

ACUBESAT

A 3U CubeSat to probe gene expression in LEO: Technical & Programmatic updates

Open Source CubeSat Workshop 2020
Saturday 2020-12-12



ARISTOTLE
UNIVERSITY
OF THESSALONIKI







Short introduction to AcubeSAT



Type: 3U CubeSat

Mission:



Study of gene expression on 190+ yeast strains



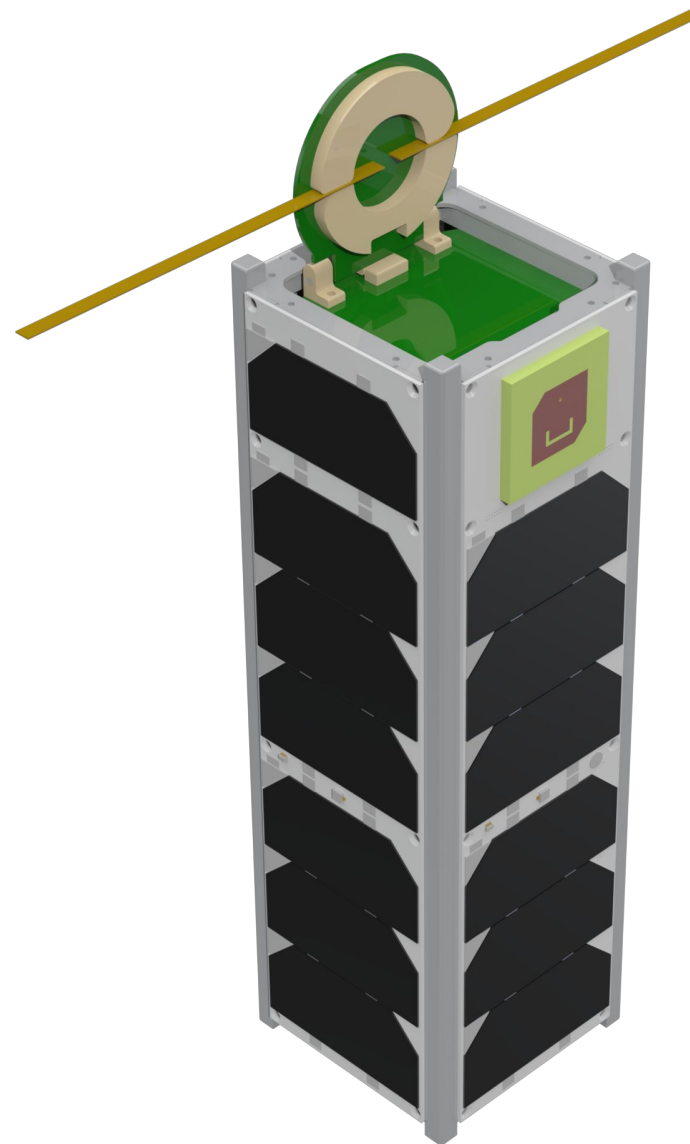
Combination of COTS and in-house subsystems



Estimated Launch: 2023



<https://gitlab.com/acubesat/documentation/cdr-public>



FLY YOUR SATELLITE!



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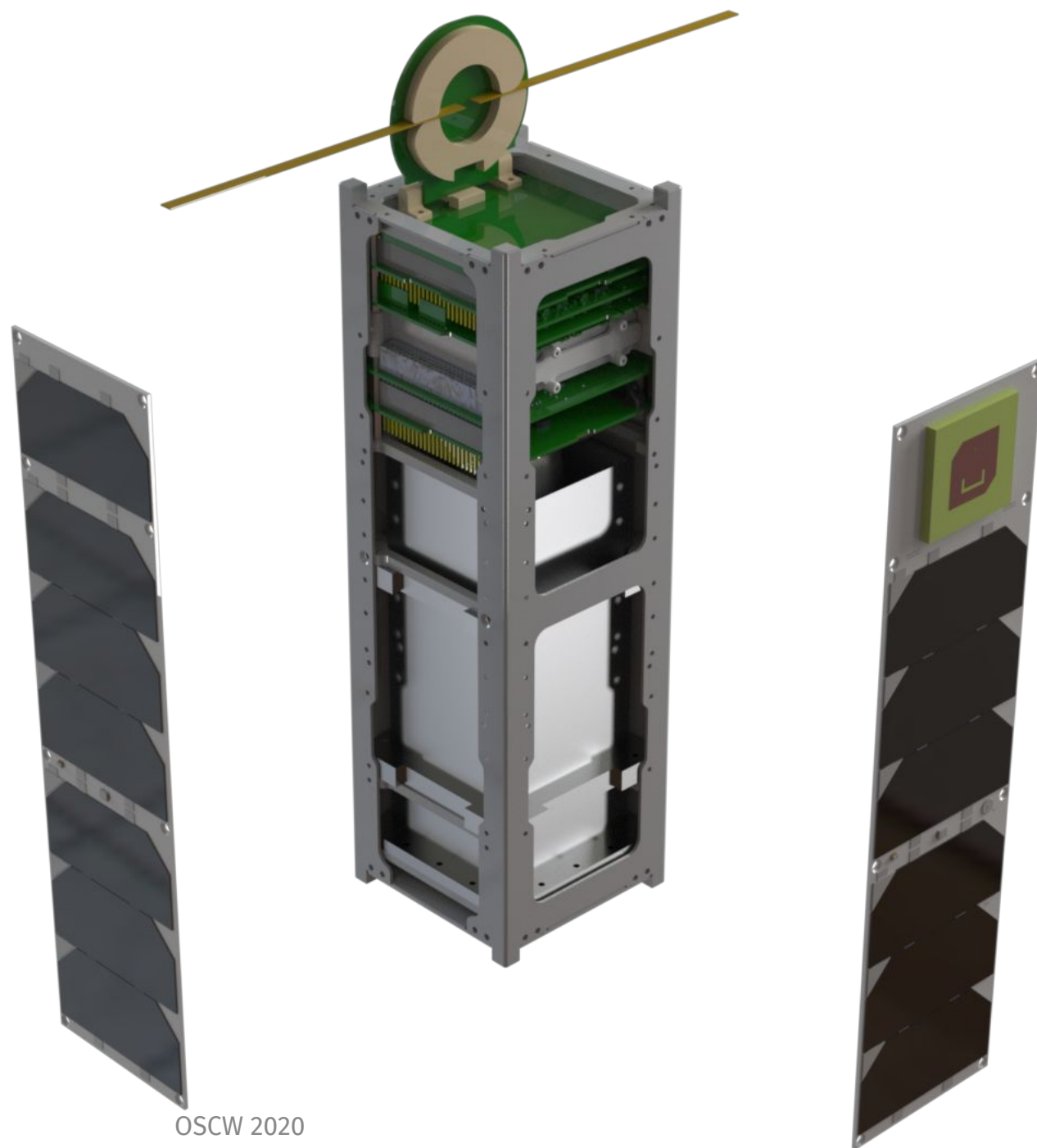
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OSCW 2020



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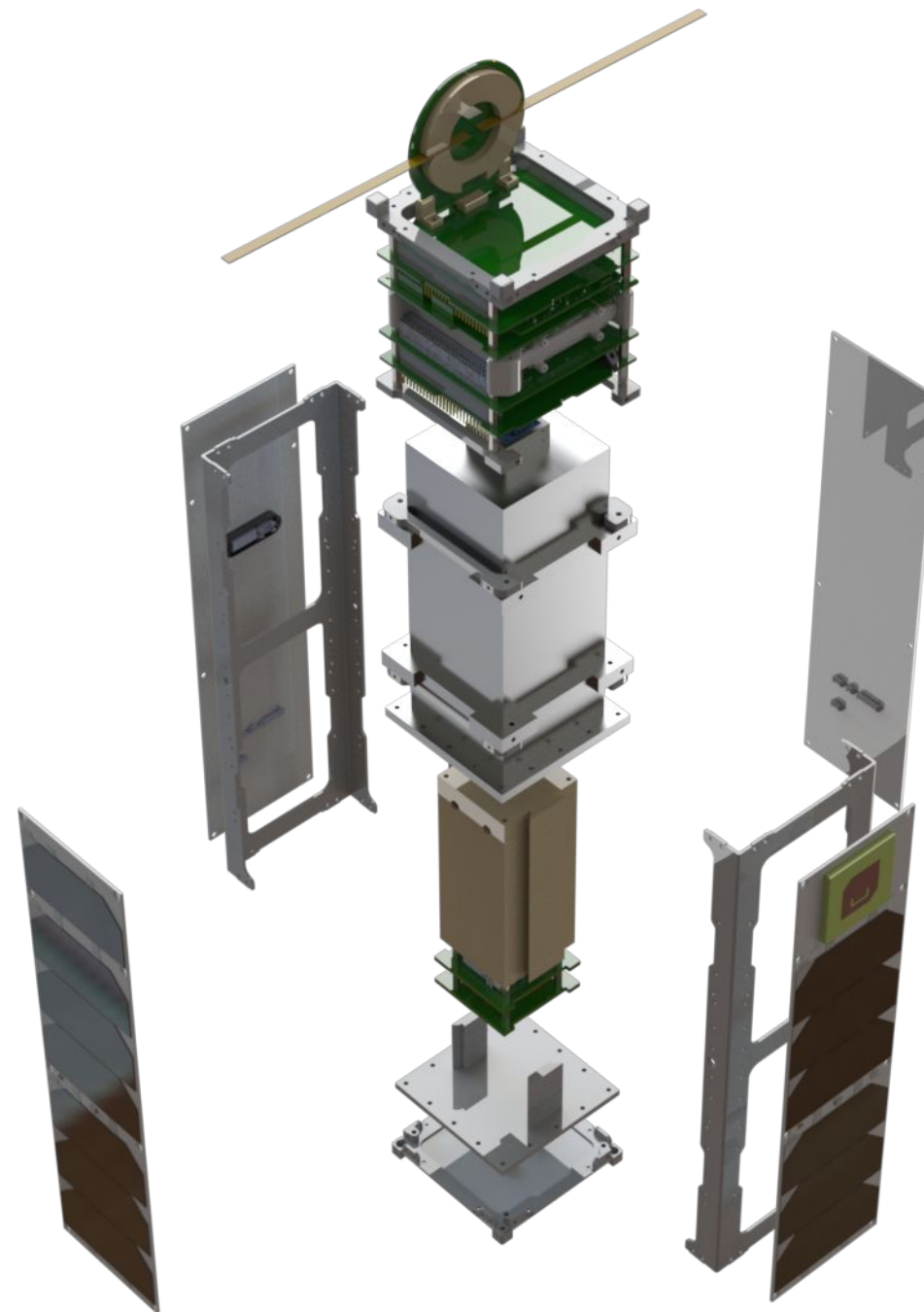
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OSCW 2020

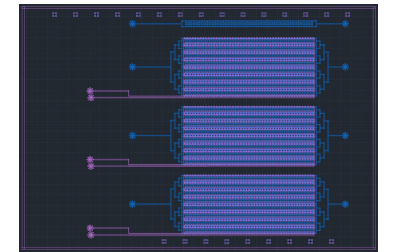
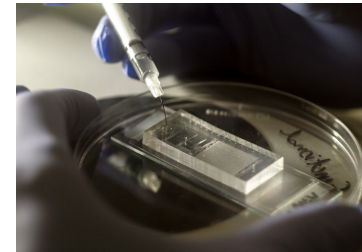
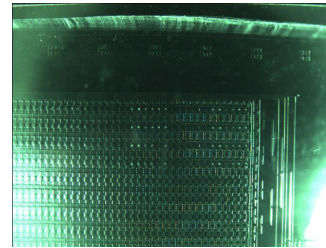
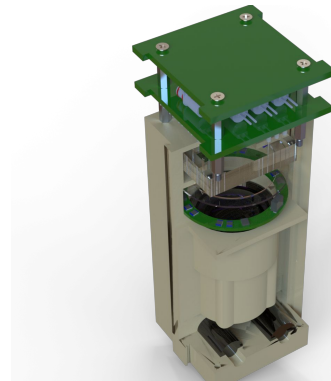
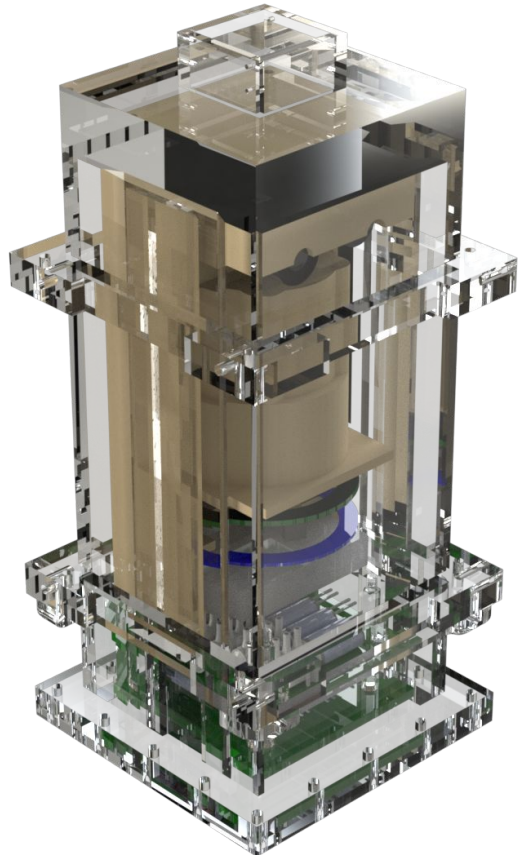


FLY YOUR SATELLITE!



Subsystem Overview

Science Unit — Payload



- <https://gitlab.com/acubesat/su/microfluidics>



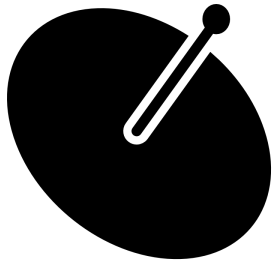
- <https://benchling.com/organizations/acubesat/>



- <https://gitlab.com/acubesat/su/su-pcb>

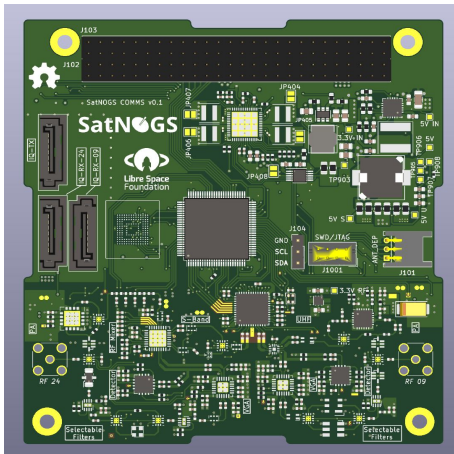


Subsystem Overview

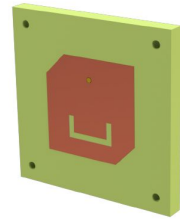


SatNOGS

SatNOGS COMMS Board



Communications

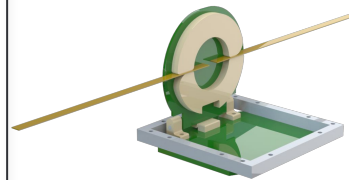


Payload Data

2.4 GHz
220 kbps



- <https://gitlab.com/acubesat/comms/s-band-antenna-sat>



TM/TC

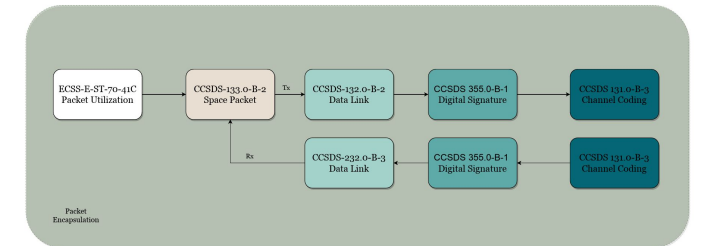
435 MHz
20 kbps

Based on [UpSat's antenna design](#)



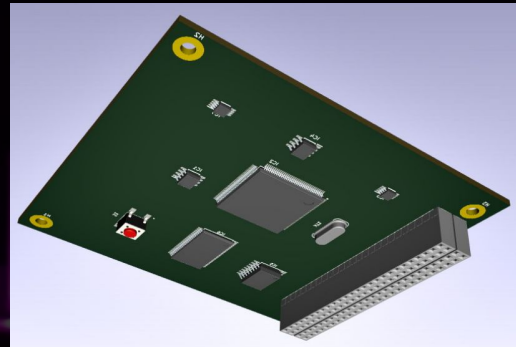
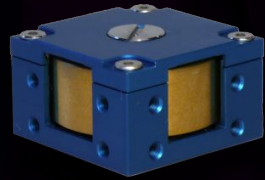
- <https://gitlab.com/acubesat/comms/uhf-antenna-sat>

CCSDS/ECSS Packet Structure

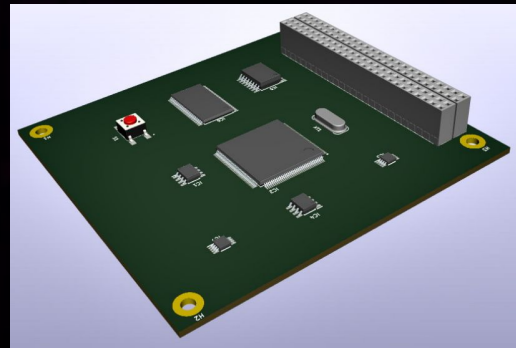
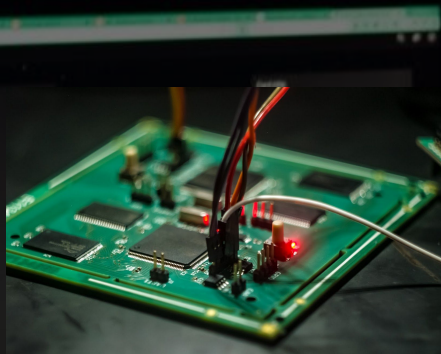
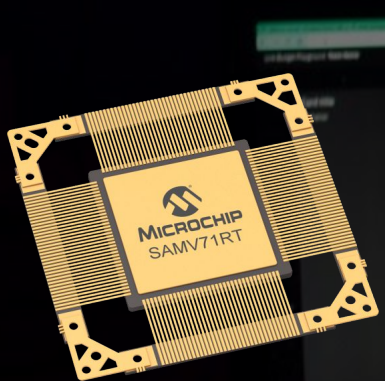


Subsystem Overview

Double-sided ADCS & OBC Board



- <https://gitlab.com/acubesat/adcs/matlab>



- <https://gitlab.com/acubesat/obc/obc-pcb>

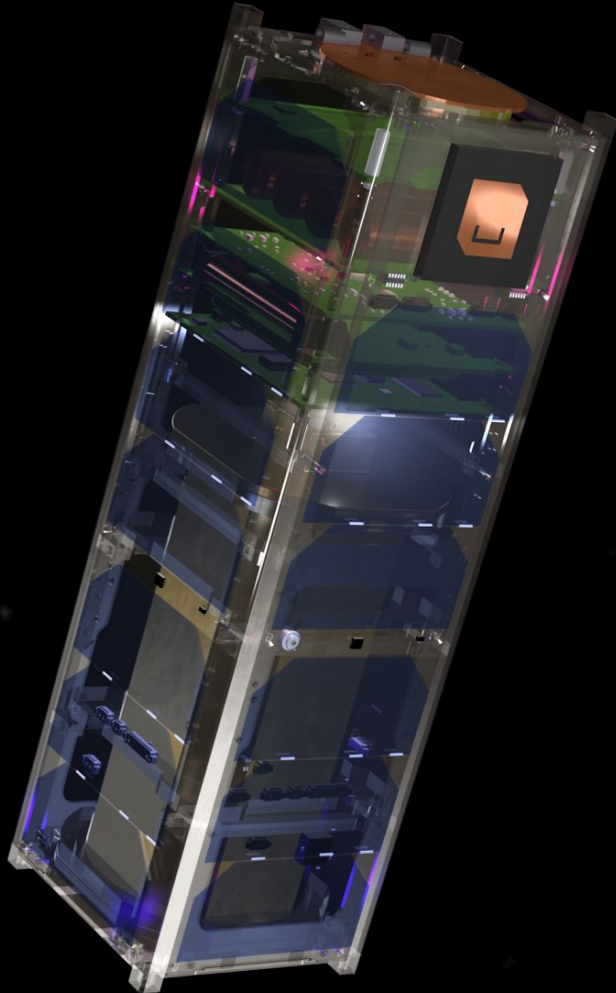


- <https://gitlab.com/acubesat/obc/ecss-services>

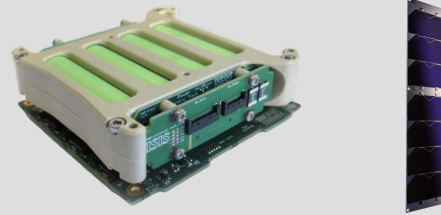


- <https://gitlab.com/acubesat/obc/analysis>

Subsystem Overview

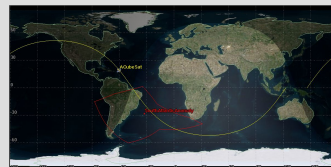


EPS



- <https://gitlab.com/acubesat/eps/power-budget>

Trajectory

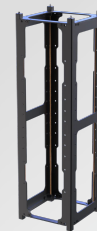


- <https://gitlab.com/acubesat/trajectory/mission-analysis>



- <https://gitlab.com/acubesat/trajectory/radiation-analysis>

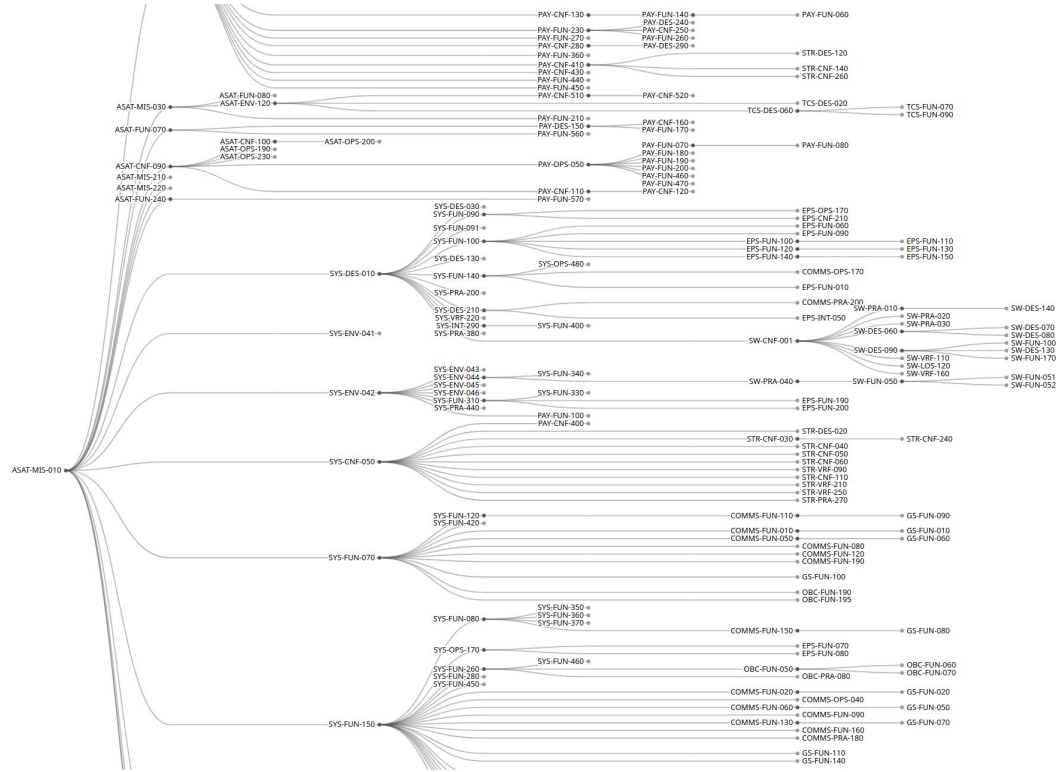
Structural



Thermal



Technical Specification — Requirements




<https://gitlab.com/acubesat/systems-engineering/ts-vcld>

<https://acubesat.asat.gr/requirements-tree/>

AcubeSAT TS-VCld													
Req ID	Requirement Text	Owner	Parent Req	Child Req	Level (S,SS,C)	Verification Method (R,A,I,T)					Verification Details		
						C	D1	D2	E1	E2			
4	SYS-DES-010	The spacecraft shall be a 3U CubeSat, according to the Fly Your Satellite! Design Specifications (FDS).	Systems Engineering	ASAT-MIS-010	SYS-DES-030, SYS-FUN-090, SYS-FUN-091, SYS-FUN-100, SYS-DES-130, SYS-FUN-140, SYS-PRA-200, SYS-DES-210, SYS-INT-290, SYS-INT-290, SYS-PRA-380, SW-CNF-001	S	R	I					D1: To be verified via physical measurements
5	SYS-INT-020	deleted											
6	SYS-DES-030	For the description of the spacecraft and of its major components, the coordinate system as defined in requirement 2.1.1.1 of the CubeSat Design Specifications for a 3U CubeSat shall be used.	Systems Engineering	SYS-DES-010	None	S	R						
7	SYS-ENV-040	deleted											
8	SYS-ENV-041	Spacecraft electronics shall not fail due to a Total Ionizing Dose of up to 10 krad (TBC).	Systems Engineering	ASAT-MIS-010	None	SS/C	A	T					C: To be verified via analysis with dedicated radiation software D1: (Optional) To be verified during radiation testing
9	SYS-ENV-042	A single event effect (SEE) shall not lead to a loss of mission.	Systems Engineering	ASAT-MIS-010	SYS-ENV-043, SYS-ENV-044, SYS-ENV-045, SYS-ENV-046, SYS-FUN-310, SYS-PRA-440, PAY-FUN-100	SS/C	A	T					C: To be verified via analysis with dedicated radiation software D1: (Optional) To be verified during radiation testing at subsystem/component level, for critical components with no radiation data
10	SYS-ENV-043	A destructive SEE shall not lead to a loss of mission.	Systems Engineering	SYS-ENV-042	None	SS/C	R						
11	SYS-ENV-044	A single event upset (SEU) shall not lead to a loss of mission.	Systems Engineering	SYS-ENV-042	SYS-FUN-340, SW-PRA-040	SS/C	R						
12	SYS-ENV-045	A single event functional interrupt (SEFI) shall not lead to a loss of mission.	Systems Engineering	SYS-ENV-042	None	SS/C	R						
13	SYS-ENV-046	A single event transient (SET) shall not lead to a loss of mission.	Systems Engineering	SYS-ENV-042	None	SS/C	R						C: With a limited scope (enumeration of mitigation strategies only)
14	SYS-CNF-050	The payload experiment shall be conducted in a payload container pressurized at 0.8-1.2 standard atmosphere.	Systems Engineering	ASAT-MIS-010	PAY-CNF-400, STR-DES-020, STR-CNF-030, STR-CNF-040, STR-CNF-050, STR-CNF-060, STR-VRF-090, STR-CNF-110, STR-VRF-210, STR-VRF-250, STR-PRA-270	SS/C	R	T	T			I	D1: Vessel qualification campaign TBD D2: Vessel qualification campaign TBD E2: Verifiable via TM data
					ADCS-FUN-030, ADCS-FUN-050								



Failure Mode and Effects Analysis (FMEA)

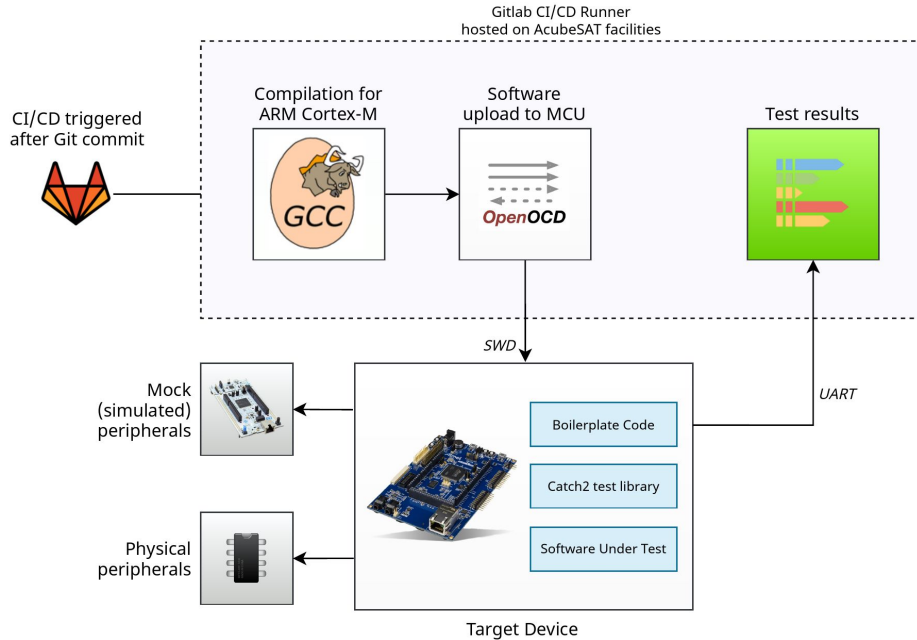
Failure Modes Effects Analysis (FMEA)												
Product:	AcubeSAT			System:	Spacecraft				Subsystem:	OBC		
ID	Item/Block	Function	Failure Mode	Failure Cause(s)	Mission Phase/Operation Mode	Failure effects: Local	Failure effects: End effects	Failure Detection method/observable symptoms	Severity Number (SN)	Compensating provisions	Recommendations	Remarks
CAN Transceiver TCAN337G #1												
OBC-150	Spacecraft Bus Transceiver	CAN bus voltage signalling	Temporary loss of function	Intrinsic, Radiation	All except Launch	Temporary inability of OBC to communicate with other subsystems	None	Loss of communication with OBC, but other subsystems can use the bus properly	2R	Dual-redundant CAN bus	None	None
OBC-160	Spacecraft Bus Transceiver	CAN bus voltage signalling	Permanent loss of function	Intrinsic, Radiation	All except Launch	Inability of OBC to communicate with other subsystems	Reduced spacecraft functionality	Loss of communication with OBC, but other subsystems can use the bus properly	2R	Dual-redundant CAN bus	None	None
OBC-170	FAULT pin	Bus fault indication	Output stuck to 0	Intrinsic, Radiation	All except Launch	No information about CAN faults	None	None	1	None	None	None
OBC-180	FAULT pin	Bus fault indication	Output stuck to 1	Intrinsic, Radiation	All except Launch	Erroneously detected CAN bus fault	None	FAULT pin set to 1, but CAN communication still possible	1	None	None	yet undetected bus failure, the spacecraft will switch
OBC-190	SILENT pin	Toggle silent mode (RX only, no ACK frame transmitted on frame reception)	Input stuck to 0	Intrinsic, Radiation	All except Launch	Increased power consumption of CAN transceiver	None	Increased power consumption of OBC subsystem	1	None	None	None
OBC-200	SILENT pin	Toggle silent mode (RX only, no ACK frame transmitted on frame reception)	Input stuck to 1	Intrinsic, Radiation	All except Launch	Inability of OBC to communicate with other subsystems	Reduced spacecraft functionality	No input received from OBC by any other subsystem	2R	Dual-redundant CAN bus	None	Covered by transceiver loss of function
OBC-210	Spacecraft Bus Transceiver	CAN bus voltage signalling	Short Circuit between power pins	Intrinsic, Radiation	All except Launch	Inability of OBC to communicate with other subsystems	Reduced spacecraft functionality	High power consumption by OBC	2R	Dual-redundant CAN bus, Current limiting resistor on component	None	None
OBC-220	Spacecraft Bus Transceiver	CAN bus voltage signalling	Babbling Idiot Failure	Radiation	All except Launch	Inability of OBC to communicate with other subsystems	No communication possible on CAN bus	Bus utilisation is 100%	2R	Dual-redundant CAN bus	None	None



– <https://gitlab.com/acubesat/systems-engineering/fmea>



Hardware In The Loop



```

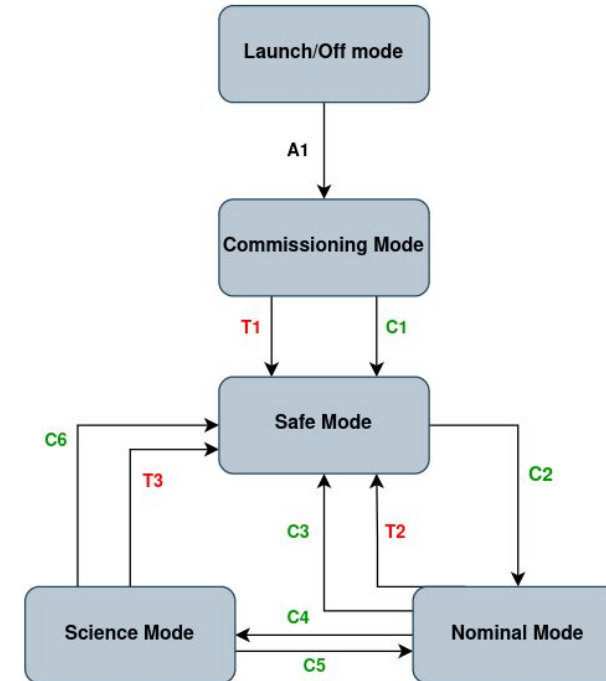
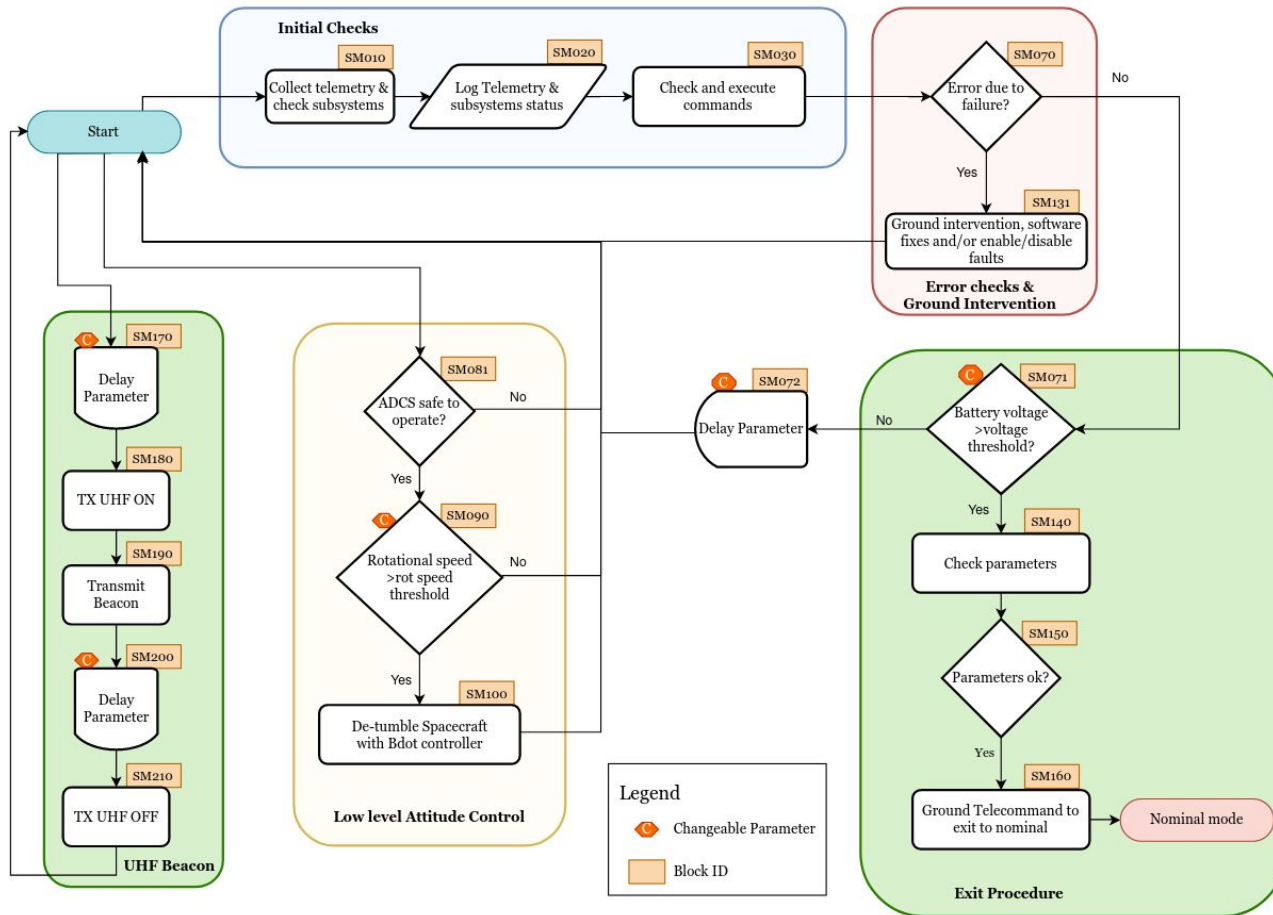
235 [---|---|---|---|---|---|---|---|---|]
236 [=====]
237 INFO:pyocd.flash.loader:Erased 499712 bytes (122 sectors)
      bytes (0 pages) at 3.94 kB/s
238 @DIAGNOSTICS:
239   CPU clock: 120 MHz
240 [101] Initializing tests...
241 [128] Running tests...
242 0.523 s: Encode
243 0.542 s: BCH (n = 1023, k = 983)
244 0.309 s: Decode
245 0.329 s: BCH (n = 1023, k = 983)
246 =====
247 test cases: 1 | 1 passed
248 assertions: - none -
249 Success
250 @RETURN 0
  
```





 - <https://gitlab.com/acubesat/obc/hil-tests>
 - <https://gitlab.com/acubesat/obc/hardware-lab>



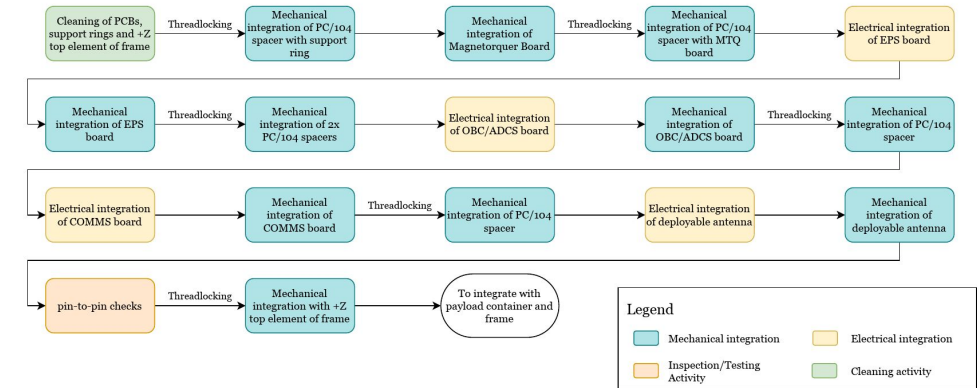
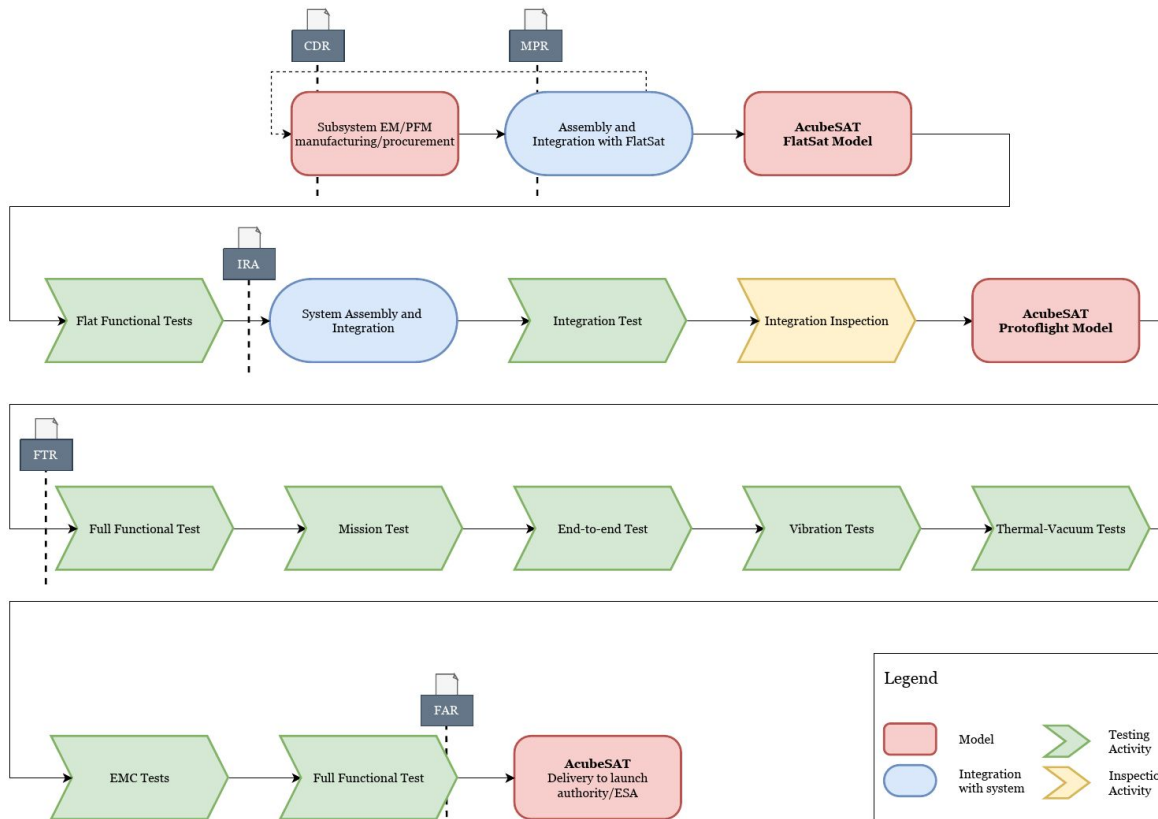
Functional Architecture



 - <https://gitlab.com/acubesat/systems-engineering/functional-architecture>



MAIV Plan



- <https://gitlab.com/acubesat/systems-engineering/maiv-plan/>

Thank you!

More information: <https://acubesat.asat.gr/>
Source Code: <https://gitlab.com/acubesat/>

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