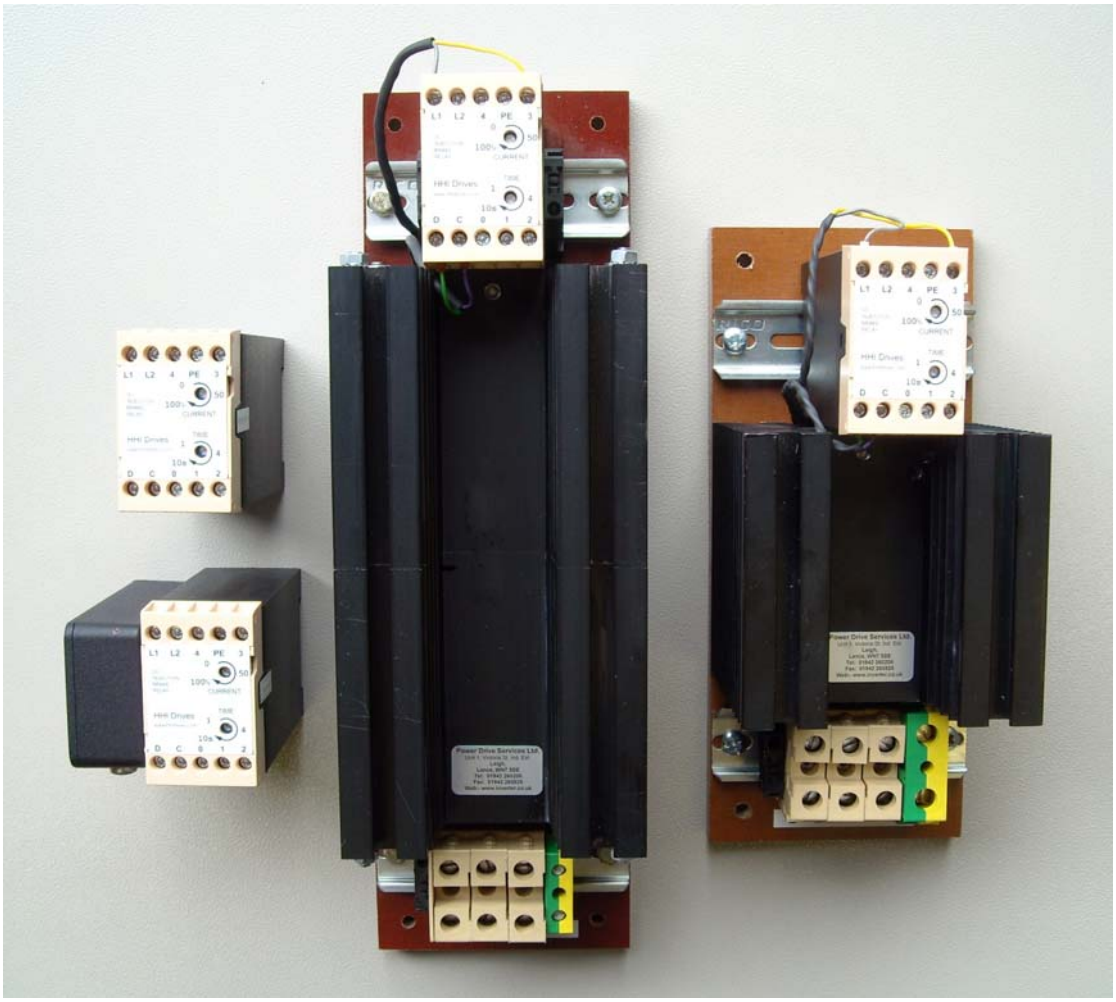
Installation Manual for DC Injection Brake Units

Power Drive Services
INJ Series DC brake modules



Installation Manual for DC Injection Brake Units

Contents.

Power Drive Services
Unit 1 Victoria Street Ind. Est.
Victoria Street
Leigh
Greater Manchester
WN7 5SE
UK

Tel. 01942 260 206
Email www.inverter.co.uk/contact.htm
Web www.inverter.co.uk

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1. Safety.

Modification of any machine may require a safety risk assessment. As a result of the risk assessment additional safety systems or interlocks may be required. Safety relays are available if required. Please contact us if you require help with a risk assessment or any other safety equipment.

Read this manual fully before installation. The assembly is an electrical system and must be installed by a competent person. Ensure all authorised persons are aware of the dangers and safe working practices.

1.1. Safety Electrical.

The voltage at some of the terminals is high enough to endanger life. The terminals have only protection against accidental contact. The module must be installed in a panel to which unauthorised access is denied.

Semiconductor fuses should be fitted to protect only the brake module. Upstream circuit breakers must be provided to protect the wiring. The wiring should conform to the latest IEE regulations, or local regulations whichever are more stringent.

1.2. Safety Mechanical.

Rotating and moving machinery can cause injury or endanger life. Only a competent person should modify the operation of any machine. Consideration must be taken of any potential hazards. These may be couplings: threaded couplings which may unscrew if the motor is stopped, couplings fixed by shear-pins would need to be checked to see if these can withstand the stopping torque, friction couplings would need to be checked to see if these withstand the torque. The machine mountings must be checked to see if they can withstand the forces during stopping.

2. Installation.

The brake module is installed downstream of the machine isolator and any motor overload relay. The module will require an auxiliary contactor of its own in most starter circuits. Please refer to the typical installation diagrams at the back of this manual. A cursory view of the diagrams will show that the brake significantly alters the starter circuit

2.1. Earth Connection.

The brake assembly must have an earth connection. The earth cable cross section should be as big as the cable used for the power wiring.

3. Setting Up.

3.0. General.

The minimum equipment required is a dc clip-on ammeter. Be sure to measure the current in the motor wiring which carries the dc injection current. One of the motor wires does not carry any current during braking.

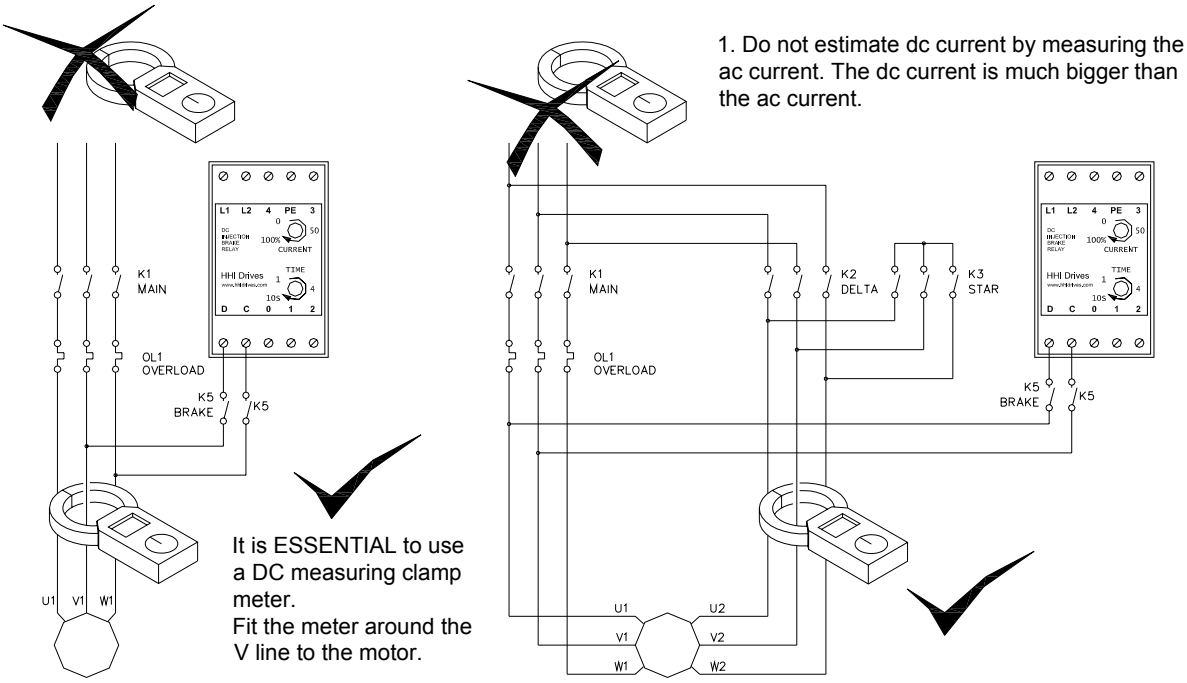
Make sure that the brake can cope with the worst case. The worst is achieved by ensuring that the test is carried out with the maximum moment of inertia (load) coupled to the motor shaft. Remove any friction from the rotating member.

A series of test start-stop cycles will be made during setting up. If the installation has been done correctly, be aware that the brake unit should deny re-starting during braking.

Also be aware that the duty is limited by the braking current, and the ambient temperature. Too many stop / start cycles in close succession may damage the unit. See the specifications for some idea of permissible duty.

The procedure requires the machine to be run up to normal speed, and the brake (stop) applied. During the braking period the current is monitored, and adjusted up to the maximum permitted by the motor, or the brake unit.

3.1. Measuring Current



2. If your clampmeter does NOT have a battery it does NOT measure dc current.

3 If it does have a battery it still may not measure dc current. Check the instruments specifications.

3.2. Current 0-100%.

The front panel of the module has a ¾ turn screw adjustment for current. Maximum current is fully *clockwise.* The current must be measured with a dc meter. The rated current of the unit will be achieved at somewhere below 100% depending on the motor. The supply voltage, and the resistance of the motor limit current. Too much current can damage the brake unit, and it is crucial that the DC current is monitored during adjustment.

The braking torque increases with current. Consistent with duty and module rating, the DC current for a DOL starter may be set up to 2 x the motor full load current (flc). Above 2 x flc the braking torque may begin to fall. For a star delta starter the dc current is applied to two windings, and should be limited to 2 x the star current, or 1.15 x the delta current (i.e. full load current).

3.3. Time 1-10s.

The front panel of the module has a ¾ turn screw adjustment for time. The duration of the braking can be adjusted between 1 and 10 seconds. The adjustment is logarithmic with 4s at 50%, and 3s at 75%. Maximum time is fully *clockwise*. (The same as the current control.)

3.4. Procedure.

3.4.1. Initially set the time for about 4 seconds (50%). The time is long enough to allow the current meter to get a good indication, and short enough to keep the duty low during repeated stop / starts.

3.4.2. Set the current adjustment to about 20% and start the machine. Stop the machine and observe the current in a motor line that is carrying the DC injection. It is not necessary to attain full speed before stop is applied.

3.4.3. Adjust the current setting and repeat the stop / start until the desired current is attained. Pay attention to the duty rating of the brake unit during setting up. Allow ½ hour for the unit to cool if setting up has taken longer than the duty rating will allow.

3.4.4. Start the machine, and allow it to get to full speed. Stop the machine and observe the residual speed when the braking has stopped. If the machine is still running, the brake time should be increased. If the machine has stopped, it may be possible to reduce the brake time. It does no harm to have the brake applied for half a second after the machine has reached standstill. The brake is now set for use.

3.5. Alternative Procedure.

The previous set-up was dominated by the current setting. In some applications you may wish to stop a little less quickly. Set the brake time first, and then increase the current until standstill is achieved within the desired time as follows

3.5.1. Initially set the current for about 30%. The current is high enough to allow the current meter to get a good indication, and short enough to keep the duty low during repeated stop / starts.

3.5.2. Set the time adjustment to the desired amount and start the machine. Allow the machine to reach full speed and stop the machine. Observe the current in a motor line that is carrying the DC injection. Check that the brake action is sustained over the desired stopping time.

3.4.3. Adjust the current setting and repeat the stop / start until the machine stops within the desired stopping time. The brake is now set for use.

3.6. Monitoring Brake Activity.

Detecting brake activity can be done in several ways as follows

3.6.1 Observe the current meter. Braking only occurs when current is flowing. The current ceases about 200ms before the brake cycle is ended.

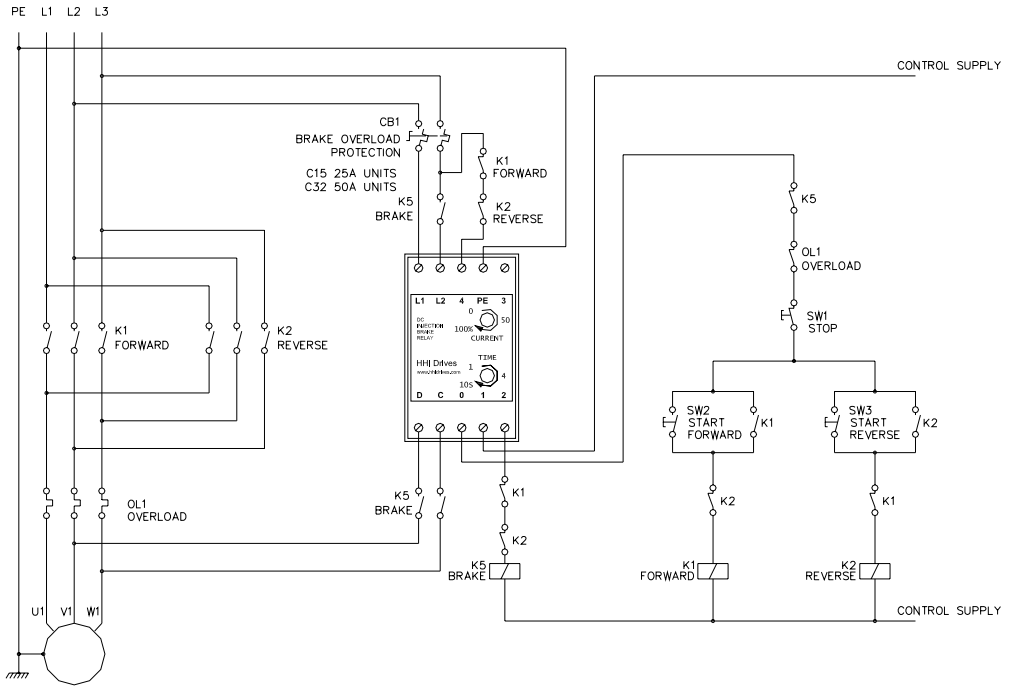
3.6.2 Listen for the brake contactor to drop out. Current ceases about 200ms earlier.

3.6.3 Listen to the sound of the motor. During braking the motor noise may be heard as a low "growl". The harmonic currents in the motor during braking are predominantly 50Hz. The characteristic hum of single phase equipment by comparison is an octave higher. Three phase equipment is higher still, and sounds more pleasant.

3.7. Temperature.

On initial setting add some extra time or current in excess of the setting that just stops the machine. Add 10% for example. After initial setting-up check the braking during a normal work period. As the motor heats up during use, the resistance of the windings will rise a little. The machine may come to rest a little later than it did during setting-up

4. Wiring Diagrams.



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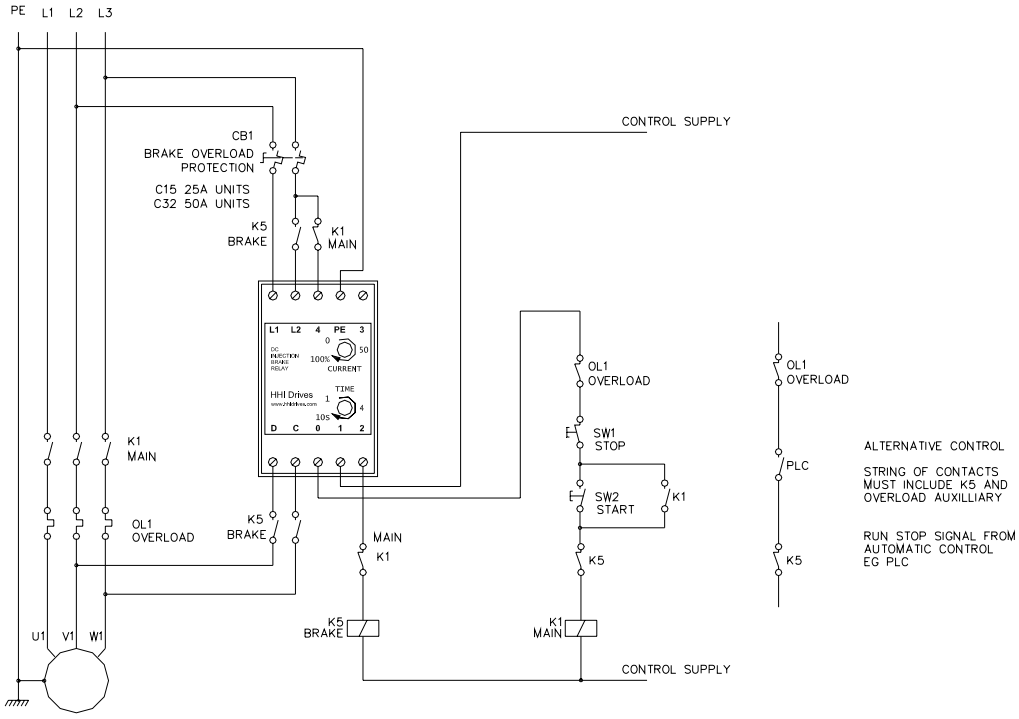

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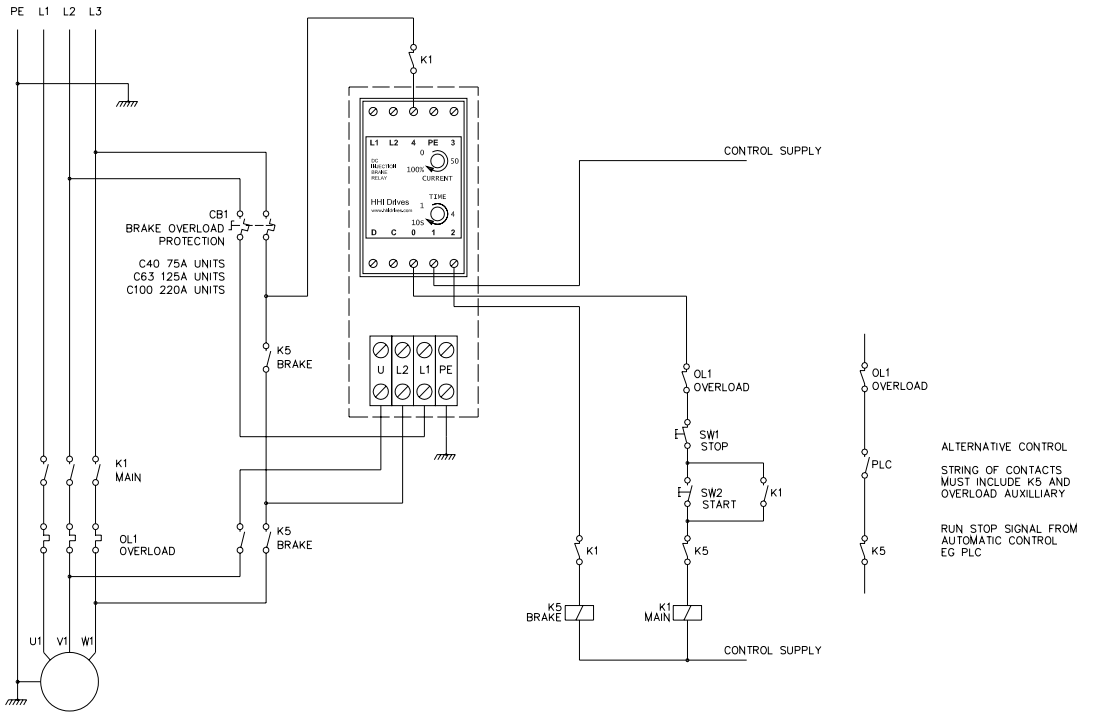

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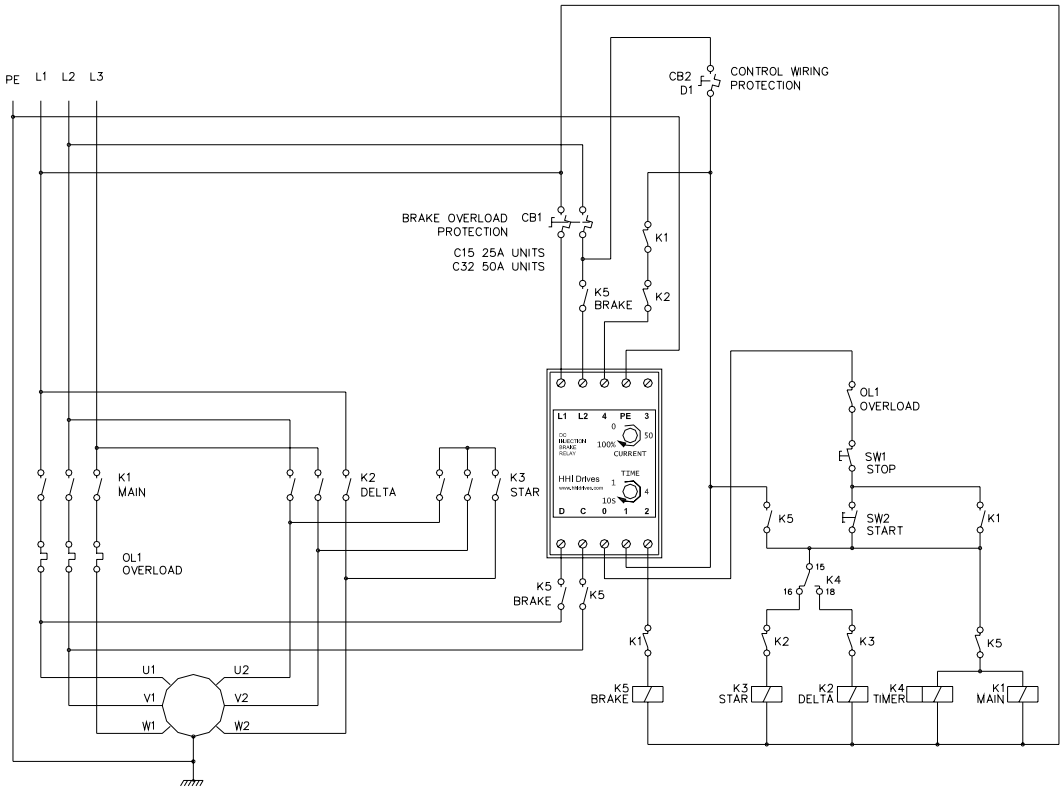

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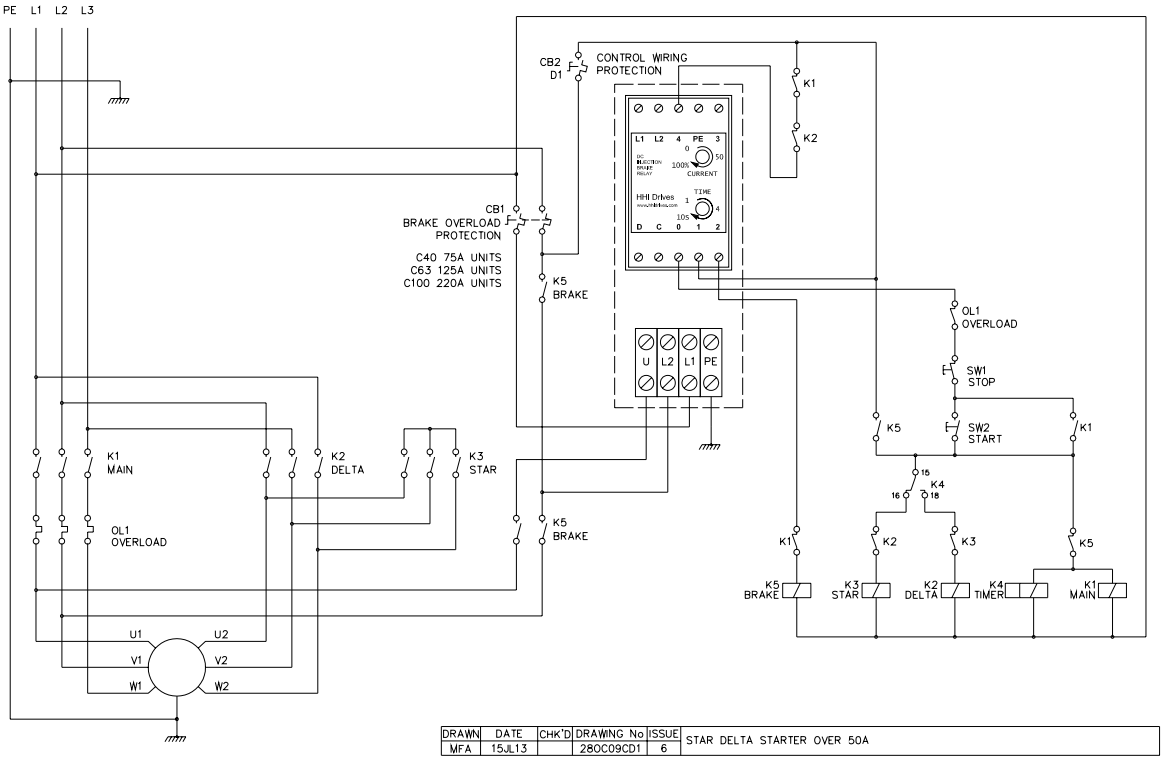

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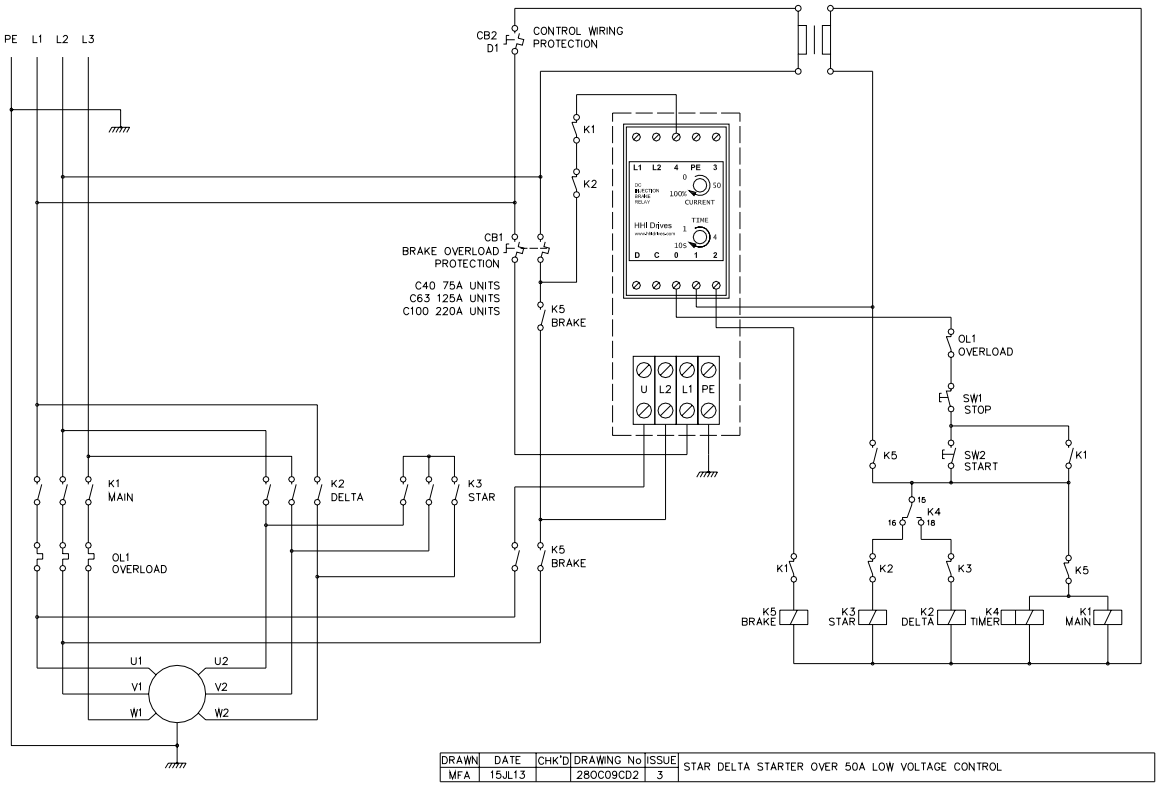


DRAWN	DATE	CHK'D	DRAWING No	ISSUE	
MFA	15JL13		280C09CD2	3	STAR DELTA STARTER OVER 50A LOW VOLTAGE CONTROL

4.1 Protection.

The wiring diagrams show C type circuit breakers as the protection for the brake modules. Circuit breakers are convenient, but may not be suitable for the application.
If the operating current of the unit is high, and the motor inductance is low you may hear the circuit breaker buzzing when the brake is applied. In these cases a D type breaker may be required. The protection of the unit becomes compromised.

Fuses are a better solution, but semiconductor types must be used. Fuses are less convenient because they cannot be reset like a circuit breaker. Fuses often get replaced by the wrong types and rating.

4.2 Fuse Ratings.

The fuses should be aR types, semiconductor or ultra rapid.
The fuse ratings are the ac rating of the fuse.
The voltage rating is the ac voltage of the circuit.
The A^2s ratings given are the total let-through, not the pre arcing.

Brake Unit	Fuse Rating A	A^2s Maximum
11A	6	0.45 kA^2s
25A	15	0.45 kA^2s
50A	32	6 kA^2s
75A	40	6 kA^2s
120A	63	80 kA^2s
220A	100	125 kA^2s

5. Specifications.

5.1.1. General Function of Terminals.

L1.L2. Ac power.
D,C. Dc output to motor.
4 Control input, referenced to L1.
PE Protective earth. Not required on 25A units.
3 Do not connect.
0,1,2. Isolated changeover contacts energised when braking.
Trim. Brake current adjustment, 0-100%.
Trim. Brake time adjustment, 1-10s.

An external contactor connects the unit to the motor. DC current is generated from the ac supply when an enable signal is given. The unit allows for manual adjustment of the current. The time for which the current is applied is also manually set on the unit. An internal contact set is energised during braking so that the start circuit can be defeated.

5.1.2. Power Input L1, L2.

The input current into terminals L1 and L2 varies with the line voltage, the resistance across D and C, and the current setting. The input current ac rms will not exceed ½ the dc output current, and in most cases will not exceed ¼ the dc output current.

5.1.3. Control Input. L1, 4

The control input is the primary of a 2VA transformer. Braking action is triggered by sudden application of voltage on terminal 4. If voltage is applied gradually the brake cycle will not be triggered, and the unit will remain in the timed-out state. For detailed information see the timing diagram in this manual. The voltage at this terminal must be from the same phase as that voltage supplied to terminal L2.

5.1.4. Output D,C.

The output voltage is a single phase, phase angle controlled half wave rectified voltage. The maximum output voltage is as follows:

V rms on L1, L2	400	230	110
V dc ave. on D, C	90	50	25

The current is not controlled, and is determined solely by the resistance across D and C, and the line voltage. It is crucial that the dc current is monitored during setting up, so that the units are not damaged. Motor resistances vary considerably, and for most applications the “current” setting will be much less than 100%.

5.1.5. Change-over Contact 0,1,2.

An isolated change-over contact is provided on terminals 0, 1 and 2. Terminals 0 and 1 are made when the unit is de-energised or timed out. Terminals 1 and 2 are made when the unit is braking. The contacts have a rated breaking voltage of 250Vac, and a maximum breaking voltage of 440Vac. The rated load is 8A or 2kVA.

The contacts are usually used only to operate a single contactor. The power contacts of the contactor are used to connect the brake unit to the motor. Further auxiliary contacts on this contactor are used to lock out any attempts to re-connect the motor whilst braking is in progress.

6. Selection.

A simple rule of thumb is that a rotating assembly cannot be stopped any sooner than it can be started. A relatively small motor turning a large mass may take 30 seconds to reach full speed. Similarly the same motor will be unable stop the same mass any sooner.

Braking is the reverse of accelerating. A standard squirrel cage motor will decelerate quite gently at first. The braking force increases until it reaches maximum near rest (5% rated speed). At rest the braking torque is minimal. To *lock* the shaft at rest always requires an auxiliary mechanical brake. Combinations of electrical braking and mechanical are not uncommon, the mechanical system provides shaft locking, whereas the electrical system offers wear free stopping.

The following tables list the recommended brake ratings. Remember to account for the line to line voltage, and the starter system which is employed. Please be aware of the intended duty of the application. For higher duties choose the next larger size of unit.

6.1. Fixed Motor Configurations

400V.

Fixed configurations occur with DOL and most soft start connected motors. In these applications the three windings in the motor are permanently wired, and only three wires go to the motor.

The first column shows the rating of the unit required to brake the motor.

The second column is the nominal motor power at 400V line to line.

The next column lists a typical motor current for the listed motor power.

The final column shows the maximum dc current which will achieve the braking. Less current will brake more gently. More current may brake more, but not proportionally more, and in some cases may brake less.

Model	Power kW	Imot Arms 400V 3ph	Brake Adc DOL
INJ-H-11A	1	2	4
	1.5	3	6
	2.2	4.4	8.8
INJ-H-25A	3	6	12
	4	8	16
	5.5	11	22
INJ-H-50A	7.5	15	30
	11	22	44
INJ-H-75A	15	30	60
	18.5	37	74
INJ-H-120A-ASS	22	44	88
	30	60	120
INJ-H-220A-ASS	37	74	148
	45	90	180
	55	110	220

6.2. Star Delta Starter Configurations.

400V.

With a star delta starter considerable advantage can be gained if you are able to re-connect the motor in star for the duration of the braking period.

The recommended dc brake current is that current flowing in series in two of the windings.

When retro-fitting a brake system to an existing starter some thought needs to be given to the modification of the circuit. The typical wiring diagrams earlier in this manual give some guidance.

Model	Power kW	Imot Arms 400V 3ph	Brake Adc YD
INJ-H-11A	1	2	2.3
	1.5	3	3.5
	2.2	4.4	5.1
	3	6	6.9
	4	8	9.2
INJ-H-25A	5.5	11	12.7
	7.5	15	17.3
	11	22	25.4
INJ-H-50A	15	30	34.7
	18.5	37	42.8
	22	44	50.9
INJ-H-75A	30	60	69.4
	37	74	85.5
INJ-H-120A-ASS	45	90	104
	55	110	127
INJ-H-220A-ASS	75	150	173
	80	160	185
	95	190	220

There will be occasions where the circuit does not lend itself to simple modification.
In cases where the windings cannot be connected in star during braking, only one winding will be dc injected. More current is required to achieve the same brake torque. The power ratings and brake types in section 6.1 should be used as a guide for the upper limit of brake current.

6.3. Fixed Motor Configurations.

230V.

Fixed configurations occur with direct on line and most soft start connected motors. In these applications the three windings in the motor are permanently wired, and only three wires go to the motor. At lower voltage, the same motor power requires more current.

Model	Power kW	Imot Arms 230V 3ph	Brake Adc DOL
INJ-L-25A	1	3.5	6.9
	1.5	5.2	10.4
	2.2	7.6	15.2
	3	10.4	20.7
INJ-L-50A	4	13.8	27.6
	5.5	19.0	38.0
	7.5	25.9	51.8
INJ-L-75A	11	38.0	75.9
INJ-L-120A-ASS	15	51.8	103.5
INJ-L-220A-ASS	18.5	64	128
	22	76	152
	30	104	208

6.4. Single Phase Motors.

230V.

A single phase machine normally has only two wires going to it, and is for smaller machines with DOL starting.

Model	Power kW	Imot Arms 230V 1ph	Brake Adc DOL
INJ-L-11A	0.25	3.2	4.8
	0.37	3.5	5.2
	0.55	4.8	7.2
	0.75	6.2	9.3
INJ-L-25A	1.1	8.7	13
	1.5	11.8	17.7
INJ-L-50A	2.2	17.5	26.3
	3	20.0	30
	4	26	39

6.5. Options.

6.5.1 Standard.

The standard brake modules have an approximately 1s delay before the brake contactor is energised. The voltage then builds up gradually over a further ½ second. The delay and gradual application is most suitable for situations where the brake is applied every time the motor is stopped. Wear on the machinery and motor is kept to a minimum.

6.5.2 EMR.

Any brake unit can be factory configured as an EMR unit.

In some situations it is more important to stop the machine, than to save wear. A typical compromise is to employ stop/start buttons for normal duty where the machine freewheels to a stop. A third switch (in the form of a normally closed trip-switch) triggers the brake immediately.

The EMR type unit can be supplied as a complete assembly with normal duty stop/start buttons, and a normally closed trip switch input. An existing starter may be used, but the wiring is a little more involved.

6.5.3 Longer Brake Times.

Some machine / motor combinations just can't stop immediately, nor can they be stopped within 10s. To this end we can supply a brake with a longer application time. Units with maximum brake times of 30s have been supplied. The "next size up" module may be required depending on the braking current required. Also be aware that the brake current must not so high that it can damage the motor.

Please consult the factory.

6.5 Duty Considerations.

INJ-L(H)-25A.

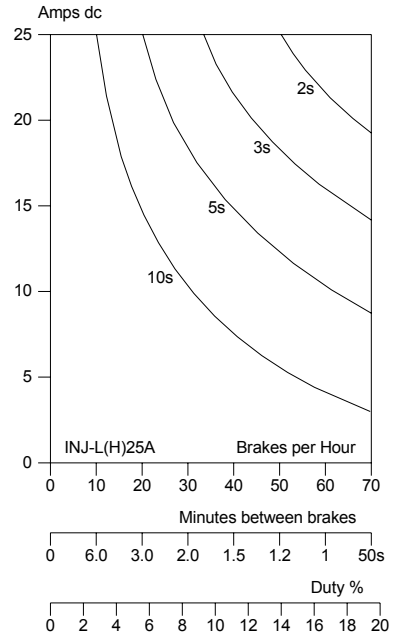
The chart right shows the duty rating of the 25A units INJ-H-25A and INJ-L-25A.

Operation of the unit at the maximum braking period of 10s is possible at any point to the left of the 10s curve.

For example a 15Amp 10s braking current can applied 20 times an hour.

Alternately the braking current can be increased to 25Amps, but only for 5s 20 times an hour.

The unit will tolerate four consecutive 10s 25Amp brake cycles, but must be allowed to cool for ½ hour before the cycles may be repeated.

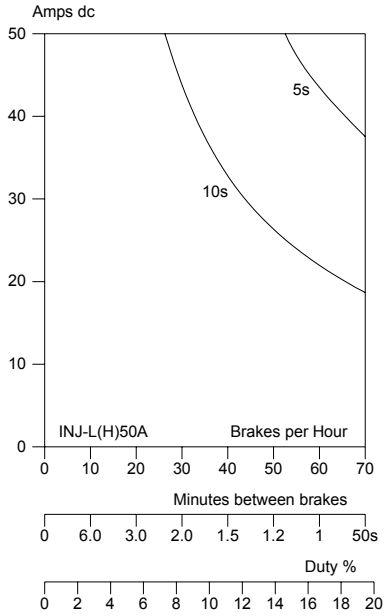


INJ-L(H)-50A.

The chart right shows the duty rating of the 50A units INJ-H-50A and INJ-L-50A. The external heatsink considerably extends the operating range so that current or brake time reduction is required only above 55 stops per hour.

INJ-L(H)-75(120, 220)A ASS.

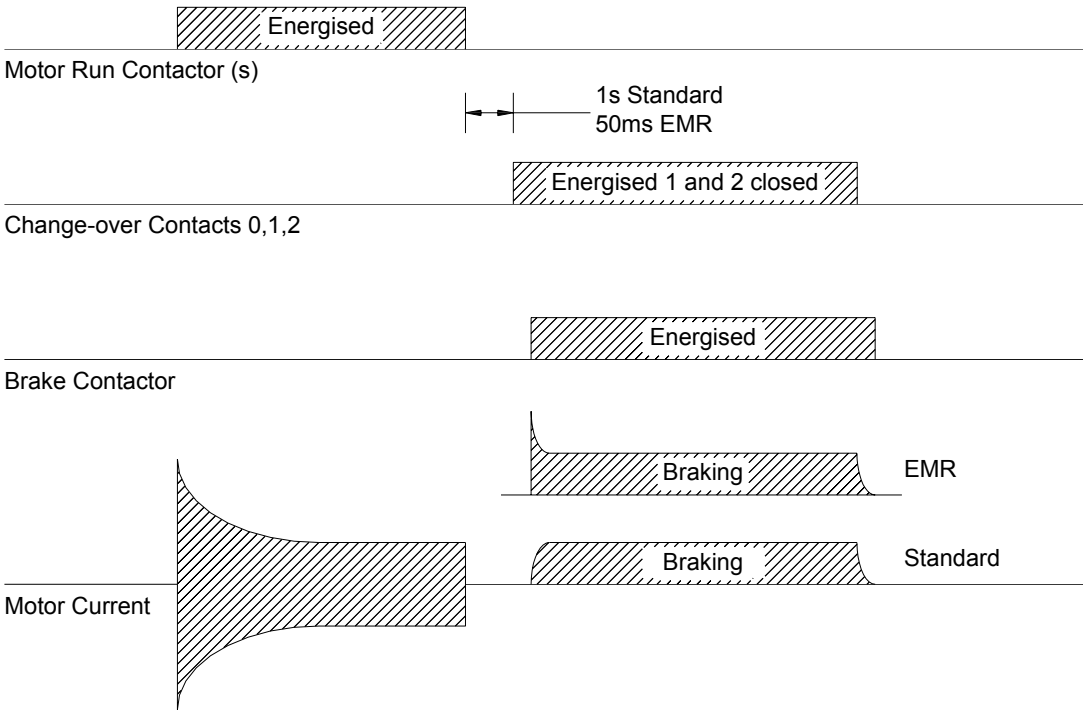
The high current assemblies have substantial heatsinks and the duty cycle is limited to 50% at 10s and rated current. The rating is equivalent to three stops per minute continuously.



7. Timing Diagram

The following diagram needs little explanation. The time between the application of the brake contactor and the release of the run contactor is governed by the brake relay, and is of the order of 1s. Current is applied 200ms after the brake contactor is energised, and removed 200ms before the brake contactor is released. The brake contactor does not have to break the current, and is conservatively rated at a thermal rating of the braking current.

For the EMR option, the brake is applied 50ms after the main contactor is released, and current build up is instantaneous. Depending on the characteristics of the motor, there will be an initial pulse of current. Where the motor stops with a jolt, the initial pulse can be as high as the starting current pulse.



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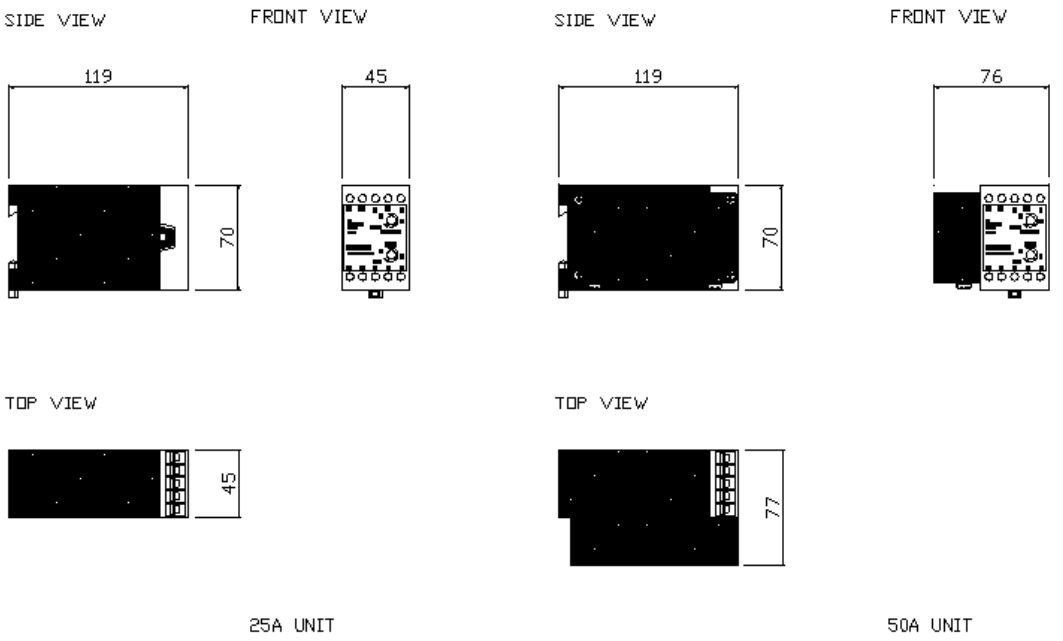
8. Physical Dimensions,

Mount units with heatsink fins running vertically.



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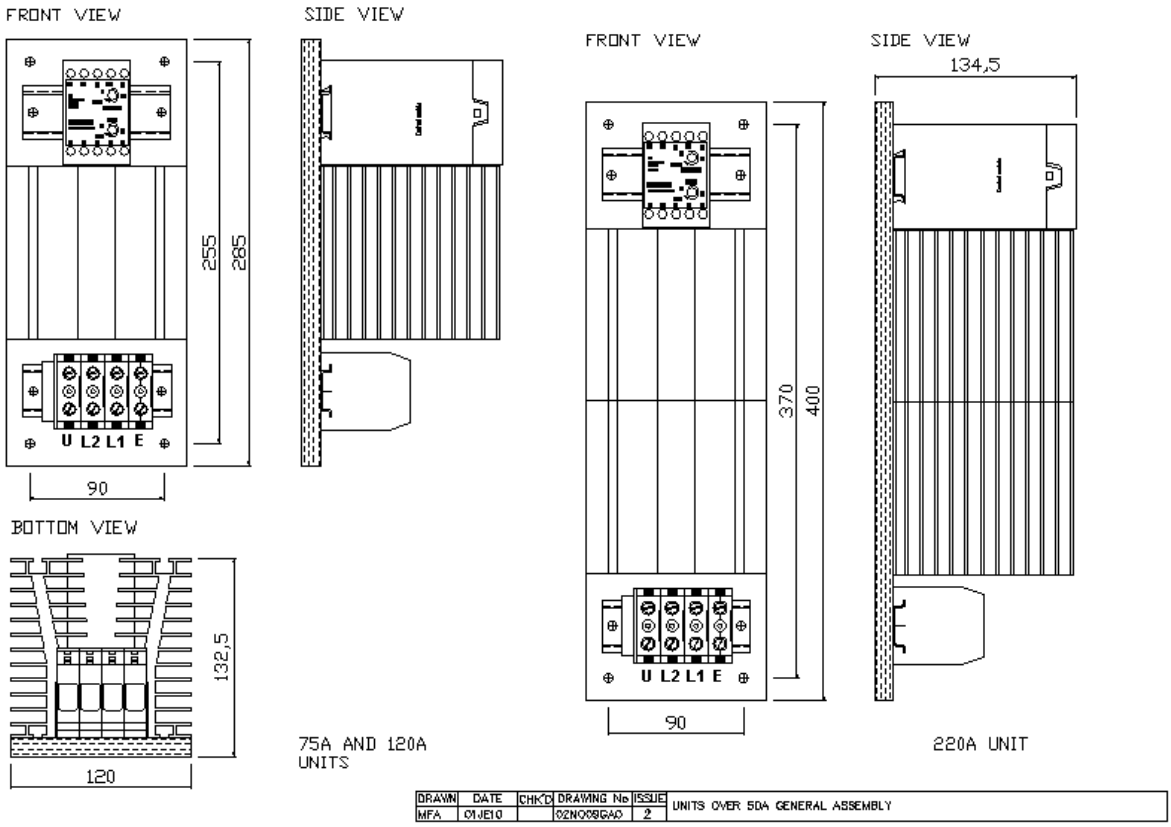

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