Instrumentation Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

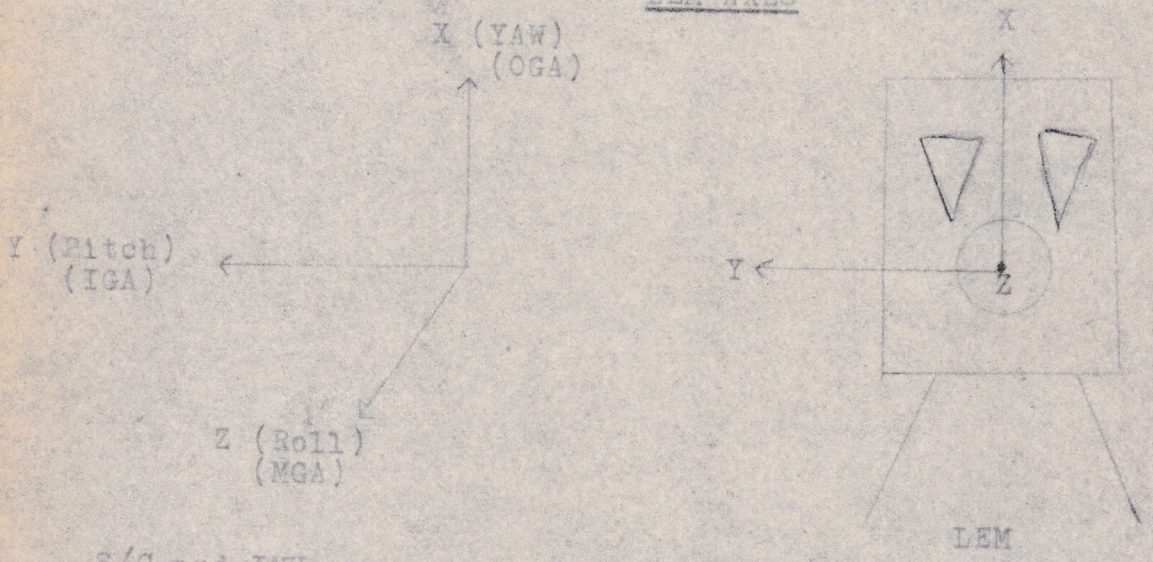
Digital Dev. Memo #256 Rev. B.

To: Eldon Hall
From: Don Bowler
Date: 15 June 1965
Subj: Block 2 Computer Interfaces

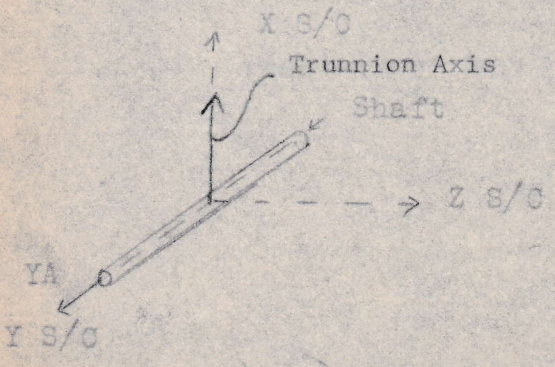
The purpose of this note is to define the more ambiguous outputs and inputs to the computer so that the interfaces can be wired up correctly and the programers will know what they should have.

Several people have been contacted with regard to the definitions and conventions observed, however no attempt has been made to standardize the signal names and angles. They should be consistent with Block 1 where applicable.

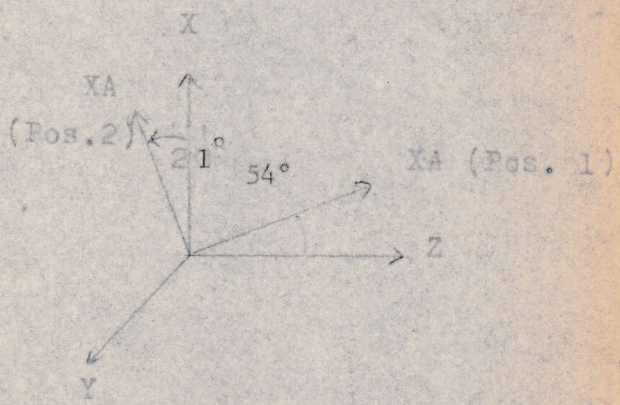
LEM AXES



S/C and IMU axes



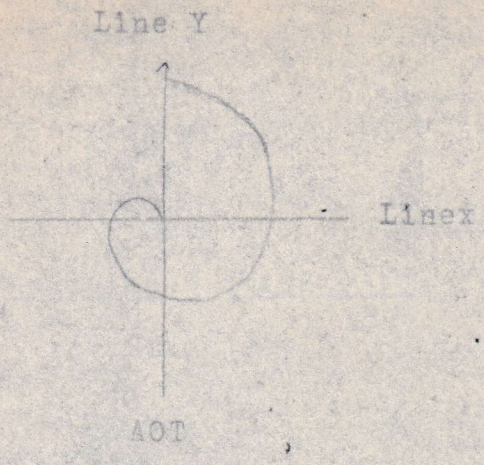
Rendezvous Radar

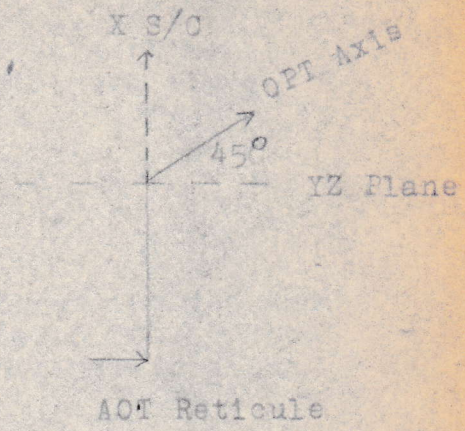


Landing Radar

Indicated axis 180° from boresight.

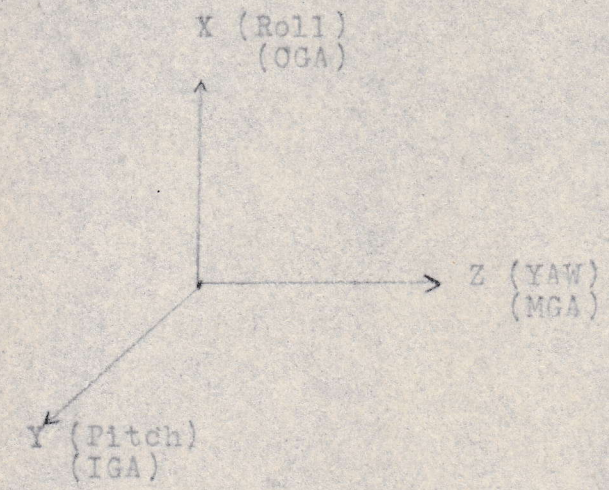
The AOT has a reticule which can be rotated. The reticule has X, Y axes in it to be used with the mark X, mark Y inputs to the computer.



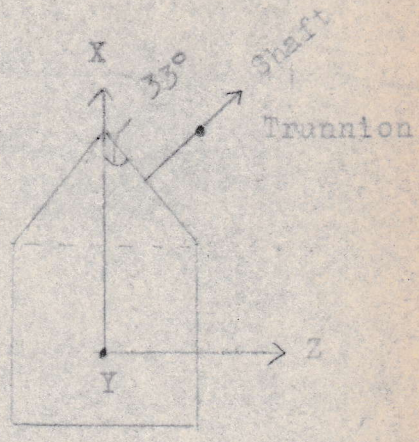


It has a field of view 45° to the Y Z plane capable of being rotated in 3 discrete steps about the X axis. The reticule rotation and discrete positions are fed in through the display keyboard.

Command Module



S/C, IMU Axes



S/C Optics

Optics trunnion is parallel to S/C Y axis.

D.D. Memo 956 Rev B
A. Saat

The figures indicate how the various axes are related and point out that the LEM and CM are different. The following definitions are brief and only one definition is given; the rest should follow in an obvious manner. Signal names are those used in D.D. Memo #185 Rev. 10.

Positive rotation about an axis is the direction a right hand threaded screw would have to be rotated to move along the axis.

Command Module

(1) Reaction Control Jets CB801 - CB816

+ x/+ Pitch Jet	Output discrete fires the jet and causes the vehicle to rotate about the + Y axis and translate along the + X axis.

There are 15 additional jets

(2) Attitude DE093 - DE098

+ Pitch Man. Rot.	Discrete input which requests positive vehicle rotation about the + Y axis till removed.

There are five additional inputs

(3) BMAG Signals YG817 - YG822

BMAG	AGC Cntr.	Rot. Axis
Pitch	42	Y
Roll	43	X
YAW	44	Z

+ Pitch BMAG	Input pulse corresponding to a positive vehicle rotation about the + Y axis.

(4) OPT CDU'S

(a) Inputs YG108 - YG111

OPT CDU	AGC Cntr.	Axis
Y	35	Trunnion
X	36	Shaft

OPT + X — Pulse input indicating optics has rotated positively about the + shaft axis. OPT CDU reading has increased positively.

(b) Outputs XA114 - XA118

OPT CDU	AGC Cntr.	Axis (Optics)	Axis (Eng.)
Y	53	Trunnion	YAW
X	54	Shaft	Pitch

(OPT Mode) + X OPT CDU — Pulse output causing counter of optics CDU to increase positively. Optics rotate positively about the shaft axis.

(TVC Mode) + X OPT CDU — Pulses to CDU causes S/C to rotate negatively about the + pitch axis. (engine rotated positively).

(5) MIN. Impulse DE188, 189, 171-174

Impulse	AGC Cntr.	S/C Axis
Pitch	None	Y
YAW	"	Z
Roll	"	X

+ Pitch — Discrete input requesting increment of S/C rotation about the + Y axis. push minimum impluse stick down.

Yaw left — -Z rot, CCW ROT of MISTICK.

Roll left — -X ROT, move Ml Stick Left.

(6) TRANS CMDS DE018 - 023

+ X TRANS COMM (MAN) Discrete input requesting S/C translation along the + X axis.

6 inputs no counter.

(7) ISS CDU'S

(a) Inputs Y6118 - Y6123

CDU		AGC Cntr.	Rot. Axis
(outer)	X	32	X
(inner)	Y	33	Y
(middle)	Z	34	Z

+ X CDU — Pulse input indicating outer CDU has increased positively (S/C has rotated positively about the + X axis.)

(b) Outputs XA126 - XA131

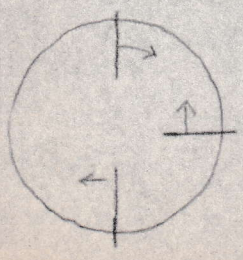
CDU		AGC Cntr.	S/C Axis	ATT. ERR.
(outer)	X	50	X	roll
(inner)	Y	51	Y	pitch
(middle)	Z	52	Z	yaw

CDU + X (coarse align.) — Pulse output causing outer gimbal rotation such that CDU readout increases positively. (gimbal rotates negatively about + X S/C axis.)

CDU + X (Saturn) — Pulse output causes S/C to roll positively about the + X axis.

CDU + X (Att. error) — Pulse output causing in phase output out of CDU, starting from zero; Roll Error needle moves clockwise. Needles move positively about respective axis for positive pulse outputs with pilot as origin. Fly to condition.

Roll (CDU + X)



Pitch (CDU + Y)

YAW (CDU + Z)

(8) GYRO Torquing XA142 - 147

+ X Gyro Select	Pulse train that selects proper channel so that gyro set pulses will cause the inertial platform to rotate about the + X axis. (outer X CDU will change in negative direction.) (note, signal goes to - torquer of gyros output axis.)

6 signals 1 counter time shared.

(9) PIPAs YG132 - YG137

PIPA	AGC Cntr.	Axis
X	37	X
Y	40	Y
Z	41	Z

$+\Delta VX$	Pulse input indicating S/C has increased velocity in + X direction.

LEM

(10) Reaction Control Jets CB801 - CB816

- X/ - P/ + R, No. 1	Output discrete fires jet no. 1 which causes S/C translation along - X axis, and rotation about - pitch and + roll axes.

There are 15 additional jets.

(11) TRIM CB160, 902, 908, 841

+ Pitch Gimbal Trim	Discrete output causing descent engine to rotate about the + Y axis (S/C will pitch negatively)

There are three additional signals.

(12) LR Antenna SD407

LRDR POS CMD	Switch closure causing landing radar antenna to go to position 2. (Position 2 defined in figure above) DE182 indicates when antenna in Pos.2. Pos. 1 manual only.

(13) ATTITUDE A858 - 860, DE095

Input	LGC Cntr.	Rot. Axis
Pitch	42	Y
Roll	44	Z
YAW	43	X

Prop. Pitch Rate CMD	In phase 800 cps input (W.R.T. G/N 800 cps) requests positive rotation proportioned to the input amplitude about the + Y axis.

(14) Rate of Descent DE102, 103, 182

Rate of Descent (+)	Discrete input requesting decrease in velocity along + vertical axis (up). No LGC counter.

There is one other signal.

(15) Radar CDU

(a) Inputs YG108 - YG111

CDU	LGC Cntr.	Axis
Shaft	36	Shaft (Y)
Trunnion	35	Trunnion (XZ plane)

+ RR Shaft	Pulse input indicating rendezvous radar shaft CDU counter has increased positively. Radar has rotated positively about + Y (shaft) axis.

(b) Outputs XA111 - XA117

CDU	LGC Cntr.	Radar Axis	Horizontal Vel. Axis
Shaft	54	Shaft (Y)	forward
Trunnion	53	Trun. (XZ)	starboard

+ RR Shaft (Radar-Mode)	Pulse output causing Rend. Radar shaft CDU to increase in a positive direction, Radar to rotate in a positive direction (+Y).
+ RR Shaft (Meter Mode)	Pulse output causing D/A counter to increase indication vehicle horizontal velocity has increased in forward direction.

(16) AOT DE203 - 205, 209

Mark X — Discrete input indicating target has crossed X axis on reticule.

(17) TRANS CMDS DE018 - 023

Same as (6) above only along LEM X,Y,Z axis.

(18) ISS CDU'S

Same as (7) above only no Saturn function and LEM X,Y,Z axes.

i.e. CDU + X — Pulse output causing in phase output of CDU, starting from zero; yaw error needle moves left. Needles move positively about respective axes for positive pulse outputs with pilot as origin. Fly to condition.

(19) GYRO Torquing

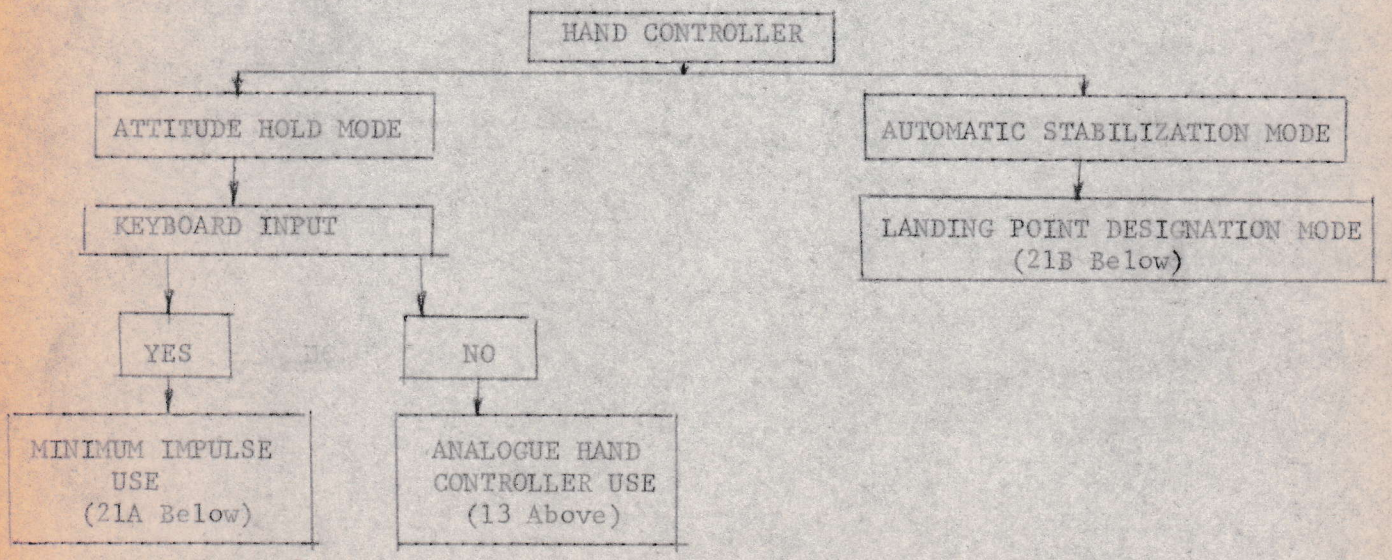
Same as (8) above only rotation about LEM X,Y,Z axes.

(20) PIPAs

Same as (9) above only along LEM X,Y,Z axes.

(21) Attitude Hand Controller DE 27-30

These signals are six separate D-C signals from the closure of the "pulse direct" switches on the rotational controller.



(21A) + PMI

Plus pitch minimum impulse input discrete which requests an increment of vehicle rotation about the +Y axis. Similarly for the other five inputs.

(21B) + EL (LPD)

A discrete input which indicates that the desired landing point is farther away.

+AZ (LPD)

A discrete input which indicates that the desired point is to the left of the line of sight.

D.D. Memo 256 Rev. A Changes

Page 1.	Redefined landing radar XA axis. Clarified rendezvous radar trunnion axis.
Page 4.	Redefined TVC rotation direction. Defined Yaw left and Roll left for minimum impluse controller.
Page 8.	Redefined rate of decrease polarity.
Page 9 -10.	Added Section (21).

Rev. B Changes

Page 3.	Corrected AGC counter assignments for Pitch and Roll BMAGs.

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