

From: allen.jones@ieee.org
To: "Ian Matheson"
Cc: "Masood Ejaz"; "Daniel Eisenbraun"
Subject: RE: IEEE Region 3: Project Update - January
Date: Tuesday, January 31, 2023 4:31:42 PM
Attachments: [IEEE Release Form - Adult.docx](#)

Ian and Daniel,

Thank you very much for your report. I read it with great interest. It looks like you've done a great job of adapting to things like parts shortages and modifying the design based on new things that you discovered as you actually proceeded through building your design. Both of those are exactly what engineers in industry have to do on a regular basis.

After reviewing your report and the other documents that you referenced, there are a couple of tips that I want to pass along.

- In the section that covers the IR Proximity Sensor, I see that the four IR LEDs all share a common current limiting resistor. This can potentially cause problems due to mismatching between LEDs. The voltage at the junction of the four LEDs and the resistor is going to be determined by the forward voltage of whichever LED in the batch happens to have the lowest forward voltage. Just from grabbing the datasheet for a random IR LED off of the DigiKey website, I'm seeing a typical V_F of 1.4 V and maximum of 2.0 V @ 50 mA. Using this LED as an example, if you had three of the LEDs with a V_F of 1.4V and one of the LEDs with a V_F of 2.0V, you could easily have a situation where the LED that had a V_F of 2.0V would just barely be turned on. For that reason, you are generally best off to give each LED its own current limiting resistor. That prevents one LED's V_F from affecting another LED.
- For the algorithm that controls the number of fans based on the car battery voltage, you may want to include some hysteresis in the software to keep the program from repeatedly switching back and forth between battery modes when it is near one of the switching thresholds. There are several factors that could cause the measured voltage to dither around the threshold. First, as the [Raspberry Pi Pico datasheet](#) points out in the "Using the ADC" section, the analog to digital converter's reference voltage on the Pico "will be somewhat noisy." Second, as the fans switch on, the battery's internal resistance and the wiring resistance will cause the measured battery voltage to drop. That could then cause the program to turn off some of the fans, which in turn, would cause the measured battery voltage to rise again, causing the fans to turn on again, ... Third, although the ADC on the Pico is 12-bits, it effectively loses some of these bits due to non-linearity problems in the RP2040 chip that is on the board. There are even a few places where *increasing* the voltage on the ADC pin will actually register as a *decrease* in voltage. This is explained in the "ADC ENOB (Effective Number of Bits)" section of the [RP2040 datasheet](#). You might be able to get around all of these problems by just adding the hysteresis that I mentioned. If not, the previously mentioned section of the Raspberry Pi Pico datasheet gives some more suggestions about how to make the Pico's reference voltage quieter.

It would be great if you could send me photos for your project. At some point, it would also be great if the three of you could do a photo in front of one of the test cars. (It's entirely up to you as to

whether you do that or not. If you do, then I need for anyone who is identifiable in the photo to sign an IEEE Release Form authorizing IEEE to use your photo.) There may be several opportunities to highlight your project in the coming year:

- SoutheastCon 2024 is coming up this spring in Orlando,
- Region 3 periodically sends out a newsletter to all IEEE members in the southeast US plus Jamaica, and
- IEEE is having it's triennial global IEEE Sections Congress in Ottawa, Canada this August. The current IEEE President has identified climate change as the key topic that he wants to address during his term and the Region 3 Director has hinted that she will want me to make some kind of presentation about climate change projects at Sections Congress.

Thanks,

Allen

Allen Jones

Chair, IEEE Richmond Section

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From: Ian Matheson <imatheson@valenciacollege.edu>

Sent: Saturday, January 28, 2023 6:33 PM

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Subject: IEEE Region 3: Project Update - January

Hi Allen,

Attached is our progress update for January. I included lots of pictures, but if you'd like the individual files just let me know.

Best,
Ian