This is an unscheduled ATM which has been prepared to provide Bendix personnel with an introduction and understanding to the SIDE and CCGE experiments.

This ATM will be updated at periodic intervals as additional information becomes available.

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Approved by J. E. Dye
J. E. Dye

Description of SIDE/CCGE Experiments for ALSEP

1. Introduction and Summary

The Suprathermal Ion Detector Experiment (SIDE) for ALSEP is designed to study the ionosphere of the moon (assuming that there is an ionosphere near the lunar surface) and also to study the raw and thermalized solar wind particles at the surface of the moon. It will also provide some indication of static electric field effects at the lunar surface.

The Cold Cathode Gauge Experiment (CCGE) will measure the pressure of the lunar atmosphere as a function of time and thus determine both the density of neutral particles in the lunar atmosphere and also the rate of loss of contaminants due to LEM or the astronauts.

The SIDE and the CCGE are combined into a single experiment package having a single electrical interface with ALSEP and a single mounting interface, common power and programming electronics, and a common data read-out and command structure. Thus, while they represent two distinct scientific experiments, they are essentially just a single experiment from the point of view of integration into ALSEP.

Figure 1-1 shows the organizational relationships between the various groups working on the SIDE and CCGE Experiments. Dr. John Freeman of Rice University is the principal investigator for the SIDE; Dr. Francis Johnson of the Graduate Research Center of the Southwest is the principal investigator for the CCGE. Marshall Laboratories is building the SIDE and the electronics for the CCGE, under contract to Rice University. National Research Corp. provides the Cold Cathode Ion Gauge (CCIG) which is the sensor for the CCGE. NRC is a subcontractor to the Graduate Research Center of the Southwest. The CCIG is provided to Marshall Laboratories, who integrates it into the experiment package. Key personnel at the various organizations are listed in Table 1-1.

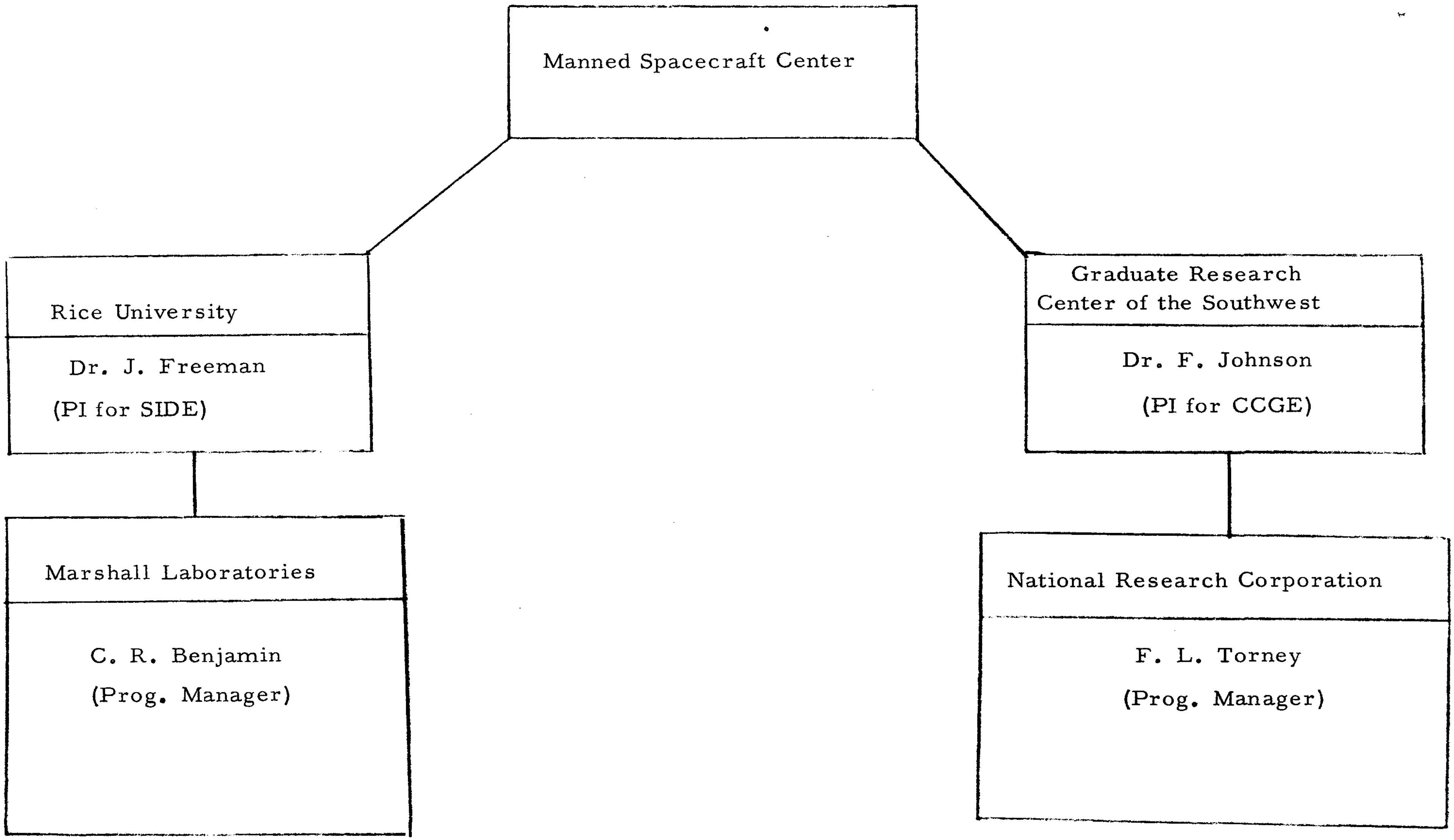

Figure 1-1 Organizational Relations for SIDE/CCGE Experiments

TABLE 1 - 1

Key Personnel on SIDE/CCGE

Rice University

Dr. John Freeman - Principal Investigator for SIDE
Wayne Smith - Program Manager
John Meyers - Project Engineer (Student)
Kit Webster - Programming and data reduction (Student)

Graduate Research Center of the Southwest

Dr. Francis Johnson - Principal Investigator for CCGE
Jim Carroll - Project Engineer
Jim Corwin -

Manned Spacecraft Center

Dallas Evans - Co-investigator of CCGE

National Research Corporation

Frank Torney - Program Manager for CCIG

Marshall Laboratories

Dick Benjamin - Program Manager
Jerry Thomas - Assistant Program Manager
Dean Aalami - Engineer on Instr. Operational System (Programmer, Command Unit, A/D Converter, etc.)
Jake Chapsky - Engineer on Low Energy Detector and High Energy Detector Electronics
Len Levine - Engineer on Cold Cathode Gauge Electronics
M. Kepler - Engineer on ETS and Simulator
Lloyd Cochran and George Kaden - Engineers on Structure, Thermal and Packaging

2. Scientific Aims of Experiment

2.1 Suprathermal Ion Detector Experiment

The SIDE will study the density and temperature of ions, caused by ultra-violet ionization of atoms in the lunar atmosphere, which constitute an "ionosphere" near the lunar surface. The experiment will count the number of ions in selected velocity and energy intervals, over a velocity range of 4×10^4 cm/sec up to 9.35×10^6

cm/sec and an energy range of 0.2 ev to 48.6 ev. From these data, the distribution of ion masses up to 120 AMU can be determined. Also, the electric potential between the instrument and the local lunar surface can be controlled by applying a known voltage between the instrument and a ground plane laid out beneath the instrument. Thus, if local electric fields exist, they will be offset at one of the ground plane voltage steps. By accumulating ion count data at different ground plane potentials, an estimate of local electric fields and their effects on ion characteristics can be made.

In addition to studies of low-energy ions, the SIDE will also measure the number of particles of higher energies, primarily the solar wind protons. This is done with a separate detector which counts the number of particles in selected energy intervals between 10 ev and 3500 ev. This detector does not have a velocity selector, and thus the mass of the particles cannot be determined.

2.2 Cold Cathode Gauge Experiment

The CCGE will determine the pressure of the ambient lunar atmosphere by measuring the density of neutral atoms and by knowing the temperature of the gauge at the time of measurement; the pressure can then be inferred from these data. By performing these measurements over an extended period of time and learning the time variations of the pressure, it may be possible to determine the primary sources of the lunar atmosphere.

In addition, the CCGE measurements will also provide an indication of the effects of gaseous products from LM and the astronauts on the lunar atmosphere, and how rapidly these man-made contaminants decay away as a function of time.

The CCGE is designed to measure pressures over the range of 10^{-6} torr to 10^{-12} torr, with a goal of 10^{-13} torr.

3. Overall Description of Instrument

This section provides a general description of the instrument used to carry out the SIDE/CCGE Experiments. Most of the following information has been extracted (verbatim) from the Familiarization Manual for the SIDE/CCGE prepared by Marshall Laboratories for Rice University. A functional block diagram of the instrument is shown in Figure 3-1. (ML Drawing 609200).

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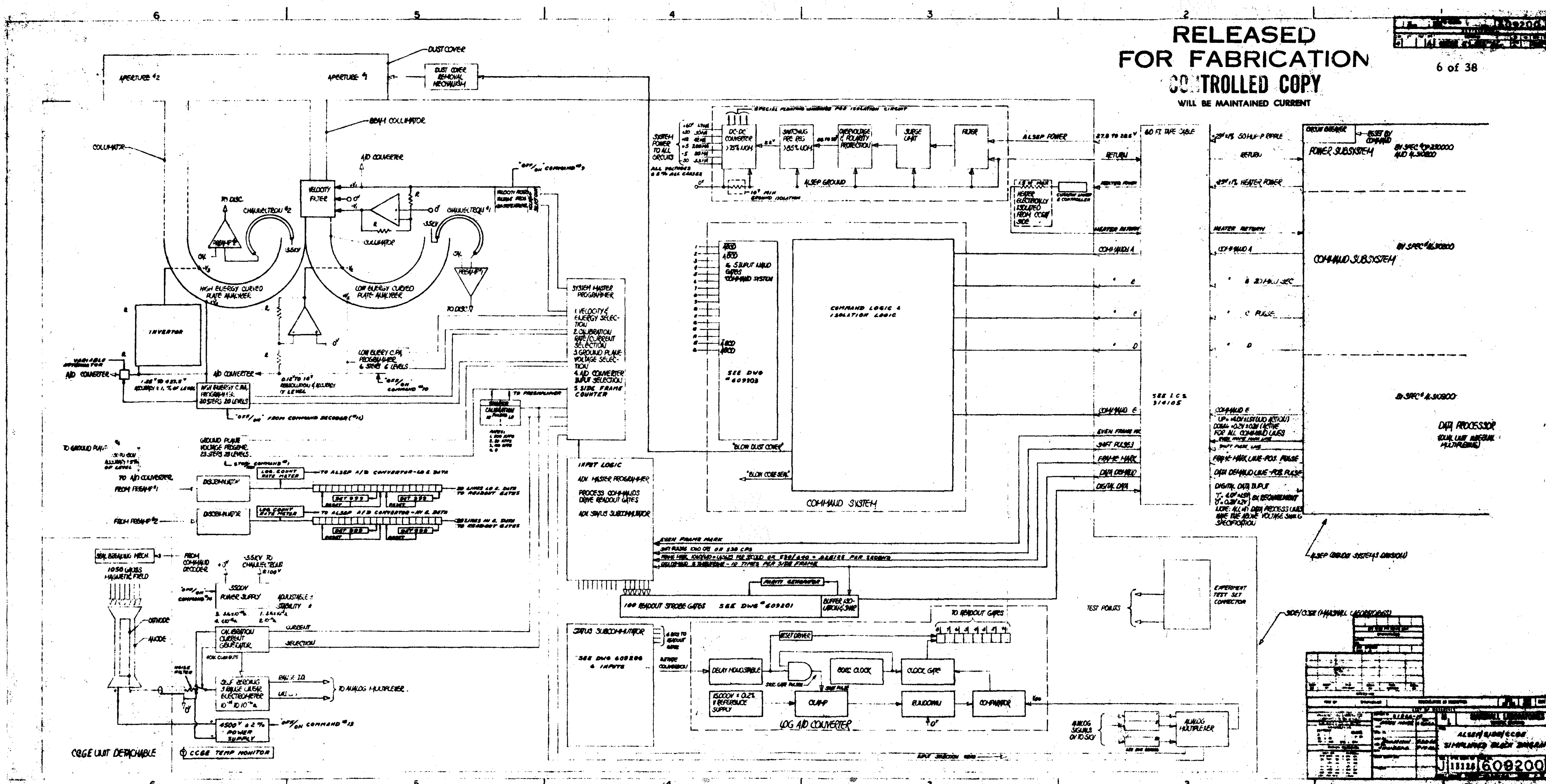


3.1 SUBSYSTEMS 1 AND 6 - INSTRUMENT OPERATIONAL SYSTEM

Essentially, this represents the experiment logic. It is composed of the following eleven subassemblies. A functional block diagram of subsystems 1 and 6 is shown in Figure 3-2. (ML Drawing 609213).

a. Power Supply
b. Command System
c. SIDE Frame Counter
d. High Energy Counter, Low Energy Counter, Velocity Filter and Ground Plane Counter.
e. Status Subcom
f. Logic Timing and Strobe Gate
g. Parity Generator
h. High Energy Accumulator and Low Energy Accumulator
i. Analog to Digital Converter
j. Heater Control Circuit
k. Dust Cover and Seal Circuit

3.1.1 POWER SUPPLY

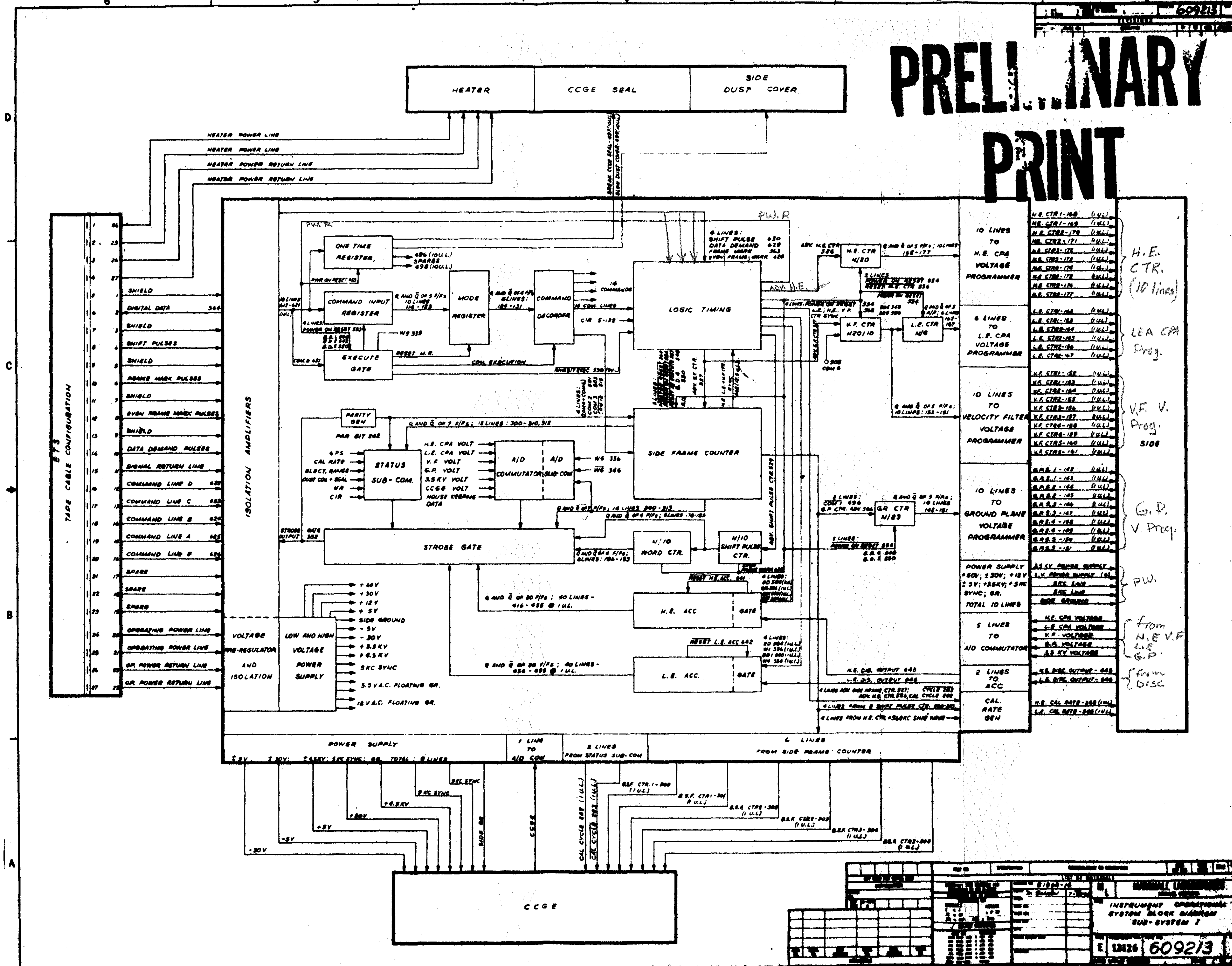
The power supply provides power to the system.

3.1.2 COMMAND SYSTEM

The Command System has five (5) command lines. Four are used to send commands and the fifth is to execute the commands. Included in the Command System are two One Time Command Registers. One is to blow the dust cover, the other to break the seal of the CCIG.

3.1.3 SIDE FRAME COUNTER

The SIDE Frame Counter is the main time keeper, or time reference, of the system. It is an N/128 counter capable of controlling each and all of the experiments 128 states.



PRELIMINARY PRINT
HEATER
CCGE SEAL
SIDE DUST COVER
HEATER POWER LINE
HEATER POWER LINE
HEATER POWER RETURN LINE
HEATER POWER RETURN LINE
ETS TAPE CABLE CONFIGURATION
SHIELD
DIGITAL DATA
SHIFT PULSES
FRAME MARK PULSES
EVEN FRAME MARK PULSES
DATA DEMAND PULSES
SIGNAL RETURN LINE
COMMAND LINE D
COMMAND LINE C
COMMAND LINE B
COMMAND LINE A
COMMAND LINE E
SPARE
OPERATING POWER LINE
GR POWER RETURN LINE
ISOLATION AMPLIFIERS
ONE TIME REGISTER
COMMAND INPUT REGISTER
MODE REGISTER
COMMAND DECODER
EXECUTE GATE
LOGIC TIMING
PARITY GEN
STATUS SUB-COM.
A/D COMMUTATOR
A/D SUB-COM
SIDE FRAME COUNTER
STROBE GATE
N/10 WORD CTR.
N/10 SHIFT PULSE CTR.
H.E. ACC
L.E. ACC.
GATE
H.E CTR N/20
V.F. CTR N/20/10
L.E. CTR N/6
GR CTR N/83
VOLTAGE PRE-REGULATOR AND ISOLATION
LOW AND HIGH VOLTAGE POWER SUPPLY
+60V
+30V
+12V
+5V
SIDE GROUND
-5V
-30V
+3.5KV
+6.5KV
5KC SYNC
5.5 V.A.C. FLOATING GR.
12 V.A.C. FLOATING GR.
10 LINES TO H.E. CPA VOLTAGE PROGRAMMER
6 LINES TO L.E. CPA VOLTAGE PROGRAMMER
10 LINES TO VELOCITY FILTER VOLTAGE PROGRAMMER
10 LINES TO GROUND PLANE VOLTAGE PROGRAMMER
POWER SUPPLY
TOTAL 10 LINES
5 LINES TO A/D COMMUTATOR
2 LINES TO ACC
CAL. RATE GEN
POWER SUPPLY
1 LINE TO A/D COM
2 LINES FROM STATUS SUB-COM
6 LINES FROM SIDE FRAME COUNTER
CCGE
PW.R
H.E. CTR. (10 lines)
LEA CPA Prog.
V.F. V. Prog. SIDE
G.P. V. Prog.
PW.
from H.E V.F L.E G.P.
from DISC
INSTRUMENT OPERATIONAL SYSTEM BLOCK DIAGRAM SUB-SYSTEM 7
609213

3.1.4 HIGH ENERGY COUNTER, LOW ENERGY COUNTER, VELOCITY FILTER AND GROUND PLANE COUNTER

The High Energy Counter controls the High Energy CPA voltage steps, the Low Energy Counter controls the Low Energy CPA voltage steps, the Velocity Filter controls voltage on the Velocity Filter and the Ground Plane Counter controls voltage steps in the Ground Plane.

3.1.5 STATUS SUBCOM

The Status Subcom commutates the following inputs into one output.

a. Electrometer Range
b. Ground Plane Step
c. Mode Register
d. Command Register
e. Dust Cover Status
f. CCGE Seal Status

3.1.6 LOGIC TIMING AND STROBE GATE

The Logic Timing controls all the circuit logic time. The Strobe Gage commutates data from various storage elements to the output isolation amplifier.

3.1.7 PARITY GENERATOR

The Parity Generator looks at outputs and counts the number of "one's" in each ALSEP Telemetry frame. If the number is odd, 0 is placed for the parity bit of the next frame. If the number is even, 1 is placed for the parity bit of the next frame.

3.1.8 HIGH AND LOW ENERGY ACCUMULATORS

The High Energy Accumulator is a 20 bit counter which accumulates the number of output pulses of the High Energy Discriminator. The Low Energy Accumulator is a 20 bit counter which accumulates the number of output pulses of the Low Energy Discriminator.

3.1.9 ANALOG TO DIGITAL CONVERTER

The Analog to Digital Converter converts data from analog to digital and transfers the information through the Strobe Gate to the Data Output.

3.1.10 HEATER AND CONTROL CIRCUIT

The Heater and Control Circuit controls the temperature within the entire experiment package.

3.1.11 DUST COVER AND SEAL CIRCUITS

The Dust Cover Circuit blows the dust cover. The Seal Circuit breaks the CCIG seal.

3.2 SUBSYSTEM 2 - LOW ENERGY ION DETECTOR

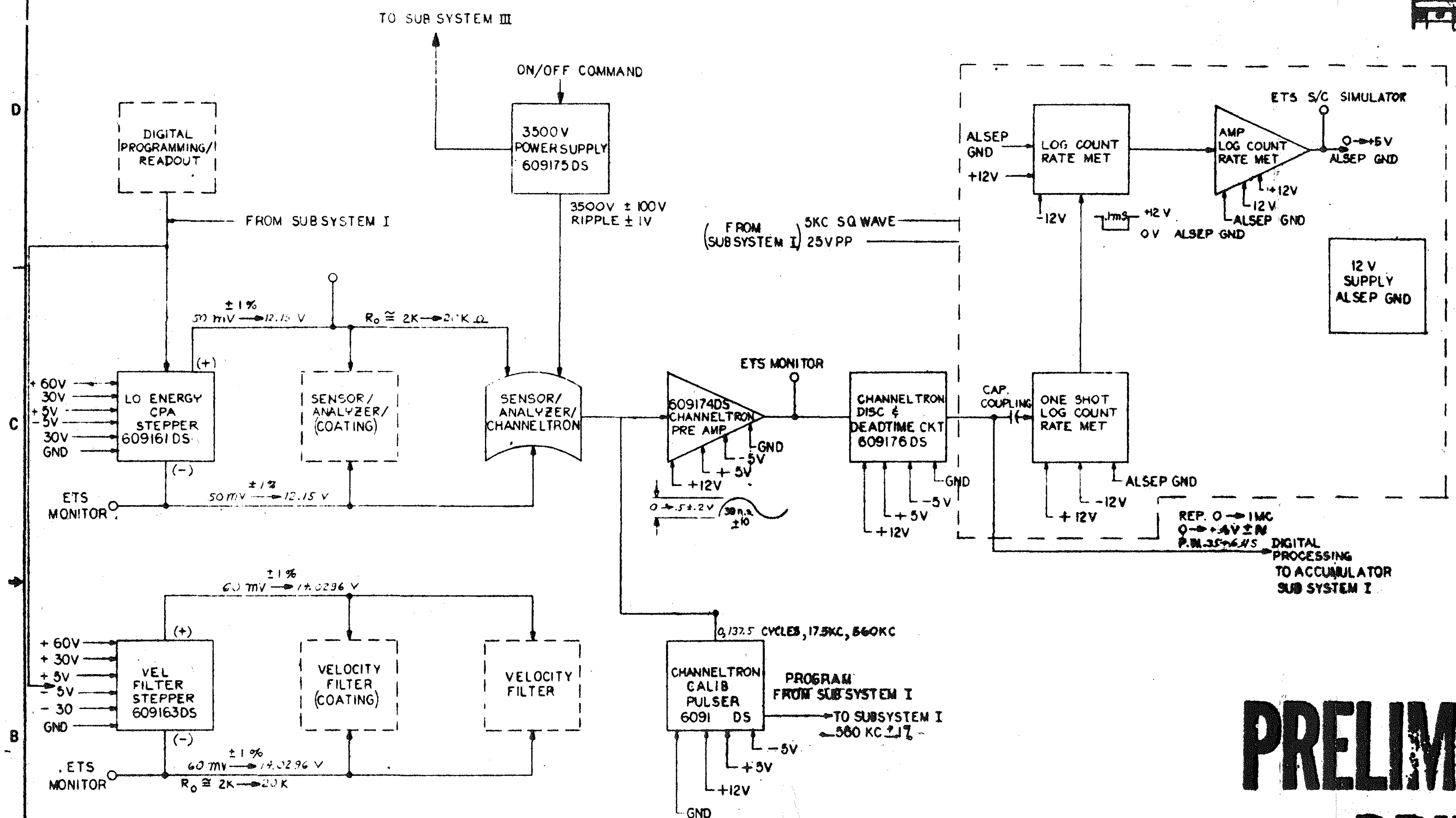
This subsystem detects low energy ions in the range of 0.2 ev to 48.6 ev. A functional block diagram of the subsystem is shown in Figure 3-3. (ML Drawing 609214). This subsystem is composed of the following subassemblies:

a. Calibration Pulser
b. 3500 Volt Power Supply
c. Discriminator/Deadtime Circuit
d. Log Count Rate Meter
e. Low Energy CPA Stepper
f. Velocity Filter Stepper
g. Channeltron Preamplifier

3.2.1 CALIBRATION PULSER

This subassembly consists of a crystal oscillator (frequency 560 KC) with 0.1% stability for temperature range of -50 degrees C to + 100 degrees C. The oscillator output is a square wave, amplitude 4v $\pm$ 1v which is divided by a string of F/F's to generate the following frequencies; 17.5 KC and 137 cps.

The three square waves are shaped to approximate the output of the Channeltron. They are used to calibrate and check the performance of the entire system from the Channeltron Preamplifier. These pulses are fed to the Channeltron Preamplifier under the control of the Command System.



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LOW ENERGY ION DETECTOR ALSEP/SIDE SUB SYSTEM II

13126 609214

During this time period, the output of the CPA is disabled by reducing the CPA voltages to zero. The three frequencies, one at a time, upon command from the Command System drive a one shot. The output of which is shaped and fed into the Channeltron Preamplifier. Zero output is also considered a calibration and check point.

3.2.2 3500 VOLT POWER SUPPLY

The 3500 Volt Power Supply consists of a step-up transformer rectifier and filtering circuitry plus an AC Amplifier for the purpose of ripple reduction. The 3500 Volt Power Supply is used for both the high and the low energy Channeltron.

3.2.3 DISCRIMINATOR/DEADTIME CIRCUIT

The Discriminator/Deadtime Circuit consists of a one shot type circuit which triggers only if its input exceeds a predetermined threshold level. The circuit has a fixed recovery time during which no input signal can produce an output signal. The input to the circuit comes from the Channeltron Preamplifier and is expected to vary both in amplitude and width.

The output of the subassembly feeds data pulses to Subsystem 1 for digital processing and to the Log Count Rate Meter for analog processing.

3.2.4 LOG COUNT RATE METER

The Log Count Rate Meter consists of a one shot circuit which produces an 0.1 millisecond pulse for every input pulse from the Discriminator/Deadtime Circuit. The one shot output is fed into a non-linear circuit with logarithmic characteristics. The non-linear circuit is also fed from a temperature compensated reference power supply of + 0.7v. The output of the non-linear circuit is amplified by a differential amplifier to produce + 5v d-c for an incoming rate of 1 KC from the Discriminator/Deadtime Circuit.

The output of the Amplifier is complementary and both outputs are used for a voltage temperature compensation arrangement for the + .7v reference power supply.

3.2.5 LOW ENERGY CPA STEPPER

The Low Energy CPA Stepper is a generator which provides the necessary steps for the Low Energy CPA to detect ions with energies in the range of 0.2ev to 48.6 ev. Six voltage steps are required. The steps are selected by the command system.

3.2.6 VELOCITY FILTER STEPPER

This generator provides the necessary voltage steps for the Velocity Filter to detect ion with velocities ranging from 4×10^{4} cm/sec to 9.35×10^{6} cm/sec. Twenty (20) voltage steps are provided. These 20 steps are used for each of the six steps in the Low Energy CPA. The 20 steps are selected by a five (5) bit binary address, provided by the Command System.

3.2.7 The Channeltron Preamplifier accepts the current pulses from the Channeltron, shapes them, and provides an input to the Discriminator/Deadtime Circuit. The Channeltron Preamplifier is optimized for the expected signal to noise characteristics of the Channeltrons, allowing for variations from Channeltron to Channeltron, life degradation, supply voltage changes, and the statistical variations in Channeltron outputs. The Channeltron Preamplifier also accepts the input pulses from the Calibration Pulser. This is done as part of the common system.

3.3 SUBSYSTEM 3 - HIGH ENERGY ION DETECTOR

This subsystem detects high energy ions in the range of 10 ev to 3500 ev. A functional block diagram of the subsystem is shown in Figure 3-4. (ML Drawing 609232).

Subsystem 3 is exactly the same as Subsystem 2 with the following exceptions:

a. Subsystem 3 does not have a Velocity Filter.
b. Subsystem 3 does not have a Low Energy CPA Stepper.
c. Subsystem 3 does have a High Energy CPA Stepper.

3.3.1 HIGH ENERGY STEPPER

The stepper provides the necessary plate voltage steps for the Analyzer to detect ions with energies in the range of

10 ev to 3500 ev per unit charge. Twenty (20) voltage steps are provided, each being selected by a five (5) bit binary address. Additionally, a zero plate voltage is selected by a means of a calibrating signal.

3.4 SUBSYSTEM 4 - COLD CATHODE GAUGE EXPERIMENT

This subsystem will (1) determine the density of any lunar ambient atmosphere, including any temporal variations either of a random character or associated with lunar local time or solar activity and (2) the rate of loss of contaminants left in the landing area by the astronauts and the Lunar Excursion Module. A functional block diagram of the Cold Cathode Gauge Experiment is shown in Figure 3-5. (ML Drawing 609234). The subsystem is composed of the following six subassemblies:

a. Electrometer
b. Sensor
c. Seal Mechanism Power Supply
d. Seal Mechanism
e. 4500 Volt Power Supply
f. Temperature Sensor & Monitoring Circuit

3.4.1 ELECTROMETER

The Auto Ranging and Auto Zero Electrometer monitors currents in the 10^{-14} to 10^{-6} range and output ranges from 15 millivolts to 15 volts full scale.

3.4.2 SENSOR

The sensor is a transducer which effects conversion of pressure to direct current.

3.4.3 SEAL MECHANISM POWER SUPPLY

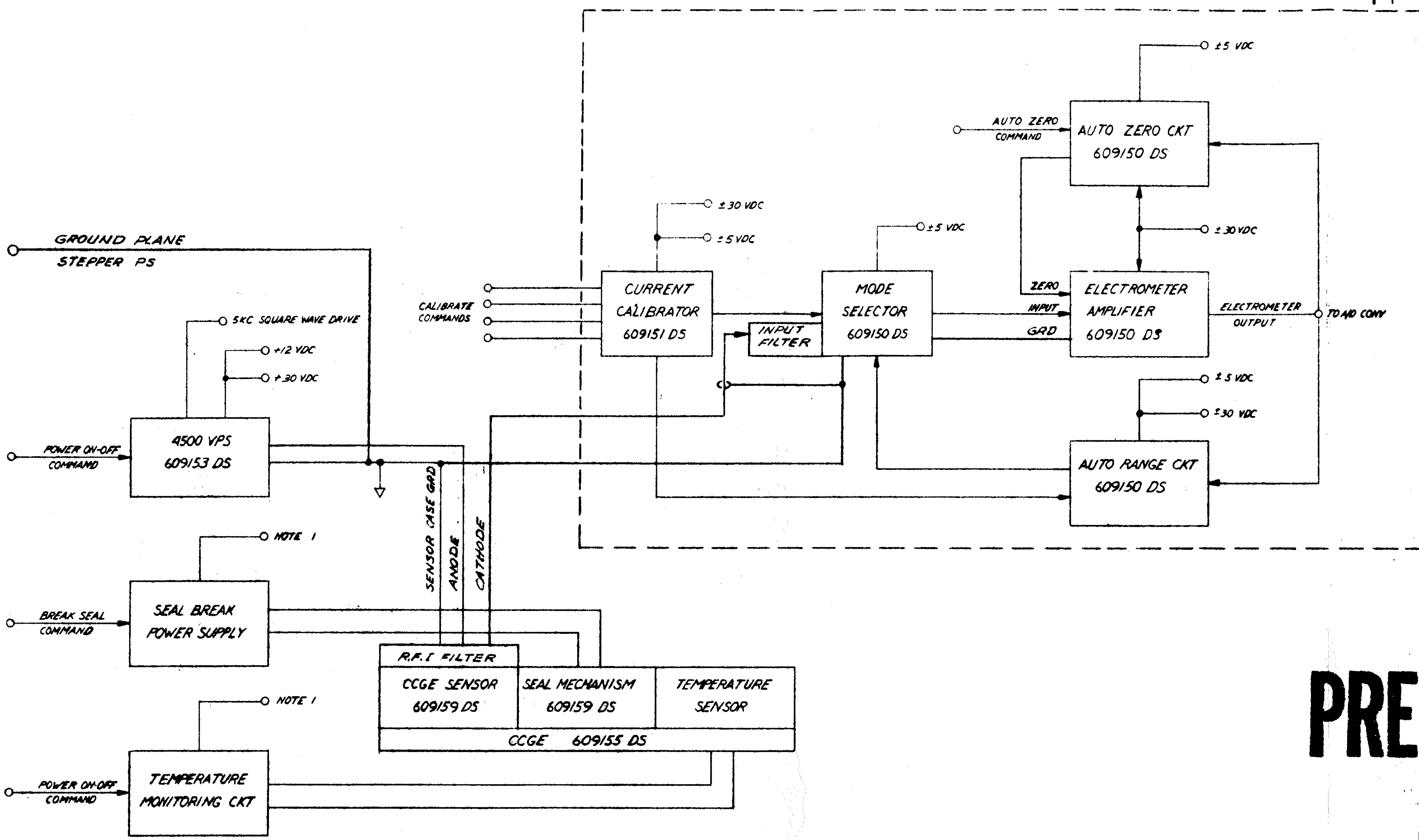
The Seal Mechanism Power Supply supplies the energy necessary to release the seal mechanism.

3.4.4 SEAL MECHANISM

The Seal Mechanism is customer furnished equipment.

3.4.5 4500 VOLT POWER SUPPLY

The 4500 Volt Power Supply provides 4500 Volt Power to the subsystem.



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1. VOLTAGES NOT DETERMINED

NOTES: UNLESS OTHERWISE SPECIFIED

MARSHALL LABORATORIES
TORRANCE, CALIFORNIA

CONTRACT NO. 51966-M

DATE 22 JULY 66

TITLE: CCGE EXPERIMENT BLOCK DIAGRAM SYSTEM IV

SIZE D | CODE IDENT NO. 13126 | DWG NO. 609234

DWG NO. 609234

3.4.6 TEMPERATURE SENSOR AND MONITORING CIRCUIT

The Temperature Sensor and Monitoring Circuit monitors output voltages of the Temperature Circuit for various voltages.

3.5 STRUCTURE/THERMAL

This section describes the structure/thermal engineering aspects of the experiment.

3.5.1 THERMAL INSULATION

The Thermal Insulation consists of multiple sheets of aluminized mylar formed into a sandwich structure.

3.5.2 LEVELING LEGS

The leveling legs consist of three legs which are tripod-mounted to a ball socket on the bottom of the experiment package. These legs are folded during storage and released by the astronaut during deployment. Leveling of the package is achieved via the ball and socket joint.

3.5.3 CHASSIS

The Chassis consists of a base, two end panels, rear panel and the front panel. The front and rear panels are removeable. The base is designed to accomodate and enclose the packaged leg assembly. The overall Chassis houses electronic circuits, sensors, CCGE, cable/reel/clip and Ground Plane.

3.5.4 THERMAL SPACER

The Thermal Spacer is a non-metallic, essentially rectangular shaped, tube approximately two inches in height. The Thermal Spacer integrates the Chassis with the Top Plate (Thermal control surface) and Grid. The function of the spacer is to provide required thermal insulation between the Top Plate and Chassis.

3.5.5 TOP PLATE AND GRID

The Top Plate serves as a support for the sensors and electronic modules, and as a heat sink. Since the Top Plate is sprayed with white paint for thermal control, the Grid is required to supply a conductive equi-potential reference surface.

3.5.6 GROUND PLANE

The Ground Plane is essentially a conductive net to be placed on the lunar surface beneath the experiment package. It supplies the lunar surface reference potential.

3.5.7 LATCH, DUST COVER

The Latch is electrically actuated on command to initiate opening of the Dust Cover to expose the Top Plate to ionic bombardment.

3.5.8 DUST COVER

The Dust Cover is used to protect the Top Plate and Sensors from external hazards up to the time the experiment is initiated on the lunar surface.

3.5.9 LEVELING GAUGE

The Leveling Gauge is used by the astronaut to determine if the experiment is within the 5 degree tolerance of level.

4. DATA FORMAT AND COMMAND LIST

4.1 DIGITAL DATA

The digital data for the SIDE/CCGE consists of 5-10 bit words in each ALSEP telemetry frame. The locations of these words in the frame are shown in Figure 4-1. A total of 10 words are used to make up the basic unit of data, which is called a SIDE frame. (The definitions in Table 4-1 are used for the SIDE/CCGE data output). The experiment programmer goes through 128 steps in completing its program; this is called a cycle. The ground plane stepper steps once per cycle; thus, 24 cycles which constitute the number of ground plane voltage steps, are called a field.

TABLE 4-1 DEFINITIONS FOR SIDE/CCGE DATA

5 SIDE words ≈ 1 ALSEP frame ≈ 0.604 sec.
10 SIDE words ≈ 2 ALS EP frames ≈ 1 SIDE frame ≈ 1.208 sec.
128 SIDE frames ≈ 1 SIDE cycle = 154.6 sec.
24 SIDE cycles ≈ 1 SIDE field ≈ 3710 sec.

Figure 4-1

Array A

Normal Configuration

	1	2	3	4	5	6	7	8
1	X	X	X	x	o	x	S	x
2	-	x	-	x	-	x	I	x
3	o	x	o	x	o	x	S	x
4	-	x	-	x	-	x	I	x
5	H	x	●	x	●	x	S	x
6	-	x	-	x	-	CV	I	x
7	o	x	o	x	o	x	S	I
8	-	x	-	x	-	x	I	x

Legend.

X = Control
x = Passive Seismic - Short period
\- = Passive Seismic - Long period seismic
● = Passive Seismic - Long period tidal and one temperature
o = Magnetometer
S = Solar Wind
I = Suprathermal Ion Detector

HF = Heat Flow
CP = Charged Particle
CV = Command Verification
H = Housekeeping

Each box contains one 10 bit word
Total bits per frame = 10 x 64 = 640 bits

The data contents of the 10 words in a SIDE frame are shown in Figure 4-2. Word #1 contains the SIDE frame number, together with a parity bit for the SIDE data in the previous ALSEP frame. Word #3 is an A/D converted measurement of the voltage applied to the Hi-Energy CPA. Words 4 and 5 together give the number of particles detected by the Hi- Energy CPA during the last counting interval.

Word #7 gives an A/D converted measurement of the voltage applied to the Velocity Filter. Word #8 is an A/D converted measurement of the voltage applied to the Lo-Energy CPA. Words #9 and #10 taken together give the number of counts detected by the Low-Energy detector during the last counting interval.

Word #2 is a housekeeping word which is an output of the A/D converter in the experiment. Word #6 is called the status subcom, and consists of digital readings which indicate the status of various parameters in the experiment. Both of these words are commutated through a variety of inputs during a SIDE cycle. These inputs are listed in Table 4-2.

The first 120 SIDE frames in a cycle are the data frames; the last 8 SIDE frames in the cycle are calibration frames. During the first 120 SIDE frames, the Hi-Energy CPA voltage goes through 20 different steps. This sequence is repeated six times i.e. in SIDE frames 0-19, 20-39, 40-59, 60-79, 80-99 and 100-119. During these 120 SIDE frames, the velocity filter goes through 120 different values. The low energy CPA voltage goes through six values, the first during the first 20 SIDE frames, the second during the next 20 SIDE frames, etc.

EVEN ODD

1st TM Frame					2nd TM Frame				
TM Word #1	TM Word #2	TM Word #3	TM Word #4	TM Word #5	TM Word #6	TM Word #7	TM Word #8	TM Word #9	TM Word #10
Data Address Counter	A/D Converted Voltage	A/D Converted Voltage	Digital Count Data	Digital Count Data	Status Subcom	A/D Converted Voltage	A/D Converted Voltage	Digital Count Data	Digital Count Data
15 FR COUNT	30 31 EW & CCGE	47 HECPA V.	56 MSD DE data	63 LSD HE data	5 Status Discretes	31 46 VEL FR V.	47 LECPA V.	56. MSD LE DATA	63 LSD LE DATA

SIDE FRAME

Word #1 - Provides identification of selected step in measurement program and/or SIDE frame count and a parity check of data in previous frame.
Word #2* - CCGE data and housekeeping data, subcommutated.
Word #3* - Voltage on high energy charged particle analyzer.
Word #4 -)
Word #5 -) Count data from high energy charged particle analyzer.
Word #6* - Various data subcommutated, such as command mode, command waiting for execution, range of electrometer, ground plane grid voltage step; also gives parity check of data in previous frame.
Word #7* - Voltage on velocity selector.
Word #8* - Voltage on low energy charged particle analyzer.
Word #9 -)
Word #10 -) Count data from low energy charged particle analyzer.

Figure 4-2 Experiment Frame Format

During SIDE frames 120-127 in each cycle, an oscillator is gated into the counting channels or background count data are taken. Also, for the CCGE, known calibration currents are used as inputs to the electrometer during some of the steps. (See Table 4-2 for a listing of these steps).

The ground plane stepper goes through 24 steps, one step/ SIDE cycle. These steps are listed in Table 4-3.

4.2 ANALOG DATA

Two analog data lines go from the SIDE/CCGE to ALSEP. These are lines No. 70 and 85 to the analog data multiplexer. These give the count rate from the Lo-Energy CPA on one of these lines and the Hi-Energy CPA count rate on the other. These are primarily back-up measurements that will give crude count rate information if something happens to the digital counting electronics on either detector.

4.3 COMMAND LIST

Five command lines are provided from ALSEP to the SIDE/ CCGE. Four of these lines are used to encode up to 16 different command functions into the experiment; the fifth line provides an execute command to carry out whatever command is coded into the other four lines.

In addition, the experiment also contains the capability to carry out four "one-time" commands. That is, the first time a pulse is placed on command line No. 1 to the experiment, it also goes to a "one-time" command register. Then, when that command is executed, the corresponding "one-time" command is also executed. Subsequent pulses on that line do not affect the "one-time" command register.

The coding of the commands on the various command lines are shown in Table 4-4. The functions carried out in the experiment by these commands are listed in Table 4-5. Note that Command No. 15 does not require an execute command, since its function is to reset the command register without executing anything.

TABLE 4-2 SUBCOMMUTATION OF SIDE/CCGE DATA OUTPUTS

SIDE FRAME NUMBER (WORD 1)	CCGE AND HOUSEKEEPING DATA - A/D CONVERTED (WORD 2)	HIGH ENERGY CPA VOLTAGE (PLATE - TO - GND) A/D CONVERTED (WORD 3)	STATUS SUBCOM-DIGITAL DATA (WORD 6)	VELOCITY FILTER VOLTAGE - A/D CONVERTED (WORD 7)	LOW ENERGY CPA VOLTAGE (PLATE - TO - GND) A/D CON-VERTED (WORD 8)
0	+5V	437.5V	GPS	29.0	12.15V
1	CCGE	406.25V	CIR	26.3	
2	Temp #1	375V	GPS	23.8	
3	CCGE	343.75V	MR	21.4	
4	Temp #2	312.5V	GPS	19.2	
5	CCGE	281.25V	CIR	17.1	
6	Temp #3	250V	GPS	14.5	
7	CCGE	218.75V	Dust Cover & Seal	13.3	
8	+ 4.5KV	187.5V	GPS	11.6	
9	CCGE	156.25V	Electrometer Range	10.0	
10	CCGE Range	125V	GPS	8.59	
11	Temp #4	93.75V	MR	7.30	
12	Temp #5	62.5V	GPS	6.40	
13	GPV	31.25V	CIR	5.13	
14	Solar Cell	12.50V	GPS	4.25	
15	GPV	8.75V	MR	3.50	
16	+ 60V	6.25V	GPS	2.89	
17	+ 30V	3.75V	CIR	2.41	
18	±12V	2.50V	GPS	2.07	
19	Ground	1.25V	MR	1.87	12.15V
20	-5V	437.5V	GPS	16.7	4.05V

TABLE 4-2 Continued

21	-30V		CIR	15.2	
22	Temp #6		GPS	13.7	
23	-3.5KV		MR	12.4	
24	+ 1.0V Cal 2.	(Same sequence as SIDE Frames 0-19)	GPS	11.1	
25	+ 30 MV Cal		Electrometer Range	9.86	
26	+ A/D Ref Voltage		GPS	8.36	
27	CCGE Range 2.		MR	7.66	
28	+15V Cal 2.		GPS	6.68	
29	GPV		CIR	5.78	
30	- A/D Ref Voltage		GPS	4.96	
31	GPV		MR	4.21	
32	+5V		GPS	3.69	
33	One-Time Command Reg. Status		CIR	2.96	
34	Temp #1		GPS	2.45	
35	One-Time Command Reg. Status		MR	2.02	
36	Temp #2		GPS	1.67	
37	- 1.0V Cal		CIR	1.39	
38	Temp #3		GPS	1.20	
39	- 12.0 V Cal	1.25V	Dust Cover & Seal	1.08	
40	+4.5 KV	437.5 V	GPS	9.65	4.05V
41	CCGE		Electrometer Range	8.77	1.35V
42	CCGE Range		GPS	7.93	
43	Temp #4		MR	7.14	
44	Temp #5		GPS	6.39	
45	GPV		CIR	5.69	
46	- 30 MV Cal		GPS	4.83	
47	GPV		MR	4.42	
48	+ 60 V		GPS	3.86	
49	+ 30 V N.	(Same sequence as SIDE Frames 0 - 19)	CIR	3.34	
50	+12 V		GPS	2.86	
51	GND		MR	2.43	
52	- 5 V		GPS	2.13	
53	- 30 V		CIR	1.71	
54	Temp #6		GPS	1.42	

TABLE 4-2 Continued

55	- 3.5 KV ?		MR	1.17	
56	+1.0 V Cal ?		GPS	0.963	
57	+30 MV Cal		Electrometer Range	0.805	
58	+ A/D Ref Voltage		GPS	0.691	
59	CCGE Range ?	1.25 V	MR	0.624	1.35 V
60	+12 V Cal	437.5 V	GPS	5.57	0.45 V
61	GPV		CIR	5.06	
62	- A/D Ref. Voltage		GPS	4.58	
63	GPV		MR	4.12	
64	+5 V		GPS	3.69	
65	Pre-Reg Duty Factor	(Same seq-	CIR	3.29	
66	Temp #1	uence as	GPS	2.79	
67	CCGE Range ?	SIDE Frames	MR	2.55	
68	Temp #2	0-19)	GPS	2.23	
69	GPV		CIR	1.93	
70	Temp #3		GPS	1.65	
71	CCGE Range ?		Dust Cover & Seal	1.40	
72	+ 4.5 KV		GPS	1.23	
73	CCGE		Electrometer Range	0.987	
74	CCGE Range		GPS	0.817	
75	Temp #4		MR	0.673	
76	Temp #5		GPS	0.556	
77	GPV		CIR	0.464	
78	Solar Cell		GPS	0.399	
79	GPV	1.25 V	MR	0.360	0.45 V
80	+60 V	437.5 V	GPS	3.22	0.150 V
81	+30 V		CIR	2.92	
82	+12 V ?		GPS	2.64	
83	GND		MR	2.38	
84	- 5 V		GPS	2.13	
85	- 30 V		CIR	1.90	
86	Temp #6		GPS	1.61	
87	- 3.5 KV ?		MR	1.47	
88	+1.0 V Cal		GPS	1.29	
89	+30 MV Cal		Electrometer Range	1.11	

TABLE 4-2 Continued

90	+ A/D Ref Voltage	(Same seq-	GPS	0.954	
91	CCGE Range	uence as	MR	0.811	
92	+ 12 V Cal	SIDE Frames	GPS	0.710	
93	GPV	0-19)	CIR	0.570	
94	- A/D Ref Voltage		GPS	0.472	
95	GPV		MR	0.389	
96	+ 5 V		GPS	0.321	
97	One-Time Command Reg Status		CIR	0.268	
98	Temp #1		GPS	0.230	
99	One-Time Command Reg Status	1.25 V	MR	0.208	0.150 V
100	Temp #2	437.5 V	GPS	1.86	0.050 V
101	- 1.0 V Cal		CIR	1.69	
102	Temp #3		GPS	1.53	
103	- 12.0 V Cal		Dust Cover & Seal	1.37	
104	+ 4.5 KV		GPS	1.23	
105	CCGE	(Same seq-	Electrometer Range	1.10	
106	CCGE Range	uence as	GPS	0.930	
107	Temp #4	SIDE Frames	MR	0.851	
108	Temp #5	0-19)	GPS	0.743	
109	GPV		CIR	0.642	
110	- 30 MV Cal		GPS	0.551	
111	GPV		MR	0.468	
112	+ 60 V		GPS	0.409	
113	+ 30 V		CIR	0.329	
114	+ 12 V		GPS	0.272	
115	GND		MR	0.224	
116	- 5 V		GPS	0.185	
117	- 30 V		CIR	0.155	
118	Temp #6		GPS	0.133	
119	- 3.5 KV	1.25 V	MR	0.120	0.050 V
120	CCGE-Elec. Zero uncorrected	0 V	Cal Rate #1	29.0	0 V

TABLE 4-2 Continued

121	CCGE-Elec. Zero Partially Corr.	0 V	Cal Rate #2	26.3	0 V
122	CCGE-Elec. Zero Corrected	0 V	Cal Rate #3	23.8	0 V
123	CCGE Range	0 V	Cal Rate #4	21.4	0 V
124	CCGE-Toward Cal. Current #1	0 V	Cal Rate #1	19.2	0 V
125	CCGE-Cal Current #1	0 V	CIR	> 29	0 V
126	CCGE-Toward Cal Current #2	0 V	Cal Rate #3	> 29	0 V
127	CCGE-Cal Current #2	0 V	Cal Rate #4	> 29	0 V

ABBREVIATIONS:

GPV-Ground Plane Voltage
GPS - Ground Plane Step
CIR - Command Input Register
MR - Mode Register

TABLE 4-3 GROUND PLANE STEPPER SEQUENCE

SIDE/CCGE Cycle Number	Ground Plane Voltage (Volts)
1	0
2	+ 0.6
3	+ 1.2
4	+ 1.8
5	+ 2.4
6	+ 3.6
7	+ 5.4
8	+ 7.8
9	+ 10.2
10	+ 16.2
11	+ 19.8
12	+ 27.6
13	0
14	-0.6
15	-1.2
16	-1.8
17	-2.4
18	-3.6
19	-5.4
20	-7.8
21	-10.2
22	-16.2
23	-19.8
24	-27.6
1	0
↓	↓
24	-27.6

TABLE 4-4 CODING OF SIDE/CCGE COMMANDS

SIDE/CCGE COMMAND NO.	ONE-TIME COMMAND NO.	COMMAND LINE NO. 1 (A)	2 (B)	3 (C)	4 (D)	5 (E)
0						X
1	1	X				X
2	2		X			X
3		X	X			X
4	3			X		X
5		X		X		X
6			X	X		X
7		X	X	X		X
8	4				X	X
9		X			X	X
10			X		X	X
11		X	X		X	X
12				X	X	X
13		X		X	X	X
14			X	X	X	X
15		X	X	X	X	

TABLE 4-5 LIST OF SIDE/CCGE COMMAND FUNCTIONS

See the Following Notes for Additional Information	Command Number	Command Name
	0	(Does Not Exist)
(1)	1	Ground Plane Stepper On/Off
	2	Solar Wind/CCIG (Reset SIDE frame ctr @ 10)
	3	16.2 & 48.6 e v (Reset SIDE frame ctr @ 39)
	4	AM U $<$ 20 (Reset velocity filter ctr @ 9)
	5	ev $>$ 0.6 ONLY (Reset SIDE frame ctr @ 79)
	6	AM U $>$ 20 ev $>$ 0.6 (Reset SIDE frame ctr @ 79 and reset velocity ctr @ 9)
	7	X10 Accumulation Interval
(2)	8	Master Reset
	9	Velocity filter volts On/Off
	10	L. E. CPA volts On/Off
	11	H. E. CPA volts On/Off
	12	Force Continuous Calib.
	13	CCIG H. V. On/Off
(3)	14	Channeltron H. V. On/Off
	15	Reset Command Input Register

	One Time Command No.	
	1	Spare
(6)	2	Break CCIG seal

	3	Spare
(5)	4	Blow Dust Cover

NOTES:

(1) When ground plane stepper On/Off command is commanded Off, ground plane counter reset shall be inhibited.

(2) Master Reset: Shall force the instrument into the normal mode. It shall perform the following:
RESETS SI CUTR TO NORMAL

a. Defeat all short cycles and X10 accumulation interval.

b. Reset SIDE frame counter (velocity ctr & H. E. & L. E. ctr)

c. ~~Reset ground plane ctr~~.

d. DO NOT DISTURB any On/Off commands.

(3) Redtag Item: A lockout plug shall be provided to force the Channeltron H. V. to Off.

(4) Power on shall cause the following at least: POWER RESET

a. A master reset

b. A reset to all command flip-flops.

c. Turns on all the internal voltages of the system (turns on V.F., H.E. CPA, L.E. CPA, Channeltron H.V., CCIG H.V.)

(5) A dust cover blow (one time command No. 4) will cause a command No. 8 (Master reset) also

(6) CCIG Seal Break (one time command No. 2) also causes a command No. 2 (CCIG Solar Wind).

5. EXPERIMENT/ALSEP INTERFACES

5.1 ELECTRICAL INTERFACES

The experiment has the following electrical interfaces with the ALSEP data subsystem.

a. Digital data output

b. Timing and control signal inputs

c. Command signal inputs

d. Analog data outputs

e. Power inputs

A detailed listing of the lines between the experiment and ALSEP and the function of each line is shown in Figure 5-1.

One unusual aspect of the electrical interfaces for the SIDE/CCGE is that it must be DC-isolated from ALSEP. This is required because the instrument ground must be referenced to the ground plane deployed beneath the experiment. Thus, the instrument ground is isolated both from the signal return to ALSEP and the power return to ALSEP.

5.1.1 DIGITAL DATA OUTPUT

The digital data output circuit is shown in Figure 5-2. Transformer coupling is used to decouple the output circuit ground from the instrument ground.

5.1.2 TIMING & CONTROL INPUTS

The interface circuit for each of the timing and control input lines is shown in Figure 5-3. This circuit is used on the input of the following lines:

a. Frame mark pulse

b. Even frame mark pulse

c. Demand pulses

d. Shift pulses

Transformer coupling is used on all of these lines to assure DC-decoupling from ALSEP.

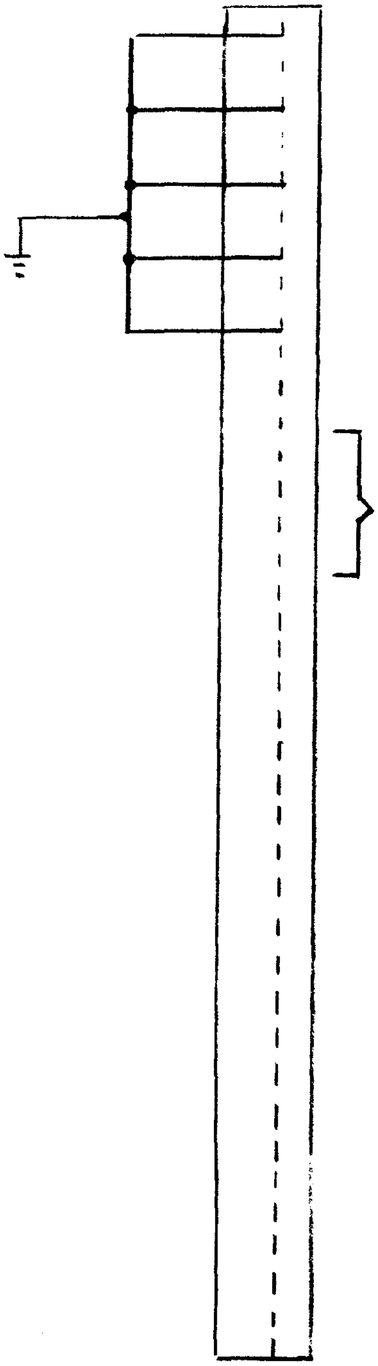
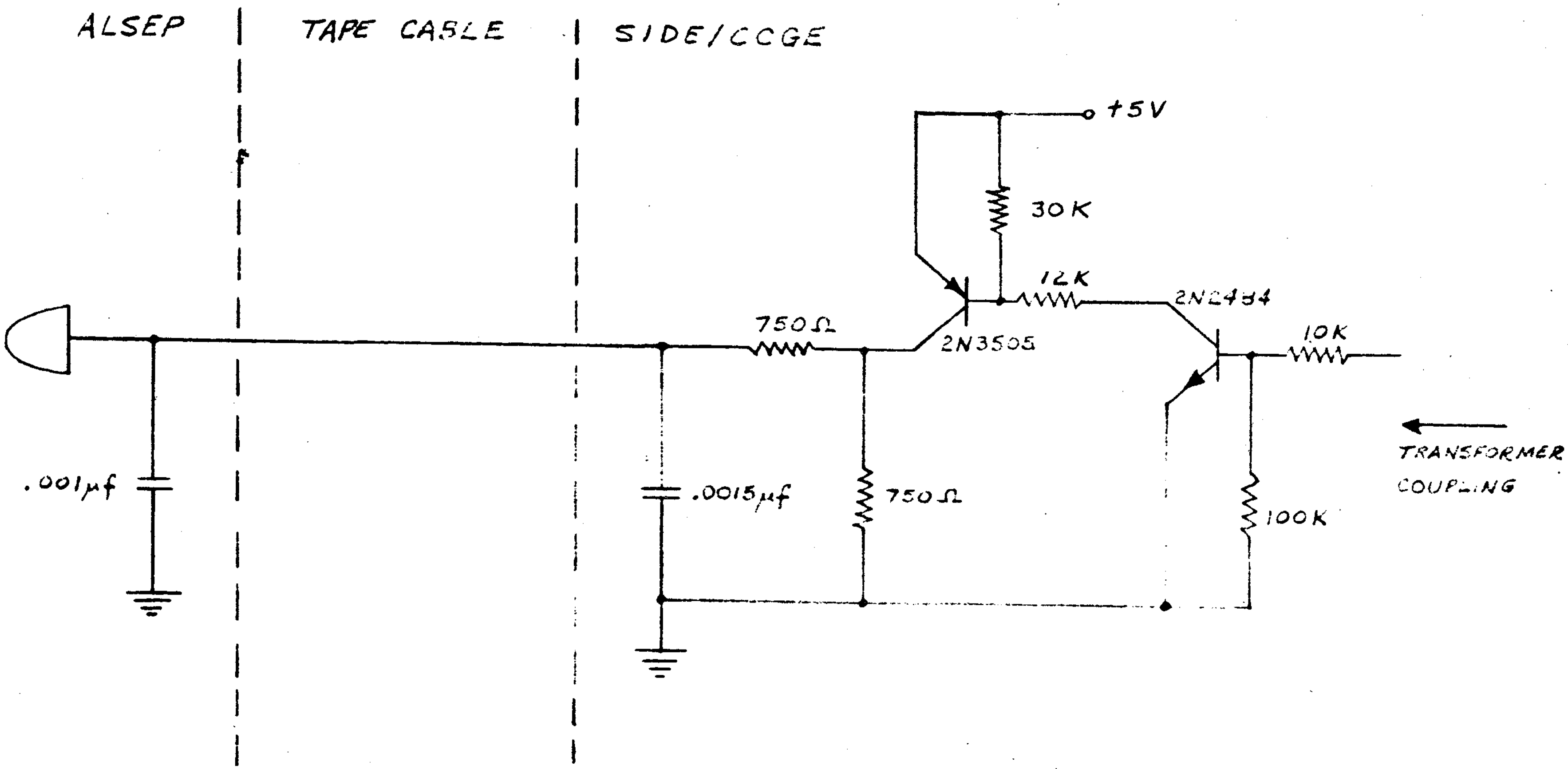


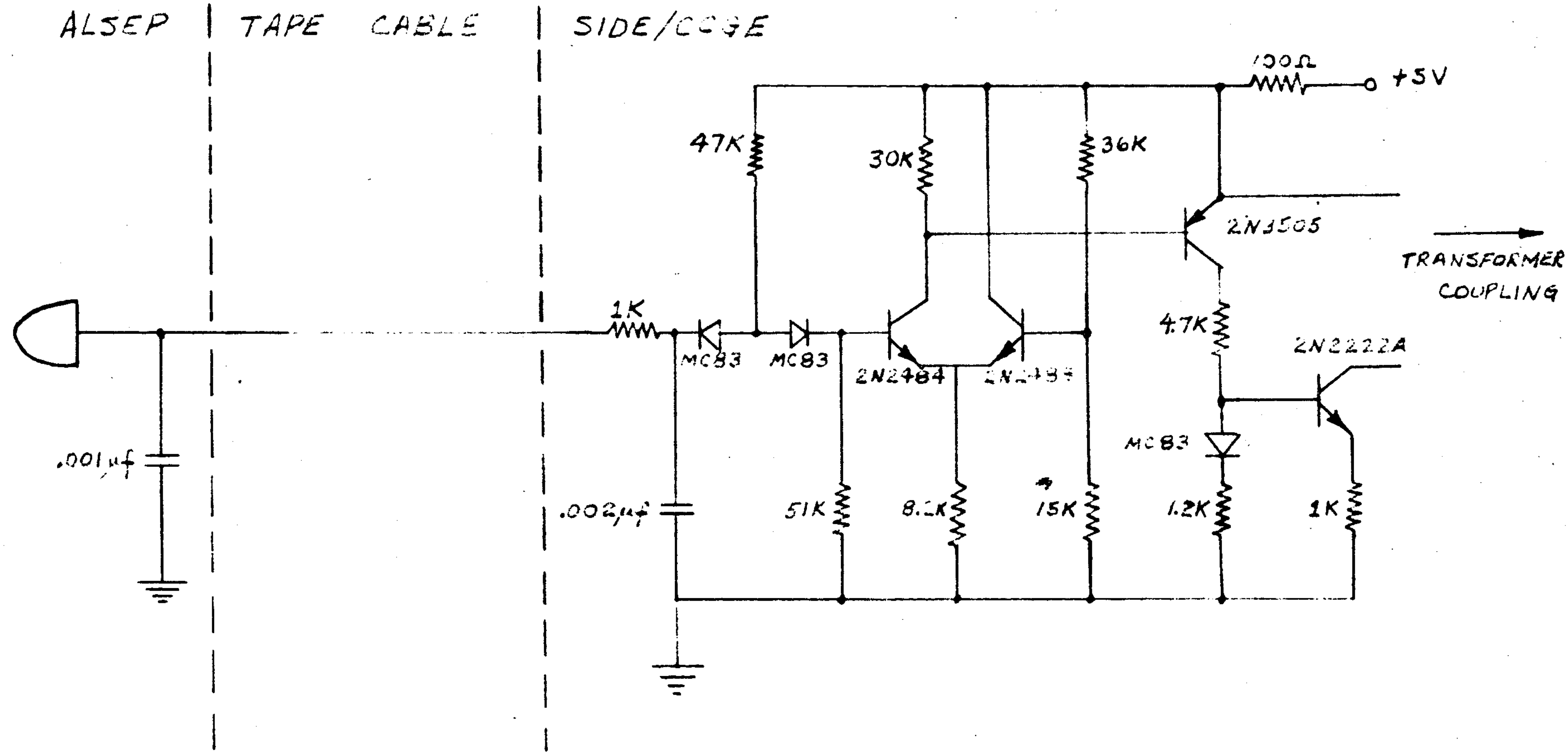
Figure 5-1 Electrical Lines between SIDE/CCGE and ALSEP



Notes:

1. The circuit in the data subsystem is Fairchild LPDTµL or equivalent.
2. Logical "0" - 0 to + 0.4 V required, data subsystem will supply no more than 215µa.
3. Logical "1" - +2.5 V to +5.5 V, data subsystem will require no more than 12µa.

Figure 5-2 Experiment / Data Subsystem Digital Data Line Interface



Notes:

1. The circuit in the Data Subsystem is Fairchild LPDTμL 9041 or equivalent.
2. Logical "O" - O to + 0.4 V maximum with maximum sink current of 0.75 ma.
3. Logical "1" - + 2.5 V to + 5.5 V, with maximum supply current of 45μa.

Figure 5-3 Experiment/Data Subsystem Timing and Control Line Interface Circuits

5.1.3 COMMAND INPUTS

The interface circuit for the command line inputs is shown in Figure 5-4. This circuit is used on the input of the following lines:

a. Command Line No. 1

b. Command Line No. 2

c. Command Line No. 3

d. Command Line No. 4

e. Command Line No. 5

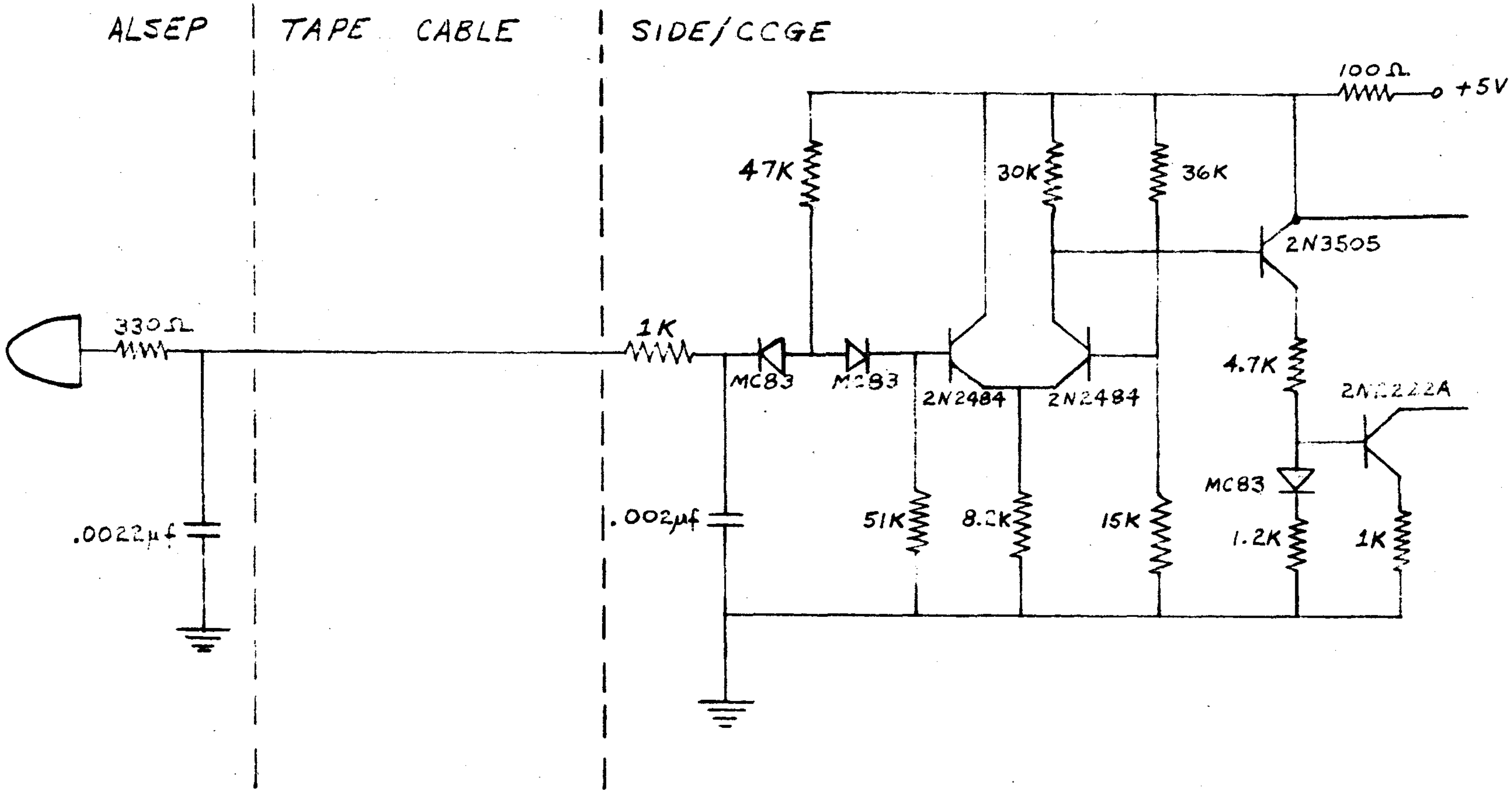
Transformer coupling is used on all these lines to assure DC-decoupling from ALSEP.

5.1.4 ANALOG DATA OUTPUTS

The two analog data lines have output interface circuits as shown in Figure 5-5. The power for these output circuits is supplied via a separate output from the power converter. DC-isolation from the instrument signal ground is achieved by capacitor coupling.

5.1.5 POWER INPUTS

The experiment input power is terminated in a transformer in the low voltage power supply. This power line is terminated in ALSEP in a circuit breaker which can be controlled by ground command. When the experiment power is switched off, the experiment is placed on standby thermal power; this power can also be switched on or off by ground command. These interfaces are shown in Figure 5-6.



Notes:

Command Pulse Characteristics

Non-active state:	+ 2.5 to + 5.5 volts with max supply current of 45 μ amp.
Active state:	0 to + 0.4 volts with max sink current of 750 μ amp.
Rise and Fall time:	10 μ sec maximum
Command Rate:	One command per second maximum - normal mode
	One command per two seconds maximum - slow mode

Driving circuit is Fairchild LPDT μ L 9042 or equivalent.

Figure 5-4 Experiment/Data Subsystem Command Signal Interface

5-5 Experiment/Data Subsystem Analog Data Line Interface Circuits

TO BE FURNISHED (NOT YET AVAILABLE)

5-6 Experiment/Data Subsystem Power Line Interface Circuits

TO BE FURNISHED (NOT YET AVAILABLE)

5.2 MECHANICAL INTERFACES

The size and form factor for the SIDE/CCGE in the stowed configuration is shown in the mechanical interface drawing, 2323521. The overall dimensions are 4.5 inches by 12 inches long by 15.25 inches high. The SIDE/CCGE is attached to the ALSEP sun shield via four tabs. Three of these are at the corners of the package, one inch above the sun shield; the fourth tab is 2-1/8 inches above the sun deck near one corner of the package.

5.3 ASTRONAUT DEPLOYMENT INTERFACES

The astronaut must carry out the following tasks during deployment of the SIDE/CCGE:

a. Release the experiment from the ALSEP sun shield by releasing the four tie-down fasteners.

b. Remove the experiment from the ALSEP sun shield, release the tripod leveling legs, the cable reel, and set the experiment down near the central station.

c. After completing deployment of the central station, engage the experiment carry tool and walk approximately 55' in the prescribed direction away from the central station.

d. Holding the experiment, remove the ground plane. Set the experiment down and deploy the ground plane next to the experiment.

e. Set the experiment on the ground plane with the long dimension E-W oriented and the end of the package containing the CCIG pointing away from the sub-earth point.

f. Remove the CCIG from the experiment package and deploy it just off the edge of the ground plane with the orifice pointing in a N-S direction, and also pointing generally away from the LM.

g. Level the experiment to within $\pm$ 5 degrees and recheck the experiment orientation.

h. Return to the ALSEP central station.

The design goal for the completion of these tasks is 9 minutes or less.

6. EXPERIMENT TEST SET (SUBSYSTEMS 5 & 7)

These subsystems are used to check out and test the entire experiment package. A functional block diagram of the Subsystems is shown in Figure 6-1. (ML Drawing 609250). As shown in the block diagram these subsystems are composed of the following major subassemblies:

a. Data Processor/Print/Phone Unit

b. Display Unit

c. ALSEP Simulator Unit

d. Monitor Unit

6.1 DATA PROCESSOR/PRINT/PHONE UNIT

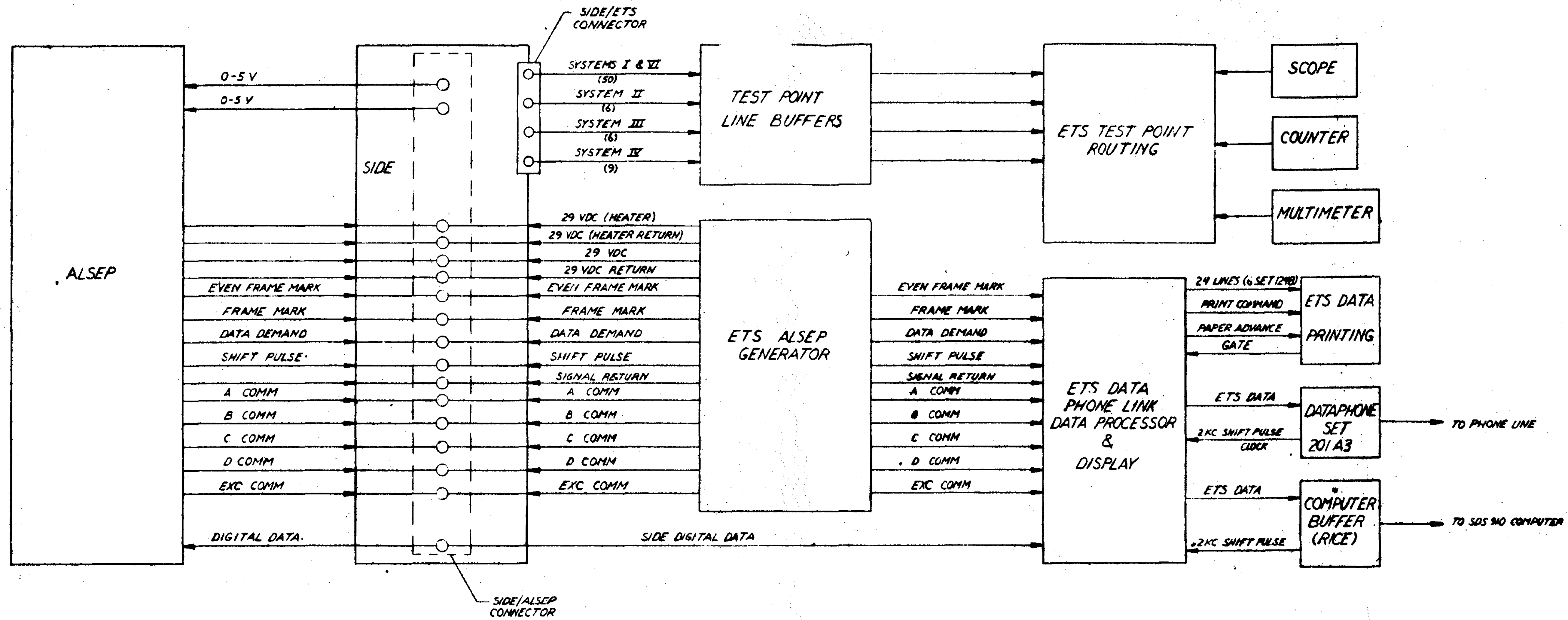
The Data Processor/Print/Phone Unit takes the digital data from the SIDE, processes the data, and routes it to the Printer, the Data Phone and the Display Unit.

6.2 DISPLAY UNIT

The Display Unit displays data from the Data Processor/Print/Phone Unit.

6.3 ALSEP SIMULATOR UNIT

609250



PRELIMINARY PRINT

NOTES: UNLESS OTHERWISE SPECIFIED

LIST OF MATERIALS

CONTRACT NO. 51966-M

MARSHALL LABORATORIES
TORRANCE, CALIFORNIA

TITLE: ETS BLOCK DIAGRAM SUBSYSTEM V ALSEP/SIDE

SIZE D | CODE IDENT NO. 13126 | DWG NO. 609250

The ALSEP Simulator Unit sends out timing and command signals which simulate the function of ALSEP and supplies power to the SIDE/CCGE.

6.4 MONITOR UNIT

The Monitor Unit brings the test points in the experiment package to the front panel of the ETS so they may be observed with the test equipment.