Galvanic Isolation

In Regards to the LFEV 2015

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***Abstract*— This paper is to explain the topic of galvanic isolation and explain its relevance to the course ECE 492 Senior Design.**

Keywords- Galvanic Isolation; relay; optocoupler; induction; capacitance; CAN;

I. INTRODUCTION

The concept of galvanic isolation is the prevention of current flow between sections of electrical systems. While current cannot flow between the sections, energy and/or information can still be exchanged between the sections. Several different methods are used to exchange this information. This paper will discuss capacitance, induction, light and electromagnetic waves as a way of transferring information between galvanically isolated systems as they will be used in the project.

II. METHODS OF ISOLATION

A. *Capacitance*

Capacitance can be used as a method of galvanic isolation though it has some limitations. Due to the nature of how capacitors work, they only provide isolation in direct current situations. It should also be noted that only certain capacitors are rated for use in galvanic isolation. These capacitors are known as class Y capacitors (site).

B. *Induction*

Induction is used by taking advantage of the induced electromagnetic field from a coiled wire. By using this induced electromagnetic field energy can be exchanged while preventing current flow. This creates galvanic isolation and allows for systems to be separated by an inductor.

C. *Light*

Light is used to galvanically isolate systems due to the nature of light being unable to let current flow. A LED is often coupled with a photo detector of some type to complete the transfer of information using light.

III. HOW IT APPLIES TO THE PROJECT

The Formula Hybrid rules are set forth by the IEEE and the SAE International organizations. These rules govern what is and isn't allowed for the competition. These rules are set forth to provide for safety in the competition.

There are four rules in the Formula Hybrid rule book that apply to galvanic isolation and therefore that part of our project.

A. *EV 1.2.4*

The tractive and GLV systems must be galvanically isolated from one another.

B. *EV 3.6.5*

Any GLV connection to the AMS must be galvanically isolated from the TSV.

C. *EV 4.5.4*

All controls, indicators, and data acquisition connections or similar must be galvanically isolated from the tractive system.

D. *EV 8.2.11*

All chargers must be UL (Underwriters Laboratories) listed. Any waivers of this

requirement require approval in advance, based on documentation of the safe design and construction of the system, including galvanic isolation between the input and output of the charger.

IV. Types of Galvanic Isolation Used

The GLV, TSV, and Dyno groups are making use of galvanic isolation in their designs. There are four main devices that these three groups are using and they are DC-DC converters, relays, opto-isolators, and isolated CAN transceivers.

A. DC-DC converters

DC-DC converters make use of induction to achieve galvanic isolation. This is not the only way DC-DC converters achieve galvanic isolation as some use capacitors. Ours, however, do take advantage of induction and are step down converters. This means they bring a higher voltage to a lower voltage. It is also important to note that the use of a DC-DC converter allows for the regulation of the voltage output.

B. Relay

Relays are in essence an electrically operated switch. They make use of two circuits. One circuit is used to open or close the other circuit. This opening or closing can be achieved in a variety of ways. One popular way is using a mechanical switch and an electromagnet. The first circuit is used to control whether the mechanical switch is open or closed.

Some other types of relays include, latching, Reed, contactor, and solid state. Latching relays maintain their last set position indefinitely. This varies from other relays which have a normal state that they default to when power is not applied.

Reed relays are often used in solenoids as they have a very fast switching speed since the armature is located in either a vacuum or inert gas glass tube. However due to the nature of the armature, Reed relays can only handle low voltage and current situations.

Contactors operate the same as a mechanical relay but are designed to be used in a high voltage and current situation. Contactors are specifically rated for the amount of current and voltage they can handle. They can be viewed as simply a more robust relay.

Solid state relays fill a unique role in the world of relays. As they have no moving parts, the relay itself has a longer life span than other relays which will eventually suffer from mechanical failure. The one drawback to solid state relays is the voltage drop across the relay. This can simply be adjusted for but it must be a consideration when designing the circuit.

C. Opto-isolator

Opto-isolators are often used when galvanic isolation is necessary in low voltage and current situations. They are also known as optocouplers, photocouplers, or optical isolators. Opto-isolators take advantage of light as a medium for transmitting information while maintaining isolation. An opto-isolator uses an LED, often a near infrared LED, to transmit the information to a photosensor. The type of photo sensor employed varies from device to device but common photosensors include photoresisters, photodiodes, and phototransistor.

D. Isolated CAN

Isolated CAN transceivers are being used to isolate the CANbus that runs through both high and low voltage subsystems. Both the TSV and Dyno teams are using devices that isolate CAN. In the case of TSV an isolated CAN transceiver is being used. This device uses a capacitor as an isolating device. The Dyno team is using an isolating CAN repeater to separate the high and low voltage systems. The difference between these two devices is that the transceiver receives CAN and transmit data to an RX and TX output. The isolated repeater takes input CAN, isolates it, and then outputs as CAN again.

References

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