

1. Purpose and Scope

The purpose of this notice is to notify all SafeStop users that the *SafeStop User Manual Version 2.0* has been revised to provide additional information regarding the importance of the SafeStop receiver maintaining a ground connection. Specifically, **if a receiver is grounded incorrectly or experiences a loss ground, the system may perform an un-commanded RELEASE**. This can happen even when the SafeStop is powered off, which would subvert the user’s expectations of the product’s behavior.

Please refer to the User Manual for additional information. Should you have questions regarding the information contained in this bulletin, or to request a copy of the User Manual, please contact us at support@torcrobotics.com.

2. User Manual Installation Overview

Previous versions of the User Manual depicted an installation method that may be susceptible to loss of ground. While powered on, a broken ground path at the receiver will render the receiver unresponsive to commands. Likewise, a loss of a ground prior to the receiver powering on will result in an un-commanded RELEASE immediately at power on. The circled region in Figure 2-1 shows the potential area for a single point ground failure.

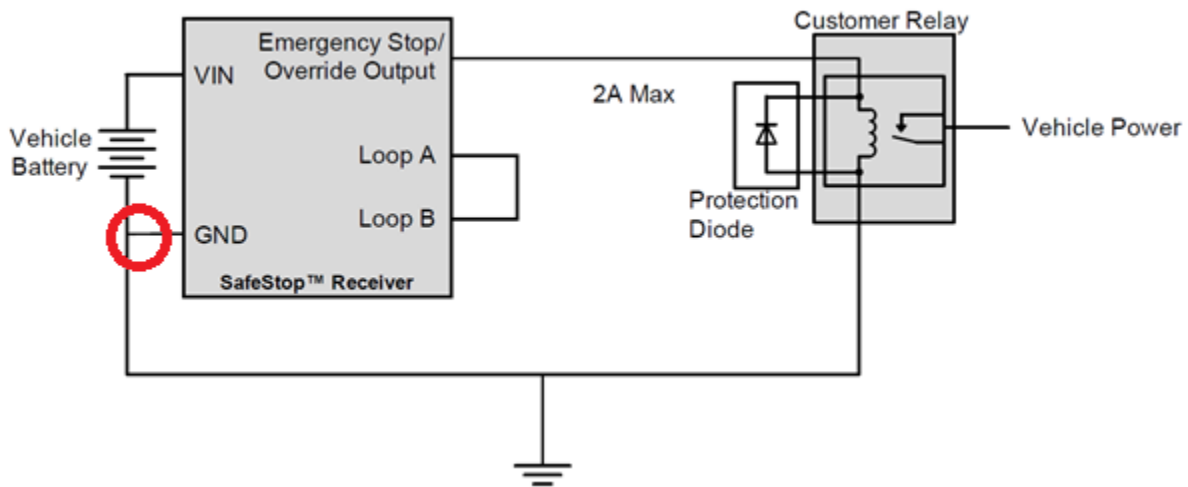


Figure 2-1: Installation as Depicted in the SafeStop User Manual

3. Potential Single Point Ground Wiring

A single point ground is created when all the ground points of the receiver are spliced together at a singular point and continues to the main vehicle ground via singular ground wire. Having an independent ground path for the user relay further worsens the problem during a loss of ground to the receiver. Figure 3-1 shows the potential wiring issues, causing a single point ground hazard.

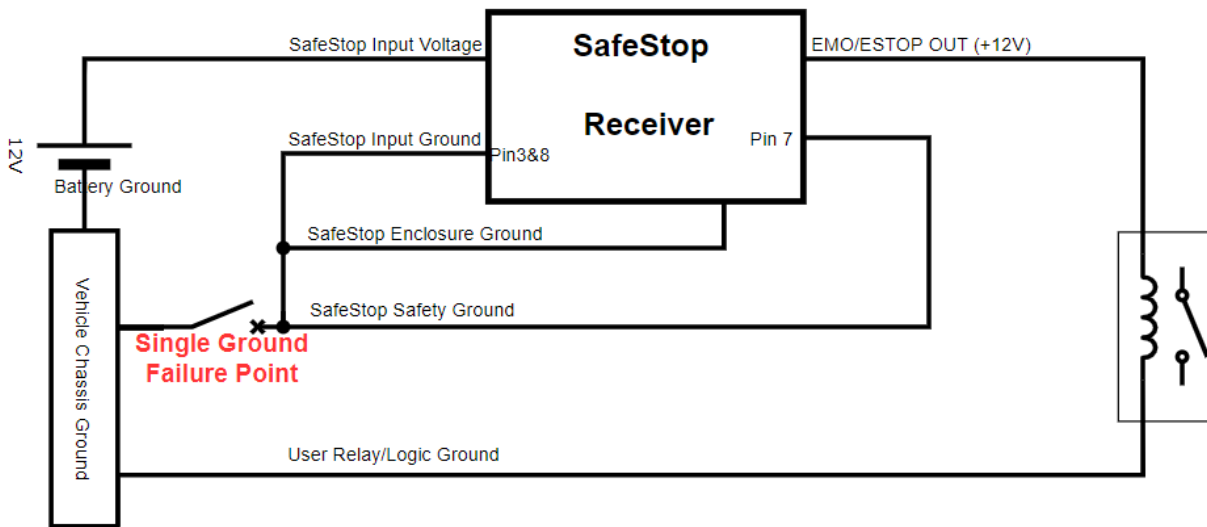


Figure 3-1: Single Point Ground Wiring Hazard

4. Loss of Ground Analysis

During a single point ground failure (Figure 4-1), an external current loop is established such that the user relay will not operate as intended due to the established external current path through the receiver and relay. During this condition, the receiver will become unresponsive, and the relay will continue to stay activated. If the loss of ground occurs prior to the receiver powering up, then an un-commanded release will occur immediately at power on and the Emergency Output (E-STOP) and Emergency Override (EMO) output will not be responsive to user inputs.

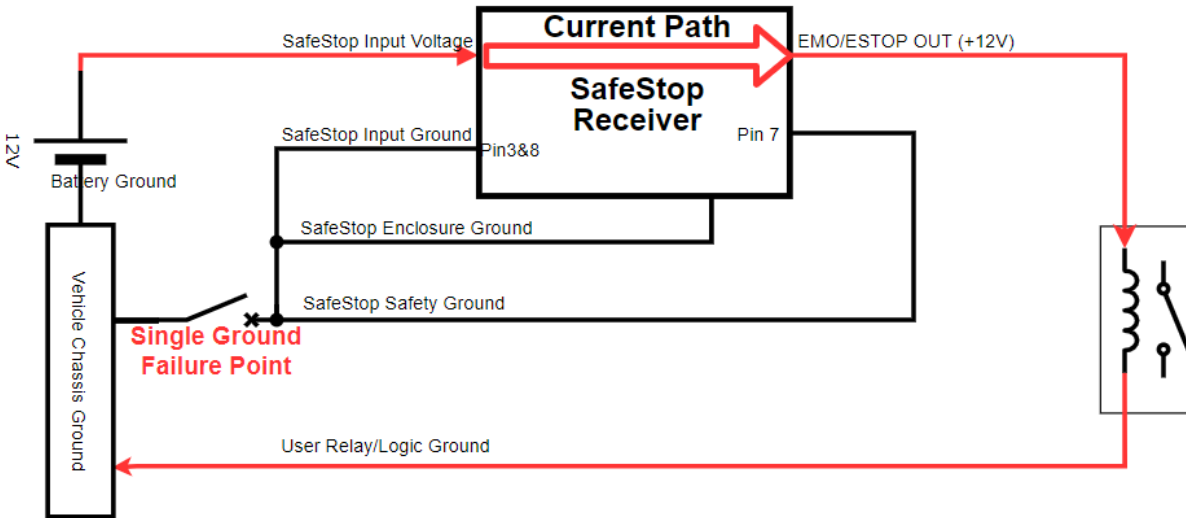


Figure 4-1: Loss of Ground External Current Path

5. Loss of Ground Mitigation

There are two methods to mitigate the single point ground failure to the SafeStop receiver. The first method is to wire the SafeStop receiver to use all seven ground contact points to the vehicle ground system (chassis). The seven ground contact points shall be wired as described below and as shown in Figure 5-1:

1. Use the four SafeStop receiver mounting holes to properly secure the receiver to the vehicle chassis ground. Remove the external powder coating around the mounting holes to ensure good bonding to the vehicle chassis ground using locking washers.
2. Wire the receiver Power Receptacle Ground (GND) Pin 3 (SS03PWR Power Cable black wire) to the vehicle chassis ground.
3. Wire the receiver Power Receptacle Ground (GND) Pin 8 (SS03PWR Power Cable green wire) to the vehicle chassis ground.
4. Wire the receiver Safety Receptacle Ground (GND) Pin 7 (SS03SFT Safety Cable black wire) to the vehicle chassis ground.

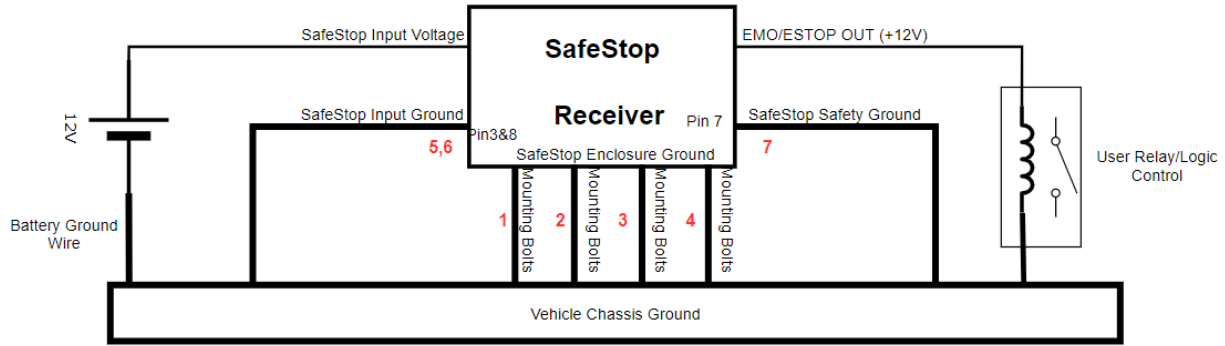


Figure 5-1: Receiver Ground Location Points

Using all seven ground contact points will provide multiple redundant ground contact points to the SafeStop receiver. The user must ensure the loss of the vehicle battery ground wire does not adversely affect the system.

6. Isolated Ground Installation

The second method pertains to situations where the installation may have isolated the receiver case ground from the vehicle ground system (Figure 6-1). The SafeStop Safety Ground (SS03SFT Safety Cable) black ground wire shall be wired directly to the relay return signal. No other return current path shall be shared with the relay return path. If the return path is shared and there is a potential for a loss of ground situation and the system may perform an un-commanded release.

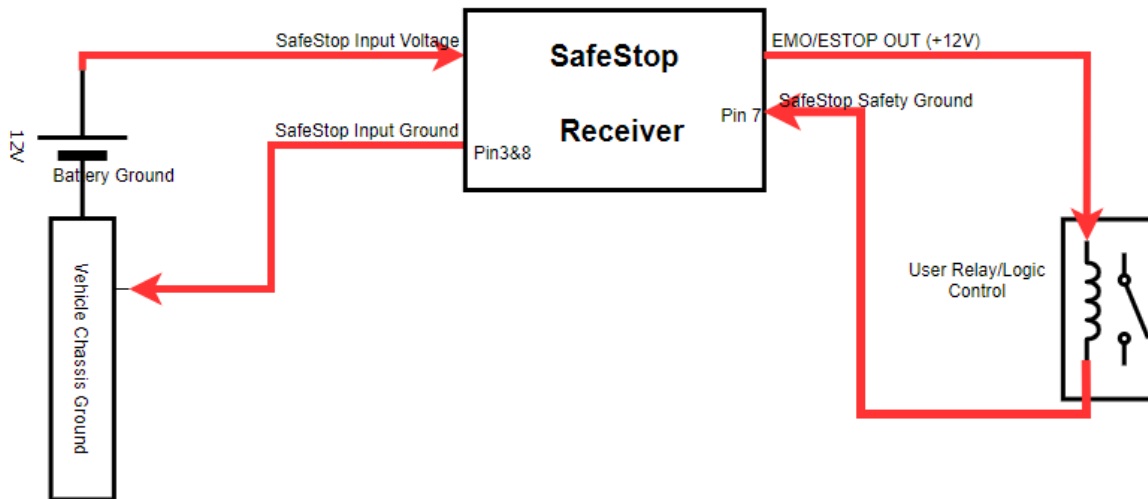


Figure 6-1-SafeStop Receiver Isolated Ground Path

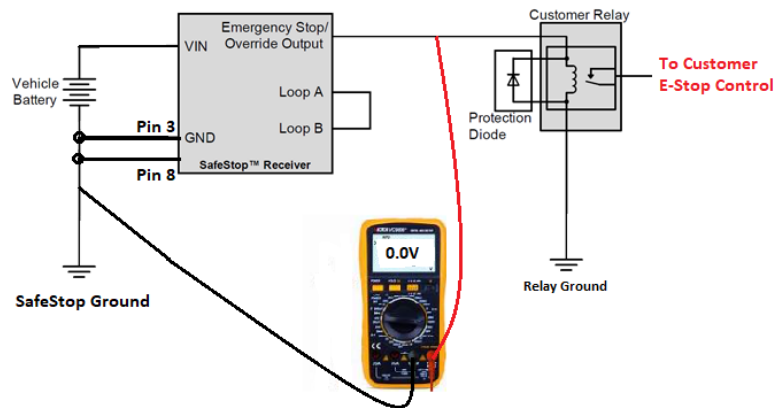


WARNING: When switching inductive loads such as relays, a protection diode must be used to suppress voltage transients.

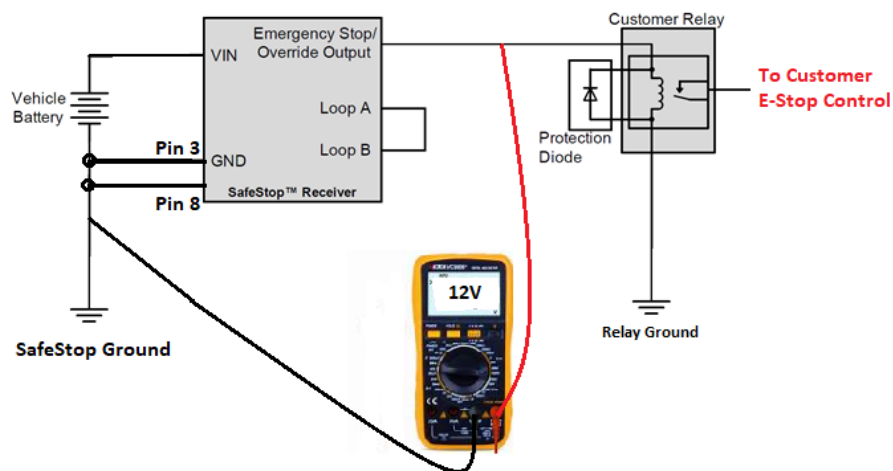
7. Loss of Ground Verification

The purpose of this verification process is to identify a loss of ground situation. During this test, do not enable any behaviors that require the SafeStop to function. This test will require the user to disconnect the ground wires to pins 3 and 8 of the SafeStop receiver power cable.

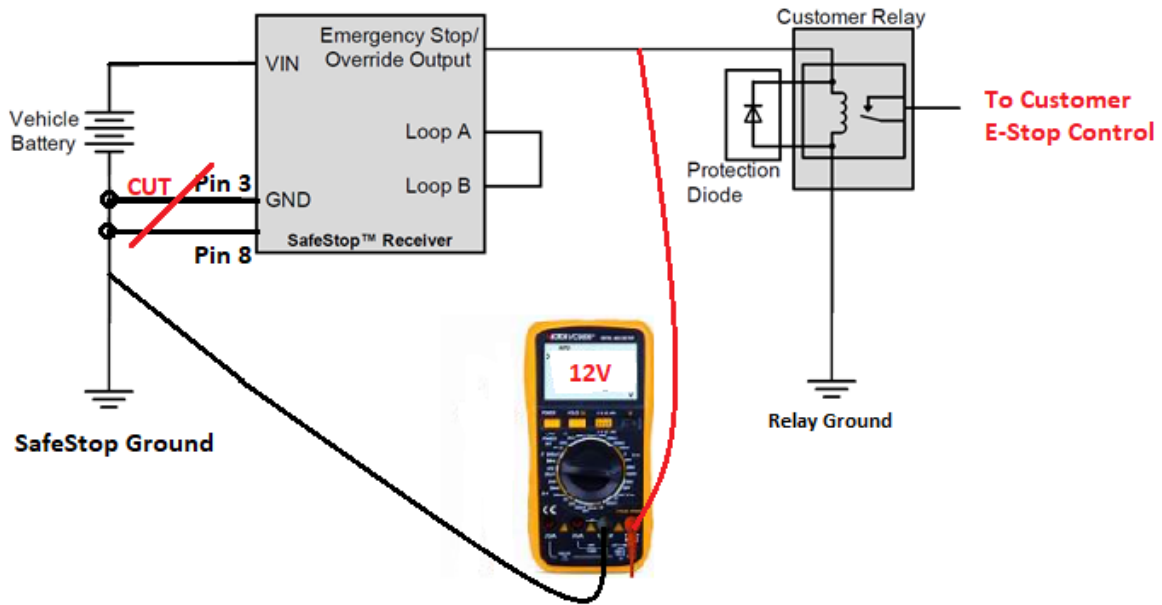
1. With the E-Stop button pressed on the SafeStop Transmitter, measure the voltage between the SafeStop receiver ground and the relay ground. The measured voltage should 0 Volts.



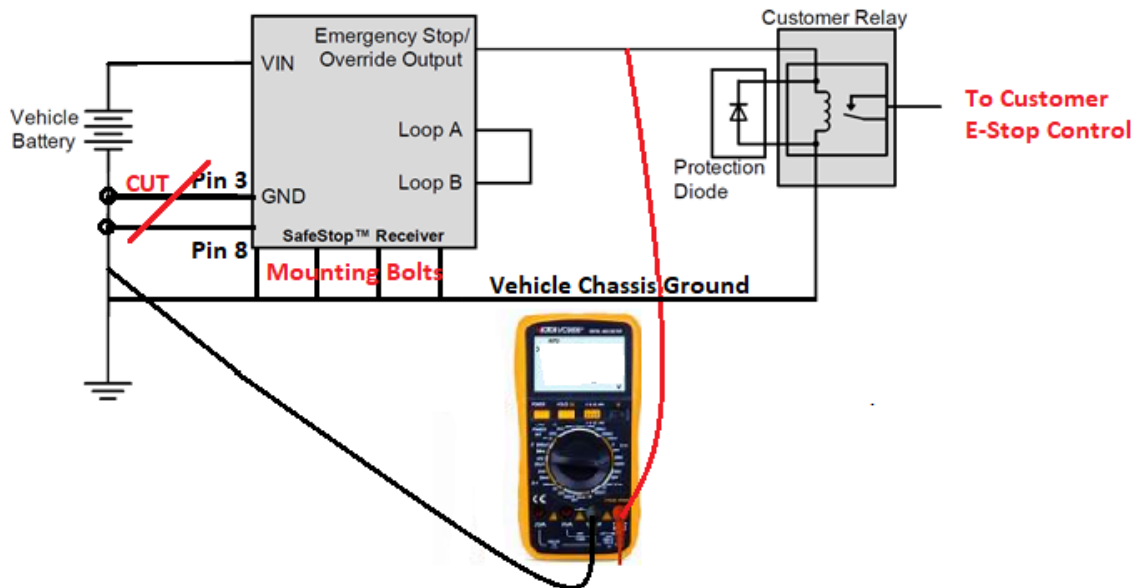
2. Release the E-Stop button on the transmitter and measure the voltage between the SafeStop receiver ground and the relay ground. The measured voltage should be 12V or within the specified output voltage range of the SafeStop E-Stop Out.



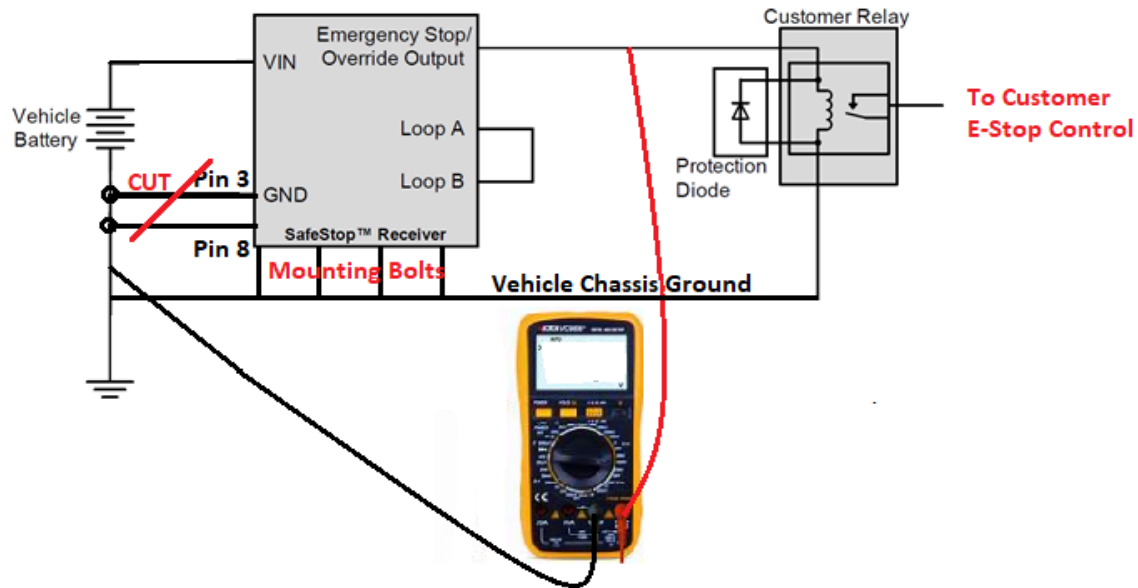
3. Release the E-Stop button. While the E-Stop button is released, disconnect the ground wires going to pin 3 and pin 8 of the Safestop receiver. If the voltage is greater than 0V, then a loss of ground hazard has been identified.



- The corrective action for the loss of ground hazard is to join the SafeStop receiver ground and the relay ground to the same continuous ground point. The chassis ground on a vehicle typically provides a continuous ground point.



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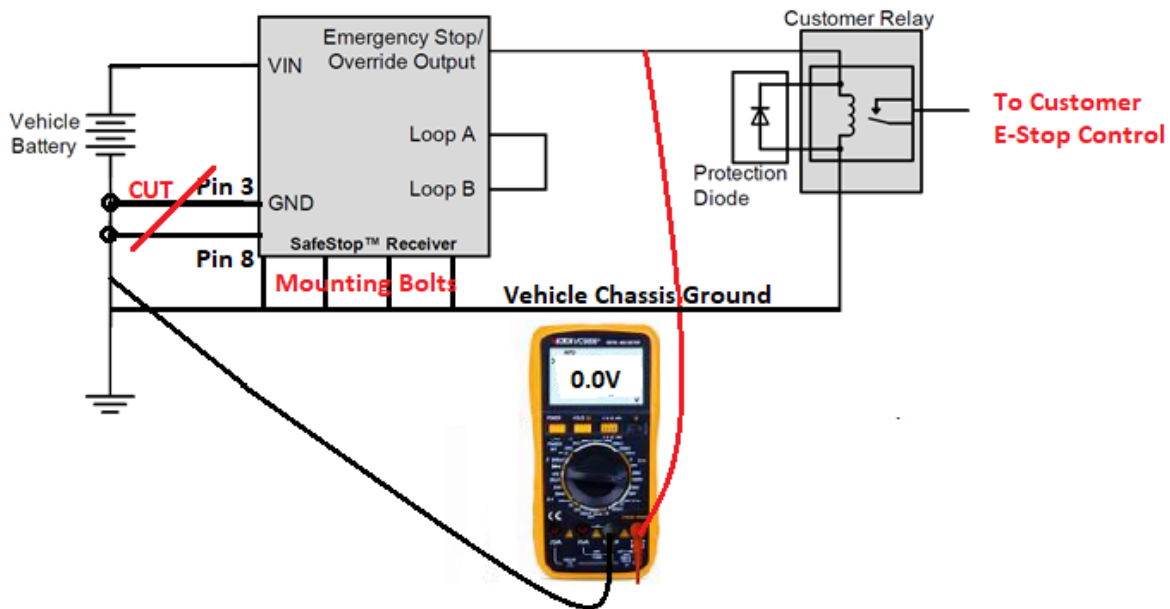


8. Loss of Ground Correction

In preparation of mounting the SafeStop receiver, remove the black powder coating around the mounting holes in the case. It is recommended to use a razor blade to remove the powder coating around the four mounting holes to expose the aluminum case. The SafeStop enclosure shall be bolted to the chassis ground using four bolts with aluminum locking washers. The relay ground wire shall be solidly connected to the continuous vehicle chassis ground reference.



Once the SafeStop receiver and a relay ground have been securely attached to a continuous ground reference, retest the E-Stop behavior. Press the E-Stop button and verify the output voltage of the E-Stop output read zero volts.



The relay loss of ground is one scenario that has been tested, however depending on end user applications, other isolated ground issues may exist. Customers shall continue to test to find all situations which would lead to a loss of ground to the SafeStop.

Once all loss of ground situations has been identified and corrected, reconnect the ground wires going to pins 3 and 8 of the SafeStop receiver power cable.



WARNING: The customer shall implement a safety verification process to assure no loss of ground exists prior to operation.

9. Summary

If a SafeStop receiver is grounded incorrectly or experiences a loss of ground, the system may perform an un-commanded release. This can happen even when the SafeStop receiver is powered off, which would subvert the user's expectations of the product's behavior.

A potential loss of ground may be prevented by ensuring that the STOP/RELEASE signal ground is always the same electrical point as the receiver ground. Use all seven ground contact points provided by the receiver to ensure loss of ground is minimized. Alternatively, an isolated receiver can be wired such that the controlled relay current return path is directly connected to the SS03SFT Safety Cable Ground (GND) wire.

10. Technical Assistance

For technical assistance or additional information regarding the information contained in this bulletin, please contact us:

| Mailing Address | Email & Phone Support |
|------------------------------|--|
| TORC Product Support | support@torcrobotics.com |
| 405 Partnership Drive | torc.ai |
| Blacksburg, VA 24060 | Phone: (800) 530-9285 |

11. Revision

Revision 1.0 – July 26, 2023 Initial Release