RTx Precharge Design Document

RocketTracks Capstone 2014

The precharge circuit for the RTx controller system allows the battery supplies to be connected to the high capacitance capacitor board without causing a massive inrush of current. The precharge circuit also incorporates the main on/off switch and emergency stop features of the system. All this is done with the use of high current relays and devices to support the current load needed to operate the RTx controller motors and system.

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# Precharge Circuit

## Precharge Circuit Overview

The capacitor precharge circuit initially connects the capacitor array board to a low resistance, high current resistor allowing the capacitors to charge gradually instead of initially being connected directly to the batteries. Two low current resistors are used to create a voltage divider to act as a reference voltage for a comparator. Once the comparator detects that the capacitors have charged to a voltage greater than the one set by the voltage divider, the comparator supplies power turning on a transistor. The transistor is high current to be able to supply sufficient current sink to turn on an external relay which bypasses the precharge resistor and connects the capacitor array board directly to the battery supplies.

## Precharge Circuit

### Component List

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| IC1 | Q1 | R1 | R2 | R3 | R\_CHARGE | RELAY3 |

### Design Overview/Component Choice

#### Voltage Divider

It was arbitrarily determined that the capacitor array had been sufficiently precharged when they had reached 95% of their maximum voltage. In this case, with a 24 volt supply the precharge state would be complete once the capacitors had reached roughly 23 volts. The resistor values were chosen to provide the appropriate voltage divider reference for the comparator and also have high enough values so as to not draw a significant amount of current from the batteries.

#### R\_Charge

The use of a 10 ohm resistor means that the charge time will be greater than a few seconds (with the capacitor array fully stuffed) but not take more than a minute to charge the capacitors. At 10 ohms, the resistor needs to be able to handle a max of 60 watts of power across it. The TEH70 is rated for applications of up to 70 watts. Although the amount of time that the resistor would produce much heat would be minimal (since once the precharge is complete the resistor is bypassed through the high current relay), this model resistor will have a heat sink with it to ensure that there is proper heat dissipation.

#### Comparator

The TL331 single comparator was chosen for being a readily available component that is able to operate at the necessary input voltage range (2v to 36v).

#### Switching Transistor

Once the capacitors have sufficiently precharged, the comparator produces an output high to turn on a high current NMOS transistor. Using an NMOS transistor allowed for low side switching to enable the high current relay. The MOS transistor was chosen so that only a voltage level at the transistor gate would be needed to turn it on instead of needing additional components to ensure sufficient current to a BJT. The STW11NM80 is also rated to handle a Vgs voltage of 30V, meaning that it won't be a problem to have 24v volts between the gate and the source.

#### Relay3

Relay3 is a high current relay that bypasses the precharge resistor once the capacitors have been sufficiently charged. It is enabled by the switching transistor, which is controlled by the output of the comparator. Relay3 needed to be rated at a sufficient current to effectively allow the capacitors to be directly connected to the batteries. It was configured in the circuit to operate using low side control. The relay is classified as “tractor parts”.

# On/Off Control and Emergency Stop

## On/Off Control and Emergency Stop Overview

The precharge system also provides an On/Off control via a switch as well as the “big-red-button”, emergency stop switch, which would disable and remove all power to the Rocket Tracks system if pressed.

## On/Off Control and Emergency Stop

### Component List

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Main\_Switch | Relay2 | Relay1 | Fuse | E-Stop |

### Design Overview/Component Choice

#### Main Switch

The Main Switch is a high current toggle switch which controls whether the rocket tracks system receives power from the batteries. It has only two states – connected or disconnected.

#### “Big-Red-Button”

The “big-red-button” is an emergency stop switch which aids in removing power from the entire system. The emergency stop switch that was chosen does not support high current; because of this, the emergency stop switch controls Relay1, which controls the enable to Relay2, which does support the high current going to the system. The high current relay is classified as “tractor parts”.