BASIC GLV SAFETY LOOP: MEMO-01

Abstract

This document describes the purpose, design, and functionality of the basic GLV safety loop for ECE492's electric formula vehicle project. The safety loop was designed using a simplified version of the past year's safety loop, manufactured on a panel cut in the machine shop, wired, and tested. The basic safety loop ultimately functioned as expected, and will be replaced with the full safety loop once completed. Data collected during integration tests is also depicted in this document.

February 17, 2017

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Introduction

One of the main responsibilities of the GLV team was to provide 24V of DC current to power the five AIRs on the four TSV battery packs. Being that the battery pack had been nearly already completed due to the work of students from past years, it was necessary to quickly develop a preliminary safety system which would allow for the testing of each of the TSV battery packs. This safety system was to provide power to the Packman boards and would ultimately power the AIRs of the four battery packets. It was also to include an emergency stop button which could immediately shut down the system as well as a latching relay which would close the circuit on a 100V load in the Dyno Room.

The Design

The design of the basic GLV safety loop is shown in the schematic in appendix A. A DT-04 connector is used to connect to the Packmen in the battery packets. On the first returning end of the connector, the circuit is composed of a basic latching system consisting of a BRB, reset button, and 24V relay in an orientation which would create a latching relay. This would allow for the safety loop to energize upon the press of the reset button and remain on until the BRB was pressed. An LED was placed in parallel with the output to the AIRs in order to indicate if the system loop is energized, and a second relay was used to close the loop on the 100V supply upon a press of the reset button. This design was chosen because it was a simple circuit which would be sufficient for early tests of the TSV system. The BRB satisfied the need to be able to quickly disable the circuit, and the reset button simulated the latching system which will be used in the full safety loop.

The safety loop was mounted on the panel shown in appendix B. This panel was cut to hold each of the buttons, the fuse, and the LED. The relay was mounted on the back of this panel to avoid manufacturing an additional plate to support the relay. The material that was used was a black painted steel panel which served the as previous year’s emergency stop panel. This material was chosen since it already held a BRB and required minimal modification.

Design Verification

Description	Test Method	Detailed Results
1.) Connectivity- The basic safety loop is wired as shown by the schematic in Appendix A.	The basic safety loop circuit was traced with an ohmmeter to ensure each connection occurred expected.	Each component was connected as expected. PASS
2.) Energize- The basic safety loop energizes upon press of the reset button.	The basic safety loop was powered by a 24V supply with no load. The reset button was pressed.	The LED turned on. PASS
3.) Deenergize- The basic safety loop deenergizes upon press of the reset button.	The basic safety loop was powered by a 24V supply with no load. The reset button was pressed. Then the emergency stop button was pressed.	The LED turned off. PASS
4.) Energize AIRS- The basic safety loop powers the AIRS upon press of the reset button.	The basic safety loop was powered by a 24V supply with the AIRs connected. The reset button was pressed.	The LED turned on. The AIRs clicked into on position. PASS
5.) Deenergize AIRs- The basic safety loop shuts off the AIRs upon press of the reset button	The basic safety loop was powered by a 24V supply with the AIRs connected. The reset button was pressed. Then the emergency stop button was pressed.	The LED turned off. The AIRs clicked into off position.
6.) Safety- Pressing the reset button does not energize the basic safety loop when the BRB is pressed.	The basic safety loop was connected to a 24V supply with no load. The emergency stop button was pressed. Then the reset button was pressed.	The LED did not turn on. PASS
In submitting this checklist as part of our report, I/We certify that the tests described above were conducted and that the results of these tests are accurately described and represented. I/We understand that any misrepresentation of the tests or the results constitutes a violation of the College policy on academic dishonesty.		
Name(s): Chris Bennett, Joseph Sluke, Kyle Phillips		*Date: 2/17/17*

Data Collection

Tests were run integrating the basic safety loop to the AIRS to test the TSV system. Each battery pack was tested individually with the basic safety loop, and then the packs were connected in series to test the entire system. Data was collected for the tests where each of the packs were connected in series in order to determine the maximum current the drawn by the AIRs on startup. The data is shown below. Scope images can be found in Appendix D.

Trial	Max Current Drawn by 5 AIRS in Series	Peak Time
1	4.6A	40.92ms
2	4.45A	48.30ms
3	4.55A	46.30ms

A second measurement was taken to determine the steady current of the 5 AIRS after the initial current spike on startup. It was found that the settling time was 323.3ms at .5Amps. Scope image is shown in Appendix E.

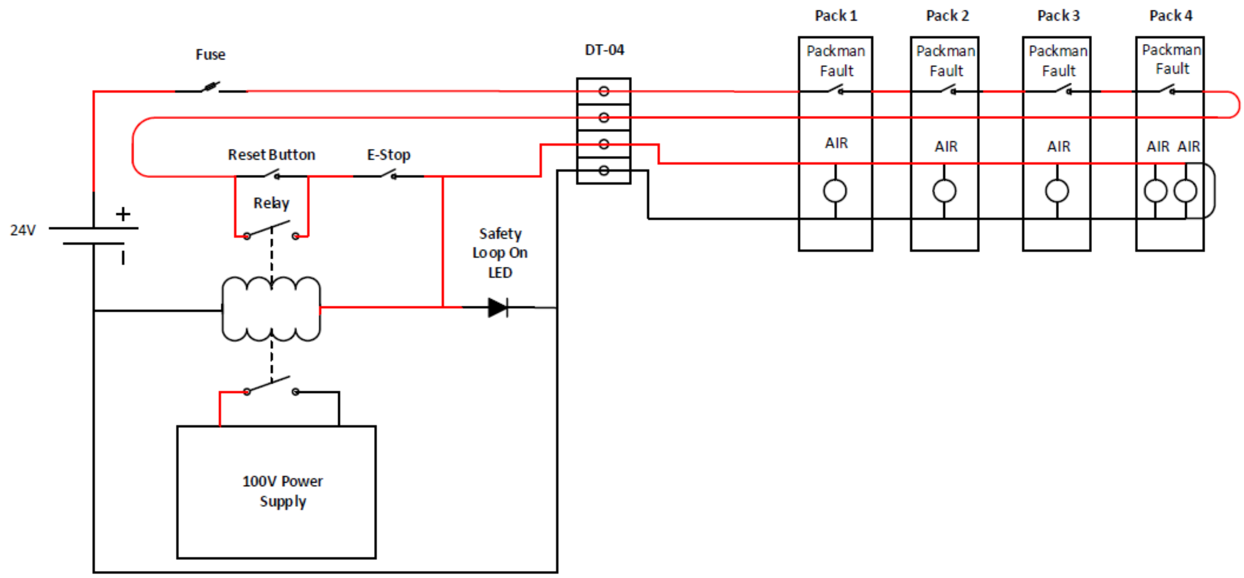
Conclusion

Upon the completion of the basic safety loop, the GLV team had provided a functioning safety system for the TSV system, and it was successfully integrated with the TSV system for testing of the battery packs. The TSI and Cooling System can also be added to the basic safety loop if these systems are completed prior to the completion of the full safety loop. Building the basic safety loop also familiarized the GLV team with the processes of panel manufacturing, wiring, and system integration, and this experience will aid in the manufacturing the full safety loop.

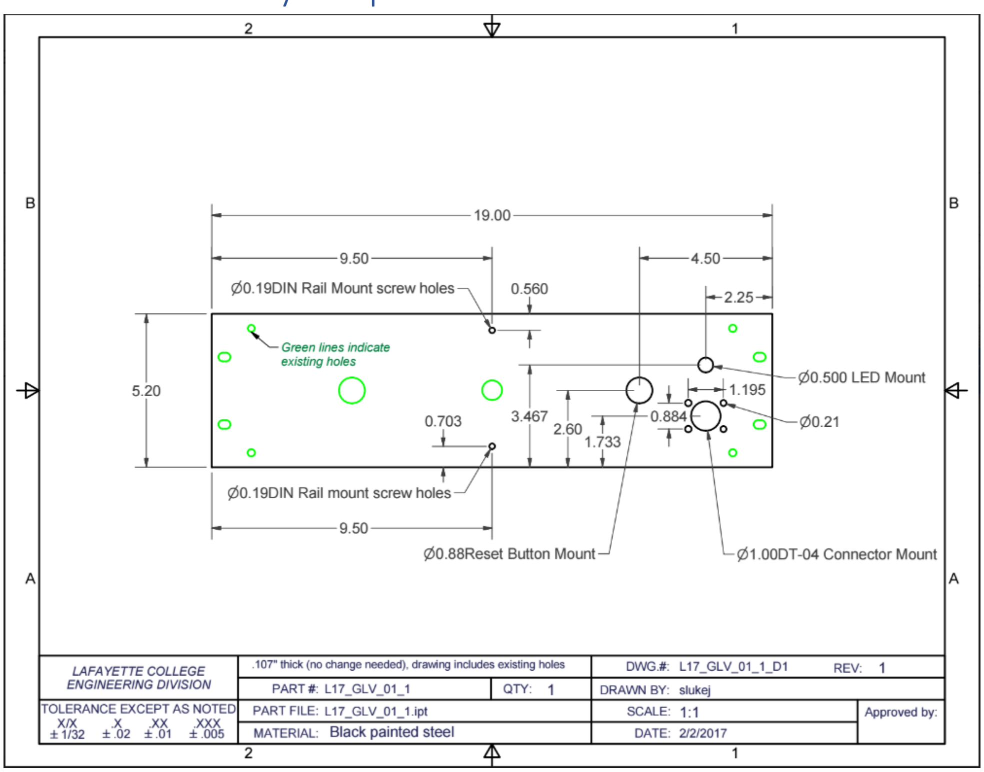
References

The GLV safety loop design from the class of 2016 created by Tim Andrews was referenced for the design of the basic safety loop.

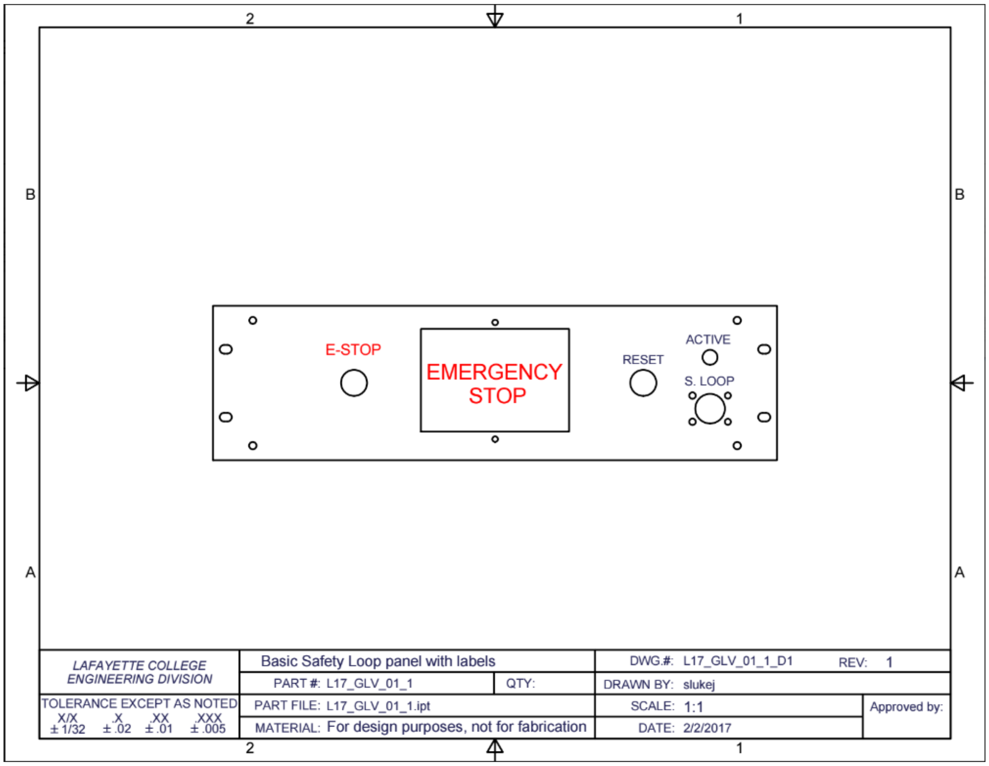
Appendix A - Basic Safety Loop Schematic



Appendix B - Basic Safety Loop Panel



Appendix C - Basic Safety Loop Panel with Labels

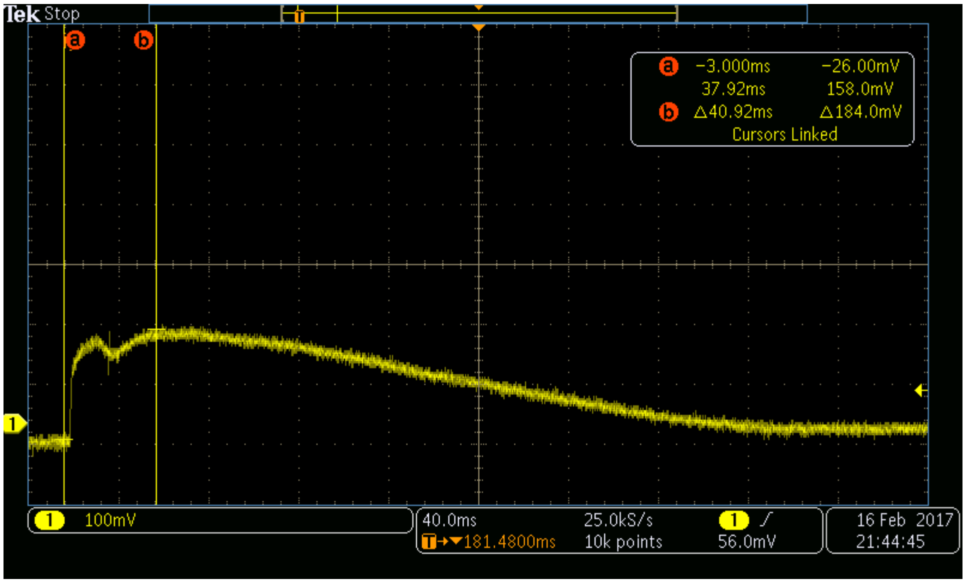


Appendix D – Maximum Current Measurement

The waveforms below measure the initial current through the AIRs upon startup. The current is measured at a rate of 1mV/100mA. The wires were wound through the current clamp four times, so the depicted current must be divided by four. In other words,

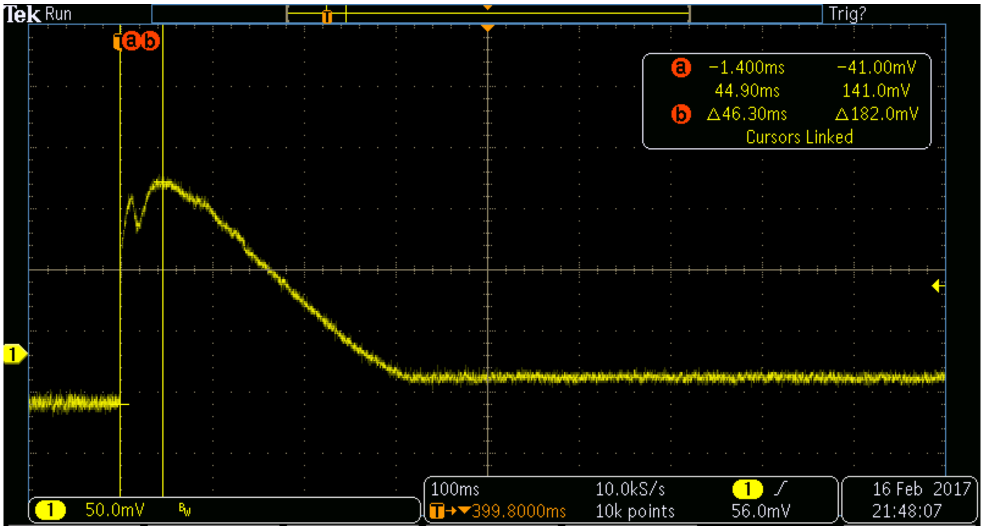
(Current in Amps)=(Measured Voltage in mV)/($10\frac{mV}{A}$) /(4 packs windings)

Trial 1



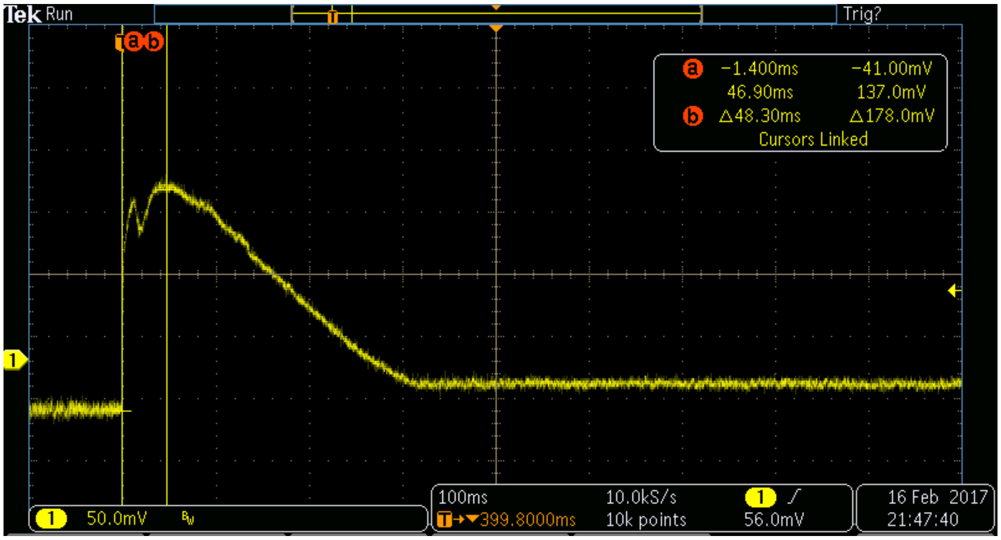
Maximum current measured was 4.6A at 40.92ms.

Trial 2



Maximum current measured was 4.45A at 48.30ms.

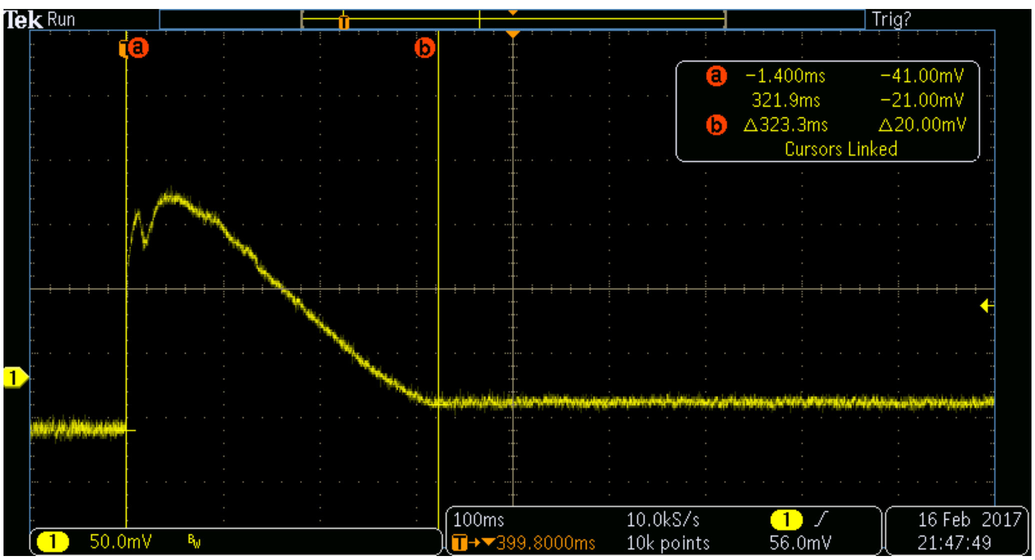
Trial 3



Maximum current measured was 4.55A at 46.30ms.

Appendix E – Nominal Current Measurement

The waveform below measures the nominal current of the four airs after the initial current spike period. This was measured in the same manner as in Appendix D.



Nominal current measured was 0.5A after 323.3ms.