2002 Custom *(Motor Monitor)* Circuit

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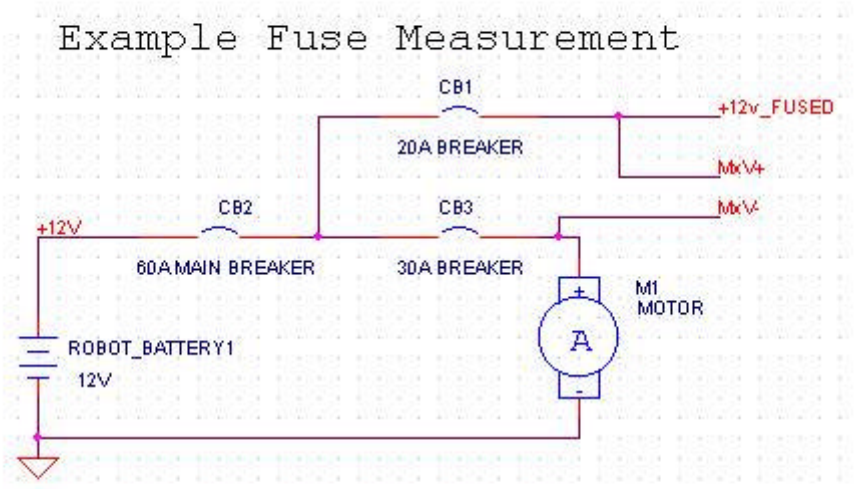
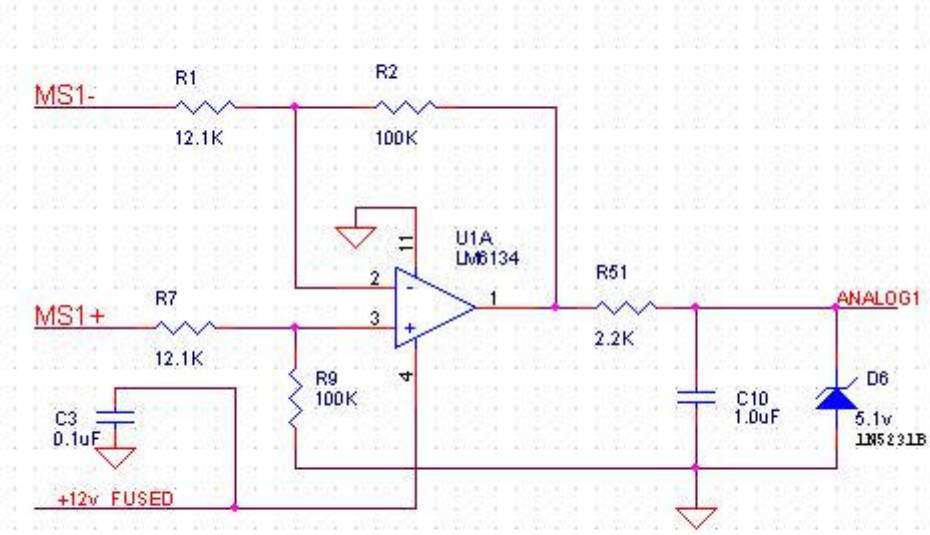
The custom circuit is used to monitor motor currents in the 2002 BG High School robot. ***(ARC)*** The novel part of this circuit is that it does NOT add any components in series with the motor/control circuit. The circuit measures the voltage across the thermal circuit breaker. *(NOTE: FIRST requires that a thermal circuit breaker be in series with every motor)*

By not adding other series devices, we are able to provide absolute full power to the motor. *(because adding series current sensing elements generally means adding voltage drops….and Hall Effect current measuring devices are quite expensive)*



NOTE: The above diagram represents how the OP-AMP circuit *(below)* is wired into the motor circuit. The CB1 circuit breaker supplies +12V_FUSED which is used to power the op-amp circuit itself and NOT for measuring current. *(This breaker is required by FIRST for the custom circuit power)*



The above circuit is a simple OP-AMP difference amplifier. It measures the voltage across the fuse (MS1+ to MS1-) and amplifies it by 8.26. *(ratio of R2 to R1 and R9 to R7)* The particular op-amp was chosen because it's common mode input voltage range allows it to sense at and above the positive voltage rail.

The output resistor and capacitor *(R51 and C10)* components are a low-pass filter that is used to filter out all "ripple" caused by the motor controller PWM circuit. The output zener diode *(D6)* is used to clamp the circuit output at about 5v. *(powered by 12v, the outputs must be clamped to protect the A/D converter which only accepts 0-5v input levels)*

Because the fuse resistance is low *(about 6 milliohms for 30A breaker and 9 milliohms for 20A breaker)* the circuit above gives you an output of 49.4 mV/Amp *(30A)* and 73.4mV/Amp *(20A).* This results in full scale current measurements of 101A for the 30A breaker, and 68A for the 20A breaker.

The initial purpose of this circuit was to measure ALL motor currents, and allow system dashboard software to measure and track full current draw and present a warning to drivers about main breaker tripping. *(since the main 60A breaker is not automatically resetting, and would immobilize the robot if it were to trip)*

The circuit was used for not only that, but it is used by the Basic Stamp to operate the goal clamp motor. It it as a sensor to detect clamp cam motor stall, which means it has reached the stops. *(and should be shut down)*

We also use the outputs of the custom circuit to better understand the current usage and efficiency of all the various motors in the system. If there is any question regarding one side of our drive system being damaged, or exhibiting excess load/friction, we use can look at the current draw of the drive motors and compare them to each other and to the values measured of a "perfect" operating drive.