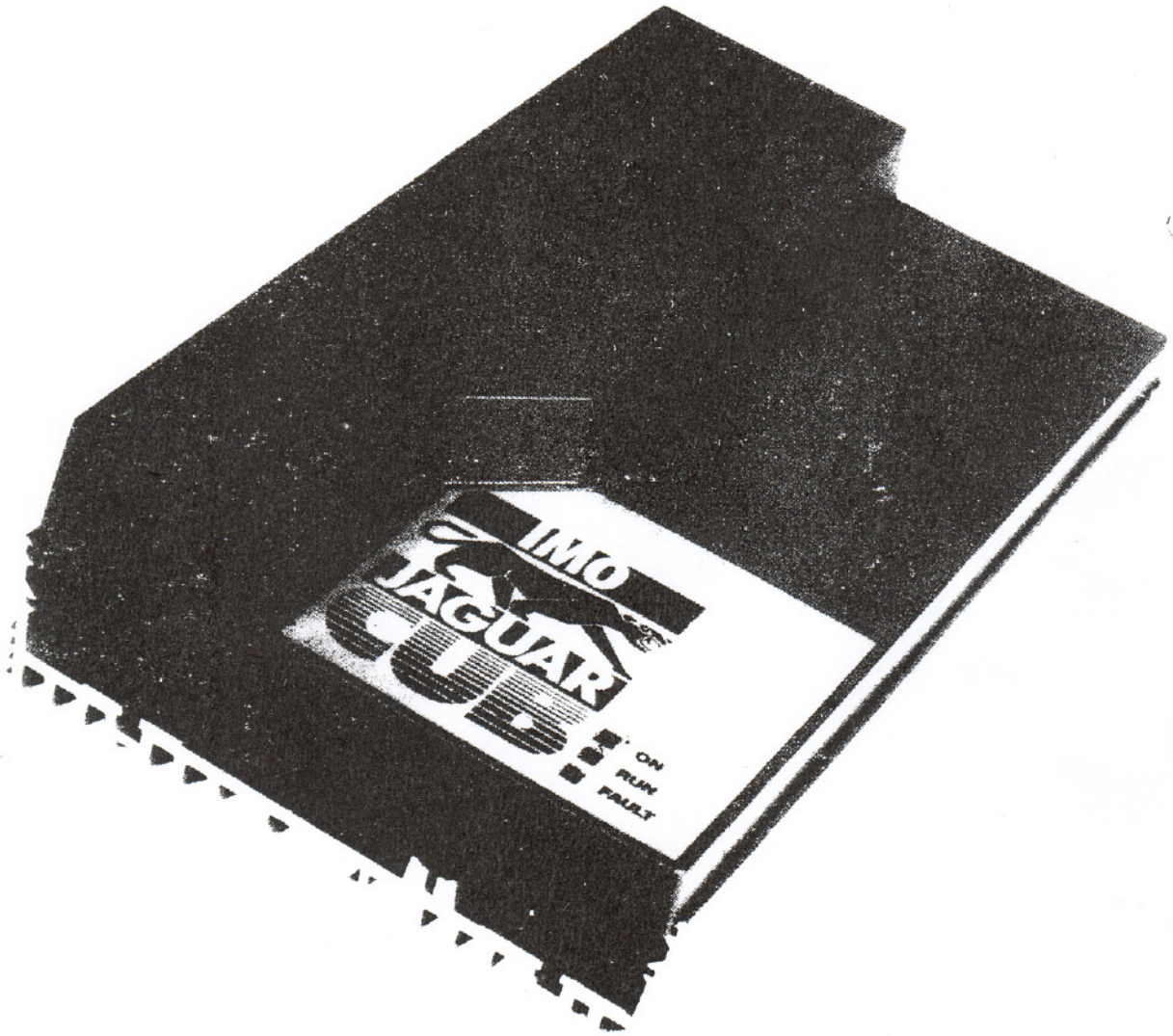
INSTRUCTION MANUAL



IMO JAGUAR CUB

AC VARIABLE SPEED DRIVE
0.37—1.5kW

Please read these instructions before installation and use. Failure to do so may result in damage not covered by warranty. If in doubt contact your supplier.

1. General

1.1 DESCRIPTION

The Inverter is suitable for speed control of standard 3 phase induction motors, wired for a 220/240 volt supply. It is capable of providing a maximum output power of either 0.75kW (4 amps). A single phase 2 wire line supply of 220/240V nominal. 50/60Hz is utilised. A simple selector link allows direct Inverter matching with: 0.37, 0.55, 0.75 kW motors (VC75); 0.55, 0.75, 1.1, 1.5 kW motors (VC150). Power bi-polar. MOS devices and hybrid drives are combined to provide an extremely efficient output section. The final power stages are encapsulated in a 'power block' which is plug replaceable. A block diagram of the Inverter is shown in fig. 1.

The output waveform is a high quality sine-wave, generated by a custom pulse-width-modulation integrated circuit. The inverter's control inputs and outputs are galvanically isolated from power circuits to allow easy system interconnection. Inverter motor connections are both phase-to-phase and phase to earth short-circuit protected.

The Inverter works over an output frequency range of 2-100Hz with a constant V/Hz ratio between 2-48Hz, suitable for constant torque applications, and a reducing V/Hz ratio between 48-100Hz giving an approximate constant HP characteristic. A selector link allows modification of the V/Hz characteristic to allow efficient operation of fans and centrifugal pumps.

Constructional protection is IP00 — chassis mounting. Speed reference input is suitable for a 10K linear potentiometer or a 0 to +10 volt level, +10 volts representing maximum motor speed.

A second link allows selection of an Auto-start condition, where the motor is energised at power up, or, a manual start mode giving in effect 'NO-VOLT' release action with push button/volt-free contact input to reset the Inverter before the run condition is achieved. A third link gives automatic V/Hz correction for 60Hz motors. For high stop-start duty applications an electronic stop-run input is provided.

Outputs are provided for motor frequency (x30) Hz and acceleration ramp (0 to +10 volts) allowing analysis of Inverter condition and multi-inverter slaving control.

A change-over relay, with volt-free contacts gives indication of a power-off or trip condition. Trip protection is also provided for over-voltage, undervoltage and over-current conditions with clearing fuses being fitted for Inverter DC link and control electronic supplies. The inverter is protected against damage from phase to phase and phase to earth short circuits.

Inverter selection links should only be adjusted when the supply has been disconnected and the internal DC link has discharged to a safe level, this takes approximately 10 minutes.

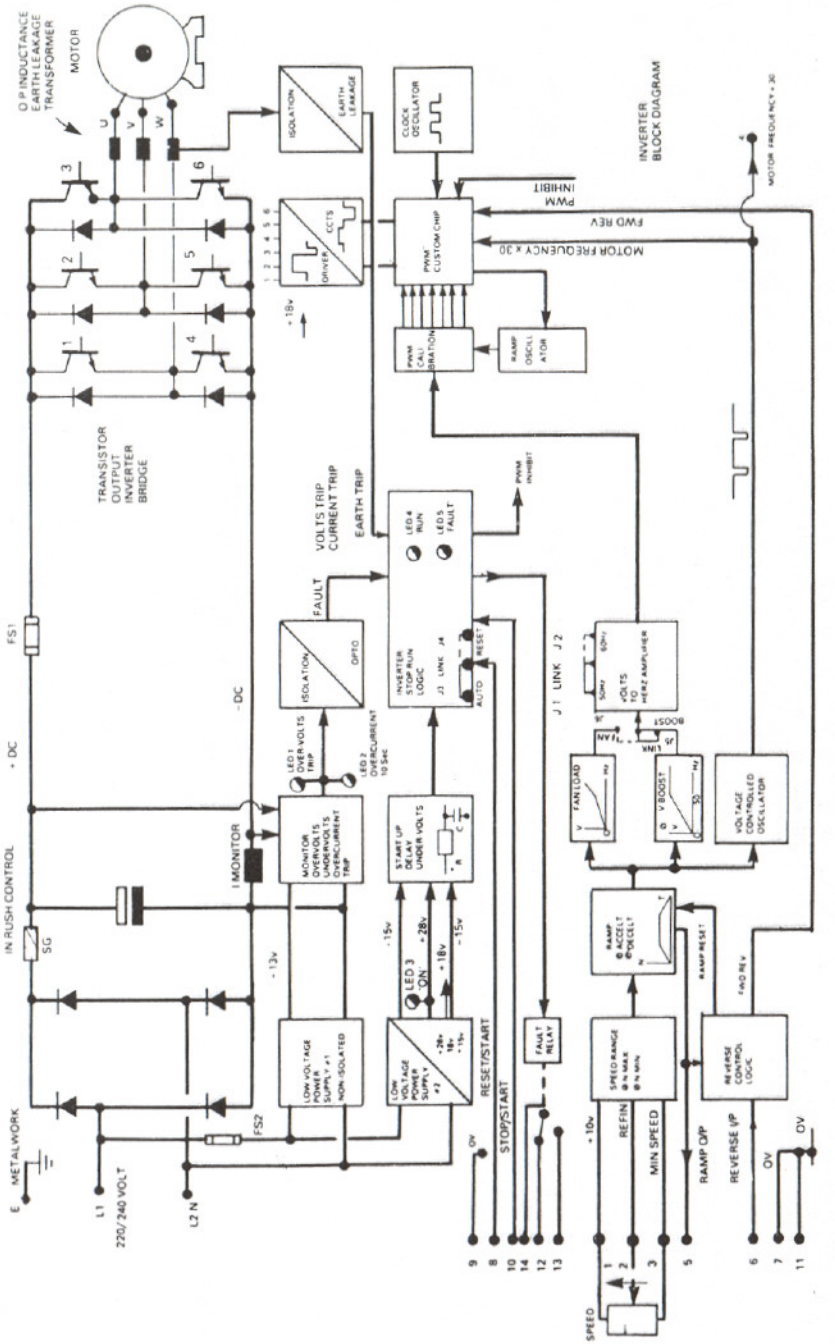


Fig. 1 Inverter Block Diagram

1.2 SPECIFICATION

	0.75 kW Inverter				
O/P Amps (cont)	2	3	4	5	7
kW — typical	.37	.55	.75	1.1	1.5
I/P Line Current (amps r.m.s.)	3.5	5	7	9	13
I/P Power factor (lag)	.95	.95	.95	.95	.95
Heat loss — watts (approx.)	25	30	42	65	100
	1.5 kW Inverter				

Fig 2

Supply	1 phase, 2 wire, 220/240 volts +/−6%, 50/60 Hz
Overload	150% x FLC for 1 minute. Trip at 2.5 x FLC approx. (peak)
Start-up Delay	300 millisecs — approx.
Frequency Range	2-100Hz +/− 5%, (2-120Hz for 60Hz motors)
Temp Range	−10 to +40°C. Derate 1.5%/°C from 40°C-60°C max.
Humidity	95% RH at 40°C, Non Condensing
Altitude	Above 1000 metres derate by 1%/100 metres
Protection	IP00-Chassis mounting, DC link fuse. Control supply fuse
Control Method	PWM sine-wave 2-48Hz, merging Quasi-square 48-100Hz
Adjustments	Max. speed, min. speed, torque boost, accel. time, decel. time
Diagnostics	LED Indication of Power on, run, fault, overvolts and over current − 10 sec. Neon Indication of residual (≥ 100V) DC link volts.
Cover	Flame retardant material. Injection moulding.

1.3 CONTROL INPUT & OUTPUTS

Terminal 1	+10 volt reference — primarily intended to supply speed-ref 10K potentiometer. Isolated. 5mA source.
Terminal 2	Speed reference input, isolated filtered input, impedance 100K ohms approx.
Terminal 3	Speed reference potentiometer 'slow end' connection, inputs via internal Nmin pot (RV2) to common 0 volt rail. Isolated.
Terminal 4	Motor frequency Output. Isolated, ramping, digital clock at C.MOS level 0 to +15 volts @ .5mA. Runs at 30 times actual motor frequency. 10 micro-second pulse.
Terminal 5	Ramp Output. Isolated 0 to +10 volt linearily ramping signal representing set motor speed and rate of accel/decel ramp. 10 volts at maximum speed. Output impedance 10K ohms.
Terminal 6	Direction Input, isolated input for push button or Logic control, 0 to +15 volts @ 5mA with respect to common zero volt rail. Filtered input with 50K ohm — approx. impedance.
Terminal 7, 9, 11	Common Zero volt connections, Isolated, may be earthed if required.

Terminal 8	Start/Reset Input. Isolated. Activated by logic input, +15 volts to zero volts @ 5 mA, or push button with respect to common zero volts. Input impedance 50Kohm. Input serves as a start input when the inverter is in the 'reset to start' mode, i.e. no-volt release. The input also serves to reset any trip condition to allow re-run. Terminal 8 is normally open, connecting it momentarily — 1 millisecond minimum — to common zero volts, activates the Inverter. Start-up delay is 300 milli secs. approx.
Terminal 10	Run/Stop Input. Isolated input, activated by logic input, +15V to OV @5mA or push button — close to run, both with respect to common zero volts. Input impedance 50K ohm, approx. Opening the input causes the motor to freewheel to standstill. Start-up delay is approx. 300 millsecs.
Termina. 12,13 & 14	Fault status relay. Volt-free change-over contacts rated 240V AC at 3 amps. Terminals 12 & 14 are normally closed at power-off and trip conditions. 13 & 12 are closed when the drive is healthy.

1.4 ADJUSTMENTS

RV1. Low Frequency Boost - Vmin. Increases the V/Hz ratio at lower motor frequencies (speed) to maintain a constant torque characteristic. Clockwise rotation increases the boost level. Boost only available in constant torque mode.

RV2. Minimum Speed — Nmin. Sets the minimum motor frequency up to a level of 30% of frequency set by Nmax. Clockwise rotation increases the minimum speed.

RV3. — Ramp Up — Controls the linear rate of rise of O/P frequency/speed. Range 0.1 secs to 60 secs. approx. Anti-clockwise rotation increases the ramp time.

RV4. —Ramp Down — Controls the linear rate of fall of O/P frequency/speed. Range 0.1 secs to 60 secs. approx. Anti-clockwise rotation increases the ramp time.

RV5. Max frequency — Nmax. Controls the maximum available O/P frequency between 40-100 Hz. Clockwise rotation increases the O/P frequency.

LINK ADJUSTMENT — SWITCH OFF SUPPLY BEFORE ADJUSTMENT
Allows selection of continuous Inverter output current — 2, 3 & 4 amps on the VC75 and 3, 4, 5 & 7 amps on the VC150, — see fig 2.

AUTO-RESET START LINKS J3/J4.
Determines the start mode of the Inverter. In the 'auto' position, J3, the drive will start approx. 300 millisecs, after connecting the line supply — terminals 10 & 11 being closed. The 'reset' setting, J4, requires a momentary closed contact on terminals 8 & 9 to obtain the run condition.

CONSTANT TORQUE/FAN LOAD — LINKS J5/J6.
J5 gives a constant V/Hz ratio with adjustable volts-boost available for constant torque loads. Alternatively it may be set for a modified V/Hz characteristic, J6, suitable for low starting torque requirement such as fans and centrifugal pumps.

V/Hz RATIO — LINK J1/J2. Allows instant correction of the Inverters V/Hz ratio. For use with 60Hz motors, select J2.

1.5 **DIAGNOSTICS**

L.E.D. indication of

ON	— LED 3
RUN	— LED 4
FAULT	— LED 5
OVERVOLTAGE	— LED 1
OVERCURRENT	— LED 2

NEON indication of residual DC link supply, extinguishes at 100V approx.
STATUS RELAY with c/over contacts.

1.6 **MOTOR RATING**

When the speed of a standard induction motor is reduced the speed of the cooling fan is also reduced and with it the amount of air necessary to ensure effective motor cooling. In addition because the inverter output voltage is not exactly sinusoidal the motor losses are also slightly increased. This increase in motor losses means that the motor cannot be continuously run at full load. Fig. 3 shows typical continuous torques available when using a standard induction motor. To protect the motor at low speeds it should be equipped with thermal relays which can be arranged to inhibit the Inverter by opening stop/run terminals 10 & 11.

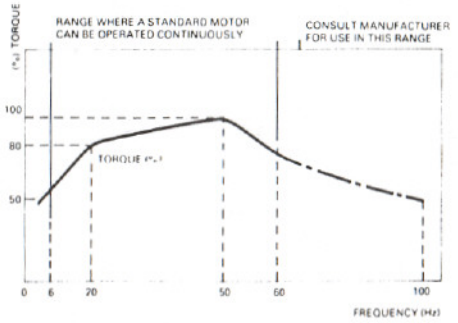


Fig 3 Motor Rating

It is possible to use a motor of larger frame size than the rating of the inverter, however, it is important to check that the inverters current rating is not exceeded. Also due to the lower inductance of larger motors there is an increase in the ripple current and hence a de-rating may be necessary. As a general rule if the next frame size larger than the rated motor is used then a de-rating on inverter output current of 0.9 x nominal rating should be used.
For more precise information on motor ratings please consult factory.

2. Installation

2.1 **ELECTRICAL**

WARNING — When connected, power circuitry of the Inverter is LIVE, in particular the DC link supply works at 350 DC and its charge takes approx. 10 minutes to leak away. The NEON indicator monitors the condition of the DC link supply, extinguishing at 100 V approx.

STOPPING AND STARTING

For up to 10 starts (max) per hour the Inverter may be controlled by switching the unit ON & OFF by a line supply contactor only. For up to 10 starts (max) per minute the electronic RUN/STOP input on terminals 10 & 11 should be utilised. In either case the motor will freewheel to a standstill and ramp up to set speed following a 300 millisec. (approx.) start delay.

INPUT FUSING

The Inverter is not fitted with incoming supply power fuses or a circuit breaker, consequently the supply must be adequately protected. See fig. 4. If you are utilising a Line & Neutral supply do not fuse the neutral!

O P Amp Setting (cont.)	Motor kW	I P Current (A.r.m.s.)	O P Cable mm²	I P Cable mm²	Input Fuse CB Amps	Control Wiring mm²	Volt rating (mm)
2	.37	3.5	1	1	6	75	240
3	.55	5	1	1	10	75	240
4	.75	7	1	1	10	75	240
5	1.1	9	1	1.5	15	75	240
7	1.5	13	1	2.5	15	75	240

Fig. 4 Cabling & Fusing

CABLING

The single phase input current is higher than outgoing three phase current with the consequent need for higher capacity cabling. See fig. 4. Control signal cabling should be screened with respect to earth at the Inverter end only.

SUPPRESSION

All contactors, solenoids and motor brakes should be suppressed with an R.C. network.

MOTOR CHOKES

Occasionally motor-line chokes are recommended to prevent nuisance over-current tripping where installed cable lengths create significant capacitive coupling to earth. Fig. 5 shows choke requirements. Mineral-filled cable may require use of chokes with shorter installations.

Cable length in metres, showing choke value in milli-henries and amps.											
10	20	30	40	50	60	70	80	90	100	Amps	Inverter
1	1	1	2	2	2	2	2	2	2	9	1.5 kW
										5	0.75 kW

Fig 5 Motor Choke Requirement

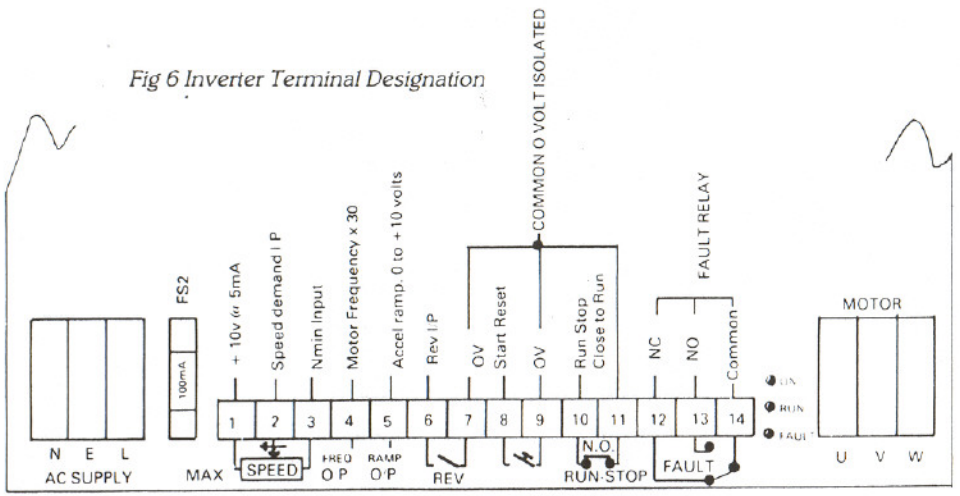
MOTOR

Ensure that the motor is linked correctly in its terminal box to give a winding voltage compatible with the Inverter O/P i.e. 220/240 volts at 50Hz, this is normally the Delta connection for motors in this kW rating. Leaving the motor connected for a higher voltage will allow the motor to run although available shaft torque will be low.

2.2 ELECTRONIC

Fig. 6 shows the general connection detail with fig. 7 representing a typical installation. Section 1.3 gives detailed information on control inputs/output.

Fig 6 Inverter Terminal Designation



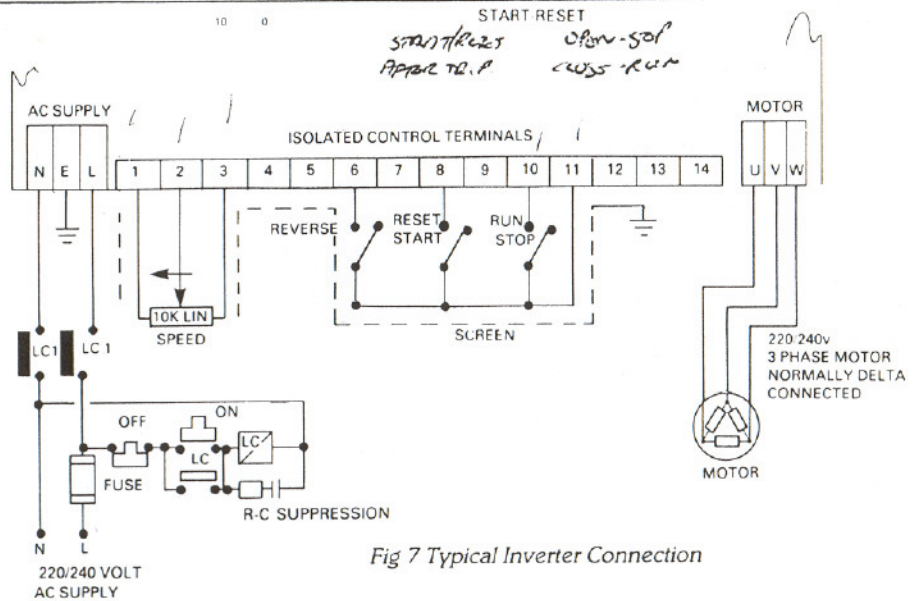


Fig 7 Typical Inverter Connection

Typical Inverter connection is shown in Fig. 7. Signal cabling should have an outer screen earthed at the Inverter end only. When using a potentiometer to control the motor speed a value of 10Kohm 1 Watt linear is recommended.

2.3 MECHANICAL

The Inverter is constructed to IP00 standard and consequently is intended for mounting inside a protected control panel.

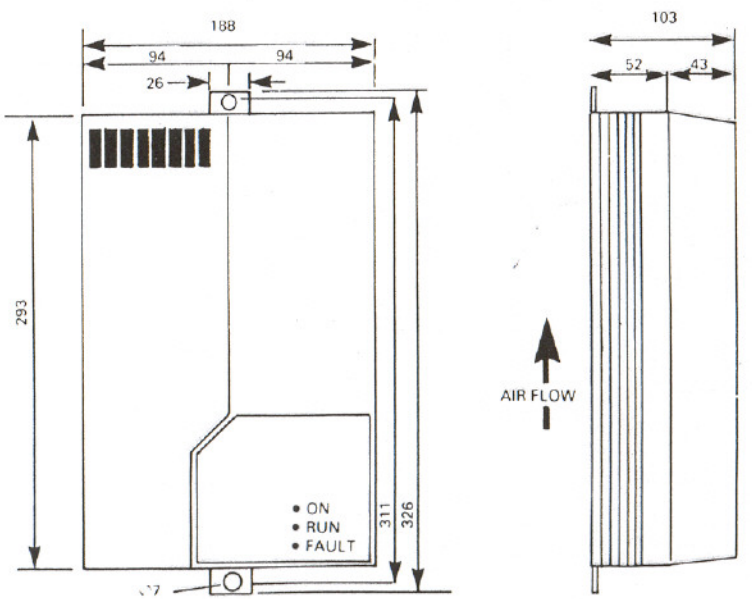
Mounting detail, showing the overall dimensions and mounting bracket fixing centres are shown in fig. 8. It is important to ensure that the unit is mounted vertically for correct air-flow through the heatsink. The plastic cover fitted to the unit is simply removed by applying sensible sideways pressure to the left hand side and pulling outwards.

Check the following before commissioning:

a) Unit is mounted vertically
b) Installation is free from dust, corrosive gas and grinding fluids.
c) Installation is vibration free
d) Ambient temperature will not exceed −10 to + 40°C
e) That there is at least 100mm clear space above and below the unit.

When mounting in an enclosure it is important to ensure that the watts loss, dissipated by the Inverter, does not create an excessive ambient temperature. Sec. 1.2 gives detail. It should be noted that the heatsink temperature may run at temperatures up to 100°C approx. and contact should be avoided with anything that might be sensitive.

Fig 8 Inverter Dimensions & Mounting detail



Dimensions in mm

3. Starting & Adjusting

3.1 CONTROL SELECTOR LINKS

Refer to fig. 9.

WARNING — Sections of the Inverter circuitry **are not isolated** from the AC supply and are therefore LIVE. Ensure that the unit is completely disconnected and DC link discharged before re-selecting control links.

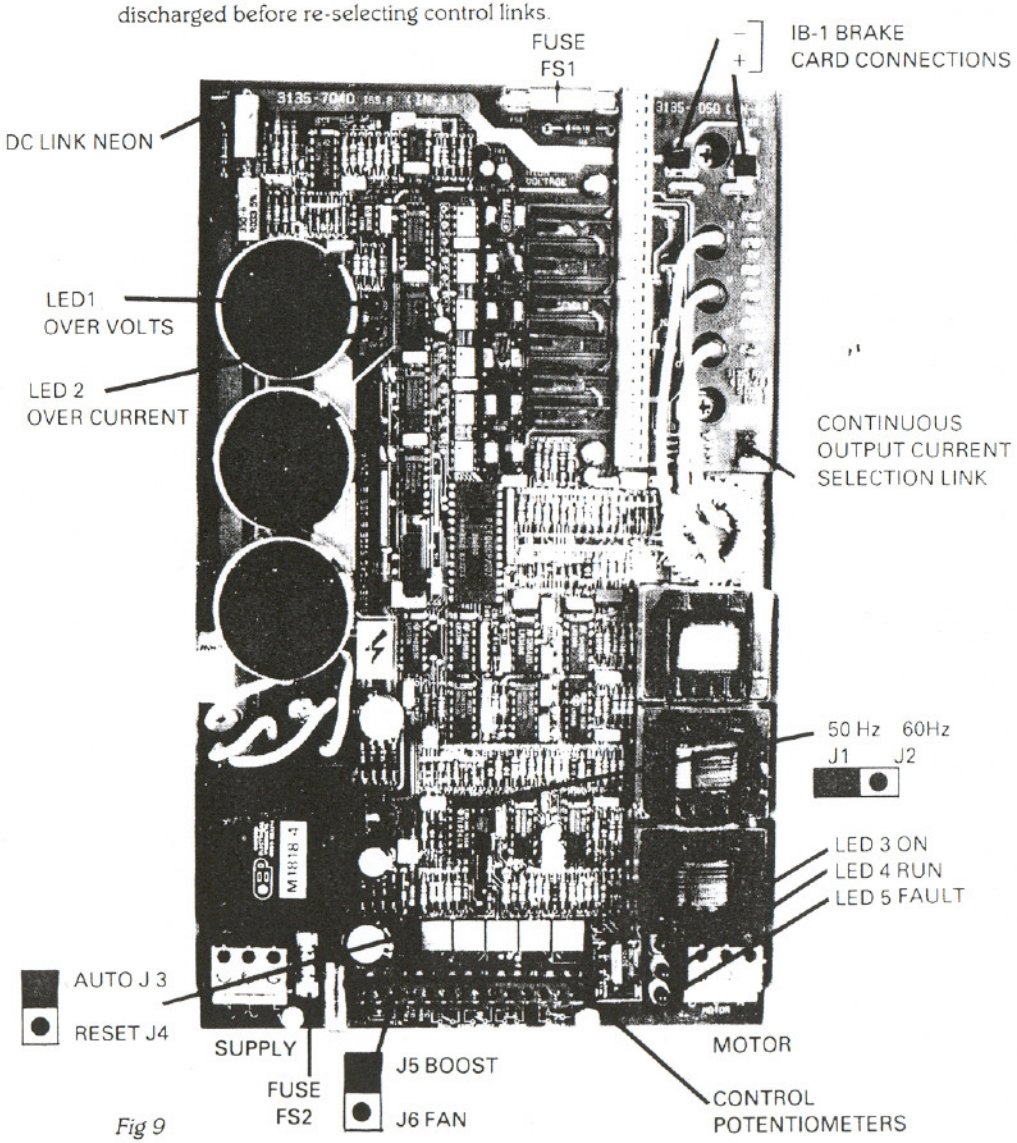


Fig 9

Continuous O/P Current — The top right hand section of the Inverter contains the selector link system clearly marked in both kW and current. Set the appropriate link to give a continuous output current rating to suit the motors nameplate requirement.

AUTO/RESET START

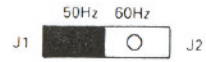
Links J3/J4 — shown here set for an auto start

CONSTANT TORQUE/FAN MODE

Links J5/J6 — shown here set for use in the constant torque mode.

50/60 Hz MOTOR

Links J1/J2 — shown here set for use with a 50Hz motor.



3.2 SWITCHING ON

Before switching on set link J3 to Auto and set the Inverters five preset potentiometers as follows:— RV1/2/5 fully counter-clockwise. RV3/4 halfway. The speed demand input voltage should be set for minimum. Switch on the AC supply. The 'ON' LED will light. Close the run switch, connecting terminals 10 & 11, the 'RUN' LED will light. Varying the speed demand input voltage will cause the motor to accelerate. If the direction of rotation is incorrect, switch off and wait until the neon warning lamp extinguishes. Inter-change two output phases and re-run, checking all preset potentiometers function. If starting is difficult adjust RV1, Vmin boost 50% clockwise to improve starting torque, then reduce it progressively to the minimum acceptable setting to avoid motor overheating.

Adjust RV2 & RV5 to set minimum and maximum speeds respectively. The Inverter will run to 100Hz with RV5 turned fully clockwise consequently caution must be exercised.

Adjust RV3 for the required acceleration time, clockwise adjustment reduces the acceleration time, too short an acceleration demand will cause the Inverter to trip on overcurrent, this being indicated by LED2 — for 10 seconds and LED5 — FAULT.

Adjust RV4 for the required deceleration time, clockwise adjustment reducing the deceleration time, too short a deceleration demand will cause the Inverter to trip on overvoltage, this being indicated by LED 1 and LED 5, FAULT. Faster deceleration can be achieved by the use of the IB-1 option braking system, see Sec. 3.8.

Trip reset — a trip condition can be reset by either disconnecting the AC supply for several seconds or momentarily closing Inverter contacts 8 & 9 — RESET.

3.3 REVERSING

The Inverter may be electronically reversed by closing terminals 6 & 7. The Inverter will ramp down the motor to zero speed at the preset decel rate then electronically interchange the output phase sequence, at zero speed there is a momentary period of approx. 100 milliseconds when the motor develops zero torque. The motor then re-accelerates to set-speed in the reverse direction.

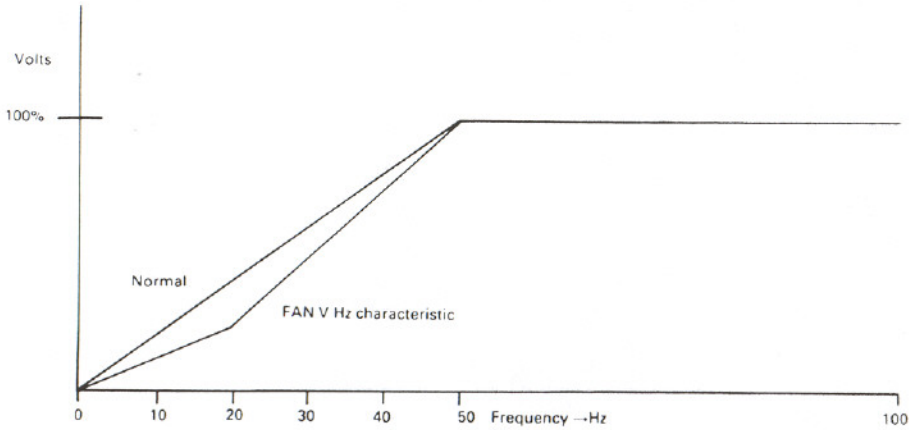
3.4 NO VOLT RELEASE

When the Reset — start mode is selected, jumper J4 "Reset", the Inverter will inhibit in the event of a mains loss in excess of approx. 30 millisecs and will not restart when the mains is reconnected until terminals 8 & 9 are momentarily closed by push button or relay contact.

3.5 FAN LOAD OPERATION

The cube law requirement of fans and centrifugal pumps allows motor operation with a reduced V/Hz ratio throughout the range up the 50Hz. This gives benefits in noise, heat and energy saving. Fig. 10 shows the modified V/Hz Inverter characteristic.

Fig 10 V/Hz Characteristics



3.6 INVERTER SLAVING

Up to 10 Inverters may be slaved as shown in Fig. 11. This connection allows ratio trimming between slaves with individual adjustment on Inverter speed range and acceleration/deceleration rates.

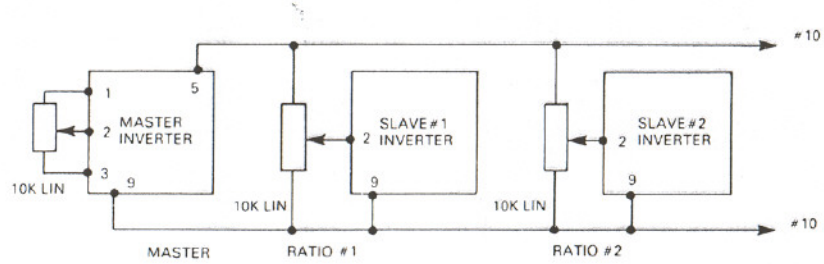


Fig 11 Slaving

3.7 FREQUENCY OUTPUT

A ramping digital clock output is available at terminal 4, the clock is a 30 times multiple of the motor frequency. It may be used with a digital counter to show motor frequency. See sec. 1.2 for O/P detail.

3.8 DYNAMIC BRAKING

The Inverters inherent braking capacity can be greatly extended by the use of the IB-1 optional braking system. During deceleration the motor acts as a generator and will increase the internal DC link supply voltage, tripping the Inverter on overvoltage unless the motor energy is dissipated. The IB-1 uses a 220/240 volt AC supply and connects a power resistor and thermal trip directly to the Inverter. See figs. 12 & 9.

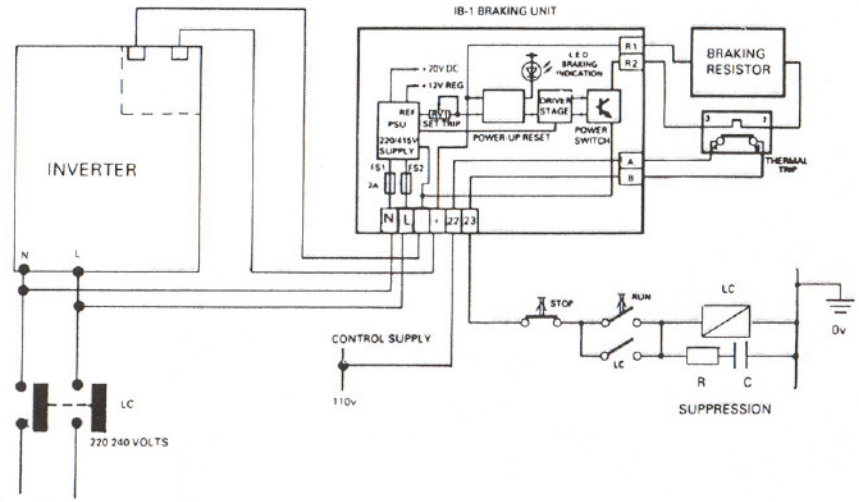
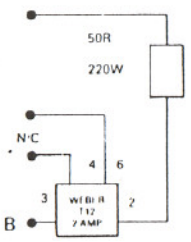


Fig 12 IB-1 Connection

Braking action occurs when the speed input reference is reduced, braking action is not provided at zero motor speed or when the Inverter is disconnected. Braking performance is detailed in fig. 13.

MOTOR KW	.37	.55	.75	1.1	1.5
RESISTOR NETWORK CONFIGURATION AND WEBER TRIP VALUE T12 SERIES TYPE T12-221SN					
% MOTOR F.L.T. BRAKING - APPROX.	75	85	110	85	62
BRAKING DUTY — APPRX.	5 SECONDS BRAKING IN EVERY 2 MINUTES — MAXIUM				
THERMAL TRIP TIME	15 SECONDS — NOMINAL				

Take care when connecting the IB-1 to the Inverter. Allow the DC link to fully discharge — approx. 10 minutes.

Fig 13 Braking Performance

Mount the power resistor in free space away from other equipment to avoid local heat damage. Wiring should be of a high standard, since any short circuits or earth faults will not be detected by the Inverter's electronic trip system.

4. Fault Finding Chart

Fault	Possible Cause	Action
Power-on LED fails to light	Supply Loss. Fuses open. Fuse FS2 open.	Check and replace fuses. If they blow again replace inverter.
Motor will not Run. RUN LED fails to light FAULT LED not lit	Stop/Start I/P terminals 10 & 11 not closed. If manual start mode in use then input 8 may require a reset-start signal	Check and make 10 & 11 Give momentary start — reset input to terminal 8
Motor will not Run RUN LED not lit FAULT LED lit	Unit tripped on fault condition	Check all motor wiring for shorts. Run inverter with no motor to check basic operation Motor chokes required Accel time too fast Change Inverter
Motor runs at low speed only, will not accelerate or starting torque inadequate.	RV1 — Volts boost set too high/low Input demand not +10V max	Re-adjust RV1 and re-run Check Link J5/J6
Inverter trips on acceleration. FAULT and Overcurrent	Acceleration time too short	Re-adjust counter-clockwise RV3 and re-run
Inverter trips on deceleration. FAULT and Overvoltage.	Deceleration time too short to brake motor and load	Re-adjust counter-clockwise RV4 and re-run Fit IB-1 braking system
Motor will not run All monitored conditions O.K.	No input demand Fuse FS1 open circuit	Check voltage terminal 2 Replace and re-run. if fuse blows again replace Inverter