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Experiment Designer's Guide for New ALSEP Experiments

This ATM provides information to assist those considering new experiments for inclusion on future ALSEP missions.

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1.0 SCOPE

1.1 Scope - This document is intended to act as a guide for experimenters by outlining general requirements for integrating experiment subsystems into the National Aeronautics and Space Administration (NASA) Apollo Lunar Surface Experiments Package (ALSEP).

The ALSEP is a set of scientific instruments and supporting subsystems which will be transported to the lunar surface aboard the Apollo Lunar Module (LM). The astronaut will provide optimum placement of the equipment on the surface, emplant sensors, and start operations. In operation, the ALSEP will be self-sufficient, using a radioisotope thermoelectric generator for electrical power, and will collect, format, and transmit geophysical and other scientific data to the earth for a period of one year after departure of the spacecraft. Command and data communications will be established via the Manned Space Flight Network (MSFN).

1.2 Associated equipment - Each experiment subsystem shall be capable of operating in conjunction with the following equipment in accordance with the interface requirements specified in paragraph 3.2 herein:

a) ALSEP Structure/Thermal Subsystem

b) ALSEP Data Subsystem

c) ALSEP Ground Support Equipment (GSE)

The central station is defined as the data subsystem including supporting structure and thermal control, the power conditioning unit including supporting structure and thermal control, all inter-connecting cables between the central station and the nearest element of each emplaced experiment and the experiment tie-down structure. Space is allocated for experiment electronics which can be packaged more effectively in the central station. These experiment electronics are not, however, a part of the central station and only a limited space is available.

2.0 APPLICABLE DOCUMENTS

2.1 Applicable Documents - The following documents, of exact issue shown form a part of this specification to the extent specified herein:

SPECIFICATIONS

Contractor

SS 100000	Technical Specification for Apollo Lunar Surface Experiments Package System

Military

MIL-I-26600 (2)	Interface Control Requirements Aeronautical Equipment
MIL-W-6858 C	Welding, Resistance, Aluminum, Magnesium, Non-hardening Steels or Alloys, Nickel Alloys, Heat-Resisting Alloys, and Titanium Alloys, Spot and Seam

STANDARDS

Military

MS 33586 A	Metals, Definition of Dissimilar

OTHER PUBLICATIONS

NASA/MSC Criteria and Standards

MSC-ASPO-EMI-10 A	NASA addendum to MIL-I-26600 (2)

TN D2747	A Meteoroid Environment for Near-Earth, Cis-lunar, and Near-Lunar Operations
NPC 200-4	Quality Requirements for Hand Soldering of Electrical Connections
NPC 250-1	Reliability Program, Provisions for Space Systems Contractors
PS-6	Ultrasonic Cleaning, Electrical and Electronic Assemblies.

Grumman Aircraft Engineering Corporation (GAEC) Documents

LED 520-1F	Design Criteria and Environments for the LEM.
LSP-530-001	LEM Standard Specification.

Bendix

ATM-241B	Acceptable Parts List
ATM-242B	Approved Materials for ALSEP Equipment

2.2 General/Design Information Documents

Bendix

ATM-226	Data Processor Functional Description
ATM-294	Magnetic Cleanliness Guidelines
ATM-295	LEM Exhaust Effects

ATM-493	ALSEP Cable Thermal Test
ATM-500	Circuit Design Using Solid Tantalum Capacitors
ATM-568	Guidelines for use of Beryllium on ALSEP Passive Seismometer
ATM-599	Materials Application in ALSEP

3.0 REQUIREMENTS

3.1 General - The ALSEP Data Subsystem has been designed for operation with up to five active experiment subsystems and this, together with weight, volume and power restrictions for ALSEP, limits the number of experiment subsystems that can be carried on any particular ALSEP. Each experiment subsystem (except for the case of purely passive experiments) should include all the electronics required for the general operation of the experiment and the carrying out of any required command functions, for processing the experiment results into a form acceptable and accessible to the Data Processor, for making available to the Data Processor engineering information indicating the functional status of the experiment and for controlling, where necessary, experiment temperature control systems.

In general, temperature control systems should be entirely passive, but electrical heating can be used as an additional back-up where tight temperature control is required or where undue weight penalties would otherwise result. Any such electrical heating power used should be kept to a minimum.

A major effort in the design of an experiment should be given to reducing the experiment weight to a minimum. The experiment should be as small and compact as possible, subject to not compromising the required experiment performance, and light weight materials such as Beryllium, Magnesium Alloys, Aluminum, fiberglass etc. should be used where possible.

The sequence required for the deployment of an experiment on the lunar surface should be kept as simple as possible and be compatible with the capabilities of a suited astronaut. An astronaut's movements are restricted by the Extravehicular Mobility Unit (EMU) suit and "feel" and finger dexterity are reduced by the thermal glove, consequently some apparently simple tasks could be difficult to perform.

3.1.1 Operational Characteristics

3.1.1.1 Mission Requirements - An experiment subsystem shall be capable of being transported to the moon stowed in ALSEP, placed on the lunar surface by one astronaut and remaining on the moon in a functional state after the departure of the astronaut.

3.1.1.2 Prelaunch Operations - Final installation of experiment subsystems into ALSEP shall take place at Bendix. There will be no checkout after ALSEP is installed in the LM. Installation in the LM may be as long as 70 days prior to launch.

3.1.1.3 Translunar Flight - Experiment subsystems shall be inoperative during the flight to the moon. There shall be no necessity for checkout or servicing of experiments aboard the LM during this phase of the mission.

3.1.1.4 Lunar Surface Operation

3.1.1.4.1 Deployment - Deployment of experiment subsystems shall be in accordance with the human factors requirements of paragraph 3.1.2.6 herein.

3.1.1.4.2 Activation - Turn-on signals for experiment subsystems shall be provided by the data subsystem on command from earth. The turn-on time for any survival power shall be within 90 minutes after removal of ALSEP from the LM. Turn-on of the functional portion of the instrument may occur as long as five days after the removal of ALSEP from the LM.

3.1.1.4.3 Performance verification - The performance of each experiment shall be verified with a few-point verification test during system acceptance test, system pre-launch (KSC) test, and on the lunar surface during initial Lunar operation. The implementation of these three tests shall be identical.

If possible the test shall excite the experiment sensor(s) or, failing this, the excitation should be applied as close to the sensor(s) as possible.

3.1.1.5 Thermal Control - Each Experiment shall provide its own thermal control system to maintain the temperature of the Experiment within acceptable limits. Bendix will supply thermal control for any experiment electronics located in the Central Station. Electronics for packaging in the Central Station shall be capable of operating over the temperature range of $0^{o}F$ to $125^{o}F$.

3.1.1.6 Dust Covers - An experiment shall be designed so that an accumulation of dust will not impair its performance. Where this is not possible, or unreasonable design penalties would be involved, dust covers shall be included in the experiment design in order to protect the sensitive regions from dust until after the Lunar Module (LM) ascent. The removal of dust covers is initiated by ground command subsequent to the departure of the LM. In the event of failure of the command link, a back-up timer in the data subsystem shall effect removal of the dust covers.

A self activating system for the removal of dust covers is required for experiments having no electrical interface with ALSEP, also self activating systems can be incorporated in other experiment designs if desired.

3.1.2 Operability

3.1.2.1 Reliability - Experiment subsystsms shall have as a design goal an overall reliability of 0.99, including launch, flight, deployment and one year of lunar operation.

3.1.2.2 Maintainability - Equipment arrangements, accessibility, and interchangeability features shall be incorporated into the design to allow efficient preflight servicing and maintenance. Equipment check-out, field maintenance, and replacement of experiment subsystems will, in general, be at the subsystem level.

3.1.2.3 Useful Life - Experiment subsystems shall have successful lunar operation for one year as a design goal. For experiments with no electrical interface with ALSEP the design life shall depend upon the requirements of the experiment.

3.1.2.4 Environment Requirements - The ALSEP shall be capable of successfully performing the required mission during or after, as applicable, being subjected to the most severe environmental conditions shown herein or any logical combination of these environments applied simultaneously. The most severe environment values shown herein are minimum design requirements.

3.1.2.4.1 Mission Environment Phases - The mission is divided into seven phases for the purpose of defining the environmental conditions. These phases and the environments expected for each are shown in Tables I, II and III.

3.1.2.4.2 Induced Environments - Defined in Table III. (These environments can not be specified until the mechanical properties of all experiments mounted on ALSEP are known and the assembly is analyzed. The values in Table III are indicative of the levels that may be seen. It is unlikely that any levels will be considerably in excess of those in Table III.)

3.1.2.4.3 Lunar Surface Environment - The lunar surface environment shall be as defined by Document LED 520-1F; however, the meteoroid environment shall be as defined in NASA Technical Note TN D2747.

The properties of the lunar surface at the deployment site can be assumed to be:

Maximum surface slope	3^{o}
Bearing strength	5 psi

3.1.2.4.4 Magnetic and Electric Field Cleanliness - The design goal for an experiment subsystem contaminant electric field shall be less than 25 volts/meter at 10 feet at frequencies less than 10 Hz. The contaminant magnetic field shall be less than 10 gammas at 10 feet over all modes of operation at frequencies less than 30 Hz. The magnetic field considerations includes the cable between the deployed package and any external or central package portion of the experiment electronics. The magnetic field induced in the experiment package after exposure to a field of 25 gauss shall be less than 10 gammas at 10 feet.

3.1.2.5 Ground Handling and Transportability - Full design recognition shall be given to the durability requirements of experiment subsystems during preflight preparation. However, special packaging and transportation methods can be used to minimize design penalties.

3.1.2.6 Human Factors - The design of each experiment subsystem is constrained by the astronaut interface requirements of paragraph 3.2.6. The problems associated with the Astronaut interface can be severe and Experimenters should consult with the Mission and Crew Engineering Department at Bendix as early as possible during experiment design.

3.1.2.7 Storage - Each experiment subsystem shall have a shelf-life of two years. Shelf-life is defined as a storage period in a controlled environment of 50°F to 80°F and a relative humidity of no more than 50 percent following acceptance and prior to installation in the LM for flight.

3.2 Interface Requirements

3.2.1 Mechanical interface - Each experiment subsystem shall mechanically interface with the central station structure/ thermal subsystem as shown in Interface Drawing

3.2.1.1 Size and Form Factors - The total volume available for all the experiments on an ALSEP is as follows:

a) In compartment 1

A rectangular mounting surface with approximate dimensions 26" x 23" (less about 16 in.^{2} cut off one corner) with an available height of 15 1/4 inches.*

b) In compartment 2

A rectangular mounting surface with approximate dimensions 7" x 23" with an available height of 18" for 17" of length and 9" for the remainder.

*See note on page 27.

c) A volume of approximately 200 cu. ins. within the central station thermally controlled volume for some experiment electronics.

The layout of the compartments is shown in figure 1. The Central Station antenna and antenna gimbal mechanism require packaging within the allocated experiment volume.

3.2.1.2 Weight - The total weight available for all experiments on ALSEP is 55 lbs. This weight to include any experiment electronics packaged in the Central Station.*

3.2.1.3 Center of Gravity - The requirements for the position of the center of gravity of an experiment depend upon other experiments and mounting positions in the ALSEP. In general the center of gravity should be fairly close to the geometrical center of the experiment when in the stowed configuration. If a separate electronics package is included, it shall have its center of gravity within 2 inches of its geometric center.

3.2.1.4 Experiment/Data Subsystem Interconnecting Cable and Cable Spool - Bendix will provide an integrated flat conductor cable spool, flat conductor cable, and central station clip. The experiment shall allocate volume for the reeled cable and weight for the spool and spool tie-down fixtures., The weight of the cable will be charged to Bendix. The general principle of operation of the Flat Conductor Cable Spool is shown in figure 2 and detailed design information in figures 3 - 6. The cable exits from the spool assembly at two locations and the spool remains midway between the experiment and the central station.

3.2.1.5 Mounting - Tabs shall be provided at the edges of each experiment package for mounting to the ALSEP structural/thermal subsystem.

3.2.2 Electrical Interface

3.2.2.1 Experiment Electrical Signal Interface - Each experiment subsystem should interface with the ALSEP data subsystem. The required interface is shown schematically in figure 7.

3.2.2.2 ALSEP Data Subsystem - The ALSEP data subsystem forms the link between the experiment subsystems and Earth.

*See note on page 27.

The Data Subsystem

a) Accepts power from the RTG Power Conditioning Unit (PCU) and controls and distributes the power to the various experiments.

b) Generates a group of digital signals for use by the experiments to control and time the experiment operation. These signals are distributed to the experiments on an "as-needed" basis.

c) Interrogates each experiment at assigned time periods and accepts the experiment digital data output.

d) Accepts analog engineering status data, converts the data to digital form and inserts the resulting data word into the bit stream.

e) Transmits the digital data stream to earth.

f) Receives and decodes earth command signals. For each command received and decoded a command pulse is generated and applied to the appropriate command line.

3.2.2.3 Logic Levels - All timing and control signals are "positive" logic. The logic levels for all signals are as follows:

Logical "ZERO"	0 to +0.4 volts
Logical "ONE"	+2.5 to +5.5 volts

These levels are compatible with the Fairchild 9040 series Low Power Micro-Logic elements.

3.2.2.4 Timing and Control Signals - The data processor (one unit of the data subsystem) generates the various timing and control signals which are provided to each experiment where required. The timing and phasing of the signals are shown in figure 8.

The timing and control pulses are provided to experiment and ALSEP supporting equipment for synchronizing data gathering with data processor collection, stepping of experiment signal multiplexers, indicating time for readout of data, and shifting out each bit of stored digital data.

Each timing and control signal is supplied on a separate line which is driven by the circuit shown in figure 9, a Fairchild LPDTμL 9041 integrated circuit. The series resistor and shunting capacitors C_1 and C_2 are used to control the rise and fall times of the signals to between the acceptable limits of 2μ secs and 10μ secs. Each driver stage is duplicated in case of failure. Only one of the driver stage circuits is powered at a given time. The driver stage specified will "sink" up to 750 μA during the logical "0" state and "source" up to 45 μA during the logical "1" state. These current limits must be observed in selecting the termination of the lines at each experiment.

3.2.2.4.1 Frame mark pulse - A mark pulse can be provided at the beginning of each data frame. An even frame mark pulse can also be provided on a separate line at the beginning of alternate data frames. The pulses have the characteristics shown in figure 8.

3.2.2.4.2 Data gate pulses - Data gate pulses are provided at the beginning of each data word allocated to an experiment. The characteristics of the pulses are shown in figure 8.

3.2.2.4.3 Data Shift Pulses - Data shift pulses are provided at the basic clock frequency of 1060 pulses per second (normal mode). The characteristics of the pulse train are shown in figure 8.

3.2.2.5 Data

3.2.2.5.1 Digital Data - At the time slot specified in the telemetry frame format, the data processor interrogates an experiment with a "data demand" pulse and accepts a 10 bit NRZ digital data word (least significant bit last) from the experiment during the demand period. The digital data line from each experiment is terminated in the data subsystem with the circuit shown in figure 10. The series resistor and shunting capacitors C_1 and C_2 are used to control the rise and fall times of the signals to between the acceptable limits of 2 μ secs and 10 μ secs. Each data subsystem input gate is duplicated in case of failure. Only one of the input gates is powered at a given time. The experiment line driver stage should be capable of "sinking" at least 215μ amps during the logical "ZERO" state and supplying at least 12μ amps during the logical "ONE" state.

The data processor formats data collected into a 64 word, 10 bits per word, telemetry frame. In normal transmission one complete frame is transmitted every 32/53 seconds and in the slow mode every 64/53 seconds. The first three words in each frame are used for synchronization and frame identification and 40 words, in fixed positions, are allocated to one experiment subsystem.* The remaining words are programmable. Of these, one word is required for Command Verification and one word for housekeeping data leaving 19* programmable words for the experiment subsystems.

The positions of the fixed words in the format frame are shown in figure 11.

The word or words allocated to an experiment will be read out whenever the experiment is signalled on the demand line by the data processor. The data shift pulses provided are used by the experiment to shift the experiment data on to the data line. The characteristics of these pulses are shown in figure 8.

3.2.2.5.2 Data demand pulses - The data demand signal is provided to an experiment by the data subsystem for the readout of each 10 bit data word. The demand signal is a D. C. level maintained on the demand line for one complete word period during the readout of the data registers. The data processor reads data at the positive going edge of the data shift pulse, hence it is necessary that the digital data NRZ level be at the digital "1" or "0" level at the positive going edge of the succeeding shift pulse and that each succeeding data bit be of proper amplitude at the positive going edge of the corresponding shift pulse. The amplitude of the data bit in the experiment output register must be maintained on the data line for at least 25 μ secs. before, and 118 μ secs after the positve going edge of the shift pulse. The data state can be changed at anytime outside this specified interval. The characteristics of the demand pulse are shown in figure 8.

3.2.2.6 Data Storage - Each experiment subsystem should provide sufficient data storage to store experiment data while awaiting read-out.

*See note on page 27.

3.2.2.7 Commands - A separate line is provided from the command decoder for each ground command function. Each command line is driven by the circuit shown in figure 12.

The command pulse has the following characteristics:

Non-active state (logical ONE)	+2.5 to +5.5 volts with maximum supply current of 45 μA.
Active state (logical ZERO)	0.0 to +0.4 volts with maximum sink current of 750 μA.
Active state duration	20 m secs.
Rise and fall times (measured from 10% to 90% amplitude points)	10 μ secs. max.
Maximum command rate	1 command/sec. (Normal mode) 1 command/2 secs. (Slow mode)

The ALSEP Command system has provision for 100 command functions. 34 commands are required for operating the data subsystem and power supply, the remaining 66 being available for experiments. 2 commands are at present allocated to the lunar dust detector leaving 64* commands for the ALSEP experiment subsystems.

3.2.2.8 Long Delay Timer - The delay timer sends timing pulses to the Delayed Command Sequencer every minute, every 12 hours and after 760 days (the latter being used to terminate the ALSEP transmission to Earth).

The Delayed Command Sequencer uses the Minute period and 12 hour period pulses to initiate the back-up commands for the

*See note on page 27.

removal of any dust covers four days after the ALSEP deployment. In addition, these pulses are used to initiate two commands, six minutes apart, every 12 hours throughout the remainder of the ALSEP life. This facility can be used to generate regular command functions for experiments if required.

3.2.2.9 Engineering Status Data (analog) - The data subsystem includes a 90 channel multiplexer which accepts analog status information in the range 0.0 to +5.0 volts from a source impedance of 10 K ohms or less. The status signal is digitized in an 8 bit A/D converter and commutated into the bit stream for transmission to earth.

Each experiment, where applicable, is provided with one or more wires in the interconnecting cable for the status signal. At the data subsystem end these lines are terminated into the multiplexer which has an input impedance in excess of 10^6 ohms during sample and 50×10^6 ohms during non-sample periods.

Each analog line is sampled once every 90 telemetry frames. 59 analog lines are required for monitoring the central station power supply, the remaining 31 being available for experiments and engineering measurements. 6 analog channels are at present allocated to the lunar dust detector leaving 25* analog channels available for ALSEP experiment subsystems.

The analog channels should furnish data in the form of voltages from 0 to 5 volts D.C. During the 10 m sec. sampling period, the variations in each status line voltage level shall not exceed 1/2 the value of the least significant bit required to satisfy the accuracy requirement on the specific input signal. Those inputs which require 8 bit conversion shall not vary more than 10 millivolts during the sampling period. Variations of 20 millivolts shall be allowed for those inputs for which only 7 bits of the available 8 bits are required: 40 millivolts for 6 bits, etc.

3.2.2.10 Shielding - Signal wires for all timing, control and digital data signals are shielded by grounding alternate wires in the flat conductor cable at the Data Subsystem end. This shielding, along with controlling rise and fall times for the digital signals, prevents objectionable cross-coupling within the cable.

3.2.2.11 Data Return Ground Line - All electrical signals on the digital data line, analog data lines, timing and control lines and command lines shall be referenced at the experiment to the data return line. The data return line is tied to the common system reference ground in the data processor.

The experiment chassis return, data return and power return lines should be separated into three distinct conductors in the inter-

*See note on page 27.

connecting cable and should be isolated from each other, in the experiment, by an impedance of at least 1 megohm.

3.2.2.12 Noise - Random noise and electrical transient feedback induced into the timing, control and command lines from circuits in the experiment electronics should be less than 100 m V peak to peak as measured at the input to the data processor.

3.2.2.13 Failure Protection - The experiment electronics shall be designed such that short-circuiting or open-circuiting at any one of the input or output lines will not impair the performance of any other line.

3.2.3 Electrical Power Interface -

3.2.3.1 Power - A total power of 30 to 35* watts is available for ALSEP experiments. This includes all functional, electronic and heater power requirements.

3.2.3.2 Electrical Power Distribution - Three power lines shall be provided to each experiment. These shall provide nominal 29 VDC normal operating power, nominal 29 VDC survival power and a power return line. The survival power line shall be switched on at the central station whenever power is removed from the operating power line.

3.2.3.3 Circuit protection - Circuit breakers will be provided for each experiment by the central station. An experiment will be switched to the survival mode if the current on the operating line exceeds 500 ± 50 m amp. Switching is initiated if the current exceeds this value for more than 200 μ secs.

Each experiment can be switched between operating and survival modes by ground command. There is no provision for reinstating an experiment if the survival power line is fused.

3.2.3.4 Power supply characteristics -

3.2.3.4.1 Operating and survival power - Both power lines shall be regulated to 29 ± 0.29 VDC at the power conditioning unit. The supply to each experiment will be through about 2 ohms in addition to the resistance of the cable from the central station to the experiment.

*See note on page 27.

3.2.3.4.2 Ripple - The ripple on the power lines at each experiment shall not exceed 100 millivolts peak-to-peak.

3.2.3.4.3 Power Supply Overload - At times when the ALSEP power supply is liable to become overloaded experiments may be switched to a stand-by mode. This switching is done automatically by the central station which removes the power from the operating power line and switches it to the survival power line. Normal operating power can be restored by ground command. Switching to stand-by mode does not occur during short-period transient overloads.

3.2.3.4.4 Survival Heater - An experiment survival heater, if required, shall be capable of maintaining the temperature of the experiment at a level that precludes damage to the experiment and its electronics, and enables the experiment to resume normal operation subsequent to the restoration of the operating power. Survival heater power requirements should be kept to a minimum.

3.2.3.4.5 Power Transients - Transients caused by varying loads at an experiment should not exceed 25 milliamps/millisecond. No experiment should draw an instantaneous current in excess of 450 milliamps at any time (including turn-on transients) and the duration of any transient should not exceed 50 milliseconds.

If the power demand during a transient exceeds the output of the power supply, the line voltage will fall. Experiments shall be designed to withstand a 20% reduction in supply voltage for up to 120 milliseconds and a 50% reduction for up to 10 milliseconds without damage to the experiment or change in operating mode.

3.2.3.5 DC Isolation of Experiments - Each experiment shall provide transformer isolation of all experiment electronics (except heater power) from the ALSEP power supply. The experiment thermal control circuits, if any, shall be designed to minimize failures which would provide a DC path back through the signal return line.

3.2.3.6 Feedback

3.2.3.6.1 Noise Feedback - The noise and/or ripple appearing on the power supply line and originating in the experiment shall not exceed 150 m V peak to peak.

3.2.3.6.2 DC - DC Converters - Experimenters should consult with Bendix on the design of DC - DC converters with a view to minimizing noise generation within the system.

3.2.4 Intercabling - A flat conductor cable shall be provided by Bendix for connecting the experiment to the central station. Shielded lines shall be obtained by grounding alternate conductors between the required lines.

3.2.4.1 Physical Characteristics - The cable conductors are parallel strips of soft copper foil 0.002 ins. thick and 0.025 ins. wide, electrically equivalent to a round conductor AWG #32. The separation between the conductor strips is 0.050 ins., center to center. The conducting strips are sandwiched in a matrix of FEP Teflon, 0.002 ins. thick, which is in turn encased in a sheath of non-thermoplastic "Kapton" (H-Film). The total thickness of the cable lies between 9 and 12 mils. Four conductor strips are paralleled together to make up conductors equivalent to a round wire AWG #26 for use as power lines. The overall width of the cable is determined by the number of conductors required.

3.2.4.2 Thermal Changes - The change of length of the cable with different temperature environments is significant and sufficient cable slack will be allowed during deployment to provide for expansion and contraction.

3.2.4.3 Electrical Characteristics

3.2.4.3.1 Electrical Resistance - The electrical conductors will be copper and will have the following resistances as a function of size and temperature (resistance in ohms/100 feet)

Wire Size	-175°C	+20°C	+125°C
32	4.4	18.8	26.5
26	1.14	4.84	6.83

3.2.4.3.2 Distribution Line Capacitance - The interconductor capacitance to be anticipated is approximately 6 pico-farad/foot.

3.2.4.3.3 Connection of Cable to Experiment - The flat conductor cable shall be hard wired at an experiment and will have a connector at the data subsystem interface.

3.2.4.3.4 Thermal Barrier - Where experiment thermal control is a problem, the number of wires to an experiment should be kept to a minimum. When possible a short thermal barrier of manganin wire should be inserted into the leads at the experiment end, where the leads pass through the experiment thermal insulation, to reduce heat leakage to and from the experiment. The thermally induced e. m. f. for manganin/copper couple is of the order of 0. 3 m V per $100^{\circ}C$ gradient.

3. 2. 5 EMI Interfaces -

3. 2. 5. 1 Electro-magnetic Interference (EMI) - An experiment shall be designed and built to meet the requirements of MIL-I-26600 as amended by MSC-ASPO-EMI-10A. The experiment shall be tested to tne requirements of these specifications during system integration tests by the ALSEP contractor.

EMI should be a consideration in the design, layout, and packaging of all electronic and electrical circuitry. All of the practices and procedures required for reduction of EMI should be employed up to the point of over-complicating design, construction, launch handling, or derating the functional and/or reliability aspects of the equipment.

3. 2. 5. 2 System grounding - System level single point grounding will be used. The signal return line and power return line will be returned to the system common ground point on separate conductors, and will have a minimum D. C. isolation of 1 megohm between each line.

Within each experiment all audio frequency signal circuits (less than 50 KHz) shall have a single point ground to the experiment common ground point.

3. 2. 5. 3 Mechanical structure and apertures - As a design goal, all doors, panels, and access part covers shall maintain continuous electrical contact over their full mating surfaces. All holes or case discontinuities, except for particle entrance apertures, shall be covered by solid metal or EMI screening wherever possible.

3. 2. 6 Astronaut Interface - The astronaut will perform the following tasks:

1) Remove the ALSEP from the LM

2) Carry the ALSEP to the deployment site (about 300 feet from the LM)

3) Deploy the Radioisotope Thermoelectric Generator (RTG)

4) Remove experiments from the Central Station sun shield.

5) Deploy the Central Station

6) Deploy each experiment in turn.

3.2.6.1 Astronaut - The design of each experiment shall be such that it allows the astronaut to perform his required tasks within the constraints of the pressurized suit, lunar gravity and environment, PLSS and Extravehicular Mobility Unit (EMU) with maximum safety and minimum task loading. These tasks include release of the experiment from its stowed position, removal and handling, carrying the experiment to the chosen deployment site and paying out the flat cable, emplacement and alignment.

3.2.6.2 Interface Requirements - The interface which exists between the astronaut and the ALSEP occurs during the extravehicular activities on the lunar surface and is necessary for the successful deployment and operation of the system hardware and experiments. Specific considerations shall be applied to the design of the ALSEP and the operational tasks which will enhance the optimum effectiveness of the human as a system component during lunar deployment through minimizing demands on human resources, knowledge and skills, training and procedural data while satisfying overall system requirements and constraints.

3.2.6.3 Thermal Protection - Two potentially hazardous conditions should be guarded against during the design of ALSEP equipment and tasks: (1) close proximity of the astronaut to excessive temperatures which would result in thermal overloading of the PLSS; (2) physical contact, by the astronaut, with surfaces having excessive temperature values resulting in degradation of the thermal overgarment and subsequent thermal overloading of the EMU.

As a specific development goal, tasks should be devised so that the astronaut shall be as well isolated as possible from excessive temperatures and equipment should be designed so that direct physical contact of the astronaut with any surface having a temperature outside the range $\pm 250^{\circ}F$ cannot occur when task procedures are adhered to and when normal caution is exercised.

3.2.6.4 Experiment deployment - The astronaut tasks required for the deployment of an experiment subsystem include:

a) Release and removal of the experiment from ALSEP

b) Release cable spool, select a suitable site and deploy to the selected site paying out the cable.

c) Deploy the experiment on the surface.

d) Level and align the experiment as required

Each experiment shall be so designed that the astronaut will be able to deploy, emplace, level and align it within the following constraints:

1) Tie-down mechanisms required for experiment mounting to the ALSEP or package structure shall be designed to provide simple release and removal by the standing astronaut. The tie-down fasteners used for ALSEP experiment are shown in figures (to be specified).

2) All leveling and alignment devices shall be designed to provide maximum commonality and simplicity. No experiment shall contain features which require intricate manipulative or visual tasks for emplacement. Where judgements of fine tolerances are required, the capability shall be provided in the design of the instrument to allow the astronaut to determine, easily and rapidly, the in-tolerance condition.

3) When a distance measurement is involved in experiment deployment, pacing shall be the primary measurement mode. If more accurate distance measurement is required, a mini-tape or similar device shall be employed.

3.2.6.5 Deployment Time - Each experiment should be designed in such a way as to minimize the length of time required for deployment. An astronaut time of 90 minutes has been allowed for removing the ALSEP from the LM, carrying the ALSEP to the deployment area, deploying the experiments and returning to the LM.

3.2.6.6 Deployment Distance - An experiment should be deployed no less than 10 feet from the Central Station and no more than 20 feet unless a greater distance is required for isolation of the experiment or for other reasons.

3.2.6.7 Cable deployment - Each experiment should incorporate a simple device for the quick release of the flat cable spool.

3.2.6.8 Experiment handling - The Bendix furnished astronaut deployment tool shall be used for carrying and deploying an experiment where practical. The mating socket required on the experiment for this tool is shown in figure 13.

3.2.6.9 Handle - Where a handle is employed for experiment emplacement it should have the following dimensions: 1.25 to 1.50 inches in diameter by 6.75 inches in length. Handles should provide a means of emplacing the instrument from the standing position and should provide at least a three inch finger clearance.

3.2.6.10 Similarity of operations - Tasks shall be designed to present familiar conditions (i.e., stereotype of those introduced during training) of performance to preclude or reduce the probability of "reversal errors" under stress created by the mission environments, fatigue, or other psycho-physiological conditions.

3.2.6.11 Task timing - Perceptual and motor tasks of significant difficulty shall be scheduled to be performed early in the deployment sequence and those of less difficulty scheduled to be performed later.

3.2.6.12 Visual tasks - Visual tasks shall be designed to the operational viewing angle of the astronaut in the EMU suit rather than the maximum. This angle encompasses a 180^{o} cone of vision circumscribed by 90^{o} left and right, 105^{o} up and 95^{o} down from the standard line of sight. All visual tasks shall be designed for performance within the constraints of the EV protective visor and sun visor. All tasks will also be designed to make full use of the astronaut's shadow and/or full sunlight as required to obtain the optimum visual advantage. A flat white finish with low absorption-to-emission ratio is required on handles and other surfaces. Sun angle during ALSEP deployment will be between 7 and 20 degrees to the East with a 45^{o} sun angle as a maximum limit design contingency.

3.2.6.13 Anthropometric requirements - Consideration shall be given in design of tasks to the requirements contained in the following subparagraphs:

a) Movements of the arms and hands behind the torso Z axis and of the hands near the ears or back of head shall be minimized or eliminated.

b) Tasks requiring twisting, turning or torso rotation shall be minimized or eliminated.

c) Task design shall avoid the necessity for the astronaut to reach to any point within a distance of 18 inches off the ground. If a bending position is required for grasping task performance, the number and duration of these tasks must be held to a minimum. If manipulative tasks are required to be performed, the working height from the lunar surface must not be less than 24 inches from the lunar surface.

d) No task shall be designed to include bending forward more than 25 degrees unrestrained or 45 degrees restrained.

e) Application of torquing motion shall not require the astronaut to exert more than 80% of the force normally exerted with the full hand, i.e. 2-5 lbs. with full hand, 4.5-6.0 oz. with fingertips.

f) Dynametric forces in excess of 46 lbs. for the right hand and 42 lbs. for the left hand shall not be required to complete a twisting or torqueing task.

g) Human strength shall be utilized in the design of lifting and transportation tasks to eliminate assistance devices with weight penalties.

1) Where man's strength is a design factor, restraints shall be incorporated to prevent the astronaut from exceeding the tensile strength of the equipment and the inertia limits.

2) Fine adjustment mechanisms shall be constructed of materials capable of withstanding maximum torque loads.

h) All carrying tasks shall be designed to ensure that the astronaut's feet are not obscured from his vision. Where practical in carrying tasks of four or more minutes duration, a supplemental means of support shall be considered to complement the grip of the astronaut, such as a wrist harness.

i) Where latching or unlatching is a requirement in the ALSEP deployment, careful attenation shall be paid to providing the optimum latch motion. If design constraints dictate that a twisting motion is necessary, it shall be in the direction of easiest wrist joint movement.

j) Manipulative operations requiring the simultaneous use of both of the astronaut's hands, other than for simple holding, shall be limited to the area between the waist and shoulders.

k) ALSEP design and task planning shall give consideration to natural tendencies of the astronaut in the EMU to seek a handhold while assuming a bending position under lunar gravity conditions. In so doing, the astronaut will push horizontally against the package and apply forces tending to dislodge it or to turn it over.

l) Equipment design shall be such that it does not require the astronaut to kneel to perform his required tasks.

3.2.6.14 Surfaces: Visual aspects - All experiment external surfaces which might cause problems for the astronaut due to reflection of sunlight should be provided with low reflective properties or be protected with a removable cover or coating which has low reflective properties. Corners, edges, adjustment and control surfaces shall be marked and colored in such a manner as to enhance the contrast quality of those surfaces. These surface finishes shall only be done to the extent that thermal design will not be affected nor external surface temperatures raised to a point where degradation of the thermal overgarment can occur.

3.2.6.15 Surfaces: Mechanical finishes - Sharp and abrasive surfaces shall be avoided in the design of the ALSEP hardware and equipment. A minimum radius of not less than 0.030 inches is necessary on all external corners and edges where material thickness permits. If this is not possible because of material thickness, Teflon tape or some other suitable substitute must be used to protect the astronaut from the sharp edge.

3.2.6.16 Glove - There shall be no handling requirement necessitating the removal of the thermal outer glove.

3.2.7 Safety -

3.2.7.1 Personnel Safety - The safety of the crew while unloading, transporting, and deploying the equipment on the lunar surface and of personnel while handling the equipment on earth shall be a prime consideration in ALSEP design.

This shall include avoidance in equipment design of sharp edges, corners, and protuberances. Inherent protection of personnel from inadvertent contact with high temperature surfaces and hazardous electrical points shall be provided.

3.2.7.2 Equipment safety - Where practicable, the various components shall be hermetically sealed or of explosion-proof construction.

3.2.7.3 Hazard proofing - The design of the complete ALSEP shall not contribute to the fire and explosion risk at the facilities, or to the toxicity risk of the crew and launch area personnel. Specific hazards which must be avoided include leakage or generation through spillage of combustible or toxic gases and ignition sources including possible discharge of static electricity.

3.2.7.4 Fail safe - The equipment shall be designed so that failures of single components or complete units shall not propagate sequentially.

3.2.7.5 Selection of specifications and standards - Requirements for selection of specifications and standars shall be in accordance with Specification SS 100000.

3.2.7.6 Materials, Parts and Processes - Materials shall be selected from the ALSEP Approved Materials List ATM - 242 B. Parts shall be selected from the Acceptable Parts List ATM-241 B. All parts, materials, and processes shall be compatible with the intended use, and shall be compatible with the environment requirements specified in 3.1.2.4 herein. In general the following types of material shall not be used without prior approval of Bendix Parts and Materials Group.

a) Flammable materials

b) Toxic materials

c) Unstable materials

d) Plastic - (only epoxy - resin based compounds, Teflon, and Mylar shall be used)

e) Dissimilar metals in direct contact which tend toward active electrolytic or galvanic corrosion.

3.2.7.6.1 Soldering - NASA Publication NPC 200-4 shall apply for hand soldering of all electrical connections.

3.2.7.6.2 Welding - Resistance welding (spot and seam) shall conform to Specification MIL-W-6858C.

3.2.7.6.3 Ultrasonic cleaning - The requirements of PS-6 shall apply.

3.2.7.7 Moisture and fungus resistance - Materials which are not nutrients for fungus shall be used whenever possible. The use of materials which are nutrients for fungus shall not be prohibited in hermetically sealed assemblies and in other accepted and qualified uses such as paper capacitors and treated transformers. If it is necessary to use fungus nutrient materials in other such qualified application, these materials shall be treated with a process which will render the resulting exposed surface fungus resistant.

3.2.7.8 Corrosion of metal parts - Metals shall be corrosion resistant type or suitability treated to resist corrosive conditions likely to be met in storage or in normal service. Unless suitably protected against electrolytic corrosion, dissimilar metals, as defined in Standard MS 33586 A, shall not be used in direct physical contact.

3.2.7.9 Interchangeability - Interchangeability and replaceability shall be as defined by SS 100000.

3.2.7.10 Workmanship - Workmanship requirements for the experiment shall comply with the requirements of Specification SS 100000.

3.2.7.11 Magnetic materials - The use of magnetic materials should be kept to a minimum in the construction of the experiment and all parts associated with it.

3.2.8 Ground Support Equipment

3.2.8.1 Experiment Subsystem Test Set (ETS) - The experiment subsystem test set should be capable of comprehensive testing and troubleshooting of an experiment subsystem while operating it in isolation from the central station and other experiments. The connection between the experiment and its subsystem test set will be via the flat cable and the test set electrical interface should be identical to that seen at the central station by the experiment. Test points can be provided within an experiment subsystem for additional connections to the test set to aid in troubleshooting faults. The number of these test points provided by an experiment depends upon the level of fault isolation desired.

In order to fully test an experiment subsystem an experiment sensor stimulator and/or simulator should be provided. This can either be built into the experiment itself for functional testing, calibration purposes etc. and/or be achieved by linking external equipment to the experiment through special connections within the experiment.

3.2.8.2.1 System Test Set - The system test set will be capable of operating and testing the integrated ALSEP system. In general, the test set will be programmed to run through a test sequence on each subsystem and will compare the results obtained with expected results. Where the results are outside acceptable limits these will be printed out. Manual operation, diagnostic, print out, etc., facilities are incorporated in the system test set design.

3.2.8.2.2 KSC System Check-out - A routine system test will be carried out at KSC before installing the ALSEP in the LM. This will be identical to the final system test carried out by Bendix.

3.2.8.3 Interface requirements

3.2.8.3.1 Physical - Each experiment test set shall interface with the appropriate experiment. The primary means of interconnection between the GSE and the experiment will be via the experiment/data handling subsystem interconnecting cable.

Secondary means of interconnecting the experiment to the GSE is optional to the design of the experiment subsystem.

3.2.8.3.2 Electrical - Each experiment test set shall provide as a minimum the same electrical signal interface that is specified in paragraph 3.2.2 of this document. However, the experiment test set-experiment interface is not limited to a single interface connector.

3.2.8.3.3 Primary Power - The experiment test set shall interconnect to a 60 cps. single phase 105-125 VAC source.

3.2.8.4 Control Access to Experiments - During the first 45 days after the deployment of the Experiments, MSFN will have 24 hrs. / day real-time control access to the ALSEP. For the remainder of the ALSEP life, real-time control access will be limited to 2 hrs. /day.

*NOTE: It is anticipated that a Passive Seismic Experiment will be included on every ALSEP, hence, the data relating to available experiment weight, power, data, etc. given in the bulk of this report should be reduced by the requirements of the Passive Seismic Experiment.

The requirements of the Passive Seismic Experiment are:

1) Pallet area - A square of side approximately 12 1/2 inches in compartment 1

2) Volume of electronics in the Central Station - 130 cubic inches

3) Weight - 25 pounds.

4) Power - 7 watts

5) Data - The 40 fixed words in the ALSEP frame are allocated to the Passive Seismic Experiment. In addition 3 programmable words are allocated to the Passive Seismic Experiment.

6) Commands - 15

7) Analog lines - 8.

TABLE I ENVIRONMENTS

Environment Considered	Storage Unpackaged	Storage Packaged	Movement to pad	Factory & KSC Checkout	Launch Pad Environment	Flight	Lunar Operations (Per Year)
Humidity (rel. %)	15 to 50	N/A	15 to 100	50 max.	50 max.	N/A	N/A
Temperature (°F)	-20 to 110	-65 to 160	-20 to 110	50 to 100	50 to 100	0 to 100	-300 to 250
Radiation	N/A	N/A	N/A	Negligible	Negligible	Less than lunar operations	See LED-520-1F 4.1.1
Solar Radiation	360 BTU/ft.^{2}hr. for 6hr./day	N/A	N/A	N/A	N/A	N/A	440 BTU/ft.^{2}hr. for 182 days
Pressure	Ambient	Sea Level to 50,000 ft.	Ambient	Ambient	Ambient	$< 1 \times 10^{-8}$ mm. Hg	$\leq 1 \times 10^{-12}$ mm. Hg
Acoustics	N/A	N/A	N/A	N/A	N/A	Table III Herein	N/A
EMI	N/A	N/A	N/A	LSP-530-001	LSP-530-001	N/A	See 3.2.5 Herein
SHOCK	Pulse, 11 ± 1 ms. rise, 1 ± 1 ms. fall, 15g. high	MIL-STD-810A Method 516.1, Proc. III	N/A	N/A	N/A	Table III Herein	N/A
Vibration	N/A	LED-520-1F Table IIa	LED-520-1F Table IIa	N/A	N/A	Table III Herein	N/A
Acceleration	2.67g. - Vert. 0.4g. - lateral	± 5g. Vert. ± 2g. - lateral	1.0g. Vert.	N/A	N/A	5 g.	1/6g. const.
Meteoroid	N/A	N/A	N/A	N/A	N/A	N/A	See NASA TN D-2747

TABLE II ENVIRONMENTAL DUTY CYCLES

Environment Considered	Storage Unpackaged	Storage Packaged	Movement to Pad	Factory & KSC Checkout	Launch Pad Environment	Flight	Lunar Operations (Per Year)
Humidity	3 Days	90 Days	1 Day	180 Days	40 Days	N/A	N/A
Acceleration	N/A	N/A	N/A	N/A	N/A	Approx. * 25 min	N/A
Vibration	N/A	1 Day	1 Day	N/A	N/A	25 min*	N/A
Shock	Single Shock	Single Shock	N/A	N/A	N/A	Single Shock	Single Shock
Temperature	3 Days	90 Days	1 Day	180 Days	40 Days	3.5 Days	182 High 183 Low
Radiation	N/A	N/A	N/A	Negligible	Negligible	3.5 Days	365 Days
Solar Radiation	6 hr/day 3 days	N/A	N/A	N/A	N/A	N/A	182 Days
Pressure	90 Days		1 Day	180 Days	40 Days	3.5 Days	365 Days
Acoustics	N/A	N/A	N/A	N/A	N/A	5 Min	N/A
Meteroids	N/A	N/A	N/A	N/A	N/A	N/A	365 Days

TABLE III - INDUCED ENVIRONMENTS

Vibration (flight)

Sinusoidal - all axes

Frequency Range cps	Induced/Acceptance Sweep rate 4 octaves/min. with increasing frequency only g's 0-peak	Qualification Includes 1.3 Safety Factor, Sweep rate 1 octave/min. with increasing and decreasing frequency g's 0-peak
5-30	0.35'' D.A.	0.46''D.A.
30-100	10 g	13 g

Random - all axes

Frequency Range cps	Induced/Acceptance (Time 2.5min.) Power Spectral Density g^2/cps	Qualification (Time 5 min.) Includes 1.3^2 Safety factor, Power Spectral Density g^2/cps
23-250	0.28	0.47
250-420	12db/octave decrease	12db/octave decrease
420-2000	6db/octave decrease	6db/octave decrease

Acceleration - launch
5g - all axes

Shock - Lunar landing

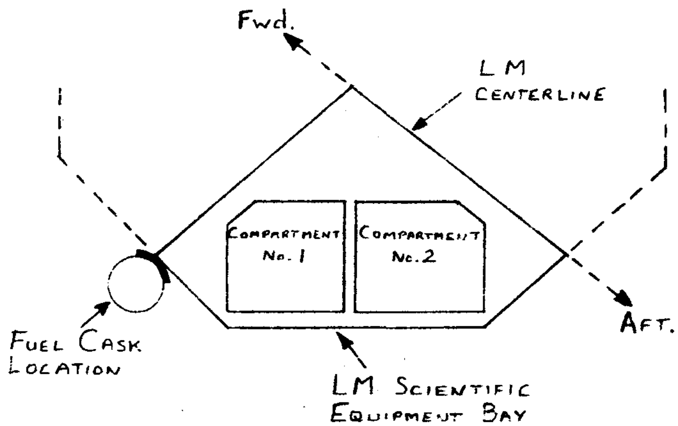
Pulse	Induced/Acceptance	Qualification
10 ms rise 1 ms decay	15.4 g height	20 g height

In addition a qualification test of 14 g steady state acceleration for at least 1 minute.

TABLE III - Continued

<u>Acoustic pressure during launch</u> (re 0.0002 microbar)

Octave Band (cps)	Level (db)
9 - 18.8	127
18.8 - 37.5	133
37.5 - 75.0	141
75.0 - 150.0	143
150 - 300	140
300 - 600	137
600 - 1200	124
1200 - 2400	121
2400 - 4800	111
4800 - 9600	107
Overall	147



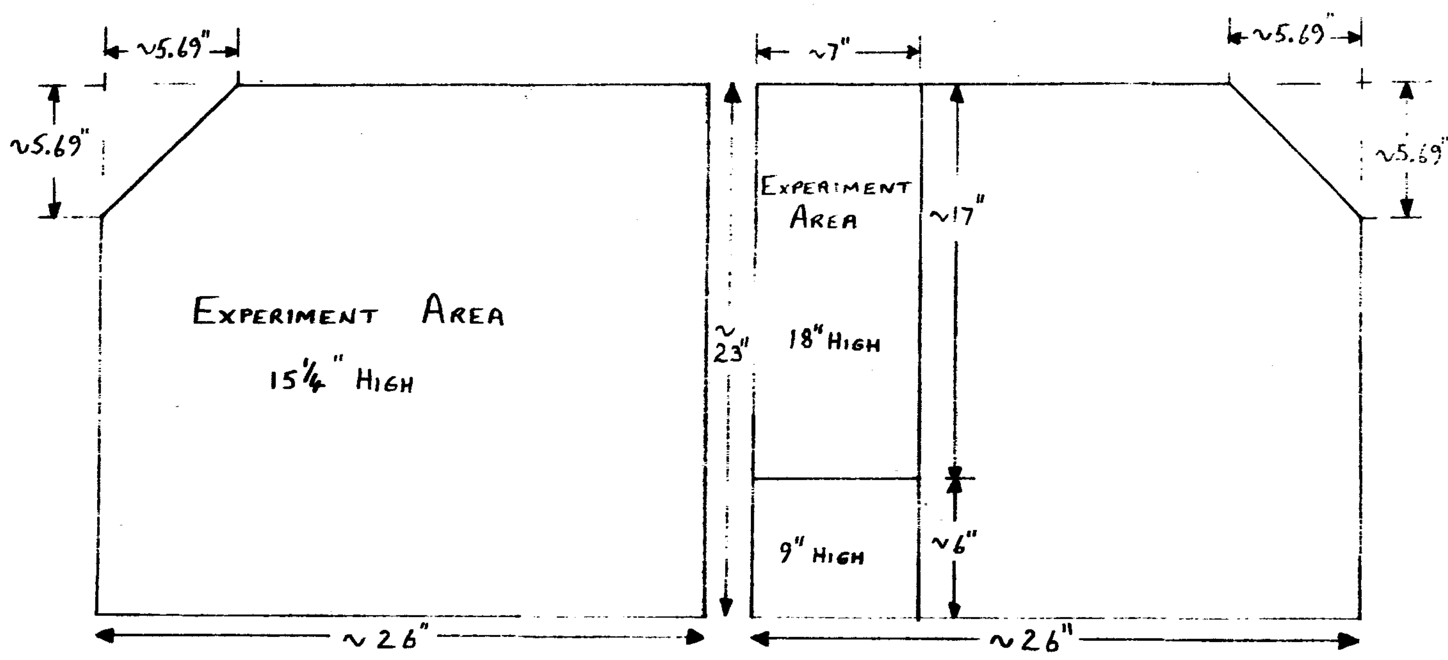


Figure 1 Approximate pallet areas available to experiments.

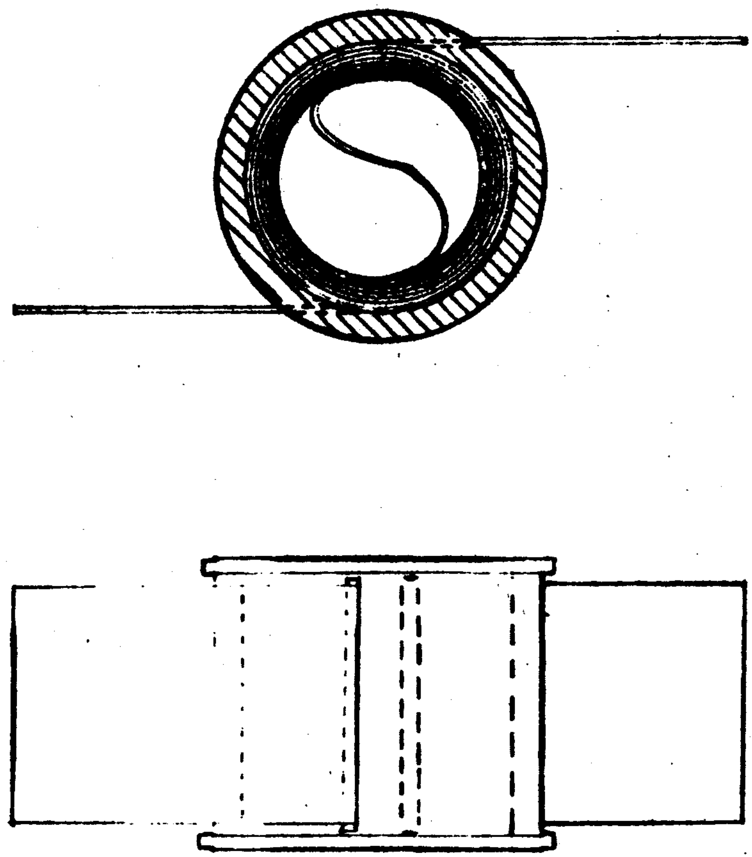


Figure 2 Tape Cable Reel

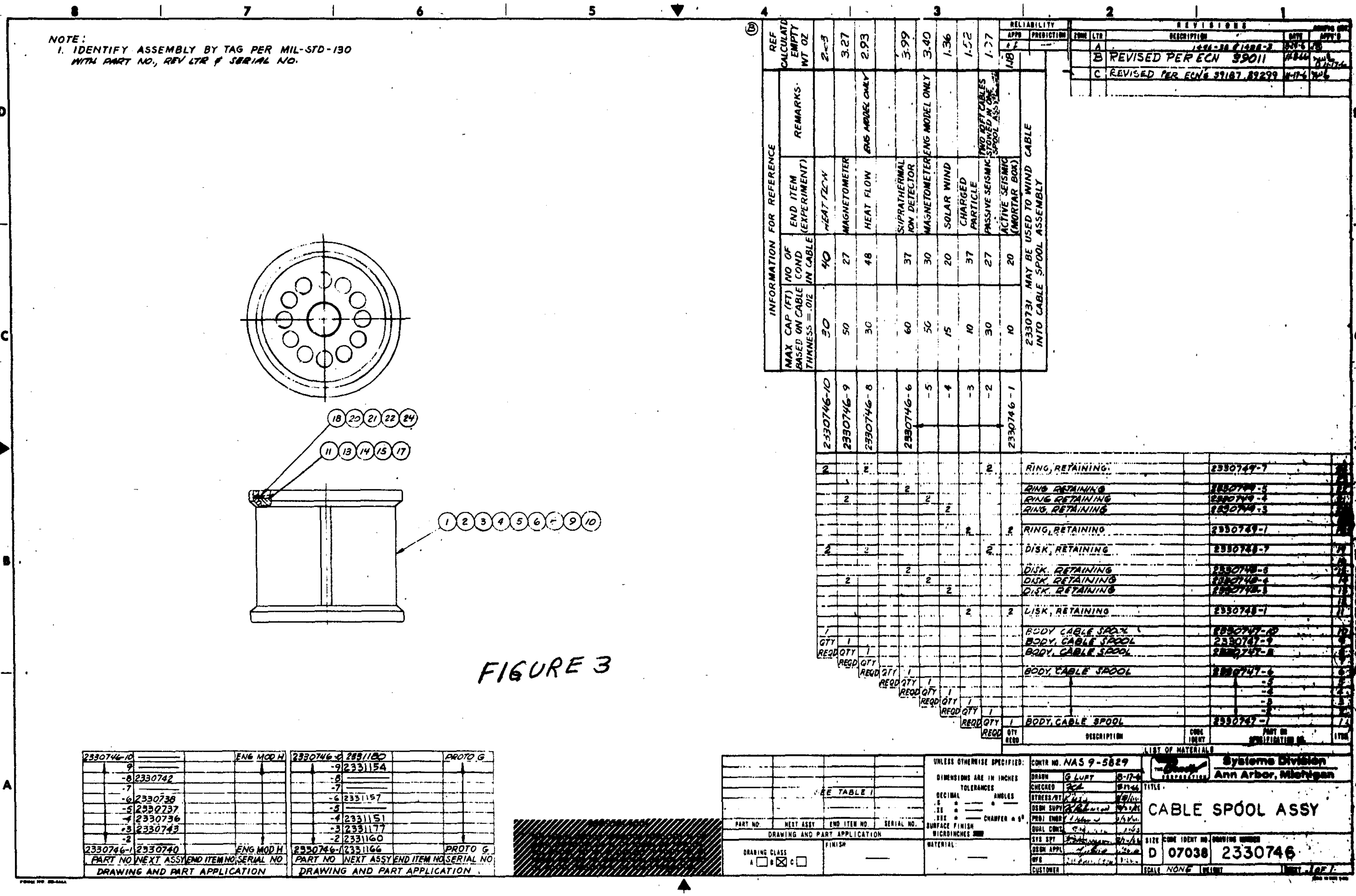
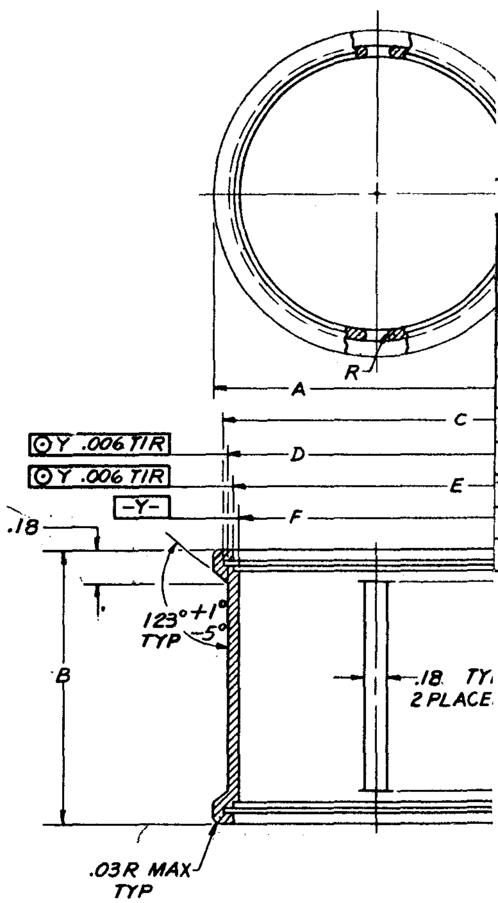

NOTE:
1. IDENTIFY ASSEMBLY BY TAG PER MIL-STD-130 WITH PART NO., REV LTR & SERIAL NO.
REVISED PER ECN 39011
REVISED PER ECN'S 39187, 39299
INFORMATION FOR REFERENCE
REF CALCULATD EMPTY WT OZ
REMARKS
END ITEM (EXPERIMENT)
NO OF COND IN CABLE
MAX CAP (FT) BASED ON CABLE THKNESS = .012
HEAT FLOW
MAGNETOMETER
ENG MODEL ONLY
SUPRATHERMAL ION DETECTOR
SOLAR WIND
CHARGED PARTICLE
PASSIVE SEISMIC
ACTIVE SEISMIC (MORTAR BOX)
2330731 MAY BE USED TO WIND CABLE INTO CABLE SPOOL ASSEMBLY
RING, RETAINING
DISK, RETAINING
BODY, CABLE SPOOL
QTY REQD
DESCRIPTION
LIST OF MATERIALS
DRAWING AND PART APPLICATION
PART NO
NEXT ASSY
END ITEM NO
SERIAL NO
ENG MOD H
PROTO G
SEE TABLE I
CONTR NO. NAS 9-5829
Systems Division
Ann Arbor, Michigan
CABLE SPOOL ASSY
D 07038 2330746

FIGURE 3

ZONE	LTR	DESCRIPTION	DATE	APPV'D
	A	STANDARD RELEASE ER 1496-38	8-24-6	
	B	REV DIMS PER ECN 38893	8-31-	
	C	REVISED PER ECN 39012.	11-2-66	
	D	INCORPORATED ECN 39188, ECN 39247	11-22-6	

NOTES:
1. BAG & TAG PER MIL-STD-130. PART NO., REV LTR & SERIAL
2. INTERPRET DIMS & SYMB IN A
3. REMOVE ALL BURRS & BREAK .005 MAX.
4. STRESS RELIEF NOT REQUIRED PRIOR



F +.005 -.010	G	PART NO
1.695	1.18	2330747-1
2.600	1.53	-2
1.695	2.03	-3
1.750	1.18	-4
3.260	1.68	-5
3.535	2.03	-6
7.665	.38	-7
2.600	2.58	-8
3.260	1.53	-9
2.600	2.18	2330747-10

FIG

DESCRIPTION	CODE IDENT	PART OR SPECIFICATION NO.	ITEM

LIST OF MATERIALS

NO. NAS 9-5829

G LUFT 8-17-6

The Bendix Corporation — Systems Division, Ann Arbor, Michigan

TITLE: BODY, CABLE SPOOL

SIZE	CODE IDENT NO	DRAWING NUMBER
D	07038	2330747

SCALE — WEIGHT

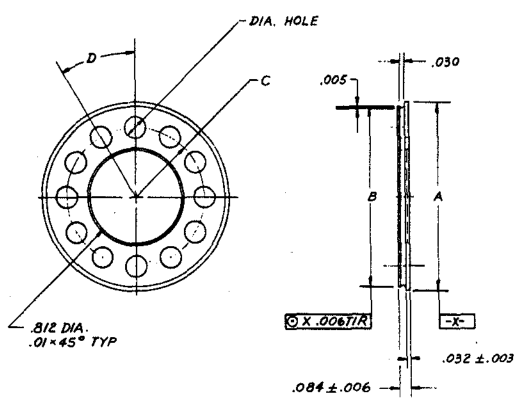
FORM NO. BB-344A

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPR'D
	B	REVISED PER ECN'S 38965, 39013 & 39248	11-22-6	

NOTES:

1. BAG & TAG PER MIL-STD-130. IDENTIFY WITH PART NO., REV LTR & SERIAL NO.
2. INTERPRET DIMS & SYMB IN ACCORDANCE WITH MIL-STD-8
3. MAGNESIUM ALLOY AZ 31B-H24 PER QQ-M-44a (1).
4. REMOVE ALL BURRS & BREAK ALL SHARP EDGES .005 MAX.



REF WEIGHT (OZ)	A +.000 -.005	B	C	D	NO. OF HOLES	DIA OF HOLES	PART NO.
.11	1.761	1.680	.62	30°	12	.25	2330748-1
.23	2.271	2.190	.75	45°	8	.37	-2
.12	1.811	1.735	.64	30°	12	.25	-3
.56	3.331	3.245	1.00	45°	8	.50	-4
.64	3.601	3.520	1.06	45°	8	.62	-5
2.02	7.731	7.650	2.12	90°	4	2.75	-6
.30	2.671	2,585	.84	45°	8	.50	2330748-7

FIGURE 5

[redacted]

PART NO.	NEXT ASSY	END ITEM NO.	SERIAL NO.
2330748-7	2330746-10		G & H
2330748-7	2330746-9		
2330748-7	2330746-8		
-6			
-5	2330746-6		
-4	2330746-5,-4		
-3	2330746-4		
-2			
2330748-1	2330746-1,3		G & H

DRAWING AND PART APPLICATION

DRAWING CLASS A ☐ B ☒ C ☐

FINISH: DICHROMATE MIL-M-3171 TYPE III

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES: DECIMAL .X ± —, .XX ± .010, .XXX ± .005; ANGLES ± 2°; CHAMFER ± 5°. SURFACE FINISH MICROINCHES

MATERIAL: SEE NOTE 3

CONTR NO. NAS 9-5829

DRAWN G LUFT 8-17-6

LIST OF MATERIALS

QTY REQD	DESCRIPTION	CODE IDENT	PART OR SPECIFICATION NO.	ITEM

The Bendix Corporation Systems Division Ann Arbor, Michigan

TITLE: DISK, RETAINING

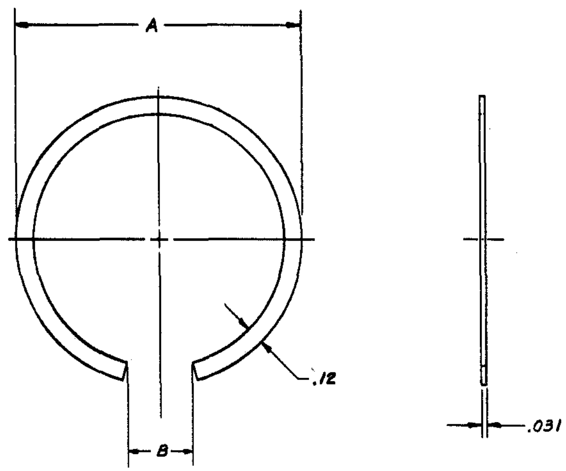
SIZE D | CODE IDENT NO. 07038 | DRAWING NUMBER 2330748

SCALE — WEIGHT SHEET

NOTE:
1. BAG & TAG PER MIL-STD-130. IDENTIFY WITH PART NO., REV LTR & SER. NO.
2. STL ST 302-28 SPRING TEMP MIL-S-5059A.
3. REMOVE ALL BURRS & BREAK ALL SHARP EDGES. .005 MAX.

RELIABILITY APPD	PREDICTION
Y Z	

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPR'D
	A	STANDARD RELEASE ER-1496-44	8-31-6	
	B	REVISED PER ECN'S 39014 & 39249	11-1-6 / 11-22-6	



REF WEIGHT OZ.	DIM B	DIM A	PART NO
.09	.20	1.887	2330749-1
.12	.25	2.390	-2
.10	.20	1.935	-3
.18	.37	3.452	-4
.19	.38	3.727	-5
.41	.75	7.857	-6
.14	.30	2.792	2330749-7

FIGURE 6

2330749

QTY REQD	DESCRIPTION	CODE IDENT	PART OR SPECIFICATION NO.	ITEM

LIST OF MATERIALS

PART NO.	NEXT ASSY	END ITEM NO.	SERIAL NO.
2330749-7	2330746-10		H & G
2330749-7	2330746-2-8		G & H
-6	———		
-5	2330746-6		
-4	2330746-9-5		
-3	2330746-4		
-2			
2330749-1	2330746-1,-3		G & H

DRAWING AND PART APPLICATION

[redacted]

DRAWING CLASS A ☐ B ☒ C ☐

FINISH: PASSIVATE PER QQ-P-35

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
TOLERANCES DECIMAL .X ± — .XX ± .010 .XXX ± .005 ANGLES ± — CHAMFER ± 5°
SURFACE FINISH MICROINCHES —

MATERIAL: SEE NOTE 2

CONTR NO. NAS 9-5829
DRAWN G LUFT 8-18-6
CHECKED
STRESS/WT
DSGN SUPV
PROJ ENGR
QUAL CONT
SYS SPT
DSGN APPL
MFG
CUSTOMER

The Bendix Corporation Systems Division Ann Arbor, Michigan

TITLE: RING, RETAINING

SIZE C | CODE IDENT NO. 07038 | DRAWING NUMBER 2330749

SCALE — WEIGHT SHEET

FORM NO. BS-543A

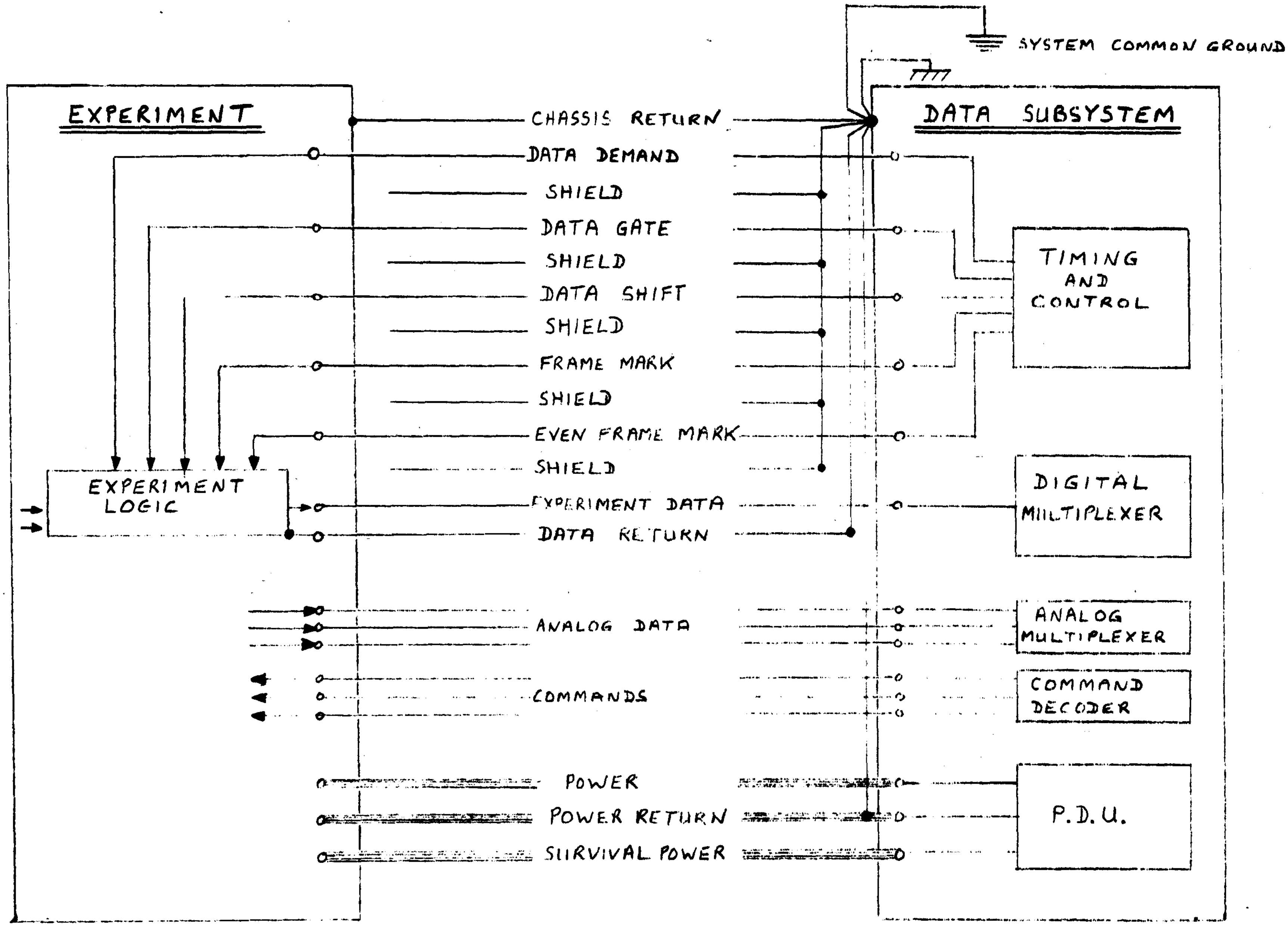
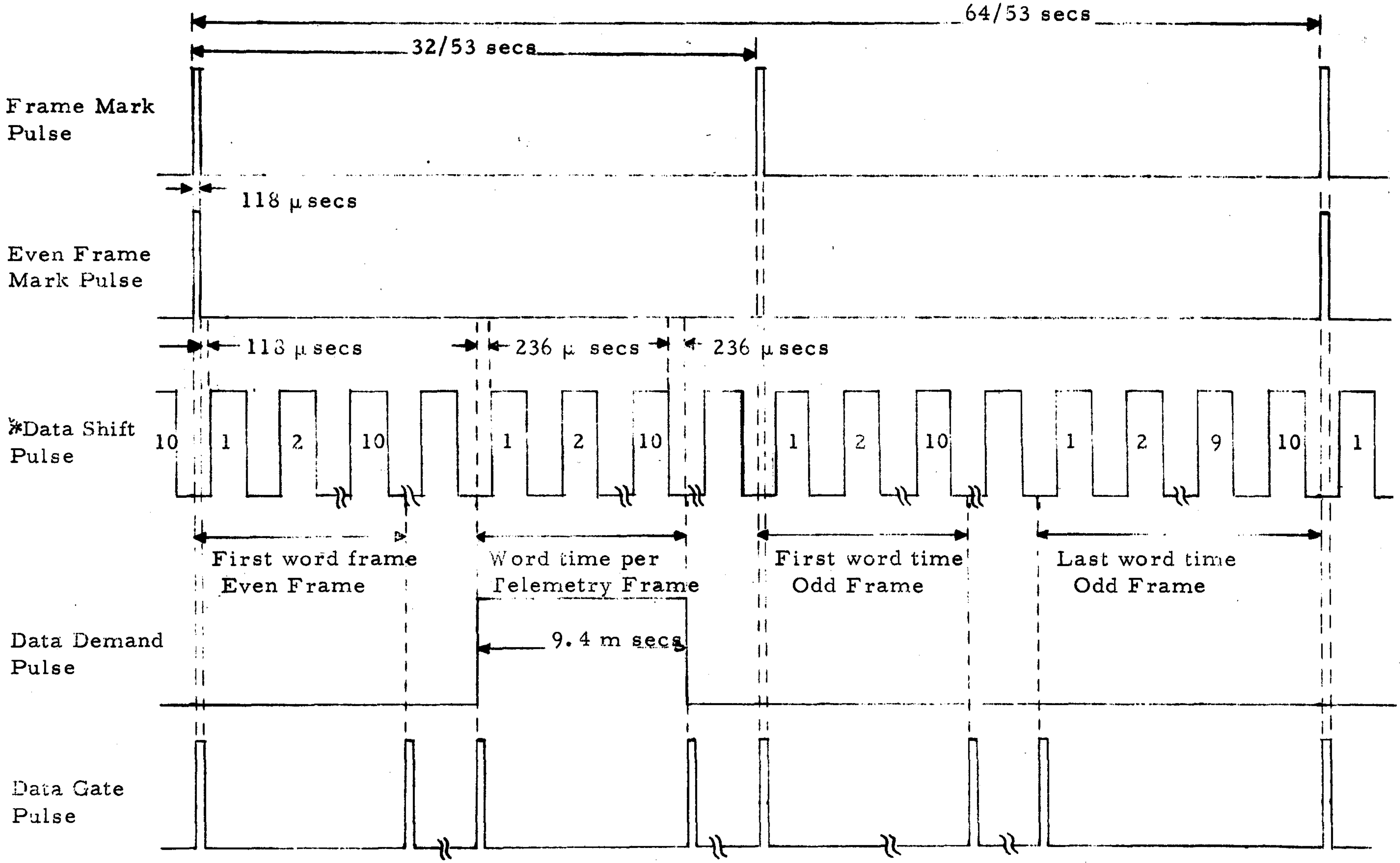
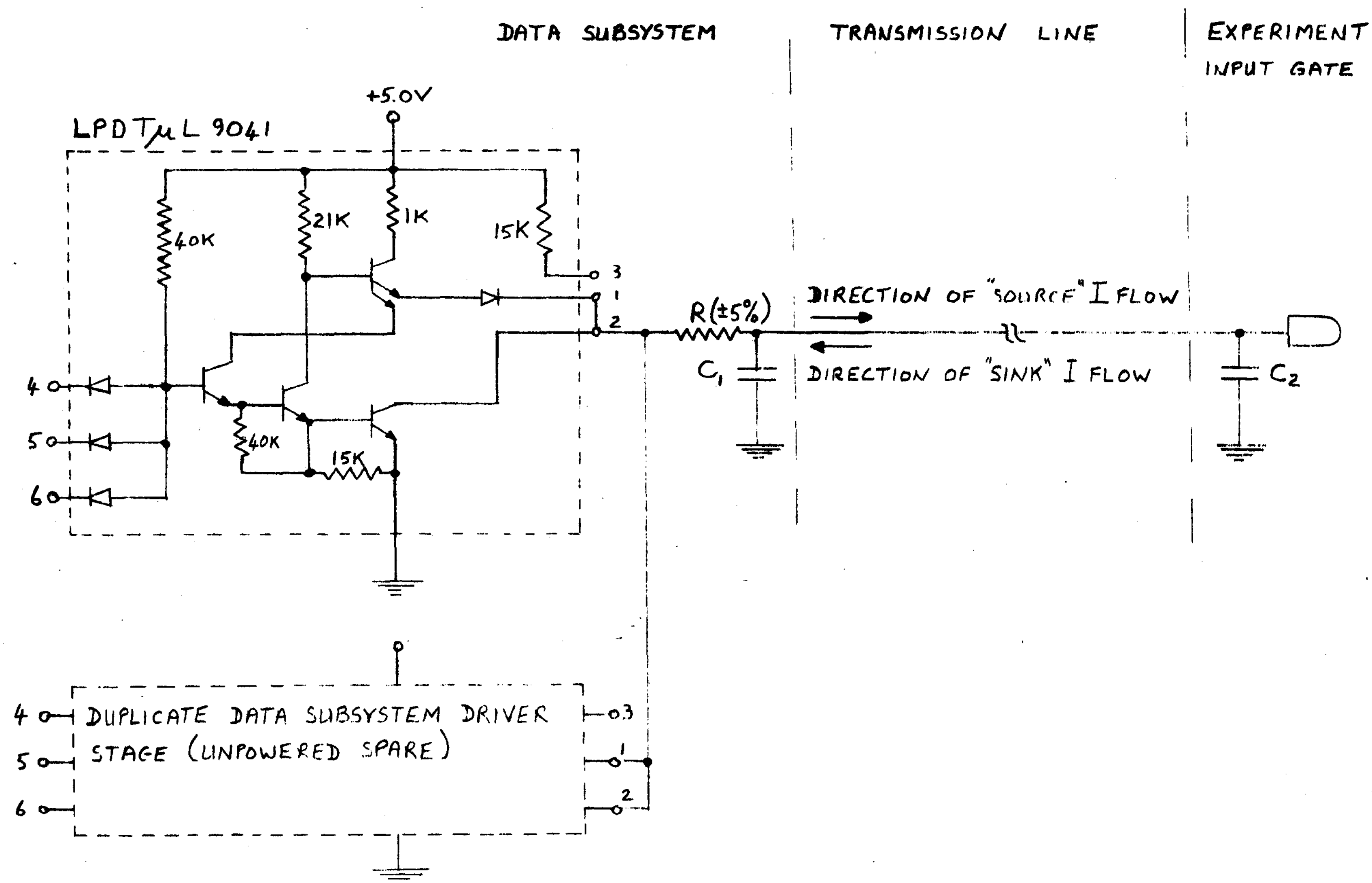


Figure 7 Schematic Electrical Interface



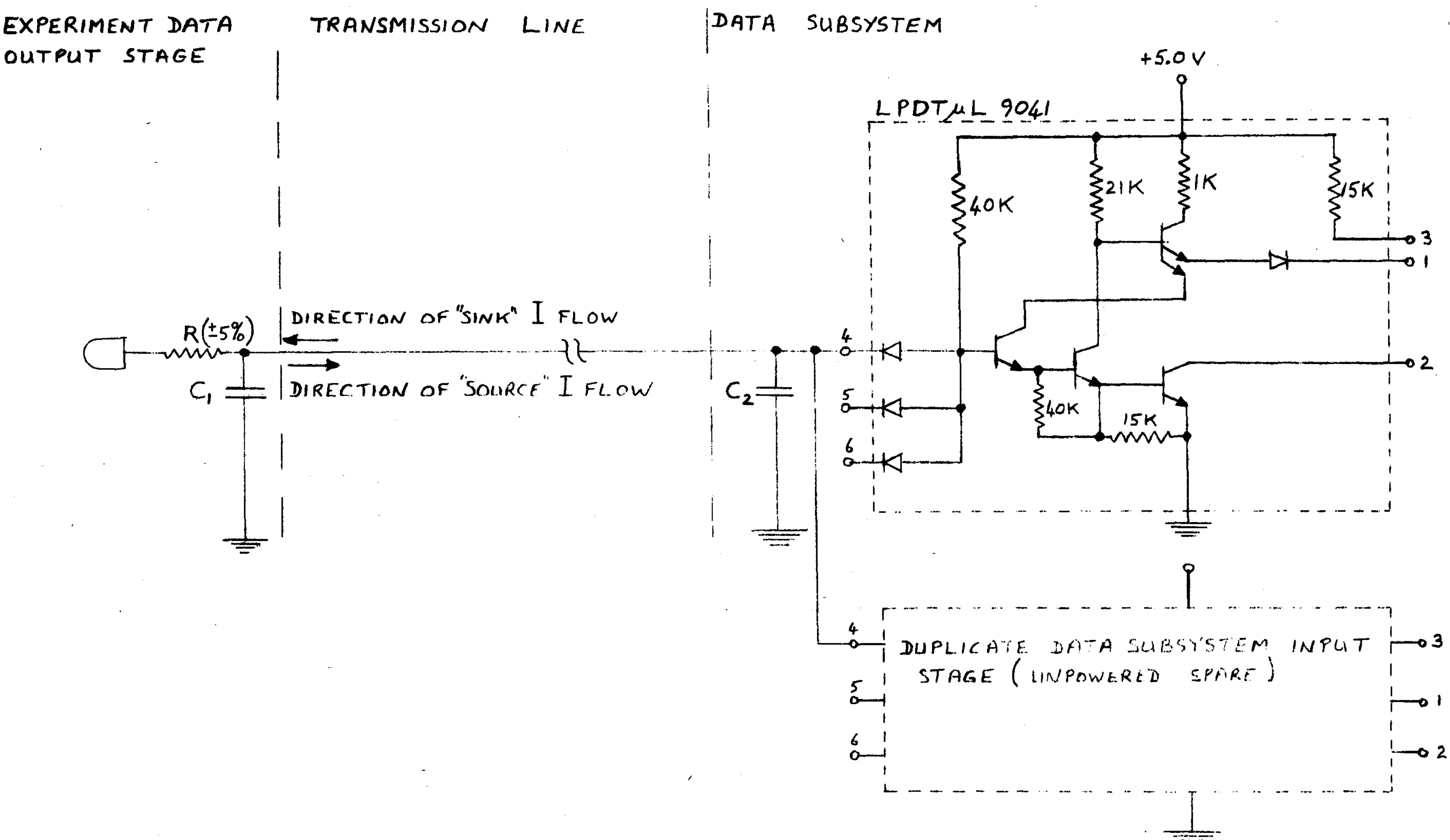
Times refer to normal mode. In the slow mode all pulse lengths and periods are doubled.
Data Processor reads data at positive going edge of shift pulse.
*Data shift pulse rate is 1060 (± 0.005%) b/s in the normal mode.

Figure 8 Data Processor Timing Control Signals



NOTE: Data subsystem driver stage and duplicate are Fairchild LPDTμL 9041 or equivalent. It is recommended that each experiment uses identical or equivalent input gates.

Figure 9 Experiment/Data Subsystem Interface, Control and Timing Pulse Driver Stage.



NOTE: Data Subsystem input gate and duplicate are Fairchild LPDTμL 9041 or equivalent. It is recommended that each experiment uses identical or equivalent driver stage.

Figure 10 Experiment/Data Subsystem Interface, Data Processor Input Gate.

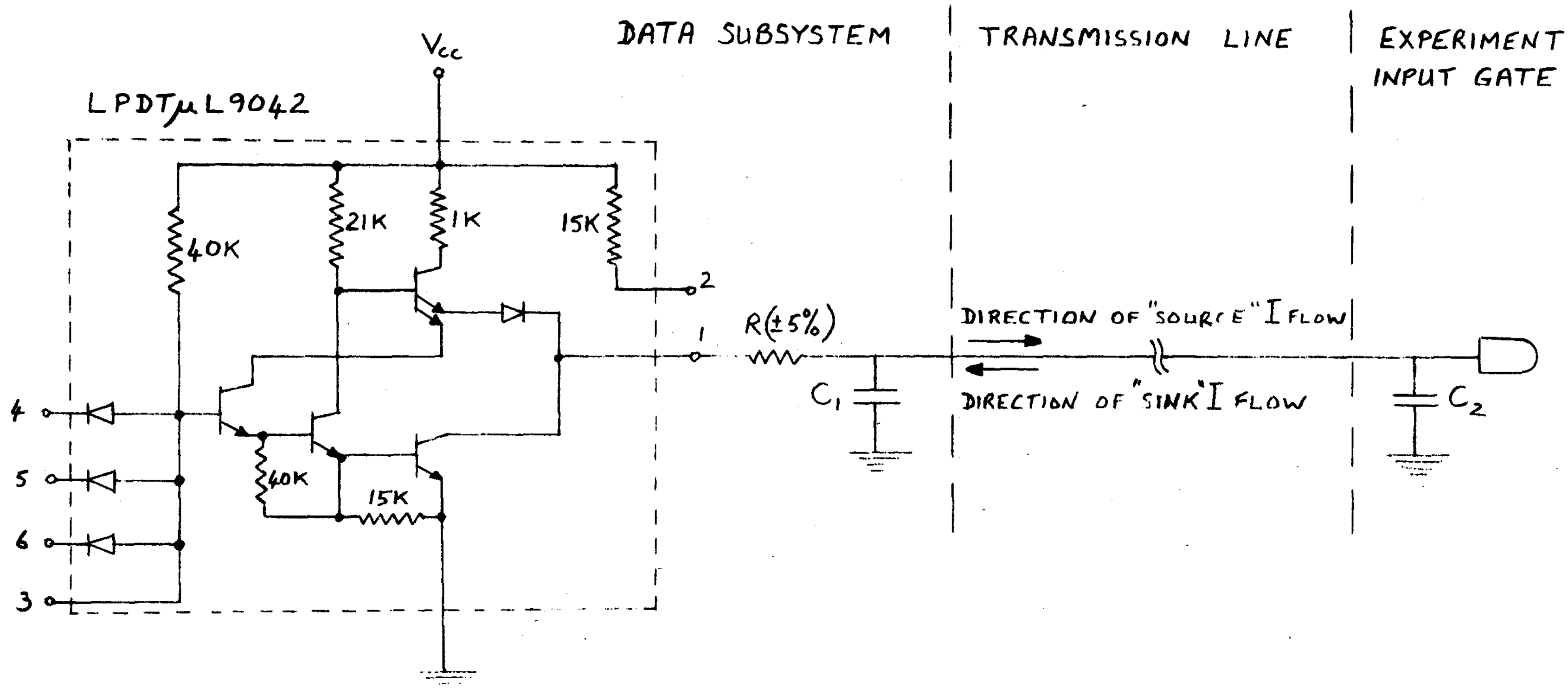
1 Sync.	2 & Ident.	3	4 F	5	6 F	7	8 F
9 F	10 F	11 F	12	13 F	14 F	15	16 F
17	18 F	19	20 F	21	22 F	23	24
25 F	26 F	27 F	28 F	29 F	30 F	31	32 F
33	34	35 F	36 F	37 F	38 F	39	40 F
41 F	42 F	43 F	44 F	45 F	46	47	48 F
49	50 F	51	52 F	53	54 F	55	56
57 F	58 F	59 F	60 F	61 F	62 F	63	64 F

Each box contains 1 10 bit word.

Whole frame contains 640 bits.

F - Fixed word

Figure 11 Telemetry Frame Format



NOTE
Command line driver stage is a Fairchild LPDTμL 9042 or equivalent. It is recommended that each experiment uses identical or equivalent input gate.

Figure 12 Experiment/Data Subsystem Interface, Command Line Driver Stage.

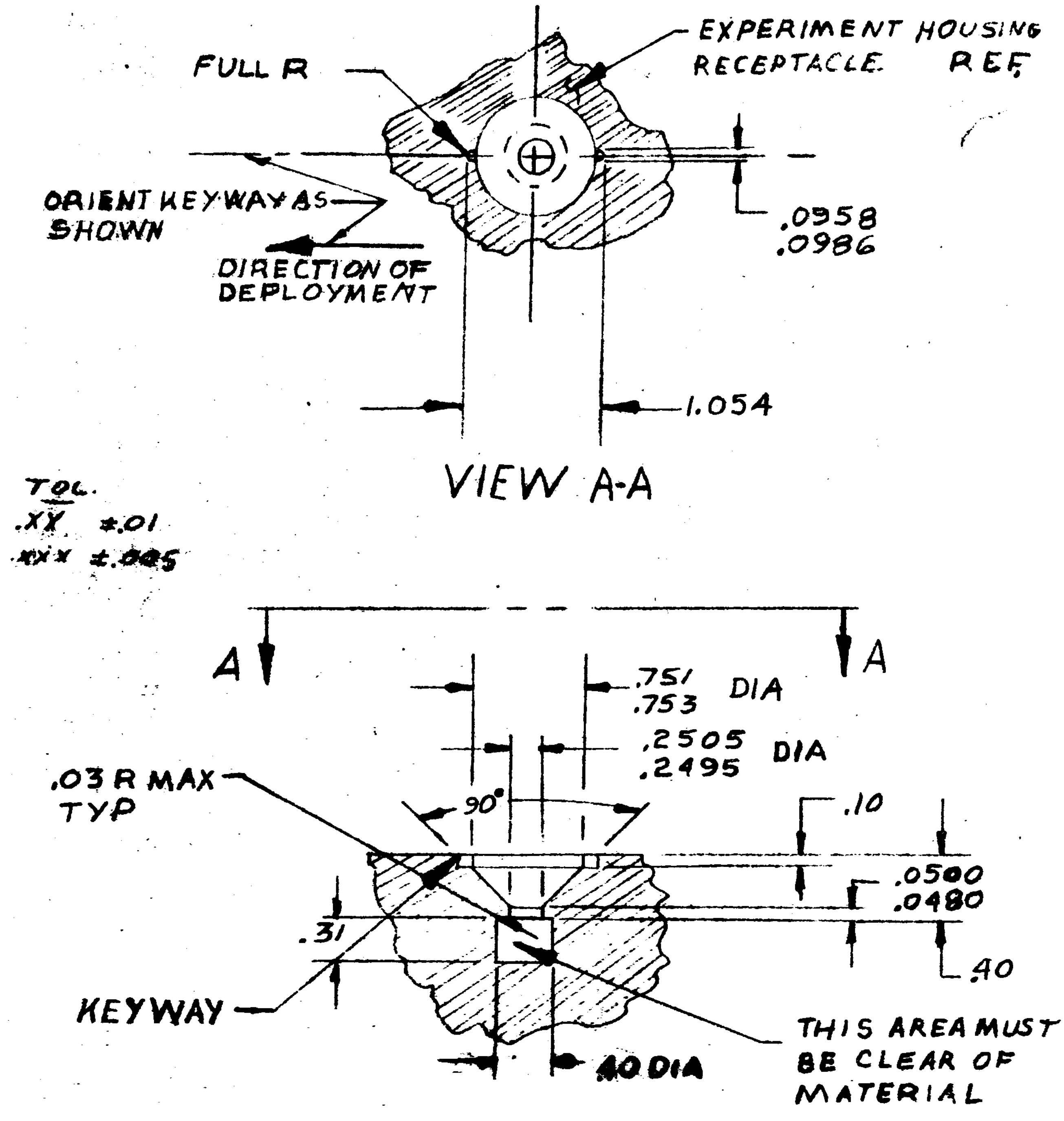


Figure 13 Deployment Tool Mating Socket