

LM

ORIENTATION

COURSE NO. 30005-012

For Training Purposes Only

DATE: April 12, 1966
REVISED: November 1966

Prepared by:

Product Support Department

LESSON PLAN

I. Introduction

A. Objective

To provide the student with an orientation of the LM spacecraft. Included will be a brief functional description of each LM operational subsystems to a block diagram level with emphasis on the major signal flow paths.

B. Motivation

In order to provide adequate operational support to the Apollo Mission one must have a basic functional knowledge of LM operational subsystems and the associated subsystem interfaces.

II. Presentation

A. Film - Apollo Lunar Mission Profile

B. LM Basic Design Concept

1. Ascent Stage

- a. Cabin area
- b. Aft equipment bay

2. Descent Stage

3. Summary

C. Crew Station

1. Controls and Display Panels

D. Propulsion Subsystem

1. General Configuration

- a. Descent
- b. Ascent
- c. Reaction Control

2. Descent Propulsion
 - a. Propellant Pressurization
 - b. Propellant Feed
 - c. Engine Control
 3. Ascent Propulsion
 - a. Propellant Pressurization
 - b. Propellant Feed
 - c. Thrust Control
 - d. RCS Crossfeed
 4. Reaction Control
 - a. Cluster Configuration
 - b. Attitude and Translational Control
 - c. Propellant Pressurization
 - d. Propellant Feed
 5. Controls and Displays
 6. Summary
- E. Environmental Control Subsystem
1. Atmosphere Revitalization Section
 - a. Pressure Schedules
 - b. Closed Suit Loop Operation
 - c. Open Suit Loop Operation
 2. Oxygen Supply and Cabin Pressure Control Section
 - a. Tankage
 - b. Descent Feed
 - c. Ascent Feed
 3. Water Management Section
 - a. Tankage
 - b. Descent Feed
 - c. Ascent Feed

4. Heat Transport Section
 - a. Primary Loop Operation
 - b. Secondary Loop Operation
 5. Controls and Displays
 6. Summary
- F. Electrical Power Subsystem
1. General Configuration
 - a. Ascent Stage
 - b. Descent Stage
 2. System Functional Description
 - a. Batteries
 - b. Electrical Control Assembly (ECA)
 - c. Relay Junction Box (RJB)
 - d. Deadface Relay Box (DFRB)
 - e. Inverters
 - f. Electroexplosive Devices
 3. Controls and Displays
 4. Summary
- G. Guidance, Navigation, and Control Subsystem *AI MASA*
1. System Concept
 2. Functional Description
 - a. Hand Controllers
 - b. Primary Guidance and Navigation Section (PGNS)
 - c. Abort Guidance Section (AGS)
 - d. Control Electronics Section (CES)
 3. Controls and Displays
 4. Summary

H. Instrumentation

1. System Concept
2. Functional Description
 - a. Signal Conditioning Electronics Assembly (SCEA)
 - b. Caution and Warning Electronics Assembly (CWEA)
 - c. Pulse Code Modulation Timing Electronics Assembly (PCMTEA)
 - d. Data Storage Electronics Assembly (DSEA)
3. Controls and Displays

I. Communications

1. Operational Capabilities
 - a. IN FLIGHT
 - b. LUNAR STAY
2. System Concept
3. Functional Description
 - a. SIGNAL PROCESSOR ASSEMBLY
 - b. S-Band
 - c. VHF
4. Controls and Displays

J. Final Summary

LM ORIENTATION

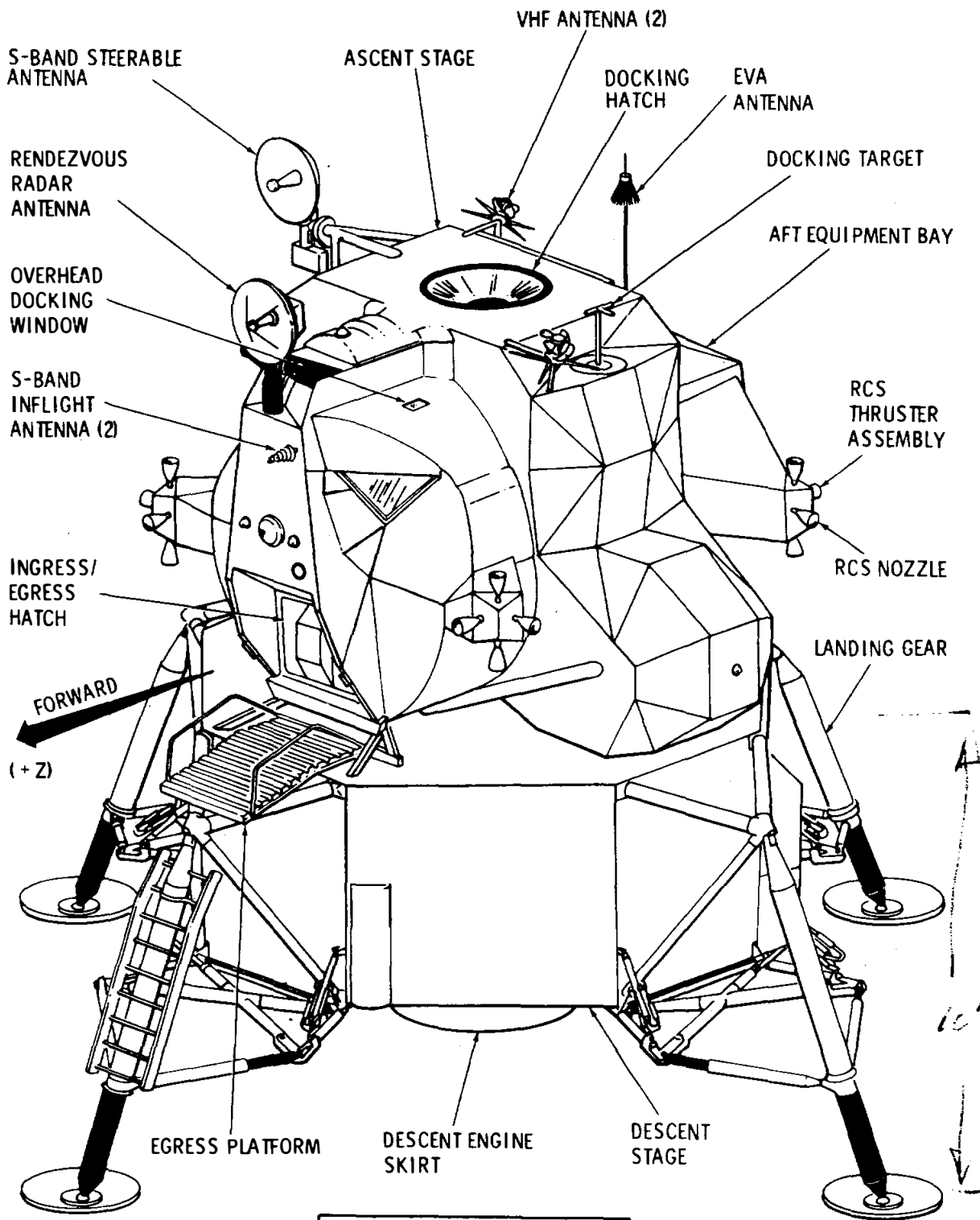
Abbreviation Document

AEA	Abort Electronics Assembly
AGS	Abort Guidance Section
AOT	Alignment Optical Telescope
ARS	Atmospheric Revitalization Section
ASA	Abort Sensor Assembly
ATCA	Attitude and Translation Control Assembly
CES	Control Electronic Section
CM	Command Module
CSM	Command and Service Module
C/W	Caution/Warning
CWEA	Caution and Warning Electronics Assembly
DECA	Descent Engine Control Assembly
DEDA	Data Entry and Display Assembly
DFRB	Deadface Relay Box
DSEA	Data Storage Electronics Assembly
DSKY	Display and Keyboard
ECA	Electric Control Assembly
ECS	Environmental Control Subsystem
EPS	Electrical Power Subsystem
EVA	Extravehicular Astronaut
GN&C	Guidance, Navigation and Control Subsystem

GOX	Gaseous Oxygen
He	Helium
H ₂ O	Water
HTS	Heat Transport Section
IMU	Inertial Measuring Unit
LM	Lunar Module
LGC	LM Guidance Computer
LR	Landing Radar
LUT	Launch Umbilical Tower
MSC	Manned Spacecraft Center (Houston)
MSFN	Manned Space Flight Network
OSCPS	Oxygen Supply and Cabin Pressure Section
Ox	Oxidizer
PCM	Pulse Code Modulation
PCMTEA	Pulse Code Modulation and Timing Electronics Assembly
PGNS	Primary Guidance and Navigation Section
PLSS	Portable Life Support System
RCS	Reaction Control Subsystem
RJB	Relay Junction Box
RR	Rendezvous Radar
S & C	Stabilization and Control
SCA	Signal Conditioner Assembly
SCEA	Signal Conditioning Electronics Assembly

SM	Service Module
TEA	Timing Electronics Assembly
TV	Television
VHF	Very High Frequency (30-300 mc)
WMS	Water Management Section

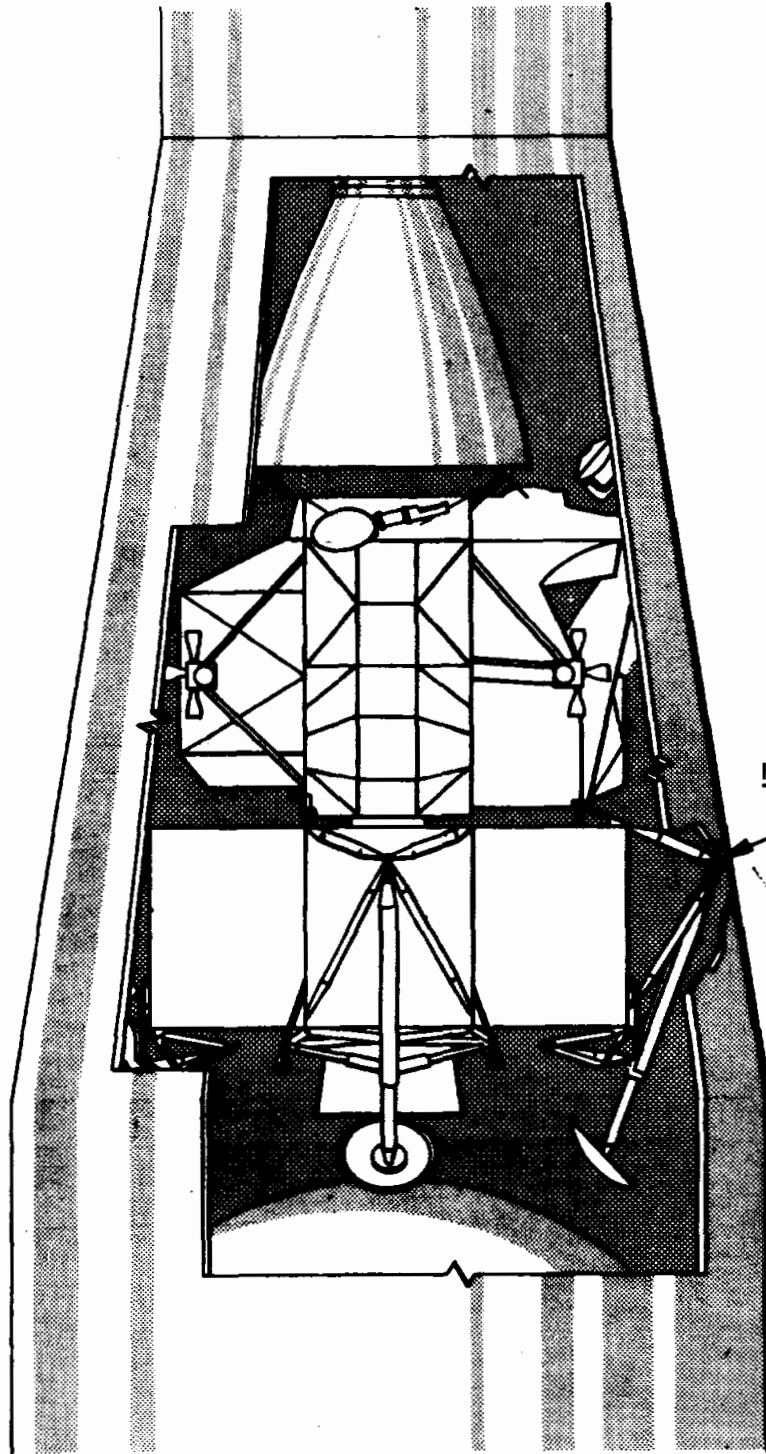
This does not constitute a complete list of IM abbreviations. Grumman document LLI-790-1 may be consulted for abbreviations not listed here.



LM VEHICLE

T30005-15
DEC 66

4:44



LM/SLA
INTERFACE

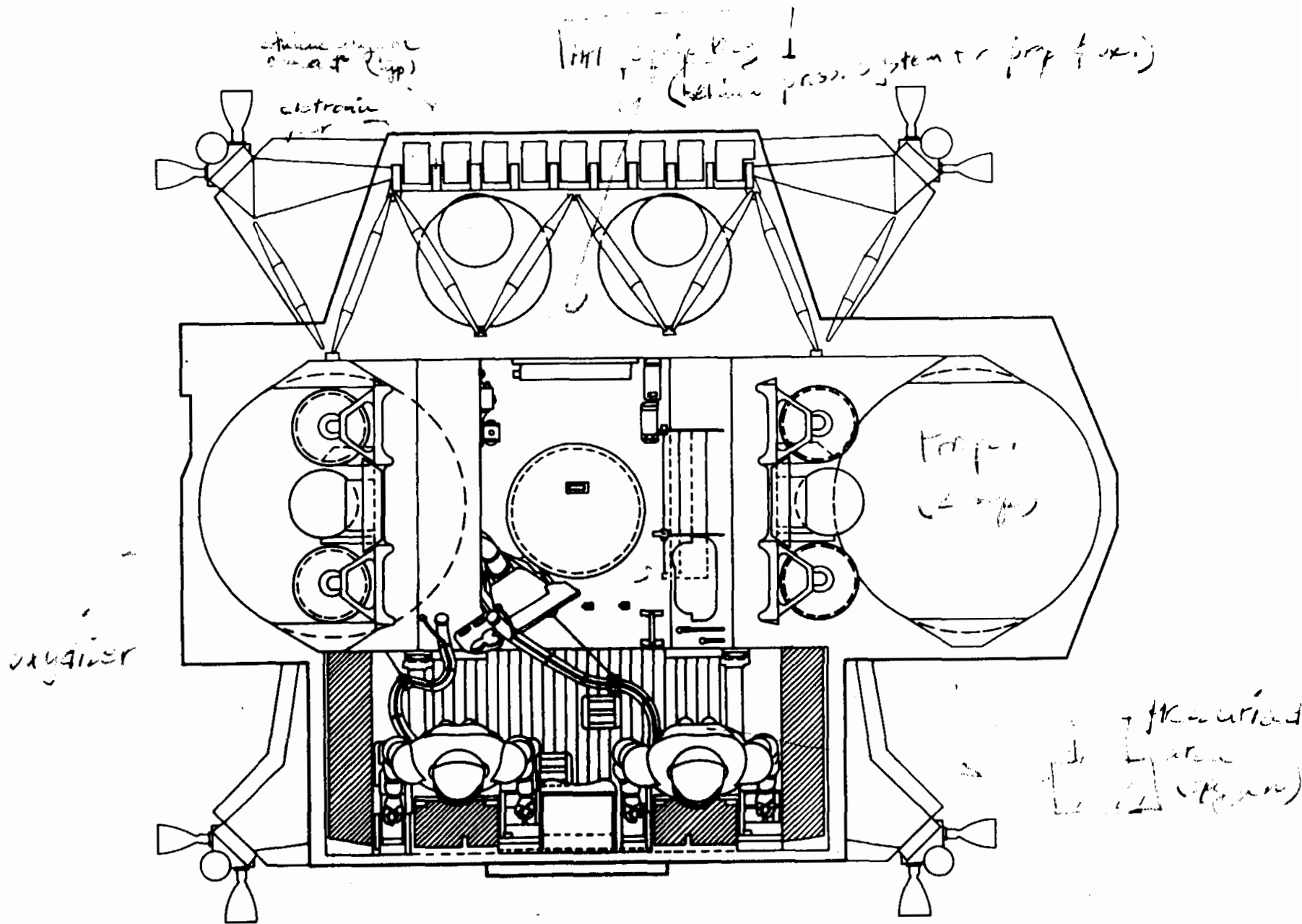
*only 4 attach
points*

SLA pivot pt

LM SLA BOOSTER INTERFACE

T30005-14
DEC 66

How long for transposition & docking?

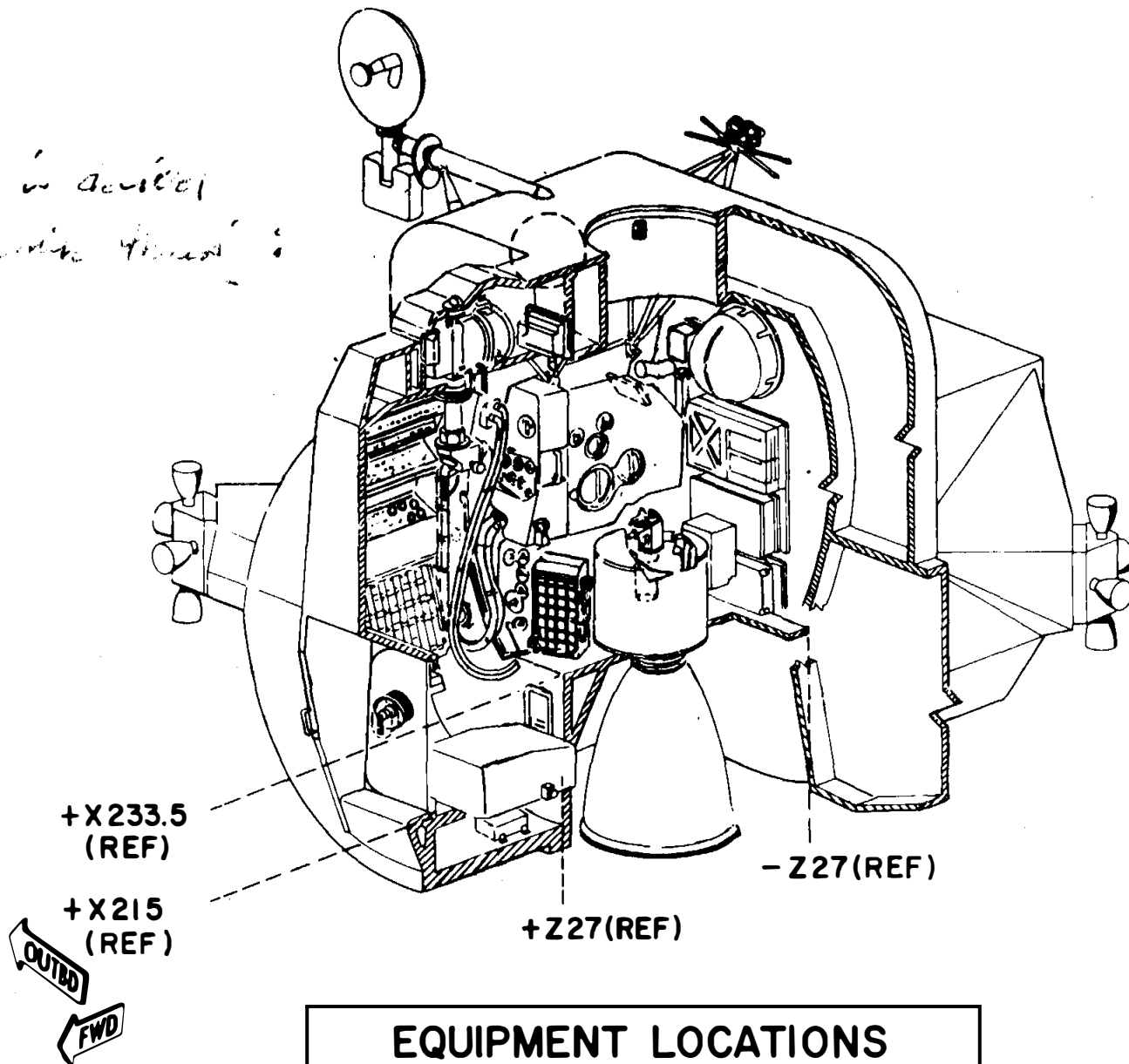


ASCENT STAGE PLAN VIEW

Top View

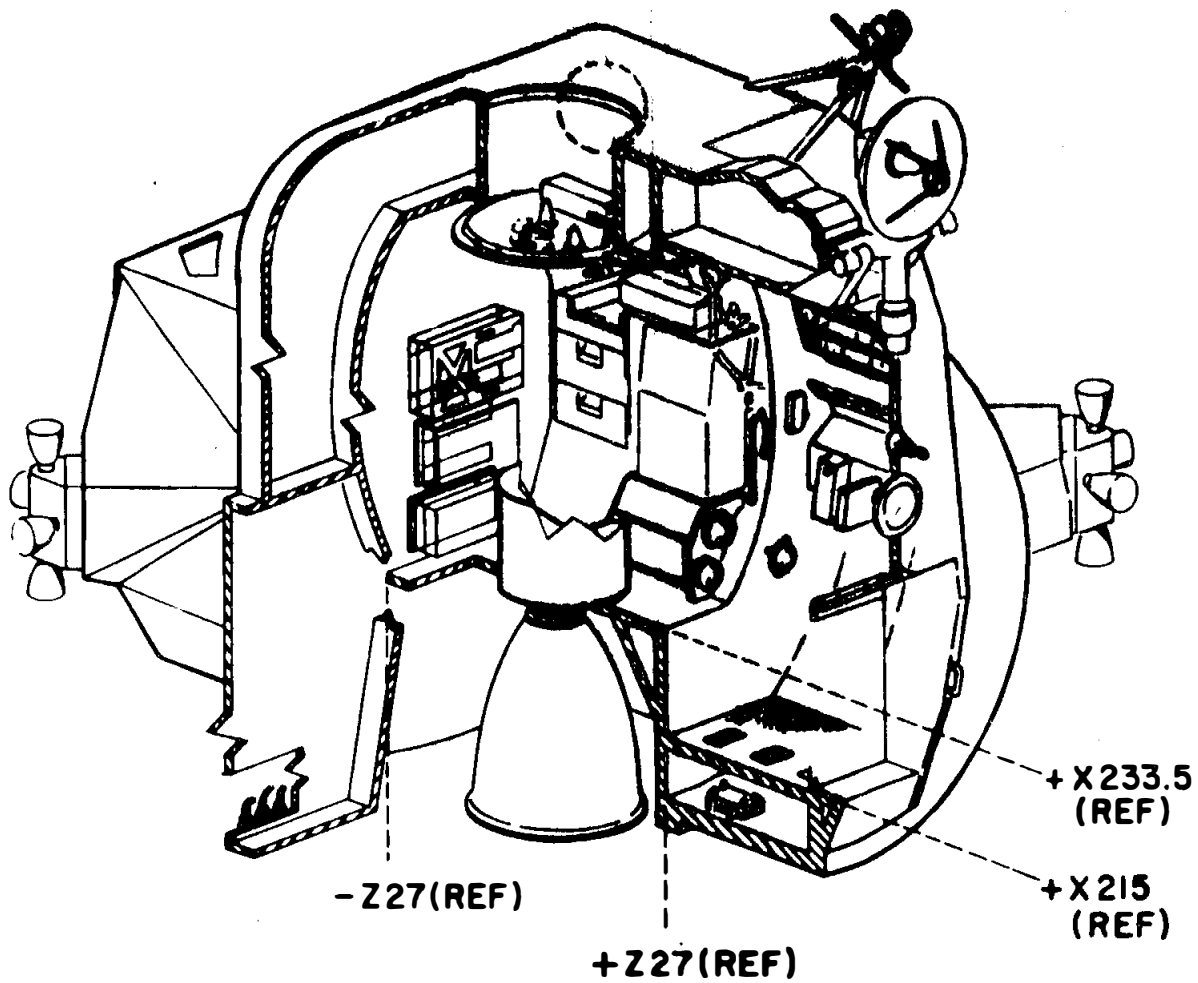
T30005-131
MAP 66

What is needed
and when?



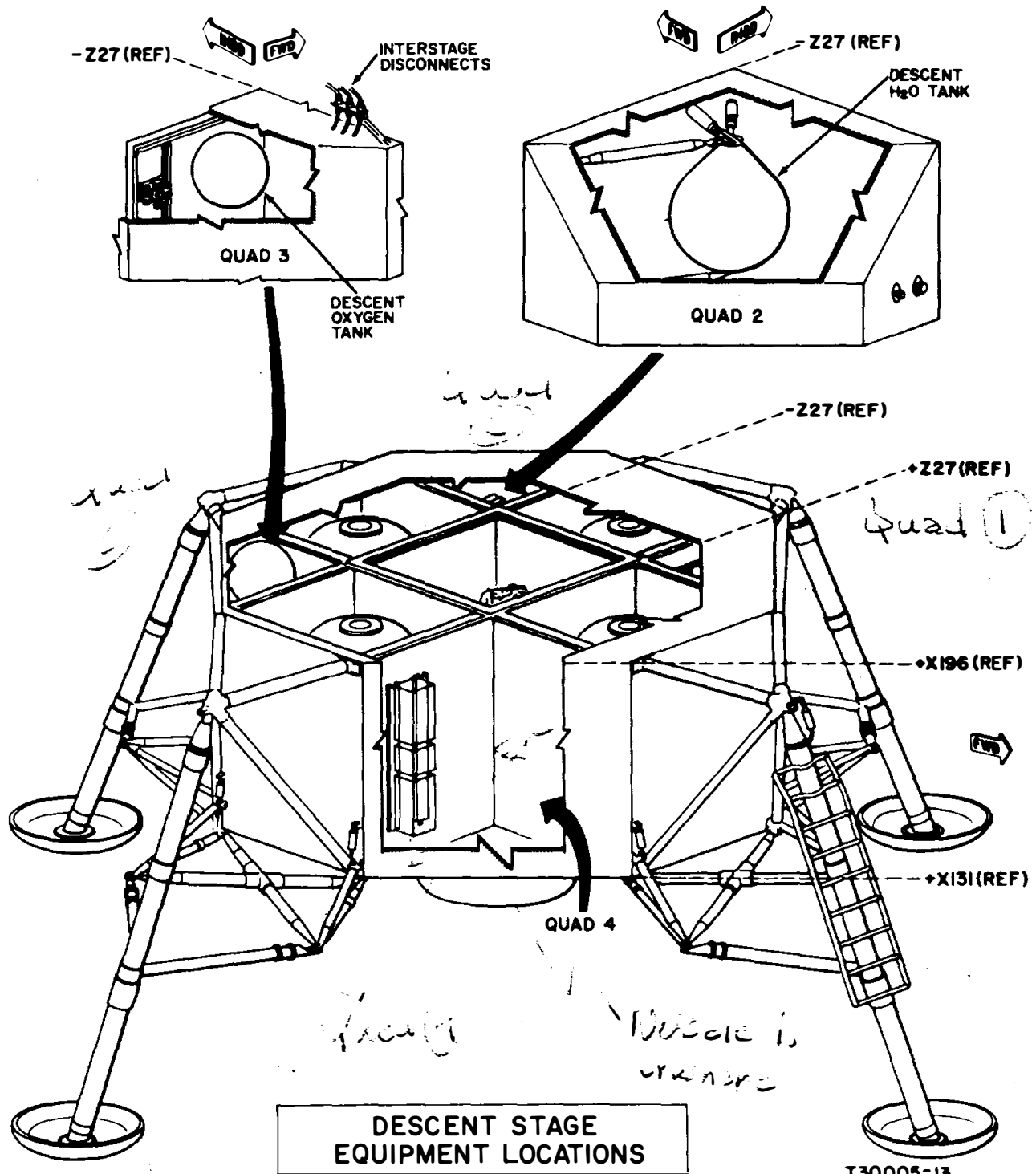
**EQUIPMENT LOCATIONS
ASCENT STAGE-R/H SIDE**

T30005-32
NOV 66

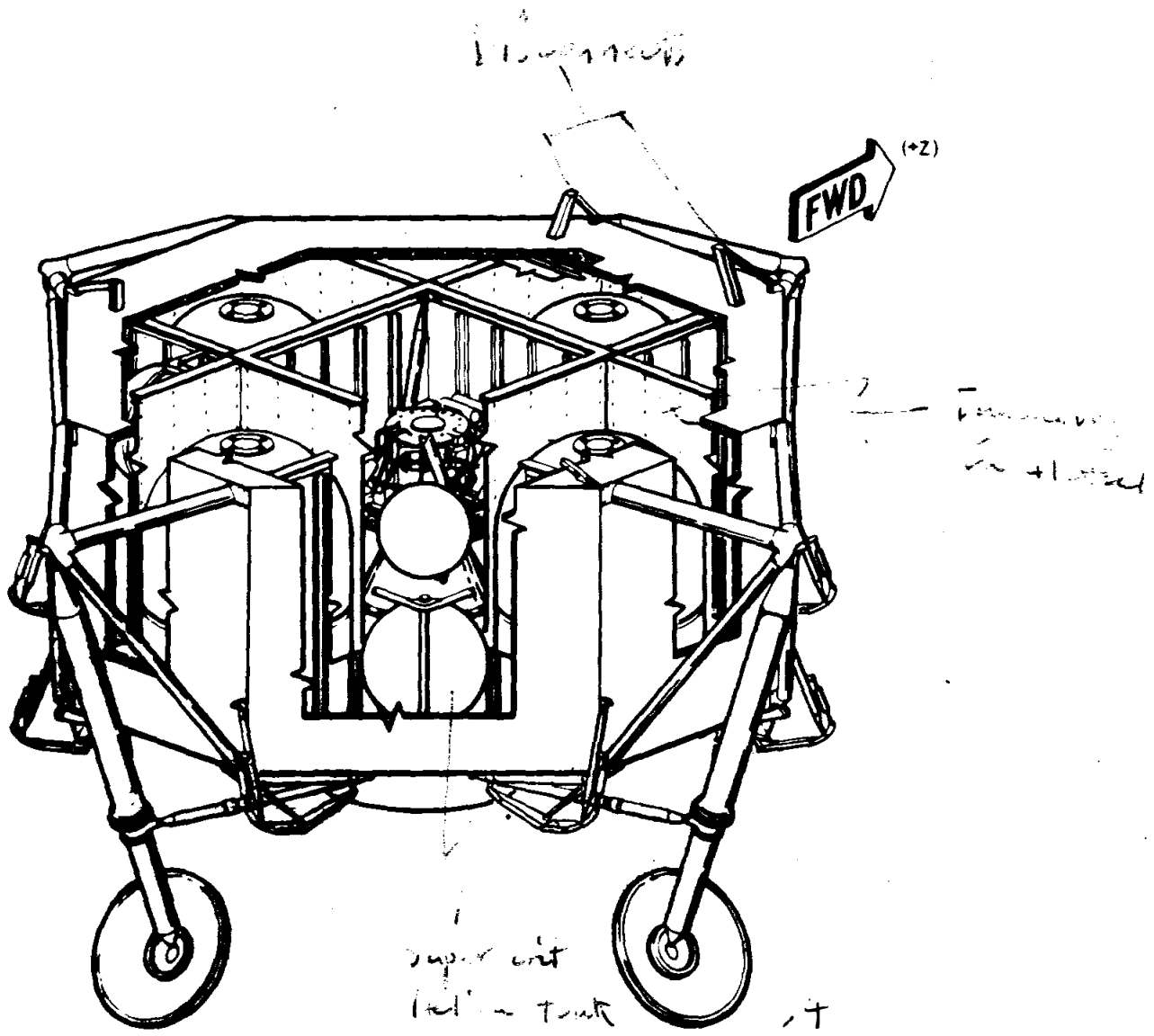


**EQUIPMENT LOCATIONS
ASCENT STAGE-L/H SIDE**

T30005-31
NOV 66



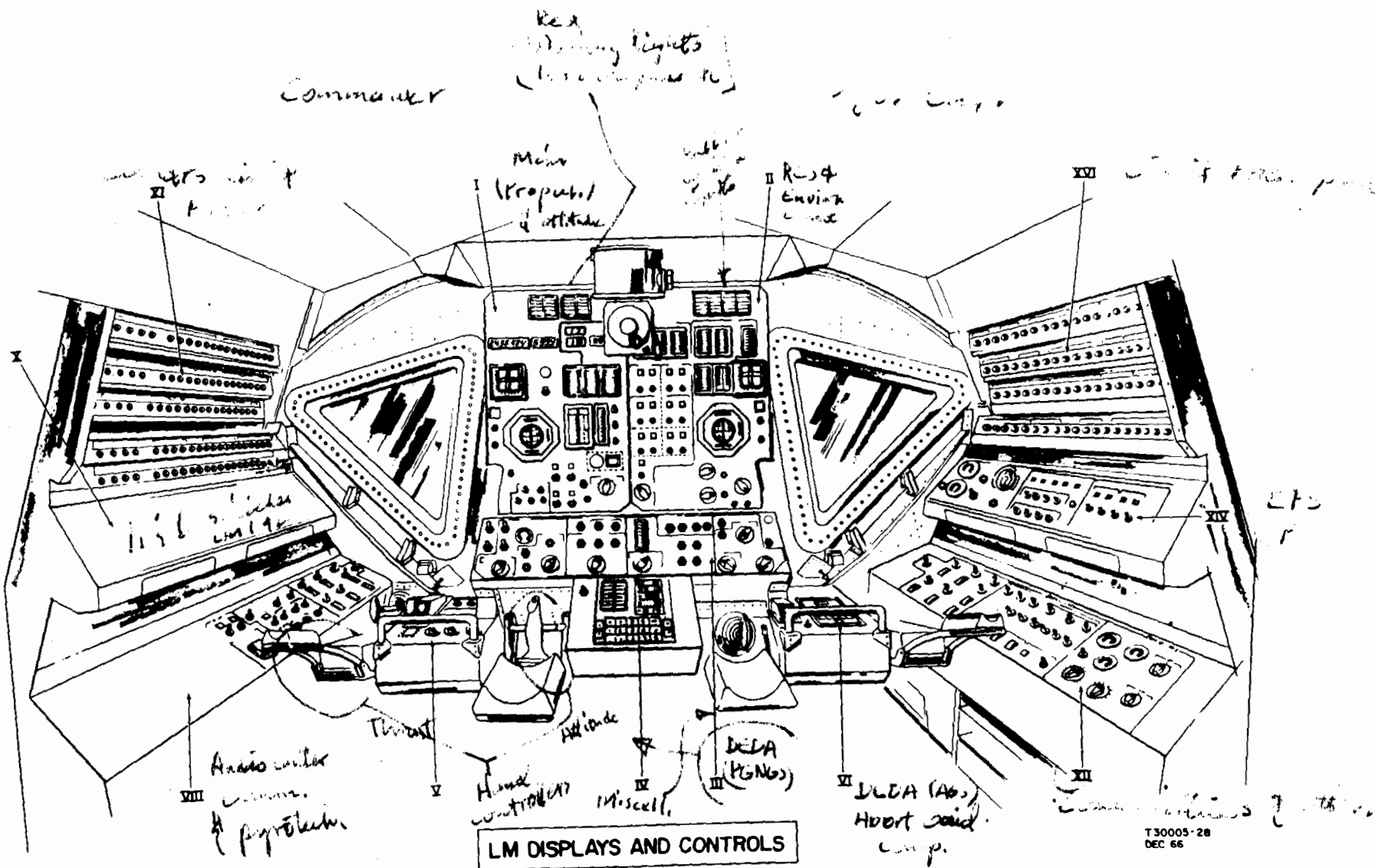
T30005-13
NOV 66



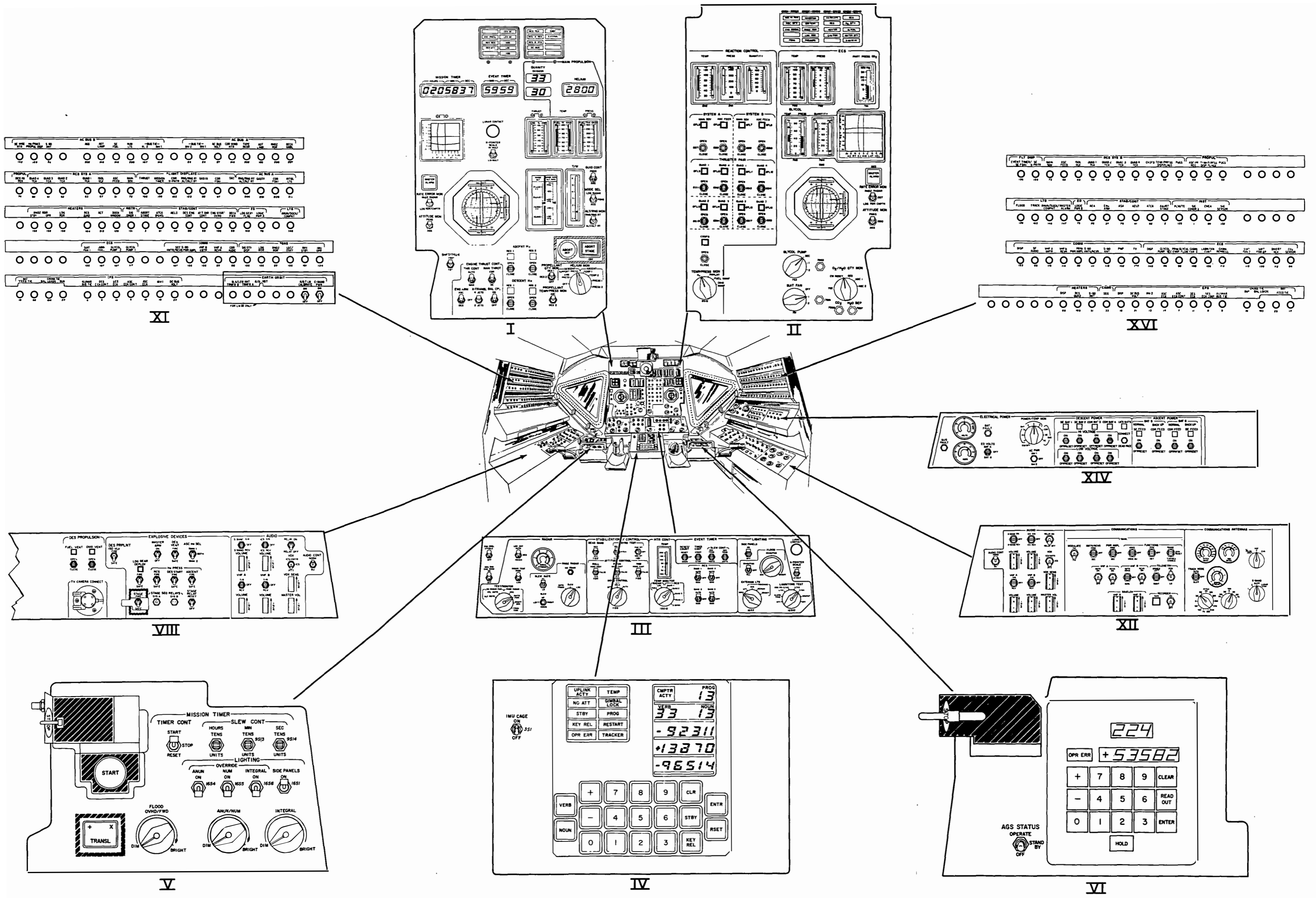
super unit
 heliostat
 used to press. prop tanks
 Crew heliostat used to start
 trans. station to super unit. Heli.

LM DESCENT STAGE

T30005-18
 NOV 66

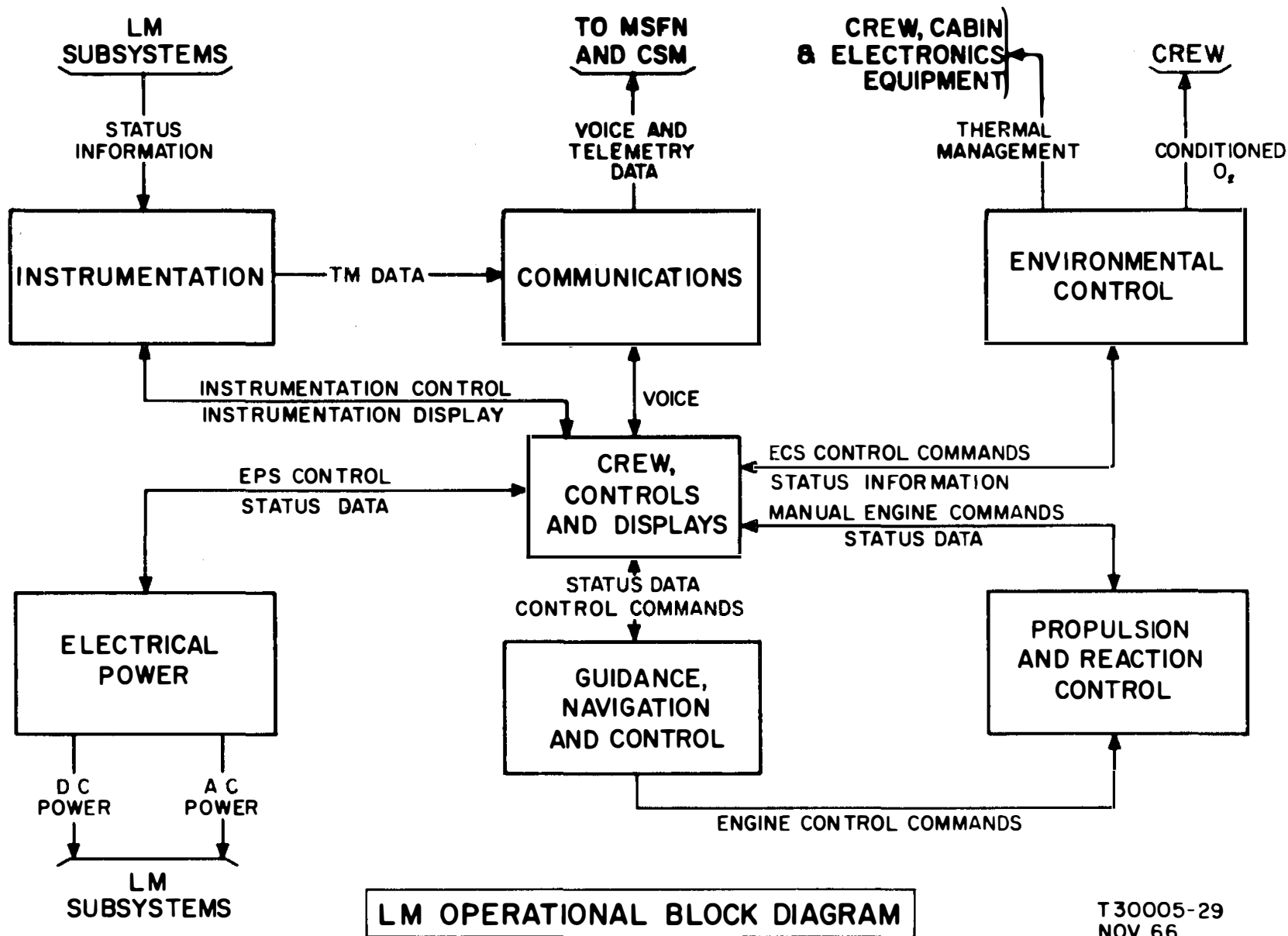


T30005-28
DEC 66

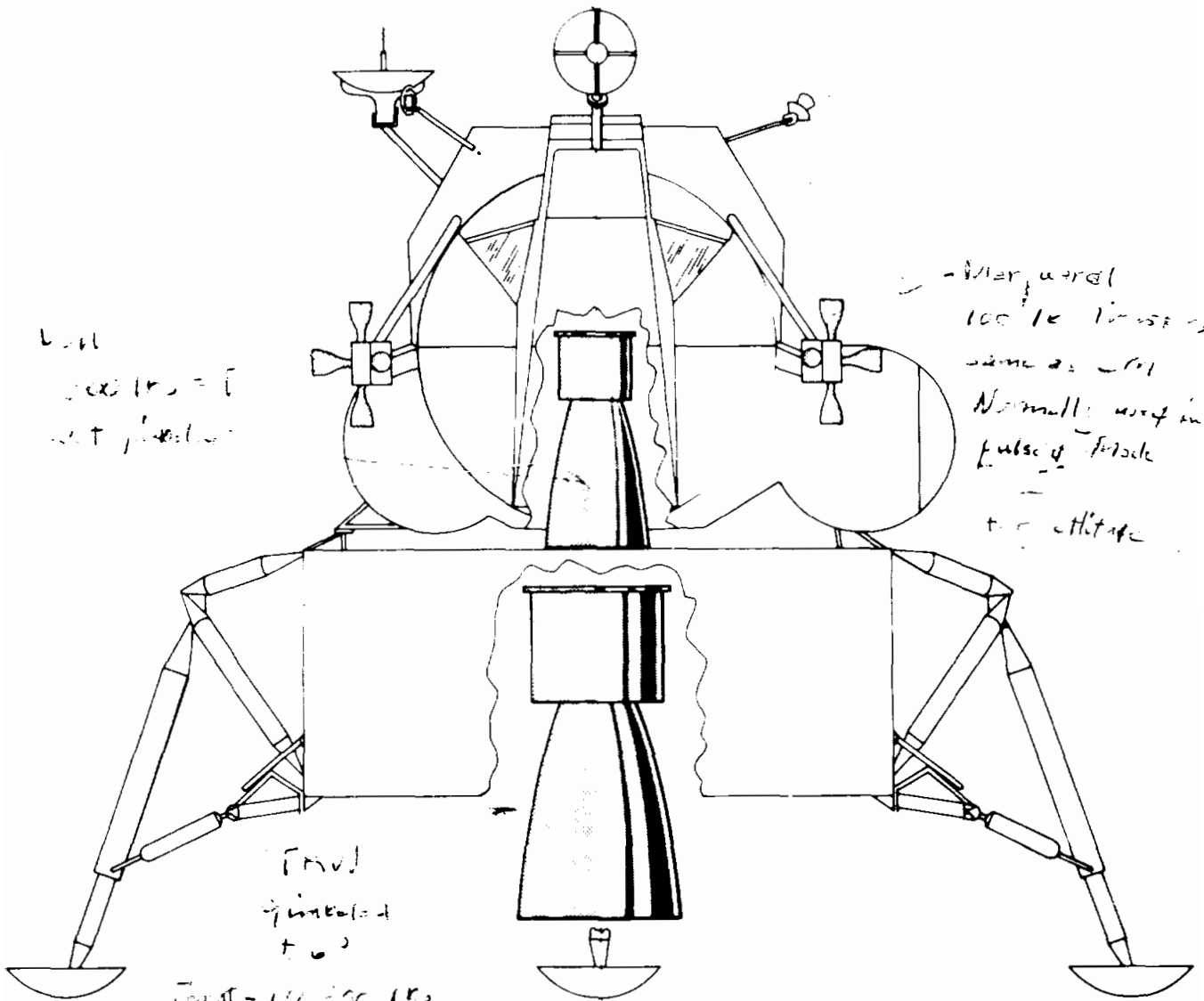


LM DISPLAYS AND CONTROLS

T30005-28
DEC 66



T 30005-29
NOV 66



LM
 200 lbs = [unclear]
 rest [unclear]

- Starboard
 100 lb thrust
 same as [unclear]
 Normally used in
 pulse mode
 to attitude

[unclear]
 gimbaled
 to [unclear]

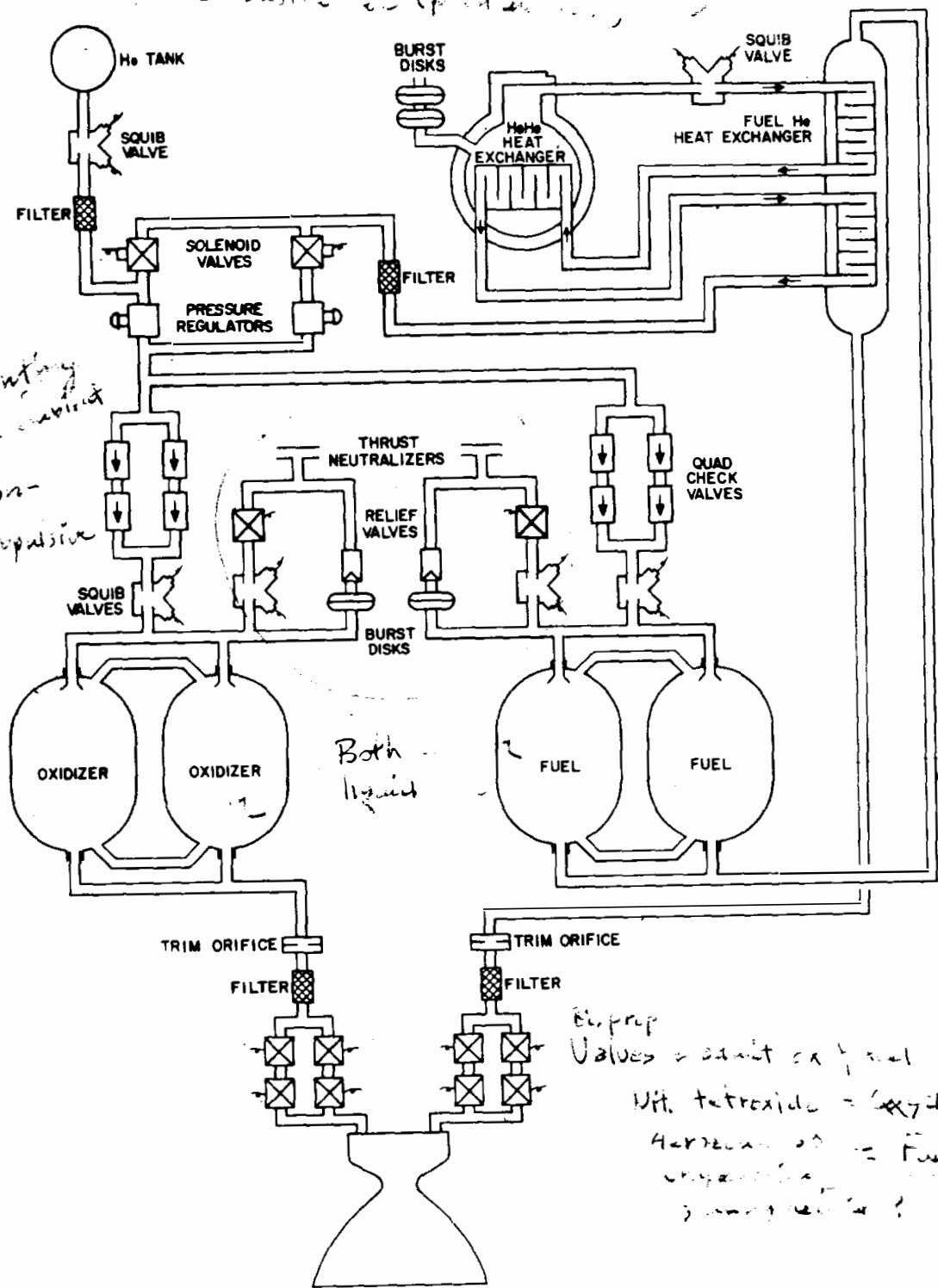
Thrust = 10,000 lbs
 Can be throttled to 1000 lbs

Variable
 Continuously
 (Not 11.000 lbs)

LEM PROPULSION

T30005-66
 FEB 66

To tank prop. to
... ..



Non-Propulsive

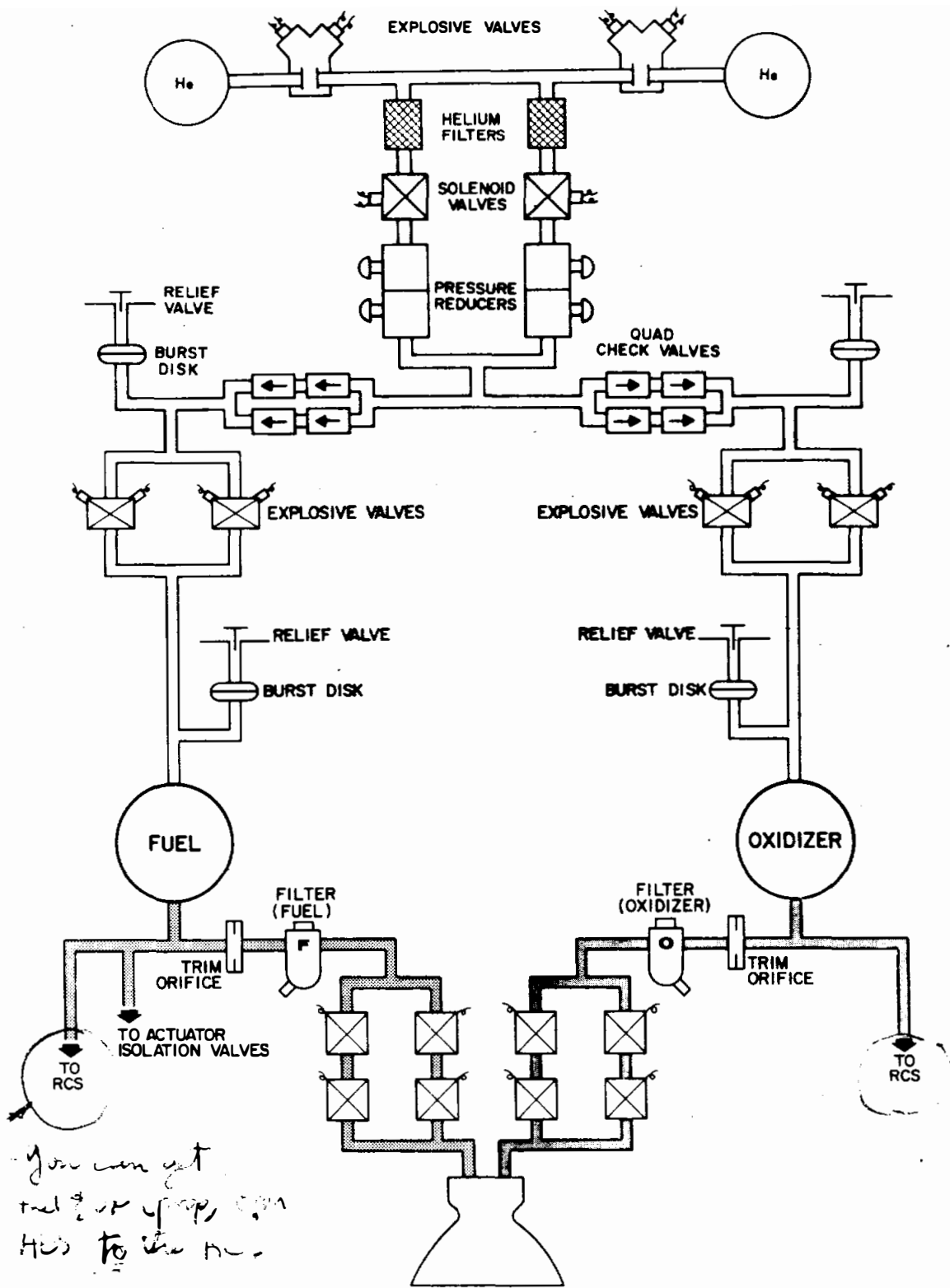
Fuel gas to He exchanger to set up the upstroke with out product.

Both liquid

Buprop Values = admit ox fuel with tetroxide = secondary hydrogen peroxide = fuel - ...

DESCENT PROPULSION SCHEMATIC

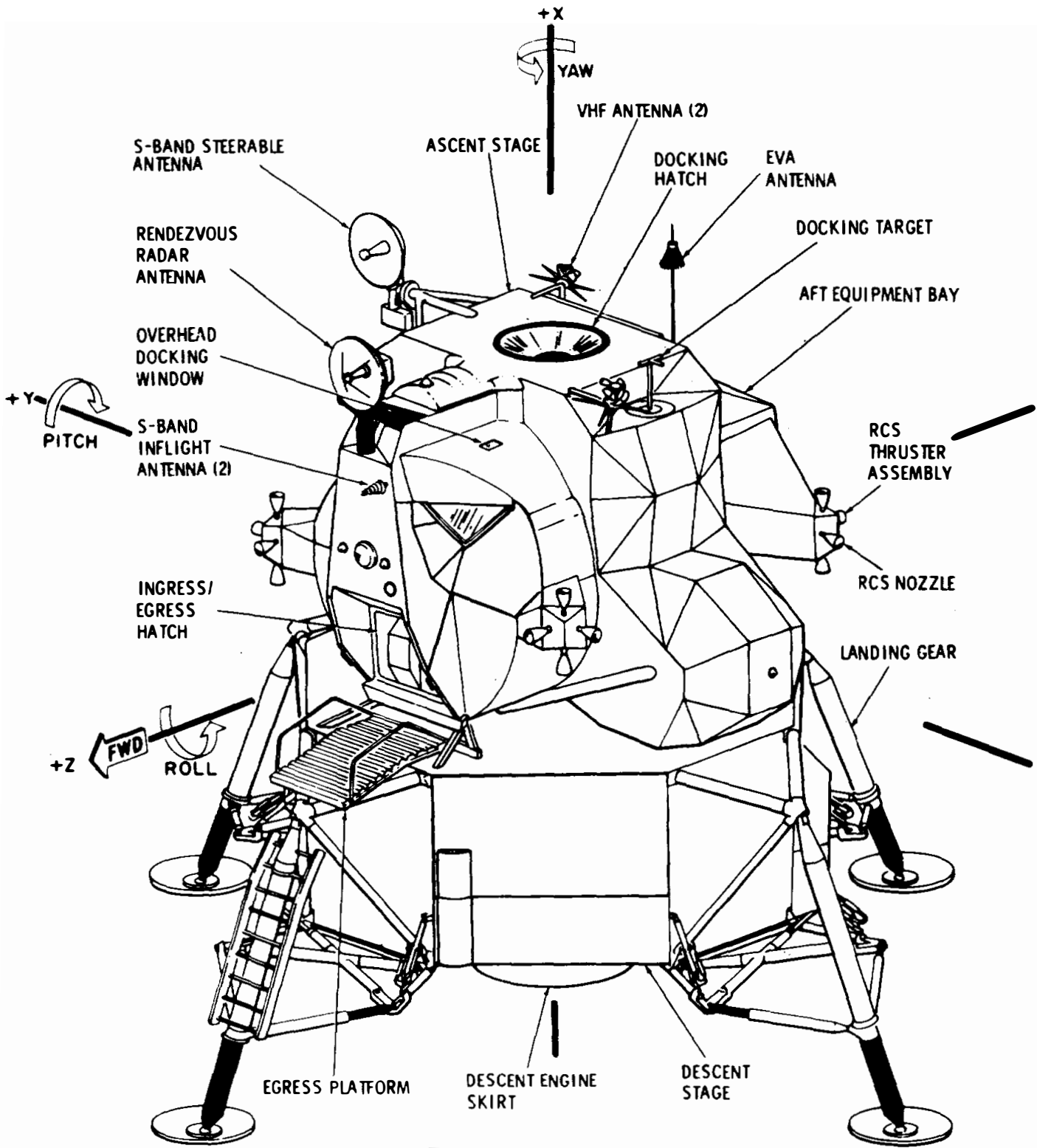
T 30005-154
 NOV 66



*You can get
 fuel & oxidizer from
 He's to the no.*

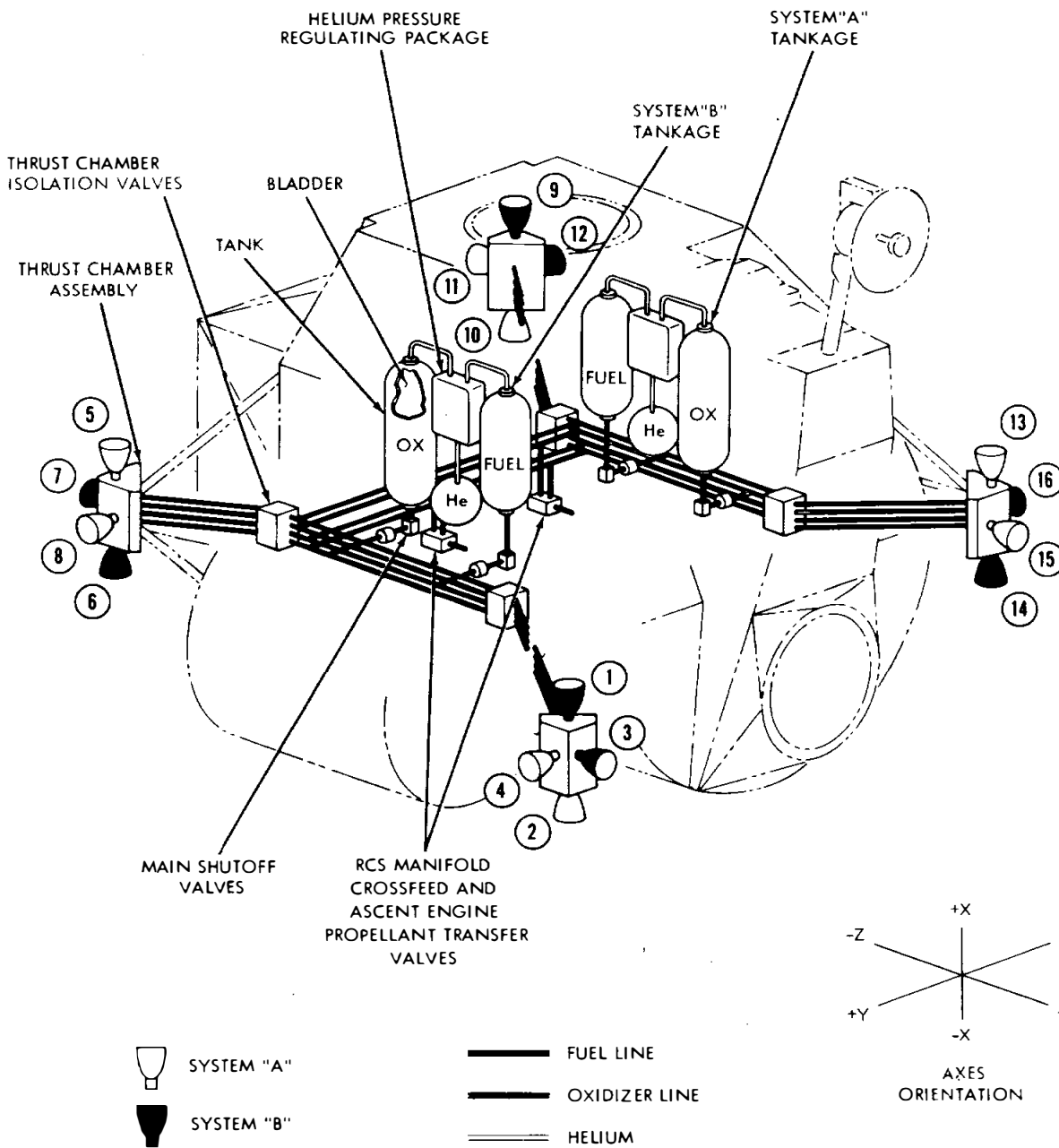
Not necessary

ASCENT PROPELLANT SYSTEM



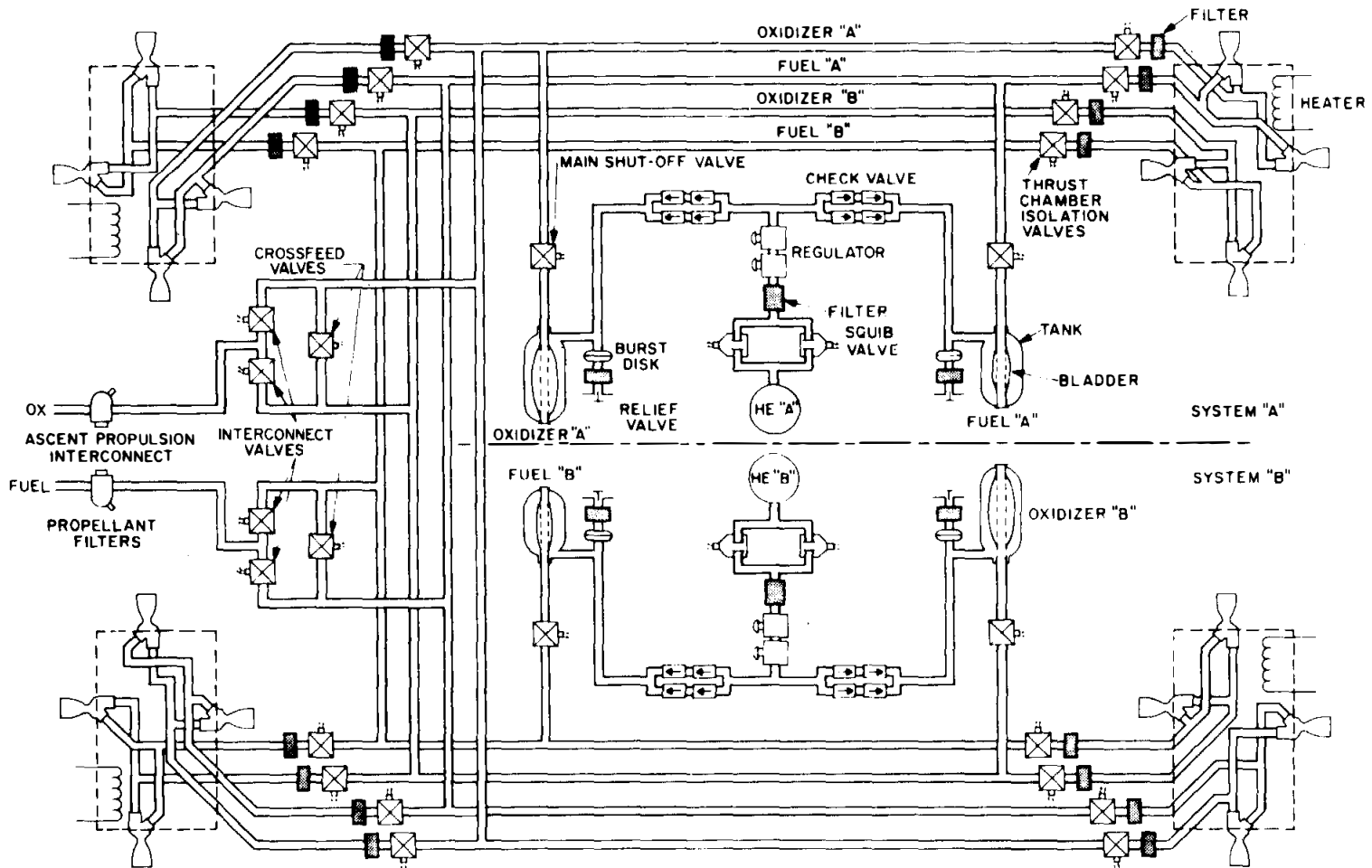
LUNAR MODULE AXES

T 30005-161
NOV 66



RCS INSTALLATION

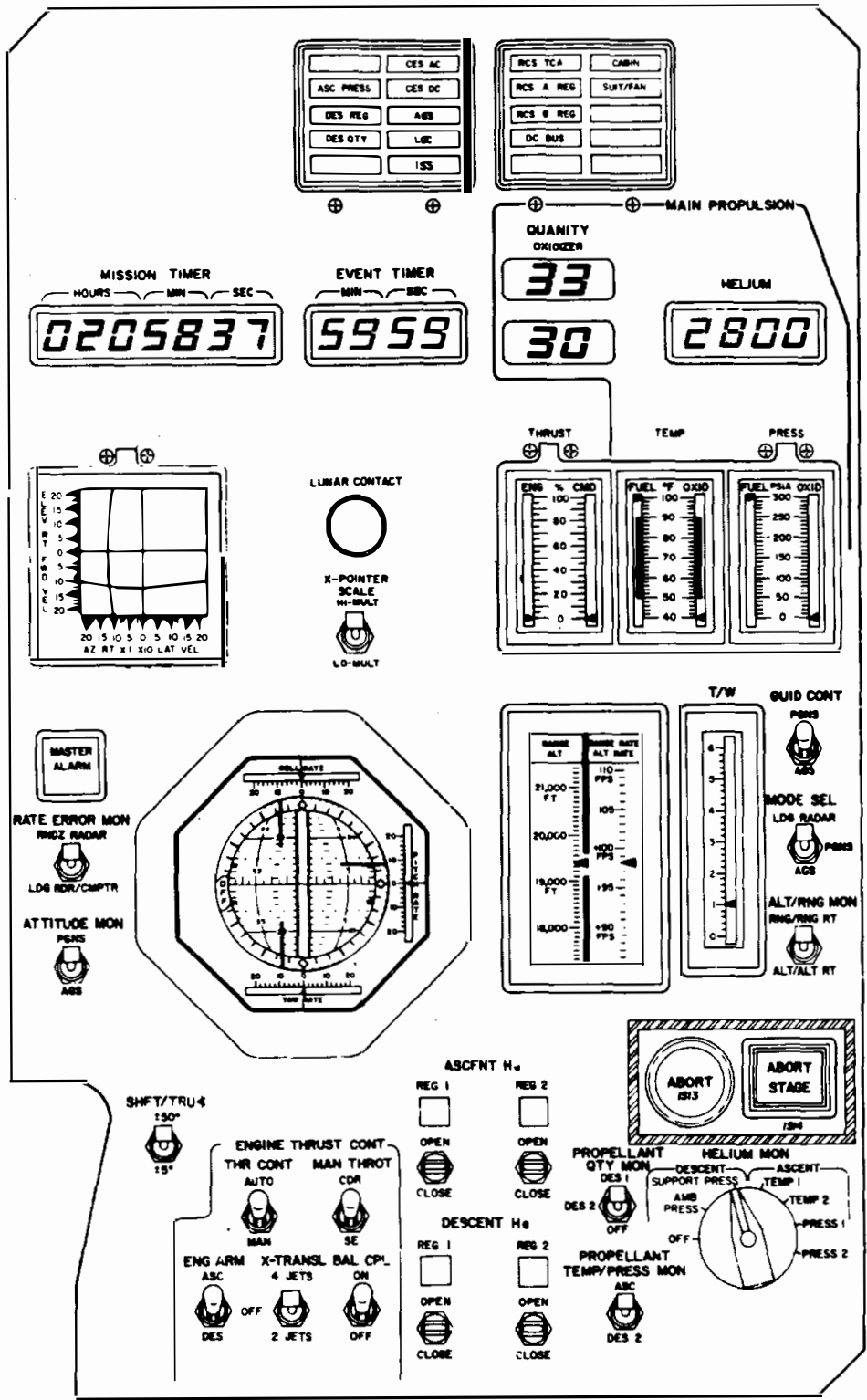
T30005-149
NOV 66



**REACTION CONTROL
SUBSYSTEM SCHEMATIC**

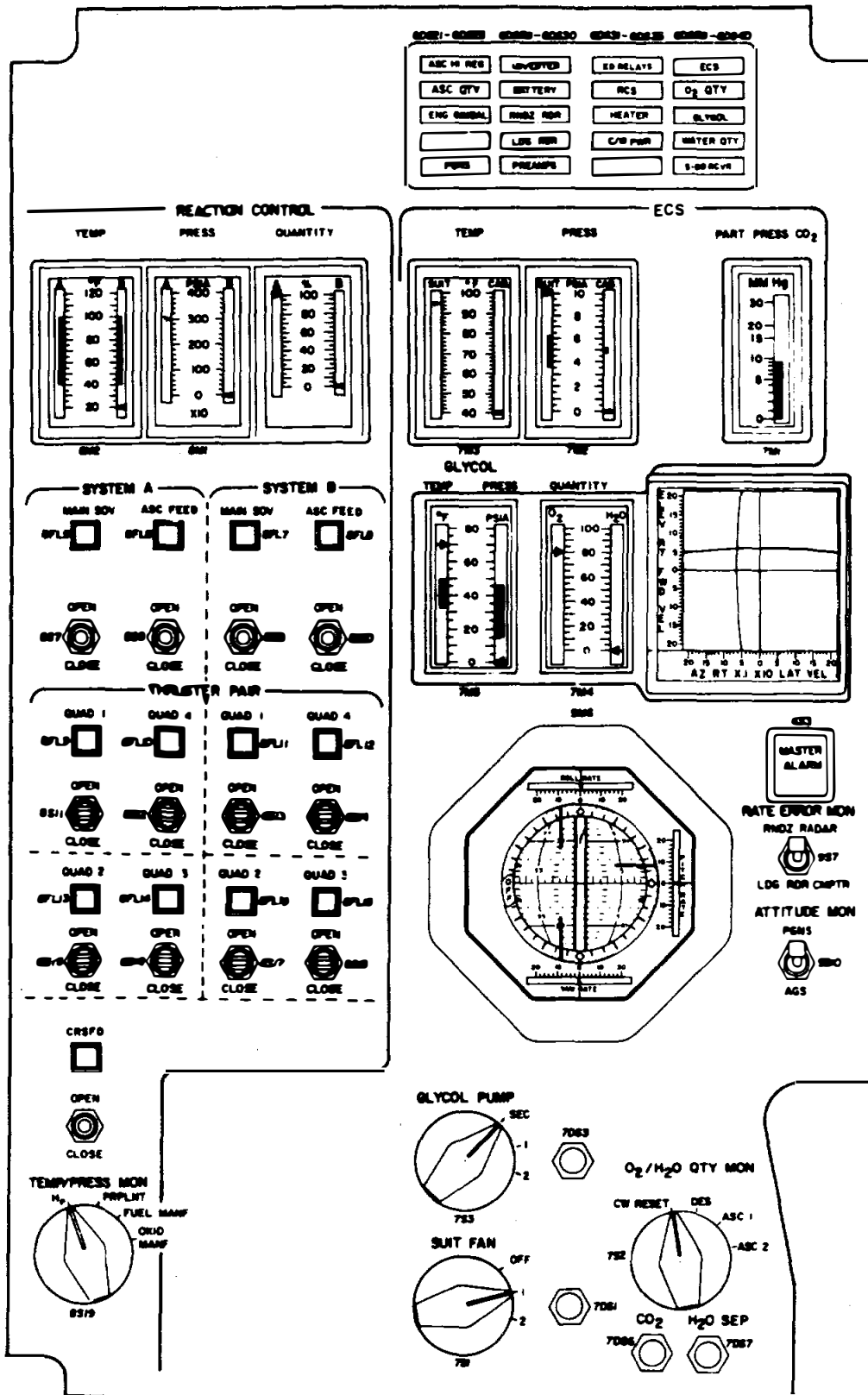
T30005-151
NOV 66

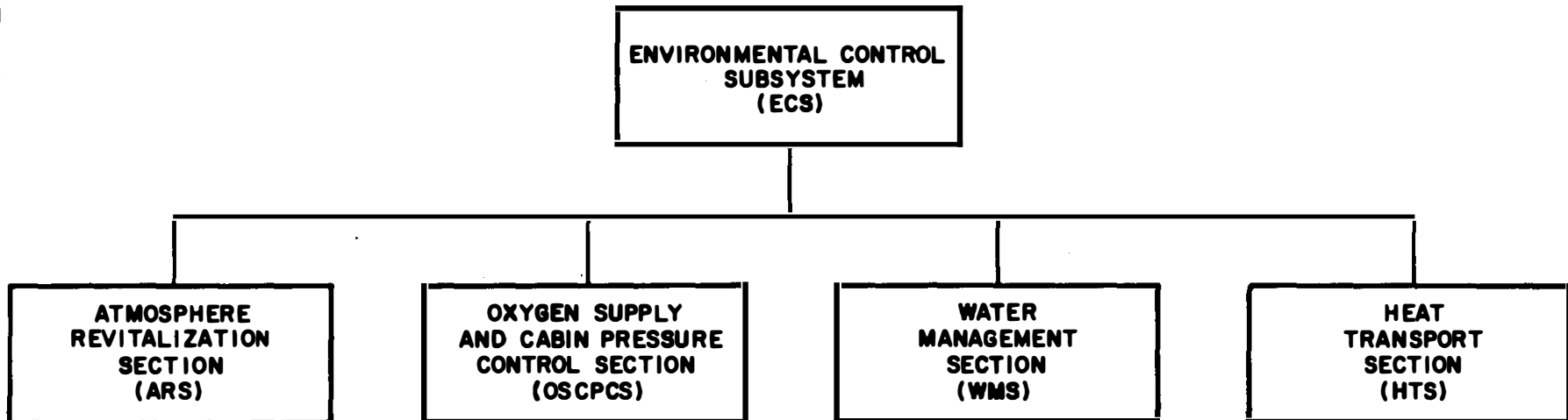
Recount 11:00 - 11:05
 Prop. 4.7



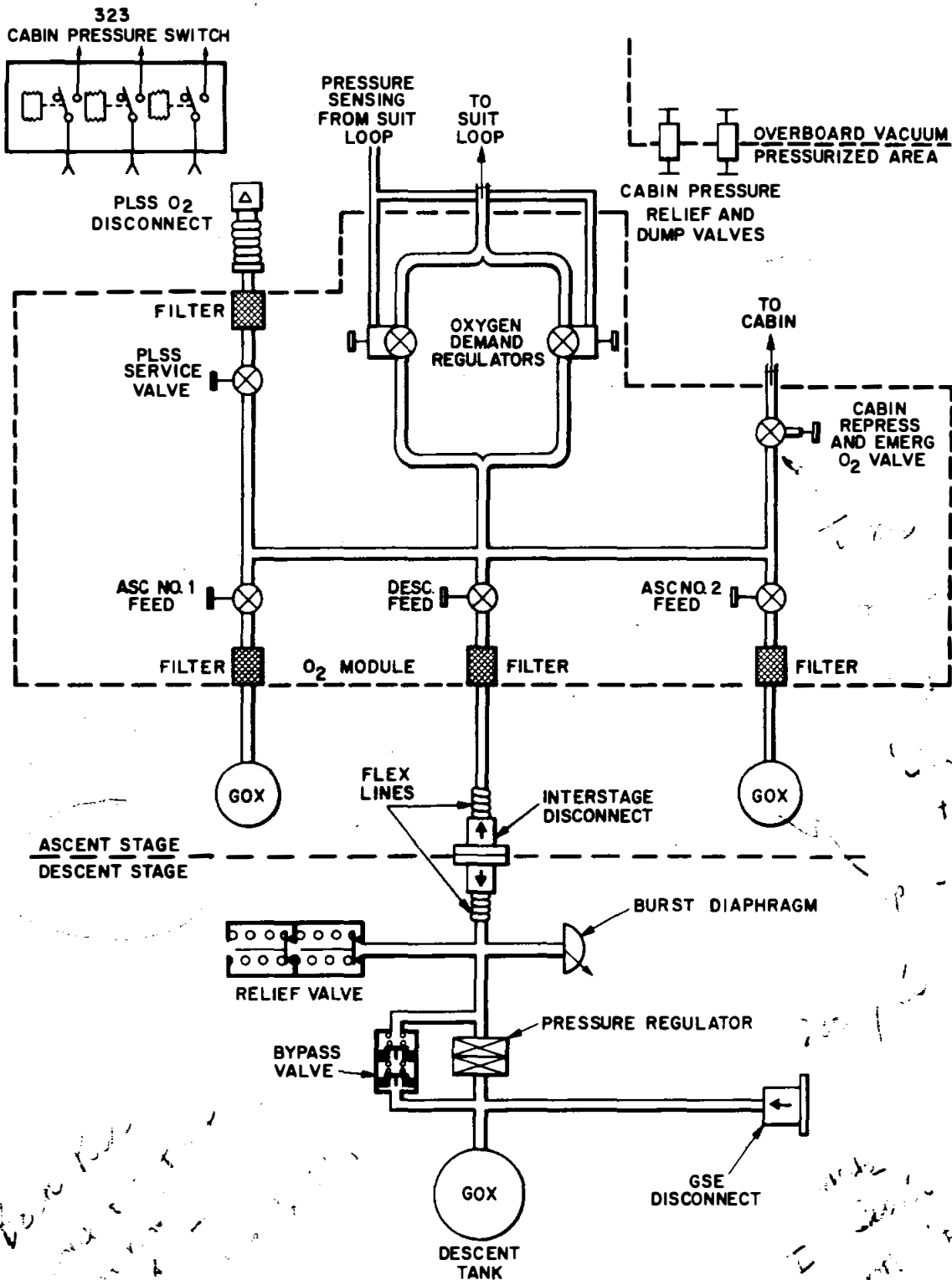
PANEL I

T30005-152
 DEC 66



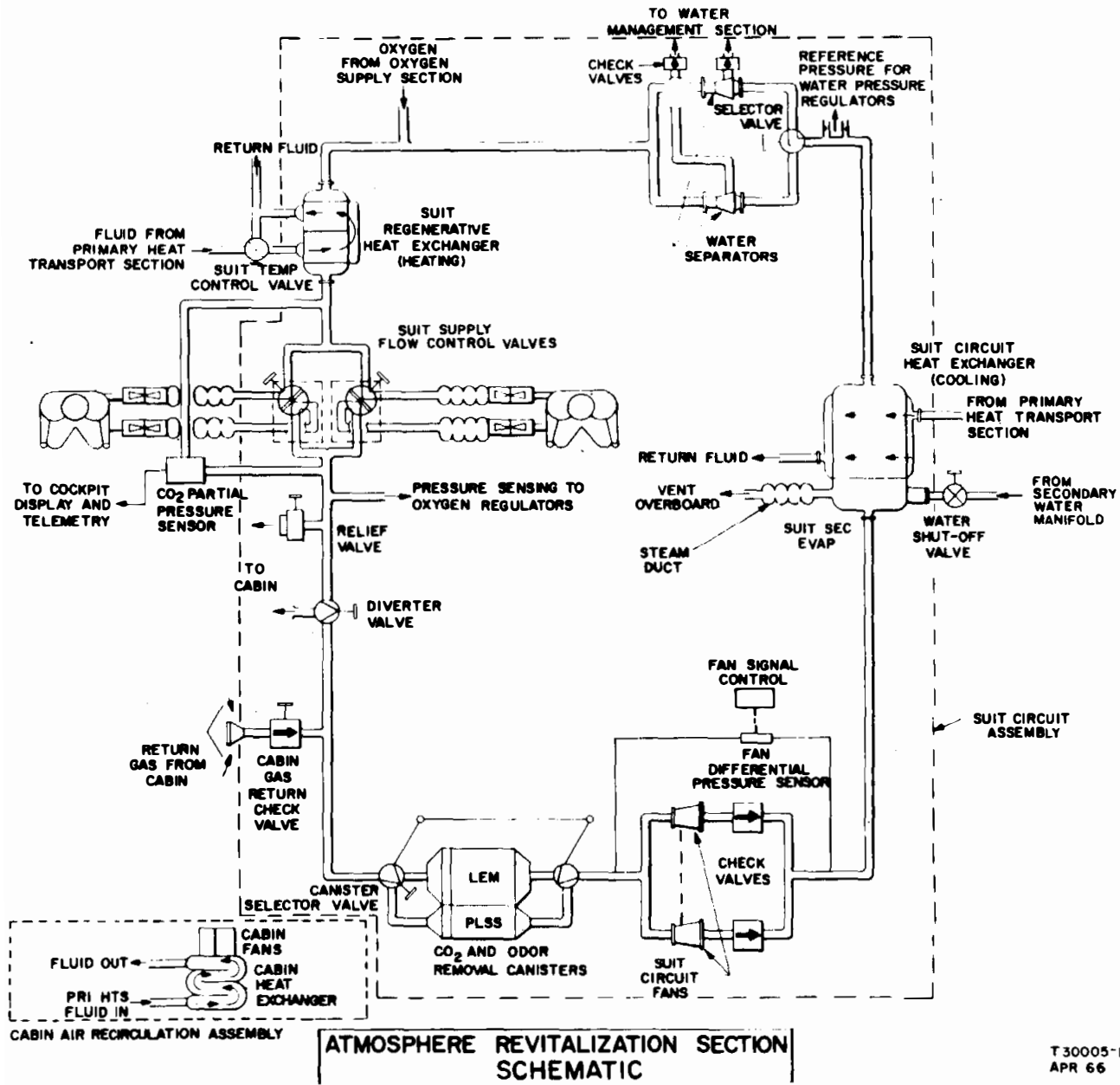


LM ECS BASIC BLOCK DIAGRAM

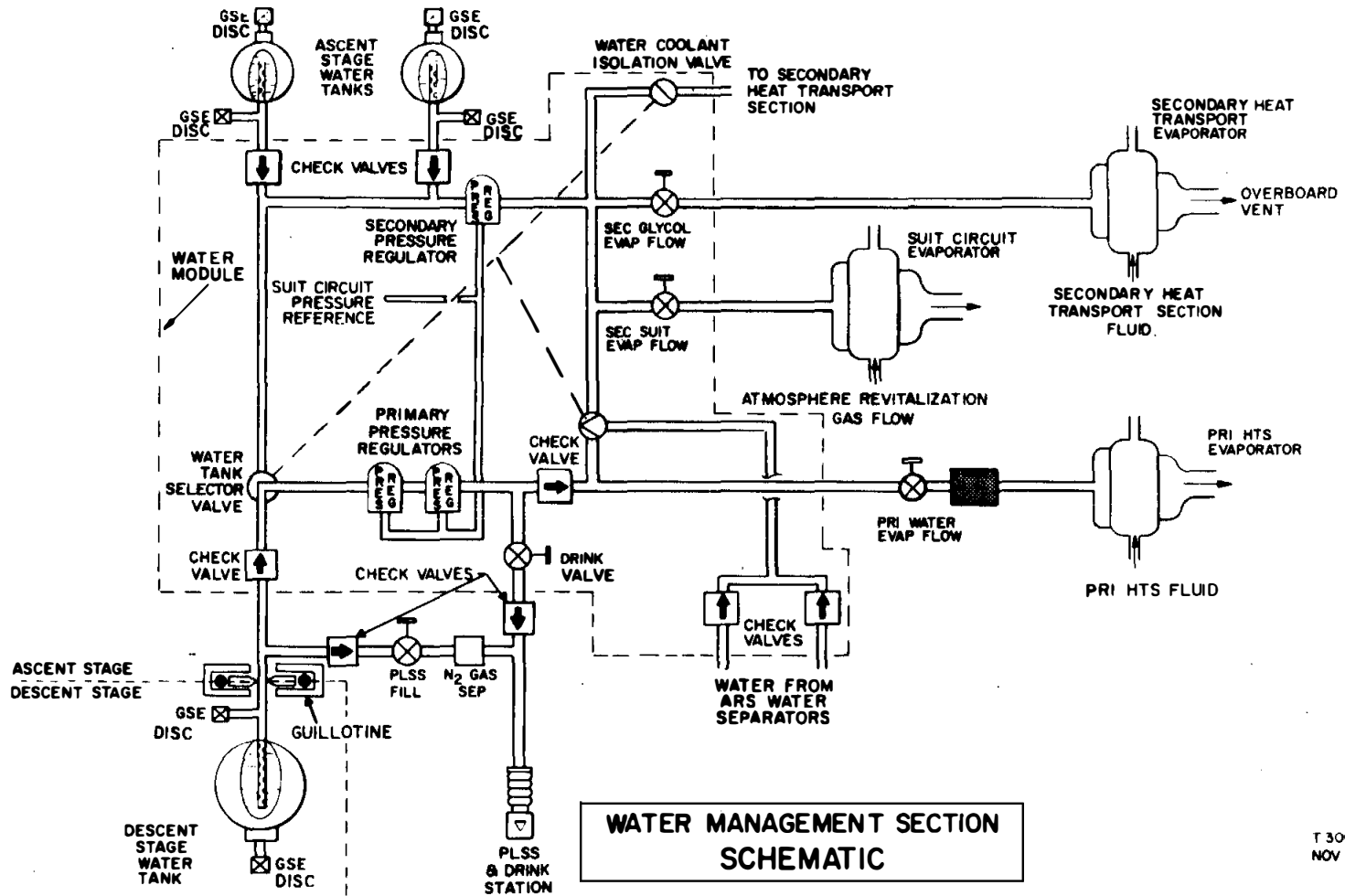


OXYGEN SUPPLY AND CABIN PRESSURE CONTROL SECTION SCHEMATIC

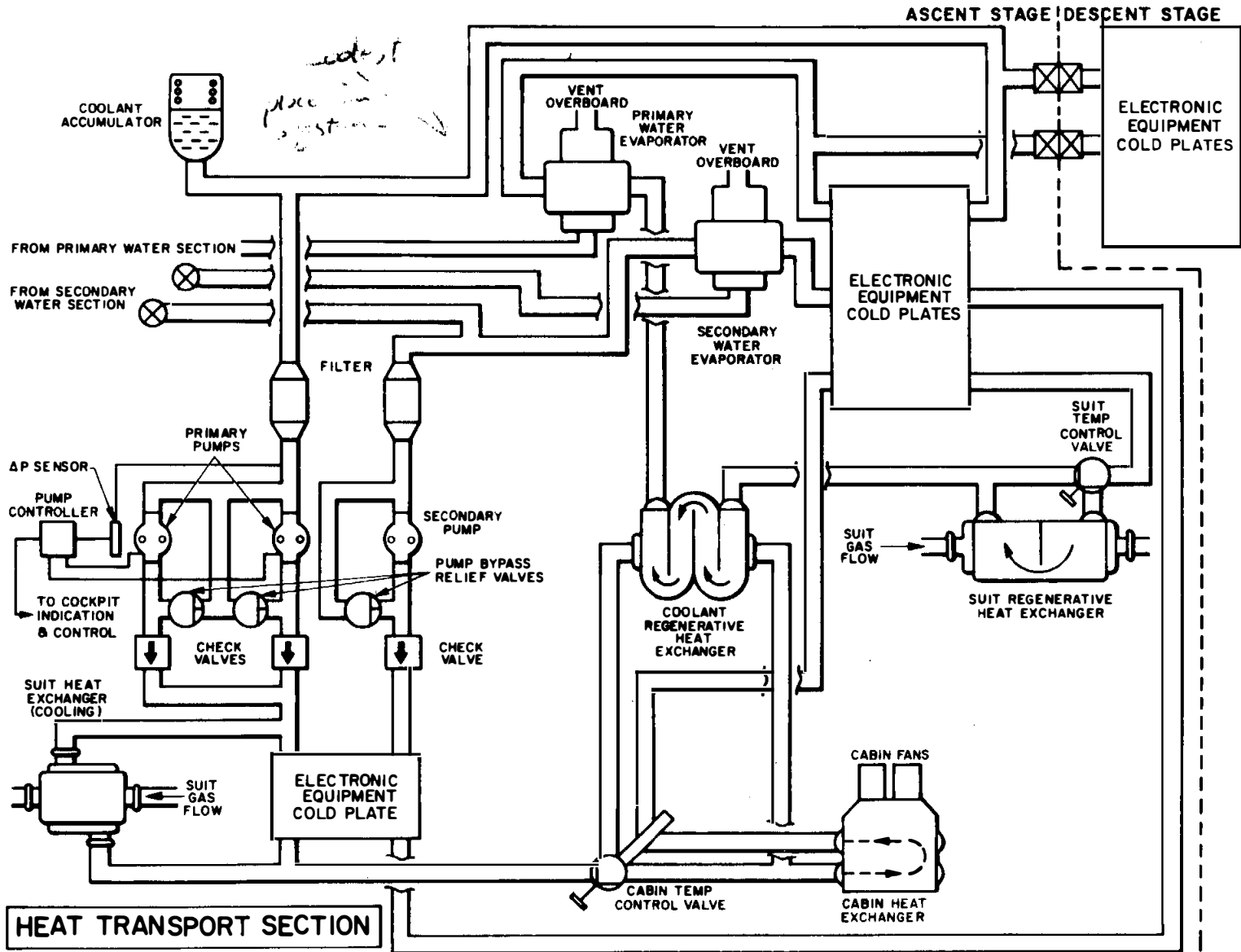
T30005-158
APR 66



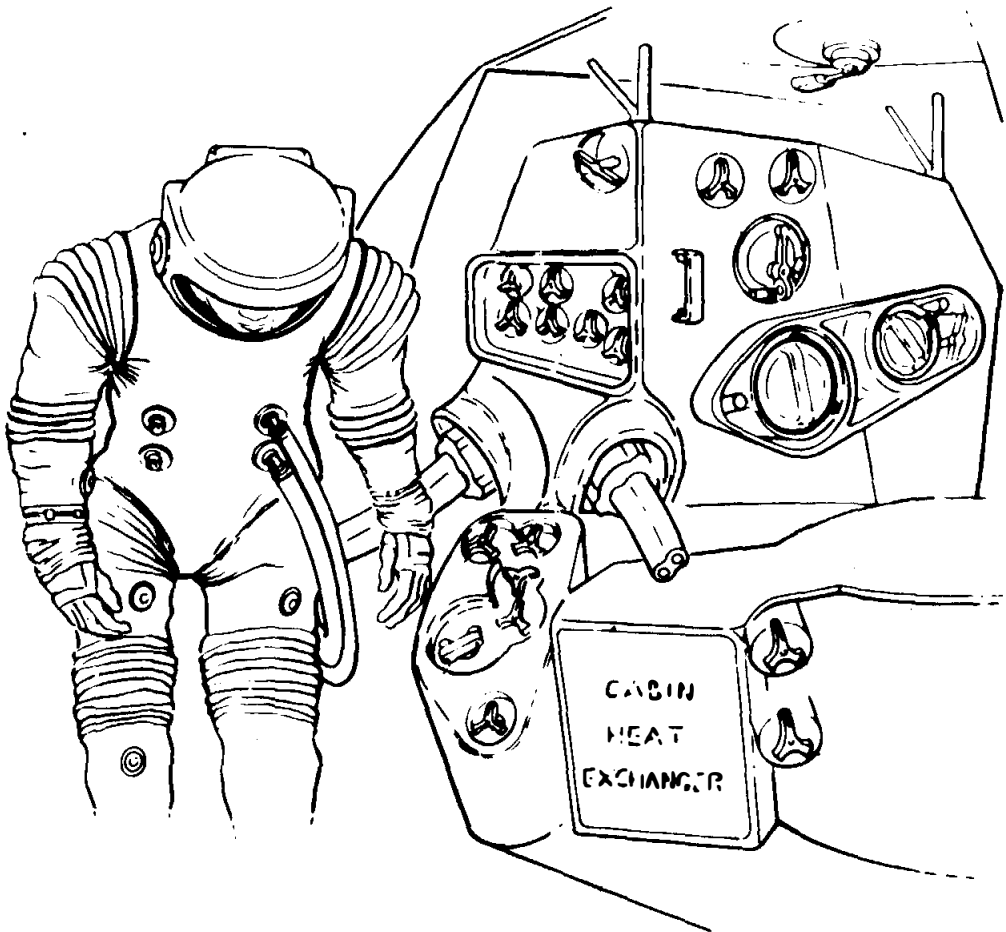
T 30005-157
APR 66



T 30005-156
NOV 66

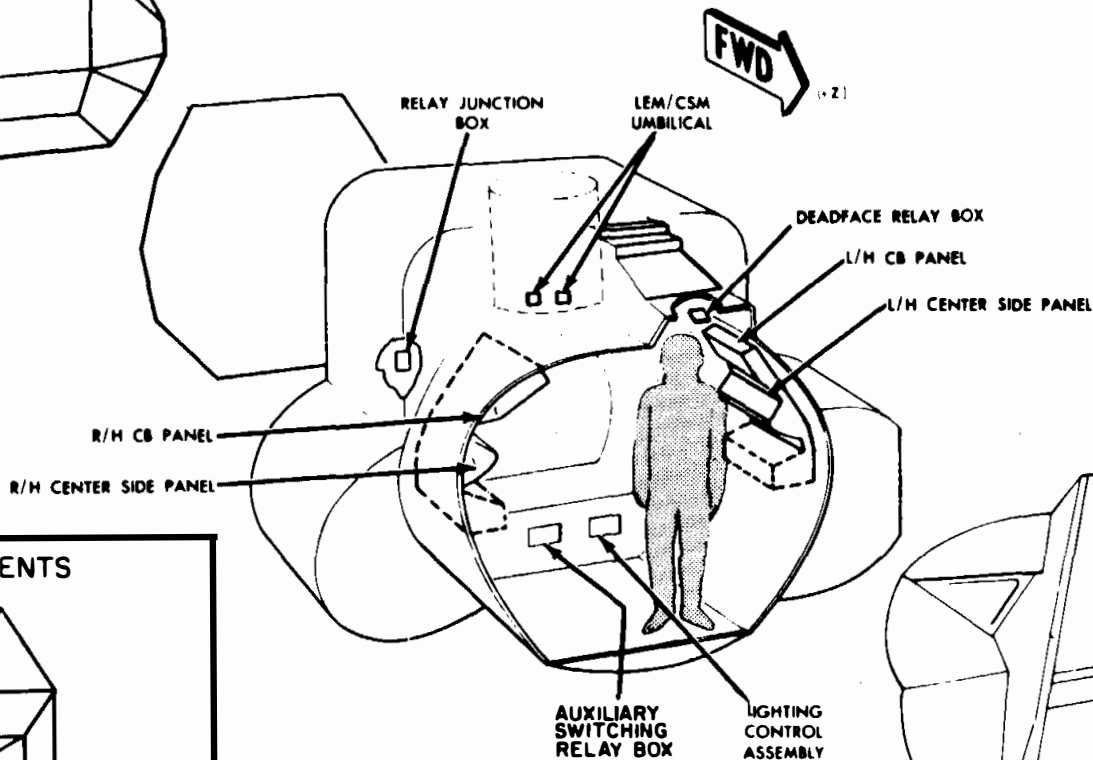
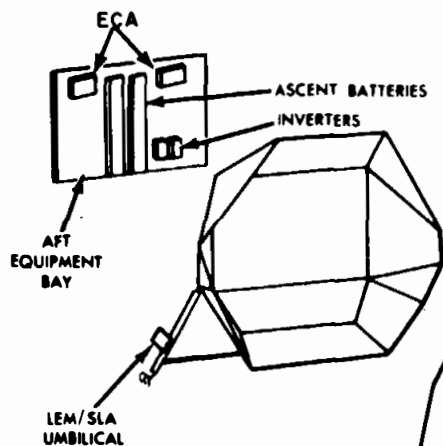


Loss of primary coolant loop - is about 1/2
 because the 1/2 of the coolant is used for the ascent stage

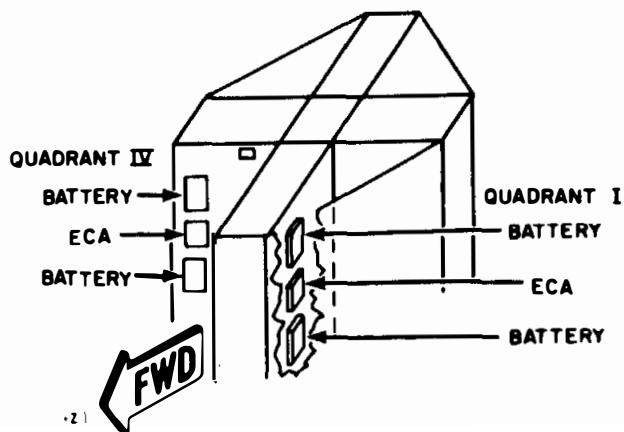


ECS - SPACE SUIT INTERFACE

T 30005-33
NOV 66

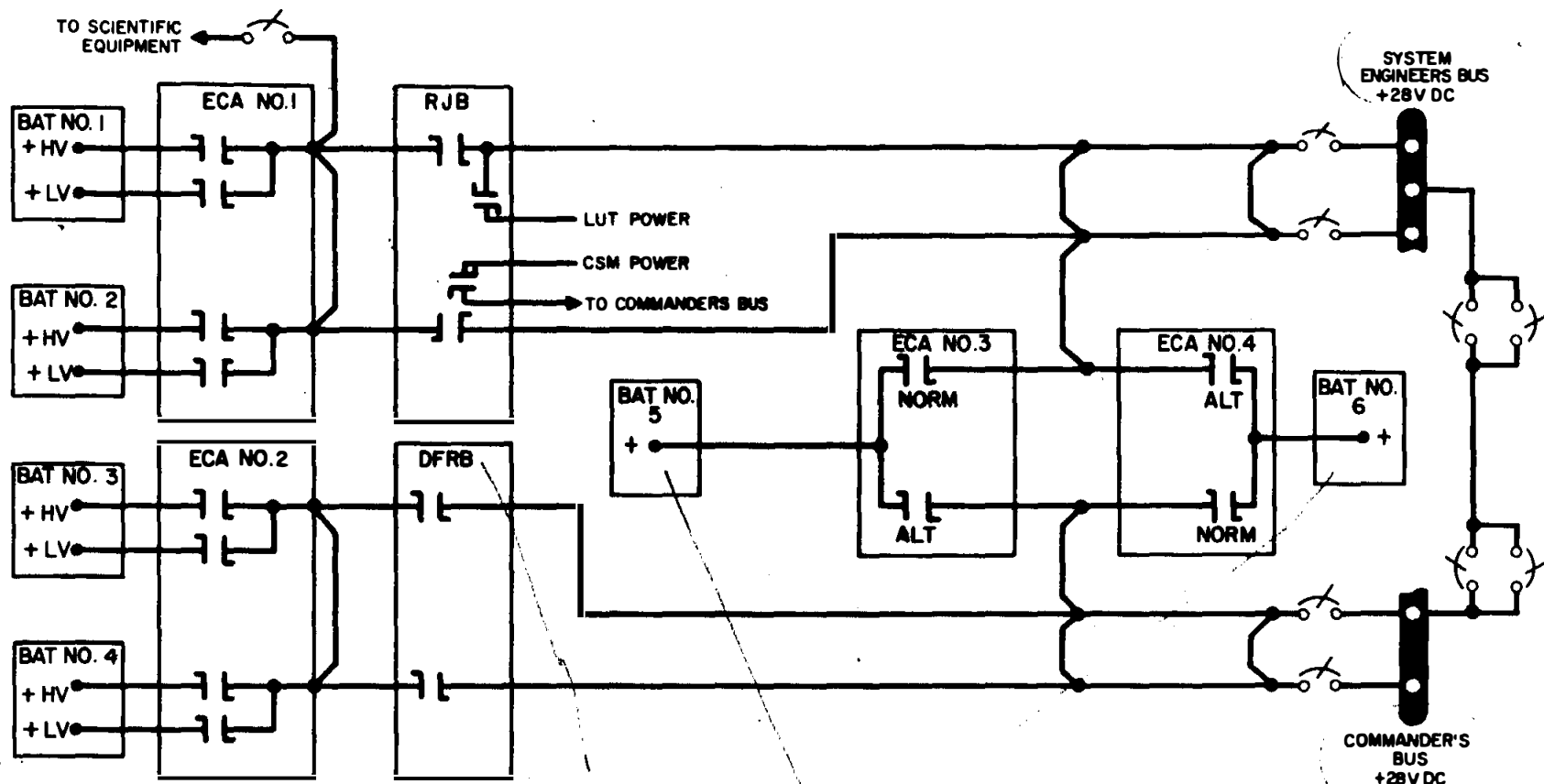


DESCENT COMPONENTS



EPS COMPONENT LOCATION

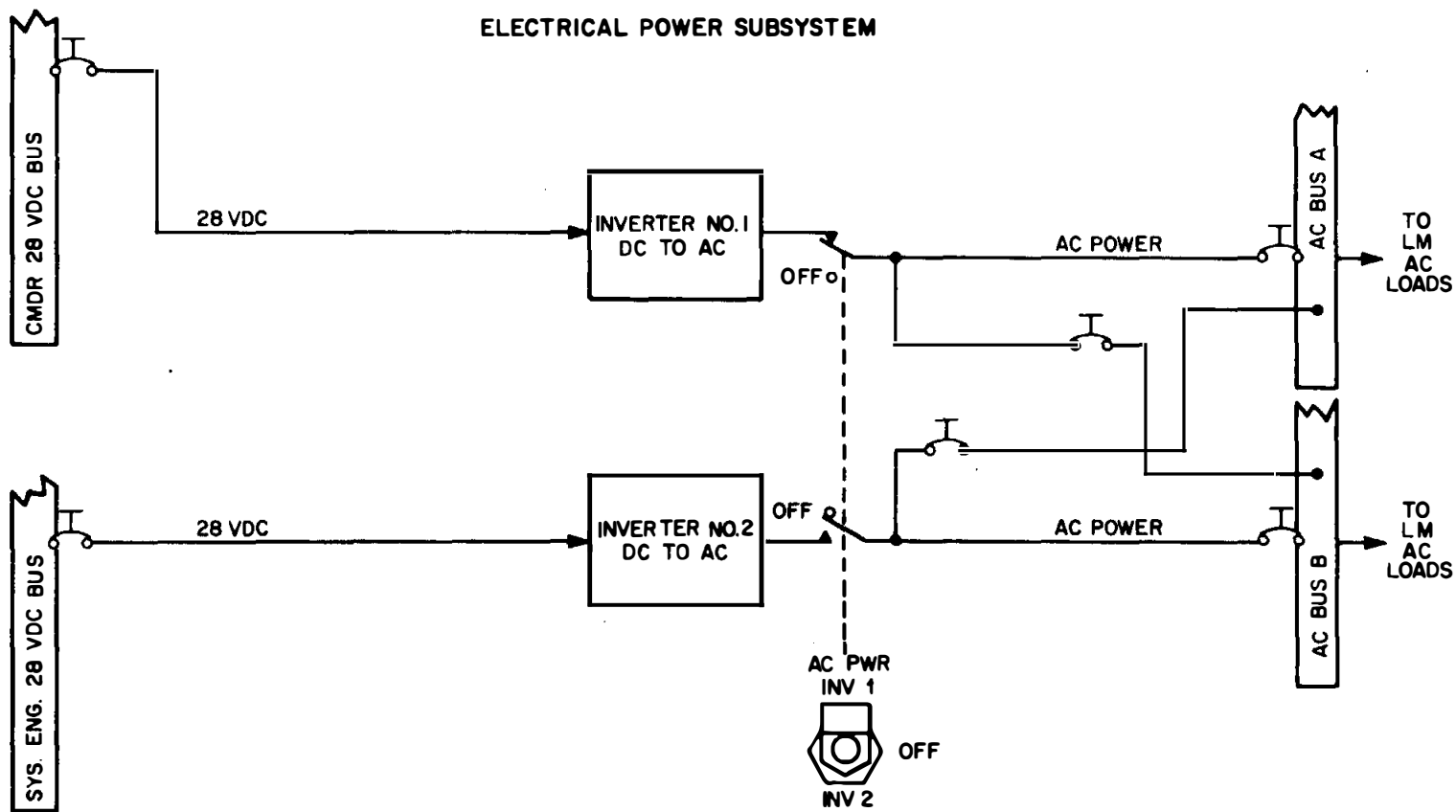
T30005-19
DEC 66



EPS FEEDER SYSTEM

T30005-126
NOV 66

ELECTRICAL POWER SUBSYSTEM

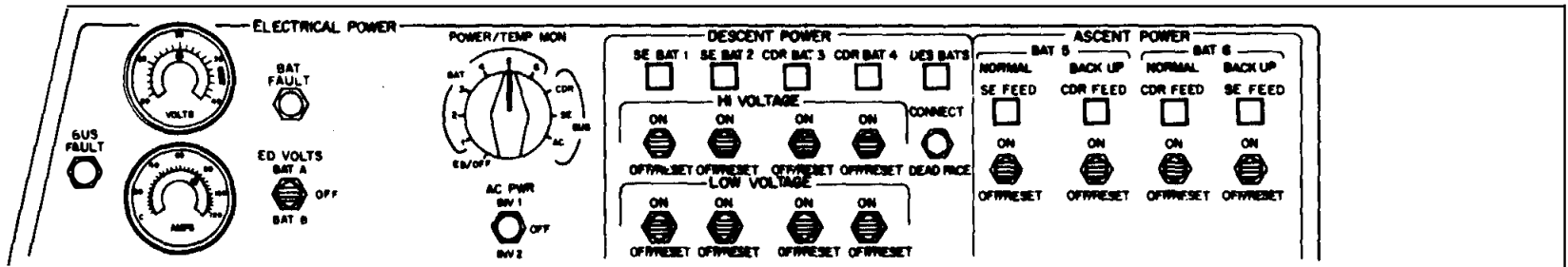


AC DISTRIBUTION BLOCK DIAGRAM

T30005-21
NOV 66

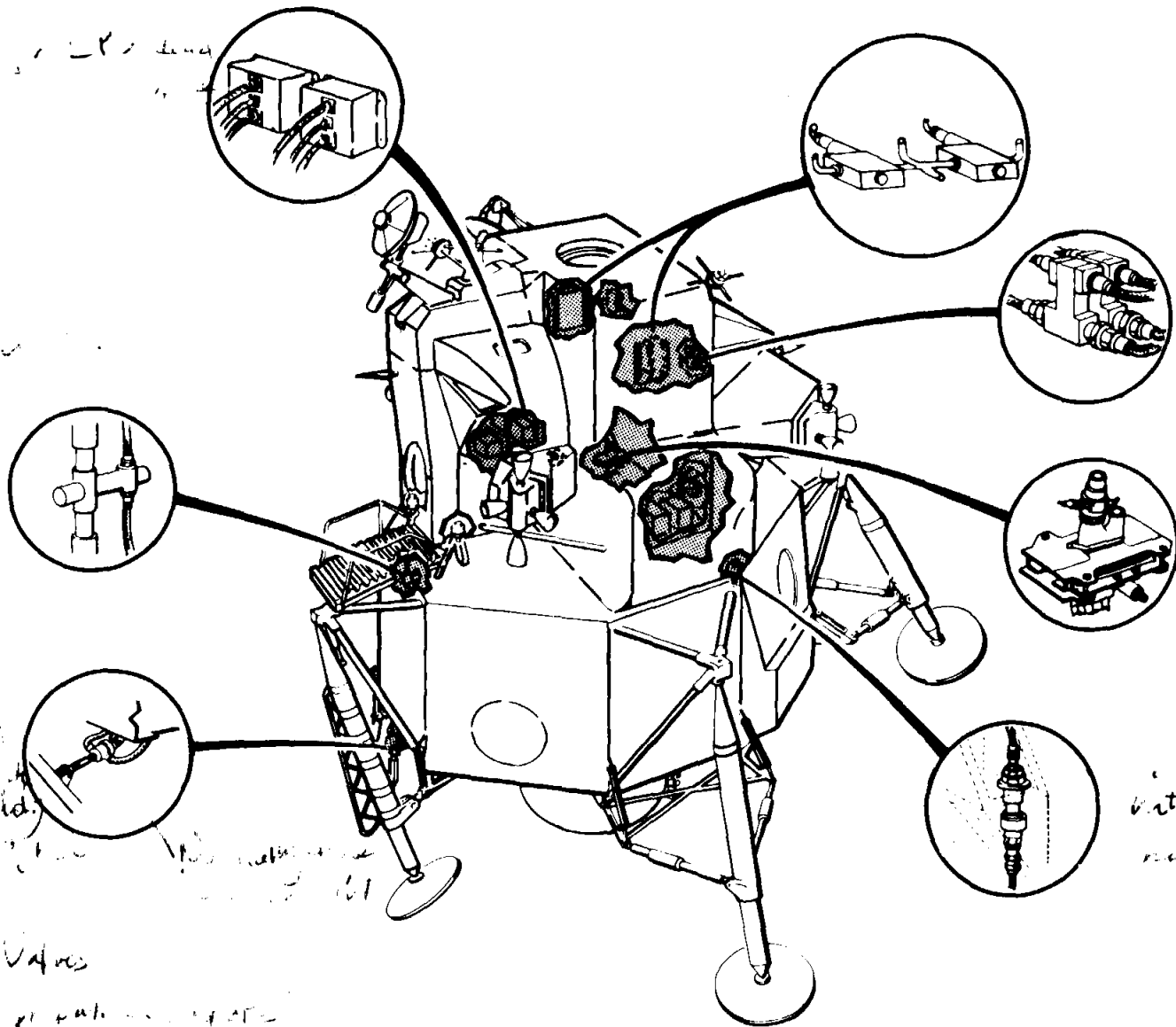
ELECTRICAL POWER SUBSYSTEM

PANEL XIV



CONTROLS AND DISPLAYS

T30005-128
DEC 66

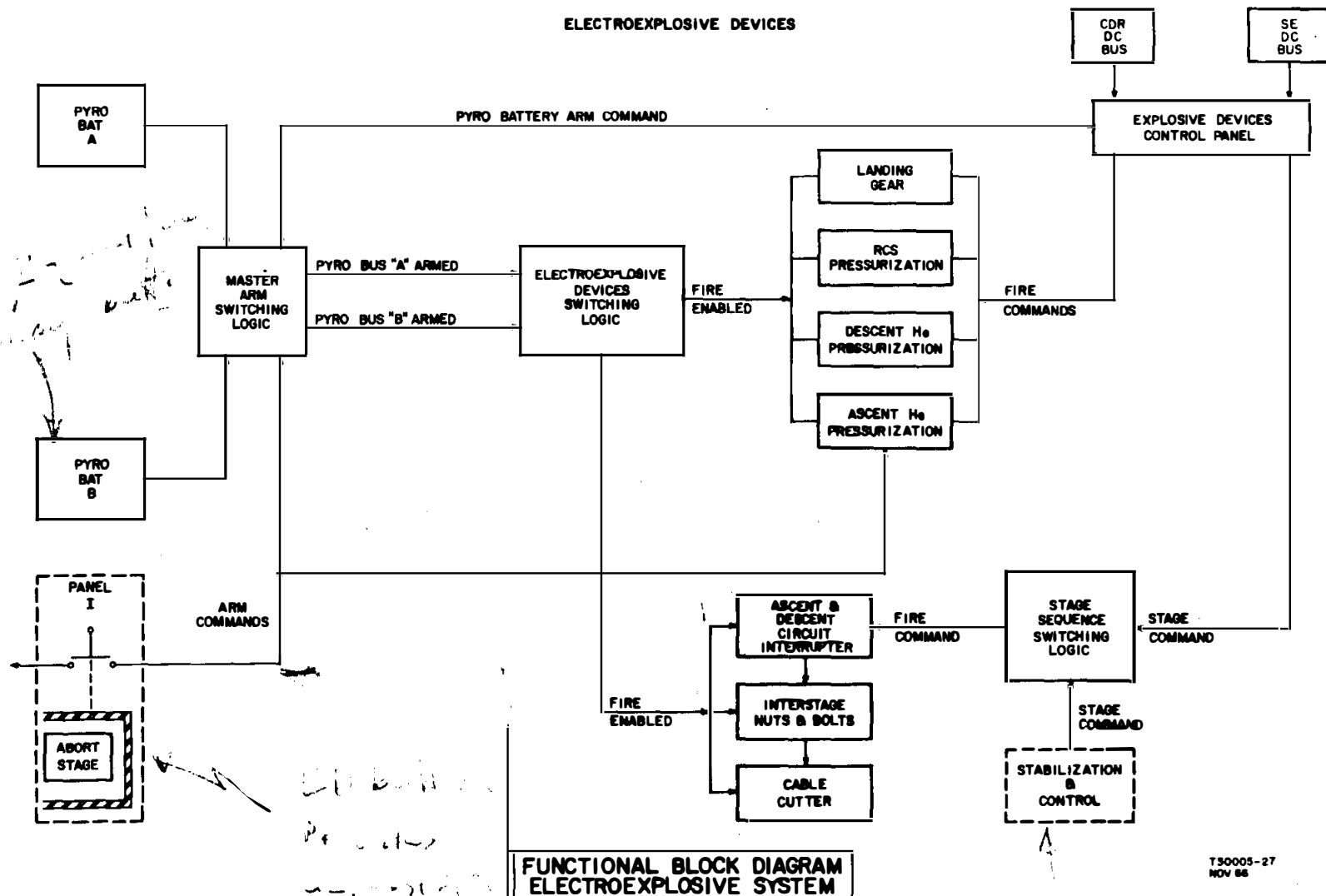


Squib Valves
 located in front of engine compartment
 on either side of engine

Distributor
 nuts, bolts (+)

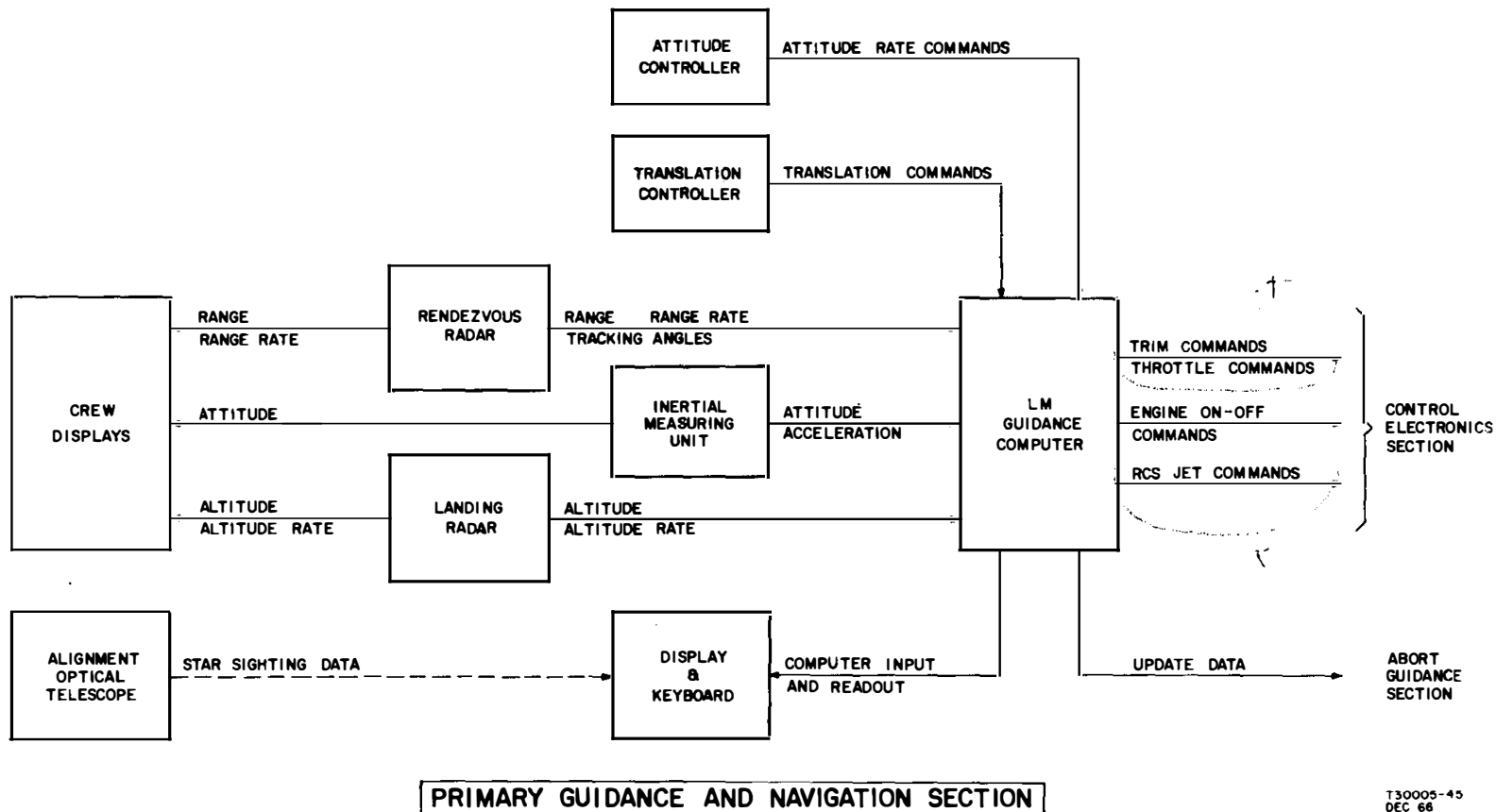
EXPLOSIVE DEVICES-LOCATIONS

ELECTROEXPLOSIVE DEVICES

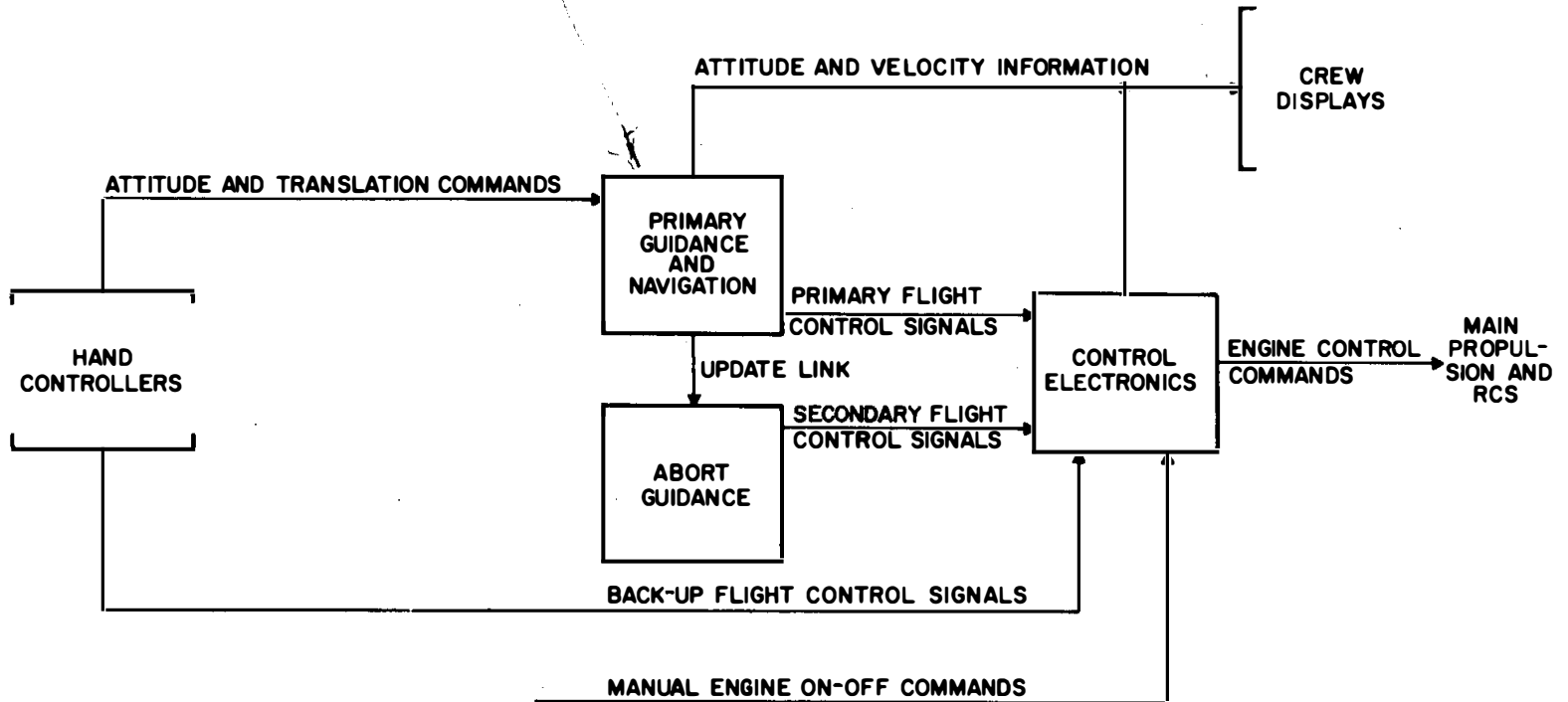


FUNCTIONAL BLOCK DIAGRAM
ELECTROEXPLOSIVE SYSTEM

T50005-27
NOV 66



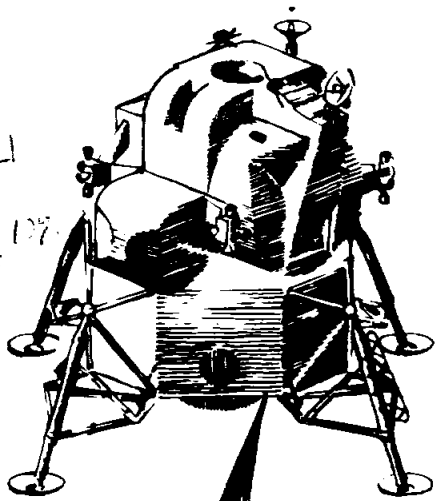
*can be manual control
& handovers*



*Down transfer
information to
main propulsion*

LM GUIDANCE, NAVIGATION AND CONTROL SUBSYSTEM

2500 ft/sec
 * 70 ft/sec
 3 meters at 100 ft
 100 ft/sec
 1000 ft/sec



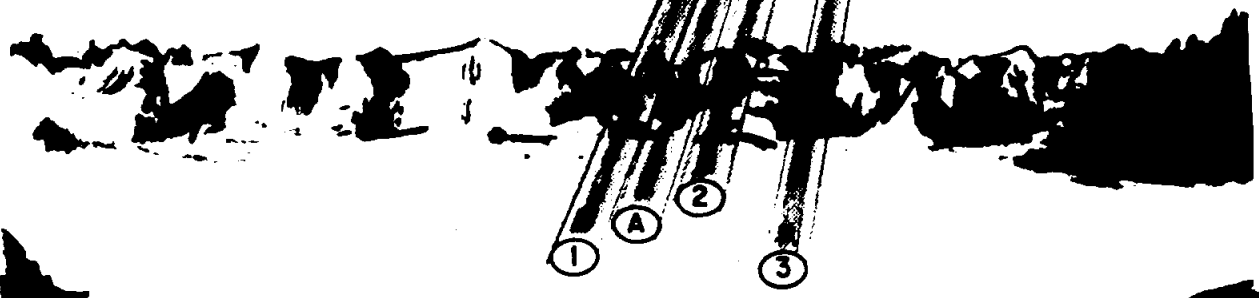
using radar
 to determine
 position
 relative

ALTITUDE → A
 ALTITUDE RATE
 (VERTICAL VELOCITY)

FORWARD (Z-AXIS) AND
 LATERAL (Y-AXIS) VELOCITY

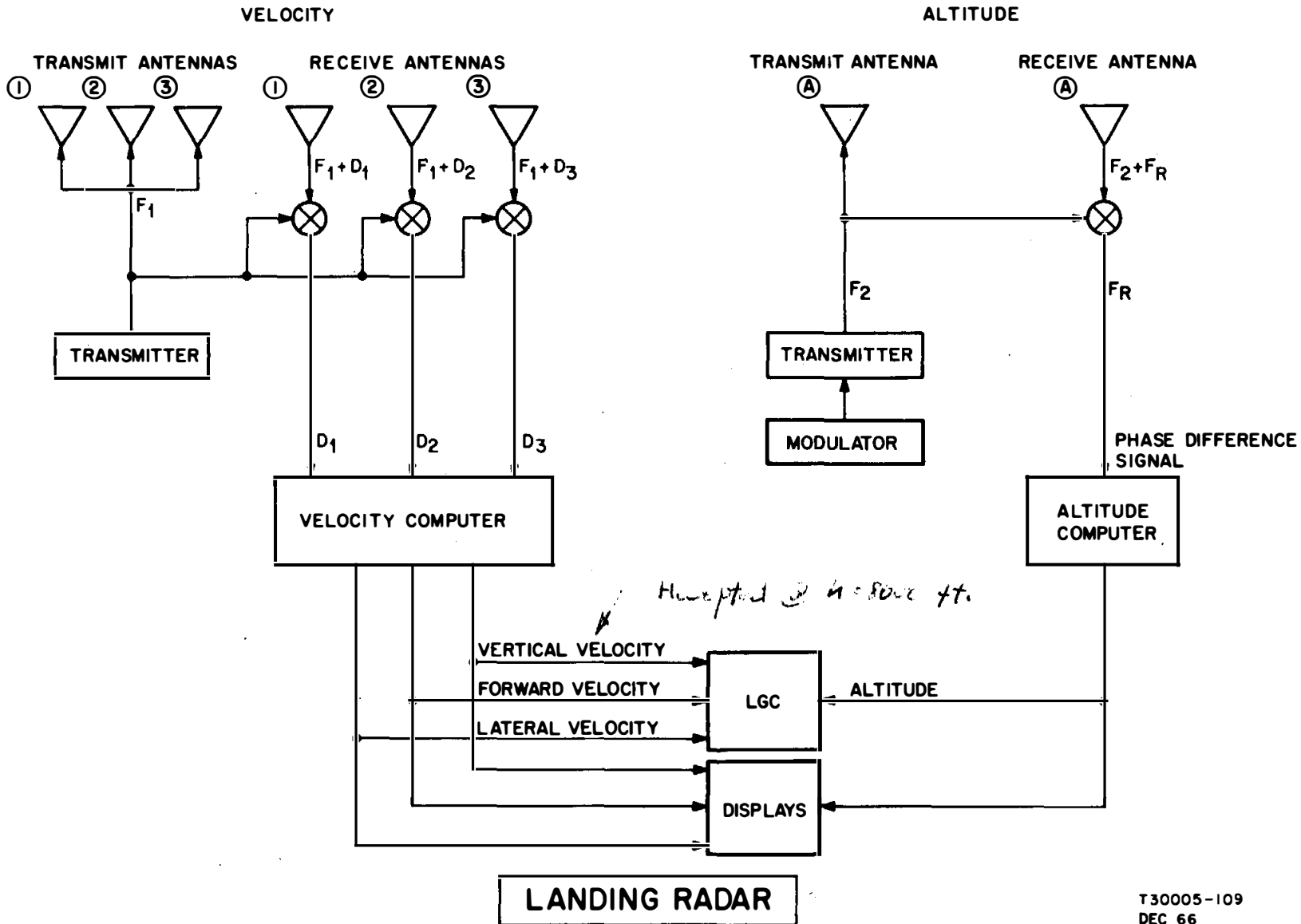
Uses Doppler
 shift
 returns
 2 beams

2-5 → lat. &
 1-5 → lon.
 etc.



LANDING RADAR OPERATION

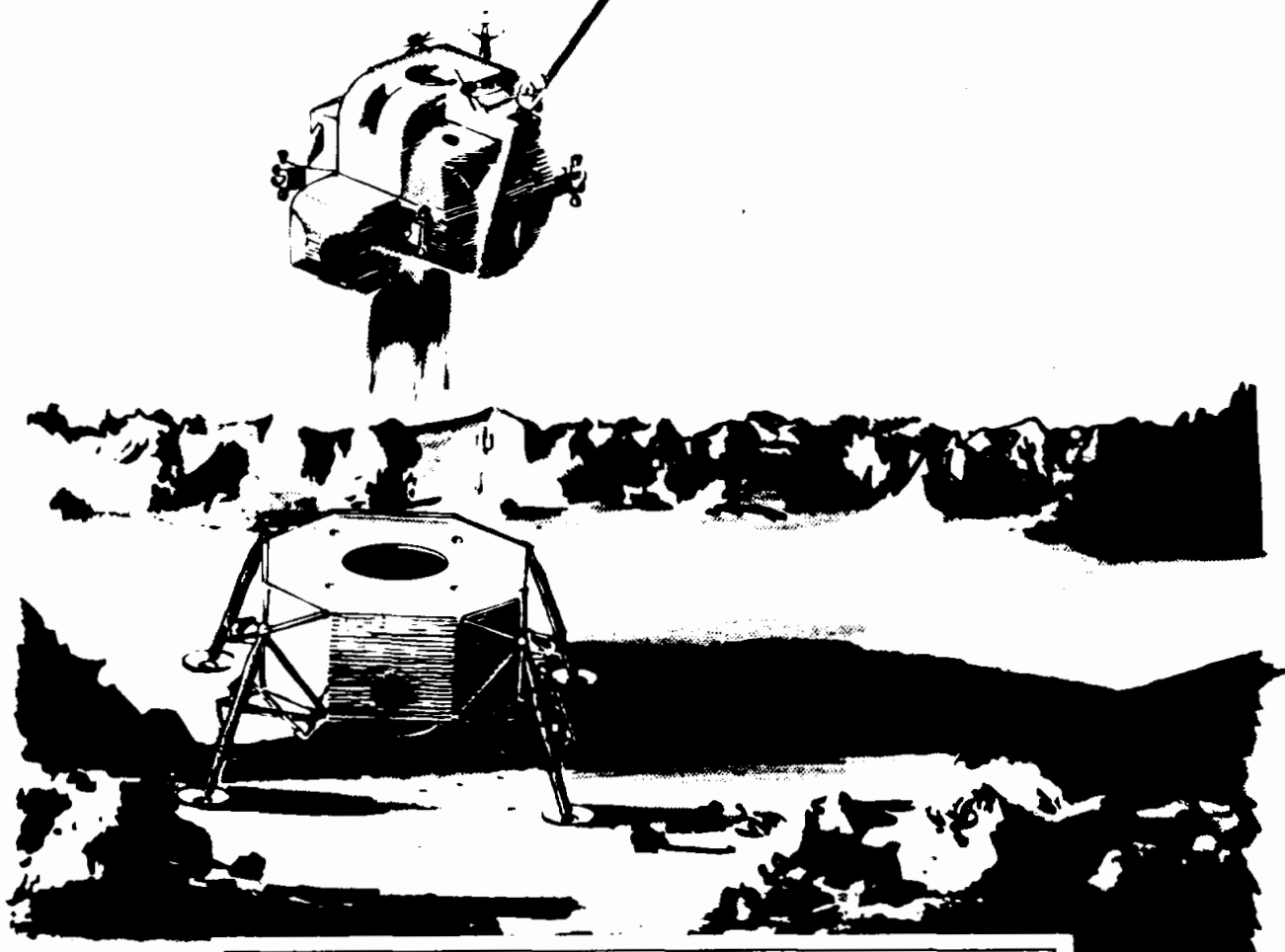
T 30005-104
 APR 66



CMC - transponder sends
back consistent reply
to the signal sent out
by CMC RA

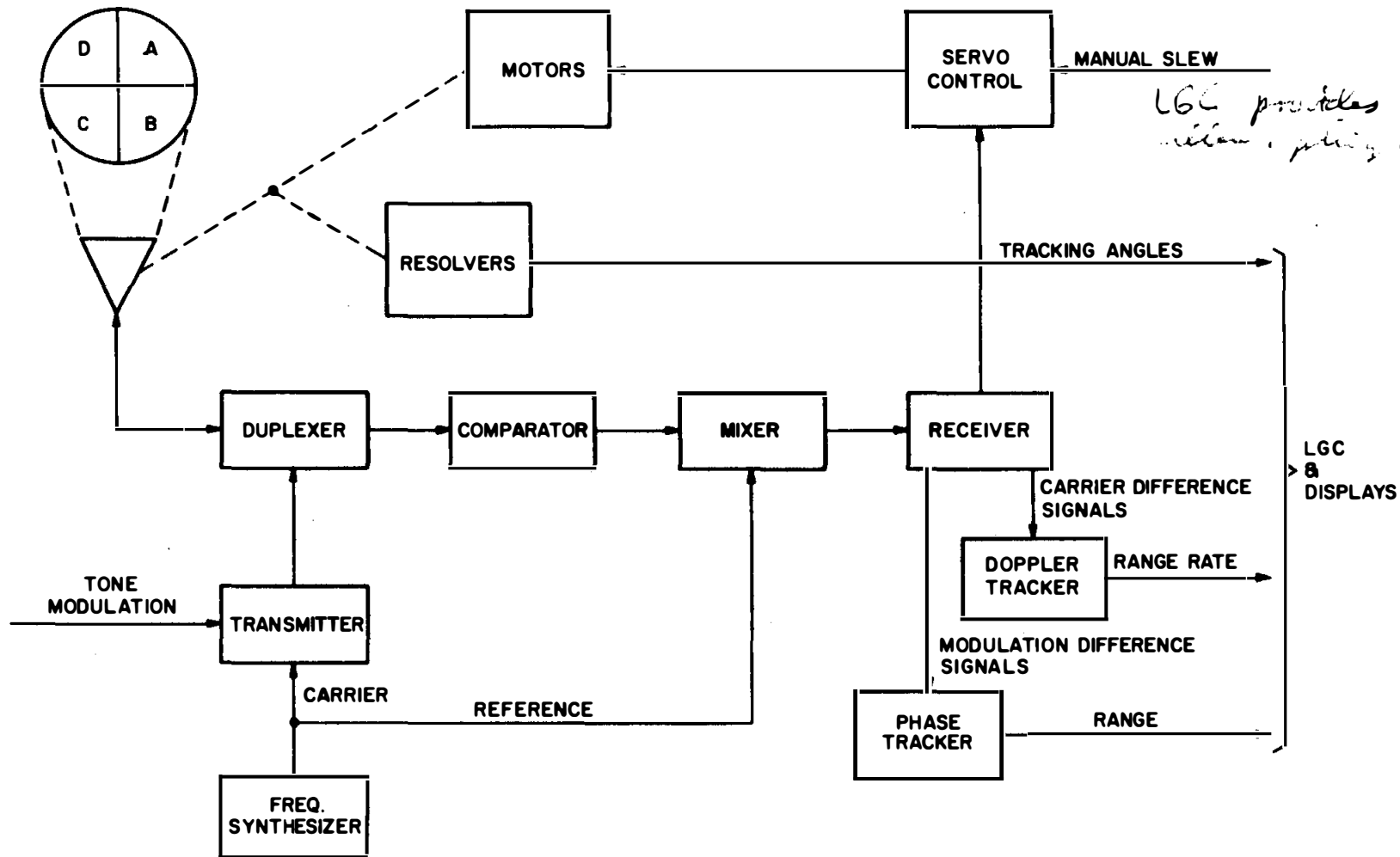
Good for range
up to 400 miles

RANGE
RANGE RATE
TRACKING ANGLES



RENDEZVOUS RADAR OPERATION

T 30005-103
APR 66



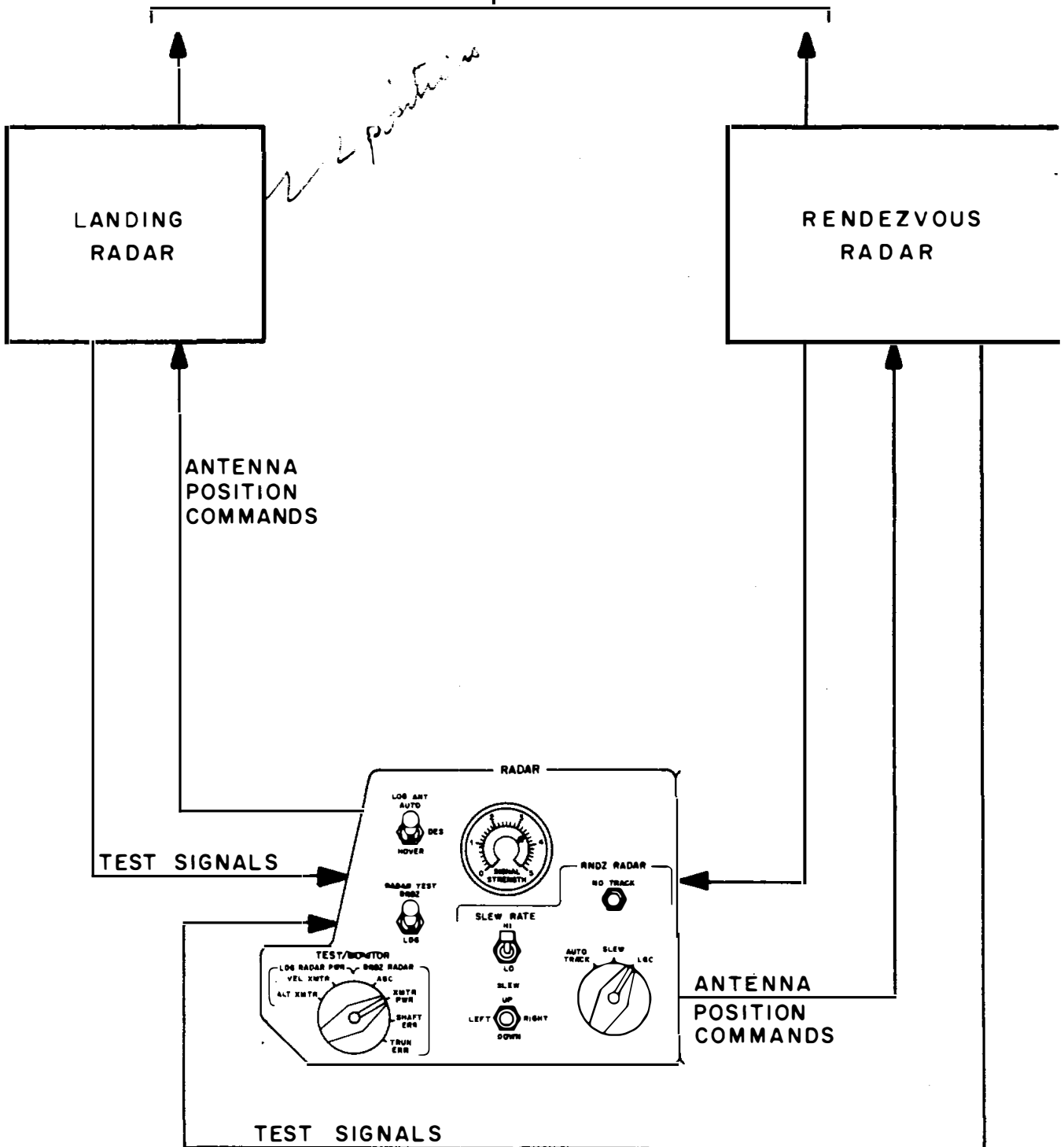
*LGC provides initial
velocity, pointing corrections*

RENDEZVOUS RADAR

T30005-108
APR 66

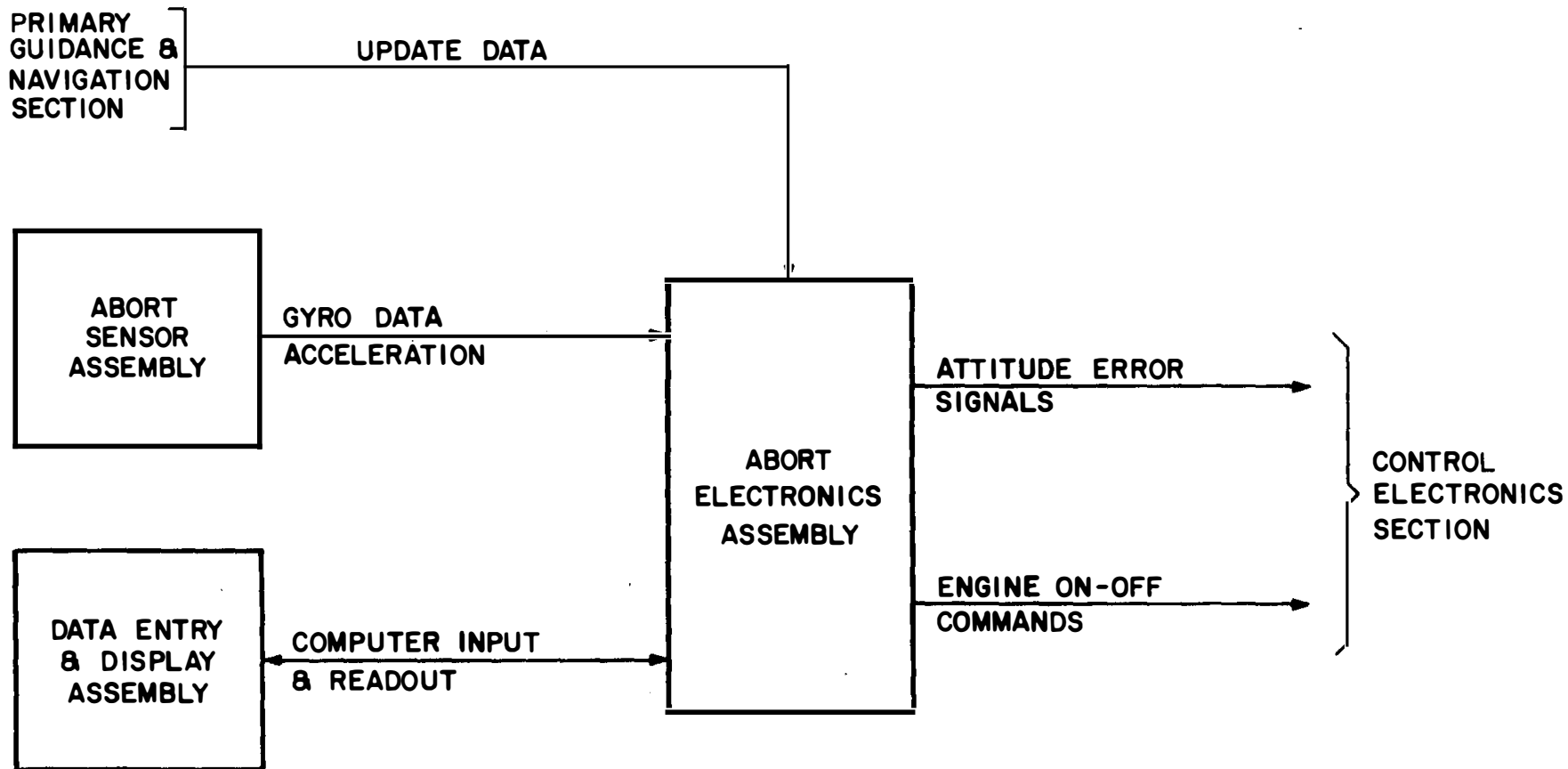
*Understand
HTL circuit in p. 1
If want to investigate on this, all + reference
in the of the no will be helpful*

CREW
DISPLAYS



PANEL III
RADAR CONTROL

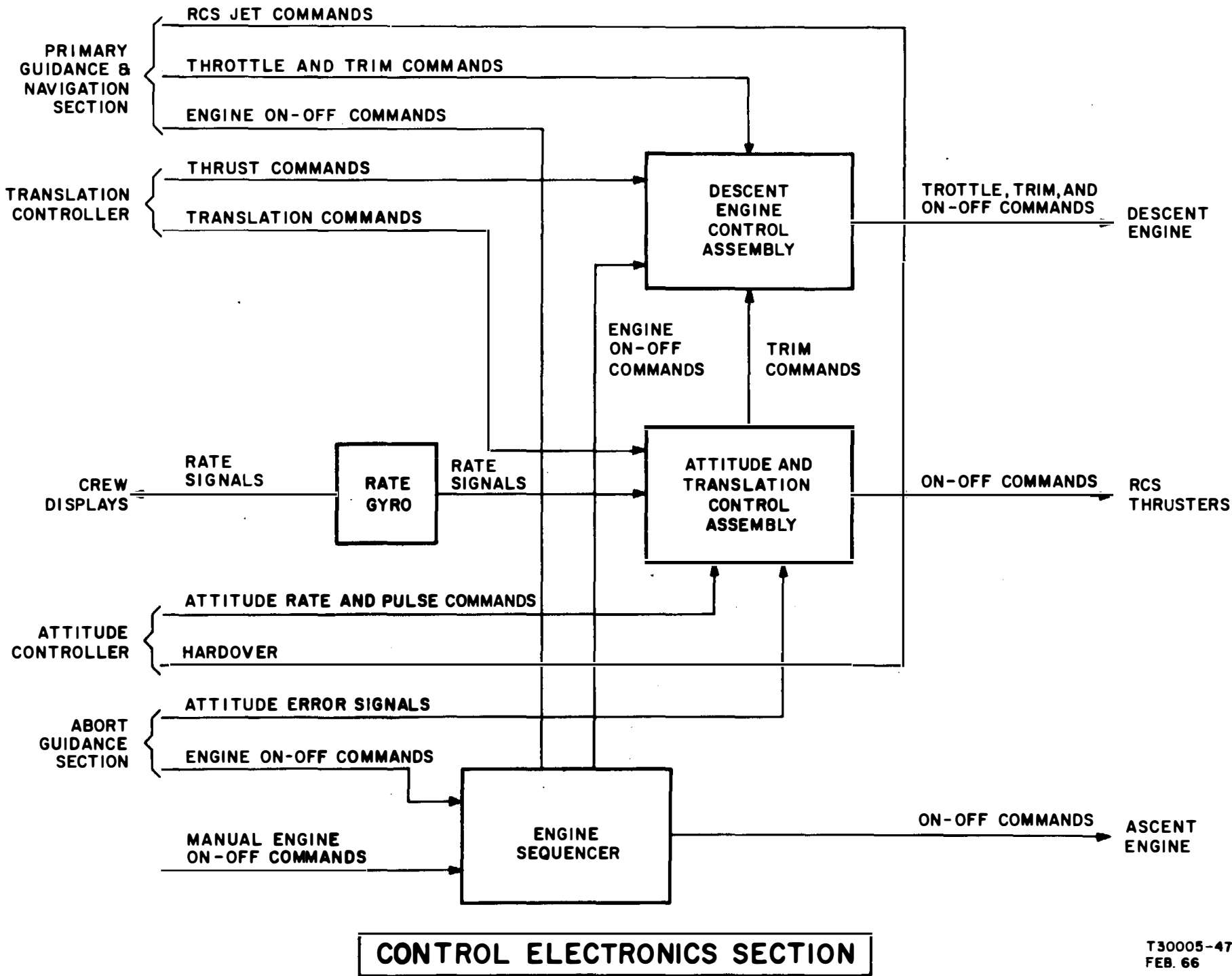
T 30005-54
DEC 66

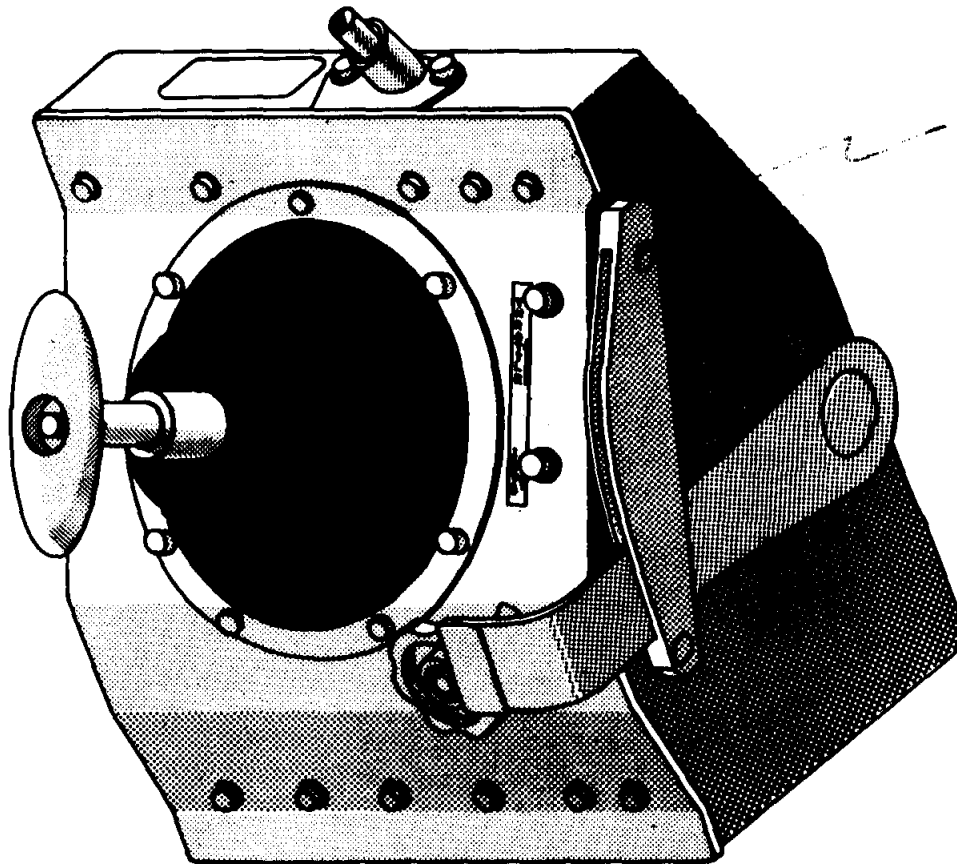


ABORT GUIDANCE SECTION

T30005-46
FEB 66

Descent only. may be used to an abort starting level of
 10000 ft (10000 ft)
 10000 ft
 In this case the engine fuel unit



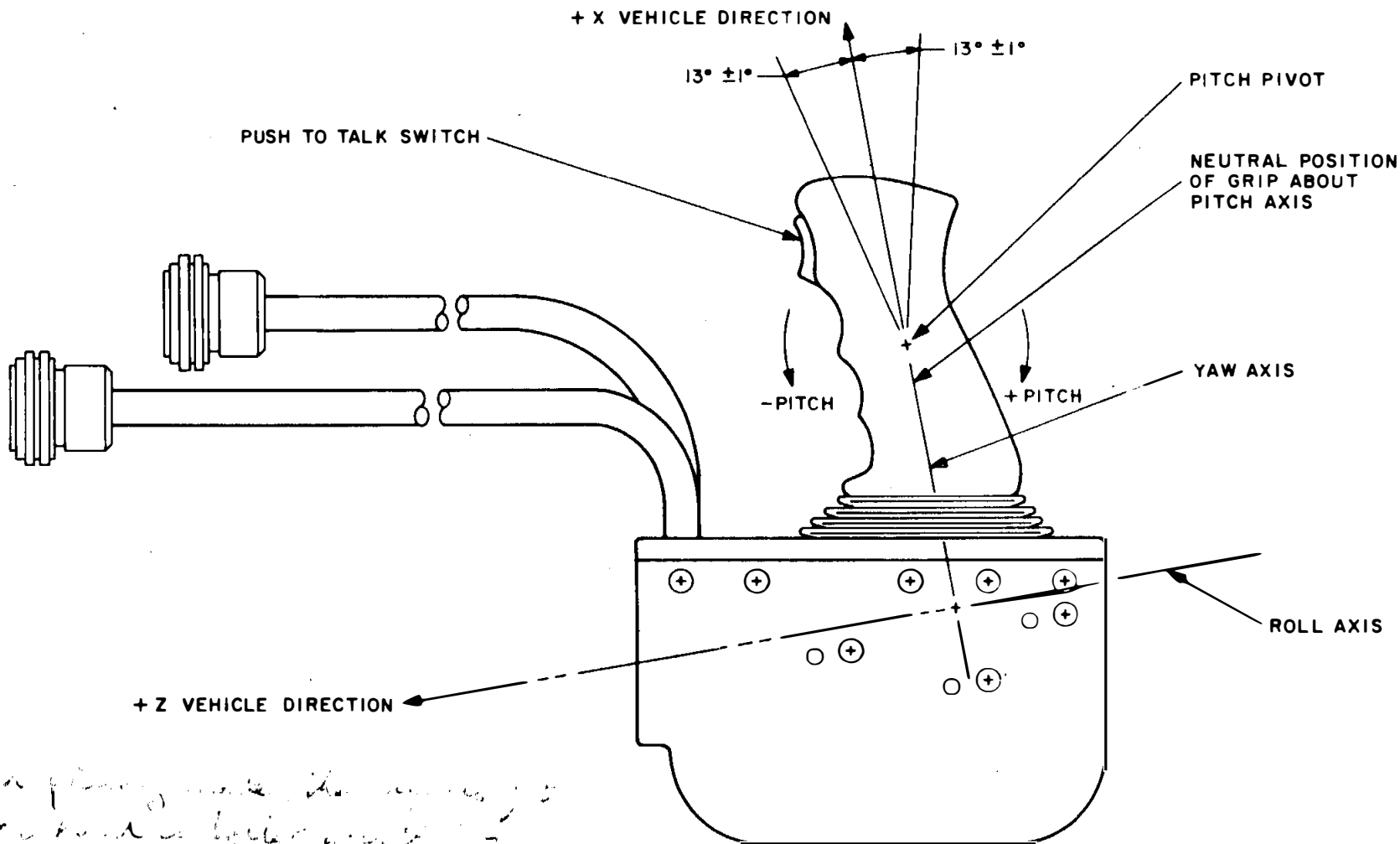


in this position
 of 7 mm gap
 +
 in the direction
 of the

THRUST TRANSLATION CONTROLLER ASSEMBLY

T30005-51
 DEC 66

120
 1 2 3 4
 1 2 3 4
 1 2 3 4

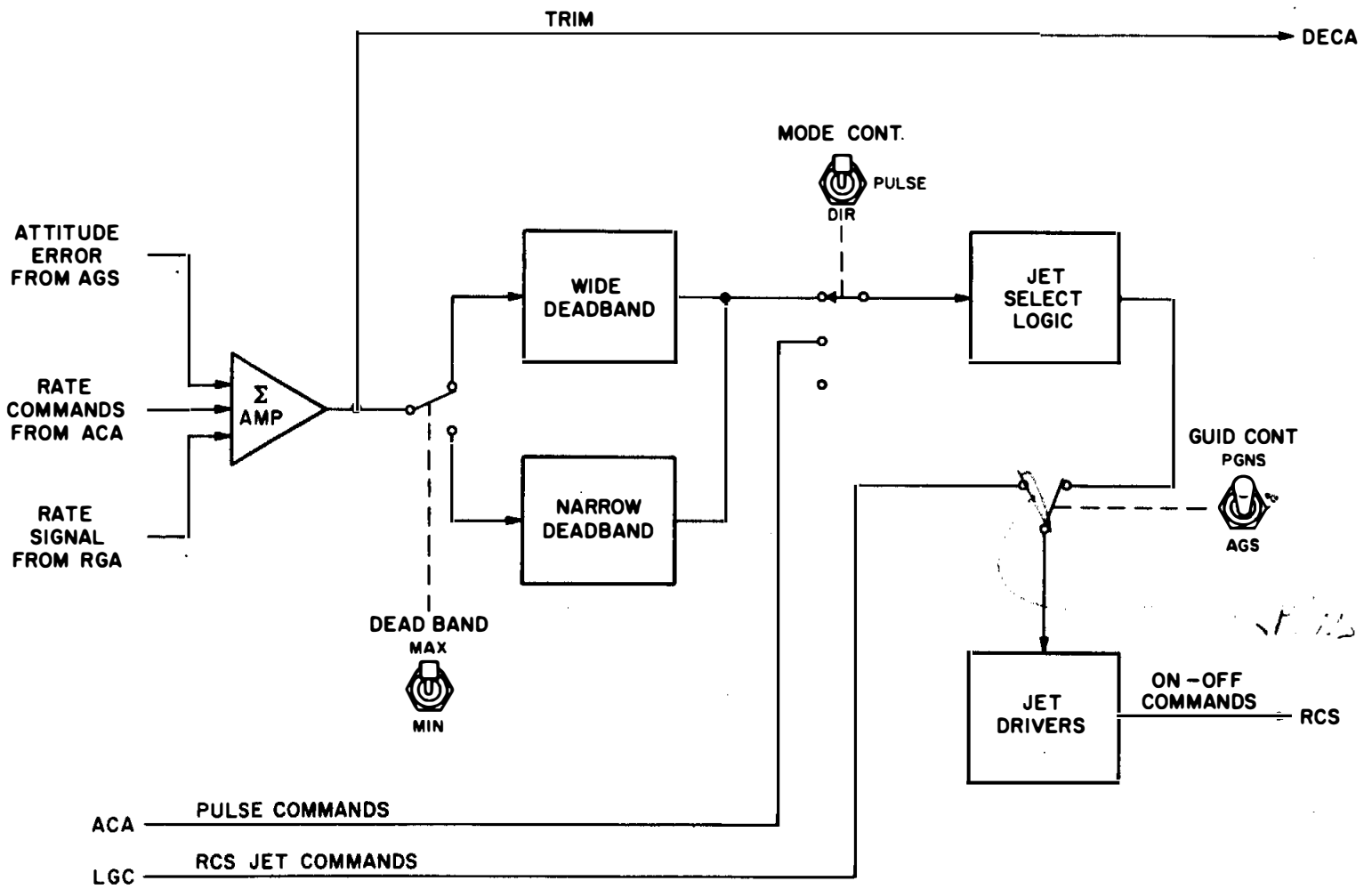


*In planning make the...
 the hand...
 1.0 of A...
 low...
 better...*

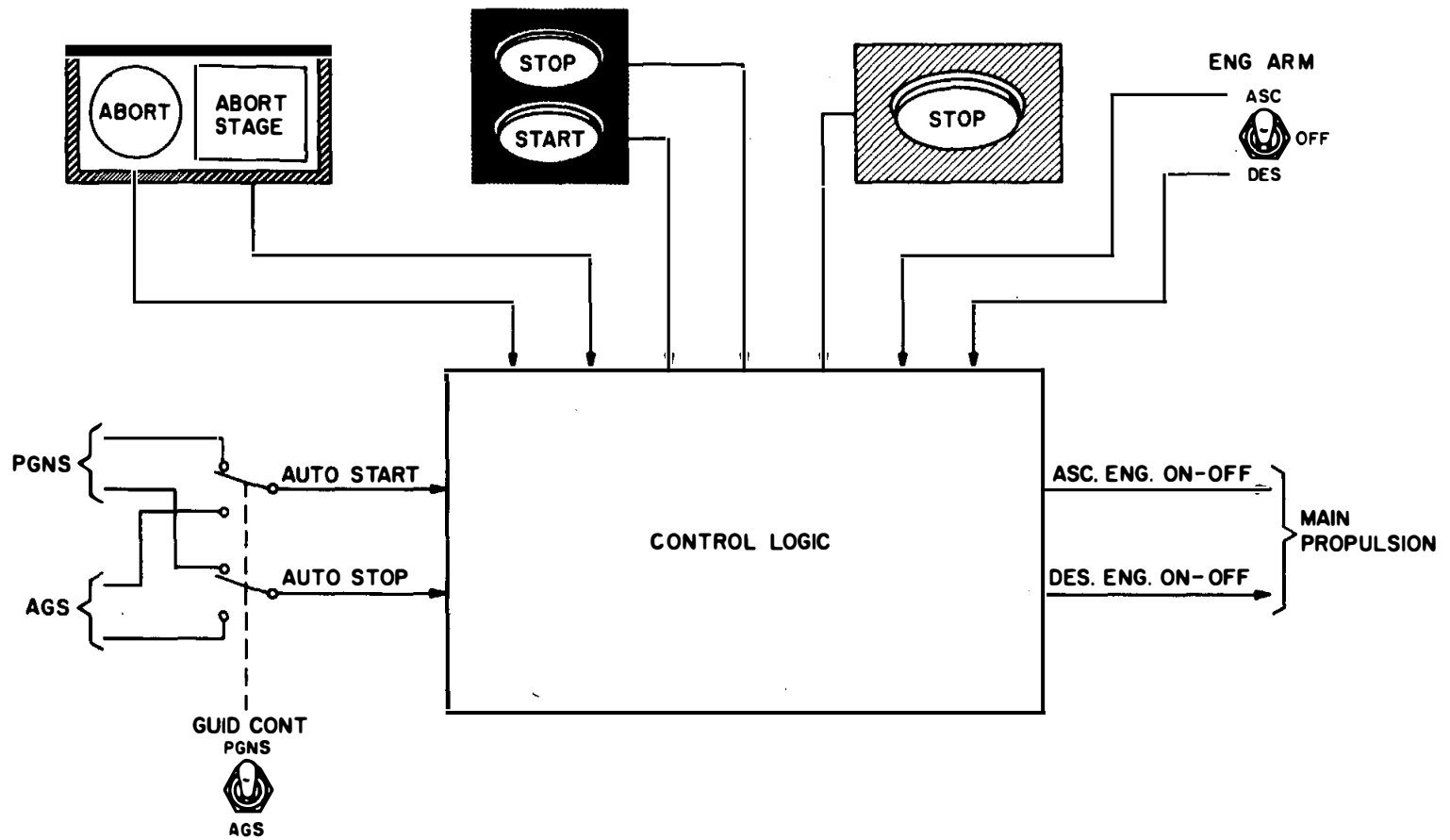
ACA MANIPULATION

Att. ...

T30005-52
 DEC 66

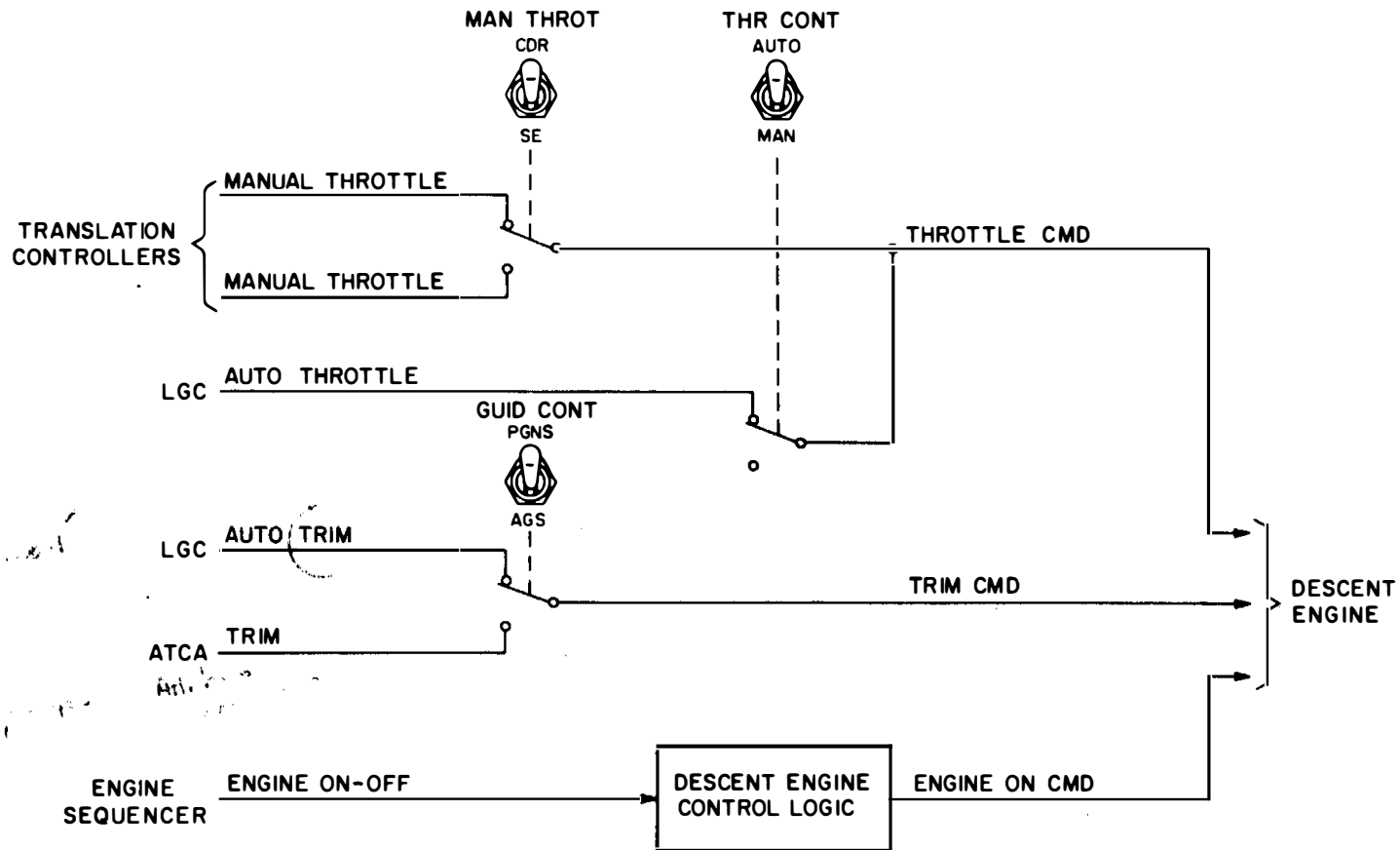


ATTITUDE AND TRANSLATION CONTROL ASSEMBLY



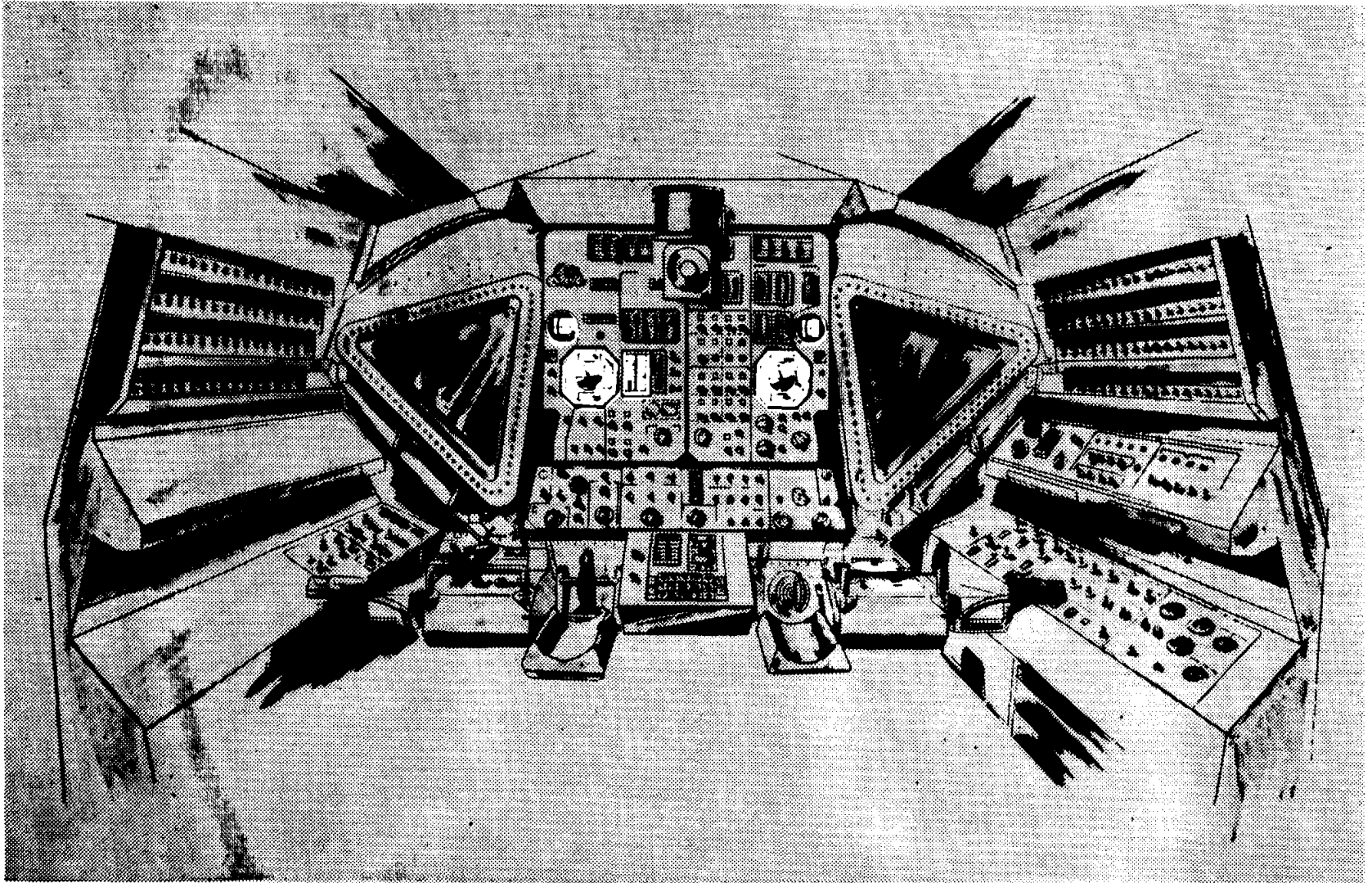
ENGINE SEQUENCER

T30005-105
APR 66



DESCENT ENGINE CONTROL ASSEMBLY

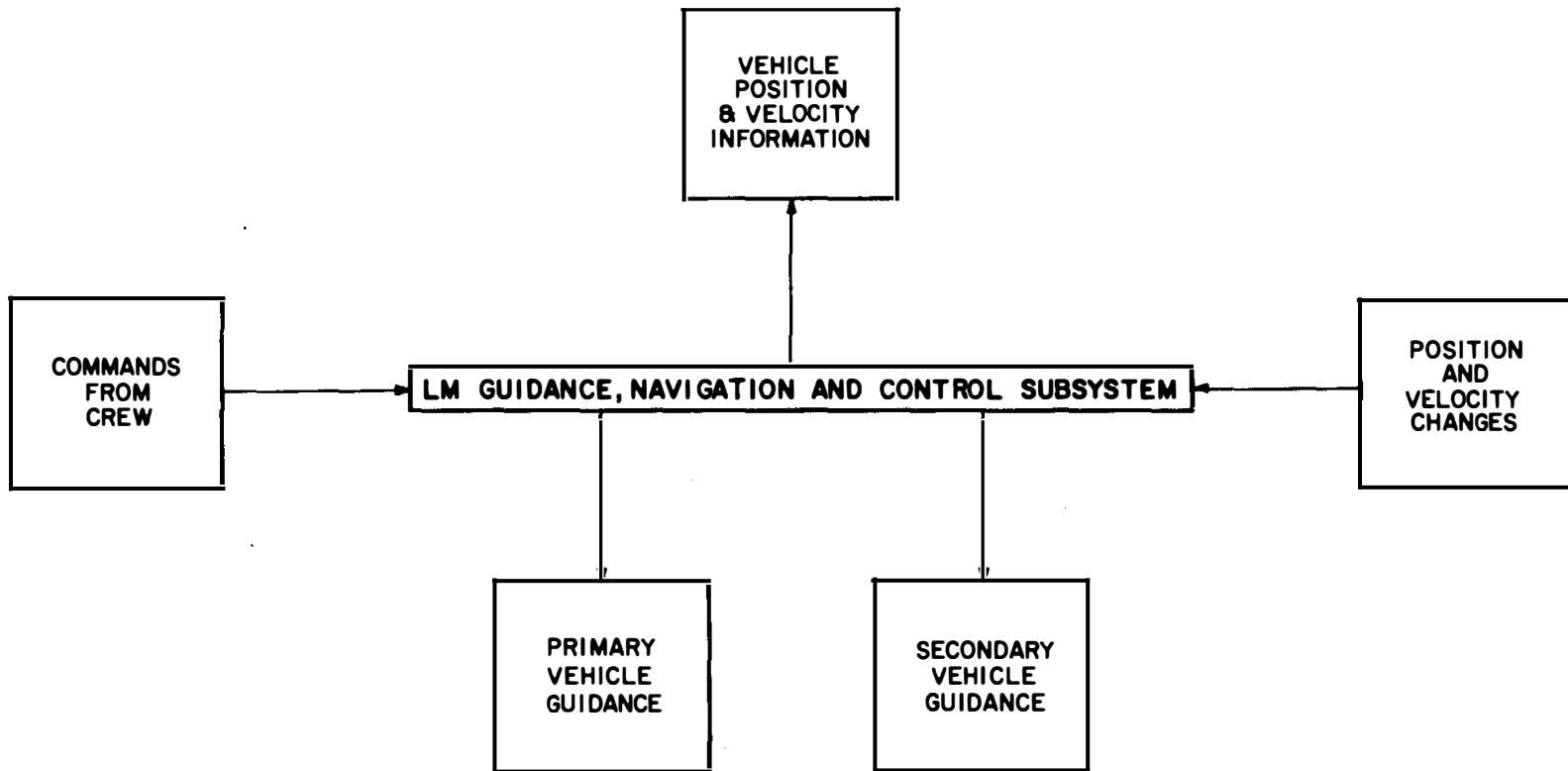
T30005-106
APR 66



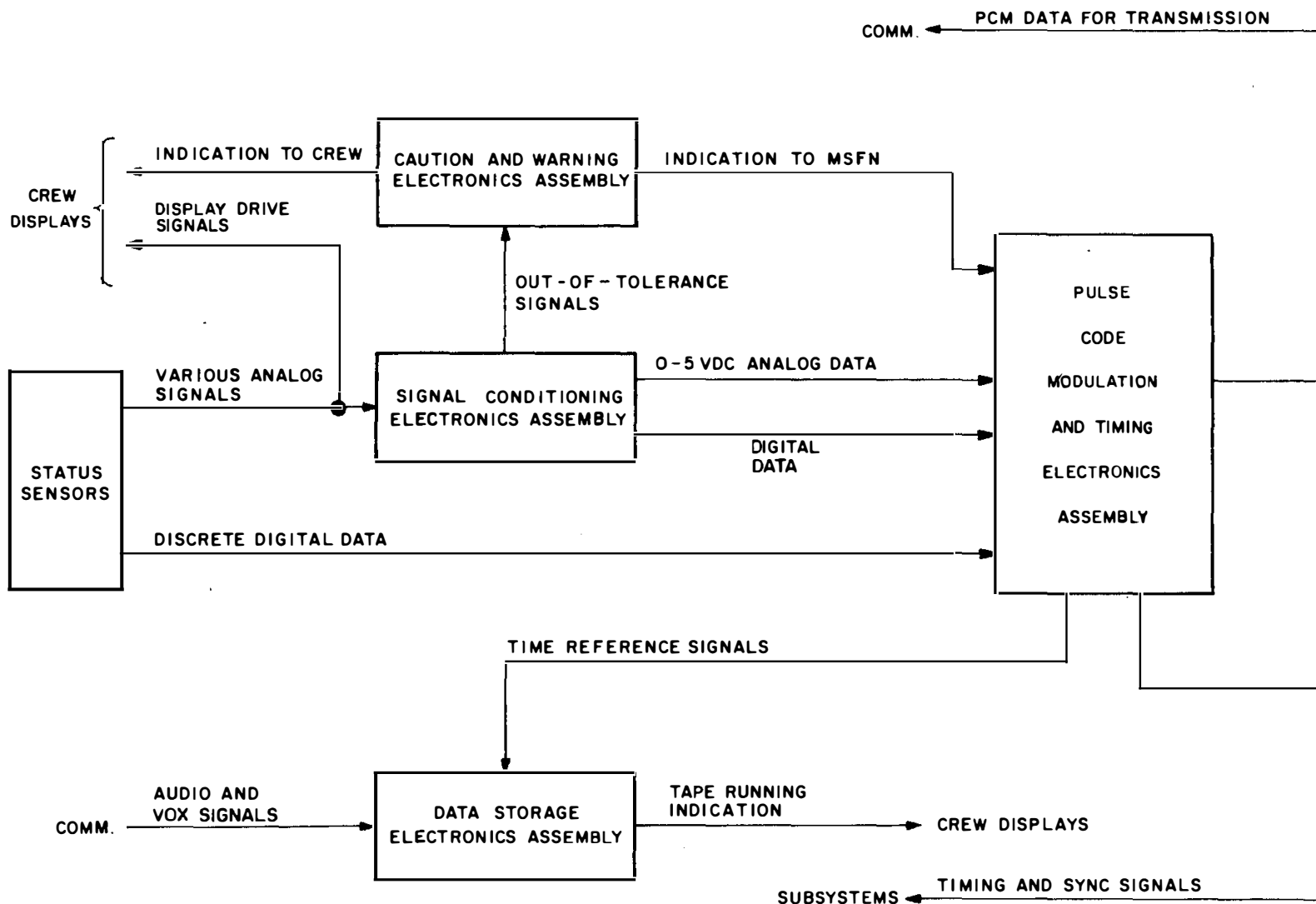
White cross

G.N. AND C. ASSOCIATED DISPLAYS

T 30005-50
APR 66

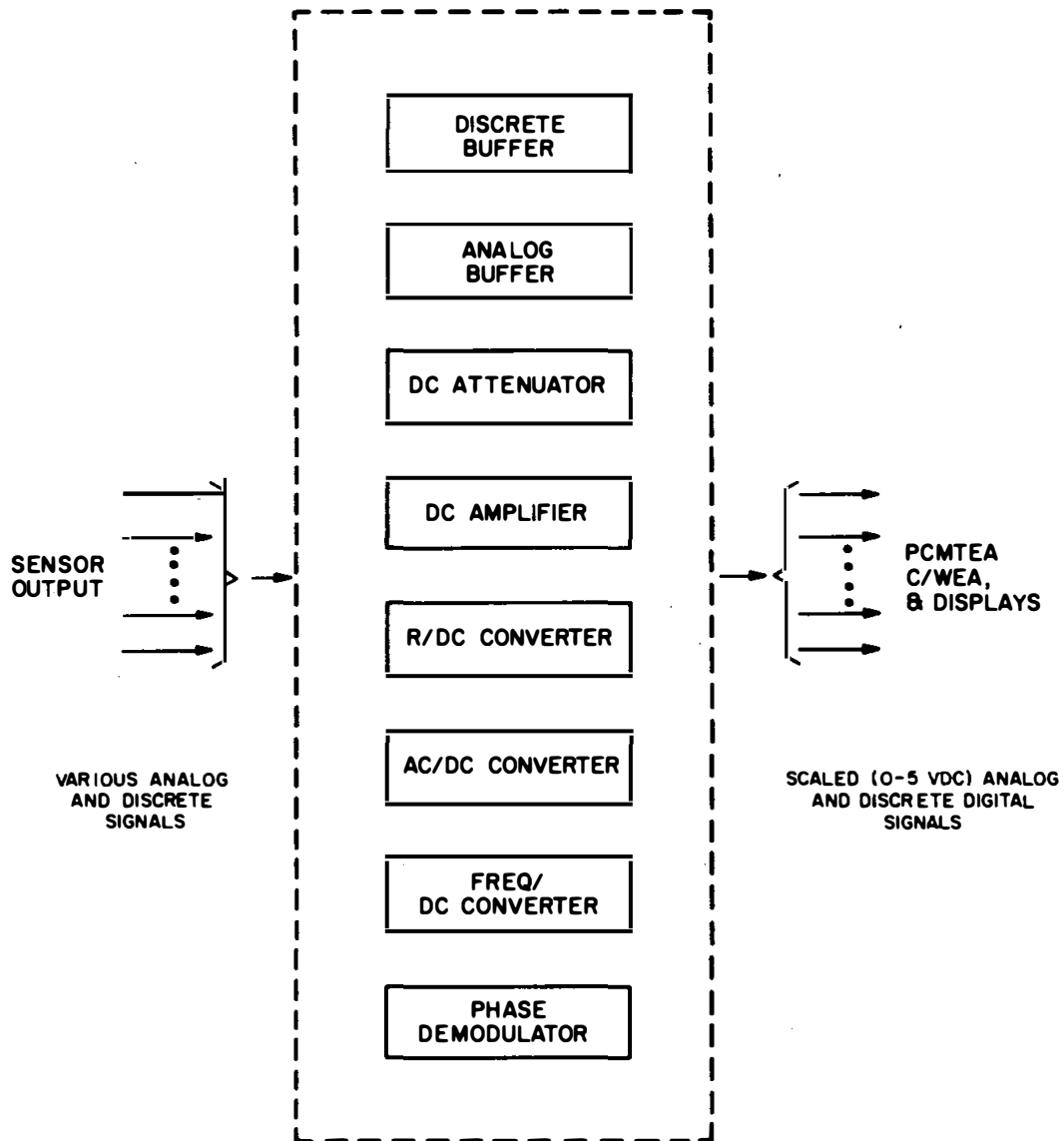


T30005-43
DEC 66



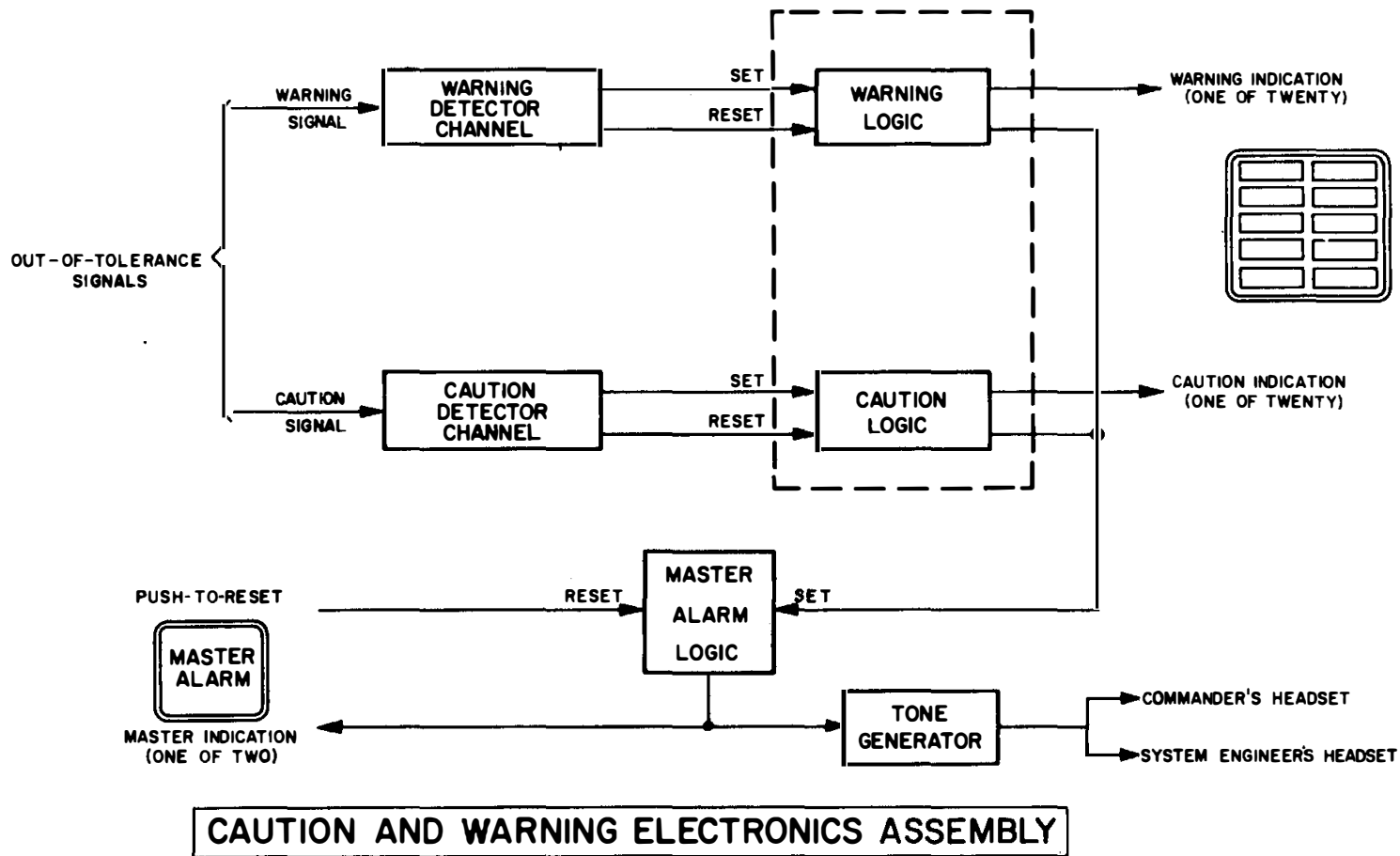
LM INSTRUMENTATION SUBSYSTEM

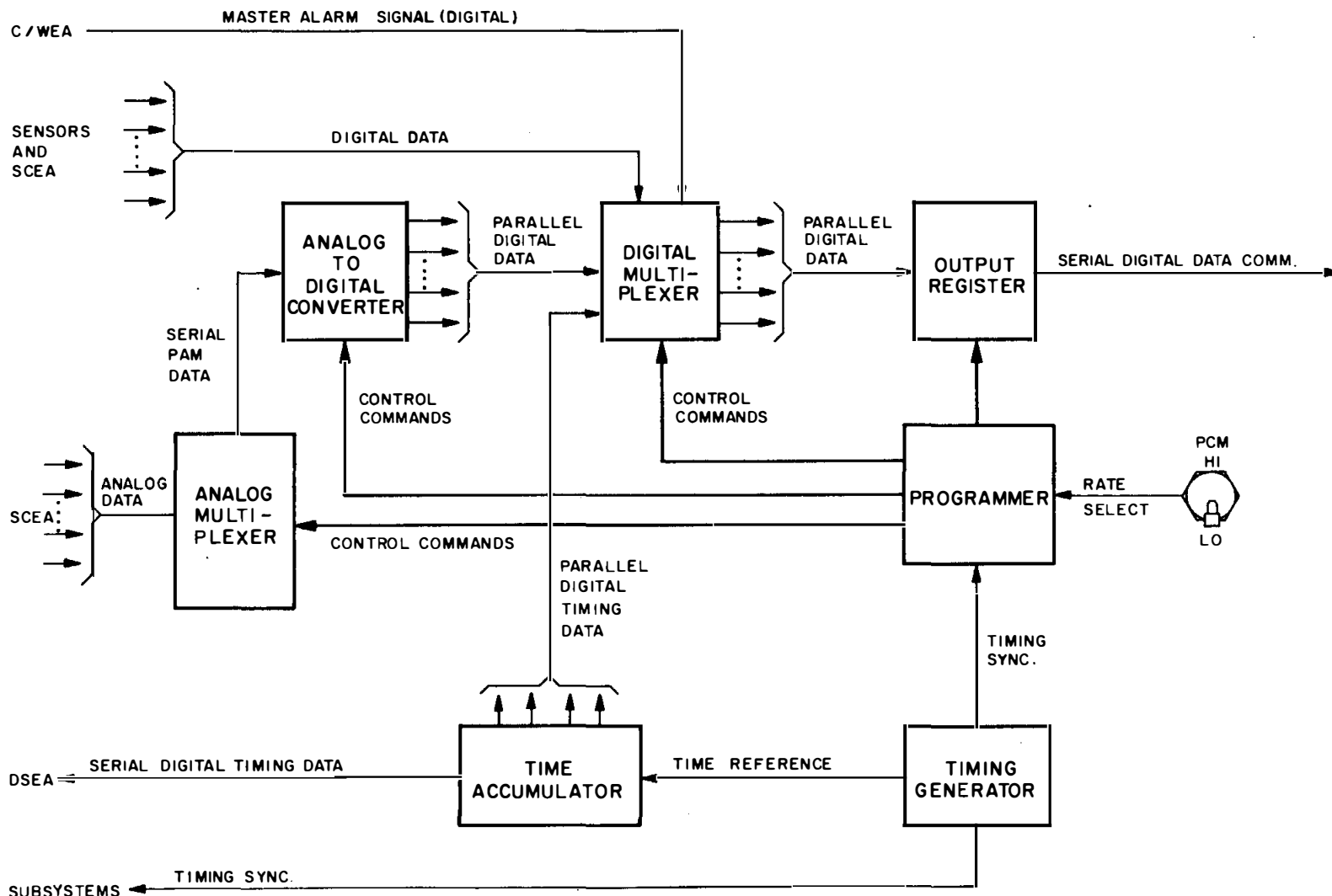
T30005-57
DEC 66



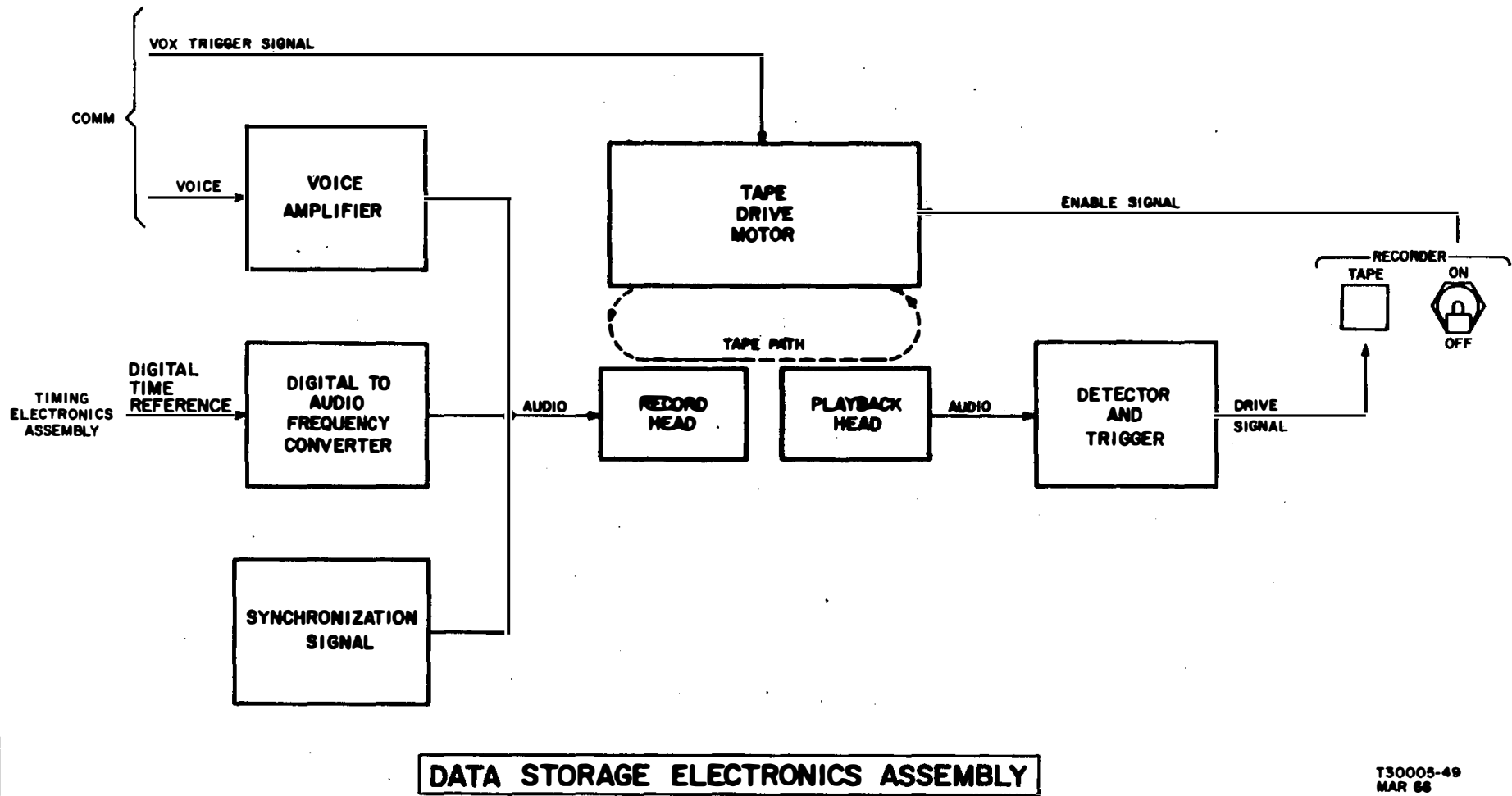
SIGNAL CONDITIONING ELECTRONICS ASSEMBLY

T30005-59
MAR 66

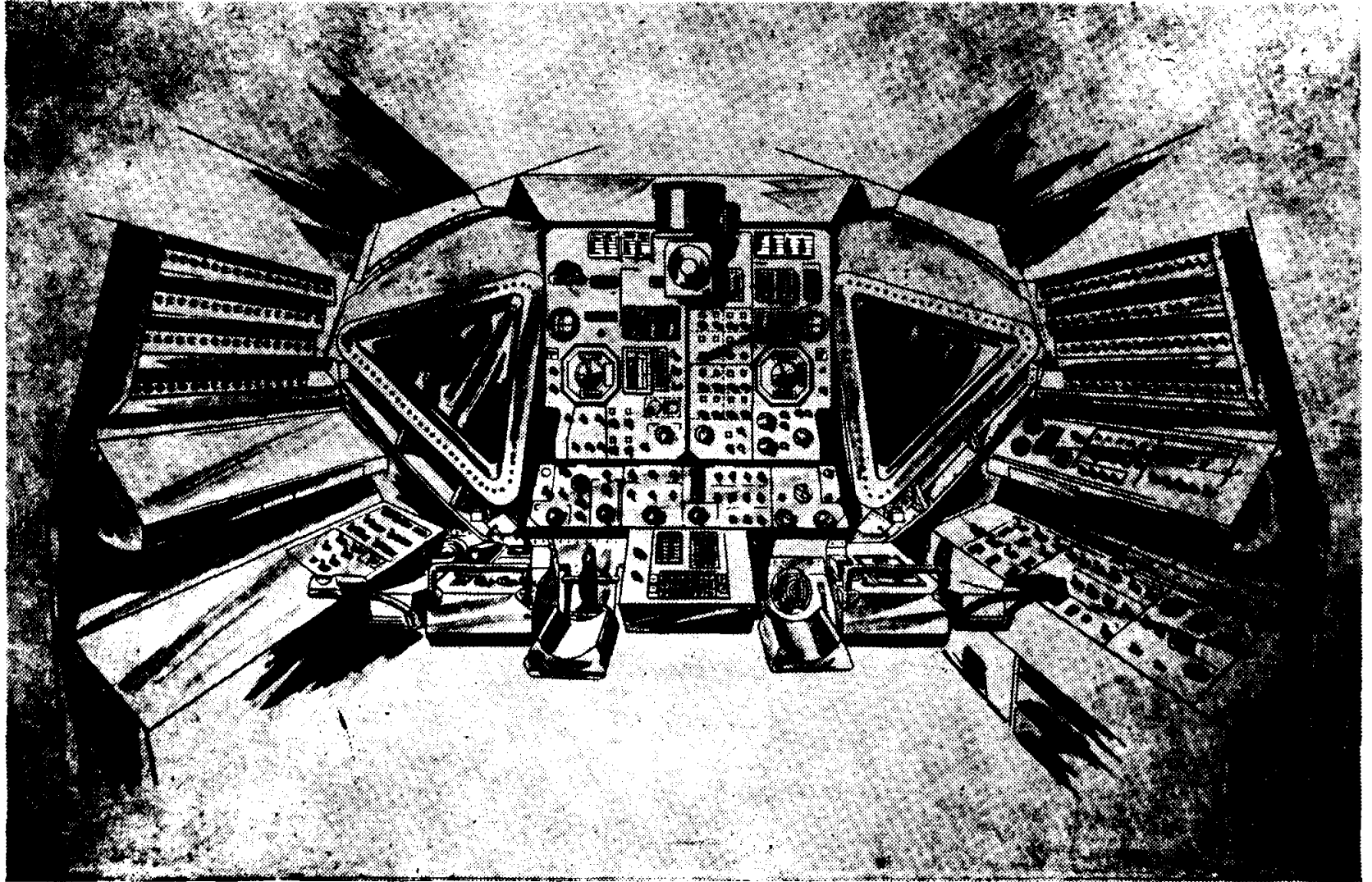




**PULSE CODE MODULATION
AND TIMING ELECTRONICS ASSEMBLY**

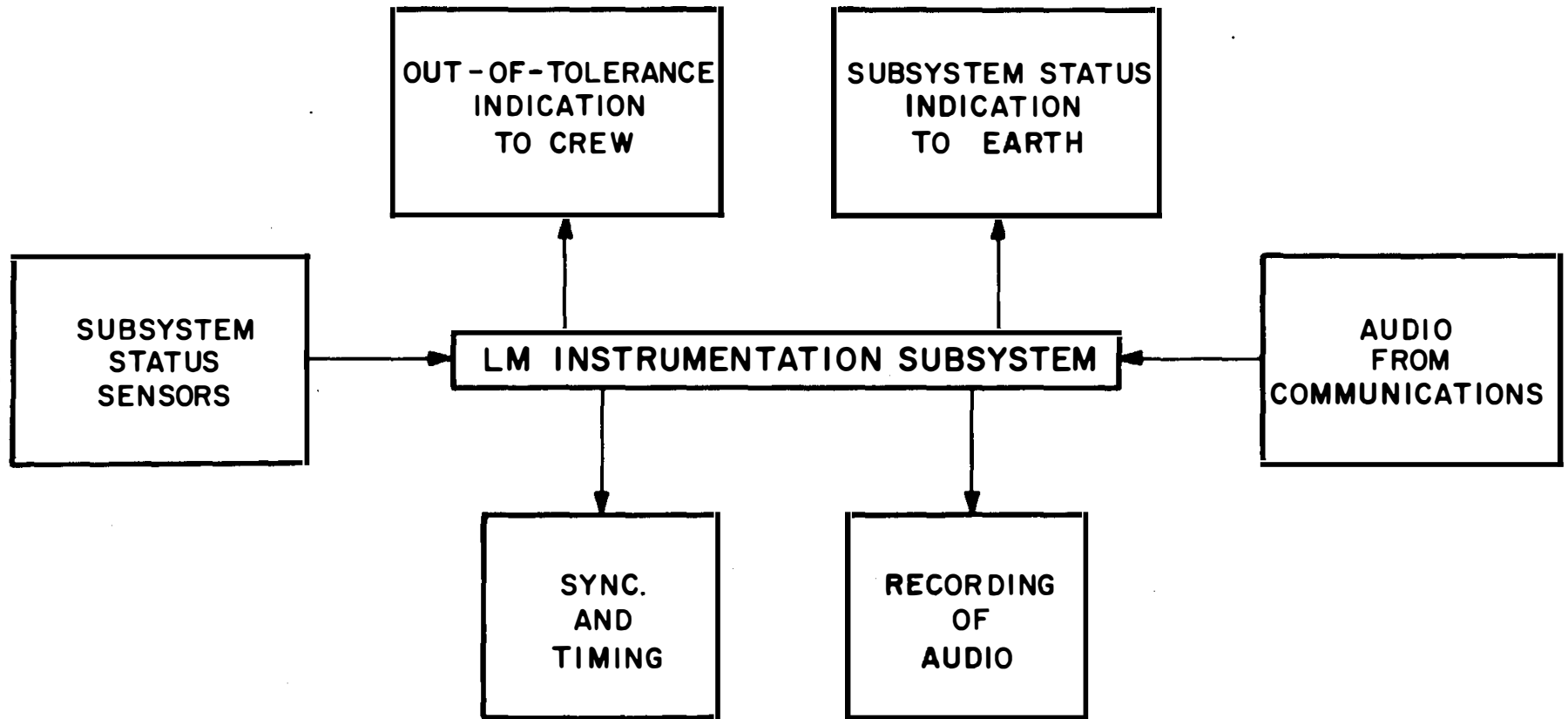


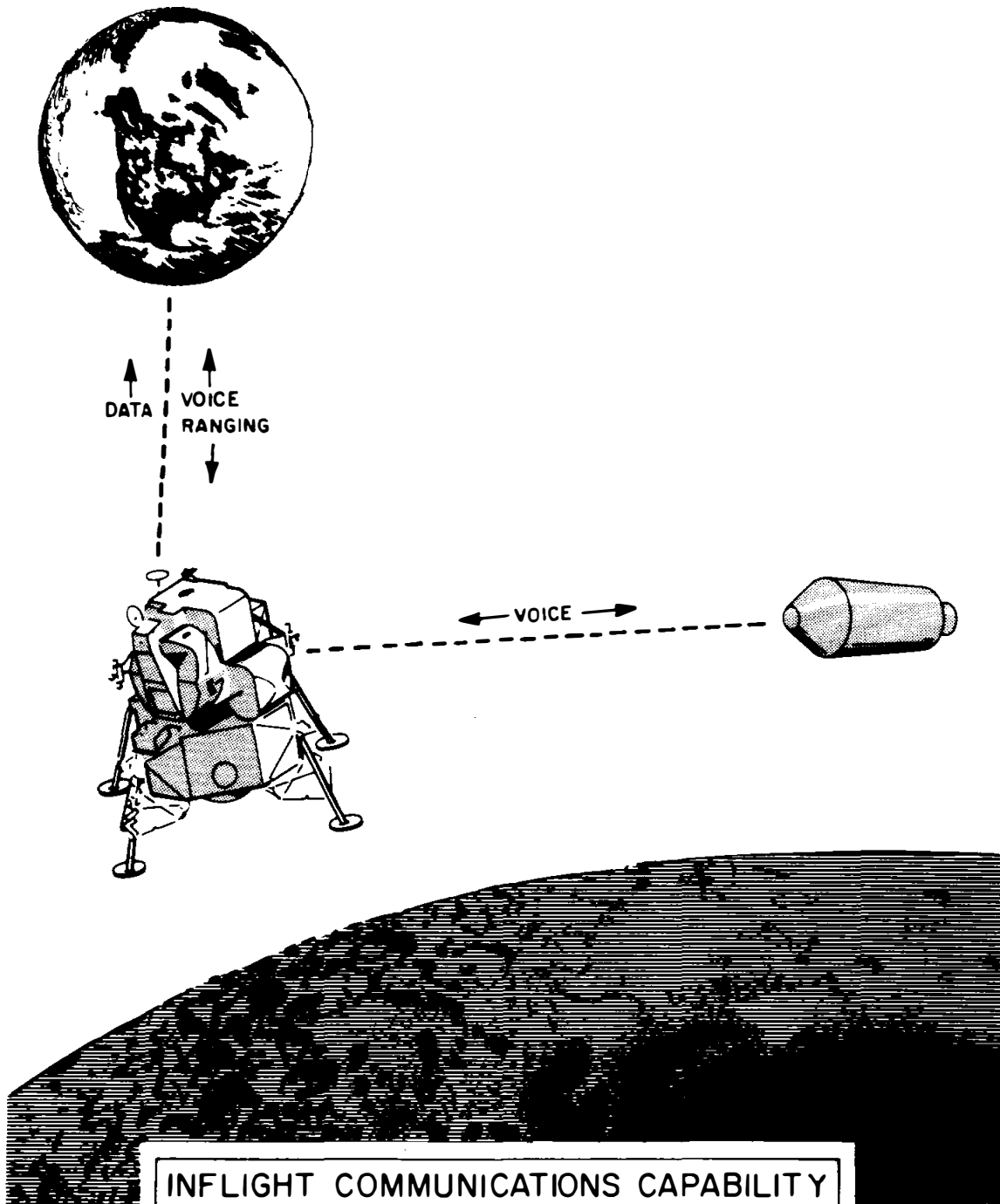
T30005-49
MAR 66



INSTRUMENTATION ASSOCIATED DISPLAYS

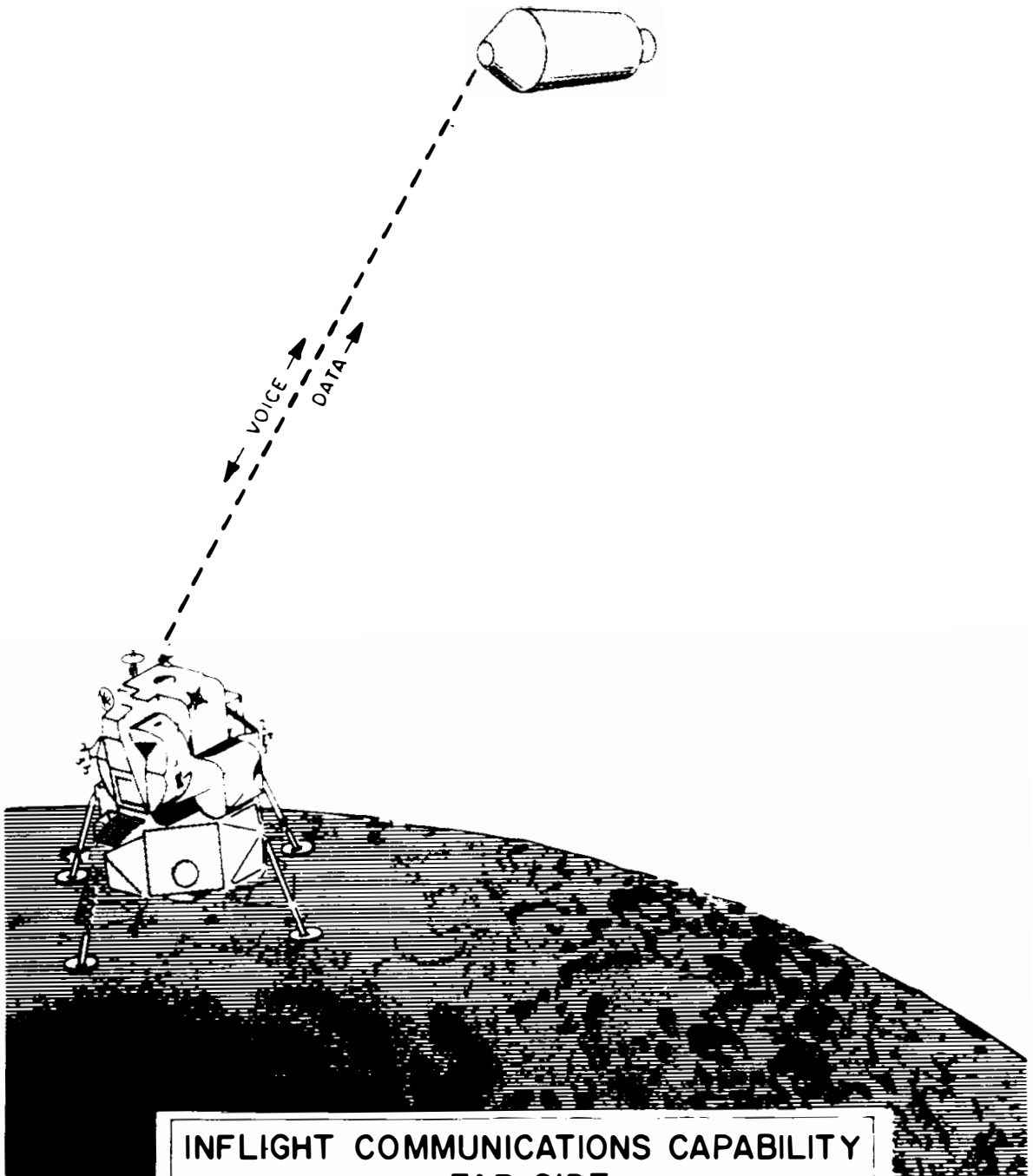
T30005-112
APR 66





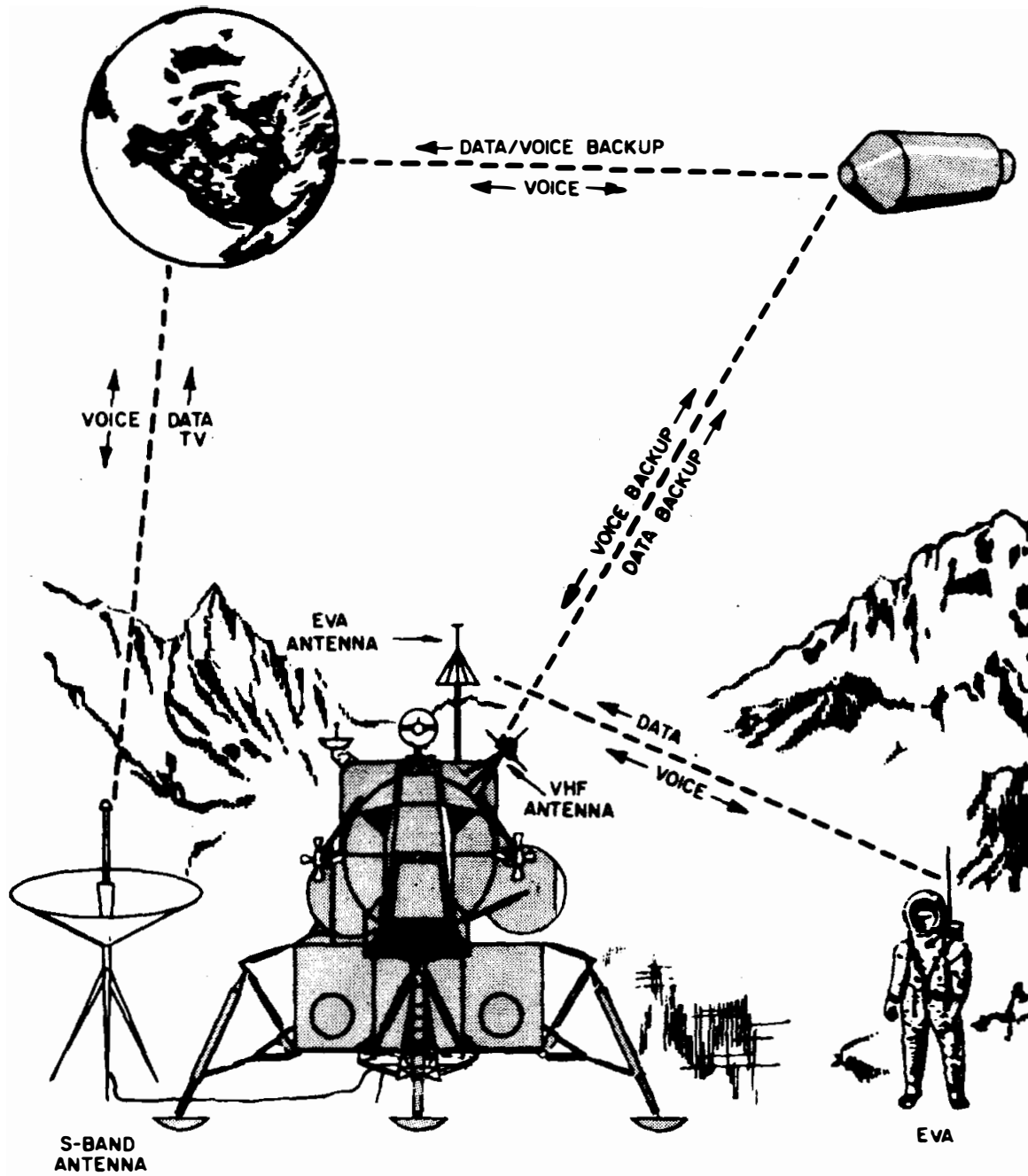
INFLIGHT COMMUNICATIONS CAPABILITY
EARTH SIDE

T30005-38
FEB 66



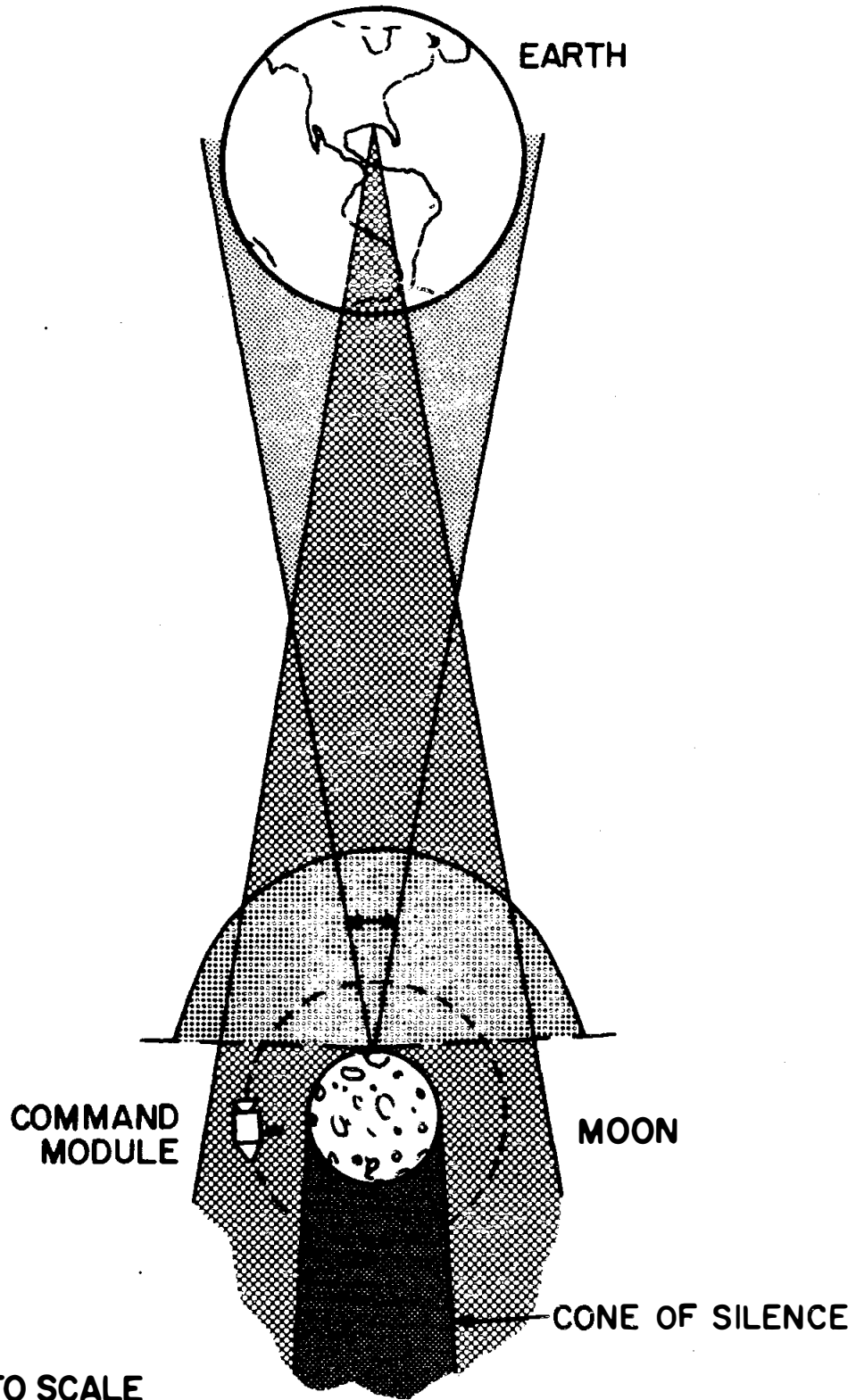
**INFLIGHT COMMUNICATIONS CAPABILITY
FAR SIDE**

T30005-39
JULY 66



**LUNAR SURFACE COMMUNICATIONS
CAPABILITY**

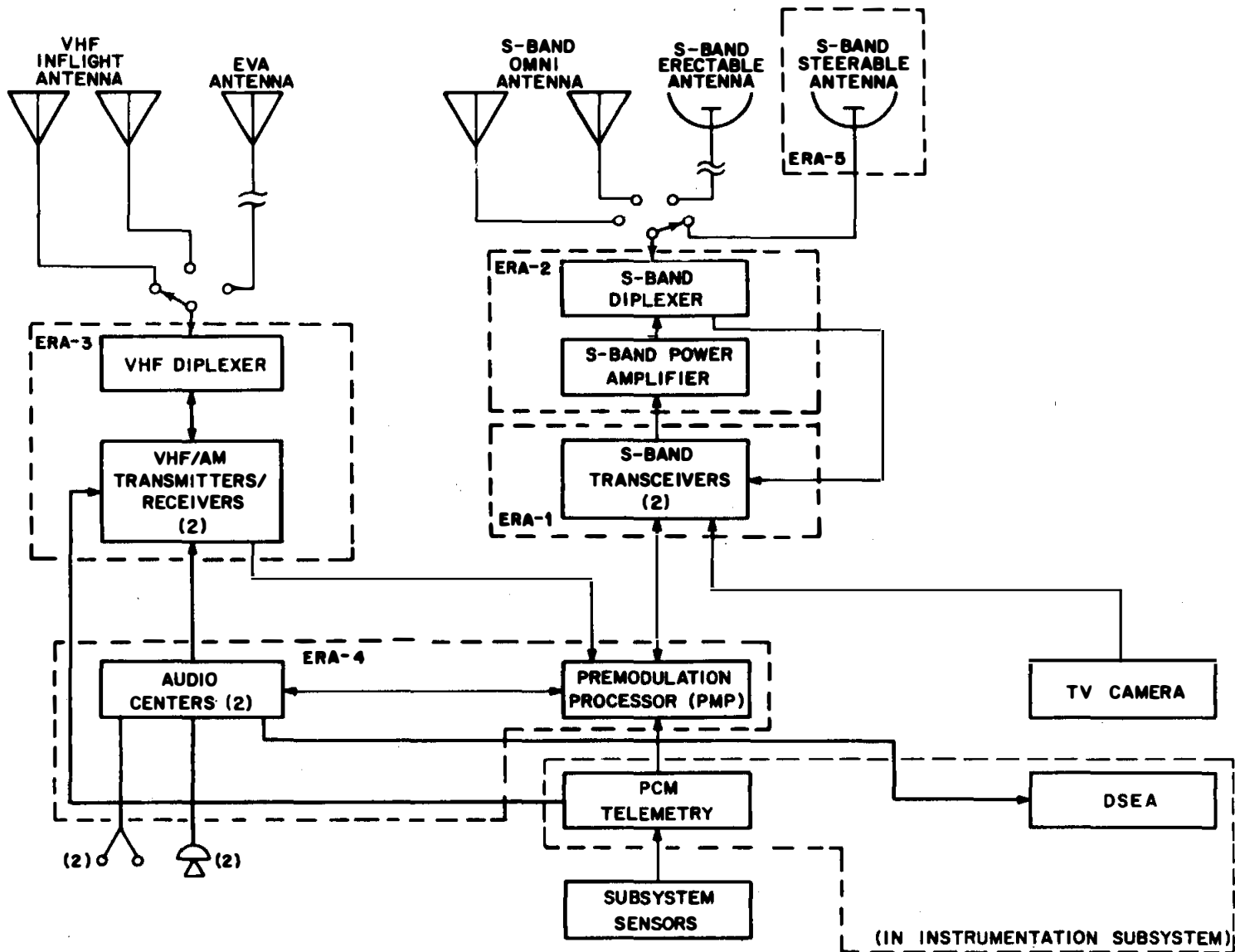
T30005-40
SEPT 66



NOT DRAWN TO SCALE

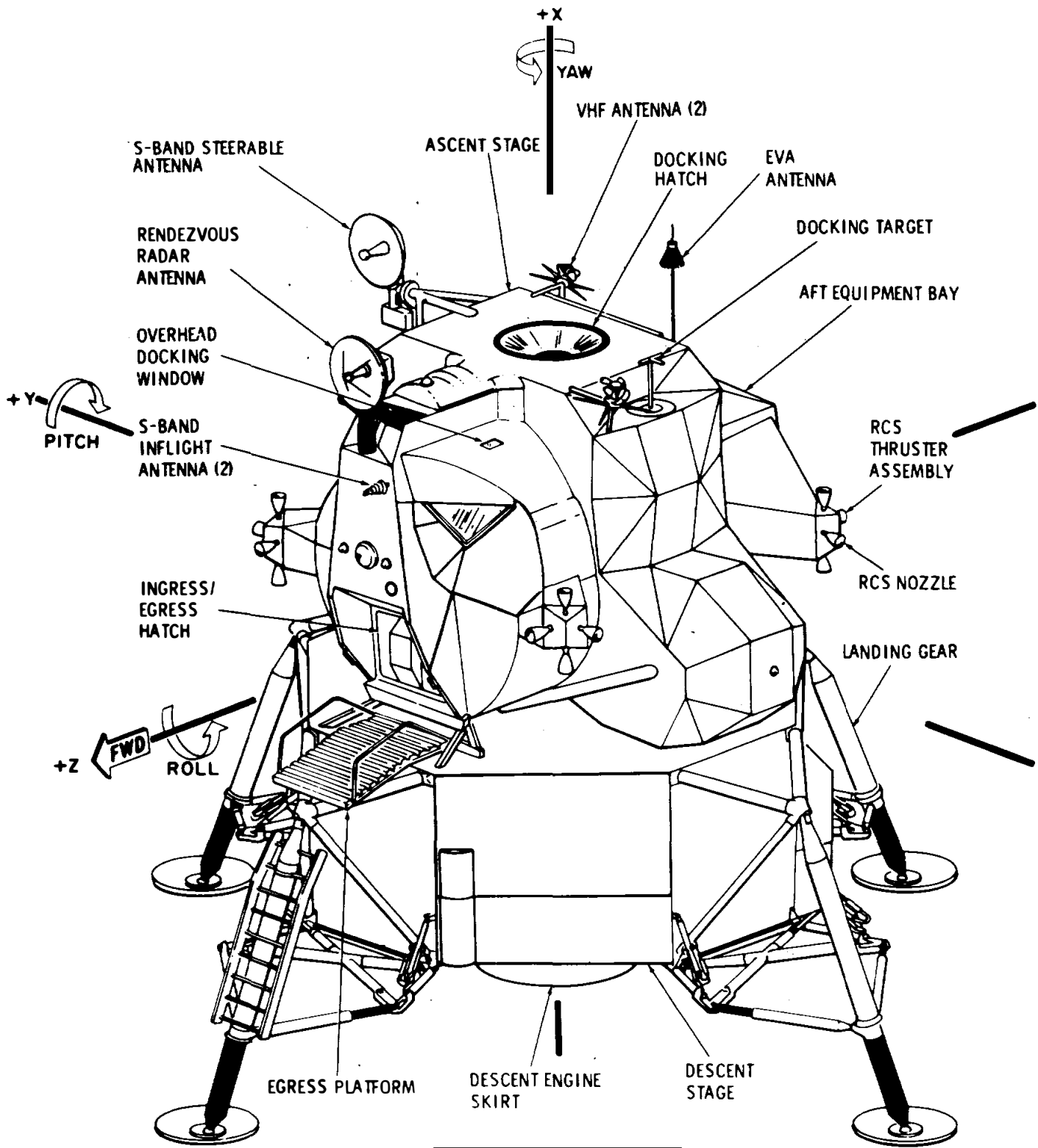
COMMUNICATIONS DURING LUNAR STAY

T30005-101
MAR 66



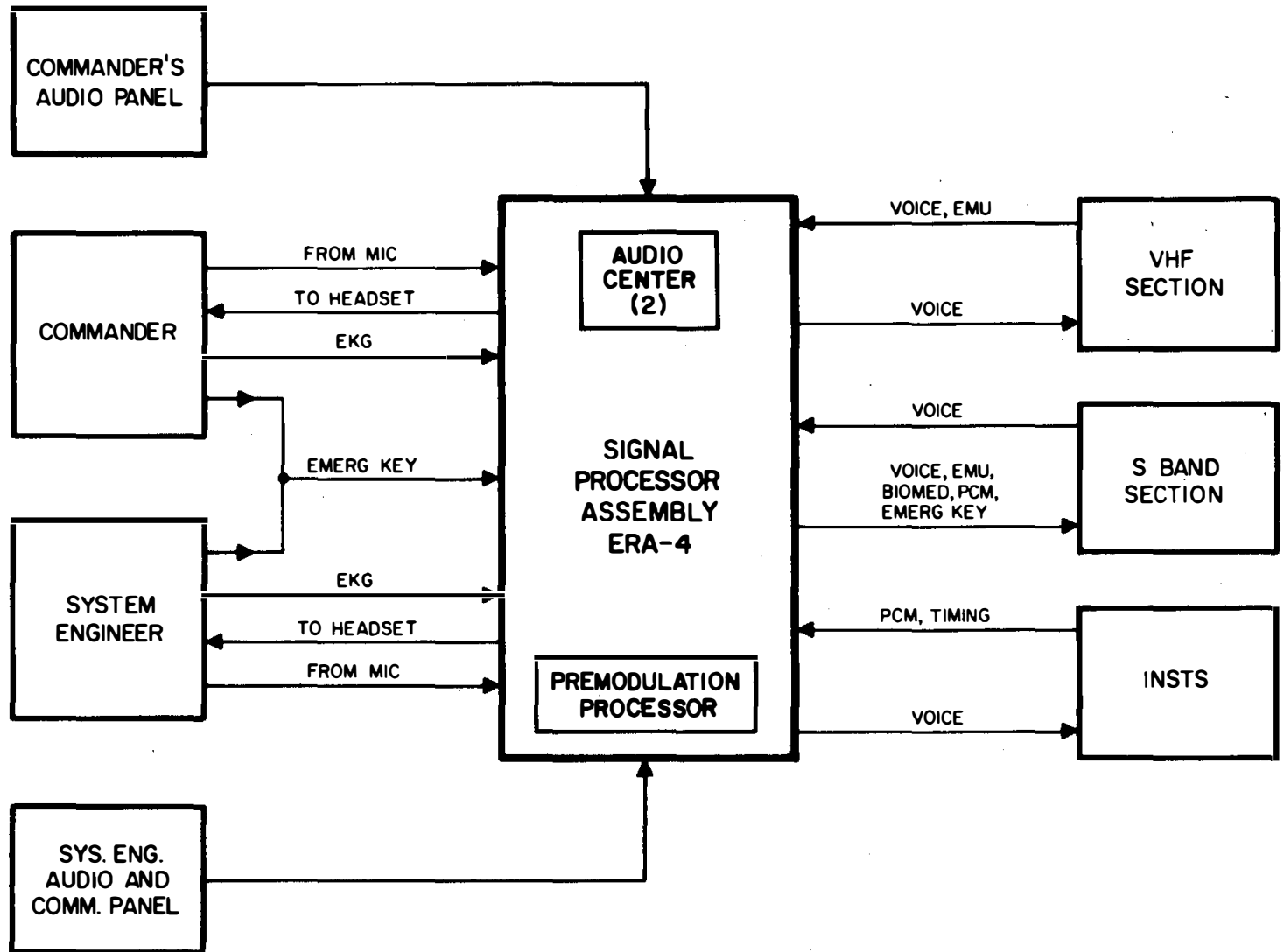
LM COMMUNICATIONS SUBSYSTEM

T30005-37
DEC 66

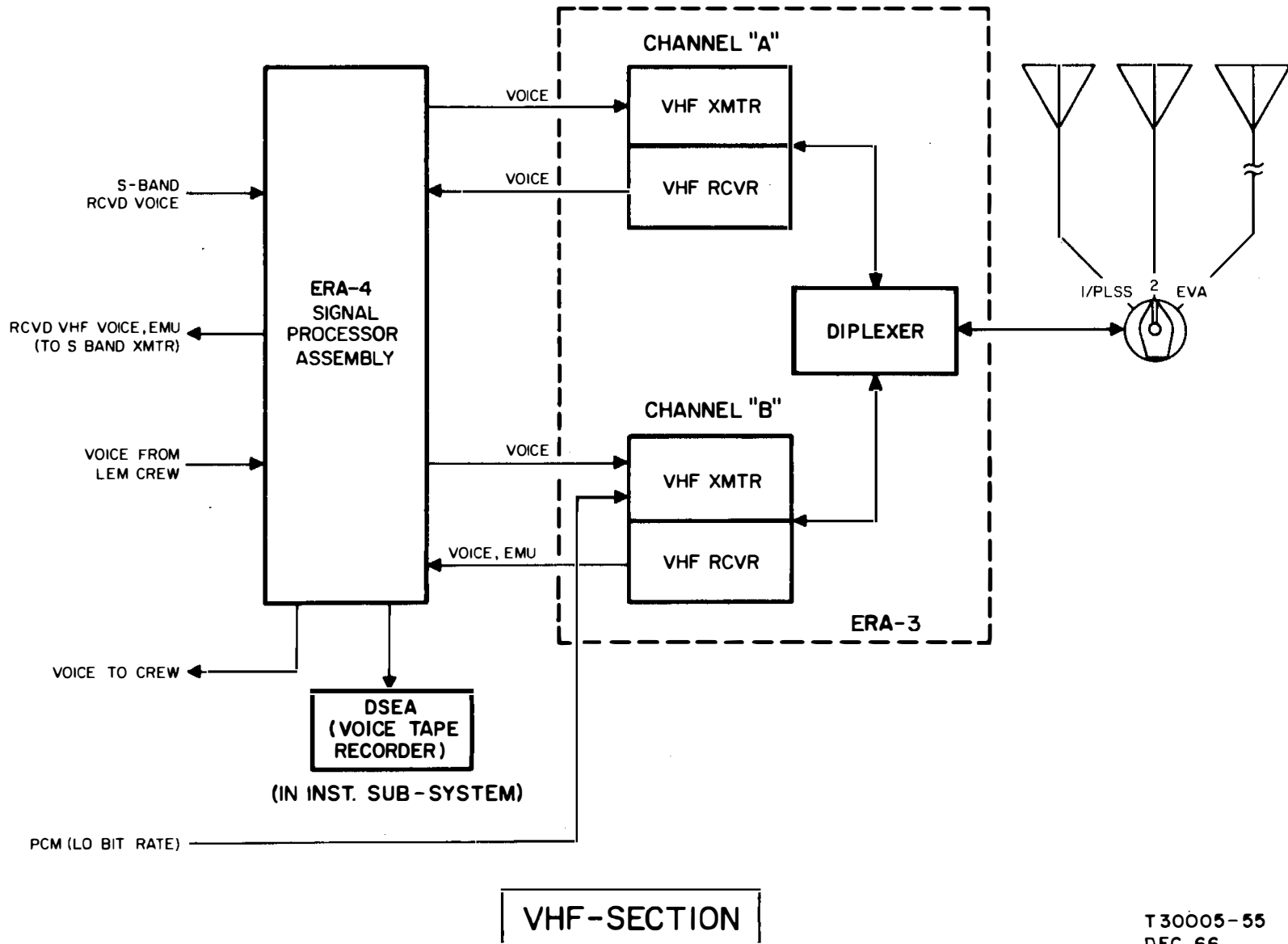


**LUNAR MODULE
AXES**

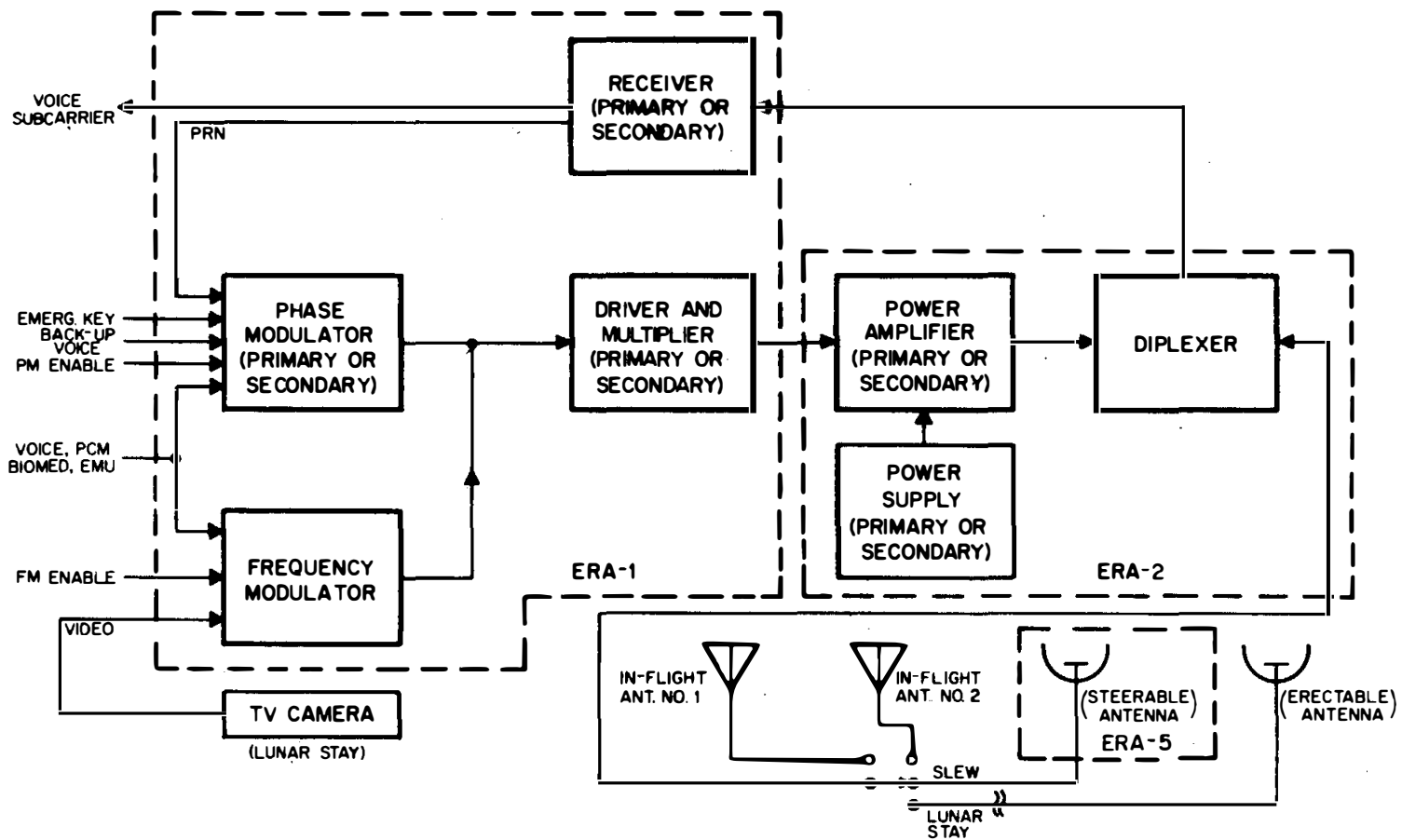
T 30005-161
NOV 66



**SIGNAL PROCESSOR ASSEMBLY
INTERFACE**

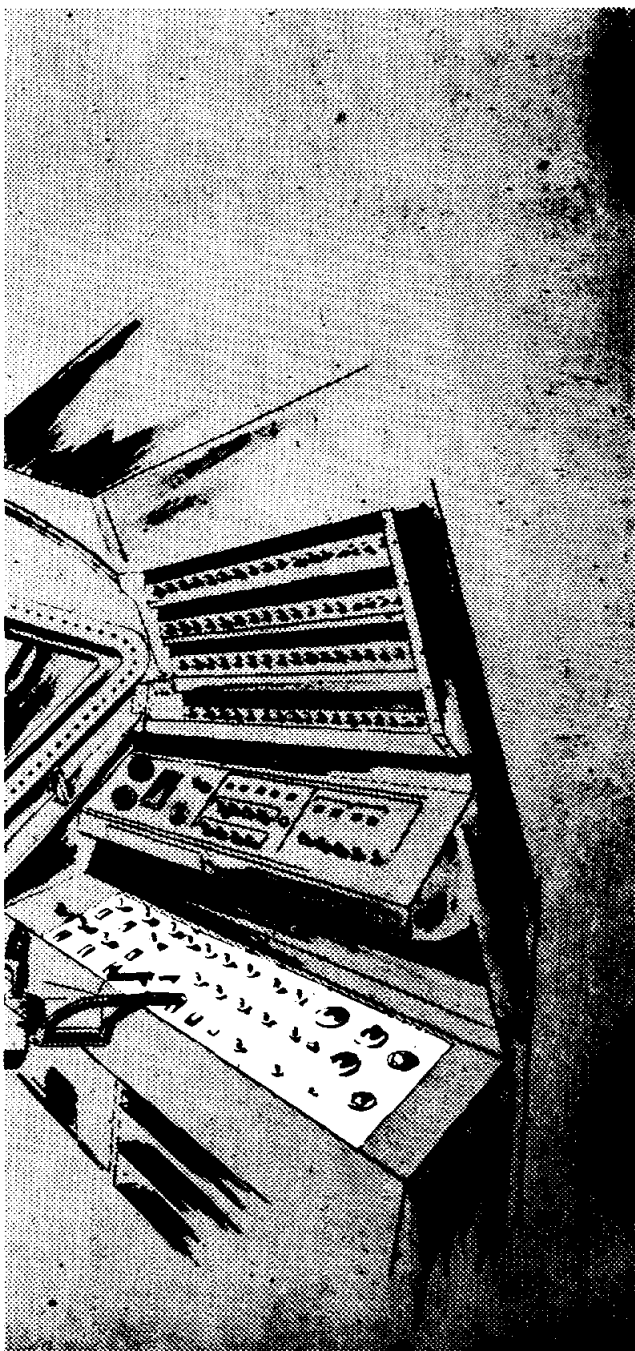


T 30005-55
DEC 66



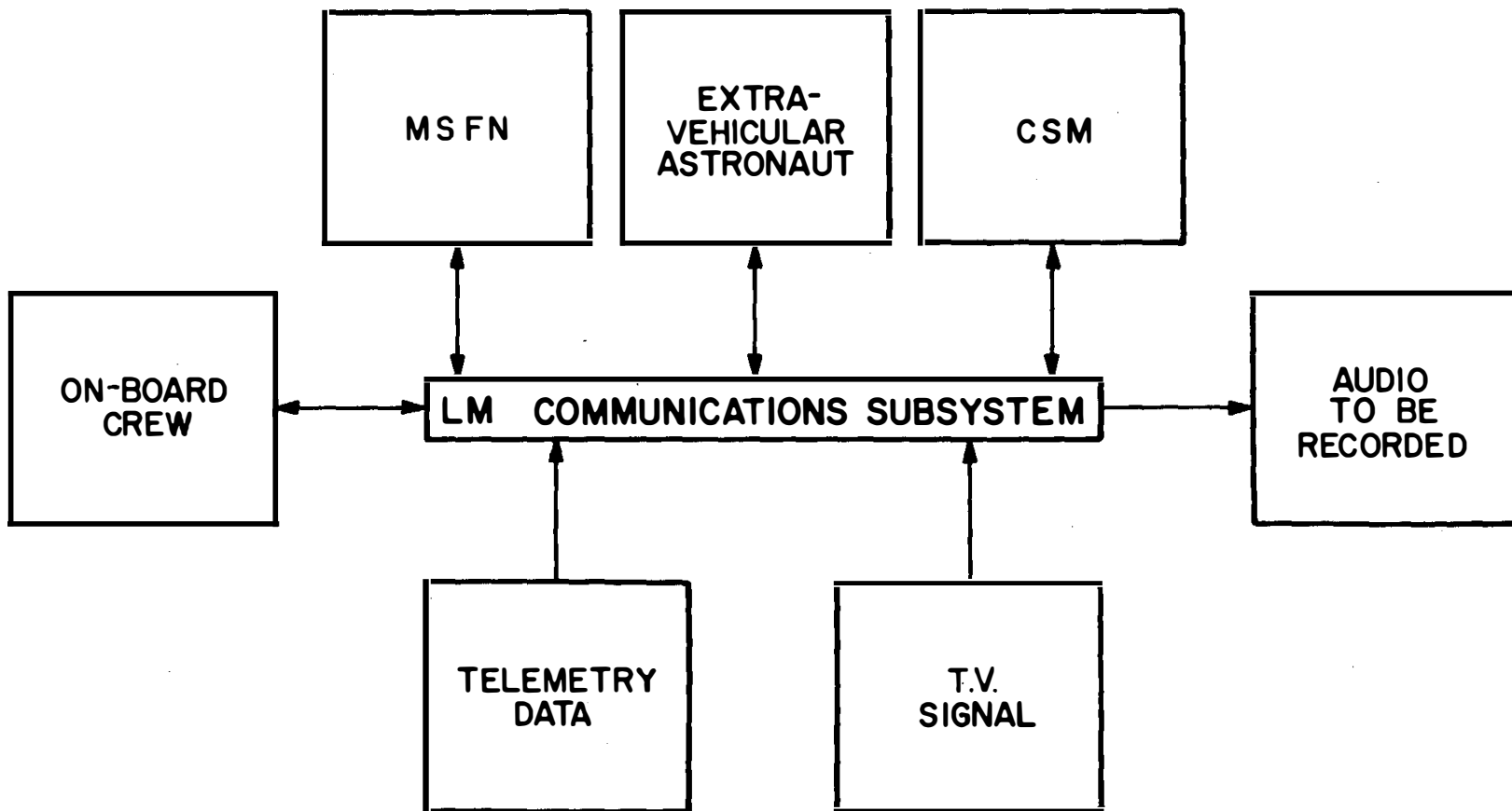
S-BAND SECTION

T 30005-56
DEC 66

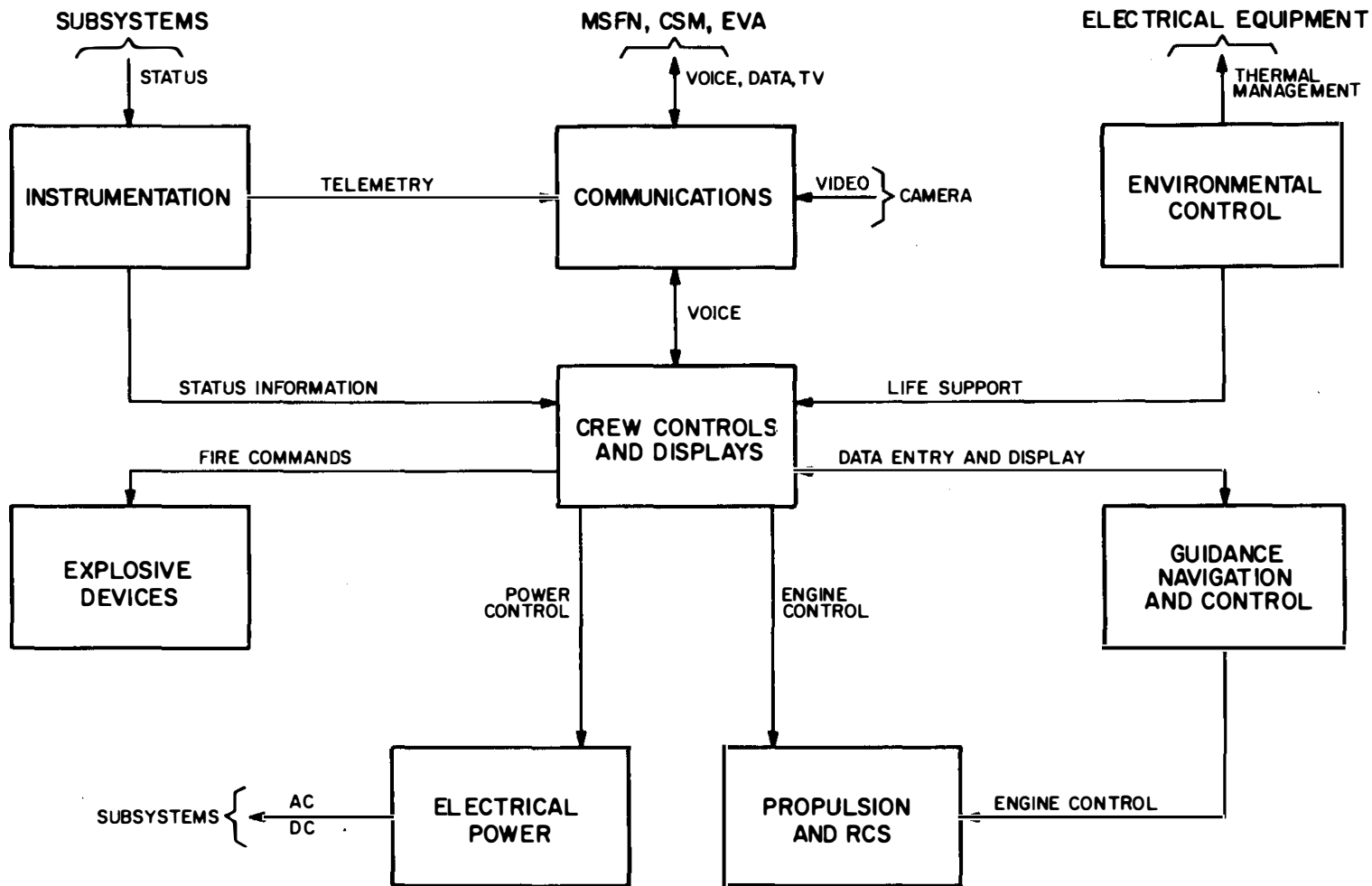


CONTROLS

T30005-113
APR 66



T30005-41
DEC 66



LM SUBSYSTEMS

T30005-60
DEC 66