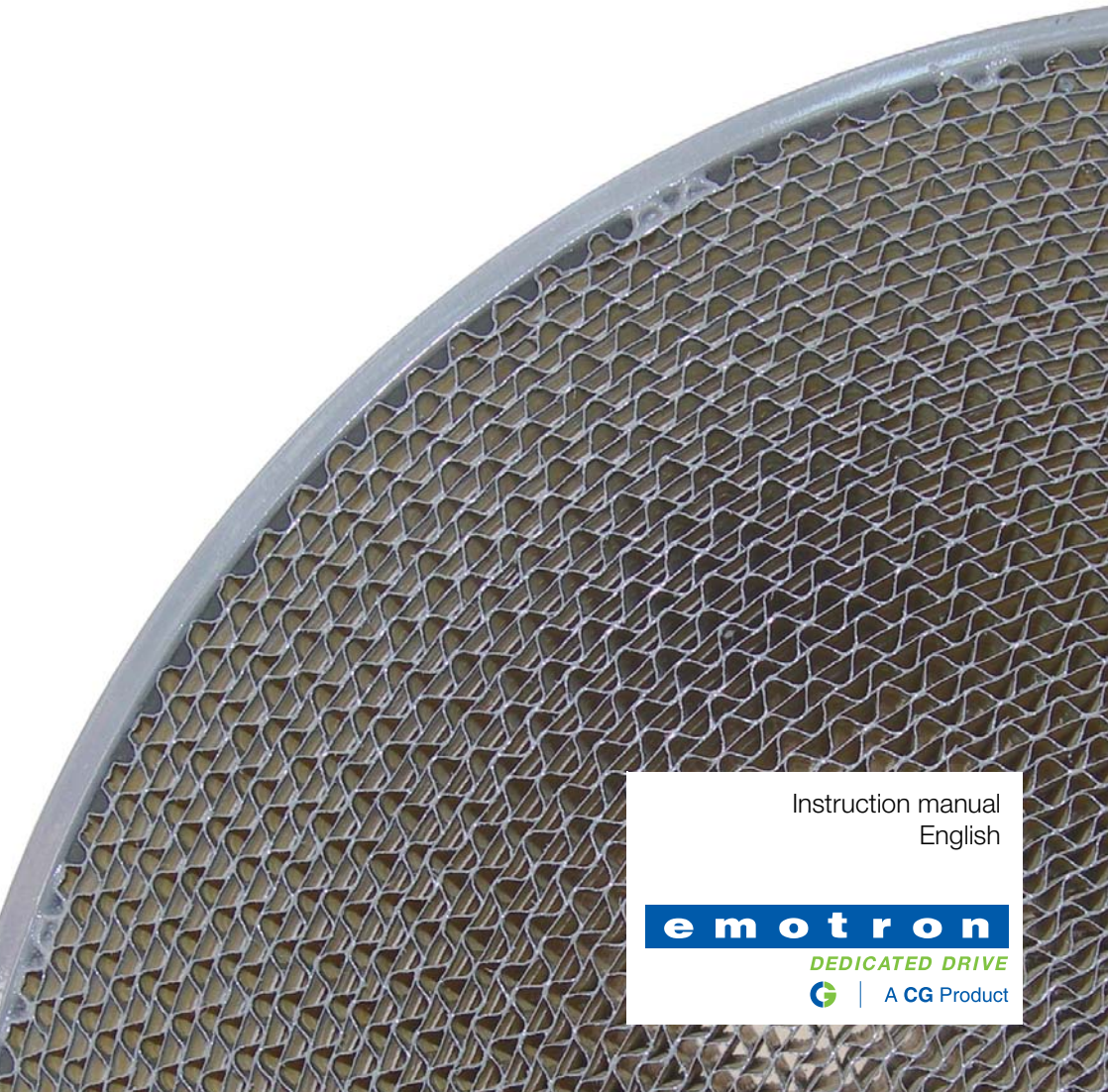
Emotron EMX-B
Drive system

for rotary heat exchangers



Instruction manual
English

emotron

DEDICATED DRIVE

A CG Product

Emotron EMX-B
Drive system

Instruction manual

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The product is protected as follows:

Patents: US 6 628 100; SE 9902821-9
SE 0100814-3; SE 0100814-3; EP 1 366 346; US 7 083 544
Registered design: US 462 937; DE 400 05 393.4; SE 66 630

Patent pending for UltraRotoSense™: EP17171733.3

Safety instructions

Instruction manual

Read this instruction manual before installing and running the drive system.

The following symbols can appear in this manual. Always read these first before continuing:

NOTE: Additional information as an aid to avoid problems.

CAUTION! Failure to follow these instructions can result in malfunction or damage to the drive system.

WARNING! Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the drive system.

Users

This instruction manual is intended for:

- installation engineers
- maintenance engineers
- operators
- service engineers

Handling the drive system

Installation, commissioning, demounting, taking measurements, etc, of or on the drive system may only be carried out by personnel technically qualified for the task. The installation must be carried out in accordance with local standards.

Opening the control unit

WARNING! Always switch off the mains voltage before opening the control unit.
Wait at least 5 minutes before starting work.

Always take adequate precautions before opening the control unit. Although the connections for the control signals and the switches are isolated from the mains voltage, do not touch the control board when the drive system is switched on.

Precautions to be taken with a connected motor

If work must be carried out on a connected motor or on the driven machine, the mains voltage must always be disconnected from the drive system first.

Earthing

The control unit must always be earthed via the mains safety earth connection.

EMC Regulations

In order to comply with the EMC Directive, it is absolutely necessary to follow the installation instructions. All installation descriptions in this manual follow the EMC Directive.

Voltage tests (Megger)

Do not carry out voltage tests (Megger) on the motor, before all the motor cables have been disconnected from the drive system.

Condensation

If the control unit is moved from a cold (storage) room to a room where it will be installed, condensation can occur. This can result in sensitive components becoming damp. Do not connect the mains voltage until all visible dampness has evaporated.

Incorrect connection

The control unit is not protected against incorrect connection of the mains voltage, and in particular against connection of the mains voltage to the motor outlets R, Y and B. The control unit can be damaged in this way.

Transport

To avoid damage, keep the drive system in its original packaging during transport. This packaging is specially designed to absorb shocks during transport.

Contents

1. Description

1.1 Introduction

Emotron EMX-B is a speed controlled drive system specially designed for driving rotary heat exchangers. The drive system consists of a motor and its associated control unit with a wide speed range from 4 to 500 rpm.

Emotron EMX-B motor is based on permanent magnet brush-less DC (PM BLDC) motor technology. These motors make it possible to drive heat exchanger rotors without gears, making the system very silent.

The system can be controlled either via terminals/analogue and digital inputs or via RS485/Modbus RTU communication protocol.

Emotron EMX-B drive system completely replaces Emotron EMX-R drive systems.

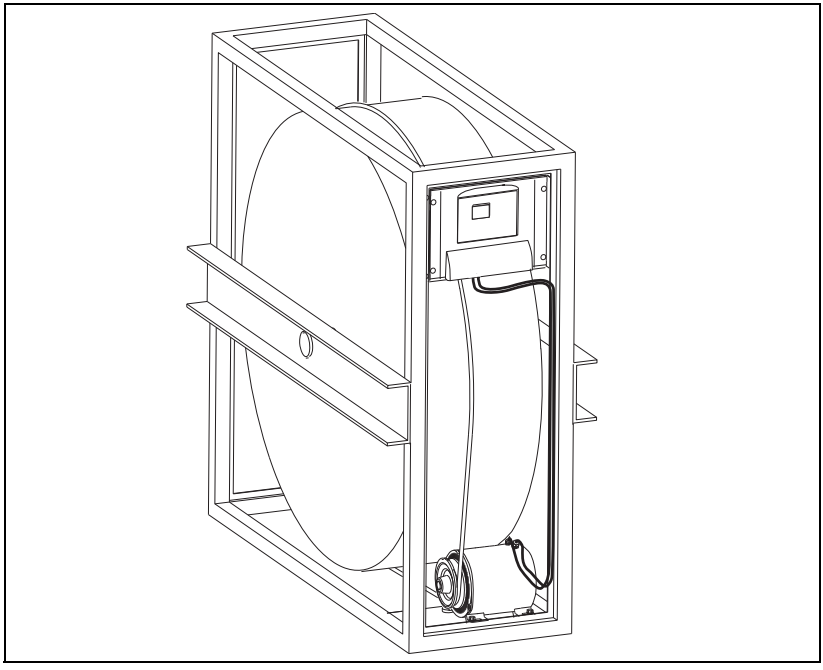


Fig. 1 EMX-B motor and control unit mounted on rotary heat exchanger

1.2 Delivery and unpacking

Check for any visible signs of damage. Inform your supplier immediately of any damage found. Do not install the equipment if damaged.

The shipment of a complete drive system consists of two boxes containing:

Box 1:

- Emotron EMX-B Control unit
- One Ferrite core

Box 2:

Emotron EMX-B motor with connected cables

1.3 Warranty

The warranty applies when the equipment is installed, operated and maintained according to instructions in this instruction manual.

1.4 General description

Emotron EMX-B is a silent speed-controlled drive system specially designed for driving rotary heat-exchangers. Emotron EMX-B is available in different sizes suitable for different sizes of rotors. The system supports a wide speed range from 4 up to 500 rpm. The drive system consists of a motor and its associated control unit which are linked by two cables. The control unit is connected to single-phase power supply, 230 VAC, 50/60 Hz.

Built-in functions:

- Automatic purging operation/Continuous purging operation
- Rotation monitor - integrated UltraRotoSense^{TM} or with external rotation sensor
- Active holding torque
- Alarm relay
- Defrosting
- Cooling recovery
- Full speed Test switch
- Short circuit/earth fault protection
- Under voltage, over voltage and over current/overload protection
- Sixteen (16) speed selections through DIP switches
- Direction of rotation through DIP switch
- Soft start/soft stop
- Non-linearity function that gives a non-linear relationship between the control signal and the efficiency
- RS485 interface with industrial Modbus RTU communication protocol

1.5 Operating indicators

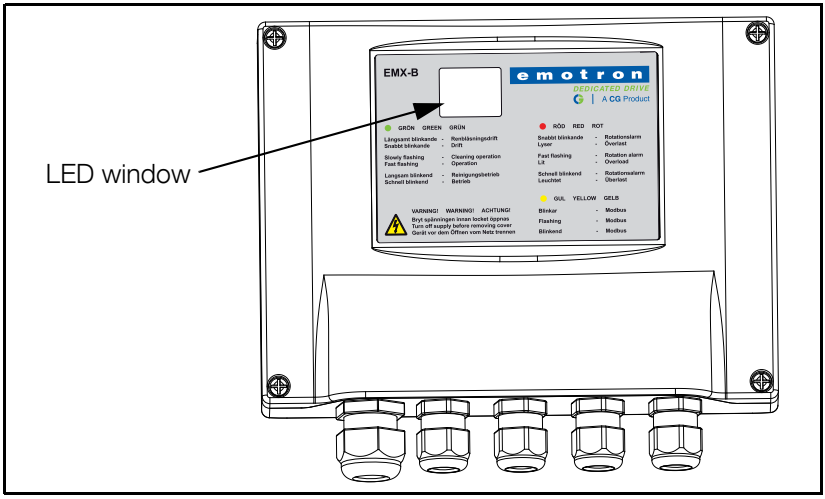


Fig. 2 Control unit with LED´s for operation indication

Three LEDs, one red, one green and one yellow, are used for indication purpose, which are as follows:

Table 1 Operating indication

Green *	Slow flashing (1 time/s) – Purging mode/Low control signal
	Rapid flashing (10 times/s) – Operation, the motor rotates continuously.
	Lit 1 second - External rotosense magnet passes sensor
Red *	Constantly Lit or flashing LED indicates alarm, see also in chapter “Troubleshooting” on page 41.
Yellow	Flashing – Modbus incoming message addressed to unit active and CRC correct. Constantly Lit - Modbus timeout

*)Exception Belt test, see page 44

All possible combinations of LED indication is described in detail in Table 13, page 43.

1.5.1 Dismantling and scrapping

The enclosures of the drives are made from recyclable material. Each drive contains a number of components demanding special treatment, for example capacitors. The circuit boards contain small amounts of tin and lead. Any local or national regulations in force for the disposal and recycling of these materials must be complied with.

Disposal of old electrical and electronic equipment

The product is designed to comply with the RoHS and REACH directives, and shall be handled and recycled in accordance with local legislations.

This symbol on the product or on its packaging indicates that this product shall be taken to the applicable collection point for the recycling of electrical and electronic equipment. By ensuring this product is disposed of correctly, you will help prevent potentially negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. The recycling of materials will help to conserve natural resources. For more detailed information about recycling this product, please contact the local distributor of the product or visit our home page www.cgglobal.com/www.emotron.com.

2. Mounting and installation

2.1 Basic mounting

Both the motor and the control unit are usually mounted in the heat exchanger housing. In this way, they do not occupy any space outside of the heat exchanger housing and are well protected during transport. Furthermore, it is often advantageous from the point of view of interference (EMC) to place the motor and control unit in the rotor housing.
Larger motors are usually mounted on a sprung motor support when a V-belt is used. In this way, problems arising if non-circular rotors are used can be prevented.
Vibration dampers should be mounted between the motor and the motor support so that any vibration from the motor is not transmitted to the rotor housing.

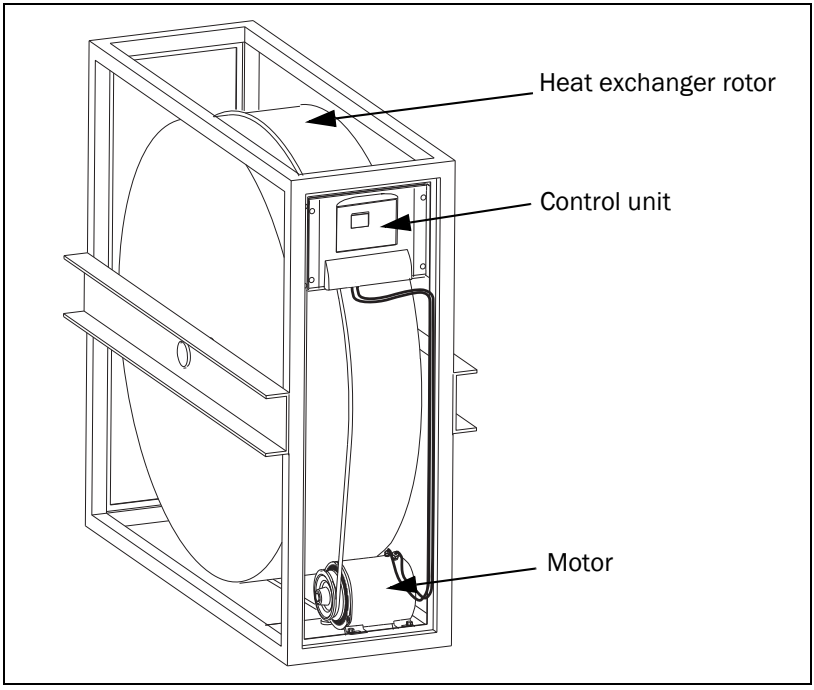


Fig. 3 Emotron motor and Control unit for rotary heat exchangers

2.2 External sensor for rotation monitor (optional)

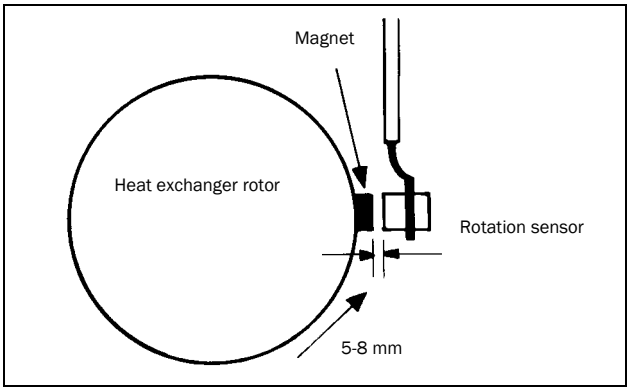


Fig. 4 Rotation monitor

Two different rotation monitors can be selected. The first, which is an integrated UltraRotoSense^{TM} rotation monitor, and secondly a rotation monitor using an external rotation sensor (optional) see also further info in chapter 3.3 page 24.

The magnet for the external rotation monitor is mounted tight on the periphery or in the body of the heat-exchanger. It is recommended to place the sensor magnet close to the axis of the rotary heat exchanger. If the housing around the rotor is magnetic itself then the sensor magnet must be isolated from the housing. The rotation sensor is mounted to ensure that the magnet passes over it at a distance of 5-8 mm, see Fig. 4.

2.3 Cable connections

2.3.1 Motor

The motor is delivered with fixed connected motor cables to simplify installation of the drive system. The length of the cables is 2.5m.

In order to secure the function of the drive system, do not change the length of the motor cables.

WARNING! Do not install a switch between the motor and the control unit.

2.3.2 Mains supply

An external slow-blow fuse rated at ≤6 A must always be installed on mains supply. The drive system does not contain a fuse. Electronic motor protection is built into the control unit, and monitors the motor at all times. The control unit is protected from short circuit within the motor.

Connect the mains cables according to Fig. 7 and Table 4.

2.3.3 Communication connections

For communication signals, the used RS485 cable type should preferably be screened and of twisted pair type to avoid EMI. The cable should be placed at least 20 cm away from any power cables. Drop cables shall be avoided to the extent possible. It is recommended to connect the screen of the cable to chassis/ mounting plate near to the EMX-B gland.

2.4 Control board

Fig. 5 and Fig. 6 shows the layout of the control board and where the parts most important to the user are located.
For safety reasons do not make changes while the mains supply is on, see also “Safety instructions” on page 1.

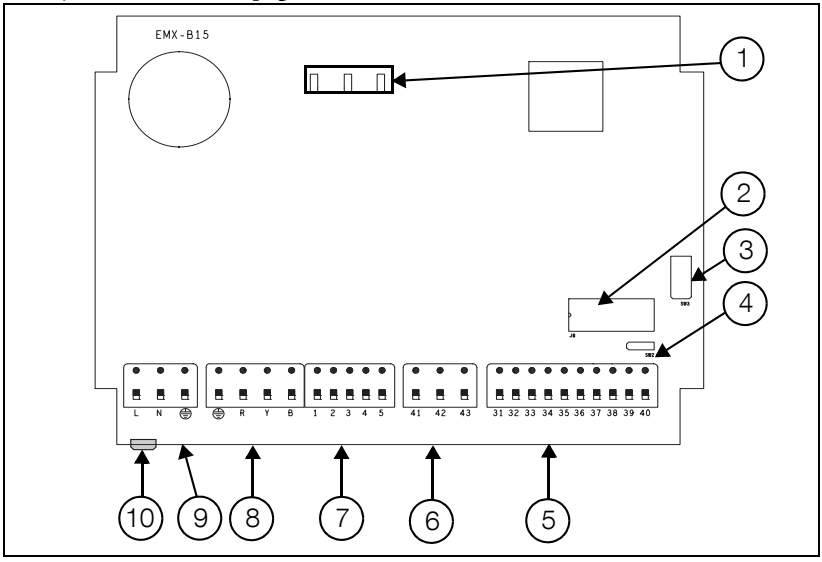


*Fig. 5 Control board layout **EMX-B15**.*

*Table 2 Location of terminals and components **EMX-B15**.*

No.	Designation
1	Three LED operation indicators
2	DIP switches
3	Test switch
4	Jumper SW2 to select signal type, voltage or current (K/I)
5	Control signal terminals and RS485 interface (31-40)
6	Alarm terminals (41-43)
7	Hall sensor terminals (1-5)
8	Motor terminals (⏚ -R-Y-B)
9	Mains supply terminals (L-N- ⏚)
10	PE connector

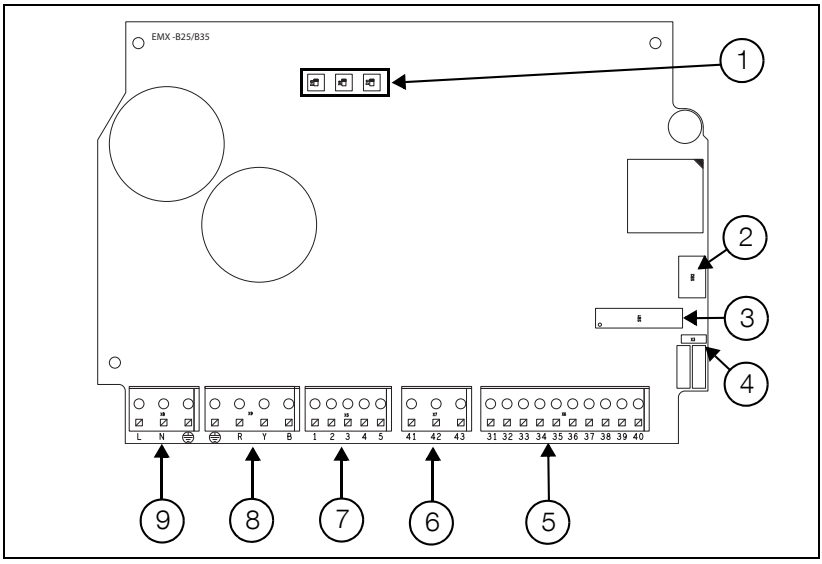


*Fig. 6 Control board layout **EMX-B25/B35**.*

*Table 3 Location of terminals and components, **EMX-B25/B35**.*

No.	Designation
1	Three LED operation indicators
2	Test switch
3	DIP switches
4	Jumper X3 to select signal type, voltage or current (K/I)
5	Control signal terminals and RS485 interface (31-40)
6	Alarm terminals (41-43)
7	Hall sensor terminals (1-5)
8	Motor terminals (⏚ -R-Y-B)
9	Mains supply terminals (L-N- ⏚)

NOTE! Minimum recommended conductor size area for the connection terminal is 0.5 mm^2.This is to achieve proper electrical contact.

2.4.1 Terminals

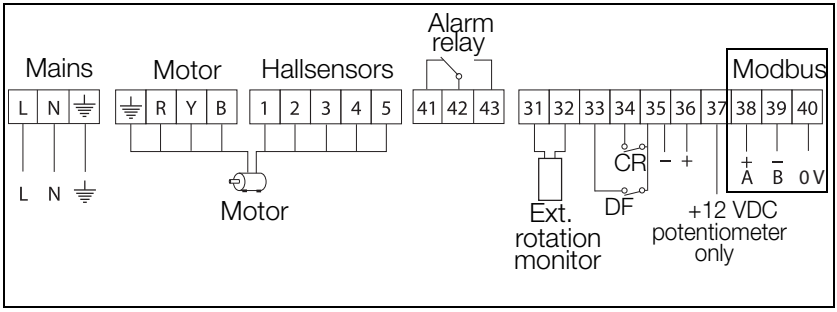


Fig. 7 Terminals on control board.

Table 4 Terminals and connections description.

Control board			**External**	**Remark**
	Terminal Name/no		**Connection**	
Mains supply	L	⟷	Line	Mount the Ferrite (included in delivery) on the mains cable acc. to Fig. 8, page 20
	N	⟷	Neutral	
	⏚	⟷	Earth	
Motor	⏚	⟷	Earth	Motor power connections
	R	⟷	R	
	Y	⟷	Y	
	B	⟷	B	
Hallsensor	1	⟷	1	Motor sensor connection
	2	⟷	2	
	3	⟷	3	
	4	⟷	4	
	5	⟷	5	
Alarm	41	⟷	NC	42 - 43 closed on alarm Reset alarm possible by shorten terminals 33, 34 and 35
	42	⟷	Common	
	43	⟷	NO	

Table 4 Terminals and connections description.

Control board			External	Remark
	Terminal Name/no		**Connection**	
Control signals	35	⟷	One end of pot.	If potentiometer is used
	36	⟷	Variable point of pot.	
	37	⟷	Other end of pot.	
	35	⟷	0 V	When external control signal is used
	36	⟷	+ signal	
External rotation monitor	31	⟷	RM -	Ext. rotation sensor (optional)
	32	⟷	RM +	
DF-Defrosting	33, 35			Activate by shorting 33 and 35
CR-Cooling recovery	34, 35			Activate by shorting 34 and 35
RS485/ Modbus	38		A +	
	39		B -	
	40		0 V	

NOTE: It is wire marking, not colour marking, that is valid.

2.4.2 Mains supply voltage cables

Dimension the mains cables according to local regulations. The cable must be able to carry the load current.

2.4.2.1 Ferrite core

The ferrite core is used to reduce disturbances and to fulfill the EMC standards.

Mount the ferrite core (included in delivery) on the mains supply cable for EMX-B15 (L, N and PE) and on the motor cable for EMX-B25/35 close to the Control unit according to Fig. 8.

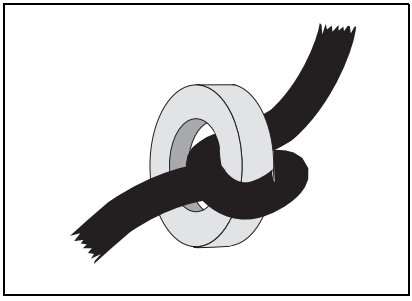


Fig. 8 Mount the Ferrite on the Mains supply cable.

2.4.3 Recommendations with respect to EMC

In order to fulfil the European EMC Directive regarding electromagnetic compatibility, the following precautions must be taken:

The motor cable must be mounted as close to the heat exchanger housing as possible. If the cable is too long, the excess should be collected together in the form of, for example, a figure "8". The area enclosed by the cable should be as small as possible. Electrical tape or cable ties can be used to achieve this.

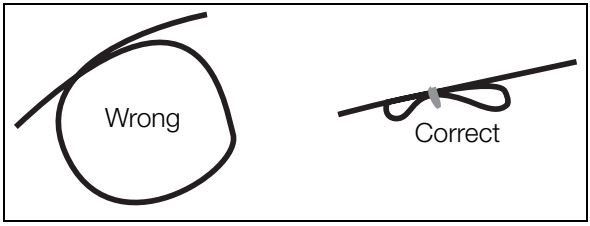


Fig. 9 Excess motor cable should be arranged such that the area enclosed is as small as possible

Special EMC couplings/glands are not necessary. An EMC filter is built into the EMX-B control unit.

For communication signals, the used RS485 cable type should preferably be screened and of twisted pair type to avoid EMI. The cable should be placed at least 20 cm away from any power cables. Drop cables shall be avoided the extent possible.

It is recommended to connect the screen of the cable to chassis/mounting plate near to the EMX-B gland.

2.5 Select type of control signal

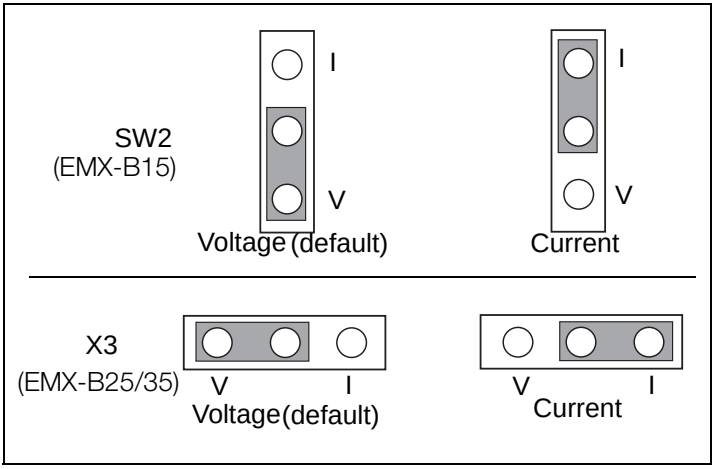


Fig. 10 Jumper connection

When SW2/X3 on the controller board is in V position then the control signal type is 'voltage' and when SW2/X3 is in I position the control signal type is "current". As default it is set to voltage.

3. Built-in functions

3.1 Holding torque

Most of the time the heat exchanger rotor seals keep the rotor stationary, but if the rotor seals are not touching the rotor and the air flow is not perpendicular to the rotor, the air flow may cause the rotor to rotate. To prevent unintentional heat recovery in this situation the motor is automatically used to provide a holding torque to keep the rotor stationary.

A rotor that does require a holding torque will try to turn slowly. The drive system immediately brakes this motion, reducing the speed to zero, and then applies a constant holding torque to keep the rotor stationary. The holding torque is at least 50% higher than the torque required for operation just before stand still.

If a holding torque has been applied and you grasp the drive belt and try to turn the heat exchanger rotor by hand, the torque will progressively increase.

The holding torque is generated by passing current through the motor phases. The higher the torque that is required, the higher the current. This holding current may create a sound which is perfectly normal.

3.2 Automatic purging

When the control signal is low, <0.5-0.6 V_{DC} at 0–10 V_{DC} (or <2.5 V_{DC} at 2 - 10V_{DC} depending on DIP7), the drive system switches to purging mode. This slow rotation does not provide any significant heat transfer, but simply serves to keep the heat exchanger rotor clean. There are two purging modes as described below.

3.2.1 Normal purging mode

In normal purging mode, when the dip-switch DIP8 is disabled (Off) the motor shaft turns two revolutions every 5 minutes.

3.2.2 Continuous purging mode

This purging mode is activated by dip-switch DIP 8 in the controller. When this dip-switch is activated the normal purge mode is not valid anymore. Instead the system will run at the lowest possible speed all the time (4 rpm or equivalent) when the control signal is below 0.5-0.6 V_{DC}.

3.3 Rotation monitor (DIP switch 6)

Two different kinds of rotation monitors can be selected. These are used to secure that the belt is not damaged and in other case notify the user via Rotation alarm.

The first, UltraRotoSense™ (patent pending) is a unique, ultra-sensitive method for detecting light load variations w/o even affecting the set operating speed of the motor using only smart built in software algorithm in the micro controller (no external equipment needed).

The second method, external rotation monitoring is using a more traditional solution with external sensor and magnet mounted on the heat exchanger. This is an alternative to UltraRotoSense™ and may be used when applicable for e.g. the very most light weight / smallest rotors.

The rotation monitors give alarms through operating indications (LED) and via the alarm relay (external signal) See Table 1, page 10. The motor does not stop with this alarm.

3.3.1 Internal UltraRotoSense™

Activated by setting DIP6 to Off.
DIP switch 6 (see chapter 3.9.2 page 30) in position “OFF” (downwards), means that the built in UltraRotoSense™ algorithm is enabled.

This method is using the motor as a sensor which means that no external hardware is necessary for belt detection. Further, it is designed to measure load variations even without changing the operating speed which allows continuous belt supervision (~every other minute). This allows a very fast alarm response in case of broken belt which may be critical for the system operating in cold outdoor temperatures. Further, since the operating reference speed is maintained during the belt test it will not affect the heat recovery process/room temperature.

UltraRotoSense™ belt testing is automatically activated every other minute in all operating states with the exception of intermittent purge mode but only if the motor current is below a value considered as a possible no-load condition.

The controller indicates that this sequence is initiated by setting both green and red led on at the same time. During this test the current set point speed is maintained. The test is ongoing only for as long as necessary to detect the presence of a load (belt intact) but for a maximum of 40 seconds. The controller then goes directly back to normal operation.

In the case where UltraRotoSense™ cannot detect a load it performs a very short ramp as a second stage check before activating rotation alarm. During this ramp it senses the complete motor load coming e.g. from inertia of the rotor as well as mechanical and brush friction, air flow though rotor etc. When/If a second stage ramp up check is performed the controller will wait for 5 minutes before activating the next belt test. The first belt test will be performed 1 minute after power up if the motor current is below the considered no-load level.

NOTE: In order to use internal UltraRotoSense™ the load on the motor should not be too low with the smallest heat exchangers.
If the load is too low for detection, use external rotation monitor instead.

3.3.2 External rotation monitor

Activated by setting DIP6 to On.
DIP switch 6 in position “ON” (upwards), means rotation monitor uses an external rotation sensor.

The rotation monitor with external rotation sensor requires a magnet fitted on the periphery of the rotor or anywhere on the rotor body. The magnet activates the external rotation sensor once every revolution. Should, for example, a belt break and the rotor stops, the pulses cease and an alarm is given. The time until the alarm is given is speed dependent and is 16 seconds at max. speed and 20 minutes at min. speed.

It is recommended to place the sensor magnet close to the rotor axis for accurate results.

The amplitude of output pulse from the external rotation sensor should have a value of 8V to 12V.

3.3.2.1 LED indications

When the magnet passes the sensor, this is indicated with Green LED is Lit 1 second and Red LED is Off.

3.4 Protection of the control unit

The control unit is monitored for both over-voltage and under voltage. If the supply voltage goes over or under the allowed limits, an alarm is triggered and the motor stops. The motor starts again automatically when the supply voltage returns to its normal value. The alarm is automatically reset.
The control unit has built-in motor protection that protects against overloading and external motor protection shall not be used. Power supply to the motor is cut in the event of overload. In order to reset the alarm, when Modbus is not used, the supply voltage to the control unit must be temporarily disconnected for at least 30 seconds to let stored voltage discharge. Reset is also possible by shorten the terminals see Table 4, page 18.
Built-in short circuit protection protects against short circuits between the phases of the motor and between the phases and earth. If this fault is continuously detected can it only be reset by power cycling.

Table 5 Protection and alarm functions

Protective function	External alarm with alarm relay	Restart	Alarm reset
Supply fault, overvoltage	Yes, immediately	Automatic	Automatic
Supply fault, undervoltage			
Motor protection/ overload	Yes, immediately	Manual reset, disconnect and reconnect power supply.*	
Short circuit/ earth fault		Manual reset, disconnect and reconnect power supply.*	
Internal Rotation monitor	Yes, immediately	Motor not stopped	Manual reset, disconnect and reconnect power supply.*
External rotation monitor	Yes, immediately	Motor not stopped	Manual reset, disconnect and reconnect power supply.*

*) Possible to reset via Modbus or shorten the terminals 33, 34 and 35 when Modbus is Off.

3.5 Defrosting

Short terminal 33 and terminal 35 to activate defrosting mode. During this mode the speed on the motor will be 4 rpm. In this case the incoming control speed is ignored and instead 4 rpm is prioritized.

3.6 Manual control using a 10 kOhm potentiometer

It is easy to control the drive system manually by using a 10 kOhm potentiometer connected as shown in the figure below.

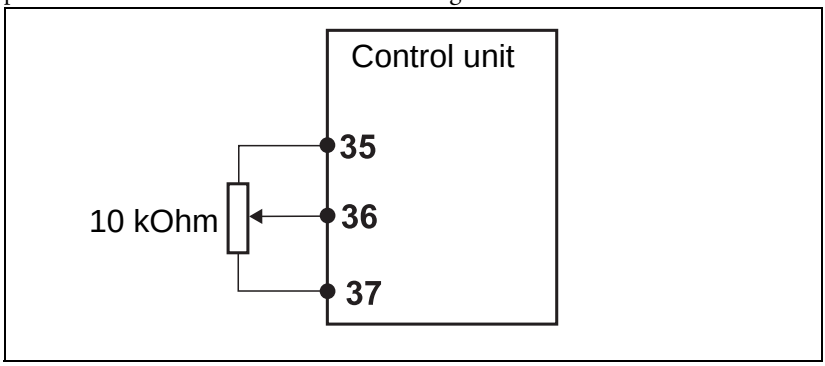


Fig. 11 Manual control using potentiometer

3.7 Test Switch

The control unit is equipped with a test switch, placed on the control board see Fig. 5, page 16 and Fig. 6, page 17. When this switch is in the “ON” position (up), the motor soft starts and the speed increases to the maximum, independently of other signal sources. When in the “OFF” position (down), the control unit goes back to normal operation.
The test switch can also be used to run the motor at maximum speed if, for example, an external control signal is missing.

3.8 Cooling recovery

By shorting terminal 34 and terminal 35, the system will go into cooling recovery. This means that the system will run at maximum speed.

3.9 DIP switches

By default, all 10 DIP switches are set to “Off”.

Clarification

 = DIP Off

 = DIP On

3.9.1 Choice of maximum speed

DIP switch 1 - 4 are used to set different maximum speeds. When all dips-witches are off the maximum speed will be 100% of the maximum speed of the drive (500 rpm). When all 4 dips-witches are on (1111) the maximum speed will be 25% of the possible maximum speed.

NOTE: After changing dip settings the control unit must be power cycled before the new settings become active.

The other combinations divides the speed range from 25 to 100% into equal pieces see Table 6, page 29. This function is primarily intended for use with rotors smaller in diameters, when it is desired to limit the speed of rotation and/or when using larger belt pulleys.

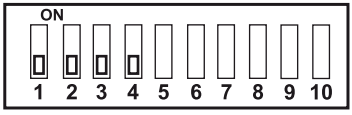


Table 6 DIP switch combinations and speed

% of maximum speed	Speed rpm	DIP 1	DIP 2	DIP 3	DIP 4
100 %	500	0	0	0	0
95 %	475	1	0	0	0
90 %	450	0	1	0	0
85 %	425	1	1	0	0
80 %	400	0	0	1	0
75 %	375	1	0	1	0
70 %	350	0	1	1	0
65 %	325	1	1	1	0
60 %	300	0	0	0	1
55 %	275	1	0	0	1
50 %	250	0	1	0	1
45 %	225	1	1	0	1
40 %	200	0	0	1	1
35 %	175	1	0	1	1
30 %	150	0	1	1	1
25 %	125	1	1	1	1

3.9.2 Setting DIP switches

WARNING!
Disconnect the voltage supply before changing the DIP switch setting.

NOTE: After changing DIP settings the control unit must be power cycled before the new settings become active.

Table 7 DIP switch setting

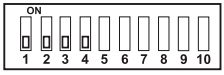
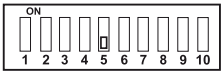
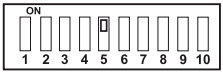
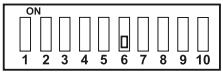
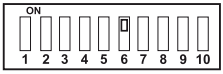
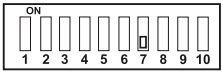
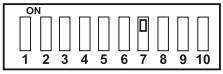
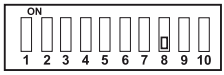
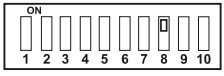
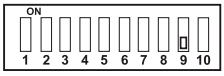
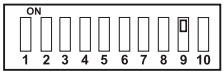
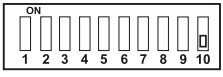
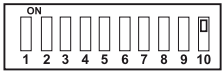
Speed	
Please refer to section chapter 3.9.1 page 28 for different speed presetting	
Direction of rotation, DIP 5	
 Clockwise from shaft end (Default setting). DIP 5=Off	
 Counter clockwise from shaft end. DIP 5=On	
Rotation monitor, DIP 6	
Internal rotation monitor (Default setting) DIP 6=Off	
External rotation monitor (External sensor required) DIP 6=On	
Control signal, DIP 7	
0-10 V / 0-20 mA (Default setting) DIP 7=Off	
2-10 V / 4-20 mA DIP 7=On	

Table 7 DIP switch setting

Type of purging mode, DIP 8	
Normal purging (Default setting) DIP 8=Off	
Continuous purging DIP 8=On	
Modbus baud rate, DIP 9	
Default: 19200, 8, N, 1 Not changeable via Modbus (Default setting) DIP 9=Off	
Default: 9600, 8, N, 1 Not changeable via Modbus DIP 9=On	
Modbus Off/On, DIP 10	
Modbus communication disabled (Default setting) DIP 10=Off	
Modbus communication enabled DIP 10=On	

3.10 Communication through Modbus

WARNING!
Disconnect the voltage supply before changing the DIP switch setting.

The drive unit has built-in Modbus RTU communication via RS485, terminals 38 (A+), 39 (B-) and 40 (0 V).
Modbus communication is enabled by setting the Dip switch 10 to On.
There are two sets of baud-rate available, selected by Dip switch 9, which are as follows:

Table 8 Two sets of baud-rate

Dip 9 = On	Dip 9 = Off (default)
Address: 30 Baud rate/Speed: 9600 Parity bit: N, none Stop bit: 1 Data bits: 8	Address: 30 Baud rate/Speed: 19200 Parity bit: N, none Stop bit: 1 Data bits: 8

When DIP switch 9 is 'ON' then the default parameters are 9600, 8, N, 1 .
When DIP switch 9 is 'OFF' then the default parameters are 19200, 8, N, 1.
None of these settings are changeable via Modbus.

3.10.1 Modbus register list

Table 9 Input Register read access (function code 04)

Register	Starting address	Name	Description	R/W	Comment	Memory*	Min	Max	Default
30002	1	Mbus Ver	Protocol version	R	Changes when there is a Modbus version change	V	1	256	
30003	2	HW	Hardware version	R	**	V	1	65535	
30004	3	SW	Software version	R	**	V	1	65535	
30006	5	Nrem	Total No. of alarms for belt failure	R	Total No. of alarms for belt failure	NV	0	65535	0
30007	6	Nlocked	Total No. of alarms for motor failure	R	Total No. of alarms for motor failure	NV	0	65535	0
30008	7	Nsp	Total No. of alarms for voltage failure	R	Total No. of alarms for voltage failure	NV	0	65535	0
30010	9	M1	Motor Type	R	EMX-B version of the motor 15, 25, 35	V	15	35	-
30011	10	n1	DIP setting for Max speed	R	Reads DIP value for 16 speed presets. 0 (100%) to 15 (25%)		0	15	0
30013	12	n	Actual speed motor	R	Motor speed in RPM. +ve clockwise & -ve counter-clockwise	V	-600	600	0
30015	14	Switch	Dip switch setting	R	Reads all 10 DIP switches		0	1024	0

* V = Volatile memory, NV =Non volatile memory
**) Decoded as “TT.XXXXXXX.YYYYYYY” (16 bits coding)
where TT is type, 0= release, 1=prerelease, 2= beta, 3= alpha
XXXXXXX is main version number
YYYYYYY is minor version number

Table 9 Input Register read access (function code 04)

Register	Starting address	Name	Description	R/W	Comment	Memory*	Min	Max	Default
30016	15	Mode	Actual Operating mode	R	0 = Normal operation 1 = Defrosting 2 = Purging 4 = Test button 8 = Belt test 16= Error except voltage error 32= Voltage error 64= Standstill		0	256	0
30017	16	Signal	Control signal / Prc Set	R	Control signal in percentage	V	0	100	0
30027	26	Current	Input current to motor	R	Input current drawn by motor; 1 = 1 mA	V	0	10000	0
30028	27	Power	Input power. Motor (W)	R	Power consumed by motor; 1 = 1 W	V	0	500	0
30029	28	DC-Voltage	DC link Voltage (V)	R	Input DCbus voltage to the motor; 1 = 1 V	V	0	400	0
30030	29	Oper	Days of operation	R	No of days of operation of the motor	NV	0	65535	0
30031	30	Vdrive	Input voltage to drive (V)	R	Input AC voltage to the drive; 1 = 1 V	V	0	400	0
30032	31	Pdrive	Input power - drive (W)	R	Power consumed by the drive	V	0	500	0
30034	33	Totalalarm	Total No. of alarms	R	Total No. of alarms	NV	0	65535	0

* V = Volatile memory
NV =Non volatile memory

Table 10 Holding Register read/write access (function code 03, 06)

Register	Starting address	Name	Description	R/W	Comment	Memory*	Min	Max	Default
40003	2	Dir	Sets/reads motor direction	R/W	**Depending on DIP5.** DIP5=0 gives 0 = clockwise 1 = counter clockwise DIP5=1 gives 0= counter clockwise 1 = clockwise		0	1	0
40007	6	Config	Linearisation	R/W	Speed variation 0 - Linear variation 1 - Non linear variation	NV	0	1	1
40008	7	Larm	Reads alarm/ resets alarm Reset alarm by writing 0 to the register.	R/W	0 = No error/Reset error 1 = Under Voltage error 2 = Over Voltage error 4 = Belt error 8 = Overload protection 16=Short Circuit/ Earth fault 32=External rotation sensor error / broken belt 64=Modbus timeout error	V	0	65535	0
40010	9	Comp E1	Compensation, 1 (5% signal) [%*10]	R/W	Compensation, 1 (5% signal) [%*10]	NV	0	1000	2
40011	10	Comp E2	Compensation, 2 (10% signal) [%*10]	R/W	Compensation, 2 (10% signal) [%*10]	NV	0	1000	5
40012	11	Comp E3	Compensation, 3 (15% signal) [%*10]	R/W	Compensation, 3 (15% signal) [%*10]	NV	0	1000	9

Table 10 Holding Register read/write access (function code 03, 06)

Register	Starting address	Name	Description	R/W	Comment	Memory*	Min	Max	Default
40013	12	Comp E4	Compensation, 4 (20% signal) [%*10]	R/W	Compensation, 4 (20% signal) [%*10]	NV	0	1000	15
40014	13	Comp E5	Compensation, 5 (25% signal) [%*10]	R/W	Compensation, 5 (25% signal) [%*10]	NV	0	1000	23
40015	14	Comp E6	Compensation, 6 (30% signal) [%*10]	R/W	Compensation, 6 (30% signal) [%*10]	NV	0	1000	33
40016	15	Comp E7	Compensation, 7 (35% signal) [%*10]	R/W	Compensation, 7 (35% signal) [%*10]	NV	0	1000	47
40017	16	Comp E8	Compensation, 8 (40% signal) [%*10]	R/W	Compensation, 8 (40% signal) [%*10]	NV	0	1000	66
40018	17	Comp E9	Compensation, 9 (45% signal) [%*10]	R/W	Compensation, 9 (45% signal) [%*10]	NV	0	1000	91
40019	18	Comp E10	Compensation, 10 (50% signal) [%*10]	R/W	Compensation, 10 (50% signal) [%*10]	NV	0	1000	122
40020	19	Comp E11	Compensation, 11 (55% signal) [%*10]	R/W	Compensation, 11 (55% signal) [%*10]	NV	0	1000	159
40021	20	Comp E12	Compensation, 12 (60% signal) [%*10]	R/W	Compensation, 12 (60% signal) [%*10]	NV	0	1000	199
40022	21	Comp E13	Compensation, 13 (65% signal) [%*10]	R/W	Compensation, 13 (65% signal) [%*10]	NV	0	1000	248
40023	22	Comp E14	Compensation, 14 (70% signal) [%*10]	R/W	Compensation, 14 (70% signal) [%*10]	NV	0	1000	296
40024	23	Comp E15	Compensation, 15 (75% signal) [%*10]	R/W	Compensation, 15 (75% signal) [%*10]	NV	0	1000	351
40025	24	Comp E16	Compensation, 16 (80% signal) [%*10]	R/W	Compensation, 16 (80% signal) [%*10]	NV	0	1000	408

Table 10 Holding Register read/write access (function code 03, 06)

Register	Starting address	Name	Description	R/W	Comment	Memory*	Min	Max	Default
40026	25	Comp E17	Compensation, 17 (85% signal) [%*10]	R/W	Compensation, 17 (85% signal) [%*10]	NV	0	1000	497
40027	26	Comp E18	Compensation, 18 (90% signal) [%*10]	R/W	Compensation, 18 (90% signal) [%*10]	NV	0	1000	620
40028	27	Comp E19	Compensation, 19 (95% signal) [%*10]	R/W	Compensation, 19 (95% signal) [%*10]	NV	0	1000	800
40029	28	Comp E20	Compensation, 20 (100% signal) [%*10]	R/W	Compensation, 20 (100% signal) [%*10]	NV	0	1000	1000
40031	30	Test	Sets/reads unit into test mode	R/W	0 = Not test mode 1 = Test mode Same operation as test switch	V	0	1	0
40034	33	Ctrl	Control signal/ PrcSet	R/W	Control signal via MODBUS	V	0	1000	0
40035	34	Address	Address	R/W	Slave ID	NV	1	256	30
40036	35	Baud	Modbus baudrate	R	Modbus Baud rate. Read only Baudrate divided by 100, ex, 96, 192, 384, 576, 1152	NV	96	192	96
40037	36	Par	Parity	R	Modbus parity Read only 0=N 1=E 2=O	NV	0	2	0
40038	37	Stop bits	Stop bits	R	Sets Modbus Stop bits 0 = one stop bit 1 = two stop bits	U / NV	0	1	0
40040	39	Defrost	Enable/Disable Defrost mode	R/W	0 = Normal operation 1= Defrosting	V	0	1	0

Table 10 Holding Register read/write access (function code 03, 06)

Register	Starting address	Name	Description	R/W	Comment	Memory*	Min	Max	Default
40046	45	Motor Test speed	Put in the test speed request in rpm (motor) **Note: Only for testing motor**	R/W	Default is 0 i.e. Motor is in normal operation. When written into the register, all the other functions are disabled and motor will run at the specified speed.	V	0	500	0
40047	46	Min speed	Minimum speed (rpm)	R/W	Minimum value of the speed	NV	4	500	4
40048	47	Cool heat mode	Cooling or heating mode	R/W	0 = Cooling mode 1= Heating mode	V	0	1	0
40049	48	Max heat	Maximum speed in heating mode (rpm)	R/W	Maximum speed of the motor is decided here when in heating mode. Only active when DIP 1-4 are all Off and when modbus enabled.	NV	0	Dep. on DIP 1-4 setting	500
40050	49	Max cool	Maximum speed in cooling mode (rpm)	R/W	Maximum speed of the motor is decided here when in cooling mode. Only active when DIP 1-4 are all Off and when modbus enabled.	NV	0	Dep. on DIP 1-4 setting	500
40051	50	Force Stop	Stop motor	R/W	0 = go back to normal operation 1= Force Motor to stop.	V	0	1	0

* V = Volatile memory
NV =Non volatile memory

3.11 Built-in configurable non-linearity

The drive system has a built-in configurable function that gives a non-linear and in second case a linear relation between the control signal and the efficiency of the heat exchanger rather than having the speed of rotation proportional to the control signal. This provides good conditions for stable temperature control.

Table 11 Non-linear speed.

Control signal %	Speed reference %	Motor shaft speed * rpm
0	1.6	4
5	1.6	4
10	1.6	4
15	1.6	4
20	1.6	4
25	2.3	11
30	3.3	16
35	4.7	23
40	6.6	33
45	9.1	45
50	12.2	61
55	15.9	79
60	19.9	99
65	24.8	124
70	29.6	148
75	35.1	175
80	40.8	204
85	49.7	248
90	62	310
95	80	400
100	100	500

*) With DIP 1-4 set in Off position.

Table 12 Control signals and speed

Control signal	Purging	Maximum speed
0 - 10 V	0.5-0.6 V	10.0 V
2 - 10 V	2.5 V	10.0 V
0 - 20 mA	1.0 mA	20.0 mA
4 - 20 mA	5.0 mA	20.0 mA

NOTE: A small hysteresis window is used to avoid setting the controller to jump between state Purge and state Normal operation (avoiding state jumping).

4. Troubleshooting

4.1 Trip conditions, causes and remedial action

Check that:

- the equipment has been correctly installed, i.e. the cables are properly stripped, that there are no loose cables, etc.
- motor and control unit of corresponding type size.
- check that the DIP switches are correctly set before powering the unit on. Power cables should not be clamped together with e.g. RS485 or analogue cables to avoid EMI.

It is always possible to test run the drive system using the TEST switch located on the control board, see Fig. 5, page 16 and Fig. 6, page 17. The switch has two fixed positions, when it is in the up position, the motor accelerates to its maximum speed independent of the control signal but dependent on DIP 1-4, and when it is in the down position the rotation speed is set by the control signal.

If any of the following is observed, then diagnosis should be performed to rectify the fault.

- Motor does not reach the intended speed.
- Motor has noisy operation at reduced speed.
- High motor speed and noisy operation.
- Motor does not start to rotate.
- Control unit trips with LEDs indicating overload condition immediately after power up without heat exchanger wheel connected.
- Control unit trips with LEDs indicating short circuit condition immediately after power up when no heat exchanger wheel connected.

Diagnosis:

1. Check the cable connections.
2. If the connections are proper, then replace the motor alone and check for the performance.
3. If performance is not as intended, replace the control unit.
4. Perform a motor diagnosis if the performance is not as intended after replacing both motor and control unit.

Motor diagnosis:

1. Disconnect power supply to the EMX-B unit and remove all the connections.
2. Measure the resistance of the motor using a digital multi-meter. Values should match as provided in Chapter 5.1 page 46. Any deviations found indicates damage to the motor.
3. Also check the connectivity between each motor phase and the PE cable. There should ideally be no connectivity.

If the motor does not reach maximum speed or respond to the control signal, check DIP switches. If the heat exchanger rotates in the wrong direction, change the setting of DIP switch 5.

If the control unit is to be exchanged, the complete unit including circuit boards must be exchanged.

WARNING!
Residual voltage remains for up to 5 minutes after disconnection of the supply voltage. The test switch and the DIP switches may only be adjusted when the supply voltage has been disconnected.

NOTE: After changing dip settings the control unit must be power cycled before the new settings become active.

Table 13 Trip condition, their possible causes and remedial action

Alarm indication **LED indication** **Flash slowly = about 1 time/s** **Flash rapidly= about 10 times/s**	**Possible cause**	**Remedy**
Green LED flashes slowly	Purging / low control signal.	- If the motor is not running and Green LED flashes slowly, check the drive system with the test switch. The motor should accelerate to its maximum speed. If the motor does accelerate to the maximum speed when the test switch is activated, the fault is external. - Is the control signal between terminals 36(+) and 35 (-) present? - Have + and - been swapped?
Red LED is lit	Overload/ motor protection	- The motor protection has been activated due to excessive load. Check that the motor cables are connected correctly; see the chapter on Mounting/Connection. - Check also that the rotor runs freely and that the diameters of the rotor and pulley are correct. If wrong pulley is mounted, change pulley or change max. speed with DIP-switch 1 to 4 acc. to chapter 3.9.2 page 30. - If the fault remains, carry out motor diagnosis. Replace the motor if it is faulty. If the fault does not lie within the motor, replace the control unit.
Red and green LED flashes slowly and alternately	Over voltage Under voltage	The supply voltage exceeds $260V_{AC}$ The supply voltage lies below $180V_{AC}$

Table 13 Trip condition, their possible causes and remedial action

Alarm indication **LED indication** **Flash slowly = about 1 time/s** **Flash rapidly= about 10 times/s**	**Possible cause**	**Remedy**
Red and green LED flashes rapidly and alternately	Earth fault in the motor/ Short circuit in the motor	- Disconnect the supply voltage, check the connection of the motor cable and check that the correct motor is connected. If the fault remains, carry out motor diagnosis. - If the motor is faulty, replace it. If the fault does not lie within the motor, replace the control unit.
Red LED flashes rapidly and Green LED is off	Internal Rotation monitor	- The exchanger rotor does not rotate; check the drive belt. - If Internal rotation monitor is used, check that the rotor or belt pulleys are not very small.
Red LED flashes rapidly and Green LED is lit	External Rotation monitor	External rotation sensor error; - Check whether the external rotation sensor is working and providing proper pulses. - Check function of the rotation sensor: Measure with a Multimeter between terminal 31 and 32, correct sensor measures: NO sensor shows > 8 V_{DC} & < 12V_{DC} NC sensor shows < 1 V_{DC} when the magnet passes the sensor. - Check whether the connection of external rotation sensor is made properly. - When DIP 6 is in external rotation sensor position (UP) and if no connection is provided at terminals 31 and 32 then this alarm is triggered.
Green LED is lit and Red LED is off	Test to check broken belt in progress	This not any alarm condition. It only indicates that an internal UltraRotoSense ™ belt test is currently being performed. For details see chapter 3.3.1 page 24.

Table 13 Trip condition, their possible causes and remedial action

Alarm indication **LED indication** **Flash slowly = about 1 time/s** **Flash rapidly= about 10 times/s**	**Possible cause**	**Remedy**
Yellow LED is lit	MODBUS timeout error	When there is no communication for more than 60 seconds, the yellow LED will be lit. As soon as communication reappears it will start flashing as per received modbus telegram.

5. Maintenance

WARNING! Residual voltage remains for up to 5 minutes after disconnection of the supply voltage. The test switch and the DIP switches may only be adjusted when the supply voltage has been disconnected.

The motor and the controller do not normally require any maintenance. There are however some things which we recommend to be checked regularly.

- Check external wiring, connections and control signals.
- Check power and motor cable connections

Preventive maintenance can optimise the product life time and secure trouble free operation without interruptions.

For more information on maintenance, please contact your CG Drives & Automation service partner.

5.1 Motor diagnosis

- Disconnect the supply voltage.
- Disconnect the motor cables from the control unit.

Measure the motor resistance between R–Y, Y–B and B–R. The values should be approximately 140 Ohm for EMX-B15, approximately 40 Ohm for EMX-B25 and approximately 28 Ohm for EMX-B35. The resistance should not differ by more than 10 Ohm between the phases. Also check the insulation resistance between R, Y, B terminals shorted and the motor body to ensure that there is no short circuit to PE.

NOTE: When checking the insulation resistance, it is important to turn the motor shaft slowly (at least one complete turn) in order to get a correct measurement.

6. Technical Data

	EMX-B15	EMX-B25	EMX-B35
Output data			
Rotation speed	4 - 500 rpm		
Rated tourque	0.8 Nm @ 500 rpm 1.3 Nm @ 300 rpm	2.0 Nm @ 500 rpm 3.3 Nm @ 300 rpm	3.0 Nm @ 500 rpm 5.0 Nm @ 300 rpm
Continuous Power	42 W	100 W	160 W
Starting & max tourque	1.8 Nm	4.8 Nm	7.5 Nm
Direction of rotation	Selectable		
Purging mode	Built-in function		
Motor protection	Built-in function		
Alarm output	Alternating contact, max 3 A, 230 VAC or 24 VDC		
Input DATA			
Mains supply VOLTAGE	230 VAC +10/ -15%, 50/60 Hz		
Maximum Fuse	4 A	6 A	6 A
Maximum current	1.0 A	3.0 A	3.0 A
Control signal	0-10 V_{DC}, 2 - 10 V_{DC}, 0 - 20 mA, 4-20 mA, 10 kΩ potentiometer.		
General DATA			
Protection class	IP 54		
Weight, control unit	0.5 kg	1.5 kg	1.5 kg
Weight, motor	4.5 kg	6.0 kg	8.0 kg
Ambient temperature	-40° to +40°C		
EMC, emission	EN61800-3		
Standards	EN 61000-6-3:2004/6100-6-4, A1:2012EMC- product standard EN 6100-6-2 EMC emission EN 61800-5-1:2007 Safety requirements – Electrical, thermal and energy		
Cable type	Motorcable: Insulated with 3 individually isolated leads- 0.5 mm^2 + PE- 2.5 mm^2 with pin type crimp lugs. Sensor cable: 5 leads- 0.75 mm^2 with pin type crimp lugs. Cable length - 2500mm.		
Cable glands	2 pcs M12 glands (Motor) 1 pc M20 and 4 pcs M16 glands (Control unit)	2 pcs M12 glands (Motor) 2 pcs M20 and 3 pcs M16 glands (Control unit)	

6.1 Dimensions

6.1.1 Control units

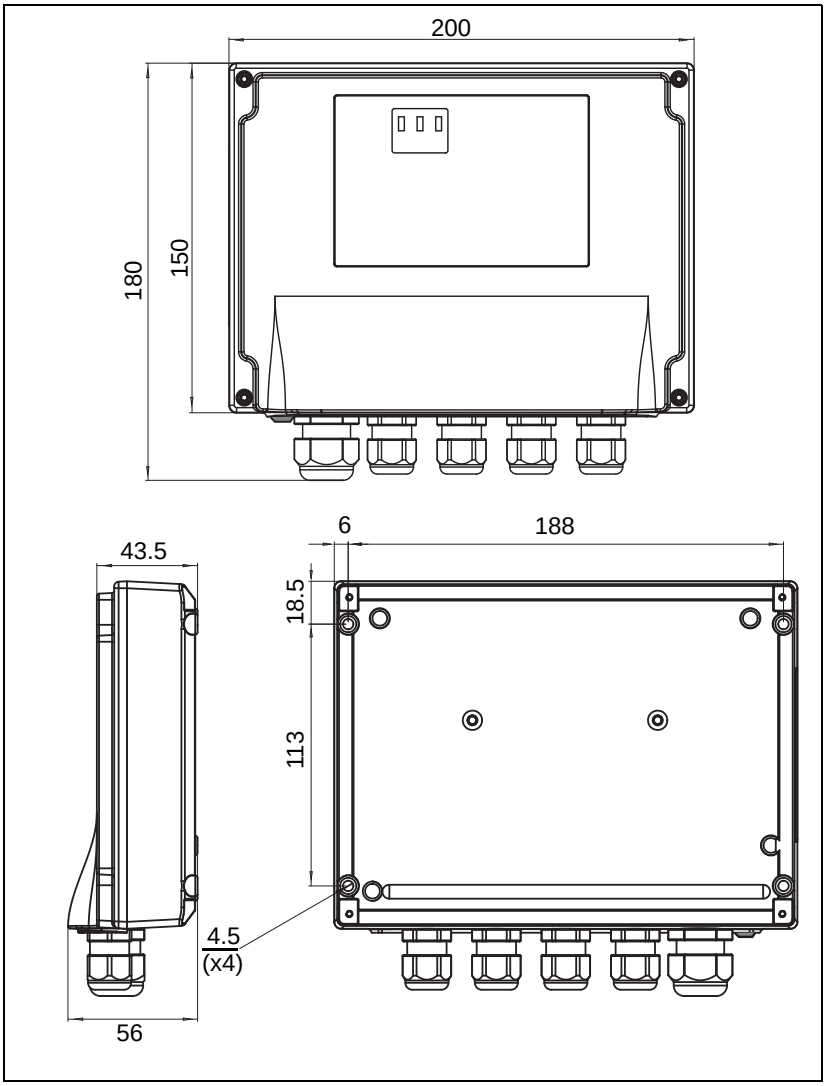


*Fig. 12 Dimensions, **EMX-B15** control unit (mm).*

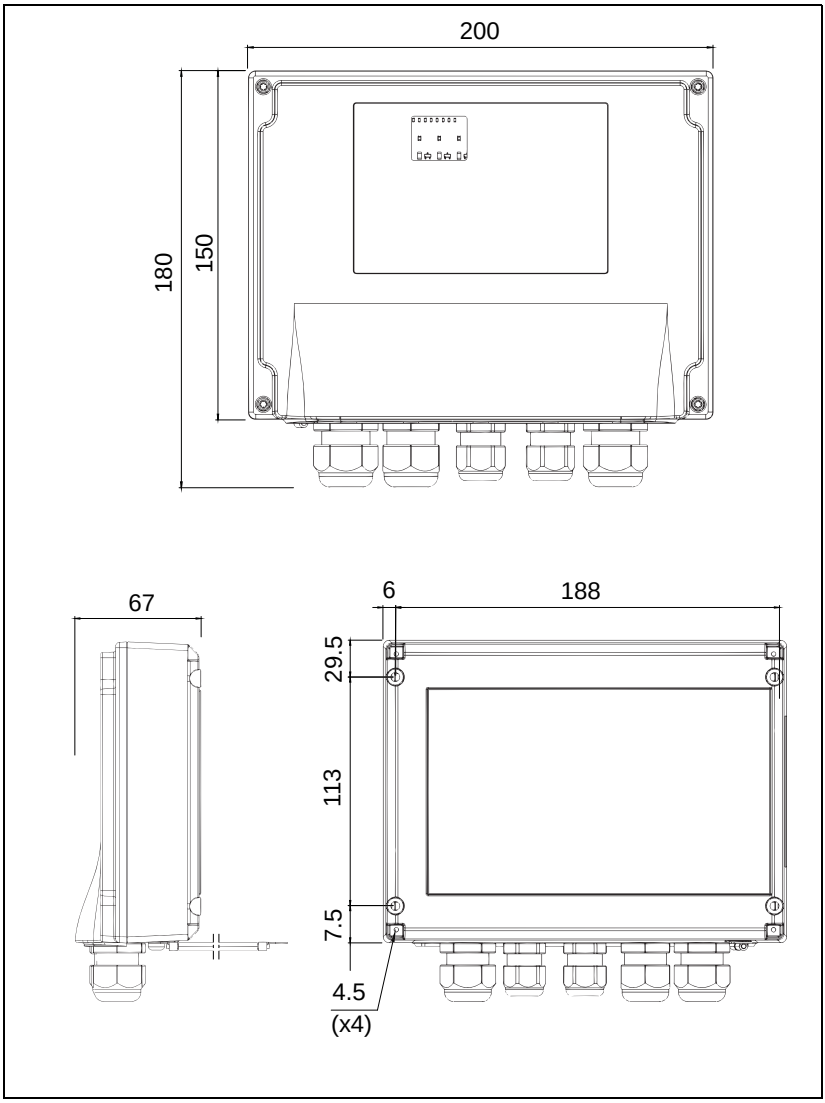


*Fig. 13 Dimensions, **EMX-B25/35** control unit (mm).*

6.1.2 Motors

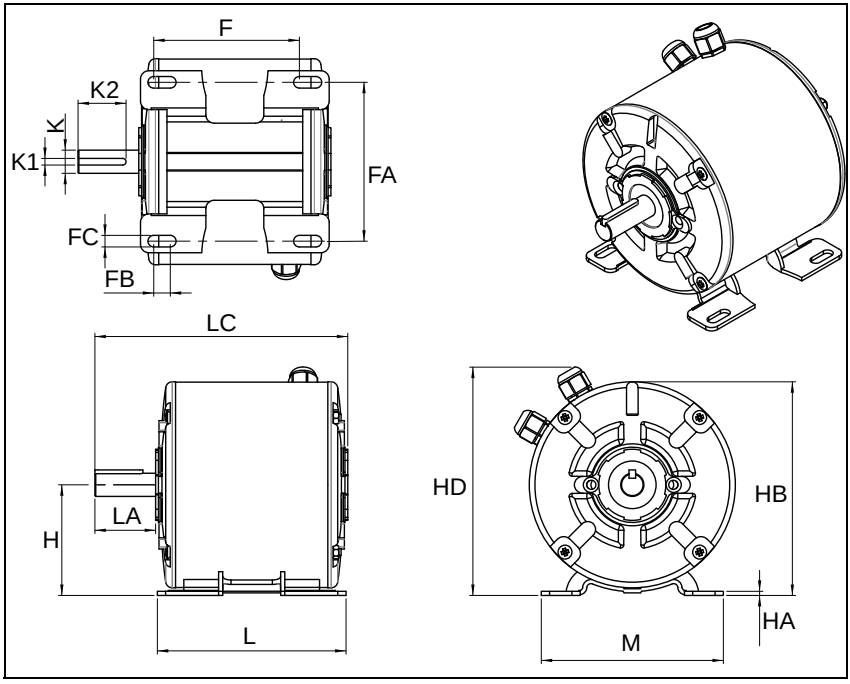


Fig. 14 Dimensions, motor.

Fig. 15 Motor dimensions, mm.

EMX-B	F	FA	FB	FC	H	HA	HB	HD
15	88	96	10	7	66.9	2.5	130	138
25	82	140	12		75.9		147	159
35	109				90	3.0	222	NA

EMX-B	K	K1	K2	L	LA	LC	M	
15	14 +0/-0.1	4	29	114	37	153	110	
25			30	115.6	39	180	160	
35		5		142	42.5	238.4	177	

6.2 Part numbers

Part number	Designation
01-5731-00	Motor EMX-B15
01-5732-00	Motor EMX-B25
01-5733-00	Motor EMX-B35
01-5762-00	Control unit EMX-B15
01-5764-00	Control unit EMX-B25
01--5766-00	Control unit EMX-B35
01-3549-00	Rotation sensor with magnet M12 x 35 mm

7. Appendix

7.1 Connection label

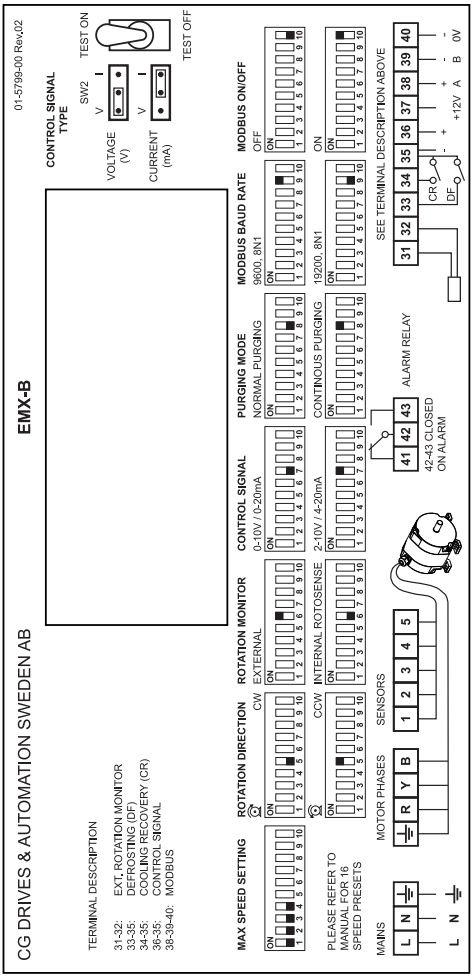


Fig. 16 Connection label placed inside front cover of control unit.

7.2 Front label

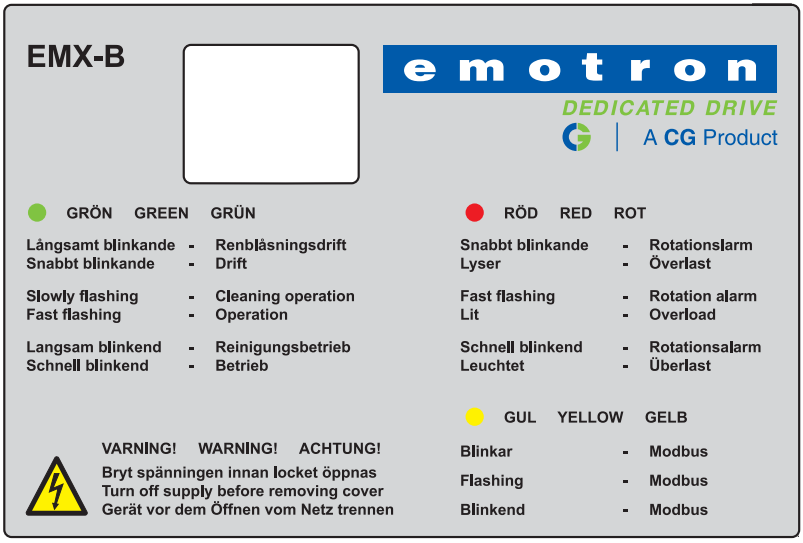


Fig. 17 Front label

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