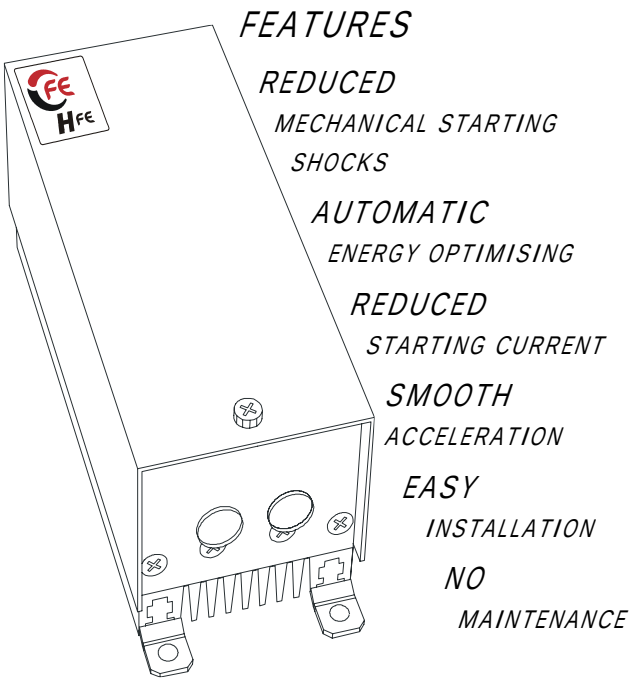
HFE
Guide to soft starting single phase AC motors



The HFE Single Phase Optimising Soft Starters can be applied beneficially to single phase AC motors operating any type of machine. Mechanical and electrical stresses are reduced or eliminated and input energy is optimised for the output power.

At start-up, the Soft Starter applies a reduced voltage to the motor terminals, reducing the inrush current and minimising shock loading. Gradually the soft starter raises the voltage resulting in a smooth acceleration to full speed.

The soft starter remains permanently in circuit after the starting ramp is complete. At full speed the controller continually adjusts the motor input energy to match the required mechanical output.

An important new feature of the module is the addition of automatic Energy Optimising based on the well-known Fairford System Patent.

With optimising selected the controller will continuously adjust the motor terminal voltage so that the input energy corresponds to the mechanical output required. This reduces wasted power, improves motor power factor, improves efficiency and reduces motor heating. The effect is particularly beneficial in those applications which run at varying loads for extended periods of time such as refrigeration, air compressors etc. This method is quite different from other systems which insert a fixed delay in the power wave under all load conditions, and which sometimes leads to burned-out motors.

Refrigeration systems which employ hermetic or semi-hermetic compressors enjoy an additional benefit from the reduction in motor heating. Because the motor runs colder, the cooling medium - in this case the refrigerant gas, does not become as hot after it has passed over the motor windings enabling the compressor to run for shorter periods, giving additional savings.

These benefits can be significant in such applications as beer coolers, supermarket refrigerated display cabinets, chillers, bakery oven fans, conveyors etc.

On the control side, the HFE can be used as an electronic contactor where a high switching frequency would normally result in a high wear rate for electro-mechanical devices. Switching the controller on and off is achieved simply with low current contacts.

APPLICATION

HFE optimising soft starters are designed to control single phase capacitor-start motors. The soft starter is normally inserted into the circuit between the motor and whatever switchgear is normally used for isolation or switching. The unit can also be fitted before switchgear so that it can be installed in the supply to equipment which has it's own mechanical control. This feature allows for easy installation on equipment such as refrigeration where the need to disturb internal wiring is avoided.

Operating Cycle

Operation of the HFE is automatic and under the control of a microprocessor. It applies a low starting voltage to the motor as soon as the supply is switched on by the conventional control switchgear. The internal automatic ramp control immediately takes over and raises the voltage progressively, causing the motor to accelerate smoothly from standstill.

At the end of the ramp period, the motor is operating in either optimising mode or if the optimising is linked out, at full line voltage. The HFE remains in circuit. When the circuit is interrupted, as for instance by the line contactor or by a downstream control device such as a thermostat, the HFE automatically resets and is ready for the next start which is initiated by re-connection.

Accelerating Ramp

Ramp times are approximately in the range of ½ to 5 seconds. The duration is adjusted by use of the ramp time potentiometer V1.

Increasing the ramp time reduces the current drawn during starting: however, it is important to ensure that the ramp time is not set too long otherwise the motor may labour unnecessarily rather than give a good linear start.

Extra starting torque may be needed for loads which have a particularly 'sticky' starting characteristic. Additional torque can be achieved by rearranging the internal connection of the starting capacitor, bringing the connection out and to the supply side of the starter as in fig 1.

Optimising function

This feature can be selected or overridden by link 'J1' alongside the Ramp Time control on the PCB (see fig 4). When selected (link in place), the optimising continuously regulates the motor terminal voltage to a level which produces the correct magnetic flux for the mechanical load demanded. In this way the energy consumption at light loads is reduced. As a consequence, motor winding and case temperatures are lower, motor life is longer, noise levels lower, power factor improved kW hour and demand levels lowered.

A useful by product of the optimising feature is an automatic sustained overvoltage limiting action.

There are two forms of optimising selectable by link 'J4' - normal mode (no link) and refrigeration mode (link in place). In the normal mode, the optimising response is designed to cope with rapidly fluctuating loads which can occur such as when a braking load is present. On the other hand, when in refrigeration mode, the HFE will make use of the relatively slow rate of load changes to extract the maximum saving in energy input. The degree of energy optimising achieved is indicated by the rate at which the green led blinks. At full voltage (zero savings) the blink rate is fast, as the optimising increases the blink rate slows down.

Safety at Work

It is the responsibility of the owner, installer and user to ensure that the installation of the equipment and the way in which it is operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation, regulations and codes of practice in the UK or elsewhere

Only qualified personnel should install this equipment, after first reading and understanding the information in this publication. The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment.

Operational Safety

The system may be configured to allow for auto restart controlled from contacts on the motor side of the unit. Users and operators must always take all necessary precautions to prevent damage to equipment and especially to prevent the risk of injury to personnel working on or near the motor and driven equipment.

The manufacturer does not assume any liability, express or implied, for any consequences resulting from inappropriate, negligent or incorrect installation, application, use or adjustment of the product or circuit design, or from mismatching of a soft starter to a motor.

The manufacturer conveys neither any licence under his patent rights nor the rights of others.

The contents of this publication are believed to be correct at the time of printing. In the interests of a commitment to continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of this publication without notice.

INSTALLATION

attention

The voltages present in every HFE unit are capable of causing severe injury and may be lethal. Installation should be undertaken by, or under the direct personal supervision of a competent and suitably qualified person only.

Isolate the supply before making connections or adjustments.

Location

The module should be fixed to a vertical surface. Because the HFE relies on air convection for cooling the heatsink any adjacent equipment should be mounted where it will not obstruct free air movement above and below the module. The minimum clearance above and below the HFE module is 40 mm.

Terminations

The terminations are made with industry standard 1/4" Faston connectors directly onto the circuit board. The incoming power supply is connected to the terminals marked 'L1' and 'L2'. For EMC compliance it is important that the line circuit is connected to L1 and the neutral circuit to L2. Outgoing connections from the HFE are taken from the terminals marked 'M1' and 'M2' to the motor or load input terminals (see fig 1). Ensure that an efficient connection is made to the earth terminals provided.

Fuses or other type of short-circuit protection are required for protection against a cable or motor terminal box fault. These must be fitted externally and on the supply side of the unit. See “Specifications” section for recommended fuse type and cut-out device.

Where EN55011 Class B emission levels for Electromagnetic Compatibility are required, the connections for control contact operation of the HFE as described in Fig 2. below are not suitable.

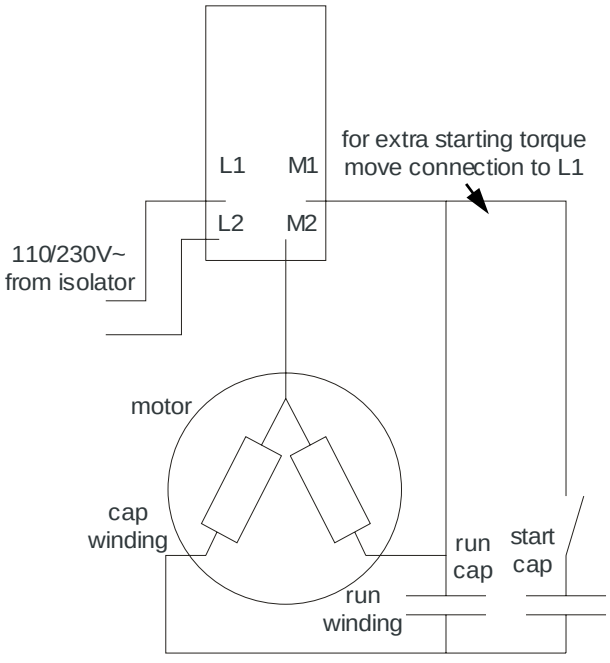


Fig 1 Typical connection for the HFE.

Additional starting torque can be achieved by rearranging the internal connection of the starting capacitor, bringing the connection out and to the supply side of the starter as shown.

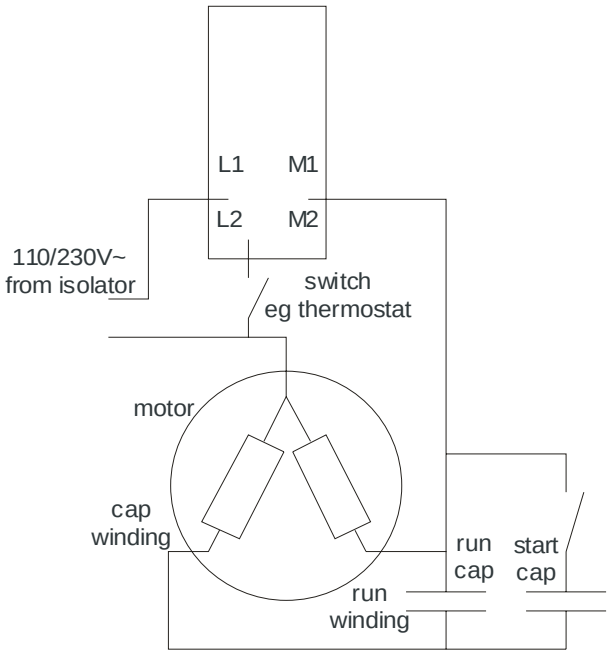
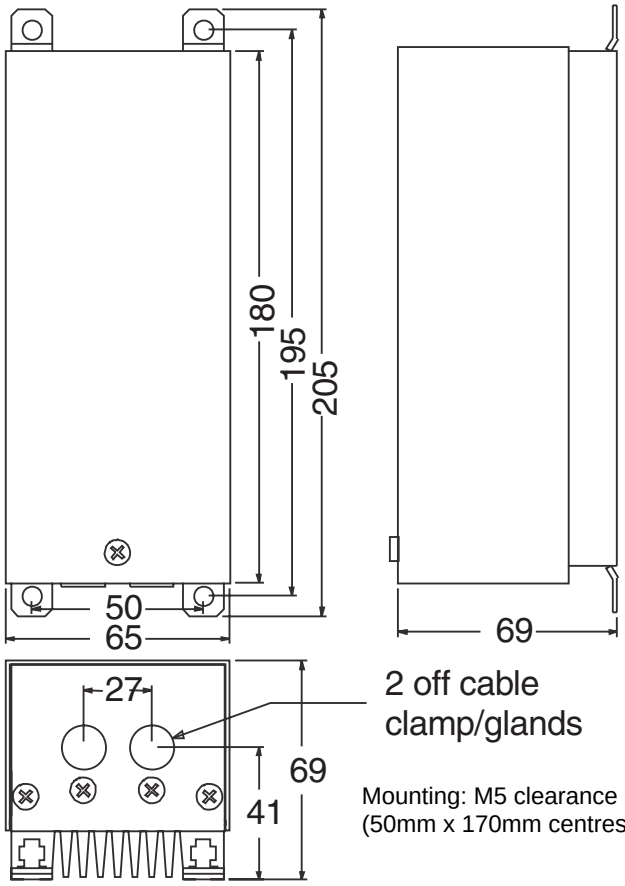
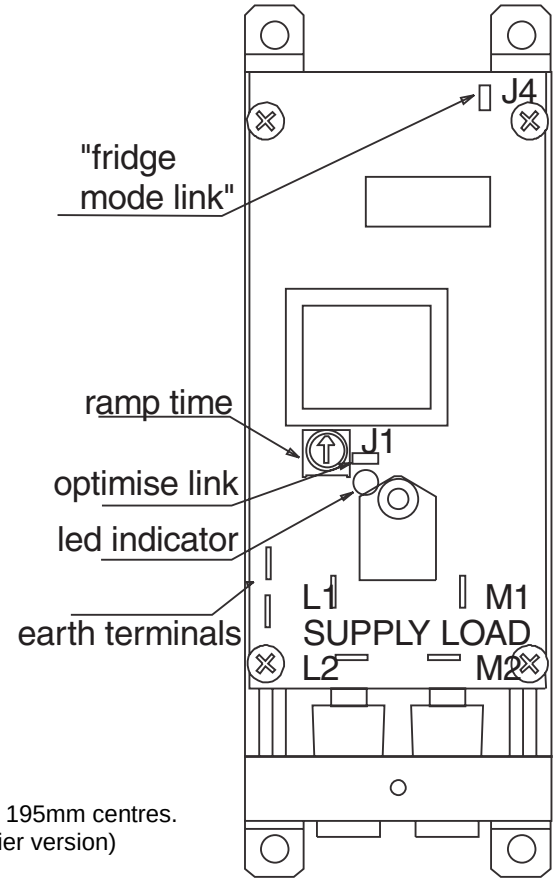


Fig 2 Control contact operation of the HFE.

This configuration will use the HFE as a “Solid State Contactor” thereby reducing the current being switched by the control contacts down to a minimum. The control element can alternatively be situated on the output side of terminal M1. This will reduce the switch on-current but the contacts will still need to be fully rated for the breaking current.

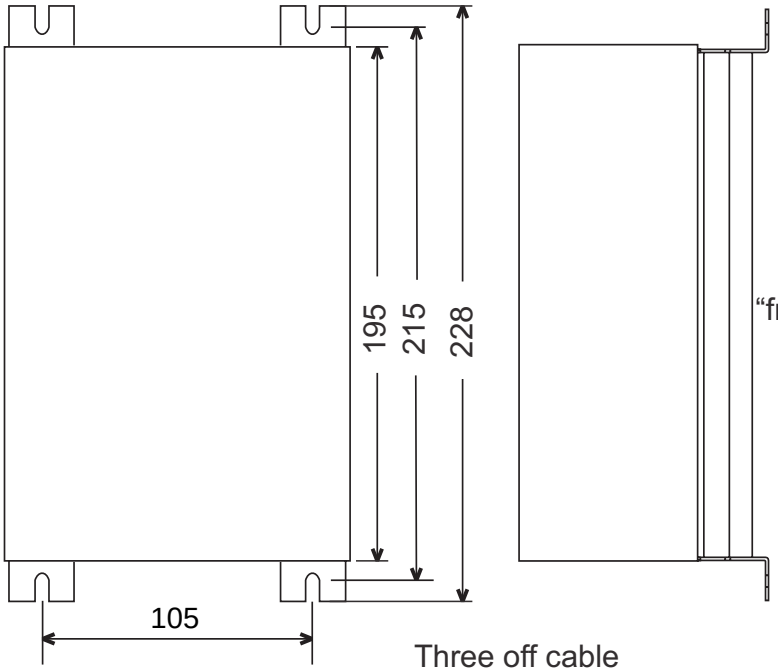
Mechanical Details HFE 17

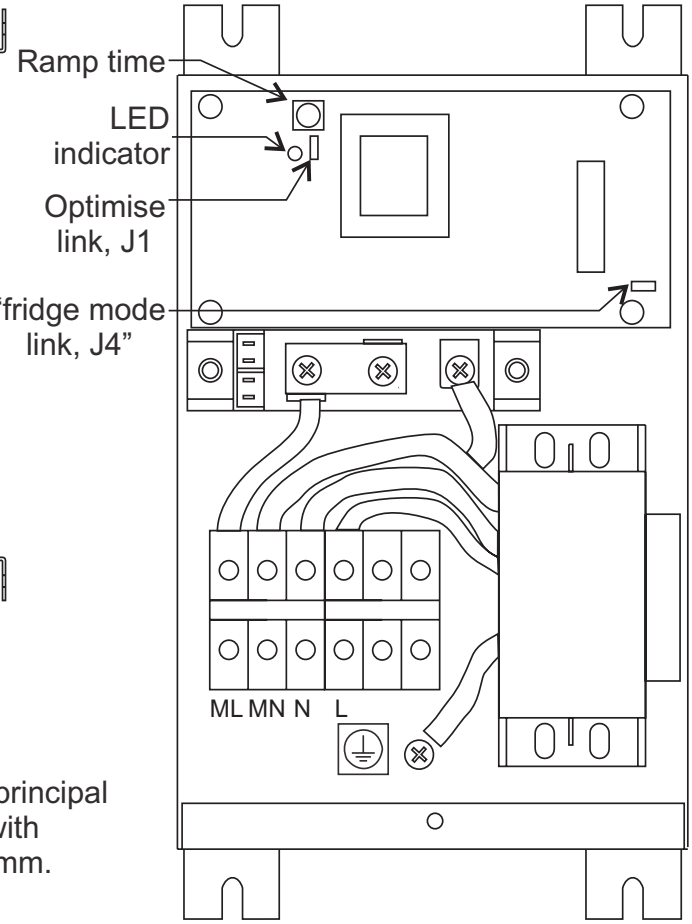




Mounting: M5 clearance 50mm x 195mm centres.
(50mm x 170mm centres for earlier version)

Mechanical Details HFE 30





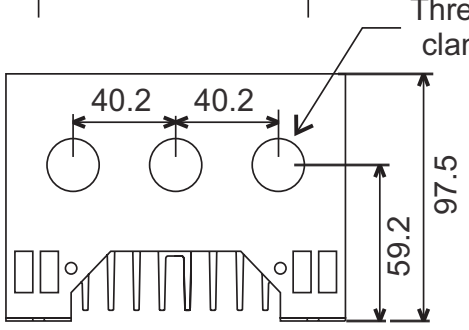


Fig 4. Location of principal components with dimensions in mm.

Mounting: M5 clearance 105mm x 215mm centres.

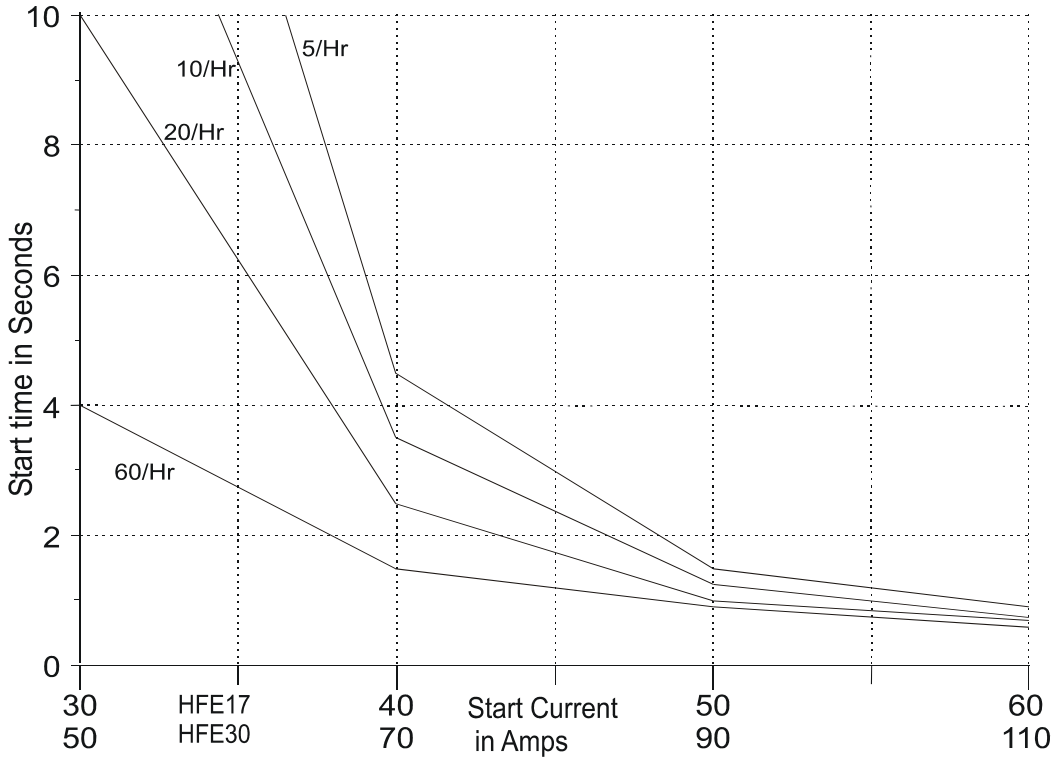
COMMISSIONING Set the ramp time potentiometer to midway (pointer vertical, see fig 4) to give a ramp of about 2 seconds and start the system. If the motor turns instantly when the soft starter is energised and accelerates satisfactorily then no further adjustment is required.

If the rate of acceleration is too great stop the unit and turn the ramp time potentiometer clockwise (maximum ramp is 5 Seconds) then restart. Adjust anti-clockwise for a shorter ramp time setting to increase the rate of acceleration.

The motor should, and normally will, turn instantly when the soft starter is energised. If it does not, rearrange the connection of the starting capacitor as shown in fig 1 .Max starting duty is shown in fig 3.

HFE 17 – For running currents up to and including 13 Amps the unit is rated for continuous duty. For currents between 13 Amps & 17 Amps. the maximum duty cycle should not exceed 60%. **Start currents must not exceed 60A.**

Fig.3 Start current vs start time / frequency chart.



SPECIFICATIONS

Design standards:	**IEC 60947-4-2, EN 60947-4-2:** "AC Semiconductor Motor Controllers and Starters".
Rated Operational Voltage, Ue:	110 to 230V ac (-15% +10%), 50/60Hz No adjustment needed.
Rated Operational Current, Ie:	HFE 17 – 17A with a 60% duty cycle or 13A continuous (see Fig 3). HFE 30 – 30A continuous (see Fig 3).
Rating Index (see Fig 3):	HFE 17 – 17A : AC-53a : 2-3 : 60-60 or 13A : AC-53a : 3-2 : 99-60 HFE 30 – 30A : AC-53a : 3-3 : 99-60
Recommended cut-out device:	HFE 17 – 13A rated MCB, Trip Characteristic "C". HFE 30 – 32A rated MCB, Trip Characteristic "C".
Form Designation:	Form 1.
Rated insulation voltage, Ui:	300V, Rated impulse withstand voltage, Uimp: 4kV (1.2/50µs).
Ingress Protection	IP30 with standard cover.
Rated short circuit current , Iq:	5kA when protected by recommended Fuse. Type of short circuit co-ordination: Type 1.
Recommended Fuse Type:	HFE 17 – 50A Semiconductor Type; Bussmann 170M3109 or Ferraz 6,6 URD 30 D08A 0050. HFE 30 – 125A Semiconductor Type; Bussmann 170M3113 or Ferraz 6,6 URD 30 D08A 0125.
Ambient Temperature	0°C to 40°C without derating.
Pedestal Voltage:	Fixed at approx. 15%.
Start Ramp Time:	Continuously variable from approx. ½S to 5S.
Terminations:	HFE 17 – Standard ¼" "Faston" connectors. HFE 30 – Terminal blocks to suit wire from 2.5mm^2 to 25mm^2 (12 to 4 awg).
Unit weight:	HFE17 – Approx. 600g, HFE30 – Approx. 2.5 Kg.

EMC immunity: Severity Level 3,

IEC 61000-4-2	6kV contact, 8kV air.
IEC 61000-4-3	10V/m over 80-1000MHz
IEC 61000-4-4	2kV/5kHz
IEC 61000-4-5	2kV line-to-ground 1kV line-to-line
IEC 61000-4-6	140dBµV over 0.15-80MHz

EMC emission: Class B (Commercial or Light Industrial), EN 55011

Fairford Electronics Limited, Coombe Works, Derby Road, Kingsbridge, Devon TQ7 1JL, United Kingdom

TEL: + 44 (0) 1548 857494 FAX: + 44 (0) 1548 853118 EMAIL: sales@fairford.co.uk WEB: www.fairford.co.uk

Registered No.: 1559267 England VAT No.: GB 367 2844 24

 Publication No FD194506, **M-1945-F**