X-524-66-149

NASA TM X-55517

A TIMING EXPERIMENT USING THE GEOS SATELLITE OPTICAL BEACON

BY
J. E. MOYE

MARCH 1966

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

A TIMING EXPERIMENT USING THE GEOS SATELLITE OPTICAL BEACON

by

John E. Moye

March 1966

Approved:

Henry H. Plotkin
Head, Optical Systems Branch

Robert J. Coates
Chief, Advanced Development Division

Goddard Space Flight Center

Greenbelt, Md.

A TIMING EXPERIMENT USING THE GEOS SATELLITE OPTICAL BEACON

ABSTRACT

30390

The GEOS I satellite, launched in November 1965, is a gravity stabilized geodetic spacecraft. It is equipped with an optical beacon consisting of four high intensity xenon flash lamps that are programmed to flash at precise times and time intervals.

During the months of February and March 1966, several passes of the GEOS satellite optical beacon flashes were observed photoelectrically at the Goddard Optical Research Facility. A total of 32 flash lamp sequences were observed, recorded and timed relative to the NASA Goddard Cesium Beam Standard. Results of the experiment verified that lamp flashes occur with sufficient accuracy at times programmed into the satellite memory, and indicate that the optical beacon may prove to be useful in checking and possibly synchronizing ground based clocks.

Donald

PURPOSE

The GEOS satellite, launched in November 1965, is a gravity stabilized geodetic spacecraft having its bottom plane surface always pointing toward the center of the earth. Its orbital parameters are

Apogee	2272.3KM
Perigee	1117.1KM
Period	120.3 Minutes
Inclination	59.4^{o}

On the bottom surface of the GEOS satellite is an optical beacon consisting of four high-intensity xenon flash lamps. The operation of these lamps is controlled by the satellite's memory and stable oscillator (clock). The four flash lamps all point in one direction and may be flashed in any combination of one to four lamps. Flash times are programmed into the satellite memory every 24-48 hours by the Applied Physics Laboratory located in Howard County, Maryland. The memory then controls the flash times of the optical beacon over pre-determined areas of the earth up to 24 hours later. A total of 200 flashes may be programmed during a single orbit.

The optical beacon is programmed in sequences of five or seven lamp flashes, the first flash synchronized to begin within $\pm$400 microseconds of the on-board satellite clock minute marker. The time interval spacing between successive flashes in a sequence is on the order of 4 seconds $\pm$40 microseconds. The flash duration is 1.2 milliseconds $\pm$200 microseconds.

A light output versus time waveform plot (as determined by the EG&G Company prior to the satellite launch date) of a GEOS flash lamp is shown in Figure 1. The light output risetime, as determined from Figure 1 is 80 microseconds (10-90% points) while the lamp pulse duration is 1.2 milliseconds measured at its 1/3 power points.

The purpose of the Optical Systems Branch experiment was to determine, based on ground observations and relative to the time standard used by APL and available to all users of GEOS, the following:

a) The start time of each flash lamp sequence
b) The time interval between successive flashes within a sequence
c) The pulse duration of the observed flashes.

EXPERIMENT SYSTEM

Figure 2 is a block diagram of the receiver-recorder system used during the experiment. The receiver telescope, the same as is used during the Goddard laser ranging experiments, has an effective aperture of 16 inches (40.6 cm) and a focal length of 300 inches (762 cm). An aperture stop of 1.5 inches (3.8 cm), located directly in front of the receiver phototube, gives a receiver field of view of 17.2 minutes[1]. During a satellite pass the telescope mount is driven along the computed satellite trajectory through the use of a paper tape mount programmer. Since the

[1] Field of view is determined by the equation $\theta = 2 \tan^{-1}(\frac{D}{2FL})$
where θ = field of view
D = diameter of aperture stop
FL = focal length of telescope.

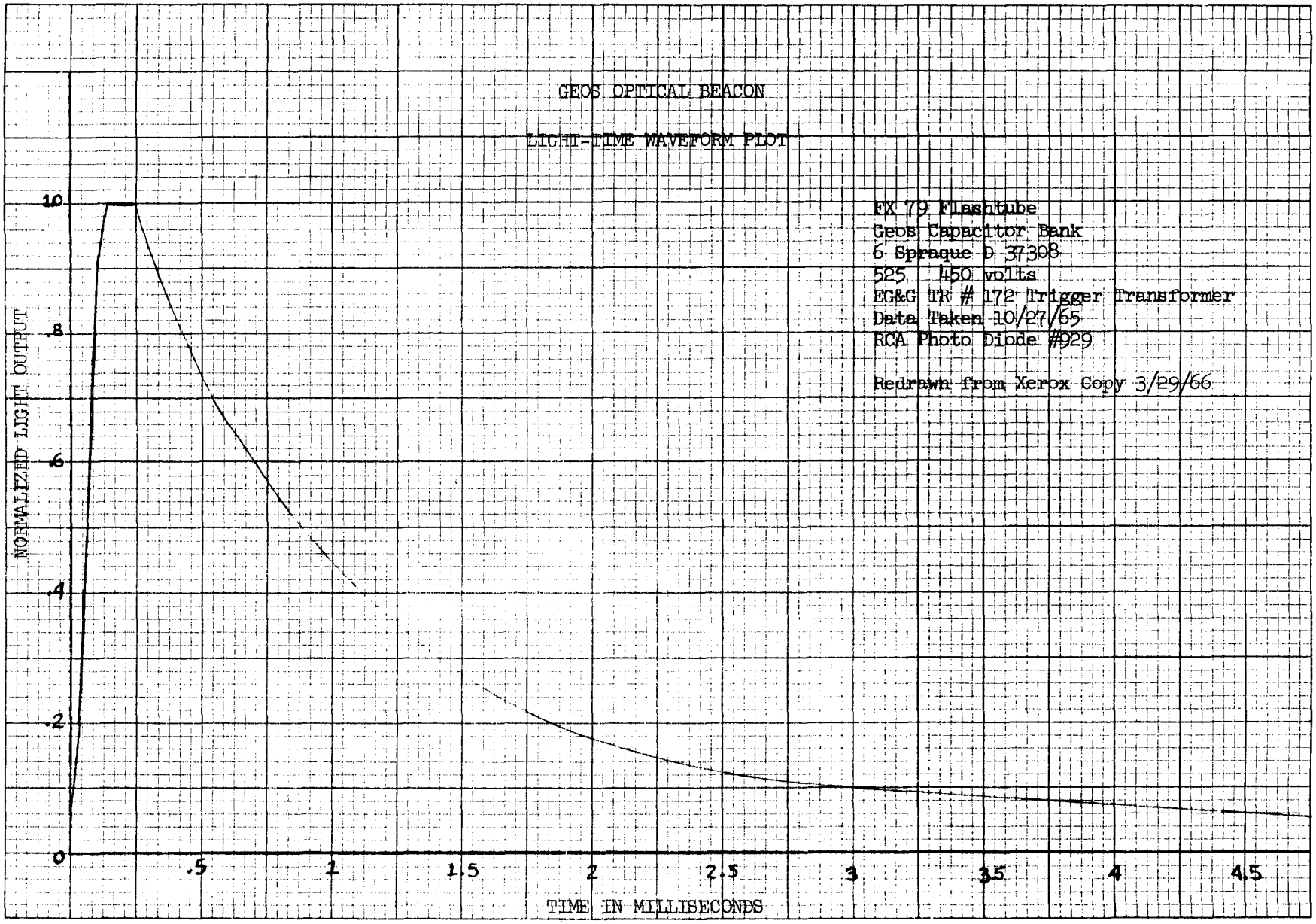

GEOS OPTICAL BEACON
LIGHT-TIME WAVEFORM PLOT
FX 79 Flashtube
Geos Capacitor Bank
6 Sprague D 37398
525 450 volts
EG&G IR # 172 Trigger Transformer
Data Taken 10/27/65
RCA Photo Diode #929
Redrawn from Xerox Copy 3/29/66
NORMALIZED LIGHT OUTPUT
0
.2
.4
.6
.8
10
.5
1
1.5
2
2.5
3
3.5
4
4.5
TIME IN MILLISECONDS

FIGURE 1

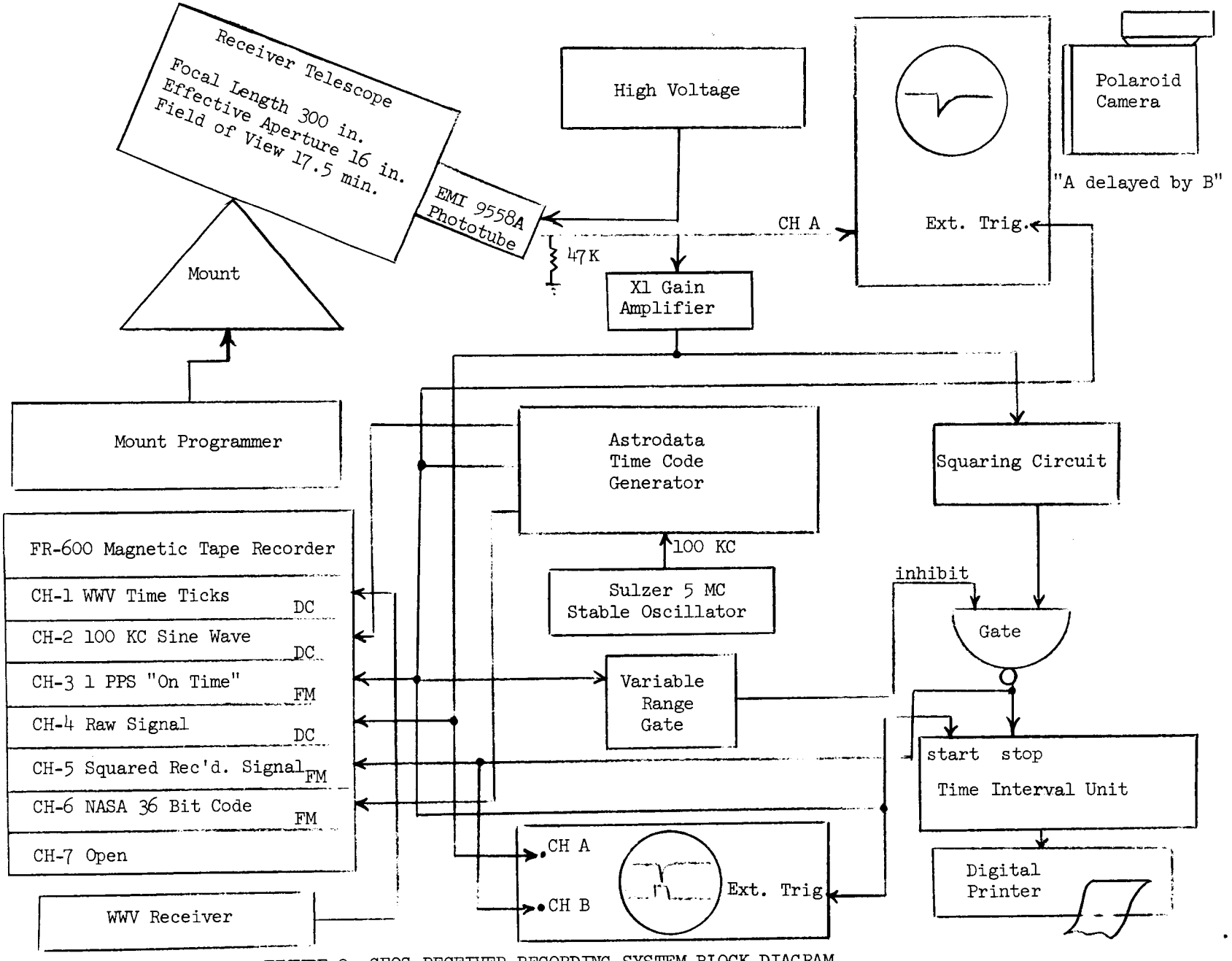
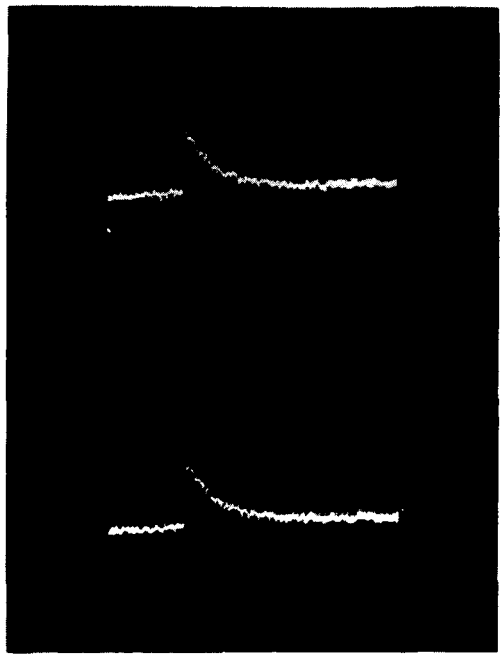


FIGURE 2. GEOS RECEIVER-RECORDING SYSTEM BLOCK DIAGRAM

prediction accuracy and mount movement is sufficient to hold the target within a 10 minute arc circle, it was not normally required to make manual corrections to the programmed drive. When the satellite was in sunlight against a dark sky, it was also possible to view it visually through an auxiliary telescope.

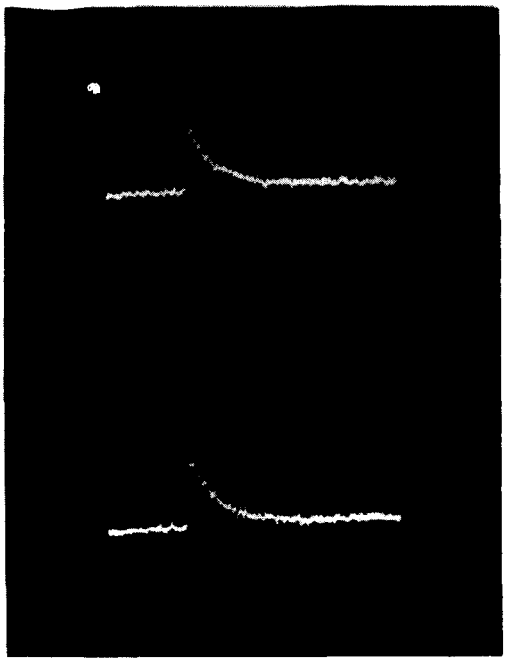
The receiver phototube was an EMI9558A with an S-20 surface. There was no attempt made to filter out a particular line within the xenon output spectrum which approximates daylight; instead the flashes were received unfiltered onto the photocathode surface. The output of the phototube was applied across a 47 kilohm load, and fed to both an oscilloscope and a X1 (unity) gain amplifier, both placed on the platform near the tracking pedestal.

The oscilloscope was located within 15 cable feet of the output of the phototube. Its purpose was to display the undistorted received signal for photographic purposes. The scope trace was initiated by a delayed (5 milliseconds) 1 PPS "on time" pulse generated by our time code generator. The flash lamp signal was thus positioned in the center of the oscilloscope sweep and was photographically recorded through the use of a polaroid camera. Figures 3 through 6 (A&B) show typical flash lamp signals received and recorded directly out of the receiver phototube. The flash lamp signal was simultaneously sent to the unity gain amplifier (cable driver) and recorded on magnetic and paper tape recorders (Figures 7 and 7A).



"A" (4 lamps)

Top - Time $07^h43^m00^s$ (F_1)
Range 7892 microsec.
Bottom - Time $07^h43^m04^s$ (F_2)
Range 7903 microsec.
Sweep 1 ms/cm*
Amplitude 1 v/cm
Measured Flash Duration ≈ 1.2 millisec.
(1/3 power point)
Elevation Angle ≈ 70°

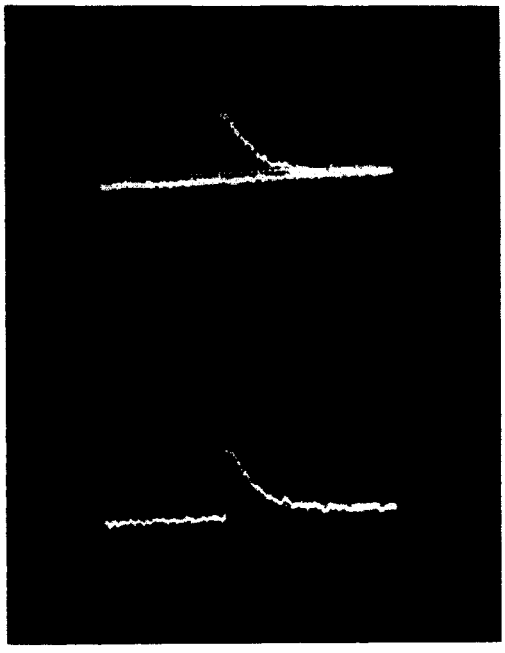


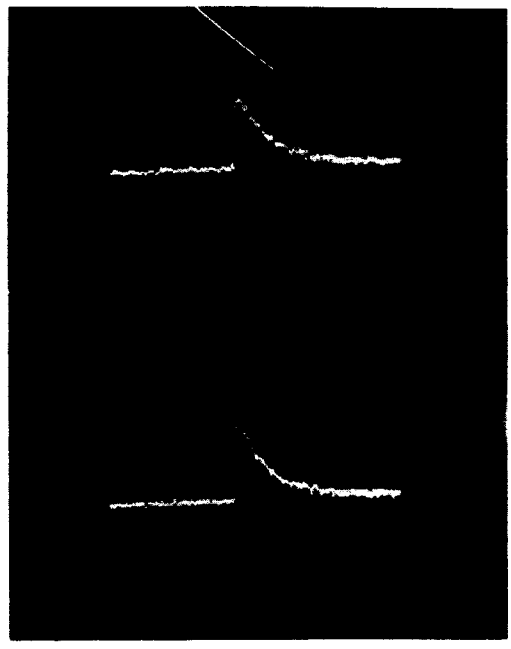
"B" (4 lamps)

Top - Time $07^h43^m20^s$ (F_6)
Range 7955 microsec.
Bottom - Time $07^h43^m16^s$ (F_5)
Range 7938 microsec.
Sweep 1 ms/cm*
Amplitude 1 v/cm
Measured Flash Duration ≈ 1.2 millisec.
(1/3 power point)
Elevation Angle ≈ 70°

*Sweep start delayed 5 milliseconds

FIGURE 3. Typical 4 Lamp GEOS Flash As
Received on March 9, 1966 - Directly Out of Phototube





"A" (4 Lamps)

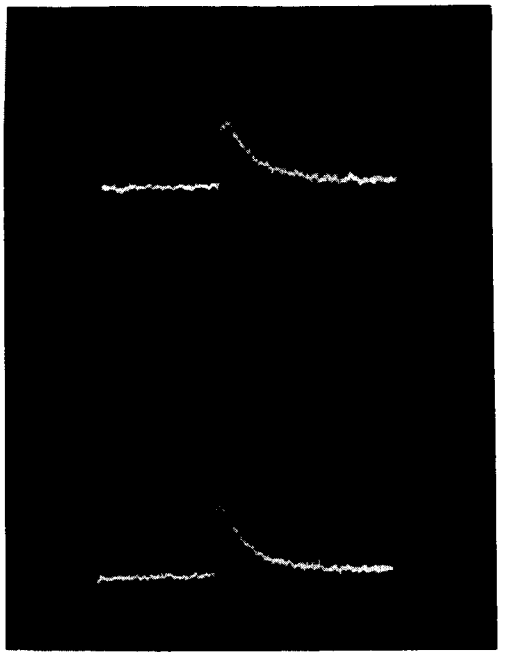
Top - Time $07^h47^m00^s$ (F_1)
Range - 9480 microsec.
Bottom - Time $07^h47^m04^s$ (F_2)
Range 9520 microsec.
Sweep 1 ms/cm*
Amplitude 1 v/cm
Measured Flash Duration $\approx$ 1.2 millisec.
(1/3 power point)
Elevation Angle $\approx 44^o$

"B" (4 Lamps)

Top - Time $07^h47^m16^s$ (F_5)
Range 9642 microsec.
Bottom - Time $07^h47^m20^s$ (F_6)
Range 9683 microsec.
Sweep 1 ms/cm*
Amplitude 1 v/cm
Measured Flash Duration $\approx$ 1.2 millisec.
(1/3 power point)
Elevation Angle $\approx 44^o$

*Sweep start delayed 5 milliseconds

FIGURE 4. Typical 4 Lamp GEOS Flash As
Received on March 9, 1966 - Directly Out of Phototube



"A" (4 lamps)

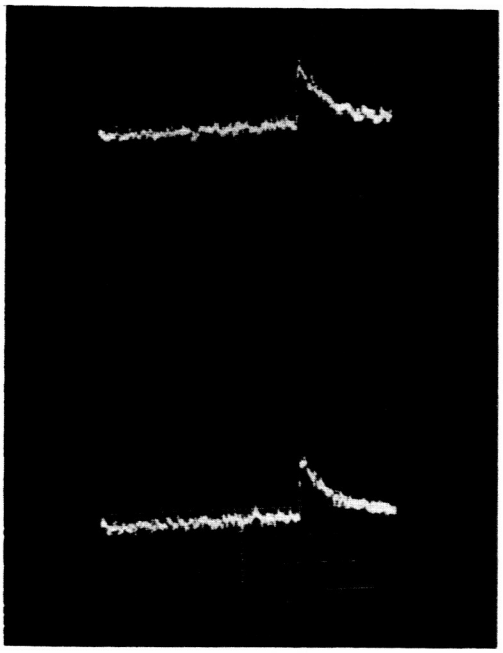
Top - Time $09^h41^m00^s$ (F_1)
Range 12,441 microsec
Bottom - Time $09^h41^m04^s$ (F_2)
Range 12,397 microsec
Sweep 1 ms/cm*
Amplitude 1 v/cm
Pulse Duration $\approx$ 1.2 millisec
Elevation Angle $\simeq$ 25.0 deg.

"B" (4 lamps)

Top - Time $09^h48^m00^s$ (F_1)
Range 9,367 microsec.
Bottom - Time $09^h48^m04^s$ (F_2)
Range 9,358 microsec.
Sweep 1 ms/cm*
Amplitude 1 v/cm
Pulse Duration $\approx$ 1.2 millisec.
Elevation Angle $\simeq$ 47.0 deg.

*Sweep start delayed 5 milliseconds

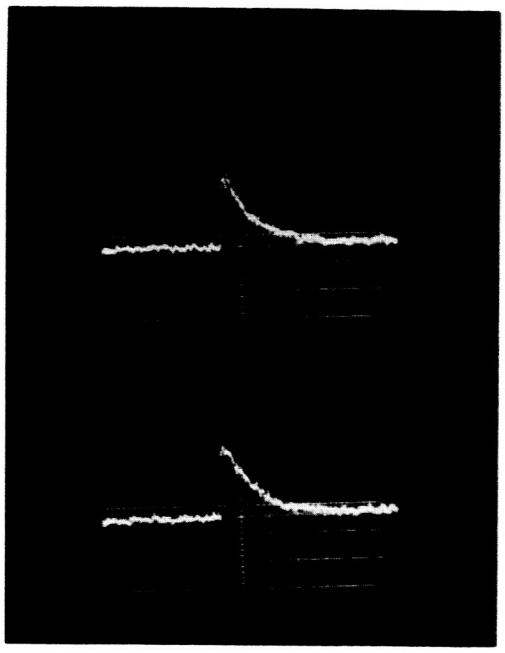
FIGURE 5. Typical 4 Lamp GEOS Flash As
Received on March 9, 1966 - Directly Out of Phototube
(Comparison of Flash Intensity for Like Flashes Within a Sequence)



"A" (4 lamps)

Top - Time $09^h41^m16^s$ (F_5)
Range 12,264 microsec
Bottom - Time $09^h41^m12^s$ (F_4)
Range 12,308 microsec.
Sweep 1 ms/cm*
Amplitude 1 v/cm
Pulse Duration ≈ 1.2 millisec
Elevation Angle ≈ 26 deg.

*Sweep start delayed 5 milliseconds



"B" (4 lamps)

Top - Time $09^h48^m12^s$ (F_4)
Range 9343 microsec.
Bottom - Time $09^h48^m16^s$ (F_5)
Range 9337 microsec
Sweep 1 ms/cm
Amplitude 1 v/cm
Pulse Duration ≈ 1.2 millisec.
Elevation Angle ≈ 46 deg.

FIGURE 6. Typical 4 Lamp GEOS Flash As
Received March 9, 1966 - Directly Out of Phototube
(Comparison of Flash Intensity for Like Flashes Within a Sequence)

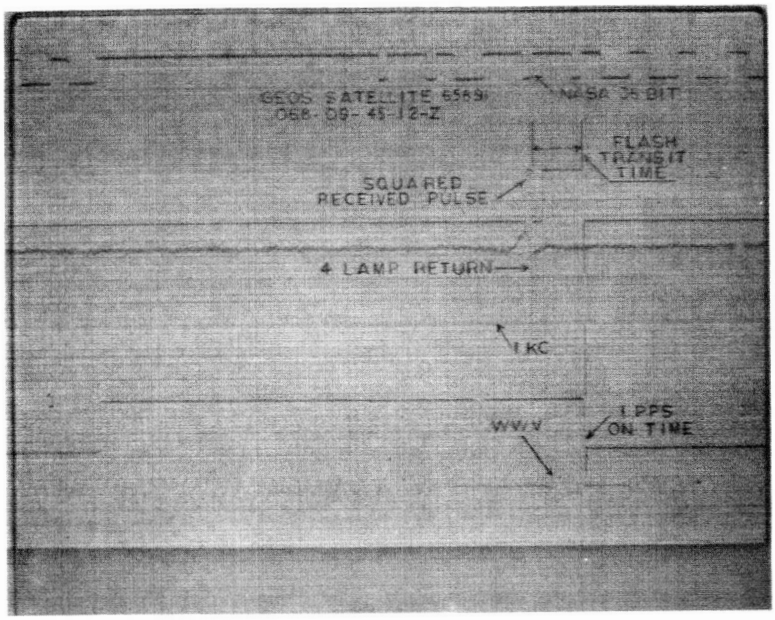


Figure 7. A typical FR600 magnetic tape playback recording onto paper tape of GEOS flash received March 9, 1966 at $09^h45^m12^s$ (Flash #4) Flash transit time - 10,014 microseconds (as measured from leading edge of 1 PPS "on time" pulse to leading edge of squared received signal). Time increases from right to left.

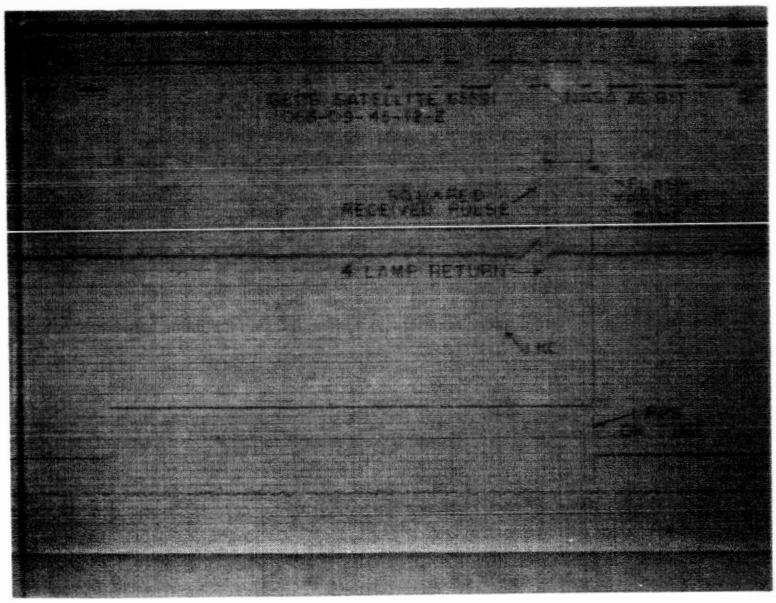


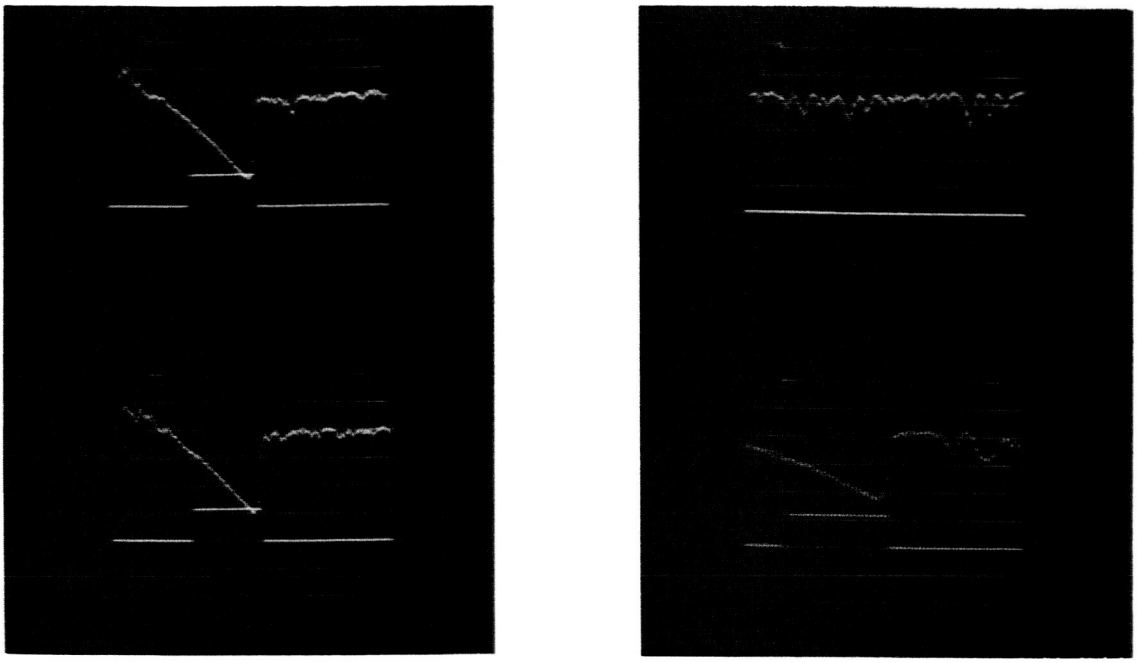
Figure 7A. A typical FR600 magnetic tape playback recording onto paper tape of GEOS flash received March 9, 1966 at $09^h48^m12^s$. Flash transit time - 9,218 microseconds (as measured from leading edge of 1 PPS "on time" pulse to leading edge of squared received signal). Time increases from right to left.

In order to provide a reliable triggering edge for time interval determinations, the flash lamp signal was squared and also recorded. This squared pulse is shown, along with the range gate in Figure 7 and again in Figure 8 A&B. The time interval counter, which had been started by the leading edge of our 1 PPS "on time" marker, was stopped by the squared received signal, thus giving the exact time interval between our reference 1 PPS "on time" marker and the arrival time of the lamp flash signal. The output of the time interval counter was then printed out on paper tape for later re-run comparisons with the data as recorded on the magnetic tape recorder. Data reduction was begun after all flash sequences within a pass were recorded.

DATA REDUCTION

The FR-600 magnetic tape recorder has a frequency response of 300 cps to 250 KC using its DC record/reproduce modules and 0-20 KC response using its FM record/reproduce modules. In order to conserve its pulse shape and characteristics, the received flash lamp signal was recorded on a DC channel* while its squared signal counterpart was recorded on an FM channel. The various other timing signals were then recorded on other channels at a tape speed of 60 ips. At the end of a pass the reference 1 PPS "on time" marker, along with the squared received flash returns, were played back from the magnetic tape recording into the time interval counter (Figure 9). The counter was started by the leading edge of the "on time" marker and stopped by the leading edge of the squared received signal. The

*Later results indicate that a differentiated signal applied to a DC record channel is not faithfully reproduced. However, the reproduction does not affect the risetime but only the decay time of the pulse.



"A"

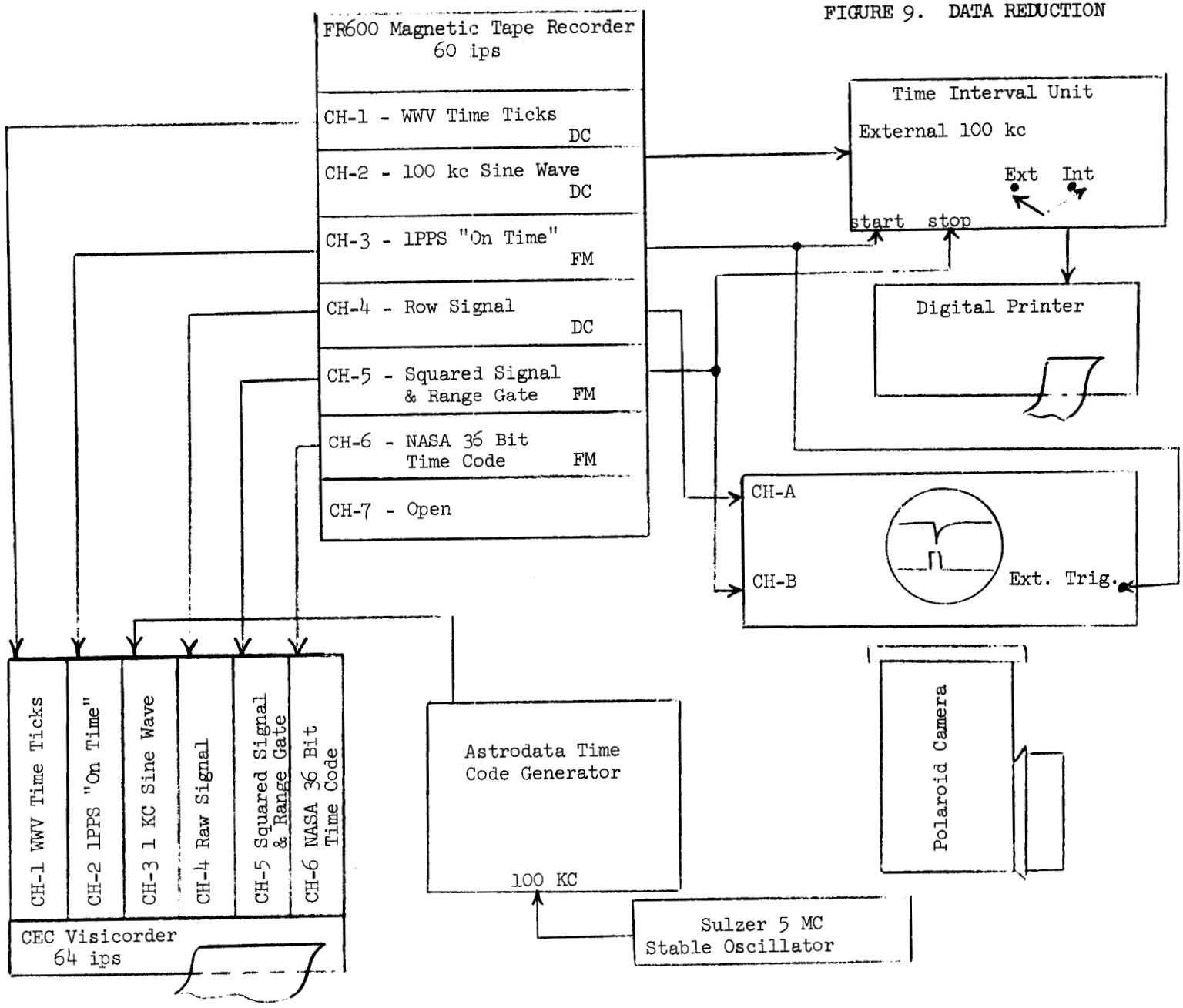
Sweep 500 microseconds/cm

"B"

Sweep 200 microseconds/cm

Figure 8. Typical playback from magnetic tape showing the flash lamp return and its squared signal counterpart. Rise time of flash lamp signal (10-90% points) is approximately 80-100 microseconds. Squared signal risetime is < 5 microseconds. The squared signal is used to stop the time interval counter to obtain accurate range measurements. Time increases from right to left.

FIGURE 9. DATA REDUCTION



time interval thus displayed was printed out on digital paper tape. Each flash sequence was played back a minimum of 12 times: first, six times against the 1 MC internal oscillator of the time interval unit, and then six times against the stable 100KC as recorded on the magnetic tape. The readings thus obtained were then averaged to give a more meaningful time interval measurement.

The satellite range information for each particular minute and second involved was obtained from the printed copy of the programmer drive tape which had been prepared on the basis of previous Minitrack data. The averaged time interval readings, as obtained above, were then compared to these computer-predicted ranges. The time differences obtained, indicated relative to our reference 1 PPS "on time" marker, when each lamp flash of a sequence occurred, or the time interval between lamp flashes. Table 1 is a record of the arrival times of the first flash of each sequence that was received. A minus sign in front of the time differences listed indicates that the lamp flash actually occurred on the satellite prior to our reference 1 PPS "on time" marker. A plus sign indicates that the lamp flash occurred after our 1 PPS "on time" marker. Listed in Column 5 are the times, relative to WWV, that the integer minute marker occurred on-board the satellite. Comparison of Column 4 and 5 indicates that the lamp flashes occur well within the ± 400 microseconds of the satellite integer minute marker.

TABLE 1

TIMING RESULTS OF FLASH #1 OF A GEOS FLASH SEQUENCE

(1) DATE DAYS	HRS.	MIN.	SEC.	(2) $T + \Delta t$ EXPECTED FLASH RECEPTION TIME (μ SEC)	(3) $(T + \Delta t_{1MC})$ ACTUAL FLASH RECEPTION TIME (μ SEC)	(4) TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY REC'D FLASHES (μSEC) $(T + \Delta t) - (T + \Delta t_{1MC})$	(5) SATELLITE INTEGER[1,2] MINUTE MARKER OCCURRENCE (μ SEC)
049	10	27	00	$00^{s}.11233$	$00^{s}.7897$	-3336	-3280
		30	00	$00^{s}.10562$	$00^{s}.7236$	-3326	-3314
		32	00	$00^{s}.10616$	$00^{s}.7292$	-3324	-3297
		33	00	$00^{s}.10797$	$00^{s}.7446$	-3351	-3312
066	07	24	00	$00^{s}.13109$	$00^{s}.13523$	+414	+436
		29	00	$00^{s}.9816$	$00^{s}.10172$	+356	+463
		35	00	$00^{s}.8887$	$00^{s}.9270$	+383	+418
		44	00	$00^{s}.11215$	$00^{s}.11610$	+395	+464
066	09	36	00	$00^{s}.9232$	$00^{s}.9695$	+463	+509
		40	00	$00^{s}.8449$	$00^{s}.8860$	+411	+485
		41	00	$00^{s}.8562$	$00^{s}.8969$	+407	+475
		43	00	$00^{s}.9142$	$00^{s}.9597$	+455	+490
067	07	29	00	$00^{s}.12207$	$00^{s}.11968$	-239	-127
		34	00	$00^{s}.9009$	$00^{s}.8778$	-221	-144
		39	00	$00^{s}.8311$	$00^{s}.8091$	-220	-153
		44	00	$00^{s}.10621$	$00^{s}.10369$	-252	-181
067	09	35	00	$00^{s}.13030$	$00^{s}.12928$	-102	-136
		40	00	$00^{s}.9915$	$00^{s}.9672$	-243	-139
		43	00	$00^{s}.8963$	$00^{s}.8774$	-189	-118
		44	00	$00^{s}.8864$	$00^{s}.8646$	-218	-156
		45	00	$00^{s}.8884$	$00^{s}.8690$	-194	-144
068	07	37	00	$00^{s}.9382$	$00^{s}.9259$	-123	+16
		39	00	$00^{s}.8395$	$00^{s}.8272$	-123	+8
		43	00	$00^{s}.7892$	$00^{s}.7802$	-090	+29
		47	00	$00^{s}.9480$	$00^{s}.9336$	-144	+21
		48	00	$00^{s}.10113$	$00^{s}.9979$	-134	+21
068	09	41	00	$00^{s}.12441$	$00^{s}.12315$	-126	+21
		43	00	$00^{s}.11198$	$00^{s}.11063$	-133	+19
		45	00	$00^{s}.10205$	$00^{s}.10078$	-127	+28
		48	00	$00^{s}.9367$	$00^{s}.9229$	-138	+14
		52	00	$00^{s}.9752$	$00^{s}.9611$	-141	+63

[1] Minus sign indicates flash occurred prior to true "on time".
Plus sign indicates flash occurred after true "on time".
"On time" is that time referenced to cesium beam standard at the Goddard Timing Laboratory - true "on time" (i.e. referred to WWV) would necessitate the subtraction of approximately 30 microseconds from each listed time difference.

[2] Telephone conversation with Mr. Glen San Lwin of APL. Obtained from telemetry received at APL. Reference time used at APL is reference to true WWV on time.

Table 2 is a record of the arrival times and time intervals of a typical 7-flash sequence. As can be seen from this table, the time interval between flashes is 4 seconds ±40 microseconds. Comparison of the data obtained from all pass sequences observed (see Appendix) indicates that this time interval between successive flashes does hold.

TIMING

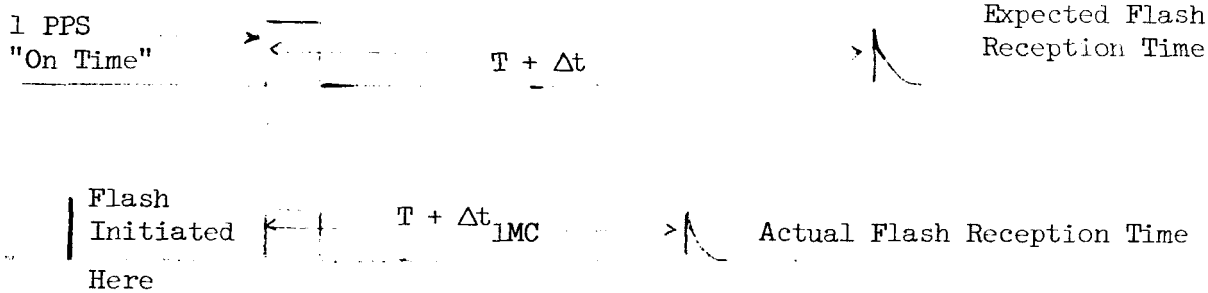
Figure 10 is a comparison of the WWV time ticks as received and the Goddard cesium beam time standard system. This time difference indicates that the WWV time ticks appears to be a poor choice as reference for this experiment. The "true WWV on time" occurs 30 microseconds ±1 microsecond ahead of the cesium beam standard 1 PPS. This delay, inherent in the WWV transmission circuitry has been verified both by NBS - Boulder personnel and members of the Goddard Timing Systems Section[2] in December 1965. The variations and drift shown in Figure 10 are in addition to and independent of this constant offset.

The purpose of the experiment was to accurately determine, relative to WWV, the start of a flash lamp sequence. It was therefore imperative that our reference 1 PPS "on time" marker be accurately set and checked constantly for drift. In addition since WWV varied so from day to day and second to second, it was thought that it would be more meaningful to reference a stable time base - the Goddard cesium standard. "On time" determination was established through the use of a highly stable secondary

[2]Private conversation with Mr. S. Wardrip of the Goddard Timing Systems Section on March 28, 1966.

TABLE 2

DAY	HOUR	MIN	SEC	FLASH NO.	TIME DIFFERENCE BETWEEN EXPECTED & ACTUALLY RECD. FLASHES μ/SEC.	TIME DIFFERENCE BETWEEN SUCCESSIVE FLASHES (SEC)	TIME DIFFERENCE BETWEEN SUCCESSIVE FLASHES (μ SEC)
068	09	48	00	1	-138	-	-
		48	04	2	-144	4.000006	+6
		48	08	3	-143	3.999999	-1
		48	12	4	-125	3.999982	-18
		48	16	5	-121	3.999996	-4
		48	20	6	-119	3.999998	-2
		28	24	7	-108	3.999989	-11



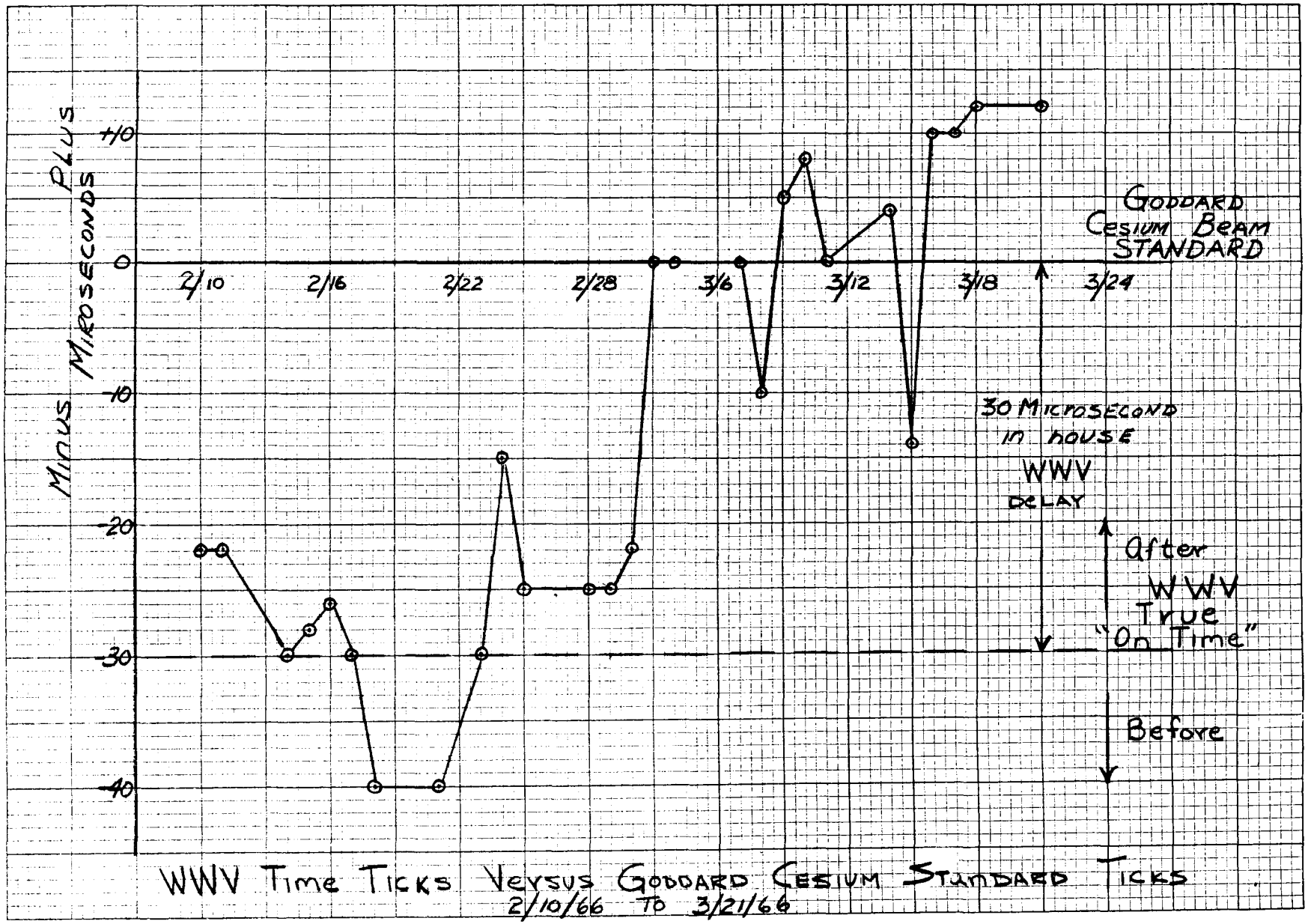

PLUS
MINUS MICROSECONDS
+10
0
-10
-20
-30
-40
2/10
2/16
2/22
2/28
3/6
3/12
3/18
3/24
GODDARD
CESIUM BEAM
STANDARD
30 MICROSECOND
IN HOUSE
WWV
DELAY
After
WWV
True
"On Time"
Before
WWV Time Ticks Versus Goddard Cesium Standard Ticks
2/10/66 To 3/21/66

FIGURE 10

quartz frequency standard and a portable clock borrowed from the Goddard Timing Laboratory.

The portable clock was first set to within 1 microsecond of the 1 PPS output of the Goddard cesium beam standard. The portable clock was then transported to the Goddard Optical Research Facility and used to set our 1 PPS "on time" marker to within one microsecond of the portable standard. In all, our time code generator 1 PPS "on time" marker was then within 2 microseconds of the Goddard cesium beam time standard and within 32 microseconds of true time referenced to WWV. At the end of a satellite pass (usually 6-8 hours later) our 1 PPS "on time" marker was again compared against the portable clock. The difference thus obtained, on the order of minus 10 microseconds, was recorded. The portable clock was again compared to the cesium standard at Goddard. Corrections for both differences then established the drift of our 1 PPS "on time" standard from either the cesium standard or true "on time" of WWV. At the end of a pass, our 1 PPS "on time" marker occurred after (late) true WWV "on time" by 34-38 microseconds. If we correct for this estimated offset, then our time is good to ± 2 microseconds relative to "true WWV on time." It should be noted that Table 1 was not corrected for these offsets.

RESULTS

Table 1 gives the time differences recorded for the first lamp flash of a sequence. The time recorded is an average of 6 readings of the flash time arrival, referenced to our 1 PPS "on time" marker and corrected for

the time of flight from the predicted satellite range at that time. Since the Goddard cesium standard is ahead of "true WWV on time" by 30 microseconds, our time difference is in error by that amount plus the drift error of our time code generator. Results of the experiment indicate the following:

1. The flash lamp sequence, except for the pass data obtained on March 7, 1966, begins prior to the ground based integer U.T. minute marker "true WWV on time".
2. The flashes begin within ±400 microseconds of the integer minute occurrence on board the satellite.
3. The time interval between flashes within a sequence is 4 seconds ±40 microseconds.
4. The pulse duration (1/3 power points) of the observed flashes is 1.2 milliseconds ±200 microseconds (Figures 3 through 6).
5. The lamp output risetime is on the order of 80-100 microseconds (Figures 8A&B).
6. Flash #2 of a sequence normally has the longest time interval, i.e. flash #2 occurs 4 seconds or more after the first flash of a sequence.
7. All other flash time intervals are normally less than 4 seconds.

The Appendix lists the times of arrival of all GEOS flashes photoelectrically recorded.

REFERENCES

1. Johns Hopkins University, Applied Physics Laboratory, "Technical Plan for a National Geodetic Satellite Program" March 1965, pp. 13-35; 60-81.

2. Systems Sciences Corporation, Technical Report #4007-2 "Plan for The Johns Hopkins University Applied Physics Laboratory Operations to Support GEOS A" October 4, 1965, Prepared under NASA Contract NASw1238, pp 4-18-4-32, 4-38 to 4-48.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of Messrs. Edwin Reid, Harold Walker, and James MacFarlane during the setting up, running and data reduction portions of this experiment. In addition, the assistance of Dr. Henry H. Plotkin and Mr. Louis O. Caudill in the preparation of this paper is greatly appreciated.

APPENDIX

GEOS FLASH DETECTION

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 1									
049	10	27	00	1	$00^{s}.11233$	$00^{s}.7900$	$00^{s}.7897$	-3336	-3280
			04	2	$04^{s}.11209$	$04^{s}.7870$	$04^{s}.7868$	-3341	
			08	3	$08^{s}.11185$	$08^{s}.7850$	$08^{s}.7852$	-3333	
			12	4	$12^{s}.11162$	$12^{s}.7850$	$12^{s}.7851$	-3311	
			16	5	$16^{s}.11139$	$16^{s}.7830$	$16^{s}.7831$	-3309	
			20	6	$20^{s}.11116$	$20^{s}.7410$*	$20^{s}.7411$	Error	
			24	7	$24^{s}.11094$	$24^{s}.7810$	$24^{s}.7812$	-3282	
SEQUENCE No. 2									
049	10	30	00	1	$00^{s}.10562$	$00^{s}.7240$	$00^{s}.7236$	-3326	-3314
			04	2	$04^{s}.10556$	$04^{s}.7210$	$04^{s}.7215$	-3341	
			08	3	$08^{s}.10552$	$08^{s}.7210$	$08^{s}.7206$	-3346	
			12	4	$12^{s}.10548$	$12^{s}.7230$	$12^{s}.7228$	-3320	
			16	5	$16^{s}.10544$	$16^{s}.7230$	$16^{s}.7228$	-3316	
			20	6	$20^{s}.10541$	$20^{s}.7240$	$20^{s}.7238$	-3303	
			24	7	$24^{s}.10538$	$24^{s}.7240$	$24^{s}.7239$	-3299	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 3									
049	10	32	00	1	$00^s.10616$	$00^s.7290$	$00^s.7292$	-3324	-3297
			04	2	$04^s.10625$	$04^s.7290$	$04^s.7285$	-3340	
			08	3	$08^s.10634$	$08^s.7290$	$08^s.7287$	-3347	
			12	4	$12^s.10644$	$12^s.7320$	$12^s.7319$	-3325	
			16	5	$16^s.10655$	$16^s.7320$	$16^s.7325$	-3330	
			20	6	$20^s.10665$	$20^s.7360$	$20^s.7357$	-3308	
049	10	32	24	7	$24^s.10676$	$24^s.7380$	$24^s.7382$	-3294	
SEQUENCE No. 4									
049	10	33	00	1	$00^s.10797$	$00^s.7450$	$00^s.7446$	-3351	-3312
			04	2	$04^s.10812$	$04^s.7470$	$04^s.7468$	-3344	
			08	3	$08^s.10828$	$08^s.7480$	$08^s.7476$	-3352	
			12	4	$12^s.10845$	$12^s.7520$	$12^s.7519$	-3326	
			16	5	$16^s.10862$	$16^s.7530$	$16^s.7526$	-3336	
			20	6	$20^s.10879$	$20^s.7550$	$20^s.7549$	-3330	
049	10	33	24	7	$24^s.10897$	$24^s.7590$	$24^s.7584$	-3313	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 1									
066	09	36	00	1	$00^{s}.9232$	$00^{s}.9700$	$00^{s}.9695$	+463	+509
			04	2	$04^{s}.9204$	$04^{s}.9600$	$04^{s}.9593$	+389	
			08	3	$08^{s}.9177$	$08^{s}.9600$	$08^{s}.9606$	+429	
			12	4	$12^{s}.9150$	$12^{s}.9630$	$12^{s}.9630$	+480	
			16	5	$16^{s}.9124$	$16^{s}.9560$	$16^{s}.9568$	+444	
			20	6	$20^{s}.9098$	$20^{s}.9580$	$20^{s}.9578$	+480	
			24	7	$24^{s}.9072$	$24^{s}.9550$	$24^{s}.9550$	+478	
SEQUENCE No. 2									
066	09	40	00	1	$00^{s}.8449$	$00^{s}.8860$	$00^{s}.8860$	+411	+485
			04	2	$04^{s}.8453$	$04^{s}.8850$	$04^{s}.8851$	+398	
			08	3	$08^{s}.8457$	$08^{s}.8870$	$08^{s}.8871$	+414	
			12	4	$12^{s}.8461$	$12^{s}.8670$	$12^{s}.8673$	+212	
			16	5	$16^{s}.8467$	$16^{s}.8910$	$16^{s}.8906$	+439	
			20	6	$20^{s}.8472$	$20^{s}.8910$	$20^{s}.8906$	+434	
			24	7	$24^{s}.8479$	$24^{s}.8950$	$24^{s}.8949$	+470	

TIME (T) (GMT) DAYS	HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (" SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (" SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (" SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (" SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (" SEC)[1,2]
SEQUENCE No. 3									
066	09	41	00	1	$00^s.8562$	$00^s.8960$	$00^s.8969$	+407	+475
			04	2	$04^s.8573$	$04^s.8980$	$04^s.8974$	+401	
			08	3	$08^s.8586$	$08^s.9010$	$08^s.9002$	+416	
			12	4	$12^s.8599$	$12^s.9040$	$12^s.9038$	+439	
			16	5	$16^s.8612$	$16^s.9060$	$16^s.9054$	+442	
			20	6	$20^s.8626$	$20^s.9060$	$20^s.9065$	+439	
			24	7	$24^s.8641$	$24^s.9110$	$24^s.9102$	+461	
SEQUENCE No. 4									
066	09	43	00	1	$00^s.9142$	$00^s.9580$	$00^s.9597$	+455	+490
			04	2	$04^s.9167$	$04^s.9570$	$04^s.9561$	+397	
			08	3	$08^s.9194$	$08^s.9630$	$08^s.9618$	+424	
			12	4	$12^s.9222$	$12^s.9680$	$12^s.9687$	+465	
			16	5	$16^s.9250$	$16^s.9680$	$16^s.9675$	+425	
			20	6	$20^s.9278$	$20^s.9720$	$20^s.9725$	+447	
			24	7	$24^s.9307$	$24^s.9790$	$24^s.9780$	+473	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (.. SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (.. SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (.. SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (.. SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (.. SEC)[1,2]
SEQUENCE No. 3									
066	07	35	00	1	$00^s.8887$	$00^s.9260$	$00^s.9270$	+383	+418
			04	2	$04^s.8902$	$04^s.9260$	$04^s.9264$	+362	
			08	3	$08^s.8917$				
			12	4	$12^s.8932$	$12^s.9320$	$12^s.9316$	+384	
			16	5	$16^s.8949$	$16^s.9350$	$16^s.9338$	+389	
			20	6	$20^s.8965$	$20^s.9370$	$20^s.9371$	+406	
			24	7	$24^s.8982$				
SEQUENCE No. 4									
066	07	44	00	1	$00^s.11215$	$00^s.11620$	$00^s.11610$	+395	+464
			04	2	$04^s.11258$	$04^s.11670$	$04^s.11697$	+439	
			08	3	$08^s.11303$	$08^s.11760$	$08^s.11749$	+446	
			12	4	$12^s.11347$	$12^s.11750$	$12^s.11767$	+420	
			16	5	$16^s.11392$	$16^s.11830$	$16^s.11832$	+440	
			20	6	$20^s.11437$	$20^s.11850$	$20^s.11845$	+408	
			24	7	$24^s.11482$	$24^s.11930$	$24^s.11929$	+447	

TIME (T) (GMT) DAYS	HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 1									
067	07	29	00	1	$00^{s}.12207$	$00^{s}.11970$	$00^{s}.11968$	-239	-127
			04	2	$04^{s}.12155$	$04^{s}.11920$	$04^{s}.11908$	-247	
			08	3	$08^{s}.12102$	$08^{s}.11850$	$08^{s}.11860$	-242	
			12	4	$12^{s}.12051$	$12^{s}.11820$	$12^{s}.11820$	-231	
			16	5	$16^{s}.12000$	$16^{s}.11760$	$16^{s}.11756$	-244	
			20	6	$20^{s}.11949$	$20^{s}.11720$	$20^{s}.11715$	-234	
			24	7	$24^{s}.11898$	$24^{s}.11700$	$24^{s}.11703$	-195	
SEQUENCE No. 2									
067	07	33	00	1	$00^{s}.9504$				-160
			04	2	$04^{s}.9468$	$04^{s}.9220$	$04^{s}.9231$	-237	
			08	3	$08^{s}.9432$	$08^{s}.9180$	$08^{s}.9187$	-245	
			12	4	$12^{s}.9397$	$12^{s}.9180$	$12^{s}.9188$	-209	
			16	5	$16^{s}.9362$	$16^{s}.9130$	$16^{s}.9122$	-240	
			20	6	$20^{s}.9328$	$20^{s}.9110$	$20^{s}.9111$	-217	
			24	7	$24^{s}.9294$	$24^{s}.9080$	$24^{s}.9086$	-208	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μSEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE[1,2] (μ SEC)
SEQUENCE No. 3									
067	07	34	00	1	$00^{s}.9009$	$00^{s}.8770$	$00^{s}.8778$	-221	-144
			04	2	$04^{s}.8980$	$04^{s}.8680$	$04^{s}.8683$	-297	
			08	3	$08^{s}.8951$	$08^{s}.8690$	$08^{s}.8703$	-249	
			12	4	$12^{s}.8922$				
			16	5	$16^{s}.8894$	$16^{s}.8660$	$16^{s}.8660$	-234	
			20	6	$20^{s}.8866$	$20^{s}.8630$	$20^{s}.8626$	-240	
			24	7	$24^{s}.8839$	$24^{s}.8610$	$24^{s}.8609$	-230	
SEQUENCE No. 4									
067	07	39	00	1	$00^{s}.8311$	$00^{s}.8090$	$00^{s}.8091$	-220	-153
			04	2	$04^{s}.8324$	$04^{s}.8080$	$04^{s}.8084$	-240	
			08	3	$08^{s}.8338$	$08^{s}.8090$	$08^{s}.8101$	-237	
			12	4	$12^{s}.8352$	$12^{s}.8150$	$12^{s}.8151$	-201	
			16	5	$16^{s}.8367$	$16^{s}.8130$	$16^{s}.8134$	-233	
			20	6	$20^{s}.8382$	$20^{s}.8160$	$20^{s}.8163$	-219	
			24	7	$24^{s}.8398$	$24^{s}.8200$	$24^{s}.8201$	-197	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE[1,2] (μ SEC)
SEQUENCE No. 5									
067	07	44	00	1	$00^{s}.10621$	$00^{s}.10360$	$00^{s}.10369$	-252	-181
			04	2	$04^{s}.10665$	$04^{s}.10420$	$04^{s}.10427$	-238	
			08	3	$08^{s}.10710$	$08^{s}.10450$	$08^{s}.10452$	-258	
			12	4	$12^{s}.10755$	$12^{s}.10530$	$12^{s}.10532$	-223	
			16	5	$16^{s}.10801$	$16^{s}.10580$	$16^{s}.10581$	-220	
			20	6	$20^{s}.10847$	$20^{s}.10620$	$20^{s}.10618$	-229	
			24	7	$24^{s}.10893$	$24^{s}.10670$	$24^{s}.10683$	-210	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μSEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 1									
067	09	35	00	1	$00^{s}.13030$	$00^{s}.12880$	$00^{s}.12928$	-102	-136
			04	2	$04^{s}.12980$	$04^{s}.12760$	$04^{s}.12764$	-216	
			08	3	$08^{s}.12930$	$08^{s}.12710$	$08^{s}.12717$	-213	
			12	4	$12^{s}.12881$	$12^{s}.12710$	$12^{s}.12719$	-161	
			16	5	$16^{s}.12832$	$16^{s}.12640$	$12^{s}.12643$	-189	
			20	6	$20^{s}.12783$	$20^{s}.12710$	$20^{s}.12512$	-271	
			24	7	$24^{s}.12735$	$24^{s}.12570$	$24^{s}.12575$	-160	
SEQUENCE No. 2									
067	09	40	00	1	$00^{s}.9915$	$00^{s}.9680$	$00^{s}.9672$	-243	-139
			04	2	$04^{s}.9884$	$04^{s}.9640$	$04^{s}.9625$	-259	
			08	3	$08^{s}.9854$	$08^{s}.9630$	$08^{s}.9623$	-231	
			12	4	$12^{s}.9824$	$12^{s}.9600$	$12^{s}.9597$	-227	
			16	5	$16^{s}.9795$				
			20	6	$20^{s}.9766$	$20^{s}.9570$	$20^{s}.9587$	-213	
			24	7	$24^{s}.9737$	$24^{s}.9550$	$24^{s}.9537$	-200	

TIME DAYS	(T) (GMT) HRS.	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100 KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1 MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE #3									
067	09	43	00	1	$00^{s}.8963$	$00^{s}.8990$	$00^{s}.8774$	-189	-118
			04	2	$04^{s}.8952$	$04^{s}.8850$	$04^{s}.8844$	-108	
			08	3	$08^{s}.8943$	$08^{s}.8800$	$08^{s}.8799$	-144	
			12	4	$12^{s}.8933$	$12^{s}.8780$	$12^{s}.8741$	-192	
			16	5	$16^{s}.8924$	$16^{s}.8880$	$16^{s}.8792$	-132	
			20	6	$20^{s}.8916$	$20^{s}.8800$	$20^{s}.8773$	-143	
			24	7	$24^{s}.8909$	$24^{s}.8910$	$24^{s}.8865$	-034	
SEQUENCE #4									
067	09	44	00	1	$00^{s}.8864$	$00^{s}.8650$	$00^{s}.8646$	-218	-156
			04	2	$04^{s}.8861$	$04^{s}.8630$	$04^{s}.8630$	-231	
			08	3	$08^{s}.8859$	$08^{s}.8640$	$08^{s}.8635$	-224	
			12	4	$12^{s}.8858$	$12^{s}.8640$	$12^{s}.8646$	-212	
			16	5	$16^{s}.8857$	$16^{s}.8630$	$16^{s}.8626$	-230	
			20	6	$20^{s}.8857$	$20^{s}.8650$	$20^{s}.8655$	-202	
			24	7	$24^{s}.8857$	$24^{s}.8670$	$24^{s}.8663$	-193	

TIME DAYS	HRS.	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100 KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1 MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER 1, OCCURRENCE(μ SEC)
SEQUENCE #5									
067	09	45	00	1	$00^{s}.8884$	$00^{s}.8680$	$00^{s}.8690$	-194	-144
			04	2	$04^{s}.8890$	$04^{s}.8670$	$04^{s}.8670$	-220	
			08	3	$08^{s}.8895$	$08^{s}.8670$	$08^{s}.8669$	-226	
			12	4	$12^{s}.8902$	$12^{s}.8700$	$12^{s}.8705$	-197	
			16	5	$16^{s}.8909$	$16^{s}.8710$	$16^{s}.8715$	-194	
			20	6	$20^{s}.8912$	$20^{s}.8720$	$20^{s}.8722$	-190	
			24	7	$24^{s}.8925$	$24^{s}.8740$	$24^{s}.8736$	-189	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE, (μ SEC)[1,2]
SEQUENCE No. 1									
068	07	37	00	1	$00.^{s}9382$	$00.^{s}9260$	$00.^{s}9259$	-123	+16
			04	2	$04.^{s}9342$	$04.^{s}9230$	$04.^{s}9227$	-115	
			08	3	$08.^{s}9305$	$08.^{s}9170$	$08.^{s}9176$	-129	
			12	4	$12.^{s}9266$				
			16	5	$16.^{s}9229$				
			20	6	$20.^{s}9191$				
			24	7	$24.^{s}9154$	$24.^{s}9080$	$24.^{s}9079$	-075	
SEQUENCE No. 2									
068	07	39	00	1	$00.^{s}8395$	$00.^{s}8270$	$00.^{s}8272$	-123	+08
			04	2	$04.^{s}8370$	$04.^{s}8240$	$04.^{s}8245$	-125	
			08	3	$08.^{s}8344$	$08.^{s}8230$	$08.^{s}8232$	-112	
			12	4	$12.^{s}8320$	$12.^{s}8200$	$12.^{s}8209$	-111	
			16	5	$16.^{s}8295$	$16.^{s}8190$	$16.^{s}8191$	-104	
			20	6	$20.^{s}8272$	$20.^{s}8180$	$20.^{s}8178$	-094	
			24	7	$24.^{s}8249$	$24.^{s}8170$	$24.^{s}8174$	-075	

TIME (T) DAYS	(GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 3									
068	07	43	00	1	$00^{s}.7892$	$00^{s}.7800$	$00^{s}.7802$	-090	+29
			04	2	$04^{s}.7903$	$04^{s}.7800$	$04^{s}.7817$	-086	
			08	3	$08^{s}.7914$	$08^{s}.7820$	$08^{s}.7833$	-081	
			12	4	$12^{s}.7926$	$12^{s}.7860$	$12^{s}.7862$	-064	
			16	5	$16^{s}.7938$	$16^{s}.7860$	$16^{s}.7868$	-070	
			20	6	$20^{s}.7955$	$20^{s}.7860$	$20^{s}.7863$	-092	
			24	7	$24^{s}.7965$	$24^{s}.7940$	$24^{s}.7945$	-020	
[illegible]									
068	07	47	00	1	$00^{s}.9480$		$00^{s}.9336$	-144	+21
			04	2	$04^{s}.9520$		$04^{s}.9365$	-155	
			08	3	$08^{s}.9560$		$08^{s}.9417$	-143	
			12	4	$12^{s}.9601$		$12^{s}.9479$	-122	
			16	5	$16^{s}.9642$		$16^{s}.9504$	-138	
			20	6	$20^{s}.9683$		$20^{s}.9563$	-120	
			24	7	$24^{s}.9725$		$24^{s}.9630$	-095	

TIME DAYS	(T) (GMT) HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE No. 5									
068	07	48	00	1	$00^{s}.10113$		$00^{s}.9979$	-134	+21
			04	2	$04^{s}.10158$		$04^{s}.10020$	-138	
			08	3	$08^{s}.10202$		$08^{s}.10056$	-146	
			12	4	$12^{s}.10247$		$12^{s}.10135$	-112	
			16	5	$16^{s}.10293$		$16^{s}.10184$	-109	
			20	6	$20^{s}.10338$		$20^{s}.10235$	-113	
			24	7	$24^{s}.10384$		$24^{s}.10300$	-084	

TIME DAYS	HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100 KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μSEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μSEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μSEC)[1,2]
SEQUENCE NO. 1									
068	09	41	00	1	$00^{s}.12441$	$00^{s}.12200$	$00^{s}.12315$	-126	+21
			04	2	$04^{s}.12397$	$04^{s}.12240$	$04^{s}.12234$	-163	
			08	3	$08^{s}.12352$	$08^{s}.12200$	$08^{s}.12201$	-151	
			12	4	$12^{s}.12308$	$12^{s}.12210$	$12^{s}.12208$	-100	
			16	5	$16^{s}.12264$	$16^{s}.12150$	$16^{s}.12161$	-103	
			20	6	$20^{s}.12220$	$20^{s}.12120$	$20^{s}.12118$	-102	
			24	7	$24^{s}.12176$	$24^{s}.12100$	$24^{s}.12095$	-081	
SEQUENCE NO. 2									
068	09	43	00	1	$00^{s}.11198$	$00^{s}.11060$	$00^{s}.11063$	-133	+19
			04	2	$00^{s}.11160$	$04^{s}.11030$	$04^{s}.11023$	-137	
			08	3	$08^{s}.11123$	$08^{s}.11098$	$08^{s}.10984$	-139	
			12	4	$12^{s}.11086$	$12^{s}.10950$	$12^{s}.10964$	-122	
			16	5	$16^{s}.11049$	$16^{s}.10930$	$16^{s}.10929$	-120	
			20	6	$20^{s}.11013$	$20^{s}.10910$	$20^{s}.10906$	-107	
			24	7	$24^{s}.10977$	$24^{s}.10890$	$24^{s}.10890$	-087	

TIME DAYS	HRS	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μSEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100 KC (μSEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μSEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μSEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μSEC)[1,2]
SEQUENCE NO. 3									
068	09	45	00	1	$00^{s}.10205$	$00^{s}.10070$	$00^{s}.10078$	-127	+28
			04	2	$04^{s}.10172$	$04^{s}.10040$	$04^{s}.10037$	-135	
			08	3	$08^{s}.10149$	$08^{s}.10020$	$08^{s}.10016$	-133	
			12	4	$12^{s}.10122$	$12^{s}.1002C$	$12^{s}.10014$	-108	
			16	5	$16^{s}.10095$	$16^{s}.9990$	$16^{s}.9989$	-094	
			20	6	$20^{s}.10064$	$20^{s}.9970$	$20^{s}.9970$	-094	
			24	7	$24^{s}.10043$	$24^{s}.9950$	$24^{s}.9958$	-085	
SEQUENCE NO. 4									
068	09	48	00	1	$00^{s}.9367$	$00^{s}.923C$	$00^{s}.9229$	-138	+14
			04	2	$04^{s}.9358$	$04^{s}.9210$	$04^{s}.9214$	-144	
			08	3	$08^{s}.9351$	$08^{s}.9210$	$08^{s}.9208$	-143	
			12	4	$12^{s}.9343$	$12^{s}.9220$	$12^{s}.9218$	-125	
			16	5	$16^{s}.9337$	$16^{s}.9220$	$16^{s}.9216$	-121	
			20	6	$20^{s}.9331$	$20^{s}.9220$	$20^{s}.9212$	-119	
			24	7	$24^{s}.9325$	$24^{s}.9230$	$24^{s}.9217$	-108	

TIME DAYS	HRS.	MIN	SEC	FLASH #	$(T+\Delta t)$ EXPECTED FLASH RECEPTION TIME (μ SEC)	$(T+\Delta t_{100KC})$ ACTUAL FLASH REC. TIMED AGAINST 100 KC (μ SEC)	$(T+\Delta t_{1MC})$ ACTUAL FLASH REC. TIMED AGAINST 1MC (μ SEC)	TIME DIFFERENCE[1] BETWEEN EXPECTED & ACTUALLY RECD. FLASHES (μ SEC) $(T+\Delta t)-(T+\Delta t_{1MC})$	SATELLITE INTEGER MINUTE MARKER OCCURRENCE (μ SEC)[1,2]
SEQUENCE NO. 5									
068	09	52	00	1	$00^{s}.9752$	$00^{s}.9620$	$00^{s}.9611$	-141	+63
			04	2	$04^{s}.9723$	$04^{s}.9630$	$04^{s}.9624$	-099	
			08	3	$08^{s}.9794$	$08^{s}.9640$	$08^{s}.9645$	-149	
			12	4	$12^{s}.9810$	$12^{s}.9690$	$12^{s}.9690$	-120	
			16	5	$16^{s}.9838$	$16^{s}.9710$	$16^{s}.9710$	-128	
			20	6	$20^{s}.9861$	$20^{s}.9730$	$20^{s}.9739$	-122	
			24	7	$24^{s}.9883$	$24^{s}.9790$	$24^{s}.9792$	-091	

[1] Minus sign indicates flash occurred prior true "on time"
Plus sign indicates flash occurred after true "on time"
"On time" is that time referenced to cesium beam standard time ticks at Goddard Timing Laboratory - true "on time" would necessitate the subtraction of approximately 30 microseconds from each listed time difference.

[2] Telephone conversation with Mr. Glen San Lwin, APL. The data was obtained from telemetry information received at APL. Reference time used at APL is referenced to true "on time" reference to WWV.