Galvanic Isolation

Stephen Mazich

What is it?

- The prevention of current flow between sections of electrical systems
- Energy and/or information can still be exchanged
- Methods to exchange information include:
  - capacitance
  - induction
  - light
  - electromagnetic waves

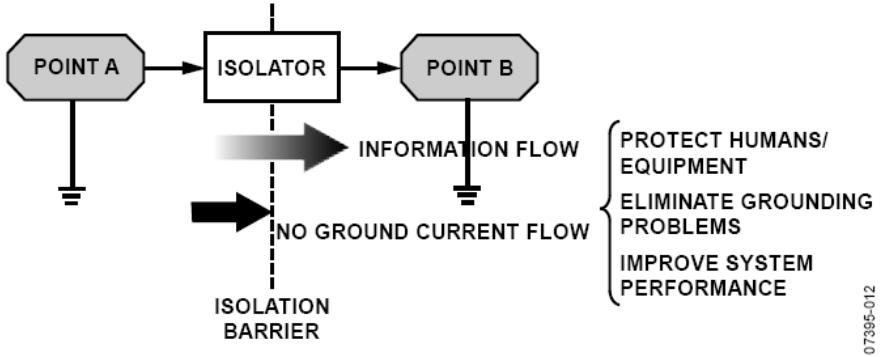

Image courtesy of Analog.com : http://www.analog.com/library/analogdialogue/archives/43-11/imgC_bb.gif

Examples

- Transformer
  - Utilizes induction
- Opto-isolator
  - Utilizes light
- Capacitor(class Y)
  - Utilizes capacitance
- Hall effect
  - Utilizes electromagnetic waves

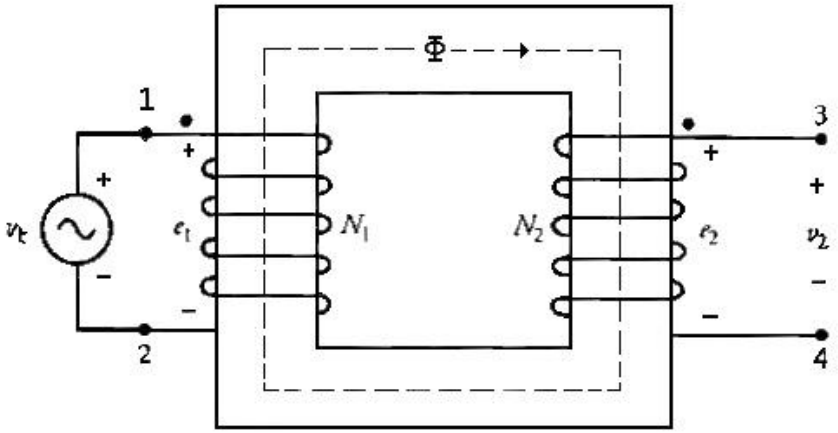

Image courtesy of AYA Instruments : http://www.ayainstruments.com/images/theory001.jpg

How does it apply to the project?

The Formula Hybrid rules

- EV 1.2.4 The tractive and GLV system must be galvanically isolated from one another.
- EV 3.6.5 Any GLV connection to the AMS must be galvanically isolated from the TSV.
- EV 4.5.4 All controls, indicators, and data acquisition connections or similar must be galvanically isolated from the tractive system.
- 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.

FORMULA® HYBRID

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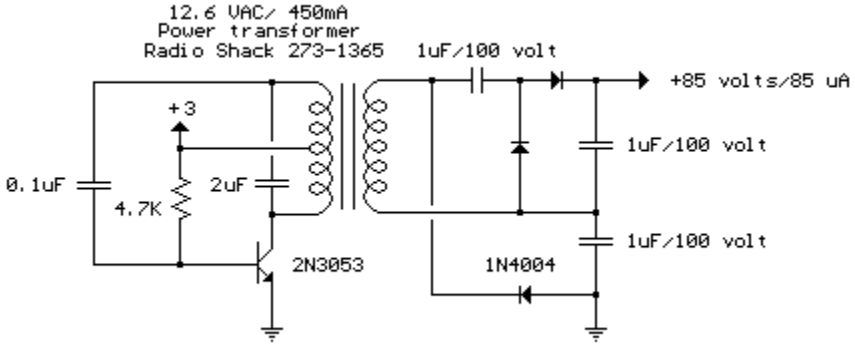
Picture courtesy of the Formula SAE Rulebook : http://students.sae.org/cds/formulaseries/rules/2015-16_fsae_rules.pdf

How are we using it?

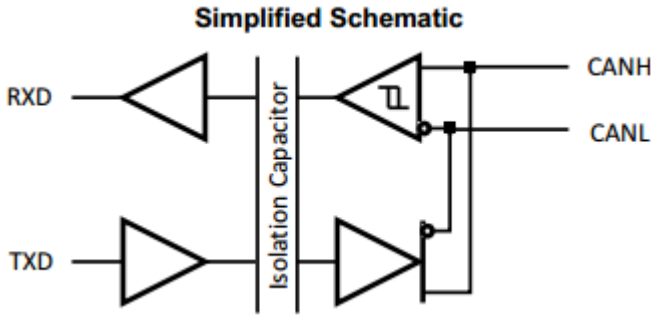
GLV

- DC-DC Converter
- Relay



TSV

- Opto-isolator
- Isolated CAN transceiver
- Relay



Dyno

- Opto-isolator
- Isolated CAN transceiver

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Images courtesy of: TI : http://www.ti.com/lit/ds/symlink/iso1050.pdf and CircuitDB : http://www.circuitdb.com/wp-content/uploads/2012/11/triple.gif

DC-to-DC Converter

- Used to convert one voltage level to another
- 3 conversion methods
  - Electronic
  - Electromechanical
  - Electrochemical
- Can regulate output voltage or current

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Image courtesy of Digi-Key : http://media.digikey.com/Photos/CUI%20Photos/MFG_PYB15-U.jpg

DC-to-DC Converter

- Types of Electronic
  - Linear - Inefficient with high voltage drop and high current due to heat dissipation
  - Switch-mode -store input energy and release it at a different voltage level
  - Magnetic - Make use of inductors
  - Capacitive (Charge Pump) - Vary connection between input and output
- Thermal Output Noise
  - Every DC-to-DC converter generates it

Relay

- An electrically operated switch
- Often composed of four components
  - Electromagnet
  - Spring
  - Armature
  - Contacts
- Relay Video

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Image courtesy of Digi-Key : http://media.digikey.com/photos/Tyco%20Photos/RT314524.JPG

Relay

- Types of Relays:
  - Latching - maintains position indefinitely
  - Reed - used in solenoids
  - Contactor - heavy duty power switch 10+ amps
  - Solid State Relay - No moving components
  - Solid State Contactor
  - Pole and Throw
    - SPST
    - SPDT
    - DPST
    - DPDT

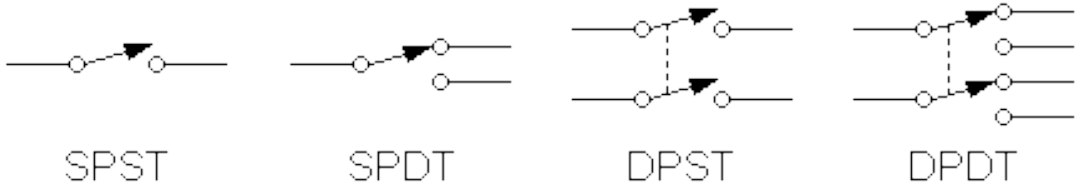

Image courtesy of : http://www.psyclops.com/tools/technotes/electron/swit_tog.gif

Opto-isolator

- Also called optical coupler and optocoupler
- Use light to transmit information
- Often uses a near infrared LED and a photosensor
- Common photosensors:
  - photoresistor
  - photodiode
  - phototransistor

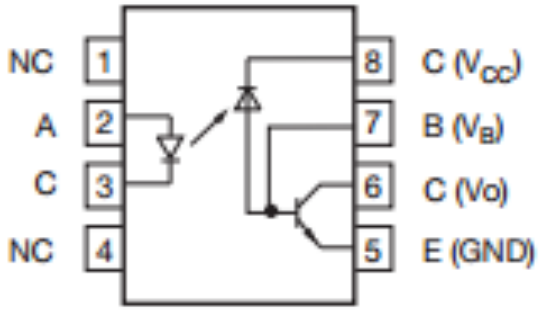

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Image courtesy of Vishay : http://www.vishay.com/docs/83604/6n135.pdf

Real world applications

- Anywhere higher and lower voltage systems need to interact
- Battery chargers
- Cell phones
- Laptops
- Formula SAE Electric Cars

Image courtesy of IIT : http://www.iit.edu/news/iittoday/wp-content/uploads/2012/05/IIT-Electric-Car1.jpg

Sources

John Huntington *Show Networks and Control Systems: Formerly Control Systems for Live Entertainment*

Jerry Whitaker *The Electronics Handbook*

Stephen Sangwine *Electronic Components and Technology*

The Offspring - “Come Out and Play (Keep ‘em Separated)” https://www.youtube.com/watch?v=XN32lLUOBzQ