SAE INTERNATIONAL

FORMULA SAE

ENERGY METER
STUDENT MANUAL

November 19, 2024

Introduction

Formula SAE Electric requires the installation of the competition provided energy meter in every vehicle. The energy meter will monitor energy usage and peak power, voltage and battery temperature. This information is used to check for power, voltage and temperature violations during the competition as well as computing the efficiency score.

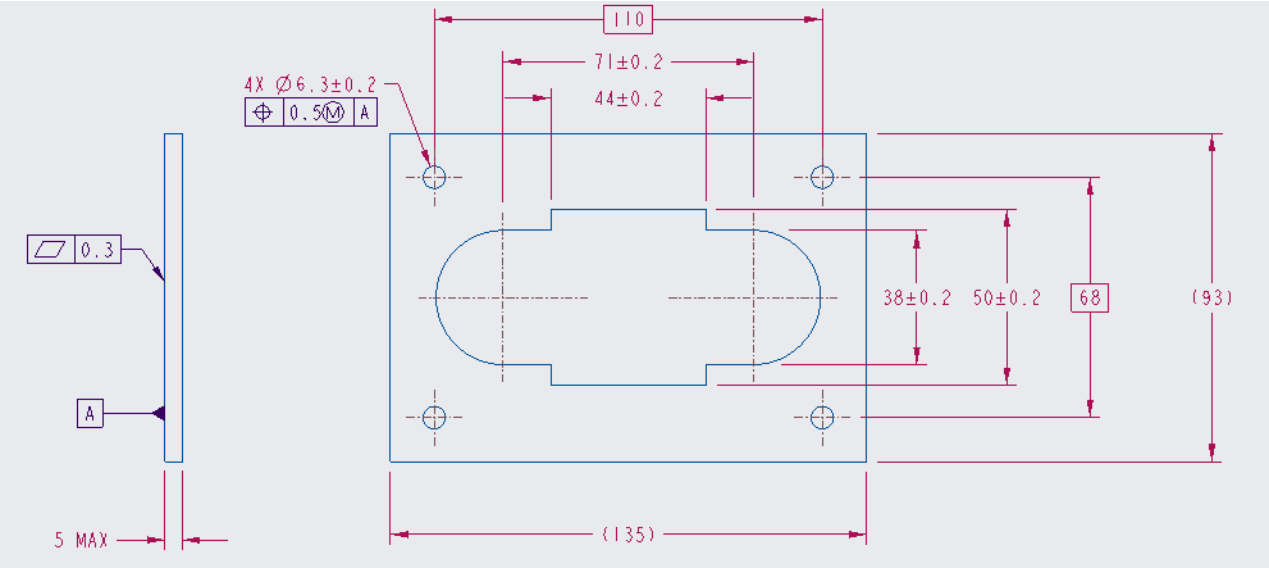
The energy meter is designed in two components, a receptacle and the energy meter. Teams will need to purchase the receptacle from SAE and install it in the vehicle prior to competition. At the competition the energy meter will be provided and installed in the receptacle. The receptacle must not be inside any tractive system enclosure and easily accessible without significant disassembly. Removal of body panels is allowed to access the energy meter.

The energy meter is based the Amphenol MSDXLF000F / MSDXLM000 manual service disconnect. The energy meter cannot be used as the FSAE Manual Service Disconnect (EV.5.5.2) and should remain installed in the receptacle for the entire duration of the competition. This includes when downloading the energy meter. Teams must plan for appropriate access to the download connector while the energy meter is installed in the vehicle. Extending the download connector is not allowed.

Teams should plan to purchase an Amphenol MSDXLM000 from the supplier of their choice to use when running not at competition. The modified receptacle used for the energy meter is compatible with the unmodified service disconnect which can be used to complete the TS connection when not at competition.

Mechanical

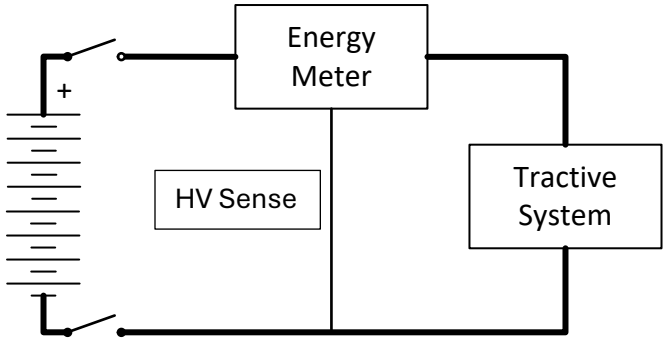
The receptacle cut-out is based off the Amphenol MSDXLF000F recommendations. Additional clearance will be required to account for the TS and GLV connectors. Below provides a summary. Modification may be required to fit to teams' specific applications.



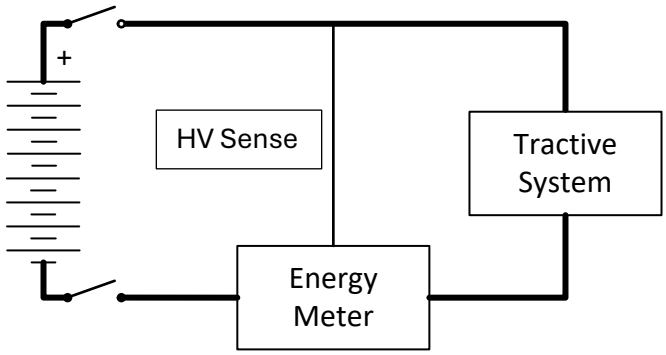
Receptacle mounting screws are M6 x 1.0, torque limit is 8 Nm. The tractive system screws are M8 x 1.25, torque limit is 13.4 Nm.

TS Wiring

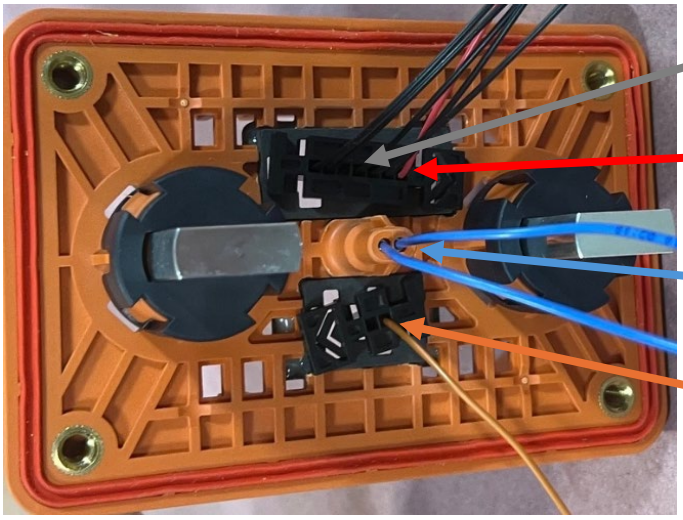
The energy meter has 3 TS connections. The first two connections must be wired in series with the high current path of the TS such that all TS power runs through the energy meter. This series connection must be in either the most positive or most negative side of the TS. The energy meter cannot be wired midpack. The third connection must be wired to the other pole of the TS for sensing voltage – connect to the wire lead in the #1 socket of the 2 pin connector. The energy meter must be connected on the tractive system (not always energized) side of the isolation relays.



Option A: Energy Meter in HV+ Path



Option B: Energy Meter in HV- Path



GLV Pins 1, 2, 3-6: Black

GLV Power Pin 7: Red Wire

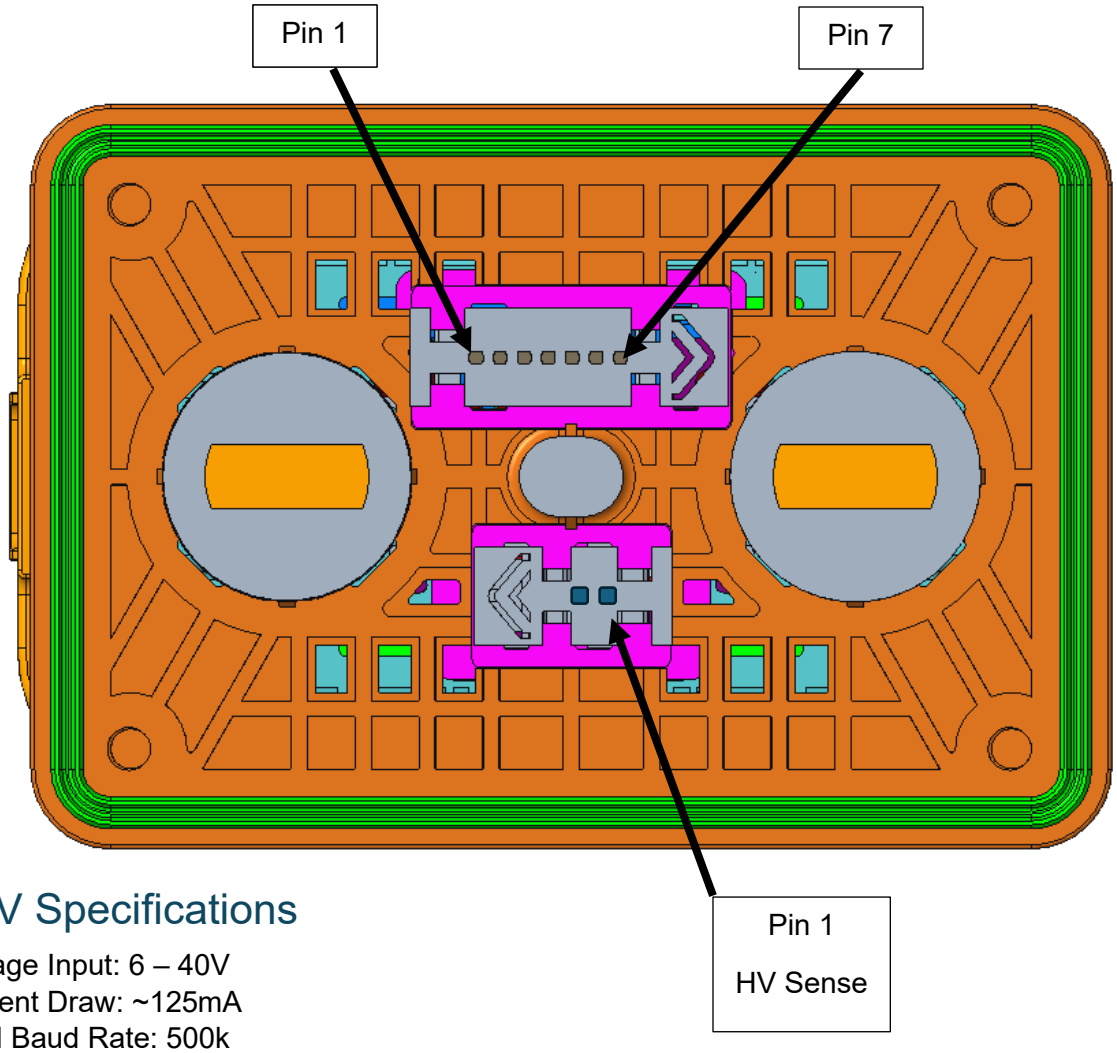
HVIL: Blue Wires

TS Sense: Orange Wire

GLV Wiring

The energy meter must be provided with GLV power from the vehicle.

Pin	Function
1	Temp Sense Ground
2	Temp Sense One Wire
3	No Connection
4	CAN Low
5	CAN High
6	GLV Negative
7	GLV Positive



GLV Specifications

Voltage Input: 6 – 40V
Current Draw: ~125mA
CAN Baud Rate: 500k

CAN Messaging

The energy meter provides a CAN bus connection which will allow access to the real-time data within the energy meter. The CAN bus also allows the addition of team signals to the energy meter data log. These team signals are not required and are provided for the convenience of the team. Use of the CAN bus connection of the energy meter is not required and is completely optional.

All signals are big endian (Motorola).

Measurement Message
Message Id: 0x10d (11 bit ID)
Transmitted by energy meter
Rate: 20ms

Data Byte	0	1	2	3	4	5	6	7
Signals	Current [A] float				Voltage [V] float			

Status Message
Message Id: 0x40d (11 bit ID)
Transmitted by energy meter
Rate: 100ms

Data Byte	0	0	1	2	3	4	5	6	7
Data Bit	0	1							
Signals	Violation	Logging	Energy [Whr] float						

Temperature Message
Message Id: 0x60d (11 bit ID)
Transmitted by energy meter
Rate: 250ms

The temperature message includes a multiplexor signal. The first bits of the first byte of the message (the multiplexor) are used to determine the meaning of bytes 3-7.

All temperatures are sent as an unsigned byte with the following scaling. degC = raw * 0.5

Data Byte	0	0	1	2	3	4	5	6	7
Data Bit	0-2	3-7							
Signal	0	Num Sensors	Min Temp	Max Temp	Temp 0	Temp 1	Temp 2	Temp 3	Temp 4
	1				Temp 5	Temp 6	Temp 7	Temp 8	Temp 9
	2				Temp 10	Temp 11	Temp 12	Temp 13	Temp 14
	3				Temp 15	Temp 16	Temp 17	Temp 18	Temp 19
	4				Temp 20	Temp 21	Temp 22	Temp 23	Temp 24
	5				Temp 25	Temp 26	Temp 27	Temp 28	Temp 29
	6				Temp 30	Temp 31			

Team Data 1 Message
Message Id: 0x30d (11 bit ID)
Received by energy meter

Data Byte	0	1	2	3	4	5	6	7
Signals	Team Signal 1 sint32				Team Signal 2 sint32			

Team Data 2 Message
Message Id: 0x30e (11 bit ID)
Received by energy meter

Data Byte	0	1	2	3	4	5	6	7
Signals	Team Signal 3 sint32				Team Signal 4 sint32			

Temperature Sensors

For the 2025 seasons teams are required to have at least 1 energy meter temperature sensor in the accumulator. The exact location is not specified, and it can be located anywhere the team prefers within the accumulator.

Starting in the 2026 season, teams will be required to have at least 1 energy meter temperature sensor per accumulator segment. The temperature sensors must be in the hottest region of each segment and meet EV.7.5.4.

The sensors used must be an Analog Devices DS18B20 wired for parasite power Vdd connector to Gnd. Multiple sensors should be connected in parallel.