Single Phase Motor Startup Device

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Team 10

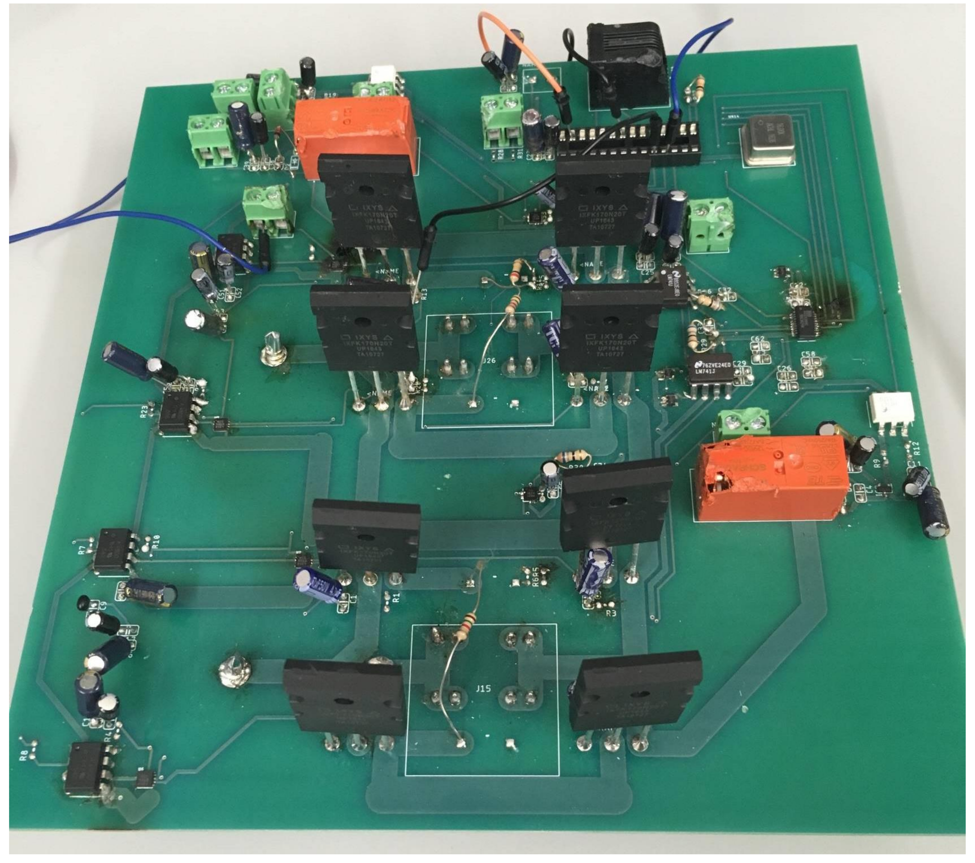
Summary

Our single phase motor startup device was created to safely bring a motor from rest up to nominal operating speeds. Large systems that rely on single phase motors often have issues during the startup phase, since they require a lot of energy to get the motor moving. This can lead to the motor drawing too much energy from the electric grid, causing brownouts and other issues to occur throughout the rest of the system connected to the grid. This device will be able to disconnect the motor from the main power grid temporarily, and supply the required energy needed for startup.

PCB

In order to control the motor's input characteristics, we designed a printed circuit board with a number of functional properties. To power the motor's start and run windings, two full h-bridge inverter circuits were built to convert the 12 V DC power from the battery to AC power. Snubber circuits and fuses were used alongside the transistors to suppress damaging voltage transients and prevent current faults. Then a transformer is used to step up the voltage by a factor of 28, to a value the motor can use. A microcontroller is used in conjunction with opto-isolators and gate drivers to direct the speed at which the transistors switch on and off in the h-bridges.

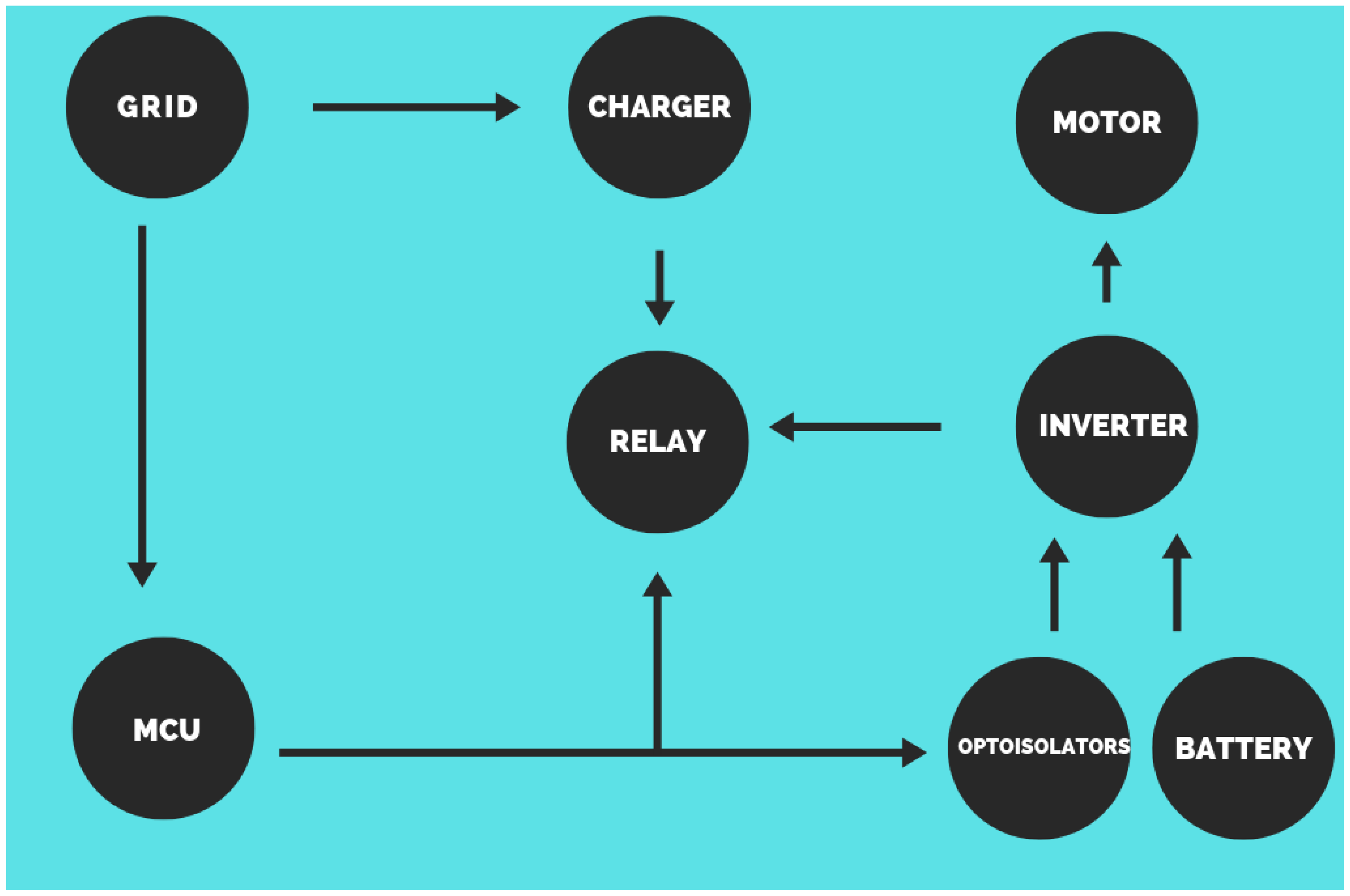
The output of each h-bridge then goes to its own double-pull double-throw relay. These relays are controlled by the microcontroller, and the output of each relay goes to the run and the start windings on the motor. Each h-bridge circuit is connected to a corresponding relay, which will switch the motor windings' hot and neutral wires between the battery circuit and the electric grid, depending on the motor's mode of operation. If the motor is attempting to start up, the microcontroller will connect it to the battery circuitry. If the motor is operating at full speed, the relays will be switched back to the electric grid.



Feedback Circuit

We also designed a feedback circuit on our PCB to track the voltage and current readings. At the output of the h-bridges, we added in-line current sensors to measure the current values of the circuit. We also added voltage dividers and op-amps, to lower the voltage and to create upper and lower bounds for the voltage waveform. Both the current and voltage signals are then sent to an A/D converter, which reads the digital output back into the microcontroller. The microcontroller may initiate a failsafe, by turning off the h-bridges, if either the voltage or the current readings are at abnormal levels.

SUBSYSTEM DIAGRAM



MCU

The dsPIC33FJ128MC802 microcontroller for the system produces PWM signals that allow for the H-bridge in the PCB unit to function properly. These signals allow for the H-bridge to have enough time to alternate in diagonal pairs to avoid shoot through. To do this, a sine table was created to produce the signal needed to control the H-bridge. The analog to digital converter and relays also rely on the microcontroller. The analog to digital converter operates to the commands of the microcontroller signal sent to it. There is an external crystal oscillator operating at 16MHz to set the frequency the microcontroller is operating at.