

# MDR A2/B2

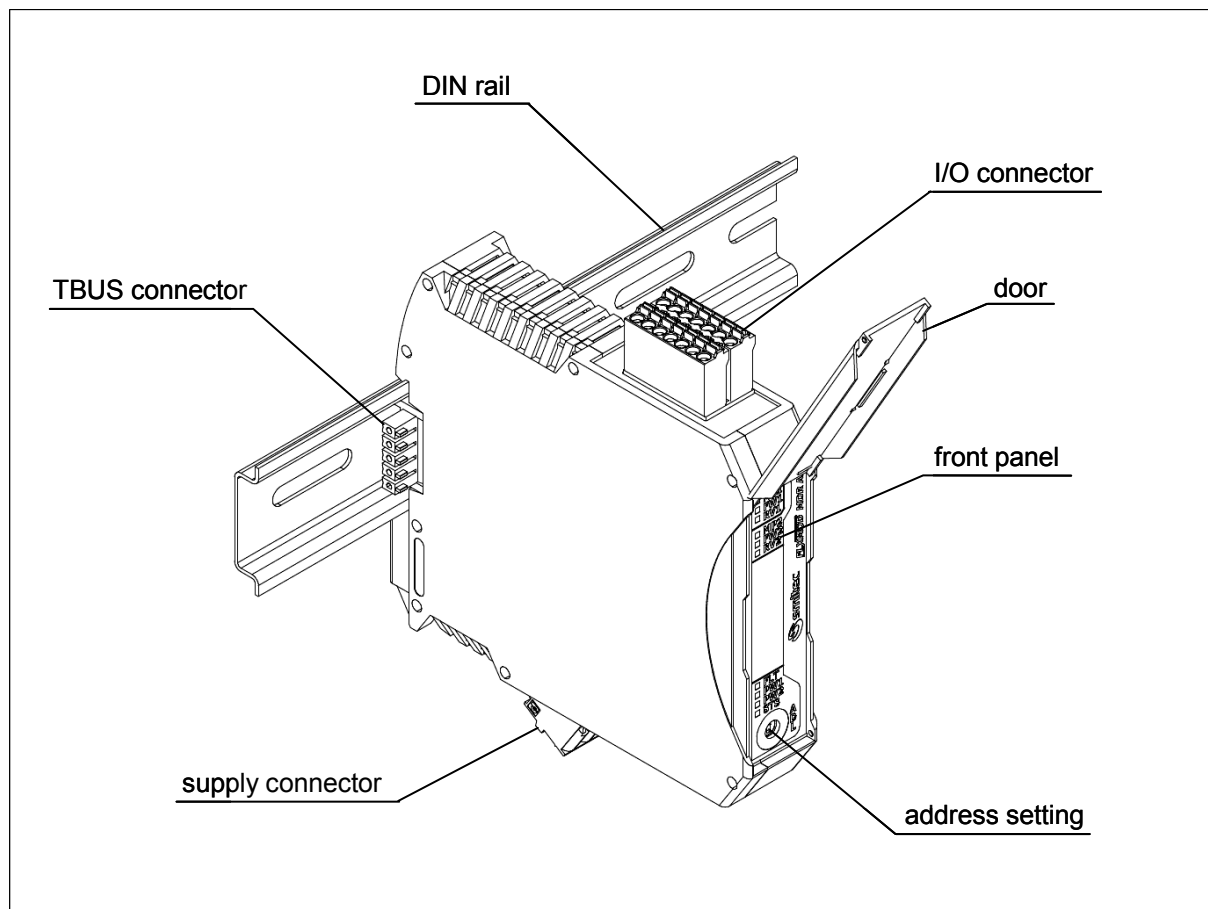
## Dual H-Bridge PWM output with Hall sensors interface

Datasheet

### Description

Dual PWM output module for resistive and inductive load with dual interface for Hall sensors. Main characteristics:

- dual power output with MOSFET H-bridge suitable for resistive and inductive load (e.g. valve coil, heating resistor, DC brush motor, etc.)
- PWM control with software-programmable frequency
- Hall sensor interface for speed/position control
- overcurrent and overload protection (thermal in MDR A2, programmable in MDR B2)
- status and diagnostic LEDs



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## Ordering informations

<b>Products</b>	<b>SMITEC part number</b>
Module with 2 PWM outputs with overcurrent and thermal overload protection, complete with accessories (power connector, inputs connector and TBUS connector)	KZ010203
Module with 2 PWM outputs with overcurrent and software programmable overload protection, complete with accessories (power connector, inputs connector and TBUS connector)	KZ010508

<b>Accessories</b>	<b>SMITEC part number</b>
Power supply connector (Phoenix Contact p/n 1910377)	KF100009
I/O connector (Phoenix Contact p/n 1738856)	KF101049
TBUS connector (Phoenix Contact p/n 2713722)	KF101034
Power supply fuse (Littelfuse p/n 0451 012 or Littelfuse 0453 012)	KD201036

<b>Documentation</b>	<b>SMITEC part number</b>
Installing instructions	DK400042
Datasheet for MDR A2/B2	DK400067
FLXIO and FLXMOD system integration manual	DK400076

## Technical data

General data	
Housing dimensions (width x height x depth)	22.5 mm x 99.0 mm x 114.5 mm
Weight	107 g (without connectors), 126 g (with connectors)
Connection method for connectors	Spring cage terminals
Conductor cross-section (power connector)	0.2 to 2.5 mm <sup>2</sup> (24 – 12 AWG)
Conductor cross-section (output connector)	0.2 to 1.5 mm <sup>2</sup> (24 – 16 AWG)
Functional earth connection	To the DIN rail with spring contact
Mode state visual indicators	Fault (FLT), status (STS), power (PWR1 and PWR2), motor power (MP1 and MP2), forward (FW1 and FW2) and reverse (RV1 and RV2) LED lamps

Environment data	
Permissible operating temperature	+5° to +45°C full load +5° to +55°C with output derating
Permissible storage and transport temperature	-25° to +85°C
Permissible humidity	10% to 95%, not condensing
Permissible air pressure (operation)	80 to 106 kPa (up to 2000 m above sea level)
Permissible air pressure (storage and transport)	70 to 106 kPa (up to 3000 m above sea level)
Degree of protection (CE)	IP20 according to IEC 60529
Degree of protection (UL)	Open Type
Overvoltage category	II
Pollution degree	2
Means of protection (UL)	Class III SELV power supply

Power supply	
Main power supply $V_M$	24 V DC $\Rightarrow$ (-15% ÷ +20% according to IEC 61131-2)
Auxiliary power supply $V_A$	24 V DC $\Rightarrow$ (-15% ÷ +20% according to IEC 61131-2)
Maximum allowed ripple on $V_M$ and $V_A$	5% of supply voltage (according to IEC 61131-2)
Current consumption from main supply	8 A max.
Current consumption from auxiliary supply	150 mA max.
Supply overvoltage protection on $V_M$	Unidirectional Zener clamp ( $V_z > 30$ V)
Supply overvoltage protection on $V_A$	Bidirectional Zener clamp ( $V_z > 30$ V)
Supply reverse polarity protection on $V_M$	Input shunt diode, reverse connected
Supply reverse polarity protection on $V_A$	Series diode
Supply fuse	12 A on main supply ( $V_M$ ), not replaceable by the user; 1 A on auxiliary supply ( $V_A$ ), not replaceable by the user
Module power supply	5 V DC from local bus
Power load from local bus at 5V DC	Approx. 0.4W
Power presence visual indicators	Two green LED lamps, lighted if main supply (PW1) and auxiliary supply (PW2) is present

<b>Power outputs</b>	
Number of outputs	2 H-bridge outputs with power MOSFETs
Output current (CE)	4 A each @ 312Hz, 8 A max @ 45°C total or 5.5 A single @ 312Hz, 5.5 A max @ 45°C total
Output current (UL)	3.5 A each @ 312Hz, 7 A max @ 55°C total or 5.5 A single @ 312Hz, 5.5 A max @ 55°C total
Output current (UL)	3.4 A each @ 312Hz, 6.8 A max @ 45°C total or 5.5 A single @ 312Hz, 5.5 A max @ 45°C total
Type of load	24 V resistive and inductive
Output current limitation (thermal)	> 30 A
Output current/time limitation (software programmable – MDR B2 model only)	1÷30000mA / 1÷65535mS by 1 mA/1 mS steps
Voltage output range	-V <sub>A</sub> to +V <sub>A</sub> , positive and negative
PWM frequency range on channel 1	Software selectable, 5 different values: 76.6 Hz, 312 Hz, 609 Hz, 2.44 kHz and 9.80 kHz
PWM frequency range on channel 2	Software selectable, 255 different values from 38.4 Hz to 9.80 kHz, according to the following formula: $f_{PWM} = \frac{9804}{n+1}$ Where <i>n</i> is an integer ranging from 0 to 254.
PWM range	0 ÷ 100% by steps of 1/256, forward and reverse
Outputs common potential isolation from GND	500 VAC, functional isolation only
Isolation between channels	none
Output state visual indicators	Three orange LED lamps for every output, indicating motor energized (MPx) and rotation direction (FWx and RVx)

<b>Hall sensors inputs</b>	
Number of digital inputs	Four (two in quadrature for each channel)
Type of inputs	For open collector sensors, 1.5 kΩ pull-up integrated on-board, 24 V tolerant
Input logic levels	V <sub>L</sub> = 1.5 V max, V <sub>H</sub> = 2.4 V min, Schmitt-triggered
Input frequency range	From 0 to 4 kHz
Quadrature inputs phase shift	90° ±18° (50% ±20%)
Hall sensors internal supply	5 V ± 10% / 100 mA, short-circuit protected

<b>Interface</b>	
Local bus	Proprietary FLXIO™
Module address setting	With rotary switch on front panel
Bus connections	By TBUS connectors on DIN rail
Interface circuitry protections	ESD protections
Level of ESD protection	±8 kV (IEC 61000-4-2, contact discharge)

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## Connections

The module has two connectors: a power connector and an I/O connector. They allow easy “plug and play” of the module, and also a fast replacement of a faulty unit.



**Warning:** Use a cable with cross-section suited to the current involved. A wire smaller than necessary could cause risk of fire and unwanted voltage drops.



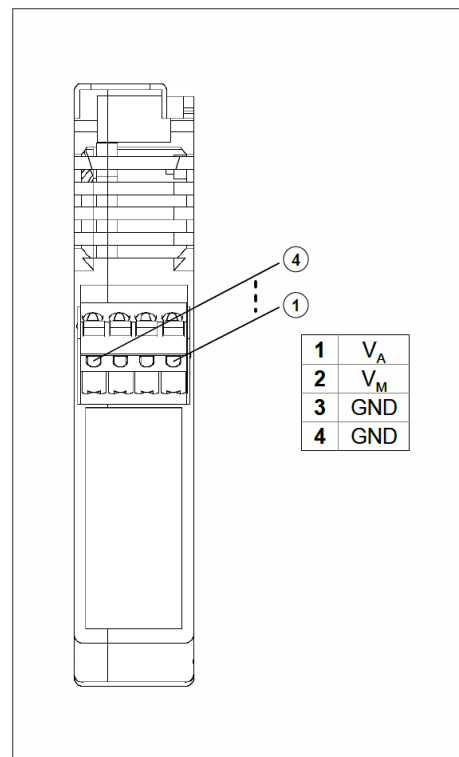
**Warning:** To ensure conformance with EMC directive 2014/30/UE, the length of the cables must not exceed 30 m!

### Power connector

The power connector is located on the bottom wall of the module. For the pinout, refer to the illustration at right.

Its function is to provide the supply for the I/O circuitry, whilst the CPU of the module is fed by the TBUS connector on the back of the unit. Two different supplies are needed for the module: a main supply ( $V_M$ ) and an auxiliary supply ( $V_A$ ).  $V_M$  supplies the power output stage (an H-bridge realized with power MOSFETs), whilst  $V_A$  feeds the Hall sensors and related acquisition circuitry in the event of a main supply failure.

The Hall section supply is obtained diode-ORing  $V_A$  and  $V_M$  supplies. Therefore, if the user doesn't need to retain the count in case of main supply failure, auxiliary supply connection is unnecessary. This condition usually occurs when the system provides some position zeroing system, or where position loss is not of concern. Where the count mustn't be lost in case of a main supply failure, the user should provide an uninterruptable external power supply (e.g. a battery and relevant charging apparatus) on pin  $V_A$ . This arrangement greatly reduces the size of the backup system, due to the limited current consumption of the sensor interface.



**Warning:**  $V_A$  and  $V_M$  supplies must have the same common potential (GND). Disregarding this rule could lead to module and/or system failure.

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Refer to the FLXIO and FLXMOD System Integration Manual for power connections topology.

For connector ratings and the applicable wiring refer to the following table

<b>Connector type: Phoenix Contact FKC 2,5/ 4-ST (1910377)</b>			
<b>Order code: KF100009</b>			
<b>Technical data</b>		<b>Conductor cross section</b>	
Nominal voltage (CE)	250V	Solid (CE)	0,2÷2,5mm <sup>2</sup>
Nominal voltage (UL)	300V	Solid (UL)	26÷12AWG - 75°C
Nominal current (CE)	12A	Flexible (CE)	0,2÷2,5mm <sup>2</sup>
Nominal current (UL)	10A	Flexible (UL)	26÷12AWG - 75°C
		Flexible, with ferrule without plastic sleeve	0,25÷2,5mm <sup>2</sup>
Stripping length	10mm	Flexible, with ferrule with plastic sleeve	0,25÷2,5mm <sup>2</sup>
Screwdriver to open contacts	0,6 x 3,5mm	2 flexible conductors with same cross section, stranded, TWIN ferrules with plastic sleeve	0,5÷1,5mm <sup>2</sup>

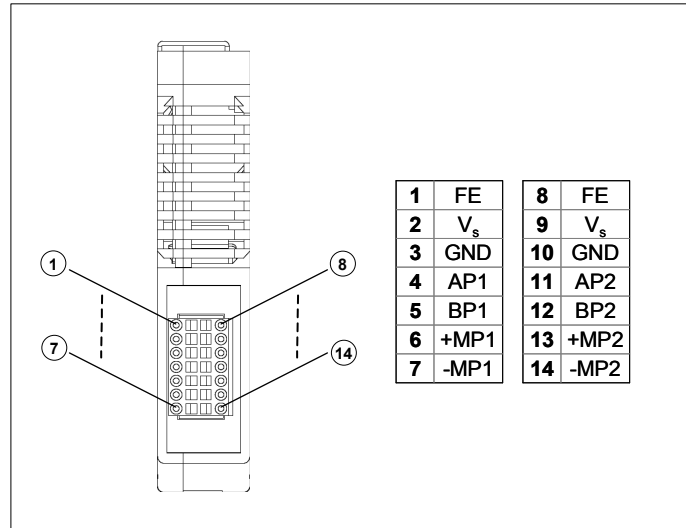


**Warning:** Pay attention to NOT supply the module with reverse polarity. This is to not blow internal fuse and/or damage the connected devices and/or burn the module itself.

## I/O Connector

Located on the upper side of the module, this connector (see illustration) permits the wiring of the loads and of the Hall sensors.

As you can see, each row of the connector has the same pinout, to ease the wiring and prevent mistakes.



For connector ratings and the applicable wiring refer to the following table

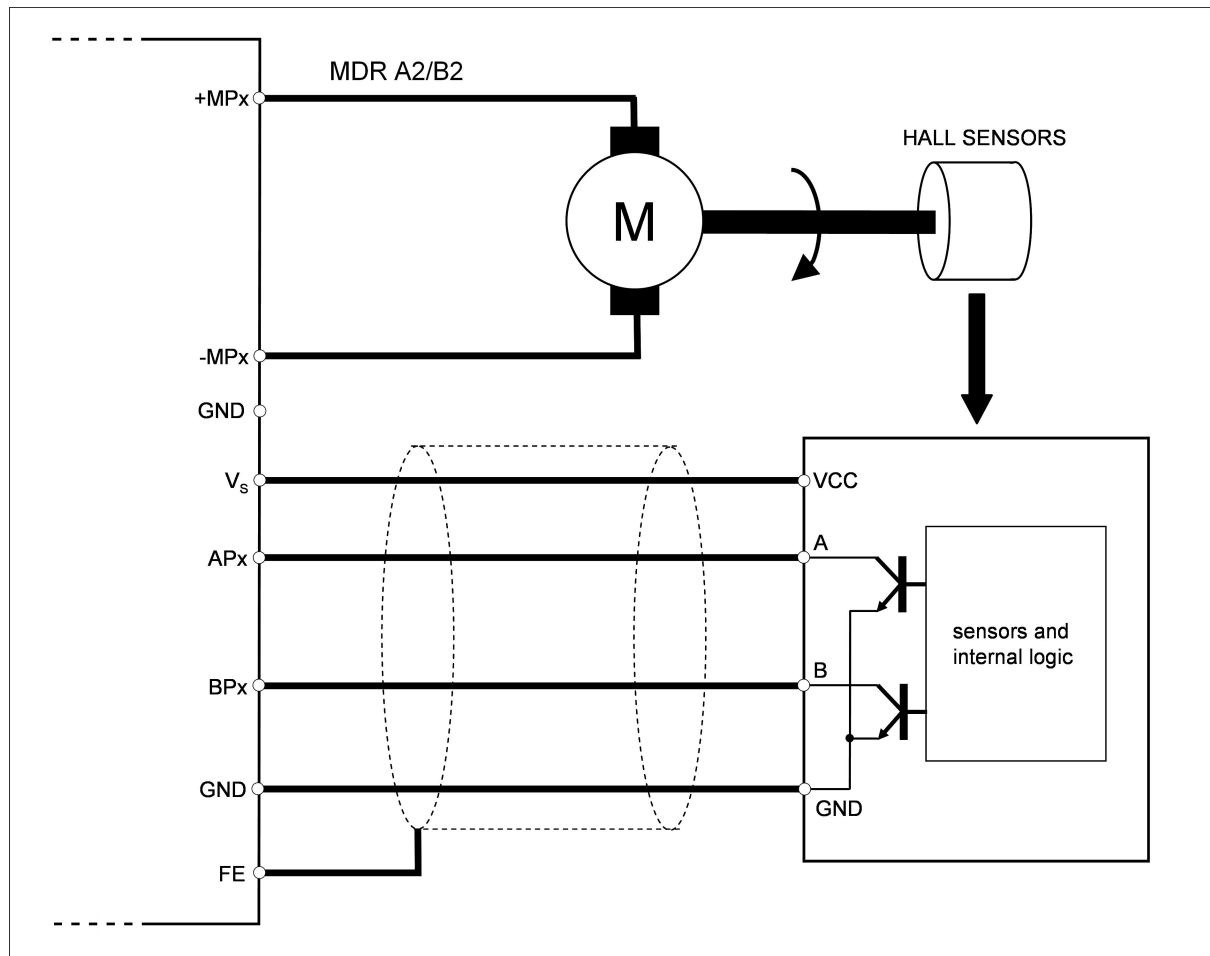
<b>Connector type: Phoenix Contact FMCD 1,5/7-ST-3,5 (1738856)</b>			
<b>Order code: KF101049</b>			
<b>Technical data</b>		<b>Conductor cross section</b>	
Nominal voltage (CE)	160V	Solid (CE)	0,2÷1,5mm <sup>2</sup>
Nominal voltage (UL)	150V	Solid (UL)	24÷16AWG - 75°C
Nominal current (CE)	8A	Flexible (CE)	0,2÷1,5mm <sup>2</sup>
Nominal current (UL)	8A	Flexible (UL)	24÷16AWG - 75°C
Stripping length	10mm	Flexible, with ferrule without plastic sleeve	0,25÷1,5mm <sup>2</sup>
Screwdriver to open contacts	0,4 x 2,5mm	Flexible, with ferrule with plastic sleeve	0,25÷0,75mm <sup>2</sup>

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## Connection notes

As stated previously, the module can also drive two brush DC-motors with related Hall sensors. Please note that UL has not evaluated the module for that purpose.

The following illustration shows the correct method of wiring.



**Recommended connections for motors and Hall sensors**

When the wiring of the motor is straightforward, a bit of care is required for the Hall sensors. The module internal circuitry is tailored to standard open-collector (or open-drain) digital output Hall sensors; pull-up resistors are integrated inside the module, and sensors should be fed by V<sub>s</sub> pin.

If the system should work in a noisy environment, the use of shielded wire is recommended; the shield must be connected to the FE pin of the connector.



g: Hall sensors internal power supply has a current capability of 100 mA max. Never  
: or the system will be damaged.





**Warning:** Reduce the risk of Hall sensors reading errors routing wires away enough from noise sources (e.g. inverter input/output wires, switching power supplies, switching contacts, etc..).

### **Notes on motors**

As previously stated, when the load of the output of the MDR module consists in a motor, only DC brush-motors can be employed. During rotation, a little sparkling on the collector is usually generated; some motors manufacturers used to insert noise-suppressing capacitors between contacts.

Driving the motor in PWM fashion causes abrupt charging/discharging of these capacitors, greatly increasing commutation losses of the output stage and consequently reducing the available output current. In extreme cases, the module couldn't start due to an overcurrent error.

Proper remedies at this problem are:

- remove capacitors from motor or reduce capacitance value
- replace capacitors with RC suppression networks
- reduce PWM switching frequency (whenever possible)
- derate the output current available to compensate for losses
- insert choke coils between module and motors (peak current reduction)

### **Notes on output power (all)**

When MDR module works, a certain amount of power is lost in heat inside the case; when the temperature inside the module reaches 85°C the safety system switch-off the outputs. The power loss is as great as the outputs current and/or the frequency of PWM are high. Rated outputs current are stated considering a single frequency of PWM (and the same for each output) and stable power absorption of the load.

Due to the wide mode of use, it is not possible to state the output ratings for all these conditions in order to keep the module temperature below its maximum. It is necessary to test the application with care considering these aspects:

- maximum temperature inside of the installation cabinet
- maximum continuous load
- contemporaneity of the absorption of the loads from the outputs
- frequency of the PWM
- proximity with other heating modules

### **Notes on output power (UL)**

In order to keep the surface temperature of the case within the maximum required by UL, special ratings are stated above in the technical data. During the application test, ever to meet this requirement, it is suggested to acquire the surface temperature of the module in centre of the left side (the one w/o label) and make sure to keep it within 80°C.

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If it not possible to acquire the temperature, it is possible to assume a rise of surface temperature at least of 10°C than inside. Proximity with other heating or not heating modules can influence significantly the real value of the temperature rising.

## **Module addressing**

Before operation you must set the address of the module by the rotary switch reachable from the front panel; the operation is easily done opening the transparent plastic cover and turning the rotor with a small bladed screwdriver.

The address determination is described in the FLXIO and FLXMOD System Integration Manual.

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## Diagnostic and status indicators

Each module is provided with a series of LED lamps on the front panel (see illustration), that indicates the status of the unit, the setting of every output (voltage or current) and a possible diagnostic warning. For the sake of clarity, different lamp colours are employed. The MDR A2 model and MDR B2 model have the same indicators.

The green power (**PWR**) LED is lighted if the 24 V supply ( $V_M$ ) is present and the internal fuse is not blown. Self monitoring of supply voltage is also implemented to deliver a best self-diagnosis. The module switches in diagnostic error when  $V_M > 30Vdc$  and when  $V_M <$  of the value set up by the master module (low voltage check is disabled by default); this status is displayed by **STS** LED.

The green power (**PW2**) LED is lighted if the 24 V auxiliary power supply ( $V_A$ ), used for Hall sensor interface, is present and the internal fuse is not blown.

The **MP1** and **MP2** LEDs if lighted indicate that respectively the output #1 and #2 are enabled (start command received and absence of fault errors).

This module is provided by outputs short circuit and overload protection. In case of short-circuit of at least one motor output, it immediately shuts down the involved output; then, for safety reasons, the internal logic shuts down all outputs and a diagnostic error is issued by **STS** LED and output relative **MP** LED.

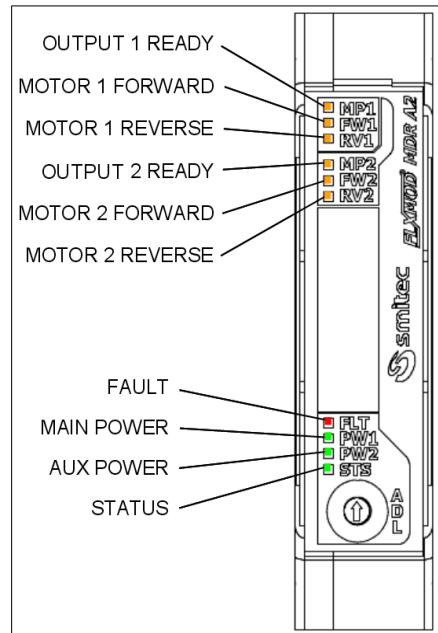
In the MDR A2 model, in output/s overload condition the self-diagnostic may take some time before the diagnostic alarm is issued, depending on the severity of the overload (thermal protection). In MDR B2 model, the output overload alarm is triggered when the counter of outputted energy (current x time) exceeds the one programmed by software.

The actions taken in this case are the same of the short-circuit condition.

Only in the not UL compliant modules (see label on the side of the case), an overall internal module temperature diagnostic issues a diagnostic error when the internal temperature exceeds 85°C. It may be caused by the combination of environment temperature and digital outputs total current. The status is displayed again by the **STS** LED.

The UL compliant modules have no temperature alarm.

The **FW1** and **RV1** LEDs turn on if the motor #1 has done a step (read by the Hall inputs) respectively in the forward or reverse direction. If the module doesn't detect any change for more than one second in the direction of rotation, the relevant LED turns off. **FW2** and **RV2** LEDs manifest the same behaviour (motor #2).



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The status of the unit is indicated by both status (**STS**) and fault (**FLT**) LEDs; their behaviour is described in the following logic state chart. The exact cause of a diagnostic error can be read out by master module and the application software.

