AEM Performance Electronics
2205 W 126th Street, Unit A
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AEM EV
VCU Pre-Start Checklist

Revision A

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Revision History

Revision	Date	Change Description
A	5/18/2020	Initial Release

Cautions and Warnings

Working on tractive systems (which includes but is not limited to motor(s), inverter(s), high voltage battery packs and high voltage cables) requires special experience and training. AEM EV has implemented fault detection and failsafe logic into its vehicle control units ("VCU"), however this does not mean that your VCU installation will be safe or effective, or that your VCU installation will not interfere with other systems on your vehicle and create a hazardous situation. It is the responsibility of the installer to understand the implications of each stage of tractive system installation and testing and to recognize what might be unique about your application that presents potential hazards or safety issues – and it is the responsibility of the installer to solve or address any such hazards or issues.

The following list includes basic recommended practices. This is not a comprehensive list; as noted below, if you are not well-versed in the appropriate installation and testing procedures, you should refer the installation and calibration to a reputable installation facility or contact AEM EV for a referral in your area.

- When access is required near the battery pack, the cell segments must be separated by using an appropriate maintenance disconnect plug.
- When working on the battery pack or tractive system, safety gloves with side shields and appropriate insulated tools must be used.
- Always wear Class 0 gloves rated at 1000V with leather protectors.
- Only use CAT III rated digital multimeters (DMM) and test leads.
- When working on the battery pack or tractive system, work with one hand while keeping the other behind your back.
- During initial system power up and testing, the vehicle must be raised off the ground and supported appropriately. Wheels and tires should be removed.
- During the VCU firmware upgrade process, battery cell segments must be separated using an appropriate maintenance disconnect plug.
- Do not make calibration changes when the inverter pulse width modulation (PWM) is enabled.

USE THIS VCU WITH EXTREME CAUTION. MISUSE AND/OR IMPROPER INSTALLATION CAN CAUSE SIGNIFICANT DAMAGE TO YOUR VEHICLE AND PROPERTY BELONGING TO YOU OR OTHERS, AS WELL AS PERSONAL INJURY OR DEATH. IF YOU ARE NOT WELL VERSED IN THE INSTALLATION OF TRACTIVE SYSTEMS OR CONFIGURING THE CALIBRATIONS IN THE AEM EV VCU THAT ARE NECESSARY TO CONTROL THE VEHICLE, YOU SHOULD REFER THE INSTALLATION AND VCU CALIBRATION TO A REPUTABLE INSTALLATION FACILITY, OR CONTACT AEM EV FOR A REFERRAL IN YOUR AREA. IT IS THE

RESPONSIBILITY OF THE INSTALLER TO ULTIMATELY CONFIRM THAT THE INSTALLATION AND CALIBRATIONS ARE SAFE FOR ITS INTENDED USE.

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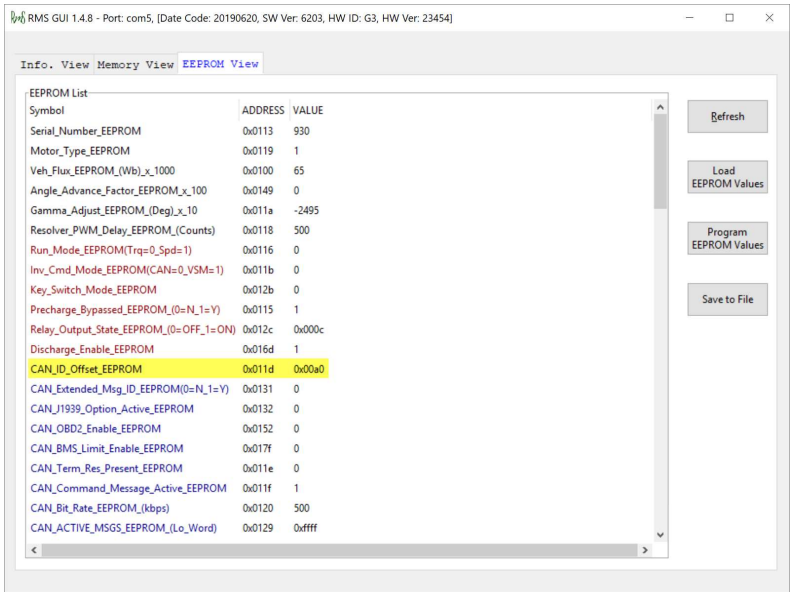
LV = Low Voltage (12v system)
HV = High Voltage (60v or greater)

1. Ensure ALL electrical voltage sources are isolated (LV and HV)
    a. Kill Switch
    b. VCU Breaker
    c. HV Lines
2. Check electrical potential of all components on vehicle to ensure all components at same potential level
    a. Use a multimeter and verify that all components are properly grounded.
3. Use a multimeter and verify all wiring (both LV and HV) between components
    a. VCU
    b. PDUs
    c. Inverters
    d. IMD
    e. BMS
    f. Batteries
    g. AEM Dash (if equipped)
    h. Keypad (if equipped)
    i. Switch Panel
    j. Steering Wheel Buttons

k. Actuators
l. Lights
m. Shifter
n. Contactors
o. Pre-Charge Resistors
p. CAN Networks
    i. Ensure all devices are on appropriate networks
    ii. Ensure terminating resistors installed/enabled in appropriate locations
        1. There must be a 120ohm resistor at each physical end of the bus

4. Connect VCU to vehicle harness
5. Enable LV power to VCU and PDUs
6. Verify LV present at VCU and PDUs
    a. Confirm VCU main relay functionality
        i. VCU300 requires a main relay, VCU200 does not
        ii. Wake Switch input will trigger main relay on VCU300

7. Identify and label Inverters
8. **The following steps will need to be accomplished with a bench top power/comms harness for inverters.**
9. Connect to Inverters and flash with updated FW from Cascadia
    a. Must have Flash Enable Jumper Installed
        b. RMS_20190620_6203
        i. This FW includes the updated CAN data rates to reduce bus loading
10. Configure Inverters with correct CAN Base Addresses (configure based on the number of inverters/motors in your system).
    a. Inverter 1: 0A0
    b. Inverter 2: 1A0
    c. Inverter 3: 2A0
    d. Inverter 4: 3A0



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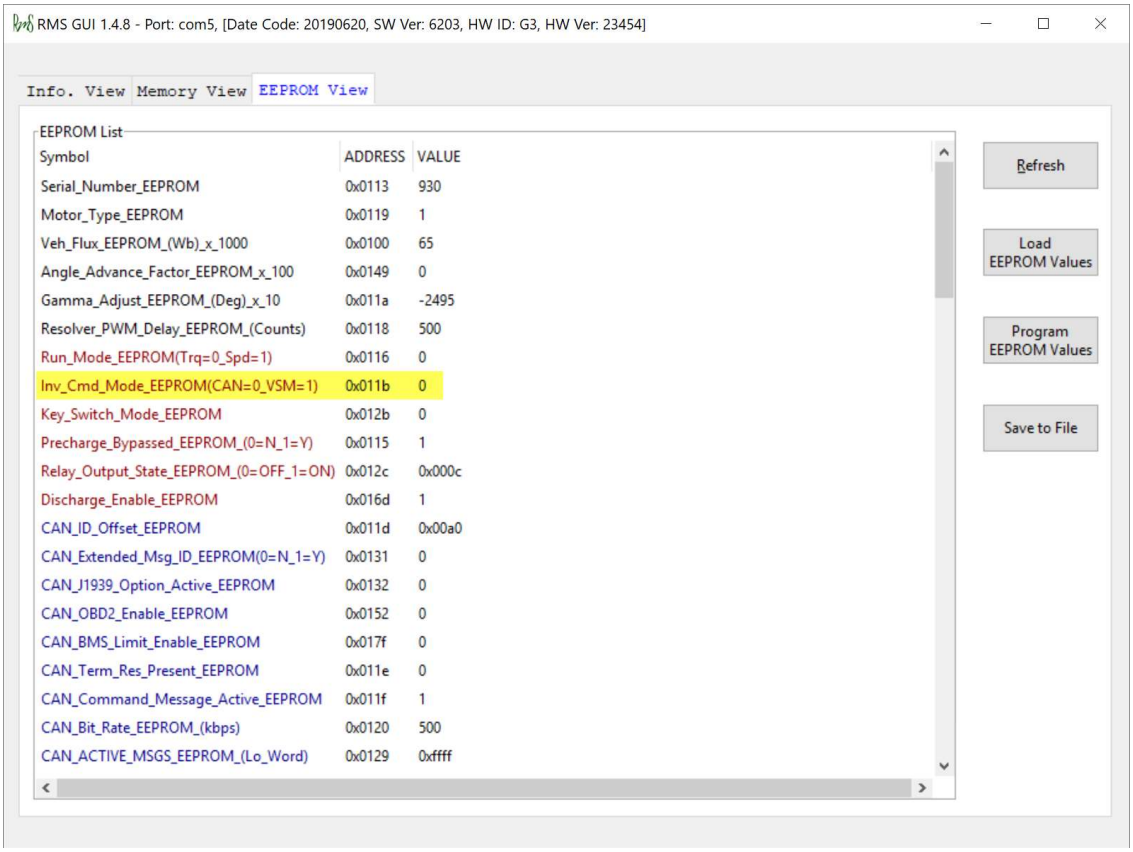
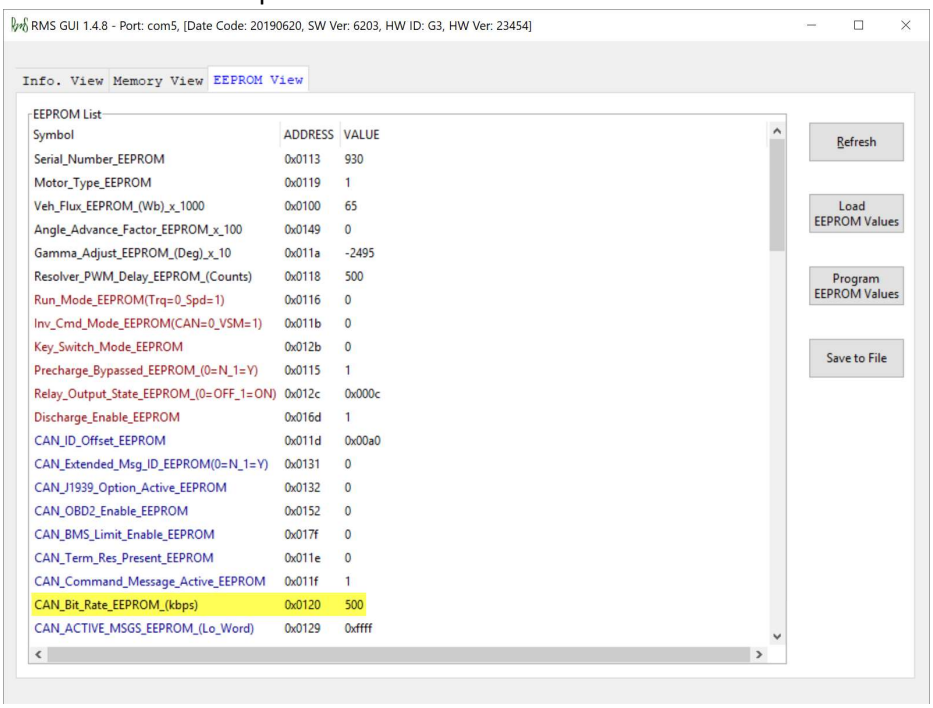
11. Confirm CAN_CONTROL_ENABLED for each Inverter



Symbol	ADDRESS	VALUE
Serial_Number_EEPROM	0x0113	930
Motor_Type_EEPROM	0x0119	1
Veh_Flux_EEPROM_(Wb)_x_1000	0x0100	65
Angle_Advance_Factor_EEPROM_x_100	0x0149	0
Gamma_Adjust_EEPROM_(Deg)_x_10	0x011a	-2495
Resolver_PWM_Delay_EEPROM_(Counts)	0x0118	500
Run_Mode_EEPROM(Trq=0_Spd=1)	0x0116	0
Inv_Cmd_Mode_EEPROM(CAN=0_VSM=1)	0x011b	0
Key_Switch_Mode_EEPROM	0x012b	0
Precharge_Bypassed_EEPROM_(0=N_1=Y)	0x0115	1
Relay_Output_State_EEPROM_(0=OFF_1=ON)	0x012c	0x000c
Discharge_Enable_EEPROM	0x016d	1
CAN_ID_Offset_EEPROM	0x011d	0x00a0
CAN_Extended_Msg_ID_EEPROM(0=N_1=Y)	0x0131	0
CAN_J1939_Option_Active_EEPROM	0x0132	0
CAN_OBD2_Enable_EEPROM	0x0152	0
CAN_BMS_Limit_Enable_EEPROM	0x017f	0
CAN_Term_Res_Present_EEPROM	0x011e	0
CAN_Command_Message_Active_EEPROM	0x011f	1
CAN_Bit_Rate_EEPROM_(kbps)	0x0120	500
CAN_ACTIVE_MSGS_EEPROM_(Lo_Word)	0x0129	0xffff

12. Confirm Inverter Bit Rates set to 500kbps



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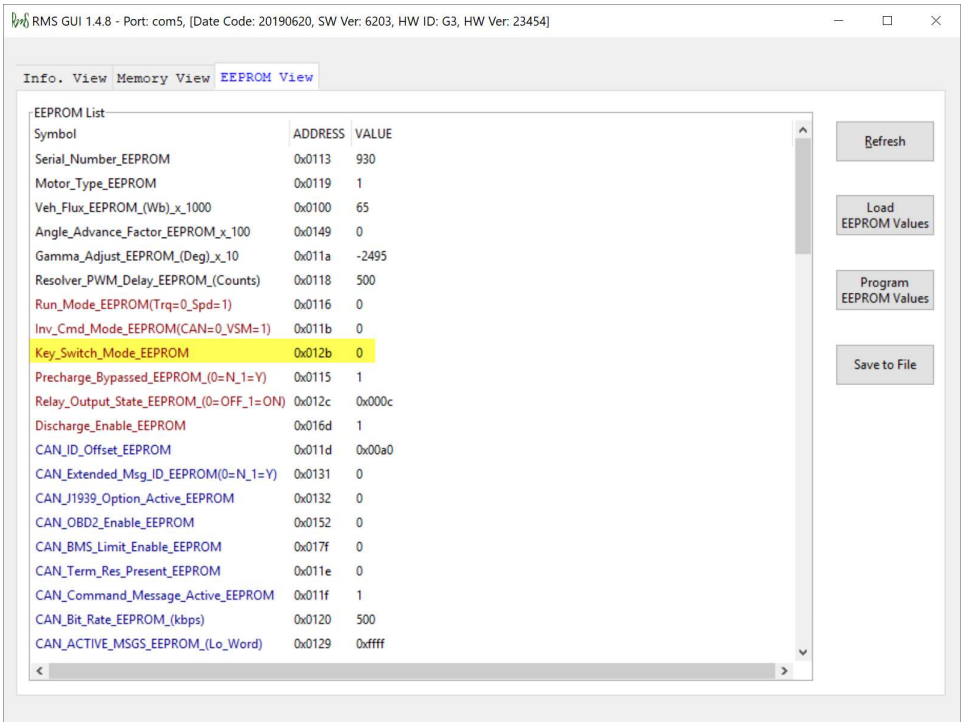
Motor_Type_EEPROM	0x0119	1
Veh_Flux_EEPROM_(Wb)_x_1000	0x0100	65
Angle_Advance_Factor_EEPROM_x_100	0x0149	0
Gamma_Adjust_EEPROM_(Deg)_x_10	0x011a	-2495
Resolver_PWM_Delay_EEPROM_(Counts)	0x0118	500
Run_Mode_EEPROM(Trq=0_Spd=1)	0x0116	0
Inv_Cmd_Mode_EEPROM(CAN=0_VSM=1)	0x011b	0
Key_Switch_Mode_EEPROM	0x012b	0
Precharge_Bypassed_EEPROM_(0=N_1=Y)	0x0115	1
Relay_Output_State_EEPROM_(0=OFF_1=ON)	0x012c	0x000c
Discharge_Enable_EEPROM	0x016d	1
CAN_ID_Offset_EEPROM	0x011d	0x00a0
CAN_Extended_Msg_ID_EEPROM(0=N_1=Y)	0x0131	0
CAN_J1939_Option_Active_EEPROM	0x0132	0
CAN_OBD2_Enable_EEPROM	0x0152	0
CAN_BMS_Limit_Enable_EEPROM	0x017f	0
CAN_Term_Res_Present_EEPROM	0x011e	0
CAN_Command_Message_Active_EEPROM	0x011f	1
CAN_Bit_Rate_EEPROM_(kbps)	0x0120	500
CAN_ACTIVE_MSGS_EEPROM_(Lo_Word)	0x0129	0xffff

13. Confirm Inverter Key Switch Mode is set to 0



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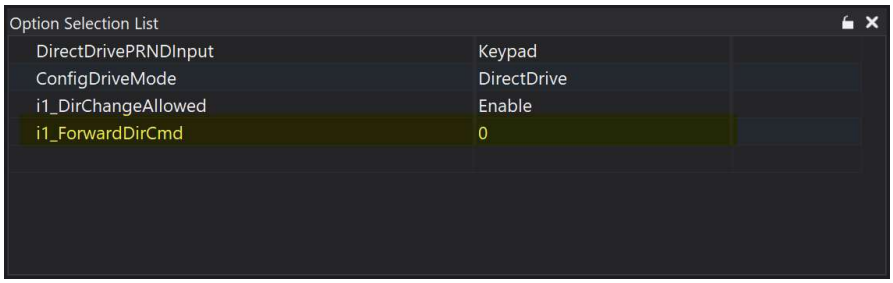
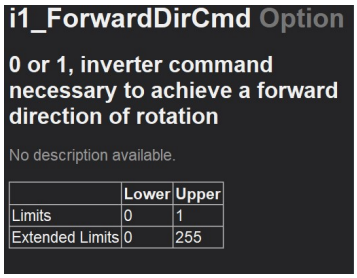
Motor_Type_EEPROM	0x0119	1
Veh_Flux_EEPROM_(Wb)_x_1000	0x0100	65
Angle_Advance_Factor_EEPROM_x_100	0x0149	0
Gamma_Adjust_EEPROM_(Deg)_x_10	0x011a	-2495
Resolver_PWM_Delay_EEPROM_(Counts)	0x0118	500
Run_Mode_EEPROM(Trq=0_Spd=1)	0x0116	0
Inv_Cmd_Mode_EEPROM(CAN=0_VSM=1)	0x011b	0
Key_Switch_Mode_EEPROM	0x012b	0
Precharge_Bypassed_EEPROM_(0=N_1=Y)	0x0115	1
Relay_Output_State_EEPROM_(0=OFF_1=ON)	0x012c	0x000c
Discharge_Enable_EEPROM	0x016d	1
CAN_ID_Offset_EEPROM	0x011d	0x00a0
CAN_Extended_Msg_ID_EEPROM(0=N_1=Y)	0x0131	0
CAN_J1939_Option_Active_EEPROM	0x0132	0
CAN_OBD2_Enable_EEPROM	0x0152	0
CAN_BMS_Limit_Enable_EEPROM	0x017f	0
CAN_Term_Res_Present_EEPROM	0x011e	0
CAN_Command_Message_Active_EEPROM	0x011f	1
CAN_Bit_Rate_EEPROM_(kbps)	0x0120	500
CAN_ACTIVE_MSGS_EEPROM_(Lo_Word)	0x0129	0xffff

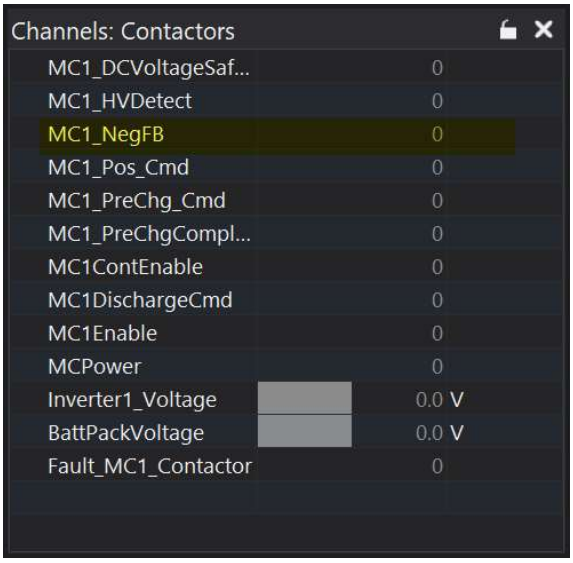
14. Wire in Terminating Resistor (if required) on last Inverter in physical bus
    a. The internally enabled resistors are not present on Cascadia Inverters until the inverter has +12v power.
15. Establish PC comms with VCU with AEMCal Software
16. Confirm motor rotation direction for each motor and set appropriately in AEMCal





17. Confirm NO Inverter FAULTS

18. Confirm CAN Tx/Rx from all devices on networks
    a. Verify with AEMCal and CAN Sniffing Tool, if available.
        i. **Note: The recommended Kvaser Leaf Lite v2 may be used in conjunction with CAN sniffing software. BUSMASTER is an open source CAN sniffing software available for download.**
    b. BMS Data
19. Confirm functionality and calibration of various VCU inputs
    a. Brake Switch
    b. APP
    c. Regen Lever
    d. Inverter Temps
    e. Coolant Temps
    f. Driveshaft Speed Sensor
    g. PRND Switch or CAN Keypad
20. Confirm functionality of physical switches, buttons, and keypad in VCU
21. With HV still disconnected, confirm the contactor sequencing for each inverter
    a. Current can be monitored from PDUs for evaluating contactors
    b. May also want to disconnect all but one set of contactors and evaluate each inverter/contactor combo independently
    c. Confirm functionality of Negative Contactor Confirmation Input



22. Ensure Torque_Request for ALL Motors is 0

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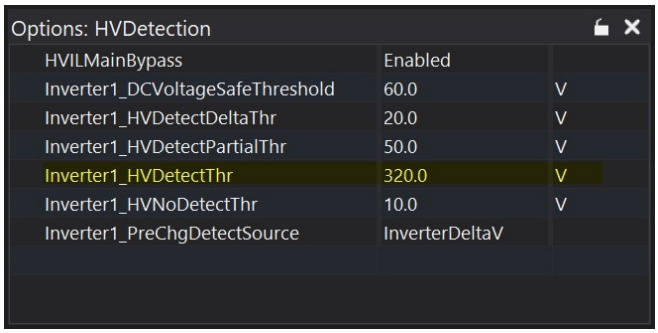
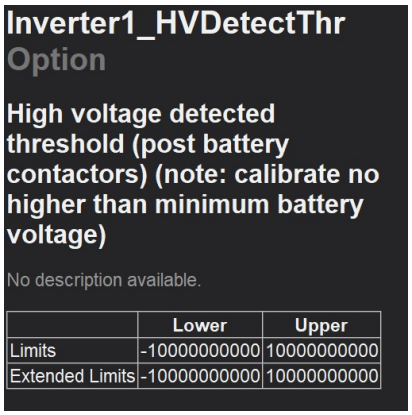
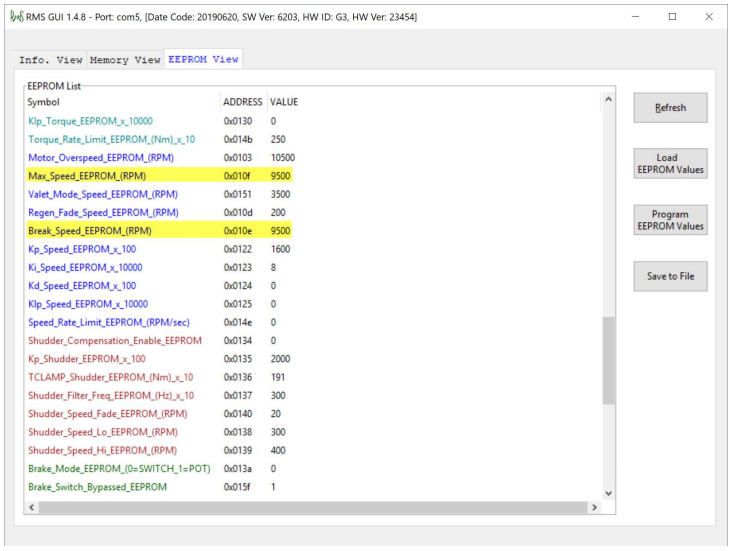
23. Calibrate HV_Detect_Threshold for each Inverter





24. Connect HV
25. Confirm contactor sequencing with HV connected
    a. Confirm each inverter independently
26. Perform calibration process for each motor/inverter
    a. Ensure cooling systems are filled/bled before proceeding
    b. May need to spin Motor 1 after calibration at low speed to help expedite calibration process of motors 2-4
    c. Confirm that BREAK_SPEED parameter set to same value as MAX_MOTOR_SPEED



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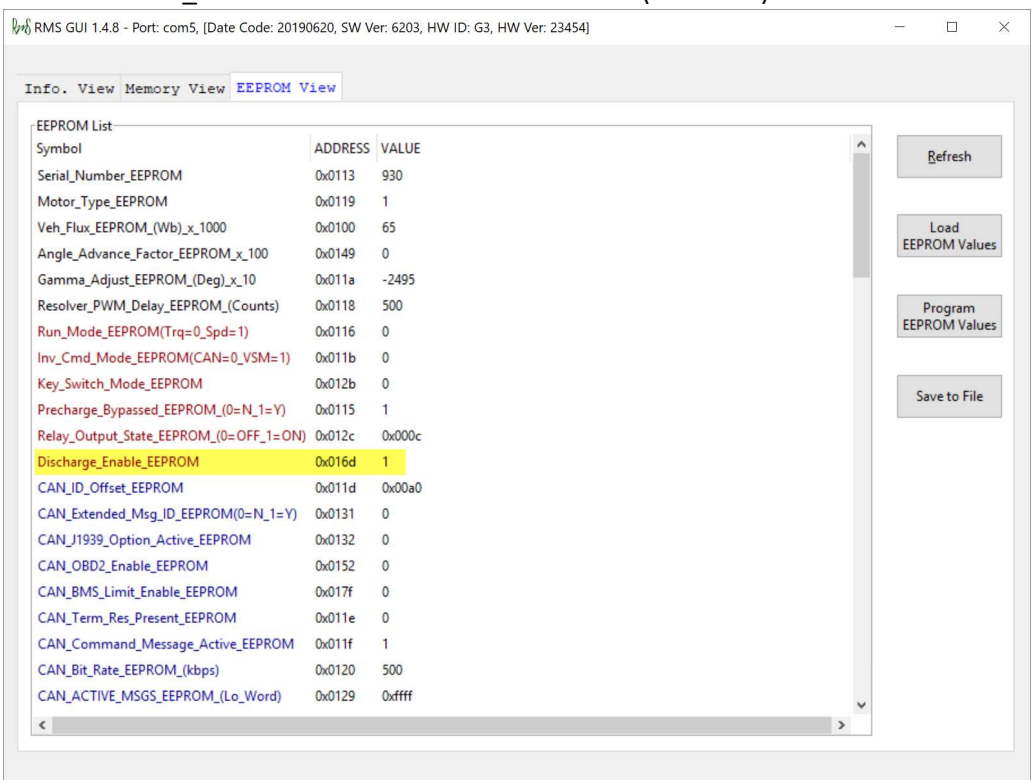
27. Confirm that INVERTER_DISCHARGE enabled on Inverters 1-4 (if desired)



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Angle_Advance_Factor_EEPROM_x_100	0x0149	0
Gamma_Adjust_EEPROM_(Deg)_x_10	0x011a	-2495
Resolver_PWM_Delay_EEPROM_(Counts)	0x0118	500
Run_Mode_EEPROM(Trq=0_Spd=1)	0x0116	0
Inv_Cmd_Mode_EEPROM(CAN=0_VSM=1)	0x011b	0
Key_Switch_Mode_EEPROM	0x012b	0
Precharge_Bypassed_EEPROM_(0=N_1=Y)	0x0115	1
Relay_Output_State_EEPROM_(0=OFF_1=ON)	0x012c	0x000c
Discharge_Enable_EEPROM	0x016d	1
CAN_ID_Offset_EEPROM	0x011d	0x00a0
CAN_Extended_Msg_ID_EEPROM(0=N_1=Y)	0x0131	0
CAN_J1939_Option_Active_EEPROM	0x0132	0
CAN_OBD2_Enable_EEPROM	0x0152	0
CAN_BMS_Limit_Enable_EEPROM	0x017f	0
CAN_Term_Res_Present_EEPROM	0x011e	0
CAN_Command_Message_Active_EEPROM	0x011f	1
CAN_Bit_Rate_EEPROM_(kbps)	0x0120	500
CAN_ACTIVE_MSGS_EEPROM_(Lo_Word)	0x0129	0xffff

28. Confirm VCU completes shut down process and returns to appropriate OPState after Ignition Switch turned off
29. If enabled, confirm Inverter Discharge functionality
30. Confirm functionality of PDU outputs for components with over-ride switches
    a. Water Pumps
    b. Cooling Fans
    c. Line Lock Solenoid
    d. Transbrake Solenoid
31. Confirm HVIL Loop functionality
    a. Main
    b. Charger
32. Confirm functionality of E-STOP Neg Contactor Control Interrupt button, if equipped
33. Confirm functionality of low level PDU outputs
    a. Shift Solenoid
    b. HV Present Lamps
    c. Headlamps
    d. Power Window Supply
    e. Park/Tail Lamps
    f. Reverse Lamps
    g. Brake Lamps
    h. Accessory LED
34. Confirm functionality of low level VCU inputs, if equipped
    a. Wheelie Bar Pressure

   b. Brake Pressure
   c. Trans Pressure
   d. Trans Temperature
35. Load dash layouts in CD5 and CD7 dashes
36. If all above checks out, proceed to START