*TIME OF FLIGHT*

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INSTRUCTION MANUAL

# TOF TIME OF FLIGHT POWER SUPPLY

TOF P.S. PC BOARD REV-5A

**WARNING**

THIS EQUIPMENT USES VOLTAGES WHICH ARE DANGEROUS TO LIFE. IT SHOULD BE SERVICED ONLY BY QUALIFIED PERSONNEL USING PROPER SAFETY PRECAUTIONS.

## TABLE OF CONTENTS

## 1.0 SPECIFICATIONS

### 1.1 PHYSICAL SPECIFICATIONS

| | |
|---|---|
| Cabinet size | 19.0" W. x 14.5" D. x 5.25" H. |
| Cabinet weight | 14 Lbs. |

### 1.2 ELECTRICAL SPECIFICATIONS

See 5.0

### 1.3 SERVICE REQUIREMENTS

| | |
|---|---|
| Input Power | 100/120/220/240 Volts<br>1 Phase, 50-60 Hz |

## 2.0 GENERAL DESCRIPTION

The (TOF) Time of Flight Power Supply was designed to be a single compact source for all the voltages used in a typical Time of Flight Mass Spectrometer. Choice of this unit should curtail instrument clutter in the immediate vicinity of the experiment. All voltages are monitored by the same meter. A voltage is only displayed while its monitor button is held down. Each end of every cable is labeled to match the receptacle to which it connects.

It is as simple and comprehensive as we can make it.

## 3.0 CONNECTIONS AND OPERATION

The following is a description of the generation, separation and detection of aniline in a supersonic beam. (ref. D. M. Lubman and R. M. Jordan, Rev. Sci. Instrum., March 1985)

A skimmed (.040" dia.) supersonic molecular beam is directed through the space (1 cm) between two plates and is ionized by a laser beam which intersects it at right angles. The ions thus created are repelled by the Repeller Plate (VA1 = +4181 Volts) and drawn through the Extraction Grid (VA2 = +3866 Volts). They are then accelerated through the Ground Grid into the Flight Tube. (Total length of the drift tube is 56" from laser centerline to detector)

During this transit the ions pass between the deflection plates VX1, VX2 & VY1 (-300 to +300 Volts). These plates steer the beam on to the Detector Grid and compensate for the transverse displacement due to any initial Beam Velocity Vector. If these plates are located at mid range as in some of our instruments, they will be larger (10 $IN^2$) and the transverse correction will require about 250 Volts. If the plates are mounted near the source, they may be smaller (1.5 $IN^2$) and require much less voltage.

After a drift time of approximately 16 microsec. the packet of aniline ions (m/e-93) will arrive at the detector. Each of these ions will impact the first microchannel plate (VD1 = -2200 Volts) with about 6000 Volts of energy. This impact will deliver approximately $10^4$ electrons onto the face of the second microchannel plate (VD2 = -1200 Volts). Each of these secondary electrons will generate another $10^4$ electrons in the second plate. These electrons exit the bottom of the plate (VD3 = -200 Volts) and accelerate the final 200 volts to the 50 Ohm anode which is at ground potential.

The duration of the current thus generated will be about 10 nanoseconds. After about 100 nanoseconds the ion packet of the $C_{13}$ isotope of aniline (m/e-94) will arrive and also generate a current for 10 nanoseconds.

## 4.0 DESCRIPTION OF FRONT PANEL CONTROLS

### 4.1 VD (SCREWDRIVER ADJUST)

Adjusts the VD output to the detector divider box from 0 to -5,000 Volts D.C.

### 4.2 VD PUSH BUTTON

Enables the meter to measure the voltage on VD Output.

### 4.3 VX1 VOLTAGE ADJUST KNOB

Adjusts the VX1 output from -330 to +330 Volts D.C.

### 4.4 VX1 PUSH BUTTON

Enables the meter to measure the voltage on the VX1 output.

### 4.5 VX2 VOLTAGE ADJUST KNOB

Adjusts the VX2 output from -330 to +330 Volts D.C.

### 4.6 VX2 PUSH BUTTON

Enables the meter to measure the voltage on the VX2 output.

### 4.7 VY1 VOLTAGE ADJUST KNOB

Adjusts the VY1 output from -275 to +275 Volts D.C.

### 4.8 VY1 PUSH BUTTON

Enables the meter to measure the voltage on the VY1 output.

4.9 **VY2 VOLTAGE ADJUST KNOB**

Adjusts the VY2 output from -275 to +275 Volts D.C.

4.10 **VY2 PUSH BUTTON**

Enables the meter to measure the voltage on the VY2 output.

4.11 **VA1 VOLTAGE ADJUST KNOB**

Adjusts the VA1 output from 0 to +4500 Volts D.C.

4.12 **VA1 PUSH BUTTON**

Enables the meter to measure the voltage on the VA1 output.

4.13 **VA2 VOLTAGE ADJUST KNOB**

Adjusts the VA2 output from 0 to +4500 Volts D.C.

4.14 **VA2 PUSH BUTTON**

Enables the meter to measure the voltage on the VA2 output.

## 5.0 DESCRIPTION OF REAR PANEL OUTPUTS

5.1 **VD SHV CONNECTOR**

Adjustable output from 0 to -5,000 Volts for the channel plate detector Voltage Divider box.

5.2 **VX1 SHV CONNECTOR**

Adjustable output from -330 to +330 Volts D.C. for one of the X axis steering plates.

5.3 **VX2 SHV CONNECTOR**

Adjustable output from -330 to +330 Volts D.C. for the other X axis steering plate.

5.4 **VY1 SHV CONNECTOR**

Adjustable output from -275 to +275 Volts D.C. for one of the Y axis steering plates.

## 5.5 VY2 SHV CONNECTOR

Adjustable output from -275 to +275 Volts D.C. for the other Y axis steering plate.

## 5.6 VA1 SHV CONNECTOR

Adjustable output from 0 to +4500 Volts D.C. for the repeller plate.

## 5.7 VA2 SHV CONNECTOR

Adjustable output from 0 to +4500 Volts D.C. for the extraction grid.

# 6.0 CIRCUITRY DESCRIPTION

## 6.1 CONTROL UNIT

The control unit includes four 12 Volt D.C. Power Supplies, five 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. D0603 REV 5

### 6.2.1 ±12 Volt D.C. Power Supplies

The two ±12 Volt D.C. 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 on the C301 supplies REG. 203 and REG. 201 which makes up two +12 Volt, 1.5 Amp regulated power supplies. The -19 Volts on C302 supplies, REG. 202 and REG. 204 which makes up two -12 Volt, 1.5 Amp regulated power supplies.

### 6.2.2 **VA1 and (VA2) Power Supplies**

VA1 (VA2) is adjusted by the Front Panel Control R102 (R101) which varies the output of PS304 (PS305) from 0 to +5000 Volts D.C. This voltage goes to the PC Board through J12 (J11) to the 10 megohm current limit resistor R5 (R7). This resistor limits the current to VA1 (VA2) to .5 milliamperes. The 100 megohm resistor R4 (R6), 97.6K resistor R30 (31) and 5K trimmer resistor R33 (34) 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, VA1 (VA2) only gets to 90% of the voltage from PS304 (PS305), so the VA1 (VA2) output is 0 to +4500 Volts D.C.

### 6.2.3 **VD Detector Voltage Power Supply.**

VD is adjusted by the front panel screwdriver control R107 which varies the output of PS303 from 0 to -5000 Volts D.C. 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 R8, 97.6K resistor R32, and 5K trimmer resistor R35, make up a voltage divider for the meter circuit. When calibrated one volt to the meter circuit represents 1000 Volts on the VD Output.

### 6.2.4 **VX and VY Power Supplies**

The VX and VY Power Supplies are resistor dividers between a +500 Volt fixed power supply (PS301) and a -500 Volt fixed power supply (PS302). If one of the 500 Volt power supplies turns on before the other, then CR1 through CR8 stops the opposite 500 Volt Power Supply from being driven to the reverse polarity.

VX1 (VX2) supply uses R17 (R15) to limit the VX1 (VX2) adjust pot R106 (R105) to 330 Volts in the positive direction, and R10 (R12) to limit the control to 330 Volts in the negative direction. The resistor divider R18 (R19), R29 (R28) and 1K trimmer resistor R25 (R24) supplies a voltage to the meter circuit which is proportional to the VX1 (VX2) output voltage (1 Volt = 1000 Volts on VX1 (VX2).

VY1 (VY2) supply uses R13 (R11) to limit the VY1 (VY2) adjust pot R104 (R103) to 275 Volts in the positive direction, and R14 (R16) to limit the control to 275 Volts in the negative direction. The resistor divider R20 (R21), R27 (R26) and 1K trimmer resistor R23 (R22) supplies a voltage to the meter circuit which is proportional to the VY1 (VY2) output voltage (1 Volt = 1000 Volts on VY1 (VY2).

### 6.2.6 **Metering Circuit**

The Metering Circuit is not enabled until a front panel push button (S101 through S107) is depressed. When no buttons are depressed the normally closed contacts connect J5-10 to ground which blanks the Digital Volt Meter. When a push button is depressed it connects the voltage divider selected to R36 and onto the buffer amplifier A1 which has a gain of 1. The output of A1 drives the Digital Volt Meter.

### 6.2.7 **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 is what makes 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 **DIVIDER BOX FOR DUAL MCP DETECTOR**

### 7.1 **-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 is 400μA at -5,000 volts.

### 7.2 **VD1 SHV CONNECTOR**

Output voltage is a fixed 44% of the -V IN (VD) input for the input of the first channel plate (0 to –2200 Volts D.C.).

## 7.3 VD2 SHV CONNECTOR

Output voltage is a fixed 24% of -V IN (VD) input for the center tap between the two channel plates (0 to –1200 Volts D.C.).

## 7.4 VD3 SHV CONNECTOR

Output voltage is a fixed 4% of -V IN (VD) input for the output of the second channel plate (0 to –200 Volts D.C.).

## 8.0 CONNECTIONS

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

| Mains voltage | Fuse value |
|---|---|
| 100V 50/60 Hz | 1.2A slow-blow |
| 120V 50/60 Hz | 1A slow-blow |
| 220V 50/60 Hz | ½A slow-blow |
| 240V 50/60 Hz | ½A slow-blow |

Before turning on power:

1. With all cables disconnected turn on power and preset VD (-V IN)to 3,000 volts using the VD (-V IN) trimmer on the front panel. With VD (-V IN) at 3,000 volts, the VD1 Output on the Divider Box will be about -1,300 volts, which represents about 600 volts for each microchannel plate. Set all other power supplies as required. Note: Do not apply voltage to the Channel Plates unless the detector is pumped below $10^{-6}$ Torr.

2. Turn off power and connect all cables which you intend to use. This will prevent a possible arc occurring when connecting to a live receptacle.

3. Turn on power and increase each voltage to the desired setting. It is best not to approach maximum VD unless you are monitoring the signal output for noise, arcing, etc.

With cables connected, set the voltages given in section 3. These are starting voltages only and should give some indication of spectra on the detector output. While observing the peaks, voltages can be trimmed for optimum sensitivity and resolution.

## 9.0 SERVICE PROCEDURES

### 9.1 SAFETY PRECAUTIONS

This equipment uses voltages up to 5000 Volts D.C. 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.

### 9.2 TROUBLE SHOOTING

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.

9.2.1 No Power.

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

9.2.2 VA1, VA2, and VD all Read Low or Zero Volts.

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

9.2.3 VX1, VX2, VY1, VY2 Do Not Adjust to Positive Voltages.

PS301 is bad or J3 is disconnected. A single output voltage not going positive is an indication that diode CR8 (VX1), CR6 (VX2), CR4 (VY1), or CR2 (VY2) is shorted.

9.2.4 VX1, VX2, VY1, VY2 Do Not Adjust to Negative Voltages.

PS302 is bad or J2 is disconnected. A single output voltage not going negative is an indication that diode CR7 (VX1), CR5 (VX2), CR3 (VY1), or CR1 (VY2) is shorted.

9.2.5 VD Reads Low or Zero Volts

Reg 204 might be putting out a low voltage. Check Reg 204 for -12.0V output. PS303 is bad. J10, J103 or J1 is disconnected.

Adjust the VD front panel control all the way counter clockwise. 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 R107 is probably bad.

9.2.6 VA1 Reads Low or Zero Volts

PS304 is bad. J102, J12 or J14 is disconnected.

9.2.7 VA2 Reads Low or Zero Volts

PS305 is bad. J101, J11, or J14 is disconnected.

9.2.8 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 feed-thru, or bad insulator on the TOF itself.**