

EMB 4000

DC injection brake (electronic motor brake)
10 ... 390 A, 400 ... 690 V



Instruction Manual

Ver. 04/2014

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SAFETY



- * Read this manual carefully before operating the equipment and follow its instructions
- * Installation, operation and maintenance should be in strict accordance with this manual, national codes and good practice. Installation or operation not performed in strict accordance with these instructions will void manufacturer's warranty.
- * Disconnect all power inputs before servicing the EMB 4000 and/or the motor.
- * After installation, check and verify that no parts (bolts, washers, etc.) have fallen into the power section (IP00).

ATTENTION



1. This product was designed and tested for compliance with IEC947-4-2 for class A equipment.
2. The EMB 4000 DC injection brakes are designed to meet UL requirements.
3. Use of the product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.
4. Utilization category is AC-53a or AC53b. Form1.
5. For further information see Technical Specification.

WARNING



- * Internal components and P.C.B's are at mains potential when the EMB 4000 is connected to mains. This voltage is extremely dangerous and may cause death or serve injury if contacted.
- * When the EMB 4000 is connected to mains, even if operation signal is disconnected full voltage may appear on EMB 4000's output.
- * Unit must be grounded to ensure correct operation, safety and to prevent damage.
- * Check that Power Factor capacitors are not connected to the output side of the EMB.

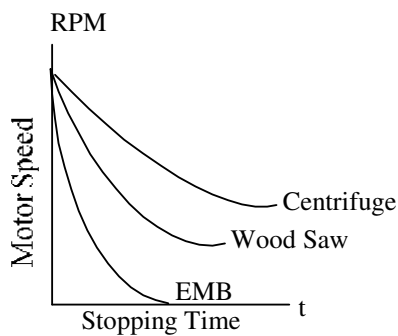
Brake Selection

The EMB 4000 DC injection brake provides fast, smooth, frictionless braking of three-phase squirrel-cage motors by injecting controlled DC current to the motor windings, after Mains contactor opened. This induces a stationary magnetic field, which exerts a braking torque on the rotor.

Stopping time can be similar to the time it takes to reach full speed on a Direct-On-Line starting.

Adjustable Braking Torque and Braking Time enable perfect matching of the brake to the driven load.

Automatic Time-Out System turns the brake off automatically when the motor comes to a full stop. This minimizes the motor heating.



Brakes ratings and Frame sizes

Max Motor FLA (Amp)	Brake Type FLC	Frame Size (Case Material)
10	EMB 4000 10	SB0
17	EMB 4000 17	SB1
31	EMB 4000 31	
44	EMB 4000 44	
58	EMB 4000 58	
105	EMB 4000 105	SB2
210	EMB 4000 210	SB3
310	EMB 4000 310	
390	EMB 4000 390	

Dimensions (mm)

Size	Width	Height	Depth
SB0	45	75	105
SB1	65	190	114
SB2	154	280	160
SB3	224	384	222

Select the brake according to the following criteria:

Motor Current & starting conditions

- Motor's Full Load Ampere (FLA) - as indicated on its nameplate (even if the motor is not fully loaded).
- For example EMB 4000 58 is suitable for a motor with nominal current of up to 58A.
- The EMB 4000 DC injection brake is designed for a duty cycle of 10% or less; e.g. 10 sec. operation, 90 sec. rest.

Duty Cycle = the ratio between operating time

$$\text{Duty Cycle} = \frac{\text{Operating time}}{\text{Rest time}} \times 100 (\%)$$

total cycle time = (rest time + operating time).

Note:

If a higher duty cycle is required select a higher EMB DC injection brake type.

Mains Voltage (line to line)

Thyristor's PIV rating, internal circuitry and insulation determines five voltage levels:

- * 220-240 V
- * 380-440 V
- * 460-500 V
- * 575-600 V
- * 660-690 V

Each brake is factory set for one of the above levels and suitable for 50 or 60 Hz.

Note:

EMB 4000 DC injection brake voltages are available only for 400 ... 600 V.

Options (see Ordering Information)

Extended braking time - consult factory

Installation Notes

Prior to Installation

Check that Motor's Full Load Ampere (FLA) is lower than or equal to EMB 4000 DC injection brake Full Load Current (FLC) and verify that Mains voltage and frequency are as indicated on the EMB 4000 DC injection brake label.

Mounting

- * The EMB 4000 DC injection brake must be mounted vertically, allow space above and below the unit for sufficient airflow.
- * It is recommended to mount the EMB 4000 DC injection brake directly on the rear metal plate for better heat dissipation.
- * Do not mount the EMB 4000 DC injection brake near heat sources.
- * Protect the EMB 4000 DC injection brake from dust and corrosive atmosphere.

Temp. Range and Heat Dissipation

The EMB 4000 DC injection brake is rated to operate over a temperature range of:

-10° C (14° F) to +50° C (122° F)

Relative non-condensed humidity inside the enclosure should not exceed 93 %.

The average heat dissipation of the EMB DC injection brake depends on the Braking Torque setting and on the duty cycle.

Heating inside the enclosure can be reduced through the use of additional ventilation.

Note:

The heat generated in the motor during braking is similar to the heat generated during starting. Therefore, high setting of the Braking Torque and/or a high duty cycle may require an external cooling fan for the motor. It is recommended to use thermistor protection in the motor to prevent restarting after a thermal trip.

Short Circuit Protection

The EMB 4000 DC injection brake must be protected against short circuit by fast-acting fuses. Recommended I^2t values:

EMB type	I^2t
10	400
17	5,000
58	15,000
105	100,000
210	600,000
390	700,000
460	1200,000

Transient Protection

Line transient voltages can cause malfunctioning of the brake and damage to the SCRs.

When higher transients are expected, an external protection should be used, (consult factory).

Wiring

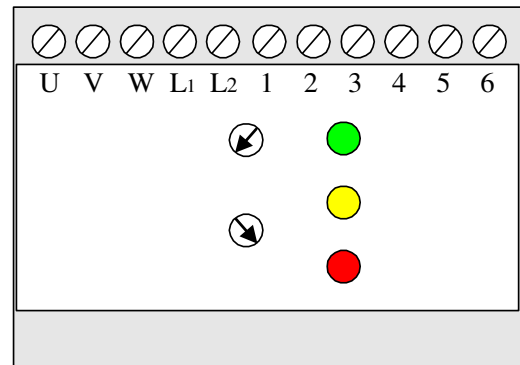
Connections to L₁, L₂, U and V should be done with power cables. Connections to terminals W and 1-6 are for control only.

Do not connect two EMB 4000 DC injection brakes in parallel as they are not synchronized and will be damaged.

Interlock between Mains contactor C₁ and braking contactor C₂ must be installed to prevent both contactors from being closed simultaneously.

EMB DC injection brake Wiring

The EMB DC injection brake is meant for installation on a Din-Rail.



Power Factor Capacitors

Power factor correction capacitors must not be installed on the load side of the EMB 4000. When required, capacitors should be installed on the EMB DC injection brakes line side.

Notes:

1. The EMB 4000 DC injection brake uses Mains power to produce the braking torque. Therefore, a power failure or disconnection will disable the DC braking and the motor will coast to a stop without braking.
2. When required to stop a motor during a power outage, an electro-mechanical brake must be used.
3. The EMB 4000 DC injection brake cannot be used for continuous holding of loads, after motor had stopped. An electro-mechanical brake should be used for holding at rest.

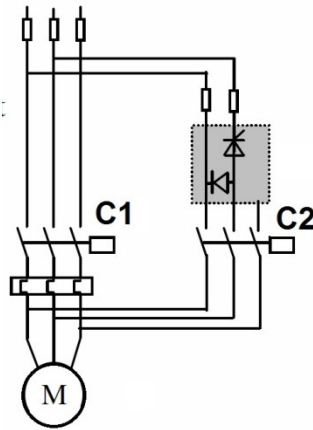
Warning
Wrong connections of EMB line and load sides will cause damage to the brake and motor.

Mode of Operation

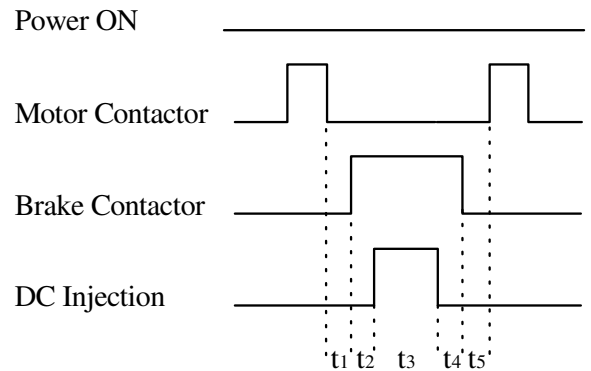
Stop signal opens motor contactor C_1 that in turn initiates the closing of brake contacts C_2 .

The thyristor is switched on after a time delay, to induce the braking current.

The torque, which is a function of the DC current, can be controlled by the firing angle of the thyristor.



The EMB 4000 DC injection brake incorporates the following built-in time delays:



Braking Time

Braking time depends on the inertia, friction of the load, speed, and braking current. The required braking time is best established by practical experience.

The EMB 4000 offers two operating modes, Automatic and Manual. Selection between the modes is done by an internal dip switch.

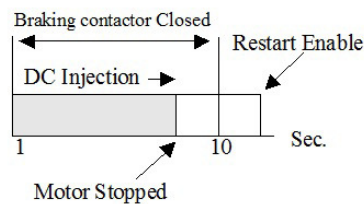
Dip sw.	Operation Mode
On	Manual
Off	Automatic

It is recommended to use the Automatic mode (factory set) to reduce the braking time and minimize motor heating.

Automatic operation

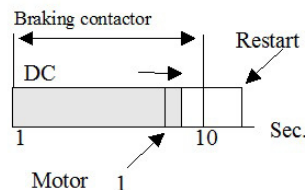
DC injection duration is automatically controlled by the EMB.

Injection ceases when Motor has come to a complete stop.



Manual operation

DC injection duration is according to the Braking Time setting on the front panel.



Notes:

- Motor heating during braking is similar to heating during Direct On Line starting. Therefore, always try the shortest DC injection time duration.
- When a motor is running unloaded, it may happen that the EMB will not detect that motor has come to a complete stop when set to the Automatic mode. In this case the braking current will be terminated after a time delay, as set on the Braking Time potentiometer.

Where:

- t_1 - Time delay between opening of motor's contactor C_1 and closing of brake contactor C_2 , allowing motor's back EMF to diminish (see table below).
- t_2 - Time delay of 0.05 sec between closing of brake contactor C_2 and initiation of DC current, to ensure that brake contactor does not switch DC current, enabling the use of regular AC contactor.
- t_3 - **In Auto Mode** - duration of DC current injection. **In Manual Mode** - maximum time of DC current injection, adjustable 1-10 sec.
- t_4 - Time delay between end of DC current injection and opening of brake contactor C_2 to ensure that the contactor does not switch DC current, enabling the use of regular AC contactor (see table below).
- t_5 - Time delay of 0.2 sec. between opening of brake contactor C_2 and enabling motor's restart.

Approximate Time Delays (sec).

EMB 4000	10	17	58	105	210	390	460
t_1	0.2	0.3	0.6	1.1	1.7	2.5	2.7
t_4	0.2	0.2	0.3	0.8	1.2	1.9	2.3

Torque at standstill

When required to maintain the DC braking current after the motor has come to a complete stop, set Auto/Man Dip Switch to On (Manual operation). Set Braking Time to a longer time than it takes the motor to come to a complete stop.

Note - DC Injection after motor has come to a complete stop may cause excessive heating of both the motor and the brake.

Wiring & operation

EMB 4000 with Direct on Line Starter

Motor contactor C₁

(with one N.O + two N.C contacts).

- * Contact **C₁** - Holding N.O contact of contactor **C₁**
- * Contact **C₁₋₁** - auxiliary N.C contact of contactor **C₁**, initiates the braking process.
- * Contact **C₁₋₂** - auxiliary N.C contact of motor contactor acts as an interlock preventing operation of brake contactor as long as motor contactor is closed.

Brake contactor C₂

(with one N.C contacts).

- * Contact **C₂₋₁** - auxiliary N.C contact of contactor **C₂**, acts as an interlock preventing operation of motor contactor as long as brake contactor is closed.

EMB 4000 contacts

- * **Ca** contact (EMB 4000 terminals 3-4), contact closes when Mains voltage is connected to EMB 4000 terminals.
- * **Cb** contact (EMB 4000 terminals 5-6), closes upon stop signal after time delay t_1 .

Notes

- * Motor contactor **C₁** cannot be operated when Mains voltage is not connected to terminals **L₁** and **L₂** (internal contact **Ca** in EMB 4000, controlling motor contactor, closes after Mains voltage is connected).
- * When operating in Manual mode, DC injection will stop after time delay t_3 as set on the Braking Time potentiometer.

Operation

Upon start signal, as **Ca** is closed, motor contactor **C₁** closes, motor will operate and contact **C₁₋₁** opens.

Upon stop signal, motor contactor **C₁** opens, contact **C₁₋₁** closes and initiates the braking process.

Contact **Ca** opens, preventing motor contactor operation, and after time delay t_1 contact **C_b** closes, closing the brake contactor **C₂**.

The orange LED on EMB 4000 DC injection brake front panel will light up indicating that brake contactor is closed.

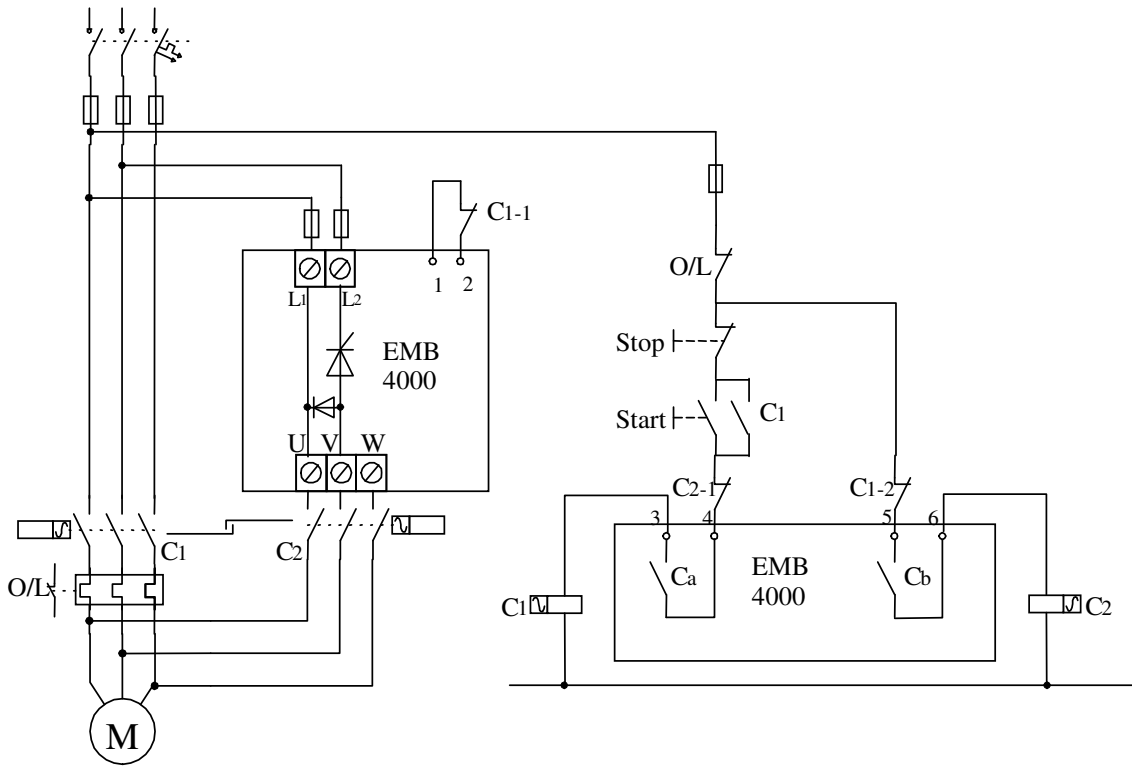
After time delay of approx. 0.05 sec. DC current will be injected to motors' winding.

The red LED on EMB 4000 DC injection brake front panel will light up indicating that braking current is now injected to the motor.

The DC injection will automatically cease when motor comes to a complete stop (when Automatic mode is selected) and the red LED turns off.

Contact **C_b** opens after time delay t_4 (this time delay is intended to ensure that the brake contactor does not open DC current - enabling the use of a regular AC contactor).

Contact **Ca** closes after time delay t_5 , permitting motor restarting.

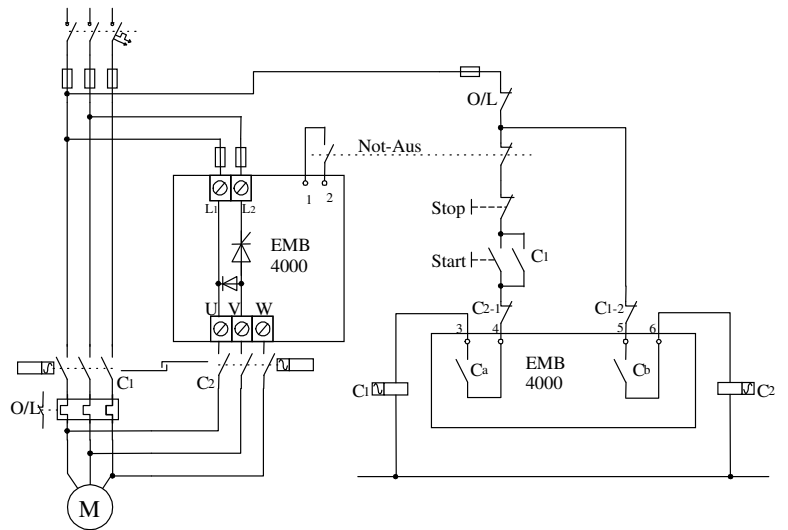


Emergency Brake

A dedicated Emergency Stop button, with two contacts initiates braking.

When Stop button is opened, contactor C₁ opens, the EMB 4000 DC injection brake is not initiated.

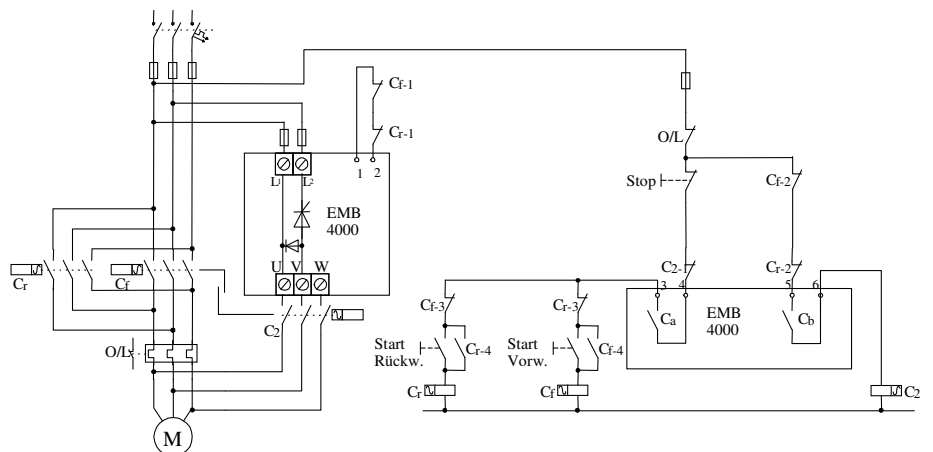
When Emergency Stop button is opened, C₁ contactor opens and the EMB 4000 DC injection brake is operated, initiating the braking process.

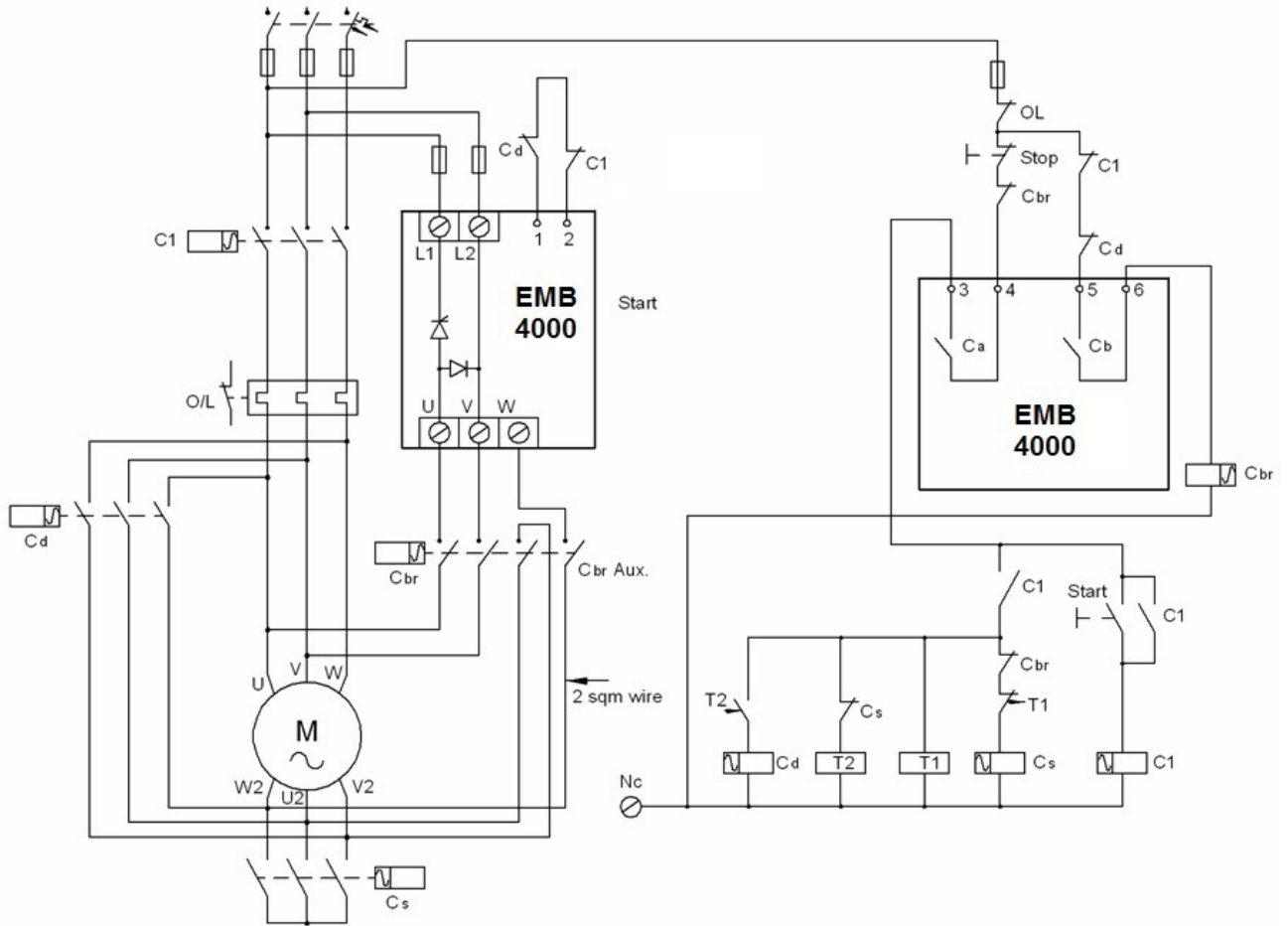


Reversing

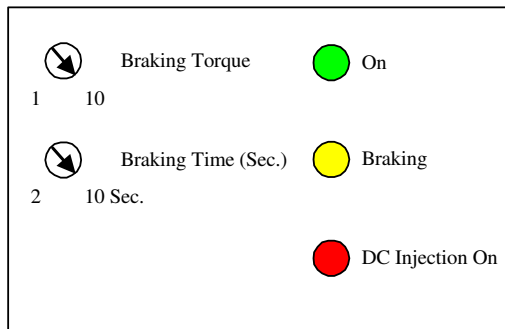
C₂ – EMB 4000 Contactor.
C_f - Forward Contactor
C_r - Reversing Contactor
Interlocked Contactors.

Braking process is initiated when Contactors C_f or C_r open.





Start-Up Procedure



Braking torque

Determines the amount of DC current the EMB 4000 DC injection brake injects to the motor. The EMB 4000 can produce a braking current of up to four times motor's nominal current.

A too high setting may cause a fast stop and high mechanical shock. A too low setting may result in prolonged time until motor stops.

Braking Time

- * **For Automatic Time-out** - The setting on the front panel determines the period of time during which the braking contactor is closed. DC current ceases automatically when motor stops.
- **For Manual Time-out** - The setting on the front panel determines the period of time during which DC current is injected to motor windings, regardless of when the motor stops.

LED Display

The Green LED indicates that power supply is connected to the EMB 4000 (L_1 , L_2).

The Yellow LED indicates that contactor C_2 is closed. Motor restart is disabled when this LED is lit.

The Red LED indicates that DC current is being injected in the motor windings.

Start-Up Procedure

During start-up the dip switch should be in the Off position for Automatic Time-Out.

1. Set Braking Torque to 5
2. Set Braking Time to 10
3. Start motor and wait until it reaches full speed.
4. Stop motor and check the braking procedure.
 - a) If braking has ceased and motor is still turning, increase braking Torque setting and try again.
 - b) If motor has stopped and the Yellow LED remains lit, decrease Braking Time setting until the Yellow LED turns off shortly after the red LED has turned off.

Note: Set Braking Time potentiometer t_3 to a slightly longer time than the time required for motor to come to a complete stop, even if the brake operates in an Automatic mode. This is required for two reasons:

1. Ensuring that even if the automatic time-out circuit did not sense that motor had stopped, the DC injection will cease shortly after motor stopped preventing excessive heating.
2. During time delay t_3 , braking contactor remains closed even if the Automatic Time-Out circuit has stopped the DC current, preventing the motor from restarting.

Measuring the Braking Current

Approximate measurement of the braking current can be made with a true RMS ammeter.

Trouble Shooting

1. Disconnect Mains voltage and check that contacts 3-4 and 5-6 are open.
2. Connect power to L_1 and L_2 . The green LED (On) should light up.
3. Check that contact between terminals 3-4 is closed.
4. Check that contact between terminals 5-6 is open.
5. Start the motor. Motor contactor should close. If it doesn't, check connection to contactor.
6. Press Stop button; motor contactor should open and brake contactor should close after a short time delay. Simultaneously the Braking Time and DC injection LEDs should be lit. If LEDs do not light up, check that auxiliary contact of Mains contactor connected between control terminals 1-2 is closed.

Fuse Selection Table (400V)

FUSE SELECTION (recommended values for mains supply of 400V)

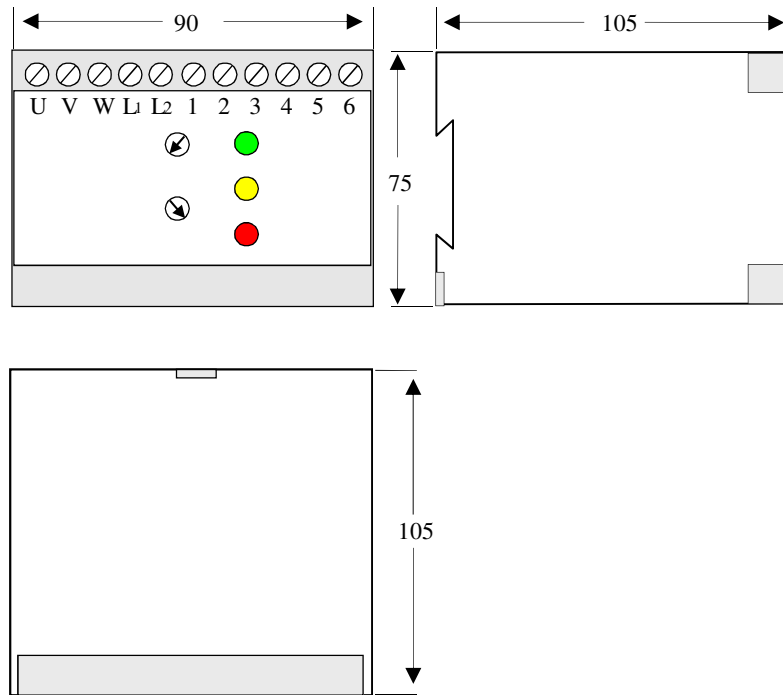
EMB 4000	Max. Thyristor I^2t (A ² Sec)	BUSSMANN		GEC ALSTOM		SIBA		FERRAZ – SHAWMUT (IEC Style 690/700V)	
		Rated (A)	P/N	Rated (A)	P/N	Rated (A)	P/N	Rated (A)	P/N
EMB 4000 10	400	30	FWP 30	32	B210612			32	URD 000-32
EMB 4000 17	5,000	50	FWP 50	63	B210615			63	6.6URD30D11A0063
EMB 4000 31	12,000	125	FW 125P	100	X320063			100	6.6URD30D11A0100
EMB 4000 58	15,000	150	FWP 150	125	X320065			125	6.6URD30D11A0125
EMB 4000 105	16,000	250	FWP 250	200	D320071	250	SQB1-250	200	6.6URD30D11A0250
EMB 4000 210	200,000	500	FWP 500	450	D320485	450	SQB1-450	450	6.6URD30D11A0450
EMB 4000 310	600,000	700	FWP 700	630	H320489	630	SQB1-630	630	6.6URD31D11A0630
EMB 4000 390	700,000	700	FWP 700	800	T320591	800	SQB1-800	800	6.6URD31D11A0800

Notes:

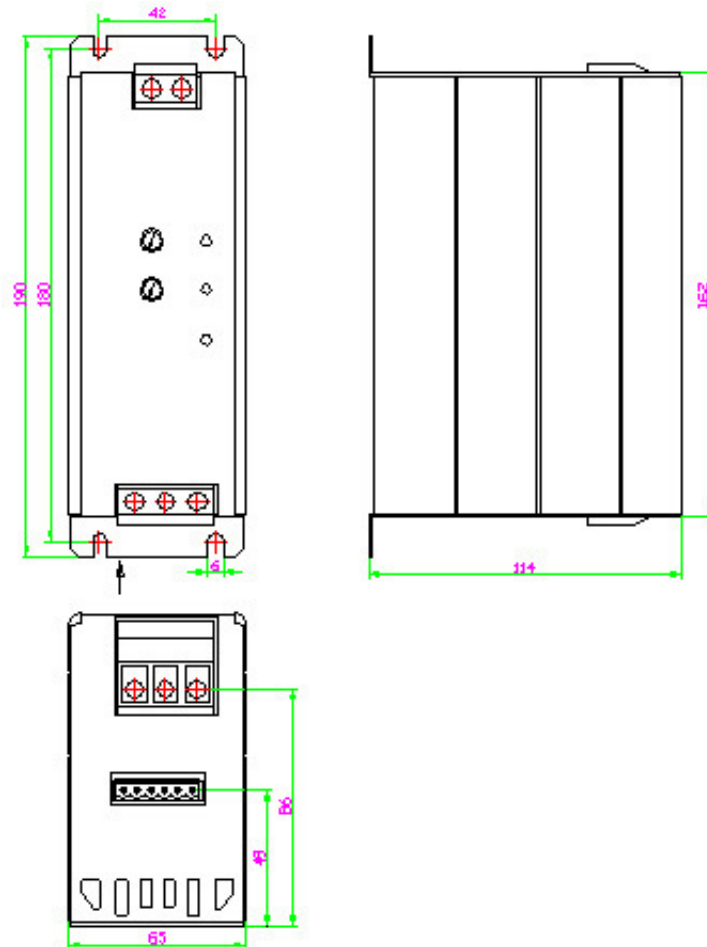
1. The above table is for maximum stop current of 400 % of FLC, maximum time of 30 sec and rated voltage of 400 V (see note 3 for exception).
2. Rating may change with different external conditions such as ambient temperature, forced cooling etc. Refer to fuse manufacturer catalogs to confirm correct values.
3. Ferraz ratings are **simulated** for 4xIn, 4 times per hour with a 10 sec. stop time for each stop.

Dimensions (in mm)

EMB 4000 - 10 A

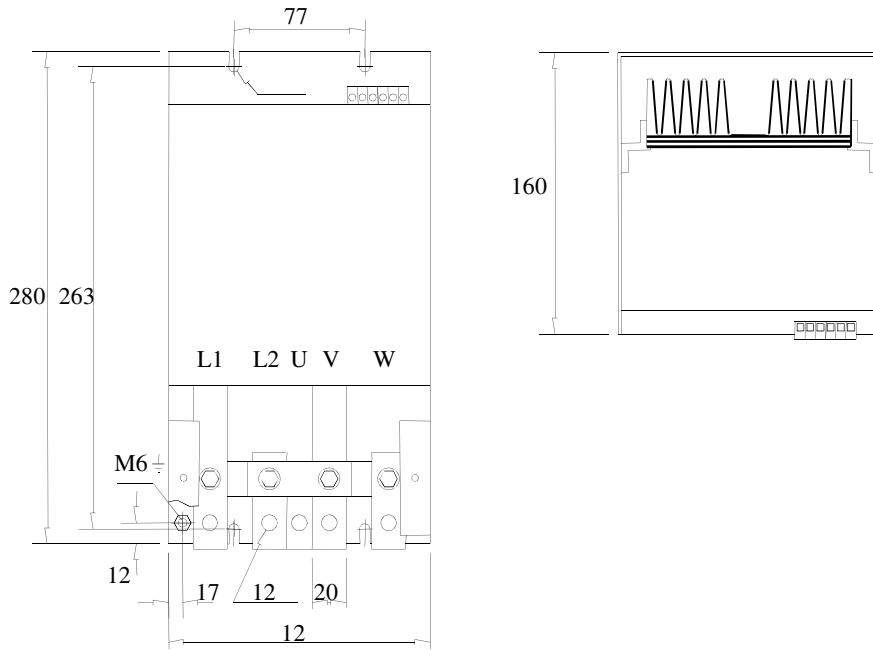


EMB 4000 - 17 ... 58 A

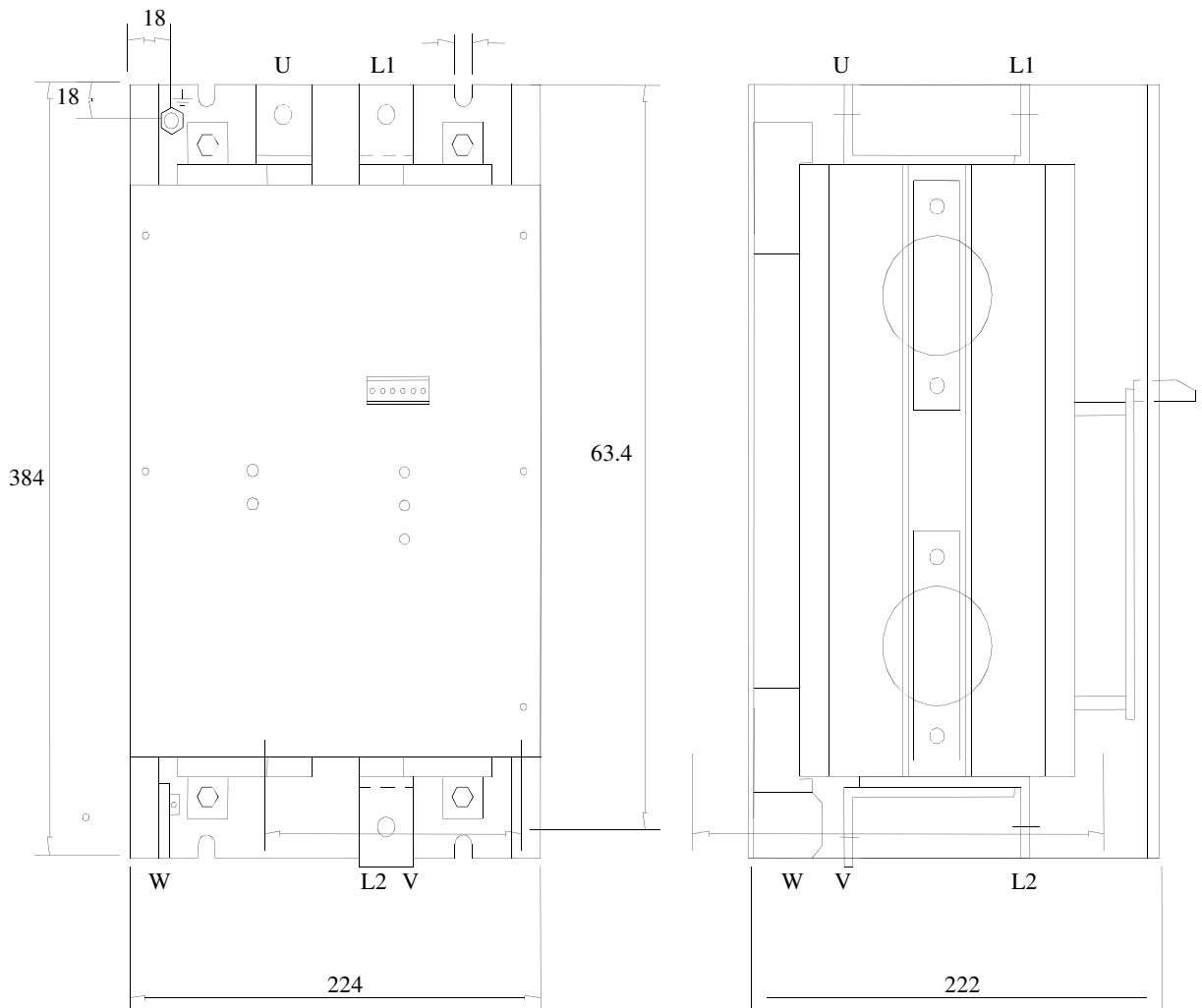


Dimensions (in mm)

EMB 4000 - 72 ... 105 A



EMB 4000 - 170 ... 390 A



Technical Information

Environment		
Supply voltage	Two phase, line to line. 220 ... 600 V AC	+10 % ... 15%
Frequency	50 / 60 Hz	
Load	Three-Phase, Three-Wire, Squirrel Cage Induction Motor	
Duty cycle	10 % max.	10 sec. operation, 90 sec. rest
Degree of protection	IP 20	
Altitude	1000 m above sea level	
Adjustments		
Braking torque	1 ... 10 times FLC	
Braking time	2 ... 10 sec.	optionally 1 ... 30 sec.
Protection		
Automatic time-out	Switches off the DC injection automatically when motor has come to a complete stop.	
Indications		
Indication lights (LEDs)	ON - Green	Illuminates when power is connected to EMB 4000 on L1 and L2.
	C2 close – Yellow	Illuminates when contactor C2 is closed.
	DC Injection ON - Red	Illuminates when DC current is being injected to the motor windings.
Temperatures		
Operating	-10° ... +50° C	
Storage	-20° ... +70° C	
Relative humidity	93 % - non condensed	



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