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INTERFACE CONTROL DOCUMENT (ICD) BETWEEN AKASH-NG 02 IAU and TELEMETRY(GUIDED FLIGHT)

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DESCRIPTION:
This document specifies the Software Requirement Specifications for AKASH-NG-OBC Mission software.

DISTRIBUTION:

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CONVENTIONS FOLLOWED

1. BIT zero corresponds to LSB (The 19th bit time after DATA Synch start)
2. BIT 15 correspond to MSB (The 4th bit time after DATA Synch start)
3. Frequency column is blank if the message is scheduled as and when required only.
4. Zeroth word correspond to first data word transmit or received after command word.
5. Zeroth word will be set to other than 0xAAXX before populating the rest of the command/Response message words in case of MLP-OBC messages. After completion of the populating of all other data words, Zeroth word will be set to 0xAAXX.
6. MLP while reading the responses from OBC shall detect 0xAAAA for a valid completed response message and proceed to decode. OBC will first put into response message buffer 0x5555 as soon as any command from MLP is received so that the partial updated message from OBC is not interpreted by MLP.
7. APPLICATION includes both Checkout and mission modes.
8. Reserved WORD/BITS are defined at designers discretion for development purposes definition can change
9. "XX" Correspond to don't care
10. All float variables posted in messages are of IEEE format as shown below

Data Type	Size Bytes	Format	Range	Sign Bit	Exponent Position	Exponent Bias
Unsigned Short Int	2	Integer	0 to 65535	-	-	-
Short Int	2	2's complement Integer	-32768 to 32767	15	-	-
Long Int/Int	4	2's complement Integer	-2147483648 to 2147483647	31	-	-
Single Precision Float	4	Single precision floating point number	8.43×10^{-37} to 3.37×10^{38} (approx abs value)	31	Bits 30 to 23	7F H

31   15   0(LSB)
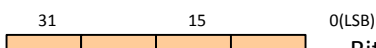
Bit no. reference for Unsigned Integer and single Precision Float

Notes on floating point representation:

1. In the 2 words of any 32 bit data, first word will be MSW representing bits 31- to 16, and second word will be LSW representing bits 15 to 0
2. Bits 22 to 00 in single precision floating point are normalized significant.
3. Most significant binary digit in normalized significant is assumed and is hidden.
4. Binary decimal point is assumed in between hidden bit and significant.

1553 COMMAND WORD

MSB   LSB

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RT					T/R	SUB ADDRESS					WORD COUNT				

T:1   WORD COUNT:0x1F OR 0 IS FOR 32 DATA WORDS

R:0

SCOPE

This document describes the data exchanges between OBC and Telemetry. Akash-NG IAU communicates with Telemetry in both Mission mode in launch configuration.

INTRODUCTION

On-Board Computer (OBC) has four 1553B interfaces. Out of these four interfaces, one(M2-External) will be used for interfacing the Missile Launch Processor(MLP), other one(M1-Internal) will be used for interfacing the Two Way Data link system (TWDL),Telemetry and Seeker.

On M2-External bus MLP act as Bus controller and OBC will act as Remote Terminal (RT) with RT address 1 for Missile1 and on M1 (Internal) bus OBC acts as Bus Controller (BC) on this bus. TWDL, Telemetry and Seeker act as RTs.
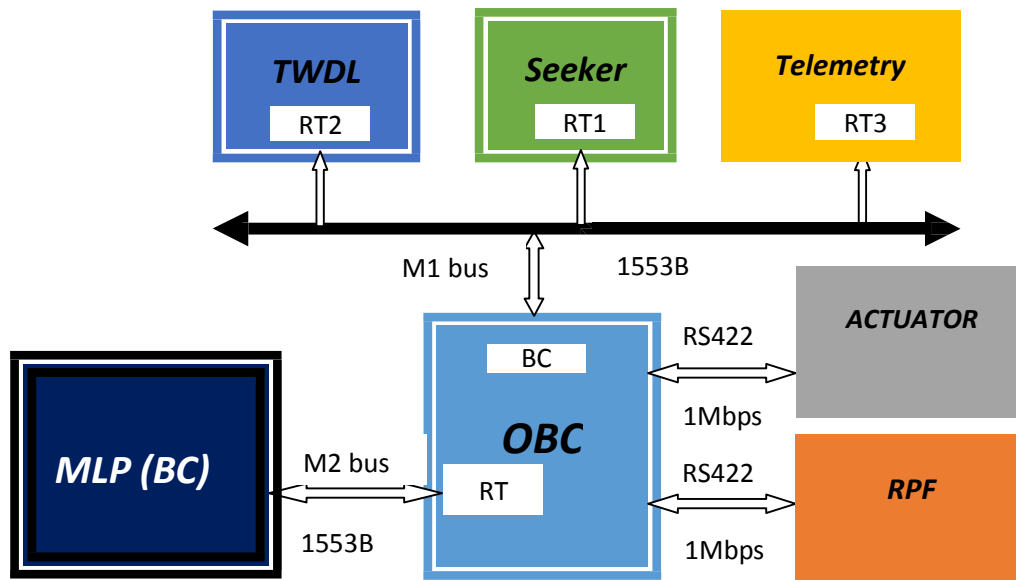
REFERENCES

The next section covers over-all message data table and detailed data exchange protocol between OBC and Checkout computer. Each message has been identified with a unique message id and detailed description.

The unique message id represented in the flowing format(D1D2D3D4D5)

Digit1	Digit2	Digit3	Digit4	Digit5
		0/1		
RT NO(0-31)		RECEIVE/ TRANSMIT	Sub Address (0-31)	

MESSAGE TABLE OF OBC & TELEMETRY DURING MISSION

S.No	Msg ID	Data Description	SRC	DEST	No of Words	Freq (ms)	Sub Add Rx	Command Word	Remarks
		MISSION DATA							
1.	03011	NAVIGATION DATA	OBC	TM	32	2.5	11	0x1960	INS Navigation Data
2.	03012	NAVIGATION DATA	OBC	TM	32	10	12	0x1980	
3.	03013	NAVIGATION DATA	OBC	TM	32	20	13	0x19A0	
4.	03013	INS CONFIGURATION DATA	OBC	TM	32	20	13	0x19A0	Pre-Liftoff INS Data
5.	03013	INS DATA LOAD DATA	OBC	TM	32	20	13	0x19A0	
6.	03013	INS DATA DUMP DATA	OBC	TM	32	20	13	0x19A0	
7.	03013	INS POSITION TEST DATA	OBC	TM	32	20	13	0x19A0	
8.	03013	INS LEVELLING DATA	OBC	TM	32	20	13	0x19A0	
9.	03014	TGT_MSL DATA	OBC	TM	32	20	14	0x19C0	Pre lift-off Surveillance, post lift off Control and Guidance Data
10.	03015	GUIDANCE DATA	OBC	TM	32	20	15	0x19E0	
11.	03015	LAUNCH POINT DATA	OBC	TM	32	20	15	0x19E0	
12.	03016	CONTROL DATA-1	OBC	TM	32	5	16	0x1A00	
13.	03016	SURVEILLANCE DATA	OBC	TM	32	10	16	0x1A00	
14.	03017	CONTROL DATA-2	OBC	TM	32	20	17	0x1A20	
15.	03018	EMA FEEDBACK DATA	OBC	TM	32	20	18	0x1A40	
16.	03019	ESTIMATOR DATA	OBC	TM	32	20	19	0x1A60	
16.	03030	OBC POST DATA	OBC	TM	32	ONCE	1	0x1820	
		GPS DATA							
17.	03020	KF CORRECTIONS	OBC	TM	32	1000	20	0x1A80	G^3OM data(Total 20 messages)
18.	03020	GNSS SAT IDS AND SNR	OBC	TM	32	1000	20	0x1A80	
19.	03020	GPS Satellite Position 1	OBC	TM	32	1000	20	0x1A80	
20.	03020	GPS Satellite Velocity 2	OBC	TM	32	1000	20	0x1A80	

21.	03020	GNSS Satellite Position 1	OBC	TM	32	1000	20	0x1A80	
22.	03020	GPS DATA	OBC	TM	32	1000	20	0x1A80	
23.	03020	GPS Pseudo Range DATA	OBC	TM	32	1000	20	0x1A80	
24.	03020	GPS Satellite Position 2	OBC	TM	32	1000	20	0x1A80	
25.	03020	GPS Satellite Velocity 3	OBC	TM	32	1000	20	0x1A80	
26.	03020	GNSS Satellite Position 2	OBC	TM	32	1000	20	0x1A80	
27.	03020	GNSS DATA	OBC	TM	32	1000	20	0x1A80	
28.	03020	GPS Delta Pseudo Range	OBC	TM	32	1000	20	0x1A80	
29.	03020	GPS Satellite Position 3	OBC	TM	32	1000	20	0x1A80	
30.	03020	GPS Satellite Clock Bias	OBC	TM	32	1000	20	0x1A80	
31.	03020	GNSS Satellite Velocity 1	OBC	TM	32	1000	20	0x1A80	
32.	03020	GPS SATELLITE IDS AND SNR	OBC	TM	32	1000	20	0x1A80	
33.	03020	Quality of PR AND DPR	OBC	TM	32	1000	20	0x1A80	
34.	03020	GPS Satellite Velocity 1	OBC	TM	32	1000	20	0x1A80	
35.	03020	GPS Satellite Clock Drift	OBC	TM	32	1000	20	0x1A80	
36.	03020	GNSS Satellite Velocity 2	OBC	TM	32	1000	20	0x1A80	
		TWDL UP LINK AND DOWN LINK DATA							
37.	02001	TWDL Configuration DATA	OBC	TWDL	11	Once	01	0x102B	TWDL messages to be captured in monitor mode in telemetry
38.	02002	TWDL DOWNLINK DATA	OBC	TWDL	18	100	02	0x1052	
39.	02004	TWDL PA MODE ON	OBC	TWDL	6	Once	04	0x1086	
40.	02005	TWDL Tx PORT SELECT	OBC	TWDL	6	Once	05	0x10A6	
41.	02101	TWDL UPLINK MESSAGE	TWDL	OBC	18	100	01	0x1432	
42.	02102	TWDL UPLINK MESSAGE	TWDL	OBC	18	100	02	0x1452	
43.	02103	TWDL UPLINK MESSAGE	TWDL	OBC	18	100	03	0x1472	
44.	02107	TWDL HEALTH	TWDL	OBC	14	1000	07	0x14EE	
45.	02108	TWDL STATUS	TWDL	OBC	14	1000	08	0x150E	
46.	02109	TWDL Version Control MSG	TWDL	OBC	18	Once	09	0x1532	

1.0   MESSAGE FORMAT FOR NAVIGATIONDATE (Rates & Accelerations)

MESSAGE NO	1	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1960
SUB	11	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT/MISSION	32	2.5ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Real Time	2	INS Real Time	float	(s)
02-03	Acc_X	2	INS sensed acceleration in body frame Acceleration –X	float	[-400, 400] (m/s^2)
04-05	Acc _Y	2	INS sensed acceleration in body frame Acceleration –Y	float	[-400, 400] (m/s^2)
06-07	Acc _Z	2	INS sensed acceleration in body frame Acceleration –Z	float	[-400, 400] (m/s^2)
08-09	Rate _X	2	INS sensed body rate Roll Rate	float	[-400, 400] (deg/s)
10-11	Rate _Y	2	INS sensed body rate Pitch Rate	float	[-400, 400] (deg/s)
12-13	Rate _Z	2	INS sensed body rate Yaw Rate	float	[-400, 400] (deg/s)
14	Sensor Status	1	Sensor Status word	U16	[0, 65535] (word)
15	DIPStatus_0	1	Relay Status 1	U16	BIT
16	DIPStatus_1	1	Relay Status 2	U16	BIT
17-18	DPitchb	2	Pitch demand in body frame	float	[-1, 1] (rad)
19-20	DYawb	2	Yaw demand in body frame	float	[-1, 1] (rad)
21-22	DRollb	2	Roll demand in body frame	float	[-1, 1] (rad)
23	EMACommand_0	1	Actuator1Command (scale factor : 182.04444444 for all)	S16	[-25, 25] (deg)
24	EMACommand_1	1	Actuator2Command	S16	[-25, 25] (deg)
25	EMACommand_2	1	Actuator3Command	S16	[-25, 25] (deg)
26	EMACommand_3	1	Actuator4Command	S16	[-25, 25] (deg)
27	EMAFeedback_0	1	Actuator1Command (scale factor : 182.04444444 for all)	S16	[-25, 25] (deg)
28	EMAFeedback _1	1	Actuator2Command	S16	[-25, 25] (deg)
29	EMAFeedback _2	1	Actuator3Command	S16	[-25, 25] (deg)
30	EMAFeedback _3	1	Actuator4Command	S16	[-25, 25] (deg)
31	OBC Time Count	1	2.5ms count Time=Time count*0.0025	U16	[0, 65535] 2.5ms count

2.0 MESSAGE FORMAT FOR NAVIGATIONDATA (Quaternion)

MESSAGE NO	2	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1980
SUB	12	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT/MISSION	32	10ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Real Time	2	INS Real Time	float	(s)
02-03	Pure_q0	2	Quaternion from ECEF to body frame	float	[-1, 1]
04-05	Pure_q1	2	Quaternion from ECEF to body frame	float	[-1, 1]
06-07	Pure_q2	2	Quaternion from ECEF to body frame	float	[-1, 1]
08-09	Pure_q3	2	Quaternion from ECEF to body frame	float	[-1, 1]
10-11	Pure_Si	2	Euler angle for NED to body transformation	float	[-179.99, 180.0] (deg)
12-13	Pure_Phi	2	Euler angle for NED to body transformation	float	[-179.99, 180.0] (deg)
14-15	Pure_Theta	2	Euler angle for NED to body transformation	float	[-90, 90] (deg)
16-17	Hybrid_q0	2	Hybrid Quaternion after GPS correction	float	[-1, 1]
18-19	Hybrid_q1	2	Hybrid Quaternion after GPS correction	float	[-1, 1]
20-21	Hybrid_q2	2	Hybrid Quaternion after GPS correction	float	[-1, 1]
22-23	Hybrid_q3	2	Hybrid Quaternion after GPS correction	float	[-1, 1]
24-25	Hybrid_Si	2	Hybrid Si after GPS correction	float	[-179.99, 180.0] (deg)
26-27	Hybrid_Phi	2	Hybrid Phi after GPS correction	float	[-179.99, 180.0] (deg)
28-29	Hybrid_Theta	2	Hybrid Theta after GPS correction	float	[-90, 90] (deg)
30	Reserved	1		U16	
31	Ins status	1		U16	

3.0 MESSAGE FORMAT FOR NAVIGATION DATA (ECEF Positions & Velocities)

MESSAGE NO	3	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19A0
SUB	13	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT/MISSION	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INSRealTime	2	INS Real Time	float	(s)
02-03	Pure_ECEF_X	2	Pure ECEF X position	float	[0, 6500000] (m)
04-05	Pure_ECEF_Y	2	Pure ECEF Y position	float	[0, 6500000] (m)
06-07	Pure_ECEF_Z	2	Pure ECEF Z position	float	[0, 6500000] (m)
08-09	Pure_ECEF_Vx	2	Pure ECEF X Velocity	float	[-1200, 1200] (m/s)
10-11	Pure_ECEF_Vy	2	Pure ECEF Y Velocity	float	[-1200, 1200] (m/s)
12-13	Pure_ECEF_Vz	2	Pure ECEF Z Velocity	float	[-1200, 1200] (m/s)
14-15	Hybrid_ECEF_X	2	Hybrid ECEF X position	float	[0, 6500000] (m)
16-17	Hybrid_ECEF_Y	2	Hybrid ECEF Y position	float	[0, 6500000] (m)
18-19	Hybrid_ECEF_Z	2	Hybrid ECEF Z position	float	[0, 6500000] (m)
20-21	Hybrid_ECEF_Vx	2	Hybrid ECEF X Velocity	float	[-1200, 1200] (m/s)
22-23	Hybrid_ECEF_Vy	2	Hybrid ECEF Y Velocity	float	[-1200, 1200] (m/s)
24-25	Hybrid_ECEF_Vz	2	Hybrid ECEF Z Velocity	float	[-1200, 1200] (m/s)
26	Reserved	1		U16	
27	INS head fail cnt	1	INS head fail count	U16	[0,65535]
28	Packet miss cnt	1	Packet miss count	U16	
29	Check sum fail cnt	1	Check sum fail count	U16	
30	FIMU temperature	1	IMU Temperature Scale factor = 0.01	S16	[0, 65535](°C)
31	Ins status	1	Ins status	U16	

4.0 MESSAGE FORMAT FOR INS CONFIGURATION DATA

MESSAGE NO	4	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19A0
SUB	13	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01		2 words	INS Application software version	U8[4]	
02-03		2 words	INS Application software checksum	U32	
04-07		4 words	INS Application software Date	U8[8]	
08-09		2 words	Calibration Software version	U8[4]	
10-11		2 words	Calibration Data checksum	U32	
12-15		4 words	Calibration Date	U8[8]	
16-17		2 words	G3oM Software version	U32(*0.1)	
18-19		2 words	G3oM Software checksum	U32	
20		1 word	FIMU Software version	U16	
21		1 word	FIMU Serial number	U16	
22-23		2 words	INS Number	U8[4]	
24		1 word	Configuration status	U16	
25		1 word	CAH Command echo	U16	
26-27		2 words	M2S Mis-alignment X Stored	SPF	
28-29		2 words	M2S Mis-alignment Y Stored	SPF	
30-31		2 words	M2S Mis-alignment Z Stored	SPF	

G3oM Software Version Scale Factor = 0.1

5.0   MESSAGE FORMAT FOR INS DATA LOAD TO TELEMETRY

MESSAGE NO	5	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19A0
SUB	13	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00		1 word	Activity Command (0x2107)	U16	
01		1 word	Mode command	U16	
02-03		2 words	Reserved	U16	
04-07		4 words	Launch point Latitude in deg	DPF	
08-11		4 words	Launch point Longitude in deg	DPF	
12-13		2 words	Launch point Altitude in m	SPF	
14-15		2 words	Missile Azimuth(si) angle in deg	SPF	
16-17		2 words	Missile Roll(phi) angle in deg	SPF	
18-19		2 words	Missile Pitch(theta) angle in deg	SPF	
20-21		2 words	Alignment Time in sec	SPF	
22-23		2 words	Navigation Time in sec	SPF	
24		1 word	Mission Data Validity	BIN	
25		1 word	CMD Command Echo	U16	
26-31		6 words	Reserved	U16(6)	

Mode word description:

S.No	Mode Command	INS Mode
1	0x0000	Mission Mode
2	0x0320	Static Simulation
3	0x0680	6 DOF Mode
4	0x0840	HILS Mode

6.0   MESSAGE FORMAT FOR INS DATA DUMP TO TELEMETRY

MESSAGE NO	6	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19A0
SUB	13	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT	32	20ms

Word	Parameter	No of	Description	Data Type	Range (units)

No		Words			
00		1 word	Activity Command (0x0406)	U16	
01		1 word	Mode command	U16	
02-03		2 words	Reserved	U16	
04-07		4 words	Launch point Latitude in deg	DPF	
08-11		4 words	Launch point Longitude in deg	DPF	
12-13		2 words	Launch point Altitude in m	SPF	
14-15		2 words	Missile Azimuth(si) angle in deg	SPF	
16-17		2 words	Missile Roll(phi) angle in deg	SPF	
18-19		2 words	Missile Pitch(theta) angle in deg	SPF	
20-21		2 words	Alignment Time in sec	SPF	
22-23		2 words	Navigation Time in sec	SPF	
24		1 word	Mission Data Validity	U16	
25		1 word	MDD Command Echo	U16	
26-31		6 words	Reserved	U16(6)	

7.0   MESSAGE FORMAT FOR INS POSITION TEST RESULTS TO TELEMETRY

MESSAGE NO	7	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19A0
SUB	13	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	CHECKOUT	32	20ms

Word No	Parameter	No of Words	Description		Data Type	Range (units)
00-01		2 words	Compensated	Gyro – X in ^{0}/hr	SPF	
02-03		2 words		Gyro – Y in ^{0}/hr	SPF	
04-05		2 words		Gyro – Z in ^{0}/hr	SPF	
06-07		2 words		Accl – X in g	SPF	
08-09		2 words		Accl – Y in g	SPF	
10-11		2 words		Accl – Z in g	SPF	
12-13		2 words	Raw	Gyro – X in ^{0}/hr	SPF	
14-15		2 words		Gyro – Y in ^{0}/hr	SPF	
16-17		2 words		Gyro – Z in ^{0}/hr	SPF	
18-19		2 words		Accl – X in g	SPF	
20-21		2 words		Accl –Y in g	SPF	
22-23		2 words		Accl – Z in g	SPF	
24		1 word	Accumulation Time in sec		U16(*0.0025)	

25		1 word	PTD Command Echo	U16	
26		1 word	Gyro-X Temperature in ^{0}C	S16(*0.01)	
27		1 word	Gyro- Y Temperature in ^{0}C	S16(*0.01)	
28		1 word	Gyro- Z Temperature in ^{0}C	S16(*0.01)	
29		1 word	Accl -X Temperature in ^{0}C	S16(*0.01)	
30		1 word	Accl -Y Temperature in ^{0}C	S16(*0.01)	
31		1 word	Accl -Z Temperature in ^{0}C	S16(*0.01)	

8.0   MESSAGE FORMAT FOR INS LEVELLING DATA TO TELEMETRY

MESSAGE NO	8	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19A0
SUB	13	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01		2 words	INS time in sec	SPF	
02-03		2 words	Remaining Alignment time in sec	SPF	
04-05		2 words	Azimuth (Ψ) in deg	SPF	
06-07		2 words	Roll (Φ) in deg	SPF	
08-09		2 words	Pitch (θ) in deg	SPF	
10-11		2 words	Gyro- X Drift in ^{0}/hr	SPF	
12-13		2 words	Gyro- Y Drift in ^{0}/hr	SPF	
14-15		2 words	Gyro- Z Drift in ^{0}/hr	SPF	
16-17		2 words	Accelerometer-X Residue in mg	SPF	
18-19		2 words	Accelerometer –Y Residue in mg	SPF	
20-21		2 words	Accelerometer –Z Residue in mg	SPF	
22		1 word	Gyro Temperature in ^{0}C	S16	
23		1 word	Acc Temperature in ^{0}C	S16	
24		1 word	INS Status	U16	
25		1 word	ALN Command Echo	U16	
26-27		2 words	M2S Mis-alignment X in deg	SPF	
28-29		2 words	M2S Mis-alignment Y in deg	SPF	
30-31		2 words	M2S Mis-alignment Z in deg	SPF	

Gyro and Accelerometer Temperature Scale Factor = 0.01

9.0   MESSAGE FORMAT FOR GUIDANCEDATA (Missile & Target Positions)

MESSAGE NO	9	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19C0
SUB	14	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	Tgt_pos_LCI_X	2	Target Position (X) in LCI-1 frame	float	[-80000, 80000] (m)
02-03	Tgt_pos_LCI_Y	2	Target Position (Y) in LCI-1 frame	float	[-22000, 22000] (m)
04-05	Tgt_pos_LCI_Z	2	Target Position (Z) in LCI-1 frame	float	[-18000, 1000] (m)
06-07	Tgt_vel_LCI_Vx	2	Target Velocity (Vx) in LCI-1 frame	float	[-1500, 1500] (m/s)
08-09	Tgt_vel_LCI_Vy	2	Target Velocity (Vy) in LCI-1 frame	float	[-1500, 1500] (m/s)
10-11	Tgt_vel_LCI_Vz	2	Target Velocity (Vz) in LCI-1 frame	float	[-1500, 1500] (m/s)
12-13	Msl_pos_LCI_X	2	Missile Position (X) in LCI-1 frame	float	[-50000, 50000] (m)
14-15	Msl_pos_LCI_Y	2	Missile Position (Y) in LCI-1 frame	float	[-30000, 30000] (m)
16-17	Msl_pos_LCI_Z	2	Missile Position (Z) in LCI-1 frame	float	[-25000, 1000] (m)
18-19	Msl_vel_LCI_Vx	2	Missile Velocity (Vx) in LCI-1 frame	float	[-1200, 1200] (m/s)
20-21	Msl_vel_LCI_Vy	2	Missile Velocity (Vy) in LCI-1 frame	float	[-1200, 1200] (m/s)
22-23	Msl_vel_LCI_Vz	2	Missile Velocity (Vz) in LCI-1 frame	float	[-1200, 1200] (m/s)
24-25	LOS_Rate_Ant_X	2	LOS rate (X) in Antenna frame	float	[-1, 1] (rad)
26-27	LOS_Rate_Ant_Y	2	LOS rate (Y) in Antenna frame	float	[-1, 1] (rad)
28-29	LOS_Rate_Ant_Z	2	LOS rate (Z) in Antenna frame	float	[-1, 1] (rad)
30	Post lift of events	1	For TES input	U16	
31	OBC Time Count	1	2.5ms count Time=Timecnt*0.0025	U16	[0, 65535] 2.5ms count

PostLiftOFF Events:

Sl.no	Bit Allocation	Events	Remarks		
1	BIT 0 (LSB)	LiftOFF			
2	1	Launcher exit flag			
3	2	Control Start			
4	3	Mid-course guidance start			
5	4	Terminal guidance start			
6	5	Second motor fire(P2)			
7	6	Target cross over flag			
8	7,8	TWDL port switch over	1		TX_Port_1
			2		TX_Port_2
9	9	RPF ON event			
10	10	Bus switch over telemetry			
11	11	Bus switch over TWDL			
12	12	Bus switch over seeker			
13	13,14,15	Seeker events	1		Pointing mode
			2		TX_ON
			3		ELO
			4		Reserved

Table: 1

10.0 MESSAGE FORMAT FOR GUIDANCE DATA (Guidance Commands)

MESSAGE NO	10	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19E0
SUB	15	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	MISSION	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	Rgo	2	Range to go	float	[-60000, 60000] (m)
02-03	MSL VEL	2	MISSILE Velocity	float	[-3000, 3000] (m/s)

Word No	Parameter	No of Words	Description	Data Type	Range (units)
04-05	Vel_close	2	MISSILE Closing Velocity	float	[-3000, 3000] (m/s)
06-07	MSLMach	2	Mach number	float	[0, 4]
08-09	Q	2	Dynamic Pressure	float	[0, 600000] (N/m^2)
10-11	Guid_cmd_LCI_X	2	Guidance command(X) in LCI-I frame	float	[-400, 400] (m/s^2)
12-13	Guid_cmd_LCI_Y	2	Guidance command (Y) in LCI-I frame	float	[-400, 400] (m/s^2)
14-15	Guid_cmd_LCI_Z	2	Guidance command (Z) in LCI-I frame	float	[-400, 400] (m/s^2)
16-17	Fy_command	2	Guidance command (Y)	float	[-500, 500] (m/s^2)
18-19	Fz_command	2	Guidance command (Z)	float	[-500, 500] (m/s^2)
20-21	Latax_limit	2	Latax limit	float	[-2000, 2000] (m/s^2)
22-23	LOS_ang_az(λ_a)	2	Missile-Target LOS angle in azimuth	float	[-4, 4] (rad)
24-25	LOS_ang_ele(λ_e)	2	Missile-Target LOS angle in elevation	float	[-4, 4] (rad)
26-27	phi_ge	2	Gimbal angle from frame-B	float	[-1, 1] (rad)
28-29	phi_ga	2	Gimbal angle from frame-B	float	[-1, 1] (rad)
30	Post liftoffevents	1	For seeker model	U16	See table1
31	OBC timeCnt	1	2.5ms count Time=Timecnt*0.0025	U16	[0, 65535] 2.5ms count

11.0 MESSAGE FORMAT FOR LAUNCH POINT DATA

MESSAGE NO	11	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x19E0
SUB	15	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	CHECKOUT	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	OBC timeCnt	1	OBC Time=Timecnt*0.0025	U16	[0, 65535] 2.5ms count
01-02	LP_lat	2	Launch point latitude	float	[-90, 90] (deg)
03-04	LP_long	2	Launch point longitude	float	[-179.99, 180.0]

Word No	Parameter	No of Words	Description	Data Type	Range (units)
					(deg)
05-06	Launch_azimuth	2	Launch point azimuth	float	[-179.99, 180.0] (deg)
07-08	href	2	Launch point altitude	float	[-1000, 1000] (m)
09-31	Dummy[23]	23	Dummy	U16	

12.0 MESSAGE FORMAT FOR CONTROL DATA

MESSAGE NO	12	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A00
SUB	16	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	MISSION	32	10ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	OBC Time Count	1	OBC Time = Time Count * 0.0025	U16	[0, 65535] 2.5ms count
01-02	qsnotch2	2	Present value of Notch-2 Filtered body (pitch) rate	float	[-5, 5] (rad/s)
03-04	rsnotch2	2	Present value of Notch-2 Filtered body (yaw) rate	float	[-5, 5] (rad/s)
05-06	rd1_intg	2	Autopilot loop Intermediate variable	float	[-2, 2] (rad)
07-08	qd1_intg	2	Autopilot loop Intermediate variable	float	[-2, 2] (rad)
09-10	fysnotch2	2	Present value of Notch-2 Filtered acceleration	float	[-400, 400] (m/s^2)
11-12	fzsnotch2	2	Present value of Notch-2 Filtered acceleration	float	[-400, 400] (m/s^2)
13-14	Pswing1	2	Present value of Low Pass Filtered Roll rate	float	[-10, 10] (rad/s)
15-16	ps_intg	2	Integral of low pass filtered roll rates	float	[-6, 6] (rad)
17-18	p_cmd	2	Roll rate command	float	[-5, 5] (rad/s)
19-20	q_cmd	2	Body (pitch) rate command	float	[-2, 2] (rad/s)
21-22	r_cmd	2	Body (yaw) rate command	float	[-2, 2] (rad/s)
23-24	gamma_e	2	Flight path angle - elevation	float	[-4, 4] (rad)
25-26	gamma_a	2	Flight path angle - azimuth	float	[-4, 4] (rad)
27-28	Ky_body_b4_lim	2	Guidance command (Y) in body frame before applying latax limit	float	[-500, 500] (m/s^2)
29-30	Kz_body_b4_lim	2	Guidance command (Z) in body	float	[-500, 500]

			frame before applying latax limit		(m/s^2)
31	reserved	1		U16	

13.0 MESSAGE FORMAT FOR SURVEILLANCE DATA

MESSAGE NO	13	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A00
SUB	16	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	CHECKOUT	32	10ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	Header	1	Surveillance Header	U16	0x5355
01	ATB Voltage	1	ATB Voltage	U16	
02	ETB Voltage	1	ETB Voltage	U16	
03	STB Voltage	1	STB Voltage	U16	
04	Lift Off Voltage	1	Lift Off Voltage	U16	
05	Actuator 1 Command	1	Actuator 1 Command received by EMA	S16	
06	Actuator 2 Command	1	Actuator 2 Command received by EMA	S16	
07	Actuator 3 Command	1	Actuator 3 Command received by EMA	S16	
08	Actuator 4 Command	1	Actuator 4 Command received by EMA	S16	
09	Actuator 1 Position Fb	1	Actuator 1 Feedback received from EMA	S16	
10	Actuator 2 Position Fb	1	Actuator 2 Feedback received from EMA	S16	
11	Actuator 3 Position Fb	1	Actuator 3 Feedback received from EMA	S16	
12	Actuator 4 Position Fb	1	Actuator 4 Feedback received from EMA	S16	
13	Actuator 1 Motor Current	1	Actuator 1 Motor current received from EMA	S16	
14	Actuator 2 Motor Current	1	Actuator 2 Motor current received from EMA	S16	
15	Actuator 3 Motor Current	1	Actuator 3 Motor current received from EMA	S16	
16	Actuator 4 Motor Current	1	Actuator 4 Motor current received from EMA	S16	

17	Pre lift OFF Events	1	Pre lift off events	U16	See table 2
18	OBC DIP register 1 BITS	1	DIP Status0	U16	See table 3
19	OBC DIP Register 2 BITS	1	DIP Status1	U16	See table 4
20	Missile Health Status	1	Missile Health Status	U16	See table 5
21	EMAS Mode	1	EMA BIT status and Mode	U16	LSB=mode MSB=BITS See table 6 See table 9 (OBC modes)
22	TWDL PLL Lock	1	TWDL Lock Status	U16	
23	INS Status	1		U16	See table 7
24	Sensor Status	1		U16	See table 8
25	INS Header Fail count	1		U16	
26	INS Checksum Fail count	1		U16	
27	INS Packet Fail count	1		U16	
28	INS FIMU Temperature	1		U16	
29	Seeker GG Flag	1		U16	
30-31	OBC Real Time Count	2	OBC Real Time Count	U32	Count * 0.0025

Note:
a) Word 18-19 correspond to PSRU RELAY Status – for details
b) Word 20 (Missile Health Status) bit description:
c) Word 17 (Missile Pre launch events) bit description:

Pre lift OFF events :(WORD 17)

Sl.no	Bit Allocation	Events	Remarks
1	BIT 0 (LSB)	RealTime flag	
2	1	Navcommand issued	
3	2,3	On board DL power mode	
4	4	THB command received	
5	5	External cut off message received	
6	6	EMA profile flag	
7	7	Ready for launch command received	
8	8	Motor1 fire command received	
9	9	Motor1 fire command issued	
10	10	TWDL message scheduling start	
11	11	Seeker message ON/OFF flag	
12	12	Seeker FrameA start	
13	13	Seeker FrameB start	
14	14	EMA operational mode	

15	15	future	

Table: 2

DIP register 1 BITS Description :(WORD 18)

Sl.no	Bit Allocation	Description	Remarks
1	BIT 0 (LSB)	ATB_FIRE_STATUS	DIP0
2	1	ETB_FIRE_STATUS	DIP1
3	2	STB_FIRE_STATUS	DIP2
4	3	Future Requirement	DIP3
5	4		DIP4
6	5	RM_D2_FIRE_STATUS	DIP5
7	6		DIP6
8	7	Future Requirement	DIP7
9	8	MID0	DIP8
10	9	MID1	DIP9
11	10	MID2	DIP10
12	11	Future Requirement	DIP11
13	12	SOL1_STA_RETURN	DIP12
14	13	SOL2_STA_RETURN	DIP13
15	14		DIP14
16	15		DIP15

Table: 3

DIP register 2 BITS Description: (WORD 19)

Sl.no	Bit Allocation	Description	Remarks
1	16	LIFT_OFF_STA_OBC_HI	DIP16
2	17	reserved	
3	18	Reserved	
4	19-23	Future Requirement	
5	MSB byte	For OBC modes	

Table: 4

Missile Health Status: (WORD 20)

Sl.no	Bit Allocation	Description	Remarks
1	BIT 0 (LSB)	INS health status	
2	1	DL health status	
3	2	Actuator health status	
4	3	Lift OFF status	
5	4	Seeker health status	
6	5	LEGF health status	
7	6	SAM health status	
8	7	Telemetry health status	

9	8	Realtime command OBC_ack	
10	9	INS_NAV_status	
11	10	ATB voltage status	
12	11	ETB voltage status	
13	12	STB voltage status	
14	13	On Battery Actuator Status	
15	14	Ready for launch cmd	
16	15(MSB)	Future	

Table: 5

EMA BIT status: (WORD 21)

Sl.no	BIT position	Status		MODE	Remarks
1	0(MSB)	IBIT completed	1	STANDBY	
2	1	PBIT completed	2	OPERATIONAL	
3	2	FBIT completed	3	PBIT	
4	3	IBIT failed	4	IBIT	
5	4	PBIT failed	5	FBIT	
6	5	FBIT failed			
7	6	CBIT failed			
8	7(LSB)	Header error			

Table: 6

INS Status Word :(WORD 23)

Sl.no	Bit No.	Parameter	Description
1	MSB 15	INS Ready	1 - For 1553B Command 0 - Busy
2	14	Hybridization	1 - ON 0 - OFF
3	13-12	Operation Mode	00 - Mission Mode 01 - Constant Simulation 10 - HILS Mode (Half Simulation) 11 - 6 DOF Mode (Full Simulation)
4	11-10	Attitude Available	11 - Reserved 10 - Heading & Levelling Angles Available 01 - Levelling Angles Available 00 - Not Available
5	09-08	Alignment Mode	01 - Static Levelling 10 - Two Position TA (Reserved) 11 - Rate Matching TA (Reserved)

6	07-04	INS Active Mode	0001 - Standby 0010 - Position Test 0111 - Mission Data Load 0110 - Mission Data Dump 0100 - Alignment 1000 - Navigation
7	03	Mission Data	1 - Data Required 0 - Data not Required
8	02	Sensor Temperature	1 - NOT OK 0 - OK
9	01	Sensor Data Validity	1 - Data Not Valid 0 - Data valid
10	LSB 0	BIST	1 - NOT OK 0 - OK

Table: 7

Sensor Status Word :(WORD 24)

Sl.no	Bit No.	Parameter	Description
1	MSB 15	FIMU Packet Header Fail	0 - OK, 1 - NOT OK
2	14	FIMU Packet Checksum Fail	0 - OK, 1 - NOT OK
3	13	FIMU Packet Fail	0 - OK, 1 - NOT OK
4	12	FIMU Packet Time out	0 - OK, 1 - NOT OK
5	11	Z - Accl Abs Fail	0 - OK, 1 - NOT OK
6	10	Y - Accl Abs Fail	0 - OK, 1 - NOT OK
7	09	X - Accl Abs Fail	0 - OK, 1 - NOT OK
8	08	Z - Gyro Abs Fail	0 - OK, 1 - NOT OK
9	07	Y - Gyro Abs Fail	0 - OK, 1 - NOT OK
10	06	X - Gyro Abs Fail	0 - OK, 1 - NOT OK
11	05	Z - Accl Fail	0 - OK, 1 - NOT OK
12	04	Y - Accl Fail	0 - OK, 1 - NOT OK
13	03	X - Accl Fail	0 - OK, 1 - NOT OK
14	02	Z - Gyro Fail	0 - OK, 1 - NOT OK
15	01	Y - Gyro Fail	0 - OK, 1 - NOT OK
16	LSB 0	X - Gyro Fail	0 - OK, 1 - NOT OK

Table: 8

OBC Mode Numbers List:

Sl.no	MODE numbers	MODE	Remarks
1	0	Check Out	
2	1	LOAD	INS
3	2	DUMP	INS
4	3	POSITION	INS
5	4	LEVELING	INS
6	5	LOAD FOR TA	INS
7	6	NAVIGATION	INS
8	7	CONFIG AND HISTORY	INS
9	8-10	reserved	
10	11	ADC TEST	IO
11	12	DAC TEST	IO
12	13	DOP TEST	IO
13	14	DIP TEST	IO
14	15	BUS SWITCH OVER	IO
15	16	FIRE BATTERY	IO
16	17	MOTOR1 FIRE	IO
17	18-20	reserved	
18	21	CONFIG	TWDL
19	22	PA MODE	TWDL
20	23	PORT SELECTION	TWDL
21	24	VERSION	TWDL
22	25-30	Reserved	
23	31	PBIT	EMA
24	32	SINUSOIDAL	EMA
25	33	STEP	EMA
26	34	LINEARITY	EMA
27	35	NULL	EMA
28	36	PROFILE TEST	EMA
29	37-40	reserved	
30	41	TWDL MSG	Message scheduling
31	42	SEEKER MSG	
32	43	BOT TWDL AND SEEKER	
33	44	BOTH OFF	
34	45-50	Reserved	

35	51	INITIAL PARAMETERS	
36	52-60	RESERVED	
37	61	REAL TIME	AUTOLAUNCH
38	62-70	RESERVED	
39	71	RDY FOR LAUNCH COMMAND	AUTO LAUNCH
40	72	EXTERNAL CUT OFF MSG	AUTO LAUNCH
41	73-80	RESERVED	
42	81	STEP	SEEKER
43	82	SINUSOIDAL	SEEKER
44	83	TX_ON	SEEKER
45	84	DOPPLER	SEEKER
46	85-255	RESERVED	

Table: 9

Note: this byte included in word 19 most significant byte and posting to checkout

14.0 MESSAGE FORMAT FOR CONTROL GAINS DATA

MESSAGE NO	14	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A20
SUB	17	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	MISSION	32	10ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	OBC TimeCnt	1	Time = Timecnt*0.0025	U16	[0, 65535] 2.5ms count
01-02	aKp_Roll	2	Roll Autopilot gain	float	[0, 6500000] (m)
03-04	aKdc	2	Autopilot gain	float	
05-06	akAlpha	2	Autopilot gain	float	
07-08	w_i	2	Autopilot gain	float	
09-10	aKq	2	Autopilot gain	float	
11-12	Meta_AP(control defelections)	2	Moment derivative due to control deflection	float	[-800000, 800000] (N-m/rad)

13-14	K_alpha_factor	2	Autopilot tuning parameter		float	[0, 1]
15-16	wc_lim	2	Autopilot tuning parameter		float	[0, 50] (rad/s)
17-18	K1m	2	Autopilot tuning parameter		float	[0, 50]
19-20	T_AP	2	Autopilot tuning parameter		float	[0, 1] (s)
21-22	w_c	2	Autopilot tuning parameter		float	[0, 60] (rad/s)
23-24	Cl_delta_AP	2	Cl control effectiveness		float	[0, 20] (rad)
25-26	L_delta_AP	2	Rolling moment control effectiveness		float	[0, 200000] (N-m/rad)
27-28	K_phi	2	Roll Autopilot gain		float	[0, 1000]
29-30	AlphaTotal	2	Total Angle of attack		float	[0, 40] (deg)
31	Post liftoff events	1	Events after lift OFF		U16	

15.0 MESSAGE FORMAT FOR EMA FEEDBACK DATA

MESSAGE NO	15	SOURCE		DESTINATION	CMD WORD
RT	3	OBC		TELEMETRY	0x1A40
SUB	18	**MODE**		**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	CHECKOUT/MISSION		32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	OBC Time Count	1	Time = Count * 0.0025	U16	[0, 65535] 2.5ms count
01	Fin1 Command (EMA received commands)	1	Angle command of each fin ([-25, 25] [deg], $180/2^{15}$ [deg]/LSB) (scale factor : 0.0054931640625)	S16	[-25, 25] (deg) (180/32768)
02	Fin2 Command	1		S16	[-25, 25] (deg)
03	Fin3 Command	1		S16	[-25, 25] (deg)
04	Fin4 Command	1		S16	[-25, 25] (deg)
05	Fin1 Absolute	1	Measured angle by absolute encoder of each fin ([-30, 30] [deg], $2*180/2^{13}$ [deg]/LSB) (scale factor : 0.0439453125)	S16	[-30, 30] (360/8192)

06	Fin2 Absolute	1			
07	Fin3 Absolute	1			
08	Fin4 Absolute	1			
09	Fin1 Velocity	1	Velocity of each fin. ±500[deg/sec] LSB=1/(8*300) rad/sec (scale factor : 0.000416666)	S16	[-500, 500] (1/2400)
10	Fin2 Velocity	1		S16	
11	Fin3 Velocity	1		S16	
12	Fin4 Velocity	1		S16	
13	Motor1 Current	1	Measured current of each fin. [-40,40] AMP LSB=1/525 (scale factor : 0.001904762)	S16	[-40, 40] (1/525)
14	Motor2 Current	1			
15	Motor3 Current	1			
16	Motor4 Current	1			
17	EMA mode and status	1		U16	
18	Linear sqrt and mode	1		U16	
19	Voltage details 1 and 2	1		U16	
20	BIT status and General status	1		U16	
21	Amplifier details 1 and 2	1		U16	
22	Amplifier details 3 and 4	1		U16	
23	Motor type and voltage index	1	Voltage index:0-19 for each voltage value	U16	
24	Voltage value	1		U16	
25	Fault details fin1 and fin2	1		U16	
26	Fault details fin3 and fin4	1		U16	
37	Control timer	1		U16	
28	V_bus voltage and card temperature	1	V_bus voltage:LSB-1V,[0-115V] Card Temperature:[-40,120],1degC	U16	
29	Frame counter amplifier 1& 2	1		U16	
30	Frame counter amplifier 3& 4	1		U16	
31	EMAPktCnt	1		U16	

16.0 MESSAGE FORMAT FOR ESTIMATOR DATA

MESSAGE NO	16	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A40
SUB	19	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	20ms

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	OBC Time Count	1	Time = Count * 0.0025	U16	[0, 65535] 2.5ms count
01	Skr timecount	1	Seeker time count	U16	
02	TG_events	1	Terminal guidance events	U16	See TG_Events Table
03	FrameB events	1	Frame-B events	U16	
04-05	R2go_frame-B	2	Measured Range to go	U16	
06-07	Vc_frame_B	2	Measured closing velocity	float	
08-09	Gimbal_el_frmB	2	Gimbal angle in elvation	float	
10-11	Gimbal_az_frmB	2	Gimabl angle in azimuth	float	
12-13	Boresight_el_frmB	2	Bore sight eror in elevation	float	
14-15	Boresight_az_frmB	2	Bore sight error in azimuth	float	
16-17	Range_est	2	Range	float	
18-19	Rdot_est	2	RANGE RATE	float	
20-21	LOS_X0(states)	2	LOS estimator state 0	float	
22-23	LOS_X1	2	LOS estimator state 1	float	
24-25	LOS_X2	2	LOS estimator state 2	float	
26-27	LOS_X3	2	LOS estimator state 3	float	
28-29	LOS_X4	2	LOS estimator state 4	float	
30-31	LOS_X5	2	LOS estimator state 5	float	

TG_Events:

Sl.no	Bit Allocation	Events	Remarks
1	BIT 0 (LSB)	TG_Flag	
2	1	Pointing mode	
3	2	Transmitter ON	
4	3	Enable Lock ON	
5	4	Angle Track Flag	
6	5	Estimator Start	

7	6	Terminal Guidance Start	
8	7,8	SES	
9	9	Frame B frozen	
10	10-15 (MSB)	Reserved	

17.0 MESSAGE FORMAT FOR OBC POST DATA

MESSAGE NO	17	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1BC0
SUB	30	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	CHECKOUT	32	ONCE

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00	header	1	0xAAAA	U16	
01	Command word	1	0x504F	U16	
02	Post results	1	Refer below bit description	U16	
03-04	Reserved	2			
05-31	Software version string	27			

bit	Remarks
0	SDRAM check
1	Flash checksum test
2	Nvram check
3-15	reserved

18.0 MESSAGE FORMAT FOR KF CORRECTIONS

MESSAGE NO	18	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	PosCorr_X	2	KF Position(X) correction	float	(m)

04-05	PosCorr_Y	2	KF Position(Y) correction	float	(m)
06-07	PosCorr_Z	2	KF Position(Z) correction	float	(m)
08-09	VelCorr_X	2	KF Velocity(X) correction	float	(m/s)
10-11	VelCorr_Y	2	KF Velocity (Y) correction	float	(m/s)
12-13	VelCorr_Z	2	KF Velocity (Z) correction	float	(m/s)
14-15	QuatCorr_q1	2	KF Quaternion1 correction	float	
16-17	QuatCorr_q2	2	KF Quaternion2 correction	float	
18-19	QuatCorr_q3	2	KF Quaternion3 correction	float	
20-21	AccBiasCorr_X	2	KF Accelerometer Bias (X) correction	float	(m/s^2)
22-23	AccBiasCorr_Y	2	KF Accelerometer Bias (Y) correction	float	(m/s^2)
24-25	AccBiasCorr_Z	2	KF Accelerometer Bias (Z) correction	float	(m/s^2)
26-27	GyroBiasCorr_X	2	KF Gyro Bias (X) correction	float	(deg/s)
28-29	GyroBiasCorr_Y	2	KF Gyro Bias (Y) correction	float	(deg/s)
30	Reserved				
31	GNSS M1[0x9181]	1		U16	

19.0 MESSAGE FORMAT FOR GNSS Satellite IDs and Signal to Noise Ratio

MESSAGE NO	19	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02	Satellite ID 1	1	GNSS Satellite IDs	S16	
03	Satellite ID 2	1	GNSS Satellite IDs	S16	
04	Satellite ID 3	1	GNSS Satellite IDs	S16	
05	Satellite ID 4	1	GNSS Satellite IDs	S16	
06	Satellite ID 5	1	GNSS Satellite IDs	S16	
07	Satellite ID 6	1	GNSS Satellite IDs	S16	
08	Satellite ID 7	1	GNSS Satellite IDs	S16	
09	Satellite ID 8	1	GNSS Satellite IDs	S16	
10	Satellite ID 8	1	GNSS Satellite IDs	S16	
11	S/N Ratio 2&1	1	Signal to Noise Ratio	U16	dB-Hz
12	S/N Ratio 4&3	1	Signal to Noise Ratio	U16	dB-Hz

13	S/N Ratio 6&5	1	Signal to Noise Ratio	U16	dB-Hz
14	S/N Ratio 8&7	1	Signal to Noise Ratio	U16	dB-Hz
15	S/N Ratio 9	1	Signal to Noise Ratio	U16	dB-Hz
16	GAGAN Satellite ID 2 &1	1	GAGAN Satellite ID	U16	
17	GAGAN S/N Ratio ID 2 &1	1	GAGAN Signal to Noise Ratio	U16	dB-Hz
18-19	GPS Sync Time	2		float	(s)
20-21	IRNSS Week Number	2		U32	
22-23	IRNSS Time	2		U32	
24-25	IRNSS Time (ns)	2		U32	(ns)
26	Status of Channel 1-8	1		U16	
27	Status of Channel 9-16	1		U16	
28	Status of Channel 17-23	1		U16	
29	Constel of Channel 17-23	1		U16	
30	Ephemeris of Channel 17-23	1		U16	
31	GNSS MI (0xC1X2)	1		U16	

20.0 MESSAGE FORMAT FOR GPS Satellite Position 1

MESSAGE NO	20	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 1-X	2	GPS ECEF Position	S32	m
04-05	Channel No 1-Y	2	GPS ECEF Position	S32	m
06-07	Channel No 1-Z	2	GPS ECEF Position	S32	m
08-09	Channel No 2-X	2	GPS ECEF Position	S32	m
10-11	Channel No 2-Y	2	GPS ECEF Position	S32	m
12-13	Channel No 2-Z	2	GPS ECEF Position	S32	m
14-15	Channel No 3-X	2	GPS ECEF Position	S32	m
16-17	Channel No 3-Y	2	GPS ECEF Position	S32	m
18-19	Channel No 3-Z	2	GPS ECEF Position	S32	m
20-21	Channel No 4-X	2	GPS ECEF Position	S32	m

22-23	Channel No 4-Y	2	GPS ECEF Position	S32	m
24-25	Channel No 4-Z	2	GPS ECEF Position	S32	m
26-27	Channel No 5-X	2	GPS ECEF Position	S32	m
28-29	Channel No 5-Y	2	GPS ECEF Position	S32	m
30	Measurement Quality Ch 1-16	1	GPS Measurement Quality	U16	
31	GNSS MI (0xA186)	1		U16	

21.0 MESSAGE FORMAT FOR GPS Satellite Velocity 2

MESSAGE NO	21	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 5-Z	2	GPS ECEF Velocity	S32	m/s
04-05	Channel No 6-X	2	GPS ECEF Velocity	S32	m/s
06-07	Channel No 6-Y	2	GPS ECEF Velocity	S32	m/s
08-09	Channel No 6-Z	2	GPS ECEF Velocity	S32	m/s
10-11	Channel No 7-X	2	GPS ECEF Velocity	S32	m/s
12-13	Channel No 7-Y	2	GPS ECEF Velocity	S32	m/s
14-15	Channel No 7-Z	2	GPS ECEF Velocity	S32	m/s
16-17	Channel No 8-X	2	GPS ECEF Velocity	S32	m/s
18-19	Channel No 8-Y	2	GPS ECEF Velocity	S32	m/s
20-21	Channel No 8-Z	2	GPS ECEF Velocity	S32	m/s
22-23	Channel No 9-X	2	GPS ECEF Velocity	S32	m/s
24-25	Channel No 9-Y	2	GPS ECEF Velocity	S32	m/s
26-27	Channel No 9-Z	2	GPS ECEF Velocity	S32	m/s
28-29	Channel No 10-X	2	GPS ECEF Velocity	S32	m/s
30	Firmware Version	1	GPS Firmware Version	U16	
31	GNSS MI (0xA18A)	1		U16	

22.0 MESSAGE FORMAT FOR GNSS Satellite Position 1

MESSAGE NO	22	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 15-X	2	GPS ECEF Position	S32	m
04-05	Channel No 15-Y	2	GPS ECEF Position	S32	m
06-07	Channel No 15-Z	2	GPS ECEF Position	S32	m
08-09	Channel No 16-X	2	GPS ECEF Position	S32	m
10-11	Channel No 16-Y	2	GPS ECEF Position	S32	m
12-13	Channel No 16-Z	2	GPS ECEF Position	S32	m
14-15	Channel No 17-X	2	GPS ECEF Position	S32	m
16-17	Channel No 17-Y	2	GPS ECEF Position	S32	m
18-19	Channel No 17-Z	2	GPS ECEF Position	S32	m
20-21	Channel No 18-X	2	GPS ECEF Position	S32	m
22-23	Channel No 18-Y	2	GPS ECEF Position	S32	m
24-25	Channel No 18-Z	2	GPS ECEF Position	S32	m
26-27	Channel No 19-X	2	GPS ECEF Position	S32	m
28-29	Channel No 19-Y	2	GPS ECEF Position	S32	m
30	PBIT 1	1		U16	
31	GNSS MI (0xC183)	1		U16	

23.0 MESSAGE FORMAT FOR GPS DATA

MESSAGE NO	23	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS TIME	2		float	(WORD)
02-03	GPS Velocity_X	2	GPS Velocity(X)	float	(m/s)
04-05	GPS Velocity_Y	2	GPS Velocity (Y)	float	(m/s)
06-07	GPS Velocity_Z	2	GPS Velocity (Z)	float	(m/s)
08-9	GPS Position_X	2	GPS Position (X)	float	(m)
10-11	GPS Position _Y	2	GPS Position (Y)	float	(m)
12-13	GPS Position _Z	2	GPS Position (Z)	float	(m)
14-15	Latitude	2	Latitude from GPS	float	(deg)
16-17	Longitude	2	Longitude from GPS	float	(deg)
18-19	Altitude	2	Altitude from GPS	float	(m)
20-21	GPS PDOP	2	GPS Position Dilution Precision	float	

22-23	GPS HDOP	2	GPS Height Dilution Precision	float	
24-25	GPS Time	2	GPS Time in sec	U32	(s)
26-27	GPS Time(ns)	2	GPS Time in nanosec	U32	(ns)
28-39	Solution Time	2	GPS Solution Time	U32	(s)
30	GNSS Receiver Status	1		U16	
32	GNSS M1[0xA1X1]	1		U16	

24.0 MESSAGE FORMAT FOR GPS Pseudo Range DATA

MESSAGE NO	24	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 1	2	GPS Pseudo Range	S32	m
04-05	Channel No 2	2	GPS Pseudo Range	S32	m
06-07	Channel No 3	2	GPS Pseudo Range	S32	m
08-09	Channel No 4	2	GPS Pseudo Range	S32	m
10-11	Channel No 5	2	GPS Pseudo Range	S32	m
12-13	Channel No 6	2	GPS Pseudo Range	S32	m
14-15	Channel No 7	2	GPS Pseudo Range	S32	m
16-17	Channel No 8	2	GPS Pseudo Range	S32	m
18-19	Channel No 9	2	GPS Pseudo Range	S32	m
20-21	Channel No 10	2	GPS Pseudo Range	S32	m
22-23	Channel No 11	2	GPS Pseudo Range	S32	m
24-25	Channel No 12	2	GPS Pseudo Range	S32	m
26-27	Channel No 13	2	GPS Pseudo Range	S32	m
28-29	Channel No 14	2	GPS Pseudo Range	S32	m
30	Almanac of Channel 1-8	1	GPS Almanac	U16	
31	GNSS MI (0xA183)	1		U16	

25.0 MESSAGE FORMAT FOR GPS Satellite Position 2

MESSAGE NO	25	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 5-Z	2	GPS ECEF Position	S32	m
04-05	Channel No 6-X	2	GPS ECEF Position	S32	m
06-07	Channel No 6-Y	2	GPS ECEF Position	S32	m
08-09	Channel No 6-Z	2	GPS ECEF Position	S32	m
10-11	Channel No 7-X	2	GPS ECEF Position	S32	m
12-13	Channel No 7-Y	2	GPS ECEF Position	S32	m
14-15	Channel No 7-Z	2	GPS ECEF Position	S32	m
16-17	Channel No 8-X	2	GPS ECEF Position	S32	m
18-19	Channel No 8-Y	2	GPS ECEF Position	S32	m
20-21	Channel No 8-Z	2	GPS ECEF Position	S32	m
22-23	Channel No 9-X	2	GPS ECEF Position	S32	m
24-25	Channel No 9-Y	2	GPS ECEF Position	S32	m
26-27	Channel No 9-Z	2	GPS ECEF Position	S32	m
28-29	Channel No 10-X	2	GPS ECEF Position	S32	m
30	Health of Satellite 1-8	1	GPS Satellite Health	U16	
31	GNSS MI (0xA187)	1		U16	

26.0 MESSAGE FORMAT FOR GPS Satellite Velocity 3

MESSAGE NO	26	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 10-Y	2	GPS ECEF Velocity	S32	m/s
04-05	Channel No 10-Z	2	GPS ECEF Velocity	S32	m/s
06-07	Channel No 11-X	2	GPS ECEF Velocity	S32	m/s
08-09	Channel No 11-Y	2	GPS ECEF Velocity	S32	m/s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
10-11	Channel No 11-Z	2	GPS ECEF Velocity	S32	m/s
12-13	Channel No 12-X	2	GPS ECEF Velocity	S32	m/s
14-15	Channel No 12-Y	2	GPS ECEF Velocity	S32	m/s
16-17	Channel No 12-Z	2	GPS ECEF Velocity	S32	m/s
18-19	Channel No 13-X	2	GPS ECEF Velocity	S32	m/s
20-21	Channel No 13-Y	2	GPS ECEF Velocity	S32	m/s
22-23	Channel No 13-Z	2	GPS ECEF Velocity	S32	m/s
24-25	Channel No 14-X	2	GPS ECEF Velocity	S32	m/s
26-27	Channel No 14-Y	2	GPS ECEF Velocity	S32	m/s
28-29	Channel No 14-Z	2	GPS ECEF Velocity	S32	m/s
30	CBIT 3	1		U16	
31	GNSS MI (0xA18B)	1		U16	

27.0 MESSAGE FORMAT FOR GPS Satellite Position 2

MESSAGE NO	27	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 19-Z	2	GPS ECEF Position	S32	m
04-05	Channel No 20-X	2	GPS ECEF Position	S32	m
06-07	Channel No 20-Y	2	GPS ECEF Position	S32	m
08-09	Channel No 20-Z	2	GPS ECEF Position	S32	m
10-11	Channel No 21-X	2	GPS ECEF Position	S32	m
12-13	Channel No 21-Y	2	GPS ECEF Position	S32	m
14-15	Channel No 21-Z	2	GPS ECEF Position	S32	m
16-17	Channel No 22-X	2	GPS ECEF Position	S32	m
18-19	Channel No 22-Y	2	GPS ECEF Position	S32	m
20-21	Channel No 22-Z	2	GPS ECEF Position	S32	m
22-23	Channel No 23-X	2	GPS ECEF Position	S32	m
24-25	Channel No 23-Y	2	GPS ECEF Position	S32	m
26-27	Channel No 23-Z	2	GPS ECEF Position	S32	m
28	GAGAN Corrections Availed	1	GPS GAGAN Corrections	U16	
29	GAGAN Corrections Applied	1	GPS GAGAN Corrections	U16	

| 30 | PBIT 2 | 1 | | U16 | |
| 31 | GNSS MI (0XC184) | 1 | | U16 | |

28.0 MESSAGE FORMAT FOR GNSS DATA

MESSAGE NO	28	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
01-02	INS Time	2	INS Time	float	(s)
03-04	GNSS Velocity_X	2	GNSS Velocity(X)	float	(m/s)
05-06	GNSS Velocity_Y	2	GNSS Velocity (Y)	float	[-1200,1200] (m/s)
07-08	GNSS Velocity_Z	2	GNSS Velocity (Z)	float	[-1200,1200] (m/s)
09-10	GNSS Position_X	2	GNSS Position (X)	float	[0, 6500000] (m)
11-12	GNSS Position _Y	2	GNSS Position (Y)	float	[0, 6500000] (m)
13-14	GNSS Position _Z	2	GNSS Position (Z)	float	[0, 6500000] (m)
15-16	GNSS Latitude	2	Latitude from GNSS	float	[-90, 90] (deg)
17-18	GNSS Longitude	2	Longitude from GNSS	float	[-179.99, 180.0] (deg)
19-20	GNSS Altitude	2	Altitude from GNSS	float	(m)
21-22	GNSS PDOP	2	GNSS Position Dilution Precision	float	(m/s^2)
23-24	GNSS HDOP	2	GNSS Height Dilution Precision	float	(m/s^2)
25-26	User Clock Bias	2	User Clock Bias	float	(s)
27-28	User Clock Drift	2	User Clock Drift	Float	(s/s)
29-30	Gyro Bias-2	2		U32	(Deg/s)
31	Constel of Channel 1-16	1		U16	
32	GNSS MI [0xC1X1]	1		U16	

29.0 MESSAGE FORMAT FOR GPS Delta Pseudo Range DATA

MESSAGE NO	29	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 1	2	GPS Delta Pseudo Range	float	m
04-05	Channel No 2	2	GPS Delta Pseudo Range	float	m
06-07	Channel No 3	2	GPS Delta Pseudo Range	float	m
08-09	Channel No 4	2	GPS Delta Pseudo Range	float	m
10-11	Channel No 5	2	GPS Delta Pseudo Range	float	m
12-13	Channel No 6	2	GPS Delta Pseudo Range	float	m
14-15	Channel No 7	2	GPS Delta Pseudo Range	float	m
16-17	Channel No 8	2	GPS Delta Pseudo Range	float	m
18-19	Channel No 9	2	GPS Delta Pseudo Range	float	m
20-21	Channel No 10	2	GPS Delta Pseudo Range	float	m
22-23	Channel No 11	2	GPS Delta Pseudo Range	float	m
24-25	Channel No 12	2	GPS Delta Pseudo Range	float	m
26-27	Channel No 13	2	GPS Delta Pseudo Range	float	m
28-29	Channel No 14	2	GPS Delta Pseudo Range	float	m
30	Almanac of Channel 9-23	1	GPS Almanac	U16	
31	GNSS MI (0xA184)	1		U16	

30.0 MESSAGE FORMAT FOR GPS Satellite Position 3

MESSAGE NO	30	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 10-Y	2	GPS ECEF Position	S32	m
04-05	Channel No 10-Z	2	GPS ECEF Position	S32	m
06-07	Channel No 11-X	2	GPS ECEF Position	S32	m
08-09	Channel No 11-Y	2	GPS ECEF Position	S32	m

10-11	Channel No 11-Z	2	GPS ECEF Position	S32	m
12-13	Channel No 12-X	2	GPS ECEF Position	S32	m
14-15	Channel No 12-Y	2	GPS ECEF Position	S32	m
16-17	Channel No 12-Z	2	GPS ECEF Position	S32	m
18-19	Channel No 13-X	2	GPS ECEF Position	S32	m
20-21	Channel No 13-Y	2	GPS ECEF Position	S32	m
22-23	Channel No 13-Z	2	GPS ECEF Position	S32	m
24-25	Channel No 14-X	2	GPS ECEF Position	S32	m
26-27	Channel No 14-Y	2	GPS ECEF Position	S32	m
28-29	Channel No 14-Z	2	GPS ECEF Position	S32	m
30	Health of Satellite 9-23	1	GPS Satellite Health	U16	
31	GNSS MI (0xA188)	1		U16	

31.0 MESSAGE FORMAT FOR GPS Satellite Clock Bias

MESSAGE NO	31	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 1	2	GPS Clock bias	S32	(s)
04-05	Channel No 2	2	GPS Clock bias	S32	(s)
06-07	Channel No 3	2	GPS Clock bias	S32	(s)
08-09	Channel No 4	2	GPS Clock bias	S32	(s)
10-11	Channel No 5	2	GPS Clock bias	S32	(s)
12-13	Channel No 6	2	GPS Clock bias	S32	(s)
14-15	Channel No 7	2	GPS Clock bias	S32	(s)
16-17	Channel No 8	2	GPS Clock bias	S32	(s)
18-19	Channel No 9	2	GPS Clock bias	S32	(s)
20-21	Channel No 10	2	GPS Clock bias	S32	(s)
22-23	Channel No 11	2	GPS Clock bias	S32	(s)
24-25	Channel No 12	2	GPS Clock bias	S32	(s)
26-27	Channel No 13	2	GPS Clock bias	S32	(s)
28-29	Channel No 14	2	GPS Clock bias	S32	(s)
30	CBIT 1	1		U16	
31	GNSS MI (0xA18C)	1		U16	

32.0 MESSAGE FORMAT FOR GPS Satellite Velocity 1

MESSAGE NO	32	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 15-X	2	GPS ECEF Velocity	S32	m/s
04-05	Channel No 15-Y	2	GPS ECEF Velocity	S32	m/s
06-07	Channel No 15-Z	2	GPS ECEF Velocity	S32	m/s
08-09	Channel No 16-X	2	GPS ECEF Velocity	S32	m/s
10-11	Channel No 16-Y	2	GPS ECEF Velocity	S32	m/s
12-13	Channel No 16-Z	2	GPS ECEF Velocity	S32	m/s
14-15	Channel No 17-X	2	GPS ECEF Velocity	S32	m/s
16-17	Channel No 17-Y	2	GPS ECEF Velocity	S32	m/s
18-19	Channel No 17-Z	2	GPS ECEF Velocity	S32	m/s
20-21	Channel No 18-X	2	GPS ECEF Velocity	S32	m/s
22-23	Channel No 18-Y	2	GPS ECEF Velocity	S32	m/s
24-25	Channel No 18-Z	2	GPS ECEF Velocity	S32	m/s
26-27	Channel No 19-X	2	GPS ECEF Velocity	S32	m/s
28-29	Channel No 19-Y	2	GPS ECEF Velocity	S32	m/s
30	PE Health status	1		U16	
31	GNSS MI (0XC185)	1		U16	

33.0 MESSAGE FORMAT FOR GPS SAT-IDs AND SNR

MESSAGE NO	33	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
01-02	INS Real Time	2	INS Real Time	float	(s)
03	Satellite ID 2 & 1	1	GPS Satellite IDs	U16	
04	Satellite ID 3 & 4	1	GPS Satellite IDs	U16	
05	Satellite ID 5 & 6	1	GPS Satellite IDs	U16	

06	Satellite ID 7 & 8	1	GPS Satellite IDs	U16	
07	Satellite ID 9&10	1	GPS Satellite IDs	U16	
08	Satellite ID 11&12	1	GPS Satellite IDs	U16	
09	Satellite ID 13&14	1	GPS Satellite IDs	U16	
10	S/N Ratio 1&2	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
11	S/N Ratio 3&4	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
12	S/N Ratio 5&6	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
13	S/N Ratio 7&8	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
14	S/N Ratio 9&10	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
15	S/N Ratio 11&12	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
16	S/N Ratio 13&14	1	Signal to Noise Ratio of GPS Satellites	U16	(dB-Hz)
17	YEAR	1		U16	
18	Month (MSB) & Day (LSB	1		U16	
19	Hours (MSB) & Minutes (LSB)	1		U16	
20	Seconds	1		U16	
21-22	GPS Week Number	2		U32	
23-24	GPS Time	2		U32	S
25-26	GPS Time(ns)	2		U32	ns
27-28	Time Tag	2		U32	ms
29-30	Interval Length	2		S32	S
31	Ephemeris of Channel 1-16	1		S32	
32	GNSS MI [0xA1X2]	1		U16	

34.0 MESSAGE FORMAT FOR Quality of Pseudo Range & Delta Pseudo Range

MESSAGE NO	34	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80

SUB	20	MODE		WORD COUNT		FREQUENCY
TYPE (T/R)	R	MISSION		32		1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02	Channel No 2 & 1	1	GPS Pseudo Range Quality	U16	
03	Channel No 4 & 3	1	GPS Pseudo Range Quality	U16	
04	Channel No 6 & 5	1	GPS Pseudo Range Quality	U16	
05	Channel No 8 & 7	1	GPS Pseudo Range Quality	U16	
06	Channel No 10 & 9	1	GPS Pseudo Range Quality	U16	
07	Channel No 12&11	1	GPS Pseudo Range Quality	U16	
08	Channel No 14&13	1	GPS Pseudo Range Quality	U16	
09	Channel No 16&15	1	GPS Pseudo Range Quality	U16	
10	Channel No 18&17	1	GPS Pseudo Range Quality	U16	
11	Channel No 20&19	1	GPS Pseudo Range Quality	U16	
12	Channel No 22&21	1	GPS Pseudo Range Quality	U16	
13	Channel No 24&23	1	GPS Pseudo Range Quality	U16	
14	Channel No 26&25	1	GPS Pseudo Range Quality	U16	
15	Channel No 28&27	1	GPS Pseudo Range Quality	U16	
16	Channel No 2 & 1	1	GPS Delta Pseudo Range Quality	U16	
17	Channel No 4 & 3	1	GPS Delta Pseudo Range Quality	U16	
18	Channel No 6 & 5	1	GPS Delta Pseudo Range Quality	U16	
19	Channel No 8 & 7	1	GPS Delta Pseudo Range Quality	U16	
20	Channel No 10 & 9	1	GPS Delta Pseudo Range Quality	U16	
21	Channel No 12&11	1	GPS Delta Pseudo Range Quality	U16	
22	Channel No 14&13	1	GPS Delta Pseudo Range Quality	U16	
23	Channel No 16&15	1	GPS Delta Pseudo Range Quality	U16	
24	Channel No 18&17	1	GPS Delta Pseudo Range Quality	U16	
25	Channel No 20&19	1	GPS Delta Pseudo Range Quality	U16	

26	Channel No 22&21	1	GPS Delta Pseudo Range Quality	U16	
27	Channel No 24&23	1	GPS Delta Pseudo Range Quality	U16	
28	Channel No 26&25	1	GPS Delta Pseudo Range Quality	U16	
29	Channel No 26&25	1	GPS Delta Pseudo Range Quality	U16	
30	Reserved	1		U16	
31	GNSS MI [0xA185]	1		U16	

35.0 MESSAGE FORMAT FOR GPS Satellite Velocity 1

MESSAGE NO	35	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 1-X	2	GPS ECEF Velocity	S32	m/s
04-05	Channel No 1-Y	2	GPS ECEF Velocity	S32	m/s
06-07	Channel No 1-Z	2	GPS ECEF Velocity	S32	m/s
08-09	Channel No 2-X	2	GPS ECEF Velocity	S32	m/s
10-11	Channel No 2-Y	2	GPS ECEF Velocity	S32	m/s
12-13	Channel No 2-Z	2	GPS ECEF Velocity	S32	m/s
14-15	Channel No 3-X	2	GPS ECEF Velocity	S32	m/s
16-17	Channel No 3-Y	2	GPS ECEF Velocity	S32	m/s
18-19	Channel No 3-Z	2	GPS ECEF Velocity	S32	m/s
20-21	Channel No 4-X	2	GPS ECEF Velocity	S32	m/s
22-23	Channel No 4-Y	2	GPS ECEF Velocity	S32	m/s
24-25	Channel No 4-Z	2	GPS ECEF Velocity	S32	m/s
26-27	Channel No 5-X	2	GPS ECEF Velocity	S32	m/s
28-29	Channel No 5-Y	2	GPS ECEF Velocity	S32	m/s
30	Measurement Quality Ch 17-23	1	GPS Measurement Quality	U16	
31	GNSS MI (0xA189)	1		U16	

36.0 MESSAGE FORMAT FOR GPS Satellite Clock Drift

MESSAGE NO	36	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80

SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 1	2	GPS Clock Drift	S32	(s/s)
04-05	Channel No 2	2	GPS Clock Drift	S32	(s/s)
06-07	Channel No 3	2	GPS Clock Drift	S32	(s/s)
08-09	Channel No 4	2	GPS Clock Drift	S32	(s/s)
10-11	Channel No 5	2	GPS Clock Drift	S32	(s/s)
12-13	Channel No 6	2	GPS Clock Drift	S32	(s/s)
14-15	Channel No 7	2	GPS Clock Drift	S32	(s/s)
16-17	Channel No 8	2	GPS Clock Drift	S32	(s/s)
18-19	Channel No 9	2	GPS Clock Drift	S32	(s/s)
20-21	Channel No 10	2	GPS Clock Drift	S32	(s/s)
22-23	Channel No 11	2	GPS Clock Drift	S32	(s/s)
24-25	Channel No 12	2	GPS Clock Drift	S32	(s/s)
26-27	Channel No 13	2	GPS Clock Drift	S32	(s/s)
28-29	Channel No 14	2	GPS Clock Drift	S32	(s/s)
30	CBIT 2	1		U16	
31	GNSS MI (0xA18D)	1		U16	

37.0 MESSAGE FORMAT FOR GPS Satellite Velocity 2

MESSAGE NO	37	SOURCE	DESTINATION	CMD WORD
RT	3	OBC	TELEMETRY	0x1A80
SUB	20	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	32	1s

Word No	Parameter	No of Words	Description	Data Type	Range (units)
00-01	INS Time	2		float	(s)
02-03	Channel No 19-Z	2	GPS ECEF Velocity	S32	m/s
04-05	Channel No 20-X	2	GPS ECEF Velocity	S32	m/s
06-07	Channel No 20-Y	2	GPS ECEF Velocity	S32	m/s
08-09	Channel No 20-Z	2	GPS ECEF Velocity	S32	m/s
10-11	Channel No 21-X	2	GPS ECEF Velocity	S32	m/s
12-13	Channel No 21-Y	2	GPS ECEF Velocity	S32	m/s
14-15	Channel No 21-Z	2	GPS ECEF Velocity	S32	m/s
16-17	Channel No 22-X	2	GPS ECEF Velocity	S32	m/s

18-19	Channel No 22-Y	2	GPS ECEF Velocity	S32	m/s
20-21	Channel No 22-Z	2	GPS ECEF Velocity	S32	m/s
22-23	Channel No 23-X	2	GPS ECEF Velocity	S32	m/s
24-25	Channel No 23-Y	2	GPS ECEF Velocity	S32	m/s
26-27	Channel No 23-Z	2	GPS ECEF Velocity	S32	m/s
28	Check sum LW	1		U16	m/s
29	Check sum HW	1		U16	
30	Reserved	1			
31	GNSS MI (0Xc186)	1		U16	

38.0 TWDL CONFIGURATION MESSAGE

MESSAGE NO	38	SOURCE	DESTINATION	CMD WORD
RT	2	OBC	TWDL	0x102B
SUB	1	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	11	ONCE

Word	Parameter	Bytes	Data type	Description
0-1	Time tag	4	U32	System Time
2	Missile ID (LSB)	2	U16	Should be >=1 and <=10
	Message ID (MSB)			**0x07**
3	Message seq no	2	U16UShort	Starts at 0. Resets on 65535
4	Up-link Rx Frequency (LSB)	2	UShort	Frequency Index [0000 - 0008]
	Down-link Tx Frequency (MSB)			Frequency Index [0000 - 000C]
5	Up-link Rx CDMA Code	2	UShort	1023 Code Index [0000 - 000A]
6	Down-link Tx CDMA Code	2	Ushort	127 Code Index [0000 - 000A]
7	Up-link Rx FEC Selection (LSB)	2	Ushort	0xXX00 -> Up-Link FEC (OFF) 0xXXFF -> Up-Link FEC (ON)
	Down-link Tx FEC Selection (MSB)			0x00XX -> Dn-Link FEC (OFF) 0xFFXX -> Dn-Link FEC (ON)
8	Tx PA ON/OFF (MSB)	2	Ushort	0x00XX- PA Mute(OFF) 0xFFXX- PA ON
	Tx PA Power level (LSB)			0xFF01- PA Power O/P 1Watt 0xFF02- PA Power O/P 5Watt 0xFF03- PA Power O/P 10Watt 0xFF04- PA Power O/P 15Watt
9	Tx. Ant. Selection	2	UShort	0x0000 - RF Port1 Selected 0xFFFF - RF Port2 Selected
10	CRC	2	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1D0F
	Total (11 Words)	22		

39.0 TWDL DOWNLINK MESSAGE

MESSAGE NO	39	SOURCE	DESTINATION	CMD WORD
RT	2	OBC	TWDL	0x1052
SUB	2	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	R	MISSION	18	100ms

DESCRIPTION	During MId Course guidance Packet-C is down linked to the Ground @100ms. During Terminal
	guidance Packet-D and Packet-E are down linked to Ground alternately @100ms.

PACKET C

Byte	Field	Bytes	Words	Data type	Description
0-1	Time tag	2	0	UShort	System Time
2	Missile ID (LSB)	2	1	UShort	Should be >=1 and <=10
3	FU MLV ID (MSB)				FU=>0-63, MLV=>0-3 [7:2-1:0]
4	Payload seq no (LSB)	1	2	UChar	Starts at 0. Resets on 255
5	**Message ID (MSB)**	1		UChar	0x03 (**Pkt-C**)
6-12	Missile position (NED in m) Xm,Ym,Zm Bits-LSB(19, 19, 18)MSB	7	3-10		Scale Factor=1; Offset 150e3 for Xm & Ym Offset 60e3 for Zm
13-17	Missile velocity (m/s) Vxm Vym Vzm Bits-LSB(14,13,13)MSB	5			Scale Factor=1; Offset 1500
18-21	Missile accln (m/s^2) Ax Ay Az Bits-LSB(11,11,10)MSB	4			Scale Factor=1; Offset 400
22-25	Body rates (deg/s) P q r Bits-LSB(11,11,10)MSB	4	11-16		Scale Factor=1; Offset 400
26-29	Euler angles (deg) Φ, θ, ψ Bits-LSB(11,11,10)MSB	4			Scale Factor=1; Offset: 180 for φ Offset: 90 for θ and ψ
30-32	Control effort (deg) $\delta_1, \delta_2, \delta_3, \delta_4$ Bits-LSB(6,6,6,6)MSB	3			Scale Factor=1; Offset 30

Byte	Field	Bytes	Word	Data type	Description
33	MissileStaus_SS_Events ID	1		UChar 4 bit + 4 bit	0 - Missile not healthy 1- Pre-launch 2- Launch phase 3- Packet C (Mid-course) 4- Packet D (Seeker phase: Seeker data) 5- Packet E (Seeker : INS Data) 6- Packet F (RPF Phase)
					0-Seeker OFF 1-Seeker ON 2-seeker pointing 3-seeker acquisition 4-seeker tracking 5-seeker tracking with range info 6-RPF ON 7-RPF Tracking 8-Warhead Initiation
34-35	Payload CRC	2	17	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (18 Words)	36			

PACKET D

Byte	Field	Bytes	Word	Data type	Description
0-1	Time tag	2	0	UShort	System Time
2	Missile ID (LSB)	2	1	UShort	Should be >=1 and <=10
3	FU MLV ID (MSB)				FU=>0-63, MLV=>0-3 [7:2-1:0]
4	Message seq no (LSB)	1	2	UChar	Starts at 0. Resets on 255
5	**Message ID (MSB)**	1		UChar	0x04**(Pkt-D)**
6-9	Missile accln (m/s^2) Ax,Ay,Az Bits-LSB(11,11,10)MSB	4	3-4		Scale Factor=1; Offset 400
10-13	Body rates (deg/s) P q r Bits-LSB(11,11,10)MSB	4	5-6		Scale Factor=1; Offset 400
14-17	Euler angles (deg) Φ, θ, ψ Bits-LSB(11,11,10)MSB	4	7-8		Scale Factor=1; Offset: 180 for φ Offset: 90 for θ and ψ
18-20	Control effort (deg) $\delta_1, \delta_2, \delta_3, \delta_4$ Bits-LSB(6,6,6,6)MSB	3	9-10		Scale Factor=1; Offset 20
21	MissileStaus_SS_Events ID	1			0 - Missile not healthy 1- Pre-launch 2- Launch phase

Byte	Field	Bytes	Word	Data type	Description		
				UChar 4 bit + 4 bit	3- Packet C (Mid-course) 4- Packet D (Seeker phase: Seeker data) 5- Packet E (Seeker : INS Data) 6- Packet F (RPF Phase)		
					0-Seeker OFF 1-Seeker ON 2-seeker pointing 3-seeker acquisition 4-seeker tracking 5-seeker tracking with range info 6-RPF ON 7-RPF Tracking 8-Warhead Initiation		
22-33	Seeker measurement R (m) R_dot (m/s) GA_El (deg) GA_Az (deg) SLR_El (deg/s) SLR_Az (deg/s) BSE_El (deg) BSE_Az (deg) Seeker flags Bits-LSB(15,13,8,8,9,9,9,9,16)MSB	12	11-16		Range,Offset 0-20000, 0 -2000 to 0, 2000 -50 to +50, 50 -50 to +50, 50 -5 to +5, 5 -5 to +5, 5 -5 to +5, 5 -5 to +5, 5	Resolution/Scale Factor 1 1 1 1 0.1 0.1 0.1 0.1	
34-35	CRC	2	17	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF		
	Total (18 Words)	36					

PACKET E

Byte	Field	Bytes	Word	Data type	Description
0-1	Time tag	2	0	UShort	System Time
2	Missile ID (LSB)	2	1	UShort	Should be >=1 and <=10
3	FU MLV ID (MSB)				FU=>0-63, MLV=>0-3 [7:2-1:0]
4	Message seq no (LSB)	1	2	UChar	Starts at 0. Resets on 255
5	**Message ID (MSB)**	1		UChar	0x**05 (Pkt-E)**
6-12	Missile position (NED in m) Xm,Ym,Zm Bits-LSB(19,19,18)MSB	7			Scale Factor=1; Offset 150e3 for Xm & Ym Offset 60e3 for Zm
13-17	Missile velocity (m/s) Vxm Vym Vzm Bits-LSB(14,13,13)MSB	5	3-10		Scale Factor=1; Offset 1500

Word	Parameter	Bytes		Data type	Description
18-21	Missile accln (m/s^2) Ax Ay Az Bits-LSB(11,11,10)MSB	4			Scale Factor=1; Offset 400
22-25	Body rates(deg/s) P, q, r Bits-LSB (11,11,10) MSB	4	11-12		Scale Factor=1; Offset 400
26-29	Euler angles (deg) Φ, θ, ψ Bits-LSB(11,11,10)MSB	4	13-14		Scale Factor=1; Offset: 180 for φ Offset: 90 for θ and ψ
30-32	Control effort (deg) $\delta_1, \delta_2, \delta_3, \delta_4$ Bits-LSB(6,6,6,6)MSB	3	15-16		Scale Factor=1; Offset 30
33	MissileStaus_SS_Events ID	1		UChar 4 bit + 4 bit	0 - Missile not healthy 1- Pre-launch 2- Launch phase 3- Packet C (Mid-course) 4- Packet D (Seeker phase: Seeker data) 5- Packet E (Seeker : INS Data) 6- Packet F (RPF Phase)
					0-Seeker OFF 1-Seeker ON 2-seeker pointing 3-seeker acquisition 4-seeker tracking 5-seeker tracking with range info 6-RPF ON 7-RPF Tracking 8-Warhead Initiation
34-35	CRC	2	17	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (18 Words)	36			

40.0 0 TWDL PA MODE ON MESSAGE

MESSAGE NO	40	SOURCE	DESTINATION	CMD WORD
RT	2	OBC	TWDL	0x1086
SUB	4	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	MISSION	6	ONCE

Word	Parameter	Bytes	Data type	Description

0-1	Time tag	4	ULong	System Time
2	Missile ID (LSB) **Message ID (MSB)**	2	UShort	Should be >=1 and <=10 **0x0A**
3	Message seq no	2	UShort	Starts at 0. Resets on 65535
4	Tx PA ON/OFF (MSB) Tx PA Power level (LSB)	2	Ushort	0x00XX- PA Mute (OFF) 0xFF01- PA Power O/P 1Watt 0xFF02-
5	CRC	2	UShort	CRC-16/AUG-CCITT,
	Total (6 Words)	12		

41.0 TWDL Tx PORT SELECT MESSAGE

MESSAGE NO	41	SOURCE	DESTINATION	CM DWORD
RT	2	OBC	TWDL	0x10A6
SUB	5	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	R	MISSION	6	ONCE

Word	Parameter	Bytes	Data type	Description
0-1	Time tag	4	ULong	System Time
2	Missile ID (LSB) **Message ID (MSB)**	2	UShort	Should be >=1 and <=10 **0x0B**
3	Message seq no	2	UShort	Starts at 0. Resets on 65535
4	Tx. Ant. Selection	2	UShort	0x0000 - RF Portl Selected 0xFFFF -
5	CRC	2	UShort	CRC-16/AUG-CCITT,
	Total (6 Words)	12		

42.0 TWDL UPLINK MESSAGE1 - PACKET A / PACKET B

MESSAGE NO	42	SOURCE	DESTINATION	CMD WORD
RT	2	TWDL	OBC	0x1432
SUB	1	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	T	MISSION	18	100ms

PACKET A (Target Dwell or TgtPlusMissile Dwell data on Rx1)

Byte	Field	Bytes	Word	Data type	Description
0-3	Time tag	4	0-1	ULong	System Time
4	Missile ID (LSB)	2	2	UShort	Should be >=1 and <=10
5	**Message ID (MSB)**				**0x01 (Pkt-A)**
6	RESERVED (LSB)	2	3	UShort	

Byte	Field	Bytes	Word	Data type	Description
7	FU MLV ID (MSB) MSB FU:6 LSB MLV:2				FU=>0-63, MLV=>0-3 [7:2-1:0]
8-9	Payload seq no	2	4	UShort	Starts at 0. Resets on 65535
10-16	Target position (NED in m) Xt, Yt, Zt Bits-LSB(19, 19, 18)MSB	7			Scale Factor=1; Offset 150e3 for Xm & Ym Offset 60e3 for Zm
17 - 21	Target velocity (m/s) Vxt, Vyt, Vzt Bits-LSB(14, 13, 13)MSB	5			Scale Factor=1; Offset 1500
22 - 24	Target accln (m/s^2) Axt Ayt Azt Bits-LSB(8, 8, 8)MSB	3	5-15		Scale Factor=1; Offset 100
25 - 28	Target position σ (m) Xt Yt Zt Bits-LSB(11, 11, 10)MSB	4			Scale Factor=1; Offset 500
29 - 31	Target velocity σ(m/s) Vxt, Vyt, Vzt Bits-LSB(8, 8, 8)MSB	3			Scale Factor=1; Offset 50
32	Target type	1	16	UShort	0-fighter aircraft 1-helicopter 2-Sub sonic cruise missile 3-Air to Surface missile 4- RPA 5-stand by 6-stand by 7-self destruction
33	Target RCS	1			
34-35	Payload CRC	2	17	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (18 Words)	36			

43.0 TWDL UPLINK MESSAGE2 - PACKET A / PACKET B

MESSAGE NO	43	SOURCE	DESTINATION	CMD WORD
RT	2	TWDL	OBC	0x1452
SUB	2	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	T	MISSION	18	100ms

PACKET B **(Target Dwell or TgtPlusMissile Dwell data on Rx2)**

Byte	Field	Bytes	Word	Data type	Description
0-3	Time tag	4	0-1	ULong	System Time

Word	Field	Bytes		Type	Description
4	Missile ID (LSB)	2	2	UShort	Should be >=1 and <=10
5	**Message ID (MSB)**				**0x02 (Pkt-B)**
6	RESERVED (LSB)	2	3	UShort	
7	FU MLV ID (MSB)				FU=>0-63, MLV=>0-3 [7:2-1:0]
8-9	Payload seq no	2	4	UShort	Starts at 0. Resets on 65535
10-16	Target position (NED in m) Xt, Yt, Zt Bits-LSB(19, 19, 18)MSB	7			Scale Factor=1; Offset 150e3 for Xm & Ym Offset 60e3 for Zm
17-21	Target velocity (m/s) Vxt Vyt Vzt Bits-LSB(14, 13, 13)MSB	5	5-16		Scale Factor=1; Offset 1500
22-28	Missile position (NED in m) Xm, Ym, Zm Bits-LSB(19, 19, 18)MSB	7			Scale Factor=1; Offset 150e3 for Xm & Ym Offset 60e3 for Zm
29-33	Missile velocity (m/s) Vxm Vym Vzm Bits-LSB(14, 13, 13)MSB	5			Scale Factor=1; Offset 1500
34-35	Payload CRC	2	17	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (18 Words)	36			

44.0 TWDL UPLINK MESSAGE3 - PACKET A / PACKET B

MESSAGE NO	44	SOURCE	DESTINATION	CMD WORD
RT	2	TWDL	OBC	0x1472
SUB	3	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	T	MISSION	18	100ms

<u>Refer Message no 42</u> (**Target Dwell or TgtPlusMissile Dwell data – Error Free**)

45.0 0 TWDL HEALTH MESSAGE

MESSAGE NO	45	SOURCE	DESTINATION	CMD WORD
RT	2	TWDL	OBC	0x14EE
SUB	7	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	T	MISSION	14	1s

Word	Field	Bytes	Type	Description

0-1	Time tag	4	ULong	System Time
2	Missile ID (LSB)	2	UShort	Should be >=1 and <=10
	Message ID			**0x08**
3	Message seq no	2	UShort	Starts at 0. Resets on 65535
4	Rx1 PLL lock	2	UShort	0xXXX0 - PLL Unlock; 0xXXXF - PLL Lock
	Rx2 PLL lock			0xXX0X - PLL Unlock; 0xXXFX - PLL Lock
	Tx PLL lock			0xX0XX - PLL Unlock; 0xXFXX - PLL Lock
5	Decoder 1 track/acquisitio	2	UShort	0xXX00 - Rx1 Acquisition 0xXXFF - Rx1 Track
	Decoder 2 track/acquisitio		UShort	0x00XX - Rx2 Acquisition 0xFFXX - Rx2 Track
6	RX1 RSSI (LSB) RX2 RSSI (MSB)	2	UShort	0x 0 x 0 Value from 0 to 127 (decimal). 0 corresponds to maximum power. 127 corresponds to lowest power.
7	TX Power Mode	2	UShort	0xFF01- PA ON in 1Watt 0xFF02- PA ON in 5Watt 0xFF03- PA ON in 10Watt 0xFF04- PA ON in 15Watt
8	RX1 Doppler	2	UShort	Doppler frequency in rx1 received signal.
9	RX2 Doppler	2	UShort	Doppler frequency in rx2 received signal.
10	RX1 Correlation	2	UShort	Correlation value in rx1 channel.
11	RX2 Correlation	2	Ushort	Correlation value in rx2 channel.
12	Tx. Ant. Selection	2	Ushort	0x0000 - RF Port1 Selected 0xFFFF - RF Port2 Selected
13	CRC	2	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (14	28		

46.0 TWDL STATUS MESSAGE

MESSAGE NO	46	**SOURCE**	**DESTINATION**	**CMD WORD**
RT	2	TWDL	OBC	0x150E
SUB	8	**MODE**	**WORD COUNT**	**FREQUENCY**
TYPE (T/R)	T	MISSION	14	1s

Word	Field	Bytes	Data type	Description
0-1	Time tag	4	ULong	System Time
2	Missile ID (LSB)	2	UShort	Should be >=1 and <=10
	Message ID (MSB)			**0x09**
3	Message seq no	2	UShort	Starts at 0. Resets on 65535

4	RX Frequency Index	2	UShort	Frequency Index [0000 - 0008]
	TX Frequency Index (MSB)			Frequency Index [0000 - 000C]
5	Up Link Rx Code	2	UShort	1023 Code Index [0000 - 000A]
6	Down Link Tx Code	2	UShort	127 Code Index [0000 - 000A]
7	Tx Ant. Selection Status	2	UShort	0x0000 - RF Port1 Selected. 0xFFFF - RF Port2 Selected.
8	Tx PA On/Mute(Off) Status (MSB)	2	Ushort	0x00XX - PA is Mute (OFF) 0xFFXX - PA is ON
	Tx Power level Index (LSB)			0xFF01 - PA ON in 1Watt 0xFF02 - PA ON in 5Watt 0xFF03 - PA ON in 10Watt 0xFF04 - PA ON in 15Watt
9	RX1 RSSI (LSB)	2	UShort	Rx1:0xXX00 to 0xXXFF Rx2:0x00XX to 0xFFXX
	RX2 RSSI (MSB)			Value from 0 to 127 (decimal). 0 corresponds to maximum power. 127 corresponds to lowest power.
10	RX1 Synthesizer lock	2	UShort	0xXXX0 - Rx1 Synthesizer not locked. 0xXXXF - Rx1 Synthesizer locked
	RX2 Synthesizer lock			0xXX0X - Rx2 Synthesizer not locked. 0xXXFX - Rx2 Synthesizer locked
	TX Synthesizer lock			0xX0XX - Tx Synthesizer not locked. 0xXFXX - Tx Synthesizer locked.
11	Rx1 CDMA Decoder Status	2	UShort	0xXX00 - Rx1 Acquisition; 0xXXFF - Rx1 Track
	Rx2 CDMA Decoder Status			0x00XX - Rx2 Acquisition; 0xFFXX - Rx2 Track
12	Up-link Rx FEC Selection (LSB)	2	UShort	0xXX00 --- Up-Link FEC (OFF) 0xXXFF --- Up-Link FEC (ON)
	Down-link Tx FEC Selection (MSB)			0x00XX --- Dn-Link FEC (OFF) 0xFFXX --- Dn-Link FEC (ON)
13	CRC	2	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (14 Words)	28		

47.0 TWDL VERSION CONTROL MESSAGE

MESSAGE NO	47	SOURCE	DESTINATION	CMD WORD
RT	2	TWDL	OBC	0x1532
SUB	9	MODE	WORD COUNT	FREQUENCY
TYPE (T/R)	T	MISSION	18	AS REQUIRED

Word	Field	Bytes	Data type	Description
0-1	Time tag	4	ULong	System Time
2	Missile ID (LSB)	2	UShort	Should be >=1 and <=10
	Message ID (MSB)			**0x0F**
3	Message seq no	2	UShort	Starts at 0. Resets on 65535
4-6	System Checksum	6	UShort	System Checksum
7-16	Reserved	20	UShort	Reserved
17	CRC	2	UShort	CRC-16/AUG-CCITT, Poly:0x1021, Init:0x1DOF
	Total (18 Words)	36		

APPENDIX-1

Sensor Status Word :

Bit No.	Parameter	Description
MSB 15	FIMU Packet Header Fail	0 - OK, 1 - NOT OK
14	FIMU Packet Checksum Fail	0 - OK, 1 - NOT OK
13	FIMU Packet Fail	0 - OK, 1 - NOT OK
12	FIMU Packet Time out	0 - OK, 1 - NOT OK
11	Z - Accl Abs Fail	0 - OK, 1 - NOT OK
10	Y - Accl Abs Fail	0 - OK, 1 - NOT OK
09	X - Accl Abs Fail	0 - OK, 1 - NOT OK
08	Z - Gyro Abs Fail	0 - OK, 1 - NOT OK
07	Y - Gyro Abs Fail	0 - OK, 1 - NOT OK
06	X - Gyro Abs Fail	0 - OK, 1 - NOT OK
05	Z - Accl Fail	0 - OK, 1 - NOT OK
04	Y - Accl Fail	0 - OK, 1 - NOT OK
03	X - Accl Fail	0 - OK, 1 - NOT OK

02	Z - Gyro Fail	0 - OK, 1 - NOT OK
01	Y - Gyro Fail	0 - OK, 1 - NOT OK
LSB 0	X - Gyro Fail	0 - OK, 1 - NOT OK

APPENDIX-2

INS Status Word :

Bit No.	Parameter	Description
MSB 15	INS Ready	1 - For 1553B Command 0 - Busy
14	Hybridization	1 - ON 0 - OFF
13-12	Operation Mode	00 - Mission Mode 01 - Constant Simulation 10 - HILS Mode (Half Simulation) 11 - 6 DOF Mode (Full Simulation)
11-10	Attitude Available	11 - Reserved 10 - Heading & Levelling Angles Available 01 - Levelling Angles Available 00 - Not Available
09-08	Alignment Mode	01 - Static Levelling 10 - Two Position TA (Reserved) 11 - Rate Matching TA (Reserved)
07-04	INS Active Mode	0001 - Standby 0010 - Position Test 0111 - Mission Data Load 0110 - Mission Data Dump 0100 - Alignment 1000 - Navigation
03	Mission Data	1 - Data Required 0 - Data not Required
02	Sensor Temperature	1 - NOT OK 0 - OK
01	Sensor Data Validity	1 - Data Not Valid 0 - Data valid
LSB 0	BIST	1 - NOT OK 0 - OK

APPENDIX-3

GPS SNR Status Word :

Bit No.	Parameter	Description
MSB 15	Channel - 16 SNR	1 - OK, 0 - NOT OK
14	Channel - 15 SNR	1 - OK, 0 - NOT OK
13	Channel - 14 SNR	1 - OK, 0 - NOT OK
12	Channel - 13 SNR	1 - OK, 0 - NOT OK
11	Channel - 12 SNR	1 - OK, 0 - NOT OK
10	Channel - 11 SNR	1 - OK, 0 - NOT OK
09	Channel - 10 SNR	1 - OK, 0 - NOT OK
08	Channel - 09 SNR	1 - OK, 0 - NOT OK
07	Channel - 08 SNR	1 - OK, 0 - NOT OK
06	Channel - 07 SNR	1 - OK, 0 - NOT OK
05	Channel - 06 SNR	1 - OK, 0 - NOT OK
04	Channel - 05 SNR	1 - OK, 0 - NOT OK
03	Channel - 04 SNR	1 - OK, 0 - NOT OK
02	Channel - 03 SNR	1 - OK, 0 - NOT OK
01	Channel - 02 SNR	1 - OK, 0 - NOT OK
LSB 0	Channel - 01 SNR	1 - OK, 0 - NOT OK

OK : 33 < SNR < 50

APPENDIX-4

GPS PR/DPR Quality Status

Bit No.	Parameter	Description
MSB 15	Channel - 16 Quality	1 - OK, 0 - NOT OK
14	Channel - 15 Quality	1 - OK, 0 - NOT OK
13	Channel - 14 Quality	1 - OK, 0 - NOT OK
12	Channel - 13 Quality	1 - OK, 0 - NOT OK

11	Channel - 12 Quality	1 - OK, 0 - NOT OK
10	Channel - 11 Quality	1 - OK, 0 - NOT OK
09	Channel - 10 Quality	1 - OK, 0 - NOT OK
08	Channel - 09 Quality	1 - OK, 0 - NOT OK
07	Channel - 08 Quality	1 - OK, 0 - NOT OK
06	Channel - 07 Quality	1 - OK, 0 - NOT OK
05	Channel - 06 Quality	1 - OK, 0 - NOT OK
04	Channel - 05 Quality	1 - OK, 0 - NOT OK
03	Channel - 04 Quality	1 - OK, 0 - NOT OK
02	Channel - 03 Quality	1 - OK, 0 - NOT OK
01	Channel - 02 Quality	1 - OK, 0 - NOT OK
LSB 0	Channel - 01 Quality	1 - OK, 0 - NOT OK

OK : Quality 6

APPENDIX-5

GPS Receiver Status

Bit No.	Parameter	Description
MSB 15-8	RESERVED	-
07	Position Availability	1 - Available, 0 - NOT Available
06	DGPS	1 - ON, 0 - OFF
05-04	Almanac Availability	00 - Available and OK 01 - Status Not Known 10 - Available but Old 11 - Not Available
03	GPS Position	1 - Available, 0 - NOT Available
02	GLONASS Position	1 - Available, 0 - NOT Available
01	GPS+GLONASS Position	1 - Available, 0 - NOT Available
LSB 0	GPS Time	1 - Available, 0 - NOT Available