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SPACE SHUTTLE

ORBITER AVIONICS SOFTWARE

NAS 9-14444

RAMP FUNCTION GENERATOR

I/O JITTER STUDY

FINAL REPORT

IBM FEDERAL SYSTEMS DIVISION
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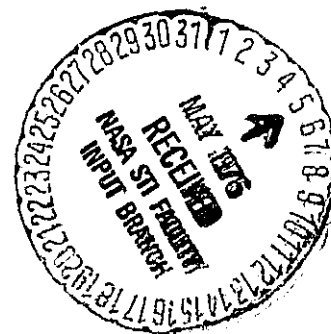## TABLE OF CONTENTS

FIGURES

1.0 MANAGEMENT OVERVIEW

This study determined the TSIP offset and priority for the Ramp Function Generator necessary for the aerosurface stimuli to arrive at the MDM every 40 milliseconds with minimum deviation (jitter).

Analysis of possible TSIP offsets produced the following recommendations:

- Set Ramp Function Generator priority at 239

- Offset Ramp Function Generator iteration point 30 ms. from TSIP.

- Although 'auto-I/O' improves the jitter of Ramp Function Generator I/O, a small jitter can be achieved without implementing it. The cost of implementing auto-I/O should be weighed against the need for improved jitter. See Figure 1 for a comparison of jitter using auto-I/O and no auto-I/O. The major improvement is the repetitiveness of the 40 ms rate, as shown by the range of deviations and the standard deviation.

Comparison of Deviations from 40 ms. for 225 Samples

	Range of deviations in ms.	Average Deviation	Standard Deviation
No 'auto-I/O'	-.65 to +.55	.13	.18
'auto-I/O'	-.26 to +.29	.11	.13

Figure 1

1

2.0 PURPOSE AND SCOPE

The purpose of this study was to evaluate the ability of the Ramp Function Generator to output linear ramp function stimuli to the Space Shuttle aerosurfaces.

3.0 OBJECTIVES

The objective of this study was to determine the best TSIP offset and priority for the Ramp Function Generator in order to:

⊙   minimize the jitter in the Ramp Function Generator output so that it will approach a linear function.

⊙   ensure stimuli data is downlisted on succeeding cycles.

⊙   ensure no contention with HDA.

4.0 METHODS

The UDF model was used to accomplish these objectives with the following environment simulated:

⊙   Single-string computer

⊙   FCOS version 5.A*

⊙   UI version 4.0*

⊙⊙   LDB polling at approximately 25 hz. with no data input or output.

⊙⊙   3 DEU's polled at 5 hz. with no data input.

⊙⊙   Display Update executing at 2 hz.

⊙⊙⊙   3-DPS Configuration Monitor displays updated at 2 hz. and 1 hz.

⊙⊙⊙   No graphic updates.

⊙   Ramp Function Generator process running at 25 hz.

⊙   HDA running at 25 hz.

*See Flight Software Development Plan, Appendix A for FCOS and UI ALT environment parameters.

Priorities used in this study were:

- SSIP — 254
- Ramp Function Generator — 239
- DEU Polling — 230
- HDA — 144
- Display Update — 142
- LDB Polling — 134

5.0 FINDINGS

Using a TSIP offset of 30 ms. and a priority of 239, the Ramp Function Generator (RFG) apparently has no problems performing its work. Figure 2 shows no significant improvement in task elapsed time when using auto-I/O.

Task Elapsed Times

Task	No 'auto-I/O'		With 'auto-I/O'	
	Average in ms.	Range in ms.	Average in ms.	Range in ms.
SSIP	6.67	5-12	6.57	5-12
RFG	5.74	6-7	5.26	4-7
HDA	5.75	4-10	5.74	4-10

Figure 2

The maximum elapsed times for SSIP, HDA and RFG are used to develop the timeline in Figure 3. This timeline clearly shows: (1) no contention between HDA and RFG; (2) stimuli developed by RFG will be downlisted the succeeding cycle.

3

Ramp Function Generator Timeline

| SSIP (Downlist) | | HDA | | RFG | | SSIP |

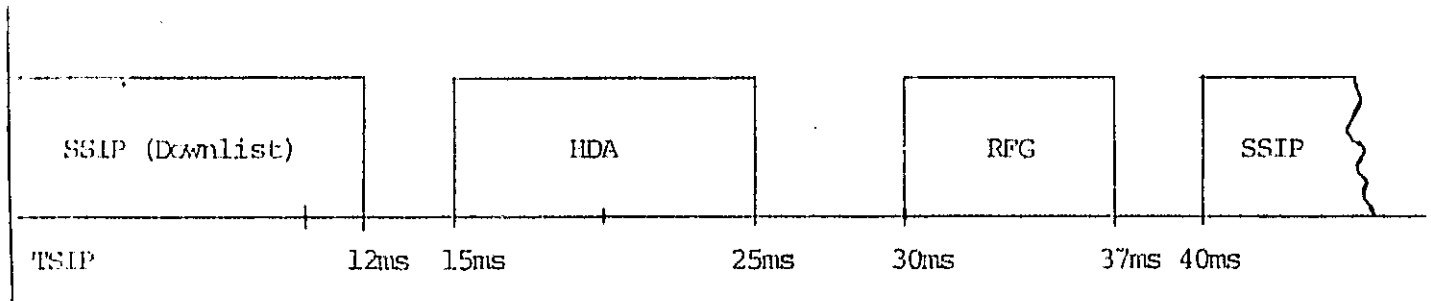TSIP   12ms 15ms   25ms 30ms   37ms 40ms

Figure 3

Auto-I/O does improve jitter on the aerosurface write commands. Figure 1 compares the deviations (jitter) from 40 milliseconds for RFG with 'auto-I/O' and without 'auto-I/O'. Both average about the same jitter; however, using 'auto-I/O' improves the variation in the jitter. This is demonstrated by the range of deviations and the standard deviations.

CPU utilization for cases with and without auto-I/O is shown in Figure 4.

CPU Utilization in %

MCDS Polling	.7
Display Update	3.3
LDB Polling	.1
SSIP	4.5
HDA	.2
RFG	5.0
Application Total	13.8

	No 'auto-I/O'	with 'auto-I/O'
Application Total	13.8	13.8
FCOS	27.9	27.2
Total CPU	41.7	41.0

Figure 4

6.0 RECOMMENDATIONS

* Set Ramp Function Generator priority at 239.

* Offset Ramp Fu.   a Generator iteration point 30 milli-
  seconds from TS.

* Weigh the cost of implementing 'auto-I/O' against the
  need for improved jitter.

7.0 REFERENCES

1. 'Computer Systems Analysis Memo-UDF-3', by R. I. Singhaus,
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2. 'Ramp Function Generator I/O Jitter Study-Initial Report',
   by R. L. Singhaus, 1/9/76.

3. 'FRT Response Study-Final Report', by R. L. Singhaus,
   11/14/75.

4. Flight Software Development Plan.