



## Industrial motor controller for BLDC-Motors 24 / 48 VDC

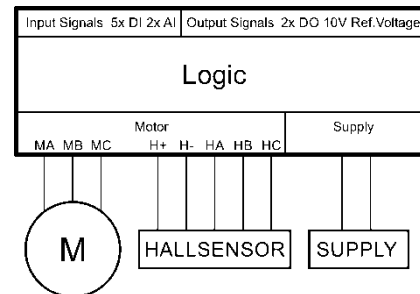
Design for output currents up to 12 A

Control with following functions:

- speed control by analog input
- additional adjustable speed input
- reversal of direction of rotation
- selectable dynamic braking
- adjustable acceleration and deceleration ramp
- current limitation or current shut off selectable
- short circuit detection

To snap onto DIN rail EN 50022

Unit width: 22,5 mm



<b>Type</b>	<b>M5-BL-12-48</b>	
<b>Artikle number</b>	<b>06.38.001</b>	
<b>Operating data:</b>		
Nominal voltage	$U_{nom}$	24 / 48 VDC
Supply voltage	$V_{CC}$	15 .. 58 VDC
5 digital inputs	$U_{DI}$	24,0 VDC
1 analog input	$U_{AI}$	0 – 10 VDC, 24 V tolerant
2 digital outputs, galvanic isolated	$U_{DO}$	24 VDC, 50 mA
3 Hall sensor inputs for open-collector sensors	$U_{HALL}$	13,5 VDC
<b>Technical data: load circuit</b>		
Max. current / continuous load current typ.	$I_{max}/I_{con}$	24 / 12 A
Short circuit current detection typ.	$I_{SC}$	150 A
Shut down time after short circuit typ.	$t_{sc}$	100 $\mu$ s
Power stage driver		MOS-FET
<b>Other data</b>		
Start ramp (start-ramp)	TR5	150 .. 4000 ms
Stop ramp (stop-ramp)	TR4	0 .. 4000 ms
Current monitoring delay (CM-delay)	TR3	0 .. 1000 ms
PWM speed2 (PWM2)	TR2	5 .. 97%
PWM speed1 (PWM1)	TR1	5 .. 97%
Current adjustable with DIP-switch		1 .. 16 A
Dynamic brake (armature short circuit)		Can be enabled
Temperature monitoring / overvoltage protection		yes / yes
Status indication : ready / error		LED1 green / LED2 red

Other data	
Size	114,5 x 22,5 x 99,0 mm
Connectors	Screw terminals cross section 0,2 .. 2,5 mm <sup>2</sup>
Installation position / Assembly	any / top-hat rail EN 50022
Installation place, typical	Switch cabinet
Permissible ambient temperature	T <sub>amb</sub> -20 .. +60 °C
Permissible humidity	up to bis 95 %, non-condensing
Storage temperature	-30 .. +85 °C
Weight	0,110 kg
Initializing delay	1 s
Hazardous substance norm	RoHS3
EMC interference immunity	EN 61000-6-2:2005-08 + AC:2005-9
EMC emitted interference	EN 61800-3:2004 +A1:2012 EN 61000-6-4:2007-01 +A1:2011-02
Power Supply for AC mains	Meanwell, SDR-480P-24
Line filter for industrial DC net	Wurth, 810913014

#### Technical data: digital input

High-Signal typ.	U > 10 V
Low-Signal typ.	U < 4 V
Impedance typ.	R <sub>DI</sub> 15 kΩ

#### Technical data: analog input

Voltage range	0 .. 10V
24V DC tolerant	Yes
Impedance typ.	R <sub>AI</sub> 98,5 kΩ

#### Technical data: Hall sensor inputs

Internal pull up resistor	10kΩ
Hall supply voltage	U <sub>HALL</sub> 13,5V DC 50mA max.
Hall sensor arrangement	120°

#### Technical data: digital output

Output type	Potential free
Supply voltage for digital output (terminal 5)	V <sub>DO</sub> 0 .. 24 V DC 50mA
Short circuit proof	Yes
OUT1 „over current“ / „current OK“	V <sub>DO</sub> / open
OUT2 „operational“ / „error“	V <sub>DO</sub> / open
Current capacity per output typ.	20mA

#### Flammability

Housing, terminals, printed circuit board	UL94V-0
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#### Initializing behavior

The module M5-BL-12-48 is operational after the stated initializing delay elapsed.

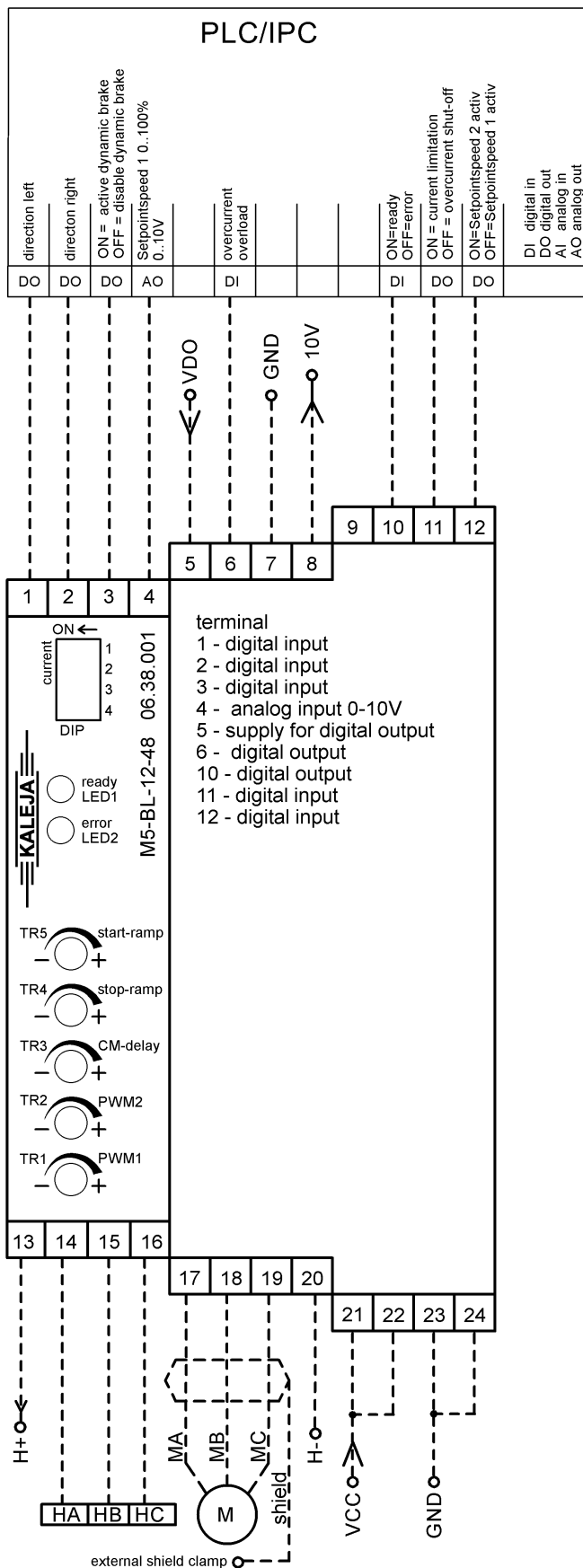
#### Description

The module M5-BL-12-48 is a motor control for brushless DC-motors, intended for the usage in an industrial environment. It ensures reliable switching on and off and controlled operation of BLDC motors.

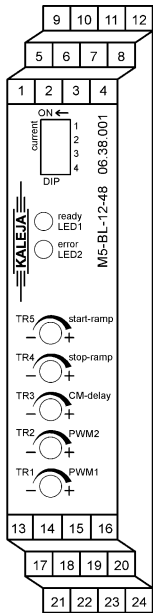
The module is provided with:

- digital inputs for CW and CCW direction
- digital input to switch between 2 independent adjustable target speeds
- digital input for activation of dynamic braking
- digital input to switch between current limitation or current shut-off mode
- analog input 0-10 V for the speed control
- potential free digital outputs to signalize operational state and over current
- trimmers to set the maximum 1 target speed TR1, 2nd target speed TR2, current monitoring delay TR3, stop-ramp TR4, and start-ramp TR5
- DIP-switches to adjust the maximum current for the current limitation or current shut-off mode

Wiring example



**Terminal assignment**



<b>9</b> NC	<b>10</b> Digital output „operational“	<b>11</b> Digital input low = current shut-off high = current limitation	<b>12</b> Digital input low =target speed PWM1 high =target speed PWM2
<b>5</b> V <sub>DO</sub> 24V DC / 50mA Supply voltage input for digital outputs	<b>6</b> Digital output „over current“	<b>7</b> GND for external potentiometer  0,5A max	<b>8</b> Voltage source +10V DC / 50mA for potentiometer
<b>1</b> Digital input „CCW“ (high active)	<b>2</b> Digital input „CW“ (high active)	<b>3</b> Digital input „activate dynamic brake“ (high active)	<b>4</b> Analog input 0 .. 10V „PWM1 scaling“ 0 .. 100%
<b>13</b> Hall +10V 50mA Voltage source for hall sensors	<b>14</b> Hall signal A 10kΩ pullup internal	<b>15</b> Hall signal B 10kΩ pullup internal	<b>16</b> Hall signal C 10kΩ pullup internal
<b>17</b> Motor phase A	<b>18</b> Motor phase B	<b>19</b> Motor phase C	<b>20</b> Hall GND
<b>21</b> V <sub>CC</sub> Supply voltage	<b>22</b> V <sub>CC</sub> supply voltage	<b>23</b> GND supply	<b>24</b> GND supply

**State table**

direction „left“ (1)	direction „right“ (2)	enable DYN. braking (3)	Current limitation/ Current shut-off (11)	Target speed (12)	Function
0	1	X	X	X	CW direction
1	0	X	X	X	CCW direction
X	X	X	0	X	Current switch-off mode active
X	X	X	1	X	Current limitation mode active
X	X	X	X	0	target speed source 1 TR1 and analog input active
X	X	X	X	1	Target speed 2 activeTR2
1	1	X	X	X	Stop with the behavior selected over digital input terminal 3
0	0	1	X	X	dynamic braking on
0	0	0	X	X	Stop without dynamic braking

0=OFF 1=ON X=no effect

**Function: Speed control - Target speed source 1**      **Function: Speed control - Target speed source 2**

Digital input „Target speed PWM2“ (12) is „low“  
 Target speed source 1 is active. PWM max. is adjusted by trimmer TR1. By means of the analog input „PWM1 scaling“ (4), the speed value can be set from 0 up to the maximum speed adjusted with TR1.  
 If the module shall only be operated with the set speed on trimmer TR1, then terminal (4) must be connected with +10V on terminal(8).

Digital input „Target speed PWM2“ (12) is „high“  
 Target speed source 2 is active. Target speed PWM2 adjustable with trimer TR2 is used.

**Function: dynamic Braking**      **Function: short circuit detection**

Dynamic braking is active when digital input „activate dynamic brake“ (3) has „high“ signal. A „low“ signal at (3), deactivates the dynamic braking function, and the motor stops with the stop ramp adjusted with trimmer TR4.

If both inputs for direction of rotation (1 and 2) are set simultaneously to „high“ signal, the device stops with the behavior set on digital input “activate dynamic brake”(3).

The dynamic brake is only permitted for motors with an internal resistance of at least 600mΩ. Motors with a smaller internal resistance can damage the module during dynamic braking.

The stop ramp must therefore be sufficiently dimensioned.

The motor is shut-off without dynamic braking in case of a detected short circuit between the motor cables. The module remains disabled for a fixed delay, after a short circuit detection. After this delay, the motor can be started again by resetting and new setting of a direction input.

**Function: temperature shut-off**

The module is equipped with a temperature sensor. If the maximum allowed temperature is exceeded, the motor is switched-off without dynamic braking  
After a cooling down, the motor can be started again by setting of a direction input.  
The necessary cooling down time is dependent on ambient temperature and mounting situation of the module.

**Function: current limitation / current shut-off**

The change between current limitation mode or current shut-off mode is made by digital input (11):

**Current limitation:** digital input "high"

When the motor current exceeds the adjusted limit value, the module decreases the speed unless the motor current is equal or lower as the adjusted limit.

**Current shut-off:** digital input "low"

When the motor current exceeds the adjusted limit value, the module shut-off the motor.  
The motor can be started again, by resetting of a direction input.

**Function: current monitoring delay**

To suppress the high peak currents when starting the motor, the current measurement is only activated after a waiting period, called current monitoring delay. The length of the current monitoring delay can be adjusted with trimmer TR3.

When a direction of rotation is set or when the target speed input is switched, the current shut-off is deactivated for the duration of the current monitoring delay.  
The short circuit detection and overload shutoff remains active.

**Function: start-ramp**

After setting of a direction of rotation the motor accelerates with the adjusted start-ramp. The slope of the starting ramp can be adjusted using the trimmer TR5 (start-ramp). The steepness of the starting ramp also applies when the speed set-point is changed at the analog input (4).

**Function: Stop-ramp**

After resetting the direction of rotation, the motor decelerates the speed with the adjusted stop-ramp. The slope of the stop-ramp can be adjusted using the trimmer TR4.  
After the stop-ramp has elapsed, the function of the dynamic brake set at digital input (3) applies.  
The steepness of the stop-ramp also applies when the speed set-point is changed at the analog input (4).  
If the motor is to be braked immediately with a dynamic brake, the TR4 trimmer must be set to the "-" position.

Function: setting motor current limit	Motor current table
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The motor current limit is adjusted with the DIP switches of the module. The corresponding setting can be found in the motor current table.

The maximum allowed continuous current is 12A. Current limit settings above 12A are only allowed for short duties.

DIP1	DIP2	DIP3	DIP4	MAX. current [A]
Off	Off	Off	Off	1
On	Off	Off	Off	2
Off	On	Off	Off	3
On	On	Off	Off	4
Off	Off	On	Off	5
On	Off	On	Off	6
Off	On	On	Off	7
On	On	On	Off	8
Off	Off	Off	On	9
On	Off	Off	On	10
Off	On	Off	On	11
On	On	Off	On	12
Off	Off	On	On	13
On	Off	On	On	14
Off	On	On	On	15
On	On	On	On	16

Status digital output	
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„operational“	State
High	Operational
Low	Error

„over current“	State
High	Motor current > MAX. current
Low	Motor current < MAX. current

Module state	Module errors
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The state of the module is indicated by the LED´s on the front side.

LED1 „ready“ green	LED2 „error“ red	Description
On	Off	Module operational
On	On	Only in mode current limitation. Current is limited by the device
Flashing	On	Module error
Flashing	blinkt	internal system error

When an error occurs, the motor is stopped. The motor can be started again after resetting the error. In case of an internal system error, the module needs to be repowered.

**Errors resetting:**

The error Nr.5 and 6 (supply errors) are reset automatically. All other errors must be reset by setting both direction inputs terminal1 and 2 to “low”.

Module errors are indicated with flashing sequence. The end of a flashing period is shown with a delay of (1s). The number of flashes indicates the No. of the module error:

1	Over current
2	Temperature overload
3	Short circuit
4	Over load
5	Over voltage of the supply voltage
6	Under voltage of the supply voltage
7	Power stage supply faulty
8	Hall signal error
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**Temperature derating**

**Derating diagram**

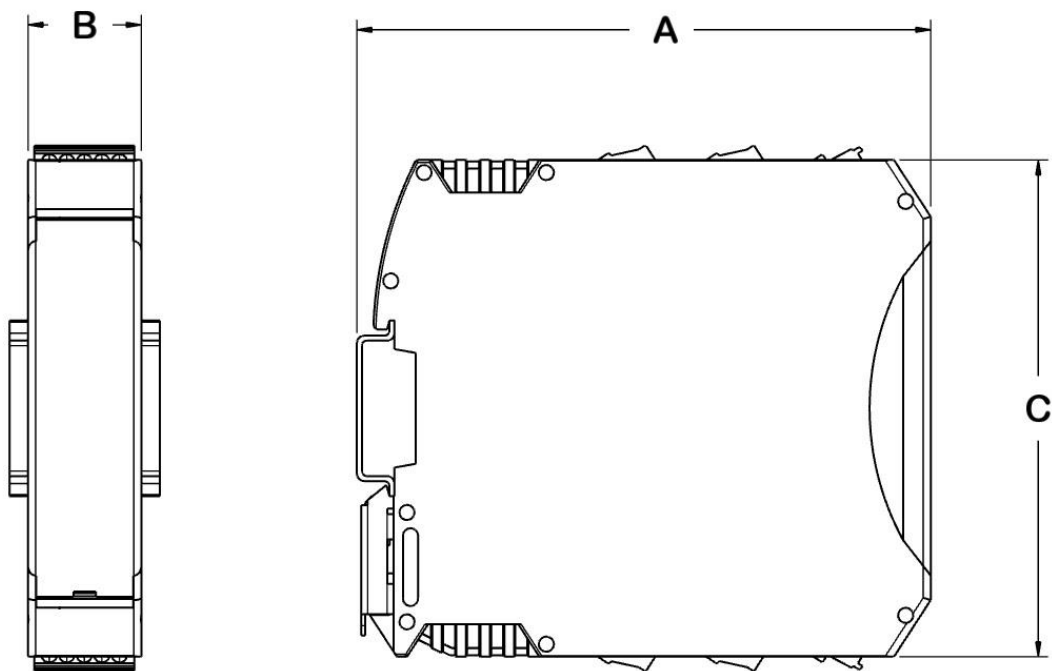
The following derating diagram was empirically measured and shall give an approximate guideline.

TBD

Operation with high continuous currents shall comply with following parameters:

- Use connection cables with maximal possible wire cross sections.
- Do not line up the modules. Minimum distance 20 mm
- Adequate air circulation must be ensured.

**Dimensional drawing**



A = 114,5 mm; B = 22,5 mm; C = 99 mm



## Safety notes

### Maximum operational data

The maximum operating data must not be exceeded.

### Installation

The installation and start-up must be performed by specialist personnel exclusively.

All affected components must be disconnected from the mains.

### Start-up

For the first start-up, the motor should be operated without load.

### Risk of death

Do not touch live parts after switching on!

The assembly must be operated exclusively on safety extra-low voltage. With operation under extra-low voltage (e.g. via autotransformer), death or injury can occur.

### Fire protection

The assembly must be installed in a switch cabinet, which is suitable as a fire protection enclosure.

The assembly must be safeguarded with a pre-fuse aligned with the nominal data.

### Field of application

The assembly may only be used as intended.

Other components must be checked for their approvals and regulations.

### Safety devices

An additional safety device must be used to bring the system into a safe state in case of a cable break, incorrect operation, failure of the control/controller unit.

### EMC / EMI

The wiring must be done according to EMC / EMI standards. If necessary, shielded cables and EMC suppressors must be used for the connected consumer.

For operation in a public low-voltage distribution network, the module must be supplied with an approved AC adapter.

If the module is supplied with an AC adapter, other equipment, operated on the same power supply, must be suitable for use in industrial environments.

### Repairs

Repairs must be performed by authorised persons exclusively. With unauthorised opening, the warranty cover is voided and this may also result in danger for the user and for the system.

### Maintenance

The assembly is wear-free by design.

For modules **with** cooling openings free air circulation must be checked at the cooling openings or on the housing at regular intervals. If necessary, the cooling holes / the housing must be cleaned.

Good ventilation must be ensured.

## Contact details



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