EE/CprE 4910 – sdmay25-26
Week 10 Report
11/14/2024 - 11/21/2024

Cost-Effective and Easily Configurable High Voltage Motor Controllers for Automotive Use
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Summary

Progress on software continues while the schematic for the first revision is nearing completion. The pinout for the MCU have been determined, skeleton code continues to be developed, and most of the schematic is ready to be reviewed. Even though our initial prototype with the development board no longer spins the motor, we have plenty of data to process and work to do to build our next revision.

Accomplishments

- Determined MCU pinout and added it to the schematic – Bryce, Marek
    - Includes alternative options for interfacing with MCU peripherals
- Created a high-level plan for FOC/FWC support next semester – Gavin
- Created footprints for each component and finalized schematic - Jonah

Pending Issues

Ordering a new ST MCU from Detroit will probably cause more problems. This is fine since software and hardware have plenty of more important work to do, but it does mean we will be without the ability to spin the motor for a while.

Individual Contributions

Member	Contributions	Week Hours	Cumulative Hours
Gavin Patel	Drew out basic FOC and FWC plan	7	55
Bryce Rega	MCU pinout, skeleton code	7	63
Marek Jablonski	Implemented MCU pinout and acc components	6	65
Jonah Frosch	Finalizing schematic, created footprints	9	59.1
Long Yu	Updated team website, ordered MLCC capacitors	6	52

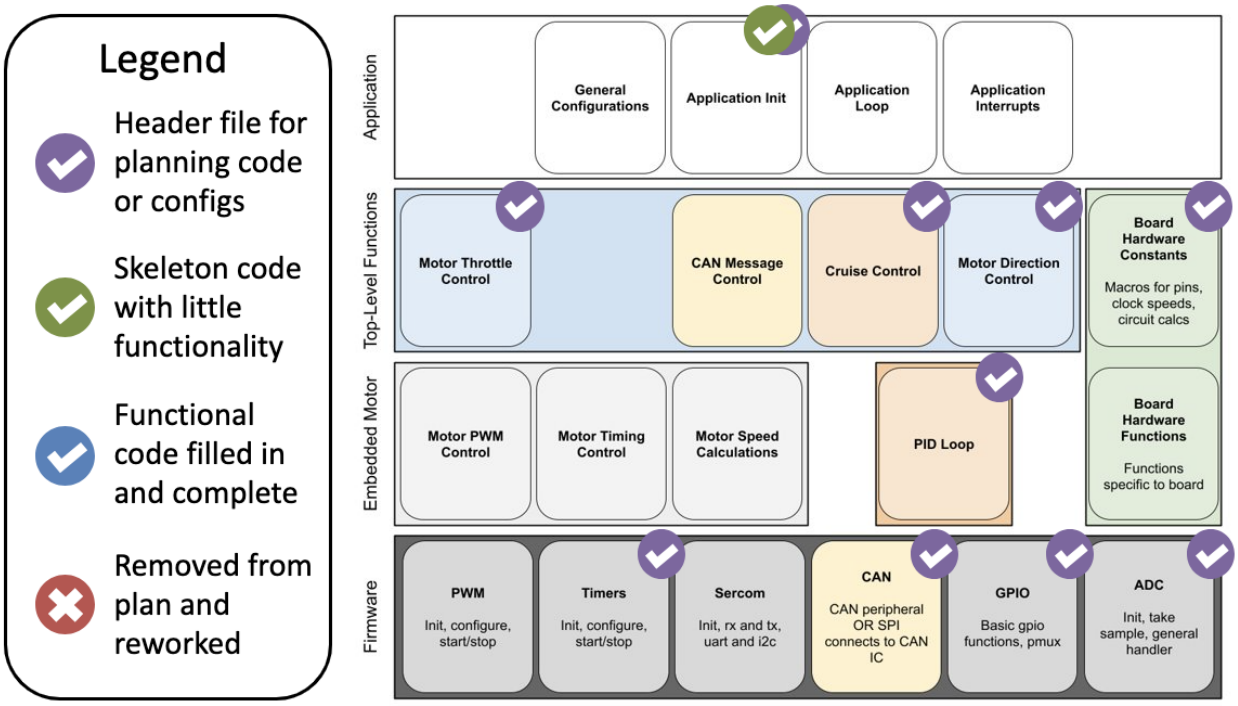
Upcoming Week

- Hardware
    - Create board outline in layout and start orienting and connecting components
    - Order replacement MCU for the dev board – Marek
- Software
    - Create a plan for how FOC/FWC can be implemented based on our current skeleton code and software diagram
    - Continue developing skeleton code and report with visual
        - Focus on firmware now that pinouts have been decided
    - Keep on reverse engineering the previously generated code to drive the skeleton code plan
- Put together updated advisor presentation (one presentation per week)

Advisor Meeting Summary

- What is the frequency of the change of current, and what information we plan to obtain from the current, needs to be fast enough to track the ac current instantaneously
    - Make sure that the 120kHz to 50kHz is fast enough for the tracking
- Showing the final product in a video near the end of the semester in a video
    - Look into how to calculate the PI value for the controller
    - Looking into something like this calculation https://e2e.ti.com/support/microcontrollers/c2000-microcontrollers-group/c2000/f/c2000-microcontrollers-forum/1060236/tms320f28035-calculating-theoretical-values-for-current-loop-pi-controller-for-motor-control
- Using the Gallium Nitride gates is just requiring more careful design, noted we will look into them in the future revision but not this one
- Electrolytic caps will not be able to handle the very high frequency on startup
    - Recommended a mix of types of caps, also careful about the connection between the caps and the place where it immediately meets should be as close as possible to where its used
- Presentation should have a dry run with them, set up on December the 4th and at the very least have most of it done so we can get feedback for it

Software Progress Tracker



More headers have been developed all around. The firmware layer no longer has clocks due to not being needed outside of configuration, which can be done custom per MCU or board revision. ADC was added, but may not be used due to the fact that we'll probably just be using the ADC for everything ADC. SERCOM was added in case we want to support UART or I2C. Board hardware constants were created now that pinout for the first revision has been complete. There can be multiple of this file depending on how many revisions there are, so keep an eye out for number of check marks.

MCU Pinout

AT SAM C21 J18	Primary		Secondary		Tertiary		
Function	Port & Pin	Peripheral	Port & Pin	Peripheral	Port & Pin	Peripheral	Debug?
Phase H	PA08	TCC0 [0]	PA16	TCC0/2	PB30	TCC1 [2]	Pin
Phase L	PA09	TCC0 [1]	PA17	TCC0/2	PB31	TCC1 [3]	Pin
Phase H	PA10	TCC1 [0]	PA30	TCC1 [0]	PB30	TCC1 [2]	Pin
Phase L	PA11	TCC1 [1]	PA31	TCC1 [1]	PB31	TCC1 [3]	Pin
Phase H	PA12	TCC2 [0]	PA16	TCC0/2	PB30	TCC1 [2]	Pin
Phase L	PA13	TCC2 [1]	PA17	TCC0/2	PB31	TCC1 [3]	Pin
Bus Voltage	PA02	AIN2	PB00	AIN0			Pin
Phase Current	PA05	AIN5	PB01	AIN1			Pin
Phase Current	PA06	AIN6	PB02	AIN2			Pin
Phase Current	PA07	AIN7	PB03	AIN3			Pin
1.5V Reference	PA03	VREFA					No
3.5V Reference	PA04	VREFB					No
HALL Sensor	PA00	EXTINT[0]	PA14	EXTINT[14]			Pin
HALL Sensor	PA01	EXTINT[1]	PA15	EXTINT[15]			Pin
HALL Sensor	PA18	EXTINT[2]	PA02	EXTINT[2]			Pin
CAN Tx	PA24	CAN0 TX	PB22	CAN0 TX	PB14	CAN1 TX	No
CAN Rx	PA25	CAN0 RX	PB23	CAN0 RX	PB15	CAN1 RX	No
DAC Analog Out	DNC		PA02	VOUT			N/A
Sercom Data	PA16	SERCOM 1/3	PA22	SERCOM 3/5			Pin
Sercom Clock	PA17	SERCOM 1/3	PA23	SERCOM 3/5			Pin
Throttle ADC	PB00	AIN0	PA08	AIN8	PB08	AIN2/4	Pin
Timer or PWM H	PA14	TC4 [0]	PA18	TC4 [0]	PB08	TC0 [0]	N/A
Timer or PWM L	PA15	TC4 [1]	PA19	TC4 [1]	PB09	TC0 [1]	N/A
Extra Button	PA19	EXTINT[3]	PA14	EXTINT[14]	PA15	EXTINT[15]	No
Extra LED	PA14	EXTINT[14]	PA15	EXTINT[15]	PA19	EXTINT[3]	No
Extra LED	PA15	EXTINT[15]	PA14	EXTINT[14]	PA19	EXTINT[3]	No
Extra GPIO	PA22	EXTINT[6]	PB22	EXTINT[6]	PB12	EXTINT[12]	Pin
Extra GPIO	PA23	EXTINT[7]	PB23	EXTINT[7]	PB13	EXTINT[13]	Pin