

Avionics Reference Document

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1 Introduction

The Avionics Reference Document (ARD) is a high level document describing what the onboard avionics system will do. The onboard avionics system is referred to as The Helix System. It consists of multiple circuit boards called Extension Boards which can read data from sensors through the rocket or interact with actuators throughout the rocket. These Extension boards are all connected together in a ring topology which allows new Extension Boards to be added or removed from the system without impacting performance of the rest of the system. These Extension Boards all connect with a central board called the Onboard Computer (OBC) which collects data, makes decisions based on data, communicates with ground support systems, and records data.

1.1 Purpose

The purpose of this document is to outline for non avionics members a unified reference for how the onboard computer will behave and why. Primary focus will be given to the different states that the rocket can be in (ie dry systems, leak check), what actions will be performed in each state, and what causes the transition between different states. This will be documented through extensive use of state machine diagrams.

Old version:

The purpose of this document is to act as a reference for how the OBC will behave. This includes:

1. How the system will react to failures such as disconnected sensors and over-pressurization events.
2. The states the rocket can be in including dry systems, leak check, launch, or even a failure state.
3. The ranges and accuracy of sensors in the system.
4. The rate at which sensors will be measured at.
5. System architecture and how data flows throughout the system.

1.2 Scope

This document includes:

1. How the system will react to failures such as disconnected sensors and over-pressurization events.
2. The states the rocket can be in including dry systems, leak check, launch, or even a failure state.
3. The ranges and accuracy of sensors in the system.
4. The rate at which sensors will be measured at.
5. System architecture and how data flows throughout the system.

Old version:

This document should be viewed from the perspective of a non-avionics member who wants to know what the onboard avionics system will do. This means outlining that steps between turning the system on to launch and recovery of the rocket. Failure modes and how to deal with errors are outlined in this document. The ARD also contains information regarding hardware that will be onboard the rocket, its specifications, and links to the relevant datasheets. Where appropriate more detailed technical information is included as reference material to the engineers designing the system.

1.3 Definitions and Acronyms

2 Hardware

2.1 Pressure Transducers

Model Number	MLH05KPSB01G
Serial Number	F8CEA38AA5
Usage	Helium Pressure PT
Datasheet Link	Link
Sensing Units	PSIG
Pressure Port Type	1/4-18 NPT (ANSI B1.20.1)
Accuracy	±0.25%
Pressure Range	0PSIG to 5000PSIG
Sample Rate	50Hz
Output Voltage Range	1.0 to 5.0 Volts
Input Voltage Range	8.0 to 30.0 Volts
Temperature Range	-40° to +125° Celcius

Model Number	ASUHGP1K55A1AA1A20000
Serial Number	E5C0ADEA35
Usage	LOX Pressure PT
Datasheet Link	Link
Sensing Units	PSIG
Pressure Port Type	3/8 Inch 24 UNF Dash 3 (SAE J514)
Accuracy	±0.25%
Pressure Range	0PSIG to 1500PSIG
Sample Rate	50Hz
Output Voltage Range	0.5 to 4.5 Volts
Input Voltage Range	8.0 to 16.0 Volts
Temperature Range	-40° to +150° Celcius

2.2 Thermocouples

Model Number	240-080
Serial Number	BB510C3CE3
Usage	Upper Air Frame Temperature
Datasheet Link	Link
Type	K
Sensing Units	Celcius
Sample Rate	10Hz
Temperature Range	-73° to +150° Celcius

Model Number	240-080
Serial Number	BB51033CE3
Usage	Unused
Datasheet Link	Link
Type	K
Sensing Units	Celcius
Sample Rate	10Hz
Temperature Range	-73° to +150° Celcius

2.3 RTDs

Model Number	1PT100K2515
Serial Number	8105874731
Usage	LOX Tank Temperature
Datasheet Link	Link
Type	PT100
Sensing Units	Celcius
Sample Rate	10Hz
Temperature Range	-200° to +150° Celcius

2.4 Hall Effect Sensors

Model Number	TCS40DPR
Serial Number	6D65BA9367
Usage	LOX Fill Valve Hall Effect
Datasheet Link	Link
Sensing Units	mT
Output Type	Push-Pull
Trip	$\pm 4.4\text{mT}$
Release	$\pm 0.9\text{mT}$
Input Voltage Range	8.0 to 16.0 Volts
Sample Rate	10Hz
Temperature Range	-40° to +150° Celcius

3 States

3.1 STATE LEAK CHECK

3.1.1 Helium Pressure PT Data

Return values

<i>STATE_LEAK_CHECK</i>	Continue in the leak check state.
<i>STATE_IDLE</i>	Finished leak check so return to the idle state.
<i>STATE_GROUND_SAFE</i>	Return to the ground safe state because the helium tank pressure is overpressurized.

When Helium Pressure PT Data is received the CANID will be printed to stdout and the data will be printed as a string to stdout. The current time and data with milliseconds is then printed to stdout. The received `can_frame` is added to the `eventTimer` so that the received frame will be received again in 1 second. The system then continues on in the leak check state.

4 EEPROM Layouts

4.1 Layout Version IDs

VersionID	Version Name
1	Sensor Board Layout Rev 1
2	Power Distro Board Layout Rev 1

4.2 Sensor Board Layout Rev 1

Sensor Board Layout Rev 1 Page #0					
Byte #	Usage	Byte #	Usage	Byte #	Usage
0	Layout Rev Number	48	PT0 Calibration Polyfit p1	96	PT1 Data CanID
1		49		97	
2		50		98	
3		51		99	
4	EEPROM Layout Compile Time	52	PT0 Calibration Polyfit p2	100	PT1 Current CanID
5		53		101	
6		54		102	
7		55		103	
8	Board Status	56	PT0 Calibration Polyfit p3	104	PT1 Data Frequency
9		57		105	
10		58		106	
11		59		107	
12	Board VIN Voltage CanID	60	PT0 Calibration Polyfit p4	108	PT1 Max Output Voltage
13		61		109	
14		62		110	
15		63		111	
16	Board current CanID	64	PT0 Calibration Polyfit p5	112	PT1 Min Output Voltage
17		65		113	
18		66		114	
19		67		115	
20	PT0 Data CanID	68	PT0 Calibration Polyfit p6	116	PT1 Max Pressure
21		69		117	
22		70		118	
23		71		119	
24	PT0 Current CanID	72	PT0 Calibration Polyfit p7	120	PT1 Min Pressure
25		73		121	
26		74		122	
27		75		123	
28	PT0 Data Frequency	76	PT0 Biquad Filter b0	124	PT1 Calibration Polyfit p1
29		77		125	
30		78		126	
31		79		127	
32	PT0 Max Voltage	80	PT0 Biquad Filter b1		
33		81			
34		82			
35		83			
36	PT0 Min Voltage	84	PT0 Biquad Filter b2		
37		85			
38		86			
39		87			
40	PT0 Max Pressure	88	PT0 Biquad Filter a1		
41		89			
42		90			
43		91			
44	PT0 Min Pressure	92	PT0 Biquad Filter a2		
45		93			
46		94			
47		95			

Sensor Board Layout Rev 1 Page #1					
Byte #	Usage	Byte #	Usage	Byte #	Usage
128	PT1 Calibration Polyfit p2	176	PT2 Current CanID	224	PT2 Calibration Polyfit p7
129		177		225	
130		178		226	
131		179		227	
132	PT1 Calibration Polyfit p3	180	PT2 Data Frequency	228	PT2 Biquad Filter b0
133		181		229	
134		182		230	
135		183		231	
136	PT1 Calibration Polyfit p4	184	PT2 Max Voltage	232	PT2 Biquad Filter b1
137		185		233	
138		186		234	
139		187		235	
140	PT1 Calibration Polyfit p5	188	PT2 Min Voltage	236	PT2 Biquad Filter b2
141		189		237	
142		190		238	
143		191		239	
144	PT1 Calibration Polyfit p6	192	PT2 Max Pressure	240	PT2 Biquad Filter a1
145		193		241	
146		194		242	
147		195		243	
148	PT1 Calibration Polyfit p7	196	PT2 Min Pressure	244	PT2 Biquad Filter a2
149		197		245	
150		198		246	
151		199		247	
152	PT1 Biquad Filter b0	200	PT2 Calibration Polyfit p1	248	Hall Effect 0 Data CanID
153		201		249	
154		202		250	
155		203		251	
156	PT1 Biquad Filter b1	204	PT2 Calibration Polyfit p2	252	Hall Effect 0 Current CanID
157		205		253	
158		206		254	
159		207		255	
160	PT1 Biquad Filter b2	208	PT2 Calibration Polyfit p3		
161		209			
162		210			
163		211			
164	PT1 Biquad Filter a1	212	PT2 Calibration Polyfit p4		
165		213			
166		214			
167		215			
168	PT1 Biquad Filter a2	216	PT2 Calibration Polyfit p5		
169		217			
170		218			
171		219			
172	PT2 Data CanID	220	PT2 Calibration Polyfit p6		
173		221			
174		222			
175		223			

Sensor Board Layout Rev 1 Page #2					
Byte #	Usage	Byte #	Usage	Byte #	Usage
256	Hall Effect 0 Data Frequency	304	TC0 Biquad Filter a1	352	RTD0 Biquad Filter b1
257		305		353	
258		306		354	
259		307		355	
260	Hall Effect 1 Data CanID	308	TC0 Biquad Filter a2	356	RTD0 Biquad Filter b2
261		309		357	
262		310		358	
263		311		359	
264	Hall Effect 1 Current CanID	312	TC1 Data CanID	360	RTD0 Biquad Filter a1
265		313		361	
266		314		362	
267		315		363	
268	Hall Effect 1 Data Frequency	316	TC1 Data Frequency	364	RTD0 Biquad Filter a2
269		317		365	
270		318		366	
271		319		367	
272	Hall Effect 2 Data CanID	320	TC1 Biquad Filter b0	368	RTD1 Data CanID
273		321		369	
274		322		370	
275		323		371	
276	Hall Effect 2 Current CanID	324	TC1 Biquad Filter b1	372	RTD1 Data Frequency
277		325		373	
278		326		374	
279		327		375	
280	Hall Effect 2 Data Frequency	328	TC1 Biquad Filter b2	376	RTD1 Biquad Filter b0
281		329		377	
282		330		378	
283		331		379	
284	TC0 Data CanID	332	TC1 Biquad Filter a1	380	RTD1 Biquad Filter b1
285		333		381	
286		334		382	
287		335		383	
288	TC0 Data Frequency	336	TC1 Biquad Filter a2		
289		337			
290		338			
291		339			
292	TC0 Biquad Filter b0	340	RTD0 Data CanID		
293		341			
294		342			
295		343			
296	TC0 Biquad Filter b1	344	RTD0 Data Frequency		
297		345			
298		346			
299		347			
300	TC0 Biquad Filter b2	348	RTD0 Biquad Filter b0		
301		349			
302		350			
303		351			

Sensor Board Layout Rev 1 Page #3					
Byte #	Usage	Byte #	Usage	Byte #	Usage
384	RTD1 Biquad Filter b2	432		480	
385		433		481	
386		434		482	
387		435		483	
388	RTD1 Biquad Filter a1	436		484	
389		437		485	
390		438		486	
391		439		487	
392	RTD1 Biquad Filter a2	440		488	
393		441		489	
394		442		490	
395		443		491	
396		444		492	
397		445		493	
398		446		494	
399		447		495	
400		448		496	
401		449		497	
402		450		498	
403		451		499	
404		452		500	
405		453		501	
406		454		502	
407		455		503	
408		456		504	
409		457		505	
410		458		506	
411		459		507	
412		460		508	
413		461		509	
414		462		510	
415		463		511	
416		464			
417		465			
418		466			
419		467			
420		468			
421		469			
422		470			
423		471			
424		472			
425		473			
426		474			
427		475			
428		476			
429		477			
430		478			
431		479			

4.3 Power Distro Board Layout Rev 1

Power Distro Board Layout Rev 1 Page #0					
Byte #	Usage	Byte #	Usage	Byte #	Usage
0	Board Status	48		96	
1		49		97	
2		50		98	
3		51		99	
4	Offboard Battery Voltage CANID	52		100	
5		53		101	
6		54		102	
7		55		103	
8	Offboard Battery Current CANID	56		104	
9		57		105	
10		58		106	
11		59		107	
12	Onboard Battery Voltage CANID	60		108	
13		61		109	
14		62		110	
15		63		111	
16	Onboard Battery Current CANID	64		112	
17		65		113	
18		66		114	
19		67		115	
20	Helix Loop CW Voltage CANID	68		116	
21		69		117	
22		70		118	
23		71		119	
24	Helix Loop CW Current CANID	72		120	
25		73		121	
26		74		122	
27		75		123	
28	Helix Loop CCW Voltage CANID	76		124	
29		77		125	
30		78		126	
31		79		127	
32	Helix Loop CCW Current CANID	80			
33		81			
34		82			
35		83			
36		84			
37		85			
38		86			
39		87			
40		88			
41		89			
42		90			
43		91			
44		92			
45		93			
46		94			
47		95			

5 CAN IDs

5.1 CAN Bus Load Calculations

The current CAN Bus config requires between 20532 bits and 24636 bits to be sent on the CAN bus every second.

Frequency	Best Case	Worst Case
100KHz	21.0%	25.0%
250KHz	8.0%	10.0%
500KHz	4.0%	5.0%
1MHz	2.0%	2.0%

5.2 ID 0 - Clock Sync

Frequency: 50Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False	0 to 4294967295	Milliseconds	UTC time

5.3 ID 1 - Emergency Signal

Frequency: 50Hz

Byte	Bit	Signed	Range	Units	Description
0		False			Status
	0-1				System Status

5.4 ID 100 - Helium Pressure PT Data

Frequency: 50Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		False		PSIG	Helium Pressure

5.5 ID 101 - LOX Pressure PT Data

Frequency: 50Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		False		PSIG	LOX Pressure

5.6 ID 102 - Methane Pressure PT Data

Frequency: 50Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		False		PSIG	Methane Pressure

5.7 ID 103 - Chamber Pressure PT Data

Frequency: 50Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		False		PSIG	Chamber Pressure

5.8 ID 200 - Helium Fill Valve Hall Effect State

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4		False		Open/Closed	Helium Fill Valve Hall Effect State

5.9 ID 201 - LOX Fill Valve Hall Effect State

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4		False		Open/Closed	LOX Fill Valve Hall Effect State

5.10 ID 202 - Methane Fill Valve Hall Effect State

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4		False		Open/Closed	Methane Fill Valve Hall Effect State

5.11 ID 300 - Helium Tank Temperature Data

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Celcius	Helium Tank Temperature

5.12 ID 301 - LOX Tank Temperature Data

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Celcius	LOX Tank Temperature

5.13 ID 302 - Methane Tank Temperature Data

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Celcius	Methane Tank Temperature

5.14 ID 303 - Nozzle Temperature Data

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Celcius	Nozzle Temperature

5.15 ID 304 - Upper Air Frame Temperature Data

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Celcius	Upper Air Frame Temperature

5.16 ID 400 - Helium Pressure PT Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	Helium Pressure PT Current

5.17 ID 401 - LOX Pressure PT Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	LOX Pressure PT Current

5.18 ID 402 - Methane Pressure PT Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	Methane Pressure PT Current

5.19 ID 403 - Chamber Pressure PT Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	Chamber Pressure PT Current

5.20 ID 404 - Helium Fill Valve Hall Effect Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	Helium Fill Valve Hall Effect Current

5.21 ID 405 - LOX Fill Valve Hall Effect Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	LOX Fill Valve Hall Effect Current

5.22 ID 406 - Methane Fill Valve Hall Effect Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		milliamps	Methane Fill Valve Hall Effect Current

5.23 ID 407 - Upper Air Frame VIN Current

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Milliamps	Upper Air Frame Board Current

5.24 ID 500 - Upper Air Frame VIN Voltage

Frequency: 10Hz

Byte	Bit	Signed	Range	Units	Description
0-3		False		Milliseconds	UTC time
4-5		True		Millivolts	Upper Air Frame Board VIN Voltage