



EC-C24-D180



Revision history

Table of revisions

Date	Changed	Rev
April 2026	First edition	0101

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General information

This user guide is the installation, operation and maintenance user guide for the EC-C24-D180 product.

Intended use of the user guide

This user guide provides essential instructions for the safe handling, installation, operation, and maintenance of the product. It is crucial reading for all personnel involved in the installation, operation, or maintenance of the product and associated equipment.

Strict adherence to all safety warnings and instructions in this user guide is mandatory to prevent personal injury and property damage. Only qualified and authorized personnel, possessing knowledge of relevant health and safety regulations and national legislation, are permitted to handle, install, operate, and maintain the product.

Illustrations in this user guide are examples and may not depict all system features.

Retain this user guide for future reference during installation, operation, and maintenance.

Product naming convention

In this user guide, EC-C24-D180 is referred to as power unit or product.

The model number of the product reflects the size and electrical characteristics of the power unit. The following naming conventions are used to indicate the power unit model:

- EC-C24-D180

Part of the name	Meaning
EC	Electric converter
C24	Voltage platform 24 V
D180	Dual inverter, maximum continuous current 180 A

Conformity according to standards

The power unit has been designed to be in conformity with the following directives and to meet the requirements specified in the following standards:

Applicable directives and standards

Standard	Explanation
Low Voltage Directive 2006/95/EC (until 19.4.2016) and Low Voltage Directive 2014/35/EU (from 20.4.2016 onwards)	Electrical equipment means any equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current. This electric machine is subject to the Low Voltage Directive 2006/95/EC or 2014/35/EC.
IEC 60034-1:2010	Rotating electrical machines - Part 1: Rating and performance
IEC 60034-5:2001/A1:2007	Rotating electrical machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification
IEC 60034-6:1991	Rotating electrical machines - Part 6: Methods of cooling
IEC 60034-7:1992/A1:2001	Rotating electrical machines - Part 7: Classification of types of construction, mounting arrangements and connection box position (IM Code)
IEC 60034-8:2007/A1:2014	Rotating electrical machines - Part 8: Terminal markings and direction of rotation
IEC 60034-14:2004/A1:2008	Amendment 1 - Rotating electrical machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of vibration severity.

Warranty

Danfoss offers warranty against defects in workmanship and materials for its products. For more information, see General terms and conditions of sale at <https://www.danfoss.com/en/terms/sales-conditions/>.

Warranty validity requires adherence to the instructions in this document and all related materials, including product installation and maintenance guidelines, and compliance with all applicable national standards and regulations.

The warranty does not cover defects resulting from improper or negligent use, operation, or installation; failure to perform regular preventive maintenance; or damage caused by external factors or the use of non-Danfoss supplied/recommended equipment and components.

Any unauthorized repairs or modifications made without Danfoss' prior written consent will invalidate the warranty.

Terms and abbreviations

The following tables define symbols, terms, and abbreviations that may appear in this user guide.

Symbols

Symbol	Variable	Unit
U	Rated voltage (phase-to-phase AC)	V _{rms}
I	Rated current (AC)	A _{rms}
P	Rated Power (S1)	kW
T	Rated torque (S1) at rated speed	Nm
T _{max}	Maximum torque	Nm
n	Rated speed	rpm
Max n	Maximum speed	rpm
f	Rated supply frequency at nominal speed	Hz
PF	Power factor (cosφ)	
Q _c	Rated coolant liquid flow	l/min
T _c	Rated coolant liquid input temperature	°C
T _{amb}	Rated ambient temperature	°C
RES_COS	Cosine signal received from the resolver	deg
RES_SIN	Sinusoidal signal received from the resolver	deg
Ω (Ohm)	Resistance	Ω

Terms and abbreviations

Term / abbreviation	Explanation
MCU	Motor controller unit
IMU	Inertial measurement unit
FOC	Field-Oriented Control
MTPA	Maximum torque per ampere
AC	Alternating current
DC	Direct current
GND	Ground in electrical connections
PMSM	Permanent Magnet Synchronous Machine
SRPM	Synchronous Reluctance assisted Permanent Magnet
S1	Duty type according to the IEC60034; Continuous running duty
S9	Duty type according to the IEC60034; Duty with non-periodic load and speed variations

Responsibility of the manufacturer

Danfoss guarantees the safety, reliability, and performance of the product only when the following conditions are met:

- Handling, mounting, installation, operation, and maintenance are performed by qualified and authorized personnel.
- The system installation adheres to all applicable regulations.
- The product is operated according to the instructions in this user guide.
- The product is installed, maintained, and serviced according to the instructions in this user guide.

Safety information

General safety statement

- Designed for use as a component in industrial and commercial installations, the product requires that the end product comply with all relevant regulations.
- The product cannot be used in hazardous areas unless specifically designed for that purpose.
- Only qualified personnel familiar with health and safety requirements and national legislation should install, use, and maintain this product. Failure to comply with these instructions may void all applicable warranties.
- These instructions are essential for the safe and correct installation, operation, and maintenance of the product. Make sure everyone who installs, operates, or maintains the product or related equipment has access to and understands these instructions.
- This user guide covers products with rotating parts and electric current that can cause serious injuries. To prevent injury, always follow safety precautions.

Safety message signal words

Safety message signal words indicate the severity of a potential hazard.

DANGER Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.








WARNING Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. CAUTION may also alert against unsafe practices.

NOTICE Indicates a potentially hazardous situation which, if not avoided, could result in property damage.

Safety symbols

The following safety and information symbols are used in this user guide and on the product.






	Danger This symbol warns of a dangerous situation that could result in serious injury or death. Do not perform the action indicated by this symbol.
	General warning This symbol indicates a potentially hazardous situation.
	Electric shock warning This symbol indicates the presence of dangerous voltage that could cause electric shock.
	Burn warning This symbol warns of a hot surface that could cause burns. The device should be installed to prevent contact with its potentially hot surfaces.
	Magnet warning This symbol warns of a strong magnetic field that could be harmful to people or property.
	Rotating shaft warning This symbol warns of a strong rotating shaft that could be harmful to people or property.
	This symbol indicates that the following content is for general information.



This symbol indicates that you need to refer to the user guide for instructions.

Personal protective equipment

To prevent injury during handling, installation, and maintenance of the product, use appropriate personal protective equipment when necessary.



	Wear safety goggles or a mask when working on the product. Bearing grease, melted nitrile rubber (from the radial lip seal), glycol, or other fluids could splash and cause permanent eye damage.
	Wear hearing protection when working on the product. Exposure to noise levels above 85 dBA can cause hearing damage.
	Wear a helmet when lifting the product to protect yourself from potential head injuries caused by falling objects.
	Wear cut-resistant gloves when handling and maintaining the product to protect against cuts.
	Wear protective footwear when lifting or moving the product to prevent foot injuries in case of lifting system or bracket failure.

Safety features

The controller adopts a dual MCU control framework, with MCU 1 used for real-time motor control and MCU 2 used for functional safety testing and whole vehicle information exchange, which has improved the real time performance of the system and the safety of the system. An isolated CAN circuit is adopted for communication protocol to reduce the impact of external interference on the controller system.

Equipped with ramp detection and speed limit algorithm to ensure vehicle safety.

Electromagnetic compatibility (EMC)

	When connecting to other equipment, ensure that only specified and compatible components of the system are used.
	<p>Individuals with heart pacemakers, metal implants, or hearing aids should be aware that electric products generate magnetic and electromagnetic fields that can be a health hazard. These individuals should consult a doctor due to the risks posed by current-carrying conductors and permanent magnets before entering the following areas:</p> <ul style="list-style-type: none"> • Areas where electrical equipment and parts are operating • Areas where electrical equipment with permanent magnets is stored, assembled, operated, or repaired <p>If necessary, perform a dedicated EMC test on the installation.</p>

Electromagnetic compatibility (EMC) is the ability of electrical equipment to function correctly in its electromagnetic environment without causing interference to other devices. Meeting EMC requirements is a legal obligation for all equipment used within the European Economic Area (EEA)

Our products are designed with high standards of EMC in mind. Connect the power cables and groundings along the instructions in this user guide to achieve the required level of electromagnetic interference (EMI) shielding.

The installer is responsible for ensuring that the equipment or system into which this product is integrated complies with the EMC legislation of the country where it will be used. Within the European Union, equipment incorporating this product must comply with the EMC Directive 2014/30/EU.

Product overview

	This product is intended as a component for integration into a larger system, requiring more planning and effort than a typical standalone product.
	To provide optimal solutions for various applications, the product is available in several sizes. This user guide covers the following: <ul style="list-style-type: none"> • EC-C24-D180

The Danfoss EC-C24-D180 motor controller offers excellent hardware and software performance for low-voltage DC input, and high-current output applications. EC-C24-D180 is intended to be used in combination with ED-DT130. Its control strategy for permanent magnet synchronous motors combines Field-Oriented Control (FOC) with Maximum Torque Per Ampere (MTPA) to maximize system efficiency.

The product offers several advanced features:

- 2-in-1 design
- IP65 enclosure class to maximize reliability
- Ramp detection and speed limitation
- Motor speed control via CANbus signal
- Configurable CANbus and Power Map curve

Intended use of the product

This product is intended to operate as a power unit and is designed to be integrated into machinery, such as:

- Scissor lift
- Mini e-SSL
- Mini e-Excavator
- Mini e-Wheel Loader
- Mini AGV

This product is exclusively for professional use and should only be operated and maintained by trained professionals.

Prohibited uses of the product

The following uses, handling procedures, and maintenance practices are prohibited (this list is not exhaustive):

- Using the product for purposes not specified in this user guide
- Failing to comply with this user guide, safety signs, and rating plate information of the product
- Operating, adjusting, or performing maintenance on the product before reading this user guide
- Operating the product beyond its designed limits
- Using non-genuine service parts or parts with incorrect materials, potentially causing corrosion and eventual mechanical failures
- Operating and maintaining the product without using the appropriate personal protective equipment
- Using product parts, such as the frame, for climbing or to support other structures
- Subjecting the product to any kind of impact forces (for example, hitting, hammering, or dropping objects)
- Operating the product using electrical connections not described in the user guide or other documentation
- Operating the product when connections are not properly tightened
- Operating the product with power cables that are not routed according to the instructions
- Touching the product's connection terminals or performing maintenance or adjustments while the power is connected
- Lifting the product from incorrect lifting points or without appropriate lifting equipment
- Lifting additional loads with the product

- Storing the product outdoors in wet or dusty environments
- Storing the product without proper support to prevent it from rolling or falling
- Using the product in potentially explosive environments
- Allowing dirt or liquid to enter the product or connection box
- Using cables that cannot withstand the maximum currents of the product

System introduction

Danfoss electric system solutions are optimized and packaged for use in specific vehicle functions. They are fully tested and validated to ensure compatibility with the design and configuration of your application.

EC-C24-D180 motor controller (MCU) is an important component of the motor control system of the whole vehicle, which mainly plays a role in regulating the motor operation state, so that it can meet the purpose of the different operational requirements of the whole vehicle. The MCU obtains the speed demand of the vehicle from the vehicle controller, obtains electrical energy from the power battery, modulates by its own inverter, and obtains the required electrical energy to drive the motor, so as to make the speed and torque of the motor meet the requirements of the whole vehicle (starting, acceleration, braking, deceleration, climbing, energy recovery, etc.).

It is recommended to use a Danfoss inverter for optimized performance.

Connections and interfaces

Electric systems are mechanically and electrically integrated into machinery.

Mechanical interfaces:

- Mounting bracket

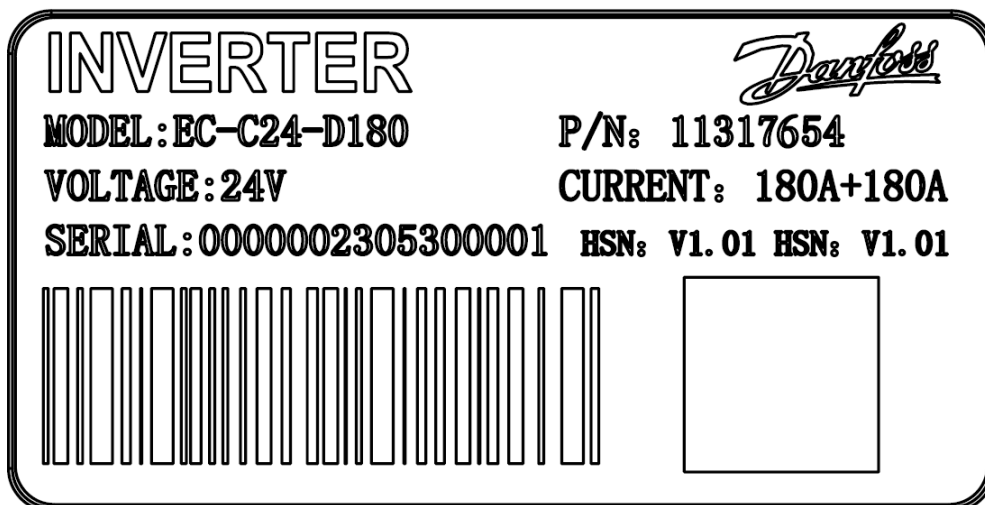
Electrical interfaces:

- Power grounding connection
- Signal connections grounding

Rating plate

Each product has a rating plate which can be found on the frame. The rating plate contains product rating and identification. See product data sheet for more details.

Rating plate



Tightening torques



Unless otherwise specified, the acceptable tightening torque range is within +/- 5 % of the stated value.

Connection	Tightening torque
Mounting bolts (M6 recommended)	Torque depends on the bolts chosen.
DC-link (M6)	7-8 Nm
Phase connections (M6)	7-8 Nm

System design

Danfoss EC-C24-D180 is a low-voltage DC input, high-current output motor controller with excellent hardware and software performance. The control policy of the permanent magnet synchronous motor adopts FOC vector control combining the maximum torque per ampere (MTPA) control technology to enhance the control efficiency of the system.

A set of inertial measurement unit (IMU) is integrated in the controller, allowing for monitoring vehicle attitude.

The controller integrates with advanced motion control technology, enabling customers to configure the control effects they desire according to their own driving habits.

Product characteristics:

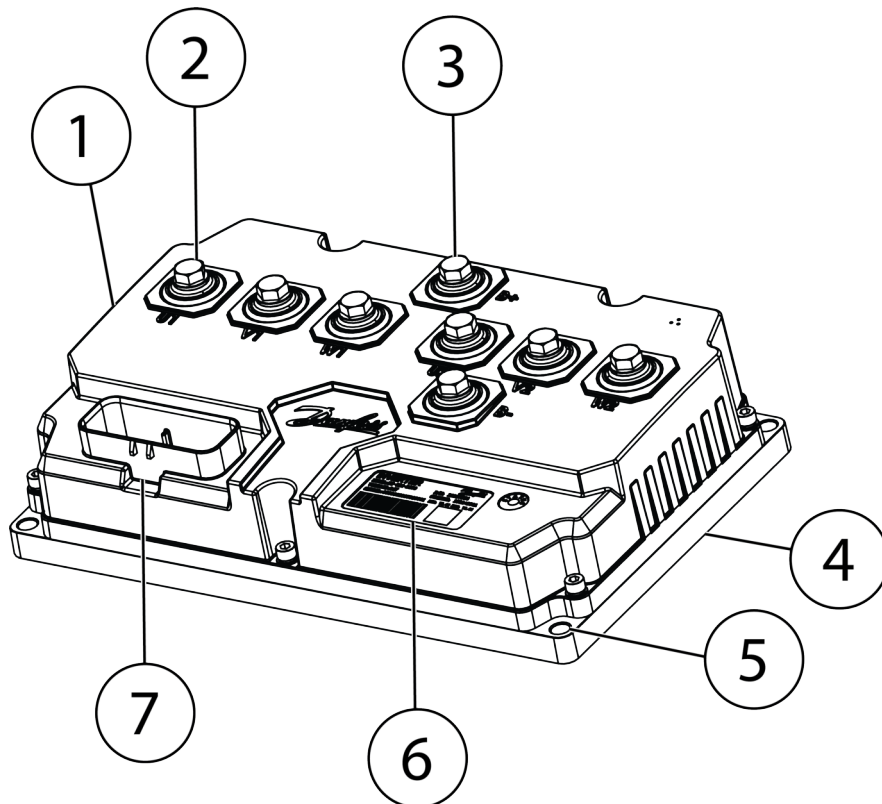
- Ramp detection and speed limit algorithm to ensure vehicle safety
- Built-in gyroscope
- Support CANopen communication
- High efficiency and low loss

Application Scenario:

- Permanent magnet synchronous motor

Main components

EC-C24-D180

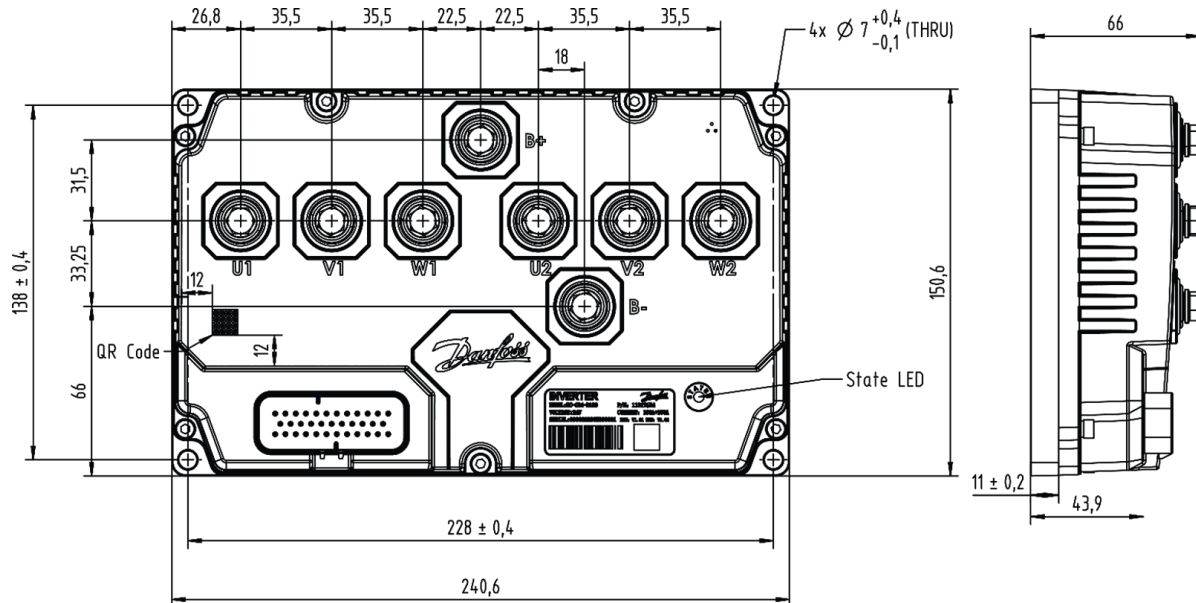


Part number	Part name
1	Motor controller case
2	Phase connections U1, V1, W1, U2, V2, and W2
3	DC-link B+ and B-
4	Cooling plate
5	Mounting bolts x4

Part number	Part name
6	Rating plate
7	Signal connector

Main dimensions

EC-C24-D180



Dimension	Length
L	240 mm
W	150 mm
H	66 mm

Transportation and storage

Transportation

	Handle with care during transportation.
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The product is shipped in first class condition. It has been inspected and packed correctly to prevent damage from ordinary handling during shipment. During transportation, shocks, falls and humidity should be avoided.

The weight of the product can be found on the rating plate, and in the product data sheet.

Receiving and unpacking

	Remove the transportation supports of the product.
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Check upon arrival and unpacking

- The product and the package must be inspected immediately upon arrival. Make sure that the rating plate data in the cover letter complies with the purchase order. Any external damage (in shaft-ends, flanges, electrical interfaces and paint) must be photographed and reported immediately.






Storage

	Keep the product on a correct base and support it to prevent accidental turning and falling.
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- Always store the product indoors. Storage temperature must be between -40°C and +85°C and relative humidity less than 60 %.
- The storage should be dry, dust free and vibration free.
- Treat the unprotected surfaces against corrosion. Seal the cable exit holes for storage.
- Avoid external vibrations stronger than those in the intended application to avert damage to the electrical components.

Installation

The following safety and information related symbols may appear in this user guide and on the product.

	Risk of electric shock.
	Magnetic and electromagnetic fields generated near the current-carrying conductors and permanent magnets in electric equipment represent a health danger to persons with heart pacemakers, metal implants and hearing aids. Persons with a heart pacemaker, metal implants or hearing aids must consult a doctor before they enter the following areas: <ul style="list-style-type: none"> • Areas in which electric equipment and parts are operated. • Areas in which electric equipment with permanent magnets are stored, mounted, operated or repaired.
	Only trained and qualified personnel familiar with the relevant safety requirements can work with the product.
	Use correct personal protective equipment when you are near the product.
	Read the instructions in this user guide before you install the product.

Required tools

Following tools are required to install the electric machine:

- Ratchet torque wrench
- Hex head wrench kit with different metric sizes
- Socket wrench kit with different metric sizes
- Cable skinning knife
- Crimping tool for cable lugs (consult cable lug manufacturer for correct size and crimping)

Mechanical installation

Allowed mounting positions

The product can be mounted in any position and rotated freely on its axis. Make sure the device is securely assembled in the chosen position.

Mounting the product

For mounting the product, follow the steps below.

1. Lift the product on the mounting structure while supporting it.
2. Attach the mounting bolts.
3. Connect the connectors and cables.

Electrical installation

Power cable

Tightly connect the controller and the battery together using high quality copper wiring terminals and well-insulated copper wires in accordance with the recommended torque value.

To achieve optimal anti-electromagnetic interference performance, do not cross the battery cable (B+, B-) through the central part of the controller as much as possible. For the power cable connection, it is recommended that the cable length between KEY_INPUT and battery should not exceed 10 m. If a washer is required between the cable lug and the wiring terminal, then a copper washer must be used. Otherwise overheating may occur.

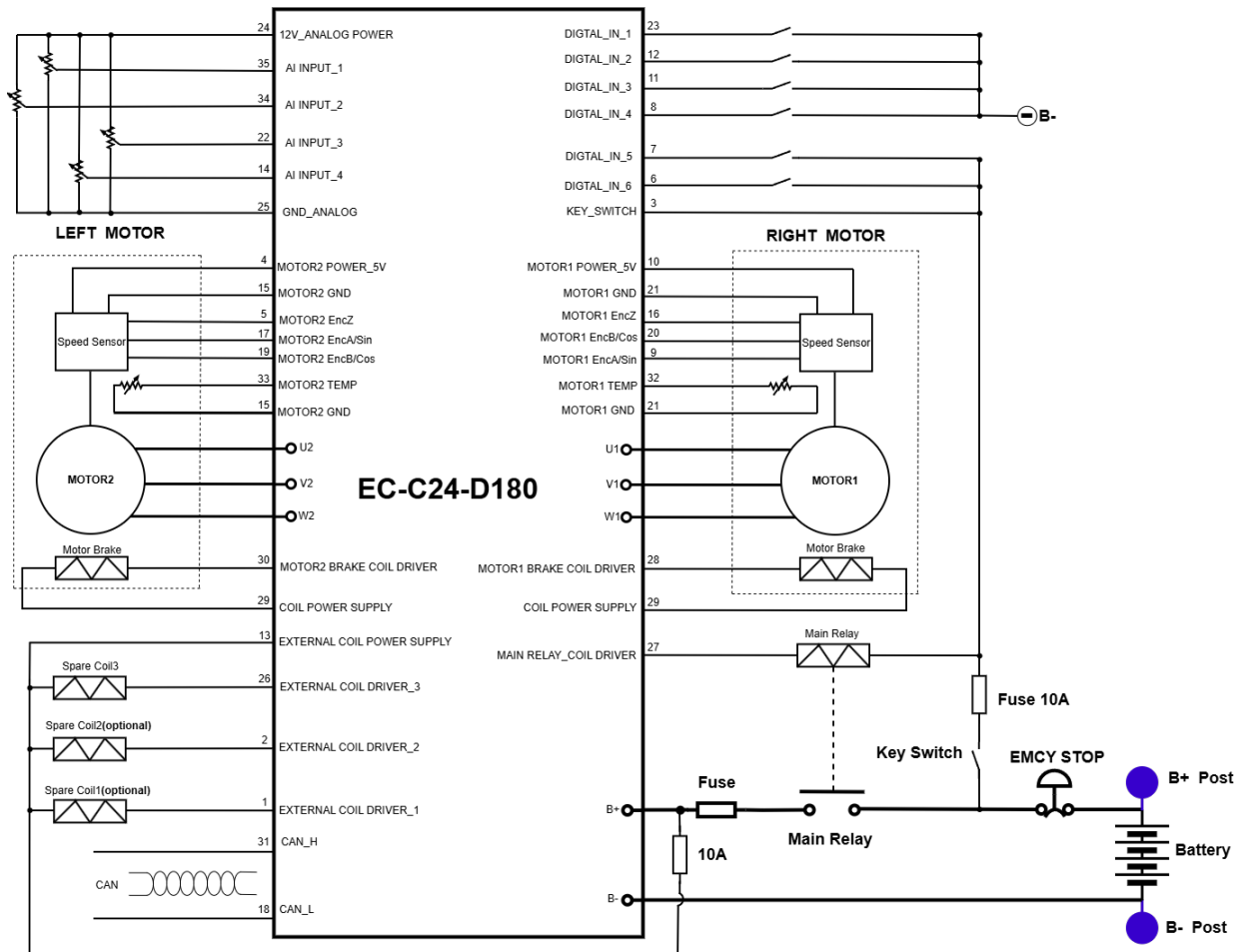
The tightening torque for the controller power connection must be within the range of 7-8 Nm. To achieve optimal inverter performance, the cables connecting the battery should run side by side and as short as possible.

In case that there are multiple high current electricity-consuming units in the system, connect the negative end of the electricity-consuming unit to the negative terminal of the battery in a star connection mode.

Connection diagram

The motor controller (MCU) is an important component of the motor control system of the whole vehicle, which mainly plays a role in regulating the motor operation state, so that it can meet the purpose of the different operational requirements of the whole vehicle. The MCU obtains the speed demand of the vehicle from the vehicle controller, obtains electrical energy from the power battery, modulates by its own inverter, and obtains the required electrical energy to drive the motor, so as to make the speed and torque of the motor meet the requirements of the whole vehicle (starting, acceleration, braking, deceleration, climbing, energy recovery, etc.).

Wiring diagram of the controller

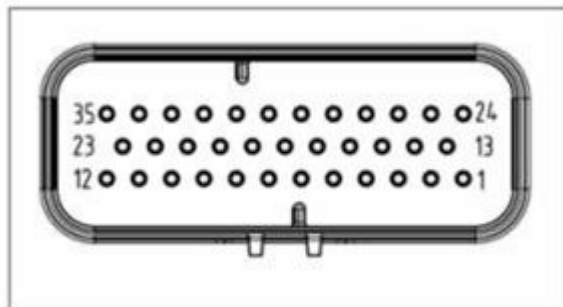


Low voltage connections

The controller is equipped with eight high current power interface terminal posts and one signal connector. Two power interface terminal posts B+, B- are used to provide busbar voltage to the controller, which is the power source for the entire power system. The remaining six power terminal posts U1, V1, W1, U2, V2, and W2 are connected to the U, V, and W of the two motors, respectively, and are used to drive the two permanent magnet synchronous motors. The recommended wire gauge for B+, B-, U1, V1, W1, U2, V2, W2 is 8 AWG or larger, with M6 bolt torque between 7-8 Nm.

The signal connector is used for low-voltage signal transmission such as key switch power supply, CAN communication command, and motor sensor, etc. The signal interface is configured as 35Pin AMP776164-1 connector.

Signal connector



MCU pin configuration

Pin number	Pin name	Pin function	Signal type	Function description
1	EXTERNAL COIL DRIVER_1	Valve coil drive output 1	PWM ON/OFF	<ol style="list-style-type: none"> 1. Continuous working current: $\leq 2A$. 2. Maximum working current: 3A (hardware overcurrent point). 3. Control type: Voltage PWM control/switch control. 4. Frequency: 0-2KHz adjustable. 5. Protection function: Short circuit protection, open circuit/online open circuit detection. 6. Output type: Open-drain output, with the load positive terminal connected to EXTERNAL COIL POWER SUPPLY, and the load negative terminal connected to this pin.
2	EXTERNAL COIL DRIVER_2	Valve coil drive output 2	PWM ON/OFF	<ol style="list-style-type: none"> 1. Continuous working current: $\leq 2A$. 2. Maximum working current: 3A (hardware overcurrent point). 3. Control type: Voltage PWM control/switch control. 4. Frequency: 0-2KHz adjustable. 5. Protection function: Short circuit protection, open circuit/online open circuit detection. 6. Output type: Open-drain output, with the load positive terminal connected to EXTERNAL COIL POWER SUPPLY, and the load negative terminal connected to this pin.
3	KEY-SWITCH	Key switch input	Power Input	<ol style="list-style-type: none"> 1. The minimum starting voltage of the controller is 16.5V, and the turn-off holding voltage is $\text{Min}=10V$. 2. Undervoltage threshold of key switch: 16V (configuration parameters can be modified). 3. Overvoltage threshold of key switch: 34V (configuration parameters can be modified). 4. With anti-reverse connection diode.
4	MOTOR2 POWER_5V	Motor 2 encoder power supply	Power Output	<ol style="list-style-type: none"> 1. Output voltage: $5.5V \pm 5\%$ (without load). 2. Maximum output current: 150mA. 3. With short circuit protection function. <p>(Note: This power output shares a power supply with 12V_ANALOG POWER, and the maximum current output refers to 12V_ANALOG POWER+MOTOR1/2 POWER_5V, which shall not exceed 150mA).</p>

MCU pin configuration (continued)

Pin number	Pin name	Pin function	Signal type	Function description
5	MOTOR2 EncZ	Z-phase input of motor 2 ABZ encoder	Digital Input	1. Maximum frequency supported as Z-phase signal input of encoder: 1MHz. 2. Built-in 2K pull-up to 5V, software control can be turned off/on.
6	DIGITAL_IN_6	Digital signal input 6	Digital Input	1. Built-in pull-up to 5V at the interface. 2. The configuration parameters of high and low threshold voltage can be adjusted. 3. High level valid.
7	DIGITAL_IN_5	Digital signal input 5	Digital Input	1. Built-in pull-up to 5V at the interface. 2. The configuration parameters of high and low threshold voltage can be adjusted. 3. High level valid.
8	DIGITAL_IN_4	Digital signal input 4	Digital Input	1. Built-in pull-up to 5V at the interface. 2. The configuration parameters of high and low threshold voltage can be adjusted. 3. Low level valid.
9	MOTOR1 EncA/MOTOR1 Sin	Motor 1 ABZ encoder A-phase input/Sin-Cos encoder SIN input	Digital Input Analog Input	1. Maximum frequency supported as A-phase signal input of encoder: 1MHz. 2. Built-in 2K pull-up to 5V, software control can be turned off/on. 3. Multiplex Sin interface of Sin-Cos encoder, with a cut off frequency of 15.9kHz.
10	MOTOR1 POWER_5V	Motor 1 encoder power supply	Power Output	1. Output voltage: 5.5V±5% (without load). 2. Maximum output current: 150mA. 3. With short circuit protection function. <i>(Note: This power output shares a power supply with 12V_ANALOG POWER, and the maximum current output refers to 12V_ANALOG POWER+MOTOR 1/2 POWER_5V, which shall not exceed 150mA).</i>
11	DIGITAL_IN_3	Digital signal input 3	Digital Input	1. Built-in pull-up to 5V at the interface. 2. The configuration parameters of high and low threshold voltage can be adjusted. 3. Low level valid.
12	DIGITAL_IN_2	Digital signal input 2	Digital Input	1. Built-in pull-up to 5V at the interface. 2. The configuration parameters of high and low threshold voltage can be adjusted. 3. Low level valid.
13	EXTERNAL COIL POWER SUPPLY	High-end power supply of valve coil drive module	Power Input	1. EXTERNAL COIL DRIVER_ 1/2/3, MAIN RELAY COIL DRIVER, COIL POWER SUPPLY. 2. This pin needs to be connected with power supply, and it is recommended to get power from the back end of the main relay. 3. With voltage detection; controller outputs fault if not powered.
14	AI INPUT_4	Analog signal input 4	Analog Input	1. Used for analog signal voltage input.
15	GND	Digital ground/analog ground interface	Power Output	/
16	MOTOR1 EncZ/AI IUPUT_5	Z-phase input of motor 1 ABZ encoder	Digital Input	1. Maximum frequency supported as I-phase signal input of encoder: 1MHz. 2. Built-in 2K pull-up to 5V, software control can be turned off/on.
17	MOTOR2 EncA/MOTOR2 Sin	Motor 2 ABZ encoder A-phase input/Sin-Cos encoder SIN input	Digital Input Analog Input	1. Maximum frequency supported as A-phase signal input of encoder: 1MHz. 2. Built-in 2K pull-up to 5V, software control can be turned off/on. 3. Multiplex Sin interface of Sin-Cos encoder, with a cut off frequency of 15.9kHz.

MCU pin configuration (continued)

Pin number	Pin name	Pin function	Signal type	Function description
18	CAN_L	CAN communication bus	CAN Bus Low	1. Supports the maximum baud rate of 1Mbps. 2. The minimum matching resistance of bus communication is 30Ω (tested with a bus length of 1.5M connecting to the upper-level control system).
19	MOTOR2 EncB/MOTOR2 Cos	Motor 2 ABZ encoder B-phase input/Sin-Cos encoder COS input	Digital Input	1. Maximum frequency supported as A-phase signal input of encoder: 1MHz. 2. Built-in 2K pull-up to 5V, software control can be turned off/on. 3. Multiplex Sin interface of Sin-Cos encoder, with a cut off frequency of 15.9kHz.
			Analog Input	
20	MOTOR1 EncB/MOTOR1 Cos	Motor 1 ABZ encoder B-phase input/Sin-Cos encoder COS input	Digital Input	1. Maximum frequency supported as A-phase signal input of encoder: 1MHz. 2. Built-in 2K pull-up to 5V, software control can be turned off/on. 3. Multiplex Sin interface of Sin-Cos encoder, with a cut off frequency of 15.9kHz.
			Analog Input	
21	GND	Digital ground/analog ground interface	Power Output	/
22	AI INPUT_3	Analog signal input 3	Analog Input	1. Used for analog signal voltage input.
23	DIGITAL_IN_1	Digital signal input 1	Analog Input	1. Built-in pull-up to 5V at the interface. 2. The configuration parameters of high and low threshold voltage can be adjusted. 3. Low level valid.
24	12V_ANALOG POWER	12V external power supply	Power Output	1. Output voltage: 12.5V±5% (without load). 2. Maximum output current: 150mA. 3. With short circuit protection function. (Note: This power output shares a power supply with MOTOR1/2 POWER_5V, and the maximum current output refers to 12V_ANALOG POWER+MOTOR1/2 POWER_5V, which shall not exceed 150mA).
25	GND	Digital ground/analog ground interface	Power Output	/
26	EXTERNAL COIL DRIVER_3	Valve coil drive output 3	PWM	1. Continuous working current: ≤2A. 2. Maximum working current: 3A (hardware overcurrent point). 3. Control type: Current-type PWM control. 4. Frequency: 0-18KHz adjustable. 5. Protection function: Short circuit protection, open circuit/online open circuit detection. 6. Output type: Open-drain output, with the load positive terminal connected to EXTERNAL COIL POWER SUPPLY, and the load negative terminal connected to this pin.
27	MAIN RELAY COIL DRIVER	Main relay coil drive output	PWM	1. Continuous working current: ≤2A. 2. Maximum working current: 3A (hardware overcurrent point). 3. Control type: Current-type PWM control. 4. Frequency: 0-2KHz adjustable. 5. Protection function: Short circuit protection, open circuit/online open circuit detection. 6. Output type: Open-drain output, with the load positive terminal connected to EXTERNAL COIL POWER SUPPLY, and the load negative terminal connected to this pin.
			ON/OFF	

MCU pin configuration (continued)

Pin number	Pin name	Pin function	Signal type	Function description
28	MOTOR1 BRAKE COIL DRIVER	Motor1 electromagneti c brake coil drive output	PWM ON/OFF	1. Continuous working current: $\leq 2A$. 2. Maximum working current: 3A (hardware overcurrent point). 3. Control type: Voltage-type PWM control. 4. Frequency: 0-2KHz adjustable. 5. Protection function: Short circuit protection, open circuit/online open circuit detection. 6. Output type: Open-drain output, with the load positive terminal connected to COIL POWER SUPPLY, and the load negative terminal connected to this pin. 7. Through the built-in circuit, the high-end COIL POWER SUPPLY can be turned on/off by software control.
29	COIL POWER SUPPLY	Electromagneti c brake coil drives high-end power supply	Power Output	1. Motor battery brake load power supply. 2. Power supply can be turned on/off by software control. 3. Maximum load current $\leq 4A$.
30	MOTOR2 BRAKE COIL DRIVER	Motor 2 electromagneti c brake coil drive output	PWM ON/OFF	1. Continuous working current: $\leq 2A$. 2. Maximum working current: 3A (hardware overcurrent point). 3. Control type: Voltage-type PWM control. 4. Frequency: 0-2KHz adjustable. 5. Protection function: Short circuit protection, open circuit/online open circuit detection. 6. Output type: Open-drain output, with the load positive terminal connected to COIL POWER SUPPLY, and the load negative terminal connected to this pin. 7. Through the built-in circuit, the high-end COIL POWER SUPPLY can be turned on/off by software control.
31	CAN_H	CAN communicatio n bus	CAN Bus High	1. Supports the maximum baud rate of 1Mbps. 2. The minimum matching resistance of bus communication is 30 Ω (tested with a bus length of 1.5M connecting to the upper-level control system).
32	MOTOR1 TEMP	Motor1 temperature sensor detection interface	Analog Input	1. Built-in 2mA constant current source. 2. The linearity is good in the resistance range of 200 Ω -2K Ω . 3. Protection function: Short circuit to ground.
33	MOTOR2 TEMP	Motor 2 temperature sensor detection interface	Analog Input	1. Built-in 2mA constant current source. 2. The linearity is good in the resistance range of 200 Ω -2K Ω . 3. Supports short circuit to ground function.
34	AI INPUT_2	Analog signal input 2	Analog Input	1. Used for analog signal voltage input.
35	AI INPUT_1	Analog signal input 1	Analog Input	1. Used for analog signal voltage input.

I/O signal cable

For a low-voltage signal input cable, it is recommended to use the 0.5 mm² cable.

It is recommended to keep the low-voltage signal cable and the power cable as far away as possible, and ensure a spacing of 100mm between the two types of cables as much as possible.

To avoid signal interference, it is recommended not to connect any signal ground wire to the vehicle frame (even when it is allowed in EN1175-1 to connect the ground wire of the signal cable to the vehicle frame in a 24V system).

When the controller is working, there is a large amount of current flowing through the busbar of the motor controller. Even selecting a power cable with a reasonable wire diameter can lead to a significant voltage drop between the battery negative end and the controller negative end, which means that there may be a voltage difference between the GND reference grounds of different units in the entire control system. Therefore, it is strongly recommended to connect all

input/output pins of the sensors provided by the motor controller directly onto the corresponding input/output pins of the controller. Do not connect the signal cable at will, which may cause instability of the entire system.

To avoid electromagnetic interference on the CANbus, it is recommended to use twisted pair cables as the CAN connection line, and to keep the CAN wiring away from the power cable. When necessary, cross it at right angles, without parallel wiring.

Grounding



**Ground the product from its signal connector to make sure it functions correctly and safely.
Ground the product's cooling plate to the vehicle chassis.**

Operation

Operation conditions



The product should be used for its intended purpose only and within limits specified by the manufacturer, concerning:

- Loading.
- Cooling.
- Speed range.
- Ambient condition such as temperature and moisture.

The product is designed for the following conditions:

- Storage temperature limits: -40°C...+85°C.
- Operating temperature limits: -40°C...+65°C.
- Maximum altitude above sea level: Up to 2000 m.
- IP class IP65

Condition monitoring during operation

	<p>Supervise the device during operation to make sure that it operates correctly and has a designed lifetime.</p>
	<p>If you notice any deviations from the normal operation, for example elevated temperatures, noise or vibration, stop the device and contact Danfoss service.</p>

Parameters

Control mode select

Parameter	Parameter	Data range	Description
Motor1 Control Mode	Motor 1 control mode selection	0~3	Control Mode Selection", 0 = Compact Speed Mode; 1= Speed Mode
Motor2 Control Mode	Motor 2 control mode selection	0~3	Control Mode Selection", 0 = Compact Speed Mode; 1= Speed Mode
Independent Control Type	Motor 1 Motor 2 Independent control type Bit 1: 0 Independent 1 Linkage Bit 2: Linkage mode Motor 1 rotation direction change Bit 3: Linkage mode Motor 2 rotation direction change Bit 4: Linkage mode Motor 1 Motor 2 encoder switching	0~15	Motor 1 Motor 2 Independent control type Bit 1: 0 Independent 1 Linkage Bit 2: Linkage mode Motor 1 rotation direction change Bit 3: Linkage mode Motor 2 rotation direction change Bit 4: Linkage mode Motor 1 Motor 2 encoder switching
Motor Param Sync	1: Motor 1 Relevant parameters synchronized to Motor 2 1: Motor 2 Relevant parameters synchronized to Motor 1	-1~2	1: Motor 1 Relevant parameters synchronized to Motor 2 1: Motor 2 Relevant parameters synchronized to Motor 1

0-Speed Mode Express →Motor1

Parameter	Parameter	Data range	Description
Kp	Motor 1 Speed mode 0 control parameter Kp	0–100 %	The Proportional (Kp) setting adjusts how quickly the system corrects its speed. A high Kp gives you a fast response but can make the speed unstable and fluctuate. A low Kp provides a slower, more stable response.
Ki	Motor 1 Speed mode 0 control parameter Ki	5—100 %	The Integral (Ki) setting works to eliminate any consistent, steady-state speed error over time. A large Ki value corrects this persistent error faster but can make the system unstable and prone to oscillation. A small Ki value corrects the error more slowly, leading to a more stable but less reactive system.

0-Speed Mode Express →Motor1 →Forward

Parameter	Parameter	Data range	Description
Accel Rate	Motor 1 Speed mode 0 forward acceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed increases when the throttle is pressed. A larger value indicates a slower response.
Decel Rate	Motor 1 Speed mode 0 forward throttle release deceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed decreases when the throttle is pressed. A larger value indicates a slower response.

0-Speed Mode Express →Motor1 →Reverse

Parameter	Parameter	Data range	Description
Accel Rate	Motor 1 Speed mode 0 reverse acceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed increases when the throttle is pressed. A larger value indicates a slower response.
Decel Rate	Motor 1 Speed mode 0 reverse throttle release deceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed decreases when the throttle is pressed. A larger value indicates a slower response.
Brake Decel Rate	Motor 1 Speed mode 0 Reverse brake deceleration rate	0.1~30.0 Seconds	Rate of vehicle deceleration (in seconds) at braking or at reverse throttle application. A larger value indicates a slower response.

0-Speed Mode Express →Motor2

Parameter	Parameter	Data range	Description
Kp	Motor 2 Speed mode 0 control parameter Kp	0—100 %	Proportional term (Kp) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.
Ki	Motor 2 Speed mode 0 control parameter Ki	5—100 %	Integration term (Ki) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.

0-Speed Mode Express →Motor2 →Forward

Parameter	Parameter	Data rate	Description
Accel Rate	Motor 2 Speed mode 0 forward acceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed increases when the throttle is pressed. A larger value indicates a slower response.
Decel Rate	Motor 2 Speed mode 0 forward throttle release deceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed decreases when the throttle is pressed. A larger value indicates a slower response.
Brake Decel Rate	Motor 2 Speed mode 0 forward brake deceleration rate	0.1~30.0 Seconds	Rate of vehicle deceleration (in seconds) at braking or at reverse throttle application. A larger value indicates a slower response.

0-Speed Mode Express →Motor2 →Reverse

Parameter	Parameter	Data rate	Description
Accel Rate	Motor 2 Speed mode 0 reverse acceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed increases when the throttle is pressed. A larger value indicates a slower response.
Decel Rate	Motor 2 Speed mode 0 reverse throttle release deceleration rate	0.1~30.0 Seconds	The rate (in seconds) at which the speed decreases when the throttle is pressed. A larger value indicates a slower response.
Brake Decel Rate	Motor 2 Speed mode 0 Reverse brake deceleration rate	0.1~30.0 Seconds	Rate of vehicle deceleration (in seconds) at braking or at reverse throttle application. A larger value indicates a slower response.

1-Speed Mode →Motor1 →Speed Controller

Parameter	Parameter	Data rate	Description
Kp	Motor 1 Speed control parameter Kp	0—100 %	Proportional term (Kp) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.
Ki LS	Motor 1 Speed control parameter Ki LS	5—100 %	Integration term (Ki) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.
Ki HS	Motor 1 Speed control parameter Ki HS	5—100 %	Integration term (Ki) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.

1-Speed Mode →Motor1 →Response →Forward

Parameter	Parameter	Data rate	Description
Full Accel Rate HS	Motor 1 Forward, high speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at forward high speed with full throttle. A larger value indicates a slower response.
Full Accel Rate LS	Motor 1 Forward, low speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at forward low speed with full throttle.
Low Accel Rate	Motor 1 Forward low throttle acceleration rate	0.1—30.0 sec	Set the rate of increase in speed (in seconds) at low throttle. This rate is usually adjusted to affect low- speed maneuverability.
Full Brake Rate HS	Motor 1 Forward, high speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds) at which the vehicle decelerates from high speed at full brake or reverse full throttle.
Full Brake Rate LS	Motor 1 Forward, low speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds) at which the vehicle decelerates from low speed at full brake or reverse full throttle.
Low Brake Rate	Motor 1 Forward, low brake deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates within the maximum speed with low brake or reverse low throttle.

1-Speed Mode → Motor1 → Response → Reverse

Parameter	Parameter	Data rate	Description
Full Accel Rate HS	Motor 1 reverse, high speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at reverse high speed with full throttle. A larger value indicates a slower response.
Full Accel Rate LS	Motor 1 reverse, low speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at reverse low speed with full throttle.
Low Accel Rate	Motor 1 reverse, low throttle acceleration rate	0.1—30.0 sec	Set the rate of increase in speed (in seconds) at low throttle. This rate is usually adjusted to affect low- speed maneuverability.
Full Brake Rate HS	Motor 1 reverse, high speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds) at which the vehicle decelerates from high speed at full brake or reverse full throttle.
Full Brake Rate LS	Motor 1 reverse, low speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds) at which the vehicle decelerates from low speed at full brake or reverse full throttle.
Low Brake Rate	Motor 1 reverse, low brake deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates within the maximum speed with low brake or reverse low throttle.

1-Speed Mode → Motor1 → Response → Neutral

Parameter	Parameter	Data rate	Description
Decel Rate HS	Motor 1 Neutral, high speed deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates with throttle released at high speed.
Decel Rate LS	Motor 1 Neutral, low speed deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates with throttle released at low speed.

1-Speed Mode → Motor1 → Response

Parameter	Parameter	Data rate	Description
Partial Decel Rate	Motor 1 Low throttle deceleration rate	0.1—30.0 sec	Set the rate (in seconds) at which the vehicle decelerates with throttle not fully released. A larger value indicates a slower response.

1-Speed Mode → Motor1 → Response → Fine Tuning

Parameter	Parameter	Data rate	Description
Typical Max Speed	Typical maximum speed	500—10000 rpm	This parameter is defined as the typical maximum motor speed of the vehicle, and the value can be estimated without accurate setting. All response speed parameters of the vehicle are normalized to the acceleration and deceleration time corresponding to typical maximum speed. For example, a typical maximum speed of 3000 rpm and an acceleration time of 3.0 seconds result in an acceleration controlled at 1000 rpm/s.
HS (High Speed)	Motor 1 Control relative high speed	0—100 %	Set the percentage at which relative high speed corresponds to the typical maximum speed.
LS (Low Speed)	Motor 1 Control relative low speed	0—100 %	Set the percentage at which relative low speed corresponds to the typical maximum speed.
Reversal Soften	Motor 1 Reverse soften control	0—100 %	Larger values near zero speed produce a soft reverse from regenerative brake to drive. It helps to soften the transition when the regenerative and drive current limits are set to different values.

1-Speed Mode → Motor2 → Speed Controller

Parameter	Parameter	Data rate	Description
Kp	Motor 2 Speed control parameter Kp	0—100 %	Proportional term (Kp) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.
Ki LS	Motor 2 Speed control parameter Ki LS	5—100 %	Integration term (Ki) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.
Ki HS	Motor 2 Speed control parameter Ki HS	5—100 %	Integration term (Ki) for speed control. The large value leads to fast speed tracking but easy oscillation; the small value leads to slow speed tracking.

1-Speed Mode → Motor2 → Response → Forward

Parameter	Parameter	Data rate	Description
Full Accel Rate HS	Motor 2 Forward, high speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at forward high speed with full throttle. A larger value indicates a slower response.
Full Accel Rate LS	Motor 2 Forward, low speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at forward low speed with full throttle.
Low Accel Rate	Motor 2 Forward low throttle acceleration rate	0.1—30.0 sec	Set the rate of increase in speed (in seconds) at low throttle. This rate is usually adjusted to affect low- speed maneuverability.
Full Brake Rate HS	Motor 2 Forward, high speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds)at which the vehicle decelerates from high speed at full brake or reverse full throttle.
Full Brake Rate LS	Motor 2 Forward, low speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds)at which the vehicle decelerates from low speed at full brake or reverse full throttle.
Low Brake Rate	Motor 2 Forward, low brake deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates within the maximum speed with low brake or reverse low throttle.

1-Speed Mode → Motor2 → Response → Reverse

Parameter	Parameter	Data rate	Description
Full Accel Rate HS	Motor 2 reverse, high speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at reverse high speed with full throttle. A larger value indicates a slower response.
Full Accel Rate LS	Motor 2 reverse, low speed, full throttle acceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the speed increases at reverse low speed with full throttle.
Low Accel Rate	Motor 2 reverse, low throttle acceleration rate	0.1—30.0 sec	Set the rate of increase in speed (in seconds) at low throttle. This rate is usually adjusted to affect low speed maneuverability.
Full Brake Rate HS	Motor 2 reverse, high speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds)at which the vehicle decelerates from high speed at full brake or reverse full throttle.
Full Brake Rate LS	Motor 2 reverse, low speed, full brake deceleration rate	0.1—30.0 sec	Set the rate (in seconds)at which the vehicle decelerates from low speed at full brake or reverse full throttle.
Low Brake Rate	Motor 2 reverse, low brake deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates within the maximum speed with low brake or reverse low throttle.

1-Speed Mode → Motor2 → Response → Neutral

Parameter	Parameter	Data rate	Description
Decel Rate HS	Motor 2 Neutral, high speed deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates with throttle released at high speed.
Decel Rate LS	Motor 2 Neutral, low speed deceleration rate	0.1—30.0 sec	The set rate (in seconds) at which the vehicle decelerates with throttle released at low speed.

1-Speed Mode → Motor2 → Response

Parameter	Parameter	Data rate	Description
Partial Decel Rate	Motor 2 Low throttle deceleration rate	0.1—30.0 sec	Set the rate (in seconds)at which the vehicle decelerates with throttle not fully released. A larger value indicates a slower response.

1-Speed Mode → Motor2 → Response → Fine Tuning

Parameter	Parameter	Data rate	Description
Typical Max Speed	Typical maximum speed	500—10000 rpm	This parameter is defined as the typical maximum motor speed of the vehicle, and the value can be estimated without accurate setting. All response speed parameters of the vehicle are normalized to the acceleration and deceleration time corresponding to typical maximum speed. For example, a typical maximum speed of 3000 rpm and an acceleration time of 3.0 seconds result in an acceleration controlled at 1000 rpm/s.
HS (High Speed)	Motor 2 Control relative high speed	0—100 %	Set the percentage at which relative high speed corresponds to the typical maximum speed.

1-Speed Mode → Motor2 → Response → Fine Tuning (continued)

Parameter	Parameter	Data rate	Description
LS (Low Speed)	Motor 2 Control relative low speed	0—100 %	Set the percentage at which relative low speed corresponds to the typical maximum speed.
Reversal Soften	Motor 2 Reverse soften control	0—100 %	Larger values near zero speed produce a soft reverse from regenerative brake to drive. It helps to soften the transition when the regenerative and drive current limits are set to different values.

Motion Restraint → Motor1

Parameter	Parameter	Data rate	Description
Forward Max Speed	Motor 1 Maximum forward speed	0~10000 rpm	Set the maximum motor speed that is allowed for forward motion.
Reverse Max Speed	Motor 1 Maximum reverse speed	0~10000 rpm	Set the maximum motor speed that is allowed for reverse motion.
Speed1 Limit	Motor 1 Gear 1 Speed limit	0~100 %	Speed limit percentage at gear 1. The maximum speed corresponding to gear 1 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 1". When there is only one gear in the forward and reverse gears, the speed limits at gear 2, gear 3 and gear 4 are invalid.
Speed2 Limit	Motor 1 Gear 2 Speed limit	0~100 %	Speed limit percentage at gear 2. The maximum speed corresponding to gear 2 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 2".
Speed3 Limit	Motor 1 Gear 3 Speed limit	0~100 %	Speed limit percentage at gear 3. The maximum speed corresponding to gear 3 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 3".
Speed4 Limit	Motor 1 Gear 4 Speed limit	0~100 %	Speed limit percentage at gear 4. The maximum speed corresponding to gear 4 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 4".
Neutral Free Sliding Enable	Motor 1 Neutral free sliding enable		When enabled, the controller does not control the motor with neutral state and the controller output power drops to zero. Note: With neutral state on a slope, the vehicle will accelerate down the slope under the force of gravity.
Restraint Forward	Motor 1 Forward sliding limit	0~100 %	The speed at which the vehicle is restrained from forward sliding by increasing torque on a slope. Too high value of this parameter may cause the motor to oscillate.
Restraint Back	Motor 1 Reverse sliding limit	0~100 %	Increase torque on slopes to limit the speed at which the vehicle slides backwards. Too high value of this parameter may cause the motor to oscillate.
Restraint Time	Motor 1 Sliding time	10~3000 ms	
Soft Stop Speed	Motor 1 Soft stop speed	0~500 rpm	It is defined as the speed threshold below which a lower deceleration rate will be used for speed control to enter soft stop mode. Setting to zero will disable the function. Note: This parameter applies only to Speed Mode and Compact Speed Mode. This function is very useful for vehicles with rapid deceleration or vehicles using the position hold function on slopes. Soft stop speed can be used to reduce rollback, but it should not be set too high to prevent the vehicle from continuing forward with the throttle released.
Over Speed Rate	Motor 1 Overspeed rate	0~200 %	Percentage of the maximum speed of the overspeed fault threshold relative to the current direction. For example, 120 % means that the forward overspeed threshold is equal to 1.2 times the Forward Max Speed
Over Speed Time	Motor 1 Overspeed time	100~5000 ms	Delay in overspeed judgment. The speed greater than the overspeed threshold is deemed overspeed when it is maintained for Over Speed Time.

Motion Restraint → Motor2

Parameter	Parameter	Data rate	Description
Forward Max Speed	Motor 2 Maximum forward speed	0~10000 rpm	Set the maximum motor speed that is allowed for forward motion.
Reverse Max Speed	Motor 2 Maximum reverse speed	0~10000 rpm	Set the maximum motor speed that is allowed for reverse motion.
Speed1 Limit	Motor 2 Gear 1 Speed limit	0~100 %	Speed limit percentage at gear 1. The maximum speed corresponding to gear 1 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 1". When there is only one gear in the forward and reverse gears, the speed limits at gear 2, gear 3 and gear 4 are invalid.
Speed2 Limit	Motor 2 Gear 2 Speed limit	0~100 %	Speed limit percentage at gear 2. The maximum speed corresponding to gear 2 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 2".
Speed3 Limit	Motor 2 Gear 3 Speed limit	0~100 %	Speed limit percentage at gear 3. The maximum speed corresponding to gear 3 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 3".
Speed4 Limit	Motor 2 Gear 4 Speed limit	0~100 %	Speed limit percentage at gear 4. The maximum speed corresponding to gear 4 is equal to "maximum forward speed or maximum reverse speed" multiplied by "speed limit at gear 4".
Neutral Free Sliding Enable	Motor 2 Neutral free sliding enable		When enabled, the controller does not control the motor with neutral state and the controller output power drops to zero. Note: With neutral state on a slope, the vehicle will accelerate down the slope under the force of gravity.
Restraint Forward	Motor 2 Forward sliding limit	0~100 %	The speed at which the vehicle is restrained from forward sliding by increasing torque on a slope. Too high value of this parameter may cause the motor to oscillate.
Restraint Back	Motor 2 Reverse sliding limit	0~100 %	Increase torque on slopes to limit the speed at which the vehicle slides backwards. Too high value of this parameter may cause the motor to oscillate.
Restraint Time	Motor 2 Sliding time	10~3000 ms	
Soft Stop Speed	Motor 2 Soft stop speed	0~500 rpm	It is defined as the speed threshold below which a lower deceleration rate will be used for speed control to enter soft stop mode. Setting to zero will disable the function. Note: This parameter applies only to Speed Mode and Compact Speed Mode. This function is very useful for vehicles with rapid deceleration or vehicles using the position hold function on slopes. Soft stop speed can be used to reduce rollback, but it should not be set too high to prevent the vehicle from continuing forward with the throttle released.
Over Speed Rate	Motor 2 Overspeed rate	0~200 %	Percentage of the maximum speed of the overspeed fault threshold relative to the current direction. For example, 120 % means that the forward overspeed threshold is equal to 1.2 times the Forward Max Speed.
Over Speed Time	Motor 2 Overspeed time	100~5000 ms	Delay in overspeed judgment. The speed greater than the overspeed threshold is deemed overspeed when it is maintained for Over Speed Time.

Motion Restraint → Position Hold

Parameter	Parameter	Data rate	Description
Position Hold Enable	Hill-holding switch		After it is enabled, when the vehicle stops, it is allowed to enter the position hold mode at zero throttle. Note: The EM brake type 2 can also enable the position hold function.
Position Hold Timeout	Maximum hill-holding duration (ms). Setting it to 0 can keep hill holding	0.0~20.0 Seconds	Maximum duration allowed for the hill-holding control mode. After timeout, the vehicle will automatically exit the hill-holding control mode and enter the sliding mode. Setting it to 0 will disable the timeout function, allowing for long- time hill-holding control.
Kp	Hill-holding control parameter Kp	2~100 %	Determine the control stiffness in the position hold mode. High Kp will produce less rollback on slopes but more rebounds; too large Kp will lead to instability.

Motion Restraint → *Position Hold (continued)*

Parameter	Parameter	Data rate	Description
Kd	Hill-holding control parameter Kd	0~100 %	Determine the damping in the position hold mode to prevent the vehicle from swinging back and forth. High Kd will improve the dynamic response of the position hold controller, but too large Kd will lead to instability.
Zero Speed Threshold	EM brake zero speed threshold rpm	5~100 rpm	Refer to the EM brake control configuration parameters.
Entry Rate	Speed of entering the position hold	5~100 %	This parameter applies to situations where parking is required without gravity assistance. It determines how quickly to reach zero speed after the speed command reaches zero. Setting this parameter too high will make the vehicle stopping look very sudden and may even cause the vehicle to slightly reverse. When this parameter is set too low, the vehicle takes a long time to park and enter the position hold mode.
Exit Rollback Reduction	Exit rollback limit	0~100 %	This function applies only when the torque preload function is disabled (see EM braking Parameters) or its timer has expired. It introduces a proportional feed forward item into the speed controller based on the position signal.

Motion Restraint → *IMU*

Parameter	Parameter	Data rate	Description
IMU Install Type	IMU install type	0~24	0— No IMU used; 17 - site installation type of Danfoss. For other mounting methods, a schematic diagram will be given when required.
Roll Offset (deg)	Roll offset	-90.00~90.00	Negative value of angle of roll at 0°.
Pitch Offset (deg)	Pitch offset	-90.00~90.00	Negative value of angle of pitch at 0°.
IMU LOS Speed	IMU fault speed limit	0~10000	Maximum speed limited when an IMU fault is detected
quaternion KP ZS	Accelerometer compensation at zero speed, KP	0.00~60.000	Confidence of the accelerometer at zero speed in the IMU calculation attitude. The larger the parameter, the higher the confidence of the accelerometer. Too large value will lead to inaccurate attitude calculated at acceleration and deceleration on ramps or at the state of wheel slipping.
quaternion KP	Accelerometer compensation KP	0.00~60.000	Confidence of the accelerometer at non-zero speed in the IMU attitude calculation. The larger the parameter, the higher the confidence of the accelerometer. Too large value will lead to inaccurate attitude calculated at acceleration and deceleration on ramps or at the state of wheel slipping.
quaternion KI	Accelerometer compensation KI (divided by 1000 in the program)	0.00~60.000	Temperature drift gain coefficient of gyroscope estimated by the accelerometer. This parameter should not be adjusted too large as the temperature drift of gyroscope is not large over the whole temperature range.

Motion Restraint → *Steering Differential*

Parameter	Parameter	Data rate	Description
Steering Differential Enable	Differential enable	On/Off	Differential enable mark: On-open differential; Off-close differential
Steering Differential Type	Differential type	0~8	0 - Low speed for the inner wheel and high speed for the outer wheel by default; 1 - High speed for the inner wheel and low speed for the outer wheel by default.
Vehicle Gear Rate	Gear ratio of vehicle reduction gearbox	0.0~20.00	Tooth space ratio of vehicle reduction gearbox, e.g. 1:50, set this value to 0.02
Vehicle Wheel Radius (cm)	Vehicle wheel radius	0.0~20.00	Wheel radius, in cm;
Vehicle Length	Vehicle length	0.0~20.00 m	Vehicle length, in m;
Vehicle Width	Vehicle width	0.0~20.00 m	Vehicle width, in m;
Steering Min Speed	Minimum speed of steering differential	0~10000 rpm	Minimum speed at which the differential starts. Set to 0, the judgment in differential is made by <i>SteerAngularRateDeath[deg]</i> . Otherwise, make a judgment by combining this speed threshold.
Steering Max Speed	Maximum speed of steering differential	0~10000 rpm	Allowed maximum differential

Motion Restraint → Steering Differential (continued)

Parameter	Parameter	Data rate	Description
Steering Differential Fault Threshold	Steering differential error threshold	0~100 %	When traveling in a straight line with no steering angular speed, judge the speed calculation factor for excessive differential. If Steering Max Speed = 2000, and this value is 50%, a major differential failure is reported when the speed difference between the left and right wheels is greater than 1000 rpm in straight-line traveling.
Steer Angular Rate Death [deg]	Determine the angle threshold in turning	0~320	Determine the angular speed threshold in turning, in deg/s

Motion Restraint → Ramp Restrictions

Parameter	Parameter	Data rate	Description
Speed Limit Method	Ramp speed limit method	0~15	Bit0: 1 - use ramp angle unit %; 0 - use ramp angle unit deg; Bit1: 0 - no speed limit on ramp; 1 - speed limit on ramp; Bit3: 0 - speed limit uphill and downhill; 1 - no speed limit uphill and speed limit downhill.
Ramps Angle Map0	Angle corresponding to ramp speed limit point 0	0.0~90.0	Ramp value corresponding to ramp speed limit point 0, i.e. 100% non-speed limit.
Ramps Angle Map1	Angle corresponding to ramp speed limit point 1	0.0~90.0	Ramp value corresponding to ramp speed limit point 1.
Ramps Angle Map2	Angle corresponding to ramp speed limit point 2	0.0~90.0	Ramp value corresponding to ramp speed limit point 2.
Ramps Angle Map3	Angle corresponding to ramp speed limit point 3	0.0~90.0	Ramp value corresponding to ramp speed limit point 3.
Ramps Angle Map4	Angle corresponding to ramp speed limit point 4	0.0~90.0	Ramp value corresponding to ramp speed limit point 4.
Ramps Angle Map5	Angle corresponding to ramp speed limit point 5	0.0~90.0	Ramp value corresponding to ramp speed limit point 5.
Ramps Angle Map6	Angle corresponding to ramp speed limit point 6	0.0~90.0	Ramp value corresponding to ramp speed limit point 6.
Ramps Angle Map7	Angle corresponding to ramp speed limit point 7	0.0~90.0	Ramp value corresponding to ramp speed limit point 7.
Ramps Speed Limit Map1	Speed corresponding to ramp speed limit point 1	0~100 %	Speed percentage corresponding to ramp speed limit point 1. Maximum speed relative to Motion Restraint at this percentage.
Ramps Speed Limit Map2	Speed corresponding to ramp speed limit point 2	0~100 %	Speed percentage corresponding to ramp speed limit point 2. Maximum speed relative to Motion Restraint at this percentage.
Ramps Speed Limit Map3	Speed corresponding to ramp speed limit point 3	0~100 %	Speed percentage corresponding to ramp speed limit point 3. Maximum speed relative to Motion Restraint at this percentage.
Ramps Speed Limit Map4	Speed corresponding to ramp speed limit point 4	0~100 %	Speed percentage corresponding to ramp speed limit point 4. Maximum speed relative to Motion Restraint at this percentage.
Ramps Speed Limit Map5	Speed corresponding to ramp speed limit point 5	0~100 %	Speed percentage corresponding to ramp speed limit point 5. Maximum speed relative to Motion Restraint at this percentage.
Ramps Speed Limit Map6	Speed corresponding to ramp speed limit point 6	0~100 %	Speed percentage corresponding to ramp speed limit point 6. Maximum speed relative to Motion Restraint at this percentage.
Ramps Speed Limit Map7	Speed corresponding to ramp speed limit point 7	0~100 %	Speed percentage corresponding to ramp speed limit point 7. Maximum speed relative to Motion Restraint at this percentage.
Ramp Increasing Rate	Speed limit change rate when the ramp steepens	0~1.000	Filter time constant of ramp speed limit from low speed to high speed. The greater the value, the slower the acceleration recovery.
Ramp Decreasing Rate	Speed limit change rate when the ramp steepens	0~1.000	Filter time constant of ramp speed limit from high speed to low speed. The greater the value, the slower the deceleration.
Ramp Speed Limit Filter	Ramp speed limit filter frequency	1~50	Ramp speed limit filter cutoff frequency coefficient. The smaller the value, the lower the cutoff frequency.
Leave Ramp Time	Leave ramp time (0 for not using this timer)	0~5000 ms	Delay time for acceleration when leaving the ramp. The time is not delayed when the value is 0.
Ramp Limit Monitor	Ramp speed limit CAN monitoring enable (temporary use, later managed via CANPDO)		Ramp slope monitoring enable switch, On - enable monitoring; Off - disable monitoring.

Current Limits → Motor1

Parameter	Parameter	Data rate	Description
Drive Current Limit	Motor 1 Drive current limit	1.0~100.0 %	Set the maximum RMS current provided by the controller to the motor during drive operation, indicated as the percentage of the controller's nominal maximum current. Reducing this value will reduce the maximum drive torque.
Regen Current Limit	Motor 1 Brake current limit	1.0~100.0 %	Set the maximum RMS regenerative current, indicated as the percentage of the controller's nominal maximum current. The regenerative current limit applies to neutral throttle braking, reverse braking and downhill driving speed limit.
Brake Current Limit	Motor 1 Regenerative current limit	1.0~100.0 %	Set the maximum RMS regenerative current at braking, indicated as the percentage of the controller's nominal maximum current. Typically, the brake current limit is set to be equal to the regenerative current limit.
Interlock Brake Current Limit	Motor 1 Interlock brake current limit	1.0~100.0 %	Set the maximum RMS regenerative current at interlock brake, expressed as a percentage of the controller's nominal maximum current.
Max Speed Point Current Limit	Motor 1 Maximum speed point current limit	1~100 %	The current re-limit at the maximum speed point on the basis of the power limiting map, with the value of the maximum speed point current limit after limit equal to the product of the two limits.

Current Limits → Motor1 → Power Limiting Map

Parameter	Parameter	Data rate	Description
PL Nominal Speed	Motor 1 Initial base speed for power limit	100~5000 rpm	Set the base speed to be used in the drive and regenerative power limit mapping curves.
Delta Speed	Motor 1 Power limit speed interval	50~1000 rpm	Set the speed increment used in the drive and regenerative power limit mapping curves.

Current Limits → Motor1 → Power Limiting Map → Drive Limiting Map

Parameter	Parameter	Data rate	Description
Nominal	Motor 1 Nominal speed drive current limit	0~100 %	Percentage of maximum drive current corresponding to the base speed.
Plus Delta	Motor 1 Nominal Plus Delta speed drive current limit	0~100 %	Percentage of maximum drive current corresponding to the base speed plus 1x incremental speed.
Plus 2xDelta	Motor 1 Nominal Plus 2xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 2x delta speed.
Plus 4xDelta	Motor 1 Nominal Plus 4xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 4x delta speed.
Plus 8xDelta	Motor 1 Nominal Plus 8xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 8x delta speed.
Plus 12xDelta	Motor 1 Nominal Plus 12xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 12x delta speed.
Plus 16xDelta	Motor 1 Nominal Plus 16xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 16x delta speed.

Current Limits → Motor1 → Power Limiting Map → Regen Limiting Map

Parameter	Parameter	Data rate	Description
Nominal	Motor 1 Nominal speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed.
Plus Delta	Motor 1 Nominal Plus Delta speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed plus 1x incremental speed.
Plus 2xDelta	Motor 1 Nominal Plus 2xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 2x delta speed.
Plus 4xDelta	Motor 1 Nominal Plus 4xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 4x delta speed.

Current Limits → Motor1 → Power Limiting Map → Regen Limiting Map (continued)

Parameter	Parameter	Data rate	Description
Plus 8xDelta	Motor 1 Nominal Plus 8xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 8x delta speed.
Plus 12xDelta	Motor 1 Nominal Plus 12xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 12xdelta speed.
Plus 16xDelta	Motor 1 Nominal Plus 16xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 16xdelta speed.

Current Limits → Motor1 → Power Limiting Map → Regen Limiting Map(Ramp)

Parameter	Parameter	Data rate	Description
Nominal	Motor 1 Nominal speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed.
Plus Delta	Motor 1 Nominal Plus Delta speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed plus 1x incremental speed.
Plus 2xDelta	Motor 1 Nominal Plus 2xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 2x delta speed.
Plus 4xDelta	Motor 1 Nominal Plus 4xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 4x delta speed.
Plus 8xDelta	Motor 1 Nominal Plus 8xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 8x delta speed.
Plus 12xDelta	Motor 1 Nominal Plus 12xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 12xdelta speed.
Plus 16xDelta	Motor 1 Nominal Plus 16xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 16xdelta speed.

Current Limits → Motor2

Parameter	Parameter	Data rate	Description
Drive Current Limit	Motor 2 Drive current limit	1.0~100.0 %	Set the maximum RMS current provided by the controller to the motor during drive operation, indicated as the percentage of the controller's nominal maximum current. Reducing this value will reduce the maximum drive torque.
Regen Current Limit	Motor 2 Brake current limit	1.0~100.0 %	Set the maximum RMS regenerative current, indicated as the percentage of the controller's nominal maximum current. The regenerative current limit applies to neutral throttle braking, reverse braking and downhill driving speed limit.
Brake Current Limit	Motor 2 Regenerative current limit	1.0~100.0 %	Set the maximum RMS regenerative current at braking, indicated as the percentage of the controller's nominal maximum current. Typically, the brake current limit is set to be equal to the regenerative current limit.
Interlock Brake Current Limit	Motor 2 Interlock brake current limit	1.0~100.0 %	Set the maximum RMS regenerative current at interlock brake, expressed as a percentage of the controller's nominal maximum current.
Max Speed Point Current Limit	Motor 2 Maximum speed point current limit	1~100 %	The current re-limit at the maximum speed point on the basis of the power limiting map, with the value of the maximum speed point current limit after limit equal to the product of the two limits.

Current Limits → Motor2 → Power Limiting Map

Parameter	Parameter	Data rate	Description
PL Nominal Speed	Motor 2 Initial base speed for power limit	100~5000 rpm	Set the base speed to be used in the drive and regenerative power limit mapping curves.
Delta Speed	Motor 2 Power limit speed interval	50~1000 rpm	Set the speed increment used in the drive and regenerative power limit mapping curves.

Current Limits → Motor2 → Power Limiting Map → Drive Limiting Map

Parameter	Parameter	Data rate	Description
Nominal	Motor 2 Nominal speed drive current limit	0~100 %	Percentage of maximum drive current corresponding to the base speed.
Plus Delta	Motor 2 Nominal Plus Delta speed drive current limit	0~100 %	Percentage of maximum drive current corresponding to the base speed plus 1x incremental speed.
Plus 2xDelta	Motor 2 Nominal Plus 2xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 2x delta speed.
Plus 4xDelta	Motor 2 Nominal Plus 4xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 4x delta speed.
Plus 8xDelta	Motor 2 Nominal Plus 8xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 8x delta speed.
Plus 12xDelta	Motor 2 Nominal Plus 12xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 12x delta speed.
Plus 16xDelta	Motor 2 Nominal Plus 16xDelta speed drive current limit	0~100 %	The percentage of maximum drive current corresponding to the base speed plus 16x delta speed.

Current Limits → Motor2 → Power Limiting Map → Regen Limiting Map

Parameter	Parameter	Data rate	Description
Nominal	Motor 2 Nominal speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed.
Plus Delta	Motor 2 Nominal Plus Delta speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed plus 1x incremental speed.
Plus 2xDelta	Motor 2 Nominal Plus 2xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 2x delta speed.
Plus 4xDelta	Motor 2 Nominal Plus 4xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 4x delta speed.
Plus 8xDelta	Motor 2 Nominal Plus 8xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 8x delta speed.
Plus 12xDelta	Motor 2 Nominal Plus 12xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 12x delta speed.
Plus 16xDelta	Motor 2 Nominal Plus 16xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 16x delta speed.

Current Limits → Motor2 → Power Limiting Map → Regen Limiting Map(Ramp)

Parameter	Parameter	Data rate	Description
Nominal	Motor 2 Nominal speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed.
Plus Delta	Motor 2 Nominal Plus Delta speed brake current limit	0~100 %	Percentage of maximum regenerative brake current corresponding to the base speed plus 1x incremental speed.
Plus 2xDelta	Motor 2 Nominal Plus 2xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 2x delta speed.

Current Limits → Motor2 → Power Limiting Map → Regen Limiting Map(Ramp) (continued)

Parameter	Parameter	Data rate	Description
Plus 4xDelta	Motor 2 Nominal Plus 4xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 4x delta speed.
Plus 8xDelta	Motor 2 Nominal Plus 8xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 8x delta speed.
Plus 12xDelta	Motor 2 Nominal Plus 12xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 12xdelta speed.
Plus 16xDelta	Motor 2 Nominal Plus 16xDelta incremental speed brake current limit	0~100 %	The percentage of maximum regenerative brake current corresponding to the base speed plus 16xdelta speed.

Throttle

Parameter	Parameter	Data rate	Description
Throttle Type	Throttle type	1~4	The throttle types can be configured as follows: (it is required to adjust the User PDO Tx Enable and User PDO Rx Enable to 0 to use the throttle) 1: Single-ended voltage throttle; (used with Enable signal) 2: WigWag bilateral voltage throttle.3-6: Reserved.
Throttle Switch Enable	Throttle switch signal enable		Determine whether the throttle switch signal detection is enabled; when enabled, the throttle output is allowed only when the throttle switch signal is active.

Throttle → Forward

Parameter	Parameter	Data rate	Description
Deadband	Forward neutral throttle voltage	0.01–5.00 Volt.	It is defined as the voltage at the throttle dead band threshold, and increase in the throttle dead band setting will result in increase of the neutral range. This parameter is useful for throttles that cannot be fully released, as it allows the deadband to be defined wide enough to ensure that the controller goes to neutral state when the throttle is released.
Map	Forward throttle mapping	0–100 %	This mapping value is the percentage of the controller output at half-throttle. Modifying this parameter can change the vehicle's response to throttle input, and setting throttle mapping to 50 % can provide linear output response. A value less than 50 % reduces the controller output at low throttle inputs, thus improving the vehicle's low-speed maneuverability. A value more than 50 % allows the vehicle to feel a quicker response at low throttle inputs.
Max	Forward full throttle voltage	0.01–5.00 Volt.	It is defined as the throttle voltage required to produce 100 % of the controller output. Lowering the throttle maximum setting results in reduction to the threshold voltage, thus reducing the throttle travel required to produce 100 % of the controller output.
Offset	Forward throttle mapping offset	0–100 %	It is defined as the initial output produced by the controller when the throttle voltage just exceeds the deadband voltage threshold. For most vehicles, setting it to 0 is appropriate; however, for heavy-duty vehicles, increasing the offset can reduce the throttle stroke required to start the vehicle, thus improving vehicle controllability.

Throttle →Reverse

Parameter	Parameter	Data rate	Description
Deadband	Reverse neutral throttle voltage	0.01~5.00 Volt	It is defined as the voltage at the throttle deadband threshold, and increase in the throttle deadband setting will result in increase of the neutral range. This parameter is useful for throttles that cannot be fully released, as it allows the deadband to be defined wide enough to ensure that the controller goes to neutral state when the throttle is released.
Map	Reverse throttle mapping	0~100 %	This mapping value is the percentage of the controller output at half-throttle. Modifying this parameter can change the vehicle's response to throttle input, and setting throttle mapping to 50 % can provide linear output response. A value less than 50 % reduces the controller output at low throttle inputs, thus improving the vehicle's low-speed maneuverability. A value more than 50 % allows the vehicle to feel a quicker response at low throttle inputs.
Max	Reverse full throttle voltage	0.01~5.00 Volt	It is defined as the throttle voltage required to produce 100 % of the controller output. Lowering the throttle maximum setting results in reduction to the threshold voltage, thus reducing the throttle travel required to produce 100 % of the controller output.
Offset	Reverse throttle mapping offset	0~100 %	It is defined as the initial output produced by the controller when the throttle voltage just exceeds the deadband voltage threshold. For most vehicles, setting it to 0 is appropriate; however, for heavy-duty vehicles, increasing the offset can reduce the throttle stroke required to start the vehicle, thus improving vehicle controllability.

Throttle

Parameter	Parameter	Data rate	Description
Throttle Filter	Throttle Command filter	0.5~125.0 Hz	Set the low-pass filter cutoff frequency of the throttle signal. A higher value allows the throttle to respond faster to changes.
HPD SRO Type	HPD/SRO type: 0 = disable HPD/SRO detection; 1= interlock input before throttle input triggers HPD; and direction input before interlock input triggers SRO; 2 = Interlocking at rest or throttle input received before direction input triggers HPD; 3 = Throttle input before interlock or direction input triggers HPD.	0~3	<p>The HPD/SRO types can be configured as follows:</p> <p>0: disable HPD/SRO detection.</p> <p>1: Applicable to material handling vehicles, etc. Interlock input preceded by throttle input triggers HPD; and interlock input preceded by direction input triggers SRO.</p> <p>A throttle input more than the "HPD throttle input threshold" or a direction input of "On" triggers the HPD/Sequencing fault.</p> <p>2: Applicable to Golf and other vehicles.</p> <p>Throttle input preceded by interlock input or direction input with the vehicle stationary triggers HPD.</p> <p>When the interlock input or direction input is Off and the vehicle is stationary, the HPD monitoring is enabled. A throttle input more than the "HPD throttle input threshold" triggers the HPD/Sequencing fault. This type does not have SRO monitoring, so the sequence of interlock and direction inputs is insignificant.</p> <p>The HPD/Sequencing fault is eliminated by returning the throttle input to less than the "HPD throttle input threshold" and returning the direction input to Off.</p> <p>3: Applicable to Golf and other vehicles.</p> <p>Throttle input preceded by interlock or direction input triggers HPD.</p> <p>When the interlock input or direction input is Off, the HPD monitoring is enabled. A throttle input more than the "HPD throttle input threshold" triggers the HPD/Sequencing fault. HPD detects the vehicle regardless of its speed, so gear reversal with throttle input more than the "HPD throttle input threshold" will result in a fault. This type does not have SRO supervision, so the sequence of interlock and direction inputs is insignificant.</p> <p>The HPD/Sequencing fault is eliminated by returning the throttle input to less than the "HPD throttle input threshold" and returning the direction input to Off.</p>

Throttle (continued)

Parameter	Parameter	Data rate	Description
Sequencing Delay	Interlock sequencing delay time	0.0~5.0 Seconds	The sequencing delay function allows the interlock switch to hold for a set period of time to prevent unintentional activation of the HPD/SRO. It is especially useful in applications where interlock switches may pop up or there are transient peaks during operation.
HPD Throttle Input limit	Upper limit of throttle input value corresponding to HPD fault	0~100 %	HPD fault corresponds to the throttle input threshold and is related to HPD/Sequencing faults.

SteeringPot →Left

Parameter	Parameter	Data rate	Description
Deadband	Left-turn neutral throttle voltage	0.01~5.00 Volt	It is defined as the voltage at the throttle deadband threshold, and increase in the throttle deadband setting will result in increase of the neutral range. This parameter is useful for throttles that cannot be fully released, as it allows the deadband to be defined wide enough to ensure that the controller goes to neutral state when the throttle is released.
Map	Left-turn throttle mapping	0~100 %	This mapping value is the percentage of the controller output at half-throttle. Modifying this parameter can change the vehicle's response to throttle input, and setting throttle mapping to 50 % can provide linear output response. A value less than 50 % reduces the controller output at low throttle inputs, thus improving the vehicle's low-speed maneuverability. A value more than 50 % allows the vehicle to feel a quicker response at low throttle inputs.
Max	Left-turn full throttle voltage	0.01~5.00 Volt	It is defined as the throttle voltage required to produce 100 % of the controller output. Lowering the throttle maximum setting results in reduction to the threshold voltage, thus reducing the throttle travel required to produce 100 % of the controller output.
Offset	Left-turn throttle mapping offset	0~100 %	It is defined as the initial output produced by the controller when the throttle voltage just exceeds the deadband voltage threshold. For most vehicles, setting it to 0 is appropriate; however, for heavy- duty vehicles, increasing the offset can reduce the throttle stroke required to start the vehicle, thus improving vehicle controllability.

Steering Pot →Right

Parameter	Parameter	Data rate	Description
Deadband	Right-turn neutral throttle voltage	0.01~5.00 Volt	It is defined as the voltage at the throttle deadband threshold, and increase in the throttle deadband setting will result in increase of the neutral range. This parameter is useful for throttles that cannot be fully released, as it allows the deadband to be defined wide enough to ensure that the controller goes to neutral state when the throttle is released.
Map	Right-turn throttle mapping	0~100 %	This mapping value is the percentage of the controller output at half-throttle. Modifying this parameter can change the vehicle's response to throttle input, and setting throttle mapping to 50 % can provide linear output response. A value less than 50 % reduces the controller output at low throttle inputs, thus improving the vehicle's low-speed maneuverability. A value more than 50 % allows the vehicle to feel a quicker response at low throttle inputs.
Max	Right-turn full throttle voltage	0.01~5.00 Volt	It is defined as the throttle voltage required to produce 100 % of the controller output. Lowering the throttle maximum setting results in reduction to the threshold voltage, thus reducing the throttle travel required to produce 100 % of the controller output.
Offset	Right-turn throttle mapping offset	0~100 %	It is defined as the initial output produced by the controller when the throttle voltage just exceeds the deadband voltage threshold. For most vehicles, setting it to 0 is appropriate; however, for heavy- duty vehicles, increasing the offset can reduce the throttle stroke required to start the vehicle, thus improving vehicle controllability.
Steering Filter	Brake pedal Command filter	0.5~125.0 Hz	Set the low-pass filter cutoff frequency for the brake signal. Higher values will make the brakes respond faster to changes.

Main Relay

Parameter	Parameter	Data rate	Description
Main Relay Type	Main relay type	0~100	The value is 0 by default.
Pull In Voltage	Pull-in voltage	0.0~100.0 Volt	Pull-in voltage of main relay. Short-time voltage of the relay pulled in by the system when the relay is connected for the first time.
Pull In Time	Pull-in time *	100~3000 ms	When the EM brake is switched on for the first time, a high initial voltage is allowed to ensure that the brake is properly plugged.
Holding Voltage	Holding voltage	0.0~100.0 Volt	Holding voltage of main relay.
Fault Detection Enable	Fault detection enable	On/Off	Main relay detection enable bit: On- enabled; Off -disabled.

EM Brake Control

Parameter	Parameter	Data rate	Description
Zero Speed Threshold	EM brake zero speed threshold rpm	5~100 rpm	Set the EM brake zero speed threshold. When the motor speed of the vehicle is less than this value, the vehicle is considered to be at zero speed, and the delay is performed using Zero Speed Threshold Time. When the EM brake is locked, setting this speed too high may lead to sudden stop and vibration of the vehicle.
Zero Speed Threshold Time	EM brake zero speed threshold time (ms)	0~500 ms	Set the duration of the motor speed lower than the EM brake zero speed to prevent the instantaneous peak of the motor speed from resulting in the EM brake error control.
Position Hold Settling Time	Speed recovery time before locking	0~5000 ms	Determine how long the position hold function is allowed to operate before the EM brake is locked. This time should be set long enough for the position to be stable. Note: This parameter applies only if speed mode or simple speed mode is selected and position holding mode is enabled or EM brake type = 2.

EM Brake Control → Mtr1 EM Brake

Parameter	Parameter	Data rate	Description
EM Brake Type	EM brake type :0 = no EM brake function; 1 = EM brake controlled by interlock; 2 = EM brake controlled by interlock and neutral throttle.	0~2	The EM brake type can be configured as follows: 0: EM brake function disabled. 1: EM brake controlled by interlock. As long as the interlock is closed (interlock = On), the controller will release the EM brake. (For the existing configuration, the EM brake is turned on upon powering on) 2: EM brake controlled by interlock and neutral throttle.
Pull In Voltage	EM brake starting voltage	0.0~100.0 Volt	When the EM brake is switched on for the first time, a high initial voltage is allowed to ensure that the brake is properly plugged in; and after 1 second, the peak voltage drops to the holding voltage.
Holding Voltage	EM brake holding voltage	0.0~100.0 Volt	After the EM brake is energized for 1s, a lower average voltage is allowed to be applied to the brake coil. But this parameter must be set high enough to allow the vehicle to safely pull in the brake under all shock and vibration conditions.
Set EM Brake On Fault	Set EM brake on fault		When it is set to On, the controller will close the EM brake if a fault occurs that requires the EM brake to be turned off.
Brake Set Time	EM brake locking delay	40~2000 ms	Estimated time for the physical release of the EM brake after the pull-in voltage is applied. It is used to ensure that the torque is established before the brake is released to prevent the vehicle from rolling back and reversing when the EM brake is released.
Torque Release Time	Torque release delay	40~2000 ms	Determine whether to record the preload torque so as to enable the preload torque after releasing the EM brake and prevent vehicle rollback.
Brake Release Time	EM brake release delay	40~2000 ms	Estimated time for the physical release of the EM brake after the pull-in voltage is applied. It is used to ensure that the torque is established before the brake is released to prevent the vehicle from rolling back and reversing when the EM brake is released.

EM Brake Control →Mtr1 EM Brake (continued)

Parameter	Parameter	Data rate	Description
Torque Preload Enable	Torque preload function switch		Determine whether to record the preload torque so as to enable the preload torque after releasing the EM brake and prevent vehicle rollback. On - preload torque function enabled; Off- preload torque function disabled.
Torque Preload Cancel Delay	Torque preload cancel delay	0~120 Seconds	The timer will be started when the EM brake is closed, and the preload torque will be canceled after timeout. Setting it to 0 disables the cancel function.

EM Brake Control →Mtr2EM Brake

Parameter	Parameter	Data rate	Description
EM Brake Type	EM brake type :0 = no EM brake function; 1 = EM brake controlled by interlock; 2 = EM brake controlled by interlock and neutral throttle.	0~2	The EM brake type can be configured as follows: 0: EM brake function disabled. 1: EM brake controlled by interlock. As long as the interlock is closed (interlock = On), the controller will release the EM brake. (For the existing configuration, the EM brake is turned on upon powering on) 2: EM brake controlled by interlock and neutral throttle.
Pull In Voltage	EM brake starting voltage	0.0~100.0 Volt	When the EM brake is switched on for the first time, a high initial voltage is allowed to ensure that the brake is properly plugged in; and after 1 second, the peak voltage drops to the holding voltage.
Holding Voltage	EM brake holding voltage	0.0~100.0 Volt	After the EM brake is energized for 1s, a lower average voltage is allowed to be applied to the brake coil. But this parameter must be set high enough to allow the vehicle to safely pull in the brake under all shock and vibration conditions.
Set EM Brake On Fault	Set EM brake on fault	On/Off	When it is set to On, the controller will close the EM brake if a fault occurs that requires the EM brake to be turned off. When it is set to Off, if a fault occurs that requires the electromagnetic brake to be closed immediately, the electromagnetic brake will delay until the speed approaches zero before closing the electromagnetic brake.
Brake Set Time	EM brake locking delay	40~2000 ms	Estimated electromagnetic brake physical holding delay time after voltage release.
Torque Release Time	Torque release delay	40~2000 ms	Determine whether to record the preload torque so as to enable the preload torque after releasing the EM brake and prevent vehicle rollback on the slope.
Brake Release Time	EM brake release delay	40~2000 ms	Estimated time for the physical release of the EM brake after the pull-in voltage is applied. It is used to ensure that the torque is established before the brake is released to prevent the vehicle from rolling back and reversing when the EM brake is released.
Torque Preload Enable	Torque preload function switch	On/Off	Determine whether to record the preload torque so as to enable the preload torque after releasing the EM brake and prevent vehicle rollback. On - preload torque function enabled; Off- preload torque function disabled.
Torque Preload Cancel Delay	Torque preload cancel delay	0~120 Seconds	The timer will be started when the EM brake is closed, and the preload torque will be canceled after timeout. Setting it to 0 disables the cancel function.

Drivers →Driver1

Parameter	Parameter	Data rate	Description
Type	Driver type	0~8	Type 8 is an ordinary on-off valve, and type 7 is proportional valve. 0- 4 indicates that output is disabled.
Pull In Voltage	Pull-in voltage	0.0~100.0	Pull-in voltage of ordinary on-off valve.
Pull In Time	Pull-in time *	100~3000	Holding time of the pull-in voltage, in the unit of ms.
Holding Voltage	Holding voltage	0.0~100.0	Holding voltage of the ordinary on-off valve.
Fault Detect Enable	Fault detection enable	On/Off	On is to enable the fault detection of this driver port enabled; Off is to disable the fault detection of this driver port.

Drivers → Driver1 → Proportional Driver

Parameter	Parameter	Data rate	Description
Max Current	Maximum current of proportional valve drive	0.00~2.00 Ampere	Maximum current of proportional valve drive
Min Current	Minimum current of proportional valve drive	0.00~2.00 Ampere	Minimum current of proportional valve drive
Dither %	Dither amplitude	0~100 %	PD duty cycle
Dither Period	Dither period	16~112 ms	PD period
Kp	Proportional valve controller Kp	1~100 %	Proportional valve controller Kp
Ki	Proportional valve controller Ki	1~100 %	Proportional valve controller Ki

Drivers → Driver2

Parameter	Parameter	Data rate	Description
Type	Driver type	0~8	0~7 - closed to change the drive output function; 8 - normal switching valve.
Pull In Voltage	Pull-in voltage	0.0~100.0	Pull-in voltage of ordinary on-off valve.
Pull In Time	Pull-in time *	100~3000	Holding time of the pull-in voltage, in the unit of ms.
Holding Voltage	Holding voltage	0.0~100.0	Holding voltage of the ordinary on-off valve.
Fault Detect Enable	Fault detection enable	On/Off	On is to enable the fault detection of this driver port enabled; Off is to disable the fault detection of this driver port.

Drivers → Driver3

Parameter	Parameter	Data rate	Description
Type	Driver type	0~8	0~7 - closed to change the drive output function; 8 - normal switching valve.
Pull In Voltage	Pull-in voltage	0.0~100.0	Pull-in voltage of ordinary on-off valve.
Pull In Time	Pull-in time *	100~3000	Holding time of the pull-in voltage, in the unit of ms.
Holding Voltage	Holding voltage	0.0~100.0	Holding voltage of the ordinary on-off valve.
Fault Detect Enable	Fault detection enable		On is to enable the fault detection of this driver port enabled; Off is to disable the fault detection of this driver port.

Motor → Motor1/Motor2

Parameter	Parameter	Data rate	Description
Change SpeedDir	Change the direction of motor speed command	On/Off	On - negated; Off- normal, not negated

Motor → Motor1/Motor2 → Motor Characterization Test

Parameter	Parameter	Data rate	Description
Test Enable	Motor identification switch	0~1	This parameter is used to enable the motor identification function. 0 - motor identification function disabled; 1 - motor identification function enabled.
Test Throttle	Motor rotation direction during motor identification	0~2	This parameter is used to change the motor rotation direction during motor identification; ensure that the motor rotate forwards during motor identification. Currently, this parameter is fixed to 1 by default.
Motor Poles	Number of motor pole pairs (number of pole pairs in the program; PC is the pole number)	2~24	Number of motor poles. This parameter must be correct. For example, this parameter is set to 10 for a motor with 5 pairs of poles.
Test Max Speed	Motor identification speed	500~5000 rpm	This parameter is used to set the maximum control speed allowed for motor identification. It has no role and is used for subsequent asynchronous motor identification.
Test Max Current	Motor identification current	20~100 %	This parameter is used to set the maximum control current allowed for motor identification. It has no role and limits the maximum identification current to 20 A for the subsequent asynchronous motor identification.

Motor → Motor1/Motor2 → Field Weakening Control

Parameter	Parameter	Data rate	Description
FW Base Speed	Field weakening start speed	200~12000	Field weakening control reference speed.
Weakening Rate Drive	Field weakening rate	0~100	It determines the field weakening control gain. Too low gain may cause that the vehicle does not accelerate smoothly when accelerating from moderate to high speeds; and too high gain may result in a possible high frequency oscillation (usually audible) when the vehicle accelerates from moderate to high speeds.

Motor → Motor1/Motor2 → Swap Motor Phases

Parameter	Parameter	Data rate	Description
Swap Motor Phases	Switching motor phase lines	On/Off	Exchange the motor phase lines. This parameter has the same effect as any two-phase cable in the physical exchange motor three-phase line. Note: This parameter is used with the "swap encoder direction" to ensure the correct motor rotation direction.

Motor → Motor1/Motor2 → Encoder

Parameter	Parameter	Data rate	Description
Encoder Type	Encoder type	0~3	0 - ABI encoder, 1 - sin/cos encoder
Swap Encoder Direction	Swap encoder direction		It changes the effective direction of rotation of the encoder. Note: This parameter is used with the "swap motor phases" to ensure the correct motor rotation direction.

Motor → Motor1/Motor2 → Encoder → Speed Filters (SinCos Sensor)

Parameter	Parameter	Data rate	Description
Sin Offset	Sin Offset	0~4095	Middle offset of Sin signal of the Sin/Cos encoder
Sin Nominal	Normalized value of Sin signal	0~4095	Normalized value of Sin signal, ADC sampling value of Max-Min
Cos Offset	Cos Offset	0~4095	Middle offset of Cos signal of the Sin/Cos encoder
Cos Nominal	Normalized value of Cos signal	0~4095	Normalized value of Cos signal, ADC sampling value of Max-Min
Fault Threshold	sincos fault detection threshold	0~500	sincos fault detection threshold

Motor → Motor1/Motor2 → Encoder

Parameter	Parameter	Data rate	Description
Encoder Steps	Number of encoder lines	24~4096	Set the encounter pulse count corresponding to each revolution of the motor.
Encoder offset	Encoder offset	0.000~1.000	Encoder angle offset, with 0.5 corresponding to a 180° electrical angle.

Motor → Motor1/Motor2 → Encoder Encoder Fault Setup

Parameter	Parameter	Data rate	Description
Fault Detection Enable	Encoder fault detection enable		Encoder fault detection enable.
Encoder Pulse Fault Detect Time	Encoder pulse fault detection time (ms)	0.0~3.0 Seconds	Time for the encoder pulse count and encoder mismatch detection, setting this parameter is to zero disables the fault detection. This parameter will set a timer after the throttle is released. If the encoder pulse count does not match, the motor will still accelerate at a high drive current. Note that the motor may rotate at high speeds for a few seconds before the controller detects the fault correctly.
Fault Stall Time	Locked rotor detection time (ms)	0~10 Seconds	The timer is started at the motor speed of zero under the maximum throttle input condition and the locked rotor fault will be set when the timer expires.

Motor → Motor1/Motor2 → Motor Temperature Control

Parameter	Parameter	Data rate	Description
Sensor Enable	Motor temperature sensor enable		When it is set to ON, the motor thermal cutback and motor temperature compensation functions are enabled. This parameter can only be used if the temperature sensor is configured correctly.
Sensor Type	Category of motor temperature sensors: 1 = KTY83—122; 2 = 2 sensors of Type 1 in series; 3 = KTY84—130 or KTY84—150; 4 = 2 sensors of Type 3 in series; 5 = PT1000.	1~5	Configurable categories of motor temperature sensors: 1: KTY83-122; 2: 2 sensors of Type 1 in series; 3: KTY84-130 or KTY84-150; 4: 2 sensors of Type 3 in series; 5: PT1000.
Sensor Offset	Motor temperature offset calibration	-50~50 deg C	This parameter can correct the temperature detected by the motor temperature sensor.
Braking Thermal Cutback Enable	Motor thermal cutback brake current enable		Setting to ON allows thermal cutback control of the drive and brake currents; Setting to OFF only allows thermal cutback control of the drive current.
Temperature Hot	Initial temperature of motor thermal current limit	0~250 deg C	Initial temperature of motor thermal current limit control.
Temperature Max	Maximum allowable motor temperature	0~250 deg C	The final temperature of the motor thermal current limit control. The current is reduced to 0 when it is higher than this temperature.
Motor Temp LOS Max Speed	Maximum allowable motor speed in case of motor temperature sensor fault	100~5000 rpm	Maximum allowable motor speed in case of motor temperature sensor fault.

Battery

Parameter	Parameter	Data rate	Description
Nominal Voltage	Rated battery voltage, in KV	24.0~144.0 Volt	Set as the nominal battery pack voltage of the vehicle. This parameter is used to determine the thresholds for system overvoltage and undervoltage protection.
User Overvoltage	Battery overvoltage, expressed as a percentage	105~200 %	Battery overvoltage, expressed as a percentage of the nominal battery voltage.
User Undervoltage	Battery undervoltage, expressed as a percentage	5~95 %	Battery undervoltage, expressed as a percentage of the nominal battery voltage.
Kp UV	Undervoltage control parameter Kp	0.0~100.0 %	Proportional term for undervoltage control (Kp).
Ki UV	Undervoltage control parameter Ki	0~100 %	Integral term (Ki) for undervoltage control.
Ramp Limit Start Voltage	Ramp limit start voltage	0~144 V	When the ramp is detected to be greater than the speed limit point and the current bus voltage is greater than the set value, the ramp speed limit is set and the its ratio is realized according to the ramp speed limit mapping.
MDC Limit Cutback Overtime	Timeout for reducing the maximum drive current limit value, in seconds	0.0~100.0 Seconds	When the undervoltage time exceeds this set time, the maximum drive current limit value will be reduced; and setting it to 0 will disable this function, that is, the maximum drive current is not allowed to be reduced in case of undervoltage.
MDC Limit Min Cutback	Minimum limiting amplitude of maximum drive current limit, indicated as a percentage	1~100 %	Minimum limiting amplitude for reducing the maximum drive current limit value in case of undervoltage.
Battery Max Drive Current	Maximum output current limit of the battery	0~1000 Ampere	Maximum battery discharge current limit.
Battery Max Regen Current	Maximum battery charging current limit	0~1000 Ampere	Maximum battery charging current limit.

Controller

Parameter	Parameter	Data rate	Description
Controller Max Temperature	Maximum controller temperature	-40~95 deg C	Maximum temperature that the controller can tolerate. It is recommended to set this value between 85°C ~ 95°C.
Controller Hot Temperature	Controller thermal cutback	-40~95 deg C	Temperature point at which the controller starts to reduce the current (driving and regenerative braking current). It is recommended to set this value between 75°C to 85°C.
Controller Min Temperature	Minimum temperature of the controller	-40~95 deg C	Minimum temperature tolerated by the controller. It is recommended to set this between -40°C to -30°C.
Controller Cold Temperature	Controller low temperature cutback	-40~95 deg C	The low temperature point at which the controller starts to reduce the current. It is recommended to set this between -30°C to -20°C.
Temperature LOS Max Speed	Derated running speed in case of temperature sensor abnormality in the controller	100~5000 rpm	Derated speed in case of temperature sensor abnormality in the controller.

Input Type

Parameter	Parameter	Data rate	Description
Analog Input1 Type	Analog input 1 type	0~10	0: No function; 1: Analog throttle input 1; 2: Analog throttle input 2; 3: Steering throttle input; 4: brake throttle input; 5: Throttle input for POT4. 6~10: Not used
Analog Input2 Type	Analog input 2 type	0~10	0: No function; 1: Analog throttle input 1; 2: Analog throttle input 2; 3: Steering throttle input; 4: brake throttle input; 5: Throttle input for POT4. 6~10: Not used
Analog Input3 Type	Analog input 3 type	0~10	0: No function; 1: Analog throttle input 1; 2: Analog throttle input 2; 3: Steering throttle input; 4: brake throttle input; 5: Throttle input for POT4. 6~10: Not used
Analog Input4 Type	Analog input 4 type	0~10	0: No function; 1: Analog throttle input 1; 2: Analog throttle input 2; 3: Steering throttle input; 4: brake throttle input; 5: Throttle input for POT4.
Analog Input5 Type	Analog input 5 type	0~10	0: No function; 1: Analog throttle input 1; 2: Analog throttle input 2; 3: Steering throttle input; 4: brake throttle input; 5: Throttle input for POT4.
Analog Input6 Type	Analog input 6 type	0~10	0: No function; 1: Analog throttle input 1; 2: Analog throttle input 2; 3: Steering throttle input; 4: brake throttle input; 5: Throttle input for POT4.

Input Type (continued)

Parameter	Parameter	Data rate	Description
Digital Input1 Type	Digital input 1 type	0~10	0: No function mapping; 1: Interlocking; 2: Forward (analog throttle works only); 3: Reverse (analog throttle works only). 4: Right-turn (analog steering throttle works, effective only) 5: Left-turn (analog steering throttle works, effective only) 6: Descending enable switch; 7: Speed stationary switch; 8: Drive interface test enable; 9: Proportional ascending valve enable input switch; 10: Proportional descending valve enable input switch.
Digital Input2 Type	Digital input 2 type	0~10	0: No function mapping; 1: Interlocking; 2: Forward (analog throttle works only); 3: Reverse (analog throttle works only). 4: Right-turn (analog steering throttle works, effective only) 5: Left-turn (analog steering throttle works, effective only) 6: Descending enable switch; 7: Speed stationary switch; 8: Drive interface test enable; 9: Proportional ascending valve enable input switch; 10: Proportional descending valve enable input switch.
Digital Input3 Type	Digital input 3 type	0~10	0: No function mapping; 1: Interlocking; 2: Forward (analog throttle works only); 3: Reverse (analog throttle works only). 4: Right-turn (analog steering throttle works, effective only) 5: Left-turn (analog steering throttle works, effective only) 6: Descending enable switch; 7: Speed stationary switch; 8: Drive interface test enable; 9: Proportional ascending valve enable input switch; 10: Proportional descending valve enable input switch.
Digital Input4 Type	Digital input 4 type	0~10	0: No function mapping; 1: Interlocking; 2: Forward (analog throttle works only); 3: Reverse (analog throttle works only). 4: Right-turn (analog steering throttle works, effective only) 5: Left-turn (analog steering throttle works, effective only) 6: Descending enable switch; 7: Speed stationary switch; 8: Drive interface test enable; 9: Proportional ascending valve enable input switch; 10: Proportional descending valve enable input switch.

Input Type (continued)

Parameter	Parameter	Data rate	Description
Digital Input5 Type	Digital input 5 type	0~10	0: No function mapping; 1: Interlocking; 2: Forward (analog throttle works only); 3: Reverse (analog throttle works only). 4: Right-turn (analog steering throttle works, effective only) 5: Left-turn (analog steering throttle works, effective only) 6: Descending enable switch; 7: Speed stationary switch; 8: Drive interface test enable; 9: Proportional ascending valve enable input switch; 10: Proportional descending valve enable input switch.
Digital Input6 Type	Digital input 6 type	0~10	0: No function mapping; 1: Interlocking; 2: Forward (analog throttle works only); 3: Reverse (analog throttle works only). 4: Right-turn (analog steering throttle works, effective only) 5: Left-turn (analog steering throttle works, effective only) 6: Descending enable switch; 7: Speed stationary switch; 8: Drive interface test enable; 9: Proportional ascending valve enable input switch; 10: Proportional descending valve enable input switch.

Input Type → Fault Detect

Parameter	Parameter	Data rate	Description
A11 Min Voltage	Analog input 1 low voltage threshold	0.00~24.00	The throttle voltage below which a throttle low voltage fault is reported.
A11 Max Voltage	Analog input 1 high voltage threshold	0.01~24.00	The throttle voltage above which a throttle high voltage fault is reported.
A12 Min Voltage	Analog input 2 low voltage threshold	0.00~24.00	The brake voltage below which a brake low voltage fault is reported.
A12 Max Voltage	Analog input 2 high voltage threshold	0.01~24.00	The brake voltage above which a brake high voltage fault is reported.
A13 Min Voltage	Analog input 3 low voltage threshold	0.00~24.00	The brake voltage below which a brake low voltage fault is reported.
A13 Max Voltage	Analog input 3 high voltage threshold	0.01~24.00	The brake voltage above which a brake high voltage fault is reported.
A14 Min Voltage	Analog input 4 low voltage threshold	0.00~24.00	The brake voltage below which a brake low voltage fault is reported.
A14 Max Voltage	Analog input 4 high voltage threshold	0.01~24.00	The brake voltage above which a brake high voltage fault is reported.

CAN interface (Input Type)

Parameter	Parameter	Data rate	Description
CAN Net Enable	CAN networking enable, 0 indicates without networking and using ID1; 1 indicates with networking, using xx	On/Off	OFF indicates CAN networking unavailable, and "CAN node 1 ID" is used as the ID of this controller. ON indicates CAN networking available, and the ID of this controller is associated with the SWICH pin. It is recommended to set this value to Off.
CAN Node ID 1	ID of CAN node	0~120	CAN node ID of the controller.
CAN PDORX Type	CAN PDO received protocol type	0~8	CAN PDO received protocol type: 0 - CAN protocol unavailable, 1 - ZAPI protocol, 2 - Dingli PCU throttle resolution protocol, 3 - not available, 4 - Curtis protocol.
CAN PDO TX Type	CAN PDO transmitted protocol type	0~8	CAN PDO transmitted protocol type: 0 - CAN protocol unavailable, 1 - ZAPI protocol, 2 - not available, 3 - not available, 4 - Curtis protocol.
Baud Rate (Kbps)	CAN baud rate	0~1000	CAN baud rate.

CAN interface (Input Type) (continued)

Parameter	Parameter	Data rate	Description
Heartbeat Rate	CAN heartbeat rate	10~500	Controller heartbeat transmission cycle.
Emergency Message Rate	Emergency message transmission interval	10~500	EMG message frame transmission cycle.

Default parameters

Parameters	Default Value	Unit
Parameters	Default Value	Unit
Parameter Version	20001100	
IMU Factory Calibration	0	
Trailer Mode Enable	2	
A Request Speed Factor	3,077	
A Feedback Speed Factor	6	
Mtr1 Forward Max Speed	4000	rpm
Mtr1 Reverse Max Speed	4000	rpm
Mtr2 Forward Max Speed	4000	rpm
Mtr2 Reverse Max Speed	4000	rpm
Motor1 Control Mode	3	
Motor2 Control Mode	3	
Independent Control Type	0	
Motor Param Sync	0	
Kp	20	%
Ki	20	%
Accel Rate	3	Seconds
Decel Rate	3	Seconds
Brake Decel Rate	3	Seconds
Accel Rate	3	Seconds
Decel Rate	3	Seconds
Brake Decel Rate	3	Seconds
Kp	20	%
Ki	20	%
Accel Rate	3	Seconds
Decel Rate	3	Seconds
Brake Decel Rate	3	Seconds
Accel Rate	3	Seconds
Decel Rate	3	Seconds
Brake Decel Rate	3	Seconds
Kp	40	%
Ki LS	40	%
Ki HS	50	%
Full Accel Rate HS	5	Seconds
Full Accel Rate LS	5	Seconds
Low Accel Rate	10	Seconds
Full Brake Rate HS	0,7	Seconds
Full Brake Rate LS	0,7	Seconds
Low Brake Rate	0,7	Seconds
Full Accel Rate HS	5	Seconds
Full Accel Rate LS	5	Seconds
Low Accel Rate	10	Seconds

Default parameters (continued)

Parameters	Default Value	Unit
Full Brake Rate HS	0,7	Seconds
Full Brake Rate LS	0,7	Seconds
Low Brake Rate	0,7	Seconds
Decel Rate HS	1,5	Seconds
Decel Rate LS	3	Seconds
Partial Decel Rate	4	Seconds
Typical Max Speed	4000	rpm
HS (High Speed)	70	%
LS (Low Speed)	40	%
Reversal Soften	30	%
Kp	40	%
Ki LS	40	%
Ki HS	50	%
Full Accel Rate HS	5	Seconds
Full Accel Rate LS	5	Seconds
Low Accel Rate	10	Seconds
Full Brake Rate HS	0,7	Seconds
Full Brake Rate LS	0,7	Seconds
Low Brake Rate	0,7	Seconds
Full Accel Rate HS	5	Seconds
Full Accel Rate LS	5	Seconds
Low Accel Rate	10	Seconds
Full Brake Rate HS	0,7	Seconds
Full Brake Rate LS	0,7	Seconds
Low Brake Rate	0,7	Seconds
Decel Rate HS	1,5	Seconds
Decel Rate LS	3	Seconds
Partial Decel Rate	4	Seconds
Typical Max Speed	4000	rpm
HS (High Speed)	70	%
LS (Low Speed)	40	%
Reversal Soften	30	%
Forward Max Speed	4000	rpm
Reverse Max Speed	4000	rpm
Speed1 Limit	100	%
Speed2 Limit	100	%
Speed3 Limit	100	%
Speed4 Limit	100	%
Neutral Free Sliding Enable	Off	
Restraint Forward	50	%
Restraint Back	50	%
Resraint Time	500	ms
Soft Stop Speed	100	rpm
Opposite Delay Time	100	ms
Over Speed Rate	20	%
Over Speed Time	3000	ms
Forward Max Speed	4000	rpm
Reverse Max Speed	4000	rpm

Default parameters (continued)

Parameters	Default Value	Unit
Speed1 Limit	100	%
Speed2 Limit	100	%
Speed3 Limit	100	%
Speed4 Limit	100	%
Neutral Free Sliding Enable	Off	
Restraint Forward	50	%
Restraint Back	50	%
Resraint Time	500	ms
Soft Stop Speed	100	rpm
Opposite Delay Time	100	ms
Over Speed Rate	20	%
Over Speed Time	3000	ms
Position Hold Enable	On	
Position Hold Timeout	20	Seconds
Kp	15	%
Kd	40	%
Zero Speed Threshold	20	rpm
Entry Rate	50	%
Exit Rollback Reduction	50	%
IMU Install Type	0	
IMU Calibration	0	
Roll Offset (deg)	0	
Pitch Offset (deg)	0	
IMU LOS Threshold	5	%
IMU LOS Speed	4000	rpm
Quaternion KP ZS	1	
Quaternion KP	0,004	
Quaternion KI	0,3	
Steering Differential Enable	Off	
Steering Differential Check Enable	0	
Steering Differential Type	0	
Vehicle GearRate	0,02	
Vehicle WheelRadius(cm)	19,05	
Vehicle Length	1,87	m
Vehicle Width	1,02	m
Steering Min Speed	0	rpm
Steering Max Speed	4000	rpm
Steering Differential Warning Threshold	0	%
Steering Differential Fault Threshold	100	%
Steer Angular Rate Death Deg/s	1	
Speed Limit Method	11	
Ramps Angle Map0	4	
Ramps Angle Map1	6	
Ramps Angle Map2	8	
Ramps Angle Map3	9	
Ramps Angle Map4	10	
Ramps Angle Map5	20	
Ramps Angle Map6	25	

Default parameters (continued)

Parameters	Default Value	Unit
Ramps Angle Map7	30	
Ramps Speed Limit Map1	47	%
Ramps Speed Limit Map2	37	%
Ramps Speed Limit Map3	29	%
Ramps Speed Limit Map4	24	%
Ramps Speed Limit Map5	19	%
Ramps Speed Limit Map6	17	%
Ramps Speed Limit Map7	14	%
Ramp Increasing Rate	1	
Ramp Decreasing Rate	0,05	
Ramp Speed Limit Filter	2	
Leave Ramp Time	1000	ms
Ramp Limit Monitor	On	
Opposite Exit Time Ms	13	ms
Stall Current Threshold	253	Ampere
Drive Current Limit	100	%
Regen Current Limit	100	%
Brake Current Limit	100	%
Interlock Brake Current Limit	50	%
EMR Current Limit	87	%
Max Speed Point Current Limit	100	%
PL Nominal Speed	1000	rpm
Delta Speed	250	rpm
Nominal	100	%
Plus Delta	100	%
Plus 2xDelta	100	%
Plus 4xDelta	100	%
Plus 8xDelta	100	%
Plus 12xDelta	100	%
Plus 16xDelta	80	%
Nominal	100	%
Plus Delta	100	%
Plus 2xDelta	100	%
Plus 4xDelta	100	%
Plus 8xDelta	100	%
Plus 12xDelta	100	%
Plus 16xDelta	100	%
Nominal	80	%
Plus Delta	70	%
Plus 2xDelta	60	%
Plus 4xDelta	50	%
Plus 8xDelta	50	%
Plus 12xDelta	50	%
Plus 16xDelta	50	%
Stall Current Threshold	253	Ampere
Drive Current Limit	100	%
Regen Current Limit	100	%
Brake Current Limit	100	%

Default parameters (continued)

Parameters	Default Value	Unit
Interlock Brake Current Limit	50	%
EMR Current Limit	87	%
Max Speed Point Current Limit	100	%
PL Nominal Speed	1000	rpm
Delta Speed	250	rpm
Nominal	100	%
Plus Delta	100	%
Plus 2xDelta	100	%
Plus 4xDelta	100	%
Plus 8xDelta	100	%
Plus 12xDelta	100	%
Plus 16xDelta	80	%
Nominal	100	%
Plus Delta	100	%
Plus 2xDelta	100	%
Plus 4xDelta	100	%
Plus 8xDelta	100	%
Plus 12xDelta	100	%
Plus 16xDelta	100	%
Nominal	80	%
Plus Delta	70	%
Plus 2xDelta	60	%
Plus 4xDelta	50	%
Plus 8xDelta	50	%
Plus 12xDelta	50	%
Plus 16xDelta	50	%
Throttle Type	2	
Throttle Swap Direction	Off	
Deadband	0,7	Volt
Map	30	%
Max	4,5	Volt
Offset	0	%
Deadband	0,7	Volt
Map	30	%
Max	4,5	Volt
Offset	0	%
Throttle Filter	10	Hz
HPD SRO Type	0	
Sequencing Delay	0,1	Seconds
HPD Throttle Input Limit	25	%
Brake Pedal Enable	Off	
Brake Type	2	
Brake Deadband	0,3	Volt
Brake Map	30	%
Brake Max	4,5	Volt
Brake Offset	0	%
Brake Filter	10	Hz
Steering Type	2	

Default parameters (continued)

Parameters	Default Value	Unit
Deadband	0,3	Volt
Map	30	%
Max	4,5	Volt
Offset	0	%
Deadband	0,3	Volt
Map	30	%
Max	4,5	Volt
Offset	0	%
Steering Filter	10	Hz
Enable	Off	
Type	2	
Deadband	0,3	Volt
Map	30	%
Max	4,5	Volt
Offset	0	%
Filter	10	Hz
Main Relay Type	25	
Pull In Voltage	24	Volt
Pull In Time	1000	ms
Holding Voltage	18	Volt
Fault Detect Voltage	16	Volt
Fault Detection Enable	On	
EM Brake Swap	Off	
Zero Speed Threshold	100	rpm
Zero Speed Threshold Time	496	ms
Position Hold Settling Time	3000	ms
EM Brake Type	2	
Pull In Voltage	24	Volt
Holding Voltage	18	Volt
Set EM Brake On Fault	On	
Brake Set Time	2000	ms
Torque Release Time	2000	ms
Brake Release Time	100	ms
Torque Preload Enable	On	
Torque Preload Cancel Delay	0	Seconds
Fault Detect Voltage	16	Volt
Fault Detect Enable	On	
EM Brake Type	2	
Pull In Voltage	24	Volt
Holding Voltage	18	Volt
Set EM Brake On Fault	On	
Brake Set Time	2000	ms
Torque Release Time	2000	ms
Brake Release Time	100	ms
Torque Preload Enable	On	
Torque Preload Cancel Delay	0	Seconds
Fault Detect Voltage	16	Volt
Fault Detect Enable	On	

Default parameters (continued)

Parameters	Default Value	Unit
Type	0	
Pull In Voltage	24	Volt
Pull In Time	1000	ms
Holding Voltage	18	Volt
Fault Detect Voltage	16	Volt
Fault Detect Enable	On	
Hyd Lower Enable	Off	
Max Current	2	Ampere
Min Current	0,05	Ampere
Dither %	0	%
Dither Period	16	ms
Kp	10	%
Ki	10	%
Type	0	
Pull In Voltage	24	Volt
Pull In Time	1000	ms
Holding Voltage	18	Volt
Fault Detect Voltage	16	Volt
Fault Detect Enable	On	
Type	0	
Pull In Voltage	24	Volt
Pull In Time	1000	ms
Holding Voltage	18	Volt
Fault Detect Voltage	16	Volt
Fault Detect Enable	On	
Motor Type	0	
Change SpeedDir	Off	
Typical Max Speed	4000	rpm
Test Enable	0	
Test Throttle	1	
Motor Poles	10	
Test Max Speed	1000	rpm
Test Max Current	20	%
SlipGain Correction Factor	100	%
User Torque LS(Ld-Lq)	25	
User Torque Flux(V.s)	95	
FW Base Speed	2200	rpm
Field Weakening Drive	100	%
Weakening Rate Drive	4	%
Min Field Current	0	Ampere
Auto Field Weakening	On	
Swap Motor Phases	0	
Encoder Type	1	
Swap Encoder Direction	Off	
Sin Offset	2120	
Sin Nominal	1630	
Cos Offset	2120	
Cos Nominal	1630	

Default parameters (continued)

Parameters	Default Value	Unit
Fault Threshold	300	
Encoder Steps	4096	
Encoder Offset	0,52	
Fault Detection Enable	Off	
Encoder Pulse Fault Detect Time	0,5	Seconds
Clear Fault Stall Time	5	Seconds
Fault Stall Time	3	Seconds
Fault Stall Speed	500	rpm
AB FilterWindow	0	
I FilterWindow	20	
Sensor Enable	On	
Sensor Type	3	
Sensor Offset	0	deg C
Braking Thermal Cutback Enable	Off	
Temperature Hot	125	deg C
Temperature Max	135	deg C
MotorTemp LOS Max Speed	800	rpm
BEMF Enable	On	
BEMF Over Speed Rate	135	%
BEMF Over Time	1	Seconds
Motor Type	0	
Change SpeedDir	On	
Typical Max Speed	4000	rpm
Test Enable	0	
Test Throttle	1	
Motor Poles	10	
Test Max Speed	1000	rpm
Test Max Current	20	%
SlipGain Correction Factor	100	%
User Torque LS(Ld-Lq)	25	
User Torque Flux(V.s)	95	
FW Base Speed	2200	rpm
Field Weakening Drive	100	%
Weakening Rate Drive	4	%
Min Field Current	0	Ampere
Auto Field Weakening	Off	
Swap Motor Phases	0	
Encoder Type	1	
Swap Encoder Direction	Off	
Sin Offset	2120	
Sin Nominal	1630	
Cos Offset	2120	
Cos Nominal	1630	
Fault Threshold	300	
Encoder Steps	4096	
Encoder Offset	0,52	
Fault Detection Enable	Off	
Encoder Pulse Fault Detect Time	0,5	Seconds

Default parameters (continued)

Parameters	Default Value	Unit
Clear Fault Stall Time	5	Seconds
Fault Stall Time	3	Seconds
Fault Stall Speed	500	rpm
AB FilterWindow	0	
I FilterWindow	20	
Sensor Enable	On	
Sensor Type	3	
Sensor Offset	0	deg C
Braking Thermal Cutback Enable	Off	
Temperature Hot	125	deg C
Temperature Max	135	deg C
MotorTemp LOS Max Speed	800	rpm
BEMF Enable	On	
BEMF Over Speed Rate	135	%
BEMF Over Time	1	Seconds
Nominal Voltage	24	Volt
User Overvoltage	140	%
User Undervoltage	80	%
Kp UV	10	%
Ki UV	0	%
Ramp Limit Start Voltage	33	Volt
MDC Limit Cutback Overtime	0	Seconds
MDC Limit Min Cutback	50	%
Battery Max Drive Current	400	Ampere
Battery Max Regen Current	400	Ampere
Controller Max Temperature	90	deg C
Controller Hot Temperature	80	deg C
Controller Min Temperature	-40	deg C
Controller Cold Temperature	-30	deg C
Temperature LOS MaxSpeed	800	rpm
EMR Enable	Off	
EMR Type	0	
EMR Dir Interlock	Off	
EMR Time Limit	3	Seconds
EMR Speed Limit	500	rpm
EMR Accel Rate	1	Seconds
EMR Decel Rate	0,5	Seconds
Interlock Type	0	
Interlock Brake Enable	On	
Interlock Brake Decel Rate HS	1,5	Seconds
Interlock Brake Decel Rate LS	3	Seconds
Interlock Brake Timeout	7	Seconds
Analog Input1 Type	1	
Analog Input2 Type	2	
Analog Input3 Type	3	
Analog Input4 Type	4	
Analog Input5 Type	0	
Analog Input6 Type	0	

Default parameters (continued)

Parameters	Default Value	Unit
Digital Input1 Type	1	
Digital Input2 Type	2	
Digital Input3 Type	3	
Digital Input4 Type	4	
Digital Input5 Type	5	
Digital Input6 Type	0	
A11 Min Voltage	0	Volt
A11 Max Voltage	5,5	Volt
A12 Min Voltage	0	Volt
A12 Max Voltage	5,5	Volt
A13 Min Voltage	0	Volt
A13 Max Voltage	5,5	Volt
A14 Min Voltage	0	Volt
A14 Max Voltage	5,5	Volt
Encoder Cross Check Enable	On	
Encoder Threshold	180	
CAN Cross Check Enable	On	
Target Threshold	100	
Error Number	100	
Travel Control Supervision Enable	On	
Stopped State Max Speed	4200	rpm
Follow Error Tolerance	500	rpm
Slide Car Check Delay	1,2	Seconds
Interlock Braking Supervision Enable	On	
Interlock Braking Supervision Tolerance	20	%
Interlock Ramp Delay	400	ms
Interlock Ramp Rate	4	Seconds
Interlock Zero Threshold	60	rpm
Interlock Braking Max Speed	300	rpm
CAN Net Enable	Off	
CAN Interlock Enable	0	
CAN NodeID DS14	6	
CAN NodeID M1	8	
CAN NodeID M2	9	
CAN NodeID Plus+1	136	
CAN PDO TX Type	1	
CAN PDO RX Type	1	
Baud Rate (Kbps)	250	
Heartbeat Rate	50	ms
Emergency Message Rate	100	ms
TPDO1 Message Rate	100	ms
TPDO2 Message Rate	100	ms
TPDO3 Message Rate	100	ms
TPDO4 Message Rate	100	ms
User PDO Recv Timeout	500	ms
User PDO Start Timeout	3000	ms
CAN Interlock ID	385	
CAN Interlock Bit	31	

Default parameters (continued)

Parameters	Default Value	Unit
CAN CRC Enable	Off	
CAN STUFFING Enable	Off	
PDO Error Cnt	10	
J1939 Receive PS	160	
J1939 Receive SA	208	
J1939 Send PS	224	
J1939 Send SA M1	239	
J1939 Send SA M2	240	
Run/Stop	On	
Gear Direction	On	
Throttle	On	
Interlock	On	
Reset Controller	Off	
Buzzer Alarm Enable	On	
Buzzer Alarm Type	1	

J1939 protocol

This standard specifies the communication protocol between the Motor Control Unit (MCU) and the Vehicle Control Unit (VCU) of vehicles. The CAN identifier of this standard is 29 bits, and the communication baud rate is 250 Kbps. This standard refers to the relevant provisions of CAN 2.0B and SAE J1939 protocol.

Format convention

Terminology

CAN: Controller Area Network

VCU: Vehicle Control Unit

MCU: Motor Control Unit

Data format

This protocol follows the Intel format with the low bit first and the high bit last. The data format follows the following specifications: Data sent by VCU and MCU: Actual Data = Message Data * Resolution + Offset. Suppose the data resolution is k , x is the data sent by the message, y is the actual value, and b is the offset, then:

$$y = kx + b$$

$$x = (y - b) / k$$

Datatype:

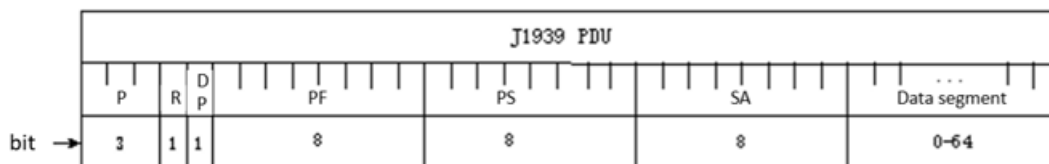
No.	Name of data type	Data type	Description
1	1 bit Bit Data	Bit	0~1
2	8 bit Unsigned Integer	UINT8	0~255
3	8 bit Signed Integer	SINT8	-128~127
4	16 bit Unsigned Integer	UINT16	0~65535
5	16 bit Signed Integer	SINT16	-32768~32767
6	32 bit Unsigned Integer	UINT32	0~4294967295
7	32 bit Signed Integer	SINT32	-2147483648~2147483647

Address allocation

Module	Abbreviation	Address	Note
Vehicle Control Unit	VCU	229 (0xE5)	New definition (Address configurable)
Motor Control Unit	MCU	46 (0x2E)	SAE1939 definition (Address configurable)

Protocol Data Unit (PDU) format

The SAE J1939-21 specification defines two PDU formats: PDU1 format (PS for the target address) and PDU2 format (PS for group extension). The PDU2 format is used for transmissions that do not point to a specific destination address. This standard adopts the PDU2 format. The frame format is as shown in the following figure:



Definition: P is the priority, R is the reserved bit, DP is the data page, PF is the PDU format, PS is the specific PDU, and SA is the source address.

CAN data frame definition

MCU Receive Data

Whether CRC-8 (Init 0x00) and Stuffing are enabled can be controlled by the corresponding parameter values. The PS and SA for MCU data reception can be modified through the J1939 Receive PS and J1939 Receive SA parameters. The PS value of VCU command frame 2 in the dual-message control mode is PS+1 of command frame 1.

R.1 VCU Command Frame 1

OUT	IN	LEN	ID						Period (ms)
VCU	MCU	8	0x18FFA1D0						<=100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	160	208	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	M1 Target Speed (Low byte first)	UINT16	1 rpm/bit	0	0~6000 (0~6000 rpm)			
BYTE2	7~0								
BYTE3	0	Reserved	1bit	Reserved	Reserved	Reserved			
	1	Interlock Enable	1bit	1 /bit	0	1: Enable 0: Disable (*1' signal must be sent to initiate rotation)			
	2	Reserved	1bit	Reserved	Reserved	Reserved			
	3	Forward	1bit	1 /bit	0	1: Forward 0: No action			
	4	Reverse	1bit	1 /bit	0	1: Reverse 0: No action			
	5	Reserved	2bit	Reserved	Reserved	Reserved			
	6	Trailer Mode	1bit	1 /bit	0	Trailer mode usage 1: Release the brake (Enter trailer mode) 0: Normal driving mode			
	7	Stuffing	1bit	1 /bit	0	0, 1 is sent alternately (Optional to enable or not)			
BYTE4	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE5	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE8	7~0	CRC-8 verification	UINT8	1 /bit	0	CRC-8 verification code (Init 0x00) (Optional to enable or not)			

Stuffing and CRC check can be configured to be enabled or not. If enabled, the VCU must send according to the rules for the message to be effectively recognized.

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

If it is in single-message mode, the 0x18FFA1D0 message can be sent or not, and the 0x18FFA1D0 message is not regarded as a determination message.

If it is in dual-message mode, the 0x18FFA1D0 message must be sent in accordance with the rules; otherwise, it will affect the motor rotation.

R.2 VCU Command Frame 2

OUT	IN	LEN	ID					Period (ms)	
VCU	MCU	8	0x18FFA1D0					<=100 ms	
			P	R	DP	PF	PS		SA
			6	0	0	255	161		208
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	M2 Target Speed (Low byte first)	UINT16	1 rpm/bit	0	0~6000 (0~6000 rpm)			
BYTE2	7~0								
BYTE3	0	Reserved	1bit	Reserved	Reserved	Reserved			
	1	Interlock Enable	1bit	1 /bit	0	1: Enable 0: Disable (*1' signal must be sent to initiate rotation)			
	2	Reserved	1bit	Reserved	Reserved	Reserved			
	3	Forward	1bit	1 /bit	0	1: Forward 0: No action			
	4	Reverse	1bit	1 /bit	0	1: Reverse 0: No action			
	5	Reserved	2bit	Reserved	Reserved	Reserved			
	6	Trailer Mode	1bit	1 /bit	0	Trailer mode usage 1: Release the brake (Enter trailer mode) 0: Normal driving mode			
	7	Stuffing	1bit	1 /bit	0	0, 1 is sent alternately (Optional to enable or not)			
BYTE4	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE5	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Init 0x00) (Optional to enable or not)			

MCU Send Data

In the communication direction, data is transmitted from the MCU to the VCU, and the VCU receives the data frame for parsing. Display the corresponding MCU parameters and respond to the faults reported by the MCU.

The SA (two SA can be set) for the MCU to send data can be set through the data parameter, and each of the two motors corresponds to its own SA.

The PS of the first message ID sent by the MCU (the PS of Motor 1 and motor 2 are the same) can be modified, and the PS values of subsequent message ids are accumulated by adding 1 to the PS of the first message.

T.1 MCU Transmit Frame 1

OUT	IN	LEN	ID						Period (ms)
MCU	VCU	8	0x18FFE0EF						100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	224	239	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	M1 Speed (Low byte first)	SINT16	1 rpm/bit	0	-6000~6000 (-6000~6000 rpm)			
BYTE2	7~0								
BYTE3	0	M1 Instruction Command	1bit	1 /bit	0	1: Run ; 0: Stop			
	1	Main Relay State	1bit	1 /bit	0	0: Main relay open 1: Main relay close			
	2	M1 Brake State	1bit	1 /bit	0	1: Release the brake 0: Brake lock			
	7~3	Reserved	5bit	Reserved	Reserved	Reserved			
BYTE4	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE5	0	Interlock State	1bit	1/bit	0	1: Interlock Enable 0: Interlock disable			
	1	M1 Forward	1bit	1 /bit	0	1: Forward 0: No action			
	2	M1 Reverse	1bit	1 /bit	0	1: Reverse 0: No action			
	6~3	Reserved	4bit	Reserved	Reserved	Reserved			
	7	Stuffing	1bit	1 /bit	0	0, 1 is sent alternately (Optional to enable or not)			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

T.2 MCU Transmit Frame 2

OUT	IN	LEN	ID						Period (ms)
MCU	VCU	8	0x18FFE0EF						100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	224	240	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	M2 Speed (Low byte first)	SINT16	1 rpm/bit	0	-6000~6000 (-6000~6000 rpm)			
BYTE2	7~0								
BYTE3	0	M2 Instruction Command	1bit	1 /bit	0	1: Run ; 0: Stop			
	1	Main Relay State	1bit	1 /bit	0	0: Main relay open 1: Main relay close			
	2	M2 Brake State	1bit	1 /bit	0	1: Release the brake 0: Brake lock			
	7~3	Reserved	5bit	Reserved	Reserved	Reserved			
BYTE4	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE5	0	Interlock State	1bit	1/bit	0	1: Interlock Enable 0: Interlock disable			
	1	M2 Forward	1bit	1 /bit	0	1: Forward 0: No action			
	2	M2 Reverse	1bit	1 /bit	0	1: Reverse 0: No action			
	6~3	Reserved	4bit	Reserved	Reserved	Reserved			
	7	Stuffing	1bit	1 /bit	0	0, 1 is sent alternately (Optional to enable or not)			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

T.3 MCU Transmit Frame 3

OUT	IN	LEN	ID						Period (ms)
MCU	VCU	8	0x18FFE1EF						100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	225	239	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	Fault Code	UINT16	1 /bit	0	See Fault Code Table			
BYTE2	7~0								
BYTE3	7~0	M1 Phase Current	SINT16	0.1 A/bit	0	-32768~32767 (-3276.8~3276.7 A)			
BYTE4	7~0								
BYTE5	7~0	M1 Torque	SINT16	0.1 Nm/bit	0	-32768~32767 (-3276.8~3276.7 Nm)			
BYTE6	7~0								
BYTE7	7~0	Motor1 Temperature	UINT8	1 °C/bit	-40	0~255 (-40~215 °C)			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

T.4 MCU Transmit Frame 4

OUT	IN	LEN	ID						Period (ms)
MCU	VCU	8	0x18FFE1EF						100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	225	240	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	Fault Code	UINT16	1 /bit	0	See Fault Code Table			
BYTE2	7~0								
BYTE3	7~0	M2 Phase Current	SINT16	0.1 A/bit	0	-32768~32767 (-3276.8~3276.7 A)			
BYTE4	7~0								
BYTE5	7~0	M2 Torque	SINT16	0.1 Nm/bit	0	-32768~32767 (-3276.8~3276.7 Nm)			
BYTE6	7~0								
BYTE7	7~0	Motor2 Temperature	UINT8	1 °C/bit	-40	0~255 (-40~215 °C)			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

T.5 MCU Transmit Frame 5

OUT	IN	LEN	ID					Period (ms)	
MCU	VCU	8	0x18FFE2EF					100 ms	
			P	R	DP	PF	PS		SA
			6	0	0	255	226		239
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	Bus Voltage	UINT16	0.1 V/bit	0	0~1050 (0.0~105.0 V)			
BYTE2	7~0								
BYTE3	7~0	Bus Current	SINT16	0.1 A/bit	0	-10000 ~ 10000 (-1000.0 ~ 1000.0 A)			
BYTE4	7~0								
BYTE5	7~0	BDI	UINT8	1 %/bit	0	0~100 % (Reserved)			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Controller Temperature 1	UINT8	1 °C/bit	-40	0~255 (-40~215 °C)			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

T.6 MCU Transmit Frame 6

OUT	IN	LEN	ID					Period (ms)	
MCU	VCU	8	0x18FFE2EF					100 ms	
			P	R	DP	PF	PS		SA
			6	0	0	255	226		240
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	Bus Voltage	UINT16	0.1 V/bit	0	0~1050 (0.0~105.0 V)			
BYTE2	7~0								
BYTE3	7~0	Bus Current	SINT16	0.1 A/bit	0	-10000 ~ 10000 (-1000.0 ~ 1000.0 A)			
BYTE4	7~0								
BYTE5	7~0	BDI	UINT8	1 %/bit	0	0~100 % (Reserved)			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Controller Temperature 2	UINT8	1 °C/bit	-40	0~255 (-40~215 °C)			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

If the first 7 bits of the sent message are respectively: 0x01 0x02 0x03 0x04 0x05 0x06 0x08, through CRC-8 verification, the eighth byte needs to send 0xF5. That is, the entire message is sent as: 0x01 0x02 0x03 0x04 0x05 0x06 0x08 0xF5.

T.7 MCU Transmit Frame 7

OUT	IN	LEN	ID						Period (ms)
MCU	VCU	8	0x18FFE3EF						100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	227	239	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	SSW Ver	UINT16	0.01 /bit	0	0~65535 (0~655.35)			
BYTE2	7~0								
BYTE3	7~0	TSW Ver	UINT16	0.01 /bit	0	0~65535 (0~655.35)			
BYTE4	7~0								
BYTE5	7~0	Lamp Display Code	UINT8	1 /bit	0	See Fault Code Table			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

T.8 MCU Transmit Frame 8

OUT	IN	LEN	ID						Period (ms)
MCU	VCU	8	0x18FFE3EF						100 ms
			P	R	DP	PF	PS	SA	
			6	0	0	255	227	240	
Data									
Position		Data Name	Datatype	Resolution	Offset	Value Range			
BYTE	BIT								
BYTE1	7~0	SSW Ver	UINT16	0.01 /bit	0	0~65535 (0~655.35)			
BYTE2	7~0								
BYTE3	7~0	TSW Ver	UINT16	0.01 /bit	0	0~65535 (0~655.35)			
BYTE4	7~0								
BYTE5	7~0	Lamp Display Code	UINT8	1 /bit	0	See Fault Code Table			
BYTE6	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE7	7~0	Reserved	UINT8	Reserved	Reserved	Reserved			
BYTE8	7~0	CRC-8 Verification	UINT8	1 /bit	0	CRC-8 verification code (Optional to enable or not)			

Fault code table

Lamp Display	Fault Name (EN)	CANopen Protocol		CANopen B Protocol
		CANopen Fault Code (Hex)	Danfoss Fault Code (Dec)	Fault Code (Hex)
1long 1short	Motor1 Overcurrent	FFB4	180	0x11
1long 2short	Motor2 Overcurrent	FFB4	180	0x12
1long 3short	Motor1 U Current Sensor Fault (M1)	6302	236	0x13
1long 3short	Motor1 V Current Sensor Fault (M1)	6302	236	0x13
1long 4short	Motor2 U Current Sensor Fault (M2)	6302	236	0x14
1long 4short	Motor2 V Current Sensor Fault (M2)	6302	236	0x14
1long 5short	Controller Severe Under temp	4411	96	0x15
1long 6short	Controller Severe Over temp	4210	62	0x16
1long 7short	B+ Severe Undervoltage	FF42	66	0x17
1long 8short	B+ Severe Overvoltage	FFCA	202	0x18
2long 1short	Controller Temp Sensor Fault (Open/Short circuit)	4211	250	0x21
2long 2short	Controller Under temp Cutback	4421	63	0x22
2long 2short	Controller Over temp Cutback	4431	67	0x22
2long 3short	B+ Undervoltage Cutback	4451	68	0x23
2long 4short	B+ Overvoltage Cutback	4452	69	0x24
2long 5short	Motor1 Temp Hot Cutback/Motor2 Temp Hot Cutback	4110	65	0x25
2long 6short	Motor1 Temp Sensor Fault/Motor2 Temp Sensor Fault	4311	218	0x26
2long 7short	Main Relay Open	5441	38	0x27
2long 8short	Main Relay Short	2250	223	0x28
2long 9short	Mtr1 MOS High Temp	4431	67	0x29
3long 1short	Main Relay Did Not Close (Not used)	FFE6	230	0x31
3long 2short	Main Relay Welded (Not used)	5442	37	0x32
3long 3short	Bus OverCurrent Cutback (Not used)	5611	101	0x33
3long 4short	Bus Severe OverCurrent (Not used)	FFB4	180	0x34
3long 5short	Motor1 Open/Motor2 Open	6528	72	0x35
3long 6short	Throttle1 Wiper High	FFF3	243	0x36
3long 7short	Throttle1 Wiper Low	FFF3	243	0x37
3long 8short	EEPROM Failure	3610	208	0x38
3long 9short	Mtr2 MOS High Temp	4431	67	0x39
4long 1short	HPD/Sequencing Fault	FF4F	79	0x41
4long 2short	Parameter Change Fault	FFC7	199	0x42
4long 3short	CAN Timeout	8130	248	0x43
4long 4short	Motor1 Stall/Motor2 Stall	FFD3	211	0x44
4long 5short	Motor1 Over Speed/Motor2 Over Speed	FFAF	175	0x45
4long 6short	Key switch Volt Fault (Beyond the range)	3101	170	0x46
4long 7short	MosDriver Volt Fault	FFE3	227	0x47
4long 8short	Motor1 U Mos Fault	FFE3	227	0x48
4long 9short	Vehicle Rev Run	7627	95	0x49
5long 1short	Motor1 V Mos Fault	FFE3	227	0x51
5long 2short	Motor1 W Mos Fault	FFE3	227	0x52
5long 3short	Motor2 U Mos Fault	FFE3	227	0x53
5long 4short	Motor2 V Mos Fault	FFE3	227	0x54

Lamp Display	Fault Name (EN)	CANopen Protocol		CANopen B Protocol
		CANopen Fault Code (Hex)	Danfoss Fault Code (Dec)	Fault Code (Hex)
5long 5short	Motor2 W Mos Fault	FFE3	227	0x55
5long 6short	Motor1 U VoltSensor Fault	FFE3	227	0x56
5long 7short	Motor1 V VoltSensor Fault	FFE3	227	0x57
5long 8short	Motor1 W VoltSensor Fault	FFE3	227	0x58
6long 1short	Motor2 U VoltSensor Fault	FFE3	227	0x61
6long 2short	Motor2 V VoltSensor Fault	FFE3	227	0x62
6long 3short	Motor2 W VoltSensor Fault	FFE3	227	0x63
6long 4short	InterCommunicate Fault	FF01	244	0x64
6long 5short	ParamSync Fault	FFC6	198	0x65
6long 6short	Precharge Failed	3130	60	0x66
6long 7short	Motor1 U MosVolt Fault	FFE3	227	0x67
6long 8short	Motor1 V MosVolt Fault	FFE3	227	0x68
6long 9short	Travel Control Fault	7628	97	0x69
6long 10short	Push Mode	7629	98	0x6A
6long 11short	Cross Check Fault	7630	99	0x6B
6long 12short	Interlock Braking Fault	7631	100	0x6C
6long 13short	BEMF Over Speed Fault	7632	102	0x6D
7long 1short	Motor1 W MosVolt Fault	FFE3	227	0x71
7long 2short	Motor2 U MosVolt Fault	FFE3	227	0x72
7long 3short	Motor2 V MosVolt Fault	FFE3	227	0x73
7long 4short	Motor2 W MosVolt Fault	FFE3	227	0x74
7long 5short	Motor1 Temp Severe Hot	FFB2	178	0x75
7long 6short	Motor2 Temp Severe Hot	FFB2	178	0x76
7long 7short	Motor1 Encoder Fault	FFA9	169	0x77
7long 8short	Motor2 Encoder Fault	FFA9	169	0x78
8long 1short	Internal Power Failure (Not used)	FFE3	227	0x81
8long 2short	+12V Supply Failure	FFE3	227	0x82
8long 3short	+12V OverCurrent Failure	FFE3	227	0x83
8long 4short	+5V Supply Failure(Not used)	FFE3	227	0x84
8long 5short	+5V OverCurrent Failure	FFE3	227	0x85
8long 6short	Throttle2Wiper High	FFE3	227	0x86
	Throttle2 Wiper Low			
	Brake High			
	Brake Low			
	A1 High			
	A1 Low			
	A12 High			
	A12 Low			
	A13 High			
	A13 Low			
	A14 High			
	A14 Low			
8long 7short	Digital InPut Overranges (Not used)	7633	103	0x87
8long 8short	Mtr1 EMBrake Failed to Set	7531	91	0x88
9long 1short	Mtr2 EMBrake Failed to Set	7532	92	0x91
9long 2short	Mtr1 EMBrake Open	7551	93	0x92
	Mtr1 EMBrake Short			

Lamp Display	Fault Name (EN)	CANopen Protocol		CANopen B Protocol
		CANopen Fault Code (Hex)	Danfoss Fault Code (Dec)	Fault Code (Hex)
9long 3short	Mtr2 EMBrake Open	7552	94	0x93
	Mtr2 EMBrake Short			
9long 4short	Speed Differential OverRange (Not used)	FFAF	175	0x94
9long 5short	Speed Differential Severe OverRange	FFAF	175	0x95
9long 6short	Gyro Fault (Data Fault)	FFB3	179	0x96
9long 7short	Coil1 Driver Open/Coil1 Driver Short	FFE3	227	0x97
	Coil2 Driver Open/Coil2 Driver Short			
	Coil3 Driver Open/Coil3 Driver Short			
9long 8short	WatchDog Fault (Not used)	6010	8	0x98
9long 9short	CoilPower Short/Pin13 Fault	FFDB	217	0x99
9long 10short	Steer High	FFFA	237	0x9A
9long 11short	Steer Low	FFFA	237	0x9B
9long 12short	Param Invalid	FFC7	199	0x9C

CANopen protocol

RX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
SYNC	80h	Master				

RX						
Object Name	ID (Hex)	Sender	Delay Time	DLC	Data	Means
Enable Contactor	000h	Master			0001b=Enable	

RX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO1RX	200h+Nodel D (RIGHT)	Master	16 ms			
Target speed				Unsigned16	0.0 0.1	Target speed (*3.0769)
Control Word				Unsigned16	2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7	Throttle enable (not used) Relay enable (not used) Electromagnetic brake enable (not used) Forward Reverse EV1 cmd EV2 cmd EV3 cmd EV4 cmd - - NMC cmd (general purpose) Electromagnetic brake release (used in trailer mode) - - 0, 1 sent cyclically (not judged)
Brake request				Unsigned8	4.0	[0-255]
Target PWM DC				Unsigned8	5.0	[0-255]
EVP1 setpoint				Unsigned8	6.0	[0-255]
-					7.0	

RX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO1RX	200h+Nodel D (LEFT)	Master	16ms			Not judged
					0.0 0.1	

RX						
Control Word				Unsigned16	2.0	-
					2.1	-
					2.2	-
					2.3	-
					2.4	-
					2.5	EV5 cmd
					2.6	EV6 cmd
					2.7	EV7 cmd
					3.0	EV8
					3.1	EV9
					3.2	-
					3.3	-
					3.4	-
					3.5	-
3.6	-					
3.7	0, 1 sent cyclically (not judged)					
EVP2 setpoint				Unsigned8	6.0	[0-255]
					7.0	

RX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO2RX	300h+Nodel D (RIGHT)	Master	16ms			Not judged
Max torque motoring				Unsigned8	0.0	[0-255]
Max torque Braking				Unsigned8	1.0	[0-255]
Control Word				Unsigned16	2.0	-
					2.1	-
					2.2	-
					2.3	-
					2.4	-
					2.5	-
					2.6	-
					2.7	-
					3.0	-
					3.1	-
					3.2	-
					3.3	-
					3.4	-
					3.5	-
3.6	-					
3.7	0, 1 sent cyclically					
Steering angle					4.0	[°]
					5.0	
					6.0	

RX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO2RX	300h+Nodel D (LEFT)	Master	16 ms			Not judged

RX						
Max Torque motoring				Unsigned8	0.0	[0-255]
Max torque braking				Unsigned8	1.0	[0-255]
Control Word				Unsigned16	2.0	-
					2.1	-
					2.2	-
					2.3	-
					2.4	-
					2.5	-
					2.6	-
					2.7	-
					3.0	-
					3.1	-
					3.2	-
					3.3	-
					3.4	-
					3.5	-
3.6	-					
					3.7	0, 1 sent cyclically
					4.0	
					5.0	
					6.0	
					7.0	

TX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
EMERGENCY	80h+NodeID (LEFT, RIGHT)	Slave	ASYN			
Emergency Error Code				Unsigned16	0.0	Fault code
					1.0	
Error register				Unsigned8	2.0	Default to 0 if not used
Danfoss Alarm Code				Signed8	3.0	Danfoss fault code
Danfoss Alarm Flags				Unsigned8	4.0	Default to 0 if not used
Danfoss Alarm Extra Info				Unsigned8	5.0	Default to 0 if not used
-					6.0	Default to 0 if not used
-					7.0	Default to 0 if not used

TX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO1TX	180h+NodeID (LEFT)	Slave	1 SYNC			
Measured speed				Signed16	0.0	Actual speed of Left motor (*6)
					1.0	

TX							
Status Word				Unsigned16	2.0	NMC status (not used)	
					2.1	Electromagnetic brake status (1:ON, 0: OFF)	
					2.2	Digital input status 0	
					2.3	Digital input status 1	
					2.4	Digital input status 2	
					2.5	Digital input status 3	
					2.6	Digital input status 4	
					2.7	Digital input status 5	
					3.0	DI6 status not used	
					3.1	DI7 status	
					3.2	DI8 status	
					3.3	DI9 status	
					3.4	DI10 status	
					3.5	DI11 status	
					3.6	DI12 status	
					3.7	0, 1 sent cyclically	
	Status byte				Unsigned8	4.0	Unused
	Analog input#1				Unsigned8	5.0	Analog input 1 [0-255]
Analog input #2				Unsigned8	6.0	Analog input 2 [0-255]	
Actual current				Signed8	7.0	Peak phase current [A*5]	

TX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO1TX	180h+NodeID (RIGHT)	Slave	1 SYNC			
Measured speed				Signed16	0.0	RIGHT actual speed (*6)
					1.0	

TX						
Status Word				Unsigned16	2.0	-
					2.1	Electromagnetic brake status (1:ON, 0: OFF)
					2.2	DI0 status
					2.3	DI1 status
					2.4	DI2 status
					2.5	DI3 status
					2.6	DI4 status
					2.7	DI5 status
					3.0	DI6 status
					3.1	DI7 status
					3.2	DI8 status
					3.3	DI9 status
					3.4	DI10 status
					3.5	DI11 status
				3.6	DI12 status	
				3.7	0, 1 sent cyclically	
Status byte				Unsigned8	4.0	
Analog input#1				Unsigned8	5.0	Analog input 1 [0,,, 255]
Analog input #2				Unsigned8	6.0	Analog input 2 [0,,, 255]
Actual current				Signed8	7.0	Peak phase current [A*5]

TX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO2TX	280h+NodeID (RIGHT)	Slave	1SYNC			
Warning/alarm				Unsigned16	0.0	Default to 0 if not used
					1.0	
Motor Temperature				Signed8	2.0	Right motor temperature [°C] (+40°C offset)
Controller Temperature				Signed8	3.0	Controller temperature [°C]
BDI %				Unsigned8	4.0	Default to 0
Battery Current				Unsigned8	5.0	Battery current [A*2]
Battery Voltage				Unsigned16	6.0	Battery voltage Vnom/1000

TX						
Object Name	ID (Hex)	Sender	Delay Time	Dimension	Position (byte.bit)	Means
PDO2TX	280h+NodeID (LEFT)	Slave	1 SYNC			
Warning/alarm				Unsigned16	0.0	Default to 0 if not used
					1.0	
Motor Temperautre				Signed8	2.0	Left motor temperature [°C] (+40°C offset)
Controller Temperature				Signed8	3.0	Controller temperature [°C]
BDI %				Unsigned8	4.0	

TX						
Battery Current				Unsigned8	5.0	Battery current [A*2]
Battery Voltage				Unsigned16	6.0	Battery voltage Vnom/1000

Fault codes

Faulty indicator

Faulty indicator

Fault CODE	Fault level (1=Alarm, 2=warning)	Alarm method	Fault name
0x11	1	1 long alarm beep and 1 short alarm beep	M1 controller overcurrent
0x12	1	1 long alarm beep and 2 short alarm beeps	M2 controller overcurrent
0x13	1	1 long alarm beep and 3 short alarm beeps	Current sensor fault 1 (M1)
0x13	1	1 long alarm beep and 3 short alarm beeps	Current sensor fault 2 (M1)
0x14	1	1 long alarm beep and 4 short alarm beeps	Current sensor fault 3 (M2)
0x14	1	1 long alarm beep and 4 short alarm beeps	Current sensor fault 4 (M2)
0x15	1	1 long alarm beep and 5 short alarm beeps	Serious undertemperature of the controller
0x16	1	1 long alarm beep and 6 short alarm beeps	Serious overtemperature of controller
0x17	1	1 long alarm beep and 7 short alarm beeps	Severe undervoltage (Bus Voltage)
0x18	1	1 long alarm beep and 8 short alarm beeps	Severe overvoltage (Bus Voltage)
0x21	1	2 long alarm beep sand 1 short alarm beep	Temperature sensor abnormality of controller (open circuit/short circuit)
0x22	2	2 long alarm beep sand 2 short alarm beeps	Controller low temperature cutback
0x22	2	2 long alarm beep sand 2 short alarm beeps	Controller thermal cutback
0x23	2	2 long alarm beeps and 3 short alarm beeps	Undervoltage cutback (Bus Voltage)
0x24	2	2 long alarm beeps and 4 short alarm beeps	Overvoltage cutback (Bus Voltage)
0x25	2	2 long alarm beeps and 5 short alarm beeps	Motor thermal cutback 1/2
0x26	2	2 long alarm beeps and 6 short alarm beeps	Motor temperature sensor fault 1/2
0x27	1	2 long alarm beeps and 7 short alarm beeps	External relay open-circuit fault
0x28	1	2 long alarm beeps and 8 short alarm beeps	External relay short-circuit fault
0x29	1	2 long alarm beeps and 9 short alarm beeps	Over high MOS temperature fault on motor 1
0x31	1	3 long alarm beeps and 1 short alarm beep	External relay not closed
0x32	2	3 long alarm beeps and 2 short alarm beeps	External relay sticking fault
0x33	2	3 long alarm beeps and 3 short alarm beeps	Bus overcurrent alarm fault
0x34	1	3 long alarm beeps and 4 short alarm beeps	Bus overcurrent shut-off fault
0x35	1	3 long alarm beeps and 5 short alarm beeps	Motor open circuit 1/2
0x36	1	3 long alarm beeps and 6 short alarm beeps	High throttle signal voltage
0x37	1	3 long alarm beeps and 7 short alarm beeps	Low throttle signal voltage
0x38	1	3 long alarm beeps and 8 short alarm beeps	EEPROM fault
0x39	1	3 long alarm beeps and 9 short alarm beeps	Over high MOS temperature fault on motor 2
0x41	2	4 long alarm beeps and 1 short alarm beep	High pedal/starting sequence fault (HPD/SRO)
0x42	1	4 long alarm beeps and 2 short alarm beeps	Parameter change fault, and restart after parameter change
0x43	1	4 long alarm beeps and 3 short alarm beeps	CAN communication fault (timeout fault, timeout parameter can be set)
0x44	1	4 long alarm beeps and 4 short alarm beeps	Motor stall fault 1/2
0x45	1	4 long alarm beeps and 5 short alarm beeps	Motor overspeed fault 1/2 (motor overspeed limit can be set)
0x46	1	4 long alarm beepsand 6 short alarm beeps	Key switch voltage is abnormal(out of range)

Faulty indicator (continued)

Fault CODE	Fault level (1=Alarm, 2=warning)	Alarm method	Fault name
0x47	1	4 long alarm beeps and 7 short alarm beeps	Voltage abnormality on drive (out of range)
0x48	1	4 long alarm beeps and 8 short alarm beeps	U-phase MOS abnormality of M1
0x49	1	4 long alarm beeps and 9 short alarm beeps	Backward sliding fault of vehicle
0x51	1	5 long alarm beeps and 1 short alarm beep	V-phase MOS abnormality of M1
0x52	1	5 long alarm beeps and 2 short alarm beeps	W-phase MOS abnormality of M1
0x53	1	5 long alarm beeps and 3 short alarm beeps	U-phase MOS abnormality of M2
0x54	1	5 long alarm beeps and 4 short alarm beeps	V-phase MOS abnormality of M2
0x55	1	5 long alarm beeps and 5 short alarm beeps	W-phase MOS abnormality of M2
0x56	1	5 long alarm beeps and 6 short alarm beeps	Detection abnormality of U-phase voltage of M1
0x57	1	5 long alarm beeps and 7 short alarm beeps	Detection abnormality of V-phase voltage of M1
0x58	1	5 long alarm beeps and 8 short alarm beeps	Detection abnormality of W-phase voltage of M1
0x61	1	6 long alarm beeps and 1 short alarm beep	Detection abnormality of U-phase voltage of M2
0x62	1	6 long alarm beeps and 2 short alarm beeps	Detection abnormality of V-phase voltage of M2
0x63	1	6 long alarm beeps and 3 short alarm beeps	Detection abnormality of W-phase voltage of M2
0x64	1	6 long alarm beeps and 4 short alarm beeps	Controller internal communication fault
0x65	1	6 long alarm beeps and 5 short alarm beeps	Parameter synchronization fault
0x66	1	6 long alarm beeps and 6 short alarm beeps	Precharge fault
0x67	1	6 long alarm beeps and 7 short alarm beeps	Voltage abnormality on U-phase upper tube of M1
0x68	1	6 long alarm beeps and 8 short alarm beeps	Voltage abnormality on V-phase upper tube of M1
0x71	1	7 long alarm beeps and 1 short alarm beep	Voltage abnormality on W-phase upper tube of M1
0x72	1	7 long alarm beeps and 2 short alarm beeps	Voltage abnormality on U-phase upper tube of M2
0x73	1	7 long alarm beeps and 3 short alarm beeps	Voltage abnormality on V-phase upper tube of M2
0x74	1	7 long alarm beeps and 4 short alarm beeps	Voltage abnormality on W-phase upper tube of M2
0x75	1	7 long alarm beeps and 5 short alarm beeps	M1 motor has severe high temperature
0x76	1	7 long alarm beeps and 6 short alarm beeps	M2 motor has severe high temperature
0x77	1	7 long alarm beeps and 7 short alarm beeps	M1 motor encoder broken line fault
0x78	1	7 long alarm beeps and 8 short alarm beeps	M2 motor encoder broken line fault
0x81	1	8 long alarm beeps and 1 short alarm beep	Internal +5 VDC power failure
0x82	1	8 long alarm beeps and 2 short alarm beeps	Output +12 VDC power failure
0x83	1	8 long alarm beeps and 3 short alarm beeps	Output +12 VDC excessive current fault
0x84	1	8 long alarm beeps and 4 short alarm beeps	Output +5 VDC power failure
0x85	1	8 long alarm beeps and 5 short alarm beeps	Output +5 VDC excessive current fault
0x86		8 long alarm beeps and 6 short alarm beeps	The voltage of analog input is out of range
0x87		8 long alarm beeps and 7 short alarm beeps	Digital switch input voltage out of range
0x88	1	8 long alarm beeps and 8 short alarm beeps	Electromagnetic brake fault of M1 motor
0x91	1	9 long alarm beeps and 1 short alarm beep	Electromagnetic brake fault of M2 motor
0x92	1	9 long alarm beeps and 2 short alarm beeps	M1 motor electromagnetic brake open/short circuit fault
0x93	1	9 long alarm beeps and 3 short alarm beeps	M2 motor electromagnetic brake open/short circuit fault

Faulty indicator (continued)

Fault CODE	Fault level (1=Alarm, 2=warning)	Alarm method	Fault name
0x94	2	9 long alarm beeps and 4 short alarm beeps	Too large speed difference between two motors
0x95	1	9 long alarm beeps and 5 short alarm beeps	The speed difference between two motors is too large
0x96	1	9 long alarm beeps and 6 short alarm beeps	Gyroscope fault (data error)
0x97	1	9 long alarm beeps and 7 short alarm beeps	Other relay coil drive open/short circuit fault
0x98	1	9 long alarm beeps and 8 short alarm beeps	Software watchdog fault
0x99	1	9 long alarm beeps and 9 short alarm beeps	Coil return short circuit fault
0x9A	1	9 long alarm beeps and 10 short alarm beeps	Steering throttle signal too high
0x9B	1	9 long alarm beeps and 11 short alarm beeps	Steering throttle signal too low
0x9C	1	9 long alarm beeps and 12 short alarm beeps	Illegal parameter

Fault code 1

Fault code	Danfoss code	Fault name
FF01	244	Controller internal communication fault
3130	60	Precharge fault
5441	38	External relay open-circuit fault
FFF3	243	High throttle signal voltage
		Low throttle signal voltage
4210	62	Serious over temperature of controller
FF42	66	Bus voltage severe undervoltage
4110	65	Motor thermal cutback 1/2
4211	250	Temperature sensor abnormality of controller (open circuit/short circuit)
4311	218	Motor temperature sensor fault 1/2
8130	248	CAN communication fault (timeout fault, timeout parameter can be set)
FFFA	237	Steering throttle signal too high
		Steering throttle signal too low
6010	8	Software watchdog fault
FFDB	217	Coil return short circuit fault
FFD3	211	Motor stall fault 1/2
FFCA	202	Bus voltage severe overvoltage
6302	236	Current sensor fault 1 (M1)
		Current sensor fault 2 (M1)
		Current sensor fault 3 (M2)
		Current sensor fault 4 (M2)
FFB4	180	M1 controller overcurrent
		M2 controller overcurrent
		Bus overcurrent shut-off fault
FFB3	179	Gyroscope fault (data error)

Fault code	Danfoss code	Fault name
FFE3	227	U-phase MOS abnormality of M1
		V-phase MOS abnormality of M1
		W-phase MOS abnormality of M1
		U-phase MOS abnormality of M2
		V-phase MOS abnormality of M2
		W-phase MOS abnormality of M2
		Detection abnormality of U-phase voltage of M1
		Detection abnormality of V-phase voltage of M1
		Detection abnormality of W-phase voltage of M1
		Detection abnormality of U-phase voltage of M2
		Detection abnormality of V-phase voltage of M2
		Detection abnormality of W-phase voltage of M2
		U-phase MOS voltage abnormality of M1
		V-phase MOS voltage abnormality of M1
		W-phase MOS voltage abnormality of M1
		U-phase MOS voltage abnormality of M2
		V-phase MOS voltage abnormality of M2
		W-phase MOS voltage abnormality of M2
		Output +12 VDC excessive current fault
		Output +5 VDC power failure
The voltage of analog input is out of range		
Other relay coil drive open/short circuit fault		
3610	208	EEPROM fault
2250	223	External relay short-circuit fault
FFC6	198	Parameter synchronization fault
FFC7	199	Parameter change fault, and restart after parameter change
		Illegal parameter
FFB2	178	M1 motor has severe high temperature
		M2 motor has severe high temperature
FFAF	175	Motor overspeed fault 1/2 (motor overspeed limit can be set)
		Too large speed difference between two motors
		The speed difference between two motors is too large
FFA9	169	M1 motor encoder broken line fault
		M2 motor encoder broken line fault
3101	170	Key switch voltage is abnormal (out of range)
4411	96	Serious undertemperature of the controller
4421	63	Controller low temperature cutback
4431	67	Controller thermal cutback
		Temperature of MOS tube of controller M1 too high
		Temperature of MOS tube of controller M2 too high
4451	68	Bus undervoltage cutback
4452	69	Bus overvoltage cutback
5611	101	Bus overcurrent alarm fault
6528	72	Motor open circuit 1/2
7531	91	Electromagnetic brake fault of M1 motor
7532	92	Electromagnetic brake fault of M2 motor
7551	93	M1 motor electromagnetic brake open/short circuit fault
7552	94	M2 motor electromagnetic brake open/short circuit fault
7627	95	When the forward throttle is pressed, the vehicle runs in the reverse direction

Fault code 2

Fault code	Fault name
0x11	M1 controller overcurrent
0x12	M2 controller overcurrent
0x13	Current sensor fault 1 (M1)
0x13	Current sensor fault 1 (M1)
0x14	Current sensor fault 3 (M2)
0x14	Current sensor fault 3 (M2)
0x15	Serious undertemperature of the controller
0x16	Serious overtemperature of controller
0x17	Severe undervoltage (Bus Voltage)
0x18	Severe overvoltage (Bus Voltage)
0x21	Temperature sensor abnormality of controller (open circuit/short circuit)
0x22	Controller low temperature cutback
0x22	Controller low temperature cutback
0x23	Undervoltage cutback (Bus Voltage)
0x24	Overvoltage cutback (Bus Voltage)
0x25	Motor thermal cutback 1/2
0x26	Motor temperature sensor fault 1/2
0x27	External relay open-circuit fault
0x28	External relay short-circuit fault
0x29	Temperature of MOS tube of controller M1 too high
0x33	Bus overcurrent alarm fault
0x34	Bus overcurrent shut-off fault
0x35	Motor open circuit 1/2
0x36	High throttle signal voltage
0x37	Low throttle signal voltage
0x38	EEPROM fault
0x39	Temperature of MOS tube of controller M2 too high
0x42	Parameter change fault, and restart after parameter change
0x43	CAN communication fault (timeout fault, timeout parameter can be set)
0x44	Motor stall fault 1/2
0x45	Motor overspeed fault 1/2 (motor overspeed limit can be set)
0x46	Key switch voltage is abnormal(out of range)
0x48	U-phase MOS abnormality of M1
0x49	When the forward throttle is pressed, the vehicle runs in the reverse direction
0x51	V-phase MOS abnormality of M1
0x52	W-phase MOS abnormality of M1
0x53	U-phase MOS abnormality of M2
0x54	V-phase MOS abnormality of M2
0x55	W-phase MOS abnormality of M2
0x56	Detection abnormality of U-phase voltage of M1
0x57	Detection abnormality of V-phase voltage of M1
0x58	Detection abnormality of W-phase voltage of M1
0x61	Detection abnormality of U-phase voltage of M2
0x62	Detection abnormality of V-phase voltage of M2
0x63	Detection abnormality of W-phase voltage of M2
0x64	Controller internal communication fault
0x65	Parameter synchronization fault
0x66	Precharge fault

Fault code	Fault name
0x67	U-phase MOS voltage abnormality of M1
0x68	V-phase MOS voltage abnormality of M1
0x71	W-phase MOS voltage abnormality of M1
0x72	U-phase MOS voltage abnormality of M2
0x73	V-phase MOS voltage abnormality of M2
0x74	W-phase MOS voltage abnormality of M2
0x75	M1 motor has severe high temperature
0x76	M2 motor has severe high temperature
0x77	M1 motor encoder broken line fault
0x78	M2 motor encoder broken line fault
0x81	#N/A
0x82	#N/A
0x83	Output +12 VDC excessive current fault
0x84	Output +5 VDC power failure
0x86	The voltage of analog input is out of range
0x88	Electromagnetic brake fault of M1 motor
0x91	Electromagnetic brake fault of M2 motor
0x92	M1 motor electromagnetic brake open/short circuit fault
0x93	M2 motor electromagnetic brake open/short circuit fault
0x94	Too large speed difference between two motors
0x95	The speed difference between two motors is too large
0x96	Gyroscope fault (data error)
0x97	Other relay coil drive open/short circuit fault
0x98	Software watchdog fault
0x99	Coil return short circuit fault
0x9A	Steering throttle signal too high
0x9B	Steering throttle signal too low
0x9C	Illegal parameter

Dismounting



Make sure that the mating structure is not damaged. Do not pluck any bores or use headed bolts or rods for pushing the product out of the mating structure.

For dismounting, follow the steps below.

1. Disconnect the connectors and cables.
2. Remove the mounting bolts and prepare the product for lifting.
3. Lift the product off while supporting it.

Aftersales

Service policy

For further information, go to <https://danfosseditron.zendesk.com/hc/en-gb> or send email to editron.service@danfoss.com.

Disposal

Dispose of the product and any of its parts by appropriate means in accordance with local laws and regulations.



Hydro-Gear

www.hydro-gear.com

Daikin-Sauer-Danfoss

www.daikin-sauer-danfoss.com

Explore our solutions at danfoss.com.

Additional product literature is available at powersource.danfoss.com.

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