

Modern robotics device detection problems

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Problem

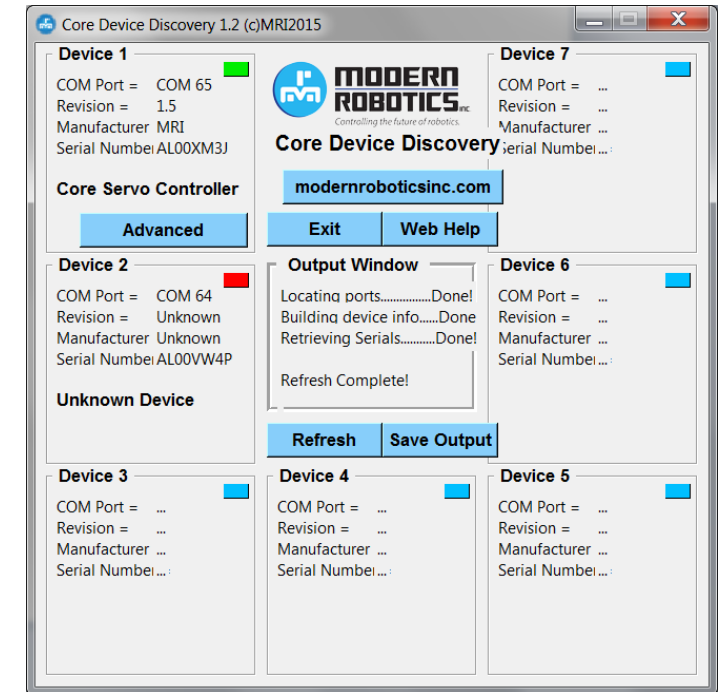
- During FTC Match in Prague (CZ) many teams observed USB problems
- Apart from USB connection problems, static and other issues some teams had consistent hardware detection problems after switch-on of robot
- Time between switch-off and switch-on of robot and battery charge seems of influence.
- Some teams only had sporadic detection of all hardware (more faulty startups than correct startups)
- Offline testing performed to analyze the issue. Results presented here

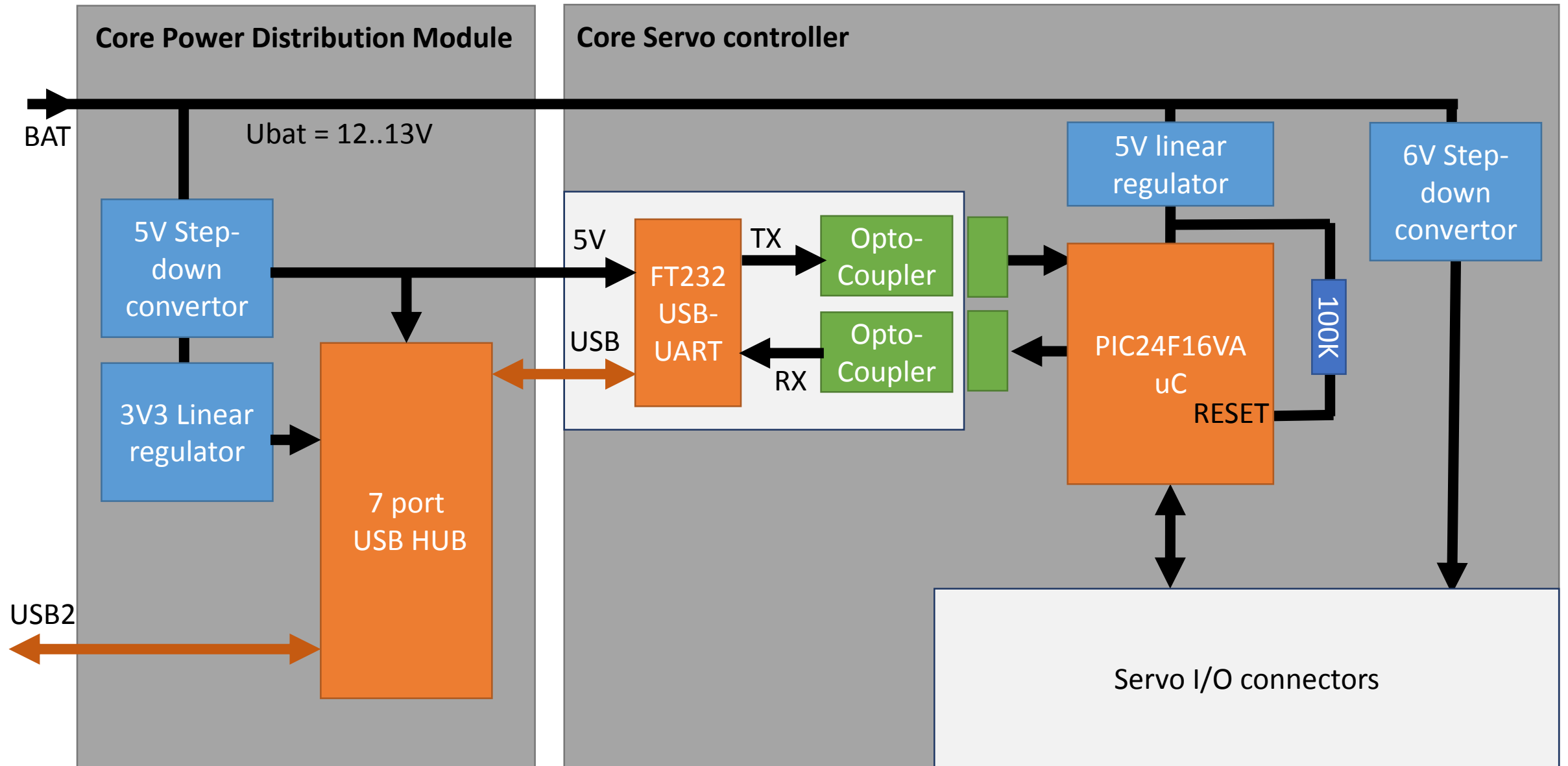
Modern robotics device detection problems

- Configuration: Typical robot configuration
 - Core Power distribution module
 - Core servo module
 - Core motor controller
 - Standard 12V 3000mAh battery, $U_{bat} = 12.5 \text{ V}$
- Battery/Servo/Motor connection made using standard cables with APP connectors (typical robot setup)
- No motors or servos connected
- USB connected to standard laptop for diagnostics

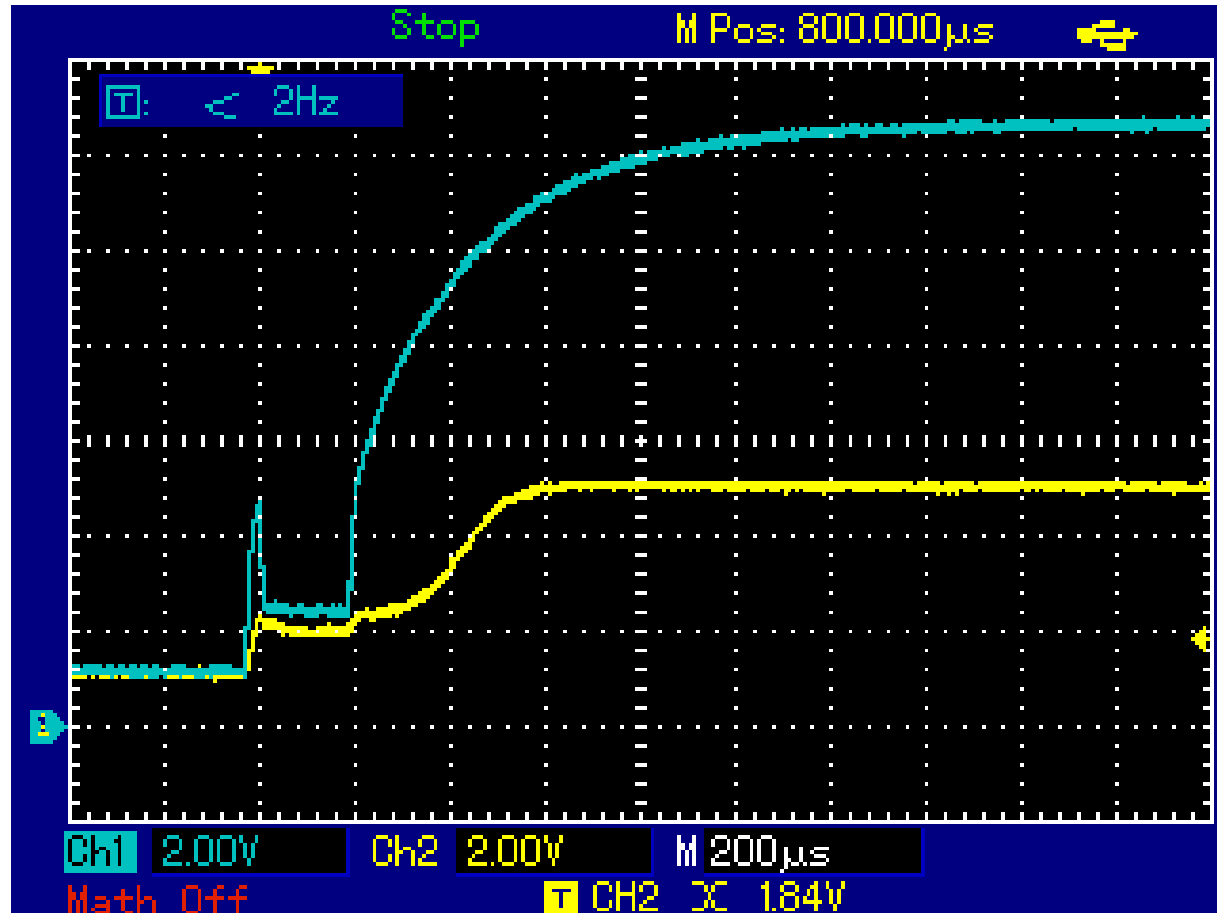
Observed effect

- After switch-on of the core power distribution module not all (motor/servo) modules are detected
- Observed using core device discovery program
- USB ports are enumerated, but core devices do not respond (PIC microcontroller locked up?)
- See block schematic of power distribution in next sheet for possible cause

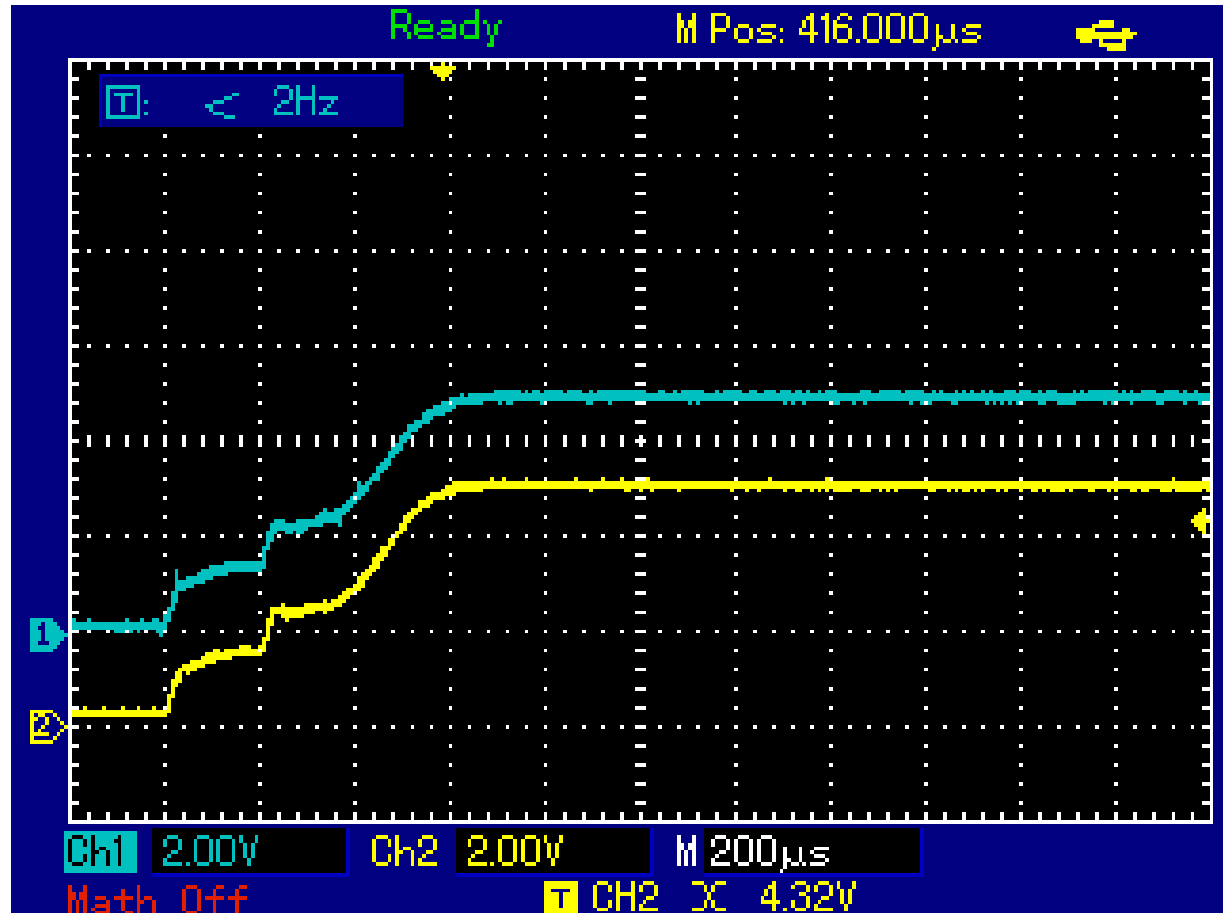




12V and 5V measurement on core module



5V and RESET voltage measurement on PIC



CH1 (Yellow) = 5V
CH2 (blue) = RESET

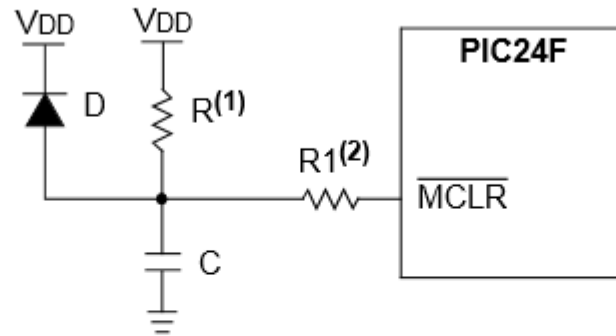
No delay in reset line!
Reset connected to 5V via $R=100\text{k}\Omega$
No capacitor on reset line

(datasheet suggests $500\text{ }\Omega < R < 10\text{k}\Omega$)

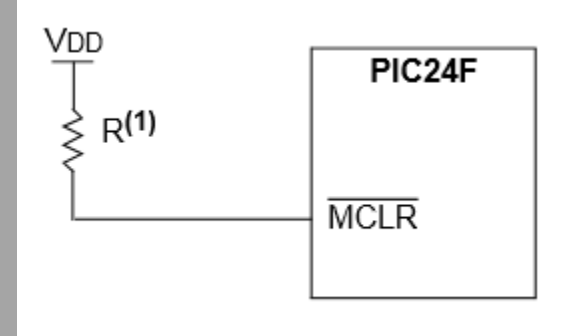
Is the 64msec power up reset timer active?
If not: can cause problems at reset!

Suggested PIC24 Reset circuit (PIC datasheet)

Figure 40-3: External Power-on Reset Circuit (for Slow VDD Rise Time)



- Note**
- 1: The value of R should be low enough so that the voltage drop across it does not violate the V_{IH} specification of the \overline{MCLR} pin.
 - 2: $R1$ limits any current flowing into \overline{MCLR} from external capacitor C in the event of \overline{MCLR}/V_{PP} pin breakdown, due to Electrostatic Discharge (ESD) or Electrical Overstress (EOS).



Actual circuit used in Core Module
R=100kOhm

(docs suggest: R=500..10k)

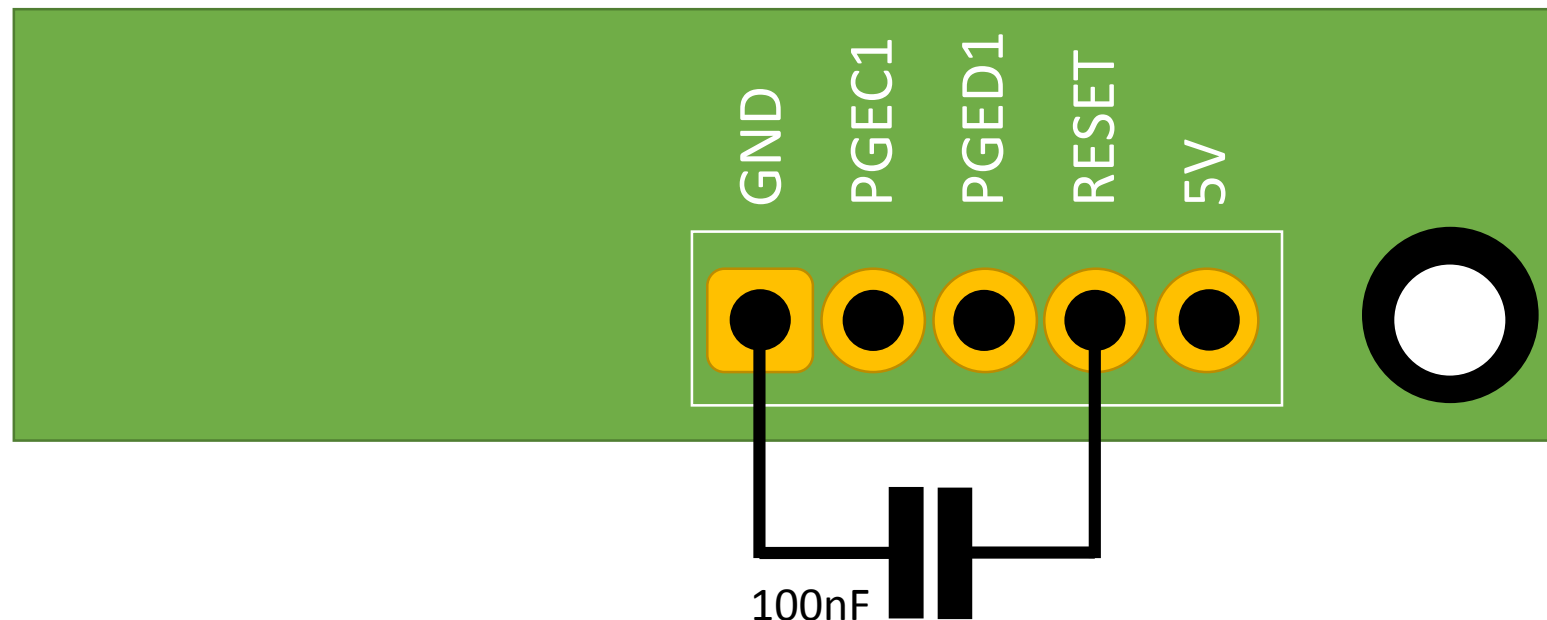
<http://ww1.microchip.com/downloads/en/DeviceDoc/39728a.pdf>

<http://ww1.microchip.com/downloads/en/DeviceDoc/reset.pdf>

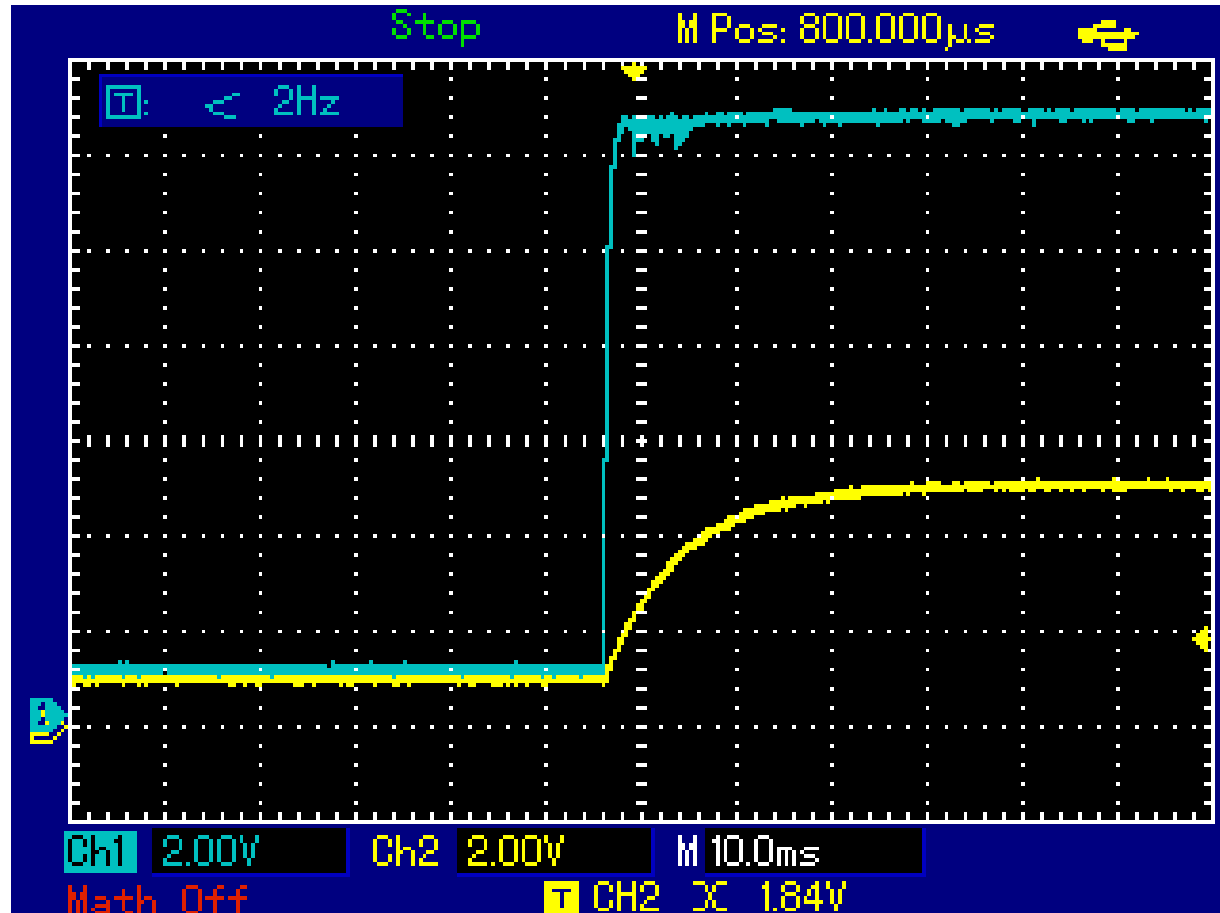
<http://ww1.microchip.com/downloads/en/DeviceDoc/39927c.pdf>

Fix on Program/Debug connector

- Located on Core module PCB
- Add 100nF Capacitor to delay rise of reset signal
- Note: may also prevent possible CM reset due to static or EMI



12V and RESET voltage measurement on PIC



After applying 100nF Capacitor fix to debug connector

CH1 (Yellow) = RESET

CH2 (blue) = 12V

Delay in reset line ~ 30msec

Switch on-detection problems solved for the patched modules.

No detection problems at startup

Conclusions

- Modern Robotics did not implement the Microchip suggested reset circuit (resistors, capacitor, diode) but a rudimentary circuit (single resistor to Vcc)
- The Vcc resistor has a higher resistance (100k) that suggested by Microchip $< 10k$
- This causes startup issues and possible EMC/ESD susceptibility
- The startup delay timer is most likely not enabled
- *Update: According to Tom Eng (FIRST) devices produced after October 2015 (having Firmware version ≥ 1.6) have the startup timer enabled, and tie the RESET line to Vcc inside the Microcontroller after startup. This is a partial fix of the problem (as it does not fully solve ESD/EMI sensitivity of reset line) but improve startup reliability*