MD Series Operation Manual

Dana (Beijing) Electric Motor Co., Ltd.

Version: 3.0 Release date: 2019- 11

Warning

• This product must be installed and manipulated by qualified personnel who are fully aware of the types of hazards involved in working with electrical circuitry and are familiar with standard practices for preventing accidents. The vehicle integrator is responsible for ensuring that proper training is given to all those who use this system in order to avoid physical, electrical and operational hazards

1 Transport and storage conditions

DANA TM4 BEIJING products must be transported and stored in well-ventilated facilities with adequate protections against dust and excessive humidity. See Table 1 for details of recommended conditions.

While the products are in the original shipping crates, there are no precautions to take against electrostatic discharge (ESD); however, when unpacking and manipulating the products, you must avoid touching the connector pins.

Table 1 Recommended transport and storage conditions

Condition	Information	ISO standard
Max. ambient temperature	+85°C	ISO 16750-4
		(5.1.2.1)
Min. ambient temperature	-40°C	ISO 16750-4
		(5.1.1.1)
Max. relative humidity	85%	-
Condensation	Not permitted	-
Precipitation	Not permitted	-
Icing	Not permitted	-
Direct exposure to sunlight	Not permitted	-

2 Receiving and unpacking the motor

DANA TM4 BEIJING products are carefully inspected and tested before being packed at our facilities; however we recommend that you carry out a full visual inspection when unpacking as it is possible that the crate and contents might become damaged during the shipping process.

Read these general safety warnings before handling the products.

<u>(i</u>

Warning

Mishandling of this product may damage the product and/or cause injury or death.

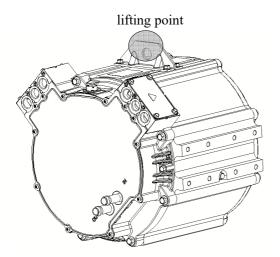
- All limitations and specifications communicated by DANA TM4 BEIJING regarding the product must be respected.
- Do not attempt to open, repair or modify the product. In case of damaged casing or suspected product malfunction, contact DANA TM4 BEIJING Customer Service.
- Use only recommended points to lift and secure the motor.
- If using chains or other lifting tools, ensure they do not touch or put pressure on any part of the product exterior (surface, connectors, and/or cables).
- Do not attach the motor to the MCU using a shared support or bracket.
- Do not apply any external load to the casing of the motor.

On opening the crate, perform a quick physical check of the contents:

- Inspect for damaged packaging materials.
- Verify that the motor has remained in place in the crate during shipping.
- Verify the contents of the crate against the list of delivered goods on the packing slip.

Refer to the following warning information before carefully lifting the motor out of the crate using the lifting bracket shown in Figure 1.

Figure 1 Lifting bracket on the motor



If the packaging and/or the product is damaged, take photographs of the damage, save all packaging materials and immediately notify the carrier as well as Customer Service at DANA TM4 BEIJING.



Mishandling of this product may damage the motor and/or cause injury or death.

- If using chains, or other lifting tools, ensure they do not touch or put pressure on any part of the product exterior (surface, connectors, and/or cables).
- To reduce risk of accident, ensure that the chains or straps are fully secured and the weight of the motor is evenly distributed before attempting to lift the motor.

3 Installing the motor and MCU in the vehicle

The final installation sequence should be defined by the integrator as it depends on the type of application. Ensure that everyone coming into contact with the product has received full training and has read all the safety warnings in this guide

3.1 Installing the motor in the vehicle

3.1.1 Planning to install the motor



Mishandling of this product may damage the product and/or cause injury or death.

When manipulating and/or installing this product, you must **NOT**:

- Attach the motor to the MCU using a shared support or bracket.
- Modify any part of the motor and/or MCU.
- Apply any external load to the casing of the motor and/or MCU.
- Install the motor in the vehicle in an inverted, up-ended or tilted position.

Before installing the motor, make sure:

The motor must not be attached to the MCU using the same support or bracket.

The motor must be decoupled from the MCU as the motor and the MCU were designed to resist to different vibration profiles. The MCU could be permanently damaged if exposed to the vibration profile of the motor.

It is the responsibility of the system integrator to design the motor support brackets and vibration damping mechanism in order to ensure that the vibration profile of the motor does not exceed the limitations referred to in the System Specifications.

The motor is a sealed unit requiring no physical customization before or after installation. You must not under any circumstances attempt to modify any part of this product as this could cause permanently damage it and cause injury to the user. This includes any modification that changes the state of the original product, such as:

- Drilling holes into the casing
- Adding and/or removing parts including hardware, screws, and connectors.

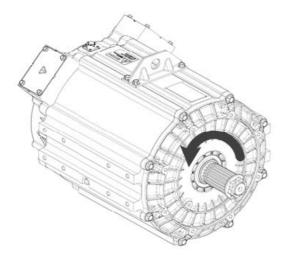
The motor casing was not designed to bear weight from external loads such as:

- Components sitting on top of the casing.
- Components suspended from the bottom of the casing.
- Components attached to the sides of the casing.

3.1.2 Default motor rotation direction

The default rotation direction of the motor is determined in relation to the front plate, see Figure 2:

Figure 2 Motor rotation seen from the front plate



Note: Depending on your integration scenario, you may want to reverse the default motor rotation

3.1.3 Securing the motor in the vehicle

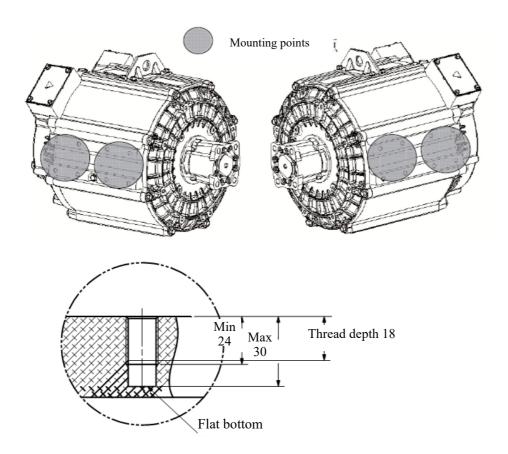
Ensure that when the motor is installed that there is nothing covering or touching the motor body and that air can circulate freely around the body of the motor

To properly install and secure the motor, it should be attached to the vehicle using all available mounting points, see Figure 3.

Table 2 Motor mounting holes specifications

Specifications	Unites	Values
Thread size	-	M12x1.75
Depth	mm	24
Torque	Nm	60
Class	-	10.9

Figure 3 Mounting points



When installing the motor in the vehicle, ensure that the position of the motor respects the limits shown in $\frac{1}{20}$ Figure 4: +/- 10 ° on the horizontal (roll) and +/- 20 ° in line with the shaft (pitch).

Figure 4 Recommended installation angles

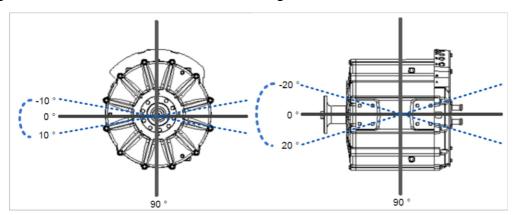
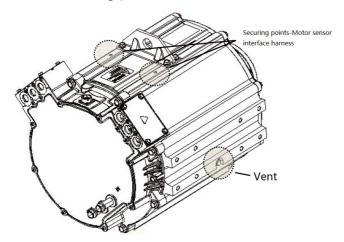


Figure 5 Securing points-Motor sensor interface harness and Vent



3.2 Installing the MCU in the vehicle

3.2.1 Respecting the physical integrity of the MCU

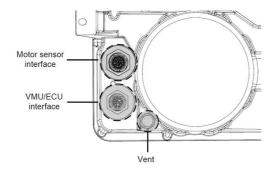
The MCU is a sealed unit requiring no physical customization before or after installation. You must not under any circumstances attempt to modify any part of the MCU as this could permanently damage the product and cause injury to the user. This includes any modification that changes the state of the original product, such as:

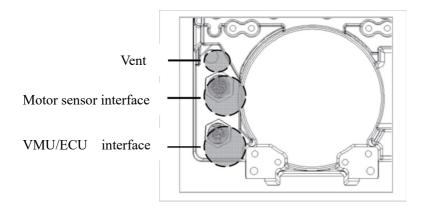
- Drilling holes into the casing.
- Adding and/or removing parts including hardware, screws, and connectors.
 In general, the MCU casing was not designed to bear weight from external loads such as:
- · Components sitting on top of the casing.
- Components suspended from the bottom of the casing.
- Components attached to the sides of the casing.

The MCU can be installed in a variety of positions, but we do not recommend that it is installed in an inverted (upside down) position as there is a risk of water accumulation that may cause product damage.

The vent see Figure 6

Figure 6 Position of vent on base of MCU casing 6-PHASE MCU:



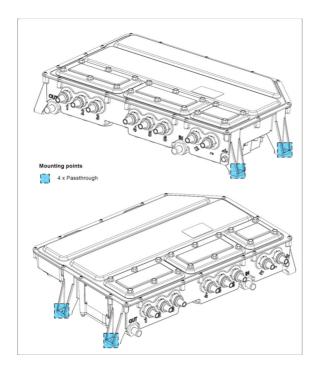


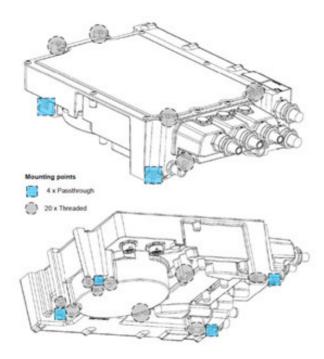
Mounting hole specification see Table 3. Four passthrough mounting points shown in Figure 7

Table 3 Mounting hole specification

	Unites	Values(3-PHASE	Values(6-PHASE
		MCU)	MCU)
Screw thread	-	M8×1.25	通孔
Depth	mm	20	8
Torque (without Vibration reduction)	Nm	20	20
Torque(with Vibration reduction)	Nm	10	10
Class	-	8.8	8.8

Figure 7 MCU Mounting points – External view of top and base of the MCU 6-PHASE MCU:





4 Installing the cooling system

As power is delivered to the wheels, temperatures of the various components within the motor and the MCU rise. Therefore, a cooling unit/radiator must be installed in the vehicle and connected to the MCU and the motor to dissipate the excess heat.

The recommended configuration is Parallel.

Note: DANA TM4 BEIJING does not provide any cooling equipment or accessories.

4.1 Requirement of cooling systeam

The cooling circuit must be rinsed with de-ionized water each time before filling. The ethylene glycol must contain some type of active corrosion inhibitors.

The ethylene glycol must respect the 'standard corresponding to its application (NB/SH/T 0521-2010).

The ethylene glycol must be diluted with de-ionized water (not distilled water).

The dilution ratio must be 60% ethylene glycol to 40% de-ionized water (minimally 50% ethylene glycol to 50% de-ionized water).

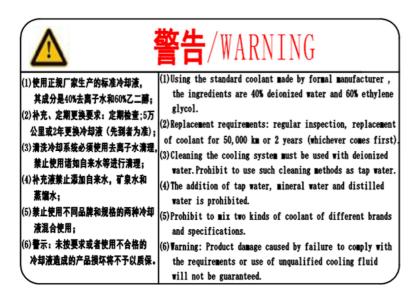
Two different types of coolant should not be mixed.

In order to meet DANA TM4 BEIJING specifications and to obtain maximum system performance, the cooling system should respect both the maximum coolant temperature and the minimum coolant flow rate as described ;above this temperature and/or with a below minimum flow rate, the system may degrade the duration of continuous performance and

peak performance in order to protect its internal components from overheating.

The OEM should add the warning label to the coolant filling port or the expansion tank at a prominent position. Also DANA TM4 BEIJING will add it on the surface of the MCU;

Figure 8 cooling warning label



4.2 Safety warnings related to handling the cooling agent



Regardless of the cooling system used, when in a system, the MCU can be irreparably damaged and may become unstable if the coolant liquid pressure reaches or exceeds a pressure of 30 PSI (static pressure measured at the entrance of the MCU – upstream of the MCU in the circuit).

Ensure that the pump is adjusted accordingly.

The cooling agent contains ethylene glycol that is a highly flammable product. Ethylene glycol can burn with an invisible flame that can cause serious burns and/or other injuries.

 Always handle the cooling agent carefully wearing appropriate safety clothing and eye-glasses.

The cooling agent can irritate the skin, the eyes and the mucous membranes.

- Always work in a well-ventilated area when handling the cooling agent; breathing
 in high concentrations of ethylene glycol can cause nausea.
- In case of contact with eyes and skin, rinse with water and consult a doctor.
- In case of ingestion, seek medical help immediately.

The cooling agent is under pressure when heated; removing the cap when the coolant is hot can cause serious burns and/or other injuries.

- Wait until the coolant reaches an ambient temperature before removing the cap. All potential dangers of handling cooling agents cannot be listed here.
- Consult manufacturer warnings and recommendations for safe handling of the cooling agent.

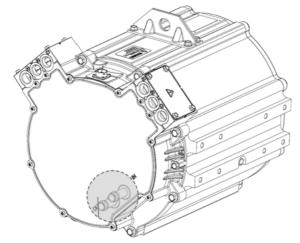
4.3 Installing the cooling system

The motor has clearly identified inlet and outlet fittings for coolant; see Figure 9.

Table 4 Hose size

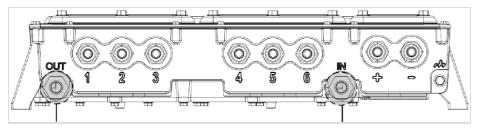
	Unites	values
Motor	inch	3/4
Drive	inch	3/4

Figure 9 Cooling inlet/outlet locations on the motor

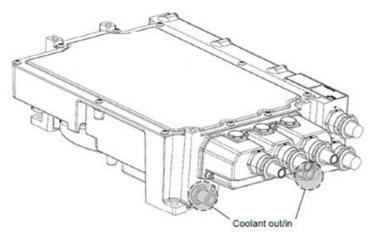


Coolant IN & OUT

6-PHASE MCU:



Coolant OUT Coolant IN



4.4 Coolant flow requirements

Table 5 Cooling flow controller (parallel)

Component	3-phase coolant flow	6-phase coolant flow
	rate (100%)	rate (100%)
System	1800L/h	2000L/h
Motor	1200L/h	1200L/h
MCU	600L/h	800L/h

Note: 1.The above table represents the coolant flow required when the coolant flow request is 100%.

2. The cooling inlet pressure of motor and motor controller shall not exceed 30PSI

 Table 6
 Cooling flow controller (series)

Component	3-phase coolant flow rate (100%)	6-phase coolant flow rate (100%)
System	1200L/h	1200L/h

Note: 1. For the series cooling system, the pump should be selected according to the Motor and MCU required by the high flow.

2.Motor and MCU cooling inlet pressure shall not exceed 30PSI.

5 Electrical installation

5.1 Safety instructions related to electrical installation

Carefully read all safety instructions before making any electrical connections in the system.



This product generates high-voltage that can cause an electric discharge or electrocution resulting in injury or death.

Before manipulating the product, verify that:

- The traction battery (high-voltage battery) is disconnected.
- The auxiliary battery (12 V/24 V battery) is disconnected.

Incorrect assembly or an incorrect electrical connection during assembly of this product can cause electrocution and/or fire.

 The assembly and connections must conform to the instructions included in this Technical Guide.

Care must be taken when manipulating electrical equipment.

 This product must be installed by qualified and authorized personnel in accordance with applicable vehicle standards and industry practices. Always use appropriate insulation and protection before manipulating the product even when the product is disconnected from a high-voltage source.

ESD sensitive – do not touch connector pins

• The internal electronics are sensitive to electrostatic discharges.

Risk of electric shock – do not open the MCU and/or motor.

 The electrical installation of the system does not require the MCU and/or the motor to be opened or disassembled.

Risk of electric shock – capacitor stores hazardous energy.

 Wait 10 minutes after disconnecting all sources of supply prior to removing cables and/or servicing.

The MCU uses common mode capacitors between the high-voltage DC bus and the chassis. Some apparatuses can cause dangerous frame current to pass through these capacitors if they are connected to a high-voltage DC bus.

 Always measure the voltage between the high-voltage DC bus and the chassis using appropriate protection and insulation before manipulating the product.

The MCU uses differential mode capacitors between the positive high-voltage DC bus (+) and the negative high-voltage DC bus (-).

Even when the product is disconnected from the high-voltage source, these capacitors can hold a voltage high enough to cause an electric discharge or death.

 Always measure the voltage between the positive high-voltage DC bus (+) and the negative high-voltage DC bus (-) using appropriate protection and insulation before manipulating the product.

5.2 Suggested installation sequence

The following steps summarize the electrical connection sequence of the motor:

- Connect the grounding strap
- 2. Connect the phase cables
- 3. Connect cooling system
- 4. Connect the motor sensor harness
- 5. Connect VMU signal cable
- 6. Connect the DC cables
- 7. Connect auxiliary battery

Note: For user safety, the grounding strap should always be installed first; reverse sequencing is performed when removing the system from the application (remove the grounding strap last)

5.2.1 Grounding the system

The system must be securely grounded to ensure user safety in case of an insulation fault in the motor and/or the MCU. An incorrectly grounded connection may result in motor/MCU functionality losses and safety risks for the user.

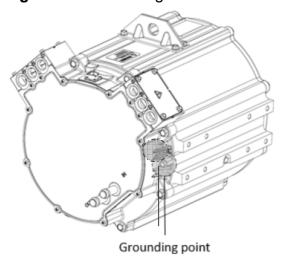
Table 7 Grounding – Strap size

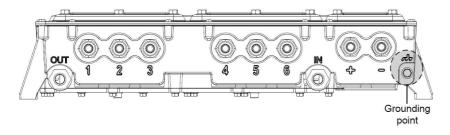
Specification	Unites	Values
Wire size(motor)	mm ²	50
Wire size(MCU)	mm ²	50

Note: To prevent oxidation of the aluminum surfaces and any malfunction of the connection during operation, we recommend that you sand the contact point on the motor and apply a layer of conductive grease on the grounding strap contact surfaces before connecting the strap.

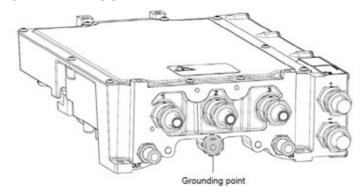
Grounding hole location see Figure 10.

Figure 10 Grounding hole location





3-PHASE MCU:



Bolt size grounding point see Table 8

 Table 8
 Thread and bolt size-Grounding point

	Unites	Motor	MCU
Thread size	-	M8 × 1.25	M8 × 1.25
Length of thread	mm	20	16
Tighten torque	Nm	20	20
Bolt	-	8.8	8.8

Note :To safely connect the grounding strap ,use a minimum screw thread engagement of 12.5mm/12mm in the ground hole on the motor/MCU and prepare the zinc coated bolt with loctitle 242 before insertion

5.2.2 Installing the phase cable harness

During installation and connection of the phase cables follow these recommendations:

Do not:

- Gather the cables in a large bundle.
- Force the cables beyond their recommended bending radius.
- Place the cables near sharp edges or on abrasive surfaces.

Ensure that:

- There is room for air to circulate around the cables.
- Cables are protected from being hit by gravel when installed in the vehicle.
- Cables do not cross and are secured in parallel using fasteners every 40 cm or less.
- Cables are secured no more than 30 cm from the exit of the MCU or motor cable glands

Note: Phase cables can be up to a length of 5 m.

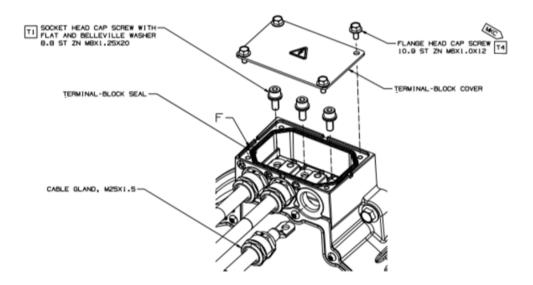
Phase cable installation mapping:

• Standard: Cables connected with logical/letter number sequence (A1-1; B1-2; etc.).

Figure 11 Lapp Group cable gland



Figure 12 Phase cable installation

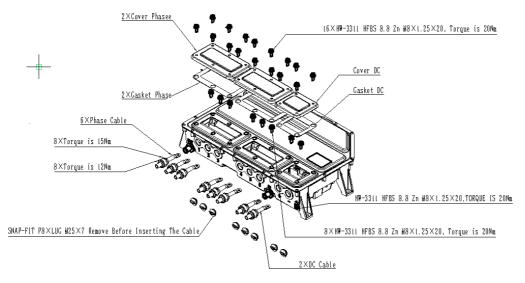


To install the phase cable

- 1. Open the terminal-block cover;
- 2. To install the fitting of cable gland;
- 3. Insert the cable and then align the hole on the lug with the screw hole inside the motor terminal box by pushing gently on the cable. Once aligned, the brass earthing sleeve of the cable gland will be in its final position.
- 4. Using a tool with a magnetized end, carefully insert the screw in the motor; torque the screw to 20 Nm.
- 5. Push the sealing cone portion of the cable gland until it is fully inserted inside the fitting portion of the gland. Then push the brass cone and compression screw portions of the cable gland towards the fitting and start turning the compression screw clockwise to catch the threads of the fitting.
- 6. Close the terminal-block cover, torque the screw to 9Nm

Figure 13 Installing phase cables

6-PHASE MCU:



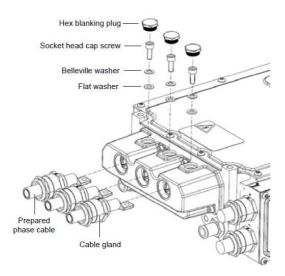


Table 9 Phase cable bending radius

Unites	Values	Bending radius
AWG (mm ²)	1(43)	8×D(110mm)
	1/0(50)	8×D(126mm)

5.2.3 Motor sensor interface harness

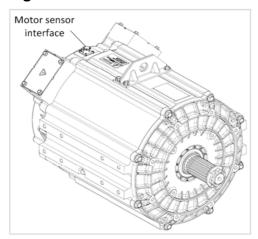
Motor sensor interface harness specification see Table 10

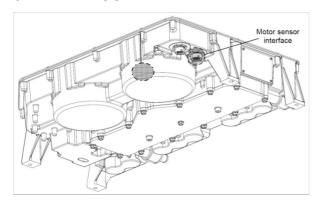
Table 10 Motor sensor interface harness specification

P/N	Bending radius
P80668 series	4×D(48mm)
P80676 series	4×D(48mm)
P80673 series	4×D(48mm)

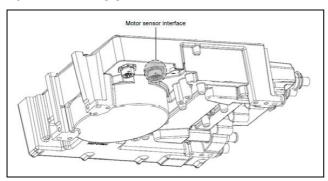
Motor sensor interface location see Figure 14.

Figure 14 Motor sensor interface location





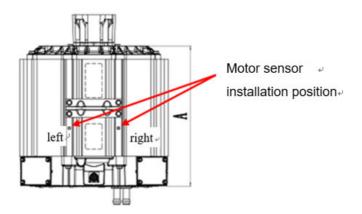
3-PHASE MCU:



Using the motor sensor harness delivered with your DANA TM4 BEIJING system, connect the cable to the MCU using its dedicated mating location. Turn the connector head until the pins are aligned with the pinholes on the motor sensor interface. Once aligned, continue to turn the connector head until you feel a click indicating that the head is locked in place.

Note: Before connecting or reconnecting the motor sensor interface harness connector, carry out a visual inspection to ensure that the pins on both connectors of the harness are undamaged. Then, in order to protect the electrical contacts against the surrounding environment, apply a contact lubricant (Electrolube ECG60800G or equivalent) to the connector heads.

Figure 15 Motor sensor installation position



Allow adequate space for manual manipulation of cable and connectors.

choose the left or right installation position installed the sensor harness

Do not plug or unplug the signal line in electric state;

Do not touch the pins inside the connector by hand when plugging or unplugging the signal line; Between the interface of the signal line at the MCU and the R type clamp at the Motor. When fixing the signal line, we should ensure that the spacing between the two fixed points isn't too large, which should be controlled at about 300mm. In the corner, it can be controlled according to the linear distance;

In order to prevent the signal wire connection from being damaged due to vibration, distortion, dead weight of cable and dead weight of other parts of the system, we should use bracket to support the signal wire;

It is forbidden to bundle the signal line with the high-voltage line (DC bus and phase cable, etc.), water pipe and low-voltage wire harness;

Do not contact with sharp edge objects or hot surface objects.

5.2.4 Connecting the VMU interface harness

VMU interface harness specification see Table 11

Table 11 VMU interface harness specification

Part	P/N	Quantity	Note
Plug	P770E0160	1	1
Contact	P770E0158	14	1、2、3
Cord grip	P770E0187	1	
Blind bolt (power supply)	P770E0163	8	1

Note:

1. Plugs and contacts supplied by DANA TM4 BEIJING at the time of purchase (Kit-0076).

- 2. Use the Amphenol-Sine Systems MFX-3954 crimp tool for this pin.
- 3. Contacts suitable for use with 22-20 AWG wire.

VMU/ECU interface harness – Plug pinout specifications see MCU technical guide

5.2.5 HVIL and EmergencyStop signals

When operating normally, the system draws power and recharges the high-voltage battery based on the torque request and limits the maximum charge/discharge currents as specified using the associated CAN protocol messages.

However, in case of hazardous behaviour or maintenance of the traction system, two hardware signals should be connected for safety purposes: HVIL and EmergencyStop.

Disclaimer: Note that if you choose not to implement this circuit, DANA TM4 BEIJING is not responsible for any effects of hazardous behaviour or system malfunction during maintenance or due to an emergency stop.

Figure 16 Suggested HVIL and EmergencyStop safety circuit

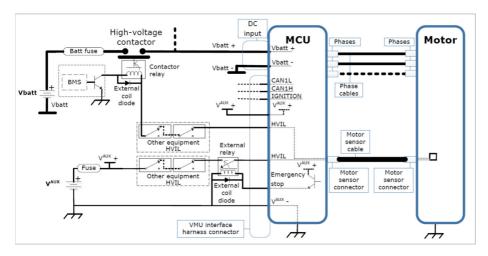


Table 12 HVIL and EmergencyStop – Absolute maximum rating

Specifications	Unites	Values
Imax – HVIL steady state	Α	2
EmergencyStop steady state	mA	250
EmergencyStop inrush current	Α	7

5.2.6 High-voltage battery

Carefully read all safety instructions before connecting the high-voltage battery.



- The high-voltage cables MUST be shielded.
- The external cables used for high voltage must be orange and shielded; the high voltage and level of current delivered by this product can be lethal.
- Failure to shield the high-voltage cables will result in non-compliance with EMI regulatory requirements.

The MCU requires a fuse on the HV DC bus. Proper fuse sizing is necessary to protect

against reverse polarity and short-circuit. DANA TM4 BEIJING recommends installing a fuse with the following characteristics:

Table 13 High-voltage battery – Recommended fuse sizing

Specifications	Units	Values
Fuse voltage rating	Vdc	650
Rated current	Adc	600
Fuse type	-	Fast-blow

The system requires a pre-charge circuit without which the system start-up sequence will fail and the MCU may be permanently damaged.

Table 14 High-voltage battery – Pre-charge circuit specifications

Specifications	Unites	Values
Precharge current limit	Adc	25

The high-voltage battery must be connected to the MCU using specific cable

table 15 High-voltage battery – Cable specifications

14	Unit	specifications		Notes
Items		6-phase products	3-phase products	Notes
Wire Size	AWG	1/0 (50)	1/0 (50)	1
	(mm ²)			
Bending	-	8 cable diameter	8 cable diameter	
radius				
Material	-	anti-pollution	anti-pollution	1、2
Voltage	V	Consistant with	Consistant with	
		HighpowerVoltage	HighpowerVoltage	
Rated	Α	340	300	3
current				
Rated temp	°C	150	150	4
Colour	-	Orange	Orange	
Shielding	-	Ture - mandatory	Ture - mandatory	5
		requirements	requirements	

Note:

- 1. The wire size or wire wall material can be adapted to fit required use.
- 2. Depending on the location of the wires, a wire tubing (orange split loom) can be used to prevent abrasion or other effects that could damage the wires.
- 3. Based on a temperature of 85 °C.
- 4. The colour orange is recommended for safety purposes when handling high voltage levels.
- 5. The external cables used for high-voltage must be orange and shielded.

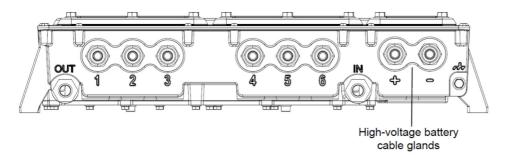
High-voltage battery cable gland specification see Table 16

 Table 16
 High-voltage battery cable gland specification

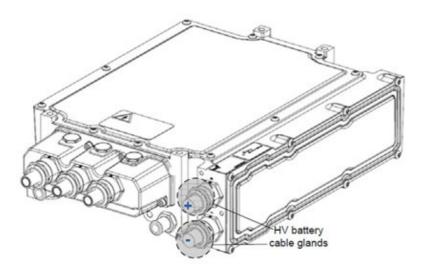
Part	P/N	Quality
Cable gland– M25x1.5	HSM-EMC-YJ-M25*1.5(13-18)	2
	HSM-EMC-YJ-M25*1.5(16-22)	
Lug HW-3300/P792E0144		2
	P792E0150/P792E0151	

High-voltage battery – Cable gland location see Figure 17.

Figure 17 High-voltage battery – Cable gland location 6-PHASE MCU:



3-PHASE MCU:



Reference document:

- [1] Motor sensor interface harness specification
- [2] System Specifications.
- [3] Phase Cable harness specifications.
- [4]Motor and MCU interface drawings.