SuperPower

SuperPower Team, ESP Team, Raspi Team

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PROJECT

CHAPTER

ONE

SUPERPOWER

Here you should find the best power supplies for your low-power projects. Because of different requirements for an Raspberry Pi and micro-controllers like the ESP32 we split the project into two boards, one for the Raspberry Pi (SuperPower-Rpi) and one for micro-controllers (SuperPower-uC) with low power.

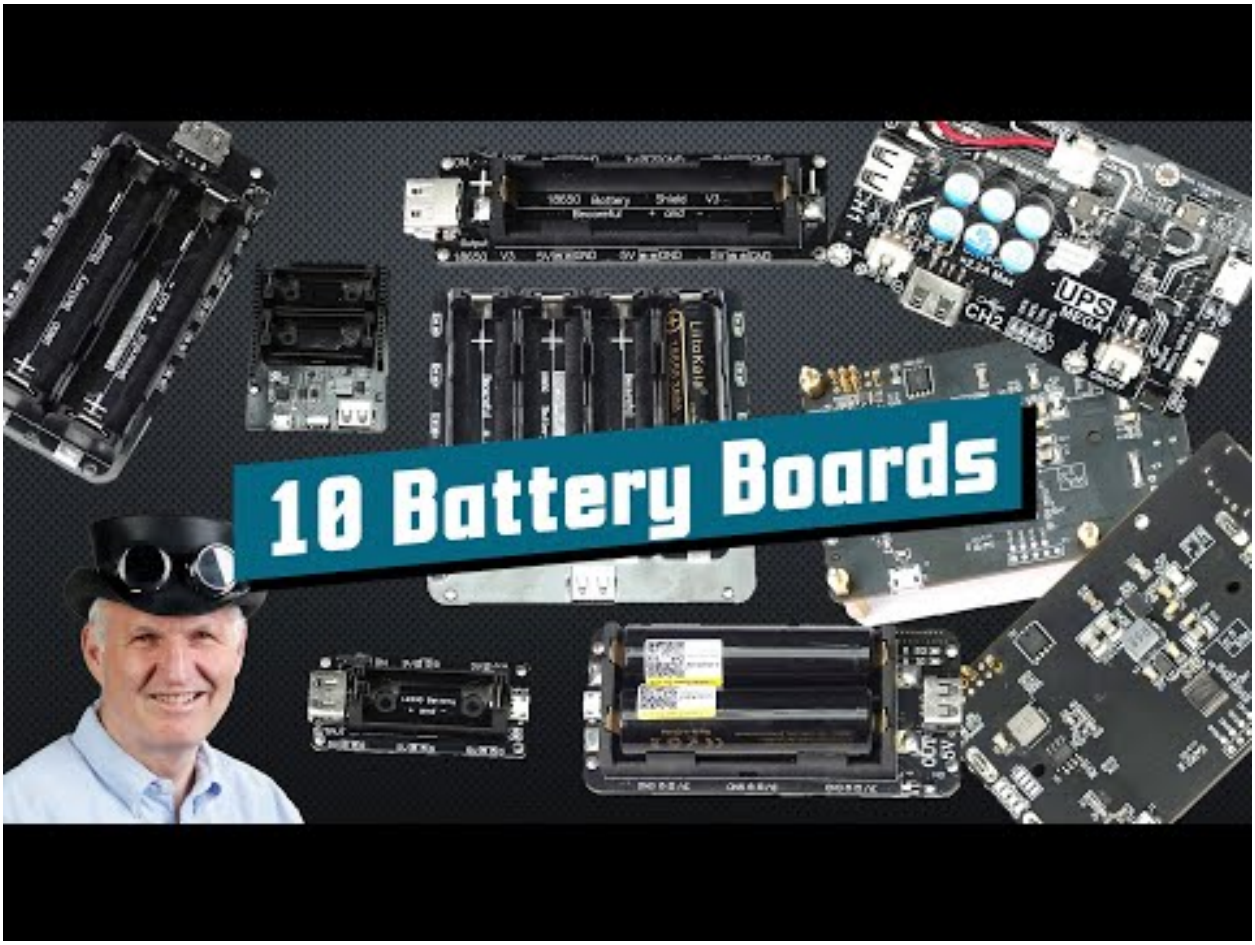
1.1 Development links

Discord Channel

Google Drive Project Files

GitHub Project

1.2 Kick-off video



CHAPTER

TWO

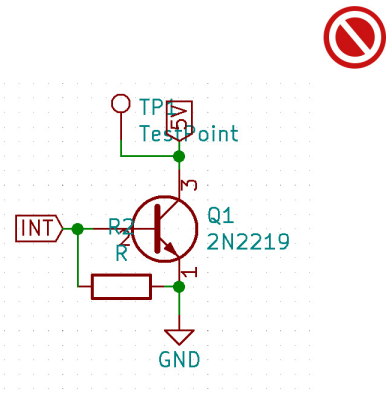
GUIDELINES

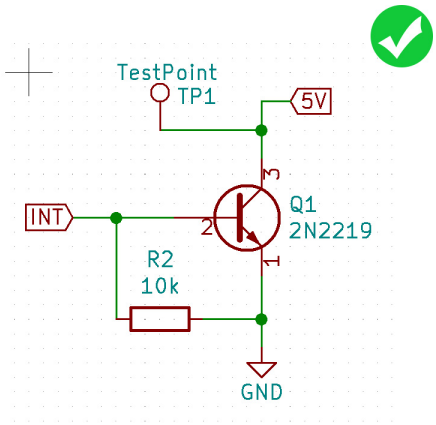
Good schematics show you the circuit. Bad schematics make you decipher them. Here you can find a bunch of guidelines we set up to get consistent schematics along the project.

2.1 Schematics

2.1.1 Clean Text placement

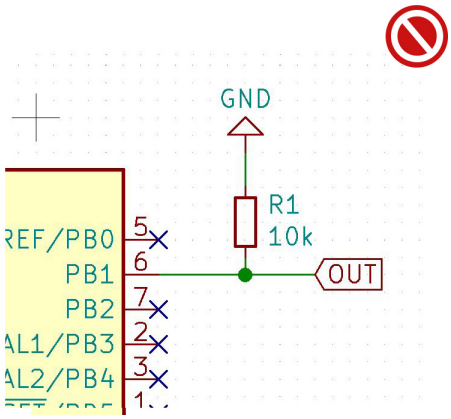
- After placing a symbol make sure the designator is close to the symbol and does not overlap other text or tracks
- Make some space and move parts if they are too close
- Do not place text verticaly

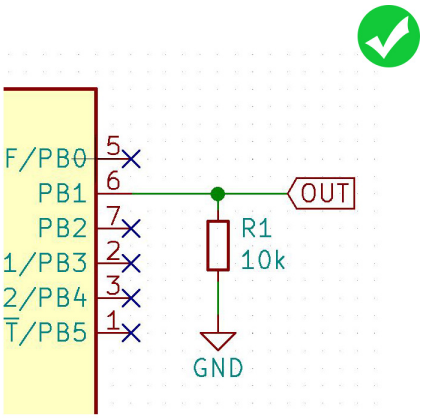




2.1.2 Layout flow

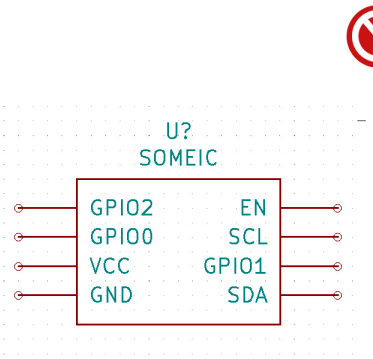
- Logical flow from left to right
- Power connectioncs should go up to positive voltages and down to negative voltages
- Rotate common symbols the same way to find similarities faster in a schematics

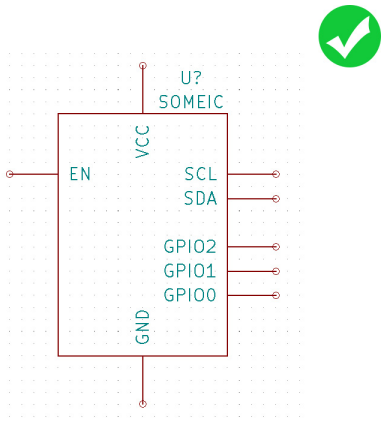




2.1.3 Schematic Symbols

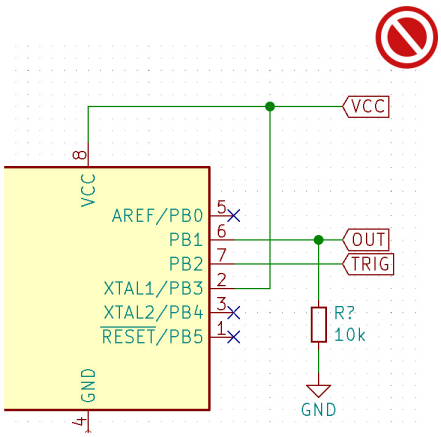
- Show pins of an IC in a position relevant to their function, not how they happen to stick out of the chip.
- Positive pins top the top
- Negative pins to the bottom
- Inputs to the left
- Outputs to the right

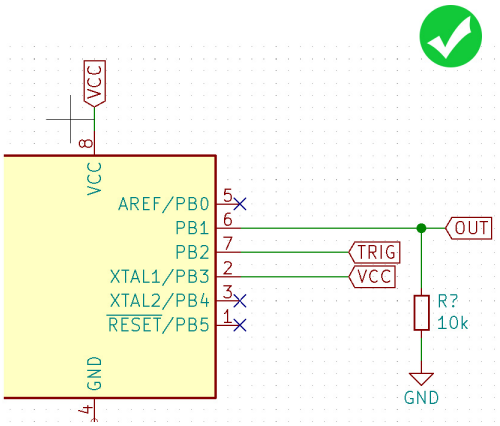




2.1.4 Direct connections, within reason

- reduce wire crossing and alike as much as possible for clarity
- draw dots on junctions if your tool does not do it for you (if not you should use a better one)





2.1.5 NETs and Labels

- Give your NETs nicely readable names
- But keep them reasonably short
- Always try to use your tool to select a NET instead of writing it by hand to avoind spelling mistakes
- Use upper case for NET Labels
- See this ANSI/IEEE standard for recommended pin name abbreviations.

CHAPTER

THREE

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CHAPTER

FOUR

OVERVIEW

The Super Power uC Project is the SuperPower for microcontrollers. A ultra low power charging device for USB and Solar charging for any type of Microcontroller (3.3v).

CHAPTER

FIVE

ORIGINAL VARIANT

The original version of the SuperPower Board consists of an ESP32 as microcontroller and it tries to fulfill most of the requirements. We tried to find the best components to fit the requirements with ultra low power.

5.1 BOM

	Component	Description	Datasheet
1	LM3671	2-MHz, 600-mA Step-Down DC-DC Converter	Link
2	TPS61032	96% Efficient Synchronous Boost Converter With 4A Switch	Link
3	LTC4162-L	35V/3.2A Multicell Lithium-Ion Step-Down Battery Charger with PowerPath and I2C Telemetry	Link
4	RV-3028-C7	Extreme Low Power RTC Module 45nA@3V	Link
5	AP9211	Single chip protection solution specially designed for 1-cell Li+	Link
6	CP2102N	highly-integrated USB-to-UART bridge controller	Link
7	MCP23009	8-Bit I2C I/O Expander with Open-Drain Output	Link

CHAPTER

SIX

LOW COST VARIANT

The low cost variant is a variant with different and cheap components. It does not fulfill the requirements 100% but still is low power.

6.1 Bill of Main IC Components

Table 1: Bill Of Materials

Reference	Quantity	Value	Datasheet	Footprint	LCSC
U1	1	FS312F-G	https://www.ic-fortune.com/upload/Download/FS312F-G-DS-12_EN.pdf	Package_TO_SOT_SMD:SOT-23-6_Handsoldering	C782736
U10	1	FP6291LR	www.feeling-tech.com.tw/km-master/ezcatfiles/cust/img/img/24/fp6291v064.pdf	Package_TO_SOT_SMD:SOT-23-6_Handsoldering	C718701
U11 U12	2	ME6210A33P	https://datasheet.lcsc.com/szlcsc/1810201611_MICRONE-Nanjing-Micro-One-Elec-ME6210A33PG_C85233.pdf	Package_TO_SOT_SMD:SOT-89-3_Handsoldering	C85233
U13	1	ESP32-WROOM-32	https://www.espressif.com/sites/default/files/documentation/esp32-wroom-32_datasheet_en.pdf	RF_Module:ESP32-WROOM-32	C82899
U2	1	FS8205A	https://www.ic-fortune.com/upload/Download/FS8205A-DS-12_EN.pdf	Package_SO:TSSOP-8_4.4x3mm_P0.65mm	C16052
U3	1	LC709203FQH	https://www.onsemi.com/pub/Collateral/LC709203F-D.PDF	Package_DFN_QFN:WDFN-8-1EP_4x3mm_P0.65mm_EP2.4x1.8mm	C152311
U4	1	TP4056	https://dlnmh9ip6v2uc.cloudfront.net/datasheets/Prototyping/TP4056.pdf	Package_SO:SOP-8_3.9x4.9mm_P1.27mm	C16581
U5	1	CH340G	https://www.mpja.com/download/35227cpdata.pdf	Package_SO:SOP-16_4.55x10.3mm_P1.27mm	C14267
U6	1	AMS1117-3.3	http://www.advanced-monolithic.com/pdf/ds1117.pdf	Package_TO_SOT_SMD:SOT-223-3_TabPin2	C6186
U7	1	PCF8563T	https://www.nxp.com/docs/en/data-sheet/PCF8563.pdf	Package_SO:SOIC-8_3.9x4.9mm_P1.27mm	C7440
U8	1	XC6206P332MR	https://www.torexsemi.com/file/xc6206/XC6206.pdf	Package_TO_SOT_SMD:SOT-23_Handsoldering	C5446
U9	1	TCA6408A	https://www.ti.com/lit/ds/symlink/tca6408a.pdf?ts=1602171918658&ref_url=https%253A%252F%252Fwww.ti.com%252Fproduct%252FTCA6408A	Package_SO:TSSOP-16_4.4x5mm_P0.65mm	C206177
Y1	1	12MHZ	https://datasheet.lcsc.com/szlcsc/Yangxing-Tech-X322512MSB4SI_C9002.pdf	Crystal:Crystal_SMD_3225-4Pin_3.2x2.5mm_HandSoldering	C9002
Y2	1	32.768KHz	https://datasheet.lcsc.com/szlcsc/1901081604_Seiko-Epson-Q13FC1350000400_C32346.pdf	Crystal:Crystal_SMD_3215-2Pin_3.2x1.5mm	C32346

6.2 Full Bill of Materials

Reference	Quantity	Value	Datasheet
C1 C2 C8 C9 C14 C15 C19 C20	8	0.1µF	~
C3 C5 C10 C11 C12 C13 C21	7	1µF	~
C4 C16 C17 C18	4	10µF	~
C6 C7	2	22pF	~
D1 D2	2	LED	~
D3	1	SM4007	http://cdn-reichelt.de/documents/datenblatt/A400/SM

Reference	Quantity	Value	Datasheet
D4	1	D_Schottky	https://datasheet.lcsc.com/szlcsc/1903051003_MDD-
J1	1	Battery connector	https://datasheet.lcsc.com/szlcsc/1811051822_JST-Sa
J2	1	Thermistor	https://datasheet.lcsc.com/szlcsc/TDK-NTCG163JF1
J3	1	USB_C_Receptacle_USB2.0	https://www.usb.org/sites/default/files/documents/usb
J4	1	Solar in	https://datasheet.lcsc.com/szlcsc/1811051822_JST-Sa
J5 J6	2	main pin header	~
J7	1	IO expander pins	~
JP1	1	CHRG_Jumper	~
JP2	1	INT override	~
JP3	1	MCULDO_override	~
L1	1	3.3u	~
Q1 Q2 Q7	3	2N7002	https://www.fairchildsemi.com/datasheets/2N/2N700
Q3 Q4	2	S8050	http://www.unisonic.com.tw/datasheet/S8050.pdf
Q5 Q6	2	AO3401A	http://www.aosmd.com/pdfs/datasheet/AO3401A.pdf
R1 R10 R18	3	1k	~
R15 R17	2	22k	~
R19 R20	2	5.1k	~
R2	1	100	~
R3 R8 R9 R11 R12	5	10k	~
R4 R5	2	1.8k	~
R6 R13 R14 R16	4	180k	~
R7	1	1M	~
U1	1	FS312F-G	https://www.ic-fortune.com/upload/Download/FS312
U10	1	FP6291LR	www.feeling-tech.com.tw/km-master/ezcatfiles/cust/i
U11 U12	2	ME6210A33P	https://datasheet.lcsc.com/szlcsc/1810201611_MICR
U13	1	ESP32-WROOM32	https://www.espressif.com/sites/default/files/documer
U2	1	FS8205A	https://www.ic-fortune.com/upload/Download/FS820
U3	1	LC709203FQH	https://www.onsemi.com/pub/Collateral/LC709203F-
U4	1	TP4056	https://dlnmh9ip6v2uc.cloudfront.net/datasheets/Prot
U5	1	CH340G	https://www.mpja.com/download/35227cpdata.pdf
U6	1	AMS1117-3.3	http://www.advanced-monolithic.com/pdf/ds1117.pdf
U7	1	PCF8563T	https://www.nxp.com/docs/en/data-sheet/PCF8563.pd
U8	1	XC6206P332MR	https://www.torexsemi.com/file/xc6206/XC6206.pdf
U9	1	TCA6408A	https://www.ti.com/lit/ds/symlink/tca6408a.pdf?ts=16
Y1	1	12MHZ	https://datasheet.lcsc.com/szlcsc/Yangxing-Tech-X32
Y2	1	32.768KHz	1901081604_Seiko-Epson-Q13FC1350000400_C323

CHAPTER

SEVEN

REQUIREMENTS

7.1 Project requirement document

Requirements ESP32 Boards shared spreadsheet

7.2 Requirements Overview

	Requirement	Discord username	Category
1	Support different ESP modules	wassfila	uC
2	power cut-off circuit + RTC Timer	Informatic0re	power
4	3v3 Output	Andreas Spiess	power
5	5V Output	Andreas Spiess	feature
6	USB charging	Andreas Spiess	charging
7	Solar charging	Andreas Spiess	charging
8	Charging while powering	Andreas Spiess	charging
9	Replacable batteries	Andreas Spiess	battery
11	Low voltage signal/alarm/interrupt	Andreas Spiess	power
12	Battery low voltage protection	Andreas Spiess	battery
13	Over charge and discharge protection	Andreas Spiess	battery
14	charge indicator	Andreas Spiess	charging
25	Charger control (enable/disable)	tealbrains	charging
26	Li-Ion Chemistry as 18650, 16340 and FlatPack	tealbrains	battery
28	Hysterisis between battery low and battery ready.	metimmee	feature
32	Modular architecture with optional components	wassfila	organisation
33	Test Points	Informatic0re	feature
34	Expose ESP32 Serial pinouts for flashing	wassfila	uC
35	LOW power consumption (of the regulator board itself)		
37	Usb C	fabrifer020	feature
38	Reverse voltage protection	fabrifer020	safety
40	Controllable 3v3 Output	leven	
43	Expose Battery pins (post protection)	tealbrains	feature
46	Having Both Holder And Connecter	Trance_Paradox	feature
50	Short Circuit Protection on the output	johnheuk	safety
53	Barrel Jack / Screw Terminals	johnheuk	feature
63	Expose unused ESP32 GPIO Pins	wassfila	uC
88	Open Hardware License	Noki	

7.3 All Initial Requirements

	status	Requirement	Discord username	Category	Why ?
1		Support different ESP modules	wassfila	uC	ESP32 WROOM, WROVER, S2
2		power cut-off circuit + RTC Timer	Informatic0re	power	Cutting off the power lowers the current draw to <1mA
3	rejected	Actionable documentation	LEMD49	organisation	Containing: principles & block diagram, wiring diagram, BOM w all components and mechanical parts / connectors, Normal operations levels (can be notes on cct diagram), troubleshooting flow....
4		3v3 Output	Andreas Spiess	power	Power supply for MCU
5		5V Output	Andreas Spiess	feature	Usefull for sensors which need 5V but should have a on/off
6		USB charging	Andreas Spiess	charging	
7		Solar charging	Andreas Spiess	charging	Power for the system when it is installed in locations where USB is not available and where swapping the battery every year or so is not desired
8		Charging while powering	Andreas Spiess	charging	
9		Replacable batteries	Andreas Spiess	battery	
11		Low voltage signal/alarm/interrupt	Andreas Spiess	power	

continues on next page

Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
12		Battery low voltage protection	Andreas Spiess	battery	
13		Over charge and discharge protection	Andreas Spiess	battery	
14		charge indicator	Andreas Spiess	charging	
15	rejected	Maximum Battery life (e.g. sensor mode current < 50uA, life 1 year)	wassfila	feature	Define the maximum achievable savings by the modular design, (e.g. short wake up, send ESP-NOW packet and back to sleep). I set 50 uA arbitrarily as suggested by tealbrains an anyone please feel free to vote or update
16	rejected	Minimum Battery life (e.g. performance mode current <200uA, life 3 Months)	wassfila	feature	Set a target for the least achievable performance of the modular design, e.g. when deprived from all external optional components. e.g. no external RTC.
17	rejected	Specify a maximum quiescent current	tealbrains	organisation	(Instead of 15. and 16.) Lifespan of device will be application dependent. The property of this circuit must be independent. For example, fix quiescent current to be < 50uA.
18	rejected	ESD security	RV3Dtech	safety	
19	rejected	I2C Interface & Arduino Library	RV3Dtech	feature	

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
20	rejected	Security of supply of the components + 5y	RV3Dtech	organisation	
21	rejected	Breadboard friendy design	Informaticore	feature	you know why
22	rejected	Multi-chemistry	tealbrains		Some users may use Li-Ion, others may use LiFePO4. NiMH is broadly available
23	rejected	Temperature (over and under) protection	Thomas	safety	Safety (can't charge battery at any temperature, there is a risk of damage), can be part of the charger IC
24	rejected	Battery heater	Thomas	feature	If used in cold areas there might be many weeks/months of continious battery temp too low for charging.
25		Charger control (enable/disable)	tealbrains	charging	Reduce the number of charging cycles (specially for solar applications, where we may not want to charge the battery constantly) in order to increase lifespan of battery. AND allow to measure the battery voltage accurately
26		Li-Ion Chemistry as 18650, 16340 and FlatPack	tealbrains	battery	Some users may use Li-Ion 18650 and 16340 or Flat Pack

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
27	rejected	LiFePO4 Chemistry	tealbrains	battery	Some users may use LiFePO4. The chemisty is better for cold climates.
28		Hysterisis between battery low and battery ready.	metimmee	feature	Solar devices in winter may bump along at minimum voltage for extended periods. For some applications, it may be better for the micro to go to sleep for an extended period to allow the battery to charge more than the minimum amount.
29	rejected	Optional OLED based small info display	Wajid	feature	can display self health and other parameters without being attached to target system
30	rejected	cascading option for increased power	Wajid		for example some project need more power then it can simply stack the power supplies to increase power
31	rejected	Designing a full featured (one or more) board and a standalone board for “any” application with the same requirements.	Vincent (inspired from Discord - I do not remember the name of the author. . .)	organisation	It allows to have a ready to go board. Or to have a module.

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	status	Requirement	Discord username	Category	Why ?
32		Modular architecture with optional components	wassfila	organisation	Although this might be the main idea already, I added it as requirement to refer to it and translate its impact on the design. This might have to be broken down into what is modular and what not ? RTC optioanl, ESP32 itself optional as mentionned in req_31 ? ...
33		Test Points	Informatic0re	feature	We need test points at any usefull position for proper validating of the circuit
34		Expose ESP32 Serial pinouts for flashing	wassfila	uC	If we plan to have a module soldered on the PCB, we would need to flash it, a serial to usb converter might not be necessary to be on the pcb as it could be similar to the ESP32-cam with external serial to usb. Use https://randomnerdtutorials.com/esp32-pinout-reference-gpios/ as aa reference (very good) And do not expose GPIO36! Ask Informatic0re why

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
35		LOW power consumption (of the regulator board itself)			In Solar powered applications, the overhead power consumtion of chargers/regulators can be too much.
36	rejected	Wemos D1 mini shield			It is nice to have the power board directly fit on the Wemos D1 mini as many other shields
37		Usb C	fabrifer020	feature	This will make it more future-proof and its going to be nice to have the new usb standard while not having to worry about wich way you connect the usb
38		Reverse voltage protection	fabrifer020	safety	To not fry our Boards with a common mistake that could be prevented with just a few components and negligible current loss for saving our boards
39	rejected	Adjustable output voltage (buck/boost)	davidfet	feature	To allow the board to be used for multiple projects which may have varying power requirements

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	status	Requirement	Discord username	Category	Why ?
40		Controllable 3v3 Output	leven		A 3.3V Output which can be tunred on and off by the MCU to power sensors and other things
41	rejected	Create (1+) standard slots for expansions	tealbrains		Some features are "nice to have" such as additional buck / boosts, or power bus controls. Ultra-low power modes such as using an RTC + SRAM. These features are not "core features" so leaving the slots unpopulated by default will allow the team to develop some expansions and the users to also develop their own expansions if they need to.
42	rejected	Define maximum/minimum acceptable size	tealbrains	dimensions	This will limit the number of options, connectors, etc and requirements that can be met. Is having a connector for 18650 for example a good idea? Or 14500? etc
43		Expose Battery pins (post protection)	tealbrains	feature	This allows the user to power some modems or loads directly from the battery without extra losses that occur using a voltage regulator

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	status	Requirement	Discord username	Category	Why ?
44	rejected	Power on-off behaviour, similar to a mobile phone	Florian	feature	Possibility to power off via a button and via a MCU signal. If external power transitions from off to on while the board is powered off because of low battery, then power it on. But do not power it on if battery level is OK, indicating powering off was intentional (via power off button or MCU signal). This behaviour would be helpful when the external power is intermittent (solar pannels, mobile units similar to a phone). It would allow automatic restarts when external power is available after a powerdown because of low battery, while allowing for voluntary shutdown too.
45	rejected	Support For ESP 32 Modules	Trance_Paradox	uC	Support for different Modules like ESP32-Wrover, ESP32-Mini, ESP32-Wroom etc And providing breakouts for those also

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
46		Having Both Holder And Connecter	Trance_Paradox	feature	Having both 18650 Holder and connector terminals for li-po battery would provide grea flexibility
47	rejected	Toggle switch to turn on and off boost circuitry		feature	boost circuit takes considerable amount of stand by current (quicient Current). if the user have the option to turn off the boost circuitry by a toggle switch(or simply by a jumper) and use only the 3.3 V from a ldo would be beneficial when working with 3.3 V low power devices.
49	rejected	consider modularity; e.g. having additional boost / display options as hats	johnheuk	feature	to keep base price / complex of basic supply as low as possible. the hats need not physically sit on top of each other or require additional board space but could be connected via 2.54mm dupont pins to keep the basic board as compact as possible
50		Short Circuit Protection on the output	johnheuk	safety	we all know why..... :D

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
51	rejected	at least the outputs should have 2.54mm jumper pins for quick connection to a breadboard, ideally there should pins and pads for the input, battery and output	johnheuk	feature	pushing modules into a breadboard can be difficult / the user may not have one to hand / they use up a lot of space. for permanent installation, solder pads would be a good idea. this would also allow the user to monitor incoming / storage & outgoing voltages more easily. some people may want to tap into the battery supply itself as batteries typically offer much, much better noise performance

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	status	Requirement	Discord username	Category	Why ?
52	rejected	ideally there should be two or three such 2.54mm pins for the output and they should be positioned on opposite sides of the board, not adjacent to one another	johnheuk	feature	the user may want to connect one set to their micro and another to a different module. i have managed to exploderise a breadboard power supply 30 seconds after powering it up after i accidentally shorted the gnd and vcc output header pins checking the voltages with a meter probe - the pins where right next to each other
53		Barrel Jack / Screw Terminals	johnheuk	feature	not everyone has a soldering iron, or one that's good enough to solder to via stitched ground planes, or may not have a spare usb lead. having a few different connection methods would be great

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
54	rejected	MPPT (power tracking) / scavange / harvest	johnheuk	power	if the device is trickle charging from a tiny solar cell, having an MPPT type charge controller may be a good idea. could also look into other harvesting methods, e.g. RF, although the power available is likely to be even lower (we can assume that many of these devices will be in range of a standard WiFi router though).
55	rejected	strain relief built into the board; e.g. holes drilled near connection points that the user can loop the wire through and perhaps add some epoxy glue to (not that epoxy really needs to be kept away from copper as it is acid catalysed and can begin to corrode exposed copper	johnheuk	feature	if a squirrel attacks a node the wiring will be less likely to be ripped from the board; fewer pads lifted etc

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	status	Requirement	Discord username	Category	Why ?
56	rejected	a hat option to measure Joules of energy consumed; this could be applied to both the esp and pi but would be particularly well suited to the pi	johnheuk	feature	a feature of Texas Instruments' Code Composer is that it will suggest alterations to code; e.g. use a timer instead of a loop. their MSP430 demo boards go further and can actually monitor real world energy usage when running code, so the user can tune their code and get a better idea of how long the supply will last. this is a feature entirely missing from the esp hat would as far as I'm aware but could be very useful for checking deep sleep type operations. we need to start thinking in terms of Joules per operation / byte sent as opposed to mA

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	status	Requirement	Discord username	Category	Why ?
61	rejected	tracking solar panel; additional add on module	johnheuk	feature	if solar is being used, an additional 'hat' option could be to have the panel track. given the low power usage requirement, it would likely be better if this was achieved through a system that didn't include RV servos or steppers being continually engaged. this could possibly be achieved via a 3d printed high gear ratio (so the panel doesn't move in the breeze even with the power removed) or some form of solenoid like lock on the panel tilt that is normally engaged; so it only energises to move. it may not need to continually track, just point in roughly the right direction at the right time of day (e.g. east in the morning, half way in between at lunch time, west in the evening) to reduce movement frequency. this could be also be achieved by rotating some form of cam or actuating some form of ratchet. this

Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
62	rejected	Smallest Board config size 4cm x 3cm	wassfila	dimensions	I input this as initial starting point as stated in the video in time 12:50. It is only to give a guideline for the moment not to deviate too much but given all other requirements this might have to be reconsidered in case some features are really attractive.
63		Expose unused ESP32 GPIO Pins	wassfila	uC	The reference board in the video shows gpio exposed on a header on the sides, and it makes sense that a maker that needs this PCB also wants to use the ESP32 gpios he paid for.

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
64	rejected	minimal config costs less than 10 €	wassfila	organisation	Given the market where charging modules cost 1 ~ 2€, and ESP boards 5 ~ 8 € including lcd screens : 10 € sounds attractive. Let us place ourself in the buyers side, and think what we would pay for it ? Let's say this board is special and would be made on demand so maybe 15 €, but if it is 20€ or 30 € would you buy it ?
65	rejected	3d printed case	wassfila	organisation	If this is agreed, it could relax constraints on fitting PCB holes to existing housing standard format as discussed in discord. This could give more flexibility and is today a reasonable expectation from every maker or every one that has a maker as a friend.

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
66	rejected	Optional Battery format 16340 (16 mm x 34 mm)	wassfila	dimensions	This is mentioned by Andreas in the video time 12:50 and because 18650 is much bigger than an ESP32 module and 16340 fits quite good and matches the size req 62
67	rejected	Operating Temperature range -20° 70°	wassfila	specification	The ESP32 operating range is -40° 125°, but the batteries have more restricted range, so we might save on other compoenents as we don't need the full range.
68	rejected	Charging Temperature range 0° 45°	wassfila	specification	Charging between 0°-5° might be possible but below 0° might damage the battery. I tool Li-Ion as reference. These could be configurable if it is LifePo.
69	rejected	The design has to be Open source	wassfila	organisation	As stated in the video timing 14:15, I take these requirements here so that they're visible to everyone even to those who do not remember every word of the video.
70	rejected	It can be manufactured by JLCPCB	wassfila	organisation	same, from the video 14:15

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
71	rejected	Parts should be availabe from LCSC	wassfila	organisation	same, from the video 14:15
72	rejected	battery ampere meter	wassfila	feature	This would allow used capacity calculation and is different than overcurrent protection. Also stated in the video 15:52 as one reference board had this function, so even if it is hardly feasible, it is worth putting this on the table.
73	rejected	Optional flat battery pack connector	Informatic0re	feature	allows an even more compact size than the 16340 so gives more flexibility

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
74	rejected	Super Capacitors	Noki		Sensors that don't require frequent updates could easily be powered from supercaps instead of batteries. Even frequent measurements are not a problem if you store them and only transmit multiple collected measurements together from time to time. Supercaps are easy to charge, are not subject to overcharge and have a good low-temperature charge and discharge performance which makes them great for outdoor usage in cold environements. Supercapacitors don't require a battery heater, but might require a larger panel to compensate for the higher self discharge.

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Table 1 – continued from previous page

	status	Requirement	Discord username	Category	Why ?
75	rejected	Parts can be hand soldered	himynameisbuzz		for user who opt not to use a specific function in the board can choose not to solder the parts and to reduce the board's cost. BGA is a no no
76	rejected	Add PTC Resetable Fuse in design	veilands		Preserve other components due mistakes in assembly and operations, increase reliability of new design
77	rejected	Inclusion of LORA Option	mtroyer	feature	Provision of a low power option for a LORA board such as an RFM95 or the like.
88		Open Hardware License	Noki		We might need to choose a license to open source our hardware properly

CHAPTER

EIGHT

DEVELOPMENT

8.1 Branching and Pull-Requests

- The master is the single point of truth and the latest version of the board. Only Merge-Requests are allowed to push changes onto the master.
- each merge-request needs 2 reviewers to be accepted.
- feature branches should start with the term `feature/` and the name of the feature which will be implemented
- try to commit often and atomar and give each commit a nice description of what had been done
- use words like `added`, `fixed`, `changed` etc. at the beginning of your commits

Examples:

```
Added Pull up resistor for xyz regulator
```

```
Changed value of Pull-Up for regulator from 10k to 100k
```

```
Fixed missing ESP32 Module
```

- a git gui tool with timeline view is strongly recommended
- each contributor shall pro actively detect conflicts he creates or created by other branches and get in touch to define a conflict resolution strategy
- key files such as readme and information such as BOM and requirements should be checked by all contributors before merge

8.2 Project phases

- Requirements
- Components selection
- Schematics design
- routing
- testing and validation

8.3 Guidelines for project progress

- Each step of the project progress shall be validated in a group meeting
- After validation, each change in the step (requirements, component) shall be agreed with the Team and not with two reviewers only and PR
- Each feature (mcu / cut_off / charging / low power . . .) shall have a maturity level
  - 1) clear concept
  - 2) design ready
  - 3) functional
  - 4) stable and bug free
- The maturity level is decided by the Team during a meeting

CHAPTER

NINE

OVERVIEW

This project is currently still under development.

The Super Power RPi edition is a battery backup unit for the Raspberry Pi single board computer. It is meant to work with the Raspberry Pi 3 and 4.

9.1 Design

The design is based on the bq25895 charger IC and the TPS61088 boost converter IC. It also integrates an STM32F412 microcontroller to provide timing and control independent of the Raspberry Pi.

The bq25895 provides some specific benefits for this project. It has a low series resistance in it's FET, so the resistance between the battery and the boost converter is quite low. It also automatically negotiates higher power USB charging. Finally, it has significant internal monitoring, which eliminates the need for external components such as an ADC.

The STM32F412 was selected as it has quite a few internal peripherals to choose from. It also has a built in RTC, which allows for maintaining time even between power cycles.

In addition to the STM32, the footprint for an ATTiny85 was provided, but not populated, such that if anyone wants to use that series of MCU, they are able.

9.2 Physical Form Factor

The Super Power RPi takes the shape of a Pi HAT PCB. It is designed to be used as either a traditional HAT, or in an underslung configuration.

The traditional HAT makes electrical connections using the 40-pin header and it is secured using the mounting holes at the 4 corners.

The underslung configuration also uses the mounting holes, but makes the electrical connections using pogo-pins. The pogo-pins connect to the 5V, GND, and I2C pins. The standoffs to be used are ____mm tall.

9.3 Use Cases

Generally speaking, any situation that needs a Raspberry Pi to operate on batteries can be a potential use-case for this design.

More specifically, the following use cases were considered:

1. Uninterruptable Power Supply (UPS). In cases where there is a potential power interruption, the Superpower provides backup power so the Raspberry Pi does not have an unexpected restart.
2. Portable Pi. In cases where it is desirable to have a portable Pi or a Pi that will operate for extended periods of time using something other than "commercial power mains", such as amateur radio Field Day competitions. This can be used to provide a computer that meets this criteria.

9.4 Potential future versions

1. Build a specific version that includes a solar MPPT IC.

[github readme](https://github.com/SensorsIot/SuperPower/tree/master/SuperPower-RPi)

CHAPTER

TEN

SPHINX HOW TO

10.1 Contribute to documentation

Sphinx is a python module that generates this website, it is possible to run it locally with the following commands

```
cd sphinx/
pip install -r requirements.txt
make html
```

Note : `requirements.txt` contain install versions of `Sphinx`, readthedocs theme `sphinx-rtd-theme` and other extension. This file is important to reproduce the same result on each generation, especially on readthedocs hosting account where it can be pointed out in the configuration.

10.2 View generated website locally

As sphinx generates a static website, it might be enough for some browsers to open the index file `sphinx\_build\html\index.html`

or any local webserver can be used, as example here VSCode plugin :

- in VSCode install LiveServer Plugin
- open in VSCode the file : `sphinx\_build\html\index.html`
- click "Go Live" from the LiveServer Plugin

10.3 View the generated website online

readthedocs hosting link : https://superpower.readthedocs.io/en/latest/

10.4 Create your own sphinx project

```
pip install sphinx
sphinx-quickstart
```

the last steps creates the documentation source from which the main file `index.rst`

Getting started with sphinx from readthedocs : getting-started-with-sphinx

Sphinx official documentation : https://www.sphinx-doc.org/en/master/

10.5 Optional use virtual env

in order not to conflict between existing python modules on the system and the ones used in this project, it is highly recommended to use a virtual environment

```
>python -m venv venv
>venv\Scripts\activate.bat
```

more about virtual environments tutorial

10.6 Get started writing reSructuredText

- Question : Why do I have to learn yet another markup format ? sphinx support github's .md why not just use that ?
- Answer : md Markdown is designed for a single page document. While rts (reStructured) is designed for a hierarchical structure with cross-references

sphinx quick start : https://www.sphinx-doc.org/en/master/usage/quickstart.html

Cheat Sheet: https://sphinx-tutorial.readthedocs.io/cheatsheet/

docutils rts : https://docutils.sourceforge.io/rst.html

docutils rts quick ref : https://docutils.sourceforge.io/docs/user/rst/quickref.html

CHAPTER

ELEVEN

USE CASE DIAGRAM

11.1 Battery protection

CHAPTER

TWELVE

INDICES AND TABLES

- genindex
- modindex
- search