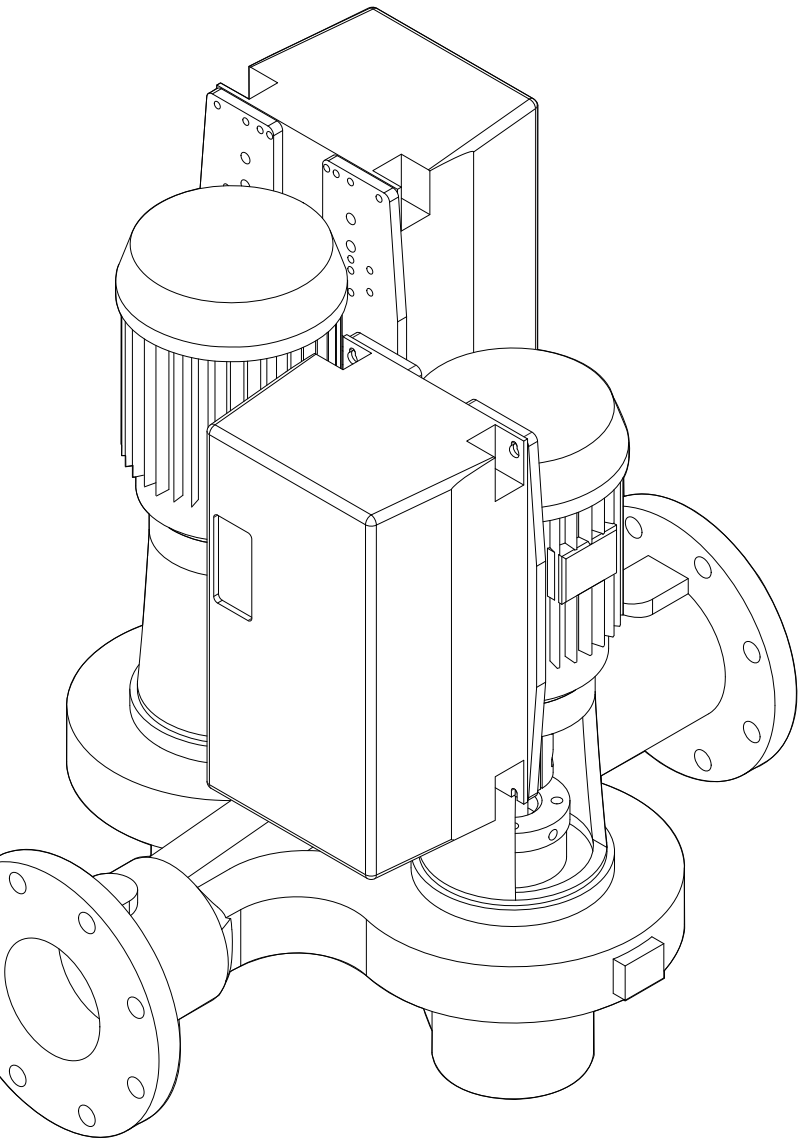
ARMSTRONG



Installation and operating instructions

Design Envelope 4312 and 4392 IVS vertical in-line twin pumping unit with integrated controls

File No: 94.84IN
Date: JULY 11, 2013
Supersedes: NEW
Date: NEW

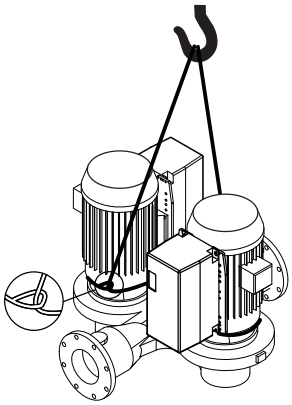
CONTENTS

1.0 UNCRATING

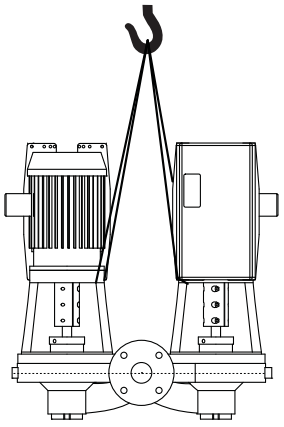
Armstrong Design Envelope 4312 IVS and 4392 IVS in-line pumps are thoroughly inspected before shipment to assure they meet with your order requirements. After removing the pump from the crate, make sure the equipment is in good order and that all components are received as called for on the packing list. Any shortages or damage should be reported immediately. Use extreme care in handling the unit, placing slings carefully so that stress will not be imposed on the integrated controls, pump or motor. **Never place cable slings around the pump shaft or integrated controls.** The eye bolts or lifting lugs on the motor are intended for lifting only the motor and not the complete unit.

1.1 HANDLING 4312 IVS & 4392 IVS UNITS

Series 4312 IVS and 4392 IVS twin pumps are handled in a similar manner to the normal twin pumping units. Extra care is required to ensure the integrated controls do not get damaged during lifting and installation. Remove the coupling guards and insert lifting straps through each pump/motor pedestal on the inner side of each coupling. As the lifting device is engaged (Using a spacer bar if necessary) and the straps tighten ensure no part of the strapping is touching any part of the control or motor fan cover. Lift the pumping unit carefully from the pallet in this manner and allow the unit to stand upright on a flat surface and re-position the straps, if necessary, to ensure safe and damage free transportation into the pipe installation



4392 IVS



4312 IVS

2.0 INSTALLATION

2.1 MECHANICAL INSTALLATION

2.1.1 LOCATION

Locate the unit as close as practical to the liquid being pumped, with a short, direct suction pipe. Ensure adequate space is left above and around the unit for operation, maintenance, service and inspection of parts.

Electric motor driven pumps should not be located in damp or dusty location without special protection.

2.1.2 STORAGE

Pumps not immediately placed into service, or removed from service and stored, must be properly prepared to prevent rusting

Rotate the shaft periodically to keep rotating element free.

For long term storage, the pump must be placed in a vertical position in a dry environment.

Internal rusting can be prevented by removing the plugs at the top and bottom of the casing and drain or air blow out all water to prevent rust build up or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rustproofing or packing the casing with moisture absorbing material and covering the flanges is acceptable. When returning to service be sure to remove the drying agent from the pump.

2.1.3 INSTALLATION

The most important consideration when installing a Series 4312 IVS and 4392 IVS pumping unit is to make sure the pump is free to 'float' with expansion and contraction of the piping. Recommended arrangements are:

- Supported from the ceiling by pipe hangers (See **FIG. 2.1** on page 9)
- Pipe supported at the ceiling, with the twin free-standing and mounted with an Armstrong Suction Guide & Flo-Trex valve. (See **FIGS. 2.2** & **2.3** on page 9)
- Piping supported at ceiling with additional floor mounted supports under Armstrong Suction Guide and Flo-Trex Valve (See **FIG. 2.4** on page 9)
- Floor mounted saddle supports (See **FIG. 2.5** on page 10)
- Where required, additional floor support may be obtained as shown in **FIG. 2.5**. Note that the pump must not be rigidly attached either to the plate or to the block. Leave a 3mm (⅛") gap between pump and base. The piping must be installed in such a manner that the pump is not used as a pipe support.

- **Do not** rigidly connect the pump to a permanent base (See **FIG. 2.7** on page 10) Note: if the pump must be connected to a permanent base, the pump must be isolated from the piping by flexible connectors and the base isolated from the building structure on an inertia base.
- **Do not** install the unit with the shaft horizontal.
- **Do not** support the installed unit by the motor eye bolts or by supports to any other part of the pump other than stated above.

IMPORTANT

All Series 4312 IVS pumps contain a tapped hole in the motor bracket above the discharge flange for draining the well. Pipe this drain hole to a floor drain to avoid overflow of the cavity caused by collecting chilled water condensate or from seal failure.

2.1.4 PUMP PIPING – GENERAL

Never connect a pump to piping, always start piping from pump.

Use as few bends as possible and preferably long radius elbows.

Do not use flexible connectors on the suction or discharge.

Make sure piping exerts no strain on pump as this would distort the casing and cause pump misalignment.

Suction and discharge pipes may be increased at pump nozzle to suit pump capacity and particular conditions of installation. Use eccentric reducers on suction connection.

Lay out the suction line with a continual rise towards the pump without high points, thus eliminating possibility of air pockets that may prevent the pump from operating.

A strainer of three or four times the area of the suction pipe, installed in the suction line, will prevent the entrance of foreign materials into the pump. 3mm (⅛") diameter perforations in the strainer are typical.

Test suction line for air leaks before starting; this becomes essential with long suction line or static lift.

Install, at pump suction, a straight pipe of a length equivalent to 4 or 6 times its diameter; this becomes essential when handling liquids above 49°C (120°F). Armstrong suction guides may be used in place of the straight pipe run and in line strainer.

Install isolation valve in both suction and discharge lines on flooded suction application; this valve is used mainly to isolate the pump for inspection or repair.

Install a non-slam check valve in discharge line between pump and isolation valve to protect pump from excessive back pressure and to prevent water running back through the pump in case of driver failure. Armstrong Flo-Trex valve may be used in place of check valve and isolation valve on pump discharge.

CAUTION

Discharge valve only must be used to reduce the pump flow, not the suction valve.

Care must be taken in the suction line layout and installation, as it is usually the major source of concern in centrifugal pump applications.

IMPORTANT

Do not run the pump for any length of time under very low flow conditions or with the discharge valve closed. To do so could cause the water in the casing to reach super heated steam conditions and will cause premature failure and could cause serious and dramatic damage to the pump and surrounding area.

2.1.5 ALIGNMENT

The pumping unit is accurately aligned at the factory prior to being shipped.

Alignment on the 4312 IVS twin may be verified by assuring an equal gap between coupling halves on both sides of the coupling.

OPERATION

2.1.6 STARTING PUMP

The pump must be fully primed on start up. Fill the pump casing with liquid and rotate the shaft by hand to remove any air trapped in the impeller. Air trapped in the casing must be removed by the manual air vent in the seal flush line. **Ensure entrained air is removed from series 4312 IVS and 4392 IVS pumps, prior to starting, through the air vent on the seal flush line. Open vent until clear of air.**

"Bump" or energize the motor for a fraction of a second and check that the rotation corresponds with the directional arrow on the pump casing.

To reverse rotation of a three phase motor, interchange any two power leads.

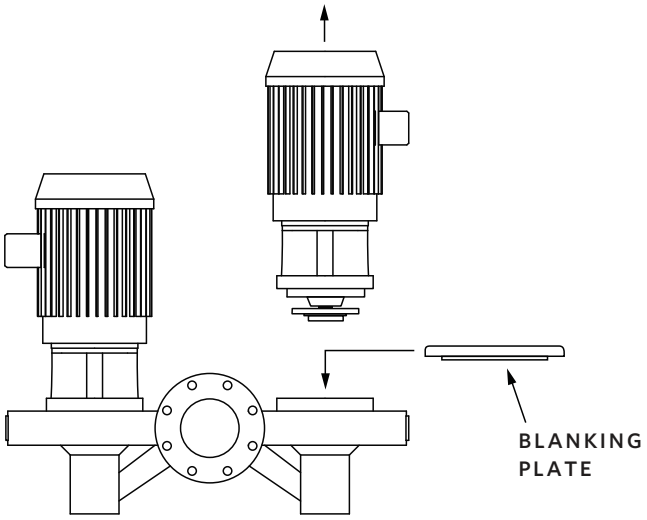
Start the pump with the discharge valve closed and the suction valve open, then gradually open the discharge valve when the motor is at operating speed. The discharge valve may be "cracked" or open slightly at start up to help eliminate trapped air.

When stopping the pump: Close the discharge valve and de- energize the motor.

CAUTION

Centrifugal pump rotation is generally "clockwise" when viewing from the motor end.

Check rotation arrow prior to operating the unit.



2.1.7 GENERAL CARE

Vertical In-Line pumps are built to operate without periodic maintenance. A systematic inspection made at regular intervals, will ensure years of trouble-free operation, giving special attention to the following;

- Keep unit clean
- Provide the motor with correctly sized overload protection
- Keep moisture, refuse, dust or other loose particles away from the pump and ventilating openings of the motor.
- Avoid operating the unit in overheated surroundings (Above 100°F/40°C).
- If mechanical seal environmental accessories are installed, ensure water is flowing through the sight flow indicator and that filter cartridges are replaced as recommended. (See file 43.85 & 43.86 for seal environmental instructions).
- Series 4312 and 4392 Vertical In–Line pumps are built to operate without periodic maintenance, other than motor lubrication on larger units. A systematic inspection made at regular intervals, will ensure years of trouble–free operation, giving special attention to the following:
- Keep unit clean.
- Provide the motor with correctly sized overload protection.
- Keep moisture, refuse, dust or other loose particles away from the pump and ventilating openings of the motor.
- If one pump requires service, install the blanking plate to allow the other pump head to continue operating.

WARNING

Whenever any service work is to be performed on pumping unit, disconnect power source to driver. Any possibility of the unit starting while being worked on, must be eliminated.

2.1.8 LUBRICATION

Pump

Lubrication is not required. There are no bearings in the pump.

Motor

Follow the lubrication procedures recommended by the motor manufacturer. Many small and medium sized motors are permanently lubricated.

Check the lubrication instructions supplied with the motor for the particular frame size indicated on the motor nameplate

Mechanical seal

Mechanical seals require no special attention. The mechanical seal is flushed from discharge of the pump casing on 4312 and towards the suction on 4392. Seal environmental controls, installed in flush lines, such as filters and separators, will prolong seal life in HVAC systems

Do not run the pump unless properly filled with water as the mechanical seals need a film of liquid between the faces for proper operation. (For 4312 see file 43d.88 and for 4392 see file 43d.81 for mechanical seal replacement instructions)

2.1.9 SYSTEM CLEANLINESS

Before starting the pump the system must be thoroughly cleaned, flushed and drained and replenished with clean liquid.

Welding slag and other foreign materials, "Stop Leak" and cleaning compounds and improper or excessive water treatment are all detrimental to the pump internals and sealing arrangement.

Proper operation cannot be guaranteed if the above conditions are not adhered to.

NOTE:

Particular care must be taken to check the following before the pump is put into operation:

A Pump primed?

B Alignment correct?

C Rotation **OK**?

D Lubrication **OK**?

E Pipe work properly supported?

F Voltage supply **OK**?

G Overload protection **OK**?

H Is the system clean?

I Is the area around the pump clean?

J Pipe work properly supported?

WARRANTY

Refer to Armstrong General Terms and Warranty sheet. Contact your local Armstrong representative for full information.

FIG. 2.1 Hanger supported pipe mounted

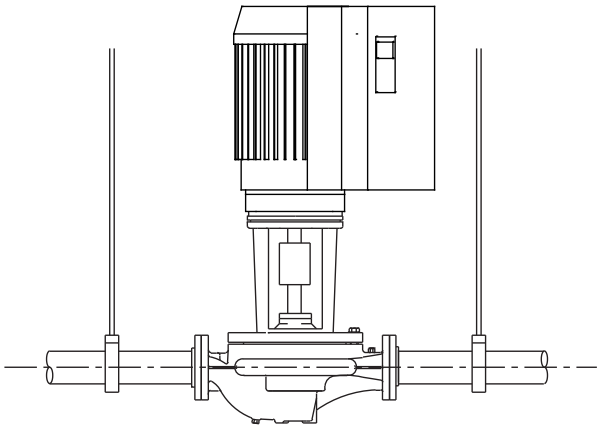


FIG. 2.2 Pipe mounted supported at ceiling

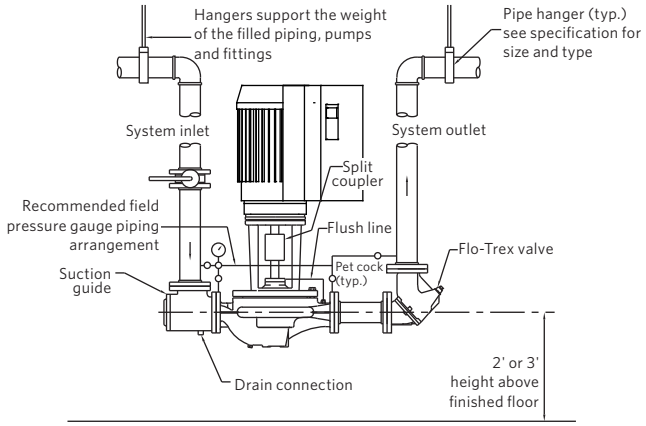


FIG. 2.3 Discharge elbow for minimum footprint

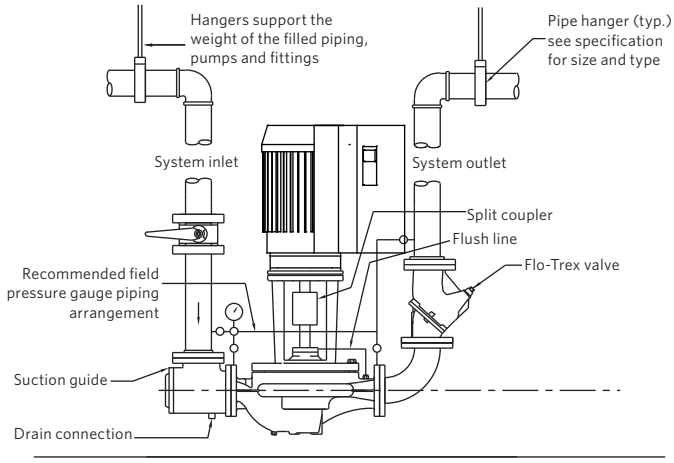


FIG. 2.4 With additional pipe supports

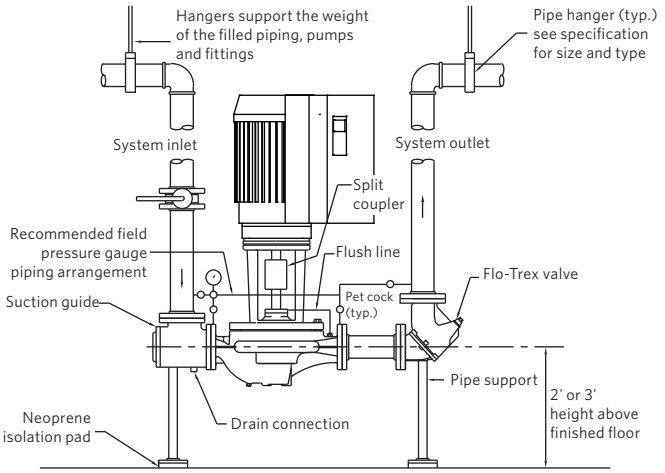


FIG. 2.5 Floor saddle support

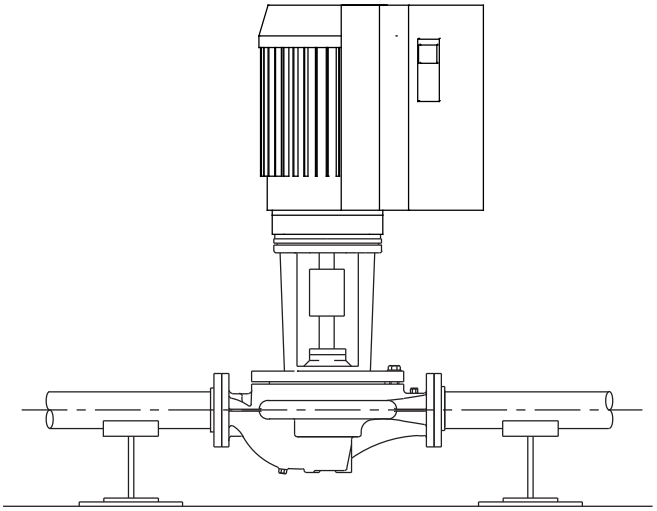


FIG. 2.6 Additional floor support

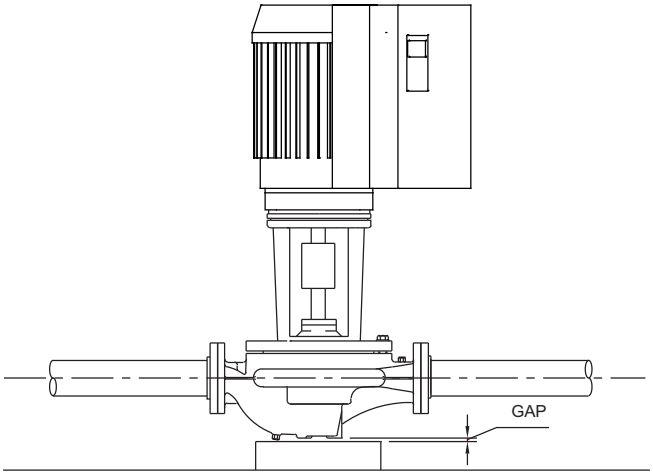


FIG. 2.7 Not recommended

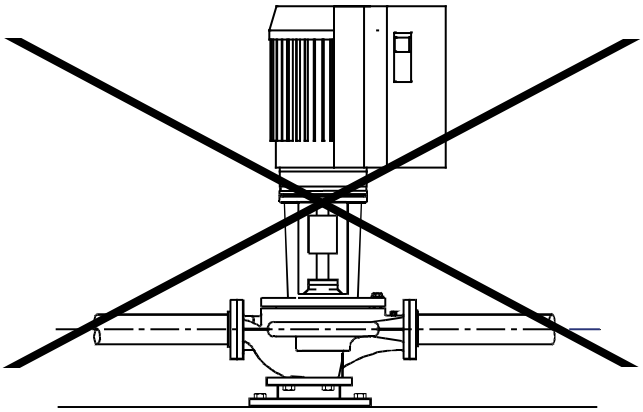
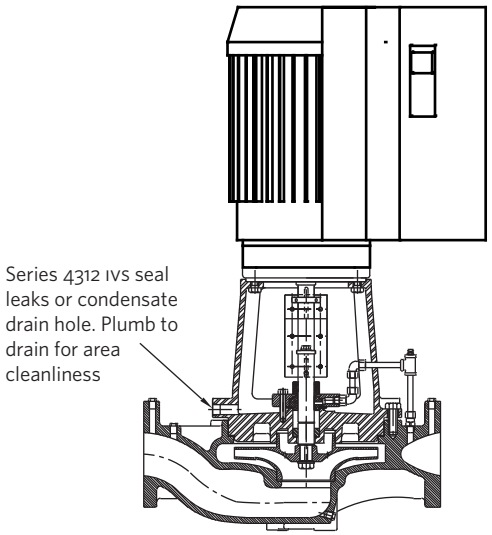


FIG. 2.8 Tapped collection well on Series 4312 IVS



INTEGRATED CONTROLS

3.1 ENCLOSURE RATING

The standard enclosure rating for Series 4312 IVS and 4392 IVS integrated controls is IP 55. If the pump is to be installed in a wet or dusty environment then a higher enclosure rating may be required (IP 56 or IP 66 option)

3.2 AMBIENT TEMPERATURE

To avoid the inverter unit getting overheated, the ambient temperature is not to exceed 40°C and the 24 hour average temperature is not to exceed 35°C. If the ambient temperature is in the range of 40°C — 55°C, a reduction of the service life of the inverter part is to be expected.

4.0 ELECTRICAL INSTALLATION

All electrical connections should be carried out by a qualified and authorized electrician in accordance with local site regulations and the latest issue of the iee regulations.

SAFETY, RISK OF DEATH

Before removing the controls cover, the system must be disconnected from the mains supply. After switching off, wait for at least 15 minutes for the capacitors to discharge before opening the cover.

CAUTION

High voltage testing (Megging) of the motor/ controls may cause damage to the electronic components and therefore should not be carried out

4.1 GROUND LEAKAGE CURRENT

Ground leakage current is primarily caused by the capacitance between motor phases and the motor frame. The rfi filter contributes additional leakage current, as the filter circuit is connected to ground through capacitors.

The size of the leakage current to the ground depends on the following factors, in order of priority:

1 Switching frequency

2 Motor grounded on site or not

The leakage current is of importance to safety during handling / operation of the IVS pump if (by mistake) the on-board inverter has not been grounded.

Since the leakage current is >3.5mA (approx 4-20mA), reinforced Grounding must be established which is required if EN 50178 is to be complied with. Never use ELCB relays that are not suitable for DC fault currents (type A).

If ELCB relays are used, they must be:

- Suitable for protecting equipment with a direct current content (DC) in the fault current (three-phase bridge rectifier)
- Suitable for power-up with short charging current to Ground
- Suitable for a high leakage current

4.2 START / STOP OF PUMP

The number of starts/stops via the mains voltage must not exceed one-time per minute.

If a higher number of starts/stops is required then the start/ stop digital input must be used (mains voltage directly connected). This is the preferred method of starting and stopping IVS pumps.

The three phase mains must be isolated before performing maintenance of the pump.

4.3 ADDITIONAL MOTOR PROTECTION

With the exception of supply fuses / MCB's to protect the installation (for over-current and short-circuit protection), no additional overload or over-temperature protection is required (i.e. thermal overloads). Protection features include:

- Mains phase loss
- Over voltage
- Under voltage
- Electronic thermal motor protection
- Short circuit on motor terminals
- Ground fault on motor terminals
- Over temperature

4.4 SUPPLY VOLTAGE

The supply voltage details can be found on the inverter nameplate. Please ensure that the unit is suitable for the electrical supply on which it is to be used. The mains supply for IVS pumps is as follows:

3 × 200-240V +/-10%

3 × 380-480V +/- 10%

3 × 525-600V +/- 10%

Supply frequency - 50/60HZ

4.5 SUPPLY FUSING

Branch circuit protection

In order to protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines etc., must be short-circuit and over-current protected according to the national/international regulations.

Short circuit protection

The inverter must be protected against short-circuit to avoid electrical or fire hazard. Armstrong recommends using the fuses detailed in the separate **IVS102 Operating Instructions** to protect service personnel or other equipment in case of an internal failure in the unit. The frequency converter provides full short circuit protection in case of a short-circuit on the motor output.

4.6 GROUNDING AND IT MAINS

The ground connection cable cross section must be at least 10 mm² or two rated mains wires terminated separately according to EN 50178 or IEC 61800-5-1 unless national regulations specify differently. Always comply with national and local regulations on cable cross sections.

The mains is connected to the main disconnect switch if this has been included.

Check the mains voltage corresponds to the mains voltage of the frequency converter name plate.

IT MAINS

Do not connect frequency converters with RFI-filters to mains supplies with a voltage between phase and earth of more than 440V for 400V converters. For 440V IT MAINS and delta earth (grounded leg), mains voltage may exceed 440V between phase and earth.

FIG. 2 Terminals for mains and grounding

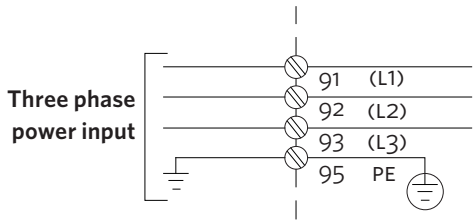


FIG. 3 Mains and grounding connections for A5 units (380-480V - 7.5 kW and below)

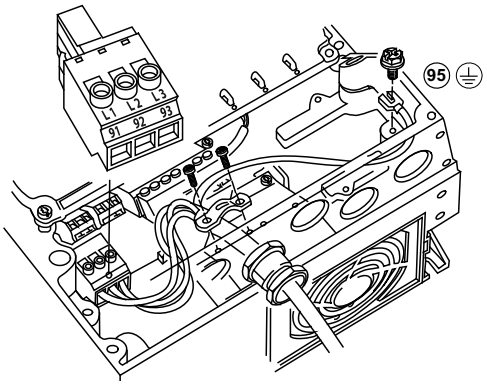


FIG. 4A Mains and grounding connections for B1 and B2 units (380-480V - 11 TO 30 kW)

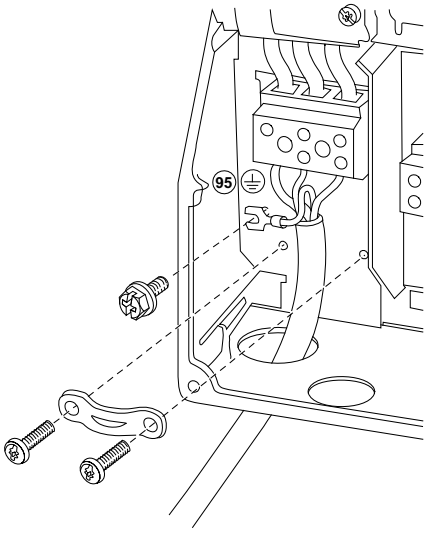
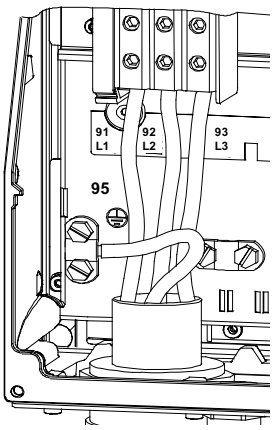


FIG. 4B Mains and grounding connections for C1 and C2 units (380-480V - 37 TO 90 kW)



4.7 RELAY CONNECTIONS

The relays on the IVS are configured as follows:

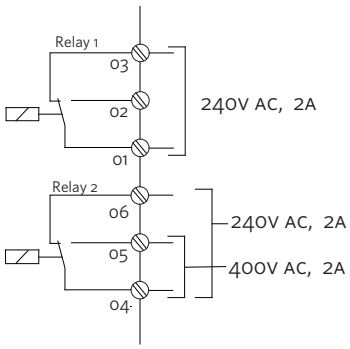
RELAY 1 – running

- Terminal 01: Common
- Terminal 02: Normal Open 240V AC
- Terminal 03: Normal Closed 240V AC

RELAY 2 – ALARM

- Terminal 04: Common
- Terminal 05: Normal Open 400V AC
- Terminal 06: Normal Closed 240V AC

FIG. 5 Relay contact details



The following illustrations identify the location of the relays within specific inverter sizes:

The illustrations in figures 6, 7 and 8 identify the location of the relays within specific inverter sizes:

FIG. 6 Relay connection: terminals for A5, B1 and B2 units

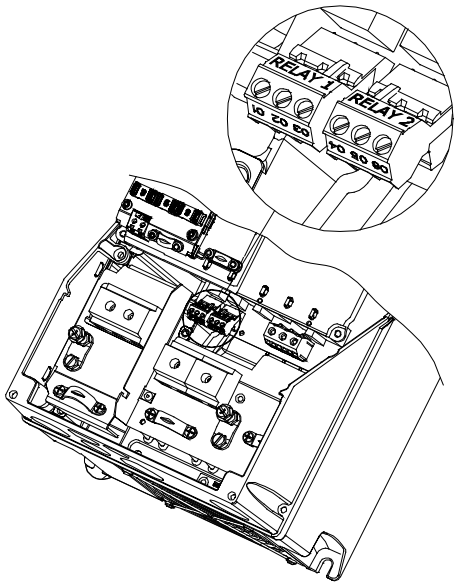
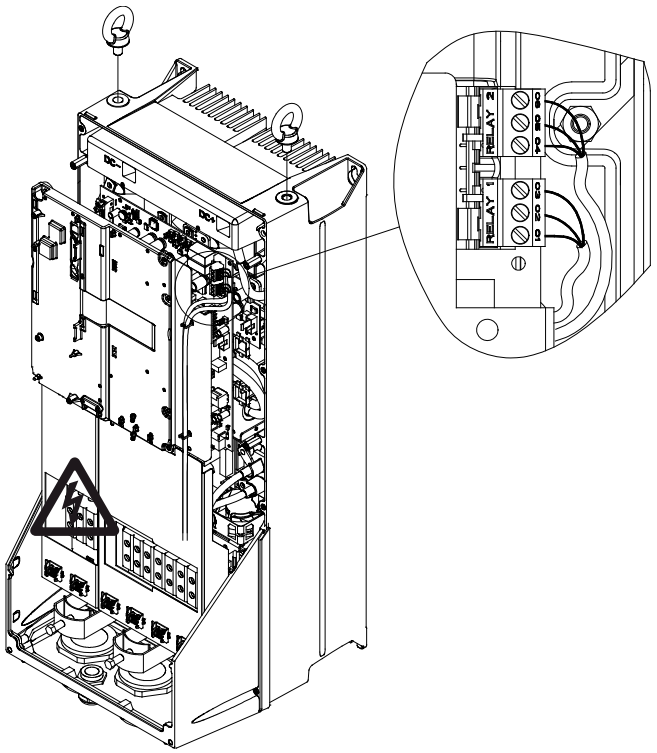


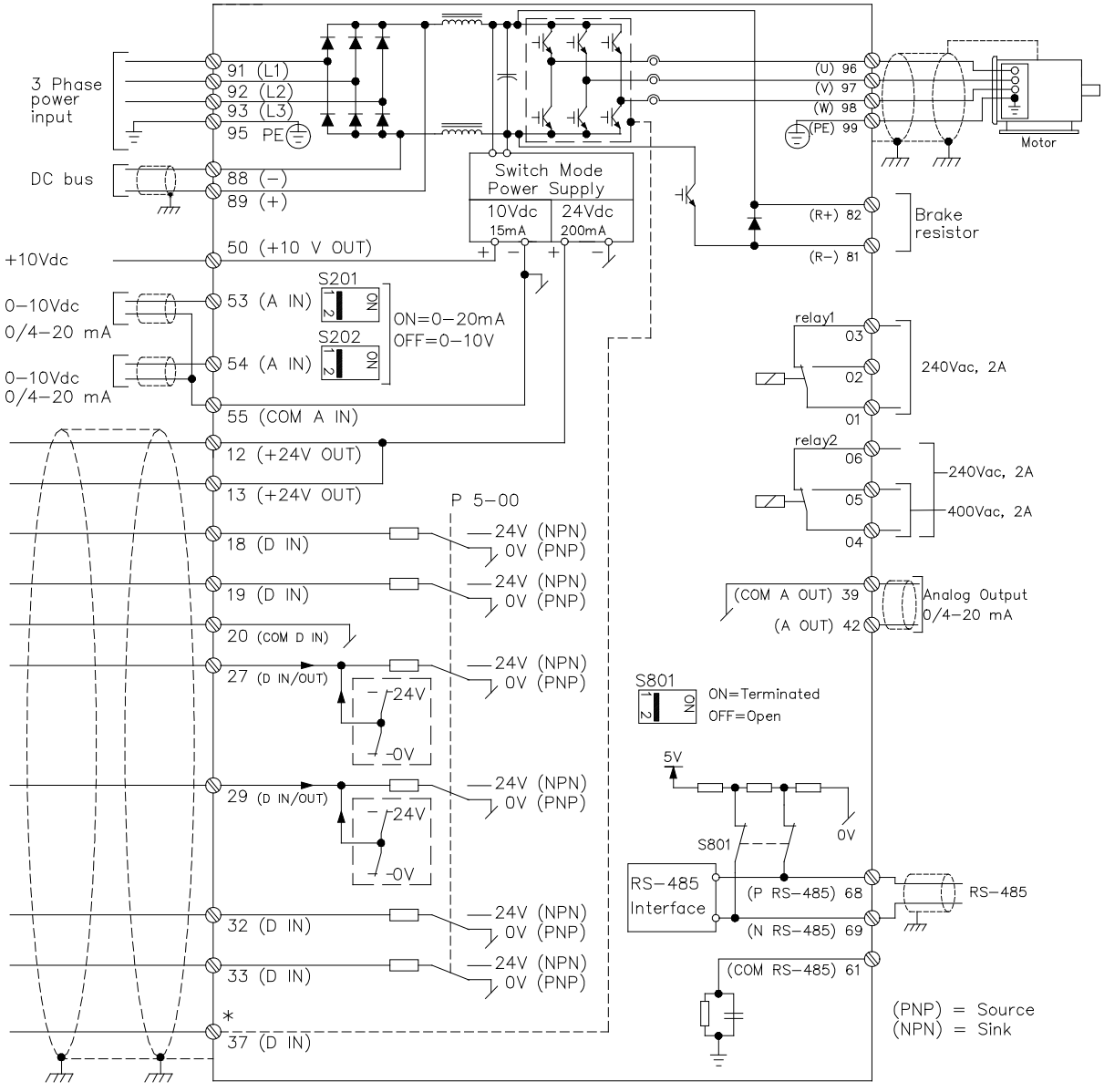
FIG. 7 Relay connection terminals for C1 and C2 units



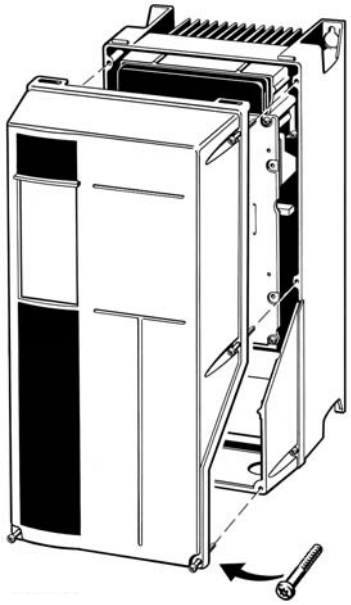
4.8 ELECTRICAL INSTALLATION AND CONTROL CONNECTIONS

FIG. 8 Diagram showing all electrical connections

***Note:** terminal 37 is not available on IVS sensorless pumps



4.8.1 ACCESS TO TERMINALS

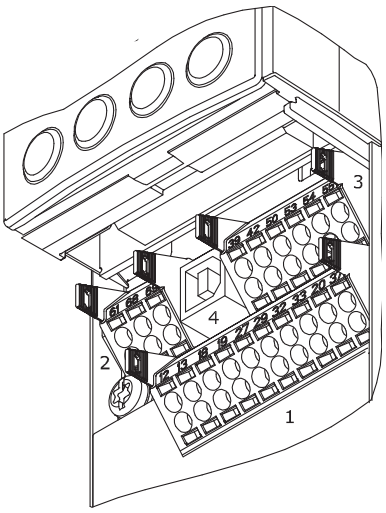


Remove front-cover to access control terminals. When replacing the front cover, please ensure proper fastening by applying a torque of 2 Nm.

4.8.2 CONTROL TERMINALS

With reference to figure 9:

FIG. 9 Control Connections



1 10-way plug for digital I/O

2 3-way plug for RS485 bus

3 6-way plug for analogue I/O

4 USB connection

Control terminal functions and factory settings are as follows:

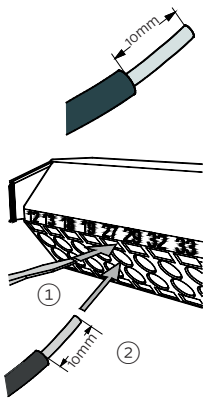
TERMINAL NO.	TYPE / DESCRIPTION	FACTORY SETTING
1,2,3	Relay 1	Running
4,5,6	Relay 2	Alarm
12	Supply	+24V DC
13	Supply	+24V DC
18	Digital Input	Start
19	Digital Input	Pump Operating Mode
20	Common	OK
27	Digital Input	Low Water Interlock
29	Digital Input	No Operation
32	Digital Input	No Operation
33	Digital Input	No Operation
37	Digital Input	No Operation
42	Analogue Output	Output Frequency (4-20mA - 0-100Hz)
53	Analogue Input	Reference (0-10V)*
54	Analogue Input	Feedback (0-10V)*

*Note that Analogue inputs AI53 and AI54 can be either Voltage (0-10V) or Current (4-20mA) input and by default both inputs are set to Voltage. Switches S201 and S202 (see figure 8) are used to configure the analogue inputs as follows:

S201 (AI53) OFF = Voltage, ON = Current

S202 (AI54) OFF = Voltage, ON = Current

Inserting Cables into Control Terminals



I Strip 10mm of insulation from the cable:

II Insert a suitable terminal screwdriver as shown and then push the cable into the terminal.

III Remove the terminal screwdriver and check the terminal has gripped the cable by gently pulling it.

Note:

Terminal plugs can be easily removed for improved access when making connections.

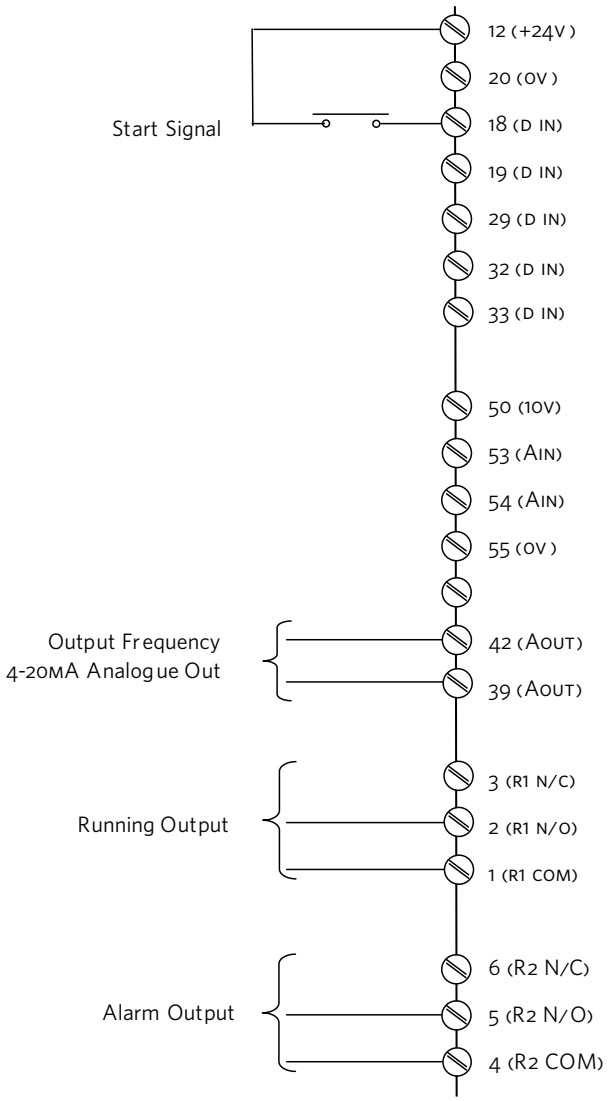
4.8.3 CONNECTION EXAMPLES

IVS Sensorless pumps can be configured in four main ways:

- **I** Sensorless
- **II** Closed loop – with feedback sensor
- **III** Constant Curve Mode – Potentiometer Control
- **IV** Constant Curve Mode – BMS signal
- **IV.I** Full Speed Override

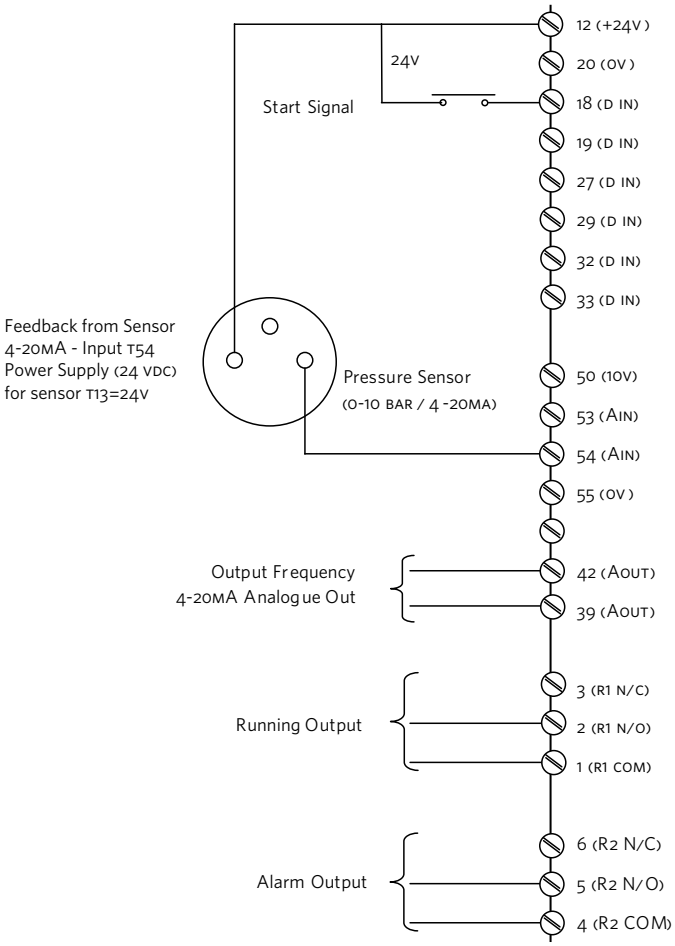
I SENSORLESS

IVS sensorless pumps are factory configured to be connected as shown below.



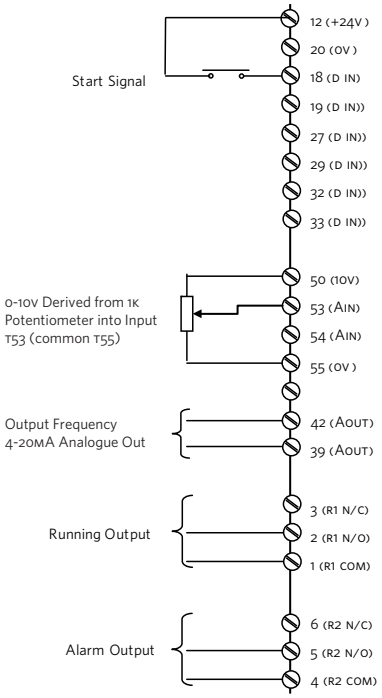
II CLOSED LOOP – WITH SENSOR FEEDBACK

To control the pump based on a 4-20mA feedback signal from a sensor use the following connection.



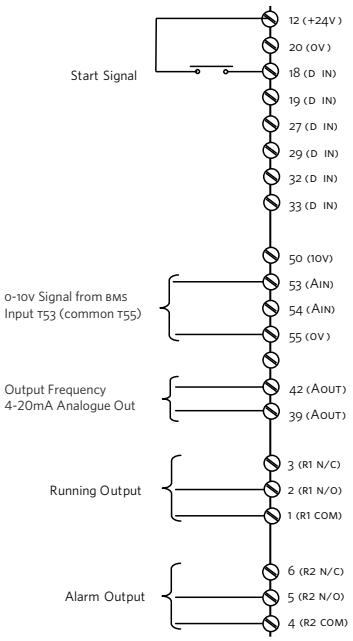
III CONSTANT CURVE MODE – POTENTIOMETER

To control the pump based on a 0-10V potentiometer signal use the connections below.



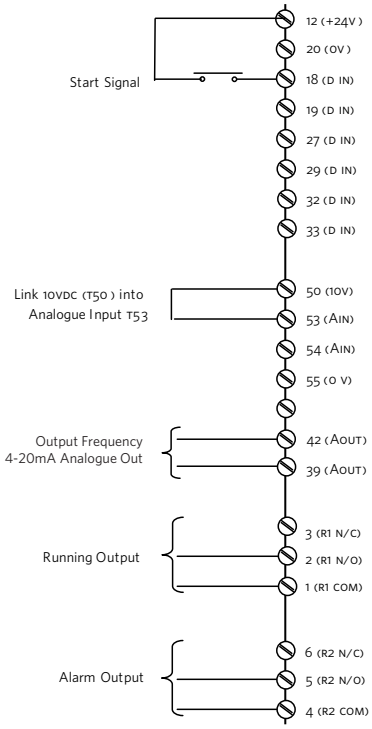
IV CONSTANT CURVE MODE – BMS SIGNAL

When the Building Management System is to be used for speed control it is necessary to disable sensorless control and provide the unit with a 0-10VDC speed reference signal.



IV.I CONSTANT CURVE MODE - BMS SIGNAL

It may be required to run the pump at full speed without automatic speed control (eg during system commissioning). This can be achieved without programming changes by making the connections below.



4.8.4 REMOTE LCP KEYPAD WIRING

For large IVS units with remote LCP keypad, see wiring arrangement below.

LCP WIRING ARRANGEMENT

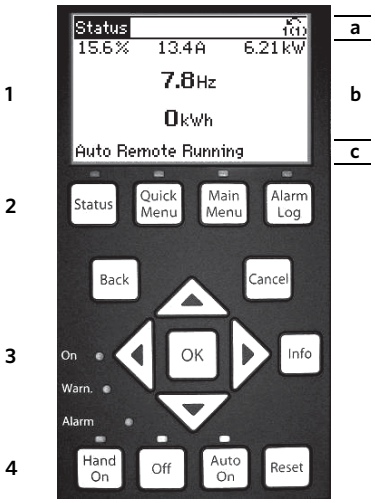
TERMINAL	WIRE COLOR
1	Green
2	Brown
3	Red
4	Yellow
5	Black
6	Orange
7	Blue
8	Purple
9	Grey

5.0 PROGRAMMING, MONITORING AND DIAGNOSTICS

IVS pumps incorporate an integrated graphical local control panel (GLCP).

5.1 GLCP FUNCTIONS AND OPERATION

The GLCP is divided into four functional groups:



1 Graphical display with status lines.

2 Menu keys and indicator lights (LEDS) – selecting mode, changing parameters and switching between display functions.

3 Navigation keys and indicator lights (LEDS).

4 Operation keys and indicator lights (LEDS).

Graphical display:

The LCD-display is back-lit with a total of six alpha-numeric lines. All data is displayed on the LCP which can show up to five operating variables while in **Status** mode.

Display lines:

a Status line: Status messages displaying icons and graphics.

b Line 1–2: Operator data lines displaying data and variables de-fined or chosen by the user. By pressing the **Status** key, up to one extra line can be added.

c Status line: Status messages displaying text.

The display is divided into three sections:

Top section (a) shows the status when in status mode or up to two variables when not in status mode and in the case of ALARM/WARNING.

The number of the Active Set-up (Sensorless mode being setup 1) is shown.

The Middle section (b) shows up to five variables with related unit, regardless of status. In case of alarm/warning, the warning is shown instead of the variables.

The Bottom section (c) always shows the state of the inverter in Status mode.

It is possible to toggle between three status read-out displays by pressing the **Status** key.

Operating variables with different formatting are shown in each status screen — see below.

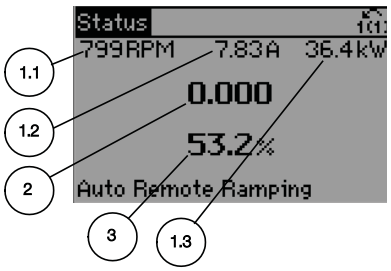
Status display I:

This read-out state is standard after start-up or initialisation. Use **Info** to obtain information about the value/measurement linked to the displayed operating variables (1.1, 1.2, 1.3, 2 and 3). See the operating variables shown in the display in this illustration. 1.1,1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.

Status display II:

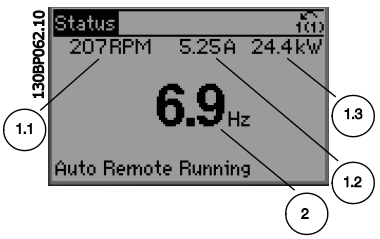
See the operating variables (1.1, 1.2, 1.3 and 2) shown in the display in this illustration.

In the example, Speed, Motor current, Motor power and Frequency are selected as variables in the first and second lines. 1.1, 1.2 and 1.3 are shown in small size. 2 is shown in large size.



Display Contrast Adjustment

Press **Status** and [▲] for darker display



Press **Status** and [▼] for brighter display

5.2 INDICATOR LIGHTS (LEDS)

If certain threshold values are exceeded, the alarm and/or warning LED lights up. A status and alarm text appear on the control panel. The **ON** LED is activated when the frequency converter receives power from mains voltage, a DC BUS terminal, or an external 24V supply. At the same time, the back light is on.

- Green led/**ON**: Control section is working.
- Yellow led/**WARN**.: Indicates a warning.
- Flashing Red led/**ALARM**: Indicates an alarm.

5.3 CONTROL KEYS

Menu keys

The menu keys are divided into functions. The keys below the display and indicator lamps are used for parameter set-up, including choice of display indication during normal operation.

Status

Indicates the status of the frequency converter and/or the motor. Three different readouts can be chosen by pressing the **Status** key: five line readouts, four line readouts or Smart Logic Control.

Use **Status** for selecting the mode of display or for changing back to Display mode from either the Quick Menu mode, the Main Menu mode or Alarm mode. Also use the **Status** key to toggle single or double read-out mode.

Quick Menu

Allows quick set-up of the inverter by access to a limited number of parameters. Quick Menu does not include all the parameters that may need to be changed when utilising Sensorless control and it is therefore recommended that parameter changes are made in Main Menu mode.

Main Menu

Is used for programming all parameters.

Alarm Log

Displays an Alarm list of the five latest alarms (numbered A1-A5). To obtain additional details about an alarm, use the arrow keys to manoeuvre to the alarm number and press **OK**. Information is displayed about the condition of the frequency converter before it enters the alarm mode.

The Alarm log button on the LCP allows access to both Alarm log and Maintenance log.

Back

Reverts to the previous step or layer in the navigation structure.

Cancel

Last change or command will be cancelled as long as the display has not been changed.

Info

Displays information about a command, parameter, or function in any display window. **Info** provides detailed information when needed.

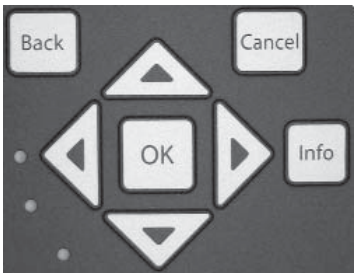
Navigation Keys

The four navigation arrows are used to navigate between the different choices available in **Quick Menu**, **Main Menu** and **Alarm Log**. Use the keys to move the cursor.

OK

Is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.

Operation Keys for local control are found at the bottom of the control panel.



Hand On

Enables control of the pump via the GLCP. It is possible to enter the pump speed data by means of the arrow keys.

The low water device input must be made for the pump to start in either hand mode or auto mode.

Off

Stops the pump.

Auto On

Enables the pump to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals the pump will start.

For the pump to operate in either Sensorless mode or any other automatic control mode it is necessary to have pressed the **Auto On** button.

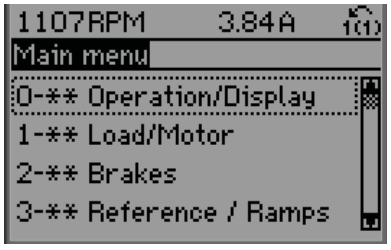
Reset

Is used for resetting the frequency converter after an alarm (trip).

5.4 PROGRAMMING

Select the Main Menu mode by pressing the **Main Menu** key. The below read-out appears on the display. The middle and bottom sections on the display show a list of parameter groups which can be chosen by toggling the up and down buttons.

Each parameter has a name and number which remain the same regardless of the programming mode. In the Main Menu mode, the parameters are divided into groups. The first digit of the parameter number (from the left) indicates the parameter group number.



All parameters can be changed in the Main Menu. However, depending on the choice of configuration (Par.1-00 Configuration Mode), some parameters can be hidden.

5.4.1 PARAMETER SELECTION

In the Main Menu mode, the parameters are divided into groups. You select a parameter group by means of the navigation keys.

The following parameter groups are accessible:

GROUP NO.	PARAMETER GROUP	GROUP NO.	PARAMETER GROUP
0	Operation/display	13	Smart Logic
1	Load/motor	14	Special functions
2	Brakes	15	FC information
3	References/ramps	16	Data readouts
4	Limits/warnings	18	Data readouts 2
5	Digital in/out	20	Drive closed loop
6	Analog in/out	21	Ext. closed loop
8	Com. and options	22	Application functions
9	Profibus	23	Time-based functions
10	CAN Fieldbus	25	Cascade controller
11	LonWorks	26	Analog I/O option MCB 109

After selecting a parameter group, choose a parameter by means of the navigation keys.

The middle section on the display shows the parameter number and name as well as the selected parameter value.

5.4.2 CHANGING DATA

The procedure for changing data depends on whether the selected parameter represents a numerical data value or a text value.

Changing a text value

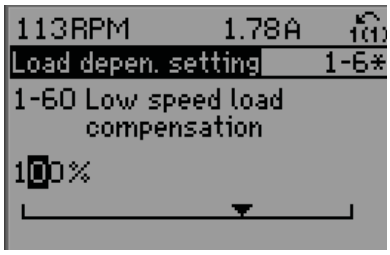
If the selected parameter is a text value, change the text value by means of the [▲] [▼] navigation keys.

The up key increases the value, and the down key decreases the value.

Place the cursor on the value you want to save and press **OK**.

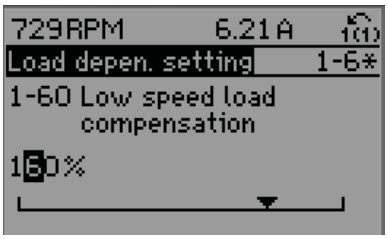
Changing Numeric Data Values

If the chosen parameter represents a numeric data value, change the chosen data value by means of the [◀] [▶] navigation keys as well as the [▲] [▼] navigation keys.



Use the [◀] [▶] navigation keys to move the cursor horizontally.

Use the [▲] [▼]navigation keys to change the data value. The up key enlarges the data value, and the down key reduces the data value. Place the cursor on the value you want to save and press **OK**.



Readout and Programming of Indexed Parameters

Parameters are indexed when placed in a rolling stack.

Par.15-30 Alarm Log: Error Code to Par.15-33 Alarm Log: Date and Time contain a fault log which can be read out. Choose a parameter, press **OK**, and use the up/down navigation keys to scroll through the value log.

Use Par.3-10 Preset Reference as another example:
Choose the parameter, press **OK**, and use the up/down navigation keys to scroll through the indexed values. To change the parameter value, select the indexed value and press **OK**. Change the value by using the up/down keys. Press **OK** to accept the new setting. Press **Cancel** to abort.

Press **Back** to leave the parameter.

6 SENSORLESS OPERATION

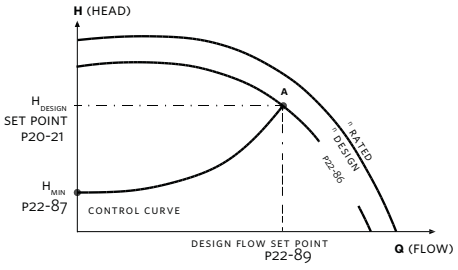
Sensorless control is an innovative concept in circulating pumps. Pump performance and characteristic curves are embedded in the memory of the speed controller during manufacture. This data includes power, speed, head and flow across the flow range of the pump. During operation, the power and speed of the pump are monitored, enabling the controller to establish the hydraulic performance and position in the pumps head-flow characteristic.

These measurements enable the pump to continuously identify the head and flow at any point in time, giving accurate pressure control without the need for external feedback signals. Patented software technology within the controller ensures trouble-free operation in all conditions.

Incorporating the pumps hydraulic data into the controller and removing sensors results in true integration of all components and removes the risk of sensor failure.

6.1 DEFAULT OPERATING MODE — QUADRATIC PRESSURE CONTROL

The default control mode for IVS Sensorless pumps is 'Quadratic Pressure Control' where the controller is set to control the speed according to a 'control curve' between max and min flow (see below diagram). It is widely recognised that fitting a differential pressure sensor at the most remote load, across the supply piping and return piping encompassing the valve & coil set, is the benchmark scheme for energy efficiency.



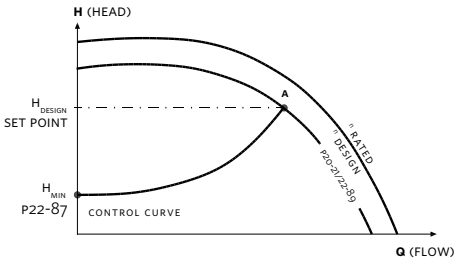
IVS Sensorless pumps can replicate this control without the need for the remote sensor. As the flow required by the system is reduced, the pump automatically reduces the head developed according to the pre-set control curve.

It is often found that using a remote differential pressure sensor to sense the pressure across a remote load could theoretically result in loads close to the pump being under-pumped. The situation would be where the load at a loop extremity is satisfied and the control valve closes while a load close to the pump needs full flow. The probability of this occurring is remote but it is possible. One answer to this is to move the sensor closer to the pump (two-thirds out in the system is a popular recommendation) although physically re-positioning the sensor at commissioning stage can be a costly exercise. With Sensorless pump control it is possible to replicate the moving of a sensor by increasing the head setting H_{MIN}.

6.1.1 SETTINGS FOR QUADRATIC (CONTROL CURVE) PRESSURE CONTROL

The design duty head and flow of the pump (provided at time of order) is shown as point 'A' in figure 10 below.

FIG. 10 QUADRATIC CONTROL SETTINGS



It is not always the case that the design duty point required will fall on the maximum speed of the pump and in the majority of cases (as shown in **FIGURE 10**) it will be at a reduced speed.

The pump will be supplied with point 'A' set as the design duty point provided at the time of order and the minimum head (at zero flow - H_{MIN}) will be set as 40% of the design head H_{DESIGN}, as the Armstrong default.

To change the control curve from the factory settings, the following parameters can be adjusted:

Par. 20-21 (Setpoint, H_{DESIGN}) in units of pump head

Par. 22-89 (Design Flow Setpoint) in units of pump flow

Par. 22-87 (Pressure at no-flow speed, H_{MIN}) in units of pump head

Note, parameters 20-21 and 22-89 should only be adjusted according to the pump performance curve.

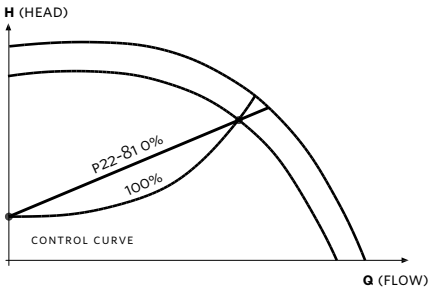
Other settings that are set to enable the pump to operate on a control curve are:

Par. 22-80 (Flow Compensation) which should be set to 'Enabled' [1]

Par 22-81 (Square-linear Curve Approximation) which should be set to '100%'

The effect of adjusting Par. 22-81 is shown in figure 11 below. A setting of 100% gives the ideal theoretical control curve between the design head and minimum head whilst 0% provides a straight line linear approximation.

FIG. 11 CURVE APPROXIMATION SETTINGS



In order for the controller to determine the true fit and position of the control curve it is necessary to set some specific parameters with data relating to specific points within the operating range of the pump. There are two ways of programming the parameters depending on whether the speed at the design duty is known or unknown.

Speed at Required System Design Point is known (Refer to Figure 10):

1. Set the design head, H_{DESIGN}, value in Par. 20-21 (Setpoint 1). after setting unit of head in Par. 20-12 (Reference/Feedback unit)
2. Set the speed of the pump at design head, H_{DESIGN}, and design flow using Par. 22-86 (Speed at Design Point [Hz])
3. Set the minimum head required, H_{MIN}, using Par. 22-87 (Pressure at No-Flow Speed).
4. Adjust the shape of the control curve if required using Par. 22-81 as shown in figure 11.

6.2 CONSTANT PRESSURE CONTROL

IVS Sensorless pumps can be configured to maintain a constant pump head in a system as the demand varies. This effectively simulates the mounting of a differential pressure sensor at, or near, the pump.

6.2.1 SETTINGS FOR CONSTANT PRESSURE CONTROL

To revert to this mode of control simply follow these steps:

1. Set the design head, H_{DESIGN}, value in Par. 20-21 (Setpoint 1). In the units set in Par.20-12 (Reference/Feedback unit.)
2. Turn off flow compensation by setting Par. 22-80 to 'Disabled' [0]

6.3 CHANGING CONTROL MODES

6.3.1 CHANGE TO EXTERNAL SENSOR CONTROL

1 Change parameter 0-10 from 1 to 2

2 Connect the sensor to terminals 54 (+) and 55 (-)

3 Move switch S202 (beside terminal input 54) to ON if the speed command is 4-20mA, or leave it OFF if it's 0-10VDC

4 If the sensor signal is neither 0-10VDC nor 4-20mA, enter the correct voltage or input range in parameters 6-10 to 6-13

5 Enter the sensor and setpoint data in the parameters listed below

PARAM.	NAME	SETUP 2 (EXTERNAL SENSOR)	
0-10	Active Set-Up	2	
6-24	Terminal 54 Low Ref. / Feedback Value	Minimum sensor value	
6-25	Terminal 54 High Ref./ Feedback Value	Maximum sensor value	
20-02	Feedback 1 Source Unit	Unit of external sensor	
20-12	Reference/Feedback Unit	Unit of external sensor	
20-13	Minimum Reference/ Feedb.	Low limit of sensor	
20-14	Maximum Reference/ Feedb.	Upper limit of sensor	
20-21	Setpoint 1	Design setpoint	
20-93	PID Proportional Gain	Needs to be fine tuned on site	Start at 2
20-94	PID Integral Time	Needs to be fine tuned on site	Start at 1
22-43	Wake Up Speed [Hz]	Need to be fine tuned on site	Start at 20

6.3.2 CHANGE TO OPEN LOOP (BAS) CONTROL

1 Change parameter 0-10 from 1 to 3

2 Connect the BAS command on terminals 53 (+) and 55 (-)

3 Move switch S201 (beside terminal input 53) to ON if the speed command is 4-20mA, or leave it OFF if it's 0-10Vdc

4 If the reference signal is neither 0-10VDC nor 4-20mA, enter the correct voltage or input range in parameters 6-10 to 6-13

5 The maximum speed (at 20mA or 10VDC) can be adjusted in parameter 3-03

6 The drive ON/OFF status can be read as a dry contact between terminals 05 and 06

7 The drive alarm status can be read as a dry contact between terminals 01 and 02

8 Terminals 42(+) and 39(-) can provide a 0/4-20mA output which by default is disabled, but can be configured to provide speed feedback or sensorless flow

6.3.3 CHANGE TO SENSORLESS CONTROL

1 Change parameter 0-10 to 1

The unit will start controlling based on the pump design data

2 If the pump operation point needs to be changed, see the parameters that need to be modified in Section 6.1 Sensorless

7.0 WARNINGS AND ALARMS

A warning or an alarm is signalled by the relevant LED on the front of the inverter and indicated by a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances operation of the pump may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the inverter will have tripped. Alarms must be reset to restart operation once their cause has been rectified. In many cases the auto reset function will restart the pump. Alternatively, the **Reset** button on the control panel can
be pressed.

After a manual reset using the **Reset** button on the control panel, the **Auto On** button must be pressed to restart the pump.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also table on following page).

Alarms that are trip-locked offer additional protection, means that the mains supply must be switched off before the alarm can be reset. After being switched back on, the inverter is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in Par. 14-20 Reset Mode (Warning: automatic wake-up is possible!). If a warning and alarm is marked against a code in the table on the following page, this means that either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault. This is possible, for instance, in Par. 1-90 Motor Thermal Protection. After an alarm or trip,

the motor carries on coasting, and the alarm and warning flash on the inverter. Once the problem has been rectified, only the alarm continues flashing.

7.1 FAULT MESSAGES

WARNING 1, 10 Volts low:

The 10V voltage from terminal 50 on the control card is below 10V. Remove some of the load from terminal 50, as the 10V supply is over-loaded. Max. 15 mA or minimum 590 Ω.

WARNING/ALARM 2, Live zero error:

The signal on terminal 53 or 54 is less than 50% of the value set in Par. 6-10 Terminal 53 Low Voltage, Par. 6-12 Terminal 53 Low Current, Par. 6-20 Terminal 54 Low Voltage, or Par. 6-22 Terminal 54 Low Current respectively.

WARNING/ALARM 3, No motor:

No motor has been connected to the output of the inverter.

WARNING/ALARM 4, Mains phase loss:

A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears in case of a fault in the input rectifier on the inverter. Check the supply voltage and supply currents to the inverter.

WARNING 5, DC link voltage high:

The intermediate circuit voltage (DC) is higher than the overvoltage limit of the control system. The inverter is still active.

WARNING 6, DC link voltage low:

The intermediate circuit voltage (DC) is below the under voltage limit of the control system. The inverter is still active.

WARNING/ALARM 7, DC over voltage:

If the intermediate circuit voltage exceeds the limit, the inverter trips after a time.

WARNING/ALARM 8, DC under voltage:

If the intermediate circuit voltage (DC) drops below the "voltage warning low" limit, the inverter checks if 24V back-up supply is connected. If no 24V backup supply is connected, the inverter trips after a given time depending on the unit.

WARNING/ALARM 9, Inverter overloaded:

The inverter is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection gives a warning at 98% and trips at 100%, while giving an alarm. You cannot reset the inverter until the counter is below 90%.The fault is that the inverter is overloaded by more than nominal current for too long.

WARNING/ALARM 10, Motor ETR over temperature:

According to the electronic thermal protection (ETR), the motor is too hot. You can choose if you want the inverter to give a warning or an alarm when the counter reaches 100% in Par. 1-90 Motor Thermal Protection. The fault is that the motor is overloaded by more than nominal current for too long. Check that the motor Par. 1-24 Motor Current is set correctly.

WARNING/ALARM 11, Motor thermistor over temp:

The thermistor or the thermistor connection is disconnected. You can choose if you want the inverter to give a warning or an alarm in Par. 1-90 Motor Thermal Protection. Check that the thermistor is connected correctly between terminal 53 or 54 (analog voltage input) and terminal 50 (+ 10 Volts supply), or between terminal 18 or 19 (digital input PNP only) and terminal 50. If a KTY sensor is used, check for correct connection between terminal 54 and 55.

WARNING/ALARM 12, Torque limit:

The torque is higher than the value in Par. 4-16 Torque Limit Motor Mode (in motor operation) or the torque is higher than the value in Par.4-17 Torque Limit Generator Mode (in regenerative operation).

WARNING/ALARM 13, Over Current:

The inverter peak current limit (approx. 200% of the rated current) is exceeded. The warning will last approx. 8-12 sec., then the inverter trips and issues an alarm. Turn off the inverter and check if the motor shaft can be turned and if the motor size matches the inverter.

ALARM 14, Earth fault:

There is a discharge from the output phases to earth, either in the cable between the inverter and the motor or in the motor itself. Turn off the inverter and remove the earth fault.

ALARM 15, In-complete hardware:

A fitted option is not handled by the present control board (hardware or software).

ALARM 16, Short-circuit:

There is short-circuiting in the motor or on the motor terminals. Turn off the inverter and remove the short-circuit.

WARNING/ALARM 17, Control word timeout:

There is no communication to the inverter. The warning will only be active when Par. 8-04 Control Timeout Function is **not** set to **off**. If Par. 8-04 Control Timeout Function is set to Stop and Trip, a warning appears and the inverter ramps down to zero speed, while giving an alarm. Par. 8-03 Control Timeout Time could possibly be increased.

WARNING 22, Hoist Mech. Brake:

Report value will show what kind it is.0 = The torque REF. was not reached before timeout 1 = There was no brake feedback before timeout

WARNING 23, Internal fans:

External fans have failed due to defect hardware or fans not mounted.

WARNING 24, External fan fault:

The fan warning function is an extra protection function that checks if thefan is running / mounted. The fan warning can be disabled in Par.14-53 Fan Monitor, [0] Disabled.

WARNING 25, Brake resistor short-circuited:

The brake resistor is monitored during operation. If it short-circuits, the brake function is disconnected and the warning appears. The inverter still works, but without the brake function. Turn off the inverter and replace the brake resistor (see Par. 2-15 Brake Check).

ALARM/WARNING 26, Brake resistor power limit:

The power transmitted to the brake resistor is calculated as a percentage, as a mean value over the last 120 s, on the basis of the resistance value of the brake resistor (Par. 2-11 Brake Resistor (OHM)) and the intermediate circuit voltage. The warning is active when the dissipated braking power is higher than 90%. If Trip [2] has been selected in Par. 2-13 Brake Power Monitoring, the inverter cuts out and issues this alarm, when the dissipated braking power is higher than 100%.

WARNING/ALARM 27, Brake chopper fault:

The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and the warning comes up. The inverter is still able to run, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive. Turn off the inverter and remove the brake resistor. Warning: There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

ALARM/WARNING 28, Brake check failed:

Brake resistor fault: the brake resistor is not connected/working.

WARNING/ALARM 29, Drive over temperature:

If the enclosure is IP00, IP20/NEMA1 or IP21/TYPE 1, the cut-out temperature of the heat-sink is 203°F +9°F (95°C +5°C). The temperature fault cannot be reset, until the temperature of the heat sink is below 158°F (70°C). The fault could be:- Ambient temperature too high-Too long motor cable

ALARM 30, Motor phase u missing:

Motor phase u between the frequency converter and the motor is missing. Turn off the frequency converter and check motor phase u.

ALARM 31, Motor phase v missing:

Motor phase V between the inverter and the motor is missing. Turn off the inverter and check motor phase V.

ALARM 32, Motor phase w missing:

Motor phase W between the inverter and the motor is missing. Turn off the frequency converter and check motor phase w.

ALARM 33, Inrush fault:

Too many power UPS have occurred within a short time period.

WARNING/ALARM 34, Fieldbus

COMMUNICATION FAULT:

The fieldbus on the communication option card is not working

WARNING/ALARM 36, Mains failure:

This warning/alarm is only active if the supply voltage to the inverter is lost and Par. 14-10 Mains Failure is **not** set to **off**. Possible correction: check the fuses to the frequency converter

WARNING/ALARM 37, Phase Imbalance:

There is a current imbalance between the power units.

ALARM 38, Internal fault:

Contact your local Armstrong supplier.

ALARM 39, Heatsink Sensor:

No feedback from the heatsink sensor.

WARNING 40, Overload of Digital Output Terminal 27:

Check the load connected to terminal 27 or remove short-circuit connection. Check Par. 5-00 Digital I/O Mode and Par. 5-01 Terminal 27 Mode.

WARNING 41, Overload of Digital Output Terminal 29:

Check the load connected to terminal 29 or remove short-circuit connection. Check Par. 5-00 Digital I/O Mode and Par. 5-02 Terminal 29 Mode.

WARNING 42, Overload of Digital Output On x 30/6 :

Check the load connected to x 30/6 or remove short-circuit connection. Check Par. 5-32 Term X 30/6 Digi Out (MCB 101).

WARNING 42, Overload of Digital Output On x 30/7 :

Check the load connected to x 30/7 or remove short-circuit connection. Check Par. 5-33 Term x 30/7 Digi Out (MCB 101).

ALARM 46, Pwr. card supply:

The supply on the power card is out of range.

WARNING 47, 24 V supply low:

The external 24 V DC backup power supply may be overloaded, otherwise contact your Armstrong supplier.

ALARM 48, 1.8 V supply low:

Contact your Armstrong supplier.

WARNING 49, Speed limit:

The speed has been limited by range in Par. 4-11 Motor Speed Low Limit [RPM] and Par. 4-13 Motor Speed High Limit [RPM].

ALARM 50, AMA calibration failed:

Contact your Armstrong supplier.

ALARM 51, AMA check Unom and Inom:

The setting of motor voltage, motor current, and motor power is presumably wrong. Check the settings.

ALARM 52, AMA low Inom:

The motor current is too low. Check the settings.

ALARM 53, AMA motor too big:

The motor is too big for the AMA to be carried out.

ALARM 54, AMA motor too small:

The motor is too small for the AMA to be carried out.

ALARM 55, AMA par. out of range:

The Par. values found from the motor are outside acceptable range.

ALARM 56, AMA interrupted by user:

The AMA has been interrupted by the user.

ALARM 57, AMA timeout:

Try to start the AMA again a number of times, until the AMA is carried out. Please note that repeated runs may heat the motor to a level where the resistance RS and RR are increased. In most cases, however, this is not critical.

WARNING/ALARM 58, AMA internal fault:

Contact your Armstrong supplier.

WARNING 59, Current limit:

The current is higher than the value in Par. 4-18 Current Limit.

WARNING 60, External Interlock:

External Interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for External Interlock and reset the inverter (via BUS, Digital I/O or by pressing **Reset**).

WARNING/ALARM 61, Tracking Error:

Tracking error. Contact your supplier.

WARNING 62, Output Frequency at Maximum Limit:

The output frequency is limited by the value set in Par. 4-19 MAX Output Frequency

WARNING 64, Voltage Limit:

The load and speed combination demands a motor voltage higher than the actual DC link voltage.

WARNING/ALARM/TRIP 65, Control Card Over Temperature:

Control card over temperature: The cut-out temperature of the control card is 176°F (80°C).

WARNING 66, Heatsink Temperature Low:

The heat sink temperature is measured as 32°F (0°C). This could indicate that the temperature sensor is defective and thus the fan speed is increased to the maximum in case the power part or control card is very hot. If the temperature is below 59°F (15°C) the warning will be present.

ALARM 67, Option Configuration has Changed:

One or more options has either been added or removed since the last power-down.

ALARM 68, Safe Stop:

Safe Stop has been activated. To resume normal operation, apply 24 V DC to terminal 37 then send a Reset signal (via BUS, Digital I/O or by pressing **Reset**).

ALARM 69, Pwr. Card Temp:

Power card over temperature.

ALARM 70, Illegal Frequency Converter Configuration:

Actual combination of control board and power board is illegal.

ALARM 90, Feedback Mon.:

ALARM 91, Analogue Input 54 Wrong Settings:

Switch S202 has to be set in position **OFF** (voltage input), when a KTY sensor is connected to the analogue input terminal 54.

ALARM 92, No Flow:

A no load situation has been detected for the system. See parameter group 22-2*.

ALARM 93, Dry Pump:

A no flow situation and high speed indicates that the pump has run dry. See parameter group 22-2*.

ALARM 94, End of Curve:

Feed back stays lower than the set point, which may be indicates a leak-age in the pipe system. See parameter group 22-5*.

ALARM 95, Broken Belt:

Torque is below the torque level set for no load indicating a broken belt. See parameter group 22-6*.

ALARM 96, Start Delayed:

Start of the motor has been delayed due to short cycle protection is ac-tive. See parameter group 22-7*.

ALARM 250, New Spare Part:

The power or Switch Mode Power Supply has been exchanged. The inverter type code must be restored in the EEPROM. Select the correct type code in Par. 14-23 Type code Setting according to the label on unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New Type Code:

The frequency converter has got a new type code.

8.0 ACOUSTIC NOISE AND VIBRATION

If the pump or the pipework close to the pump is making noise or vibrations at certain frequencies, try the following:

- Speed Bypass, parameters 4-6*
- Over-modulation, parameter 14- 03 set to **OFF**
- Switching pattern and frequency parameters 14-0*
- Resonance Dampening, parameter 1-64

TABLE 1 Alarm/warning code list

NO.	DESCRIPTION	WARNING	ALARM /TRIP	ALARM /TRIP LOCK	PARAMETER REFERENCE
1	10 volts low	x			
2	Live zero error	(x)	(x)		Par. 6-01 **Live Zero Time-out Function**
3	No motor	(x)			Par. 1-80 **Function at Stop**
4	Mains phase loss	(x)	(x)	(x)	Par. 14-12 **Function at Mains Imbalance**
5	DC link voltage high	x			
6	DC link voltage low	x			
7	DC over voltage	x	x		
8	DC under voltage	x	x		
9	Inverter overloaded	x	x		
10	Motor ETR over temperature	(x)	(x)		Par. 1-90 **Motor Thermal Protection**
11	Motor thermistor over termperature	(x)	(x)		Par. 1-90 **Motor Thermal Protection**
12	Torque limit	x	x		
13	Over current	x	x	x	
14	Earth fault	x	x	x	
15	Incomp. HW		x	x	
16	Short circuit		x	x	
17	Control word timeout	(x)	(x)		Par. 8-04 **Control Time-out Function**
23	Internal fans				
24	External fans				
25	Brake resistor short circuited	x			
26	Brake resistor power limit	(x)	(x)		Par. 2-13 **Brake Power Monitoring**
27	Brake chopper short circuited	x	x		
28	Brake check	(x)	(x)		Par. 2-15 **Brake Check**
29	Power board over temp	x	x	x	
30	Motor phase U missing	(x)	(x)	(x)	Par. 4-58 **Missing Motor Phase Function**

NO.	DESCRIPTION	WARNING	ALARM/TRIP	ALARM/ TRIP LOCK	PARAMETER REFERENCE
31	Motor phase V missing	(x)	(x)	(x)	Par. 4-58 **Missing Motor Phase Function**
32	Motor phase W missing	(x)	(x)	(x)	Par. 4-58 **Missing Motor Phase Function**
33	Inrush fault		x	x	
34	Fieldbus communication fault	x	x		
36	Mains failure				
38	Internal fault		x	x	
40	Overload T27				
41	Overload T29				
42	Overload X30/6-7				
47	24V supply low	x	x	x	
48	1.8V supply low		x	x	
49	Speed limit				
50	AMA calibration failed		x		
51	AMA check U_{nom} and I_{nom}		x		
52	AMA low I_{nom}		x		
53	AMA motor too big		x		
54	AMA motor too small		x		
55	AMA parameter out of range		x		
56	AMA interrupted by user		x		
57	AMA timeout		x		
58	AMA internal fault	x	x		
59	Current limit	x			
60	External interlock				
62	Output frequency at maximum limit	x			
64	Voltage limit	x			
65	Control board-over temperature	x	x	x	
66	Heat sink temperature low	x			
67	Option configuration has changed		x		
68	Safe stop activated		x		
70	Illegal FC configuration				
80	Drive initialized to Default Value		x		
92	No-flow	x	x		Par. 22-2*
93	Dry pump	x	x		Par. 22-2*
94	End of curve	x	x		Par. 22-5*
95	Broken belt	x	x		Par. 22-6*
96	Start delayed	x			Par. 22-7*
97	Stop delayed	x			Par. 22-7*
98	Clock fault	x			Par. 0-7*

TABLE 2 IVS 102 parameter settings

	PAR.	NAME	SETUP 1 (SENSORLESS)	SETUP 2 (EXTERNAL SENSOR)	SETUP 3 (EXTERNAL BMS)
OPERATION/ DISPLAY	0-20	Display line 1.1 small	Frequency [Hz, #1613]	Frequency [Hz, #1613]	Frequency [Hz, #1613]
	0-21	Display line 1.2 small	Power (kW , #1610)	Power (kW , #1610)	Power (kW , #1610)
	0-22	Display line 1.3 small	Current [A, #1614]	Current [A, #1614]	Current [A, #1614]
	0-23	Display line 2 large	Feedback [unit, #1652]	Feedback 1 [unit]	Feedback 1 [unit]
	0-24	Display line 3 large	Sensorless readout [#1850]	Sensorless readout	[0] None
LOAD AND MOTOR	1-00	Configuration mode	Closed loop	Closed loop	Open loop
	1-03	Torque characteristics	Variable torque	Variable torque	Variable torque
	1-21	Motor power [hp]	Motor nameplate power	Motor nameplate power	Motor nameplate power
	1-22	Motor voltage	Motor nameplate volts	Motor nameplate volts	Motor nameplate volts
	1-23	Motor frequency	60 or 50 per nameplate	60 or 50 per nameplate	60 or 50 per nameplate
	1-24	Motor current	FLA per nameplate	FLA per nameplate	FLA per nameplate
	1-25	Motor nominal speed [rpm]	Motor nameplate speed	Motor nameplate speed	Motor nameplate speed
	1-73	Flying start	Enabled	Enabled	Enabled
BRAKES	2-17	Over-voltage control	Enabled	Enabled	Enabled
REFERENCE/ RAMPS	3-02	Minimum reference	0	Not used	0
	3-03	Maximum reference	Hdesign [in unit of mapped perf data]	Not used	Max frequency of app (50 or 60Hz)
	3-15	Reference 1 source	[0] No function	[0] No function	Analog input 53
	3-16	Reference 2 source	[0] No function	[0] No function	[0] No function
	3-17	Reference 3 source	[0] No function	[0] No function	[0] No function
	3-41	Ramp up time	Desired ramp time (60s typical)	Desired ramp time (60s typical)	Desired ramp time (60s typical)
	3-42	Ramp down time	Desired ramp time (60s typical)	Desired ramp time (60s typical)	Desired ramp time (60s typical)
LIMITS/ WARNINGS	4-10	Motor speed direction	Clockwise	Clockwise	Clockwise
	4-11	Motor speed low limit [rpm]			
	4-12	Motor speed low limit [Hz]	Min frequency of application	Min frequency of application	Min frequency of application
	4-13	Motor speed high limit [rpm]			
	4-14	Motor speed high limit [Hz]	Max frequency of application	Max frequency of application	Max frequency of application
	4-16	Torque limit mode(%)	100	100	100
	4-18	Current limit(%)	Leave at default (110) or increase if motor has difficulty starting. Do not set beyond S.F.X 100.		
DIGITAL IN/OUT	5-01	Terminal 27 mode	Input	Input	Input
	5-10	Terminal 18 digital input	Start	Start	Start
	5-11	Terminal 19 digital input	[0] No operation	[0] No operation	[0] No operation
	5-12	Terminal 27 digital input	Depends if float switch is req'd	[0] No operation	Run Permissive
	5-13	Terminal 29 digital input	Jog	Jog	Jog
	5-14	Terminal 32 digital input	[0] No operation	[0] No operation	[0] No operation
	5-15	Terminal 33 digital input	[0] No operation	[0] No operation	[0] No operation
	5-16	Terminal x30/2 digital input	[0] No operation	[0] No operation	[0] No operation
	5-17	Terminal x30/3 digital input	[0] No operation	[0] No operation	[0] No operation
	5-18	Terminal x30/4 digital input	[0] No operation	[0] No operation	[0] No operation
	5-40	Function relay 1	[0] No operation	[0] No operation	Alarm
	5-40	Function relay 2	[0] No operation	[0] No operation	Running

	PAR.	NAME	SETUP 1 (SENSORLESS)	SETUP 2 (EXTERNAL SENSOR)	SETUP 3 (EXTERNAL BMS)
ANALOG IN/OUT	6-00	Live zero timeout time	Not used	1s	Not used
	6-01	Live zero timeout function	Not used	Stop	Not used
	6-10	Terminal 53 low voltage	Not used	Not used	0.07
	6-11	Terminal 53 high voltage	Not used	Not used	10
	6-12	Terminal 53 low current	Not used	Not used	4
	6-13	Terminal 53 high current	Not used	Not used	20
	6-14	Terminal 53 low ref./feedb. value	Not used	Not used	0
	6-15	Terminal 53 high ref./feedb. value	Not used	Not used	60
	6-20	Terminal 54 low voltage	Not used	0.07	Not used
	6-21	Terminal 54 high voltage	Not used	10	Not used
	6-22	Terminal 54 low current	Not used	4	Not used
	6-23	Terminal 54 high current	Not used	20	Not used
	6-24	Terminal 54 low ref./feedb. value	Not used	Minimum sensor value	0
	6-25	Terminal 54 high ref./feedb. value	Not used	Maximum sensor value	60
	6-50	Terminal 42 output	[0] No operation	[0] No operation	[0] No operation
COMMUNICATION AND OPTION	8-30	Protocol	FC, MC	Depends on controller	Depends on controller
	8-31	Address	1	Depends on controller	Depends on controller
	8-32	Baud rate	9600	Depends on controller	Depends on controller
	8-33	Parity/stop bits	Even Prity, 1 Stop bit	Depends on controller	Depends on controller
SPECIAL FUNCTIONS	14-10	Mains failure	[0] No function	[0] No function	[0] No function
	14-11	Main voltage at mains fault	Set to 83.5% of site voltage	Set to 83.5% of site voltage	Set to 83.5% of site voltage
	14-12	Function at mains imbalance	[0] No function	[0] No function	[0] No function
	14-60	Function at over temperature	[1] Derate	[1] Derate	[1] Derate
	14-61	Function at inverter overload	[1] Derate	[1] Derate	[1] Derate
	14-62	Inverter overload derate current (%)	95	95	95
DRIVE CLOSED LOOP	20-00	Feedback 1 source	Sensorless pressure	Analog input 54	[0] No function
	20-02	Feedback 1 source unit	Unit used for feedback 1 source	Unit of external sensor	[0] No function
	20-12	Reference/feedback unit	Unit of par 2021 (ex: ft WG)	Unit of external sensor	[0]
	20-13	Minimum reference/feedb.		Low limit of sensor	Not used
	20-14	Maximum reference/feedb.	Max of head and flow mapped	Upper limit of sensor	Not used
	20-20	Feedback function	Minimum	Minimum	Not used
	20-21	Setpoint 1	Design head in unit in par 2012	Design setpoint	Not used
	20-60	Sensorless unit	Unit of par 1850 (ex: GPM)	not used	Not used
	20-70	Closed-loop type	Not used	Fast pressure	Not used
	20-71	PID performance	Not used	Normal	Not used
	20-93	PID proportional gain	Start at 0.05	Needs to be fine tuned on site	Not used
	20-94	PID integral time	Start at 0.1	Needs to be fine tuned on site	Not used
APPLICATION FUNCTIONS	22-43	Wake up speed [Hz]	Not used	Need to be fine tuned on site	Not used
	22-50	End of curve function	Off	Off	Off
	22-80	Flow compensation	[1] Enabled	Not used	[0] Disabled
	22-81	Square-linear curve approximation	100%	Not used	100%
	22-84	Speed at no-flow [Hz]	Not used	Freq. at no flow and min head set	Not used
	22-86	Speed at design point [Hz]	Not used	Not used	Not used
	22-87	Pressure at no-flow speed	40% of maximum system head	Not used	Not used
	22-89	Flow at design point	Flow at design point	Not used	Not used

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