



## **Acousto-Optic Amplifier / Driver**

**Including: Basic Modulator Alignment**

### **Instruction Manual**

### **50oC Series – Analog Modulation**

Key to model types : **50o.C-m**

Base model features 1.0Vpp, 50ohm modulation input level and 24/28Vdc supply.

'o' indicates the base models standard frequency

1	:	30-60MHz
2	:	60-100MHz
3	:	80-130MHz
4	:	125-175MHz
5	:	150-250MHz
5 (HF)	:	240-300MHz

'C' indicates case style

and where appended,

'm' indicates options (combinations possible)

2	:	2 Watt output
3	:	3 Watt output
6	:	6 Watt output
V	:	5.0V Modulation Input
L	:	+15V supply operation
HG	:	High Gain

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## 1. GENERAL

The 50oC- series Power Amplifiers are modular broadband RF amplifiers specifically designed for use with Isomet acousto-optic modulators and deflectors. The driver accepts a low level signal from a suitable frequency source such as the Isomet VCO's and synthesizers. An additional input permits amplitude modulation capability. This can be overridden using the BIAS adjustment pot.

Figure 2 is a block diagram of 50oC series amplifier.

A high-frequency, diode ring mixer is used to modulate the RF carrier according to the signal applied to the driver MOD (Video) input. An input swing of 1 volt peak will result in 100% depth of amplitude modulation. **The video input level must not exceed  $\pm 2$  volts**

A BIAS adjustment potentiometer is included. This injects a DC offset onto the modulation signal input and can be used as follows: :

- 1: Maximum BIAS setting (= fully CCW). This overrides the modulation input.  
No modulation input is required to turn the driver fully ON.
- 2: At half setting, a bipolar modulation signal (e.g.  $\pm 0.5V$ )\* can be applied.
- 3: At minimum setting (= fully CW), a modulation input will always necessary.

\*Note: For the 50oC-V types the respective level is  $\pm 2.5V$

The mixer output is applied to a MMIC pre-amplifier stage. This also serves to isolate the Oscillator and Mixer from the final power amplifier stage. The driver output power level is set by the Power adjust potentiometer at the input of this MMIC amplifier.

The amplitude-modulated MMIC output drives the input to a DMOS FET based power amplifier. This amplifier is designed to operate at full rated power into a  $50\Omega$  load with 100% duty cycle.



Figure 3 illustrates the principal waveforms of the 50oC Driver.

Conduction cooling of the driver from the mounting face to a heat sink or forced-air convection cooling is mandatory. The mounting face 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.**

All 50oC series amplifiers require a stable d-c power for operation. The required voltage is +24 / 28Vdc at a current drain of approximately 550mA EXCEPT model 50oC-L. This lower power driver operates from 15Vdc. The external power source should be regulated to  $\pm 2\%$  and the power supply ripple voltage should be less than 25mV for best results.

## 2. 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.

Figure 4 shows the intensity vs. RF envelop voltage transfer function of the acousto-optic modulator in normalized units with the typical waveforms superimposed. It will be noted that the driving RF waveform is a double-sideband amplitude-modulated carrier. 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.



### 3. INSTALLATION AND ADJUSTMENT

- 3.1 Install the Amplifier on a heat sink as shown in figure 1. Use heat conducting compound between the Amplifier and mounting face and the heat sink.
- 3.2 With no d-c power applied, connect the positive (+) DC to the center terminal of the feed-thru terminal as shown in figure 1. Connect the 0V or ground connection to the earth tab.  
DO NOT APPLY POWER.

The 50oC-2 is internally regulated and can accept a wide supply voltage range of between +22V to +28Vdc, with no change in RF power.

For the higher power types 50oC -3, -4, -6, -7, the output power is supply dependent - see test data sheet supplied with unit.

**DO NOT EXCEED +28Vdc or apply reverse polarity.**

Also for the lower power type 50oC-L, the output power is supply dependent.

**DO NOT EXCEED +15Vdc or apply reverse polarity.**

- 3.3 Connect the RF output SMA jack to an acousto-optic modulator (or 50Ω RF load, if it is desired to measure the modulator RF output power).
- 3.4a Connect a 50 ohm RF signal source to the RF input SMA jack.  
The input level should be < 1mW range.
- 3.4b If required, connect a 50 ohm signal source to the (Video) Modulation input SMB jack  
Alternatively adjust the BIAS fully ON. (Turn counter clockwise to increase the bias level).
- 3.5 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 a nominal level of 2.0Watt as stated in the test data sheet.

**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 make accurate Bragg alignment difficult. It is therefore recommended that initial alignment be performed at a low RF power level.**



**If supplied as a set with a VCO or Synthesizer frequency source, the RF power will be factory set and should not require readjustment. Section 3.6 is included for reference.**

- 3.6 The PWR ADJ pot is a multi-turn type. Minimum power is when fully anti-clockwise (CCW). Use an insulated alignment tool or screwdriver, rotate the PWR ADJ potentiometer CCW at least 11 turns, then CW approximately 5 turns for ~ half maximum power.
- 3.7 Apply +15V, + 24V, or +28V DC power to the driver as appropriate for the model.  
(see Section 1 and driver test sheet)
- 3.8a Apply a ~ 0.8mW (570mVp-p) frequency signal to the RF IN input (e.g. from VCO or IMS)
- 3.8b Check the BIAS adjust pot is fully ON (counter clockwise).  
Alternatively if remote amplitude control or modulation is required, apply +1.0V signal to the Modulation input (+5.0V for the 50oC-V type)
- 3.9 Observe the diffracted first-order output from the acousto-optic modulator and the un-deflected zeroth order beam. Adjust the Bragg angle (rotate the modulator) to maximise first order beam intensity.  
  
Note: depending on RF power level, the diffraction efficiency may not exceed 20-30% at this point in the alignment procedure.
- 3.10 After the Bragg angle has been optimised, slowly increase the RF power (rotate PWR ADJ CW) until maximum first order intensity is obtained. If however the intensity reduces, then the initial RF power level could be too high and should be reduced immediately

The RF drive level for peak diffraction efficiency is termed the saturation power;  $P_{sat}$ . For applications using a well focussed input beam into the AOM, the correctly adjusted Bragg angle condition is indicated when the zero order shows a characteristic dark line through the middle of the beam at or near the  $P_{sat}$  drive level.



#### 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 residue of the cleaning solution. 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.

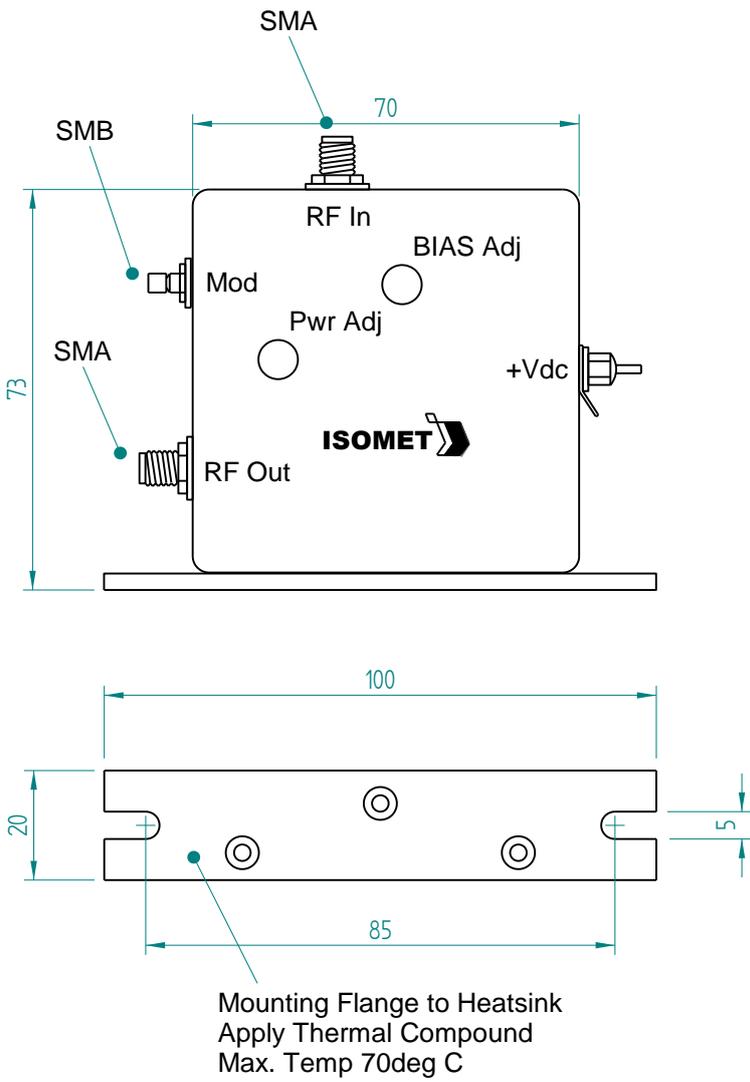


Figure 1: Driver Installation

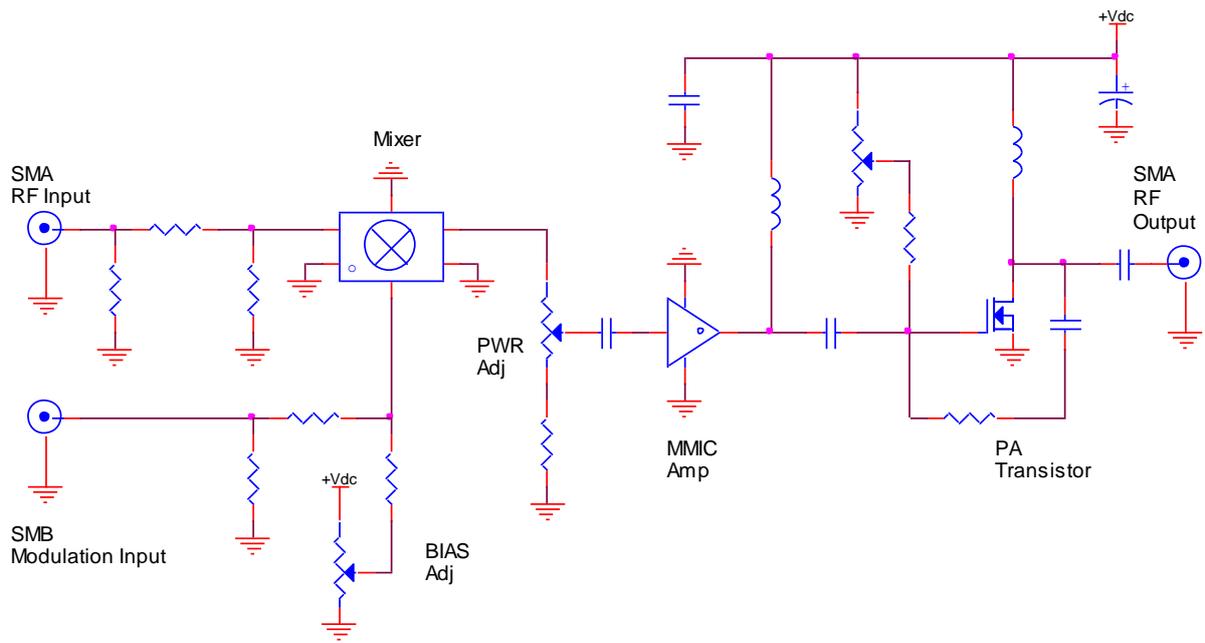
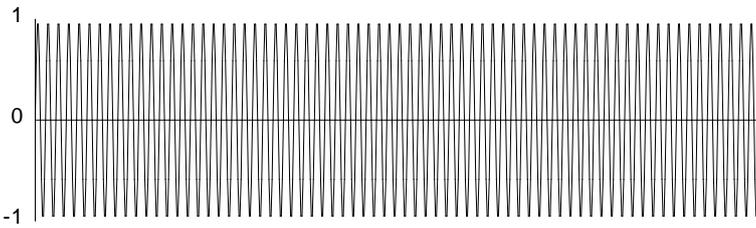
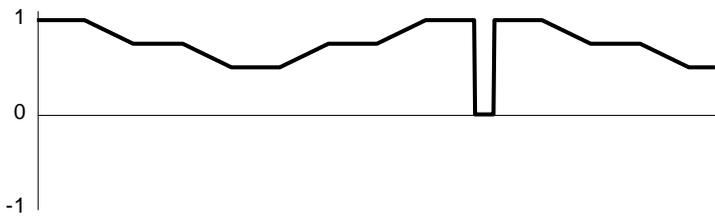


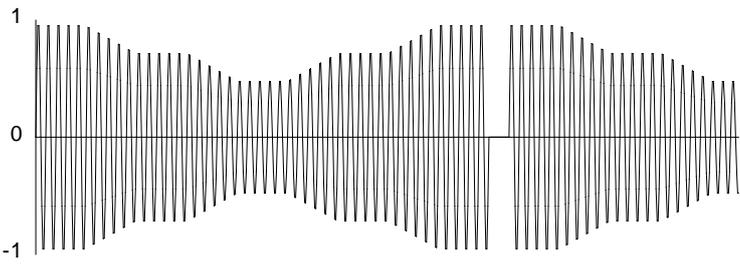
Figure 2: Driver Block Diagram



RF Carrier



Modulation Input



Modulated RF

Figure 3: Typical Analog Modulation Waveforms (BIAS at zero)

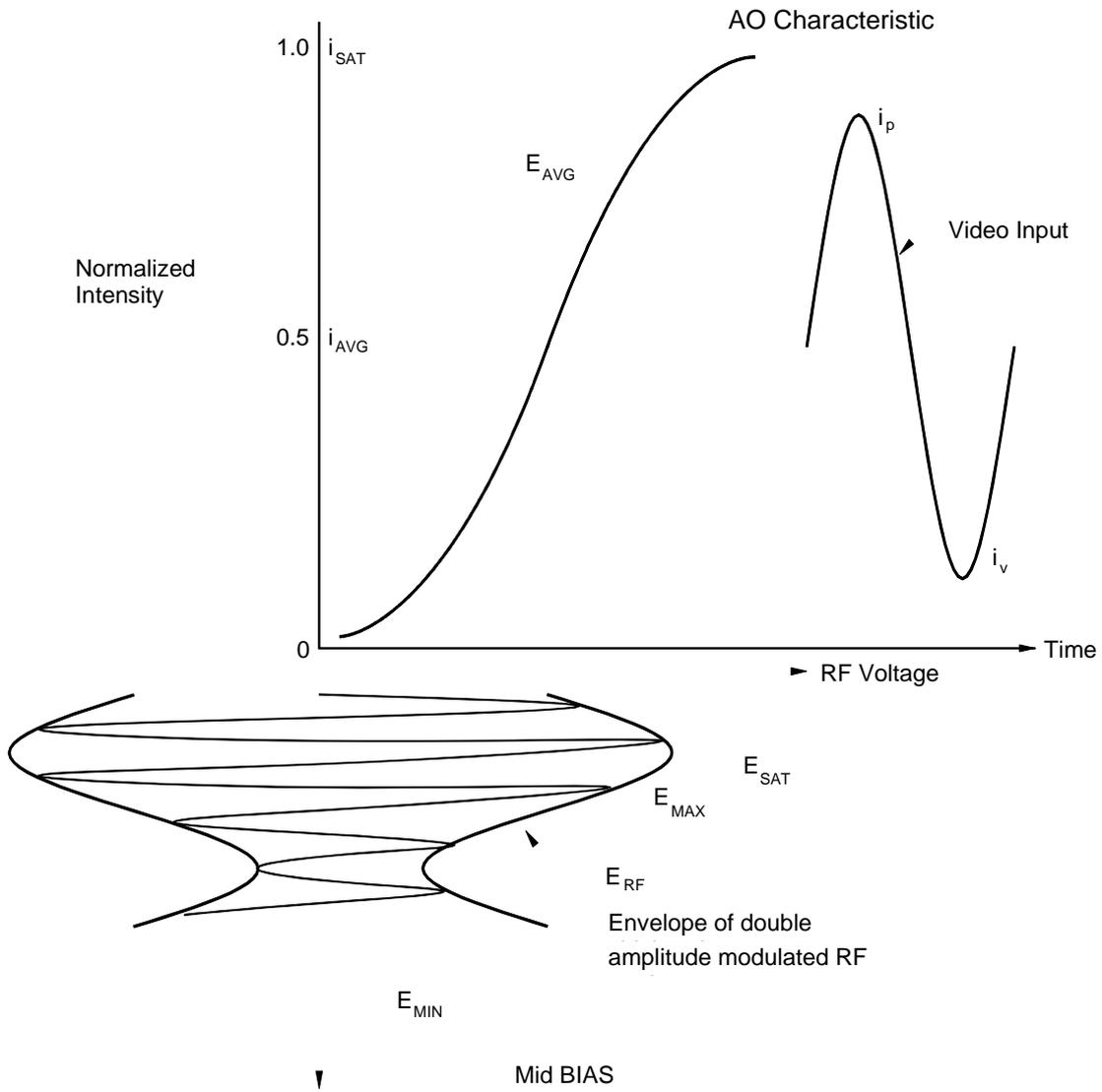
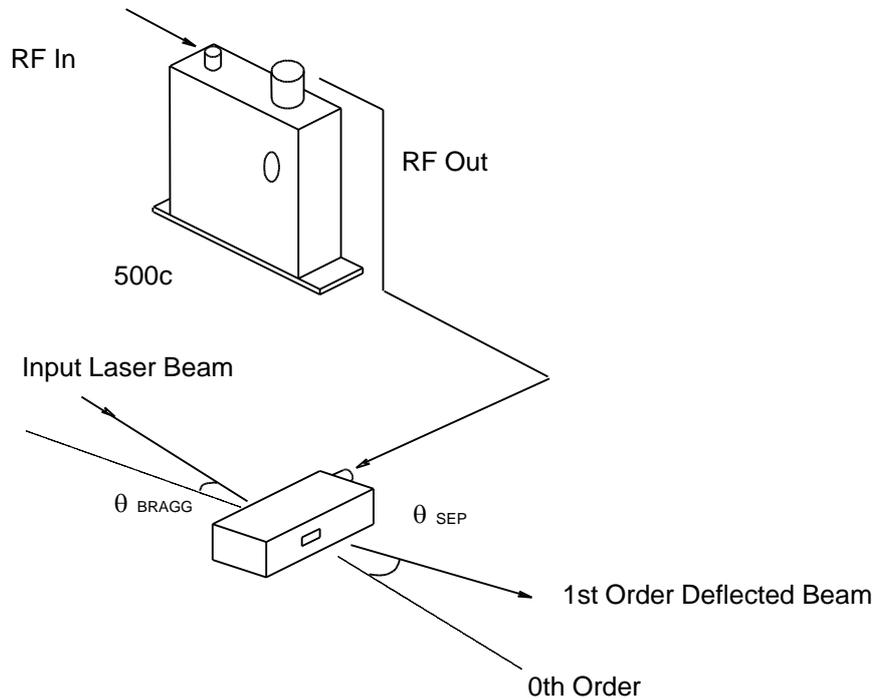


Figure 4.  
Intensity vs. RF Envelope Voltage Transfer

**Schematic for an AO modulator with 500c series amplifier**



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

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

The separation angle between the zeroth order and the first order outputs is :

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

Optical rise time for a Gaussian input beam is approximated by :

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

where :  $\lambda$  = wavelength

fc = drive frequency

v = acoustic velocity of AO interaction material = 4.21mm/usec (TeO<sub>2</sub>)  
 = 3.63mm/usec (PbMoO<sub>4</sub>)  
 = 5.70mm/usec (Quartz)  
 = 5.96mm/usec (Fused Si)

d =  $1/e^2$  beam diameter

Figure 5: Modulation System