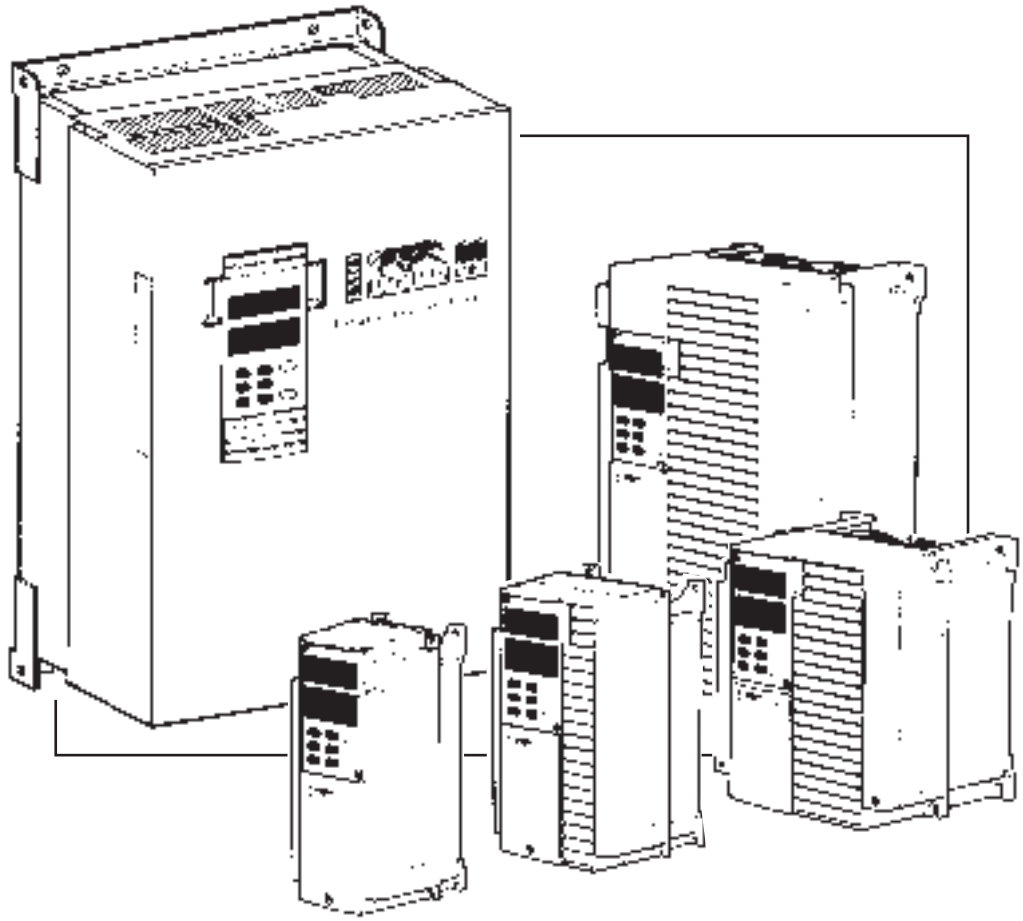


IMO Jaguar VX

Torque Vector System

High-performance, sensorless vector inverters

VX40 EN - VX220K - D
VX750P EN - VX280K - D

Power ratings from 0.4kW to 220kW (280kW pump rated)

User's Guide

NOTE - Failure to read and comply with these instructions prior to installation and use of the inverter, may result in damage to the drive and/or driven equipment and subsequent invalidation of the warranty.
In line with IMO's policy of continuous improvement, the contents of this document are subject to change without prior notice.

IMO JAGUAR DRIVES
5 YEAR WARRANTY

IMO JAGUAR drives are covered by a unique 5 year warranty against failure arising as a result of inferior material or workmanship.

In the event of a unit failing with 5 years of despatch from IMO, we will repair or replace the drive free of charge.

Whenever possible, in the interest of providing the fastest service to our customers, we will replace the failed drive with a new or service exchange unit at IMO's discretion. This may not be possible, however, if the failed unit is in poor condition owing to abuse or neglect. In such circumstances, the customer may elect to have the unit repaired within the warranty if viable, but physical refurbishment will be chargeable.

IMO will, upon request, provide a service exchange unit in advance of receipt of the failed unit if an order number is provided along with details of the failed unit. Replacements will be despatched at IMO's cost and credit will be issued upon receipt of the failed unit in good physical condition. Full credit will not be given if in IMO's judgment the unit has been physically or electrically abused. A no-fault-found charge will be levied upon units returned and found not to be faulty.

The terms of warranty do not provide for on-site service although a service engineer will be provided upon receipt of an order. IMO may elect to waive any charge should the findings on site indicate that any problem found lies within the scope of the warranty.

Contents

1 Introduction

1-1 The *Jaguar VX* Inverter Range

The *Jaguar VX* range comprises 'Industrial-rated' inverters for motors from 0.4kW to 220kW, and 'Pump-rated' inverters for motors from 7.5kW to 280kW.

All inverters in the range are identified by the prefix VX followed by a number which designates the power output rating.

Inverters from 0.4kW to 22kW are designated VX40 to VX2200. Inverters from 30kW are designated VX30K etc.

Pump-rated inverters, all sizes, are identified by the suffix P.

Examples:

Order code	*Description*	*Order code*	*Description*
VX750	7.5kW Industrial-rated	VX30K	30kW Industrial-rated
VX750P	7.5kW Pump-rated	VX30KP	30kW Pump-rated

1-2 Terminology

In this manual, the word 'parameter' has the conventional, dictionary meaning, namely, 'a quantity constant in the case considered'. For example, the rated voltage and current are two parameters of a motor or of an inverter.

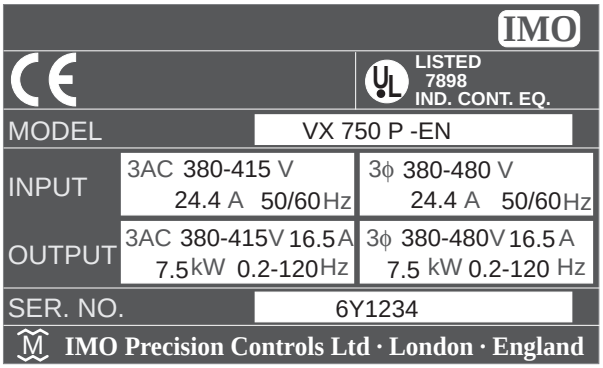
The term 'Function', with the initial capital letter, is used to designate the fixed or adjustable values written to and readable from the inverter operating software. Without the initial capital, the word 'function' has its ordinary meaning.

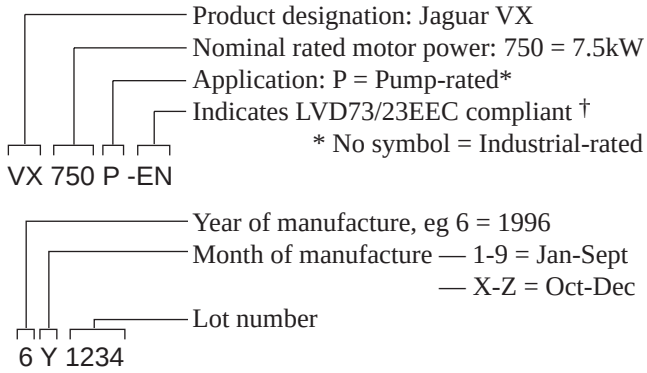
NOTES 1 Throughout this manual the -EN and -D suffixes have been omitted for simplicity and for considerations of space, but all inverters described in this publication are of the EMC and LVD conformant revision designated by the -EN and -D suffixes, as shown in the illustration below.

2 Earth terminals. Jaguar VX… -EN and -D now carry the standard ⏚ symbol instead of the lettering 'GND(PE)'.

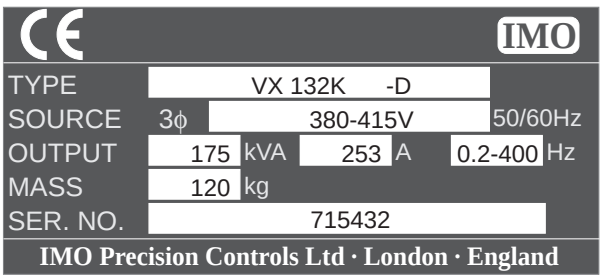
1-3 Rating plate data — typical only

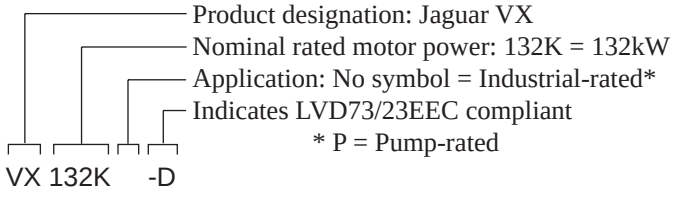
Typical example 1:
0.4kW to 22kW range





Typical example 2:
30kW to 280kW range





† If the inverter is to be installed for LVD-compliance, the data shown on the **left hand** side of the rating plate applies. For non-LVD-compliance it is possible to use the data shown on the right.

2 Inspection, Handling & Storage

2-1 Product enquiries

If at any time you have a difficulty or a question regarding the inverter, please contact IMO Precision Controls Ltd at the address on the back cover of this Manual. The following information will be required:

(a) Inverter type (from the Rating Plate).

(b) Serial number (from the Rating Plate).

(c) Date of purchase.

(d) The nature of the trouble (for instance, the location and extent of damage, the point which is unclear or the circumstances under which a malfunction occurred).

2-2 Inspection

Immediately after unpacking the inverter, please inspect as follows.

Check the rating plate on the side of the inverter cover to ensure that the inverter specification corresponds to the order specification. Typical rating plate data is shown on page 2.

Inspect the inverter to determine whether the unit has been damaged in transit. Look for loose components and damage to any part of the cover, side panels, mounting brackets or other components.

2-3 Storage

Temperature (1)	-20ºC to +65ºC	Avoid places where sudden changes in temperature occur which could cause condensation or freezing.
Relative humidity (2)	20% to 90%	
Environment	The inverter should not be placed in direct sunlight. The surrounding atmosphere should ideally be dry, free from dust, corrosive or inflammable gases, oil mist, steam, dripping water and vibration. A salty environment must be avoided.	

(1) Short-term temperature conditions during transport or storage.

(2) Condensation or freezing may occur in places where large variations in temperature occur, even if the relative humidity is within the specified range. Such places should be avoided.

2-4 Storage Precautions

- Do not place the inverter directly onto the floor. It should always be placed on a stand or shelf.
- If the inverter is being stored in a less-than-ideal environment, cover it with a plastic sheet for protection.
- If you are concerned about humidity affecting the inverter, place a desiccating agent (such as silica gel) inside the inverter, then cover the inverter with a plastic sheet for protection.

2-5 Handling

Be sure to take a firm grip of the **chassis** of the unit when carrying the inverter.

WARNING

STRAIN HAZARD: Improper lifting practices can cause serious injury. Lift heavy loads only with adequate equipment and trained personnel.

CAUTION

Hold and lift the inverter by the chassis/heatsink, not by the cover. The cover is a protective shield only, and is not intended for lifting and carrying.

Lifting the inverter by the cover or other front parts may damage it. The cover is intended only to prevent inadvertent access to the internal components. Be careful not to apply too much force to it.

3 Technical Data

3-1 General Specifications

ENVIRONMENT

Ambient temperature (operating)
-10°C to +50°C
Jaguar VX Inverters ≤22kW:
When temperature exceeds +40°C, remove ventilation covers. Refer to pages 12 and 13.

Ambient temperature (storage)
-20°C to +65°C

Atmospheric pressure (operating)
min. 900mb; equivalent to 1000m (3280ft)

Relative humidity (non-condensing)
20% to 90%

Vibration tolerance
5.9m/s^2 (= 0.6G) maximum

EMC
Please refer to Chapter 6, page 30 for data.

Enclosure

When all removable covers are in position:

VX Inverters ≤22kW	IP20
VX Inverters ≥30kW	IP00 (IP20 optional)

When side covers are removed:

VX Inverters ≤22kW	IP20
VX Inverters ≥30kW	IP00 (IP20 optional) Covers not removable

INPUT

3-phase supply system

Jaguar VX Inverters ≤22kW **— LVD-compliant**
50/60Hz, ±5%: 380V to 415V, +10% -15%
Phase imbalance — voltage — ≤3%

Jaguar VX Inverters ≤22kW **— non-LVD-compliant**
50/60Hz, ±5%: 380V to 480V, +10% -15%
Phase imbalance — voltage — ≤3%

Jaguar VX Inverters ≥30kW **— LVD-compliant**
50Hz, ±5%: 380V, 400V to 415V, +10% -15%
60Hz, ±5%: 380V to 415V, +10% -15%
Phase imbalance — voltage — ≤3%

Jaguar VX Inverters ≥30kW **— non-LVD-compliant**
50Hz, ±5%: 380V, 400V to 420V +10% -15%
60Hz, ±5%: 380V to 420V, 440V to 460V, +10% -15%
Phase imbalance — voltage — ≤3%

Overload protection:

Jaguar VX Inverters ≤22kW

Industrial-rated	150% FLC for 60s 200% FLC for 0.5s
Pump-rated	120% FLC for 60s

Jaguar VX Inverters ≥30kW

Industrial-rated	150% FLC for 60s 180% FLC for 0.5s
Pump-rated	120% FLC for 60s

Surge protection

Jaguar VX Inverters ≤22kW

Phase to earth	Up to 1.2 x 50µs, 4kV$_{pk}$
Phase-to-phase	Up to 10 x 200µs, 2kV$_{pk}$

Jaguar VX Inverters ≥30kW

Phase to earth	Up to 1.2 x 50µs, 4kV$_{pk}$
Phase-to-phase	Up to 1.2 x 50µs, 2kV$_{pk}$

Momentary voltage dip recovery
When the input voltage is ≥310V, the inverter can be operated continuously. When the input voltage falls below 310V, the inverter can be operated for 15ms (within 85% nominal load of a standard motor). *Jaguar VX* inverters are equipped to recover smoothly from a transient loss of supply voltage. Refer to Function 10, page 46.

OUTPUT

Inverter output voltage

3-phase PWM waveform, 0V to V_L input (1)

Inverter output frequency

Frequency range

Industrial-rated inverters	0.2Hz to 400Hz
Pump-rated inverters	0.2Hz to 120Hz

Maximum frequency

Industrial-rated inverters	50Hz to 400Hz
Pump-rated inverters	50Hz to 120Hz

Base frequency

Industrial-rated inverters	50Hz to 400Hz
Pump-rated inverters	50Hz to 120Hz

Starting frequency

0.2Hz to 60Hz

Carrier (PWM) frequency range (2) (selectable)

VX Inverter	*Available Range*
VX40 to VX2200 VX750P to VX2200P	2kHz to 15.6kHz
VX30K to VX55K	2kHz to 10kHz
VX75K to VX220K VX30KP to VX75KP	2kHz to 6kHz
VX90KP to VX280KP	2kHz to 4kHz

Output accuracy (stability) — analog

±0.2% of maximum frequency (at 25°C ±10°C)

Output accuracy (stability) — digital

±0.01% of maximum frequency (at -10°C to +50°C)

Setting resolution — analog

1/3000 = 0.034% of maximum frequency

Setting resolution — digital

0.01Hz at maximum frequency up to 99.99Hz
0.1Hz at maximum frequency at ≥100Hz

Inverter output protection

Phase to phase and phase to earth short circuit protected.

Inverter cooling

VX40 and *VX75* — Natural convection.
All other models are equipped with cooling fans.

Selectable V/f and torque characteristics

V/f ratio

Base frequency adjustable. Refer to Function 03, page 44. Constant torque characteristic up to base speed with selectable automatic voltage regulation (AVR).

Maximum output voltage can be independently clamped within the range 320V to V_L. (1)

Torque boost

Choice of automatic boost dependent on a mathematical model, or manual selection of boost value.

Starting torque

For high starting torque with standard motors, *ie* greater than 150% at 1Hz, torque vector control (Function 29, page 50) should be selected.

NOTES

(1) The output voltage cannot exceed the power supply system (line) voltage V_L. For maximum values of V_L please refer to page 4, 'Input'.

(2) *Jaguar VX* inverters ≤22kW may automatically reduce the carrier (PWM) frequency to 10kHz to assist inverter protection.

3-2 RATINGS: Industrial-rated Inverters, 0.4kW to 22kW at 400V

Inverter order code VX…		*40*	*75*	*150*	*220*	*400*	*550*	*750*	*1100*	*1500*	*1850*	*2200*
Standard motor rating	kW	0.4	0.55 to 0.75	1.1 to 1.5	2.2	3.0 to 4.0	5.5	7.5	11.0	15.0	18.5	22.0
Inverter output capacity (1)	kVA	1.1	1.8	2.7	4.0	6.5	9.3	13	17	22	28	32
Min. supply capacity (2)(6)	kVA	0.7	1.2	2.2	3.1	5.0	7.2	10	15	20	24	29
Inverter output current	A	1.5	2.5	3.7	5.5	9.0	13.0	18.0	24.0	30.0	39.0	45.0
Inverter 100% rated RMS input - without reactor	A	1.7	2.9	5.5	7.7	12.6	18.2	24.4	36.3	48.5	59.0	72.0
RMS input with DC reactor	A	1.0	1.7	3.2	4.4	7.2	10.4	14.0	20.8	27.8	33.8	41.0
RMS input with AC inductor	A	1.1	1.8	3.5	5.0	8.1	11.7	15.6	23.3	31.1	37.8	46.0
Input power factor at 100% FLC with DC reactor fitted		0.96	0.95	0.94	0.93	0.94	0.95	0.95	0.95	0.94	0.95	0.96
Weight	kg	2.4	3.2	3.2	3.2	3.2	5.3	5.3	10.6	10.6	10.6	10.6
Fuse/MCCB ratings (3)	A	4	6	10	15	15	30	40	50	60	75	75
Max. input cable size (2)	mm^2	1.5	1.5	1.5	1.5	2.5	2.5	4.0	6.0	10.0	16.0	16.0
Max. input cable size (4)	mm^2	2.5	2.5	2.5	2.5	2.5	4.0	6.0	10.0	16.0	25.0	35.0
Max. DC reactor cable size	mm^2	1.5	2.5	2.5	2.5	2.5	2.5	4.0	6.0	10.0	16.0	16.0
Max. motor cable size	mm^2	2.5	2.5	2.5	2.5	4.0	4.0	4.0	6.0	10.0	16.0	16.0
Max. dyn. brake cable size	mm^2	2.5	2.5	2.5	2.5	2.5	2.5	4.0	4.0	4.0	4.0	4.0

3-3 RATINGS: Industrial-rated Inverters, 30kW to 220kW at 400V

Inverter order code VX…		*30K*	*37K*	*45K*	*55K*	*75K*	*90K*	*110K*	*132K*	*160K*	*200K*	*220K*
Standard motor rating	kW	30	37	45	55	75	90	110	132	160	200	220
Inverter output capacity (3)	kVA	42	52	63	78	104	122	145	175	211	261	288
Min. supply capacity (2)(6)	kVA	39	47	57	69	93	111	134	160	192	240	263
Inverter output current	A	60	75	91	112	150	176	210	253	304	377	415
Inverter 100% rated RMS input - without reactor	A	96	117	142	173	*Not recommended*						
RMS input with DC reactor	A	55	67	81	99	134	160	193	231	278	345	379
RMS input with AC inductor	A	62	75	91	111	*Not recommended*						
Input power factor at 100% FLC with DC reactor fitted		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Efficiency at full load, 50Hz		0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Weight	kg	36	37	44	54	61	88	88	120	125	177	177
Fuse/MCCB ratings (4)	A	75	100	100	125	175	200	225	300	350	400	500
Max. input cable size (2)	mm^2	50	50	50	50	90	90	150	150	180	300	300
Max. input cable size (5)	mm^2	*Not recommended*										
Max. DC reactor cable size	mm^2	As input cable sizes										
Max. motor cable size	mm^2	As input cable sizes										
Max. dyn. brake cable size	mm^2	As input cable sizes										

NOTES (1) At 415V. (3) At 400V. (5) Without DC reactor.
(2) With DC reactor fitted. (4) Recommended values, when used with a DC reactor.
(6) Not applicable for generator-fed supply systems. If in doubt, please contact IMO Precision Controls Ltd.

Recommended cable sizes are based on 600V cable rating, PVC insulated, max. ambient temperature +50°C.

For inverter heat dissipation values, refer to page 14.

Cable sizes and fuse ratings shown above are for guidance only. If in doubt, please consult IMO Precision Controls Ltd.

3-4 RATINGS: Pump-rated Inverters, 7.5kW to 22kW at 400V

Inverter order code VX…		*750P*	*1100P*	*1500P*	*1850P*	*2200P*
Standard motor rating	kW	7.5	11.0	15.0	18.5	22.0
Inverter output capacity (1)	kVA	11.9	16.5	21.6	26.6	31.6
Min. supply capacity (2)(6)	kVA	10	15	20	24	29
Inverter output current	A	16.5	23.0	30.0	37.0	44.0
Inverter 100% rated RMS input - without reactor	A	24.4	36.3	48.5	59.0	72.0
RMS input with DC reactor	A	14.0	20.8	27.8	33.8	41.0
RMS input with AC inductor	A	15.6	23.3	31.1	37.8	46.0
Input power factor at 100% FLC with DC reactor fitted		0.95	0.95	0.94	0.95	0.96
Weight	kg	6.5	6.5	11.5	11.5	12.0
Fuse/MCCB ratings (3)	A	40	50	60	75	75
Max. input cable size (2)	mm^2	4.0	6.0	10.0	16.0	16.0
Max. input cable size (4)	mm^2	6.0	10.0	16.0	25.0	35.0
Max. DC reactor cable size	mm^2	4.0	6.0	10.0	16.0	16.0
Max. motor cable size	mm^2	4.0	6.0	10.0	16.0	16.0
Max. dyn. brake cable size	mm^2	4.0	4.0	4.0	4.0	4.0

3-5 RATINGS: Pump-rated Inverters, 30kW to 280kW at 400V

Inverter order code VX…		*30KP*	*37KP*	*45KP*	*55KP*	*75KP*	*90KP*	*110KP*	*132KP*	*160KP*	*200KP*	*220KP*	*280KP*
Standard motor rating	kW	30	37	45	55	75	90	110	132	160	200	220	280
Inverter output capacity (3)	kVA	42	52	63	78	104	122	145	175	211	261	288	360
Min. supply capacity (2)(6)	kVA	39	47	57	69	93	111	134	160	192	239	263	355
Inverter output current	A	60	75	91	112	150	176	210	253	304	377	415	520
Inverter 100% rated RMS input - without reactor	A	96	117	142	173	*Not recommended*							
RMS input with DC reactor	A	55	67	81	99	134	160	193	231	278	345	379	483
RMS input with AC inductor	A	62	75	91	111	*Not recommended*							
Input power factor at 100% FLC with DC reactor fitted		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Efficiency at full load, 50Hz		0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Weight	kg	36	36	37	44	54	61	88	88	120	125	177	177
Fuse/MCCB ratings (4)	A	75	100	100	125	175	200	225	300	350	400	500	600
Max. input cable size (2)	mm^2	50	50	50	50	90	90	150	150	180	300	300	300
Max. input cable size (5)	mm^2	*Not recommended*											
Max. DC reactor cable size	mm^2	As input cable sizes											
Max. motor cable size	mm^2	As input cable sizes											
Max. dyn. brake cable size	mm^2	As input cable sizes											

NOTES (1) At 415V. (3) At 400V. (5) Without DC reactor.
(2) With DC reactor fitted. (4) Recommended values, when used with a DC reactor.
(6) Not applicable for generator-fed supply systems. If in doubt, please contact IMO Precision Controls Ltd.

Recommended cable sizes are based on 600V cable rating, PVC insulated, max. ambient temperature +50°C.

For inverter heat dissipation values, refer to page 14.

Cable sizes and fuse ratings shown above are for guidance only. If in doubt, please consult IMO Precision Controls Ltd.

3-6 Typical DC Reactor Data

IMO Precision Controls Ltd recommend the use of a DC reactor to improve power factor and reduce the harmonics reflected into the supply network. Cable size and fuse rating must be increased if a reactor is not applied. Refer to the ratings tables on pages 6 and 7. Physical dimensions are approximate.

*Inverter * order code*	*Reactor type no.*	*Height* mm	*Width* mm	*Depth* mm	*Weight* kg	*Inductance* mH	*Current* A	*Heat Loss* W
VX1100	VXLC11	*Optional application For further data please consult IMO Precision Controls Ltd*				2.2	25	21.0
VX1500	VXLC15					1.8	34	28.3
VX1850	VXLC18					1.4	34	28.3
VX2200	VXLC22					1.2	49	34.6
VX30K	VXLC30	210	150	110	14	0.86	80	63
VX37K	VXLC37	210	150	130	17	0.7	100	56
VX45K	VXLC45	210	150	140	21	0.58	120	58
VX55K	VXLC55	210	150	156	25	0.47	146	66
VX75K	VXLC75	250	200	150	25	0.35	200	95
VX90K	VXLC90	280	220	170	32	0.29	238	94
VX110K	VXLC110	290	220	180	36	0.24	291	115
VX132K	VXLC132	360	200	180	40	0.215	326	100
VX160K	VXLC160	350	220	170	45	0.177	395	115
VX200K	VXLC200	310	230	180	50	0.142	494	140
VX220K	VXLC220	320	230	200	50	0.126	557	160
VX280KP	VXLC280	340	230	210	58	0.1	700	170

* For Industrial-rated and Pump-rated inverters, *ie VX…, VX…P, VX…K* and *VX…KP*. This information is correct at the time of going to press, but is subject to change without notice.

3-7 Practical Motor Cable Length in metres

The figures given in these tables are proven lengths. Under certain operating conditions the maximum length may be considerably greater. If further assistance is required, please consult IMO Precision Controls Ltd.

*Inverter order code VX… **		*40*	*75*	*150*	*220*	*400*	*550*	*750*	*1100*	*1500*	*1850*	*2200*
Unscreened cable (1)	Without AC choke	50	50	100	100	100	200	200	200	200	200	200
	With AC choke	400										
Screened cable	Without AC choke	30	30	60	60	60	120	120	120	120	120	120
	With AC choke	200										

*Inverter order code VX… **		*30K*	*37K*	*45K*	*55K*	*75K*	*90K*	*110K*	*132K*	*160K*	*200K*	*220K*	*280KP*
Unscreened cable (1)	Without AC choke	200											
	With AC choke	400											
Screened cable	Without AC choke	120											
	With AC choke	200											

* For Industrial-rated and Pump-rated inverters, *ie VX…, VX…P, VX…K* and *VX…KP*.

(1) Armoured, or in conduit or trunking.

NOTES

1 It is recommended that MICC-type cable is NOT used for motor supply, due to high capacitance and hence a greater limitation of maximum length.

2 Longer motor cable lengths **without** motor chokes can be achieved by reducing the Carrier Frequency (Function 81).

3-8 Circuit Breaker (RCD) Trip Ratings for Inverters Rated 0.4kW to 22kW

Trip ratings in mA

*Inverter ** *order code*	*Motor cable length* (m)					
	10	*30*	*50*	*100*	*200*	*300*
VX40	30	30	100	100	—	—
VX75	30	30	100	100	—	—
VX150	30	30	100	100	—	—
VX220	30	30	100	100	—	—
VX400	30	30	100	100	200	—
VX550	30	30	100	100	200	—
VX750	30	30	100	100	200	—
VX1100	30	30	100	100	200	—
VX1500	30	100	100	100	200	—
VX1850	30	100	100	200	200	500
VX2200	30	100	100	200	200	500

* For Industrial-rated and Pump-rated inverters,
ie VX…, VX…P.

NOTE

If the length of the motor cable is greater than 50m, it may be necessary to set the carrier frequency, Function 81, to 0 to reduce the effect of leakage current at high PWM frequencies.

Consult IMO Precision Controls Ltd before using a motor cable in excess of 100m.

To calculate the approximate earth leakage current in the motor circuit

$$I_{leakage} = 6 \cdot \sqrt{2} \cdot V_L \cdot F_s \cdot (C_c + C_m) \quad \text{in milliamps}$$

Where F_s = value of Function 81 in Hz — please refer to IMO Precision Controls.
Average C_c for armoured cable is approximately 330pF per metre,
Average C_m is approximately 4.7nF for 7.5kW motors, and *pro rata* for other sizes.

NOTES 1 Values for C_c and C_m must be in farads.

2 Local or National Regulations may enforce a maximum permissible earth leakage trip rating of 30mA or 100mA etc for certain types of installation. Always adhere to such regulations. If in doubt, please consult IMO Precision Controls Ltd.

3-9 Control Specifications

Internal Power Supply +10V DC

All inverters

Terminal 13: +10.0V, 10mA max. (Pot. 1kΩ).

Terminal 12: 0 to +10V input, impedance 20kΩ (≤22kΩ), or 22kΩ (≥30kW).

Terminal C1: 4 to 20mA input, impedance 250Ω.

Inverters 30kW to 280kW

Terminal V1: -10V to +10V bipolar input, impedance 22kΩ. (Option for ≤22kW).

Internal Power Supply +24V DC

Inverters 0.4kW to 22kW

Terminal P24: 100mA max., +24V DC (+27V max.)

Inverters 30kW to 280kW

Terminal CMS: 37.5mA max., +24V DC (+27V max.)

> CAUTION
> Terminal P24/CMS output capacity is limited as above. Derate individual outputs accordingly.

Outputs

Terminals Y1E…Y5E

When using the internal +24V power supply, **total maximum** output is 100mA (≤22kW) or 37.5mA (≥30kW). Derate according to the number of channels required, *eg* $\frac{37.5\text{mA}}{5\text{ channels}} = 7.5\text{mA/channel}$

When using an external +24V power supply, each channel is rated at 50mA (≤22kW) or 37.5mA (≥30kW).

Terminals FMA, FMP, all inverters

0V to +10V DC at 2mA maximum. Minimum connected impedance 5kΩ.

Resolutions:

FMA: 8-bit D-A = 0.05V.

FMP: 0.067Hz in the O/P freq. range 0.2Hz to 15Hz; 0.149Hz in the O/P freq. range 15Hz to 300Hz.

Inputs (Terminals X1…X5, FWD, REV etc)

Inverters 0.4kW to 22kW

All inputs: 4.6mA per channel. When all inputs are in use, total current is:
11 x 4.5mA = 49.5mA.

Inverters 30kW to 280kW

All inputs: 2.93mA per channel. When all inputs are in use, total current is:
11 x 2.93mA = 32.2mA.

Microprocessor Scan Time

3.0 milliseconds, all Functions.

Response Time

From input *command* to output *change:*

Analog signal inputs

4ms to 20ms *plus* the value of Function 59

Digital signal inputs

4ms to 17ms

Serial communications

40ms *plus* baud rate

3-10 Summary of Optional Equipment

Full specifications and data for optional equipment are available on separate Data Sheets. Please consult IMO Precision Controls Ltd. All options are installed within the inverter unless marked *.

***Keypad Extension Cable** VXPOD

Permits the Keypad to be remotely mounted.

***EMC Filter**

Choice of either Free-standing or Footprint filters to enable compliance with the relevant EMC requirements. Please consult IMO Precision Controls Ltd for further information. Refer to *EMC*, page 30. For details of Footprint filters refer to page 88.

***Braking Units, Resistors and Thermal Trip**

Refer to page 84.

PID Control Mode Unit VXPID

Digitally-adjustable P, I and D terms through the medium of a supplementary Function menu.

Reference input 0V to 10V DC.

Feedback input 0V to 10V DC or 4-20mA DC.

***Function Copy Unit** VXCOPY

Saves and loads stored set-ups for up to 12 complete Function sets. 'Copy', 'edit', 'verify' and 'write-protect' modes available. Operates from an 85V to 265V AC supply. Target or donor drives do not need to be powered up to transfer data.

Encoder Feedback Module VXEFC

Enables *Jaguar VX* inverters to be operated in closed-loop control mode. Speed control range 180 to 3600rpm. Speed variation ±0.2% at 3600rpm. Encoder output, 20 to 2000 pulses per revolution. Also available with RS485 port, optional.

Serial Communications Module VXRS485

RS422 or RS485, multi-drop up to 31 *Jaguar VX* inverters of all sizes. Available as opto-isolated or non-isolated signal I/O.

Synchronisation Module VXSYNC

Provides a multi-synch tasking capability via rotary encoders for precision 'Master/Slave' and 'Follower' applications. Also available with RS485 port, optional.

***Power Regeneration Module**

Enables a *Jaguar VX* inverter to deliver regenerated power back to mains supply system. Please consult IMO Precision Controls Ltd.

Relay Output Module VXROC

Converts programmable outputs Y1E…Y5E to relay outputs. Contact rating 48V DC, 0.5A.

Additional Control I/O Terminals

R0, T0 Auxiliary control power supply input.

AX1, AX2 Run relay output. Rating 220V AC, 0.5A. Terminals AX1 & AX2 are standard on inverters of 30kW rating and above.

V1 Voltage input for auxiliary frequency input reference. Bipolar ±10V DC. Terminal V1 is **standard** on inverters ≥30kW rating; Z = 22kΩ. Optional for inverters ≤22kW; Z = 20kΩ.

4 Mechanical Installation

WARNING FIRE AND EXPLOSION HAZARD: Fires or explosions may result from mounting inverters in hazardous areas such as locations where flammable or combustible vapours or dusts are present. Inverters should be installed away from hazardous areas, even if used with motors suitable for use in these locations.

CAUTION

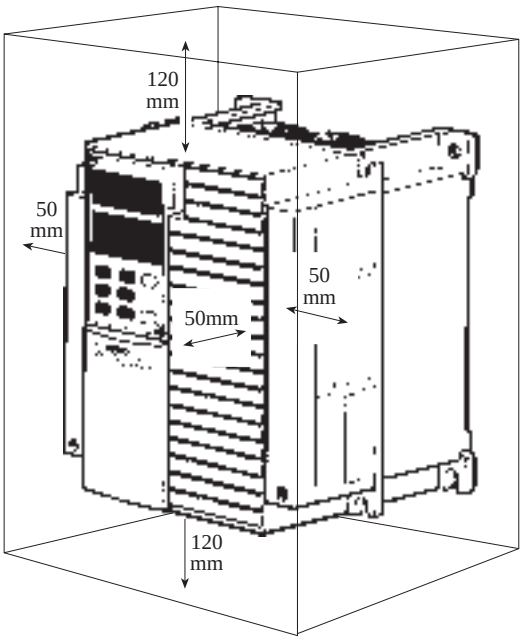
Be sure to remove the silica-gel desiccant dryer packet(s) before installing the inverter. If not removed, these packets may become lodged in the fan or air passages and cause the inverter to overheat.

CAUTION

The temperature of the inverter cooling fins rises to approximately 90°C (194°F). The mounting surface for the inverter must be of heat resistant material.

CAUTION

Do not install the inverter upside down or horizontally. Do not install one inverter above another or any apparatus that generates heat while the inverter is operating, unless adequate precautions are taken.



Minimum clearances from adjacent equipment.

CAUTION

Because the air heated by the inverter is expelled upwards by the built-in cooling fans (where fitted), do not place the inverter below any material which has a low resistance to heat.

4-1 Environment

Install the inverter in a location that meets the following requirements:

- The ambient temperature is between -10°C and +50°C (+14°F to +122°F).
- If the ambient maximum temperature exceeds 40°C (104°F), **remove the ventilation cover(s)** located on top of the inverter to allow increased air flow (inverters ≤22kW only). For information about covers refer to page 13.
- The relative humidity is between 20% and 90%. Avoid any location subject to damp atmosphere, condensation, freezing, or where the inverter would come into contact with water, mist or spray.
- Do not install the inverter in any location subject to direct sunlight, dust, corrosive gas, inflammable gas, or oil mist.
- The inverter should be installed at an altitude below 1000m (3281 feet).
- Vibration measured at the location of the inverter installation should be less than 0.6G.
- The inverter should NEVER be installed in any location classified as a Hazardous Area.

4-2 Position and materials

- Position the inverter vertically so that the inscriptions on the keypad panel are the right way up.
- Secure the inverter firmly to a rigid structure.
- The material of the mounting panel must be able to tolerate the temperature attainable by the inverter heatsink, normally 90°C (194°F).
- The dimensions of the fixing screws required are shown in the overall dimension diagrams on pages 15, 16 and 17.
- The fixing screws should be used with nuts or washers that will resist vibration.
- **Do not overtighten the fixing screws.**

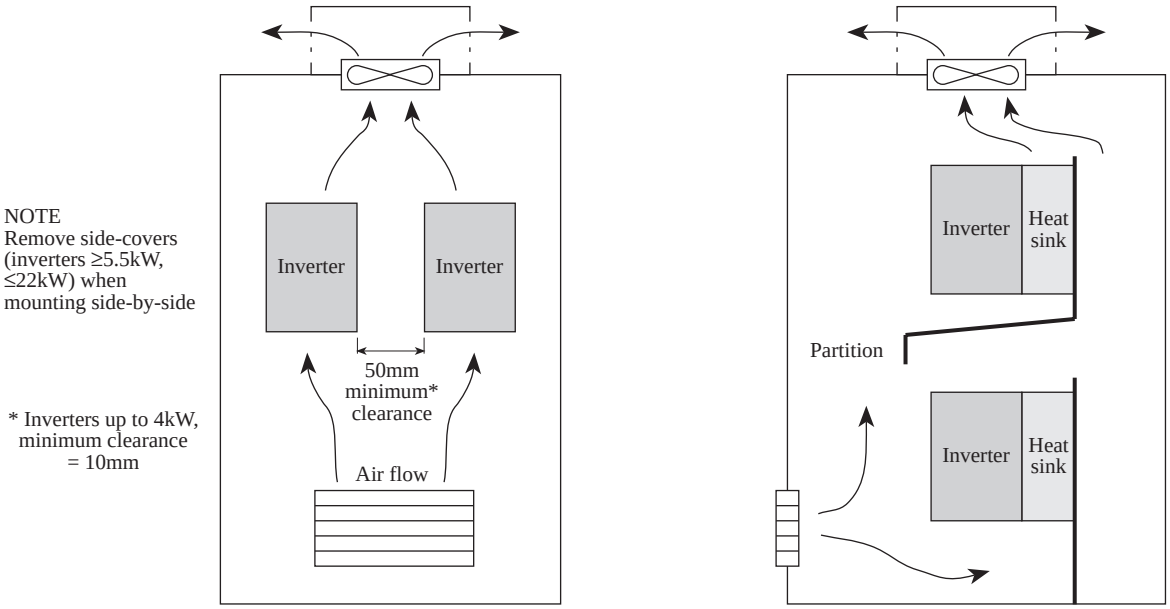
4-3 Ventilation and cooling

If the inverter is to be installed in a closed cubicle or cabinet, the minimum clearances to adjacent equipment must be allowed, as shown in the diagram on page 11. If two or more inverters are to be installed in the same enclosure, they should ideally be side by side and the minimum clearance (10mm for inverters up to 4kW or 50mm for all larger sizes *AND provided that* ambient temperature does not exceed 40°C) should be allowed between them.

If an inverter is to be mounted above heat-producing equipment of any type, precautions must be taken to ensure that the heat generated by the lower unit does not affect the upper. A deflector plate may be fitted below the inverter to nullify the heating effect, as illustrated below.

Alternatively, satisfactory cooling may be achieved by 'through-panel' mounting, where the heatsinks of the inverters project through the mounting panel into free air or into a ventilating duct. The duct may be supplied with forced air cooling if necessary.

An adapter is required to enable a *Jaguar VX* inverter to be mounted in this way. Please consult IMO Precision Controls Ltd.



(a) Side-by-side installation. Ventilated enclosure. Front view.

(b) Vertical installation. Ventilated enclosure. Side view.

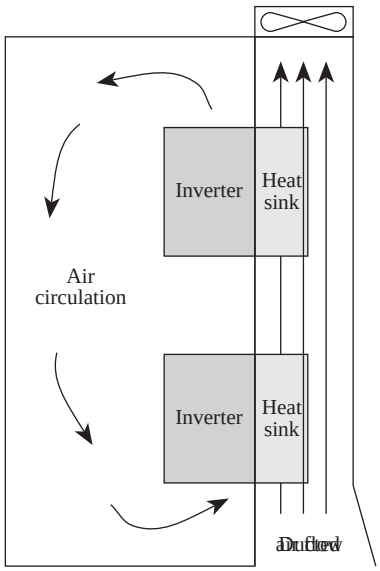
Installation recommendations for two or more inverters, to ensure adequate ventilation.

CAUTION

Because the ambient temperature greatly affects inverter life and reliability, do not install the inverter in any location that exceeds the maximum specified temperature of 50°C.

Leave the ventilation covers (inverters ≤22kW) in place for temperatures of 40°C or below, and **remove them for temperatures between 40°C and 50°C**. With covers removed, enclosure rating is IP20. (Covers — refer to page 13.)

(c) Vertical installation. Ducted external cooling. Side view. Optional adaptors are available to facilitate through-hole mounting.



4-4 Enclosure Size Calculations

PWM carrier frequency and heat loss

The quantity of heat generated by an inverter varies according the frequency of the PWM carrier wave, adjusted by Function 81, page 64. Heat loss data is given on page 14.

Unventilated enclosures

$$A = \frac{q}{h \,.\, (T_s - T_a)}$$

where A = effective surface area of the enclosure in m^2

q = total heat loss of all heat-generating equipment in the enclosure

h = thermal radiation factor of the material of the enclosure, typically 5 to 6 $W/m^2/^oC$ for steel

T_s = enclosure surface temperature in ^oC

T_a = ambient temperature in ^oC

NOTE Maximum permissible ambient temperature is 50^oC

Force-ventilated enclosures

$$Q = \frac{q}{\rho \,.\, C \,.\, (T_o - T_a)}$$

where Q = quantity of ventilating air required in m^3/s (x60 x60 = m^3/h)

q = total heat loss (in kW) of all heat-generating equipment in the enclosure

ρ = relative density of air, 1.057 kg/m^3 at 50^oC

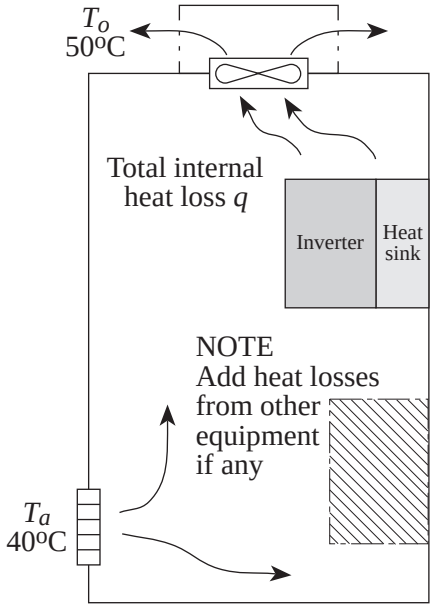
C = specific heat of air,

typically 1.0 kJ/ kg .^oC

T_o = exhaust temperature of cooling air in ^oC

T_a = ambient temperature in ^oC

NOTE Maximum permissible enclosure surface temperature is 50^oC



Please consult IMO Precision Controls Ltd or the supplier of the enclosure if data is required

4-5 Inverter covers (≤22kW only)

Front cover

It is not necessary to remove the inverter front cover for cooling. It should be left in place, except when wiring up, for safety.

Top covers

There are two removable covers fitted to the top face of the inverter. Normally these should be left in place, but removed if the ambient temperature of the installation is likely to exceed 40^oC.

Side covers

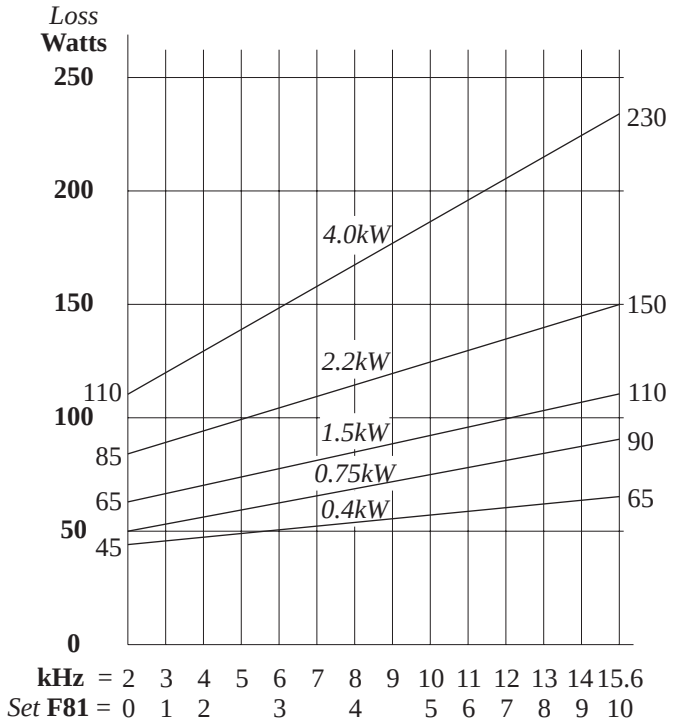
Inverters from 5.5kW to 22kW are fitted with removable side covers. THESE MUST BE REMOVED if two or more inverters are to be installed side-by-side or if the ambient temperature of the installation is likely to exceed 40^oC. With side covers removed, enclosure rating is IP20.

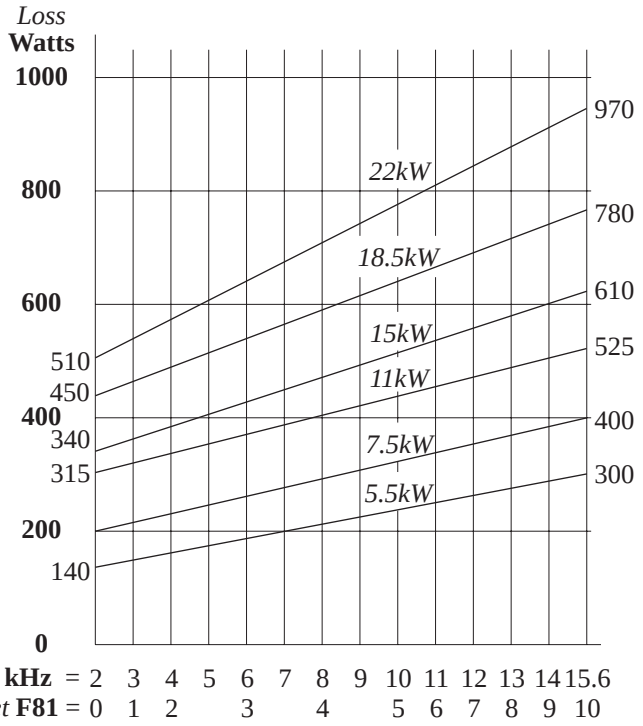
4-6 Removing the keypad panel

The keypad panel can be mounted remotely from the inverter if desired. A 2m cable is available for this purpose. With the inverter front cover in place, loosen the two keypad panel fixing screws from the front and remove the keypad panel. Plug the connection cable into the connector behind the keypad panel and into the connector exposed in the inverter front cover. Keypad dimensions are shown on page 15.

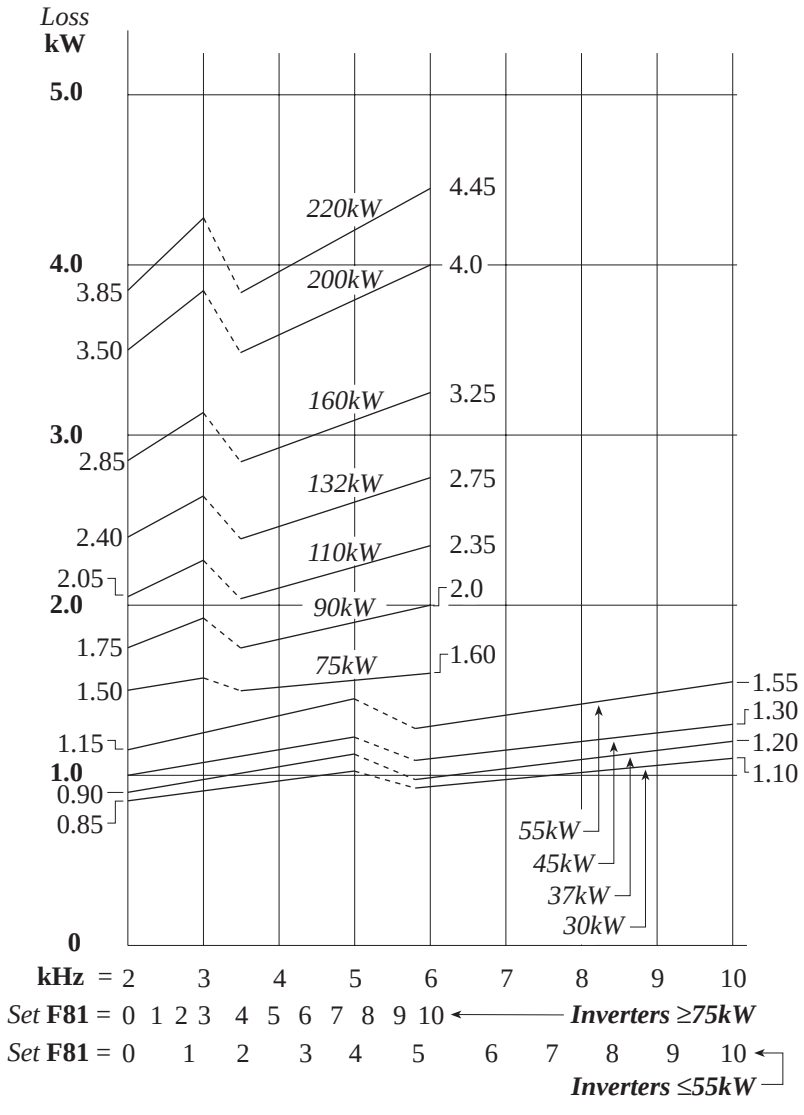
4-7 Heat dissipation

Jaguar VX40 to VX2200 and VX750P to VX2200P

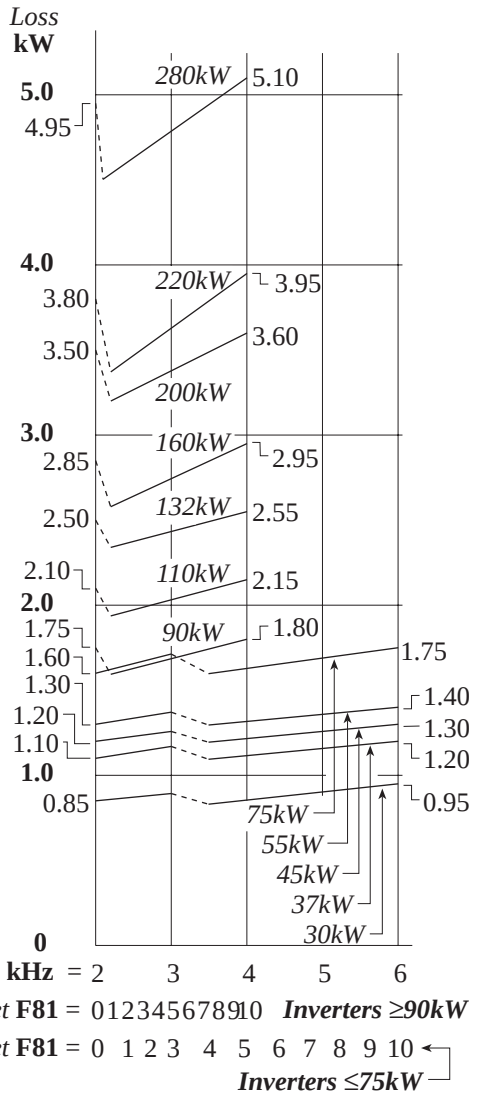




Jaguar VX30K to VX220K



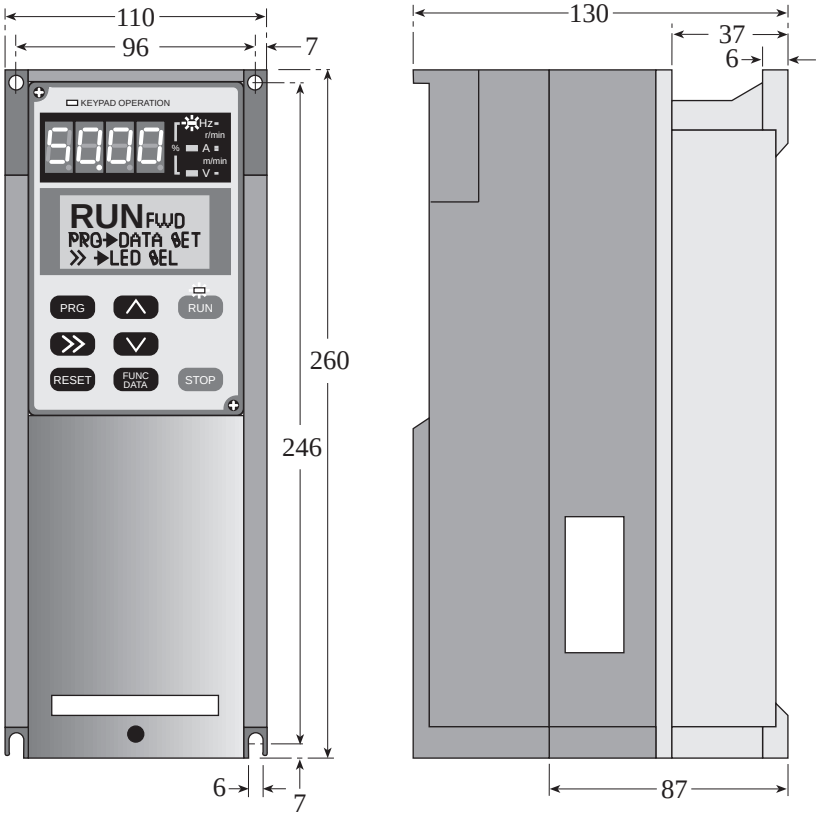
Jaguar VX30KP to VX280KP

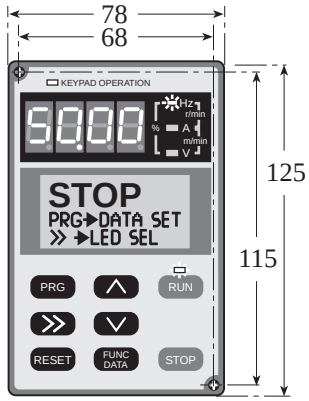


Heat losses at all available PWM switching (carrier) frequencies.

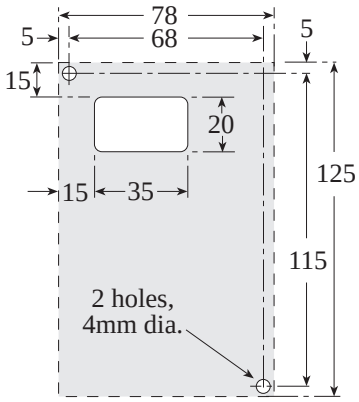
4-8 Dimensions

Jaguar VX40



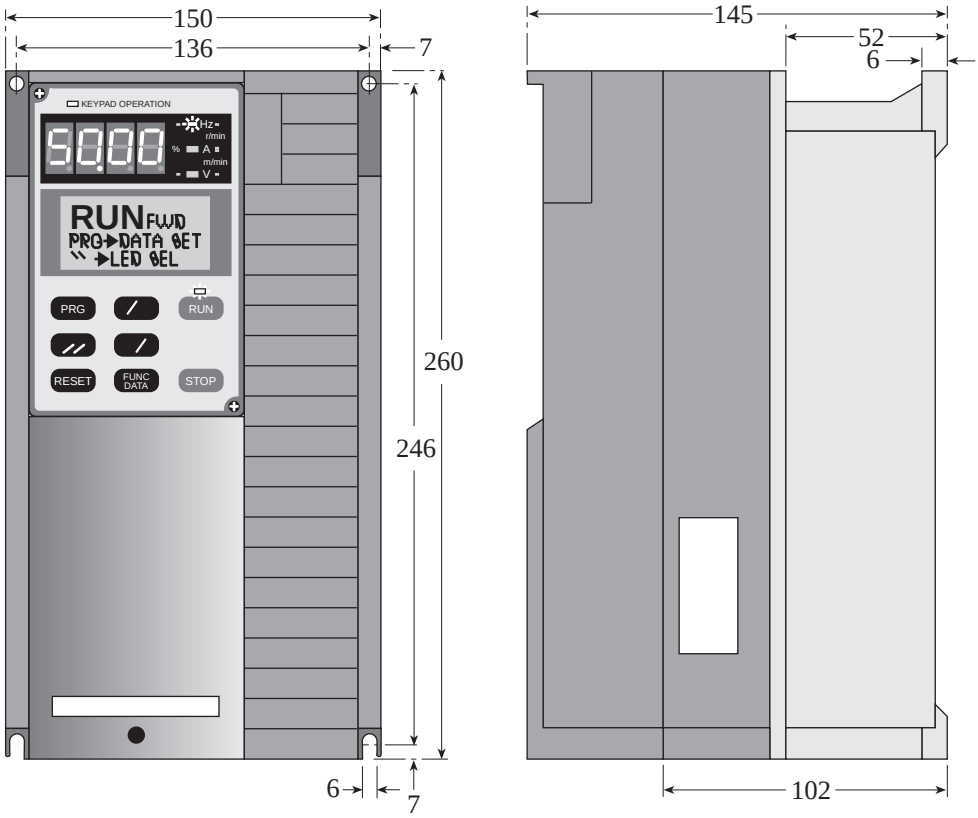


Keypad panel mounting dimensions. Common to all modules.

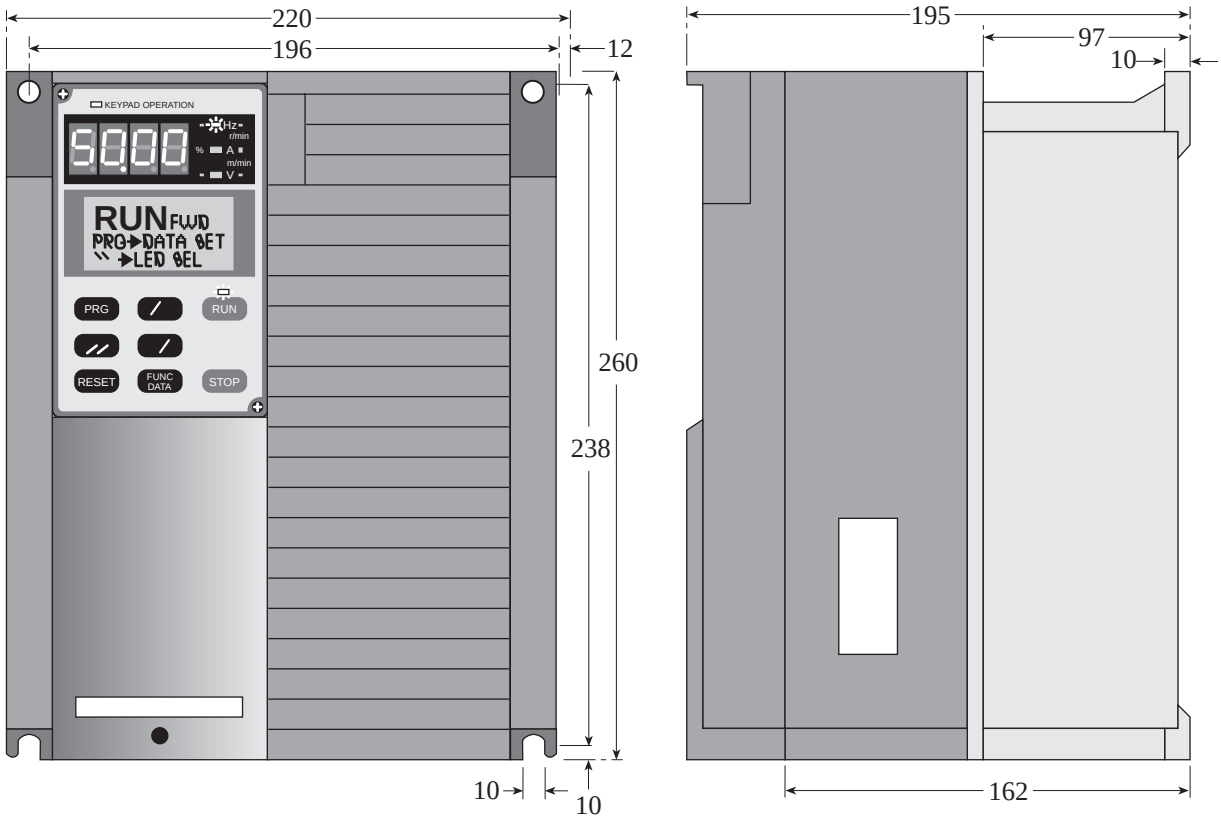


Remote mounting for keypad. Drilling and cutout dimensions. Pod depth (thickness) 15mm.

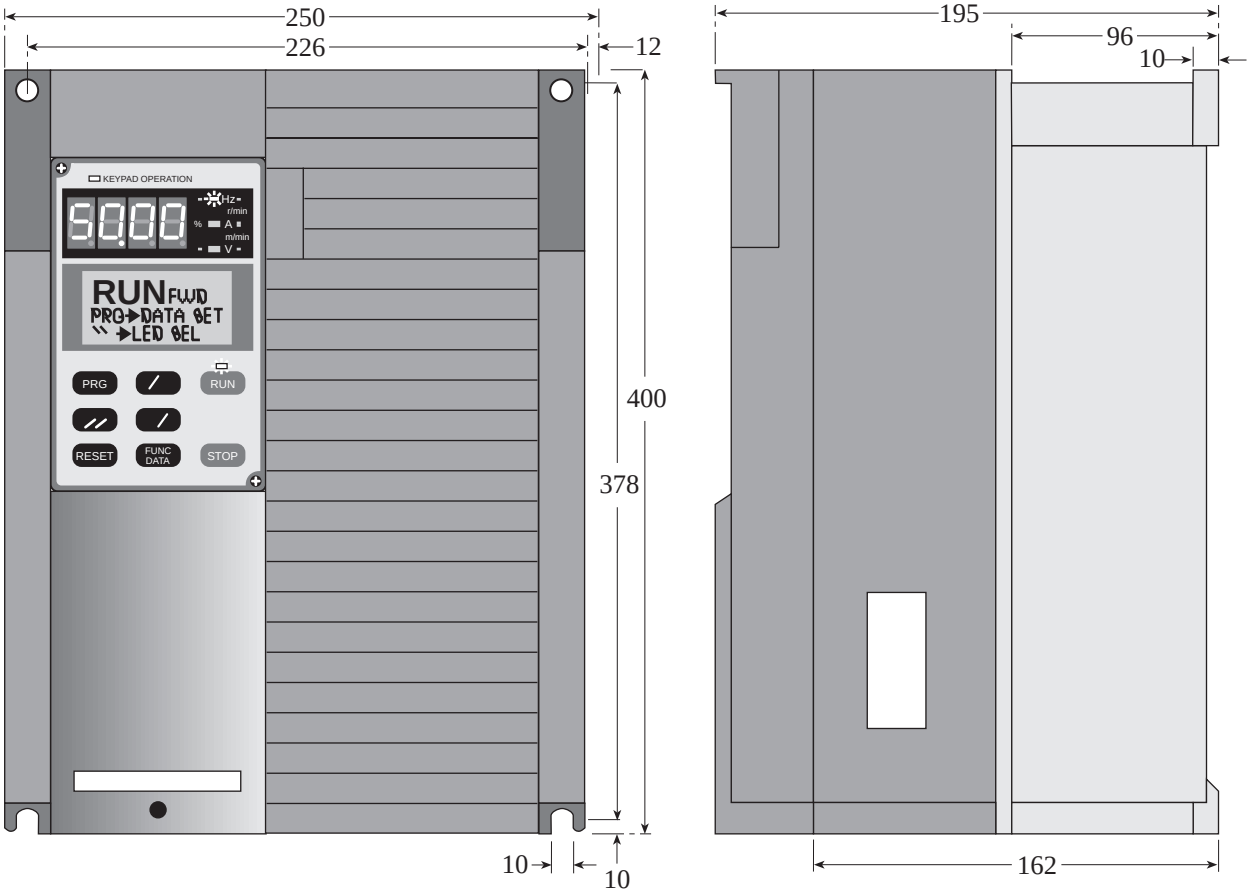
Jaguar VX75 to VX400



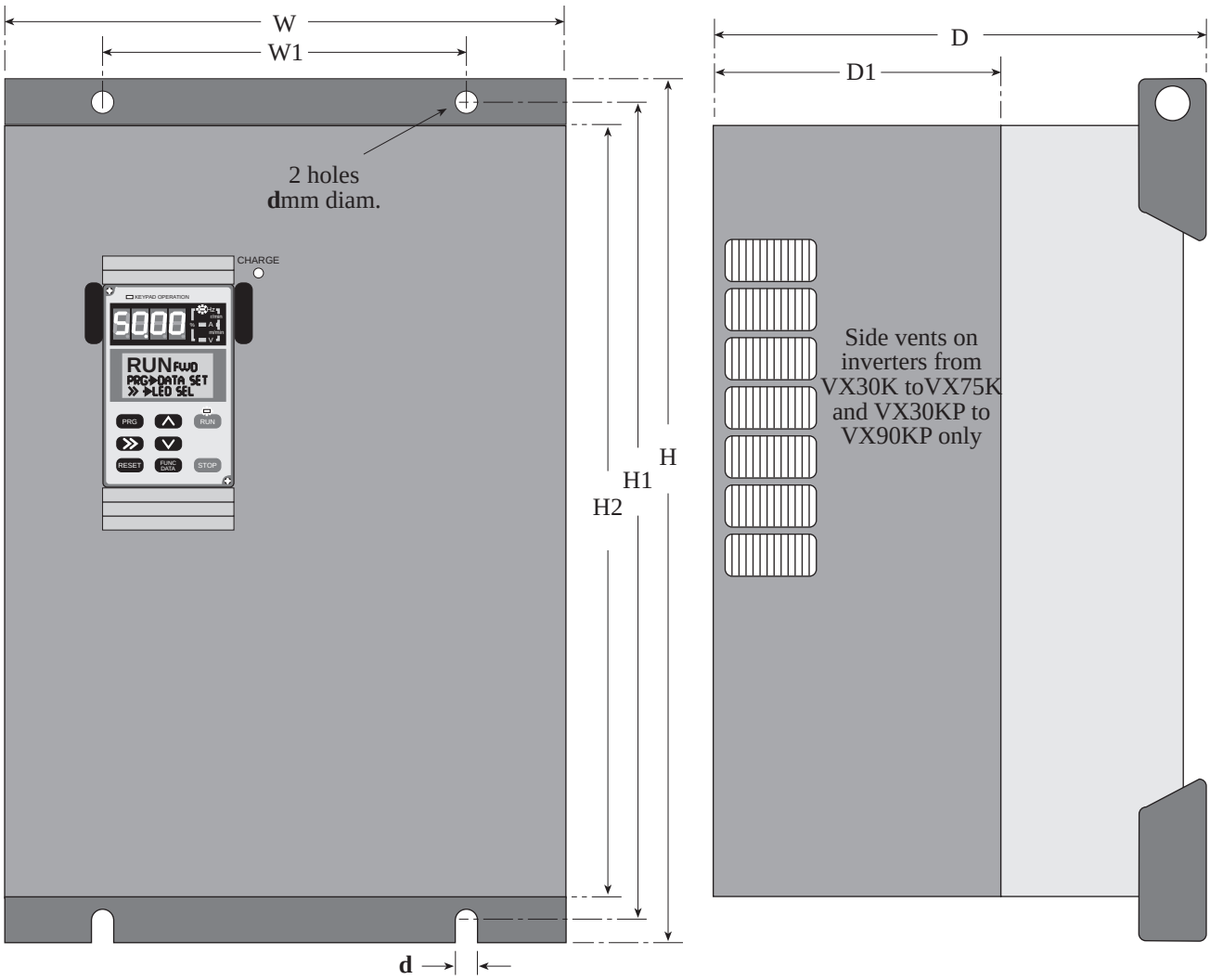
Jaguar VX550, VX750, and VX750P, VX1100P



Jaguar VX1100 to VX2200 and VX1500P to VX2200P



Jaguar VX30K to VX220K, VX30KP to VX280KP



Inverter order code	W	W1	H	H1	H2	D	D1	**d**
VX30K VX30KP VX37KP	340	240	550	530	500	290	185	10
VX37K VX45KP	375	275	550	530	500	290	185	10
VX45K VX55KP	375	275	675	655	625	275	170	10
VX55K VX75KP	530	430	675	645	610	290	185	15
VX75K VX90KP	530	430	740	710	675	300	180	15
VX90K VX110KP	530	430	740	710	675	330	205	15
VX110K VX132KP	530	430	740	710	675	330	205	15
VX132K VX160KP	530	430	1000	970	935	435	295	15
VX160K VX200KP	530	430	1000	970	935	435	295	15
VX200K VX220KP	680	580	1000	980*	NA	435	320	NA
VX220K VX280KP	680	580	1000	980*	NA	435	320	NA

* These inverters have the upper fixing plate only. Dimension H1 is from the upper fixing hole centre line to the underside of the module. Dimensions are in mm.

5 Electrical Installation

WARNING — ELECTRICAL SHOCK HAZARD

Do not touch any electrical parts of the inverter when the power supply is connected, even if the inverter output is at STOP. After the power supply has been disconnected, the built-in smoothing capacitors will hold a residual charge. It takes up to 7 minutes for the capacitors to discharge completely. To avoid danger, wait until the charge indicator LED is extinguished.

On inverters rated ≤22kW the LED (CRG) can be seen when the front cover is removed. On inverters rated ≥30kW the LED can be seen through an aperture, marked CHARGE, in the front cover. If in doubt, use an approved voltage tester to check that the voltage has fallen to a safe level before touching any electrical parts.

5-1 Power connections

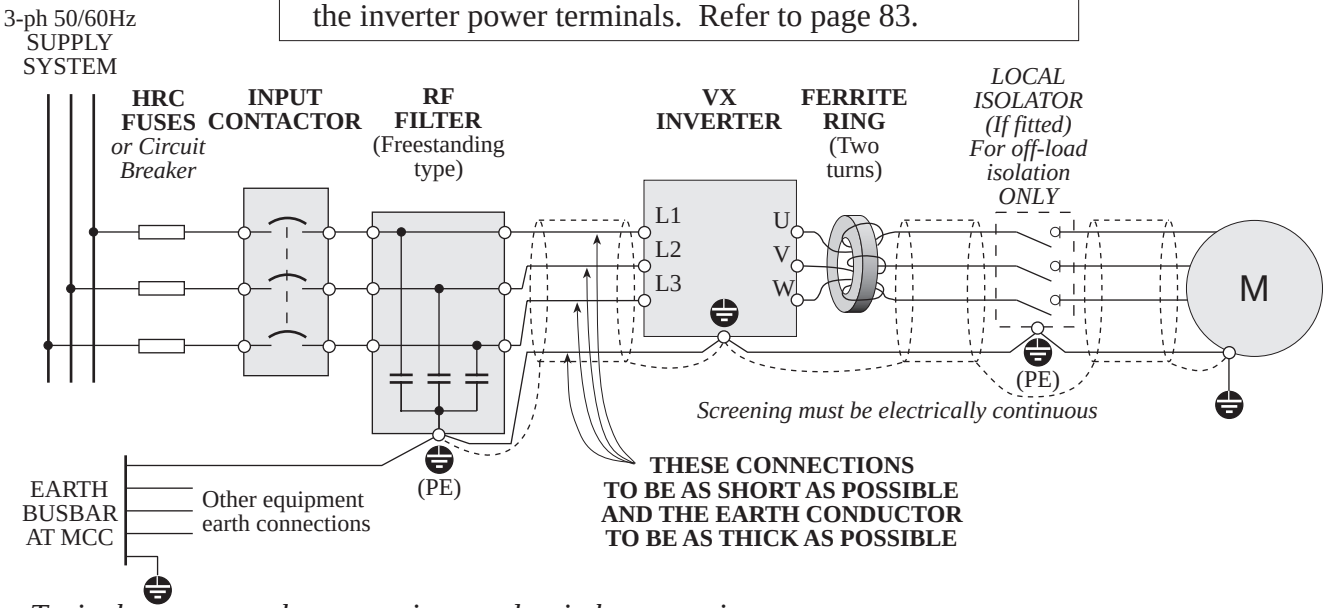
Terminal label	*Terminal duty*	*Description*
L1, L2, L3	Power supply	3-phase incoming power supply, 50Hz or 60Hz.
U,V,W	Motor supply	Connections to 3-phase induction motor.
(+), P1	DC reactor	Inverters VX40 to VX2200 and VX750P to VX2200P
P(+), P1		Inverters VX30K to VX220K and VX30KP to VX280KP
(+), DB	External braking resistor	Inverters VX40 to VX750, VX750P and VX1100P
(+), (-)*	Braking Unit	Inverters VX1100 to VX2200 and VX1500P to VX2200P
P(+), N(-)*		Inverters VX30K to VX220K and VX30KP to VX280KP
	*Do not connect a braking **resistor** directly to these terminals. A **Braking Unit** is essential. Refer to pages 20 and 87.	
⏚	**Safety earth**	**WARNING! INVERTER *MUST* BE EARTHED.**

NOTE The motor chassis should be EARTHED to the same earth busbar as the inverter, as shown in the diagram below.

5-1-1 Typical power circuit connections

CAUTION

Take care when performing any insulation tests between the inverter power terminals. Refer to page 83.



Typical power supply connections and switchgear options.

5-1-2 Access to terminals

The front cover can be removed and replaced without detaching the keypad panel.

Loosen the inverter cover screw or screws from the front. If the cover is moulded plastic, grip it at the sides, close to the bottom, and exert a firm inward pressure to release the internal moulded catches.

5-1-3 Safety earthing

For safety and to reduce electronic noise, the earth (ground) terminal should be connected to the supply system earth busbar in the motor control centre or switchgear enclosure.

WARNING

ELECTRICAL SHOCK HAZARD: The inverter chassis, motor base and equipment enclosure structure should be earthed in accordance with the national and local safety specifications in force.

5-1-4 Input circuit protection

Details of fuse and circuit breaker ratings can be found on pages 6 and 7.

CAUTION

Do not connect any supply voltage that exceeds the standard specification voltage fluctuation permissible (refer to *Technical Data*, page 4). If excessive voltage is applied to the inverter, internal components will be damaged and the Warranty invalidated.

CAUTION

Connect the power supply only to the power terminals L1, L2, L3, NOT to the output terminals U, V, W.

CAUTION

Do not connect the power supply to the control circuit terminals.

It is essential that the supply circuit to the inverter terminals L1, L2, L3 is properly protected against short circuit and earth faults.

The alternatives are a fused contactor (for fuse ratings refer to pages 6 and 7) or a circuit breaker of equivalent rating to ensure that all three phases of the supply to the inverter are closed simultaneously.

For starting and stopping the motor in routine service it is recommended to use the inverter control circuit, terminals (FWD)-(P24)/(CMS) and (REV)-(P24)/(CMS), or the RUN and STOP keys on the keypad panel, rather than to switch the supply contactor or circuit breaker.

Do not connect the inverter to a single phase power supply. Only single-phase inverters can be used with single-phase power.

Pay particular attention to the following:

- Ensure that the incoming power supply is connected to the main power supply terminals L1, L2, L3. Connecting the power supply to any other terminals will damage the inverter.
- Be sure to complete both the inverter and motor earth connections to prevent accidental electrical shock. Refer to the diagram on page 18.
- Always use crimped terminations for the power conductors for maximum reliability.
- Ensure that all connections are correctly tightened, and inspect them for tightness at regular intervals. For torque data, refer to pages 26 and 28.
- If the power connections are to be changed after power has been turned off, note that the smoothing capacitors in the DC section of the main circuit take some time to become fully discharged. To avoid danger, wait until the charge LED (CRG) is extinguished. The CRG LED is not visible until the front cover is removed from inverters ≤22kW. If in any doubt, use an approved voltage tester.

5-1-5 Circuit isolation

Safety isolation of the complete drive circuit may be achieved by the intrinsic design of the contactor or circuit breaker, or a separate isolator may be installed for the purpose, according to local needs. Refer also to *Operational Guidelines*, page 32.

An isolator may be installed between the inverter and the motor to meet operational safety requirements where necessary. **On no account should this be used to control the start/stop operation of the motor**. Auxiliary contacts (early break, late make) should interface with the inverter control terminals. Consult IMO Precision Controls Ltd for further details if in any doubt.

5-1-6 Motor circuit connections

Connect a 3-phase squirrel-cage induction motor to the inverter output terminals U, V, W in the correct sequence, using screened or armoured cable. If the operational commands (FWD and REV) do not match the desired direction of motor rotation, interchange any two of the U, V, W connections, NOT the L1, L2, L3 connections.

continued…

The motor circuit is protected by the inverter control software. The installation of any type of automatic or semi-automatic switchgear in the inverter output circuit **is not recommended** except when two or more motors are to be supplied in parallel from the output of one inverter.

If the length of the motor cable is greater than 50m, it may be necessary to set the carrier frequency, Function 81, to 0 to reduce the effect of leakage current at high PWM frequencies.

- Consult IMO Precision Controls Ltd before using a motor cable in excess of 100m.

CAUTION

Do not connect filter capacitors on the output side of the inverter.

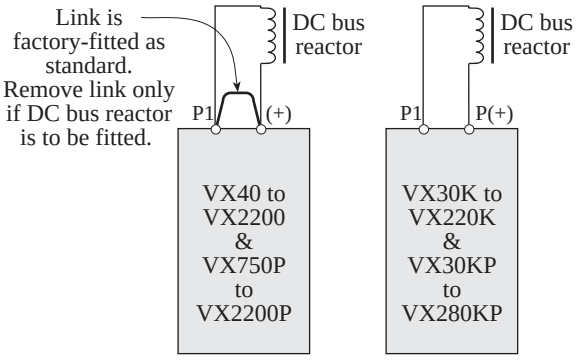
CAUTION

Motor thermal overload protection should be provided by a motor thermistor and thermistor relay.

CAUTION

Do not connect a power factor correcting capacitor or a surge absorber, or any form of automatic switchgear to the output side of the inverter.

5-1-7 DC bus reactor connections



Connections for the DC bus reactor.

IMO Precision Controls Ltd recommends the use of a DC reactor to improve power factor and reduce the harmonics reflected into the supply network. The use of a DC reactor **is essential** on all inverters of ≥30kW rating, and optional on inverters ≤22kW. For typical reactor data, refer to page 8.

At the time of shipment from the factory, terminals P1 and (+) [or P1 and P(+)] are connected by a short-circuiting link (on inverters of ≤55kW rating only). Remove the link before connecting the DC reactor.

If a DC reactor is not installed on inverters ≤22kW, make sure that terminals P1 and (+) **are linked** as shown in the diagram above.

5-1-8 External braking connections

All Inverters — *IMPORTANT*

CAUTION

Do not connect the power supply to any **braking** terminals on the inverter.

Do not short-circuit between braking terminals. **Do not** connect any resistor with an ohmic value of less than the standard application braking resistor (refer to page 86).

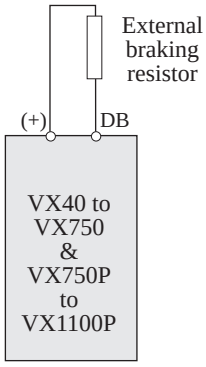
CAUTION

When using an external braking resistor, it is **essential** that a series-connected thermal overload trip circuit is installed and that it opens the **main power supply switch** if a braking transistor fault occurs. Refer to the diagram on page 87.

Terminals (+), DB
Inverters VX40 to VX750 and VX750P to VX1100P.

The standard on-board braking resistor is connected to the (+) and DB terminals internally. If the thermal capacity of the internal braking resistor is insufficient (if frequent braking or high-torque braking are required, for example), a higher-capacity external braking resistor can be connected instead, to increase the braking capability.

- Connect the terminals of the external braking resistor to the (+) and DB terminals of the inverter.
- Use conductor with a length of 5m maximum.



Connections for an external braking resistor. **Disconnect the internal resistor.**

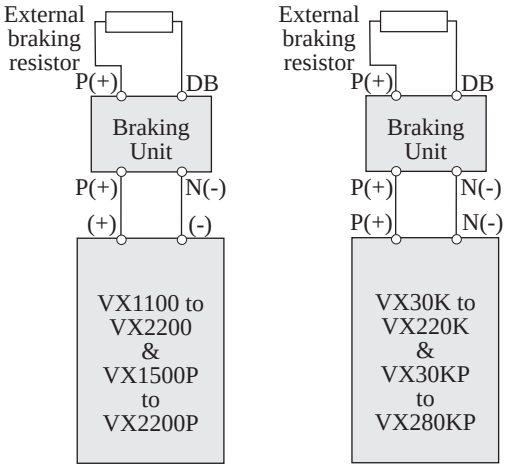
CAUTION

Disconnect the internal braking resistor from terminals (+) and DB. Securely insulate the ends of the disconnected conductors.

Terminals (+), (-)
VX1100 to VX2200 and VX1500P to VX2200P.

These inverters do not have an internal braking resistor. To provide a braking capability it is necessary to install an optionally-available external Braking Unit and braking resistor. Connect according to the following procedure.

- Connect the (+) and (-) terminals of the inverter to the P(+) and N(-) terminals respectively of the braking unit. Conductor length 5m maximum.



Connections for an external Braking Unit and resistor.

- Connect the terminals of the braking resistor to the P(+) and DB terminals of the Braking Unit. Conductor length 5m maximum.

Terminals P(+), N(-)
VX30K to VX220K and VX30KP to VX280KP.

These inverters do not have an internal braking resistor.

- Connect the P(+) and N(-) terminals of the inverter to the P(+) and N(-) terminals respectively of the Braking Unit. Conductor length 5m maximum.

CAUTION

If external braking is not installed, **leave** the terminals **unconnected, NOT linked.** They should NEVER be short-circuited **nor connected directly** to a braking resistor.

5-1-9 Low Voltage Directive (LVD)

IMO Jaguar Inverters carrying the suffix -EN or -D as part of their model number are compliant with Low Voltage Directive 73/23/EEC and conform to the low voltage requirements of DIN VDE 0160/1988/92 for 'over voltage category 2, pollution degree 2' when wired and earthed in accordance with the installation instructions herein and installed within a steel enclosure which satisfies the requirements of 'pollution degree 2' and used in conjunction with a 3-phase AC power supply which is recognised 'over voltage category 2' and has an earthed neutral point.

NOTES

1 Throughout this manual the -EN and -D suffixes have been omitted for simplicity and for considerations of space, but all inverters described in this publication are of the EMC and LVD conformant revision designated by the -EN and -D suffixes. These suffixes form part of the model number shown on the product rating plate (page 2) and on the packaging *eg* VX400-EN, VX200KP-D.

2 Use ring- or spade-type crimped terminals for all power and earth cabling.

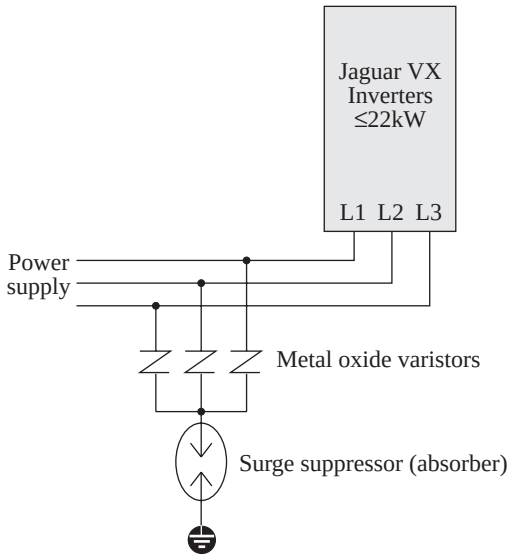
5-1-10 External surge diverters ≤22kW

If the power supply is over voltage category 3 (VDE 0160/1988/92), connect an external surge diverter network in the supply to the inverter as shown in the diagram below.

Specification:

Varistor Metal oxide
Max. applied voltage: 510V rms AC (670V DC)
Max. clamping voltage: 1340V
Max. energy: 110.0 Joule, 0.6W
Current: 4500A once or 2500A twice

Surge absorber
DC spark-over voltage: 1500V DC
Surge current capacity: 8 x 20µs at 2000A or 8 x 2µs at 100A, 300 times.



Application of a surge diverter.

5-2 Control terminals

5-2-1 Control input terminals — general

Refer to the diagram on page 24 and the table on page 25 for details of the control circuits and terminals.

Refer to the diagrams on pages 26 to 29 for details of the layout and location of control terminals.

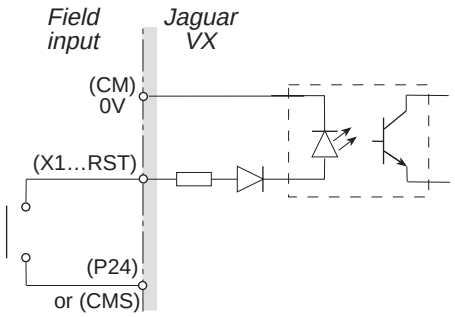
WARNING

The stop and start inputs should not be relied upon alone to ensure the safety of personnel. If a safety hazard could arise from the unexpected starting of the motor, an interlock mechanism should be provided to prevent the motor from running except when it is safe for it to do so.

CAUTION

Do not connect the 3-phase power supply to the control circuit terminals.

continued…

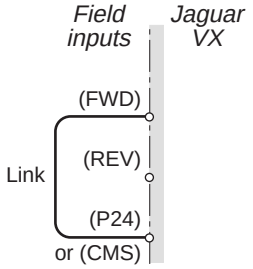


General control input circuit.

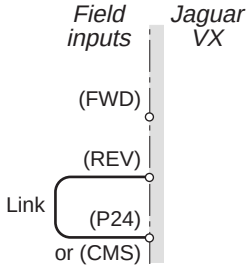
External control equipment should be equipped with contacts of high reliability which also do not have any closing defects.

> CAUTION
> Please refer to the data concerning maximum capacity under *Control Specifications*, page 10.

5-2-2 RUN/STOP command input terminals



Terminals linked (as shipped).



Terminals linked to reverse motor rotation.

The RUN/STOP command terminals (FWD)-(P24)/(CMS) are short-circuited by a solid link at the time of shipment, and Function 01 is set to 0 (Keypad Operation).

NOTE Whilst (FWD) is connected to (P24)/(CMS), Function 01 *cannot be changed.*

In this condition, the inverter starts when the RUN key on the keypad panel is pressed, and stops when the STOP key is pressed. The inverter will then accelerate and decelerate in accordance with either:

if Function 00 = 0	the ∧ and ∨ keypad keys;
if Function 00 = 1	frequency reference inputs: analog terminals 13, 12, 11, C1 or digital terminals X1, X2.

To reverse the direction of operation permanently, disconnect the (FWD)-(P24)/(CMS) link and instead link terminals (REV)-(P24)/(CMS) as illustrated above.

5-2-3 Analog frequency reference terminals

Terminals (13), (12), (11) and (C1) are used for connecting a 0V to +10V analog voltage input or a 4-20mA analog current input for frequency reference, as shown on page 24.

- **Voltage reference**

Input 0V to +10V DC at terminals (12)-(11), for zero to maximum output frequency (Function 02) or 0V to +5V input if gain is set to 200% (Function 14 = 200.0).

A potentiometer 1kΩ 1W, may use the internal +10V power supply at terminal (13).

- **Current reference**

Input 4-20mA at terminals (C1)-(11). Positive reference to (C1); negative to (11).

- **Bipolar reference (≥30kW standard, ≤22kW option)**

Input ±10V DC at terminals (V1)-(11) to control both the output frequency and direction of motor rotation.

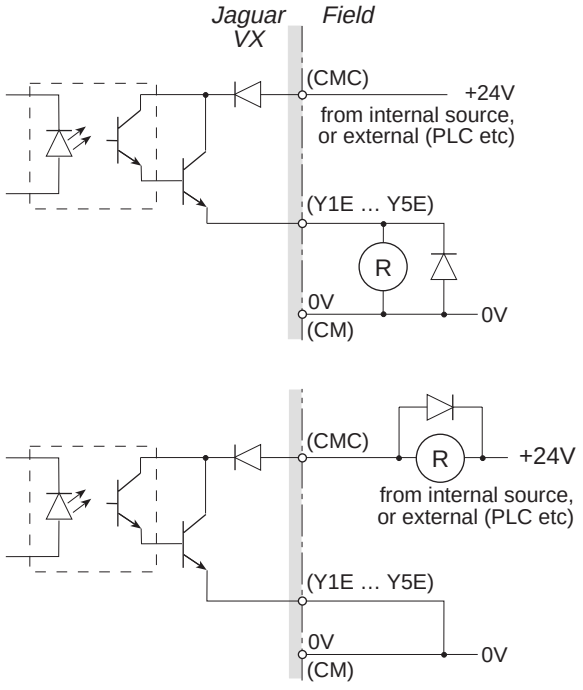
5-2-4 Programmable digital input terminals (X1…X5)

Terminals X1…X5 can be configured for a variety of control functions. Refer to Function 32, page 52, for complete details.

When the inverter is configured for 'motorised pot.' control, terminal X1 allows an 'increase speed' signal to be given when ON (X2 off); terminal X2 similarly reduces the speed when ON (X1 off).

Terminals X1, X2, X3 provide for multistep operation, with 7 different frequencies. Refer to Functions 32 and 20 to 26.

5-2-5 Programmable output terminals (Y1E…Y5E)

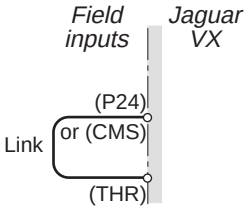


Typical programmable output circuits.

> CAUTION
> Please refer to the data concerning maximum capacity for terminals Y1E…Y5E under *Control Specifications*, page 10.

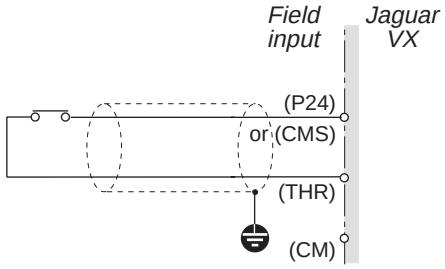
5-2-6 External alarm input terminal (THR)

> CAUTION
> Motor thermal overload protection should be provided by a motor thermistor and thermistor relay.



Terminals linked (as shipped).

Terminals (THR)-(P24)/(CMS) are short-circuited at the time of shipment as illustrated above. To use the (THR) terminal, remove the link and connect a relay which opens when an external fault occurs (*ie* connect through a normally-closed contact), as illustrated below.



External protection relay control.
NC contact stops the inverter when open.

5-2-7 Control and auxiliary power supply terminals ≥30kW only

R0, T0*	Auxiliary power input for control circuits	Connect to the AC power supply upstream of protective switchgear if the keypad display is required after mains power loss.	
U1, U2	Control power supply tap change	If the input voltage is as shown below, move the cable from U1 to U2 position, pages 28 and 29.	
		Frequency Hz	*Power supply* V
		50	380
		60	380 to 400
V1*	Bipolar frequency reference	±10V DC input.	

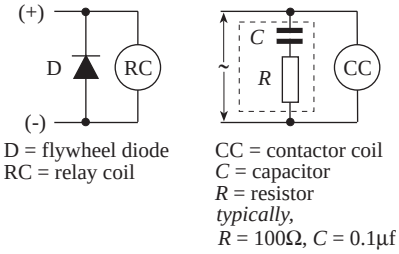
* Optional for inverters ≤22kW.

5-2-8 Notes About Control Wiring

- **Specification**

Use pvc-insulated control cables, screened overall, 0.75mm^2 cross-section, not >50m long.

- **Voltage surge suppression**



D = flywheel diode
RC = relay coil

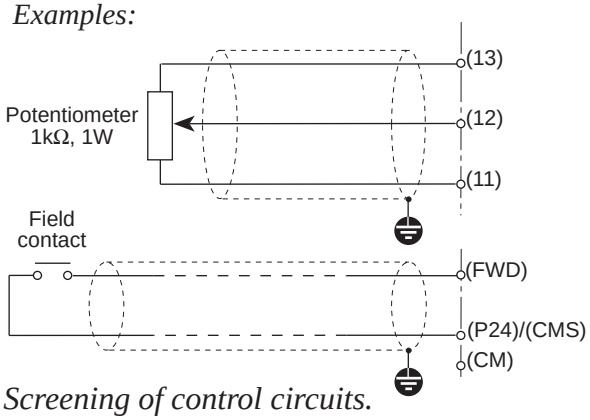
CC = contactor coil
C = capacitor
R = resistor
typically,
R = 100Ω, *C* = 0.1µf

Surge suppression for relay and contactor operating coils.

Sudden changes of flux in the operating coils of relays and magnetic contactors induce high transient EMFs which may cause surge voltages (noise). Such voltages may result in malfunction of internal or external control circuits. It is advisable to suppress these coils as shown above.

- **Control circuit wiring and screening**

Examples:



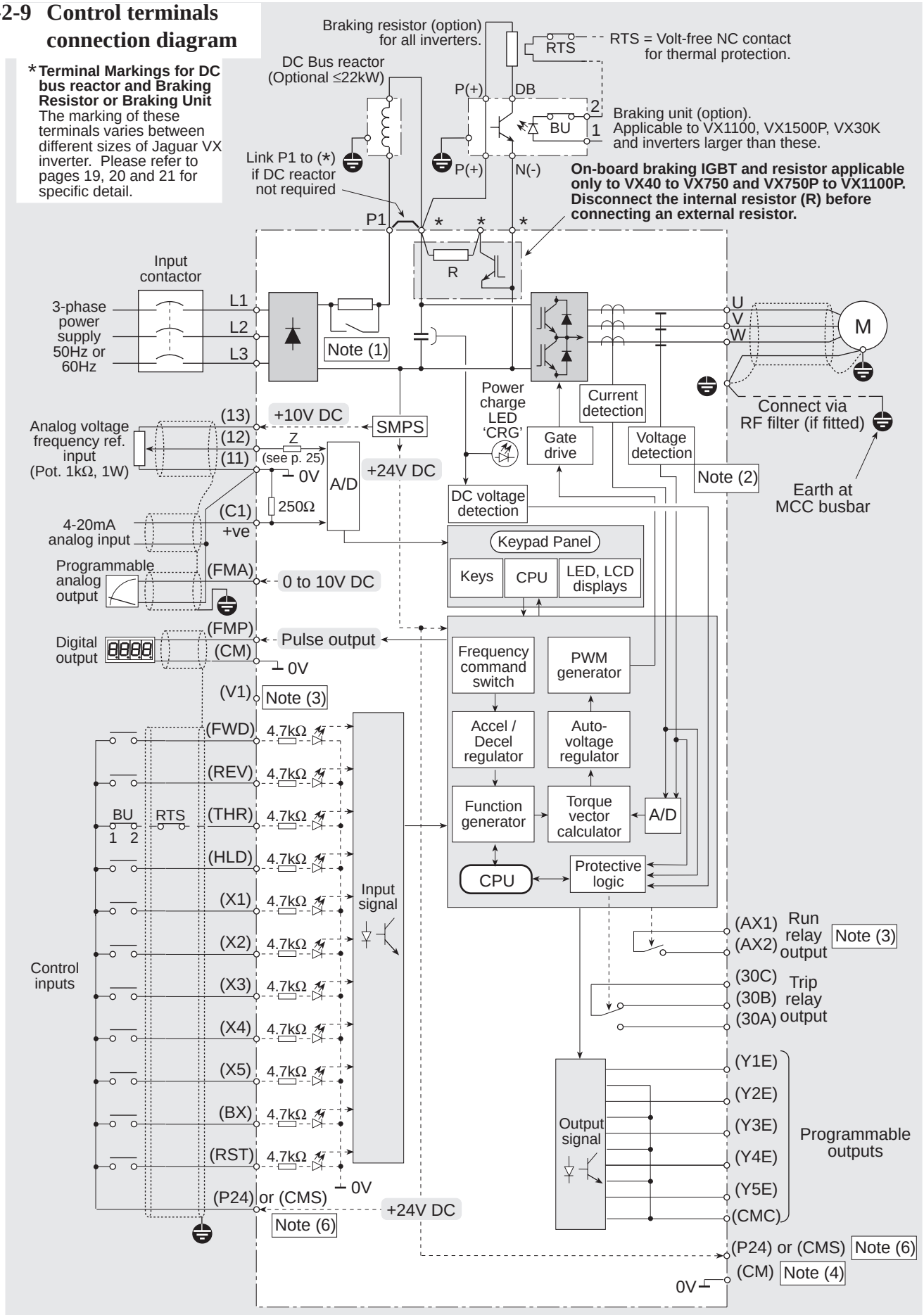
Screening of control circuits.

Control circuit wiring should be kept as far away as possible from the power supply circuit wiring. If the control circuit wiring must cross the power circuit or other wiring, it should be arranged to cross at right-angles.

The screening should be connected to earth, at the drive end only, for control circuits as shown above and on page 24. If an external process controller or PLC is used, the screening should be connected to a 0V common terminal at the NON-drive end. The inverter end should be left unconnected.

> CAUTION
> Do not perform an insulation test on the inverter control circuit terminals. Refer to page 83.
> For continuity testing, use a high resistance tester, not a megger or a buzzer.

5-2-9 Control terminals connection diagram



NOTES (1) For inverters rated ≤22kW the inrush contactor is replaced by an SCR.
(2) Voltage detection circuit applicable for inverters ≥30kW only.
(3) Standard for inverters ≥30kW, optional for smaller models.
(4) Two terminals (CM) standard for inverters ≤22kW, one for ≥30kW.
(5) If motor thermistors are required, please consult IMO.
(6) Internal +24V DC supply terminal designated P24 (≤22kW) or CMS (≥30kW).

0V Common Terminals (11) and (CM) are optically isolated.
Relay status shown as at inverter 'power ON' or 'healthy'.

5-2-10 Control terminals list

Purpose	*Terminal*	*Terminal Name*	*Description*		
Analog frequency setting	11	Speed reference 0V common	Use with terminals 12, 13, C1, FMA (and V1, ≥30kW only).		
	12	Potentiometer input	Maximum speed signal is at +10V with 0V to +10V DC input. Input impedance (Z, see p. 24) 20kΩ (≤22kW), 22kΩ (≥30kW).		
	13	Potentiometer supply	Regulated +10V DC power supply for a 1W, 1kΩ speed control potentiometer. Input 10mA max.		
	C1	Current loop input	Maximum speed demand is at 20mA with a 4-20mA DC input, impedance 250Ω. Inverter output frequency is proportional to current input signal, zero speed = 4mA.		
	V1(1)	Auxiliary freq. reference	Bipolar ±10V input. Impedance 20kΩ (≤22kW), 22kΩ (≥30kW).		
Programmable inputs	CM(2)	0V common	0V common terminals for general use.		
	FWD	Forward and STOP command	FWD-P24/CMS	closed: Motor runs forward. open: Motor decelerates to rest.	If FWD and REV are both closed or both open, inverter output STOPS.
	REV	Reverse and STOP command	REV-P24/CMS	closed: Motor runs in reverse. open: Motor decelerates to rest.	
	HLD	FWD/REV command hold	HLD-P24/CMS	closed: Latches momentary FWD or REV inputs. open: FWD/REV non-latching.	
	BX	Coast-to-stop command	BX-P24/CMS	closed: Inhibit inverter output instantaneously. open: Normal.	
	THR	External Trip/Alarm input	THR-P24/CMS	closed: Normal. open: Trips inverter output instantaneously (OH2).	
	RST	Trip/Alarm RESET	If RST-P24/CMS closed for ≥100ms, inverter internal fault trips are reset, and also alarm 30A/B/C (see below).		
	X1	Programmable input 1	Preset speeds or motorised potentiometer.		
	X2	Programmable input 2			
	X3	Programmable input 3	Preset speeds or mains-to-inverter changeover.		
	X4	Programmable input 4	Preset acc/dec command. LOC/REM changeover. DC injection brake command.		
	X5	Programmable input 5	Preset acc/dec times. 2nd motor V/f ratio. Data protection enable/disable.		
	P24(3) or CMS(3)	+24V DC power supply	24V current source for programmable I/O terminals and for FWD, REV, HLD, BX, THR, RST and X1 to X5.		
Meter outputs	FMA	Frequency meter — Analog	Output frequency, current, torque or load factor can be selected. 0V to +10V DC at 2mA max. (Min. impedance 5kΩ)		
	FMP	Frequency meter — Pulse	Pulse output proportional to inverter output frequency. Pulse frequency 6 to 100 x O/P Hz at +10V DC (adjustable).		
Programmable outputs	CMC	Programmable O/P common	Common for open-emitter O/Ps Y1E…Y5E		**O/P ratings:** Please refer to data for 24V Supply and Terminals Y1E…Y5E, page 10.
	Y1E	Programmable output 1	Up to 16 different outputs can be programmed from the operating Functions representative of dynamic operating conditions. Factory defaults: Y1E Inverter running Y2E FAR Y4E Overload early warning Y3E FDT Y5E Undervoltage		
	Y2E	Programmable output 2			
	Y3E	Programmable output 3			
	Y4E	Programmable output 4			
	Y5E	Programmable output 5			
Relay outputs	30A 30B 30C	Normally open Normally closed Common	Relay changes state when an internal protection function is active and when the inverter trips. Contact: 48V DC, capacity 0.5A.		
	AX1(4) AX2(4)	Run relay	Relay closes when inverter is running Contact: 220V AC, capacity 0.5A.		

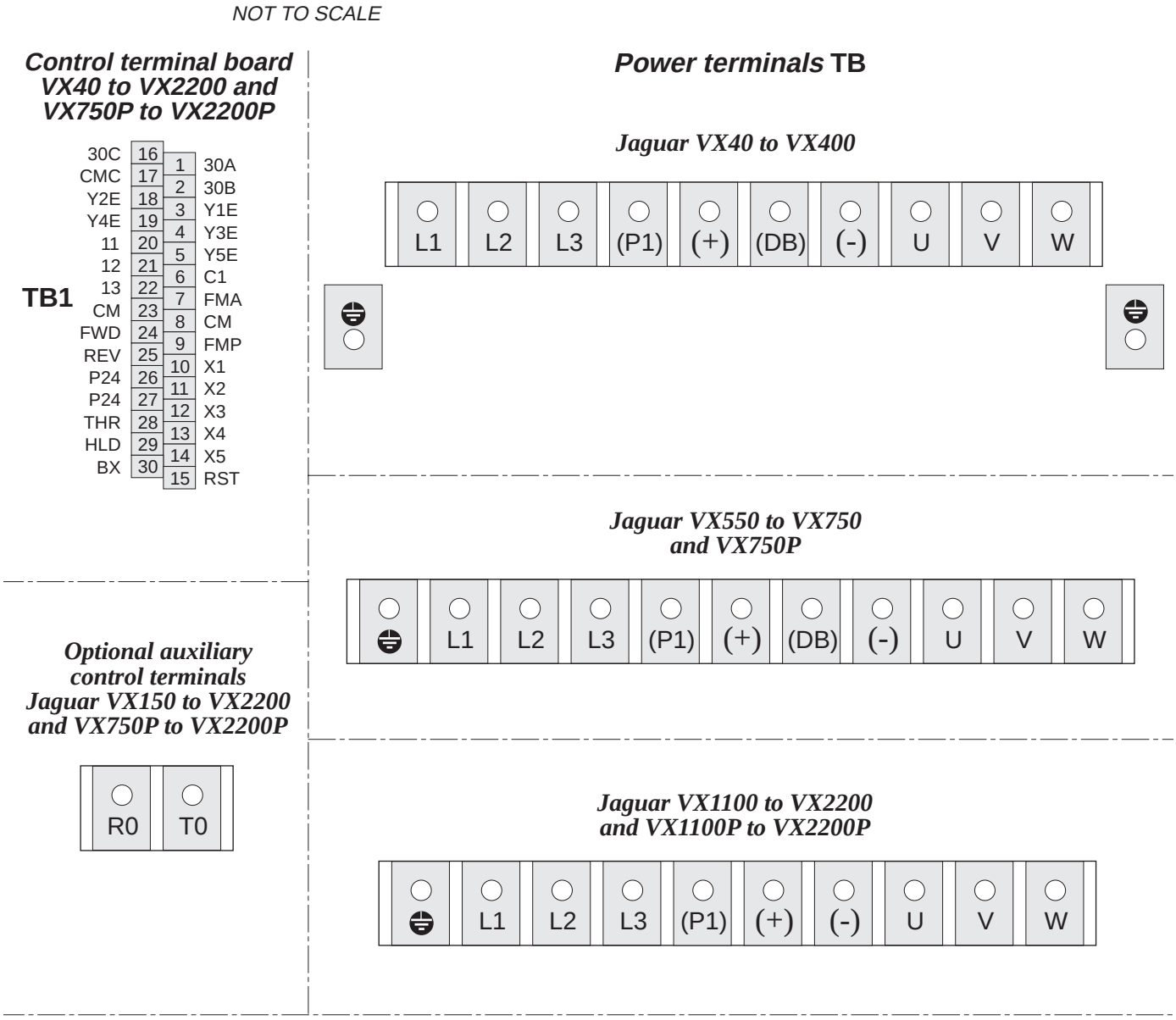
(1) Option for ≤22kW.

(2) Two CM terminals for ≤22kW; one for ≥30kW.

(3) Two P24 terminals for ≤22kW; two CMS for ≥30kW.

(4) ≥30kW only.

5-2-11 Control terminals — layout and locations



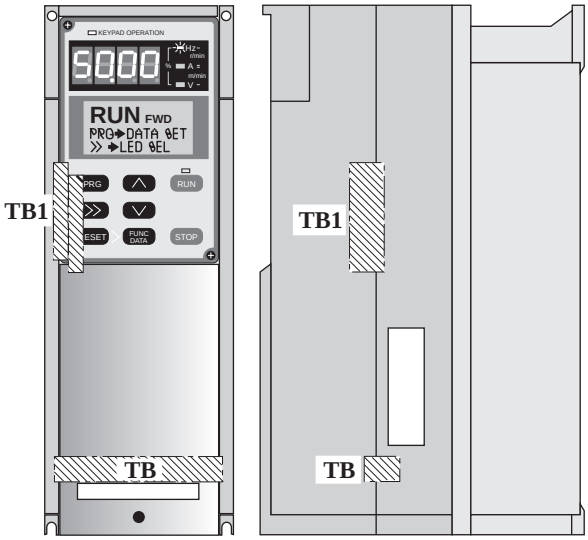
Terminal Screw Sizes and Recommended Torque

Inverter order code	*Size*	*TB and* ⏚ *Torque* Nm	*Torque* lb in	*TB1*	**RO, TO*
VX40	M3.5	1.2	10.6	M3.5	M3
VX75	M3.5	1.8	15.9	M3.5	M3
VX150 to VX400	M4	1.8	15.9	M3.5	M3
VX550 and VX750 VX750P and VX1100P	M5	3.5	31.0	M3.5	M3
VX1100 to VX2200 VX1500P to VX2200P	M5	5.8	51.3	M3.5	M3

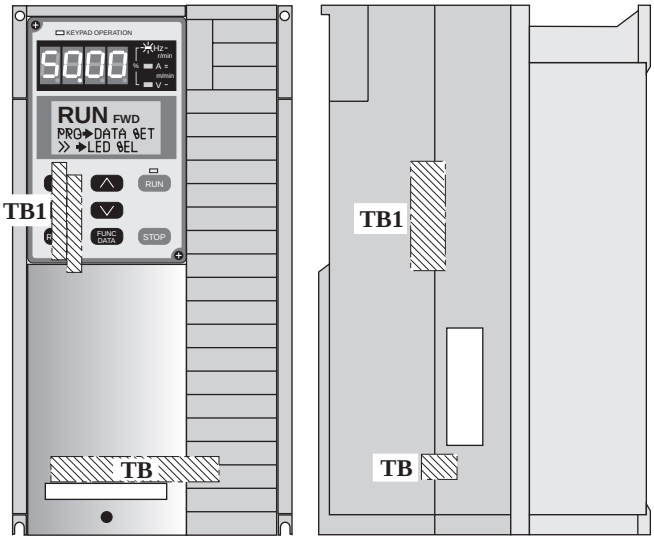
*Option

General arrangement — Power, control and (optional) auxiliary power terminals, inverters ≤22kW.

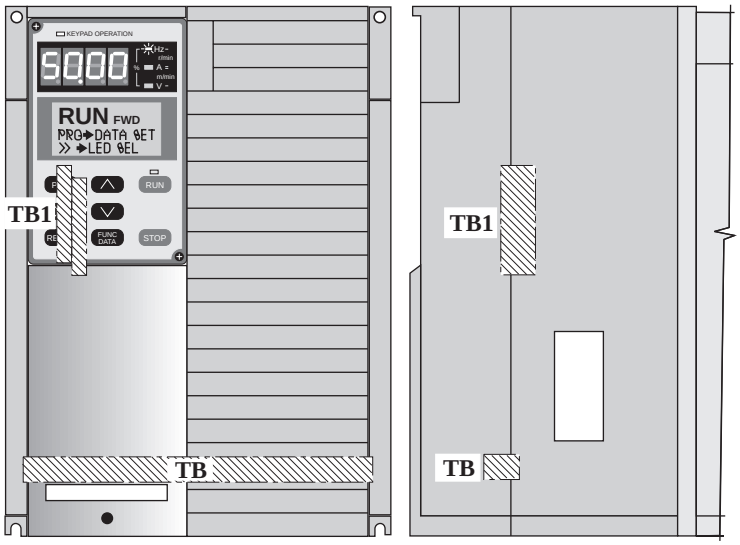
Jaguar VX40



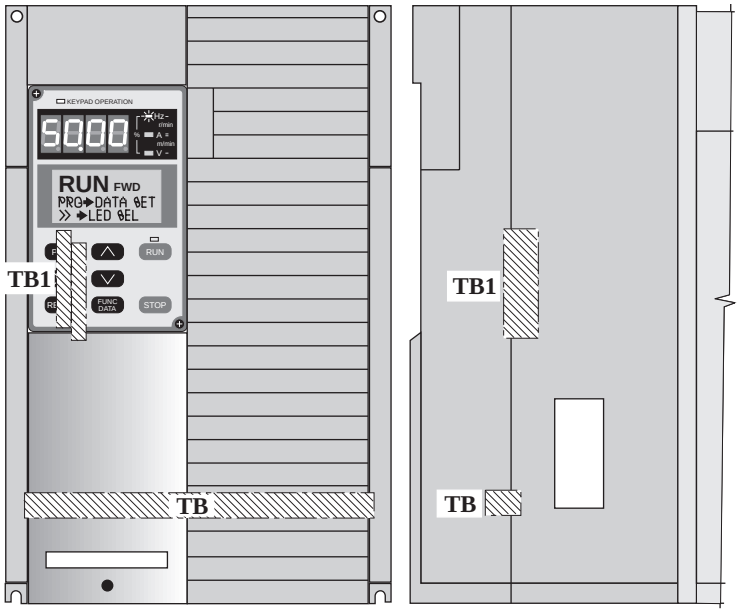
Jaguar VX75 to VX400



Jaguar VX550, VX750, and VX750P, VX1100P

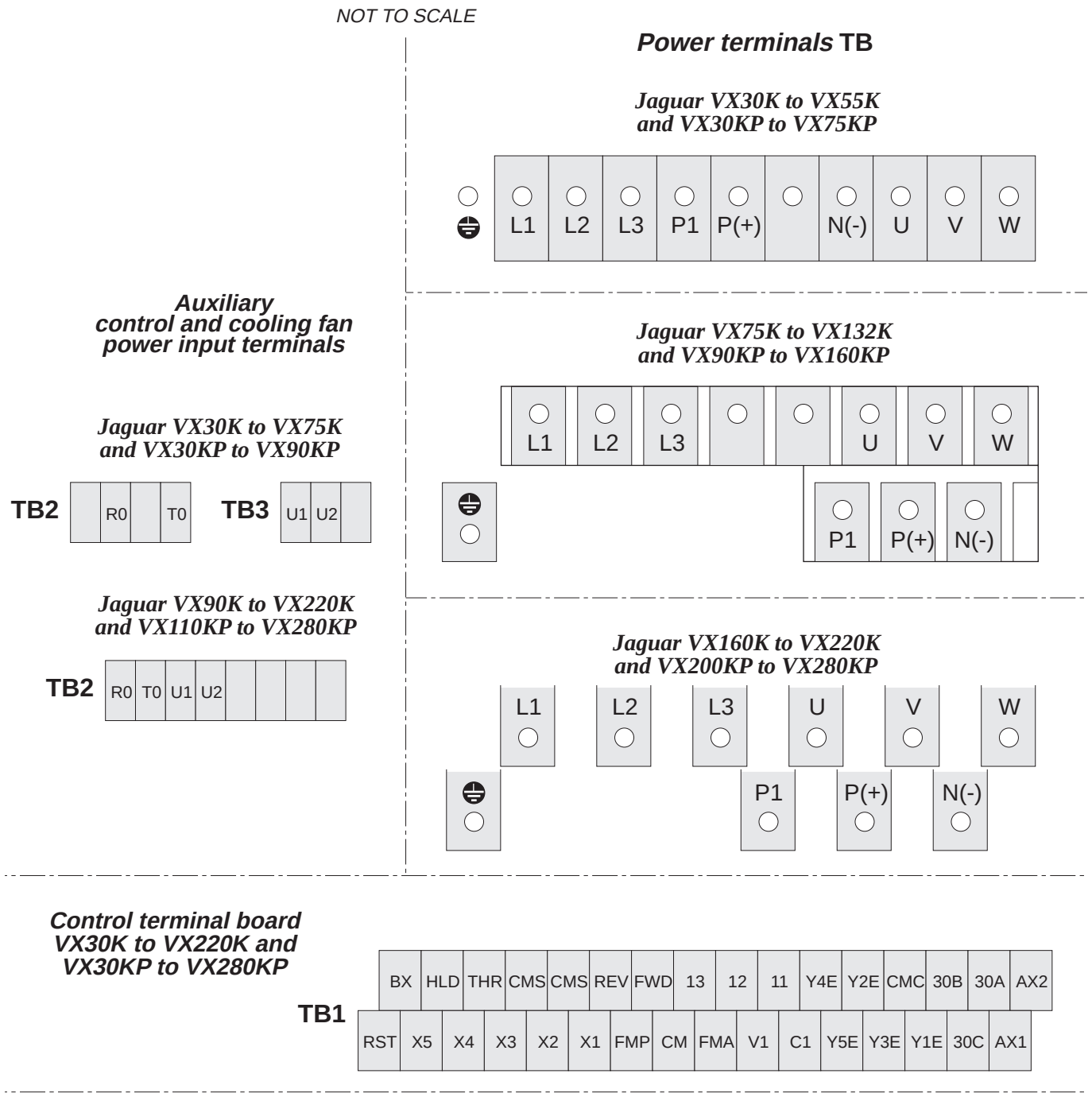


Jaguar VX1100 to VX2200, and VX1500P to VX2200P



NOT TO SCALE

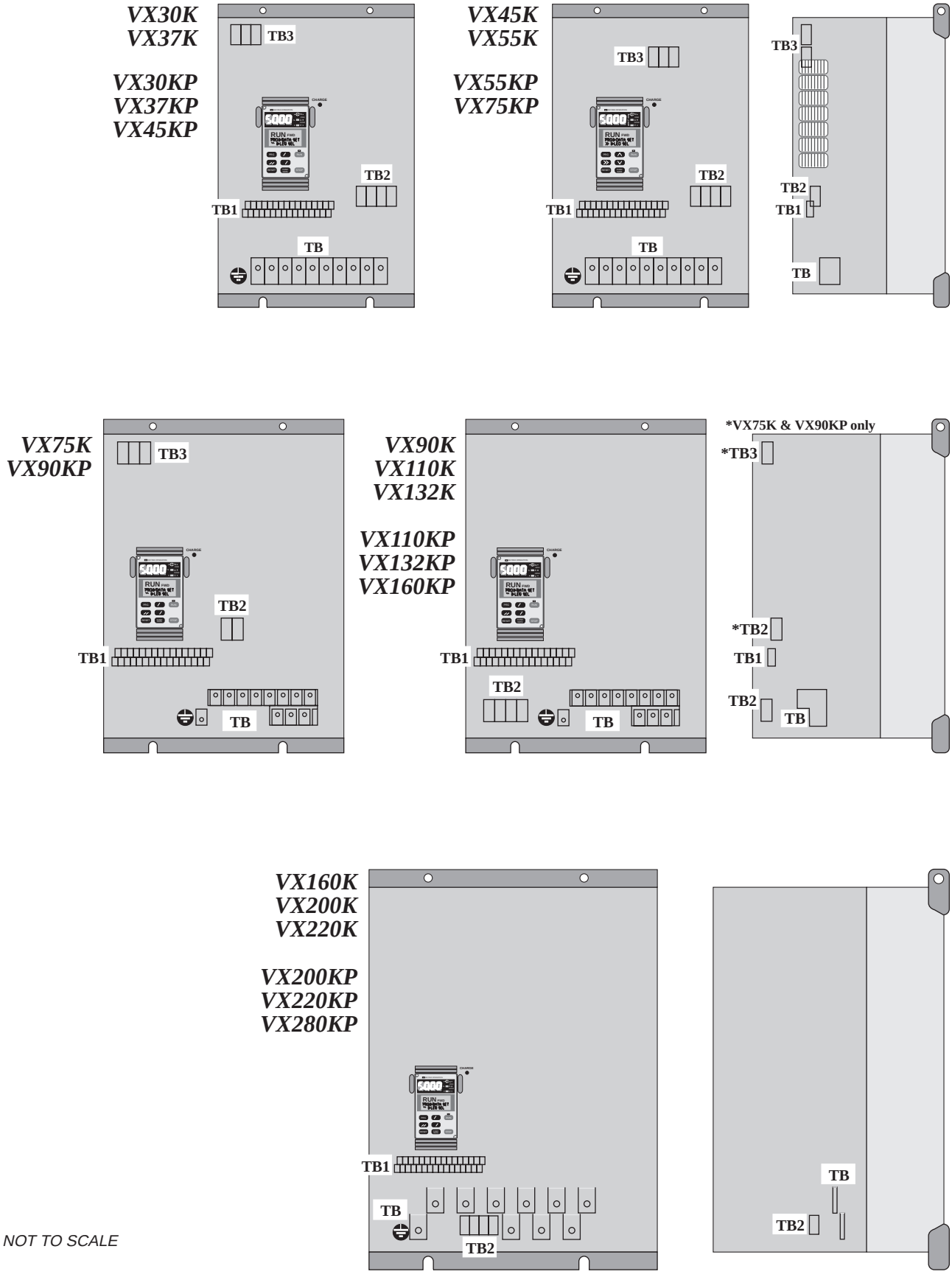
General locations —
Power, control and auxiliary power terminals, inverters ≤22kW.



Terminal Screw Sizes and Recommended Torque

Inverter order code	*TB*			⏚			*TB1*	*TB2*
	Size	*Torque* Nm	lb in	*Size*	*Torque* Nm	lb in		
VX30K to VX55K VX30KP to VX75KP	M8	13.5	120	M8	13.5	120	M3.5	M4
VX75K to VX132K VX90KP to VX160KP	M10	27.0	240	M8	13.5	120	M3.5	M4
VX160K to VX220K VX200KP to VX280KP	M12	48.0	425	M10	27.0	240	M3.5	M4

General arrangement — Power, control and auxiliary power terminals, inverters ≥30kW.



NOT TO SCALE

General locations — Power, control and auxiliary power terminals, inverters ≥30kW.

6 Electromagnetic Compatibility (EMC)

6-1 Complex Components

In accordance with the provisions described in the European Commission Guidelines Document on Council Directive 89/336/EEC, IMO Precision Controls Ltd has chosen to classify the *Jaguar VX* range of inverters as "Complex Components". The objective of this decision is to enable IMO Precision Controls Ltd to maximise their support for customers' own implementation of EC directives.

Classification as a "Complex Component" allows a product to be treated as an "apparatus", and thus permits *compliance with the essential requirements of the EMC Directive* to be demonstrated to both an integrator of *Jaguar VX* inverters (a constructor of switchboards, for example) and to his customer or the installer and the user.

6-2 Standards and Marking

At the time of going to press, *Jaguar VX* inverters up to 55kW are supplied 'CE-marked', signifying compliance with EC Directive 89/336/EEC when fitted with specified filter units installed and earthed in accordance with the data in this Product Manual. It is intended that the complete range of *Jaguar VX* inverters shall be CE-marked in the future.

An *"EC Declaration of Conformity"*, citing conformity with European Harmonised Standard EN60 947-1, "Specification for Low Voltage Switchgear and Controlgear", will be available.

This Specification requires the following performance criteria to be met:

EMC Immunity

Fast transient bursts (IEC801-4)

Electromagnetic (IEC801-3)

Electrostatic disturbances (IEC801-2)

Surges 1.2/50µs 8/20 (IEC1000-4-5)

EMC Emissions

EN50081-1 or EN50081-2, as specified in the *EC Declaration of Conformity* related to the inverter.

Normally, *Jaguar VX* inverters will offer compliance with the more severe level of EN50081-1 although the less arduous option of EN50081-2 would be adequate for industrial applications. Reference must, however, be made to the *EC Declaration of Conformity* for precise details, as there are differences between models.

Low Voltage Directive (LVD)

Jaguar VX inverters carrying the suffix -EN or -D as part of their model number are compliant with Low Voltage Directive 73/23/EEC and conform to the low voltage requirements of DIN VDE 0160/1988/92 for 'over voltage category 2, pollution degree 2' when wired and earthed in accordance with the installation instructions herein and installed within a steel enclosure which satisfies the requirements of 'pollution degree 2' and used in conjunction with a 3-phase AC power supply which is recognised 'over voltage category 2' and has an earthed neutral point.

NOTE Throughout this manual the -EN and -D suffixes have been omitted for simplicity and space considerations, but all inverters described in this publication are of the EMC and LVD conformant revision designated by the -EN and -D suffixes. These suffixes form part of the model number shown on the product rating plate (page 2) and on the packaging *eg* VX400-EN, VX200KP-D.

6-3 Inverters from 30kW to 280kW

Inverters in this range are most likely to be used under conditions or in environments of a more-specialised nature, where EMC requirements are best considered on a case-by-case basis. That being so, the value of 'CE-marking' for standard environments is questionable, and can be unnecessarily costly. IMO Precision Controls Ltd will advise on appropriate EMC countermeasures in collaboration with the users of inverters in the 30kW to 280kW range.

6-4 Power supply input filters

It is strongly recommended that the appropriate *Jaguar VX* input filter is used, as shown in the diagrams opposite, to limit RF current flowing into the main supply circuit. Without an input filter a *Jaguar VX* installation may not meet statutory requirements. For details of Footprint filters, refer to page 88.

6-5 Electromagnetic emissions — general

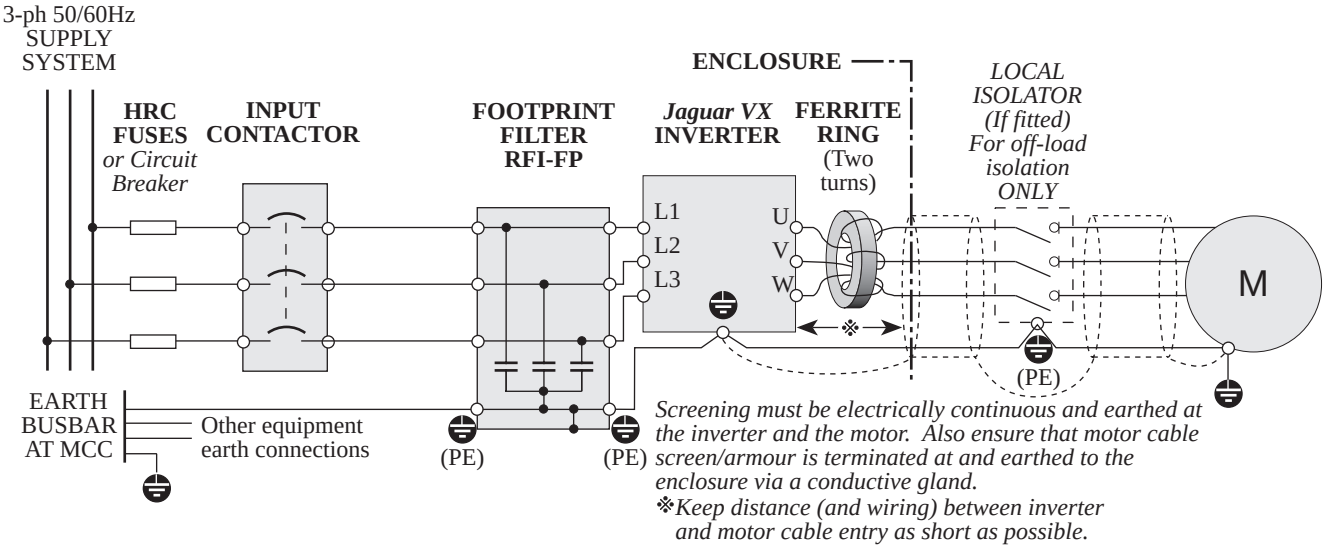
Jaguar VX inverters contain high-power semi-conductor devices which are switched at high speeds to synthesise a near-sinusoidal current waveform across the frequency range of the output. Typically, the transition time from the OFF state to fully-conducting is of the order of 200ns (200 x 10^{-9} s) for these devices. Such rapidly-changing voltages and currents will generate some degree of electromagnetic emission.

Emissions will be predominantly conducted through the motor and the mains supply cables, although some radiated emissions will be detected in close proximity to the drive system.

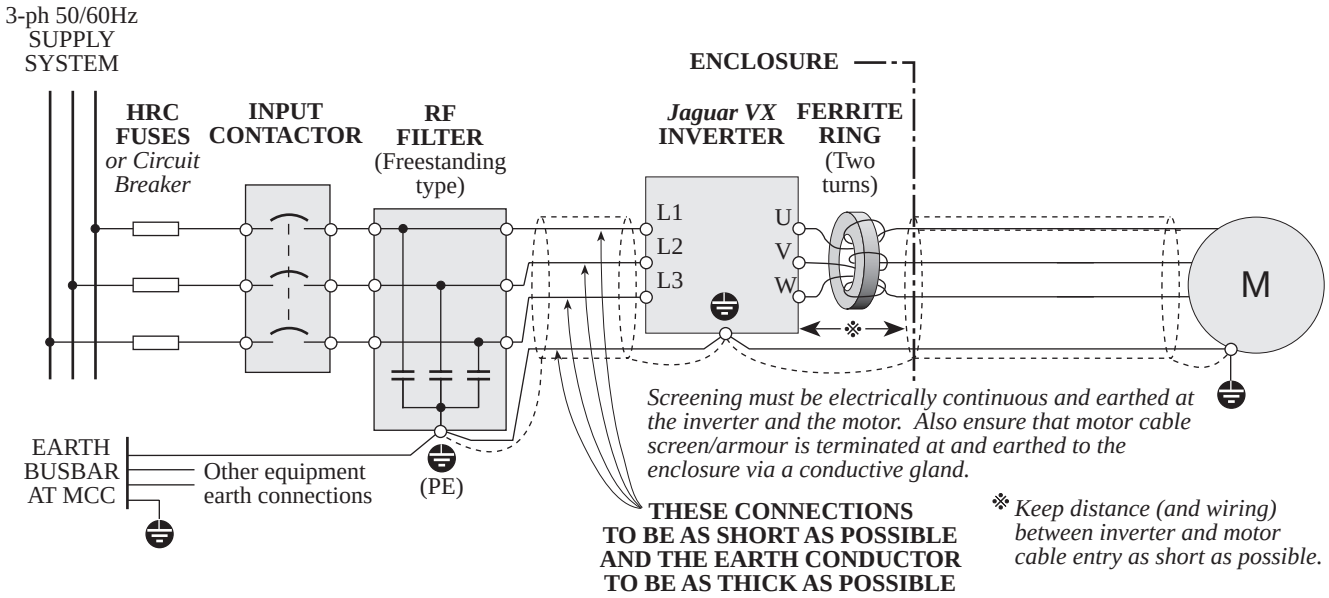
It is *essential* that precautions are taken both at the design stage and at the time of installation to prevent radio-frequency interference (RFI) from the drive system affecting sensitive equipment in close proximity.

6-6 General precautions

- Use the correct filtering equipment and arrangements as recommended by IMO Precision Controls Ltd and illustrated below.
- Use screened or armoured cable for the motor supply, taking care to connect the screen to earth at *both* ends as shown in the diagrams below.
- Segregate power cables from control wiring by at least 300mm.
- Avoid parallel cable runs to minimise 'noise coupling'. Wherever runs of power and control cable must cross, try to achieve this at right angles.
- Do not share earth conductors (except where conductors in the drive system connect to an earth bar for the installation) and do not use the earth terminal of the inverter for connecting earth conductors from other equipment.
- The earth conductor between a free-standing filter and the inverter should be as short and as thick as practicable.
- Always use screened control wiring. For local control circuits, earth the screen at the drive end ***only,*** as illustrated on page 24**.** If using an external controller (*eg* a PLC or similar) terminate the screen at the NON-drive end ***only.***
- Use the lowest possible switching (carrier) frequency that will operate the application satisfactorily. Refer to Function 81, 'Motor Sound', page 64.
- ***Jaguar VX* inverters should be installed, and are designed to operate, within an electrically-shielded metal enclosure.**



Essentials for successful protection against RF emissions — Method 1 — with Footprint Filter.



Essentials for successful protection against RF emissions— Method 2 — with Free-standing Filter.

NOTE Higher-powered drive installations above 30kW may require several ferrite rings, strategically placed, to ensure EMC compliance. For further information, please consult IMO Precision Controls Ltd

7 Operational Guidelines

7-1 Power switching

The inverter should never be connected directly to a mains power supply. The minimum requirement is for power fuses to protect the inverter circuit, as shown in the diagram below. (Ratings, pages 6 and 7.)

- **Power input switchgear**

The practical choices for power control switchgear are:

- A circuit breaker rated to interrupt the short circuit fault level at the inverter. This may also provide a locking facility to prevent accidental connection when maintenance is in progress.
- A contactor, with fuses to provide for the interruption of a short circuit fault.
- Fuses alone, for fault protection. Note that if the inverter is to be equipped with a braking resistor, fuses alone do not provide any means for tripping the supply. Automatic switchgear is essential.

- **Isolation**

A separate isolating device in the supply circuit provides means of applying a safety isolation as required by most safety regulating authorities. It is possible to use only the protection fuses (if fitted) as the means of applying a safety isolation provided there is a procedure to prevent unauthorised replacement. The use of an isolator for starting and stopping the drive system **is not recommended**.

Those types of contactor and circuit breaker designed to be detachable from a plug-in base may be acceptable as a means of safety isolation.

A local isolator may be fitted in the motor circuit if desirable for the application. **On no account should this be used to control the start/stop operation of the motor**. Early-break late-make auxiliary contacts must be provided to the inverter electronic control terminals. Refer also to paragraph 5-1-5, page 19.

The provision of appropriate padlocking and possibly interlocking facilities should be considered for any isolators used in drive system circuits.

7-2 Operation

> CAUTION
>
> Motor thermal overload protection should be provided by a motor thermistor and thermistor relay.

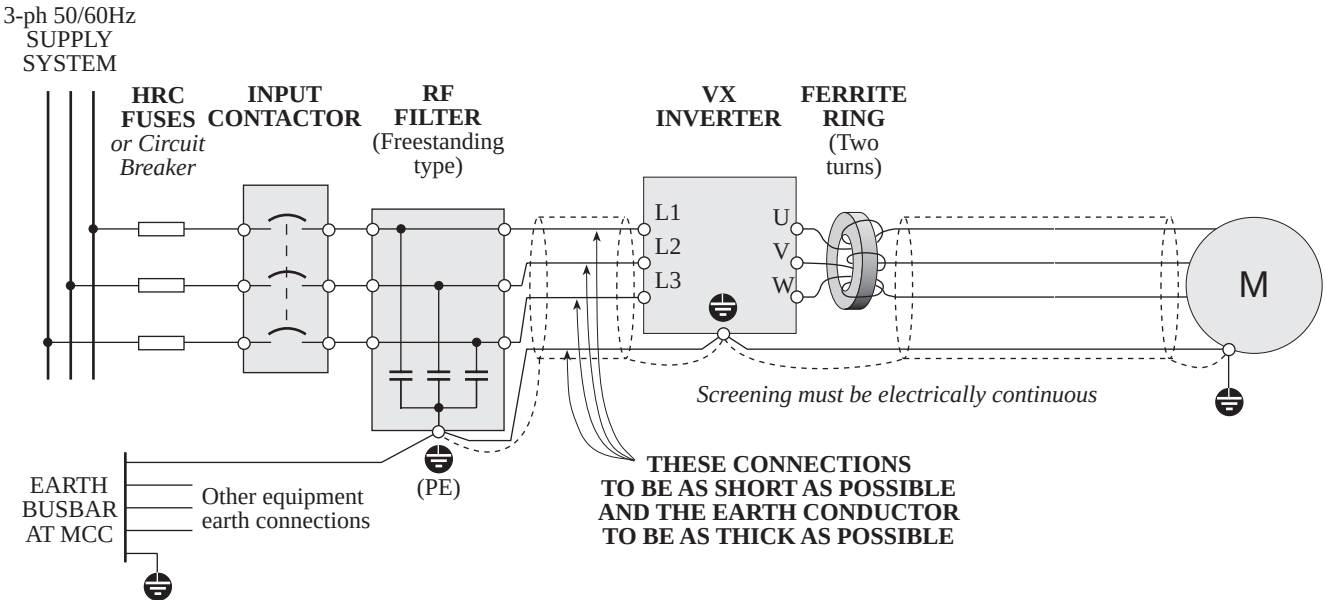
- **Starts per hour**

It is preferable that the drive system (the inverter, the motor and the driven load) are started and stopped electronically, by the control features available on the inverter. This method permits an unlimited number of starts per hour.

If it is unavoidable that the drive system must be started and stopped by switching the input contactor, the inverter is **restricted to 6 starts per hour maximum for any size of motor**.

- **Protection of a braking resistor circuit**

It is **essential** that a braking resistor is equipped with a series-connected overload trip connected so as to **trip the power supply to the inverter** in case of overheating. Refer to the external braking circuit protection diagram, page 87.



Typical power supply connections and switchgear options.

7-3 Long cable runs

- **Supply input cable**

There is no restriction to the length of the input supply cable other than the constraint imposed by voltage drop.

- **Motor cable**

NOTE

If the length of the motor cable is greater than 50m, it may be necessary to set the carrier frequency, Function 81, to 0 to reduce the effect of leakage current at high PWM frequencies.

Consult IMO Precision Controls Ltd before using a motor cable in excess of 100m.

Normally, when AC inductors are fitted to the motor cables, the maximum practical length of the motor cable is 400m if unscreened and 200m if screened. Refer to page 8. However, the use of inductors may impose limitations on motor performance.

- **Screening of power cabling**

Screening of power cables is necessary to reduce RF emissions. Preferably, screening should be of the type intended only for that purpose, but steel wire armouring, metal conduit, or metal trunking may be adequate.

Care must be taken to ensure that any screening, of whatever type, is connected so as to be electrically continuous. In the case of metal conduit or trunking this means ensuring that all discontinuities are securely bridged by properly-applied bonding conductors.

- **Control cables**

Use pvc-insulated control cables, screened overall, 0.75mm^2 cross-section, not >50m long.

Screening should be terminated to 0V at the source end if external controllers such as PLCs are used, or otherwise earthed at the inverter as shown in the diagram on page 24. Analog frequency reference input signals can be filtered — refer to Function 59, page 58.

- **Cable runs**

Low-voltage control cabling should always be routed at least 300mm away from power cables. If it is necessary for control cables to cross the line of power cables, they should cross as nearly as possible at right angles.

7-4 Keypad control mode

If Function 01 is set = 0 (the default setting), operation of the motor can be controlled from the keypad panel. As delivered, terminals (FWD)-(P24)/(CMS) are linked, applying a terminal 'run' input. While this signal is present, Function 01 cannot be changed to give terminal control. The same applies if terminals (REV)-(P24)/(CMS) are linked, or if there is an external RUN control circuit and its contact is closed.

When the STOP key is pressed, the motor decelerates to rest in the time set in Function 06.

In keypad control mode, the motor will start when the RUN key is pressed and will accelerate in the time set in Function 05 up to the speed set in Function 02.

NOTE Terminals (FWD)-(P24)/(CMS) or (REV)-(P24)/(CMS) **must be linked** as shown on page 22, otherwise the output frequency will remain at 0Hz regardless of the frequency reference set in Function 02.

While the motor is running, its speed can be raised (not above the value of Function 02) and reduced by the $\wedge$ and $\vee$ keys. If the speed is altered in this way and a STOP command is given or the FUNC/DATA key is pressed, that speed becomes the maximum to which the motor will accelerate at the next RUN command. The acceleration time to this lower speed will be the same unless Function 05 is changed.

7-5 Terminal control mode

Terminals data, pages 24 and 25.

To change to terminal control mode, first remove the link from terminals (FWD)-(P24)/(CMS) or (REV)-(P24)/(CMS), or otherwise ensure that these terminals are connected to an external normally-open contact. When this circuit is OPEN, set Function 01 = 1.

For simple start/stop control, a single normally-open contact connected to terminals (FWD)-(P24)/(CMS) enables the motor to be run in a forward direction and stopped at will. Using terminals (REV)-(P24)/(CMS) gives operation in a reverse direction. In either case, speed is controlled by the voltage input control at terminals (11), (12), limited by the settings of Functions 02, 11 and 12. Acceleration is normally controlled by the setting of Function 05. Deceleration after a STOP command is normally controlled by Function 06.

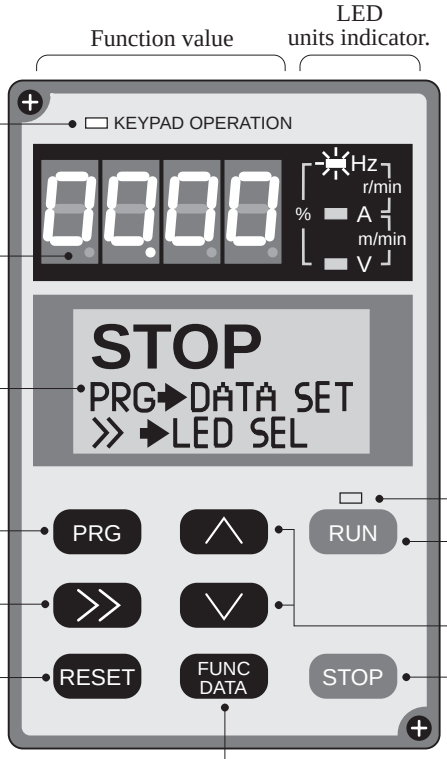
There is provision in the *Jaguar VX* range of inverters for preset speeds and preset pattern operation controlled by external contacts. For full details please refer to *Descriptions of Functions*, under Functions 20 to 26, 32, and 66 to 72.

7-6 Motor cooling

Motors driven by *Jaguar VX* inverters can generate high torque output at low speeds. At low speeds, the effectiveness of a shaft-mounted cooling fan is greatly reduced. If it is intended to operate a motor at low speed and high torque, additional cooling will be required.

8 Getting Started

8-1 Keypad panel



LED is illuminated when the inverter is in Keypad control mode, Function 01 = 0. Not illuminated when Function 01 = 1.

LED digital display. Flashes when the inverter is stopped. When running, displays selected operating value. In trip mode, displays trip code. Display is updated at 100ms intervals.

LCD multifunction display. Used for reading and setting Function values and for interrogation of trip events etc. Can display values as bar charts. Display is updated at 300ms intervals.

Programming key. Selects between operating and programming modes.

Shift key. In operating mode, selects the value displayed in the LED digital display. In programming mode, moves cursor position.

Reset key. In programming mode, changes the LCD multifunction display from Data change mode to Function select mode. In trip mode, releases the trip condition.

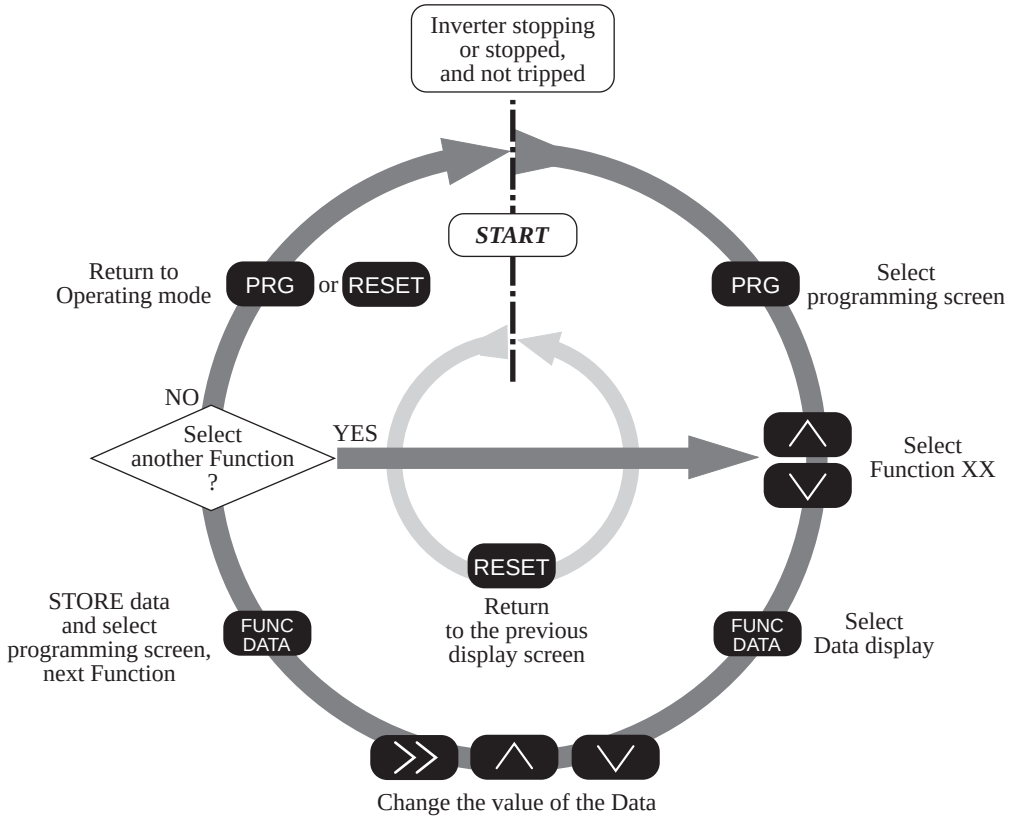
LED is illuminated when the inverter is running.

RUN and STOP keys. Active only when Function 01 = 0.

UP and DOWN keys. In operating mode, increment and decrement the output frequency. In programming mode, increment and decrement the data value.

'Function' or 'Data' selector key. In programming mode, selects the data screen and stores the data.

Programming key sequence



8-2 Keypad functions and procedures

Keypad Panel Functions

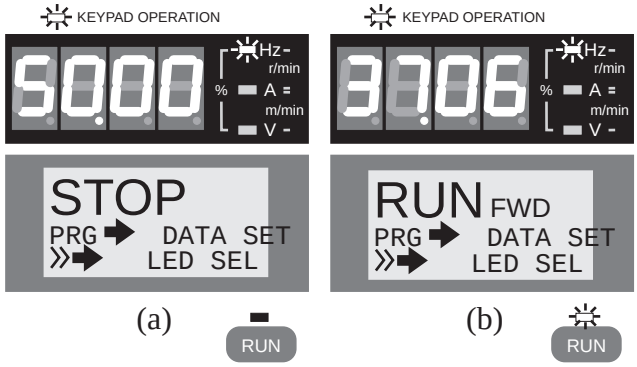
1 To display the status of the drive, and to enable additional data to be seen when required, *eg* history of trip events.

2 To allow the operator to start and stop the motor and to control its speed from the keypad panel, if desired.

3 To permit all Function values to be read, changed, stored and implemented.

Keypad Panel Displays

The appearance of the display windows when the operating condition is 'normal' is illustrated below.



Power-on

When the supply is switched on, the displays appear as shown at (a). The LED digital display flashes, and shows the value of the frequency input reference to which the drive will respond when a RUN command is given. The 'Keypad Operation' LED is illuminated if Function 01 = 0.

Inverter running

A typical normal running indication is shown at (b).

The LCD multifunction display panel shows RUN accompanied by either FWD or REV.

The LED digital display will normally show the exact output frequency value at any instant. Any one of 8 other operating parameter values of the inverter, motor and driven load (such as current, voltage, torque etc) can be selected for display during the RUN period. The units related to the value are indicated by the three LEDs on the right. Refer to the diagram on page 36.

Protective STOP

The LED digital display changes to show the trip code (refer to page 69), *flashing.*

The LCD multifunction display panel shows trip data. Refer to the diagrams on page 40.

Actions of the keypad panel keys

(PRG) Select programming mode ('CHANGE THE SET POINT' of a Function, page 37) or return to normal mode.

(≫) to READ active operating values of the inverter, motor, and driven load, page 36. In programming mode, to shift the cursor to another column.

(RESET) to:

- RESET the inverter after a protective trip.

NOTE Find and correct the cause of any trip before resetting.

- Return to the previous display in programming mode.
- Cancel a change of Function value written prior to a store command (FUNC/DATA).
- Return to the data selection LCD screen when reading the status of Input/Output terminals.
- Return to the data selection LCD screen when reading the trip status.

(∧) and (∨) Increment or decrement by 1 digit, in programming mode. In 'Keypad Operation' mode (Function 01 = 0) these keys raise and lower the motor speed, but not above the value set in Function 02. If ∨ is used to reduce the speed below the value set in Function 02, pressing STOP or FUNC/DATA makes that speed the new reference until changed.

(FUNC DATA) to:

- STORE the value of a Function.
- READ the set points of all Functions;
  — 'DATA CHECK', page 38.
- READ status of Input/Output terminals;
  — 'I/O CHECK', page 39.
- READ status of present and previous Trip events;
  — 'TRIP INDICATION CHECK', page 40.
- READ the 'factor' and other information about the present Trip event;
  — 'TRIP FACTOR CHECK', page 40.

(RUN) START the motor in 'Keypad Operation' mode (Function 01 = 0).

(STOP) STOP the motor in 'Keypad Operation' mode (Function 01 = 0).

- When the inverter is being operated in 'Terminal Operation' mode (Function 01 = 1), the RUN/STOP keys are not functional.

NOTE Whilst terminals (FWD) or (REV) and (P24)/(CMS) are connected by a link or an external control circuit contact, Function 01 *cannot be changed*.

8-3 Keypad function diagrams

OPERATING-PARAMETER DISPLAY MODE

Values are shown on the LED digital display. Units are indicated by the LED digital display units indicator.

Step through all 9 data displays to return to the start. *PRESS* PRG to exit the sequence at any time.

Timeout when reading data

STOP
PRG ➡ DATA SET
» ➡ LED SEL

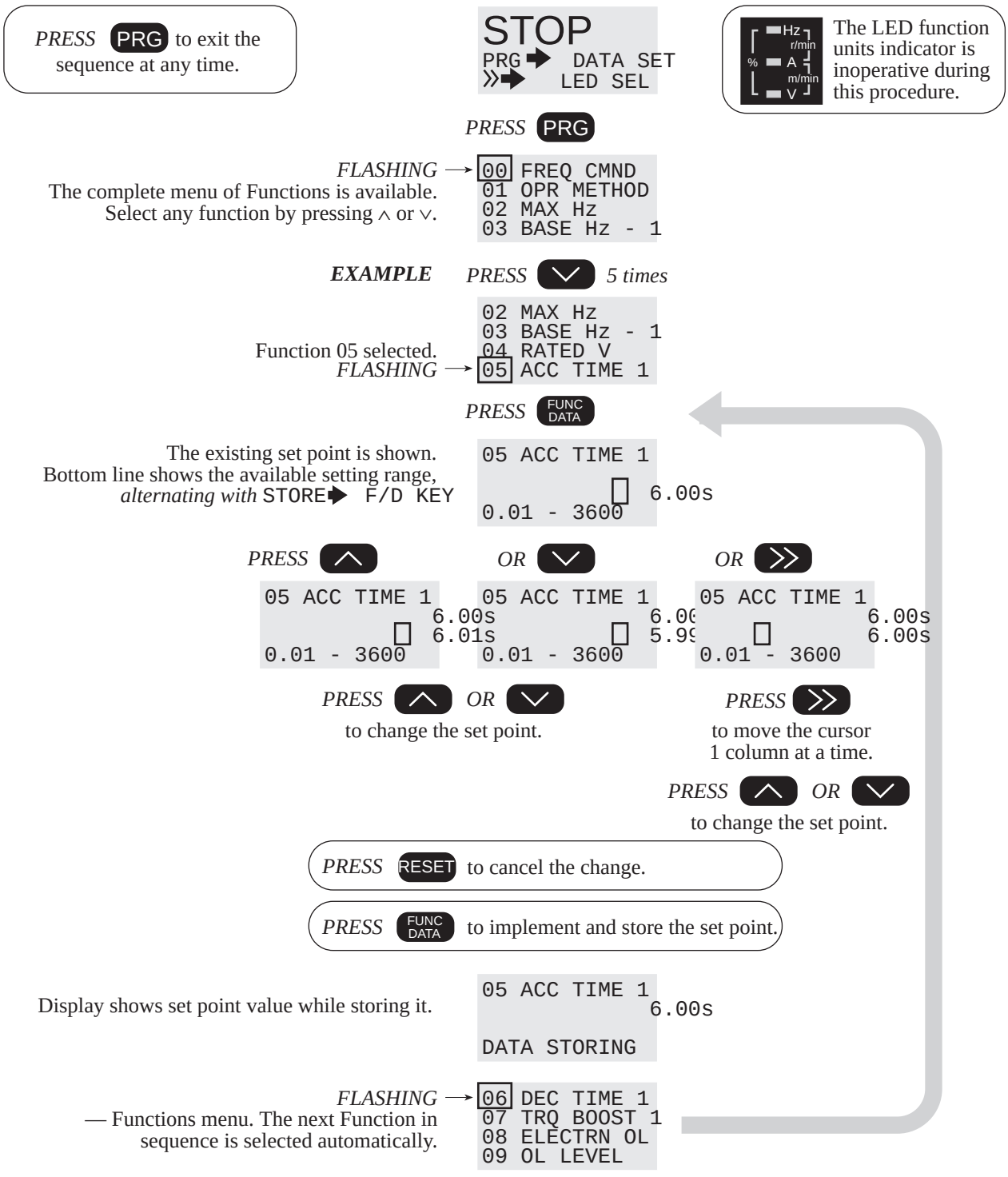
» → 4 sec → Any readout

PRESS » to return to the same display.

VALUE & UNITS SHOWN BY THE LED DIGITAL DISPLAY	LCD DISPLAY SEQUENCE	CORRESPONDING LED FUNCTION UNITS INDICATOR SEQUENCE
	STOP PRG ➡ DATA SET » ➡ LED SEL	
	PRESS »	
Inverter output frequency, Hz	<LED MONITOR> OUTPUT FREQUENCY	Hz
	PRESS »	
Inverter output current, Amps	<LED MONITOR> OUTPUT CURRENT	A
	PRESS »	
Inverter output voltage, Volts	<LED MONITOR> OUTPUT VOLTAGE	V
	PRESS »	
Motor speed, revs per minute	<LED MONITOR> MOTOR SPEED	r/min
	PRESS »	
Line speed, metres per minute	<LED MONITOR> LINE SPEED M/MIN	m/min
	PRESS »	
Load speed, revs per minute	<LED MONITOR> MACHINE SPEED R/MIN	r/min
	PRESS »	
Torque limit (driving), per cent motor FLT	<LED MONITOR> TORQUE LIMIT (DRIVING)	%
	PRESS »	
Torque limit (braking), per cent motor FLT	<LED MONITOR> TORQUE LIMIT (BRAKING)	%
	PRESS »	
Actual motor torque, per cent motor FLT	<LED MONITOR> MOTOR TORQUE	%
	PRESS »	

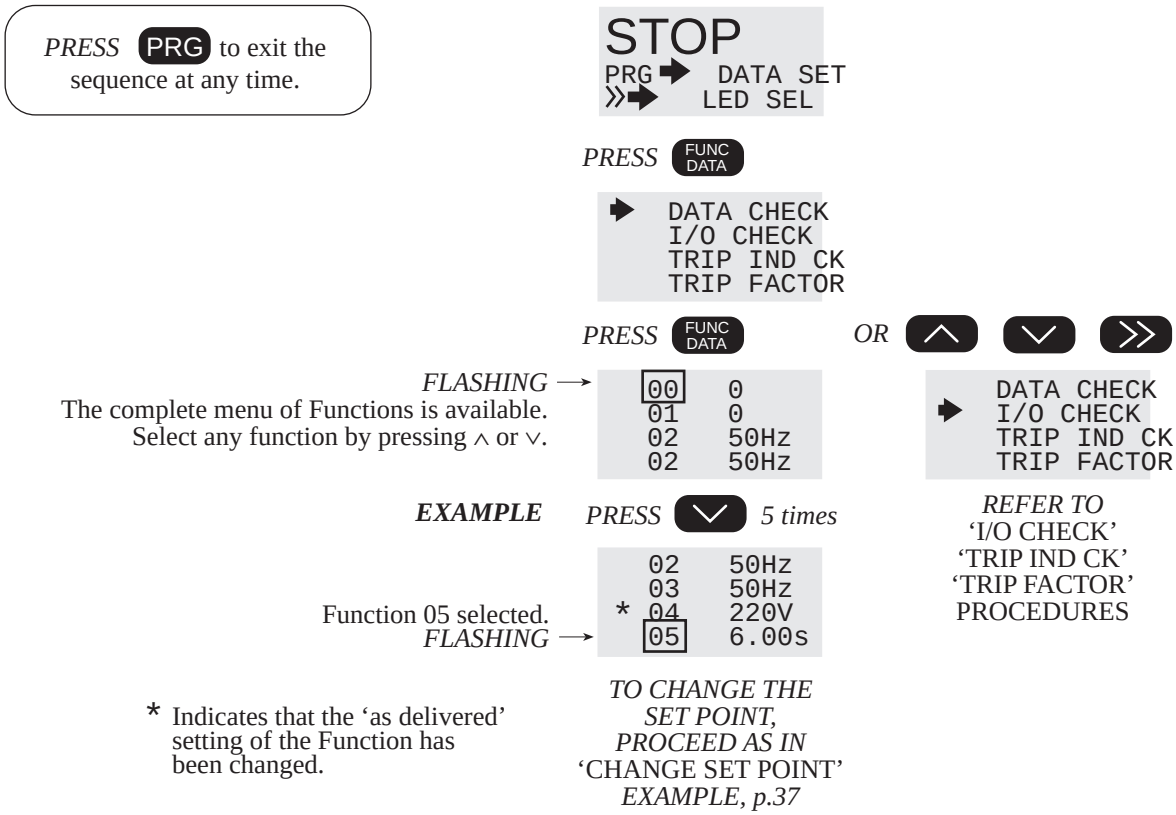
CHANGE THE SET POINT of a selected Function

The diagram illustrates how to select Function 05 as an example, and how to change and store its set point.



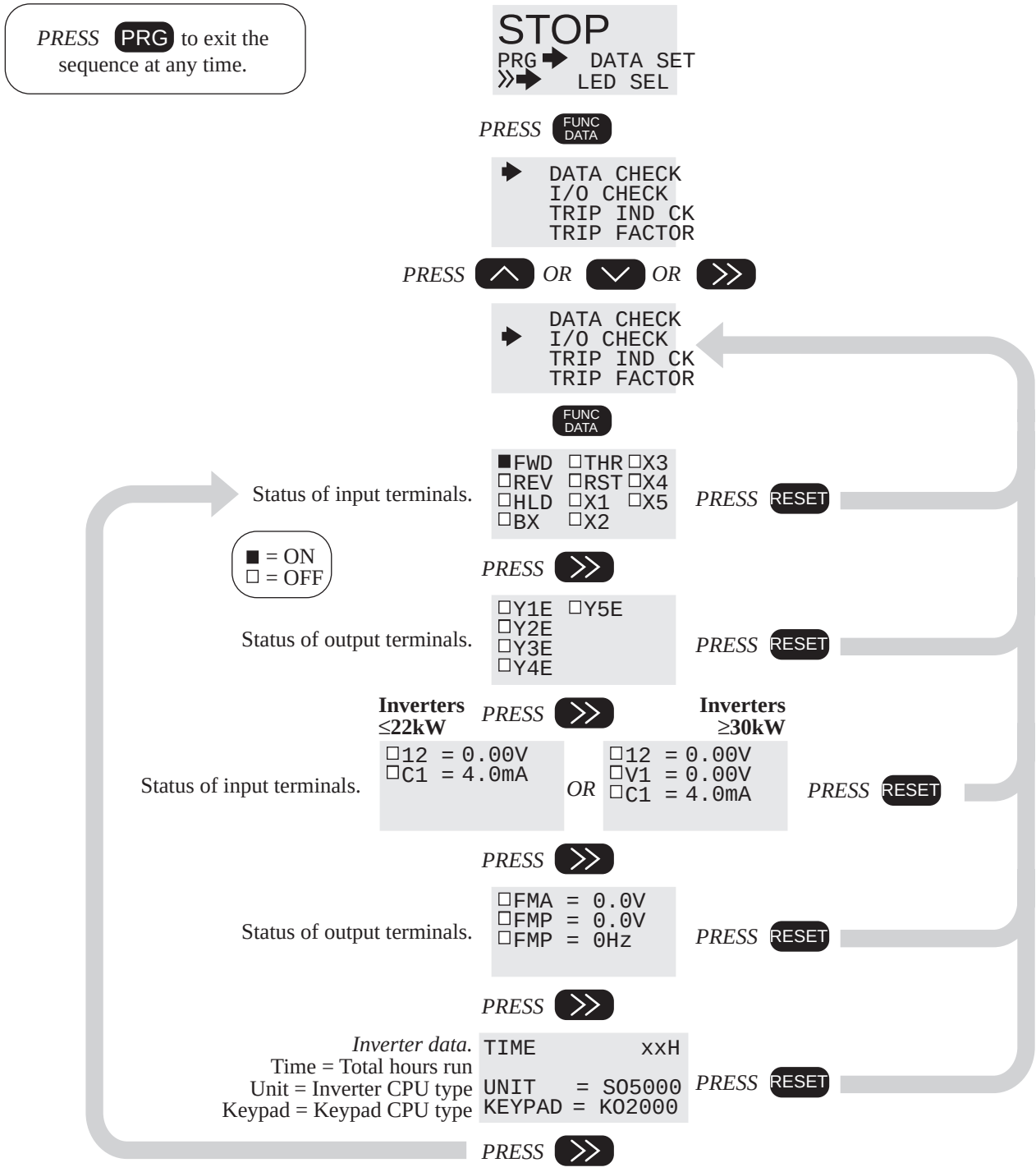
DATA CHECK

Procedure to READ Function set points. This procedure also permits the set points to be changed and stored.



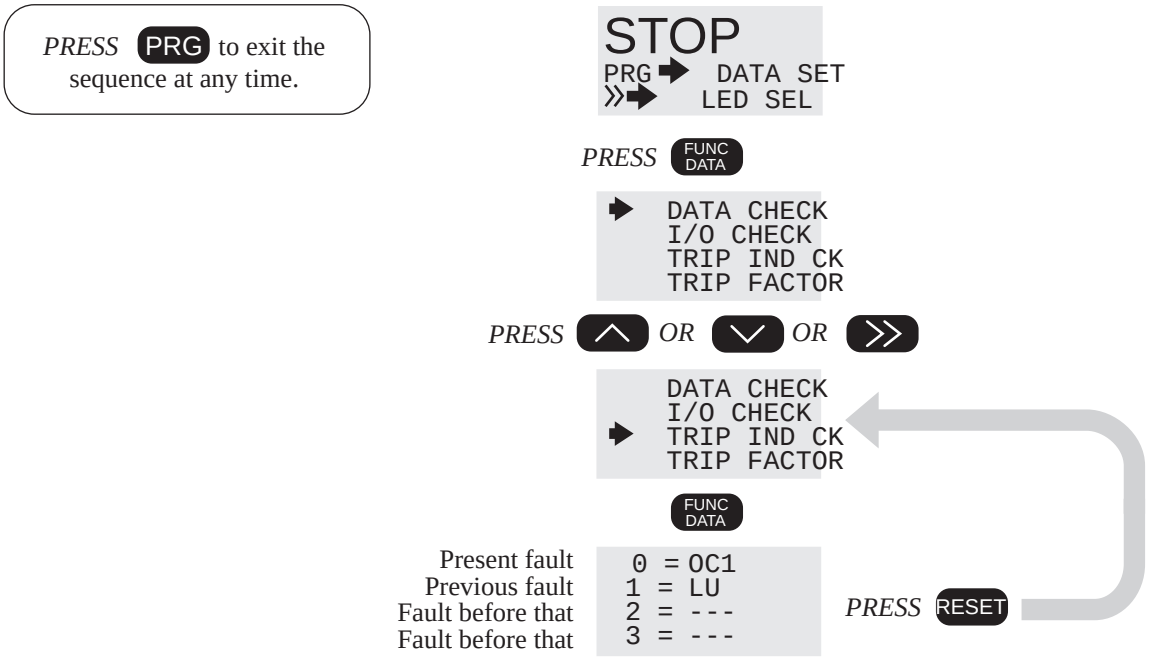
I/O CHECK

Procedure to READ the status of the input/output terminals.



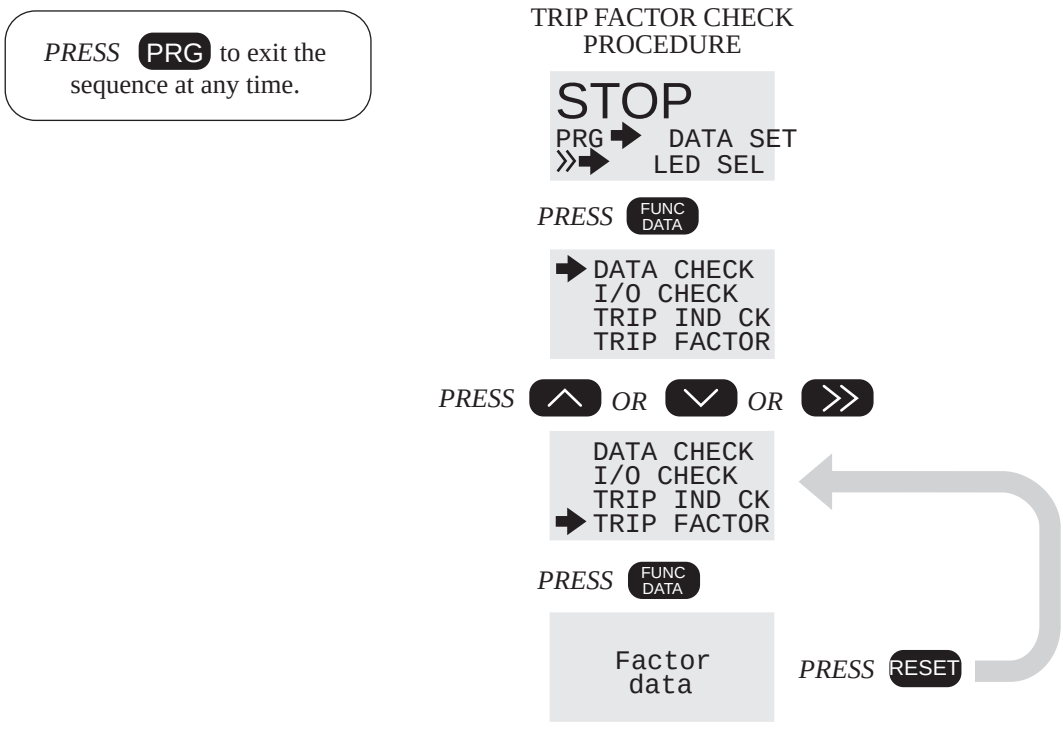
TRIP INDICATION CHECK

Procedure to READ the four most-recent trip status indications.



TRIP FACTOR CHECK

Procedure to READ the "factor" associated with the cause of the present trip.



9 Inverter Functions

9-1 Functions Index

Group	*Func*	*Name*	*LCD Display*	*Setting range*	*Unit*	*Resol.*	*Def.*	
Basic Functions	00	Frequency command	00 FREQ COMND	0 = KEYPAD, ∧ or ∨ keys 1 = TERMINAL, 0 to +10V 2 = TERMINAL, 4 to 20mA	—	—	0	
	01	Operating mode	01 OPR METHOD	0 = KEYPAD, RUN/STOP keys 1 = TERMINAL, (FWD) & (REV)	—	—	0	
	02	Max. O/P frequency	02 MAX Hz	*VX*, 50-400Hz *VX…P*, 50-120Hz	Hz	1	50	
	03	Base freq., motor 1	03 BASE Hz -1	*VX*, 50-400Hz *VX…P*, 50-120Hz	Hz	1	50	
	04	Max. O/P V, motor 1	04 RATED V -1	0 = Output dependent on supply V* 320 to 480 = output V not > supply V	V	1	400	
	05	Accel. time, motor 1	05 ACC TIME 1	0.01 to 3600	s	0.01	6.00	
	06	Decel. time, motor 1	06 DEC TIME 1	0.00 = ramp inhibit, or 0.01 to 3600	s	0.01	6.00	
	07	Torque boost, motor 1	07 TRQ BOOST 1	0.0 = auto; 0.1 to 20.0 fixed boost	—	0.1	0.0 [0.1]	
	08	Electronic thermal O/L, *type*	08 ELECTRN OL	0 = Inactive 1 = Active for standard motor 2 = Active for inverter-rated motor	—	—	1	
	09	Electronic O/L, *level*	09 OL LEVEL	20% to 105% of inverter rating	A	0.01	†	
	10	Restart after momentary power supply failure	10 RESTART	0 = Inactive 1 1 = Inactive 2 2 = Active, smooth recovery 3 = Active, restart at set Hz 4 = Active, restart at start Hz	—	—	0	
	11	O/P freq. HI limit	11 H LIMITER	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	70	
	12	O/P freq. LO limit	12 L LIMITER	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	0	
	13	Min. O/P freq. (bias)	13 FREQ BIAS	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	0	
	14	Freq. I/P ref. gain	14 FREQ GAIN	0.0 to 200.0%	%	0.1	100.0	
	15	Driving torque limit	15 DRV TORQUE	20 to 180, 999% (999 = no limit)	%	1	180 [120]	
	16	Braking torque limit	16 BRK TORQUE	0, 20 to 180, 999% (999 = no limit)	%	1	150 [100]	
	17	DC inj. brk. Start frequ.	17 DC BRK Hz	0.0 to 60.0Hz	Hz	0.1	0.0	
	18	DC inj. brk. Brkg. *level*	18 DC BRK LVL	0.0 to 100%	%	0.1	0.0	
	19	DC inj. brk. Brkg. *time*	19 DC BRK t	0 (brake inactive), or 0.1 to 30.0s	s	0.1	0	
	20 to 26	Pre-set multistep frequencies 1 to 7	20 MULTI Hz -1 to 26 MULTI Hz -7	*VX* 0.00, 0.20 to 400.0Hz *VX…P* 0.00, 0.20 to 120.0Hz (0.00 = preset disabled)	Hz	0.01	0.00	
	27	Internal electronic thermal O/L for internal braking resistor	27 DBR OL	0 = Inactive 1 = Active for intl. R, invrs. ≤7.5kW 2 = Inactive	—	—	1 [0]	
	28	Slip compensation	28 SLIP COMP	-9.9Hz to +5.0Hz	Hz	0.1	0.0	
	29	Torque vector control	29 TRQ VECTOR	0 = Inactive 1 = Active	—	—	0	
	30	Number of motor poles	30 MTR POLES	2 to 14 (even nos. only)	—	2	4	

Functions marked by heavy outlines can be set whilst the inverter is running. *Def.* = factory-set defaults. *Resol.* = resolution. Default values are for all inverters. Where *VX…P* defaults differ, they are shown in square brackets […].

* During setting of Function 04 = 0, LCD display shows 0V. † Approx. rated current for inverter-rated motors. Supply V dependent on frequency and inverter model. Refer to 'Input', page 4.

Group	*Func*	*Name*	*LCD Display*	*Setting range*	*Unit*	*Resol.*	*Def.*	
31	31	*Function Block 32 to 41*	31 • 32—41 •	0 = Functions 32 to 41 hidden 1 = Functions 32 to 41 displayed	—	—	0	
Prog. I/P terminals	32	Select the functions of terminals X1 to X5	32 X1-X5 FUNC	0000 to 2222	—	—	0000	
Acc./Dec. times	33 34 35 36 37 38	Accel time 2 Decel time 2 Accel time 3 Decel time 3 Accel time 4 Decel time 4	33 ACC TIME 2 34 DEC TIME 2 35 ACC TIME 3 36 DEC TIME 3 37 ACC TIME 4 38 DEC TIME 4	0.00 = Ramp inhibited, coasting 0.01 to 3600s	s	0.01	10.00 10.00 15.00 15.00 3.00 3.00	
2nd motor	39	Base freq., motor 2	39 BASE Hz -2	*VX*, 50-400Hz *VX…P*, 50-120Hz	Hz	1	50	
	40	Max. O/P V, motor 2	40 RATED V -2	0 = Output dependent on supply V* 320 to 480 = output V not > supply V	V	1	400	
	41	Torque boost, motor 2	41 TRQ BOOST 2	0.0 = auto; 0.1 to 20.0 fixed boost	—	0.1	2.0	
42	42	*Function Block 43 to 51*	42 • 43—51 •	0 = Functions 43 to 51 hidden 1 = Functions 43 to 51 displayed	—	—	0	
Digital O/P	43	FMP terminal, pulse rate multiplier	43 FMP PULSES	x6 to x100	—	1	24	
	44	Voltage O/P adjustmt.	44 FMP V-ADJ	50% to 120%	%	1	100%	
Analog O/P	45	FMA terminal, voltage adjustment	45 FMA V-ADJ	65% to 200%	%	1	100%	
	46	FMA terminal function	46 FMA FUNC	0 = O/P freq. 1 = O/P current 2 = O/P torque 3 = %FLT	—	—	0	
O/P term. functions	47	Select the functions of terminals Y1E to Y5E	47 Y1-Y5 FUNC	00000 to FFFFF	—	—	01234	
	48	FAR function (‘At Speed’ window)	48 FAR HYSTR	0.0 to 10.0Hz	Hz	0.1	2.5	
	49	FDT function *level*	49 FDT LEVEL	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	50	
	50	FDT function *hyster.*	50 FDT HYSTR	0.0 to 30.0Hz	Hz	0.1	1.0	
	51	O/L alarm *level*	51 OL WARNING	Approx. 20 to 105% inverter rated current	A	0.01	†	
52	52	*Function Block 53 to 59*	52 • 53—59 •	0 = Functions 53 to 59 hidden 1 = Functions 53 to 59 displayed	—	—	0	
Frequency control	53	Skip frequency 1	53 JUMP Hz 1	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	0	
	54	Skip frequency 2	54 JUMP Hz 2	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	0	
	55	Skip frequency 3	55 JUMP Hz 3	*VX*, 0-400Hz *VX…P*, 0-120Hz	Hz	1	0	
	56	Skip hysteresis	56 JUMP HYSTR	0 to 30Hz	Hz	1	3	
	57	Starting frequency	57 START Hz	0.2Hz to 60.0Hz	Hz	0.1	0.5	
	58	Holding time	58 HOLDING t	0.0 to 10.0s	s	0.1	0.0	
	59	Frequency I/P reference filter	59 FILTER	0.01 to 5.00s	s	0.01	0.05	

Functions marked by heavy outlines can be set whilst the inverter is running. *Def.* = factory-set defaults. *Resol.* = resolution. Default values are for all inverters. Where *VX…P* defaults differ, they are shown in square brackets […].

* During setting of Function 04 = 0, LCD display shows 0V. † Approx. rated current for inverter-rated motors. Supply V dependent on frequency and inverter model. Refer to ‘Input’, page 4.

Group	Func	Name	LCD Display	Setting range	Unit	Resol.	Def.	
60	60	*Function Block 61 to 79*	60 • 61—79 •	0 = Functions 61 to 79 hidden 1 = Functions 61 to 79 displayed	—	—	0	
LED & LCD displays	61	LEDs, function for normal display	61 LED MNTR 1	0 to 8	—	—	0	
	62	LEDs display at STOP	62 LED MNTR 2	0 = Set point (flashing) 1 = Actual output value only	—	—	0	
	63	Coefficient for machine speed and line speed	63 SPEED COEF	0.01 to 200.00 x Hz output	—	0.01	0.01	
	64	LCD display function	64 LCD MNTR	0 to 3: Drive status, standard screen or bar graphs	—	—	0	
Pattern operations	65	Pattern operation, mode select	65 PATTERN	0 to 3: Inactive or cyclic	—	—	0	
	66 to 72	Pattern stages 1 to 7	66 STAGE 1 to 72 STAGE 7	Operation time 0.00 to 6000s FWD/REV codes F1 to F4 ACC/DEC codes R1 to R4	s	0.01	0.00 F1	
	73	ACC/DEC mode	73 ACC PTN	0 to 2: linear, S-curve, non-linear	—	—	0	
Special Functions 1	74	Series brake motor driving	74 SERIES BRK	*Not available*			—	
	75	Energy saving	75 ENERGY SAV	0 = Inactive 1 = Active	—	—	0 [1]	
	76	REV phase sequ. lock	76 REV LOCK	0 = Inactive 1 = Active	—	—	0	
	77	Data initialising (data reset)	77 DATA INIT	0 = Inactive 1 = Active	—	—	0	
	78	Language of displays	78 LANGUAGE	0 to 3	—	—	1	
	79	LCD display brightness	79 BRIGHTNESS	0 (bright) to 10 (dark)	—	—	5	
80	80	*Function Block 81 to 94*	80 • 81—94 •	0 = Functions 81 to 94 hidden 1 = Functions 81 to 94 displayed	—	—	0	
Special Functions 2	81	PWM carrier frequency (motor sound)	81 MTR SOUND	0 (low) to 10 (high) carrier frequency	—	—	10	
	82	Auto-restart, start delay	82 RESTART 1	0.0 to 5.0s	s	0.1	0.1	
	83	Auto-restart, frequency fall rate	83 FALL RATE	0.00 to 100.00	Hz/s	1	10.00	
	84	Auto-reset, number of restarts	84 AUTO RESET	0 to 7	—	—	0	
	85	Auto-reset, interval	85 RESET INT	2 to 20s	s	—	5	
Motor characteristics	86	Motor 1, frame size	86 MOTOR CAP	0 = 1 higher 1 = nominal 2 = 1 lower 3 = 2 lower	—	—	1	
	87	Motor 1, rated current	87 MOTOR 1-Ir	0.00 to 2000A	A	0.1	†	
	88	Motor 1, no-load current	88 MOTOR 1-Io	0.00 to 2000A	A	0.1	†	
	89	Motor 2, rated current	89 MOTOR 2-Ir	0.00 to 2000A	A	0.1	†	
	90	Motor 1, auto-tuning	90 TUNING	0 = Inactive 1 = Active	—	—	0	
	91	Motor 1, %R1 value	91 %R1 SET	0.00 to 50.00%	%	0.01	†	
	92	Motor 1, %X value	92 %X SET	0.00 to 50.00%	%	0.01	†	
Special Functions 3	93 94	*Manufacturer's use only*	93 DD FUNC 1 94 DD FUNC 2					
	95	Data security	95 DATA PRTC	0 = Unlocked 1 = Data secure	—	—	0	

9-2 Descriptions of Functions

NOTES

1 **Title boxes with a heavy outline** indicate Functions which can be changed when the inverter is running.

2 When the value of a Function is changed from the factory-set default value, the symbol * appears beside that Function in the LCD multifunction display.

Frequency command source
00 FREQ COMND

The frequency (speed) reference input is selected from the following three options:

= 0 Use the ∧ and ∨ keys on the keypad panel.

= 1 Input reference 0 to 10V at terminals (12)-(11) or 4-20mA at terminals (C1)-(11). Please refer to Function 32, page 52, X4 = 1.

= 2 If a 0-10V input is used as well as 4-20mA, the two inputs will be added together.

NOTE If Preset Speeds, terminals X1…X5, are selected (Functions 20 to 26), this will override all the above options.

Operating mode
01 OPR METHOD

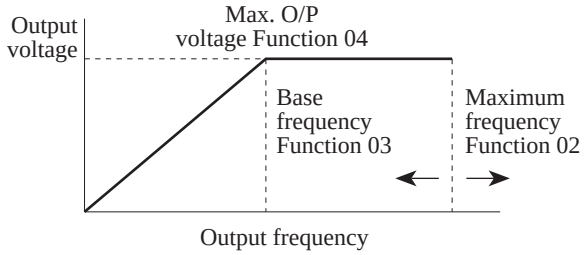
Commands may be given either at the keypad panel or by external contacts wired to terminals.

= 0 The keypad RUN and STOP keys are active; terminals are inactive. This is the default value, and *cannot be changed* when terminals (FWD)-(P24)/(CMS) or (REV)-(P24)/(CMS) are linked or if an external RUN/REV control contact is closed.

NOTE When the (FWD)-(REV) terminals are open-circuit, the inverter will not run in keypad mode and will not indicate the direction. The displays shows 0Hz.

= 1 Terminals (FWD), (REV) and (HLD) are active; the RUN and STOP keys are inactive at the keypad.

Absolute maximum O/P frequency
02 MAX Hz



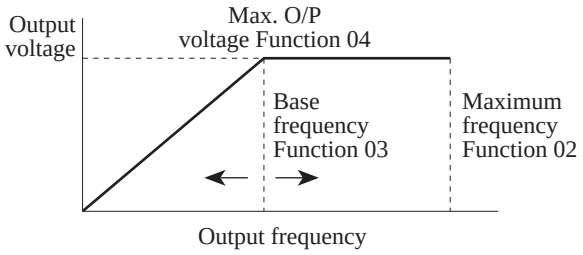
Setting range

VX inverters 50 to 400Hz in steps of 1Hz.

VX …P inverters 50 to 120Hz in steps of 1Hz.

The selected upper limit of output frequency that the inverter will deliver at the maximum value of the input reference signal, *ie* 10V or 20mA.

Base frequency, Motor 1
03 BASE Hz -1



Setting range

VX inverters 50 to 400Hz in steps of 1Hz.

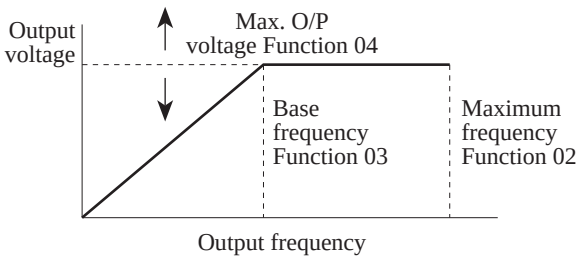
VX …P inverters 50 to 120Hz in steps of 1Hz.

Set Function 03 at the rated frequency of the motor.

The output voltage-to-frequency (V/f) ratio delivered by the inverter is constant up to the base frequency. Torque output is nominally constant from zero speed up to base frequency; above base frequency, power is constant.

If the base frequency is greater than the maximum frequency, Function 02, the output voltage will not rise to the rated voltage.

Maximum O/P voltage, Motor 1
04 RATED V -1



Setting range 0, or 320 to 415/420/460/480* in steps of 1V

If required, clamps the maximum output voltage for the inverter.

NOTE The output voltage cannot be higher than the input voltage V_L.

= 0 Maximum output voltage is increased or decreased according to the input voltage V_L.

= 320 to 415/420/460/480* Regardless of the level of input voltage V_L, the maximum output voltage is clamped at the value selected.

* Dependent on inverter model and system frequency. For details, refer to ‘Input’, page 4.

Acceleration time, Motor 1
05 ACC TIME 1

Deceleration time, Motor 1
06 DEC TIME 1

The time from start to maximum frequency and from maximum frequency to stop can be set within the range of 0.01 - 3600 seconds.

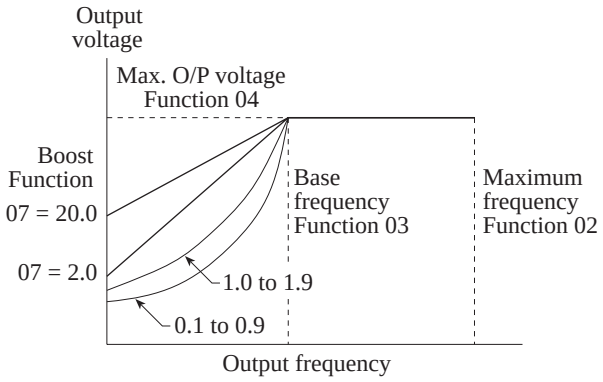
Range	*Resolution*
0.01 - 9.99 s	0.01 s
10.0 - 99.9 s	0.1 s
100 - 999 s	1 s
1000 - 3600 s	10 s

Function 05 cannot be set to less than 0.01s minimum.

When Function 06 = 0.00, the deceleration ramp is inhibited and the motor coasts to rest (≤22kW only).

For S-ramp and non-linear acceleration and deceleration, refer to Function 73.

Torque boost, Motor 1
07 TRQ BOOST 1



Setting range 0.0, or 0.1 to 20.0

Torque boost can be switched between automatic and manual mode. In manual mode the boost is adjustable up to a maximum of 20 per cent.

= 0.0 Torque boost is automatically controlled to compensate for the primary resistance of the motor.

= 2.0 to 20.0 Torque boost is linear up to base frequency as illustrated above.

= 1.0 to 1.9 Torque boost is non-linear.

= 0.1 to 0.9 Torque boost is non-linear but follows a 'weaker' curve.

Electronic thermal overload — type
08 ELECTRN OL

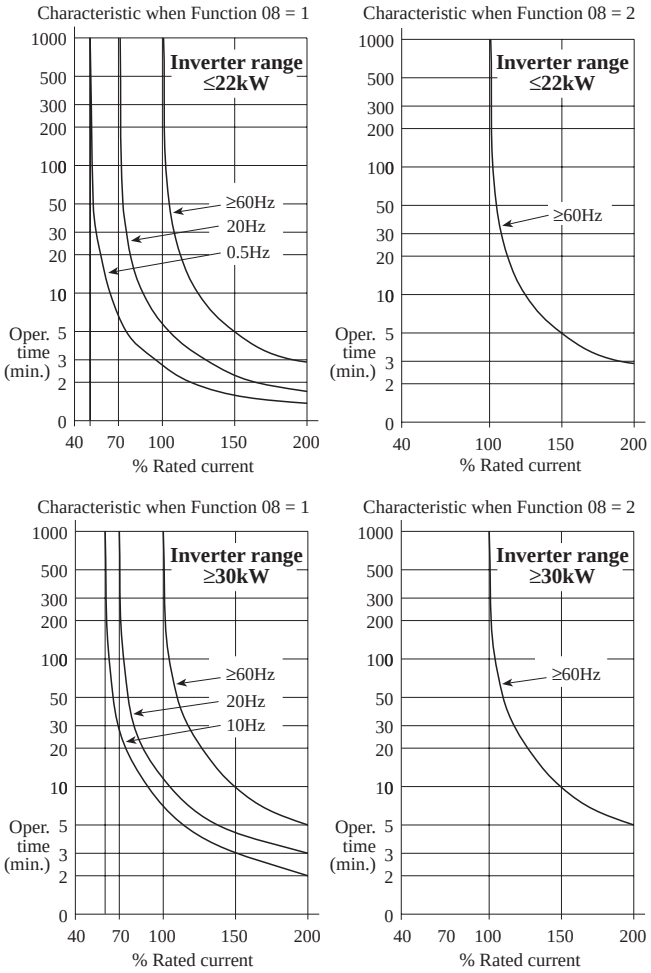
Function 08 selects the type of electronic thermal overload to suit the motor(s) being used.

= 0 Inactive: *eg* multi-motor application.

= 1 Active: standard motor. Self-derating for low frequency operation, see diagrams below.

= 2 Active: inverter-rated, larger fame size, or force-ventilated motor.

Internal thermal overload — level
09 OL LEVEL



Function 09 sets the operating level of the overload in amps. The setting range is between 20 - 105% of the inverter rated output current (refer to pages 6 and 7).

Example for a VX400 inverter:

Rated full load current is 9.0A at 50Hz. The setting range is 20% to 105% of rated current. To convert the 50Hz current to 60Hz multiply by 1.08

20% of 9.0A x 1.08 = 1.95A

105% of 9.0A x 1.08 = 10.2A

∴ the set point value must fall within the range from 1.95A to 10.2A.

Range (A)	*Resolution* (A)
0.01 - 9.99	0.01
10.0 - 99.9	0.1
100 - 999	1
1000 - 3600	10

Restart after momentary power failure
10 RESTART

WARNING

RESTART HAZARD: A motor which can restart unexpectedly presents a potential hazard to personnel working near the driven equipment.

One of five different restarting sequences can be selected according to what best suits the operation of the system and the driven load.

The choices are illustrated below and on the facing page, and are summarised as follows:

= 0 Inactive. If the power supply fails, the inverter is immediately disabled.

The display shows LU trip.

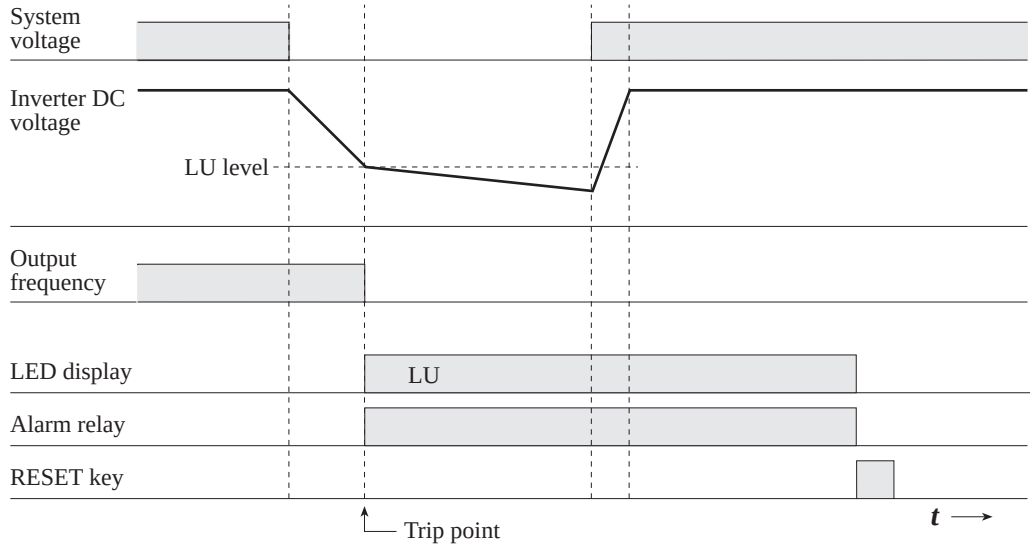
= 1 Inactive. If the power supply fails, the inverter is immediately disabled.

The display shows LU trip only when the power supply is restored.

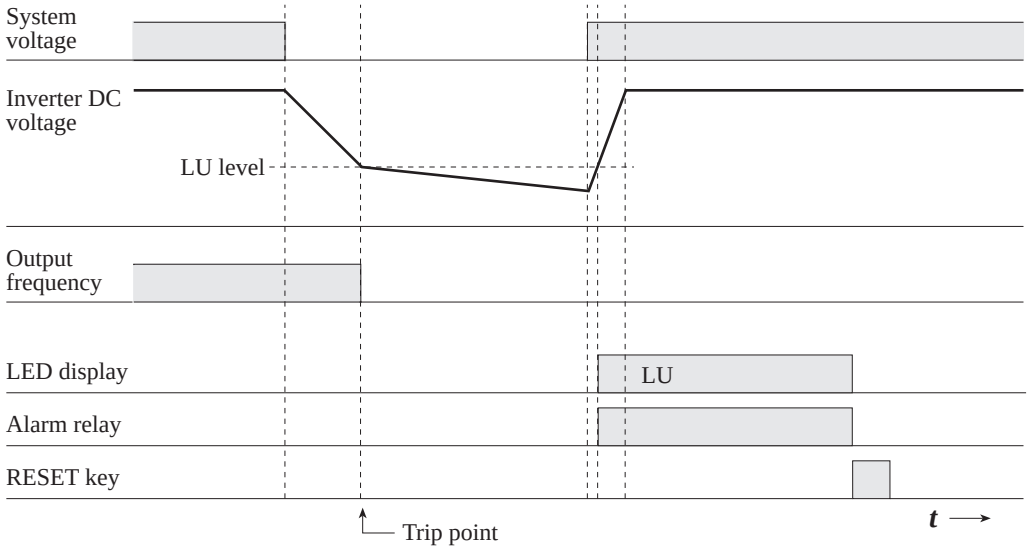
To restart in either of the above settings:

Press RESET (keypad mode, 01 = 0) or apply a reset signal to terminal (RST)-(P24)/(CMS) (terminal mode, 01 = 1) to enable the inverter. Press RESET (either mode) to cancel the LU trip signal.

Function 10 = 0: inactive, LU trip, alarm, no restart



Function 10 = 1: inactive, LU trip, alarm when supply restored, no restart



= 2 Restart with smooth recovery. This setting is intended for high-inertia loads. The inverter is allowed to regenerate for a time after the power supply has failed, so as to reduce the speed of the load.

When power is restored, the inverter output is restarted at its last output frequency. The load is then decelerated for a brief period before accelerating up to speed reference input. The rate of deceleration is adjustable by Function 83.

The interval between loss of inverter output and restart is adjustable by Function 82.

Press RESET (either mode) to cancel the LU trip signal.

= 3 Restart with smooth recovery. This setting is intended for normal loads. When the power supply fails, the inverter output is immediately stopped and the motor allowed to coast.

When power is restored, the inverter output is restarted at its last output frequency. The load is then decelerated for a brief period before accelerating up to speed input reference. The rate of deceleration is adjustable by Function 83.

The interval between loss of inverter output and restart is adjustable by Function 82.

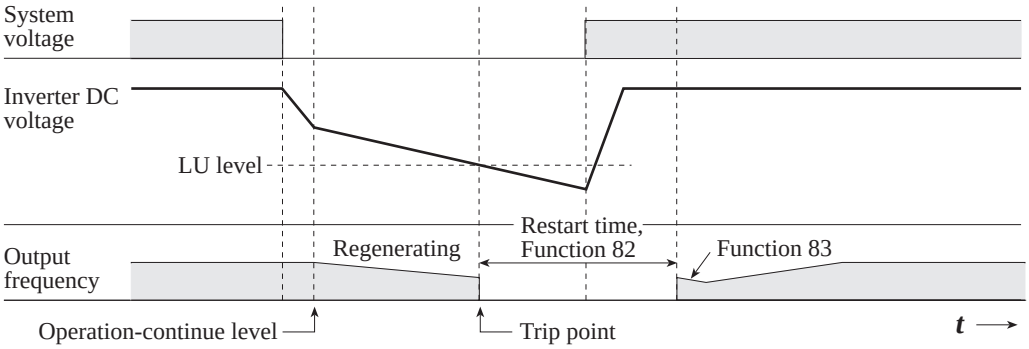
Press RESET (either mode) to cancel the LU trip signal.

= 4 Restart with smooth recovery. This setting is intended for low-inertia loads. When the power supply fails, the inverter output is immediately stopped and the motor allowed to coast.

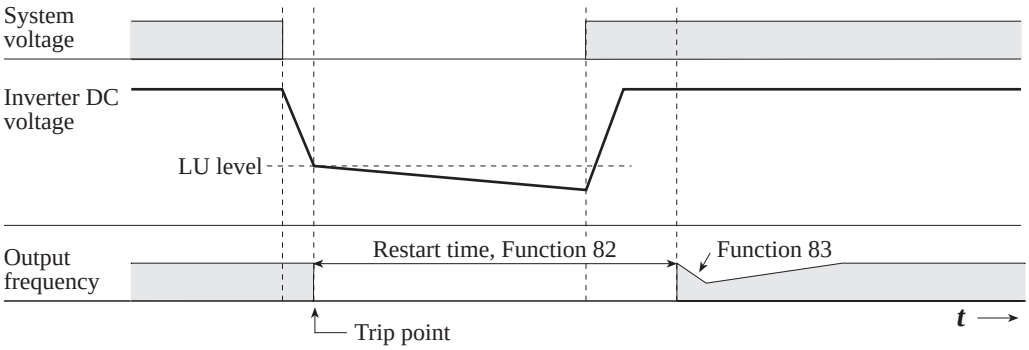
When power is restored, the inverter output is restarted at starting frequency (Function 57). The load is then accelerated up to speed reference input.

Press RESET (either mode) to cancel the LU trip signal.

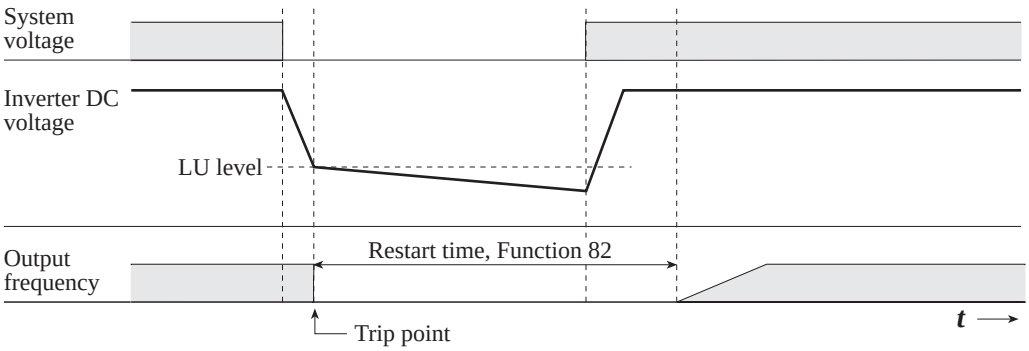
Function 10 = 2: active, LU alarm, smooth restart when supply restored



Function 10 = 3: active, LU alarm, restart at failure frequency

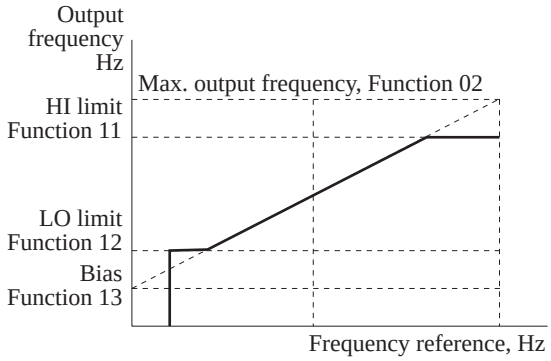


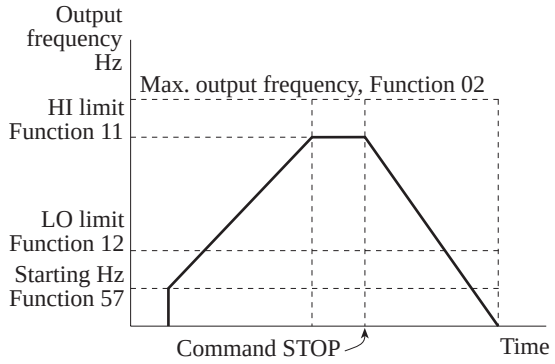
Function 10 = 4: active, LU alarm, restart at normal starting frequency



Frequency limiter — High
11 H LIMITER

Frequency limiter — Low
12 L LIMITER





The effects of the high and low limits for the output frequency are illustrated above.

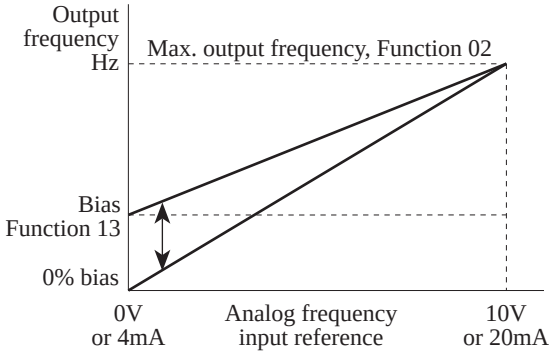
Setting range

for *VX* inverters	0 - 400Hz
for *VX …P* inverters	50 - 120Hz

Example of setting

- If Function 12 > Function 11 then Function 11 has priority.
- If Function 57 (starting frequency) > freq. I/P reference, the inverter is inhibited.
- If frequency I/P reference > Function 11, the inverter operates at the High limit, Function 11.

Bias frequency
13 FREQ BIAS



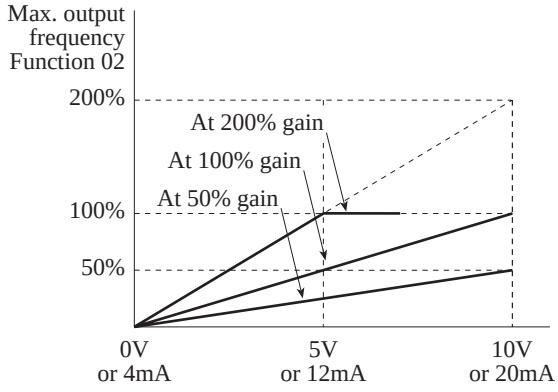
Effective for either the voltage terminals (12)-(11) or the current terminals (C1)-(11) analog frequency input reference.

This Function modifies the output frequency demand by adding a bias frequency to the analog input frequency reference.

Setting range

for *VX* inverters	0 - 400Hz
for *VX …P* inverters	0 - 120Hz

Gain — frequency input reference
14 FREQ GAIN



Effective for either the voltage terminals (12)-(11) or the current terminals (C1)-(11) analog frequency reference input.

Setting range 0.0% to 200%

Applies a gain to the analog input signal as a percentage of the maximum frequency Function 02.

Torque limit — Driving
15 DRV TORQUE

Torque limit — Braking
16 BRK TORQUE

These Functions set limits on the driving torque and braking torque.

When the set point of Function 15 or Function 16 is reached, the output frequency is reduced if the inverter is driving, and increased if the inverter is braking, so that the torque does not rise above the set value.

Setting range

Function 15, driving 20 to 180 (% of FLT)
or 999 (no limit)

Function 16, braking 0 (coast to stop)
or 20-180 (% of FLT)
or 999 (no limit)

However, the upper limit is +5Hz with respect to the frequency input reference.

DC brake — Starting frequency
17 DC BRK Hz

DC brake — Braking level
18 DC BRK LVL

DC brake — Braking time
19 DC BRK t

Function 17 starting frequency:

This sets the frequency at which DC brake operation starts during deceleration.

Setting range 0.0 to 60.0 Hz

If Function 17 = 0.0, braking will start at the minimum frequency (0.20 Hz).

Function 18 braking level:

This adjusts the DC brake output.

Setting range 0 to 100 %

Function 19 braking time:

This sets the operating time for the DC brake.

Setting range 0 or 0.1 to 30.0 s

If Function 19 = 0, the motor will decelerate to the DC brake starting frequency, and will then coast to rest.

Please refer to *Motor Braking*, page 84, for additional guidance.

Multistep frequency setting value 1
20 MULTI Hz-1

Multistep frequency setting value 2
21 MULTI Hz-2

Multistep frequency setting value 3
22 MULTI Hz-3

Multistep frequency setting value 4
23 MULTI Hz-4

Multistep frequency setting value 5
24 MULTI Hz-5

Multistep frequency setting value 6
25 MULTI Hz-6

Multistep frequency setting value 7
26 MULTI Hz-7

Multistep frequencies (preset speeds) 1 to 7 are set by control terminals X1, X2 and X3 as shown in the table below.

Multistep frequency settings	*Programmable input terminals*		
	X1	X2	X3
See F00	□	□	□
1	■	□	□
2	□	■	□
3	■	■	□
4	□	□	■
5	■	□	■
6	□	■	■
7	■	■	■

■ = ON □ = OFF

The above settings are also used as the speed settings when Function 65, Pattern Operation, has been selected. During pattern operation, multistep operation (preset speeds) has priority if control terminals X1, X2 and X3 have been set as above.

The preset speeds terminals X1…X5 are factory-set for this purpose but may be programmed for other uses. Refer to Function 32, page 52.

Preset speeds can be set for any output frequency but will be limited by the maximum frequency, Function 02, and the high and low frequency limits, Functions 11 and 12.

Setting range

VX inverters 0.00 or 0.20 to 400.00 Hz

VX…P inverters 0.00 or 0.20 to 120.00 Hz

(0.00 = preset disabled)

Electronic thermal overload relay for braking resistor
27 DBR OL

Monitors the frequency of operation and continuous operation time for the braking resistor. The Function trips the inverter when necessary to protect the braking resistor.

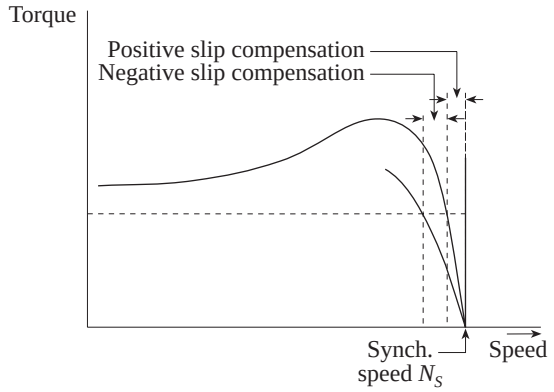
= 0 Inactive

= 1 Active for internal braking resistor

= 2 Inactive

NOTE Only inverters rated ≤7.5kW are equipped with internal braking resistors. Function 27 is redundant for inverters of higher rating, for which 27 = 0 is fixed.

Slip compensation control
28 SLIP COMP



Setting range 0.0 and -9.9Hz to 5.0Hz.
0.0 = no compensation.

When the motor loading increases, the motor slows down. Conversely, if load reduces, speed increases, The object of slip compensation is to keep the motor speed constant under varying load.

As illustrated above, slip compensation can be either positive or negative. Positive slip raises the motor speed to compensate for a load torque increase. A negative value of compensation magnifies the motor speed droop.

Function 28 sets the 'compensation frequency' C_f for slip compensation.

$$C_f = \frac{\text{Slip \% at rated load}}{100} \times \text{Base Hz}$$

The exact value for the % slip at full load will vary from one motor to another.

Example: Rating plate data — Poles *(p)* = 4; Base frequency *(f)* = 50Hz; Full load speed (N_L) = 1440 rpm.

$$N_S = \frac{f \times 120}{p} = \frac{50 \times 120}{4} = 1500\text{rpm}$$

$$\text{Set Function 28} = \frac{(N_S - N_L) \times f}{N_S}$$

$$= \frac{(1500 - 1440) \times 50}{1500} = 2\text{Hz}$$

Torque vector control
29 TRQ VECTOR

= 0 Torque vector control inactive

= 1 Active

To obtain the maximum amount of motor torque under a variety of operating conditions, the output torque is accurately calculated by the inverter software in accordance with the load conditions. The voltage vector is controlled to the optimum value based on the result of the calculation. Torque vector control can only be used for a single motor. The motor must have the same rating as the inverter, or lower.

If torque vector control is selected, the following values will be changed from those of present settings:

Function 04 — Rated voltage

If Function 04 = 0 the following will automatically be applicable: 380 to 480V systems = AVR control

If a value other than 0 is set, that voltage value will be applied.

Function 28 — Slip compensation control

If Function 28 = 0.0 and Function 21 = 1 (*ie* in torque vector mode) the inverter will apply a predetermined value of compensation stored in the preprogrammed 'motor map' for the relevant motor capacity.

If a value other than 0.0 is set, the motor will be operated at whatever slip compensation control amount is currently set.

Function 07 — Torque boost

Automatic torque boost will be applicable. Thus, any other setting which is different from this will be ignored.

Conditions for selecting torque vector control

1 A motor rated at lower than 0.2 kW should not be used.

2 Torque vector control cannot be used if two motors are supplied from the inverter.

3 The motor used should be a standard motor with the same frame size or one size larger or one or two sizes smaller than the inverter. It may be a special inverter motor. Refer to IMO Precision Controls Ltd.

4 The motor should have either 2, 4 or 6 poles.

5 The cable connecting the motor and inverter should not be more than 50m in length.

6 There should be no filter or reactor connected between the inverter and the motor.

NOTE If using a motor which is non-standard, or if the impedance between the inverter and the motor cannot be ignored, use the auto-tuning Function 90 to find the constant before using torque vector control. However, it may not be possible to obtain the full performance or tuning may not be possible under some conditions. In such cases, torque vector control cannot be used.

Number of motor poles

30 MTR POLES

Available settings — 2 to 14 (even numbers only)

If the correct value is not set, the rotational speed of the motor will be incorrectly displayed.

NOTE: FUNCTION BLOCKS

The remaining Functions, with the sole exception of Function 95, are grouped into 'Function blocks'. As delivered, none of these Functions will be shown or accessible when scrolling through the Functions list on the LCD display. Thus, after Function 31, the next visible Function will be 42, then 52, 60, 80 and 95. Functions 00 to 30 are always visible and accessible.

The invisible Functions in any block are caused to appear on the LCD display and are made accessible to read and to write by setting the 'Function block' Function value to 1.

Function block 32 to 41

31 • 32—41 •

32 Terminals X1…X5, input functions

33 Acceleration time 2

34 Deceleration time 2

35 Acceleration time 3

36 Deceleration time 3

37 Acceleration time 4

38 Deceleration time 4

Set 31 = 1 to access Functions 32 to 41.

Set 31 = 0 to make Functions 32 to 41 inaccessible.

Select functions of terminals X1 to X5

32 X1—X5 FUNC

Accessible when 31 = 1. Refer also to Functions 20…26.

Setting range 0 0 0 0 to 2 2 2 2

Function 32 enables external control contacts connected to terminals X1…X5 to be used for the different purposes listed in the table below. When Function 32 is selected, four digits appear in the multifunction display, any one of which may be set to 0, 1 or 2. The first digit determines the function of terminals X1 and X2; the second digit determines the function of terminal X3, the third, the function of X4 and the fourth, terminal X5.

	0	1	2
X1 X2	Multistep frequency setting — refer to Functions 20 to 26	UP/DOWN control, initial value = 0	UP/DOWN control, initial value = previous value
X3		Changeover operation from line to inverter (for 50Hz line)	Changeover operation from line to inverter (for 60Hz line)
X4	Acceleration/ Deceleration time ACC 2 to 4 DEC 2 to 4 (3 steps each)	Current input selection	DC brake command
X5		2nd motor V/f selection	Enabling signal for change of Function value

Multistep frequency selection — terminals X1, X2 and X3

Terminal	X1, X2	X3	X4	X5
Setting	0	0	*	*

* Not relevant

Terminals X1, X2 and X3 are used in combination to select the multistep frequencies 1 to 7. Refer to Functions 20…26.

RAISE/LOWER control — Method 1

Zero speed interlock

Starting frequency is always 0Hz

Terminal	X1, X2	X3	X4	X5
Setting	1	*	*	*

* Not relevant

Inverter output frequency can be controlled by inputs to terminals X1 and X2 acting as a 'motorised pot'. Terminal X1 raises the frequency, X2 lowers it. Either circuit changes the frequency only whilst an input signal is present. Neither can change the direction of rotation.

RAISE/LOWER control — Method 2

Restart at last frequency

Starting frequency when the inverter is stopped by a STOP command = last value applied by either input signal.

Terminal	X1, X2	X3	X4	X5
Setting	2	*	*	*

* Not relevant

Operation is otherwise the same as X1, X2 = 1

Changeover operation — terminal X3

Terminal	X1, X2	X3	X4	X5
Setting	*	1†	*	*

* Not relevant

† X3 = 2 for 60Hz line operation

If an inverter drive system is provided with a bypass supply (mains power) this command switches between the inverter output and the bypass.

If at the moment of switching the inverter input frequency reference is zero, the inverter outputs 50Hz momentarily, and then decelerates to a stop. The timing for signal input to terminal X3, and the switching of the motor power supply from commercial power to inverter, can be simultaneous.

Acceleration/Deceleration time — terminals X4, X5

Terminal	X1, X2	X3	X4	X5
Setting	*	*	0	0

* Not relevant

Acceleration and deceleration times preset by Functions 33…38 can be selected by inputs to terminals X4 and X5 acting in combination. Refer to Functions 33…38.

Current input selection — terminal X4

Terminal	X1, X2	X3	X4	X5
Setting	*	*	1	*

* Not relevant

When a signal is received at terminal X4, analog voltage input (12)-(11) is ignored and only the analog current input (C1)-(11) is valid.

DC brake selection — terminal X4

Terminal	X1, X2	X3	X4	X5
Setting	*	*	2	*

* Not relevant

DC braking operates at the DC braking start frequency, Function 17, or less while the motor is decelerating or stopped. The braking is ON while the braking command is on. If the inverter receives an external operation command, that command takes priority.

Acceleration time 2
33 ACC TIME 2

Deceleration time 2
34 DEC TIME 2

Acceleration time 3
35 ACC TIME 3

Deceleration time 3
36 DEC TIME 3

Acceleration time 4
37 ACC TIME 4

Deceleration time 4
38 DEC TIME 4

Accessible when 31 = 1

Setting range

Acceleration time 0.01s to 3600s

Deceleration time 0.00s to 3600s
(0.00 = Coasting)

Functions 33 to 38 set the acceleration and deceleration times for multistep operation. Valid only if terminals X4 and X5 have been set to 'data 0' — refer to Function 32. If X4 and X5 are set to any value other than 0, input signals will not be valid.

Accel./Decel time settings	*Programmable input terminals*	
	X4	X5
Accel/Decel time 1	□	□
Accel/Decel time 2	■	□
Accel/Decel time 3	□	■
Accel/Decel time 4	■	■

■ = ON □ = OFF

Base frequency — Motor 2
39 BASE Hz -2

Accessible when 31 = 1

Setting range

VX inverters 50 to 400Hz in steps of 1Hz.

VX …P inverters 50 to 120Hz in steps of 1Hz.

Set Function 39 at the rated frequency of the motor.

The output voltage-to-frequency (V/f) ratio delivered by the inverter is constant up to the base frequency. Torque output is nominally constant from zero speed up to base frequency; above base frequency, power is constant.

If the base frequency is greater than the maximum frequency, Function 02, the output voltage will not rise to the rated voltage.

Maximum O/P voltage, Motor 2
40 RATED V -2

Accessible when 31 = 1

Setting range 0, or 320 to 415/420/460/480* in steps of 1V

If required, clamps the maximum output voltage for the inverter.

NOTE The output voltage cannot be higher than the input voltage V_L.

= 0 Maximum output voltage is increased or decreased according to the input voltage V_L.

= 320 to 415/420/460/480* Regardless of the level of input voltage V_L, the maximum output voltage is clamped at the value selected.

* Dependent on inverter model and system frequency. For details, refer to 'Input', page 4.

Torque boost, Motor 2
41 TRQ BOOST 2

Accessible when 31 = 1

Setting range 0.0, or 0.1 to 20.0

Torque boost can be switched between automatic and manual mode. In manual mode the boost is adjustable up to a maximum of 20 per cent.

= 0.0 Torque boost is automatically controlled to compensate for the primary resistance of the motor.

= 2.0 to 20.0 Torque boost is linear up to base frequency as illustrated above.

= 1.0 to 1.9 Torque boost is non-linear.

= 0.1 to 0.9 Torque boost is non-linear but follows a 'weaker' curve.

Refer to the diagram illustrating Function 07, page 45.

Function block 43 to 51

42 • 43—51 •

43	**FMP terminal, pulse rate multiplier**
44	**FMP terminal, voltage O/P adjust**
45	**FMA terminal, voltage O/P adjust**
46	**FMA terminal, function**
47	**Terminals Y1E…Y5E, select outputs**
48	**FAR signal ('at-speed' window)**
49	**FDT signal, level**
50	**FDT signal, hysteresis**
51	**Overload alarm, level**

Set 42 = 1 to access Functions 43 to 51.

Set 42 = 0 to make Functions 43 to 51 inaccessible.

Terminal FMP, pulse rate multiplier
43 FMP PULSES

Accessible when 42 = 1

Setting range 6 to 100

Sets the pulse frequency output at terminal FMP.

The setting is determined by the following formula :

FMP frequency =
Output Hz x selected multiplier Function 43

The upper limit for FMP frequency output is 6 kHz.

Terminal FMP, voltage O/P adjustment
44 FMP V-ADJ

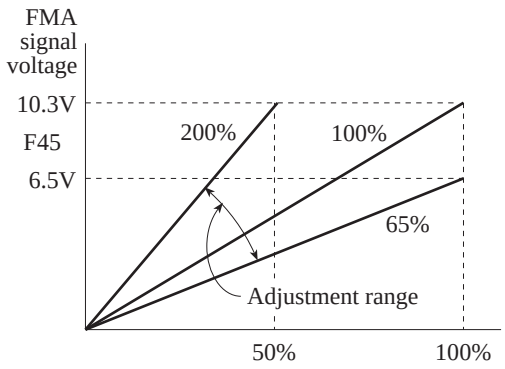
Accessible when 42 = 1

Setting range 50% to 120%

Adjusts the DC voltage output from terminal FMP.

Terminal FMA, voltage O/P adjustment
45 FMA V-ADJ

Accessible when 42 = 1



Setting range 65% to 200%

Adjusts the DC voltage output from terminal FMA.

Adjusts the voltage to the level required for a 'full scale' (100%) reading of the value selected in Function 46.

Terminal FMA, function
46 FMA FUNC

Accessible when 42 = 1

Setting range 0 to 3

Select one of the following parameters to be monitored at the output of terminal FMA:

Data	*Parameter*	*Meaning of 100%*
0	Output frequency	Maximum frequency
1	Output current	Inverter rated current x 2.0
2	Output torque	Rated torque x 2.0
3	Load rate	Rated load x 2.0

Terminals Y1E to Y5E, function
47 Y1-Y5 FUNC

Accessible when 42 = 1

Setting range 0 0 0 0 0 to F F F F F

Assigns functions to terminals Y1E, Y2E…Y5E, using a 5-digit selection from 1 to 9 plus C, d, E, F. The same output function can be assigned to two or more different terminals at the same time.

The output at terminal Y1E is determined by the first digit selected, at terminal Y2E by the second digit, Y3E by the third, and so on.

Output function E, indication of stage number in Pattern Operation (Functions 66 to 72), uses Y3E, Y4E and Y5E. Terminals Y1E and Y2E can be assigned to any of the other outputs controlled by data 0 to 9, C and d.

Output function F, cause of trip signal, uses Y2E, Y3E, Y4E and Y5E. Refer to the table on page 68. Terminal Y1E can be assigned to any of the other outputs controlled by data 0 to 9, C and d.

Data	*Output termlnal function*	*Symbol*
0	Inverter running	RUN
1	Frequency equivalence signal (F48)	FAR
2	Frequency level detection (F49, F50)	FDT
3	Overload early warning (F51)	OL
4	Undervoltage detection	LU
5	Keypad operation mode	
6	Torque limiting	
7	Inverter stopped	STP
8	Auto-restart mode	RES
9	Auto-reset mode	
A	(Not available)	
B	(Not available)	
C	Time-up signal (100ms pulse) in Pattern Operation	
d	Cycle completion signal (100ms pulse) in Pattern Operation	
E	Stage Number indication signal (3-bit signal) in Pattern Operation. Uses three output terminals Y3E, Y4E and Y5E.	
F	Cause of trip signal (4 bit signal) in alarm trip mode. Uses four output terminals Y2E, Y3E, Y4E and Y5E. Refer to the table on page 68.	

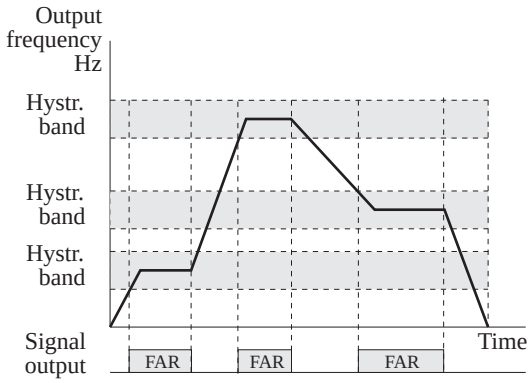
Example of assignment

To output: From Y1E, Overload early warning;
From Y2E, Auto-restart mode;
From Y3E, Auto-reset mode;
From Y4E, Inverter running;
From Y5E, Inverter stopped;

Set: Function 47 = 3 8 9 0 7

FAR function signal, hysteresis
48 FAR HYSTR

Accessible when 42 = 1



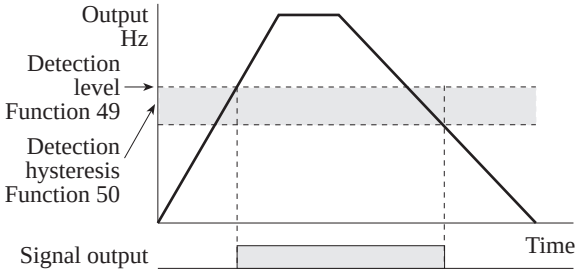
Setting range 0.0 to 10.0Hz

Sets the band width (‘hysteresis’) within which the FAR signal is an active output. The same band width is applied to each frequency reference input.

The FAR Function is in effect an at-speed window. Note that the FAR Function signal becomes inactive immediately when a change-of-speed signal is given.

FDT function signal, level
49 FDT LEVEL

Accessible when 42 = 1



Setting ranges

VX inverters 0 to 400Hz in steps of 1Hz.

VX …P inverters 0 to 120Hz in steps of 1Hz.

FDT function signal, hysteresis
50 FDT HYSTR

Accessible when 42 = 1

Setting range 0.0 to 30.0Hz

Sets the band width (‘hysteresis’) within which the FDT signal is an active output. Note that the FDT signal is activated by Function 49 and de-activated by the lower edge of the hysteresis band.

Overload alarm, level
51 OL WARNING

Accessible when 42 = 1

Setting range Approx 20 to 105% of inverter rated current.

Function 51 sets the alarm level for the motor overload. Because it has the same inverse time characteristic as the electronic thermal overload relay, it is possible to use it as an overload early warning by setting the value lower than the electronic thermal overload relay level setting.

Refer to:

Function 09, Internal thermal overload — level;

Function 47 data 3, overload early warning.

Function block 53 to 59

52 • 53—59 •

53 Skip frequency 1
54 Skip frequency 2
55 Skip frequency 3
56 Skip hysteresis
57 Starting frequency
58 Holding time
59 Frequency input reference filter

Set 52 = 1 to access Functions 53 to 59.

Set 52 = 0 to make Functions 53 to 59 inaccessible.

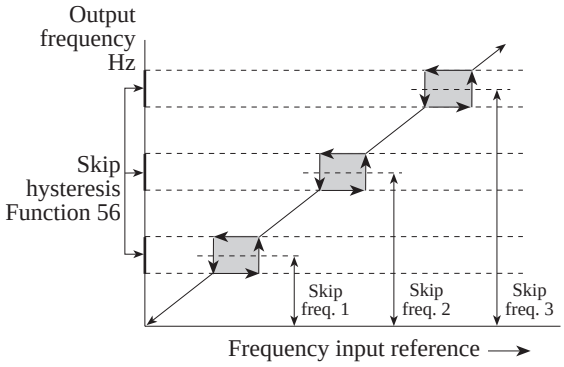
Skip frequency 1
53 JUMP Hz 1

Skip frequency 2
54 JUMP Hz 2

Skip frequency 3
55 JUMP Hz 3

Skip frequency, hysteresis
56 JUMP HYSTR

Accessible when 52 = 1



Setting ranges

VX inverters 50 to 400Hz in steps of 1Hz.

VX …P inverters 50 to 120Hz in steps of 1Hz.

If a skip ('jump') frequency is set to 0Hz (the default value), the skip function will become inactive.

Minimum resolution for each skip frequency and for hysteresis is 1Hz.

Up to three skip frequencies can be set.

The skip hysteresis band width, Function 56, is the same for all skip frequency set points.

Starting frequency
57 START Hz

Accessible when 52 = 1

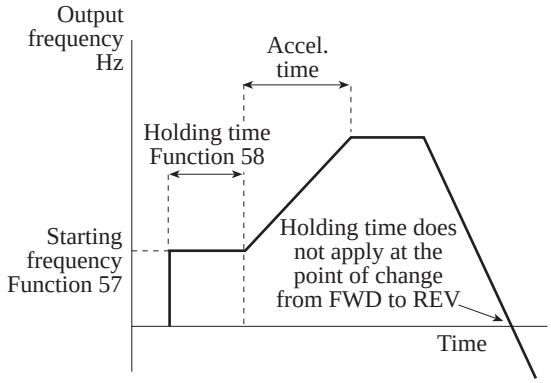
Setting range 0.2 to 60.0Hz

Function 57 sets the starting frequency in steps of 0.1Hz (min. starting frequency 0.2Hz).

Refer to the illustrations for Functions 11, 12 and 58.

Holding time
58 HOLDING t

Accessible when 52 = 1



Setting range 0.0 to 10.0s

Function 58 sets the time for which the starting frequency, Function 57, will be held before acceleration begins. Resolution is 0.1s. The holding time is not included in the acceleration time.

Function 58 also operates when Pattern Operation is selected (Function 65). In this case, **holding time is included in the time value set in Stage 1**.

Frequency I/P reference filter
59 FILTER

Accessible when 52 = 1

Setting range 0.01 to 5.00s

Function 59 sets the time constant for the input filter to eliminate the effects of electronic noise included in the analog input signal (both voltage and current inputs). Resolution is 0.01.

If the time constant is too long, response to analog signals is adversely affected.

Function block 61 to 79

60 • 61—79 •

61 LED digital display in normal mode
62 LED digital display in stop mode
63 Machine speed/Line speed coefficient
64 LCD display options
65 Pattern operation, mode select
66 Pattern operation, Stage 1
67 Pattern operation, Stage 2
68 Pattern operation, Stage 3
69 Pattern operation, Stage 4
70 Pattern operation, Stage 5
71 Pattern operation, Stage 6
72 Pattern operation, Stage 7
73 Acceleration/Deceleration mode
74 *Not available*
75 Energy saving
76 Reverse lock
77 Data reset
78 Language of displays
79 LCD display screen contrast

Set 60 = 1 to access Functions 61 to 79.

Set 60 = 0 to make Functions 61 to 79 inaccessible.

LED digital display function, normal mode
61 LED MNTR 1

LED digital display function, stop mode
62 LED MNTR 2

Accessible when 60 = 1

Setting ranges Function 61 — 0 to 8
Function 62 — 0 or 1

Functions 61 and 62 select what information appears on the LED digital display during running, stopping and frequency setting.

Function 62 selects the display information in stop mode.

61	*During Running*	*During Stopping*		*During Frequency Setting*	*Units*
		62 = 0	*62 = 1*		
0	Frequency output	Frequency I/P ref.	Frequency output	Frequency reference	Hz
1	Current output			Frequency reference	A, Hz
2	Voltage output			Frequency reference	V, Hz
3	Motor synch. speed	Motor synch. speed ref.	Motor synch. speed	Motor synch. speed ref.	r/min
4	Line speed	Line speed ref.	Line speed	Line speed ref.	m/min
5	Machine speed	Machine speed ref.	Machine speed	Machine speed ref.	r/min
6	Torque limit (drive)			Frequency reference	%, Hz
7	Torque limit (brake)			Frequency reference	%, Hz
8	Torque calculation			Frequency reference	%, Hz

Coefficient for machine and line speeds
63 SPEED COEFF

Accessible when 60 = 1

Setting range 0.01 to 200.00 times Hz O/P in 0.01 steps

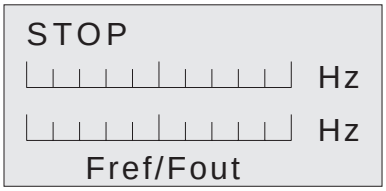
Function 63 is applied as a multiplier to the output frequency to produce a figure for machine speed in rev/min or line speed in m/min for LED display.

LCD display function
64 LCD MNTR

Accessible when 60 = 1

Setting range 0 to 3 in unit steps

F64 = 0: LCD display shows RUN/STOP as illustrated on page 35.



F64 = 1: Freq. I/P ref & O/P freq.

F64 = 2: Freq. & current O/Ps

F64 = 3: Freq. & torque O/Ps

Function 64 changes the LCD display in RUN and STOP modes to show output as a bar graph. Full scale deflection = 200% x value.

Pattern operation, Mode select
65 PATTERN

Accessible when 60 = 1

Setting range 0 to 3 in unit steps

Function 65 is the mode selector for Pattern Operation, to enable the drive to operate the pattern set up using Functions 66 to 72. The selectable modes of operation of the pattern are:

= 0 Inactive (no pattern operation — default).

= 1 Mono cycle — perform the pattern once on demand.

= 2 Continuous cycle — perform the pattern repeatedly until a STOP command is given.

= 3 Mono cycle with continuous final speed.

Pattern operation, Stage 1
66 STAGE 1

Pattern operation, Stage 2
67 STAGE 2

Pattern operation, Stage 3
68 STAGE 3

Pattern operation, Stage 4
69 STAGE 4

Pattern operation, Stage 5
70 STAGE 5

Pattern operation, Stage 6
71 STAGE 6

Pattern operation, Stage 7
72 STAGE 7

Accessible when 60 = 1

By means of Functions 66 to 72, Acc/Dec Functions 05, 06 and 33 to 38, and Multistep frequency Functions 20 to 26, the user can cause a motor to follow a timed pattern of seven Stages (or less if desired).

The initial action is to set as many different acceleration and deceleration times as required by the desired pattern. A different Acc/Dec time (Functions 05, 06 and 33 to 38) can be assigned to any Stage.

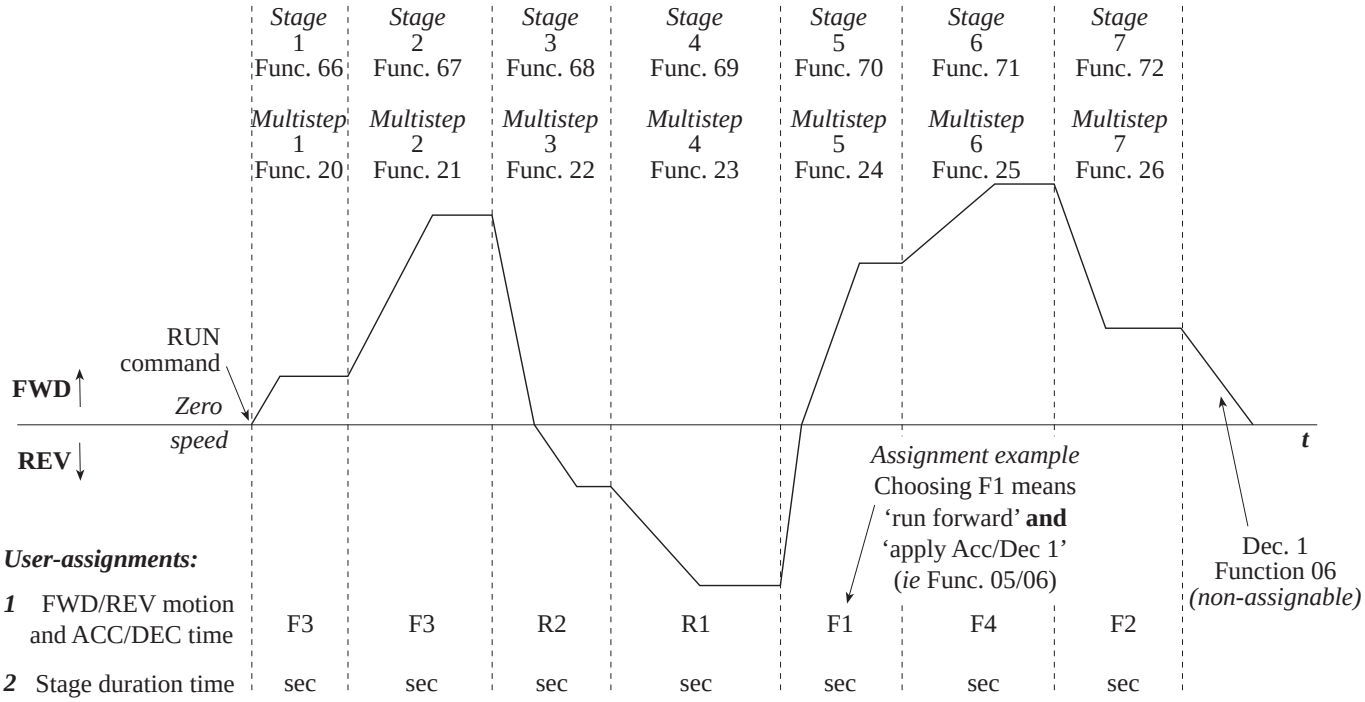
As many Multistep frequencies, 20 to 26, must be set as there are Stages in the desired pattern. The inverter software always uses these frequency commands in their successive order as shown in the upper diagram on the facing page.

Setting procedure

When the necessary acceleration and deceleration times and the multistep frequencies have been set, the user assigns the direction, acc/dec, and duration to each Stage in turn. When Function 66 is selected, for example, the LCD screen appears as shown in the lower diagram opposite. The direction of rotation and the required acceleration or deceleration time is set first. The ∧ key selects forward motion (F1 to F4); the ∨ key selects reverse motion (R1 to R4). Each of the selectable symbols F1 etc, R1 etc, is associated with a specific Accel/Decel Function, *eg* if F1 is selected, Acc/Dec 1 (05 and 06) will be used in that Stage. Please refer to page 54. ***Before*** pressing FUNC/DATA to store this symbol, set the duration time for the Stage. Press » to enter the time-setting data for the duration of the Stage, then use ∧ and ∨.

Finally press FUNC/DATA and proceed to set Stage 2.

continued on page 62



PATTERN
SETTING
PROCEDURE

```
STOP
PRG➡  DATA SET
»➡    LED SEL
```

PRESS PRG *then* ⌄ *to SELECT*

FLASHING →

```
66 STAGE 1
67 STAGE 2
68 STAGE 3
69 STAGE 4
```

PRESS FUNC DATA *to open dialog window*

The existing set point is shown.
Bottom line shows the available setting range,
alternating with STORE➡ F/D KEY

```
66 STAGE 1
          0.00s← F1 FLASHING
0.00/6000
```

PRESS ⌃ to change F1 to F2 etc

OR ⌄ to change F1 to R1 etc

DO NOT PRESS FUNC DATA *YET!*

SET the duration time for Stage 1 in seconds

PRESS »

to move the cursor to the 1000s column of the time (extreme left)

PRESS ⌃ to change the set point one unit of 1000s at a time

or PRESS » to move the cursor to the 100s column, etc

ADJUST the required duration time for Stage 1 in seconds then

PRESS FUNC DATA

to complete the setting for Stage 1

Stage operating time

Setting range 0.00 to 6000s

If time is set = 0.00 (the default value), the stage is skipped. The resolutions for each of the different time scales are as follows:

Setting time	*Resolution*
0.01 to 9.99s	0.01s
10.0 to 99.9s	0.1s
100 to 999s	1s
1000 to 3600s	10s

Direction of rotation and accel/decel time

Code	*Direction*	*Accel/decel time*	*Function number*
∧ F4	Forward	ACC4/DEC4	37/38
∧ F3	Forward	ACC3/DEC3	35/36
∧ F2	Forward	ACC2/DEC2	33/34
∧ F1	Forward	ACC1/DEC1	05/06
∨ R1	Reverse	ACC1/DEC1	05/06
∨ R2	Reverse	ACC2/DEC2	33/34
∨ R3	Reverse	ACC3/DEC3	35/36
∨ R4	Reverse	ACC4/DEC4	37/38

NOTE The final deceleration to stop is always DEC1 (F06). The motor does not coast to rest at the end of the sequence.

Assigning the frequencies to the Stages

Stage number	*Function number*	*Multistep frequency*	*Function number*
1	66	1	20
2	67	2	21
3	68	3	22
4	69	4	23
5	70	5	24
6	71	6	25
7	72	7	26

NOTE Each Stage uses the pre-assigned Multistep frequency as shown above. This assignment cannot be varied by the user.

Pattern operation control

When a pattern operation has been set up, it starts when a RUN command is given by the keypad RUN key, or terminal (FWD)-(P24)/(CMS).

A STOP command by keypad STOP key, or (FWD)-(P24)/(CMS) off, or (BX)-(P24)/(CMS) on, acts as a PAUSE. The timer is halted until a new RUN command is given. The speed prior to the stop is then regained and the timer resumes counting.

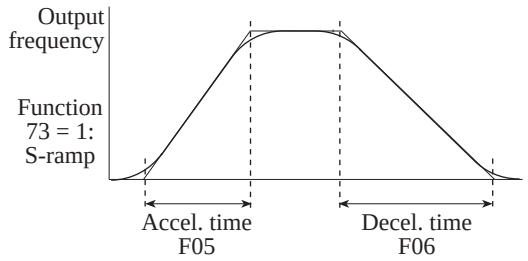
TO HALT THE PATTERN COMPLETELY, apply a STOP command and a RESET command. The next RUN command will initiate the pattern from the beginning, not from the point where it was halted.

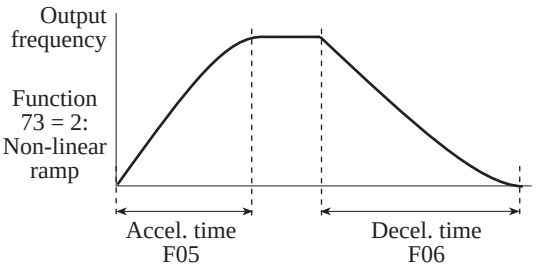
Pattern operation data output

Pattern stages can be signalled from output terminals Y3E, Y4E, Y5E. Refer to Function 47.

Acceleration/Deceleration pattern, Mode 73 ACC PTN

Accessible when 60 = 1





Setting range 0 to 2 in unit steps

Three modes for acceleration and deceleration are available:

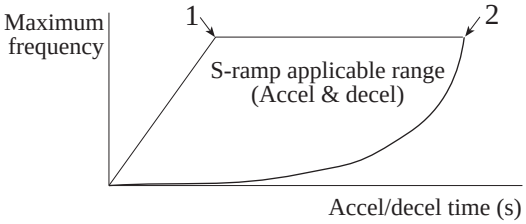
= 0 Linear mode (the default. mode).

= 1 S-ramp mode adds a smoothing curve at the beginning and end of linear ramps to produce stepless change of speed.

= 2 Non-linear mode changes the ramps to an exponential curve.

The selected mode is automatically applied to all acceleration and deceleration Functions, *ie* 05, 06, 33…38.

The limitations to the range of the S-ramp are that the ratio of the maximum frequency (Function 02) to the acceleration or deceleration time must be less than 1896, and that the ratio of the *square* of the acceleration or deceleration time to the maximum frequency must be less than 700. Referring to the diagram,



Point 1 $\dfrac{\text{Max. frequency 02 (Hz)}}{\text{Accel./Decel. time (s)}} < 1896$

Point 2 $\dfrac{[\text{Accel./Decel. time (s)}]^2}{\text{Max. frequency 02 (Hz)}} < 700$

CAUTION

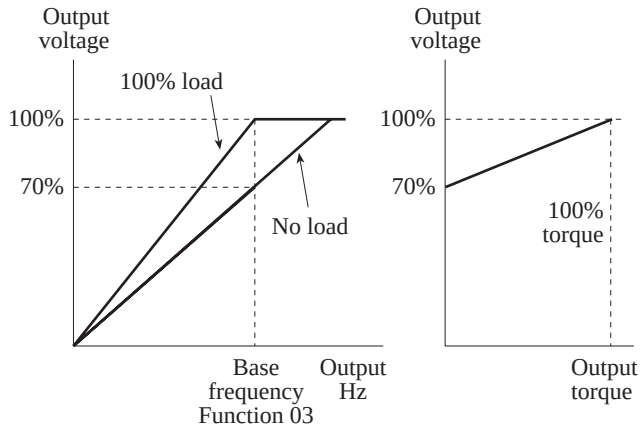
S-ramp mode extends the acceleration and deceleration times, Functions 05, 06 and 33 to 38.

Series brake, Motor driving
74 SERIES BRK

Not available

Energy-saving operation
75 ENERGY SAV

Accessible when 60 = 1



Setting range 0 or 1

Function 75 = 0: Energy-saving inactive.

Function 75 = 1 automatically weakens the V/f ratio during periods of operation when the motor is at less than full load. By reducing the output voltage, energy is not wasted in fluxing the motor unnecessarily. Function 75 is inactive during acceleration and deceleration.

NOTE If Torque Vector Function 29 is in use, Function 75 should be set to 0.

Reverse phase sequence lock
76 REV LOCK

Accessible when 60 = 1

Setting range 0 or 1

Function 76 = 1 prevents the motor being run in reverse even if a reverse command is given. The purpose of this feature is to prevent accidental damage to equipment which is designed for operation in one direction only.

Data initialisation (reset to default values)
77 DATA INIT

Accessible when 60 = 1

Setting range 0 or 1

To reset the values of all parameters to their original default values as set during manufacture, set Function 77 = 1 then press the Function/Data key on the keypad panel.

Language of displays
78 LANGUAGE

Accessible when 60 = 1

Setting range 0 = German
1 = English
2 = Spanish
3 = Italian

LCD screen contrast
79 BRIGHTNESS

Accessible when 60 = 1

Setting range 0 (full contrast) to 10 (least)

Function block 81 to 94

80 • 81—94 •

81 PWM carrier frequency
82 Auto-restart — start delay
83 Auto-restart — frequency fall rate
84 Auto-reset — number of restarts
85 Auto-reset — interval
86 Motor 1 — frame size
87 Motor 1 — rated current
88 Motor 1 — no-load current
89 Motor 2 — rated current
90 Motor 1 — tuning
91 Motor 1 — %R1 value
92 Motor 1 — %X value
93 Reserved for manufacturer's use only
94 Reserved for manufacturer's use only

Set 80 = 1 to access Functions 81 to 94.

Set 80 = 0 to make Functions 81 to 94 inaccessible.

PWM carrier frequency
81 MTR SOUND

Accessible when 80 = 1

Setting range 0 to 10

VX Inverter	*Available Range*
VX40 to VX2200 VX750P to VX2200P	2kHz to 15.6kHz
VX30K to VX55K	2kHz to 10kHz
VX75K to VX220K VX30KP to VX75KP	2kHz to 6kHz
VX90KP to VX280KP	2kHz to 4kHz

In the range ≤22kW, the inverter may automatically reduce the carrier frequency to 10kHz if necessary to assist inverter protection.

The higher the PWM frequency the closer the output current waveform approximates to a true sine wave. High PWM frequencies will increase RF emissions from the motor and the output cable and significantly increase the heat dissipated by the inverter due to increased switching losses in the power switching devices. However, the motor itself will run cooler, more quietly and more efficiently.

Auto restart, Restart delay
82 RESTART 1

Accessible when 80 = 1

Setting range 0.0 to 5.0s

Refer to the diagrams for Function 10.

Sets the time interval from the moment when the DC bus voltage falls to the LU level to the initiation of the restart.

Auto restart, Frequency fall rate
83 FALL RATE

Accessible when 80 = 1

Setting range 0.00 to 100.00 Hz per second

Refer to the diagrams for Function 10.

Sets the slope of the initial reduction of output frequency, enabling the inverter to 'overtake' and synchronise with a load which is still spinning during a break in supply.

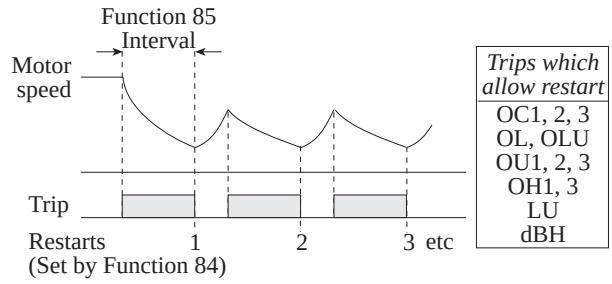
WARNING

RESTART HAZARD: A motor which can restart unexpectedly presents a potential hazard to personnel working near the driven equipment.

Auto reset, Number of resets
84 AUTO RESET

Auto reset, Interval between resets
85 RESET INT

Accessible when 80 = 1



Setting ranges Number of resets, 0 to 7

Interval between resets, 2 to 20s

These Functions enable the inverter to attempt to restart automatically after a trip. If the trip persists after the selected number of re-tries is used up, the inverter remains tripped and stopped.

If the trip is cleared during the restart attempt period, the inverter resumes operation as normal but the cause of the trip is not recorded.

NOTE that Pattern Operation resumes at the point it reached when the trip occurred.

Motor 1, Frame size
86 MOTOR CAP

Motor 1, Rated current
87 MOTOR 1 Ir

Motor 1, No-load current
88 MOTOR 1 Io

Accessible when 80 = 1

Setting ranges Function 86 — 0 to 3
Functions 87 & 88 — 0.00 to 2000A

Function 86 adjusts the software to take account of motors of other ratings.

= 0 Motor one frame size above inverter rating.

= 1 Equal ratings.

= 2 Motor one frame size lower rating.

= 3 Motor 2 frame sizes lower rating.

Functions 87 and 88 are pre-set for a motor of equal nominal rating to the inverter rating but may, however, require fine tuning. For a motor of a frame size different to that of the inverter, Functions 87 and 88 will require adjustment.

For Function 87, use motor rating plate data.

Function 88 can be approximated from:

$$I_o = I_r \times \sqrt{[1 - (\cos \phi)^2]}$$

Motor 2, Rated current
89 MOTOR 2 Ir

Accessible when 80 = 1

Setting range 0.00 to 2000A

Motor 1, Impedance
90 TUNING

Accessible when 80 = 1

Setting range 0 or 1

Provides for auto-tuning the inverter to the primary resistance and the leakage reactance of a motor and its cable.

The motor must be correctly connected to the inverter, and the inverter must be in stop mode.

Set Function 90 = 1 and press the Function/Data key. Tuning will be completed in about 5 seconds.

The results of the auto-tuning can be inspected and changed in Functions 91 and 92 if desired.

NOTES

1 **It is essential that Motor Capacity (Function 86) is correctly set prior to tuning.**

2 If the auto-tuning procedure is not successful (may happen with non-standard motors), code Er7 will be displayed on the keypad panel. In this event, tune manually using Functions 91 and 92.

3 The *Jaguar VX* does not measure motor magnetising current (entered manually, Function 88), therefore the motor does not rotate during tuning.

Motor 1, Impedance (%R1 setting)
91 %R1 SET

Accessible when 80 = 1

Setting range 0.00 to 50.00%

NOTE The R_1 value of a motor can be directly measured (star or delta) using a multimeter.

This Function allows manual insertion of a value for the percentage resistive impedance of the motor. If Function 90, auto-tuning, is used first and is successful, the $\%R_1$ value will be shown in Function 91.

To calculate $\%R_1$, the following expression may be used:

$$\%R_1 = \frac{\sqrt{3} \cdot I \cdot (R_1 + R_{cable})}{V} \times 100$$

where I is the rated full load current of the motor,
V is the motor rated voltage Function 04,
and R_{cable} is given in ohms.

Motor 1, Impedance (%X setting)
92 %X SET

Accessible when 80 = 1

Setting range 0.00 to 50.00%

NOTE The results of auto-tuning to the primary reactance are stored in Function 92, and can be examined, after an autotune function.

However, if necessary, the %X can be calculated and entered manually. Consult the motor manufacturer to obtain the motor 'equivalent circuit' parameters to use in the example below.

Example

DATA Motor: 7.5kW, 415V, 50Hz, FLC = 16A.
Cable: 200m x 2.5mm^2, 4-core.

I = the rated FLC of the motor (above),

V = the motor rated voltage (Function 04).

Manufacturer's data for the equivalent circuit:

X_1 = 3.1 Ω (motor stator reactance in ohms)

X_2 = 4.05 Ω (referred rotor reactance in ohms)

X_M = 92 Ω (magnetising reactance in ohms)

NOTE It is **essential** to check whether this data is for star- or delta-connection of the motor. If quoted for delta-connection the data is **not useable** for the *Jaguar VX* until converted to star configuration.

Equivalent star impedances are given by:

$$\frac{X_{delta}}{3} = X_{star}$$

continued overleaf

∴ the data for **star** connection becomes:

$$X_1 = \frac{3.1}{3} = 1.03\ \Omega$$

$$X_2 = \frac{4.05}{3} = 1.35\ \Omega$$

$$X_M = \frac{92}{3} = 30.66\ \Omega$$

To find X_{cable}, first determine L in Henrys per metre (H / m) from:

$$L = 10^{-7} \cdot 4 \log_e \cdot \left(\frac{D}{R}\right)$$

where D is the distance between the conductors,
and R is the radius of a conductor,
(the dimensions being in consistent units).

So, $$L = 10^{-7} \cdot 4 \log_e \cdot \left(\frac{5mm}{0.5mm}\right)$$

$$= 9.21 \cdot 10^{-7}\ H / m$$

∴ $$X_{cable} = 100\pi \cdot (9.21 \cdot 10^{-7})\ \Omega / m$$

$$= 2.89 \cdot 10^{-4}\ \Omega / m$$

For a 200m cable,

$$X_{cable} = 200 \cdot 2.89 \cdot 10^{-4}\ \Omega$$

$$= 0.0578\ \Omega$$

This value is *delta*-configured, so for star configuration divide by 3:

∴ $$X_{cable} = 0.0193\ \Omega$$

(The calculated value is insignificant in relation to the other values in this case, even for a 200m cable, and could be ignored.)

Calculation of motor %X

In the following expression:

$$\%X = \frac{[(X_2 \cdot X_M) / (X_2 + X_M)] + X_{cable} + X_1}{V / (\sqrt{3} \cdot I)} \times 100$$

substitute the data values for X_1, X_2 etc:

$$\%X = \frac{[(1.35 \cdot 30.66) / (1.35 + 30.66)] + 0.0193 + 1.03}{415 / (\sqrt{3} \cdot 16)} \times 100$$

$$= \underline{15.64\ \%}$$

This value can then be entered manually into Function 92.

Manufacturer dedicated use

93 DD FUNC 1

Manufacturer dedicated use

94 DD FUNC 2

DO NOT ATTEMPT TO CHANGE FUNCTIONS 93 and 94!

Security

95 DATA PRTC

Setting range 0 or 1

Set Function 95 = 1 to prevent any interference with data settings. Data can be read, but not changed.

Set Function 95 = 0 to allow full access.

Quick settings:

Select Function 95 on the LCD screen, press FUNC/DATA, then

press » & ∧ together 95 = 1

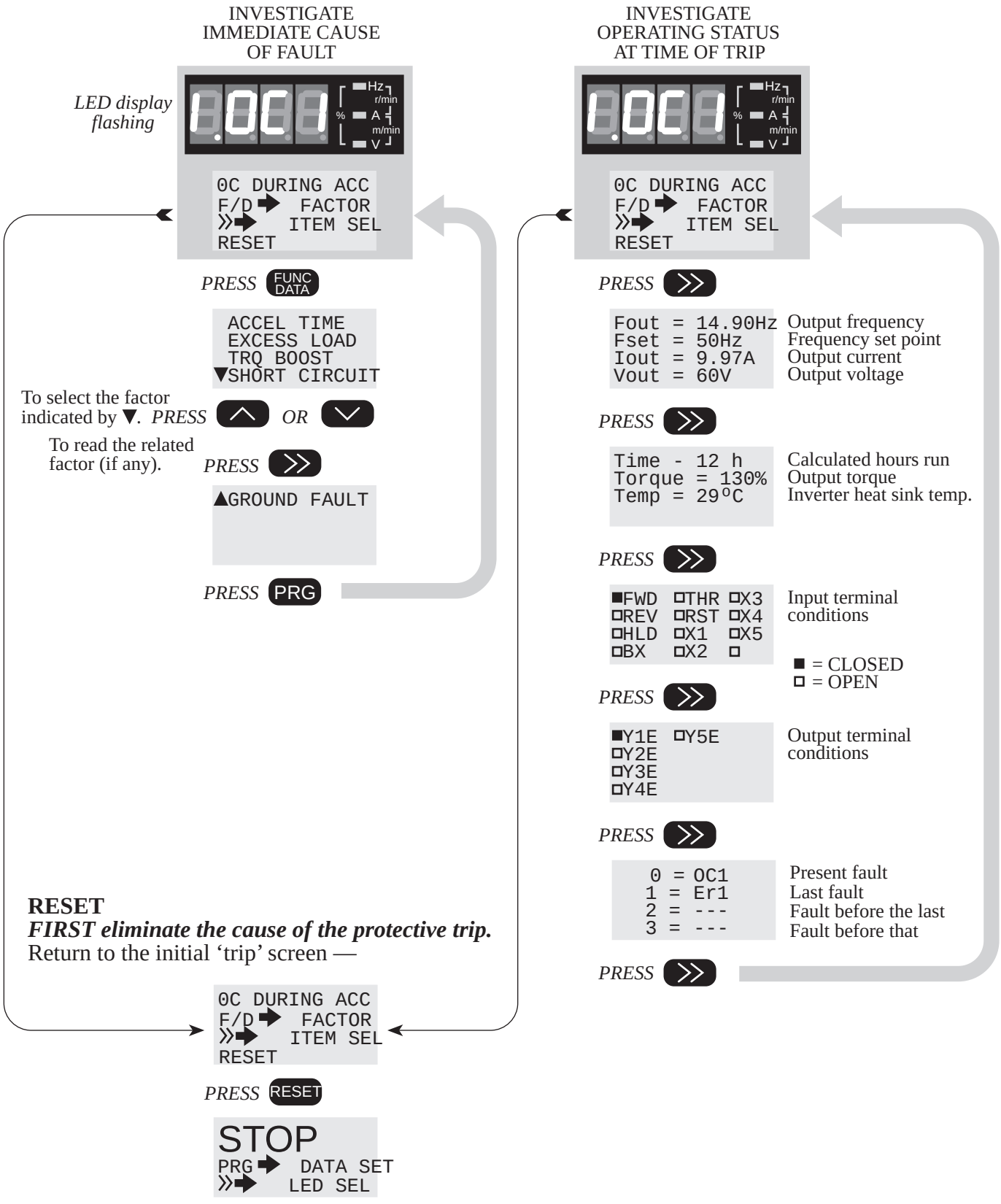
press » & ∨ together 95 = 0

NOTE It may be impossible to alter any Function data, including Function 95, if Function 32 (input at terminal X5) has been configured to prevent the change of Function values. Refer to Function 32, Data Security Mode, page 53.

10 Trouble Shooting

10-1 Trip investigation procedure

Procedure to interrogate the inverter software to determine the factors that were the immediate cause of a protective trip, and the status of the drive system at the time.



RESET

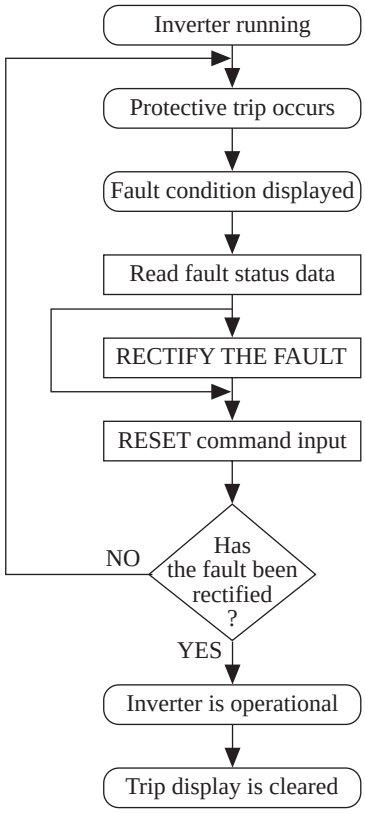
FIRST eliminate the cause of the protective trip.

Return to the initial 'trip' screen —

10-2 Electronic protection

When the protection is activated, the inverter is immediately tripped. The motor coasts to a stop. The trip code (*eg* OC1) is displayed on the LED monitor.

The inverter will remain disabled until the conditions that caused the trip are removed and the inverter is reset either by pressing the RESET key or by giving a reset control command input at terminal (RST).



NOTE If the electronic protection acts to trip the inverter (stop output) or if some other abnormality occurs, investigate the cause of the trouble by using the appropriate flow diagram on the following pages. If you cannot identify and correct the problem in this way, or if you think the inverter may have been damaged, please consult IMO Precision Controls Ltd.

The different abnormal operating conditions which cause an electronic protective trip or alarm to occur are shown in the table on page 69.

Each trip code is indicated on the LED digital display, and further data is available by interrogating the LCD multifunction display as shown in the diagram on page 67.

10-3 Trip alarms — programmable output terminals

Output terminals Y2E…Y5E are available to signal externally that the inverter has tripped. Please refer also to Function 47.

The status of terminals Y2E…Y5E when a trip condition occurs is shown in the diagram below.

Trip code	*Fault condition*	*Programmable output terminals*			
		Y2E	Y3E	Y4E	Y5E
0	Normal	□	□	□	□
1	OC1	□	□	□	■
2	OC2	□	□	■	□
3	OC3 (EF for ≥30kW)	□	□	■	■
4	OU1, OU2, OU3	□	■	□	□
5	LU	□	■	□	■
6	OL	□	■	■	□
7	OLU	□	■	■	■
8	OH1, OH3	■	□	□	□
9	OH2, dbH	■	□	□	■
10	FUS	■	□	■	□
11	Er1, Er3	■	□	■	■
12	Er2	■	■	□	□
13	Er4	■	■	□	■
14	Er5	■	■	■	□
15	Er6, Er7	■	■	■	■

■ = ON □ = OFF

10-4 Non-tripping electronic protection

- **Stall prevention**

During acceleration and deceleration, if the inverter output current or the DC bus voltage exceed the preset limit the ramp (accel/decel) is temporarily stopped.

If the same limits are exceeded during steady-state operation, the frequency is reduced.

The ramp is restarted or the frequency restored when the out-of-limit parameter becomes normal, thus avoiding a transient condition causing a trip. Note that acceleration or deceleration time is extended when the ramp is halted.

If the duration of the excess value is too long however, the overload trip (OLU) will operate and the inverter will be tripped.

- **Input surge**

The inverters are protected from the following surge conditions —

Jaguar VX Inverters ≤22kW

Phase to earth Up to 1.2 x 50µs, $4kV_{pk}$

Phase-to-phase Up to 10 x 200µs, $2kV_{pk}$

Jaguar VX Inverters ≥30kW

Phase to earth Up to 1.2 x 50µs, $4kV_{pk}$

Phase-to-phase Up to 1.2 x 50µs, $2kV_{pk}$

A surge absorber is connected to the main power terminals (L1, L2, L3) and to the control power supplementary input terminals (optional R0, T0).

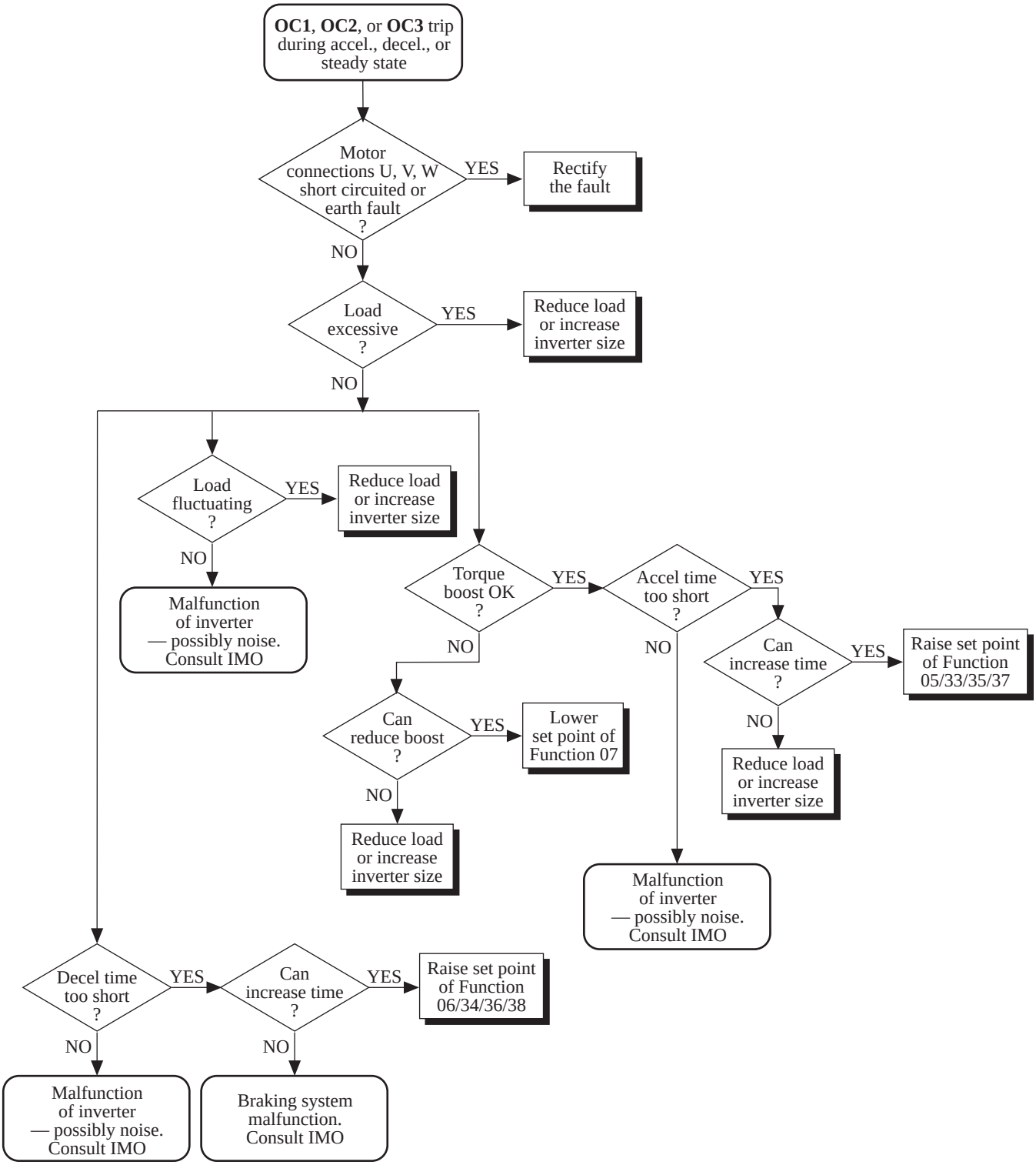
10-5 Trip and alarm codes and displays

Function	*Keypad Panel Displays*		*Protective Operation*		*Page*
	LED	*LCD*			
Overcurrent protection	OC1	OC DURING ACC	During acceleration	Operates if inverter output current momentarily exceeds the overcurrent detection level for any reason.	*70*
	OC2	OC DURING DEC	During deceleration		
	OC3	OC AT SET SPD	During steady state		
Overvoltage protection	OU1	OV DURING ACC	Operates if the DC bus voltage exceeds the overvoltage detection level because of regeneration. Does not operate or protect against excessive supply input voltage applied in error.		*71*
	OU2	OV DURING DEC			
	OU3	OV AT SET SPD			
Undervoltage protection	LU	UNDERVOLTAGE	Operates if the power supply voltage falls and the DC bus voltage falls below the undervoltage detection level. (Set during manufacture and not adjustable.) If the 'restart after momentary power failure' has been activated, operation will resume automatically when the power supply is restored (refer to Function 10). No signal will be output at the alarm output terminal. If the input voltage falls to a level where the inverter control circuit cannot be maintained, all protective functions will be automatically reset.		*72*
Fin overheating	OH1	FIN OVERHEAT	Operates if the inverter heatsink temperature rises above the overtemperature detection level. (Set during manufacture and not adjustable.)		*73*
External protection input	OH2	EXT FAULT	Operates when the external alarm circuit operates (terminal THR).		*73*
Inverter overheating	OH3	HIGH AMB TEMP	Operates if the air temperature inside the inverter (principally the control section) rises above the detection level. (Set during manufacture and not adjustable.)		*73*
Braking resistor overheating	dbH	DBR OVERHEAT	Operates when the internal braking resistor overheats. (Applicable only to inverters ≤7.5kW).		*74*
Motor overload	OL	MOTOR OL	Operates when the motor current (inverter output current) exceeds the electronic thermal overload setting (Function 09). This function protects a standard 3-phase 4-pole motor. Other motors may not be protected; check the characteristics of the motor before setting Function 09. If using more than one motor, install a separate thermal protection relay.		*75*
Inverter overload	OLU	INVERTER OL	Operates when the output current exceeds the specified overload current rating.		*75*
Fuse blown	FUS	DC FUSE OPEN	Operates when a fuse blows in the DC bus circuit due to a short circuit in the smoothing capacitors or IGBT. (Applicable only to inverters ≥11kW).		*75*
Earth fault	EF	GROUND FAULT	Operates if any output conductor is shorted to earth.		*75*
Memory error	Er1	MEMORY ERROR	Operates when a memory error occurs due to a data writing error etc.		*76*
Communication error	Er2	KEYPD COM ERROR	Operates when a RUN or STOP command is input at the keypad but the data from the keypad disagrees with the data from the external controller, or if a transmission break is detected. If RUN/STOP commands are applied at the inverter control terminals, inverter operation will continue although Er2 appears on the display.		*76*
CPU error	Er3	CPU ERROR	Operates when an error occurs in the CPU due to noise etc.		*76*
	Er4/5	—	Error when using an optional card.		—
Tuning error	Er7	TUNING ERROR	Operates when an open circuit (or poor contact) occurs in the inverter output circuit during tuning. May also occur if the motor cable is too long.		*76*

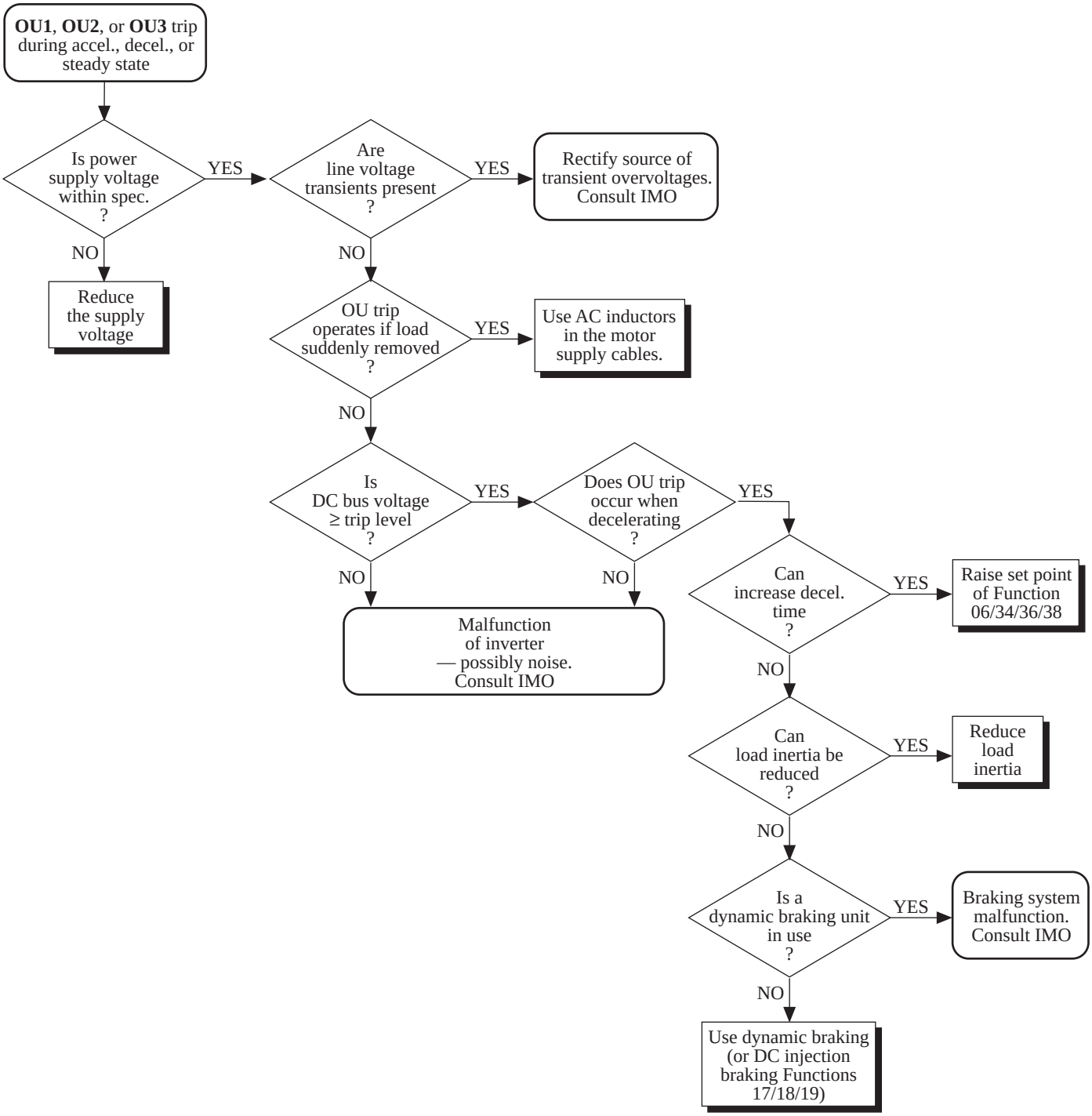
10-6 Troubleshooting flow diagrams — 1

STATUS ? QUERY ACTION

Overcurrent trip OC1, OC2, OC3

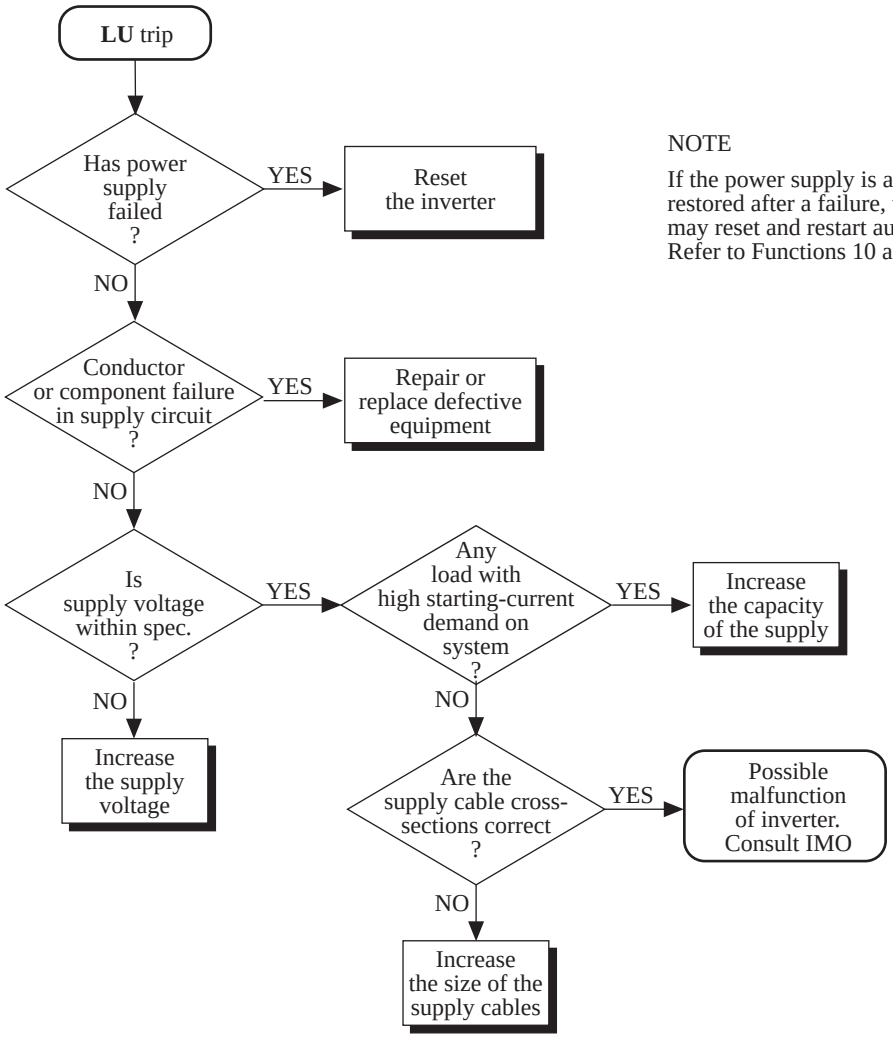


Overvoltage trip OU1, OU2, OU3



STATUS ? QUERY ACTION

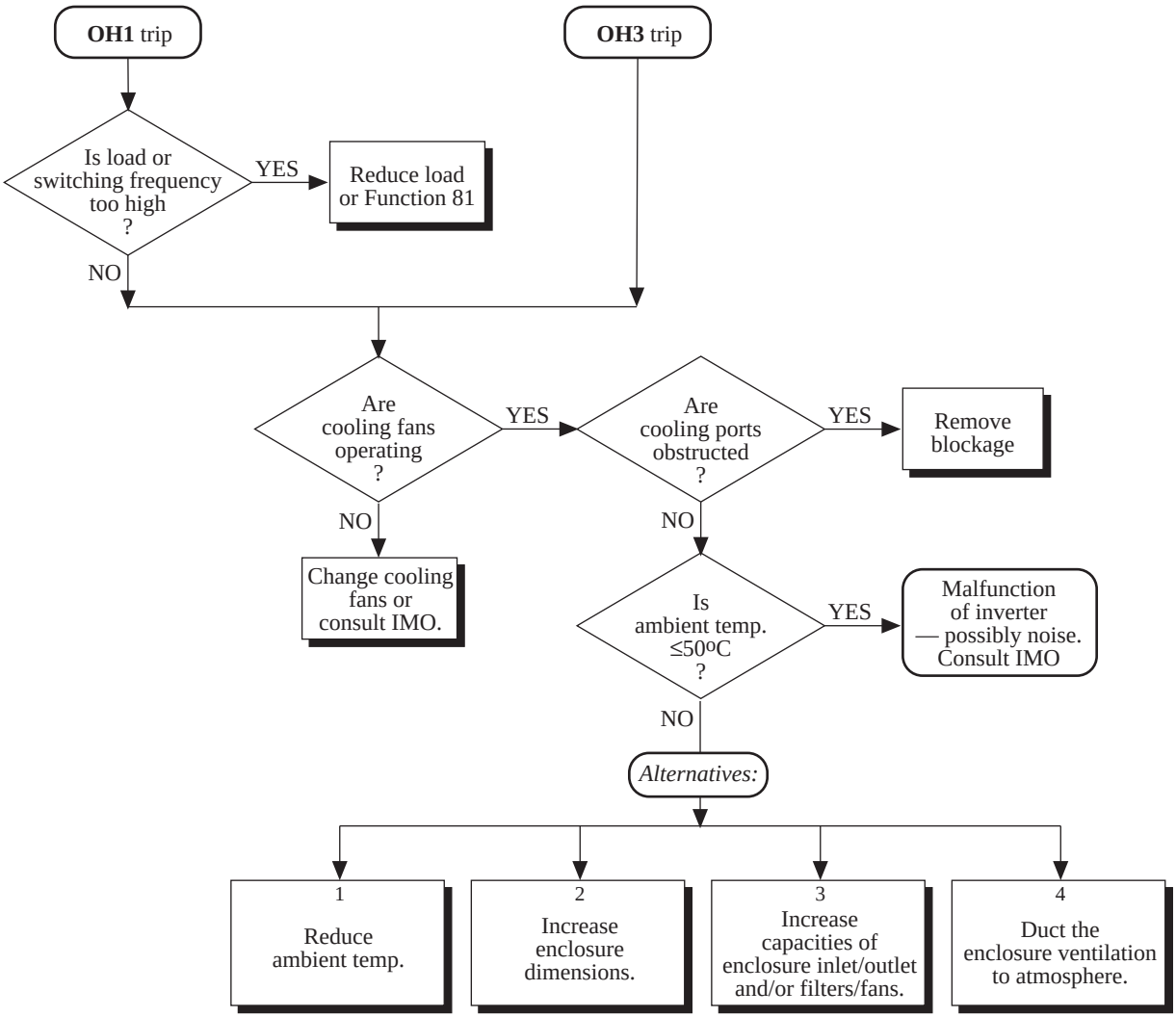
Undervoltage trip LU



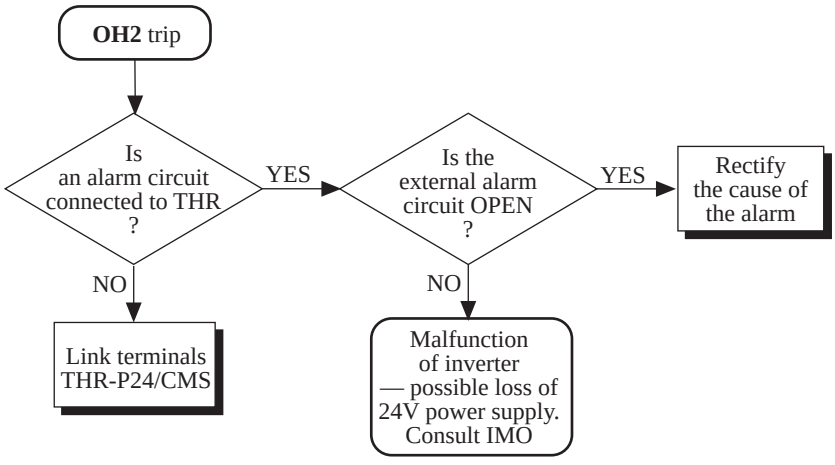
NOTE

If the power supply is automatically restored after a failure, the inverter may reset and restart automatically. Refer to Functions 10 and 82.

Heat sink overtemperature OH1
Inverter overheating OH3

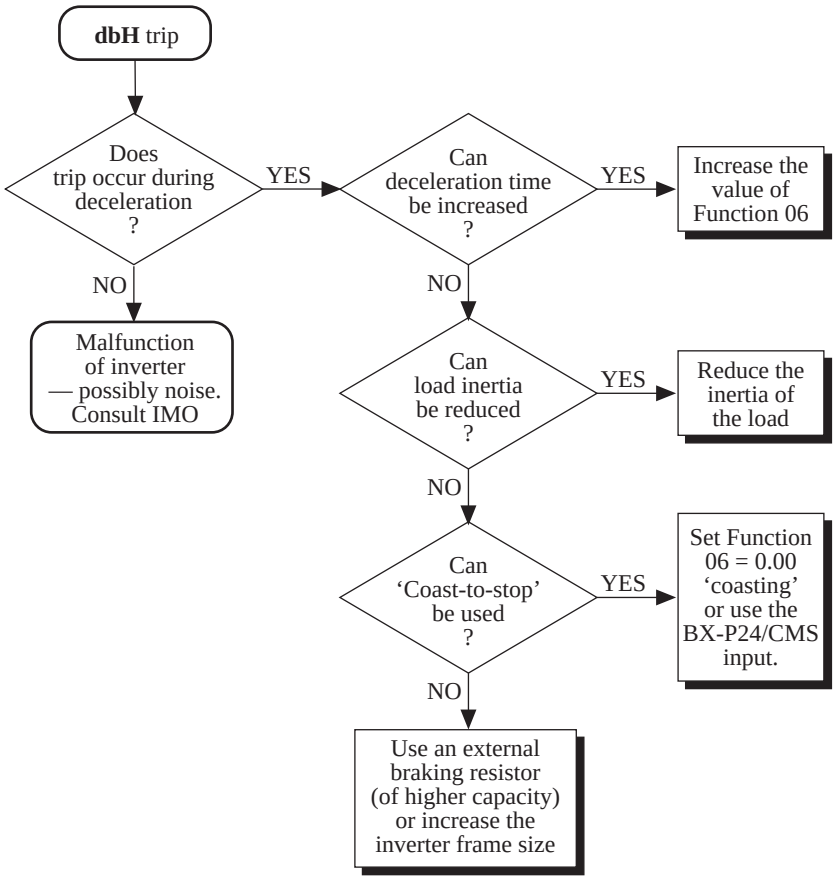


External trip alarm input OH2

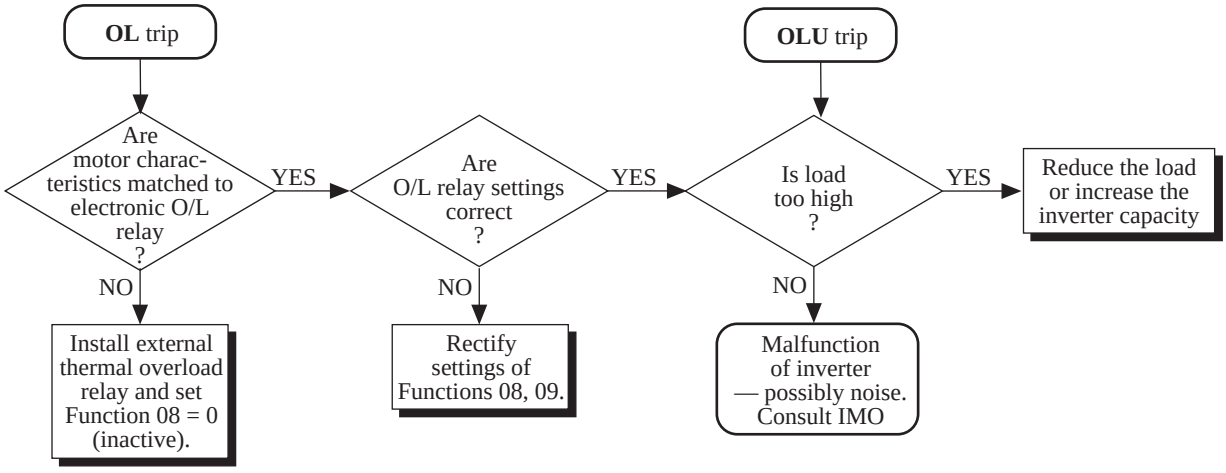


STATUS ? QUERY ACTION

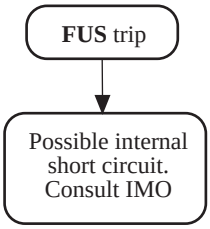
Internal braking resistor overheating dbH
(Inverters ≤7.5kW only)



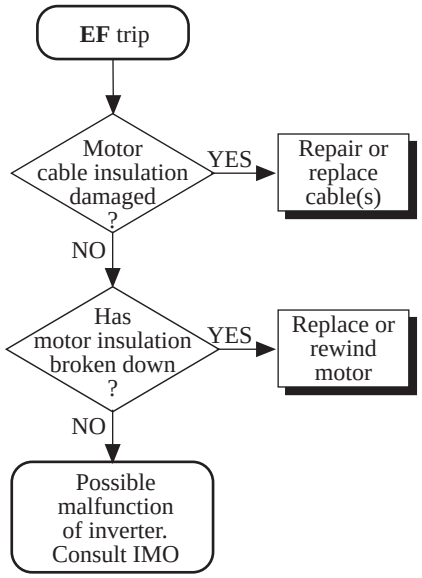
Motor overload OL
Inverter overload OLU



Inverter fuse failure FUS
(Inverters ≥11kW only)



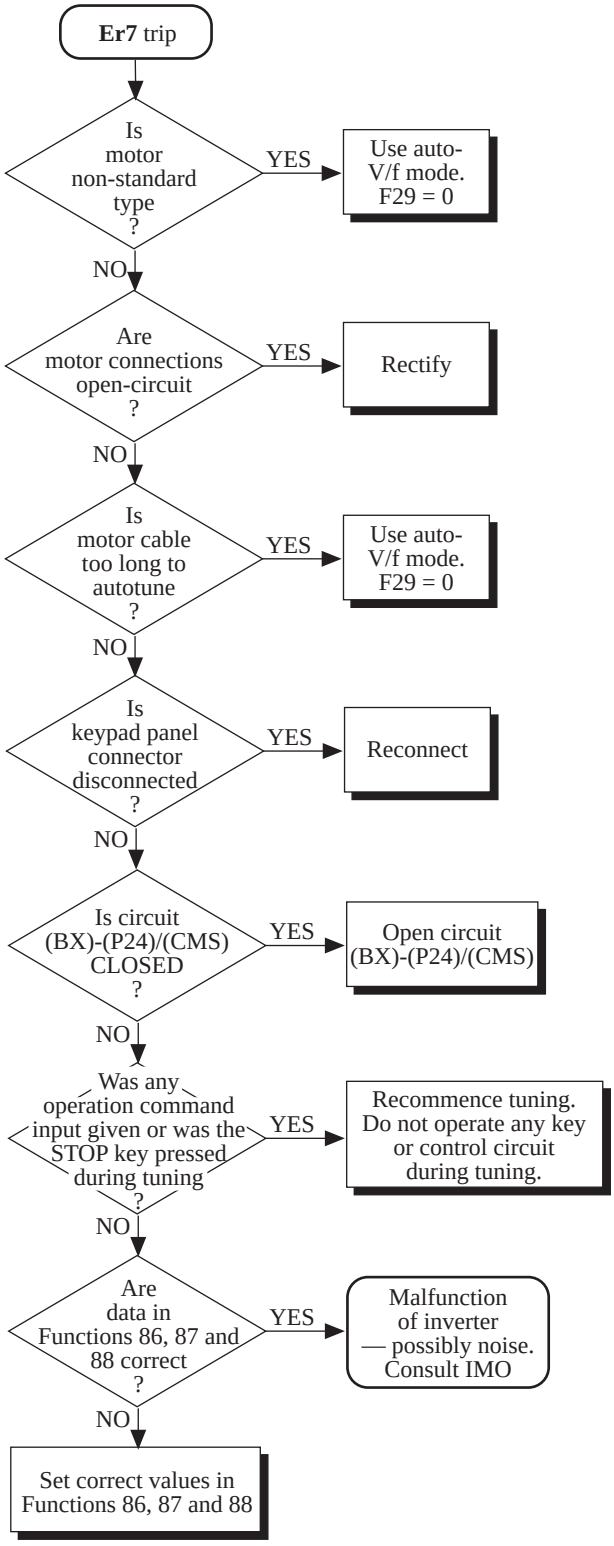
Earth fault EF
(Inverters ≥30kW only)



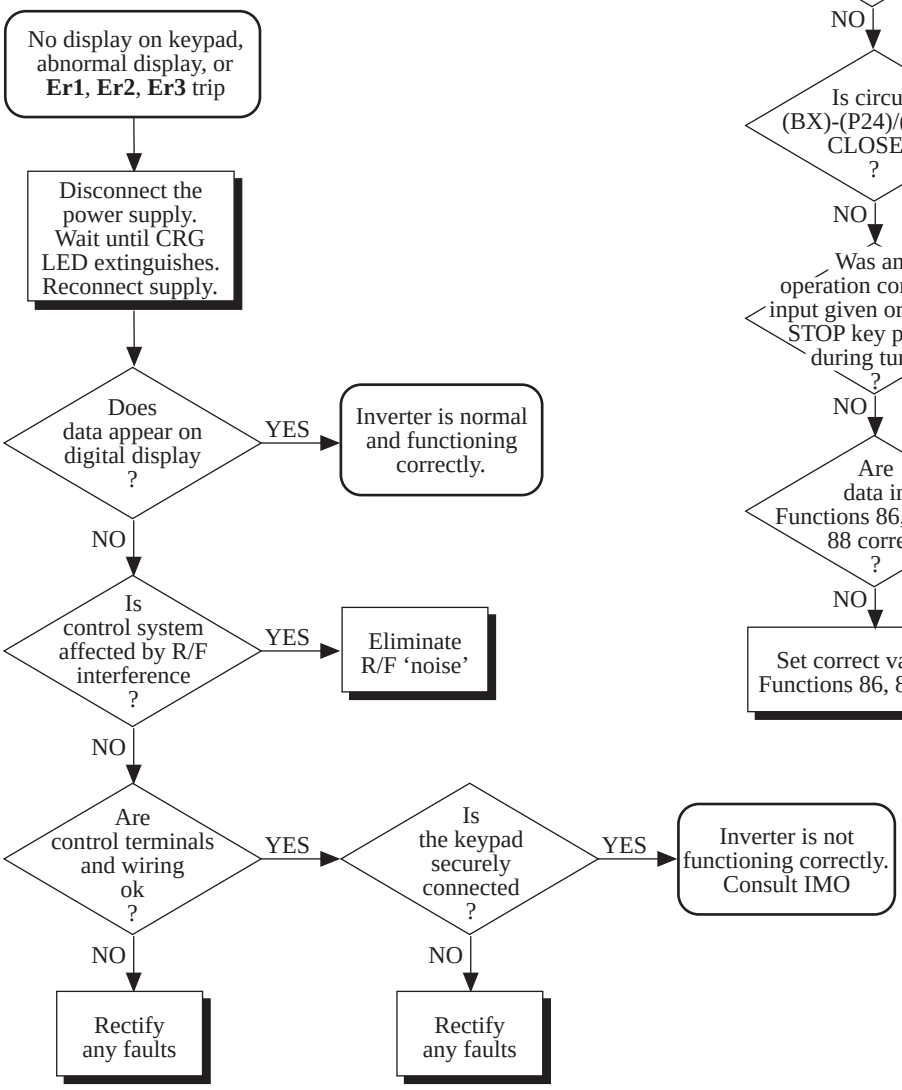
Troubleshooting Flow Diagrams — 10, 11

STATUS ? QUERY ACTION

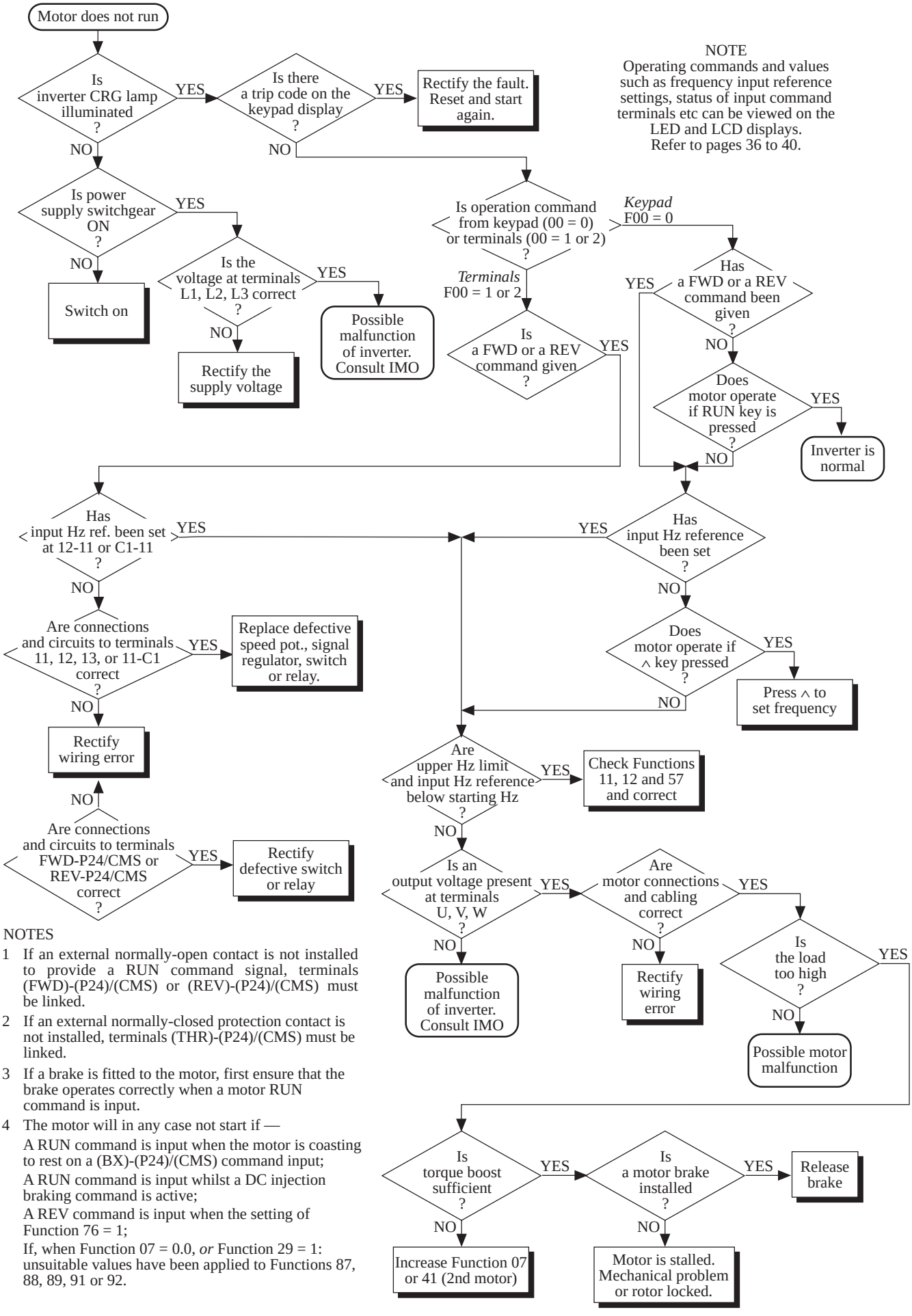
Inverter power output error Er7



Memory error Er1
Communication error Er2
CPU error Er3



Motor does not run



NOTES

1 If an external normally-open contact is not installed to provide a RUN command signal, terminals (FWD)-(P24)/(CMS) or (REV)-(P24)/(CMS) must be linked.

2 If an external normally-closed protection contact is not installed, terminals (THR)-(P24)/(CMS) must be linked.

3 If a brake is fitted to the motor, first ensure that the brake operates correctly when a motor RUN command is input.

4 The motor will in any case not start if —

A RUN command is input when the motor is coasting to rest on a (BX)-(P24)/(CMS) command input;

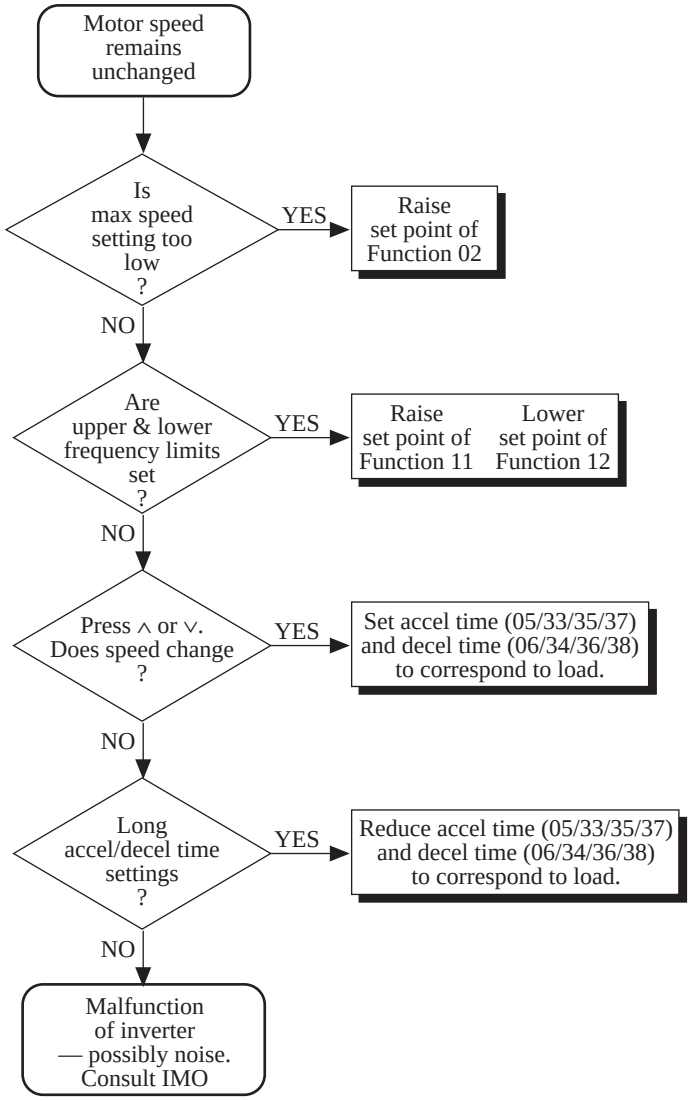
A RUN command is input whilst a DC injection braking command is active;

A REV command is input when the setting of Function 76 = 1;

If, when Function 07 = 0.0, *or* Function 29 = 1: unsuitable values have been applied to Functions 87, 88, 89, 91 or 92.

STATUS ? QUERY ACTION

Motor runs but speed does not change 1 — KEYPAD operation



NOTES 1 The motor speed cannot change if —

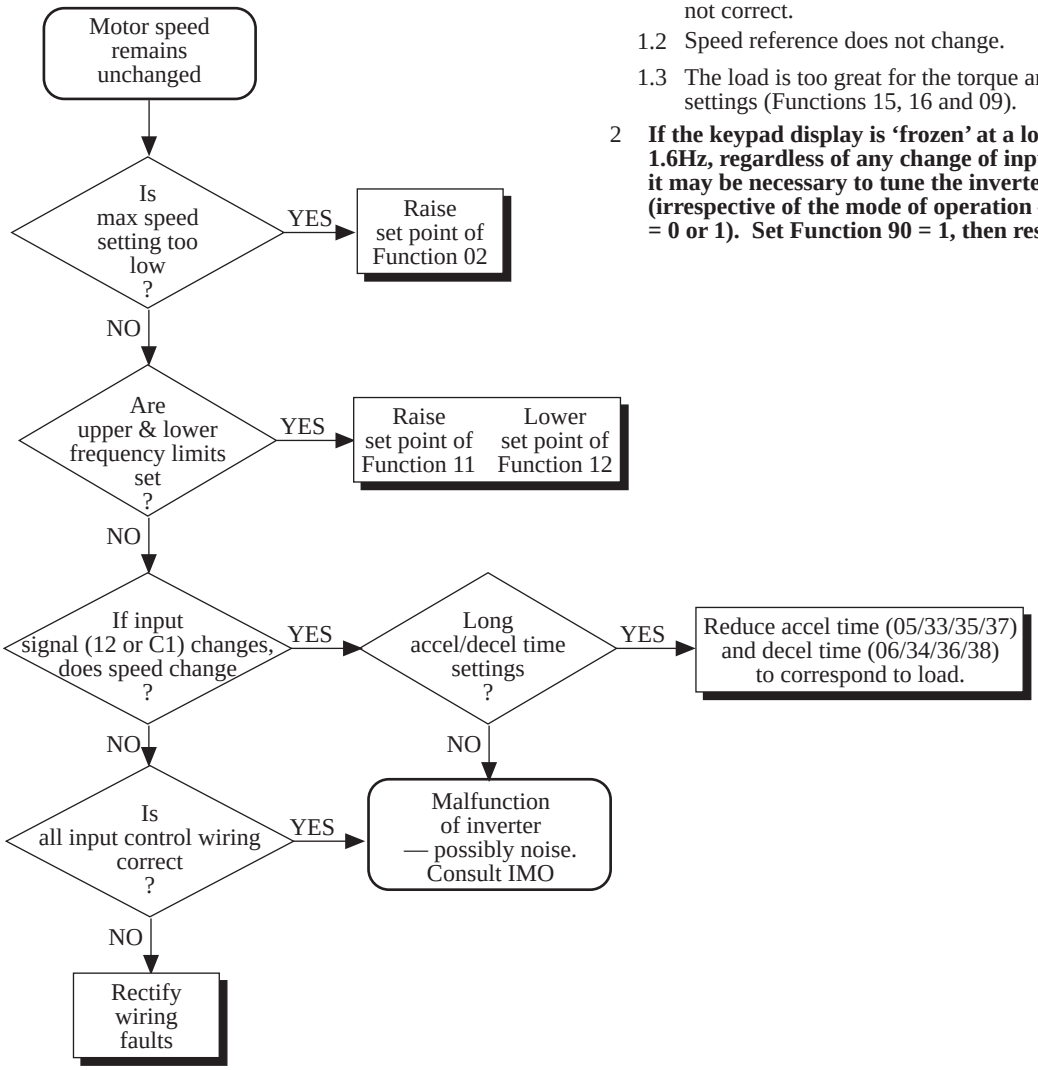
1.1 The settings of Functions 02, 11, 12, 13 and/or 14 are not correct.

1.2 Speed reference does not change.

1.3 The load is too great for the torque and current limit settings (Functions 15, 16 and 09).

2 **If the keypad display is 'frozen' at a low frequency,** *eg* **1.6Hz, regardless of any change of input reference signal, it may be necessary to tune the inverter to the load (irrespective of the mode of operation —** *ie* **Function 29 = 0 or 1). Set Function 90 = 1, then restart the inverter.**

Motor runs but speed does not change 2 — TERMINAL operation



NOTES 1 The motor speed cannot change if —

1.1 The settings of Functions 02, 11, 12, 13 and/or 14 are not correct.

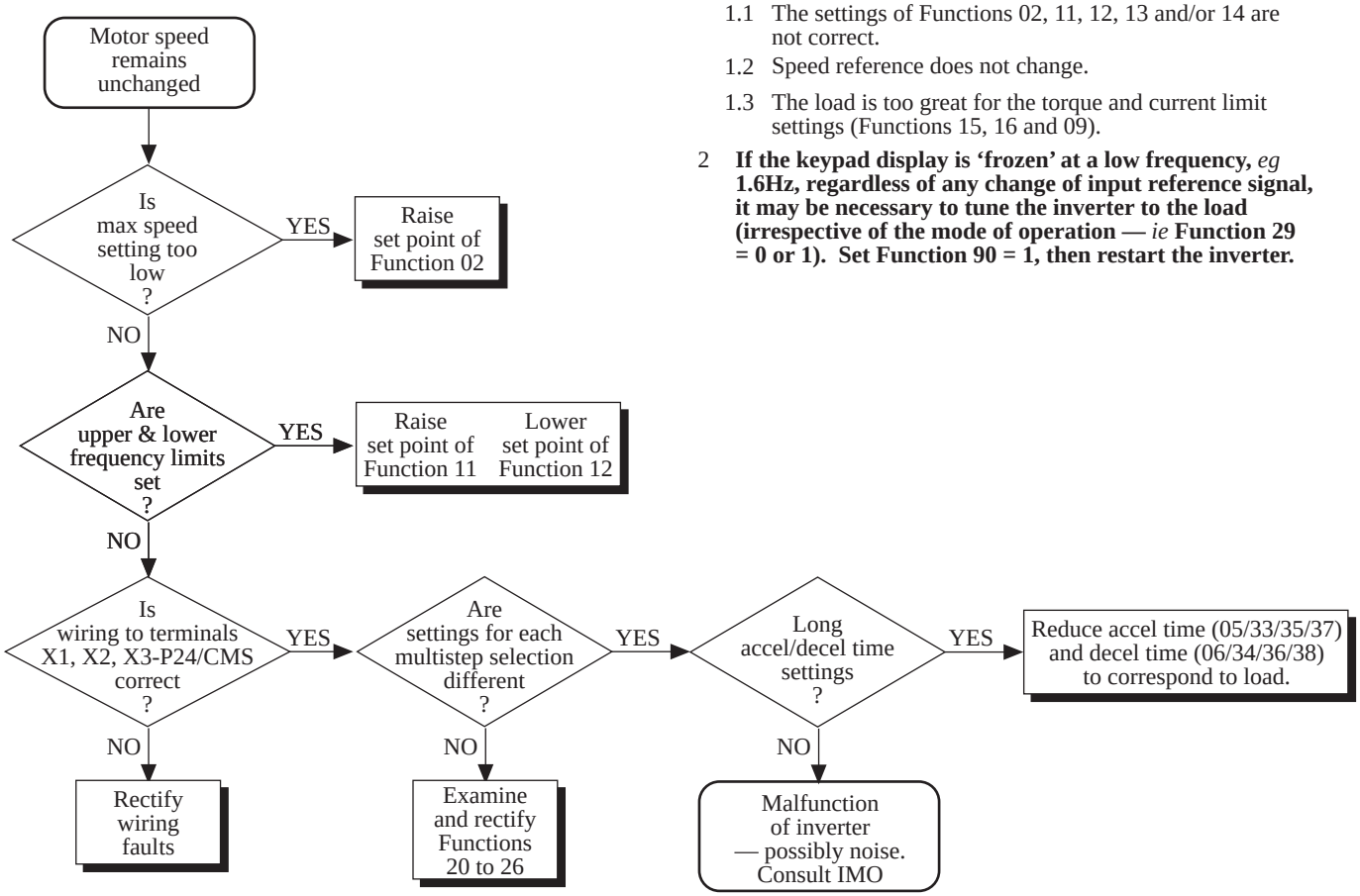
1.2 Speed reference does not change.

1.3 The load is too great for the torque and current limit settings (Functions 15, 16 and 09).

2 **If the keypad display is 'frozen' at a low frequency,** *eg* **1.6Hz, regardless of any change of input reference signal, it may be necessary to tune the inverter to the load (irrespective of the mode of operation —** *ie* **Function 29 = 0 or 1). Set Function 90 = 1, then restart the inverter.**

STATUS ? QUERY ACTION

Motor runs but speed does not change 3 — MULTISTEP operation



NOTES 1 The motor speed cannot change if —

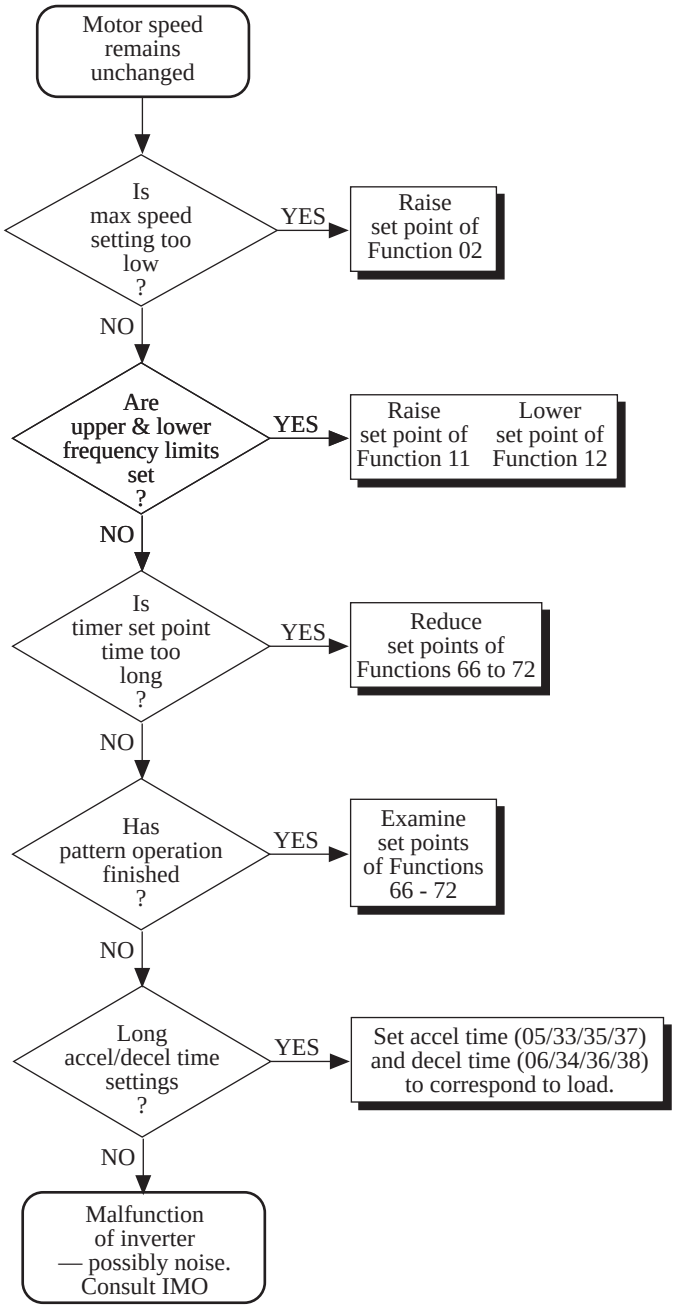
1.1 The settings of Functions 02, 11, 12, 13 and/or 14 are not correct.

1.2 Speed reference does not change.

1.3 The load is too great for the torque and current limit settings (Functions 15, 16 and 09).

2 **If the keypad display is 'frozen' at a low frequency,** *eg* **1.6Hz, regardless of any change of input reference signal, it may be necessary to tune the inverter to the load (irrespective of the mode of operation —** *ie* **Function 29 = 0 or 1). Set Function 90 = 1, then restart the inverter.**

Motor runs but speed does not change 4 — PATTERN operation



NOTES 1 The motor speed cannot change if —

1.1 The settings of Functions 02, 11, 12, 13 and/or 14 are not correct.

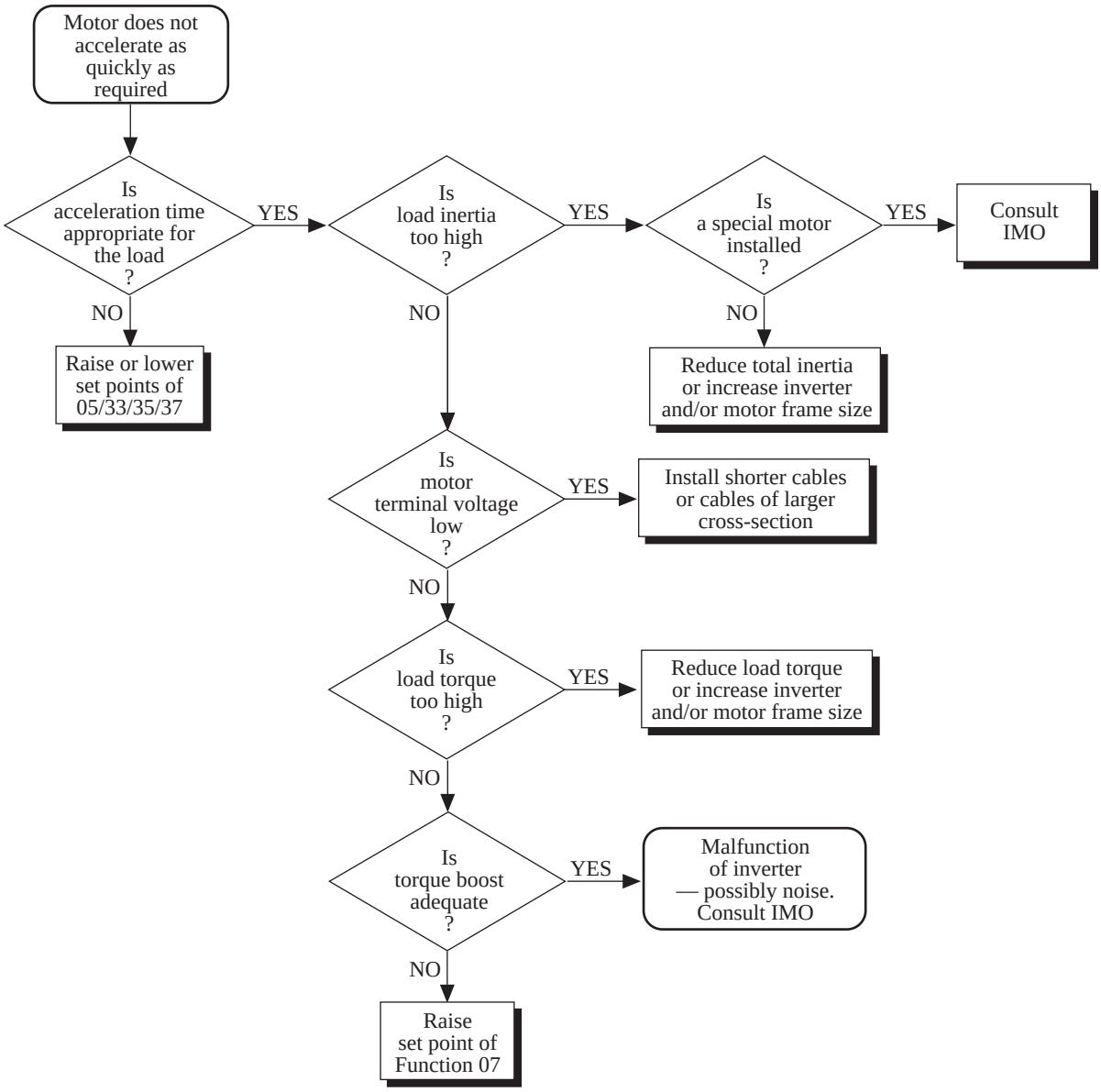
1.2 Speed reference does not change.

1.3 The load is too great for the torque and current limit settings (Functions 15, 16 and 09).

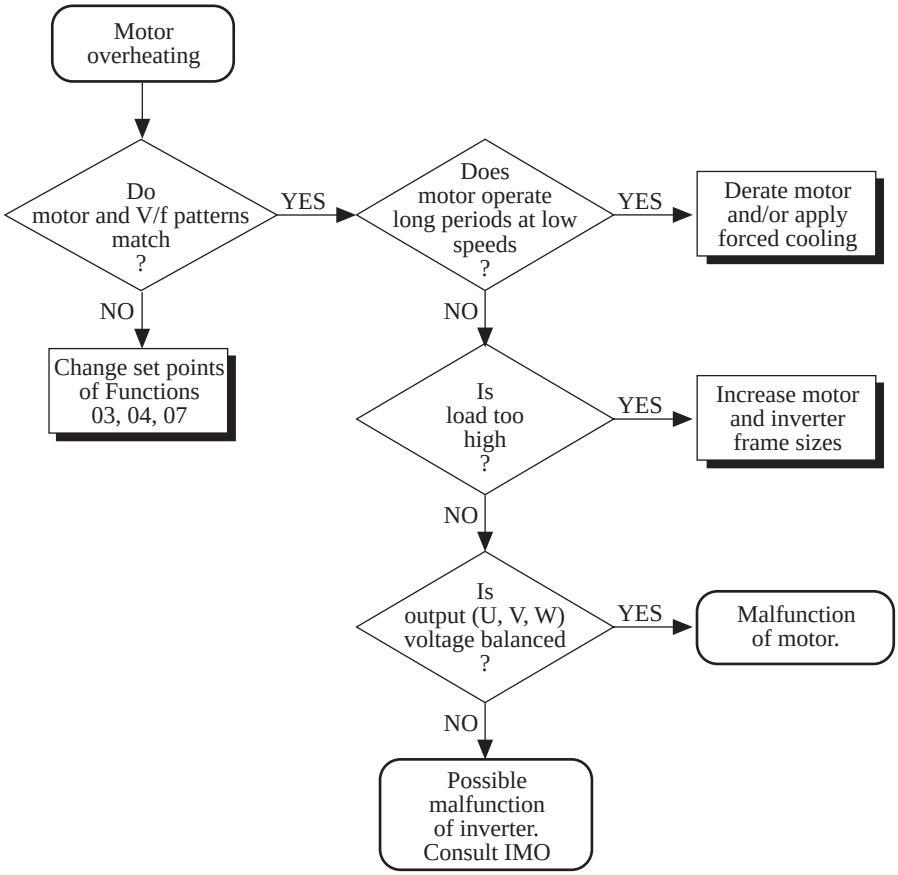
2 **If the keypad display is 'frozen' at a low frequency,** *eg* **1.6Hz, regardless of any change of input reference signal, it may be necessary to tune the inverter to the load (irrespective of the mode of operation —** *ie* **Function 29 = 0 or 1). Set Function 90 = 1, then restart the inverter.**

STATUS ? QUERY ACTION

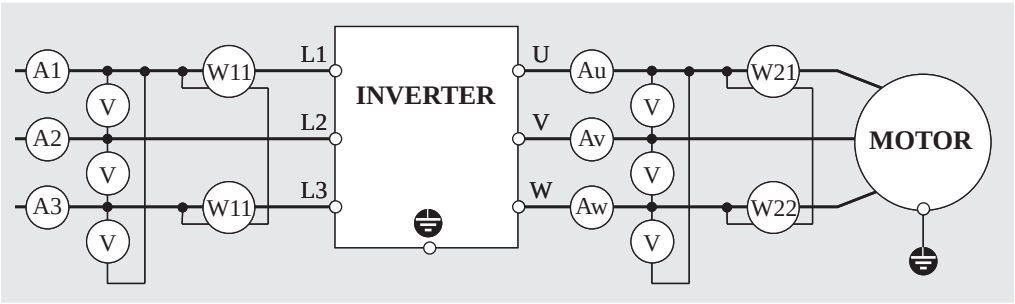
Motor loses power during acceleration



Motor overheats



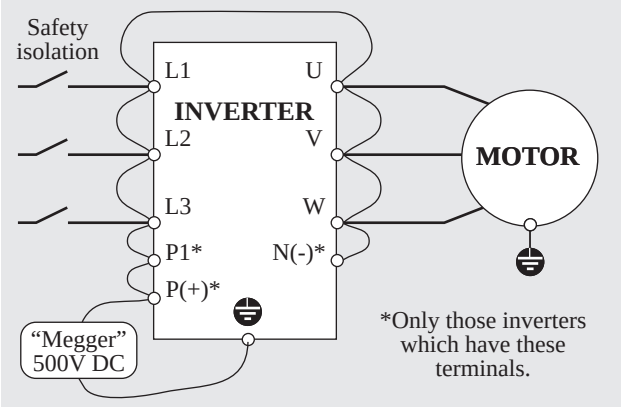
10-7 Connections for measurements and insulation testing



Connections for measurements.

Use moving-iron ammeters, and electrodynamometer wattmeters on the input and output circuits.

Use moving-iron voltmeters on the input circuit, and rectifier voltmeters on the output.



Connections for insulation testing.

Insulation testing, power circuit

WARNING

SWITCH OFF and ISOLATE the main power supply to the inverter before testing.

CAUTION

Do not perform insulation tests on control circuits.

Inverters VX40 to VX2200 and VX750P to VX2200P
Connect **only** terminals L1, L2, L3, U, V, W and the earth in the test loop.

Inverters VX30K to VX220K and VX30KP to VX280KP
Connect all terminals shown in the diagram.

Continuity testing, control circuits
Use a high resistance tester, not a megger or a buzzer.

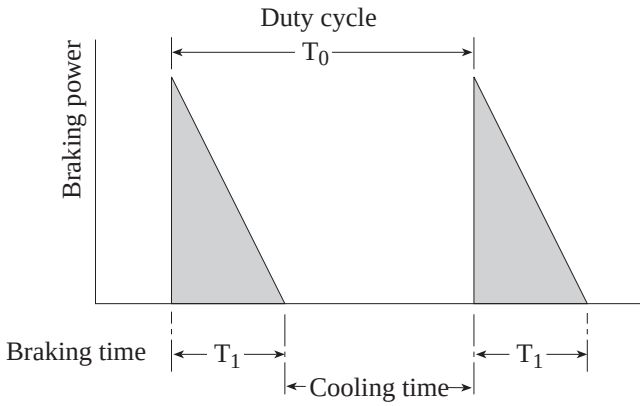
11 Motor Braking and Overhauling Loads

11-1 Introduction

When a rotating mass is electrically braked to a standstill by reducing the frequency of the supply at the motor terminals, the motor effectively assumes the characteristics of an asynchronous generator for at least some period of the deceleration time. The kinetic energy of the load is converted by the motor to electrical energy. As the input rectifier of the inverter is not designed to deliver reverse current into the power supply system, the voltage of the DC bus is thus caused to rise by the regeneration, and may rise to an unacceptable level if not controlled. The inverter would then trip (overvoltage trip codes OU2 and OU3). Control of deceleration would be lost; the load would be freewheeling.

The DC bus can absorb, typically, between 3% and 5% of regenerative power, equivalent to the normal heat losses when driving.

To absorb higher levels of regenerative energy it is necessary to convert excess DC voltage into heat by delivering regenerative current to a resistor in short pulses controlled by transistor switching.



The factors which influence the amount of regenerative power are:

The speed of the motor and load in rpm

The inertia of the motor and load, $J_M + J_L$

The deceleration rate, $\Delta\omega/\Delta t$

The rating of the resistor will depend on the Duty Cycle as shown above.

Jaguar VX inverters ≤7.5kW are equipped with an integral braking resistor and transistor control for light duty braking applications. VX and VX…P drives of higher rating are equipped to accept the connection of an external braking unit and external resistor. Refer to Section 5-1-8, page 20, for important installation details.

11-2 Overhauling loads

The braking components, whether internal or external, may be active not only when a high inertia load is being decelerated but also when the regenerative period has to be constant and prolonged, as in a hoisting application when a load, which may be up to the maximum for which the inverter is rated, must be lowered at a controlled speed.

In this case, the mass of the load would attempt to overspeed the motor for a large part of the duty cycle, again with the consequence that the DC bus voltage would become excessive. Obviously, it would be dangerous to permit the inverter to trip, as the load would then be out of control.

Due consideration must be given to the choice of a resistor of adequate capacity for this duty.

11-3 Braking resistor selection

A preferred method of calculating the ohmic value and power rating of a braking resistor is shown on the following page.

Other methods of approximating resistor values are available, and may be followed when data is not available; please consult IMO Precision Control Ltd for further assistance.

Alternatively, suitable components may be chosen from the table on page 86.

NOTE When using the table, the following three requirements must be satisfied simultaneously:

1 Maximum braking torque must be incapable of exceeding stated values.

2 Dissipated energy for continuous braking must not exceed the power-dissipation capacity of the resistor, in kW seconds, shown in the table.

3 Average power dissipated during one complete duty cycle (see diagram) must not exceed the value shown in the last column of the table.

11-4 Example of braking resistor calculations

Data:

Inverter *Jaguar* VX750, 7.5kW, Industrial-rated

Motor Rating (P) = 7.5kW (7500W)
Speed (N) = 1440 rpm
Mom. of inertia (J_M) = 0.0338 kg m^2 (1)

Load Mom. of inertia (J_L) = 1.45 kg m^2 (2)
Resistive torque (M_r) = 3.77 N m (3)

Max. DC bus link voltage 805 V_{DC} (typical)

Required performance:
Duty cycle = 30 s
Deceleration time to standstill (Δt) = 3 s

Calculations:

1 Motor and load

angular shaft speed

$$\omega_N = \frac{2\pi N}{60} = 150.8 \text{ rad s}^{-1}$$

max. torque [or as rated] (4)

$$\frac{P}{\omega_N} = \frac{7500}{150.8} = 49.73 \text{ N m}$$

2 Total system moment of inertia J_T

$$J_T = J_M + J_L = 0.0338 + 1.45 = 1.484 \text{ kg m}^2$$

3 Required braking torque

$$M_b = J_T \times \frac{\Delta\omega}{\Delta t} = 1.484 \times \frac{150.8}{3} = 74.59 \text{ N m}$$

4 Motor braking torque

$$M_m = M_b - M_r = 74.59 - 3.77 = 70.83 \text{ N m}$$

5 Instantaneous braking power

$$P_b = M_m \times \omega_N = 70.83 \times 150.8 = 10680 \text{ W}$$

6 Average braking power during deceleration

$$\frac{P_b}{2} = \frac{10680}{2} = 5340 \text{ W}$$

7 Braking energy

$$5340 \times 3 = 16020 \text{ W s} \quad (5)$$

8 Average power during one duty cycle

$$5340 \times \frac{3}{30} = \underline{534 \text{ W}} \quad (6)$$

9 Maximum power

= Instantaneous braking power P_b

= 10680 W

$$\therefore \text{ Resistance} = \frac{(V_{DC})^2}{P_b} = \frac{805^2}{10680} = \underline{60\ \Omega} \quad (7)$$

NOTES

(1)(4) Data available from the manufacturer of the motor.

(2)(3) Data available from the manufacturer of the driven machine.

(5) Must not exceed the corresponding value in column *X* of the table on the following page.

(6) If the calculated figure exceeds the corresponding value in column *Y* of Table 11-5 on the following page, please consult IMO Precision Controls Ltd.

(7) The calculated figure **must never** be lower than that stated in column 5 (Ω) of Table 11-5 on the following page.

In some applications it may be necessary to take account of losses due to gearing, and of inertia reflected from the driven machine to the motor.

For the values and ratings of standard resistors, please consult Table 11-5 on the following page.

11-5 Table of External Braking Units and Resistors

									Braking from 100% speed to standstill at 100% torque		*Engineering Data*	
											X	*Y*
Motor	*Inverter*	*Braking Unit*		*Resistor*			*Max. Braking Torque at 50Hz*		*Max contin.*	*Duty cycle*	*Dissip. capac.*	*Av. loss*
kW	*Type*	*Type*	*Qty*	Ω	kW	*Qty*	%	Nm	sec	%	kW s	kW
0.4	VX40	—	—	200	0.2	1	150	4.02	45	22	9	0.044
0.75	VX75	—	—	200	0.2	1	150	7.57	45	10	17	0.038
1.5	VX150	—	—	160	0.4	1	150	15.0	45	10	34	0.075
2.2	VX220	—	—	160	0.4	1	150	22.1	30	7	33	0.077
4.0	VX400	—	—	130	0.4	1	150	37.0	20	5	37	0.093
5.5	VX550	—	—	80	0.8	1	150	54.3	20	5	55	0.138
7.5	VX750	—	—	60	0.9	1	150	74.3	10	5	38	0.188
11	VX1100	VXDBU11/22	1	40	1.4	1	150	108	10	5	55	0.275
15	VX1500	VXDBU11/22	1	35	1.4	1	150	147	10	5	75	0.375
18.5	VX1850	VXDBU11/22	1	27	1.8	1	150	181	10	5	93	0.463
22	VX2200	VXDBU11/22	1	22	1.8	1	150	216	8	5	88	0.55
30	VX30K	VXDBU30/37	1	15	3.6	1	100	195	10	10	150	1.5
37	VX37K	VXDBU30/37	1	12	4.8	1	100	242	10	10	185	1.85
45	VX45K	VXDBU45/55	1	10	6.0	1	100	293	10	10	225	2.25
55	VX55K	VXDBU45/55	1	7.5	7.2	1	100	359	10	10	275	2.75
75	VX75K	VXDBU75/110	1	6.0	9.6	2	100	487	10	10	375	3.75
90	VX90K	VXDBU75/110	1	5.0	12	2	100	584	10	10	450	4.5
110	VX110K	VXDBU75/110	1	3.75	14.4	2	100	711	10	10	550	5.5
132	VX132K	VXDBU132	1	3.33	18	3						
160	VX160K	VXDBU75/110	2	3.0	19.2	4						
200	VX200K	VXDBU75/110	2	2.5	24	4						
220	VX220K	VXDBU75/110	2	1.88	28.8	4						

NOTE When using this table, the following three requirements must be satisfied simultaneously:

1 Maximum braking torque must be incapable of exceeding stated values. If the required braking torque as calculated exceeds the value quoted in column 9 of the above table, increase the braking time (T_1 in the diagram on page 84.

2 Dissipated energy for the duration of the braking period must not exceed the dissipating capacity of the resistor, in kW seconds, shown in column *X* above.

3 Average power dissipated during one complete duty cycle (see diagram on page 84) must not exceed the value shown in column *Y*.

CAUTION

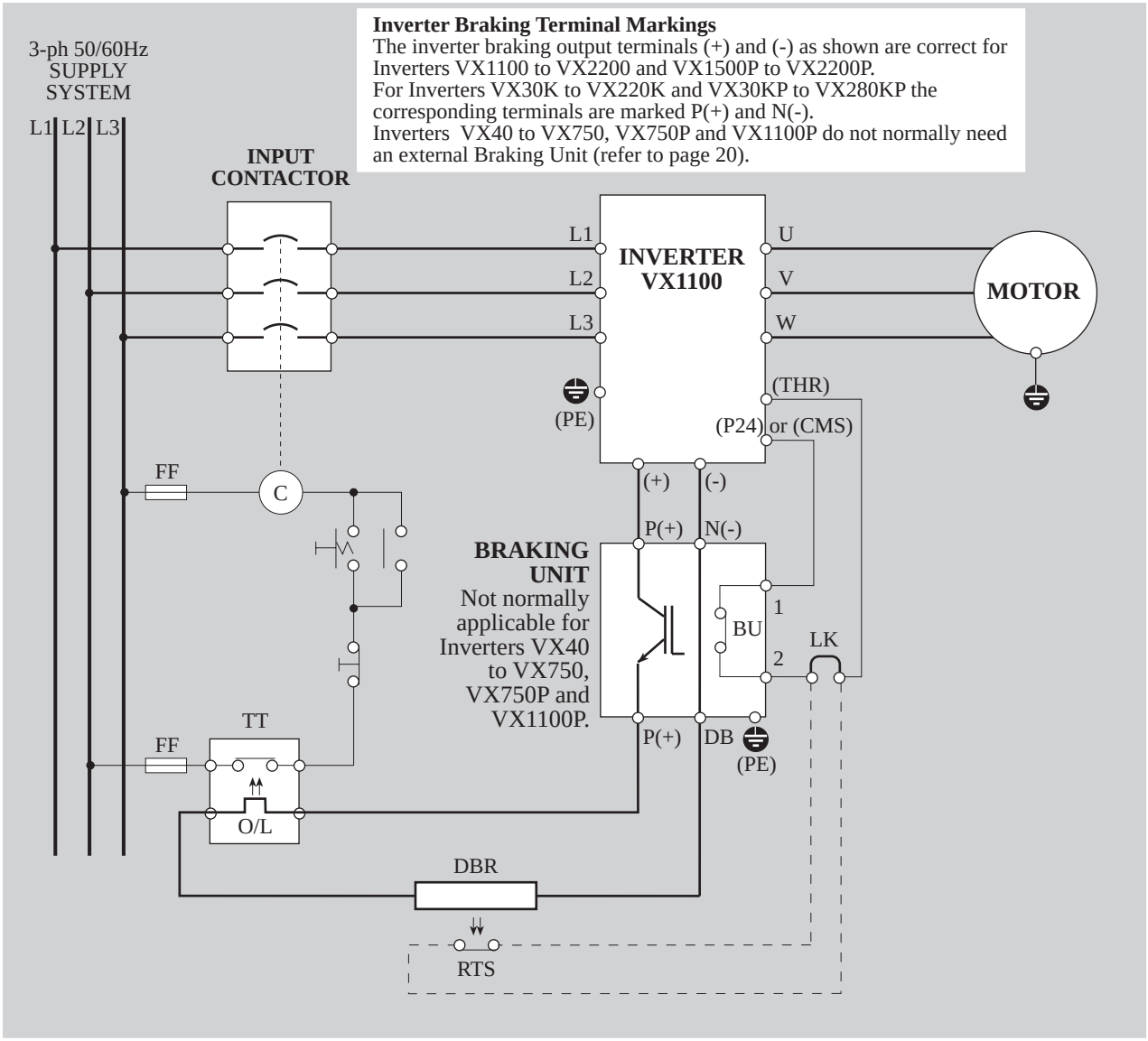
Do NOT use a lower value of resistance than stated in Ω in column 5 of the above table.

11-6 Braking circuit protection

CAUTION

When using an external braking resistor, it is **essential** that a series-connected thermal overload trip circuit is installed and that it opens the **input contactor** if a braking transistor fault occurs.

Example of Braking Protection



Essential braking circuit protection. Typical for VX1100 to VX2200, VX1500P to VX2200P, and VX30K and VX30KP and larger.

KEY

DBR	External dynamic brake resistor.
FF	Control circuit fuses.
O/L	Series-connected thermal overload sensor.
RTS	Resistor over-temperature sensor.
TT	Thermal trip switch.
⏚	Earth (ground) terminal.

NOTES

(1) Thermistor contact RTS is optional. Remove link LK if required.

(2) Observe correct polarity and connections.

(3) It is **essential** that control circuit (THR)-(P24)/(CMS) is completed as shown above to enable the Braking Unit to function correctly.

(4) If using an external braking resistor on inverters VX40 to VX750, VX750P and VX1100P **ensure that the internal resistor is disconnected first.** Refer to page 20.

(5) The example shows the braking connections only. It is NOT for EMC-compliance. Refer to pages 23, 30 and 31.

12 RFI-FP 'Footprint' EMC Filters

for *Jaguar VX* Inverter Drives

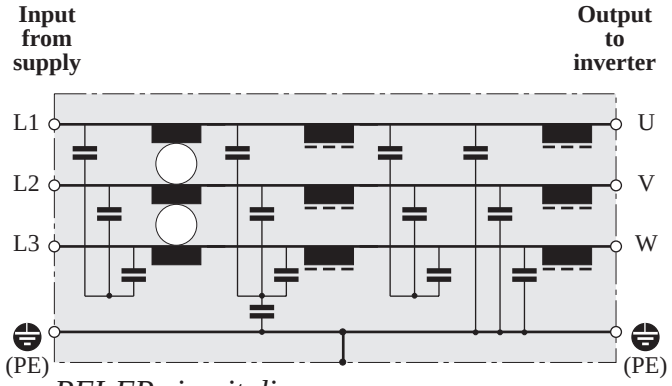
WARNING

The RF filter must be earthed in accordance with the circuit diagram 'Method 1' on page 31.

A *Jaguar VX* inverter may be mounted on the face of the Footprint Filter using the integral tapped mounting points, so that valuable space may be saved within the enclosure.

Alternatively, the filter may be mounted (upright) alongside the inverter, if preferred.

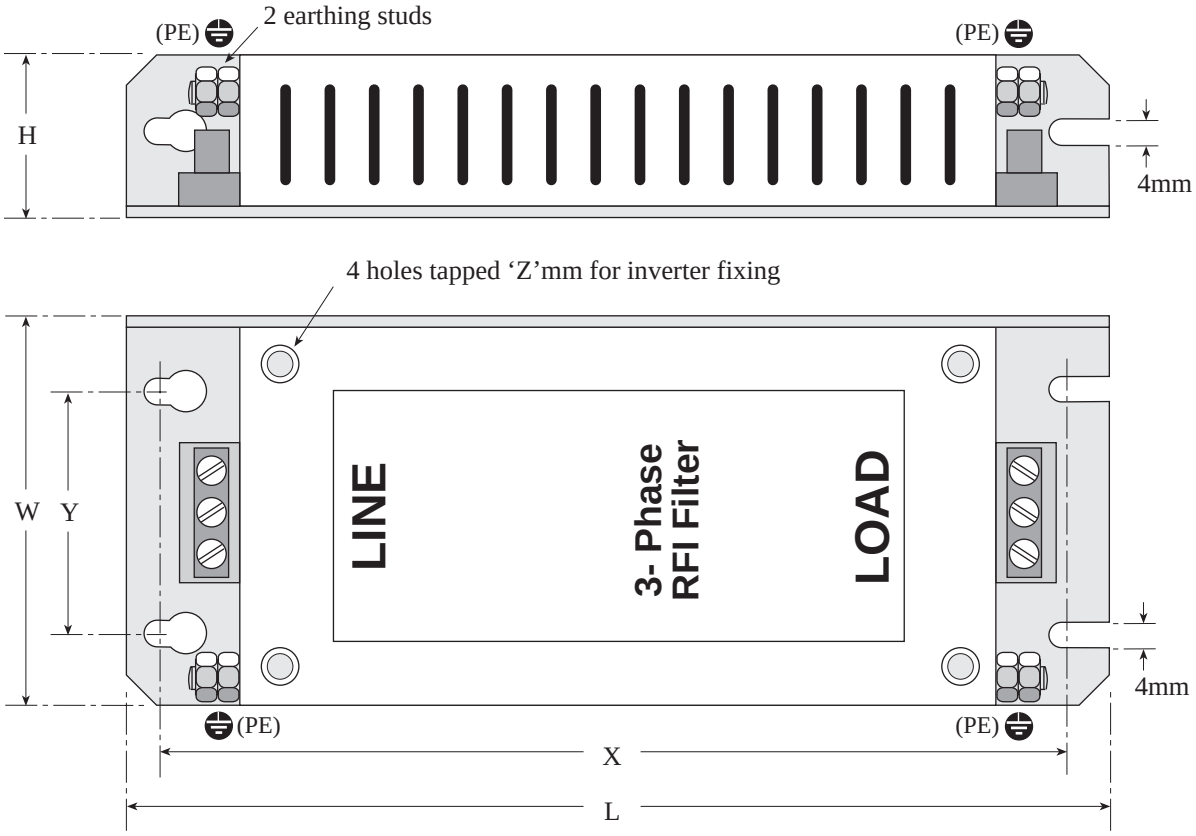
Please refer to the circuit diagram 'Method 1' on page 31 for details of connections.



RFI-FP circuit diagram.

Earth Leakage Current

Under normal running conditions, with three phases energised, the effective leakage is approximately 1mA. However, at power-up, or if one phase fails, the leakage current may be up to 70mA.



RFI-FP principal dimensions.

Dimensions

Part number	*Jaguar VX inverter range*	*Rated current*	*Dimensions* (mm)					
			L	W	H	X	Y	Z
RFI 40 FP	*VX40*	5A	300	115	40	290	92	M5
RFI 150 FP	*VX75* to *VX150*	5A	300	155	40	290	105	M5
RFI 400 FP	*VX220* to *VX400*	15A	300	155	40	290	105	M5
RFI 750 FP	*VX550* to *VX750*	25A	300	225	40	290	105	M6
RFI 1500 FP	*VX1100* to *VX1500*	50A	460	250	65	445	125	M6
RFI 2200 FP	*VX1850* to *VX2200*	75A	460	250	65	445	125	M6

Safety Precautions

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 & Safety at Work Act in the United Kingdom and other 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 question or doubt should be referred to IMO Precision Controls Ltd.

Operational Safety

Users and operators of the equipment must 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 the driven equipment.

The stop and start inputs should not be relied upon alone to ensure the safety of personnel. If a safety hazard could arise from the unexpected starting of the motor, an interlock mechanism should be provided to prevent the motor from running except when it is safe for it to do so.

Warnings, Cautions & Notes

'WARNING', 'CAUTION' and 'NOTE' paragraphs appear in the text of this instruction manual wherever they are applicable as precautionary reminders to installers and operators.

WARNING
Denotes operating procedures and practices which, if not correctly followed and strictly observed, may result in danger, personal injury or loss of life.

CAUTION
Denotes operating procedures and practices which, if not correctly followed and strictly observed, may result in damage to or destruction of equipment.

NOTE
Notes call attention to information that is especially significant in understanding and operating the equipment.

Documentation

Every effort has been made by IMO Precision Controls Ltd to ensure that this document accurately and completely represents the *Jaguar VX* range of inverters at the time of going to press. Information with respect to installation is necessarily generalised, and the supplier accepts no liability for contingencies over which he has no control in respect of the selection, installation and/or operation of equipment.

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