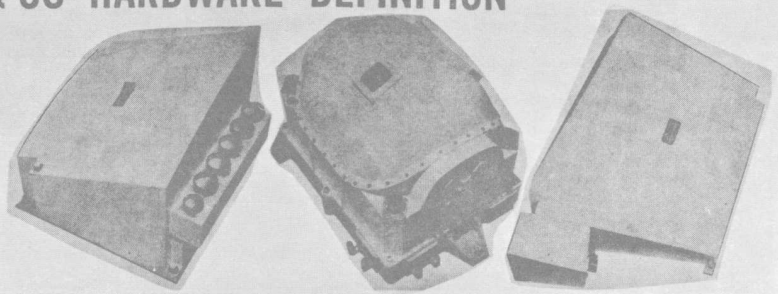

GEMINI

GEMINI - G & CS HARDWARE DEFINITION



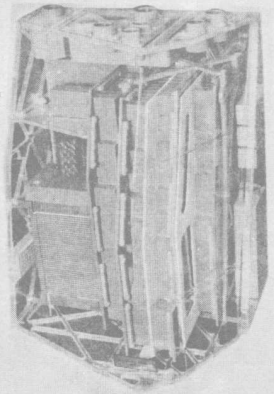
TRANSPONDER
WH

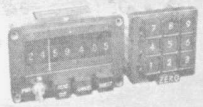
ATTITUDE DISPLAY
LEAR

ELECTRONICS M-H
PLATFORM ELECTRONICS
INERTIAL PLATFORM
POWER SUPPLY

HORIZON SENSOR
ATL

RENDEZVOUS RADAR
WH



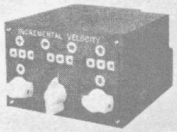


ACME
M-H

MDIU
IBM

COMPUTER
IBM

RCS
NAA-AUTO



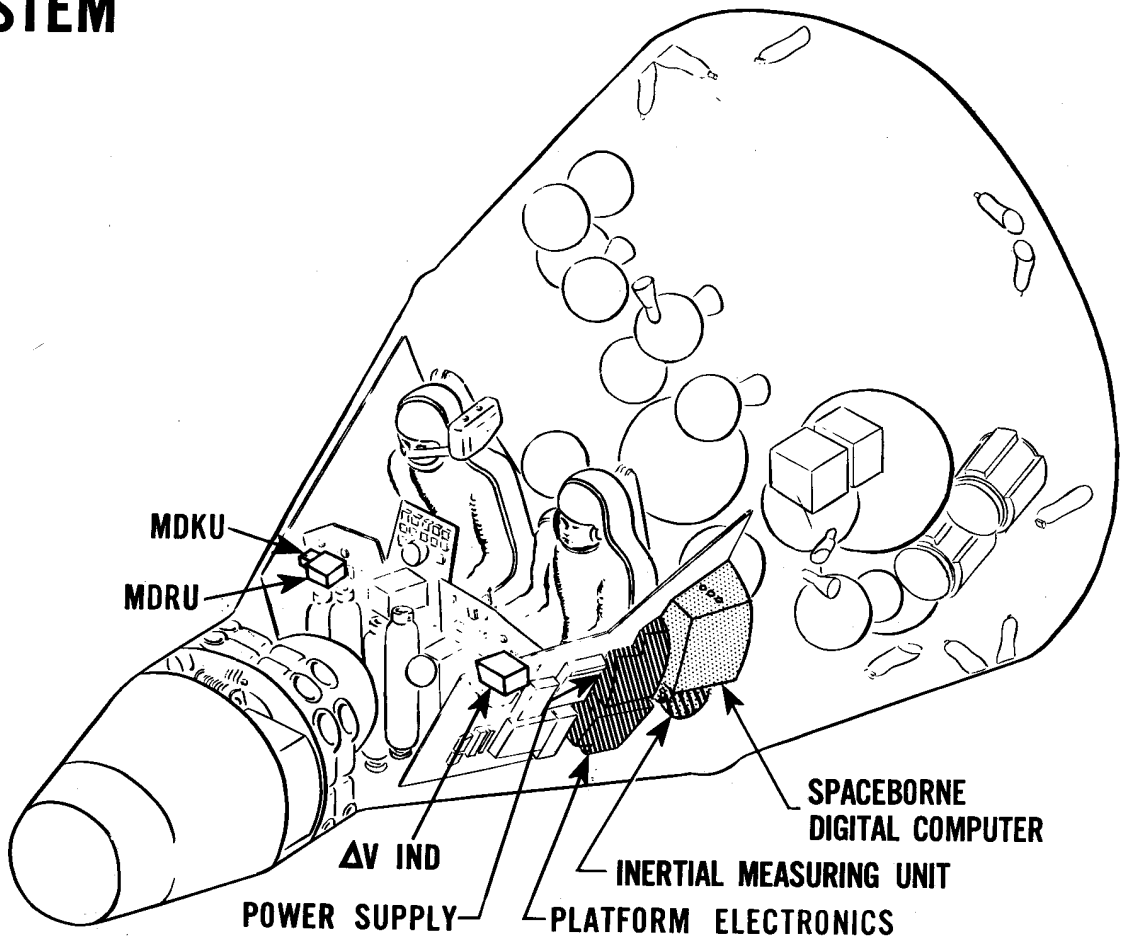
DATA TELEMETRY

TIME REF SYS
MAC

ΔV IND
IBM

DIG COM SYS
MOTOROLA

INERTIAL GUIDANCE SYSTEM



IBM RESPONSIBILITIES

- DESIGN, TEST, PROVIDE
  - ▷ DIGITAL COMPUTER
  - ▷ MANUAL DATA INSERTION UNIT
  - ▷ ΔV INDICATOR
  - ▷ AGE
- OVERALL PERFORMANCE OF INERTIAL GUIDANCE SYSTEM (M-H ASSOC CONTRACTOR)
- TECHNICAL CONTROL OF M-H WORK (VIA MAC)
- ALL INTERFACE TO DIGITAL COMPUTER (VIA MAC)
- SYSTEM HARDWARE LAB INTEGRATION OF SDC, MDIU, IMU, RADAR, ACME, CLOCK, ΔV IND, TELEM ETC
- SYSTEM ANALYSIS & SIMULATION STUDIES COMPLEMENTARY TO MAC

GUIDANCE & CONTROL FUNCTIONS

ASCENT GUIDANCE

- ▷ FOR STAGE I & STAGE II
- ▷ BACKUP FOR TITAN II GUIDANCE

RENDEZVOUS

- ▷ CATCH-UP
- ▷ CLOSED LOOP

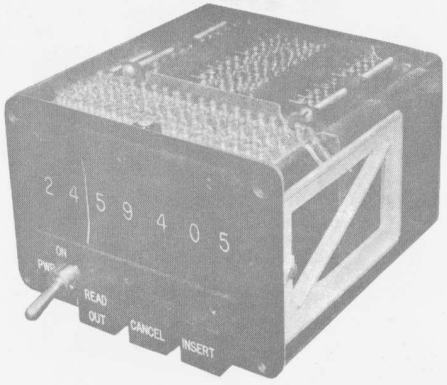
TOUCH DOWN PREDICT

- ▷ S/C EPHEMERIS DATA
- ▷ ABORT TO PREFERRED LANDING SITE

RE-ENTRY

- ▷ GUIDED TO 60,000 ft

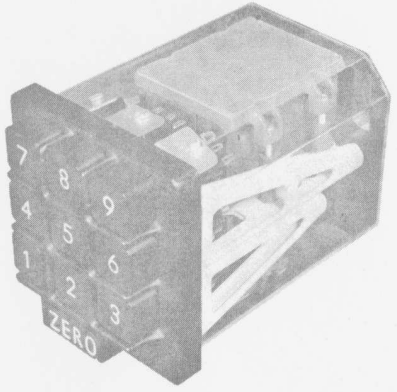
GEMINI
MANUAL DATA INSERTION UNITS



MANUAL DATA READOUT

- READOUT OF DATA
  - UP TO 99 QTYS
  - VERIFICATION OF INSERTS
  - VARIOUS COMPUTED QUANTITIES

  7 DIGITS
  - 2 ADDRESS
  - 5 DATA



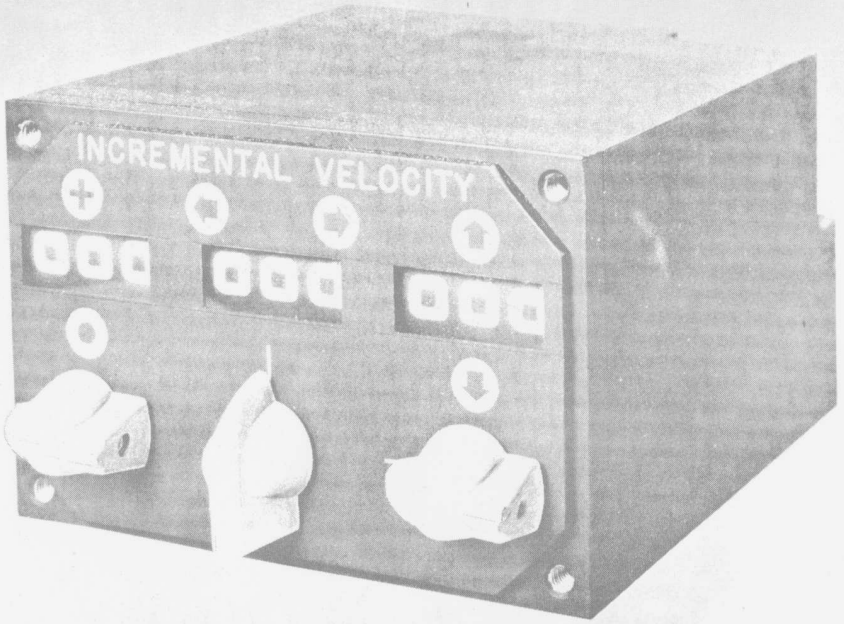
MANUAL DATA KEYBOARD

- INSERTION OF DATA BY ASTRONAUT
  - ORBITAL PARAMETERS
  - TARGET COORDINATES
  - TIME TO RETRO-GRADE
  - RE-ENTRY EQUATION COEFFICIENTS

OVERALL WT 4 lbs, POWER 4.1 w

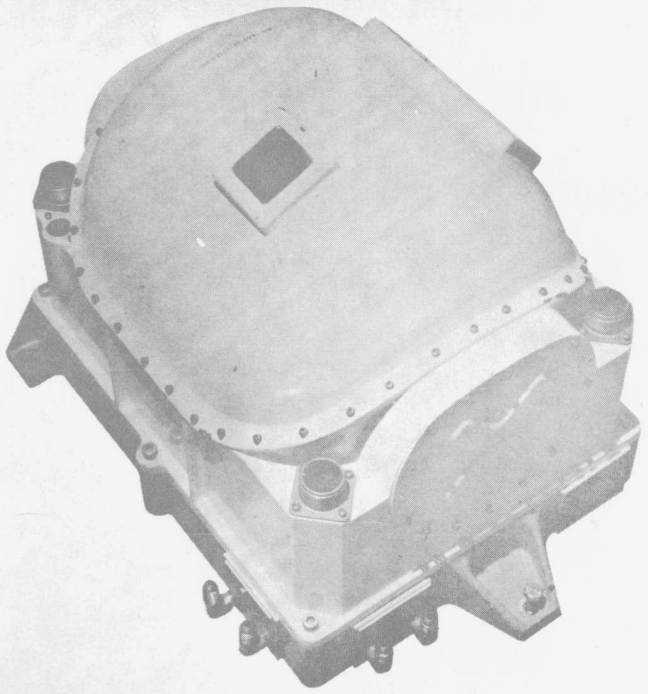
GEMINI

INCREMENTAL VELOCITY INDICATOR



- READOUT OF INCREMENTAL VELOCITY (0-999 ft/sec) IN 3 BODY AXES
- USED FOR MONITORING & CONTROL OF THRUSTING MANEUVERS
- AUTOMATIC OR MANUAL SET UP
- WEIGHT 3.75 lbs, POWER 8 w

GEMINI
INERTIAL PLATFORM



IMU FUNCTIONS

- ATTITUDE REF FOR ALL MISSION PHASES
- PROVIDES THREE GIMBAL ANGLE OUTPUTS
- PROVIDES THREE INTEG ACCEL (Δ V) OUTPUTS
- ALIGNMENT IN ORBIT
- TORQUED AT ORBIT RATE

MEMORY ALLOCATION S/C #4

	COUNT	PERCENT
ASCENT GUIDANCE	2700	21.9
RENDEZVOUS-CATCHUP	2700	21.9
TOUCHDOWN PREDICT	800	6.5
RE-ENTRY	3300	26.9
MDIU	850	6.9
I/O	275	2.3
GO-NO-GO	175	1.4
PRE-LAUNCH	400	3.3
COMMON SUBROUTINES	1000	8.2
TOTAL	12,200	99.3%
TOTAL AVAILABLE	12,288	

COMPUTER SOLUTION RATES

ASCENT GUIDANCE

1 ST STAGE .5 SEC

2 ND STAGE .8 SEC

RENDEZVOUS

CATCHUP .3 sec

RADAR DATA TRACKING COMP CYCLE .4 SEC

RADAR DATA SMOOTHING COMP CYCLE .25 SEC

TOUCHDOWN PREDICT 1 SEC

REENTRY 1 SEC

RATIO OF TOTAL PROGRAM EXECUTION TIMES

MULTIPLY	420 μsec	6.8%
DIVIDE	840 μsec	.9%
REMAINING OPERATIONS (14)	140 μsec	92.3%

RELIABILITY

MTBF

	MDIU	IVI	COMPUTER	PLATFORM	IMU ELECTRONICS	POWER SUPPLY
OPERATING IN ORBIT MTBF	17500	3800	2560	1180	3250	7300

IGS TOTAL 500

MISSION RELIABILITY

MODE	TIME (HOURS)	PROBABILITY
PRE-LAUNCH	2.0	.9959
ASCENT	0.1	.9969
RENDEZVOUS	5.0	.9897
ORBIT (ON)	4.0	.9918
ORBIT (OFF)	44.0	.9830
RE-ENTRY	0.5	.9990

MISSION RELIABILITY .9569

IGS PHYSICAL DATA

UNIT	POWER (WATTS)	WEIGHT (LBS.)	VOLUME (CU.IN.)
PLATFORM	42	31	815
PLATFORM ELECTRONICS	122	38	940
IGS PWR. SUPPLY	76	43	881
MDRU	3	3	81
MDKU	--	1	54
IVI	8	3	75
COMPUTER	95	58	2592
TOTAL	346	177	5438

Summary of Salient Computer Characteristics

TYPE	General Purpose, Binary, Serial Fixed Point	
MEMORY	4096 WDS (39 Bits/Wd) Random	
ARITH. TIMES	Add, Subtract, Transfer	140 usec
	Multiply	420 usec
	Divide	840 usec
CLOCK RATE	Arith Bit Rate	500 KC
	Memory Cycle	250 KC
LOGIC SIG. LEVELS		0 And +8 Volts
INPUTS	Discretes	40
	Analog	3
	Data Channels	5
OUTPUTS	Discretes	20
	Analog	5
	Data Channels	4

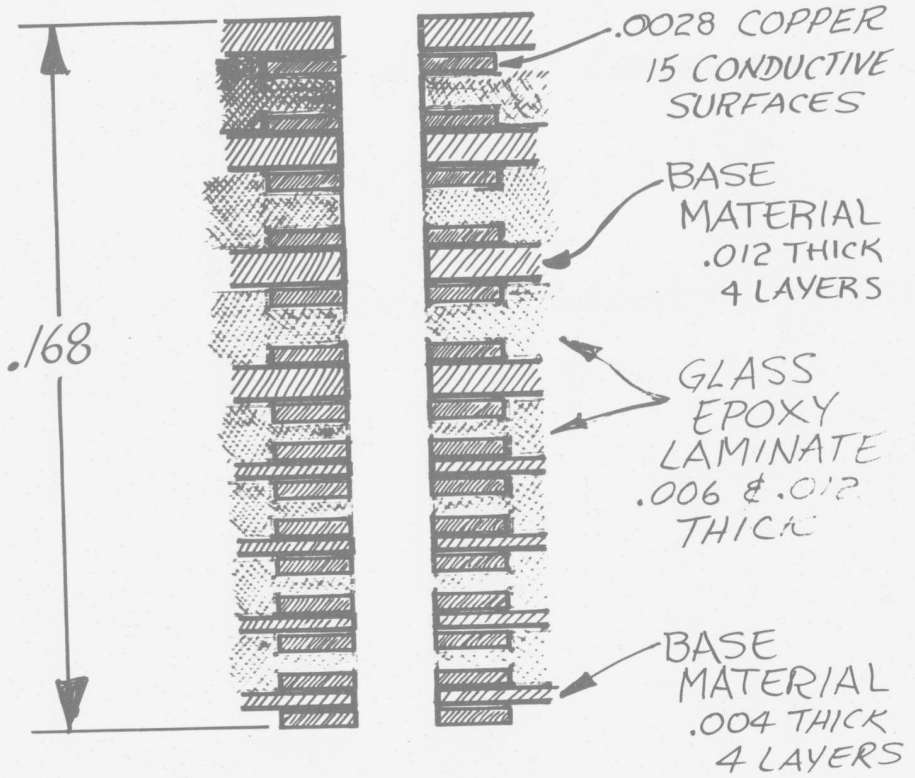
Mechanical Features

Weight	56.3 #
Volume	1.34 cu. ft.
Power	85 watts
Predicted MTBF	2100 hrs. plus
Component Count	11,650
Conductive Cooling	
Multilayer Interconnections	
Circuit Modules	510 (103 types)
Ext. Structural Use of Magnesium & Mag. Lit.	

COMPONENTS

SILICON PLANER EPITAXIAL SEMICONDUCTORS:	
TRANSISTORS	1,097
DIODES	5716
RESISTORS: C.C., M.F., W.W.	4211
CAPACITORS: GLASS, CER. TANT	617
GLASS DELAY LINES	5
MAGNETIC MODULATORS	3
400 CPS FILTER	1
TOTAL	11,650

LAYER BUILDUP OF TYPICAL GEMINI MULTILAYER INTERCONNECTION BOARD (MIB)



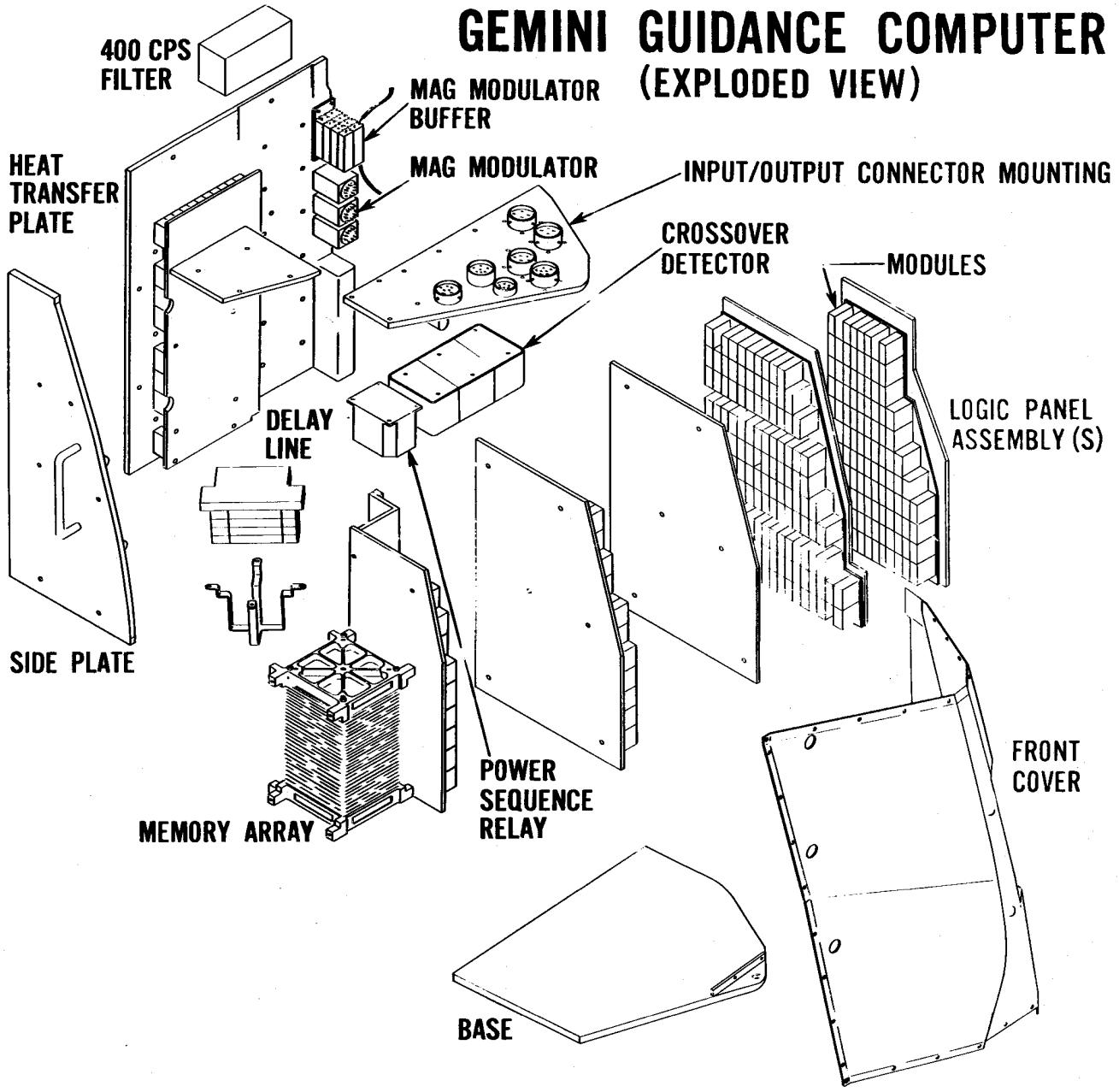
GEMINI AGE

- Test Program Console
- Memory Loader
- IGS Bench Test Equipment
- MDIU/ΔV Tester
- Test Console Computer System

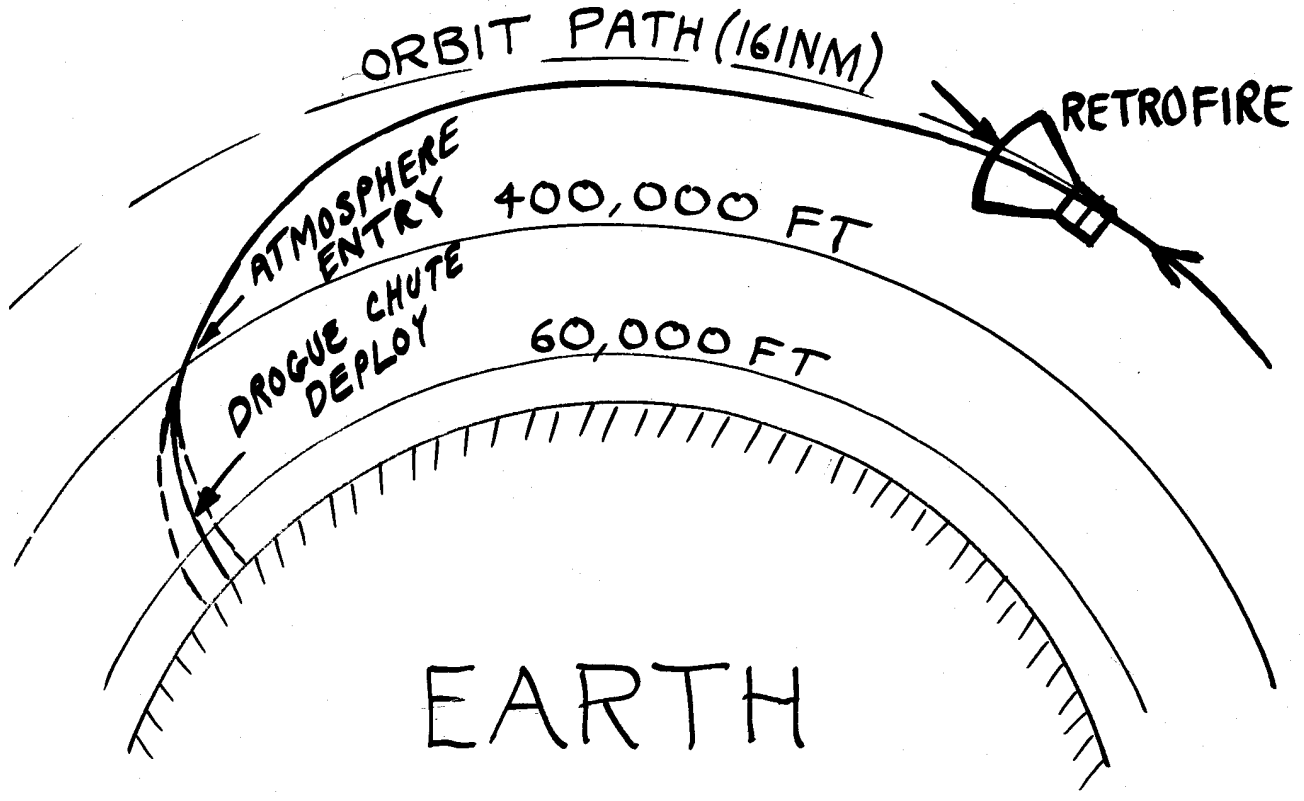
AGE FEATURES

- 19" Rack & Panel
- RFI Design Features
- Standard Modular System
- Heavy Duty Cabinets
- Flexible
- Mobile

GEMINI GUIDANCE COMPUTER
(EXPLODED VIEW)



RE-ENTRY


ORBIT PATH (161NM)
RETROFIRE
ATMOSPHERE ENTRY
400,000 FT
DROGUE CHUTE DEPLOY
60,000 FT
EARTH

CAPABILITIES

- INITIAL CONDITIONS FROM GROUND UPDATE OR TD PREDICT MODE.
- NAVIGATION FROM RETRO.
- DISPLAY OF RETRO ΔV.
- COMPUTE DESIRED BANK ANGLE AND ACTUAL BANK ANGLE.
- COMP & DISPLAY ROLL ERROR.
- COMP & DISPLAY DOWNRANGE & CROSSRANGE ERROR.
- MAX LIFT COMMAND AT 80,000 FT.

RE-ENTRY GUIDANCE

- PRE-RETRO
  - SET INITIAL VALUES & ALIGN IMU.
  - TEST T_R.
- RETRO (T_R TO T_R+60)
  - NAVIGATE INCLUDING THRUST MEASURED BY IMU.
  - NO ATTITUDE COMMANDS.
  - DISPLAY RETRO ΔV.
- COAST (T_R+60 TO 400,000 FT. ALTITUDE).
  - CONTINUE NAVIGATION (NO IMU INPUTS)
  - NO ATTITUDE COMMANDS.
- ATMOSPHERIC (400,000 FT. ALTITUDE TO 0.4 FT/SEC^2 ACC.)
  - CONTINUE NAVIGATION (WITH IMU INPUTS).
  - COMMAND $B_C=0$ (MAX LIFT).

CAPABILITIES

NAVIGATION

PREPROGRAMMED COMMANDS

VEHICLE ATTITUDE CONTROL

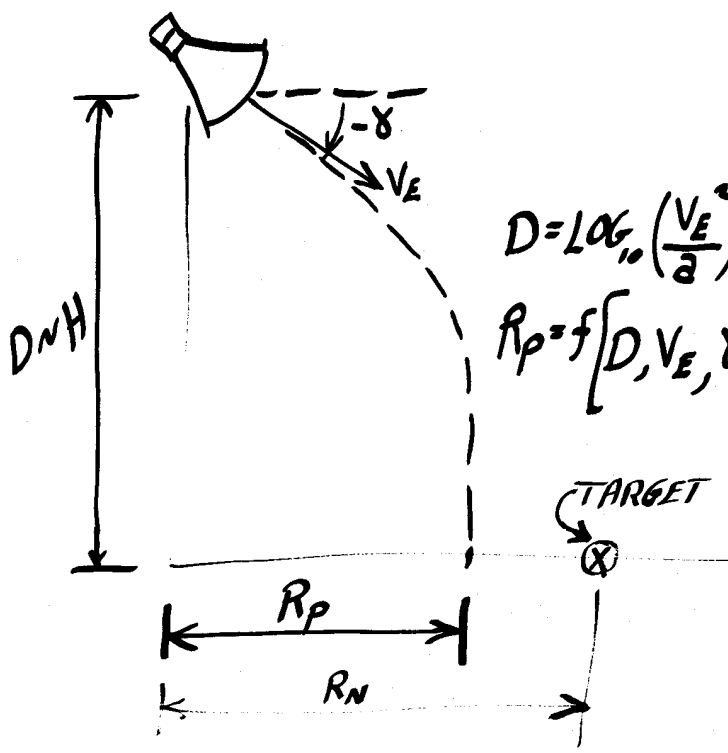
EXPLICIT STEERING

ORBIT INSERTION

REENTRY GUIDANCE (CONT.)

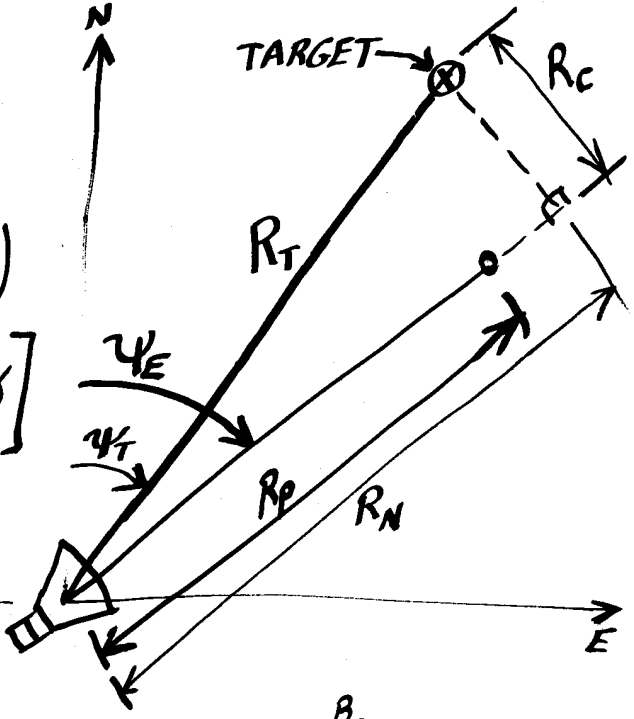
- ATMOSPHERIC (0.4 FT/SEC^2 ACC. TO 80,000 FT. ALTITUDE).
  - CONTINUE NAVIGATION (WITH IMU INPUTS)
  - COMPUTE: RANGE & HEADING TO TARGET.
    PREDICTED RANGE TO TOUCHDOWN.
    VEHICLE HEADING.
    DOWNRANGE & CROSSRANGE ERRORS.
  - DETERMINE B_E FROM BANK LOGIC.
- PRE-DROGUE (80,000 TO 60,000 FT. ALTITUDE)
  - COMMAND $B_C = 0$ (MAX LIFT).
- DROGUE CHUTE DEPLOYMENT.

RE-ENTRY CONTROL LOGIC



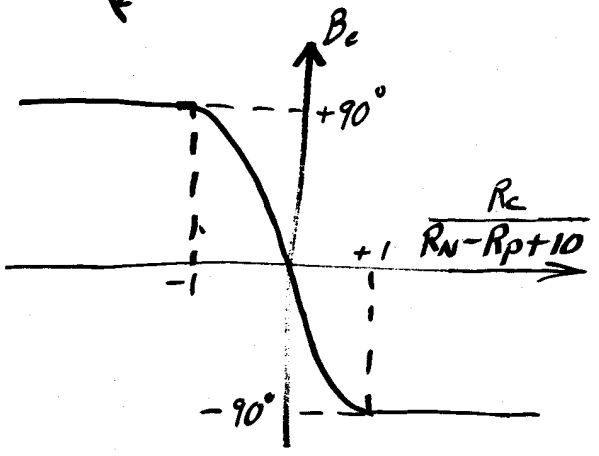
$$D = LOG_{10}\left(\frac{V_E^2}{a}\right)$$

$$R_P = f\left[D, V_E, \gamma\right]$$



WHEN $R_N > R_P$

$$B_c = f\left[\frac{R_c}{R_N - R_P + 10}\right]$$



WHEN $R_N < R_P$

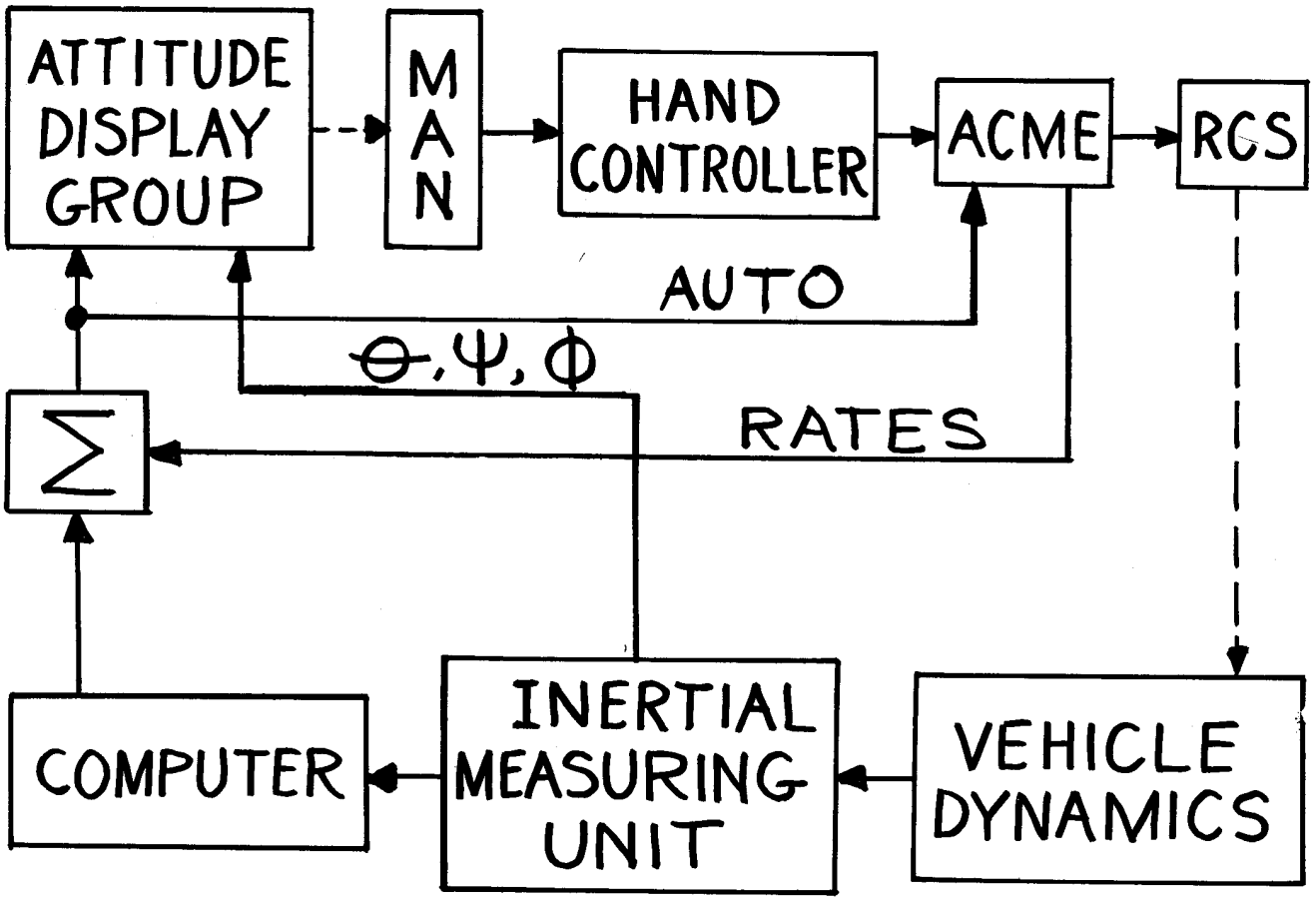
$R_c > 1 \quad B_c = -90°$

$R_c < -1 \quad B_c = +90°$

$-1 < R_c < 1$ COMMAND CONSTANT ROLL

RE-ENTRY SIMULATION

ACTUAL SYSTEM



DYNAMIC DISPLAYS

ATTITUDE DISPLAY
- ATTITUDE BALL
- FDI NEEDLES

	MAX DEFLECTION
ROLL + ROLL RATE	15 DEG OR DEG/SEC
PITCH RATE // R_{DOWN}	10 DEG/SEC // 100 NM
YAW RATE // R_{CROSS}	10 DEG/SEC // 12.5 NM

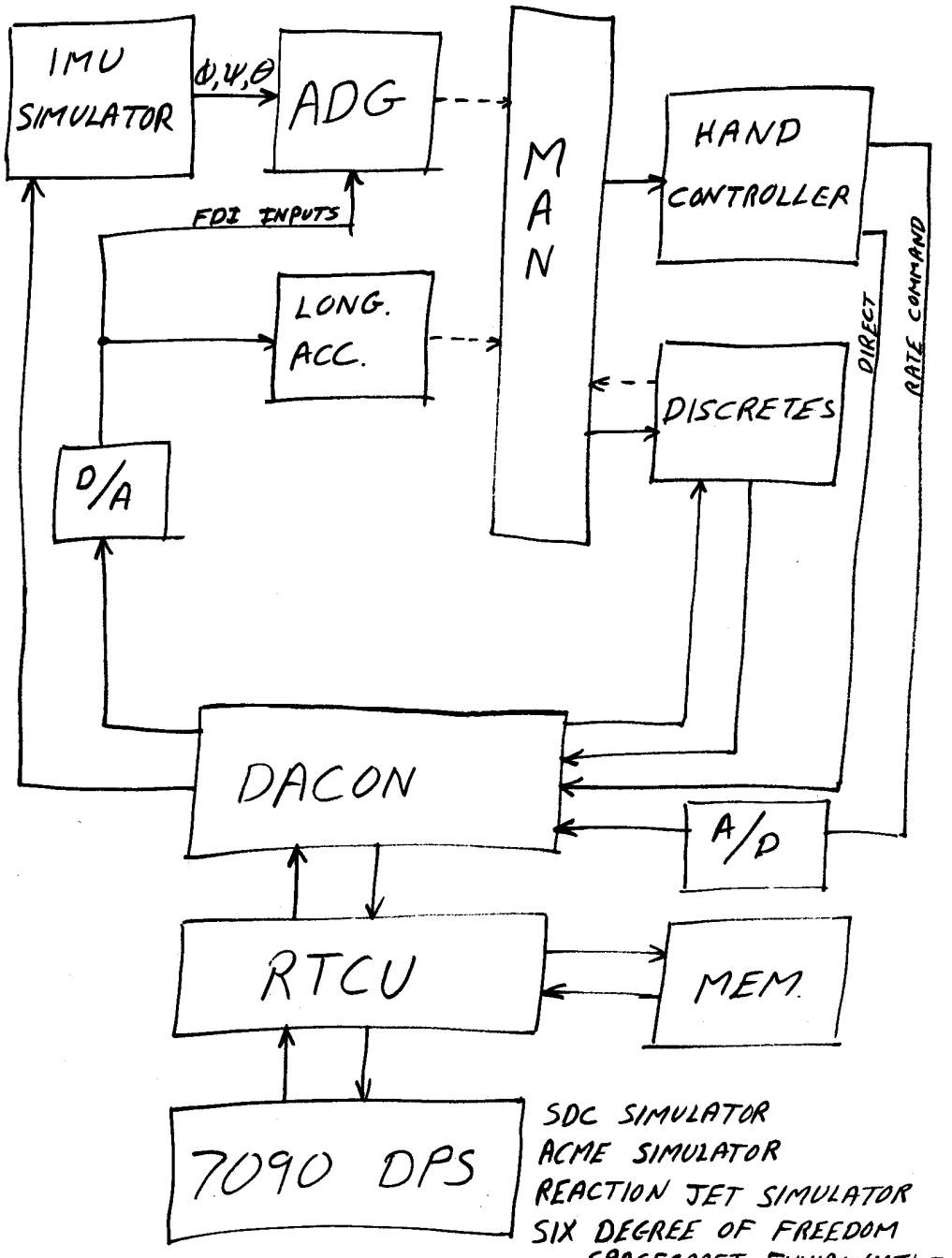
LONGITUDINAL ACCELERATION

ACME MODES

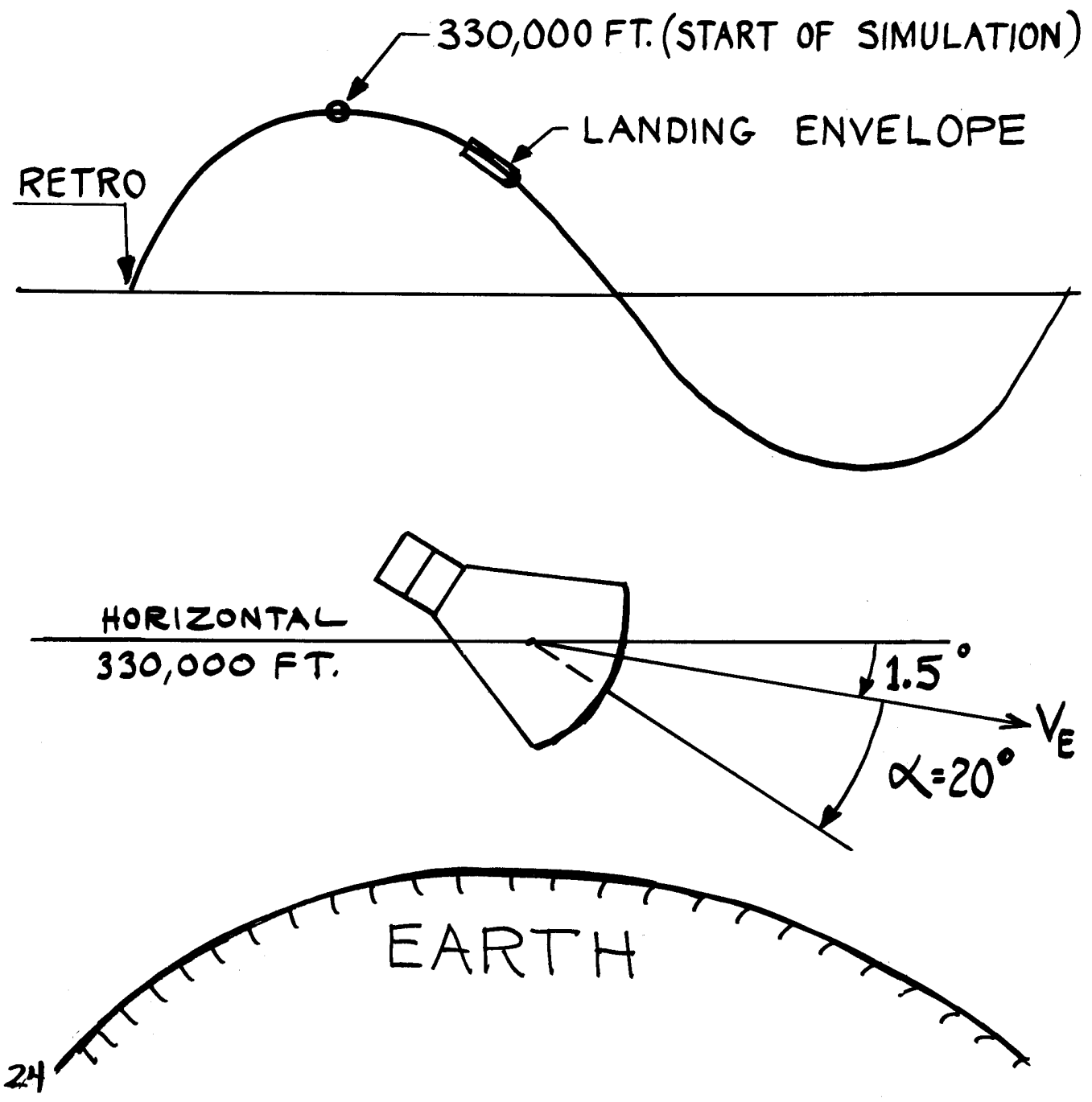
RATE COMMAND

DIRECT

RE-ENTRY (AUTOMATIC)


IMU SIMULATOR
Φ,Ψ,Θ
ADG
MAN
HAND CONTROLLER
FDI INPUTS
LONG. ACC.
DISCRETES
DIRECT
RATE COMMAND
D/A
DACON
A/D
RTCU
MEM
7090 DPS
SDC SIMULATOR
ACME SIMULATOR
REACTION JET SIMULATOR
SIX DEGREE OF FREEDOM
SPACECRAFT ENVIRONMENT

SIMULATION INITIAL COND.



Simulated Mission Profile

Altitude

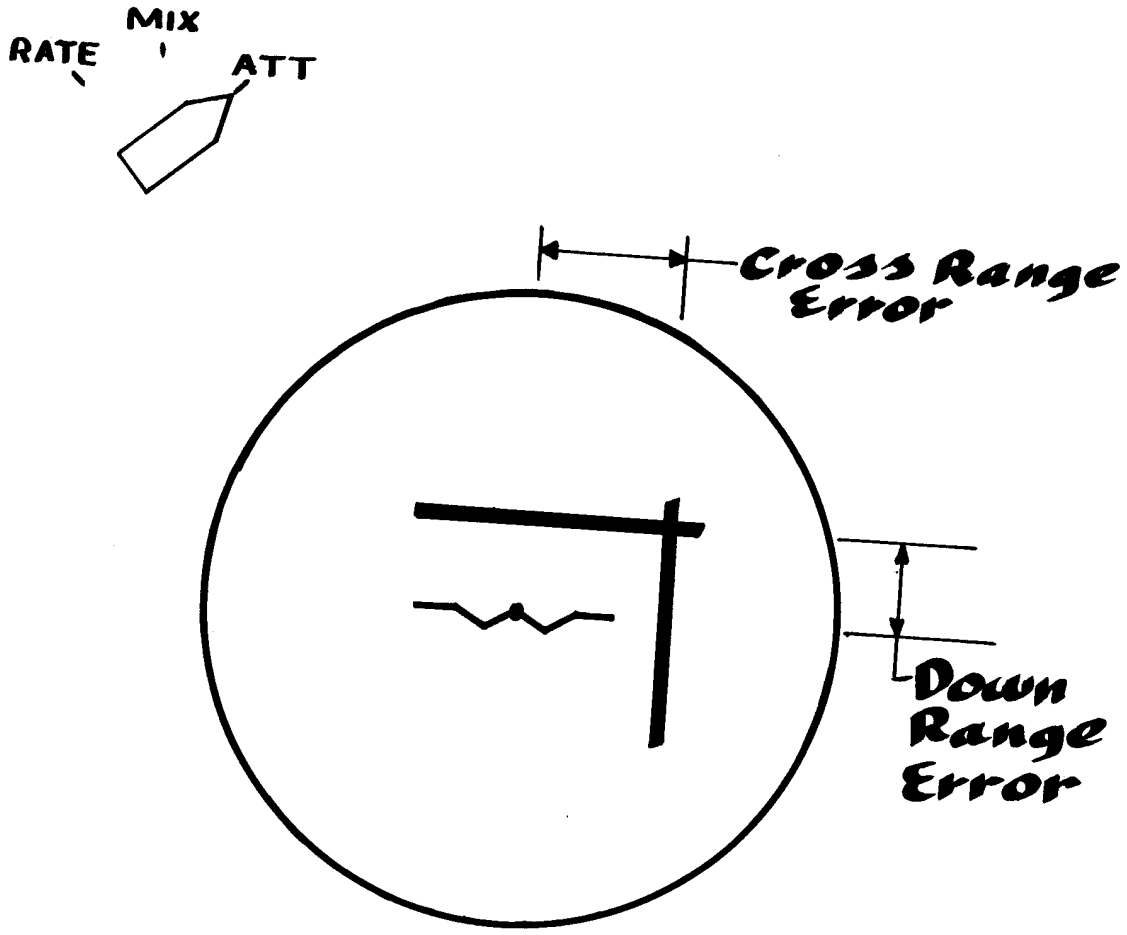
330 K — Maintain 0° Roll Angle

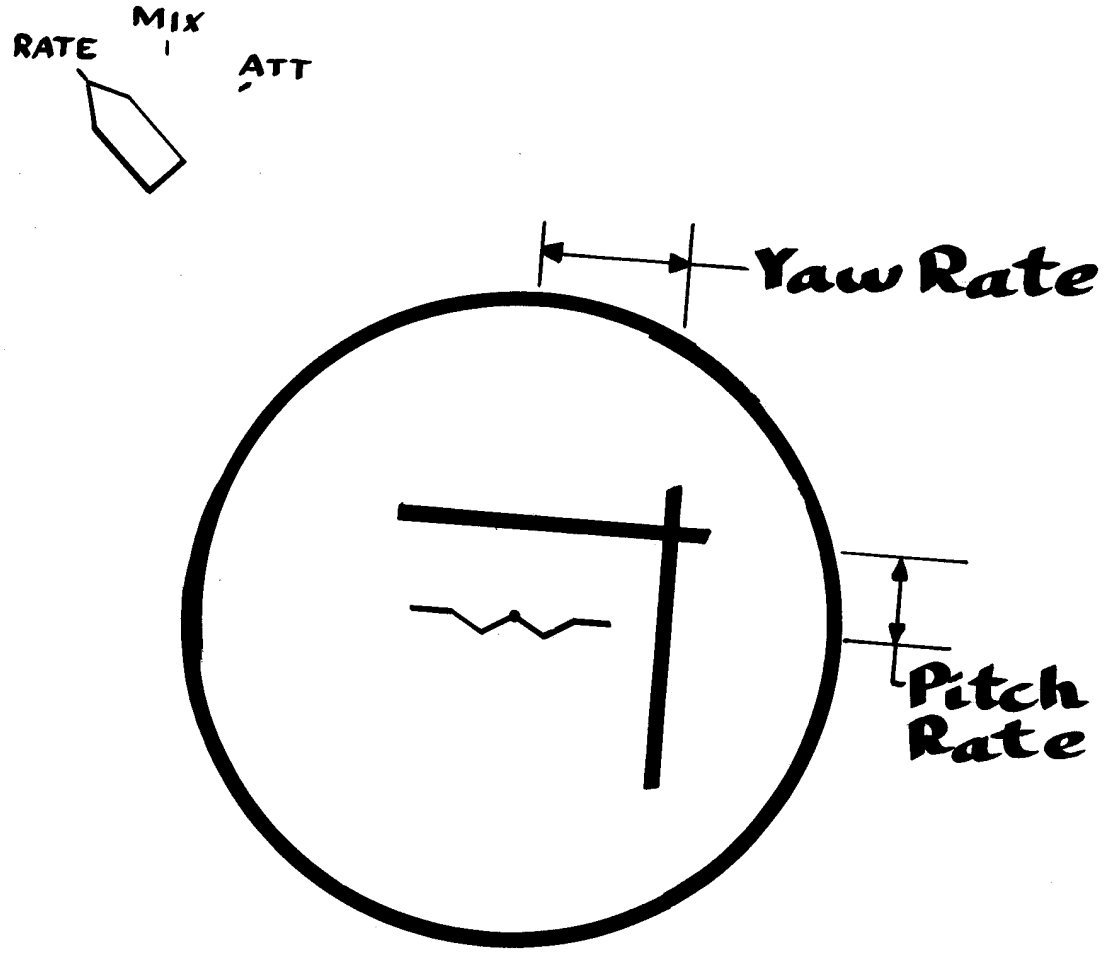
~300 K — when acceleration $\leq .4$ ft/sec^2

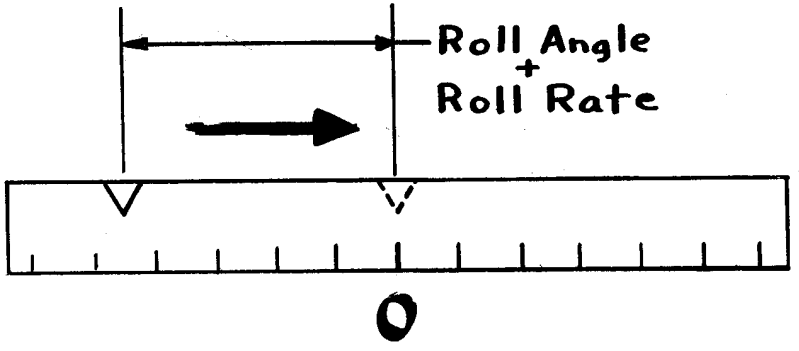
- cross range and down range navigation
- operator nulls overhead FDI
- Pitch + Yaw Rate control

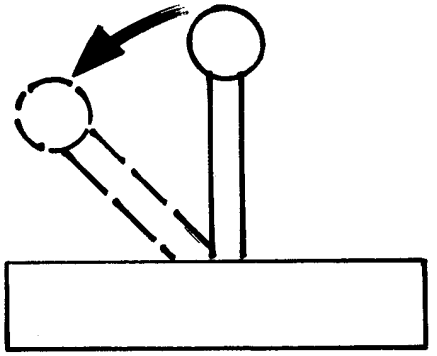
80 K — Return to 0° Roll Angle

60 K — End of Simulation Run


MIX
RATE
ATT
Cross Range Error
Down Range Error

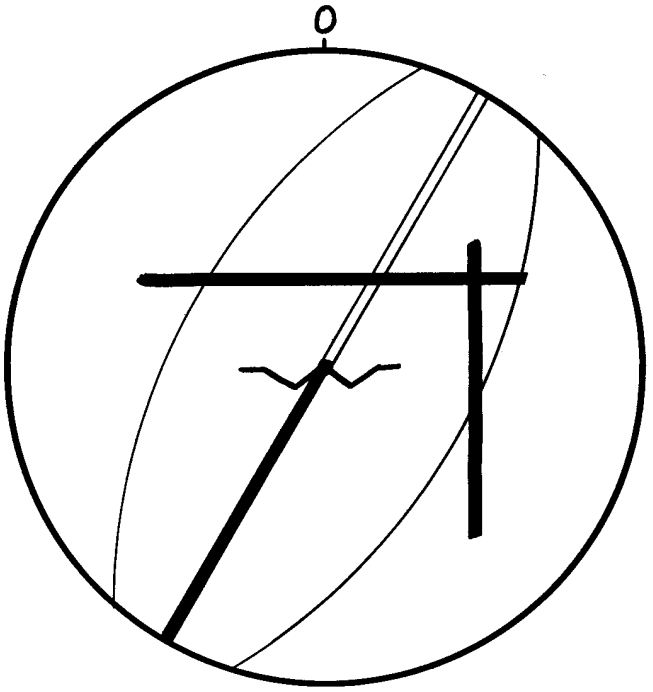

MIX
RATE
ATT
Yaw Rate
Pitch
Rate





Control Modes

1. Rate Command — Pitch, Yaw } ± 4°/sec.
2. Direct



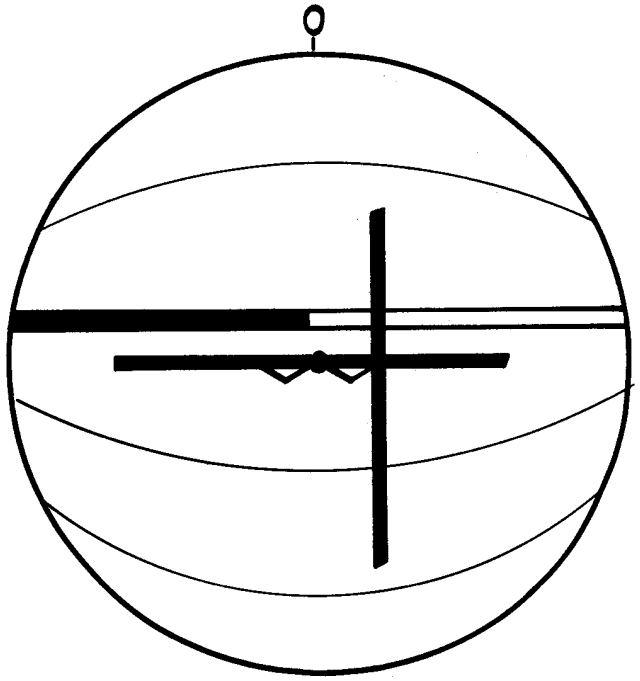
Case:

Both cross range and down range error exists

Situation:

Roll angle between

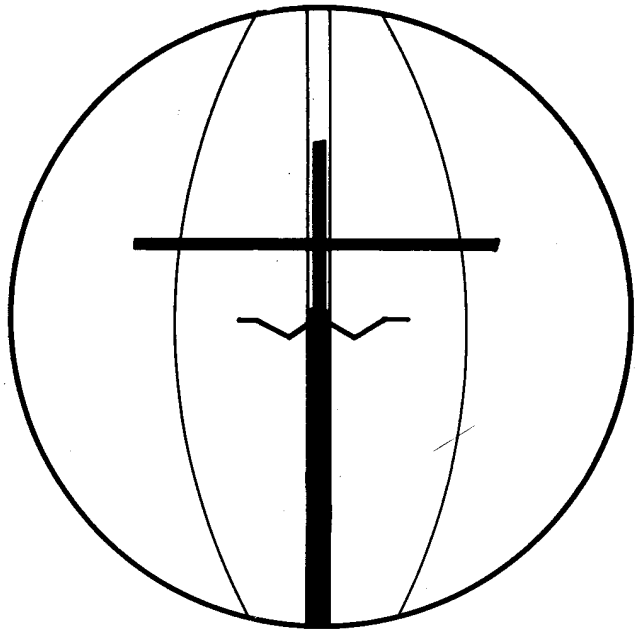
$\pm[>0° \& < 90°]$



Case: No down range error

Some cross range error
> 1 mile

Situation: Roll angle ±90°



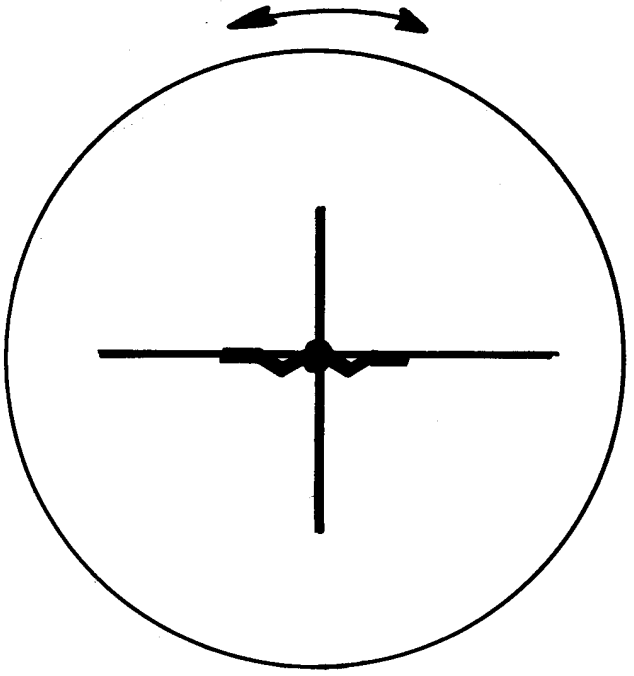
Case:

Cross Range error is zero

Some Down Range Error

Situation:

Max Lift, 0° Roll



Case:

No Down Range Error

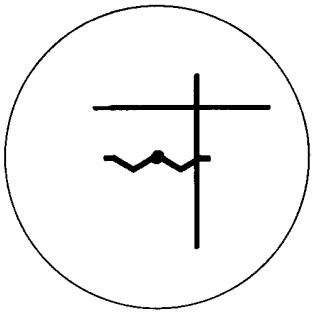
No Cross Range Error > 1 mile

Situation:

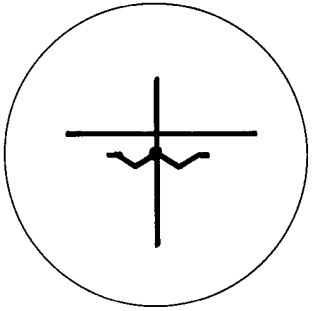
Zero Lift

Constant Roll Rate

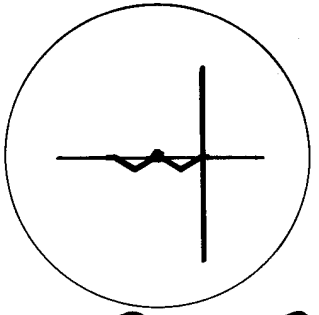
Summary



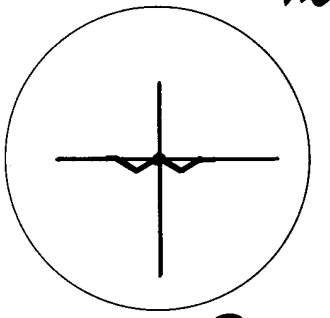
Cross Range & Down Range errors
$\pm[\geq 0° \leq 90°]$



Down Range Error
Cross Range Error = 0°
[0° roll]



Cross Range Error
No Down Range Error
$\pm[90°]$



No Down Range Error
Cross Range Error < 1 mile
[constant roll rate]

IGS

ASCENT GUIDANCE

MAJOR FUNCTION

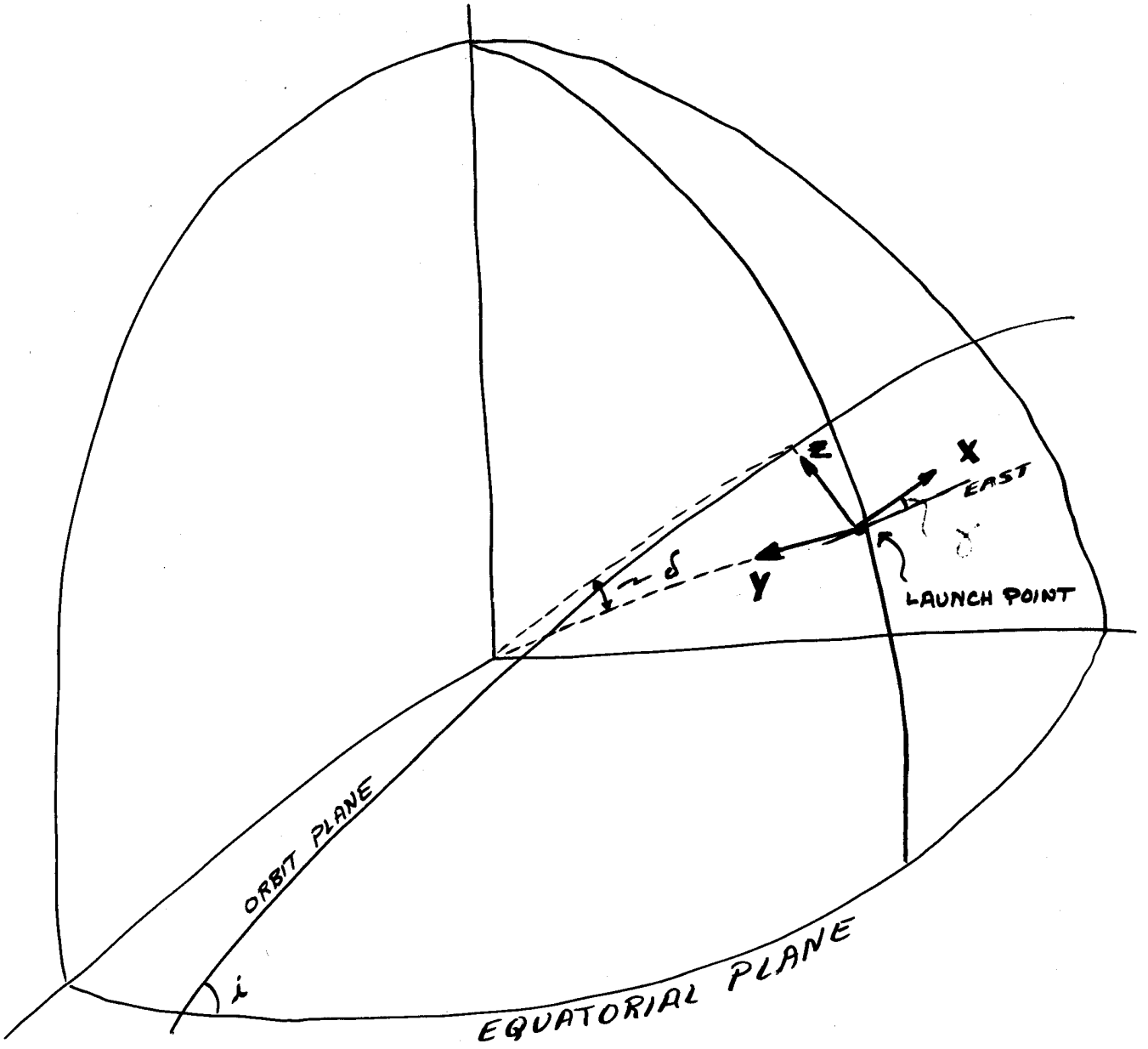
BACKUP

TO PRIMARY GUIDANCE SYSTEM

FOR

CREW SAFETY

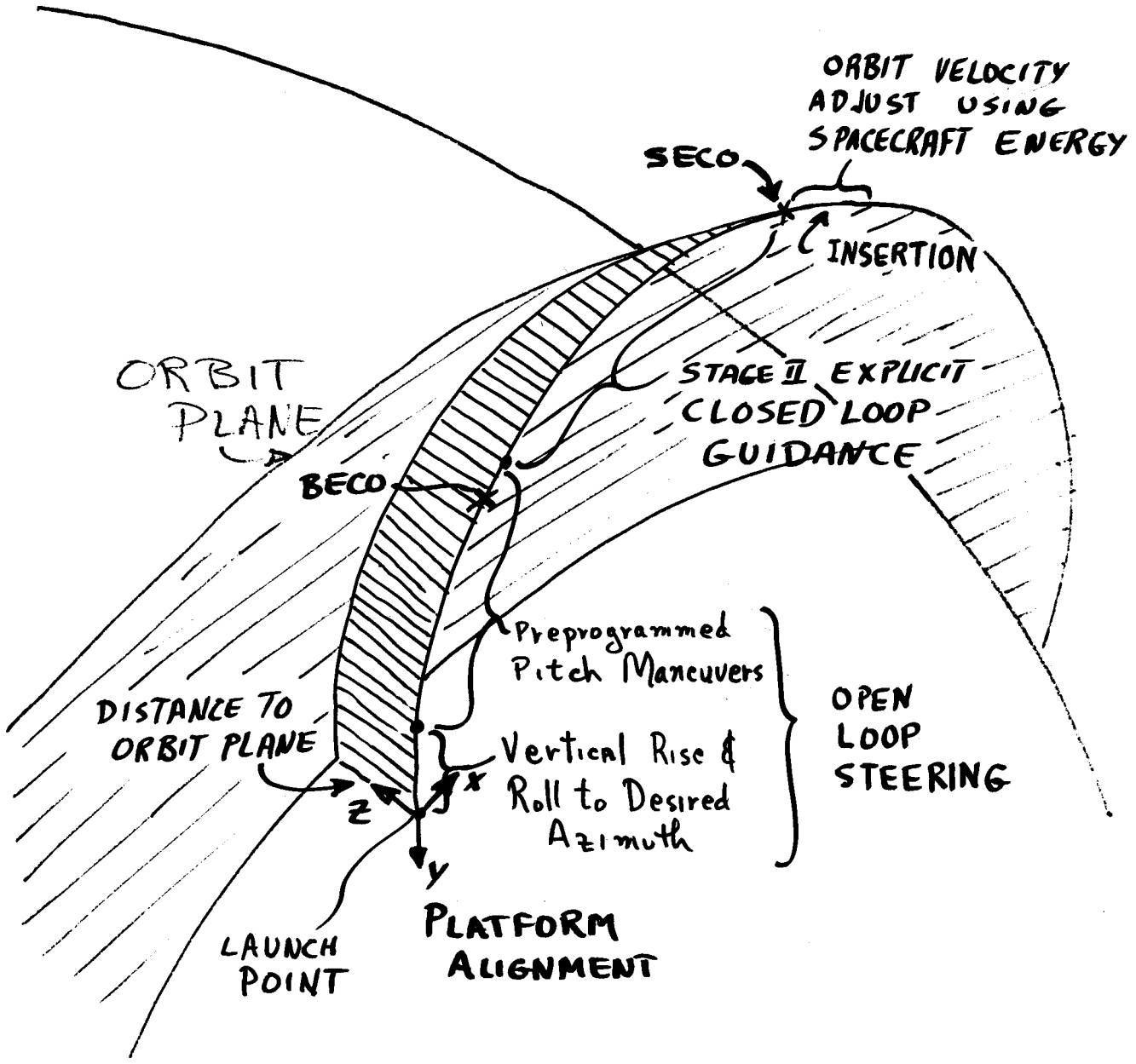
MISSION SAFETY



Y- axis oriented to geodetic vertical

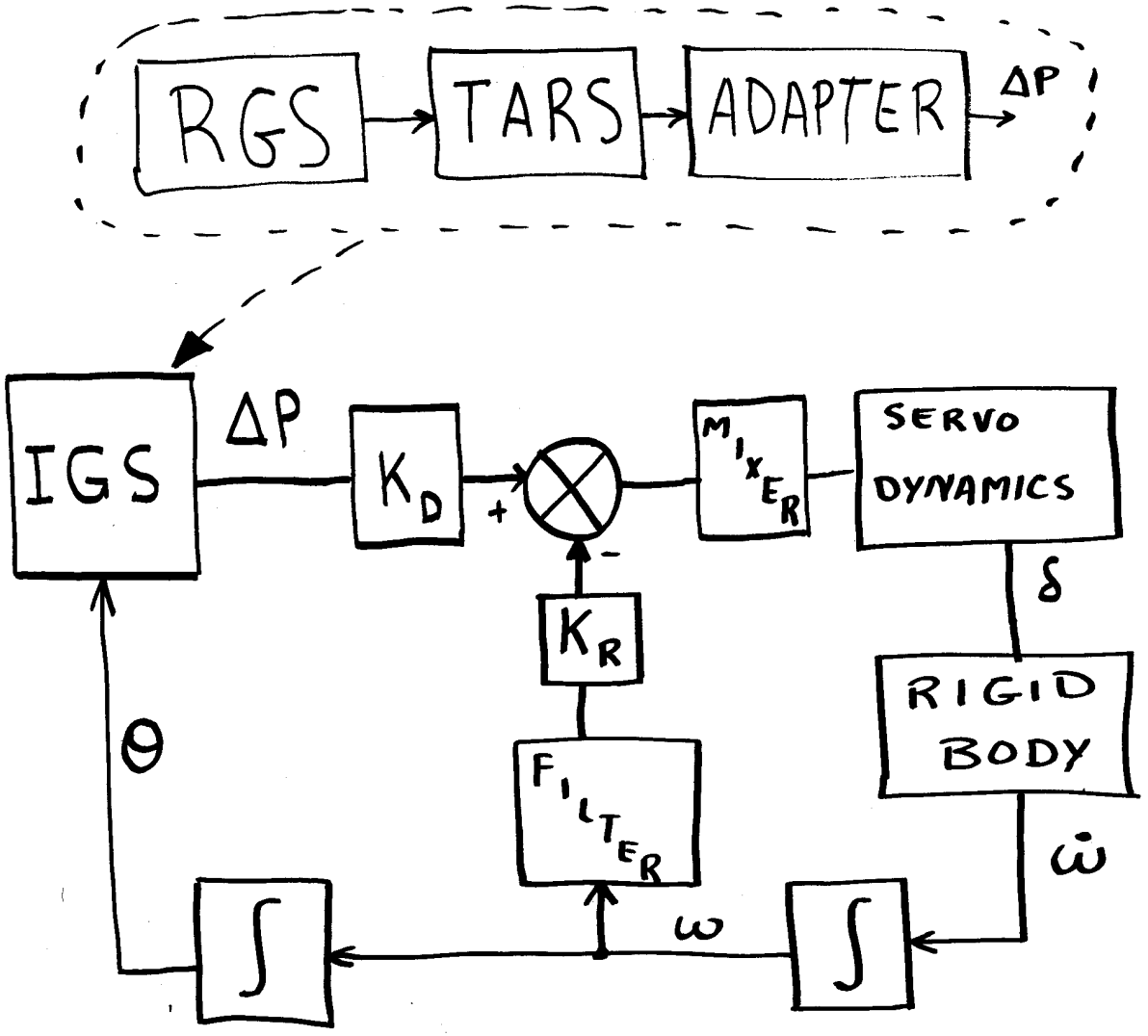
X- axis parallel to orbit plane

GEMINI ASCENT



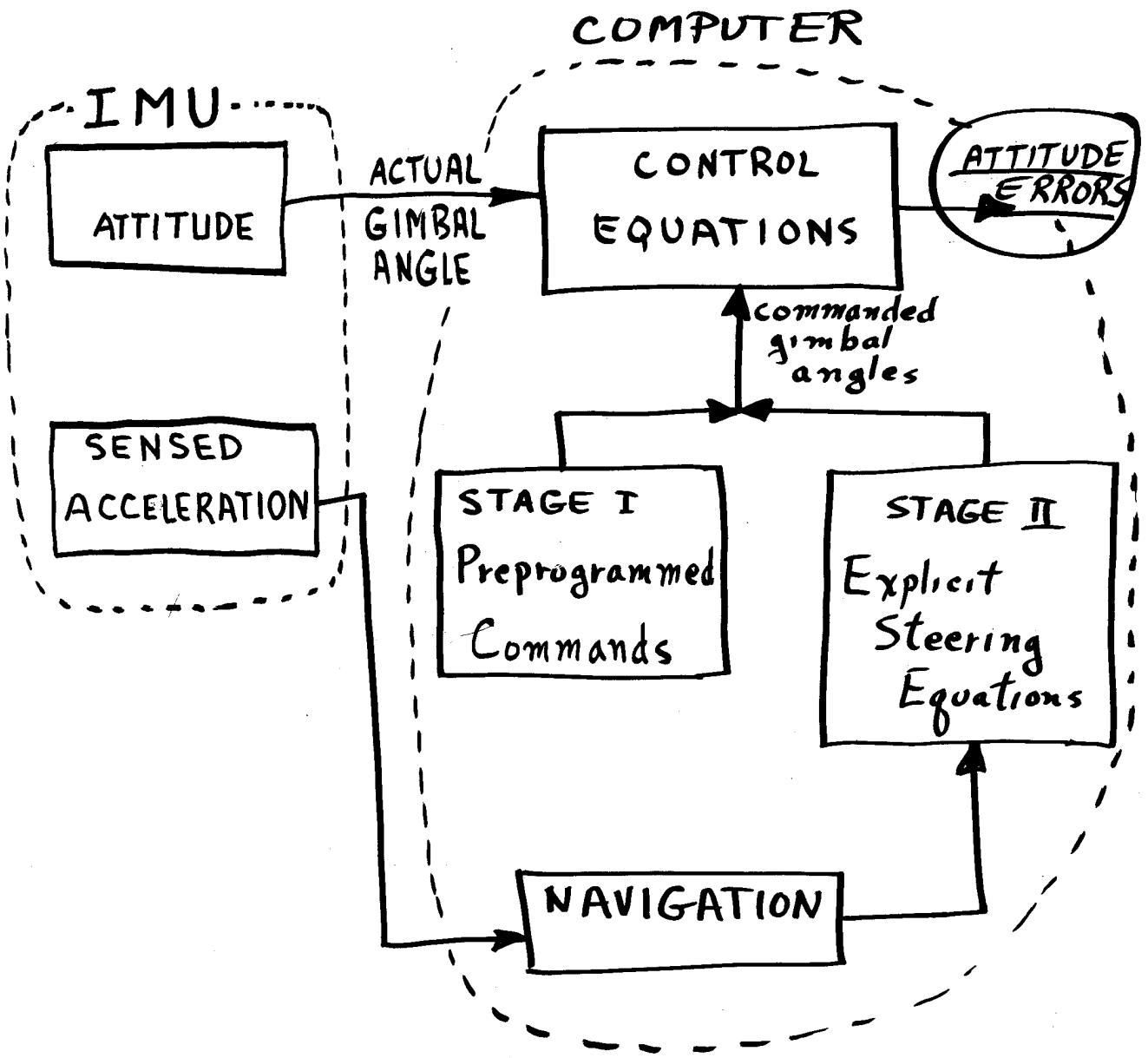
INITIALIZATION QUANTITIES

- γ Platform azimuth with respect to East
- δ Angle between y-axis & orbit plane
- $\Delta\Phi_R$ Magnitude & Direction of roll maneuver
- V_f^* Final Velocity

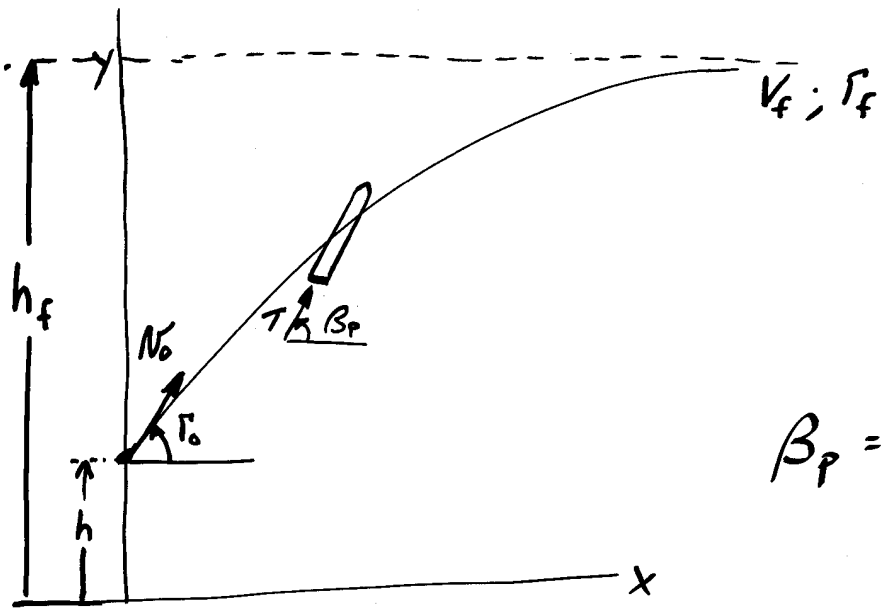


AUTOPILOT CONFIGURATION

IGS


COMPUTER
IMU
ATTITUDE
ACTUAL GIMBAL ANGLE
CONTROL EQUATIONS
ATTITUDE ERRORS
commanded gimbal angles
SENSED ACCELERATION
STAGE I
Preprogrammed Commands
STAGE II
Explicit Steering Equations
NAVIGATION

EXPLICIT STEERING



$$\beta_p = \tan^{-1}\left[a_1 + b_1 (t_c - t)\right]$$

Constraint Equations

VELOCITY $$\int_t^{t_c} a_T \sin\beta_p \, dt = -\dot{y}(t) = -A$$

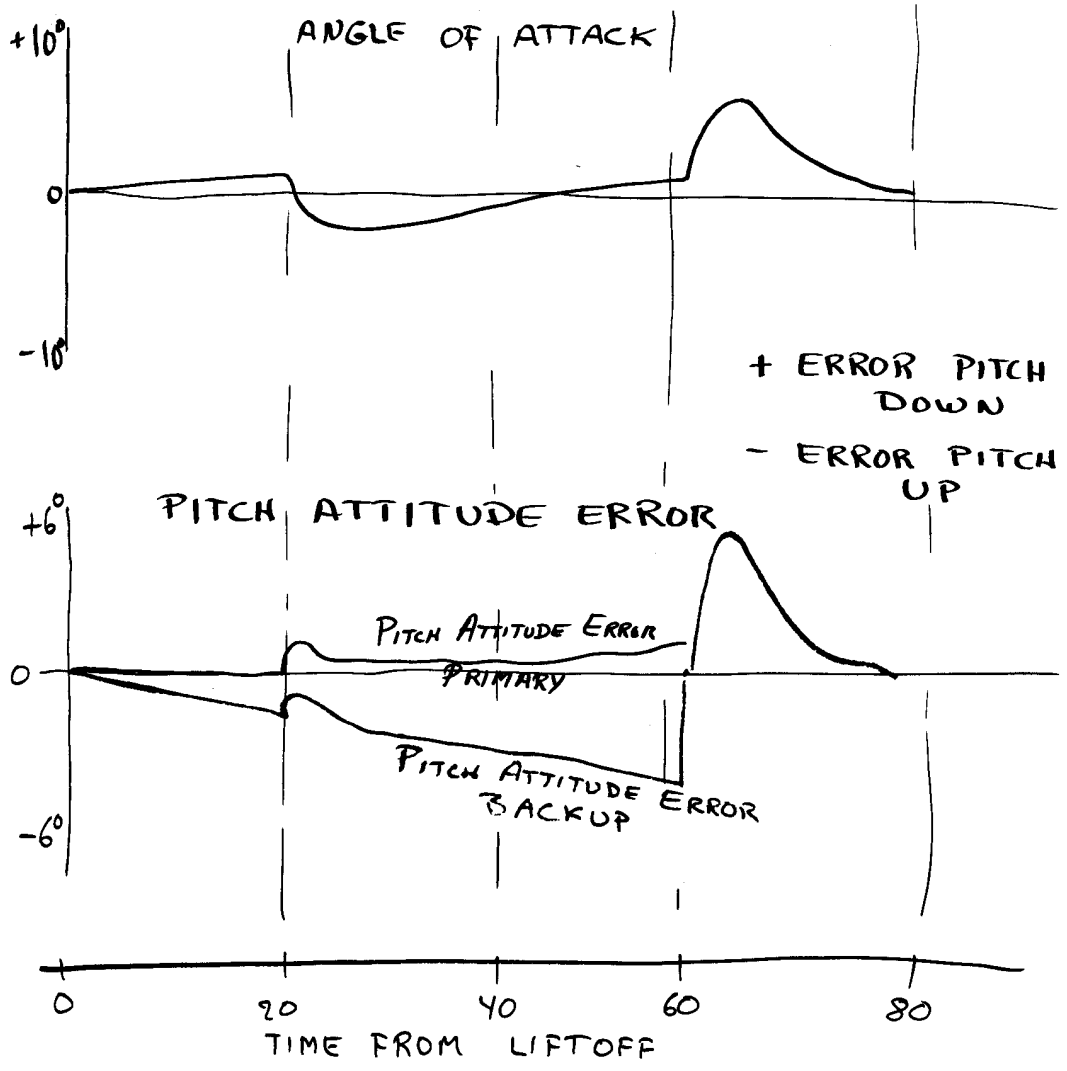
POSITION $$\int_t^{t_c}\int_t^{t_c} a_T \sin\beta_p \, dt = h_f - h(t) - \int_t^{t_c} \dot{h}(t)\, dt = -B$$

ADDITIONAL FEATURES

- AZIMUTH & VELOCITY UPDATES
- SWITCHOVER FADE-IN
- OPTIONAL EXPLICIT YAW STEERING

TYPICAL

SLOW MALFUNCTION



CABIN DISPLAYS

FDI's

IVI's

Three Malfunction Lights

- COMPUTER
- ACCELEROMETER
- ATTITUDE

CATCH-UP
&
RENDEZVOUS

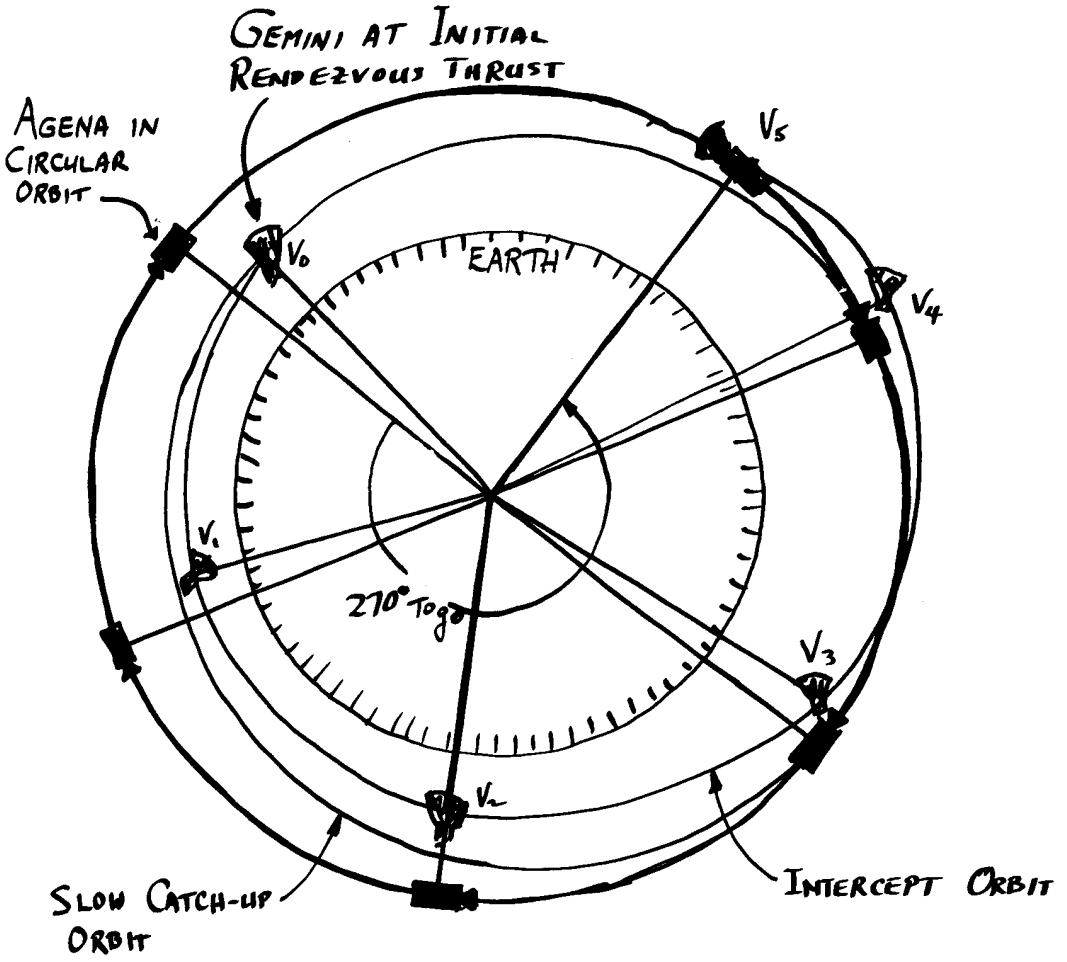
ORBIT DATA

	HEIGHT	PERIOD	i
TARGET	161 n mi	5400 s	28.5°

GEMINI	HEIGHT	CATCH-UP RATE	i
FAST-	87–161	5.3	28.72°
SLOW-≈	144-161	1.2	28.72°

INTERCEPT- DEPENDS UPON INITIAL MANEUVER AT 270° TO GO.

Typical Rendezvous (in plane)



V_0 = Main Thrust

V_1 = Vernier Thrust at 210° To G.

V_2 = Vernier Thrust at 150° To G.

V_3 = Vernier Thrust 90° To G.

V_4 = Vernier Thrust 30° To G.

V_5 = Braking and Docking

IGS FEATURES

CATCH-UP

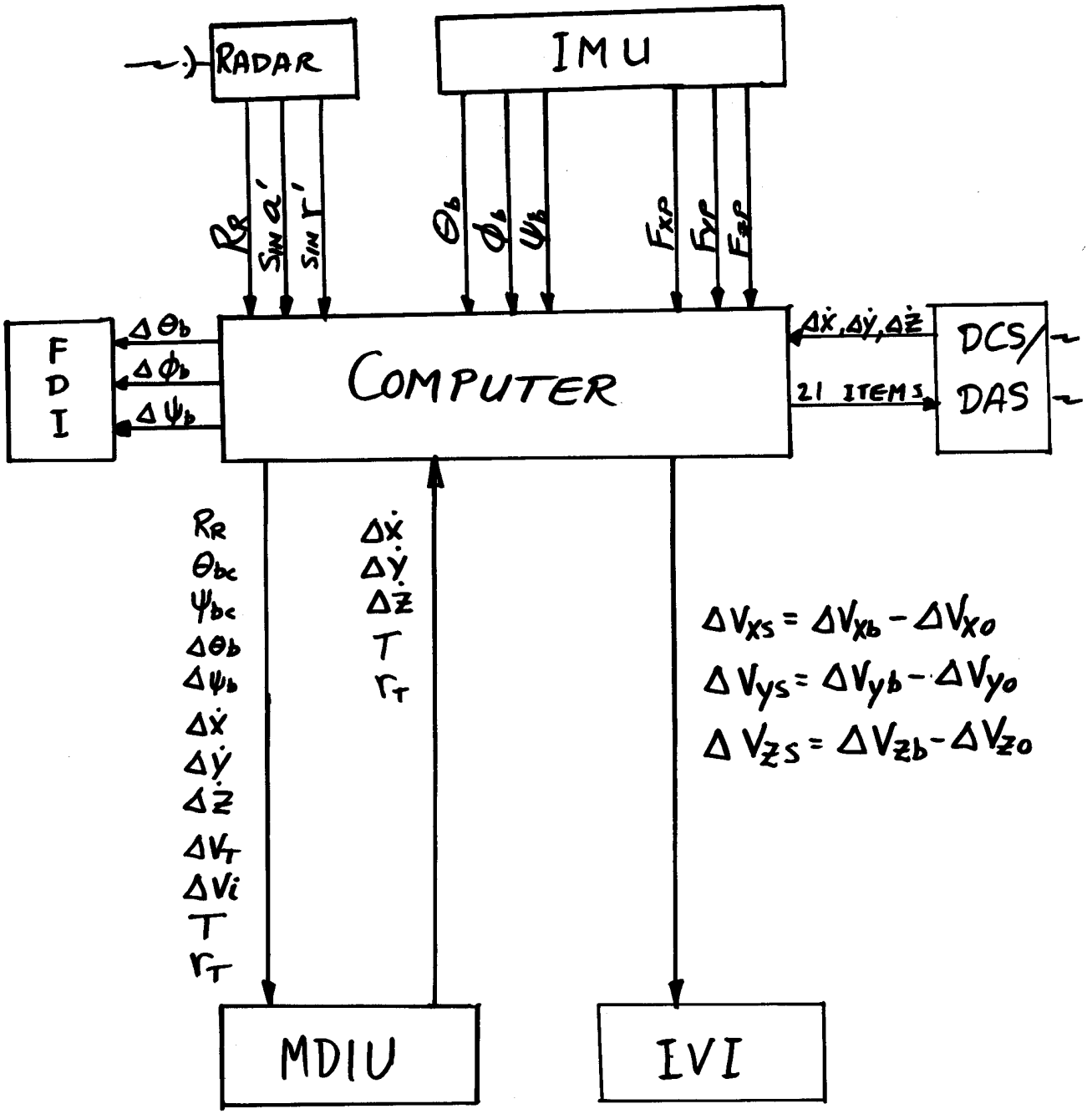
- ACCEPTS DCS OR MDIU INPUTS FOR MANEUVERING $(\Delta\dot{x}, \Delta\dot{y}, \Delta\dot{z})$
- SOLVES FOR THRUST ATTITUDE ERRORS FOR FDI DISPLAY
- COMPUTES BODY ORIENTED VELOCITIES TO BE GAINED FOR IVI DISPLAY
- MONITORS THRUSTING TO COUNT DOWN IVI DISPLAY
- TELEMETRY OF DAS QUANTITIES

IGS FEATURES

RENDEZVOUS

- STORES RADAR TIME HISTORY
- IGNORES BAD RADAR DATA
- COMPUTES AND DISPLAYS 270° CHARACTERISTIC VELOCITY ($\Delta V_i + \Delta V_f$) USING C/W EQUATIONS
- ACCEPTS ASTRONAUT DECISION TO RENDEZVOUS
- PREDICTS 250 SECONDS AHEAD AND RE-COMPUTES TRANSFER THRUST
- SOLVES FOR THRUST ATTITUDE AND DISPLAYS ERRORS ON FDI.
- ANNOUNCES THE TIME TO INITIATE THRUSTS
- PREDICTS RADAR LOS ATTITUDE FOR RE-ACQUISITION
- MONITORS THRUST TO COUNT DOWN IVI
- COMMANDS ATTITUDE FOR PLATFORM GYROCOMPASSING
- COMMANDS RE-ACQUISITION MANEUVER
- TELEMETRY OF DAS QUANTITIES

DATA FLOW DIAGRAM



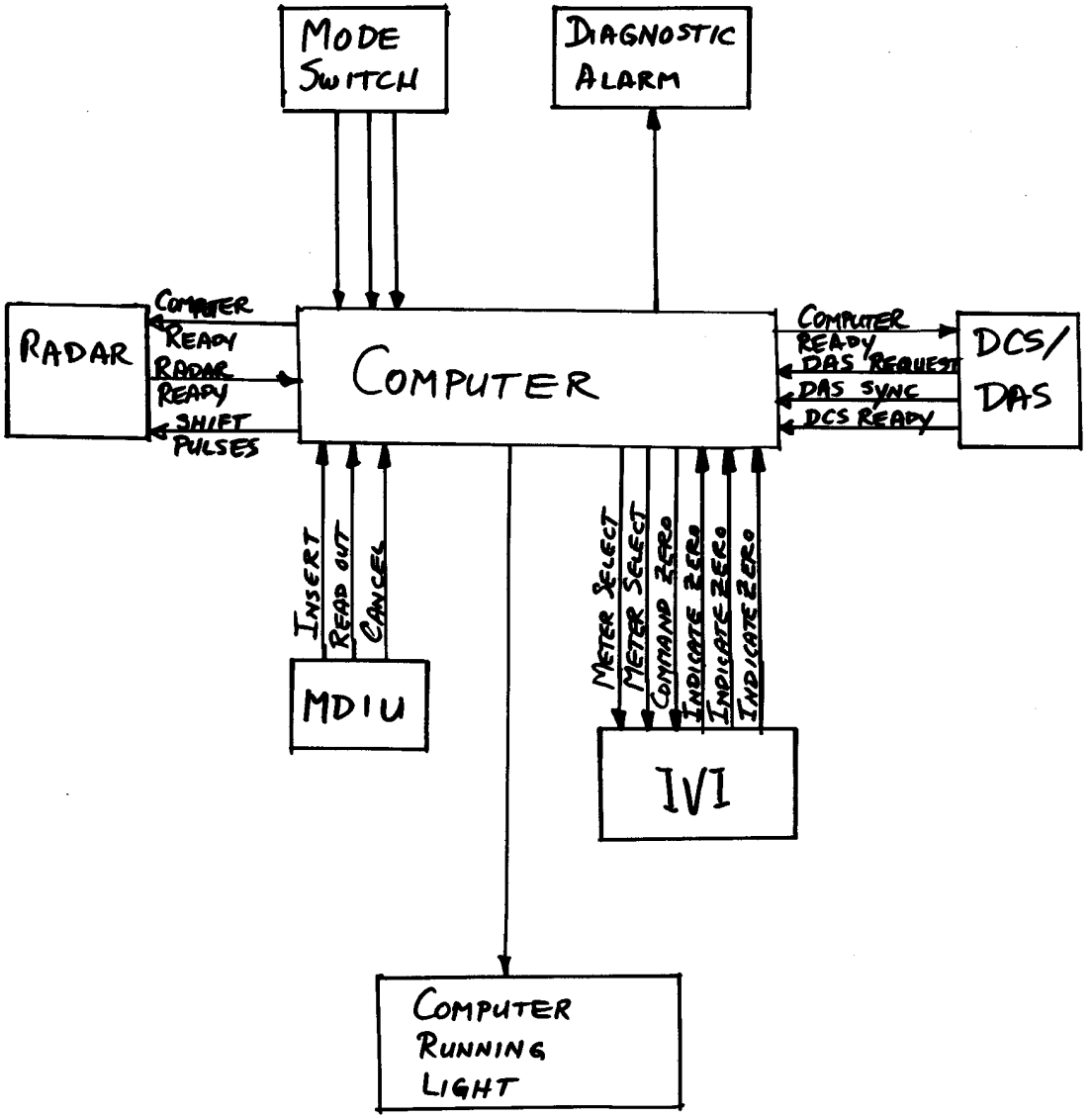
DAS QUANTITIES

1	θ_b
2	ψ_b
3	ϕ_b
4	$SF_{x'}$
5	$SF_{y'}$
6	$SF_{z'}$
7	t
8	FTAG
9	V_{xo}
10	V_{yo}
11	V_{zo}
12	θ_{bc}
13	ψ_{bc}
14	T_x
15	ΔV_{xm}
16	ΔV_{ym}
17	ΔV_{zm}
18	R_R
19	SIN a'
20	SIN r'
21	T_M

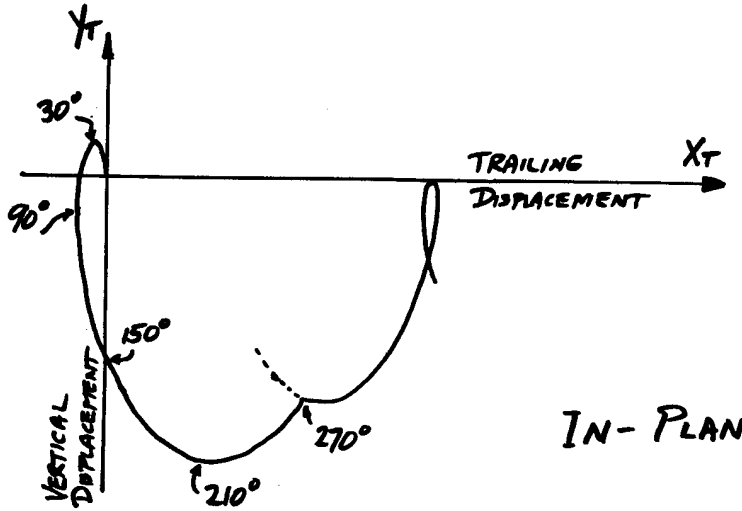
DATA QUANTITIES

PARAMETER	QUANTIZATION	RANGE
R_R	49.178 ft.	1,510,797 ft
$\sin a'$	0.001	0 -.425
$\sin r'$	0.001	0 -.425
θ_b	0°.036	0 - 360°
ϕ_b	0°.036	0 - 360°
ψ_b	0°.036	0 - 360°
F_{XP}	0.11 ft/sec	±440 ft/sec
F_{YP}	0.11 ft/sec	±440 ft/sec
F_{ZP}	0.11 ft/sec	±440 ft/sec
$\Delta\theta_b$	0°.0666 0°.4	± 20°
$\Delta\phi_b$	0°.0666 0°.4	± 20°
$\Delta\psi_b$	0°.0666 0°.4	± 20°
ΔV_{Xb}	1 ft/sec	± 999 ft/sec
ΔV_{Yb}	1 ft/sec	± 999 ft/sec
ΔV_{Zb}	1 ft/sec	± 999 ft/sec

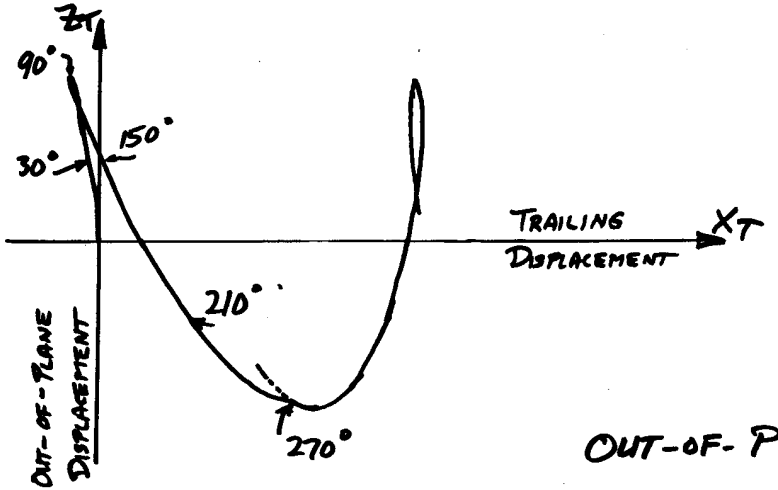
DISCRETES


MODE SWITCH
DIAGNOSTIC ALARM
RADAR
COMPUTER READY
RADAR READY
SHIFT PULSES
COMPUTER
COMPUTER READY
DAS REQUEST
DAS SYNC
DCS READY
DCS/ DAS
INSERT
READ OUT
CANCEL
MDIU
METER SELECT
METER SELECT
COMMAND ZERO
INDICATE ZERO
INDICATE ZERO
INDICATE ZERO
IVI
COMPUTER RUNNING LIGHT

Typical Relative Trajectories

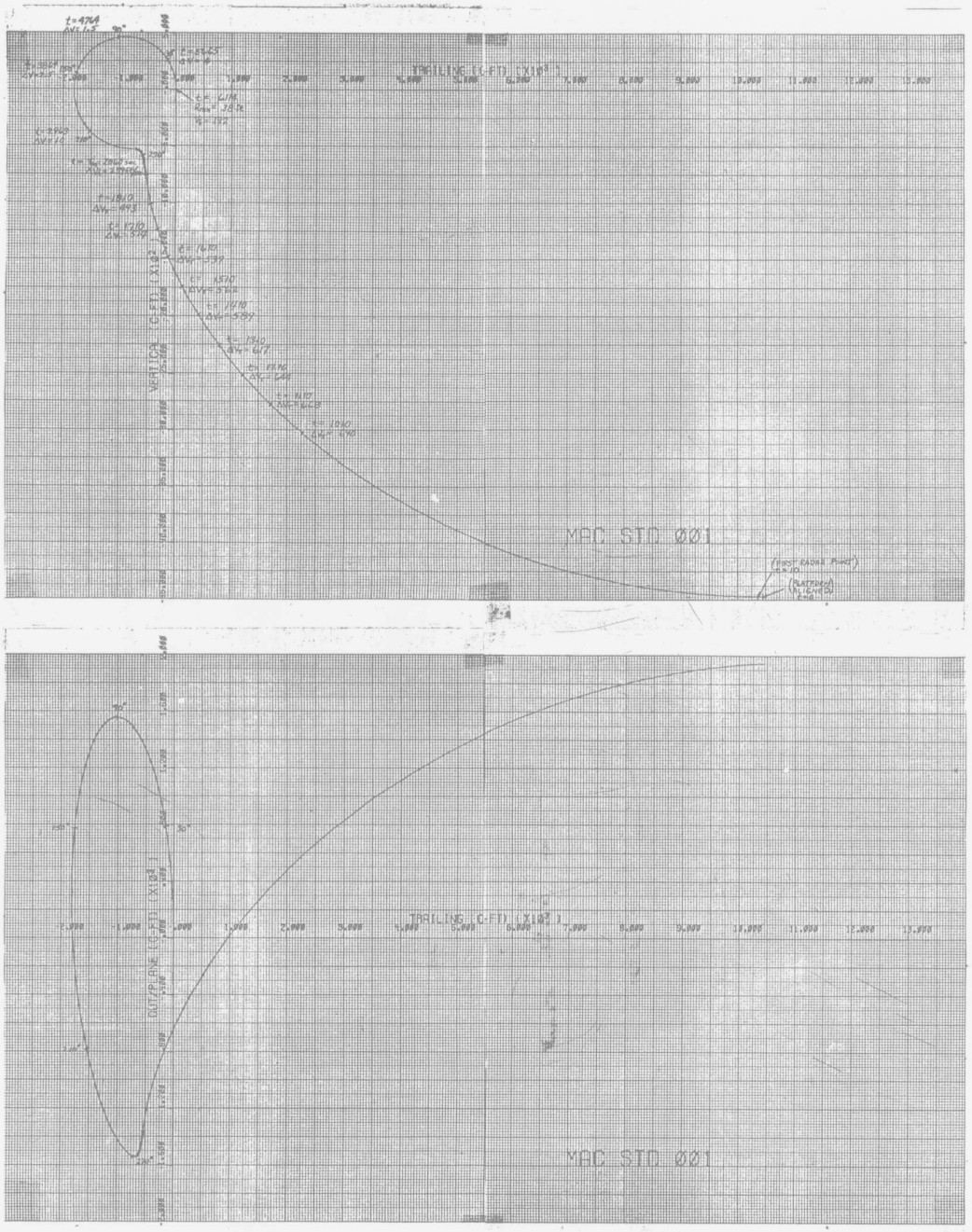


In-Plane

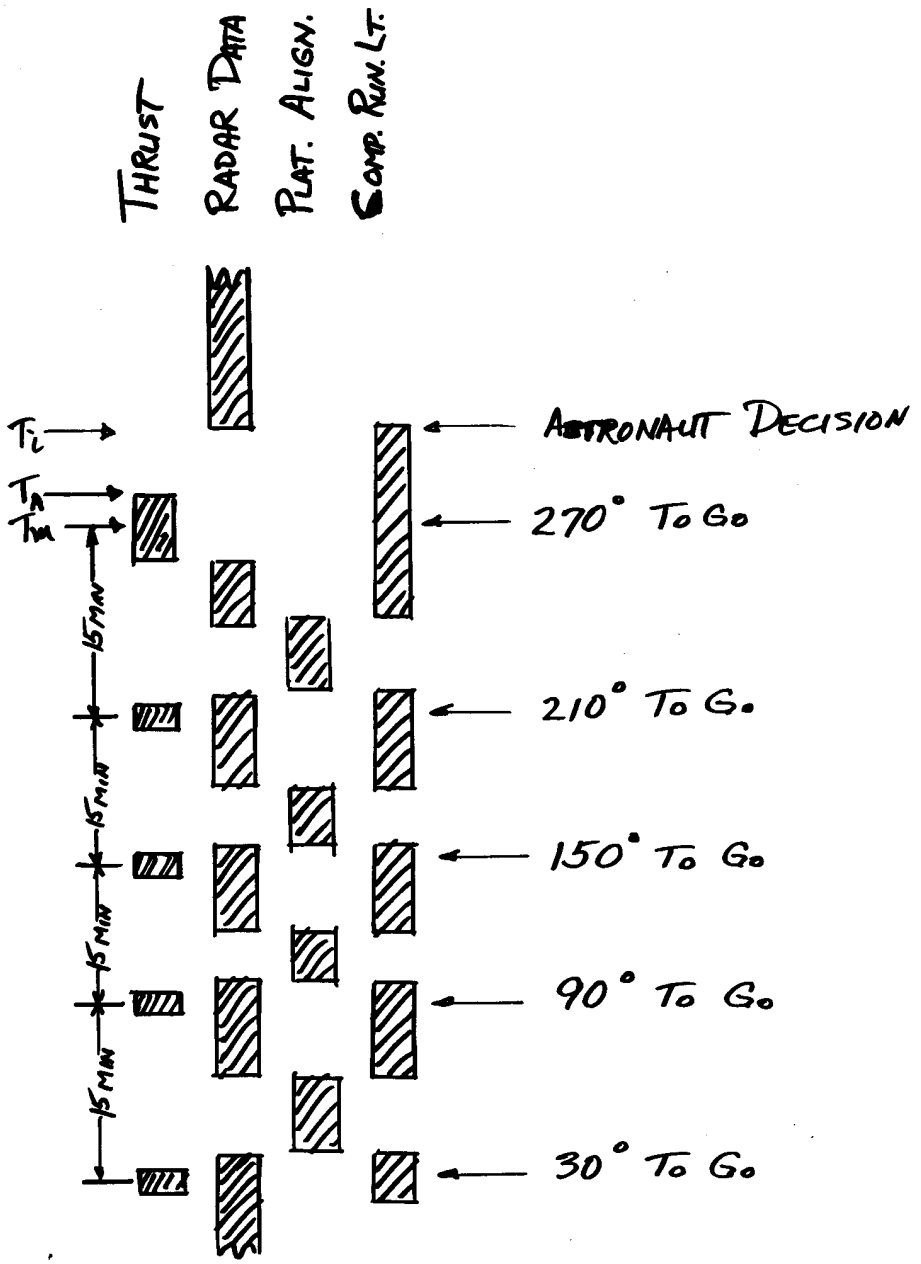


Out-of-Plane

RENDEZVOUS AT FIRST APOGEE



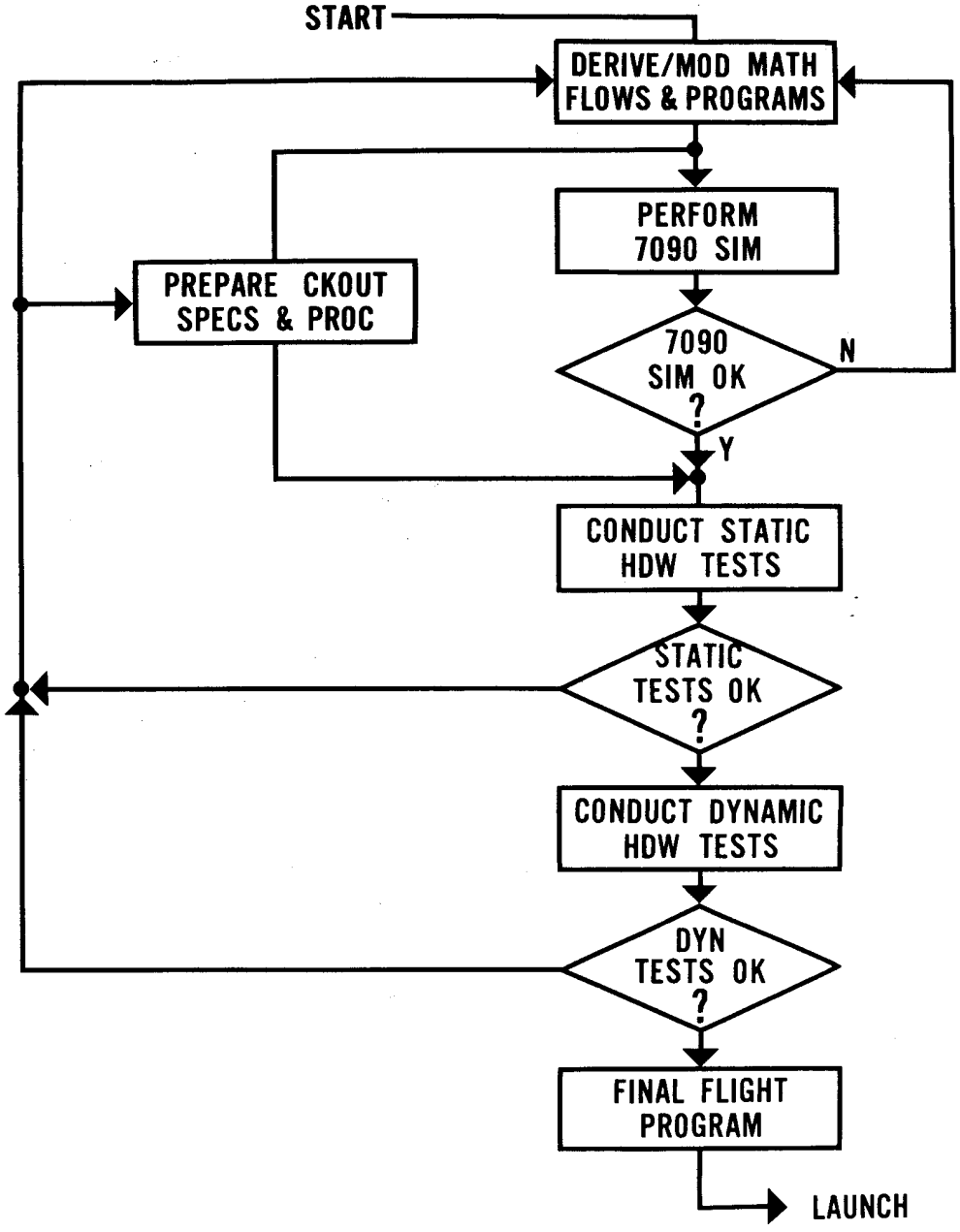
EVENT CHART

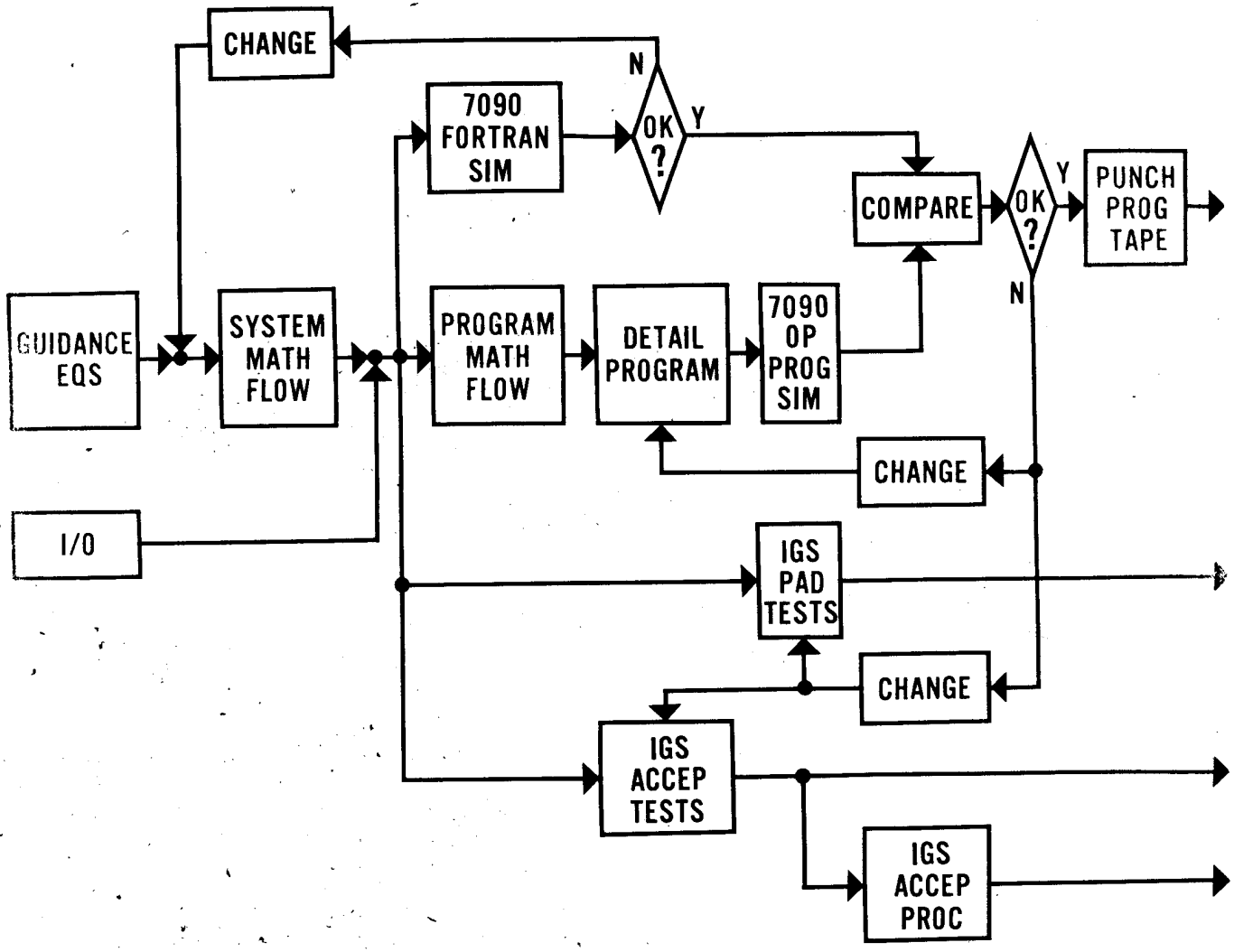

THRUST
RADAR DATA
PLAT. ALIGN.
COMP. RUN. LT.
T_L
T_A
T_M
15 MIN
15 MIN
15 MIN
15 MIN
ASTRONAUT DECISION
270° TO GO
210° TO GO
150° TO GO
90° TO GO
30° TO GO

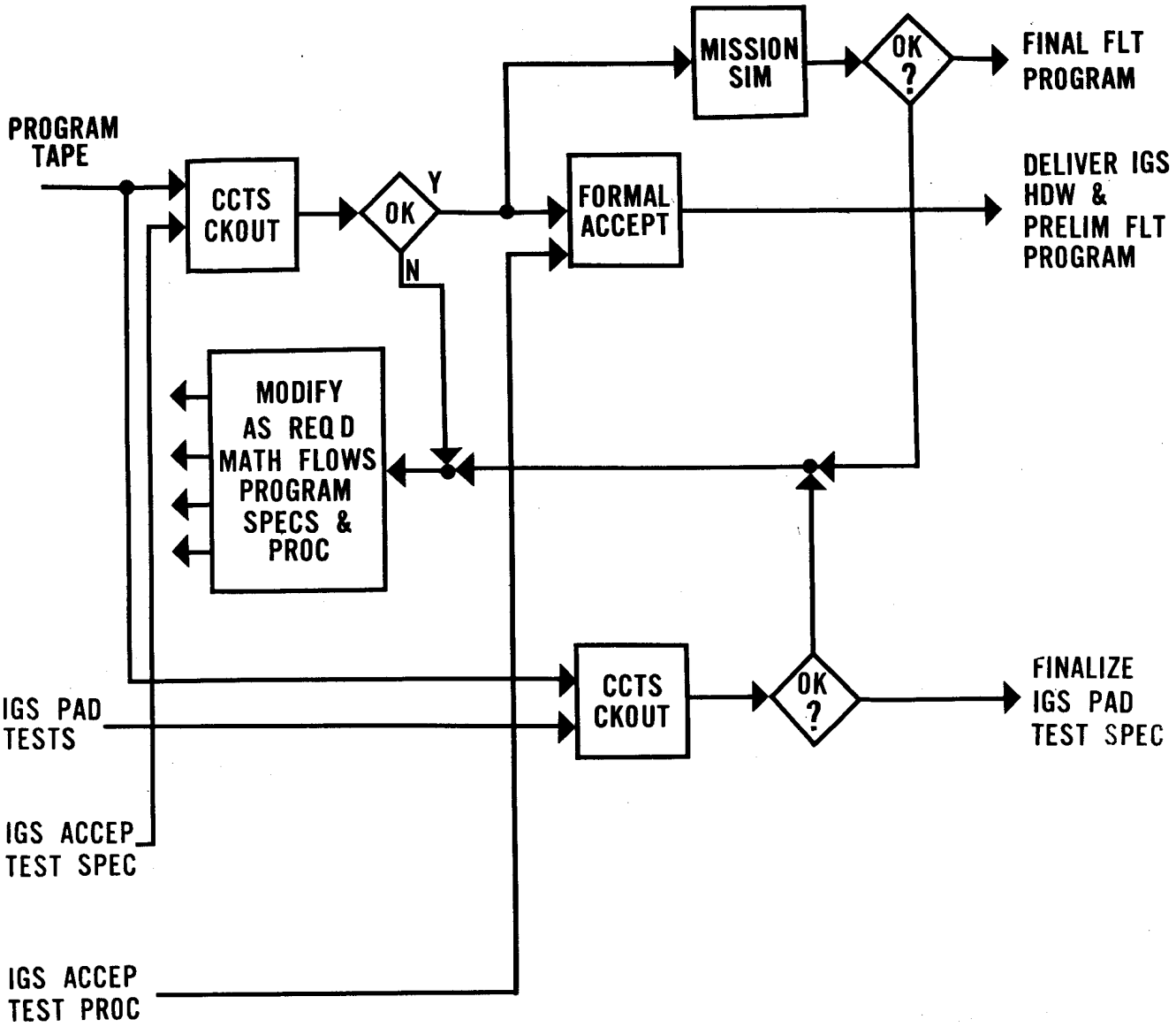
IGS COMPUTER

FLIGHT PROGRAM

- DESCRIBE HOW PROGRAM IS DERIVED OR MODIFIED
- DESCRIBE STEPS IN VERIFICATION OF PROGRAM FLIGHT READINESS
- REVIEW IMPACTS OF PROGRAM MODIFICATION


START
DERIVE/MOD MATH FLOWS & PROGRAMS
PERFORM 7090 SIM
PREPARE CKOUT SPECS & PROC
7090 SIM OK ?
N
Y
CONDUCT STATIC HDW TESTS
STATIC TESTS OK ?
CONDUCT DYNAMIC HDW TESTS
DYN TESTS OK ?
FINAL FLIGHT PROGRAM
LAUNCH


CHANGE
N
7090 FORTRAN SIM
OK ?
Y
COMPARE
OK ?
Y
PUNCH PROG TAPE
N
GUIDANCE EQS
SYSTEM MATH FLOW
PROGRAM MATH FLOW
DETAIL PROGRAM
7090 OP PROG SIM
CHANGE
I/O
IGS PAD TESTS
CHANGE
IGS ACCEP TESTS
IGS ACCEP PROC


PROGRAM TAPE
CCTS CKOUT
OK
Y
N
MISSION SIM
OK ?
FINAL FLT PROGRAM
FORMAL ACCEPT
DELIVER IGS HDW & PRELIM FLT PROGRAM
MODIFY AS REQ D MATH FLOWS PROGRAM SPECS & PROC
IGS PAD TESTS
CCTS CKOUT
OK ?
FINALIZE IGS PAD TEST SPEC
IGS ACCEP TEST SPEC
IGS ACCEP TEST PROC

PROGRAM VERIFICATION

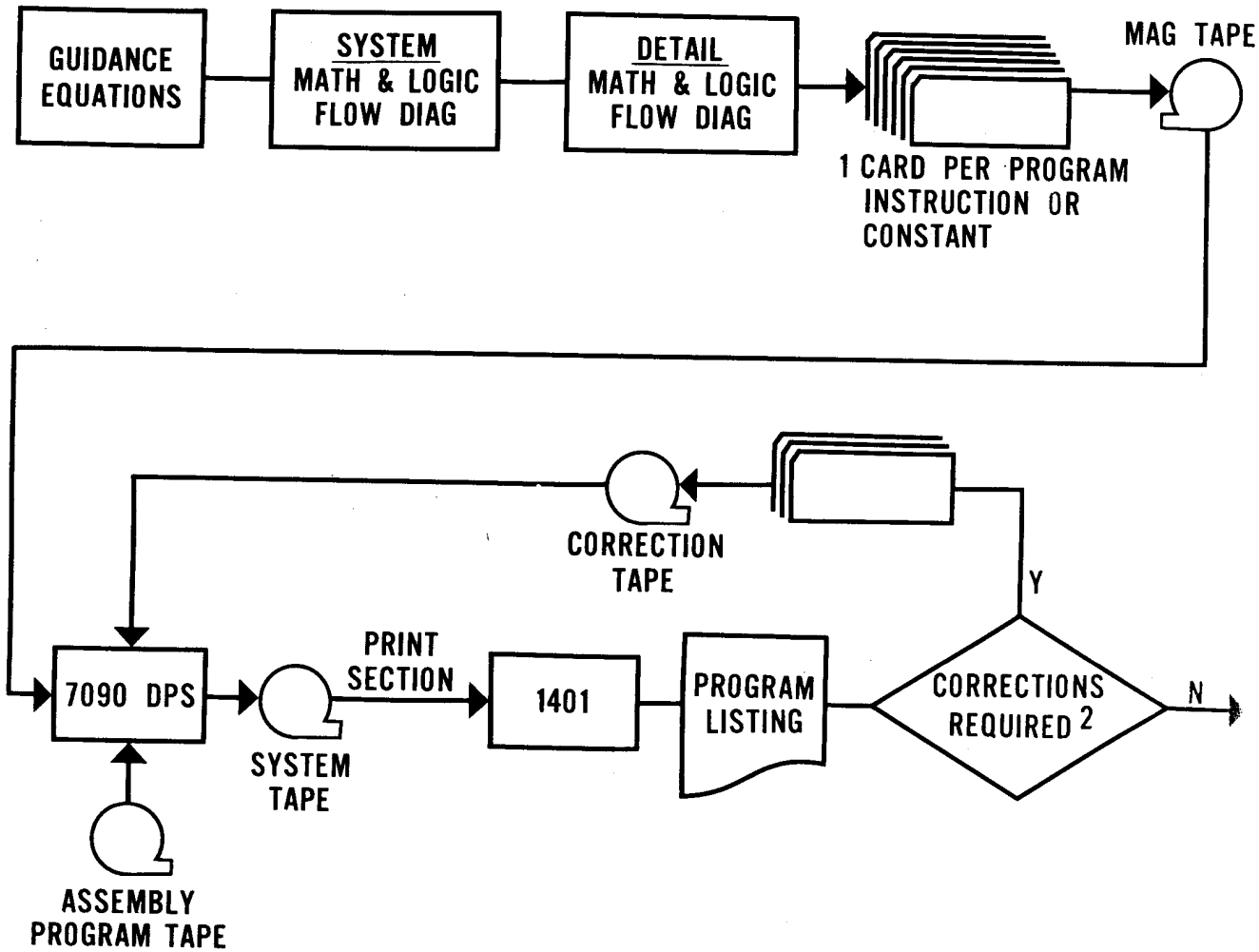
STEP 1 - SIMULATE SYSTEM MATH FLOW

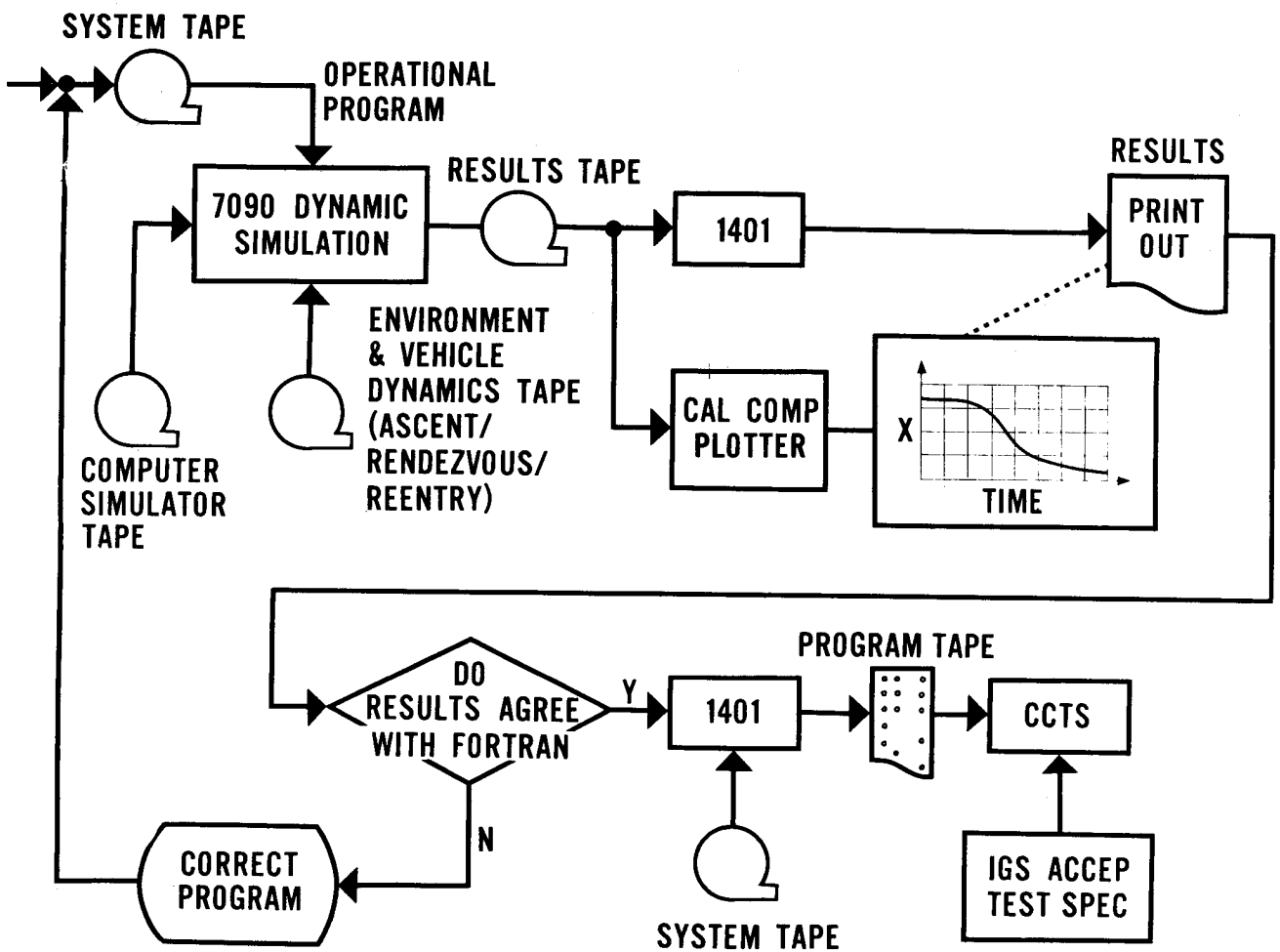
- ALL DIGITAL 7090 SIMULATION
- ALL MODES DYNAMICALLY SIMULATED
- CHECK SYSTEM MATH
- DERIVE IGS MODE TESTS

PROGRAM VERIFICATION

STEP 2 - SIMULATE PROGRAM MATH FLOW

- ALL DIGITAL 7090 SIMULATION
- EMPLOYS SIMULATED GEMINI COMPUTER & ACTUAL OPERATIONAL PROGRAM
- RESULTS COMPARED WITH FORTRAN RUNS TO VALIDATE OPERATIONAL PROGRAM
- DERIVE PARAMETER TOLERANCES FOR IGS MODE TESTS


GUIDANCE EQUATIONS
SYSTEM MATH & LOGIC FLOW DIAG
DETAIL MATH & LOGIC FLOW DIAG
MAG TAPE
1 CARD PER PROGRAM INSTRUCTION OR CONSTANT
CORRECTION TAPE
Y
7090 DPS
PRINT SECTION
1401
PROGRAM LISTING
CORRECTIONS REQUIRED 2
N
SYSTEM TAPE
ASSEMBLY PROGRAM TAPE


SYSTEM TAPE
OPERATIONAL PROGRAM
7090 DYNAMIC SIMULATION
RESULTS TAPE
1401
RESULTS
PRINT OUT
ENVIRONMENT & VEHICLE DYNAMICS TAPE (ASCENT/ RENDEZVOUS/ REENTRY)
COMPUTER SIMULATOR TAPE
CAL COMP PLOTTER
X
TIME
DO RESULTS AGREE WITH FORTRAN
Y
N
PROGRAM TAPE
1401
CCTS
CORRECT PROGRAM
SYSTEM TAPE
IGS ACCEP TEST SPEC

PROGRAM VERIFICATION

STEP 3 - CCTS CHECKOUT

- DEBUG IGS ACCEPTANCE TESTS, PAD TESTS, & OPERATIONAL PROGRAM
- ALL TESTS CONDUCTED WITH IGS UNITS & /OR HARDWARE SIMULATORS
- PRIMARILY A STATIC TEST AS INPUTS GENERALLY REMAIN CONSTANT

PROGRAM VERIFICATION

STEP 4 - FORMAL ACCEPTANCE

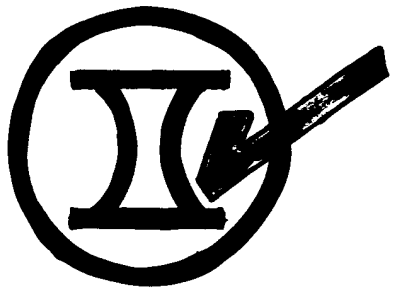
- UTILIZES IGS ACCEPTANCE TEST PROCEDURE DERIVED FROM IGS ACCEPTANCE TEST SPECIFICATION
- TESTS CONDUCTED ON DELIVERABLE IGS
- RESULTS IN DELIVERABLE PRELIMINARY FLIGHT PROGRAM

PROGRAM VERIFICATION

STEP 5 - MISSION SIMULATIONS

- DYNAMIC MISSION SIMULATION CONDUCTED ON ACTUAL IGS HARDWARE & HARDWARE SIMULATORS
- UTILIZES 7090 TO SIMULATE IGS ENVIRONMENT (e.g., S/C DYNAMICS, GRAVITY, ATMOSPHERICS)
- INPUTS & OUTPUTS VARY AS IN ACTUAL FLIGHT
- INDIVIDUAL MODES SIMULATED FIRST- THEN COMPLETE MISSION
- RESULTS IN FINALIZING OPERATIONAL FLIGHT PROGRAM

GEMINI MISSION VERIFICATION SIMULATION



MISSION SIMULATION with HARDWARE in the LOOP

- Real Time
- Closed Loop
- Realistic Missions

PURPOSE :

Qualify Operational Program for Flight

Simulation Components

Hardware

DC	BB#1, Prod#9
MDR	Prototype
MDK	"
IVI	"
IGS PS	"
TRS	"
ADG	"
ACE Loads	Interface Simulator
GLV Loads	"
DAS	"
DCS	Dynamic Simulator
Radar	"
IMU	"
Discrete Controls & Displays	Mock-up

Facilities of System Simulation Laboratory

7090 DPS

Simulation Components

Software

- Data Control Program
  - Interface Test Routines
  - Data Transfer & Conversion
  - Data Storage
  - Mode Control
- Ascent Environment
- Rendezvous Environment
- Reentry Environment

  } Revisions of previous simulations

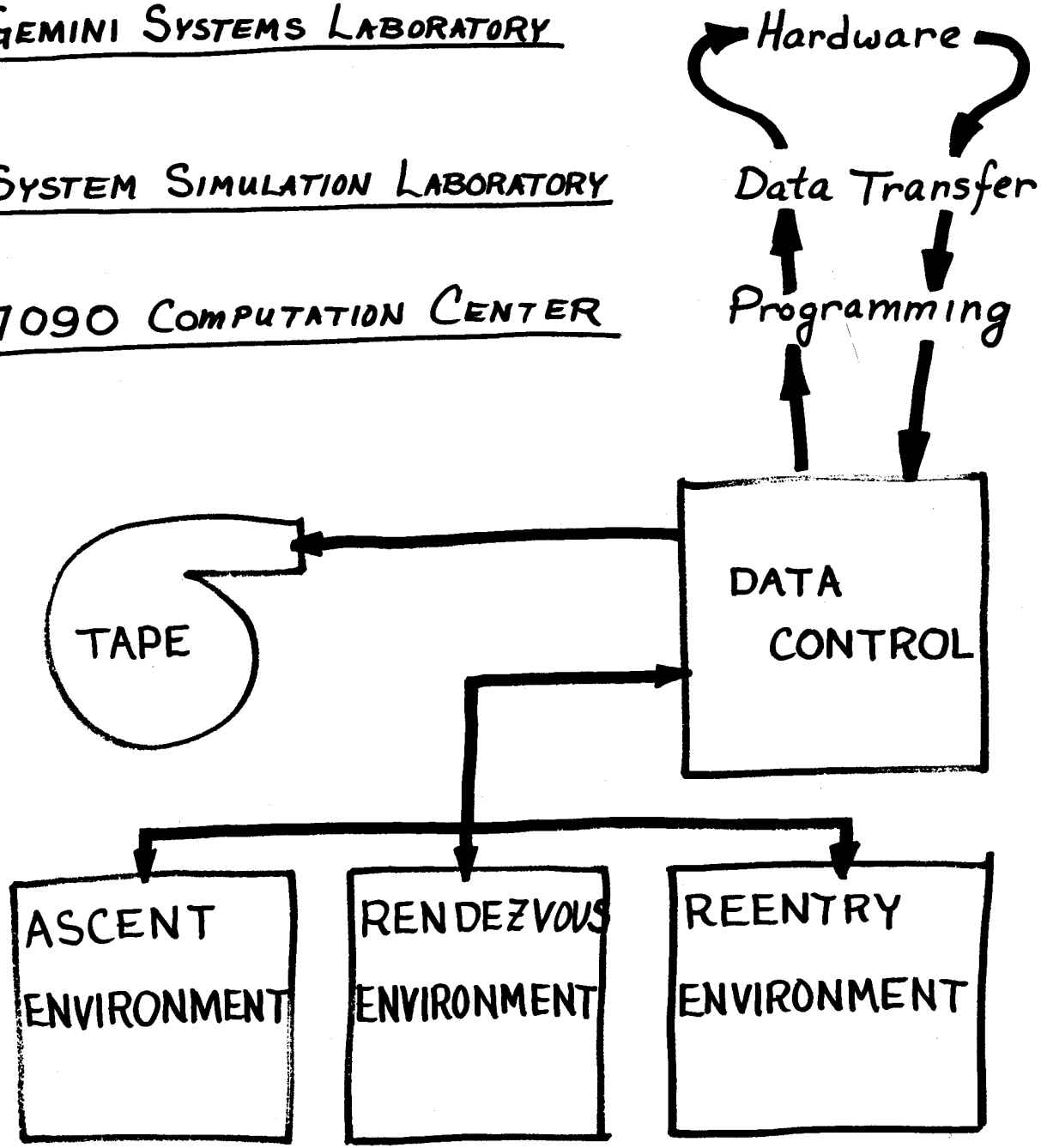
Specific missions assembled from above basic programs

- Data Reduction Program
  - Reduce, Print, Plot
    - DAS, Discrete, Environment Data

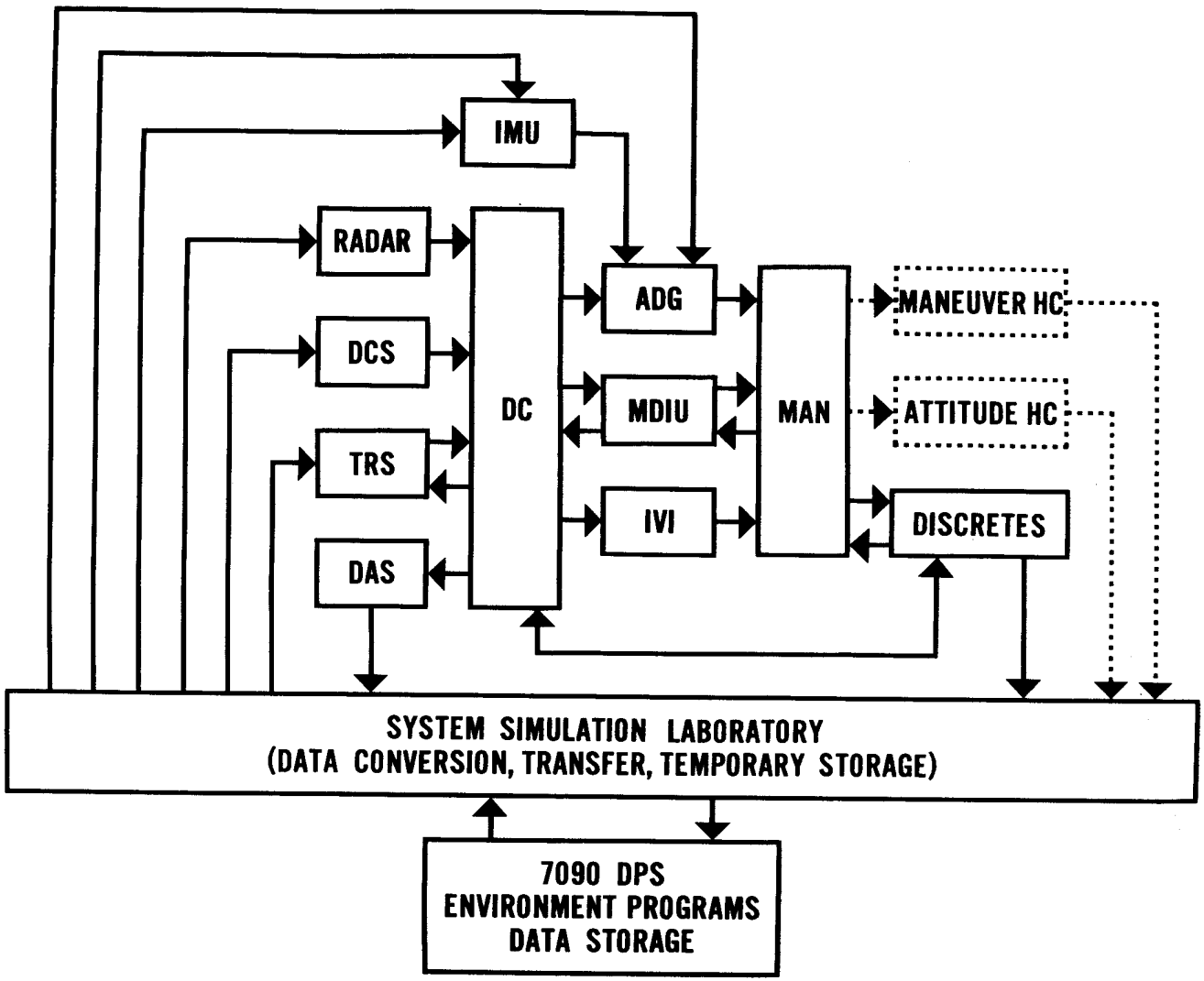
GEMINI SYSTEMS LABORATORY

SYSTEM SIMULATION LABORATORY

7090 COMPUTATION CENTER



MISSION VERIFICATION SIMULATION



PROGRAM MODIFICATION

- COMPUTER MEMORY IS FULL ±2%
- PROGRAM CHANGES REQUIRING ADDITIONAL INSTRUCTIONS DIFFICULT
- ATM PROPOSED AS MEANS OF INCREASING PROGRAM STORAGE CAPABILITY
- ALL PROGRAM CHANGES REQUIRE RE-VERIFICATION OF PROGRAM FLIGHT READINESS

IGS ACCEPTANCE & PAD TESTS

- VERIFY IGS PERFORMANCE AT IBM, MAC, HANGAR, & PAD
- BOTH DOCUMENTS SIMILAR & PRIMARILY CONSIST OF INTERFACE & MODE TESTS
- INTERFACE TESTS CONDUCTED FIRST
- MODE TESTS CONDUCTED PRIMARILY TO VERIFY OPERATIONAL PROGRAM
- PARAMETER TOLERANCES DETERMINED BY EQUIPMENT SPECIFICATIONS & DIGITAL 7090 SIMULATIONS