

SubDrive HPX

Variable Speed Controller Installation Guide



SUBDRIVE HPX VARIABLE SPEED CONTROLLER INSTALL GUIDE

ATTENTION! IMPORTANT INFORMATION FOR INSTALLERS OF THIS EQUIPMENT!

This equipment is intended for installation by technically qualified personnel. Failure to install it in compliance with national and local electrical codes, and within Franklin Electric recommendations, may result in electrical shock or fire hazard, unsatisfactory performance and equipment failure. Franklin installation information is available from pump manufacturers and distributors and directly from Franklin Electric. Call Franklin toll free 800-348-2420 for information.

⚠ WARNING

Serious or fatal electrical shock may result from failure to connect the motor, control enclosures, metal plumbing, and all other metal near the motor or cable, to the power supply ground terminal using wire no smaller than motor cable wires. To reduce risk of electrical shock, disconnect power before working on or around the water system. Allow 15 minutes for power to discharge. Do not use motor in swimming areas.

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Overview

The Franklin Electric SubDrive HPX provides a means of creating a complete system solution for variable speed water pumping applications. The goal of the SubDrive HPX is to create a Variable Frequency Drive (VFD) system that is simple to setup, operate and maintain.

The SubDrive HPX Install Guide is intended to be a quick reference to the Franklin Electric specific hardware and software functionality provided with this drive. There are additional features and functions the drive can perform that are outside of the Franklin Electric specific software. For advanced operation and features, refer to the Altivar (ATV) 61 Installation Manual and the Altivar 61 Programming Manual that are on the CD-ROM included in the packaging.

Installation

Before you begin, receive and inspect the drive controller.

1. Verify the part number to the purchase order. Remove the SubDrive HPX from the packaging and check for damage in transit.
2. Check the line voltage to verify it is compatible with the voltage range of the drive.
3. Read and review these instructions and the Schneider Electric Altivar 61 Installation Manual included in the packaging before performing any procedure on this drive.
4. Mount the drive in accordance to the instructions in the Altivar 61 Installation Manual.
5. Install the CI card and Human Machine Interface (HMI).
6. Wire the drive. Connect the motor and line supply verifying the voltage is correct and the power is off. Connect the control and associated wiring.
7. Program the drive according to the software programming guide included in this manual.

Nameplate Examples

Be aware of the fact that the nameplate on drives includes ratings calculated using IEC (kW) and NEMA (hp) standards. For 230 V drives, this may result in two different amp ratings on the "I(A)" lines of the nameplate. The primary difference in these two ratings is the method of calculation. When comparing amp ratings, the NEMA (hp) rating should be used.

EXAMPLE: SubDrive HPX Chassis or "Open" Drive (5 to 200 hp nameplate)



IEC Amps

NEMA Amps
Use this value for motor sizing.

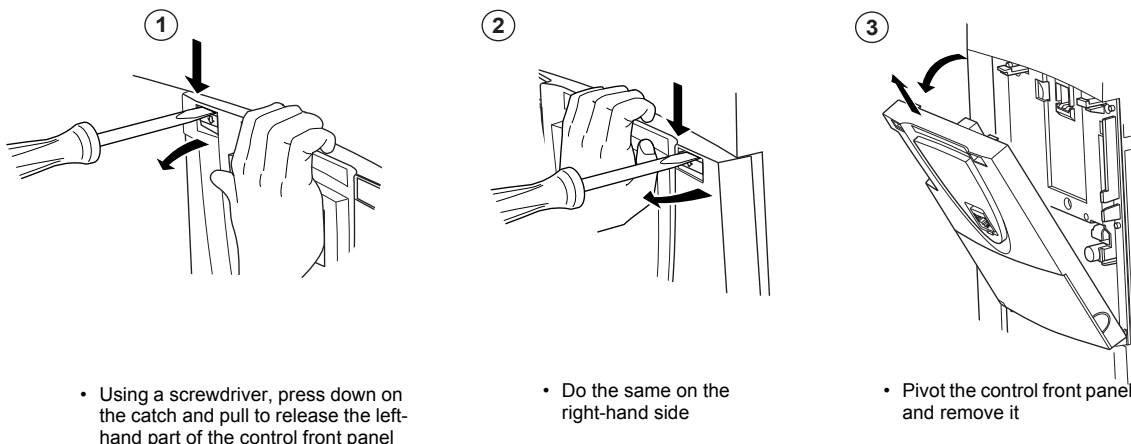
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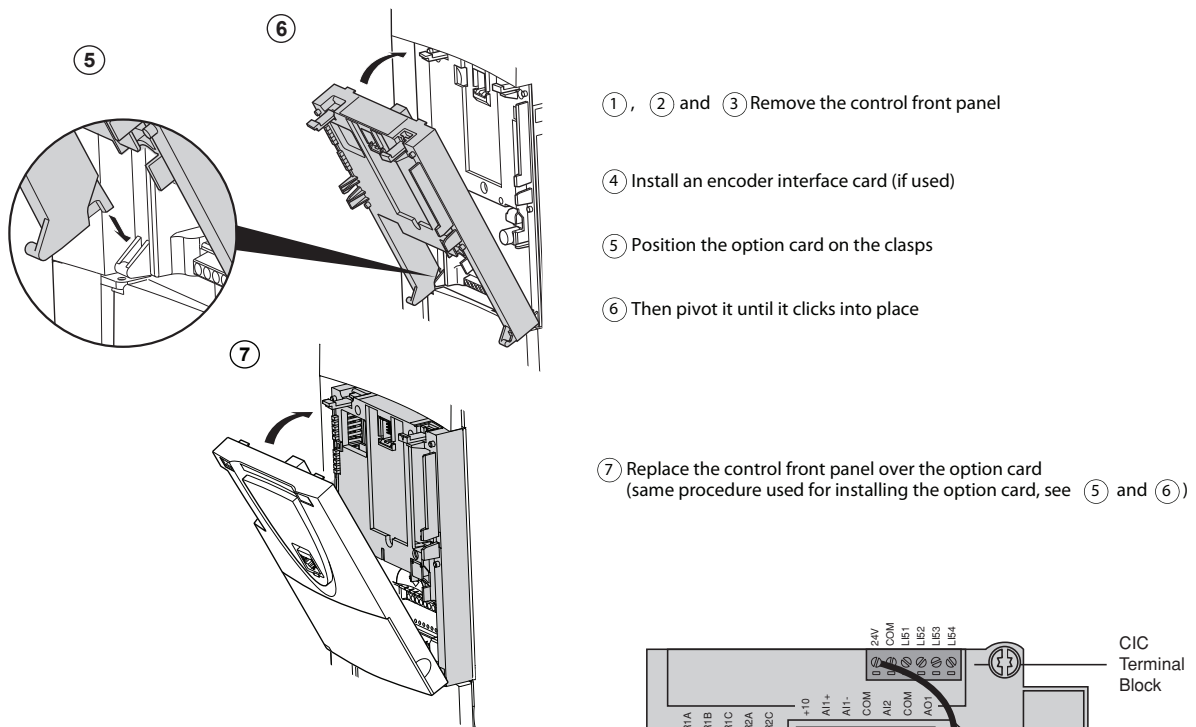
Controller Inside (CI) Card Installation

The CI card should ideally be installed once the drive is mounted and prior to wiring the drive. Check that the red capacitor charging LED is off and verify the DC bus voltage in accordance to the procedure for verifying the DC bus voltage in the Altivar 61 Installation Manual. The CI card is installed under the drive control front panel. If the drive has a graphic display installed, remove it and then remove the control front panel as listed below.

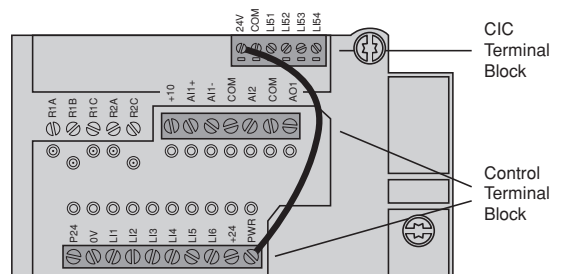
Removing the control front panel



Install the CI card



The CI card requires 24 V power to operate. Using the supplied jumper wire connect CI card 24 V terminal to Control Terminal Block PWR terminal as shown.



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Connections

Before wiring, perform the DC Bus Voltage Measurement procedure (see Altivar 61 Installation Manual). Please consult all city, state and federal regulations for proper wiring practices. Good wiring practice requires the separation of control circuit wiring from all power wiring. Power wiring to the motor must have the maximum possible separation from all other power wiring, whether from the same drive controller or other drive controllers. Do not run power and/or control or multiple power wirings in the same conduit. This separation reduces the possibility of coupling electrical transients from power circuits into control circuits or from motor power wiring into other power circuits. Follow the practices below when wiring the SubDrive HPX drive controller:

- Use metallic conduit for all drive controller wiring. Do not run control and power wiring in the same conduit.
- Separate metallic conduits carrying power wiring or low-level control wiring by at least 3 inches (76 mm).
- Separate existing, non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control wiring by at least 12 inches (305 mm).
- Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.
- Equip all inductive circuits near the controller (relays, contactors, solenoid valves) with noise suppressors.
- Do not run control wires through venting or through the rear air intake of the drive controller.

Input Wiring

Connect input power leads L1 and L2 (for single-phase) or L1, L2, and L3 (for three-phase) to the input of the circuit breaker. Refer to Power Terminals section of the Altivar 61 Simplified Manual for exact location, lug data, wire size range and tightening torque specs for drive controller input terminals L1, L2, and L3.

All branch circuit components and equipment such as feeder cables, disconnect devices, and protective devices must be rated for the higher of the following two currents:

1. The input current of the drive controller, or
2. The Motor Full Load Current (MFLC).

The input current and MFLC are printed on the nameplate. The branch circuit feeder protection must be sized according to the NEC. DC link chokes and AC line reactors are used to add reactance to the branch circuit, minimize drive controller input line current, reduce controller nuisance tripping due to transient overvoltage, reduce harmonic distortion, and help improve controller immunity to voltage imbalance.

Output Wiring

Connect motor conductors to the lugs provided, and connect the motor ground to the ground bar provided. Connect the motor conductors to U/T1, V/T2, and W/T3 output terminal. The ampacity of motor power conductors should be sized and attached according to the motor full load current, National Electrical Code, and applicable local codes.

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Refer to the nameplate for torque requirements. The drive controller is sensitive to the amount of capacitance (either phase-to-phase or phase-to-ground) present on the output power conductors. If excessive capacitance is present, the drive controller may trip on overcurrent.

Follow the guidelines below when selecting output cable:

- Cable type: the cable selected must have a low capacitance phase-to-phase and to ground. Do not use mineral-impregnated cable because it has a very high capacitance. Immersion of cables in water increases capacitance.
- Cable length: the longer the cable, the greater the capacitance. These cable lengths may cause ground faults. Franklin Electric recommends a reactor or motor protection filter be installed between the driver controller and motor protection filter. A selection tool has been developed to determine the best reactor to use on a site. Contact the Franklin Hotline or salesman to obtain the selection tool.

Note: NEMA MG-1 Part 31 compliant motors are recommended but not required. Consult the motor manufacturer or vendor literature to address any specific limitations governing the application.

Do not use lightning arrestors or power factor correction capacitors on the OUTPUT of the drive controller.

Single-Phase Connection

For a select few small drives (230 V and 460 V) it is possible to run a three-phase output with a single-phase input. De-rating the current of the three-phase drive by 1.73 (230 V) and 2.00 (460 V) allows the drive to be used with a single-phase input. (The CI Card automatically derates the drive when single-phase is selected.)

Control Pilot Devices

Pressure Transducer

One of the primary applications for SubDrive HPX is to maintain constant pressure in a water system. For this purpose, the application requires a pressure transducer to provide feedback to the drive. The AST4000 has been included with the drive and the specifications are as follows:

Process Connection: 1/4" NPT male
Pressure Range: 0-100 psi
Pressure Unit: PSI
Outputs: 4-20 mA (2-Wire loop powered)
Electrical: 10 ft.
Wetted Material: 17-4 PH
Voltage: 10-28 VDC



Optional Transducers are available or may be purchased separately. If purchased separately the following items should be taken into consideration:

- Pressure transducers must be of the 4 to 20 mA output type.
- The transducer full scale range can be as high as 250 psi.

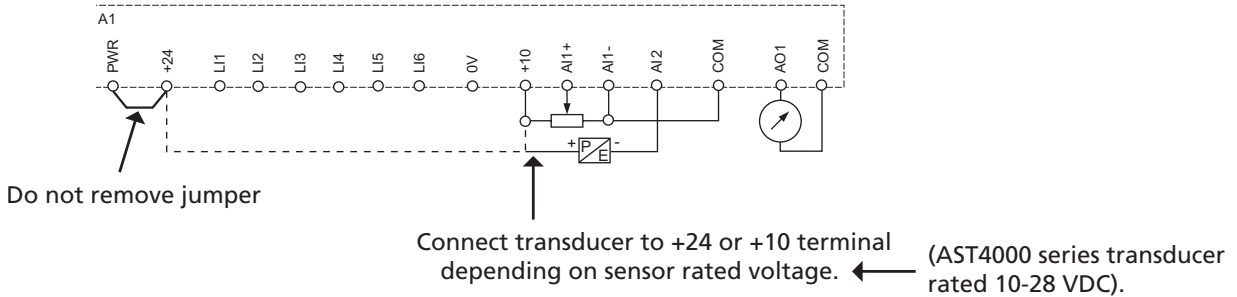
CAUTION: Adhere to the safety guidelines (maximum pressure rating) of the pressure tanks in the system, while making sure to install the tank and sensor per applicable codes and also including a pressure relief valve.

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Transducer Connections

- For SubDrive HPX, the pressure transducer red (+) lead is connected to drive terminal "+10" or "+24" (depending on the voltage rating of the sensor), while the black (-) lead is connected to drive terminal AI2.



Shielding Connections

- Connect the transducer shield back at the drive ground point. A shielded cable improves the lightning immunity of the sensor. **Do not ground at the sensor end of the cable.**

NEMA 1 Conduit Kit Connection

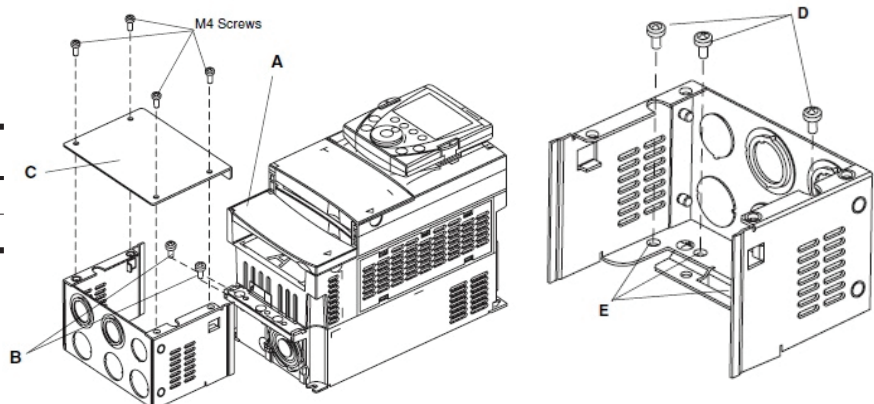
To install the standard conduit kit (Model # 225937901 - 225937905). Non-standard conduit kit installations may vary depending on the size of the drive.

- Remove the power terminal protective cover.
 - Open the hinged portion of the cover by lifting the right edge (A).
 - Turn the gray screw counterclockwise to the unlocked position.
 - Lift the protective cover (A) straight up and remove it from the drive controller.
- Remove the three green ground screws (D) from the drive controller and install them in the three holes (E) at the base of the conduit box.
- Attach the conduit box to the drive controller using the two M5 screws (B).
- Make all power and control connections to the drive controller through the knockouts provided.

Note: Knockouts are provided for the control cables. Use either a hole saw or a punch to cut entries for power conduit passage.
- Attach the cover (C) to the conduit box using the four M4 screws.
- Torque the hardware to the following values:

Recommended Torque Values

Hardware size	Torque
M4, 8-32	13 lb-in (1.47 N•m)
M5	26 lb-in (2.94 N•m)

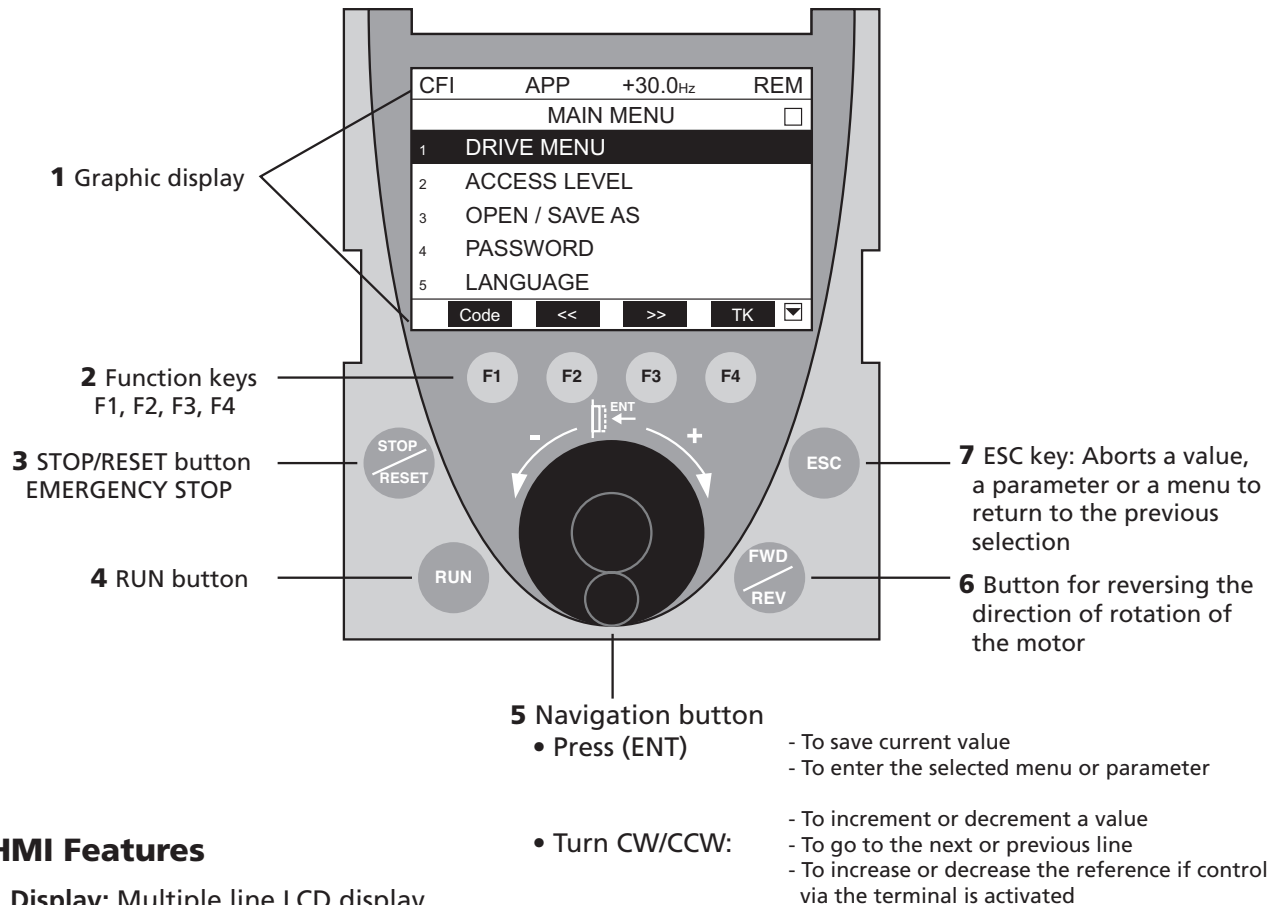


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SOFTWARE SETUP GUIDE

The Software Setup Guide covers the software configuration and control strategy of the SubDrive HPX variable speed controller. The Franklin Electric software is stored in the Controller Inside (CI) card. The CI card will need to be installed prior to modifying the software settings.

Graphic Display Terminal



HMI Features

1 Display: Multiple line LCD display.

2 Function buttons:

- F1 - Displays the code of the selected parameter or Help info.
- F2 - Navigate to left or right OR returns to previous menu.
- F3 - Navigate to left or right OR advances to the next menu.
- F4 - Command and reference via the terminal.

3 Red Stop/Reset Button: Using this button will stop the drive. Input power must be cycled to restart the drive. The reset feature is currently disabled.

4 Green Run Button: Currently disabled. Do not use.

5 Navigation Button/Dial: "Push and Turn" dial to navigate within menu screens or to change parameters of values.

6 FWD/REV Button: Currently disabled. Do not use.

7 ESC Button: Exits a menu or parameter, or cancels a value to return to the previous value in memory.

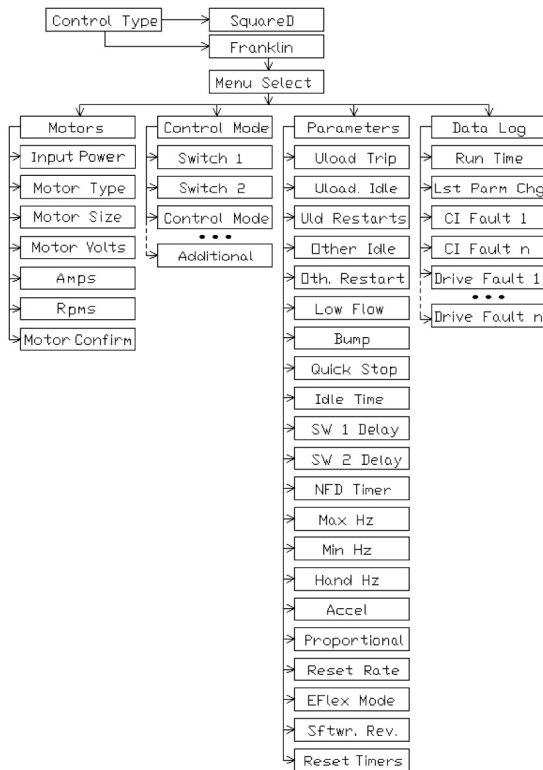
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Set Date and Time

From Main Menu > Drive Menu > Franklin Elec > DATE/TIME SETTINGS
 Set time (24 hour format) and date (DD/MM/YYYY), rotate dial to change value of highlighted selection. Move to the left or right using F2 and F3. Push Navigation Button/Dial or ESC to set and exit.

Franklin Electric Menu Tree



Motor Selection Menu

To Select the Motor

From Main Menu > Drive Menu > Franklin Elec
 Verify Menu Select is set to Motors

Select Input Power

1-phase Input (only available on select 230 V/460 V drives)
 3-phase Input

Select the Motor Type

Submersible 60 Hz (SubM 60 Hz)
 Surface 60 Hz (SurF 60 Hz)
 Submersible 50 Hz (SubM 50 Hz)
 Surface 50 Hz (SurF 50 Hz)

Enter the Motor Size

Enter motor horsepower (hp) or kilowatts (kW) [50 Hz only]

Enter the Motor Voltage

Enter the rated Motor Voltage

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Enter the Motor Amps

Enter the rated Motor Amps. If Service Factor (SF) amps are applicable for the given motor (e.g., Submersible 60 Hz applications), then enter the SF amps as listed on the motor nameplate or as specified in the Franklin documentation (AIM manual).

Enter the Motor RPMs (Surface Only)

Enter the motor RPMS from the nameplate data.

Use the Motor Confirm parameter to accept the motor settings

Used to confirm (save) the motor settings that have been made up to this point. Toggle to Yes to confirm motor selections. Drive will not operate until confirmation is made.

If a motor parameter (Volts, Amps, RPMs) requires modification, Motor Confirm will change to No and the changes will not take effect until is toggled to Yes.

Modbus add Prg. C is not used.

Control Scheme Selection Menu

To Select the Control Setup

From Main Menu > Drive Menu > Franklin Elec
Select Menu Select > Cntl Mode

The SubDrive HPX provides five different control modes

1. Switch Control (Switch Cn)
2. Pressure Cycle (Press Cyc)
3. Flow Control (Flow Cntl)
4. Pressure Regulator (Press Reg)
5. Level Control (Level Cnt)

A pressure transducer (4-20 mA) is required to support Pressure Cycling or Pressure Regulation. A flow sensor (4-20 mA) is required to support Flow Control. For each of these cases, the 4-20 mA transducer inputs shall terminate using the AI2 inputs on the HPX.

For the other control cases, Switch Control and Level Control, the switch/level inputs shall terminate to the SW1 (LI51) and SW2 (LI52) inputs on the HPX. A pressure or flow transducer can still be attached to the AI2 inputs, but it will only be a display parameter, not a control parameter, when either is used with Switch Control or Level Control as the selected mode of operation.

When Pressure Regulation is selected, the Pipe Fill parameters are displayed to allow the Pipe Fill feature to be enabled/disabled and, if enabled, are customizable to meet the application needs.

For all control modes other than Flow Control, the AI2 4-20 mA input is used to read pressure. Not all modes require a pressure sensor (i.e. Switch Control, Level Control) but it is available to give additional feedback for the system. When a pressure sensor can exist for the mode, the user can select PSI or Bars for the pressure units. Once the units have been selected, all pressure settings and values are reported in that fashion. Next step is to set the transducer value to the rating (max) listed on the pressure sensor.

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SubDrive HPX OPERATION

Programmable Switch Inputs

Whether or not a transducer is used, system control normally involves one or two switches. The SubDrive HPX allows connection of two switches at the setup console. When a switch is open, there will be approximately 24 Volts DC across its connection terminals. When closed, the voltage across the terminals drops to 0 Volts. Terminals LI51 and LI52 are for SW1 and SW2 respectively.

The Franklin Electric menu allows the control switches SW1 and SW2 to be designated as one of 8 types:

0. Not Used – no switch connected to this input
1. Trip if Open – if this switch opens, the drive stops the pump, displays trip cause, times out, and if the maximum trips haven't been exceeded, the drive will resume operation following the timeout.
2. Trip if Closed – if this switch closes, the drive stops the pump, displays trip cause, times out, and if the maximum trips haven't been exceeded, the drive will resume operation following the timeout.
3. Run when Open – this is a simple RUN/STOP command (run when switch is open).
4. Run when Close – also a simple RUN/STOP command, but for opposite switch sense.
5. Flow SW Open – stops pump if it closes while running, but allows pump start if open.
6. Flow SW Close – stops pump if it opens while running, but allows pump to start if closed.
7. Second Target – shifts the pressure or flow target when closed.

Note: Types 5 and 6 are intended to be “low flow” switches that protect the pump from dry run.

As a general rule, if the two switches are both designated as Run when Open/Close, pump run only occurs if both conditions are met. The exception to this rule is the Level Control scheme, discussed on page 12. **At least one switch input must be configured for a Run condition or the drive will not be enabled to run.**

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Pressure Transducer Location and Installation

Pressure transducers should be located as close as possible to the pressure tank inlet. If the transducer is instead located on the main delivery, there is the possibility of providing unstable feedback to the pressure regulator controls. The result is a sustained pressure oscillation, and the only cure is to slow down the control. To slow the control, use a larger Prop. Band and/or a lesser Reset Rate. See discussion for control loop parameter settings.

Location of the transducer near the tank and use of a diaphragm seal will also help to prevent transducer damage by water hammer.

The user can choose the pressure units by selecting "PSI" or "Bar" within the control menu. To configure the HPX for the targeted pressure transducer, go to the control menu and look for the "Xducer" option. The transducer setting is the maximum pressure value that is represented when the transducer output is 20mA (at max).

Flow Transducer Location and Installation

Flow transducers should be installed in a location that represents the most stable and accurate location to measure water flow in the system.

The HPX treats the flow transducer 4-20 mA feedback as a percentage, so 0% correlates to 4mA or less and 100% correlates to 20mA+.

Programmable Control Methods

Switch Control (Switch Cn)

This mode allows, among other things, pressure cycling on a conventional water pressure switch with an adjustable differential (ie. 40/60 PSI).

No transducer is required; the pump runs as permitted by the states of both SW1 and SW2. If either switch is absent, declare *SW1* or *SW2* to be *Run when Open (Run Open)* and attach nothing at the control card terminals. Minimum off time is still set by *Idle Time (Idle)*. The pump runs at *Maximum Frequency (Max)*. If a transducer is present, it acts to report the pressure and does not have any impact on the switch control method.

The pressure units (PSI or Bar) and transducer setting are available for the optional pressure sensor.

At least one of the switches has to be configured for a run condition or else the system will not engage.

Pressure Cycle (Press Cyc)

For this control mode, a pressure transducer monitors the pressure levels to start and stop the pump, but no attempt is made to regulate the pressure between these two limits. Rather, the pump runs at *Maximum Frequency (Max)*. The pump will be stopped when pressure reaches *Target XX PSI + Limit XX PSI* and will restart when pressure falls to *Target XX PSI - Limit XX PSI* and *Idle Time (Idle)* has been met. In other words, Target is the average pressure and 2*Limit is the total fluctuation. *Idle Time (Idle)* sets a minimum pump off interval between runs. This type of control uses a large pressure tank in order to limit the pump cycles per day.

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Pressure units can be selected as "PSI" or "Bar".

SW1 and SW2 configuration is required to establish the mechanisms that will enable the system to run and optionally force the system to trip on an external discrete fault input. At least one of the switches has to be configured for a run condition or else the system will not engage. Typically the other switch is configured to trip on an over-pressurization event.

Flow Control (Flow Cntl)

This control mode is intended for reverse osmosis filtration, where a fixed flow is needed but pressure across the filters will increase with time. A 4 to 20 mA flow transducer is connected in place of the pressure transducer. The user enters the desired flow rate as a percentage of the flow transducer range, *Target 10 - 95%*.

The flow target can be shifted to the second target under control of an external switch. It is connected to a switch input that is declared to be type *Second Target*. When the external switch is closed, the second flow target is active.

SW1 and SW2 configuration is required to establish the mechanisms that will enable the system to run and optionally force the system to trip on an external discrete fault input. At least one of the switches has to be configured for a run condition or else the system will not engage. Typically the other switch is configured to trip on an over-pressurization event. *Proportional Band (P)* and *Reset Rate (I)* adjustments are available to control system dynamic performance. These parameters should only be adjusted by experienced personnel who have had some time to analyze the performance. These parameters only make sense for pressure regulation and flow control modes of operation.

Pressure Regulation (Press Reg)

This control mode adjusts pump speed to maintain constant pressure. A pressure transducer is required, and should be installed as described for the *Pressure Cycle* control.

Speed is continually adjusted to drive the pressure to *Target XX PSI*. If the pump is stopped, it will not be restarted until the pressure demand returns. Restart will also be delayed by *Idle Time*.

The pressure target can be shifted to the second target under control of an external switch. It is connected to a switch input that is declared to be type *Second Target*. When the external switch is closed, the second target is active.

Pressure units can be selected as "PSI" or "Bar".

Max Frequency (Max) is the highest frequency that the pump will be allowed to run, even if pressure must be sustained below *Target XX PSI*. *Max Frequency (Max)* cannot be set above the motor frequency defined during motor selection.

Min Frequency (Min) is the lowest frequency that the pump can run during pressure regulation. For submersible applications, this parameter cannot be set below 30 Hz. For surface applications, this parameter cannot be set below 10 Hz. Care should be taken to ensure that the minimum frequency setting is not set above the frequency at which the pump develops pressure Target at zero flow. The advantage of setting *Min Frequency (Min)* above, say, 30 Hz is a quicker acceleration to pumping speed when the pump is started. This is because the acceleration to *Min Frequency (Min)* is done at 60 Hz/second, but acceleration above *Min Frequency (Min)* is at the rate *Accel*. It might also be the case

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that a low frequency like 30 Hz does not provide enough power to overcome the head in the system. For a case where 30 Hz results in deadhead, cautiously adjusting the minimum frequency upwards should improve the control response, especially for systems that have some persistence of demand.

Proportional Band (P) and *Reset Rate (I)* adjustments are available to control system dynamic performance. These parameters should only be adjusted by experienced personnel who have had some time to analyze the performance. These parameters only make sense for pressure regulation and flow control modes of operation.

A constant pressure system must have some method to decide when the water flow has gone to zero and the pump should be stopped. If this is done with a flow switch, set *Low Flow* to OFF and designate either SW1 or SW2 as a flow switch. The SubDrive HPX also has the capability to detect zero flow by temporarily reducing speed. If the speed reduction does not cause pressure to drop, then pump shutdown is initiated because the check valve has evidently closed. To use this feature, set *Low Flow* to ON.

Low/zero flow detection can also be accomplished by using the *Bump* feature. With the *Bump* setting ON, the temporary speed reduction is preceded by a pressure increase by the amount *Limit*. This traps more water in the pressure tank during the ensuing zero flow interval, and allows a greater water draw-off before the pump is restarted.

A different low flow detection method is enabled when Dip Test is set to ON. In this case, the temporary speed reduction is preceded by a pressure decrease by the amount of *Limit*. If a pressure drop is not detected during the zero-flow test, the system will allow the pump to stop. This is useful in situations where over-pressurization could be encountered using the *Bump* feature.

Only one of the two low-flow mechanisms is allowed to be enabled at any given time. If one of the two is enabled, and the other is enabled, the original feature that was enabled will transition to disabled. So either one or the other can be enabled, or both can be disabled, but both cannot be enabled simultaneously.

SW1 and SW2 configuration is required to establish the mechanisms that will enable the system to run and optionally force the system to trip on an external discrete fault input. At least one of the switches has to be configured for a run condition or else the system will not engage. Typically the other switch is configured to trip on an over-pressurization event.

Pipe Fill Mode (Pipe Fill Ena)

Pipe Fill Mode is useful to prevent water hammer in new installation or as a method to purge a water system. Pipe fill mode is only available in the pressure regulation control scheme. It can be enabled by toggling *Pipe Fill Ena* to ON. The pipe fill motor startup speed will be the Pipe Fill Spd. The motor start up speed will be maintained for the duration specified by Pipe Fill Time (*Pipe Fill Tim*). Pipe Fill Mode will terminate and return to normal pressure regulation mode when the Pipe Fill Pressure Target (*Pipe Fill Tgt*) is met.

Level Control (Level Cnt)

When Level Control is selected, no transducer is used. Pump run is initiated by SW1, which is assumed to be at the lower limit (of water level or water pressure). The pump runs at *Maximum Frequency (Max)*. SW2 is assumed to be the higher limit and will stop the pump. Whenever the pump is stopped, it will be idle for *Idle Time (Idle)* and then will run again if allowed by the state of both SW1 and SW2.

One example of Level Control is reservoir filling. Here, SW1 is a level sensing switch set at the minimum reservoir level and SW2 is another level sensing switch set at the maximum reservoir level.

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Another example of Level Control is pressure cycling with a large storage tank. For this application, SW1 and SW2 are pressure sensing and determine the minimum and maximum tank pressures.

If a transducer is attached to AI2, it is interpreted as a pressure sensor. The sensor would report pressure but Level Control would not be impacted by this value, used only as an additional feedback for the system. Pressure units can be selected (PSI or Bar) and the transducer setting is available to set the max pressure value.

Frequency of Starts For Submersible Applications

Franklin's AIM manual recommends that *submersible* motors of 7.5 horsepower and larger have no more than 100 starts per day. This guideline was developed for line start applications, but still holds true for adjustable frequency drives. Although starting with a drive is "soft" (i.e., starting current is limited), there is still a wear consideration: radial and thrust bearings spend a longer time at speeds below 30 Hz, where lubrication is marginal.

One method to guarantee that there are fewer than 100 starts per day is to set *Idle Time* to 15 minutes. If it is known that the system will run for at least 15 minutes after it is started, then *Idle Time* could be set to 0 and there would be fewer than 100 starts per day. To reduce the frequency of starts on a pressure regulating system, we have defined the parameter *Limit* (seen on the Set Target Menu). With the bump feature enabled, and the bump feature detecting low flow, the drive will not restart until pressure has fallen below the Target. The "success" of the bump feature leaves the pressure in the ballpark of $Target + Limit$, and the drive will not restart until the pressure drops below *Target*. With the dip test feature enabled, and the dip test succeeding, the drive will not restart until the pressure falls below $Target - Limit$. For example, with the success of a dip test, if Target is 50 PSI and Limit is 5 PSI, then the pump restarts when pressure falls to 45 PSI. With a 100 gallon tank pre-charged to 35 PSI, 6.4 gallons must be drawn to bring the pressure down from 50 PSI to 45 PSI. Increasing *Limit* will reduce the frequency of starts on a system that often supplies trickle flow. With the *Bump* feature enabled, a successful *Bump* has left the tank pressure above the *Target*, so additional water can be drawn before the pump will restart.

For any pressure regulation application, we recommend that the tank pre-charge be 70% of *Target*, for example 35 PSI for a 50 PSI *Target*.

Tank Sizing

Franklin Electric recommends that the tank sizing occurs as a function of 10% of the anticipated max flow rate (i.e. system capable of 100 gpm = 10 gal tank minimum)

Parameter Menu

Adjusting the Control and Fault parameters are done by the following screen:

From Main Menu > Drive Menu > Franklin Elec

Verify Menu Select is set to Parameter

The Parameter configuration allows you to customize various operating parameters including Fault trip levels and timing along with control loop response.

Fault Trip Adjustment

With pressure regulation active, the SubDrive HPX provides underload detection that can be adjusted to meet site specific needs. The underload *Trip Point* can be adjusted from 30% to 100%; the underload *Trip Point* takes into account both the current motor power (displayable on the monitoring screen) and the current motor speed (also available on the monitoring screen). The underload *Idle*

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Time can be adjusted to enforce the time it takes following an underload detection before the drive can resume operations. If an underload event is detected, and the drive resumes operations, and the underload *Idle Time* period expires, then the total underload count is decremented and basically serves as a “smart reset” function. The underload *Restarts* setting is intended to be used to detect a persistent, repetitive underload condition (dry well) (pump failure) and, if the underload count exceeds the *Restarts* setting, enforce a drive lockout (lockout terminated by cycling power to the drive). Setting the *Restarts* parameter to 0 disables the underload counting mechanism.

All other faults, such as a trip when SW2 opens (SW2 configured to trip when open), are taken care of by the *Other Trip* settings. *Idle Pst Trp* is the time, in minutes, where the drive is enforced to an idle state for the entire time period before the drive can resume operation. In addition to that is a *Restart* setting that will enforce a drive lockout (power cycle required to resume operations) when the other-trip count exceeds the *Restart* setting. The other-trip Restart setting cannot be set to 0; in other words, the other-trips counting mechanism cannot be disabled.

Enables

The Enables section allows the user to enable one of two low flow methods and also determines the manner in which the motor will stop when the drive goes to an idle state.

Dip Test – Dip test is a feature that detects zero flow by temporarily reducing the target pressure to *Pressure Target - Limit*. If the target reduction was not accompanied with a pressure drop, then pump shutdown is initiated because there was no demand and the check valve has evidently closed, allowing the pressure to be maintained with the drive idle.

Bump Mode – The bump test feature also can be used for low flow detection. In this case, target pressure is temporarily increased to *Pressure Target + Limit*. When the Pressure Target returns to normal (no *Limit* imposed), then the drive will monitor the pressure of the system to see if the pressure remains above *Pressure Target*. If the pressure is maintained, the drive will go to an idle state (no demand and check valve is closed). That the pressure was increased above the *Pressure Target*, this traps more water in the pressure tank during the ensuing zero flow interval, and allows a greater water draw-off before the pump is restarted.

Quick Stp – The *Quick Stp* setting configures the drive for the type of motor stop to enforce during a motor shutdown. If the *Quick Stp* option is set to “yes”, the drive will freewheel stop to attempt a quick, almost immediate stop of the motor. If the option is set to “no”, the drive will ramp to a stop when the drive transitions to an idle state. If a fault or trip is encountered, the Quickstop option is ignored and the drive will freewheel stop.

Timers

The timers section allows the user to adjust various time increments used in the control sequences.

The Idle delay is present to configure the amount of time following the drive going to an idle (non-trip) state.

SW1 and SW2 Delay sets the amount of time where the switch state must persist before the switch state is recognized.

NFD timer sets the amount of time that is enforced between subsequent No Flow Detect (NFD) activities involving the Dip Test or Bump feature.

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Hertz

The Hertz section allows users to adjust the min and max operating condition of the drive.

The Min and Max setting serves as frequency limits that will be imposed when the drive is in a run state.

For Submersible applications, the Min can be set no lower than 30 Hz in order to prevent damage to the motor. For Centrifugal applications, the Min is allowed to be set as low as 10 Hz.

For Submersible applications, the Max is limited to 60 Hz for a 60 Hz motor selection and 50 Hz for a 50 Hz.

The Hand setting sets the fixed frequency that is enforced with hand mode selected in a panelized application. This setting is therefore very likely unused by the application.

The Accel adjustment controls the drives acceleration speed in Hertz per second. This adjustment applies to the acceleration after minimum speed has been achieved.

Note: For submersible applications, the minimum setting is 30 Hz per second. A submersible motor should not run at speeds below 30 Hz for time periods beyond one second.

Control Loop

The SubDrive HPX allows the user to modify the control loop parameters for pressure regulation and flow control modes to optimize the control response. Changes to the control loop parameters should only be made by skilled individuals that have also had the opportunity to assess the system performance over a period of time. If changes to the control parameters are under consideration, then it is suggested that the user ensures that the Bump and Dip Test features are disabled. After completing an analysis of the system, ensure that the Bump and Dip Tests are restored to their original settings.

Proportional (*Proportion/*) – This adjustment changes the proportional gain for the proportional element of the PID controller. The default for this parameter is set to 33% (gain = 1/3).

Reset Rate (*Rst Rate*) – This adjustment establishes the reset time interval for the integrator term in the PID controller. The default for this parameter is set to 14 minutes.

EFlex Ctrl

EFlex Enable (Eflx Enble) is not used at this time and should remain set to No.

Reset Timers

If none of the fault counting mechanisms have been encountered that can latch the drive in a lockout state, then the Reset Timers parameter allows the user to immediately resume operation following a system trip or a bump or dip test. The Reset Timers feature leaves the underload and other-trips counters unaffected.

Modbus add Prg. C is not used.

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Monitor Screen Configuration (Optional)

Selecting the Control Scheme is done by moving to the following screen:

From Main Menu > Monitoring Config.

The Monitoring Configuration allows you to customize the main display screen.

Monitor Config. has three configuration options:

- o Parameter Bar Selection (Param. Bar Select)
- o Monitor Screen Type
- o Com Map Config. (Not used)

Parameter Bar Selection (Param. Bar Select)

This selection allows you to customize the values to be viewed on the main screen. Select the item and a check mark indicates the item will be displayed. The options for display are listed in the table below.

Parameter	Description	Parameter	Description
Alarm Groups	Current Alarm Group Numbers	Run time	in secs, mins or hrs, motor time
Frequency Ref.	Frequency reference via the graphic display	Power on time	in secs, mins or hrs, drive alive time
Output frequency	in Hz, targeted output frequency	IGBT alarm counter	in secs, length of time IGBT temp alarm active
Measured output fr.	Encoder card installed, mtr speed, otherwise 0	PID reference	PID reference as a process value
Pulse in work freq.	in Hz, freq of "Pulse Input" (Freq Meter)	PID feedback	PID feedback as a process value
Motor current	in A	PID error	PID error as a process value
Motor speed	in rpm	PID Output	in Hz, accessible w/PID function configured
Motor voltage	in V	Pressure/Flow	pressure (PSI) or pressure (Bar) or Flow (%)
Motor power	as a % of the rated power	Menu Select	Menu: Motors, Control, Param, Datalog
Motor torque	as a % of the rated torque	Motor Type	Subm 60 Hz, Surf 60 Hz, Subm 50 Hz, Surf 50 Hz
Mains voltage	in V, DC bus line voltage	Motor Size	Motor Size in hp or kW
Motor thermal state	as a %	Motor Volts	Motor Voltage Rating
Drv. thermal state	as a %	Config active	Active Configuration (n0, 1 or 2). Not used
DBR thermal state	as a %, only accessible on high rating drives	Utilized param set	Set n1, 2 or 3. Not used
Input Power	in kW, electrical power consumed by drive	Local / Remote	Local / Remote status. Not used
Consumption	in Wh, kWh or MWh, accum consumption.		

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Monitor Screen Type

This menu allows the user to modify the monitoring screen's display method.

The Display value type provides the following options:

- o Digital – Display a maximum of two (2) parameters on the display.
- o Bar Graph – Displays a maximum of two (2) parameters listed above as a bar graph.
- o List – Displays a maximum of five (5) parameters from the Param Bar Select listed above in a values-listed format.

Data Log (Fault History)

The Data Log is useful in order to review the drive operation and fault history.

The Run Time line indicates the total run time of the motor.

Last Program Change (*Lst Prm Chg*) indicates the last parameter to be changed along with Date (MM/DD), time and the name of the parameter changed.

Controller Faults

Clear Log is a way for the user to clear the fault log.

Controller Faults (Cntrl. Faults) lists all the controller fault logs including the date of the fault (MM/DD), time and the name of the parameter.

Drive Faults

Fault log containing the most recent problems that were encountered related to motor selection, wiring issues or drive/motor/pump problems.

