















# Drives for Hybrid and Electric Vehicles

24 to 800 VDC



ENGINEERING YOUR SUCCESS.

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# Drives for Hybrid and Electric Vehicles

## Low Voltage Mobile Drives - MC Drives



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# Parker Hannifin

## The global leader in motion and control technologies

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**Global Product Design**

Parker Hannifin has more than 40 years experience in the design and manufacturing of drives, controls, motors and mechanical products. With dedicated global product development teams, Parker draws on industry-leading technological leadership and experience from engineering teams in Europe, North America and Asia.

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**Electromechanical Worldwide Manufacturing Locations**

**Europe**
Littlehampton, United Kingdom
Dijon, France
Offenburg, Germany
Filderstadt, Germany
Milan, Italy

**Asia**
Wuxi, China
Jangan, Korea
Chennai, India

**North America**
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Milan, Italy



Littlehampton, UK




Filderstadt, Germany




Dijon, France

# Low Voltage Mobile Drives - MC Drives

## Overview

### Description

Parker MC series represents the latest design standards for compact and reliable controllers for mobile applications.
Providing a motor control solution for battery systems between 24 and 96 VDC, the MC motor controllers provide OEMs with a superb combination of power, performance and functionality.
The compact dimensions and high efficiency of this controller make integration into very tight spaces a reality without sacrificing output performance.
It's design has been optimized to produce the lowest possible installed cost, whilst still maintaining superior reliability even in the most demanding of applications.



### Product Features

- Auto-tuning
- Possible customization (firmware)
- High efficiency cold plate heat sink design
- IP65 protection class
- Motor temperature sensor input
- Encoder supply output (5 V)
- Encoder input, A/B (ACIM) and Sin/Cos (PMAC)
- Dual, configurable throttle inputs
- Configurable CAN communication
- Parker IQAN compatible
- Ability to control vehicle control tasks separately from motor control
- 5 configurable coil drive outputs
- 2 configurable digital outputs
- 2 Analogue inputs / 6 Digital inputs
- Powerful MC configuration utility for system design and diagnostics
- Safety Interlock relay for battery connection

### Applications

- Utility vehicles
- handling equipment, handling gantries
- Refuse Truck
- Bus and Coach
- City van
- Turf care
- Street sweepers
- Other hydraulic pump control

### Technical characteristics - overview

| Model | MC |
|---|---|
| Motor type | AC induction + PMAC |
| Nominal voltage | 24/96 VDC |
| Max 2 min current | 800 Arms |
| Max 2 min power | 60.6 kVA |
| Switching freq. | 10 kHz |
| Operating temperature | -40 °C to 50 °C |
| Storage temperature | -40 °C to 95 °C |
| Protection | IP65 |
| Control type | Speed or Torque control |
| Feedback | Quadrature encoder (ACIM)<br>Sin/Cos (PMAC) |
| Communications | CANopen, RS232/485 serial |
| Cooling | Air-cooled |
| Certifications | EMC: designed to EN12895,<br>Safety: designed to EN1175,<br>CE marked to EN 61800-5-1 (Safety, Low Voltage Directive) |
| Output Frequency | 300 Hz (AC induction)<br>400 Hz (PMAC) |

# Product Details

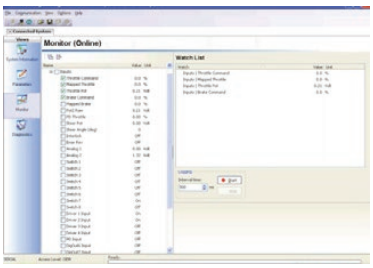
Thanks to an IP65 protection class, the drive can be direct vehicle mounted without an enclosure.
(no direct high pressure spray)



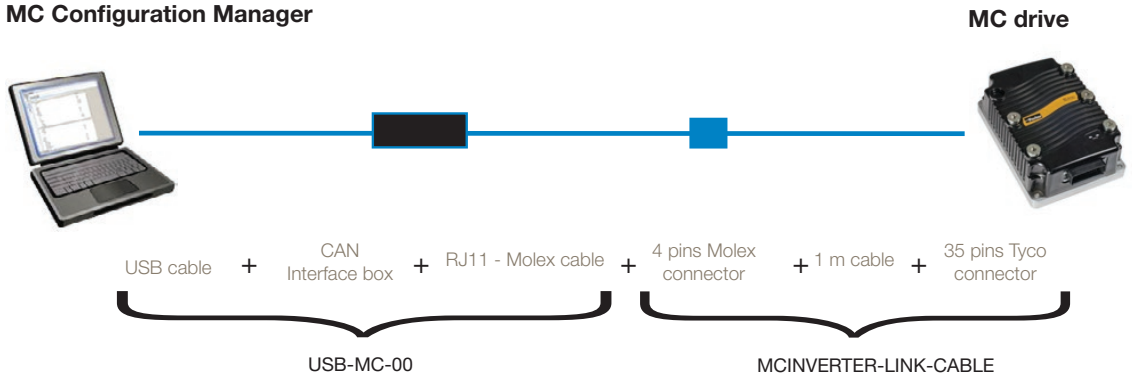

## Software

**MC Configuration Manager Software (free dowload on parker.com)**

- The unique Auto-Tune function allows quick and easy characterization of the motor
- System monitoring
- System diagnostics
- Adjust system variables and programmable parameters
- Online or offline use



Software and connecting devices are required as shown here.




| Order Code | Description |
|---|---|
| USB-MC-00 | PC interface cable |
| MCINVERTER-LINK-CABLE | MC drive interface cable |



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# Technical Data

| Part number | Switcing frequency | Max Output frequency | Rms output 1 hour Current A rms | Rms output 2 min current A rms | Nominal Input Voltage VDC | Weight [kg] |
|---|---|---|---|---|---|---|
| MCC-02-0180-01-00 | 10kHz | 400Hz (PMAC) | 90 | 180 | 24 | 1.7 |
| MCC-02-0250-01-00 | | | 125 | 250 | 24 | |
| MCC-02-0375-01-00 | | | 185 | 375 | 24 | |
| MCC-04-0200-01-00 | | | 100 | 200 | 36-48 | |
| MCC-04-0350-01-00 | | | 175 | 350 | 36-48 | |
| MCC-08-0175-01-00 | | | 80 | 175 | 48-80 | |
| MCC-08-0250-01-00 | | | 144 | 250 | 48-80 | |
| MCD-03-0500-01-00 | | | 235 | 500 | 24-36 | 2.8 |
| MCD-04-0450-01-00 | | | 215 | 450 | 36-48 | |
| MCD-08-0350-01-00 | | | 149 | 350 | 48-80 | |
| MCE-03-0650-01-00 | | | 285 | 650 | 24-36 | 4.1 |
| MCE-04-0550-01-00 | | | 250 | 550 | 36-48 | |
| MCE-04-0600-01-00 | | | 260 | 600 | 36-48 | |
| MCE-08-0450-01-00 | | | 185 | 450 | 48-80 | |
| MCF-03-0800-01-00 | | | 365 | 800 | 24-36 | 6.8 |
| MCF-04-0650-01-00 | | | 325 | 650 | 36-48 | |
| MCF-08-0550-01-00 | | | 190 | 550 | 48-80 | |
| MCF-08-0650-01-00 | | | 195 | 650 | 48-80 | |
| MCF-09-0550-01-00 | | | 200 | 550 | 72-96 | |
| MCF-09-0650-01-00 | | | 200 | 650 | 72-96 | |

Notes: All current ratings are rms values per motor phase.
Continuous current for design life is the maximum long-term current, at an internal heatsink long-term temperature of 70 °C, at which the controller will achieve its design life (20,000 h for 24 ... 96 VDC). Note that much higher 1 h ratings can be achieved with additional heatsinking.



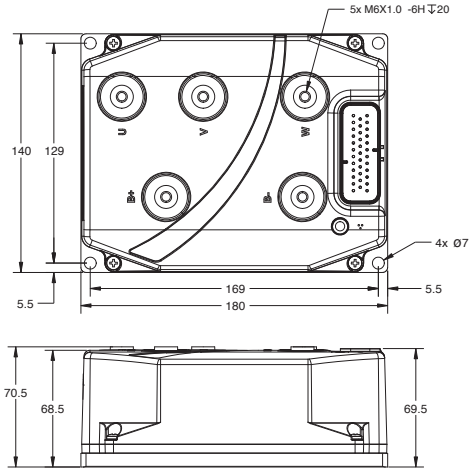
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# Dimensions

Dimensions [mm]

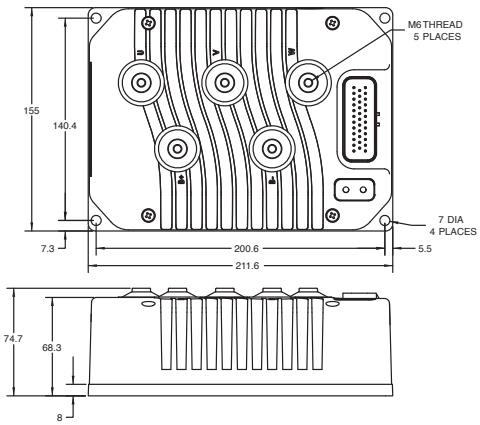
## MC C





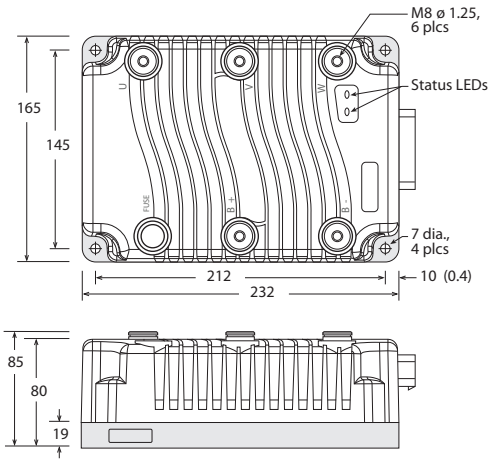

## MC D



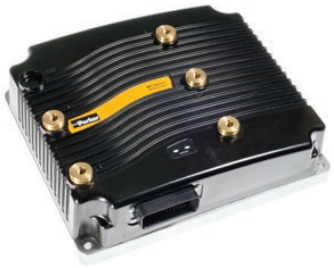


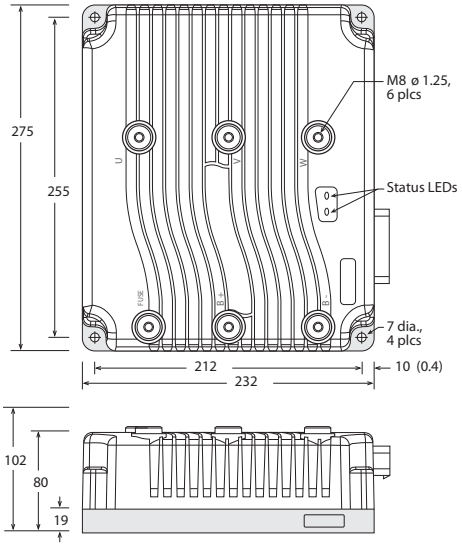

## MC E






## MC F








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# Order Code

| | 1 | 2 | 3 | | 4 | | 5 | | 6 | | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Order example | **M** | **C** | **C** | **-** | **04** | **-** | **0450** | **-** | **01** | **-** | **00** |

| 1 | **Inverter family** | |
|---|---|---|
| | **M** | Mobile Inverter |
| 2 | **Control module build** | |
| | **C** | Low Voltage - 24 to 96 VDC |
| 3 | **Frame size** | |
| | **C** | MC Series |
| | **D** | |
| | **E** | |
| | **F** | |
| 4 | **Operating voltage** | |
| | **Low Voltage MC Series Inverter** | |
| | **02** | 24 VDC |
| | **03** | 36 VDC |
| | **04** | 48 VDC |
| | **08** | 80 VDC |
| | **09** | 96 VDC |
| 5 | **Peak current ratings (2 min)** | |
| | **24 VDC Nominal Voltage** | |
| | **0180** | 180 A - MC Series Frame C |
| | **0250** | 250 A - MC Series Frame C |
| | **0375** | 375 A - MC Series Frame C |
| | **36 VDC Nominal Voltage** | |
| | **0500** | 500 A - MC Series Frame D |
| | **0650** | 650 A - MC Series Frame E |
| | **0800** | 800 A - MC Series Frame F |
| | **48 VDC Nominal Voltage** | |
| | **0200** | 200 A - MC Series Frame C |
| | **0350** | 350 A - MC Series Frame C |
| | **0450** | 450 A - MC Series Frame D |
| | **0550** | 550 A - MC Series Frame E |
| | **0600** | 600 A - MC Series Frame E |
| | **0650** | 650 A - MC Series Frame F |
| | **80 VDC Nominal Voltage** | |
| | **0175** | 175 A - MC Series Frame C |
| | **0250** | 250 A - MC Series Frame C |
| | **0350** | 350 A - MC Series Frame D |
| | **0450** | 450 A - MC Series Frame E |
| | **0550** | 550 A - MC Series Frame F |
| | **0650** | 650 A - MC Series Frame F |
| | **96 VDC Nominal Voltage** | |
| | **0550** | 550 A - MC Series Frame F |
| | **0650** | 650 A - MC Series Frame F |

| 6 | **Branding** | |
|---|---|---|
| | **01** | Parker branded |
| 7 | **Special options** | |
| | **00** | Version for PMAC and induction motors |



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# Full Voltage Range Mobile Drives - MD Drives

## Overview

### Description

Parker MD Series represents the latest design in compact motor controllers. With a compact, rugged and cost effective design these reliable controllers are intended to meet the high performance requirements of on-road and off-road electric vehicles (EV) and Hybrid Electric Vehicles (HEV)
Thanks to the high efficiency it is possible to integrate these controllers into very tight spaces without sacrificing performance.
Its high voltage range, up to 800VDC, is well matched to the needs of the automotive and commercial transport markets. The same hardware platform handles both AC Induction and Permanent Magnet AC motor technologies.



### Product Features

- Supports both PMAC and AC motors
- Up to 800 VDC peak supply voltage
- Up to 225 kW peak power output *
- Up to 90 kW continuous power output *
- Advanced flux vector control
- Integrated logic circuit
- Includes an additional dedicated safety supervisory processor (sizes MD-4A, 4B, 4C)
- Safety interlock pulsed enable signal (sizes MD-4A, 4B, 4C)
- Autocheck system diagnostic
- Hardware & software failsafe watchdog operation
- Integrated fuse holder (sizes MD-42, 44, 46)

### Applications

- Utility vehicles
- Handling equipment, handling gantries
- Refuse Truck
- Bus and Coach
- City van
- Turf care
- Street sweepers
- Agricultural implements, tractors
- Other hydraulic pump control

### Technical characteristics - overview

| Model | | MD |
|---|---|---|
| Motor type | | AC induction + PMAC |
| Nominal voltage | | 24-800 VDC |
| Max 10 sec current | | 780 Arms |
| Switching freq. | | 8 kHz |
| Protection | | IP66 (sizes MD-42, 44, 46)<br>IP6k9k and IP67 protection (sizes MD-4A, 4B, 4C) |
| Environment, Sizes MD-4B, 4C | | ISO 16750 |
| Safety | Sizes MD-4B, 4C | Electrical safety to ISO 6494, IEC 60664 and UL840<br>Functional safety to ISO26262<br>Pulsed safety enable input<br>Pulsed status output |
| | Sizes MD-4A | HVIL (High Voltage Interlock H/W & S/W)<br>Designed to meet the electrical isolation of electrically propelled vehicles ISO 6469 |
| Cooling | | Cold plate cooling<br>(low voltage sizes MD-42, 44, 46) |
| | | Water Glycol cooling<br>Oil cooling on request<br>(high voltage sizes MD-4A, 4B, 4C) |

* with a cooling liquid temperature of 65°C



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# Technical Data

| Part number | Nominal Battery Voltage | Max Operating Voltage | Min Operating voltage | Continuous Current (60 min) | Peak Current (2 min) | Peak Current (10 sec) | Weight |
|---|---|---|---|---|---|---|---|
| | [VDC] | [VDC] | [VDC] | [Arms] | [Arms] | [Arms] | [kg] |
| **MD-42-02-300-00** | 24-36 | 52.2 | 12.7 | 120 | 300 | 360 | 1.3 |
| **MD-44-02-450-00** | | | | 180 | 450 | 540 | 2.7 |
| **MD-46-02-650-00** | | | | 260 | 650 | 780 | 4.6 |
| **MD-42-04-275-00** | 36-48 | 69.6 | 19.3 | 110 | 275 | 330 | 1.3 |
| **MD-44-04-450-00** | | | | 180 | 450 | 540 | 2.7 |
| **MD-46-04-650-00** | | | | 260 | 650 | 780 | 4.6 |
| **MD-42-08-180-00** | 72-80 | 116 | 39.1 | 75 | 180 | 215 | 1.3 |
| **MD-44-08-350-00** | | | | 140 | 350 | 420 | 2.7 |
| **MD-46-08-550-00** | | | | 220 | 550 | 660 | 4.6 |
| **MD-44-12-300-00** | 96-120 | 150 | 48 | 120 | 300 | 360 | 2.7 |
| **MD-4A-80-024-00** | 200-800 | - | - | 19 | 24 (1 min) | - | 3.7 |
| **MD-4A-80-053-00** | 200-800 | - | - | 33 | 53 (1 min) | - | 2.3 |
| **MD-4B-40-300-00** | 128-400 | - | - | 120 | 250 | 300 | 10 |
| **MD-4C-80-400-00** | 50-800 | - | - | 120 | 300 | 450 | 10.7 |

Note: Switching Frequency = 16 kHz

## Operating temperature

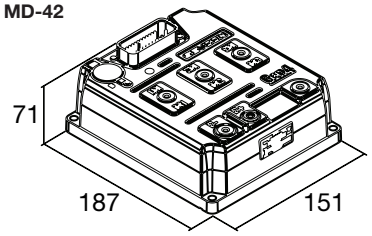
| | Temperature range (without derating) |
|---|---|
| **Sizes MD-42, 44, 46** | -40°C to +85°C |
| **Size MD-4A-80-024** | Air Cooled - Ambient -40°C up to +45°C full operation |
| **Size MD-4A-80-053, 4B, 4C** | Water/Glycol coolant - Full operation up to 65°C |



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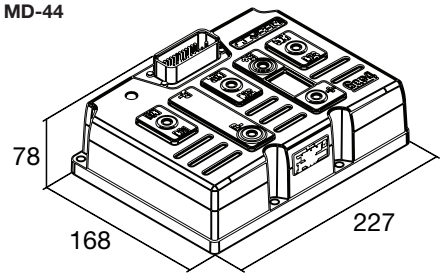
# Dimensions

**MD-42**



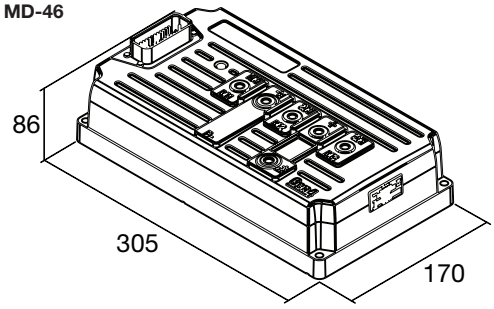



**MD-44**



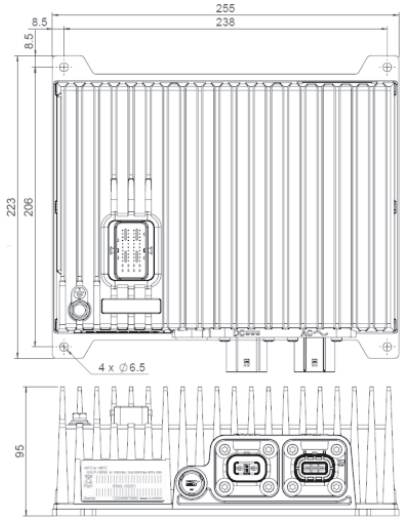



**MD-46**






**MD-4A-80-024**

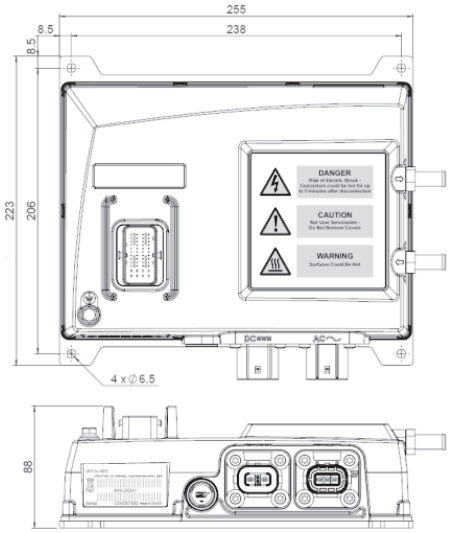






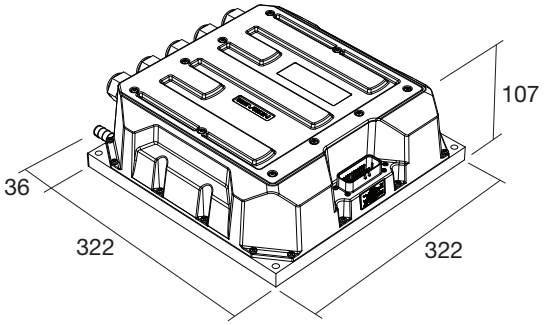

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**MD-4A-80-053**



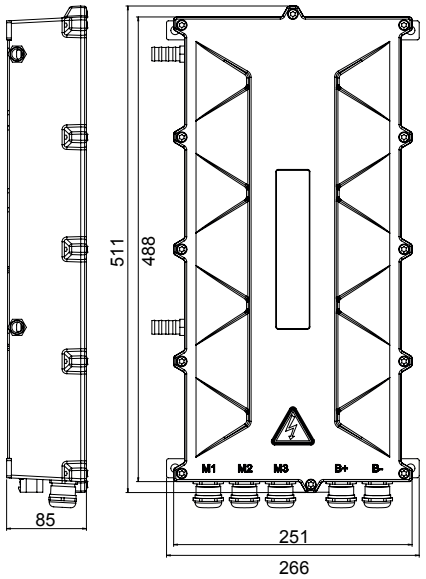



**MD-4B**






**MD-4C**









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# Product Details

## MULTIPLE MOTOR FEEDBACK OPTIONS

MD drive provides a number of motor feedback possibilities from a range of hardware inputs and software control, allowing a great deal of flexibility.

- Absolute UVW encoder input (ACIM)
- Absolute Sin/Cos encoder input (MD-42, 44, 46)
- Incremental AB encoder input (ACIM)
- Resolver input (MD-4A, 4B, 4C)
- Programmable 5V to 10V encoder power supply

## INTEGRATED I/O

MD drive includes a fully-integrated set of inputs and outputs (I/0) designed to handle a wide range of vehicle requirements. This eliminated the need for additional external I/O modules or vehicle controllers and connectors.

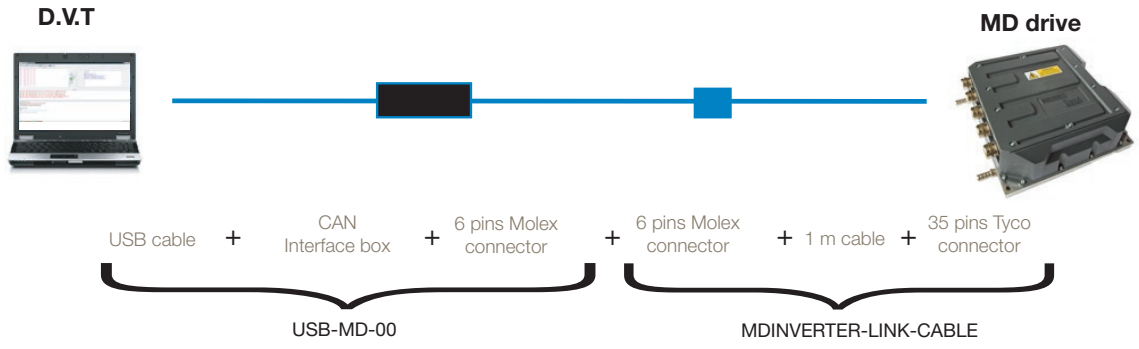
| Low voltage frame sizes MD-42, 44, 46 | High voltage frame sizes MD-4A, 4B, 4C |
|---|---|
| • 8 digital inputs<br>• 2 analogue inputs (can be configured as digital)<br>• 3 contactor/solenoid outputs | • 12V or 24V nominal supply<br>• All I/O protected to 40V (size 8,10,hvlp))<br>• 4 analogue inputs 0-10V<br>• 4 digital inputs<br>• 3 power supplies 0-10V 100mA (2 for size A)<br>• 3 digital outputs PWM max 2A ( 2 for size A) |

## OTHER FEATURES

- A CANopen bus allows easy interconnection of drives and devices such as displays and driver controls.
- The CANbus allows the user to wire the vehicle to best suit vehicle layout since inputs and outputs can be connected to any of the controllers on the vehicle and the desired status is passed over the CAN network to the relevant motor controller.
- The MD drive can dynamically change the allowed battery current by exchanging CAN messages with a compatible Battery Management System.
- Configurable as vehicle control master or motor slave.

## CONFIGURATION TOOLS - D.V.T

Parker offers a range of configuration tools for the MD drive range with options for Windows based PC or calibrator handset unit. These tools provide a simple yet powerful means of accessing the CANopen bus for diagnostics or parameter adjustment. The handset unit features password protected access levels and a customized logo start-up screen.




| Order Code | Description |
|---|---|
| USB-MD-00 | Dongle + PC interface cable |
| MDINVERTER-LINK-CABLE (except MD-4A) | MD drive interface cable |



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# Order Code

| | 1 | 2 | | 3 | 4 | | 5 | | 6 | | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Order example | **M** | **D** | **-** | **4** | **2** | **-** | **04** | **-** | **200** | **-** | **00** |

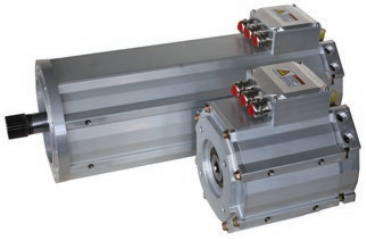
| | | |
|---|---|---|
| **1** | **Drive family** | |
| | **M** | Mobile |
| **2** | **Drive** | |
| | **D** | Drive |
| **3** | **Series** | |
| | **4** | Gen4 |
| | **5** | Gen5 |
| **4** | **Frame Size** | |
| | **2** | |
| | **4** | Low voltage sizes (24-120 VDC) |
| | **6** | |
| | **A** | |
| | **B** | High voltage sizes ( up to 800 VDC) |
| | **C** | |
| **5** | **Max. Operating Voltage** | |
| | **02** | 24 VDC |
| | **04** | 48 VDC |
| | **08** | 80 VDC |
| | **12** | 120 VDC |
| | **40** | 400 VDC |
| | **80** | 800 VDC |
| **6** | **Peak Current Rating (2 min)** | |
| | **024** | 24 Arms (1 min) |
| | **053** | 53 Arms (1 min) |
| | **180** | 180 Arms |
| | **275** | 275 Arms |
| | **300** | 300 Arms |
| | **350** | 350 Arms |
| | **400** | 400 Arms |
| | **450** | 450 Arms |
| | **550** | 550 Arms |
| | **650** | 650 Arms |
| **7** | **Special options** | |
| | **00** | Standard |



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# Related Products

## Global Vehicle Motor (GVM)



**Description**

PMAC servomotors offer the best solution to meet the requirements of vehicle duty performance. The torque density and speed capabilities of Parker Permanent Magnet AC motors (PMAC) provide the speed and torque required to achieve breakthrough performance in a variety of vehicle platforms.

**Product Features**

- High efficiency
- Compactness (High power density)
- Can be used either as motor or generator
- Operating voltages available from 24 to 800 VDC

## Electro-Hydraulic Pumps (EHP)



**Description**

The Electro-Hydraulic Pump (EHP) kits are designed for hybrid electric and all electric mobile applications. EHP systems consist of an electric motor directly coupled to an hydraulic pump controlled by a high performance mobile hardened drive.
Parker's global expertise in hydraulic, electric motor, and drive technologies is brought together in the EHP to create a system that has been optimally adapted to the customer requirements.

**Product Features**

- Complete Electro-Hydraulic Pump solutions
- Pre engineered system with fully validated pressure, flow and voltage data
- Wide range of motor/pump combinations to adapt to every battery pack

## CFR - Low voltage induction motors



**Description**

This low cost air-cooled induction motors (ACIM) range has been specifically developed for battery-operated vehicles. Typically adapted for Electro-Hydraulic Pumps (EHP), the Parker's product support team will work with pump division to coordinate mechanical solution.

**Product Features**

- Ruggedised low voltage induction motor
- Speed up to 3500 rpm
- Power up to 40 kW
- IP rating: IP20 to IP65
- Built-in thermal sensor for monitoring motor temperature



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# Parker's Motion & Control Technologies

**At Parker, we're guided by a relentless drive to help our customers become more productive and achieve higher levels of profitability by engineering the best systems for their requirements. It means looking at customer applications from many angles to find new ways to create value. Whatever the motion and control technology need, Parker has the experience, breadth of product and global reach to consistently deliver. No company knows more about motion and control technology than Parker. For further info call 00800 27 27 5374**



## Aerospace

### Key Markets

Aftermarket services
Commercial transports
Engines
General & business aviation
Helicopters
Launch vehicles
Military aircraft
Missiles
Power generation
Regional transports
Unmanned aerial vehicles

### Key Products

Control systems & actuation products
Engine systems & components
Fluid conveyance systems & components
Fluid metering, delivery & atomization devices
Fuel systems & components
Fuel tank inerting systems
Hydraulic systems & components
Thermal management
Wheels & brakes



## Climate Control

### Key Markets

Agriculture
Air conditioning
Construction Machinery
Food & beverage
Industrial machinery
Life sciences
Oil & gas
Precision cooling
Process
Refrigeration
Transportation

### Key Products

Accumulators
Advanced actuators
$CO_2$ controls
Electronic controllers
Filter driers
Hand shut-off valves
Heat exchangers
Hose & fittings
Pressure regulating valves
Refrigerant distributors
Safety relief valves
Smart pumps
Solenoid valves
Thermostatic expansion valves



## Electromechanical

### Key Markets

Aerospace
Factory automation
Life science & medical
Machine tools
Packaging machinery
Paper machinery
Plastics machinery & converting
Primary metals
Semiconductor & electronics
Textile
Wire & cable

### Key Products

AC/DC drives & systems
Electric actuators, gantry robots & slides
Electrohydrostatic actuation systems
Electromechanical actuation systems
Human machine interface
Linear motors
Stepper motors, servo motors, drives & controls
Structural extrusions



## Filtration

### Key Markets

Aerospace
Food & beverage
Industrial plant & equipment
Life sciences
Marine
Mobile equipment
Oil & gas
Power generation & renewable energy
Process
Transportation
Water Purification

### Key Products

Analytical gas generators
Compressed air filters & dryers
Engine air, coolant, fuel & oil filtration systems
Fluid condition monitoring systems
Hydraulic & lubrication filters
Hydrogen, nitrogen & zero air generators
Instrumentation filters
Membrane & fiber filters
Microfiltration
Sterile air filtration
Water desalination & purification filters & systems



## Fluid & Gas Handling

### Key Markets

Aerial lift
Agriculture
Bulk chemical handling
Construction machinery
Food & beverage
Fuel & gas delivery
Industrial machinery
Life sciences
Marine
Mining
Mobile
Oil & gas
Renewable energy
Transportation

### Key Products

Check valves
Connectors for low pressure fluid conveyance
Deep sea umbilicals
Diagnostic equipment
Hose couplings
Industrial hose
Mooring systems & power cables
PTFE hose & tubing
Quick couplings
Rubber & thermoplastic hose
Tube fittings & adapters
Tubing & plastic fittings



## Hydraulics

### Key Markets

Aerial lift
Agriculture
Alternative energy
Construction machinery
Forestry
Industrial machinery
Machine tools
Marine
Material handling
Mining
Oil & gas
Power generation
Refuse vehicles
Renewable energy
Truck hydraulics
Turf equipment

### Key Products

Accumulators
Cartridge valves
Electrohydraulic actuators
Human machine interfaces
Hybrid drives
Hydraulic cylinders
Hydraulic motors & pumps
Hydraulic systems
Hydraulic valves & controls
Hydrostatic steering
Integrated hydraulic circuits
Power take-offs
Power units
Rotary actuators
Sensors



## Pneumatics

### Key Markets

Aerospace
Conveyor & material handling
Factory automation
Life science & medical
Machine tools
Packaging machinery
Transportation & automotive

### Key Products

Air preparation
Brass fittings & valves
Manifolds
Pneumatic accessories
Pneumatic actuators & grippers
Pneumatic valves & controls
Quick disconnects
Rotary actuators
Rubber & thermoplastic hose & couplings
Structural extrusions
Thermoplastic tubing & fittings
Vacuum generators, cups & sensors



## Process Control

### Key Markets

Alternative fuels
Biopharmaceuticals
Chemical & refining
Food & beverage
Marine & shipbuilding
Medical & dental
Microelectronics
Nuclear Power
Offshore oil exploration
Oil & gas
Pharmaceuticals
Power generation
Pulp & paper
Steel
Water/wastewater

### Key Products

Analytical Instruments
Analytical sample conditioning products & systems
Chemical injection fittings & valves
Fluoropolymer chemical delivery fittings, valves & pumps
High purity gas delivery fittings, valves, regulators & digital flow controllers
Industrial mass flow meters/controllers
Permanent no-weld tube fittings
Precision industrial regulators & flow controllers
Process control double block & bleeds
Process control fittings, valves, regulators & manifold valves



## Sealing & Shielding

### Key Markets

Aerospace
Chemical processing
Consumer
Fluid power
General industrial
Information technology
Life sciences
Microelectronics
Military
Oil & gas
Power generation
Renewable energy
Telecommunications
Transportation

### Key Products

Dynamic seals
Elastomeric o-rings
Electro-medical instrument design & assembly
EMI shielding
Extruded & precision-cut, fabricated elastomeric seals
High temperature metal seals
Homogeneous & inserted elastomeric shapes
Medical device fabrication & assembly
Metal & plastic retained composite seals
Shielded optical windows
Silicone tubing & extrusions
Thermal management
Vibration dampening

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