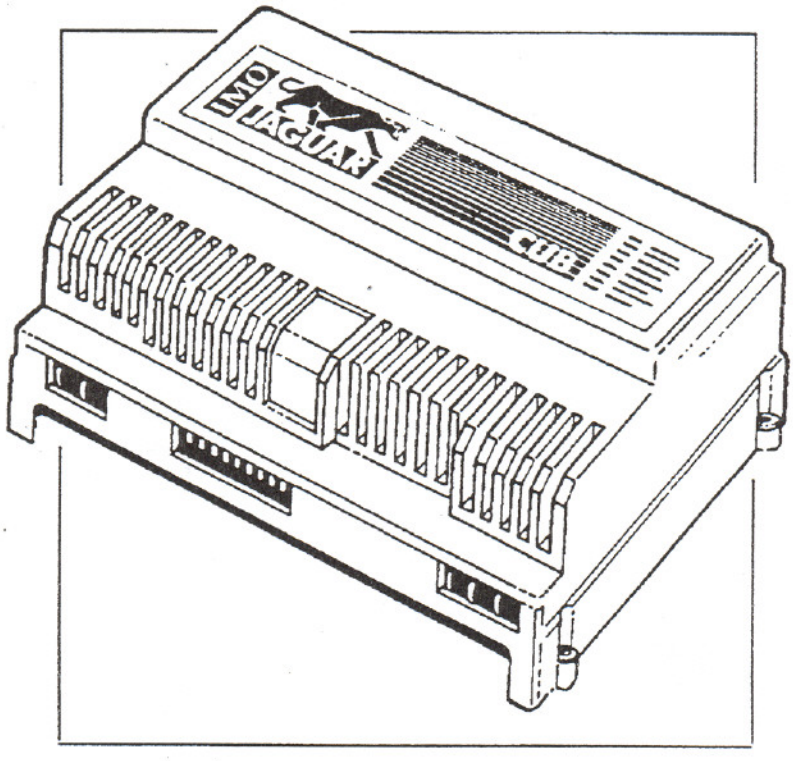

IMO Jaguar CUB

AC Variable Speed Drives
for use with standard induction motors

Models VC55D & VC75D

(Power ratings 0.55 & 0.75kW)

User Guide

"Failure to read these instructions prior to installation and use, may result in damage to the drive and / or the driven equipment and invalidation of the warranty"

Safety Information

Persons supervising and performing the electrical installation or maintenance of a VCD Drive must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the VCD Drive are capable of inflicting a severe electric shock and may be lethal. The Stop function of the VCD Drive does not remove dangerous voltages from the VCD Drive terminals. Mains supplies should be removed before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the VCD Drive 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 and regulations and codes of practice in the UK or elsewhere.

The VCD Drive software incorporates an optional Auto-start facility. In order to prevent the risk of injury to personnel working on or near the motor or its driven equipment and to prevent potential damage to equipment, users and operators, all necessary precautions must be taken if operating the VCD Drive in this mode.

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the VCD Drive with the motor.

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

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Part Number 0411-0800
VCD Issue 3 June 1994

Using a Variable Speed Drive

Low Motor Speeds

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 cooling of the motor. In addition, because the output of variable speed drives is not exactly sinusoidal, the motor losses are slightly increased. More heat is then generated in the motor and the available torque is reduced.

To protect the motor at low speeds, thermal relays should be used to trip the Drive should the motor start to over-heat. To gain full performance at low speeds, additional cooling of the motor may be required.

Excessive Motor Speeds

Standard squirrel-cage AC induction motors are designed as single-speed machines. If it is intended to use a variable speed drive to run a motor at speeds above its designed maximum, it is strongly recommended that the motor manufacturer be consulted first.

The principal risks of over-speeding are destruction of the rotor by centrifugal force or of the bearings by vibration and heat.

Rating of the VCD Drive

If a motor of next higher rating than that of the VCD Drive is used, the Drive should be derated by 10% to allow for the lower motor inductance. For more information consult the supplier of the VCD Drive.

Constant Torque applications

If one of the higher switching frequencies of the Drive is selected with constant torque applications, some derating of the Drive output current may be required. For loads having a square-law characteristic (e.g. fans), no such derating should be required. For further information, consult the supplier of the VCD Drive.

IP Rating

The enclosure of the VCD 55 and VCD 75 conforms to international enclosure specification IP10 when the Drive is properly mounted. It is therefore necessary to consider the location of the Drive in the light of local safety regulations applicable to the type of installation.

Hazardous Areas

The use of a variable speed drive of any type may invalidate the Hazardous Area Certification of ex-protected squirrel-cage induction motors. Approval and certification should be obtained for the complete installation of motor and Drive.

Preliminary Checks

Check that the VCD Drive has not been damaged and that it is suitable for the application.

Technical Characteristics

		VCD 55	VCD 75
Motor Rating [1]	kW	0.55	0.75
Supply Voltage	V-AC rms	200 to 240 single phase ±10%	
Supply Frequency	Hz	48 to 62	
Full Load Input Current [2]	Arms	7.0	9.0
150% Overload Input Current [2]	Arms	10.5	13.5
Heat Dissipation	W	50	75
Displacement Factor [3]		0.95	0.95
Power Factor [4]		0.52	0.53
Maximum Switch-on [5] Surge at supply peak	A	137	137
Maximum I^2t of Switch-on Surge [5]	A^2s	13.4	18.3

		VCD 55	VCD 75
Full Load Output Current	Arms	3.0	4.0
150% Overload Output Current	Arms	4.5	6.0
Output Frequency Ranges [6]	Hz	0 to 100 0 to 120 0 to 220 0 to 440	
Switching Frequencies [7]	kHz	2.9, 5.9, 8.8, 11.7 14.6, 17.6, 20.5	
Acceleration Time 0Hz to ULF	secs	0.2 to 30	
Deceleration Time ULF to 0Hz	secs	0.2 to 30	
Braking		Ramp, Coast, DC Injection or optional Dynamic Braking	
Drive Protection		[I x t] Overload Current Limit Peak Limit Short Circuit Over-voltage	
Environmental Protection		IP10	
Ambient Air Temperature when in use	°C	0 to +40	
Ambient Air Temperature when in storage	°C	-25 to +50	
Efficiency	%	95	95
Humidity		Non-condensing	
Derating for Altitude		Derate FLC by 1% for every 100m above 1000m	
Maximum Altitude	m	4000	

Notes for tables opposite

[1] Typical motor power for stated output current, based on a typical 6-pole motor at 220V.

[2] With 220V supply and minimum source impedance.

[3] Displacement Factor is the cosine of the phase angle between the fundamental voltage and the fundamental current. It approximates to unity with a low-impedance supply.

[4] Power Factor is:
[Average Power Supplied] ÷ [Vrms x Irms].
The values shown are with 220V supply and minimum source impedance.

[5] With 240V +10% supply and minimum source impedance.

[6] 440Hz ULF is not available when the switching frequency is set at 2.9kHz.

[7] No derating of output current is required up to a switching frequency of 11.7kHz.

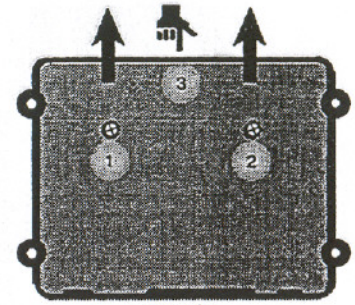
Physical Characteristics

		VCD 55	VCD 75
Dimensions	mm	w263 x h184 x d115	
Weight	kg	1.3	

Configuring the VCD Drive

Removing the PCB

Mounted on the pcb inside the VCD Drive are two banks of DIL switches that are used to configure the Drive. These switches should be set before the Drive is installed. In order to do this, the pcb assembly has to be removed from the housing.



Terminals

Remove the two screws **1** & **2** (shown in the diagram above) from the base of the VCD Drive. Lift the printed circuit board assembly at point **3** and slide it in the direction of the arrows.

Setting the Switches

Locate the two banks of DIL switches, SW1 and SW2, on the pcb. (See diagram on the next page).

Make the required settings. (The functions of the switches are described on the following pages).

Re-assembly

When the DIL switches have been set, locate the edge of the pcb assembly under the tabs in the housing and fasten using the two screws.

DIL Switch Bank SW1

	Function	OFF	ON	See Page
SW1-1	Boost	Auto	Fixed	5
SW1-2	Ramp UP	2-30 secs	0.2-2 secs	5
SW1-3	Ramp DOWN			5
SW1-4	Start Mode	Manual	Auto	5

SW1-5	off	on	off	on
SW1-6	on	off	off	on
Stop Mode	Standard Ramp	Coast	High Level Ramp	DC Brake

See Stop Mode Switches on page 5

Default setting: Standard Ramp

	Function	OFF	ON	See Page
SW1-7	Status Relay energised de-energised	Healthy Tripped	Running Stopped	5
SW1-8	Analog Output Mode	Freq.	Current	6

DIL Switch Bank SW2

	Function	OFF	ON	See Page
SW2-1	[I x t] Range	high	low	6
SW2-2	Wire-proof Mode	See VCD 55/75 Technical Manual		

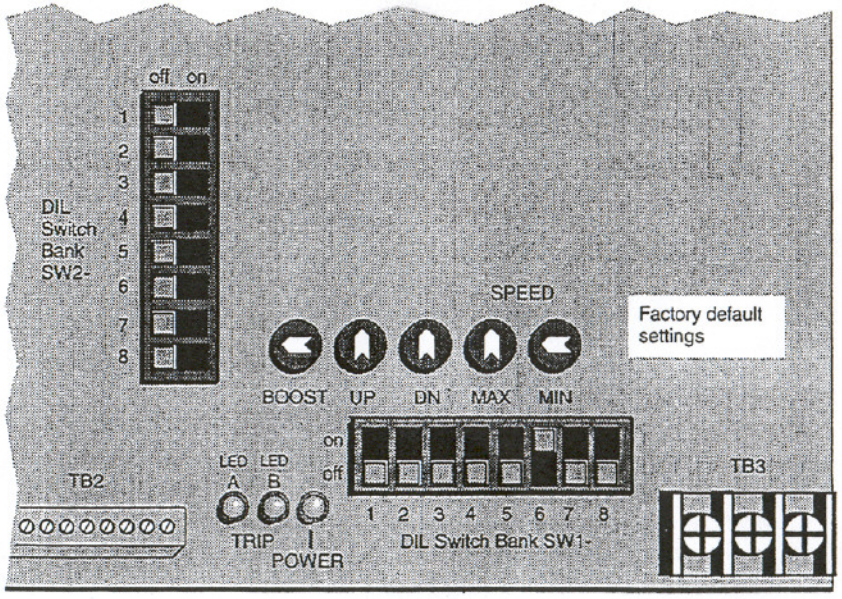
SW2-3	off	on	off	on
SW2-4	off	off	on	on
ULF (Hz)	100	120	220	440

(**ULF** = Upper Limit Frequency) See Page 6

SW2-5	X	off	on	off	on	off	on
SW2-6	off	on	on	off	off	on	on
SW2-7	off	off	off	on	on	on	on
Freq. (kHz)	2.9	5.9	8.8	11.7	14.6	17.6	20.5

See Switching-Frequency Switches on page 7

SW2-8	Not used



SW1-1 Boost Switch

The **Boost** switch is used to select either a fixed boost or a boost that automatically increases with load demand. See *Boost /DC-Braking Preset* on page 11 for more details.

SW1-2 Ramp UP Switch

The **Ramp UP** switch is used to select a range of acceleration times. The required acceleration time from 0Hz to ULF is set using the **Ramp UP** preset. (See page 13).

SW1-3 Ramp DOWN Switch

The **Ramp DOWN** switch is used to select a range of deceleration times. The required deceleration time from ULF to 0Hz is set using the **Ramp DOWN** preset. (See page 13).

SW1-4 Start Mode Switch

The **Start Mode** switch is used to select either manual or automatic starting of the motor when power is applied to the VCD Drive. In Manual mode, a START command is required to start the motor. In Automatic mode, the motor starts when power is applied to the Drive, provided the **Stop** switch is closed.

SW1-5, SW1-6 Stop Mode Switches

The **Stop Mode** switch is used to select the means of stopping the motor, as follows:

In **Standard Ramp** mode, the ramp time is dependent on the **Ramp DOWN** preset setting, but is automatically extended for high inertia loads.

In **High Level Ramp** mode, the ramp time is dependent on the setting of the **Ramp DOWN** preset. This mode of braking should be used when there is a high-inertia load and a short stopping time is required. A braking unit must be fitted for this mode of braking to be effective. Refer to the CDS/VCD Options Manual.

When **Coast** is selected, the time taken for the motor to stop will depend on frictional and windage losses and on the load inertia. The deceleration may not be linear.

When **DC-Braking** is selected, the motor is decelerated quickly. For more details, see *Boost /DC-Braking Preset* on page 11.

SW1-7 Status Relay Switch

The **Status Relay** switch is used to select whether the Status Relay will be energised when the VCD Drive is healthy or running. The contacts are available on pins 2, 3 and 4 of the Control Signal terminal block, TB2. See *Status Relay* on page 9.

SW1-8 Analog Output Mode Switch

The **Analog Output** switch is used to select whether a Run Frequency or a Motor Current signal is sent to the Analog Output on terminals 14 and 15 of TB2.

SW2-1 [I x t] Range Switch

The **[I x t] Range** switch is used to select between two power levels for motor protection. When the current level related to the selected power level is reached, the VCD Drive starts to time-out towards an Overload Trip.

On both settings, the Drive trips after 30 seconds when the power reaches 150% of the selected level. For lower overload levels, the time-out is proportionally longer. During the time-out period, the two **TRIP** LEDs flash alternately. See *Fault Status Codes* on page 14.

Settings	VCD 55	VCD 75
high	550W	750W
low	370W	550W

SW2-2 Wire-proof Mode Switch

The **Wire-proof Mode** switch is used to re-define the functions of the START/STOP and FWD/REV Control inputs. Refer to the VCD55/75 Technical Manual for further details.

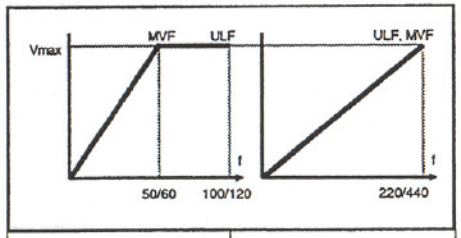
SW2-3, SW2-4 ULF Switches

The **ULF** switches are used to select the maximum frequency the VCD Drive will generate. This determines the maximum motor speed.

If the motor is a standard 50/60Hz squirrel-cage design, the ULF would normally be set at 100/120Hz. If a special high-speed motor is used, one of the higher values of ULF may be selected.

If the ULF selection is changed, ensure the **MAXIMUM SPEED** preset potentiometer is set correctly before running the motor. See *Max Speed Preset* on page 12.

Directly related to the ULF is the Maximum-Voltage Frequency (MVF). This is the lowest output frequency at which the VCD Drive delivers the rated voltage. The relationship between ULF and MVF is given below.



ULF	MVF
100	50
120	60
220	220
440	440

Factory setting: ULF = 100Hz,
MVF = 50Hz

Note

An ULF of 440Hz is not available when the Drive switching frequency is set at 2.9kHz. See *SW2-5 to SW2-7 Switching-Frequency Switches* below.

SW2-5, SW2-6, SW2-7 Switching-Frequency Switches

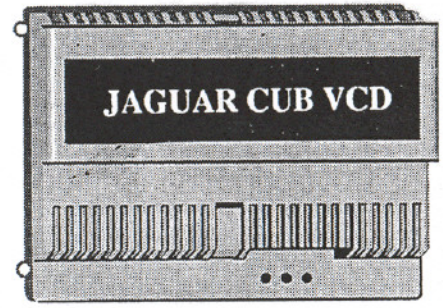
The sinewave output from the VCD Drive is produced by PWM signals applied to the gates of the IGBT inverter bridge. Factors to be considered when setting the Switching Frequency are the effect on the the Drive and the motor and the relationship with the ULF.

Mounting the Drive

The location for the VCD Drive should be free from dust, corrosive vapours, gases and all liquids. Care must be taken to avoid condensation of vaporised liquids including atmospheric moisture. If condensation is likely to occur when the VCD Drive is not in use, an anti-condensation heater must be installed. This heater must be switched off when the Drive is in use. An automatic changeover arrangement is recommended for this.

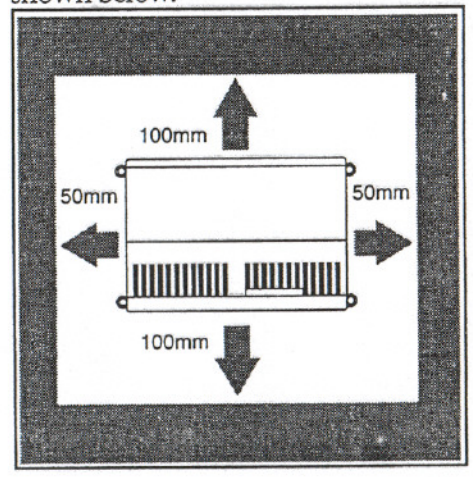
VCD Drives are not to be installed in classified hazardous areas unless they are correctly mounted in an approved enclosure and certified.

The VCD Drive must be mounted on a vertical surface so that the terminals face downwards. Any other mounting position may interfere with the cooling of the Drive. See the diagram below.

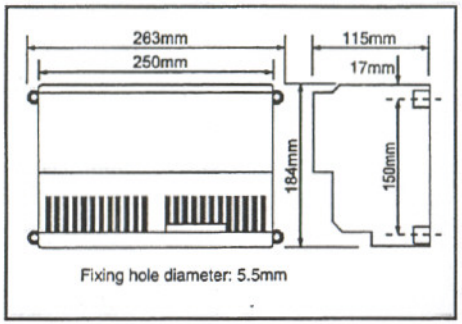


Care must be taken to ensure that adequate ventilation is provided. This is especially important if the VCD Drive is to be mounted in an enclosure. Ensure that the temperature of the air immediately beneath the VCD Drive is no higher than 40°C.

The minimum clearances around the Drive must be respected and are shown below:



Fixings



Connecting the Power Circuits

Warning

The voltages present in the Supply cables, Output cables, terminals and certain internal parts of the VCD Drive are capable of causing severe electric shock and may be lethal.

A period of 10 minutes must elapse after isolating the supply to allow internal capacitors to discharge fully, otherwise dangerous voltages may still be present in the unit.

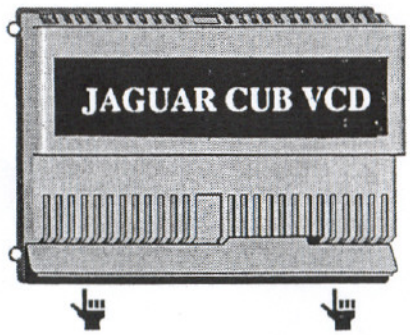
Before proceeding, make sure you have read and understood the section *Safety Information* at the front of this User Guide.

All connections to the VCD Drive are made using terminal blocks TB1, TB2 and TB3. Access to these is gained by lifting both ends of the cover plate and removing it from the housing. (See diagram opposite). The cover should be re-fitted before the VCD Drive is put into service.

	VCD 55	VCD 75
Fuses *IMPORTANT Fuses/MCB must be fitted*	10A	16A
	Slow-acting fuses or MCB/MCCB having thermal and magnetic trips.	
Cabling	1.5mm² PVC/SWA 600/1000V ac/dc Cable runs between the VCD Drive and the motor that are longer than 100 metres of standard 4-core or 75 metres of armoured 4-core may give rise to spurious tripping of the VCD Drive. Line chokes may be needed to prevent this. Refer to the VCD 55/75 Technical Manual for details on maximum recommended cable lengths. Installations prone to mains voltage disturbances may need special attention. If necessary, consult the supplier of the VCD Drive.	
Earthing	Star Earth Point as close to the VCD Drive as possible. Refer to the Connection Diagram on page 10.	
Supply Isolation	A mains supply isolator may be used but it should not be used for control purposes since its operation may trip the VCD Drive.	

Caution

Earth impedance must conform to the requirements of local industrial safety regulations and should be inspected and tested at regular intervals.



RFI Suppression

In common with all inverter drives, the VCD Drive produces a certain amount of radio frequency interference. It is the user's responsibility to ensure compliance with local requirements for the suppression of RFI.

The recommended wiring arrangement for suppressing RFI is shown in grey in the Connection Diagram overleaf. In some cases, a filter on the mains supply will also be required.

Filters designed for use with the VCD Drive are available from the supplier. In some cases, general-purpose mains supply RFI filters may be sufficient.

All contactor coils, solenoids and brake coils must be suppressed with an RC network or equivalent.

Control Specifications

Local Speed Reference

Analog Input	Input Signal	Input Impedance
TB2-12	0 to +5V	100kΩ
TB2-10	0 to +10V	20kΩ

TB2-9 See note	+5V ±2% 0.5mA max	Speed Reference Supply
TB2-11	0 to +5V	Potential Divider output
TB2-13	Common	

Note

For 0V to +10V Speed Control input, connect TB2-11 to TB2-12.

Analog Output

Output Signal TB2-14	SW1-8 set for Frequency	SW1-8 set for Current
0 to +5V (Load >100kΩ) or 0 to 1mA (Load <500Ω)	0Hz to ULF ± 3% Accuracy	0 to 150% FLC ± 15% Accuracy

TB2-15	-V Analog Output

Digital Inputs

Digital Input	Action	Function
TB2-5	Momentary Low	Start
TB2-6	Continuous Low	Not Stop
	Momentary High	Stop
TB2-7	Continuous Low	Reverse
	Continuous High	Forward

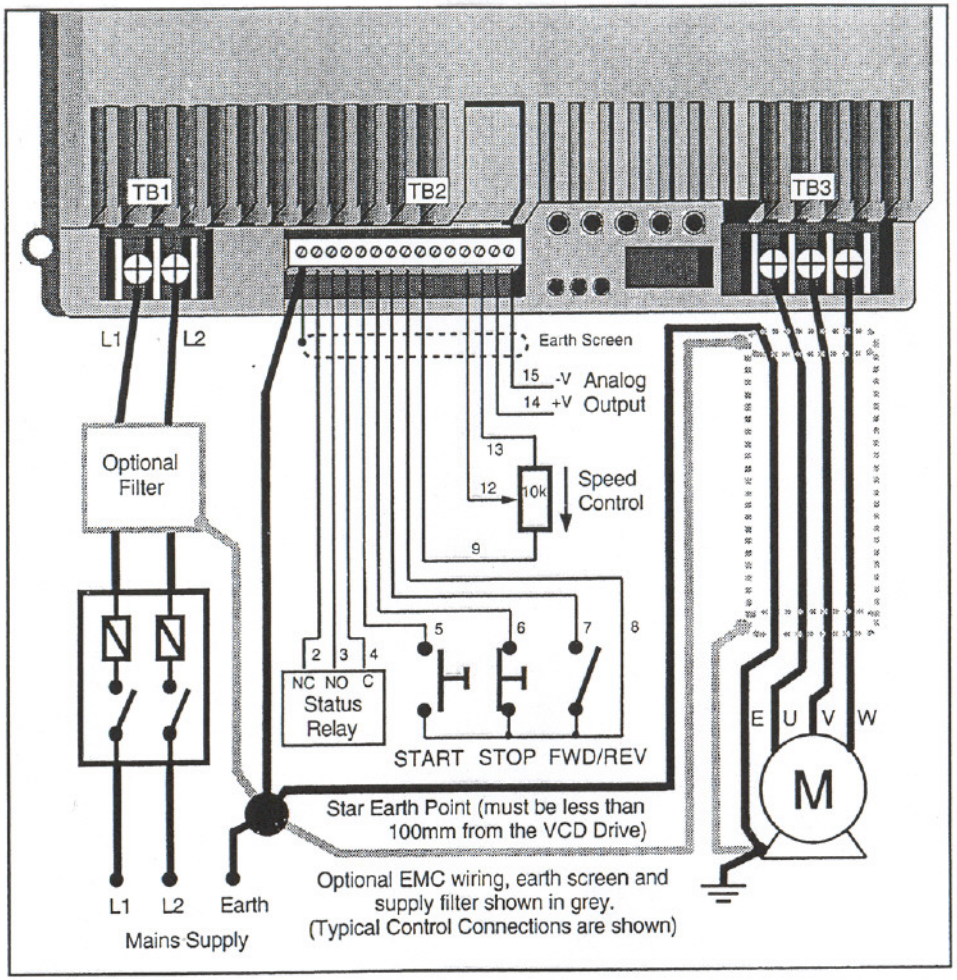
TB2-8	Common

Digital input signals may be obtained by switching the input to common.

Status Relay

Output	Relay Contact	Rating
TB2-2	Normally Closed	Volt-free contacts 110V, 0.5A ac 24V, 1A dc non-inductive
TB2-3	Normally Open	
TB2-4	Common	

DIL Switch SW1-7 is used to select whether the Status Relay is to be energised when the VCD Drive is running or healthy. See the DIL switch settings on page 4.



Interfacing

The control electronics are interfaceable with other industrial control products referenced to potentials within ±50V peak relative to the earth of the mains supply to the VCD Drive.

Connecting the Control Circuits

Refer to the Connection Diagram above. Note that the control connections shown are typical and not mandatory.

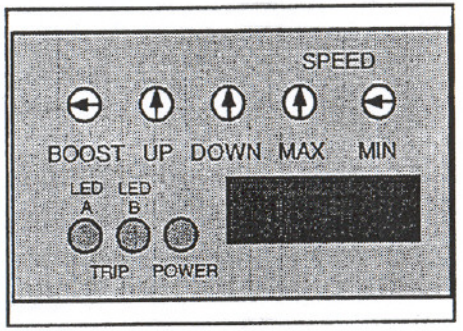
Refer to the Control Specifications for details of the signal inputs and outputs.

Setting Up the VCD Drive

Warning

During the setting up of the VCD Drive, the motor and its load will be driven. Before proceeding, ensure that it will be safe to do so. Make sure you have read and understood the Safety Warning at the front of this User Guide.

1 Locate the **BOOST, UP, DOWN, MAX** and **MIN** preset potentiometers on the control panel. (See below).



Ensure that **BOOST** and **MIN** are set fully anti-clockwise as shown above. Ensure that **UP, DOWN** and **MAX** are at mid-point as shown above.

2 Ensure that the following controls are set as shown:

Speed Control	minimum
START switch	open
STOP switch	closed
FWD/REV switch	open

3 Switch on the mains supply. Check that the **POWER** LED lights. If the VCD Drive is configured for Auto-start, the motor should start to rotate. If the VCD Drive is configured for Manual start, momentarily close the **START** switch to start the motor.

To stop the motor, momentarily open the **STOP** switch.

4 Adjust the presets to suit the requirements of the application. The functions of the presets are described below.

Boost / DC-Braking Preset

Fixed Boost gives an increase in voltage at low speeds. This increase is set using the **BOOST** preset. Auto Boost gives voltage boost that is proportional to load current. In this case, the **BOOST** preset is used to set the maximum available Boost at full load current (FLC).

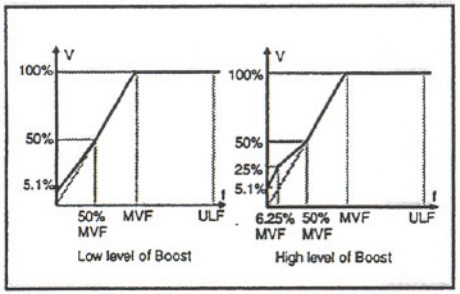
The **BOOST** preset also affects the value of the low frequency that is generated for a period when the DC-Brake is in operation.

Fixed Boost mode

The maximum setting of Boost is 25% of the supply voltage at a frequency that is 6.25% of the MVF. The amount of Boost reduces linearly from the full amount at 6.25% of MVF to zero at 50% of MVF.

At frequencies below 6.25% of MVF, the Boost curve can follow one of two slopes. For low levels of Boost, the Boost curve remains linear so long as the voltage at zero frequency does not exceed 5.1% of the supply voltage. For higher Boost levels, the slope of the Boost curve changes at

6.25% MVF to a new slope that reaches 5.1% of supply volts at zero frequency. (See diagram below).

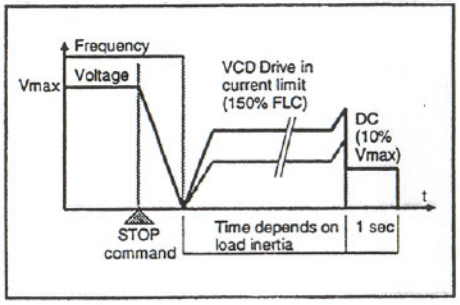


If the VCD Drive is configured for Fixed Boost and the motor fails to start, turn the **BOOST** preset clockwise to increase the starting torque. Boost should be set at the minimum required to start the motor under load. If the setting is too high, the motor may become over-heated.

Auto Boost mode

In Auto Boost mode, the Boost level varies linearly with load current, ie. 0% Boost at 0% FLC – to the **BOOST** Preset level at 100% FLC.

DC-Braking



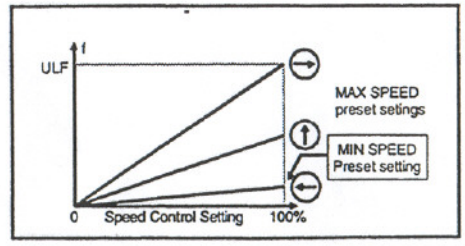
DC-Braking follows a pre-defined sequence as shown above. When a **STOP** command is received, the voltage applied to the motor is reduced linearly to zero at full frequency. This is followed by the injection of a braking current until the motor is almost stationary. A dc voltage of 10% Vmax is then applied for 1 second to ensure the motor is absolutely stationary. The Boost level influences the V/f ratio which affects the frequency of the injection braking current.

The Drive cannot be re-started until the 1 second of direct current has elapsed. This includes the **Stop** switch being operated when the motor is stationary.

Max Speed Preset

The **MAXSPEED** preset sets the maximum speed that can be demanded by the external Speed Control. Clockwise rotation increases the speed.

Set the **MAXSPEED** preset for the required maximum speed to be given by the Speed Control. If the Analog Output is configured for Frequency, monitor it to ensure that the motor is not driven excessively fast when making adjustments.



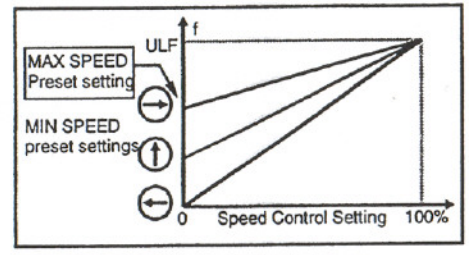
Caution

Take care when setting the Speed Control at maximum. The VCD Drive can drive the motor beyond its normal maximum speed.

Min Speed Preset

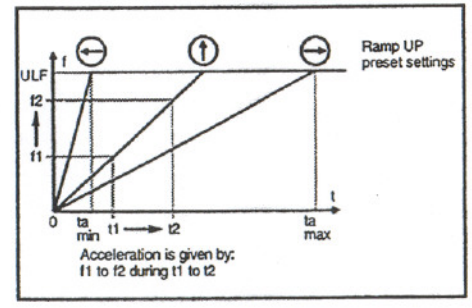
The **MINSPEED** preset sets the minimum speed that can be demanded by the external Speed Control. Clockwise rotation increases the speed.

Set the **MINSPEED** preset for the required minimum speed to be given by the Speed Control.



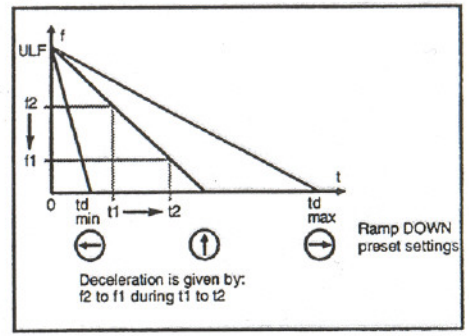
Ramp UP Preset

The **UP** preset should be set for required acceleration time from 0Hz to ULF. Clockwise rotation of the preset increases the time taken to accelerate from 0Hz to ULF. The **UP** preset operates over the time span set by DIL switch SW1-2.



Ramp DOWN Preset

The **DOWN** preset should be set for the required deceleration time from ULF to 0Hz. Clockwise rotation of the preset increases the time taken to decelerate from ULF to 0Hz. The **DOWN** preset operates over the time span set by DIL switch SW1-3.



Note

If the acceleration time is set too short, the VCD Drive may trip on Over-current. If the deceleration time is set too short, the VCD Drive may trip on Over-voltage and Over-current. Refer to *Fault Status Codes* on the next page.

Fault Status Codes

LED A	LED B	Status	Possible Cause
off	off	Drive OK	
off	on	Over-voltage trip	High mains supply or excessive deceleration rate
on	off	Under-voltage trip	Low mains supply
on	on	Power Supply fault	Internal fault
off	flash	Over-current trip	Excessive load current
flash	off	DC Link start up	Internal fault
on	flash	Frequency link error	ULF set at 440Hz when switching frequency is 2.9kHz
flash	on	Watchdog timer error	Recovery from software or hardware upset
flash	flash	[I x t] trip	Unit has timed to overload trip
flashing together			
flash	flash	[I x t] integration	Unit is timing towards overload trip
flashing alternately			