

FSAE Electric Car
ME 498

CarMan User Manual

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Introduction:

Simply put, CarMan is the brain of the car. It contains a large portion of the electronics systems car while linking various parts of the car together. These include the tractive system interface, grounded low voltage boards, the high voltage relays that connect the motor controller to the batteries and it also displays information about the state of the car. The tractive system interface is what monitors the high voltage systems of the car, most importantly it detects dangerous ground faults and shuts the high voltage systems if needed. The purpose of this document is to help the incoming 2020-2021 team pick up where the 2019-2020 team left off and carry these projects to the finish line.

Google Drive File Paths:

CompleteAssembly > 2019-2020-Complete > Enclosure > CarMan

CompleteAssembly > 2019-2020-Complete > Enclosure > CarMan > RelayBoardMK2

Design Overview:

The CarMan enclosure is the result of numerous design reviews and collaboration between sub-teams. Below is a list of important features:

- 5 piece, riveted aluminum shell and an interlocking 3 piece lid allowing for access to each section of the enclosure
- Low voltage shelf for GLV components
- High voltage relay board.
- Mixed voltage TSI Board
- 21 connectors/cables and 5 electrical boards

Design Objectives:

Several goals were identified and considered during the design process. They are listed below and ranked in order of importance:

- Rules compliance and strain relief (See Rules: EV.7.1.5, EV.7.3, EV.7.5.7)
- Cable organization and ability to access all electrical components
- Cost and ease of fabrication
- Water resistance
- Minimize use of loose fasteners. These tend to fall into the enclosure which can be dangerous and hard to remove. Flush mount press fit nuts where used instead.

The current CarMan enclosure meets most of these objectives. Though a formal competition-style inspection was never performed, the enclosure is assumed to be rules compliant. All cables, connectors and boards fit and are accessible. Waterproofing and testing have not been performed.

Rules:

The electrical enclosure for the Formula Car must comply with the following rules in order to pass electrical inspection.

- Article EV 3: TSI wiring/Construction
 - TSI Components must be physically protected by moving parts and human contact
- Article EV 5: TS Voltage Isolation
 - TSI wiring and components must be isolated from GLV by separation or insulation

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- Article EV 6.1: Fusing
 - placement of fuses
- Article EV 10.5: Rain Test, Electrical System Tests
 - must operate in wet/damp conditions

Current State:

CarMan has reached a stage of significant completion. The enclosure has been assembled and many of the major electronic components have been installed. This includes the tractive system interface, relay board and grounded low voltage systems. In addition the side panels, connectors and wiring had also been completed.

Errata:

Several issues must be addressed before the system is 100% complete. These involve the completion and installation of the SCADA displays and panels on the front of the enclosure. Though a design was completed, manufacture has not begun. In addition, the enclosure must be water resistant and rules compliant. We estimate that this will be the largest focus of the incoming interconnect team. Though the enclosure was designed to minimize seams, manufacturing tolerances were not met and the u-shaped aluminum panel that makes up the front, bottom and back of the enclosure had to be split into 3 pieces. As a result there are two large seams at the bottom of the enclosure. In addition to the seams, panel edges must also be waterproofed. The team had planned on using rubber gaskets, aluminum HVAC tape and silicone sealant to fill these gaps. A garolite isolation wall between high voltage and low voltage zones of the enclosure was also designed but never implemented. Finally it is recommended to instal flush mount press fit nuts directly into the connector panels to eliminate the amount of loose fasteners on the enclosure.

The relay board also requires some work. Though largely finished some final improvements must be made. At the recommendation of Professor Nadovich insulating paint should be used on the base plate. In addition, several components are missing. These are the fuses mounted to the aluminum bars. The interconnect team had planned on modifying existing fuse holders by bending one of the existing wire terminals to make contact with the bar. This was never implemented. (see Professor Helm).

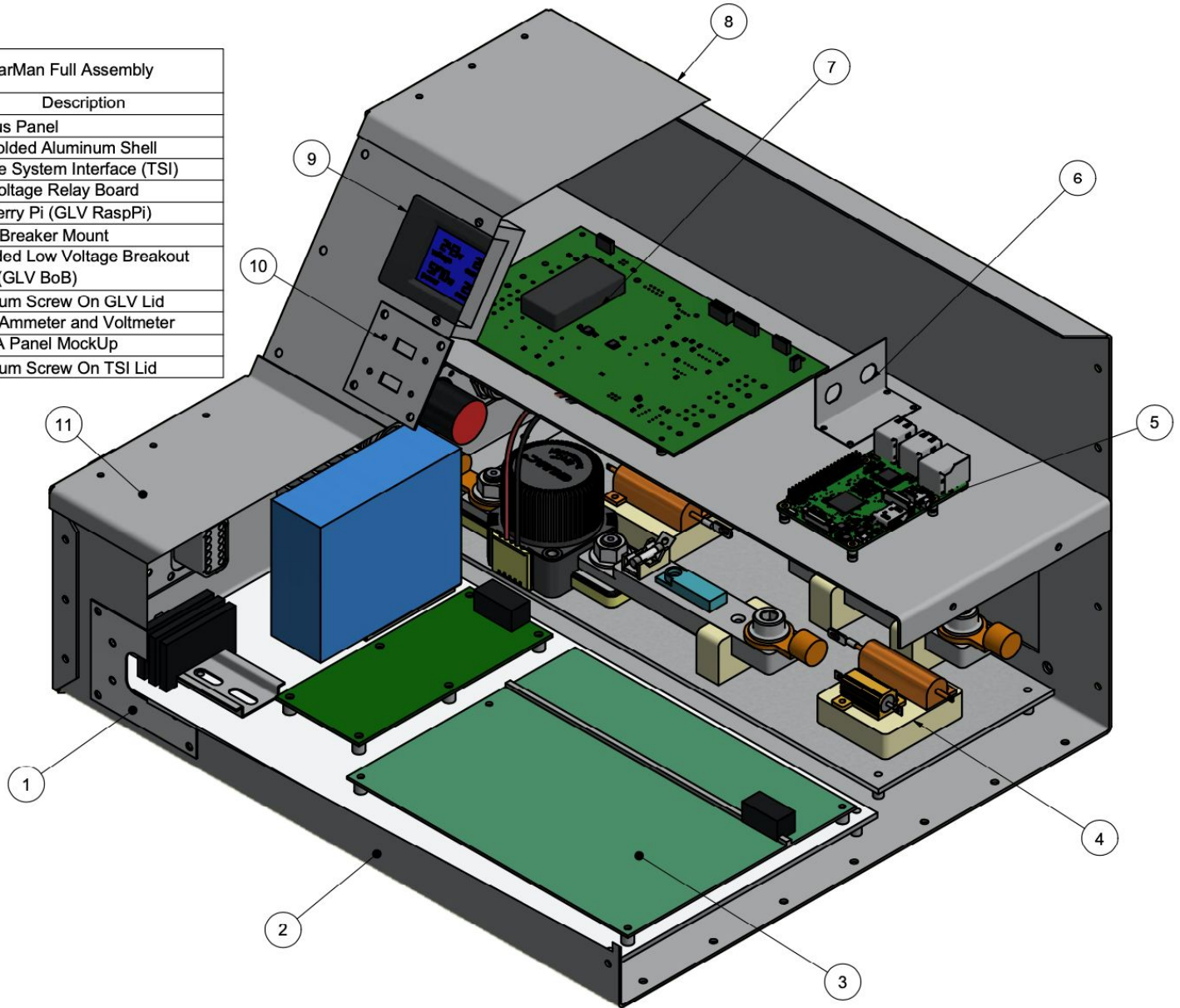
Future Team Recommendations:

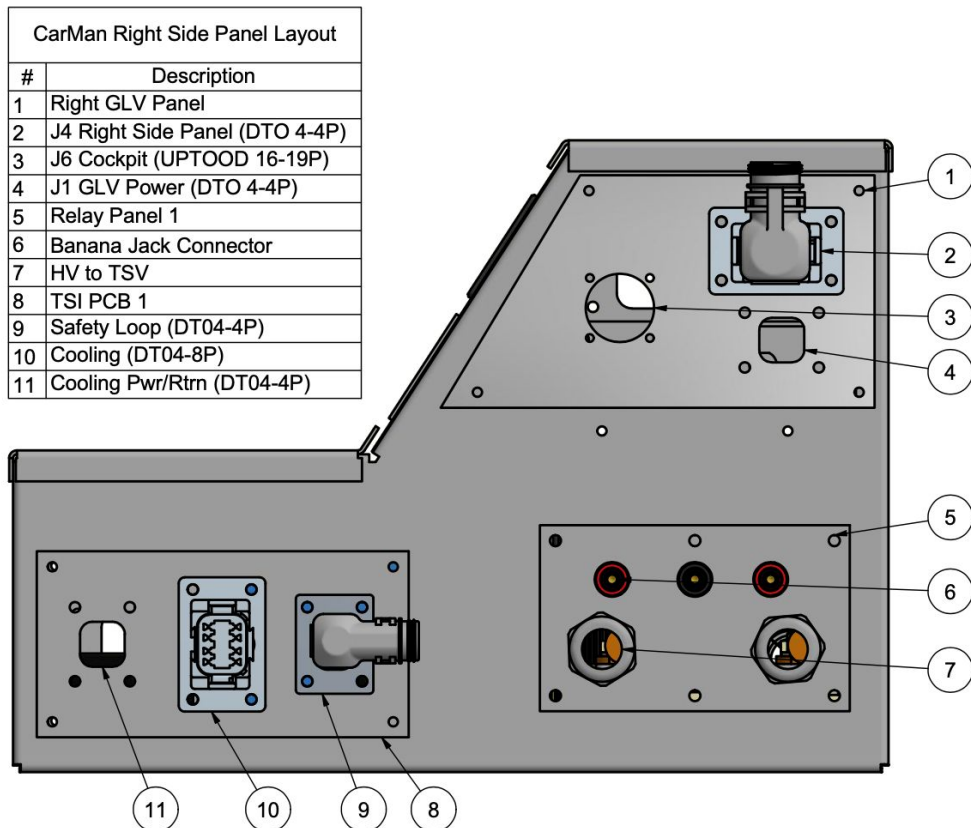
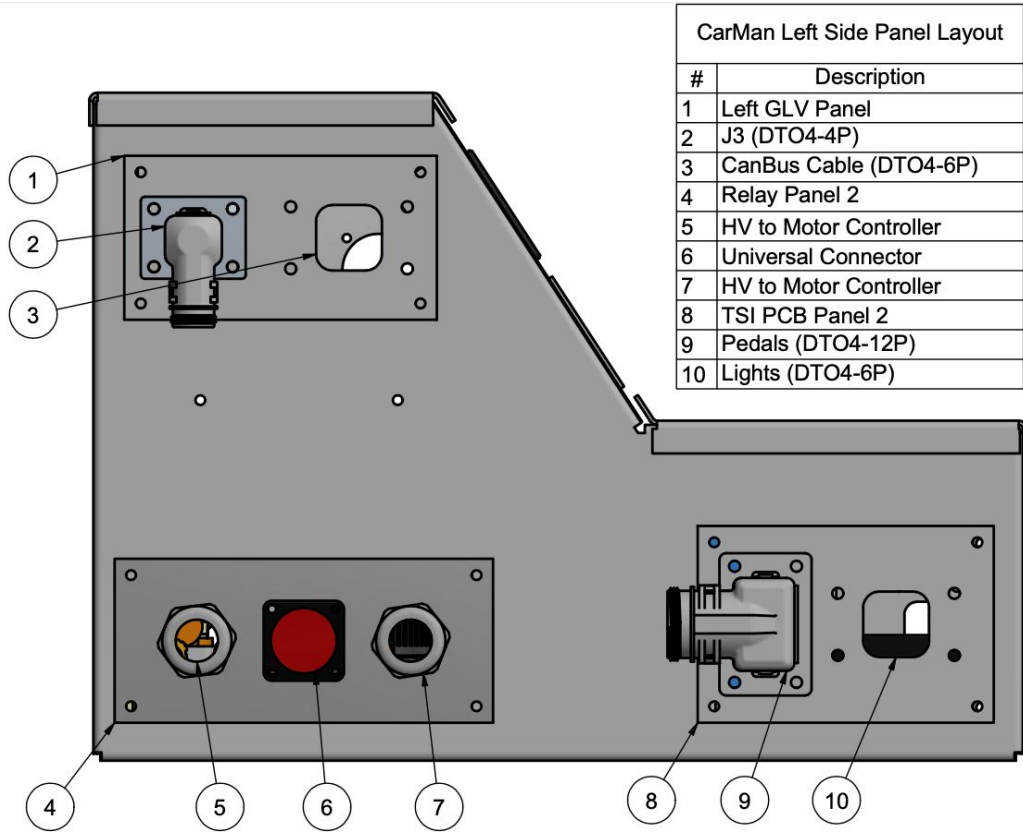
The 2019-2020 recommends making the design changes listed above and using the current CarMan enclosure on the car. Significant amount of design and redesign went into CarMan and the current system has many many advantages. Though modifications may be needed there is no reason to start from scratch completely. If a full frame redesign occurs, ask for more space. Combine as many electrical systems as possible to minimize connectors and cabling on the car. A single enclosure with the TSI, GLV, relays, motor controller and possibly some cooling components would be ideal.

Component Layout:

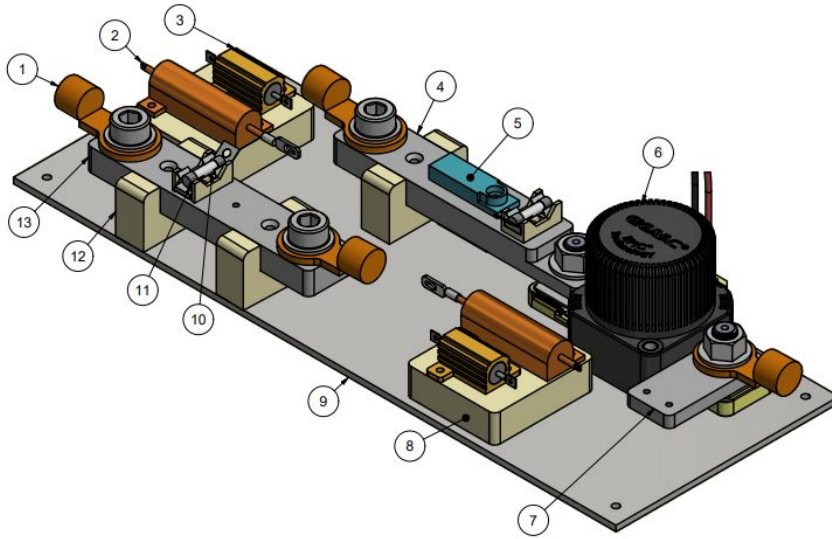
CarMan houses the tractive system interface, grounded low voltage interface and the high voltage relay board. Each has a high voltage or low voltage compartment and several connector panels. The TSI is mounted at the front of the enclosure. It faces the relay board which is separated by an isolation wall. Above the relay board is a low voltage shelf for the GLV BoB and SCADA. Each subsystem and mounting board was assembled outside the enclosure and installed as one piece.

CarMan Full Assembly	
#	Description
1	Can Bus Panel
2	1/16"Folded Aluminum Shell
3	Tractive System Interface (TSI)
4	High Voltage Relay Board
5	Raspberry Pi (GLV RaspPi)
6	Circuit Breaker Mount
7	Grounded Low Voltage Breakout Board (GLV BoB)
8	Aluminum Screw On GLV Lid
9	Digital Ammeter and Voltmeter
10	SCADA Panel MockUp
11	Aluminum Screw On TSI Lid



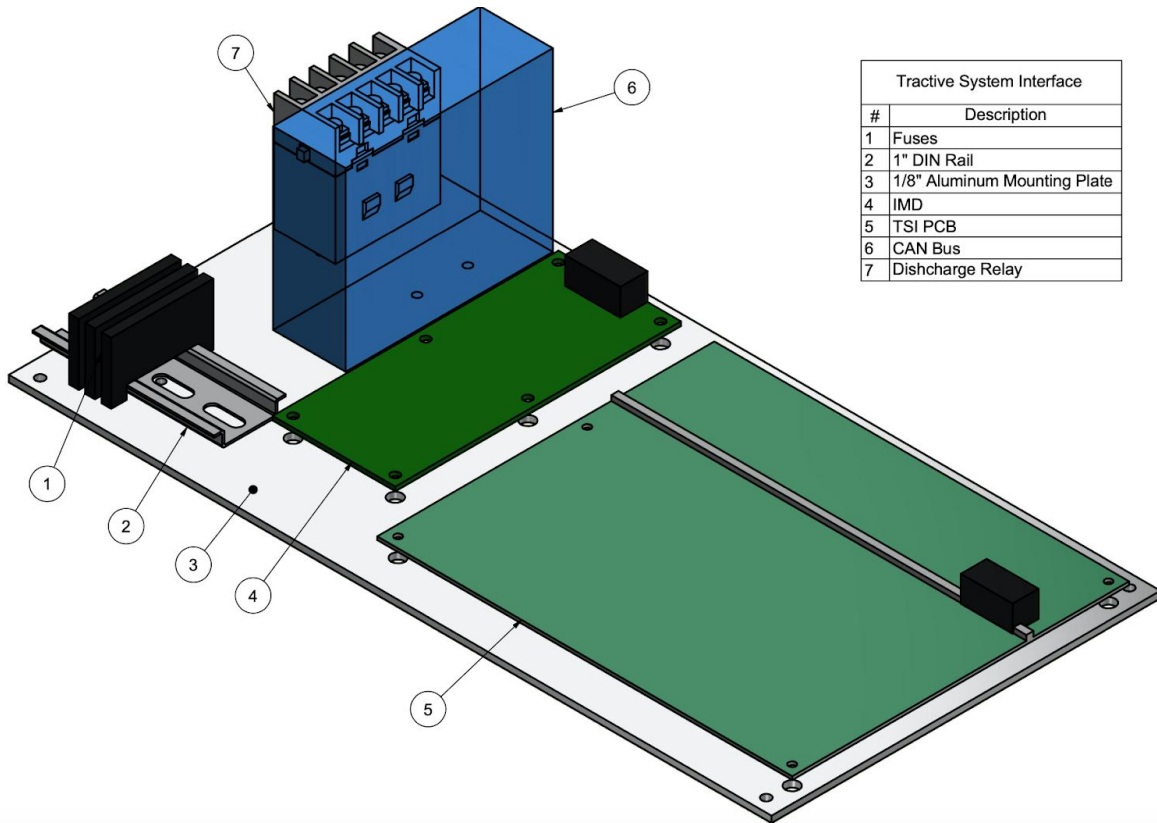


Relay Board



Parts List		
ITEM	QTY	DESCRIPTION
1	4	High Voltage Cable Terminal
2	2	HS50 Resistor
3	2	UAL-25
4	1	Precharge Bar
5	1	Current Sensor
6	1	GX14 Step AIR
7	1	Resistor Connector Bar
8	2	Garolite Resistor Block
9	1	1/8" Aluminum Mounting Plate
10	2	477 Series Fuse
12	2	Fuse Holder
12	3	Garolite U Spacer
13	1	Discharge Bar

Tractive System Interface



Tractive System Interface	
#	Description
1	Fuses
2	1" DIN Rail
3	1/8" Aluminum Mounting Plate
4	IMD
5	TSI PCB
6	CAN Bus
7	Discharge Relay

CarMan Bill of Materials						
#	Description	Part #	Quantity	Cost	Total	Website
1	12" x 12"x 5/8" Garolite Sheet	8491K39	1	\$45.03	45.03	mcmaster.com
2	8-32 Flush-Mount Press-Fit Nut	94674A520	4	\$8.44	33.76	mcmaster.com
3	8-32 Aluminum Rivet Nut	93482A611	1	\$9.72	9.72	mcmaster.com
4	5/32" Diameter Aluminum Blind Rivets	97447A030	1	\$13.15	13.15	mcmaster.com
5	6-32 Screw-to-Expand Inserts	92395A113	1	\$12.00	12	mcmaster.com
6	8-32 Screw-to-Expand Inserts	92395A114	1	\$12.60	12.6	mcmaster.com
7	10-24 Stainless Steel Press-Fit Nut	96439A450	1	\$7.63	7.63	mcmaster.com
8	1/2" Gore Gasket Tape	95705K121	1	\$36.62	36.62	mcmaster.com
9	8-32 Button Head Hex Drive Screw	98164A134	3	\$6.54	19.62	mcmaster.com
10	#8 Lock Washer	91757A105	1	\$3.10	\$3.10	mcmaster.com
11	6-32 Rivet Nut	94020A311	2	\$8.12	16.24	mcmaster.com
12	Female Threaded Hex Standoff 1/4" Hex, 3/4" Long, 4-40 Thread	91115A166	10	\$1.87	18.7	mcmaster.com
13	6-32 Press Fit Nuts	94674A510	3	\$7.02	21.06	mcmaster.com
14	#8 Male-Female Threaded Hex	91075A113	10	\$1.87	18.7	mcmaster.com
15	316 Stainless Steel Button Head Hex Drive Screw	98164A106	1	\$9.44	9.44	mcmaster.com
16	Low Profile Rivet Nut, 4-40	98560a526	1	\$12.66	12.66	mcmaster.com
17	M6 Aluminum Heavy-Duty Rivet Nut	94020A387	1	\$6.92	6.92	mcmaster.com
			TOTAL COST =		296.95	