Conceptual Study of a Micrometeoroid Deep Space Satellite

FINAL REPORT

Vol. IV

Reliability

MARTIN

Conceptual Study of a Micrometeoroid Deep Space Satellite

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Reliability

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January 1965

ER 13700-IV

Submitted to the NASA Langley Research Center in compliance with Contract No. NAS 1-4162.

MARTIN
BALTIMORE DIVISION
BALTIMORE, MARYLAND 21203

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VOLUME IV. RELIABILITY

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ER 13700-IV

I. INTRODUCTION

The study results contained in this volume treat the reliability of various conceptual designs of a micrometeoroid deep space satellite. Herein, reliability is concerned not only with the probability of survival of equipment in the cislunar operating environment, but with basic tradeoffs between equipment reliability, modes of operation, and levels of micrometeoroid data acquisition capability--in short, with mission success probability.

Reliability and mission success probability have been mentioned in Volumes I, II and III, and have generally been referred to this volume. Overall integrated reliability implications on design concepts are treated herein.

As will be noted, the analysis treats the reliability of vehicle systems and components in some detail. This, although not generally accomplished in a conceptual design study, has been performed in order to arrive at a completely integrated vehicle system.

Early in the study, it became apparent that little was known about the micrometeoroid population in cislunar space. The micrometeoroid deep space satellite is a probe which must define micrometeoroid penetration rates and their variation with earth altitude in cislunar space. Since capacitance panels are the primary sensor as well as the volume critical equipment on board the vehicle, their characteristics became the chief design concept constraint--all operating modes must optimize collection of statistically significant penetration data, and no other sensor or combination of sensors should substantially decrease the probability of successfully acquiring micrometeoroid penetration data. With the requirements established, the large number of possible concepts was quickly reduced to a manageable number of potentially successful configurations which were progressively reduced in number through finer and finer evaluation stages.

II. EVALUATION GUIDELINES AND PHILOSOPHY

Reliability or, more properly, mission success probability studies had a number of specific objectives and philosophies.

1. Definition of Success

Classical reliability concepts might define success as the probability that the vehicle will perform in the manner intended within the specified environment for at least one year. Obviously, such a definition ultimately results in a number of opinions of success (e.g., "fairly successful," "operated through first 10 orbits," "partially successful"), depending entirely upon observer bias. To anticipate that every bit of data capability designed into the vehicle must be returned in order to have success is unrealistic; loss of one or more capabilities does not indicate mission disaster.

Therefore, several levels of mission success have been defined: the probability that penetration data from capacitor panels will be acquired for 6 or 12 month periods, or the probability that both penetration data and specific levels of other sensor data will be acquired. These definitions anticipate the requirement for a numerical measure of success which can be used throughout the program, in which each derived success probability has a specific data acquisition capability associated with it. This measure, or index, quickly shows what a given data capability will cost (success-wise), and whether it is worth the cost.

2. Evaluation Uniformity

Throughout the study, extreme care has been taken to ensure that a uniform base for evaluation and comparison has been used. For example, parts counts in the various equipments are uniform and equitable, stress levels and derating factors have been defined for various operating modes, and one group of basic failure rates has been used throughout the analyses. By this adherence to a common standard, fair evaluation of the various operating modes and equipment have been made without the use of weighting factors. Although it may be justly said that the quantitative values of success probability derived and those that will be achieved by the vehicle will never be the same, these values are, however, true levels of success; they are, as nearly unbiased as possible, estimates of the relative success probabilities of various concepts. Additionally, these estimates establish reliability goals, aid in system integration, point out major critical problem areas and possible solutions, and indicate what a given capability will cost in terms of operational success.

III. SUMMARY OF EFFORT

Major results of the study of the micrometeoroid deep space satellite using a number of configurations, modes of operation, and onboard equipment are shown in a number of tabulations and charts, and are defined below. Sample tables and figures are given throughout the text. Complete data are included in Chapter VII.

A. CHOICE OF LAUNCH VEHICLE, PANEL CONFIGURATION, AND VEHICLE ORIENTATION

Tables 1, 2 and 3 summarize the effects of major operational parameters on the probability of mission success.

The tables show three capacitance panel configurations, along with a limited number of satellite supporting functions when used with the Atlas-X-259 and the Atlas-Agena launch vehicles. Two omissions are obvious: the Saturn SIB launch vehicle and spheroidal- and polyhedron-shaped capacitance panels. The Saturn S1B vehicle was eliminated early in the study program as not being suitable for the cislunar micrometeoroid mission. The spheroidal- and polyhedron-shaped capacitance panels were not deemed practical at this point, although their continuously uniform intercept area is an ideal penetration measuring shape.

Each table has an assumed micrometeoroid directionality and orientation required to maintain maximum sensor area in a preferred direction. The effects of complexity, orientation, panel configuration, and launch vehicle on relative levels of failure will be noted. The major concept chosen as optimum is the Atlas-Agena launch vehicle using the "Z" capacitance panel configuration and a apogee altitude of 135,000 to 165,000 miles. An additional advantage of the Atlas-Agena is the payload capability for the direct injection mission; the vehicle weight is sufficiently within payload capability at this point to ensure adequate growth potential, plus a margin sufficient to permit flexible mission planning and operation.

B. CHOICE OF MAJOR ITEMS OF EQUIPMENT

Figure 1 shows the baseline configuration in a reliability reference diagram. Salient features of this configuration, determined by a number of tradeoffs during the study, are:

(1) Two separate telemetry systems are provided, Pri I and Pri II.

(2) Penetration data from segmented capacitance panels (Panel A, 0.001-in. thick; Panel B, 0.002-in.) are transmitted on both Pri I and Pri II.

TABLE 1

Effect of Launch Vehicle, Panel Configuration and Orientation on Levels of Mission Success Probability

Point Perpendicular Ecliptic and Parallel Sun Line Orientation

	Capacitance Panel Configuration	Atlas-X-259						Atlas-Agena					
		Flat Plate		X		Z		Flat Plate		X		Z	
Control and Sampling	Variation in sampling area--no control fail	0 at 0.5		0.175 to 0.25		0.16 to 0.205		0 at 0.5		0.175 to 0.25		0.16 to 0.205	
Control and Sampling	Variation in sampling area--with control fail	0 to 0.5		0 to 0.25		0.16 to 0.205		0 to 0.5		0 to 0.25		0.16 to 0.205	
Control and Sampling	Control required	Solar paddles roll control		Injection and ecliptic spin stab.		None		Solar paddles roll control		Injection and ecliptic spin stab.		None	
Enable	Spin-up	100		100		100		--		--		--	
Enable	Despin	100		100		100		--		--		--	
Enable	Remove residual spin	--		--		--		--		--		--	
Enable	Hinges--90° rotation	8		12		8		8		12		8	
Enable	Hinges--180° rotation	4		--		--		4		--		--	
Enable	Sequence panels	--		--		--		--		--		--	
Final stage orbit variation 3		100,000-165,000		100,000-165,000		100,000-165,000		135,000-165,000		135,000-165,000		135,000-165,000	
Failure Level $\times 10^{-6}$		6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Failure Level $\times 10^{-6}$	Control	75,000	150,000	--	--	--	--	75,000	150,000	--	--	--	--
Failure Level $\times 10^{-6}$	Enable	1,800	1,800	1400	1400	1000	1000	1,800	1,800	1400	1400	1000	1000
Failure Level $\times 10^{-6}$	Orbit error prob	2,700	2,700	2700	2700	2700	2700	60	60	60	60	60	60
Failure Level $\times 10^{-6}$	Inject prop. orient	--	--	1000	1000	--	--	--	--	100	100	--	--
Total failure level $\times 10^{-6}$		79,500	154,500	5100	5100	3700	3700	76,860	151,860	1560	1560	1060	1060

FAILURE LEVEL ASSUMPTIONS $\times 10^{-6}$

Spin-up--100
Despin--100
Remove residual spin--100

Panel sequencing--100 per panel
Solar paddle deploy--200 (two)
Hinge--90° rotation--100
Hinge--180° rotation--200

Inject orientation
X-259--1000; Agena--100
Roll control
6 mo--75,000 12 mo--150,000

TABLE 2

Effect of Launch Vehicle, Panel Configuration and Orientation on Levels of Mission Success Probability

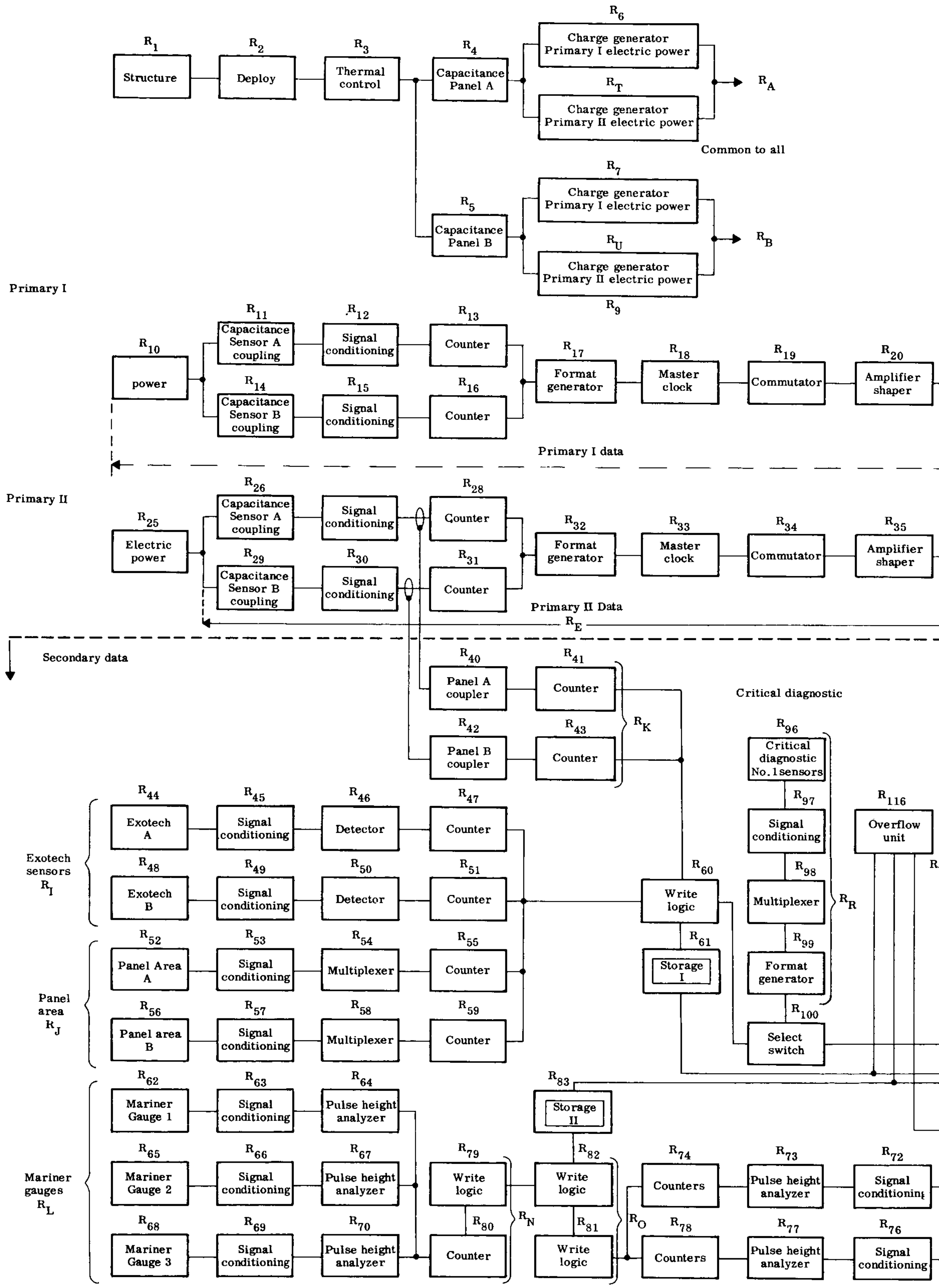
		Capacitance Panel Configuration	Atlas-X-259						Atlas-Agena					
			Flat Plate		X		Z		Flat Plate		X		Z	
Point Inertial Axis Orientation (preferred)	Control and Sampling	Control required	Spin-inject to proper orientation		Spin-inject to proper orientation		None		Spin-inject to proper orientation		Spin-inject to proper orientation		None	
		Variation in sampling area--no control fail	0 at 0.5		0.175 to 0.25		0.16 to 0.205		0 at 0.5		0.175 to 0.25		0.16 to 0.205	
		Variation in sampling area--with control fail	0 to 0.5		0 to 0.25		0.16 to 0.205		0 to 0.5		0 to 0.25		0.16 to 0.205	
	Enable	Spin-up	100		100		100		100		100		--	
		Despin	100		100		100		--		--		--	
		Remove residual spin	--		--		--		--		--		--	
		Hinges--90° rotation	8		12		8		8		12		8	
		Hinges--180° rotation	4		--		--		4		--		--	
		Sequence panels	--		--		--		--		--		--	
	Final stage orbit variation 3σ		100,000-165,000		100,000-165,000		100,000-165,000		135,000-165,000		135,000-165,000		135,000-165,000	
	Failure Level x 10^{-6}		6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
		Enable	1800	1800	1400	1400	1000	1000	1800	1800	1400	1400	1000	1000
		Control	--	--	--	--	--	--	--	--	--	--	--	--
		Orbit error probability	2700	2700	2700	2700	2700	2700	60	60	60	60	60	60
		Inject prop. orient	1000	1000	1000	1000	--	--	100	100	100	100	--	--
	Total failure level x 10^{-6}		5500	6500	5100	6100	3700	3700	1960	1960	1560	1560	1060	1060

TABLE 2

Effect of Launch Vehicle, Panel Configuration and Orientation on Levels of Mission Success Probability

Orientation	Category	Capacitance Panel Configuration	Atlas-X-259						Atlas-Agena					
			Flat Plate		X		Z		Flat Plate		X		Z	
Random (omnidirectional) Orientation	Control and Sample	Variation in sampling area--no control fail	0 to 0.5 (0.25 mean)		0 to 0.25 (0.19 mean)		0.16 to 0.205		0 to 0.5 (0.25 mean)		0 to 0.25 (0.19 mean)		0.16 to 0.205	
	Control and Sample	Variation in sampling area--with control fail	0 to 0.5		0 to 0.25		0.16 to 0.205		0 to 0.5		0 to 0.25		0.16 to 0.205	
	Control and Sample	Control required	Tumble		Tumble		None		Tumble		Tumble		None	
	Enable	Spin-up	100		100		100		--		--		--	
	Enable	Despin	100		100		100		--		--		--	
	Enable	Remove residual spin	100		100		--		--		--		--	
	Enable	Hinges--90° rotation	8		12		8		8		12		8	
	Enable	Hinges--180° rotation	4		--		--		4		--		--	
	Enable	Sequence panels	--		--		--		--		--		--	
		Final stage orbit variation 3σ	100,000-165,000		100,000-165,000		100,000-165,000		135,000-165,000		135,000-165,000		135,000-165,000	
	Failure Level x 10^{-6}		6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
	Failure Level x 10^{-6}	Enable	1800	1800	1400	1400	1000	1000	1800	1800	1400	1400	1000	1000
	Failure Level x 10^{-6}	Control	--	--	--	--	--	--	--	--	--	--	--	--
	Failure Level x 10^{-6}	Orbit error probability	2700	2700	2700	2700	2700	2700	60	60	60	60	60	60
	Failure Level x 10^{-6}	Failure to tumble	1000	2000	1000	2000	--	--	1000	2000	1000	2000	--	--
	Failure Level	Total failure level x 10^{-6}	5500	6500	5100	6100	3700	3700	2860	3860	2460	3460	1060	1060

Failure to maintain tumble--1000 6 mo
--2000 12 mo



R1 Structure
R2 Deploy
R3 Thermal control
R4 Capacitance Panel A
R6 Charge generator Primary I electric power
RT Charge generator Primary II electric power
RA
Common to all
R7 Charge generator Primary I electric power
R5 Capacitance Panel B
RU Charge generator Primary II electric power
R9
RB
Primary I
R10 power
R11 Capacitance Sensor A coupling
R12 Signal conditioning
R13 Counter
R14 Capacitance Sensor B coupling
R15 Signal conditioning
R16 Counter
R17 Format generator
R18 Master clock
R19 Commutator
R20 Amplifier shaper
Primary I data
Primary II
R25 Electric power
R26 Capacitance Sensor A coupling
Signal conditioning
R28 Counter
R29 Capacitance Sensor B coupling
R30 Signal conditioning
R31 Counter
R32 Format generator
R33 Master clock
R34 Commutator
R35 Amplifier shaper
Primary II Data
RE
Secondary data
R40 Panel A coupler
R41 Counter
R42 Panel B coupler
R43 Counter
RK
Critical diagnostic
R96 Critical diagnostic No. 1 sensors
R97 Signal conditioning
R98 Multiplexer
R99 Format generator
R100 Select switch
RR
R116 Overflow unit
Exotech sensors RI
R44 Exotech A
R45 Signal conditioning
R46 Detector
R47 Counter
R48 Exotech B
R49 Signal conditioning
R50 Detector
R51 Counter
R60 Write logic
R61 Storage I
Panel area RJ
R52 Panel Area A
R53 Signal conditioning
R54 Multiplexer
R55 Counter
R56 Panel area B
R57 Signal conditioning
R58 Multiplexer
R59 Counter
Mariner gauges RL
R62 Mariner Gauge 1
R63 Signal conditioning
R64 Pulse height analyzer
R65 Mariner Gauge 2
R66 Signal conditioning
R67 Pulse height analyzer
R68 Mariner Gauge 3
R69 Signal conditioning
R70 Pulse height analyzer
R79 Write logic
R80 Counter
RN
R83 Storage II
R82 Write logic
R81 Write logic
RO
R74 Counters
R73 Pulse height analyzer
R72 Signal conditioning
R78 Counters
R77 Pulse height analyzer
R76 Signal conditioning

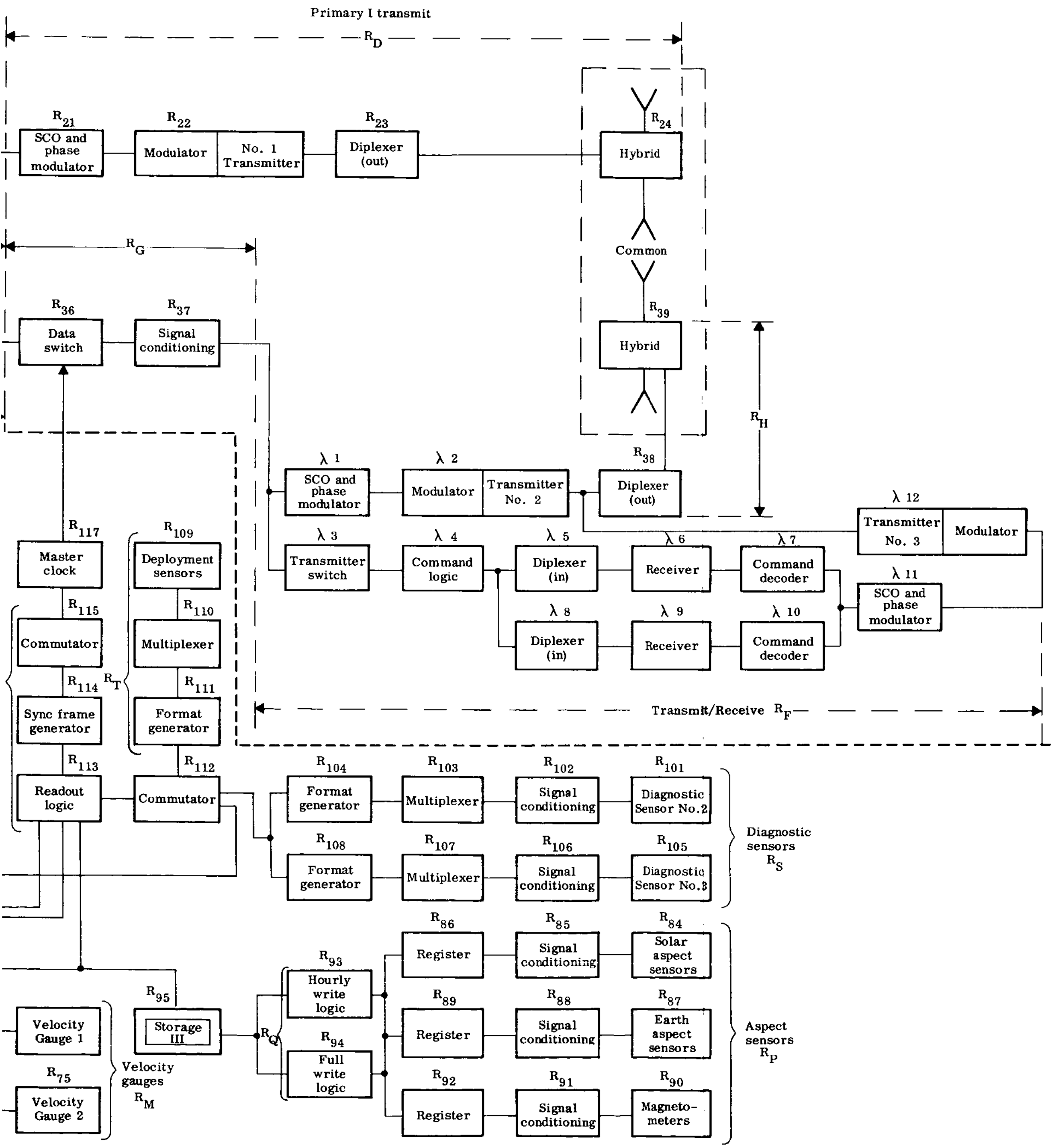


Fig. 1. Master Reliability Reference Diagram

(3) Pri I transmits only penetration data.

(4) Pri II transmits penetration data except on command, when secondary data is transmitted. Fail-safe condition of Pri II either maintains penetration data transmission or returns to penetration data transmission from secondary data transmission in the case of command switching failure.

(5) Pri I and Pri II each have their own power supplies. Pri I power has no storage batteries, power being supplied by solar cell arrays, Pri I power is lost during short duration dark periods, but overall reliability is improved by circuit simplification and parts reduction. Pri II power has sufficient storage battery capacity to furnish power to the secondary data system and to Pri I penetration counters during dark periods.

(6) Unique Hall effect coupling devices are provided to ensure complete isolation of Pri I and Pri II penetration data processing systems from the common capacitance sensors (Panel A and Panel B), ensuring true data processing redundancy.

(7) All penetration data is accumulated in counters, not core storage devices. The reduction in parts and added simplicity provide higher equipment reliability.

(8) Penetration data counters are solid-state flip-flop counters rather than nondestructive readout magnetic core counters, leading to higher reliability.

(9) A unique method of determining capacitance panel operative area is incorporated. Great circuit simplification has been achieved and many parts eliminated, with a resultant gain in equipment reliability.

(10) Panel area segmentation reduces the effect of shorted capacitance panels on accurate penetration data acquisition. Segmentation, coupled with determination of operative area, permits accurate determination of penetrations per unit of effective area.

(11) Secondary data from velocity and Mariner gauges, IR flash detectors, attitude sensors and diagnostic instrumentation are processed by separate and parallel signal conditioning and data formatting channels. Loss of any one channel will not cause loss of all data.

(12) Three separate data storages are provided in the secondary data system. Loss of any one storage will not cause loss of all data. The probability of obtaining data is further enhanced by counters and readout techniques which allow partial recovery of data in the event of storage failure.

(13) Redundant transmitters are provided in the Pri II telemetry channel.

(14) Duplicate command receivers are provided.

(15) Only one master oscillator is provided in the Pri II channel to eliminate possible phasing difficulties, with the consequent loss of vital data.

(16) Mariner gauge data are arranged such that the loss of data from any one of the gauges will still permit successful data acquisition.

C. INCREMENTAL INCREASES IN PROBABILITY OF MISSION SUCCESS OF THE BASELINE CONFIGURATION

Table 4 and Fig. 2 show improvements possible in the baseline configuration with modes of operation, definition of mission success, and redundancy.

It will be noted that, for the various data transmission modes (Designations A through E), only primary penetration data can be acquired with an overall probability of mission success in excess of 90% for the 12-month mission. Continuous transmission and transmission on command four times per zone have the highest probability of success and are substantially equal (97.1%). Automatic on/off transmission 10 minutes per hour has the lowest probability of success (94.5%) for the 12-month mission.

As expected, the probability that all data will be received, both penetration and secondary data, using the baseline configuration is very low (2%).

These values are overall values of mission success probability from launch vehicle separation through deployment and for 12 months operation.

Figure 2 shows the plotted values of Table 4. The bands of success probability show the spread of probability of success to be expected as transmitting modes are varied.

TABL

Mission Success Probabil

Desig-nation	Modification to Baseline Configuration Required for Change in Operating Modes or for Success Probability Improvement	Definition of Mission Success	Success Probability Model (see master reliability reference diagram, Fig. 1 and mathematical success probability models, Table
A	Baseline configuration--high quality parts, continuous transmission Pri I/Pri II channels	Return only penetration data from 0.001- and 0.002-mil capacitance panels, R and R	P_A
B	Baseline configuration--high quality parts, command on/off transmission four times/zone on Pri I/Pri II channels--add command control switch (R_{4})	Return only penetration data from 0.001- and 0.002-mil capacitance panels, R and R	P_B
C	Baseline configuration--high quality parts, automatic on/off transmission 10 min/hr on Pri I/Pri II channels--add programmer (R_{2}), power switch (R_{3})	Return only penetration data from 0.001- and 0.002-mil capacitance panels, R and R	P_C
D	Baseline configuration--high quality parts, transmission once per day on Pri I/Pri II channels--add storage (R_{1}), command control switch (R_{4}), read logic (R_{5})	Return only penetration data from 0.001- and 0.002-mil capacitance panels, R and R	P_D
E	Baseline configuration--high quality parts, transmission once per orbit--add R_{1}, R_{4}, R_{5} as in D above	Return only penetration data from 0.001- and 0.002-mil capacitance panels, R and R	P_E
F	Baseline configuration--high quality parts, transmit as in A, B, C, D, E above	Return all data, penetration and secondary data	P_F
G	Change baseline configuration--high quality parts, transmit as in A, B, C, D, E above. Changes: modified panel area multiplexer (R_{54}, R_{58}), two out of three mariner gauges required (ground interpretation), either or both hourly or full write logic (R_{93}, R_{44}), redundant master clock (R_{117}), either or both critical or full diagnostic (R_R, R_S)	Return all data, penetration and secondary data	P_G

E 4

ity Tradeoff Summary

		Operating Mode									
		Continuous Transmission		Command On/Off 4 Times/Zone		Automatic On/Off 10 min/hr		Transmit Once per Day		Transmit Once per Orbit	
23	Mission Time Transmit Time (hr)	6 mo 4320	12 mo 8640	6 mo 300	12 mo 600	6 mo 720	12 mo 1440	6 mo 180	12 mo 360	6 mo 60	12 mo 120
		0.991674	0.971409	--	--	--	--	--	--	--	--
		--	--	0.991599	0.971239	--	--	--	--	--	--
		--	--	--	--	0.983718	0.944570	--	--	--	--
		--	--	--	--	--	--	0.989743	0.964807	--	--
		--	--	--	--	--	--	--	--	0.989844	0.965164
		0.147557	0.021545	0.146529	0.021287	0.140208	0.019402	0.144850	0.020799	0.145109	0.020839
		0.372131	0.123555	0.369413	0.121933	0.353600	0.111264	0.365605	0.119275	0.365954	0.119504

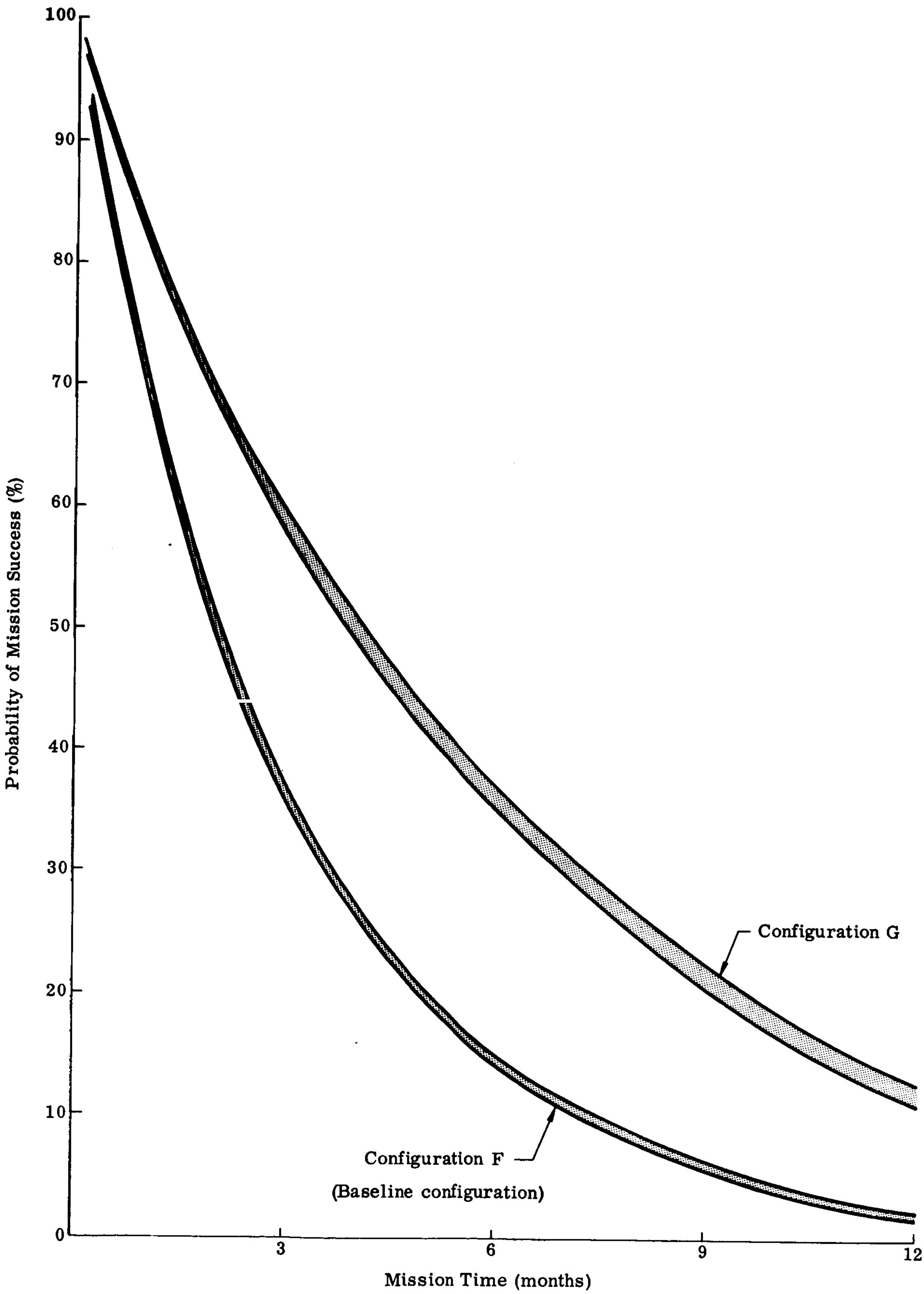


Fig. 2. Probability of Mission Success For Various Configurations--Operating Modes 1 to 5

IV. TECHNICAL APPROACH

With the many conceivable combinations of equipments and modes of operation which could be assembled into a micrometeoroid deep space satellite, the choice of one or two of the best combinations posed several problems. First, it was impossible to fully evaluate all combinations and, failing this, to have reasonable assurance that a better combination had not been overlooked. Secondly, it was imperative that the best combination of equipments and modes of operation be chosen.

1. Major Considerations Which Affect Prime Data Acquisition or Gross Operating Modes

Such parameters as shape and arrangement of capacitance panels, spinning and tumbling vehicles, and the choice of Atlas-X-259, Atlas-Agena, or Saturn S1B were compared, and several combinations chosen for further analysis. A significant reduction in combinations of vehicles and basic design configurations was quickly and effectively made.

2. The Effect of Various Onboard Systems Concepts on Mission Success Probability

A preliminary analysis of a group of basic systems design concepts was made, and the affects of data acquisition capability or success probability was evaluated. Results of this evaluation defined the requirements for a baseline configuration.

3. Modes of Operation and Levels of Success Probability of the Baseline Configuration

With a baseline configuration established, various combinations of vehicle operating modes, data acquisition capability, redundancy, and basic electronic circuitry were evaluated. These tradeoff studies demonstrated mission success probability variation with specific changes, and aided definition of guidelines and restraints which would point the way to successful development of the micrometeoroid deep space satellite.

V. MISSION PROBABILITY OF SUCCESS EVALUATION

Mission success analysis was based on evaluation of the micrometeoroid data acquisition capability of a number of mission essential elements and the reliability of satellite items of equipment used in a number of operating modes. This was accomplished by the sequence of analyses listed below:

(A) Choice of launch vehicle, panel configuration and vehicle orientation

- (1) Micrometeoroid penetration data sampling.
- (2) Capacitance panel segmentation.
- (3) Launch vehicle effects on mission success.
- (4) Summary.

(B) Equipment operating stresses and parts failure rates

- (1) Identification of subsystem functional operations.
- (2) Equipment operating phases, times and stress levels.
- (3) Definition of parts failure rates; equipment parts reliability.

(C) Preliminary vehicle reliability estimates and system definition

- (1) Preliminary vehicle configurations for primary data telemetry.
- (2) Reliability estimating.
- (3) Summary of evaluation.

(D) Definition and evaluation of the baseline configuration

- (1) Baseline configuration.
- (2) Reliability estimating.
- (3) Reliability summaries.
- (4) Evaluation of configurations.

A. CHOICE OF LAUNCH VEHICLE, PANEL CONFIGURATION, AND VEHICLE ORIENTATION

1. Micrometeoroid Penetration Data Sampling

In sampling penetration rates of the largely unknown micrometeoroid population in cislunar space, capacitance panels must fulfill several basic requirements:

(1) The sample must be representative of the micrometeoroid population.

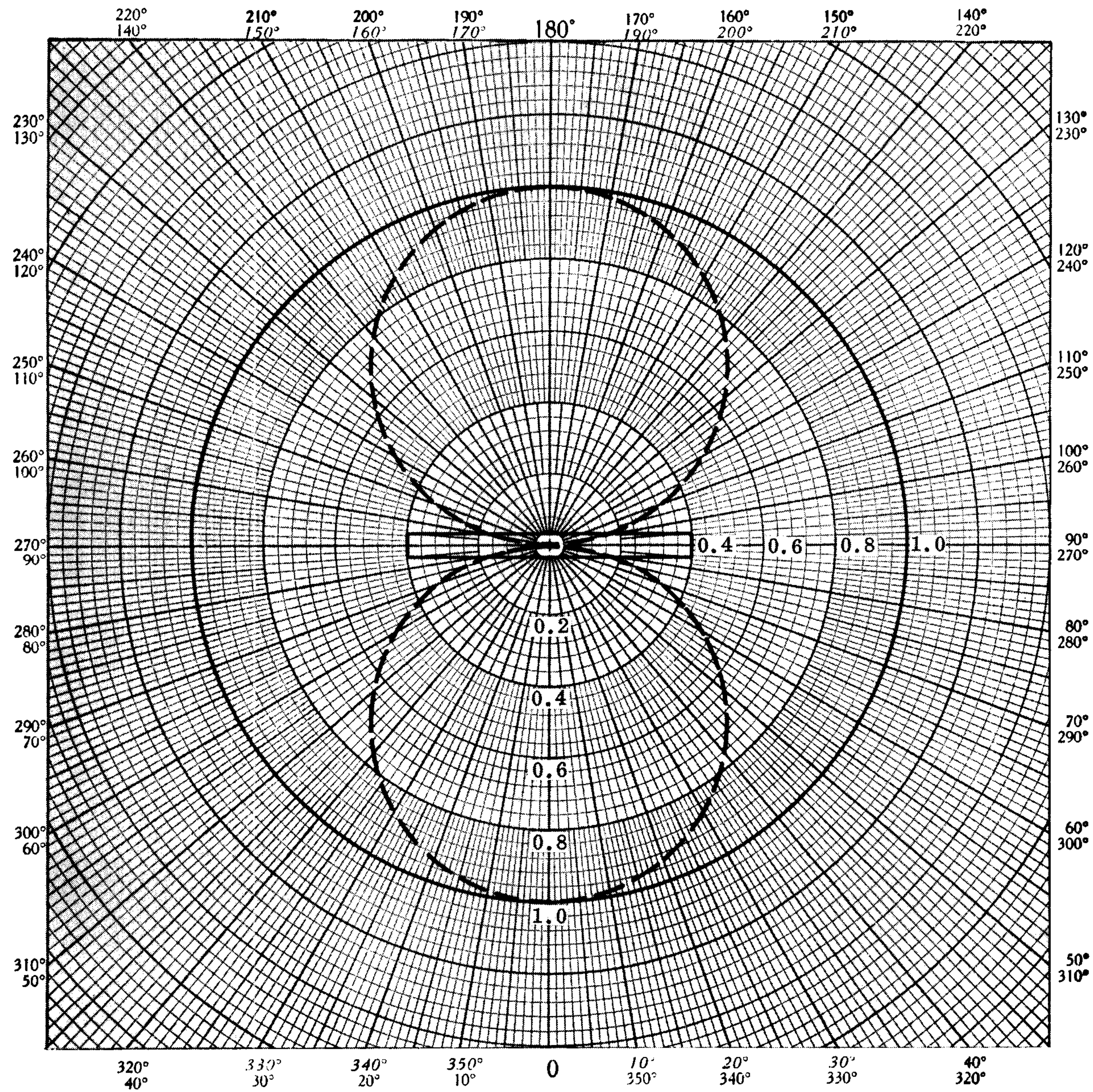
(2) Every micrometeoroid in the population must have an equal chance of penetrating the sensors.

(3) Every combination of micrometeoroids must have an equal chance of being selected into the sample.

As an example, a sphere (or a polyhedron, which approaches the limiting envelope of a sphere) presents the same area to micrometeoroids regardless of orientation, and can sample a meteoroid shower from one direction, as well as particles from any other direction or from a random direction at the same time and still fulfill basic sampling requirements at any instant in time.

The projected area of a flat plate sensor varies from 0 to a maximum equal to its one sided sensor area when viewed through 4π steradians. Over a long period of time, it can sample omnidirectional micrometeoroids and partially meet sampling requirements as well as the sphere, whether it tumbles or remains stable. The probability of its meeting the sampling requirements or sporadic particles or showers does not, however, meet the basic requirements because of its projected area variation; the variation of instantaneous projected area is shown in Fig. 3. If it is desired to sample in only one direction or in one plane, the flat plate can be oriented to present a maximum target area in the required direction equal to its one sided sensor area or 50% if sensors are on both sides of the structure. Since the sphere or polyhedron offers an intercept area of only 25% of its total sensor area, the gain in efficient use of sensor area can be appreciated. If, however, flat plate orientation cannot be maintained, its mean intercept area is the same as that of the sphere--25% of its total sensor area.

Since it was not practical to use a sphere or polyhedron to meet the sampling requirements in an unknown environment, and since the flat plate did not meet basic sampling requirements, a number of other sensor configurations were made and evaluated. Use of crossed plates ("X" plates) is an example (Fig. 4). Here, however, due to mutual occulting effect of the plates, mean sensor intercept area was reduced to about 19% of the total sensor area and the sampling area variation in any one direction varied from 0 to 25% of the total sensor area. The "X" plates could not basically meet the sampling requirements.



LEGEND:

- - - xx' and yy' instantaneous target area
—— zz' instantaneous target area

Mean sensor intercept area = 25% of total sensor area

Sampling area variation = 0 to 50% of total sensor area

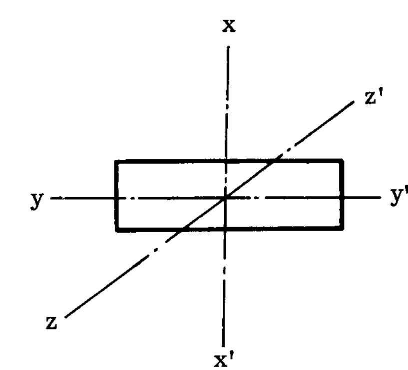
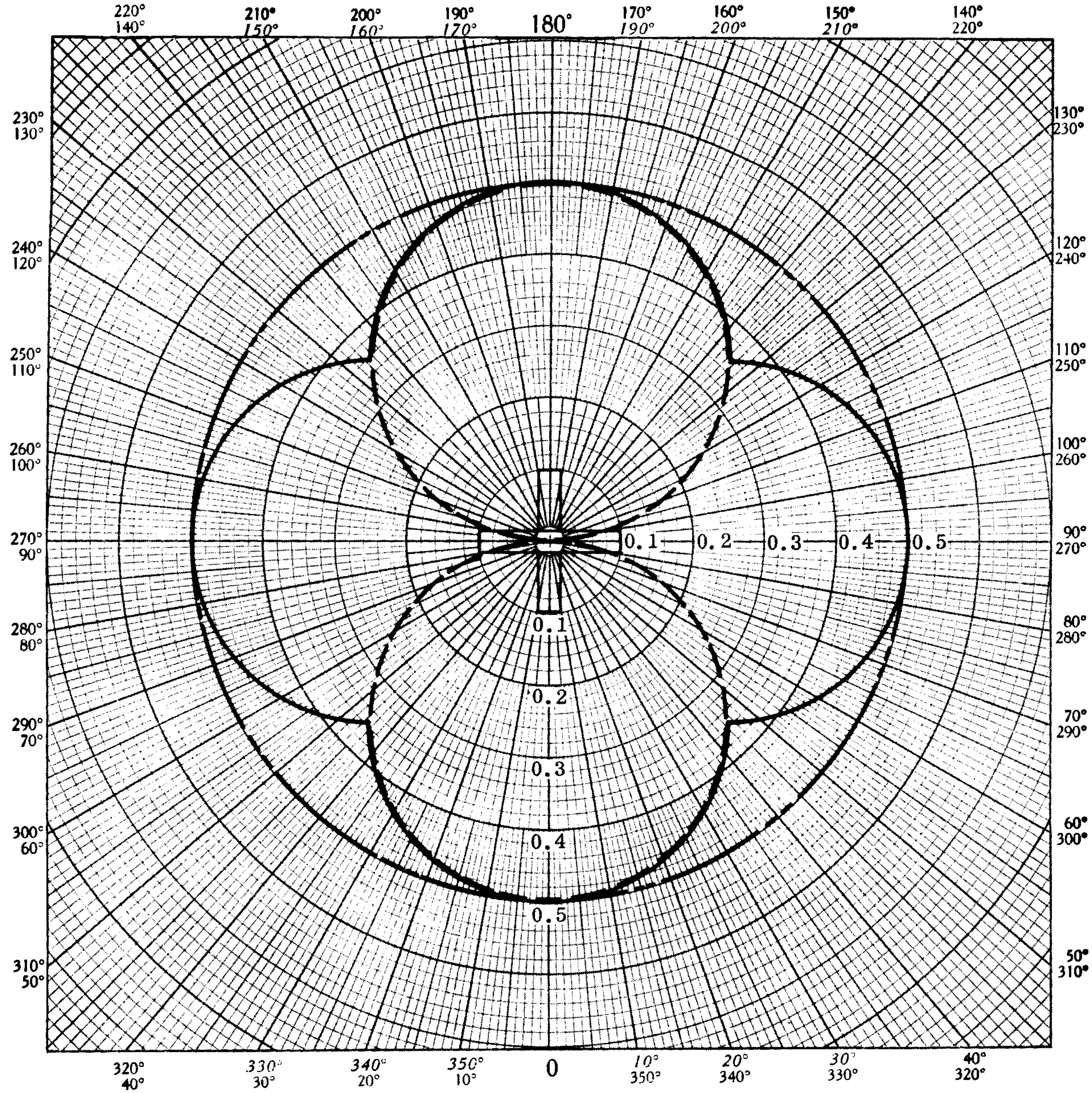


Fig. 3. Projected Target Area Flat Plate



LEGEND:

- ——— xx' instantaneous target area
- — — — yy' instantaneous target area
- —·—·— zz' instantaneous target area

Mean sensor intercept area = 19% of total sensor area

Sampling area variation = 0 to 25% of total sensor area

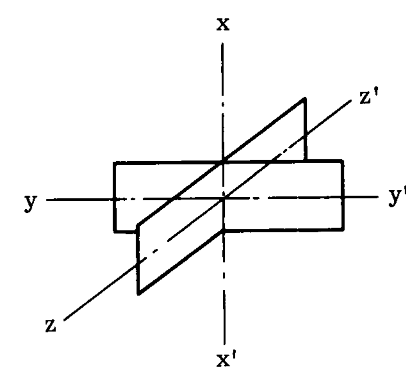


Fig. 4. Projected Target Area "x" Plates

The "Z" configuration, consisting of four equal paddles of "Z" cross section came closest to meeting the basic sampling requirements. Here, as in the cases of the "X" configuration, mutual occulting of the plates reduced the mean intercept area to about 18.5%, although the min/max variation ranged from approximately 16% to 20.5% of the total sensor area. The results of the planimeter integration of the "Z" are shown in Fig. 5. In addition to its sampling characteristics, the "Z" offered substantial gain in reliability, since the number of hinge points and its deployment angular rotation requirements were less than for either the flat plate or "X" configurations, for a vehicle which must be folded within the confines of an Agena aerodynamic fairing.

2. Capacitance Panel Segmentation

Determination of micrometeoroid flux variation with altitude required division of the earth-moon space into a number of altitude sampling zones. Five distinct altitude divisions were anticipated--zones one through five. The number of zones into which the space could be divided was governed chiefly by the practical sensor area which could be folded into available aerodynamic shrouds. Of course, only two zone divisions would be required to determine an altitude flux variation, but variations in penetration models dictated that considerable flexibility must be anticipated in zone definition, which could only be completely established by analysis of actual data.

In the five altitude division cases, the space has been divided into a number of equal penetration probability zones such that, in each zone, the measured mean number of penetrations in an area (AT) is 16.

For purposes of analysis, it has been assumed that the Poisson distribution defines the spatial distribution of micrometeoroid penetrations on the sensor panels where:

$$p\,(K;\lambda AT) = e^{-\lambda AT}\,\frac{(\lambda AT)^K}{K!}$$

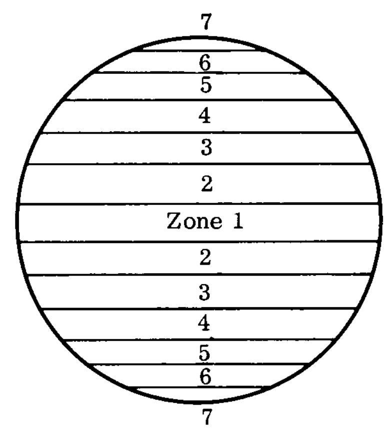
p	= point probability of exactly K penetrations
K	= exact expected number of penetrations
λAT	= the micrometeoroid distribution = 16 penetrations for each zone

Tables of the point probability of exactly K penetrations along with density function and distribution function curves have been made for each of the five zones (Tables 5 through 9 and Figs. 6 and 7, included in Chapter VII).

The primary failure mode of the capacitance panels is permanent shorting, which will render the panel useless for acquisition of penetration data. This shorting can be caused by either permanent mechanical contact caused by

Altitude	Azimuth 0	15	30	45	60	75	90	105	120	135	150	165	180
0	7.20	7.80	7.06	6.10	7.06	7.80	7.20	7.80	7.06	6.10	7.06	7.80	7.20
15	7.87	8.28	6.84	7.19	7.74	8.10	7.87	8.10	7.74	7.19	6.84	8.28	7.87
30	8.00	8.16	8.22	8.16	8.22	8.16	8.00	8.16	8.22	8.16	8.22	8.16	8.00
45	7.59	8.00	8.50	8.44	8.50	8.00	7.59	8.00	8.50	8.44	8.50	8.00	7.59
60	8.00	8.50	8.74	8.89	8.74	8.50	8.00	8.50	8.74	8.89	8.74	8.50	8.00
75	7.98	8.05	8.23	8.24	8.23	8.05	7.98	8.05	8.23	8.24	8.23	8.05	7.98
90	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14
105	7.98	8.05	8.23	8.24	8.23	8.05	7.98	8.05	8.23	8.24	8.23	8.05	7.98
120	8.00	8.50	8.74	8.89	8.74	8.50	8.00	8.50	8.74	8.89	8.74	8.50	8.00
135	7.59	8.00	8.50	8.44	8.50	8.00	7.59	8.00	8.50	8.44	8.50	8.00	7.59
150	8.00	8.16	8.22	8.16	8.22	8.16	8.00	8.16	8.22	8.16	8.22	8.16	8.00
165	7.87	8.28	6.84	7.19	7.74	8.10	7.87	8.10	7.74	7.19	6.84	8.28	7.87
180	7.20	7.80	7.06	6.10	7.06	7.80	7.20	7.80	7.06	6.10	7.06	7.80	7.20

Zone 1 13.052% total
Zone 2 25.216% total
Zone 3 22.608% total
Zone 4 18.459% total
Zone 5 13.053% total
Zone 6 6.756% total
Zone 7 0.086% total



X7.18 = 0.94
X7.70 = 1.93
X8.16 = 1.84
X8.20 = 1.51
X8.40 = 1.10
X8.15 = 0.55
X7.14 = 0.01

Mean sensor intercept area = $\frac{1}{2} \times \frac{7.88}{21.4}$ = 18.5% of total sensor area

Sensor area variation = 16.0 to 20.5% of the total sensor area

Fig. 5. Mean Projected Area--Z Configuration

structural failure or by the micrometeoroid penetration mechanism itself. If the sensor area consists of single element, any one short circuit will destroy the prime sensor. If, however, each sensor is divided into a number of individual segments, the probability of loss of a substantial sensor area decreases as the number of isolated segments is increased.

Total target areas for each of the five altitude zone configurations were divided into a number of equal area segments: 10, 100, and 1000. Spatial distribution of a given number of penetrations in the segmented panels is included in Tables 5 through 9 and is shown in Fig. 8 (in Chapter VII). It will be noted in the five-zone case that the probability of any one panel receiving more than one hit if there are 1000 segments is approximately 0.3%. If all penetrations shorted the panels, the probability of the loss of data from shorts caused by micrometeoroid penetrations is substantially zero.

If segmentation alone would eliminate the possibility of loss of data due to shorting of capacitance panels, any practical number of panel divisions could be made, depending upon levels of probability desired. However, each panel segment must be effectively isolated to permit electrical charging and penetration sensing. This coupling has a finite failure probability and there is a tradeoff between segmentation and coupling reliability. Table 10 and Fig. 9 show this relationship for the five-altitude zone case for 6- and 12-month operating periods. Three panel sensing conditions are shown: 75%, 50% and 5% of all penetrations will not cause shorting. The effect of shorting probability and sensing/charging coupling element reliability will be noted. For the conditions of this study, approximately 300 segments for each of the 0.001 - and 0.002-in. capacitance sensors is optimum. It will be noted that, at this level of segmentation, the probability of measuring penetration if 75% of all penetrations will not cause shorting is only 92%. If area sensing is achieved, the probability of measuring penetrations for a given unit area is increased to substantially 100%, with a short increase in mission time necessary to acquire the required 80 penetrations.

It will be further noted that only 120 segments of 0.001-in. panels and 144 segments of 0.002-in. panels were indicated in the technical writeup. This segmentation was made using sensing/charging couplings of conventional design. With improved coupling reliability achieved during the study, improved success probability has been achieved and the number of panel segments can increase. This is a simple fabrication modification, easily achieved.

3. Launch Vehicle Effects on Mission Success

Assuming that the Atlas-X-259 and Atlas-Agena have essentially the same launch reliability, several performance characteristics significantly affect probability of mission success:

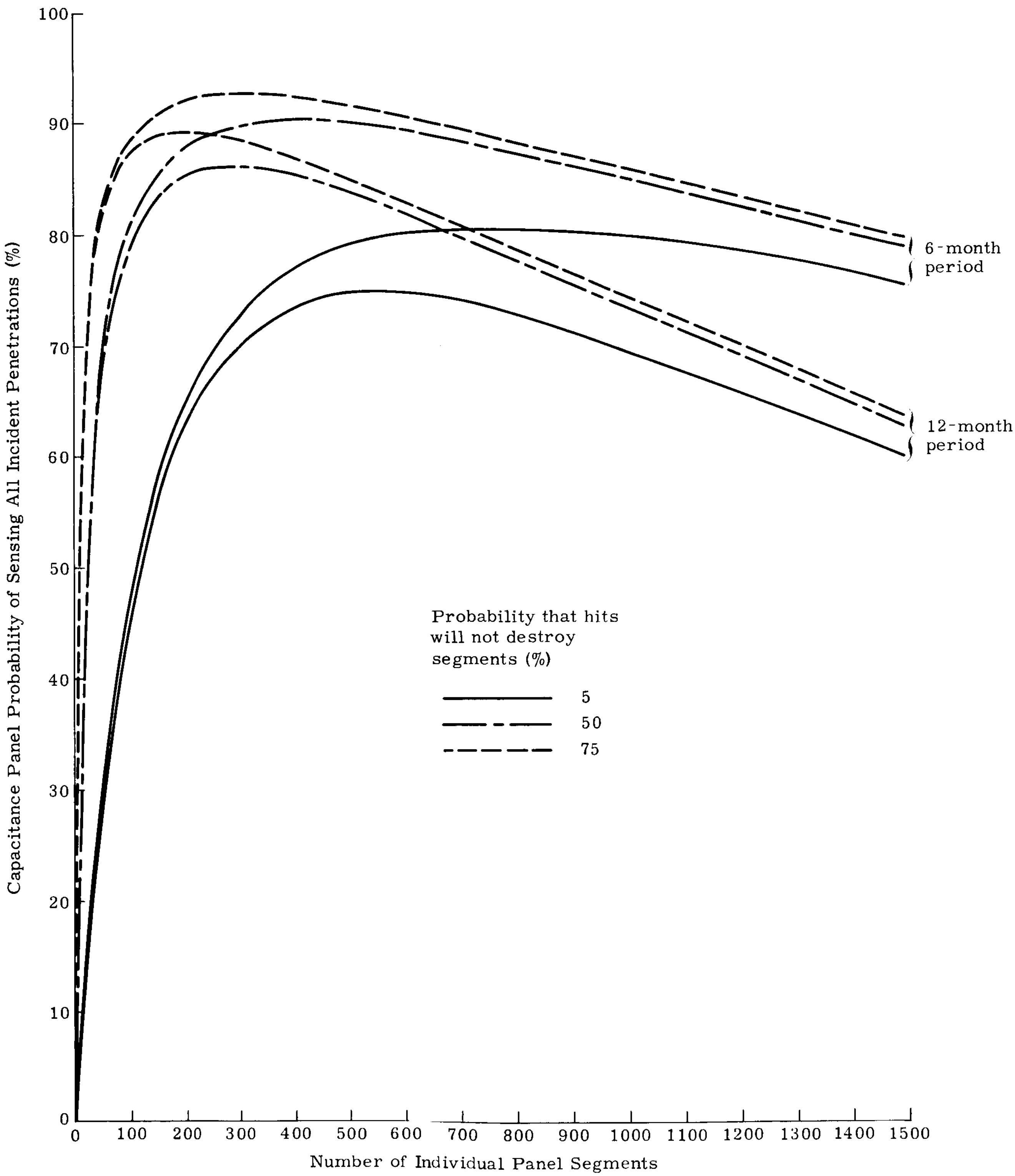


Fig. 9. Capacitance Panel Success Probability Versus Panel Segmentation

TABLE 10

Capacitance Panel Success Probability Variation with Panel Survival Capability and Segmentation

Panel Penetrations (n)	Number of Panel Segments: 100 p	100 E	200 p	200 E	300 p	300 E	400 p	400 E	500 p	500 E	600 p	600 E	700 p	700 E	800 p	800 E	900 p	900 E	1000 p	1000 E	1500 p	1500 E
0	0.449329	45	0.670320	134	0.765673	230	0.818731	328	0.852144	425	0.875027	525	0.891812	624	0.904837	724	0.914846	823	0.923116	923	0.947906	1422
1	0.359463	36	0.268128	53	0.204435	61	0.163746	65	0.136343	70	0.116816	70	0.102113	72	0.090484	72	0.081421	74	0.073849	74	0.050713	76
2	0.143785	14	0.053626	12	0.027292	8	0.016375	6	0.010907	5	0.007798	5	0.005846	4	0.004524	4	0.003623	3	0.002954	3	0.001357	2
3	0.038343	4	0.007150	1	0.002429	1	0.001091	1	0.000582	0	0.000347	0	0.000223	0	0.000151	0	0.000108	0	0.000079	0	0.000024	0
4	0.007668	1	0.000715	0	0.000162	0	0.000055	0	0.000023	0	0.000012	0	0.000006	0	0.000004	0	0.000002	0	0.000002	0	0.000000	0
5	0.001227	0	0.000057	0	0.000009	0	0.000002	0	0.000001	0	0.000000	0	0.000000	0	0.000000	0	0.000000	0	0.000000	0		
6	0.000164	0	0.000004	0	0.000000	0	0.000000	0	0.000000	0												
7	0.000019	0	0.000000	0																		
8	0.000002	0																				
9	0.000000	0																				

		100	200	300	400	500	600	700	800	900	1000	1500
Penetrations Measured--50% Probability Hits Will Not Destroy Segments	With 1 penetration	36	53	61	65	70	70	72	72	74	74	76
	2 penetrations	21	18	12	9	8	8	6	6	5	5	3
	3 penetrations	7	2	2	2							
	4 penetrations	2										
	Penetrations sensed	66	73	75	76	78	78	78	78	79	79	79
	Penetrations not sensed (lost)	14	7	5	4	2	2	2	2	1	1	1
	Probability of segments operating	0.825000	0.912500	0.937500	0.950000	0.975000	0.975000	0.975000	0.975000	0.987500	0.987500	0.987500
	Reliability coupling device--6 mo	0.984994	0.970213	0.955654	0.941314	0.927189	0.913275	0.899570	0.886072	0.872775	0.859678	0.797084
	Reliability coupling device--12 mo	0.970213	0.941313	0.913275	0.886072	0.859678	0.834070	0.809226	0.785121	0.761735	0.739045	0.635341
	Probability sensing all penetrations--6 mo	0.812620	0.885319	0.895926	0.894248	0.904009	0.890443	0.877081	0.863920	0.861865	0.848932	0.787120
	Probability sensing all penetrations--12 mo	0.800426	0.858948	0.856195	0.841768	0.838186	0.813218	0.788995	0.765493	0.752213	0.729807	0.627399
Penetrations Measured--75% Probability Hits Will Not Destroy Segments	With 1 penetration	36	53	61	65	70	70	72	72	74	74	76
	2 penetrations	24	21	14	11	9	9	7	7	5	5	4
	3 penetrations	9	2	2	2							
	4 penetrations	3										
	Penetrations sensed	72	76	77	78	79	79	79	79	79	79	80
	Penetrations not sensed (lost)	8	4	3	2	1	1	1	1	1	1	0
	Probability of segments operating	0.900000	0.950000	0.962500	0.975000	0.987500	0.987500	0.987500	0.987500	0.987500	0.987500	1.000000
	Reliability coupling device--6 mo	0.984994	0.970213	0.955654	0.941314	0.927189	0.913275	0.899570	0.886072	0.872775	0.859678	0.797084
	Reliability coupling device--12 mo	0.970213	0.941313	0.913275	0.886072	0.859678	0.834070	0.809226	0.785121	0.761735	0.739045	0.635341
	Probability sensing all penetrations--6 mo	0.886495	0.921702	0.919817	0.917781	0.915599	0.901859	0.888325	0.874996	0.861865	0.848932	0.797084
	Probability sensing all penetrations--12 mo	0.873192	0.894247	0.879027	0.863920	0.848932	0.823644	0.799111	0.775307	0.752213	0.729807	0.635341
Penetrations Measured--5% Probability Hits Will Not Destroy Segments	Penetrations sensed	36	53	61	65	70	70	72	72	74	74	76
	Penetrations not sensed (lost)	44	27	19	15	10	10	8	8	6	6	6
	Probability of segments operating	0.450000	0.662500	0.762500	0.812500	0.875000	0.875000	0.900000	0.900000	0.925000	0.925000	0.950000
	Reliability coupling device--6 mo	0.984994	0.970213	0.955654	0.941312	0.927189	0.913275	0.899570	0.886072	0.872775	0.859678	0.797084
	Reliability coupling device--12 mo	0.970213	0.941313	0.913275	0.886072	0.859678	0.834070	0.809226	0.785120	0.761735	0.739045	0.635341
	Probability sensing all penetrations--6 mo	0.443247	0.642766	0.728686	0.764816	0.811290	0.799116	0.809613	0.797465	0.807317	0.795202	0.757230
	Probability sensing all penetrations--12 mo	0.436596	0.623620	0.696372	0.719934	0.752218	0.729811	0.728303	0.706608	0.704605	0.683617	0.603574

n = number of penetrations in each panel segment
p = probability of exactly n penetrations in any panel segment
e = expected number of panel segments having exactly n penetrations
λ = (coupling device, each segment) = 0.035×10^{-6}

(1) Payload capability. The wide margin of payload capability of Atlas-Agena over Atlas-X-259 permits a more flexible choice of operational equipments and gains in the probability of mission success incident to duplication of equipments for redundancy. Atlas-Agena is therefore a first choice.

(2) Spinup and despin. Atlas-X-259 must spin up as well as be despun--one additional reliability problem, particularly in view of the large penetration panels required.

(3) Perigee/apogee limits. The probability of achieving desired perigee/apogee limits for Atlas-Agena is superior to that of the Atlas-X-259. Figure 10 compares the two vehicles.

Atlas-Agena is significantly superior to Atlas-X-259 for the micrometeoroid deep space satellite application.

4. Summary

Tables 1, 2, and 3 summarize the effects of launch vehicle, panel configuration and orientation on levels of mission success probability. Each table has an assumed micrometeoroid directionality. It is obvious that, if the directionality of the population were known or were it desired to sample a given area or direction, the most efficient utilization of sensor area would be the properly oriented flat plate, followed, in order, by the "X" and the "Z" configurations. Additionally, if population directionality were unknown, the tumbling flat plate is the preferred configuration followed by the tumbling "X" and the tumbling or nontumbling "Z". In both cases, the flat plate and the X-shaped sensors have an orientation requirement to ensure a substantially uniform sampling area over a long period of time. Only the "Z" configuration requires no specific orientation. Of course, the maximum "Z" projected area in any given direction is inferior to either the flat plate or the "X", but it has no null spot in its intercept pattern.

Based upon penetration sampling criteria and failure levels shown, the Atlas-Agena launch vehicle using the "Z" capacitance panel configuration, a apogee altitude of 135,000 to 165,000 miles, and a tumbling or spinning vehicle is superior to the other combinations shown from a success probability standpoint and was therefore chosen as the prime concept for further evaluation. An additional advantage of the Atlas-Agena is the payload capability for the direct injection mission; the resultant vehicle weight is sufficiently within payload capability at this point to assure adequate growth potential plus a margin sufficient to permit flexible mission planning and operation.

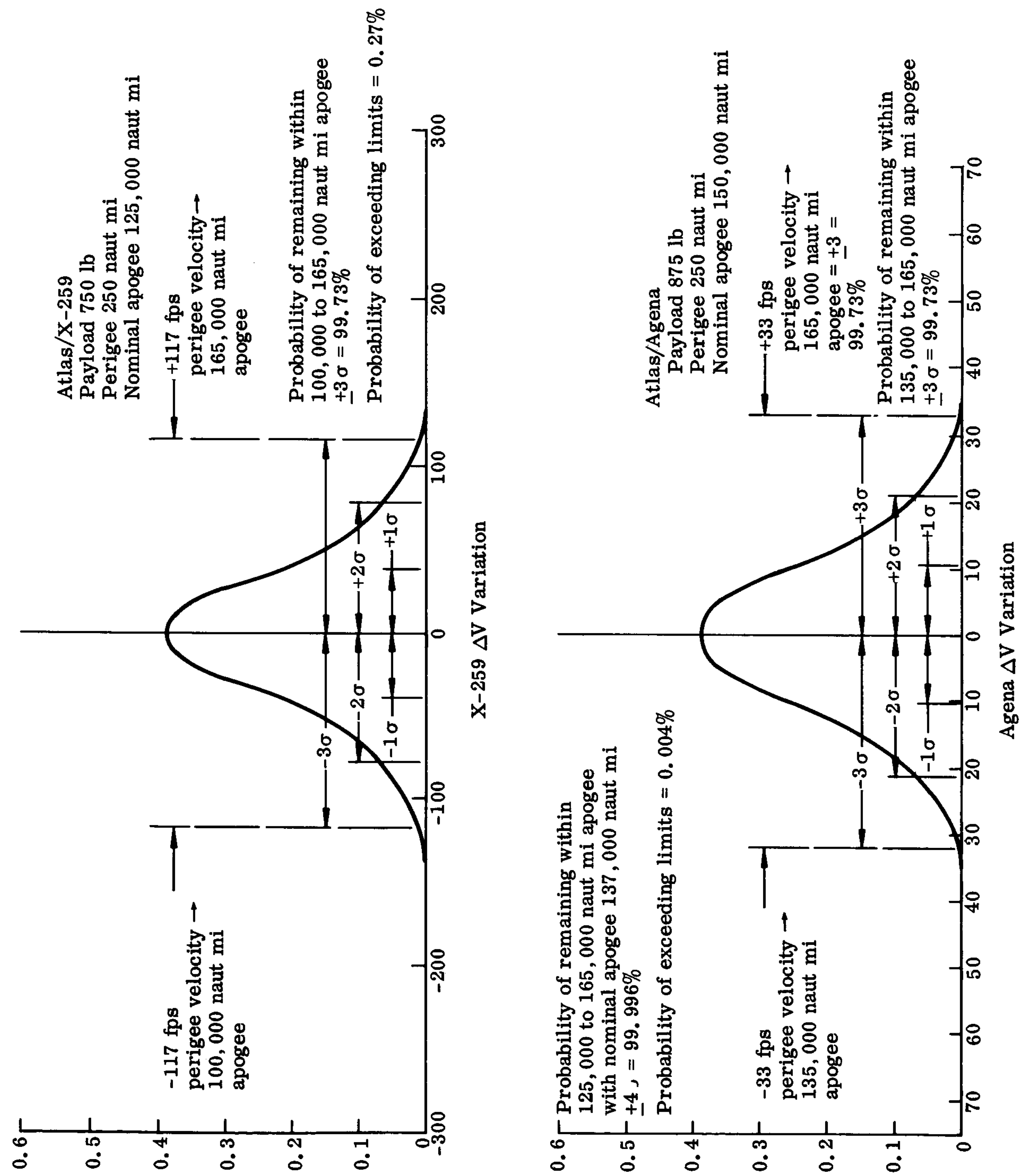


Fig. 10. Probability of Achieving Desired Perigee/Apogee Limits

B. EQUIPMENT OPERATING STRESSES AND PARTS FAILURE RATES

1. Functional Analysis Matrices

During the satellite mission, a number of basic functions must be performed by the launch vehicle, as well as the satellite, to achieve mission success. Tables 11 and 12 tabulate these functions, along with appropriate orbital times. These matrices have been used as an orderly systems integrating tool in the development of an integrated design concept and various modes of operation. Through their use, equipment operating times, phases and environmental stress levels were estimated.

2. Equipment Operating Phases, Times, and Stress Levels

In evaluating equipment reliability, it was necessary to establish a uniform basis of equipment failure rates under various environmental conditions. During the launch into orbit phase, the vehicle will experience a wide range of mechanical, thermal, and electrical stresses, with the majority of equipments in a nonoperating state. Once in orbit, the fundamental stresses will be electrical and thermal. These stress levels have a significant effect on the reliability of equipment during both launch and orbit.

Table 13 lists the relative environmental stress levels (K_{op}) to which various equipments will be subjected during launch through separation. These stress levels are applied to basic tabulated failure rates to yield the estimated failure rate under the given phase stress level.

During orbit, thermal and electrical stress levels will be encountered, depending upon the operating status of equipment and the sunlight/shade period exposure of the vehicle. A uniform electrical stress level of power loading/ power rating = 0.4 was used for all orbital operations.

Table 14 shows the temperature conditions for transmitters and all other equipment during sunlight and dark periods, tumbling or spin-oriented, and with active and passive thermal control. It was assumed that wide fluctuations in equipment temperature would adversely affect reliability. The factor T_N listed for the various operating conditions has been used with MIL-HDBK 217 in the establishment of a group of uniform parts failure rates for use in these analyses.

3. Parts Failure Rates

Using MIL-HDBK 217 and the stress levels defined above, failure rates for tumbling and spinning vehicles and for vehicles with active and passive thermal control have been defined. Table 15 lists failure rates for parts used on a tumbling vehicle with active thermal control. Tables 16, 17 and 18 show the balance of vehicle configurations considered. It will be noted that failure rates of nonoperating, nonenergized parts are taken as 0.1 times the failure rate of nonoperating parts.

Operation		Flight Phase	Prelaunch							
		Event	Service	Precount and Countdown	Hold for Launch Window	Launch	Booster 1 Burnout	Booster 1-A Separate	Sustainer Burnout	Vernier Burnout
		Mission time start	--	--	--	0^h-0^m-0^s	138.3^s	138.3^s	278.1^s	296.5^s
		Time of event	3^m	2^d	1^h approx	138.3^s	0^s	0^s	147.8^s	18.4^s
		Mean distance to lunar orbit	--	--	--	*	*	*	*	*
	Function	Mean earth distance (naut mi)	0	0	0	92,000 ft	92,000 ft	92,000 ft	223,500 ft	237,500 ft
Navigation and Guidance	1.	Determine position, velocity, and acceleration--earth reference	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D
	2.									
	3.	Determine satellite attitude	A, C, F	A, C, F	A, C, F	C, F	C, F	C, F	C, F	C, F
	4.	Determine time reference	A, D	A, C, D, F	C, D, F	C, D, F	C, D, F	C, D, F	C, D, F	C, D, F
	5.	Compute required course	A, C	A, C	A, C	C	C	C	C	C
	6.	Compute current course	A, C	A, C	A, C	C	C	C	C	C
	7.	Provide steering commands	A, C	A, C	A, C	C	C	C	C	C
	8.	Provide velocity control commands	A, C	A, C	A, C	C	C	C	C	C
	9.	Provide time reference memory	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F
	10.	Provide functional sequence commands	A, C	A, C	A, C	C, F	C, F	C, F	C, F	C, F
	11.	Provide position, velocity, and acceleration and attitude reference memory	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D
	12.	Provide range safety data	A, B, C, G	A, B, C, G	A, C, D, G	A, C, D, G	A, C, D, G	A, C, D, G	A, C, D, G	A, C, D, G
	13.	Provide start-stop control	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F
	14.	Provide command control	A, D, F	A, D, F	A, D, F	A, F	A, F	A, F	A, F	A, F
	15.	Provide monitoring critical functions	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G
Stabilization and Control	16.	Determine attitude error	A, B, C, F	A, B, C, F	A, B, C, F	B, C	B, C	B, C	B, C	B, C
	17.	Provide attitude booster control commands	A, B, C, F	A, B, C, F	A, B, C, F	B	B	B	B	B
	18.	Provide TVC commands	A, B, C	A, B, C	B, C	B	B	B	B	B
	19.	Provide tumble rate control: 3-axis	A, F, D	A, F, D	A, F, D	A, F, D	A, F, D	A, F, D	A, F, D	A, F, D
	20.	Provide earth reference line	A, C, D, F	A, C, D, F	A, C, D	C	C	C	C	C
	21.	Provide start-stop control	A, B, C, F	A, B, C, F	A, B, C, F	B	B	B	B	B
	22.	Provide monitoring critical functions	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G
	22(a).	Determine sun reference	A, F, D	A, F, D	A, D	D	D	D	D	D
	22(b).	Provide tumble control	A, F, D	A, F, D	A, D	D	D	D	D	D
Reaction Control	23.	Provide attitude control	A, B, C, F	A, B, C, F	A, B, C	B	B	B	B	B
	24.	Provide spinup	A	A	--	--	--	--	--	--
	25.	Provide despin	A, F	A, F	A, F	--	--	--	--	--
	26.	Provide start-stop control	A, B, C, F	A, B, C, F	A, B, C, F	B	B	B	B	B
	27.	Provide monitoring critical functions	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G
Electrical Power	28.	Provide power source (not from storage)	A	A	A	--	--	--	--	--
	29.	Provide load/voltage control	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F
	30.	Provide load priority sequencing	A, F	A, F	A, F	F	--	F	F	F
	31.	Distribute power	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F
	32.	Provide start-stop control	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F
	33.	Provide load share between power sources	F	F	F	--	--	--	--	--
	34.	Provide energy storage	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F
	35.	Provide energy storage control	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F	B, C, F
	36.	Provide monitoring critical functions	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G

TABLE 11

Phase Function Matrix

Ascent										
Booster 1-B Separate	Coast 1	Fire Agena	Shutdown Agena	Coast 2	Fire Agena	Shutdown Agena	Separation Agena	Outboard Zone 1	Outboard Zone 2	Ou Z
296.5^{s}	351.0^{s}	351.0^{s}	450.0^{s}	52.5^{m}	52.5^{m}	54^{m}	55^{m}	1^{h}	1^{h}	3.5^{hr}
0^{s}	54.5^{s}	0^{s}	99.0^{s}	45^{m}	0^{m}	1.5^{m}	1^{m}	5^{m}	0^{m}	2.5^{h}
*	*	*	*	*	*	*	*	102,762 naut mi	102,762 naut mi	92,75
237,500 ft	265,000 ft	265,000 ft	40 naut mi	100 naut mi	100 naut mi	100 naut mi	100 naut mi	238 naut mi	238 naut mi	10,25
A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, D	A, D	D	D
C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F	F
C, D, F	C, D, F	C, D, F	C, D, F	C, D, F	C, D, F	D, F	D, F	D, F	D, F	D, F
C	C	C	C	C	C	--	--	--	--	--
C	C	C	C	C	C	--	--	--	--	--
C	C	C	C	C	C	--	--	--	--	--
C	C	C	C	C	C	--	--	--	--	--
A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, D, F	A, D, F	D, F	D, F	D, F
C, F	C, F	C, F	C, F	C, F	C, F	A, F, D	A, F, D	F	F	F
A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, C, D	A, D	A, D	D	D	D
A, C, D, G	A, C, D, G	A, C, D, G	A, C, D, G	--	--	--	--	--	--	--
B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F	F
A, F	A, F	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F	D, F	D, F	D, F
A, B, C, D, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, D, F, G	A, D, F	D, F	D, F	D, F
B, C	C	C	C	C	C, F	C, F	F	F	F	F
B, C	C	C	C	C	C	C	--	--	--	--
B, C	C	C	C	C	C	--	--	--	--	--
A, F, D	A, F, D	A, F, D	A, F, D	A, F, D	A, F, D	A, F, D	D, F	D, F	D, F	D, F
C	C	C	C	C	C, F	F	F	D, F	D, F	D, F
B	C	C	C	C	C, F	F	F	F	F	F
A, B, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, D, F, C	A, D, F	D, F	D, F	D, F
D	D	D	D	D	D	D	D	D, F	D, F	D, F
D	D	D	D	D	D	D, F	D, F	D, F	D, F	D, F
B, C	C	C	C	C	C	--	F	F	F	F
--	--	--	--	--	--	--	--	--	--	-
--	--	--	--	--	--	--	--	--	--	-
B, C	C	C	C	C, F	C	F	F	F	F	F
A, B, C, F, G	A, C, F, G	A, C, D, F, G	A, C, D, F, G	A, C, D, F, G	A, C, D, F, G	A, D, F	A, D, F	D, F	D, F	D, F
--	--	--	--	--	--	--	--	F	F	F
B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F
F	F	F	F	F	F	F	F	F	F	F
B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F
B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F
--	--	--	--	--	F	F	F	F	F	F
B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F
B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	C, F	F	F	F
A, B, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, D, F, G	A, C, D, F	A, C, D, F	D, F	D, F	D, F

	Data Acquisition						
oard ne 3	Outboard Zone 4	Outboard Zone 5	Inboard Zone 5	Inboard Zone 4	Inboard Zone 3	Inboard Zone 2	Inboard Zone 1
	13^{hr}	36^{h}	108^{h}	108^{h}	132^{h}	141^{h}	143^{h}
	9.5^{h}	23^{h}	78^{h}	0^{h}	24^{h}	9^{h}	2^{h}
naut mi	70,600 naut mi	44,000 naut mi	41,500 naut mi	41,500 naut mi	65,600 naut mi	83,000 naut mi	88,000 naut mi
naut mi	32,400 naut mi	59,000 naut mi	61,500 naut mi	61,500 naut mi	37,400 naut mi	20,000 naut mi	15,000 naut mi
	D	D	D	D	D	D	D
	F	F	F	F	F	F	F
	D, F	F, D	D, F	D, F	D, F	D, F	D, F
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	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F
	D	D	D	D	D	D	D
	--	--	--	--	--	--	--
	F	F	F	F	F	F	F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	F	F	F	F	F	F	F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	F	F	F	F	F	F	F
	D, F	D, F	D, F	D, F	D, F	D, F	D, F

Operation	Function	Flight Phase	Prelaunch					
		Event	Service	Precount and Countdown	Hold for Launch Window	Launch	Booster 1 Burnout	
		Mission time start	--	--	--	0^h-0^m-0^s	138.3^s	13
		Time of event	3^m	2^d	1^h_{approx}	138.3^s	0^s	0^s
		Mean distance to lunar orbit	--	--	--	*	*	
	Function	Mean earth distance (naut mi)	0	0	0	92,000 ft	92,000 ft	92
Communications and Telemetry	37.	Provide data link to earth	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A,
	38.	Provide command control link	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A,
	39.	Provide tracking signals	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	B, C, F	B, C, F	B,
	40.	Provide tracking	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A	A	A
	41.	Provide data storage	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A,
	42.	Provide range safety command control	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C	A,
	43.	Provide data priority sequence	A, D, F	A, D, F	A, D, F	A, F	A, F	A,
	44.	Provide start-stop control	A, B, C, D, F	A, B, C, D, F	A, B, C, D, F	A, B, C, F	A, B, C, F	A
	45.	Provide substorage	F	F	F	F	F	F
	46.	Provide monitoring critical functions	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A
Scientific Experiments	47.	Provide scientific experiments	A, D, F	A, D, F	A, D, F	A, F	A, F	A
	48.	Provide experiment priority sequencing	A, D, F	A, D, F	A, D, F	A, F	A, F	A
	49.	Provide start-stop control	A, D, F	A, D, F	A, D, F	A, F	A, F	A
	50.	Provide monitoring critical functions	A, D, F	A, D, F	A, D, F	A, F	A, F	A
Temperature Control	51.	vide equipment temp ol	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B
	52.							
	53.	Provide start-stop control	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B
	54.	Provide monitoring critical functions	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, D, F, G	A, B, C, F, G	A, B, C, F, G	A
Propulsion	55.	Provide velocity increments	A, B, C	A, B, C	A, B, C	B	B	B
	56.	Provide velocity corrections	A, B, C	A, B, C	A, B, C	--	--	
	57.	Provide thrust vector control	A, B, C	A, B, C	A, B, C	B	B	B
	58.	Provide start-stop control	A, B, C, F	A, B, C, F	A, B, C, F	B, C	B, C	B
	59.	Provide monitoring critical functions	A, B, C, G	A, B, C, G	A, B, C, G	A, B, C, G	A, B, C, G	A
Structural	60.	Provide main and equipment support	A, B, C, F	A, B, C, F	A, B, C, F	B, C, F	B, C, F	B
	61.	Provide ingress and egress	A, B, C, F	A, B, C, F	--	--	--	
	62.	Provide meteoroid protection	--	--	--	--	--	
	63.	Provide radiation protection	--	--	--	--	--	
	63(a).	Deploy equipments and experiments	F	F	F	--	--	
	63(b).	Verify equipments and experiments	F	F	F	--	--	
Separation	64.	Provide separation fairing heat shield	A, B, C	A, B, C	A, B, C	B, C	B, C	B
	65.	Provide separation LV stages	A, B, C	A, B, C	A, B, C	--	--	B
	66.							
	67.	Provide separation, spacecraft	A, F	A, F	A, F	--	--	
Range Safety	68.	Provide LV destruct	A, B, C, G	A, B, C, G	A, B, C, G	B, C, G	B, C, G	B
	69.	Provide range safety command control	A, B, C, G	A, B, C, G	A, B, C, G	A, B, C, G	A, B, C, G	A

A = GSE
B = Atlas
C = Agena

D = DSIF
F = Satellite
G = Range safety

-- Not required
* Insignificant distance

TABLE 11 (continued)

	Ascent									
Booster 1-A Separate	Sustainer Burnout	Vernier Burnout	Booster 1-B Separate	Coast 1	Fire Agena	Shutdown Agena	Coast 2	Fire Agena	Shutdown Agena	Separation Agena
3^s	278.1^s	296.5^s	296.5^s	351.0^s	351.0^s	450.0^s	52.5^m	52.5^m	54^m	55^m
	147.8^s	18.4^s	0^s	54.5^s	0^s	99.0^s	45^m	0^m	1.5^m	1^m
	*	*	*	*	*	*	*	*	*	*
)00 ft	223,500 ft	237,500 ft	237,500 ft	265,000 ft	265,000 ft	40 naut mi	100 naut mi	100 naut mi	100 naut mi	100 naut mi
, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, C, F, G	A, C, D, F, G	A, C, D, F, G	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F
, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, C, F, G	A, C, F, G	A, C, D, F, G	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F
, F	B, C, F	B, C, F	B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	C, F
	A	A	A	A	A, D	A, D	A, D	A, D	A, D	A, D
, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, D, C, F	A, D, C, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F
, C	A, B, C	A, B, C	A, B, C	A, C	A, C	A, C	A, C	A, C	--	--
	A, F	A, F	A, F	A, F	A, D, F	A, D, F	A, D, F	A, D; F	A, D, F	A, D, F
, C, F	A, B, C, F	A, B, C, F	A, B, C, F	A, C, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F	A, C, D, F
	F	F	F	F	F	F	F	F	F	F
, C, F, G	A, B, C, F, G	A, B, C, F, G	A, B, C, F, G	A, C, F, G	A, C, F, G	A, C, D, F, G	A, C, D, F, G	A, C, D, F, G	A, C, D, F	A, D, F
	A, F	A, F	A, F	A, F	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F
	A, F	A, F	A, F	A, F	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F
	A, F	A, F	A, F	A, F	A, F	A, F	A, D, F	A, D, F	A, D, F	A, D, F
	A, F	A, F	A, F	A, F	A, F	A, F	A, D, F	A, D, F	A, D, F	A, D, F
, F	B, C, F	B, C, F	B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	F
. F	B, C, F	B, C, F	B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	F
, C, F, G	B, C, F	B, C, F	B, C, F	C, F	C, F	C, F	C, F	D, C, F	D, C, F	D, F
	B	B	B	--	C	C	C	--	C	--
--	--	B	--	--	--	--	--	--	--	--
	B	B	--	--	C	C	--	--	--	--
	B, C	B, C	B	--	C	C	--	C	C	--
, C, G	A, B, C, G	A, B, C, G	A, B, C, G	A, C, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, C, F, G	A, F, G
, F	B, C, F	B, C, F	B, C, F	C, F	C, F	C, F	C, F	C, F	C, F	F
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	B, C	B, C	--	--	--	--	--	--	C	C
ngs)	--	--	B	--	--	--	--	--	--	C
--	--	--	--	--	--	--	--	--	--	C
, G	B, C, G	B, C, G	B, C, G	C, G	C, G	C, G	C, G	C, G	C, G	C, G
, C, G	A, B, C, G	A, B, C, G	A, C, G	A, C, G	A, C, G	A, C, G	A, C, G	A, C, G	A, C, G	A, G

Data Acquisition									
Outboard Zone 1	Outboard Zone 2	Outboard Zone 3	Outboard Zone 4	Outboard Zone 5	Inboard Zone 5	Inboard Zone 4	Inboard Zone 3	Inboard Zone 2	Inboard Zone 1
h	1^h	3.5^{hr}	13^{hr}	36^h	108^h	108^h	132^h	141^h	143^h
m	0^m	2.5^h	9.5^h	23^h	78^h	0^h	24^h	9^h	2^h
02,762 naut mi	102,762 naut mi	92,750 naut mi	70,600 naut mi	44,000 naut mi	41,500 naut mi	41,500 naut mi	65,600 naut mi	83,000 naut mi	88,000 naut mi
38 naut mi	238 naut mi	10,250 naut mi	32,400 naut mi	59,000 naut mi	61,500 naut mi	61,500 naut mi	37,400 naut mi	20,000 naut mi	15,000 naut mi
), F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F	F	F
	D	D	D	D	D	D	D	D	D
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
--	--	--	--	--	--	--	--	--	--
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F	F	F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
	F	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F	F
, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F	D, F
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	F	F	F	F	F	F	F	F	F
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	F	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F	F
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TA

Equipment

Operation	Equipment	Function	Service	Precount and Countdown	Hold for Launch Window	Launch	Outboa Zone
	Flight phase		Prelaunch				
	Event		Service	Precount and Countdown	Hold for Launch Window	Launch	Outboa Zone
	Mission time start		--	--	--	$0^h - 0^M - 0^S$	1^h
	Time of event		3 months	2 days	1-hr approx	138.8^S	5^M
	Mean distance to lunar orbit		*	*	*	*	102,762
	Mean earth distance (naut mi)		0	0	0	92,000 ft	238 NM
Operation	Equipment	Function					
Mission programming and sequencing	Master systems counter	26, 32, 44, 67	KLMNPRS	MPR	JMP	JMP	MPQ
	Data program sequencer	41, 43, 14	KLMNPRS	MPR	JMP	MPQ	MPQS
	Communications input decoder	14	LMNPR	MPR	JMP	MPQ	MPQ
	Separate--despin counter	58, 26, 8	LMNPR	MPR	JMP	JMP	MPQ
	Power supply	28	LMNPR	MPQ	MPQ	MPQ	MPQ
	Master clock/ time ref	4, 13	LMNPRST	MPQST	MPQST	MPQT	MPQT
	Data selection counters	10, 43, 49	KLMNPRS	MPRS	JMPS	MPQ	MPQS
Stabilization and control	Sun sensors	3, 22(a)	KLMNPR	MPR	JMP	JMP	MPQ
	Attitude logic	16	KLNRT	LNR	JLN	JMP	MPQ
	Switching logic	17, 21	KLNRT	LNR	JLN	JMP	MPQ
	MSDC	22	KLMNPQ	MPQ	MPQ	MPQ	MPQ
Reaction control	Roll/pitch/ yaw jets	23, 24, 25	KLMNPR	MPR	M	M	
	Propellant feed and pressure	23, 24, 25	KLMNPR	MPR	M	M	
	MSDC	28	KLMNPQ	MPQ	MPQ	MPQ	
Environmental control	Coatings--reflectors filters, radiators	51	KR	--		--	MQ
	Temperature control louvers	51,53	KLMPR	MQ	MQ	MQ	KMQ
	Auxiliary heating	51,53	KLMNPR	KMNPR	MQ	MPQ	MPQ
	Thermal shield	51	KM	--	--	--	MQ
	Launch pad protection	51,52,53	KLMQ	MQ	MQ	--	--
	MSDC	54	KLMNPQ	MPQ	MPQ	MPQ	MPQ
Structures	Alignment and deployment	60	KLMNPR	M	M	M	KMPQ
	CG control	60	KLMNR	J	J	J	--
	Spinup platform	60	KLMNPR	MPQ	MPQ	MPQ	--
	Meteoroid shielding	63	KLMNPR	JMP	JP	JP	PQ
	Radiation shielding	64	KLMNPR	JMP	JP	JP	PQ
	Support structure	60	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Launch pad access	62	KQ	--	--	--	--
	Spinup shroud and actuator	60	KLMNPR	JMP	JMP	MQ	--
	MSDC	65	KLMNPQ	MPQ	MPQ	MPQ	MPQ
Separation	Separate Atlas/satellite	67	KLMNPR	JMP	JMP	JMP	--
	Separation actuators	67	KLMNPR	JMP	JMP	JMP	--
	Retro	67	KLMNPR	JMP	JMP	JMP	--
	MSDC	67	KLMNPQ	MPQ	MPQ	MPQ	--

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Function Matrix

	Data Acquisition								
'd	Outboard Zone II	Outboard Zone III	Outboard Zone IV	Outboard Zone V	Inboard Zone V	Inboard Zone IV	Inboard Zone III	Inboard Zone II	Inboard Zone I
	1^h	3.5 hr	13^H	36^H	108^H	108^H	132^H	141^H	143^H
	0^M	2.5^H	9.5^H	23^H	78^H	0^H	2.4^H	9^H	2^H
NM	102,762 NM	92,750 NM	70,600 NM	44,000 NM	41,500 NM	41,500 NM	65,600 NM	83,000 NM	88,000 NM
	238 NM	10,250 NM	32,400 NM	59,000 NM	61,500 NM	61,500 NM	37,400 NM	20,000 NM	15,000 NM
	--	--	--	--	--	--	--	--	--
	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	--	--	--	--	--	--	--	--	--
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT
	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS	MPQS
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	MQ	MQ	MQ	MQ	MQ	MQ	MQ	MQ	MQ
	KMQ	KMQ	KMQ	KMQ	KMQ	KMQ	KMQ	KMQ	KMQ
	--	--	--	--	--	MPQ	--	--	--
	MQ	MQ	MQ	MQ	MQ	MQ	MQ	MQ	MQ
	--	--	--	--	--	--	--	--	--
	MPQ	MPQ	MPQ	MQP	MPQ	MPQ	MPQ	MPQ	MPQ
	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	PQ	PQ	PQ	PQ	PQ	PQ	PQ	PQ	PQ
	PQ	PQ	PQ	PQ	PQ	PQ	PQ	PQ	PQ
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--

TABLE 1

Operation	Equipment	Function	Service	Precount and Countdown	Hold for Launch Window	Launch	Outboard Zone I
	Flight phase		Prelaunch				
	Event		Service	Precount and Countdown	Hold for Launch Window	Launch	Outboard Zone I
	Mission time start		--	--	--	$0^h - 0^M - 0^S$	1^h
	Time of event		3 months	2 days	1-hr approx	138.8^S	
	Mean distance to lunar orbit		*	*	*	*	102,762 NM
	Mean earth distance (naut mi)		0	0	0	92,000 ft	238 NM
Operation	Equipment	Function					
Scientific experiments and engineering experiments	Capacitance sensors	47	KLNR	LNR	JLN	JMP	KMPQ
	Exotech sensors	47	KLNR	LNR	JLN	JMP	KMPQ
	Mariner gauge sensors	47	KLNR	LNR	JLN	JMP	KMPQ
	Earth aspect sensors	47	KLNR	LNR	JLN	JMP	KMPQ
	Velocity gauge detector	47	KLNR	LNR	JLN	JMP	KMPQ
	Diagnostic sensors	50	KLMNPQ	MPQ	MPQ	MPQ	MPQ
	MSDC	49,50	KLMNPQ	MPQ	MPQ	MPQ	MPQ
	Experiment selector	48	KLMNPQ	JMP	JMP	JMP	MPQ
	Solar aspect sensors	47	KLNR	LNR	JLN	JMP	KMPQ
Onboard power	Solar panels	28	KLMNPR	JMP	JMP	JMP	MPQ
	Deployment sensors	28	KLMNPR	JMP	JMP	JMP	MPQ
	Actuate/adjust	28	KLMNPR	JMP	JMP	JMP	MPQ
	Battery/charger	34,35	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Booster/regulator	29	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Power amplifiers	31	LMNPR	MPQ	MPQ	MPQ	MPQ
	Synchronized supply	31	KLMNPRT	MPQT	MPQT	MPQT	MPQT
	Power switching and logic	30,32,33	LMNPR	MPQ	MPQ	MPQ	MPQ
	Wiring harness and fusing	31	LMNPR	MPQ	MPQ	MPQ	MPQ
	MSDC	36	KLMNPQ	MPQ	MPQ	MPQ	MPQ
Communications and telemetry	Antenna--VHF array	37,38 39	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Antenna electronics	37,38	KLMNPR	JMP	JMP	JMP	MPQ
	Command or R&R receivers	38	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Command control logic	38	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Transmitters	37,38,39	KLMNPR	MPQ	MPQ	MPQ	MPQ
	Decoders	38	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Data storage	41	KLMNPRS	MPQ	MPQ	JMP	MPQ
	Program unit	45	KLMNPRS	MPQ	MPQ	JMP	MPQ
	A/D converters	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Sensor monitors	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Signal conditioning	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Program sequencer and encoder	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Master clock	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Communication	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	Coding matrix	43	KLMNPRS	MPQ	MPQ	MPQ	MPQ
	MSDC	44	KLMNPQ	MPQ	MPQ	MPQ	MPQ

NOTES:
J = Standby
K = Adjust alignment
L = Measure environment levels--ground
M = Measure environment levels
R = Stimulate intended operation
S = Set in
T = Synchronize
N = Measure operating input/output (ground)
P = Measure operating input/output (air)
Q = Operate in intended manner

* Distance insignificant

/

ER

2 (continued)

Data Acquisition								
utboard Zone II	Outboard Zone III	Outboard Zone IV	Outboard Zone V	Inboard Zone V	Inboard Zone IV	Inboard Zone III	Inboard Zone II	Inboard Zone I
1^h	3.5 hr	13^H	36^H	108^H	108^H	132^H	141^H	143^H
0^M	2.5^H	9.5^H	23^H	78^H	0^H	2.4^H	9^H	2^H
2,762 NM	92,750 NM	70,600 NM	44,000 NM	41,500 NM	41,500 NM	65,600 NM	83,000 NM	88,000 NM
8 NM	10,250 NM	32,400 NM	59,000 NM	61,500 NM	61,500 NM	37,400 NM	20,000 NM	15,000 NM
KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ	KMPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQT	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT	MPQT
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ
MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ	MPQ

TABLE 13

Equipment Operating Phases, Times and Stress Levels

Phase	Equipment	Applicable System Concept	K_{OP} Operating	K_{OP} Nonoperating	Equipment Operating Time (hr)	Equipment Nonoperating Time (hr)	$\sum K_{OP} T$
Service (3 mo)	(1) Power	A, B, C, D, E, F	1	0.1	60	2100	Failures replaced/repaired
	(2) Process/telemetry	A, B, C, D, E, F	1	0.1	60	2100	
	(3) Instrumentation		1	0.1	60	2100	
	(4) Environ control	A, B, C, D, E, F	1	0.1	60	2100	
	(5) Structures	A, B, C, D, E, F	1	0.1	2160	--	
	(6) Operating mechanisms	A, B, C, D, E, F	1	0.1	10	2150	
	(7) Interrogation & command		1	0.1	60	2100	
	(8) Attitude sensing		1	0.1	30	2130	
	(9) Capacitance sensors	A, B, C, D, E, F	1	0.1	60	2100	
	(10) Secondary sensors		1	0.1	60	2100	
Countdown (2 days)	Oper--(1)(2)(3)(4)(5)(7)(8)(9)(10) Nonop--(6)		1	0.1	8 --	40 48	8 4.8
Launch window (1 hr)	Oper--(1)(3)(4)(5)(7) Nonop--(2)(6)(8)(9)(10)		1	0.1	1 --	-- 1	1.0 0.1
Boost (0.1 hr)	Oper--(1)(3)(4)(5)(7) Nonop--(2)(6)(8)(9)(10)		500	500	0.1	0.1	50 50
Separate deploy (0.025)	Oper--(1)(2)(3)(4)(5)(6)(7)(9)(10) Nonop--(8)		50	10	0.025	0.025	1.25 0.25
Zone 1 out (1 hr)							
Zone 2 out (3 hr)		See individual systems concepts					
Zone 3 out (9 hr)							

K_{OP} = operating stress level (environment)(ambient and induced)

A, B, C, D, etc.--see master tradeoff matrix

TABLE 14

Temperature Stress Levels Used in Determining Part Failure Rates

Vehicle Attitude	Thermal Control	Light/Dark Condition	Applicable Equipment	Temperature Range (°F)	T_N (MIL-HDBK-217)
Spinning	Passive	Full sunlight	Transmitter and exposed equipment--operating	85° to 40°	0.1
			Transmitter and exposed equipment--nonoperating	30° to -30°	0.6
			All other equipment--protected	85° to 55°	0.1
		Shadow period	Transmitter and exposed equipment--operating	65° to 40°	0.1
			Transmitter and exposed equipment--nonoperating	10° to -50°	0.8
			All other equipment--protected	30° to 0°	0.3
	Active	Full sunlight	Transmitter and exposed equipment--operating	80° to 45°	0.1
			Transmitter and exposed equipment--nonoperating	40° to 0°	0.3
			All other equipment--protected	75° to 65°	0.1
		Shadow period	Transmitter and exposed equipment--operating	40° to 20°	0.1
			Transmitter and exposed equipment--nonoperating	40° to -20°	0.5
			All other equipment--protected	20° to 0°	0.3
Tumbling	Passive	Full sunlight	Transmitter and exposed equipment--operating	100° to 0°	0.3
			Transmitter and exposed equipment--nonoperating	50° to -60°	0.8
			All other equipment--protected	100° to 37°	0.1
		Shadow period	Transmitter and exposed equipment--operating	40° to -20°	0.5
			Transmitter and exposed equipment--nonoperating	0° to -80°	1.0
			All other equipment--protected	40° to 0°	0.3
		Full sunlight	Transmitter and exposed equipment--operating	90° to 40°	0.1
			Transmitter and exposed equipment--nonoperating	35° to 0°	0.3
			All other equipment--protected	80° to 60°	0.1
		Shadow period	Transmitter and exposed equipment--operating	40° to 0°	0.3
			Transmitter and exposed equipment--nonoperating	10° to -40°	0.7
			All other equipment--protected	30° to 0°	0.3

NOTE:

During shadow period, temperature is expected to decrease approximately 20° F per hour. Mean shadow period is assumed to be 2 hours.

TAB

Failure Rates of Pa

Item	Qty	Source	Service/Countdown/Hold						Boost					
			Equipment Operating			Equipment Nonoperating			Equipment Operating			Equipment Nonoperating		
			Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6	Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6	Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6	Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6
Inductance		MIL HDBK 217	0.4	1	0.025	--	1	0.0025	0.4	500	12.5	--	500	1.25
Transistor		MIL HDBK 217	0.4	1	0.042	--	1	0.0042	0.4	500	21.0	--	500	2.1
Resistor (dissipation)		MIL HDBK 217	0.4	1	0.02	--	1	0.002	0.4	500	10.0	--	500	1.0
Resistor (composition)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Capacitor (glass)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Capacitor (tantalum wet slug)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Diode		MIL HDBK 217	0.4	1	0.020	--	1	0.002	0.4	500	10.0	--	500	1.0
RF and IF coils and low voltage transformer		MIL HDBK 217	0.4	1	0.030	--	1	0.003	0.4	500	15.0	--	500	1.5
High voltage transformer		MIL HDBK 217	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	2.5
Solar array (28 volts)		Martin and AVCO data	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	25
Solar array (36-54 volts)		Martin and AVCO data	0.4	1	0.10	--	1	0.010	0.4	500	50.0	--	500	50.0
Batteries (chargable)		Martin MI-60-54 (rev)	0.4	1	1.4	--	1	1.4	0.4	500	700	--	500	700
Batteries and heaters		Martin MI-60-54 (rev)	0.4	1	1.45	--	1	1.45	0.4	500	725	--	500	725
Fuses, continuous load		Martin MI-60-54 (rev)	0.4	1	0.3	--	1	0.03	0.4	500	15.0	--	500	1.50
Fuses, intermittent load		Martin MI-60-54 (rev)	0.4	1	0.8	--	1	0.08	0.4	500	40.0	--	500	4.0
Crystals		Martin MI-60-54 (rev)	0.4	1	0.6	--	1	0.6	0.4	500	300	--	500	300

*Lower figures apply to transmitter only Spin configuration ☐ Tumble configuration ☒ Active thermal

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ts Used in Equipment

Deploy/Spin/Despin						Orbital Sunlight Period								Orbital Dark Period							
Equipment Operating			Equipment Nonoperating			Equipment Operating				Equipment Nonoperating				Equipment Operating				Equipment Nonoperating			
Electric Stress	Thermal/Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal/Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$
0.4	50	1.25	--	50	0.125	0.4	0.1 0.1	1	0.025 0.025	--	0.1 0.3	1	0.0025 0.0032	0.4	0.3 0.3	10	0.33 0.33	--	0.3 0.7	10	0.033 0.04 *
0.4	50	2.1	--	50	0.21	0.4	0.1 0.1	1	0.042 0.042	--	0.1 0.3	1	0.0042 0.0046	0.4	0.3 0.3	10	0.46 0.46	--	0.3 0.7	10	0.046 0.083 *
0.4	50	1.0	--	50	0.10	0.4	0.1 0.1	1	0.02 0.02	--	0.1 0.3	1	0.002 0.002	0.4	0.3 0.3	1	0.02 0.02	--	0.3 0.7	1	0.002 0.002 *
0.4	50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.3	1	0.001 0.001	0.4	0.3 0.3	1	0.01 0.01	--	0.3 0.7	1	0.001 0.001 *
0.4	50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.3	1	0.001 0.001	0.4	0.3 0.3	10	0.10 0.10	--	0.3 0.7	10	0.01 0.02 *
0.4	50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.3	1	0.001 0.001	0.4	0.3 0.3	10	0.10 0.10	--	0.3 0.7	10	0.01 0.02 *
0.4	50	1.0	--	50	0.10	0.4	0.1 0.1	1	0.020 0.020	--	0.1 0.3	1	0.002 0.002	0.4	0.3 0.3	10	0.20 0.20	--	0.3 0.7	10	0.02 0.02 *
0.4	50	1.5	--	50	0.15	0.4	0.1 0.1	1	0.030 0.030	--	0.1 0.3	1	0.003 0.004	0.4	0.3 0.3	10	0.30 0.30	--	0.3 0.7	10	0.03 0.05 *
0.4	50	2.5	--	50	0.25	0.4	0.1 0.1	1	0.050 0.050	--	0.1 0.3	1	0.005 0.006	0.4	0.3 0.3	10	0.60 0.60	--	0.3 0.7	10	0.06 0.085 *
0.4	50	2.5	--	50	2.5	0.4	0.1	1	0.05	--	0.1	1	0.005	--	--	10	--	--	0.2	10	0.045
0.4	50	5.0	--	50	5.0	0.4	0.1	1	0.10	--	0.1	1	0.010	--	--	10	--	--	0.2	10	0.300
0.4	50	70.0	--	50	70.0	0.4	0.1	1	1.4	--	0.3	1	1.4	0.4	0.3	10	15.4	--	0.5	10	15.4
0.4	50	72.5	--	50	72.5	0.4	0.1	1	1.45	--	0.1	1	1.45	0.4	0.1	10	1.45	--	0.1	10	1.45
0.4	50	1.5	--	50	0.15	0.4	0.1	1	0.03	--	0.1	1	0.003	0.4	0.1	10	0.3	--	0.2	10	0.3
0.4	50	4.0	--	50	40	0.4	0.1	1	0.08	--	0.1	1	0.008	0.4	0.1	10	0.8	--	0.2	10	0.8
0.4	50	30	--	50	30	0.4	0.1	1	0.6	--	0.1	1	1.1	0.4	0.1	10	2.2	--	0.2	10	1.1 *

control [X] Passive thermal control [ ]

2

TABLE 1

Item	Source	Service/Countdown/Hold						Boost					
		Equipment Operating			Equipment Nonoperating			Equipment Operating			Equipment Nonoperating		
		Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6	Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6	Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6	Electric Stress	Thermal/Mechanical Stress	FR = λ x 10^6
Relays (standard)	Martin MI-60-54 (rev)	0.4	1	0.01	--	1	--	0.4	500	1.0	--	500	--
Magnetic cores	Estimated	0.4	1	0.00001	--	1	0.000001	0.4	500	0.005	--	500	0.0005
Microswitches	Martin MI-60-54 (rev)	0.4	1		--	1	--	0.4	500	--	--	500	--
Hall effect unit	Estimated to be the same as a resistor	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Switching relay	MIL HDBK 217	0.4	1	0.5	--	1		0.4	500	50.0	--	500	5.0
Panel actuator	Estimated	1	1	20	--	1	0.2		500	--	--	500	20
Hinges and springs	Estimated	1	1	5	--	1	0.5		500	--	--	500	5
Deployment timer	Estimated synthesized	1	1	2000	--	1	--		500	--	--	500	--
Thermal battery	Martin MI-60-54 (rev)	1	1	--	--	1	--		500	--	--	500	--
Shutters and hinges	Estimated synthesized	1	1	1	--	1	0.1		500	50.0	--	500	5
Thermostatic control	Martin MI-60-54 (rev)	1	1	1	--	1	0.1		500	50.0	--	500	5
Batteries and heaters (cycle battery)	Martin MI-60-54 (rev)	1	1	2.45	--	1	2.45		500	1225	--	500	1225
Wires (distribution)	Martin MI-60-54 (rev)	1	1	0.001	--	1	0.001		500	5.0	--	500	5.0

Spin configuration ☐ Active thermal control ☒

Tumble configuration ☒ Passive thermal control ☐

(continued)

Deploy/Spin/Despin						Orbital Sunlight Period								Orbital Dark Period							
Equipment Operating			Equipment Nonoperating			Equipment Operating				Equipment Nonoperating				Equipment Operating				Equipment Nonoperating			
Electric Stress	Thermal/Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal/Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$	Electric Stress	Thermal Stress	Mechanical Stress	$FR = \lambda \times 10^6$
0.4	50	0.01	--	50	--	0.4	0.1	1	0.01	--	0.1	1	0.01	0.4	0.3	10	0.01	--	0.3	10	0.01
0.4	50	0.0005	--	50	0.00005	0.4		1	0.00001	--	0.1	1	0.00001	0.4	0.3	10	0.00001	--	0.3	10	0.00001
0.4	50	--	--	50	--	0.4		1	0.5/cy	--	0.1	1	--	0.4	0.3	10	5.0/cy	--	0.3	10	--
0.4	50	0.5	--	50	0.05	0.4	0.1	1	0.01	--	0.1	1	0.001	0.4	0.3	10	0.01	--	0.3	10	0.001
0.4	50	5.0	--	50	0.50			1	0.50	--		1	0.50			10	0.50	--		10	0.50
	50	20	--	50	--			1	--	--		1	--			10	--	--		10	--
	50	5	--	50	--			1	--	--		1	--			10	--	--		10	--
	50	2,000	--	50	--			1	--	--		1	--			10	--	--		10	--
	50	20,000	--	50	--			1	--	--		1	--			10	--	--		10	--
	50	1	--	50	0.1			1	1	--		1	--			10	1.5	--		10	
	50	1	--	50	0.1			1	1	--		1	--			10	1.5	--		10	--
	50	122.5	--	50	122.5			1	2.45	--		1	2.45			10	2.45	--		10	2.45
	50	0.5	--	50	0.5			1	0.001	--		1	0.001			10	0.001	--		10	0.001

C. PRELIMINARY VEHICLE RELIABILITY ESTIMATES AND SYSTEM DEFINITION

1. Preliminary Vehicle Configuration for Primary Data Telemetry

Prior to the definition of a complete baseline vehicle configuration, effects of various equipment changes on a minimum system were determined. To simplify the preliminary analysis, secondary data was not considered. Table 19 shows the variations considered to a minimal system, A_0, and Fig. 11 shows a simplified reliability block diagram along with system characteristics. Figures 12 through 20 are block diagrams for the balance of the systems considered.

2. Reliability Estimating

Parts counts of each component required were made (Table 20), and reliability estimates established using the basic failure rates defined previously. A summary of systems and vehicle reliabilities is shown in Table 21 for spinning and tumbling vehicles, with active and passive thermal control, and transmitting penetration data continuously. Little difference can be noted between spinning/tumbling and active/passive thermal control conditions, chiefly because equipments are operating continuously and failure caused by temperature extremes have been minimized.

3. Summary of Evaluations

Preliminary reliability estimates aided in defining the baseline configuration as follows:

(1) Primary data should be transmitted on each of two separate telemetry channels, each having its own power supply.

(2) Counters, in lieu of core shortages, should be utilized for penetration data accumulation.

(3) Area multiplexers, although required, significantly degraded reliability and should be simplified if possible.

(4) Housekeeping data acquisition, because of its complexity, must be effectively isolated - - first from primary data, later from secondary data.

(5) Range and range-rate capability, unnecessary for the complete mission, should be applied to only one of the two primary data channels.

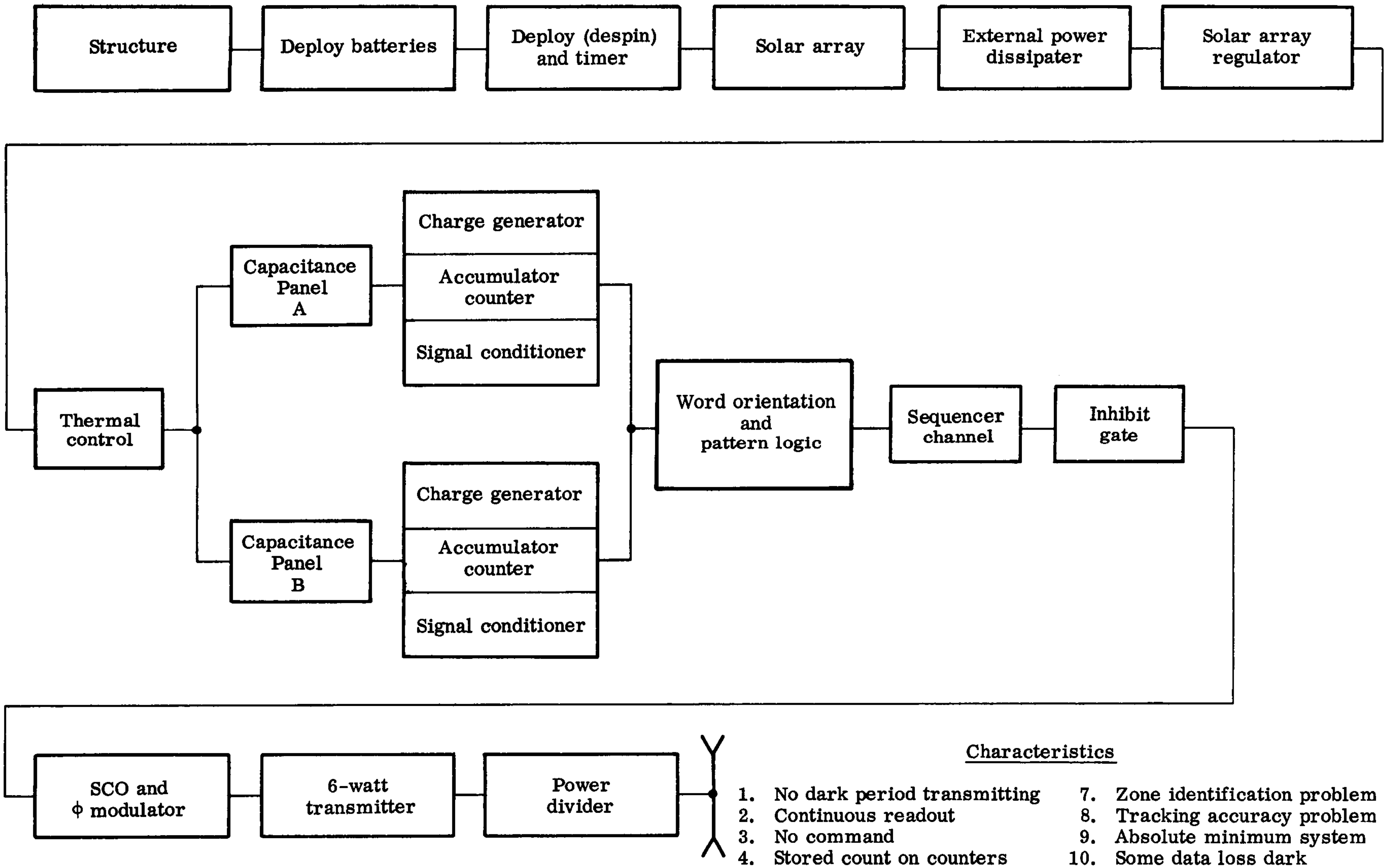
(6) If possible, any secondary data should be completely isolated from the primary data system, preferably on a separate data channel.

TABLE 19

Primary Data T/M System

Configuration	RF Channels	Command	Range and Range Rate	Transmitter Range	Main Storage	Scientific Data	Bits of Storage	Housekeeping Data	Data Transmission Programmed	RF Carrier As Beacon and Angles + Minitrack
A_0	1	--	--	Apogee	--	Hit count	--	--	Cont	X
A_1	Completely redundant system for A_0									
A_2	1	--	--	Apogee	--	Hit count and area*	--	--	Cont	X
B_0	1	--	X*	Apogee	--	Hit count	--	--	Cont	Backup*
B_1	1	--	X	Apogee	--	Hit count and area*	--	--	Cont	Backup
B_2	1	--	X	Apogee	--	Hit count and area*	--	--	Cont	X
C_0, C_1	1	Backup only*	X	Apogee	--	Hit count -C_0 and area -C_1	--	For command backup*	Cont	Backup
C_1										
D_0, D_1	(2 SCO) 1*	Backup only*	X	Apogee	--	Hit count -D_0 and area -D_1	--	For command backup*	Cont	Backup
E_0	1	--*	--*	100,000 naut mi*	X*	Hit count and area*	7000*	--*	Timer*	X*
E_1	1	--	--	Apogee*	X	Hit count and area*	7000*	--	Timer	X
E_2	1	--	X*	100,000 naut mi*	X	Hit count and area*	7000*	--	Timer	Backup*
E_3	1	--	X	Apogee*	X	Hit count and area*	7000*	--	Timer	Backup
E_4	1	Backup only*	X	100,000 naut mi*	X	Hit count and area*	7000*	For command backup*	Timer or command	Backup
E_5	1	Backup only*	--	100,000 naut mi*	X	Hit count and area*	7000*	For command backup*	Timer or command	X

*Change from one above.



<u>Characteristics</u>

1. No dark period transmitting
2. Continuous readout
3. No command
4. Stored count on counters
5. Angle track and minitrack
6. Fixed format
7. Zone identification problem
8. Tracking accuracy problem
9. Absolute minimum system
10. Some data loss dark period $< 0.2\%$ max

Fig. 11. Minimum System No. A_0

TABLE 21

Configuration	Name of Subsystem	Spin: Active Thermal Control 6 mo	Spin: Active Thermal Control 12 mo	Spin: Passive Thermal Control 6 mo	Spin: Passive Thermal Control 12 mo	Tumble: Active Thermal Control 6 mo	Tumble: Active Thermal Control 12 mo	Tumble: Passive Thermal Control 6 mo	Tumble: Passive Thermal Control 12 mo
A_0	Structure	.9999	.9998	.9999	.9998	.9999	.9998	.9999	.9998
	Electrical power and deploy	.9933	.9866	.9933	.9866	.9933	.9866	.9933	.9866
	Transmitter, phase modulator, SCO	.9839	.9682	.9839	.9681	.9839	.9681	.9823	.9648
	Signal conditioner and accumulator counter	.9860	.9724	.9860	.9724	.9860	.9724	.9860	.9724
	Charge generator	.9894	.9790	.9894	.9790	.9894	.9790	.9894	.9790
	Word orientation	.9402	.8840	.9402	.8840	.9402	.8840	.9402	.8840
	Pattern logic	.9625	.9264	.9625	.9264	.9625	.9264	.9625	.9264
	Sequencer and inhibit gate	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	A_0 reliability (%)	86.15	74.25	86.15	74.24	86.15	74.24	86.00	73.99
A_1	Structure	.9999	.9998	.9999	.9998	.9999	.9998	.9999	.9998
	Electrical power and deploy, Transmitter and SCO, Signal conditioner and accumulator counter, Charge generator, Word orientation, Pattern logic	Redundant 6 months (R = 0.8628) $R^2 + 2RQ = 0.7444 + 2 \times 0.1372 \times 0.8628 = 0.9812$ (6 months) 12 months (R = 0.7447) $R^2 + 2RQ = 0.5546 + 2 \times 0.2553 \times 0.7447 = 0.9348$ (12 months)							
		.9812	.9348	.9812	.9348	.9812	.9348	.9812	.9348
	Sequencer and inhibit gate	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	Diplexer	.9931	.9863	.9931	.9863	.9931	.9863	.9931	.9863
	A_1 reliability (%)	97.30	91.92	97.30	91.92	97.30	91.92	97.30	91.92
A_2 (area data required)	Configuration A_0 reliability (%)	86.15	74.25	86.15	74.24	86.15	74.24	86.15	73.99
	Area multiplexer (%)	90.85	83.53	90.85	83.53	90.85	83.53	90.85	83.53
	A_2 reliability (%)	78.27	62.02	78.27	62.01	78.27	62.01	73.13	61.80
A_2 (area data not required)	If area multiplexer data is not required for success and if the multiplexer is positively isolated from the penetration data system.								
	A_2 reliability (%)	86.15	74.25	86.15	74.24	86.15	74.24	86.00	73.99
B_0	Add to A_0:								
	Diplexer	.9931	.9863	.9931	.9863	.9931	.9863	.9931	.9863
	R & Ṙ switch gate	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	A_0 reliability	.8615	.7303	.8615	.7302	.8543	.7302	.8529	.7277
	R & Ṙ receiver	.9825	.9652	.9825	.9652	.9825	.9652	.9825	.9652
	R & Ṙ required for success								
	B_0 reliability (%)	83.94	70.49	83.94	70.48	83.94	70.48	83.80	70.24
	R & Ṙ not required for success								
	A_0 reliability (%)	86.15	73.03	86.15	73.02	85.43	73.02	85.29	72.77
B_1	Add area channel to B_0:								
	B_0 reliability (%)	83.94	70.49	83.94	70.48	83.94	70.48	83.80	70.24
	Area multiplexer	90.85	83.53	90.85	83.53	90.85	83.53	90.85	83.53
	Area multiplexer required for success								
	B_1 reliability (%)	76.25	58.88	76.25	58.87	76.25	58.87	76.13	58.67
	Area multiplexer not required for success								
	B_0 reliability (%)	83.94	70.49	83.94	70.48	83.94	70.48	83.80	70.24

TABLE 21 (continued)

		Spin				Tumble			
		Active Thermal Control		Passive Thermal Control		Active Thermal Control		Passive Thermal Control	
Configuration	Name of Subsystem	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
B_2	Add R + $\dot{R}$ to A_1:								
	A_1 reliability	.9730	.9192	.9730	.9192	.9730	.9192	.9730	.9192
	Diplexer	.9931	.9863	.9931	.9863	.9931	.9863	.9931	.9863
	R & $\dot{R}$ switch	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	R & $\dot{R}$ receiver	.9825	.9652	.9825	.9652	.9825	.9652	.9825	.9652
	R & $\dot{R}$ required for success								
	B_2 reliability (%)	94.80	87.25	94.80	87.25	94.80	87.25	94.80	87.25
	R & $\dot{R}$ not required for success (less R & $\dot{R}$ receiver)								
	A_1 reliability (%)	97.30	91.92	97.30	91.92	97.30	91.92	97.30	91.92
C_0	Add to A_0:								
	R + $\dot{R}$ receiver	.9825	.9652	.9825	.9652	.9825	.9652	.9825	.9652
	R + $\dot{R}$ switch gate	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	A_0 reliability	.8615	.7303	.8615	.7302	.8543	.7302	.8329	.7277
	Command logic, receiver, and decoder	.9784	.9572	.9784	.9572	.9784	.9572	.9784	.9572
	Signal conditioning channel (H/K)	90.85	83.53	90.85	83.53	90.85	83.53	90.85	83.53
	H/K deployment data processing	.9085	.8353	.9085	.8353	.9085	.8353	.9085	.8353
	Diplexer	.9931	.9863	.9931	.9863	.9931	.9863	.9931	.9863
	C_0 reliability (%)	74.61	55.43	74.61	55.42	73.99	55.42	72.14	55.23
C_1 area added	Add to C_0:								
	Area multiplexer reliability (%)	90.85	83.53	90.85	83.53	90.85	83.53	90.85	83.53
	C_1 reliability (%)	67.78	46.30	67.78	46.29	67.22	46.29	65.54	46.14
D_0 and D_1	Add to C_1:								
	Redundant SCO channels								
	A_0 reliability	.8661	.7504	.8661	.7503	.8661	.7503	.8647	.7480
	R & $\dot{R}$ receiver	.9825	.9652	.9825	.9652	.9825	.9652	.9825	.9652
	R & $\dot{R}$ switch gate	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	Command logic, receiver, and decoder	.9784	.9572	.9784	.9572	.9784	.9572	.9784	.9572
	H/K deployment channel	.9085	.8353	.9085	.8353	.9085	.8353	.9085	.8353
	Diplexer	.9931	.9863	.9931	.9863	.9931	.9863	.9931	.9863
	Area multiplexer	.9085	.8353	.9085	.8353	.9085	.8353	.9085	.8353
	D_0 (without area) reliability (%)	75.01	56.96	75.01	56.95	75.01	56.95	74.89	56.77
	D_1 (with area) reliability (%)	68.15	47.68	68.15	47.57	68.15	47.57	68.04	47.42
E_0 and E_1	Add to A_2:								
	Read-write and parity generator	.9691	.9392	.9691	.9392	.9691	.9392	.9691	.9392
	7000-bit storage and timer switch	.9831	.9665	.9831	.9665	.9831	.9665	.9831	.9665
	A_2 reliability	.7827	.6202	.7827	.6201	.7827	.6201	.7313	.6180

TABLE 21 (continued)

Configuration	Name of Subsystem	Spin				Tumble			
		Active Thermal Control		Passive Thermal Control		Active Thermal Control		Passive Thermal Control	
		6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
	E_0 and E_1 reliability (%)	74.57	56.30	74.57	56.29	74.57	56.29	69.67	56.10
E_2 and E_3	Add $R + \dot{R}$ to E_0 or E_1:								
	E_0 or E_1 reliability	.7457	.5630	.7457	.5629	.7457	.5629	.6967	.5610
	Diplexer	.9931	.9863	.9931	.9863	.9931	.9863	.9931	.9863
	R & $\dot{R}$ switch gate	.9986	.9972	.9986	.9972	.9986	.9972	.9986	.9972
	R & $\dot{R}$ receiver	.9825	.9652	.9825	.9652	.9825	.9652	.9825	.9652
	E_2 or E_3 reliability (%)	72.66	53.44	72.66	53.44	72.66	53.44	67.88	53.26
E_4 and E_5	Add to E_2 and E_3:								
	E_2 or E_3 reliability								
	Signal conditioning H/K channel; H/K data processing	.9085	.8353	.9085	.8353	.9085	.8353	.9085	.8353
	E_4 or E_5 reliability (%)	66.00	44.64	66.00	44.63	66.00	44.63	61.67	44.48

(7) Wherever possible, command control should be reduced to a minimum.

D. DEFINITION AND EVALUATION OF THE BASELINE CONFIGURATION

1. The Baseline Configuration

Essential elements of the baseline configuration are shown in Fig. 1. Salient features previously summarized as required to maximize reliability, and thereby mission success probability, have been incorporated. An attempt was made to supply a third telemetry channel but, since this channel proved impractical, redundant transmitters in the Pri II channel were provided. In this transmit/receive loop (R_f) range and range-rate capability was also incorporated.

2. Reliability Estimating

Reliability estimating followed the procedure used in Section C above. Component parts counts were made (Table 22) and component failure rates (Table 23) were estimated using the basic failure rates defined for reliability estimating.

3. Reliability Summaries

The five data transmission modes required equipments not listed on the Master Reliability Reference Diagram (Fig. 1) are as follows:

(1) Continuous transmission--no additions.

(2) Command on/off transmission (4 times per zone)--command control switch to Pri I and Pri II channels, and command control channel on transmit/receive loop (R_f).

(3) Automatic on/off transmission (10 minutes per hour)--Pri I, programmer and power switch; Pri II, programmer and power switch to R_E, command control channel to transmit/receive loop (R_f).

(4) Transmit once-per-day--Pri I, storage and readout logic to R_c and command control switch to R_d; Pri II, storage, readout logic and command control switch to R_E, command control channel to transmit/receive loop (R_f).

(5) Transmit once-per-orbit--same as transmit once-per-day except storage is larger.

Component reliabilities for the five telemetry transmitting modes are summarized in Table 24 (high quality parts) and Table 25 (integrated circuitry), and follow the letter/number designations shown in Fig. 1. Necessary redundant applications are shown in supplementary reliability block diagrams (Figs. 21 through 25). Reliability of components/equipments is summarized in Tables 26 and 27.

4. Evaluation of Baseline and Modified Configurations

Table 4 summarizes mission success probabilities for various modifications to the baseline configuration. Designations A through G tabulate the various modifications to the baseline configuration necessary to modify operating modes to meet specific operational requirements or for incremental improvements in mission success probability. Associated with each designation is a definition of mission success probability based on micrometeoroid data acquisition capability as shown in Fig. 1, along with a designated mission success probability model shown in Table 28.

Designations A through E give probabilities of mission success for the five data transmission modes and do not include secondary data. As will be noted, continuous transmission and command on/off transmission four times per zone are substantially equal and have the highest probability of success for a 12-month mission (97.1%), followed, in order, by transmit once-per-orbit, transmit once-per-day, and automatic on/off transmission--10 minutes per hour (94.5%).

When the definition of mission success includes the acquisition of secondary data (Designation F), the 12-month probability of success decreases to values of 2.1 to 1.9% for the various modes of transmission, continuous transmission and command on/off transmission four times per zone still remaining highest. By modifying equipments and redefining data acquisition requirements (G), a substantial gain is achieved to approximately 12.4 to 11.1% for the 12-month mission. Figure 2 shows plots of F and G success probabilities. These probabilities are shown as zones which indicate the variation of success over the five operating modes.

TABLE 28

Mathematical Success Probability Models

$$P_A = R_A/R_B \Big\{(R_C \times R_D \times R_E \times R_F \times R_G \times R_H \times R_{25}) + \big[R_C \times R_D (1 - R_E \times R_F \times R_G \times R_H \times R_{25})\big]$$
$$+ \big[R_E \times R_F \times R_G \times R_H \times R_{25} (1 - R_C \times R_D)\big]\Big\}$$

$$P_B = R_A/R_B \Big\{(R_C \times R_D \times R_{④} \times R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{④}) + \big[R_C \times R_D \times R_{④} (1 - R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{④})\big]$$
$$+ \big[R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{④} (1 - R_C \times R_D \times R_{④})\big]\Big\}$$

$$P_C = R_A/R_B \Big\{(R_C \times R_D \times R_{②} \times R_{③} \times R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{②} \times R_{③})$$
$$+ \big[R_C \times R_D \times R_{②} \times R_{③} (1 - R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{②} \times R_{③})\big]$$
$$+ \big[R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{②} \times R_{③} (1 - R_C \times R_D \times R_{②} \times R_{③})\big]\Big\}$$

$$P_D = R_A/R_B \Big\{(R_C \times R_D \times R_I \times R_{④} \times R_{⑤} R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{①} \times R_{④} \times R_{⑤})$$
$$+ \big[R_C \times R_D \times R_{①} \times R_{④} \times R_{⑤} (1 - R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{①} \times R_{④} \times R_{⑤})\big]$$
$$+ \big[R_E \times R_F \times R_G \times R_H \times R_{25} \times R_{①} \times R_{④} \times R_{⑤} (1 - R_C \times R_D \times R_{①} \times R_{④} \times R_{⑤})\big]\Big\}$$

$P_D = P_E$

The following probabilities are shown for the continuous transmission mode only. Command control switches ($R_{④}$), programmers ($R_{②}$), power switches ($R_{③}$), storage ($R_{①}$) and logic ($R_{⑤}$) are added to the basic model as in P_B, P_C, P_D, P_E to give the various operating modes.

$$P_F = R_A/R_B \Big\{(R_C \times R_D \times R_E \times R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_L \times R_M \times R_N \times R_O \times R_{83} \times R_P \times R_Q$$
$$\times R_{95} \times R_R \times R_S \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{117})$$
$$+ \big[(1 - R_C \times R_D) R_E \times R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_L \times R_M \times R_N \times R_O \times R_{83} \times R_P \times R_Q$$
$$\times R_{95} \times R_R \times R_S \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{117})\big]$$
$$+ \big[(R_C \times R_D) (1 - R_E) (R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_L \times R_M \times R_N \times R_O \times R_{83} \times R_P \times R_Q$$
$$\times R_{95} \times R_R \times R_S \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{117})\big]\Big\}$$

P_G (Two of three mariner gauges, modified panel area multiplexer (R_{54}, R_{58}), either or both hourly or full write logic, either or both critical or full diagnostic data, redundant master clocks.)

<u>Two out of three mariner gauges (ground interpretation)</u>

$$R_{LL} = R_{62} \times R_{63} \times R_{64} \times R_{65} \times R_{66} \times R_{67} \times R_{68} \times R_{69} \times R_{70}$$
$$+ (1 - R_{62} \times R_{63} \times R_{64}) (R_{65} \times R_{66} \times R_{67} \times R_{68} \times R_{69} \times R_{70})$$
$$+ (1 - R_{65} \times R_{66} \times R_{67}) (R_{62} \times R_{63} \times R_{64} \times R_{68} \times R_{69} \times R_{70})$$

$$+ (1 - R_{68} \times R_{69} \times R_{70}) (R_{62} \times R_{63} \times R_{64} \times R_{65} \times R_{66} \times R_{67})$$

Either or both hourly or full write logic

$$R_{QQ} = R_{93} \times R_{94} + (1 - R_{93}) R_{94} + (1 - R_{94}) R_{93}$$

Redundant master clocks

$$R_{CC} = (R_{117})^2 + 2 (1 - R_{117}) R_{117}$$

Either or both critical or full diagnostic data

$$R_{DD} = R_R \times R_S + (1 - R_R) R_S + (1 - R_S) R_R$$

$$\begin{aligned} R_G = R_A/R_B \Big\{ & (R_C \times R_D \times R_E \times R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_{LL} \times R_M \times R_N \times R_O \\ & \times R_{83} \times R_P \times R_{QQ} \times R_{95} \times R_{DD} \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{CC}) \\ & + \big[(1 - R_C \times R_D) (R_E \times R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_{LL} \times R_M \times R_N \times R_O \\ & \times R_{83} \times R_P \times R_{QQ} \times R_{95} \times R_{DD} \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{CC}\big] \\ & + \big[(R_C \times R_D) (1 - R_E) (R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_{LL} \times R_M \times R_N \times R_O \\ & \times R_{83} \times R_P \times R_{QQ} \times R_{95} \times R_{DD} \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{CC}\big]\Big\} \end{aligned}$$

$$P_H = P_G$$

P_I (Same as P_H plus redundant velocity gauge signal conditioning, pulse height analyzers, and counters and redundant aspect sensor signal conditioning and registers.)

Redundant velocity gauge signal conditioning, pulse height analyzers and counters

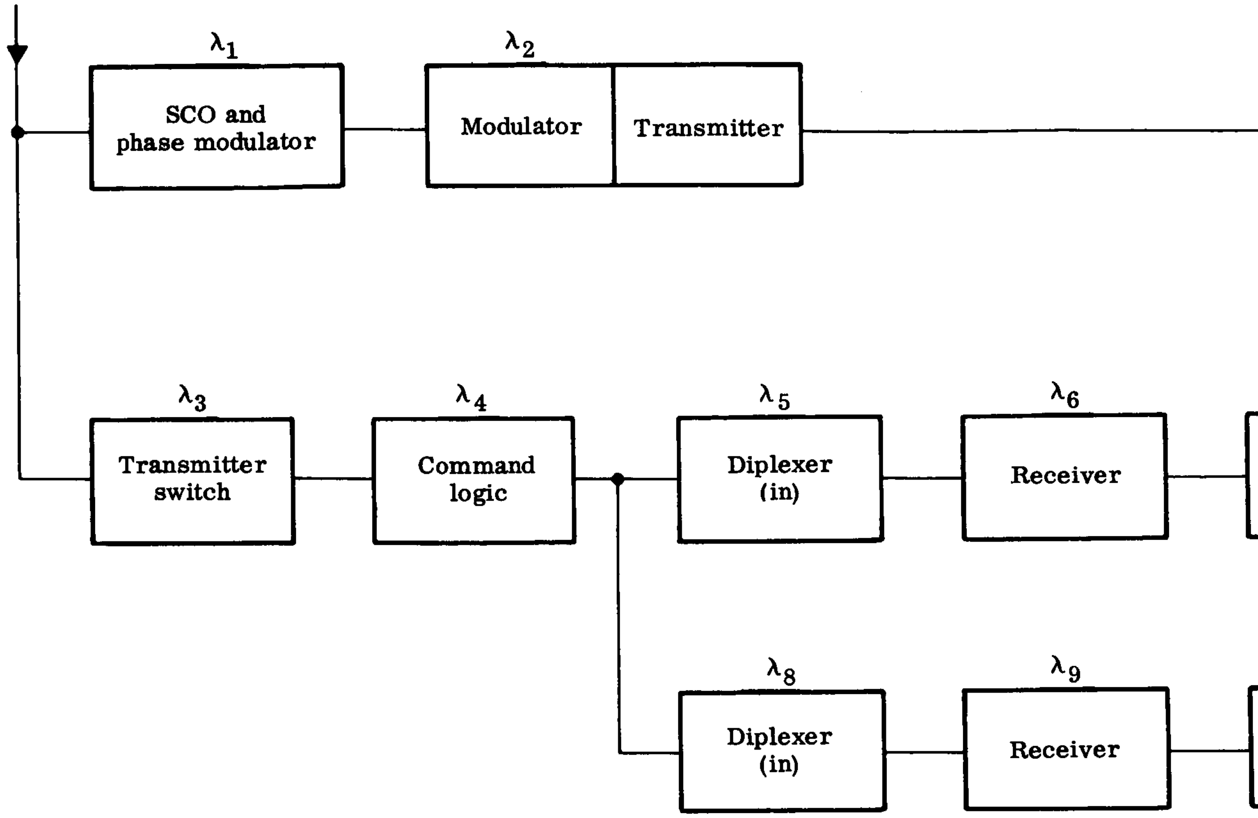
$$\begin{aligned} R_{MM} = {} & R_{71} \times R_{72} \times R_{73} \times R_{74} \times R_{75} \times R_{76} \times R_{77} \times R_{78} \\ & + (1 - R_{71} \times R_{72} \times R_{73} \times R_{74}) (R_{75} \times R_{76} \times R_{77} \times R_{78}) \\ & + (1 - R_{75} \times R_{76} \times R_{77} \times R_{78}) (R_{71} \times R_{72} \times R_{73} \times R_{74}) \end{aligned}$$

Redundant aspect sensor signal conditioning and registors

$$\begin{aligned} R_{PP} = \Big\{ & \big[(R_{84} \times R_{85} \times R_{86})^2 + 2 (1 - R_{84} \times R_{85} \times R_{86}) (R_{84} \times R_{85} \times R_{86})\big] \\ & \times \big[(R_{87} \times R_{88} \times R_{89})^2 + 2 (1 - R_{87} \times R_{88} \times R_{89}) (R_{87} \times R_{88} \times R_{89})\big] \\ & \times \big[(R_{90} \times R_{91} \times R_{92})^2 + 2 (1 - R_{90} \times R_{91} \times R_{92}) (R_{90} \times R_{91} \times R_{92})\big]\Big\} \end{aligned}$$

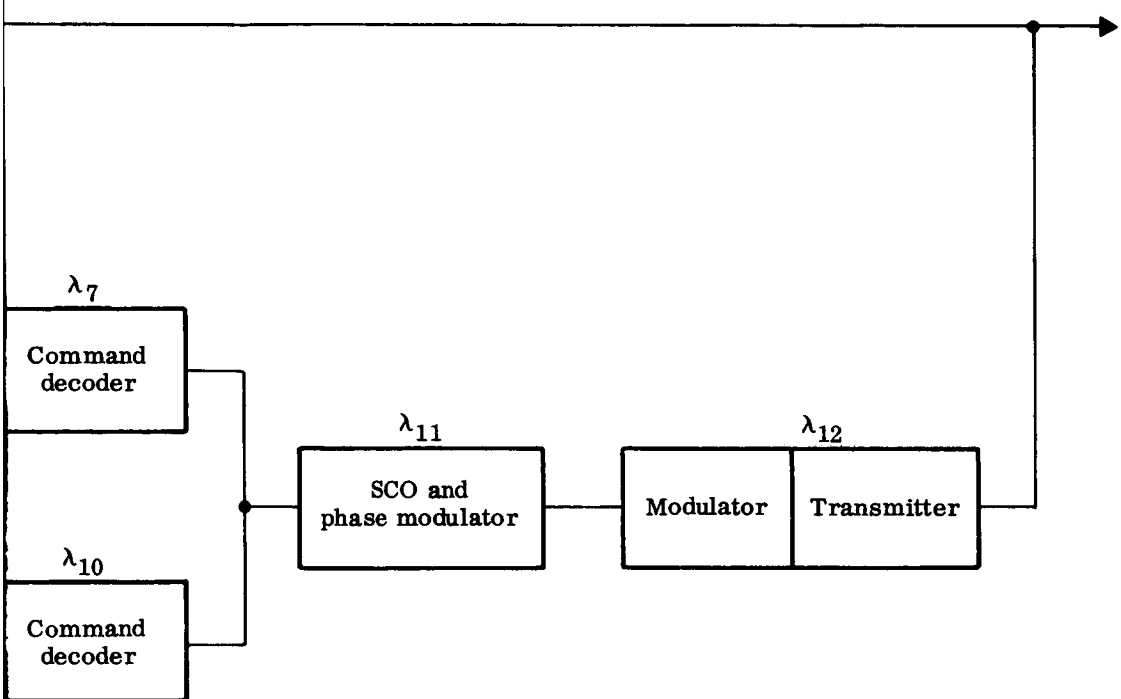
$$\begin{aligned} P_I = R_A/R_B \Big\{ & (R_C \times R_D \times R_E \times R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_{LL} \times R_{MM} \times R_N \times R_O \\ & \times R_{83} \times R_{PP} \times R_{QQ} \times R_{95} \times R_{DD} \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{CC}) \\ & + \big[(1 - R_C \times R_D) (R_E \times R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_{LL} \times R_{MM} \times R_N \times R_O \\ & \times R_{83} \times R_{PP} \times R_{QQ} \times R_{95} \times R_{DD} \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{CC})\big] \\ & + \big[(R_C \times R_D) (1 - R_E) (R_F \times R_G \times R_H \times R_{25} \times R_I \times R_J \times R_K \times R_{60} \times R_{61} \times R_{LL} \times R_M \times R_N \times R_O \\ & \times R_{83} \times R_{PP} \times R_{QQ} \times R_{95} \times R_{DD} \times R_T \times R_U \times R_{100} \times R_{112} \times R_{116} \times R_{CC})\big]\Big\} \end{aligned}$$

2



$$R_F = e^{-(\lambda_1 + \lambda_2)t} + \frac{e^{-(\lambda_3 + \lambda_4)t}\left[e^{-(\lambda_5 + \lambda_6 + \lambda_7)t} \times e^{-(\lambda_8 + \lambda_9 + \lambda_{10})t} + e^{-(\lambda_5 + \lambda_6 + \lambda_7)t} \ldots\right.}{\left[\begin{pmatrix}\lambda_1 + \lambda_2 \\ \text{operating}\end{pmatrix} + \begin{pmatrix}\lambda_{11} \ldots \\ \text{nono}\ldots\end{pmatrix}\right.}$$

$$\frac{}{\left[e^{-\begin{pmatrix}\lambda_{11} + \lambda_{12} \\ \text{operating}\end{pmatrix} t} - e^{-\left[\begin{pmatrix}\lambda_1 + \lambda_2 \\ \text{operating}\end{pmatrix} + \begin{pmatrix}\lambda_{11} + \lambda_{12} \\ \text{nonoperating}\end{pmatrix}\right] t}\right]}$$



$$1 - e^{-(\lambda_8 + \lambda_9 + \lambda_{10})\, t}\Big) + e^{-(\lambda_8 + \lambda_9 + \lambda_{10}) t}\left(1 - e^{-(\lambda_5 + \lambda_6 + \lambda_7)\, t}\right)\Big] \begin{pmatrix} \lambda_1 + \lambda_2 \\ \text{operating} \end{pmatrix} \text{x}$$

$$\begin{pmatrix} \lambda_{12} \\ \text{rating} \end{pmatrix} - \begin{pmatrix} (\lambda_{11} + \lambda_{12}) \\ \text{operating} \end{pmatrix} \Big]$$

Fig. 21. Transmit/Receive (R_F) Reliability Block Diagram

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The design concept which promises to have the highest probability of acquiring the desired micrometeoroid data in cislunar space will have the following salient features.

(1) The telemetry system is divided into two complete and separate transmitting channels (Pri I and Pri II), each having its own power supply. Penetration data from segmented capacitance Panels A and B (0.001-in. and 0.002-in. thickness) are transmitted on both Pri I and Pri II telemetry channels. It will be noted that Pri I continuously transmits Panels A and B penetration data. Pri II, substantially a mirror of Pri I, transmits Panels A and B penetration data continuously except when, on command, secondary data is transmitted. The fail-safe condition of Pri II either maintains the Panels A and B penetration data mode or returns to the penetration data mode from the secondary data mode in the case of command switching failure.

(2) Capacitance panel charge generators are redundant in that power, through suitable means, is supplied to each Panel A and Panel B from both Pri I and Pri II electrical power supplies.

(3) Pri I channel power supply has no storage batteries in the system, power being supplied from solar cell arrays. This results in a loss of power during a small number of short duration dark periods, but overall channel reliability is improved substantially by means of the resultant circuit simplifications and reduction in parts. The Pri II channel power supply has sufficient storage battery capacity in the system to furnish power to the various sensors, Pri I and Pri II penetration counters, and secondary data processing equipment during dark periods. Isolation provisions in case of battery failure result in loss of Pri II power during infrequent dark periods only.

(4) Since penetration data from the same Panels A and B are transmitted on each of two channels (Pri I and Pri II), it is vital to ensure that data sensing elements required for each Pri I and Pri II channel do not mutually interfere, the loss of one automatically causing the loss of one complete panel or a part thereof. Of a number of coupling devices analyzed, a unique Hall effect device appears to be the only device, which regardless of its operating condition, will not cause failure of either a sensing panel or of the data processing capability of either Pri I or Pri II channels. The isolation method is unique and should permit true redundant penetration data acquisition.

(5) All penetration data of Pri I and Pri II is accumulated in counters, not core storages, resulting in a substantial reduction in numbers of parts, in circuit simplification and, consequently, in improved equipment reliability.

(6) Penetration data counters in Pri I and Pri II channels are solid-state flip-flop counters. Nondestructive readout magnetic core counters were considered since their count would be maintained during power interruption. They were rejected because of lower reliability and a simple isolated bus was added to the Pri II power system to maintain Pri I count during dark periods. Loss of the bus results only in a scrambled penetration count after a dark period. With adequate satellite observation periods, this count loss effect on data acquisition capability is negligible.

(7) Continuous transmission of micrometeoroid data on two separate telemetry channels has a slightly higher probability of success than command transmit 4 times per zone. If this transmission is reduced, continuous transmission and command transmit two to three times will be substantially the same; if for observation requirements or because of micrometeoroid satellite data transmission interference with other programs, command transmission can be used with no substantial degradation in mission success probability.

(8) Capacitance panels should be segmented; the number of segments depending upon the shorting probability of sensors/couplings and reliability optimization.

(9) Based on accepted statistical sampling requirements, the "Z" configuration appears to be the best practical compromise of sensor configuration at this time.

(10) Atlas-Agena should be used as a launch vehicle in preference to Atlas-X-259 or Saturn S1B.

(11) A tumbling or a spinning vehicle can be used. Thermal control for the spinning vehicle is slightly more reliable than for the tumbling vehicle. However, thermal analyses have shown that passive techniques can adequately provide thermal control for the tumbling vehicle.

(12) Integrated circuitry and redundancy of substantially all sensor data processing electronics are necessary to achieve the desired level of mission success probability.

(13) A micrometeoroid satellite incorporating the aforementioned features can meet the minimum 90% telemetry reliability requirement specified.

B. RECOMMENDATIONS

To achieve the highest probability of mission success for the micrometeoroid deep space satellite at the earliest date, the following recommendations are made.

(1) Analysis and test of capacitance sensor coupling devices and charging devices should be started at the earliest possible date.

(2) Optimum panel segmentation, based upon further tradeoff between panel shorting potential and charging/sensor coupling reliability need be conducted.

(3) Mockup and test of capacitance panel percent area sensors developed by the Martin Company should be performed.

(4) A study and development of a more reliable means of long-term vehicle attitude sensing should be conducted if complete definition of micrometeoroid characteristics are to be made at an early date.

(5) Studies aimed at simplification of diagnostic sensing and data processing systems should be performed.

(6) Studies of possible "Z" configuration modifications to provide a substantially constant sampling area for any orientation should be performed.

(7) Addition of the capability for measuring percentage operating area to the Pri I and Pri II primary data loops; their capability is now present in the secondary loop.

VII. ILLUSTRATIONS AND TABLES

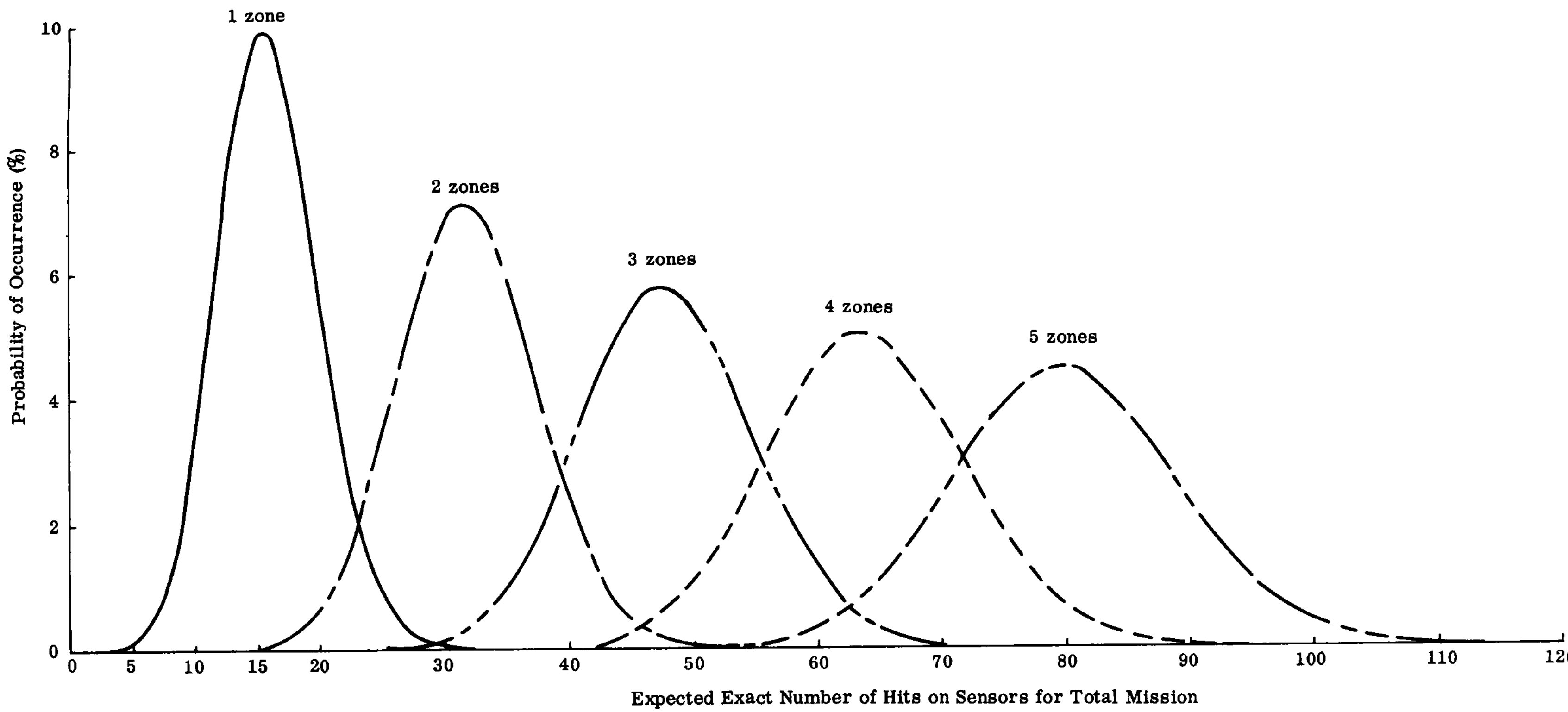


Fig. 6. Expected Penetrations in Sensor Panels Versus Altitude Zone

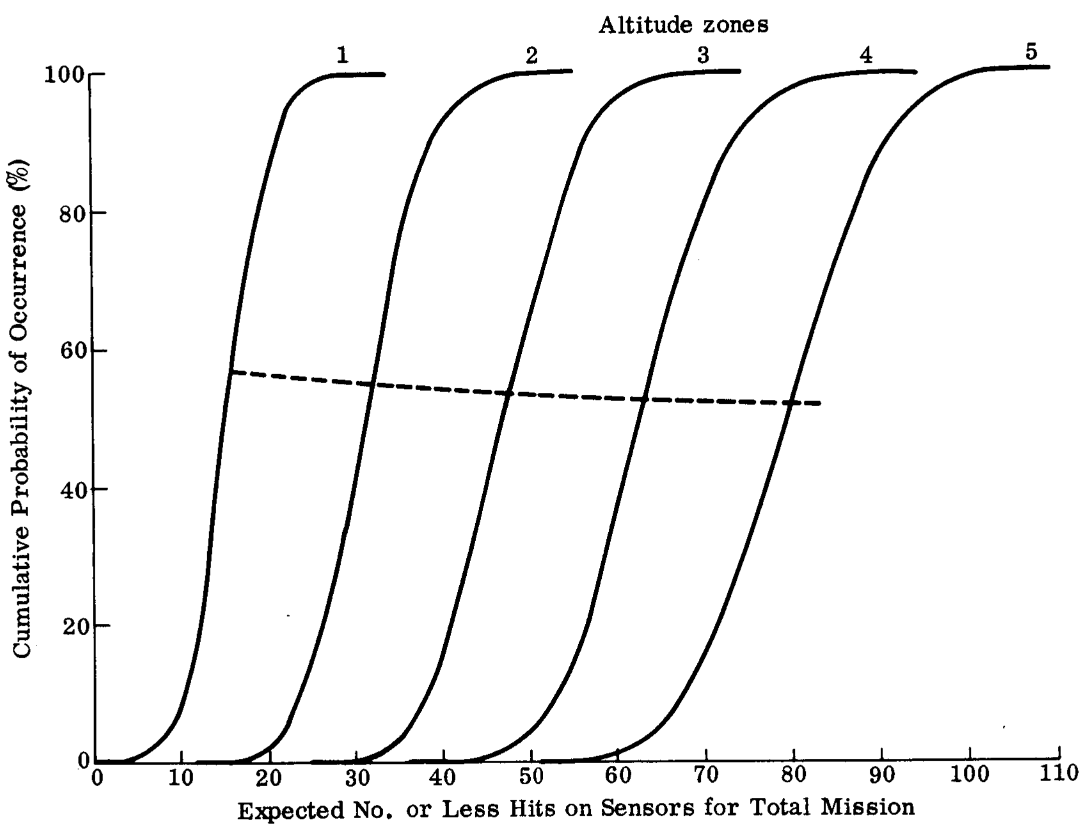


Fig. 7. Distribution of Expected Penetrations on Sensor Area

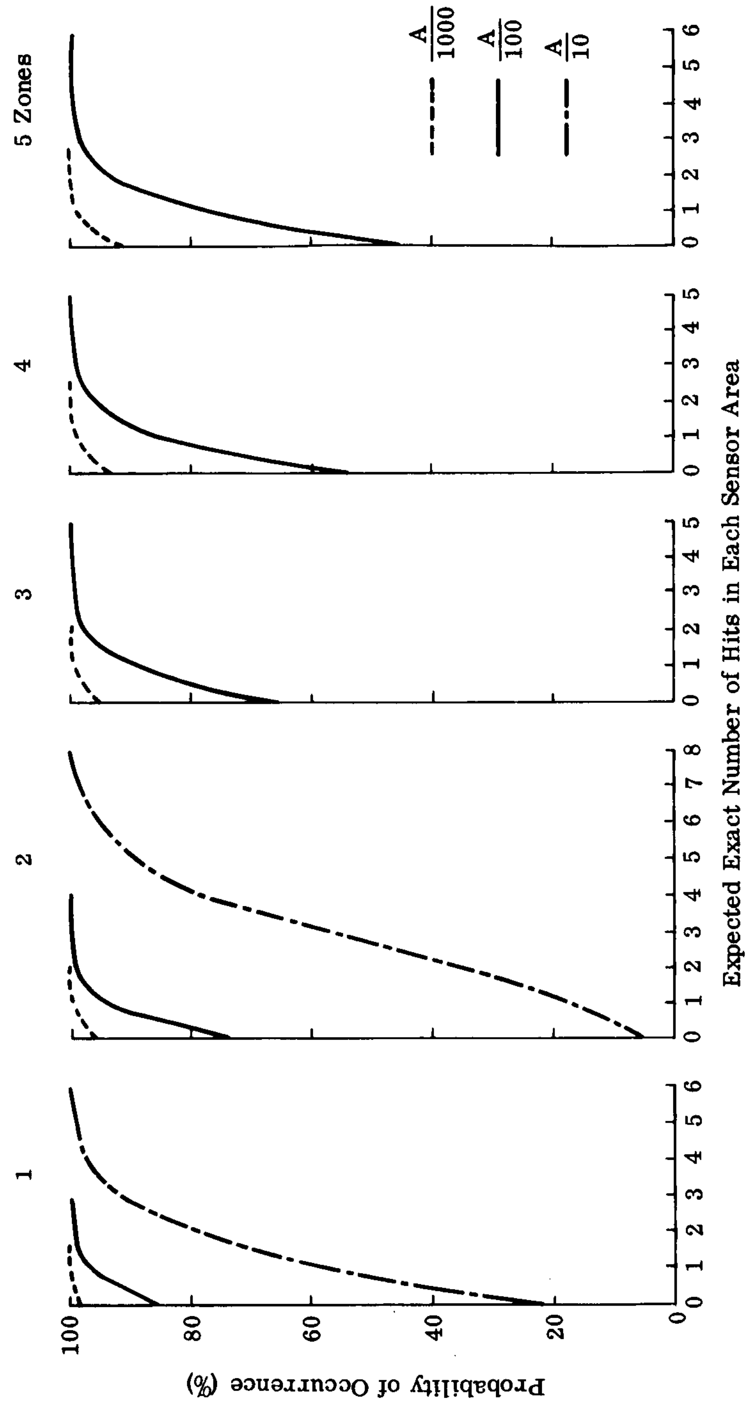
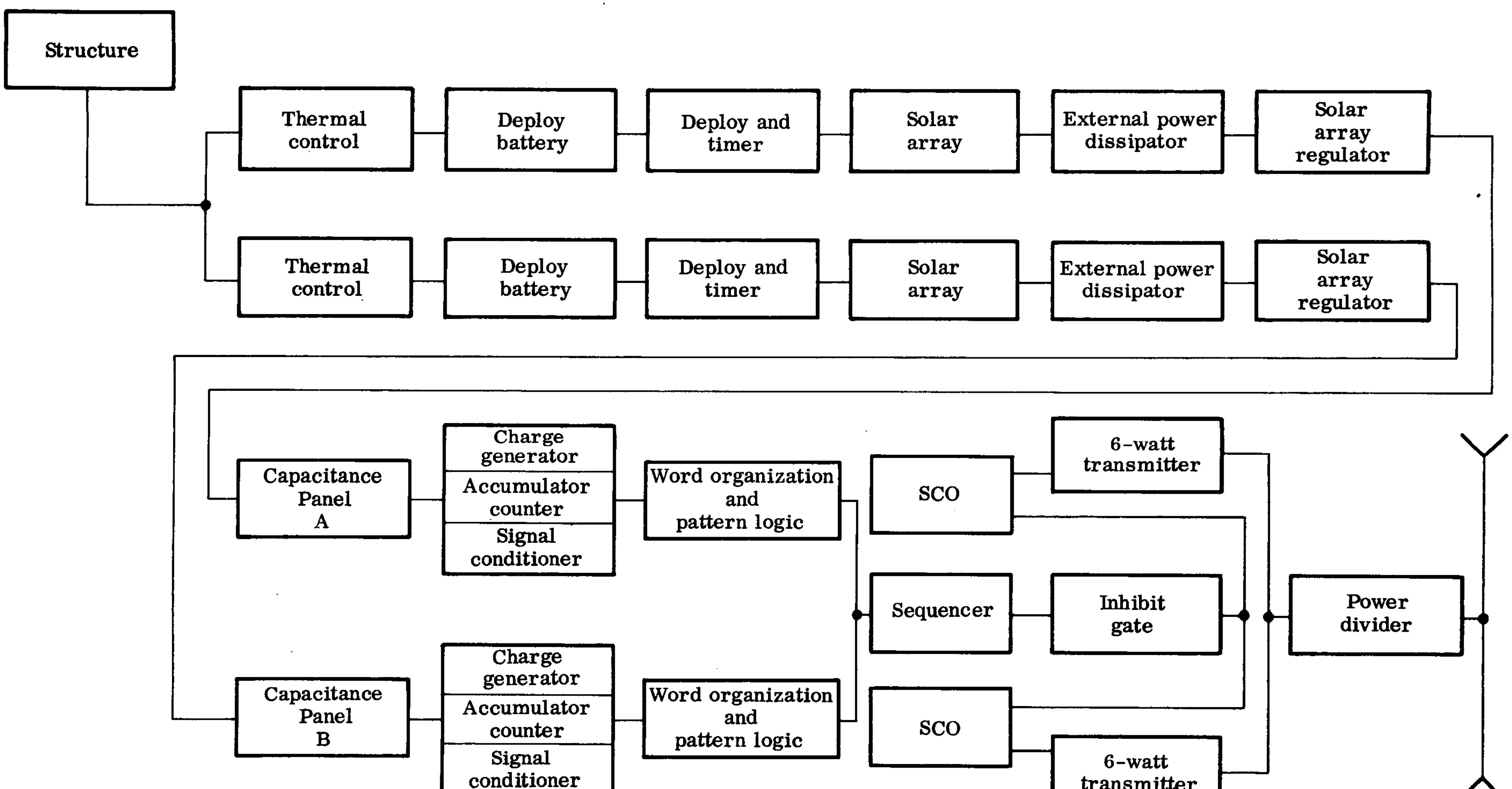


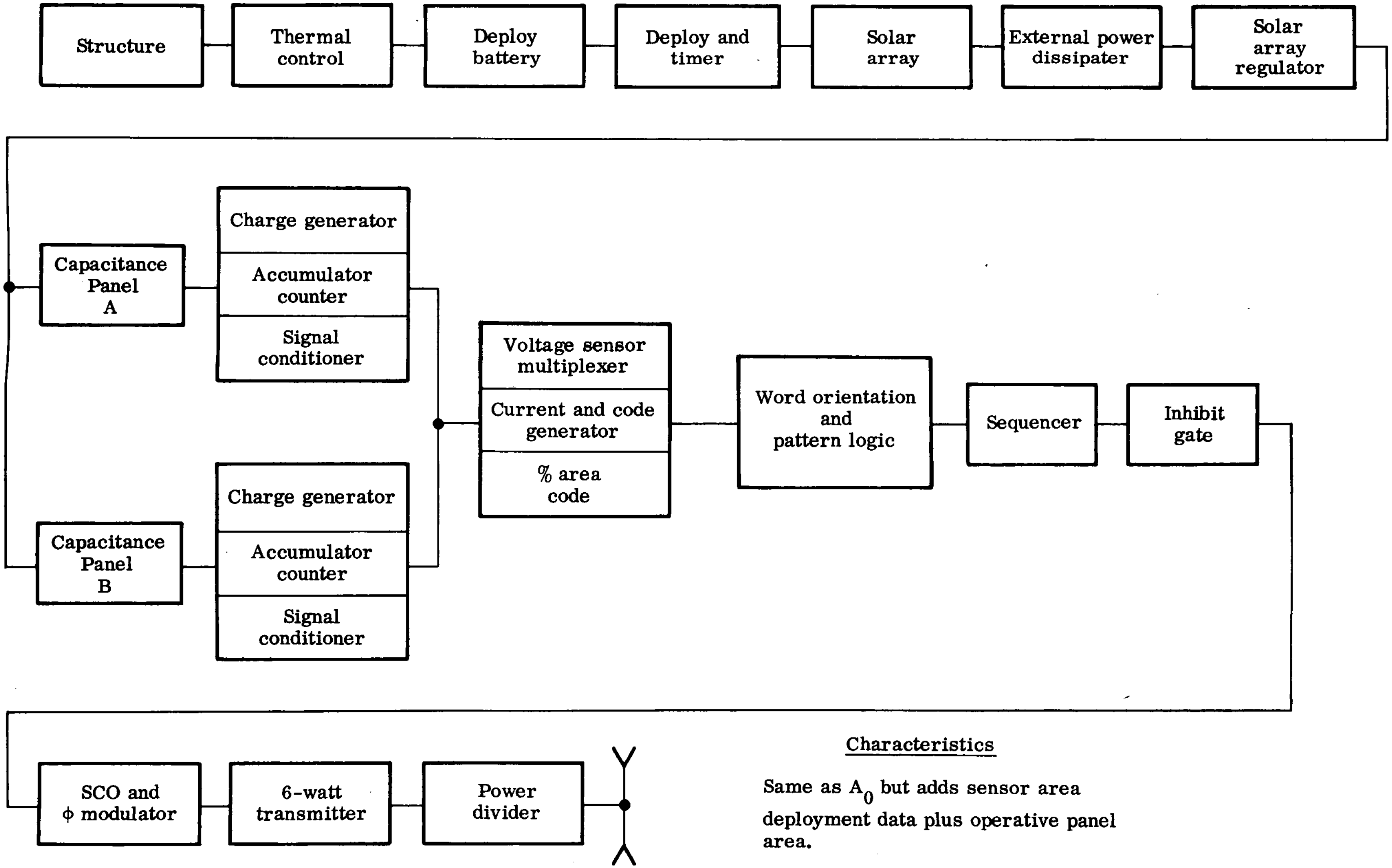
Fig. 8. Expected Penetrations in Individual Cell Divisions



<u>Characteristics</u>

Same as A_0 except each of two capacitance panels has own power, logic, counters, and transmitters.

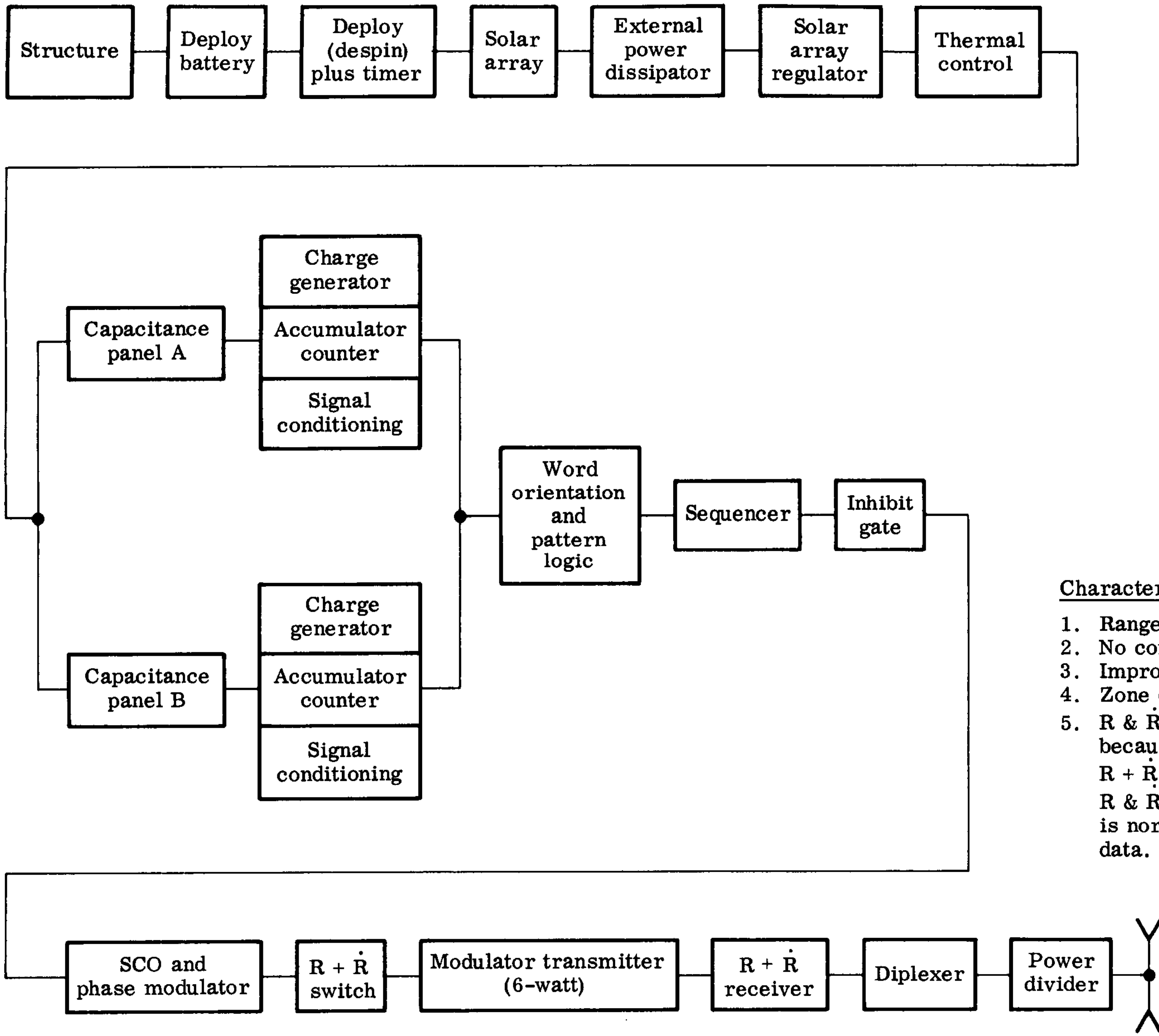
Fig. 12. System A_1



Characteristics

Same as A_0 but adds sensor area deployment data plus operative panel area.

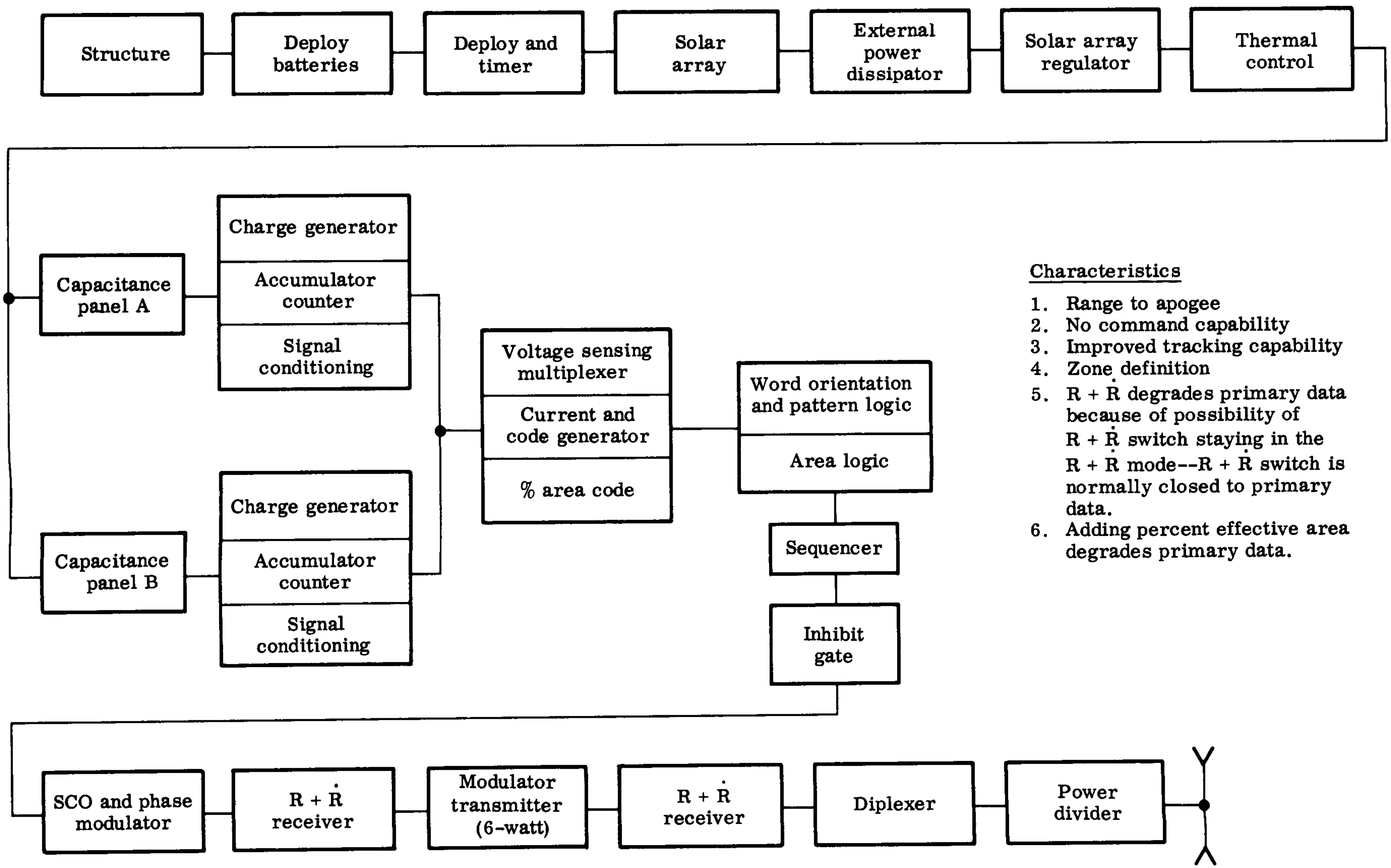
Fig. 13. System A_2



Characteristics

1. Range to apogee
2. No command capability
3. Improved tracking capability
4. Zone definition
5. R & Ṙ degrades primary data because of possibility of R + Ṙ switch staying in the R & Ṙ mode--R + Ṙ switch is normally closed to primary data.

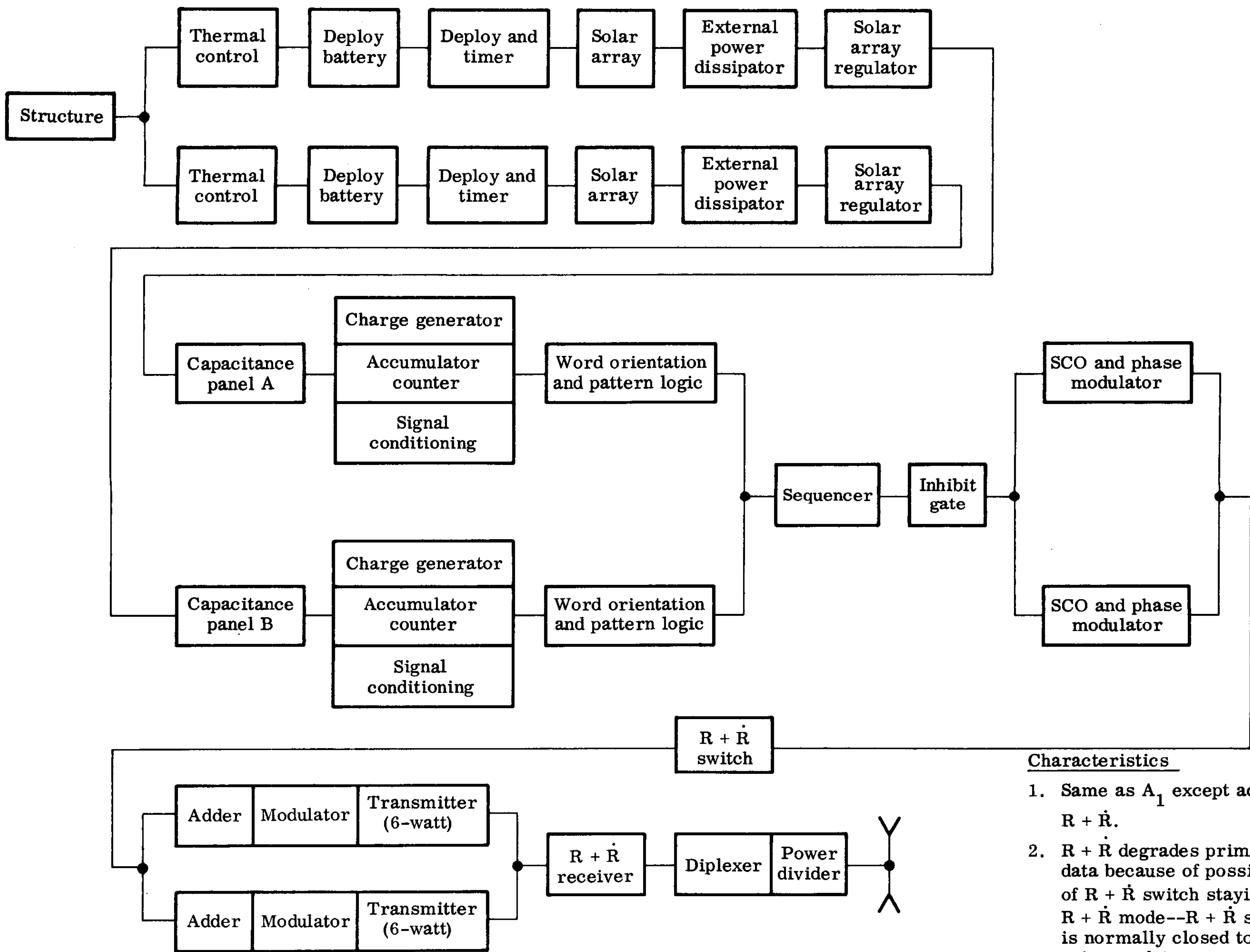
Fig. 14. System B_O: Add R and $\dot{R}$ to A_O



Characteristics

1. Range to apogee
2. No command capability
3. Improved tracking capability
4. Zone definition
5. R + Ṙ degrades primary data because of possibility of R + Ṙ switch staying in the R + Ṙ mode--R + Ṙ switch is normally closed to primary data.
6. Adding percent effective area degrades primary data.

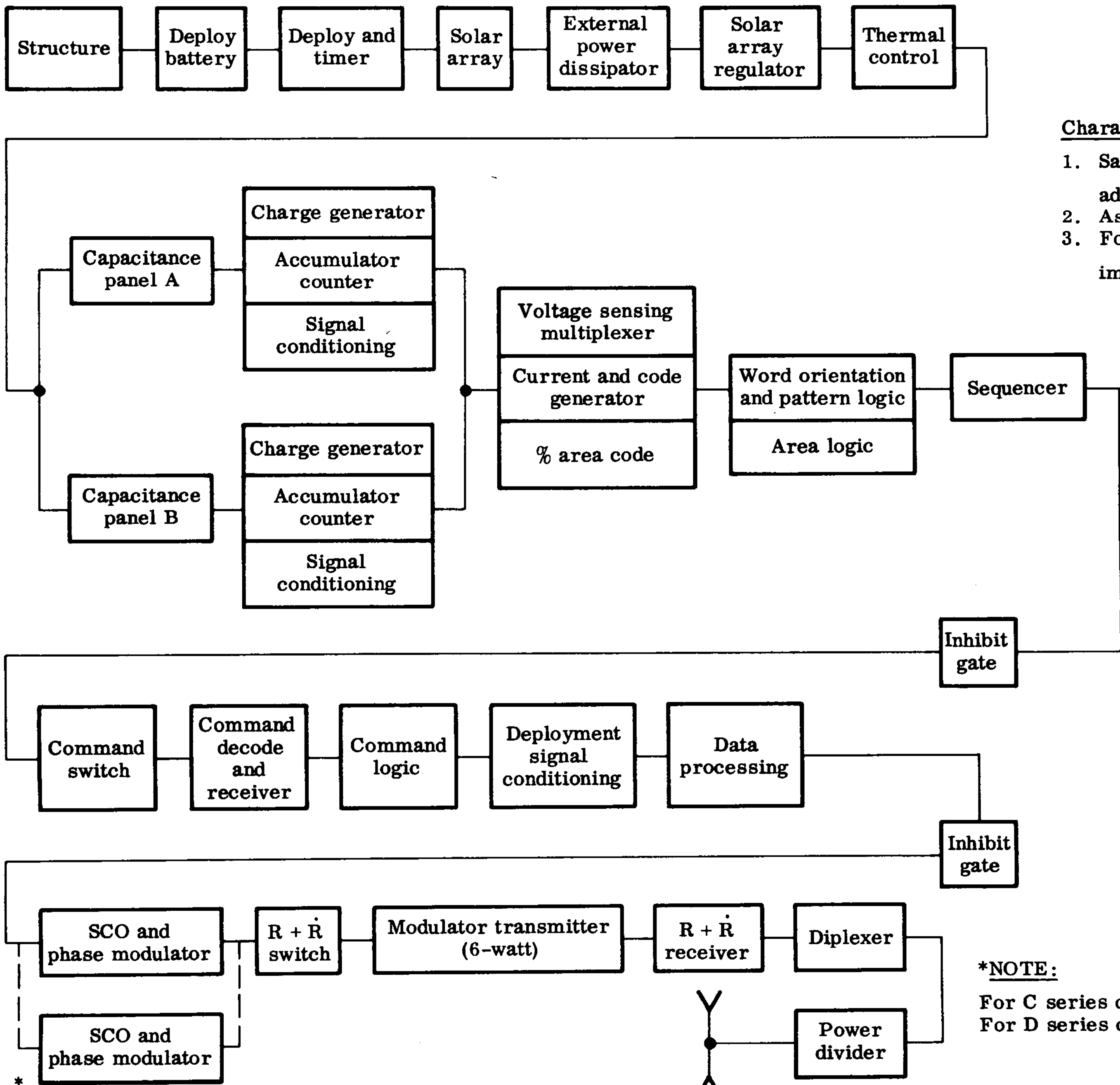
Fig. 15. System B_1: Add Sensor Area Data to B_0



<u>Characteristics</u>

1. Same as A_1 except added R + Ṙ.
2. R + Ṙ degrades primary data because of possibility of R + Ṙ switch staying in R + Ṙ mode--R + Ṙ switch is normally closed to primary data.

Fig. 16. System B_2: Add R and Ṙ to A_1



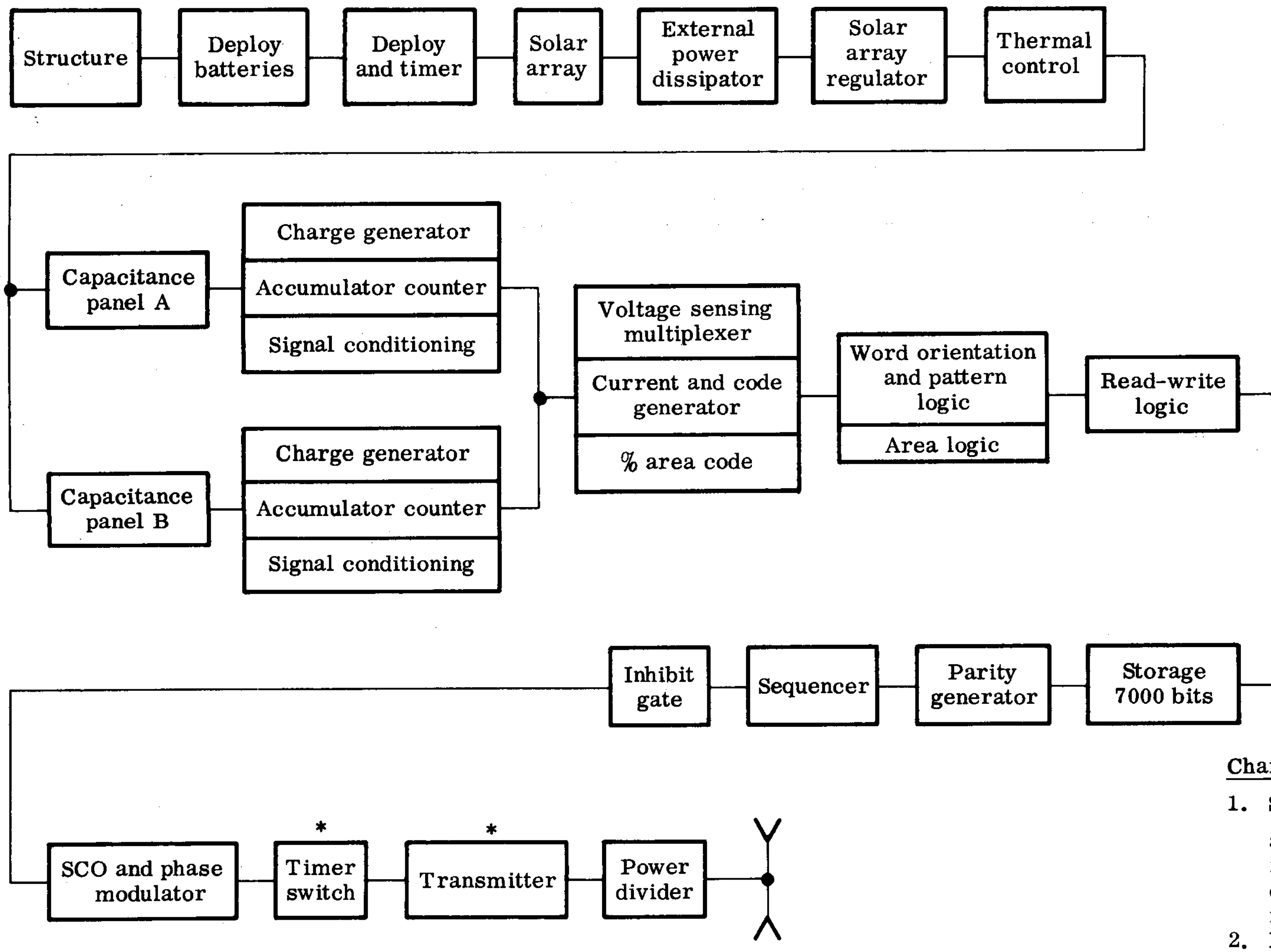
Characteristics

1. Same as B_1, except added command backup.
2. Assures deployment mode.
3. For D_0 configuration, improves reliability.

*NOTE:

For C series configuration, use 1 SCO.
For D series configuration, use 2 SCO's.

Fig. 17. C_0 and D_0: Add to B_1 Command Backup Deployment Channel



*NOTE:

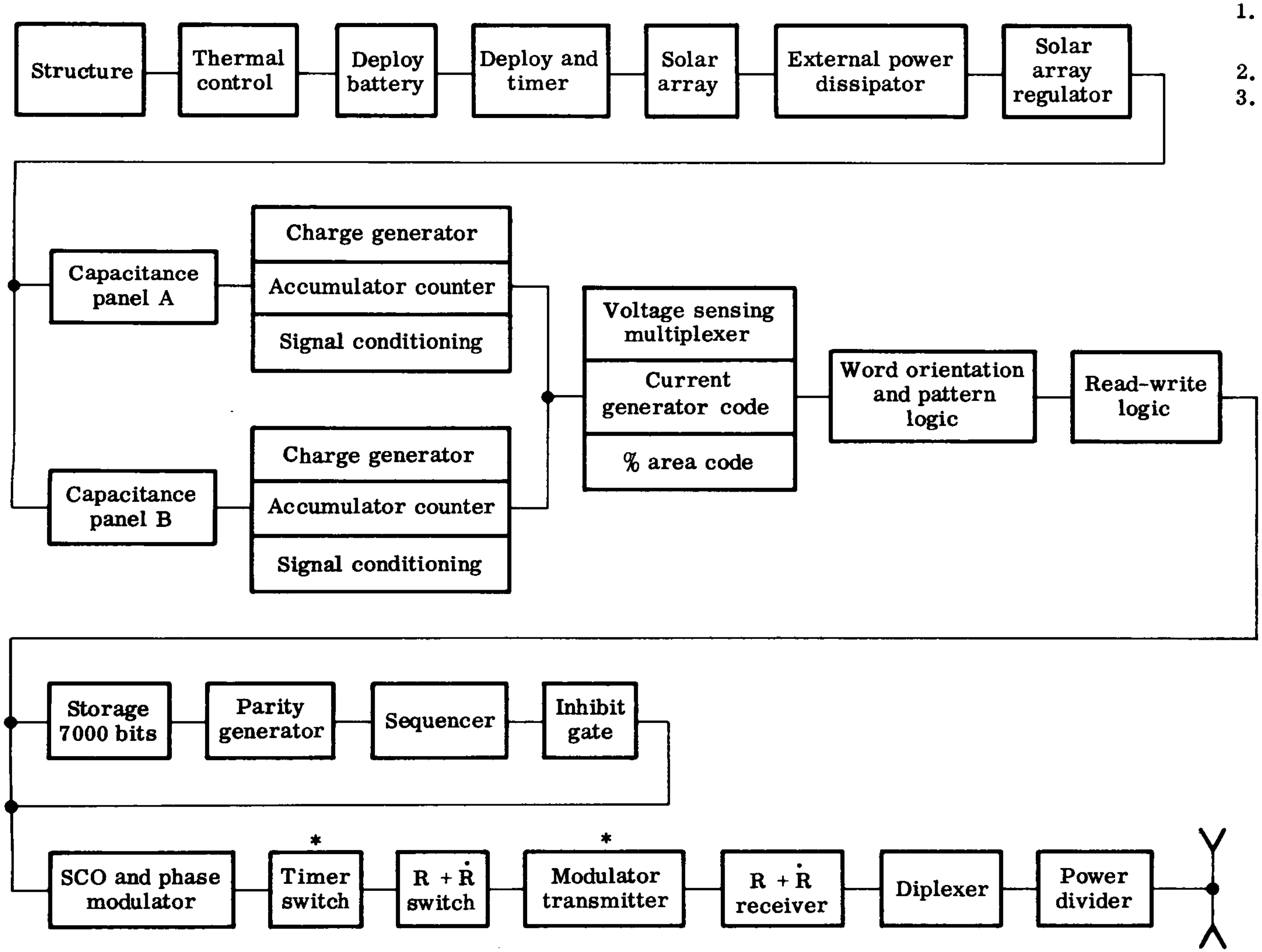
E_0 (3 watts)--transmit three times per orbit.

E_1 (6 watts)--transmit once per orbit.

Characteristics

1. Same as A_2, except added storage channel results in less power dissipated in transmitter channel.
2. No longer continuous transmission but at definite times (see Note).
3. Timer switch degrades primary data.

Fig. 18. E_0 and E_1: Add Storage Channel to A_2



*NOTE:

E_2 (3 watts)--transmit three times per orbit.

E_3 (6 watts)--transmit once per orbit.

Characteristics

1. Same as E_0 and E_1, except following:
2. Improved tracking.
3. R + Ṙ degrades primary data because of possibility of R + Ṙ switch staying in the R + Ṙ mode--R + Ṙ switch normally closed to primary data at definite times.

Fig. 19. E_2 and E_3: Add R + Ṙ to E_0 and E_1

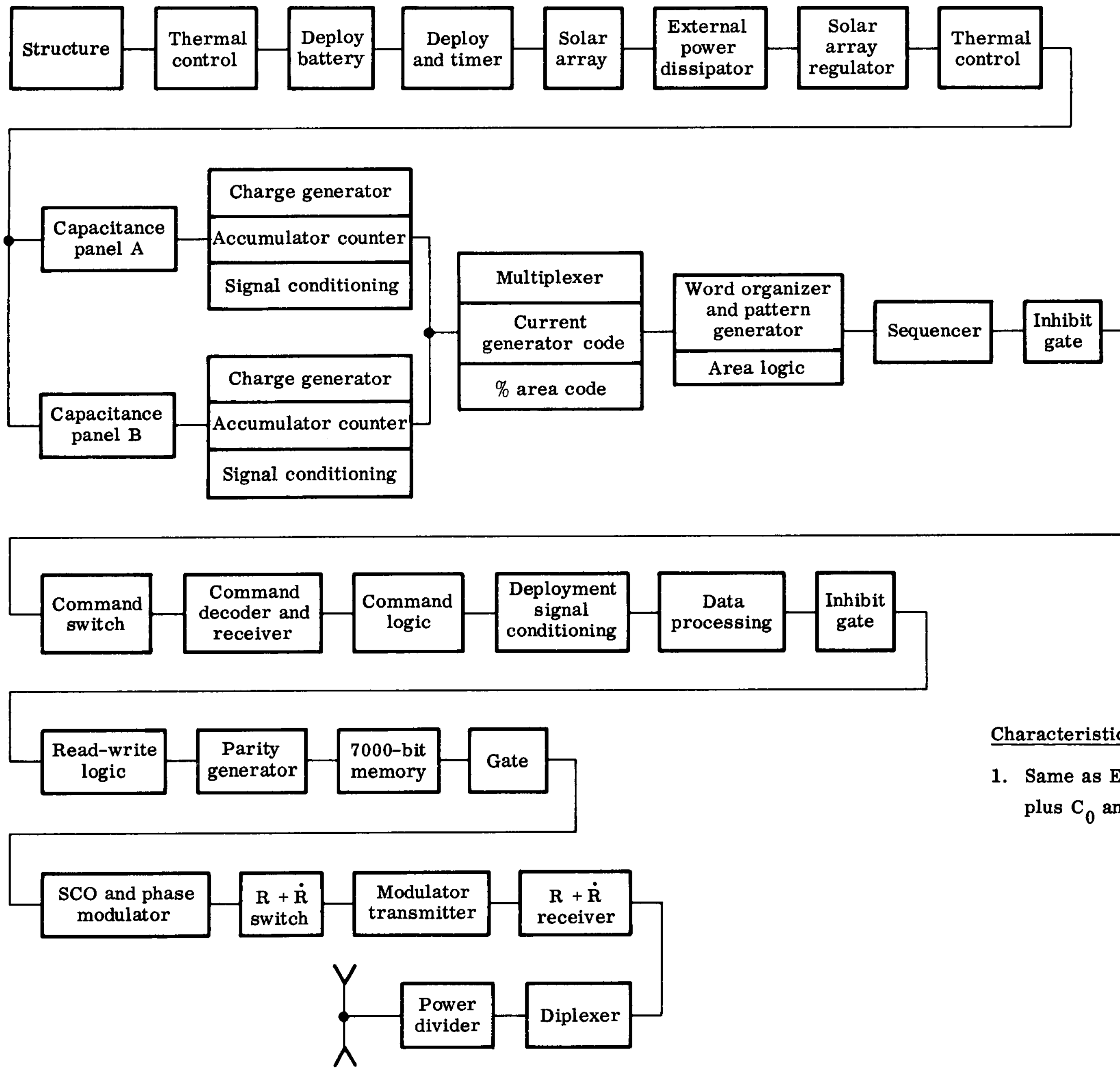
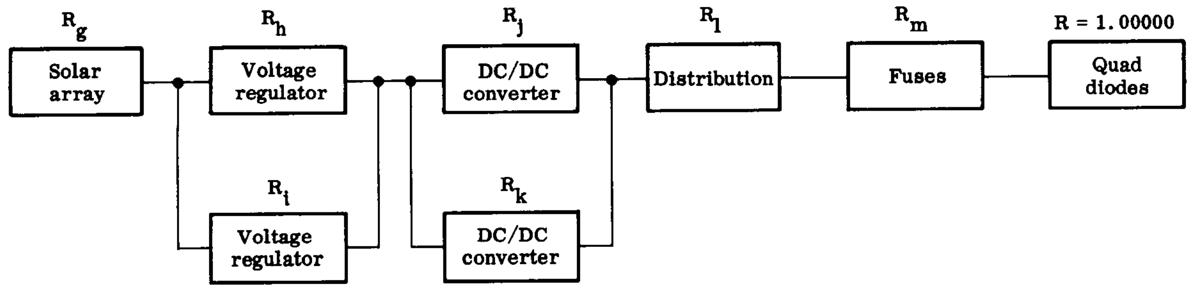


Fig. 20. E_4 and E_5

Characteristics

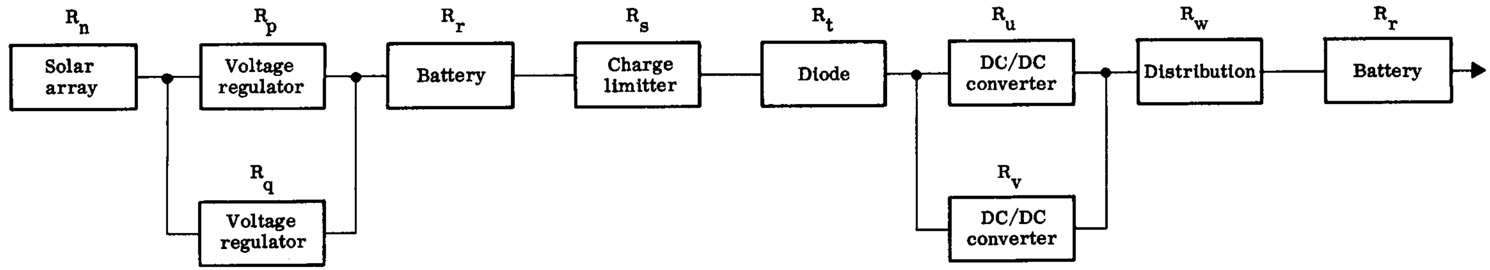
1. Same as E_2 and E_3 plus C_0 and D_0.



$$\text{Primary I}_{\text{electrical}} = R_{10} = R_g \left[R_h R_i + R_h Q_i + R_i Q_h\right] \left[R_j R_k + R_j Q_h + R_k Q_j\right] R_l R_m$$

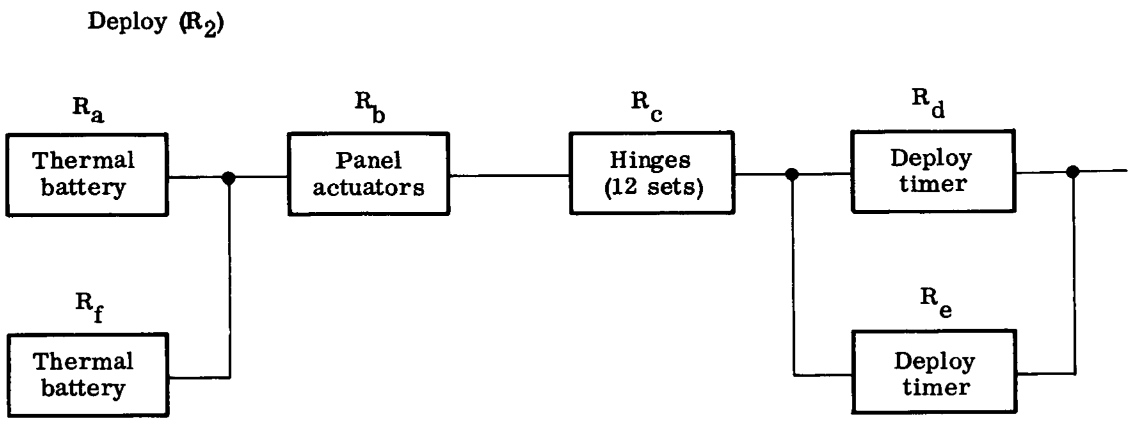
	Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
	6 Months	12 Months	6 Months	12 Months	6 Months	12 Months	6 Months	12 Months	6 Months	12 Months
R_g	0.999562	0.999124	0.999562	0.999124	0.999562	0.999124	0.999562	0.999124	0.999562	0.999124
R_h	(0.997335	(0.994677	(0.997160	(0.994320	(0.997178	(0.994355	(0.997154	(0.994309	(0.997149	(0.994299
R_i	0.997335)	0.994677)	0.997160)	0.994320)	0.997178)	0.994355)	0.997154)	0.994309)	0.997149)	0.994299)
R_j	(0.998774	(0.997547	(0.998774	(0.997547	(0.998774	(0.997547	(0.998774	(0.997547	(0.998774	(0.997547
R_k	0.998774)	0.997547)	0.998774)	0.997547)	0.998774)	0.997547)	0.998774)	0.997547)	0.998774)	0.997547)
R_l	0.999568	0.999136	0.999568	0.999136	0.999568	0.999136	0.999568	0.999136	0.999568	0.999136
R_m	0.999725	0.999449	0.999266	0.998531	0.999266	0.998531	0.999266	0.998531	0.999266	0.998531
R_{10}	0.998847	0.997676	0.998388	0.996755	0.998388	0.996756	0.998388	0.996755	0.998388	0.996755

Fig. 22. Primary I Electrical Power--R_{10}



R Designation	Component/ Equipment	Continuous Transmission		Command On/Off Transmission (4/zone) 300 hr	600 hr	Automatic On/Off Transmission 10 min/hr 720 hr	1440 hr	Transmit Once/Day (storage required)		Transmit Once/Orbit (storage required)	
		6 Months	12 Months	6 Months	12 Months	6 Months	12 Months	6 Months	12 Months	6 Months	12 Months
R_n	Solar array	0.999562	0.999124	0.999562	0.999124	0.999562	0.999124	0.999562	0.999124	0.999562	0.999124
R_p	Voltage regulator	(0.997317	(0.994640	(0.997160	(0.994320	(0.997178	(0.994355	(0.997154	(0.994309	(0.997149	(0.994299
R_q	Voltage regulator	0.997317)	0.994640)	0.997160)	0.994320)	0.997178)	0.994355)	0.997154)	0.994309)	0.997149)	0.994299)
R_r	Battery W/heater	0.993754	0.987547	0.989471	0.979053	0.989471	0.979053	0.989471	0.979053	0.989471	0.979053
R_s	Charge limiter	0.999646	0.999292	0.999646	0.999292	0.999646	0.999292	0.999646	0.999292	0.999646	0.999292
R_t	Diode	0.999913	0.999827	0.999913	0.999827	0.999913	0.999827	0.999913	0.999827	0.999913	0.999827
R_u	DC/DC converter	(0.998774	(0.997547	(0.998774	(0.997547	(0.998774	(0.997547	(0.998774	(0.997547	(0.998774	(0.997547
R_v	DC/DC converter	0.998774)	0.997547)	0.998774)	0.997547)	0.998774)	0.997547)	0.998774)	0.997547)	0.998774)	0.997547)
R_w	Distribution	0.997847	0.995695	0.997847	0.995695	0.997847	0.995695	0.997847	0.995695	0.997847	0.995695
	R_{25}	0.990735	0.981534	0.986464	0.973089	0.986464	0.973090	0.986464	0.973089	0.986464	0.973089

Fig. 23. Primary II Electrical Power--R_{25}



$$R_{deploy} = R_2 = \left[R_a \times R_f + R_a Q_f + R_f Q_a\right] R_b \times R_c \left[R_d \times R_e + R_d Q_e + R_e Q_d\right]$$

R_a, R_f = 0.980200

$R_a R_f + R_a Q_f + R_f Q_a$ = 0.999608

R_a = 0.999608

R_b = 0.999760

R_c = 0.999940

R_d, R_e = 0.998000

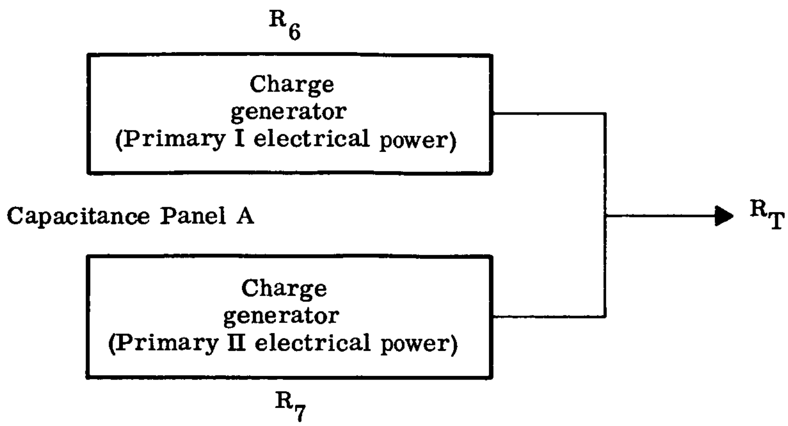
$R_d \times R_e + R_d Q_e + R_e Q_d$ = 0.999996

$R_{deploy} = R_2$ = 0.999608 x 0.999760 x 0.999940 x 0.999996 = 0.999304

Fig. 24. Deployment System--R_2

Capacitance Panel A = R_T

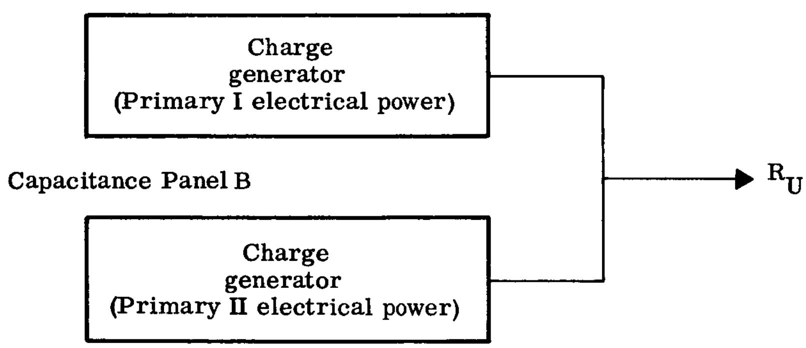
Capacitance Panel B = R_U



$$R_T = R_6 \times R_7 + R_6\, Q_7 + R_7\, Q_6$$

$$\text{6 months} \left\{ \begin{array}{ll} R_6 = 0.996114 & Q_6 = 0.003886 \\ R_7 = 0.996114 & Q_7 = 0.003886 \end{array} \right\} R_T = 0.999985 \text{ (6 months)}$$

$$\text{12 months} \left\{ \begin{array}{ll} R_6 = 0.992243 & Q_6 = 0.007757 \\ R_7 = 0.992243 & Q_7 = 0.007757 \end{array} \right\} R_T = 0.999940 \text{ (12 months)}$$

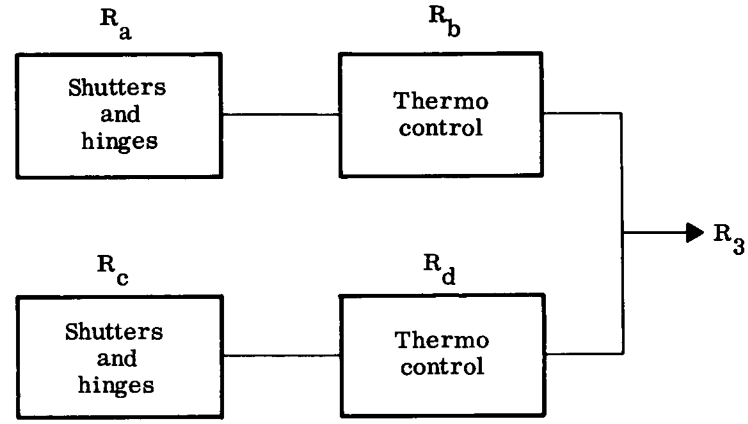


$$R_U = R_8 \times R_9 + R_8\, Q_9 + R_9\, Q_8$$

$$\text{6 months} \left\{ \begin{array}{ll} R_8 = 0.996114 & Q_8 = 0.003886 \\ R_9 = 0.996114 & Q_9 = 0.003886 \end{array} \right\} R_U = 0.999985 \text{ (6 months)}$$

$$\text{12 months} \left\{ \begin{array}{ll} R_8 = 0.992243 & Q_8 = 0.007757 \\ R_9 = 0.992243 & Q_9 = 0.007757 \end{array} \right\} R_U = 0.999940 \text{ (12 months)}$$

Fig. 25. Charge Generator (R_T - R_U)



$$R_a R_b R_c R_d + R_a R_b R_c Q_d + R_a R_b R_d Q_c + R_a R_b Q_c Q_d + R_a R_c R_d Q_b$$
$$+ R_b R_c R_d Q_a + R_c R_d Q_a Q_b$$

$$\text{6 months} \left\{ \begin{array}{ll} R_a = R_c = 0.995665 & Q_a = Q_c = 0.004335 \\ R_b = R_d = 0.995665 & Q_b = Q_d = 0.004335 \end{array} \right\} R_3 = 0.999906 \quad \text{(6 months)}$$

$$\text{12 months} \left\{ \begin{array}{ll} R_a = R_c = 0.991349 & Q_a = Q_c = 0.008651 \\ R_b = R_d = 0.991349 & Q_b = Q_d = 0.008651 \end{array} \right\} R_3 = 0.999630 \quad \text{(12 months)}$$

Fig. 26. Thermal Control (active)--R_3

TABLE 5

One Altitude Zone Meteoroid Hit Probability $p\,(K;\,\lambda t) = e^{-\lambda t}\,\frac{(\lambda t)^K}{K!}$ --λt = 16 Hits x No. Zones = 16

K	Unit Area $\frac{\lambda t}{1} = 16$		10 Panel Segments $\frac{\lambda t}{10} = 1.6$		100 Panel Segments $\frac{\lambda t}{100} = 0.16$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.016$	
	One	$\sum_0^K p\,(K;\,\lambda t)$	$p\,(K;\,\lambda t)$	$\sum_0^K p\,(K;\,\lambda t)$	$p\,(K;\,\lambda t)$	$\sum_0^K p\,(K;\,\lambda t)$	$p\,(K;\,\lambda t)$	$\sum_0^K p\,(K;\,\lambda t)$
0	0.00000011	0.00000011	0.20189652	0.20189652	0.85214379	0.85214379	0.98412732	0.98412732
1	0.00000180	0.00000191	0.32303443	0.52493095	0.13634301	0.98848680	0.01574604	0.99987336
2	0.00001440	0.00001632	0.25842754	0.78335849	0.01090744	0.99939423	0.00012597	0.99999932
3	0.00007682	0.00009314	0.13782802	0.92118651	0.00058173	0.99997596	0.00000067	0.99999999
4	0.00030730	0.00040044	0.05513121	0.97631773	0.00002327	0.99999923		
5	0.00098335	0.00138379	0.01764199	0.99395971	0.00000074	0.99999998		
6	0.00262226	0.00400604	0.00470453	0.99866424	0.00000002	0.99999999		
7	0.00599374	0.00999978	0.00107532	0.99973956				
8	0.01198747	0.02198725	0.00021506	0.99995463				
9	0.02131106	0.04329832	0.00003823	0.99999286				
10	0.03409770	0.07739602	0.00000612	0.99999898				
11	0.04959665	0.12699267	0.00000089	0.99999987				
12	0.06612887	0.19312154	0.00000012	0.99999999				
13	0.08138938	0.27451092						
14	0.09301644	0.36752736						
15	0.09921753	0.46674489						
16	0.09921753	0.56596242						
17	0.09338121	0.65934362						
18	0.08300552	0.74234914						
19	0.06989938	0.81224853						
20	0.05591951	0.86816803						
21	0.04260534	0.91077337						
22	0.03098570	0.94175907						
23	0.02155527	0.96331434						
24	0.01437018	0.97768452						
25	0.00919692	0.98688143						

TABLE 5 (continued)

K	Unit Area $\frac{\lambda t}{1} = 16$		10 Panel Segments $\frac{\lambda t}{10} = 1.6$		100 Panel Segments $\frac{\lambda t}{100} = 0.16$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.016$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
26	0.00565964	0.99254107						
27	0.00335386	0.99589493						
28	0.00191644	0.99781143						
29	0.00105737	0.99886880						
30	0.00056393	0.99943274						
31	0.00029106	0.99972380						
32	0.00014553	0.99986932						
33	0.00007056	0.99993989						
34	0.00003320	0.99997310						
35	0.00001518	0.99998827						
36	0.00000675	0.99999502						
37	0.00000292	0.99999744						
38	0.00000123	0.99999917						
39	0.00000050	0.99999967						
40	0.00000020	0.99999987						
41	0.00000008	0.99999995						
42	0.00000003	0.99999998						
43	0.00000001	0.99999999						

TABLE 6

Two Altitude Zone Meteoroid Hit Probability $p(K; \lambda t) = e^{-\lambda t} \frac{(\lambda t)^K}{K!}$ --λt = 16 Hits x No. Zones = 32

K	Unit Area $\frac{\lambda t}{1} = 32$		10 Panel Segments $\frac{\lambda t}{10} = 3.2$		100 Panel Segments $\frac{\lambda t}{100} = 0.32$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.032$	
	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$
0	0.00000000	0.00000000	0.04076220	0.04076220	0.72614904	0.72614904	0.96850658	0.96850658
1	0.00000000	0.00000000	0.13043905	0.17120126	0.23236769	0.95851673	0.03099221	0.99949879
2	0.00000000	0.00000000	0.20870249	0.37990374	0.03717883	0.99569556	0.00049588	0.99999467
3	0.00000000	0.00000000	0.22261599	0.60251973	0.00396574	0.99966130	0.00000529	0.99999996
4	0.00000000	0.00000000	0.17809279	0.78061251	0.00031726	0.99997856	0.00000004	0.99999999
5	0.00000000	0.00000000	0.11397938	0.89459191	0.00002030	0.99999887		
6	0.00000002	0.00000002	0.06078900	0.95538091	0.00000108	0.99999995		
7	0.00000009	0.00000011	0.02778926	0.98317017	0.00000005	0.99999999		
8	0.00000035	0.00000045	0.01111570	0.99428587				
9	0.00000123	0.00000168	0.00395225	0.99823812				
10	0.00000393	0.00000561	0.00126472	0.99950284				
11	0.00001143	0.00001704	0.00036792	0.99987076				
12	0.00003048	0.00004752	0.00009811	0.99996887				
13	0.00007503	0.00012256	0.00002415	0.99999302				
14	0.00017150	0.00029406	0.00000552	0.99999854				
15	0.00036587	0.00065993	0.00000118	0.99999972				
16	0.00073174	0.00139167	0.00000024	0.99999996				
17	0.00137739	0.00276906	0.00000004	0.99999999				
18	0.00244870	0.00521776						
19	0.00412412	0.00934188						
20	0.00659860	0.01594047						
21	0.01005500	0.02599548						
22	0.01462546	0.04062094						
23	0.02034846	0.06096940						
24	0.02713129	0.08810069						
25	0.03472805	0.12282874						

TABLE 6 (continued)

K	Unit Area $\frac{\lambda t}{1} = 32$		10 Panel Segments $\frac{\lambda t}{10} = 3.2$		100 Panel Segments $\frac{\lambda t}{100} = 0.32$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.032$	
	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)
26	0.04274221	0.16557095						
27	0.05065744	0.21622838						
28	0.05789421	0.27412259						
29	0.06388327	0.33800586						
30	0.06814215	0.40614802						
31	0.07034029	0.47648830						
32	0.07034029	0.54682859						
33	0.06820876	0.61503735						
34	0.06419648	0.67923383						
35	0.05869393	0.73792776						
36	0.05217238	0.79010014						
37	0.04512206	0.83522220						
38	0.03799752	0.87321972						
39	0.03117745	0.92933914						
40	0.02494196	0.92933914						
41	0.01946690	0.94880604						
42	0.01483192	0.96363796						
43	0.01103771	0.97467567						
44	0.00902743	0.98270310						
45	0.00570839	0.98841149						
46	0.00397105	0.99238255						
47	0.00270370	0.99508625						
48	0.00180246	0.99688870						
49	0.00117712	0.99806583						
50	0.00075336	0.99881918						
51	0.00047269	0.99929187						

TABLE 6 (continued)

K	Unit Area $\frac{\lambda t}{1} = 32$		10 Panel Segments $\frac{\lambda t}{10} = 3.2$		100 Panel Segments $\frac{\lambda t}{100} = 0.32$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.032$	
	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$
52	0.00029089	0.99958277						
53	0.00017563	0.99975840						
54	0.00010408	0.99986248						
55	0.00006055	0.99992303						
56	0.00003460	0.99995763						
57	0.00001943	0.99997706						
58	0.00001072	0.99998777						
59	0.00000581	0.99999359						
60	0.00000310	0.99999669						
61	0.00000163	0.99999832						
62	0.00000084	0.99999916						
63	0.00000043	0.99999958						
64	0.00000021	0.99999979						
65	0.00000010	0.99999990						
66	0.00000005	0.99999995						
67	0.00000002	0.99999998						
68	0.00000001	0.99999999						

TABLE 7

Three Altitude Zone Meteoroid Hit Probability $p(K; \lambda t) = e^{-\lambda t} \frac{(\lambda t)^K}{K!}$ --λt = 16 Hits x No. Zones = 48

K	Unit Area $\frac{\lambda t}{1} = 48$		10 Panel Segments $\frac{\lambda t}{10} = 4.8$		100 Panel Segments $\frac{\lambda t}{100} = 0.48$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.048$	
	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$
0	0.00000000	0.00000000	0.00822974	0.00822974	0.61878339	0.61878339	0.95313378	0.95313378
1	0.00000000	0.00000000	0.03950278	0.04773253	0.29701603	0.91579942	0.04575042	0.99888421
2	0.00000000	0.00000000	0.09480668	0.14253921	0.07128385	0.98708326	0.00109801	0.99998222
3	0.00000000	0.00000000	0.15169069	0.29422990	0.01140542	0.99848868	0.00001757	0.99999978
4	0.00000000	0.00000000	0.18202883	0.47625873	0.00136865	0.99985733	0.00000021	0.99999999
5	0.00000000	0.00000000	0.17474767	0.65100640	0.00013139	0.99998872		
6	0.00000000	0.00000000	0.13979813	0.79080453	0.00001051	0.99999923		
7	0.00000000	0.00000000	0.09586158	0.88666611	0.00000072	0.99999996		
8	0.00000000	0.00000000	0.05751694	0.94418305	0.00000004	0.99999999		
9	0.00000000	0.00000000	0.03067570	0.97485875				
10	0.00000000	0.00000000	0.01472433	0.98958308				
11	0.00000000	0.00000000	0.00642516	0.99600824				
12	0.00000000	0.00000000	0.00257006	0.99857830				
13	0.00000000	0.00000000	0.00094894	0.99952724				
14	0.00000001	0.00000001	0.00032535	0.99985259				
15	0.00000002	0.00000003	0.00010411	0.99995670				
16	0.00000005	0.00000008	0.00003123	0.99998793				
17	0.00000015	0.00000023	0.00000881	0.99999674				
18	0.00000041	0.00000064	0.00000235	0.99999909				
19	0.00000103	0.00000167	0.00000059	0.99999968				
20	0.00000247	0.00000414	0.00000014					
21	0.00000564	0.00000978	0.00000003					
22	0.00001231	0.00002210						
23	0.00002570	0.00004779						
24	0.00005140	0.00009919						
25	0.00009868	0.00019788						

TABLE 7 (continued)

K	Unit Area $\frac{\lambda t}{1} = 48$		10 Panel Segments $\frac{\lambda t}{10} = 4.8$		100 Panel Segments $\frac{\lambda t}{100} = 0.48$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.048$	
	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$
26	0.00018219	0.00038007						
27	0.00032389	0.00070395						
28	0.00055524	0.00125919						
29	0.0091901	0.00217820						
30	0.00147042	0.00364863						
31	0.00227678	0.00592541						
32	0.00341517	0.00934058						
33	0.00496752	0.01430811						
34	0.00701298	0.02132108						
35	0.00961780	0.03093888						
36	0.01282373	0.04376260						
37	0.01663619	0.06039879						
38	0.02101413	0.08141292						
39	0.02586354	0.10727646						
40	0.03103625	0.13831272						
41	0.03633513	0.17464785						
42	0.04152586	0.21617370						
43	0.04635445	0.26252815						
44	0.05056849	0.31309664						
45	0.05393972	0.36703636						
46	0.05628493	0.42332128						
47	0.05748248	0.48080376						
48	0.05748248	0.53828624						
49	0.05630937	0.59459560						
50	0.05405699	0.64865259						
51	0.05087717	0.69952976						

TABLE 7 (continued)

K	Unit Area $\frac{\lambda t}{1} = 48$		10 Panel Segments $\frac{\lambda t}{10} = 4.8$		100 Panel Segments $\frac{\lambda t}{100} = 0.48$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.048$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
52	0.04696354	0.74649329						
53	0.04253302	0.78902631						
54	0.03780713	0.82683344						
55	0.03299531	0.85982875						
56	0.02828169	0.88811044						
57	0.02381616	0.91192661						
58	0.01970993	0.93163653						
59	0.01603520	0.04767173						
60	0.01282816	0.96049989						
61	0.01009429	0.97059418						
62	0.00781493	0.97840911						
63	0.00595423	0.98436335						
64	0.00446568	0.98882902						
65	0.00329773	0.99212675						
66	0.00239835	0.99452510						
67	0.00171822	0.99624332						
68	0.00121286	0.99745618						
69	0.00084373	0.99829991						
70	0.00057856	0.99887846						
71	0.00039114	0.99926960						
72	0.00026076	0.99953036						
73	0.00017146	0.99970182						
74	0.00011122	0.99981304						
75	0.00007118	0.99988421						
76	0.00004495	0.99992917						
77	0.00002802	0.99995719						

TABLE 7 (continued)

K	Unit Area $\frac{\lambda t}{1} = 48$		10 Panel Segments $\frac{\lambda t}{10} = 4.8$		100 Panel Segments $\frac{\lambda t}{100} = 0.48$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.048$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
78	0.00001725	0.99997444						
79	0.00001048	0.99998491						
80	0.00000629	0.99999120						
81	0.00000373	0.99999493						
82	0.00000218	0.99999711						
83	0.00000126	0.99999837						
84	0.00000072	0.99999909						
85	0.00000041	0.99999949						
86	0.00000023	0.99999972						
87	0.00000013	0.99999985						
88	0.00000007	0.99999992						
89	0.00000004	0.99999996						
90	0.00000002	0.99999998						
91	0.00000001	0.99999999						

TABLE 8

Four Altitude Zone Meteoroid Hit Probability $p(K;\lambda t) = e^{-\lambda t}\frac{(\lambda t)^K}{K!}$ --λt = 16 Hits x No. Zones = 64

K	Unit Area $\frac{\lambda t}{1}$ = 64		10 Panel Segments $\frac{\lambda t}{10}$ = 6.4		100 Panel Segments $\frac{\lambda t}{100}$ = 0.64		1000 Panel Segments $\frac{\lambda t}{1000}$ = 0.064	
	$p(K;\lambda t)$	$\sum_0^K p(K;\lambda t)$	$p(K;\lambda t)$	$\sum_0^K p(K;\lambda t)$	$p(K;\lambda t)$	$\sum_0^K p(K;\lambda t)$	$p(K;\lambda t)$	$\sum_0^K p(K;\lambda t)$
0	0.00000000	0.00000000	0.00166155	0.00166155	0.52729243	0.52729243	0.93800500	0.93800500
1	0.00000000	0.00000000	0.01063396	0.01229552	0.33746715	0.86475958	0.06003232	0.99803732
2	0.00000000	0.00000000	0.03402869	0.04632421	0.10798494	0.97274907	0.00192103	0.99995835
3	0.00000000	0.00000000	0.07259454	0.11891875	0.02303776	0.99578682	0.00004098	0.99999933
4	0.00000000	0.00000000	0.11615126	0.23507001	0.00368604	0.99947286	0.00000066	0.99999999
5	0.00000000	0.00000000	0.14867261	0.38374362	0.00047181	0.99994468		
6	0.00000000	0.00000000	0.15858519	0.54232881	0.00005033	0.99999501		
7	0.00000000	0.00000000	0.14499217	0.68732098	0.00000460	0.99999961		
8	0.00000000	0.00000000	0.11599374	0.80331472	0.00000037	0.99999998		
9	0.00000000	0.00000000	0.08248443	0.88579915	0.00000003	0.99999999		
10	0.00000000	0.00000000	0.05279004	0.93858919				
11	0.00000000	0.00000000	0.03071420	0.96930339				
12	0.00000000	0.00000000	0.01638090	0.98568429				
13	0.00000000	0.00000000	0.00806444	0.99374873				
14	0.00000000	0.00000000	0.00368660	0.99743533				
15	0.00000000	0.00000000	0.00157295	0.99900828				
16	0.00000000	0.00000000	0.00062918	0.99963746				
17	0.00000000	0.00000000	0.00023686	0.99987432				
18	0.00000000	0.00000000	0.00008421	0.99995853				
19	0.00000000	0.00000000	0.00002836	0.99998689				
20	0.00000000	0.00000000	0.00000908	0.99999597				
21	0.00000000	0.00000000	0.00000285	0.99999982				
22	0.00000000	0.00000000	0.00000083	0.99999965				
23	0.00000000	0.00000000	0.00000025	0.99999990				
24	0.00000001	0.00000001	0.00000006	0.99999996				
25	0.00000001	0.00000002	0.00000002	0.99999998				

TABLE 8 (continued)

K	Unit Area $\frac{\lambda t}{1} = 64$		10 Panel Segments $\frac{\lambda t}{10} = 6.4$		100 Panel Segments $\frac{\lambda t}{100} = 0.64$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.064$	
	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)	p (K; λt)	$\sum_{0}^{K}$ p (K; λt)
26	0.00000004	0.00000006	0.00000001	0.99999999				
27	0.00000009	0.00000015						
28	0.00000020	0.00000034						
29	0.00000043	0.00000078						
30	0.00000093	0.00000170						
31	0.00000191	0.00000362						
32	0.00000383	0.00000744						
33	0.00000742	0.00001486						
34	0.00001397	0.00005437						
35	0.00002554	0.00005437						
36	0.00004540	0.00009977						
37	0.00007854	0.00017813						
38	0.00013227	0.00031058						
39	0.00021706	0.00052765						
40	0.00034730	0.00087495						
41	0.00054213	0.00141708						
42	0.00082610	0.00224318						
43	0.00122955	0.00347273						
44	0.00178843	0.00526116						
45	0.00254355	0.00780471						
46	0.00353885	0.01134356						
47	0.00481886	0.01616242						
48	0.00642515	0.02258757						
49	0.00839203	0.03097960						
50	0.01074180	0.04172140						
51	0.01347990	0.05520130						

TABLE 8 (continued)

K	Unit Area $\frac{\lambda t}{1} = 64$		10 Panel Segments $\frac{\lambda t}{10} = 6.4$		100 Panel Segments $\frac{\lambda t}{100} = 0.64$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.064$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
52	0.01659065	0.07179195						
53	0.02003399	0.09182594						
54	0.02374399	0.11556994						
55	0.02762937	0.14319931						
56	0.03157643	0.17477573						
57	0.03545423	0.21022996						
58	0.03912191	0.24935188						
59	0.04243733	0.29178920						
60	0.04526648	0.33705569						
61	0.04749270	0.38454839						
62	0.04902473	0.43357311						
63	0.04980290	0.48337601						
64	0.04980290	0.53317890						
65	0.04903670	0.58221560						
66	0.04755074	0.62976634						
67	0.04542160	0.67518794						
68	0.04274974	0.71793768						
69	0.03965193	0.75758962						
70	0.03625320	0.79384281						
71	0.03267894	0.82652175						
72	0.02904794	0.85556969						
73	0.02546669	0.88103638						
74	0.0220252	0.90306163						
75	0.01879488	0.92185650						
76	0.01582726	0.93758377						
77	0.01315513	0.95083889						

TABLE 8 (continued)

K	Unit Area $\frac{\lambda t}{1} = 64$		10 Panel Segments $\frac{\lambda t}{10} = 6.4$		100 Panel Segments $\frac{\lambda t}{100} = 0.64$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.064$	
	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$
78	0.01079395	0.96163285						
79	0.00874447	0.97037732						
80	0.00699557	0.97737289						
81	0.00552737	0.98290025						
82	0.00431404	0.98721430						
83	0.00332649	0.99054079						
84	0.00253447	0.99307526						
85	0.00190831	0.99498357						
86	0.00142013	0.99640370						
87	0.00104470	0.99744840						
88	0.00075978	0.99820818						
89	0.00054636	0.99875454						
90	0.00038852	0.99914306						
91	0.00027325	0.99941631						
92	0.00019008	0.99960639						
93	0.00013081	0.99973720						
94	0.00008906	0.99982626						
95	0.00006000	0.99988626						
96	0.0000400	0.99992626						
97	0.00002639	0.99995265						
98	0.00001724	0.99996988						
99	0.00001114	0.99998103						
100	0.00000713	0.99998816						
101	0.00000452	0.99999268						
102	0.00000284	0.99999551						
103	0.00000176	0.99999727						

TABLE 8 (continued)

K	Unit Area $\frac{\lambda t}{1} = 64$		10 Panel Segments $\frac{\lambda t}{10} = 6.4$		100 Panel Segments $\frac{\lambda t}{100} = 0.64$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.064$	
	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_0^K p(K; \lambda t)$
104	0.00000108	0.99999836						
105	0.00000066	0.99999902						
106	0.00000040	0.99999942						
107	0.00000024	0.99999966						
108	0.00000014	0.99999980						
109	0.00000008	0.99999988						
110	0.00000005	0.99999993						
111	0.00000002	0.99999996						
112	0.00000002	0.99999998						
113	0.00000001	0.99999999						

TABLE 9

Five Altitude Zone Meteoroid Hit Probability $p(K; \lambda t) = e^{-\lambda t} \frac{(\lambda t)^K}{K!}$ --λt = 16 Hits x No. Zones = 80

K	Unit Area $\frac{\lambda t}{1} = 80$		10 Panel Segments $\frac{\lambda t}{10} = 8.0$		100 Panel Segments $\frac{\lambda t}{100} = 0.8$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.08$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
0	0.00000000	0.00000000	0.00033546	0.00033546	0.44932897	0.44932897	0.92311635	0.92311635
1	0.00000000	0.00000000	0.00268370	0.00301916	0.35946317	0.80879214	0.07384931	0.99696565
2	0.00000000	0.00000000	0.01073480	0.01375397	0.14378527	0.95257740	0.00295397	0.99991962
3	0.00000000	0.00000000	0.02862614	0.04238011	0.03834274	0.99092014	0.00007877	0.99999840
4	0.00000000	0.00000000	0.05725229	0.09963240	0.00766855	0.99858869	0.00000158	0.99999997
5	0.00000000	0.00000000	0.09160366	0.19123606	0.00122697	0.99981566	0.00000003	0.99999999
6	0.00000000	0.00000000	0.12213822	0.31337428	0.00016360	0.99997925		
7	0.00000000	0.00000000	0.13958653	0.45296081	0.00001870	0.99999795		
8	0.00000000	0.00000000	0.13958653	0.59254733	0.00000187	0.99999982		
9	0.00000000	0.00000000	0.12407692	0.71662425	0.00000017	0.999999999		
10	0.00000000	0.00000000	0.09926153	0.81588579				
11	0.00000000	0.00000000	0.07219021	0.88807599				
12	0.00000000	0.00000000	0.04812680	0.93620280				
13	0.00000000	0.00000000	0.02961649	0.96581929				
14	0.00000000	0.00000000	0.01692371	0.98274300				
15	0.00000000	0.00000000	0.00902598	0.99176899				
16	0.00000000	0.00000000	0.00451299	0.99628197				
17	0.00000000	0.00000000	0.00212376	0.99840573				
18	0.00000000	0.00000000	0.00094389	0.99934963				
19	0.00000000	0.00000000	0.00039743	0.99974706				
20	0.00000000	0.00000000	0.00015897	0.99990603				
21	0.00000000	0.00000000	0.00006056	0.99996659				
22	0.00000000	0.00000000	0.00002202	0.99998861				
23	0.00000000	0.00000000	0.00000766	0.99999627				
24	0.00000000	0.00000000	0.00000255	0.99999882				
25	0.00000000	0.00000000	0.00000082	0.99999964				

TABLE 9 (continued)

K	Unit Area $\frac{\lambda t}{1} = 80$		10 Panel Segments $\frac{\lambda t}{10} = 8.0$		100 Panel Segments $\frac{\lambda t}{100} = 0.8$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.08$	
	$p(K;\lambda t)$	$\sum_{0}^{K} p(K;\lambda t)$	$p(K;\lambda t)$	$\sum_{0}^{K} p(K;\lambda t)$	$p(K;\lambda t)$	$\sum_{0}^{K} p(K;\lambda t)$	$p(K;\lambda t)$	$\sum_{0}^{K} p(K;\lambda t)$
26	0.00000000	0.00000000	0.00000025	0.99999990				
27	0.00000000	0.00000000	0.00000007	0.99999997				
28	0.00000000	0.00000000	0.00000002	0.99999999				
29	0.00000000	0.00000000						
30	0.00000000	0.00000000						
31	0.00000000	0.00000000						
32	0.00000000	0.00000000						
33	0.00000000	0.00000000						
34	0.00000000	0.00000000						
35	0.00000001	0.00000001						
36	0.00000002	0.00000003						
37	0.00000003	0.00000006						
38	0.00000007	0.00000013						
39	0.00000015	0.00000028						
40	0.00000029	0.00000057						
41	0.00000057	0.00000115						
42	0.00000109	0.00000224						
43	0.00000203	0.00000427						
44	0.00000370	0.00000797						
45	0.00000657	0.00001454						
46	0.00001143	0.00002597						
47	0.00001945	0.00004542						
48	0.00003242	0.00007785						
49	0.00005294	0.00013078						
50	0.00008470	0.00021548						
51	0.00013286	0.00034834						

TABLE 9 (continued)

K	Unit Area $\frac{\lambda t}{1} = 80$		10 Panel Segments $\frac{\lambda t}{10} = 8.0$		100 Panel Segments $\frac{\lambda t}{100} = 0.8$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.08$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
52	0.00020440	0.00055273						
53	0.00030852	0.00086126						
54	0.00045707	0.00131833						
55	0.00066483	0.00198315						
56	0.00094976	0.00293291						
57	0.0013329	0.00426590						
58	0.00183861	0.00610451						
59	0.00249303	0.00859754						
60	0.00332404	0.01192157						
61	0.00435939	0.01628097						
62	0.00562502	0.02190599						
63	0.00714289	0.02904887						
64	0.00892861	0.03797748						
65	0.01098905	0.04896654						
66	0.01332007	0.06228660						
67	0.01590456	0.07819116						
68	0.01871124	0.09690240						
69	0.02169420	0.11859660						
70	0.02479337	0.14338996						
71	0.02793619	0.17132615						
72	0.03104021	0.20236636						
73	0.03401667	0.23638303						
74	.0.03677478	0.27315780						
75	0.03922643	0.31238423						
76	0.04129098	0.35367521						
77	0.04289971	0.39657492						

TABLE 9 (continued)

K	Unit Area $\frac{\lambda t}{1} = 80$		10 Panel Segments $\frac{\lambda t}{10} = 8.0$		100 Panel Segments $\frac{\lambda t}{100} = 0.8$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.08$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
78	0.04399971	0.44057463						
79	0.04455667	0.48513129						
80	0.04455667	0.52968795						
81	0.04400658	0.57369454						
82	0.04293325	0.61662779						
83	0.04138145	0.65800924						
84	0.03941090	0.69742014						
85	0.03709261	0.73451275						
86	0.03450476	0.76901752						
87	0.03172851	0.80074602						
88	0.02884410	0.82959013						
89	0.02592728	0.85551741						
90	0.02304647	0.87856389						
91	0.02026064	0.89882452						
92	0.01761794	0.91644247						
93	0.01515522	0.93159769						
94	0.01289806	0.94449575						
95	0.01086152	0.95535728						
96	0.00905127	0.96440855						
97	0.00746497	0.97187351						
98	0.00609385	0.97796736						
99	0.00492432	0.98289168						
100	0.00393946	0.98683114						
101	0.00312036	0.98995151						
102	0.00244734	0.99239884						
103	0.00190085	0.99429969						

TABLE 9 (continued)

K	Unit Area $\frac{\lambda t}{1} = 80$		10 Panel Segments $\frac{\lambda t}{10} = 8.0$		100 Panel Segments $\frac{\lambda t}{100} = 0.8$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.08$	
	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)	p (K; λt)	$\sum_0^K$ p (K; λt)
104	0.00146219	0.99429969						
105	0.00111405	0.99687594						
106	0.00084079	0.99771673						
107	0.00062863	0.99834536						
108	0.00046565	0.99881101						
109	0.00034176	0.99915278						
110	0.00024855	0.99940133						
111	0.00017914	0.99958047						
112	0.00012796	0.99970843						
113	0.00009059	0.99979901						
114	0.00006357	0.99986259						
115	0.00004422	0.99990681						
116	0.00003050	0.99993731						
117	0.00002085	0.99995816						
118	0.00001414	0.99997230						
119	0.00000950	0.99998181						
120	0.00000634	0.99998814						
121	0.00000419	0.99999233						
122	0.00000275	0.99999508						
123	0.00000179	0.99999686						
124	0.00000115	0.99999802						
125	0.00000074	0.99999876						
126	0.00000047	0.99999923						
127	0.00000030	0.99999952						
128	0.00000018	0.99999970						
129	0.0000001l	0.99999982						

TABLE 9 (continued)

K	Unit Area $\frac{\lambda t}{1} = 80$		10 Panel Segments $\frac{\lambda t}{10} = 8.0$		100 Panel Segments $\frac{\lambda t}{100} = 0.8$		1000 Panel Segments $\frac{\lambda t}{1000} = 0.08$	
	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$	$p(K; \lambda t)$	$\sum_{0}^{K} p(K; \lambda t)$
130	0.00000007	0.99999989						
131	0.00000004	0.99999993						
132	0.00000003	0.99999996						
133	0.00000002	0.99999998						
134	0.00000001	0.99999999						

TABL

Failure Rates of Parts

Item	Quantity	Source	Service/Countdown/Hold						Boost						
			Eqpt Operating			Eqpt Nonoperating			Eqpt Operating			Eqpt Nonoperating			Eqpt
			Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress
Inductance		MIL HDBK 217	0.4	1	0.025	--	1	0.0025	0.4	500	12.5	--	500	1.25	0.4
Transistor		MIL HDBK 217	0.4	1	0.042	--	1	0.0042	0.4	500	21.0	--	500	2.1	0.4
Resistor (dissipation)		MIL HDBK 217	0.4	1	0.02	--	1	0.002	0.4	500	10.0	--	500	1.0	0.4
Resistor (composition)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5	0.4
Capacitor (glass)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5	0.4
Capacitor (tantalum wet slug)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5	0.4
Diode		MIL HDBK 217	0.4	1	0.020	--	1	0.002	0.4	500	10.0	--	500	1.0	0.4
RF and IF coils low voltage transformer		MIL HDBK 217	0.4	1	0.03	--	1	0.003	0.4	500	15.0	--	500	1.5	0.4
Hi-volt transform		MIL HDBK 217	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	2.5	0.4
Solar array (28 v)		Martin and AVCO data	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	2.5	0.4
Solar array (36 v)		Martin and AVCO data	0.4	1	0.10	--	1	0.010	0.4	500	50.0	--	500	50.0	0.4
Batteries (chargeable)		MI-60-54 (rev)	0.4	1	1.4	--	1	1.4	0.4	500	700	--	500	700	0.4
Batteries and heaters		MI-60-54 (rev)	0.4	1	1.45	--	1	1.45	0.4	500	725	--	500	725	0.4
Fuses, continuous load		MI-60-54 (rev)	0.4	1	0.3	--	1	0.03	0.4	500	15.0	--	500	1.50	0.4
Fuses, intermittent load		MI-60-54 (rev)	0.4	1	0.8	--	1	0.08	0.4	500	40.0	--	500	4.00	0.4
Crystal		MI-60-54 (rev)	0.4	1	0.6	--	1	0.60	0.4	500	300.0	--	500	300.0	0.4

*Lower figures apply to transmitter only

Active thermal control [X]

Spin configuration [X]

/

.E 16

s Used in Equipment

Deploy/Spin/Despin						Orbital Sunlight Period								Orbital Dark Period							
Eqpt Operating			Eqpt Nonoperating			Eqpt Operating				Eqpt Nonoperating				Eqpt Operating				Eqpt Nonoperating			
Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6
0.4	50	1.25	--	50	0.125	0.4	0.1 0.3	1	0.025 0.033	--	0.1 0.8	1	0.0025 0.0045	0.4	0.3 0.5	10	0.33 0.38	--	0.3 1.0	10	0.033 0.05*
0.4	50	2.1	--	50	0.21	0.4	0.1 0.3	1	0.042 0.046	--	0.1 0.8	1	0.0042 0.0095	0.4	0.3 0.5	10	0.46 0.65	--	0.3 1.0	10	0.046 0.20*
0.4	50	1.0	--	50	0.10	0.4	0.1 0.3	1	0.02 0.02	--	0.1 0.8	1	0.002 0.002	0.4	0.3 0.5		0.02 0.02	--	0.3 1.0		0.002 0.002*
0.4	50	0.5	--	50	0.05	0.4	0.1 0.3	1	0.01 0.01	--	0.1 0.8	1	0.001 0.001	0.4	0.3 0.5		0.01 0.01	--	0.3 1.0		0.001 0.001*
0.4	50	0.5	--	50	0.05	0.4	0.1 0.3	1	0.01 0.01	--	0.1 0.8	1	0.001 0.002	0.4	0.3 0.5	10	0.1 0.1	--	0.3 1.0	10	0.01 0.02*
0.4	50	0.5	--	50	0.05	0.4	0.1 0.3	1	0.01 0.01	--	0.1 0.8	1	0.001 0.002	0.4	0.3 0.5	10	0.1 0.1	--	0.3 1.0	10	0.01 0.02*
0.4	50	1.0	--	50	0.10	0.4	0.1 0.3	1	0.02 0.02	--	0.1 0.8	1	0.002 0.004	0.4	0.3 0.5	10	0.20 0.20	--	0.3 1.0	10	0.02 0.20*
0.4	50	1.5	--	50	0.15	0.4	0.1 0.3	1	0.03 0.039	--	0.1 0.8	1	0.003 0.005	0.4	0.3 0.5	10	0.39 0.45	--	0.3 1.0	10	0.039 0.06*
0.4	50	2.5	--	50	0.25	0.4	0.1 0.3	1	0.05 0.065	--	0.1 0.8	1	0.005 0.006	0.4	0.3 0.5	10	0.65 0.75	--	0.3 1.0	10	0.065 0.10*
0.4	50	2.5	--	50	0.25	0.4	0.1	1	0.05	--	0.1	1	0.005	--	--	10	--	--	0.2	10	0.045
0.4	50	5.0	--	50	5.0	0.4	0.1	1	0.10	--	0.1	1	0.010	--	--	10	--	--	0.2	10	0.090
0.4	50	70.0	--	50	70.0	0.4	0.1	1	1.4	--	0.1	1	1.4	0.4	0.3	10	15.4	--	0.5	10	15.4
0.4	50	72.5	--	50	72.5	0.4	0.1	1	1.45	--	0.1	1	1.45	0.4	0.1	10	1.45	--	0.1	10	1.45
0.4	50	1.50	--	50	0.15	0.4	0.1	1	0.03	--	0.1	1	0.003	0.4	0.1	10	0.3	--	0.2	10	0.03
0.4	50	4.00	--	50	0.40	0.4	0.1	1	0.08	--	0.1	1	0.008	0.4	0.1	10	0.8	--	0.2	10	0.08
0.4	50	30.0	--	50	30.0	0.4	0.1	1	0.60	--	0.1	1	1.1	0.4	0.1	10	2.2	--	0.2	10	1.10*

2

TABL

Failure Rates of Part

Item	Quantity	Source	Service/Countdown/Hold: Eqpt Operating: Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Service/Countdown/Hold: Eqpt Nonoperating: Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Boost: Eqpt Operating: Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Boost: Eqpt Nonoperating: Elec.. Stress	Therm/Mech Stress	FR = λ x 10^6
Inductance		MIL HDBK 217	0.4	1	0.025	--	1	0.0025	0.4	500	12.5	--	500	1.25
Transistor		MIL HDBK 217	0.4	1	0.042	--	1	0.0042	0.4	500	21.0	--	500	2.1
Resistor (dissipation)		MIL HDBK 217	0.4	1	0.02	--	1	0.002	0.4	500	10.0	--	500	1.0
Resistor (composition)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Capacitor (glass)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Capacitor (tantalum wet slug)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Diode		MIL HDBK 217	0.4	1	0.020	--	1	0.002	0.4	500	10.0	--	500	1.0
RF & IF coils low voltage transformer		MIL HDBK 217	0.4	1	0.030	--	1	0.003	0.4	500	15.0	--	500	1.5
Hi-volt transformer		MIL HDBK 217	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	2.5
Solar array (28 v)		Martin and Avco data	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	25.0
Solar array (36 v)		Martin and Avco data	0.4	1	0.10	--	1	0.010	0.4	500	50.0	--	500	50.0
Batteries (chargeable)		Martin	0.4	1	1.4	--	1	1.4	0.4	500	700	--	500	700
Batteries and heaters		MI-60-54(REV)	0.4	1	1.45	--	1	1.45	0.4	500	725	--	500	725
Fuses, continuous load		MI-60-54(REV)	0.4	1	0.31	--	1	0.03	0.4	500	15.0	--	500	1.50
Fuses, intermittent load		MI-60-54(REV)	0.4	1	0.8	--	1	0.08	0.4	500	40.0	--	500	4.00
Crystal		MI-60-54(REV)	0.4	1	0.6	--	1	0.6	0.4	500	300.0	--	500	300.

* Lower figures apply to transmitter only.

Passive thermal control [X]

Tumble configuration [X]

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Used in Equipment

Deploy/Spin/Despin					Orbital Sunlight Period								Orbital Dark Period							
Operating		Eqpt Nonoperating			Eqpt Operating				Eqpt Nonoperating				Eqpt Operating				Eqpt Nonoperating			
Therm/Mech Stress	FR = λ x 10^6	Elect/ Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^{16}
50	1.25	--	50	0.125	0.4	0.1 0.1	1	0.025 0.025	--	0.1 0.3	1	0.0025 0.0033	0.4	0.3 0.4	10	0.33 0.35	--	0.3 0.5		0.033 0.038*
50	2.10	--	50	0.21	0.4	0.1 0.1	1	0.042 0.042	--	0.1 0.3	1	0.0042 0.0046	0.4	0.3 0.4	10	0.46 0.55	--	0.3 0.5	10	0.046 0.065*
50	1.0	--	50	0.10	0.4	0.1 0.1	1	0.02 0.02	--	0.1 0.3	1	0.0020 0.002	0.4	0.3 0.4		0.020 0.020	--	0.3 0.5		0.002 0.002*
50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.3	1	0.001 0.001	0.4	0.3 0.4		0.01 0.01	--	0.3 0.5		0.001 0.001*
50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.3	1	0.001 0.001	0.4	0.3 0.4	10	0.10 0.20	--	0.3 0.5	10	0.010 0.02*
50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.3	1	0.001 0.001	0.4	0.3 0.4	10	0.11 0.20	--	0.3 0.5	10	0.010 0.02*
50	1.0	--	50	0.10	0.4	0.1 0.1	1	0.02 0.02	--	0.1 0.3	1	0.002 0.002	0.4	0.3 0.4	10	0.20 0.20	--	0.3 0.5	10	0.02 0.02*
50	1.5	--	50	0.15	0.4	0.1 0.1	1	0.03 0.03	--	0.1 0.3	1	0.003 0.004	0.4	0.3 0.4	10	0.39 0.42	--	0.3 0.5	10	0.039 0.045*
50	2.5	--	50	0.25	0.4	0.1 0.1	1	0.05 0.05	--	0.1 0.3	1	0.005 0.006	0.4	0.3 0.4	10	0.65 0.70	--	0.3 0.5	10	0.065 0.075*
50	2.5	--	50	2.5	0.4	0.1	1	0.05	--	0.1	1	0.005	--	--	10	--	--	0.2	10	0.045
50	5.0	--	50	5.0	0.4	0.1	1	0.10	--	0.1	1	0.010	--	--	10	--	--	0.2	10	0.090
50	70.0	--	50	70.0	0.4	0.1	1	1.4	--	0.3	1	1.4	0.4	0.3	10	15.4	--	0.5	10	15.4
50	72.5	--	50	72.5	0.4	0.1	1	1.45	--	0.1	1	1.45	0.4	0.1	10	1.45	--	0.1	10	1.45
50	1.50	--	50	0.15	0.4	0.1	1	0.03	--	0.1	1	0.003	0.4	0.1	10	0.3	--	0.2	10	0.03
50	4.00	--	50	0.40	0.4	0.1	1	0.08	--	0.1	1	0.008	0.4	0.1	10	0.8	--	0.2	10	0.08
50	30.0	--	50	30.0	0.4	0.1	1	0.60	--	0.1	1	1.10	0.4	0.1	10	2.2	--	0.2	10	1.10*

TABLE 20

Basic Parts Counts

Configuration	Name of Subsystem	No. Units	Q	R	D	C	L	Crystal	T	Relays	Magnetic Cores
Basic subsystems	Power supply section	1	8	30	4	3	16				
	Capacitance panel signal conditioners A and B	2	34	268	70	174	58		3		
	Word orientation unit	1	132	531	657	204					
	Pattern logic	1	103	412	305	157					
	Sequencer and inhibit gate	1	9	26	23	9					
	Transmitter channel	1	25	85	21	64	31	1			
	Charge generator	2	12	28	24	22	4		2		
	Percent area multiplexer A and B	2	352	1736	1574	410					
	$R + \dot{R}$ channel	1	24	97	5	107	38				
	Command backup deployment channel	1	168	683	471	202	8		3	65	
	Storage channel	1	234	1160	460	240					7000
A_0	Power supply	1	8	30	4	3	16				
	Capacitance panel										
	Signal conditioner	2	34	268	70	174	58		3		
	Word orientation unit	1	123	505	634	195					
	Sequencer and inhibit gate	1	9	26	23	9					
	Pattern logic	1	103	412	305	157					
	Transmitter channel	1	25	85	21	64	31	1			
A_0 total		7	302	1326	1057	602	105	1	3		
A_1	Power supply	1	8	30	4	3	16				
	Transmitter channel	1	25	85	21	64	31	1			
A_1 total	(A_0 total + A_1)	9	335	1441	1082	669	152	2	3		
A_2	Area multiplexer channel	2	352	1736	1574	410					
A_2 total	(A_0 total + A_2)	9	654	3062	2631	1012	105	1	3		
B_0	Add $R + \dot{R}$ channel to A_0 total:										
	A_0 total	7	302	1326	1057	602	105	1	3		

E 18

Used in Equipment

Deploy/Spin/Despin						Orbital Sunlight Period								Orbital Dark Period							
Eqpt Operating			Eqpt Nonoperating			Eqpt Operating				Eqpt Nonoperating				Eqpt Operating				Eqpt Nonoperating			
Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6	Elect. Stress	Therm Stress	Mech Stress	FR = λ x 10^6
0.4	50	1.25	--	50	0.125	0.4	0.1 0.1	1	0.025 0.025	--	0.1 0.6	1	0.0025 0.004	0.4	0.3 0.4	10	0.33 0.35	--	0.3 0.8	10	0.033 0.045*
0.4	50	2.1	--	50	0.21	0.4	0.1 0.1	1	0.042 0.042	--	0.1 0.6	1	0.0042 0.0073	0.4	0.3 0.4	10	0.46 0.58	--	0.3 0.8	10	0.046 0.093*
0.4	50	1.0	--	50	0.10	0.4	0.1 0.1	1	0.02 0.02	--	0.1 0.6	1	0.002 0.002	0.4	0.3 0.4		0.02 0.002	--	0.3 0.8		0.002 0.002*
0.4	50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.6	1	0.001 0.001	0.4	0.3 0.4		0.01 0.01	--	0.3 0.8		0.001 0.002*
0.4	50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.6	1	0.001 0.001	0.4	0.3 0.4	10	0.01 0.1	--	0.3 0.8	10	0.01 0.02*
0.4	50	0.5	--	50	0.05	0.4	0.1 0.1	1	0.01 0.01	--	0.1 0.6	1	0.001 0.002	0.4	0.3 0.4	10	0.1 0.01	--	0.3 0.8	10	0.01 0.02*
0.4	50	1.0	--	50	0.10	0.4	0.1 0.1	1	0.02 0.02	--	0.1 0.6	1	0.002 0.002	0.4	0.3 0.4	10	0.20 0.20	--	0.3 0.8	10	0.02 0.036*
0.4	50	1.5	--	50	0.15	0.4	0.1 0.1	1	0.030 0.030	--	0.1 0.6	1	0.003 0.005	0.4	0.3 0.4		0.030 0.42	--	0.3 0.8	10	0.03 0.05*
0.4	50	2.5	--	50	0.25	0.4	0.1 0.1	1	0.05 0.05	--	0.1 0.6	1	0.005 0.008	0.4	0.3 0.4		0.065 0.070	--	0.3 0.8	10	0.0065 0.009*
0.4	50	2.5	--	50	2.5	0.5	0.1	1	0.5	--	0.1	1	0.005	--	--	10	--	--	0.2	10	0.045
0.4	50	5.0	--	50	5.0	0.4	0.1	1	0.10	--	0.1	1	0.010	--	--	10	--	--	0.2	10	0.090
0.4	50	70.0	--	50	70.0	0.4	0.1	1	1.4	--	0.3	1	1.4	0.4	0.3	10	15.4	--	0.5	10	15.4
0.4	50	72.5	--	50	72.5	0.4	0.1	1	1.45	--	0.1	1	1.45	0.4	0.1	10	1.45	--	0.1	10	1.45
0.4	50	1.5	--	50	0.15	0.4	0.1	1	0.03	--	0.1	1	0.003	0.4	0.1	10	0.3	--	0.2	10	0.03
0.4	50	4.0	--	50	0.40	0.4	0.1	1	0.08	--	0.1	1	0.008	0.4	0.1	10	0.8	--	0.2	10	0.08
0.4	50	30	--	50	30.0	0.4	0.1	1	0.6	--	0.1	1	1.1	0.4	0.1	10	2.2	--	0.2	10	1.1*

Passive thermal control [X]

Spin configuration [X]

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TABL

Failure Rates of Part

Item	Quantity	Source	Service/Countdown/Hold						Boost					
			Eqpt Operating			Eqpt Nonoperating			Eqpt Operating			Eqpt Nonoperating		
			Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6	Elect. Stress	Therm/Mech Stress	FR = λ x 10^6
Inductance		MIL HDBK 217	0.4	1	0.025	--	1	0.0025	0.4	500	12.5	--	500	1.25
Transistor		MIL HDBK 217	0.4	1	0.042	--	1	0.0042	0.4	500	21.0	--	500	2.1
Resistor (dissipation)		MIL HDBK 217	0.4	1	0.02	--	1	0.002	0.4	500	10.0	--	500	1.0
Resistor (comp) position		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Capacitor (glass)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Capacitor (tantalum wet slug)		MIL HDBK 217	0.4	1	0.01	--	1	0.001	0.4	500	5.0	--	500	0.5
Diode		MIL HDBK 217	0.4	1	0.020	--	1	0.002	0.4	500	10.0	--	500	1.0
RF and IF coils and low voltage transformer		MIL HDBK 217	0.4	1	0.030	--	1	0.003	0.4	500	15.0	--	500	1.5
Hi-volt transformer		MIL HDBK 217	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	2.5
Solar array (28 v)		Martin and Avco data	0.4	1	0.05	--	1	0.005	0.4	500	25.0	--	500	25.0
Solar array (36 v)		Martin and Avco data	0.4	1	0.10	--	1	0.010	0.4	500	50.0	--	500	50.0
Batteries (chargeable)		MI-60-54(REV)	0.4	1	1.4	--	1	1.4	0.4	500	700	--	500	700
Batteries and heaters		MI-60-54(REV)	0.4	1	1.45	--	1	1.45	0.4	500	725	--	500	725
Fuses, continuous load		MI-60-54(REV)	0.4	1	0.3	--	1	0.03	0.4	500	15.0	--	500	1.5
Fuses, intermittent load		MI-60-54(REV)	0.4	1	0.8	--	1	0.08	0.4	500	40.0	--	500	4.0
Crystal		MI-60-54(REV)	0.4	1	0.6	--	1	0.6	0.4	500	300.0	--	500	300.0

* Lower figures are for transmitter only.

	R + R channel count	1	24	97	5	107	38				
B_0 totals		8	326	1423	1062	709	143	1	3		
B_1	Area multiplexer channel	2	352	1736	1574	410					
B_1 totals	(B_0 totals + B_1)	10	678	3159	2636	1119	143	1	3		
C_0 or D_0	Backup deployment command channel: command receiver, decoder and logic	1	45	173	78	71	8			34	
	H/K deployment signal condition-ing		41	142	63	43				10	
	H/K deployment data processing		82	368	330	88			3	21	
	Subtotal A		168	683	471	202	8		3	65	
C_0 or D_0 total	(B_1 totals + subtotal A)	11	846	3842	3107	1321	151	1	6	65	
A_2	A_2 totals	1	654	3062	2631	1012	105	1	3		
E_0 or E_1	Read-write and parity generator	1	157	820	260	180					
	7000-bit storage and timer switch		57	260	140	80					7000
	Miscellaneous		20	80	60	20					
	Subtotal B	1	234	1160	460	280					
E_0 or E_1 total	(A_2 total + subtotal B)	10	888	4222	3091	1292	105	1	3		7000
E_0 or E_1	E_0 or E_1 totals	1	888	4222	3091	1292	105	1	3		7000
E_2 or E_3	R + Ṙ channel	1	24	97	5	107	38				
E_2 or E_3 total	(E_0 or E_1 total + E_2 or E_3) R + Ṙ channel	11	912	4319	3096	1399	143	1	3		7000
E_2 or E_3	E_2 or E_3 totals	1	912	4319	3096	1399	143	1	3		7000
E_4 or E_5	Backup deployment command channel, command receiver, decoder and logic	1	45	173	78	71	8			34	7000
	H/K deployment signal condition-ing		41	142	63	43				10	
	H/K deployment data processing		82	368	330	88			3	21	
	Subtotal C	1	168	683	471	202	8		3	65	
E_4 or E_5 total	(E_2 or E_3 total + subtotal C)	12	1080	5002	3567	1601	151	1	6	65	7000

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Preliminary Estimates

Word Orientation Unit Parts Count

Unit	No.	Subassembly	Totals						
			Q's	R's	C's	D's	L's	T's	Sw's
Word orientation unit	1	Word generator	28	120	28	140	--	--	--
		Parity generator	10	45	10	51	--	--	--
		15-stage counter	10	40	50	25	--	--	--
		14-stage counter	8	30	40	16	--	--	--
		Accumulator Counter A	14	45	14	70	--	--	--
		Accumulator Counter B	14	30	14	70	--	--	--
		Words 3 and 4	28	142	28	170	--	--	--
		Word No. 5	14	71	14	75	--	--	--
		Control logic	6	28	6	30	--	--	--
Totalfor word orientation unit			132	531	204	657	--	--	--

Preliminary Estimates

Percent Area Multiplexer Channel Parts Count

Unit	No.	Subassembly	Totals			
			Q's	R's	C's	D's
130-input multiplexer	1	13 10X1 matrix	130	650	130	600
		2 4-bit counters	16	64	32	64
		13 Enable logic	13	65	13	52
		Reset logic	3	8	2	15
	1	Detection	11	25	14	14
	1	7-bit counter	14	56	14	42
Total for each area multiplexer			176	868	205	787
Total for 2			352	1736	410	1574

Preliminary Estimates

Transmitting Channel Parts Count

Unit	No.	Subassembly	Total Counts					
			Q's	R's	D's	C's	L's	Crystal
Transmitting channel	1	Transmitter	9	25	8	40	31	1
		Transmitter mod section	8	30	4	9	--	--
		SCO and SCO mod	8	30	9	15	--	--
		Power divider T coupling, (coax)	--	--	--	--	--	--
Transmitting channel totals			25	85	21	64	31	1

Preliminary Estimates

Capacitance Panel Signal Conditioning Unit Parts Count

Unit	No.	Subassembly	Total Counts					
			Q's	R's	D's	C's	L's	T's
Signal conditioning Panel A	1	13 Filter units	--	52	--	52	26	--
		Signal cond box	2	12	3	5	--	--
		Detector	6	24	15	12	--	--
		3 Dc-dc converters	6	12	18	21	6	3
		3 Regulators	12	30	18	12	--	--
Signal conditioning Panel A Totals			26	180	52	102	32	3
Signal conditioning Panel B	1	13 Filter units	--	52	--	52	26	--
		Signal cond box	2	12	3	5	--	--
		Detector	6	24	15	15	--	--
Signal conditioning Panel B Totals			8	88	18	72	26	--
Signal conditioning Panels A & B Totals			34	268	70	174	58	3

Preliminary Estimates

Power Supply System and Charge Generator Parts Count

Unit	No.	Subassembly	Power Regulator and Dissipator	Totals					
				L's	Q's	R's	C's	D's	T
Power supply unit		Solar array		--	--	--	--	--	--
	1	Regulator		4	4	12	3	4	1
		Dissipator		12	4	18	--	--	--
		Battery		--	--	--	--	--	--
		Deploy and timer		--	--	--	--	--	--
Total parts count for power supply unit				16	8	30	3	4	1
Charge generators A and B	2			4	12	28	22	24	2
Total parts count for charge generator A and B				4	12	28	22	24	2

Preliminary Estimates

Pattern Logic, Sequencer, and Inhibit Gate Parts Count

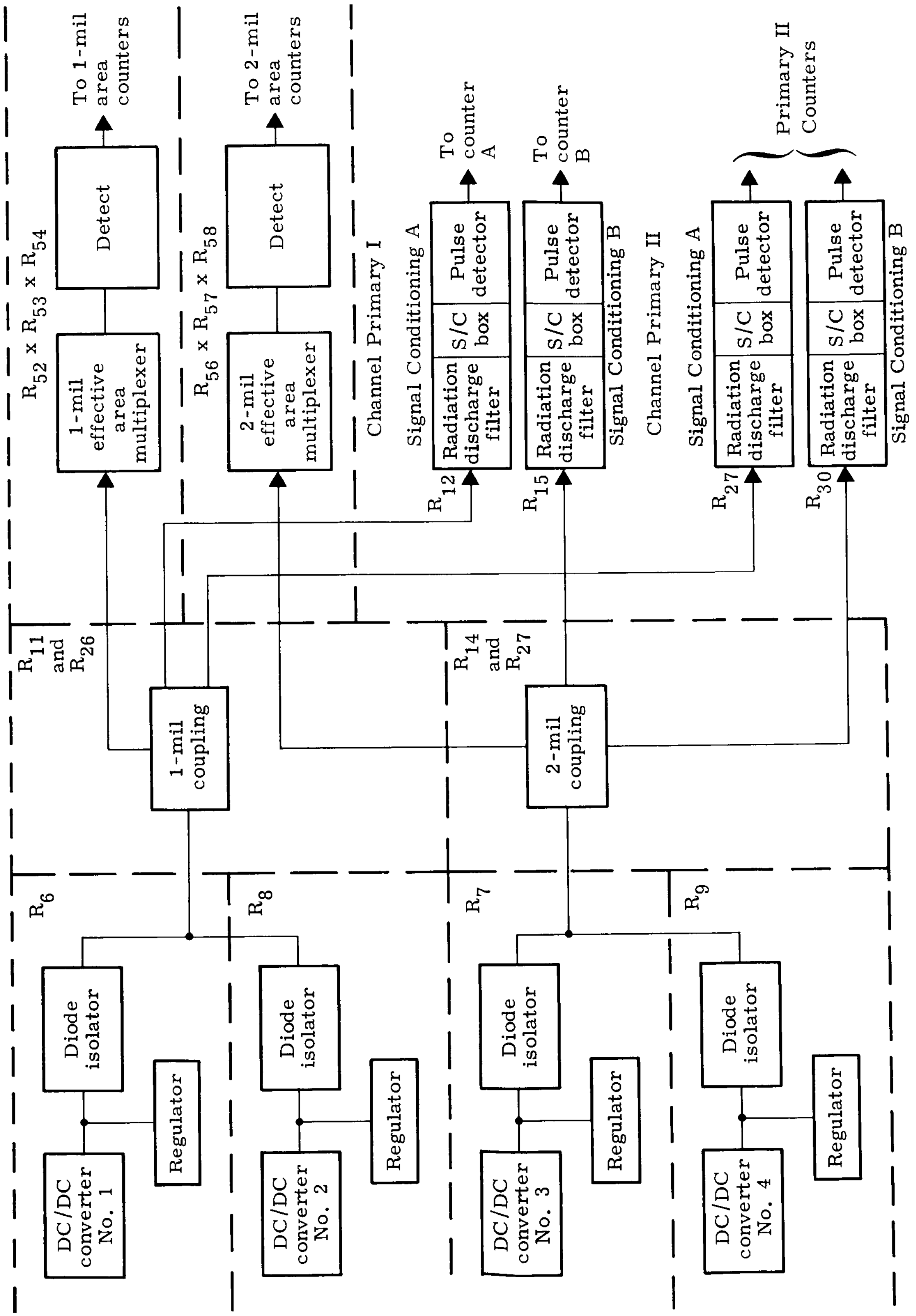
Unit	No.	Subassembly	Totals				
			Q's	R's	C's	D's	Crystal
Pattern logic	1	20-kc oscillator	2	8	2	--	1
		Conversion logic	4	12	8	6	--
		Divider chain	42	168	84	126	--
		60-sec logic	16	62	16	46	--
		60-min logic	16	62	16	46	--
		8-bit increment counter	19	80	21	60	--
		Divide chain reset logic	4	20	10	21	--
Total parts for pattern logic			103	412	157	305	1
Sequencer and inhibit gate	1	Totals	9	26	9	23	--

TABLE 22

Component Count

Q = transistor, R = resistor, C = capacitor, D = diode, L = inductor, T = transformer, CRY = crystal, O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
		Total for 2 command receivers	20	96	106	8	36			
		Total for 2 decoders	20	90	100	10	8			30 relays
		Total for command logic		16	3	13				20 relays
		GRAND TOTAL	40	192	209	31				50 relays
Electrical Power--Pri II (R_{25})										
Solar array	1	R_n								
Voltage regulator	2	R_p, R_q	4	12	3	4	4			
DC/DC converter	2	R_u, R_v	2	4	4	2	2	1		
Distribution	1	R_w								
Battery	1	R_r								
Charge limiter	1	R_s	1	2		1				
Diode	1	R_t				1				
Hybrid (R_{24}, R_{39})										
Hybrid	1	R_{24}, R_{39}								1 coax line
Capacitance, Exotech, and Area Counters (R_{41}, R_{43}, R_{47}, R_{51}, R_{55}, R_{57})										
7-bit counter	1	RSFF (7) TOTALS	14	56	33	56				
		TOTAL for 8	112	448	264	448				
Exotech Signal Conditioning and Detectors ($R_{44} \times R_{45}$, $R_{48} \times R_{49}$, R_{46}, R_{50})										
Exotech signal conditioning $R_{44} \times R_{45}$, $R_{48} \times R_{49}$	1	18 preamplifiers and filters TOTALS	72	306	90	52	18			
Detector	3	R_{46} or R_{50} TOTALS	25	94	39	55				



Block Logic for Charge Generators and Capacitance Panel Coupling to Detection

TABLE 22 (continued)

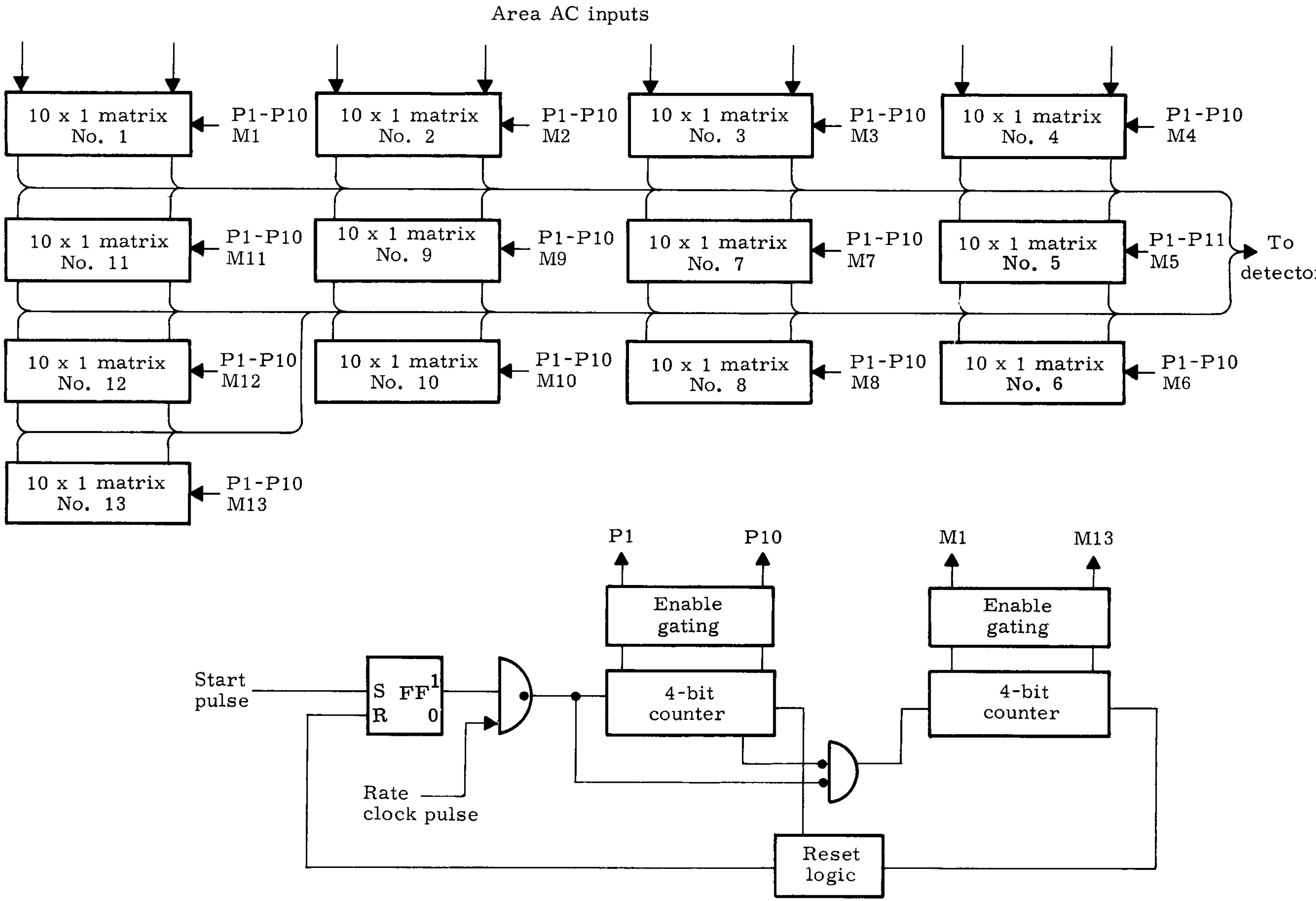
Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Data Switch (R_{36}) and Signal Conditioner (R_{37})										
Signal conditioner	1	2 amplifier	4	10	4	4				
		2 filters		6	6		2			
		TOTAL for signal conditioner	4	16	10	4	2			
Transmitter Switch (λ_3)										
Transmitter switch	1	Driver redundant flip-flop and relays Diplexer--in (λ_5, λ_8)	4	4		4				4 relays
Diplexer--in	1	TOTAL		1	1		1			
Above totals are for each diplexer in, of which there are 2.										
		TOTAL for 2		2	2		2			
Command Receiver and Decoder for Minimum of 10 Commands with Command Logic										
Command receiver (λ_6 or λ_9)	1	State-of-art information totals	10	48	53	4	18			
Command decoder (λ_7 or λ_{10})	1	State-of-art information totals	10	45	50	5	4			15 relays
Command logic (λ_4)	1	Relay networks totals		16	3	13				20 relays

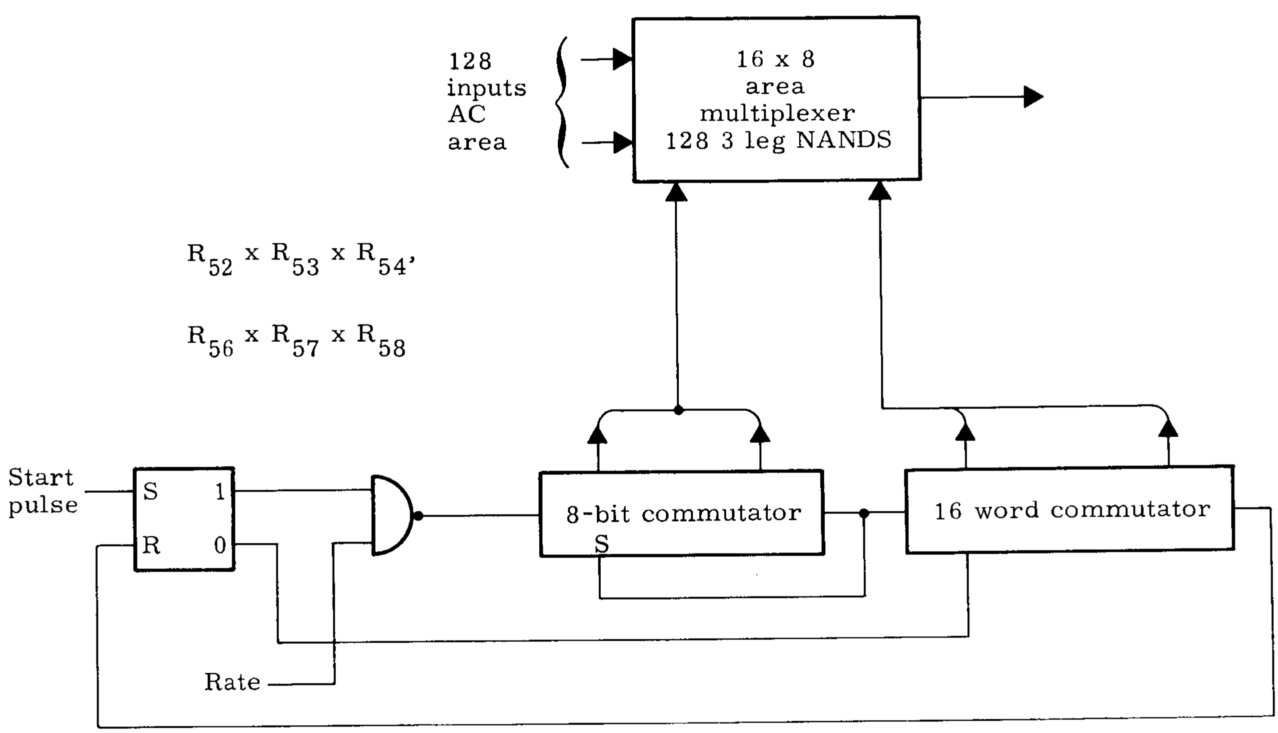
TABLE 22 (continued)

Q = transistor　C = capacitor　L = inductor　CRY = crystal
R = resistor　D = diode　T = transformer　O = other

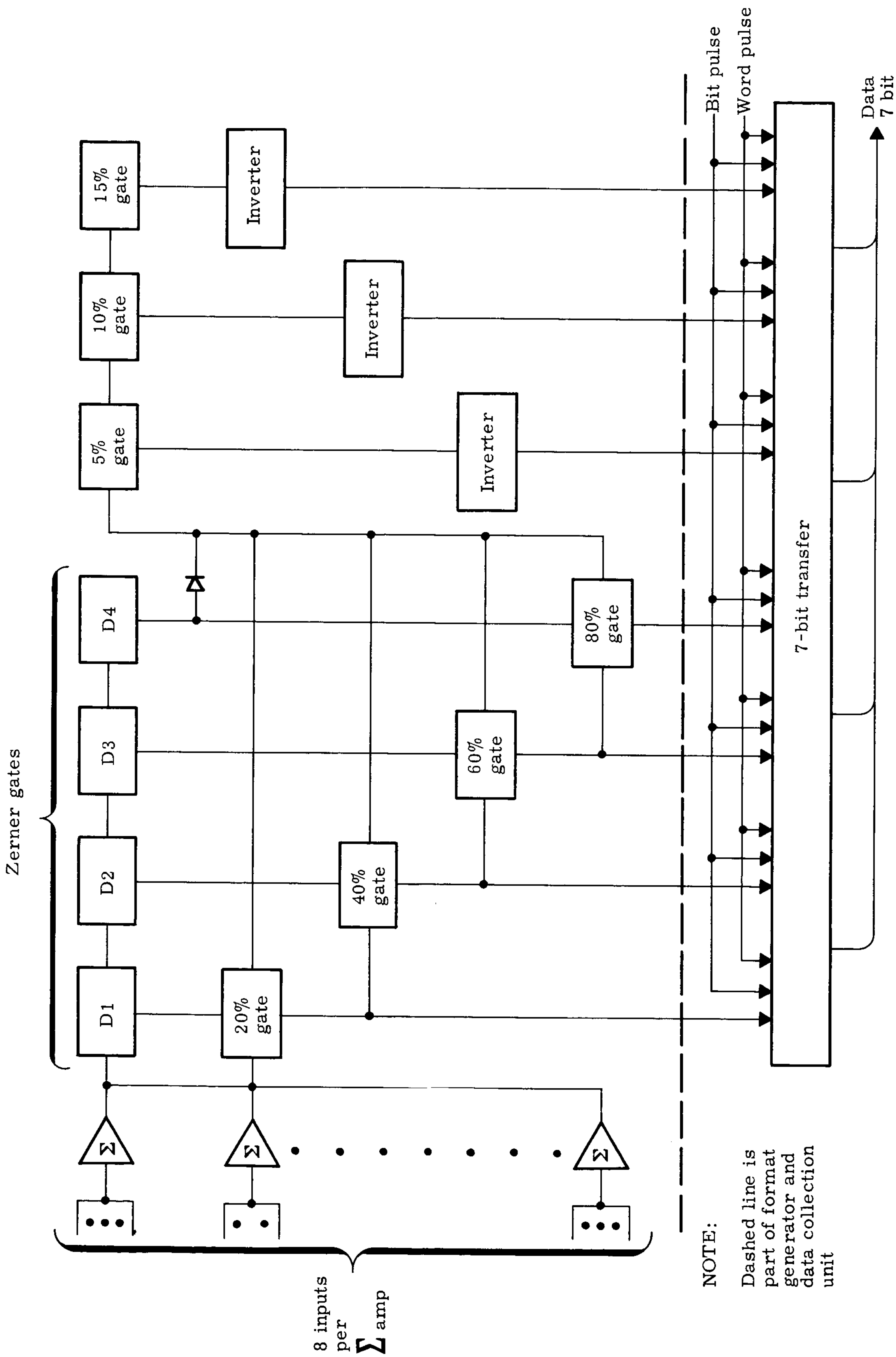
Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Signal Conditioning, Area Multiplexer, Detector for 130 Input Analogs: Configuration No. 1 ($R_{56} \times R_{57} \times R_{58}$, $R_{52} \times R_{53} \times R_{54}$)										
10 x 1 matrix	13	3-leg NANDS--10 per matrix	130	650	130	600				
4-bit counters	2	RSFF--4 per counter	16	64	32	64				
Enable and reset logic	13	Diode gating		65	13	52				
Signal conditioner and detector	1	Amplifiers	3	21	15	34				
	TOTAL		152	800	190	750				
Above totals are for each, of which there are two.										
	TOTAL for both		304	1600	380	1500				
Signal Conditioning, Area Multiplexer, Detector for 128 Input Analogs: Configuration No. 2 ($R_{52} \times R_{53} \times R_{54}$, $R_{56} \times R_{57} \times R_{58}$)										
16 x 8 matrix	16	3-leg NAND --8 per matrix	128	768	128	512				
8-channel commutator	3	8 RSFF per commutator	48	192	48	144				
Miscellaneous	1	RSFF	2	8	2	6				
		2-leg NAND	1	4	2	4				
	TOTAL		179	972	280	666				
Percent Effective Area Circuit for 130 Input Analogs: Configuration No. 3 ($R_{52} \times R_{53} \times R_{54}$, $R_{56} \times R_{57} \times R_{58}$)										
Detection unit	1	17 summation amplifiers	51	272	68	170				
percent effective	1	7 zener gates		7		8				
area logic		4 20% increment gates	8	13	10	4				
		130 limiting resistors		130						
		3 inverters	3	9	4	6				
	TOTAL		62	431	82	188				
Write Logic (R_{60})										
7-bit transfer gates	10	3-leg NAND--7 per gate	70	280	70	350				
14-bit read gate	1	2-leg NAND	14	28	14	42				



Effective Area Multiplexer Unit--Configuration No. 1--($R_{52} \times R_{53} \times R_{54}$) or ($R_{57} \times R_{58} \times R_{59}$)



Area Multiplexer--Configuration No.2--($R_{52} \times R_{53} \times R_{54}$) or ($R_{56} \times R_{57} \times R_{58}$)



Percent Area Multiplexer Unit, Configuration 3--(R_{52} x R_{53} x R_{54}), (R_{56} x R_{57} x R_{58})

TABLE 22 (continued)

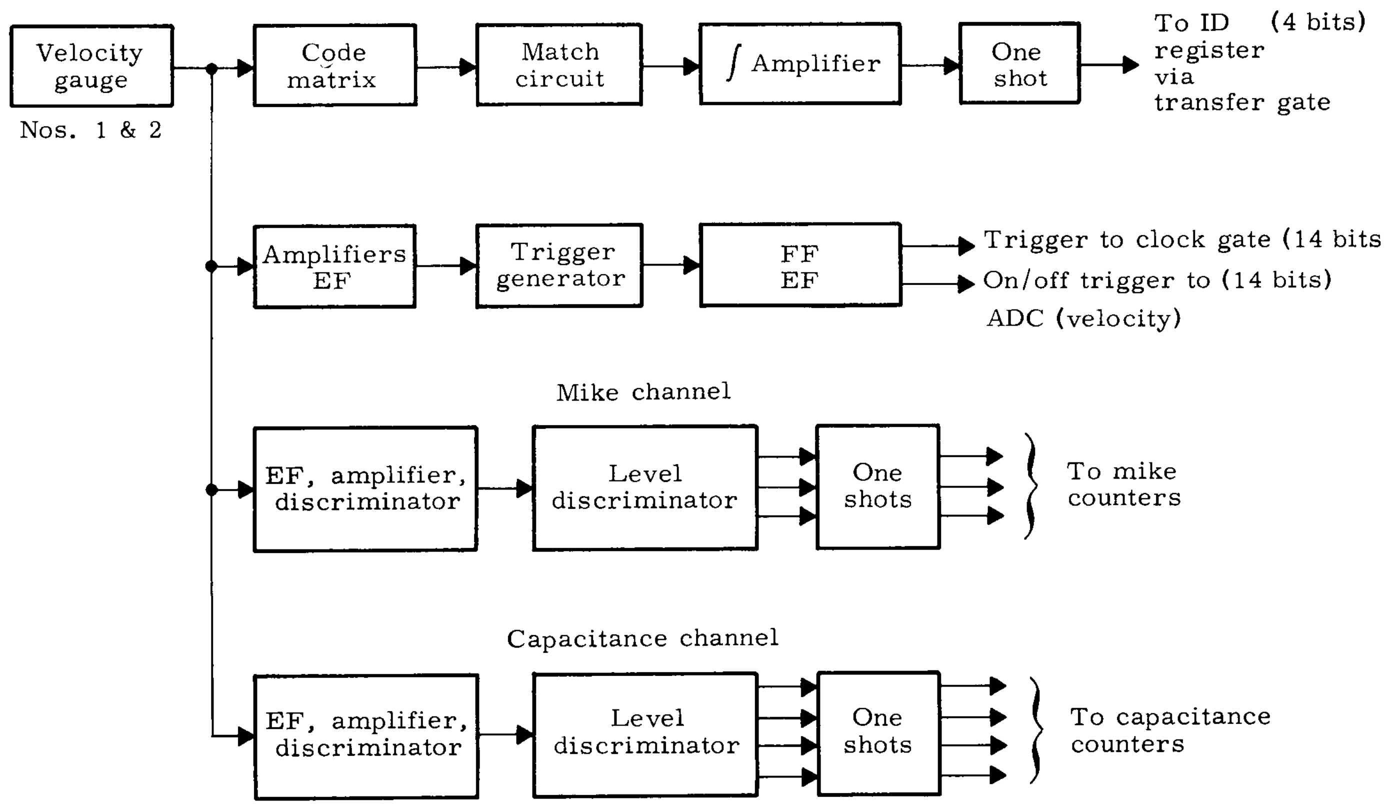
Q = transistor   C = capacitor   L = inductor   CRY = crystal
R = resistor   D = diode   T = transformer   O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
		Write Logic (R_{60})								
Hit time register	1	RSFF (14)	28	112	14	84				
7-bit bay register	1	RSFF (7)	14	48	14	36				
10-word commutator	1	RSFF (10)	20	80	20	80				
Bit generator	1	RSTFF (8)	16	64	32	64				
		RSFF (2)	4	16	4	12				
		Inverter (2)	2	10	2	10				
		2-leg NAND (2)	2	4	2	4				
Bay No. code matrix	1	30 (4-leg) NORS	30	120	30	180				
Miscellaneous		Diode gating and parity generator	1	56	15	45				
	TOTAL		201	818	217	907				
		1000-Bit Core Storage (R_{61})								
1000-bit storage	1	R_{61}	12	28	9	40		3		4650 storage cores
		Mariner Gauge Signal Conditioning ($R_{62} \times R_{63} \times R_{64}$, $R_{65} \times R_{66} \times R_{67}$, $R_{68} \times R_{69} \times R_{70}$)								
Approximately the same parts count as velocity gauge signal conditioning unit, plus an applied factor was used.										
Velocity S/C unit	1		146	543	228	248				
Applied factor			14	77	52	62				
	TOTAL component count		160	620	280	310				
		Above total for each, of which there are 3.								
	TOTAL for 3		480	1260	840	930				

TABLE 22 (continued)

Q = transistor C = capacitor L = inductor CRY = crystal
R = resistor D = diode T = transformer O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Velocity Gauge Signal Conditioning ($R_{71} \times R_{72} \times R_{73}$, $R_{75} \times R_{76} \times R_{77}$)										
Code matrix identification	1	Emitter followers (13)	13	42	13	13				
		4 amplifiers and 4 emitter followers	16	56	20	12				
Identification detectors	4	4 integral amplifiers	12	56	24	8				
		4 one-shots	12	40	16	24				
		2 amplifiers 2 emitter followers	6 2	20 8	8 2	4 2				
Velocity trigger generator	1	2 one-shots	6	20	8	12				
	1	RSFF and emitter followers	3	12	3	7				
Mike level discriminator	1	Emitter follower, amplifier, and detector	7	22	8	9				
		3 complementary flip-flops	12	54	30	36				
Capacitance level discrimination	1	Emitter follower, amplifier, and detector	7	22	8	9				
		4 complementary flip-flops	16	72	40	48				
Memory	1	7 one shots	21	70	28	42				
	Subtotal		133	494	208	226				
	Miscellaneous		13	49	20	22				
	TOTAL		146	543	228	248				
	TOTAL for 2		292	1086	456	496				
Velocity Gauge Counters (R_{74} and R_{78})										
7-bit counter	1	RSFF (7)	14	56	33	56				
	TOTAL for R_{74}		14	56	33	56				
	TOTAL for $R_{78} = 6 \times R_{74}$		84	336	198	336				



EF = emitter follower
FF = flip-flop

Velocity Gauge Signal Conditioning Block Diagram--($R_{71} \times R_{72} \times R_{73}$),($R_{75} \times R_{76} \times R_{77}$)

TABLE 22 (continued)

Q = transistor C = capacitor L = inductor CRY = crystal

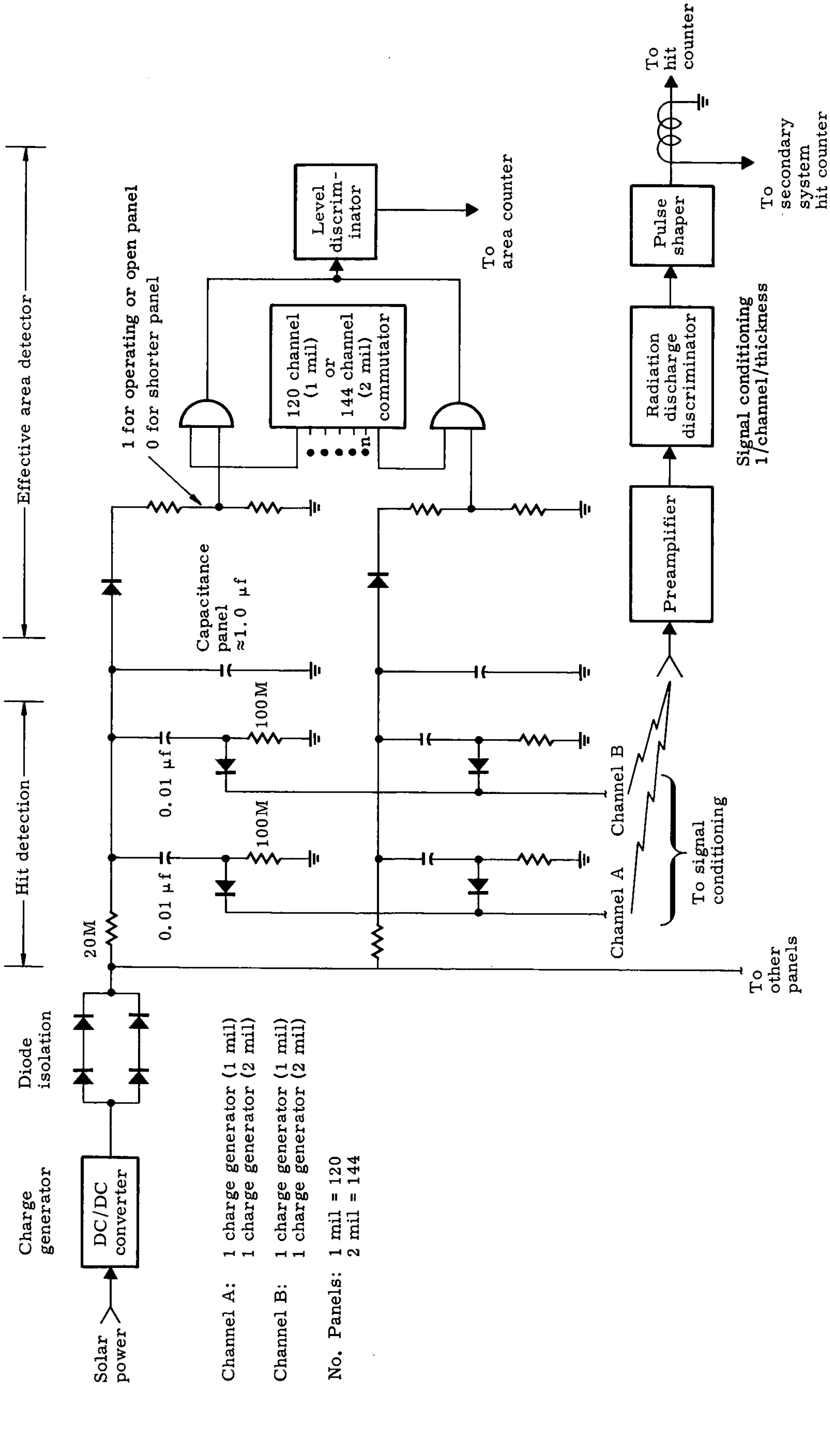
R = resistor D = diode T = transformer O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Vehicle Structure (R_1)										
Structure	1	R_1								
Deploy (R_2)										
Thermal battery	2	R_a, R_f								
Panel actuators	12	R_b (motors and gear trains.)								
Hinges	12 sets	R_c								
Deploy timer	2	R_d, R_e (motor actuated switch)								
Thermal Control: Active (R_3)										
Shutters and hinges	5 pair	R_a, R_c								
Thermostatic control	2	R_b, R_d								
Capacitance Panels: Panel A (R_4)--1 mil; Panel B (R_5)--2 mil										
Panel A--1 mil	120 segments									
Panel B--2 mil	144 segments									
Charge Generator (R_6, R_7, R_8, R_9)										
DC/DC converter	1		2	4	7	6	2	1		

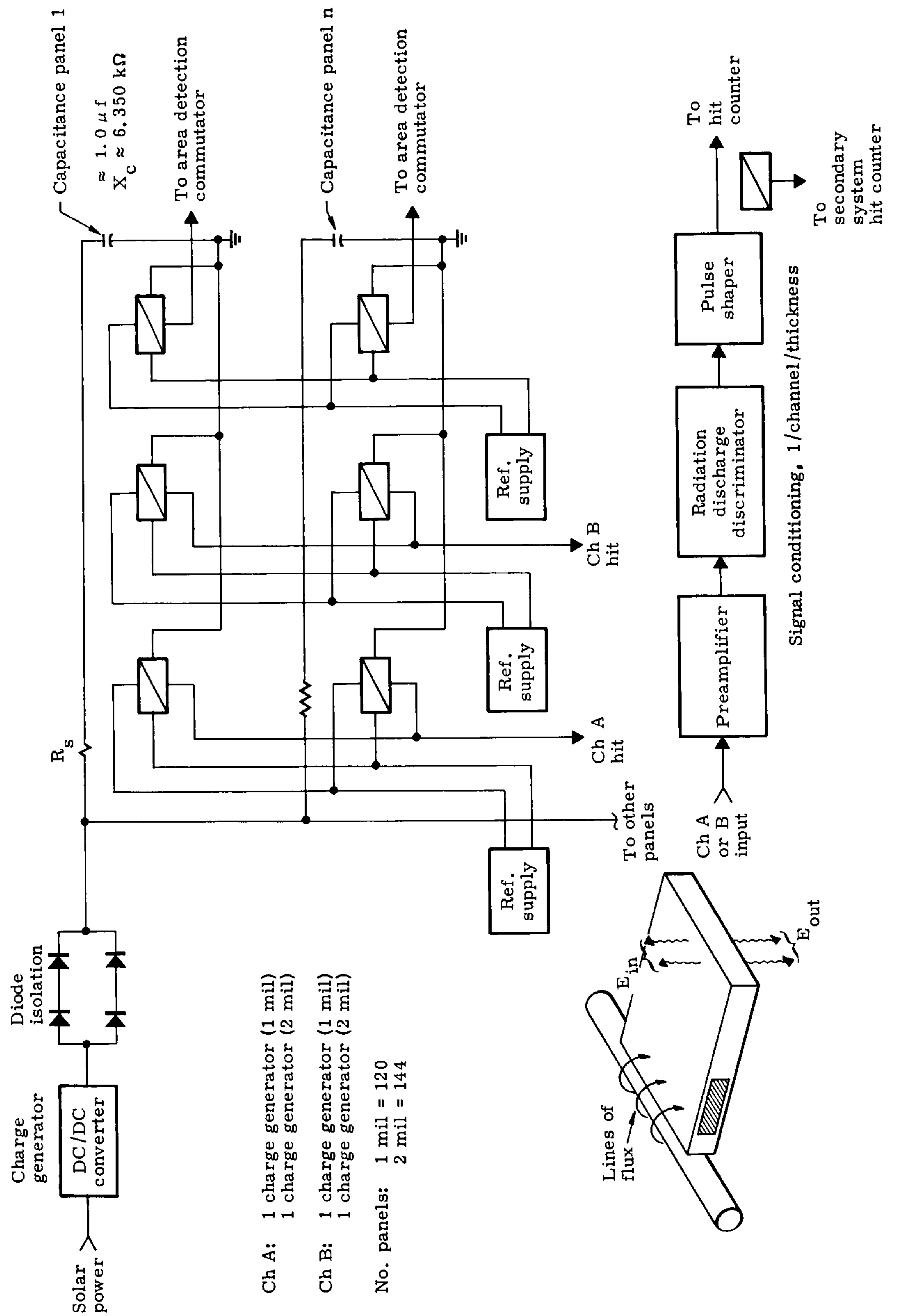
TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
		Charge Generator (R_6, R_7, R_8, R_9)								
Regulator	1		4	10	4	6				
Diode isolator	1					4				
		TOTAL	6	14	11	16	2	1	--	
Above totals give count for each charge generator, of which there are 4.										
		TOTAL for 4	24	56	44	56	8	4		
		Electric Power: Pri I (R_{10})								
Solar array	1	R_g								
Voltage regulator	2	R_h, R_i	4	12	3	4	4			
DC/DC converter	2	R_j, R_k	2	4	4	2	2	1		
Distribution	1	R_l								
Fuses	2	R_m								
		Miscellaneous (R_{11}, R_{14}, R_{26}, R_{29}, R_{40}, R_{42})								
Capacitance panel coupling To Primary Systems		R_{11}, R_{26}		300	180	180				
		R_{14}, R_{27}		360	218	218				
		TOTAL A		660	398	398	for each			
Capacitance panel to indicator To Secondary System		R_{40}, R_{42}		5	3	2	4			
		TOTAL B		5	3	2	4 for each			
		TOTAL capacitance coupling 2 x (A + B)		1330	802	802	8			



Hit and Area Detection



Hall Device Hit and Area Detection

TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

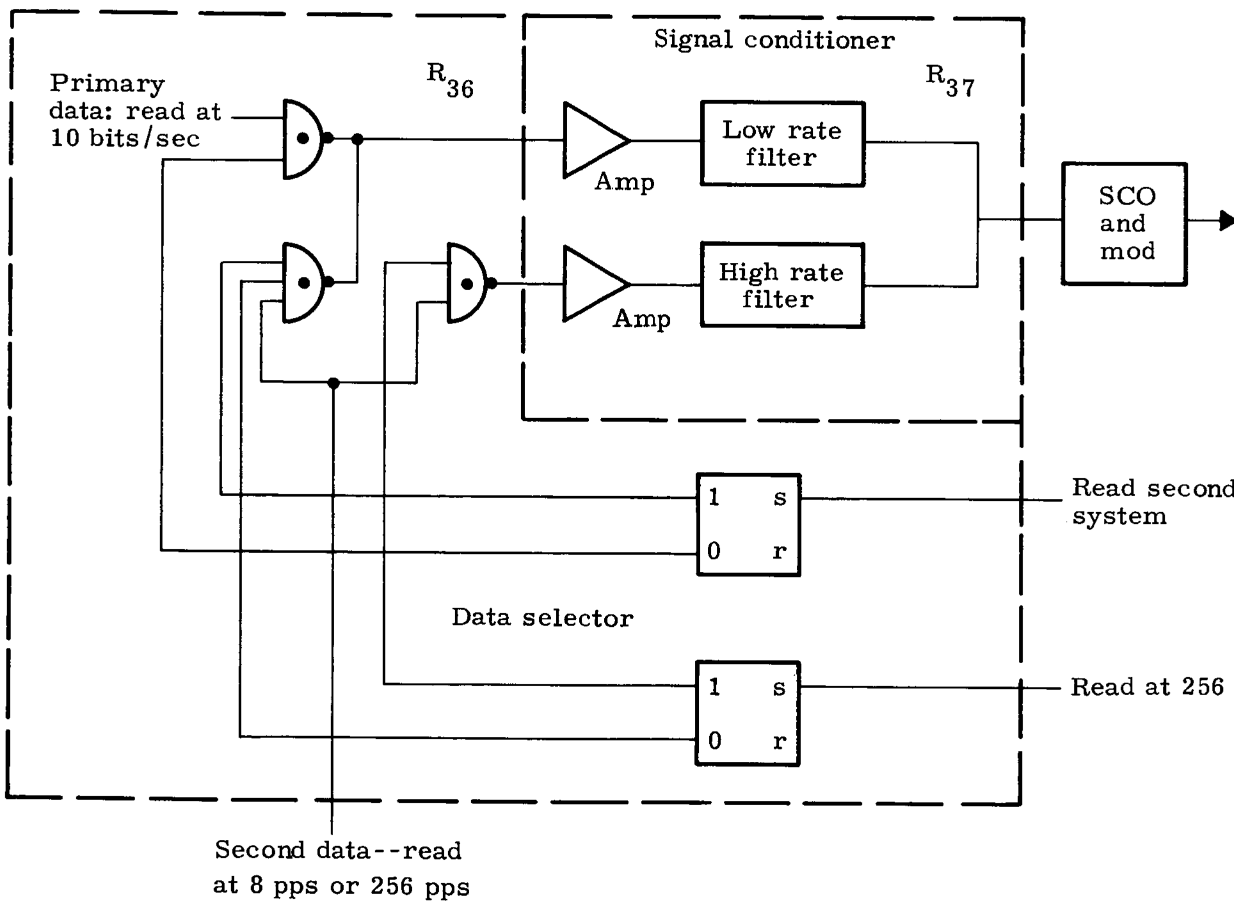
Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Capacitance Panel Signal Conditioning (R_{12}, R_{15}, R_{27}, R_{30})										
Signal conditioning	1	TOTALS	8	40	28	18	3			
Above totals are for each capacitance panel signal conditioning unit, of which there are 4.										
		TOTAL for 4	32	160	112	72	12			
Capacitance Panel Counters (R_{13}, R_{16}, R_{28}, R_{31})										
7-bit counter	1	RSFF (7) TOTALS	14	56	33	56				
Above totals are for each counter, of which there are 4.										
		TOTAL for 4	56	224	132	224				
Format Generator, Master Clock, Commutator ($R_{17} \times R_{18} \times R_{19}$, $R_{32} \times R_{33} \times R_{34}$)										
Clock divider chain	1									
		14 RSTFF	28	112	64	112				
		2 4-deg NANDS	2	8	2	12				
		1 2-deg NANDS	1	2	1	2				
		Oscillator and converter	8	20	10	6			1	
Commutator:	1									
Bit time generator		8 RSTFF	16	64	32	64				
		2 RSFF	4	16	4	12				
		2 inverters	2	10	2	10				
		2 2-leg NANDS	2	4	2	4				
Word time generator		4 RSTFF	8	32	16	32				
Format generator	1	30 3-leg NANDS	30	180	30	121				
		1 inverter	1	5	1	5				
		TOTAL	102	453	164	380			1	
Above totals are for each $R_{17} \times R_{18} \times R_{19}$ or $R_{32} \times R_{33} \times R_{34}$, or which there are 2 units total										
		TOTAL for 2 units	204	906	328	760			2	
Amplifier Shaper (R_{20}, R_{35})										
Amplifier shaper	1		6	18	8	18				
		TOTAL	6	18	8	18				
Above totals are for each amplifier shaper, of which there are 2.										
		TOTAL for 2	12	36	16	36				

TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
		SCO and Phase Modulator ($R_{21}, \lambda_1, \lambda_{11}$)								
SCO and phase modulator	1	TOTALS	8	30	15	9				
		Above totals are for each SCO and phase modulator, of which there are 3.								
		TOTAL for 3	24	90	45	27				
		Modulator Transmitter ($R_{22}, \lambda_2, \lambda_{12}$)								
Modulator transmitter	1	TOTALS	17	55	49	12	31		1	
		Above totals are for each modulator transmitter, of which there are 3.								
		TOTAL for 3	51	165	147	36	93	--	3	
		Diplexer--out (R_{23}, R_{38})								
Diplexer out	1	TOTALS		1	1		1			
		Above totals for each diplexer out, of which there are 2.								
		TOTAL for 2		2	2		2			
		Data Switch (R_{36}) and Signal Conditioner (R_{37})								
Data switch	1	2 RSFF	4	16	4	12				
		1 3-leg NAND	1	4	1	3				
		2 2-leg NAND	2	6	2	4				
		TOTAL for data switch	7	26	7	19				

1. Read primary at 10 bits/sec
2. Read secondary at 8 bits/sec
3. Read secondary at 256 bits/sec



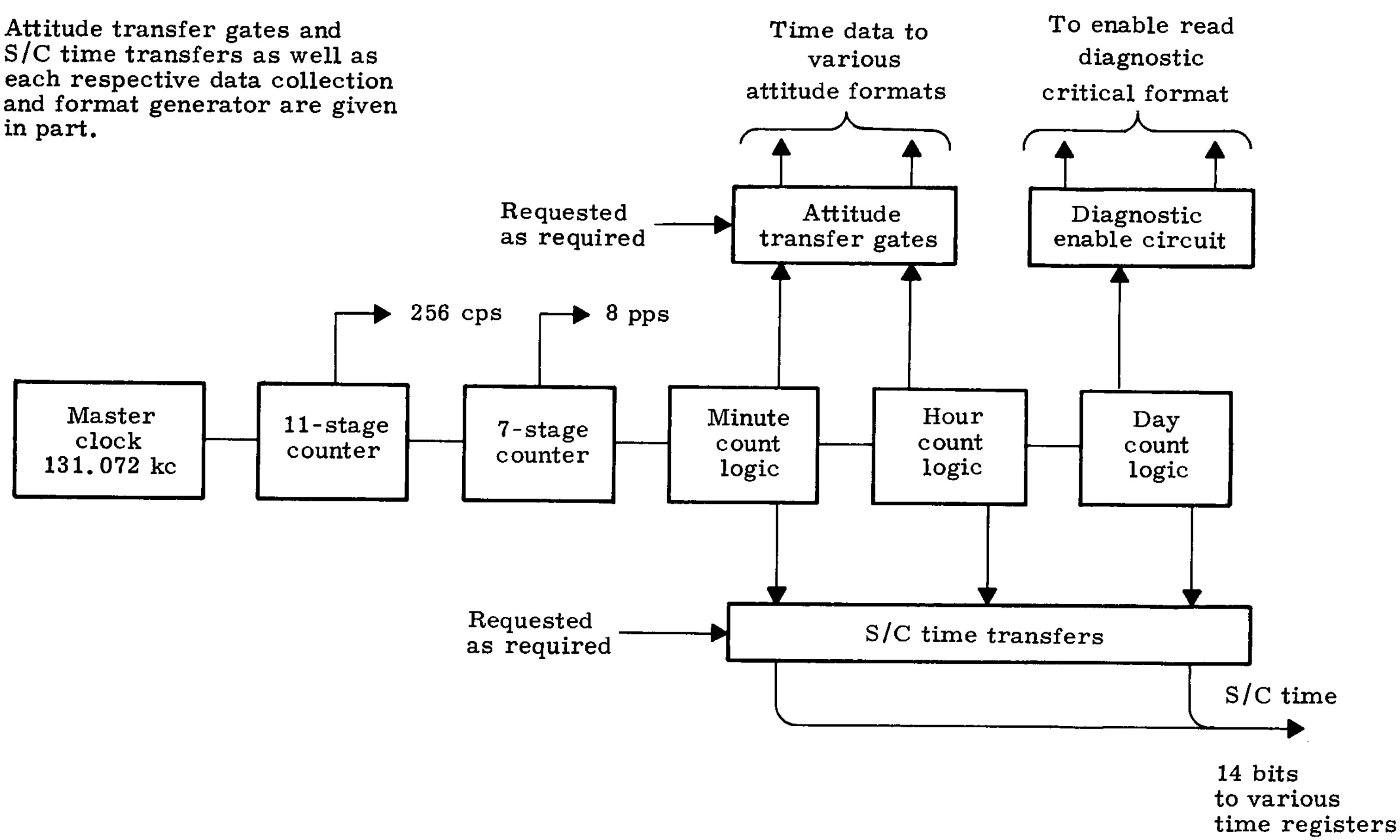
Data Selector and Signal Conditioner

TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Master Clock Logic (R_{117})										
Master clock and main divider	1	RSTFF (20)	40	142	77	132			1	
Minute ÷ logic	1	RSTFF (7) plus gating	16	62	16	46				
Hour ÷ logic	1	RSTFF--7 plus gating	16	62	16	46				
Bay logic	1	Gating	4	12	8	6				
Transfer gates	1	3 -leg NAND (35)	35	140	35	175				
Diagnostic logic	1	Gating	4	20	10	21				
Attitude drive	1	Gating	10	30	14	35				
	Subtotal		125	468	176	461			1	
	Miscellaneous		13	47	18	46				
	TOTAL		138	515	194	507			1	

NOTE: Attitude transfer gates and S/C time transfers as well as each respective data collection and format generator are given in part.



Master Clock Logic--R_{117}

TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Diagnostic and Deployment Commutator (R_{112})										
3-bit counter	1	3 RSFF	6	24	6	18				
		2 2-leg NOR								
		4 2-leg NAND	4	8	4	6				
		Miscellaneous	6	14	6	18				
	TOTAL		18	52	18	46				
Read Logic (R_{113}) and Read Storage Commutator (R_{115})										
Read logic (R_{113})	1	17 RSFF	34	126	34	102				
		7 RSTFF	14	136	28	136				
		22 inverters	22	110	22	110				
		11 3-leg NANDs	11	44	11	55				
		Miscellaneous	9	10	10	25				
	TOTAL		90	426	105	426				
Read storage commutator (R_{115})	1	4 4-leg NANDs, 3 2-leg NANDs and miscellaneous gating	11	50	15	50				
	TOTAL		11	50	15	50				
Sync Frame Generator (R_{114})										
8-bit transfer gate (R_{114})	2	2-leg NAND 8 per gate plus miscellaneous	24	96	24	120				
		2 RSFF	4	16	4	12				
	TOTAL		28	112	28	132				
Memory Overflow Data Collection and Format Generation (R_{116})										
10-word commutator	1	RSFF (10) plus gating and reset	20	80	20	80				
8-bit commutator	1	RSTFF (8) plus gating and reset logic	24	94	42	94				
7-bit transfer gate	7	3-leg NAND--7 per gate	49	147	49	245				
7-bit counter	4	RSFF--7 per counter	28	224	28	168				
		Miscellaneous diode gating and built in redundancy	84	269	84	219				
	TOTAL		205	807	223	806				

TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Diagnostic Sensor No. 3 Unit, Signal Conditioning, and Multiplexer ($R_{105} \times R_{106}$, R_{107})										
Diagnostic No. 3 multiplexers (R_{107})	1	Commutator, ADC and gating	330	1060	440	750				
	TOTAL		330	1060	440	750				
Critical Diagnostic No. 3 Data Collection and Format Generator (R_{108})										
7-bit hold register	22	RSFF--7 per register plus miscellaneous gating	315	1300	315	950				
10-word format generator	2	Bit and word generators	175	700	175	875				
Commutator	2	3-leg NANDs--75 per commutator	150	575	192	541				
	Subtotal		640	2575	682	2366				
		Miscellaneous gating	64	259	69	236				
	TOTAL		704	2834	751	2602				
Deployment Sensors, Multiplexer, Data Format Generator ($R_{109} \times R_{110} \times R_{111}$)										
10-bit commutator	1	70 3-leg NANDs	70	280	70	350				
10-word commutator	1	Bit and word generators	59	230	77	215				
Miscellandous (R_{111})		3 3-leg NOR	3	15	3	6				
		3 leg NAND	1	2	1	3				
	TOTAL		133	527	151	574				
Multiplexer (R_{110})	1	21 3-leg NANDs totals	21	105	21	42				
	Miscellaneous: Sensors, gating, and signal conditioning		15	28	19	119				
	GRAND TOTAL ($R_{109} \times R_{110} \times R_{111}$)		169	660	191	735				

TABLE 22 (continued)

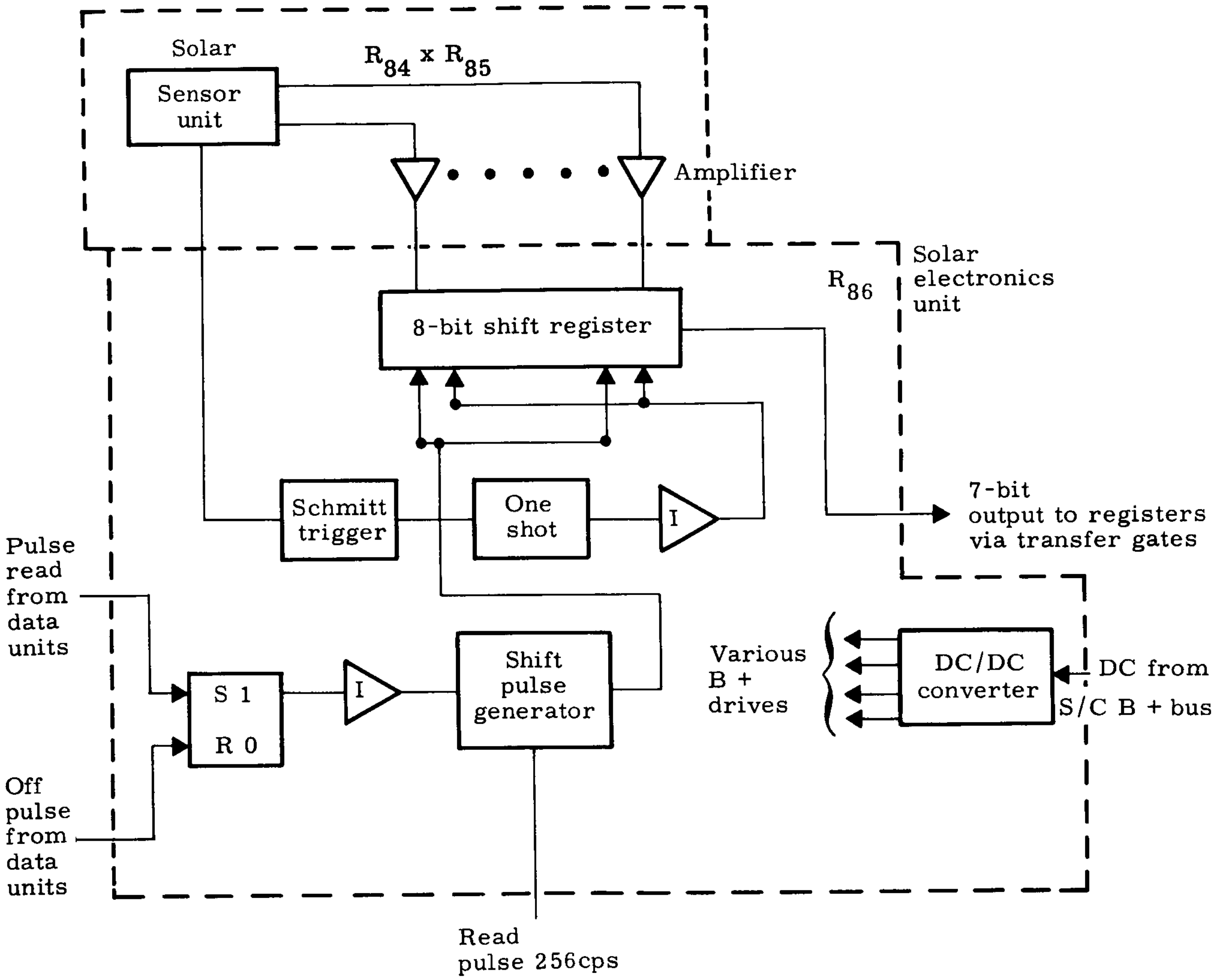
Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Select Switch (R_{100})										
Select switch (R_{100})	1	3 3-leg NAND	3	12	3	15				
		1 3-leg NOR	1	5	1	2				
	TOTAL		4	17	4	17				
Diagnostic Sensor No. 2 Unit, Signal Conditioning, and Multiplexer (R_{101} x R_{102}, R_{103})										
Diagnostic No. 2 unit and signal conditioning		42 A signal conditioning	168	840	353	672				
		4 A signal conditioning	16	80	49	64				
		12 B signal conditioning	36	160	90	128				
		2 C signal conditioning	4	20	8	16				
	TOTAL		224	1100	500	880				
Diagnostic No. 2	1	Commutator, ADC and gating logic	330	1060	440	750				
	TOTAL		330	1060	440	750				
Critical Diagnostic No. 2 Data Collection and Format Generator (R_{104})										
7-bit holdregister	22	RSFF--7 per register plus miscellaneous gating	315	1300	315	950				
10-word format generator		2 bit and word generators	175	700	175	875				
Commutator		2 3-leg NANDS--75 per commutator	150	575	192	541				
		Miscellaneous gating	64	259	69	236				
	TOTAL		704	2834	751	2602				
Diagnostic Sensor No. 3 Unit, Signal Conditioning, and Multiplexer (R_{105} x R_{106}, R_{107})										
Diagnostic No. 3 unit (R_{105} x R_{106})	1	42 A signal conditioning	168	840	353	672				
		4 A signal conditioning	16	80	49	64				
		12 B signal conditioning	36	160	90	128				
		2 C signal conditioning	4	20	8	16				
	TOTAL		224	1100	500	880				

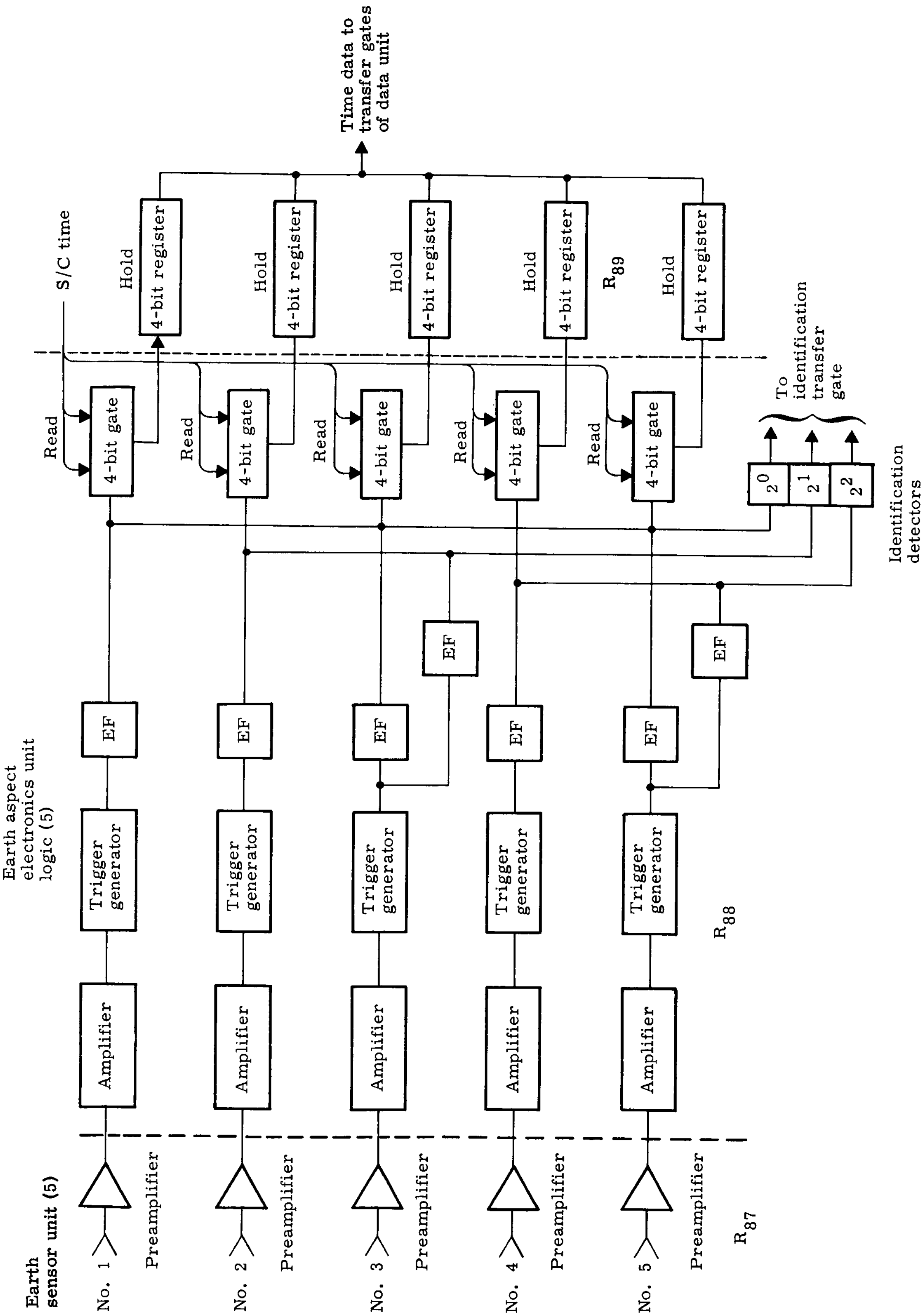
TABLE 22 (continued)

Q = transistor, R = resistor, C = capacitor, D = diode, L = inductor, T = transformer, CRY = crystal, O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Solar Aspect Unit, Signal Conditioning, and Register (R_{84} x R_{85} x R_{86})										
		DC/DC converter	8	30	4	3	4	1		
		One-shot	2	10	2	4				
		RSFF	2	8	2	6				
	TOTAL		18	72	14	28	20	1		
	TOTAL for 5		90	360	70	140		5		
8-bit shift register (R_{86})	1	RSTFF (8) total	16	64	32	64				
	TOTAL for 5		80	320	160	320				
	GRAND TOTAL		275	1310	510	810	20	5		
Earth Aspect Unit, Signal Conditioning, and Register (R_{87} x R_{88} x R_{89})										
Earth aspect unit (R_{87})	5	Preamplifiers total for 5	20	75	15	10				
Earth aspect signal conditioning (R_{88})	5	5 amplifiers	15	60	10	8				
		5 trigger generators	10	50	15	25				
		3 detectors	9	36	21	18				
			7	28	7	7				
	TOTAL for 5		41	174	53	58				
Earth aspect electronic unit (R_{89})	5									
4 bit transfer gates	5	2-leg NANDS--4 per gate	20	40	20	60				
4 bit registers	5	RSFF--4 per register	40	160	40	120				
	TOTAL for all		60	200	60	180				
	GRAND TOTAL		121	449	128	248				



Solar Aspect Sensor Logic--R_{84} x R_{85} x R_{86}

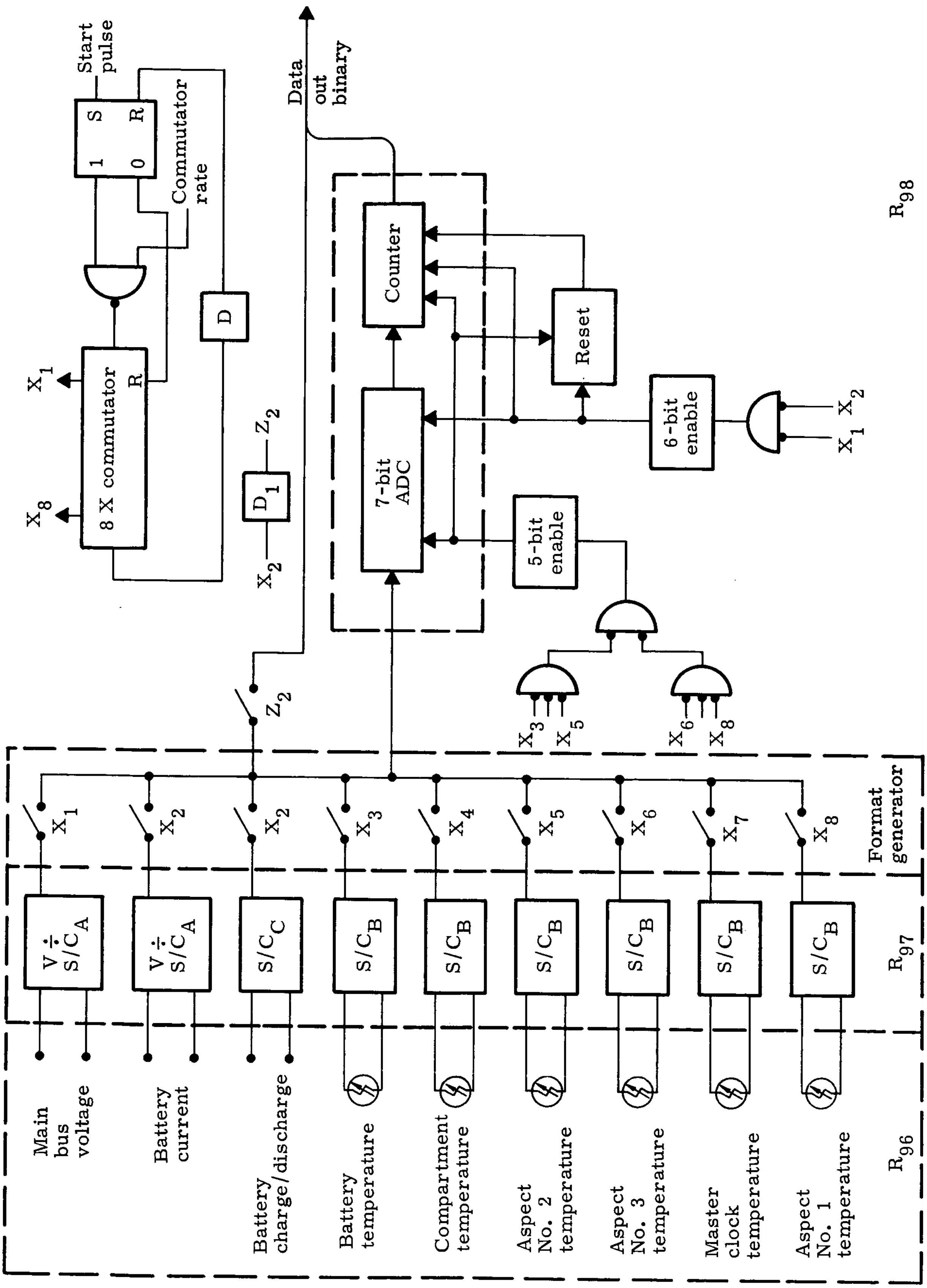


Earth Aspect Unit, Signal Conditioning and Electrical Unit--R_{87} x R_{88} x R_{89}

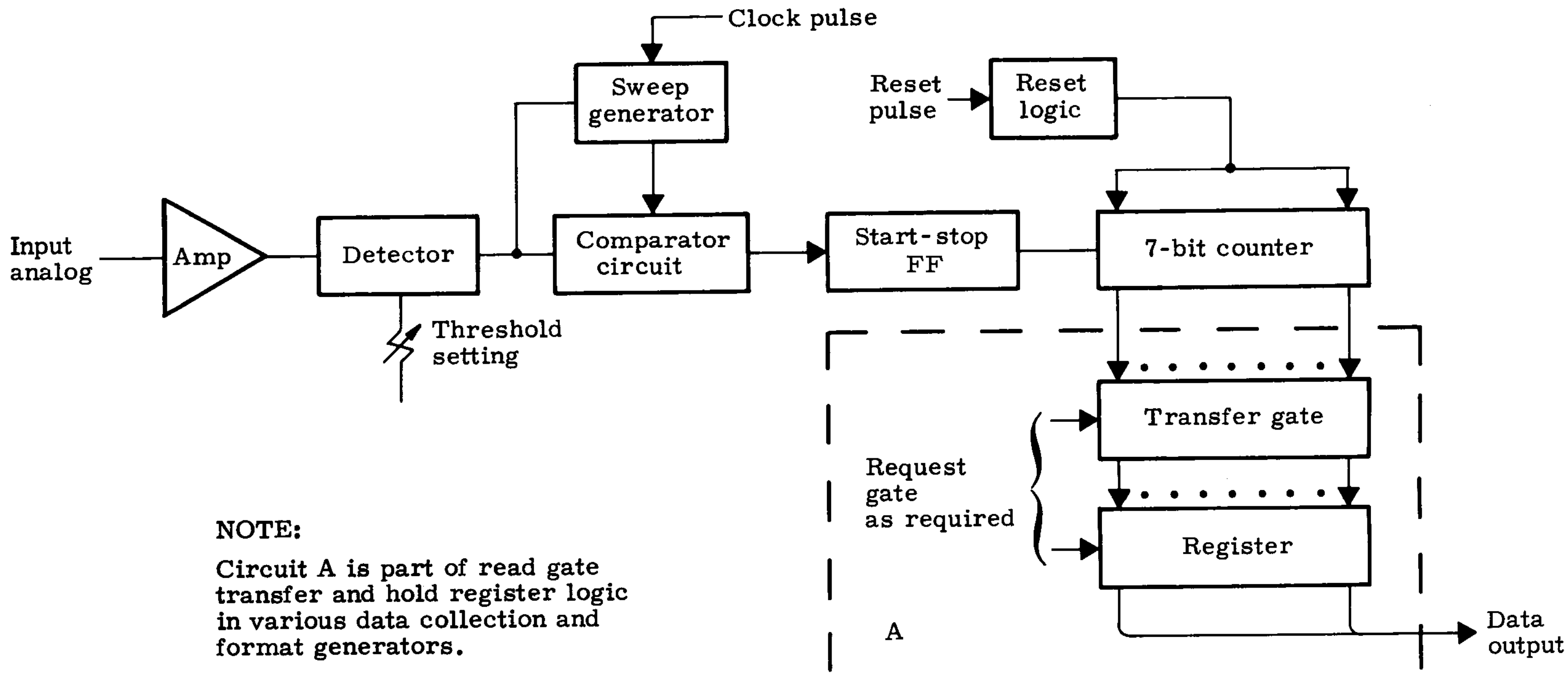
TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Full Attitude Data Collection and Format Generator (R_{94})										
		Miscellaneous	40	160	45	142				
	TOTAL		253	1005	276	960				
12, 000-Bit Core Storage (R_{95})										
12, 000-bit core storage		R_{95}	137	348	116	478		37		60, 000 storage cores
Critical Diagnostic No. 1 Unit and Multiplexer (R_{96} x R_{97}, R_{98})										
Critical dignostic No. 1 unit (R_{96} x R_{97})	1	21 signal conditioning A								
		2 signal conditioning A								
		6 signal conditioning B								
		1 signal conditioning C								
	TOTAL		112	554	224	442				
Multiplexer unit (R_{98})	1	7 bit ADC	33	128	42	81				
		8 channel commutator 20 2-leg NANDS	24	94	40	90				
		Counter and reset logic	24	80	32	48				
		Enble logic	8	16	8	24				
		Miscellaneous gating	48	160	64	96				
	TOTAL		137	478	186	339				
Critical Diagnostic No. 1 Data Collection and Format Generator (R_{99})										
7-bit transfer gate	1	3-leg NAND read (33)	33	128	42	81				
7-bit hold register	9	RSFF--7 per register	126	505	126	378				
10-word format generator	1	70 (3-leg) NANDS	70	280	70	350				
Commutator	1	Bit and word generators--28 RSFF and gating	59	230	77	215				
		Miscellaneous	110	420	124	240				
	TOTAL		398	1563	439	1264				



Critical Diagnostic Configuration No. 1--R_{96} x R_{97} x R_{98}



NOTE:
Circuit A is part of read gate transfer and hold register logic in various data collection and format generators.

Parts count for 7-bit A/D converter

Item	R	C	D	Q
Amplifier, detector, and sweep generator	52	19	27	14
Comparator circuit and start-stop reset	12	9	12	5
7-bit counter	64	14	42	14
Totals	128	42	81	33

Typical 7-Bit A/D Converter Unit

TABLE 22 (continued)

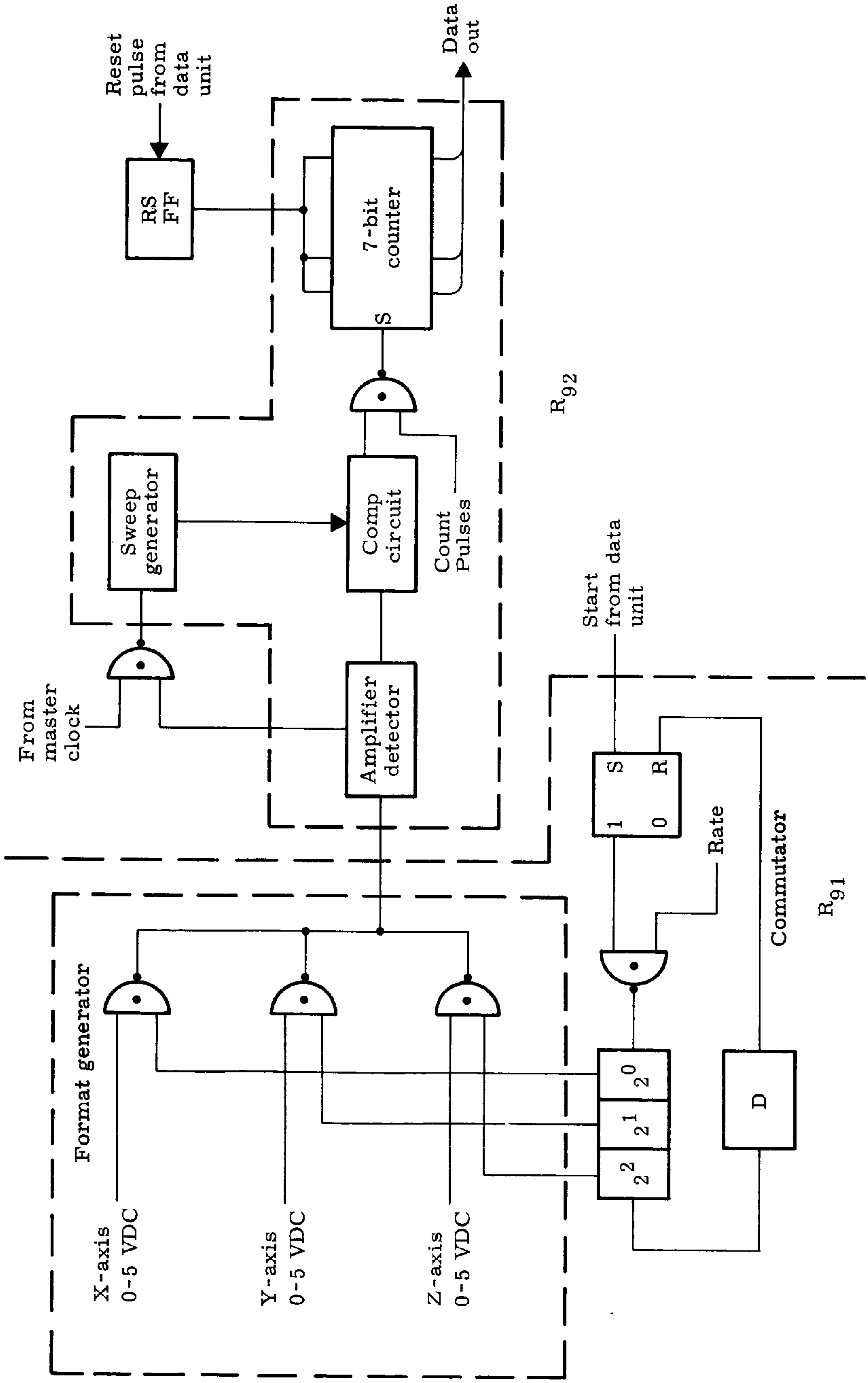
Q = transistor C = capacitor L = inductor CRY = crystal
R = resistor D = diode T = transformer O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Mariner Gauge Data Collection and Format Generation (R_{79})										
Hit time read gate	1	2-leg NAND (14)	14	28	14	42				
Hit time register	1	RSFF (14)	28	112	14	84				
7-bit transfer gate	10	3-leg NAND--7 per gate	70	280	70	350				
10-word commutator	1	RSFF (10)	20	80	20	80				
8-bit commutator	1	RSFF (8)	16	64	32	64				
Parity generator	1	RSFF and emitter follower	3	11	3	11				
Miscellaneous		2 RSFF	4	16	4	12				
		3-leg NOR	1	5	1	2				
		2-leg NAND	1	2	1	3				
		2 2-leg NOR and diode gates	2	6	2	14				
		TOTAL	159	604	161	662				
Mariner Gauge Counter (R_{80})										
7-bit counter	1	RSFF (7)	14	56	33	56				
		Partial total	14	56	33	56				
		R_{80} = 6 x Partial total	84	336	198	336				
Velocity Gauge Write Logic (R_{81})										
Time read gate	1	2-leg NAND (14)	14	28	14	42				
Time register	1	RSFF (14)	28	112	14	84				
7-bit transfer gate	4	3-leg NAND--7 per gate	35	100	35	135				
10-word commutator	1	Bit and word generators	29	150	29	150				

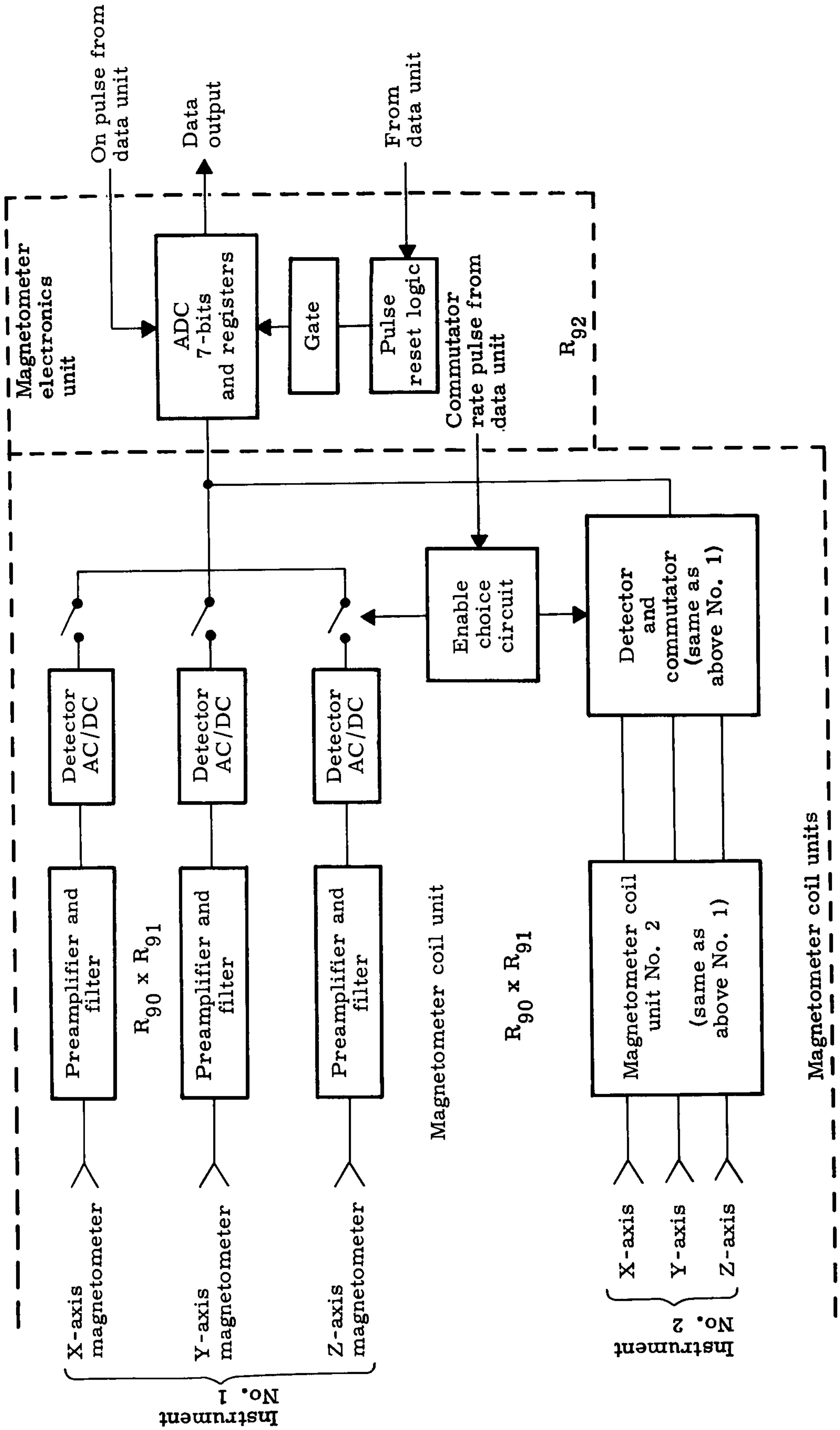
TABLE 22 (continued)

Q = transistor
R = resistor
C = capacitor
D = diode
L = inductor
T = transformer
CRY = crystal
O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Magnetometer Unit, Electronic Unit and Registers (R_{90}, R_{91}, R_{92})										
Magnetometer unit (R_{90})	2	3 preamplifiers and filters	9	45	9	9	6			
		3 AC/DC detectors	6	31	4	8				
	TOTAL		15	76	13	17	6			
Electronic unit (R_{91})	1	3 input commutator	12	36	15	31				
		7 bit ADC	33	128	42	81				
		Time logic	12	44	19	39				
		Miscellaneous gating	5	17	7	10				
	TOTAL		62	225	83	161				
7-bit register (R_{92})	1	RSFF (7) Totals	14	56	33	56				
	TOTAL for 6		84	336	198	336				
Hourly Attitude Write Logic (R_{93})										
7-bit hold register	8	RSFF--7 per register	112	448	112	335				
10-word format	1	70 (3-leg) NANDs	70	280	70	350				
Commutator	1	Word and bit generators	59	230	77	215				
Miscellaneous	1	Gating	75	296	81	278				
	TOTAL		316	1254	340	1178				
Full Attitude Data Collection and Format Generator (R_{94})										
10-word commutator	1	70 3-leg NANDS	70	280	70	350				
10-~~bit~~ commutator	1	Word and bit generators	59	230	77	215				
7-bit registers	6	RSFF--7 per register	84	335	84	253				



Magnetometer Electronics Unit--R_{91} x R_{92}



Magnetometer Block Diagram--R_{90} x R_{91} x R_{92}

TABLE 22 (continued)

Q = transistor; R = resistor; C = capacitor; D = diode; L = inductor; T = transformer; CRY = crystal; O = other

Unit	No.	Basic	Q	R	C	D	L	T	CRY	O
Velocity Gauge Write Logic (R_{81})										
Time read gate	1	2-leg NAND (14)	14	28	14	42				
Time register	1	RSFF (14)	28	112	14	84				
7 bit transfer gate	4	3-leg NANDS--7 per gate	35	100	35	125				
Commutator	1	Bit and word generators	29	150	29	150				
Miscellaneous			4	10	4	9				
		TOTAL	110	400	110	410				
Write Logic Mariner Velocity (R_{82})										
R_{82}	1	3 2-leg NAND	3	6	3	6				
		2 RSFF	4	16	8	18				
		TOTAL	7	22	11	18				
10,000-Bit Core Storage (R_{83})										
10,000-bit storage	1	R_{83}	118	290	96	392		31		50,500 storage cores
Solar Aspect Unit, Signal Conditioning, and Register (R_{84} x R_{85} x R_{86})										
Solar aspect cell amplifier, (T_{84})	7	7/aspect sensor total	21	126	56	70				
	TOTAL for 5		105	630	280	350				
	1	1 Schmitt trigger generator	2	9	2	2				
		2 Inverter	2	10	2	10				
		1 Shift pulse generator	2	5	2	3				

TABLE 23

Equipment Failure Rates--High Quality Parts

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Capacitance	4	0.040	0.0040	0.400	0.040
		Diode	2	0.040	0.0040	0.400	0.040
		Transformer	1	0.030	0.0030	0.300	0.030
		Total		0.284	0.0284	2.72	0.272
	Fuse, continuous R_m		2	0.060	0.006	0.600	0.600
	Fuse, intermittent		2	0.160	0.016	1.600	1.600
	Distribution for R_{10}, R_ℓ	Bus, wires		0.1			0.1
	Distribution for R_{25}, R_w	Bus, wires		0.5			0.25
	Battery with heater R_r, R_x	Cycle battery	1	2.45			2.45
Deploy (R_2)	Panel actuators R_b	One shot	12	240			
	Hinges R_c	Sets	12	60			
	Deploy timer R_d, R_e	500 MCBF	2	2000			
	Thermal battery R_a, R_f	50 MCBF	2	20,000			
Thermal control (R_3)	Shutters and hinges R_a, R_c	(Spares-4 required)		1.0		1.5	
	Thermo static control R_b, R_d			1.0		1.5	

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
R_{12}, R_{15}, R_{27}, R_{30}	Signal conditioning A or B	Inductance	3	0.075	0.007	0.990	0.099
		Transistor	8	0.336	0.034	3.680	0.368
		Resistor (composition)	40	0.400	0.040	0.400	0.040
		Capacitor	28	0.280	0.028	2.800	0.280
		Diodes	18	0.360	0.036	3.600	0.360
		Total		1.451	0.145	11.470	1.147
R_6, R_7, R_8, R_9	Charge generator	Inductances	2	0.050	0.005	0.660	0.066
		Transistors	6	0.252	0.025	2.760	0.276
		Resistors	14	0.140	0.014	0.140	0.014
		Capacitors	11	0.110	0.011	1.100	0.110
		Diodes	16	0.320	0.032	3.200	0.320
		Transformer (LV)	1	0.030	0.003	0.300	0.030
		Total		0.902	0.090	8.160	0.816
R_{13}, R_{16}, R_{28}, R_{31}	Counter	Transistors	14	0.588	0.0588	6.440	0.644
		Resistors	56	0.560	0.0560	0.560	0.056
		Capacitors	33	0.330	0.0330	3.300	0.330
		Diodes	56	1.120	0.1120	11.200	1.120
		Total		2.598	0.2598	21.500	2.150
$R_{17} \times R_{18} \times R_{19}$, $R_{32} \times R_{33} \times R_{34}$	Organization unit	Transistors	102	4.284	0.428	47.000	4.700
		Resistors	453	4.530	0.453	4.530	0.453
		Capacitors	164	1.640	0.164	16.400	1.640
		Diodes	380	7.600	0.760	76.000	7.600
		Total		18.054	1.805	143.930	14.393
R_{11}, R_{26}	Capacitor panel A coupling	Resistors	300	3.000	0.300	3.000	0.300

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Diodes	598	11.760	1.176	117.600	11.760
		Total		27.610	2.761	220.170	22.017
	Programmer for automatic on/off transmission in primary system	Transistors	60	2.520	0.252	27.600	2.760
		Resistors	245	2.450	0.245	2.520	0.245
		Capacitors	94	0.940	0.094	9.400	0.940
		Diodes	180	3.600	0.360	36.000	3.600
		Total		9.510	0.951	75.520	7.545
R_{21} λ λ_1, λ_{11}	SCO and phase modulator	Transistors	8	0.336	0.034	3.680	0.368
		Resistors	30	0.300	0.030	0.300	0.030
		Capacitors	15	0.150	0.015	1.500	0.150
		Diodes	9	0.180	0.018	1.800	0.180
		Total		0.966	0.097	7.280	0.728
R_{22} λ_2, λ_{12}	Modulator transmitter	Transistors	17	0.714	0.071	7.820	0.782
		Resistors	55	0.550	0.055	0.550	0.055
		Diodes	12	0.240	0.024	2.400	0.240
		Capacitors	49	0.490	0.049	4.900	0.490
		Inductance	31	0.772	0.077	10.230	1.023
		Crystal	1	0.600	1.100	2.200	1.100
		Total		3.366	1.376	28.100	3.690
R_{23}, R_{38}	Diplexer (out)	Resistor	1	0.010	0.001	0.010	0.001
		Capacitor	1	0.010	0.001	0.100	0.010
		Inductance	1	0.025	0.002	0.330	0.033
		Total		0.045	0.004	0.440	0.044
R_{24}, R_{30}	Hybrid	Coaxial line	1	0.500	0.050	1.000	0.100
	Transmitter switch command automatic on/off	Transistors	4	0.168	0.017	1.840	0.184

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Diodes	180	3.600	0.360	36.000	3.600
		Capacitors	180	1.800	0.180	18.000	1.800
		Total		8.400	0.840	57.000	5.700
R_{14}, R_{29}	Capacitor panel capacitor coupling B	Resistors	360	3.600	0.360	3.600	0.360
		Diodes	218	4.360	0.436	43.600	4.360
		Capacitors	218	2.180	0.218	21.800	2.180
		Total		10.140	1.014	69.000	6.900
R_{40}, R_{42}	Capacitor panel coupling into secondary	Inductance	4	0.100	0.010	1.320	0.1312
		Resistors	5	0.050	0.005	0.050	0.005
		Diodes	2	0.040	0.004	0.400	0.040
		Capacitors	3	0.030	0.003	0.300	0.030
		Total		0.220	0.022	2.070	0.207
R_{20}, R_{35}	Amplifier shaper	Transistors	6	0.252	0.025	2.760	0.276
		Resistors	18	0.180	0.018	0.180	0.018
		Capacitors	8	0.080	0.008	0.800	0.080
		Diodes	18	0.360	0.036	3.600	0.360
		Total		0.872	0.087	7.340	0.734
	Organization unit plus area or Exotech in primary system	Transistors	122	5.120	0.512	56.000	5.600
		Resistors	565	5.650	0.565	5.650	0.565
		Capacitors	288	2.880	0.288	28.800	2.880
		Diodes	480	9.600	0.960	96.000	9.600
		Total		23.250	2.325	186.450	18.645
	Organization unit plus area plus Exotech counters in primary system	Transistors	142	6.000	0.600	65.000	6.500
		Resistors	677	6.770	0.677	6.770	0.677
		Capacitors	308	3.080	0.308	30.800	3.080

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Resistors	4	0.040	0.004	0.040	0.004
		Diodes	4	0.040	0.004	0.400	0.040
		Switching relay	2	1.000	0.100	1.000	0.100
		Total		1.248	0.125	3.280	0.328
λ_4	Command logic	Resistors	16	0.160	0.016	0.160	0.016
		Diodes	13	0.260	0.026	2.600	0.260
		Capacitors	3	0.030	0.003	0.300	0.030
		Relays	20	0.200	0.200	0.200	0.200
		Total		0.650	0.245	3.260	0.506
λ_3	Transmitter switch	Transistors	4	0.168	0.017	1.840	0.184
		Resistors	4	0.040	0.004	0.040	0.004
		Capacitors	4	0.040	0.004	0.400	0.040
		Switching relay	4	2.000	2.000	2.000	2.000
		Total		2.248	2.025	4.280	2.228
λ_5, λ_8	Diplexer (in)	Resistor	1	0.010	0.001	0.010	0.001
		Capacitor	1	0.010	0.001	0.100	0.010
		Inductance	1	0.025	0.003	0.330	0.033
		Total		0.045	0.005	0.440	0.044
R_{36}	Data switch	Transistors	7	0.294	0.029	3.320	0.332
		Resistors	26	0.260	0.026	0.260	0.026
		Diodes	19	0.380	0.038	3.800	0.380
		Capacitors	7	0.070	0.007	0.700	0.070
		Total		1.004	0.100	8.080	0.808
R_{37}	Signal conditioner	Transistors	4	0.168	0.017	1.840	0.184
		Resistors	16	0.160	0.016	0.160	0.016

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period		Orbital Dark Period	
				Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$	Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$
		Diodes	4	0.080	0.008	0.800	0.080
		Capacitors	10	0.100	0.010	1.000	0.100
		Inductances	2	0.050	0.005	0.066	0.066
		Total		0.558	0.056	3.866	0.446
λ_6, λ_9	Command receiver	Transistors	10	0.420	0.042	4.600	0.460
		Resistors	48	0.480	0.048	0.480	0.048
		Diodes	4	0.080	0.008	0.800	0.080
		Capacitors	53	0.530	0.053	5.300	0.530
		Inductances	18	0.450	0.045	6.670	0.667
		Total		1.960	0.196	17.850	1.785
λ_7, λ_{10}	Command decoder	Transistors	10	0.420	0.042	4.600	0.460
		Resistors	45	0.450	0.045	0.450	0.045
		Capacitors	50	0.500	0.050	5.000	0.500
		Inductances	4	0.100	0.010	1.320	0.132
		Relays (standard)	15	0.150	0.150	0.150	0.150
		Diodes	5	0.100	0.010	1.000	0.100
		Total		1.720	0.307	12.520	1.387
$R_{44} \times R_{45}$, $R_{48} \times R_{49}$	Exotech signal conditioning A or B	Transistors	72	3.024	0.302	33.120	3.312
		Resistors	306	3.060	0.306	3.060	0.306
		Capacitors	90	0.900	0.090	9.000	0.900
		Diodes	52	1.040	0.104	10.400	1.040
		Inductances	18	0.450	0.045	0.694	0.694
		Total		8.474	0.847	56.274	6.252
R_{46}, R_{50}	Exotech detector	Transistors	25	1.050	0.105	11.400	1.140
		Resistors	94	0.940	0.094	0.940	0.094

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Capacitors	39	0.390	0.039	3.900	0.390
		Diodes	55	1.100	0.110	11.000	1.100
		Total		3.480	0.348	27.240	2.724
$R_{52} \times R_{53} \times R_{54}$, $R_{56} \times R_{57} \times R_{58}$	130 Input area multiplexer and signal conditioning	Transistors	152	6.384	0.638	69.920	6.992
		Resistors	800	8.000	0.800	8.000	0.800
		Capacitors	190	1.900	0.190	19.000	1.900
		Diodes	750	15.000	1.500	150.000	15.000
		Total		31.284	3.128	246.920	24.692
$R_{62} \times R_{63} \times R_{64}$, $R_{65} \times R_{66} \times R_{67}$, $R_{68} \times R_{69} \times R_{70}$	Mariner gauge signal conditioning and pulse height analyzer	Transistors	160	6.720	0.672	73.600	7.360
		Resistors	620	6.200	0.620	6.200	0.620
		Capacitors	280	2.800	0.280	28.000	2.800
		Diodes	310	6.200	0.620	62.000	6.200
		Total		21.920	2.192	169.800	16.980
$R_{71} \times R_{72} \times R_{73}$, $R_{75} \times R_{76} \times R_{77}$	Velocity gauge signal conditioning	Transistors	146	6.032	0.603	67.160	6.716
		Resistors	543	5.430	0.543	5.430	0.543
		Capacitors	228	2.280	0.228	22.800	2.280
		Diodes	248	4.960	0.496	49.600	4.960
		Total		18.702	1.870	144.990	14.499
R_{90}	Magnetometer unit	Transistors	15	0.630	0.063	6.900	0.690
		Resistors	76	0.760	0.076	0.760	0.076
		Capacitors	13	0.130	0.013	1.300	0.130
		Diodes	17	0.340	0.034	3.400	0.340
		Inductances	6	0.150	0.015	0.198	0.198
		Total		2.010	0.201	12.558	1.434
R_{91}	Magnetometer signal conditioning	Transistors	62	2.604	0.260	28.520	2.852

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period		Orbital Dark Period	
				Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$	Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$
		Resistors	225	2.250	0.225	2.250	0.225
		Diodes	161	3.220	0.322	32.200	3.220
		Capacitors	83	0.830	0.083	8.300	0.830
		Total		8.904	0.890	71.270	7.127
R_{92}	Magnetometer registers	Transistor	84	3.528	0.354	38.640	3.864
		Resistors	336	3.360	0.336	3.360	0.336
		Diodes	336	6.720	0.672	67.200	6.720
		Capacitors	198	1.980	0.198	19.800	1.980
		Total		15.588	1.560	129.000	12.900
	Total for 50% load cycle			7.794	0.780	64.500	6.450
R_{84}	Solar aspect unit	Transistors	105	4.410	0.440	47.300	4.730
		Resistors	630	6.300	0.630	6.300	0.630
		Capacitors	280	2.800	0.280	28.000	2.800
		Diodes	350	7.000	0.700	70.000	7.000
		Total		20.510	2.050	151.600	15.160
R_{85}	Solar aspect signal conditioning	Transistors	90	3.780	0.378	41.400	4.140
		Resistors	360	3.600	0.360	3.600	0.360
		Capacitors	70	0.700	0.070	7.000	0.700
		Diodes	140	2.800	0.280	28.000	2.800
		Transformer	5	0.150	0.015	1.500	0.150
		Inductances	20	0.500	0.050	0.660	0.066
		Total		11.530	1.153	82.160	8.216
R_{86}	Solar aspect register	Transistors	80	3.410	0.340	37.300	3.730
		Resistors	320	3.200	0.320	3.200	0.320
		Capacitors	160	1.600	0.160	16.000	1.600

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Diodes	320	6.400	0.640	64.000	6.400
		Total		14.610	1.460	120.500	12.050
R_{87}	Earth aspect unit	Transistor	20	0.840	0.084	9.200	0.920
		Resistors	75	0.750	0.075	0.750	0.075
		Capacitors	15	0.150	0.015	1.500	0.150
		Diodes	10	0.200	0.020	2.000	0.200
		Total		1.940	0.194	13.450	1.345
R_{88}	Earth aspect signal conditioning	Transistors	41	1.720	0.172	18.900	1.890
		Resistors	174	1.740	0.174	1.740	0.174
		Capacitors	53	0.530	0.053	5.300	0.530
		Diodes	58	1.160	0.116	11.600	1.160
		Total		5.150	0.515	37.540	3.754
R_{89}	Earth aspect registers	Transistors	60	2.520	0.252	27.600	2.760
		Resistors	200	2.000	0.200	2.000	0.200
		Capacitors	60	0.600	0.060	6.000	0.600
		Diodes	180	3.600	0.360	36.000	3.600
		Total		8.720	0.872	71.600	7.160
$R_{96} \times R_{97}$	Critical diagnostic signal conditioning	Transistors	112	4.704	0.470	51.520	5.152
		Resistors	554	5.540	0.554	5.540	0.554
		Capacitors	224	2.240	0.224	22.400	2.240
		Diodes	442	8.840	0.884	88.400	8.840
		Total		21.324	2.132	167.860	16.786
R_{98}	Diagnostic multiplexer and gating	Transistors	137	5.754	0.575	63.020	6.302
		Resistors	478	4.780	0.478	4.780	0.478
		Capacitors	186	1.860	0.186	18.600	1.860

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Diodes	339	6.780	0.678	67.800	6.780
		Total		19.174	1.917	154.200	15.420
$R_{101} \times R_{102}$, $R_{105} \times R_{106}$	Full diagnostic signal conditioning	Transistors	224	9.408	0.941	103.040	10.304
		Resistors	1100	11.000	1.100	11.000	1.100
		Capacitors	500	5.000	0.500	50.000	5.000
		Diodes	880	17.600	1.760	176.000	17.600
		Total		43.008	4.301	340.040	34.004
R_{103}, R_{107}	Full diagnostic multiplexers	Transistors	330	13.860	1.386	151.800	15.180
		Resistors	1060	10.600	1.060	10.600	1.060
		Capacitors	440	4.400	0.440	44.000	4.400
		Diodes	750	15.000	1.500	150.000	15.000
		Total		43.860	4.386	356.400	35.640
R_{61}	Core storage 1000 bits	Transistors	10	0.420	0.042	4.600	0.460
		Diodes	38	0.760	0.076	7.600	0.760
		Sensistors	1	0.042	0.004	0.460	0.046
		Zener Diodes	2	0.040	0.004	0.400	0.040
		Resistors (wire)	4	0.080	0.008	0.080	0.008
		Resistors (carbon)	24	0.240	0.024	0.240	0.024
		Capacitors (ceramic)	8	0.080	0.008	0.800	0.080
		Capacitors (tantalum)	1	0.010	0.001	0.100	0.010
		Transformers	3	0.090	0.009	0.900	0.090
		Thermistors	1	0.042	0.004	0.460	0.046
		Storage cores	4600	0.046	0.005	0.046	0.005

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
		Core switches	50	0.000	0.000	0.000	0.000
		Total		1.850	0.185	15.686	1.569
	Total for 25% parts operative			0.4625	0.04625	3.922	0.392
R_{83}	Core storage 10,000 bits	Transistors	100	4.200	0.420	45.540	4.554
		Diodes	385	7.700	0.770	77.700	7.770
		Sensistors	4	0.168	0.017	1.840	0.184
		Zener diodes	7	0.140	0.014	1.400	0.140
		Resistors (wire)	41	0.820	0.082	0.820	0.082
		Resistors (carbon)	249	2.490	0.249	2.490	0.249
		Capacitors, ceramic	83	0.830	0.083	8.300	0.830
		Capacitors, tantalum	13	0.130	0.013	1.300	0.130
		Transformers	31	0.930	0.093	9.300	0.930
		Thermistors	14	0.588	0.059	6.440	0.644
		Storage cores	50,000	0.500	0.050	0.500	0.050
		Core switches	500	0.005	0.000	0.005	0.000
		Total		18.501	1.850	155.635	15.564
	Total for 25% parts operative			4.625	0.462	38.910	3.891
R_{95}	Core storage 12,000 bits	Transistors	115	4.830	0.483	52.900	5.290
		Diodes	462	9.240	0.924	92.400	9.240
		Sensistors	5	0.210	0.021	2.300	0.230
		Zener diodes	8	0.160	0.016	1.600	0.160
		Resistors (wire)	49	0.980	0.098	0.980	0.098
		Resistors (carbon)	299	2.990	0.299	2.990	0.299

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period		Orbital Dark Period	
				Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$	Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$
		Capacitors, (~~ce~~ramic)	100	1.000	0.100	10.000	1.000
		Capacitors, tantalum	16	0.160	0.016	1.600	0.160
		Transformers	37	1.110	0.111	11.100	1.110
		Thermistors	17	0.714	0.071	7.360	0.736
		Storage cores	60,000	0.600	0.060	0.600	0.060
		Core switches	600	0.006	0.001	0.006	0.001
		Total		22.000	2.200	183.836	18.384
	Total for 25% parts operative			5.500	0.550	45.959	4.596
R_{60}	Capacitor and Exotech write logic	Transistors	201	8.400	0.840	92.000	9.200
		Resistors	818	8.180	0.818	8.180	0.818
		Capacitors	217	2.170	0.217	21.700	2.170
		Diodes	907	18.140	1.814	181.140	18.140
		Total		36.890	3.689	303.280	30.328
R_{41}, R_{43}, R_{47}, R_{51}, R_{55}, R_{59}	Capacitor, area, and Exotech counters	Transistors	14	0.588	0.059	6.440	0.644
		Resistors	56	0.560	0.056	0.560	0.056
		Capacitors	33	0.330	0.033	3.300	0.330
		Diodes	56	1.120	0.112	11.200	1.120
		Total		2.598	0.2600	21.500	2.150
	Total for 50% load cycle			1.299	0.130	10.750	1.075
R_{79}	Mariner write logic	Transistors	159	6.678	0.668	73.140	7.314
		Resistors	604	6.040	0.604	6.040	0.604
		Capacitors	161	1.610	0.161	16.100	1.610
		Diodes	662	13.240	1.324	132.400	13.240
		Total		27,568	2.757	227.680	22.768

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
R_{80}	Mariner counters	Transistors	84	3.528	0.353	38.640	3.864
		Resistors	336	3.360	0.336	3.360	0.336
		Capacitors	198	1.980	0.198	19.800	1.980
		Diodes	336	6.720	0.672	67.200	6.720
		Total		15.588	1.559	129.000	12.900
	Total for 50% load cycle			7.794	0.779	64.500	6.450
R_{81}	Velocity write logic	Transistors	110	4.620	0.462	50.800	5.080
		Resistor	400	4.000	0.400	4.000	0.400
		Diodes	110	2.200	0.220	22.000	2.200
		Capacitors	410	4.100	0.410	41.000	4.100
		Total		14.920	1.492	117.800	11.780
R_{74}	Velocity counters	Transistors	14	0.588	0.059	6.440	0.644
		Resistors	56	0.560	0.056	0.560	0.056
		Capacitors	33	0.330	0.033	3.300	0.330
		Diodes	56	1.120	0.112	11.200	1.120
		Total		2.598	0.260	21.500	2.150
	Total for 50% load cycle			1.299	0.130	10.750	1.075
R_{78}	Velocity counters	Transistors	84	3.528	0.353	38.640	3.864
		Resistors	336	3.360	0.336	3.360	0.336
		Capacitors	198	1.980	0.198	19.800	1.980
		Diodes	336	6.720	0.672	67.200	6.720
		Total		15.588	1.559	129.000	12.896
	Total for 50% load cycle			7.794	0.779	64.500	6.448
R_{93}	Hourly attitude write logic	Transistors	316	13.272	1.327	145.360	14.536
		Resistors	1254	12.540	1.254	12.540	1.254

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period		Orbital Dark Period	
				Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$	Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$
		Capacitors	340	3.400	0.340	34.000	3.400
		Diodes	1178	23.560	2.356	235.600	23.560
		Total		52.772	5.277	427.500	42.750
R_{94}	Full attitude write logic	Transistors	253	10.626	1.063	116.260	11.626
		Resistors	1005	10.050	1.005	10.050	1.005
		Capacitors	276	2.760	0.276	27.600	2.760
		Diodes	960	19.200	1.920	192.000	19.200
		Total		42.636	4.264	345.910	34.591
R_{99}	Critical diagnostic format generator	Transistors	398	16.716	1.672	183.080	18.308
		Resistors	1563	15.630	1.563	15.630	1.563
		Capacitors	439	4.390	0.439	43.900	4.390
		Diodes	1264	25.280	2.528	256.400	25.640
		Total		62.016	6.202	499.010	49.901
R_{104}, R_{108}	Full diagnostic format generators	Transistors	704	29.568	2.957	323.840	32.384
		Resistors	2834	28.340	2.834	28.340	2.834
		Capacitors	751	7.510	0.751	75.100	7.510
		Diodes	2602	52.040	5.204	520.400	52.040
		Total		117.458	11.746	947.680	94.768
R_{117}	Master clock	Transistors	138	5.796	0.580	63.480	6.348
		Resistors	515	5.150	0.515	5.150	0.515
		Capacitors	194	1.940	0.194	19.400	1.940
		Diodes	507	10.140	1.014	101.400	10.140
		Crystal	1	0.600	1.100	2.200	1.100
		Total		23.626	3.403	191.630	20.043

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period		Orbital Dark Period	
				Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$	Operating $\lambda \times 10^6$	Nonoperating $\lambda \times 10^6$
$R_{109} \times R_{110} \times R_{111}$	Deployment sensors, multiplexer, and data format generator	Transistors	169	7.098	0.710	77.740	7.774
		Resistors	660	6.600	0.660	6.600	0.660
		Diodes	735	14.700	1.470	147.000	14.700
		Capacitors	191	1.910	0.191	19.100	1.910
		Total		30.308	3.031	250.440	25.044
R_{116}	Memory overflow unit	Transistors	205	8.610	0.861	94.300	9.430
		Resistors	807	8.070	0.807	8.700	0.870
		Diodes	806	16.120	1.612	161.200	16.120
		Capacitors	223	2.230	0.223	22.300	2.230
		Total		35.030	3.503	286.500	28.650
R_{113}	Read logic	Transistors	90	3.780	0.378	41.400	4.140
		Resistors	426	4.260	0.426	4.260	0.426
		Capacitors	105	1.050	0.105	10.500	1.050
		Diodes	426	8.520	0.852	85.200	8.520
		Total		17.610	1.7610	141.360	14.136
R_{115}	Read storage commutator	Transistors	11	0.462	0.046	5.060	0.506
		Resistors	50	0.500	0.050	0.500	0.050
		Capacitors	15	0.150	0.015	1.500	0.150
		Diodes	50	1.000	0.100	10.000	1.000
		Total		2.112	0.211	17.060	1.706
R_{112}	Diagnostic and deployment commutator	Transistors	18	0.756	0.076	8.280	0.828
		Resistors	52	0.520	0.052	0.520	0.052
		Diodes	46	0.920	0.092	9.200	0.920
		Capacitors	18	0.180	0.018	1.800	0.180
		Total		2.376	0.238	19.800	1.980

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
R_{114}	Sync frame generator	Transistors	28	1.176	0.118	12.880	1.288
		Resistors	112	1.120	0.112	1.120	0.112
		Diodes	132	2.640	0.264	26.400	2.640
		Capacitors	28	0.280	0.028	2.800	0.280
		Total		5.216	0.522	43.200	4.320
R_{100}	Selector switch	Transistors	4	0.168	0.017	1.840	0.184
		Resistors	17	0.170	0.017	0.170	0.017
		Diodes	17	0.340	0.034	3.400	0.340
		Capacitors	4	0.040	0.004	0.400	0.040
		Total		0.718	0.072	5.810	0.581
R_{82}	Write logic mariner velocity	Transistors	7	0.294	0.029	3.220	0.322
		Resistors	22	0.220	0.022	0.220	0.022
		Diodes	18	0.360	0.036	3.600	0.360
		Capacitors	11	0.110	0.011	1.100	0.110
		Total		0.984	0.098	8.140	0.814

TABLE 23 (continued)

System	Module	Part	Qty	Orbital Sunlight Period Operating $\lambda \times 10^6$	Orbital Sunlight Period Nonoperating $\lambda \times 10^6$	Orbital Dark Period Operating $\lambda \times 10^6$	Orbital Dark Period Nonoperating $\lambda \times 10^6$
Electrical power (R_{10}, R_{25})	Regulator R_h, R_i R_k, R_q	Inductance	4	0.100	0.128	1.320	0.132
		Transistor	4	0.168	0.184	1.840	0.184
		Resistor (power)	12	0.240	0.240	0.240	0.024
		Capacitance	3	0.030	0.030	0.300	0.030
		Diode	4	0.080	0.080	0.800	0.080
		Total		0.618	0.662	4.500	0.450
	Dissipater	Inductance	12	0.300	0.0300	3.960	0.396
		Transistor	4	0.168	0.0168	1.840	0.184
		Resistor	18	0.360	0.0360	0.360	0.036
		Total		0.828	0.0828	6.160	0.616
	Solar array	Solar array-36V	1	0.100	0.010		0.300
	R_g						
	Thermal battery		2	50cy			
	R_a, R_f						
	Battery with heater	Trickle charge	1	1.45	1.45	1.45	1.45
	R_r						
	Power supply diode	Diode	1	0.020	0.020	0.020	0.020
	R_t						
	Charge limiter	Transistor	1	0.042	0.0042	0.460	0.046
	R_s	Resistor	2	0.020	0.0020	0.020	0.002
		Diode	1	0.020	0.0020	0.200	0.020
		Total		0.082	0.0082	0.680	0.068
	Dc/dc converter	Inductance	2	0.050	0.005	0.660	0.066
	R_j, R_k,	Transistor	2	0.084	0.0084	0.920	0.092
	R_u, R_v	Resistance	4	0.040	0.0040	0.040	0.004

TABLE 24

Component Reliabilities (high quality parts)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Fuses (continuous)	R_m	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT OF CONTINUOUS TRANSMISSION							
			$\lambda (x\ 10^{-6}) = 0.060$ $-\lambda t$	257	515								
			Nonoperating Time, t' (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$										
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60								
			$\lambda (x\ 10^{-6}) = 0.600$ $-\lambda t'$	18	36								
		$\sum$	$\lambda t + \lambda t'$	275	551								
			Reliability	.999725	.999449								
Fuses (intermittent)	R_m	Sunlight	Operating Time, t (hr)			4290	8580	DATA IDENTICAL TO THAT OF COMMAND ON/OFF TRANSMISSION					
			$\lambda (x\ 10^{-6}) = 0.160$ $-\lambda t$			686	1373						
			Nonoperating Time, t' (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$										
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$										
			Nonoperating Time, t' (hr)			30	60						
			$\lambda (x\ 10^{-6}) = 0.1600$ $-\lambda t'$			48	96						
		$\sum$	$\lambda t + \lambda t'$			734	1469						
			Reliability			.999266	.998531						

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Solar Array	R_g	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT OF CONTINUOUS TRANSMISSION							
			$\lambda (x\ 10^{-6}) = 0.100$ $-\lambda t$	429	858								
			Nonoperating Time, t' (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$										
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60								
			$\lambda (x\ 10^{-6}) = 0.3$ $-\lambda t'$	9	18								
		$\sum$	$\lambda t + \lambda t'$	438	876								
			Reliability	.999562	.999124								
Voltage Regulator	R_h, R_i	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	180	360	60	120
			$\lambda (x\ 10^{-6}) = 0.618$ $-\lambda t$	2651	5302	185	371	445	890	111	222	37	74
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	4110	8220	4230	8460
			$\lambda (x\ 10^{-6}) = 0.662$ $-\lambda t'$			2641	5282	2363	4728	2721	5442	2800	5600
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60	30	60	30	60	30	60	30	60
			$\lambda (x\ 10^{-6}) = 0.450$ $-\lambda t'$	14	27	14	27	14	27	14	27	14	27
		$\sum$	$\lambda t + \lambda t'$	2665	5329	2840	5680	2822	5645	2846	5691	2851	5701
			Reliability	.997335	.994677	.997160	.994320	.997178	.994355	.997154	.994309	.997149	.994299

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Battery with Heater (cycle batt)	R_x	Sunlight	Operating Time, t (hr)			4290	8580	DATA IDENTICAL TO THAT OF COMMAND ON/OFF TRANSMISSION					
			$\lambda (x\ 10^{-6}) =$ 2.450 $-\lambda t$			10510	21021						
			Nonoperating Time, t' (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$										
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$										
			Nonoperating Time, t' (hr)			30	60						
			$\lambda (x\ 10^{-6}) =$ 2.450 $-\lambda t'$			74	147						
		$\sum$	$\lambda t + \lambda t'$			10584	21168						
			Reliability			.989471	.979053						
Change Limiter	R_s	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT OF CONTINUOUS TRANSMISSION							
			$\lambda (x\ 10^{-6}) =$ 0.082 $-\lambda t$	352	704								
			Nonoperating Time, t' (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$										
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60								
			$\lambda (x\ 10^{-6}) =$ 0.068 $-\lambda t'$	2	4								
		$\sum$	$\lambda t + \lambda t'$	354	708								
			Reliability	.999646	.999292								

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Diplexer (out)	R_{23}, R_{38}	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	180	360	60	120
			$\lambda (x\ 10^{-6}) = 0.045$ $-\lambda t$	193	386	14	27	32	65	8	16	3	5
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	4110	8220	4230	8460
			$\lambda (x\ 10^{-6}) = 0.004$ $-\lambda t'$			16	32	14	28	16	33	17	34
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) = 0.440$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60	30	60	30	60	30	60	30	60
			$\lambda (x\ 10^{-6}) = 0.044$ $-\lambda t'$	1	3	1	3	1	3	1	3	1	3
		$\sum$	$\lambda t + \lambda t'$	194	389	31	62	47	96	25	52	21	42
			Reliability	.999806	.999611	.999969	.999938	.999953	.999904	.999975	.999948	.999979	.999958
Hybrid	R_{24}, R_{39}	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	180	360	60	120
			$\lambda (x\ 10^{-6}) = 0.5$ $-\lambda t$	2145	4290	150	300	360	720	90	180	30	60
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	4110	8220	4230	8460
			$\lambda (x\ 10^{-6}) = 0.05$ $-\lambda t'$			199	399	178	357	206	411	212	423
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) = 1.0$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60	30	60	30	60	30	60	30	60
			$\lambda (x\ 10^{-6}) = 0.1$ $-\lambda t'$	3	6	3	6	3	6	3	6	3	6
		$\sum$	$\lambda t + \lambda t'$	2148	4296	352	705	541	1083	299	597	245	489
			Reliability	.997852	.995709	.999648	.999295	.999459	.998918	.999701	.999403	.999755	.999511

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Data Switch (Block all data)	R_{36}	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	180	360	60	120
			$\lambda (x\ 10^{-6}) = 1.004$ $-\lambda t$	4307	8614	301	602	723	1446	181	361	60	120
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	3930	7860	4230	8460
			$\lambda (x\ 10^{-6}) = 0.100$ $-\lambda t'$			399	798	357	714	393	786	423	846
		Dark Period	Operating Time, t (hr)			15	30	10	20				
			$\lambda (x\ 10^{-6}) = 8.080$ $-\lambda t$			121	242	81	162				
			Nonoperating Time, t' (hr)	30	60	15	30	20	40	30	60	30	60
			$\lambda (x\ 10^{-6}) = 0.808$ $-\lambda t'$	24	48	12	24	16	32	24	48	24	48
		$\sum$	$\lambda t + \lambda t'$	4331	8662	833	1666	1177	2354	598	1195	507	1014
			Reliability	.995678	.991375	.999167	.998335	.998823	.997647	.999402	.998804	.999493	.998986
Signal Conditioning	R_{37}	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	360	720	60	120
			$\lambda (x\ 10^{-6}) = 0.558$ $-\lambda t$	2394	4788	167	335	402	804	201	402	33	67
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	3930	7860	4230	8460
			$\lambda (x\ 10^{-6}) = 0.056$ $-\lambda t'$			223	447	199	400	20	440	237	474
		Dark Period	Operating Time, t (hr)			15	30	10	20				
			$\lambda (x\ 10^{-6}) = 3.866$ $-\lambda t$			58	116	39	77				
			Nonoperating Time, t' (hr)	30	60	15	30	20	40	30	60	30	60
			$\lambda (x\ 10^{-6}) = 0.446$ $-\lambda t'$	13	27	7	13	9	18	13	27	13	27
		$\sum$	$\lambda t + \lambda t'$	2407	4815	455	911	649	1299	434	869	283	568
			Reliability	.997596	.995198	.999545	.999090	.999351	.998702	.999566	.999132	.999717	.999434

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
SCO and Phase Modulator	R_{21}	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	180	360	60	120
			$\lambda (x\ 10^{-6}) = 0.966$ $-\lambda t$	4144	8288	290	580	696	1391	174	348	58	116
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	4110	8220	4230	8460
			$\lambda (x\ 10^{-6}) = 0.097$ $-\lambda t'$			387	774	346	692	399	797	410	821
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) = 7.280$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60	30	60	30	60	30	60	30	60
			$\lambda (x\ 10^{-6}) = 0.728$ $-\lambda t'$	22	44	22	44	22	44	22	44	22	44
		$\sum$	$\lambda t + \lambda t'$	4166	8332	699	1398	1064	2127	595	1189	490	981
			Reliability	.995842	.991701	.999301	.998602	.998936	.997873	.999405	.998811	.999510	.999020
Modulator/Transmitter	R_{22}	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	180	360	60	120
			$\lambda (x\ 10^{-6}) = 3.366$ $-\lambda t$	14440	28880	1010	2020	2424	4847	606	1212	202	404
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	4110	8220	4230	8460
			$\lambda (x\ 10^{-6}) = 1.376$ $-\lambda t'$			5490	10980	4912	9825	5655	11311	5820	11641
		Dark Period	Operating Time, t (hr)										
			$\lambda (x\ 10^{-6}) = 28.100$ $-\lambda t$										
			Nonoperating Time, t' (hr)	30	60	30	60	30	60	30	60	30	60
			$\lambda (x\ 10^{-6}) = 3.690$ $-\lambda t'$	111	221	111	221	111	221	111	221	111	221
		$\sum$	$\lambda t + \lambda t'$	14551	29101	6611	13221	7447	14893	6372	12744	6133	12266
			Reliability	.985554	.971318	.993411	.986865	.992580	.985217	.993648	.987337	.993886	.987809

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission		Automatic On/Off Transmission		Transmit Once/Day		Transmit Once/Orbit	
				6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
SCO and Phase Modulator	$(\lambda_1), (\lambda_{11})$	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	360	720	60	120
			$\lambda (\times 10^{-6}) = 0.966$ $-\lambda t$	4144	8288	290	580	696	1391	348	696	58	116
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	3930	7860	4230	8460
			$\lambda (\times 10^{-6}) = 0.097$ $-\lambda t'$			387	774	346	692	381	762	410	821
		Dark Period	Operating Time, t (hr)			15	30	10	20				
			$\lambda (\times 10^{-6}) = 7.280$ $-\lambda t$			109	218	73	146				
			Nonoperating Time, t' (hr)	30	60	15	30	20	40	30	60	30	60
			$\lambda (\times 10^{-6}) = 0.728$ $-\lambda t'$	22	44	11	22	14	29	22	44	22	44
		$\sum$	$\lambda t + \lambda t'$	4166	8332	797	1594	1129	2258	751	1502	490	981
			Reliability	.995842	.991701	.999203	.998407	.998872	.997745	.999249	.998498	.999510	.999010
Transmitter No. 2	$(\lambda_2),(\lambda_{12})$	Sunlight	Operating Time, t (hr)	4290	8580	300	600	720	1440	360	720	60	120
			$\lambda (\times 10^{-6}) = 3.366$ $-\lambda t$	14440	28880	1010	2020	2424	4847	1212	2424	202	404
			Nonoperating Time, t' (hr)			3990	7980	3570	7140	3930	7860	4230	8460
			$\lambda (\times 10^{-6}) = 1.376$ $-\lambda t'$			5490	10980	4912	9825	5408	10815	5820	11641
		Dark Period	Operating Time, t (hr)			15	30	10	20				
			$\lambda (\times 10^{-6}) = 28.10$ $-\lambda t$			422	843	281	562				
			Nonoperating Time, t' (hr)	30	60	15	30	20	40	30	60	30	60
			$\lambda (\times 10^{-6}) = 3.690$ $-\lambda t'$	111	221	55	111	74	148	111	221	111	221
		$\sum$	$\lambda t + \lambda t'$	14551	29101	6977	13954	7691	15382	6731	13460	6133	12266
			Reliability $(e^{-\lambda_2 t})$	.985554	.971318	993047	.986143	.992339	.984737	.993291	.986629	.993885	.987808

TABLE 24 (continued)

					Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
					6 mo	12 mo				
Panel Actuator	R_b	Sunlight	Operating Time, t (hr)		1 shot	1 shot	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) =$ 240	$-\lambda t$	240	240				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t$						
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$		240	240				
			Reliability		.999760	.999760				
Hinges and Springs	R_c	Sunlight	Operating Time, t (hr)		1 shot	1 shot				
			$\lambda (x\ 10^{-6}) =$ 60	$-\lambda t$	60	60				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t$						
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$		60	60				
			Reliability		.999940	.999940				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Deploy Timer	R_d, R_e	Sunlight	Operating Time, t (hr)	1 shot	1 shot	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			λ (x 10^{-6}) = 2000 $-\lambda t$	2000	2000				
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			λ (x 10^{-6}) = $-\lambda t$						
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	2000	2000				
			Reliability	.998000	.998000				
Thermal Battery	R_a, R_f	Sunlight	Operating Time, t (hr)	1 shot	1 shot				
			λ (x 10^{-6}) = 20,000 $-\lambda t$	20,000	20,000				
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			λ (x 10^{-6}) = $-\lambda t$						
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	20,000	20,000				
			Reliability	.980200	.980200				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Shutters and Hinges	R_a, R_c	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 1.0$ $-\lambda t$	4290	8580				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.5$ $-\lambda t$	45	90				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	4335	8670				
			Reliability	.995665	.991349				
Thermo Control	R_b, R_d	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 1.0$ $-\lambda t$	4290	8580				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.5$ $-\lambda t$	45	90				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	4335	8670				
			Reliability	.995665	.991349				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
		Sunlight	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						
Battery with Heater (Trickle Charge)	R_r	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 1.450$ $-\lambda t$	6220	12,441				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 1.450$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 1.450$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 1.450$ $-\lambda t'$	44	87				
		$\sum$	$\lambda t + \lambda t'$	6264	12,528				
			Reliability	.993754	.987547				

TABLE 24 (continued)

					Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
					6 mo	12 mo				
DC/DC Converter	R_j, R_k, R_u, R_v	Sunlight	Operating Time, t (hr)		4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.284$	$-\lambda t$	1218	2437				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) = 0.028$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) = 2.720$	$-\lambda t$						
			Nonoperating Time, t' (hr)		30	60				
			$\lambda (x\ 10^{-6}) = 0.272$	$-\lambda t'$	8	16				
		$\sum$	$\lambda t + \lambda t'$		1226	2453				
			Reliability		.998774	.997547				
Distribution	R_l	Sunlight	Operating Time, t (hr)		4290	8580				
			$\lambda (x\ 10^{-6}) = 0.1$	$-\lambda t$	429	858				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t$						
			Nonoperating Time, t' (hr)		30	60				
			$\lambda (x\ 10^{-6}) = 0.1$	$-\lambda t'$	3	6				
		$\sum$	$\lambda t + \lambda t'$		432	864				
			Reliability		.999568	.999136				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Distribution for R_{25}	R_w	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.5$ $-\lambda t$	2145	4290				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.25$ $-\lambda t'$	8	15				
		$\sum$	$\lambda t + \lambda t'$	2153	4305				
			Reliability	.997847	.995695				
Power Diode	R_t	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 0.020$ $-\lambda t$	86	172				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.020$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 0.020$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.020$ $-\lambda t'$	1	1				
		$\sum$	$\lambda t + \lambda t'$	87	173				
			Reliability	.999913	.999827				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Signal Conditioning A or B	$R_{12}, R_{15}, R_{27}, R_{30}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 1.451$ $-\lambda t$	6225	12,450				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.145$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 11.470$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 1.147$ $-\lambda t'$	34	68				
		$\sum$	$\lambda t + \lambda t'$	6259	12,518				
			Reliability	.993760	.987559				
Counter	$R_{13}, R_{16}, R_{28}, R_{31}$	Sunlight	Operating Time, t (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 2.598$ $-\lambda t$	5572	11,145				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 0.2598$ $-\lambda t'$	557	1114				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 21.500$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 2.150$ $-\lambda t'$	64	129				
		$\sum$	$\lambda t + \lambda t'$	6193	12,388				
			Reliability	.993826	.987688				

TABLE 24 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Data Collection and Format Generator	$R_{17}, R_{18}, R_{19}, R_{32}, R_{33}, R_{34}$	Sunlight	Operating Time, t (hr)	2145	4290	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 18.054 \quad -\lambda t$	38,726	77,452				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 1.805 \quad -\lambda t'$	3872	7744				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 143.930 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 14.393 \quad -\lambda t'$	432	864				
		$\sum$	$\lambda t + \lambda t'$	43,030	86,060				
			Reliability	.957883	.917540				
Charge Generators	R_7, R_9, R_6, R_8	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 0.902 \quad -\lambda t$	3870	7739				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.090 \quad -\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 8.160 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 0.816 \quad -\lambda t'$	24	49				
		$\sum$	$\lambda t + \lambda t'$	3894	7788				
			Reliability	.996114	.992243				

TABLE 24 (continued)

					Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Amplifier Shaper	R_{20}, R_{35}	Sunlight	Operating Time, t (hr)		2145	4290	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) =$ 0.872	$-\lambda t$	1870	3741				
			Nonoperating Time, t' (hr)		2145	4290				
			$\lambda (x\ 10^{-6}) =$ 0.087	$-\lambda t'$	187	373				
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) =$ 7.340	$-\lambda t$						
			Nonoperating Time, t' (hr)		30	60				
			$\lambda (x\ 10^{-6}) =$ 0.734	$-\lambda t'$	22	44				
		$\sum$	$\lambda t + \lambda t'$		2079	4158				
			Reliability		.997923	.995850				
		Sunlight	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t$						
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t$						
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) =$	$-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$							
			Reliability							

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Transmitter Switch	λ_3	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 2.248 \quad -\lambda t$	9644	19,288				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 2.025 \quad -\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 4.288 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 2.228 \quad -\lambda t'$	67	134				
		$\sum$	$\lambda t + \lambda t'$	9711	19,422				
			Reliability	.990336	.980765				
Command Logic	λ_4	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 0.650 \quad -\lambda t$	2788	5577				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.245 \quad -\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 3.260 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.506 \quad -\lambda t'$	15	30				
		$\sum$	$\lambda t + \lambda t'$	2803	5607				
			Reliability	.997201	.994410				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Diplexer (in.)	λ_5, λ_8	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) =$ 0.045 $-\lambda t$	193	386				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ 0.005 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ 0.440 $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) =$ 0.044 $-\lambda t'$	1	2				
		$\sum$	$\lambda t + \lambda t'$	194	388				
			Reliability	.999806	.999612				
Receiver	λ_6, λ_9	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) =$ 1.960 $-\lambda t$	8408	16,817				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ 0.196 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ 17.850 $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) =$ 1.785 $-\lambda t'$	54	107				
		$\sum$	$\lambda t + \lambda t'$	8462	16,924				
			Reliability	.991574	.983219				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Command Decoder	λ_7, λ_{10}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 1.720 \quad -\lambda t$	7379	14,758				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.307 \quad -\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 12.520 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.387 \quad -\lambda t'$	42	83				
		$\sum$	$\lambda t + \lambda t'$	7421	14,841				
			Reliability	.992606	.985267				
		Sunlight	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = \quad -\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = \quad -\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = \quad -\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = \quad -\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Exotech A and Signal Conditioner	R_{44}-R_{45}, R_{48}-R_{49}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 8.474$ $-\lambda t$	36,353	72,707				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.847$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 56.274$ $-\lambda t$	1688	3376				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 6.252$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	38,041	76,083				
			Reliability	.962674	.926741				
Exotech Detector	R_{46}, R_{50}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 3.480$ $-\lambda t$	14,929	29,858				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.348$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 27.240$ $-\lambda t$	817	1634				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 2.724$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	15,746	31,492				
			Reliability	.984377	.968998				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Mariner Signal Conditioner	$R_{62} \times R_{63} \times R_{64}$, $R_{68} \times R_{69} \times R_{70}$ $R_{65} \times R_{66} \times R_{67}$,	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 21.920$ $-\lambda t$	94,037	188,073				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 2.192$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 169.800$ $-\lambda t$	5094	10,188				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 16.980$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	99,131	198,261				
			Reliability	.905624	.820155				
Area Multiplexer	$R_{52} \times R_{53} \times R_{54}$, $R_{56} \times R_{57} \times R_{58}$	Sunlight	Operating Time, t (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 31.284$ $-\lambda t$	67,104	134,208				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 3.128$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 246.920$ $-\lambda t$	7408	14,815				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 24.692$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	74,512	149,023				
			Reliability	.928196	.861548				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Velocity Signal Conditioner	$R_{71} \times R_{72} \times R_{73}$, $R_{75} \times R_{76} \times R_{77}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 18.702$ $-\lambda t$	80,232	160,463				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 1.870$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 144.990$ $-\lambda t$	4350	8700				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 14.499$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	84,582	169,163				
			Reliability	.918891	.844361				
Magnetometer Unit	R_{90}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 2.010$ $-\lambda t$	8623	17,246				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.201$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 12.558$ $-\lambda t$	377	753				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 1.434$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	9000	17,999				
			Reliability	.991040	.982160				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Magnetometer Signal Conditioner	R_{91}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) =$ 8.904 $-\lambda t$	38.198	76.396				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ 0.890 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) =$ 71.270 $-\lambda t$	2138	4276				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ 7.127 $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	40.336	80.672				
			Reliability	.960467	.922497				
Magnetometer Registers	R_{92}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) =$ 7.794 $-\lambda t$	33.436	66.872				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ 0.780 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) =$ 64.500 $-\lambda t$	1935	3870				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ 6.45 $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	35.371	70.742				
			Reliability	.965247	.931702				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Solar Aspect Unit	R_{84}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 20.510$ $-\lambda t$	87,987	175,976				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 2.050$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 151.600$ $-\lambda t$	4548	9096				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 15.160$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	92,535	185,072				
			Reliability	.911617	.831046				
Solar Aspect Signal Conditioner	R_{85}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 11.530$ $-\lambda t$	49,464	98,927				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 1.153$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 82.160$ $-\lambda t$	2465	4930				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 8.216$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	51,929	103,857				
			Reliability	.949396	.901353				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Solar Aspect Register	R_{86}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 14.610$ $-\lambda t$	62,677	125,354				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 1.460$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 120.50$ $-\lambda t$	3615	7230				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 12.05$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	66,292	132,584				
			Reliability	.935858	.875830				
Earth Aspect Unit	R_{87}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 1.940$ $-\lambda t$	8323	16,645				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.194$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 13.450$ $-\lambda t$	404	807				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 1.345$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	8727	17,452				
			Reliability	.991311	.982697				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Earth Signal Conditioner	R_{88}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 5.150$ $-\lambda t$	22,094	44,187				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.515$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 37.540$ $-\lambda t$	1126	2252				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 3.754$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	23,220	46,439				
			Reliability	.977048	.954623				
Earth Aspect Registers	R_{89}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 8.720$ $-\lambda t$	37,409	74,818				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.872$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 71.600$ $-\lambda t$	2148	4296				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 7.100$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	39,557	79,114				
			Reliability	.961215	.923934				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Critical Diagnostic Signal Conditioner	$R_{96} \times R_{97}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6})$ = 21.324 $-\lambda t$	91,480	182,960				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6})$ = 2.132 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6})$ = 167.860 $-\lambda t$	5036	10,072				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6})$ = 16.786 $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	96,516	193,032				
			Reliability	.907995	.824455				
Multiplexer Unit	R_{98}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6})$ = 19.174 $-\lambda t$	82,256	164,513				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6})$ = 1.917 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6})$ = 154.200 $-\lambda t$	4626	9252				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6})$ = 15.420 $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	86,882	173,765				
			Reliability	.916786	.840496				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Full Diagnostic Signal Conditioners	$R_{101} \times R_{102}, R_{105} \times R_{106}$	Sunlight	Operating Time, t (hr)	15	30	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 43.008$ $-\lambda t$	645	1290				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 4.301$ $-\lambda t'$	18,387	36,774				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 340.040$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 34.004$ $-\lambda t'$	1020	2040				
		$\sum$	$\lambda t + \lambda t'$	20,052	40,104				
			Reliability	.980148	.960690				
Full Diagnostic Multiplexers	R_{103}, R_{107}	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (\times 10^{-6}) = 43.860$ $-\lambda t$	658	1316				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 4.386$ $-\lambda t'$	18,750	37,500				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 356.400$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 35.640$ $-\lambda t'$	1069	2138				
		$\sum$	$\lambda t + \lambda t'$	20,477	40,954				
			Reliability	.979731	.959873				

TABLE 24 (continued)

					Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
					6 mo	12 mo				
1K Memory	R_{61}	Sunlight	Operating Time, t (hr)		4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.4625$	$-\lambda t$	1984	3968				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) = 0.046$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)		30	60				
			$\lambda (x\ 10^{-6}) = 3.922$	$-\lambda t$	118	235				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) = 0.392$	$-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$		2102	4203				
			Reliability		.997900	.995804				
10K Memory	R_{83}	Sunlight	Operating Time, t (hr)		4290	8580				
			$\lambda (x\ 10^{-6}) = 4.625$	$-\lambda t$	19,841	39,682				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) = 0.462$	$-\lambda t'$						
		Dark Period	Operating Time, t (hr)		30	60				
			$\lambda (x\ 10^{-6}) = 38.910$	$-\lambda t$	1167	2335				
			Nonoperating Time, t' (hr)							
			$\lambda (x\ 10^{-6}) = 3.891$	$-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$		21,008	42,017				
			Reliability		.979211	.958854				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Storage C (12K)	R_{95}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 5.500$ $-\lambda t$	23,595	47,190				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.550$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 45.959$ $-\lambda t$	1379	2758				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 4.596$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	24,974	49,948				
			Reliability	.975335	.951278				
		Sunlight	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Capacitor and Exotech Write Logic	R_{60}	Sunlight	Operating Time, t (hr)	429	858	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 36.890$ $-\lambda t$	15,826	31,652				
			Nonoperating Time, t' (hr)	3861	7722				
			$\lambda (\times 10^{-6}) = 3.689$ $-\lambda t'$	14,243	28,486				
		Dark Period	Operating Time, t (hr)	3	6				
			$\lambda (\times 10^{-6}) = 303.28$ $-\lambda t$	910	1820				
			Nonoperating Time, t' (hr)	27	54				
			$\lambda (\times 10^{-6}) = 30.328$ $-\lambda t'$	819	1638				
		$\sum$	$\lambda t + \lambda t'$	31,798	63,596				
			Reliability	.968702	.938384				
Capacitor, Area, and Exotech Counters	$R_{41}, R_{43}, R_{47}, R_{51}, R_{55}, R_{59}$	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 1.299$ $-\lambda t$	5573	11,145				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.130$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 10.750$ $-\lambda t$	322	645				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 1.075$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	5895	11,790				
			Reliability	.994122	.988279				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Mariner Write Logic	R_{79}	Sunlight	Operating Time, t (hr)	644	1288	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 27.568$ $-\lambda t$	17,754	35,508				
			Nonoperating Time, t' (hr)	3646	7292				
			$\lambda (\times 10^{-6}) = 2.757$ $-\lambda t'$	10,052	20,104				
		Dark Period	Operating Time, t (hr)	4	8				
			$\lambda (\times 10^{-6}) = 227.680$ $-\lambda t$	911	1821				
			Nonoperating Time, t' (hr)	26	52				
			$\lambda (\times 10^{-6}) = 22.768$ $-\lambda t'$	592	1184				
		$\sum$	$\lambda t + \lambda t'$	29,309	58,617				
			Reliability	.971116	.943066				
Mariner Counters	R_{80}	Sunlight	Operating Time, t (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 7.794$ $-\lambda t$	16,718	33,436				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 0.779$ $-\lambda t'$	1671	3342				
		Dark Period	Operating Time, t (hr)	15	30				
			$\lambda (\times 10^{-6}) = 64.500$ $-\lambda t$	968	1935				
			Nonoperating Time, t' (hr)	15	30				
			$\lambda (\times 10^{-6}) = 6.450$ $-\lambda t'$	97	194				
		$\sum$	$\lambda t + \lambda t'$	19,454	38,907				
			Reliability	.980734	.961839				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Velocity Write	R_{81}	Sunlight	Operating Time, t (hr)	429	858	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			λ (x 10^{-6}) = 14.920 $-\lambda t$	6401	12,801				
			Nonoperating Time, t' (hr)	3861	7722				
			λ (x 10^{-6}) = 1.492 $-\lambda t'$	5761	11,521				
		Dark Period	Operating Time, t (hr)	3	6				
			λ (x 10^{-6}) = 117.800 $-\lambda t$	353	707				
			Nonoperating Time, t' (hr)	27	54				
			λ (x 10^{-6}) = 11.780 $-\lambda t'$	318	636				
		$\sum$	$\lambda t + \lambda t'$	12,833	25,665				
			Reliability	.987249	.974660				
Velocity Counters	R_{74}	Sunlight	Operating Time, t (hr)	4290	8580				
			λ (x 10^{-6}) = 1.299 $-\lambda t$	5573	11,145				
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = 0.130 $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			λ (x 10^{-6}) = 10.750 $-\lambda t$	322	645				
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = 1.075 $-\lambda t'$	5895	11,790				
		$\sum$	$\lambda t + \lambda t'$						
			Reliability	.994122	.988279				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Velocity Counter	R_{78}	Sunlight	Operating Time, t (hr)	2145	4290	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 7.794$ $-\lambda t$	16,718	33,436				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.779$ $-\lambda t'$	1671	3342				
		Dark Period	Operating Time, t (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 64.50$ $-\lambda t$	968	1935				
			Nonoperating Time, t' (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 6.448$ $-\lambda t'$	97	193				
		$\sum$	$\lambda t + \lambda t'$	19,454	38,906				
			Reliability	.980734	.961839				
		Sunlight	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						

TABLE 24 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Full Attitude Write Logic	R_{94}	Sunlight	Operating Time, t (hr)	150	300	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 42.636$ $-\lambda t$	6395	12,791				
			Nonoperating Time, t' (hr)	4140	8280				
			$\lambda (x\ 10^{-6}) = 4.264$ $-\lambda t'$	17,653	35,306				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 345.910$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 34.591$ $-\lambda t'$	1038	2075				
		$\sum$	$\lambda t + \lambda t'$	25,086	50,172				
			Reliability	.975226	.951066				
Hourly Attitude Write Logic	R_{93}	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 52.772$ $-\lambda t$	792	1583				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (x\ 10^{-6}) = 5.277$ $-\lambda t'$	22,559	45,118				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 427.50$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 42.750$ $-\lambda t'$	128	256				
		$\sum$	$\lambda t + \lambda t'$	23,479	46,957				
			Reliability	.976795	.954128				

TABLE 24 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Critical Format Generator	R_{99}	Sunlight	Operating Time, t (hr)	15	30	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 62.016$ $-\lambda t$	930	1860				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (x\ 10^{-6}) = 6.202$ $-\lambda t'$	26,514	53,027				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 499.010$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 49.901$ $-\lambda t'$	1497	2994				
		$\sum$	$\lambda t + \lambda t'$	28,941	57,881				
			Reliability	.971474	.943762				
Full Diagnostic Format Generator	R_{104}, R_{108}	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 117.458$ $-\lambda t$	1762	3524				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (x\ 10^{-6}) = 11.746$ $-\lambda t'$	50,214	100,428				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 947.680$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 94.768$ $-\lambda t'$	2843	5686				
		$\sum$	$\lambda t + \lambda t'$	54,819	109,638				
			Reliability	.946656	.896158				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Master Clock	R_{117}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 23.626$ $-\lambda t$	101,356	202,711				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 3.403$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 191.630$ $-\lambda t$	5749	11,498				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 20.043$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	107,105	214,209				
			Reliability	.898431	.807179				
Deploy Data Format Generator	$R_{109} \times R_{110} \times R_{111}$	Sunlight	Operating Time, t (hr)	1	1				
			$\lambda (x\ 10^{-6}) = 30.308$ $-\lambda t$	30	30				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 3.031$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 250.440$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 25.044$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	30	30				
			Reliability	.999970	.999970				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Memory Overflow Unit	R_{116}	Sunlight	Operating Time, t (hr)	10	20	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) =$ 35.030 $-\lambda t$	350	701				
			Nonoperating Time, t' (hr)	4280	8560				
			$\lambda (x\ 10^{-6}) =$ 3.503 $-\lambda t'$	14,993	29,986				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ 286.500 $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) =$ 28.650 $-\lambda t'$	860	1719				
		$\sum$	$\lambda t + \lambda t'$	16,203	32,406				
			Reliability	.983927	.968112				
Read Logic	R_{113}	Sunlight	Operating Time, t (hr)	180	360				
			$\lambda (x\ 10^{-6}) =$ 17.610 $-\lambda t$	3170	6340				
			Nonoperating Time, t' (hr)	4110	8220				
			$\lambda (x\ 10^{-6}) =$ 1.761 $-\lambda t'$	7238	14,475				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ 141.360 $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) =$ 14.136 $-\lambda t'$	424	848				
		$\sum$	$\lambda t + \lambda t'$	10,832	21,663				
			Reliability	.989226	.978570				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Diagnostic and Deploy Commutator	R_{112}	Sunlight	Operating Time, t (hr)	15	30	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 2.376$ $-\lambda t$	36	71				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (x\ 10^{-6}) = 0.238$ $-\lambda t'$	1017	2035				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 19.80$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.980$ $-\lambda t'$	59	119				
		$\sum$	$\lambda t + \lambda t'$	1112	2225				
			Reliability	.998889	.997779				
Sync Frame Generator	R_{114}	Sunlight	Operating Time, t (hr)	180	360				
			$\lambda (x\ 10^{-6}) = 5.216$ $-\lambda t$	939	1878				
			Nonoperating Time, t' (hr)	4110	8220				
			$\lambda (x\ 10^{-6}) = 6.522$ $-\lambda t'$	2145	4291				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 43.200$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 4.320$ $-\lambda t'$	130	259				
		$\sum$	$\lambda t + \lambda t'$	3214	6428				
			Reliability	.996791	.993592				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Selector Switch	R_{100}	Sunlight	Operating Time, t (hr)	2145	4290	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.718$ $-\lambda t$	1540	3080				
			Nonoperating Time, t' (hr)	2145	429				
			$\lambda (x\ 10^{-6}) = 0.072$ $-\lambda t'$	154	309				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 5.810$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.581$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	1694	3389				
			Reliability	.998306	.996615				
Write Logic	R_{82}	Sunlight	Operating Time, t (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.984$ $-\lambda t$	2111	4221				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.098$ $-\lambda t'$	210	420				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 8.140$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.814$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	2321	4641				
			Reliability	.997682	.995369				

TABLE 24 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Commutator	R_{115}	Sunlight	Operating Time, t (hr)	180	360	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 2.112$ $-\lambda t$	380	760				
			Nonoperating Time, t' (hr)	4110	8220				
			$\lambda (x\ 10^{-6}) = 0.211$ $-\lambda t'$	867	1734				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 17.060$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.706$ $-\lambda t'$	51	102				
		$\sum$	$\lambda t + \lambda t'$	1298	2596				
			Reliability	.998703	.997408				
		Sunlight	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						

TABLE 25

Component Reliabilities (integrated circuitry)

					Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Counters	R_{13}, R_{16}, R_{28}, R_{31}	Sunlight	Operating Time, t (hr)		2145	4290	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.260$	$-\lambda t$	558	1115				
			Nonoperating Time, t' (hr)		2145	4290				
			$\lambda (x\ 10^{-6}) = 0.0260$	$-\lambda t'$	56	112				
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) = 2.150$	$-\lambda t$						
			Nonoperating Time, t' (hr)		30	60				
			$\lambda (x\ 10^{-6}) = 0.215$	$-\lambda t'$	6	13				
		$\sum$	$\lambda t + \lambda t'$		620	1240				
			Reliability		.999380	.998760				
Format Generator	$R_{32} x R_{33} x R_{34}, R_{17} x R_{18} x R_{19}$	Sunlight	Operating Time, t (hr)		2145	4290				
			$\lambda (x\ 10^{-6}) = 1.805$	$-\lambda t$	3872	7743				
			Nonoperating Time, t' (hr)		2145	4290				
			$\lambda (x\ 10^{-6}) = 0.180$	$-\lambda t'$	386	772				
		Dark Period	Operating Time, t (hr)							
			$\lambda (x\ 10^{-6}) = 14.393$	$-\lambda t$						
			Nonoperating Time, t' (hr)		30	60				
			$\lambda (x\ 10^{-6}) = 1.439$	$-\lambda t'$	43	86				
		$\sum$	$\lambda t + \lambda t'$		4301	8601				
			Reliability		.995708	.991436				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Amplifier Shaper	R_{20}, R_{35}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.087$ $-\lambda t$	373	746				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.009$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 0.734$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.073$ $-\lambda t'$	2	4				
		$\sum$	$\lambda t + \lambda t'$	375	750				
			Reliability	.999625	.999250				
Data Switch	R_{36}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 0.100$ $-\lambda t$	429	858				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.010$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 0.808$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.081$ $-\lambda t'$	2	5				
		$\sum$	$\lambda t + \lambda t'$	431	863				
			Reliability	.999569	.999138				

TABLE 25 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Signal Conditioning	R_{37}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.056$ $-\lambda t$	240	480				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.006$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 0.387$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.039$ $-\lambda t'$	1	2				
		$\sum$	$\lambda t + \lambda t'$	241	482				
			Reliability	.999759	.999518				
		Sunlight	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						

TABLE 25 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Counters	$R_{40} \times R_{41}, R_{42} \times R_{43}, R_{47}, R_{51}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 0.130$ $-\lambda t$	558	1115				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.013$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 1.075$ $-\lambda t$	32	64				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.108$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	590	1179				
			Reliability	.999410	.999820				
Write Logic	R_{60}	Sunlight	Operating Time, t (hr)	429	858				
			$\lambda (\times 10^{-6}) = 3.689$ $-\lambda t$	1583	3165				
			Nonoperating Time, t' (hr)	3861	7722				
			$\lambda (\times 10^{-6}) = 0.369$ $-\lambda t'$	1425	2849				
		Dark Period	Operating Time, t (hr)	3	6				
			$\lambda (\times 10^{-6}) = 30.328$ $-\lambda t$	91	182				
			Nonoperating Time, t' (hr)	27	54				
			$\lambda (\times 10^{-6}) = 3.033$ $-\lambda t'$	82	164				
		$\sum$	$\lambda t + \lambda t'$	3179	6360				
			Reliability	.996826	.993662				

TABLE 25 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Write Logic	R_{79}	Sunlight	Operating Time, t (hr)	644	1288	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 2.757$ $-\lambda t$	1776	3551				
			Nonoperating Time, t' (hr)	3646	7292				
			$\lambda (x\ 10^{-6}) = 0.276$ $-\lambda t'$	1006	2012				
		Dark Period	Operating Time, t (hr)	4	4				
			$\lambda (x\ 10^{-6}) = 22.768$ $-\lambda t$	91	182				
			Nonoperating Time, t' (hr)	26	52				
			$\lambda (x\ 10^{-6}) = 2.277$ $-\lambda t'$	59	118				
		$\sum$	$\lambda t + \lambda t'$	2932	5863				
			Reliability	.997072	.994153				
Counter	R_{80}	Sunlight	Operating Time, t (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.7794$ $-\lambda t$	1672	3344				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.0779$ $-\lambda t'$	167	334				
		Dark Period	Operating Time, t (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 6.450$ $-\lambda t$	97	194				
			Nonoperating Time, t' (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 0.645$ $-\lambda t'$	10	19				
		$\sum$	$\lambda t + \lambda t'$	1946	3891				
			Reliability	.998056	.996116				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Counters	R_{74}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.130$ $-\lambda t$	558	1115				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.0130$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.075$ $-\lambda t$	32	64				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.108$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	590	1179				
			Reliability	.999410	.998820				
Counters	R_{78}	Sunlight	Operating Time, t (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.779$ $-\lambda t$	1670	3342				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (x\ 10^{-6}) = 0.078$ $-\lambda t'$	167	335				
		Dark Period	Operating Time, t (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 6.450$ $-\lambda t$	97	194				
			Nonoperating Time, t' (hr)	15	30				
			$\lambda (x\ 10^{-6}) = 0.645$ $-\lambda t'$	10	19				
		$\sum$	$\lambda t + \lambda t'$	1944	3890				
			Reliability	.998056	.996116				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Full Write Logic	R_{94}	Sunlight	Operating Time, t (hr)	150	300	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 4.264$ $-\lambda t$	640	1279				
			Nonoperating Time, t' (hr)	4140	8280				
			$\lambda (\times 10^{-6}) = 0.426$ $-\lambda t'$	1764	3527				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 34.591$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 3.459$ $-\lambda t'$	104	208				
		$\sum$	$\lambda t + \lambda t'$	2508	5014				
			Reliability	.997495	.994996				
Format Generators	R_{99}	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (\times 10^{-6}) = 6.202$ $-\lambda t$	93	186				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 0.620$ $-\lambda t'$	2650	5301				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 49.901$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 4.990$ $-\lambda t'$	150	299				
		$\sum$	$\lambda t + \lambda t'$	2893	5786				
			Reliability	.997111	.994230				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Register	R_{92}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 0.779$ $-\lambda t$	3342	6684				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.078$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 6.450$ $-\lambda t$	194	387				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.645$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	3536	7071				
			Reliability	.996470	.992952				
Hourly Logic	R_{93}	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (\times 10^{-6}) = 5.277$ $-\lambda t$	79	158				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 0.528$ $-\lambda t'$	2257	4514				
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 42.750$ $-\lambda t$	128	256				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 4.275$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	2464	4928				
			Reliability	.997539	.995084				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Register	R_{86}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 1.461$ $-\lambda t$	6268	12,535				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.146$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 12.050$ $-\lambda t$	362	723				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 1.205$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	6630	13,258				
			Reliability	.993392	.986828				
Register	R_{89}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 0.872$ $-\lambda t$	3741	7482				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.087$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 7.160$ $-\lambda t$	215	430				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.716$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	3956	7912				
			Reliability	.996052	.992120				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Write Logic	R_{81}	Sunlight	Operating Time, t (hr)	429	858	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			λ (x 10^{-6}) = 1.492 $-\lambda t$	640	1280				
			Nonoperating Time, t' (hr)	3861	7722				
			λ (x 10^{-6}) = 0.149 $-\lambda t'$	575	1151				
		Dark Period	Operating Time, t (hr)	3	6				
			λ (x 10^{-6}) = 11.780 $-\lambda t$	35	71				
			Nonoperating Time, t' (hr)	27	54				
			λ (x 10^{-6}) = 1.178 $-\lambda t'$	32	64				
		$\sum$	$\lambda t + \lambda t'$	1282	2566				
			Reliability	.998719	.997438				
Write Logic	R_{82}	Sunlight	Operating Time, t (hr)	2145	4290				
			λ (x 10^{-6}) = 0.098 $-\lambda t$	210	420				
			Nonoperating Time, t' (hr)	2145	4290				
			λ (x 10^{-6}) = 0.010 $-\lambda t'$	21	43				
		Dark Period	Operating Time, t (hr)	30	60				
			λ (x 10^{-6}) = 0.814 $-\lambda t$	24	49				
			Nonoperating Time, t' (hr)						
			λ (x 10^{-6}) = 0.084 $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	255	512				
			Reliability	.999745	.999490				

TABLE 25 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Format Generator	R_{104}, R_{108}	Sunlight	Operating Time, t (hr)	15	30	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 11.746$ $-\lambda t$	176	352				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 1.175$ $-\lambda t'$	5023	10,046				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 94.768$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 9.477$ $-\lambda t'$	284	569				
		$\sum$	$\lambda t + \lambda t'$	5483	10,967				
			Reliability	.994532	.989094				
Multiplexer and Format Generator	$R_{109} \times R_{110} \times R_{111}$	Sunlight	Operating Time, t (hr)	1	1				
			$\lambda (\times 10^{-6}) = 3.031$ $-\lambda t$	3	3				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.303$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	3	3				
			Reliability	.999997	.999997				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Select Switch	R_{100}	Sunlight	Operating Time, t (hr)	2145	4290	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 0.072$ $-\lambda t$	154	309				
			Nonoperating Time, t' (hr)	2145	4290				
			$\lambda (\times 10^{-6}) = 0.007$ $-\lambda t'$	15	30				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 0.581$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.058$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	169	339				
			Reliability	.999831	.999662				
Multiplexer	R_{103}, R_{107}	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (\times 10^{-6}) = 4.386$ $-\lambda t$	66	132				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 0.439$ $-\lambda t'$	1877	3753				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 35.640$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 3.564$ $-\lambda t'$	107	214				
		$\sum$	$\lambda t + \lambda t'$	2050	4099				
			Reliability	.997952	.995908				

TABLE 25 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Sync Frame Generator	R_{114}	Sunlight	Operating Time, t (hr)	180	360	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.522$ $-\lambda t$	94	188				
			Nonoperating Time, t' (hr)	4110	8220				
			$\lambda (x\ 10^{-6}) = 0.052$ $-\lambda t'$	214	427				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 4.320$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.432$ $-\lambda t'$	13	26				
		$\sum$	$\lambda t + \lambda t'$	321	641				
			Reliability	.999679	.999358				
Commutator	R_{115}	Sunlight	Operating Time, t (hr)	180	360				
			$\lambda (x\ 10^{-6}) = 0.211$ $-\lambda t$	38	76				
			Nonoperating Time, t' (hr)	4110	8220				
			$\lambda (x\ 10^{-6}) = 0.021$ $-\lambda t'$	86	173				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 1.706$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.171$ $-\lambda t'$	5	10				
		$\sum$	$\lambda t + \lambda t'$	129	259				
			Reliability	.999871	.999742				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Commutator	R_{112}	Sunlight	Operating Time, t (hr)	15	30	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 0.238 \quad -\lambda t$	4	7				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (x\ 10^{-6}) = 0.024 \quad -\lambda t'$	103	205				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 1.980 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 0.198 \quad -\lambda t'$	6	12				
		$\sum$	$\lambda t + \lambda t'$	113	224				
			Reliability	.999887	.999776				
Read Out Logic	R_{113}	Sunlight	Operating Time, t (hr)	180	360				
			$\lambda (x\ 10^{-6}) = 1.761 \quad -\lambda t$	317	634				
			Nonoperating Time, t' (hr)	4110	8220				
			$\lambda (x\ 10^{-6}) = 0.176 \quad -\lambda t'$	723	1447				
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) = 14.136 \quad -\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 1.414 \quad -\lambda t'$	42	85				
		$\sum$	$\lambda t + \lambda t'$	1082	2166				
			Reliability	.998919	.997837				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Overflow Unit	R_{116}	Sunlight	Operating Time, t (hr)	10	20	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 3.503$ $-\lambda t$	35	70				
			Nonoperating Time, t' (hr)	4280	8560				
			$\lambda (\times 10^{-6}) = 0.350$ $-\lambda t'$	1498	2996				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) = 28.650$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 2.865$ $-\lambda t'$	86	172				
		$\sum$	$\lambda t + \lambda t'$	1619	3238				
			Reliability	.998382	.996767				
Master Clock	R_{117}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 2.363$ $-\lambda t$	10,137	20,274				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 0.340$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 19.163$ $-\lambda t$	575	1150				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) = 2.004$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	10,712	21,424				
			Reliability	.989345	.978804				

TABLE 25 (continued)

				Continuous Transmission 6 mo	Continuous Transmission 12 mo	Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
Exotech A or B, Signal Conditioner, Detector	$R_{44} \times R_{45} \times R_{46}, R_{48} \times R_{49} \times R_{50}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION
			$\lambda (x\ 10^{-6}) = 0.847$ $-\lambda t$	3634	7267				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.085$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 5.627$ $-\lambda t$	169	338				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.563$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	3803	7605				
			Reliability	.996204	.992422				
Panel Area A or B, Signal Conditioner, % Area Multiplexer	$R_{52} \times R_{53} \times R_{54}, R_{56} \times R_{57} \times R_{58}$	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 1.0494$ $-\lambda t$	4502	9004				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.10494$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 5.196$ $-\lambda t$	16	31				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) = 0.5196$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	4518	9035				
			Reliability	.995492	.991004				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Mariner Gauge 1, 2, or 3, Signal Conditioner, Pulse Height Analyzer	$R_{62} \times R_{63} \times R_{64}, R_{65} \times R_{66} \times R_{67}, R_{68} \times R_{69} \times R_{70}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) = 4.384$ $-\lambda t$	18,807	37,615				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 33.960$ $-\lambda t$	1019	2038				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	19,826	39,653				
			Reliability	.980369	.961123				
Velocity Gauge 1 or 2, Signal Conditioner, Pulse Height Analyzer	$R_{71} \times R_{72} \times R_{73}, R_{75} \times R_{76} \times R_{77}$	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (x\ 10^{-6}) = 3.740$ $-\lambda t$	16,045	32,089				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (x\ 10^{-6}) = 28.998$ $-\lambda t$	870	1740				
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	16,915	33,829				
			Reliability	.983227	.966735				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Magnetometers	R_{91}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 1.781$ $-\lambda t$	7640	15,281				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 14.254$ $-\lambda t$	428	855				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	8068	16,136				
			Reliability	.991964	.983993				
Solar Aspect Sensor Signal Conditioning	$R_{84} \times R_{85}$	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 4.102$ $-\lambda t$	17,597	35,195				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 30.320$ $-\lambda t$	910	1819				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	18,507	37,014				
			Reliability	.981663	.963662				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Critical Diagnostic 1, Signal Conditioning, Multiplexer	$R_{96} \times R_{97} \times R_{98}$	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 4.265$ $-\lambda t$	18,297	36,594				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 33.572$ $-\lambda t$	1007	2014				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	19,304	38,608				
			Reliability	.980881	.962128				
Diagnostic Sensors 2 or 3, Signal Conditioning	$R_{101} \times R_{102}, R_{105} \times R_{106}$	Sunlight	Operating Time, t (hr)	15	30				
			$\lambda (\times 10^{-6}) = 8.602$ $-\lambda t$	129	258				
			Nonoperating Time, t' (hr)	4275	8550				
			$\lambda (\times 10^{-6}) = 0.860$ $-\lambda t'$	3676	7353				
		Dark Period	Operating Time, t (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)	30	60				
			$\lambda (\times 10^{-6}) = 6.801$ $-\lambda t'$	204	408				
		$\sum$	$\lambda t + \lambda t'$	4009	8019				
			Reliability	.995999	.992014				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
Signal Conditioning	R_{88}	Sunlight	Operating Time, t (hr)	4290	8580	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 1.130$ $-\lambda t$	4848	9695				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 7.508$ $-\lambda t$	225	450				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	5073	10,145				
			Reliability	.994940	.989906				
Earth Aspect Sensors	R_{87}	Sunlight	Operating Time, t (hr)	4290	8580				
			$\lambda (\times 10^{-6}) = 0.1940$ $-\lambda t$	832	1664				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)	30	60				
			$\lambda (\times 10^{-6}) = 1.345$ $-\lambda t$	40	81				
			Nonoperating Time, t' (hr)						
			$\lambda (\times 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$	872	1745				
			Reliability	.999128	.998257				

TABLE (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
10K Storage	R_{83}	Sunlight	Operating Time, t (hr)	1070	2140	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (\times 10^{-6}) = 1.737$ $-\lambda t$	1858	3717				
			Nonoperating Time, t' (hr)	3220	6440				
			$\lambda (\times 10^{-6}) = 0.174$ $-\lambda t'$	560	1120				
		Dark Period	Operating Time, t (hr)	3	6				
			$\lambda (\times 10^{-6}) = 14.869$ $-\lambda t$	45	89				
			Nonoperating Time, t' (hr)	27	54				
			$\lambda (\times 10^{-6}) = 1.480$ $-\lambda t'$	40	80				
		$\sum$	$\lambda t + \lambda t'$	2503	5006				
			Reliability	.997500	.995006				
1K Storage	R_{61}	Sunlight	Operating Time, t (hr)	1070	2140				
			$\lambda (\times 10^{-6}) = 0.174$ $-\lambda t$	186	372				
			Nonoperating Time, t' (hr)	3220	6440				
			$\lambda (\times 10^{-6}) = 0.017$ $-\lambda t'$	55	109				
		Dark Period	Operating Time, t (hr)	3	6				
			$\lambda (\times 10^{-6}) = 1.487$ $-\lambda t$	4	9				
			Nonoperating Time, t' (hr)	27	54				
			$\lambda (\times 10^{-6}) = 0.148$ $-\lambda t'$	4	8				
		$\sum$	$\lambda t + \lambda t'$	249	498				
			Reliability	.999751	.999502				

TABLE 25 (continued)

				Continuous Transmission		Command On/Off Transmission	Automatic On/Off Transmission	Transmit Once/Day	Transmit Once/Orbit
				6 mo	12 mo				
12K Storage	R_{95}	Sunlight	Operating Time, t (hr)	1070	2140	DATA IDENTICAL TO THAT FOR CONTINUOUS TRANSMISSION			
			$\lambda (x\ 10^{-6}) =$ 2.0840 $-\lambda t$	2230	4460				
			Nonoperating Time, t' (hr)	3220	6440				
			$\lambda (x\ 10^{-6}) =$ 0.2084 $-\lambda t'$	671	1342				
		Dark Period	Operating Time, t (hr)	3	6				
			$\lambda (x\ 10^{-6}) =$ 17.843 $-\lambda t$	54	107				
			Nonoperating Time, t' (hr)	27	54				
			$\lambda (x\ 10^{-6}) =$ 1.784 $-\lambda t'$	48	96				
		$\sum$	$\lambda t + \lambda t'$	3003	6005				
			Reliability	.997001	.994012				
		Sunlight	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		Dark Period	Operating Time, t (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t$						
			Nonoperating Time, t' (hr)						
			$\lambda (x\ 10^{-6}) =$ $-\lambda t'$						
		$\sum$	$\lambda t + \lambda t'$						
			Reliability						

TABLE 26

High Quality Summary

RELIABILITY (COMPONENTS/EQUIPMENTS) SUMMARY

R Designation	Component/Equipment	Continuous Transmission		Command On/Off Transmission 4 Times/Zone		Automatic On/Off Transmission 10 Minutes/Hour		Transmit Once/Day (storage reqd)		Transmit Once/Orbit (storage reqd)	
		6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
1	Structure	0.999900	0.999800	0.999900	0.999800	0.999900	0.999800	0.999900	0.999800	0.999900	0.999800
2	Deploy	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304
3	Thermal control (active)	Passive 1.000000	Passive 1.000000	0.999906	0.999630	0.999906	0.999630	0.999906	0.999630	0.999906	0.999630
4	Capacitance Panel A	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
5	Capacitance Panel B	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
T	Charge generator Panel A	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940
U	Charge generator Panel B	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940
	R_A/R_B	0.999170	0.998980	0.999076	0.998610	0.999076	0.998610	0.999076	0.998610	0.999076	0.998610
10	Pri I electrical power	0.998847	0.997676	0.998388	0.996755	0.998388	0.996756	0.998388	0.996755	0.998388	0.996755
11	Capacitance Sensor A coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
12	Signal conditioner Panel A	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
13	Counter Panel A	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688
14	Capacitance Sensor B coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
15	Signal conditioner Panel B	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
16	Counter Panel B	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688
17	Format generator										
18	Master clock	0.957883	0.917540	0.957883	0.917540	0.957883	0.917540	0.957883	0.917540	0.957883	0.917540
19	Commutator										
20	Amplifier shaper	0.997923	0.995850	0.997923	0.995850	0.997923	0.995850	0.997923	0.995850	0.997923	0.995850
	R_C	0.931305	0.867309	0.930878	0.866509	0.930878	0.866510	0.930878	0.866509	0.930878	0.866509
21	SCO and phase modulator	0.995842	0.991701	0.999301	0.998602	0.998936	0.997873	0.999405	0.998811	0.999510	0.999020
22	Transmitter Pri I	0.985554	0.971318	0.993411	0.986865	0.992580	0.985217	0.993648	0.987337	0.993886	0.987809
23	Diplexer-out	0.999806	0.999611	0.999969	0.999938	0.999953	0.999904	0.999975	0.999948	0.999979	0.999958
24	Hybrid	0.997852	0.995709	0.999648	0.999295	0.999459	0.998918	0.999701	0.999403	0.999755	0.999511
	R_D	0.979158	0.958751	0.992336	0.984729	0.990941	0.981963	0.992735	0.985523	0.993135	0.986317
25	Electric power	0.990735	0.981534	0.986464	0.973089	0.986464	0.973090	0.986464	0.973089	0.986464	0.973089
26	Capacitance sensor A coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
27	Signal conditioner Panel A	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
28	Counter Panel A	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688
29	Capacitance sensor B coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
30	Signal conditioner Panel B	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
31	Counter Panel B	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688	0.993826	0.987688
32	Format generator										
33	Master clock	0.957883	0.917540	0.957883	0.917540	0.957883	0.917540	0.957883	0.917540	0.957883	0.917540
34	Commutator										
35	Amplifier shaper	0.997923	0.995850	0.997923	0.995850	0.997923	0.995850	0.997923	0.995850	0.997923	0.995850
	R_E	0.932380	0.869330	0.932380	0.869330	0.932380	0.869330	0.932380	0.869330	0.932380	0.869330
36	Data switch	0.995678	0.991375	0.999167	0.998335	0.998823	0.997647	0.999402	0.998804	0.999493	0.998986
37	Signal conditioning	0.997596	0.995198	0.999545	0.999090	0.999351	0.998702	0.999566	0.999132	0.999717	0.999434
	R_G	0.993284	0.986614	0.998712	0.997426	0.998175	0.996352	0.998968	0.997937	0.999210	0.998420
	R_F	0.999412	0.997932	0.993999	0.988014	0.994604	0.989178	0.994594	0.989191	0.993657	0.987350
38	Diplexer--out	0.999806	0.999611	0.999969	0.999938	0.999953	0.999904	0.999975	0.999948	0.999979	0.999958
39	Hybrid	0.997852	0.995709	0.999648	0.999295	0.999459	0.998918	0.999701	0.999403	0.999755	0.999511
	R_H	0.997658	0.995322	0.999617	0.999233	0.999412	0.998822	0.999676	0.999351	0.999734	0.999469
A	$e^{-(\lambda_1 + \lambda_2)}$ to operating	0.981456	0.963257	0.992717	0.985485	0.991524	0.983121	0.993057	0.986163	0.993399	0.986841
	$e^{-\lambda_3 t}$	0.990336	0.980765	0.990336	0.980765	0.990336	0.980765	0.990336	0.980765	0.990336	0.980765
	$e^{-\lambda_4 t}$	0.997201	0.994410	0.997201	0.994410	0.997201	0.994410	0.997201	0.994410	0.997201	0.994410
B	$e^{-(\lambda_3 + \lambda_4)t}$ operating	0.987564	0.975282	0.987564	0.975282	0.987564	0.975282	0.987564	0.975282	0.987564	0.975282
	$e^{-\lambda_5 t}$	0.999806	0.999612	0.999806	0.999612	0.999806	0.999612	0.999806	0.999612	0.999806	0.999612
	$e^{-\lambda_6 t}$	0.991574	0.983219	0.991574	0.983219	0.991574	0.983219	0.991574	0.983219	0.991574	0.983219
	$e^{-\lambda_7 t}$	0.992606	0.985267	0.992606	0.985267	0.992606	0.985267	0.992606	0.985267	0.992606	0.985267
C	$e^{-(\lambda_5 + \lambda_6 + \lambda_7)t}$ operating	0.984051	0.968357	0.984051	0.968357	0.984051	0.968357	0.984051	0.968357	0.984051	0.968357
	$e^{-\lambda_8 t}$	0.999806	0.999612	0.999806	0.999612	0.999806	0.999612	0.999806	0.999612	0.999806	0.999612
	$e^{-\lambda_9 t}$	0.991574	0.983219	0.991574	0.983219	0.991574	0.983219	0.991574	0.983219	0.991574	0.983219
	$e^{-\lambda_{10} t}$	0.992606	0.985267	0.992606	0.985267	0.992606	0.985267	0.992606	0.985267	0.992606	0.985267

TABLE 26 (continued)

RELIABILITY (COMPONENTS/EQUIPMENTS) SUMMARY

	R Designation	Component/Equipment	Continuous Transmission		Command On/Off Transmission 4 Times/Zone		Automatic On/Off Transmission 10 Minutes/Hour		Transmit Once/Day (storage reqd)		Transmit Once/Orbit (storage reqd)	
			6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
	D	$e^{-(\lambda_8 + \lambda_9 + \lambda_{10})t}$ operating	0.984051	0.968357	0.984051	0.968357	0.984051	0.968357	0.984051	0.968357	0.984051	0.968357
	E	$1 - e^{-(\lambda_5 + \lambda_6 + \lambda_7)t}$	0.015949	0.031643	0.015949	0.031643	0.015949	0.031643	0.015949	0.031643	0.015949	0.031643
	F	$1 - e^{-(\lambda_8 + \lambda_9 + \lambda_{10})t}$	0.015949	0.031643	0.015949	0.031643	0.015949	0.031643	0.015949	0.031643	0.015949	0.031643
	G	$\lambda_1 + \lambda_2$ (operating)	4.332	4.332	4.332	4.332	4.332	4.332	4.332	4.332	4.332	4.332
	H	$\lambda_{11} + \lambda_{12}$ (operating)	4.332	4.332	4.332	4.332	4.332	4.332	4.332	4.332	4.332	4.332
	I	$\lambda_{11} + \lambda_{12}$ (nonoperating)	1.494	1.494	1.494	1.494	1.494	1.494	1.494	1.494	1.494	1.494
	J	$e^{-(\lambda_{11} + \lambda_{12})t}$ operating	0.981588	0.963515	0.998700	0.997402	0.996881	0.993772	0.998440	0.996882	0.999740	0.999480
	K	$e^{-\left(\frac{\lambda_1 + \lambda_2}{\text{operating}} + \frac{\lambda_{11} + \lambda_{12}}{\text{nonoperating}}\right)t}$	0.975316	0.951241	0.998252	0.996507	0.995805	0.991628	0.997903	0.995810	0.999650	0.999300
	(1)	Storage	-	-	-	-	-	-	0.998675	0.997352	0.997735	0.995479
	(2)	Programmer	-	-	-	-	0.959806	0.921228	-	-	-	-
	(3)	Power switch	-	-	-	-	0.994650	0.989329	-	-	-	-
	(4)	Command control switch	-	-	0.994650	0.989329	-	-	0.994650	0.989329	0.994650	0.989329
	(5)	Readout logic	-	-	-	-	-	-	0.989597	0.979302	0.991193	0.982464
	(1)	Storage	-	-	-	-	-	-	0.998675	0.997352	0.997735	0.995479
	(2)	Programmer	-	-	-	-	0.959806	0.921228	-	-	-	-
	(3)	Power switch	-	-	-	-	0.994650	0.989329	-	-	-	-
	(4)	Command control switch	-	-	0.994650	0.989329	-	-	0.994650	0.989329	0.994650	0.989329
	(5)	Readout logic	-	-	-	-	-	-	0.989597	0.979302	0.991193	0.982464
Penetration Data	40	Panel coupler A	-	-	-	-	-	-	-	-	-	-
	41	Counter	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279
	42	Panel coupler B	-	-	-	-	-	-	-	-	-	-
	43	Counter	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279
		R_R	0.988279	0.976695	0.988279	0.976695	0.988279	0.976695	0.988279	0.976695	0.988279	0.976695
Exotech Data	44	Exotech A	-	-	-	-	-	-	-	-	-	-
	45	Signal conditioning	0.962674	0.926741	0.962674	0.926741	0.962674	0.926741	0.962674	0.926741	0.962674	0.926741
	46	Detector	0.984377	0.968998	0.984377	0.968998	0.984377	0.968998	0.984377	0.968998	0.984377	0.968998
	47	Counter	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279
	48	Exotech B	-	-	-	-	-	-	-	-	-	-
	49	Signal conditioning	0.962674	0.926741	0.962674	0.926741	0.962674	0.926741	0.962674	0.926741	0.962674	0.926741
	50	Detector	0.984377	0.968998	0.984377	0.968998	0.984377	0.968998	0.984377	0.968998	0.984377	0.968998
	51	Counter	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279
		R_I	0.887484	0.787629	0.887484	0.787629	0.887484	0.787629	0.887484	0.787629	0.887484	0.787629
Area Data	52	Panel area A	-	-	-	-	-	-	-	-	-	-
	53	Signal conditioning	0.928196	0.861548	0.928196	0.861548	0.928196	0.861548	0.928196	0.861548	0.928196	0.861548
	54	Multiplexer	-	-	-	-	-	-	-	-	-	-
	55	Counter	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279
	56	Panel area B	-	-	-	-	-	-	-	-	-	-
	57	Signal conditioning	0.928196	0.861548	0.928196	0.861548	0.928196	0.861548	0.928196	0.861548	0.928196	0.861548
	58	Multiplexer	-	-	-	-	-	-	-	-	-	-
	59	Counter	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279	0.994122	0.988279
		R_J	0.851449	0.724967	0.851449	0.724967	0.851449	0.724967	0.851449	0.724967	0.815449	0.724967
	60	Write logic	0.968702	0.938384	0.968702	0.938384	0.968702	0.938384	0.968702	0.938384	0.968702	0.938384
	61	Storage I	0.997900	0.995804	0.997900	0.995804	0.997900	0.995804	0.997900	0.995804	0.997900	0.995804
		$R_{60} \times R_{61}$	0.966668	0.934446	0.966668	0.934446	0.966668	0.934446	0.966668	0.934446	0.966668	0.934446
Mariner Gages	62	Mariner gage 1	-	-	-	-	-	-	-	-	-	-
	63	Signal conditioning	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155
	64	Pulse height analyzer	-	-	-	-	-	-	-	-	-	-
	65	Mariner gage 2	-	-	-	-	-	-	-	-	-	-
	66	Signal conditioning	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155
	67	Pulse height analyzer	-	-	-	-	-	-	-	-	-	-
	68	Mariner gage 3	-	-	-	-	-	-	-	-	-	-
	69	Signal conditioning	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155	0.905624	0.820155
	70	Pulse height analyzer	-	-	-	-	-	-	-	-	-	-
		R_L	0.742752	0.551681	0.742752	0.551681	0.742752	0.551681	0.742752	0.551681	0.742752	0.551681

TABLE 26 (continued)

RELIABILITY (COMPONENTS/EQUIPMENTS) SUMMARY

	R Designation	Component/Equipment	Continuous Transmission		Command On/Off Transmission 4 Times/Zone		Automatic On/Off Transmission 10 Minutes/Hour		Transmit Once/Day (storage reqd)		Transmit Once/Orbit (storage reqd)	
			6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Velocity Gages	71	Velocity gage 1	-	-	-	-	-	-	-	-	-	-
	72	Signal conditioning	0.918891	0.844361	0.918891	0.844361	0.918891	0.844361	0.918891	0.844361	0.918891	0.844361
	73	Pulse height analyzer	-	-	-	-	-	-	-	-	-	-
	74	Counters	0.994122	0.988279	0.994122	0.988279	0.994122	0.998279	0.994122	0.998279	0.994122	0.998279
	75	Velocity gage 2	-	-	-	-	-	-	-	-	-	-
	76	Signal conditioning	0.918891	0.844361	0.918891	0.844361	0.918891	0.844361	0.918891	0.844361	0.918891	0.844361
	77	Pulse height analyzer	-	-	-	-	-	-	-	-	-	-
	78	Counters	0.980734	0.961839	0.980734	0.961839	0.980734	0.961839	0.980734	0.961839	0.980734	0.961839
		R_M	0.823226	0.677701	0.823226	0.677701	0.823226	0.677701	0.823226	0.677701	0.823226	0.677701
Logic	79	Write logic	0.971116	0.943066	0.971116	0.943066	0.971116	0.943066	0.971116	0.943066	0.971116	0.943066
	80	Counter	0.980734	0.961839	0.980734	0.961839	0.980734	0.961839	0.980734	0.961839	0.980734	0.961839
		R_N	0.952406	0.907078	0.952406	0.907078	0.952406	0.907078	0.952406	0.907078	0.952406	0.907078
Logic	81	Write logic	0.987249	0.974660	0.987249	0.974660	0.987249	0.974660	0.987249	0.974660	0.987249	0.974660
	82	Write logic	0.997682	0.995369	0.997682	0.995369	0.997682	0.995369	0.997682	0.995369	0.997682	0.995369
		R_O	0.984960	0.970146	0.984960	0.970146	0.984960	0.970146	0.984960	0.970146	0.984960	0.970146
	83	Storage II	0.979211	0.958854	0.979211	0.958854	0.979211	0.958854	0.979211	0.958854	0.979211	0.958854
			0.979211	0.958854	0.979211	0.958854	0.979211	0.958854	0.979211	0.958854	0.979211	0.958854
Aspect Sensors	84	Solar aspect sensors	0.911617	0.831046	0.911617	0.831046	0.911617	0.831046	0.911617	0.831046	0.911617	0.831046
	85	Signal conditioning	0.949396	0.901353	0.949396	0.901353	0.949396	0.901353	0.949396	0.901353	0.949396	0.901353
	86	Register	0.935858	0.875830	0.935858	0.875830	0.935858	0.875830	0.935858	0.875830	0.935858	0.875830
	87	Earth aspect sensors	0.991311	0.982697	0.991311	0.982697	0.991311	0.982697	0.991311	0.982697	0.991311	0.982697
	88	Signal conditioning	0.977048	0.954623	0.977048	0.954623	0.977048	0.954623	0.977048	0.954623	0.977048	0.954623
	89	Register	0.961215	0.923934	0.961215	0.923934	0.961215	0.923934	0.961215	0.923934	0.961215	0.923934
	90	Magnetometers	0.991040	0.982160	0.991040	0.982160	0.991040	0.982160	0.991040	0.982160	0.991040	0.982160
	91	Signal conditioning	0.960467	0.922497	0.960467	0.922497	0.960467	0.922497	0.960467	0.922497	0.960467	0.922497
	92	Register	0.965247	0.931702	0.965247	0.931702	0.965247	0.931702	0.965247	0.931702	0.965247	0.931702
		R_P	0.692833	0.480017	0.692833	0.480017	0.692833	0.480017	0.692833	0.480017	0.692833	0.480017
Logic	93	Hourly logic	0.976795	0.954128	0.976795	0.954128	0.976795	0.954128	0.976795	0.954128	0.976795	0.954128
	94	Full write logic	0.975226	0.951066	0.975226	0.951066	0.975226	0.951066	0.975226	0.951066	0.975226	0.951066
		R_Q	0.952596	0.907439	0.952596	0.907439	0.952596	0.907439	0.952596	0.907439	0.952596	0.907439
	95	Storage III	0.975335	0.951278	0.975335	0.951278	0.975335	0.951278	0.975335	0.951278	0.975335	0.951278
Critical Diagnostic	96	Critical diagnostic 1	0.907995	0.824455	0.907995	0.824455	0.907995	0.824455	0.907995	0.824455	0.907995	0.824455
	97	Signal conditioning	-	-	-	-	-	-	-	-	-	-
	98	Multiplexer	0.916786	0.840496	0.916786	0.840496	0.916786	0.840496	0.916786	0.840496	0.916786	0.840496
	99	Format generators	0.971474	0.943762	0.971474	0.943762	0.971474	0.943762	0.971474	0.943762	0.971474	0.943762
		R_R	0.808691	0.653981	0.808691	0.653981	0.808691	0.653981	0.808691	0.653981	0.808691	0.653981
	100	Select switch	0.998306	0.996615	0.998306	0.996615	0.998306	0.996615	0.998306	0.996615	0.998306	0.996615
Full Diagnostic	101	Diagnostic sensors 2	-	-	-	-	-	-	-	-	-	-
	102	Signal conditioning	0.980148	0.960690	0.980148	0.960690	0.980148	0.960690	0.980148	0.960690	0.980148	0.960690
	103	Multiplexer	0.979731	0.959873	0.979731	0.959873	0.979731	0.959873	0.979731	0.959873	0.979731	0.959873
	104	Format generator	0.946656	0.896158	0.946656	0.896158	0.946656	0.896158	0.946656	0.896158	0.946656	0.896158
	105	Diagnostic sensors 3	-	-	-	-	-	-	-	-	-	-
	106	Signal conditioning	0.980148	0.960690	0.980148	0.960690	0.980148	0.960690	0.980148	0.960690	0.980148	0.960690
	107	Multiplexer	0.979731	0.959873	0.979731	0.959873	0.979731	0.959873	0.979731	0.959873	0.979731	0.959873
	108	Format generator	0.946656	0.896158	0.946656	0.896158	0.946656	0.896158	0.946656	0.896158	0.946656	0.896158
		R_S	0.826383	0.682910	0.826383	0.682910	0.826383	0.682910	0.826383	0.682910	0.826383	0.682910
Deployment	109	Deployment sensors										
	110	Multiplexer	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970
	111	Format generator										
		R_T	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970	0.999970
	112	Commutator	0.998889	0.997779	0.998889	0.997779	0.998889	0.997779	0.998889	0.997779	0.998889	0.997779
Logic	113	Readout logic	0.989226	0.978570	0.989226	0.978570	0.989226	0.978570	0.989226	0.978570	0.989226	0.978570
	114	Sync frame generator	0.996791	0.993592	0.996791	0.993592	0.996791	0.993592	0.996791	0.993592	0.996791	0.993592
	115	Commutator	0.998703	0.997408	0.998703	0.997408	0.998703	0.997408	0.998703	0.997408	0.998703	0.997408
		R_U	0.984773	0.969779	0.984773	0.969779	0.984773	0.969779	0.984773	0.969779	0.984773	0.969779
	116	Overflow unit	0.983927	0.968112	0.983927	0.968112	0.983927	0.968112	0.983927	0.968112	0.983927	0.968112
	117	Master clock	0.898431	0.807179	0.898431	0.807179	0.898431	0.807179	0.898431	0.807179	0.898431	0.807179

TABLE 27

Integrated Circuitry Summary

RELIABILITY (COMPONENTS/EQUIPMENTS) SUMMARY

	R Designation	Component/Equipment	Continuous Transmission		Command On/Off Transmission 4 Times/Zone		Automatic On/Off Transmission 10 Minutes/Hour		Transmit Once/Day (storage reqd)		Transmit Once/Orbit (storage reqd)	
			6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
	1	Structure	0.999900	0.999800	0.999900	0.999800	0.999900	0.999800	0.999900	0.999800	0.999900	0.999800
	2	Deployment	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304	0.999304
	3	Thermal control (active)	Passive 1.000000	Passive 1.000000	0.999906	0.999630	0.999906	0.999630	0.999906	0.999630	0.999906	0.999630
	4	Capacitance panel A	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	5	Capacitance panel B	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	T	Charge generator A	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940
	U	Charge generator B	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940	0.999985	0.999940
		R_A/R_B	0.999170	0.998980	0.999076	0.998610	0.999076	0.998610	0.999076	0.998610	0.999076	0.998610
	10	Primary I--electric power	0.998847	0.997676	0.998388	0.996755	0.998388	0.996756	0.998388	0.996755	0.938388	0.996755
	11	Capacitance sensor A coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	12	Signal conditioner panel A	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
	13	Counter panel A	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760
	14	Capacitance sensor B coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	15	Signal conditioner panel B	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
	16	Counter panel B	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760
	17	Format generator										
	18	Master clock	0.995708	0.991436	0.995708	0.991436	0.995708	0.991436	0.995708	0.991436	0.995708	0.991436
	19	Commutator										
	20	Amplifier shaper	0.999625	0.999250	0.999625	0.999250	0.999625	0.999250	0.999625	0.999250	0.999625	0.999250
		R_C	0.980601	0.961560	0.980150	0.960673	0.980150	0.960674	0.980150	0.960673	0.980150	0.960673
	21	SCO and phase modulator	0.995842	0.991701	0.999301	0.999602	0.998936	0.997873	0.999405	0.998811	0.999510	0.999020
	22	Transmitter primary I	0.985554	0.971318	0.993411	0.986865	0.992580	0.985217	0.993648	0.987337	0.993886	0.987809
	23	Diplexer out	0.999806	0.999611	0.999969	0.999938	0.999953	0.999904	0.999975	0.999948	0.999979	0.999958
	24	Hybrid	0.997852	0.995709	0.999648	0.999295	0.999459	0.998918	0.999701	0.999403	0.999755	0.999511
		R_D	0.479158	0.958751	0.992336	0.984729	0.990941	0.981963	0.992735	0.985523	0.993135	0.986317
	25	Electric power	0.990735	0.981534	0.986464	0.973089	0.986464	0.973090	0.986464	0.973089	0.986464	0.973089
	26	Capacitance sensor A coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	27	Signal conditioner panel A	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
	28	Counter panel A	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760
	29	Capacitance sensor B coupling	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	30	Signal conditioner panel B	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559	0.993760	0.987559
	31	Counter panel B	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760	0.999380	0.998760
	32	Format generator										
	33, 34	Master clock, commutator	0.995708	0.991436	0.995708	0.991436	0.995708	0.991436	0.995708	0.991436	0.995708	0.991436
	35	Amplifier shaper	0.999625	0.999250	0.999625	0.999250	0.999625	0.999250	0.999625	0.999250	0.999625	0.999250
		R_E	0.981733	0.963801	0.981733	0.963801	0.981733	0.983801	0.981733	0.983801	0.981733	0.983801
	36	Data switch	0.999569	0.999138	0.999569	0.999138	0.999569	0.999138	0.999569	0.999138	0.999569	0.999138
	37	Signal conditioner	0.999759	0.999518	0.999759	0.999518	0.999759	0.999518	0.999759	0.999518	0.999759	0.999518
		R_G	0.999328	0.998656	0.999328	0.998656	0.999328	0.998656	0.999328	0.998656	0.999328	0.998656
		R_F	0.999412	0.997932	0.993999	0.988014	0.994604	0.989178	0.994594	0.989191	0.993657	0.987350
	38	Diplexer --out	0.999806	0.999611	0.999969	0.999938	0.999953	0.999904	0.999975	0.999948	0.999979	0.999958
	39	Hybrid	0.997852	0.995709	0.999648	0.999295	0.999959	0.998918	0.999701	0.999403	0.999755	0.999511
		R_H	0.997658	0.995322	0.999617	0.999233	0.999412	0.998822	0.999676	0.999351	0.999734	0.999469
Penetration Data	40	Panel coupler A										
	41	Counter	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.999820
	42	Panel coupler B										
	43	Counter	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820
		R_K	0.998820	0.997641	0.998820	0.997641	0.998820	0.997641	0.998820	0.997641	0.998820	0.997641
Exotech Data	44	Exotech A										
	45	Signal conditioner	0.996204	0.992422	0.996204	0.992422	0.996204	0.992422	0.996204	0.992422	0.996204	0.992422
	46	Detector										
	47	Counter	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820

TABLE 27 (continued)

RELIABILITY (COMPONENTS/EQUIPMENTS) SUMMARY

	R Designation	Component/Equipment	Continuous Transmission		Command On/Off Transmission 4 Times/Zone		Automatic On/Off Transmission 10 Minutes/Hour		Transmit Once/Day (storage reqd)		Transmit Once/Orbit (storage reqd)	
			6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Exotech Data	48	Exotech B										
	49	Signal conditioning	0.996204	0.992422	0.996204	0.992422	0.996204	0.992422	0.996204	0.992422	0.996204	0.992422
	50	Detector										
	51	Counter	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820
		R_I	0.991252	0.982578	0.991252	0.982578	0.991252	0.982578	0.991252	0.982578	0.991252	0.982578
Area Data	52	Panel Area A										
	53	Signal conditioning	0.995492	0.991004	0.995492	0.991004	0.995492	0.991004	0.995492	0.991004	0.995492	0.991004
	54	Multiplexer (% area)										
	55	(Eliminated)										
	56	Panel Area B										
	57	Signal conditioning	0.995492	0.991004	0.995492	0.991004	0.995492	0.991004	0.995492	0.991004	0.995492	0.991004
	58	Multiplexer (% area)										
	59	(Eliminated)										
		R_J	0.991004	0.982089	0.991004	0.982089	0.991004	0.982089	0.991004	0.982089	0.991004	0.982089
	60	Write logic	0.996826	0.993662	0.996826	0.993662	0.996826	0.993662	0.996826	0.993662	0.996826	0.993662
	61	Storage I	0.999751	0.999502	0.999751	0.999502	0.999751	0.999502	0.999751	0.999502	0.999751	0.999502
Mariner Gages	62	Mariner Gauge 1										
	63	Signal conditioning										
	64	Pulse height analyzer	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123
	65	Mariner Gauge 2										
	66	Signal conditioning										
	67	Pulse height analyzer	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123
	68	Mariner Gauge 3										
	69	Signal conditioning										
	70	Pulse height analyzer	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123	0.980369	0.961123
		All sensors R_L	0.942255	0.887844	0.942255	0.887844	0.942255	0.887844	0.942255	0.887844	0.942255	0.887844
		Any 2 out of 3	0.998858	0.995583	0.998858	0.995583	0.998858	0.995583	0.998858	0.995583	0.998858	0.995583
Velocity Gages	71	Velocity Gauge 1										
	72	Signal conditioning	0.983227	0.966735	0.983227	0.966735	0.983227	0.966735	0.983227	0.966735	0.983227	0.966735
	73	Pulse height analyzer										
	74	Counters	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820	0.999410	0.998820
	75	Velocity Gauge 2										
	76	Signal conditioning	0.983227	0.966735	0.983227	0.966735	0.983227	0.966735	0.983227	0.966735	0.983227	0.966735
	77	Pulse height analyzer										
	78	Counters	0.998056	0.996116	0.998056	0.996116	0.998056	0.996116	0.998056	0.996116	0.998056	
		R_M	0.964287	0.929848	0.964287	0.929848	0.964287	0.929848	0.964287	0.929848	0.964287	0.929848
Logic	79	Write logic	0.997072	0.994153	0.997072	0.994153	0.997072	0.994153	0.997072	0.994153	0.997072	0.994153
	80	Counter	0.998056	0.996116	0.998056	0.996116	0.998056	0.996116	0.998056	0.996116	0.998056	0.996116
		R_N	0.995134	0.990292	0.995134	0.990292	0.995134	0.990292	0.995134	0.990292	0.995134	0.990292
Logic	81	Write logic	0.998719	0.997438	0.998719	0.997438	0.998719	0.997438	0.998719	0.997438	0.998719	0.997438
	82	Write logic	0.999745	0.999490	0.999745	0.999490	0.999745	0.999490	0.999745	0.999490	0.999745	0.999490
		R_O	0.998464	0.996929	0.998464	0.996929	0.998464	0.996929	0.998464	0.996929	0.998464	0.996929
	83	Storage II	0.997500	0.995006	0.997500	0.995006	0.997500	0.995006	0.997500	0.995006	0.997500	0.995006
Aspect Sensors	84	Solar aspect sensors	0.981663	0.963662	0.981663	0.963662	0.981663	0.963662	0.981663	0.963662	0.981663	0.963662
	85	Signal conditioning										
	86	Register	0.993392	0.986828	0.993392	0.986828	0.993392	0.986828	0.993392	0.986828	0.993392	0.986828
	87	Earth aspect sensors	0.999128	0.998257	0.999128	0.998257	0.999128	0.998257	0.999128	0.998257	0.999128	0.998257
	88	Signal conditioning	0.994940	0.989906	0.994940	0.989906	0.994940	0.989906	0.994940	0.989906	0.994940	0.989906
	89	Register	0.996052	0.992120	0.996052	0.992120	0.996052	0.992120	0.996052	0.992120	0.996052	0.992120
	90	Magnetometers										
	91	Signal conditioning	0.991964	0.983993	0.991964	0.983993	0.991964	0.983993	0.991964	0.983993	0.991964	0.983993
	92	Register	0.996470	0.992952	0.996470	0.992952	0.996470	0.992952	0.996470	0.992952	0.996470	0.992952
		R_P	0.954428	0.910934	0.954428	0.910934	0.954428	0.910934	0.954428	0.910934	0.954428	0.910934

TABLE 27 (continued)

RELIABILITY (COMPONENTS/EQUIPMENTS) SUMMARY

	R Designation	Component/Equipment	Continuous Transmission		Command On/Off Transmission 4 Times/Zone		Automatic On/Off Transmission 10 Minutes/Hour		Transmit Once/Day (storage reqd)		Transmit Once/Orbit (storage reqd)	
			6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Logic	93	Hourly logic	0.997539	0.995084	0.997539	0.995084	0.997539	0.995084	0.997539	0.995084	0.997539	0.995084
	94	Full write logic	0.997495	0.994996	0.997495	0.994996	0.997495	0.994996	0.997495	0.994996	0.997495	0.994996
		Both	0.995040	0.990104	0.995040	0.990104	0.995040	0.990104	0.995040	0.990104	0.995040	0.990104
		Either or both	0.999994	0.999974	0.999994	0.999974	0.999994	0.999974	0.999994	0.999974	0.999994	0.999974
	95	Storage III	0.997001	0.994012	0.997001	0.994012	0.997001	0.994012	0.997001	0.994012	0.997001	0.994012
Critical Diagnostic	96	Critical Diagnostic 1	0.980881	0.962128	0.980881	0.962128	0.980881	0.962128	0.980881	0.962128	0.980881	0.962128
	97, 98	Signal conditioning, multiplexer										
	99	Format generators	0.997111	0.994230	0.997111	0.994230	0.997111	0.994230	0.997111	0.994230	0.997111	0.994230
		R_R	0.978047	0.956576	0.978047	0.956576	0.978047	0.956576	0.978047	0.956576	0.978047	0.956576
	100	Select switch	0.999831	0.999662	0.999831	0.999662	0.999831	0.999662	0.999831	0.999662	0.999831	0.999662
Full Diagnostic	101	Diagnostic Sensors 2	0.995999	0.992014	0.995999	0.992014	0.995999	0.992014	0.995999	0.992014	0.995999	0.992014
	102	Signal conditioning										
	103	Multiplexer	0.997952	0.995908	0.997952	0.995908	0.997952	0.995908	0.997952	0.995908	0.997952	0.995908
	104	Format generator	0.994532	0.989094	0.994532	0.989094	0.994532	0.989094	0.994532	0.989094	0.994532	0.989094
	105, 106	Diag Sensors 3 & Sig. Cond.	0.995999	0.992014	0.995999	0.992014	0.995999	0.992014	0.995999	0.992014	0.995999	0.992014
	107	Multiplexer	0.997952	0.995908	0.997952	0.995908	0.997952	0.995908	0.997952	0.995908	0.997952	0.995908
	108	Format generators	0.994532	0.989094	0.994532	0.989094	0.994532	0.989094	0.994532	0.989094	0.994532	0.989094
		R_S	0.977180	0.954881	0.977180	0.954881	0.977180	0.954881	0.977180	0.954881	0.977180	0.954881
Deployment	109	Deployment sensors	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	110	Multiplexer										
	111	Format generator	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997
		R_T	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997	0.999997
Logic	112	Commutator	0.999887	0.999776	0.999887	0.999776	0.999887	0.999776	0.999887	0.999776	0.999887	0.999776
	113	Read out logic	0.998919	0.997837	0.998919	0.997837	0.998919	0.997837	0.998919	0.997837	0.998919	0.997837
	114	Sync frame generator	0.999679	0.999358	0.999679	0.999358	0.999679	0.999358	0.999679	0.999358	0.999679	0.999358
	115	Commutator	0.999871	0.999742	0.999871	0.999742	0.999871	0.999742	0.999871	0.999742	0.999871	0.999742
		R_U	0.998469	0.996939	0.998469	0.996939	0.998469	0.996939	0.998469	0.996439	0.998469	0.996939
	116	Overflow unit	0.998382	0.996767	0.998382	0.996767	0.998382	0.996767	0.998382	0.996767	0.998382	0.996767
	117	Master clock	0.989345	0.978804	0.989345	0.978804	0.989345	0.978804	0.989345	0.978804	0.989345	0.978804