
24Vdc Supply / 100mA (Opto-isolator feed)	Input	+ve pin 9
DP -Write Enable	Opto-Input	+Sig pin 8, -Rtn pin 21
DP/Manual Select	Opto-Input	+Sig pin 7, -Rtn pin 20
DP Inc	Opto-Input	+Sig pin 6, -Rtn pin 19
DP UP/-DWN	Opto-Input	+Sig pin 5, -Rtn pin 18
DP Adjust Select	Opto-Input	---
Bit 2		+Sig pin 4, -Rtn pin 17
Bit 1		+Sig pin 3, -Rtn pin 16
'Interlock Valid' monitor (Open = Fault, Closed = OK)	Output	+Sig pin 2, -Rtn pin 15
Interlock (Connect to AO modulator 'INT, normally closed)	Input	+Sig pin 1, -Rtn pin 14

Isolated signal return pins are 16, 17, 18, 19, 20. These are connected internally to the isolated ground.

Return / 0V pins are 14, 22, 23, 24, 25. These connected internally to the driver chassis (non-isolated) ground

Notes:

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

2.0 Mounting Holes

4 x M5

RF Amplifier Outline

Dimensions : mm
1" = 25.4mm

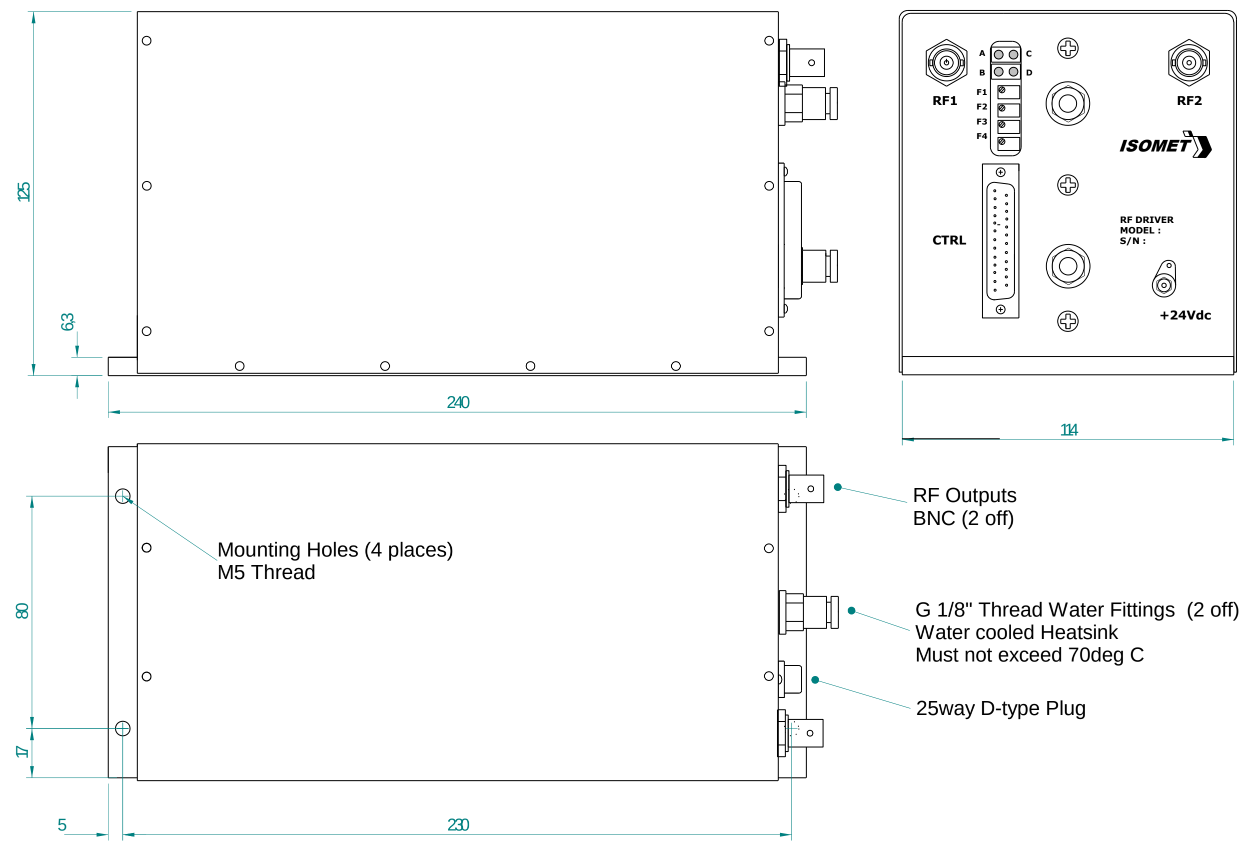


Figure 1: Driver Installation

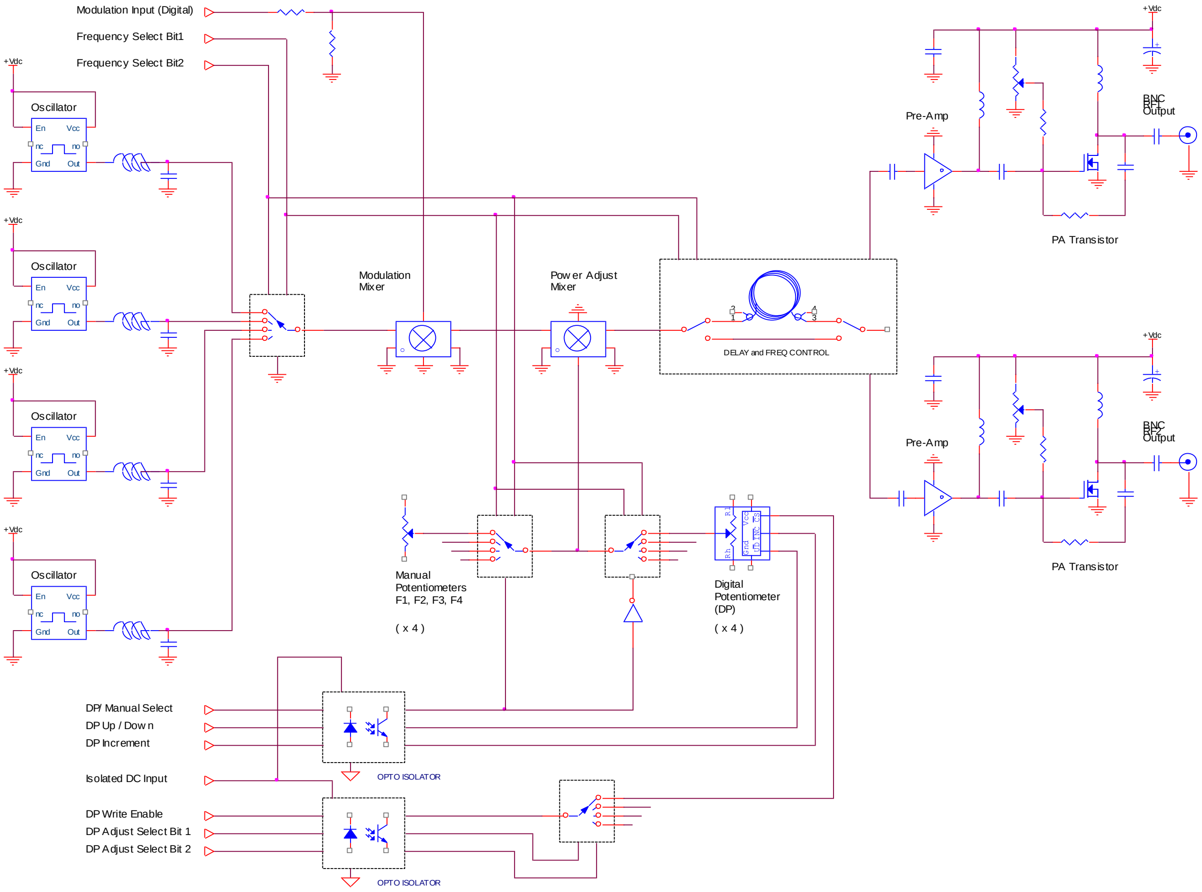
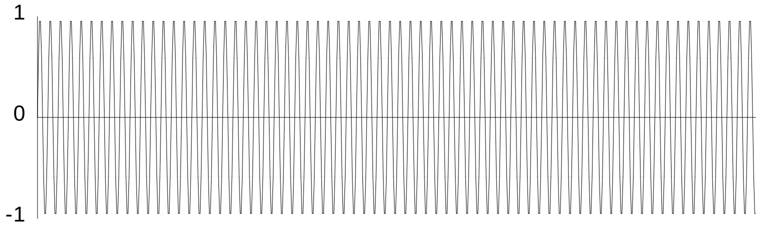
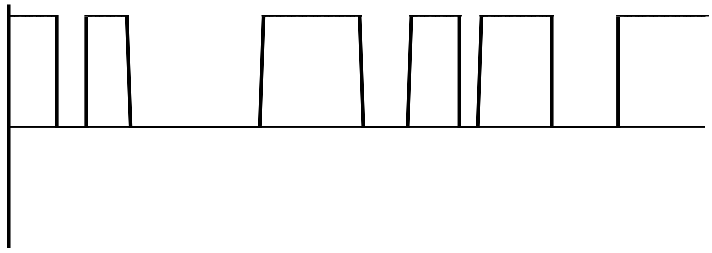


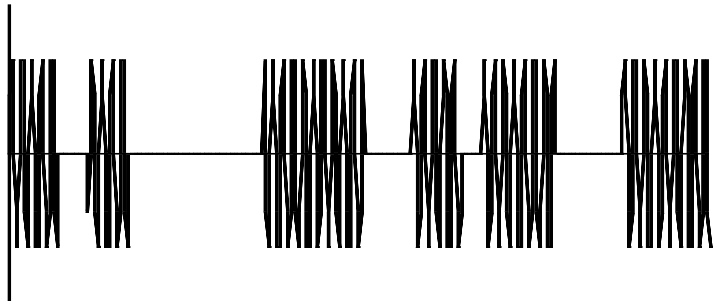
Figure 2: Driver Block Diagram



RF Carrier



Modulation Input



Modulated RF

Figure 3: Typical Digital Modulation Waveforms

Connection options for AOM600-1108 Dual Frequency Operation

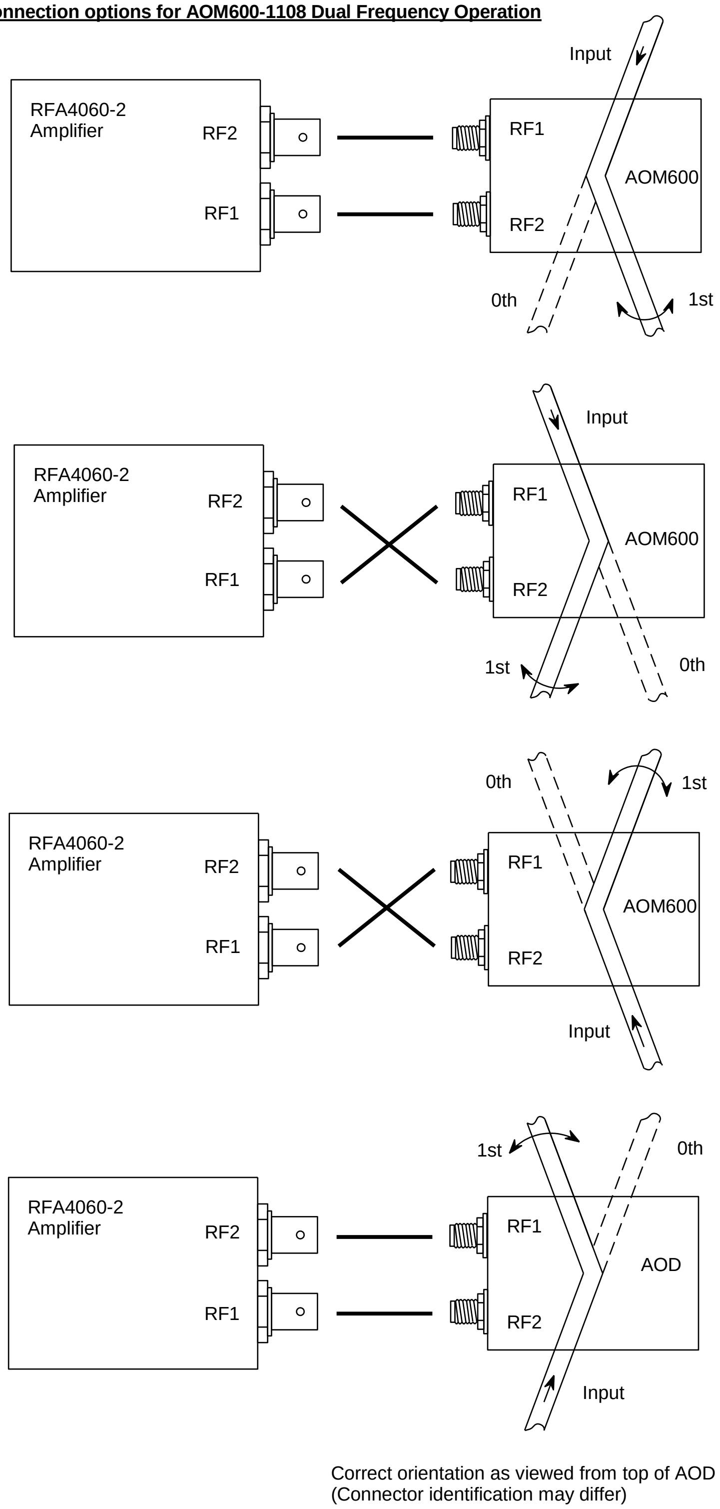


Figure 4: Connection orientation

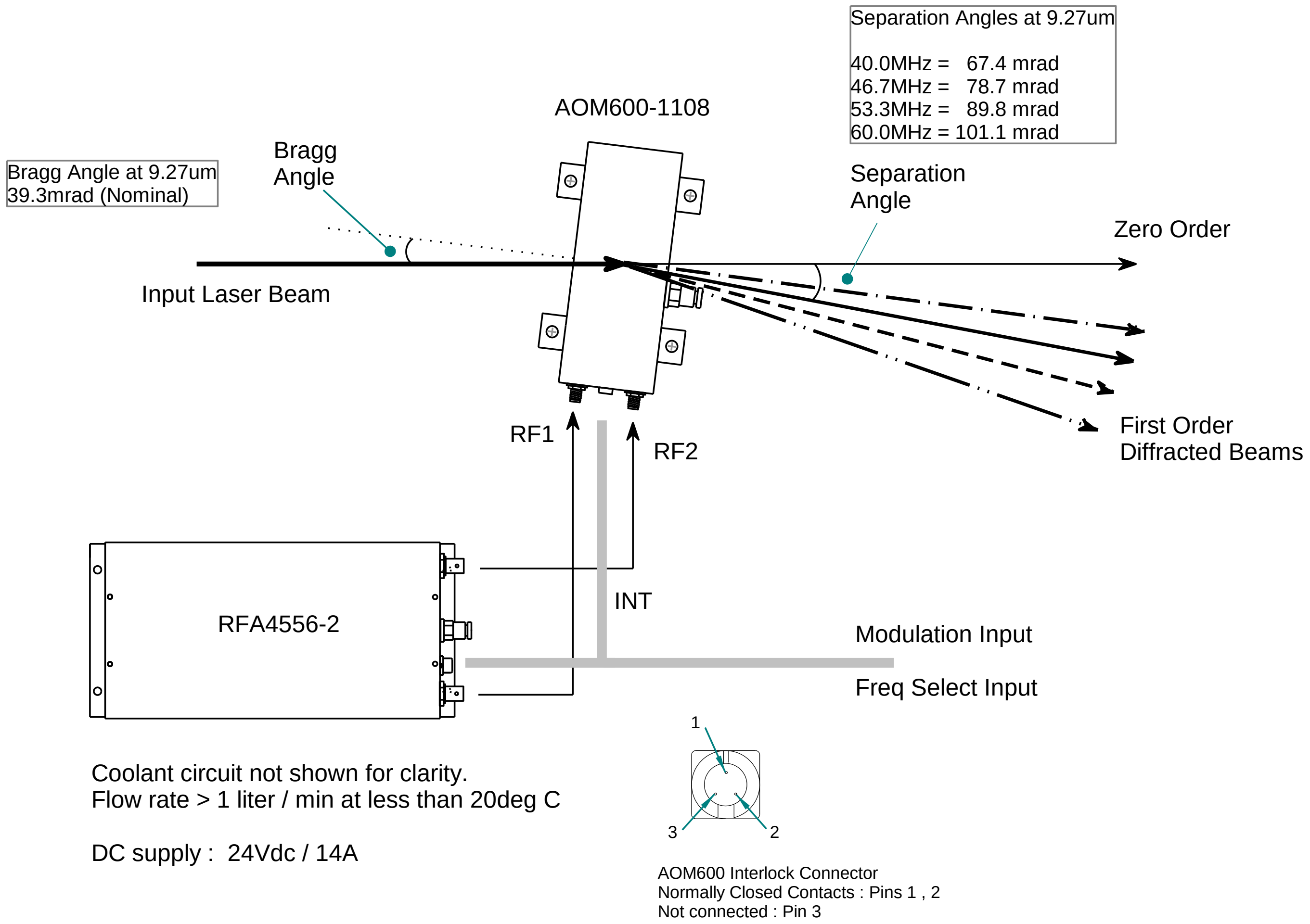
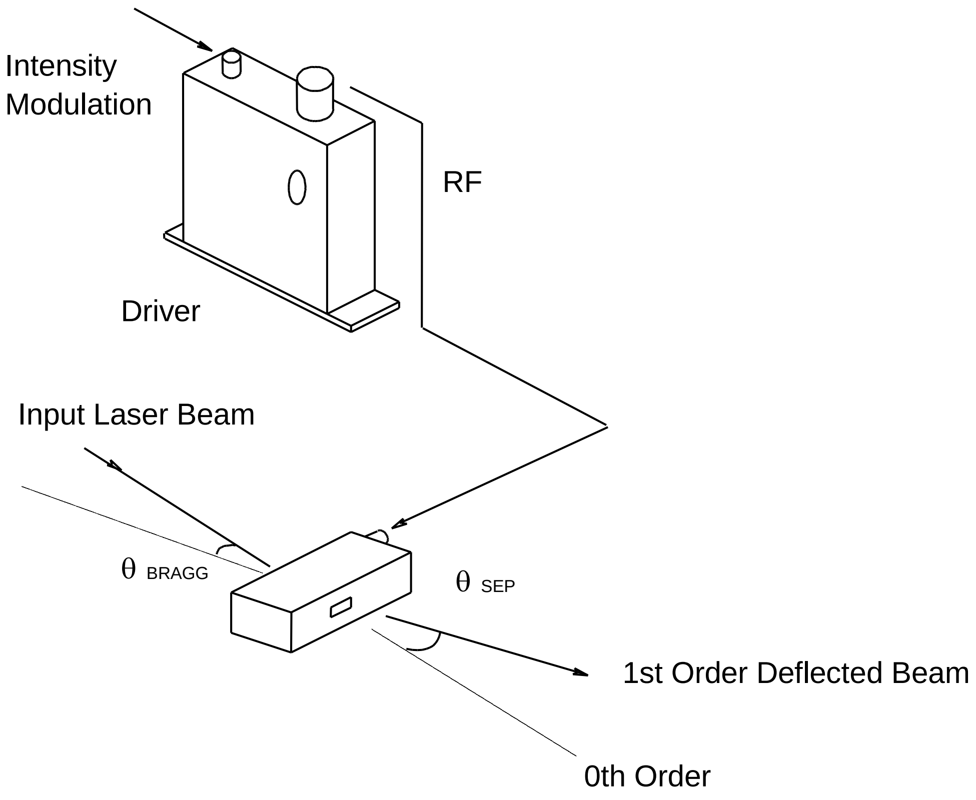


Figure 5: Typical Connection Configuration

Basic AO Modulator Parameters



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

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

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

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

Optical rise time for a Gaussian input beam is approximately:

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

where:	λ = wavelength	
	fc = centre frequency	= 40.00 / 46.67 / 53.33 / 60.00 MHz
	v = acoustic velocity of interaction material	= 5.5mm/usec (Ge)
	d = $1/e^2$ beam diameter	

Figure 6. Modulation System