

Design Envelope 4200H & 4280 End Suction Horizontal Pumping Units

Installation and operating instructions

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1.0 INTRODUCTION

This document contains specific information regarding the safe installation, operating and maintenance of the Armstrong Design Envelope pumps and should be read and understood by installing, operating and maintenance personnel. The equipment supplied has been designed and constructed to be safe and without risk to health and safety when properly installed, operated and maintained. The instructions following must be strictly adhered to. If clarification is needed on any point please contact Armstrong quoting the equipment serial number.

1.1 INSTRUCTIONS FOR SAFE USE

 No installation of this equipment should take place unless this document has been studied and understood. Handling, transportation and installation of this equipment should only undertaken by trained personnel with proper use of lifting equipment. See later diagrams for lifting advice. Refer to the pump nameplate for pump speed, pressure and temperature limitations. The limits stated must not be exceeded without written permission from Armstrong.

1.2 TEMPERATURE

 Install the unit with adequate access for routine maintenance. Adequate space, particularly at the fan inlet 2" (50 mm), is necessary to facilitate airflow. Where several units are installed in close proximity, care must be taken to ensure that there is no re-circulation of exhausted warm air.

Where under normal operating conditions the limit of 68°C/155°F (Restricted Zone) for normal touch, or 80°C/176°F (Unrestricted Zone) for unintentional touch, may be experienced, steps should be taken to minimize contact or warn operators/users that normal operating conditions will be exceeded. In certain cases where the temperature of the pumped liquid exceeds the above stated temperature levels, pump casing temperatures may exceed 100°C/212°F and not withstanding pump insulation techniques appropriate measures must be taken to minimize risk for operating personnel. The ambient temperature for standard motors must be no greater than 40°C/104°F.

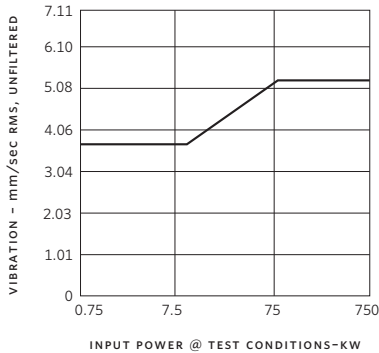
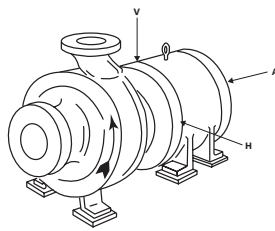
1.3 NOISE LEVELS

Typical Pumping Unit Sound Pressure Level, Decibels, A-Weighted, at 1 m (3 ft.) from unit.

FRAME DESIGNATION	1500 RPM				3000 RPM			
	IVS102		TEFC		IVS102		TEFC	
	kw	db-a	kw	db-a	kw	db-a	kw	db-a
80	0.55-0.75	55	0.55-0.75	47	0.55-0.75	55	0.55-1.1	58
90	1.1-1.5	60	1.1-1.5	49	1.1-1.5	60	1.5-2.2	262
100	2.2	59	2.2	53	2.2	59		
100	3	62	3	53	3	62	3	64
112	4	64	4	54	4	63	4	66
132	5.5-7.5	62	5.5-7.5	60	5.5-7.5	62	5.5-7.5	69
160			11-15	63			11-18.5	74
180			18.5-22	65			22	75
200			30	65			30 -37	78
225			37-45	66			45	78
250			55	67			55	81
280			75-90	70			75-90	81

1.4 VIBRATION LEVELS

Armstrong end-suction horizontal pumps are designed to meet vibration levels set by Hydraulic Institute Standard HI Pump Vibration 9.6.4. Standard levels are as detailed below



1.5 STORAGE

Pumps not immediately placed into service, or removed from service and stored, must be properly prepared to prevent excessive rusting. Pump port protection plates must not be removed until the pump is ready to connect to the piping.

Rotate the shaft periodically (at least monthly) to keep rotating element free and bearings fully functional.

For long term storage (longer than three months), 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 buildup or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rust proofing 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.

1.6 UNCRATING

Armstrong pumping units 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 and hooks carefully so that stress will not be imposed on the integrated controller, 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.

1.7 HANDLING DESIGN ENVELOPE 4200H & 4280 PUMPING UNITS

Design Envelope pumping units Series DE 4200H end-suction base mounted & DE 4280 end-suction close coupled units bring the convenience of 'plug & play' units, involve integrated controls that are not delicate though do need more care during installation than standard pump and motor components and must be handled accordingly.

Spacer bars for lifting straps or chains, may be used to ensure the straps or chains do not exert pressure the pump and motor housings and really must be used, with extra care, around the controls housing. (See 1.7 figures below)

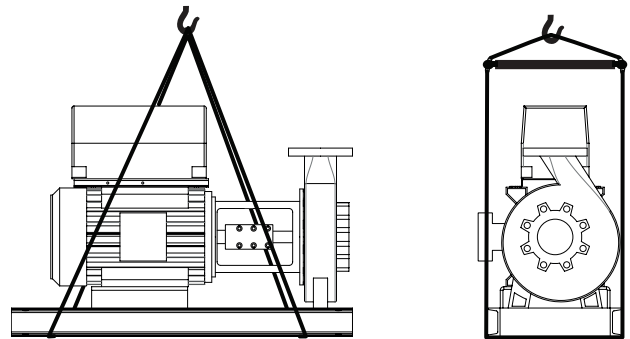


FIG 1.7.1 LIFTING HORIZONTAL DESIGN ENVELOPE PUMPS USING SPACER BEAMS

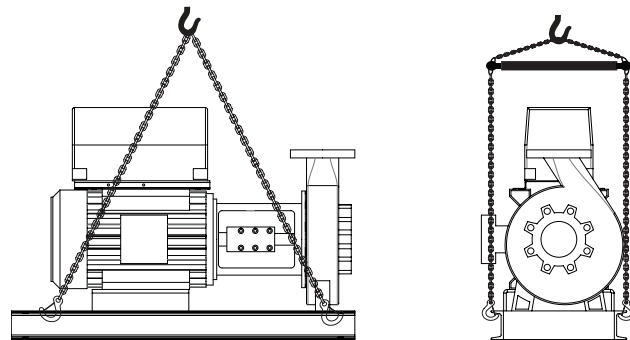


FIG 1.7.2 - LIFTING HORIZONTAL DESIGN ENVELOPE PUMPS USING BASE LIFTING HOLES

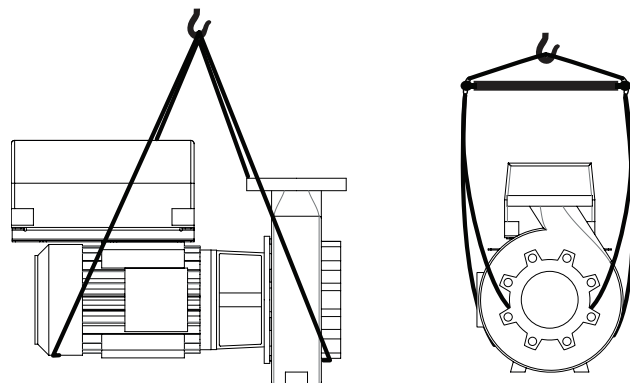


FIG 1.7.3 - LIFTING CLOSE COUPLED DESIGN ENVELOPE PUMPS

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.

2.0 INSTALLATION

2.1 LOCATION

In open systems, 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.

In closed systems, where possible, the pumps should be installed immediately downstream of the expansion tank /make-up connection. This is the point of zero pressure change and is necessary for effective pump operation. Do not install more than one expansion tank connection into any closed hydronic system. Electric motor driven pumps should not be located in damp or dusty location without special protection.

Airflow into the motor and/or motor fan should not be obstructed.

It is good practice to leave sufficient space around equipment for maintenance and service needs.

2.2 INSTALLATION

The following text and illustrations are offered as general suggestions for the preparation of a satisfactory foundation.

Foundation should be sufficiently substantial to absorb any vibration and permanently support the baseplate at all points. This is essential in maintaining the alignment of a direct coupled unit.

Horizontal Design Envelope units are inherently soft start and operate the majority of the time at lower than nominal speed. This means that the huge (About 3-times the weight of the pumping unit) inertia bases are not required and much more simple vibration isolation may be used.

If the unit is to be mounted on fabricated steel work or similar structure, the unit should be set over, or as near as possible to, the supporting beams or walls and to be so supported that the baseplate cannot be distorted by any yielding or springing of the structure or base.

The (4) corner holes should be used as a minimum. All (6) holes can be used on larger bases. Secure evenly spaced straps placed under the baseplate is also acceptable for lift-

ing the entire unit.

Horizontal Design Envelope pumping units are supplied with rigid split couplings (Design Envelope 4200H) or are close-coupled (Design Envelope 4280), as such no alignment is necessary in the field.

Place pumping unit on the foundation and insert metal wedges on either side of the foundation bolts under base plate. Leave approximately 0.75 ins (19mm) space if grouting.

Carefully level the unit by adjusting the wedges until base is supported in a level position

With the proper gauge, check suction and discharge flanges of the pump for proper positioning.

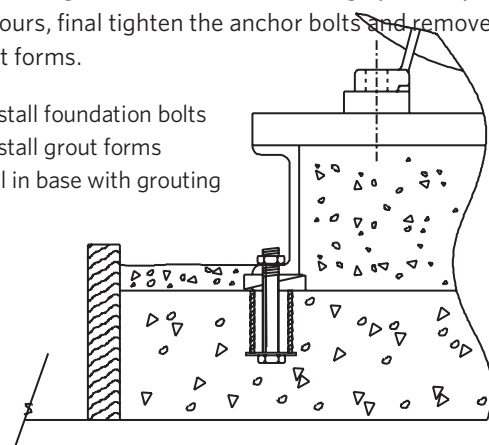
When the baseplate is completely level, the foundation bolts should be tightened evenly and firmly.

2.2.1 GROUTING

Armstrong's fabricated steel base plates, as supplied with 4200H Design Envelope pumps, are manufactured to ANSI/HI 1.3.5 rigidity standards for free-standing base plates. As such, no grouting in place is necessary for the base plate to hold shaft alignment of any Armstrong base mounted pumping unit. End-suction horizontal base mounted Design Envelope pumping units are supplied with rigid couplings which need no re-alignment at installation or following seal service. Thus grouting is not necessary; though the following instructions are for installers who still wish to also secure the base in place with grout:

- Construct a dam around the foundation with grout forms, as shown in the illustration.
- Use a good mixture of non-shrinking grout. The grout should be the consistency of heavy cream.
- Spaces are provided in the base plate to permit pouring of the cement and stirring. Fill under the base completely, stirring to assure proper distribution of the grout. Check to see that the grout flows under the base plate evenly.
- When the grout has hardened thoroughly, usually after 48 hours, final tighten the anchor bolts and remove the grout forms.

- Install foundation bolts
- Install grout forms
- Fill in base with grouting



2.3 PUMP PIPING – GENERAL

Never connect a pump to piping, unless extra care is taken to measure and align the piping flanges well. Always start piping from pump.

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

Ensure piping exerts no strain on pump as this could distort the casing causing breakage or early failure due to pump misalignment.

All connecting pipe flanges must be square to the pipework and parallel to the pump flanges.

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

Layout 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 effectively.

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. $\frac{1}{8}$ " (3 mm) diameter perforations in the strainer is typical.

In open systems, test suction line for air leaks before starting; this becomes essential with long suction line or static lift.

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

Install an isolation valve in both suction and discharge lines on flooded suction application; these valves are used primarily to isolate the pump for inspection or repair.

Install a non-slam non-return 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 on open systems. Armstrong Flo-Trex valves may be used in place of isolation valves and non-return check valves. Flo-Trex valves use plug & disk design which may also be used for throttling excessive system flow for constant speed pumps and, if necessary, for variable speed pumps. **Do not** throttle variable speed pumps unless absolutely necessary.

2.4 ALIGNMENT

Design Envelope 4200H units are accurately aligned at the factory prior to being shipped and do not need re-aligning when installed.

Alignment on a Design Envelope 4200H unit may be verified by assuring an equal and parallel gap between coupling halves on both sides of the coupling.

OPERATION

2.5 STARTING PUMP



Ensure that the pump turns freely by hand, or with some gentle mechanical help such as a strap or Allen key in the shaft hole or coupling bolt head.

Ensure that all protective guarding is securely fixed in position.

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. On Design Envelope 4200H any air trapped in the casing as the system is filled must be removed by the manual air vent in the seal flush line. **Ensure entrained air is removed from Design Envelope 4200H pumps, prior to starting, through the air vent on the seal flush line. Open vent until clear of air.**

Bump or energize the motor momentarily and check that the rotation corresponds with the directional arrow on the pump casing (clockwise when viewed from drive end.).

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.

Do not run the pump against a closed discharge valve for an extended period of time (a few minutes maximum.)



Check rotation arrow prior to operating the unit. The rotation of all Armstrong end-suction commercial pumping units is clock-wise when viewed from the drive end. (Looking from behind the motor).

2.6 GENERAL CARE

Armstrong end-suction commercial 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
- Keep moisture, refuse, dust or other loose particles away from the pump and cooling openings of the motor and controller.
- Avoid operating the unit in overheated surroundings (Above 100°F/40°C).

WARNING:



Whenever any service work is to be performed on a pumping unit, disconnect the power source to the driver, **lock it off** and tag with the reason. Any possibility of the unit starting while being serviced must be eliminated.

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 Armstrong files 43.85 and 43.86 for seal environmental instructions).

2.7 LUBRICATION

Pump

Lubrication is not required. There are no bearings in the pump that need external lubrication service.

Motor

Follow the lubrication procedures recommended by the motor manufacturer. Many small and medium sized motors are permanently lubricated and need no added lubrication. Generally if there are grease fittings evident the motor needs periodic lubrication. None if not.

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 fitted with a flush line. The seal is flushed from discharge of the pump casing on Design Envelope 4200H pumps.

The Design Envelope 4200H pump is flushed from the pump discharge because the mechanical seal chamber is isolated from the liquid in the pump by a throttle bushing. Because the seal chamber is isolated, seal environmental controls such as filters and separators, when installed in the Design Envelope 4200H flush line are very effective, as only the seal chamber needs cleansing, and 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.

Mechanical seals may 'weep' slightly at start-up. Allow the pump to continue operating for several hours and the mechanical seal to 'seat' properly prior to calling for service personnel.

The following Armstrong files are available for mechanical seal replacement instructions:

- Series 4300: TC Motor Frame – File 43.88
- Series 4380: File 43.81

2.8 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** Rotation **ok**?
- C** Lubrication **ok**?
- D** Pipe work properly supported?
- E** Voltage supply **ok**?
- F** Is the system clean?
- G** Is the area around the pump clean?

WARRANTY

Does not cover any damages to the equipment resulting from failure to observe the above precautions. Refer to Armstrong General Terms and Warranty sheet. Contact your local Armstrong representative for full information.

3.0 INTEGRATED CONTROLS

3.1 ENCLOSURE RATING



The standard enclosure rating for Design Envelope 4200H & 4280 integrated controls is IP55 for indoor applications. If the pump is to be installed in a wet or dusty environment then a higher enclosure rating may be required (contact Armstrong).

3.2 AMBIENT TEMPERATURE



To avoid the IVS102 unit getting overheated, the ambient temperature is not to exceed 133°F (45°C) average daily temperature. Operating in higher ambient temperatures will require derating of the inverter.

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 inverter 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/inverter 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 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 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 IVS102 name-plate. Please ensure that the unit is suitable for the electrical supply on which it is to be used. The mains supply for pumps is as follows:

1 × 200-240V ± 10%

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.


 Do not connect frequency converters with RFI-filters to mains supplies with a voltage between phase and ground of more than 440 v for 400 v converters and 760 v for 690 v converters. For 400 v IT mains and delta earth (grounded leg), mains voltage may exceed 440 v between phase and earth. For 690 v IT mains and delta earth (grounded leg), mains voltage may exceed 760 v between phase and earth.

FIG. 2 Terminals for mains and grounding

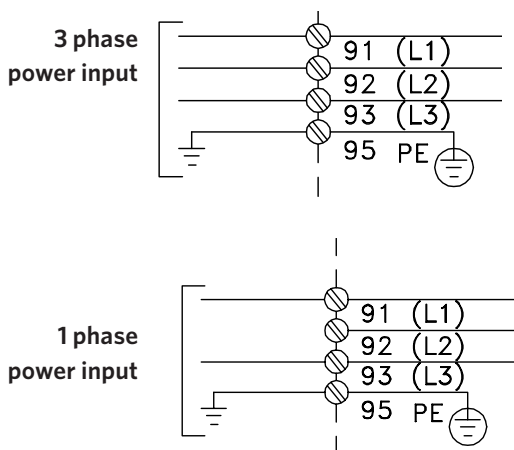


FIG. 3 Mains and grounding connections for A5 units (200-240V - 1.5HP 1PH/5HP and below 3PH, 380-480V/525-600V - 10HP and below)

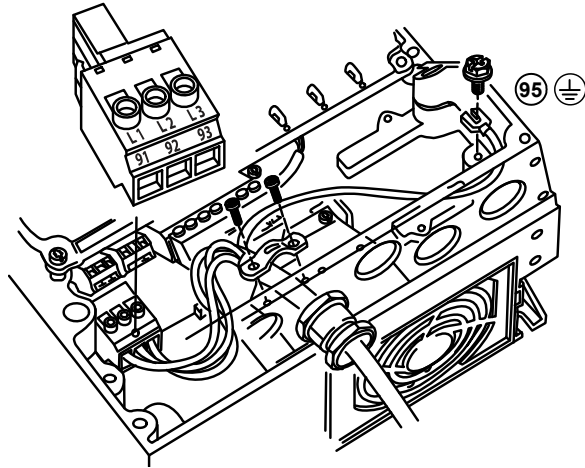


FIG. 4A Mains and grounding connections for B1 and B2 units (200-240V - 2 TO 7.5HP 1PH/7.5 TO 20HP 3PH, 380-480V - 15 TO 40HP, 525-600V - 15 TO 50HP)

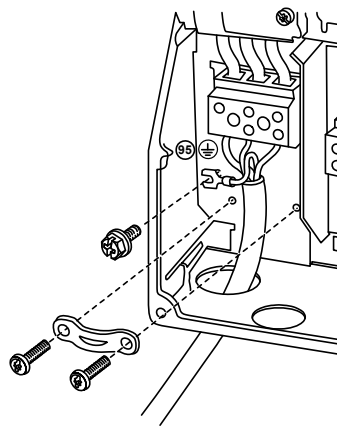


FIG. 4B Mains and grounding connections for C1 and C2 units (200-240V - 25 TO 60HP, 380-480V - 50 TO 125HP, 525-600V - 60 TO 125HP)

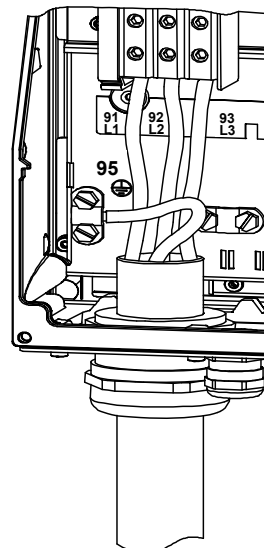


FIG. 4C Mains and grounding connections for D1 and D2 units (380-480V - 150 to 350HP, 525-600V - 150 to 350HP)

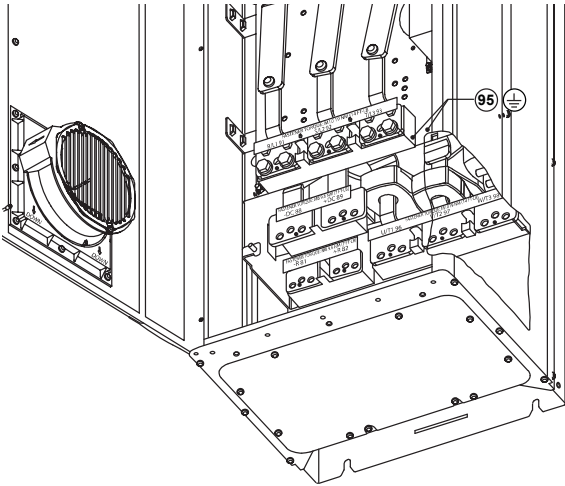


FIG. 6 Relay connection: terminals for A5, B1 and B2 units

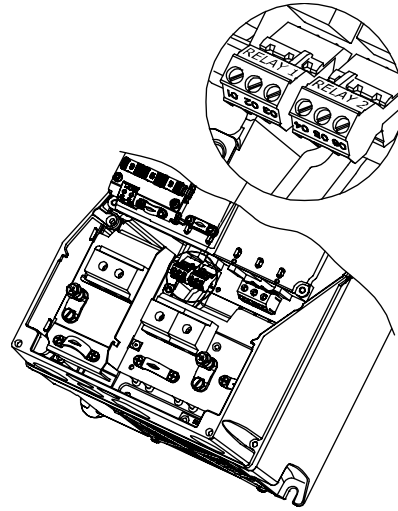
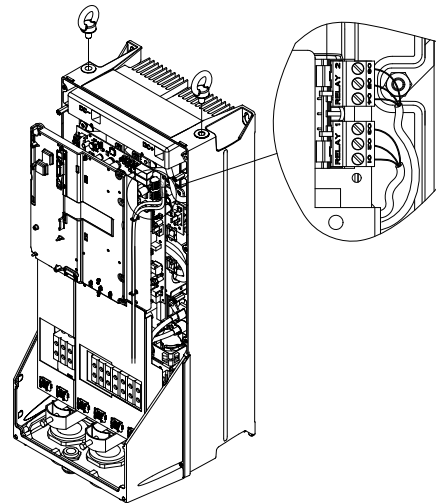


FIG. 7 Relay connection terminals for C1 and C2 units



4.7 RELAY CONNECTIONS

The relays on the are configured as follows:

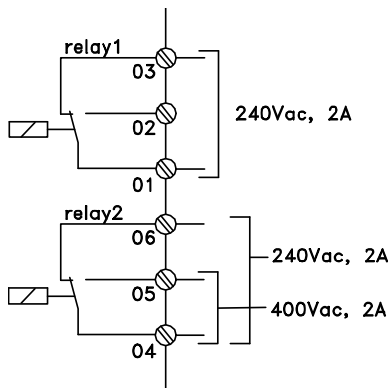
Relay 1 - RUNNING

- 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

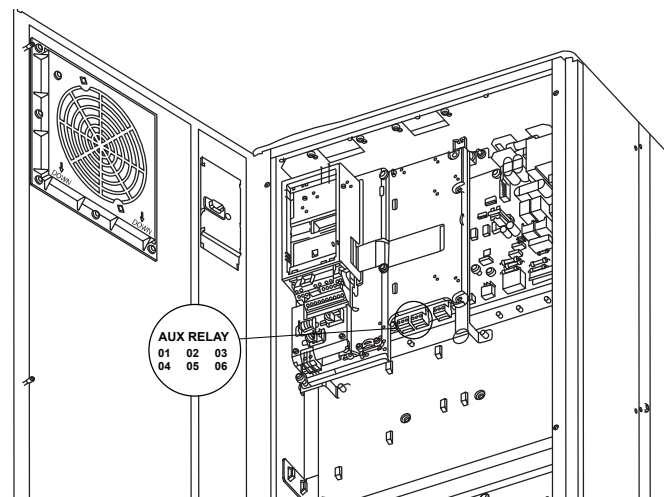
FIG. 5 Relay contact details



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:

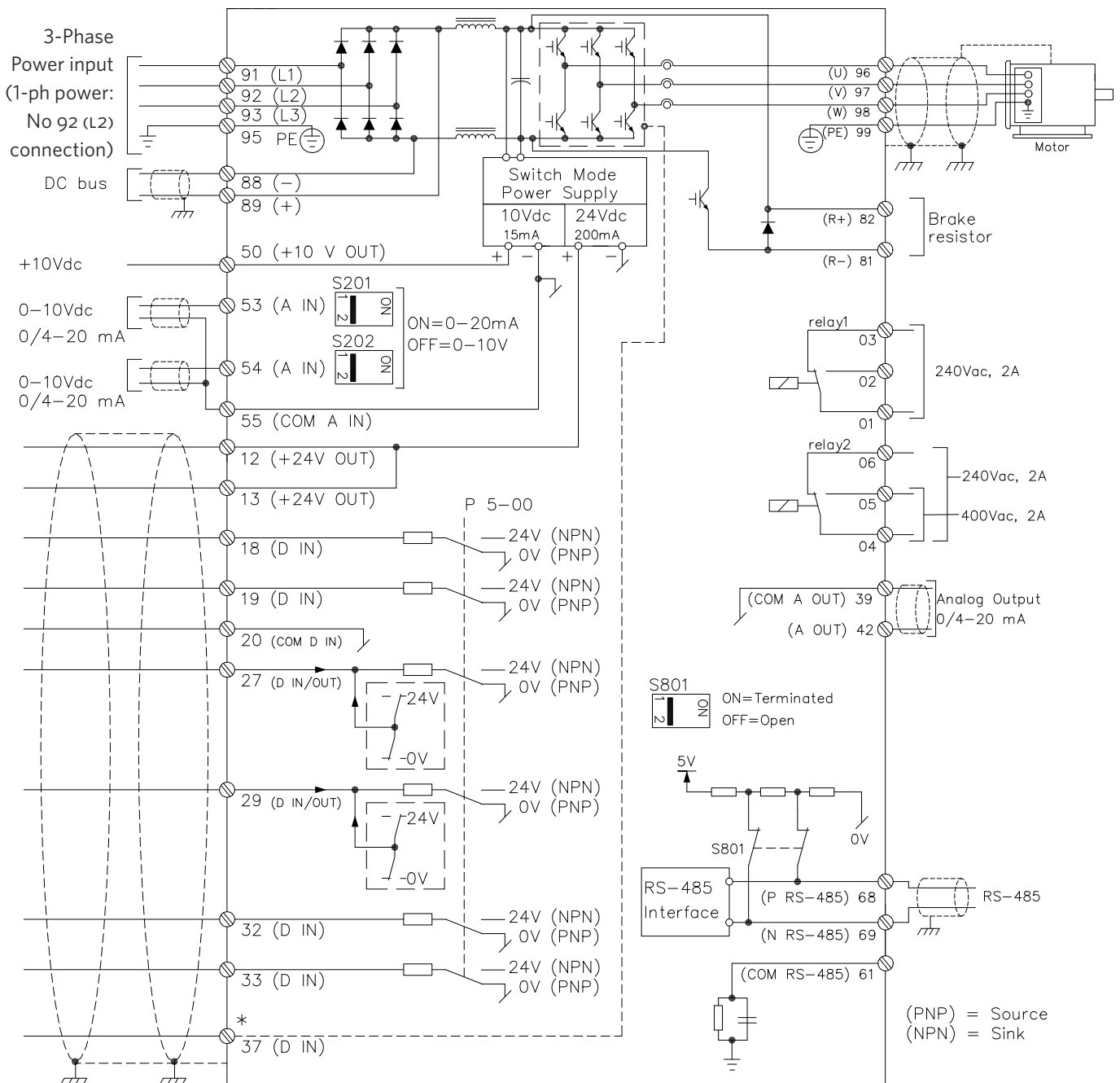
FIG. 8 Relay connection terminals for C1 and C2 units



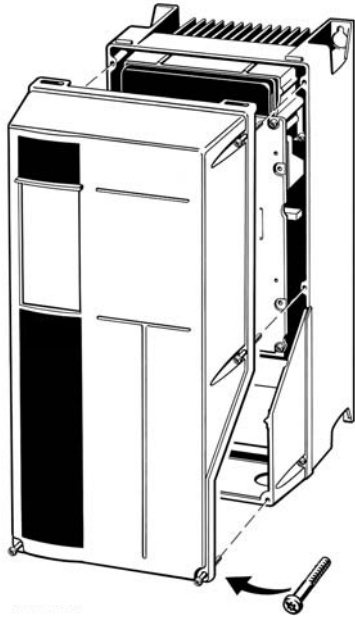
4.8 ELECTRICAL INSTALLATION AND CONTROL CONNECTIONS

FIG. 9 Diagram showing all electrical connections

*Note: terminal 37 is not available on sensorless pumps



4.8.1 ACCESS TO TERMINALS

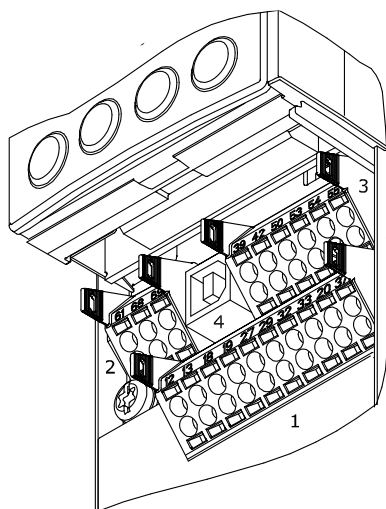


Remove front-cover to access control terminals. For D1 and D2 chassis units access swings open. (see Fig. 2.13). When replacing the front cover, please ensure proper fastening by applying a torque of 2 Nm.

4.8.2 CONTROL TERMINALS

With reference to figure 10:

FIG. 10 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

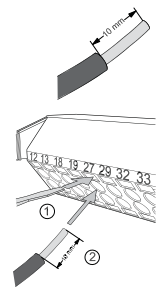
TERMINAL NO.	TYPE / DESCRIPTION	FACTORY SETTING
1, 2, 3	Relay 1	Running
4, 5, 6	Relay 2	Alarm
12	Supply	+24V DC
13	Supply	+24V DC
18	Digital Input	Start
19	Digital Input	Pump Operating Mode
20	Common	0v
27	Digital Input	Low Water Interlock
29	Digital Input	No Operation
32	Digital Input	No Operation
33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

*Note that Analogue inputs A153 and A154 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 9) are used to configure the analogue inputs as follows:

S201 (A153) OFF = Voltage, ON = Current
S202 (A154) 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.

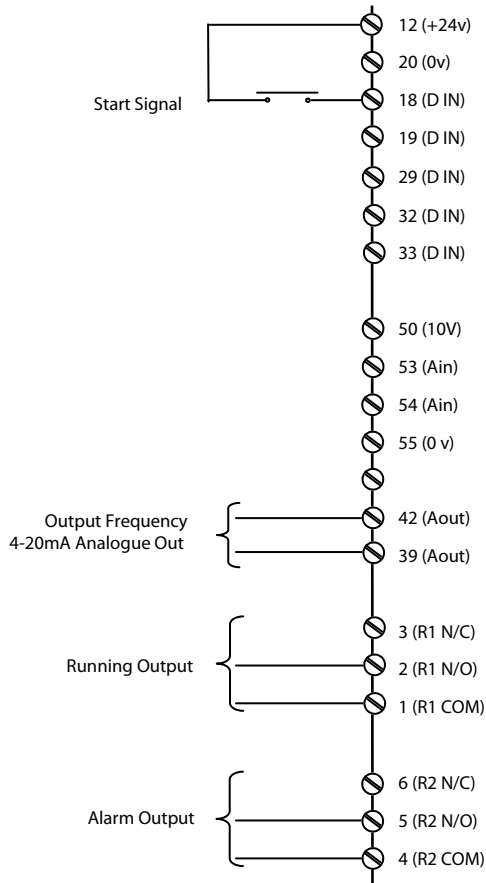
4.8.3 CONNECTION EXAMPLES

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

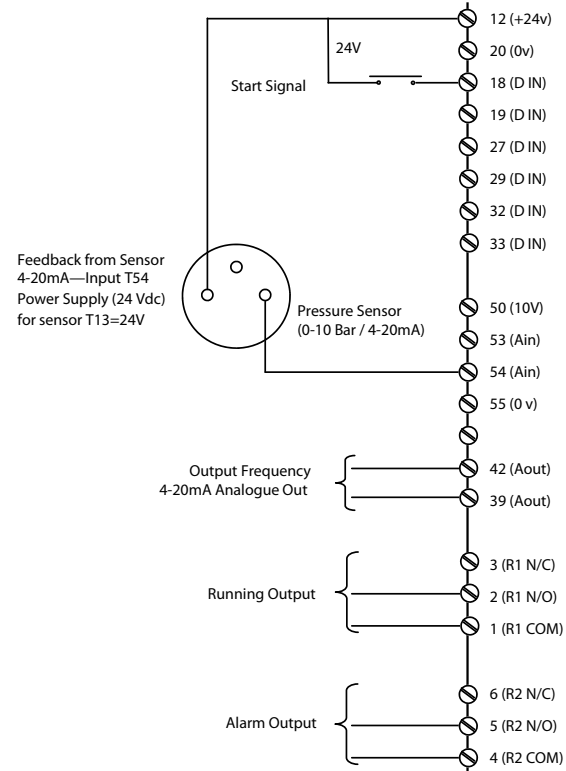
I SENSORLESS

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



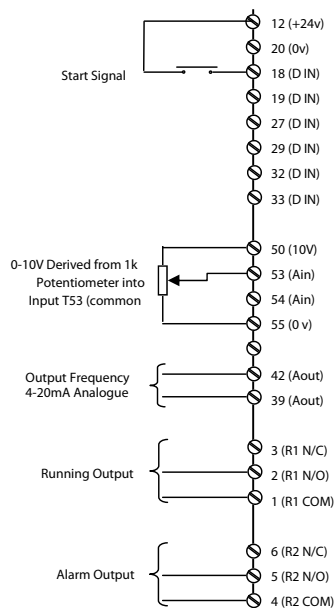
II CLOSED LOOP - WITH SENSOR FEEDBACK

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



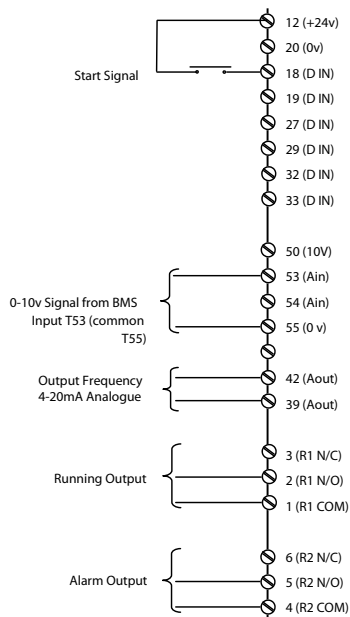
III CONSTANT CURVE MODE - POTENTIOMETER

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



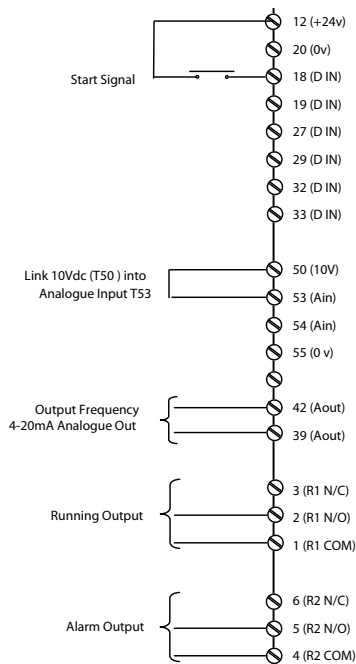
IV CONSTANT CURVE MODE - BMS SIGNAL

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.1 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.

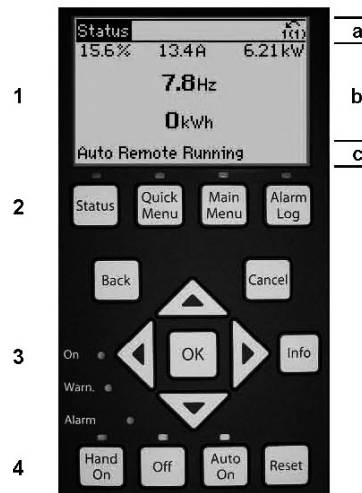


5 PROGRAMMING, MONITORING AND DIAGNOSTICS

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.

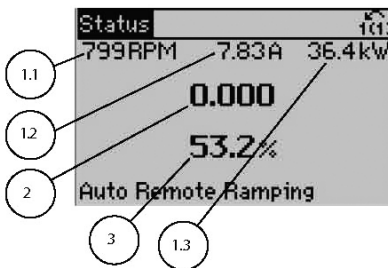
Operating variables with different formatting are shown in each status screen — see below.

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).

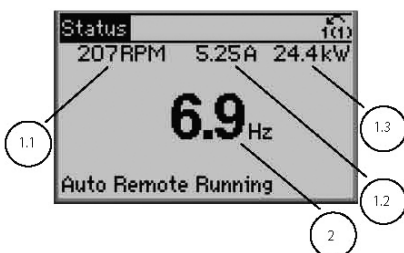
See the operating variables shown in the display in this illustration. 1.1,1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.



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 24 v 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.



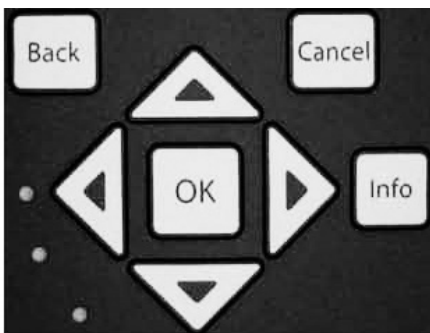
Navigation keys

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

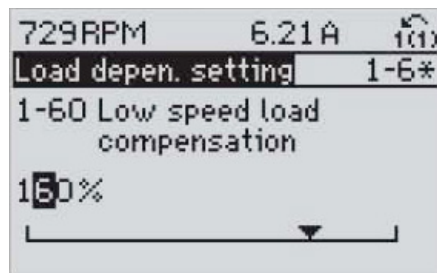
If the chosen parameter represents a numeric data value, change the chosen data value by means of the [◀] [▶] navigation keys as well as the [▲] [▼] navigation keys.



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.

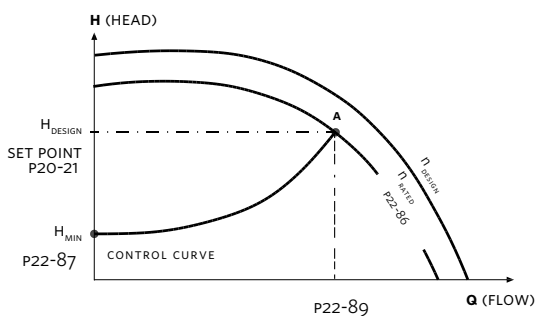
These measurements enable the pump to continuously identify the head and flow at any point in time, giving accurate pressure control without the need for external feedback signals. Patented software technology within the controller ensures trouble-free operation in all conditions.

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 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 and coil set, is the benchmark scheme for energy efficiency.

FIG. 11 QUADRATIC CONTROL SETTINGS



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.

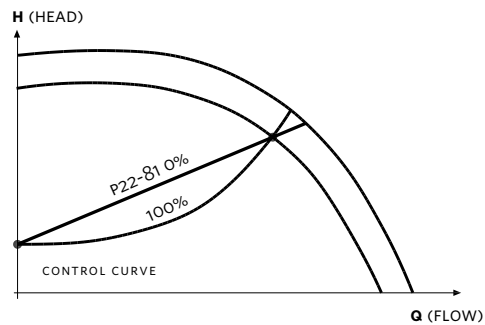
It is often found that using a remote differential pressure sensor to sense the pressure across a remote load could theoretically result in loads close to the pump being under-pumped. The situation would be where the load at a loop extremity

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 'Hmin'.

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 11 in column 1.

FIG. 12 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 11):

- 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 12.

6.2 CONSTANT PRESSURE CONTROL

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

- 1 To revert to this mode of control simply follow these steps:
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 (IPS/BAS/BMS) 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

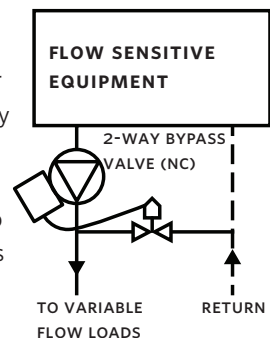
- 1 Change parameter 0-10 to 1
The unit will start controlling based on the pump design data
- 2 If the pump operation point needs to be changed, see the parameters that need to be modified in Section 6.1 Sensorless

6.4 SPECIAL APPLICATION PROCEDURES

6.4.1 2-WAY BYPASS VALVE CONTROL

Application

This configuration is ideal for systems with flow sensitive systems or equipment, down-stream of a 2-way (normally closed) system bypass valve. The valve will be opened and closed as system flow, which is also monitored by the controls, registers below or above a pre-set (adjustable) minimum flow value, using the built-in outputs and relays in the Design Envelope pumping unit on-board controls.



Operation

When system flow drops below a pre-set value, a digital output is energized to open the valve.

When system flow rises above the pre-set value, the digital output is de-energized to close the valve.

The relay will energize/de-energize depending on which pump is running in the duty/standby configuration.

Site requirements

- 1 Control valve already installed with wiring run to the pumps (but not terminated)
- 2 Enough space to remove the Duty and Standby controllers' covers safely

Personnel requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate simple control wiring
- 3 Ability to configure Armstrong controls
- 4 All work will be done on low voltage, however, when removing the controller cover high voltage may be exposed. An electrician license is required in some areas
- 5 Torx screw driver set

Wiring

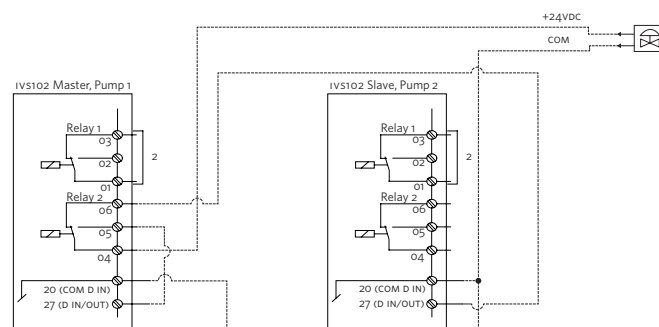
If Duty/Standby configuration, then the contact wires have to be wired to the Master controller. If it's unknown which controller is the Master controller, verify the settings of parameters 13-00 to 13-02.

The Master controller is the unit that has the following parameters configured as follows:

PARAMETER	NAME	VALUE
13-00	slc Controller mode	[1] On
13-01	Start event	[37] Digital input D132
13-02	Stop event	[26] Logic rule 0

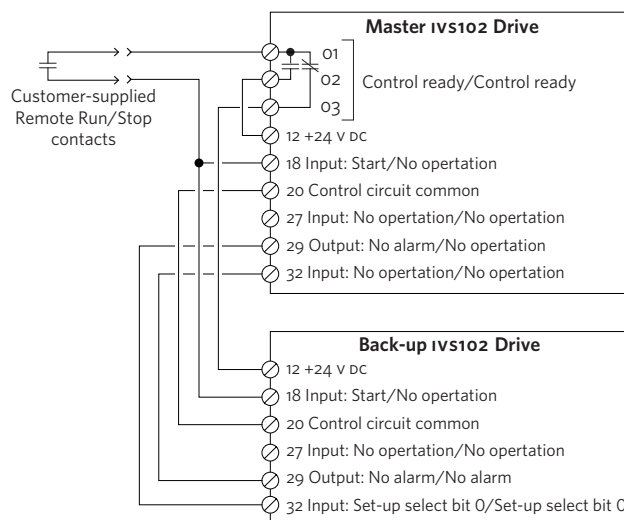
2 Way control valve wiring

- 1 Connect the **Positive** terminal of the control valve to the Master controller Relay 2 [Terminal 4].
- 2 Connect the **Common** terminal of the control valve to the com of the Master **And** Slave controller (If Applicable) [Terminal 20].
- 3 Connect Relay 2 [Terminal 6] on the Master controller to Digital Out [Terminal 27] on the Slave controller (If Applicable).
- 4 Connect Digital Out [Terminal 27] on the Master controller to Relay 2 [Terminal 5] on the Master controller.



Alternation wiring (if applicable)

- 1 As per the IVS102 Manual



Adjustable site parameters:

For Master controller:

PARAMETER NUMBER	PARAMETER VALUE		COMMENTS
	SETUP 1	SETUP 2	
13-12	Min. Sensorless flow		Minimum sensorless Flow value

For Slave controller: (If applicable)

PARAMETER NUMBER	PARAMETER VALUE		COMMENTS
	SETUP 1	SETUP 2	
13-12	Min. Sensorless flow		Minimum sensorless Flow value

Ensure flow is maintained during alternation

- 1 Tune the following parameters to ensure the system pressure doesn't drop below the minimum required (the threshold that opens the contact) during alternations. This has to be done on both controller and both should have the same final parameters.

2 Configure these parameters when the controller is running (Setup 1):

PARAMETER	NAME	SUGGESTED VALUE
3-41	Ramp up Time	15 sec

Configure this parameter when the controller is **not** running (Setup 2):

PARAMETER	NAME	SUGGESTED VALUE
3-42	Ramp Down time	120 sec

Testing

- 1 Place both controllers in Auto Mode.
- 2 Reduce the flow to the running pump until it reaches below the value in P13-12.
- 3 Verify the control valve starts to open.
- 4 Increase the flow to the running pump until it reaches above the value in P13-12.
- 5 Verify the valve starts to close.

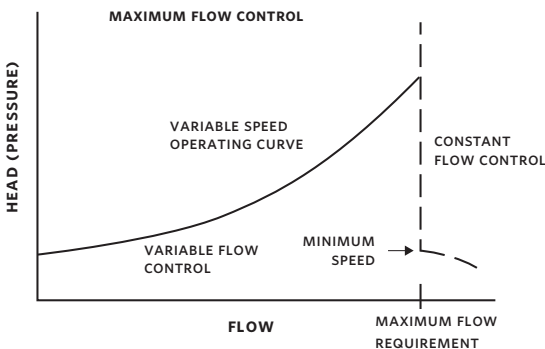
6.4.2 MAXIMUM FLOW CONTROL

Application

This configuration is ideal for HVAC hydronic systems where pumps are generally oversized and a flow limit is required for system equipment stability and resulting energy savings. This setup can be used in over-pumped systems, perhaps with a reverse acting differential pressure (DP) valve or systems with decoupling lines between primary and secondary systems.

Note that the flow limit can be maintained only to the speed limits of the controls. It is possible for a grossly oversized system head to pump more flow than the maximum required should the system curve fall below the minimum speed of the controls. A dry-contact relay will close when minimum speed is attained, which can be used for an alarm or other device.

This application is not compatible with other set-up switching applications, such as duty / standby control



Operation

When the system flow reaches a set point (Maximum flow - Design flow default), the controls will switch to Setup 2. Setup 2 is configured for Constant Flow operation set for maximum flow. If the system control valves continue to open, the controls will reduce pump speed to maintain maximum flow, resulting in lower pressure and energy usage. As system valves close the controls will increase pump speed until the pressure reaches a pre-set point in Setup 2 (Pump design head default), which will cause the controls to return to the variable flow control curve in Setup 1

Note: This application is not compatible with other applications that require switching between setups such as Duty / Standby operation

Personnel requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to configure Armstrong controls
- 3 All work will be done on low voltage, however, when removing the controller cover high voltage may be exposed. An electrician license is required in some areas

IVS102 Program adjustment

Adjust default parameters as indicated by the tables below. Cycle power to the controller **after** the parameters have been set.

PARAMETER NUMBER	PARAMETER VALUE		COMMENTS
	SETUP 1 (QUADRATIC)	SETUP 2 (MAX FLOW)	
13-12.0	Design Flow (Normally same as P22-89)	—	Maximum Flow value
13-12.2	—	Maximum Pressure Set point (Normally same as P20-21)	Maximum head value
20-21	Design Pressure (Unit specified in 20-12)	Design Flow (Unit specified in 20-12)	Set point 1
22-87	40% of maximum system head	—	Pressure at No-flow speed
22-89	Flow at Design Point	—	Flow at Design Point

Note: PID parameters may require adjusting.

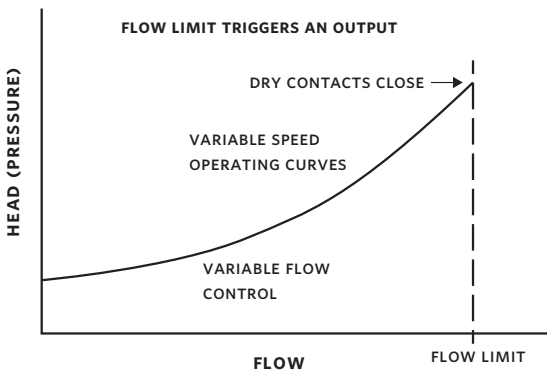
Testing

- 1 Adjust the system to increase the flow.
- 2 When the system flow has reached the Maximum Design Flow in parameter 13-12.1 in setup 1, ensure the controls switch to Setup 2.
- 3 Continue to open system valves and notice the flow remaining constant while the pressure decreases.
- 4 Reduce the load and notice the flow remains constant and the pressure increasing.
- 5 When the Maximum Pressure Set point in parameter 13-12.1 in setup 2 is reached, ensure the controls switch to setup 1

6.4.3 FLOW LIMIT BREACH CLOSES A DRY-CONTACT RELAY

Application

This configuration is designed for HVAC hydronic systems where pumps are generally oversized and a system flow limit breach knowledge is required for, perhaps, system equipment stability, resulting energy savings and/or valve control for flow sensitive equipment. This setup is ideal for use in systems sensitive to over-pumping, perhaps with a reverse acting differential pressure (DP) valve or systems with decoupling lines between primary and secondary systems.



Operation

The system flow is compared to a pre-entered maximum flow value (Trigger limit_Design flow default). When system flow exceeds the trigger limit, for a duration specified by parameter 5-51, Relay 1 will energize and the dry contacts will close. When the system flow falls below the trigger limit, for a duration specified by parameter 5-42, then Relay 1 will de-energized and the dry contact will open.

Personnel requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate simple control wiring
- 3 Ability to configure Armstrong controls

- 4 All work will be done on low voltage, however, when removing the controller cover high voltage may be exposed. An electrician license is required in some areas

Controls programming

Configure the IVS102 controls parameters, if required, as indicated by the tables below.

PARAMETER NUMBER	PARAMETER VALUE	COMMENTS
	SETUP 1	
13-12	Design flow default	Enter a flow at which you want the relay to trigger* for Comparator 0

Testing

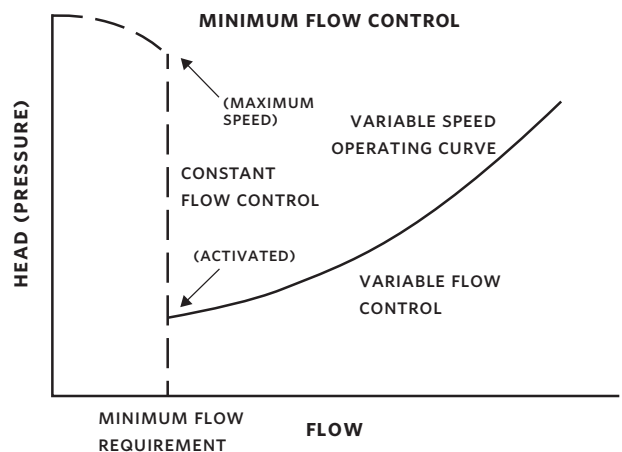
- 1 Open system valves to increase system flow.
- 2 When the system flow exceeds the design flow, ensure the IVS102 controller switches to Setup 2.
- 3 When system valves close and the system flow falls below the design flow, ensure the IVS102 controller returns to Setup 1

6.4.4 MINIMUM FLOW CONTROL

Application

This configuration is ideal for HVAC hydronic systems where a minimum flow limit is required for system equipment stability. This setup provides protection for flow sensitive system equipment, perhaps with a reverse acting differential pressure (DP) valve or systems with decoupling lines between primary and secondary systems

Note: Flow may drop below minimum requirements should demand continue to drop after the pump control has reached its maximum speed. For this scenario on-board controls will close a dry-contact relay when the maximum pump controlled speed is attained. The contact can be used to trigger an alarm or open a system bypass valve, etc. The contact will open when the speed drops below the maximum allowed.



Operation

When the system flow reaches a set point (minimum flow _ 15% of design flow default), the controls will switch to Setup 2. Setup 2 is configured for Constant Flow operation set for minimum flow. If the system control valves continue to close, the controls will increase pump speed to maintain minimum flow level, resulting in higher system pressure to the maximum allowable speed. As system valves open the controls will reduce pump speed until the pressure reaches a pre-set point in Setup 2, which will cause the controls to return to the variable flow control curve in Setup 1

Note: This application is not compatible with other applications that require switching between setups such as Duty/ Standby

Personnel requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate simple control wiring
- 3 Ability to configure Armstrong controls
- 4 All work will be done on low voltage, however, when removing the controller cover high voltage may be exposed. An electrician license is required in some areas

IVS102 Program adjustment

Adjust the parameters as indicated by the tables below. Cycle power to the controller after the parameters have been set.

PARAMETER NUMBER	PARAMETER VALUE		COMMENTS
	SETUP 1 (QUADRATIC)	SETUP 2 (MAX FLOW)	
13-12.0	Minimum flow set point	—	Minimum flow value
13-12.2	—	Pressure at minimum flow	Comparator 2 value
20-21	Design pressure	Minimum flow set point.	Selection design head (Set-up 1) - Min flow set point (Set-up 2)
22-87	40% of maximum system head	—	Pressure at No-flow speed
22-89	Flow at Design point	—	Flow at Design point

Note: PID parameters may require adjusting.

Testing

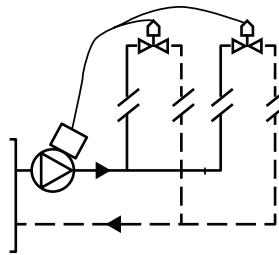
- 1 Adjust system valve to reduce the system flow.
- 2 When the system flow reaches the Minimum Design Flow in parameter 13-12.1 in setup 1, ensure the IVS102 controller switches to Setup 2.

- 3 Continue to close the system valves and notice the flow remaining constant while the pressure increases.
- 4 Open more system valves and notice the flow remains constant and the pressure dropping.
- 5 When the system pressure has reached the Minimum Pressure Set point in parameter 13-12.1 in setup 2, ensure the IVS102 controls switch to setup 1

6.4.5 MULTIPLE SENSOR CONTROL

Application (Single or duty / standby operation)

This configuration is designed for multi-zone HVAC systems where [max 2] system differential pressure (DP) feedback sensors are required for circulating pump speed control and zone flow stability. The system pump controls will ensure each sensor setting is maintained with as little over-pressure as feasible



Operation

For multi zone, multi set-point control for different pressures, each set-point must be specified. By selecting Multi set-point minimum, [5], in 20-20 Feedback Function, the IVS102 controller will increase the speed of the pump if either of the feedbacks is below its set-point and decrease the speed of the lowest error pump if both feedbacks are above their individual set-points

Site requirements

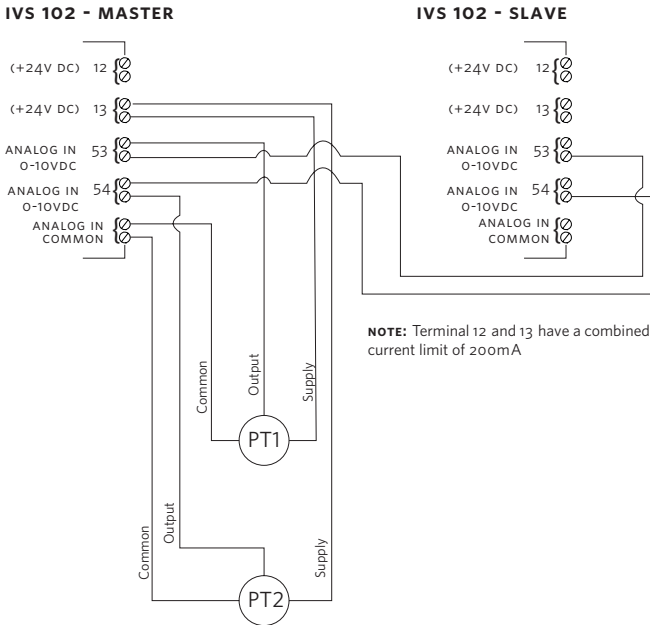
- 1 0-10VDC Pressure Transducers wired though not connected to the IVS102 controller
- 2 Enough space to remove the IVS102 controller cover safely

Personnel requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate simple control wiring
- 3 Ability to configure Armstrong controls
- 4 Wiring tools including Torx screw driver set
- 5 All work will be done on low voltage, however, when removing the IVS102 controller cover high voltage may be exposed. Follow and maintain all local safety standards and regulations

Wiring

Wire the two Pressure Transducers as shown below.



IVS102 controller programming

Set the parameters as indicated by the table below.

PARAMETER NUMBER	PARAMETER VALUE	COMMENTS
	SETUP 1	
6-14	minimum sensor measurement range	Terminal 53 Low Ref./ Feedback value
6-15	maximum sensor measurement range	Terminal 53 High Ref./ Feedback value
6-24	minimum sensor measurement range	Terminal 54 Low Ref./ Feedback value
6-25	maximum sensor measurement range	Terminal 54 High Ref./ Feedback value
20-02	Measurement unit of external sensor	Feedback 1 source unit
20-05	Measurement unit of external sensor	Feedback 2 source unit
20-20	[5] Multi setpoint minimum	Feedback function
20-21	Design setpoint for sensor 1	Setpoint 1
20-22	Design setpoint for sensor 2	Setpoint 2

Multiple [2] sensors with duty/standby configuration

For setup with Duty/Standby configuration, wire and program the controllers as per the 'Duty/Standby setup guide'. Wire the Pressure Transducers as shown in the diagram above. Program the additional parameters, specified above, to both controllers.

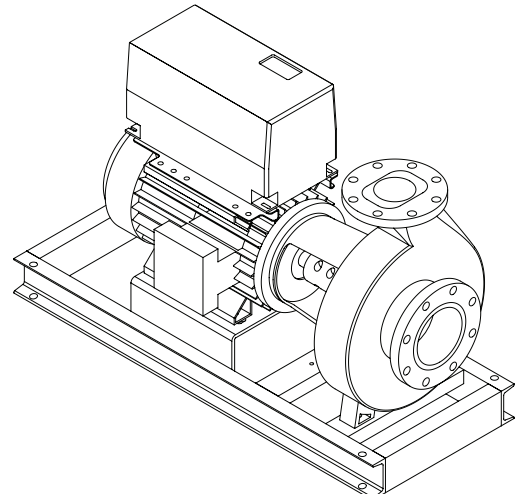
Testing

- 1 Increasing a sensor set-point and verify the pump increases speed to reach all set-points.
- 2 Decrease all set-points and verify the pump reduces speed to cover all set-points.

6.4.6 MOTOR PRE-HEAT APPLICATION

Applications

This configuration is ideal for protecting Design Envelope pumping unit motors in locations where ambient conditions cause condensation to occur in motors; particularly intermittently used close-coupled or short-coupled chilled water pumping units installed in regions with humid climate conditions



Operation

Manual method

When an operator enables the feature from the keypad (LCP), the IVS102 controller will apply DC current to the motor when the motor is idle

Sensor method

When a site sensor has determined there is moisture present, the IVS102 controller will change to a setup where the pre-heat feature is enabled and will apply DC current to the motor when the motor stops.

When the sensor has determined moisture is no longer present. The IVS102 will change to a setup where the pre-heat feature is temporarily disabled

Site requirements

Sensor method

Digital Sensor with tools to install

Enough space to remove the IVS102 controller cover safely

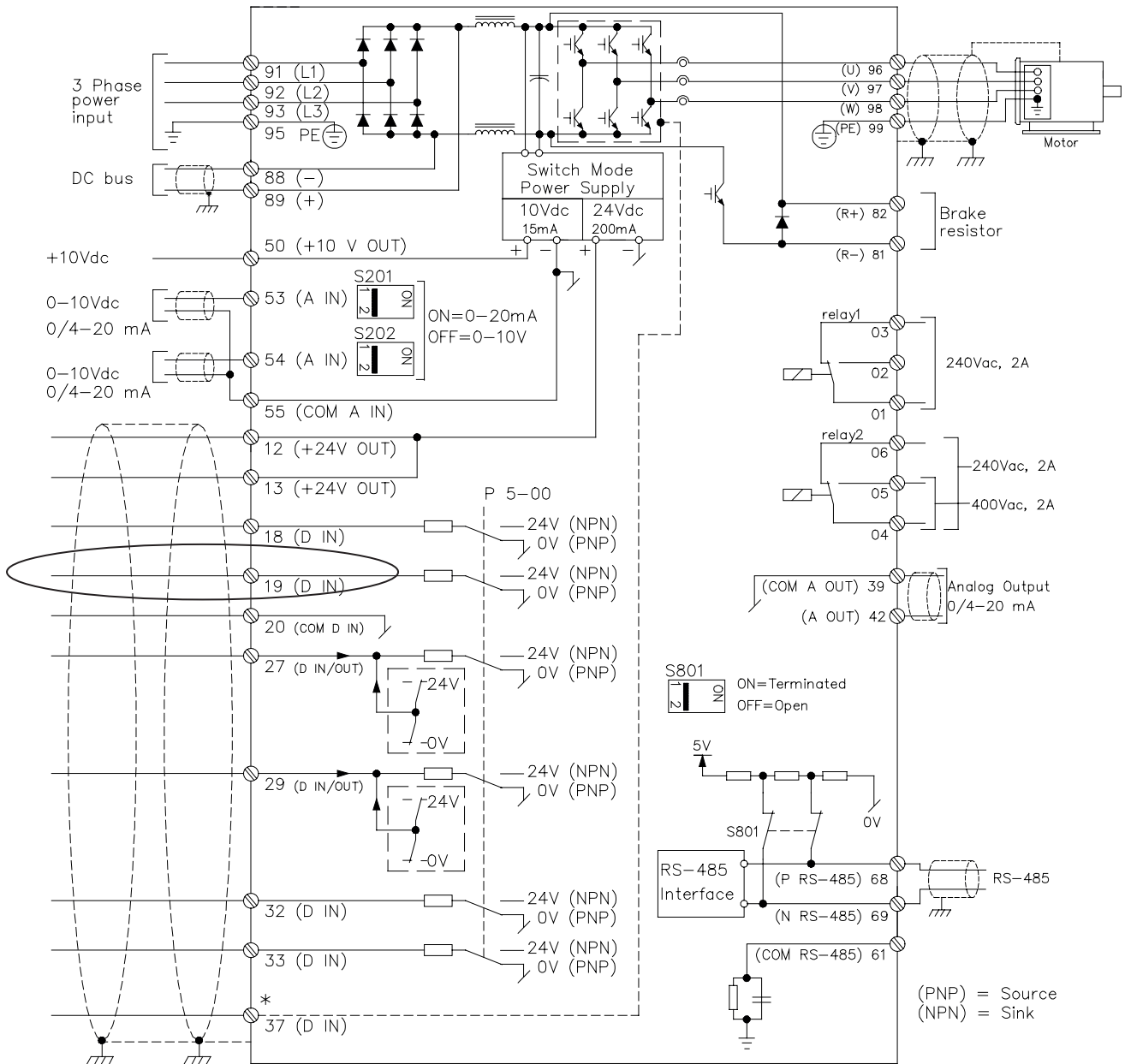
Personnel requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate simple control wiring
- 3 Ability to configure Armstrong controls
- 4 All work will be done on low voltage, however, when removing the drive cover high voltage may be exposed. An electrician license is required in some areas
- 5 Torx screw driver set

Wiring

Sensor method

Connect the digital input to Terminal 19. Power can be taken from Terminal 12 or 13.



ivs 102 controller Programming

The controls will already be configured if the pre-heat feature has been ordered. Should the pre-heat feature require removing, the parameters as indicated by the tables below can be adjusted. Cycle power to the drive **after** the parameters have been set.

PARAMETER NUMBER	PARAMETER VALUE		COMMENTS
	SETUP 1	SETUP 2	
1-80	[0] Coast	[0] Coast	Disable function

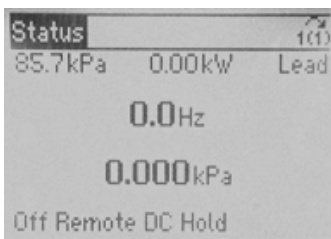
Testing

Manual method

- 1 When the motor is stopped the text “dc Hold” will appear at bottom of the LCP keypad screen as shown.
- 2 If the pre-heat feature is disabled in setup 1 the “dc Hold” text will not appear

Sensor method

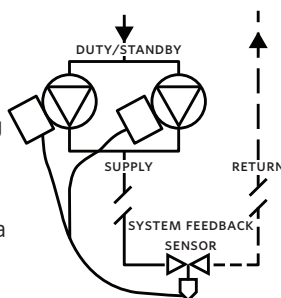
- 1 When the sensor has detected moisture, the setup will be changed to 2 which will be indicated in the top right hand corner of the LCP keypad screen. When the motor is stopped the text “dc Hold” will appear at bottom of the LCP screen as shown.
- 2 If the pre-heat feature is disabled in setup 2 the “dc Hold” text will not appear.



6.4.7 START STANDBY PUMP BY FALLING SENSOR READING

Applications (Duty / Standby operation only)

This configuration is ideal for, perhaps, old, retrofit or otherwise suspect systems which are susceptible to pump and/or piping debris or air blockages, or even broken pump coupling or shaft. The controls may be operating at a high speed; however the system is not being served and system components, such as a system feedback differential pressure sensor register set-point errors. This set-up in the pump controls will trigger a standby pump activation, replacing the duty



pump, and will close a dry-contact relay for an alarm, or other purpose, when a pre-set sensor reading level is reached. Early warning from the controls allows system investigation prior to major tenant inconveniences.

Operation

The sensor reading is compared with a site dependent constant threshold, programmed in 13-12.0. If the sensor value falls below that threshold for longer than a delay programmed in 13.12.1, the pumps alternate.

Site Requirements

- 1 Installed sensor with wiring run to the controller
- 2 Clearance to remove the Master controller cover safely

Personnel Requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate a sensor’s wiring
- 3 Ability to configure Armstrong controllers
- 4 Familiarity with array variables
- 5 All work will be done on low voltage, however, when removing the controller cover high voltage will be exposed. In some areas an Electrician license is required
- 6 No special tools are required

Wiring

The sensor has to be wired to the Master controller. If you don’t know which controller is the Master controller, verify the settings of parameters 13-00 to 13-02.

The Master controller is the unit that has the following parameters configured as follows:

PARAMETER	NAME	VALUE
13-00	slc controller mode	[1] On
13-01	Start event	[37] Digital input D132
13-02	Stop event	[26] Logic rule 0

- 1 Connect the sensor to the Master controller terminals

	TERMINAL (FUNCTION)		
SENSOR TYPE	54 (AI)	12 (24VDC)	55 (COM)
0-10Vdc	PWR	+	-
0/4-20mA 2 wires	+	-	
0/4-20mA 3 wires	+ / PWR	-	COM

- 2 Move switch s202 (beside terminal input 54) to ON if the sensor signal is 4-20mA, or leave it OFF if it’s 0-10Vdc

Sensor Configuration

3 Configure the sensor signal in the Master controller as follows:

PARAMETER	NAME	DESCRIPTION
6-24	Terminal 54 Low Ref. / Feedback value	minimum sensor reading value (when signal is 0V or 4mA)
6-25	Terminal 54 High Ref. / Feedback value	maximum sensor reading value (when signal is 10V or 20mA)
0-22	Display line 1.3 small	Set to [1664] Analog Input 54 to read the sensor value on the top right corner of the keypad display

These parameters have to be entered when the controller is running (Setup 1) and again when it's not running (Setup 2).

Alternation Programming

1 Configure the alternation in the Master controller as per table below.

Note: All parameters below are arrays. The index in the array is the number after the dot. For example 13-10.1 is the second element of the array parameter 13-10.

PARAMETER	NAME	VALUE	DESCRIPTION
13-12.0	Comparator value	Site dependent *(see note below)	...this threshold differential pressure, Comparator 0 becomes TRUE.
13-12.1	Comparator value	Site dependent (suggested 20s)	...this many seconds, Comparator 1 becomes TRUE.
13.20.1	sl Controller Timer 1	023;59;58.000	Alternation time

Ensure flow is maintained during alternation

2 Tune the following parameters to ensure the system pressure (sensor signal) doesn't drop below the minimum required (the threshold above) during alternations.

This has to be done on both controllers and both should have the same final parameters.

Configure these parameters when the controller is running (Setup 1):

PARAMETER	NAME	SUGGESTED VALUE
3-41	Ramp up time	15 sec

Configure this parameter when the controller is **not** running (Setup 2):

PARAMETER	NAME	SUGGESTED VALUE
3-42	Ramp down time	120 sec

TESTING

1 Testing alternation when the sensor value drops.

Recommended method: Close the DP sensor isolation valve slowly until the read value drops below the threshold.

Alternate method: Increase the set-point to a value higher than currently read by the sensor.

In both cases the pumps should alternate after the number of seconds entered in 13.12.1 and alternate again after the number of seconds entered in 13.20.1

2 Return everything to normal.

3 Force alternations by pressing the ok and Right arrow keys simultaneously. Keep in mind this can only be done every (value entered in 13.20.1) seconds.

Verify that during alternations the sensor pressure doesn't drop below threshold.

6.4.8 START STANDBY BY SYSTEM CONTACT OPENING

Applications (Duty / Standby operation only)

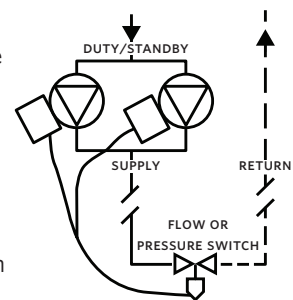
This configuration is ideal for, perhaps, old, retrofit or otherwise suspect systems which are susceptible to pump and/or piping debris or air blockages, or even broken pump coupling or shaft.

The controls may be operating at a high speed; however the system is not being served and system components, such as a pressure

or flow switch register low satisfaction levels. This set-up in the pump controls will trigger a standby pump activation, replacing the duty pump, and will close a digital output for an alarm, or other purposes, when the system contact opens. Early warning from the controls allows system investigation prior to major tenant inconveniences.

Operation

If the contact opens for longer than a delay programmed in parameter 13.12.1, the pumps alternate.



At start up and after each alternation, the open contact is ignored for a period of time programmed in 13.20.1

If the contact stays open (the issue is not fixed by running the other pump), the pumps will continue to alternate every [time in seconds programmed in 13.20.1] until the issue is resolved

Site Requirements

- 1 Switch already installed with wiring run to the pumps (but not terminated)
- 2 Enough space to remove the Master drive cover safely

Personnel Requirements

- 1 Armstrong Tier 3 training or equivalent
- 2 Ability to terminate simple control wiring
- 3 Ability to configure Armstrong drives
- 4 All work will be done on low voltage, however, when removing the drive cover high voltage may be exposed. In some areas an Electrician license is required
- 5 No special tools are required

Wiring

The contact wires have to be wired to the Master drive. If it's unknown which drive is the Master drive, verify the settings of parameters 13-00 to 13-02.

The Master drive is the unit that has the following parameters configured as follows:

PARAMETER	NAME	VALUE
13-00	sLc Controller Mode	[1] On
13-01	Start Event	[37] Digital input DI32
13-02	Stop Event	[26] Logic rule 0

- 1 Connect the switch to the Master drive terminals 12 (24Vdc output) and 19 (Digital Input)
- 2 24VDC output provided (Terminal 27) when contact opens

Site programming options

Configure the alternation in the Master drive as per the table below.

Note: All parameters below are arrays. The index in the array is the number after the dot. For example 13-10.1 is the second element of the array parameter 13-10.

PARAMETER	NAME	VALUE	DESCRIPTION
13-12.1	Comparator value	Site dependent (suggested 20s)	...this many seconds, Comparator 1 becomes TRUE.
13.20.1	sL Controller timer 1	023:59:58.000	Alternation time

Ensure flow is maintained during alternation

- 1 Tune the following parameters to ensure the system pressure doesn't drop below the minimum required (the threshold that opens the contact) during alternations.

This has to be done on both drives and both should have the same final parameters.

Configure these parameters when the drive is running (Setup 1):

PARAMETER	NAME	SUGGESTED VALUE
3-41	Ramp up time	15 sec

Configure this parameter when the drive is **not** running (Setup 2):

PARAMETER	NAME	SUGGESTED VALUE
3-42	Ramp down time	120 sec

Testing

- 1 Testing alternation when the sensor value drops.

Recommended method: Close the flow / pressure switch isolation valve slowly until the contact opens.

Alternate method: Disconnect one of the contact wires from the IVS102 controls (terminals 12 and 19).

In both cases the pumping units should alternate after the number of seconds entered in 13.12.1 and alternate again every [number of seconds entered in 13.20.1]

- 2 Return everything to normal.
- 3 Force alternations by pressing the ok and Right arrow keys simultaneously. Keep in mind this can only be done every (value entered in 13.20.1) seconds.

Verify that during alternations the contact doesn't open.

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 10 v voltage from terminal 50 on the control card is below 10 v. Remove some of the load from terminal 50, as the 10 v 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 over-voltage 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 24 v back-up supply is connected. If no 24 v 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

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 the fan 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 ISIP00, IP20/NEMA1 or IP21/TYP1, 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 heatsink 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 x30/6 :

Check the load connected to x30/6 or remove short-circuit connection. Check par. 5-32 Term x30/6 Digi Out (MCB 101).

WARNING 42, Overload of Digital Output On x30/7 :

Check the load connected to x30/7 or remove short-circuit connection. Check par. 5-33 Term x30/7 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 R_s and R_r 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 VDC 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 active. 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 temperature	(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
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	

NO.	DESCRIPTION	WARNING	ALARM /TRIP	ALARM /TRIP LOCK	PARAMETER REFERENCE
40	Overload τ_{27}				
41	Overload τ_{29}				
42	Overload $x_{30/6-7}$				
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	[0] No operation	[0] No operation	[0] No operation
	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
COMMUNI- CATION 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 Parity, 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 102	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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