"LEW-II"

The New

Lightning Early Warning

System

At

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Albuquerque, NM

June, 1980

DISCLAIMER

1.0 The LEW System

1.1 Overview

Between 1971 and 1973 Sandia Labs developed a system of sensors, displays, and computers to serve as an electrostatic, or potential gradient (PG) trend indicator.

Since that time this system has been used, and trusted, by the many Sandia departments concerned with explosives, triggers, and a number of other safety aspects both in and out of the test field.

The success of the system has warrented an update of the system, and a brief description of these advancements follow.

1.2 The Previous System

The system to date consisted of four major components:

1) The Sweeney Electrostatic Sensor
2) The User Display
3) The Central Computer
4) The RFPG units.

1) The Sweeney Sensors, Figure 1.1, are placed in and around the Sandia East area of Kirtland AFB. Most are connected to the computer system via landline, some traveling many miles. Both power and a data return is provided by these lines.

Disadvantages

a) The running of landlines limits the geographical location of the sensors, is extremely expensive, and creates extraordinary maintenance problems.

b) The landlines are inherently suseptable to noise and E.M. radiation. Thus when most needed, the data is least reliable.

2) The User Display, Figure 1.2, is used by the concerned parties as a trend indicator and warning device.

The right hand side contains a silkscreened map of SLA, with a red light located at each sensor location. Any sensor reading over 2000 V/m causes that respective lamp to light.

The left side has several indicators showing the highest reading in the system, error status, a user-selectable readout showing the actual reading (in V/m) of one station, and user selectable "CAUTION" and "ALARM" points. These two selectors affect the operation of three warning lamps, an audio alarm, and some switch closures at the rear of the unit. The display is also connected to the computer via landline.

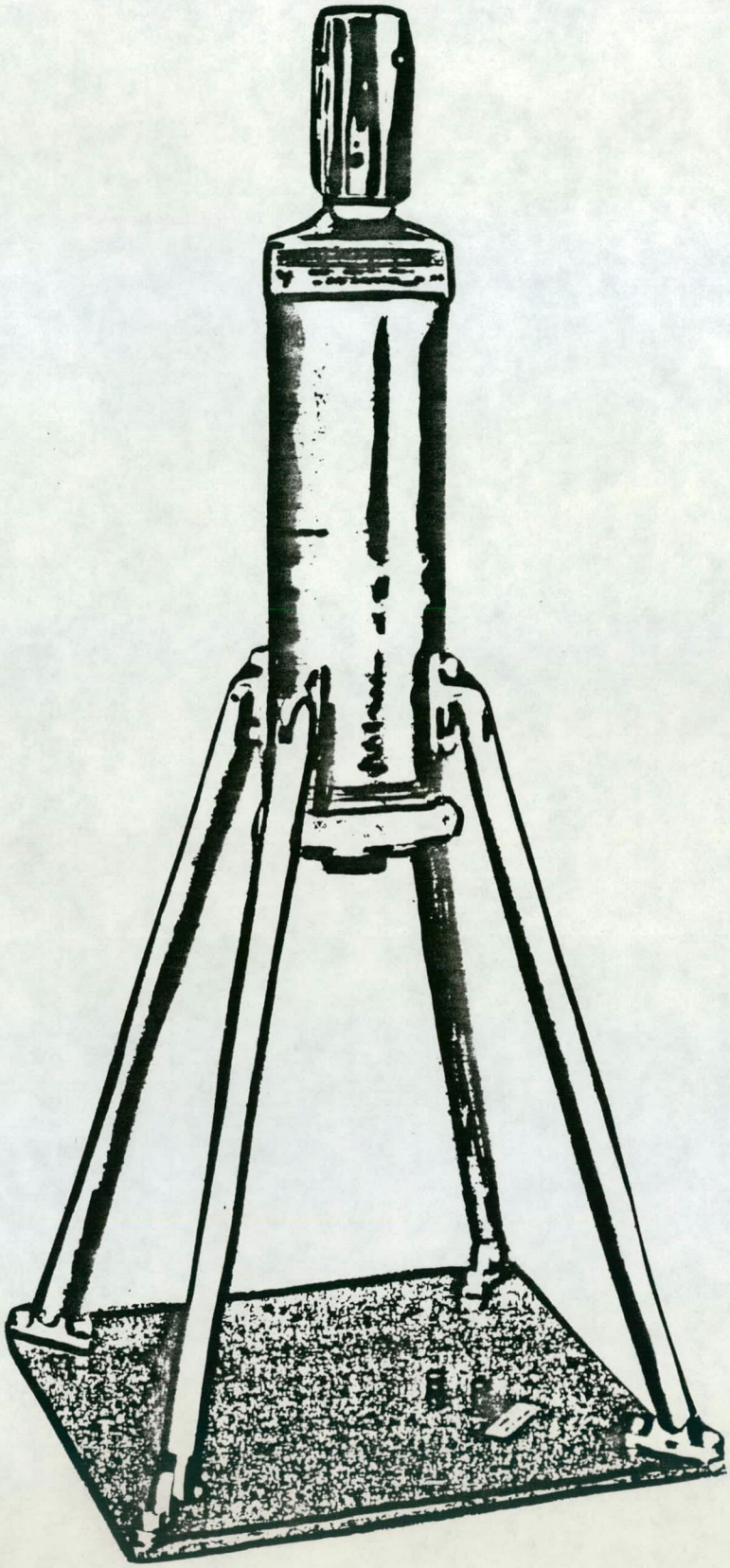


Figure 1.1
Sweeney P.G. Sensor

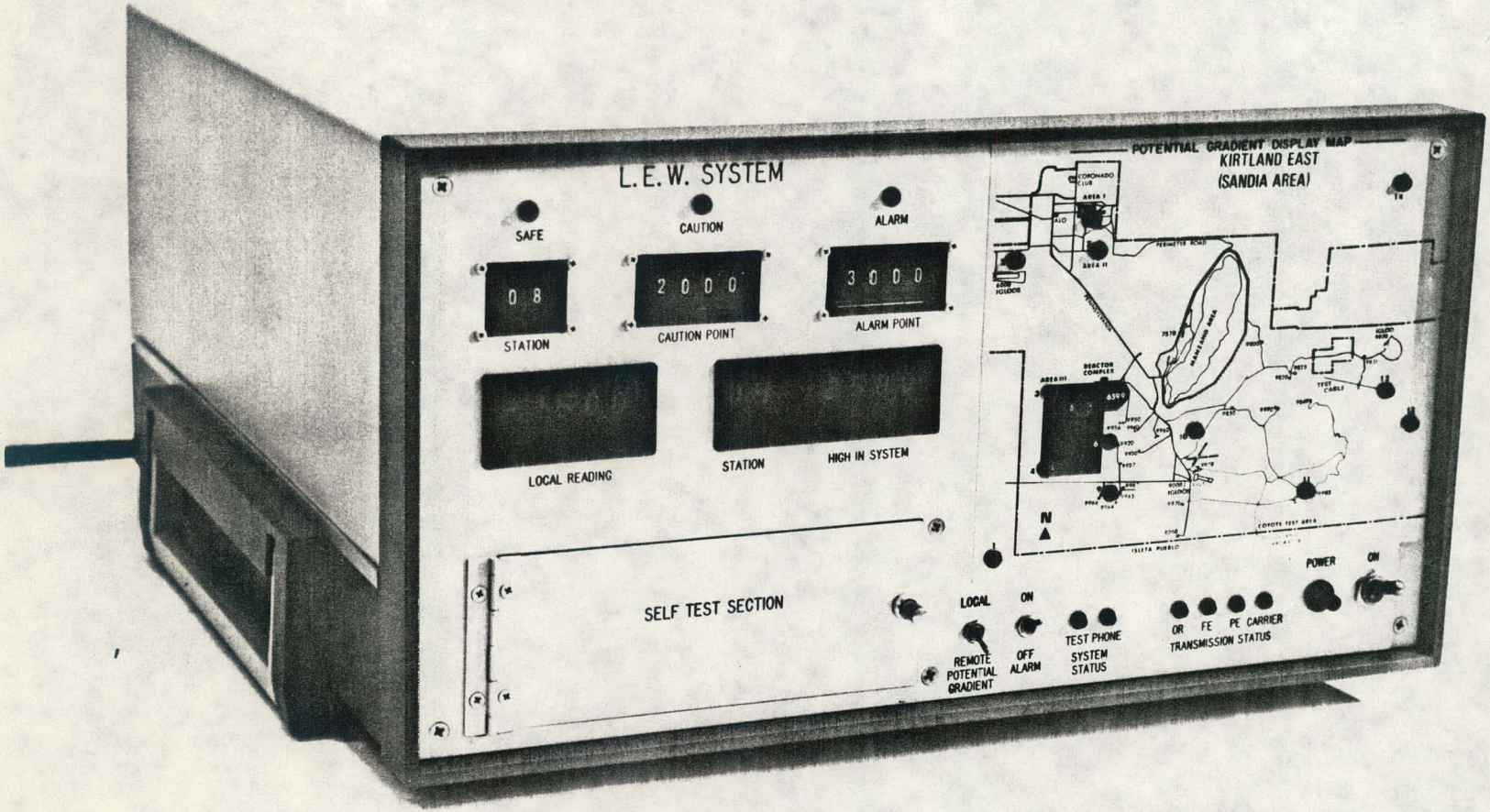


Figure 1.2
Previous User Display

Disadvantages

a) The unit is capable of displaying only 16 sensor locations maximum.

b) Any physical relocation or additon of a sensor to the system meant major hardware modification to the map.

c) Again, the use of landlines was expensive and introduced data error.

d) The display could be viewed by only a small number of people, and the prohibitive cost ($5K each) prevented widespread use of the display.

3) The computer, an HP-M-series, operates as the controller and data device. It collects the PG readings and retransmits it to the user display.

Disadvantages

a) The computer operates under a core-resident program system. Any power failure causes the downing of the whole system until the people maintaining the system can reboot the computer.

4) Several RF-linked Sweeney probes were later added to the system. Each is called, or "paged" by a unique audio frequency. The unit is battery operated, and solar cell charged.

Disadvantages

a) As ambient temperature in the unit varies (as low as 15^{o}F and as high as 100^{o}F) component values change significantly, causing false, and sometimes no activation.

b) The computer/RF interface could page only 4 sensors maximum.

1.3 The New System, LEW-II

In light of the disadvantages discussed, the following improvements have been made. The entire new system is expected to be in operation by Autumn of 1980.

1) A new user display (See Section 2) has been designed. Many of the desirable features of the previous display have been incorporated into the new unit. However, the following improvements have been made:

a) The display is microprocessor-based (TM990/100). All displays, switches, etc., are software controlled and can serve a variety of functions. This adds a great degree of flexibility to specific user needs.

b) The original hardware map has been replaced by a television screen. Any of two maps can be generated, or altered, without hardware modification. All readings from all sensors are displayed, and the user can alter the display special effects relative to those readings to create a unique visual indicator.

Also, up to ten additional monitors can be connected to the display unit offering a wider degree of distribution for less investment. At current costs, a new display and four remote monitors can be purchased for the price of one previous display.

c) An RF receiver, as well as a landline, can be used for data input.

d) The unit has a self diagnostic program which decreases maintenance down-time.

2) The Sweeney Sensor system, Section 3, has been redesigned for a total RF system. Paging is accomplished by Manchester Phase encoding. Up to 127 sensors can be incorporated without hardware modification.

Again, the system is battery operated, with a solar cell charging system. Conservative power requirements and precise timing circuits will allow maintenance-free operation up to one year. Improvements include:

a) The units can be placed practically anywhere the sun shines.

b) The use of RF increased the reliability of the data.

c) The use of a digital paging scheme reduces chances of false activation.

3) The computer system will be updated with new software and a disc operated system to increase the reliability and ease-of-use of the system.

Therefore, the entire LEW-II system is now general in nature. It is no longer restricted to use by Sandia Labs only. Any corporation or laboratory concerned with the same safety measures as SLA will find this system to be a major asset to their overall operation.

2.0 LEW-II Panel Features

2.1 Understanding Potential Gradient

Potential Gradient (P.G.) is a voltage measurement made one meter above the ground. The reading may have either polarity, depending on the conditions of the atmosphere with respect to those of the earth. Ground reference is earth.

The magnitude of the reading varies with the static conditions in the area. As an example, a calm clear day may offer readings between 0-1000 V/m, while 6000-10,000 V/m readings may accompany a stormy day. It is this "trend" in conditions that can be used to foresee possible lightning and storm conditions.

To date, there is no exact method of measuring P.G. levels. However, the information presented can be used to accurately predict upcoming events by comparing each reading to all the rest, and, by comparing current readings to past readings.

2.2 Front Panel Description

Figure 2.1 depicts the front panel of LEW-II. A brief description of each feature is presented here.

A * "CAUTION POINT" SELECTOR SWITCH: User-selectable setting (in V/M) used to activate caution flags on display.

B * FLAG LIGHTS: "Safe" lights when reading on display is below CAUTION POINT A. "Caution" lights when reading is between CAUTION POINT A and ALARM POINT C. "Alarm" lights when reading is above ALARM POINT C.

C * "ALARM POINT" SELECTOR SWITCH: User-selectable setting (in V/m) used to activate alarm flags on display.

D CRT DISPLAY: Black and white television screen depicting probe locations, station numbers, and station readings on either of two area maps.

E * SELECTED READOUT: LED digit readout used to display the P.G. reading of one station from all those displayed on the CRT, or that of the local probe.

Q * STATION SELECT SELECTOR SWITCH: Selects which station to display on readout E.

F SELECTED STATION READOUT: LED digit readout which displays the station number on STATION SELECT SWITCH Q. A "ØØ" will be displayed when LOCAL/REMOTE SWITCH I is in "LOCAL" position.

G * AUDIO ALARM: Attention-getting device activated when ALARM FLAG LIGHT B is on.

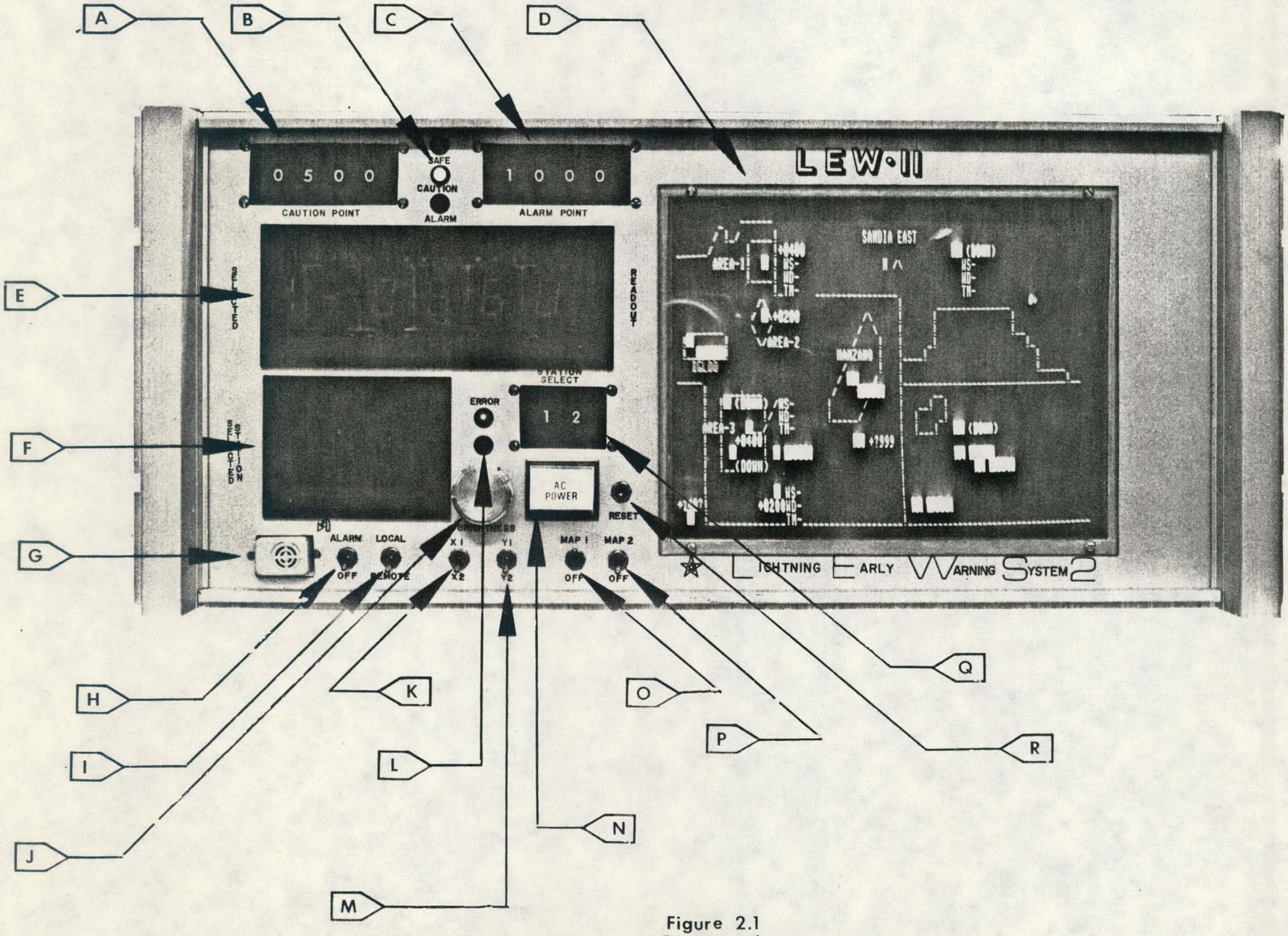


Figure 2.1
Front Panel

H * ALARM ON/OFF SWITCH: Disengages audio alarm.

I * LOCAL/REMOTE SWITCH: When in "LOCAL" position, the STATION SELECT SWITCH Q is disengaged, and a "ØØ" will appear on SELECTED STATION READOUT F. The local probe reading will appear on SELECTED READOUT E. When in "REMOTE" position normal operation resumes.

K X1/X2 SWITCH: Reserved for future modification.

J BRIGHTNESS CONTROL: Modified intensity of CRT display.

M Y1/Y2 SWITCH: Reserved for future modification.

L * ERROR FLAG LIGHT: When on, indicates an error was detected during reception of data. Data on CRT or readouts may be incorrect. (Other light is reserved for future modifications.)

N * A.C. POWER SWITCH: Turns unit on and off.

O "MAP-1" SWITCH: Causes one of two area maps to be displayed on CRT screen.

R RESET SWITCH: Resets displays and microprocessor.

P "MAP-2" SWITCH: Causes one of two area maps to be displayed on CRT screen.

*Identical to older display units.

2.3 Back Panel Description

Figure 2.2 depicts the back panel of LEW-II.

S * USER LOOPS: Relay switch points activated with respect to FLAG LIGHTS B. These closures may be used to activate other equipment (lights, alarms, etc.) chosen by the user, and will carry 2 AMPS @ 120 VAC.

T * LOCAL PROBE INPUT: Socket which accepts an additional "local" P.G. probe to monitor P.G. conditions near the LEW-II site. Probe is read by placing LOCAL/REMOTE SWITCH I in "LOCAL" position, or when "ØØ" is selected on STATION SELECT Q.

U * LOCAL PROBE FUSE: 1/16 AMP @ 120 VAC, FAST BLOW.

V COMPOSITE VIDEO OUT: Allows connection of up to 10 remote T.V. monitors which will display a copy of the CRT screen. Use 50 ohm coax, 2000 ft. max. length. Monitor should have a minimum bandwidth of 10 MHz for maximum clarity.

W * MODEM INPUT: Input connection for telephone data lines.

*Identical to older display units.

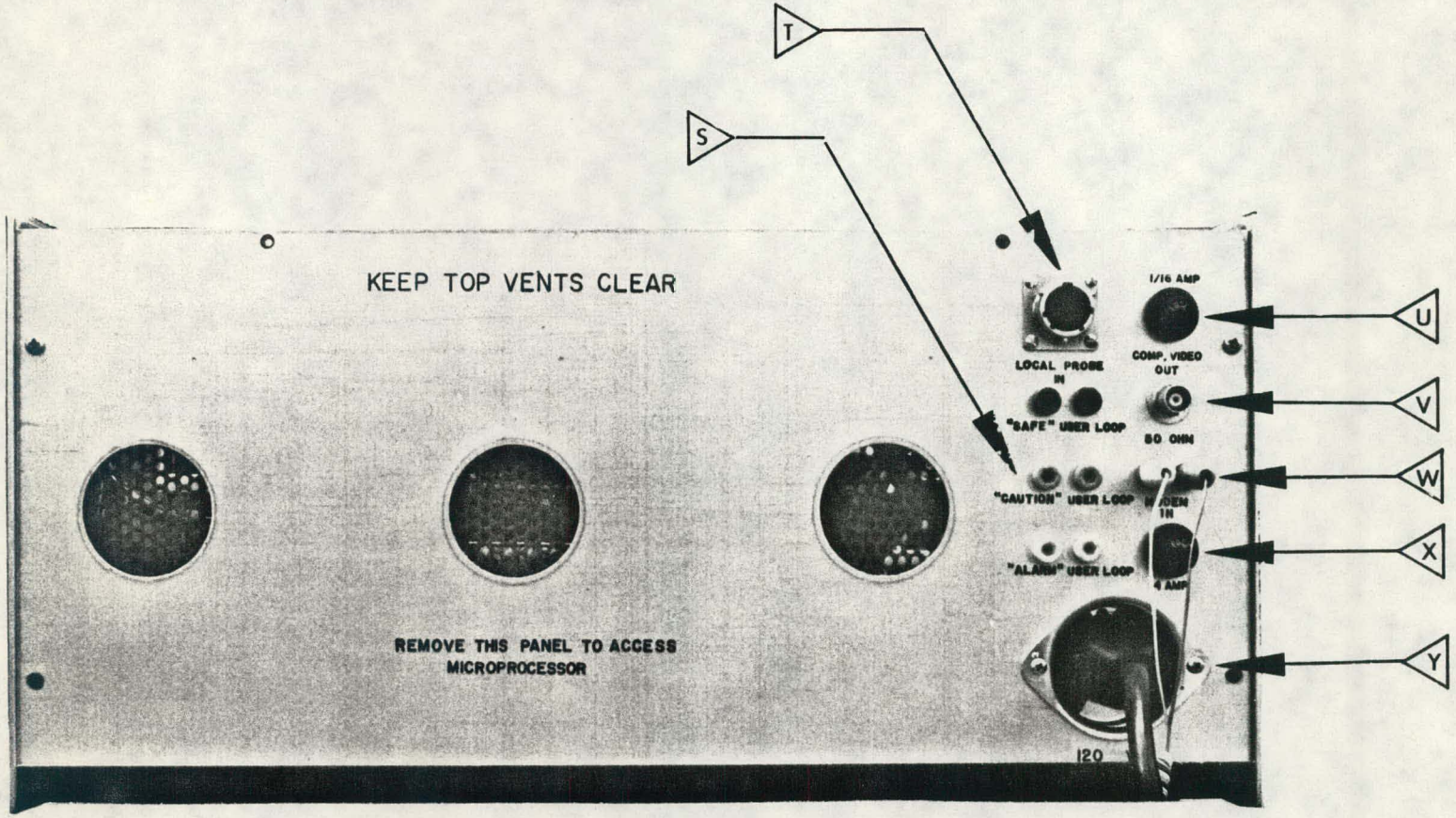
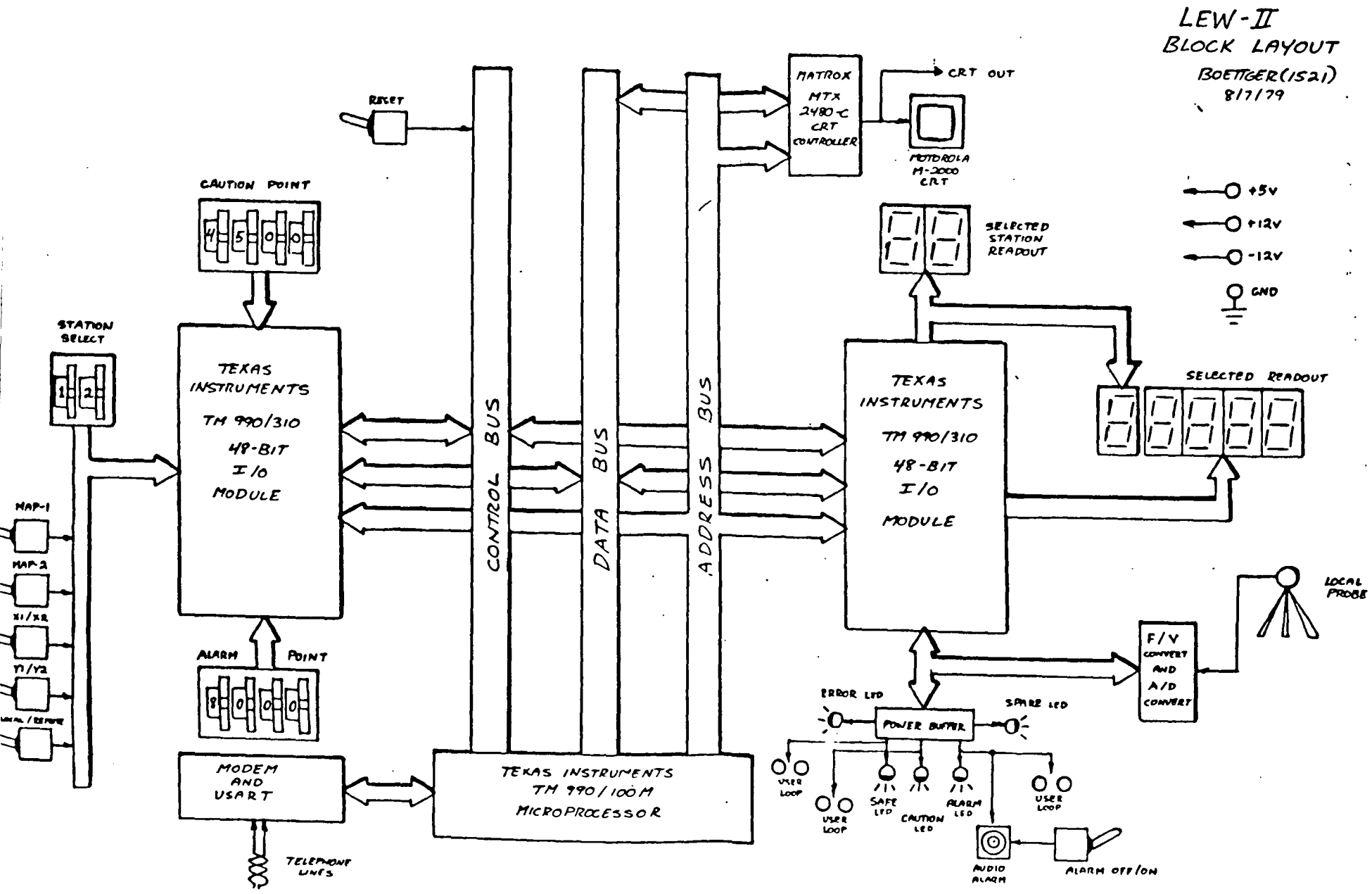


Figure 2.2
Rear Panel

Figure 2.3
LEW-II Layout



3.0 RFPG-II Monitor

3.1 Overview

The new Radio Frequency Potential Gradient Monitor (RFPG-II) is a weather-tight structure. It incorporates the latest technology in active filtering, digital Manchester Phase decoding, solar cell charging, and RF gear.

Figure 3.1 dipicts the outside of the unit, and Figure 3.2 the inside. Figure 3.3 is a logical diagram of its operation.

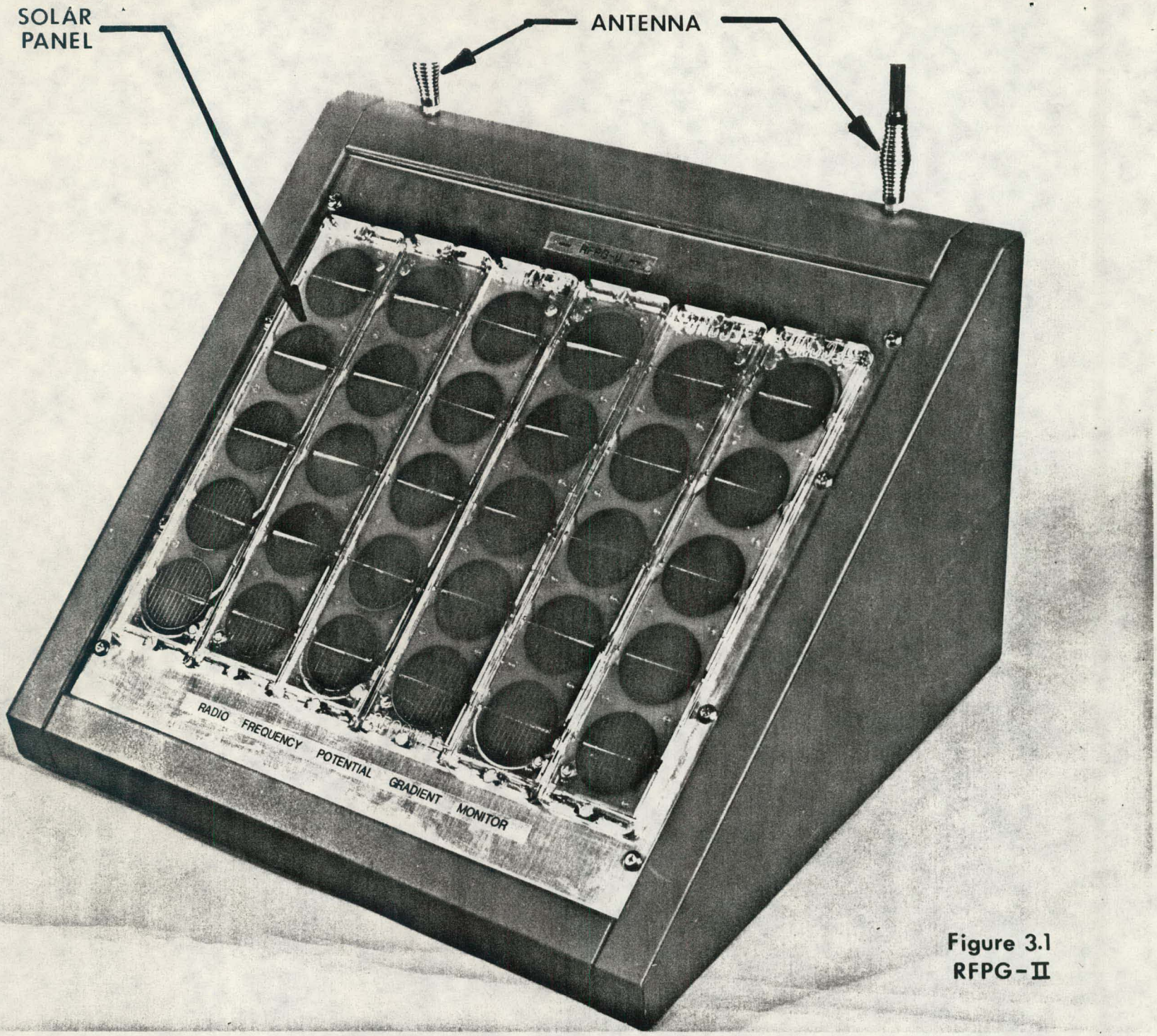


Figure 3.1
RFPG-II

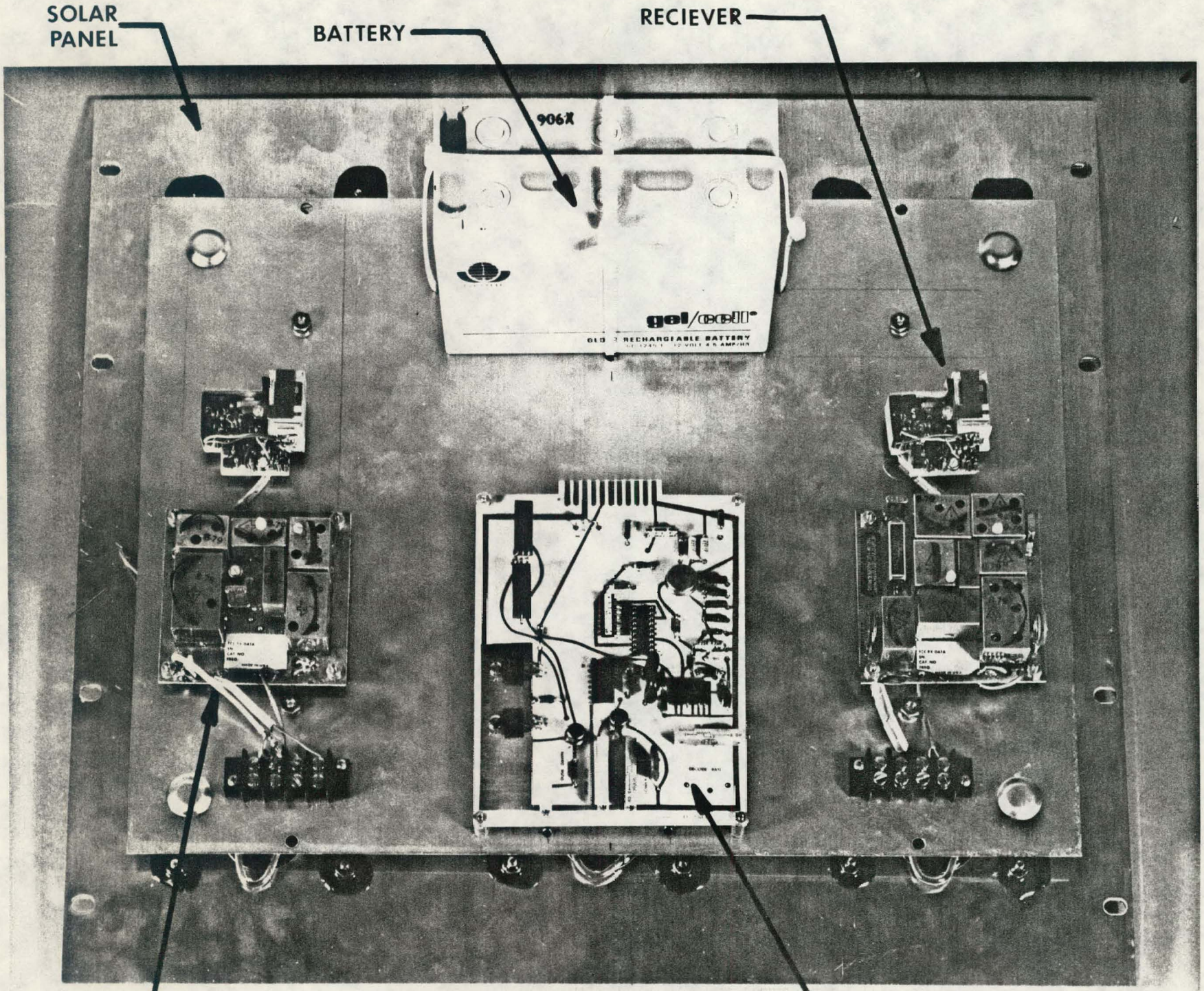
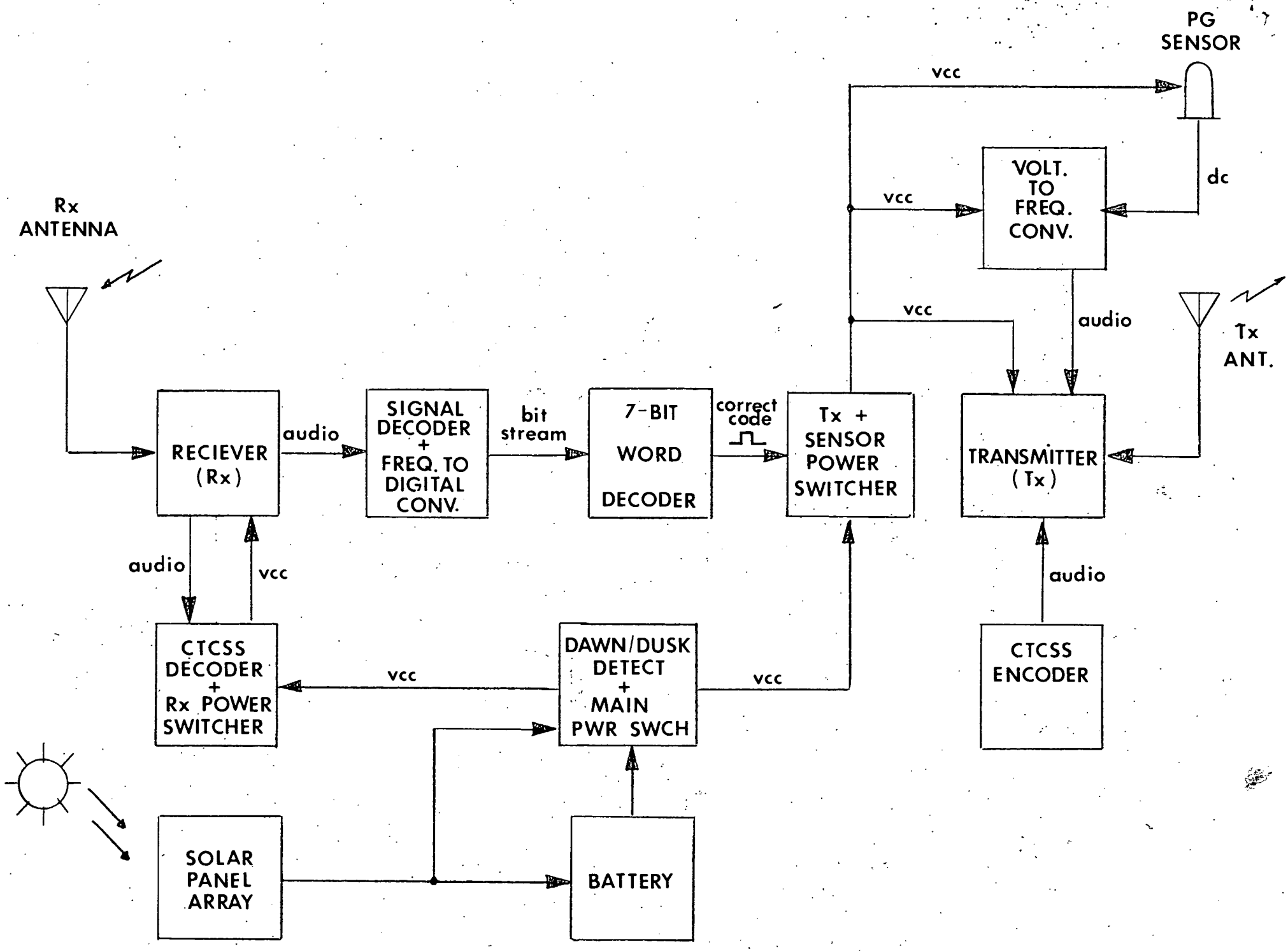


Figure 3.2
RFPG-II



RFPG-11 BLOCK DIAGRAM