EDAX INTERNATIONAL, Inc.

# DETECTING UNIT

# USERS' MANUAL

ORDERING CODE:
80-05100-00

FIRST EDITION
MAY 1976

# 184 PRE-AMPLIFIER INSTALLATION AND ADJUSTMENT PROCEDURE



85 McKEE DRIVE
MAHWAH, NJ 07430
USA

9499.240.40811
August 1989
Revision 3

## FIELD MODIFICATIONS REQUIRED FOR INSTALLATION OF ECON IV - 184

**(ECON IV Delivered After Installation of the Analyzer)**

**WARNING: The reference test points (TPx) cited in this document are applicable only to Revision 7 and later.**

| 00 To 06 | SIGNAL NAME | 07 + |
|---|---|---|
| TP 1 | Amplifier Out ✓ | TP 2 |
| TP 2 | | TP 3 |
| TP 3 | Trigger | TP 4 |
| TP 4 | | Dropped |
| TP 5 | Amplifier Inhibit ✓ | TP 5 |
| None | Ground | TP 1 |
| TP 7 | Pre-Amp Input | TP 6 |

**Equipment Required**

a. Oscilloscope
b. DVM
c. Soldering Iron
d. Common Tools
e. Wire Wrap Tool

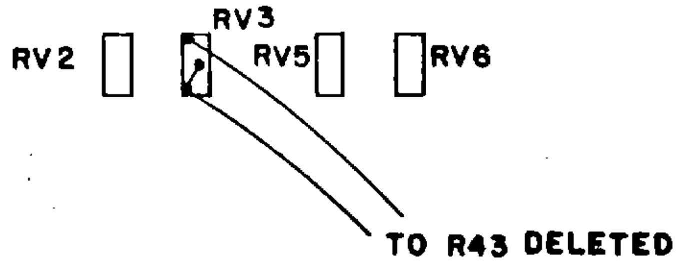
## ADC - ANALOG MODIFICATION

Due to signal output conditions of the 184, R60 and R61 in the fast discriminator and amp-inhibit circuitry must be deleted.

For ECON IV low-end measurement, R43 is (depending on various parameters) too critical, and must be replaced by RV3 (a 10K pot).

Insert RV3 between RV2 and RV5, and run jumpers to R43 as shown in the illustration below.

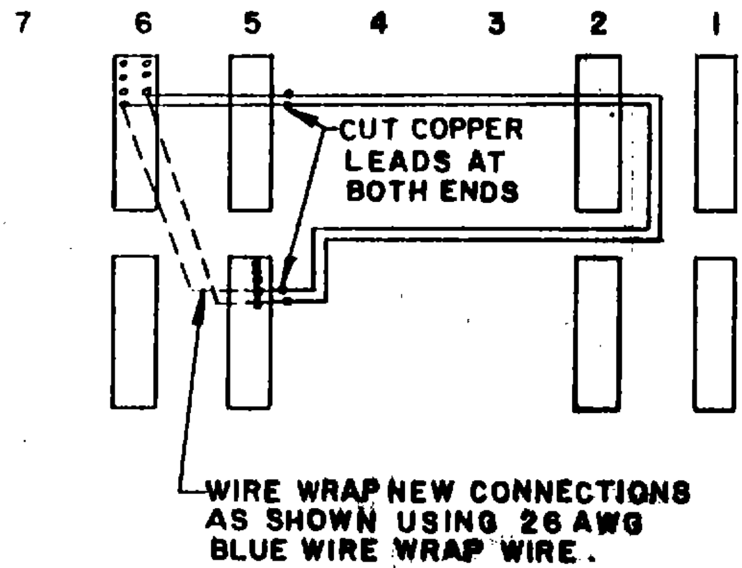
**NOTE:** Reference and ADC analog PCB layout print.

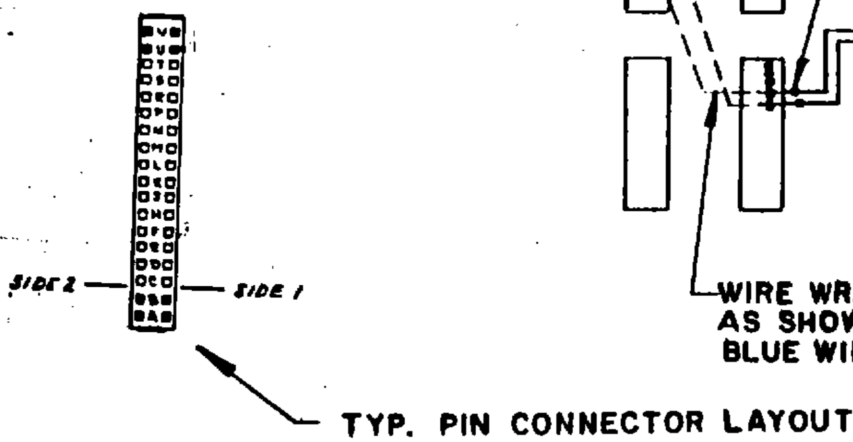



## BACKPLANE MODIFICATION

The two copper leads from Slot 5 ASI to Slot 6 BS2 and Slot 5 AR1 to Slot 6 BT1 must be cut and replaced with wirewrap connections using 26 AWG blue wirewrap (see illustration below). This is done to eliminate interference.

| SLOTS | |
|---|---|
| From | To |
| Slot 5 AS1 | Slot 6 BS2 |
| Slot 5 AR1 | Slot 6 BT1 |

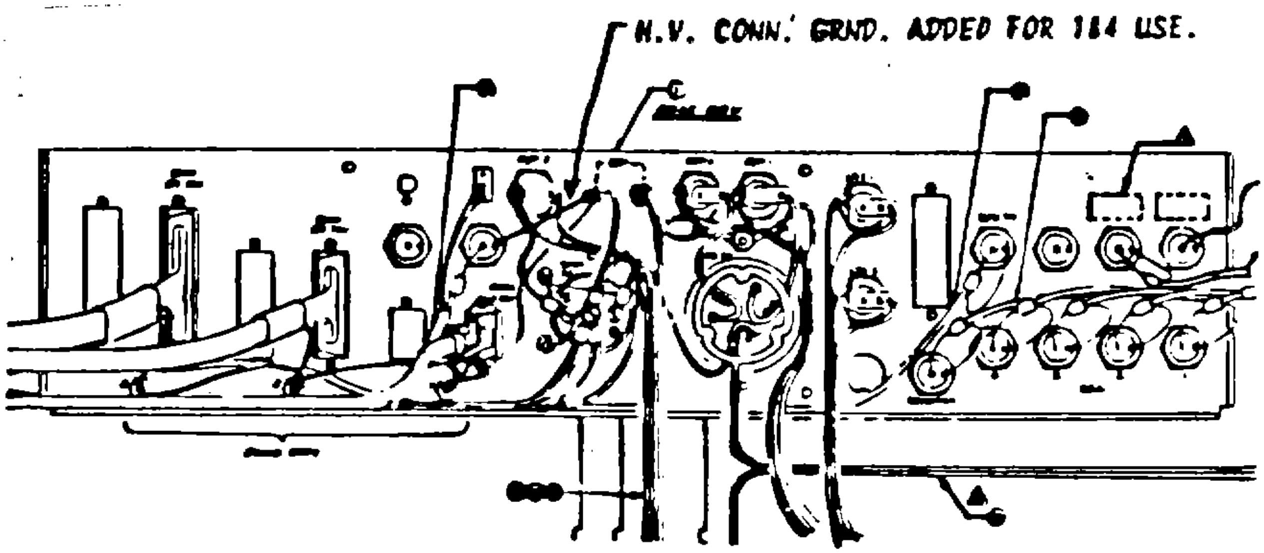


HIGH VOLTAGE BOX MODIFICATION

PV9100 CONNECTOR PANEL MODIFICATION

The high-voltage connector on the PV9100 connector panel must be grounded to the system ground lug on the connector panel using 16 AWG wire (see illustration below).




Remove the 183A-Preamp-to-PV9100 connector panel harness and install the 184 PA/AMP to the PV9100 connector panel harness.

## 184 PRE-AMP DESCRIPTION

The pulsed optical feedback pre-amp system consists of a silicon detector, a charge-sensitive amplifier and dual discriminator, a dual-current driver, and two LEDs (light emitting diodes).

A charge is built up in the silicon detector and is amplified by the pre-amp, where U=Q/C. In this case, C = approximately 0.1 pF.

There is no resistor feedback, so the pre-amp output will rise until it is reset by the discriminator which senses the output level.

As soon as a certain level is reached, LED 1 receives sufficient current to reset the gate of the FET input. Below a second level, the LED is switched OFF. If the system is switched on, LED 2 will increase the current through the detector to start the system, and will switch OFF as soon as the system is in normal operation.

A heater control is included, the adjustment of which will provide the correct temperature at the input FET for optional S/N ratio. The detector operates at 77 degrees K (liquid nitrogen temperature).

The 184 amplifier is a Gaussian-shape amplifier. At the input of the 184 is an integrator/differentiator followed by three dual integrators. Each section includes additional amplification, so that the overall amplification is approximately 200 times.

The fast discriminator is also connected to the input, which then outputs to the control logic along with the pramp inhibit pulse.

When a fast-discriminator (FD) pulse is seen, a one shot will be triggered in order to set a pulse "around" the Gaussian shape.

The amplifier is followed by a buffered base-line restorer, with a feedback loop consisting of an amplifier with high-time constant, comparing the input with the zero level. This amplifier will sense the output for the zero level only, so that its input and output is switched OFF during a pulse. After amplification, the signal will be fed back to the input of the baseline restorer.

The baseline restorer will then receive signals from both the Gaussian-shape amplifier output and the DC-level output of the integrator amplifier, the addition of which, since the baseline restorer has active feedback, will cause zero output until the FD pulse interrupts the feed-back loop.

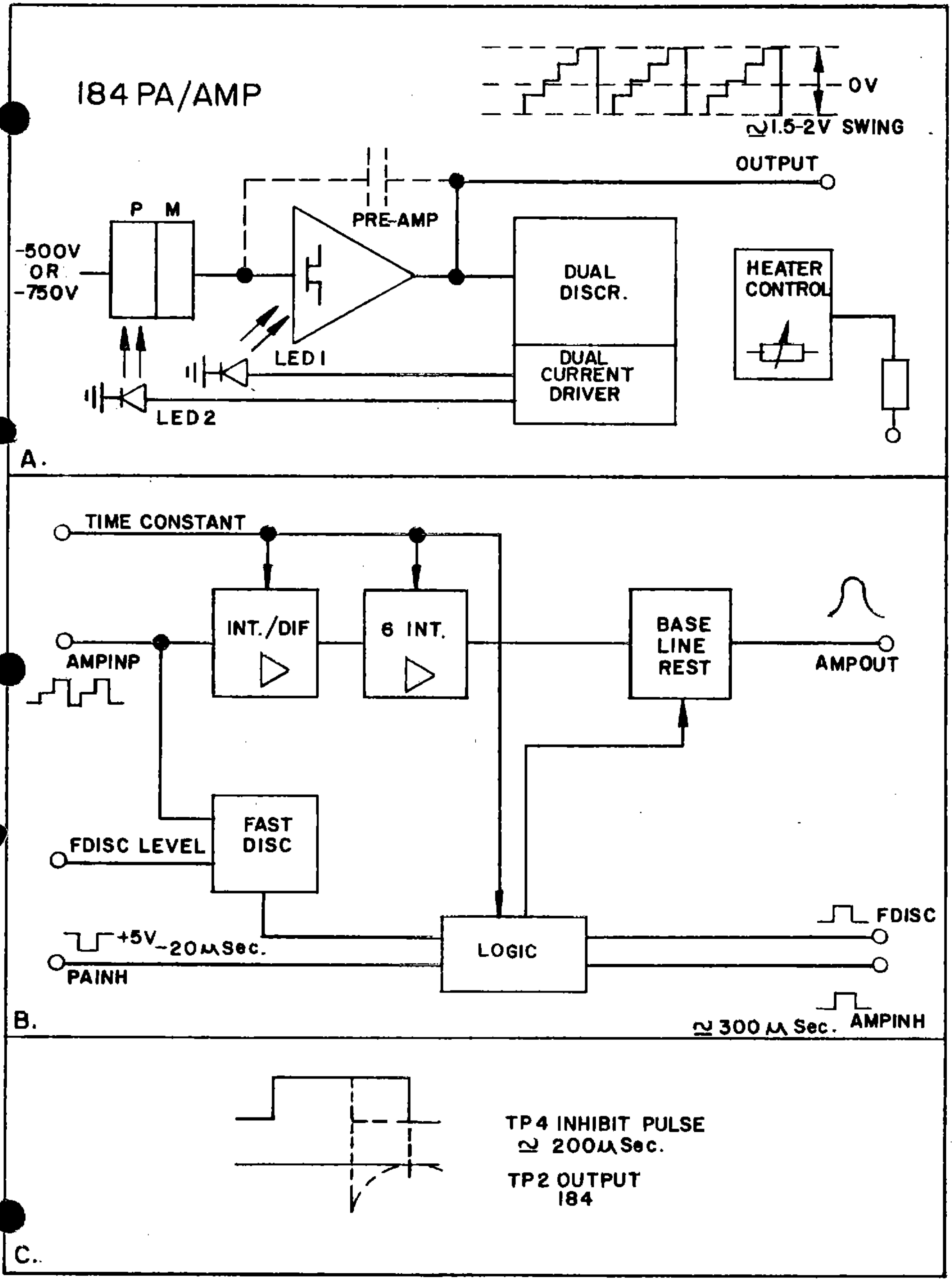
Separation of the baseline restorer and main amplifier is accomplished by a capacitor in the signal path which, when charged, isolates the baseline restorer during the inhibit pulse until the input returns to normal. During inhibit the input is grounded.
The fast discriminator is capable of two switching levels, which, depending on application, provide a time constant of 4 or 8 microseconds to the main amplifier. These in turn will create a one shot time of 40 or 80 microseconds respectively.

## ADJUSTMENT 184 - ADC

| | | |
|---|---|---|
| 184 Preamp: | RV1-Inhibit (200 microseconds) | (CCW) |
| | RV2-Heater Control | (CCW) |
| 184 Amplifier: | | |
| | RV1-Fast Discriminator Level | (CCW) |
| | RV2-Gain (See Note 1 below) | (CCW) |
| | RV3-Inhibit | (CW) |
| | RV4-Set Pulse around Gaussian Shape | (CW) |
| ADC: | RV1-Pulse Pile-up Rejection | |
| | RV2-Zero (See Note 2 below) | |
| | RV3-Low End Smoothing | |
| | RV5-Zero (See Note 2 below) | |
| | RV6-BLM | |

**NOTE 1** The jumper near RV2 provides a wider gain range: jumper on W2 (ST) for lower gain, jumper on W1 (EC) for higher gain.

**NOTE 2** There is no zero adjustment on the 184. The zero value is always 0V ± 10mv. During installation the zero adjustments (RV2/RV5) on the ADC analog PCB are to be used. RV2 = Course adjust, RV5 = Fine adjust. Adjust the gain first, then the zero.


184 PA/AMP
0V
≈1.5-2V SWING
OUTPUT
P
M
PRE-AMP
-500V
OR
-750V
DUAL
DISCR.
HEATER
CONTROL
LED1
DUAL
CURRENT
DRIVER
LED2
A.
TIME CONSTANT
INT./DIF
6 INT.
BASE
LINE
REST
AMPINP
AMPOUT
FAST
DISC
FDISC LEVEL
FDISC
+5V
~20 μSec.
LOGIC
PAINH
B.
≈300 μ Sec.
AMPINH
TP4 INHIBIT PULSE
≈ 200μSec.
TP2 OUTPUT
184
C..

## ADJUSTMENT PROCEDURE 184/ADC ANALOG

In order to achieve the proper alignment and calibration of the 184 and the PV9100 system, it is essential to proceed in a logical manner. It is, therefore, strongly recommended that you follow the steps in order of the following outline:

1. Adjust inhibit pulse.

2. Adjust fast discriminator.

3. Adjust gain of 184 amplifier using a known sample.

4. Calibrate the system using a known sample as described in the PV9100 Service Manual, Calibration Procedure, Chapter 3, Section 5.

5. Perform BLM adjustment.

6. Re-calibrate the system. This is necessary due to the interaction of the BLM adjustment and RV3 on the ADC Analog board with the gain and zero.

The BLM adjustment is critical to overall performance. Setting it as low as possible will both optimize light-element performance and maintain linearity at the low end. For this reason, a 100-130eV setting is recommended.

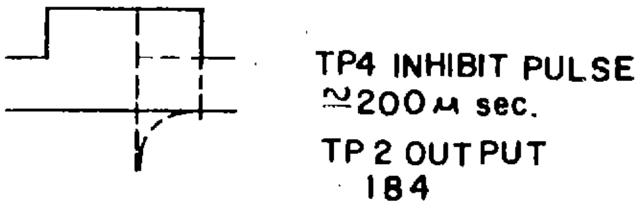
This setting may show a noise peak when analyzing for heavier elements. However, the noise in most cases will be small and acceptable for heavier element analysis. Keep in mind that light-element analysis will be limited by the beryllium window.

## 184 ADJUSTMENT PROCEDURE

Place the 184 amplifier on the extender board in Slot #1.

**INHIBIT ADJ.:** Connect channel one of the oscilloscope to TP2 (AMP out). The output should indicate 0V. If this is not the case, the fast discriminator must be adjusted (see Fast Discriminator Adjustment). Connect channel two of the oscilloscope to TP4 (Inhibit Pulse).

Set the trigger on TP4. TP2 should be a straight line. If TP2 shows a negative pulse, adjust RV3 of the 184 until it disappears (see illustration below). The inhibit pulse (TP4) will now be approximately 200 microseconds.




**FAST DESCR. ADJ.:** Connect channel one of the oscilloscope to TP2. Be sure to ground the probe on C37. The output should be a straight line at the 0V level, showing noise only with X-rays switched OFF.

Set the oscilloscope sweep to 1ms scale.

Set the fast discriminator (RV1 of the 184) with X-rays OFF. The correct setting should be 40-60 cps. If the oscilloscope setting shows negative or positive peaks similar to the illustration below, the fast discriminator level is set too high. The fast discriminator pot (RV1) is connected counter-clockwise on older revision boards, and clockwise for newer revision boards. Turning the pot to the right (left for newer revision boards) increases the fast discriminator cps. If the pot is turned too far, the output will jump to either positive or negative values.


Remove the extender board and return the 184 amplifier to the card cage.

**GAIN ADJ. 184 BOARD:** Using a sample with a known element, adjust RV2 until the peak energies are at the correct energy separation. If the gain is too far out of range, move the jumper that is between RV2 and RV3 on the 184 amplifier board. W1 (EC) allows higher gain, W2 (ST) allows lower gain.

**NOTE:** The ideal sample is zinc. Use the Zn Lalpha and Zn Kalpha peaks (1.012 - 8.63) for adjusting the gain. The correct separation between the peaks should be approximately 7.62 KeV. Zero adjustment (RV2/RV5 on ADC analog board) will position the peaks properly. Zn La = 1.012, Zn Ka = 8.63.

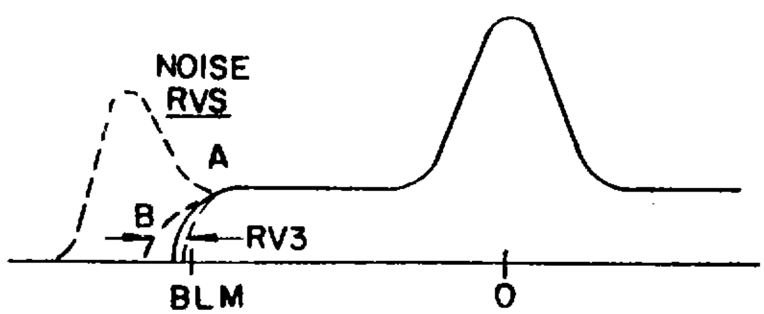
As an alternative, use an aluminum/copper sample, noting the position and separation of their respective Ka peaks. Al Ka = 1.487 KeV, Cu Ka = 8.04.

Adjust zero and perform system calibration.

**BLM ADJ. #1:** Coarse adjustment for the BLM (RV6) is accomplished with X-rays on by lowering the BLM until a noise peak appears, then increasing the BLM until the noise peak just disappears (see illustration below).

Adjust RV6 on the ADC analog board until the BLM is between 100 and 130eV (required for low-end linearity). Adjustment of RV3 will raise or lower the channel at which the BLM noise peak appears (see illustration below). Since RV3 is implemented to compensate for tolerance differences between ADC analog boards, the adjustment may be very noticeable, or hardly noticeable at all. It is suggested that the majority of the BLM adjustment be done with RV6 on the ADC analog board.

Repeat the proceeding adjustments. Turning RV3 or RV6 to the left (CCW) will lower the BLM channels. Turning RV3 or RV6 to the right will raise the BLM channels (see Figure A). Whenever RV3 or RV6 is adjusted, changing the BLM level, the entire system calibration and BLM adjustment procedure must be repeated.



To check the peak shifts at higher count rates, create a spectrum at 1000 cps, then another at 10,000 cps. The peak shift should be less than 10eV. If the peak shift is greater then 10eV, re-check and adjust the fast discriminator as required. As an alternative, and only if the fast discriminator does not correct the peak shift, RV4 may be used.

**NOTE:** RV4 is preset at the factory. Any adjustment of RV4 should be made cautiously and in very small increments.

**BLM ADJ. #2:** To set the BLM to its final value, use a silicon ($SiO_2$) wafer sample. Set the high voltage at 10kV to obtain at least 1000 cps. Adjust the BLM until the noise peak just disappears and the background is straight. Note that the BLM should be set to 110-130eV.

Perform a final system calibration.

To verify the ability to measure boron, measure the peak at 1000 cps using 10kV (see figures C & D).

## 184 PREAMP TEST PROCEDURE

The output of the 184 pre-amp will ramp between -1V and +1V, with a swing of 1.5-2V (Figure 1).

The output of PAINH is low during the reset. Adjust RV1 to get a 20 microsecond pulse.

Pin 1 of A1 is shown in Figure 3.

When LED 1 works, the result will be Figure 4, to be measured on R1.

When the system is switched on, the output of the amplifier is negative. As a result, LED 2 will be at a -1.5V level, until the preamp starts ramping and LED 2 is grounded. Measure this on R7.

Adjust RV2 for optimal noise readings. Measure voltage on R2 (connector side).

## 184 AMPLIFIER - PULSE SHAPER

Use a Fe55 source. It will produce a Mn K alpha peak at 5894 eV.

Adjust RV1 such that the right count rate is shown (with background at approximately 10 C/S). Measure the FDISC signal - pulse width should be 1.5 - 2 microseconds. Short circuit input BM2. Now the FDISC signal is .5 - 1 microsecond. In case of problems, check comparator input U10-2. The pulse is shown in Figure 1-D.

Measure the output of the zero-line restorer at TP2. Check and verify that the DC level is 0V $\pm$10 mV. The result should be as in Figure 1 - A. In case something is wrong, check TP2 (amplifier out). Use a second probe to check U14-10. This pulse should be adjusted with RV4 such that it fits "around" the main Gaussian pulse (Figure 1-C).

Check the input PAINH (Figure 2-A). Check TP4 and TP2 with channels 1 and 2 respectively. Adjust RV3 (inhibit pulse) on TP4 (2-B), such that the output on TP2 (2-C) is a straight line with a little undershoot (solid line). If the pulse on TP4 is too short, the result will be a dotted line.

Note that T1 and T2 are the result of X-ray events and may appear at different times. Check AMPINH at TP5. This pulse is 100 microseconds wider than at TP4.

The short-circuit resistor R5 is switched on during inhibit, plus 560 microseconds, unless pulses show up. Check at U7 if the result is as in Figure 2-J.

Check U2-16. The result is shown in 2-K. As a result of the inhibit transients, a positive pulse will be seen. After 600 microseconds, C6 is added to the circuit, resulting in a higher time constant. The average DC level is 0V.

Again check TP2 and U14-10. The pulse width is approximately 80 microseconds. Now short circuit input AP2. Both pulses should be approximately 40 microseconds. The gain of the amplifier is the same.

Adjust the gain (RV2) such that the output pulse (TP2) is approximately 5.9KeV for Mn K alpha (Fe 55). The amplifier output voltage (TP2) is 590mV. The jumper location at EC or ST allows different adjustment ranges.

Calibrate the system, using a Co57 source.

If the zero is out range, adjust RV2 and RV5 on the ADC analog board.

Check resolution degradation and peak shift at higher count rates
(Reference Service Manual).

# PREAMPLIFIER 184

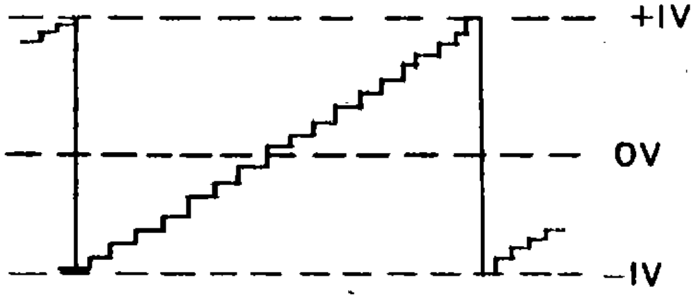



Figure 1 Preamp out

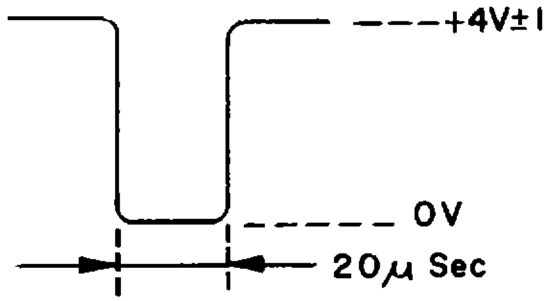



Figure 2 PAINH

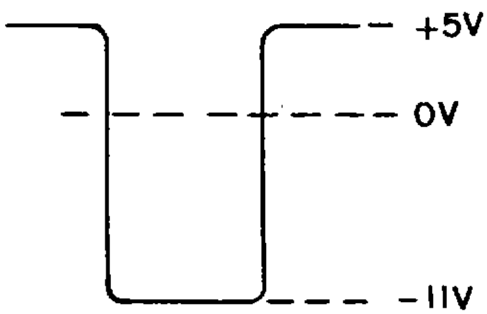



Figure 3 Pin 1 (A1)

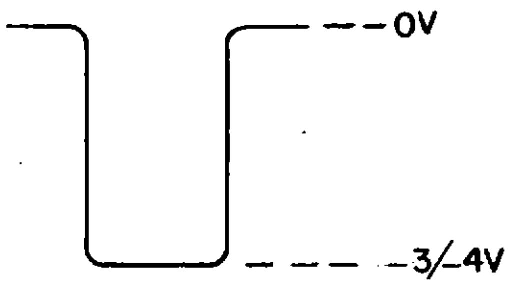
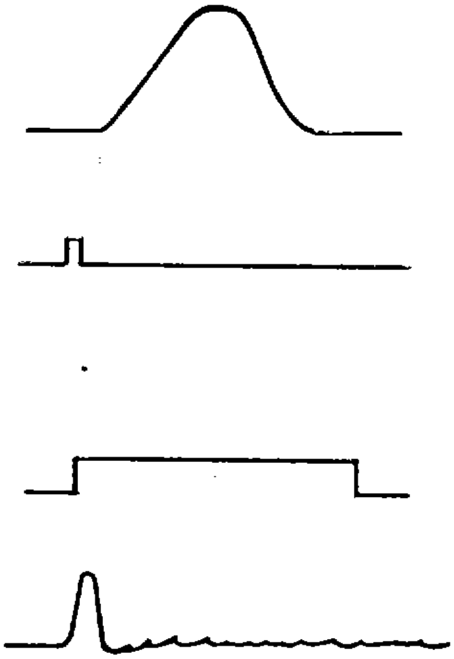



Figure 4 R1/R3/RV1

## 184 AMP PULSE SHAPER

FIGURE I



A. AMPOUT TP2

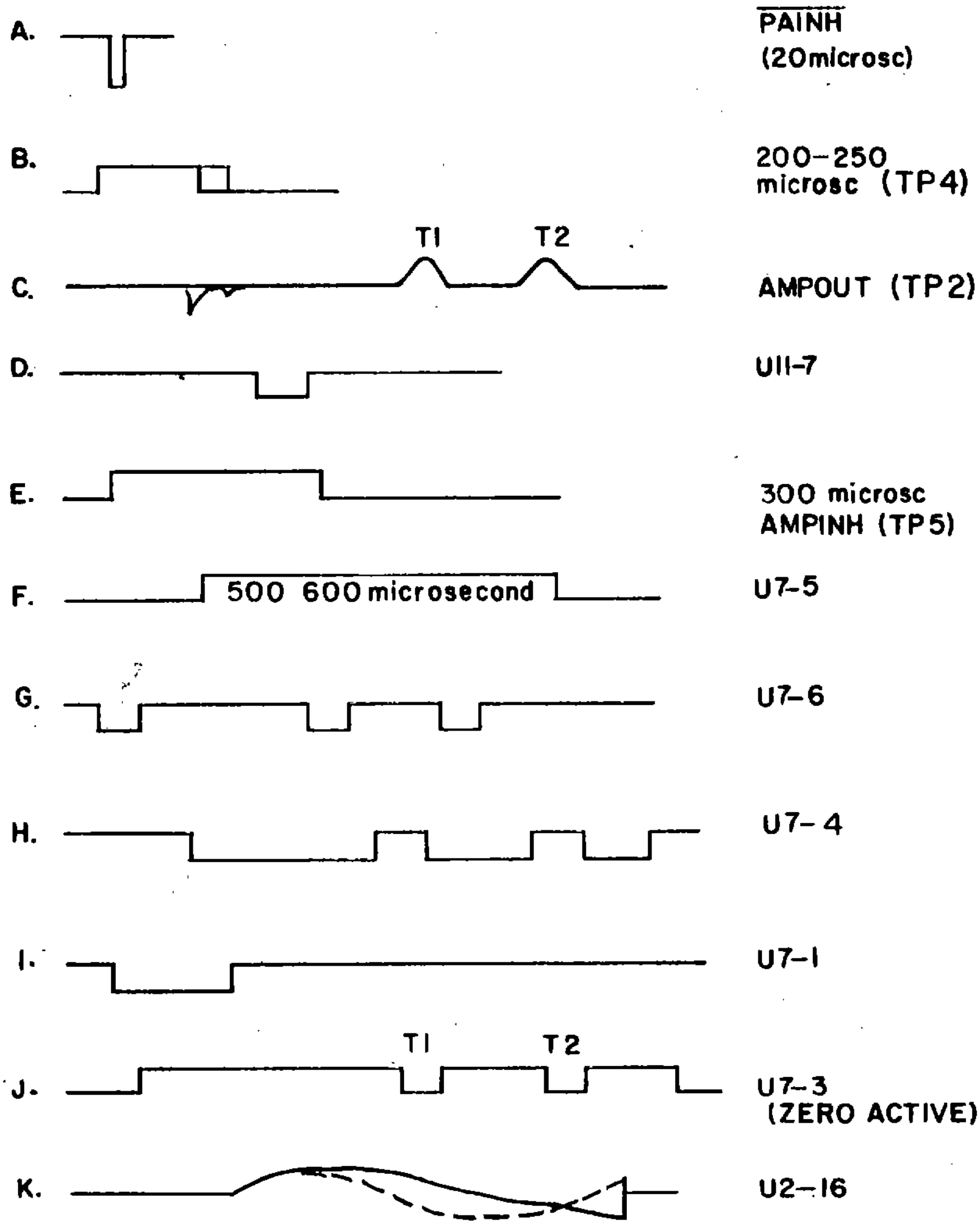
B. UI8-I2 FDISC

C. UI4-IO 40/80 (microsecond pulse)

D. UIO-2 (I or 2 microsc width)

FAST DISCRIMINATOR PULSE

FIGURE 2


A.
PAINH
(20microsc)
B.
200-250
microsc (TP4)
T1
T2
C.
AMPOUT (TP2)
D.
U11-7
E.
300 microsc
AMPINH (TP5)
F.
500 600 microsecond
U7-5
G.
U7-6
H.
U7- 4
I.
U7-1
T1
T2
J.
U7-3
(ZERO ACTIVE)
K.
U2-16

## 184 AMPLIFIER/PREAMPLIFIER TROUBLESHOOTING HINTS

1. BLM Adjustment Problems:

   Verify that the BLM "noise" peak at the left of the BLM cut-off point really is a noise peak. A small amount of noise is normal. If you find that the noise varies with the positioning of the analyzer or the color monitor, or the noise decreases with the monitor turned off, you are not necessarily looking at noise. Instead, you may be observing "interference" caused by RFI or EMI sources, or possibly a poorly grounded cable on the analyzer (see Figure A). Do not be deceived by interference, as it can result in improper BLM adjustment.

2. "Hole in the Spectrum":

   This phenomenon is virtually always observed at the low end, anywhere between the BLM cutoff point, and up to 800-1000eV.

   There are generally two possible causes for this problem:

   a. A hardware problem within the analyzer or on the DU.
   b. A contaminated DU.

   Both types of problems have been observed, and are therefore definite possibilities.

   A hardware problem should be resolved as any other hardware problem, board swapping and test point checking, a general process of elimination. Check memories A and B at both 10eV/ch and 20eV/ch to see if the "hole" is consistent to channel # or eV#. If the "hole" is consistent between 10eV/ch and 20eV/ch, there may be a digital problem with the analyzer.

   To check for a contaminated DU, carry out a low-end analysis using samples that should "normally" be observed in the area that is presently occupied by the "hole".

   While analyzing in this area, connect an oscilloscope to TP1 (AMPOUT) on the 184 amplifier board in slot #1. You should note prominent "Gaussian" waveforms at this point. If you do not, the DU is more than likely contaminated (e.g., oxygen - Ka = 530mV, carbon - Ka = 280mV, iron - La = 710mV, etc.)

   If you do see these prominent Gaussian waveforms, check once again for a hardware problem in the analyzer.

   Also check extensively for proper grounding and shielding, particularly between the analyzer and the DU.

If you have carried out trouble-shooting to the extent that you feel the problem is a contaminated DU, follow the steps below in order to attempt to "revive" the DU.

a. Close the window, then remove the DU.
b. Dump the L/N and warm the DU to room temperature.
c. Re-install the DU on the microscope.
d. Pump down the column to $10^{-6}$ Torr or better, then open the window.
e. Continue the pumping for 24 to 48 hours.
f. Close the window.
g. Cool down the DU with nitrogen gas and then with L/N.
h. Let the DU sit for at least eight hours, or overnight if possible.
i. Power up the analyzer and allow it to come to operating temperature.
j. Perform system calibration with a $SiO_2$ sample.
k. Perform an analysis for several light elements, including boron if the DU is an Econ (see figures A,B,C and D for Econ low-end settings).

If the above eleven steps fail, the DU will need to be returned for repair.

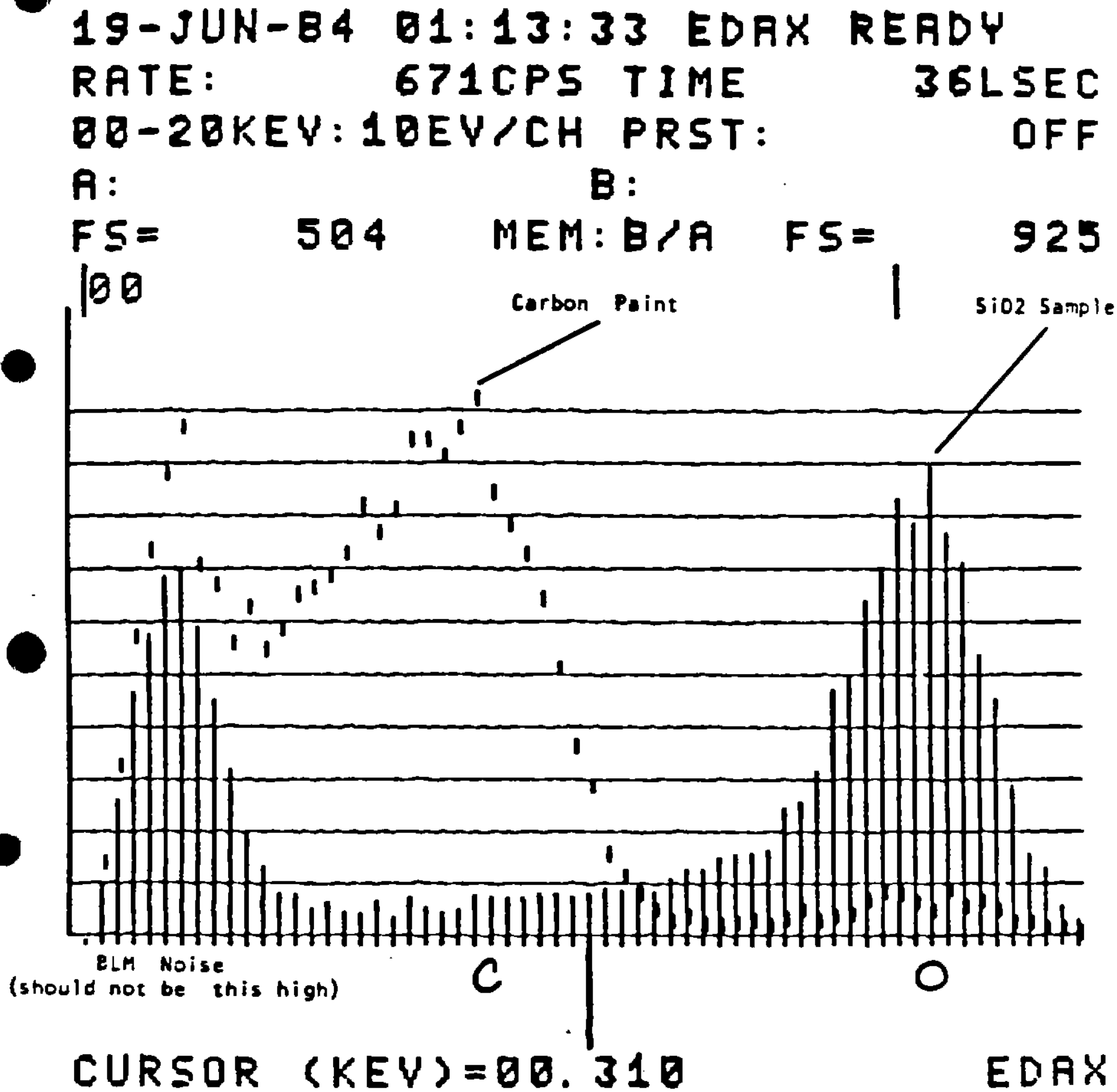
**HIGH RESOLUTION**

In many cases, high resolution can be caused by a "noisy" input. This type of noise (at the input) may not always be detectable due to the varying frequencies of the noise.

One area to check is the fast-discriminator output, while looking for noise-related pulses. If noise pulses are detected here, it may help to raise the fast-discriminator level to between 200 and 300 cps.

If the noise that has been detected seems high, the fast-discriminator setting may need to be closer to 300 cps, while about 200 cps might be adequate for a lower noise level. If this procedure gives a better result, the fast discriminator is picking up interference spikes (high-frequency). Check to see if the interference (fast-discriminator counts with X-rays off) is related to a source close by.

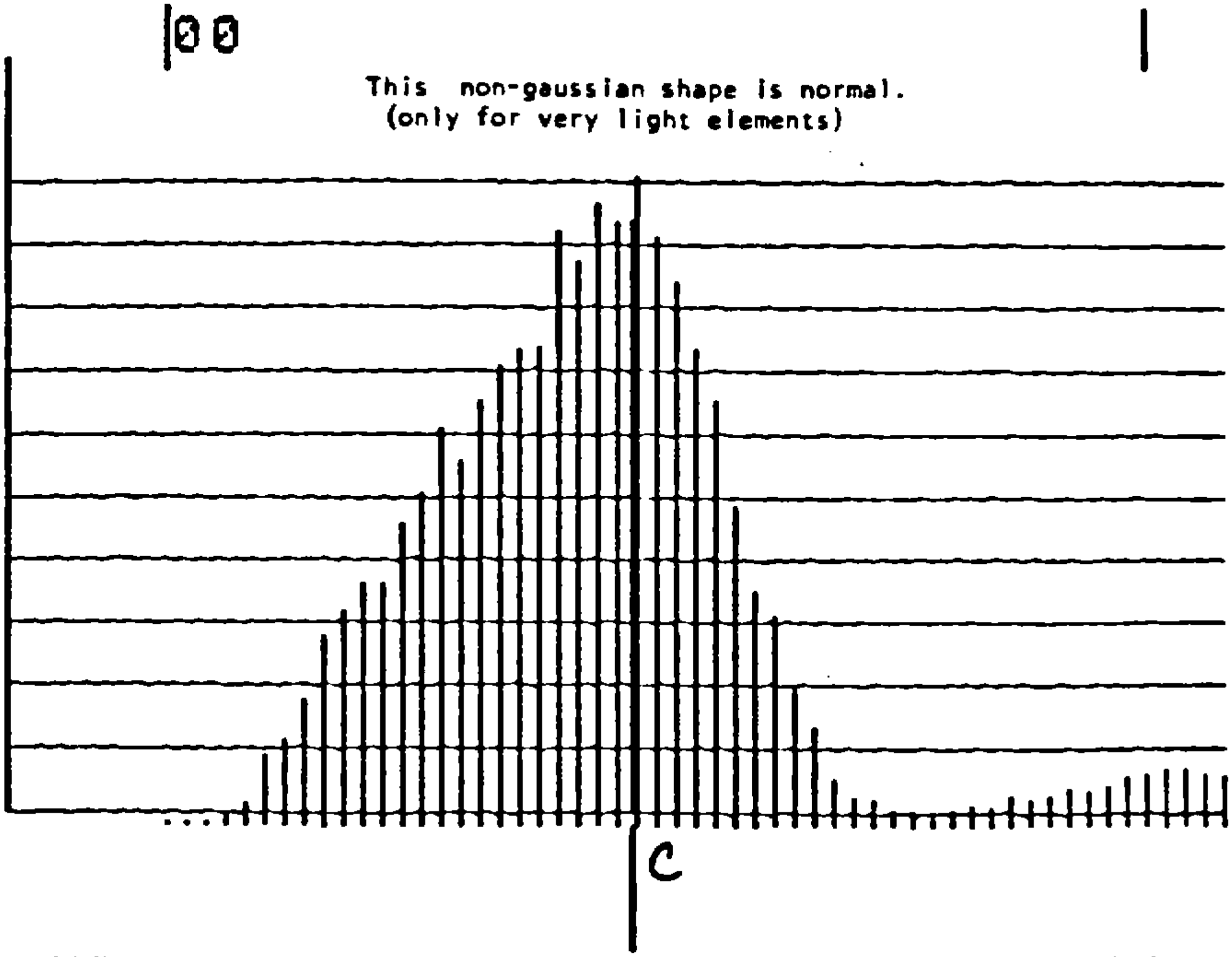
Also, the routing of cabling to and from the DU is important. Keeping the cabling as straight as practical and as far away from **ANY** type of known noise source is mandatory.



19-JUN-84 01:13:33 EDAX READY
RATE: 671CPS TIME 36LSEC
00-20KEV:10EV/CH PRST: OFF
A: B:
FS= 504 MEM:B/A FS= 925
00
Carbon Paint
SiO2 Sample
BLM Noise
(should not be this high)
C
O
CURSOR (KEV)=00.310 EDAX


FIGURE A

19-JUN-84 01:57:26 EDAX STORE
RATE: 79CPS TIME: 86LSEC
00-20KEV:10EV/CH PRST: OFF
A: B:
FS= 525 MEM: A FS= 200




CURSOR (KEV)=00.230 EDAX

FIGURE B

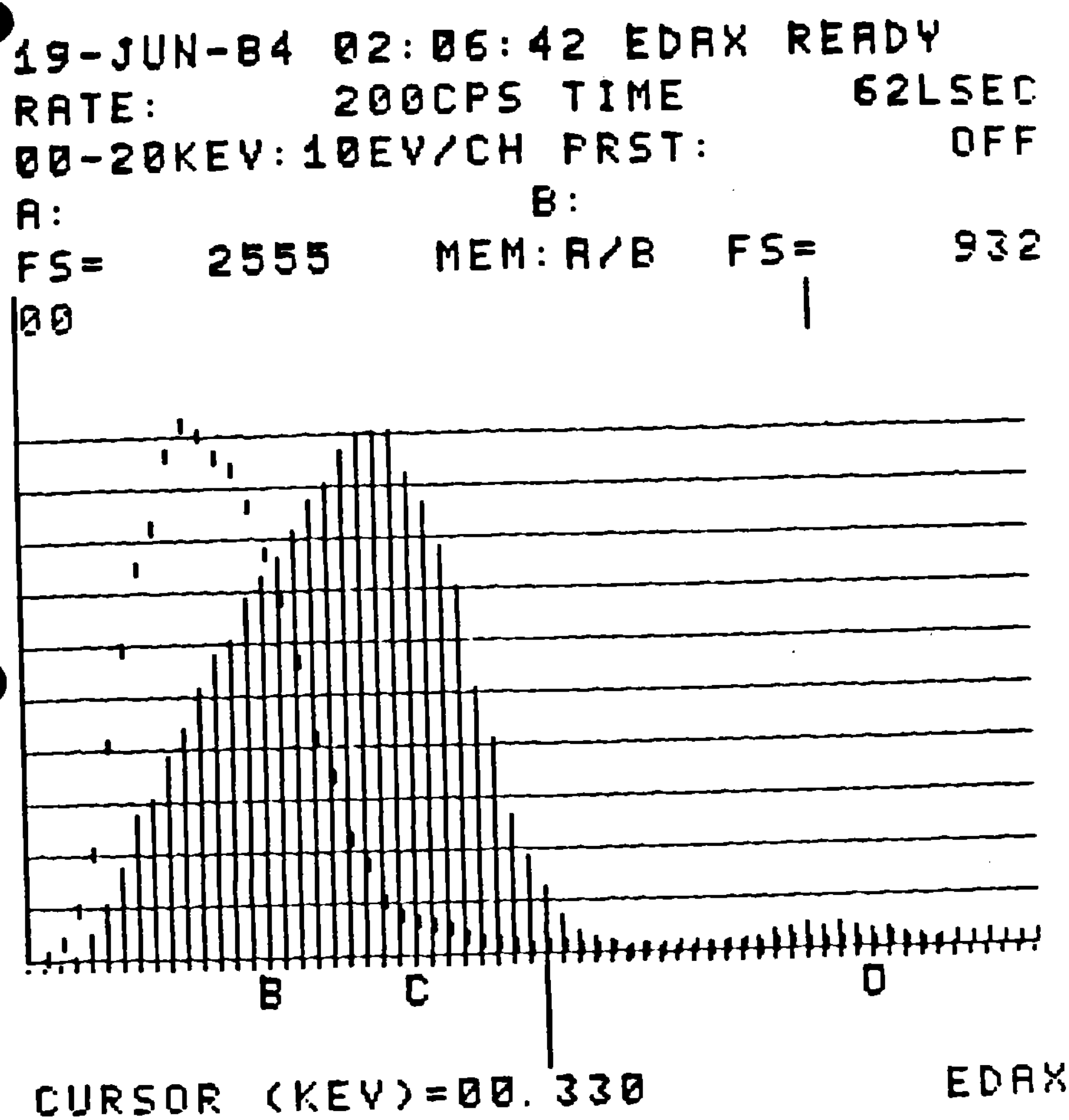
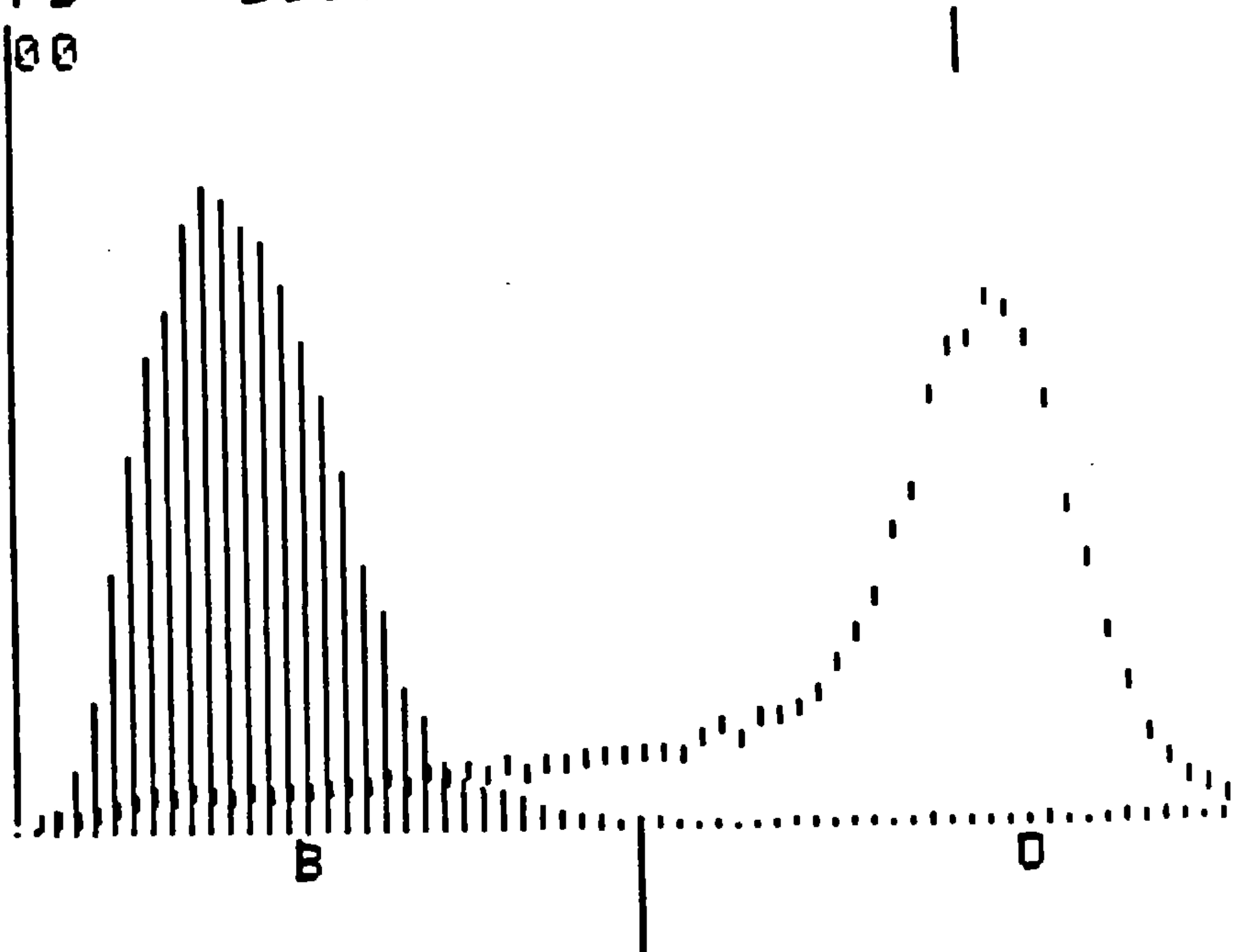

19-JUN-84 02:06:42 EDAX READY
RATE: 200CPS TIME 62LSEC
00-20KEV:10EV/CH PRST: OFF
A: B:
FS= 2555 MEM:A/B FS= 932
00
B C D
CURSOR (KEV)=00.330
EDAX

FIGURE C

19-JUN-84 02:05:02 PEAK IDENT
RATE: 160CPS TIME 73LSEC
00-20KEV:10EV/CH PRST: OFF
A: B:
FS= 2008 MEM:B/A FS= 928




CURSOR (KEV)=00.330 EDAX

FIGURE D

## CONTENTS

All figures, overviews and forms are located at the back in the manual.

# 1. INTRODUCTION

## 1.1 Description of the unit:

The Detecting Unit comprises a solid state Si-detector, a box with a preamplifier/output amplifier and a dewar with liquid nitrogen.

The dewar with liquid nitrogen (LN) is required to cool down the Si-detector and the first stage of the preamplifier. This stage is formed around an FET (Field Effect Transistor). The cooling down is necessary in order to reduce the noise of both the detector and FET.

Detector and FET have been mounted close together and to a flat part at one side of a metal bar. This bar is called the coldfinger.

The bar has been connected to the inner casing of the dewar, which is filled with liquid nitrogen.

The coldfinger with detector, FET and some other parts are enclosed in a metal tube called the (end) cap. This cap is at one side bolted to the outer casing of the dewar. The other side has been closed with a 7.5 $\mu$m thick Be window. Between the sensitive part of the detector and this Be window, is a space of about 3.5 mm.

CAUTION

DO NOT TOUCH THE BE WINDOW!
THE WINDOW IS EXTREMELY FRAGILE!

The space between the inner and outer casing of the dewar and the cap have been pumped to a vacuum of about $2.10^{-6}$ mm Hg, thus providing the necessary heat isolation.

At atmospheric pressure the Be window has to stand almost one atmosphere and will therefore be slightly concave.

The contents of the dewar are either 5 l, 7.5 l, or 10 liters. The 10 liter dewar has a spherical shape.

In Figure 1, a cross-section of the Detecting Unit is shown.

The preamplifier/output amplifier is mounted in a metal box which is fixed to the dewar collar. Characteristic for the amplifier is its time constant. This time constant refers to the total differentiating and integrating time of the active pulse shaping circuits in the amplifier.

The output pulse has a Gaussian shape and the width at the base will be approximately 10 time constants. In general, a smaller time constant allows a higher count rate for the same amount of dead time. However, the resolution will be less as the noise will not be filtered out as effectively.

## 1.2 Dewars

A dewar is a container which has a high degree of heat isolation. The container is built up out of an outer casing and an inner casing. The inner casing of the dewar has been fixed to the top-side of the outer casing via a collar of fiberglass. The space between the two casings has been pumped to a vacuum of about $2.10^{-6}$ mm Hg (Torr).

At the dewar a valve is present for pumping. The valve is normally covered by a black plastic cap. To prevent imploding of the dewar during pumping, an air exhaust nozzle is present. As soon as the vacuum exceeds a certain value, the plastic insert in this nozzle will break. The dewar is protected in this way.

At the top side and around the inner casing, a getter is present. This getter absorbs vapours which would cause deterioration of the vacuum.

The inner casing of the aluminum dewar normally contains liquid nitrogen, which has a temperature of $-195^{\circ}C$ ($78^{\circ}K$).

In spite of all measures, the liquid nitrogen in the dewar will slowly evaporate and the dewar has to be filled up at regular intervals.

ONE SHOULD PREVENT THE DEWAR FROM RUNNING OUT OF LIQUID NITROGEN.

The whole unit would otherwise be warmed up to room temperature. This means that the system has to be cooled down again (noise of detector and FET), and this must be done according to a strict procedure. See Section 4.3.

The following filling schedule must be used:

| Contents of Dewar | Fill-up-after |
|---|---|
| 5 liter | 3 days |
| 7.5 liter | 5 days |
| 10 liter | 7 days |

ATTENTION:

If liquid nitrogen is poured out of a dewar, the liquid nitrogen will start boiling immediately. Nitrogen gas is then formed. The whole appearance looks alarming. There is, however, no immediate danger.

Only in case of longer contact with liquid nitrogen, the skin will be affected.

## 1.3 COLLIMATORS

Over the end of the cap, at the window side, a collimator can be fitted. A collimator reduces the glancing angle to the sample. Scattered radiation from the pole pieces in an electron microscope is thus prevented from reaching the detector.

In EXAM systems the collimator has been mounted in the housing of the sample chamber.

## 1.4 VERSIONS - TYPE NUMBERS

The detecting unit is part of an x-ray analysis system. These systems can be used with electron microscopes (column or EDAX systems) but also as stand alone systems (EXAM systems).

The Detecting Unit in an EDAX system has to be mounted to the column of the electron microscope. The hardware layout of the cap and the positioning of the amplifier box, therefore, depend on the microscope type.

The complete assembly of dewar with cap and amplifier has been mounted on an adjustable support. This support has a scale with indicator and enables an easily retracting and repositioning of the unit once mounted to the column.

There are three versions of EXAM Detecting Units:

The units for EXAM-II systems and EXAM-III systems have a 5 liter dewar. The dewar of the EXAM SIX Detecting Unit and of the latest versions of the EXAM III is spherical and has a contents of 10 liters.

The caps of the three EXAM type Detecting Units are all different.

Figure 2 shows some detecting unit versions.

In general, the Detecting Unit model is indicated as follows:

EDAX - MICROSCOPE TYPE - MAX. RESOLUTION - DEWAR SIZE

As an example:

EDAX - TEM301 - 154 - 7.5, or

EDAX - EXAM - 169 - 5.0.

The ECON Detector:

The normal Detecting Unit has a thin, 7.5 µm Be window which enables still the detection of Fluorine radiation. Lighter elements are almost absorbed completely by the window. However, for these light elements, the ECON detector is available. This detector can only be used with electron microscopes. ECON stands for EDAX Carbon Oxygen Nitrogen detector.

The detector has two windows. One is a 12.5 µm Be window, which permits detection up to NaKα. Behind this window a collodium window is mounted.

Both windows can be flapped aside. This is, however, only possible in vacuum, thus only if the Detecting Unit has been mounted to the evacuated column of an electron microscope.

The collodium window acts as a contamination window and light window, to prevent that dirt or light (due to fluorescence from the specimen) can reach the detector.

In front of the detector, behind the collodium window, a magnetic ring has been fitted. This magnet deflects electrons, which otherwise might reach the detector. Normally these electrons are trapped by the Be window.

Once mounted to the evacuated column the Be window can be flapped aside in case light elements have to be detected. Detecting with the collodium window only is possible up to CK α.

ECON spectrometers are protected against loss of vacuum by providing a microswitch interlock which prevents venting of the microscope when the vacuum seal beryllium window is open. Your EDAX serviceman will see that it is properly interfaced to your microscope.

Amplifier-Versions: 108/303/183/183A

Preamplifier: 108 (obsolete)

This preamplifier works in cooperation with the 303 amplifier. The circuit diagram equals almost the preamplifier of the 183. The circuit is mounted on one P.C. board. It includes the LED (light emitting diode, see Section 1.5) control but not the fast discriminator, which has been mounted on the 3(

The preamplifier 108 and amplifier 303 are obsolete and can be replaced by the 183.

Amplifier: 303 (obsolete)

To be used with 108 preamplifier.

Preamplifier/Amplifier: 183

The first 183 type amplifiers had a fast discriminator with delay line.

It is possible to interchange the 183 by its later version 183A.

Preamplifier/Amplifier: 183A (serial number 105 and upwards)

This is the latest version amplifier.

The specification has been given in Section 2.2

## 1.5 PULSED OPTICAL FEEDBACK LOOP

An xray photon striking the sensitive area of the detector will generate a charge pulse. This pulse is passed onto a charge sensitive preamplifier formed around the FET. The charge is collected on a feedback capacitor. The output of the preamplifier will therefore ramp (increase) in a staircase function with every charge pulse. The height of every step is proportional to the generated charge in the detector and thus to the energy of the xray photon.

To stabilize the working points of the FET and other elements in the preamplifier, a D.C. feedback loop resistor would be required. The configuration is shown in Figure 3, upper diagram.

The resistor should have to have a value of about 1000 Megohm. Resistors of this type, however, cause a number of problems:

* The resistor value appears to be frequency dependent.
* It introduces all kinds of noise.
* Due to its large size, extra capacity is introduced in the circuit.
* Its behaviour at low temperature ($100^{O}K$) is not stable.

To prevent all these problems, an optical feedback loop is used instead of this feedback resistor. Such a loop incorporates an LED, the light of which is falling on the gate-drain junction of the FET. This junction is photo-sensitive. The FET has to be removed from its casing in order to reach the gate-drain junction. The combination of FET and LED behave like a pure high ohmic resistor up to high frequencies (MHz range).

As stated, the output of the preamplifier will be a staircase function. In the output amplifier, every step of the stair is converted into a "Gaussian" shaped pulse. To prevent that the output of the preamplifier charges up too high, the output level must be reset.

Moreover, the noise caused by the current fluctuations in the photo diode at higher count rates and the non-linearity of the voltage versus light characteristic of the LED make it necessary to reset (pulse) the output level.

By pulsing the feedback loop, the average current in the photodiode will be held more equal to the total detector current. Moreover, all working ranges (of LED, FET and other elements) are kept smaller. This improves linearity.

The pulsing of the feedback loop is effected as follows:

The output voltage of the preamplifier is sensed and as soon as an upper limit (-0.1V) is reached, a pulse is applied to the LED.

The LED emits light on the FET junction and the output of the amplifier will jump to -2.1V.

During the reset action, the counting of pulses is inhibited by a logic signal to prevent analyzing of spurious pulses.

The LED is mounted close to the FET but in such a way that the light of the LED by no means can reach the detector.

In Figure 4 the complete block diagram of the amplifier has been shown.

## 1.6 RESOLUTION

It is common use to specify the resolution of the detecting system as the Full Width at Half Maximum (FWHM) of the MnKα peak. The energy of this peak is 5,894 eV.

Thus, a Detecting Unit with a resolution of 169 eV, has for the MnKα peak a width of 169 eV (or less) at a position of half the maximum intensity.

The resolution of the FeKα peak (6400 eV) should be approximately 3 eV more than the specified detector resolution.

In the envelope in the back of the manual, the detector test sheet has been enclosed. The resolution given in the sheet has been measured on the MnKα peak. This peak is generated by a $Fe^{55}$ source and the resolution is determined at an input countrate of 3,000 cps.

The exact determination of the resolution has been described in Section 4.4.

## 2. SPECIFICATIONS

### 2.1 Detecting Unit:

| | |
|---|---|
| Detector type | Silicon, drifted with lithium Si(Li). |
| Detector sensitive area | $10mm^2$. Some special units $30mm^2$ (with a natural decrease in resolution). |
| Resolution | * Specified as F.W.H.M. on MnK α (5.89 KeV) from a $Fe^{55}$ source, at 3,000 cps input count-rate and an amplifier time constant of 8 μsecs.<br>* In general: $F.W.H.M_E^2 = R^2 + 2.735\ (E-5894)$ where R is the resolution on MnK α and E is the energy of the peak in eV.<br>* Resolution degradation at 20,000 cps less than 15eV. |
| Peakshift | Less than 5eV from 1,000 cps to 20,000 cps. |
| Peak/Background Ratio | Measured with a $Fe^{55}$ source. Intensity ratio of peak at 5.89 KeV and 1 KeV will be better than 1,000 to 1. |
| Detector H.V. | -750V or -500V bias to a 100Å Au layer on the sensitive area. |
| Window | Beryllium, 7.5 μm thick. Window for ECON detector is 12.5μm thick (old version) or 7.5 μm (new version). |
| Dewar | Aluminum, inner as well as outer casing have a wall thickness of 1mm. |
| Dewar Sizes | 5 liter, 7.5 liter and 10 liter |
| Liquid Nitrogen Consumption | Between 1 and 2 liters per day, depending on length of end cap. |
| Filling up Schedule | Every 3 days for 5 liter dewar<br>Every 5 days for 7.5 liter dewar<br>Every 7 days for 10 liter dewar |
| Dewar Pumping Valve | 2 threadings, 5/8-18 NF |
| Valve operator | Ordering code - 76-0039191 |

## 2.2 AMPLIFIER (Type 183A):

| | | |
|---|---|---|
| Power requirements | : | +24 V, 60 mA<br>-24 V, 65 mA<br>+12 V, 86 mA<br>-12 V, 42 mA |
| Output | : | Direct coupled +12 V saturated output. 10 V linear into 1 Kohm with 93 ohm output impedance. |
| Polarity : | | |
| Input | : | Positive |
| Output | : | Positive |
| Pulse Shaping | : | Active filtering, Gaussian shaped output pulse. |
| Shaping time constant | : | 1, 2, 4, 6, 8, 10, 16 μsecs.<br>internally adjustable.<br>Standard factory adjusted to 8 μsecs for column units and 4 μsecs for EXAM units. |
| Count rate capability | : | 200,000 cps at 5.9 KeV. |
| Gain stability | : | $\pm$ 0.01%/$^o$ C |
| Base line stability | : | $\pm$ 200 μV/$^o$ C |
| Non-linearity (integral) | : | 0.1% |

# 3. INSTALLATION

A Detecting Unit will normally be installed by an EDAX service engineer. In some instances, however, the users might have to install a Detecting Unit. This will be the case if e.g. the electron microscope has to be serviced, but also in case the unit is returned after repair.

In this section the general installation procedure has been described, assuming that the unit is installed for the first time. This general description may serve as a guideline for non-straight forward installations.

It is of course the responsibility of the user if he decides to do the re-installation.

This chapter, therefore, provides also the data for making the proper decision.

## 3.1 PREPARING THE DETECTING UNIT

The Detecting Unit is shipped dry. However,

THE DETECTING UNIT SHOULD NOT STAY DRY FOR LONGER THAN 30 DAYS!

The Be window is at arrival protected by means of a black plastic cover, which fits over the window and cap. The cover has a hole, which allows air to enter the space inside the cover, when the cover is removed. The cover should always be removed very slowly.

ATTENTION

* HANDLE THE DETECTING UNIT WITH EXTREME CARE!
* SPECIAL ATTENTION MUST BE PAID NOT TO DAMAGE THE BE WINDOW!

Proceed as follows:

* Prepare a table to place the Detecting Unit on after unpacking. The unit can be put on foam. Care must be taken that the unit does not capsize as it has to stand on the support for a while.
* Unpack the unit. Save the box and packing material. It might be useful in case of an unexpected repair.
* Position the unit on the table.
* Dry the inside of the dewar out. This can be done by blowing a dry gas (air, argon) via a plastic hose in the dewar. Use only a slight overpressure. Dry for 15 minutes. All moisture will then be removed from the dewar.

* Fill the dewar with clean liquid nitrogen. Clean LN is transparent. The LN will start boiling and the styrofoam filling cap should not be inserted until the gas forming has ceased a little.

CAUTION

THE UNIT MAY NOT BE CONNECTED TO THE SUPPLY FOR THE FIRST TEN HOURS.

* During the cooling down of the detecting unit, much more L.N. is used than after the detecting unit has been cooled down. The dewar should, therefore, be topped off at this stage after 1 day.

## 3.2 PREADJUSTMENT CALIBRATION

Some work is involved in mounting a detecting unit, especially in case the unit has to be mounted to the column of certain electron microscope types.

Also, the mounting of the detecting unit for an EXAM II system is rather comprehensive.

It is, therefore, advantageous to check the operation of the unit before mounting. This can easily be performed with aid of a radioactive source.

Radiation safety regulations in many countries do not allow importation or dispatch of radiation sources without special allowance of the authorities involved. A list with licensing officials in the U.S. and a list with some addresses of the following companies has been given at the back of the manual.

Sources can be ordered from:

AMERSHAM - SEARLE

or from

NEW ENGLAND NUCLEAR

These companies sell radiation sources world-wide.

Usable sources are $Co^{57}$ and $Fe^{55}$. A rough specification of these sources is as follows:

| | | | |
|---|---|---|---|
| $Co^{57}$ | activity | : | 10 $\mu$Ci |
| | half time | : | 260 days |
| | radiation | : | $FeK\alpha$, $FeK\beta$ and $\gamma$ rays |
| $Fe^{55}$ | activity | : | 50 $\mu$Ci |
| | half time | : | 2.7 years |
| | radiation | : | mainly $MnK\alpha$ |

The sources are usually delivered on a paper disc. Suitable diameter: 20mm.

If no source is available, the detecting unit should be checked out after mounting. See below, Section 3.4.

This procedure has to be performed also as final test.

In the following it is assumed that the $Co^{57}$ source is available. The fast discriminator (F. DISC) setting on the amplifier is first adjusted. This is performed without x-rays. After that the base line monitor (BLM) setting on the rear panel of the analyzer is adjusted and finally the system is calibrated using the GAIN and ZERO potentiometers on the amplifier (coarse setting) and on the front panel of the analyzer (fine setting).

Check-out procedure

* Ensure that the detecting unit has cooled down for at least 10 hours, if the dewar has been empty and was filled again with liquid nitrogen.

  THE DETECTING UNIT IS SWITCHED OFF AT THIS POINT.

* The $Co^{57}$ source has not yet been fixed over the window.

* Connect the D.C. supply/signal cable between the socket on the rear panel of the analyzer and the socket on the amplifier box. The socket on the analyzer has been indicated with "183 AMPLIFIER".

* Connect the H.V. cable between the power supply and the H.V. filter on the detecting unit.

* Switch on the power supply. Check immediately all voltages by means of the selector and indicator. All voltages should read in the green field. Switch off immediately if this is not the case.

  NOTE: The H.V. supply has a separate small on/off switch next to the socket on the front panel of the power supply. Ensure that this switch is in the on-position.

* Select on the front panel of the analyzer, MEMA and energy range 0 - 8 KeV.

* No preset condition should be selected. The vertical expand switch should be in minimum position.

* Depress pushbutton ANALYZE. The X in EDAX in the righthand lower corner of the video monitor will start flashing. Noise will be stored in the analyzer and thus will be displayed on the video monitor.

  If no noise is stored, tap with the fingers to the dewar, in order to introduce noise.

  Mostly a high noise peak will be seen at the lower energy side of the spectrum. This is caused by microphonics in the dewar due to filling up or due to manipulating of the dewar. This noise will settle down.

* Wait for half an hour, to enable the detecting circuitry to stabilize.

* Depress pushbutton COUNTRATE. The total incoming countrate is now displayed. The number shown should be around 20 cps (10 - 40 is normal).

  This countrate might, at this point, be very high or completely zero.

  As no x-rays are present, this countrate is only present due to the setting of the fast discriminator.

  If the countrate is high, this circuitry is oscillating and if the countrate is below 10 cps, the setting is not sensitive enough. In both cases the pulse pile-up rejection system in the analyzer is not working properly.

  Adjust, the incoming countrate to around 20 cps by means of the potentiometer F. DISC on the amplifier.

  CAUTION

  Use a screwdriver which is small enough so that the potentiometer is not damaged.

* Fix the $Co^{57}$ source over the window using adhesive tape.

  BE CAREFUL! DO NOT TOUCH THE WINDOW.

* Select a convenient vertical scale position. Select energy range 0 - 20 KeV. Depress DISPLAY, CLEAR and ANALYZE respectively.

* The spectrum from the source will show up on the video monitor.

  Check that the FeK$\alpha$, FeK$\beta$ and $\gamma$ peaks are present. Check also for "strange" peaks. See Section 6.5.

* Select HORIZONTAL EXPAND X4. Shift the spectrum by means of the lever switch so that the energy range from 0 to 1 KeV covers the screen.

  Check that no data is stored below 400eV.

  This can be adjusted by means of the base line monitor (BLM) potentiometer on the rear panel of the analyzer. (Righthand lower side.)

CALIBRATION

The system has been calibrated in the factory before shipment. The pre-adjustment procedure with the $Co^{57}$ source which is described below, serves, therefore, as a test.

The lines which are generated by the source are the FeK$\alpha$ (6.4 KeV), FeK$\beta$ (7.05 KeV) and the $\gamma$ (14.4 KeV) rays.

* Because the equipment has been calibrated in the factory, it should be possible to calibrate exactly using only the G(AIN) and Z(ERO) potentiometers on the front panel of the analyzer, which are fine controls.

In the description, however, the complete calibration procedure has been described.

* Switch the system off, by means of the main switch on the power supply unit.

* Wait for three minutes.

* Connect the H.V. cable from the detecting unit to the power supply unit and the signal cable from the detecting unit to the analyzer.

* At this stage, the radiation source is not yet attached over the detector window.

* Switch on and wait for half an hour in order to enable the system to stabilize.

* By means of the GAIN potentiometer on the detector amplifier (type 183) the distance between two peaks can be adjusted. The ZERO potentiometer on the amplifier enables matching of the analyzed spectrum to the energy scale.

The calibration procedure is performed according to the following outline:

In MEMB of the analyzer the FeK$\alpha$ peak is stored. The energy of this peak is 6.4 KeV and the energy range selected for this measurement is 0 - 8 KeV.

The $\gamma$-ray peak is at 14.4 KeV, which is exactly 8 KeV more than the FeK $\alpha$ energy.

The analyzer is now used in the compare mode. The $\gamma$ray peak will be stored in MEMA. The energy range selected is now 8 - 16 KeV. In the compare mode, the contents of MEMB appears as a dot histogram on the screen, while the peak in MEMA appears as a bar histogram.

By means of the GAIN potentiometer on the amplifier for coarse control and later on the G(AIN) potentiometer on the analyzer (for fine control) the distance between the peaks can be adjusted to 8 KeV. This means that the two peaks (one bar, one dot) on the screen will coincide. The two peaks may now not match the energy scale. This matching to the scale is done with the ZERO potentiometers on the amplifier, for coarse adjustment and on THE control panel of the analyzer for fine adjustment.

It must be noticed that after every new setting of a potentiometer, in sequence, the push-buttons DISPLAY, CLEAR and ANALYZE should be depressed as otherwise, the differences due to adjustments cannot be observed.

Proceed as follows:

* Select the 0 - 8 KeV range. Select MEMB. Depress DISPLAY pushbutton and then the CLEAR pushbutton.

* Depress ANALYZE pushbutton. Observe the 6.4 KeV (FeKα) and the 7.05 KeV (FeKβ) peaks on the display.

  They might be off scale at this stage.

  Wait until the Kα peak has accumulated about 1,000 cps in its highest channel. Adjust the VERTICAL RANGE selector in order to observe the peak completely.

* Select MEMA. Then depress the DISPLAY and CLEAR pushbuttons, in order to clear this memory.

* Select energy range 8 - 16 KeV.

* Depress sequentially COMPARE A/B and ANALYZEpushbuttons.

* The stored information in MEMB now shows as a dot histogram while the γ peak appears as a bar histogram.

* If the bar histogram is below the dot peak (lower energy location), increase the GAIN of the amplifier by turning the potentiometer clockwise. In case the peaks are already close together, use the fine control G(AIN) potentiometer on the control panel of the analyzer.

* If the bar histogram is above the dot peak (higher energy location) the GAIN of the amplifier should be decreased by turning the potentiometer counter clockwise.

If the two peaks coincide, matching to the energy scale must be performed. This is effected by the ZERO potentiometers on amplifier and analyzer.

Proceed as follows:

* Select the 0 - 8 KeV energy range and depress the MEMB, DISPLAY and CLEAR pushbutton.

* Select window 1 and adjust the centroid to 6.4 KeV.

* Depress pushbutton ANALYZE and note where the FeKα peak (6.4 KeV) is located.

* Adjust the ZERO and/or the Z(ERO) potentiometers to get the peak exactly at 6.4 KeV. There is a bigger influence of the ZERO potentiometer on the amplifier.

  Check the position of the γ-ray peak (14.4 KeV). If this peak is off, readjust the GAIN and ZERO controls again until the calibration is sufficiently exact.

  The GAIN and ZERO adjustments interact with each other.

## 3.3 MOUNTING INSTRUCTIONS

After the unit has been checked out as intensively as possible and after the fast discriminator (F. DISC) and baseline monitor (BLM) have been set, the mounting can be started.

There are four general types of mounting procedures:

* Mounting of detecting unit to the column of an electron microscope.
* Mounting of an ECON detector.
* Mounting of the detecting unit of an EXAM II system.
* Mounting of the detecting unit of an EXAM III system.

The following descriptions are rather general, but give sufficient information for any particular case. The disassembling procedure follows logically from the mounting procedure or vise versa. Special situations have been indicated.

* <u>Mounting of a detecting unit to the column of an electron microscope.</u>

  The standard detecting units for column systems have a support, with which the unit is mounted to the column of the electron microscope. The detecting unit is retractable via this support.

  By means of a long lead screw the assembly of dewar with end cap and amplifier can be moved along the support. This enables adjustment of the detector position with respect to the specimen.

  The support has a scale. In case the surface center of the detector coincides with the length axis of the microscope, the scale indicator is at zero.

  The end cap is electrically isolated from the column of the microscope. This is necessary to prevent ground loops. See Section 6.5

  In the following a general mounting procedure has been given.

  * Switch off the electron microscope. Also switch off the analyzer.
  * Wait for 10 minutes to allow the filament of the microscope to cool down.
  * Admit air to the column. See the user's manual of the electron microscope for the correct procedure.

* In case of a TEM take out the aperture(s) from the specimen stage.

* Open the column in order to obtain access to the specimen stage. See user's manual of electron microscope.

* Retract the detecting unit on its support as far as possible and position the collimator.

* Slide the vacuum sealing part over the end cap and/or insert into the entry of the electron microscope. Mostly a teflon bush with O-rings is used for this purpose.

* Adjust the detector end cap by means of the support mechanism in such a way that the detector is as close as possible to the specimen. Check for collisions with apertures, coldfingers, etc. by observing the movement of the cap and stage through an adjacent port.

* Slide the collimator over the end of the cap.

* Remount the column (in case of a TEM).

* Evacuate the column.

* Mounting of an ECON detector.

The ECON detector cannot be used with every electron microscope. This is because the diameter of the end cap is larger, (approximately 4.5 cm) than for standard detecting units. This requires a sufficiently wide entry in the column of the microscope.

In principal, the ECON detector is mounted to the electron microscope in the same way as described for a standard detecting unit, the only difference is that the interlock of the window opening mechanism has to be wired into the circuitry of the vacuum system. This has to be done in such a way that the microscope cannot be vented in case the detector window is open.

The connection to the vacuum system and the checkout of the unit should be performed by an EDAX service engineer.

* Mounting of a detecting unit of an EXAM II system.

The first installation is normally performed by an EDAX service engineer.

In the following the disassembly procedure has been described. All other mounting follows logically.

In order to be able to take the detecting unit out of the cabinet, the top cover of the cabinet has to be removed.

* Switch off the complete system.

* Wait for 5 minutes.

* Remove the front panel of the EXAM cabinet (four screws).

* Remove the printed circuit board holder behind this front panel (2 screws). Ensure that all cables are disconnected.

* Unscrew the four bolts with which the cabinet has been fixed to the plate on top of the console.

* Disconnect the two pole cable from the interlock behind the rear panel.

* Lift the cabinet about 10 cm and turn it counter clockwise (seen from rear panel) over almost $90^o$, so that it can be removed without jamming the dewar.

* The detecting unit has been fixed to the sample chamber by means of a clamping plate. This plate is fixed to the chamber by one bolt. Loosen this bolt.

* Slide the unit a little backwards. Turn the leveling screws in the dewar so that they are free from the bottom. The dewar should be supported by hand.

* By pulling the dewar carefully backwards and meanwhile, loosening the bolt more and more, the detecting unit can be removed.

In mounting the dewar, two points should be kept in mind.

* In order to see if the window lines up correctly, the metal hood with the warning sign should be removed (4 Allen screws). The window can then be seen and easily positioned.

* The unit should be fixed tight but not too much, by means of the clamping plate. A plastic sleeve has been fitted around the end cap. If the plate is tightened too much, the cap may make contact with the chamber. Ground loops causing distortion may be the result.

  Check with an ohm meter if the unit is isolated.

* <u>Mounting of the detecting unit of an EXAM III system.</u>

It is assumed that the unit has been prepared as described in Section 3.1.

The mounting procedure is simple.

The end cap of the detecting unit should be inserted into the lefthand top entry of the analyzing chamber (seen from the front side). The mounting ring on the end cap is fixed to the chamber by means of four Allen screws.

Between this ring and the housing a teflon isolating plate should be present. Moreover, the four screws are isolated by teflon inserts.

After mounting, check with an ohm meter if the unit is isolated from the analyzing chamber.

## 3.4 FINAL ADJUSTMENTS - CALIBRATION

Once the detecting unit has been mounted, the fast discriminator (F. DISC) and base line monitor (BLM) settings should be checked.

The system should also be recalibrated.

Finally, a resolution check should be performed. The resolution, measured on $FeK\alpha$ from a radiation source will be about 3eV less than the resolution measured after the unit has been mounted to the column of an electron microscope or to the sample chamber of an EXAM system. See Section 4.4 for the resolution check.

Even if the unit has been checked out, adjusted and calibrated with aid of a radiation source, final adjustments should be performed.

In the procedure described below it is assumed that no pre-adjustments have been carried out. This might be the case if no radiation source is present.

* FAST DISCRIMINATOR

    * The electron microscope or EXAM system is switched off.

    * Switch on the analyzer.

    * Wait for one hour.

    * Depress in sequence DISPLAY, CLEAR and ANALYZE pushbuttons. Select window zero (RESET WINDOW).

    * Depress pushbutton COUNTRATE. In the righthand upper corner of the video monitor the total incoming countrate is displayed.

    * Adjust the fast discriminator (F. DISC) potentiometer on the amplifier until approximately 20 c.p.s. are displayed.

CAUTION

Use a small screwdriver and thus prevent damaging of the small potentiometer.

* BASE LINE MONITOR

The base line monitor should be adjusted to suppress the pulses with energies between 0 and 400eV. This setting is performed for standard detecting units. In case of an ECON detector, which is used to detect also very light elements, the BLM cutoff should be at approximately 180eV.

* Depress pushbutton ANALYZE and select energy range 0 - 8 KeV.

* Expand this range by setting selector HORIZONTAL EXPAND to position X4.

* Tap with the fingers to the dewar. Noise pulses will be stored and displayed in the low energy range.

* Adjust the BLM potentiometer on the rear panel of the analyzer so that no pulses are stored in the range from 0 to 400eV (standard units) or 0 to 200eV (ECON detecting units).

* CALIBRATION

In general, if the calibration is performed on two elements which are wide apart in energy, the adjustments will be more accurate.

A sample containing Al and Mo is suitable. Energy of AlK$\alpha$ is 1.486 KeV and of MoK$\alpha$ is 17.441 KeV.

Also a pure Cu sample can be used. The system can then be calibrated on the CuK$\alpha$ (8.040 KeV) and CuL$\alpha$ (0.930 KeV) lines. These energy ranges are still reasonably apart.

A disadvantage is that the intensity of the CuL$\alpha$ line is low, which gives some difficulty in the exact determination of the peak position.

If the calibration is checked, use always the same standard.

In case routine measurements are performed, it might be worthwhile to calibrate the system on a standard which is similar to the unknown samples.

The calibration procedure is the same as described in Section 3.2.

# 4. OPERATION

## 4.1 Switching On/Off

The detector high voltage is supplied from the 407 power supply. The D.C. voltages for the detecting unit (mainly for the amplifier) are also supplied by the power supply but the wiring is via the analyzer.

The detector H.V. can be switched on and off separately by the switch next to the BNC connector for the H.V. cable on the power supply.

The amplifier and additional circuitry in the end cap cannot be switched on or off separately. They are switched on and off by the main switch on the power supply.

CAUTION

NEVER connect or disconnect any cable in case the EQUIPMENT is switched on.

ALSO

Wait for 10 minutes after switching off before connecting or disconnecting any CABLE.

In view of stability it is recommended to leave the equipment switched on permanently.

In case the equipment has been switched off for a longer period (more than an hour) it will be unstable after switching on for the first hour.

## 4.2 FILLING-UP PROCEDURE OF THE DEWAR

IT MUST BE PREVENTED THAT THE DEWAR RUNS OUT OF LIQUID NITROGEN.

If the dewar runs out of liquid nitrogen, it has to be cooled down again, according to a special procedure (section 4.3). Besides that, all components inside the dewar are subject to unnecessary mechanical stresses due to contraction of several parts. Also, there is a risk that water gets into the dewar, which would cause (later on) degradation of resolution due to microphonics.

The filling-up schedule is as follows:

| DEWAR SIZE | FILL UP AFTER |
|---|---|
| 5 liter | 3 days |
| 7.5 liter | 5 days |
| 10 liter | 7 days |

To fill-up, proceed as follows:

* Remove the styrofoam filling cap.

* Top off with clean (transparent) liquid nitrogen. Use a funnel with a sieve, if it can be expected that ice crystals or other particles are present in the buffer dewar.

NOTE: The unit does not need to be switched off during filling up.

Directly after filling, noise will be stored in the lower end of the spectrum due to the boiling liquid nitrogen. Therefore, wait one hour before starting an analysis.

## 4.3 RE-FILLING PROCEDURE OF THE DEWAR

In case the dewar accidentally runs out of liquid nitrogen, proceed as follows:

* SWITCH OFF THE SYSTEM

  The FET and/or the detector will be destroyed if the unit is cooled down while the voltage is still applied.

* Wait for 10 minutes. Disconnect the H.V. cable and discharge the H.V. at the H.V. box by connecting the center pin of the BNC connector to the frame.

* Dry the dewar by flushing a dry gas (air, Nitrogen, argon) via a plastic hose in the dewar for 5 minutes. All moisture will then be removed.

* Fill the unit immediately with clean (transparent) liquid nitrogen. The liquid nitrogen will boil violently for 10 minutes. This is normal. Leave the styrofoam lid off.

* After the boiling has ceased, fill the dewar completely and replace the lid.

* WAIT FOR 10 HOURS BEFORE SWITCHING ON AGAIN.

## 4.4 RESOLUTION CHECK

The resolution should be checked periodically, e.g. every two weeks. A stable reference sample, or the $Co^{57}$ source should be used. Ensure that a reference sample is always measured under the same conditions.

The result of every check should be noted in the record sheets. See Section 7.3.

In case the resolution is checked on FeK$\alpha$ (from the $Co^{57}$ source), its value will be e.g. approximately 3eV more than the specified resolution of MnK$\alpha$.

In the following procedure it is assumed that the resolution on FeK$\alpha$ is determined.

Proceed as follows:

* Ensure that the system has been switched on for at least 12 hours without interruption.

* Check the calibration. Adjust zero and gain if necessary. See Section 3.5.

* Depress pushbutton DISPLAY on the analyzer. Select PRESET PEAK HEIGHT and adjust with the two selectors 1 x $10^4$.

* Select window 1. Adjust the centroid in that window to 6400eV.

* Depress CLEAR and ANALYZE. Check that the FeK$\alpha$ peak is stored symmetrically around the centroid. The lefthand and righthand channel next to the centroid should increase equally and contain approximately the same value. If this is the case depress DISPLAY.

* Adjust the window width to one channel, which coincides with the centroid.

* Select PRESET PEAK HEIGHT.

* Depress CLEAR and then ANALYZE. As soon as 10,000 counts have been stored in the centroid channel, the analyzer will automatically go to the readout mode.

* Depress DISPLAY. Expand the peak with the horizontal expand selector.

* Determine the F.W.H.M. as is indicated in figure 5.

# 5. MAINTENANCE

## 5.1 CLEANING THE Be WINDOW

Oil vapors in an electron microscope might result in an oil film covering the Be window of the detecting unit.

In EXAM systems, e.g. used for cement analysis, (cement) dust might settle down on the window.

In both cases a loss in intensity will be the result. The intensity decrease will be relatively more for the lighter elements than for the heavier elements due to the difference in absorption of the dirt film for the different elements.

Dirt, like cement dust, can be removed by pouring out methyl alcholol over the end cap close to the end and in such a way that the liquid flushes over the window.

To remove oil or other viscous substance from the window, which cannot successfully be removed by flushing with methyl alcohol, proceed as follows:

* Switch off the equipment by means of the on/off switch on the power supply, type 407.
* Remove the detecting unit.
* Clean the window by using Q-tips and methyl alcohol.

  Dip the Q-tip in the methyl alcohol and wipe the window, very carefully and with very little pressure.

## 5.2 MICROPHONICS

Microphonics is the phenomena of noise introduction caused by mechanical vibrations.

These vibrations can be initiated by:

* Sound, directly transmitted to the dewar.
* Mechanical vibrations, transported to the detecting unit via connecting parts.
* Ice crystals or other particles in the dewar.
* A rough inner wall of the dewar.

The noise will show up for the major part in the lower energy end of the spectrum. Besides that the resolution will be affected.

If problems are caused by sound and/or mechanical vibrations the best solution is to move the equipment to a place where these sources are not present.

It is not likely that sound or mechanical vibrations occur at a column detecting unit, as the environmental requirements for the microscope prevent this.

* Ice crystals or other particles in the dewar

  As the liquid nitrogen is always in a light movement, ice crystals (or other particles) in the liquid nitrogen will move along the dewar wall. This results in noise introduction. The ice crystals can sometimes be seen in the liquid nitrogen.

  Ice crystals get into the liquid nitrogen due to careless filling up procedures. Any moisture in a dewar will immediately turn into ice crystals. Always keep the dewar closed with the fill cap to prevent ice being formed in the dewar neck. Special care should be exercised to prevent that ice crystals in the buffer dewar are poured out into the dewar of the detecting unit.

  To prevent this, fill the dewar using a funnel and filter paper in case the buffer dewar is suspected.

  To remove ice crystals and/or other particles proceed as follows:

  * Switch off the instrument.
  * Wait for 10 minutes and discharge the H.V. by connecting the center pin of BNC connector on the H.V. box to the frame.
  * Pour out the liquid nitrogen or let the liquid nitrogen evaporate.
  * Foreign particles can be removed with a vacuum cleaner.
  * Dry the dewar out. This can be done by blowing dry air or a dry gas like argon - via a plastic hose and with some overpressure into the dewar for 5 minutes.
  * Fill the dewar with clean (transparent) liquid nitrogen. Leave the styrofoam filling cap off for 10 minutes as the liquid nitrogen will boil violently in the beginning.
  * After that fill up and close the dewar with the cap.
  * Wait for 10 hours before switching on again.

Rough inner wall of dewar

Liquid nitrogen tends to boil at sharp edges. In case the inner wall of the dewar is corroded, the boiling and moving of the liquid nitrogen will cause microphonics.

Corrosion will only occur if the dewar has run out of liquid nitrogen very often and has, moreover, not been treated well. The corroded bottom of the dewar can be polished again.

This can be done using a long shaft with a flat plate on one end to which fine sandpaper has been fixed. The shaft can be driven by a drilling machine. Tools for this purpose are on the market. The wall thickness is 1mm. After polishing the bottom, clean the inside with a vacuum cleaner.

The bottom of the dewar should, after polishing, be treated to prevent corrosion again.

For this treatment, two aluminum treatment products are used. They are available from:

AMCHEM PRODUCTS INC.
Ferndale, Michigan
U.S.A.

This firm sells the brand names Alumiprep and Alodine.

There are other firms selling equivalent products.

Proceed as follows:

* Pour a mixture of 100ml ALUMIPREP and 300ml water in the dewar.
* Wait for 4 hours.
* Pour the liquid out and rinse with water.
* Rinse after that with methyl alcohol and dry the dewar with dry air.
* Pour 15ml ALODINE in the dewar and rinse.
* Wait for 1/2 hour.
* Dry the dewar out with dry air or argon gas.
* Fill the dewar with liquid nitrogen again. See Section 4.2.
* Wait 10 hours before switching on the unit.

## 6. TROUBLESHOOTING

Keeping in mind that many customers have a service department at their disposal, some information is given, a service technician of the customer needs, to solve a number of problems. However, it must be remarked that the possibilities are extremely limited due to insufficient training and lack of proper instrumentation. In repairing detecting units, especially a leak detector and diffusion pump are necessary instrumentation.

Repair efforts, other than performed by qualified personnel, are not encouraged. However, due to special circumstances, a repair could be successful when performed with some guidance.

* In all cases if the spectrum on the video monitor looks abnormal, the very first action should be the checking of the supply voltages of the 407 power supply. All voltages should read in the green field of the indicator on the front panel of the power supply.

* In case of problems with the detecting circuitry, the incoming countrate with and without x-rays should be checked.

  The total incoming countrate is displayed on the video monitor as the upper right hand top reading in case the COUNTRATE pushbutton on the analyzer is kept depressed.

  Without x-rays the incoming countrate should read 15 - 30 cps. The reading can be adjusted by means of the potentiometer F DISC (fast discriminator) on the amplifier of the detecting unit. The level of 15 - 30 cps is a sensitivity for a proper functioning of the fast discriminator circuit. If the F DISC potentiometer is not adjusted properly, the reading may be below the 15 cps down to 0 cps but may also be very high (from some hundred to some thousand counts per second). In the latter case the fast discriminator circuit is oscillating.

  With x-rays, the incoming countrate may not be too high. In case the incoming countrate exceeds 100,000 cps no counts are stored at all. The stored countrate is displayed on the same position as the incoming countrate, but with the pushbutton COUNTRATE released.

  The reason that the stored countrate decreases with an increasing incoming countrate is due to the pulse pile-up rejector. At higher countrates detector pulses start piling up, the pulse height versus energy relation is gone and the pulses will be rejected.

## 9100/40 SHIPMENT CHECKLIST

REV. 6-4-82

| | QTY REQUIRED | DESCRIPTION |
|---|---|---|
| MANUALS | 1 | ✓Microcomputer Processors Handbook ✓ MICROCOMPUTERS AND MEMORIES |
| | 1 | ✓Microcomputer Interface Handbook ✓ O.K. |
| | 1 | ✓9100 Operator's Manual /40 "SQ" 1.2D ✓ O.K. |
| | 1 | B/O Schematics ? |
| | 1 | ✓Service Manual ✓ O.K. |
| | 1 | ✓Set EDAX EDITor ✓ O.K. |
| | 1 | ✓Intro to RT-11 ✓ O.K. |
| | 1 | ✓RT-11 System Message Manual ✓ O.K. |
| | 1 | ✓RT-11 Pocket Guide ✓ O.K. |
| SOFTWARE 1.2D | 2 | SW9144 (50 or 60 Hz as Spec.) Floppies ✓ O.K.<br>✓50 Hz: 4035-009-50041<br>60 Hz: 4035-009-60041 |
| CABLES | 1 | ✓A.C. Power Cable ✓ |
| | 4 | ✓SCA Output Cables (15') ✓ |
| | 1 | ✓EXTERNAL GROUND CABLE ✓ |
| SPARE PARTS | 5 | ✓Lamps - Keyboard Assy. ✓ |
| | 2 | Fuses - 10A for 110V Systems<br>✓ 5A for 220V Systems ✓ |
| | 2 | ✓Fuses - ½ A ✓ |
| | 1 | ✓Fuses - 2 A ✓ |
| | 10 | ✓RETAINER WASHER 2535-700-07001 ✓ |
| K | 1 | ✓Key Chain +2 Keys ✓ |

WORK ORDER: 2-09-138

SW9100 REV. LEVEL: 1.2D

DOCUMENT CONTROL #5A

INSPECTOR: Ralph R. [signature]

DATE: 10-20-82

EDAX (EUROPE) B.V.

MAIN OFFICE: 2180 AG HILLEGOM/HOLLAND
P.O. Box 272/Pastoorslaan 28

EUROPEAN SALES AND SERVICE FOR **EDAX** INTERNATIONAL INC.

## SPECIFICATIONS FOR EDAX DETECTING UNIT

CUSTOMER : E. E. STOCK

S-NUMBER : 20485

MODEL : JSM-35-149-10

SERIALNUMBER: 1778

DATE : ____________

SYSTEM RESOLUTION FOR 5.9KeV MANGANESE Ka XRAYS
(Taken with a radioactive FE55 Source): 145.4 eV F.W.H.M.
(See attached printout).

THE PEAK/BACKGROUND RATIO IS:

5,9/1.0 = 1471

5,9/5.0 = 1136

TEST AMPLIFIER: 183 A S/N 1206 P

AMPLIFIER TIME CONSTANTS: 8 microseconds

ENERGY CALIBRATION: 20 eV/Channel

OPERATING VOLTAGE: 750 volts negative

SEE MANUAL FOR OPERATING INSTRUCTIONS.

FINAL TEST BY: R. HOEKSTRA

32

6 5900 35 78206

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 05560 | 19 | 22 | | | | | | | | |
| 05600 | 34 | 29 | 38 | 38 | 62 | 119 | 206 | 429 | 802 | 1468 |
| 05800 | 2673 | 4226 | 6129 | 7891 | 9410 | 10021 | 9405 | 8237 | 6289 | 4380 |
| 06000 | 2812 | 1641 | 845 | 411 | 205 | 97 | 49 | 42 | 33 | 37 |
| 06200 | 29 | 32 | 46 | | | | | | | |

$$20\left(\frac{1129}{1903} + 6 + \frac{1289}{1909}\right) = 145{,}4 \text{ EV}$$

SPECTROMETER COOLING PROCEDURE

## IMPORTANT NOTICE

Proper attehtion must be paid to these instructions or a loss in warranty may result.

This spectrometer has been shipped to you without liquid nitrogen. It must not be allowed to remain at room temperature for longer than one month. The following steps must be taken prior to making any electrical connections to the spectrometer:

1. Sit spectrometer vertically and remove styrofoam fill cap.
2. If a source of dry air (or inert gas such as Nitrogen, Argon, or Helium) is available, the interior of the dewar should be flushed with the dry gas for 5 minutes to completely remove humid air from within the dewar.
3. Immediately fill dewar with clean, transparent liquid Nitrogen. The Nitrogen will boil violently for ten to fifteen minutes. Do not be alarmed.
4. After the boiling has diminished, fill the dewar completely and replace lid.
5. Allow the internal components and detector to cool for at least twelve hours.
6. After the twelve hour cooling time elapsed, the high voltage and preamp/amplifier power cables can be attached. Power may be turned on and normal calibration procedures may be carried out. The spectrometer will achieve optimum performance after approximately forty-eight hours at liquid nitrogen temperature.
7. Once the spectrometer has been cooled, it should be maintained at liquid nitrogen temperature by refilling the dewar every three days or as recommended by your EDAX serviceman. The spectrometer should not be allowed to cycle from liquid nitrogen to room temperature and back, because one risks condensing water in the dewar. This water (or any other foreign materials) in the dewar may cause resolution degradation at a later date. Also temperature cycling places unnecessary stresses on all internal spectrometer components.
8. Please see your instruction manual for additional information.

An optimum incoming countrate for the column systems and EXAM II and III systems is around 6000 cps.

In case of a pulsed EXAM II system, the optimum countrate is approximately 15,000 cps.

These figures are only related to dead time losses. They are not related to specific applications.

Finally, it is clearly wrong if the stored countrate is higher than the total incoming countrate. See Section 6.4.

## 6.1 INCREASE IN L.N. CONSUMPTION

In case the liquid nitrogen consumption increases, gradually or suddenly the cause will, in most cases be a vacuum leak. Such a leak might be in the Be window, at an O-ring connection, but also in the dewar wall. The only way to find the leak is by using a leak detector.

In section 6.2 the procedure for leak detection, as well as pumping down of the dewar has been described.

A very slow increase in L.N. consumption might be caused by a saturated getter in the dewar. This getter catches vapors originating from components inside the cap. The situation can be improved by repumping the dewar. See Section 6.2.

## 6.2 LEAK DETECTION - PUMPING PROCEDURES

There are different types of leak detectors on the market. Most systems, however, operate as follows:

* The detecting unit has to be connected to a vacuum pump. A rough vacuum of approximately 100 microns is reached.
* By means of an injector gun, helium (sometimes freon) can be sprayed on small parts of the outside surface.
* The helium detector inside the system detects very small amounts of helium. A meter and alarm indicate a leaky spot.

### Re-pumping Procedure

In case the dewar has to be re-pumped in order to improve the vacuum proceed as follows:

* Switch off the equipment, wait for 10 minutes and remove the detecting unit. Pour out the liquid nitrogen and let the dewar warm to room temperature.
* Discharge the H.V. by connecting the center pin of the BNC connector on the H.V. box to the frame.

* Remove the black plastic cover which seals the vacuum valve connector on the dewar.

* Connect the valve operator to the valve but do not open the valve at this point. The valve operator can be ordered. See Section 2.1.

* Connect the valve operator to the high vacuum installation.

* When the pressure reads under 100 microns, open the valve and wait until the pressure reads 100 microns again. If this does not occur, there will be a vacuum leak.

* Open the diffusion pump and pump until the pressure reads $2.10^{-6}$ mm Hg (Torr.)

* Close the valve on the detecting unit. Close the diffusion pump and remove the detecting unit from the vacuum system.

## 6.3 DRIFT

With drift is meant an instability in the positioning of the spectrum with respect to the energy scale. This instability can originate from the amplifier or from the ADC.

As soon as the zero circuitry drifts, the baseline will drift and the entire spectrum will shift.

In case the gain circuitry is instable the position between the peaks will shift.

The coarse control of the zero circuit is located at the amplifier (potentiometer ZERO) while the zero fine control is located at the left hand lower side on the front panel of the analyzer (potentiometer Z).

The coarse gain control is at the amplifier while the fine gain control is again on the analyzer.

In case of drift, proceed as follows:

* Check the supply voltages. All readings should be in the green field of the indicator on the front panel of the power supply.

* Check if the blowers in the power supply, as well as on the rear door of the analyzer, are running. Check also if the filters are clean.

* It should be determined if the drift is caused by an instability in the zero circuitry, the gain circuitry, or both.

  This can easily be checked by first calibrating the system accurately on two peaks and then checking the position of the two peaks after some hours of operation. If both peaks are shifted over the same amount and in the same direction, the instability is in the zero circuit.

If the centroid of one peak is shifted in one direction and the centroid of the other peak in opposite direction the problem will be in the gain circuit.

* Moreover, to determine whether the problem is located in the amplifier or in the ADC can be checked as follows:

    * Switch the system off.

    * Wait 5 minutes and remove the H.V. cable and signal/supply cable for the detecting unit at the analyzer side.

    * Connect a pulse generator with a pulse of 5V amplitude and a width of 100 secs to the input of the analyzer on the rear panel.

    * If the amplitude of the test pulse is very stable, information should be stored in one channel.

In case of drift problems, most likely only an EDAX service engineer can repair the unit.

## 6.4 CHECKING THE 183 AMPLIFIER

In case no pulses are stored in the analyzer (no spectrum display) or in case wrong information is stored, it can be checked if the problem is in the detecting unit, the amplifier or in the analyzer.

For this check, an oscilloscope is required. A 10MHz, single beam type is sufficient.

* Connect a radioactive source (e.g. $Co^{57}$) over the Be-window.

  This is the best way to ensure that x-rays are striking the detector.

* Check the PREAMP output on the amplifier front panel. This output will show as a staircase ramp function, between an upper level of -0.1V and a lower level of -2.1V. In case no x-rays are falling on the detector, this output should ramp slowly, but no staircase will be seen.

* Check the AMPLIFIER INSPECT. The output will be Gaussian shaped pulses of different amplitude. The width at the base is the same for all pulses and equals about 10X the time constant of the amplifier.

* Without x-rays, the noise at AMPLIFIER INSPECT should be 40 - 60 mV peak to peak and symmetrical around the base line.

  The noise at AMPLIFIER OUTPUT should be 40 - 50mV peak to peak, only positive (above the baseline).

* The fast discriminator pulses have a width of 0.5 μsec and an amplitude of 4 to 6V. This pulse is generated for every output pulse.

* The INHIBIT output shows a negative pulse of 150 - 200 μsecs with an amplitude of approximately 4V. This pulse occurs only at the reset of the pre-amplifier output. Thus at the moment the voltage level jumps from -0.1V to -2.1V.

See also figure 6.

## 6.5 GROUND LOOPS

Ground loops might cause a number of problems. A ground loop enables the coupling of a signal from a certain point in the system to an input at another point. Such a signal, which might also be a spurious signal, will then cause interferences, and/or oscillations.

There are some clear indications, when this problem occurs. If e.g. the stored countrate is higher than the total incoming countrate.

NOTE: The incoming countrate is displayed when the pushbutton COUNTRATE is depressed. When this pushbutton is released, the stored countrate is displayed.

Also, "strange" broad peaks which show up in the spectrum, might be an indication of a ground loop problem.

The detecting unit is mounted electrically isolated from the electron microscope or from the sample chamber of an EXAM system.

If this is not the case a ground loop will be formed with possibly the above mentioned results.

* In case of broad "strange" peaks in the spectrum or in case the stored countrate is higher than the incoming countrate, check with an ohm meter if the detecting unit has been mounted isolated.

* If the detecting unit is not isolated, check if the plastic sleeves or discs are in place. They are located around the end cap.

The electron microscope has been connected with a supply line to the mains. This line includes mostly a ground connection.

The power supply for the EDAX system has also been connected to the mains with a supply cable including a ground wire.

The entire system thus forms a loop - analyzer - ground - electron microscope - capacitive couplings - analyzer.

This loop can be cut as follows:

Disconnect the ground wire in the mains plug of the cable to the power supply.

CAUTION

The analyzer is now floating and does not have a safety ground. Therefore, connect a ground strap between the analyzer chassis and the electron microscope.

This may also solve the problem.

## 7. ABOUT SERVICE

In case of a defect in the interior of the end cap or in case a broken window or vacuum leak, the unit has to be sent to the factory for repair.

It is difficult to repair the unit on site. The reason is two fold.

First of all there is the problem of leak detection and pumping down of the dewar. Moreover, special experience is required for the repair of certain defects.

Our detecting units are reliable and of a high quality, however, a delicate instrument like this may, like all instruments unexpectedly break down. The information in this manual is given with the intension to minimize breakdowns due to improper operation.

It is necessary to point out the cost issue in case of a repair. The nature of the detecting unit brings along relative high repair costs with respect to its total price. The reason is that the unit has to be leak checked and pumped down (labor) for every repair while, moreover parts like detectors (special fabrication) and FET's (special selected) are expensive.

An important effect is the following:

> In case the window breaks, it is likely that the FET (and perhaps the detector) will be damaged if the detecting unit was switched on. This means that initially, the user's may think that "only" the window has to be repaired. It is, therefore, very important to fill out the repair request form. See hereafter, sections 7.1 and 7.2.

To cover possible repair costs of your instrument, including the detecting unit, it should be normal practice to have the disposal of a service budget.

As an average about 6% to 8% of your total equipment price should be reserved for service every year.

An attractive possibility is to conclude an all-in service contract for this money. Such a contract will cover all repairs, parts and labor and includes mostly regular preventive maintenance calls.

Besides all-in contracts, several different types of contracts exist. For detailed information, contact your sales or service engineer.

### 7.1 SERVICING PROCEDURES

In case of a serious problem with your detecting unit, the following actions should be taken:

* Contact your service engineer. In most cases it is desired that the service engineer inspects your unit.

In case the damage is obvious, e.g. a broken window, an extra service call is not justified. In other cases, the fault might for instance be in the amplifier which can easily be repaired locally.

* The service engineer - or in other cases, the user - should fill out the repair request form. Such a form is enclosed in the envelope together with the specification sheet at the back of the manual.

* The factory should be phoned and a Return Authorization (R.A.) number should be asked for. This number should be filled out in the Repair Request Form. In most cases, the repair price and the repair time will be given immediately. This is, of course, only possible if sufficient data are available. Important data at this point are: age of detecting unit, type and fault.

* In case the detecting unit cannot be repaired immediately, or in case it turns out that it is not worthwhile or very difficult (expensive) to repair the unit, a loaner will be offered. In that case, there will normally be a monthly charge.

## 7.2 REPAIR REQUEST FORM

This form, one copy available in the envelope at the back of the manual, has to be filled out as accurately as possible in case the unit is sent to the factory for repair. Input of a good quality on the defect and other items will contribute to a shorter repair time. It is worthhile to keep a copy of the completed request form. As soon as the unit is returned, a new form will be sent along. Moreover, in case this is necessary, a Repair Feedback Form will also be included. This form gives an explanation of the breakdown and states, if appropriate, advice to prevent future breakdowns.

## 7.3 DETECTING UNIT RECORD SHEETS

At the back of the manual, record sheets have been included. These sheets should be used as a log book to record the history of the detecting unit. In cases of a repair, a copy of the record sheet should be enclosed.

## DETECTING UNIT RECORD SHEET
## REPAIRS

CUSTOMERS NAME : ______________________________

ADDRESS : ______________________________

TELEPHONE NUMBER : ______________________________

DET. UNIT TYPE : ______________________________

ELECTRON MICROSCOPE : ______________________________

EXAM TYPE : ______________________________

DATE OF INSTALLATION : ______________________________

| DATE | REPAIR DETAILS |
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DETECTING UNIT RECORD SHEET
RESOLUTION

CUSTOMERS NAME : ______________________

ADDRESS : ______________________

TELEPHONE NUMBER : ______________________

DET. UNIT TYPE : ______________________

ELECTRON MICROSCOPE : ______________________

EXAM TYPE : ______________________

DATE OF INSTALLATION : ______________________

| DATE | RESOLUTION TEST |
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LIST 1

LICENSING OFFICIALS IN AGREEMENT STATES

ALABAMA 205-269-7634 -10/1/66

Mr. Aubrey Godwin, Director
Division of Radiological Health
Alabama State Department of Public Health
State Office Building, Room 313
Montgomery, Alabama 36104

ARIZONA 602-271-4845 -5/15/67

Mr. Donald C. Gilbert, Executive Director
State of Arizona Atomic Energy Commission
First Floor - Commerce Building
1601 West Jefferson Street
Phoenix, Arizona 85007

ARKANSAS 501-661-2302 -7/1/63

Mr. David D. Snellinga, Jr., Director
Division of Radiological Health
Arkansas State Board of Health
Little Rock, Arkansas 72201

CALIFORNIA 916-322-2073 -9/1/62

Dr. Simon Kinsman, Chief
Radiological Health Section
Department of Health
744 "P" Street
Sacramento, California 95814

COLORADO 303-388-6111 -2/1/68

Mr. R. D. Siek, Director
Occupational and Radiological
Health Division
Colorado Department of Public Health
4210 East 11th Avenue
Denver, Colorado 80220

GEORGIA 404-762-6111 -12/15/69

Mr. Richard H. Fetz, Director
Radiological Health Service
Georgia Department of Public Health
State Health Building
Atlanta, Georgia 30303

IDAHO 208-384-2390 Ext. 362 -10/1/6

Mr. Michael A. Christie, Chief
Radiation Control Section
Environmental Protection Division
Idaho Dept. of Environmental & Community
Services
Statehouse
Boise, Idaho 83707

KANSAS 912-296-3821 -1/1/65

Mr. Robert C. Will, Chief
Radiation Control Section
Environmental Health Division
Kansas State Department of Health
525 Kansas Avenue
Topeka, Kansas 66603

KENTUCKY 502-564-3700 -3/26/62

Mr. Charles M. Hardin, Director
Radiological Health Program
Kentucky State Department of Health
275 East Main Street
Frankfort, Kentucky 40601

LOUISIANA 504-389-5963 -5/1/67

Mr. B. Jim Porter, Director
Division of Radiation Control
Louisiana Board of Nuclear Energy
P. O. Box 44033, Capitol Station
Baton, Rouge, Louisiana 70804

LIST 1. - LICENSING OFFICIALS IN AGREEMENT STATES - PAGE 3

NEW YORK 518-474-7755 -10/15/62

Mr. T. K. DeBoer
Director of Technical Development Program
Division of Industrial Sciences and Technologies
New York State Department of Commerce
99 Washington Avenue
Albany, New York 12210

WASHINGTON 206-753-3459 -12/31/66

Mr. Clifford Lewis, Acting Supervisor
Radiation Control Unit
Division of Health
Washington State Department of Social and Health Services
Olympia, Washington 98501

TEXAS 512-454-3781 -3/1/63

Mr. Martin C. Wakasch, P.E., Director
Division of Occupational Health and Radiation Control
Texas State Department of Health
Austin, Texas 78756

## LIST 1. - LICENSING OFFICIALS IN AGREEMENT STATES - PAGE 2

FLORIDA 904-354-3961 Ext. 326 -7/1/64

Mr. Ulray Clark, Acting Administrator
Radiological & Occupational Health Section
Florida Division of Health
P. O. Box 210
Jacksonville, Florida 32201

MISSISSIPPI 601-354-6657 -7/1/62

Mr. Eddie S. Fuente, Supervisor
Radiological Health Unit
Mississippi State Board of Health
Jackson, Mississippi 39205

NEBRASKA 402-471-2168 -10/1/66

Mr. Ellis Simmons, Director
Division of Radiological Health
State Department of Health
Lincoln Building 1003 "O" Street
Lincoln, Nebraska 68509

NEVADA 702-882-7870 -7/1/72

Mr. William C. Horton
Radiation Control Specialist
Division of Health
Department of Health, Welfare and Rehabilitation
Carson City, Nevada 89701

NEW HAMPSHIRE 603-271-2281 -5/1/66

Mr. John R. Stanton, Director
Radiation Control Agency
Division of Public Health Services
State Laboratory Building
Hazen Drive
Concord, New Hampshire 03301

NEW MEXICO 505-287-2573 -5/1/74

Mr. Edward L. Kaufman
Program Manager
Radiation Protection Section
Environmental Improvement Agency
P. O. Box 2378
Santa Fe, New Mexico 87501

MARYLAND 301-383-2747 -1/1/71

Mr. Robert E. Corcoran, Chief
Division of Radiological Health
Maryland State Dept. of Health & Mental Hygiene
610 North Howard Street
Baltimore, Maryland 21218

NO. CAROLINA 919-829-4283 -8/1/64

Mr. Dayne H. Brown, Director
State Radiation Protection Program
North Carolina State Board of Health
Raleigh, North Carolina 27602

NO. DAKOTA 701-224-2374 -9/1/69

Mr. Gene A. Christianson, Director
Division of Environmental Engineering
Radiological Health Program
State Department of Health
Bismarck, North Dakota 58501

OREGON 503-229-5797 -7/1/65

Dr. Marshall Parrott, Director
Radiological Health Section
Division of Health
Department of Human Resources
1400 South West Fifth Avenue
Portland, Oregon 97201

SO. CAROLINA 803-758-5549 -9/15/69

Mr. Heyward Shealy, Director
Division of Radiological Health
South Carolina State Board of Health
J. Marion Sims Building
2600 Bull Street
Columbia, South Carolina 29201

TENNESSEE 615-741-3161 -9/1/65

Mr. Robert H. Wolle, Director
Division of Radiological Health
Tennessee Department of Public Health
727 Cordell Hull State Office Building
Nashville, Tennessee 37219

## LIST 2

ADDRESSES: AMERSHAM - SEARLE
NEW ENGLAND NUCLEAR

### AMERSHAM - SEARLE

#### IN THE UNITED STATES & LATIN AMERICA

AMERSHAM - SEARLE CORPORATION
2636 S. Clearbrook Drive
Arlington Heights, Illinois 60005
U.S.A.

TELEPHONE: (312) 593-6300
TELEX: 28-2452

#### IN CANADA

AMERSHAM - SEARLE CORPORATION
400 Iroquois Shore Road
Oakville, Ontario, Canada

TELEPHONE: (416) 364-2183
TELEX: 069-82216

### NEW ENGLAND NUCLEAR

#### IN THE UNITED STATES

NEN WEST
17210 South Gramercy Place
Gardena, California 90247

TELEPHONE: (213) 321-3311
TELEX: 65-3593

#### IN CANADA

NEN CANADA LTD.
11475 Cote de Liesse
Dorval, Quebec H9P 1B3

TELEPHONE: (514) 636-4971
TELEX: 05-821808

NEW ENGLAND NUCLEAR - Continued

IN EUROPE

NEN CHEMICALS GmBH
D 6072 Dreieichenham
Siemensstrasse 1
West Germany

TELEPHONE: 06103-85035
TELEX: 841-417993

**EPIC**
**(EDAX Peak Identification Chart)**

# EDAX
LABORATORIES

Division of EDAX International, Inc.
P.O. Box 135, Prairie View, Illinois 60069
Phone (312) 634-0600 Telex 72-6407

**CHART A . . .** A listing of the principal emission lines from the elements in order of increasing energy, organized to permit ready identification of the major lines by verification of the minor lines accompanying them.

To use EPIC, identify the peaks in the spectrum starting with the most intense. For each line, confirm the identification by the minor lines listed. Their intensities are expressed as a percentage of the corresponding principal line, e.g. (20) means the accompanying line is 20% as large as the major line. Then eliminate the major line and all of its minor lines from further consideration and proceed to the next intense line remaining. In this way all of the elemental peaks will be readily identified.

**CHART B . . .** A listing of each element from carbon upwards by increasing atomic number with attendant K, L & M line energies (up to 40 keV) and abundances () relative to the principal emission line.

## CHART A

| Energy | Element | Atmoic Number | Principal Emission Line | Less Intense Minor Line Energy | Line | Intensity | Lesser Intense Minor Line Energy | Line | Intensity | Even Less Intense Minor Line Energy | Line | Intensity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0-1 keV** | | | | | | | | | | | | |
| 0.277 | C | 6 | K | | | | | | | | | |
| 0.331 | Mo | 42 | M | | | | | | | | | |
| 0.341 | Ca | 20 | Lα | | | | | | | | | |
| 0.355 | Nb | 41 | Mγ | | | | | | | | | |
| 0.392 | N | 7 | K | | | | | | | | | |
| 0.395 | Sc | 21 | Lα | | | | | | | | | |
| 0.452 | Ti | 22 | Lα | | | | | | | | | |
| 0.461 | Ru | 44 | Mγ | | | | | | | | | |
| 0.496 | Rh | 45 | Mγ | | | | | | | | | |
| 0.511 | V | 23 | Lα | | | | | | | | | |
| 0.525 | 0 | 8 | K | | | | | | | | | |
| 0.532 | Pd | 46 | Mγ | | | | | | | | | |
| 0.568 | Ag | 47 | Mγ | | | | | | | | | |
| 0.573 | Cr | 24 | Lα | | | | | | | | | |
| 0.606 | Cd | 48 | Mγ | | | | | | | | | |
| 0.637 | Mn | 25 | Lα | | | | | | | | | |
| 0.677 | F | 9 | K | | | | | | | | | |
| 0.691 | Sn | 50 | Mγ | | | | | | | | | |
| 0.705 | Fe | 26 | Lα | | | | | | | | | |
| 0.733 | Sb | 51 | Mγ | | | | | | | | | |
| 0.776 | Co | 27 | Lα | | | | | | | | | |
| 0.778 | Te | 52 | Mγ | | | | | | | | | |
| 0.833 | La | 57 | Mα | | | | | | | | | |
| 0.848 | Ne | 10 | K | | | | | | | | | |
| 0.851 | Ni | 28 | Lα | | | | | | | | | |
| 0.883 | Ce | 58 | Mα | | | | | | | | | |
| 0.929 | Pr | 59 | Mα | | | | | | | | | |
| 0.930 | Cu | 29 | Lα | | | | | | | | | |
| 0.972 | Ba | 56 | Mγ | | | | | | | | | |
| 0.978 | Nd | 60 | Mα | | | | | | | | | |

# EPIC
# WALL CHART
# ALSO
# AVAILABLE

| Energy | Element | Atomic Number | Principal Emission Line | Less Intense Minor Line | | | Lesser Intense Minor Line | | | Even Less Intense Minor Line | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Energy | Line | Intensity | Energy | Line | Intensity | Energy | Line | Intensity |
| **1-2 keV** | | | | | | | | | | | | |
| 1.012 | Zn | 30 | Lα | | | | | | | | | |
| 1.041 | Na | 11 | Kα | | | | | | | | | |
| 1.081 | Sm | 62 | Mα | | | | | | | | | |
| 1.098 | Ga | 31 | Lα | | | | | | | | | |
| 1.131 | Eu | 63 | Mα | | | | | | | | | |
| 1.185 | Gd | 64 | Mα | | | | | | | | | |
| 1.188 | Ge | 32 | Lα | | | | | | | | | |
| 1.240 | Tb | 65 | Mα | | | | | | | | | |
| 1.253 | Mg | 12 | Kα | | | | | | | | | |
| 1.282 | As | 33 | Lα | | | | | | | | | |
| 1.293 | Dy | 66 | Mα | | | | | | | | | |
| 1.347 | Ho | 67 | Mα | | | | | | | | | |
| 1.379 | Se | 34 | Lα | | | | | | | | | |
| 1.405 | Er | 68 | Mα | | | | | | | | | |
| 1.462 | Tm | 69 | Mα | | | | | | | | | |
| 1.480 | Br | 35 | Lα | | | | | | | | | |
| 1.486 | Al | 13 | Kα | | | | | | | | | |
| 1.521 | Yb | 70 | Mα | | | | | | | | | |
| 1.581 | Lu | 71 | Mα | | | | | | | | | |
| 1.586 | Kr | 36 | Lα | | | | | | | | | |
| 1.644 | Hf | 72 | Mα | | | | | | | | | |
| 1.694 | Rb | 37 | Lα | | | | | | | | | |
| 1.709 | Ta | 73 | Mα | | | | | | | | | |
| 1.739 | Si | 14 | Kα | | | | | | | | | |
| 1.774 | W | 74 | Mα | | | | | | | | | |
| 1.806 | Sr | 38 | Lα | | | | | | | | | |
| 1.842 | Re | 75 | Mα | | | | | | | | | |
| 1.914 | Os | 76 | Mα | | | | | | | | | |
| 1.922 | Y | 39 | Lα | | | | | | | | | |
| 1.977 | Ir | 77 | Mα | | | | | | | | | |
| **2-3 keV** | | | | | | | | | | | | |
| 2.013 | P | 15 | $K\alpha_1$ | 2.028 | $K\alpha_4$ | (10) | 2.137 | Kβ | (6) | | | |
| 2.042 | Zr | 40 | $L\alpha_1$ | 2.124 | $L\beta_1$ | (45) | | | | | | |
| 2.048 | Pt | 78 | Mα | 2.127 | Mβ | (50) | | | | | | |
| 2.121 | Au | 79 | Mα | 2.204 | Mβ | (50) | | | | | | |
| 2.166 | Nb | 41 | $L\alpha_1$ | 2.257 | $L\beta_1$ | (45) | 2.163 | $L\alpha_2$ | (10) | | | |
| 2.195 | Hg | 80 | Mα | 2.282 | Mβ | (50) | | | | | | |
| 2.267 | Tl | 81 | Mα | 2.362 | Mβ | (55) | | | | | | |
| 2.293 | Mo | 42 | $L\alpha_1$ | 2.394 | $L\beta_1$ | (45) | | | | | | |
| 2.307 | S | 16 | $K\alpha_1$ | 2.322 | $K\alpha_4$ | (50) | 2.465 | Kβ | (10) | | | |
| 2.342 | Pb | 82 | Mα | 2.442 | Mβ | (60) | | | | | | |
| 2.419 | Bi | 83 | Mα | 2.524 | Mβ | (60) | | | | | | |
| 2.424 | Tc | 43 | $L\alpha_1$ | 2.536 | $L\beta_1$ | (45) | | | | | | |
| 2.558 | Ru | 44 | $L\alpha_1$ | 2.683 | $L\beta_1$ | (45) | | | | | | |
| 2.621 | Cl | 17 | $K\alpha_1$ | 2.631 | $K\alpha_4$ | (10) | 2.815 | Kβ | (8) | | | |
| 2.696 | Rh | 45 | $L\alpha_1$ | 2.834 | $L\beta_1$ | (40) | 3.001 | $L\beta_2$ | (25) | | | |
| 2.838 | Pd | 46 | $L\alpha_1$ | 2.990 | $L\beta_1$ | (40) | 3.171 | $L\beta_2$ | (25) | | | |
| 2.957 | Ar | 18 | $K\alpha_1$ | 3.190 | Kβ | (15) | | | | | | |

| Energy | Element | Atomic Number | Principal Emission Line | Less Intense Minor Line | | | Lesser Intense Minor Line | | | Even Less Intense Minor Line | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Energy | Line | Intensity | Energy | Line | Intensity | Energy | Line | Intensity |
| **2-3 keV (cont'd)** | | | | | | | | | | | | |
| 2.984 | Ag | 47 | $L\alpha_1$ | 3.150 | $L\beta_1$ | (40) | 3.347 | $L\beta_2$ | (25) | | | |
| 2.991 | Th | 90 | $M\alpha$ | 3.145 | $M\beta$ | (60) | 3.369 | $M\gamma$ | (5) | | | |
| **3-4 keV** | | | | | | | | | | | | |
| 3.077 | Pa | 91 | $M\alpha$ | 3.239 | $M\beta$ | (60) | 3.465 | $M\gamma$ | (5) | | | |
| 3.133 | Cd | 48 | $L\alpha_1$ | 3.316 | $L\beta_1$ | (42) | 3.528 | $L\beta_2$ | (25) | | | |
| 3.165 | U | 92 | $M\alpha$ | 3.336 | $M\beta$ | (60) | 3.563 | $M\gamma$ | (5) | | | |
| 3.286 | In | 49 | $L\alpha_1$ | 3.487 | $L\beta_1$ | (75) | 3.713 | $L\beta_2$ | (17) | | | |
| 3.312 | K | 19 | $K\alpha$ | 3.589 | $K\beta$ | (15) | | | | | | |
| 3.443 | Sn | 50 | $L\alpha_1$ | 3.662 | $L\beta_1$ | (75) | 3.904 | $L\beta_2$ | (17) | | | |
| 3.604 | Sb | 51 | $L\alpha_1$ | 3.843 | $L\beta$ | (75) | 4.100 | $L\beta_2$ | (17) | | | |
| 3.690 | Ca | 20 | $K\alpha$ | 4.012 | $K\beta$ | (15) | | | | | | |
| 3.769 | Te | 52 | $L\alpha$ | 4.029 | $L\beta_1$ | (75) | 4.301 | $L\beta_2$ | (17) | | | |
| 3.937 | I | 53 | $L\alpha$ | 4.220 | $L\beta_1$ | (75) | 4.507 | $L\beta_2$ | (17) | | | |
| **4-5 keV** | | | | | | | | | | | | |
| 4.088 | Sc | 21 | $K\alpha$ | 4.460 | $K\beta_1$ | (20) | | | | | | |
| 4.109 | Xe | 54 | $L\alpha$ | 4.42 | $L\beta_1$ | (50) | 4.72 | $L\beta_2$ | (20) | | | |
| 4.286 | Cs | 55 | $L\alpha$ | 4.619 | $L\beta_1$ | (50) | 4.935 | $L\beta_2$ | (20) | | | |
| 4.465 | Ba | 56 | $L\alpha$ | 4.827 | $L\beta_1$ | (50) | 5.193 | $L\beta_2$ | (20) | | | |
| 4.508 | Ti | 22 | $K\alpha$ | 4.931 | $K\beta_1$ | (20) | | | | | | |
| 4.650 | La | 57 | $L\alpha$ | 5.041 | $L\beta_1$ | (50) | 5.383 | $L\beta_2$ | (20) | | | |
| 4.839 | Ce | 58 | $L\alpha$ | 5.261 | $L\beta_1$ | (50) | 5.612 | $L\beta_2$ | (20) | | | |
| 4.949 | V | 23 | $K\alpha$ | 5.426 | $K\beta_1$ | (20) | | | | | | |
| **5-6 keV** | | | | | | | | | | | | |
| 5.033 | Pr | 59 | $L\alpha$ | 5.488 | $L\beta_1$ | (50) | 5.849 | $L\beta_2$ | (20) | | | |
| 5.229 | Nd | 60 | $L\alpha$ | 5.721 | $L\beta_1$ | (50) | 6.088 | $L\beta_2$ | (20) | | | |
| 5.411 | Cr | 24 | $K\alpha$ | 5.946 | $K\beta_1$ | (18) | | | | | | |
| 5.432 | Pm | 61 | L | 5.960 | $L\beta_1$ | (50) | 6.338 | $L\beta_2$ | (20) | | | |
| 5.635 | Sm | 62 | $L\alpha$ | 6.204 | $L\beta_1$ | (50) | 6.586 | $L\beta_2$ | (20) | | | |
| 5.845 | Eu | 63 | $L\alpha$ | 6.455 | $L\beta_1$ | (50) | 6.842 | $L\beta_2$ | (20) | | | |
| 5.894 | Mn | 25 | $K\alpha$ | 6.489 | $K\beta_1$ | (20) | | | | | | |
| **6-7 keV** | | | | | | | | | | | | |
| 6.056 | Gd | 64 | $L\alpha$ | 6.712 | $L\beta_1$ | (50) | 7.102 | $L\beta_2$ | (20) | | | |
| 6.272 | Tb | 65 | $L\alpha$ | 6.977 | $L\beta_2$ | (50) | 7.365 | $L\beta_2$ | (20) | | | |
| 6.398 | Fe | 26 | $K\alpha$ | 7.057 | $K\beta_1$ | (20) | | | | | | |
| 6.494 | Dy | 66 | $L\alpha$ | 7.246 | $L\beta_1$ | (50) | 7.634 | $L\beta_2$ | (20) | | | |
| 6.719 | Ho | 67 | $L\alpha$ | 7.524 | $L\beta_1$ | (50) | 7.910 | $L\beta_2$ | (20) | | | |
| 6.924 | Co | 27 | $K\alpha$ | 7.648 | $K\beta_1$ | (20) | | | | | | |
| 6.947 | Er | 68 | $L\alpha$ | 7.809 | $L\beta_1$ | (50) | 8.188 | $L\beta_2$ | (20) | | | |
| **7-8 keV** | | | | | | | | | | | | |
| 7.179 | Tm | 69 | $L\alpha$ | 8.100 | $L\beta_1$ | (50) | 8.467 | $L\beta_2$ | (20) | 9.424 | $L\gamma_1$ | (5) |
| 7.414 | Yb | 70 | $L\alpha$ | 8.400 | $L\beta_1$ | (50) | 8.757 | $L\beta_2$ | (20) | 9.778 | $L\gamma_1$ | (5) |
| 7.471 | Ni | 28 | $K\alpha$ | 8.263 | $K\beta_1$ | (20) | | | | | | |

| Energy | Element | Atomic Number | Principal Emission Line | Less Intense Minor Line | | | Lesser Intense Minor Line | | | Even Less Intense Minor Line | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Energy | Line | Intensity | Energy | Line | Intensity | Energy | Line | Intensity |
| **7-8 keV (cont'd)** | | | | | | | | | | | | |
| 7.654 | Lu | 71 | Lα | 8.708 | $L\beta_1$ | (50) | 9.038 | $L\beta_2$ | (20) | 10.142 | $L\gamma_1$ | (6) |
| 7.898 | Hf | 72 | Lα | 9.021 | $L\beta_1$ | (50) | 9.346 | $L\beta_2$ | (20) | 10.514 | $L\gamma_1$ | (10) |
| **8-9 keV** | | | | | | | | | | | | |
| 8.040 | Cu | 29 | Kα | 8.904 | $K\beta_1$ | (20) | | | | | | |
| 8.145 | Ta | 73 | Lα | 9.342 | $L\beta_1$ | (50) | 9.650 | $L\beta_2$ | (20) | 10.893 | $L\gamma_1$ | (10) |
| 8.396 | W | 74 | Lα | 9.671 | $L\beta_1$ | (50) | 9.960 | $L\beta_2$ | (20) | 11.284 | $L\gamma_1$ | (10) |
| 8.630 | Zn | 30 | Kα | 9.570 | $K\beta_1$ | (20) | | | | | | |
| 8.651 | Re | 75 | Lα | 10.008 | $L\beta_1$ | (50) | 10.274 | $L\beta_2$ | (20) | 11.683 | $L\gamma_1$ | (10) |
| 8.910 | Os | 76 | Lα | 10.354 | $L\beta_1$ | (50) | 10.597 | $L\beta_2$ | (20) | 12.093 | $L\gamma_1$ | (10) |
| **9-10 keV** | | | | | | | | | | | | |
| 9.174 | Ir | 77 | Lα | 10.706 | $L\beta_1$ | (50) | 10.919 | $L\beta_2$ | (20) | 12.510 | $L\gamma_1$ | (10) |
| 9.241 | Ga | 31 | Kα | 10.262 | Kβ | (21) | | | | | | |
| 9.441 | Pt | 78 | Lα | 11.069 | $L\beta_1$ | (50) | 11.249 | $L\beta_2$ | (20) | 12.940 | $L\gamma_1$ | (10) |
| 9.712 | Au | 79 | Lα | 11.440 | $L\beta_1$ | (50) | 11.583 | $L\beta_2$ | (20) | 13.379 | $L\gamma_1$ | (10) |
| 9.874 | Ge | 32 | Kα | 10.979 | Kβ | (21) | | | | | | |
| 9.987 | Hg | 80 | Lα | 11.821 | $L\beta_1$ | (50) | 11.922 | $L\beta_2$ | (20) | 13.828 | $L\gamma_1$ | (10) |
| **10-11 keV** | | | | | | | | | | | | |
| 10.267 | Tl | 81 | Lα | 12.211 | $L\beta_1$ | (50) | 12.270 | $L\beta_2$ | (20) | 14.289 | $L\alpha_1$ | (10) |
| 10.542 | As | 33 | Kα | 11.722 | Kβ | (22) | | | | | | |
| 10.550 | Pb | 82 | Lα | 12.612 | $L\beta_1$ | (50) | 12.621 | $L\beta_2$ | (20) | 14.762 | $L\gamma_1$ | (10) |
| 10.837 | Bi | 83 | Lα | 13.021 | $L\beta_1$ | (50) | 12.978 | $L\beta_2$ | (20) | 15.245 | $L\gamma_1$ | (10) |
| **11-12 keV** | | | | | | | | | | | | |
| 11.129 | Po | 84 | $L\alpha_1$ | 13.445 | $L\beta_1$ | (50) | 13.338 | $L\beta_2$ | (20) | 15.741 | $L\gamma_1$ | (10) |
| 11.207 | Se | 34 | Kα | 12.492 | Kβ | (24) | | | | | | |
| 11.425 | At | 85 | $L\alpha_1$ | 13.574 | $L\beta_1$ | (50) | 14.065 | $L\beta_3$ | (10) | 16.249 | $L\gamma_1$ | (10) |
| 11.725 | Rn | 86 | $L\alpha_1$ | 14.313 | $L\beta_1$ | (50) | 14.509 | $L\beta_3$ | (10) | 16.768 | $L\gamma_1$ | (10) |
| 11.907 | Br | 35 | Kα | 13.286 | Kβ | (24) | | | | | | |
| **12-13 keV** | | | | | | | | | | | | |
| 12.029 | Fr | 87 | $L\alpha_1$ | 14.768 | $L\beta_1$ | (50) | 14.448 | $L\beta_2$ | (20) | 17.300 | $L\gamma_1$ | (10) |
| 12.338 | Ra | 88 | $L\alpha_1$ | 15.233 | $L\beta_1$ | (50) | 14.839 | $L\beta_2$ | (20) | 17.845 | $L\gamma_1$ | (10) |
| 12.631 | Kr | 36 | Kα | 14.107 | Kβ | (24) | | | | | | |
| 12.650 | Ac | 89 | $L\alpha_1$ | 15.710 | $L\beta_1$ | (50) | 15.929 | $L\beta_3$ | (10) | 18.405 | $L\gamma_1$ | (10) |
| 12.967 | Th | 90 | $L\alpha_1$ | 16.199 | $L\beta_1$ | (50) | 15.621 | $L\beta_2$ | (20) | 18.979 | $L\gamma_1$ | (10) |
| **13-14 keV** | | | | | | | | | | | | |
| 13.288 | Pa | 91 | $L\alpha_1$ | 16.699 | $L\beta_1$ | (50) | 16.022 | $L\beta_2$ | (20) | 19.565 | $L\gamma_1$ | (10) |
| 13.373 | Rb | 37 | Kα | 14.956 | Kβ | (24) | | | | | | |
| 13.612 | U | 92 | $L\alpha_1$ | 17.217 | $L\beta_1$ | (50) | 16.425 | $L\beta_2$ | (20) | 20.164 | $L\gamma_1$ | (10) |
| 13.942 | Np | 93 | $L\alpha_1$ | 17.747 | $L\beta_1$ | (50) | 16.837 | $L\beta_2$ | (20) | 20.781 | $L\gamma_1$ | (10) |

| Energy | Element | Atomic Number | Principal Emission Line | Less Intense Minor Line | | | Lesser Intense Minor Line | | | Even Less Intense Minor Line | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Energy | Line | Intensity | Energy | Line | Intensity | Energy | Line | Intensity |
| **14-15 keV** | | | | | | | | | | | | |
| 14.140 | Sr | 38 | Kα | 15.830 | Kβ | (24) | | | | | | |
| 14.931 | Y | 39 | Kα | 16.734 | Kβ | (25) | | | | | | |
| **15-16 keV** | | | | | | | | | | | | |
| 15.744 | Zr | 40 | Kα | 17.663 | Kβ | (27) | | | | | | |
| **16-17 keV** | | | | | | | | | | | | |
| 16.581 | Nb | 41 | Kα | 18.700 | Kβ | (12) | | | | | | |

| Energy* | Individual Energies | Element | Atomic Number | Principal Emission Line | Less Intense Minor Line | | | Lesser Intense Minor Line | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Energy | Line | Intensity | Energy | Line | Intensity |
| **Above 17 keV** | | | | | | | | | | |
| 17.441 | (17.476, 17.371) | Mo | 42 | $K\alpha_{1,2}$ | 19.599 | Kβ | )25) | | | |
| 18.325 | (18.364, 18.248) | Tc | 43 | $K\alpha_{1,2}$ | 20,608 | Kβ | (24) | | | |
| 19.233 | (19.276, 19.147) | Ru | 44 | $K\alpha_{1,2}$ | 21.646 | Kβ | (24) | | | |
| 20.165 | (20.213, 20.070) | Rh | 45 | $K\alpha_{1,2}$ | 22.712 | Kβ | (24) | | | |
| 21.121 | (21.174, 21.017) | Pd | 46 | $K\alpha_{1,2}$ | 23.807 | Kβ | (26) | | | |
| 22.101 | (22.159, 21.987) | Ag | 47 | $K\alpha_{1,2}$ | 24.921 | Kβ | (26) | | | |
| 23.106 | (23.170, 22.980) | Cd | 48 | $K\alpha_{1,2}$ | 26.080 | $K\beta_{1,3}$ | (27) | 26.639 | $K\beta_2$ | (5) |
| 24.136 | (24.206, 23.998) | In | 49 | $K\alpha_{1,2}$ | 27.252 | $K\beta_{1,3}$ | (27) | 27.856 | $K\beta_2$ | (5) |
| 25.191 | (25.267, 25.040) | Sn | 50 | $K\alpha_{1,2}$ | 28.467 | $K\beta_{1,3}$ | (28) | 29.104 | $K\beta_2$ | (5) |
| 26.271 | (26.355, 26.105) | Sb | 51 | $K\alpha_{1,2}$ | 29.705 | $K\beta_{1,3}$ | (29) | 30.388 | $K\beta_2$ | (5) |
| 27.377 | (27.408, 27.197) | Te | 52 | $K\alpha_{1,2}$ | 30.973 | $K\beta_{1,3}$ | (29) | 31.698 | $K\beta_2$ | (6) |
| 28.508 | (28.607, 28.312) | I | 53 | $K\alpha_{1,2}$ | 32.271 | $K\beta_{1,3}$ | (29) | 33.036 | $K\beta_2$ | (6) |
| 29.666 | (29.774, 29.453) | Xe | 54 | $K\alpha_{1,2}$ | 33.598 | $K\beta_{1,3}$ | (29) | 34.408 | $K\beta_2$ | (6) |
| 30.851 | (30.968, 30.620) | Cs | 55 | $K\alpha_{1,2}$ | 34.962 | $K\beta_{1,3}$ | (30) | 35.815 | $K\beta_2$ | (6) |
| 32.062 | (32.188, 31.812) | Ba | 56 | $K\alpha_{1,2}$ | 36.317 | $K\beta_{1,3}$ | (28) | 37.251 | $K\beta_2$ | (7) |
| 33.299 | (33.436, 33.028) | La | 57 | $K\alpha_{1,2}$ | 37.771 | $K\beta_{1,3}$ | (30) | 38.723 | $K\beta_2$ | (7) |
| 34.566 | (34.714, 34.273) | Ce | 58 | $K\alpha_{1,2}$ | 39.232 | $K\beta_{1,3}$ | (32) | | | |
| 35.860 | (36.020, 35.544) | Pr | 59 | $K\alpha_{1,2}$ | | | | | | |
| 37.182 | (37.355, 36.841) | Nd | 60 | $K\alpha_{1,2}$ | | | | | | |
| 38.532 | (38.718, 38.165) | Pm | 61 | $K\alpha_{1,2}$ | | | | | | |
| 39.911 | (40.111, 39.516) | Sm | 62 | $K\alpha_{1,2}$ | | | | | | |

*Weighted Average Energy of $K\alpha_1$ and $K\alpha_2$. Individual energies of unresolved peaks listed in next column.

**CHART B**

| ELEMENT | ATOMIC NUMBER | $K\alpha$ | $K\beta$ | (*) | $L\alpha$ | $L\beta_1$ | (*) | $L\beta_2$ | (*) | $L\gamma$ | (*) | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 6 | 0.277 | | | | | | | | | | |
| N | 7 | 0.392 | | | | | | | | | | |
| O | 8 | 0.525 | | | | | | | | | | |
| F | 9 | 0.677 | | | | | | | | | | |
| Ne | 10 | 0.848 | | | | | | | | | | |
| Na | 11 | 1.041 | | | | | | | | | | |
| Mg | 12 | 1.253 | | | | | | | | | | |
| Al | 13 | 1.486 | | | | | | | | | | |
| Si | 14 | 1.739 | | | | | | | | | | |
| P | 15 | 2.013 | 2.137 | (6) | | | | | | | | |
| S | 16 | 2.307 | 2.465 | (10) | | | | | | | | |
| Cl | 17 | 2.621 | 2.815 | (8) | | | | | | | | |
| Ar | 18 | 2.957 | 3.190 | (15) | | | | | | | | |
| K | 19 | 3.312 | 3.589 | (15) | | | | | | | | |
| Ca | 20 | 3.690 | 4.012 | (15) | 0.341 | | | | | | | |
| Sc | 21 | 4.088 | 4.460 | (20) | 0.395 | | | | | | | |
| Ti | 22 | 4.508 | 4.931 | (20) | 0.452 | | | | | | | |
| V | 23 | 4.949 | 5.426 | (20) | 0.511 | | | | | | | |
| Cr | 24 | 5.411 | 5.946 | (18) | 0.573 | | | | | | | |
| Mn | 25 | 5.894 | 6.489 | (20) | 0.637 | | | | | | | |
| Fe | 26 | 6.398 | 7.057 | (20) | 0.705 | | | | | | | |
| Co | 27 | 6.924 | 7.648 | (20) | 0.733 | | | | | | | |
| Ni | 28 | 7.471 | 8.263 | (20) | 0.851 | | | | | | | |
| Cu | 29 | 8.040 | 8.804 | (20) | 0.930 | | | | | | | |
| Zn | 30 | 8.630 | 9.570 | (20) | 1.012 | | | | | | | |
| Ga | 31 | 9.241 | 10.262 | (21) | 1.098 | | | | | | | |
| Ge | 32 | 9.874 | 10.979 | (21) | 1.188 | | | | | | | |
| As | 33 | 10.542 | 11.722 | (22) | 1.282 | | | | | | | |
| Se | 34 | 11.207 | 12.492 | (24) | 1.379 | | | | | | | |
| Br | 35 | 11.907 | 12.286 | (24) | 1.480 | | | | | | | |
| Kr | 36 | 12.631 | 14.107 | (24) | 1.586 | | | | | | | |
| Rb | 37 | 13.373 | 14.956 | (24) | 1.694 | | | | | | | |
| Sr | 38 | 14.140 | 15.830 | (24) | 1.806 | | | | | | | |
| Y | 39 | 14.931 | 16.734 | (25) | 1.922 | | | | | | | |
| Zr | 40 | 15.744 | 17.633 | (27) | 2.042 | 2.124 | (45) | | | | | |
| Nb | 41 | 16.581 | 18.700 | (12) | 2.166 | 2.257 | (45) | | | | | 0.355 |
| Mo | 42 | 17.441 | 19.599 | (25) | 2.293 | 2.394 | (45) | | | | | 0.331 |
| Tc | 43 | 18.325 | 20.608 | (24) | 2.424 | 2.536 | (45) | | | | | |
| Ru | 44 | 19.233 | 21.646 | (24) | 2.558 | 2.683 | (45) | | | | | 0.461 |
| Rh | 45 | 20.165 | 22.712 | (24) | 2.696 | 2.834 | (40) | 3.001 | (25) | | | 0.496 |
| Pd | 46 | 21.121 | 23.807 | (26) | 2.838 | 2.990 | (40) | 3.171 | (25) | | | 0.532 |
| Ag | 47 | 22.101 | 24.921 | (26) | 2.984 | 3.150 | (40) | 3.347 | (25) | | | 0.568 |
| Cd | 48 | 23.106 | 26.167 | (27) | 3.133 | 3.316 | (42) | 3.528 | (25) | | | 0.606 |
| In | 49 | 24.136 | 27.346 | (27) | 3.286 | 3.487 | (75) | 3.713 | (17) | | | |
| Sn | 50 | 25.191 | 28.564 | (28) | 3.443 | 3.662 | (75) | 3.904 | (17) | | | 0.691 |
| Sb | 51 | 26.271 | 29.805 | (28) | 3.604 | 3.843 | (75) | 4.100 | (17) | | | 0.733 |
| Te | 52 | 27.377 | 31.097 | (29) | 3.769 | 4.029 | (75) | 4.301 | (17) | | | 0.778 |
| I | 53 | 28.508 | 32.402 | (29) | 3.937 | 4.220 | (75) | 4.507 | (17) | | | |
| Xe | 54 | 29.666 | 33.737 | (30) | 4.109 | 4.42 | (50) | 4.72 | (20) | | | |
| Cs | 55 | 30.851 | 35.104 | (30) | 4.286 | 4.619 | (50) | 4.935 | (20) | | | |

(*) Approximate intensity relative to principal line of series

| ELEMENT | ATOMIC NUMBER | Kα | Kβ (*) | Lα | $L\beta_1$ (*) | $L\beta_2$ (*) | Lγ (*) | M |
|---|---|---|---|---|---|---|---|---|
| Ba | 56 | 32.062 | 36.504 (31) | 4.465 | 4.829 (50) | 5.193 (20) | | 0.972 |
| La | 57 | 33.299 | 37.951 (31) | 4.650 | 5.041 (50) | 5.383 (20) | | 0.833 |
| Ce | 58 | 34.566 | 39.232 (32) | 4.839 | 5.261 (50) | 5.612 (20) | | 0.883 |
| Pr | 59 | 35.860 | | 5.033 | 5.488 (50) | 5.849 (20) | | 0.929 |
| Nd | 60 | 37.182 | | 5.229 | 5.721 (50) | 6.088 (20) | | 0.978 |
| Pm | 61 | 38.532 | | 5.432 | 5.960 (50) | 6.338 (20) | | |
| Sm | 62 | 39.911 | | 5.635 | 6.204 (50) | 6.586 (20) | | 1.081 |
| Eu | 63 | | | 5.845 | 6.455 (50) | 6.842 (20) | | 1.131 |
| Gd | 64 | | | 6.056 | 6.712 (50) | 7.102 (20) | | 1.185 |
| Tb | 65 | | | 6.272 | 6.977 (50) | 7.365 (20) | | 1.240 |
| Dy | 66 | | | 6.494 | 7.246 (50) | 7.634 (20) | | 1.293 |
| Ho | 67 | | | 6.719 | 7.524 (50) | 7.910 (20) | | 1.347 |
| Er | 68 | | | 6.947 | 7.809 (50) | 8.188 (20) | | 1.405 |
| Tm | 69 | | | 7.179 | 8.100 (50) | 8.467 (20) | 9.424 (5) | 1.462 |
| Yb | 70 | | | 7.414 | 8.400 (50) | 8.757 (20) | 9.778 (5) | 1.521 |
| Lu | 71 | | | 7.654 | 8.708 (50) | 9.038 (20) | 10.142 (6) | 1.581 |
| Hf | 72 | | | 7.898 | 9.021 (50) | 9.346 (20) | 10.514 (10) | 1.644 |
| Ta | 73 | | | 8.145 | 9.342 (50) | 9.650 (20) | 10.893 (10) | 1.709 |
| W | 74 | | | 8.396 | 9.671 (50) | 9.960 (20) | 11.284 (10) | 1.774 |
| Re | 75 | | | 8.651 | 10.008 (50) | 10.274 (20) | 11.683 (10) | 1.842 |
| Os | 76 | | | 8.910 | 10.354 (50) | 10.597 (20) | 12.093 (10) | 1.914 |
| Ir | 77 | | | 9.174 | 10.706 (50) | 10.919 (20) | 12.510 (10) | 1.977 |
| Pt | 78 | | | 9.441 | 11.069 (50) | 11.249 (20) | 12.940 (10) | 2.074 |
| Au | 79 | | | 9.712 | 11.440 (50) | 11.583 (20) | 13.379 (10) | 2.148 |
| Hg | 80 | | | 9.987 | 11.821 (50) | 11.922 (20) | 13.828 (10) | 2.224 |
| Tl | 81 | | | 10.267 | 12.211 (50) | 12.270 (20) | 14.289 (10) | 2.301 |
| Pb | 82 | | | 10.550 | 12.612 (50) | 12.621 (20) | 14.762 (10) | 2.380 |
| Bi | 83 | | | 10.837 | 13.021 (50) | 12.978 (20) | 15.245 (10) | 2.458 |
| Po | 84 | | | 11.129 | 13.445 (50) | 13.338 (20) | 15.741 (10) | |
| At | 85 | | | 11.425 | 13.574 (50) | 14.065 (10) | 16.249 (10) | |
| Rn | 86 | | | 11.725 | 14.313 (50) | 14.509 (10) | 16.768 (10) | |
| Fr | 87 | | | 12.029 | 14.768 (50) | 14.448 (20) | 17.300 (10) | |
| Ra | 88 | | | 12.338 | 15.233 (50) | 14.839 (20) | 17.845 (10) | |
| Ac | 89 | | | 12.650 | 15.710 (50) | 15.929 (10) | 18.405 (10) | |
| Th | 90 | | | 12.967 | 16.199 (50) | 15.621 (20) | 18.979 (10) | 3.058 |
| Pa | 91 | | | 13.288 | 16.699 (50) | 16.022 (20) | 19.565 (10) | 3.148 |
| U | 92 | | | 13.612 | 17.217 (50) | 16.425 (20) | 20.164 (10) | 3.239 |
| Np | 93 | | | 13.942 | 17.747 (50) | 16.837 (20) | 20.781 (10) | |

(*) Approximate intensity relative to principal line of series

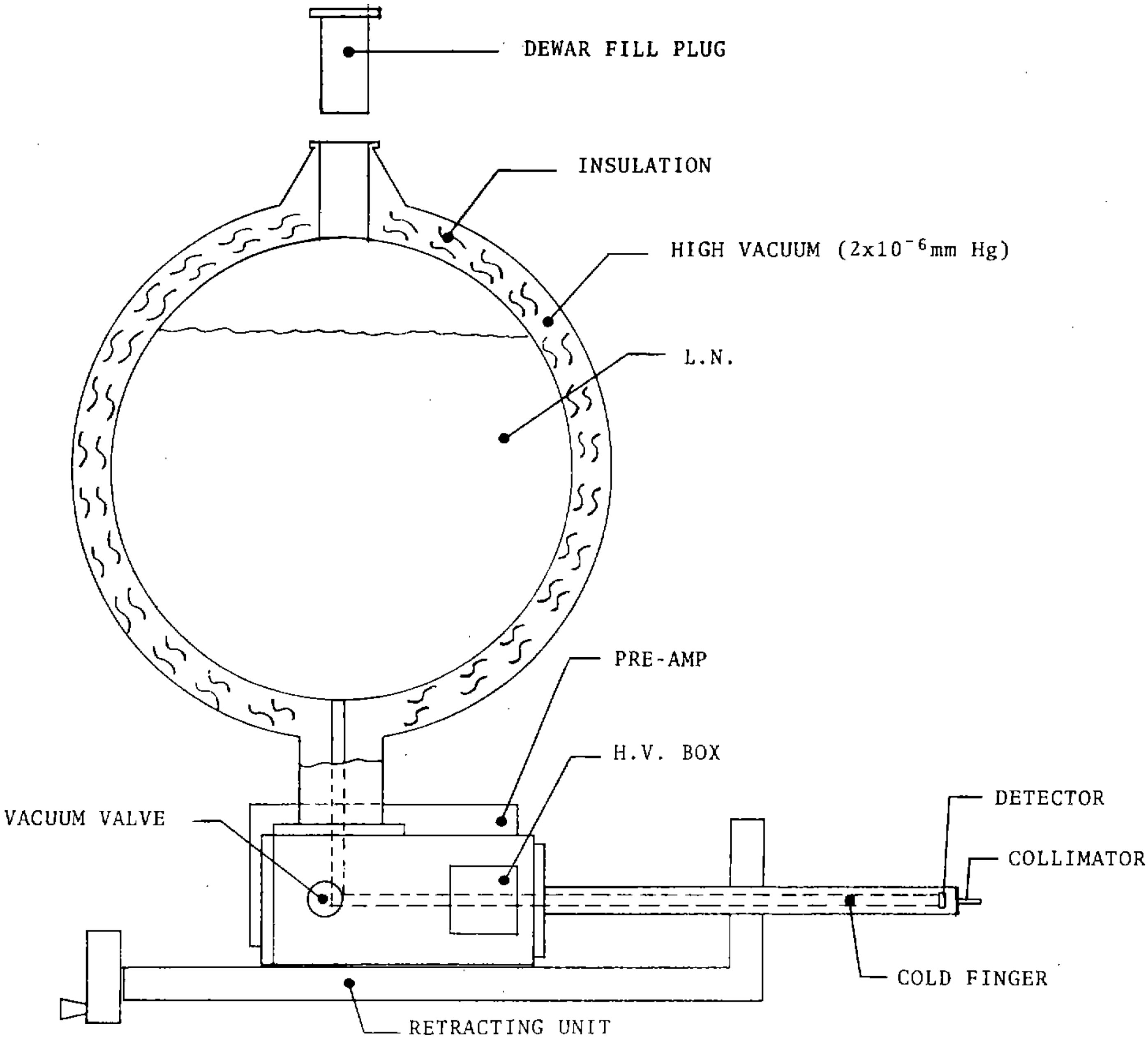
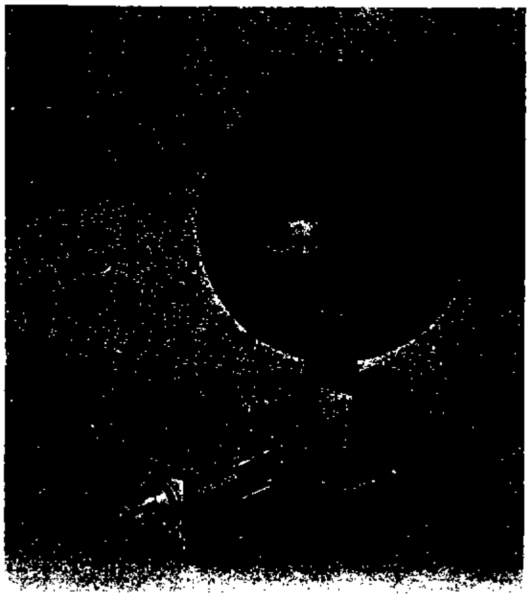
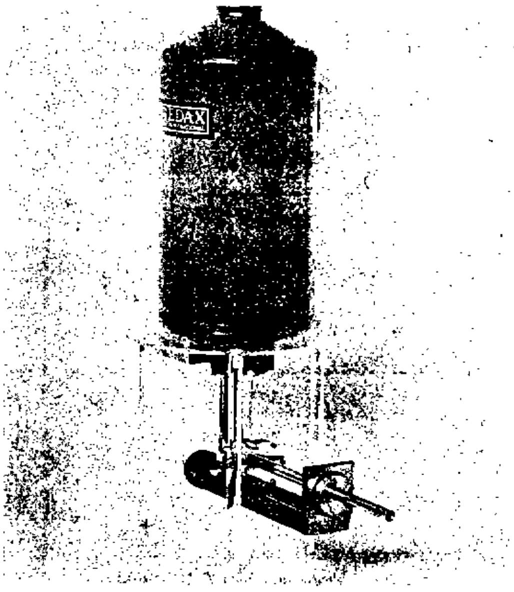
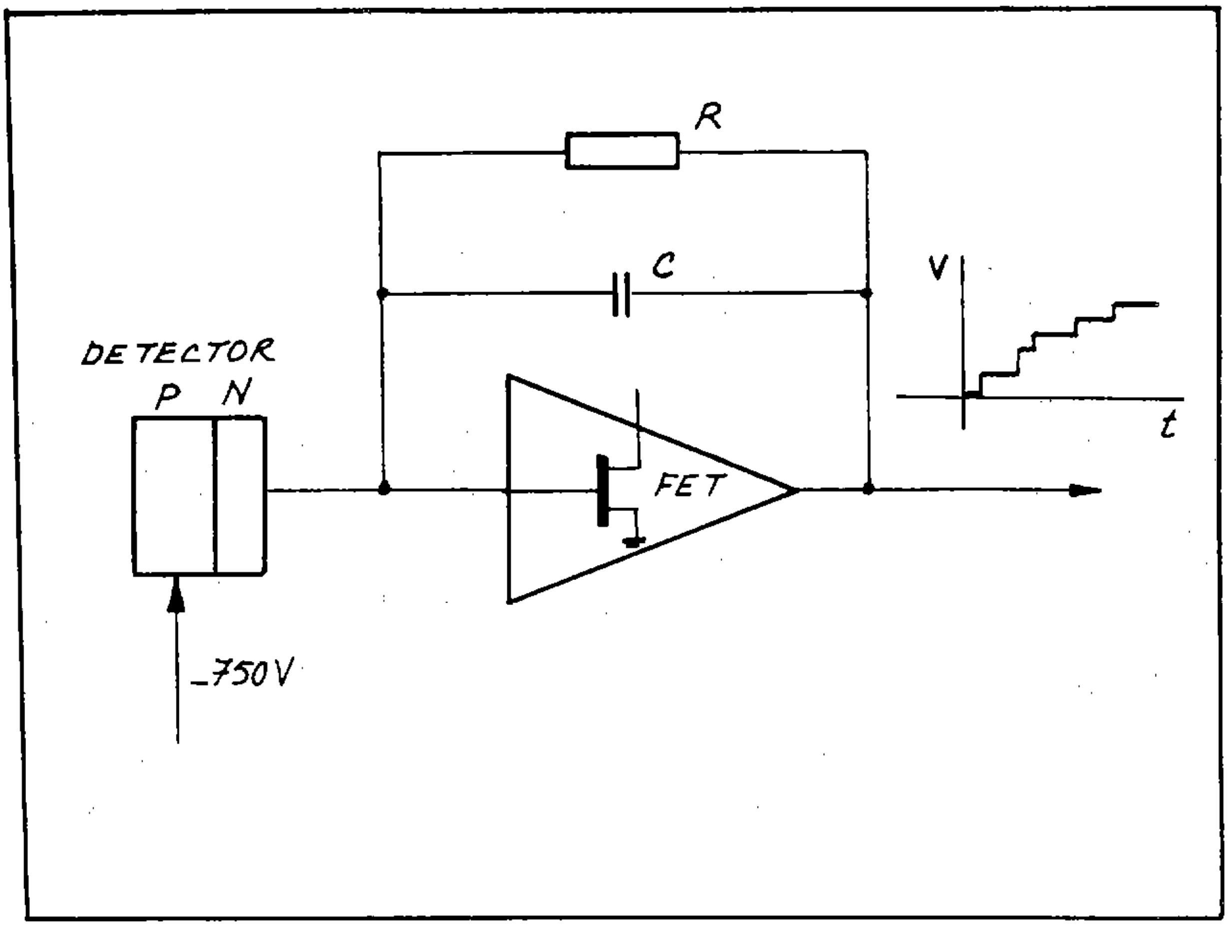

DEWAR FILL PLUG
INSULATION
HIGH VACUUM (2x10⁻⁶mm Hg)
L.N.
PRE-AMP
H.V. BOX
VACUUM VALVE
DETECTOR
COLLIMATOR
COLD FINGER
RETRACTING UNIT

FIGURE 1




EDAX


EDAX


R
C
V
t
DETECTOR
P
N
FET
-750V

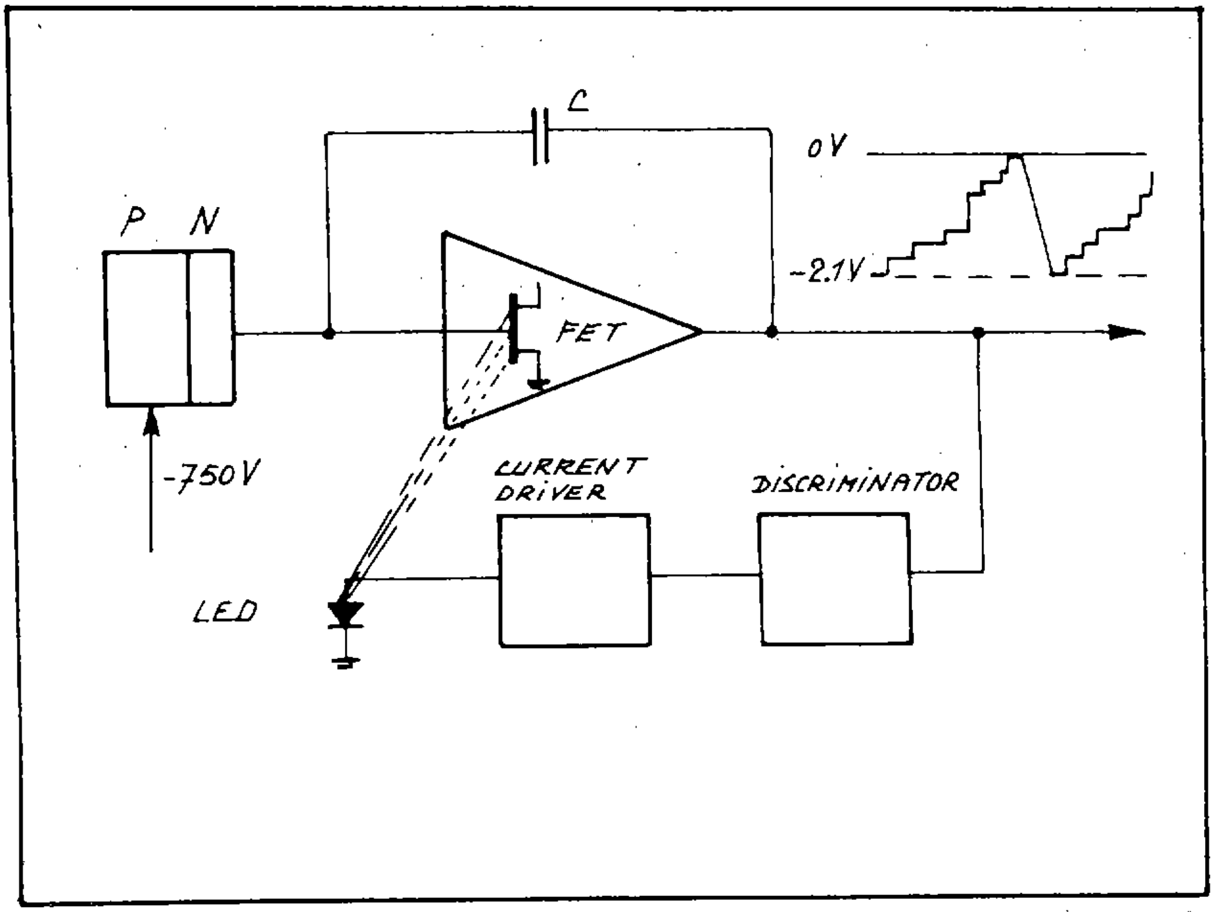

C
0V
-2.1V
P
N
FET
-750V
CURRENT DRIVER
DISCRIMINATOR
LED

FIGURE 3

Edax ADC: Wilkinson type, 0-8V,
4096 ch with
gain stability: 0.001 %/°C
zero stability: 0.1 eV/°C
peak stability: + to - 1 ch

## BLOCK DIAGRAM 183 PRE-AMPL./AMPL.

OLD VERSION OF AMPLIFIER

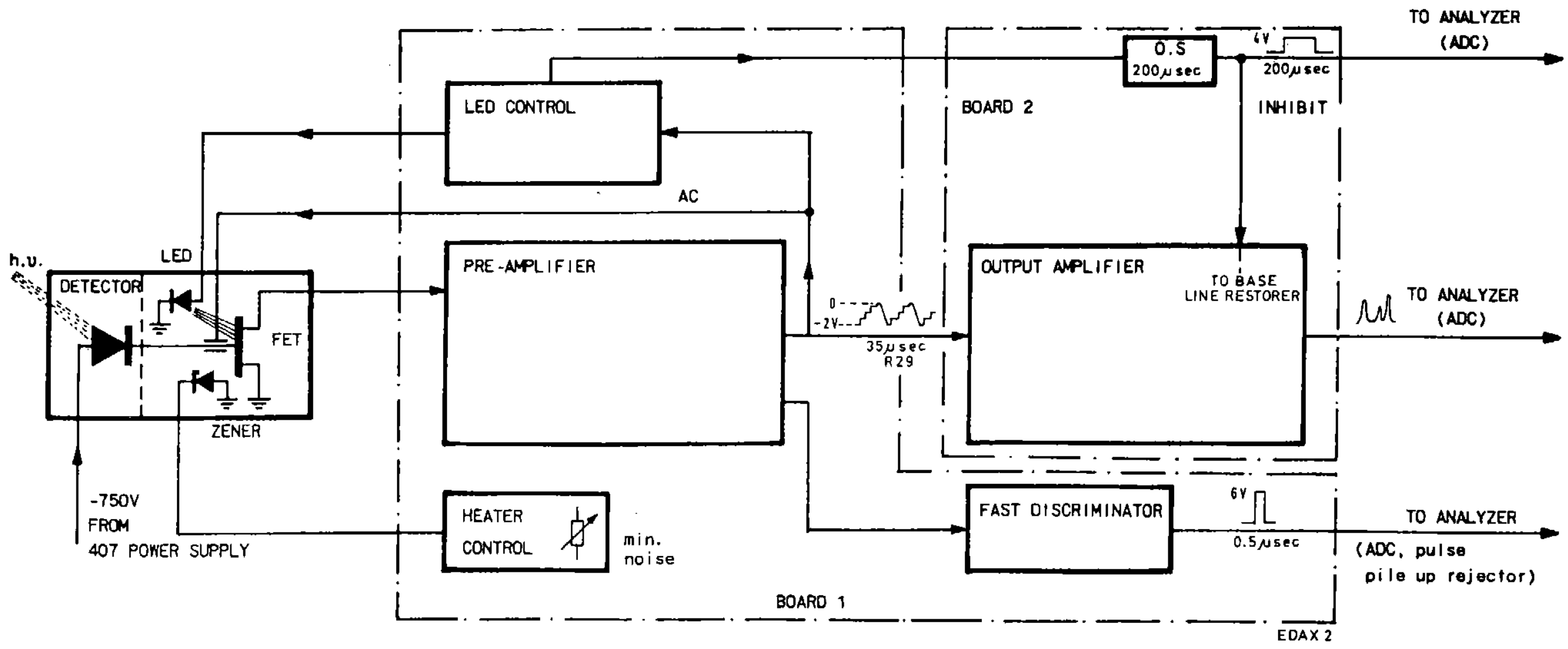
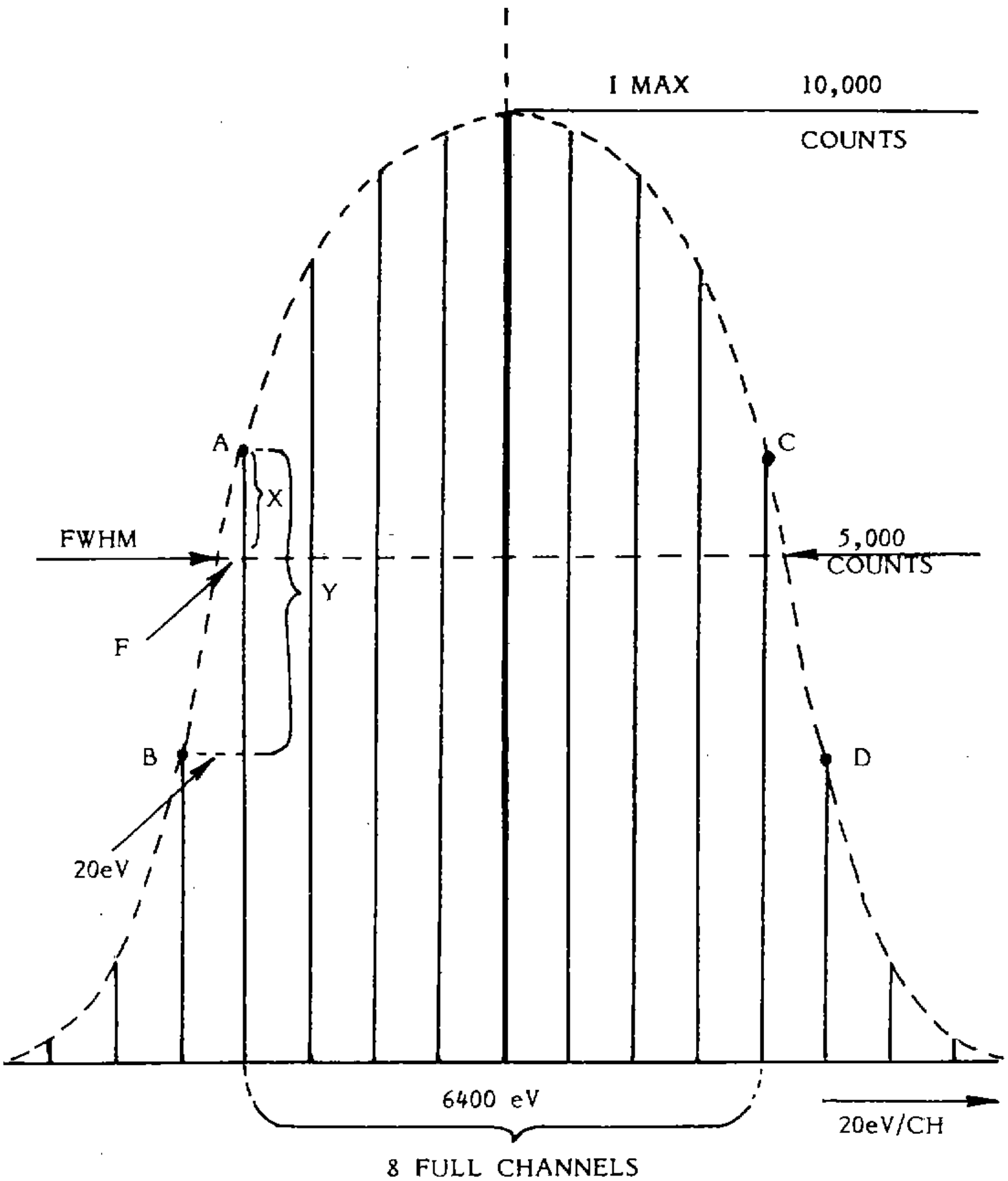



FIGURE 4

## DETERMINATION OF DETECTOR RESOLUTION




$$RES = 20 \left\{ \frac{A-5000}{A-B} + \frac{C-5000}{C-D} + \text{NUMBER OF FULL CHANNELS} \right\} eV$$

FIGURE 5

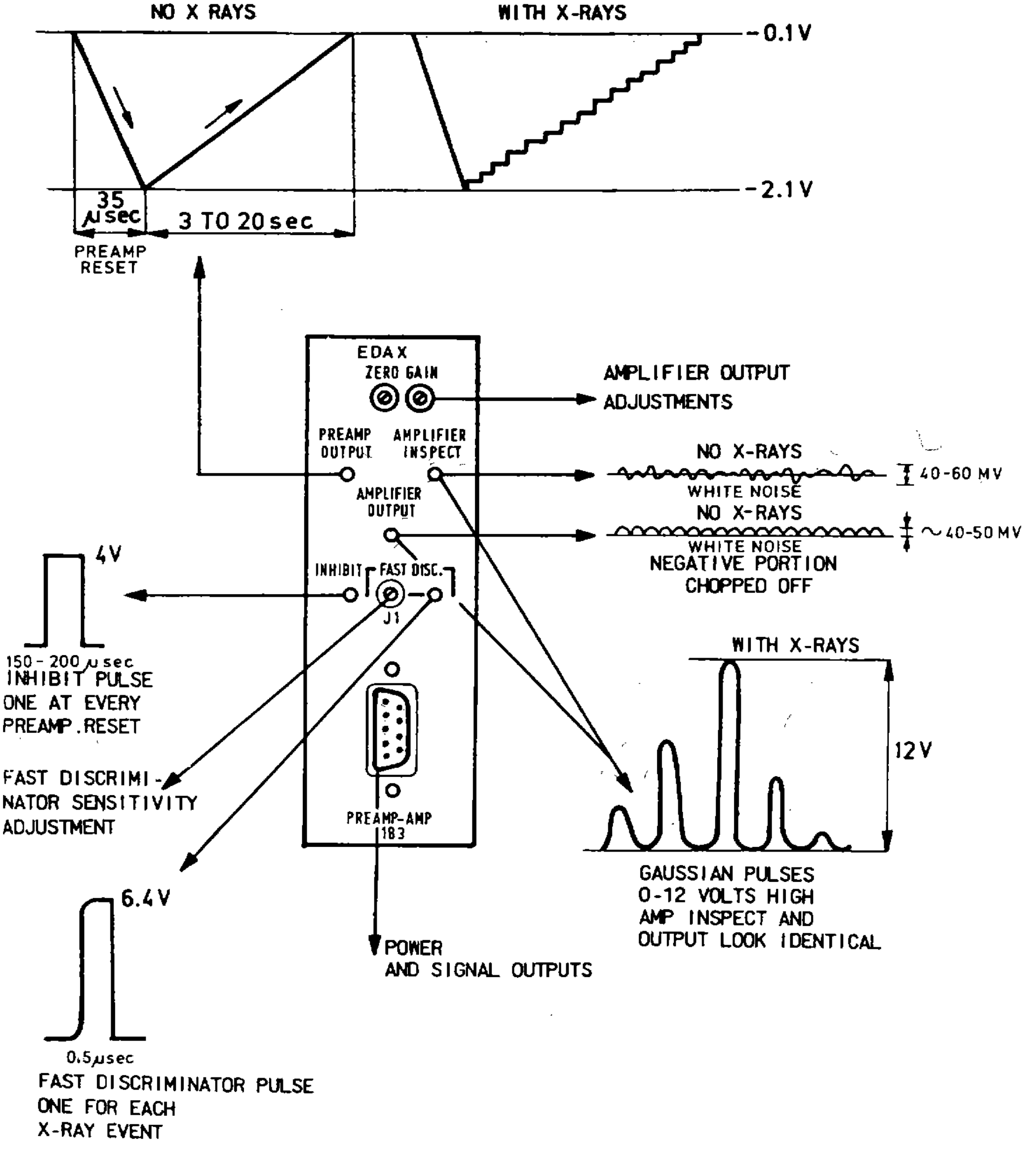

NO X RAYS
WITH X-RAYS
-0.1V
-2.1V
35 μsec
3 TO 20 sec
PREAMP RESET
EDAX
ZERO GAIN
AMPLIFIER OUTPUT ADJUSTMENTS
PREAMP OUTPUT
AMPLIFIER INSPECT
NO X-RAYS
WHITE NOISE
40-60 MV
AMPLIFIER OUTPUT
NO X-RAYS
WHITE NOISE
~40-50 MV
NEGATIVE PORTION CHOPPED OFF
4V
INHIBIT
FAST DISC.
J1
150-200 μsec
INHIBIT PULSE
ONE AT EVERY PREAMP. RESET
WITH X-RAYS
12V
FAST DISCRIMINATOR SENSITIVITY ADJUSTMENT
PREAMP-AMP 183
6.4V
GAUSSIAN PULSES 0-12 VOLTS HIGH AMP INSPECT AND OUTPUT LOOK IDENTICAL
POWER AND SIGNAL OUTPUTS
0.5μsec
FAST DISCRIMINATOR PULSE
ONE FOR EACH X-RAY EVENT

FIGURE 6

REPAIR REQUEST FOR
DETECTING UNIT

EDAX
INTERNATIONAL Inc.

P.O. Box 135, Prairie View, Illinois 60069
Phone (312) 634-0600 Telex 72-6407

DATE: ____________________

CUSTOMERS NAME: ____________________

ADDRESS: ____________________

TELEPHONE NUMBER: ____________________

P.O./W.O.: ____________________

R.A.: ____________________

DETECTING UNIT MODEL: ____________________

S/N : ____________________

AMPLIFIER MODEL: ____________________

S/N : ____________________

ANALYZER MODEL: ____________________

S/N : ____________________

MICROSCOPE MODEL: ____________________

S/N : ____________________

MICROSCOPE PORT: ____________________

1. Enclose with this request a copy of all record sheets.

2. Describe as accurately as possible the problems of the detecting unit that require repair:

3. If the Be-window is broken, indicate whether the power was on during the breakdown.

______________________________________________

4. Specify the rate of liquid nitrogen consumption with the power on.

______________________________________________

5. How many times did dewar run out of L.N.? ____________________

6. If the detecting unit has been warmed up, has power been switched off before refilling with LN?

______________________________________________

7. How long did you wait before switching on after refilling the dewar?

______________________________________________

8. Has amplifier ever been replaced?

______________________________________________

9. Please check with oscilloscope and draw following waveforms.

| PREAMPLIFIER OUTPUT | AMPLIFIER INSPECT | AMPLIFIER OUTPUT |
|---|---|---|

10. Remarks and questions.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

EDAX
INTERNATIONAL Inc.

P.O. Box 135, Prairie View, Illinois 60069
Phone (312) 634-0600 Telex 72-6407

# ECON
# DETECTING UNIT

SERVICE MANUAL

ORDERING CODE: 80-20110-00

Edax ADC: Wilkinson type, 0 - 8V,
4096 ch with
gain stability: 0.007 %/°C
zero stability: 0.1 eV/°C
peak stability: + to - 1 ch

## BLOCK DIAGRAM 183 PRE-AMPL./AMPL.

OLD VERSION OF AMPLIFIER

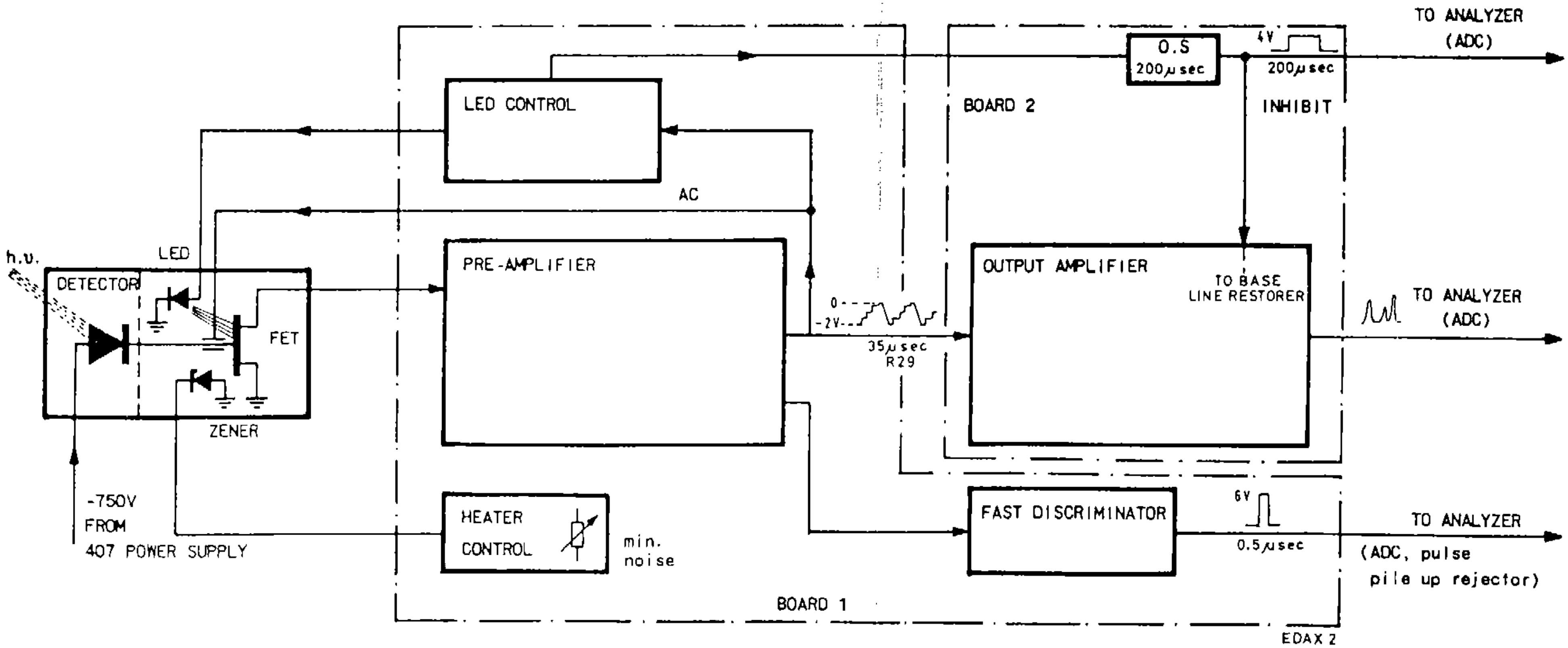



FIGURE 4

Edax ADC: Wilkinson type, 0-8V,
4096 ch with
gain stability: 0.001 %/°C
zero stability: 0.1 eV/°C
peak stability: + to - 1 ch

# BLOCK DIAGRAM 183 PRE-AMPL./AMPL.

OLD VERSION OF AMPLIFIER

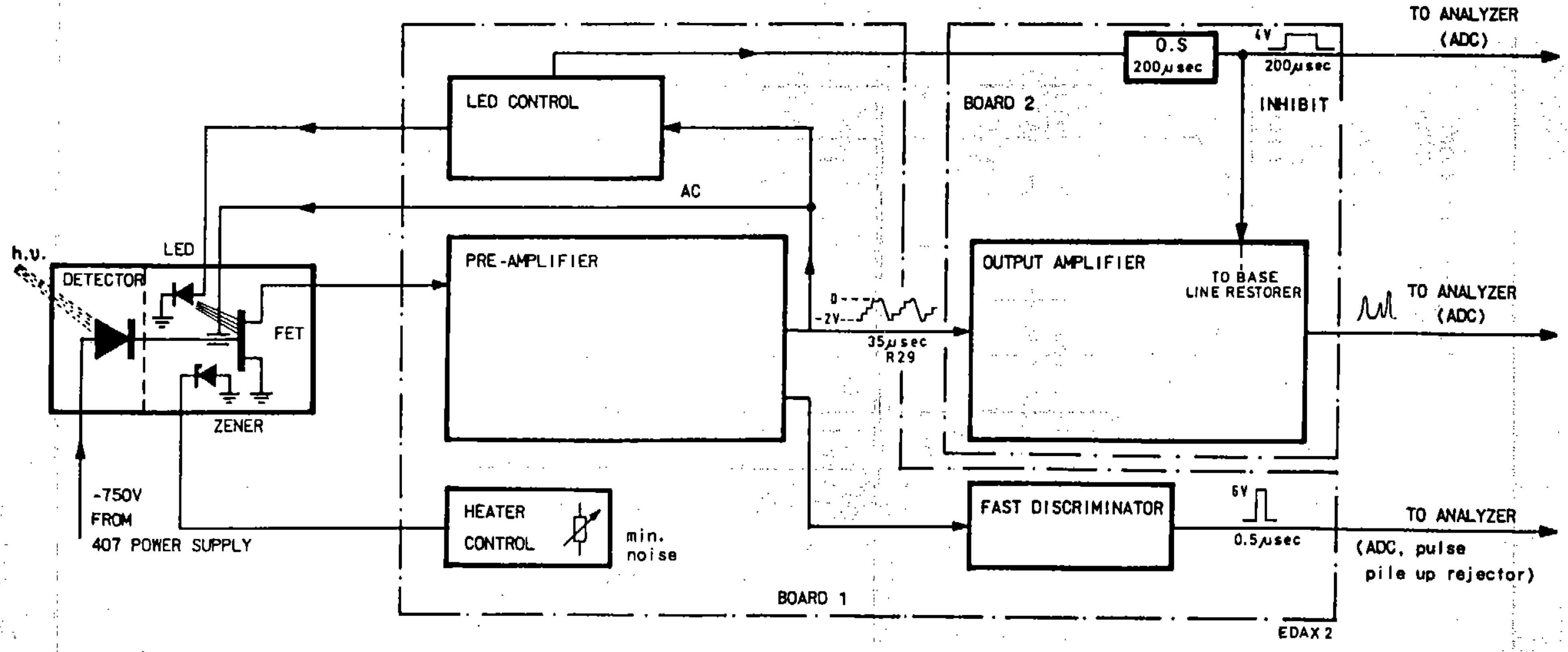



FIGURE 4

## CONTENTS



## LIST OF FIGURES

# 1. INTRODUCTION

The ECON detecting unit enables detection of ultra light elements.

ECON stands for EDAX Carbon Oxygen Nitrogen.

In general, the unit is only used with the Scanning Electron Microscopes, as the mechanical size of the end cap does not allow mounting to a Transmission Electron Microscope.

This booklet gives special information on the ECON detector, in addition to the standard EDAX detecting units. The latter units have been described in section four of the Service Manual (ordering code: 80-20000-00) as well as in the User's Manual (ordering code: 80-05100-00).

The information given here, is mainly intended for the field service engineer, and includes installation as well as operation instruction.

In the EDITor, Volume 6, number 3 (July 1976), application information has been given. A copy of this volume has been included in this manual.

## 2. DESCRIPTION OF THE UNIT

Figure 1 shows the ECON detecting unit.

The detector has been mounted to a coldfinger and inside an end cap. This end cap has an opening at a position, faced by the detector. Around this opening an O-ring is fitted.

The above described end cap assembly is surrounded by a cylinder. The front end of this cylinder has two window positions and one open position, rotated over 120 degrees with respect to each other.

A mechanism including a short lever, a long lever and a handle allow rotation and translation of the cylinder with respect to the end cap.

It is thus possible to select a different window. In case the handle is moved in the direction of the long lever, the cylinder will close the opening in the end cap with one of the windows or the detector will be directly facing the sample if the open window was in front. The rotation/translation movements can of course only be carried out if the detecting unit has been mounted to an evacuated column.

The rotation of the cylinder is possible with aid of the long lever. The short lever provides only a locking action.

Two windows are available. One is a 7.5 $\mu$m Be window, which is in line with the detector if the detecting unit is at atmospheric pressure. The other window is an alumized FORMVAR (plastic) window. This window is used as a contamination filter and light filter. It can be replaced while moreover windows of different thickness can be inserted.

A warning box has been included, indicating the status of the detecting unit during operation.

The box has been connected to a microswitch assembly on the detecting unit via a 15 foot cable. The circuitry can be supplied form the +5V supply of the current source on the rear panel of the analyzer. The cable for this connection has also a length of 15 feet.

Finally, a cable should be connected to the interlock circuitry of the vacuum system of the microscope. The cable (3 pole) is not supplied with the equipment.

The circuitry prevents the column from being vented with the FORMVAR window or the open position in line of the detector.

## 3. SPECIFICATIONS

In addition to the specification of EDAX detecting units as given in the User's Manual, (80-05100-00),the following information is important:

| | | |
|---|---|---|
| Detector surface | : | $10mm^2$ |
| Be-window | : | 7.5μm thick |
| Aluminized FORMVAR window | : | exchangeable |
| Time constant 183ampl. | : | 8μsecs |
| Dewar size | : | 10 l. |
| Distance detector surface to Be window | : | For PSEM500 24mm |

PSEM 500 - ECON

| | | |
|---|---|---|
| Take-off angle | : | $14^o$ |
| Distance specimen - detector | : | 35mm |
| Solid angle | : | 0.01023 steradians |

CRET - ECON

| | | UPPER | LOWER |
|---|---|---|---|
| Take-off angle | : | $-12^o$ | $0^o$ |
| Distance specimen - detector | : | 41.5mm | 29mm |
| Solid angle | : | 0.00763 | 0.01488 |

HHS-2R ECON

| | | UPPER | LOWER |
|---|---|---|---|
| Take off angle | : | $0^o$ | $12^0$ |
| Distance specimen-detector | : | 75mm | 77mm |
| Solid Angle | : | 0.00223 | 0.00211 |

# 4. INSTALLATION

## WARNING

The detecting unit is a delicate instrument! Do not touch the windows! If the black plastic cover is removed from the cylinder, the plastic (super thin) VORMAR window is exposed. Take off this plastic cover slowly, allowing air to enter into the cap via the small hole.

* Unpack the unit, very carefully.
* Position the unit on a table taking care that it can not fall over.
* Dry the dewar out with a dry gas (air, nitrogen) which can be flushed inside the dewar.
* Fill up the dewar with clean transparent liquid nitrogen (L.N.).

## WARNING

During cooling down, the unit may not be connected to the supply for at least 10 hours. The FET and/or detector may otherwise be damaged.

* Mount the unit to the SEM. This will not be very complicated, as the accessability at the SEM will normally be good.
* Connect the 2 pole cable to the +5V of the current source (black wire) on the rear panel of the 707 or 711 analyzer and the other wire to ground.
* A cable (3 pole) should be connected form the warning box to the interlock circuit of the SEM vacuum system. See also the wiring diagram, Figure 2.
* Do not yet connect the cables from the analyzer to the 183 amplifier.
* Switch on the analyzer. The red indicator should light up.
* Switch on the analyzer. The red indicator should light up.
* Switch off the analyzer again.
* After 10 hours have elapsed, switch on the analyzer, fix a $Co^{57}$ source over the window and adjust and check out the detecting unit.

# 5.MAINTENANCE

A set of Allen keys, a spare FORMVAR window and four bulbs have been delivered with the unit.

The ECON detecting unit does not need any special handling and maintenance other than described in the Detecting Unit User's Manual (ordering code: 80-05100-00) and as described in chapter four of the 707/711 Service Manual (ordering code: 80-20000-00).

As the outer cylinder is sliding on O-rings and teflon bushes no lubrication is required.

The be window can be cleaned by flushing with methyl-alcohol. If the dirt is not removed by this process, the window can be cleaned by wiping with a Q-tip dipped in methyl-alcohol.

Be extremely careful not to damage the window.

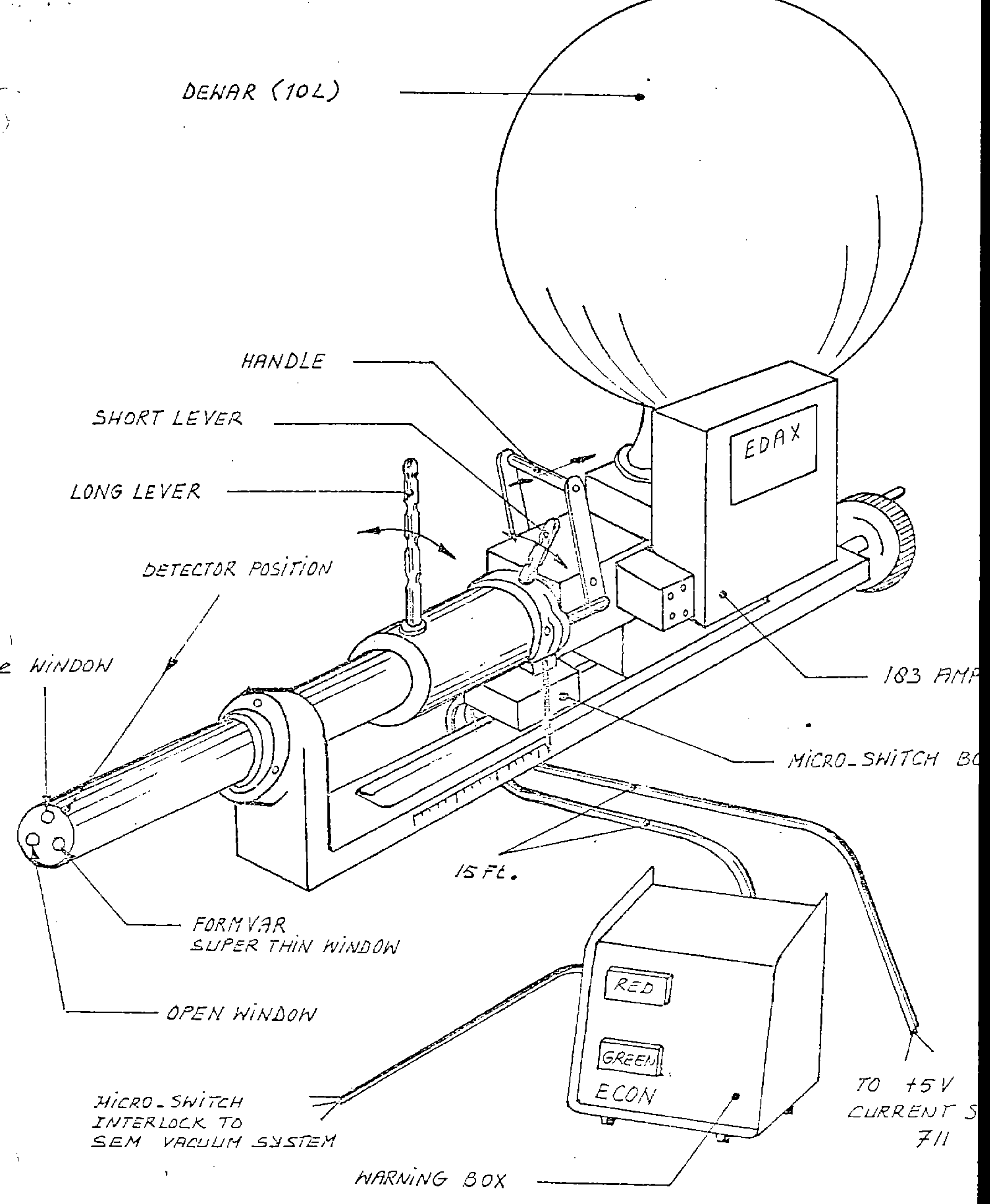

DEWAR (10L)
HANDLE
SHORT LEVER
LONG LEVER
DETECTOR POSITION
EDAX
Be WINDOW
183 AMP
MICRO-SWITCH BO
15 Ft.
FORMVAR
SUPER THIN WINDOW
OPEN WINDOW
RED
GREEN
ECON
MICRO-SWITCH
INTERLOCK TO
SEM VACUUM SYSTEM
TO +5V
CURRENT S
711
WARNING BOX

FIGURE 1

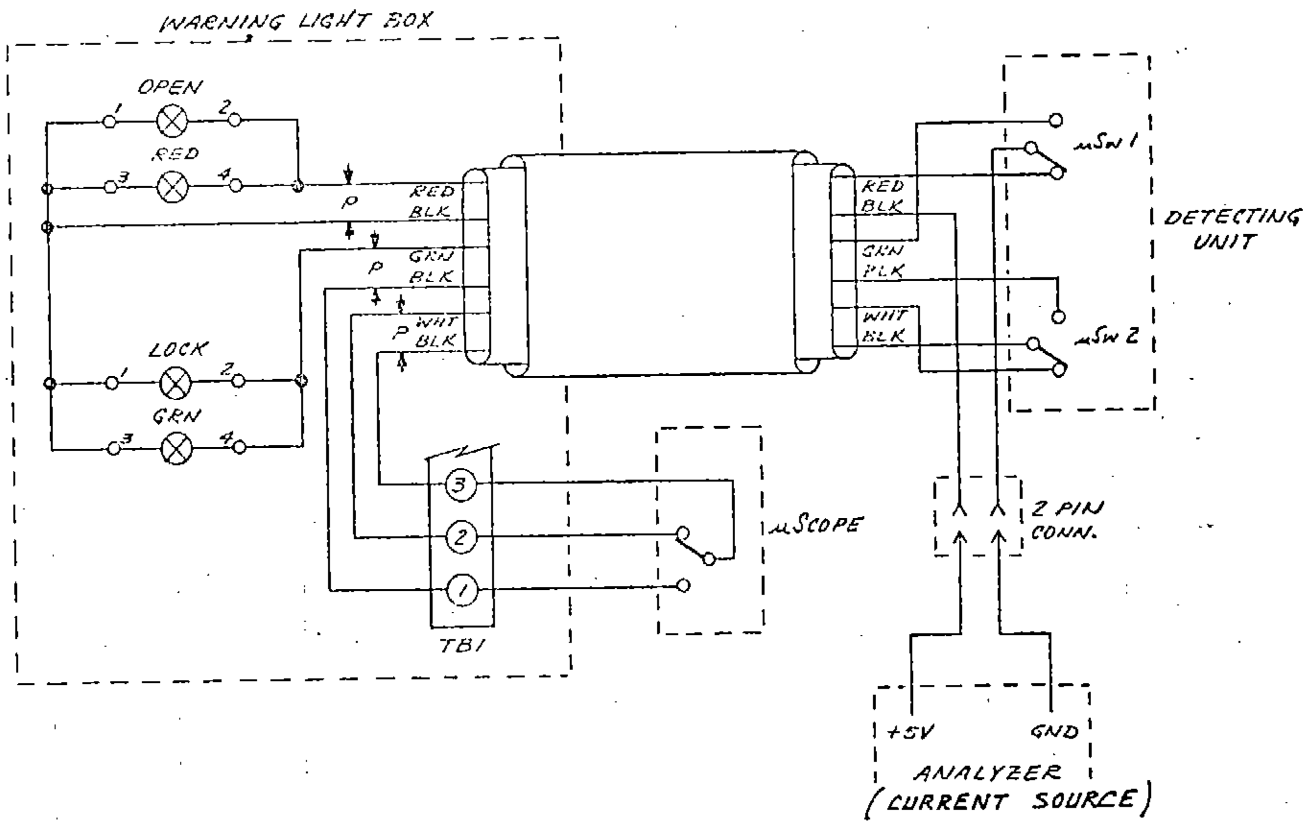



FIGURE 2

DWG NO 18-00204-62

| NO. | REVISION RECORD | DATE | APPR. |
|---|---|---|---|
| 1 | RTP 1530 | 1-19-77 | |

MATERIAL

FINISH

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED

| FRAC. | DEC. | ANG. |
|---|---|---|
| ± 1/64 | ± .005 | ± 30' |

SCALE

| | SIGNATURE | DATE |
|---|---|---|
| DWN | R. CADE | 1-17-77 |
| CHK | | |
| DES | | |
| APPR | | |
| APPR | | |



TITLE ECON VACUUM STATUS

EDAX INTERNATIONAL Inc.
PRAIRIE VIEW, ILLINOIS

SCHEMATIC

DWG NO 18-00204-62 | REV 1 | SH 1 OF 1

# 6. SPARE PARTS LIST

DATE ISSUED 01/28/77

DRAWING NO. 76-0119801 DESC. HHS 2R ECON SPECTROMETER

| COMPONENT PART NO. | DESCRIPTION | QTY/ ASSY | U/M |
|---|---|---|---|
| 0081580001 | 158E H.V. BOX | 1 | |
| 15-0034701 | TANDEM MICRO SWITCH ACTUATOR | 1 | |
| 15-0058791 | PSEM 500 ECON WASHER | 4 | |
| 15-0058891 | PSEM 500 ECON PUSH ROD NUT | 2 | |
| 23-0015391 | PLATINUM CONTACT | 1 | |
| 23-0019900 | 2 PIN GLASS FEED THRU (USED ON DEWAR) | 1 | |
| 23-0034200 | 7 PIN GLASS FEED THRU (USED ON DEWAR) | 1 | |
| 31-0005300 | MINIATURE PRECISION SNAP SWITCH | 2 | |
| 36-0001000 | #8-32X1/2 LG. SOCKET HEAD CAP SCREW | 6 | |
| 36-0008200 | S.H.C.S. #4-40 X 1/2 LONG (S.S.) | 10 | |
| 36-0008700 | S.H.C.S. #4-40 X 3/8 LG. (S.S.) | 4 | |
| 36-0009700 | S.H.C.S. #6-32 X 3/8 LG. STAINLESS STEEL | 6 | |
| 36-0010100 | S.H.C.S. #8-32 X 1 LG. STAINLESS STEEL | 2 | |
| 36-0013900 | S.H.C.S. #2-56 X 1/2 LG. (S.S.) | 2 | |
| 36-0020030 | 1/4 D X 3/8 SOC.HD SHOULDER SCR #10-24 THD (S.S.) | 2 | |
| 36-1001500 | S.H.C.S. #4-40 X 1 LG (S.S.) | 4 | |
| 36-1004900 | S.H.C.S. #2-56 X 1/4 LG (S.S.) | 3 | |
| 36-1010700 | #6-32 X 5/8 SOCKET HD SCREW S.S. | 4 | |
| 36-1011000 | #8-32X1/2LG OVAL PHILLIPS HD SCREW SS | 4 | |
| 37-0000800 | .489 I.D. X .070 DIA. O-RING | 1 | |
| 37-0002500 | 1.984 I.D. X .139 DIA. O-RING | 1 | |
| 37-0004200 | 2.300 I.D. X .103 DIA. O-RING | 1 | |
| 37-0004300 | 1.484 I.D. X .139 DIA. O-RING | 1 | |
| 37-0008100 | 1.925 I.D. X .103 DIA. O-RING | 1 | |
| 76-0005291 | BE WINDOW FOR JEM 50A | 1 | |

27-00335-71 BULB FOR WARNING BOX TYPE: 02-903 OF UNIMAX-SWITCH

DATE ISSUED 01/28/77

DRAWING NO. 76-0119801 DESC. HHS 2R ECON SPECTROMETER

| COMPONENT PART NO. | DESCRIPTION | QTY/ ASSY | U/M |
|---|---|---|---|
| 76-0026101 | SEAL OFF VALVE-THREADED | 1 | |
| 76-0032091 | JSHU3 C.M. 183 MTG. BLOCK | 1 | |
| 76-0046291 | ECON MAGNET | 2 | |
| 76-0069792 | PSEM 500 ECON INTERLOCK B LOCK | 1 | |
| 76-0069891 | PSEM 500 ECON LOCK | 1 | |
| 76-0069991 | PSEM 500 ECON CAP STOP | 1 | |
| 76-0074891 | PSEM 500 ECON WASHER | 2 | |
| 76-0074991 | PSEM 500 ECON PIVOT SCREW | 2 | |
| 76-0075091 | PSEM 500 ECON PUSH ROD | 2 | |
| 76-0075292 | PSEM 500 ECON ELECTRON TRAP HOLDER | 1 | |
| 76-0075391 | PSEM 500 ECON ELECTRON TRAP | 1 | |
| 76-0075591 | PSEM 500 ECON STAR | 1 | |
| 76-0075691 | PSEM 500 ECON SLEEVE CAP | 1 | |
| 76-0075892 | PSEM 500 ECON END CAP | 1 | |
| 76-0075992 | PSEM 500 ECON HANDLE | 1 | |
| 76-0090891 | P-500 ECON PIVOT ROD SUPPORT | 2 | |
| 76-0094033 | CRET ECON DEWAR SUPPORT BLOCK | 1 | |
| 76-0094894 | CRET ECON DEWAR SUPPORT BLOCK | 1 | |
| 76-0095491 | PSEM 500 ALIGNMENT SCREW | 1 | |
| 76-0095591 | PSEM 500 ECON SHIPPING COVER | 1 | |
| 76-0095691 | PSEM 500 ECON CAP HANDLE | 1 | |
| 76-0095791 | PSEM 500 ECON LOCKHANDLE | 1 | |
| 76-0096092 | CRET ECON INNER CAP | 1 | |
| 76-0096191 | CRET ECON STAR | 1 | |
| 76-0105101 | RESISTOR HEATER ASSEMBLY | 1 | |
| 76-0105301 | FIBER OPTIC LIGHT ASSEMBL Y | 1 | |
| 76-0105701 | FET HOLDER ASSEMBLY | 1 | |
| 77-0001593 | SPHERICAL DEWAR PSEM 500 10 LITRE BOTTOM LOOKER | 1 | |
| 78-0013991 | JSM 35 COLD FINGER | 1 | |
| 78-0014701 | CRET ECON FLEXIBLE COLD FINGER | 1 | |
| 78-1001692 | PSEM 500 ECON DETECTOR BASE | 1 | |
| 78-2001691 | ECON BORON NITRIDE ROD | 1 | |
| 78-3003092 | DETECTOR HOLDER (UNIVER-SAL) | 1 | |
| 78-3003491 | PSEM 500 ECON DETECTOR HOLDER | 1 | |

DATE ISSUED 01/28/77

DRAWING NO. 76-0119801. DESC. HHS 2R ECON SPECTROMETER

| COMPONENT PART NO. | DESCRIPTION | QTY/ ASSY | U/M |
|---|---|---|---|
| 78-4002091 | 3MM KEL-F | 1 | |
| 78-5013133 | HHS 2R OUTER CAP,ENGRAVED | 1 | |
| 78-5013194 | HHS 2R OUTER CAP | 1 | |
| 78-5013293 | HHS 2R CAP | 1 | |
| 97-0045695 | HHS 2R ECON | REF | |

- END -

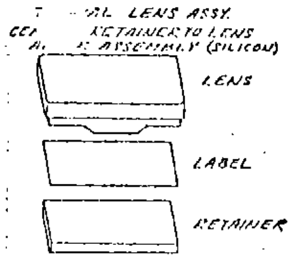
DATE ISSUED 01/23/77

DRAWING NO. 76-0119901 DESC. HHS 2R ECON EXTERNAL PARTS

| COMPONENT PART NO. | DESCRIPTION | QTY/ ASSY | U/M |
|---|---|---|---|
| 15-0027600 | 5/64 SHORT ARM ALLEN WRENCH | 1 | |
| 15-0033100 | 9/64 ALLEN WRENCH | 1 | |
| 15-0033200 | 5/32 ALLEN WRENCH | 1 | |
| 15-0033400 | 3MM ALLEN WRENCH | 1 | |
| 15-0034501 | SPHERICAL DEWAR FUNNEL ASS'Y | 1 | |
| 36-0010200 | S.H.C.S. #10-32 X 1/2 LG. STAINLESS STEEL | 6 | |
| 36-1000600 | PHILLIPS FLAT HD. #0-80 X 1/8 LG. (S.S.) | 2 | |
| 36-1001000 | S.H.C.S. #8-32 X 3/8 LG ( S.S.) | 12 | |
| 36-1010000 | SOCKET HD SCREW M8 X 20MM | 4 | |
| 36-1012000 | #8-32 X 2LG. PHILLIPS FLAT HD SCREW | 4 | |
| 36-1012900 | SOCKET HD. SCREW M4X14MM S.S. | 4 | |
| 36-4002600 | WALDES TRUARC RETAINING RING N5000-200 | 1 | |
| 37-0004000 | 1.674 I.D. X .103 DIA. O-RING | 1 | |
| 37-0008100 | 1.925 I.D. X .103 DIA. O-RING | 1 | |
| 76-0095291 | CRET ECON INDICATOR | 1 | |
| 76-0095391 | CRET ECON SLEEVE | 1 | |
| 76-0119501 | HHS 2R ECON RETRACTABLE FRAME ASSEMBLY | 1 | |
| 76-0119692 | HHS 2R ECON SIDE PLATE | 2 | |
| 76-0119793 | HHS 2R ECON FRONT PLATE | 1 | |
| 97-0045695 | HHS 2R ECON | REF | |

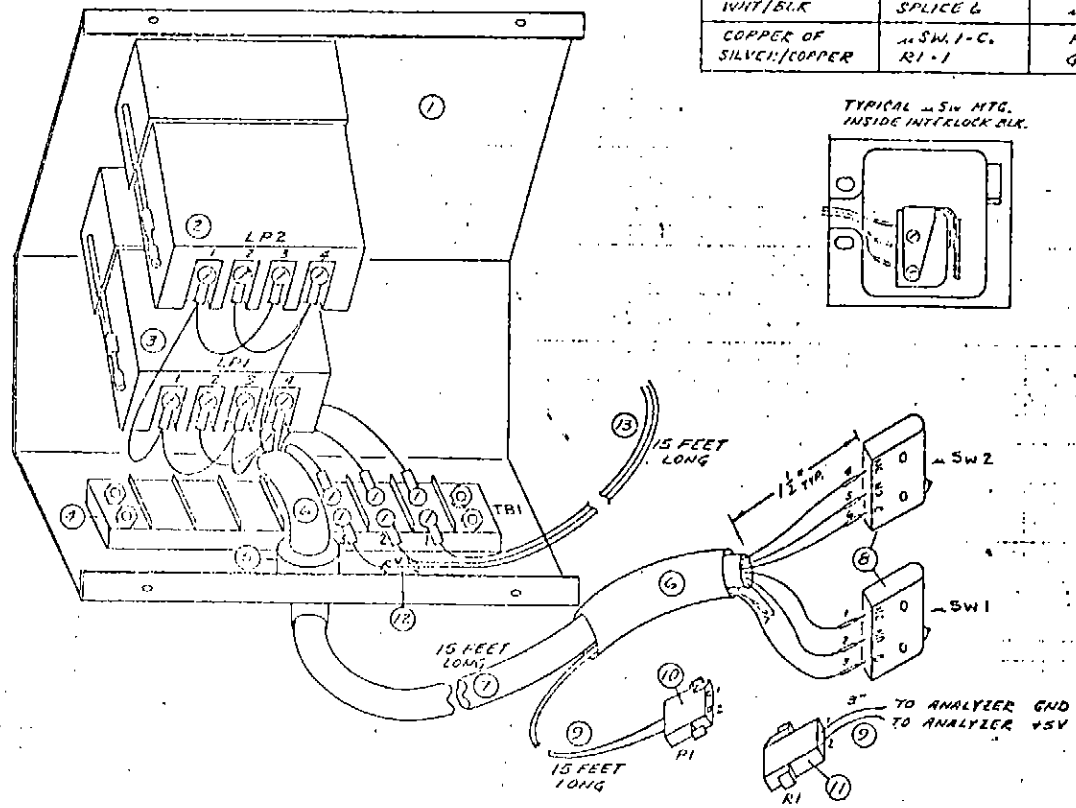
- END -

| ITEM | DESIGN | QTY | EDAX PART NO |
|---|---|---|---|
| 1 | FRONT PA[illegible] | 1 | 30-00304 93 |
| | COVER [illegible] | 1 | 18-00172 93 |
| 2 | LOCK L[illegible] L | 1 | 30-00305 91 |
| | RETAINER | 1 | 15-00437 91 |
| | LAMP HOUSING | 1 | 27-00334 71 |
| | LAMP BULB | 2 | 27-00335 71 |
| | LENS GRN | 1 | 27-00337 71 |
| | TERM | 4 | 23-00395 71 |
| 3 | OPEN LABEL | 1 | 30-00306 91 |
| | RETAINER | 1 | 15-00437 91 |
| | LAMP HOUSING | 1 | 27-00334 71 |
| | LAMP BULB | 2 | 27-00335 71 |
| | LENS RED | 1 | 27-00336 71 |
| | TERM | 4 | 23-00395 71 |
| 4 | BARRIER STRIP | 1 | 23-00307 00 |
| | 6-32 x 1/2 PHH | 4 | 36-10030 00 |
| | 6-32 NUT | 4 | 36-00031 00 |
| | TERM | 3 | 23-00395 71 |
| 5 | STRAIN RELIEF | 1 | 17-00313 71 |
| 6 | SHRINK TUBE | 1 FT | 33-00021 00 |
| 7 | CABLE 6 COND. | 16 FT | 33-00027 00 |
| 8 | [illegible] SW. | 1 | 15-00327 01 |
| | SHRINK TUBE | 1 FT | 33-00011 00 |
| 9 | SHIELDED CABLE | 16 FT | 33-00100 71 |
| 10 | CONN. 2 PIN (M) | 1 | 23-00202 00 |
| | CONN. PINS (F) | 2 | 23-00016 00 |
| 11 | CONN. 2 PIN (F) | 1 | 23-00201 00 |
| | CONN. PINS (M) | 2 | 23-00017 00 |
| 12 | HOLE PLUG | 1 | 15-00336 71 |
| 13 | CABLE | 15 FT | 33-00033 00 |
| | TERM | 3 | 23-00395 71 |




| COLOR | FROM | TO |
|---|---|---|
| RED OF RED/BLK | LP1-2<br>LP1-4<br>SPLICE 1 | LP1-4<br>SPLICE 1<br>μSW.1-N.C. |
| BLK OF RED/BLK | LP2-3<br>LP2-1<br>LP1-1<br>LP1-4 | LP2-1<br>LP1-1<br>LP1-4<br>SPLICE 7 |
| SILVER OF SILVER/COPPER | SPLICE 7<br>R1-2 | P1-2<br>+5V (REF) |
| GRN OF GRN/BLK | LP2-2<br>LP2-4<br>SPLICE 2 | LP2-4<br>SPLICE 2<br>μSW.1-N.O. |
| BLK OF GRN/BLK | TB1-1<br>SPLICE 5 | SPLICE 5<br>μSW.2-N.O. |
| WHT OF WHT/BLK | TB1-2<br>SPLICE 4 | SPLICE 4<br>μSW.2-N.C. |
| BLK OF WHT/BLK | TB1-3<br>SPLICE 6 | SPLICE 6<br>μSW.2-C. |
| COPPER OF SILVER/COPPER | μSW.1-C.<br>R1-1 | P1-1<br>GND (REF) |

BOTTOM VIEW




NOTE: 1. ALL CABLE LENGTHS ARE MEASURED FROM ONE EXTERIOR HOUSING TO ANOTHER, ± 1 INCH.

2. LABEL ALL CONNECTIONS AND TERMINALS OF TB1 WITH BRADY MARKERS.

FIGURE 3

| NO | REVISION RECORD | DATE | APPR. |
|---|---|---|---|
| 1 | PIP 1330 | 1-19-77 | [illegible] |

DWG NO. 18-00204-23

| MATERIAL | DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED: FRAC. ± 1/64, DEC. ± .005, ANG. ± .30' | SIGNATURE | DATE |
|---|---|---|---|
| FINISH | SCALE | DWN [illegible] | 1-12-77 |
| | | CHK | |
| | | DES | |
| | | APPD | |
| | | APPD | |



TITLE ECOM VACUUM STATUS

EDAX INTERNATIONAL Inc. PRAIRIE VIEW, ILLINOIS

ASSEMBLY

DWG NO 18-00204-23 SH 1 OF 1