LUMINARY Memo #167  Revision 1

To: Distribution
From: B. McCoy, P. Rye
Date: 17 September 1970
Subject: Luminary 1D: Which One, What Kind, How Many?

Luminary 1D will be released for the third time on 19 September 1970; its revision # is 178. The new changes incorporated are PCRs 322, 1056 and 1058. Herewith are the descriptions.

PCR 322: One of the major causes of the predatory "throttle castellations" was the response time of the DPS throttle (THROTLAG). The previous value was 0.2 seconds; the new value is 0.08 seconds.

PCR 1056: The required ullage time for a very light Ascent Stage burn using 2 jets is 14 seconds before ignition. The previous Luminary 1D had assumed 3.5 seconds of ullage before ignition causing 2-3 fps overburn. The Apollo 14 crew will be using 4 jet ullage and this would contribute another 2-3 fps to the overburn. Luminary 178 will turn on ullage at 6 seconds prior to ignition. For 4 jet ullage, the required ullage time is 30 seconds. Since, the LGC turns it on at TIG -6 seconds, the astronaut can release the ACA when V99 appears (at TIG -5 seconds). Specifically, "P42TABLE +6" was changed to 2390 (-29.9 +6 seconds) and S40.13 uses "FRCS4" instead of "FRCS2" to assume 4 jet ullage, and also it uses "6.5 SECS" to assume 6.5 seconds of ullage (ullage is turned off at TIG +0.5 seconds). The value of K1VAL (total APS impulse in one second) was 2800 lbf·sec which is based on a "dry" (not yet fired) APS engine. The TPI impulsive burn and most conceivable burns on the APS (except lunar ascent) will be done on a "wet" engine. The value of 2800 lbf·sec caused an overburn of roughly 2 fps. This value was changed to 3150 lbf·sec (extrapolation of data from LM Data Book).
PCR 1058: When it was found that the Landing Analog Displays Routine (R10) gave results with errors up to 3.5 fps in the cross pointer display, a new R10 was suggested to effectively eliminate these errors. In the process the altitude-rate glitch was eliminated. The word saving was 119 words; the new R10 takes 1% longer. The main cause of the errors was the single precision dot products; these were changed to double precision. Also, some computational simplifications were made to the dot products, knowing that the IMU is aligned to the landing site. A PIPA bias correction term is added to increase accuracy; computation of VBIAS formerly done in P66 is now done in SERVICER. Altitude is based on a simpler extrapolation than before. R10 now computes altitude and Alt-Rate every pass (every 1/4 second) outputting Alt-Rate before a 12 cs pause, Altitude immediately after the pause. Flag bit SWANDISP is now set immediately after SERVICER computes the parameters necessary for R10 so that R10 may start near TIG -30 rather than at ignition. The DIDFLAG definition remains the same; just DID the initialization. IMODES33 bit 7 is no longer used.

ACB L-11 and Anomaly L-1B-04 were not incorporated into the new R10 as originally conceived, but they are in Luminary 178: The forward velocity for NOUN 60 will be computed if the MODE SELECT switch is not in PGNCS (and incidentally accurate to 0.1 fps); R10 will be initialized if the RR CDU ENABLE bit is removed by e.g. moving the RR MODE switch into and out of LGC.

The R10FLAG has been redefined. When it's set by P12, P70, P71, the inertial Y velocity will be displayed on the lateral velocity cross pointer while the forward velocity crosspointer is set to be zero.

Flow Charts for R10 and its interface parameter computation are attached. For more details see Luminary Memo #162 by Don Eyles. This memo superceeds Memo #162 where differences occur.
Changes to other areas due to R10 design:

1. downlist mnemonics changes
   
   LATVEL to LATVMETR
   FORVEL to FORVMETR

2. VBIAS calculation moved from STRTP66A into NORMLZE;

3. For erasable overlay purposes ZAXIS computation moved to Ascent Guidance from P12 initialization.

4. The erasable ACSAVE, used in ascent, was moved to avoid conflict with the new configuration of R10 erasables.

5. New scaling was implemented to accommodate the double precision value used in R1 of Noun 60.
RIO COMPUTATIONS IN SERVICER

COPYCYC1

NORMILAIZE

HCALCLAD = HCALC1
DALTRATE = \left( \frac{UNIT/R/XVIS}{HCALCLAD} \right)^2
HDOTLAD = HDOTDISP

G-VBIAS = GDT12-VBIAS

RUNIX = (UNIT/R/1+1) x 2
RUNIY = (UNIT/R/1+2+3) x 2
RUNIZ = (UNIT/R/1+3+3) x 2
SINGLE PRECISION,
FULL SCALE

RVBOTH

VSURFACE = \frac{\overrightarrow{WM} \times \overrightarrow{RIS}}{1}

Set bit 11
FLAGWD 7

Interface parameters for R10 have been computed
LANADISP

PPIPCTR2 ← PPIPCTR1
TBASE2 ← LTIME1

Bit 11
FLAG 7

CLEAR: SERVICER completed
SET: SERVICER not completed

DISPSET + 1
Page 10

VVECT ← VVSURFACE

DT ← TIME1 - PIPTIME1

VVECT ← VVECT + (PPIP + PIPTMP) × LANAKPIP

VVECT ← VVECT + (G - VBIAS) × DT

ALTSTUFF

continued on next sheet
ALTSTUFF

DALTRATE = RUNIT • VVECT
ALTTRATE = DALTRATE • DT
ALTITUDE = (ALTTRATE+HDOTLAD) • DT + HCALCCLAD

MODE SELECT

AGS, LDR

CLEAR

DDIBIT

SET: initialization already performed

RR CDU CDU ENABLE BIT

CLEAR

SET: Crosshairs Enabled

ALTRROUT

Set bit 2
CHAN 14

Drive Tape Meter

Scale ALTTRATE to 0.5 fps/bit; round to 0.5 fps

Set bit 3
CHAN 14

Signify Altitude Rate
Tape Meter Driven Below

continued on next sheet

PAGE 10
from preceding sheet

PAUSE
12 cs.

ALTROUT

Reset bit 2
CHAN 14

Scale ALTITUDE
to 2.345 ft/bit

Lower limit
+ ZERO

Set bit 3
CHAN 14

CROSCOMP

Page 9

Limit FORVTEMP command to 198 fps. Scale in units of 0.5571 fps and round to nearest 0.5571 fps.

CDUSCMD = FORVTEMP - FORVMETR + (-ZERO)
FORVMETR = FORVMETR + CDUSCMD

continued on next sheet
From proceeding sheet

Limit LATVEL command to 198 fps. Scale in units of 0.5571 fps and round to nearest 0.5571 fps.

\[ \text{CDUTCMD} = \text{LATVEL} - \text{LATUMETR} + (-\text{ZERO}) \]
\[ \text{LATUMETR} = \text{LATUMETR} + \text{CDUTCMD} \]

Set bits 11 and 12 of CHAN 14

Drive Cross Pointers

TASKOVER
CROSComp

R10BIT

SET: Ascend

CLEAR: Descend

VHZ = RUNITZ(VVECT) + RUNITX(VVECTZ, +1)

VHY = VVECTY

FORVTEMP = (VHZ, +1) M32 - (VHY, +1) M22

LATVEL = (VHY, +1) M32 + (VHZ, +1) M22

FORVEL, +1 = FORTEMP, +1

LATVEL = (VVECTY, +1) + VSURFACE + Z, +3

for DSKY

Return to Caller
DISPRSET →
CROSCOMP
page 9

DISPRSET+1

RESET
DIDBIT

Bit 8
IMODES33

CLEAR
SET
Reset bit 2
CHAN 12

Reset bit 8
CHAN 12

Reset bit 8
IMODES33

TASKOVER

DISPINIT →
CROSCOMP
page 9

Set
DIDBIT

Set bit 8
CHAN 12

LATVMETR,
FORVMETR = ZERO

INTLZE
in 1 second
page

TASKOVER

Initialization is done
below

Enable Tape Meter

INTLZE

Set bit 2
CHAN 12

Enable R2
CDU ER. ENTER

Set bit 8
IMODES33

Indicate Tape
Meters Enabled

TASKOVER

Indicate Tape
Meters Disabled

Reset bit 8
IMODES33