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MEMO

TO: R. Larson
FROM: W. Bernikowich
DATE: 8 July 1970
SUBJECT: ALTITUDE RATE DATA

Summary:

PART 1. Glitching of the altitude rate is shown to exist only on the first pass of the $\dot{H}$ computation after READACCS and SERVICER when the $\dot{H}$, H reversal exists and COPYCYC2 is executed during the 40 ms delay in SPEEDRUN. (See "Altitude Rate Glitch" memo dated 10 June 1970.)

PART 2. When $\dot{H}$, H execution sequence is nominal, doing the COPYCYC2 during the 40 ms pause apparently has no affect on the altitude rate values pulsed to the meter.

Discussion:

The findings as derived from the basic trace of R10 show that where reversal of $\dot{H}$ and H computations exists and COPYCYC2 is done while R10 is in its 40 ms pause, altitude rate glitching is observed on the first $\dot{H}$ pass after READACCS and SERVICER. The remaining three altitude rate values for that two-seconds cycle appear to be nominal. Where reversal is present but COPYCYC2 is executed at a time other than the 40 ms delay period, no $\dot{H}$ glitches are observed of the magnitude that are seen when both conditions (reversal plus COPYCYC2 at 40 ms) exist.

Conversely, where no $\dot{H}$, H reversal exists (i.e., the execution sequence is nominal: R, S, $\dot{H}$, H, $\dot{H}$, H, . . .), doing the COPYCYC2 during the 40 ms pause has no apparent affect on the altitude rate. This can be readily observed in PART II of this document.

The $\dot{H}$ compensation by DALTRATE (DT) has no bearing of major significance on the altitude rate in nominal descent at low altitudes (20,000 ft. is the estimate, and in P64, P66) because the product DALTRATE (DT) approaches zero as the altitude descreases and the rotation of $\overline{\text{RUNIT}}$ becomes relatively

small. Glitch magnitude of the altitude rate, therefore, decreases with decreasing altitude. Hence glitching of $\dot{H}$ is more likely to be greater in magnitude at the beginning of the descent than in the middle or near the end of the trajectory.

Conclusion:

The new DALTRATE (DT), where DALTRATE is provided by COPYCYC2 during the 40 ms pause in R10, is overcompensating the altitude rate when the $\dot{H}$, H execution sequence is reversed at the beginning of the powered descent.

Altitude rate glitching can be eliminated by restoring nominal $\dot{H}$, H computation sequence or by doing the COPYCYC2 calculations outside of the 40 ms delay period.

PART 1

Contents:

a. The altitude rate equation
b. Summary of altitude rate data over 3 1/2 seconds period
c. Sequence of events time chart
d. Computed DT, $\overline{V_t}$, $\overline{R_u}$, DALTRATE

Digital Simulation Statistics:

a. $\dot{H}$, H execution sequence is reversed
b. Zero per cent TLOSS
c. P63 altitude is 51, 350 ft.
d. Luminary 167

ALTITUDE RATE EQUATION

The equation used to compute the altitude rate is

$$\dot{H} = \dot{H}_t + \text{DALTRATE (DT)}$$

where

$$\dot{H}_t = \overline{V_t} \cdot \overline{R}_{unit}$$

and

$$\overline{V_t} = \overline{V}_{t_n} + \Delta\overline{V} + G\overline{DT}$$

t = Landing Analog Displays time

t_n = PIPTIME, time at which PIPAs are read

$DT = t - t_n$

$DALTRATE = (ABS\ (\overline{UNIT}/R/ \times \overline{V}_{1S}))^2 / ABS\ (\overline{R}_{1S})$

Altitude rate output is expressed in bit units such that 0.5 ft./sec./bit.

ALTITUDE RATE SUMMARY

$\dot{H}_t$ ft/sec.	$\dot{H}_{tbits}$ ft/sec.	DALTRATE(DT) ft/sec.	$\dot{H}$ ft/sec.	Time sec.
-19.22	-19.0	+9.5	-9.5	372831.55
-11.53	-11.5	+12.0	+0.5	32.05
-15.38	-15.0	+4.5	-10.5	32.55
-17.94	-17.5	+7.0	-10.5	33.05
-21.78	-21.5	+9.5	-12.0	33.55
-12.81	-12.5	+12.0	-0.5	34.05
-16.66	-16.5	+4.5	-12.0	34.55
-19.22	-19.0	+7.0	-12.0	35.05

SEQUENCE OF EVENTS

SPEEDRUN T=372831.512

DT = 195 cs.

$\overline{V}_t$ = 03677, 0, 20004 m/cs * 2(-5) (octal)

PAUSE 31.514

CONTINUE 31.551

ARCOMP 31.555

$\overline{R}_u$ = 17423, 0, 01702 (octal)

$\overline{V}_t$ = 03677, 0, 20004 (octal)

* * *

READACCS 31.561

SERVICER 31.576

SPEEDRUN 31.763

DT = 220 cs.

$\overline{V}_t$ = 03674, 0, 20002

PAUSE 31.765

CONTINUE 31.801

DATAOUT (H) 31.801

COPYCYC1 31.908

* * *

SP 32.014

DT = 245 cs.

$\overline{V}_t$ = 03671, 0, 17776

P 32.016

COPYCYC2 32.023

$\overline{R}_u$ = 17427, 0, 74154

DALTRATE = 03200_8

COPYCYCL 32.024

CONT 32.051

AR 32.055

$\overline{R}_u$ = 17427, 0, 74154

$\overline{V}_t$ = 03671, 0, 17776

* * *

SP 32.263

DT = 70 cs.

$\overline{V}_t$ = 03663, 0, 17775

P 32.265

CONT 32.301

DATAOUT (H) 32.306

* * *

SP 32.513

DT = 95 cs.

$\overline{V}_t$ = 03660, 0, 17771

P 32.515

CONT 32.551

AR 32.555

$\overline{R}_u$ = 17427, 0, 74154

$\overline{V}_t$ = 03660, 0, 17771

* * *

SP 32.763

DT = 120 cs.

$\overline{V}_t$ = 03655, 0, 17767

P 32.765

CONT 32.801

DATAOUT (H) 32.806

* * *

SP 33.013

DT = 145 cs.

$\overline{V}_t$ = 03652, 0, 17763

P 33.015

CONT 33.051

AR 33.055

$\overline{R}_u$ = 17427, 0, 74154

$\overline{V}_t$ = 03652, 0, 17763

* * *

SP 33.263

DT = 170 cs.

$\overline{V}_t$ = 03650, 0, 17760

P 33.265

CONT 33.301

DATAOUT (H) 33.305

* * *

SP 33.512

DT = 195 cs.

$\overline{V}_t$ = 03645, 0, 17754

P 33.514

CONT 33.551

AR 33.555

$\overline{R}_u$ = 17427, 0, 74154

$\overline{V}_t$ = 03645, 0, 17754

* * *

READACCS 33.561

SERVICER 33.574

SP 33.763

DT = 220 cs.

$\overline{V}_t$ = 03642, 0, 17752

P 33.765

CONT 33.801

DATAOUT (H) 33.805

COPYCYC1 33.908

* * *

SP 34.013

DT = 245 cs.

$\overline{V}_t$ = 03637, 0, 17746

P 34.015

COPYCYC2 34.023

$\overline{R}_u$ = 17432, 0, 74173

DALTRATE = 03165_8

COPYCYCL 34.024

CONT 34.051

AR 34.055

$\overline{R}_u$ = 17432, 0, 74173

$\overline{V}_t$ = 03637, 0, 17746

* * *

SP 34.263

DT = 70 cs.

$\overline{V}_t$ = 03634, 0, 17745

P 34.265

CONT 34.301

DATAOUT (H) 34.306

* * *

SP 34.513

DT = 95 cs.

$\overline{V}_t$ = 03631, 0, 17741

P 34.515

CONT 34.551

AR 34.555

$\overline{R}_u$ = 17432, 0, 74173

$\overline{V}_t$ = 03631, 0, 17741

* * *

SP 34.763

DT = 120 cs.

$\overline{V}_t$ = 03626, 0, 17736

P 34.765

CONT 34.802

DATAOUT (H) 34.807

* * *

SP 35.013

DT = 145 cs.

$\overline{V}_t$ = 03623, 0, 17733

P 35.015

CONT 35.051

AR 35.055

$\overline{R}_u$ = 17432, 0, 74173

$\overline{V}_t$ = 03623, 0, 17733

* * *

PART 2

Contents:

a. Table of altitude rate data over 5 seconds period
b. Sequence of events time chart
c. Computed DT, $\overline{V}_t$, $\overline{R}_u$, DALTRATE

Digital Simulation Statistics:

a. Nominal $\dot{H}$, H execution sequence
b. 9.5% TLOSS
c. P63 altitude is 16,000 ft.
d. LUMINARY 163

ALTITUDE RATE SUMMARY II

$\dot{H}_t$ ft/sec.	$\dot{H}_{t\ bits}$ ft/sec.	DALTRATE(DT) ft/sec.	$\dot{H}$ ft/sec.	Time sec.
-160.197	-160.0	0	-160.0	373251.83
-158.915	-158.5	0	-158.5	52.33
-160.197	-160.0	0	-160.0	52.83
-160.197	-160.0	0	-160.0	53.33
-161.478	-161.0	0	-161.0	53.83
-161.478	-161.0	0	-161.0	54.33
-161.478	-161.0	0	-161.0	54.83
-162.760	-162.5	0	-162.5	55.33
-162.760	-162.5	0	-162.5	55.83
-162.760	-162.5	0	-162.5	56.33
-164.042	-164.0	0	-164.0	56.83

SEQUENCE OF EVENTS II

READACCS		T=373251.591
SERVICER		51.601
SPEEDRUN		51.794
	DT = 220 cs.	
	$\overline{V}_t$ = 77420, 77776, 02431 m/cs * 2(-5) (octal)	
PAUSE		51.796
CONTINUE		51.831
ARCOMP		51.835
	$\overline{R}_{unit}$ = 17777, 0, 77662 (octal)	
	$\overline{V}_t$ = 77420, 77776, 02431 (octal)	
POSUPDAT		51.990
	* * *	
SPEEDRUN		52.044
	DT = 245 cs.	
	$\overline{V}_t$ = 77417, 77776, 02426	
PAUSE		52.046
CONTINUE		52.081
DATAOUT (H)		52.086
VELUPDAT		52.097
COPYCYC1		52.152
	* * *	
SPEEDRUN		52.294
	DT = 270 cs.	
	$\overline{V}_t$ = 77417, 77776, 02423	
PAUSE		52.296
COPYCYC2		52.308
	$\overline{R}_u$ = 17777, 0, 77664	
	DALTRATE = 00050_8	
COPYCYCL		52.309
CONTINUE		52.332
ARCOMP		52.336
	$\overline{R}_u$ = 17777, 0, 77664	
	$\overline{V}_t$ = 77417, 77776, 02423	
	* * *	

SP 52.544

DT = 95 cs.

$\overline{V}_t$ = 77415, 77776, 02417

P 52.546

CONT 52.581

DATAOUT (H) 52.586

* * *

SP 52.794

DT = 120 cs.

$\overline{V}_t$ = 77415, 77776, 02414

P 52.796

CONT 52.831

AR 52.835

$\overline{R}_u$ = 17777, 0, 77664

$\overline{V}_t$ = 77415, 77776, 02414

* * *

SP 53.044

DT = 145 cs.

$\overline{V}_t$ = 77415, 77776, 02411

P 53.046

THROTTLE 53.051

CONT 53.081

DATAOUT (H) 53.086

FINDCDUW 53.099

* * *

SP 53.294

DT = 170 cs.

$\overline{V}_t$ = 77415, 77776, 02406

P 53.296

CONT 53.331

AR 53.335

$\overline{R}_u$ = 17777, 0, 77664

$\overline{V}_t$ = 77415, 77776, 02406

* * *

SP		53.542
	DT = 195 cs.	
	$\overline{V}_t$ = 77414, 77776, 02403	
P		53.544
CONT		53.581
DATAOUT (H)		53.586
	* * *	
READACCS		53.591
SERVICER		53.609
SPEEDRUN		53.794
PAUSE		53.796
CONT		53.831
AR	$\dot{H}$ = -161.0 ft/sec.	53.836
POSUPDAT		54.007
	* * *	
SP		54.044
P		54.046
CONT		54.081
DATAOUT	(H)	54.086
VELUPDAT		54.106
COPYCYC1		54.197
	* * *	
SP		54.294
P		54.296
COPYCYC2		54.316
	$\overline{R}_u$ = 17777, 0, 77667	
	DALTRATE = 00046_8	
COPYCYCL		54.317
CONT		54.331
AR	$\dot{H}$ = -161.0 ft/sec.	54.337
	* * *	
SP		54.544
P		54.546
CONT		54.581
DATAOUT	(H)	54.586
	* * *	

SP		54.794
P		54.796
CONT		54.831
AR	$\dot{H}$ = -161.0 ft/sec.	54.836
	* * *	
SP		55.044
P		55.046
CONT		55.081
DATAOUT	(H)	55.086
THROTTLE		55.090
FINDCDUW		55.102
	* * *	
SP		55.294
P		55.296
CONT		55.331
AR	$\dot{H}$ = -162.5 ft/sec	55.336
	* * *	
SP		55.542
P		55.544
CONT		55.581
DATAOUT	(H)	55.586
	* * *	
READACCS		55.591
SERVICER		55.608
SPEEDRUN		55.794
PAUSE		55.796
CONT		55.831
AR	$\dot{H}$ = -162.5 ft/sec.	55.836
POSUPDAT		56.005
	* * *	
SP		56.044
P		56.046
CONT		56.081
DATAOUT	(H)	56.086

VELUPDAT		56.106
COPYCYC1		56.192
	* * *	
SP		56.294
P		56.296
COPYCYC2		56.313
	$\bar{R}_u$ = 17777, 0, 77671	
	DALTRATE = 00045_8	
COPYCYCL		56.314
CONT		56.331
AR	$\dot{H}$ = -162.5 ft/sec.	56.336
	* * *	
SP		56.544
P		56.546
CONT		56.582
DATAOUT	(H)	56.588
	* * *	
SP		56.794
P		56.796
CONT		56.831
AR	$\dot{H}$ = -164.0 ft/sec.	56.836

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