Notes

* btw you should take some measurements on the board as well on the Ton/Fsw, voltage ripple
* Voltage ripple target, Nano has 5V +/- 5% requirement, ripple needs to stay within these parameters.
  + Anything less than ~10A will have FETs in the IC/package
  + Anything more than ~10A will require external FETs
  + Look at FETs and inductors togethers.
  + 10-20A range, 20-30A range, Don’t want to push more than 30-35A range through FETs. More than 35A need multiple phases.
  + Can have phases with DC by interleaving PWM signal control signals, get lower output voltage ripple.
  + Integrated FET ICs, need to rely on datasheet for inductance range.
  + Once you choose inductor, capacitor, can calculate transient response. Transient response, means you are at steady state at 1A, suddenly jump to 5A, what should be the response of the regulator? If output voltage dips down, then tegra chip dies. Instantaneous load step 🡪 if current increases, then voltage should decrease. Energy needs to come from caps and inductor, and controller needs to compensate for change in load by changing duty cycle.
  + Lower Fsw means better efficiency
  + FIRST STEP: CHOOSE INDUCTOR.
    - Ex, 1uH inductor. 10A of current going through it.
    - Isat, if you pull more than Isat, then effective inductance decreases
    - Irms, at that current, inductor will start to heat up. 1A, 1.2A for Isat, try to aim for less than 20%
    - Transient current through inductor to be 1A, when you get a load step your inductor will try to pull more current to charge capacitor to maintain same voltage, this can way exceed your steady state + ripple voltages.
    - 2x fudge factor on the Irms rating.
    - Smaller inductor 🡪 can get away with higher switching frequencies
      * Get conduction losses.
    - Take energy to drive FETs, get losses when you transition from on to off for FETs
* Synchronous vs Asynchronous Buck converters
  + Synchronous buck converters use two FETs
  + Asynchronous buck converters use a diode.
    - On-time of the diode becomes longer for lower output voltages as the PWM signal that controls the single MOSFET is on for less time, so typically less efficient for lower voltage applications.
* Can increase switching frequency to decrease inductor ripple current.
* A higher inductance reduces the ripple current and therefore increases the maximum output current with the selected IC.
* Higher the inductor value, the higher is the maximum output current because of the reduced ripple current.
* Generally a trade off between conduction loss and size, as parts that are larger tend to have lower on resistances.
* DCM, diode emulation (both FETs are turned off and you use the internal diode on the bottom FET for your current loop), DEM, all the same name.
* Constant on vs fixed freq, either change frequency or on time to match perturbations to load current. Current mode or voltage mode control means fixed freq.
* Be careful with Irms (thermal current), check against the datasheet for how much rise in temperature you get. DCR = DC resistance of the inductor, P = I^2 R. Little weird, because the current is a sawtooth
  + Try to stay close to 0.3 or 0.2 for the Inductor power loss (cell 53)
* **55 should be a hard limit on temperatures for parts on the board.**
* 0.1uF caps help with high frequency inrush current
  + Series resistance and parasitic inductance (doesn’t like changes in current), and so power supplies cannot provide instantaneous changes in current. So you have local caps. Some of the larger caps also have significant ESL and ESR, and won’t be able to supply current for faster times. Amount of charge necessary is not much, but need to provide it else will see a massive dip in current.
  + Don’t have to worry about them during buck converter calcs, they don’t contribute much to the different stats.
* Power burned across inductor and temp rise (remember that you should keep rise below 55C)
  + Currently 33 mohm inductor, try to find around 10-15 mohm range and see if that nets better results
  + Higher inductance 🡪 Higher DCR
  + Increasing Fsw gets you smaller inductor, ex Ton = 600 ns means you can use 2.2 uH inductor.
  + Buck converter is weird bc Ton is heavily tied to Vin, maybe need to switch out the part.
  + **Keep Isat 20% higher than Imax!!!**
  + **Lower Fsw means better efficiency, BUT if you don’t have a good inductor you will burn a lot of power with ripple current.**
  + **There is no one right answer, just try to optimize! Will always be tradeoffs between variables, and target might change based off of your requirements, i.e., if you are pressed for space less efficiency might be tolerable.**
* **Capacitors**
  + **Keep in mind that ripple current will burn power across input cap ESR.**
  + **Want to keep percent of Vout from 2-3%. A lot of ICs need a 5% noise tolerance on the INPUT side.**
  + **Can increase the number of output caps to smooth out ripple. Putting them in parallel puts ESR and ESL in parallel, lower the effective ESR and ESL.**
  + **Lower ESR and ESL to get better ripple voltage performance.**
  + **Greyed out values are intermediate calculations.**
  + For flooded areas use the thinnest part.
* 1% is fine for resistor divider.
* AP6503
  + EA means error amplifier?
  + RS is a type of flip flop
    - RS FF is reset when clock falls even when EA comparator is outputting a zero?
  + Using HS MOSFET, provides power to output until it senses too high voltages, then turns HS off and LS on.
* 5V Buck Converter
* 3V3 Buck Converter
* MP2619

Links

* <file:///C:/Users/joshuay/Downloads/AN041_EN.pdf>
* <https://www.ti.com/lit/an/slva630a/slva630a.pdf?ts=1625760738199&ref_url=https%253A%252F%252Fwww.google.com%252F>
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