

Caravel M.V.PCB: TinyTapeout Variant

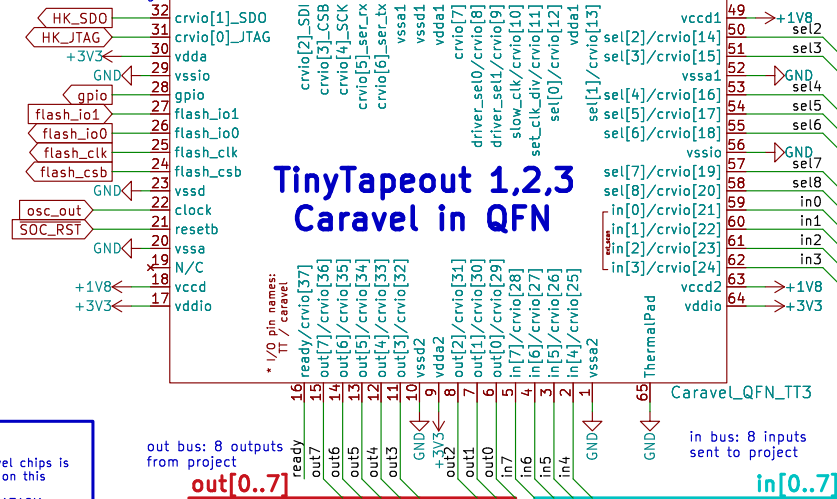
Sample of a minimum viable PCB for TinyTapeout ASICs on QFN.

This version has a symbol and net names to match TinyTapeout function assignments. Two options here:
1) TinyTapeout with Caravel CPU available
2) TinyTapeout stand-alone (no CPU)

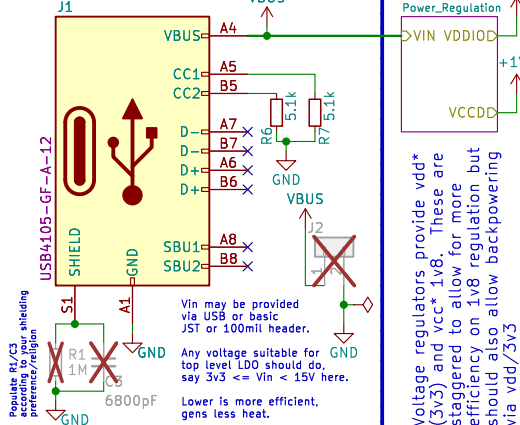
If using the CPU, the orange boxes are needed (namely external flash memory) and a way to access the HK SPI to program it. It is possible to go stand-alone, in which case some passives and configuration choices are in order (see grey hierarchical sheet below).

Always REQUIRED elements are:
* power: regulated 3v3 and 1v8
* osc: a CMOS clock signal
* a bit of reset smoothing

TinyTapeout 1,2,3 Caravel in QFN



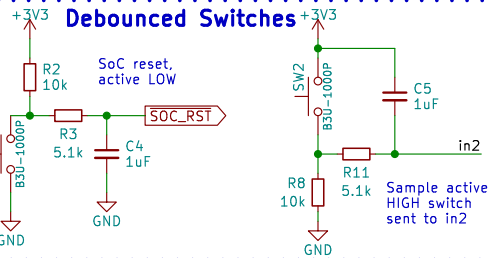
Power Supply



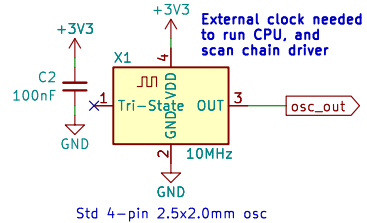
Vin may be provided via USB or basic JST or 100mil header.
Any voltage suitable for top level LDO should do, say 3v3 <= Vin < 15V here.
Lower is more efficient, gens less heat.

Voltage regulators provide vdd* (3v3) and vcc* 1v8. These are staggered to allow for more efficiency on 1v8 regulation but should also allow backpowering via vdd/3v3

Debounced Switches



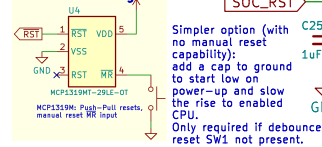
CMOS Clock Osc



Caravel Reset

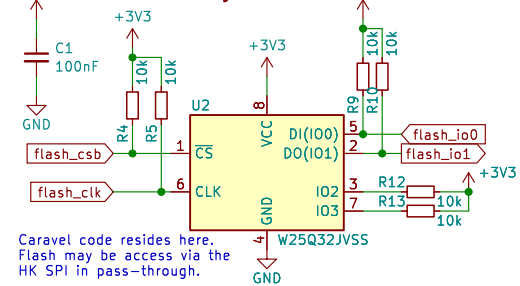
The resetb (active LOW) pin on Caravel chips is pulled HIGH internally, BUT counting on this is glitchy and dangerous. Caravel reference designs use a MCP1319M, as shown here, as a voltage supervisor to manage this and allow debounced reset switch.

Caravel ref design



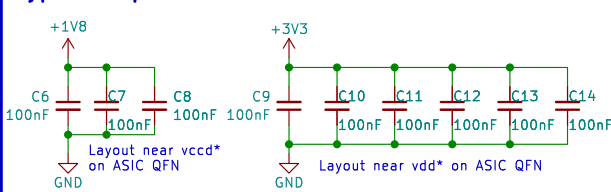
Simpler option (with no manual reset capability): add a cap to ground to start low on power-up and slow the rise to enabled CPU.
Only required if debounced reset SW1 not present.

Flash Memory



Caravel code resides here. Flash may be accessed via the HK SPI in pass-through.

Bypass Caps



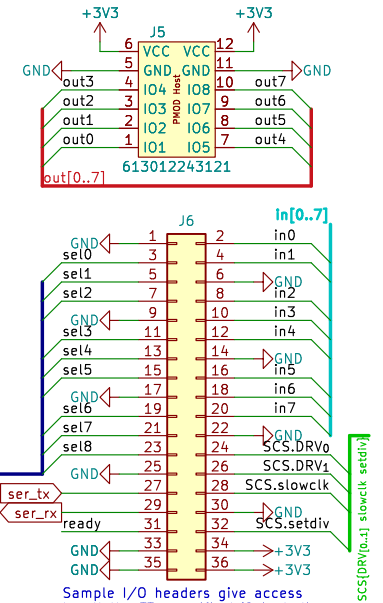
REQUIRED Always needed

TTSA REQ Needed when using TT stand-alone

CPU REQ Needed to use Caravel CPU

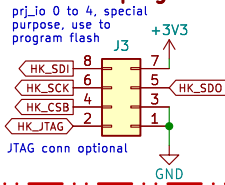
OPTIONAL Customize as required

I/O headers

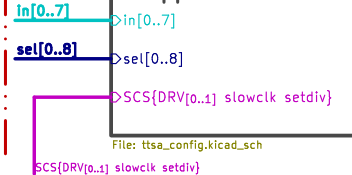


Sample I/O headers give access to all the TT-specific I/O including inputs, output, active project select and scan chain/slow clock control.

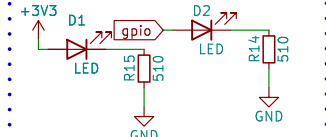
Housekeeping SPI



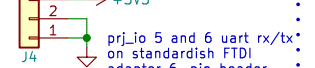
TT Stand-alone Support



Power Good and GPIO LED



Caravel Serial



Fids for Pick & Place



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Sheet: /
File: caravel-mvp.kicad_sch

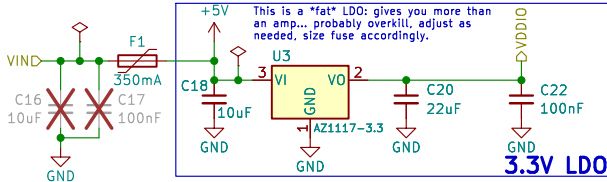
Title: Caravel Minimum Viable PCB Example: TinyTapeout Version

Size: A4 Date: 2023-10-27
KiCad E.D.A. kicad 7.0.8-7.0.8-ubuntu22.04.1

Rev: 1.3
Id: 1/3

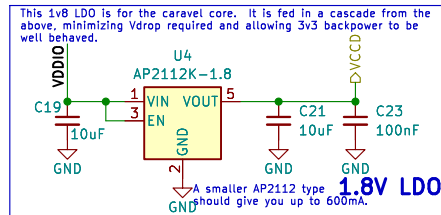
Voltage Regulators

Simple voltage regulation for logic and core. In a distinct sheet to allow you to easily do fancy stuff, like use switchers or whatever is needed.



NOTE: On our simple TinyTapeout demo boards, with power good LEDs and everything, idle draw on the 3v3 supply was below 40mA, so both the 3v3 and the 1v8 LDOs have more than a little margin.

Chances are you could get away with much (much) smaller regulators and maybe even a zener diode shunt type thing for the 1v8 core.



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Sheet: /Power_Regulation/

File: power_reg.kicad_sch

Title: Voltage Regulation

Size: User Date: 2023-09-30

KiCad E.D.A. kicad 7.0.8-7.0.8-ubuntu22.04.1

Rev: 1.2

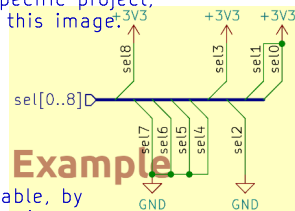
Id: 2/3

Stand-Alone TinyTapeout Reqs and Knobs

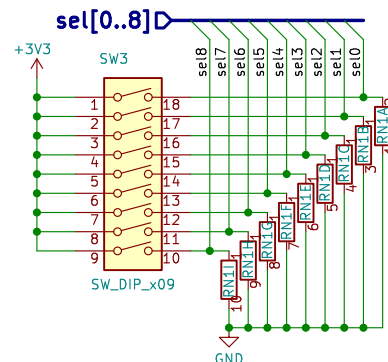
If not using the Caravel CPU, you can save space and cost by dumping its support components but that means you need to handle a bit of its work externally. Here are the related components and configs.

Project Selection

Projects are selected using the 9 active_select bits (sel* here). If you're only interested in a single specific project, you can hardwire it here as shown in this image:
For example, I want project #267, which in binary (MSB) is: 1 0000 1011
Bringing every '1' bit high and tying ever '0' to ground, will select this value.



Or we can make things more configurable, by using switches or other means. The main thing to consider is always ensuring the signals are in a defined state (pulled high or low, not floating).



Rather than hard-wiring a selection, here is one scheme to allow any of the projects to be active using a DIP switch and resistor network.

When a switch is open, the line is pulled low. When it is closed, that bit goes high.

The pull down resistors on each sel* isn't required when you have everything you need to run the Caravel CPU because, as part of the running firmware, it is trivial to enable pull-up or -down on any of the I/O pins.

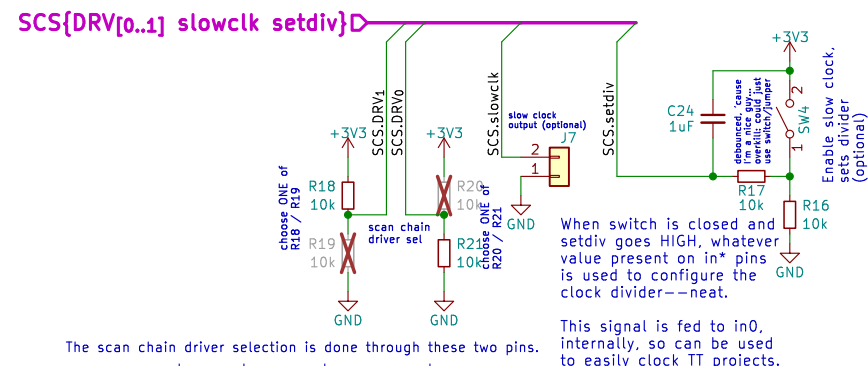
Input State

in[0..7]

Depending on your use case, it might be worth ensuring the state of the input pins is always valid—i.e. using pull-ups or pull-downs. This is highly application specific but digital doesn't like floaties so much... worst case maybe just sit all the in* on some weak (high value) resistors to ground.

Scan Chain Driver And Clocking

The scan chain stuff is a little involved... best to refer to the TinyTapeout documentation. Still, notes here should be somewhat helpful.



The scan chain driver selection is done through these two pins.

DRV_1	DRV_0	setting
0	0	external
0	1	logic an.
1	X	internal

You mostly likely want internal, here, so populating as shown using DNP's.

Or you can use jumpers, such as in the TT demo board here: TinyTapeout 123 Demo PCB schematic

When switch is closed and setdiv goes HIGH, whatever value present on in* pins is used to configure the clock divider--neat.

This signal is fed to in0, internally, so can be used to easily clock TT projects.

Note: none of these components are in the sample layout. This allows you to delete this sheet from the top level and not muck about, if you aren't going stand-alone.

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Sheet: /TT SA Config/

File: ttsa_config.kicad_sch

Title: Stand-Alone TinyTapeout Requirements and Config

Size: A4 Date: 2023-10-24

KiCad E.D.A. kicad 7.0.8-7.0.8-ubuntu22.04.1

Rev: 1.2

Id: 3/3