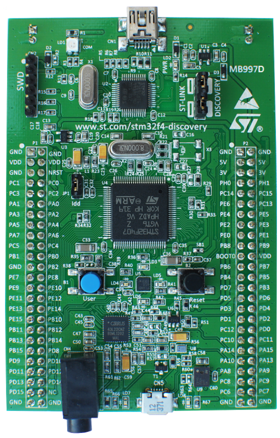
Project: Envirosensing HAT for use with the STMDiscovery

Project Description



The discovery board has a STM32 microcontroller on board, a range of peripherals, circuitry to control power and programming the microcontroller, and a standard pin interface. In this project in teams of 3 you will be designing and manufacturing a HAT that connects to the discovery using the standard pin headers and which will then give the board the ability to detect new environmental parameters.

HATs: “Hardware Attached on Top” have become a common way to extend popular small low cost electronics boards in the hobbyist market. Probably the most common is the wide range of HATs available for Raspberry Pis (see some 2022 examples here).

HATs make use of the fact that the base board has a microprocessor or microcontroller that is capable of doing many things, along with the power and interface circuitry to run it, and importantly a standardised interface and header to the micros pins. For instance, the Raspberry Pi foundation has a published 40 pin interface standard for the Pis that further include standard mechanical dimensions and power requirements.

Minimal Project Requirements   version 0.01

We will be building an autonomous logging daughter-board for your STM32Discovery Boards. The core requirements for it are:

Basic requirements:

- (at least) 1x digital sensor (some communication port)
- (at least) 1x analog sensor (ADC input)
- An 18650 connector (DNP)
- A Li-Ion battery charger
- Input voltage polarity protection
- Battery polarity protection
- Battery Under-voltage cutout protection
- (Soft requirement) Modularity between perceived elements to allow for bypassing to ensure you meet partial mark requirements in the event of module failure.
- USB micro connector, detect and input and have an onboard FTDI

- Working in teams of 3 each team will have a budget of R1500 for all components, manufacture, assembly and shipping. Currently, this is approximately $100 (useful to think in USD as the part prices are listed in such)
- Each team member must take the lead in 1 submodule:
    - Power management
    - Microcontroller interfacing
    - Sensing

Further requirements

1. The HAT must operate off 5V and down convert that to 3V3 before pushing that single wire out the current wires on the debug connector. Everything needs to be powered off the 3V3 line. Only the battery can be charged from the 5V rail.

2. The HAT needs to keep key configuration data in a non-volatile medium along with sensor data timestamped throughout the operational period.

3. The HAT needs to measure at a minimum of 1/60 Hz which is required to be soft-configurable.

4. You need Test points and disconnects over your essential wires.

5. You will need debug pins available for testing

6. There will be an assigned connector output for testing purposes. This is highlighted below

Connector	**Pin Number**	**Function**
USB	1	Link
	2	Link
	3	Link
	4	Link
	5	Link
Debug	1	5V Input Power
	2	Device Current Out
	3	Device Current In

	4	Analog Data Read
	5	Digital Data Line (1)
	6	Digital Data Line (2)
	7	Digital Data Line (3)*RESV
	8	Digital Data Line (4)*RESV
	9	Plug Detect
	10	GND

On USB plug-in event

Once the device has been plugged in, the HAT needs to provide its data through an automatic connection.

JLC Requirements

You will be making the basic $2/4 double layer PCB from JLCPCB.
We will be making use of their Assembly and populating most/all items through their service. Any other items not purchased need to be purchased and populated manually which will carry a very high risk of you potentially breaking your board.

5 copies of each HAT will be produced: 1x for destruction, 1x testing, 1x for each student in the team for software development and debugging.

Power Budget

A power budget is an effective estimate of device lifetime and current consumption.
This could be per reading, or per day with x% of time spent in y mode of operation, or number of months of operation expected given a y rate of readings.

Sensors are likely to be your largest power consumer. Take some time to consider what power performance your device needs for your given use case. Then, with this goal in hand, make some assumptions and carry out some simple calculations to get a rough idea of what level of power performance is plausible with a given selection of sensors. These estimates will not be an exact representation of how the system will ultimately perform but should help you make informed design decisions.

Monetary Budget

You will need to plan out how you will spend your money. As indicated in the lecture you need to use components available in the JLCPCB catalogue. The following values are given as a rough guideline to help you in selecting how to use the ZAR1500 = ~$100 //18/02/22

- Shipping and customs: $20

- Manufacture: ~$11 = $4 (2layer) + $7(assembly) //Assumes non-extended items which are allowed but cost extra (~$3 per item) per item for assembly
- Components: $69

Bonus potential

During grading, each team's HAT will have its power consumption measured during Idle (non-sensing) state. Teams will be ranked according to power consumption, the HAT which consumes the lowest idle power will receive bonus marks.

Note, do not make the mistake of thinking this is solely the responsibility of the Power submodule lead. Power consumption especially in an idle state depends on (1) all submodules circuit design, (2) all submodule PCB layout and component selection, and (3) microcontroller configuration and software settings making this challenge a factor for all team members.

Restrictions

As students discover exploits to our requirements, restrictions will be added here. This document is a living document and will be updated throughout the course. Announcements about large revisions will be made. Ultimately it is your responsibility to ensure that your final design adheres to the final requirements.

1. A voltage divider is not a valid analog sensor