

RAPID IMU REALIGN

NOTE: This procedure assumes a good GDC alignment

- 1 V41 N20E
Load R,P,Y from GDC Ball
- 2 V40
Verify R,P,Y on GDC Ball - ENTR
(Releases Platform And Recovers PGNS Control Modes)
- 3 V25 N07E
77E, 10000E, 1E (Sets REFSMMAT FLAG)
- 4 V37E 51E, PRO (Sets Drift Flag)
V37E 00E
- 5 Perform P52, Option 3

NOTE: If Loss of Alignment Is Due To Temporary Loss of DC BUS, Update CMC Clock With V55 To Complete Recovery.

CHANGING LANDING SITE REFSMMAT FOR OUT-OF-PLANE BURNS

- 1 V37E 52E
- 2 F 04 06 R1=00001
R2=00004 (LOAD LANDING SITE OPTION)
PRO
- 3 F 06 34 GET ALIGN
PRO (SPECIFIES PRESENT TIME)
- 4 F 06 89 LAT, LONG/2, ALT (.001, .001°, .01rm)

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INITIALIZATION
PROCEDURES

		<u>Present Pitch</u>	<u>ΔVy</u>	<u>R1</u>
	Load R1:	0 \pm 90°	<u>+</u>	RLS LAT \pm 35°
		180 \pm 90°	<u>+</u>	RLS LAT \mp 35°
		PRO		
5	F 06 22	NEW ICDU ANGLES PRO		
6	F 50 25	R1=00013 CMC MODE-FREE ENTR TO GYRO TORQUE		
7	16 20	UNTIL TORQUING COMPLETE		
8	F 50 25	R1=00014 ALIGNMENT CHECK CMC MODE - AUTO ENTR		
9	P30			
10	P40			
11		YAW BACK TO 0° (MANUALLY)		
12		V37E 52E		
13	F 04 06	R1=00001 R2=00004 (LOAD LANDING SITE OPTION) PRO		
14	F 06 34	GET ALIGN (LOAD TIME OBTAINED FROM MSFN) PRO		
15	F 06 89	LAT, LONG/2,ALT (LAT WILL BE CHANGED BACK PRO TO STORED RLS)		
16	F 06 22	NEW ICDU ANGLES PRO		

- 17 F 50 25 R1=00013
CMC MODE-FREE
ENTR TO START TORQUING
- 18 16 20 UNTIL TORQUING COMPLETE
- 19 F 50 25 R1=00014 ALIGNMENT CHECK
CMC MODE - AUTO
PRO (TO SELECT 2 STARS IF TIME PERMITS)
ENTR (TO LEAVE P52)

GDC ALIGNMENT TO IMU GIMBAL ANGLES

IMU - on
SCS - operating

- 1 Damp vehicle rates
- 2 ATT SET dials - set to IMU angles on
FDAI 1
- FDAI SELECT - 1
FDAI SOURCE - ATT SET
ATT SET - IMU
ATT SET dials - null FDAI 1 err
needles
- ATT SET - GDC
GDC ALIGN PB - push until needles
nulled
- FDAI SEL - 1/2

BACKUP GDC AND/OR IMU ALIGNMENT
(IMU or CMC failed)

SCS - operating
RECORD: R,P,Y ALIGN from MSFN

- 1 IMU PWR - OFF
Wait ~5 min for gyros to run
down before step 8
- 2 Set SCT to 0° SHFT, 352.5° TRUN
OPTICS PWR - OFF
- 3 ATT SET dials - R,P,Y ALIGN

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Mnvr to position stars in SCT
0° mark - Sirius (15)
R line - Rigel (12)

or

	<u>NORTH</u>		<u>SOUTH</u>
0° mark -	Navi (3)		AcruX (25)
R line -	Polaris (5)		Atria (34)

5

FDAI SELECT - 1
ATT SET - GDC
GDC ALIGN PB - push until needles
nulled

6

ATT SET dials - 0,0,0

7

MNVR to 0,0,0 and null error needles

8

IMU PWR - on (up)
(IMU drives to 0°, 0°, 0°)
Wait 90 sec.

9

Uncage IMU
IMU CAGE - on (up) ~5 sec
then release

IN-PLANE GDC ALIGNMENT

CMC - on
ISS - on
SCS - operating

1

F 04 06 V37E 52E
00001
Load R2=00002
PRO

2

F 06 34 GET ALIGN 0,0,0
PRO

3

F 06 22 R,P,Y

4

Set ATT SET dials to R,P,Y on DSKY

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5 FDAI SELECT - 1
ATT SET - GDC
GDC ALIGN - push

6 V37E XXE

PGNS ORDEAL INITIALIZATION
(In-Plane Alignment Req'd)

1 FDAI 1 or 2 - ORB RATE
EARTH/LUNAR - as req'd

2 V82E
F 04 12 00002 SPECIFY VEHICLE
00001
PRO

3 F 06 16 GET EVENT (hrs,min,.01sec)
PRO

4 F 16 44 HA, HP (.1nm,.1nm)
Calculate Average
ALT SET - Set Average
PRO

5 V83E
F 16 54 R,RDOT,THETA (.01nm,.1fps,.01°)
MODE - HOLD/FAST
SLEW - To THETA
MODE - OPR/SLOW
PRO

SCS ORDEAL INITIALIZATION
(IN-PLANE GDC ALIGNMENT REQ'D)

1 FDAI 1 or 2 - ORB RATE
EARTH/LUNAR - as req'd

2 MSFN Supply Altitude
ALT SET - Set

3 SC +X At the Horizon

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G
7-6MODE - HOLD/FAST
SLEW FDAI (See table)
MODE - OPR/SLOW

<u>LUNAR</u>		<u>EARTH</u>	
<u>Alt(nm)</u>	<u>Angle*</u>	<u>Alt(nm)</u>	<u>Angle*</u>
8	7°	100	14°
60	20°	200	19°
170	32°	500	29°

*Angle from +X S/C axis to horiz

COAS LOS DETERMINATION

CMC - on
 ISS - on
 SCS - operating
 SC CONT - SCS
 MAN ATT (3) - MIN IMP
 OPT ZERO - OFF
 OPT MODE - MAN
 G/N PWR OPTICS - on
 OHC - Drive trun <10°
 OPT MODE - CMC
 OPT ZERO - ZERO (15 sec)

1 V37E 52E

2 F 04 06 00001
00003
PRO

3 F 50 25 00015
ENTR

4 F 01 70 000DE STAR CODE
LOAD BORESIGHT STAR CODE
OPT ZERO - OFF
PRO

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5 06 92 SHAFT, TRUN (.01°, .001°)

Center target
MARK with VERB key
Record SHAFT, TRUN _____, _____
(REPEAT) KEY RLSE
(EXIT) V37E XXE
OPT MODE - MAN
OHC - Drive trun <10°
OPT ZERO - ZERO

CMC/LGC CLOCK SYNC/TEPHEM UPDATE

V16 N65E (On LM request)
(hr,min,.01sec)
Voice CMC time to LM
V05 N01E 1706E (On LM request)
Voice TEPHEM to LM

V55 CMC TIME UPDATE

(See EXT VERBS pg. G/1-27)

ALIGN LM IMU TO CSM IMU

ATT DB - MIN
RATE - LO
LIMIT CYCLE - ON
SC CONT - SCS
MAN ATT (3) - RATE CMD
BMAG MODE (3) - ATT1/RATE2
V06 N20E
Voice ICPU angles to LM*
Terminate attitude hold on LM cmd
V06 N20 (On LM request)
On LM MARK, Key ENTR
Copy ICPU angles and transmit to
MSFN

*LM (IGA)p = P20 + 180°
LM (OGA)y = 300° - R20 + Δθ
LM (MGA)r = 360° - Y20

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Align LM IMU to CSM GDC

SCS - on
GDC - on and aligned

- 1 On LM Request, hold att:
ATT DB - MIN
RATE - LO
LIMIT CYCLE - ON
BMAG MODE (3) - ATT 1/RATE 2
- 2 On LM Request, Read GDC FDAI R,P,Y then
ATT SET dials - Set to FDAI R,P,Y
FDAI SELECT - 1
FDAI SOURCE - ATT SET
FDAI SCALE - 5/1
ATT SET - GDC
Null FDAI 1 error needle using ATT SET dials
Read ATT SET dial angles to LM
- 3 On LM Request, terminate att hold

ALIGN LM AGS TO CSM IMU/GDC

CMC - on
ISS - on and orientation known

or

SCS - on
GDC - on and aligned

- 1 Upon LM request, MNVR to
R = $300^\circ + \Delta\theta$
P = 180°
Y = 0°
and hold att., min DB
(If SCS: RATE-LO, LIMIT CYCLE-ON)
- 2 Notify LM when at attitude
- 3 When LM alignment complete - terminate att hold

Align CSM GDC to LM IMU

GDC - on (req)

- 1 Request LM to Hold Attitude, Min DB
- 2 Request and copy LM Readout of V06N20 angles:

LM(OGA)y	.	°
LM(IGA)p	.	°
LM(MGA)r	.	°

- 3 ATT SET dials - Set to
 - R = $300^\circ + \Delta\theta$ - LM (OGA)y
 - P = LM (IGA)p - 180°
 - Y = 360° - LM (MGA)r

- 4 FDAI SELECT - 1
ATT SET - GDC
GDC ALIGN - Push

- 5 Notify LM att hold not req

Align CSM GDC to LM AGS

- 1 Request LM MNVR to 0,0,0 on AGS FDAI, min DB

- 2 ATT Set dials - Set to
 - R = $300^\circ + \Delta\theta$
 - P = 180°
 - Y = 0°

- 3 FDAI SELECT - 1
ATT SET - GDC

- 4 When LM at Attitude:
GDC ALIGN - Push

- 5 Notify LM Att Hold not req'd

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Align CSM IMU to LM IMU

CMC - on
ISS - on
SCS - on

- 1 Verify LM in MIN DB, ATT HOLD
- 2 Request and copy LM Readout of V06N20E

LM(OGA)y	.	°
LM(IGA)p	.	°
LM(MGA)r	.	°
- 3 Calculate Gimbal Angles:

CM (OGA)	=	$300^\circ + \Delta\theta$	-	LM (OGA)y
CM (IGA)	=	LM (IGA)p	-	180°
CM (MGA)	=	360°	-	LM (MGA)r
- 4 V41N20E
Load Gimbal Angles
- 5 V40E
Allow 10 sec before step 7
Notify LM Att Hold Not Req.
- 6 Set REFSMFLG:
V25N7E, 77E, 10000E, 1E
- 7 V37E51E
PRO
V37E00E
- 8 Request MSFN Uplink REFSMMAT
then Perform P52 (OPT 3)
or
V06N20 On CM Mark - ENTR
Voice Angles to MSFN for calculation
of Gyro Torquing Angles.
Perform V42 GYRO TORQUING using ground
calculated Torquing Angles (p. G/1-24)

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Align CSM IMU TO LM AGS

CMC - on
ISS - on

- 1 Request LM MNVR to 0,0,0
on AGS FDAI

- 2 When LM at Attitude:
V41N20E
LOAD: R1 = $300^\circ + \Delta\theta$
R2 = 180°
R3 = 0°

- 3 V40E
Allow 10 sec before step 5
Notify LM Att Hold not req.

- 4 Set REFSMFLG:
V25N7E, 77E, 10000E, 1E

- 5 V37E51E
PRO
V37E00E

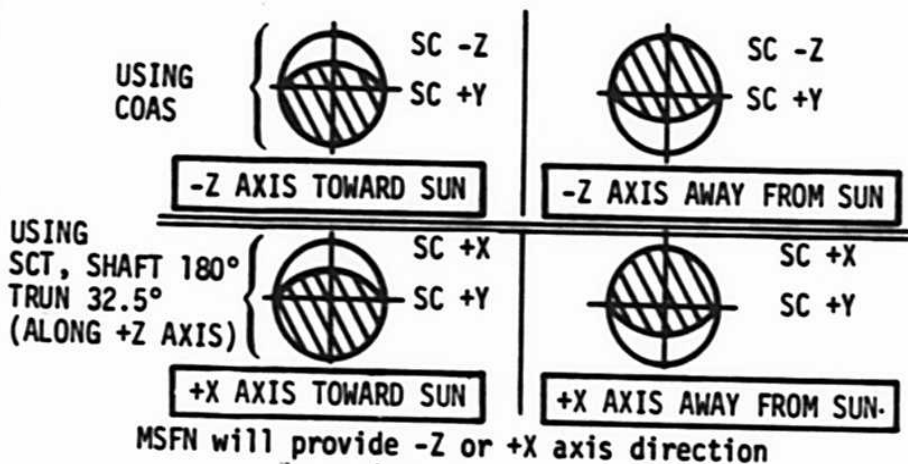
- 6 Request MSFN Uplink REFSMMAT,
then, if desired, perform P52 (OPT 3)

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CRESCENT ALIGN

If SCT: Drive optics to 180,32.5
G&N PWR OPT - OFF

- 1 MNVR to acquire EARTH in Optical System's field-of-view. Then MNVR to align required Reference line along Earth's Crescent.



- 2 (For GDC only, see step 8)
If CMC not avail:
Verify IMU PWR - OFF (5 min)
Go to Step 9
- 3 V41N20E, load desired angles
from MSFN or 0,0,0
- 4 V40, Verify Ref. Line Aligned with Crescent
ENTR
Allow 10 sec before step 6
- 5 V25N07E, 77E, 10000E, 1E
- 6 V37E51E, PRO, V37E00E
Request MSFN uplink REFSMMAT and,
if desired, do P52 (OPT 3)

- 7 Align GDC to IMU, if desired
or
- 8 FDAI SELECT - 1
ATT SET - GDC
ATT SET DIALS - 0,0,0 (or angles from MSFN)
Verify Ref line aligned to crescent, then:
GDC ALIGN - Push
- 9 Do not perform this step if CMC avail:
IMU PWR - ON (up)
Wait 90 sec
IMU CAGE - on (up) ~5 sec then release

GDC REFSMMAT DETERMINATION

GDC - on
CMC - on
IMU - off
OPT ZERO - OFF
OPT MODE - MAN
G/N PWR OPTICS - ON
OHC - Drive trun <10°
OPT ZERO - ZERO (15 sec)

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- 1 Acquire Apollo Nav star
in optics
FDAI Scale - 5/1
Hold att (ATT DB - MIN, RATE - LO)
Align GDC to 0,0,0
V25 N20E
E,E,E
 - 2 V37E00E
V96E

- 3 Initiate P51 logic
as follows:
 V21N1E
 1214E
 63E (65 if P53 desired)
 V25N26E
 13001E
 3425E
 30005E
 V30E
(Note: Major mode lts. on DSKY do not
change from 00 to 51)
- 4 F 50 25 00015 ACQ STARS
 PRO
- 5 F 51 PLEASE MARK
 If necessary, mnvr and:
 V25N20E
 Load present GDC angles
 OPT ZERO - OFF
 Null FDAI needles with Min imp
 then:
 MARK
- 6 F 50 25 00016 TERM MARKS
 PRO
- 7 F 01 71 000DE STAR CODE
 Load star code
 PRO to 5 after 1st MARK (8 if DE = 00)
 to 9 after 2nd MARK (8 if DE = 00)
- 8 F 06 88 CELESTIAL BODY VECTOR
 Load vector
 PRO to 5 after 1st MARK
 to 9 after 2nd MARK
- 9 F 06 05 STAR ANGLE DIFFERENCE (.01°)
 (Expect <.1°)
 (RECYCLE) V32E to 4
 (AcCEPT) PRO

10 F 37 OOE
 OHC - Drive trun <10°
 OPT ZERO - ZERO
 CMC has now calculated
 a REFSMMAT for the GDC,
 has set REFSMFLG and
 DRIFTFLG.

GDC REFSMMAT REALIGN (P52)

GDC - on and REFSMMAT Known (pg G/7-13)
 CMC - on
 SCS - operating
 IMU - off
 OPT ZERO - OFF
 OPT MODE - MAN
 G/N PWR OPTICS - ON
 OHC - Drive trun <10°
 OPT ZERO - ZERO (15 sec.)

1 Acquire nav. target in
 optics
 Hold att (ATT DB-MIN, RATE-LO)
 V25N20E
 Load GDC angles
 V37E52E

2 F 04 06 R1 00001
 R2 00001 PREF PRO to 5
 2 NOM PRO to 3
 3 REFSMMAT PRO to 7 (P51 preferable)
 4 LDG SITE PRO to 3

3 F 06 34 GET ALIGN (0,0,0 initially)
 (hr,min,..01 sec)
 Load desired GET
 TO SPECIFY PRESENT TIME - PRO on (0,0,0)
 PRO (NOM go to 5)

4 F 06 89 LAT, LONG/2, ALT (.001°, .001°, .01nm)
 Load ldg site coords
 PRO

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- 5 F 06 22 NEW ICDU ANGLES OG,IG,MG (.01°)
(If MG > + 70°, MNVR and reload N20)
V32E - to 5
Align GDC to new angles
V25N20E
Load new angles
PRO
- 6 F 50 25 00013 GYRO TORQUE
PRO (NO ATT It-on then off,
PROG ALM - ignore)
- 7 F 50 25 00015 ACQ STARS
(opt 3) PRO
(Not opt 3) OPT ZERO - ZERO
G/N PWR OPTICS - OFF
V37EXXE - procedure complete
- 8 F 01 70 000DE STAR CODE
Load desired code
OPT MODE - CMC (verify)
OPT ZERO - OFF
PRO to 10 (to 9 if DE = 00)
*F 05 09 00404 (TA > 90°) *
MNVR & reload N20 - PRO to 10
- 9 F 06 88 CELESTIAL BODY VECTOR
Load desired vector
PRO
*F 05 09 00404 (TA > 90°) *
MNVR & reload N20 - PRO to 10
- 10 06 92 SHAFT, TRUN (.01,.001°)
(MARK ROUTINE) OPTICS MODE - MAN
- 11 F 51 PLEASE MARK
(If required) V25N20E
Load present GDC angles
Null FDAI needles with
min imp, then:
MARK
- 12 F 50 25 00016 TERMINATE MARKS
PRO

- 13 F 01 71 000DE STAR CODE
Load code (if necessary)
PRO to 8 after 1st MARK (to 14 if DE=00)
to 15 after 2nd MARK (to 14 if DE=00)
- 14 F 06 88 CELESTIAL BODY VECTOR
Verify vector
PRO to 8 after 1st MARK
to 15 after 2nd MARK
- 15 F 06 05 STAR ANGLE DIFFERENCE (.01°)
(Expect < .1°, if not V32E to 17)
(Accept) PRO
- 16 F 06 93 TORQUING ANGLES OG,IG,MG (.001°)
N93 is indicative of BMAG drift
since last alignment
If torque angles excessive
perform P51
Otherwise: OHC - Drive trun <10°
OPT ZERO - ZERO
G/N PWR OPTICS - OFF
V37EXXE - procedure complete

- 17 F 50 25 00014 ALIGNMENT CHECK
PRO to 7

LM STEERABLE ANT POINTING

1. Select V64 (pg G/1-27)
2. Mnvr to N51 angles:

R1 = +03000, R2 = 09000 (+Z orien)
R1 = -03000, R2 = 27000 (-Z orien)