EECE72545

Project Functional Requirements

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STM32F303RE Nucleo

The STM32F303RE Nucleo Development board includes the main processor for the controller board. It includes a programming interface, local power regulation, and breakouts for many of its pins. These pins interface with the rest of the Embedded Controller Board, and the pins include:

- Serial
- CANbus
- SPI
- I2C
- Timers
- ADC
- Power

Serial

Serial communications will be used to control and receive messages from the Embedded Control Board. It will also aid in debugging. The serial communications will use 3V3 logic levels from the STM32 to a RS232 transceiver. The requirements for the serial transceiver are:

- 3-5V Supply Voltage
- Minimum 100Kbps data rate
- Minimum of 2 TX/RX pins (one of each); recommended 4 (two of each)
- Accepts ±25V RS232-levels
- Small package, SMD, ceramic charge-pump capacitors
- Leaded SMD package

Suggested device: ICL3232

CANbus

The Embedded Control Board will eventually connect to a CANbus network. A CANbus transceiver will interface to the integrated CAN controller in the STM32 via 3.3V logic levels. The requirements for the CANbus transceiver are:

- Compatible with 3.3V logic levels
- Integrated ESD and fault protection
- Low current standby
- High-speed CAN capable
- Leaded SMD package

Suggested device: MCP2542

DC Motor

The Embedded Control Board will control two brushed DC motors, each with a IR LED-based encoder. The DC motor driver must be able to drive both DC motors, independently, in both directions. Protection systems are

a requirement. The motor driver must operate at the maximum battery voltage. Low $R_{DS(ON)}$ for lower temperature operation is a desirable feature. The requirements for the DC motor driver are:

- Compatible with 3.3V logic levels
- Integrated over-current, thermal and fault protection
- Low current standby
- 14.8V supply voltage capable
- $R_{DS(ON)}$ <=500mΩ
- Leaded, thermally enhanced SMD package

Suggested device: DRV8814

The motor encoders use LED interruption to create a signal proportional to the speed of the DC motors. The maximum frequency of the signal will be approx. 2Khz. A low-pass RC filter will filter out higher-frequency noise, and an inverting Schmitt trigger will provide signal conditioning and additional noise filtering.

Suggested device: 74LVC2G14

Stepper Motor

The Embedded Control Board will control a stepper motor, with two limit switches to indicate the rotational limits in both directions. The stepper driver must be able to drive a unipolar motor. Protection systems are a requirement. The stepper driver must operate at the maximum battery voltage. Low $R_{DS(ON)}$ for lower temperature operation is a desirable feature. The requirements for the stepper motor driver are:

- Compatible with 3.3V logic levels
- Step/direction controls
- Integrated over-current, thermal and fault protection
- Low current standby
- 14.8V supply voltage capable
- $R_{DS(ON)}$ <=1Ω
- Mixed decay mode
- Leaded, thermally enhanced SMD package

Suggested device: DRV8884

The limit switches activate when the camera module reaches either the left or right rotational limits. Limit switches exhibit switch bounce on activation A low-pass RC filter, and an inverting Schmitt trigger will provide switch debouncing.

Suggested device: 74LVC2G14

Power Budget

The Embedded Controller Board will use two power supply voltages, in addition to the battery voltage. The 3V3 power rail will be supplied by the 5V rail. The following is the power budget for the 5V and 3.3V rails, with 20% extra already calculated:

Rail	Budget (with 20%)	Power	Power adjusted for efficiency
3V3	32mA	106mW	180mW (50% & 85%)
5V	557mA	2.78W	3.2W (85%)
Total			**3.38W**

With the 3.3V being drawn from the 5V supply, the 5V supply will need to provide

$$\frac{3.38W}{5V} = 676mA$$

5V Switching Power Supply

The 5V power supply will power many parts of the Embedded Controller, as well as the servo motor. A switching power supply will provide efficient power conversion. The requirements for the 5V switching power supply are:

- 5V output voltage
- Greater than 14.8V maximum input voltage
- Minimum 700mA output current
- Better than 85% efficiency at >100mA output current
- Compatibility with low-ESR ceramic output capacitors
- Small, leaded SMD package

Suggested device: TPS562201

3V3 Linear Power Supply

The 3V3 power supply will power many of the ICs on the Embedded Controller. A linear power supply will provide low-noise power. The requirements for the 3V3 switching power supply are:

- 3V3 output voltage
- 5V input voltage
- Minimum 50mA output current
- Low quiescent current
- Thermal protection
- Leaded SMD package

Suggested device: CAT6219