# Acousto-Optic Modulator Driver
## Including:  Basic Modulator Alignment

# Instruction Manual
# 830c Series – Analog Modulation

Key to model types:     **83o.C-m-ff**

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

'o' indicates the base model standard frequency

| | | |
|---|---|---|
| 1 | : | 40MHz |
| 2 | : | 80MHz |
| 3 | : | 110MHz |
| 4 | : | 150MHz |
| 5 | : | 200MHz |

'C' indicates case style

and where appended,

'm' indicates options  (combinations possible)

| | | |
|---|---|---|
| 3 | : | 3 Watt output |
| 4 | : | 4 Watt output |
| 7 | : | 7 Watt output |
| V | : | 5.0V Modulation Input |
| L | : | +9 to +15V supply operation (refer driver test data sheet) |
| B | : | BIAS control |

'ff' indicates non-standard frequency

| | | |
|---|---|---|
| 27 | : | 27MHz |
| 50 | : | 50MHz |
| 105 | : | 105MHz |
| 175 | : | 175MHz |

1.      GENERAL

The 830C series Analog Driver is a fixed frequency RF power source specifically designed for use with Isomet acousto-optic modulators and Q-switches, operating at a fixed centre frequency.  The driver accepts an analogue modulating signal at baseband video frequency and provides a double-sideband amplitude modulated RF output to the acousto-optic modulator.  Examples of popular driver specifications are listed below:

Model

832C-L-V          80MHz, 1.1W (1.7W) output, 5.0V Modulation Input, +12Vdc (+15Vdc) supply

834C-4-160       160MHz, 5.0W output, 1.0V Modulation Input, +24Vdc supply

831C-L            40MHz, 1.1W (1.7W) output, 1.0V Modulation Input, +12Vdc (+15Vdc) supply


Figure 2 is a block diagram of 830c series driver.   The center frequency of the driver is determined by the free-running quartz-crystal oscillator.   This frequency is accurate to within $\pm$ 0.005% and its stability is better than $\pm$ 0.003%; the oscillator is not temperature stabilized.


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**

(Note: For the  830c-V types the respective levels are ; 5 volt input swing and $\pm$ 10 volt maximum)


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.


BIAS Control Option '-B'

The BIAS control potentiometer can be used to set a minimum intensity level or may be used in place of a modulation input to manually turn the driver from off to on.

When the BIAS is Zero, the modulation is controlled only by the signal amplitude on the modulation input. When the BIAS control is set at a mid-point, the depth of modulation may be controlled by a bipolar video input signal. When the BIAS is at Maximum, no the modulation input is required.



Figure 3 illustrates the principal waveforms of the 830c 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 830c series drivers require a stable d-c power for operation.   The required voltage is +24 / 28Vdc at a current drain of approximately 470mA EXCEPT model 830c-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:

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

where $i_1$ is the instantaneous intensity in the first order diffracted beam and $E_{RF}$ is the instantaneous RF <u>envelop</u> 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 Driver on a heat sink as shown in figure 1.  Use heat conducting compound between the Driver and mounting face and the heat sink.

3.2     With no d-c power applied, connect the positive (+) DC voltage to the red wireas shown in figure 1.  Connect the 0V or ground connection to the black wire
(Some models may require an additional 5V supply. If fitted, connect the 3rd wire to +5V)
DO NOT APPLY POWER.

The maximum RF output power is supply dependent - see test data sheet supplied with unit.
**DO NOT EXCEED +28Vdc or apply reverse polarity**.

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

3.4     Connect a 50 ohm signal source to the Modulation input MCX Female connector

3.5     Adjustment of the RF output power is best done with Driver connected to the acousto-optic modulator.   The Driver maximum output power is factory preset to a nominal level of 0.5Watt.

**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.**

3.6    If fitted, remove the PWR ADJ snap-in plugs from the driver case (see fig 1).

The PWR ADJ pot is a multi-turn type.  Minimum power is when fully anti-clockwise (CCW).

With an insulated alignment tool or screwdriver:

Rotate the PWR ADJ potentiometer CCW at least 11 turns, then CW approx 5 turns.


3.7    Apply +12V, +15V or +24V DC power to the driver as appropriate for the model.

(see Section 1 and driver test sheet)


3.8    Apply +1.0V dc input level to the (Video) Modulation input

(+5.0V for the 830c-V type)


3.9    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.

Note: the diffraction efficiency may not exceed 20-30% at this point in the alignment procedure.
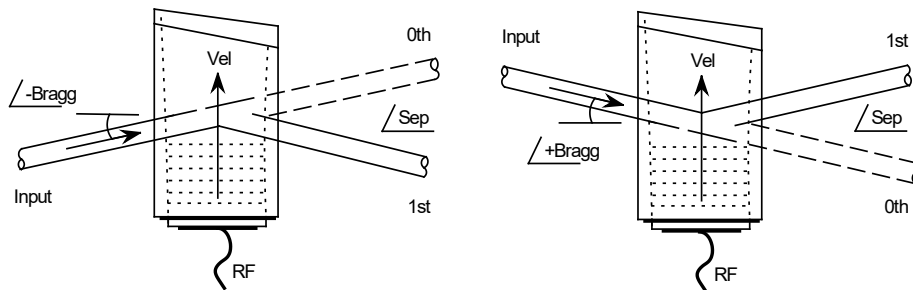


For most AO devices, Bragg angle rotation can be +ve or –ve and the laser can be input to either aperture face.


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. This peaked RF drive level is termed the saturation power; Psat.    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 Psat drive level.


The AOM and driver are now configured for analog modulation.  Connect the desired external 50Ω drive source to the MOD driver input.


**The video input must not exceed specified limits.**

## 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.
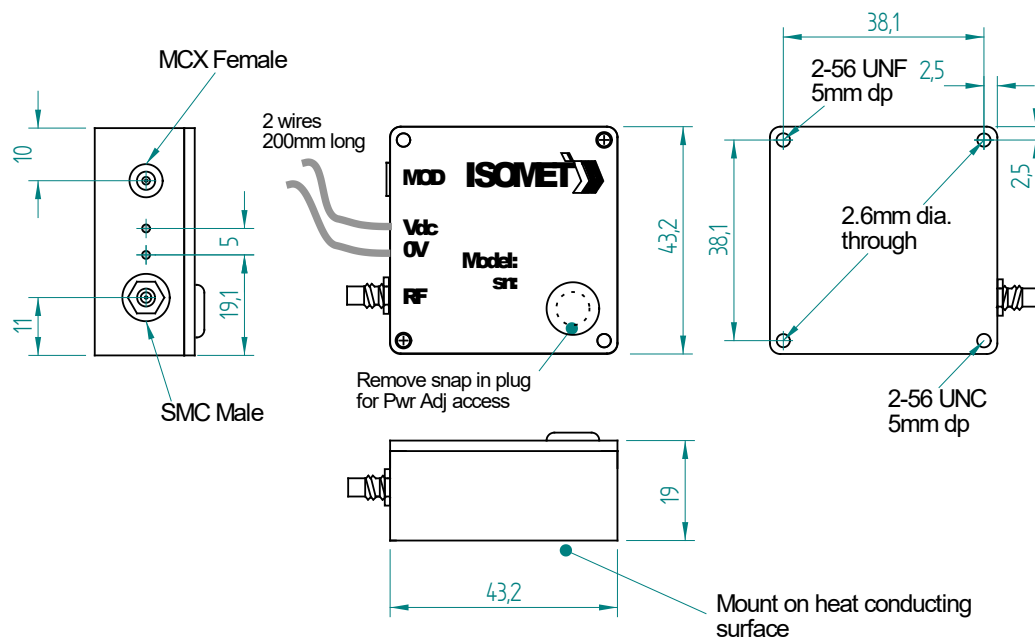
Figure 1:   Driver Installation
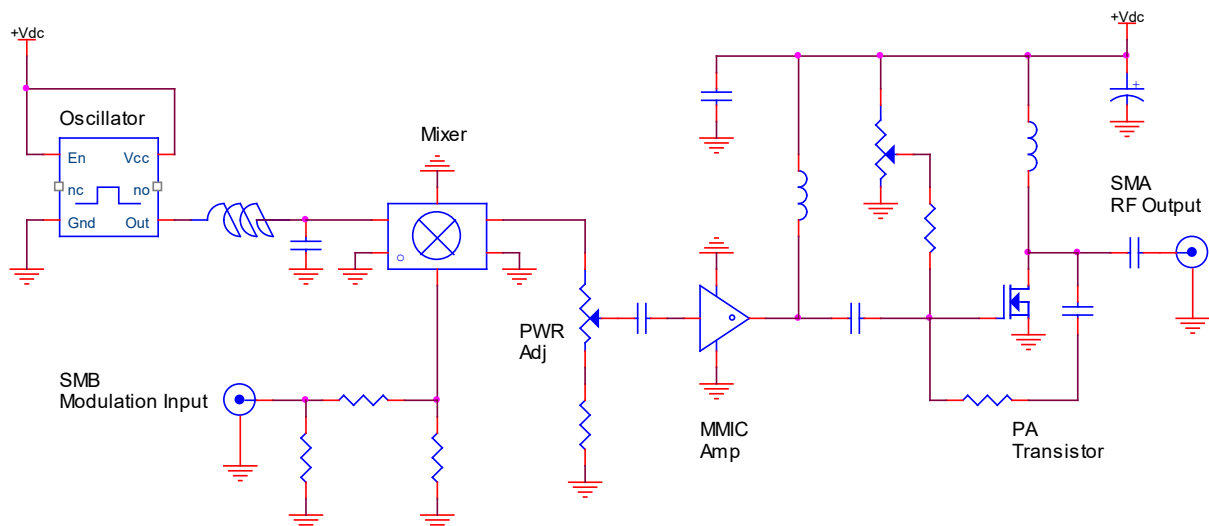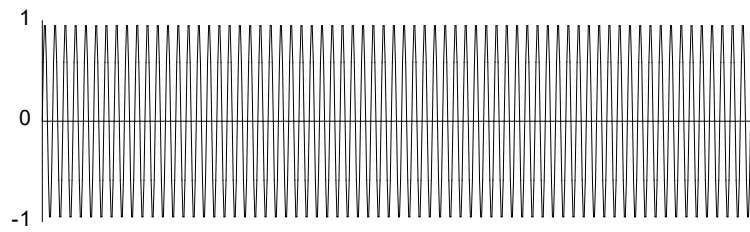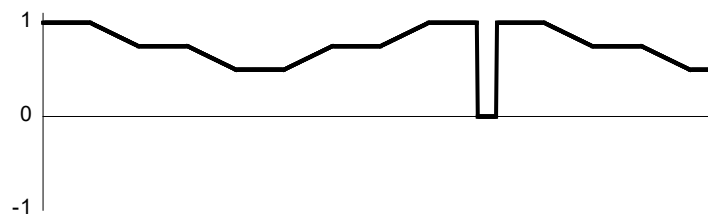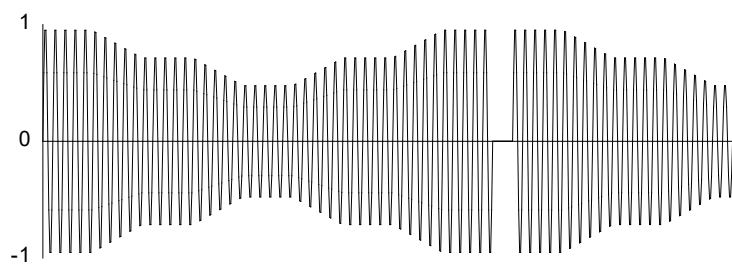


Figure 2:   Driver Block Diagram

RF Carrier



Modulation (Video) Input



Modulated RF

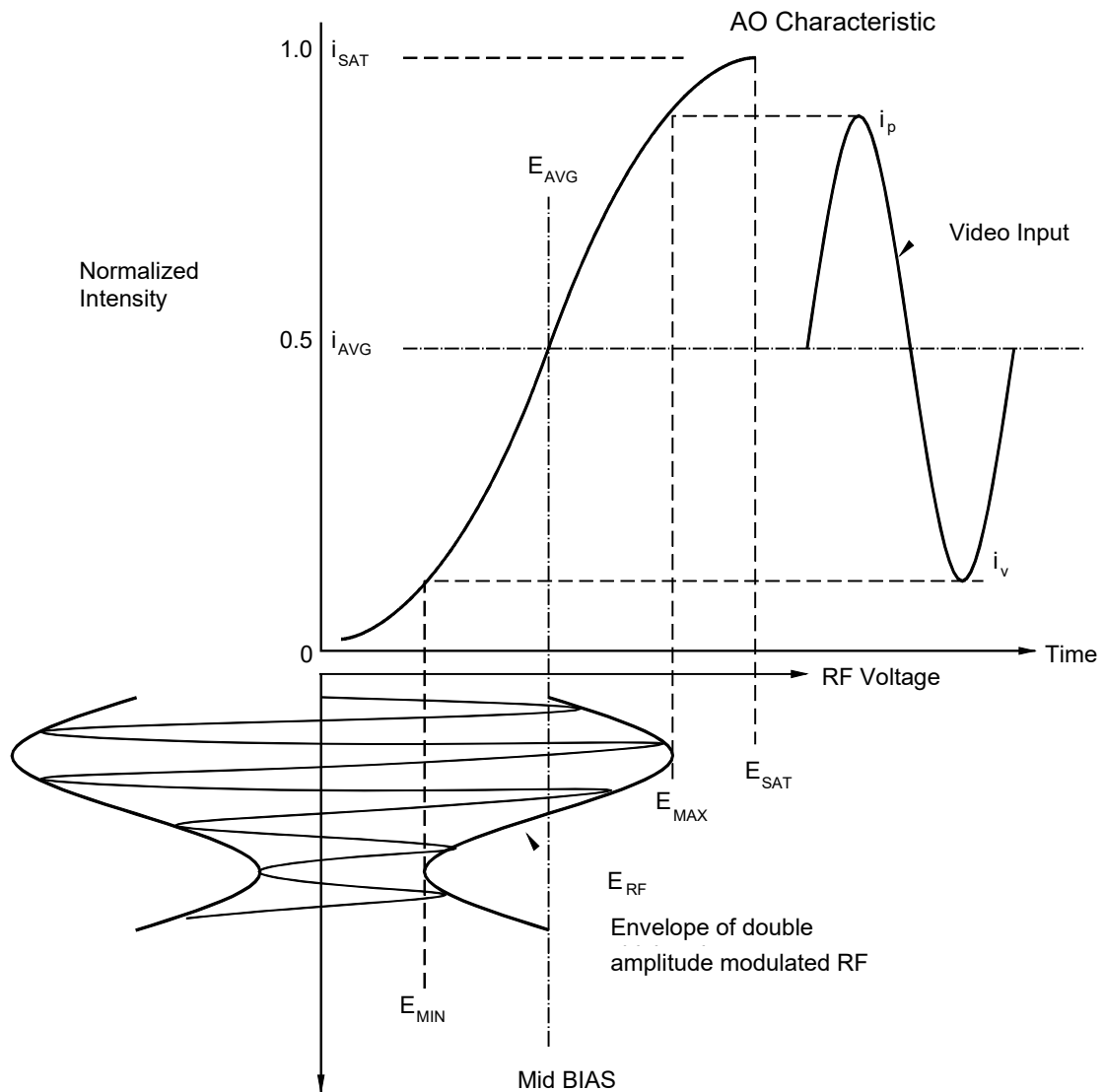Figure 3:  Typical Analog Modulation Waveforms

Figure 4.
Intensity vs. RF Envelope Voltage Transfer

Where fitted, the BIAS control sets the average drive at $E_{AVG}$.

Depth of modulation may then be controlled by a bipolar video signal.

**Schematic for an AO modulator with 830c series analogue driver**

Intensity
Modulation

RF

830c

Input Laser Beam

$\theta_{BRAGG}$

$\theta_{SEP}$

1st Order Deflected Beam
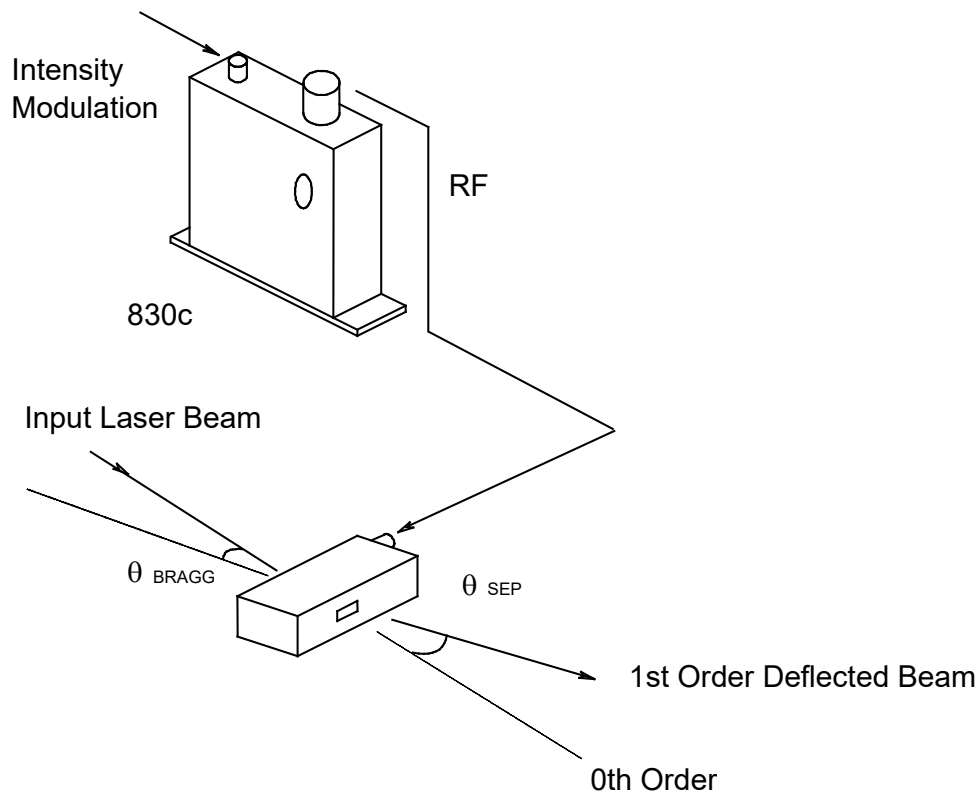
0th Order

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 outputs is :

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

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

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

where : $\lambda$ = wavelength
fc = centre frequency
v = acoustic velocity of AO interaction material = 4.21mm/usec (TeO$_2$)
= 3.63mm/usec (PbMoO$_4$)
= 5.96mm/usec (Fused Si)
d = 1/e$^2$ beam diameter

Figure 5:  Modulation System