TIME OF FLIGHT

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INSTRUCTION MANUAL

QUADRUPOLE ION TRAP
D-1203 POWER SUPPLY REV-2A
D-1040 REMOTE PULSER PC BOARD REV-6
Updated Jan 19, 2010

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

WARNING

The RF cable and the Ion Trap are part of the Ion Trap Power Supply circuitry. In addition, one of the Ion Trap end caps must be connected to a Pulser, or to the RF BIAS (A1) cable to complete the circuit. If the Ion Trap Power Supply is turned on without these connections, the power supply can be severely damaged.

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1.0 SPECIFICATIONS

1.1 MECHANICAL SPECIFICATION

Cabinet size	19" W. x 16" D. x 7" H.
Cabinet weight	24 Lbs.
Remote Pulser Size	5.5" W. x 4.3" D. x 1.1" H.
Remote Pulser Weight	1 Lbs.

1.2 ELECTRICAL SPECIFICATIONS

RF Output Voltage	0 to 4000 volts p-p
Input Bias Voltage	**3500 volts MAX.**

1.3 SERVICE REQUIREMENTS

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

2.0 GENERAL DESCRIPTION

Time of flight mass spectrometers have become widely used devices due to: (1) their ability to rapidly detect an entire mass spectrum on every pulse; (2) their ability to analyze and detect high mass; and (3) their potential for high sensitivity in trace analysis.

This has led to their use in experiments ranging from laser ionization and spectroscopy of small molecules and clusters to desorption of large proteins and other biomolecules.

However, a drawback of TOF devices is the lack of a means of storing ions prior to analysis. This inability to store ions compared to trap methods such as FTICR and ITMS place TOF at a disadvantage in terms of being able to manipulate ions for MS/MS or ion-molecule experiments, or for enhancing sensitivity through storage and integration of the signal. Thus a method of interfacing ion trap storage technology to time-of-flight might provide a hybrid instrument with some of the best properties of each individual device

A further limitation of the TOF in various situations is the resolution, which is determined by the initial spatial and energy distribution of the ions in the acceleration region of the TOF. Ions of the same mass must start at the same place with the same velocity in order to arrive at the detector at the same time. Thus, the ionization process has been usually restricted to a narrow space between the acceleration electrodes, thus affecting the ionization volume and consequently the sensitivity.

Resolution was also limited by the requirement that all ions have the same start time. Ions from a continuous external ion beam are thus difficult to introduce into the TOF with resulting time resolution. Ions can be injected axially to the flight path by beam deflection methods, where the ions are swept across a slit. This results in good resolution, but a poor duty cycle and thus poor sensitivity. Ions can be injected normal to the flight path, but these results in a limited mass window, and less than ideal resolution.

The QUADRUPOLE ION TRAP can be used to overcome these limitations. Ions can be created and stored during the time between extraction pulses. Since the extraction event is approximately 6 microseconds in duration it can be seen that duty cycle approaches 100% for storage times of over 1 millisecond.

In addition, ions which are extracted from the trap provide peaks with excellent resolution due to a small and well defined spatial and energy distribution. In the trap this appears to be independent of where or how they were created, but only depends on how long they have been stored in the trap. Ions created by an atmospheric pressure plasma source have been focused into the trap by an Einsel tube, accumulated and stored for up to 10 seconds in the trap. These ions were then ejected into the reTOFMS. The resulting peaks were less than 10 nanoseconds wide providing a resolution of well over 2000.

3.0 SYSTEM OPERATION

Ions can be created within the trap by laser excitation of residual species, intersection of laser with molecular beam, or by laser ablation of a sample probe. To accommodate these experiments, the ring electrode can be machined by cross drilling. Openings of 2.4mm (.094") have been used with no apparent degradation of trap performance. These openings can be made to cross in the geometric center of the trap, or slightly off center to be up-stream of the beam, or so that the new ions will be created outside the spot of maximum ion density.

Ions can be created external to the trap by any means available including ion beams of various sorts. These ions are then injected into the trap through the end cap opposite the TOF. If they are made near the trap, they can be focused and drifted toward the opening in the end cap by weak electrostatic fields. If they are generated farther away, they can be transported by Einsel tube or Brubaker (RF only) lens. Use of a quadrupole filter for this would allow the trap to be selectively charged. For this purpose, opposing end caps are normally furnished with a 3mm (.125") dia. aperture. For more sensitivity when the injected ion beam cannot be tightly focused, this opening can be enlarged and covered with a mesh.

Ability to operate at bias voltages of up to 3500V adds experimental flexibility. Ions can be extracted from the trap and accelerated into a field-free flight tube which is at ground potential. This feature can be used to add kinetic energy to the ions in order to increase the sensitivity at the detector.

The trap mechanism is designed to operate either as an open structure to minimize ion-molecule collisions, or as a closed one for use with a buffer gas, etc. It can be readily changed from open to closed by adding two ceramic rings.

4.0 ION TRAP INSTALLATION

The trap structure is designed to replace the reflector plate and extraction grids of the ion source of all TOF instruments manufactured by Jordan TOF Products, Inc. To install on one of these ion sources, the end caps and ring electrode are mounted on four .120" dia. Alumina sleeves, using .370" long spacers between end caps and ring electrode.

The trap assembly is thicker than the elements it replaces. The difference in thickness (.69") can usually be compensated for by changing the location of other components. Jordan TOF Products, Inc. will be glad to assist you in modifying your present source in order to make the trap fit properly.

To mount in another way, such as to the face of a flange, drill and tap 4 #0-80 holes in a 1.50" square. Thread studs into the holes. Slide ceramic sleeves over the studs. Slide the trap elements onto the sleeves using the furnished spacers. Sleeves can be obtained from the manufacturer when needed for initial installation or replacement. The acceleration grid should be located .125 inches from the outer face of the exit end cap.

5.0 DESCRIPTION OF CONTROLS

5.1 RF AMPLITUDE

Adjusts the amplitude of the RF voltage from 0-4000 volts p-p.

5.2 EXTERNAL RF AMPLITUDE CONTROL BNC CONNECTOR

A 0 to +9 volts input adjusts the RF amplitude from 0-4000 volts p-p. The RF amplitude linearly follows the input voltage.

5.3 INTERNAL/EXTERNAL RF AMPLITUDE CONTROL SWITCH

Switched up, the RF amplitude is controlled by the adjust knob. Switched down, the RF amplitude is controlled by an external DC voltage.

5.4 EXTRACTION DELAY FINE ADJUST KNOB

Adjusts the delay between the RF turning off and the start of the extraction pulse. The adjustment is from 200 to 900 nanoseconds.

5.5 EXTRACTION DELAY COARSE SCREWDRIVER ADJUST

Adjusts the delay between the RF turning off and the start of the extraction pulse. The adjustment is up to 4.2 microseconds.

5.6 EXTRACTION DURATION FINE ADJUST KNOB

Adjusts the duration of the extraction pulse from 300 to 900 nanoseconds.

5.7 EXTRACTION DURATION COARSE SCREWDRIVER ADJUST

Adjusts the duration of the extraction pulse up to 15 microseconds.

5.8 PULSE/RF SYNC. SWITCH

MAN POSITION: After a Trigger signal is received, the power supply waits until the RF voltage is going through zero volts in the positive direction, and then it clamps the RF voltage going to the Ion Trap. At this time the Extraction Delay is started for the extraction pulse.

AUTO POSITION: After a Trigger signal is received, the power supply waits until the RF voltage is going through zero volts in the positive direction, and then it clamps the RF voltage going to the Ion Trap. At this point in time the Extraction Delay is started. After the adjusted Extraction Delay (up to 5µS), the power supply waits until the remaining RF voltage goes through zero volts in the positive direction. The extraction pulse is again delayed by the Phase Adjust (up to 1µS). When the RF Amplitude is greater than 1500 volts, all of the RF energy in the first cycle is not fully discharged during the clamp, so there remains a greatly reduced second cycle of RF. The Phase Adjust (up to 1µS) allows the extraction pulse to be synchronized with the same phase angle of the remaining RF voltage for each extraction pulse.

MIDDLE POSITION: After a Trigger signal is received, the power supply waits until the RF voltage is going through zero volts in the positive direction and then it starts the sequence for the extraction pulse. The extraction pulse is delayed by the Phase Adjust (up to 1µS). This allows the extraction pulse to be synchronized with the same phase angle of the RF voltage for each extraction pulse.

5.9 PHASE ADJUST FINE ADJUST KNOB

Adjusts the delay from when the RF goes through zero in the positive direction and the start of the extraction pulse. The adjustment is from 75 to 500 nanoseconds. This adjustment only works when the PULSE/RF SYNC. SWITCH is in the AUTO or MIDDLE position.

5.10 PHASE ADJUST COARSE SCREWDRIVER ADJUST

Adjusts the delay from when the RF goes through zero in the positive direction and the start of the extraction pulse. The adjustment is up to 1.1 microseconds. This adjustment only works when the PULSE/RF SYNC. SWITCH is in the AUTO or MIDDLE position.

5.11 PULSE VOLTAGE SCREWDRIVER ADJUST

Adjusts the extraction pulse amplitude (400V max).

5.12 OVER LOAD SCREWDRIVER ADJUST

Adjusts the level of RF power that will turn on the "OVER LOAD" LED.

5.13 TRIGGER INPUT BNC CONNECTOR

WARNING: Maximum repetition rate is 1 KHz when the RF is being clamped for Ion extraction. If the RF is not being clamped, there is no limitation on the repetition rate.

On the rising edge of a TTL signal (1 volt min.), the timing sequence will begin. See section 5.8 (PULSE/RF SYNC. SWITCH) for a description of the timing sequence options.

5.14 PULSER TRIGGER MONITOR RF BNC CONNECTOR

When the voltage on this connector is high (about 4 volts) the extraction pulse is being applied to the end cap. The Data System should be synchronized with the rising edge of this wave form.

5.15 RF TRIGGER MONITOR BNC CONNECTOR

When the voltage on this connector is high (about 4 volts) the RF has been turned off.

5.16 OVER CURRENT LED

When the current to the RF generator exceeds 2.75 amps the LED will turn on and the RF will turn off until the RESET button is pushed. This fault will only occur if there is a major problem with the RF generator.

5.17 OVER LOAD LED

When the power to the RF generator exceeds the wattage set with the OVER LOAD adjust, the LED will turn on until the power drops below the set level.

5.18 OVER POWER LED

When the power to the RF generator exceeds 50 watts the LED will turn on and the RF will turn off until the RESET button is pushed. This fault usually occurs when the Ion Trap is dirty or if the RF OUTPUT cable is disconnected from the power supply.

5.19 METER

The meter reads RF voltage p-p until a push button is depressed.

5.20 RF POWER PUSH BUTTON

When this push button is depressed the meter will read the power going to the RF generator. For a given RF output voltage a rise in power is an indication of a dirty Ion Trap.

5.21 PULSE VOLTAGE PUSH BUTTON

When this push button is depressed the meter will read the extraction voltage that is being applied to the end cap.

5.22 BIAS VOLTAGE PUSH BUTTON

When this push button is depressed the meter will read the voltage that the Ion Trap is being biased to.

5.23 RESET PUSH BUTTON

When this push button is depressed the meter will read the power setting of the adjusted OVER LOAD trip point. This push button also resets the OVER CURRENT and OVER POWER faults and restarts the power supply.

6.0 DESCRIPTION OF REAR PANEL CONNECTIONS

6.1 TRAP RF OUT SHV CONNECTOR

This is the RF output for the Ring Electrode of the Ion Trap.

6.2 TRAP BIAS OUT SHV CONNECTOR

This is the BIAS IN voltage that is connected to the repeller End Cap (VA1) of the Ion Trap.

6.3 PULSE V. SHV CONNECTOR

This connects to the "PULSE V" SHV connector on the Remote Pulser which supplies the extraction voltage to the extraction End Cap (VA2) of the Ion Trap.

6.4 PULSER BIAS SHV CONNECTOR

This connects to the "BIAS" SHV connector on the Remote Pulser.

6.5 TRIGGER BNC CONNECTOR

This connects to the "TRIGGER" BNC connector on the Remote Pulser.

6.6 +12V BNC CONNECTOR

This connects to the "+12V" BNC connector on the Remote Pulser.

6.7 BIAS IN SHV CONNECTOR

This is the input from the Bias power supply which elevates the voltages to the Ion Trap **(3500 volts DC max.)**.

7.0 CONNECTIONS

WARNING: Do not attempt to monitor the pulser output with an oscilloscope, volt meter, capacitor, etc. without first referring to Section 11 PERFORMANCE TESTING

Before connecting the mains, make certain the Voltage Selector Switch is set properly (100/120/220/240). 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

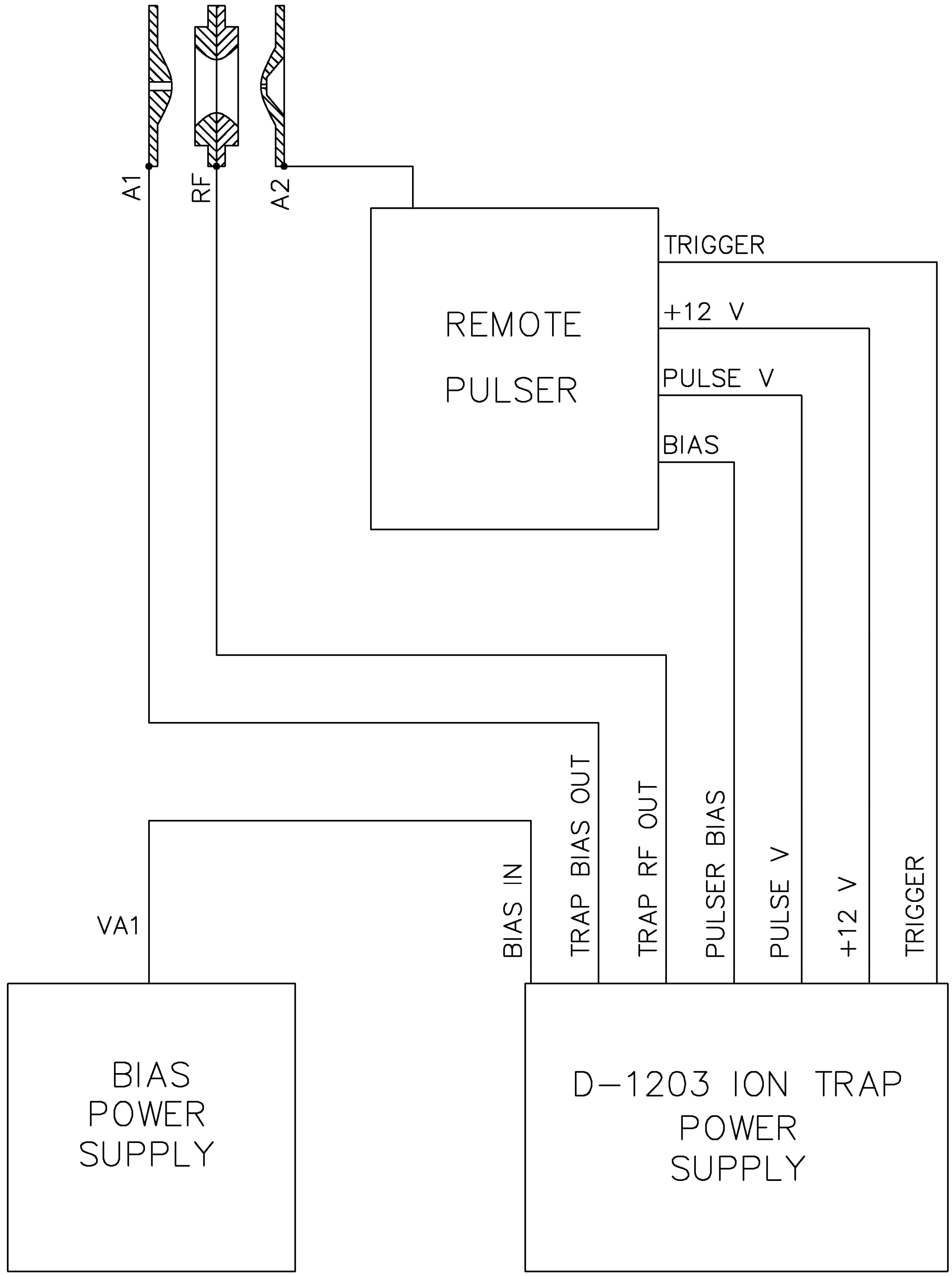
The RF cable and the Ion Trap are part of the Ion Trap power supplies' circuitry. If the Ion Trap Power Supply is turned on without these connections, the power supply can be severely damaged.

Using the 6' SHV cables supplied with the Ion Trap Power Supply, connect the "TRAP RF OUT" to the SHV feedthrough which goes to the center ring of the Ion Trap (RF). Connect the "TRAP BIAS OUT" to the SHV feedthrough which goes to the repeller End Cap of the Ion Trap (A1). If the Ion Trap is to be operated at an elevated potential a bias voltage must be connected to the "BIAS IN" SHV connector on the rear of the Ion Trap Power Supply.

Connect the Ion Trap Power Supply to the Remote Pulser with the cables supplied. Connect the "PULSE V" SHV connector on the power supply to the "PULSE V" SHV connector on the Remote Pulser. Connect the "PULSER BIAS" SHV connector on the power supply to the "BIAS" SHV connector on the Remote Pulser. Connect the "TRIGGER" BNC connector on the power supply to the "TRIGGER" BNC connector on the Remote Pulser. Connect the "+12V" BNC connector on the power supply to the "+12V" BNC connector on the Remote Pulser. **The Remote Pulser is connected directly to the SHV feedthrough that goes to the extraction End Cap of the Ion trap**.

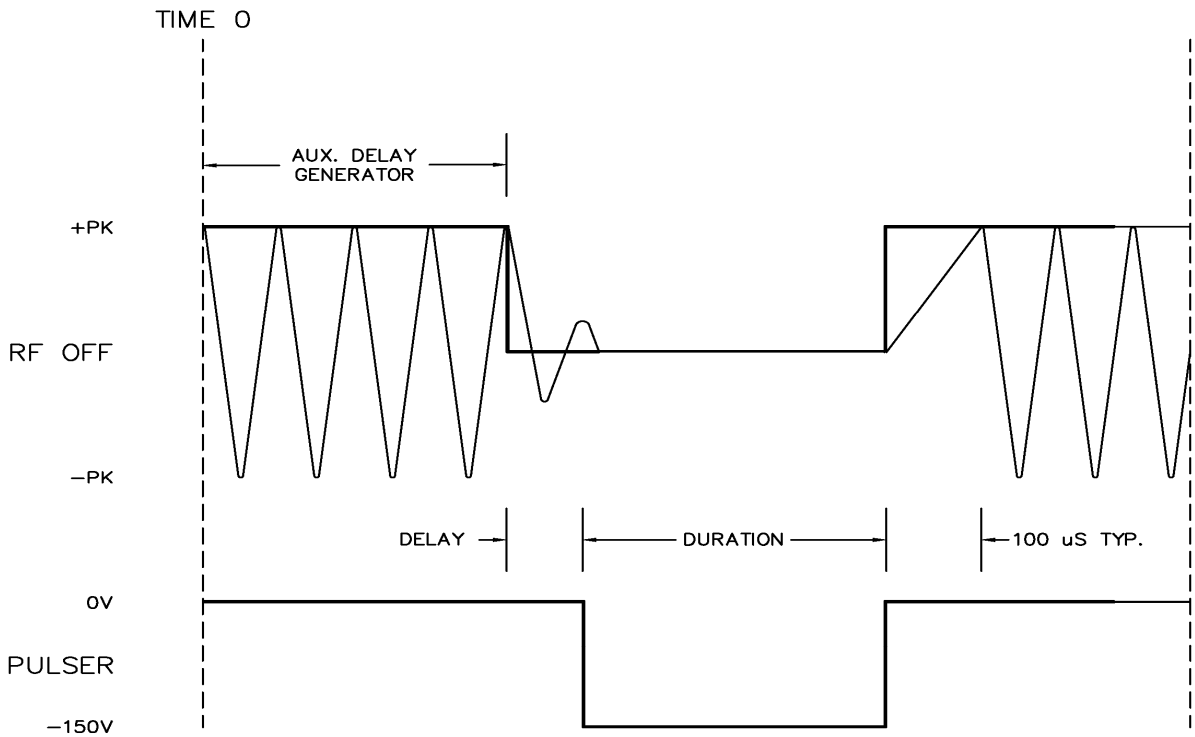
The Remote Pulser which is used for ION extraction should be wired so that when it is not being triggered, the Pulser output voltage is the "Bias" voltage. When the Pulser receives a trigger signal the Pulser output should be a negative voltage (-150 volts) to draw the Ions out of the Ion Trap. The PULSER POLARITY OPTION drawing number C01045-D shows the placement of the jumpers inside the Remote Pulser.

Depending on the application, there are many different ways that the cables can be routed to the various instruments which are needed to operate the Ion Trap. A typical case wiring diagram is shown on page 8. **In an application where the Ion Trap is not used at an elevated potential, the BIAS IN cable and the "Bias Power Supply" shown can be replaced with shorting SHV connector.**



ION TRAP CABLING

7.1 TIMING



AUX. DELAY + DELAY = TRAPPING TIME
DURATION = EXTRACTION TIME (2-5μS TYP.)
DELAY = SETTLING TIME FOR RF TURN OFF (.5-4μS TYP.)

The above timing diagram shows the typical timing delays needed for the operation of the Ion Trap. It is recommended that a Digital Delay Generator be used for controlling the interval that the RF is on from TIME 0. This time must be a very precise interval because it determines the Ion storage time. In some cases this can be in seconds. Use of a Digital Delay Generator can minimize timing jitter which will vary the storage time. If the storage time is not critical then a simple R/C timing delay can be used.

The initial time delay is from TIME 0 until the RF is triggered off. After a delay of about 2 to 3 microseconds to allow for the RF field to disappear, the end cap is dipped in voltage to extract the Ions from the Ion Trap. After a typical duration of 2 to 5 microseconds for Ion extraction, the end cap Pulser is turned off and the RF is turned back on. **It takes about 100 microseconds for the RF to come up to the adjusted voltage. The Ion Trap will continue to store Ions until the process is repeated.**

The Data System connected to the MCP output should be triggered from the rising edge of the PULSER TRIGGER MONITOR with the Data System Trigger Delay adjusted for the calculated flight time of the Ions from the Ion Trap. The Data System Trigger Input impedance should be set for "High ohm" (2K ohm), not "50 ohm" input impedance.

8.0 OPERATION

The TOF can be operated in its standard mode leaving the extraction end cap voltage continuously on. In this condition, any ions created inside the trap by a laser pulse will arrive at the detector as more or less resolved peaks in the usual fashion. If ions are created outside of and focused into the trap, they will continue through the trap and appear as continuous noise on the detector.

Once it is established that there actually are ions, the RF voltage to the trap can be turned on and Pulser timing adjusted to operate in the storage mode.

9.0 OPERATION PRECAUTIONS

Make certain that system pressure is at least below 1 x 10^{-5} Torr before turning on any voltages. A common failure is to assume that a lack of signal indicates a need for more sample (pressure). The power supplies, and especially the Pulser are vulnerable to even a brief arc-down.

Keep the operating voltages and pressure down until everything is running smoothly. The trap is by nature a sensitive device. If you cannot make enough ions at 1 x 10^{-6} Torr, the fault is probably with ion generation or timing.

10.0 MAINTENANCE

10.1 CONTAMINATION

Most problems with the Ion Trap are due to contamination. The most troublesome contaminant can be easily avoided. This is silicone pump fluid. Do not use silicone pump fluid in instrument applications, especially where Microchannel Plates are used. Polyphenol Ether such as SANTOVAC V is known to be satisfactory. For very large pumps the cost may seem prohibitive. It is not likely to be as expensive as a shut down for instrument cleaning and replacement of Microchannel Plates.

Other common contaminants are recondensed hydrocarbons from fingerprints, etc. and other substances which are introduced as samples for analysis.

10.1.1 SYMPTOMS

Non conducting substances can condense onto electrode surfaces and form a dielectric coating which will surface charge and cause a distortion in the local field. Evidence of this is usually time dependent. Elements which have been fine tuned for sensitivity must be readjusted. This is most noticeable with turn-on.

Conducting substances can coat insulators and create leakage paths between elements. This will cause various circuit elements to "talk to each other" and erratic meter readings or variations in the detected signal. Sensitivity can build up, and then drop due to breakdown between elements.

As the Ion Trap gets dirty the amount of power that is needed for an adjusted RF amplitude will increase. This will continue until the power becomes so great that the OVER POWER will trip the power supply.

10.1.2 REMEDY

Ceramic parts can be cleaned by air abrasive cleaning followed by acid etching. After the parts are clean, they may be fired in air. Metal parts can be scrubbed with fine abrasive, then solvent and acid cleaned.

Grids can only be cleaned by washing in solvents and etchants, however this is seldom successful. It is usually better to replace them.

10.2 OPERATING ENVIRONMENT

Time between cleaning depends directly upon pressure and ion density.

When used in conjunction with a pulse nozzle or other source of a pressure burst, the elements of the Ion Trap can experience arc down due to a local pressure transient. This can be very hard to detect since it is synchronized with other events in the experiment. It is helpful to remember that Total Pressure Gauges only tell you the average pressure. Local pressure can be momentarily much higher. If there is a possibility of this, it can be tested by changing the carrier gas to one which is more stable (less easily ionized) and taking note of any difference.

Many fail to note that cold traps must be valved off from the experiment before they are allowed to warm up. A clean experiment at the end of a working day can be a contaminated experiment the following day due to recondensation from the cold trap.

10.3 VISUAL INSPECTION

Contaminated metal parts can cause performance problems while appearing to be clean and shiny.

Discoloration of ceramic components indicates a need for cleaning. The discoloration should be removed as in 10.1. Although standard ceramic cleaning solutions can be used, be sure to mechanically remove any visible discolorations before using chemicals.

Ceramic sleeves should be inspected for drag marks which are caused by sliding off the metal parts of the trap for cleaning or inspection. These can cause leakage between elements of the trap. This should be suspected when the RF voltage seems to sag.

11.0 PULSER PERFORMANCE TESTING

The output of the pulser should only be monitored by the following procedure:

The timing for the Remote Pulser is synchronized with the RF Output voltage. Because of this, the Ion Trap Power Supply will need to be connected to the Ion Trap. The Ion Trap Power Supply needs to be adjusted for a minimum 200 volts out. Also, the “PULSE / RF SYNC.” switch should be in the “MAN” position.

Disconnect the "BIAS IN" SHV connector on the power supply rear panel and connect a shorting SHV connector in its place. A good high speed oscilloscope (100 MHZ) with a high speed 10X probe (100 MHZ) can be connected to the output of the Remote Pulser through a SHV panel connector. Trigger the oscilloscope off of the "PULSER TRIGGER MONITOR" BNC connector. Turn the "PULSE V." adjust to zero volts (completely counter-clockwise) before turning on the ION TRAP Power Supply. While watching the output of the Remote Pulser on the Oscilloscope, slowly turn up the Pulse voltage to the desired amplitude. Turn off the ION TRAP Power Supply before disconnecting the Oscilloscope from the Remote Pulser.

WARNING: Failure to follow the above test procedure will almost certainly result in the destruction of the Remote Pulser transistors.

12.0 PULSER SERVICE PROCEDURES

12.1 SAFETY PRECAUTIONS

WARNING: Before removing the top cover or disconnecting any of the rear panel connections turn off the "POWER" and disconnect the power supply from its power source. Also turn off any power supply connected to the "BIAS IN" connector and disconnect all of the cables from the rear panel. Even though the power is disconnected the "BIAS IN" voltage will elevate half of the circuitry on the Remote Pulser Assembly Board C01040, which can result in a dangerous electrical shock.

12.2 TROUBLESHOOTING

The majority of the problems with the Pulser power supply are caused by arcing due to a high pressure burst near the ion source. If the Pulser power supply periodically has problems, pressure or voltage parameters may have to be changed.

12.2.1 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 No. 1 and/or a dot over Pin 1. The IC sockets have a notch on the one end to show the position of Pin 1.

12.3 NO PULSER OPERATION

If there is no indicated Pulse Voltage, go on to the next step. If there is an indicated Pulse Voltage, check the "PULSER TRIGGER MONITOR" BNC connector on the front panel for the proper waveform. Since the timing for the Remote Pulser is synchronized with the RF Output voltage, the Ion Trap Power Supply will need to be connected to the Ion Trap. The Ion Trap Power Supply needs to be adjusted for a minimum 200 volts out. Also, the “PULSE / RF SYNC.” switch should be in the “MAN” position. If there is no "PULSER TRIGGER MONITOR" the problem is more than likely the timing circuitry on the main PC Board D1222 R1. If the "PULSER TRIGGER MONITOR" waveform is correct then check the "TRIGGER" output connector on the rear panel. If there is no "TRIGGER" then the problem is more than likely the ICL7667 (A2) on the Ion Trap Control PC Board D1201.

If the above steps don't uncover the problem then the problem is more than likely with the Remote Pulser.

12.4 NO PULSE VOLTAGE

Turn off the "POWER" and also turn off the external bias power supply. Disconnect the "PULSE V", "PULSER BIAS", and the "BIAS IN" SHV connectors on the rear panel. Connect a shorting SHV connector to the "BIAS IN" SHV connector. Turn on the "POWER" and verify the Pulse Voltage on the front panel meter. If there is still no Pulse Voltage after the above steps are followed, the problem is more than likely a bad component on the PULSER PC Board C1221.

WARNING: The circuitry on the back half of the PULSER PC Board in the Remote Pulser Assembly, C01040 is floating at -Pulse Voltage. Be careful not to touch either heat sink on this PC Board.

Check the voltages on J3. J3 pin 1 should be +12V and J3 pin 2 should be -12V. Check the voltage on the cathode of CR2 and connector J2 pin 2. They should both be about +9V. The voltage on A3 pin 6 should be variable from 0V to the voltage on pin 3 as the front panel PULSE V. pot is adjusted. The voltage on A4 pin 39 should be about 80% of the voltage on A3 pin 6. If these voltages are correct, check that the voltage from A4 pin 17 to pin 18 is the same voltage as the one measured on A4 pin 39.

If the Pulse Voltage works when the cables are disconnected the problem is with the Remote Pulser or that the output of the Remote Pulser is being loaded down. Turn off the ION TRAP Power Supply and reconnect the "PULSE V" and "PULSER BIAS" cables from the Remote Pulser and disconnect the Remote Pulser output connector from the system SHV vacuum feed through. Turn on the ION TRAP Power Supply and check the pulse voltage. If there is still no Pulse Voltage then the problem is a bad cable or a blown Remote Pulser Module. If the Pulse Voltage works when the Remote Pulser output is disconnected, the Remote Pulser is being loaded down by something in the system.

12.5 BAD REMOTE PULSER

First follow steps 12.3 and 12.4 to verify proper operation of the Pulse Voltage power supply.

It should be noted that 90% of the time a bad Remote Pulser can be fixed with just a new Pulser Repair Kit. The other 10% of the time, PS1 or PS2 will also need to be replaced in addition to the Pulser Repair Kit. It is very seldom that anything else goes bad.

To check the Remote Pulser, disconnect the output from the TOF system and disconnect the "PULSE V" and "BIAS" cables from the Remote Pulser. Connect a shorting SHV connector to the "BIAS" SHV connector on the Remote Pulser. Remove the Remote Pulser top cover and then turn on the ION TRAP Power Supply.

The Remote Pulser output should have a pulse with an amplitude of approximately 11 volts. Check the +12V input voltage, +12V across C2 (1uF, 35V), +5V across C13 (1uF, 35V) and -12V across C1 (1uF, 35V). If these voltages are correct, check that when the "TRIGGER" pulse goes high (+3 volts amplitude minimum), the voltage at the junction f R5 and A4 pin 1 goes from +12 volts down to about +3 volts. If it doesn't then R8, A4 orQ4 is bad. Check for an inverted trigger pulse on A2 pin 2 or pin 4 depending on which jumper option is selected. If there is no inverted trigger pulse then the output of A3 is possibly bad, but that is very seldom the case. Check for an inverted or non-inverted trigger pulse on A1 pin 10 depending on which jumper option is selected. If the pulse on A1 pin 10 is correct, the problem is more than likely a blown Q1 (VPO550N3), Q2 (VNO550N3), or A1 (IR2110). If Q1, Q2, or A1 is bad all three parts should be replaced as a set to insure good performance and reliability. It is recommended that A2 (ICL7667CPA) be replaced also.

12.6 DETAILED INSTRUCTIONS FOR FIXING THE REMOTE PULSER

The Remote Pulser has two high voltages connected to the two SHV connectors marked "PULSE V" and "BIAS". There are two transistors inside the Remote Pulser that connect the output SHV connector to either the "PULSE V" or the "BIAS" input voltages. As you can see on the REMOTE PULSER SCHEMATIC C01040, when the Q1 (VP0550N3) transistor is turned on, it connects the OUTPUT to the "PULSE V" input voltage. When Q1 is turned off and Q2 (VN0550N3) is turned on, it connects the OUTPUT to the "BIAS" input voltage. When Q1 or Q2 is damaged, it usually acts like a short circuit. If Q1 is damaged, the OUTPUT is continually connected the "PULSE V" input voltage. If Q2 is damaged, the OUTPUT is continually connected the "BIAS" input voltage. If Q1 and Q2 are both damaged, the "PULSE V", "BIAS", and OUTPUT are continually connected together. This causes the Pulse Voltage power supply to overload and stay at zero volts. When both the "PULSE V" and "BIAS" connectors are disconnected, the Pulse Voltage power supply should then operate normally. If the Pulse Voltage front panel meter is adjustable from 0 to 400 volts, this indicates that the Pulse Voltage power supply is operating correctly.

In most cases if a "Pulser Repair Kit" is installed in a Remote Pulser, it will then operate properly. A "Pulser Repair Kit" consists of:

1- Q1 (VP0550N3) Transistor
1- Q2 (VN0550N3) Transistor
1- A1 (IR2110) Integrated Circuit
1- A2 (ICL7667CPA) Integrated Circuit

If all four of these parts are installed in the Remote Pulser, it will usually cause the Remote Pulser to operate properly.

A severe arc will also damage the PS1 (TI# 0722MG) power supply module. This module is easy to test for proper operation.

To repair the Remote Pulser, the following procedure should be performed:

Turn off the Ion Trap power supply.
Disconnect the two SHV connectors marked "PULSE V" and "BIAS".
Disconnect the BNC connector marked "TRIGGER".
Remove the top cover of the Remote Pulser (four screws).
Remove the two output transistors Q1 (VP0550N3) and Q2 (VN0550N3). They are mounted on red sockets next to the output.
Remove A1 (IR2110) the 14 pin IC, and A2 (ICL7667CPA) the 8 pin IC.

NOTE: The amount of current drawn from the “+12V” BNC connector is limited by Poly Switch P1 (Raychem RXE030). Under normal conditions the Remote Pulser draws only 100mA of current from the “+12V” BNC connector. At this current, the Poly Switch has a resistance of about one ohm. At approximately 500mA of current draw, the Poly Switch heats up and its resistance increases until the current draw is about 60mA. When the excessive current draw is removed, the Poly Switch reverts to its one ohm resistance.

First measure the voltage on the “+12V” BNC connector. Check for +12V on the cathode of CR3 (Square Pad). If the difference between these two voltages is greater than 0.2 volts, there is too much current draw. The fault can be further isolated by alternately removing PS1 and PS2.

NOTE: C & D Technologies changed the part number of NMS1212 to NMS1212C.

PS1 (C&D NMS1212) is located near the output connector. The -12 volts generated by PS1 can be measured across C1 (1uF, 35V). If no voltage is measured, check the +12V and -12V on the output pins of PS1. Please notice that the 0V output pin is connected to the “PULSE V.” SHV connector. If no voltage is measured across C1, but the proper voltages are measured on the output pins of PS1, then L3 (220uH, 250mA) could be open circuit. If there are no measured output voltages, check the input voltage pins for +12 volts. If there is no voltage on the input pins of PS1, then L1 (220uH, 250mA) could be open circuit.

PS2 (C&D NMS1212) is located near the output connector. The +12 volts generated by PS2 can be measured across C2 (1uF, 35V). If no voltage is measured, check the +12V and -12V on the output pins of PS2. Please notice that the 0V output pin is connected to the “BIAS” SHV connector. If no voltage is measured across C2, but the proper voltages are measured on the output pins of PS2, then L4 (220uH, 250mA) could be open circuit. If there are no measured output voltages, check the input voltage pins for +12 volts. If there is no voltage on the input pins of PS2, then L2 (220uH, 250mA) could be open circuit.

If one of the power supplies is bad, replace it with a new part, and check the output voltages. If it tests OK, install the new "Pulser Repair Kit". Please notice that pin 1 of the two integrated circuits is pointing in opposite directions. Pin 1 of the integrated circuits is marked with a rounded indentation on one end. Pin 1 of the integrated circuit sockets is marked with a rounded notch on one end. **Please notice that Q1(VP0550N3) is the transistor located closest to the Remote Pulser output connector**.

The Remote Pulser should now operate properly.

13.0 REMOTE PULSER CIRCUITRY DESCRIPTION

The Remote Pulser can more accurately be described as a remote high voltage switch. The output SHV connector is quickly connected to either the “PULSE V” or “BIAS” SHV connectors through the output transistors.

The Remote Pulser contains two isolation power supplies that create +12 volts that floats on the "BIAS" input voltage, and -12 volts that floats on the "PULSE V" input voltage. There is also a fiber optics transmitter and receiver to elevate the "TRIGGER" pulse to the "BIAS" input voltage potential to trigger A1 (IR2110).

13.1 REMOTE PULSER POLARITY OPTIONS

The Remote Pulser can be configured two different ways. Typically, the ions are pulled out of the Ion Trap through the A2 Extraction End Cap, the Remote Pulser should be jumpered as shown on Drawing #C01045-D. To push the ions out of the Ion Trap with the A1 Repeller End Cap, the Remote Pulser should be jumpered as shown on Drawing #C01045-P.

13.2 CIRCUIT DESCRIPTION

See Remote Pulser Schematic, Drawing No. D01040 REV 6.

13.2.1 ISOLATED POWER SUPPLY CIRCUIT

The Ion Trap Power Supply delivers "+12" volts to the isolation power supplies PS1 and PS2. PS1 and PS2 take the +12 volts and convert it into two independent, isolated and unregulated "12 volt power supplies. One of the power supplies (PS1) is wired as a -12 volt power supply that floats on the "PULSE V" and powers the pull up circuitry of the IR2110 (VB and VS). The other 12 volt power supply (PS2) is wired as a +12 volt power supply that powers the pull down circuitry of the IR2110 (VCC and COM). The +12 volt supply is reduced to +5 volts by Q3, and the voltage is set by R3 and R4. The +5 volt power supply powers the fiber optics receiver A3.

13.2.2 TRIGGER CIRCUITRY

A "TRIGGER" pulse (0V to +3V minimum, +20V maximum) is received from the PULSER Power Supply. This pulse turns on Q4 (2N7000) which lights an LED inside A4 through R8 (110 ohms). This pulse of light operates the inverting logic gate receiver A3. This timing pulse goes to a connector block (CB1) which determines whether the output pulse of the Remote Pulser has the same waveform as the trigger input, or if the output pulse is the inverted waveform of the trigger input.

13.2.3 PULSING CIRCUITRY

For best performance, the output of the Remote Pulser should be connected directly to a coaxial feedthrough. Because of the sub 10nS rise and fall time of the output, the load connected to the output of the Remote Pulser is very critical. A cable connected to the output has both inductance and capacitance which will reflect back any energy the cable was not able to absorb. This will result in the rise and fall of the output pulse to resemble a staircase with the steps being about 20nS wide. The capacitance of the cable will cause the output transistors to work harder at charging and discharging the output capacitance. This will result in the output transistors heating up as the repetition rate is increased.

The heart of the Remote Pulser is A1 (IR2110). This IC takes a trigger pulse from A2 (ICL7667CPA) and controls both the pull up transistor Q1 (VP0550N3) and the pull down transistor Q2 (VN0550N3). A1 has its own delay circuits that turn off one of the transistors 10nS before turning on the other transistor. This delay causes less heating of the transistors which results in a high repetition rate of 200 kHz.

Diode CR1 is used to limit the minimum output voltage of the Remote Pulser to approximately 11 volts. If the output of the Remote Pulser is allowed to go below 11 volts pin 6 of A1 will go below zero volts and cause A1 to lock-up.

The Remote Pulser contains a dual inverter logic IC A2 (ICL7667CPA) which can be jumpered such that the Pulser output is either a pulsing or dipping (inverted) waveform. Drawings #C01045-P and #C01045-D show the jumper connections needed for the two options.

14.0 <u>IDENTIFYING POSSIBLE PROBLEMS WITH THE D-1203 POWER SUPPLY</u>

Historically the D1203 Ion Trap Power Supply has proven to be very reliable. The following are answers to questions that have been asked through the years.

14.1 NO RF OUTPUT VOLTAGE

The RF Output cable must be connected to the Ion Trap. Also the “TRAP BIAS OUT” cable needs to be connected to an Ion Trap end cap, OR a Pulser needs to be connected to one of the end caps.

Verify that the switch located below the “RF AMPLITUDE” turns counting knob is flipped in the up position.

It is possible that the vacuum tube that clamps the RF Output voltage could be broken such that it shorts the RF to ground continuously. The easiest way to inspect the vacuum tube is by removing the cover for the coil box located at the rear of the power supply. If the tube looks good, the plate cap connector at the top of the vacuum tube can be disconnected and suspended in the air to verify that the poser supply s operating correctly (do not eternally trigger the power supply). If this fixes the problem, verify that the voltage on the transistor can of Q1 (VN0640N2) is -120 volts (located on the C1227 Ion Trap Power Supply RF Switch PC Board). If this voltage is near ground or positive, the vacuum tube is being turned on electrically and the problem is more than likely with the circuit that controls the grid of the vacuum tube. When the problem is fixed, use all 14 of the screws when reinstalling the cover for the coil box.

NOTE: If the RF is being shut down at a repetition rate greater than 1 kHz, it will overload the RF circuit. This can cause a low RF Output voltage and possibly cause an “OVER CURRENT” or “OVER POWER”LED to light as well.

14.2 LOW RF OUTPUT VOLTAGE

If the RF Output voltage cable is longer than the standard six foot length, it will load down the RF Output voltage. The adjustable +27 volt power supply can be adjusted to allow for the added cable length. The voltage of the +27 volt power supply can be adjusted to a greater voltage which will allow the RF Output voltage to go higher in voltage. The adjustment for the +27 volt power supply (R8, 2K) is located on the D1202 Control PC Board next to VR1 (LM317LH). **The adjustable +27 volt power supply should be adjusted such that the <u>maximum</u> RF Output voltage is 4,200 volts.**

If the RF transistors (D44H11) on the rear panel have been replaced, the adjustable +27 volt power supply might need to be readjusted such that the maximum RF Output voltage is +4,200 volts.

14.3 MONITORING THE RF OUTPUT VOLTAGE

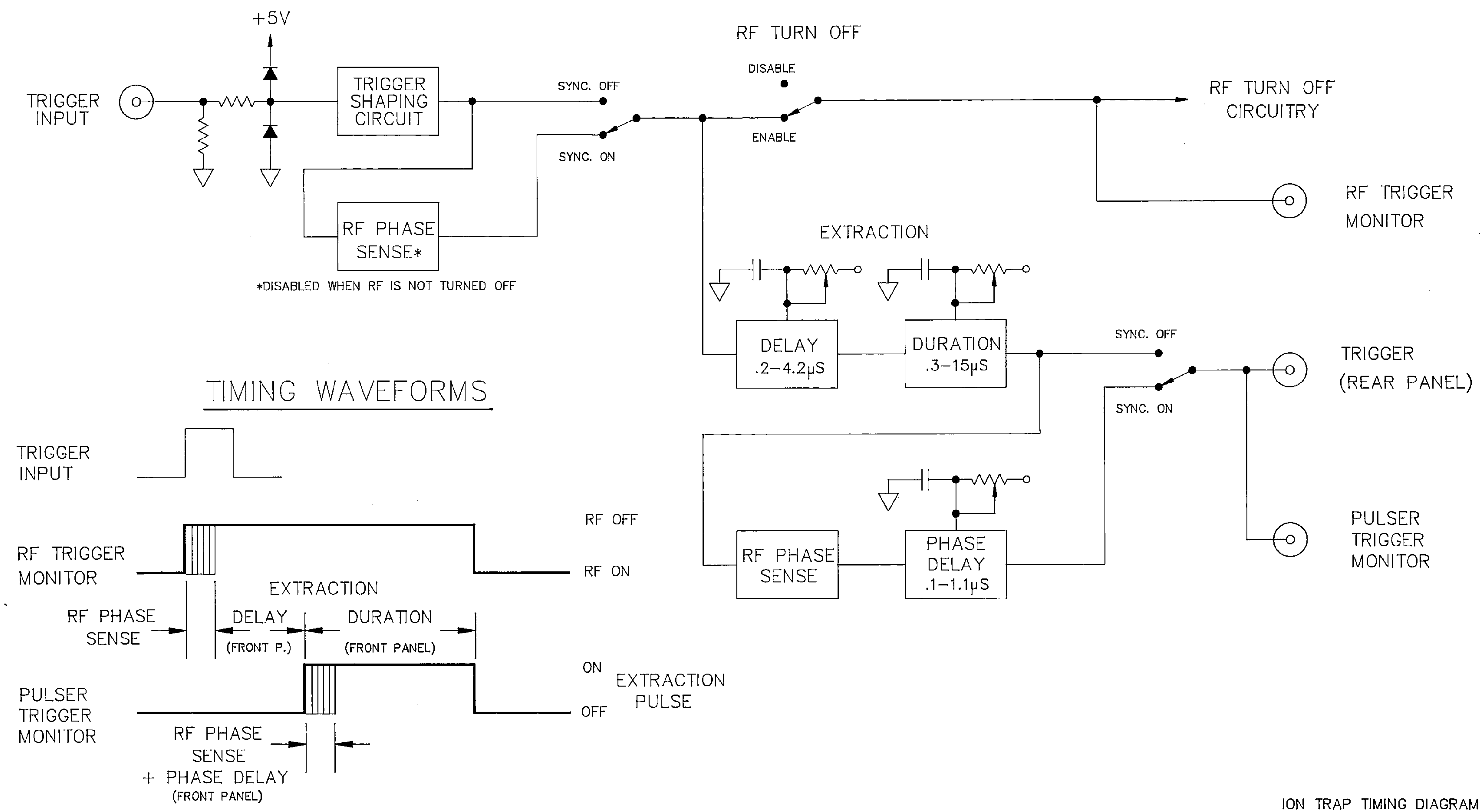
An oscilloscope can be connected to one of the Ion Trap’s end caps with a 10X or 100X scope probe. The wave on the oscilloscope will be roughly 20% of the voltage supplied by the Ion Trap Power Supply. Connect the oscilloscope probe to one of the vacuum feedthroughs A1 or A2. Remember, either the “TRAP BIAS OUT” cable needs to be connected to the other Ion Trap end cap, OR a Pulser needs to be connected to the other Ion Trap end cap.

14.4 NO PULSER TRIGGER OUTPUT

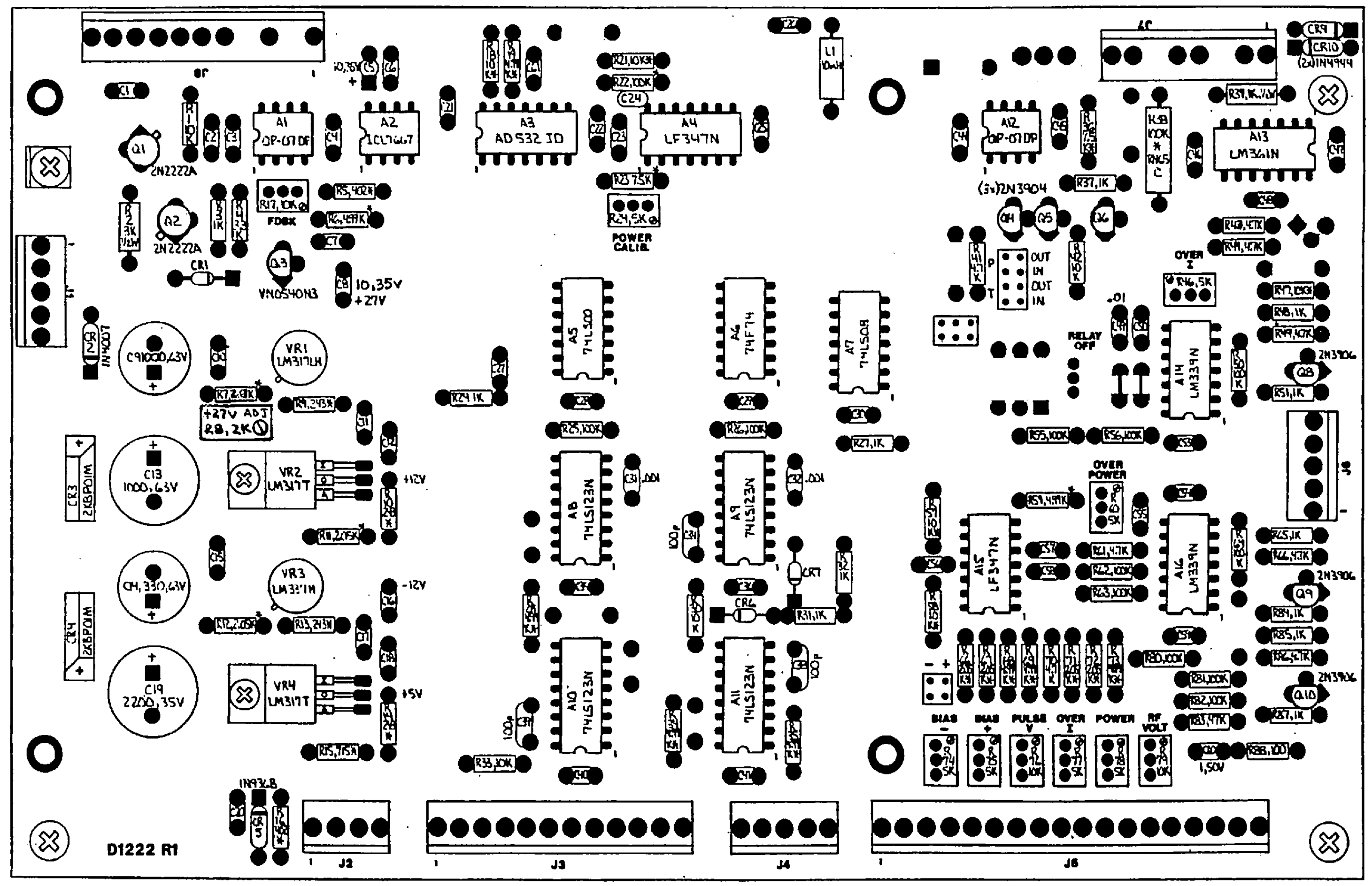
Verify that the trigger pulse into theD1203 Power Supply is greater than one volt.

If the switch located below the “EXTRACTION DURATION” controls is in the “AUTO” position (flipped to the right), flip it to the “MAN.” Position (flipped to the left). This should fix the problem. In the “AUTO” position, after the “TRIGGER” pulse is received, the RF is clamped and the “EXTRACTION DELAY” is started.

After the adjusted “EXTRACTION DELAY” is completed, the phase sense circuit waits for any residual RF to cross through zero volts, the this circuit synchronizes the “PULSER TIRGGER OUTPUT” with the phase of any residual RF. The problem occurs when the RF Output voltage is adjusted low and the “EXRACTION DELAY” is adjusted long. For example: When the RF is adjusted for 1,000 volts the RF Output voltage is fully clamped in one cycle (one microsecond). If the “EXTRACTION DELAY” is adjusted for 2µs, there is no residual RF voltage to synchronize to, so there is no pulse on the “PULSER TRIGGER OUTPUT”.



ION TRAP TIMING DIAGRAM
B1227
R. M. JORDAN COMPANY
Grass Valley, CA



ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1	DRAWN	8-5-94	

NOTES:

1- RESISTOR VALUES ARE IN OHMS, ±5%
   * RESISTOR VALUE ±1%
2- CAPACITOR VALUES ARE IN MICROFARADS
   * UNMARKED CAPACITORS ARE .1,50V
3- UNMARKED DIODES ARE IN4148

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ARE:

FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS | DATE

DRAWN

CHECKED

ISSUED

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APPLICATION

DO NOT SCALE DRAWING

ION TRAP P.S. CONTROL PC BOARD

R. M. JORDAN CO.
990 Golden Gate Terrace
GRASS VALLEY, CALIFORNIA 95945
(916) 272-4580

SIZE D | FSCM NO. | DWG. NO. D1201 | REV. 2A

SCALE | SHEET 1 OF 1

ZONE	REV.	DESCRIPTION	DATE	APPROVED
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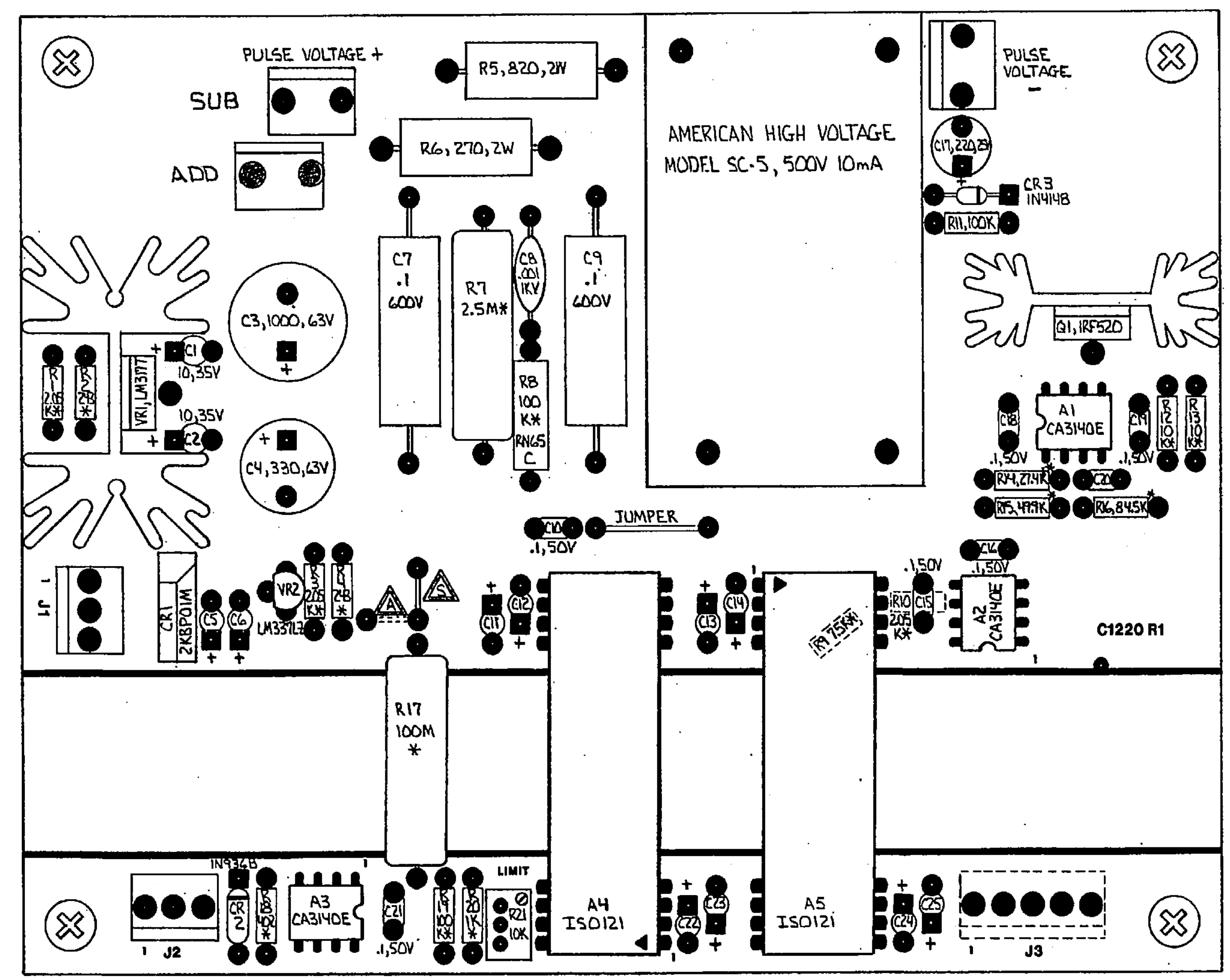

NOTES:

1 ~ RESISTOR VALUES ARE IN OHMS ±5%
* RESISTOR VALUE ±1%

2 ~ CAPACITOR VALUES ARE IN MICROFARADS
* UNMARKED CAPACITORS 1,35V TANT.

△S ~ JUMPER HERE WHEN PULSER WIRED SUBTRACTIVE

△A ~ JUMPER HERE WHEN PULSER WIRED ADDITIVE

PARTS LIST

ION TRAP P.S. PULSER PC BOARD

R. M. JORDAN CO.
990 Golden Gate Terrace
GRASS VALLEY, CALIFORNIA 95945
(916) 272-4588

SIZE C | DWG. NO. C1225 | REV. 1

SHEET 1 OF 1

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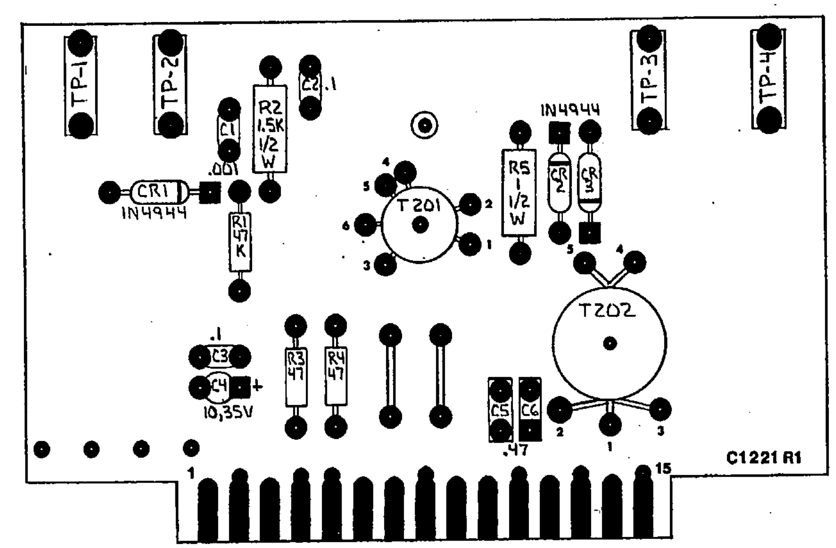

NOTES:

1 ~ RESISTOR VALUES ARE IN OHMS
* RESISTOR VALUE ±1%

2 ~ CAPACITOR VALUES ARE IN MICROFARADS

	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

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CONTRACT NO.

APPROVALS	DATE
DRAWN	
CHECKED	
ISSUED	

NEXT ASSY | USED ON

APPLICATION

ION TRAP P.S. RF OSC. PC BOARD

R. M. JORDAN CO.
990 Golden Gate Terrace
GRASS VALLEY, CALIFORNIA 95945
(916) 272-4588

SIZE	FSCM NO.	DWG. NO.	REV.
C		C1226	1

SCALE | SHEET 1 OF 1

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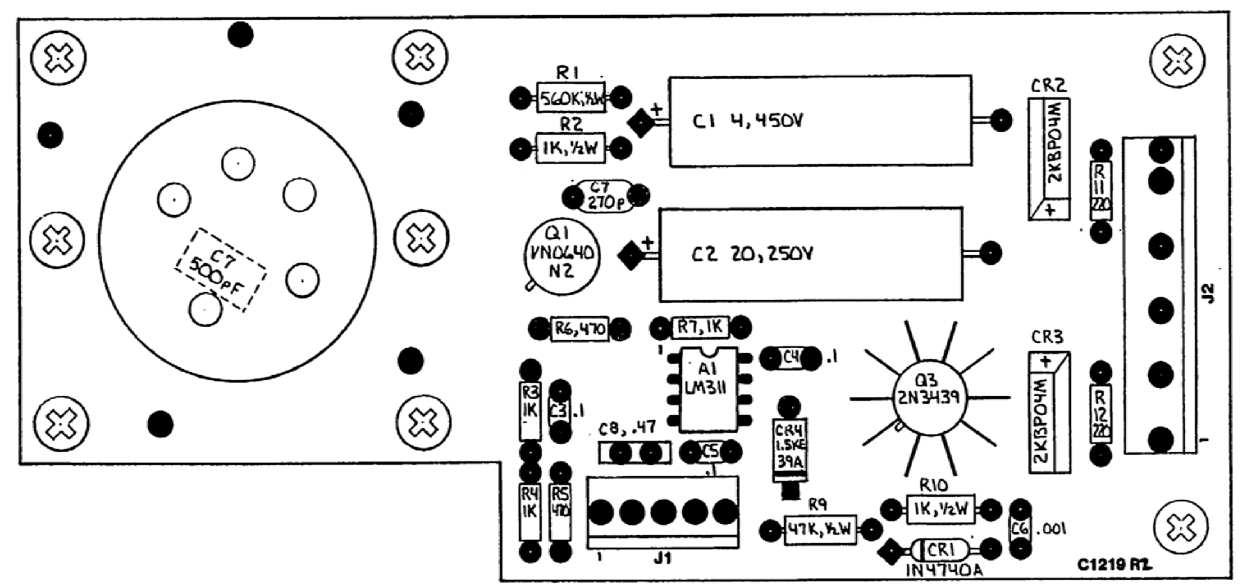

NOTES:

1~ RESISTOR VALUES ARE IN OHMS
    * RESISTOR VALUE ±1%
2~ CAPACITOR VALUES ARE IN MICROFARADS

ION TRAP P.S. RF SWITCH PCB

R. M. JORDAN CO.
990 Golden Gate Terrace
GRASS VALLEY, CALIFORNIA 95945
(916) 272-4588

SIZE C | DWG. NO. C1227 | REV. 2

SHEET 1 OF 1

DO NOT SCALE DRAWING

ZONE	REV.	DESCRIPTION	DATE	APPROVED
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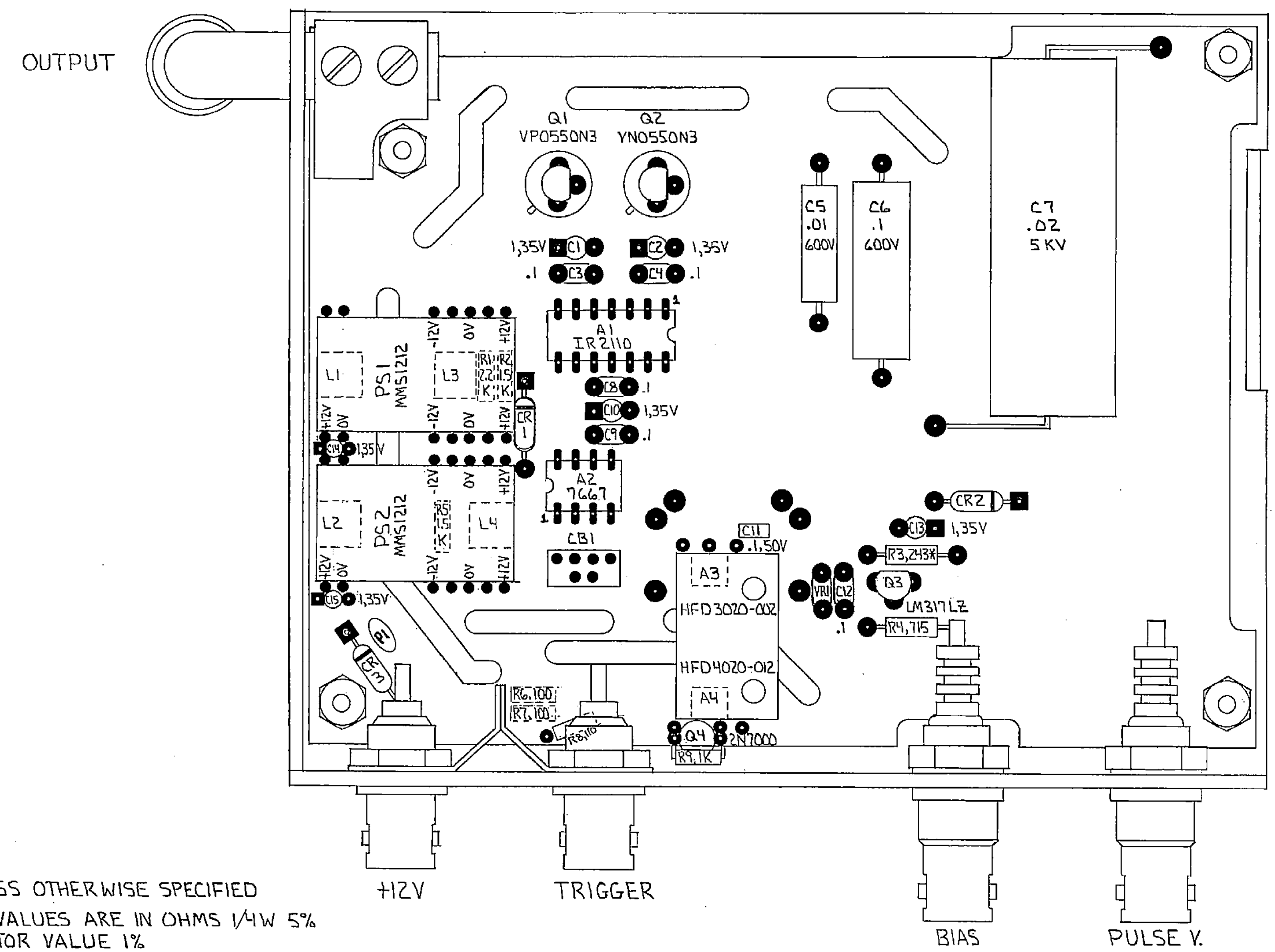
	6	POWER SUPPLY CHANGE	11-4-05	



NOTES: UNLESS OTHERWISE SPECIFIED

1~ RESISTOR VALUES ARE IN OHMS 1/4W 5%
  * RESISTOR VALUE 1%
2~ CAPACITOR VALUES ARE IN MICROFARADS
3~ ALL DIODES ARE IN4007
4~ INDUCTORS ARE 220 MICROHENRIES, .25 AMPS, 7mm FOOTPRINT

PARTS LIST

QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

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REMOTE PULSER ASSEMBLY

TOF ELECTRONICS
10227 Missouri Bar Road
NEVADA CITY, CALIFORNIA 95959
(530) 478-5955 randall@gv.net

SIZE C | FSCM NO. | DWG. NO. C01040 | REV. 6

SCALE 2 TO 1 | SHEET 1 OF 1

BISHOP GRAPHICS, INC. REORDER NO. 20511

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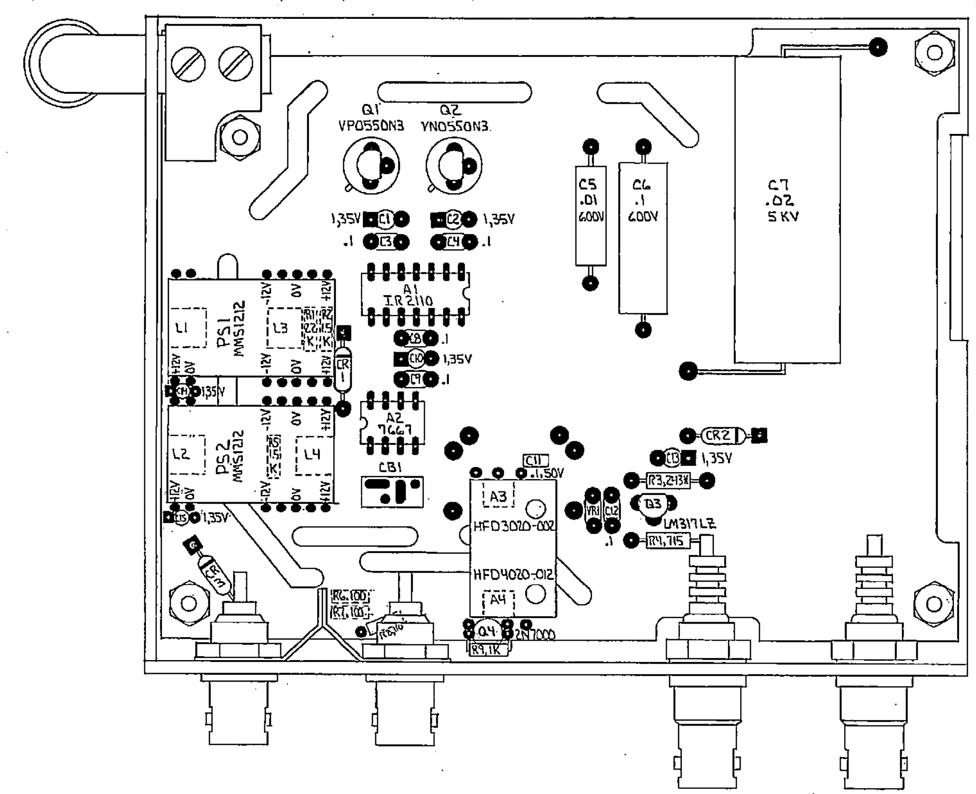
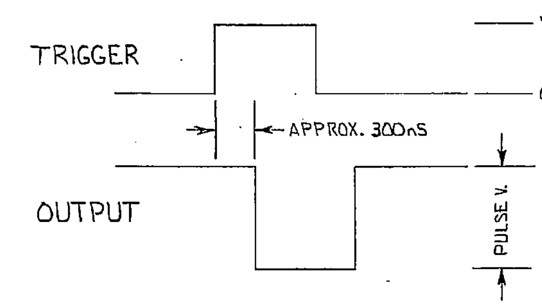
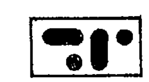
	6	CHANGED	11-4-05	

REVISIONS





FOR DIPPED WAVEFORM SHOWN ABOVE
SET JUMPERS ON CB1 AS SHOWN



QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

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PULSER POLARITY OPTION

TOF ELECTRONICS
10227 Missouri Bar Road
NEVADA CITY, CALIFORNIA 95959
(530) 478-5955 randall@gv.net

SIZE C | FSCM NO. | DWG. NO. C01045-D | REV. 6

SCALE | SHEET

ZONE	REV.	DESCRIPTION	DATE	APPROVED
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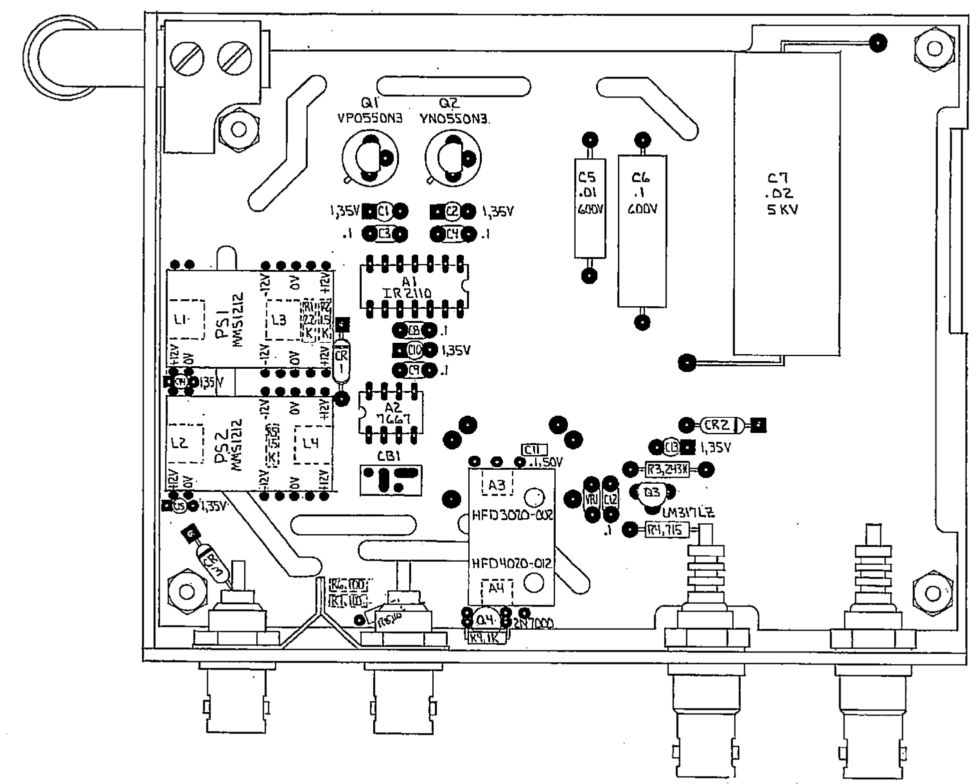
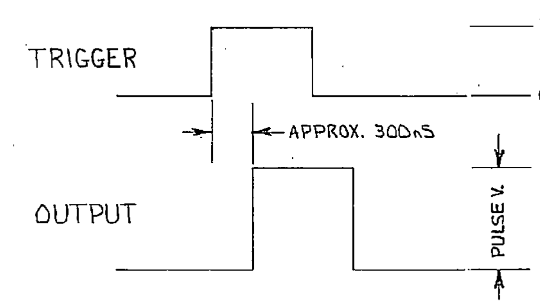
	6	CHANGED	11-4-05	





FOR PULSE WAVEFORM SHOWN ABOVE
SET JUMPERS ON CB1 AS SHOWN.

	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
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MATERIAL

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APPLICATION	

CONTRACT NO.

APPROVALS	DATE
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ISSUED	

PULSER POLARITY OPTION

TOF ELECTRONICS
10227 Missouri Bar Road
NEVADA CITY, CALIFORNIA 95959
(530) 478-5955 randall@gv.net

SIZE C | FSCM NO. | DWG. NO. C01045-P | REV. 6

SCALE | SHEET