

FEATURES

- Intel® Movidius™ Myriad™ 2 VPU based AI Accelerator & Computer Vision board for CubeSats
- Based on the CogniSAT™ platform from Ubotica™
- PC/104 form factor, the recognized specification for CubeSat boards
- Command/Control Interface: CAN
 - Direct operation mode → AI and CV engine as a slave over USB 2.0/3.0 or Ethernet
 - Custom operation mode → AI and CV for directly interfaced sensors with control over SPI, CAN, USB 2.0/3.0 or Ethernet
- Parallel and MIPI camera interfaces for direct sensor connection
- Compatible with Ubotica™ CVAI Toolkit™ SW, for full control over AI and CV algorithm deployment
- Optional microSD card for non-volatile storage
- Additional integrated peripherals:
 - Optional Floating Gate Dosimeter
 - Optional IMU (3D accelerometer & gyroscope)
- Operates from single 5V supply
- Ultra-low power consumption: Typical 2W/Max 5W
- Integrated SEL protection, auto-restart/trip signal

OVERVIEW

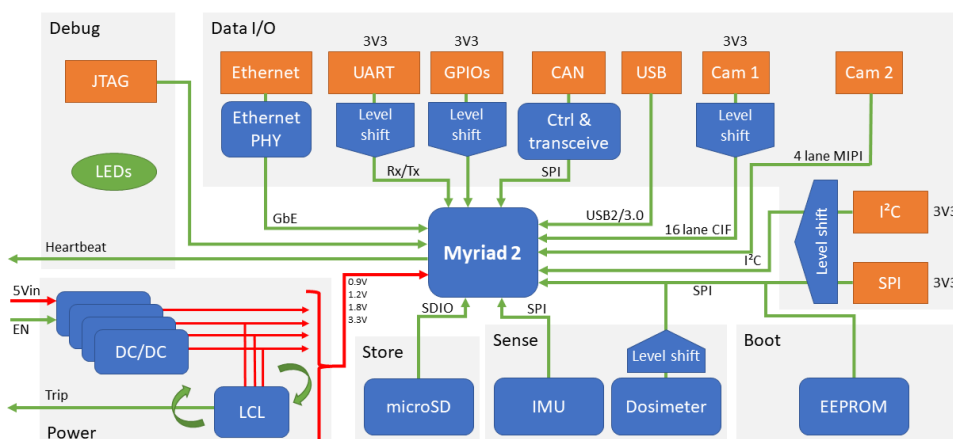
The CogniSAT-XE1™ board is manufactured by Réaltra under license from Ubotica Technologies Ltd. and is based on the CogniSAT™ platform which is the first CubeSat compatible board capable of running sophisticated Machine Learning (ML) and Artificial Intelligence (AI) algorithms for Computer Vision (CV) and other applications in real time on-board a satellite.

The CogniSAT-XE1™ board delivers the performance of the Myriad™ 2's CV and AI compute acceleration in a PC104 form-factor for CubeSat and SmallSat missions. The board is built around the Intel® Movidius™ Myriad™ 2 Computer Vision and Artificial Intelligence COTS VPU whose 12 vector cores provide high-performance parallel and hardware accelerated compute within an ultra-low power envelope.

The CogniSAT-XE1™ board is supplied with the unique CogniSAT-HCS™ that greatly simplifies the process of deploying user algorithms to the hardware.

The CogniSAT-XE1™ combines the power efficient compute performance of the Myriad™ 2 VPU with a wide range of interfaces and peripherals for integration into satellite platforms. The user can select as a build option Gigabit Ethernet or USB2.0/3.0 as the primary control and data interface to the board, enabling data rates sufficient to handle AI & CV applications at near-streaming input.

Custom CV pipelines can easily be deployed and executed with the transfer of only a single configuration file using the Ubotica™ CogniSAT-HCS™ software development kit. Runtime updates enable the updating of pipelines without requiring application re-compile or system reboot.



CogniSAT™ XE1 AI Accelerator & Vision Processing CubeSat Board – Architecture

APPLICATION NOTES

DUAL OPERATIONAL MODES

In Direct Mode, a master host communicates with the CogniSAT-XE1™ board over Ethernet or USB to load AI and CV algorithms and models to the Myriad 2 and submit image frames to the board and receive processing results. The host can dynamically update the Myriad 2 application algorithms & models, enabling flexible runtime solutions.

In Custom Mode, the board can be controlled over CAN or SPI as well as Ethernet and USB. In this mode, frames from a directly connected image sensor (over MIPI or standard 16-lane parallel interface) can be captured and processed.

EFFICIENT NEURAL NETWORK INFERENCE

Neural Network frameworks (e.g., TensorFlow, PyTorch, Caffe) can be used for model development and training, with the model compiled to target the Myriad 2 device. Pre-trained and pre-qualified models available in the OpenVINO™ application zoo can be used with transfer learning or can be deployed directly on the CogniSAT-XE1™ board, via the Ubotica™ CogniSAT-HCS™ software development kit.

CUSTOMISABLE CV AND IMAGE SIGNAL PROCESSING (ISP) PIPELINES

Custom CV pipelines can easily be deployed and executed on the CogniSAT-XE1™ board using the Ubotica™ CogniSAT-HCS™. The software supports the graphical design of application-specific CV and ISP pipelines that utilise a combination of the power-efficient Myriad 2 streaming hardware blocks and software filters implemented on the vector engines. Deployment to the CogniSAT-XE1™ involves the transfer of only a single configuration file. Runtime updates enable the updating of pipelines without requiring application re-compile or system reboot.

USB/ETHERNET INTERFACE

Data transfer and command and control of the CogniSAT-XE1™ board is through either the USB or Ethernet interface. The board acts as a server to the client application on the On-Board Computer (OBC). Running on the OBC, board operation is completely controlled by Ubotica™ software. The OBC transmits the firmware (boot image) and the NN blobs and/or DPE configurations to the board over the chosen interface. After the initial transmission, images can be transmitted to the board over the interface, and the result of the operation transmitted back over the same interface. A power cycle of the board requires a re-transmission of the firmware.

SPECIFICATIONS

	Min	Typ	Max	Unit	Notes
Physical Characteristics					
Length		94.0	98.0	mm	PC/104 form factor (Max includes Connectors)
Width		90.0	99.0	mm	PC/104 form factor (Max includes Connectors)
Height		15.0	18.5	mm	(Max includes Connectors)
Mass		80		g	
Electrical Characteristics					
Supply Voltage		5		V	
Power		2	5	W	Dependant on application
Environmental**					
Operating Temperature	-40		+70	°C	
Storage Temperature	-55		+85	°C	
Shock			1500	g	3-axes, SRS, 5g @ 30Hz / 1500g @ 1kHz to 10kHz
Vibration (Sine)			15.0	g	3-axes, 3g @ 5Hz - 125Hz, max g @ 20Hz - 40Hz, 2 Oct/min
Vibration (Random)			14.2	g _{rms}	3-axes, 20Hz - 2,000Hz, max g 50Hz - 800Hz 2min/axis
Thermal-Vacuum	Operation from -40°C to +70°C at 5x10 ⁻⁶ mbar				

**The CogniSAT-XE1™ board is designed using COTS components and is ruggedized for space applications.

RADIATION PERFORMANCE INFORMATION

The CogniSAT-XE1™ AI Accelerator board has a radiation tolerant design supporting the Myriad 2 VPU processor with the following performance as measured through tests in a radiation environment.

TID^a: A minimum unshielded Total Ionization Dose (TID) of 49 krad (Si) without any functional degradation.

SEL^b: Latch-up Immune with a minimum effective LET of 110 MeV•cm²/mg

SEFI^c: The SEFI cross section related to the Myriad 2 SoC is 1x10⁻⁴ cm²/device

Note: Myriad 2's internal DDR memory is significantly less sensitive to ionizing bit upset effects (cross-section of 6x10⁻¹⁵ cm²/bit at an LET of 2.3 MeV•cm²/mg) than its other memories, while the CMX memory has sensitivity approximately equivalent to that of the caches (cross-section of 4x10⁻¹⁰ cm²/bit at an LET of 2.3 MeV•cm²/mg)^d

References:

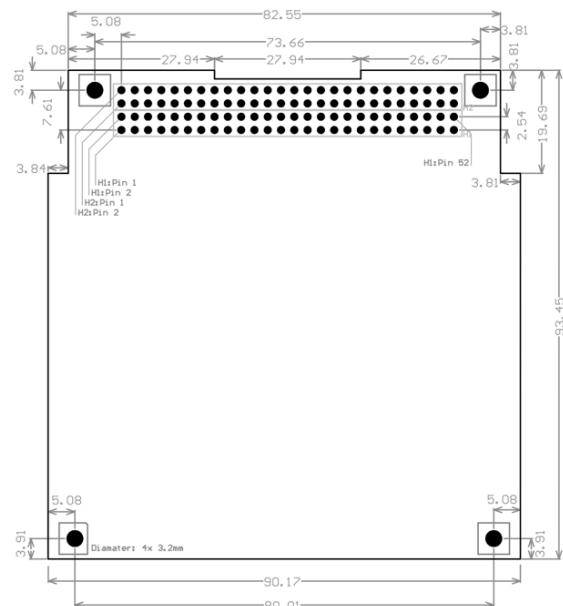
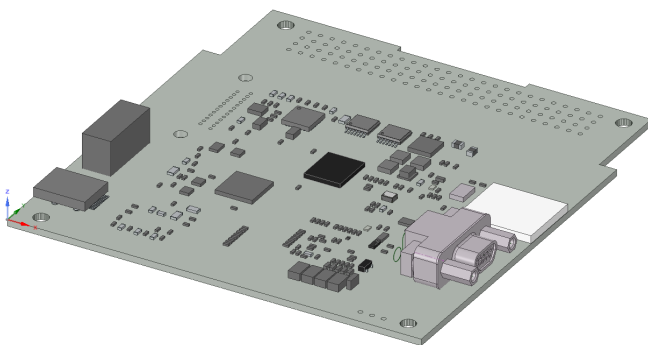
[a] TID mean dose rate of 372 rad(Si)/h. Tests conducted at the Co-60 facility, ESA ESTEC, 2019.

[b] & [c] SEL & SEFI tests conducted at RADEF, Finland. Heavy ion tests in vacuum at ambient temperature, with fluence up to 1x10⁷ Ions/cm². Effective LET range from 2.3 to 110 MeV•cm²/mg.

Incident angles 0°, 30°, 45° & 60°. Ref: A. B. de Oliveira, O. Lexell, and F. Sturesson, "Multi-chips heavy ions SEE testing of the COTS Myriad-2 vision processing unit", RADECS 2021, Vienna, Austria.

[d] SEU heavy ion tests conducted in air at ambient temperature at GSI, Germany. Ref: L. Buckley, A. Dunne, G. Furano, and M. Tali, "Radiation Test and in Orbit Performance of MpSoC AI Accelerator", IEEE Aerospace Conference 2022, Montana, USA.

MECHANICAL INTERFACE



CogniSAT-XE1™ Board 3D model

CogniSAT-XE1™ Board dimensions (all dimensions in mm)

ELECTRICAL INTERFACE

Two headers (designated H1 and H2) are provided to support inter-connection with other boards in the satellite and support middle, top and bottom stacking. In addition, up to six other connectors provide additional interfaces.

Stacking Headers

The pinout for the stacking headers is shown below. The labels in grey indicate signals that can be factory activated/de-activated. All non-labelled pins are unused and are electrically isolated. The general purpose GPIOs are level shifted with factory configured direction control per channel.

H1		H2	
CAN Low	1	2	LU interrupt
CAN High	3	4	LU interrupt
Heartbeat	5	6	LU interrupt
GPIO52	7	8	
GPIO55	9	10	GPIO57
GPIO58	11	12	
	13	14	
	15	16	
UART Tx	17	18	
UART Rx	19	20	
	21	22	
	23	24	
	25	26	
	27	28	
	29	30	
	31	32	
	33	34	
	35	36	
	37	38	
	39	40	
I2CO SDA	41	42	
I2CO SCL	43	44	
	45	46	
5V alternative	47	48	
5V alternative	49	50	
5V alternative	51	52	
	1	2	Enable
	3	4	Enable
	5	6	Enable
	7	8	Enable
	9	10	Enable
	11	12	
	13	14	
	15	16	
	17	18	
	19	20	
	21	22	
	23	24	
5V BU	25	26	5V BU
	27	28	
GND	29	30	GND
	31	32	GND
	33	34	
	35	36	
	37	38	
	39	40	
	41	42	
	43	44	
	45	46	
	47	48	
	49	50	
	51	52	

Additional Interfaces

The additional interfaces are provided via dedicated connectors on the board. All interfaces are provided on EM grade boards, but interfaces can be optionally removed from FM grade boards to reduce power & mass.

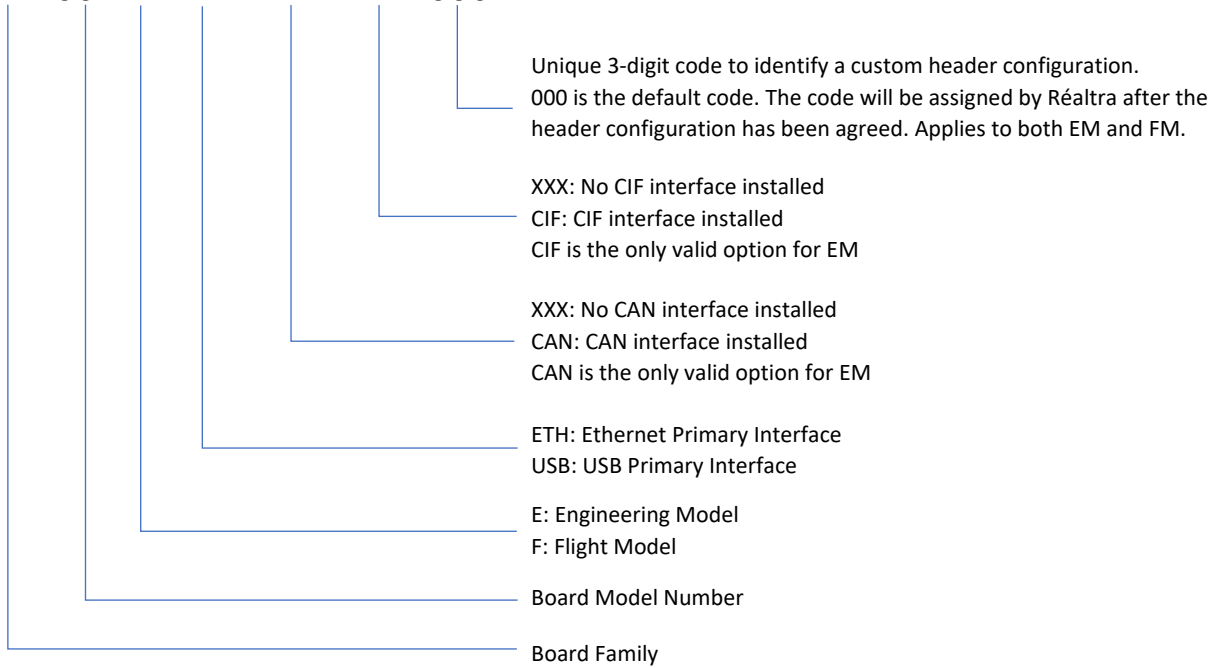
Interface	Designator	Connector	Pins	EM	FM	Notes
Ethernet	J2	Micro-D	9	Yes	Optional	10/100/1000BaseT
USB	J1	Micro-D	9	Yes	Optional	2.0/3.0
CAN	H1	2.54mm Header	2	Yes	Optional	Command and Control, supporting Cubesat Space Protocol (does not replace USB or Ethernet)
CIF	J3	Micro-D	25	Yes	Optional	16-lane parallel direct camera interface (3.3V)
MIPI	J4	Flat Flex Connector (FFC)	30	Yes	Optional	4-lane Camera Serial Interface 2 (CSI-2) direct camera interface (LVCMOS voltage levels)
SPI	J7	Micro-D	4	Yes	Optional	Available for inter-device communications configured to act as a master or a slave (3.3V logic)
UART	J7 and H1	Micro-D and 2.54mm Header	2	Yes	Yes	RX and TX only. Low-level runtime OBC debug interface (3.3V logic)

I ² C	H1	2.54mm Header	2	Yes	Yes	Used for communications with other boards on the CubeSat board stack. Can operate as master or slave & from 100Kb/s – 3.4 Mb/s
JTAG	J6	2mm Header	12	Yes	No	Direct programming and debugging (6 signal pins)

ORDERING INFORMATION

Part Number:

RLT-AIA-001-X-XXX-XXX-XXX-000



WHILE EVERY EFFORT IS MADE TO ENSURE THE ACCURACY OF ALL INFORMATION PROVIDED, RÉALTRA PROVIDES TECHNICAL DATA IN GOOD FAITH "AS IS" WHICH MAY CONTAIN ERRORS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

To make an enquiry, request a quotation or learn about Réaltra's other products and services, please contact:



Réaltra Space Systems Engineering
The Realtime Building,
Clonshaugh Business Park,
Dublin,
D17 H262,
Ireland.



+353 1 848 6112



info@realtra.space



www.realtra.space



@RealtraSpace



www.linkedin.com/company/realtra

Note: and CogniSAT-XE1™ and CogniSAT-HCS™ are Trademarks owned by Ubotica Technologies Ltd.

Note: Information in this document is subject to change without notice and becomes contractual only after written confirmation by Réaltra Space Systems Engineering.