



## **RF Amplifier**

**Including: Basic Deflector Alignment**

## **Instruction Manual RFA1170-4-ZP Series**

Models -

RFA1170-4-ZP : 55-105MHz, > 240W total RF output (Zero Phase shift)

(= RFA1170-4-HR)

**DO NOT OPERATE  
the RFA1170-4 types  
or  
LS700-1109 type AO DEVICES \*  
WITHOUT LIQUID COOLING**

\* (refer AO data sheet)

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1. GENERAL

The Model RFA1170-4 (-ZP) is a class AB amplifier designed to drive the LS700- series of Isomet high power Germanium acousto-optic deflectors with up to 300Watts across a 50MHz bandwidth. When fitted with iMIP4 input PCB, the RFA1170-4 power amplifier exhibits zero phase shift across the four RF output channels.

The RFA1170-4-ZP is requires an external frequency input and Logic level gate signal for operation

This model is optimized for very fast rise and fall times and may be operated CW.  
(Always refer to the AO device data sheet).

The RFA1170-4 + iMIP4 combo includes a number of features to aid monitoring and control:

- Temperature monitoring and thermal Interlock for the Amplifier and associated AO deflector
- Opto-isolated control signals e.g. to enable RF output (Active High)

Additional features and remote communication are available when fitted with an optional controller card. (Under development)

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

<u>Model</u>	<u>Use with</u>	<u>Output Frequency</u>	<u>Phase Shifted Outputs</u>	<u>Output Power per Channel</u>
RFA1170-4-ZP	LS700-1109	55 - 105MHz	No	> 80.0 Watt



Figure 2 shows a block diagram of the Driver.

The iMIP4 input PCB includes a pre-amplifier stage and 4-way signal divider

The required input signal level for maximum output is 0dBm (1mW nominal).

The Gate signal on the 9-way D-type is common to all four outputs, and enables the RF power amplifiers.

The design includes thermal protection. This interlock signal is also common to all four outputs

Each channel is amplified by a class A power stage to generate the final output level of up to 90W per output.

The overall gain of the unit is fixed.

**Water cooling is required. 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.**
- **SERIOUS DAMAGE TO THE AMPLIFIER WILL RESULT IF THE (FLOATING) INTERLOCK INPUT SIGNALS ARE CONNECTED TO CHASSIS GROUND OR 0V**

A low impedance d-c power source is required. The operating voltage is +24V at a current drain of approximately 32A. The external power supply should be capable of > 40A, with  $\pm 2\%$  regulation and <200mV ripple voltage for best results.

Figure 1 shows the connections.

### 3. INSTALLATION AND ADJUSTMENT

3.1 For continuous or duty cycle operation >2% , connect cooling water at a flow rate greater than 2 litre/minute at less than 25 deg.C  
(Water connections are provided to suit 8mm OD plastic tubing.)

3.2 With no d-c power applied, connect +24V DC to the screw terminals of the feed-thru DC connector. **DO NOT APPLY POWER.** The DC supply should be capable of 40A

3.2 Connect the (4) RF output TNC jacks to the (4) RF inputs of the acousto-optic deflector (or a 50Ω RF high power load). The order of connection is not critical for the RFA1170/4-ZP. The deflector will not be damaged if the order is incorrect but the amplifier outputs must be terminated.

The cable lengths from the amplifier to the RF connections of the deflector must be equal.

3.4 Connect the Interlock of the acousto-optic deflector (7-way circular connector) to the 7-way connector J9 of the RFA1170/4. A suitable cable will be supplied.

The interlock signals trigger a fault disabling the RF output, if the temperature of the modulator or internal driver temperature exceeds 30°C.

There are two LED indicators

- 1: The bulkhead LED (above RF output J2) is bi-colour.
- RED indicates 24Vdc is ON but the thermal interlocks and/or GATE signal are inactive.
  - Yellow indicates interlocks are OK and the GATE signal is active.  
RF will be output as soon as RF input is applied

2: LED stack on the iMIP4 interface PCB

A GREEN (or RED) LED will beat at 1Hz indicating that the interface control circuitry has initialized correctly

**DO NOT connect any of the interlock signal wires to chassis ground or 0V.**

3.5 Connect the input frequency source to the SMA input

The frequency source should be capable of 1mW drive into 50 ohms .

3.6 Connect an RF Gate input to the 9way D-type connector.

**For the RFA1170/4-ZP with Active HIGH gate**

- Connect pin 1 to a TTL or 5V CMOS compatible signal source (5Vdc is available on Pin 5 of the same connector)
- Connect pin 2 to signal ground

RF output is enabled when pin 1 is driven logic HIGH

Refer page 16, GATE Response

The amplifier is designed for 100% duty factor on the GATE input

No damage, provided coolant is flowing.

3.7 Adjustment of the RF output power is best done with amplifier connected to the acousto-optic modulator

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

3.8 RF power is adjusted at the signal source to the RFA1170/4

3.9 Set the power to a low value e.g. 0.2mW

3.10 Apply + 24V DC to the amplifier. Ensure the cooling water is on.

- 3.12 Input a constant 70MHz (80MHz) input signal or Input a pulsed 70MHz (80MHz) input signal for duty cycle limited AO devices

This will operate the AO device at its mid-scan position.

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

Observe the diffracted first-order output from the acousto-optic modulator and the undeflected zeroth order beam. Adjust the Bragg angle (rotate the deflector) to maximise first order beam intensity.

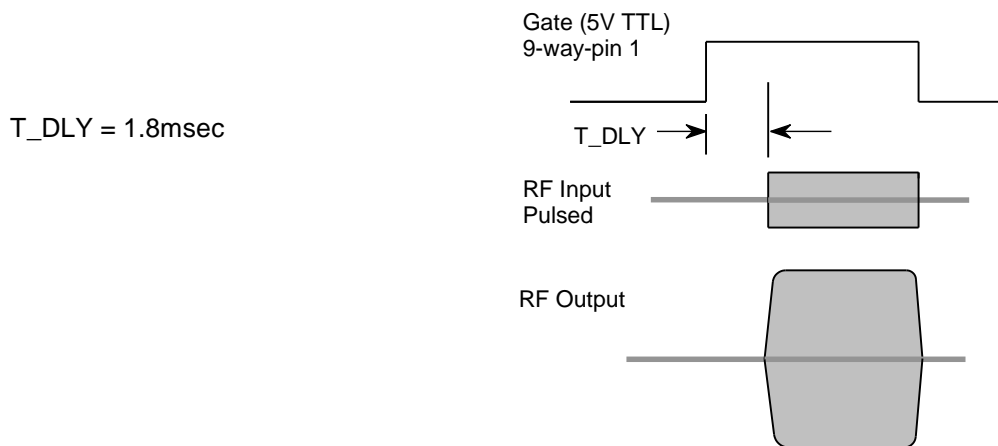
- 3.14 After Bragg angle has been optimized, slowly increase the RF power until maximum first order intensity is obtained. Record this intensity value ( $I_{SAT}$ ).

- 3.15 To equalise deflection efficiency across the extremes of the scan, alternate between the minimum and maximum desired frequencies (e.g. 55MHz and 100MHz input resp') and adjust the Bragg angle to give the same efficiency at both positions. Fine tuning of the incident Bragg angle and RF power may be necessary for optimum results.

- 3.16 The amplifier is now ready for use.

### GATE Response

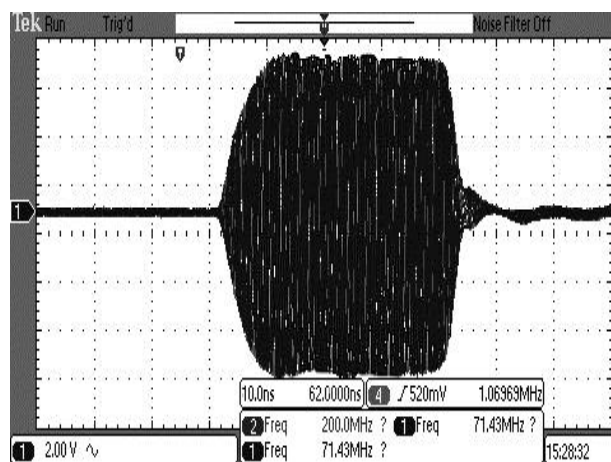
The Gate (5V TTL high) should be applied 2msec prior to the active RF signal pulse input .  
 The Gate may remain HIGH continuously. The RF amplifiers are design to be biased at 100% duty factor.



### Pulsed Response

All versions of the RA1170-4 are designed for fast pulse operation up to CW operation  
 Typical output RF waveform is shown below

45W / 70MHz pulsed output  
 10%-90% rise / fall time = < 10nsec



#### 4. MAINTENANCE

##### 4.1 AO Device - 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

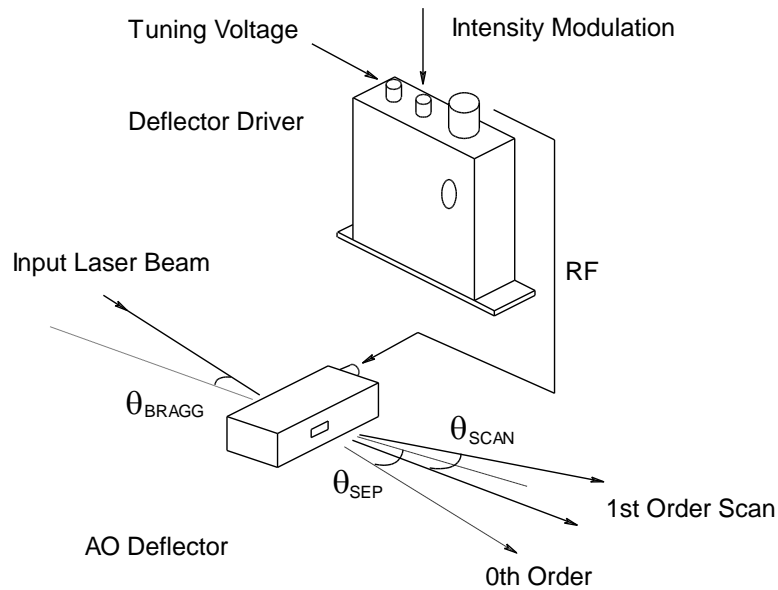
No troubleshooting procedures are proposed other than a check of alignment and operating procedure. If difficulties arise, take note of the symptoms and contact the manufacturer.

##### 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.



**Schematic of Acousto-optic scanner and drive electronics.**



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

$$\theta_{\text{Bragg}} = \frac{\lambda \cdot f_c}{2 \cdot v}$$

The separation angle between the zeroth order and mid scan point of the first order is:

$$\theta_{\text{sep}} = \frac{\lambda \cdot f_c}{v}$$

The first order scan angle is:

$$\theta_{\text{scan}} = \frac{\lambda \cdot \delta f}{v}$$

Modulation rate (Gaussian profile) is:

$$T_r = 0.65 \cdot d/v$$

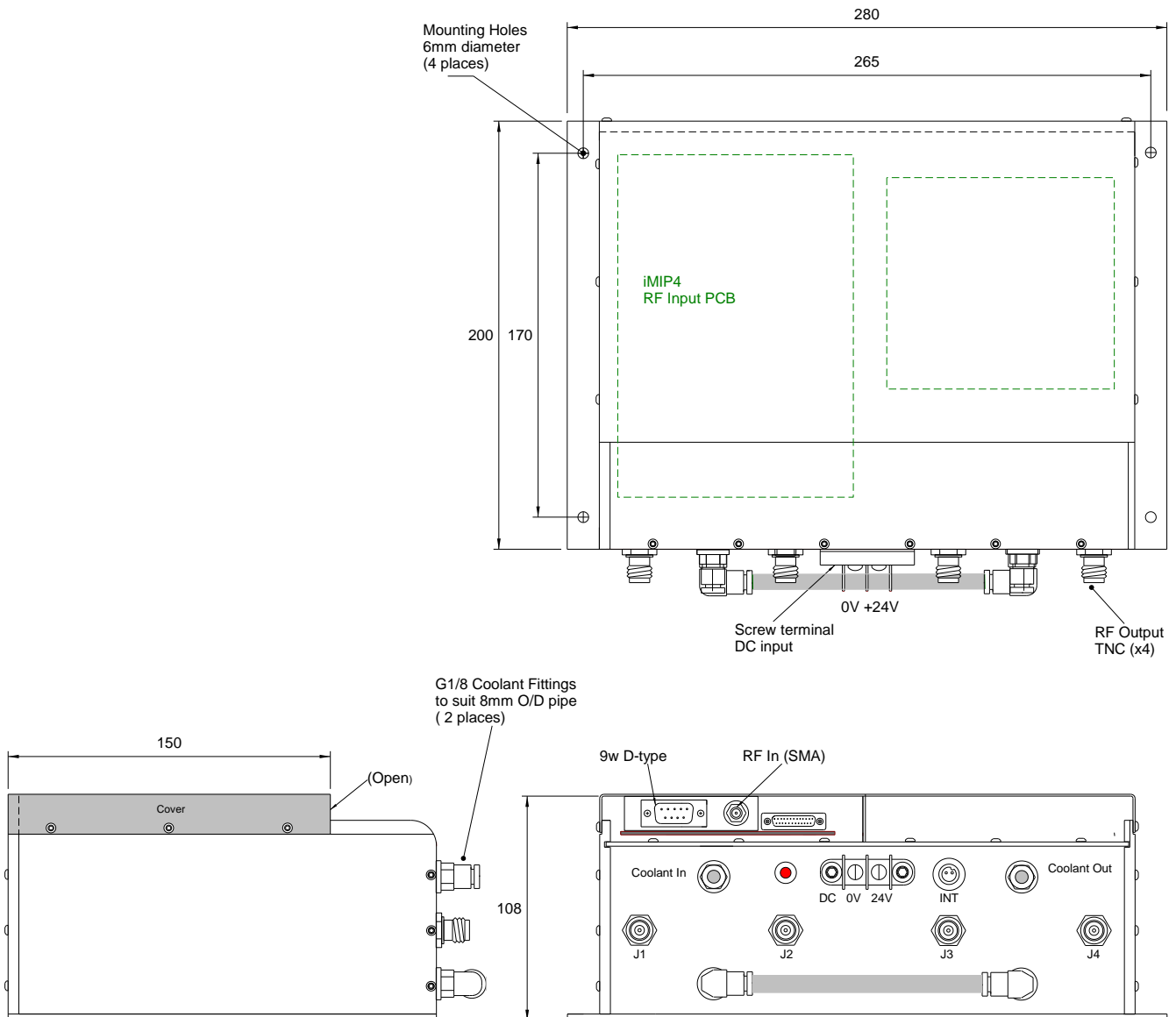
Scanning Resolution is:

$$N = \delta f \cdot d/v$$

where :

- $\lambda$  = wavelength
- $\delta f$  = scan frequency bandwidth
- $f_c$  = centre frequency
- $v$  = acoustic velocity of interaction material (5.5mm/us for Ge)
- $d$  = beam waist along acoustic axis

### Outline



### Connector Summary

- J1:** TNC, RF Output Ch1
- J2:** TNC, RF Output Ch2
- J3:** TNC, RF Output Ch3
- J4:** TNC, RF Output Ch4

**SMA,:** RF Input

**INT:** 7-way Circular Panel Plug, Binder 712 (AOD Temp and isolated Interlock Input)

**9w-D:** Gate Input, pin1 signal, pin2 return

Figure 1: Driver Installation

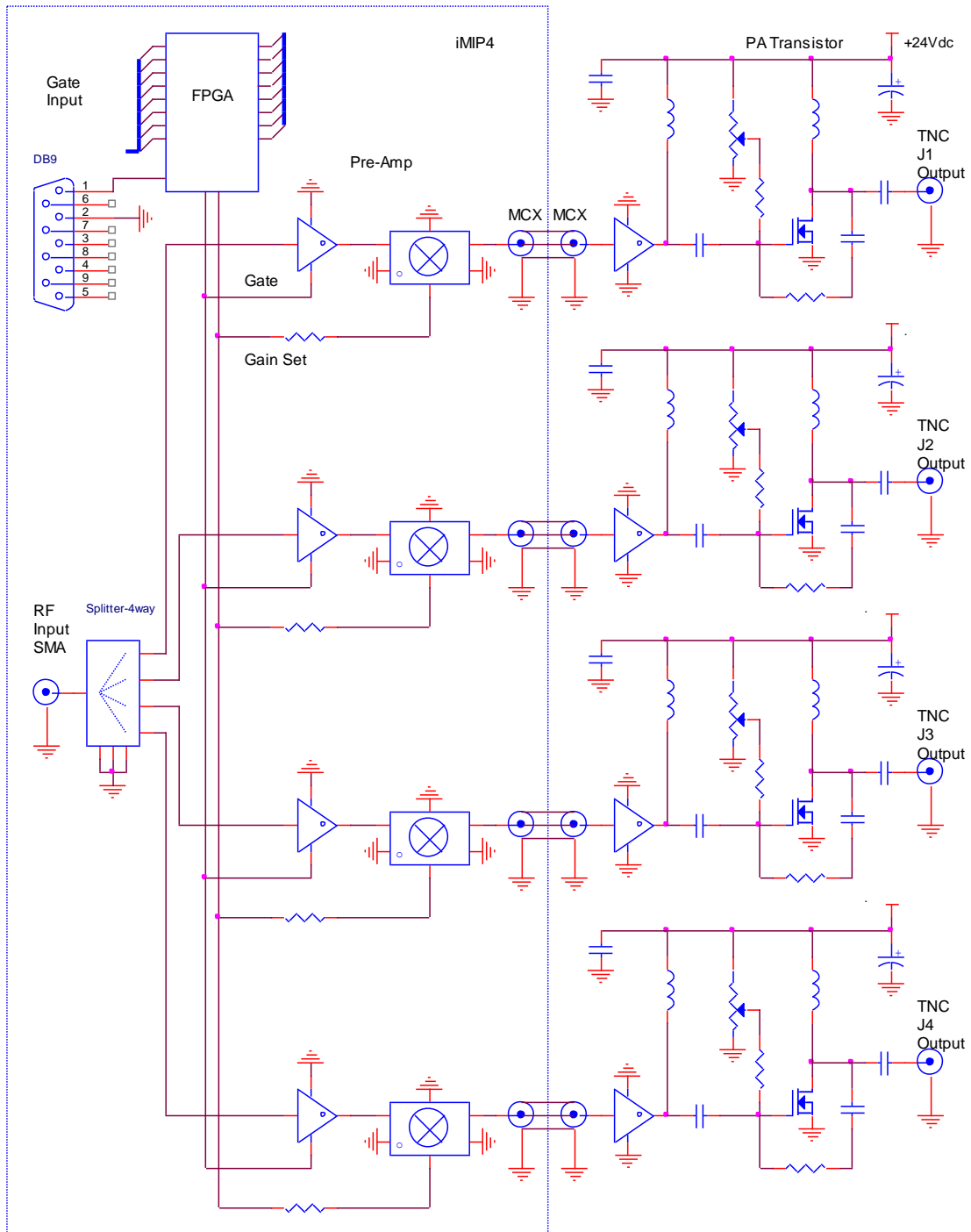


Figure 2: Driver Block Diagram

Signal	Connector	Spec
RF input	SMA	0dBm , 640mVpp, (50ohm) , 1mW Maximum
Gate	9-way D-type Pin 1 = signal Pin 2 = return (0V)	Positive 5V logic High = ON
5Vdc, 20mA	9-way D-type Pin 5	Can be tied to Pin1 to permanently Gate amplifier ON
INT	7-way Binder	I2C (cable supplied)
Vdc	Screw terminal	24Vdc , 40A

LED indicators, 2 off :

1: The bulkhead LED fitted above RF output J2

RED indicates 24Vdc is ON, but interlocks and/or GATE signal are inactive.

YELLOW indicates interlocks are OK and GATE signal is active

2: LED stack on the iMIP4 interface PCB

GREEN (or RED) LED will beat at 1Hz indicating that the interface control circuitry has initialized correctly

Figure 3: Signal listing

**Connection options for Beam Steered AO Deflectors**

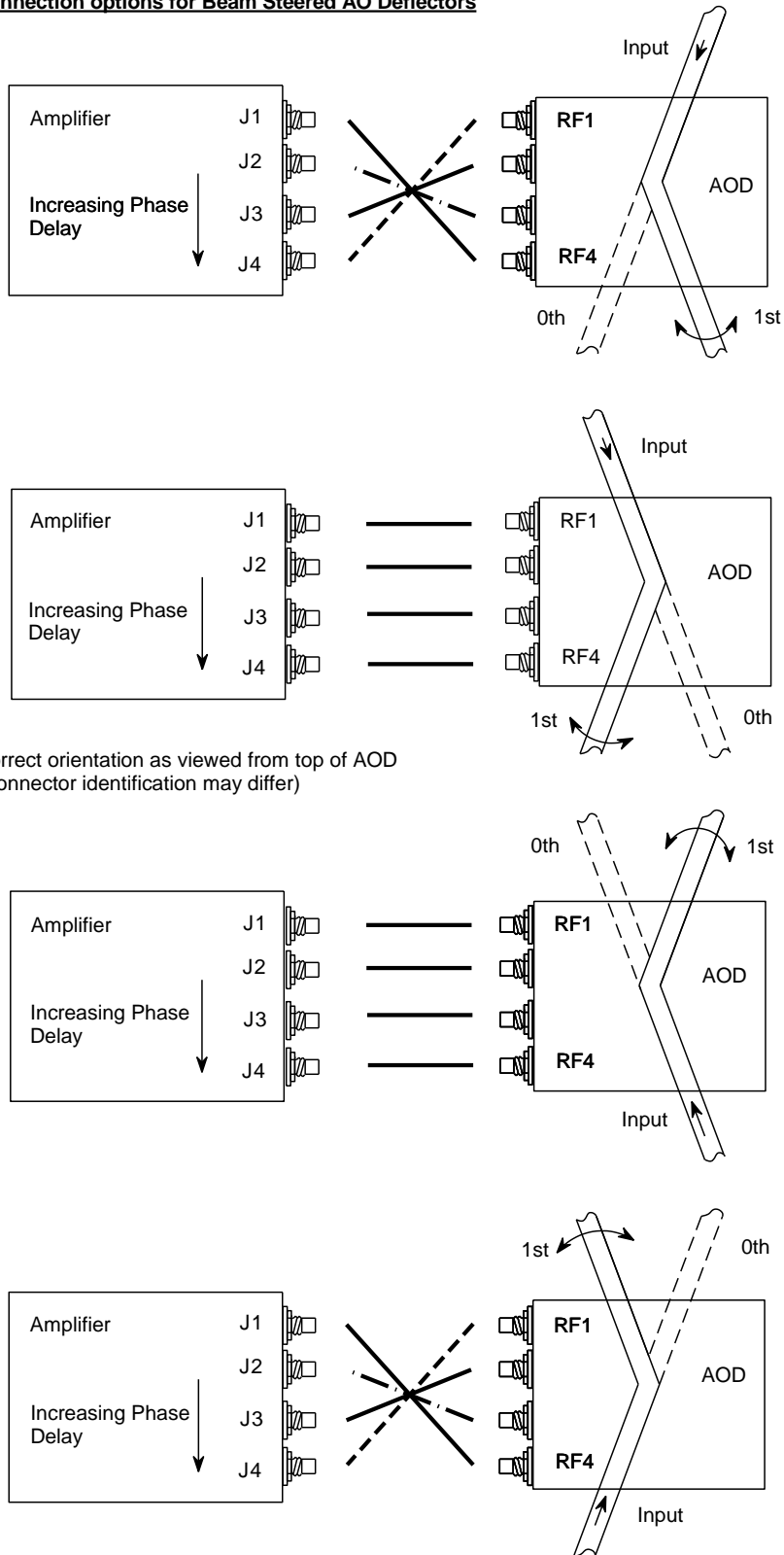


Figure 4: Connection Orientation. (Ignore reference to Phase Delay for model RFA1170-4-ZP)