TIME OF FLIGHT

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INSTRUCTION MANUAL

D-803I ITAR TIME OF FLIGHT POWER SUPPLY
FOR
D-850I ION TRAP ANGULAR REFLECTRON

AREF P.S. PC BOARD REV-4A

Updated Mar 6, 2008

WARNING

THIS EQUIPMENT USES VOLTAGES WHICH
ARE DANGEROUS TO LIFE. IT SHOULD BE
SERVICED ONLY BY QUALIFIED PERSONNEL,
USING PROPER SAFETY PRECAUTIONS.
DISCONNECT ALL CABLES AND POWER CORD
BEFORE REMOVING TOP COVER

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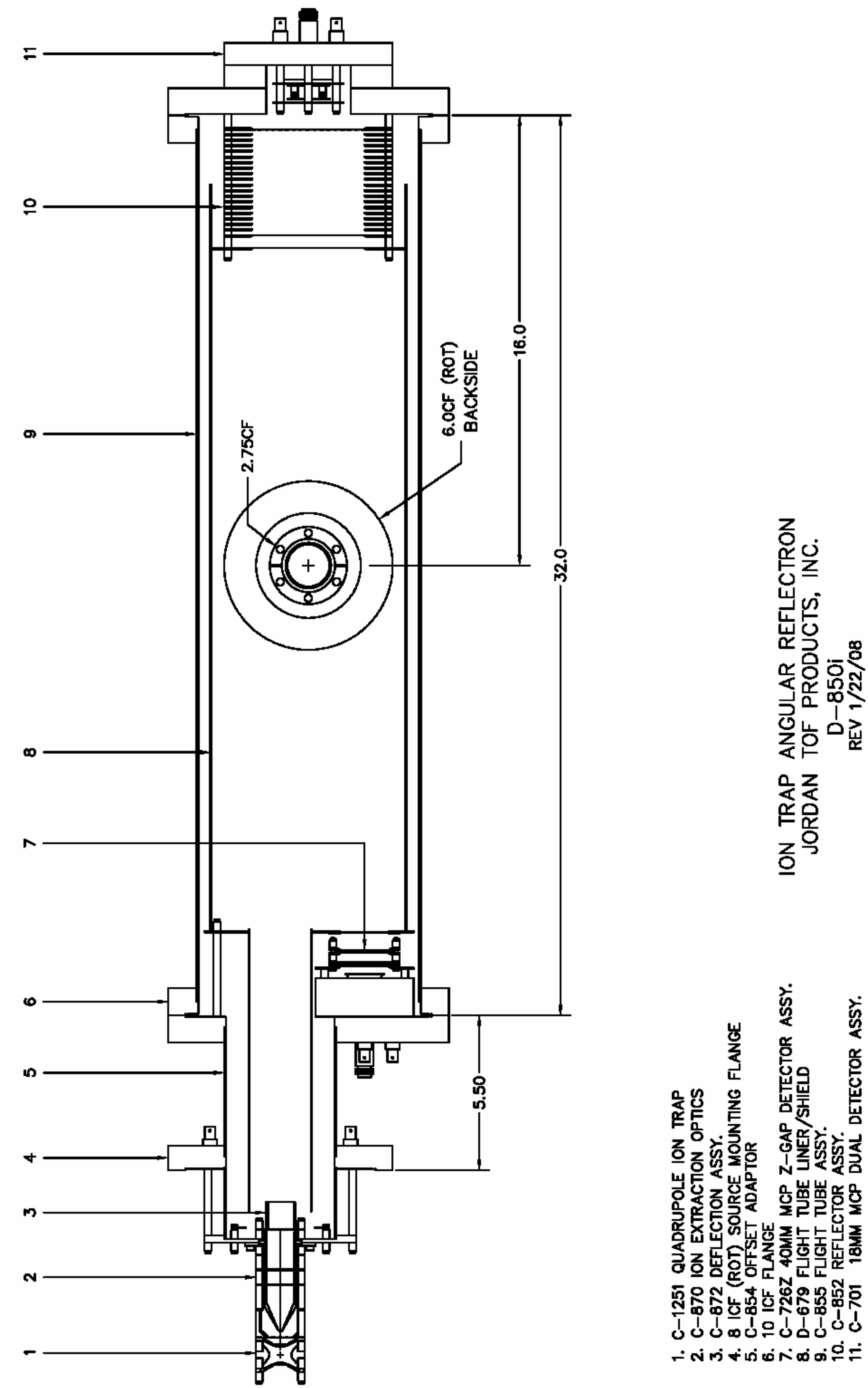
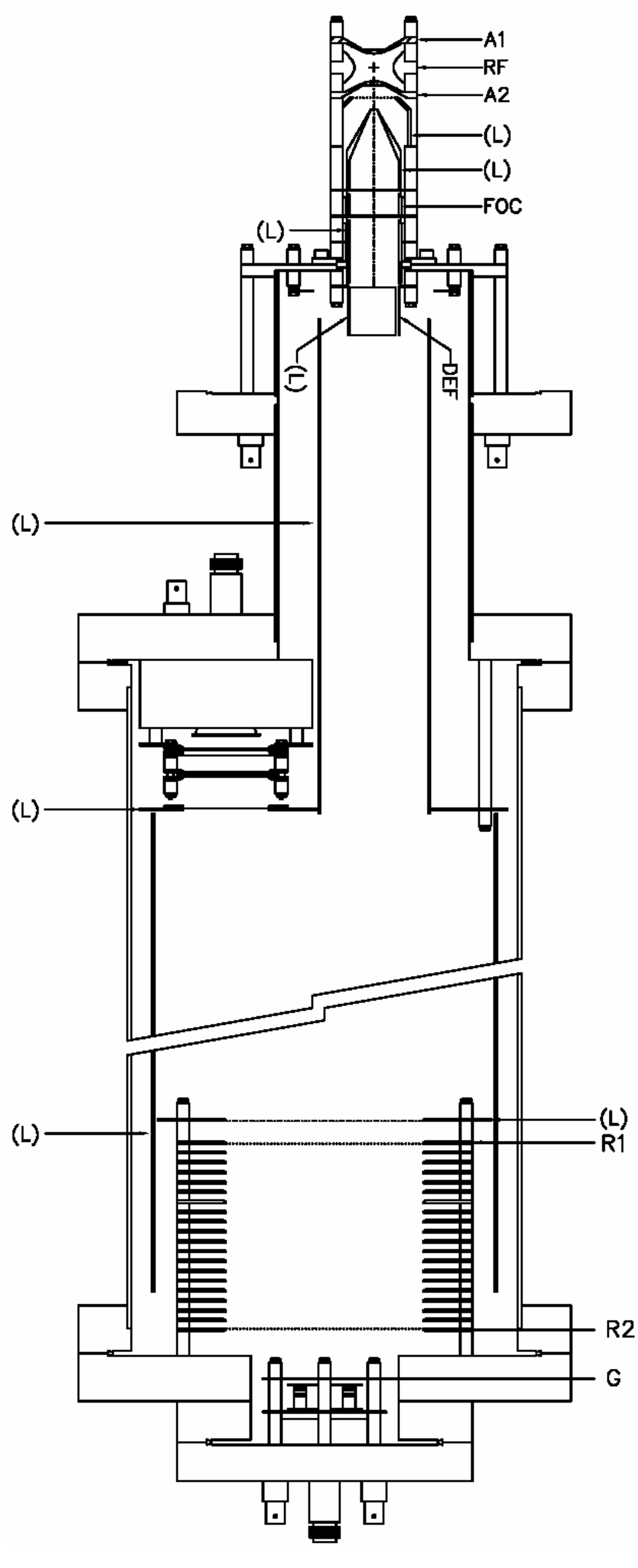
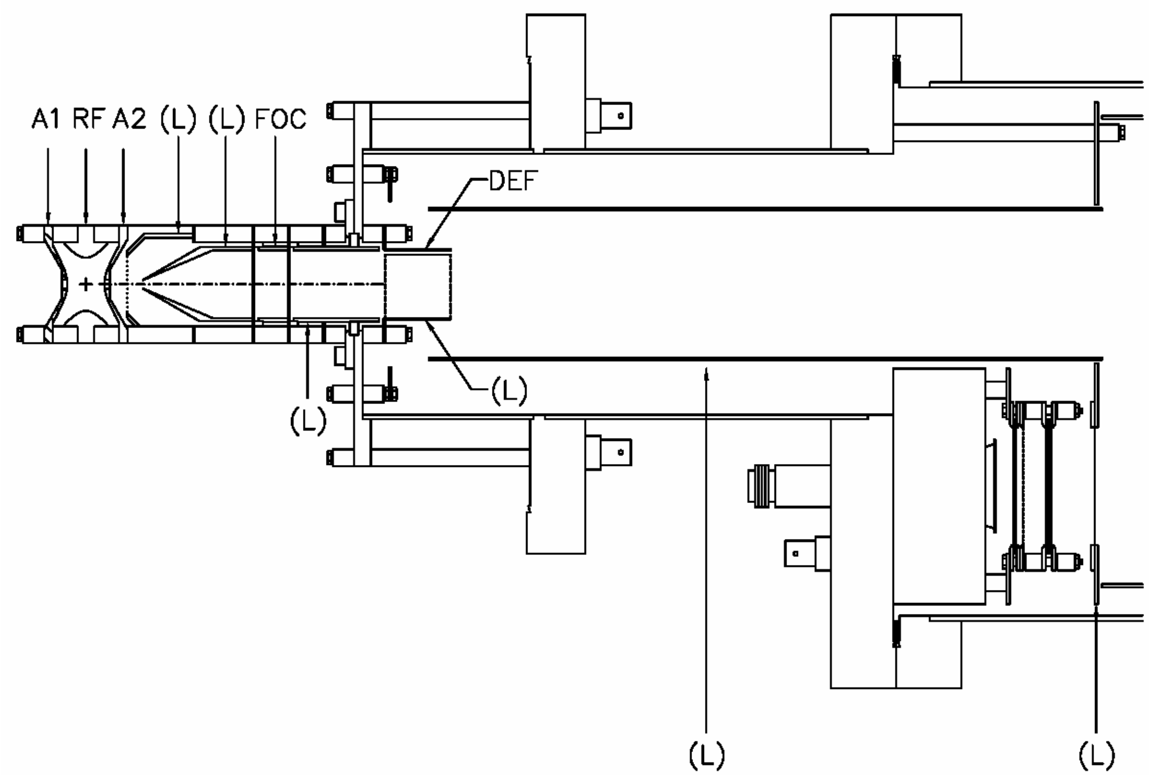


D-850I ION TRAP AREF ASSEMBLY

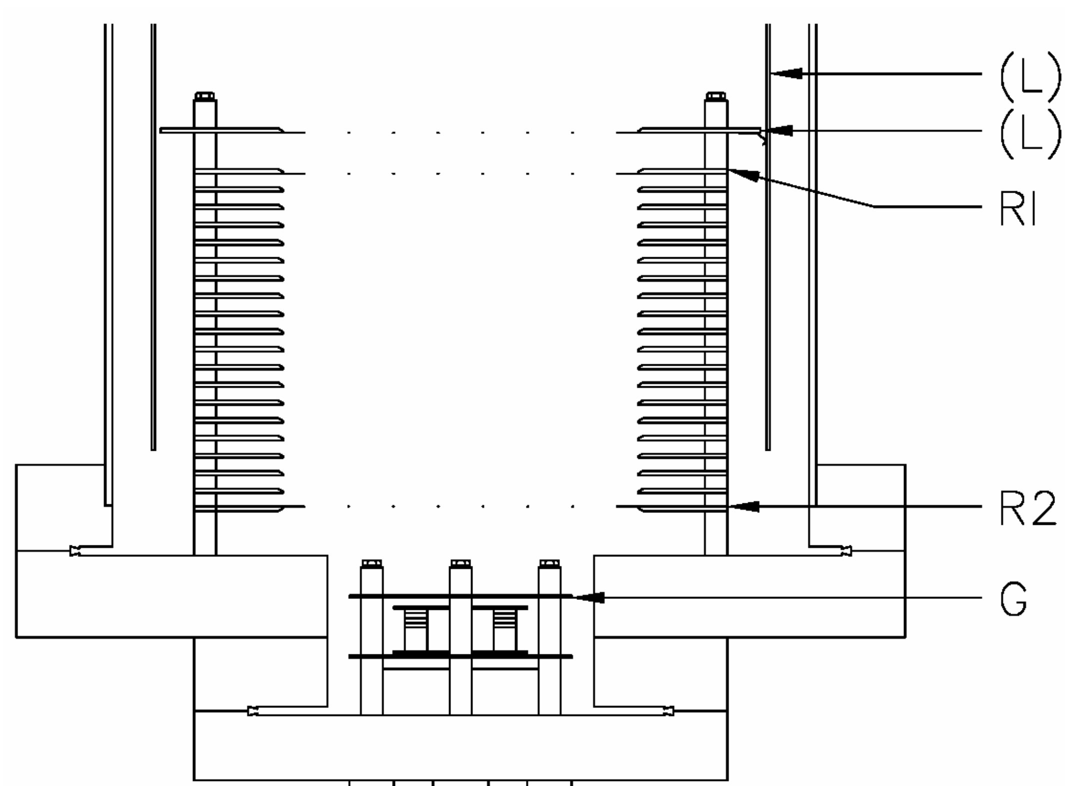


D-850I ION TRAP AREF WIRING ILLUSTRATION
Connections in Brackets ( ) Are Made Internally

ION SOURCE WIRING DETAIL



REFLECTOR AND LINEAR DETECTOR WIRING DETAIL



Connections in Brackets ( ) Are Made Internally

1.0 SPECIFICATIONS

1.1 PHYSICAL SPECIFICATIONS

Cabinet size	19.0" W. x 14.5" D. x 5.25" H.
Cabinet weight	20.5 Lbs.

1.2 ELECTRICAL SPECIFICATIONS

See Section 5.0

1.3 SERVICE REQUIREMENTS

Input Power	100/120/220/240 volts 1 Phase, 50-60 Hz

2.0 GENERAL DESCRIPTION

This D-803I Ion Trap Angular Reflectron (ITAR) Power Supply has been designed for use with our D-850I Ion Trap Angular Reflectron Time Of Flight.

All voltages are monitored by the same meter, which only displays a voltage when a monitor button is held down. Each end of every cable is labeled to match the receptacle to which it connects.

3.0 SYSTEM OPERATION AND INITIAL STARTUP SETTINGS

The following is a brief discussion of system operation as well as suggested startup settings. The voltages in this section are intended for initial operation only and will likely have to be adjusted to optimize performance according to experimental variables.

When Ions are created and stored in the Ion Trap, they are at ground potential or near ground. If they are created outside the Ion Trap by EGUN ionization or some other external source, they need to be near ground so that they can be stopped by the buffer gas (typically Helium) and stored and cooled in the Ion Trap. They are ejected from the trap by a voltage pulse which is applied to either the Repelling End Cap (VA1, positive pulse), the Extraction End Cap (VA2, negative pulse), or both (bipolar, push/pull). Typically, when using unipolar pulsed extraction, the Repeller (A1) is grounded by way of a ground cap and the Extractor (A2) is pulsed from ground to -400 volts. Bipolar extraction is applied to both End Caps.

After leaving the trap the ions are accelerated through the acceleration grid, which is electrically connected to the flight tube liner (L = -1,200V+/-) by way of an internal connection.

NOTE: The feedthrough marked ‘L’ on the flight tube side of the Offset Adaptor is only used when a gate valve is installed between the source flange and flight tube. In this case the SHV Tee and cable provided must be used to carry the liner potential across the gap in the liner.

After acceleration, the ion beam passes through the Einsel lens (FOC = -1,200V+/-), where they are focused, and then though the deflection field (DEF = -1,140V+/-). The deflection plate steers the beam to the reflector assembly. This is explained in greater detail at the end of section 10.0.

When the ions reach the reflector, they first pass through the input grid, which is at Liner potential, then through the retarding grid (VR1 = -700V). They are then reflected out of the reflector assembly by the reflecting grid (VR2 = +100V). Typically, the voltage across the reflector assembly will be about 800 volts, and the reflector voltage (VR2) will be about 300 volts more positive than the ion's starting voltage. The ions starting voltage is calculated as (VA1 + VA2 /2) or the average of VA1 and VA2.

NOTE: When operating in the linear mode, VR1 and VR2 should be set to Liner potential.

The input grid (G) of the linear detector is connected to the liner (L) potential externally by way of the SHV Tee and cable provided. The input grid of the detector in the reflected mode is connected to the Liner (L) potential internally and hence does not have a feedthrough marked 'G' (see "Wiring Detail", pg. 2)

The Ions then impact the first microchannel plate (VD = -5,000 volts Max.).

The turn-on voltage for a new Dual detector is typically VD = -3,500V, which produces an input voltage of VD1 = -1,540V (see section 10.0).

The turn-on voltage for a new Z-Gap detector is typically VD = -2,500V, which produces an input voltage of VD1 = -2,500V (see section 10.0).

4.0 DESCRIPTION OF FRONT PANEL CONTROLS

4.1 VD (SCREWDRIVER ADJUST)

Adjusts the detector voltage to the divider box from 0 to -5000 volts DC.

4.2 VD PUSH BUTTON

Enables the meter to measure the voltage on VD Output.

4.3 LINER VOLTAGE ADJUST KNOB

Adjusts the LINER output from 0 to -4500 volts DC.

4.4 LINER PUSH BUTTON

Enables the meter to measure the voltage on the LINER output.

4.5 FOCUS VOLTAGE ADJUST KNOB

Adjusts the FOCUS output from 0 to -4500 volts DC.

4.6 FOCUS PUSH BUTTON

Enables the meter to measure the voltage on the FOCUS output.

4.7 DEF COARSE (SCREWDRIVER ADJUST)

Adjusts the maximum voltage to which the DEF VOLTAGE ADJUST KNOB can be set, from 0 to -4500 volts DC.

4.8 DEF VOLTAGE ADJUST KNOB

Adjusts the DEF output from 0 to the DEF COARSE setting.

4.9 **DEF PUSH BUTTON**

Enables the meter to measure the voltage on the DEF output.

4.10 **VR1 VOLTAGE ADJUST KNOB**

Adjusts the VR1 output from 0 to -4500 volts DC.

4.11 **VR1 PUSH BUTTON**

Enables the meter to measure the voltage on the VR1 output.

4.12 **VR2 VOLTAGE ADJUST KNOB**

Adjusts the VR2 output from 0 to +450 volts DC.

4.13 **VR2 PUSH BUTTON**

Enables the meter to measure the voltage on the VR2 output.

5.0 DESCRIPTION OF REAR PANEL OUTPUTS

5.1 **LINER SHV CONNECTOR**

Adjustable output from 0 to -4500 volts DC for the flight tube liner.

5.2 **FOCUS SHV CONNECTOR**

Adjustable output from 0 to -4500 volts DC for the Einsel lens.

5.3 **DEF SHV CONNECTOR**

Adjustable output from 0 to -4500 volts DC for the deflection plate.

5.4 **VR1 SHV CONNECTOR**

Adjustable output from 0 to -4500 volts DC for the reflector retarding grid.

5.5 **VR2 SHV CONNECTOR**

Adjustable output from 0 to +450 volts DC for the reflector reflecting grid plate.

5.6 **VD SHV CONNECTOR**

Adjustable output from 0 to -5000 volts for the channel plate detector Voltage Divider Box.

6.0 CIRCUITRY DESCRIPTION

6.1 **CONTROL UNIT**

The control unit includes four 12 volt DC Power Supplies, six high voltage regulated Power Supplies, and a printed circuit board that contains all the voltage dividers as well as the amplifier for the Digital Volt Meter.

6.2 **CIRCUIT DESCRIPTION**

See Control Unit Schematic, Drawing No. D0803I REV 1A

6.2.1 ±12 VOLT DC POWER SUPPLIES

The two ±12 volt DC Power Supplies are used to power all of the High Voltage Power Supplies as well as the metering circuit on the PC Board.

Line Power (100/120/220/240 volts, 50 or 60 Hz) is brought in through a fuse, line switch, interlock switch, and a voltage selector switch to the main power transformer T301.

The power indicator light is powered from one of the 120 volt primaries of T301.

The 28 volt center tapped secondary of T301 is full wave rectified and supplies +19 volts to C301 and -19 volts to C303. The +19 volts at C301 supplies REG. 203 and REG. 201, which makes up two +12 volt, 1.5 Amp regulated power supplies. The -19 volts at C302, supplies REG. 202 and REG. 204, which makes up two -12 volt, 1.5 Amp regulated power supplies.

6.2.2 VD DETECTOR VOLTAGE POWER SUPPLY

VD is adjusted by the front panel screwdriver control R106 which varies the output of PS302 from 0 to -5000 volts DC. This voltage goes to the PC Board through J10 to the rear panel VD Output which is used to power the Voltage Divider Box for the MCP detector. The 100 megohm resistor R3, 97.6K resistor R17 and 5K trimmer resistor R16 make up a voltage divider for the meter circuit. When calibrated, one volt to the meter circuit represents 1000 volts on the VD Output.

6.2.3 LINER AND (FOCUS) POWER SUPPLIES

LINER (FOCUS) is adjusted by the Front Panel Control R105 (R104) which varies the output of PS301 (PS305) from 0 to -5000 volts DC. This voltage goes to the PC Board through J8 (J9) to the 10 megohm current limit resistor R8 (R6). This resistor limits the current at LINER (FOCUS) to .5 milliamperes. The 100 megohm resistor R7 (R5), 97.6K resistor R19 (21) and 5K trimmer resistor R18 (20) make up a voltage divider for the meter circuit. When calibrated, one volt to the meter circuit represents 1000 volts on the output. Because the current limit resistor and the meter voltage divider resistors make a voltage divider to the output, LINER (FOCUS) only gets to 90% of the voltage from PS301 (PS305), so the LINER (FOCUS) output is 0 to -4500 volts DC.

6.2.4 DEF POWER SUPPLY

DEF is adjusted by the Front Panel Control R103 and the COARSE DEF control R107. Depending on the COARSE DEF setting, the DEF knob can vary the output of PS306 from 0 to -4500 volts DC. This voltage goes to the PC Board through J7 to the 10 megohm current limit resistor R11. This resistor limits the current at DEF to .5 milliamperes. The 100 megohm resistor R10, 97.6K resistor R23 and 5K trimmer resistor R22 make up a voltage divider for the meter circuit. When calibrated, one volt to the meter circuit represents 1000 volts on the output. Because the current limit resistor and the meter voltage divider resistors make a voltage divider to the output, DEF only gets to 90% of the voltage from PS306, so the DEF output is 0 to -4500 volts DC.

6.2.5 VR1 POWER SUPPLY

VR1 is adjusted by the Front Panel Control R102 which varies the output of PS303 from 0 to -5000 volts DC. This voltage goes to the PC Board through J6 to the 10 megohm current limit resistor R13. This resistor limits the current at VR1 to .5 milliamperes. The 100 megohm resistor R12, 97.6K resistor R25 and 5K trimmer resistor R24 make up a voltage divider for the meter circuit. When calibrated, one volt to the meter circuit represents 1000 volts on the output. Because the current limit resistor and the meter voltage divider resistors make a voltage divider to the output, VR1 only gets to 90% of the voltage from PS303, so the VR1 output is 0 to -4500 volts DC.

6.2.6 VR2 POWER SUPPLY

VR2 is adjusted by the Front Panel Control R101 which varies the output of PS304 from 0 to +500 volts DC. This voltage goes to the PC Board through J5 to the 10 megohm current limit resistor R15. This resistor limits the current at VR2 to .05 milliamperes. The 100 megohm resistor R14, 97.6K resistor R27 and 5K trimmer resistor R26 make up a voltage divider for the meter circuit. When calibrated, one volt to the meter circuit represents 1000 volts on the output. Because the current limit resistor and the meter voltage divider resistors make a voltage divider to the output, VR2 only gets to 90% of the voltage from PS304, so the VR2 output is 0 to +450 volts DC.

NOTE: The reflector has a resistance of 190 megohms between the VR1 and VR2 SHV feedthroughs. Due to the series resistance in the power supply R13 (R15), there is some interaction between the VR1 and VR2 output voltages. Both VR1 and VR2 should be rechecked after adjustment.

6.2.7 METERING CIRCUIT

The Metering Circuit is not enabled until a front panel push button (S101 through S106) is depressed. When no buttons are depressed the normally closed contacts connect J4-9 to ground. When a push button is depressed it connects the voltage divider selected to R28 and onto the buffer amplifier A1 which has a gain of 1. The output of A1 drives the Digital Volt Meter.

6.2.8 DIGITAL VOLT METER

The Digital Volt Meter is the small PC Board that is screwed to the front panel. An input voltage of " 5.0 volts will read " 5000 (volts) on the LED display.

See Digital Volt Meter schematic, Drawing No. D0814 REV 1

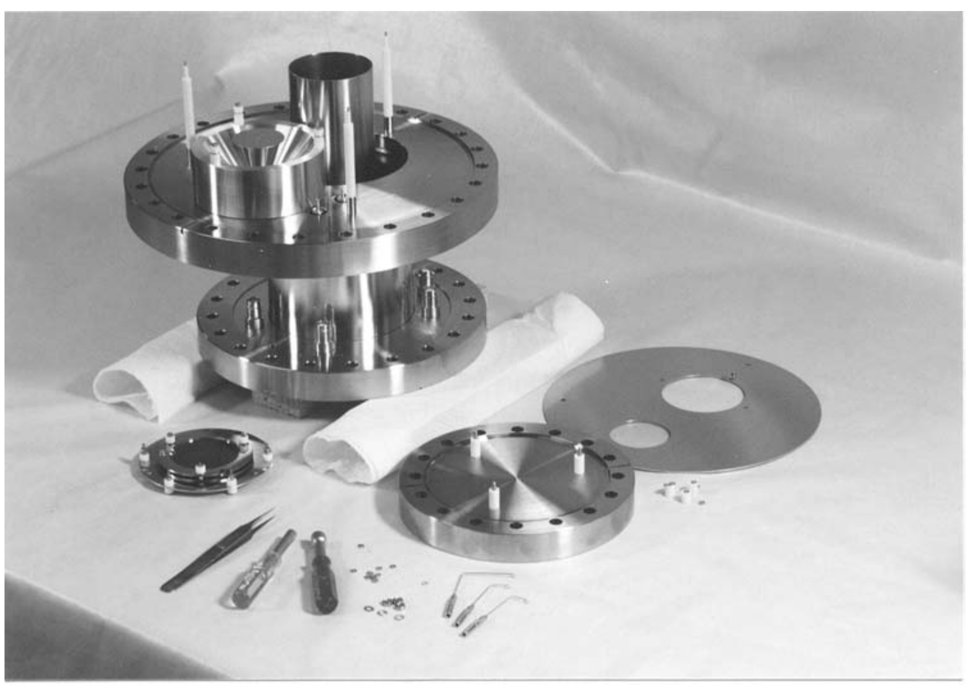
Most of the functions of the Digital Volt Meter are done by the 4½ digit Volt Meter IC A2 (ICL7135CPA). This IC compares an input voltage to a reference voltage of 1 volt and displays the ratio of these two voltages as a percentage on the LED display. When the two voltages are equal the LED display will read 9999. The input voltage from the AREF PC Board (0 to " 5 volts) is divided by a factor of 10 by R24 and R25. The reference voltage is created by CR2 (6.2 volts) and divided by R18 and R19 down to 1 volt. It should be noted that the reference voltage does not need to be exactly 1 volt and the input divider ratio does not need to be exact. What is important is that they are temperature stable. The trimmer resistors for each output are what make the Digital Volt Meter read correctly.

When a front panel push button is depressed the gate of Q1 is allowed to float which turns on Q1. When Q1 turns on, this turns off Q8 and Q11 which enables the "-" LED and 4 digit LED display.

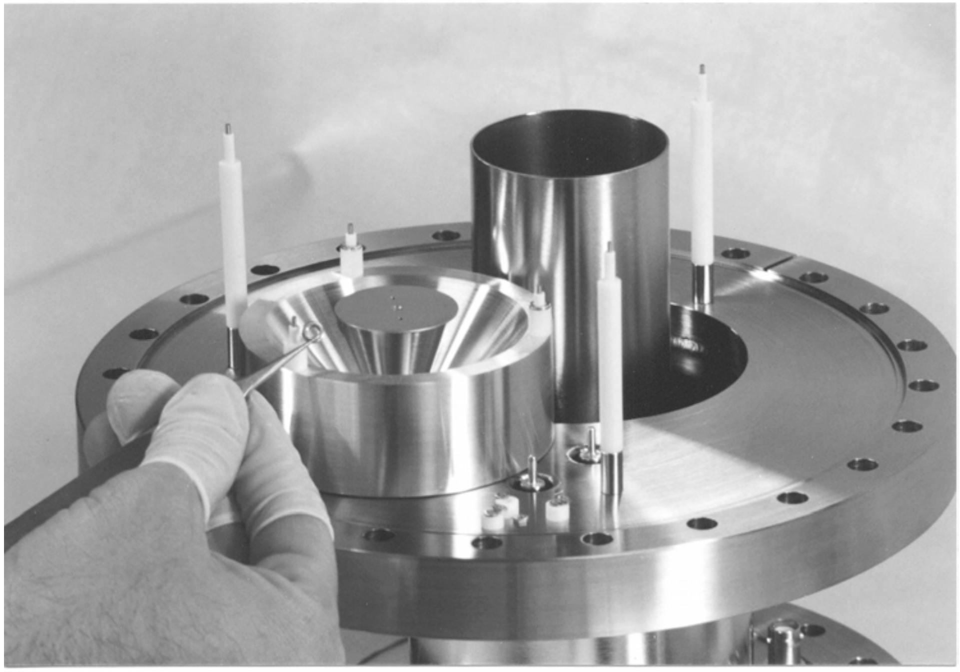
A3, Y1 and Q12 create a 100 kHz TTL square wave which is the timing for A2.

7.0 INSTALLATION PROCEDURE FOR 40mm CHANNEL PLATE DETECTOR

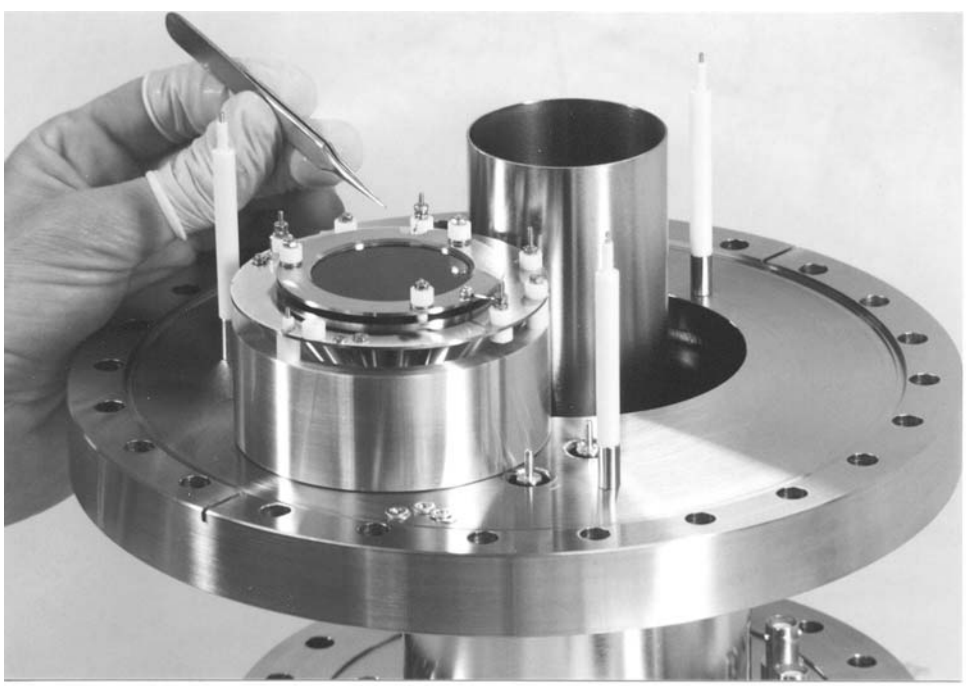
1. On machines **with liners,** remove 0-80 nuts, washers and ceramic insulators. **On machines without liners,** remove the three socket cap screws from the destination plate. On machines fitted with a mass gate, the DEF wire must be removed from the barrel connector. Being careful not to damage the mesh, remove the destination plate.



2. Remove the three 0-80 nuts and washers securing the ceramic insulators to the anode shield. Remove insulators and discard the #4 washers.



3. Now the channel plate subassembly is ready to be installed. Remove the subassembly from the vacuum envelope. Inspect the channel plates for cracks and debris before installing. Now install the assembly where the #4 washers once were. Be sure that the #2 engraved on the subassembly is adjacent to the shield tube. Reinstall the 0-80 nuts and washers.



4. Wire the detector using the lead kit provided. Push appropriate lead onto the SHV feedthru while guiding it onto the like numbered stud on the assembly. Secure the lead onto the stud with the 0-80 nuts and washers provided. Check to make sure that the numbers on the assembly correspond to the numbers on the feedthroughs. (i.e.: D1 to 1, D2 to 2, D3 to 3 and for Z-Gap detectors, D4 to 4).

5. Reinstall the destination plate.
6. Refer to detector manuals for startup instructions.

8.0 DIVIDER BOX FOR DUAL MCP DETECTOR

NOTE: If using a Z-Gap Detector, refer to Section 9.0.

8.1 -V IN SHV CONNECTOR

This is the input voltage for the voltage divider that provides the three voltages necessary for the dual MCP detector. The current draw at -5,000 volts is 400µA.

8.2 VD1 SHV CONNECTOR

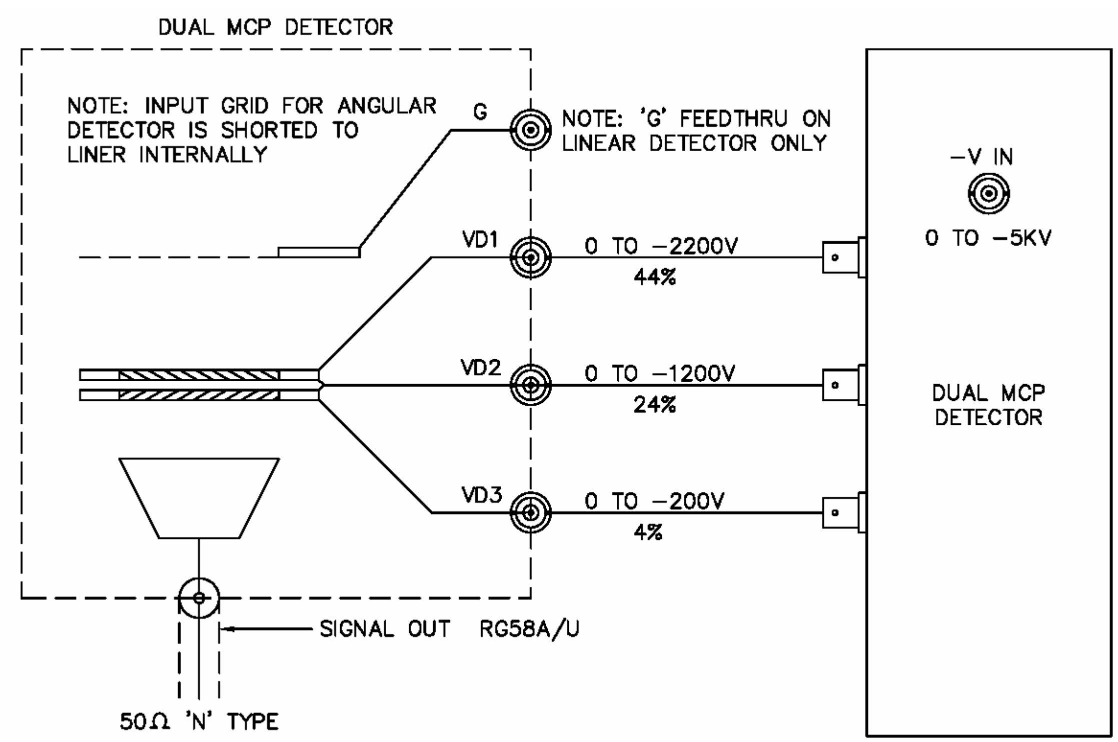
Output voltage is a fixed 44% of the -V IN (VD) input for the input of the first channel plate.

8.3 VD2 SHV CONNECTOR

Output voltage is a fixed 24% of -V IN (VD) input for the center tap between the two channel plates.

8.4 VD3 SHV CONNECTOR

Output voltage is a fixed 4% of -V IN (VD) input for the output of the second channel plate.



WIRING DIAGRAM/DUAL MCP DETECTOR

9.0 DIVIDER BOX FOR Z-GAP MCP DETECTOR

NOTE: If using a Dual Detector, refer to Section 8.0.

9.1 -V IN SHV CONNECTOR

This is the input voltage for the voltage divider that provides the four voltages necessary for the Z-Gap MCP detector. The current draw at -5000 volts is 750µA.

9.2 VD4 SHV CONNECTOR

Output voltage is slightly less than -V IN (<20V). This is connected to the input of the first channel plate.

9.3 VD1 SHV CONNECTOR

Output voltage is fixed 58% of the -V IN (VD) input voltage. This is connected to the output of the second channel plate.

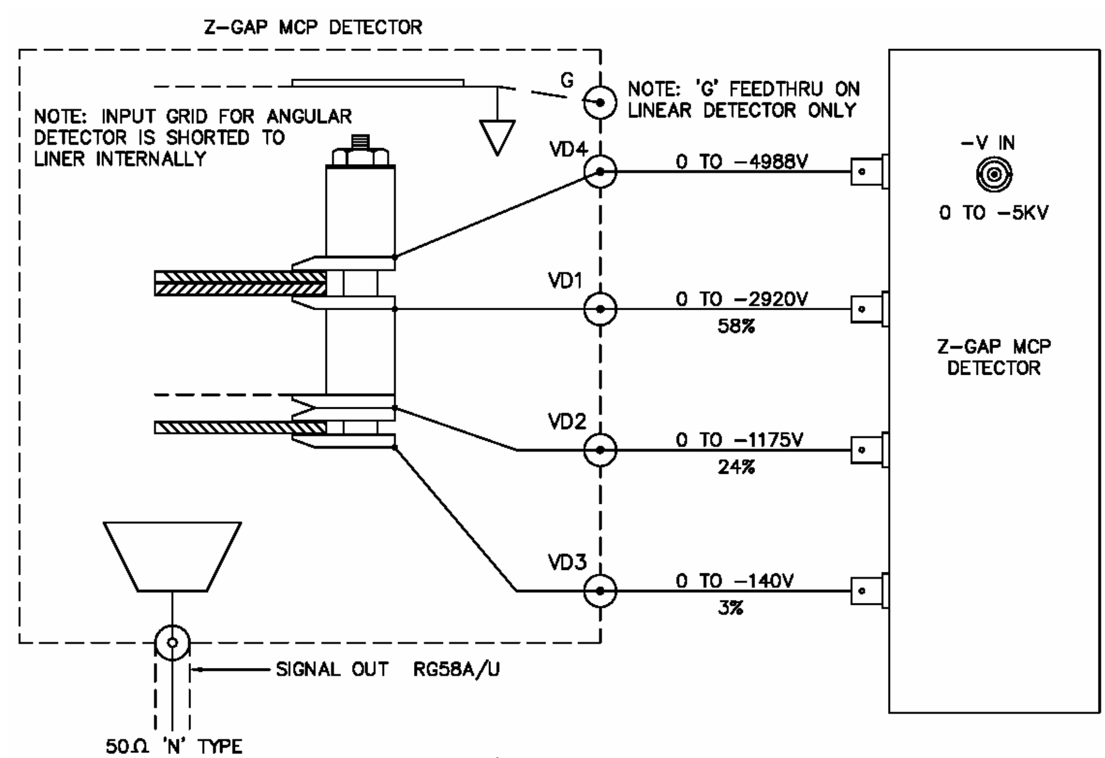
NOTE: The first and second channel plates are in series with no center tap. These two plates are matched at the factory for their strip currents being equal. Each plate will have (VD4-VD1) ÷ 2 volts across it.

9.4 VD2 SHV CONNECTOR

Output voltage is fixed 24% of the -V IN (VD) input voltage. This is connected to the input of the third channel plate.

9.5 VD3 SHV CONNECTOR

Output voltage is fixed 3% of the -V IN (VD) input voltage. This is connected to the output of the third channel plate.



WIRING DIAGRAM/Z-GAP MCP DETECTOR

9.6 OPERATION OF THE Z-GAP MCP DETECTOR

The turn-on voltage of a new Z-Gap detector is about VD = -2,500 volts and should have sufficient gain at VD = -2,700 to -2,900 volts. The detector should first be tested according to the "Initial Checkout" procedure in Section 4.0 of the detector manual.

New channel plates have trapped gas in the pores that can only be eliminated by applying a voltage. If the voltage is turned up too quickly, a temporary high local pressure can occur, causing damage to the channel plates.

The voltage should be increased slowly from VD = -2,000 to -2,500 volts in 100 volt steps, while watching for signs of arcing or a sudden increase in noise. Allow the detector to remain for a few minutes at each step, giving enough time for the gas to be eliminated from the pores of the channel plates. This is referred to as "seasoning".

If you do not observe a signal at VD = -2,900V, there is likely a problem elsewhere in the system.

Do not exceed VD = -3,500V on a new detector or irreparable damage to the channel plates can occur. It is at this voltage that the signal/noise ratio rapidly decreases (noise increases faster than signal). Avoid operating the detector above VD = -3,500V until it has been used for several months and the gain has started to decline.

If at any time you require more sensitivity, be sure to make adjustments according to the above procedure.

10.0 CONNECTIONS

Before connecting the mains, make certain that the Voltage Selector Switch (100/120/220/240) is set properly. If the voltage wheel needs to be changed, a fuse with a value shown in the following table should be inserted into the fuse holder.

Mains voltage	Fuse value
100V 50/60 Hz	1-2/10A slow-blow
120V 50/60 Hz	1A slow-blow
220V 50/60 Hz	½A slow-blow
240V 50/60 Hz	½A slow-blow

Before hooking up cables:

1. Preset VD (-V IN) using the VD (-V IN) trimmer on the front panel to:

   Dual Detector
   -3,000 volts. With VD (-V IN) at -3,000 volts, the VD1 Output from the Divider Box will be about -1,300 volts, corresponding to about 600 volts per channel plate. This is slightly below the turn–on voltage.

   Z-Gap Detector
   -2,000 volts. With VD (-V IN) at -2,000 volts, the VD4 Output from the Divider Box will be about -1,980 volts, corresponding to about 500 volts per channel plate. This is well below the turn-on voltage (see Section 3.0).

   NOTE: Do not apply voltage to the Channel Plates unless the detector is pumped below 10-6 Torr.

   Be sure to perform the "Initial Checkout" procedure found in Section 4.0 of the detector manual prior to using the detector for ion detection.

2. Turn off power before connecting the cables. This will prevent a possible arc occurring when connecting to a live receptacle. The provided SHV TEE and cable are used to connect the liner (L) voltage to the input grid (G) of the linear detector.
   NOTE: The input grid of the reflected mode detector is connected to the liner (L) internally and hence does not have a feedthrough marked 'G' (see "Wiring Detail", pg. 2).
3. Turn on power and increase each voltage to the desired setting. It is best not to increase VD unless you are monitoring the signal output for noise, arcing, etc.

With cables connected, set the voltages given in section 3.0. These are initial starting voltages only, but should give some indication of signal from the detector output. While observing the spectra, voltages can be trimmed for optimum sensitivity and resolution. Some adjustment of (DEF) might be necessary when changing from linear mode to reflected mode due to the difference in target location.

It should be noted that the actual deflection voltage is (DEF) minus the (LINER) voltage. The suggested initial startup voltage of (DEF = -1140V) minus (LINER = -1200V) gives an actual deflection voltage of +60 volts.

The intensity of the focusing voltage is the difference in potential between the (FOCUS) voltage and the (LINER) voltage. Theoretically the polarity of the difference is not important, but the optimum voltage should be found by trial and error. Begin with the Focus (FOC) voltage of the Einsel lens at (Liner) potential. When performance has been otherwise optimized, this can be adjusted. Some improvement in performance should be observed, typically at Focus = Liner potential +/-100 volts, up to +/-1,000 volts.

11.0 <u>SERVICE PROCEDURES</u>

11.1 SAFETY PRECAUTIONS

This equipment uses voltages up to 5000 volts DC and capacitors which store dangerous amounts of energy. The control unit should be unplugged from the power line before opening.

Although bleeder resistors are provided, all of the outputs should be shorted to ground before touching any electrical components.

If energized testing of internal circuits is required, connections to test points should be made with equipment off. The cover interlock can then be overridden by pulling the plunger.

11.2 TROUBLESHOOTING

THE FOLLOWING TESTS SHOULD BE MADE WITH ALL OF THE CABLES DISCONNECTED FROM THE REAR PANEL. **BE SURE THAT THE POWER IS OFF BEFORE CONNECTING OR DISCONNECTING A CABLE FROM THE REAR PANEL.**

NOTE: All of the circuits in the control unit are high impedance circuits that will be changed by a low impedance volt meter. Even a 10 megohm volt meter can change the circuit parameters by as much as a factor of two.

11.2.1 NO POWER

Check power source and 1 Amp slow blow fuse (120V) on rear panel.

11.2.2 LINER, VR1 AND VD1 ALL READ LOW OR ZERO VOLTS

Reg 201 or Reg 202 is bad. Connector J202 or J203 has a loose pin.

11.2.3 FOCUS, DEF AND VR2 ALL READ LOW OR ZERO VOLTS

Reg 203 or Reg 204 is bad. Connector J202 or J203 has a loose pin.

11.2.4 VD READS LOW OR ZERO VOLTS

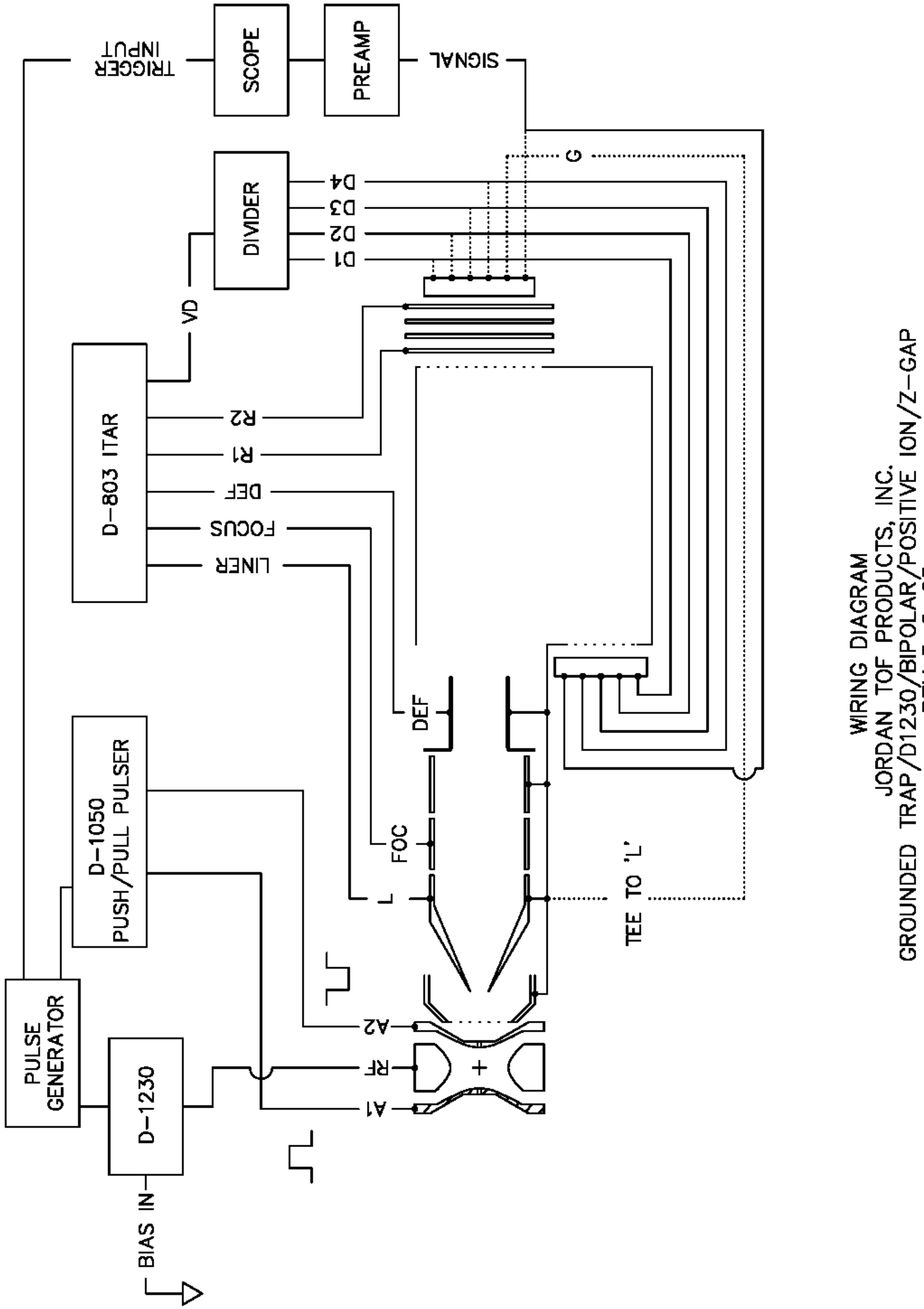
Reg 201 can be putting out a low voltage. Check Reg 201 for -12.7V output. PS302 is bad. J10 or J105 is disconnected, or J1 is disconnected.

Adjust the VD front panel control all the way counterclockwise. Slowly turn up VD while monitoring the output voltage on the front panel meter. If the voltage stays at zero volts and then suddenly jumps up to a high voltage then R106 is probably bad.

11.2.5 SUBSTITUTION TESTING

All integrated circuits in this equipment are mounted in sockets and can easily be changed. Do not reverse position of IC's or they will be destroyed. IC's have a notch on the end near Pin #1 and/or a dot over Pin #1. The IC sockets have a notch on one end to show the position of Pin #1.

NOTE: If the outputs act normal with the cables disconnected, it is an indication that the power supply is working properly and that the problem is a shorted cable, bad feedthrough, or bad insulator on the AREF itself.


TRIGGER INPUT
SCOPE
PREAMP
SIGNAL
G
DIVIDER
D4
D3
D2
D1
VD
D-803 ITAR
R2
R1
DEF
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LINER
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