An Open-Source on-board computer platform for CubeSats

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VISIONSPACE

VST104 project - overview and cooperation

- Development of hardware boards dedicated to CubeSat applications in PC104 format
- Aimed to OnBoard Computer (OBC) boards and development & testing auxiliaries
- Platform for MCS testing and future FPGA onboard algorithms development
- Contribution to the LibreCube initiative and support the local university club - TUDSaT

VISION SPACE

LIBRECUBE

TUD SaT

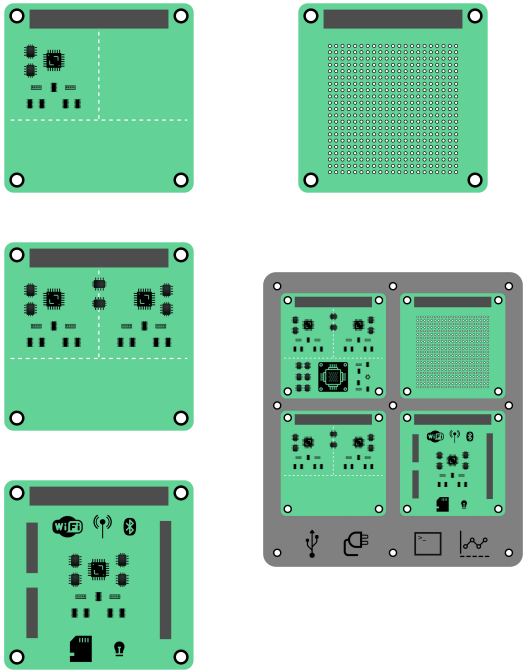
VST104 boards family - summary and overview

Towards the main goal

- **board_zero** - universal development board
- **board_sierra** - single MCU OBC board
- **board_delta** - double redundant OBC board

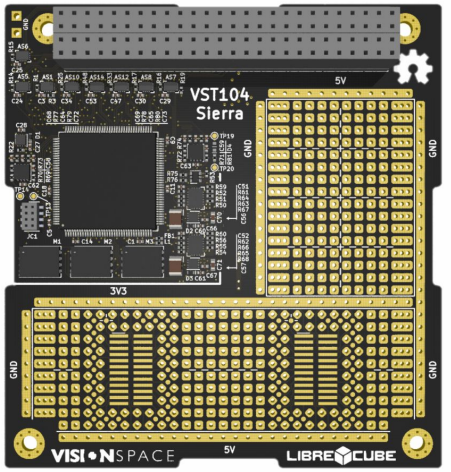
Project auxiliary boards

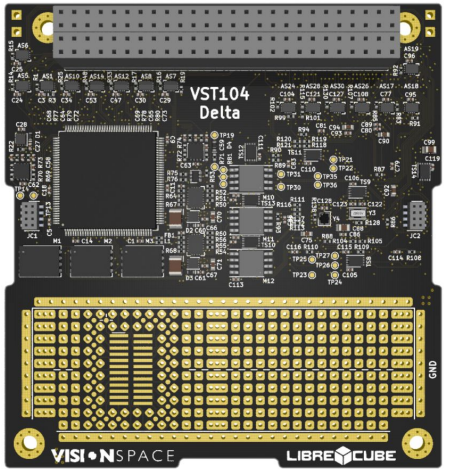
- **element_foxtrot** - flatsat adapter for above boards
- **board_whiskey** - WiFi radio subsystem equivalent



OBC boards specifications

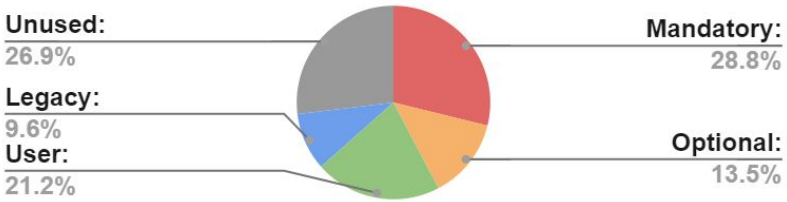
- All used components are suitable for space:
  - Mechanical failure qualifications AEC-Q100 or AEC-Q200
  - Military rated operational temperatures (-40°C to +125°C)
- No radiation hardened components, but:
  - Double redundant OBC - switch off & isolate
  - Triple redundancy external memory - per OBC
- Compact design with maximal payload sector





OBC boards peripherals

- Main peripherals with robust options:
  - 2x CAN bus
  - 4x UART
  - 2x I2C
  - 2x SPI
- 22 general purpose USER pins
- System check and maintenance signals:
  - WatchDogs
  - CPU mode
  - Fault collector
  - KillSwitches
  - Synchronisation

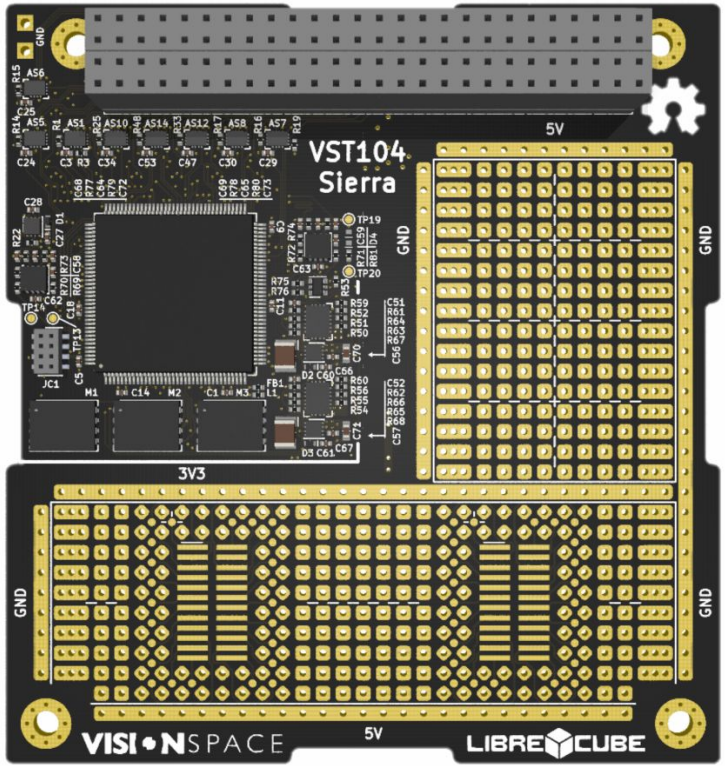


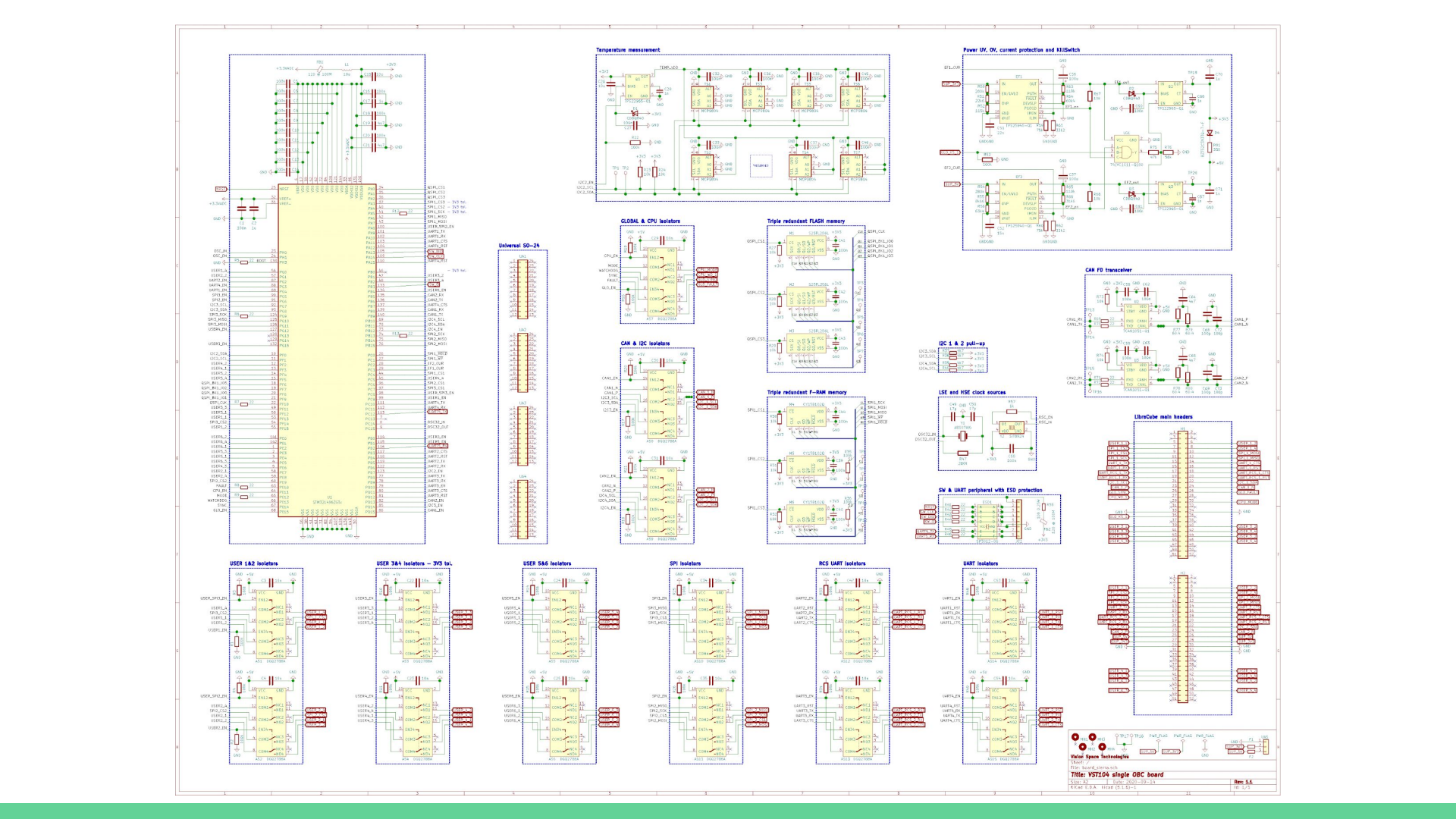
Header H1			
	1	2	
	3	4	
USER_1_1	5	6	USER_1_2
SPI_1_CS2	7	8	USER_1_4
SPI_1_CS1	9	10	SPI_1_MOSI
SPI_1_CLK	11	12	SPI_1_MISO
UART_1_TX	13	14	UART_1_CTS
UART_1_RX	15	16	UART_1_RST
UART_RCS_1_TX	17	18	UART_RCS_1_CTS
UART_RCS_1_RX	19	20	UART_RCS_1_RST
I2C_1_SCL	21	22	I2C_1_SDA
CAN_1_H	23	24	CAN_1_L
GLO_SYNC	25	26	GLO_FAULT
CPU_WD_1	27	28	CPU_WD_2
-	29	30	CPU_MODE
SUP_3V3_REF	31	32	SUP_5V_REF
GND	33	34	GND
GLO_KS_1	35	36	GLO_KS_2
-	37	38	-
USER_3_1	39	40	USER_3_2
USER_3_3	41	42	USER_3_4
USER_5_1	43	44	USER_5_2
USER_5_3	45	46	USER_5_4
	47	48	
	49	50	
	51	52	

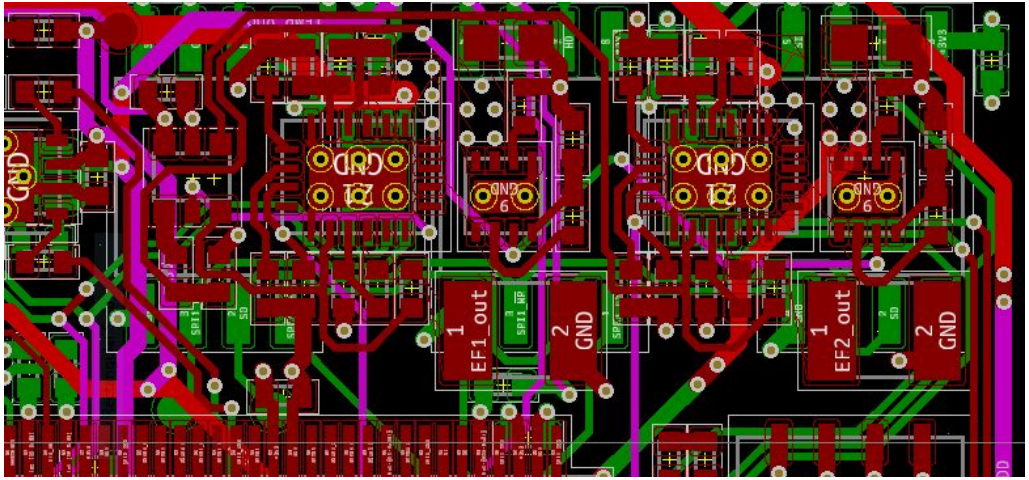
Header H2			
	1	2	
	3	4	
USER_2_1	5	6	USER_2_2
SPI_2_CS2	7	8	USER_2_4
SPI_2_CS1	9	10	SPI_2_MOSI
SPI_2_CLK	11	12	SPI_2_MISO
UART_2_TX	13	14	UART_2_CTS
UART_2_RX	15	16	UART_2_RST
UART_RCS_2_TX	17	18	UART_RCS_2_CTS
UART_RCS_2_RX	19	20	UART_RCS_2_RST
I2C_2_SCL	21	22	I2C_2_SDA
CAN_2_H	23	24	CAN_2_L
SUP_5V	25	26	SUP_5V
SUP_3V3	27	28	SUP_3V3
GND	29	30	GND
AGND	31	32	GND
-	33	34	-
-	35	36	-
-	37	38	-
USER_4_1	39	40	USER_4_2
USER_4_3	41	42	USER_4_4
USER_6_1	43	44	USER_6_2
-	45	46	-
USER_6_3	47	48	USER_6_4
	49	50	
	51	52	

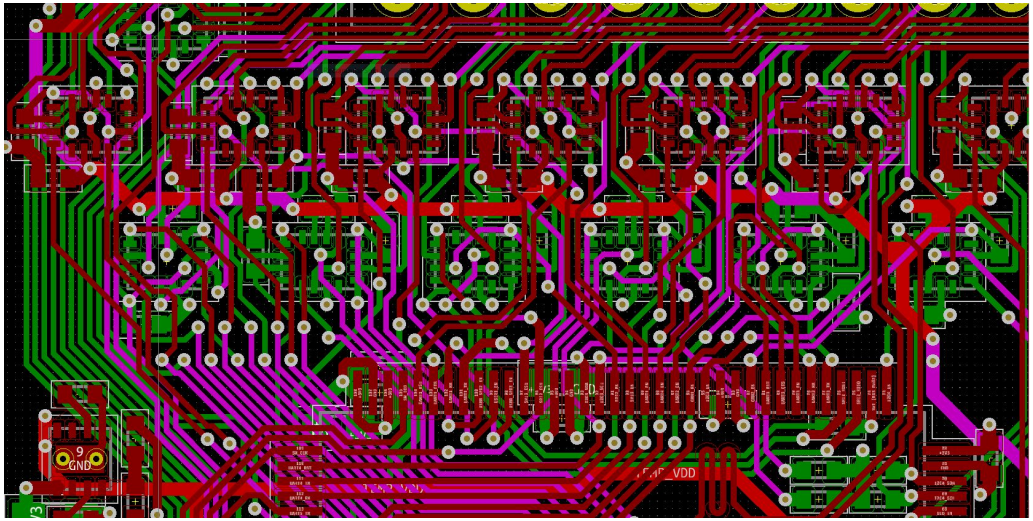
board_sierra - single MCU OBC board

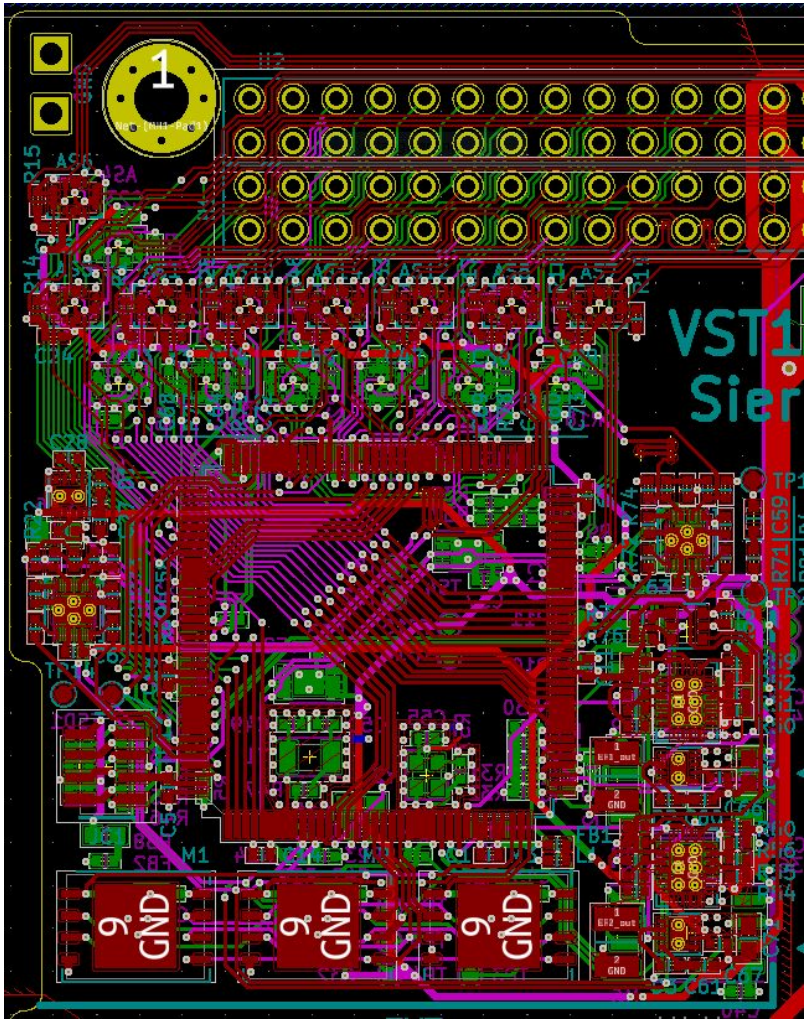
- *MCU:* STM32L496 - up to 78 [MHz]
- *Clock:* 32.768 [kHz] LSE & 26 [MHz] HSE
- *External memory* (triple redundant - SEE): 256 [Mbit] Flash & 2 [Mbit] F-RAM
- *Peripherals* (redundant): CAN bus, I2C, USART, SPI, multiple A/D I/O applications
- *Debugging and program:* SWI & UART
- *Multiple interesting features*

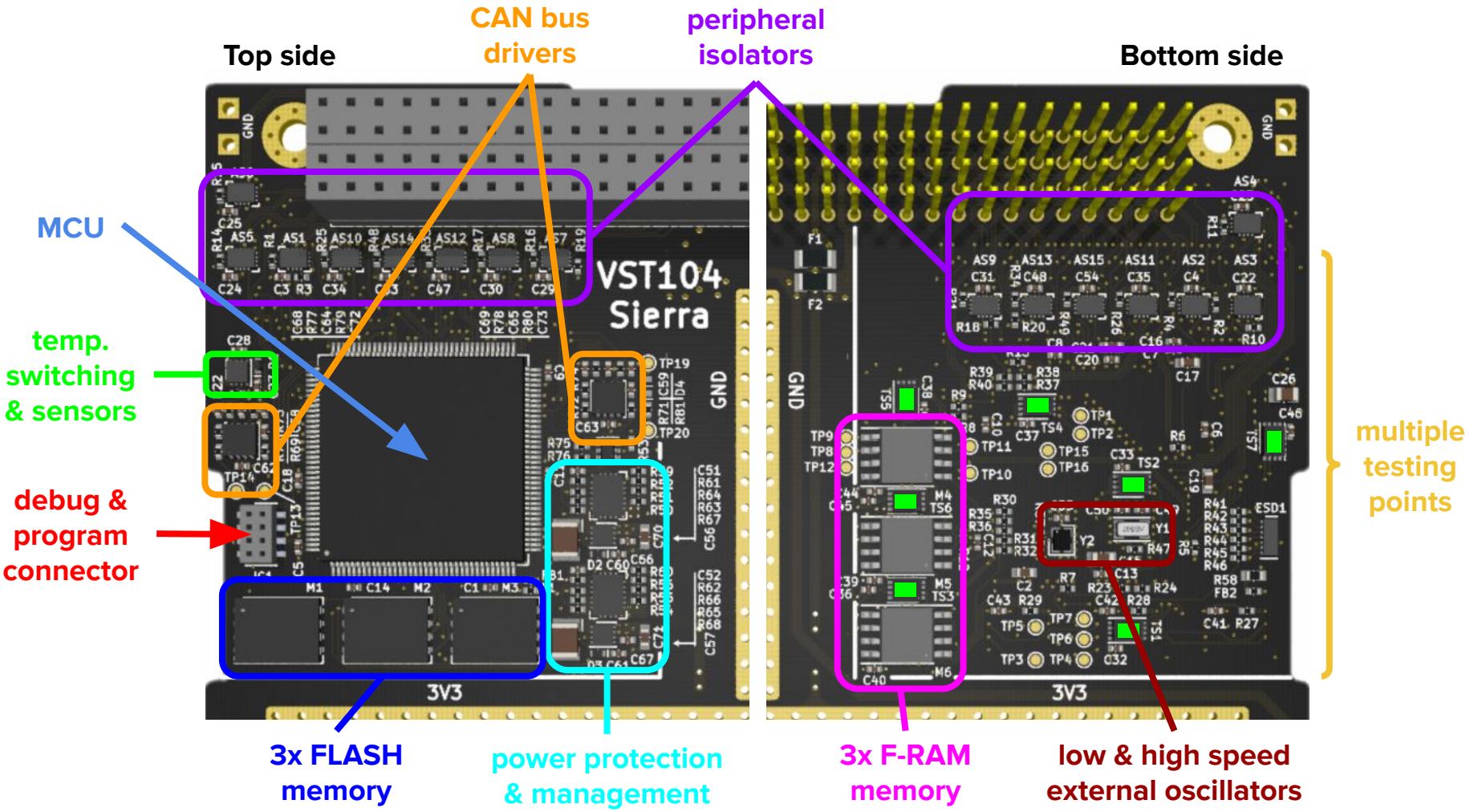



Temperature measurement
Power UV, OV, current protection and KillSwitch
CAN FD transceiver
Universal SO-24
GLOBAL & CPU isolators
Triple redundant FLASH memory
CAN & I2C isolators
Triple redundant F-RAM memory
I2C 1 & 2 pull-up
LSE and HSE clock sources
SW & UART peripheral with ESD protection
LibreCube main headers
USER 1&2 isolators
USER 3&4 isolators — 3V3 tol.
USER 5&6 isolators
SPI isolators
RCS UART isolators
UART isolators
Vilnius Space Technologies
VS7104 single OBC board


GND
GND
GND
1
EF1_out
2
GND
1
EF2_out
2
GND

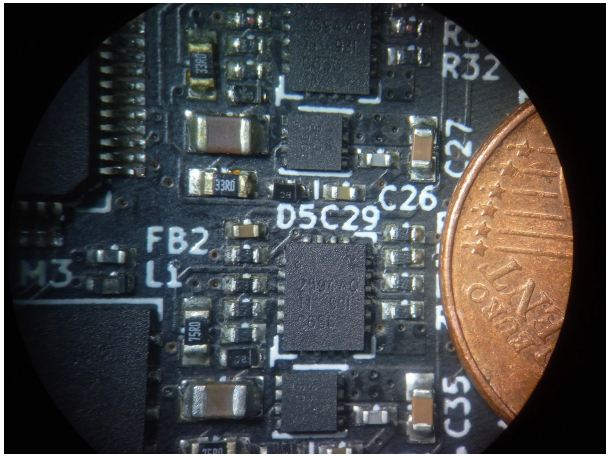

GND
VDD

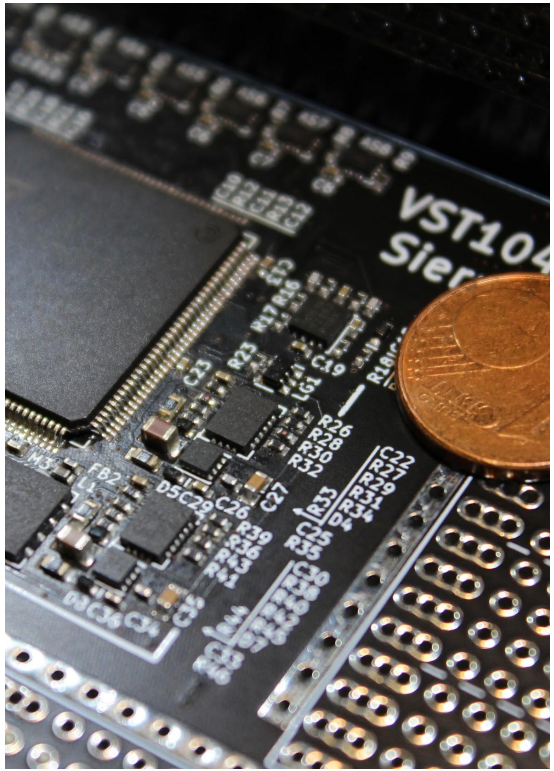

1
VST1
Sier
GND
GND
GND


Top side
CAN bus drivers
peripheral isolators
Bottom side
MCU
temp. switching & sensors
debug & program connector
multiple testing points
VST104 Sierra
3x FLASH memory
power protection & management
3x F-RAM memory
low & high speed external oscillators

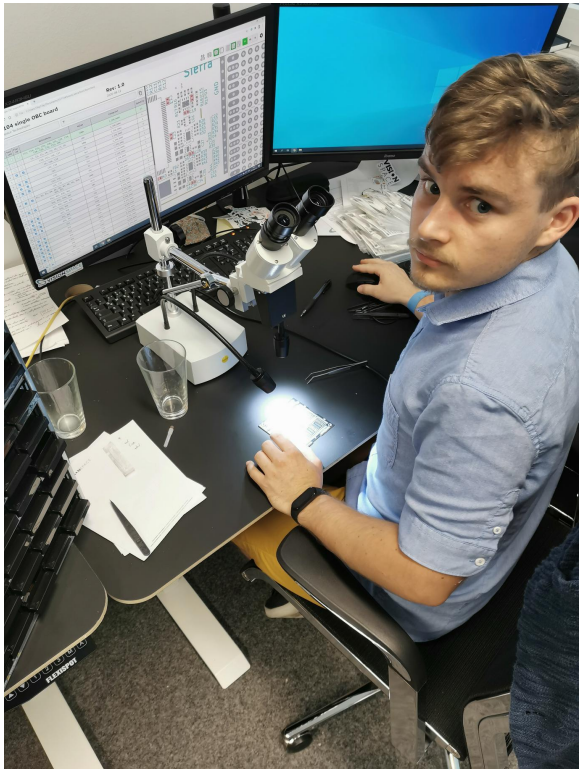
Soldering

1. Isopropyl & Stencil
2. Soldering paste
3. Tweezers & Microscope
4. Hot-air rework station
5. Flip sides and repeat
6. Clean, check & cry



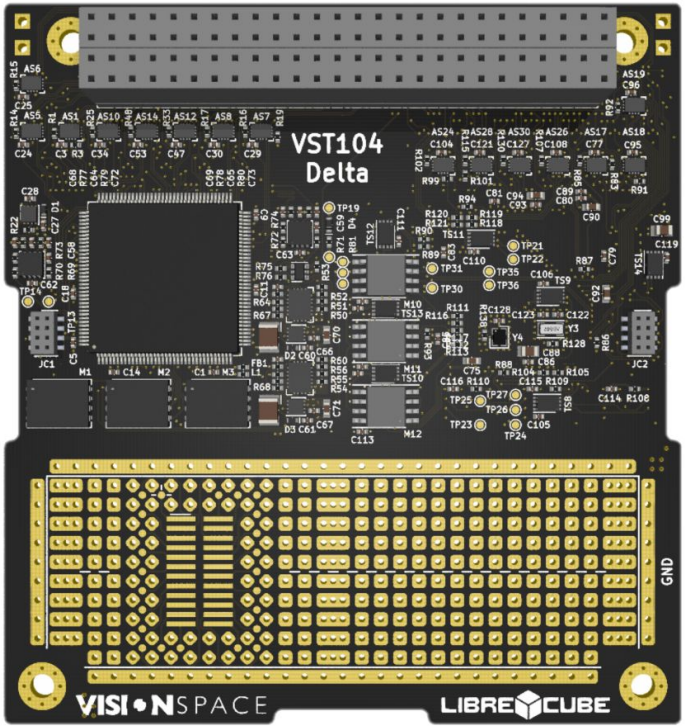


“No, 0402 is not that small...”



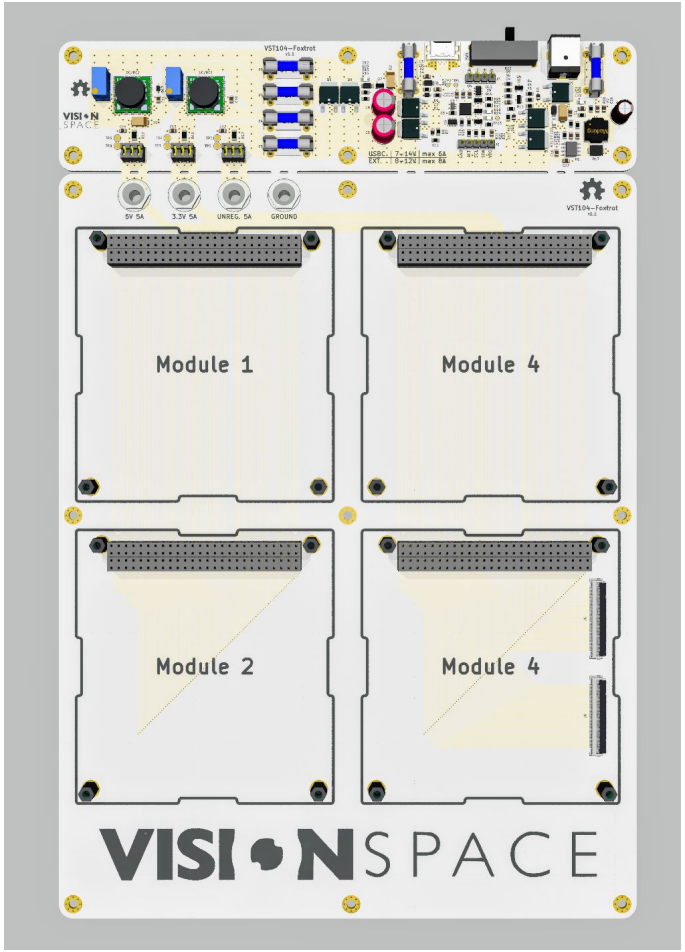
board_delta - double redundant OBC board

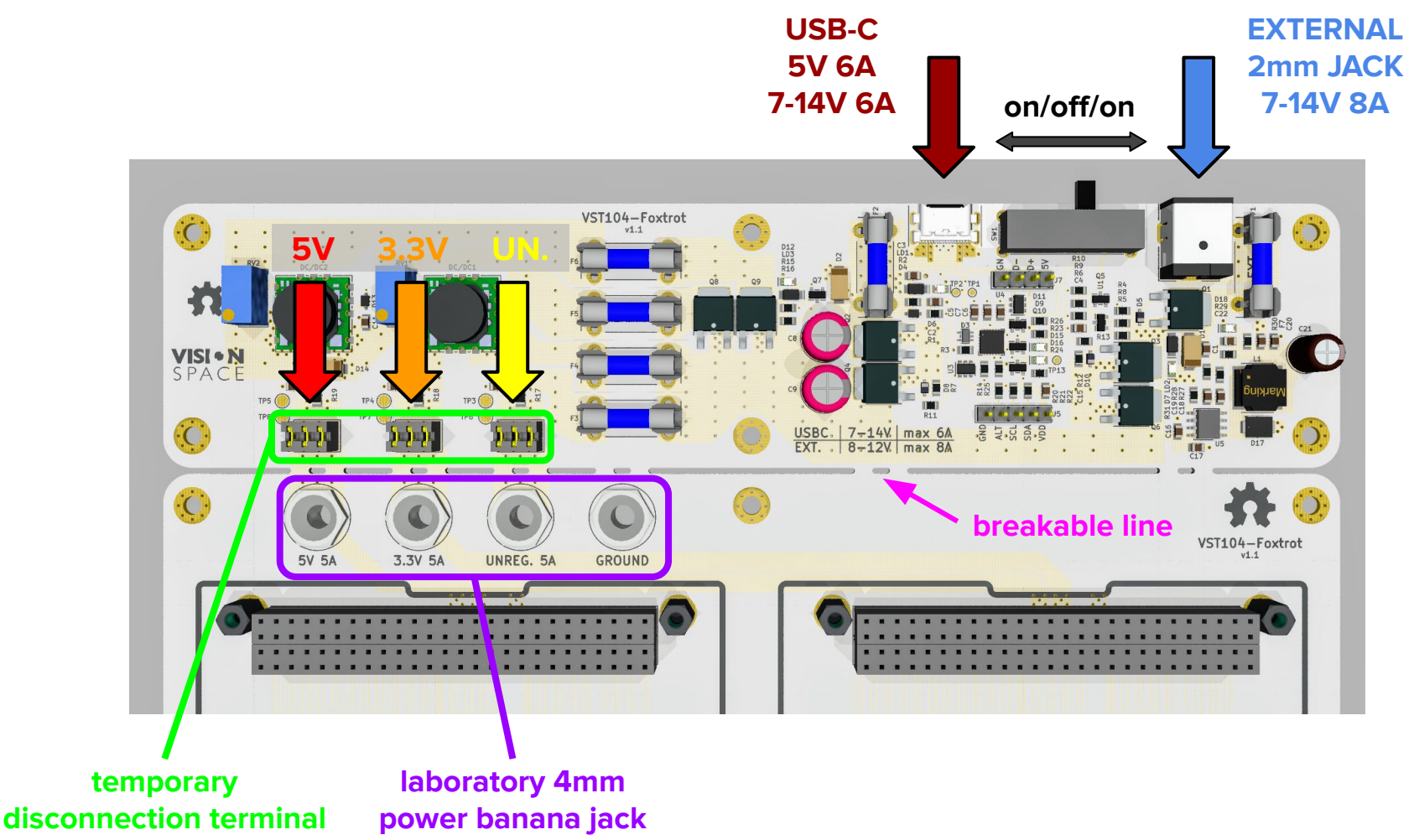
- Implementation of board_sierra in full double redundant configuration
- Same layout of both OBCs (almost):
  - No changes in code needed
  - Similar electrical characteristics
- Expecting watchdog and kill-switch logic implementation in PCDU (power board)
- Empty space under “VST104 Delta” marking for future logic integration



element_foxtrot - flatsat

- Spacecraft & subsystems development
- Separate modules testing and debugging
- Future project presentation and show-off
- Replacement of PCDU by power supply with protection & conversion circuitry
- Possibility of extension to another foxtrot




USB-C
5V 6A
7-14V 6A
on/off/on
EXTERNAL
2mm JACK
7-14V 8A
5V
3.3V
UN.
VST104–Foxtrot
v1.1
VISION SPACE
USBC. | 7–14V | max 6A
EXT. | 8–12V | max 8A
breakable line
5V 5A
3.3V 5A
UNREG. 5A
GROUND
temporary
disconnection terminal
laboratory 4mm
power banana jack

tunable DC/DC convertors

separate fusing

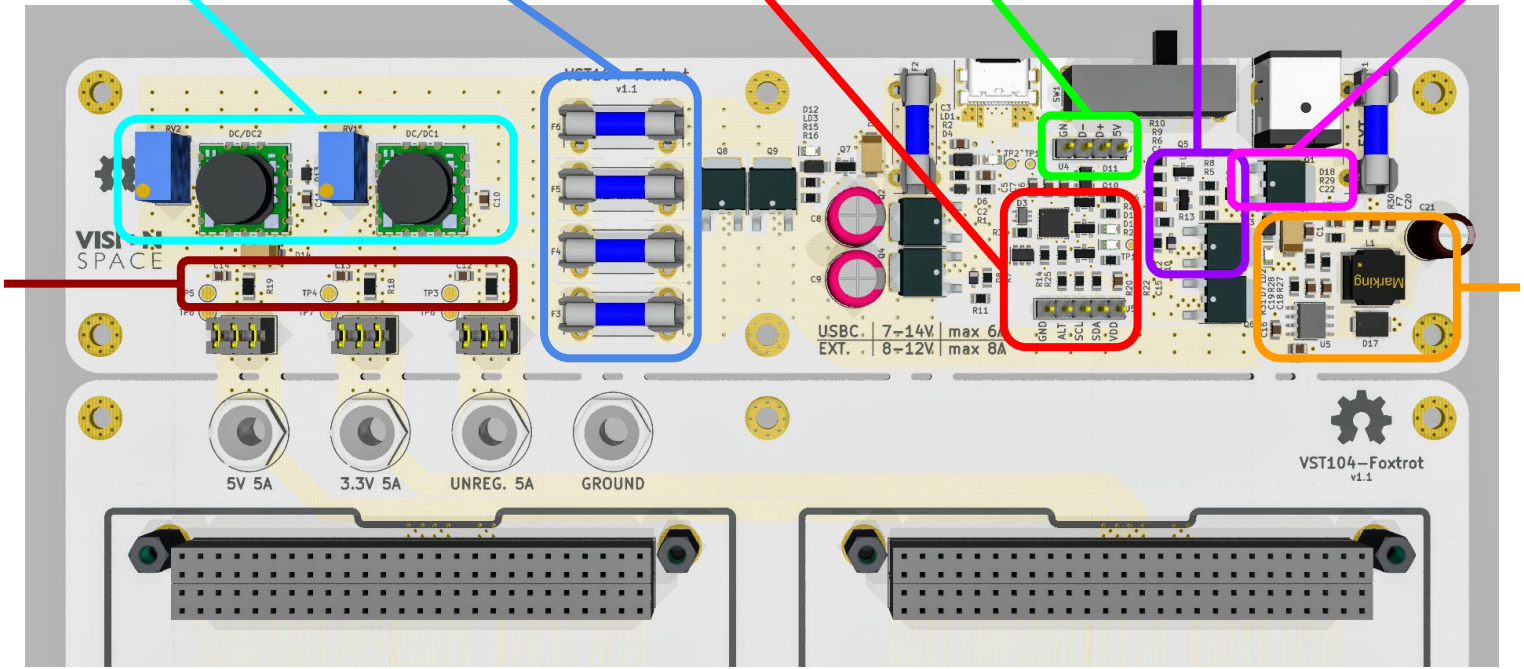
USB-C handshaking

USB data bus

overvoltage protection

reverse polarity protection

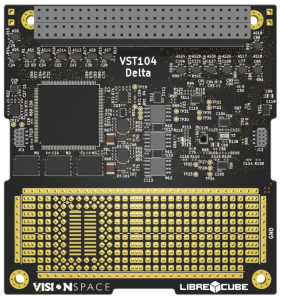
current sensing resistors

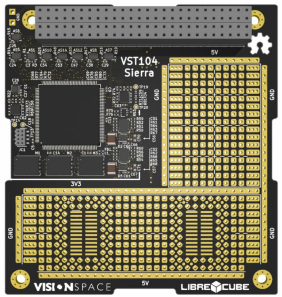


5V for USB data bus

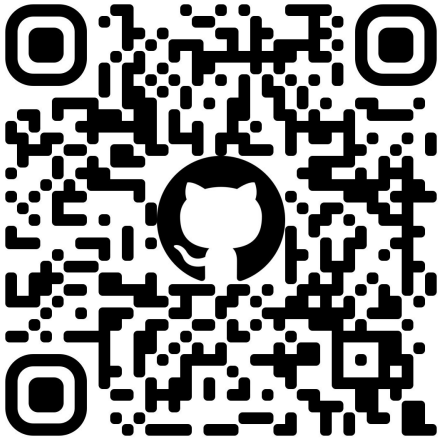
Future work

- Assembly and testing of board_delta
- Addition of external RTC with independent power source
- Redesign of temperature monitoring circuitry for board_delta





Check out our GitHub!



github.com/visionspacetec/VST104

Feel free to contact us :)

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