emDrive 150

BLDC motor controller

Datasheet V2.1

Important Notice

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General

- Advanced BLDC / PMSM / induction motor controller for e-drive systems
- CANOpen compatible (profile DS402)
- Multiple rotor position sensors supported

Motor control features

- True sinus mode motor currents with hall sensors (observer for motor position)
- Vector current control minimizes torque ripple and vibrations of motor – No motor audible noise
- Vector current control with inexpensive hall sensors in motor
- Four quadrant control (forward / backward with regeneration)
- Integrated speed regulator
- Throttle input controls motor torque, motor speed or combination of both – Latest option gives similar control response as internal combustion engine

Position sensors

- Supported position sensors
  - Standard three hall sensors with 60 or 120 degree configuration
  - Absolute digital SSI encoder with RS422 interface
  - Resolver
  - 5 V analogue SIN / COS (not recommended for high pole count motors)
  - Incremental encoder for induction motor

Protection functions

- Maximum motor current protection
- Thermal protection of motors (input for temperature sensor in the motor) – Gradual decrease of maximum motor current when motor temperature reaches limit
- Controller thermal protection – Gradual decrease of maximum motor current
- Hall sensor failure detection and safe motor shut down
- Low battery protection with battery voltage measurement – Gradual decrease of maximum current when battery voltage indicates empty battery
- High voltage battery protection – Prevents over voltage situations when regenerating with full or damaged battery
- Motor stall protection – limits motor current if motor is blocked for certain time
- Optional throttle out of range detection for detecting of damaged throttle or broken wire
- Full self-test at start – Check all MOSFET-s, motor connection and battery connection

Logging functionality and serial diagnostic

- Internal FLASH memory for storing last 2 hours of all important values (battery voltage, battery current, motor current, speed, motor and controller temperature …)
- Same values can be sent to serial port / over CANOpen for PC logging
- Fast data acquisition functionality (every FOC cycle)

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Additional functions

- Control for magnetic brake
- Output for brake light, active when regenerating (optional)
- Additional analog input used for control of maximum speed or regenerative braking

Set up and customization

- All settings are stored as parameters and can be changed – No »hard-wired« limits and settings
- CANOpen protocol (full DS402 compatible) for adjustment of settings
- Settings are adjusted with text commands or GUI configuration SW
- Support any number of motor poles

Electronic design

- All connections have automotive EMC protection
- All control connections are protected against short circuit to ground
- Low EMC design, with proper cable wiring easily reaches class B EMC emission regulations
- Main contactor not required

Communication interfaces

- 1x RS232 interface used for monitoring and FW upgrade
- 1x CAN 2.0B interface with optional galvanic isolation

Housing

- Aluminum base plate for heat sink, plastic top cover
- High current screw terminals for battery connection and motor phases
- Dimensions (Height x Width x Length) 58 x 200 x 150 mm, weight 1,7 kg
- IP65 protection

Specifications

emDrive150	150_250/60	200_400/60	150_300/120	unit
Electrical data				
Output continuous current	150	200	150	A$_{RMS}$
Output maximum peak current (one minute)	250	400	300	A$_{RMS}$
Input DC link voltage range	20 to 60	20 to 60	20 to 120	V
Supply voltage range (Ignition voltage)	12 to 60	12 to 60	70 to 120	V
Supply current max. (Ignition current)	200	200	80	mA
Output continuous power*	10	13	21	kVA
Output maximum peak power (one minute)*	17	27	43	kVA
Switching frequency	16			kHz
Operating ambient temperature**	-20 to 65			°C

* depends on load and cooling

** maximum back plate temperature 50 °C

Connector

System connector AmpSeal 35 pin waterproof
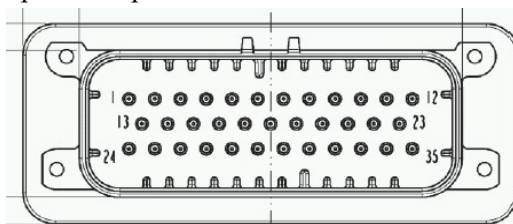
emDrive control interface mating connector is 35 pin female AMPSEAL with ordering code:

- connector housing (Manufacturer Part No: 776164-1)
- female crimp pins (Manufacturer Part No: 770854-3 (gold) or 770854-1 (tin))

Pin	Name	Description/comment
1	Ignition GND	Ground. Used for ignition. Internally connected with pin 3
2	Ignition VCC	Power supply for controller logic (check emDrive specification!)
3	Logic GND	Ground. Used for throttle and other inputs
4	VCC out	5 V for powering throttle and brake control
5	Throttle input	Analog input (0-5 V). Throttle input
6	FW upgrade input	Used for FW upgrade. Only for factory use
7	RS232 Tx	Used for FW upgrade. Only for factory use
8	RS232 Rx	Used for FW upgrade. Only for factory use
9	SSI Clock +	Absolute digital SSI encoder with RS422 interface (output)
10	SSI Clock -	Absolute digital SSI encoder with RS422 interface (output)
11	SSI Data +	Absolute digital SSI encoder with RS422 interface (input)
12	SSI Data -	Absolute digital SSI encoder with RS422 interface (input)
13	Forward digital input	Motor rotation direction. Switch to GND (Active Low)
14	Reverse digital input	Motor rotation direction. Switch to GND (Active Low)
15	Brake digital input	Electrical braking (regeneration). Switch to GND (Active Low)
16	Open collector output 1	Digital output
17	Open collector output 2	Digital output
18	Brake input	Analog input (0-5 V). Electrical braking (regeneration).
19	CAN GND	In standard (non-isolated) version this pin is connected with pin 3
20	Resolver exc +	Resolver power supply (output). 15 Vpp (10 kHz)
21	Resolver exc -	Resolver power supply (output). 15 Vpp (10 kHz)
22	SIN/COS (SIN)*	SIN/COS sensor. Analog input (0-5 V)
23	SIN/COS (COS)	SIN/COS sensor. Analog input (0-5 V)
24	Feedback GND	Ground. Used for sensors feedbacks. Internally connected with pin 3
25	Hall U**	Hall sensor input
26	Hall V**	Hall sensor input
27	Hall W**	Hall sensor input
28	Feedback VCC	5 V used for powering position sensors
29	Motor temperature	Temperature sensor input (KTY or NTC). For GND use pin 24
30	CANL	CAN bus Low signal
31	CANH	CAN bus High signal
32	Resolver SIN +	Resolver sensor. Analog input (0-5 V)
33	Resolver SIN -	Resolver sensor. Analog input (0-5 V)
34	Resolver COS +	Resolver sensor. Analog input (0-5 V)
35	Resolver COS -	Resolver sensor. Analog input (0-5 V)

* input is optionally used for detection of driving mode selection (normal, sport, eco)
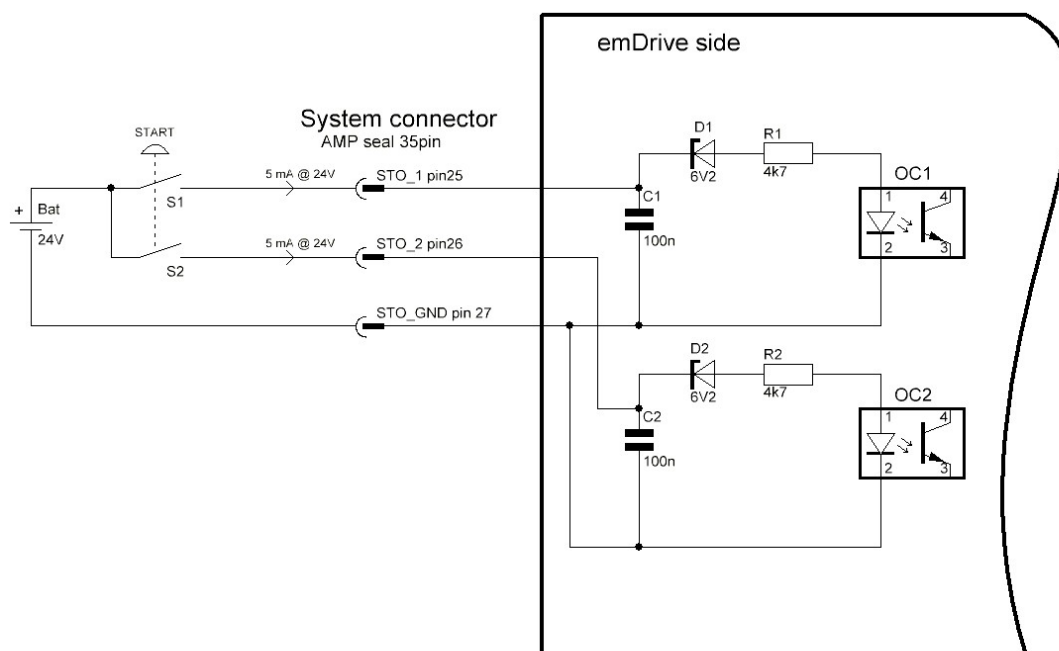** input is on emDrive150 optionally used for Functional safety (STO).

⚠️ *Warning: In standard (non-isolated) version controller has no galvanic insolation between power stage and control section. Screw connection BAT– is internally connected with pins 1, 3 and 24.*

Functional safety (STO)

The Safe Torque Off (STO) inputs are a digital input intended for nominal 24 VDC, positive logic (enabled when high).

Electrical data	Value
Absolute maximum voltage range	-30 V to +30 V
Logic threshold	15,5 V ± 2,5 V
Typical input current at +24 V_{DC}	3,5 mA
Maximal response time at nominal voltage	60 ms

System will not respond to 1ms "disable" test pulses with frequency less than 100 Hz.

Status LEDs

LED \ status	OFF	Flashing	ON
CAN Run (green)	NMT state stopped	NMT state pre-operational	NMT state operational
CAN Error (red)	No CAN error	Single flash - CAN state passive	CAN bus OFF
		Double flash - Heartbeat lost	
Drive (green)	Controller in - Preoperational mode, - PWM disabled, - Safety procedure not started, - Brake enabled	Controller in - Operational mode, - Safety ok, - PWM disabled, - Brake disabled	Controller in - Drive mode PWM enabled, - Brake disabled
Warning (yellow)	All protections are inactive	/	One or more of protections active (object 0x2027)
Error (red)	No drive error	/	Drive error (object 0x603F)

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Dimension and connection

ISO 9001:2000 certified