Group 12

THE TWO WHEEL DEAL

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Criticality Levels

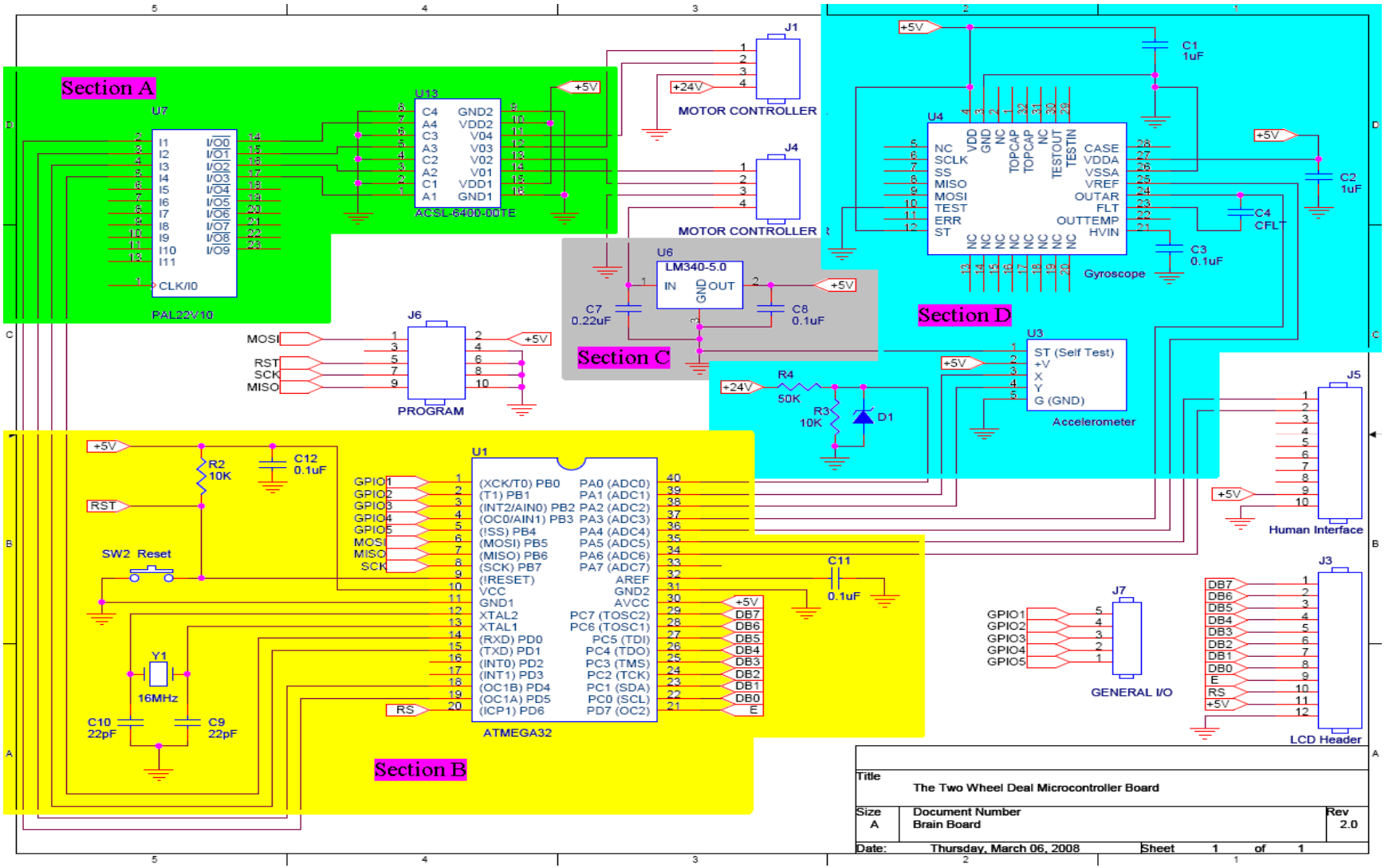
- HIGH
  - Failure that causes system instability
  - Possible damage to user and/or system
- MEDIUM
  - Failure that affects balancing algorithm
  - Affects steering function
- LOW
  - LCD malfunction, incorrect battery level
  - No damage to device

Component Analysis

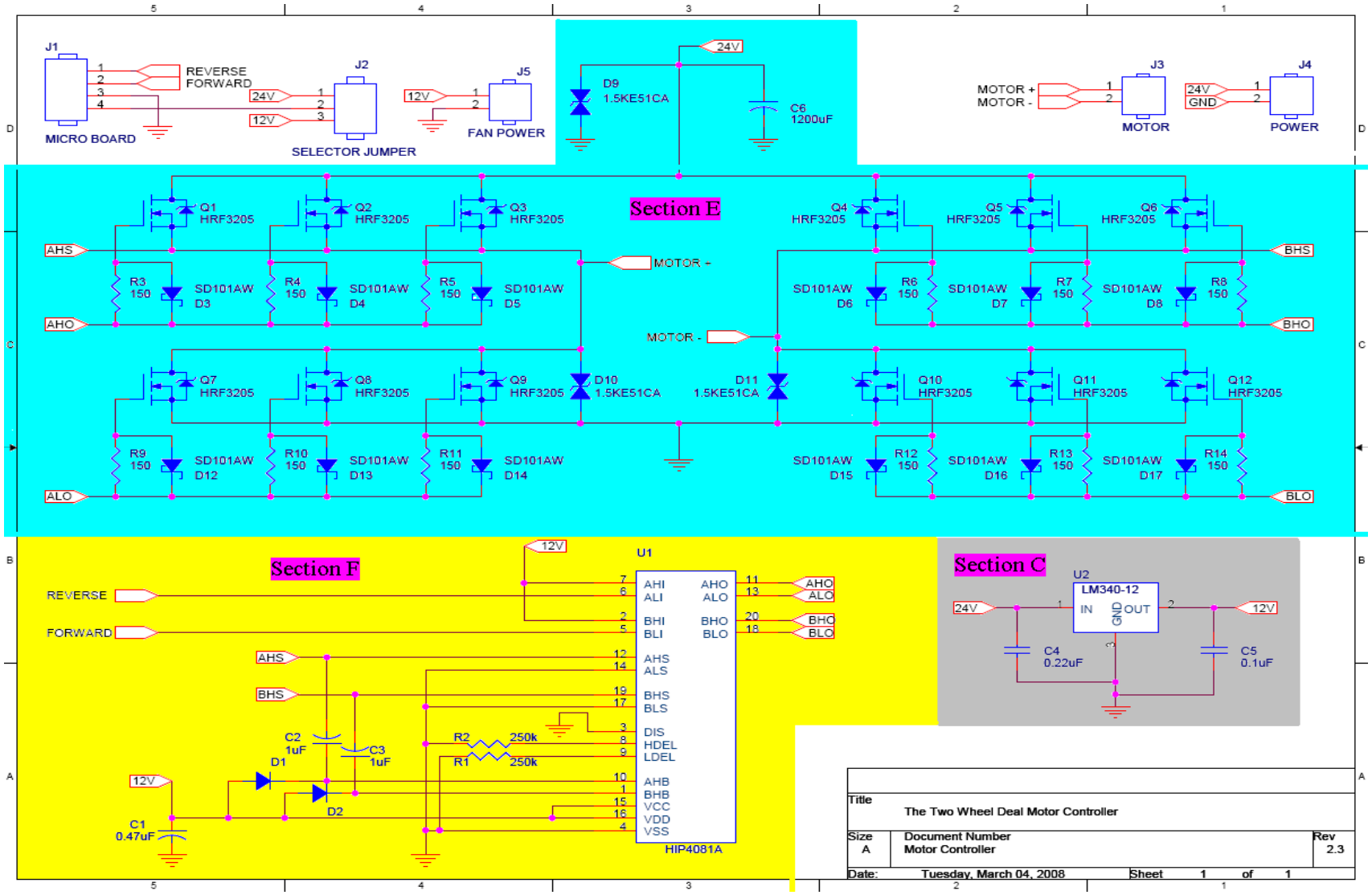
Failure Rates in the worst case scenario

- ATmega32 Microcontroller
  - MTTF = 1.393 (400) years
- Voltage Regulators
  - MTTF = 9.794 (255) years
- Accelerometer
  - MTTF = 19.467 years
- Gyroscope
  - MTTF = 50.244 years
- Power MOSFETs
  - MTTF = 2.374 (1,600) years

FMECA: Brain Board



FMECA: Motor Controllers



Section B: Microcontroller

Table 2-Brain Board Section B

Failure No.	Failure Mode	Possible Causes	Failure Effects	Method of Detection	Criticality	Remarks
B1	Micro remains in reset	Reset switch is broken and stays in "pressed" state.	Microcontroller fails to run program, also cannot reprogram FLASH memory	Observation with DMM	Medium	Medium Criticality because system will not balance after power up so user isn't in danger of falling off.
B2	V_{CC} shorted to ground	C_{12} fails and shorts out	No power to microcontroller—cannot drive motors	Observation with DMM	High	High Criticality because if the micro is no longer powered, then the wheels stop and it could throw rider and damage the device.
B3	ADC inputs are all zero	C_{11} fails and shorts out	AREF for ADC channels is 0V causing all ADC outputs to be zero	Observation with DMM	High	If the micro no longer receives vital system feedback, then system becomes unstable which may injure rider and damage the device.

Section C: Voltage Regulators

Table 3-Brain Board Section C

Failure No.	Failure Mode	Possible Causes	Failure Effects	Method of Detection	Criticality	Remarks
C1	System performance seems random and erratic	Bypass capacitors C_4, C_5, C_7, C_8 became disconnected or failed	Introduces substantial amounts of noise which affects sensor outputs	Observation while riding	Medium-High	Medium criticality because system will still operate. If this isn't fixed right away, personal injury and device damage could occur.
C2	$V_{CC} = 0V$	Bypass capacitors C_4, C_5, C_7, C_8 became shorted or failed	No power to microcontroller stops the motors from turning.	Observation by DMM measurement	High	

Section D: Sensors

Table 4-Brain Board Section D

Failure No.	Failure Mode	Possible Causes	Failure Effects	Method of Detection	Criticality	Remarks
D1	No response to changes in tilt	Either one or both axis of the accelerometer failed	System will not respond accurately, balancing alg. wont respond to small changes	Observation while riding	Medium-High	Depending on which axis fails, system may still balance. Could result in instability, injury, or damage to device.
D2	No response to quick changes in tilt	Failure of gyroscope, filter capacitor is disconnected or shorted out	System will respond the same way for quick and slow movements which may disrupt balancing	Observation while riding	Medium-High	The system should still balance itself but response may be slow. If rider changes angle quickly, they will fall off. Damage or injury may result.

Section F: MOSFETs

Table 5-Motor Controller Board Section E						
Failure No.	**Failure Mode**	**Possible Causes**	**Failure Effects**	**Method of Detection**	**Criticality**	**Remarks**
E1	Cannot control motors	The MOSFETs could have overheated and burned up	One or both motors stop working	Observation	High	High criticality because if the motor stops while the user is riding, injury and damage to device will occur.
E2	Operation is bumpy or unstable	Gate resistor and/or diode network may be destroyed	Shoot-through current may burn out components, rapidly discharge batteries.	Observation	High	High Criticality because the rider can fall off and get hurt and batteries/electronics could be destroyed.

Questions?