Proprietary

DMOC445 Manual & Operating Instructions

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APPROVALS:

Rev XX

Project Engineer _____

Date XX-XX-XXXX

Date _____

Customer Service_____

Date _____

Table of Contents

1. Foreword

The information provided in this manual is intended for use by persons with appropriate technical skills. Any effort to perform repairs to, or service your unit without the proper tools or knowledge required for the work can result personal injury and product damage.

How to Report Errors

If, while reading through this manual, you discover an error in the technical information provided, Azure Dynamics asks that you notify its Customer Service Department at the phone number provided. Please be prepared to provide the following information:

Your name

Name and edition of your manual

Page number(s) where the error(s) appear

Serial number of your unit

Please feel free to call with any suggestions that you may have regarding the content of your manual. If additional service information is needed or to order replacement parts, please call Monday-Friday 8AM to 5:30PM USA Eastern Time:

Phone: 781-932-9009

Or Fax: 781-932-9219

Information contained in this manual is based on the latest product information available at the time of publication. The right is reserved to make changes at any time without notice

2. Safety

For your safety and the safety of others, please read and understand this entire manual before installing. If you have any questions regarding the contents of this manual, please call the Azure Dynamics Customer Service Department before proceeding.

1. Warning Labels

Labels will be located on the right–hand side of the page to indicate areas in a procedure where you should be taking appropriate precautions. Labels include:

WARNING and **DANGER**

RISK OF ELECTRIC SHOCK

2.

3. Safety Symbols

Always use caution when working on or around any electrical equipment. Wear eye protection at all times. The following symbols will be located in the right-hand margin of your manual to indicate sections in a procedure where extra caution and/or safety equipment is required.

Hearing Protection Required

Eye Protection Required

Always follow any safety instructions that are given at the beginning of a procedure. If you are uncertain as to the safe and proper handling of your equipment, contact the Azure Dynamics Customer Service Department.

3. Overview

The Azure Dynamics Digital Motor Controller (DMOC) is a rugged traction inverter for controlling 3-phase AC motors and generators. A flexible control-software architecture allows for application-specific customization by loading software application modules. These application modules communicate with the motor-control core and implement the interface to the higher level controls or directly to the driver inputs and outputs. The application module can be as simple as a CAN communication layer or as complex as to provide a complete electric vehicle control. The DMOC is based on state-of-the-art control techniques and electronic devices, and offers several layers of protections to prevent safety critical conditions.

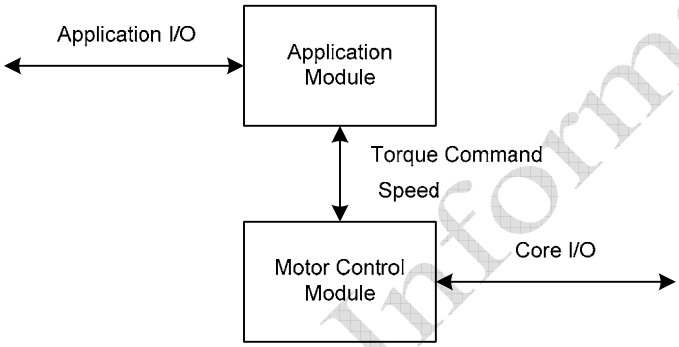


Figure with application module and control core

Typical applications for the DMOC include the following:

- Traction drive for EVs, HEVs, and FCEVs
- Generator controller for Hybrid APUs
- Generator controller for Distributed Generation
- 3-phase motor controller for industrial applications

Note that this document only addresses the generic DMOC features. Application specific details can be found in the following manuals which are revised and distributed separately:

- CAN Controlled DMOC
- Pedal Controlled DMOC

The DMOC is designed to operate in a system as illustrated in the figure below.

On the DC-side, it is connected to an energy storage system (ESS) such as a battery pack or super capacitor bank. In general, the ESS needs to be able to sink and source power. The DMOC can be used with sources that can only source power, such as fuel-

cells, but special protections are needed in such cases in order to ensure the safety of the DMOC and ESS.

On the AC-side, the DMOC connects to a Azure Dynamics supported three-phase motor, such as an AC Induction Motor or Permanent Magnet Motor. Specific instructions on how to safely install the DMOC and make the necessary electrical connections are given in this document. Since the DMOC is part of a high-voltage system it is extremely important the directions of the document are followed and that only personnel trained to work with high voltage install and maintain this product.

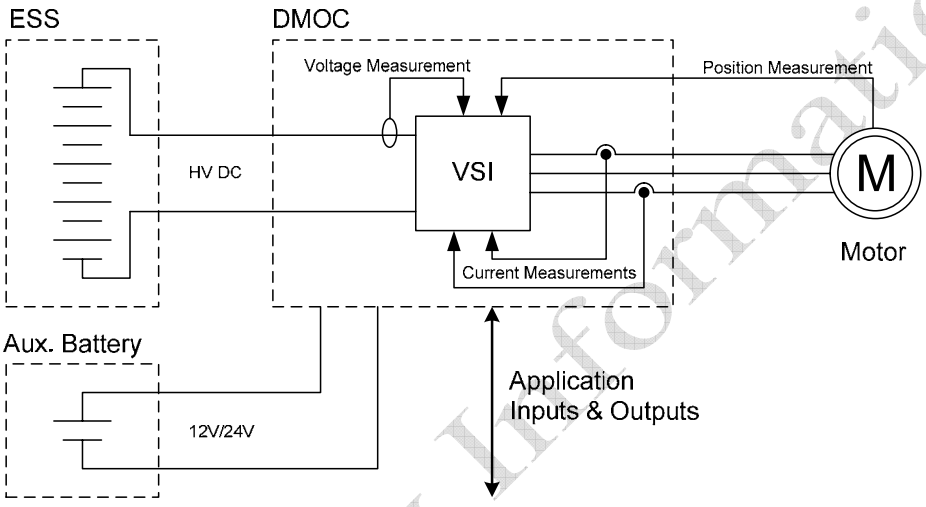


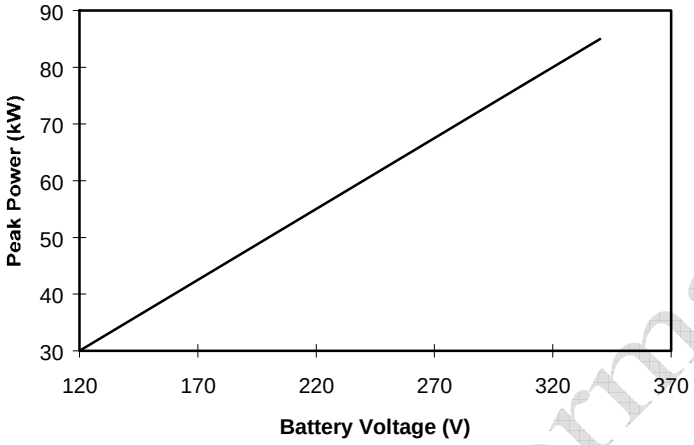
Figure with typical DMOC connections

Azure's PC based diagnostics/calibration tool ccShell allows to access and modify DMOC calibrations and to visualize and capture signals in real-time. While the meaning of the most important calibrations and signals of the DMOC core is described in this document, the reader is referred to the ccShell manual for information on how to install and use this tool.

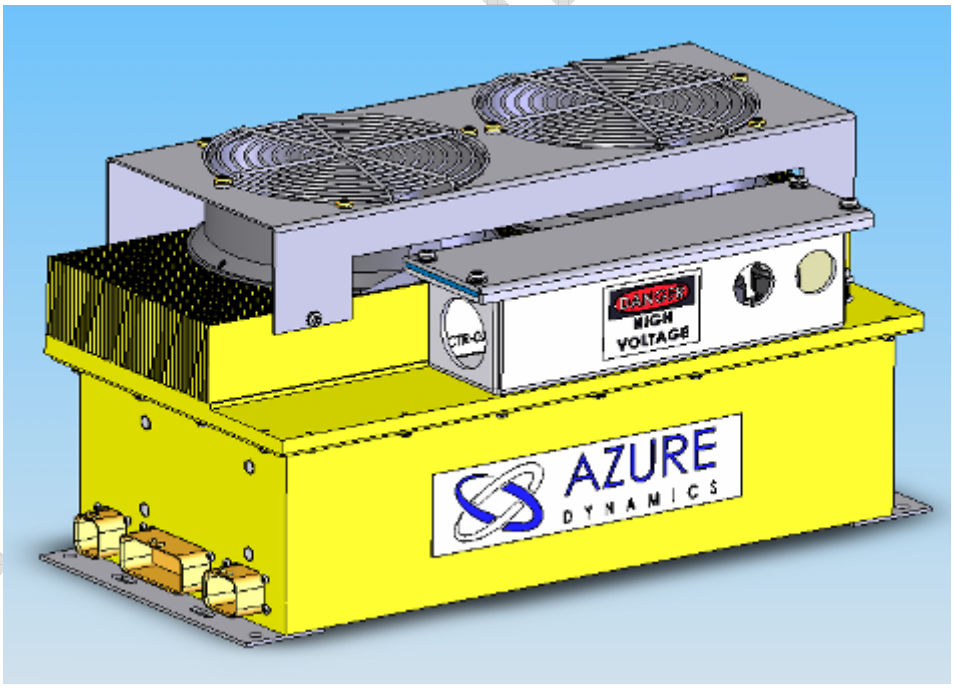
4. Specification

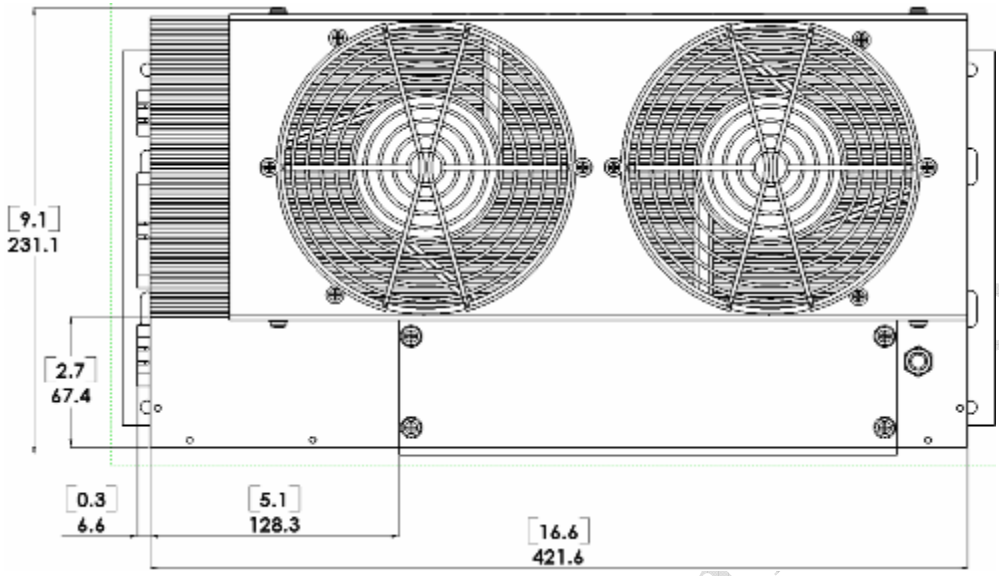
Dimensions	450.1mm x 237.3mm x 231.1mm (mating plugs not connected)	
Weight	14.7kg	
Min. Nominal Battery Voltage	120VDC	
Max. Nominal Battery Voltage	312VDC	
Min. Operational Voltage	100VDC	
Max. Operational Voltage	400VDC	
Unit Peak Efficiency	97%	
Min. /Max. Operating Ambient Temperature	-40°C to 75°C	
Max. Motor Current	280A rms	
Peak Power	78kW @ 312V	
Continuous Power	38kW @ 312V	
Max. Voltage "On Charge"	450VDC	
Minimal Auxiliary Supply Input Voltage	11 VDC	12 VDC
Maximal Auxiliary Supply Input Voltage	15 VDC	30 VDC

Battery Voltage vs. Peak Power
DMOC445

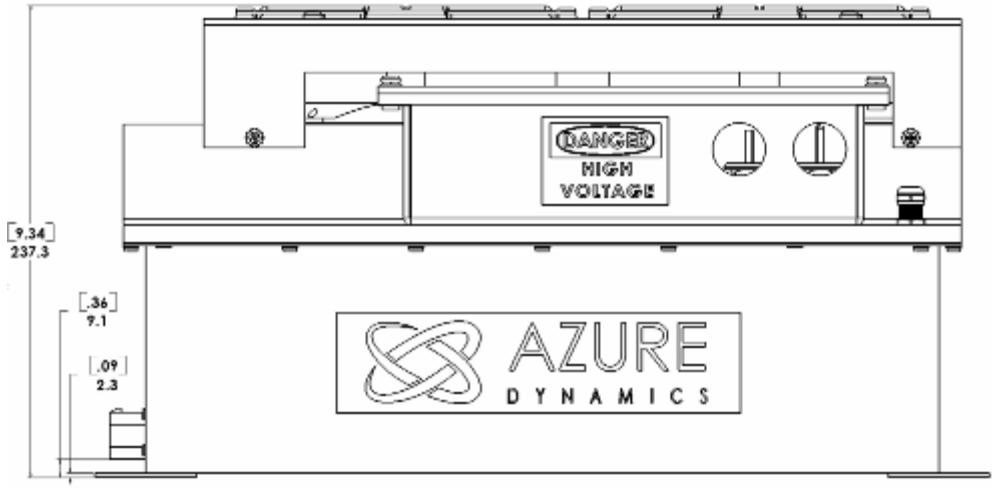


5. Dimensions

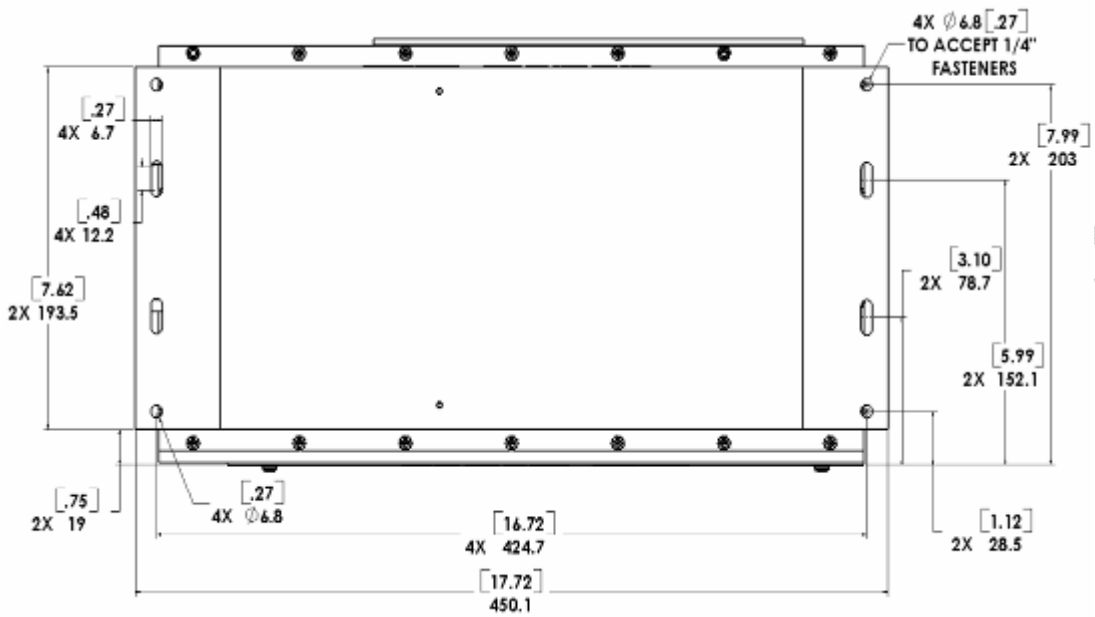




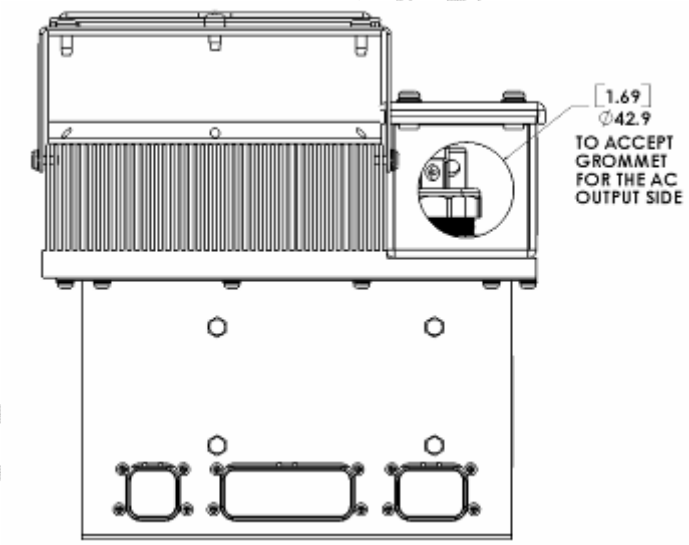
1. FIGURE



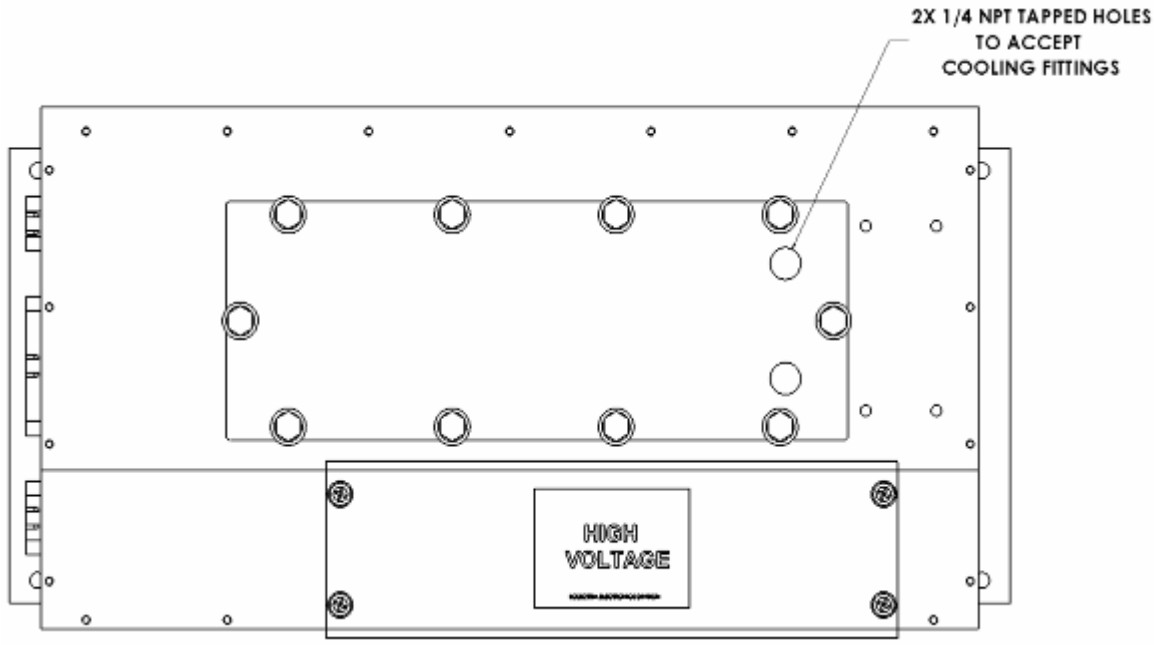
2. FIGURE



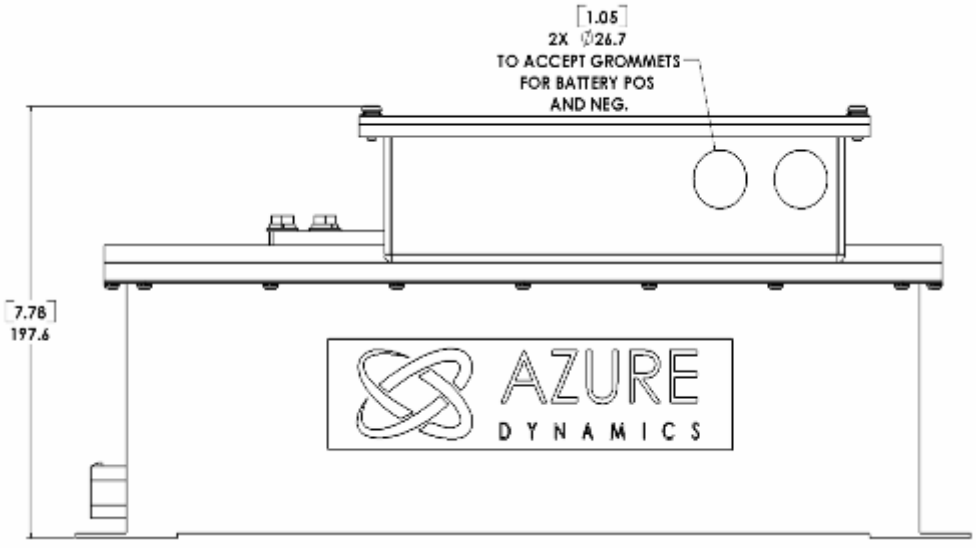
3. FIGURE



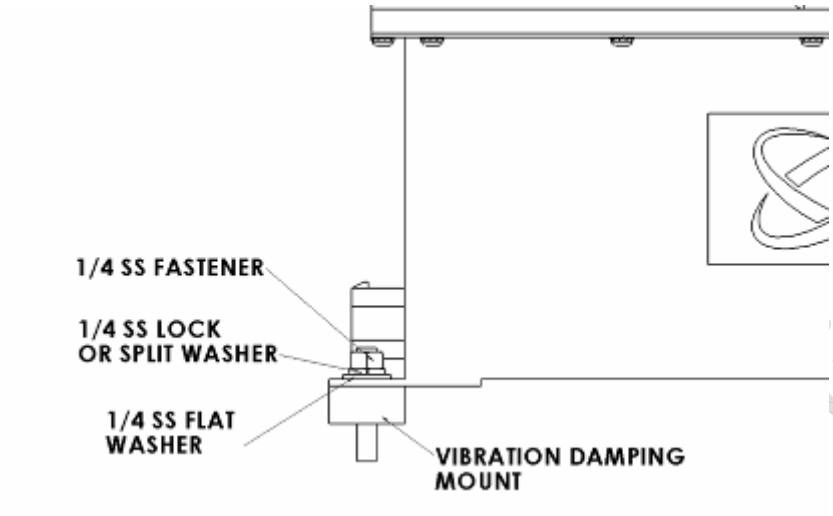
4. FIGURE



5. FIGURE



6. FIGURE



7. FIGURE

6. General Information

1. Mechanical

The DMOC has a light-weight aluminum package which is **rated IP 54.** The component cover and heatsink base are gold Iridited per MIL-C_5541-E-Class 1a for corrosion protection. When installing the DMOC into a system, avoid locations in which the DMOC is frequently exposed to water. Also, the DMOC is not designed to withstand pressure-washing and needs to be protected accordingly.

In order to isolate the DMOC from vehicle vibrations and shock, it is very important that the controller be vibration damping mounted. Please refer to the "Installation" section in this document for further information.

Two DMOC versions exist: air-cooled and liquid cooled. For the air-cooled version, the cooling fans are automatically turned on by the DMOC thermal management system. The liquid cooled version required cooling mixture of water (43%) and ethylene glycol (57%) by volume.

- Maximum and minimum cooling pressure to apply at the inlet side is 12-10 psig,
- Maximum and minimum cooling temperature at inlet is +55C and +40C.
- Normal cooling flow rate is 7.5 to 10 LPM @ 1.4 and 2.5 psi, respectively.
- The cooling chamber cover plate has been tapped to accept 1/4NPT fittings (see figure 5).

Electrical

Shock Hazard:

Extreme caution should be used whenever working on or near the high voltage system.

2. High-Voltage Connections

All high-voltage connections are made in the terminal box which is attached to the heatsink of the DMOC. It is imperative that appropriate safety steps are taken when connecting or disconnecting high-voltage cables. This manual provides some recommended safety practices, but they are not meant to be comprehensive and it is important that only people with up to date high-voltage training install or uninstall the DMOC. All high-voltage connections have to be assumed to be "hot" at all times, independent of the state of the DMOC or signals reported by the DMOC.

For correct operation of the traction drive, the AC connections to the motor need to be appropriately shielded and the connection to the terminal box must be made according to the instructions in this document. Since the DMOC is only intended to be used with Azure motors, the motor wiring will be "dressed-up" appropriately for connecting with the DMOC. Do not shorten or lengthen the motor cables without duplicating the original connection and shielding configuration.

The DC connection may be non-shielded. Only 4 AWG 600 V rated cables are to be used, which need to be properly fused as close as possible to the energy storage system (ESS). Note that the DMOC does not provide any internal fusing on the high-voltage connections. It is also very important that ESS be galvanically isolated (i.e. no direct electrical connection) from the chassis of the vehicle as well as from the low voltage system of the vehicle.

Some versions of the DMOC do not provide an internal contactor with pre-charge function. These units are clearly marked as such and require an external pre-charge mechanism (typically provided by the ESS). If a DMOC is connected without correct pre-charge, the unit can be damaged.

For additional safety as well as for controlling EMI, the DMOC needs to be grounded to the frame of the vehicle by means of a braided ground strap (preferably one that is short and wide in dimension).

3. Low Voltage Power Connections

The DMOC requires a 12 V or 24 V auxiliary supply in order to power its internal circuits as well as the main contactor (if present) and the cooling fans (in case of an air-cooled heatsink). Air-cooled inverters need to be configured specifically for one nominal voltage. Units without fans can operate from either voltage.

The 12/24 V auxiliary supply needs to be able to source 10/5 A of current and must protected by a 15/7 A fuse. The auxiliary supply also acts as an enable signal for the internal power supply of the DMOC. In other words, even a DMOC without contactor or cooling fan requires 12/24 V to be present in order to operate.

4. Signal Connections

Three connectors located on the side of the DMOC cover near the mounting holes provide all signal connections. Please select mating connectors from the table below. AMPSEAL connector contacts will accept 20 to 16 AWG wire with insulation diameter of 1.7 – 2.7 mm. Use CERTI-CRIMP Straight Action Hand Tool, AMP P/N: 58440-1.

Table 2. AMPSEAL Automotive Plugs.

No. of positions	AMP Brand	AMP Connector P/N	AMP Terminal P/N
8	AMPSEAL	776286-1	770854-3
35	AMPSEAL	776164-1	770854-3
14	AMPSEAL	776273-1	770854-3

The smallest connector has eight pins and provides the signals for CAN communications as well as RS-232. A second connector with 14 pins is used for connecting the motor speed-sensor cable. The third and largest connector has 35 pins and carries general digital and analog IO pins as well as the inputs for the auxiliary 12/24V power supply. Application specific connections to the 35-pin connector are described in the applications user manuals.

Important: None of the GND_D and GND_A pins should be connected to vehicle chassis.

Note: Not all signals/functions are necessarily implemented. Please refer to the application specific manuals to find out what is supported by the software of your DMOC.

Table 3. Typical Signal Connector Pin-out.

Pin #	Signal:	Function:
J6: Primary Control Interface Connector, 35-pin Amp seal		
1	KEYED_12V_SRC	Keyed-12V and relay power
2	SOC_BUF	12V open-collector gauge drive
3	ACCEL_PEDAL	Accelerator pot signal
4	BRAKE_LO	Brake pedal pot low
5	GND_A	Top Board Gnd
6	PEDAL_LO	Accelerator pot low
7	REGEN_DISABLE-	Regen brake disable (active low)
8	DRIVE_DISABLE-	Interlock (active low)
9	NONISO_ADIO2	Analog/digital I/O
10	AHC_DATA_-	Amp-hour counter input (active low)
11	ANAIN3/LED_OVERTEMP	Analog input or LED
12	BACKUP_LT_SINK/LED_EMPTY	Isolated MOSFET collector or LED
13	KEYED_12V_SINK	Keyed-12V and relay power
14	BRAKE_LT_SRC	Isolated MOSFET drain
15	POWER_SAVER	Power saver potentiometer
16	GND_A	Top Board Gnd
17	ANAIN1	Analog input 0-5V
18	REVERSE-	Reverse direction (active low)
19	GND_D	Top Board Gnd
20	GND_D	Top Board Gnd
21	GND_A	Top Board Gnd
22	AHC_GND	Amp-hour counter return
23	BACKUP_LT_SRC/LED_FULL	Isolated MOSFET collector or LED
24	BRAKE_LT_SINK	Isolated MOSFET collector (source)
25	SPEEDO_BUF	12V open-emitter gauge drive
26	BRAKE_PEDAL	Brake pedal pot signal
27	ANAIN0	Analog input 0-5V

28	PEDAL_HI	Accelerator pot high
29	FORWARD-	Forward direction (active low)
30	DRIVE_ENABLE-	Interlock (active low)
31	NONISO_ADIO1	Analog/digital I/O
32	AHC_DATA_+	Amp-hour counter input
33	AHC_NEG	Amp-hour counter input
34	ANAIN2/LED_MALFN	Analog input or LED
35	GND_D	Top Board Gnd

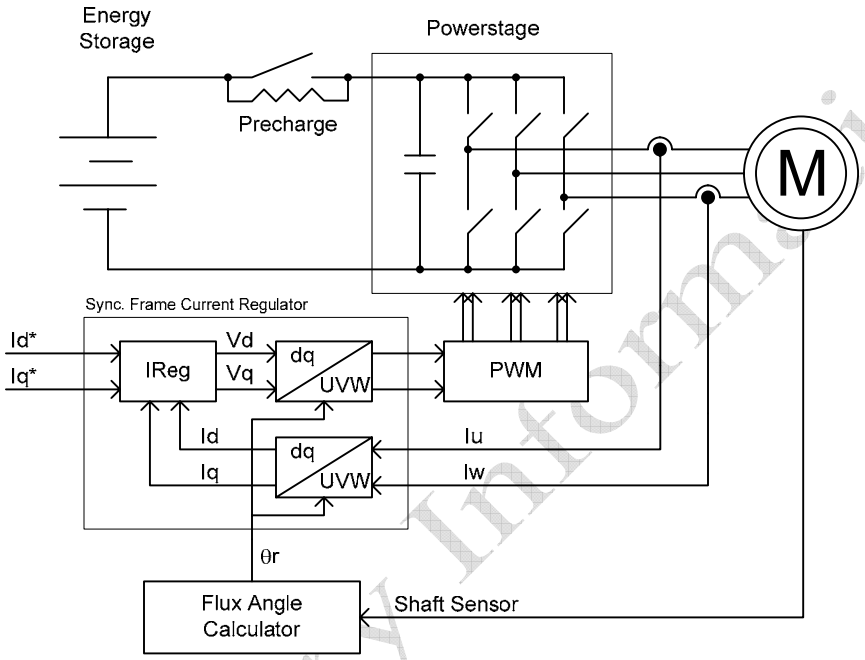
J4: Motor Signal Connector (14-pin Amp seal)		
1	ENC_A1	Motor position encoder input
2	ENC_A2	Motor position encoder input
3	ENC_B1	Motor position encoder input
4	ENC_B2	Motor position encoder input
5	GND_D	Top Board Gnd
6	ENC_I1	Motor position encoder input
7	ENC_I2	Motor position encoder input
8	FUSED_+5V	Fused digital +5V
9	MTR_TEMP	Motor temp input
10	GND_A	Top Board Gnd
11	+5Ref	Analog 5V reference
12	GND_D	Top Board Gnd
13	NONISO_DI1	Digital Input
14	NONISO_DO1	Digital Output

J5: Communications Connector (8-pin Amp seal)		
1	RS232_TXD	RS232 Tx
2	RS232_RXD	RS232 Rx
3	GND_B	Comm. GND (RS232 & CAN)
4	CANH	CAN High
5	GND_B	Comm. GND
6	CANL	CAN Low
7	GND_B	Comm. GND
8	Chassis GND	Chassis GND

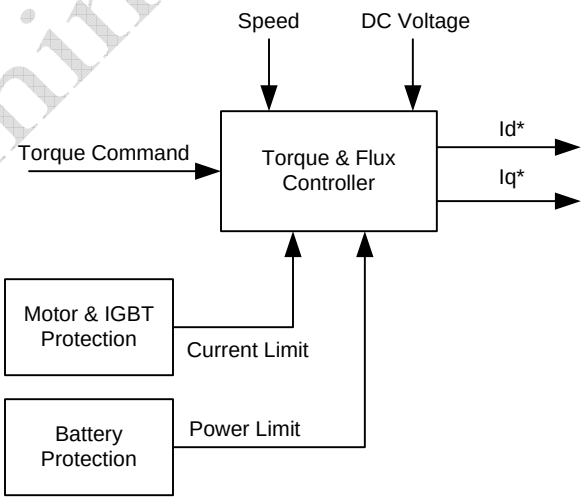
7. Modes of Operation

1. Motor Control

At its core, the DMOC is a voltage source inverter (VSI) with high-bandwidth synchronous frame current regulation.



Synchronous Frame Current Regulator



Torque Controller with Protections

2. Variables and Calibration

DMOC diagnostics and configuration is achieved by means of Azure's diagnostics tool called ccShell, which allows access to a number of variables (signals) and parameters (a.k.a. calibrations). Variables are read-only while parameters can be modified (depending on the access rights) in order to configure the DMOC. Parameter changes can be made persistent by saving them to non-volatile memory (EEPROM). There also exists a special category of non-volatile parameters which are saved to EEPROM and maintain their values when the unit is powered down. Non volatile parameters and variables can be identified by their prefix. The following naming convention is used:

- EE1, EE2, EEX: parameters
- EE3: non-volatile variables

3. Error Codes

The DMOC stores error conditions in non-volatile variables and maintains an error history by means of five variables:

- **EE3LastError**: Most recent error
- **EE3LastError1** – **EE3LastError3**: Error history, where Error3 is the oldest error.
- **EE3ErrorCounter**: Total number of errors

Only the four (4) most recent errors are retained.

Error codes are stored in a 16-bit representation where each bit is a signal for a specific error.

- Bit 0: Over-current phase A (hardware protection)
- Bit 1: Over-current phase B (hardware protection)
- Bit 2: Over-current phase C (hardware protection)
- Bit 3: Over-voltage on DC link (hardware protection)
- Bit 4: Relay error (hardware protection)
- Bits 5-6: Reserved
- Bit 7: Desat Error
- Bit 8: Relay error (software protection)
- Bit 9: Phase over-current (software protection)
- Bit 10: Over-voltage DC link (software protection)
- Bit 11: Current sensor offset calibration error (software protection)
- Bit 12: Over-speed protection (software protection)
- Bits 13-15: Reserved

Most errors can be reset by the application software. However, a small subset of errors is considered critical and can not be cleared without completely powering down the controller. Errors falling into the critical category are: desat-error and current sensor calibration error.

4. Status Code

The status of the DMOC is displayed by the variable ISR2StatusCode. Similar to the error code, the information is coded in a bit-wise fashion:

Bit 0: 0= contactor open, 1=contactor closed

Bit 1: 0=power stage not ready, 1=power stage ready

Bit 2: 0=power stage OK, 1=power stage faulted

Bit 3: 0=more torque available, 1=max torque limit reached

Bit 4: 0=more power available, 1=max power limit reached

Bit 5: 0=no thermal limit active, 1=thermal limit active

Bits 6-7: reserved

5. Finite State Machines (FSM)

Most of the DMOC modes of operation are handled by finite state machines (FSM). The states of the individual FSM are represented by variables which can be viewed using ccShell. FSMs exist both at the core level and the application level. Please refer to the application specific documentation for information regarding the application FSM. At the core level, two FSMs are the most noteworthy: the Relay FSM and the Power stage FSM.

The Relay FSM handles the pre-charge of the DMOC (if present).

FSM Variable:	ISR2RelayState	
State	**Name**	Description
0	RELAY_OFF	Relay open
1	RELAY_CLOSING	Relay closing and debouncing
2	RELAY_ON	Relay is closed
3	RELAY_FAULT	Low 12/24V supply or mechanical problem

The Power stage FSM handles the enabling and disabling of the power switches (IGBTs). During regular operation the power stage state should be either disabled or enabled.

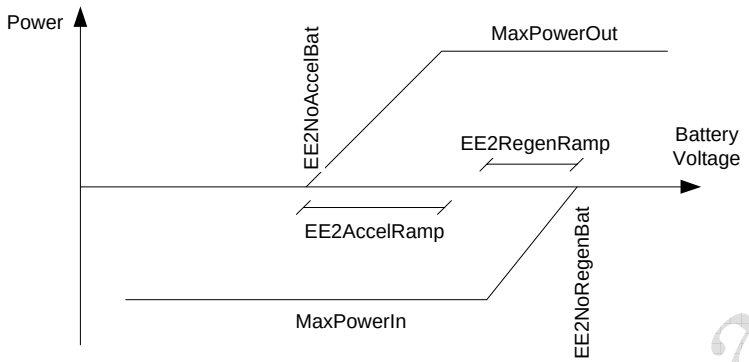
FSM Variable:	ISR2PowerStageState	
State	**Name**	**Description**
0	POWER_STAGE_POWERUP	Power stage is off
1	POWER_STAGE_DISABLED	Power stage is disabled, but ready to operate
2	POWER_STAGE_ENABLED	Power stage is enabled and IGBTs are switching
3	POWER_STAGE_FAULT	Power stage faulted and will stay in this state until fault is acknowledged by system controller
4	POWER_STAGE_FAULT_ACKN	Temporary state after fault has been acknowledged
5	POWER_STAGE_CRITICAL_FAULT	Power stage is in critical fault state (which can not be cleared by software)

6. Principal Variables

The most frequently used DMOC diagnostics variables are displayed below.

Name	Description
ISR2BatVoltage	Battery voltage reading
ISR2CANComState	Reflects state of CAN bus Finite State Machine
ISR2DeviceConnectState	Reflects state of CAN connection Finite State Machine
ISR2DeviceLimit	Limiting due to heatsink temperature and motor speed (100% = no limit)
ISR2HeatsinkTemp	Heatsink temperature
ISR2Hertz	Motor speed
ISR2HertzDesired	Speed set-value to regulator
ISR2IdF	Direct current
ISR2IdSet	Set-point for direct torque
ISR2IqF	Quadrature current
ISR2IqSet	Set-point for quadrature torque
ISR2MotorLimit	Limiting due to motor temperature (100% = no limit)
ISR2MotorPTCVoltage	Motor temperature sensor output (non-linear PTC reading)
ISR2PowerInLimit	Power limiting due to battery over voltage (100% = no limit)
ISR2PowerOutLimit	Power limiting due to battery under voltage (100% = no limit)
ISR2PowerStageState	State of power stage FSM
ISR2PSPowerupReqCtr	If different from zero, the power stage FSM is forced to state ‘power up’
ISR2RealTorque	Actual torque command to current regulator
ISR2RelayState	State of relay FSM
ISR2SpeedLimit	Torque limiting based on speed (100% = no limit)
ISR2SpeedRegTorqueDesired	Output from speed regulator (before limits)
ISR2TorqueDesired	Torque desired by speed regulator (after all limits)

7. Main Parameters



Name	Description
EE1EncoderDirection	Sequence of phase wires
EE1LoggingRate	Controls the ccShell Logger tool
EE1SpeedoDiv	Speedometer calibration
EE1UsDCScale	Calibration factor for voltage reading
EE2AccelBatRamp	Under voltage ramp
EE2FanOffTemp	Temperature below which the fans turn off
EE2FanOnTemp	Temperature above which the fans turn on
EE2IsMax	Maximal motor phase current (Amps peak)
EE2NegOverspeed	Maximal negative motor speed
EE2NoAccelBat	Minimal battery voltage (zero power is provided below)
EE2NoRegenBat	Maximal battery voltage (zero power is provided above)
EE2PosOverspeed	Maximal positive motor speed
EE2RegenBatRamp	Over voltage ramp
EE2ShaftDirection	Direction of positive speed (CW, CCW)

8. Installation Requirements

1. Mounting

The DMOC is recommended for mounting with cooling fans face-up on a flat rigid surface and located in a compartment that provides easy access for servicing and replacement.

The DMOC should be kept dry at all times, however, it is understood that some water splash to the underside of a vehicle is unavoidable. The DMOC is factory sealed to withstand small amounts of moisture.

- Avoid locations where the DMOC will be routinely exposed to water.
- Do not wash the DMOC with a pressure sprayer. Large amounts of water will cause a malfunction.
- If you have reason to believe water has entered the DMOC, do not open the case. Disconnect the DMOC and return it for service as soon as possible.
- When not in use, keep the protective plastic cap over the unit's serial data port or connector.
- Vibration damping mount should have ¼ inch nominal diameter threaded stud on each end of the mount. A minimum of four (4) mounts are required to secure the DMOC on a stationary surface.
- Position vibration damping mounts, DMOC, washers and fasteners as depicted on figure 7.
- Torque all ¼ inch fasteners on the vibration damping mounts to 10-11 ft-lb.
- If non-factory supplied vibration damping mounts are used, please consult with the new vibration damping mount manufacturer for the proper fastener torque.
- All power wires, cables and cooling hoses should be strain relieved thru the use of cable or hose clamps that are attached to solid surface.
- 42.9mm [1.69 inched] diameter thru hole is provided to accept grommet or similar cable retention device for the AC wires (see figure 4). Grommet should meet IP57.
- 26.7mm [1.05 inched] diameter thru hole is provided to accept grommet or similar cable retention device for the battery positive and negative wires (see figure 6). Grommet should meet IP57.

DMOCs with extensive water damage may not be repairable. DMOCs returned to Azure Dynamics with the factory seal broken will be ineligible for warranty service

All electronic systems must be isolated from vehicle vibration. This is done through the use of vibration mounts.

All DMOCs are shipped from the factory with vibration mounts in the accessory kit. Attaching the DMOC directly onto the solid surface or rigid vehicle frame without vibration damping mounts is not recommended. This method of mounting of the DMOC will greatly reduce the life expectance of the unit and void the unit warranty.

Vibration mounts must be operated in compression, with the weight of the DMOC on them. For improved vibration protection, or when the DMOC is not mounted face-up, heavy-duty mounts must be used. Heavy-duty mounts are available through Azure Dynamics.

2. Electrical Connections

Shock Hazard:

Extreme caution should be used whenever working on or near the high voltage system.

- To prevent the possibility of electric shock, switch off the DMOC completely before connecting or disconnecting any cables.
- Never pull on the wires or cables in the DMOC harness. The connectors can only be removed by lifting the retention clip with the small screwdriver and then pulling connector plug out of the receptacle.

Figure 1. Removing 8-Pin “Comm.” Connector.

3. Connecting the 14-pin, AMP, Motor Sensor

The 14-pin, AMP, Motor Sensor connection allows the DMOC to monitor the speed, direction and temperature of your motor.

Push the 14-pin, AMP, Motor Sensor Connector into the 14-pin connector port, located to the right of the 35-pin connector port.

4. Connecting the 35-Pin AMP, Vehicle Interface Cable

To connect the 35-Pin AMP, Vehicle Interface Cable to the DMOC, push the connector head into the 35-Pin connector port, located between the 8-Pin and 14-Pin connector ports.

5. Connecting the 8-pin AMP Connector, Communications

To connect the 8-pin, AMP, Communication (RS232/CAN) Connector to the DMOC, push the connector head into the 8-Pin connector port, located to the left of the 35-Pin connector port.

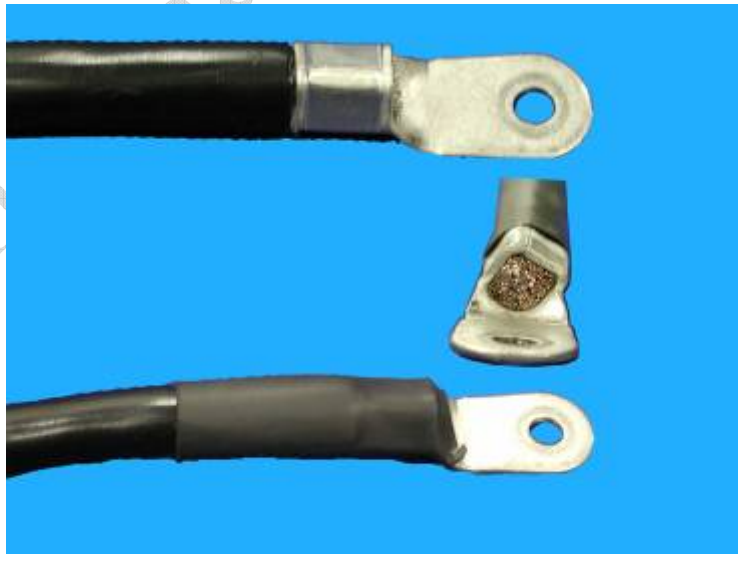
Figure 2. All three DMOC connectors in the position.

6. Connecting the Motor Cable

Shock Hazard:

Extreme caution should be used whenever working on or near the high voltage system.

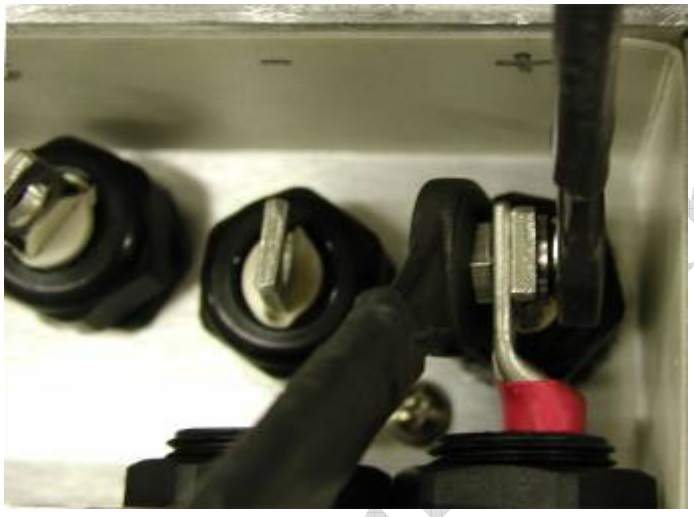
- Do not connect or disconnect while high-voltage is present



It is important that all cables be properly crimped.

Improper crimping can lead to failures and fires.

Use a Thomas & Betts TBM5 Crimper or equivalent.



Use two opposing wrenches so that you will not apply torque to the controller terminal.

It is important to use the correct tightening hardware and install it correctly.

Figure 3. Motor Terminals.

Figure 4. Fasteners, 1/4 X 5/8, Stainless

Above illustrations show a typical flat washer/lock washer/nut installation. It is important to ensure the locking washer is fully compressed and is adjacent to the nut. After the terminal is completely assembled, there should be a **minimum of two to three threads showing on the screw when the nut is properly tightened.**

The cable that connects the DMOC AC terminals to the electric motor should be shielded. This cable shield should be properly terminated using a 360 degree connection to the DMOC terminal box cable entrance fitting (See Figure 5 below). The rubber seal, which is a removable part of the entrance fitting, should be slid underneath the cable shield as shown in Fig. 5 and Fig 6. Next slide the shield with rubber seal (underneath) into the entrance fitting (see Fig 7). Ensure that the cable shield makes contact with the fitting around the entire inside wall of the fitting (i.e. a complete 360 degree connection). Trim off excess cable shielding such that no shielding extends into terminal box as shown in Fig 8. NOTE: EXCESS SHIELDING INSIDE TERMINAL BOX CAN CREATE A ELECTRIC SHOCK HAZARD. Finally, install the entrance fitting cap (nut, Fig 9) and tighten using a suitable wrench to ensure that adequate compression of the rubber seal is achieved. Make sure to put the black plastic flange washer

underneath the fitting cap. The flange washer (Fig.10) makes contact with the shield and rubber seal.

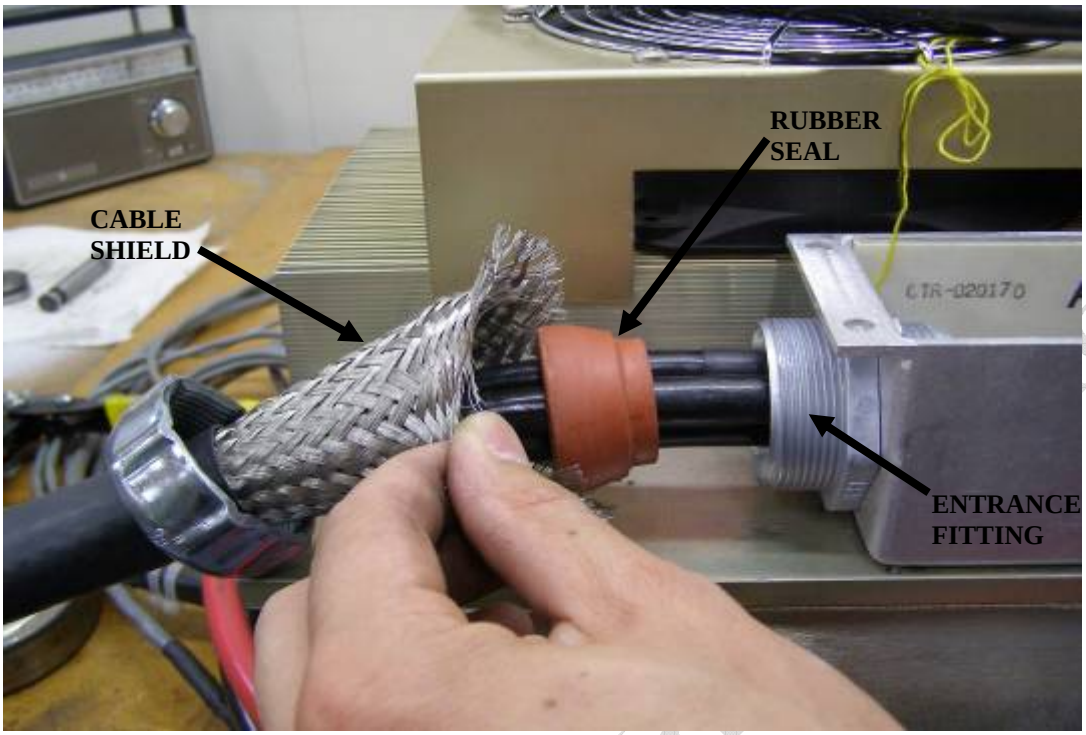


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Figure 5. Shielded AC motor cable connection at DMOC terminal box.

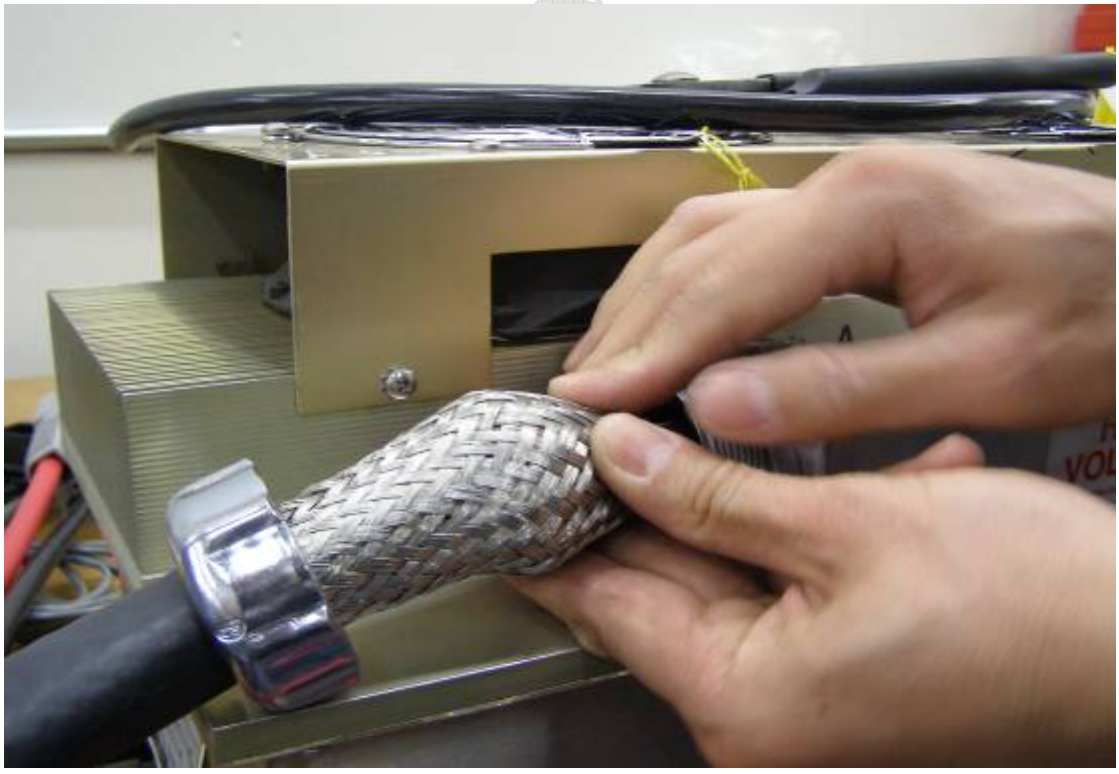

Figure 6. Shows fitting rubber seal slid underneath cable shield.

Figure 7. Shows AC motor cable inserted into entrance fitting with 360 degree connection of the cable shield to the inside wall of fitting.

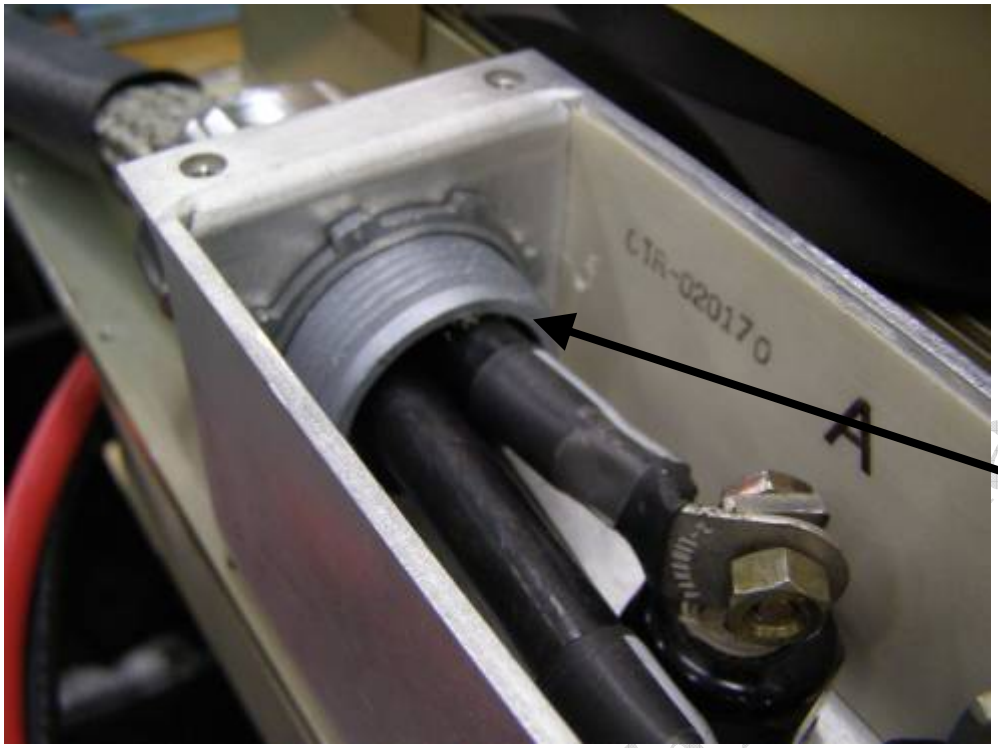

Figure 8. Trim off excess cable shielding inside terminal box. If excess cable shielding makes contact with DMOC AC terminals then a shock hazard will be created. Make sure that no shielding enters into terminal box.

Figure 9. Screw on entrance fitting cap (nut) with black plastic flange washer underneath cap.

Figure 10. Shows black plastic flange washer.

7. Connecting the High Voltage Battery Pack

Shock Hazard:

Extreme caution should be used whenever working on or near the high voltage system.

Follow the same general guidelines and precautions when connecting DMOC battery terminals.

Figure 6. High Voltage Battery Terminals

8. Water Ingress Prevention

After completing all high voltage connections junction box cover has to be reinstalled using proper gasket. Cable fittings for the HV battery cables and motor cable need to be tightened-up to ensure liquid tight seal between cable jackets and fitting grommets. Illustrations below demonstrate proper cable fitting installation.

Figure 7. HV Battery Cable Fittings.

Figure 8. Motor Cable Fitting.

9. Grounding and Shielding

One of the more important factors in the design and maintenance of vehicle electric traction system is proper shielding and grounding. Inadequate shielding or grounding can lead to unreliable operation of systems, such as EMI, electrostatic discharge damage to sensitive electronics and personnel shock hazard. Perform all grounding and shielding connections as shown on the following diagram.

Figure 9. DMOC Grounding and Shielding.

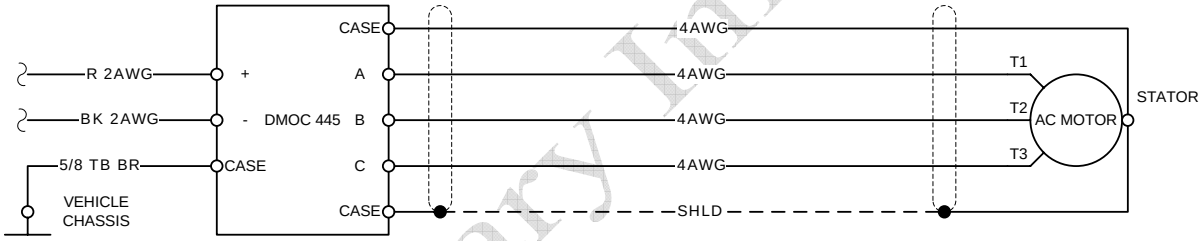

Figure 10. Example of the DMOC Grounding Strap Connection.