This unscheduled ATM describes the test results obtained in pre-integration testing of the LSM Engineering Model.

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Approved by: Jack E. Dye

1. INTRODUCTION - The LSM Engineering Model was tested at a subsystem level prior to ALSEP system integration on 8-Feb through 14-Feb-67. Extensive amount of this time was utilized for test set-up and resolvement
L LSM to GSE interfaces. The test procedure utilized for these tests was per ATM-616.

Philco engineer, Mr. David Scheff, assisted in the performance of all testing as specified herein.

2. ENGINEER MODEL STATUS - The LSM Engineering Model as received had the following functional limitations:

A. Engineering Model functional acceptance tests had not been completed. prior to delivery.

B. High powered, including an approximate 60 watt turn-on transient.

C. Only the X and Y sensor electronics were functional. X and Z channel readouts were tied together to simulate a 3 rd channel.

D. X and Y sensor electronic channels had different gains.

E. Only X axis sensor is capable of being flipped by its flipper motor.

F. Sensor electronics exhibit high magnetic off sets.

G. Z axis status bits read incorrectly.

As a result of the above limitations, deviations and omissions were dictated in original prescribed test procedure, ATM-616.

3. TEST RESULTS

3.1 Test External to Flux Tanks - The following tests were performed to detect major problems resulting from shipping. See Figure 1.

3.1.1 Engineering Sensor Readouts - It is apparent from the engineering data that the sensor outputs, although constant, were set a prefix values (see table 1-1)

3.1.2 LSM Initial Conditions - The initial conditions, immediately after turn-on of the LSM, were verified per table 1-2. The following malfunctions were noted:

1) Y and Z flip positions were in the fail mode.
2) X Gimbal position indicated 90°.
3) Cal Inhibit was not inhibited.

Also the differences in the X and Y saturated data readouts indicated possible improper gain settings in the respective sensor electronic channels. This difference was noted through-out the test.

3.1.3 Command and Resetability - The response of the LSM to specific commands were noted in table 1-3. The discrepancies were as follows:

1) The range status changed from 400 to 100 to 200 gammas upon command.

2) Z axis offset did not respond properly to offset commands. None of the positive offset positions could be obtained.

3) No response was received from initiation of the site survey command. This response was attributed to the fact that 4 flip/cal cycles had to be performed prior to initiation of the site survey.

3.1.4 Input Power Test - The maximum instantaneous peak power during normal or scientific mode, both with filter in and out, was determined as contained in table 1-4. This data indicates a high powered LSM, but yet within the revised scientific mode power levels which dictate a 7 watt peak during lunar night.

A measure of the high frequency induced noise was conducted (see figure 2) and found to be exceptionally low. LSM breadboard (category 2 tests) test results indicated out of spec noise levels at high frequencies.

As a protective measure, LSM turn-on and turn-off transients were recorded (see figure 3). Because of the protected turn-on procedures which involved slowly increasing the 29 volt supply (see ATM-616) and vice versa for turn-off, true transients were not obtainable.

No indication of the predicted high (approx. 400Vpp) turn-off transient could be detected.

It was also noted that the peak values were lower in the filter-in condition as compared to the filter out condition. These values were expected to remain relatively constant.

3.1.5 Flip-Cal Verification - Prior to installing the Engineering Model in the flux tanks, the functional status fo the flip/cal mode was checked. A flip/cal command was initiated and both the X and Y sensor motors activated and the respective sensors flipped from the 0°to 180° position. The Z motor did not energize as expected. A second flip/cal command did not flip the Y xensor from 180° back to zero. Operation of the Y motor was unexpected. The X and Z motor status was as predicted.

3.2 In Flux Tank Tests - The Engineering Model sensors were placed in their respective flux tanks (see figure 1). The gamma control console was adjusted for a magnetic null reading. A null could not be obtained by only adjusting the helmholtz coils. To obtain the lowest magnetic output on all channels, maximum solinoid outputs had to be utilized. The resulting minimum null readings were as follows:

X -105.4 gammas
Y -067 gammas
Z +105.4 gammas

These results indicated possible improper functioning of the sensor electronics.

3.2.1 Data and Shift Pulse Timing and Level Tests - The requirement for the data amplitude to be maintained $>$ 20 microseconds before the shift pulse initiation was verified (see figure 4). The data pulse is "up" approximately 225 μ sec prior to shift pulse which fulfills the above requirement.

Amplitude checks indicated that the logical 1 amplitudes were within tolerance but that the logical zero level contained a 1.8 volt D.C. level (see figure 5) which is outside the 0-.4volt required range. To eliminate this level, a 4K $\sim$ resistor was shunted across the data line at the LSM break-out box. This resistor reduced the logical zero value to within the required limit of 0-.4 volts (see figure 6). The logical one value was also reduced but maintained the proper limits 2.5 to 5.5 V.

Flip-Cal Power Profile - The flip-Cal power profile was recorded as indicated on strip chart recording figure 7 and 8. The following discrepancies were noted:

1) Both flip motor windings are not energized simulataneously followed by drop out of the control winding. Process is reversed based on LSM Breadboard results.

2) Y motor energized but did not flip sensor.

3) Normal operating current remained high (250ma) immediately after LSM turn-on for several seconds before settling to a lower level. This condition was noted everytime the LSM was initialized.

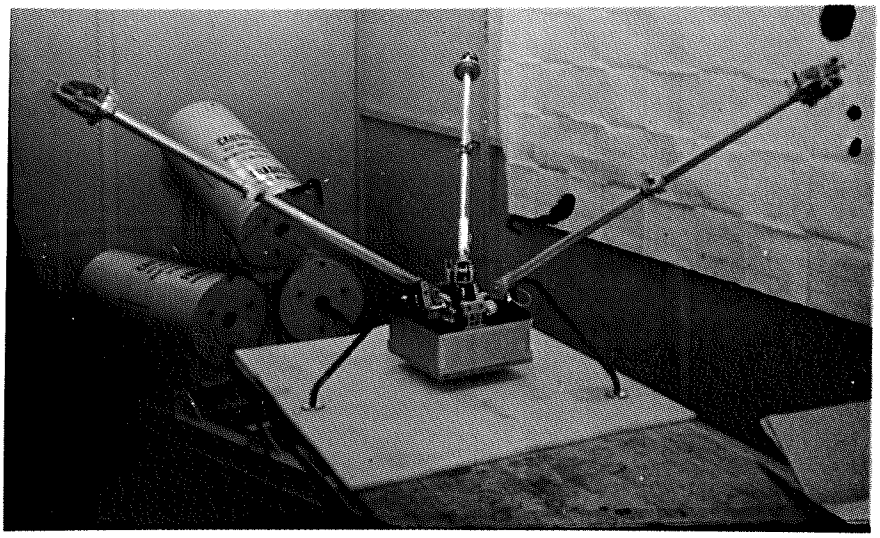
4) The following out of spec peak power levels occured:

Raster Mode	6.9 watts
Flip/Cal	15.9 watts

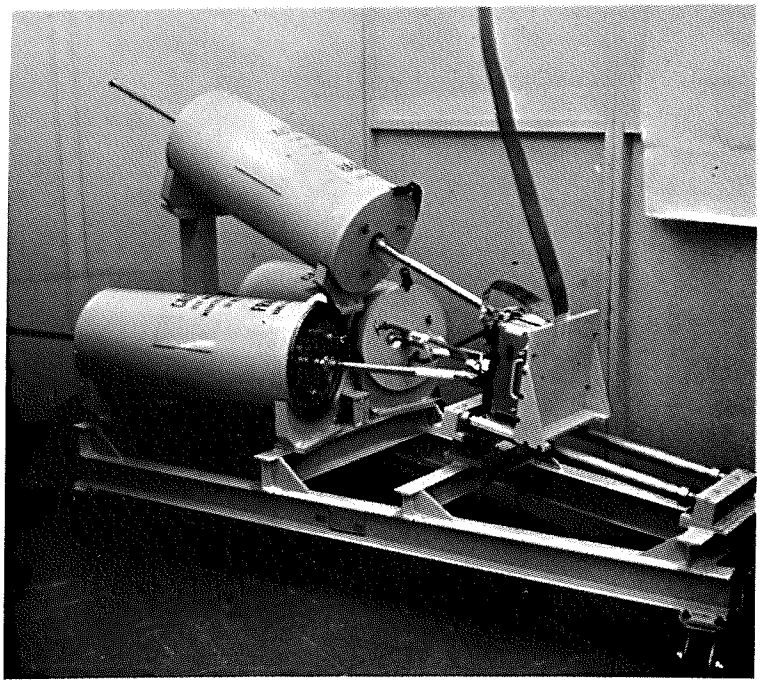
During this test the flip/cal rasters were recorded. (figure 7 and 8) The raster amplitude variations, as shown, were attributed to malfunctioning in sensor electronics.

SUMMARY

The pre-integration tests verified the functional limitation as noted by Ames, but also clarified other function limitation as noted herein. It was established that the electrical interfaces were per the ICS except for the high power transients and DC level on the data line. Functional operation of Engineering Model was limited to command responses, flip/cal in the X axis and the scientific mode, but with improper nulling on the sensors. Although this operation would impose limitations on the system testing, the data obtained during these modes was constant and therefore, useful. The LSM Engineering Model was therefore, submitted for system testing on 14-Feb-67.

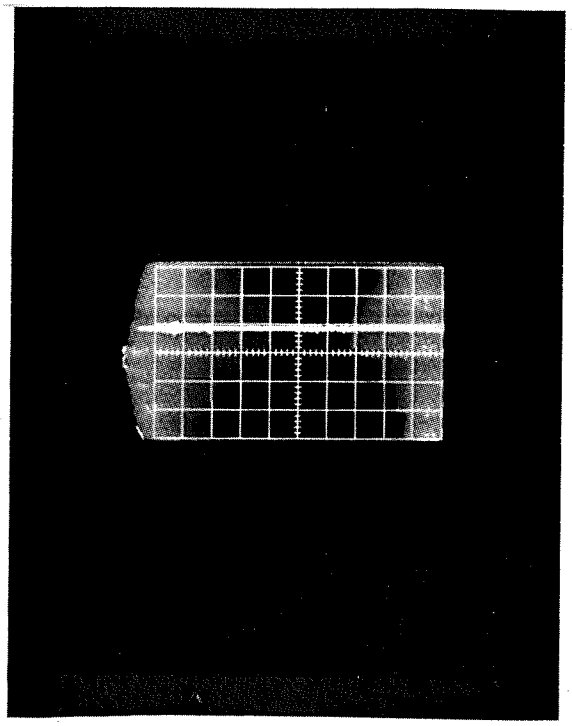


LSM Engineering Model Deployed



LSM Engineering Model in Flux Tanks

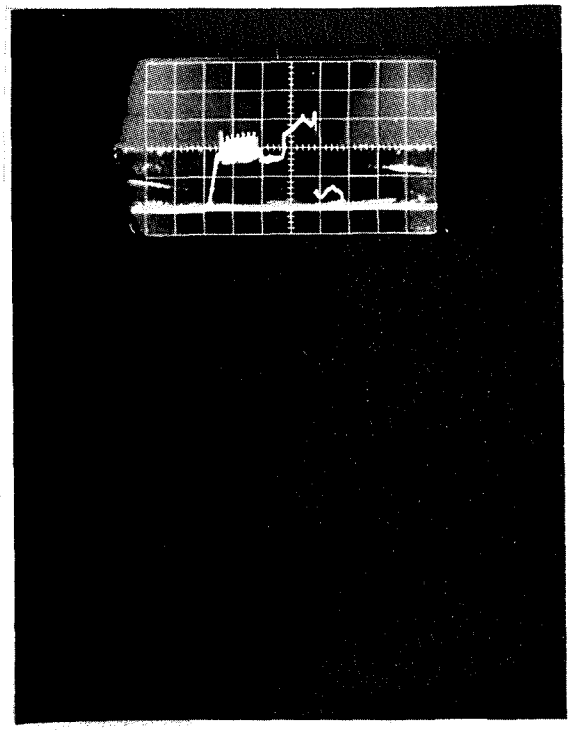
FIGURE I



← Time

Vertical 50mv/cm
Sweep 2 microseconds/cm

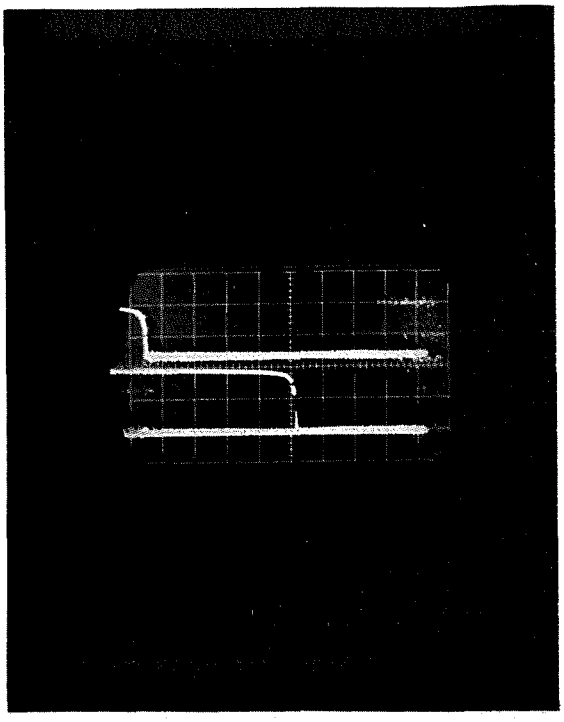
FIGURE 2 LSM High Frequency Noise on Power Line



← Time

Vertical .2 volts/cm

FIGURE 3 LSM Turn-Off and Turn-On Transients



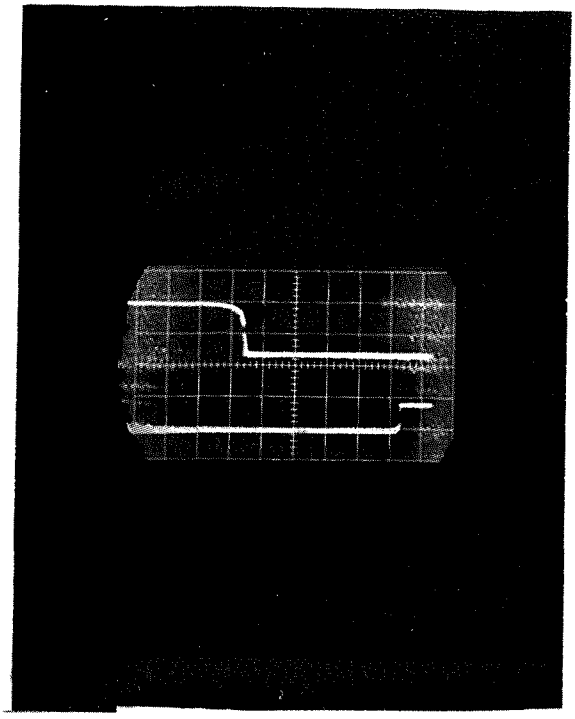
Shift Pulse

Data Pulse

← Time

Vertical 2 volts/cm
Sweep 50 micro-sec/cm

FIGURE 4 Shift and Data Pulse Phasing



Shift Pulse

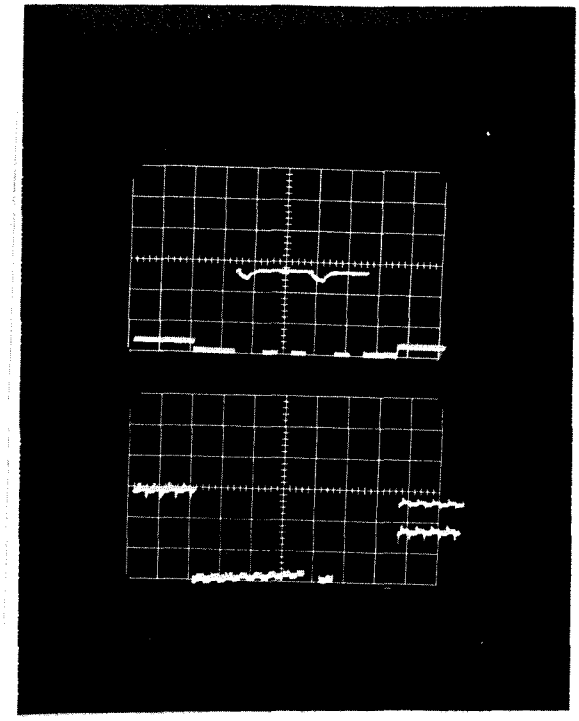
Data Line

Time ←

Vertical 2 volts/cm

Sweep 50 micro-sec/cm

FIGURE 5 D-C Level on Data Line



Data Pulse
Vertical 1.0 volts/cm

Data Pulse
0.1 volts/cm

← Time

FIGURE 6 Suppression of DC Level on Data Line

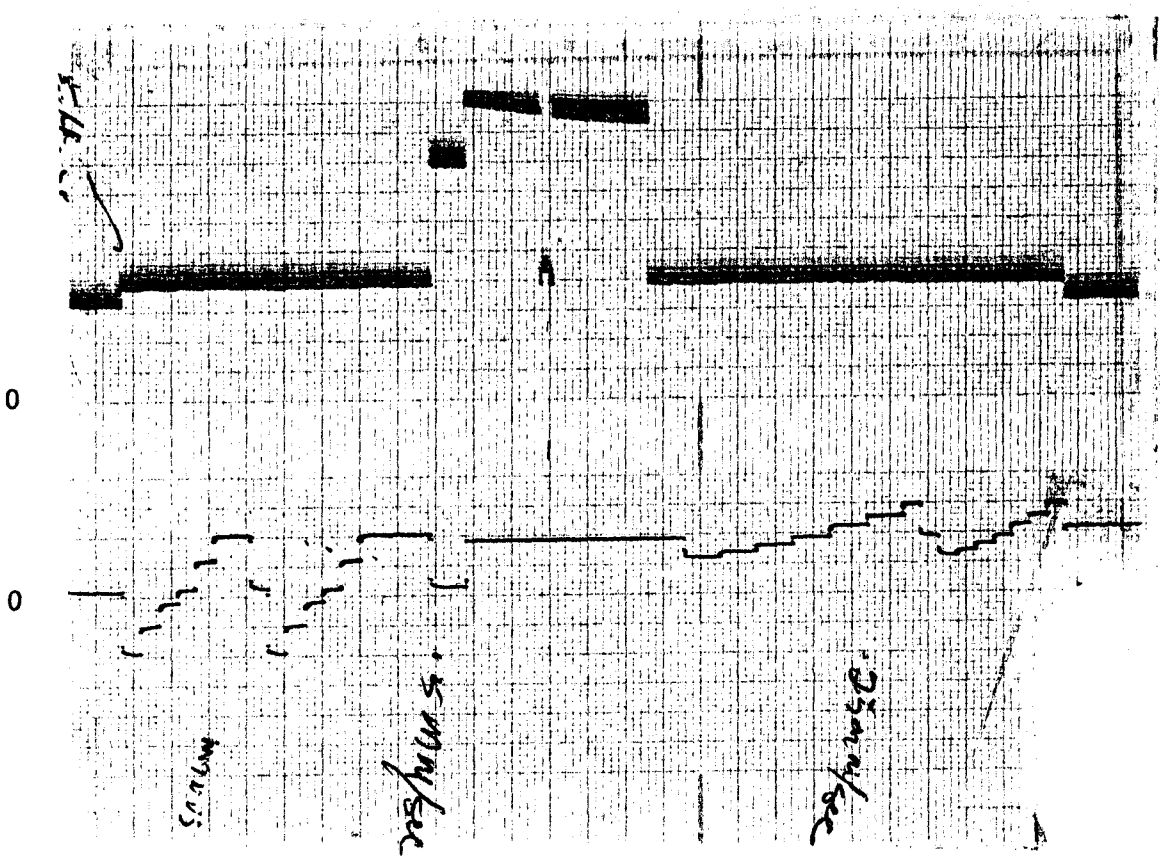


FIGURE 7 Flip/Cal Cycle
Filter-In

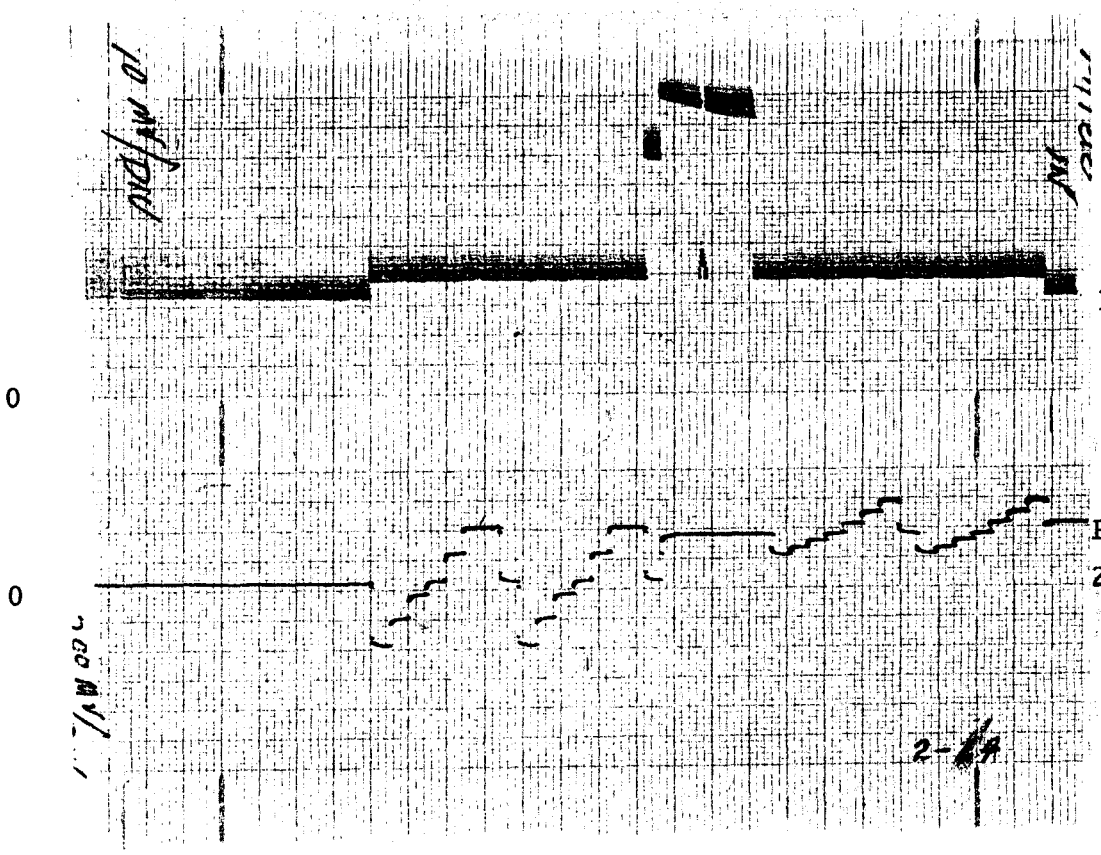


FIGURE 8 Flip/Cal Cycle
Filter-Out

Table 1-1

liminary Procedures

ı	Para. Ref.	Test	Requirement
	5.3.2	CMC ATP	Sat/Unsat
	5.3.2	GCC ATP	Sat/Unsat
	5.3.2	Test Equipment Calibration	Sat/Unsat
	5.3.2	AC Power Elapsed Time - CMC	205.5 hours
	5.3.2	AC Power Elapsed Time - GCC	46.2 hours
	5.3.2	LSM Power Elapsed Time	200.1 hours
	5.3.2	LSM Temperature (room ambient)	25°C

ineering Sensor Readout

ı	Parameter	Sub-Frame Channel	Sensor Data BCD	Engr.	Tolerance	Printer Data
	Para. Reference		b	c	d	e
	Temperature #1 X Sensor	1 and 9	127	+150°C	*	127
	Temperature #2 Y Sensor	2 and 10	002	-50°C	*	002
	Temperature #3 Z Sensor	3 and 11	67	+27°C	*	067
	Temperature #4 GFU Sensor	4 and 12	127	+150°C	*	127
	Temp. #5 Electronics Sensor	5 and 13	002	-50°C	*	002
	Level #1	6 and 14	043	-5°C	± 4 deg.	043
	Level #2	7 and 15	043	-5°C	*	043
	Voltage #1 Reference Supply	8 and 16	106	5.25V	5 + 0.04V	106

* ± 5°C of room ambient temperature

3-391.4
2-217.9
1 391.4

0604311

-18094

3-391.4
2-217.9
1 391.4

-17974
-17994

3-391.4
2-217.9
1 391.4

0500211

3-391.4
2-217.9
1 391.4

-17834
-17924

3-391.4
2-217.9
1 391.4

0412701

-17714

3-391.4
2-217.9
1 391.4

-17904

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1 391.4

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-18094

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2-217.9
1 391.4

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1 391.4

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1 391.4

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0704311

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1 391.4

GSE OK 2-9-67

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1 391.4

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-17724

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2-217.9
1 391.4

-17924

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2-217.9
1 391.4

1212701

-18114

Table 1-1 (A)

```
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-18454
        0704311
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        0604311
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-18444
        0500211
-18214
-18464
        0412701
-18624
-18464
-18504
        0306700
-18344
-18444
        0200200
-18214
-18484
        0112711
```

TABLE 1-2 STATIC INITIAL CONDITIONS 2-9-67

```
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-18464
        1610600
-18634
-18584
-18494
        1504300
-18334
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        1404300
-18234
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        1300211
-18644
-18484
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-18354
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-18234
-18454
        1000210
-18644
-18484
-18504
        0912701
```

```
3-399.2
2 216.4
1-391.4
3-399.2
2 216.4
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3-399.2
2 216.4
1-391.4
3-399.2
2 216.4
1-391.4
3-399.2
2 216.4
1-391.4
```

SAMPLE OF TABLE DATA

Table 1-2 (A)

ENGINEERING STATUS

ITEM	FUNCTION		REQUIRED INITIAL STATUS	ACTUAL INITIAL STATUS	PRINTER DATA
	Paragraph Reference				
a	Mode		Scientific	Scientific	Scientific
b	Range		400 gamma	400	400
c	Filter		In	in	In
d	Flip Position	X	0 degrees	*180°	*180°
		Y	0 degrees	F	F
		Z	0 degrees	F	F
e	Gimbal Position	X	0 degrees (Pre)	90°	90°
		Y	0 degrees (Pre)	0	0
		Z	0 degrees (pre)	0	0
f	Field Offset	X	0 Percent	0%	0%
		Y	0 Percent	0%	0%
		Z	0 Percent	0%	0%
g	Offset Hold		Neutral (not at x, y, or z)	Neutral	Neutral
h	Flip/Cal Inhibit		Inhibited	Not Inhibited	Not Inhibited
i	Temperature Control		X axis	X	X

* X Sensor was in 180° position

SCIENTIFIC DATA*

ITEM	Para. Ref.	Readout	X axis	Y axis	Z axis	A	R
j	5.3.3.2.a	Data Display	-391.4	+211.7	-391.4		
k	5.3.3.2.b	Printer	391.4	+211.7	-391.4		

* Requirements: Saturated Data, + or - 399.2 gamma

Table 1-2

TEST DATA
TABLE 1-3

RESETABILITY

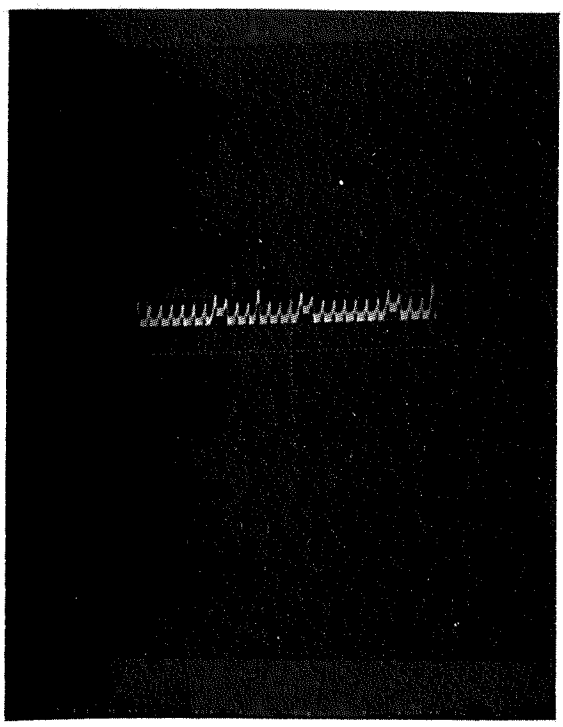
ITEM	FUNCTION	COMMAND EXECUTED STATUS		RESET STATUS	
		Condition	Status Verification	Initial Conditions	Status Verification
	Paragraph Reference	5.3 4.a	5.3.4.b	5.3 4.c	5.3 4.c
a	Mode	Scientific	Scientific	Scientific	Scientific
b	Range	200 gamma	100	400 gamma	400
c	Filter	out	out	in	in
d	X axis Field Offset	+75%	+75%	0%	0%
e	Y axis Field Offset	+50%	+50%	0%	0%
f	Z axis Field Offset	+25%	-75%	0%	0%
g	Offset Hold	Z axis	Z	Neutral	Neutral
h	F/C Inhibit	Not inhibited	Inhibited	Inhibited	Not Inhibited
i	Temperature Control	Y axis	Y axis	X axis	X
	Paragraph Reference	5.3 4.c	5.3 4.f	5.3 4.h	5.3 4.h
j	Mode	Cal	Scientific	Scientific	Scientific
	Paragraph Reference	5.3 4.i	5.3 4.j	5.3 4.1	5.3 4.1
k	Mode	Site Survey (Cal Status)	No Response	Scientific	

Item	Function	Command Executed Status: Condition	Command Executed Status: Status Verification	Reset Status: Initial Conditions	Reset Status: Status Verification
	Para. Ref.	5.3.5.1.1.f	5.3.5.1.1.f	5.3.5.1.2.B	5.3.5.1.2.B
a	Mode:	Scientific	Sci.	Sci.	Sci.
b	Range	200 gamma	200	400 gamma	400
c	Filter	out	out	in	in
d	X Axis Field Offset	+75%	+75	0%	0%
e	Y Axis Field Offset	+50%	+50	0%	0%
f	Z Axis Field Offset	+25%	-25	0%	0%
g	Offset Ratchet	Z Axis	Z	Neutral	Neutral
h	F/C Inhibit	Not Inhibited	Not. Inhibited	Inhibited	Not Inhibited
i	Temp. Control	Y Axis	Y	X Axis	X

Input Power * 150 ma p-p at freq. < 250 hz
75 ma p-p at freq. > 250 hz

Test		Turn-On Transient: Peak Current	Turn-On Transient: Peak Power	Peak Current	Average Voltage	Average Current	Peak Power	Average Power	$\frac{di}{dt}$	Peak-Peak Current Ripple: Ampl	Peak-Peak Current Ripple: Freq.	Turn-off Voltage Transient: +	Turn-off Voltage Transient: -
Par	5.3.5.1.1			g	h	i	J(gxh)	k(hxi)	l	m	m	p	p
Ref	5.3.5.1.2	c	e	d	d	d	d	d	d	d	d	d	d
Filter Out 5.3.5.1.1				265 ma	26.45	208 ma	7 watts	5.5 w	13A/sec	70ma pp	26 cps		
Filter In		340	8.9	230	26.45	183	6.08	4.8	12	60	26		
Tolerance		Ref.	11 watts max.	Ref.	29.0+0.3V	Ref.	7 watts max.	3.5 wts max	250 amp sec max	*	ref.	100V max	-50V max

Table 1-4

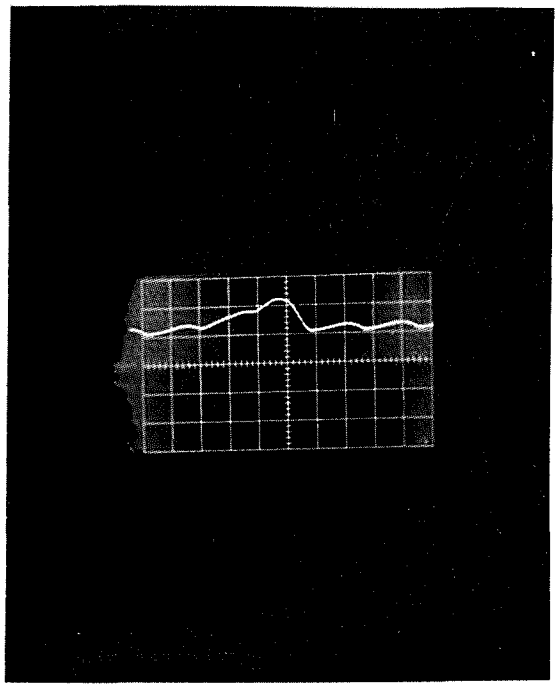


LSM Power Line
Ripple

← Time

Vertical 50 mv/cm
Sweep .1 sec/cm

Table 1-4 A Input Power Filter Out
Frequency Determination

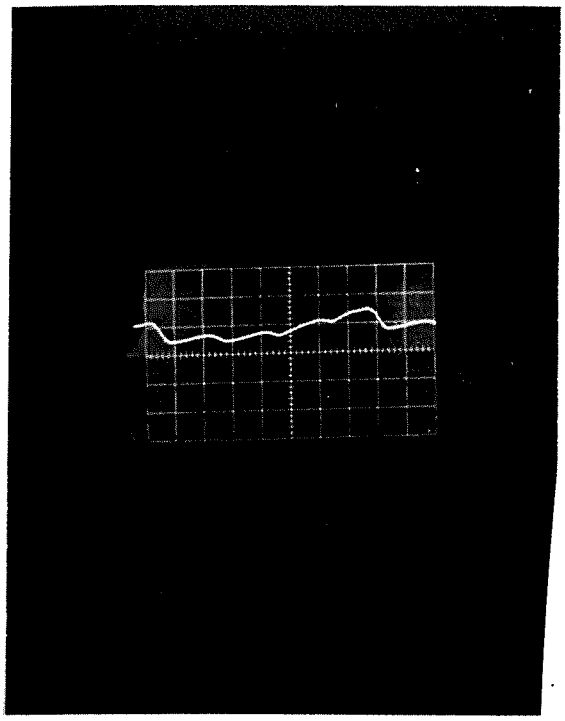


Power Line Ripple

Time ←

Vertical	50mv/cm
Sweep	50milli sec/cm

Table 1-4 B Ripple Filter-Out



LSM Power Line Ripple
with Digital Filter-In

Time ←

Vertical	50 mv/cm
Sweep	5 milli sec/cm

Table 1-4 C Peak Current Filter-In