

## Balthazar System

I see Balthazar laptop as a box consisting of: mainboard + all the periphery needed that make up a complete laptop: display, audio, keyboard, mousepad, wireless, usb, hdmi... and additionally: a buffered gpio (general purpose in/out) connector (not that laptop usually needs it...).

The technology used benefits from the current rapid mobile platform development – as do all open-source single-board computers: Raspberry Pi, [Orange Pi 4](#) – and a bit more advanced [Firefly-RK3399](#). They all use SOC (system on chip) as the miniaturized combination of cpu/gpu/etc. The laptop should however be a pushed-up version of these single board computers - but still a single board computer.

One format of recent computers is also the mini-pc. They are usually based on intel or amd laptop computer processors. [LattePanda](#) seems to be on the side of single-board-computers but uses Intel processors. [Prices are also pushed up](#).

The interchangeable module should basically be the mainboard itself, while the stable part should be the skeleton: a specifically designed housing with display, keyboard, audio, mousepad, power supply. To upgrade – one buys a new board and inserts it in the place of the old board.

## Balthazar PSU

Based on the above, these are the outlines for the PSU low voltage board:

1. Universal power adapter – 12Vdc/5A (60VA max) – the most usual laptop power connector / either exterior or inserted into chassis skeleton / with possibility to be charged from wide array of additional choices (solar panels, usb connector – external power banks...)
2. Input RFI filter / in-rush current connection protection
3. Texas Instruments BQ24171 4.5-17V Buck/ boost converter and LiPo battery pack single cell charger (VSYS=4.2V)
4. Large LiPo battery pack (10000mAh) – single cells / in parallel = 3.6V – three terminal connector (-Vbat=gnd, thermistor NTC\_TS, +Vbat=3.6V)
5. Options: charge to/from/use external 5V battery pack (usb-A, usb-C connectors), solar panel charger and inductive charger (both higher impedance sources than power adapter or battery pack).
6. Buck/ boost converters - VSYS voltage -> 3.3 and 5V / VSYS voltage is the main motherboard voltage line – use appropriate buck or boost converters there for all separate functional modules (cpu, gpu, ram, etc.)
7. On-board stereo power amplifier: 2x3W/5V class-D - PAM8403

## **Blocks**

1. Buck/boost dc/dc converter / battery charger with 3.5V to 17V input range
2. Battery fuel gauge
3. I2C / SMBus addressable or not...
4. Buck/boost fixed voltage dc/dc converters – as needed (12V, 5V, 3.3V, 1.8V...)
5. Stereo audio amplifier (D class 5V / 2 x 3W)

## **Integrated circuits**

Texas Instruments BQ25713 USB-C Battery Charger

-> <http://www.ti.com/lit/ds/symlink/bq25713.pdf>

Texas Instruments BQ24193 I2C Controlled 4.5-A Single Cell USB/Adapter Charger

-> <http://www.ti.com/lit/ds/symlink/bq24193.pdf>

Renesas / Intersil ISL9519 Battery Charger

-> [https://www.marutsu.co.jp/contents/shop/marutsu/ds/ISL9519\\_Web.pdf](https://www.marutsu.co.jp/contents/shop/marutsu/ds/ISL9519_Web.pdf)

Texas Instruments BQ24171 Stand-Alone Battery Charger

-> <http://www.ti.com/lit/ds/symlink/bq24171.pdf>

Texas Instruments BQ27Z561 Battery Fuel Gauge

-> <http://www.ti.com/lit/ds/symlink/bq27z561.pdf>

optional: Texas Instruments BQ24210 Solar Panel Charger

Texas Instruments BQ24210 800-mA Single-Input Single-Cell Solar Panel Charger (2010)

-> <http://www.ti.com/lit/ds/symlink/bq24210.pdf>

Diodes Incorporated PAM8403 Stereo 3W class-D audio amplifier

-> <https://www.diodes.com/assets/Datasheets/PAM8403.pdf>

Maxim MAX98306 Stereo 3.7W Class D Audio Amplifier

-> <https://datasheets.maximintegrated.com/en/ds/MAX98306.pdf>

## BQ25713 related (2018)

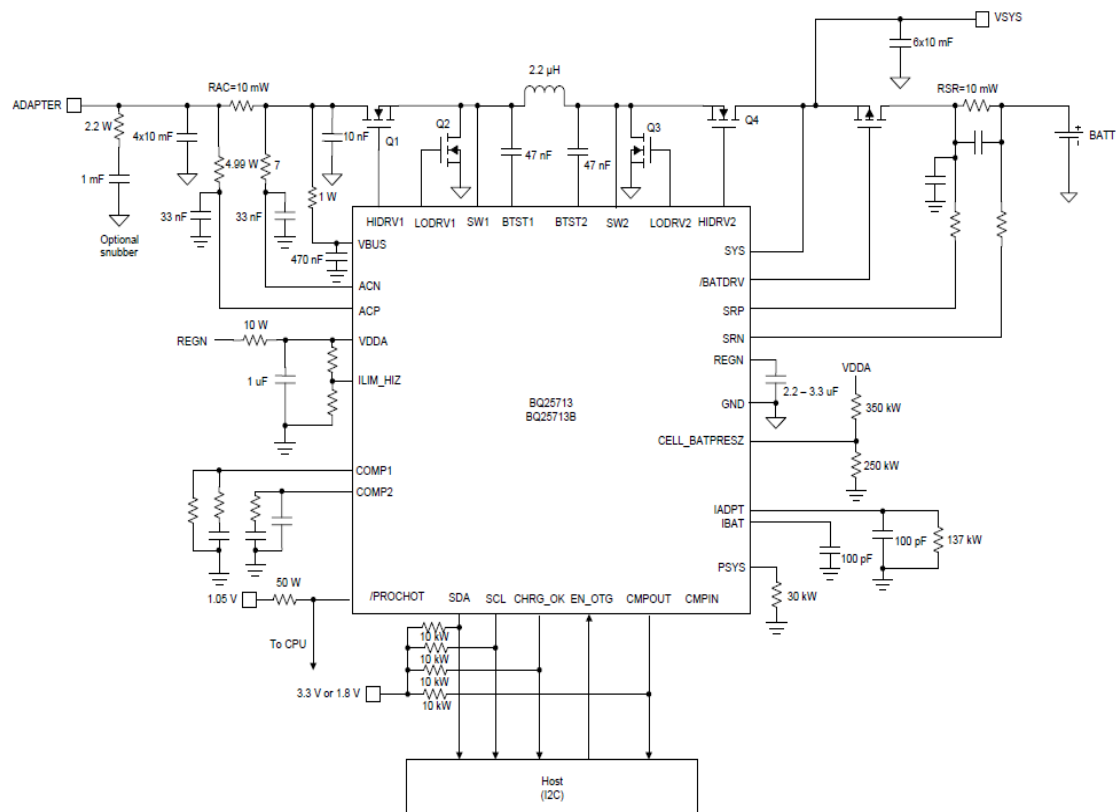
The valid adapter range is from 3.5V to 24V with at least 500-mA current rating. When CHRG\_OK goes HIGH, the system is powered from adapter through the charger. When adapter is removed, the system is connected to battery through BATFET. Typically the battery depletion threshold should be greater than the minimum system voltage so that the battery capacity can be fully utilized for maximum battery life (3.3V?). Four external N-channel MOSFETs are used for a synchronous switching battery charger. The gate drivers are internally integrated into the IC with 6 V of gate drive voltage. 30 V or higher voltage rating MOSFETs are preferred.

## Input Capacitor

Input capacitor should have enough ripple current rating to absorb input switching ripple current. The worst case RMS ripple current is half of the charging current when duty cycle is 0.5 in buck mode. If the converter does not operate at 50% duty cycle, then the worst case capacitor RMS current occurs where the duty cycle is closest to 50%. Low ESR ceramic capacitor such as X7R or X5R is preferred for input decoupling capacitor and should be placed to the drain of the high side MOSFET and source of the low side MOSFET as close as possible. Minimum 4 - 6 pcs of 10- $\mu$ F 0805 size capacitor is suggested for 45 - 65 W adapter design.

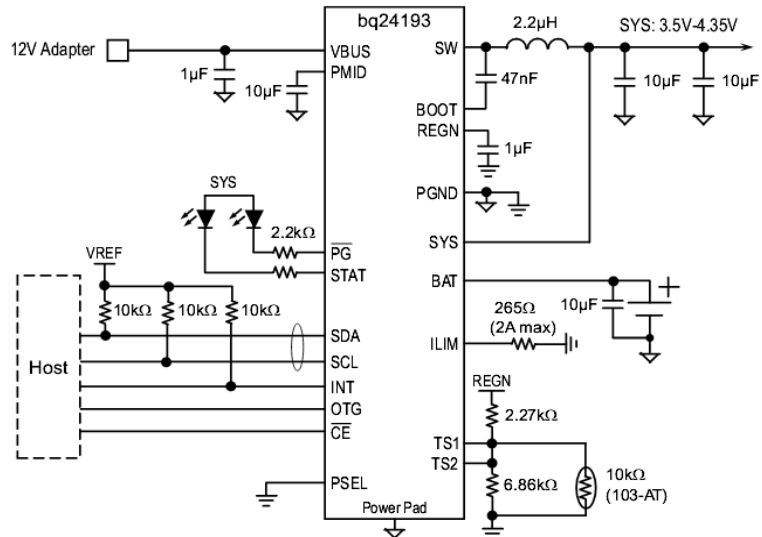
## Output Capacitor

To get good loop stability, the resonant frequency of the output inductor and output capacitor should be designed between 10 kHz and 20 kHz. The preferred ceramic capacitor is 25-V X7R or X5R for output capacitor. Minimum 6 pcs of 10- $\mu$ F 0805 size capacitor is suggested to be placed by the inductor. Place the capacitors after Q4 drain. Place minimum 10  $\mu$ F after the charge current sense resistor for best stability.



## BQ24193 related (2014)

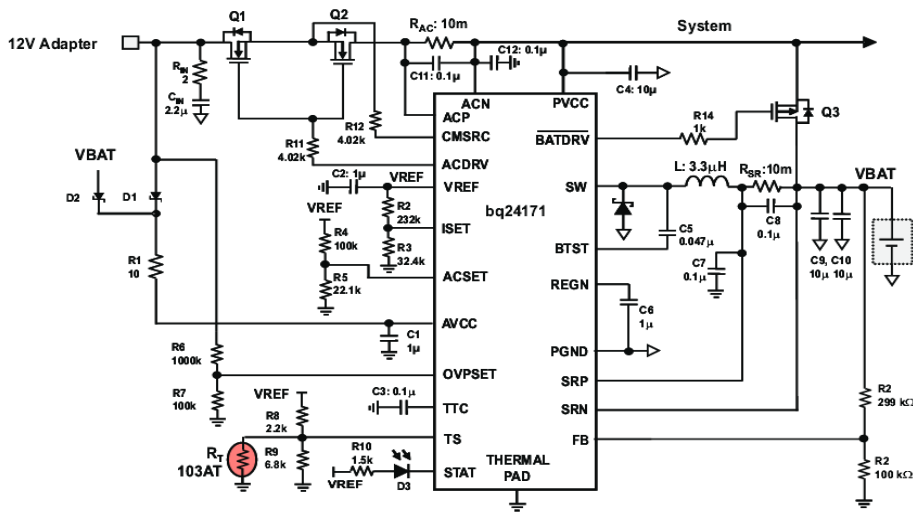
The bq24193 accommodates a wide range of input sources from USB, wall adapter, to car battery. The device provides automatic power path selection to supply the system (SYS) from input source (VBUS), battery (BAT), or both. It integrates an input reverse-blocking FET (RBFET, Q1), high-side switching FET (HSFET, Q2), low-side switching FET (LSFET, Q3), and BATFET (Q4) between the system and battery. The bq24193 is a host controlled device, but it can operate in default mode without host management. In default mode, bq24193 can be used as an autonomous charger with no host or with host in sleep.



**Figure 34. bq24193 with PSEL, USB On-The-Go (OTG) and Support JEITA Profile**

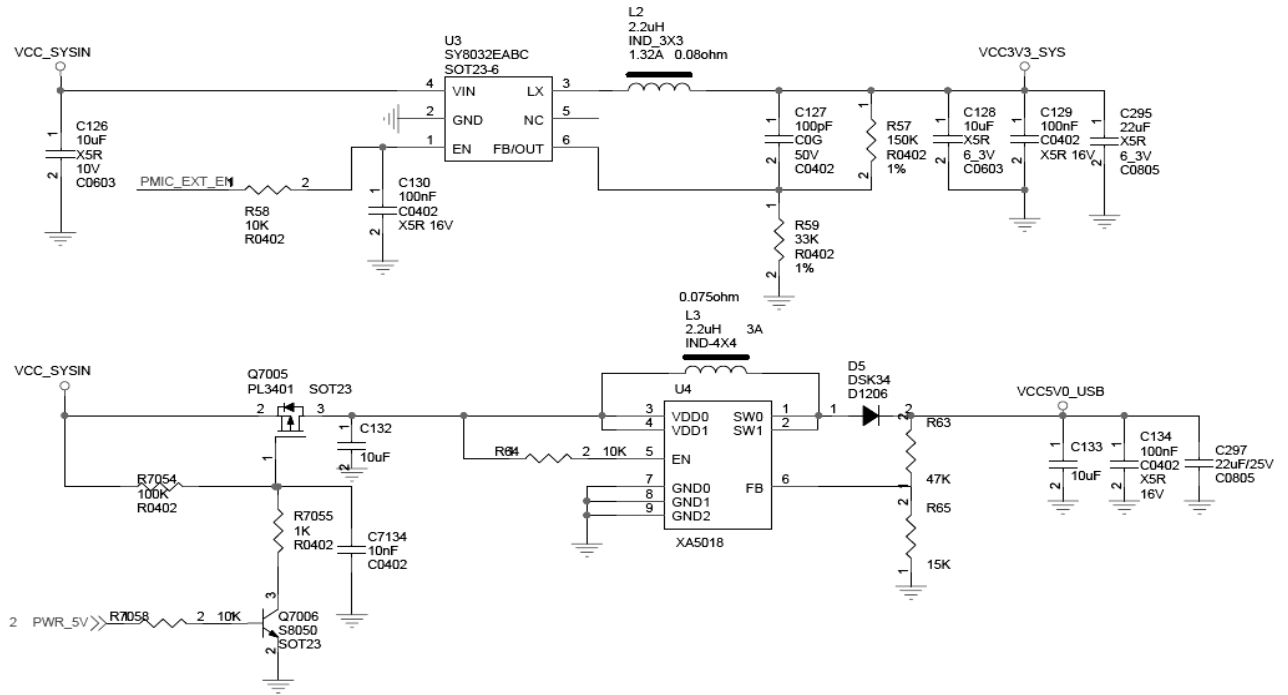
## BQ24171 related (2010)

- 4.5V to 17V input operating voltage. Much cheaper than BQ25713 – available individually. There are several methods to damping or limiting the overvoltage spike during adapter hot plug-in. An electrolytic capacitor with high ESR as an input capacitor can damp the overvoltage spike well below the IC maximum pin voltage rating. A high current capability TVS Zener diode can also limit the overvoltage level to an IC safe level.



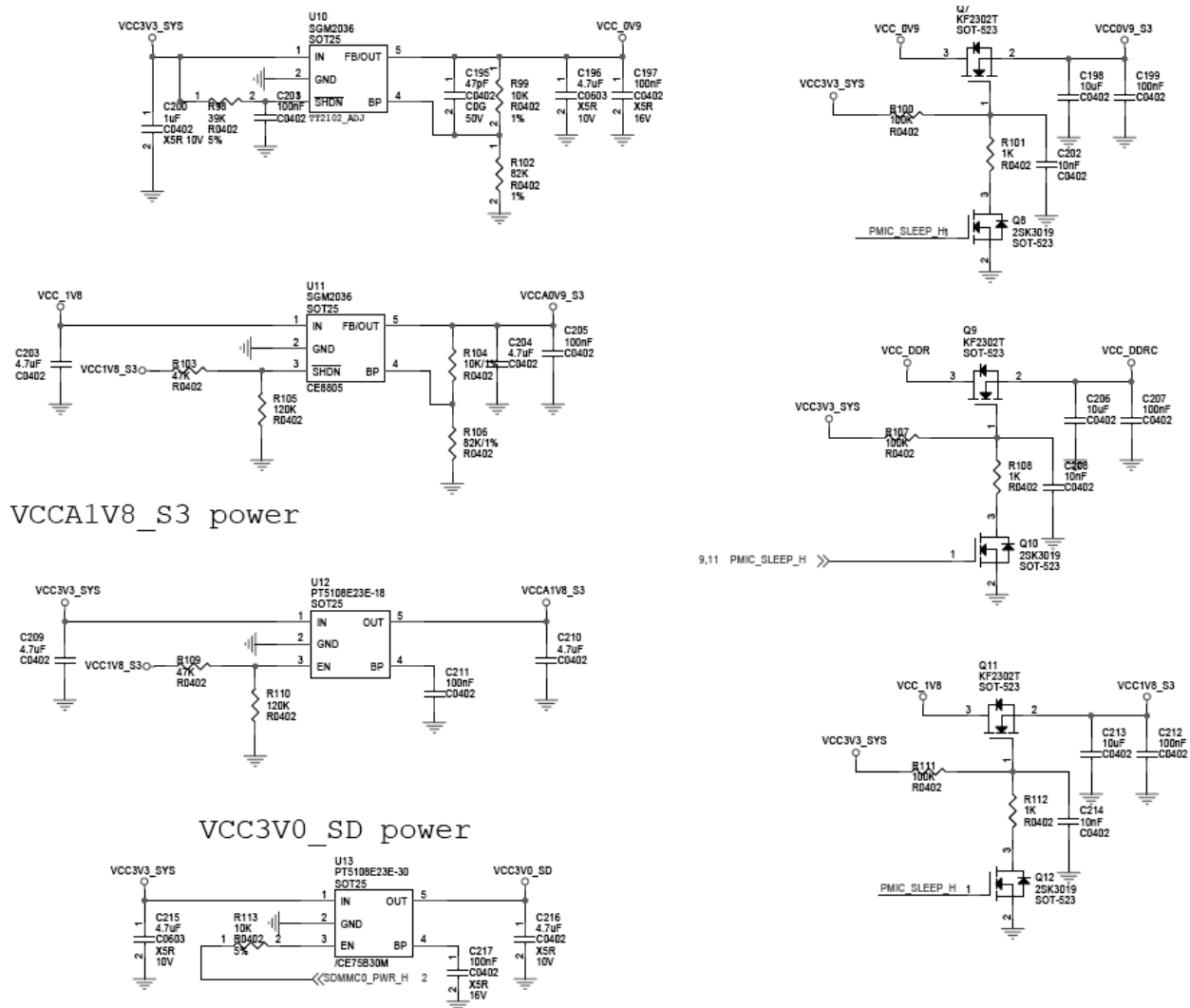
12-V input, 2-cell battery 8.4 V, 2-A charge current, 0.2-A precharge/termination current, 3-A DPM current, 18-V input  
OVP

## VSYS Buck/ boost dc/dc converters

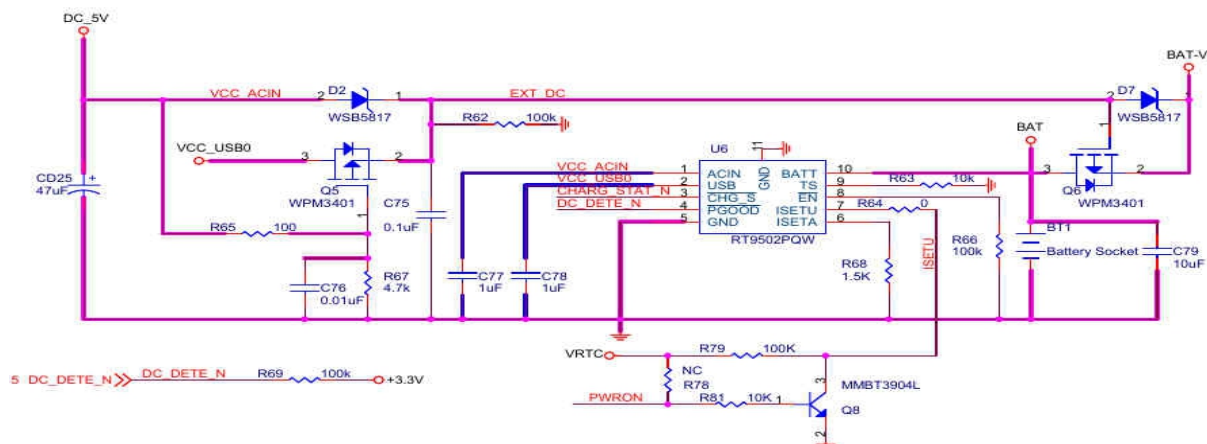


## Buck/ boost dc/dc converters (these are on the mainboard)

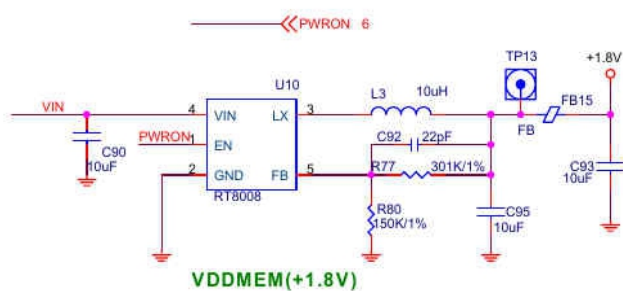
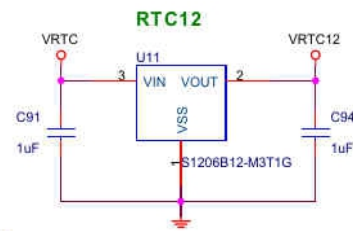
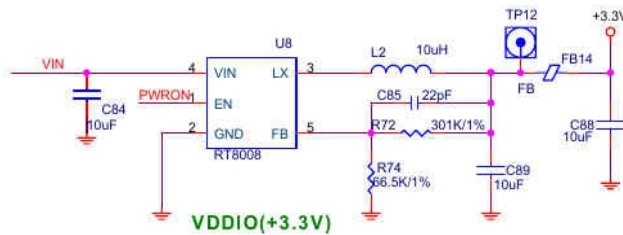
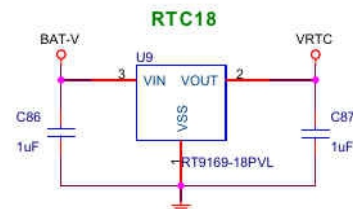
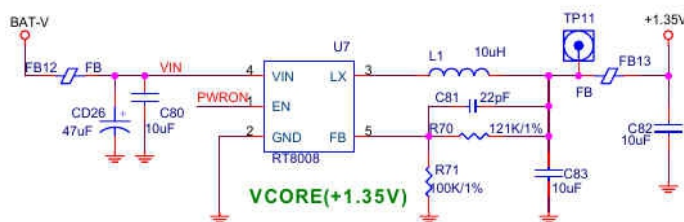
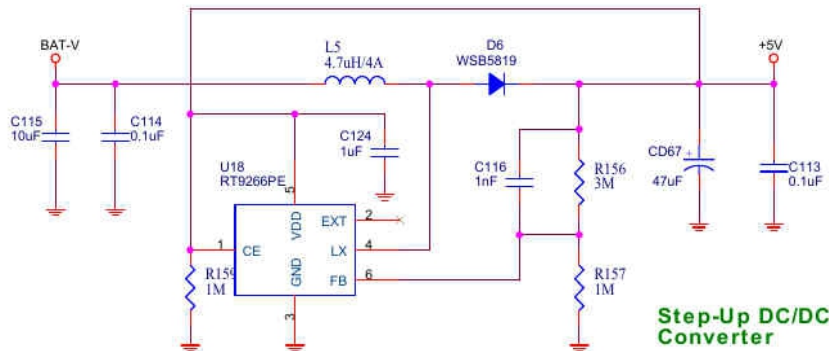
This is solution by pinebookpro v2.1 (uses RK3399 SOC – powered by 1.8V)



In addition to ICs for power provision, there is the usual step-up converter (RT9266) which converts the 3.8-4.2v battery directly into a stable +5V supply. This can be seen in pretty much every design (whether using the AXP209, AXP803, ACT8600, ACT8846 ...). Note below that the DCin is wired (via the two MOSFETs and Schottky Diodes) directly to BAT-V (and thus supplies the +5V rail) but that, thanks to those MOSFETs and Schottkys, if either VBUS powers up or the battery powers up, they replace the power stream to BAT-V in a priority-cascade.

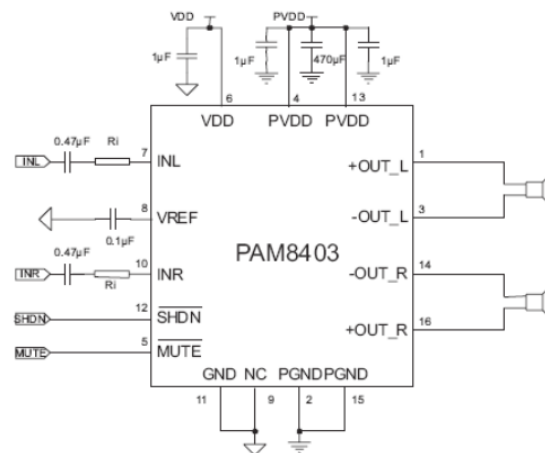


This example is included to show that power-provision **can** be done without a dedicated PMIC (but also demonstrating quite how many components it actually needs, to do so). Perhaps it might even still be a viable solution, by replacing some of the discrete (fixed) SY8008 LDOs with SYR828 and SYR829 I2C-controllable high-current voltage regulators.



## Stereo audio power amplifiers:

Diodes Incorporated PAM8403 Class D 2x3W / 5V (package SOP-16)



MAX98306 Class D stereo amplifier 2x3.7W /5V (package 14 TDFN )

