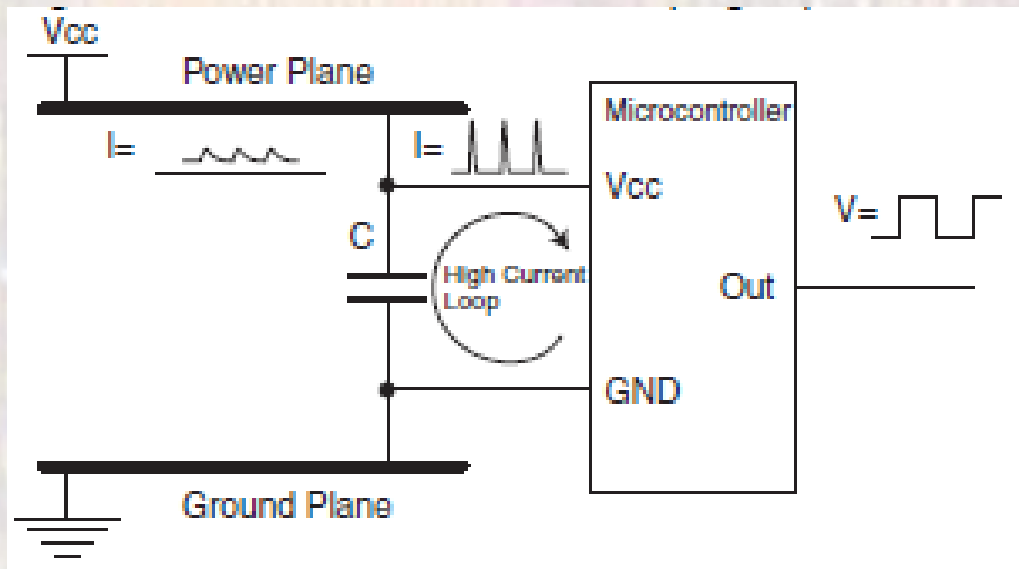# Supply Bypassing

Last updated 1/15/24

Supply Bypassing

- Supply Bypassing

  - Digital circuits create current spikes on the supply pins
    - Shoot through current
    - Charging and discharging current
    - I/O switching

  - While the average supply current may be a few tens of milliamps, spikes associated with an 8 bit I/O switching can be hundreds of milliamps and a few nanoseconds wide

  - Power supplies and realistic circuit board traces cannot support these current spikes → noise on the supply voltage

  - Supply voltage noise can disrupt the normal operation of the processor or other circuits
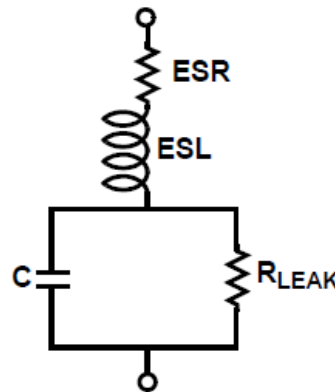
Supply Bypassing

- Supply Bypassing

  - Bypass capacitors are used to supply these spikes of current, preventing noise on the supply voltage pins
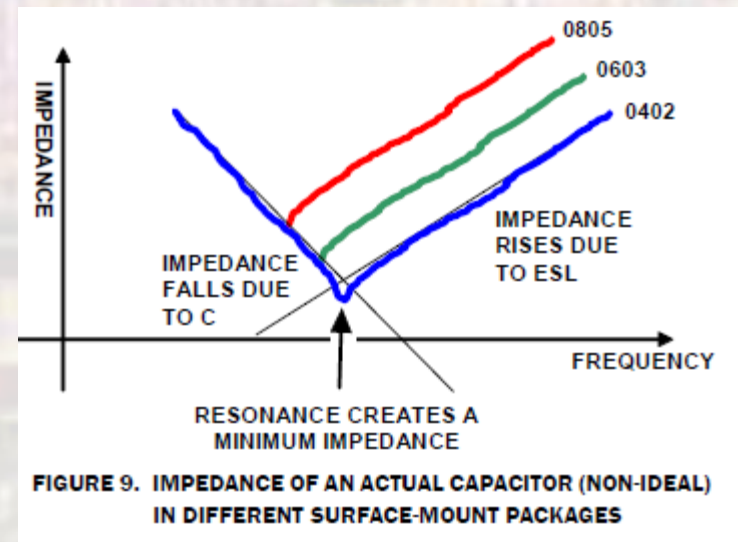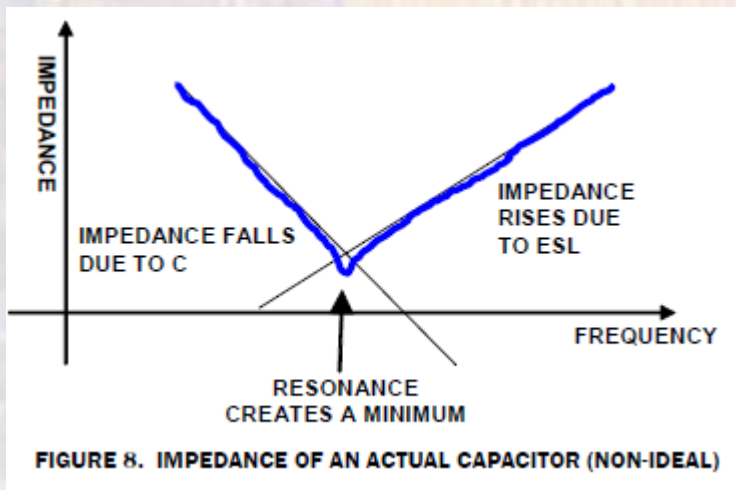
Supply Bypassing

• Realistic capacitor model

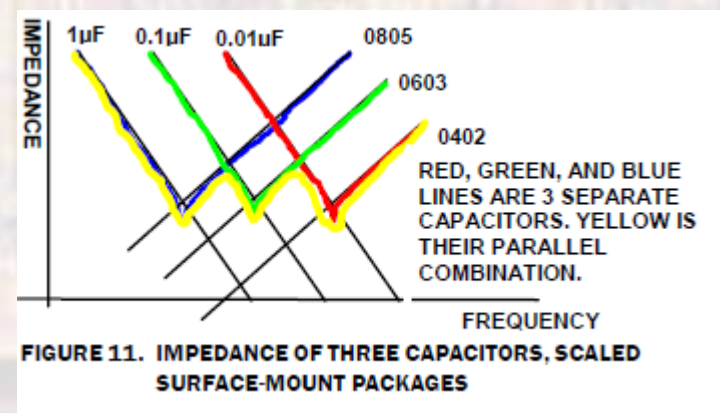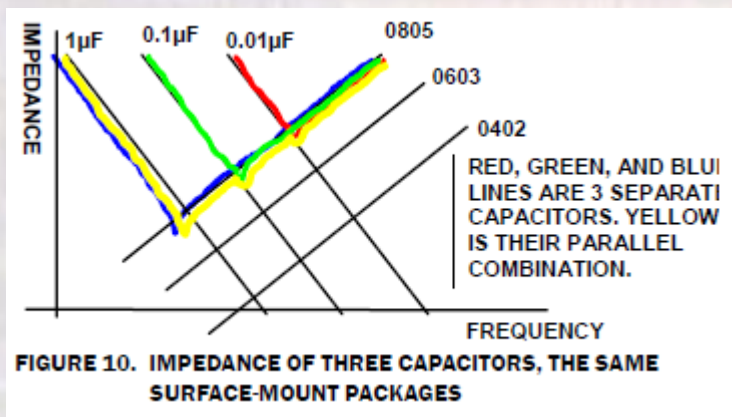| ABBREVIATION	EXPLANATION	SOURCE AND DETAILS
ESR	Equivalent Series Resistance	Wire and connections to the plate Produces heat
ESL	Equivalent Series Inductance	Depends on package type Surface mount better Smaller SMD better
RLEAK	Leakage Resistance	Type of dielectric

Supply Bypassing

- Realistic capacitor model

FIGURE 8. IMPEDANCE OF AN ACTUAL CAPACITOR (NON-IDEAL)

FIGURE 9. IMPEDANCE OF AN ACTUAL CAPACITOR (NON-IDEAL) IN DIFFERENT SURFACE-MOUNT PACKAGES

Supply Bypassing

- Realistic capacitor model

FIGURE 10. IMPEDANCE OF THREE CAPACITORS, THE SAME SURFACE-MOUNT PACKAGES

FIGURE 11. IMPEDANCE OF THREE CAPACITORS, SCALED SURFACE-MOUNT PACKAGES

Supply Bypassing

- Supply Bypassing

  - Most systems use 2 bypass capacitors
    - 1uF - 10uF for low frequency high current spikes
    - .001uF - .01uF for high frequency spikes
  - Placed as close to the IC as possible to reduce inductance

FIGURE 21. FREQUENCY RESPONSE OF TWO SCALED CAPACITORS IN PARALLEL (FOR REFERENCE)

Supply Bypassing

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