

CarMan User Manual

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Abstract

This document is intended to inform the LFEV team how to setup and engage the 2020 GLV system.

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Executive Summary

Introduction

This document will outline how to set up all of the subsystems of the CarMan and how each system should work. It also lists some basic troubleshooting methods for simple errors within the system. For issues that cannot be resolved from this manual, please reference the CarMan maintenance manual.

User Breakdown

Driver

The only piece of equipment in the GLV system that the driver uses is the Cockpit Panel. Please see the Cockpit Panel subsection for help.

Pit Crew

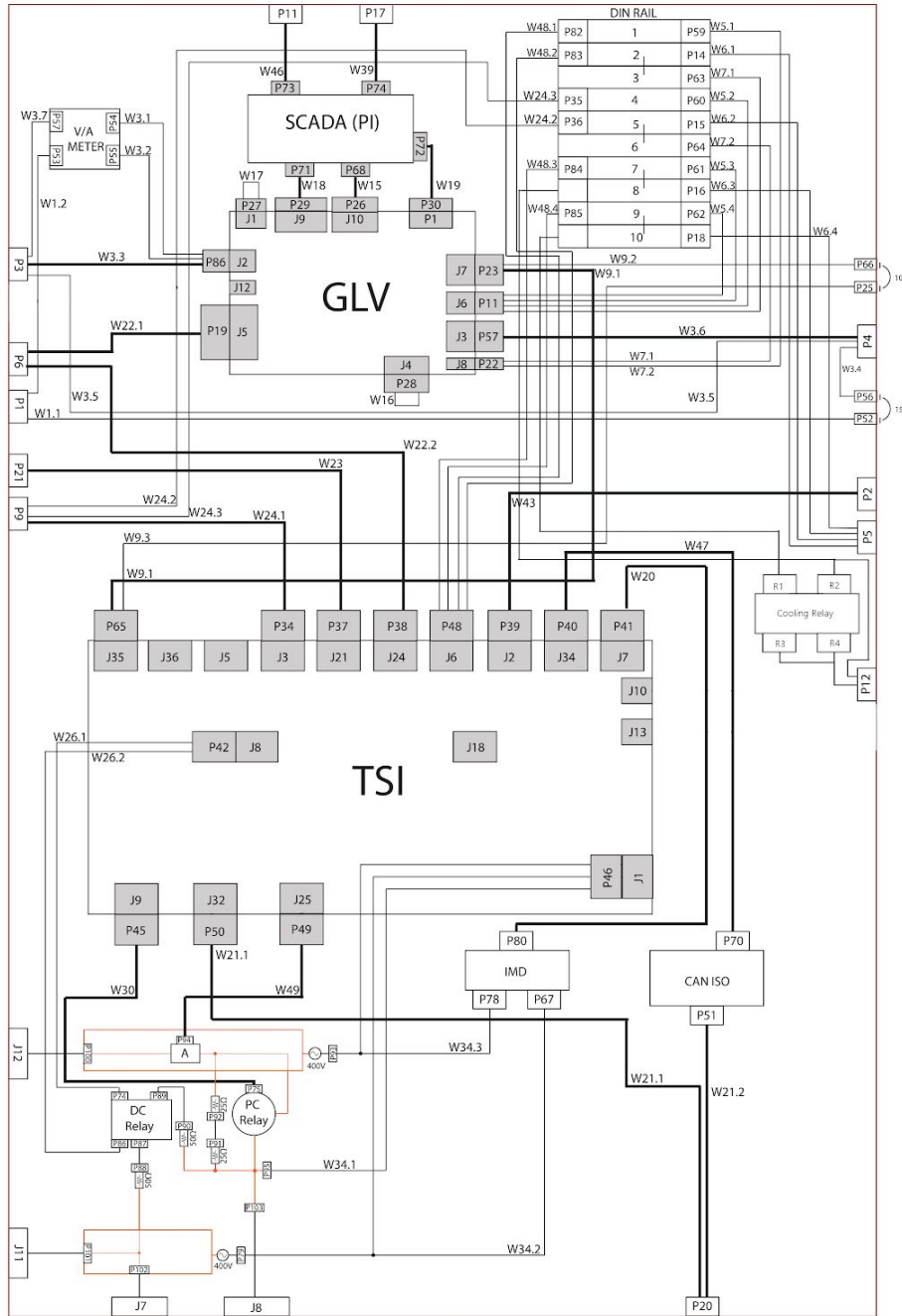
The crew will have access to all vehicle components. The crew is responsible for problem diagnosis and will have access to each BRB for emergencies.

System Integrator

The system integrator will be responsible for all components within the GLV system.

CarMan System

The following diagram represents the entire GLV system.



The GLV is connected to several systems. The CARMAN provides housing and connections for the safety loop, power, and TSI. The Cockpit, Right side, and Left side interact with parts of the safety loop. These systems are always accessible by the LFEV team to monitor the GLV system. In addition, when the GLV system is being tested there is another connection to the DYNO power supply. The GLV controls when the high voltage turns on in the DYNO setup.

GLV Power

GLV Battery

The GLV Battery is a 24V 9.9AH Lithium Iron Phosphate battery. This battery shows up to 2000 charge/discharge cycles according to Power Stream. This is used onboard the LFEV to power the GLV system.

Part Number: LFP256099

GLV Charging

The GLV Battery must be charged for proper operation of the GLV system. The GLV battery can be charged using a PST-G100-24F8 charger. This charger charges the 24V battery at 1.5A, and it includes a plug and forget algorithm which allows it to be plugged in without the possibility of overcharging the battery. The charger has lights which indicate when the battery has finished charging.

GLV Shore Power

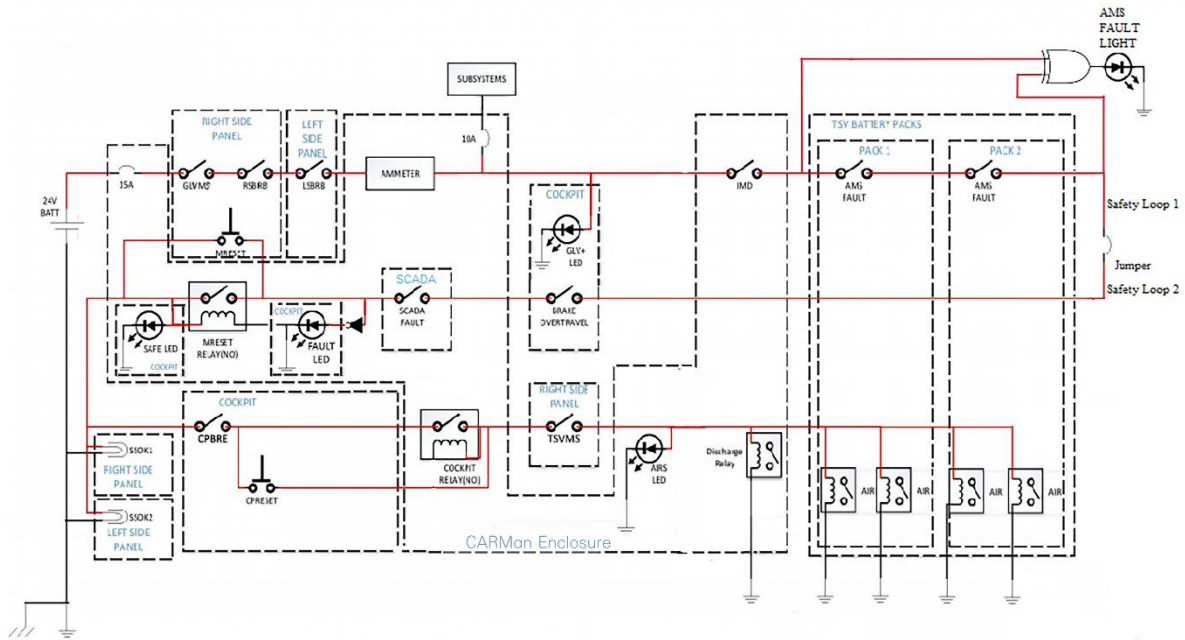
The GLV Shore Power is a power supply used when the GLV system is being tested. This supply provides 24V to the GLV system.

GLV Power

The GLV system is used in the LFEV as a power supply for the SCADA, TSI, and TSV systems. The GLV system provides a 24V supply through its J10 port. For further power information refer to the 2020 GLV maintenance manual.

Safety Loop

The safety loop is a system that allows the driver, surrounding personnel, and system components to shutdown the system in case of emergency or system failure. This user’s manual will detail the connections of the safety loop, and the processes involved in engaging and disengaging the safety loop.



Setting Up the Safety Loop

In order to setup up the Safety Loop the following systems need to be connected: the Tractive System Interface (TSI) system, the Tractive System Voltage (TSV) system, a manual disconnect jumper, and the Supervisory Control and Data Acquisition (SCADA) system (However the Safety loop can be programmed to function without the SCADA system connected). Refer to the 2020 GLV Maintenance Manual for more information on the Safety Loop.

Getting Started

Engaging the Safety Loop

In order to engage the safety loop the following startup procedure must be followed.

Startup Procedure		Check
1	GLV Battery is connected to port J1	
2	Twist open right side BRB	
3	Twist open left side BRB	
4	Turn on GLVMS on right side panel	
5	Check GLV light is on	
6	Check IMD Fault light is on then goes off	
7	Check if Fault light is off	
8	Check Current/Voltage and Power Display on GLV Box is on and displays 24V	
9	Check VSCADA Display on GLV Enclosure is on	
10	Press green Mreset button on right side panel	
11	Check if SSOKs are on	
12	Check Safe light is on	
13	Assure that driver is conscious and ready	
14	Make sure no one is in front of or behind the car	
15	Driver should twist open cockpit BRB	
16	Driver should press green Mreset on cockpit panel	
17	Turn on TSVMS on right side panel	
18	Check AIRs light is on	
19	Check TSEL light is on	
20	Driver should press brake, and not accelerator, and press drive button	
21	Check Drive light on	
22	Drive	
Shutdown Procedure		Check
1	Press Drive button and brake to exist drive mode	
2	Drive LED is off	

3	Press Cockpit BRB	
4	HV LED is off	
5	TSEL is off	

Disengaging the Safety Loop

In the case of an emergency the Safety loop can be disengaged completely at any point using either of the side panel BRBs or the GLV Master Switch (GLVMS). The driver can also disengage the safety loop using the brake overtravel or the Cockpit BRB. A jumper found on one of the TSV packs can be used as a manual disconnect jumper as well. In addition, the SCADA, IMD and TSV systems have the ability to disengage the safety loop if there is a fault detected.

Re-engaging the Safety Loop After a Fault

After the safety loop is disengaged it is possible to close the loop again depending on the location of the fault. Only certain steps of the startup procedure need to be executed to re-engage the safety loop based on the following faults:

- Steps 1 – 22:
 - o Right side BRB has been pressed.
 - o Left side BRB has been pressed.
 - o GLVMS key has been removed or disengaged.
- Steps 7 – 22:
 - o IMD Fault
 - o AMS Fault
 - o Jumper Removal
 - o Brake Overtravel
 - o SCADA Fault
- Steps 15 – 22:
 - o Cockpit BRB has been pressed.
- Steps 17 – 22:
 - o TSVMS key has been removed or disengaged.

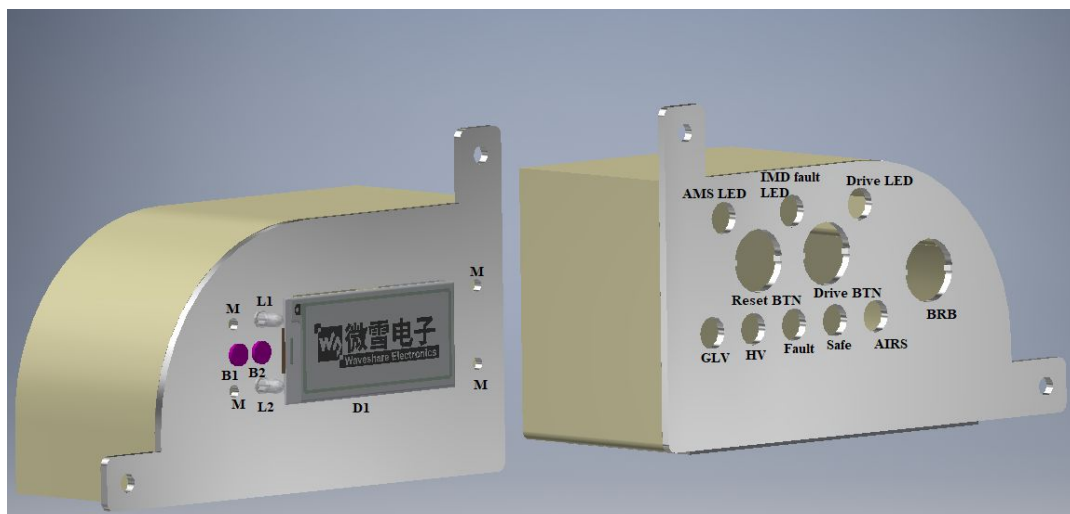
Cockpit Panel

Description:

- The aluminum panel: used as a mounting frame for the following components.
- Cockpit BRB: the driver can use this to disengage the safety loop.
- Red LED: indicates a fault in the safety loop.
 - o IMD Fault
 - o Fault LED
- Green LED: indicates the status of the safety loop.
 - o GLV LED
 - o Safe LED
 - o Airs LED
 - o Drive LED
 - o HV LED
- Drive BTN: used to enter drive mode.
- Driver Reset BTN: used as a part of the safety loop.



Current setup in dyno room. Used for testing only.



Preliminary cockpit panel design to be integrated to the car.

Right Side Panel

Description:

- The aluminum panel: used as a mounting frame for the following components.
- GLVMS: used to power the GLV.
- Emergency Estop (BRB): used to disengage the safety loop.
- IMD Reset AMS Reset (Master Reset): used as a part of the safety loop.
- TSVMS: used to enable power to the AIRS.
- Safety System OK (SSOK): indicates that the Master Reset has been pressed according to the startup procedure.



Left Side Panel

Description:

- The aluminum panel: used as a mounting frame for the following components.
- Emergency Estop (BRB): used to disengage the safety loop.
- Safety System OK (SSOK): indicates that the Master Reset has been pressed according to the startup procedure.



TSI Programming

We are using a PIC32MZ2048EFM064 (NOT PIC32MZ2048EFH064!!! double check the device name in MPLAB X IDE to ensure successful programming) for the TSI board. The development environment is MPLab X IDE with Harmony 2.06 extension.

MPLab should be on every computer in AEC 400. Here is the guide for installing Harmony extension:

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1. Download harmony 2.06 extension from:

<https://www.microchip.com/mymicrochip/filehandler.aspx?ddocname=en606317>

2. Install the extension on the computer.

3. Open MPLab and click on Tool -> Plugins

4. Active MPLAB@ Harmony Configurator in Available Tab

5. Enjoy

To use the Harmony Configurator, run MPLAB X IDE. In Tool -> embedded you can find the MPLab harmony configurator. Using the configurator you can easily configure the chip and generate basic code.

To program the chip, you need to use Pickit3. We have one in AEC 400. To program you need to connect ~MCLR Vcc Vss PGEC and PGED to the Pickit3 and click run in MPLab. Detailed instruction and connection for Pickit 3 can be found here:

<http://ww1.microchip.com/downloads/en/DeviceDoc/52116A.pdf>

Sensors and Isolators

High Voltage Current Sensor

The current sensor is used for measuring current through the high voltage bus bars. The data sheet and calibration data are provided here:

<https://sites.lafayette.edu/motorsports/files/2019/04/Current-Sensor-Calibration-Factor-Sheet1.pdf>

IMD

Isolation Monitoring Device (IMD) is used for monitoring the insulation resistance between the HV+ of the TSV and the chassis ground. A pinout for the IMD can be found on the datasheet here under IR155-3204:

https://www.bender.de/fileadmin/content/Products/d/e/IR155-32xx-V004_D00115_D_XXEN.pdf

The recommended wiring of IMD can be found in this document:

<https://formula-hybrid.org/wp-content/uploads/Bender-wiring-Rev-1.pdf>

The main connections that need to be connected are the power and three grounds to the GLV signals, the OKHS used in a 24V relay to control the safety loop and also used in a PMOS transistor to control IMD fault LED. The high voltage side needs to be connected to the corresponding high voltage bus bars.

CAN Isolator

The CAN Isolator used in the TSI enclosure connects to the CAN signals coming from the motor controller. This is used to ensure the high voltage signal is isolated from the low voltage. This is mounted on din rail and should span the high and low voltage sides of the box.

https://advdownload.blob.core.windows.net/productfile/PIS/BB-CANOP/Product%20-%20Datasheet/CANOP_4218ds20181204233352.pdf

FAQ

If you are having trouble with setting up the GLV system here are some common issues:

- Why is the safety loop not closing?
 - o There are several reasons why the safety loop won't close. Most often a BRB hasn't been untwisted and remains open. However, the best way to understand why the safety loop is closed is to look at either the Cockpit panel or the SCADA display. Then refer to the startup procedure to find the problem.
- Why is the SCADA not booting?
 - o The SCADA system is housed by the CARMAN. Either the GLV isn't receiving power (which would be indicated by the GLV LED) or the SCADA isn't plugged into the GLV BOB.
- Why is the SCADA relay not closing?
 - o The SCADA relay is operated by the SCADA and can be opened according to a fault found in another part of the system. The problem may be best found by interrogating the data displayed by the SCADA system. However, the initial state of the SCADA relay can be programmed to be normally open or closed. If the programming jumper is not placed in the correct pin then this may explain this problem.

Acknowledgments

This document is largely based on the template created and used by the Class of 2015 team.