Electrical System Datasheet

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Contents

1 General Description 1
2 Features 2
3 Wiring Diagram 2
4 Testing 3

1 Overview

The electrical system can be broken down into two main functional systems, the safety critical system, and the electronic instrument cluster.

Like the previous vehicle the safety critical features such as the brake light, reverse light and beeper, and sensors to activate them operate autonomously from the electronic cluster control system to create a robust, safe system.

The electronic instrument cluster consists of a small data acquisition network and a driver display interface.

2 General Description

For 2018, the main goal was to consolidate the previously tested perfboard electrical system into a single custom PCB ready for mass manufacturing. This new electronic instrument cluster along with a waterproof ABS plastic enclosure will create a robust, reliable system.

While providing the operator with vehicle speed, engine RPM, gear position, temperatures, and other diagnostic info. The on board computer will also be equipped to save that data and wirelessly transmit this information along with video and audio to a base station in the pit. This data can be used to monitor the vehicle's systems while providing valuable information to optimize future designs for all systems.

The electronic instrument cluster display consists of 5 small OLED screens and a 20x4 character LCD. The screens were selected based on previous experiences with difficulty to clearly read information from a TFT display in sunlight.

The display driver and data collection is handled by an ATMEL ATMEGA2560 series microcontroller. The custom PCB designed via KiCAD enables a large amount of sensors and other instrumentation to fit in a small form factor. The on board computer collects data using a MPU6050 IC (accelerometer and gyroscope), MAX31855 and K-Type thermocouples (temperature), and US18 Hall Effect sensors (gear position and engine operation). Another feature is a motor driver circuit to control the electronic gear shifter. All the operation data is stored to the on board SD card while also being wirelessly transmitted to the pit crew base station via a RFM95W LoRa module.

The Hall Effect sensor was mounted perpendicular to the outer diameter of the driving gear in the gearbox and on the starter cover to allow the microcontroller to detect the car speed and engine RPM. The status of multiple Hall Effect sensors placed in the gearbox to read the shifter position is also passed to the microcontroller, such that the current gear position can be displayed. Additionally, thermocouples are directly threaded into the engine sump and the gearbox for accurate temperature readouts.

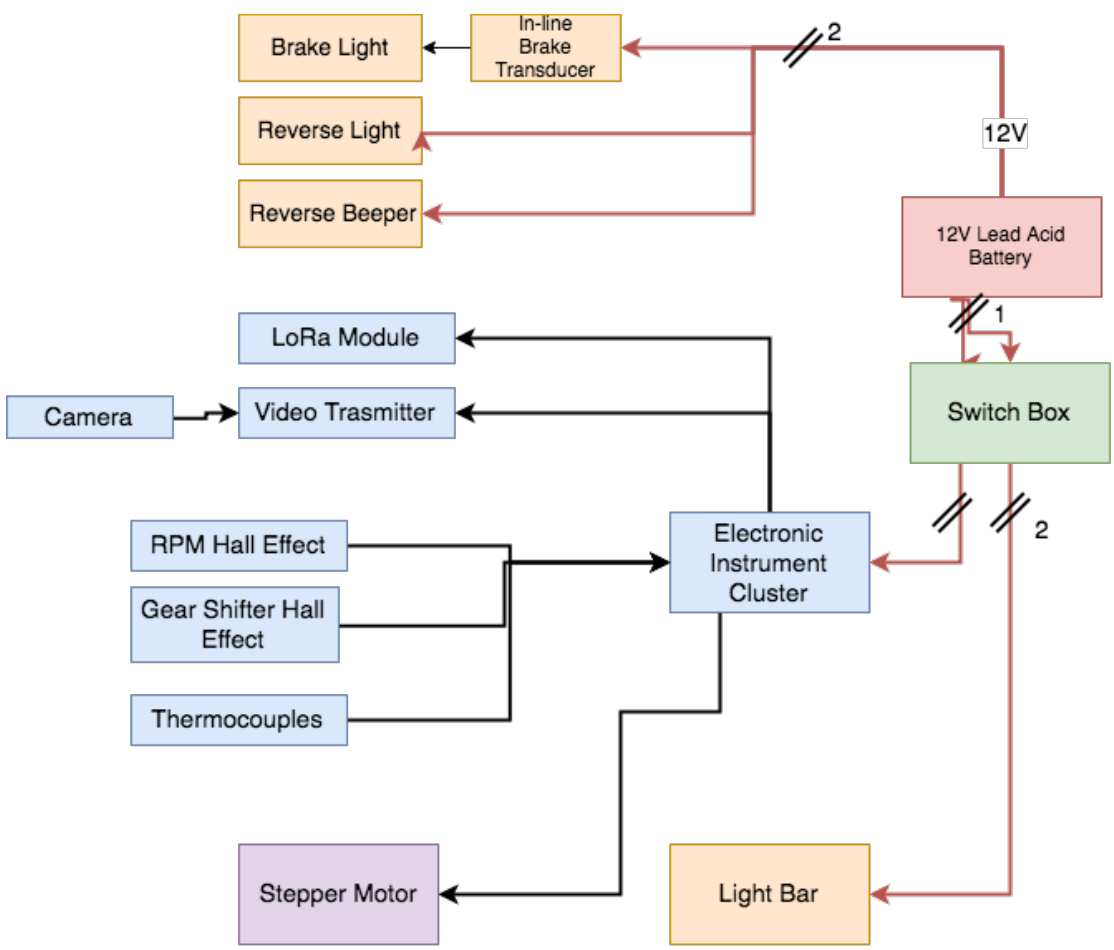
The power required for each component of the system is supplied by an 12 Volt lead-acid battery. The electronic instrument cluster steps the voltage down to 5V for all the electronics using a buck converter. It also handles all the power distribution for the vehicle. The lead-acid battery is connected to the engine alternator to charge it.

3 Features

- 12V Lead Acid Battery
- Brake and Reverse Lights
  - In Line Brake Pressure Transducer Switch
- Reverse Beeper
- Light Bar
  - NOMA 12V 7W Lights
- Main Electronic Instrument Cluster
- Line Locking Braking Board
- Wireless Data Telemetry Board

4 Wiring Diagram

22AWG was used for most wiring due to its availability at MUN, with its current capacity of 5A this will be suitable as even with safety factor no single system will draw that much current in a worst case scenario.



5 Testing

Once assembled, the PCB was tested using a lab oscilloscope and digital multimeter. Testing included verifying signal integrity, and monitoring the reset lines, and checking 12V, 5V, and 3.3V power rails during typical operation. The 5V buck circuit was simulated to operate at 94% efficiency during typical operating load. This efficiency dipped to around 84% during significant loads around 5A which is outside operation conditions. The hardware verification proved the system to be reliable.

After being designed by the Memorial Baja team the PCB was manufactured by the ALL PCB board house located in China. Then the board was populated and hand soldered in the lab. The enclosure was 3D-Printed with ABS plastic and waterproofed. Finally it was mounted to the vehicle and wired in.

For a full scale run these improvements increased manufacturability greatly as the entire electronic system can be assembled as a module by a pick and place machine, while the enclosure design could be optimized for injection molding.