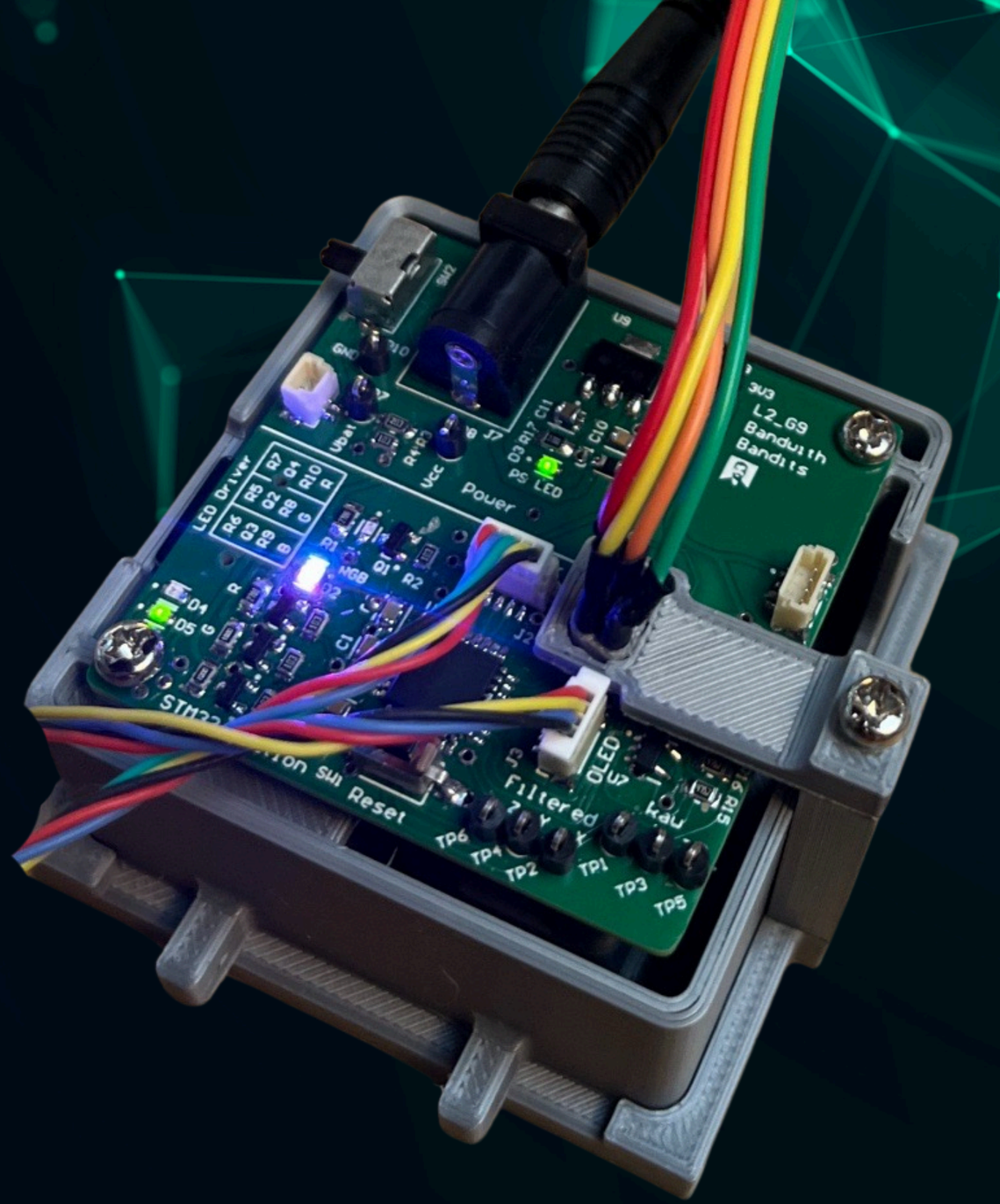
STEP TRACKER

Brought to you by the Bandwidth Bandits



Balancing Innovation and Creativity

Lab 2 Group 9

Bandwidth Bandits

MEET THE TEAM

Ace Viray
Team Lead
Microcontroller Subcircuit
Pace Identification

Sophie Vuillemin
Electrical Lead
Analog Filter Subcircuit
Step Count

Claudia
Software Lead
Accelerometer Interface
Calibration

Amadee Thotawatta
Mechanical Lead
Power Supply
Self-test

COMMUNICATION & COLLABORATION

Group Charter

Part 2: Team Processes

Guiding Principles and Norms: How will you operate together for the duration of the project?

1. **Communication:** Outline how the team will communicate — include frequency and methods (e.g. email, Facebook, team meetings).

1. Microsoft Teams (channel): organization of files, class materials, assessment task files (i.e. Design Review PowerPoints)
- Messenger: general questions and brainstorming
- Face to face meetings on Monday workshop sessions, Tuesdays during lab sessions, meetings before class if needed and additional meetings on Thursdays before major deliverables as needed

2. **Decision-Making:** How will decisions be made in this team? How will you stay on track?

- Primary form of decision making will be a majority vote with a pros and cons assessment during in person with the whole team or during team meetings
- If someone is absent, meeting notes and the decisions will be communicated to them over MS Teams, and if they disagree, a resolution will be discussed over chat
- Small decisions that do not have major impacts on the project may be made by the group leader by also informing the rest of the team on the decision made

3. **Conflict Resolution:** How will you resolve differences?

- For small conflicts, discuss as a group and try to resolve
- When an agreement cannot be reached, refer to the group contract and see if a decision has already been made
- Where a resolution cannot be reached between the group, escalate the matter to the tutor and/or Subject Coordinator to help mediate the conflict

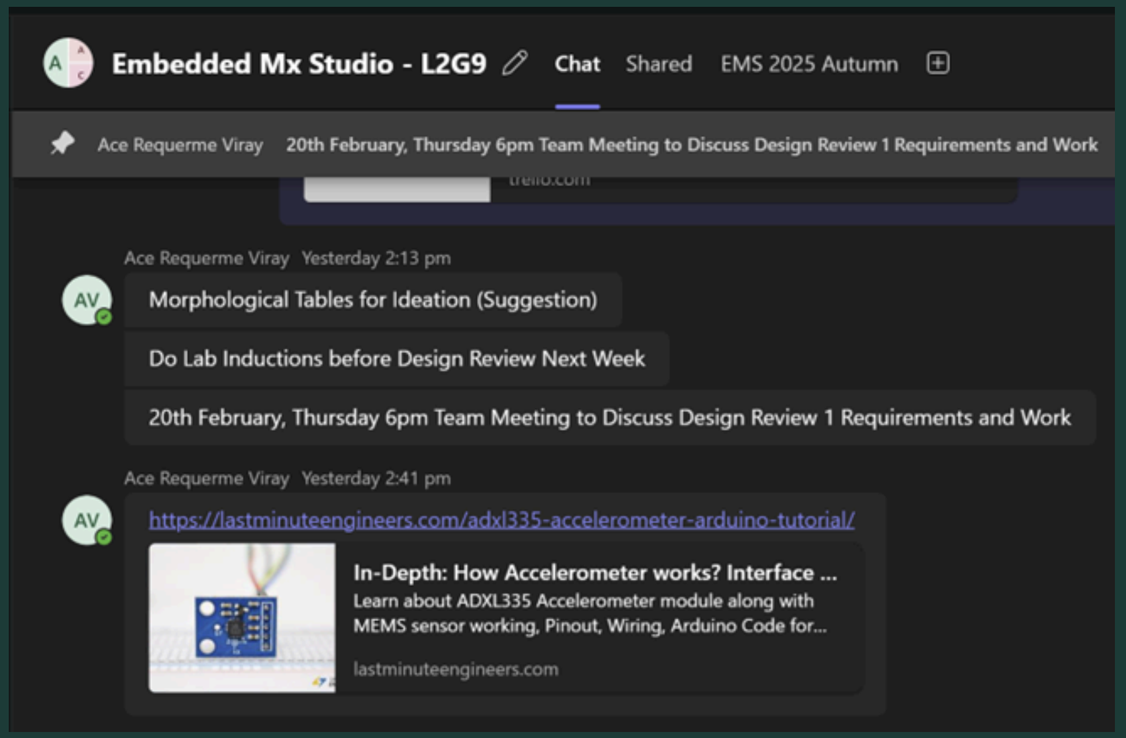
4. **Commitments:** How will you handle different levels of participation and commitment? What process will you follow if someone does not live up to his or her responsibilities? What are the consequences for poor performance?

- Delegate tasks equally, set internal deadlines, and follow up with the team through group meetings to hold team members accountable
- If a team member is facing issues fulfilling their role, they should communicate with the team so responsibilities can be redistributed (can work in pairs to make the workload easier)
- Follow the Gantt chart for major milestones
- Poor performance will relay back to 'Conflict Resolution' and if issues persist to get in touch with lab tutor/s

5. **Diversity:** How will you accommodate different learning and working styles?

- If any member is unsure of their work/task, it is encouraged to ask another member to peer review their work and provide constructive feedback and areas for improvement

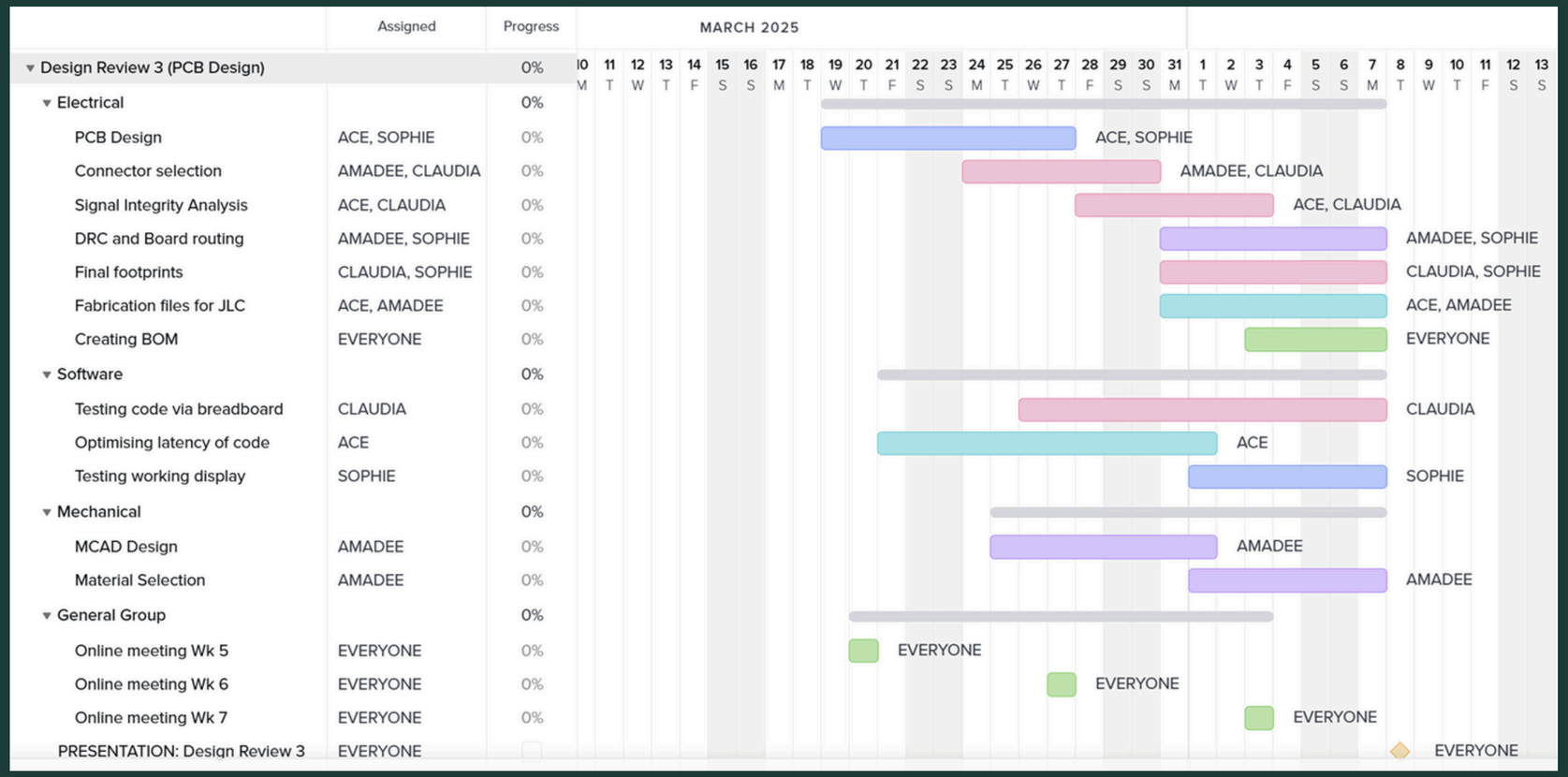
Teams: File Sharing & Comms



COMMUNICATION & COLLABORATION

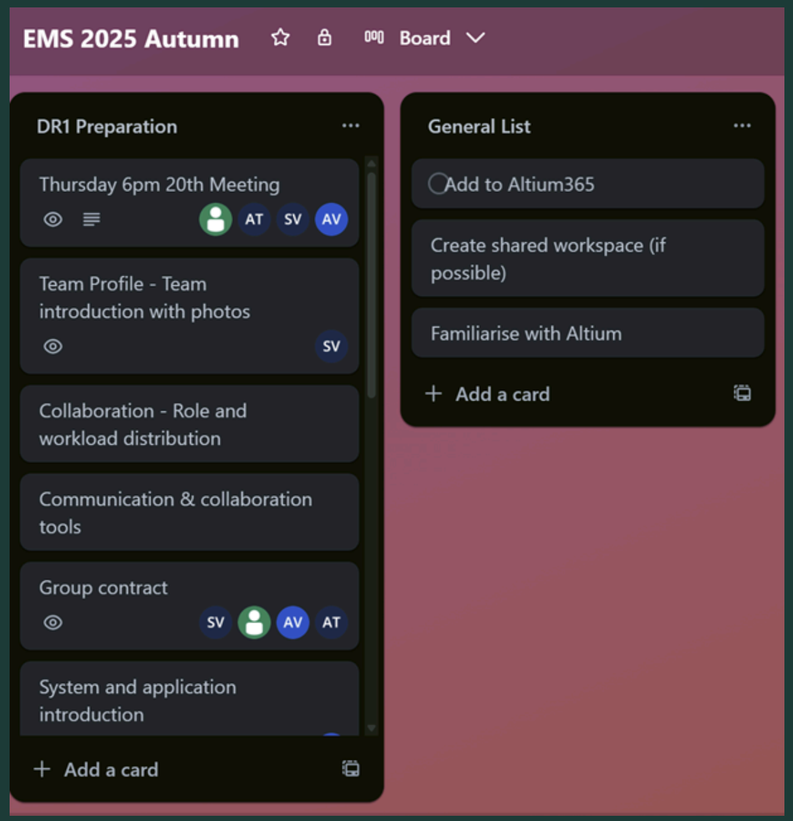
Gantt Chart

- Events
- Delegation
- Progress completion
- Dates

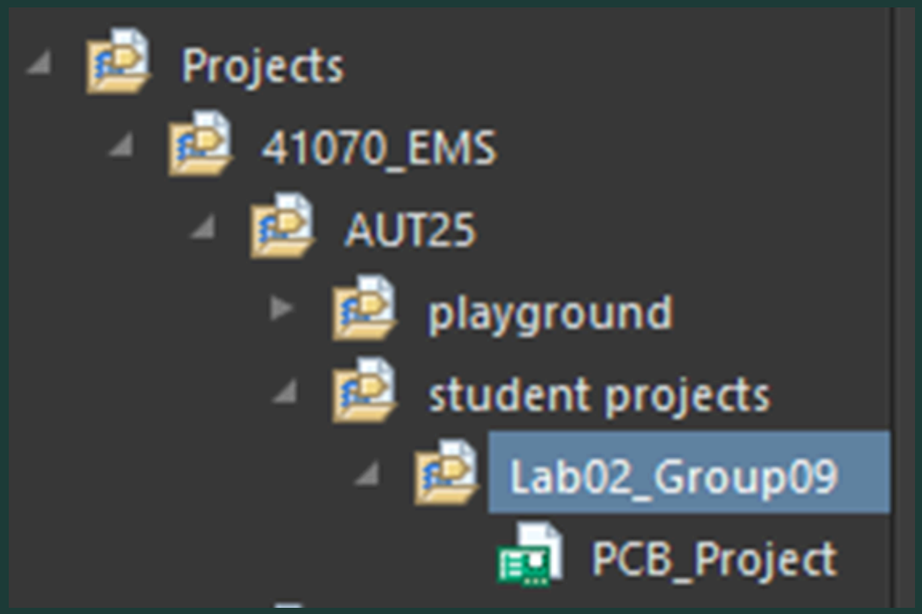


COMMUNICATION & COLLABORATION

Trello: Delegation



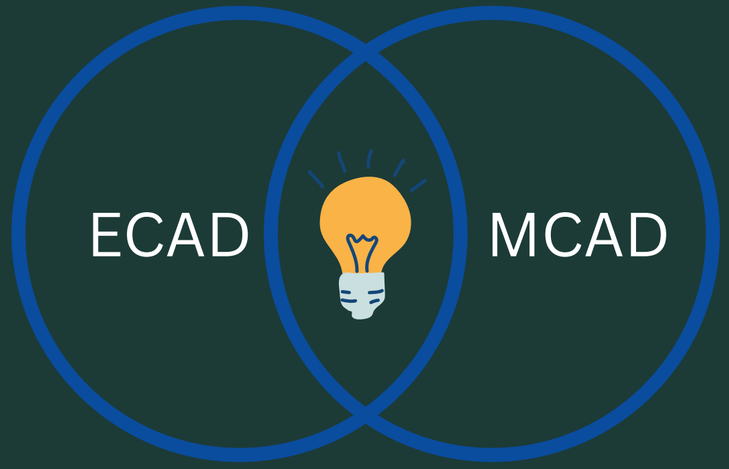
Altium365: PCB Cloud



SYSTEM OVERVIEW

Mechatronics systems are at the forefront of innovation!

Step tracker system through ECAD and MCAD collaboration!



FUNCTIONAL REQUIREMENTS LIST

Legend	Category
	Electronics
	Software
	Mechanical
	Testing

Functional Requirements List for Embedded Mx Studio - L2G9 (aka Bandwith Bandits)		
ID	**Requirement Category**	**Requirement Description**
1.01	Safety and Standards	Follow AS/NZS 3000
1.02	Test Points	Include for power supply, filter output and input, and ground
1.03	Power Supply	PCB powered on its own
1.04	Indicator LED	In line with power supply to indicate power ON
1.05	ADXL335 Power	Power by PCB with LED that meets datasheet spec
1.06	Power Switch	Turn system on or off with PCB switch
1.07	Two Power Mode	Have two power supplies, internal and external
1.08	External Power	Connected via Power barrel connector 2.0mm ID and 5.5mm OD
1.09	Internal Power	Connected to a Battery for dynamic usage
1.1	ADXL335 Interface	Amphenol ICC Minitek 127 connector on PCB
1.11	Self-Test Routine	Read datasheet for understand which pin should be triggered high and what mV to expect to be read
1.12	Signal Filtering	X, Y, Z axis undergo filter with specified order, type, cutoff frequency and implemntation complexity justified
1.13	Z Output Interface	BNC Connector to connect PCB to lab equipment
1.14	ADC Sampling	Internal STM32 12bit ADC to sample analog signal
1.15	User Button Input	Input for subroutine
1.16	Visual Pace Identifier	Like LED to identify walking/running
1.17	Visual Display	Connect screen over I2C or SPI to send data
2.01	ADXL335 Self-Test Routine	Activate ST pin and observe output change in all axis
2.02	Calibration Routine	Calibrate all 6 axis (+/-X, +/-Y, +/- Z), store or hardcode values
2.03	Step Counter	Count walking steps in any orientation, reset via a button
2.04	Pace Identification	Classify walking pace, indicate on LEDs
2.05	Display Integration	Illustrate successful calibration, step count and pace on LCD screen
2.06	Optional Feature	Battery level monitoring
3.01	Board Housing	Enclosure to house PCB with fasteners
3.02	Durability	Use fasteners for secure fit
3.03	Peripheral Cutouts	Cutouts for LEDs, buttons, switches, LCD, cable connections
3.04	Visibility	Ensure indicator LEDs are visible
3.05	Wearability	Provide means to attach enclosure to body
3.06	Mounting Interface	Mounting plate for experimental demo and test set up
4.01	Subroutine Demonstration	Show working: self-test, calibration, step count, pace ID
4.02	Z-Axis Signal Test	Measure filtered signal at +/- 1g and 20Hz in z-direction
4.03	Signal-to-Noise Ratio (SNR)	Measure SNR in decibels (dB)
4.04	RMS Noise	Measuring RMS noise at 20Hz (demodulated amplitude)
4.05	Phase Accuracy	Recording phase difference between original and output signal
4.06	Sensitivity Calculation	Flip ADXL335 to record measurements [mV/g] to find sensitivity
4.07	Filter Reporting	Include cut-off frequency and filter order

HARDWARE REQUIREMENTS LIST

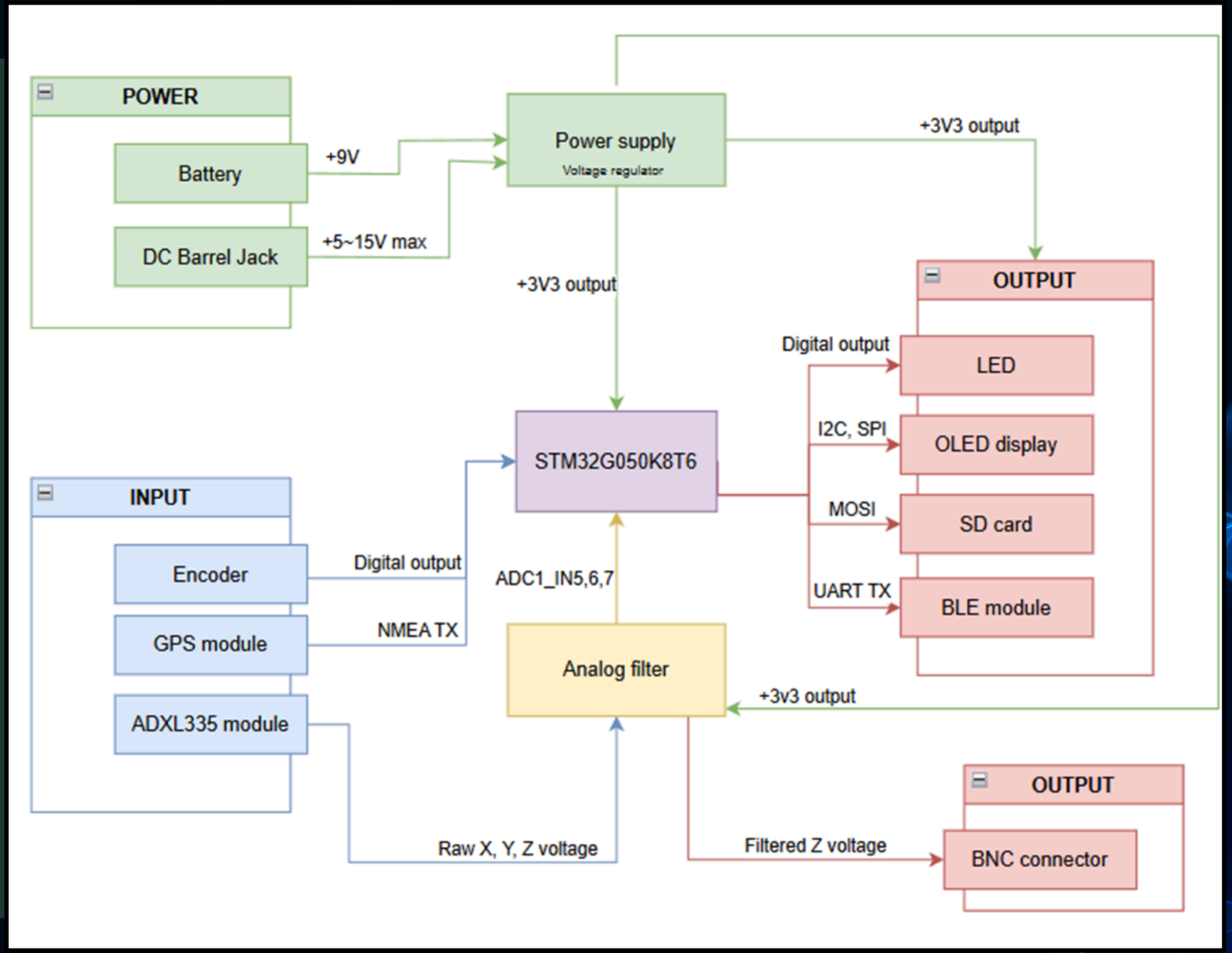
Hardware Requirements List for Embedded Mx Studio - L2G9 (aka Bandwith Bandits)

ID	Requirement by Section	Value			Units	Notes
		Min	Exact	Max		
1	Analog Filter					
1.1	Circuit Topology/Type	-	Bessel or Butterworth	-		Chebyshev rejected due to ripples
1.2	Cutoff Frequency	40	50	60	Hz	At least double 20Hz (testing setup), due to Nyquist theory
1.3	Passband ripple	0	<0.05	0.2	dB	Minimal distortion preferred
1.4	Phase shift	0	-	100	Degrees	Lower for Bessel than butterworth
1.5	Filter Topology/Type	-	Sallen-Key/ Multiple Feedback	-		Sallen-Key simpler to implement, and unity gain
1.6	Filter order	1	2	3		Higher order has steeper attenuation
1.7	BNC Connector / u.fl male	-	1	-		Must include a connector to BNC from system requirements
2	Op-amp Specifications					
2.1	Supply Voltage	1.8	3.3	5.5	V	Align with power supply
2.2	Output Voltage Swing	0	Rail-to-Rail	V+	V	Maximum signal range
2.3	Gain Bandwidth Product	100k	1M	20M	Hz	Higher than 50Hz cutoff
2.4	Slew rate	0.1	>1	10	V/us	Higher for faster signal changes
2.5	Input offset voltage	-	Sallen-Key or Multiple Feedback	-		Sallen-Key simpler to implement, and unity gain
2.6	Noise Density	1	10	100	nV/sqrt(Hz)	Lower means better signal clarity
2.7	Common Mode Rejection Ratio (CMMR)	60	80	100	dB	Higher CMMR rejects interference
3	Power Supply Specifications					
3.01	Operating voltage for ADXL335	1.8	-	3.6	V	External voltage supply (VDD), specified in datasheet
3.02	Supply current for ADXL335	-	350	-	uA	Specified by datasheet
3.03	Operating supply voltage for STM32G050	2	-	3.6	V	Absolute max rating: -0.3 - 4.0V
3.04	Current into VDD power pin on STM32G050	-	-	100	mA	Absolute maximum current
3.05	External power - lab power supply	-	9	-	V	Design requirement as per Studio Brief
3.06	Power LED current draw	-	5	10	mA	D3 in schematic
3.07	RGB LED current draw - LED Driver	-	5	10	mA	D2 in schematic
3.08	ADXL335 self-test LED	-	5	10	mA	D4 in schematic
3.09	ADXL335 power LED	-	5	10	mA	D5 in schematic
3.1	Output voltage of linear dropout (LDO) voltage regulator	-	3.3	-	V	LD117 can have fixed output voltages: 1.2V, 1.8V, 2.5V, 3.3V, 5.0V
3.11	Output current of linear droput (LDO) voltage regulator	-	-	800mA		Up to 800mA , specified by datasheet
3.12	Decoupling capacitors	0.1	-	10	uF	2 decoupling capacitors (0.1uF and 10uF) as specified in LD117 datasheet
4	ADXL335 Interface					
4.1	Mosfet supply	1.8	3.3	3.6	V	Specified by datasheet
4.2	Mosfet channel	-	N channel	-		Maximum current flow from drain to source
4.3	Self Test Logic Input High Voltage	-	2.4	-	V	Required amount to actuate self test on ADXL335
4.4	Self Test Logic Input High Current	-	60	-	uA	Required amount to actuate self test on ADXL336
4.5	Self Test Expected Output X	-150	-325	-600	mV	Specified by datasheet
4.6	Self Test Expected Output Y	150	325	600	mV	Specified by datasheet
4.7	Self Test Expected Output Z	150	550	1000	mV	Specified by datasheet
4.8	Minitek Pin Assignment	-	Mirrored pins	-		Must mirror the ADXL335 breakoutboard pins
4.9	Safety Regulation	100	-	1000	Ohm	Protect from inrush current
5	Microcontroller					
5.01	Operating voltage	2	-	3.6	V	Specified by datasheet
5.02	Output voltage	2	-	3.3	V	Required output voltage
5.03	Flash memory	-	-	64	kB	Specified by datasheet
5.04	Clock speed	-	-	16	MHz	Internal clock speed specified by datasheet
5.05	Dimensions	-	6.5 x 4.4mm, 0.65mm pitch	-		TSSOP20 packaged dimensions specified by datasheet
5.06	ADC Sampling Size	8		12	bits	Specified by datasheet
5.07	Total Pins	0	32	64		Specified by datasheet
5.08	UART Communications	2	-	3		Required for additional features/modules
5.09	Programming Method	-	SWD Debugger	-		Required for programming
5.1	SPI Communications	1	-	3		Required for additional module
5.11	I2C Communications	1	-	3		Required for additional module
6	User Interface and Communication Protocols					
6.1	Supply Voltage for Additional Components	-	-	3.3	V	Align with given power supply
6.2	GPS Module Communication	-	USART	-		Required to transmit NMEA data
6.3	SD Card Module Communication	-	SPI	-		Using FATFS to integrate
6.4	Bluetooth Module	-	USART	-		Required to transmit data messages
6.5	Encoder (button) Pin Allocation	1	-	3	Pins	To vary complexity and useability of button
6.6	LED Pace Indicator Pin Allocation	1	-	3	Pins	To vary complexity of displaying pace
6.7.1	Display Size	128x32	-	416x496	Pixel	Vary pixel and resolution dimensions
6.7.2	Display Communication	-	I2C	-		To send data to display

Sections:

- Analog Filter
- Op-amp Specifications
- Power Supply Specifications
- ADXL335 Interface
- Microcontroller
- User Interface and communication protocols

SYSTEM BLOCK DIAGRAM



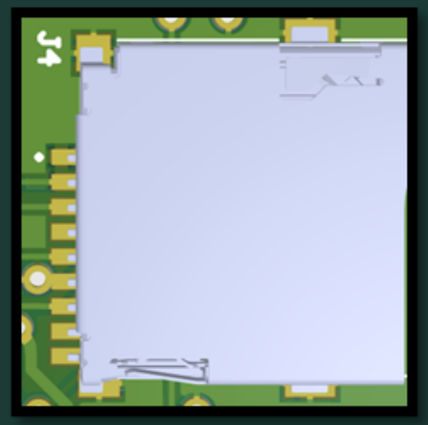
PCB

INNOVATION & CREATIVITY

Innovation:

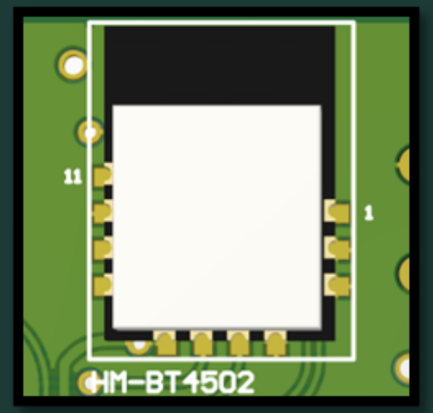
U.fl connector

Creativity:

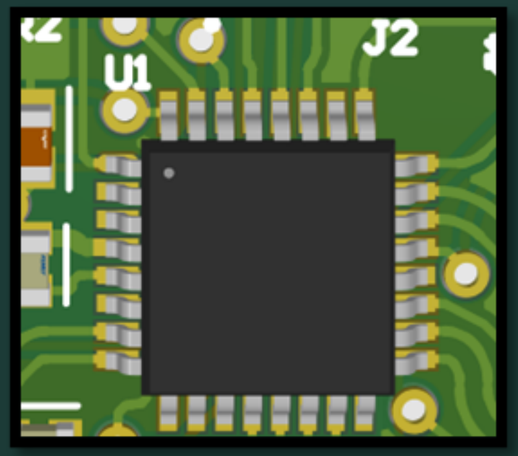


SD Card

GPS Module



BLE Module



Embedded Chip Design

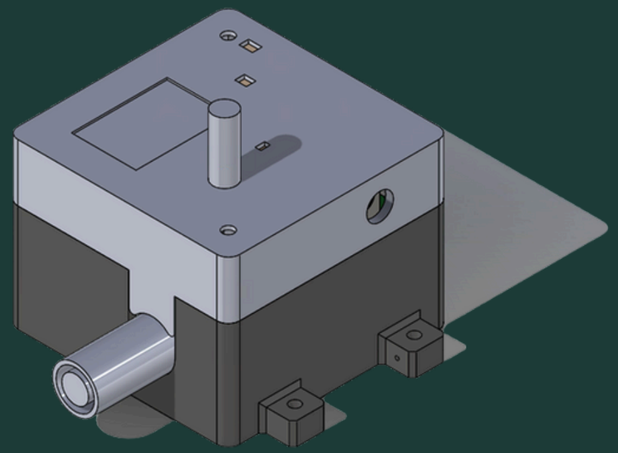
User Experience:

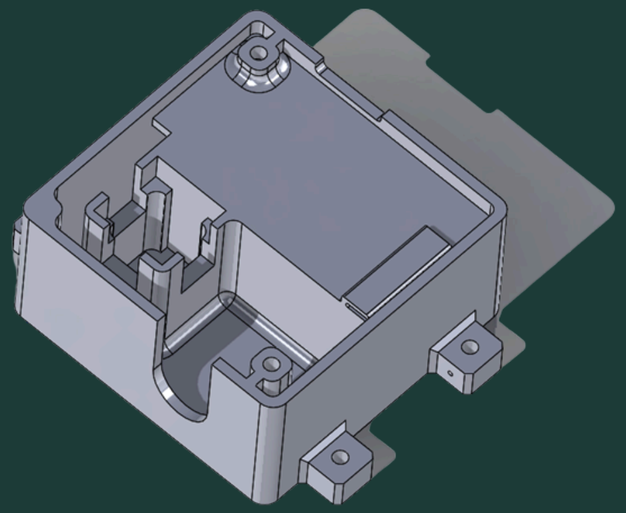
Smaller form factor

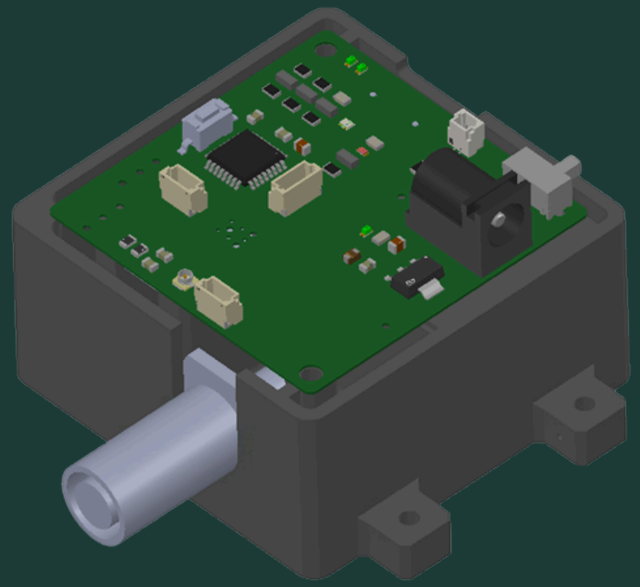
ENCLOSURE

INNOVATION & CREATIVITY

- Integrated mount for ADXL335
- Battery compartment with lid
- Compact with efficient cable management
- PLA = biodegradable!







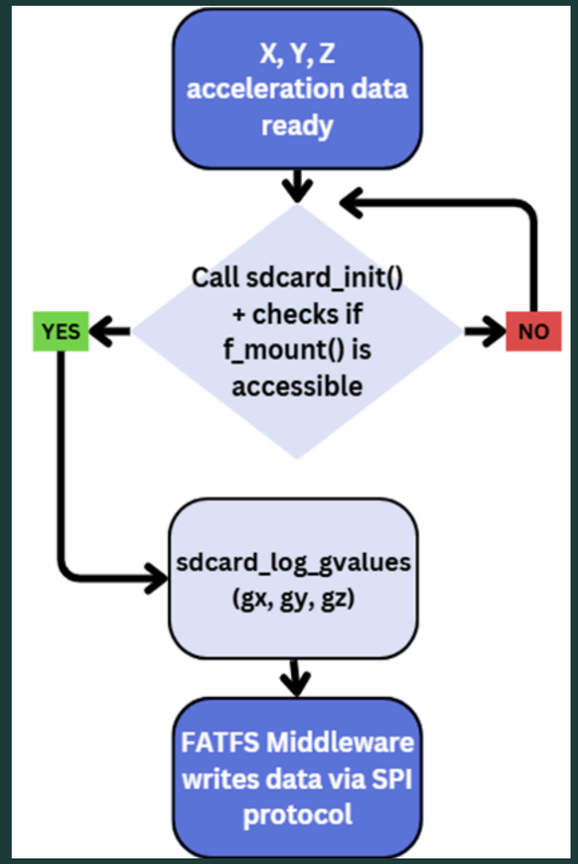
- Silicone straps + watch pins (customisable)
- OLED screen + encoder
- Visual indicators (LEDs)

EMBEDDED SOFTWARE

INNOVATION & CREATIVITY

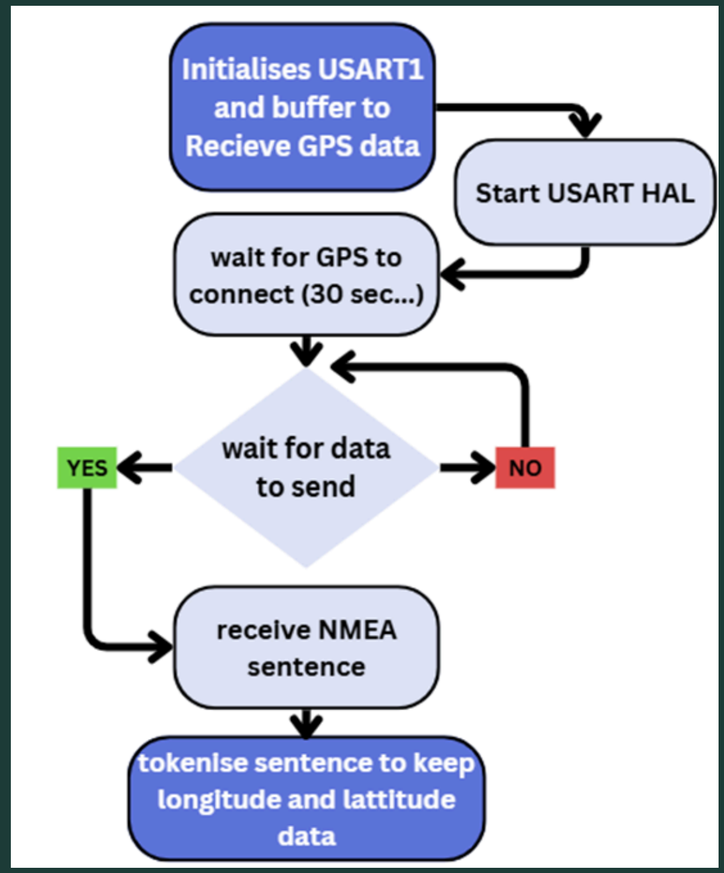
Bluetooth BLE Debugger Working

Accessible via Android and Laptop



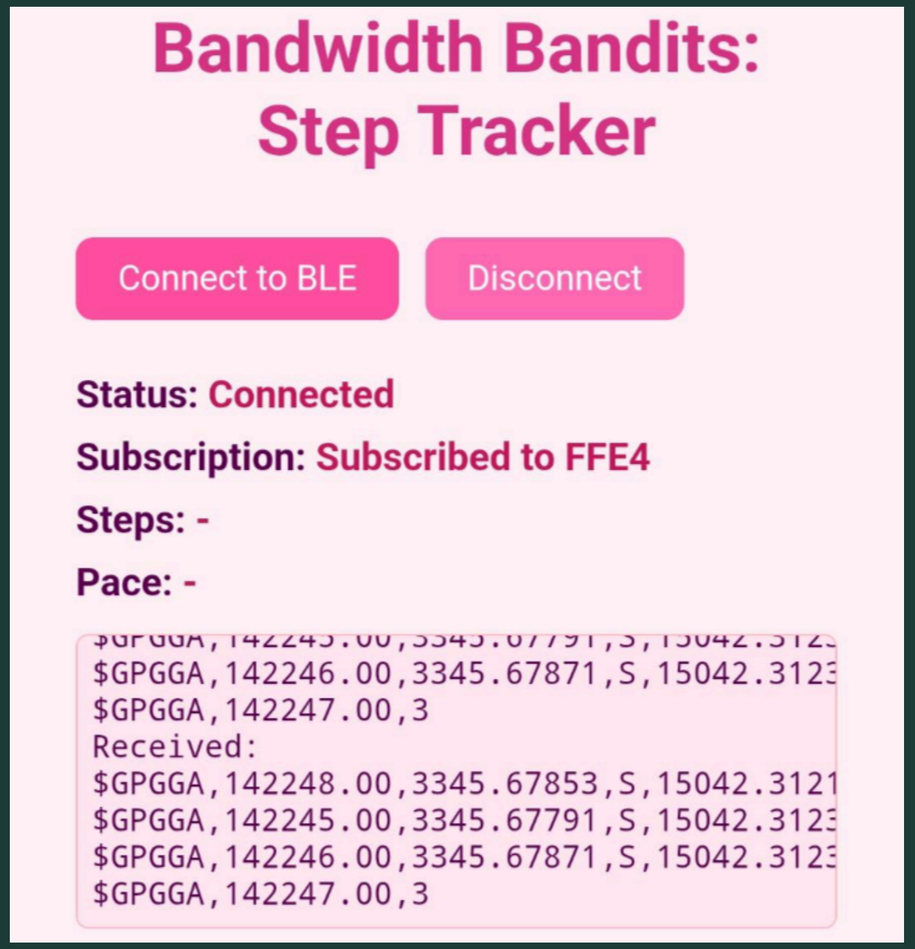
SD Card Process

Storing Acceleration Data



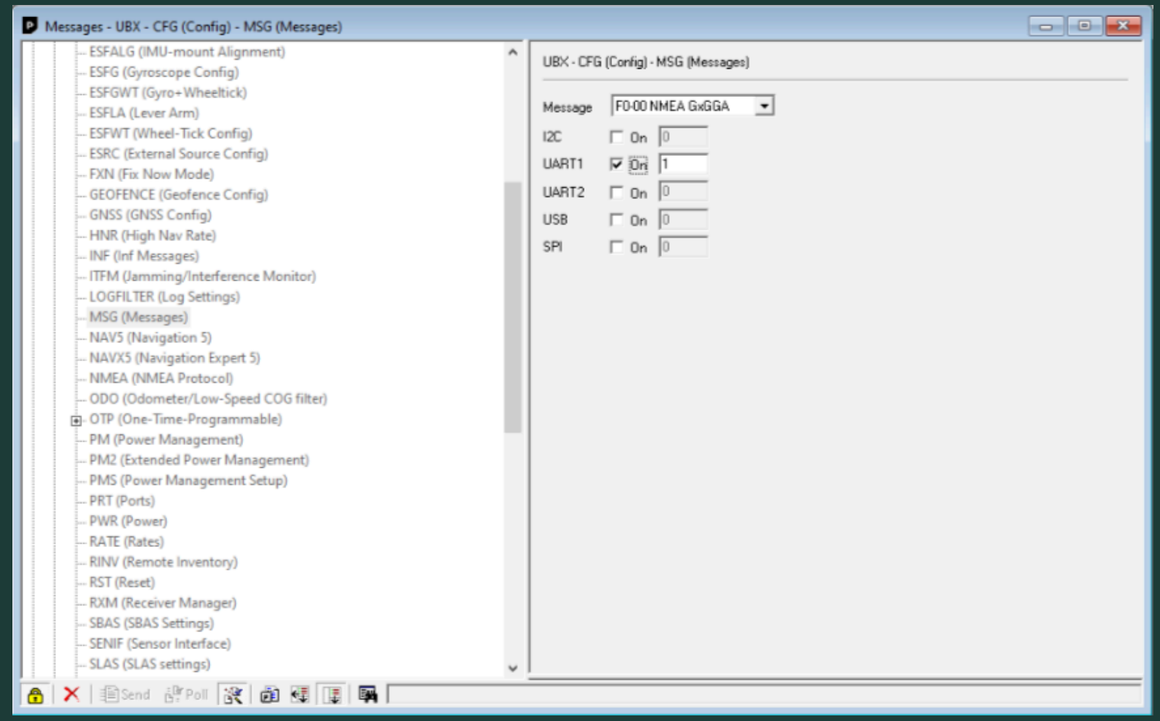
GPS Module

Extra Feature for Step Tracking



GPS Module

Read and store GPGGA data

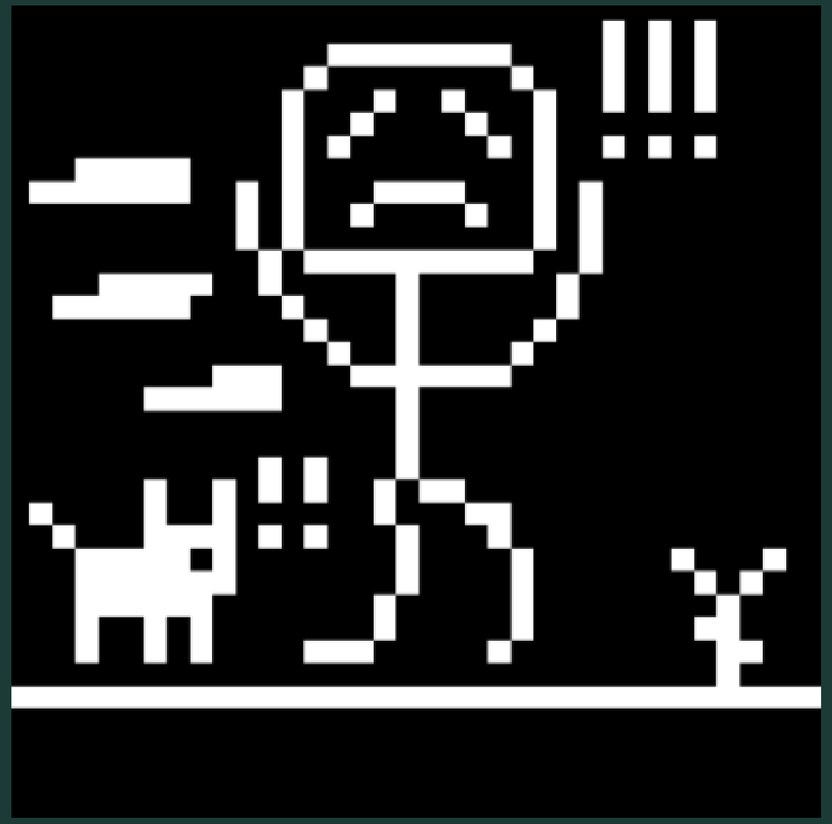


Select data type via CFG in Ublox

```
[From STM32]
--- Trying SD Card Mount ---

[From STM32] SD card stats:
  31154688 KiB total drive space.
  31044288 KiB available.

[From STM32] I was able to open 'taa.txt' for writing

[From STM32] Wrote 19 bytes to 'taa.txt'!

[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
[From STM32] STM32 BLE has connected
```

SD card allows to write and store data

Read and store GPGGA data



Convert drawings into bitmaps for OLED display

BOM

$16.12 + $13.35 + $1.37 = $30.8

No.	Parts	Qty	Price
1	Core PCB Components		
1.01	STM32G050K8T6	1	$1.87
1.02	Amphenol Minitek127	1	$0.46
1.03	CAP 0805 0.10 µF 50 V	3	$0.07
1.04	CAP 0805 4.70 µF 50 V	1	$0.19
1.05	CAP 0805 47,000 pF 50 V	6	$0.58
1.06	CAP 0805 10 µF 50 V	1	$0.28
1.07	DIODE SCHOTTKY 20V 500MA 0805	1	$0.34
1.08	LED RED CLEAR CHIP SMD	1	$0.20
1.09	LED RGB CLEAR 4SMD	1	$0.45
1.1	LED GREEN CLEAR CHIP SMD	3	$0.42
1.11	IC OPAMP GP 1 CIRCUIT SOT23-5	6	$1.20
1.12	IC REG LINEAR 3.3V 800MA SOT223	1	$0.29
1.13	SWITCH SLIDE SPDT 200MA 30V	1	$0.94
1.14	N-type Power MOSFET, 60 V	5	$0.44
1.15	Chip Resistor 280R	6	$0.04
1.16	Chip Resistor 10k	6	$0.54
1.17	Chip Resistor 20k	1	$0.10
1.18	Chip Resistor 100R	2	$0.15
1.19	Chip Resistor 47.5k	6	$0.13
1.2	Push Button Switch, 50 mA	1	$0.33
1.21	Test point loop	10	$2.93
1.22	CONN HEADER SMD 5POS 1MM	1	$0.79
1.23	CONN HEADER SMD 4POS 1MM	2	$0.73
1.24	CONN WIRE HDR 2POS 1MM STSMD	1	$0.29
1.25	CONN U.FL RCPT STR 50 OHM SMD	1	$0.54
1.26	Power Barrel Con, 2.0mm ID, 5.5mm OD	1	$0.68
1.27	CONN SOCKET 28-32AWG CRIMP TIN	15	$0.79
1.28	CONN RCPT HSG 4POS 1.00MM	2	$0.17
1.29	CONN RCPT HSG 5POS 1.00MM	1	$0.12
1.3	CONN RCPT HSG 2POS 1.00MM	1	$0.06
Total			$16.12

2	User Interface		
2.1	Micro SD Card Connector	1	$0.36
2.2	BLE Module	1	$2.95
2.3	OLED I2C IIC 128x64 Pixel SSD1306	1	$2.78
2.4	Rotary Encoder Module, 360° Rotation	1	$5.32
2.5	9V Battery Clip Connector	1	$0.16
2.6	9V Battery	1	$1.78
Total			$13.35

3	Additonal Feature		
3.1	NEO-6M GPS Module	1	$1.37
Total			$1.37

Total Price:

$16.12 + $13.35 + $1.37 = $30.83

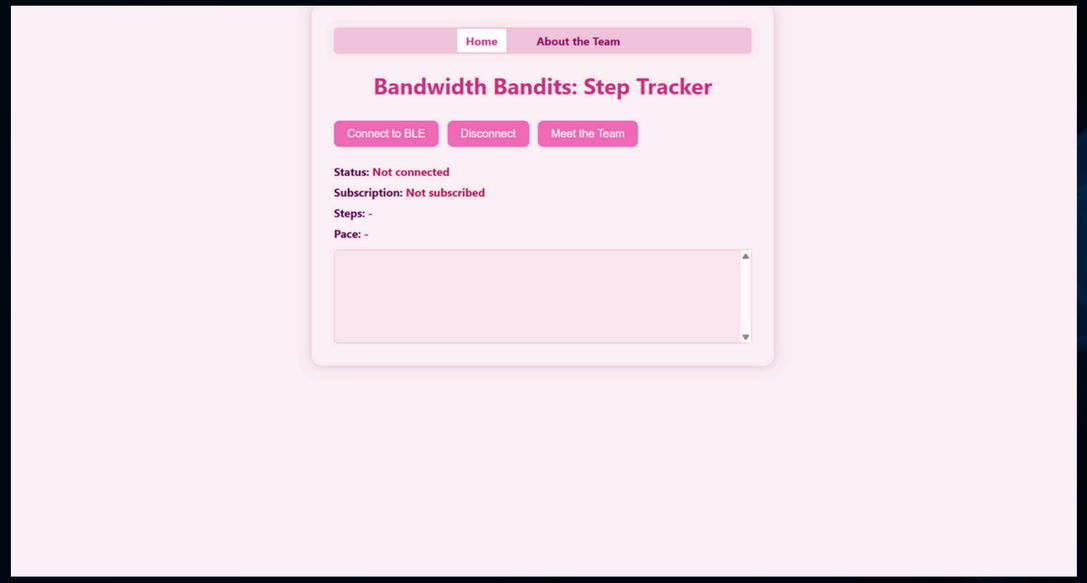
EVALUATION FEEDBACK

End of Week Altium Reviews

Make sure to mention how we implemented feedback throughout our presentation

VISIT OUR WEBSITE

Bandwidth Bandits



https://24570335.github.io/step-tracker-site/

Bandwidth Bandits

THANK YOU!

FOR YOUR ATTENTION