RF Amplifier

Including: Basic Deflector Alignment

Instruction Manual

RFA1160/4 Series

Models -

RFA1160/4	: 50-90 MHz, Four channel 280W total RF output
RFA1160/4-PO	: 55-105MHz, > 240W total RF output. Optimized for Duty cycle apps **Caution: refer to notes page 7**
RFA1160/4-ZP	: 55-105MHz, > 240W total RF output (Zero Phase shift)
RFA1160/4-ZP-PO	: 55-105MHz, > 240W total RF output. Optimized for Duty cycle apps **Caution: refer to notes page 7** (Zero Phase shift)

DO NOT OPERATE
the RFA1160/4 types
or
LS600-1100 type AO DEVICES *
WITHOUT COOLING

* (refer AO data sheet)

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ISOMET

1. GENERAL

The Model RFA1160/4 is a class AB amplifier designed to drive the LS600- series of Isomet High Power Germanium Acousto-Optic Deflectors with up to 280Watts across a 50-90 MHz bandwidth. The standard RFA1160/4 exhibits progressive phase shifting across four RF output channels. Phase shifting is the basis of the beam-steering technique used in Isomet wideband AO deflectors.
The RFA1160/4-PO is optimized for very fast rise and fall times. This unit is not designed to operate CW. Maximum duty cycle 25%.

The RFA1160/4-ZP has zero phase shift across the four RF output channels.
The RFA1160/4-ZP–PO has zero phase shift across the four RF output channels and is optimized for very fast rise and fall times. This unit is not designed to operate CW. Maximum duty cycle 25%.

Passive phase shifting is employed only on the standard RFA1160/4 between adjacent output channels J1 and J2 and similarly between channels J3 and J4. Depending on the input source, active or passive phase control can be applied between the channel pairs J1-J2 and J3-J4. e.g. The Isomet iDDS-2 synthesizer offers active phase control. When used as the input source for the RFA1160/4, the result is near exact acoustic beam-steering across the full scan range of the LS600. Active phase control provides a more uniform diffraction efficiency scan response at lower average RF power.

The RFA1160/4 includes a number of additional features to aid test and control:

- Eight Analog outputs representing the forward and reflected RF power for each output (Qualitative).
- Thermal Interlock logic levels for the Amplifier and associated AO deflector Interlock
- Analog outputs representing the Temperature of the Amplifier and Deflector (10mV/*C)
- Opto-isolator compatible RF gate signal required to enable RF output (Active low)
- Integral DC-DC converters providing power for ancillary components such as the iDDS-2.

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

Model	Use with	Output Frequency	Phase Shifted Outputs	Output Power per Channel
RFA1160-4	LS600-10 LS600-1011	50 - 90MHz	Yes	> 70.0 Watt
RFA1160-4-ZP	LS600-1109	55 - 105MHz	No	> 60.0 Watt
RFA1160-4-(ZP)-PO (Pulse optimized)	LS600-1109	55 - 105MHz	(No)/Yes	> 60.0 Watt

Figure 2 is a block diagram of the Driver. A pre-amplifier stage amplifiers and divides the input signal (Input= 0dBm nominal).
Outputs J1 and J2 respond to the input on J7
Outputs J3 and J4 respond to the input on J8
The RF_gate signal on J6 is common to all four outputs.
The Interlock signal on J9 is also common to all four outputs

For the RFA1160-4 variant only, the output channels J2 and J4 feature a fixed delay element to give a specified phase shift between the matching outputs on J1 and J3 respectively.

Each channel is further amplifier by a class A power stage to generate the final output level of up to 70W 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 capable of > 40A, with ± 2% regulation and <200mV ripple voltage for best results.

Figure 1 shows the connections.

3. INSTALLATION AND ADJUSTMENT

3.1 For continuous of high duty cycle operation connect cooling water at a flow rate not less than 0.25 litres/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 the + 24V DC in to the center terminals of the feed-thru DC inputs. DO NOT APPLY POWER. The DC supply should be capable of 40A

3.3 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 important to the RFA1160/4 and RFA1160/4-PO. 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, the deflection efficiency will vary considerably as the input frequency is changed.

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

Figure 4 illustrates the connection order depending in the orientation of the input laser beam with respect to the AO deflector.
[Connection order is not important for the RF1160/4-ZP]

3.4 Connect the Interlock of the acousto-optic deflector (7-way circular or 3-pin mini-snap connector) to the enable inputs on the 7-way connector J9 of the RFA1160/4.

- Connect J9/pin 5 to pin 5 of the 7-way (or to pin 1 of the snap connector)
- Connect J9/pin 6 to pin 6 of the 7-way (or to pin 2 of the snap connector)

The interlock connection becomes open circuit disabling the RF output, if the temperature of the modulator exceeds 40ºC or the internal driver temperature exceeds 43ºC. An LED indicator illuminates when the Interlocks are closed and the RF is enabled.

DO NOT connect either interlock signal wire to chassis ground or 0V.

3.5 Connect the input frequency source 1 to RF1, SMA input connector J7.
Connect the input frequency source 2 to RF2, SMA input connector J8.
The frequency source should be capable of 1mW drive into 50 ohms .

Note: For the RFA1160/4-ZP and –ZP-PO use the RF splitter provided to connect both RF1 and RF2 to a common source.

3.6 Connect an RF Gate input to the 25way D-type connector J6.

For RFA1160/4 and RFA1160/4-ZP with Active Low Gate

- Connect pin 17 to a 12V CMOS logic signal or open collect source
- Connect pin 16 to signal ground

RF output is enabled when pin 17 is logic LOW or shorted to pin 16

"Duty cycled" models:

For RFA1160/4-PO and RFA1160/4-ZP-PO with Active HIGH gate

- Connect pin 17 to a TTL or 5V CMOS compatible signal source
- Connect pin 16 to signal ground

RF output is enabled when pin 17 is driven logic HIGH

Refer 3.16 below

3.7 Signal monitoring signals are available from the 25way D-type connector J6
See table in Figure 3

3.8 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 RFA1160/4
e.g. iHHS-2 amplitude setting.

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 to the RFA1160/4 (RFA1160/4-ZP).
Or Input a pulsed 70MHz (80MHz) input signal to the RFA1160/4-PO (RFA1160/4-ZP-PO), with a duty cycle less than 25%.
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}).

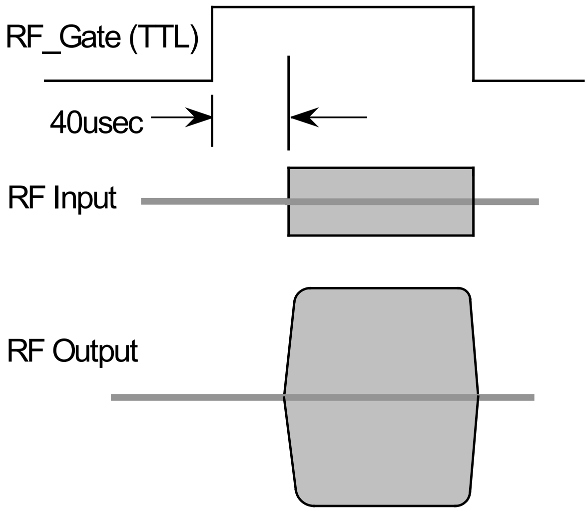
3.15 To equalise deflection efficiency across the extremes of the scan, alternate between the minimum and maximum desired frequencies (e.g. 50MHz and 90MHz input resp') and adjust the Bragg angle to give the same efficiency at both positions. Fine tuning of the incident Bragg angle and RF power may be necessary for optimum results.

3.16 The amplifier is now ready for use.

Note:

RFA1160/4-(ZP)-PO versions must not be operated CW for extended periods.
This version includes Thermistor protection that will reduce the transistor gain as the dissipation increases. The optimum Duty cycles range is 10-20%

Duty cycle MUST BE controlled via the RF_gate input to J6. Duty cycling the RF input only is insufficient. The RF_gate (TTL high) should be applied 40usec prior to the active RF signal pulse input and should terminate with the RF input. (see below)



Bulkhead LED indicator,

RED indicates that the 24Vdc is ON, and the thermal interlocks are valid.

If the 24V supply is ON and the LED is OFF, check the AOD thermal interlock signal.

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.

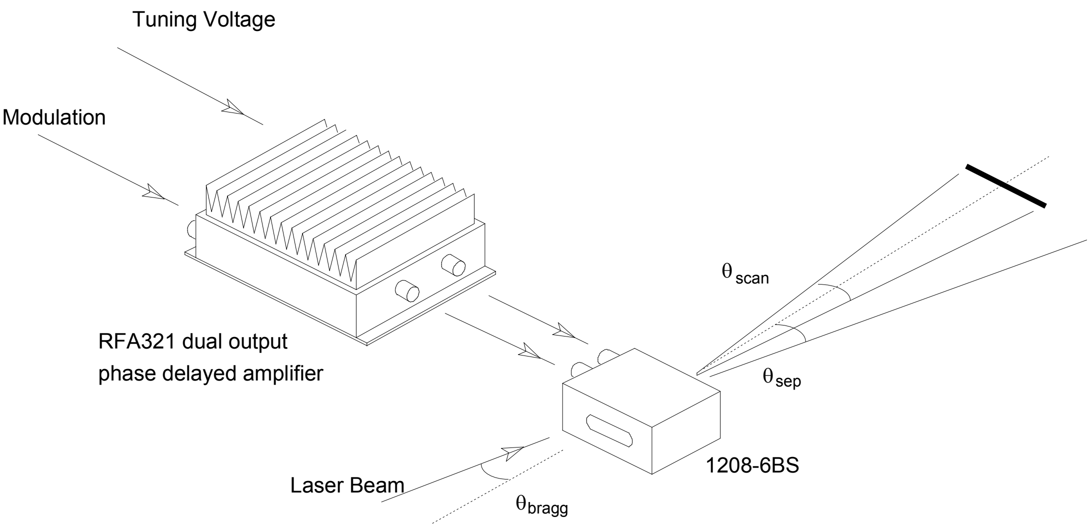
4.2 Troubleshooting

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:

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

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

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

The first order scan angle is :

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

Modulation rate (Gaussian profile) is:

$$Tr = 0.65\ d/v$$

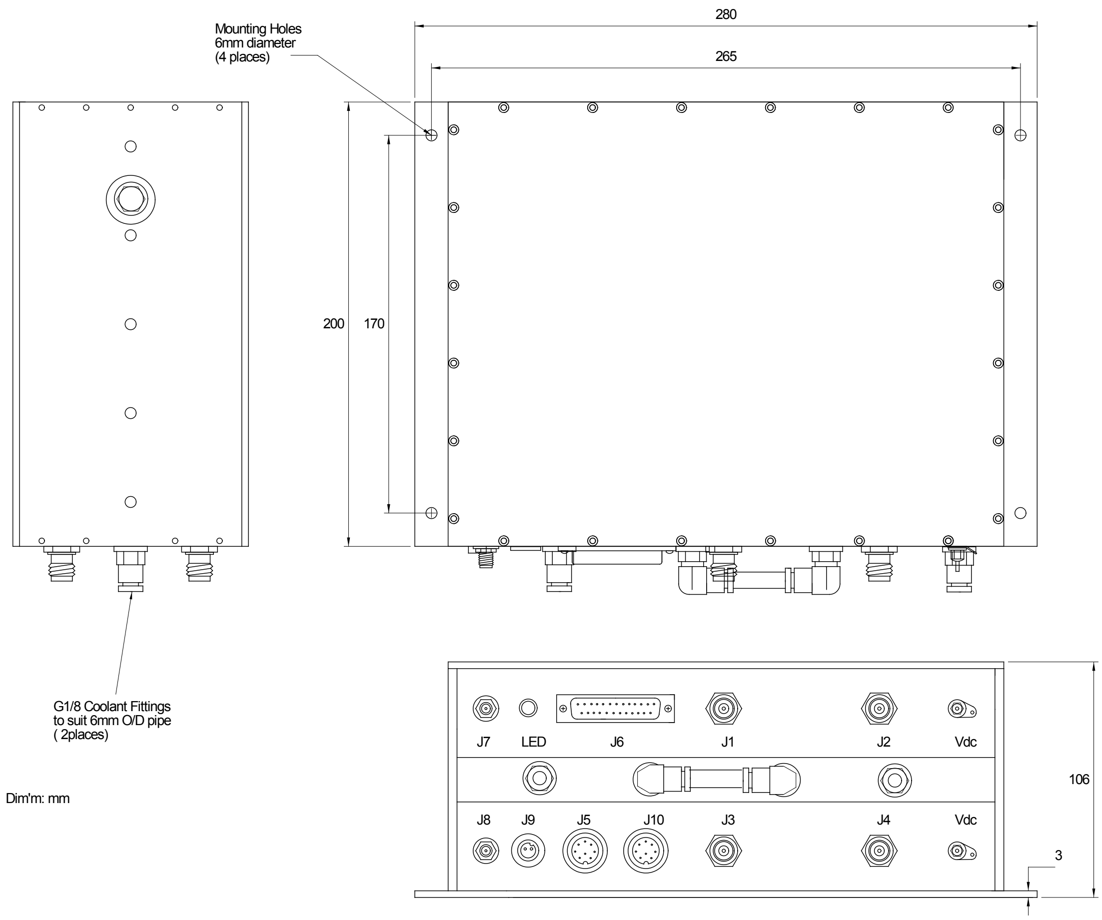
Scanning Resolution is:

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

where :

λ	=	wavelength
δf	=	scan frequency bandwidth
fc	=	centre frequency
v	=	acoustic velocity of interaction material (5.5mm/us for Ge)
d	=	beam waist along acoustic axis

Connection Summary



Connector Summary

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

J5: 3-way Circular Panel Socket, Binder 680 (+/-12Vdc Auxiliary Supply Output)

J6: 25-way Filtered D-type Connector (Amp GATE, VSWR Ch1, Ch2, Ch3, Ch4;
Interlock status, Temperature AOD, Amp)

J7: SMA, RF_1 Input
J8: SMA, RF_2 Input (Phase delayed, RFA1160/4)

J9: 7-way Circular Panel Plug, Binder 712 (AOD Temp and isolated Interlock Input)
J10: 5-way Circular Panel Socket, Binder 680 (+5Vdc , +/-12Vdc *iDDS* Supply Output)

Figure 1: Driver Installation

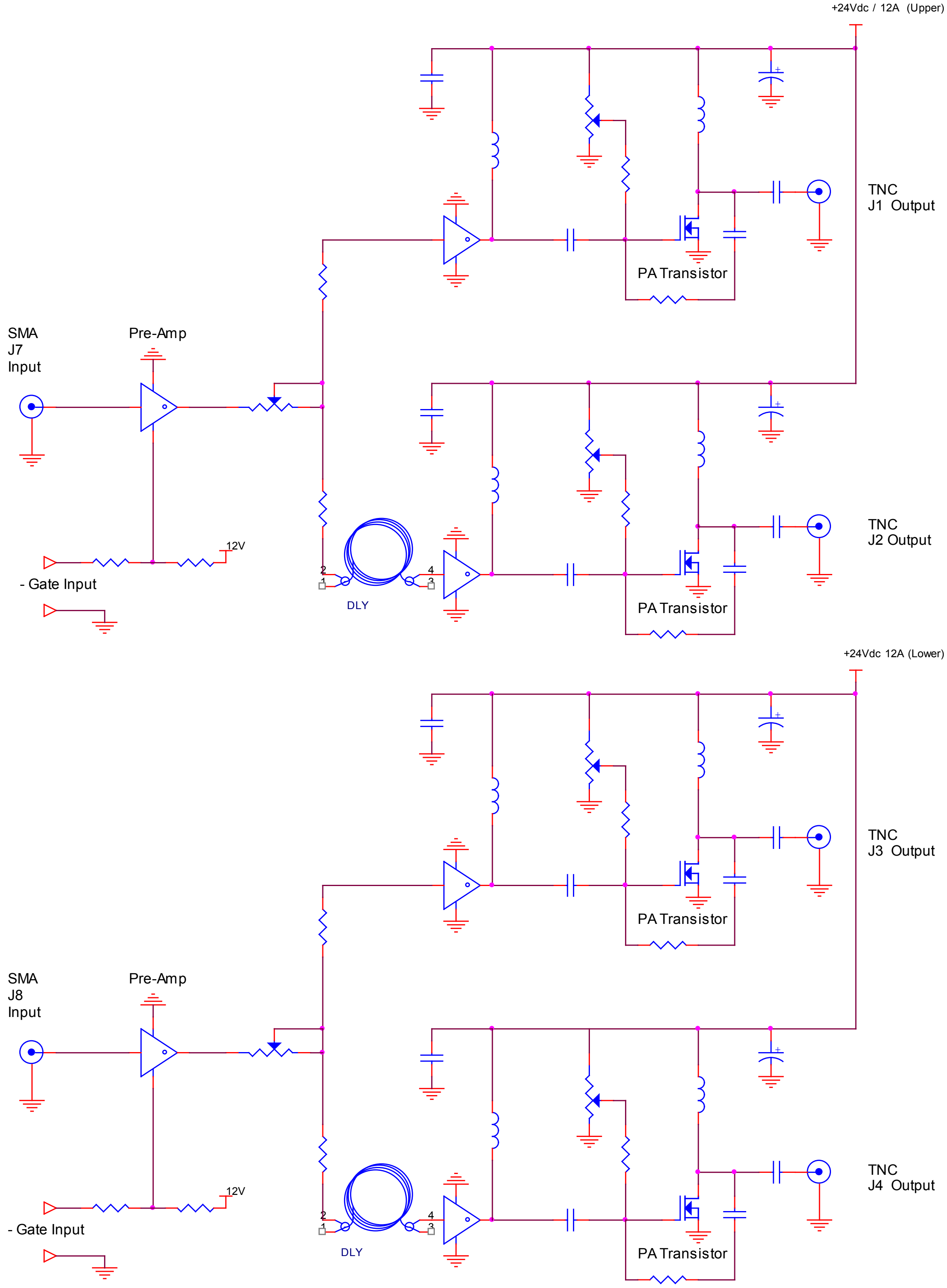


Figure 2: Driver Block Diagram

Signal Designation	Signal	Type	Description	Connector	Label	Pin
RF_Out1	Output	0-60W 50 ohm	RF output at specified freq.	TNC	J1	
RF_Out2	Output	0-60W 50 ohm	Phase modified RF output at specified freq.	TNC	J2	
RF_Out3	Output	0-60W 50 ohm	Phase modified RF output at specified freq.	TNC	J3	
RF_Out4	Output	0-60W 50 ohm	Phase modified RF output at specified freq.	TNC	J4	
FWD_1	Output	Analog	RF forward pwr J1	25D-Type Skt	J6	1
REV_1	Output	Analog	RF reverse pwr J1	25D-Type Skt	J6	2
Rtn_1	Output		Signal return	25D-Type Skt	J6	18
FWD_2	Output	Analog	RF forward pwr J2	25D-Type Skt	J6	3
REV_2	Output	Analog	RF reverse pwr J2	25D-Type Skt	J6	4
Rtn_2	Output		Signal return	25D-Type Skt	J6	19
FWD_3	Output	Analog	RF forward pwr J3	25D-Type Skt	J6	5
REV_3	Output	Analog	RF reverse pwr J3	25D-Type Skt	J6	6
Rtn_3	Output		Signal return	25D-Type Skt	J6	20
FWD_4	Output	Analog	RF forward pwr J4	25D-Type Skt	J6	7
REV_4	Output	Analog	RF reverse pwr J4	25D-Type Skt	J6	8
Rtn_4	Output		Signal return	25D-Type Skt	J6	21
T_Amp	Output	Analog	Amplifier Temperature	25D-Type Skt	J6	10
T_Amp_rtn	Output		Signal return	25D-Type Skt	J6	22
T_AOD_OUT	Output	Analog	AOD Temperature	25D-Type Skt	J6	9
T_AOD_OUTrtn	Output		Signal return	25D-Type Skt	J6	23
RF_gate	Input	Logic	**RF enable / RF_GATE**	25D-Type Skt	J6	17
RF_gate_rtn				25D-Type Skt	J6	16
INT-Amp	Input	Logic	Amp' Thermal interlock Status	25D-Type Skt	J6	15
INT-rtn	Input		Signal return	25D-Type Skt	J6	25
INT-AOD	Input	Logic	AOD Thermal interlock Status	25D-Type Skt	J6	14
INT-rtn	Input		Signal return	25D-Type Skt	J6	(25)
Reserved	Input	Analog	+Vmod	25D-Type Skt	J6	
Reserved	Input	Analog	- Vmod	25D-Type Skt	J6	
RF_In1	Input	0-10mW 50 ohm	RF output at specified freq.	SMA	J7	
RF_In2	Input	0-10mW 50 ohm	Phase modified RF output at specified freq.	SMA	J8	
AOD_INT_SW	Input	NC Contact	AOD Thermal interlock SW	7-way 712 Plg (Binder)	J9	5
AOD_INT_rtn	Input	NC Contact	Signal return (not 0V)	7-way 712 Plg (Binder)	J9	6
T_AOD	Input	Analog	AOD Temperature	7-way 712 Plg (Binder)	J9	2
AOD_rtn	0V		Signal return	7-way 712 Plg (Binder)	J9	3
5V_in	Output	Supply	Temp sensor supply	7-way 712 Plg (Binder)	J9	1
3v3_gate	Output	Supply	Lapse counter	7-way 712 Plg (Binder)	J9	4
+24Vdc	Input	Supply	20A minimum	Solder feed through		
+24Vdc	Input	Supply	20A minimum	Solder feed through		
0V	Input	Supply	return	Solder tag		
0V	Input	Supply	return	Solder tag		
+5Vdc	Output	Supply	iDDS supply	5-way 680 Skt (Binder)	J10	1
0V	Output	Supply	Supply return	5-way 680 Skt (Binder)	J10	2
+12Vdc	Output	Supply	Supply	5-way 680 Skt (Binder)	J10	3
0V	Output	Supply	Supply return	5-way 680 Skt (Binder)	J10	4
-12Vdc	Output	Supply	Supply	5-way 680 Skt (Binder)	J10	5
+12Vdc	Output	Supply	Auxiliary Supply	3-way 680 Skt (Binder)	J5	
0V	Output	Supply	Supply return	3-way 680 Skt (Binder)	J5	
-12Vdc	Output	Supply	Auxiliary Supply	3-way 680 Skt (Binder)	J5	

Figure 3: Signal listing

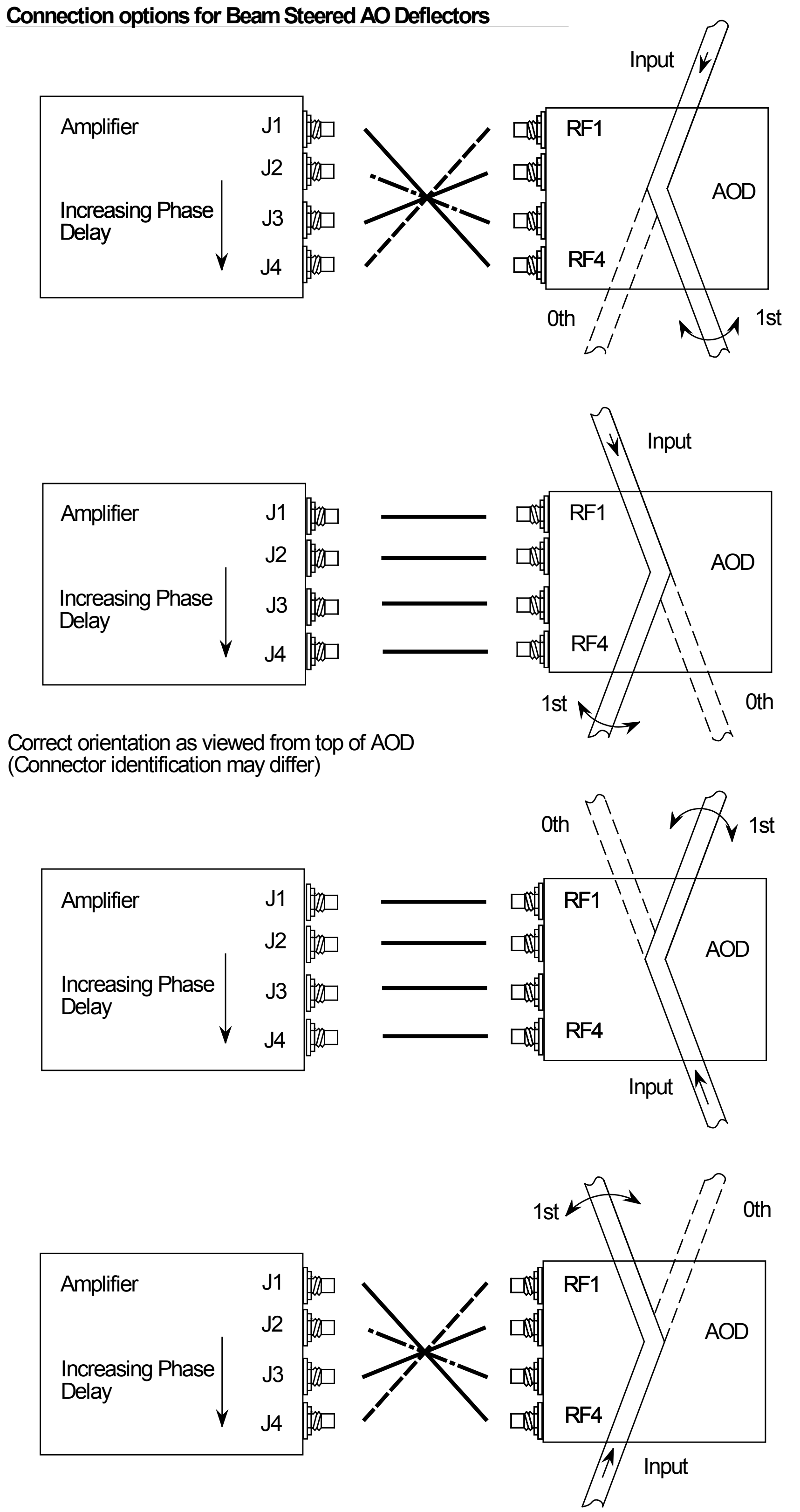


Figure 4: Connection Orientation. (Applies to RFA1160/4 and RFA1160/4-PO)