Aerospace Systems Division

LEAM Reliability Numerical Analysis, Reliability Mathematical Model, Failure Mode, Effects and Criticality Analysis, and Single Point Failures	NO. ATM 1013 REV. NO.
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	DATE 9 June 1971

Introduction

Presented herein are the results of the reliability analysis conducted on the LEAM. This ATM comprises Reliability Numerical Analysis, Reliability Mathematical Models, Failure Modes, Effects and Criticality Analysis, and Single Point Failures.

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LEAM Reliability P. E.

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ALSEP Reliability

Conclusions

Probability of success for two years mission are as follows:

P_S = .7854 (Total System)

P_S = .8303 (Less Housekeeping Data)

P_S = .8068 (Less Single Sensor)

P_S = .8466 (Less Single Sensor and Less Housekeeping Data)

This reliability analysis was based on continuous operation at 40°C.

The failure modes, effects and criticality analysis, has shown that there are 19 single point failures. Most of these failures are in the elements that are in series with the whole experiment. For instance, the power supply subsystem, if this fails the whole experiment is lost. The only way to overcome this loss is to fabricate a redundant power supply. However, this is impractical since this will add to the size and weight of the system. Also, the design goal power requirement of 3.0 watts will not be achieved. The discrete components which are part of the total single point failures have very low stress levels. The stress ratio on each of these components is less than 0.1. Redundancy on these components would help reduce the overall criticality of the experiment, however, the low stress ratio weight overrules the possibility of redundancy. All of these factors will be considered for Qual and flight units in order to minimize the failures and increase the overall reliability of the system.

Reliability Analysis

The Reliability Analysis has been performed on the system under four conditions:

1. Total System, with 100% of the data being returned, and all housekeeping functions being performed.

2. Total System with all housekeeping functions omitted.

3. Total System with the single sensor omitted for an 80% return of the data and with all housekeeping functions being performed.

4. Total System with all housekeeping functions and the single sensor omitted.

A Failure Mode, Effect and Criticality Analysis (FMECA) was performed in order to determine those potential failure modes associated with the design, occurrence of which could result in experiment failure. The analysis presented herein is intended to discover critical failure areas and present a possible means of removing the failure from the system, either by design or operation. The analysis highlights array single point failures, that is, a failure that could fail the experiment.

The analysis was performed at two levels, system level and block level.

For analysis at system level a failure of a "block" of the system is assumed and the effect of this failure is related to the system.

For block level analysis, failure of a component part of the block is assumed and the effect of this failure is related to that block. The following four categories were used to identify the criticality of the failure.

1. Criticality 1 - A failure that results in the loss of 100% of the expected data

2. Criticality 2 - A failure that results in the loss of more than 50% of the expected data but less than 100%

3. Criticality 3 - A failure that results in the loss of less than 50% of the expected data

4. Criticality 4 - A failure that results in no data loss.

Any failure that results in the loss of 50% or more of the expected data is defined as single point failure. All single point failures fall into the Criticality ranking 1 and 2. All failures that fall in this category will be reviewed and if possible corrective action or alternate mode of operation will be insitituted to minimize the loss.

The value of failure probability was calculated as follows:

$$F.P. = Q \times 10^{-5}$$

$$Q = \alpha \lambda T$$

where,

α = Percentage of this type of failure, (Open or Short)

λ = Failure rate (10^{-8} failures/hours)

$\therefore$ = F.P. = ($\alpha \times \lambda \times T$).

Summary of Data

The single thread reliability block diagram, Figure 1 is presented in the following manner: The number appearing in the lower left corner is the number of times the circuit appears within the LEAM. The number in the lower right corner is the subsystem failure rate which is the product of the number of times the circuit is used within the LEAM and the failure rate of the circuit. Those circuits which are asterisked are the housekeeping functions which are excluded from consideration during the analysis.

Table 1 is a capitulation of the major subsystems with appropriate failure rates. The two figures at the bottom line are:

1. λ or failure rate

2. P_S probability of success for 17520 Hrs of operation.

In Appendix A, are the detail reliability analysis, showing total quantity of parts used within each subsystem, the individual failure rates and the total subsystem failure rate which is used in the determination of the probability of success.

Appendix B shows the detailed analysis of assumed failure modes of blocks of the system and its effect on the system output. Also, it presents the assumed failure modes of component parts of the block and its effect on the block output.

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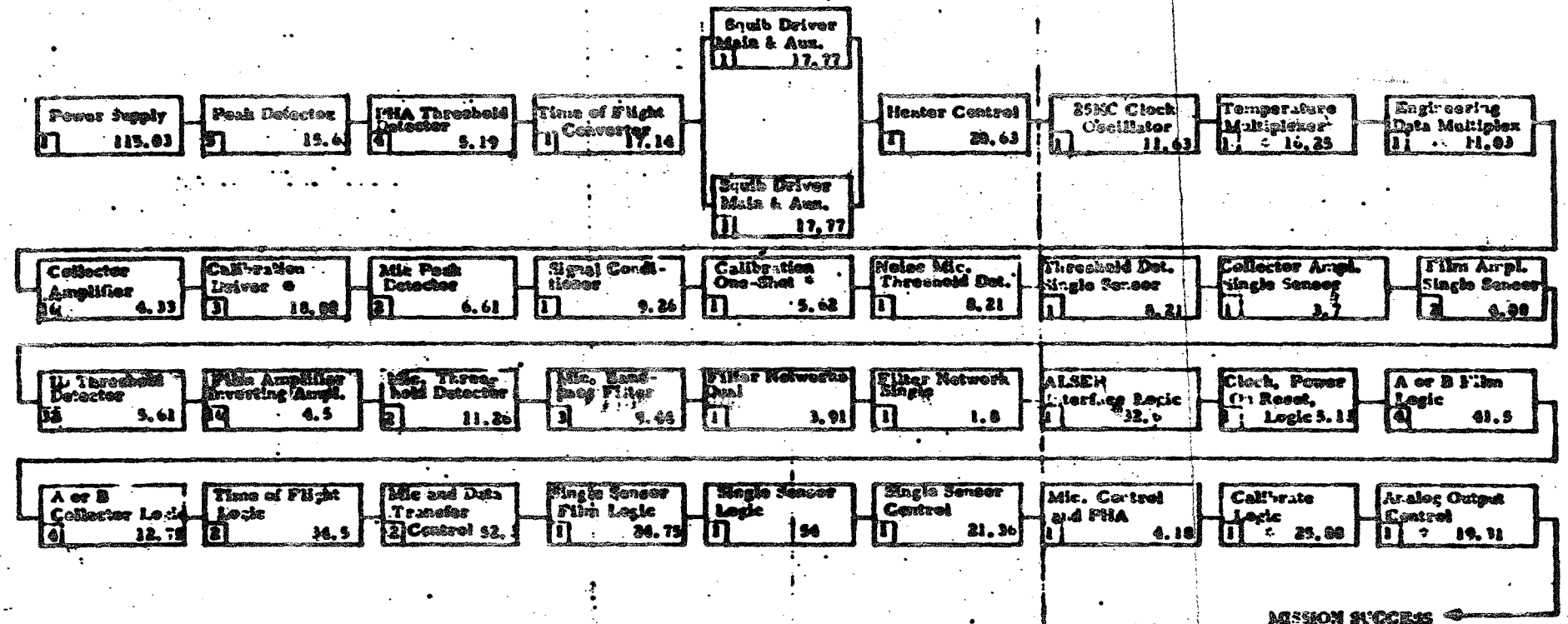

Name of Sub-system
n — xxxxx — Failure Rate $\times 10^{-6}$ Failures/Hour

Number of sub-systems per LEAM

*Not essential to the experiment

LEAM

RELIABILITY BLOCK DIAGRAM

FIGURE 1

Unit	Total System	Less Housekeeping	Less Single Sensor	Less Single Sensor & Less Housekeeping
Power Supply	115.03	115.03	115.03	115.03
Peak Detector	78.15	78.15	62.52	62.52
PHA Threshold Det.	20.76	20.76	20.76	20.76
T. of F. Converter	17.14	17.14	17.14	17.14
Heater Control	20.63	20.63	20.63	20.63
Clock Osc.	11.63	11.63	11.63	11.63
Temp. Multi.	16.25		16.25	
Engr. Multi.	11.03		11.03	
Collector Ampl.	69.28	69.28	69.28	69.28
Calibration Driver	56.64		37.76	
Mic. BP Filter	28.32	28.32	9.44	18.88
Main Mic TD	22.52	22.52	22.52	22.52
Film Ampl.	72	72	72	72
ID Threshold Det.	179.52	179.52	179.52	179.52
Film Ampl. S.S.	8.16	8.16		
Collect. Ampl. S.S.	3.70	3.70		
Th. Det. S.S.	7.77	7.77		
Noise Mic., T.D.	8.21	8.21		
Cal. One-Shot	5.62		5.62	
Signal Cond.	9.26	9.26	9.26	9.26
Mic., PD	13.22	13.22	6.61	6.61
Filt. Networks Dual Sensor	3.91	3.91	3.91	3.91
Filt. Networks Single Sensor	1.80	1.80		
Alsep Interface	32.60	32.60	30.80	30.80
Clock, Power On Reset	5.13	5.13	5.13	5.13
Logic, Film Dual Sensor	166.00	166.00	166.00	166.00
Logic, Collector	51.00	51.00	51.00	51.00
Time of Flight Logic	69.00	69.00	69.00	69.00

TABLE 1

MAJOR SUBSYSTEM FAILURE RATES

Unit	Total System	Less Housekeeping	Less Single Sensor	Less Single Sensor & Less Housekeeping
Mic & Data Transfer No. 1	52.30	52.30		
Mic & Data Transfer No. 2	52.30	52.30		
Logic Film S.S.	24.75	24.75		
S.S. Logic	54.00	54.00		
Control S.S.	21.36	21.36		
Main Mic.	4.18	4.18	4.18	
Calibrate Logic	25.88		25.88	
Analog Output Logic	19.31		19.31	
Total γ =	1376.36	1062.21	1223.63	950.62
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
P_s =	.7854	.8303	.8068	.8466

APPENDIX A

RELIABILITY PREDICTION WORKSHEETS

TIME-ZERO corporation

ATM 1013

RELIABILITY PREDICTION

EQUIPMENT Power Supply 10121001

CUSTOMER Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
C ( )	M39003/01 - ( )	Capacitor, Tantalum	14	0.05	0.70
C ( )	M39014/( ) - ( )	Capacitor, Ceramics	6	0.20	1.20
R ( )	RCR05, 20	Resistor, Comp.	24	0.04	0.96
R ( )	RNC--H	Resistor, Film	14	0.21	2.96
CR ( )	S1N5417	Diode	7	1.00	7.00
CR ( )	S1N4938	Diode	19	0.30	5.70
CR ( )	S1N753A, 759A	Diode, Zener	3	.90	2.70
CR 30	W4568A	Diode, Ref.	1	.9	.9
Q ( )	S2N2907A	Transistor, PNP	5	1.50	7.50
Q ( )	S2N930	Transistor, NPN	3	1.00	3.00
Q ( )	S2N2222A	Transistor, NPN	3	1.00	3.00
Q ( )	S2N4150	Transistor, NPN Pwr.	2	5.00	10.00
Q14	S2N2920	Transistor, Dual NPN	1	2.00	2.00
1	TZ10128902	IC, Op Amp	1	1.0	1.0
1	SM54L72F	IC, JK M/S FF	1	1.00	1.00
R12	RWR81S	Resistor, W.W.	1	0.12	0.12
T1	SP30490	Power XFMR	11 wdgs	1/wdg	11.00
T2	SP30491	Driver XFMR	4 wdgs	1/wdg	4.00
T3	SP30493	Current Sense	3 wdgs	1/wdg	3.00
L ( )	SP30488.89	Inductor	6	1.00	6.00
					73.72

TIME-ZERO corporation

ATM 1013

RELIABILITY PREDICTION

EQUIPMENT Oscillator (P.S.)

CUSTOMER Bendix PL10126000

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-3} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	7	0.04	0.28
R ( )	RNC55H	Resistor, Film	4	0.21	0.84
C1	TZ7301	Capacitor, Film	1	2.00	2.00
C2	M39014/05	Capacitor, Ceramic	1	0.20	0.20
Q1	S2N 2920	Transistor, Dual NPN	1	2.00	2.00
Q2	S2N2907A	Transistor, PNP	1	1.50	1.50
Q ( )	S2N2222A	Transistor, NPN	2	1.00	2.00
					8.82

TIME-ZERO corporation

RELIABILITY PREDICTION

ATM 1013

EQUIPMENT F/F Driver

CUSTOMER Bendix PL 10126001

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	8	0.04	0.32
R ( )	RNC55H	Resistor, Film	2	0.21	0.42
C1	M39014/02	Capacitor, Ceramic	1	0.20	0.20
CR ( )	S1N751A	Diode, Zener	2	.9	1.8
CR ( )	S1N4938	Diode	4	0.30	1.20
Q ( )	S2N930	Transistor, NPN	2	1.00	2.00
Q3	S2N2222A	Transistor, NPN	1	1.00	1.00
Q4	S2N2907A	Transistor, PNP	1	1.50	1.50
Z1	SM54L72F	IC F/F	1	1.00	1.00
					9.44

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Switching Pre-Regulator

CUSTOMER Bendix PL 10126002

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	4	0.04	0.16
R ( )	RNC--H	Resistor, Film	8	0.21	1.68
C2	M39014/02	Capacitor, Ceramic	1	0.20	0.20
CR ( )	S1N5417	Diode	2	1.00	2.00
CR ( )	S1N75-A	Diode, Zener	2	.9	1.8
CR ( )	S1N4938	Diode	4	0.30	1.20
CR9	S1N4568A	Diode, Ref.	1	.9	.9
Q ( )	S2N2907A	Transistor, PNP	2	1.50	3.00
Q2	S2N2905A	Transistor, PNP	1	1.50	1.50
Q4	S2N930A	Transistor, NPN	1	1.00	1.00
Z1	TZ8902-2	IC, Op Amp	1	1.00	1.00
					14.44

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Surge Limiter

CUSTOMER Bendix 10120027

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	2	0.04	0.08
R ( )	RNC55-	Resistor, Film	3	0.21	0.63
C1	M39003/01	Capacitor, Tantalum	1	0.05	0.05
CR1	S1N4938	Diode	1	0.30	0.30
Q1	S2N2102	Transistor NPN	1	1.00	1.00
Q2	S2N4150	Transistor, NPN Pwr.	1	5.00	5.00
					7.06

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Rectifier Filter, +12V, +24V

CUSTOMER Bendix PL 10126006

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	$\lambda \times 10^{-6}$ FAILURES/HR	TOTAL
C2	M39014/02	Capacitor, Ceramic	1	0.20	0.20
C ( )	M39003/01	Capacitor, Tantalum	3	0.05	0.15
CR ( )	S1N4938	Diode	4	0.30	1.20
					1.55

TIME-ZERO corporation

RELIABILITY PREDICTION

ATM 1013

EQUIPMENT See Below

CUSTOMER Bendix P.L. 10126003

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
PEAK DETECTOR, FILM					
R ( )	RCR05G---JR	Resistor, Comp.	12	0.04	0.48
R9	RNC55H----FR				
C5	HRMC705A	Cap., Temp. Comp.	1	0.20	0.20
C1	M39014/02-( )	Capacitor, Ceramic	1	0.20	0.20
C ( )	M39003/01-( )	Capacitor, Tantalum	3	0.05	0.15
CR1	SM1N914	Diode	1	0.30	0.30
Q ( )	TZ10128651	Transistor, Dual PNP	2	3.00	6.00
Q ( )	S2N2222A	Transistor, NPN	3	1.00	3.00
Q5	TZ2N3384	FET, P-Channel	2	1.5	3.00
Z13	1 Gate SM54L04	Hex Inverter	1 gate	1.00	1.00
Z14	1/2 of SM54L00 TZ-8901-5	Quad Nand Gate	0.5	1.00	.5
Z15	SM54L73 TZ-8901-9	F/F	1	1.00	1.00
					15.63

TIME-ZERO corporation

ATM 1013

RELIABILITY PREDICTION

EQUIPMENT See Below

CUSTOMER Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
PHA THRESHOLD DETECTOR		**PL 10126011**			
R ( )	RCR05G---JS	Resistor, Comp.	5	0.04	0.20
R ( )	RNC55H----FR	Resistor, M.F.	9	0.21	1.89
CR ( )	SM1N914	Diode	3	0.30	0.90
Z ( )	TZ10128902-4	IC, Op. Amp	3	1.00	2.00
C ( )	M39014	Capacitor, Ceramic	1	0.20	0.20
					5.19
TIME OF FLIGHT CONVERTER		**PL 10126004**			
R ( )	RCR05G---JS	Resistor, Comp.	20	0.04	0.80
R ( )	RNC--H----GS	Resistor, M.F.	4	0.21	0.84
C ( )	M39014/05-( )	Capacitor, Ceramic	6	0.20	1.20
C1	TZ10127301	Capacitor, Film	1	2.00	2.00
CR ( )	SM1N914	Diode	11	0.30	3.30
Q ( )	S2N2369A	Transistor, NPN	4	1.00	4.00
Q ( )	TZ10128701	FET, P-Channel	2	1.5	3.00
Z ( )	TZ10128902	IC, Op. Amp.	2	1.00	2.00
					17.14

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT SQUIB Driver Section

CUSTOMER Bendix PL10126005

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
Main Driver					
R ( )	RCR05---JS	Resistor, Comp.	7	.04	0.28
Q1	S2N2484	Transistor, NPN	1	1.0	1.00
Q2	S2N2907A	Transistor, PNP	1	1.5	1.50
CR ( )	SM1N914	Diode	2	0.3	0.60
C ( )	M39003/01	Capacitor, Tantalum	2	0.05	0.10
					3.48
Auxillary					
C ( )	M39003/01 ( )	Capacitor, Tantalum	3	.05	.15
R ( )	RCR05---JS	Resistor, Comp.	26	0.04	1.04
Q ( )	S2N2484	Transistor, NPN	5	1.0	5.00
Q ( )	S2N2907A	Transistor, PNP	3	1.5	4.50
CR ( )	SM1N914	Diode	6	0.3	1.80
CR ( )	TZ 8551	Diode, Ref. 5.6V	2	.9	1.80
					14.29
K1, 2, 3, 4	431-( )	Relay	4		

The relays are guaranteed 10^6 operations at 0.5 Amps. 28 volts DC at 125°C. If we assume the relay has been operated 49 times prior to flight, the reliability can be determined for the 50 operations by

$$R = \frac{10^6 - \text{No. of operations}}{10^6} = .999999$$

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Heater/Control

CUSTOMER Bendix PL101026007

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
HEATER/CONTROL					
R ( )	RCR0----JS	Resistor, Comp.	10	.04	0.40
R ( )	RNC55H---FS	Resistor, Film	3	.21	.63
R ( )	44008	Thermistor	1	1.0	1.0
R ( )		Heating Element	1	3.0	3.0
CR	S1N757A	Zener Diode	1	.9	.9
CR	SM1N914	G.P. Diode	9	0.3	2.7
Q ( )	SN2222A	Transistor, NPN	3	1.0	3.0
Q ( )	S2N930	Transistor, NPN	1	1.0	1.0
Z4	TZ 8902-4	Op. Amp. (HA2622)	1	1.0	1.0
Z ( )	TZ 8901-9	F.F.	2	2.0	4.0
Z2	TZ 8901-5	Quad NAND Gate	1	2.0	2.0
Z5	SM54L00F	Quad NAND Gate	1	1.0	1.0
					20.63

TIME-ZERO corporation

RELIABILITY PREDICTION

ATM 1013

EQUIPMENT 25 KHz Oscillator

CUSTOMER Bendix PL 10126008

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
R ( )	RCRO-G---JS	Resistor, Comp.	4	0.04	0.16
R ( )	RNC55H----FR	Resistor, M.F.	7	0.21	1.47
C ( )	HRMC71A201F	Cap., Temp. Comp.	2	0.20	0.40
C3	M39014/01-( )	Capacitor, Ceramic	1	0.20	0.20
C ( )	M39003/01-( )	Capacitor, Tantalum	2	0.05	0.10
CR ( )	SM1N914	Diode	5	0.30	1.50
CR ( )	TZ85551	Diode, Zener, 4.7V	2	.9	1.8
Q5	S2N2369A	Transistor, NPN	1	1.00	1.00
Z1	SM54L04F	IC, Hex Inverter	1	1.00	1.00
					11.63

TIME-ZERO corporation

ATM 1013

RELIABILITY PREDICTION

20

EQUIPMENT Temperature Multiplexer

CUSTOMER Bendix PL10126012

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	$\lambda 10^{-8}$ FAILURES/HR	TOTAL
R ( )	RCR05G---JS	Resistor, Comp.	16	.04	.64
R ( )	RNC55H----FR	Resistor, M.F.	6	.21	1.26
C ( )	M39003/01	Capacitor Tantalum	1	.05	.05
C ( )	M39014/( ) - ( )	Capacitor Ceramic	4	.20	.80
Q ( )	TZ10128701	FET, P-Channel	5	1.5	7.50
Q ( )	S2N2222A	Transistor, NPN	5	1.0	5.00
Z1	TZ8902-4	IC Op. Amp.	1	1.0	1.00
					16.25

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Engineering Data MPX

CUSTOMER Bendix PL 1012601 3

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	7	0.04	0.28
C ( )	M39003/01	Capacitor, Tantalum	5	0.05	0.25
CR ( )	SM1N914	Diode	5	0.30	1.50
Q ( )	TZ2N3384	FET Transistor	5	1.5	7.50
		Transistor PNP	1	1.5	1.5
					11.03

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Collector Amplifier

CUSTOMER Bendix 10106014

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G---JS	Resistor, Comp.	5	0.04	0.20
R ( )	RNC55H----FR	Resistor, M.F.	8	0.21	1.68
C ( )	M39014/05-( )	Capacitor, Ceramic	2	0.20	0.40
C3	M39003/01-( )	Capacitor, Tantalum	1	0.05	0.05
Z ( )	TZ10128902	IC, Op. Amp.	2	1.00	2.00
					4.33

TZ form 4-00 (5-70)

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT See Below

CUSTOMER Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
CALIBRATION DRIVER 10126015					
R ( )	RCR05G---JS	Resistor, Comp.	21	0.04	0.84
C ( )	M39014/( ) - ( )	Capacitor, Ceramic	5	0.20	1.00
C ( )	M39003/01-( )	Capacitor, Tantalum	2	0.05	0.10
CR1	SM1N914	Diode	2	0.30	0.60
Q ( )	S2N2222A	Transistor, NPN	5	1.00	5.00
Q ( )	S2N2907A	Transistor, PNP	5	1.50	7.50
Z1	TZ8901-5	IC, Quad NAND Gate	1	2.00	2.00
Z2	SM54L04F	IC, Hex Inverter	1	1.00	1.00
R ( )	RNC--H	Resistor, Film	4	0.21	0.84
					18.88

TIME-ZERO corporation

RELIABILITY PREDICTION

ATM 1013

EQUIPMENT: Mic. Bandpass Filter

CUSTOMER: Bendix 10126016

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	19	0.04	0.36
R ( )	RNC55H	Resistor, Film	13	0.21	2.73
C ( )	M39014/( )	Capacitor, Ceramic	7	0.20	1.40
C ( )	M39003/01	Capacitor, Tantalum	1	0.05	0.05
C ( )	M2DM--	Capacitor, Mica	4	0.10	0.40
Q1	2N930	Transistor, NPN	1	1.00	1.00
Q2	2N2605	Transistor, PNP	1	1.50	1.50
Z ( )	10128902	IC, Op. Amp.	2	1.00	1.00
					9.44

TIME-ZERO corporation

RELIABILITY PREDICTION

ATM 1013

EQUIPMENT Mic. Threshold

CUSTOMER Bendix 10126017

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	15	0.04	0.60
R ( )	RNC55H	Resistor, Film	1	0.21	0.21
C1	TZ10127301	Capacitor, Parylene	1	2.00	2.00
C2	M39003/01	Capacitor, Tantalum	1	0.05	0.05
CR ( )	SM1N914	Diode	3	0.30	0.90
Q ( )	2N930	Transistor, NPN	2	1.00	2.00
Q2	2N2432A	Transistor, NPN	1	1.00	1.00
Q4	TZ2N3384	FET	1	1.50	1.50
Z1	TZ10128902	IC, Op. Amp.	1	1.00	1.00
		IC	1	1.00	1.00
		Gates	2	0.50	1.00
					11.26

TIME•ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT See below

CUSTOMER Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
FILM AMPLIFIER/INHIBIT PL10126009					
R ( )	RCR05G---JS	Resistor, Comp.	4	0.04	0.16
R ( )	RNC55H----FR	Resistor, M.F.	9	0.21	1.89
C ( )	M39014/( ) - ( )	Capacitor, Ceramic	2	0.20	0.40
C ( )	M39003/1- ( )	Capacitor, Tantalum	1	0.05	0.05
Z ( )	TZ10128902	IC, Op. Amp.	2	1.00	2.00
					4.50
ID THRESHOLD DETECTOR 10126010					
R ( )	RCR05G---JR	Resistor, Comp.	9	0.04	.36
C ( )	M39014/05- ( )	Capacitor, Ceramic	2	0.20	0.40
CR ( )	SM1N914	Diode	2	0.30	0.60
Z1	SM54L00F	IC, Quad 2-Input Gate	1/4	1.00	0.25
Q ( )	2N2369A	Transistor, NPN	1	1.00	1.00
Q ( )	2N3251A	Transistor, PNP	2	1.50	3.00
					5.61

TZ form 4.99 (5-70)

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT See Below

CUSTOMER Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	$\lambda \times 10^{-6}$ FAILURES/HR	TOTAL
FILM AMPLIFIER, SINGLE SENSOR 10126018					
R ( )	RCR05G---JS	Resistor, Comp.	4	0.04	0.16
R ( )	RNC55H----FR	Resistor, M.F.	7	0.21	1.47
C ( )	M39014/05-( )	Capacitor, Ceramic	2	0.20	0.40
C3 ( )	M39003/01-( )	Capcitor, Tantalum	1	0.05	0.05
Z ( )	TZ10128902-1	IC, Op. Amp.	2	1.00	2.00
					4.08

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Collector Amplifier, Single Sensor

CUSTOMER Bendix 10126019

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	5	0.04	0.20
R ( )	RNC55H	Resistor, Film	5	0.21	1.05
C ( )	M39014/05	Capacitor, Ceramic	2	0.20	0.40
C3	M39003/01	Capacitor, Tantalum	1	0.05	0.05
Z ( )	TZ8902-1	IC, Op Amp	2	1.00	2.00
					3.70

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Threshold Detector, Single Sensor

CUSTOMER Bendix 10126020

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	5	0.04	0.20
R ( )	RNC55H	Resistor, Film	7	0.21	1.47
CR ( )	SM1N914	Diode	3	0.30	0.90
Z ( )	TZ8902-4	IC, Op Amp	2	1.00	2.00
				Subtotal	4.57
Z5	SM54L73F	IC, Dual F/F	1	1.00	1.00
Z6	SM54L00	IC	1	1.00	1.00
C9	M39014	Capacitor, Ceramic	1	0.20	0.20
Z ( )	SM54L04	Gates	2	0.50	1.00
				Subtotal	3.20
				Total	7.77

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT See Below

CUSTOMER Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
Threshold Detector, Noise Microphone 10126023					
R ( )	RCR05G---JS	Resistor, Comp.	11	0.04	0.44
R ( )	RNC55H---FS	Resistor, M.F.	2	0.21	0.42
	TZ10127301	Capacitor, Film	1	2.00	2.00
C2	M39003/01-( )	Capacitor, Tantalum	1	0.05	0.05
CR ( )	SM1N914	Diode	13	0.30	0.30
Q1	S2N930	Transistor, NPN	1	1.00	1.00
Q2	S2N2432A	Transistor, NPN	1	1.00	1.00
Z1	TZ10128902-4	IC, Op. Amp.	1	1.00	1.00
		Gates	2	0.05	1.00
	4400 Series	YSI Thermistor	1	1.00	1.00
					8.21

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Calibrate One Shot

CUSTOMER Bendix 10126024

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	9	0.04	0.36
R1	RNC55H	Resistor, Film	1	0.21	0.21
C ( )	M39014/01	Capacitor, Ceramic	3	0.20	0.60
C4	M39003/01	Capacitor, Tantalum	1	0.05	0.05
C2	HRMC705	Capacitor, Temp. Comp.	1	0.20	0.20
CR ( )	SM1N914	Diode	4	0.30	1.20
Q ( )	S2N2222A	Transistor, NPN	3	1.00	3.00
					5.62

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Signal Conditioner

CUSTOMER Bendix 10126025

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
R ( )	RCR05G	Resistor, Comp.	4	0.04	0.16
R ( )	RNC--H	Resistor, Film	15	0.21	3.05
C ( )	M39014/05	Capacitor, Ceramic	2	0.20	0.40
C3	M39003/01	Capacitor, Tantalum	1	0.05	0.05
CR ( )	SM1N914	Diode	6	0.30	1.80
CR ( )	TZ8551	Diode, Zener, 6.2V	2	.90	1.80
Z1	TZ8901-5	IC (525BH)	1	2.00	2.00
					9.26

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Peak Detector, Microphone

CUSTOMER Bendix, 10126026

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
R ( )	RCR05G---JS	Resistor, Comp.	9	0.04	0.36
C ( )	M39014/02-( )	Capacitor, Ceramic	2	0.20	0.40
C2	M39003/01-( )	Capacitor, Tantalum	1	0.05	0.05
CR1	SM1N914	Diode	1	0.30	0.30
Q ( )	S2N2920	Transistor, Dual NPN	2	2.00	4.00
Q3	S2N3251A	Transistor, PNP	1	1.50	1.50
					6.61

TZ form 4.00 (5-70)

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Filtering Networks - Dual Sensor

CUSTOMER 10122015 & 10122009, Bendix

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
C ( )	M39003	Capacitor, Tantalum	15	0.05	.75
Z ( )	SM54L04 Gates	Hex Inverter	2 gates	0.5	1.00
	YSI4400	Thermistor	1	1.0	1.00
R	RCR0	Resistor, Comp.	9	0.04	.36
C ( )	M39014	Capacitor, Ceramic	4	.2	.80
					3.91

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Filtering Networks - Single Sensor

CUSTOMER Bendix 10124003

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	$\lambda \times 10^{-6}$ FAILURES/HR	TOTAL
	4400	Thermistor	1	1.00	1.00
R ( )	RCR	Resistor, Comp.	10	0.04	.40
C ( )	M39003	Capacitor, Tantalum	8	0.05	.40
					1.80

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT Dual Sensor Logic

CUSTOMER Bendix 10121009

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
A Film or B Film (No. 1 or No. 2) in other words, 4 times					
Z ( )	Amelco 52 Series	IC	18.5	2	37.0
Z ( )	SM54L	IC	4.5	1	4.5
					41.5
A Collector or B Collector (No. 1 or No. 2) (means 4 times)					
Z( )	Amelco 52 Series	IC	5	2	10.0
Z ( )	SM54L	IC	2 3/4	1	2.75
					12.75
Time of Flight (No. 1 or No. 2) (means 2 times)					
Z ( )	Amelco 52 Series	IC	16	2	32.0
( )	SM54L	IC	2.5	1	2.5
					34.5
Micr. & Data Transfer Control Dual Sensor No. 1					
Z ( )	Amelco 52 Series	IC	20	4.52	40
Z ( )	SM54L	IC	8.5	1	8.5
Q ( )	2N2222	Transistor, NPN	3	1	3.00
C ( )	M39014	Cap., Ceramic	3	.2	.6
R ( )	RCR	Resistors, Comp.	5	.04	.2
					52.30
Micr. & Data Transfer Control (No. 2)					
Z ( )	Amelco 52 Series	IC	20	2	40.0
Z ( )	SM54L	IC	8.5	1	8.5
Q ( )	2N2222	Transistor	3	1	3
)	M39014	Cap., Ceramic	3	.2	.6
)	RCR	Resistor, Comp.	5	.04	.20
					52.30

TZ form 6-99 (5-70)

TIME-ZERO corporation

ATM 1013

RELIABILITY PREDICTION

EQUIPMENT Single Sensor

CUSTOMER Bendix 10121009

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
Single Sensor Film Logic (Sheet 14)					
Z ( )	Amelco 52 Series	IC	10.25	2	20.5
Z ( )	SM54L	IC	4.25	1	4.25
					24.75
Single Sensor Logic (Sheet 16)					
Z ( )	Amelco 52 Series	IC	27	2	54
Single Sensor Control (Sheet 15)					
Z ( )	Amelco 52 Series	IC	9.5	2	19.0
Z ( )	SM54L	IC	1		1.0
Q7	2N2222A	Transistor	1	1	1.0
C7	M39014	Cap., Ceramic	1	.2	.2
R12	RCR	Resistor, Comp.	4	.04	.16
					21.36

TIME-ZERO corporation

RELIABILITY PREDICTION

EQUIPMENT See Below Logic

CUSTOMER Bendix 10120009

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-6} FAILURES/HR	TOTAL
Main Mic. Control & PHA (Sheet 17)					
Z ( )	Amelco 52 Series	IC	.75	2	1.5
Z ( )	SM54L	IC	1/6	1	.20
Q ( )	2N2222A	Transistor, NPN	2	1	2.00
C ( )	M39014	Cap., Ceramic	2	.2	.4
R ( )	RCR	Resistor, Comp.	2	.04	.08
					4.18
Calibrate Logic (Sheet 17)					
Z ( )	Amelco 52 Series	IC	11.75	2	23.5
Z ( )	SM54L	IC	1	1	1.0
CR1	LVA	Zener, 6.2 Volt	1	.9	.9
C ( )	M39014	Cap., Ceramic	2	.2	.4
( )	RCR	Resistor, Comp.	2	.04	.08
					25.88
Analog Output Control (Sheet 18)					
Z ( )	Amelco 52 Series	IC	8.25	2	16.5
Z ( )	SM54L	IC	1/3	1	.33
Q ( )	2N2222A	Transistor, NPN	2	1	2.0
C ( )	M39014	Cap., Ceramic	2	.2	..40
R ( )	RCR	Resistor, Comp.	2	.04	..08
					19.31

TIME • ZERO corporation

RELIABILITY PREDICTION

ATM 1013

EQUIPMENT Logic

CUSTOMER Bendix 10121009

CIRCUIT SYMBOL	PART/TYPE NO.	DESCRIPTION	QTY	λ 10^{-8} FAILURES/HR	TOTAL
ALSEP Interface Logic (Sheet 19)					
Z ( )	Amelco 52 Series	IC	12.5	2.00	25.00
Z ( )	SM54L	IC	3.0	1.00	3.00
C ( )	M39014	Capacitor, Ceramic	.4	.2	.80
R ( )	RCR	Resistor, Comp.	5.0	.04	.2
CR ( )	LVA	Zener Diode 6.2V	4.0	.9	3.6
					32.6
Clock, Power On Reset (Sheet 20)					
Z ( )	Amelco 52 Series	IC	1.25	2.00	2.5
Z ( )	SM54L	IC	2.5	1	2.5
C	M39003	Capacitor, Tantalum	1	.05	.05
R	RCR	Resistor, Comp.	2	.04	.08
					5.13

APPENDIX B

FMEAC

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Leam Blocks	DWG NO:	PAGE: 641 OF 1082	
ASSY: Associated Sub-blocks	DWG NO:	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
ALSEP interface - Ref. 10121009 Sheet 19					
Transmitter Circuit					
1. Z34H-output buffer	No output	No data out	Total loss of experiment.	7.008	1
2. R28	Open	"	"	.03504	1
3. C19	Short	"	"	1.0512	1
Shift Clock Circuit					
4. Z32 J-Pin 3 Shift clock and demand pulse receiver gate.	No output	Loss of Shift Register Clocks	Total loss of experiment.	7.008	1
5. Z32 J-Pins 6 and 11	No output	Loss of Shift Register Clocks for words 1 thru 6 or 5 thru 10	Loss of more than 50% of the experiment.	7.008	2
6. C16, C17	Short	Loss of Shift Register Clocks	Total loss of experiment.	1.0512	1
7. CR4, CR5	Short	"	"	1.4016	1
8. R25, R26	Open	"	"	.03504	1

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM LEAM Blocks	DWG NO	PAGE 7A42of1CCB	
ASS'Y Assoc. Sub-Blocks	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
Calibration Driver - Ref. 10126015					
18. C6	Short	5V supply will be shorted to ground.	Total loss of experiment.	1.0512	1
Time of Flight Converter - Ref. 10126004					
19. C5	Short	5V supply will be shorted to ground.	Total loss of experiment.	1.0512	1

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Leam Blocks	DWG NO	PAGE: 243 OF 602	
ASS'Y: Associated Sub-Blocks	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q × 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
Frame Mark Pulse Circuit					
9. Z31 J	No output	No data out	Total loss of experiment	7.008	1
10. R24	Open	"	"	.03504	1
11. C15	Short	"	"	1.0512	1
12. CR3	Short	"	"	1.4016	1
Frame Counter Circuit					
13. Z30K	No output	Loss of Frame Counter data.	Loss of more than 50% of the experiment.	7.008	2
14. Power Supply Sub-system (Ref. 10121001)	No output	Loss of Power Supply outputs	Total loss of experiment.		1
15. Squib Drvier Sub-system (Ref.10126005)	Squibs do not fire	Loss of Squib driver sub-system.	Total loss of experiment.		1
16. 25KHz oscillator (Ref. 10126008)	No output.	Loss of control logic clocks.	Total loss of experiment.		1
17. Heater Control Sub-system (Ref.10126007)	Inoperative	Loss of Heater Control operation.	Total loss of experiment (In Lunar night the foam epoxy will shrink and will crack boards, assembly and piece parts.)		1

WESTINGHOUSE corporation	FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET	SYSTEM: Bendix LEAM	PREPARED BY: A. Lakhani	NO. 10120031	REV A
		END ITEM: Central Electronics	DWG NO	PAGE 448 OF 465	
		ASS'Y: Data Mux. & Shift Clock Circuit	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-3}	CRITICALITY
		END ITEM	SYSTEM		
Data Mux. Ckt.					
1. Word 1, 2 Gate	Incorrect Output	Word 1, 2 Output Fails	Loss of Word 1, 2	7.008	3
2. Word 3, 4 Gate	Incorrect Output	Word 3, 4 Output Fails	Loss of Word 3, 4	7.008	3
3. Word 5, 6 Gate	Incorrect Output	Word 5, 6 Output Fails	Loss of Word 5, 6	7.008	3
4. Word 7, 8 Gate	Incorrect Output	Word 7, 8 Output Fails	Loss of Word 7, 8	7.008	3
5. Word 9, 10 Gate	Incorrect Output	Word 9, 10 Output Fails	Loss of Word 9, 10	7.008	3
Shift Clock Ckt.					
6. Word 1, 2 Buffer Clock Gate	Incorrect Output	Loss of Word 1, 2, Shift Clk.	Loss of Word 1, 2	7.008	3
7. Word 3, 4 Buffer Clock Gate	Incorrect Output	Loss of Word 3, 4 Shift Clk.	Loss of Word 3, 4	7.008	3
8. Word 5, 6 Buffer Clock Gate	Incorrect Output	Loss of Word 5, 6 Shift Clk.	Loss of Word 5, 6	7.008	3
9. Word 7, 8 Buffer Clock Gate	Incorrect Output	Loss of Word 7, 8 Shift Clk.	Loss of Word 7, 8	7.008	3
10. Word 9, 10 Buffer Clock Gate	Incorrect Output	Loss of Word 9, 10 Shift Clk.	Loss of Word 9, 10	7.008	3

[illegible] corporation	FAILURE MODE, EFFEC[illegible] CRITICALITY ANALYSIS WORKSHEET	SYSTEM LEAM	PREPARED BY A. Lakhani	NO [illegible]031	REV A
		SUB ITEM Central Electronic	DWG NO	PAGE 45 of [illegible]	
		ASSY Shift Register Ckt	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
11. Word 1, 2 Shift Register	No Output	Word 1, 2 Output Fails	Loss of Word 1, 2	140.160	3
12. Word 3, 4 Shift Register	No Output	Word 3, 4 Output Fails	Loss of Word 3, 4	140.160	3
13. Word 5, 6 Shift Register	No Output	Word 5, 6 Output Fails	Loss of Word 5, 6	140.160	3
14. Word 7, 8 Shift Register	No Output	Word 7, 8 Output Fails	Loss of Word 7, 8	140.160	3
15. Word 9, 10 Shift Register	No Output	Word 9, 10 Output Fails	Loss of Word 9, 10	140.160	3

TIME-ZERO corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO: 101[illegible]31 | REV: A
END ITEM: Central Electronics | DWG NO | PAGE 1046 OF 64100
ASSY: Buffer Load Gates | DWG NO | DATE: 14 May 1971

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
Front Film ID Buffer Load Gates	Incorrect Output	Front Film ID Signal(s) Incorrect	Loss of Front Film ID(1-4* Bits)	7.008	3
17. Front Film PHA Buffer Load Gates	Incorrect Output	Front Film PHA Signal(s) Incorrect	Loss of Front Film PHA (1-3 Bits)	7.008	3
18. Front Film Accum Buffer Load Gates	Incorrect Output	Front Film Accum. Signal(s) Incorrect	Loss of Front Film Accum. (1-3 Bits)	7.008	3
19. Rear Film ID Buffer Load Gates	Incorrect Output	Rear Film ID Signal(s) Incorrect	Loss of Rear Film ID (1-4 Bits)	7.008	3
20. Rear Film PHA Buffer Load Gates	Incorrect Output	Rear Film PHA Signal(s) Incorrect	Loss of Rear Film PHA (1-3 Bits)	7.008	3
21. Rear Film Accum Buffer Load Gates	Incorrect Output	Rear Film Accum. Signal(s) Incorrect	Loss of Rear Film Accum. (1-3 Bits)	7.008	3
22. Front Collector ID Buffer Load Gts	Incorrect Output	Front Collector Signal(s) Incorrect	Loss of Front Collector ID (1-4 Bits)	7.008	3
23. Mic PHA Buffer Load Gates	Incorrect Output	Mic PHA Signal(s) Incorrect	Loss of Mic PHA (1-3 Bits)	7.008	3
24. Mic Accum. Buffer Load Gates	Incorrect Output	Mic Accum. Signal(s) Incorrect	Loss of Mic Accum(1-3 Bits)	7.008	3
25. Rear Collector ID Buffer Load Gates	Incorrect Output	Rear Collector ID Signal(s) Incorrect	Loss of Rear Collector ID (1-4 Bits)	7.008	3
26. TOF Buffer Load Gates	Incorrect Output	TOF Signal(s) Incorrect	Loss of TOF (1-6 Bits)	7.008	3

* (1-4) is 1, 2, 3, or 4.

TIME-ZERO corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO. 1031 | REV A
END ITEM: Central Electronics | DWG NO | PAGE 447 OF 641.10
ASSY: Buffer Load Gates | DWG NO | DATE 14 May 1971

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE: END ITEM	EFFECT OF FAILURE: SYSTEM	FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
27. thru 37	IDENTICAL TO 16 THRU 26 EXCEPT THAT THE FAILURE IS RELATED TO DUAL SENSOR 2				
38. Film ID (Sen 2) Buffer Load Gates	Incorrect Output	Film ID Signal Incorrect	Loss of Film ID (1-2 Bits)	7.008	3
39. Collector ID(Sen 3) Buffer Load Gts	Incorrect Output	Collector ID Signal Incorrect	Loss of Collector ID (1-2 Bits)	7.008	3
40. Film PHA (Sen3) Buffer Load Gates	Incorrect Output	Film PHA Signal Incorrect	Loss of Film PHA (1-3 Bits)*	7.008	3
41. Film Accum (Sen3) Buffer Load Gates	Incorrect Output	Film Accum. signal incorrect	Loss of Film Accum(1-3 Bits)	7.008	3
42. Noise Mic Accum (Sen3) Buffer Load Gates	Incorrect Output	Noise Mic Accum Signal Incorrect	Loss of Noise Mic Accum (1-2 Bits)	7.008	3
43. Analog Data Sync (Sen3) Buffer Load Gate	Incorrect Output	Analog Data Sync Signal Incorrect	Loss of Analog Data Sync	7.008	3
44. Heater Status (Sen 3) Buffer Load Gt	Incorrect Output	Heater Status Signal Incort	Loss of Heater Status Signal	7.008	3
45. Main Mic PHA (Sen3) Buffer Load Gates	Incorrect Output	Main Mic PHA Signal Incorrect	Loss of Main Mic PHA (1-3 Bits)	7.008	3
46. Main Mic Accum (Sen3) Buffer Load Gates	Incorrect Output	Main Mic Accum Signal Incorrect	Loss of Main Mic Accum (1-3 Bits)	7.008	3

*(1-3) is 1, 2, or 3.

TRW SYSTEMS corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM	PREPARED BY	NO	REV
LEAM	A. Lakhani	1[illegible]031	A
END ITEM	DWG NO	PAGE 1248 OF [illegible]	
Central Electronics			
ASS'Y	DWG NO	DATE 14 May 1971	
Latch/Counter Ckt.			

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
47. Front Film ID Latch	Incorrect Output	Front Film ID Signal Incorrect	Loss of Front Film ID (1-4 Bits)*	7.008	3
48. Front Film PHA Counter					3
(a) C401 Flip Flop	Incorrect Output	Front Film PHA Signal Inc.	Loss of Front Film PHA	7.008	3
(b) C402 Flip Flop	Incorrect Output	Front Film PHA Signal Inc.	Loss of 2 bits of Front Film PHA	7.008	3
(c) C403 Flip Flop	Incorrect Output	Front Film PHA Signal Inc.	Loss of 1 bit of Front Film PHA	7.008	3
49. Front Film Accum Counter					
(a) C404 Flip Flop	Incorrect Output	Front Film Accum Signal Inc.	Loss of Front Film Accum.	7.008	3
(b) C405 Flip Flop	Incorrect Output	Front Film Accum. Sig. Inc.	Loss of 2 bits of Front Film Ac.	7.008	3
(c) C406 Flip Flop	Incorrect Output	Front Film Accum. Sig. Inc.	Loss of 1 bit of Front Film Ac.	7.008	3
50. Rear Film ID Latch	Incorrect Output	Rear Film ID Signal(s) Inc.	Loss of Rear Film (1-4 Bits)	7.008	3
51. Rear Film PHA Counter					
(a) C411 Flip Flop	Incorrect Output	Rear Film PHA Sig. Inc.	Loss of Rear Film PHA	7.008	3
(b) C412 Flip Flop	Incorrect Output	Rear Film PHA Sig. Inc.	Loss of 2 bits of Rear Film PHA	7.008	3
(c) C413 Flip Flop	Incorrect Output	Rear Film PHA Sig. Inc.	Loss of 1 bit of Rear Film PHA	7.008	3
52. Rear Film Accum. Counter					
(a) C414 Flip Flop	Incorrect Output	Rear Film Accum. Sig. Inc.	Loss of Rear Film Accum.	7.008	3
(b) C415 Flip Flop	Incorrect Output	Rear Film Accum. Sig. Inc.	Loss of 2 bits of Rear Film Ac.	7.008	3
(c) C416 Flip Flop	Incorrect Output	Rear Film Accum. Sig. Inc.	Loss of 1 bit of Rear Film Ac.	7.008	3

* 1, 2, 3, or 4

FMIT-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO.: 10120031 | REV: A
END ITEM: Central Electronics | DWG NO | PAGE 349 OF 410
ASSY: Latch/Counter Ckt | DWG NO | DATE: 14 May 1971

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
53. Front Collector ID Latch	Incorrect Output	Front Collector Signal(s) Incorrect	Loss of Front Film Collector (1-4 Bits)*	7.008	3
54. Mic PHA Counter					
(a) C433 Flip Flop	Incorrect Output	Mic PHA Signal Incorrect	Loss of Mic PHA	7.008	3
(b) C434 Flip Flop	Incorrect Output	Mic PHA Signal Incorrect	Loss of 2 bits of Mic PHA	7.008	3
(c) C435 Flip Flop	Incorrect Output	Mic PHA Signal Incorrect	Loss of 1 bit of Mic PHA	7.008	3
55. Mic Accum. Counter					
(a) C430 Flip Flop	Incorrect Output	Mic Accum. Sig. Incorrect	Loss of Mic Accum.	7.008	3
(b) C431 Flip Flop	Incorrect Output	Mic Accum. Sig. Incorrect	Loss of 2 bits of Mic Accum.	7.008	3
(c) C432 Flip Flop	Incorrect Output	Mic Accum. Sig. Incorrect	Loss of 1 bit of Mic Accum.	7.008	3
56. TOF Counter					
(a) C421 Flip Flop	Incorrect Output	TOF Signal Incorrect	Loss of TOF	7.008	3
(b) C422 Flip Flop	Incorrect Output	TOF Signal Incorrect	Loss of 5 bits of TOF	7.008	3
(c) C423 Flip Flop	Incorrect Output	TOF Signal Incorrect	Loss of 4 bits of TOF	7.008	3
(d) C424 Flip Flop	Incorrect Output	TOF Signal Incorrect	Loss of 3 bits of TOF	7.008	3
(e) C425 Flip Flop	Incorrect Output	TOF Signal Incorrect	Loss of 2 bits of TOF	7.008	3
(f) C426 Flip Flop	Incorrect Output	TOF Signal Incorrect	Loss of 1 bit of TOF	7.008	3
57. THRU 66 SAME AS 47 THRU 56 EXCEPT THAT THE FAILURE IS RELATED TO DUAL SENSOR 2.					

1, 2, 3, or 4

TRW-ZERO corporation

FAILURE MODE, EFFECTS CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO. 0031 | REV A
END ITEM: Central Electronics | DWG NO | PAGE 1450 OF 64[illegible]
ASS'Y: Sen. 3 Latch/Counter | DWG NO | DATE 14 May 1971
CKT'S

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
67. Film ID Latch (Sen. 3)	Incorrect Output	Film ID Signal(s) Incorrect	Loss of Film ID (1-2 bits)*	7.008	3
68. Collector ID Latch (Sen. 3)	Incorrect Output	Collector ID Signal(s) Inc.	Loss of Collector ID (1-2 bits)	7.008	3
69. Film PHA Counter (Sen. 3)	Incorrect Output				
(a) C603 Flip Flop	Incorrect Output	Film PHA Signal Incorrect	Loss of Film PHA	7.008	3
(b) C604 Flip Flop	Incorrect Output	Film PHA Signal Incorrect	Loss of 2 bits of Film PHA	7.008	3
(c) C605 Flip Flop	Incorrect Output	Film PHA Signal Incorrect	Loss of 1 bit of Film PHA	7.008	3
70. Film Accum. Counter (Sen. 3)					
(a) C600 Flip Flop	Incorrect Output	Film Accum. Signal Inc.	Loss of Film Accum.	7.008	3
(b) C601 Flip Flop	Incorrect Output	Film Accum. Signal Inc.	Loss of 2 bits of Film Accu.	7.008	3
(c) C602 Flip Flop	Incorrect Output	Film Accum. Signal Inc.	Loss of 1 bit of Film Accum.	7.008	3
71. Noise Mic Accum Counter (Sen. 3)					
(a) C630 Flip Flop	Incorrect Output	Noise Mic Accum. Signal Inc.	Loss of noise mic accum.	7.008	3
(b) C631 Flip Flop	Incorrect Output	Noise Mic Accum. Signal Inc.	Loss of 1 bit of noise mic ac.	7.008	3

* 1 or 2

LTV-ESPO corporation

FAILURE MODE, EFFECT, CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 1[illegible]0031	REV: A
END ITEM: Central Electronics	DWG NO	PAGE: 351	OF: 410
ASSY: Sen 3 Counters	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
72. Analog Data Sync Ckt. (Sen. 3)	Incorrect Output	Loss of Analog Data Sync Signal	Loss of Analog Data Sync Sig. No loss to the experiment	7.008	4
73. Heater Status Ckt. (Sen. 3)	Incorrect Output	Loss of Heater Status Sig.	Status of the Heater Undeter.	7.008	3
74. Main Mic PHA Counter (Sen 3)					
(a) C623 Flip Flop	Incorrect Output	Main Mic PHA Sig. Incorrect	Loss of Main Mic PHA	7.008	3
(b) C624 Flip Flop	Incorrect Output	Main Mic PHA Sig. Incorrect	Loss of 2 bits of Main Mic PHA	7.008	3
(c) C625 Flip Flop	Incorrect Output	Main Mic PHA Sig. Incorrect	Loss of 1 bit of Main Mic PHA	7.008	3
75. Main Mic Accum Counter (Sen 3)					
(a) C620 Flip Flop	Incorrect Output	Main Mic. Accum. Sig. Inc.	Loss of Main Mic Accum.	7.008	3
(b) C621 Flip Flop	Incorrect Output	Main Mic. Accum. Sig. Inc.	Loss of 2 bits of Main Mic Ac	7.008	3
(c) C622 Flip Flop	Incorrect Output	Main Mic. Accum. Sig. Inc.	Loss of 1 bit of Main Mic Acc.	7.008	3

TIME-ZERO corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO: 031 | REV: A
END ITEM: Sens. Electronics | DWG NO: | PAGE: 1852 OF 6416
ASSY: Amplifier-Detector Ckts. | DWG NO: | DATE: 14 May 1971

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
76. Front Film ID Pre-amplifiers Circuit	No Output	1/4 of Front Film ID Sig. Missing	Loss of 1/4 of Front Film ID Incorrect TOF	19.4472	3
77. Front Film Analog Inhibit Circuit	No Output	1/4 of Front Film ID Sig. Missing	Loss of 1/4 of Front Film ID Incorrect TOF	19.4472	3
78. Front Film Threshold Det. Ckt.	No Output	1/4 of Front Film ID Sig. Missing	Loss of 1/4 of Front Film ID Incorrect TOF	83.5704	3
79. Front Film Sig. Inverter Gate	No Output	1/4 of Front Film ID Sig. Missing	Loss of 1/4 of Front Film ID Incorrect TOF	7.008	3
80. Front Film Logic Inhibit Gate	No Output	1/4 of Front Film ID Sig. Missing	Loss of 1/4 of Front Film ID Incorrect TOF	7.008	3
81. Front Film Summer Amplif.	No Output	Front Film PHA & Accum. Signals Missing	Loss of Front Film PHA & Accum.	6.72768	3
82 Summer Peak Detector	No Output	Front Film PHA & Accum. Signals Missing	Loss of Front Film PHA & Accum.	84.6216	3
83. Summer Threshold Detector	No Output	Front Film PHA & Accum. Signals Missing	Loss of Front Film PHA & Accum.	2.99592	3
84. Summer Signal Inverter GATE	No Output	Front Film PHA & Accum. Signals Missing	Loss of Front Film PHA & Accum.	7.008	3
85. Clock Sync Flip Flop	No Output	Front Film PHA & Accum. Signals Missing	Loss of Front Film PHA & Accum.	7.008	3

TRW-2250 corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO: 101 | REV: A
END ITEM: Sen. Electronics Assy | DWG NO: | PAGE: 453 OF 641
Amplifier-Detector Ckt. | DWG NO: | DATE: 14 May 1971

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
86. Rear Film ID Preamplifier Ckt	No Output	1/4 of Rear Film ID Sig. missing	Loss of 1/4 of Rear Film ID Incorrect TOF	19.4472	3
87. Rear Film Analog Inhibit Circuit	No Output	1/4 of Rear Film ID Sig. missing	Loss of 1/4 of Rear Film ID Incorrect TOF		3
88. Rear Film Threshold Detector Ckt.	No Output	1/4 of Rear Film ID Sig. missing	Loss of 1/4 of Rear Film ID Incorrect TOF		3
89. Rear Film Signal Inverter Gate	No Output	1/4 of Rear Film ID Sig. missing	Loss of 1/4 of Rear Film ID Incorrect TOF	7.008	3
90. Rear Film Logic Inhibit Gate	No Output	1/4 of Rear Film ID Sig. missing	Loss of 1/4 of Rear Film ID Incorrect TOF	7.008	3
91. Rear Film Summer Amplifr.	No Output	Rear Film PHA & Accum. Signal Missing	Loss of Rear Film PHA & Accum.	6.72768	3
92. Summer Peak Detector	No Output	Rear Film PHA & Accum. Signal Missing	Loss of Rear Film PHA & Accum.	84.6216	3
93. Summer Threshold Detector	No Output	Rear film PHA & Accum. Signal Missing	Loss of Rear Film PHA & Accum.	2.99592	3
94. Summer Signal Inverter Gate	No Output	Rear Film PHA & Accum. Signal Missing	Loss of Rear Film PHA & Accum.	7.008	3
95. Clock Sync Flip Flop	No Output	Rear Film PHA & Accum. Signal Missing	Loss of Rear Film PHA & Accum.	7.008	3

TIMEPLEX corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM | PREPARED BY: A. Lakhani | NO: 1012 | REV: A
END ITEM: Sens. Electronics | DWG NO | PAGE: 1854 OF 6410
ASSY: Amplifier Detector Circuit | DWG NO | DATE: 14 May 1971

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
96. Front Collector ID Preamplifier	No Output	1/4 of Front Film & ID Signal Missing	Loss of 1/4 of Front Collector ID. Incorrect TOF	19.4472	3
97. Front Collector Analog Inhibit Ckt.	No Output	1/4 of Front Film & ID Signal Missing	Loss of 1/4 of Front Collector ID. Incorrect TOF	19.4472	3
98. Front Collector Threshold Det. Circuit	No Output	1/4 of Front Film & ID Signal Missing	Loss of 1/4 of Front Collector ID. Incorrect TOF	83.5704	3
99. Front Collector Signal Inverter	No Output	1/4 of Front Film & ID Signal Missing	Loss of 1/4 of Front Collector ID. Incorrect TOF	7.008	3
00. Front Collector Logic Inhibit Gate	No Output	1/4 of Front Film & ID Signal Missing	Loss of 1/4 of Front Collector ID. Incorrect TOF	7.008	3
01. Mic Preampl.	No Output	Mic PHA & Accum. signals Missing	Loss of Mic PHA & Accum.	37.3176	3
02. Band Pass Flt.	No Output	Mic PHA & Accum. signals Missing	Loss of Mic PHA & Accum.	37.3176	3
03. Mic Peak Det.	No Output	Mic PHA & Accum. signals Missing	Loss of Mic PHA & Accum.	37.3176	3
04. Mic Threshold Detector	No Output	Mic PHA & Accum. signals Missing	Loss of Mic PHA & Accum.	37.3176	3
05. Mic Inverter Gates	No Output	Mic PHA & Accum. signals Missing	Loss of Mic PHA & Accum.	7.008	3
06. Rear Collector ID Preamplifier	No Output	1/4 of Rear Collector ID Missing	Loss of 1/4 of Rear Collector ID	19.4472	3
07. Rear Collector Analog Inhibit Ckt.	No Output	1/4 of Rear Collector ID Missing	Loss of 1/4 of Rear Collector ID	19.4472	3

TRW SYSTEMS corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 1012[illegible]	REV: A
END ITEM: Sens. Electronics	DWG NO	PAGE: 1455 OF 6[illegible]	
ASS'Y: Amplifier-Detector Circuit	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
08. Rear Collector Threshold Detector	No Output	1/4 of Rear Collector ID Signal Missing	Loss of 1/4 of Rear Collector ID. Loss of TOF	83.5704	3
09. Rear Collector Signal Inverter	No Output	1/4 of Rear Collector ID Signal Missing	Loss of 1/4 of Rear Collector ID. Loss of TOF	7.008	3
10. Rear Collector Logic Inhibit Gate	No Output	1/4 of Rear Collector ID Signal Missing	Loss of 1/4 of Rear Collector ID. Loss of TOF	7.008	3
11. TOF Circuit	No Output	Loss of TOF Signal	Loss of the measurement of transit time between the front and rear films		3
12. THRU 147. SAME AS 76 THRU 111 EXCEPT THAT THE FAILURE IS RELATED TO DUAL SENSOR 2					

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 101[illegible]31	REV: A
END ITEM: Sens. Electronics	DWG NO:	PAGE: 2056 OF 6[illegible]00	
ASS'Y: Amplifier-Detector Circuit	DWG NO:	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
48. Film ID Pre-amplifier (Sen. 3)	No Output	1/2 of Film ID Sig. Missing	Loss of 1/2 of Film ID	24.7032	3
49. Film Analog Inhibit Circuit (Sen3)	No Output	1/2 of Film ID Sig. Missing	Loss of 1/2 of Film ID	24.7032	3
50. Film Threshold Detector (Sen. 3)	No Output	1/2 of Film ID Sig. Missing	Loss of 1/2 of Film ID	24.7032	3
51. Film Signal Inverter (Sen. 3)	No Output	1/2 of Film ID Sig. Missing	Loss of 1/2 of Film ID	7.008	3
52. Film Logic Inhibit Gate (Sen. 3)	No Output	1/2 of Film ID Sig. Missing	Loss of 1/2 of Film ID	7.008	3
53. Collector ID Preamplifier (Sen. 3)	No Output	1/2 of Collector ID Sig. Ms	Loss of 1/2 of Collector ID	24.7032	3
54. Collector Analog Inhibit Ckt. (Sen. 3)	No Output	1/2 of Collector ID Sig. Msg	Loss of 1/2 of Collector ID	24.7032	3
55. Collector Thres-old Det. (Sen. 3)	No Output	1/2 of Collector ID Sig. Msg	Loss of 1/2 of Collector ID		3
56. Collector Sig. Inverter (Sen. 3)	no Output	1/2 of Collector ID Sig. Msg	Loss of 1/2 of Collector ID	7.008	3
57. Collector Logic Inhibit Gate (Sen. 3)	No Output	1/2 of Collector ID Sig. Msg	Loss of 1/2 of Collector ID	7.008	3
58. Film Summer Amplifier (Sen. 3)	No Output	Film PHA & Accum. Sig. Msg.	Loss of Film PHA & Accu.		3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Sens. Electronics	DWG NO	PAGE 2157 OF 6610	
ASS'Y: Amplifier Detector Circuit	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
159. Summer Peak Detector (Sen. 3)	No Output	Film PHA & Accu. Sig. Msg.	Loss of Film PHA & Accum.		3
160. Summer Threshold Detector (Sen3)	No Output	Film PHA & Accu. Sig. Msg.	Loss of Film PHA & Accum.		3
161. Summer Signal Inverter (Sen. 3)	No Output	Film PHA Accu. Sig. Msg.	Loss of Film PHA & Accum.	7.008	3
162. Clock Sync Flip Flop (Sen. 3)	No Output	Film PHA Accu. Sig. Msg.	Loss of Film PHA & Accum.	7.008	3
163. Noise Mic Preamplifier (Sen. 3)	No Output	Loss of Noise Mic Signal	Loss of Noise Mic AccumData	36.792	3
164. Band Pass Filter (Sen. 3)	No Output	Loss of Noise Mic Signal	Loss of Noise Mic Accum.Data		3
165. Noise Mic Peak Det. (Sen3)	No Output	Loss of Noise Mic Signal	Loss of Noise Mic Accum.Data		3
166. Noise Mic Threshold Det. (Sen3)	No Output	Loss of Noise Mic Signal	Loss of Noise Mic Accum.Data	42.048	3
167. Noise Mic Inverter Gates(Sen3)	No Output	Loss of Noise Mic Signal	Loss of Noise Mic Accum.Data	7.008	3
168. Main Mic Preamplifier (Sen. 3)	No Output	Main Mic & PHA Accum. Sig. Missing	Loss of Main Mic PHA & Accum.	67.8024	3
169. Band Pass Filter (Sen. 3)	No Output	Main Mic & PHA Accum. Signals Missing	Loss of Main Mic PHA & Accum.		3

LITTON-LERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 101xx031	REV: A
END ITEM: Sens. Electronics	DWG NO	PAGE: 2-58	OF: 64-10
ASS'Y: Amplifier-Detector Circuit	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
170. Main Mic Peak Detector (Sen. 3)	No Output	Main Mic PHA & Accum. Signals Missing	Loss of Main Mic PHA & Accum. Data		3
171. Main Mic Threshold Detector	No Output	Main Mic PHA & Accum. Signals Missing	Loss of Main Mic PHA & Accum. Data	40.048	3
172. Main Mic Inverter Gates	No Output	Main Mic PHA & Accum. Signals Missing	Loss of Main Mic PHA & Accum. Data	7.008	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Heater Control	DWG NO: 10126007	PAGE: 2359	OF: 6410
ASSY: Component Parts	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE: END ITEM	EFFECT OF FAILURE: SYSTEM	FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
1. Z1	Inoperative	Loss of ON and OFF Mode	No loss to the experiment (can go to automatic mode)	7.008	4
2. Z2	Inoperative	Loss of ON and OFF Mode	No loss to the experiment (can go to automatic mode)	7.008	4
3. Z3	Inoperative	Loss of ON and OFF Mode	No loss to the experiment (can go to automatic mode)	7.008	4
4. Z4	Inoperative	Loss of automatic mode	No loss to the experiment	7.008	4
5. Z5	Inoperative	Loss of ON and OFF Mode	No loss to the experiment (can go to automatic mode)	7.008	4
6. Q1	Open	Heater OFF all the time	Total loss of the experiment	3.504	1
	Short	Heater ON all the time	Excess power drain-no loss to the experiment	3.504	4
7. Q2	Open	Heater OFF all the time	Total loss of the experiment	3.504	1
	Short	Heater ON all the time	Excess power drain -no loss to the experiment	3.504	4
8. Q3	Open	Loss of OFF mode	No loss to the experiment	3.504	4
	Short	Heater on all the time	Excess power drain- no loss to the experiment	3.504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Heater Control	DWG NO: 10126007	PAGE: 246 OF 1614	
ASS'Y: Component Parts	DWG NO:	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
9. Q4	Open	Loss of ON Mode	No loss to the experiment	3.504	4
	Short	Heater ON all the time	Excess power drain - no loss to the experiment	3.504	
10. CR1	Open	Loss of automatic mode	No loss to the experiment	.03504	4
	Short	No effect	No loss to the experiment	1.4016	4
11. CR2	Open	Loss of automatic Mode	No loss to the experiment	1.5768	4
	Short	Heater ON all the time in the automatic mode	Excess power drain in the automatic mode. No loss to the experiment.	2.1024	4
12. CR3	Open	No effect	No loss to the experiment	.03504	4
	Short	Loss of automatic mode	No loss to the experiment	1.4016	4
13. CR4	Open	No effect	No loss to the experiment	.03504	4
	Short	Loss of automatic mode	No loss to the experiment	1.4016	4
14. CR5, CR6	Open	Loss of automatic mode for survival power	No loss to the experiment	.03504	4
	Short	No effect	No loss to the experiment	1.4016	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Heater Control	DWG NO: 10126007	PAGE: 256 OF 541	
ASS'Y: Component Parts	DWG NO:	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
15. CR7, CR8	Open	Loss of automatic mode for operational power	No loss to the experiment	.03504	4
	Short	No effect	No loss to the experiment	1.4016	4
16. CR9	Open	Might damage Q3 possible loss of OFF mode	No loss to the experiment	.03504	4
	Short	Possibly no effect	No loss to the experiment	1.4016	4
17. CR10	Open	Might damage Q4, possible loss of ON mode.	No loss to the experiment	.03504	4
	Short	Possibly no effect	No loss to the experiment	1.4016	4
18. R1	Open	Loss of ON and OFF mode	No loss to the experiment (can go to automatic mode)	.03504	4
19. R2	Open	Heater ON all the time	Excess power drain - no loss to the experiment	.03504	4
20. R3	Open	Loss of Automatic mode	No loss to the experiment	.03504	4
21. R4	Open	Loss of Automatic mode	No loss to the experiment	.03504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM	PREPARED BY	NO	REV
LEAM	A. Lakhani	10120031	A
END ITEM	DWG NO	PAGE 226	OF 1064
Heater Control	10126007		
ASSY	DWG NO	DATE	
Component Parts		14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
22. R5	Open	Loss of automatic mode	No loss to the experiment	.03504	4
23. R6	Open	Loss of automatic mode	No loss to the experiment	.03504	4
24. R7	Open	Loss of automatic mode	No loss to the experiment	.03504	4
25. R8	Open	Loss of automatic mode	No loss to the experiment	.03504	4
26. R9	Open	Loss of automatic mode	No loss to the experiment	.03504	4
27. R10	Open	Heater OFF all the time	Total loss to the experiment	.03504	1
28. R11	Open	Heater ON all the time	Excess power drain - no loss to the experiment	.03504	4
29. R12	Open	Loss of OFF mode	No loss to the experiment	.03504	4
30. R13	Open	Loss of ON mode	No loss to the experiment	.03504	4
31. K1	Open	Loss of ON mode	No loss to the experiment	-	4
32. K2	Open	Loss of OFF mode	No loss to the experiment	-	4

TIME-ZERO corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 101 [illegible] 1	REV: A
END ITEM: 25KHz Oscillator	DWG NO:	PAGE: 2763 OF 6[illegible]	
ASSY: Component Parts	DWG NO:	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. Transistor Q1	Open	Frequency accuracy degraded	Accuracy of output data degraded	3.504	3
2. Transistor Q2	Open	Loss of clock	Total loss of experiment	3.504	1
3. Transistor Q3	Open	Loss of clock	Total loss of experiment	3.504	1
4. Transistor Q4	Open	Loss of clock	Total loss of experiment	3.504	1
5. Transistor Q5	Open	Loss of clock	Total loss of experiment	3.504	1
6. Diode CR1	Open	Frequency Change	Inaccuracy in the output data	1.0512	3
7. Diode CR2	Open	Frequency Change	Inaccuracy in the output data	1.0512	3
8. Diode CR3	Open	Frequency Change	Inaccuracy in the output data	1.5768	3
9. Diode CR4	Open	Frequency Change	Inaccuracy in the output data	1.5768	3
10. Diode CR5	Open	Frequency Change	Inaccuracy in the output data	1.5768	3
11. Diode CR6	Open	No effect	No effect	1.5768	4
	Short	Frequency Accur. Degraded	Accuracy of output data degrad.	2.1024	3
12. Diode CR7	Open	No effect	No effect	1.5768	4
	Short	Frequency Accuracy Degrad.	Accuracy of the output data degraded	2.1024	3

E-ZEM corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM 25 KHz Oscillator	DWG NO	PAGE 264 OF 641	
ASS'Y Component Parts	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
3. Resistor R1	Open	No output	Total loss of experiment	.03504	1
4. Resistor R2	Open	No output	Total loss of experiment	.03504	1
5. Resistor R3	Open	No output	Total loss of experiment	.03504	1
6. Resistor R4	Open	No output	Total loss of experiment	.03504	1
7. Resistor R5	Open	No output	Total loss of experiment	.03504	1
8. Resistor R6	Open	No output	Total loss of experiment	.03504	1
9. Resistor R7	Open	No output	Total loss of experiment	.03504	1
0. Resistor R8	Open	No output	Total loss of experiment	.03504	1
1. Resistor R9	Open	No output	Total loss of experiment	.03504	1
2. Resistor R10	Open	No output	Total loss of experiment	.03504	1
3. Resistor R11	Open	No output	Total loss of experiment	.03504	1
4. Capacitor C1	Short	No output	Total loss of experiment	.876	1
5. Capacitor C2	Short	No output	Totalloss of experiment	.876	1
6. Capacitorr C3	Short	Degradation in performance	Accuracy of the output data degraded	.07008	1

TIME-ZERO corporation

FAILURE MODE, EFFECT CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY:	NO: 10[illegible]031	REV: A
END ITEM: 25 KHz Oscillator	DWG NO:	PAGE: 2465 OF: 6410	
ASS'Y: Component Parts	DWG NO:	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10⁻⁵	CRITICALITY
		END ITEM	SYSTEM		
27. Capacitor C5	Short	No output	Total loss of experiment	.0438	1
28. Capacitor C6	Short	No output	Total loss of experiment	.0438	1
29. MED Z1	Inoperative	No output	Total loss of experiment	7.008	1

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM Dual Sens. 1 Elect.	DWG NO 10122003	PAGE 3066 OF 5410	
ASS'Y A Film ID	DWG NO 10126009	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1	Open	Lose Film bias	Minor effect probably loose efficiency	.03504	3
2. C1	Short	"	"	.07008	3
3. R3	Open	No D.C. path for bias current.	"	.03504	3
4. R4, 5, 6, 12	Open	Changes the amplifier gain.	Incorrect film signal.	.03504	3
5. R7, 14	Open	Loss of Film signal	Loss of Film ID	.03504	3
6. C3	Short	"	"	.0438	3
7. Z1, Z2	Inoperative	"	"	5.256	3
8. R8, 9, 10 13	Open	Lose the ability to inhibit cross-coupled signals from respective film channels.	Noise on line, allows 2nd signal.	.03504	3
9. R11	Open	Raise the gain of cross-coupled signals to twice as high.	"	.03504	3
10. C2	Short	Lose in-flight calibration	No effect	.07008	4
11. R6*	Open	"	"	.03504	4

*Outboard

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO. 10120031	REV A
END ITEM Dual Sens Electron	DWG NO. 10122015	PAGE 67M	OF 91[illegible]
ASSY Film ID Threshold	DWG NO. 10123010	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1	Open	Q1, Q2 turns off. Produces delay in detecting threshold signals.	Lose accuracy in Film	.03504	3
2. R2, R3, R5, R6	Open	Lose the ability to drive Q1, Q2 on. Loss of threshold detector.	Loss of channel 1 of Film I.D.	.03504	3
3. C1	Short	"	"	1,0512	3
4. CR2	Short	Loss of channel 1 output.	"	1.4016	3
5. R4	Open	No leakage path for Q2. Q2 probably be "on" all the time.	"	.03504	3
6. R9	Open	May not be able to turn Q3 "on".	"	.03504	3
7. R10	Open	Lose the ability to drive T2L gate.	"	.03504	3
8. Q1, Q2, Q3	Open, Short	Loss of channel 1 data.	"	3.504	3
9. R7, CR1	Open	Lose positive feedback may not have the ability to drive T2L gate long enough.	"	.03504	3
10.R8	Open	Respond to inputs less than 10mV. Pick up erroneous data.	Channel 1 Film I.D. data erroneous.	.03504	3
11.C2	Short	Q3 probably stay "on" all the time after a hit is registered.	"	1.0512	3
12.CR2	Open	Putting gate input to -5V through R10.		.03504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO	REV A
END ITEM Dual Sen 1 Electron	DWG NO 10122015	PAGE 2813 OF 6480	
Film ID Thrshld.	SCH 10128010	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
13. CR1	Short	Probably no effect.	No effect	1.4010	4

FMECA on Film ID Threshold Detector for Channels 2, 3 and 4 is same as Channel 1.

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FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Dual Sens 1 Electron.	DWG NO: 10122015	PAGE: 935	OF: 9401
ASSY: Film PHA Threshld.	DWG NO: 10126011	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE: END ITEM	EFFECT OF FAILURE: SYSTEM	FAILURE PROBABILITY Q × 10^{-5}	CRITICALITY
1. R1, R2, R3 R4	Open	Loss of Film PHA signal for the respective channel	Partial loss of Film PHA experiment.	.03504	3
2. Z1, Z2	Inoperative	Loss of Film PHA output	Loss of Film PHA experiment.	5.256	3
3. R14	Open	"	"	.03504	3
4. CR3	Short	"	"	.03504	3
5. R7	Open	Amplifier operates open loop. Erroneous data.	"	1.4016	3
6. R6, R13	Open	Saturates the amplifier. Decreases the accuracy of output data.	Accuracy of Film PHA degraded.	.03504	3
7. R5, R8	Open	No effect	No effect	.03504	4
8. R9, R10, R11	Open	Threshold will change to 0V instead of -10mV	Incorrect Film PHA level	.03504	3
9. R12	Open	Drive the output positive	"	.03504	3
10. CR1	Open	Lose negative output No correspondence with PHA level.	"	.03504	3
	Short	Lose 10mV threshold	"	1.4016	3
11. CR2	Open	Lose feedback in quiescent state. Output goes to positive saturation.	Incorrect Film PHA level	.03504	3

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FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Dual Sens 1 Electron.	DWG NO: 10122015	PAGE: 2470 OF 6410	
ASSY: Film PHA Thrshld.	DWG NO: 10128011	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q × 10⁻⁵	CRITICALITY
		END ITEM	SYSTEM		
11. CR2	Short	Alters the quiescent level. Probably lose "1" state level for driving T^2L gate.	Incorrect Film PHA level.	1.4016	3
12. CR3	Open	Probably lose the T^2L gate its driving.	"	.03504	3
13. Z13, Z14, Z15	Output Always "0"	Loss of PHA data	Loss of Film PHA experiment.	7.008	3
	Output Always "1"	PHA data inaccurate.	Accuracy of Film PHA data degraded.	7.008	3

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FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM Dual Sens 1 Electron	DWG NO 10122015	PAGE 71 35 OF 64	
ASS'Y Film Peak Detector	PWB 6003	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1, R8	Open	Inbalance the input	Accuracy of Film PHA experiment degraded.	.03504	3
2. R2, R4	Open	Q2 may turn "on" at high temperature	Probably lose Film PHA at high temperature	.03504	3
3. R3	Open	Lose the Film peak detector output	Loss of Film PHA experiment	.03504	3
4. R5	Open	Get overshoot on output, would not turn on as fast	Film PHA data inaccurate	.03504	3
5. R6	Open	Q3 and Q4 may turn "on" at high temperature.	Probably lose Film PHA at high temperature.	.03504	3
6. R7	Open	Lose discharge path for C2 - Q3 may not turn on.	Loss of Film PHA - experiment	.03504	3
7. R9, R11	Open	Lose load decay.	Loss of Film PHA - experiment	.03504	3
8. R10	Open	Output will not be synchronous with clock.	Film PHA data inaccurate	.03504	3
9. R12	Open	Lengthen the recovery time Develop error in output	Film PHA data inaccurate	.03504	3
10. R13	Open	Increases the gain	Film PHA data inaccurate	.03504	3
11. C1	Short	Probably hold Q1A, Q2A, "off"	Film PHA data erroneous	1.0512	3
12. C2	Short	Output may overshoot	Lose accuracy in the Film PHA data	.219	3
13. C3	Short	Slows the output	Lose accuracy in the Film PHA data	.219	3

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FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	DWG NO 10120031	REV A
END ITEM Dual Sens 1 Electron	DWG NO 10122015	PAGE 7236	OF 64 10
ASSY Film Peak Detect.	DWG NO 10126003	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q × 10⁻⁵	CRITICALITY
		END ITEM	SYSTEM		
13. C3	Short	Slows the output	Lose accuracy in the Film PHA data.	.219	3
14. C4	Short	Get D.C. level output.	PHA data erroneous	.219	3
15. C5	Short	Q2A will remain "off", over drive Q1A	Loss of Film PHA experiment.	1.0512	3
16. Q1A, Q1B, Q2A, Q2B Q3	Open, Short	Lose the Film peak detector output.	Loss of Film PHA experiment.	3.504	3
17. Q4	Open	Output data erroneous.	PHA data erroneous	3.504	3
18. Q5, Q7	Open	Lose the Film peak detector output.	Loss of Film PHA experiment.	3.504	3
	Short	Output will not be synchronous with clock.	Film PHA data inaccurate	3.504	3
19. Q6	Open	Lose load decay	Loss of Film PHA experiment.	3.504	3
	Short	Output will not be synchronous with clock	Film PHA data inaccurate	3.504	3
20. CR1	Short	Lose accuracy in Film PHA data.	Film PHA data inaccurate	1.4016	3

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FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM Dual Sens l Electron.	DWG NO 10122015	PAGE 37B OF 64[illegible]	
ASS'Y Mic P/A, BPF	DWG NO 10126016	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1	Open	No voltage applied	Loss of Mic	.03504	3
2. C3	Short	"	"	1.0512	3
3. R3, 4, 5, 6, 8, 9, 10, 15, 18 and 19	Open	Loss of input signal	"	.03504	3
4. Q1, 2	Open	"	"	3.504	3
5. R2, 7, 11, 20	Open	Partial loss of input signal	Mic data not referenced properly	.03504	3
6. R12, 13, 21 22	Open	Change ampl. gain	Mic data erratic	.03504	3
7. R14, 17	Open	Changes BPF characteristics	"	.03504	
8. C2	Short	Changes calibration signal	Will not calibrate properly	.219	3
9. R7*	Open	"	"	.03504	
10. C1, C5, C13	Short	Loss of input signal	Loss of Mic signal	.219	3
11. Z1, Z2	Inoperative	"	"	5.256	3
12. C6, C7, C9 C10	Short	Changes BPF characteristics	Mic data erratic	.3504	3

* Outboard of 6016

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Dual Sens 1 Electron.	DWG NO: 10122015	PAGE: 75	OF: 64
ASSY: Main Mic Thrshld.	DWG NO: 10126017	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
14. Q3	Open	No log decay	Mic PHA data erroneous	3.504	3
	Short	Lose accuracy	Loss of accuracy in Mic PHA experiment.	3.504	3
15. Q4	Open	PHA data erroneous	PHA data erroneous	3.504	3
	Short	Lose accuracy	Loss of accuracy in Mic PHA experiments.	3.504	3
16. CR1, CR3	Short	Probably lose Mic PHA	Loss of Mic PHA experiment.	.03504	3
17. CR2	Short	Probably no effect.	No effect.	.03504	4
18. Z1	Inoperative	Lose Mic PHA	Loss of Mic PHA experiment.	5.256	3
19. Z13, Z14	Inoperative	Lose Mic PHA	Loss of Mic PHA experiment.	7.008	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO. 10120031	REV A
END ITEM Dual Sens 1 Electron.	DWG NO. 10122015	PAGE 1648	OF 1654
ASS'Y Mic Peak Detec.	DWG NO. 10126026	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1, R7	Open	Imbalance the input Change the gain.	Lose accuracy in the Mic PHA data.	.03504	3
2. R2, R5	Open	Q2 may turn "on" at high temperature.	Possibility of losing Mic PHA at high temperature.	.03504	3
3. R3	Open	Q3 may turn "on" at high temperature.	Possibility of losing Mic PHA at high temperature.	.03504	3
4. R4	Open	Lose the Mic Peak detector output.	Loss of Mic PHA experiment.	.03504	3
5. R6	Open	Lose discharge path for C2 - Q3 may not turn "on"	Loss of Mic PHA experiment.	.03504	3
6. R8	Open	Get overshoot on output.	Mic PHA data inaccurate.	.03504	3
7. R9	Open	Lengthen the recovery time - develop error in the output.	Mic PHA data inaccurate.	.03504	3
8. C1	Short	Probably hold Q1A, Q2A, off.	Mic PHA data inaccurate	1.0512	3
9. C2	Short	Output may overshoot	Mic PHA data inaccurate	.219	3
10. C3	Short	Slows the output	Mic PHA data inaccurate	1.0512	3
11. Q1A, Q1B, Q2A, Q2B, Q3	Open, Short	Lose the Mic Peak detector output	Loss of Mic PHA experiment.	3.504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Dual Sens 1 Electron.	DWG NO: 10122015	PAGE: 774	OF: 6400
ASSY: Calibration Driver	DWG NO: 10126015	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1	Open	C1 takes longer time to discharge - no effect on circuit.	No effect	.03504	4
2. R2	Open	Lose A Film 1, 2 and A, B collector calibration pulses.	No major loss - A Film 1, 2 and A, B collector will not calibrate.	.03504	3
3. R3, R4	Open	Possibility of circuit stop functioning at high temperature.	May lose calibrate pulses at high temperature.	.03504	3
4. R5	Open	Lose A, B collector calibration pulses.	A, B collector will not calibrate.	.03504	3
5. R6	Open	Lose A Film 1, 2 calibration pulses.	A Film 1, 2 will not calibrate.	.03504	3
6. R7	Open	Possibility of loosing A, B collector calibration pulses at high temperature.	A, B collector may not calibrate at high temperature.	.03504	3
7. R8	Open	Probably no effect - may change time constant on pulse duration.	No effect.	.03504	3
8. R9	Open	No positive feed back - A Film 1, 2 and A, B collector will have short calibration output pulses.	Lose accuracy on calibration.	.03504	3
9. R10, R13	Open	Lose A Film 3, 4 calibration pulses.	A Film 3, 4 will not calibrate.	.03504	3
10. R11, R12	Open	Possibility of circuit stop functioning at high temp.	May lose calibrate pulses at high temperature.	.03504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM Dual Sens 1 Electron.	DWG NO 10122015	PAGE 278 OF 5400	
ASS'Y Calibration Driver	DWG NO 10126015	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
11. R14	Open	Lose B Film and main Mic calibration pulses.	B Film and main Mic will not calibrate.	.03504	3
12. R15	Open	Possibility of losing B Film and main Mic calibration pulses at high temperature.	B Film and main Mic may not calibrate at high temp.	.03504	3
13. R16	Open	Lose B Film calibration pulses.	B Film will not calibrate.	.03504	3
14. R17	Open	Possibility of losing main Mic calibration pulse at high temperature.	Main Mic may not calibrate at high temperature.	.03504	3
15. R18	Open	Lose main Mic calibration pulse.	Main Mic will not calibrate	.03504	3
16. R19	Open	Possibility of losing B Film calibration pulses at high temperature.	B Film may not calibrate at high temperature.	.03504	3
17. R20	Open	Lose B Film calibration pulse.	B Film will not calibrate.	.03504	3
18. R21	Open	Output pulse will be narrow.	Lose calibration accuracy on B Film and main Mic.	.03504	3
19. C1, C2	Short	No effect.	No effect.	1.0512	4
20. C3	Short	Lose B Film and main Mic calibration pulses.	B Film and main Mic will not calibrate.	1.0512	4
21. C4	Short	Circuit would latch up lose A Film 1, 2 and A, B collector calibration pulses.	A Film 1, 2 and A, B collector will not calibrate.	1.0512	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Dual Sens 1 Electron.	DWG NO: 10122015	PAGE: 4379 OF 6410	
ASS'Y: Calibration Driver	DWG NO: 10126015	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
22. C5	Short	Lose B Film and main Mic calibration pulses.	B Film and main Mic will not calibrate.	1.0512	3
23. C6	Short	5V supply will be shorted to ground.	Total loss of the LEAM experiment.	.219	1
24. Q1	Open, Short	Lose A Film 1, 2 and A, B collector calibration pulses.	A Film 1, 2 and A, B collector will not calibrate.	3.504	3
25. Q2	Open, Short	Lose A Film 1, 2 calibration pulses.	A Film 1, 2 will not calibrate.	3.504	3
26. Q3, Q4	Open, Short	Lose A, B collector calibration pulses.	A, B collector will not calibrate.	3.504	3
27. Q5, Q6	Open, Short	Lose A Film 3, 4 calibration pulses.	A Film 3, 4 will not calibrate.	3.504	3
28. Q7	Open, Short	Lose B Film and main Mic calibration pulses.	B Film and main Mic will not calibrate.	3.504	3
29. Q8	Open, Short	Lose main Mic calibration pulses.	Main Mic will not calibrate.	3.504	3
30. Q9, Q10	Open, Short	Lose B Film calibration pulses.	B Film will not calibrate.	3.504	3
31. CR1	Short	Probably no effect.	No effect.	1.4016	4
32. CR2	Short	Lose B Film and main Mic calibration pulses.	B Film and main Mic will not calibrate.	1.4016	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Sensor 3 Electron.	DWG NO: 10124003	PAGE: 3044	OF: 6410
ASS'Y: Film Amp. ID	DWG NO: 10126018	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1	Open	Lose Film Bias	Minor effect probably lose efficiency.	.03504	3
2. C1	Short	"	"	.07008	3
3. R3	Open	No D.C. path for bias current.	"	.3504	3
4. R4, 5, 6, 10	Open	Changes the amplifier gain.	Incorrect Film signal	.03504	3
5. R7, R12	Open	Loss of Film signal	Loss of Film ID	.03504	3
6. C3	Short	"	"	.219	3
7. Z1, Z2	Inoperative	"	"	5.256	3
8. R9	Open	Raise the gain of cross-coupled signals to twice as high.	Lose efficiency	.03504	3
9. R8, R11	Open	Lose the ability to inhibit cross coupled signals.	"	.03504	3
10. C2	Short	Lose In-Flight calibration	No effect	1.0512	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 0120031	REV: A
END ITEM: Sensor 3 Electronics	DWG NO: 10124003	PAGE: 81 45 OF 10 64	
ASSY: Noise Mic Thrshld.	DWG NO: 10126023	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
1. R1	Open	Possibility of not inhibiting Mic signal.	Probably no effect	.03504	4
2. R2, R3, R4	Open	No Mic Inhibit	Loss of accuracy in noise Mic data.	.03504	3
3. R5, R8, R9, R10, R13	Open	Lose noise Mic threshold	Loss of noise Mic data.	.03504	3
4. R6	Open	Possibility of inhibiting all the time.	Loss of accuracy in noise Mic data.	.03504	3
5. R7	Open	No effect - slight offset on PHA	No effect	.03504	4
6. R11, R12	Open	Lose accuracy	Loss of accuracy in noise Mic data.	.03504	3
7. C1	Short	Loss of noise Mic threshold	Loss of noise Mic data.	10.512	3
8. C2	Short	Loss of accuracy	Loss of accuracy in noise Mic data.	.219	
9. Q1, Q2	Open	No Mic Inhibit	Loss of accuracy in noise Mic data	3.504	3
	Short	Lose noise Mic threshold	Loss of noise Mic data	3.504	3
10. Z1	Inoperative	Lose noise Mic data	Loss of noise Mic data	5.256	3
11. Z4 (Outboard)	Inoperative	Lose noise Mic data.	Loss of noise Mic data	7.008	3
12. CR1, CR3	Short	Lose noise Mic data	Loss of noise Mic data	.03504	3
13. CR2	Short	Probably no effect	No effect	.03504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: Squib Driver	DWG NO: 10126005	PAGE: 8246 OF 8400	
ASS'Y	DWG NO	DATE: 14 May 1971	

	CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE: END ITEM	EFFECT OF FAILURE: SYSTEM	FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
1.	Resistor R29	Open	Squibs 1, 2, 3, 4 will not fire	Total loss of experiment	.03504	1
2.	Resistor R30	Open	Squibs 1, 2 will not fire	Instrument over heats to 230°F operating or 110°F non-operating. Degradation in the potential life of the experiment.	.03504	2
3.	Resistor R1	Open	Squibs 1, 2 will not fire	"	.03504	2
4.	Resistor R2	Open	Decreases the margin of safety. The squibs will still fire, however, inadvertently because Q1 may turn ON at higher temperature.	No effect	.03504	4
5.	Resistor R3	Open	Probably no effect. Q2 may turn ON at high temperature and fire the squib. Margin of safety is decreased.	No effect	.03504	4
6.	Resistor R4	Open	Squibs 1, 2 will not fire	Same as Item 2	.03504	3
7.	Resistor R27	Open	Decreases the margin of safety - otherwise no effect on the output.	No effect	.03504	4
8.	Resistor R5	Open	Squib 2 will not fire	No loss to the experiment	.03504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM	PREPARED BY	NO	REV
LEAM	A. Lakhani	10120031	A
END ITEM: Squib Driver	DWG NO: 10126005	PAGE 83 OF 100	
ASSY	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE: END ITEM	EFFECT OF FAILURE: SYSTEM	FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
9. Resistor R6	Open	Squib 2 will fire incorrectly	No loss to the experiment	.03504	4
10. Resistor R7	Open	No effect	No loss to the experiment	.03504	4
11. Resistor R8	Open	Squib 2 will not fire	No loss to the experiment	.03504	4
12. Resistor R9	Open	Squib 2 will not fire	No loss to the experiment	.03504	4
13. Resistor R10	Open	Decreases the margin of safety. May fire Squib 2 incorrectly.	No loss to the experiment	.03504	4
14. Resistor R11	Open	"	No loss to the experiment	.03504	4
15. Resistor R12	Open	Squib 2 will not fire	No loss to the experiment	.03504	4
16. Resistor R13	Open	No effect	No loss to the experiment	.03504	4
17. Resistor R33	Open	No effect	No loss to the experiment	.03504	4
18. Capacitor C1	Short	Squib 2 will not fire	No loss to the experiment	.219	4
19. Capacitor C3	Short	Place heavy load on +12v supply. Squibs 1, 2, 3, 4 will not fire.	Total loss of the experiment	.219	1
20. Capacitor C4	Short	Squibs 1, 2 will not fire	Same as Item 2	.219	2

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM	PREPARED BY	NO	REV
LEAM	A. Lakhani	10126031	A
END ITEM: Squib Driver	DWG NO: 10126005	PAGE 8446 OF 6401	
ASSY	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
21. Transistor Q1	Open	Disables Squibs 1, 2	Same as Item 2	3.504	2
	Short	Fires Squibs 1, 2 too soon	Collects extra dust-no major loss	3.504	3
22. Transistor Q2	Open	Disables Squibs 1, 2	Same as Item 2	3.504	2
	Short	Fires Squibs 1, 2 too soon	Collects extra dust. No major loss	3.504	3
23. Transistor Q3	Open	Fires Squib 2 too soon	Collects extra dust. No Major loss	3.504	3
	Short	Disables Squib 2	No effect. Main squib still operating	3.504	4
24. Transistor Q4	Open	Disables Squib 2	No effect	3.504	4
	Short	Fires Squib 2 too soon	Collects extra dust. No major loss	3.504	3
25. Transistor Q5	Open	Disables Squib 2	No effect	3.504	4
	Short	Fires Squib 2	Collects extra dust. No major loss	3.504	3
26. Diode CR1	Short	Decreases the margin of safety at high temperature.	No effect	1.4016	4
27. Diodes CR2	Short	Disables Squibs 1, 2	Same as Item 2	1.4016	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM Squib Driver	DWG NO 10126005	PAGE 4985 OF 6410	
ASS'Y	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
28. Diode CR3	Short	No effect on the output	No effect	1.4016	4
29. Diode CR6	Short	No effect on the output. At high temperature decreases the margin of safety	No effect	1.4016	4
30. Diode CR7	Short	Disables Squib 2	No effect	1.4016	4
31. Resistor R31	Open	Squibs 3, 4 will not fire	Total loss of the experiment dust cover cannot be removed	.03504	1
32. Resistor R14	Open	Squibs 3, 4 will not fire	"	.03504	1
33. Resistor R15	Open	Decreases the margin of safety. The squibs will still fire, however, inadvertently because Q6 may turn ON at higher temperature.	No effect	.03504	4
34. Resistor R16	Open	Probably no effect. Q6 may turn ON at high temperature and fire the squib. Margin of safety is decreased.	No effect	.03504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 101c0031	REV A
END ITEM Squib Driver	DWG NO 10126005	PAGE 8654 OF 9405	
ASS'Y	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
35. Resistor R17	Open	Squibs 3, 4 will not fire	Total loss of the experiment dust cover will not be removed	.03504	1
36. Resistor R18	Open	Decreases the margin of safety - otherwise no effect on the output.	No effect	.03504	4
37. Resistor R19	Open	Squib 4 will not fire	No effect	.03504	4
38. Resistor R20	Open	Squib 4 will not fire	No effect	.03504	4
39. Resistor R21	Open	No effect	No effect	.03504	4
40. Resistor R22	Open	Squib 4 will not fire	No effect	.03504	4
41. Resistor R23	Open	Squib 4 will not fire	No effect	.03504	4
42. Resistor R24	Open	Decreases the margin of safety. May fire Squib 4 incorrectly.	No effect	.03504	4
43. Resistor R25	Open	"	No effect	.03504	4
44. Resistor R26	Open	Squib 4 will not fire	No effect	.03504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	10120031	REV A
END ITEM Squib Driver	DWG NO 10126005	PAGE 187 OF 641	
ASS'Y	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
45. Resistor R28	Open	No effect	No effect	.03504	4
46. Resistor R32	Open	No effect	No effect	.03504	4
47. Capacitor C2	Short	Squib 4 will not fire	No effect	.219	4
48. Capacitor C5	Short	Squibs 3, 4 will not fire	Total loss of the experiment dust cover will not be removed.	.219	1
49. Transistor Q6	Open	Disables Squibs 3, 4	"	3.504	1
	Short	Fires Squibs 3, 4	Collects extra dust, no major loss.		
50. Transistor Q7	Open	Disables Squibs 3, 4	Total loss of the experiment dust cover will not be removed.	3.504	1
	Short	Fires Squibs 3, 4 too soon	Collects extra dust. No major loss	3.504	3
51. Transistor Q8	Open	Fires Squibs 4	Collects extra dust. No major loss	3.504	3
	Short	Disables Squibs 4	Total loss of the experiment	3.504	1
52. Transistor Q9	Open	Disables Squib 4	No effect	3.504	4
	Short	Fires Squib 4	Collects extra dust-no major loss	3.504	3
53. Transistor Q10	Open	Disables Squib 4	No effect	3.504	4
	Short	Fires Squib 4	Collects extra dust. No major loss.	3.504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY J. Comer	NO 10120031	REV A
END ITEM Power Supply	DWG NO 10121001	PAGE 5490 OF 64100	
ASS'Y Pre-Reg.	DWG NO 10126002-1	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
Q1	Short	Keep start volts applied	Minor power loss	3.504	4
R3	Open	"	"	.03504	4
CR4	Short	"	"	1.4016	4
R2, 5, 6, 8	Open	Shifts operating point of Q1 No I_{cbo} path	None	.03504	4
CR1, 2	Open	No reverse voltage protection	None	.876	4
CR1, 2	Short	None, the other diode blocks	None	8.76	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO 10120031	REV A
END ITEM Squib Driver	DWG NO 10126005	PAGE 5288 OF 5410	
ASSY	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
54. Diode CR4	Short	No effect on the output	No effect	1.4016	4
55. Diode CR5	Short	No effect on the output, at high temperature decreases the margin of safety.	No effect	1.4016	4
56. Diode CR8	Short	Decreases the margin of safety at high temperature.	No effect	1.4016	4
57. Diode CR9	Short	Disables Squibs 3, 4	Total loss of the experiments dust cover will not be removed.	1.4016	1
58. Diode CR10	Short	Disables Squib 4	No loss to the experiment	1.4016	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 1020031	REV: A
END ITEM: Power Supply	DWG NO: 10121001	PAGE: 5589 OF: 64101	
ASSY: Pre-Reg.	DWG NO: 10126002-1	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
R1, 4, 9, 10, 14, 11	Open	Power supply will not turn ON or turn OFF	Total loss of experiment	.03504	1
CR 4, 8, 9	Open	"	"	1.0512	1
Q1, 2, 3, 4	Open	"	"	3.504	1
CR5	Short	"	"	1.4016	1
CR3	Short	"	"	1.4016	1
Q2, 3, 4	Short	All voltages are unregulated	Almost complete loss of experiment	3.504	2
CR 7	Short	Change current of reference diode	"	1.4016	2
R12	Open	No sync, signal may go into series regulation.	Increases losses, regulation power	.03504	2
C2	Short			1.0512	2

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 10120031	REV: A
END ITEM: Power Supply	DWG NO: 10121001	PAGE: 91 55 OF 6410	
ASS'Y: Surge Limiter	DWG NO: 10126027	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
Q1, Q2	Open	No voltage applied	Complete loss of experiment	Q1=3.504 Q2=157.68	1
R1, 2, 5	Open	"	"	.03504	1
C1	Short	"	"	.219	1
CR1	Open	"	"	.03504	1
Q1, Q2	Short	Surges Not Limited	Nil	Q1=3.504 Q2=8.76	3
C1	Open	"	"	.0438	3
CR1	Short	Increases losses	"	1.4016	3
R2, R3	Open	No I_{cbo} path	None	.03504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY J. Comer	NO 10120031	REV A
END ITEM Power Supply	DWG NO 10121001	PAGE 9256 OF 6410	
ASSY Surge Limiter	DWG NO 10126027	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
Q1a, 1b, 2, 3, 4	Open or Short	No output of oscillator	Complete loss of experiment	3.504	1
R1, 2, 4, 5, 6, 8, 10	Open	"	"	.03504	1
C1, 3	Open	"	"	C1=1.752 C3=.0438	1 1
C1, 3	Short	"	"	C1=10512 C3=.219	
R5 (outboard)	Open	"	"	.03504	1
R2, 3	Open	Shifts Freq.	May cause some interference	.03504	3
R9, 11	open	No path for I_{cbo}	None	.03504	4

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 10120031	REV: A
END ITEM: Power Supply	DWG NO: 10121001	PAGE 93 57 OF 104	
ASS'Y: F. F. Driver	DWG NO: 10126001	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
R1	Open	No voltage applied to T2	Total loss of experiment	.03504	1
R5, 4	Open	No voltage applied to Z1	"	.03504	1
CR1	Short	"	"	1.4016	1
R2, 3	Open	Q1, 2 inoperative	"	.03504	1
T2	Open Winding	"	"	52.56	1
T2	Shorted Winding	"	"	52.56	1
Q1, 2	Open or short	No drive signal	"	3.504	1
CR3, 4, 5, 6	Open	Raises current limited point	Minor	.03504	4
	Short	No current limiting	"	1.4016	4
C1	Short	No current limiting	"	1.0512	4
R10	Open	No current limiting	"	.03504	4

TIME·ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 10120031	REV: A
END ITEM: Power Supply	DWG NO: 10121001	PAGE: 5634 OF 6401	
ASS'Y: F. F. Driver	DWG NO: 10126001	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
Q4, 3	Open	No current limiting	Minor	3.504	4
CR2	Open	"	"	1.0512	4
R8, 6	Open	"	"	.03504	4
R9, 7	Open	No I_{cbo} path	Nil	.03504	4
Q3, 4	Short	No power supply output	Total loss of experiment	3.504	1

ATM 3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 10121003	REV: A
END ITEM:	DWG NO:	PAGE: 5975 OF 6410	
ASS'Y: Power Supply	DWG NO: 10121001	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
CR1	Short	Causes Q2 to fail	Total loss of experiment	1.4016	1
L5	Open	No output voltages	"	31.536	1
C1, 2, 12, 13	Short	"	"	.219	1
R3	Open	"	"	.03504	1
R5	Open	Shifts freq. of operation	Minor	.03504	3
R1	Open	Shifts current limit	Nil	.03504	4
T3	Open Secondary	No current limiting	"	22.77	4
Q1, 2	Open or Short	Converter Inoperative	Total loss of experiment	157.68	1
T3, T1	Open Primary	"	"	87.6	1
CR4, 5	Open	Increase Losses	Major degradation	.03504	2
C5	Short	Increase losses and current limits	Total loss of experiment	.219	1
T1	Short Secondary	"	Total loss of experiment	61.32	1

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 10120031	REV: A
END ITEM:	DWG NO:	PAGE: 960	OF: 4100
ASS'Y: Power Supply	DWG NO: 10121001	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
C4	Open	Increases losses in pre-regulator	Major change in voltages	.0438	2
R4	Open	"	"	.03504	
CR2, 3	Short	"	"	.03504	1
C3	Short	P. S. Current Limit	Total loss of experiment	.219	1
T1	Open Secondary 4-5, 5-6	Shifts regulation	Minor	35.08	3
CR 2, 3	Open	Shifts regulation	Minor	.03504	3
T1	Open 7-8, 8-9	Lowers +24v	Minor	35.08	3
	Open 15-16	Will not fire squib	Total loss of experiment	35.08	1
	Open 10-11, 13-14	Lower -7.5 volts	Minor	35.08	3
	Open 11-12, 12-13	Lower 5 volts	Erratic operation of exp.	35.08	2

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: J. Comer	NO: 10[illegible]0031	REV: A
END ITEM:	DWG NO:	PAGE: 97[illegible]	OF: 6[illegible]0
ASSY: Power Supply	DWG NO: 10121001	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY Q x 10^{-5}	CRITICALITY
		END ITEM	SYSTEM		
CR 6, 7	Short	No + 5 volts	Total loss of exp.	1.4016	1
L2	Open	"	"	31.536	
C 6, 8	Short	"	"	.2191	1
CR 6, 7	Open	Lowers 5 volt output	Partial loss of exp.	.03504	2
CR 8, 9	Open	Lower -5 volt output	"	.03504	2
CR 8, 9	Short	No -5 volt output	Total loss of exp.	1.4016	1
L3	Open	"	"	31.536	1
C7, 9	Short	"	"	.219	1
L4	Open	No -7.5 volt output	Partial loss of exp.	31.536	2
CR 10, 11	Open	Lower -7.5 volt output	"	.03504	2
C10, C11	Short	P. S. Current limits	Total loss of exp.	.219	1
CR10-11	Short	"	"	1.4016	1

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM: LEAM	PREPARED BY: A. Lakhani	NO: 10120031	REV: A
END ITEM: TOF Converter	DWG NO: 10126004	PAGE: 38 of 64	
ASS'Y	DWG NO	DATE: 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
1. R1, 13, R14	Open	Q1 will be not conduct	Loss of TOF experiment.	.03504	3
2. R2	Open	Q2 will be turned "off" no current flow to the input of Z1.	Loss of TOF experiment.	.03504	3
3. R3	Open	Changes the input offset to Z1.	Lose accuracy in TOF data.	.03504	3
4. R4	Open	Changes the input characteristic to Z1	Probably lose TOF experiment.	.03504	3
5. R5, R10	Open	Will hold Q3, Q4 off.	Loss of TOF experiment.	.03504	3
6. R6	Open	Q3 may turn "on" at high temperature.	TOF data erroneous.	.03504	3
7. R7	Open	Q4 may turn "on" at high temperature.	TOF data erroneous.	.03504	3
8. R8, R9	Open	Lose FET drivers.	Loss of TOF experiment.	.03504	3
9. R11	Open	Lose -5V to Z1 and Z2	Loss of TOF experiment.	.03504	3
10. R12, 15	Open	May change offset conditions.	Lose accuracy in TOF data.	.03504	3
11. R16, R17	Open	Lose Z2 offset null	Lose accuracy in TOF data.	.03504	3
12. R18	Open	Lose the threshold detector input.	Loss of TOF experiment.	.03504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM	PREPARED BY	NO	REV
LEAM	A. Lakhani	10120031	A
END ITEM: TOF Converter	DWG NO: 10126004	PAGE 9765	OF 6401
ASS'Y	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
13. R19	Open	Lose D.C. Current Path	No effect	.03504	4
14. R20, R21	Open	Lose Z1 offset null	Lose accuracy in TOF data.	.03504	3
15. R22	Open	Changes offset conditions to Z1.	Lose accuracy in TOF data.	.03504	3
16. R23	Open	Lose TOF output.	Loss of TOF experiment.	.03504	3
17. R24	Open	Lose TOF output.	Loss of TOF experiment.	.03504	3
18. C1	Short	Changes input characteristics to Z1	Probably lose TOF experiment.	10.512	3
19. C2, C3	Short	Q3, Q4, will have extra base charge when the input is low.	Minor loss in the accuracy.	1.0512	3
20. C4, C6, C7	Short	Lose capacitive coupling.	Probably pick up erroneous data.	1.0512	3
21. C5	Short	5V supply will be shorted to ground (through 12 ohm resistor)	Total loss of the LEAM experiment.	1.0512	1
22. Z1, Z2	Inoperative	Lose TOF output	Loss of TOF experiment	5.256	3
23. Q1, Q2, Q3, Q4	Open, Short	Lose TOF output	Loss of TOF experiment	3.504	3
24. Q5, Q6	Open	Lose high current Pull - up probably loose FET drive.	Probably lose TOF data.	3.504	3
	Short	Lose TOF output	Loss of TOF Experiment.	3.504	3

TIME-ZERO corporation

FAILURE MODE, EFFECT & CRITICALITY ANALYSIS WORKSHEET

SYSTEM LEAM	PREPARED BY A. Lakhani	NO	REV A
END ITEM TOF Converter	DWG NO 10126004	PAGE 64/100 OF 64/10	
ASSY	DWG NO	DATE 14 May 1971	

CIRCUIT OR FUNCTION	FAILURE MODE	EFFECT OF FAILURE		FAILURE PROBABILITY $Q \times 10^{-5}$	CRITICALITY
		END ITEM	SYSTEM		
25. CR1, CR8	Short	No effect	No effect	1.4016	4
26. CR2, CR3	Short	Q3, will not turn "on"	Loss of TOF experiment.	1.4016	3
27. CR4, CR11	Short	Q4 will not turn "on"	Loss of TOF experiment.	1.4016	3
28. CR5, CR6	Short	Lose high current Pull-up capability Probably loose FET drive.	Probably lose TOF data	1.4016	3
29. CR7	Short	Lose TOF output	Loss of TOF experiment	1.4016	3
30. CR9	Short	Pick up erroneous signal	TOF data erroneous	1.4016	3
31. CR10	Short	Lose clamp to threshold detector.	No effect.	1.4016	4