



FASTEC DRIVE

User Manual

V1.0

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Electrical Safety and Regulations Compliance

In its description of high and medium risk electrical products (as are listed in the WorkSafe website¹) the Electricity (Safety) Regulations do not include products of the type of the Fastec Drive

In design, development and manufacturing Fastec Drive references the following standards:

1. AS/NZS 3820: 2009 Essential safety requirements for electrical equipment (Incorporating amendment 1).
2. AS/NZS 3100: 2017 Approval and test specification – General requirements for electrical equipment.
3. AS/NZS 61000.3.2: 2013 Electromagnetic compatibility (EMC) Part 3.2: Limits for harmonic current emissions (equipment input current $\leq 16A$ per phase).
4. AS/NZS 61000.3.3: 2012 Electromagnetic compatibility (EMC) Part 3.3: Limits – Limitation of Voltage changes, voltage fluctuations and flicker in public low voltage supply systems, for equipment with rated current $\leq 16A$ per phase and not subject to conditional connection.
5. AS/NZS 61000.3.11: 2002 Electromagnetic compatibility (EMC) Part 3.11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems – Equipment with rated current less than or equal to 75A and subject to conditional connection.
6. AS/NZS 61000.3.12: 2013 Electromagnetic compatibility (EMC) Part 3.12: Limits – Limits for harmonic currents produced by equipment connected to public low voltage systems with input current $> 16A$ and $\leq 75A$ per phase.

¹ <https://worksafe.govt.nz/topic-and-industry/electricity/appliances-and-fittings/core-requirements/>

7. IEC 61800-3: 2018 Adjustable speed electrical power drive systems Part 3: EMC requirements and specific test methods.

Fastec Drive is a component of a power drive system. Therefore factors other than Fastec Drive may determine the performance of the total system.

Safety Precautions

Safety precautions must be observed to avoid the risk of injury.

Operation	Risk
Before installation	<ul style="list-style-type: none"> ● Check that the product has not been damaged ● For safety, ensure that the power demand from the motor and load does not exceed the Drive's capacity
During installation	<ul style="list-style-type: none"> ● Install the product on flame-resistant surfaces such as a metal enclosure and away from any combustible material
During wiring	<ul style="list-style-type: none"> ● Turn the power off before wiring ● Wiring should be carried out by a qualified person ● Ensure that the wire diameters are correct for the application ● A circuit breaker must be installed between the Drive and the power supply to prevent over-current damage ● Ground to electrical best practice
Before power on	<ul style="list-style-type: none"> ● Ensure that all wiring is securely connected ● Check that the motor can be operated safely
After power on	<ul style="list-style-type: none"> ● Do not touch electrical components in the drive system. ● The Drive will detect any short circuit on the motor side. Presume electrical components on the motor side are live until tested.
During operation	<ul style="list-style-type: none"> ● Do not touch the electrical components in the drive system. ● Observe safety precautions for the machine ● Only qualified persons should undertake work on the Drive
During maintenance	<ul style="list-style-type: none"> ● Turn power off before maintenance. ● The DC link capacitors may retain a residual charge which can cause an electric shock if touched. The power stage must be tested before any part is touched. ● Only qualified persons should undertake work on the Drive
Operation	Caution
During Installation	<ul style="list-style-type: none"> ● When multiple drive units are installed, leave at least a 5cm gap between them and keep ventilation channels clear. ● Keep loose material away from the Drives.
During wiring	<ul style="list-style-type: none"> ● If a braking resistor is used, connect it to the port designated on the Drive.

Before power on	<ul style="list-style-type: none">● Make sure that all peripherals are correctly connected and commissioned.
After power on	<ul style="list-style-type: none">● Configure the drive parameters correctly. If parameters are changed ensure that all prerequisites are met.● Do not change parameters that are marked for manufacturer's use without reference to the manufacturer
During operation	<ul style="list-style-type: none">● Ensure that environmental standards are met.

Product Introduction

FASTEC Drive can run a 3 phase motor up to 7.5kW capacity on 1 phase power supply². The Drive can be operated using a control box for simple on/off operations and it can be integrated into a control system using PtP communication or digital and analogue inputs and outputs signals. FASTEC Drive can run in Sensorless Vector Control mode (SLVC) or V/F mode. When running in SLVC mode, FASTEC Drive can automatically recognize the motor's parameters and self calibrate its control algorithm. This simplifies the pre-installation work required to be completed by the user.

FASTEC Drive System Layout

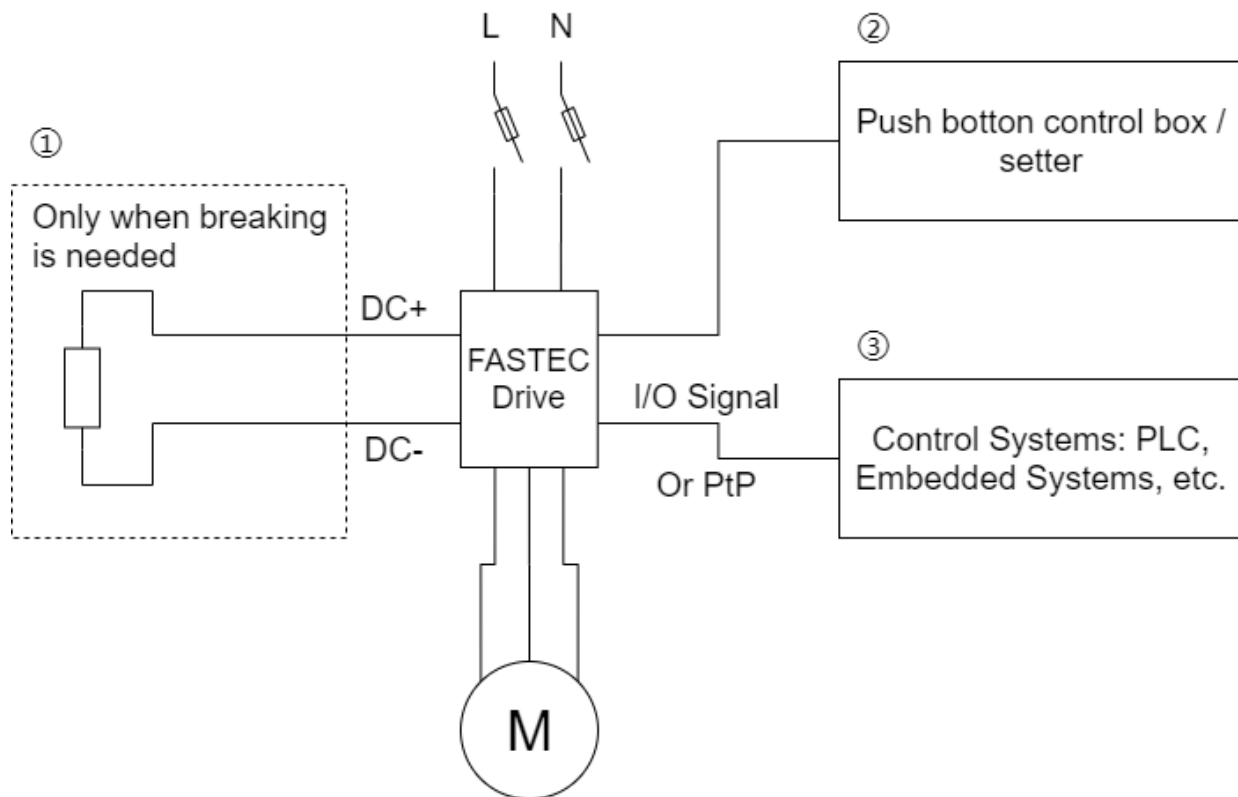


Fig 1.

² Given the motor accepts 230V 3AC supply and a few other preconditions;

Braking Circuit

A braking circuit is needed when the motor operates in generator mode (an example would be a cable car on the downward travel). A braking circuit is a standard feature of Fastec Drive, so to operate in generator mode requires only that an appropriately selected braking resistor is connected. The connection is shown in ① of Fig 1.

Fastec Ltd can help in selecting the correct resistor.

Control Boxes

FASTEC provides two control boxes. If the motor is to be controlled manually, use the push-button control box of Fastec Drive. However, if more flexibility is required, the Setter would be used. The Setter can program Fastec Drive to operate in different modes. Both Control boxes are shown in ② of Fig 1. The push-button control box and the Setter can be connected to FASTEC Drive simultaneously.

For machines that require more functions, as shown in ③ of Fig 1, FASTEC Drive can be integrated into the control system using PtP communication or I/O ports. The machine controller (which controlled the single phase motor) is then replaced by a logic controller which controls Fastec Drive (which controls the 3 phase motor). FASTEC provides a system integration and retrofit service so that users can make full use of FASTEC Drive's performance.

Environment, Storage, Installation

Environment

- The ambient temperature must be within the range of -20 °C to 50 °C;
- The relative humidity must be within the range of 0% to 95% without condensation;
- The Drive must be free of any corrosive gas or liquid, gas, steam, dust or moisture. The environment must be free of strong electromagnetic interference or radioactive radiation.

Storage

If the Drive is stored for 2 months or more it must be pre-charged for at least 30 minutes before being used. To pre-charge the Drive, connect it to a single-phase power supply with 220V - 240V and 50Hz / 60Hz.

Note: It is good practice to pre-charge the Drive for a few minutes before use.

Installation

Installation requirements for FASTEC Drive.

- The input power to FASTEC Drive should be connected through a circuit breaker and fuse to protect against overcurrent.
- Shielded cable is recommended to be used to connect FASTEC Drive to the motor. An example of a shielded cable is shown below.

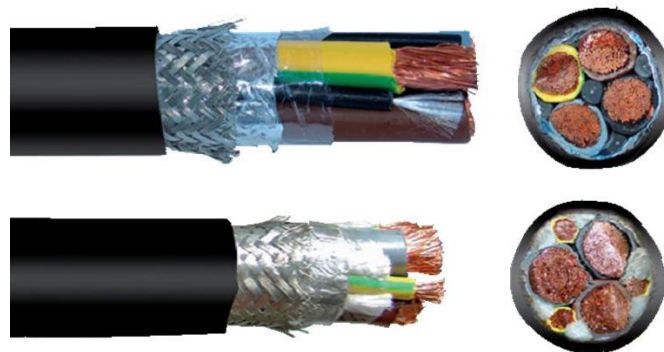


Fig 2.

- For reliable EMC performance, multi-earthing is recommended. If multi-earthing is not possible, there should be maximum conductance in the drive system to improve EMC performance and efficiency. For example, the electrical cabinet’s backplate can be used to provide a better EMC connection.
- The motor cable should be as close to the motor as possible. The length of unshielded motor cable should not exceed 5m. The length of shielded cable should not exceed 10m.
- Only correctly dimensioned cables should be used in the drive system and all connections firmly made.
- If PTP communication is used, the communication cable and power cable (input and motor side) should be as distant from each other as possible and shielded communication cables should be used. If a crossing between the communication cable and power cable is unavoidable, the crossing should be at 90°.
- The drive unit should preferably be installed in a metal electrical cabinet.
- An isolation transformer should be used to supply the control system.

Fastec can provide technical assistance with installation.

Control Interface Installation

For many applications FASTEC Drive will need to be controlled by a controller. The controller can be a PLC or a terminal box with digital signals. Requirements for the installation of the control interface are shown as follows.

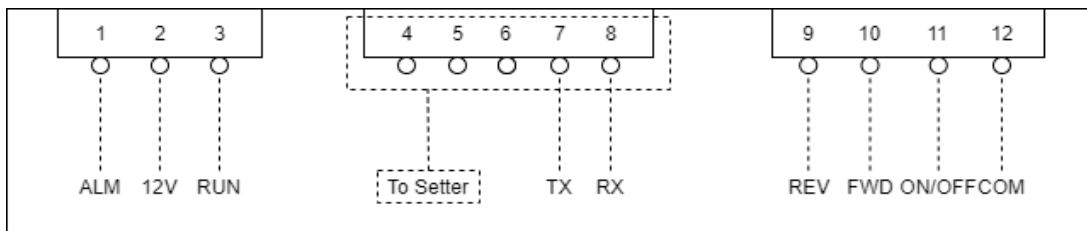


Fig 3.

Functions of the ports:

- Port 1: ALARM signal. This is a drain signal powered by port 2. The number of pulses in 1 indicates the type of error. Refer to Error Message Description for more details.
- Port 2: 12V supply for port 1 and 3.
- Port 3: RUN signal. This is a drain signal and indicates the ON/OFF status of FASTEC Drive.
- Ports 1 - 3 give the status of FASTEC Drive either by attaching an LED or by applying the signal to a PLC's digital input.
- 4 - 8: Setter interface and PtP terminals.
- 9 - 12: Digital inputs for the run, stop and reverse signals.

Note that 9-12 only needs edge signals. A constant current flowing through the terminals can cause overheating and damage.

Product Dimensions

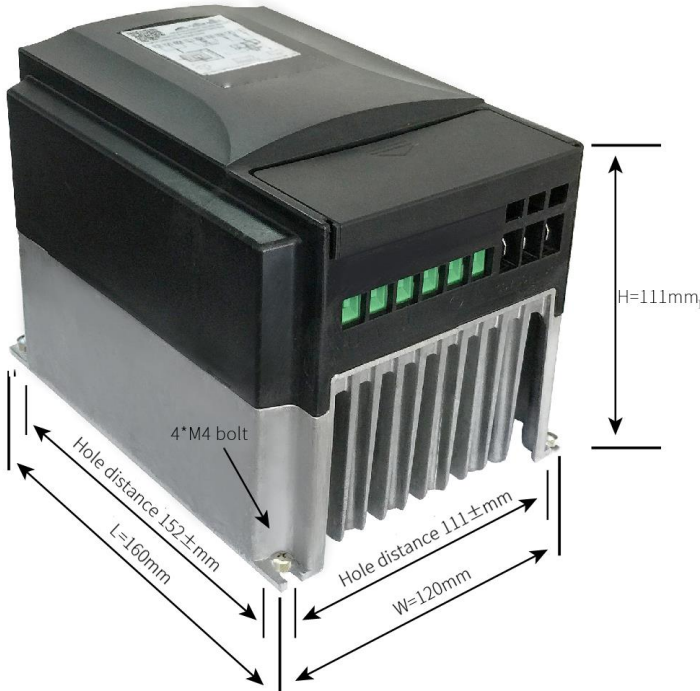


Fig 4.

Product Configuration

Standard Configuration

The standard configuration is pre-programmed by Fastec from information provided by the user.

The user does not need to have experience with electrical drives and can complete the installation from instructions provided. It is recommended that installation is done by an electrician.

The process is as follows:

1. FASTEC is given details of the motor and of the equipment. The enquiry form is available on the FASTEC website;
2. FASTEC loads the information and supplies the Drive with all functions pre-programmed;
3. The user/electrician installs FASTEC Drive;

In standard configuration, FASTEC Drive will run on V/F mode.

Advanced Configuration

With advanced configuration, users can make modifications to the wide range of functions available in FASTEC Drive. Examples are: switching between V/F mode and SLVC mode, switching between the different drive control interfaces and modifying the drive control parameters. Users should have some experience with electrical drive technology.

With advanced configuration, a Setter must be used to access the configuration interface. The Setter control panel is shown in fig 5.







Fig 5.

Using the Setter, the following operations can be performed:





- Run and stop the motor with the ON/OFF button;
- Manually set the output frequency of FASTEC Drive with a + and - button and adjust the motor speed when the motor is running with the + and - button;
- Read FASTEC Drive’s operating status and error messages;
- Change FASTEC Drive’s parameters;

Setter LED description

LED	Description
	LED is lit when FASTEC Drive is running the motor.
	LED is lit during the motor parameter recognition process. The load connected to the motor shaft must be disconnected for safety and accuracy reasons.
	LED is lit when the Setter is in parameter modification mode.

	<p>LED blinks when communication between the Setter and FASTEC Drive is established. Communication is established automatically when the Setter is plugged into the correct slot and powered on.</p>
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Membrane button Description

Button	Description
	<p>The ON/OFF button is used by FASTEC Drive to run and stop the motor. The button “flips” its status every time it is pushed.</p>
	<p>The + and - buttons scroll between parameters and change their values.</p>
	<p>The set button is used in the parameter reading or setting mode. Using a long press, the Setter will enter or exit the reading or setting mode. Using a short press, the Setter switches parameters between different groups or different parameters.</p>
	<p>The enter button, when in operating mode, changes the parameters displayed by the Setter. In parameter setting mode, the enter button switches between the parameter and its value and saves the value to FASTEC Drive.</p>

Display description

The Setter uses 6 seven-segment displays to display information with text. When powered on, the Setter will show the version of the Setter and the Drive unit. The user can navigate by pressing the *set* button.

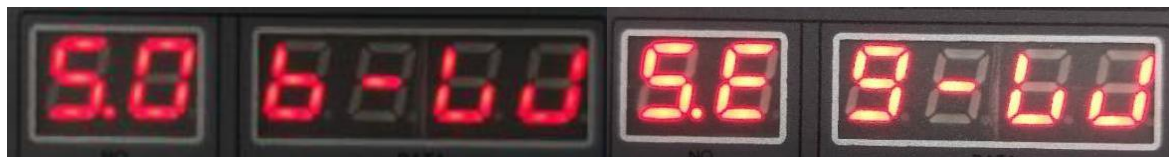










Fig 6.








Steps to change FASTEC Drive’s parameters are:

- Check all connections.
- Power on FASTEC Drive and:

- To read the Drive status, press *set* twice and all status parameters can be accessed.
Use *set* and *enter* to navigate between the parameters;
- To access and read the Drive parameters, press and hold *set* for 1.5s and the Setter will enter the parameter page;
- To access and modify the Drive parameters, press and hold *set* for another 1.5s after the first time and the ADJUST led will turn on;

The Drive status code and meanings are listed as follows.

Status Code	Data	Unit	Meaning
	Output Frequency	Hz	The output frequency of FASTEC Drive. It can be adjusted by the + and - button
	Reserved	None	Used by FASTEC engineering. Not available to users
	Input Voltage	V	The RMS value of FASTEC Drive's input voltage. Read-only
	Output Voltage	V	The RMS value of FASTEC Drive output voltage. Read-only
	Output Current	A	The RMS value of FASTEC Drive output current. Read-only
	Ambient temperature	°C	The ambient temperature of FASTEC Drive. Read-only
	Reserved	None	Used by FASTEC engineering. Not available to users
	Error code	None	Error code for FASTEC Drive. Refer to Error Message Description for details. Read-only

	Reserved	None	Used by FASTEC engineering. Not available to users
	Reserved	None	Used by FASTEC engineering. Not available to users
	Torque Current	A	The motor torque current calculated by FASTEC Drive. Read-only
	Excitation Current	A	The motor excitation current calculated by FASTEC Drive. Read-only
	D Axis Current	A	The motor D axis current calculated by FASTEC Drive. Read-only
	Q Axis Current	A	The motor Q axis current calculated by FASTEC Drive. Read-only
 R	Maximum Current	A	The maximum output current of FASTEC Drive. Read-only

Parameters for Advanced Configuration

FASTEC Drive is accessible to users wishing to use advanced configuration options. When the Setter is plugged in and parameters adjustment activated, users can change parameters that involve the motor control algorithms. Below are the parameters that can be changed.

Parameter Number	Parameter	Accepted Range	Default Value	Note	
1	1	Function Selection	00 - 3FF	80	Function Setting Description
	2	Minimum Frequency	0.0 - 3.0	0.5	
	3	Maximum Frequency	50.0 - 240.0	200.0	

	4	Over-current Threshold	0.0 - 30.0		Normally set at 1.2 times the rated current
	5	Maximum Current	0.0 - 30.0		Normally set at 2 times the rated current
	6	Temperature Protect	80 - 100	96	The fan is automatically controlled when 96 is set. With any other value the fan will run continuously
	7	Over-voltage Protection	220 - 290	280	
	8	Carrier Wave Period	128 - 255	128	Controls the switching frequency of IGBT
	9	Speed Ramp	0 - 200	16	Speed ramp slope time
2	1	Rated Frequency	30.0 - 100.0	50	Rated motor frequency
	2	Rated Voltage	80.0 - 240.0	200	Rated motor voltage (= 0.9 * motor plate rated voltage)
	3	Low-Speed Frequency	0 - 50	5	Low-speed adjustment frequency
	4	Low-Speed Voltage	0 - 240	20	Low-speed adjustment voltage
	5	Minimum Voltage	0 - 20	10	Minimum output voltage
	6	1/TR	-	-	Reserved
	7	Stator Voltage	-	-	Reserved
	8	Stator Inductance	-	-	Reserved
	9	Stator leak Inductance	-	-	Reserved
	A	TROT	-	-	Reserved
	B	Reserved	-	-	Reserved

	C	Reserved	-	-	Reserved
	D	Reserved	-	-	Reserved
3	1	KP-N	0 - 255	80	High-speed PI P factor. Modification not recommended
	2	KI-N	0 - 255	8	High-speed PI I factor. Modification not recommended
	3	KP-U	0 - 255	32	Low-speed PI P factor. Modification not recommended
	4	KI-U	0 - 255	32	Low-speed PI I factor. Modification not recommended
	5	Reserved	-	-	Reserved
	6	Reserved	-	-	Reserved
4	1	Reserved	-	-	Reserved
	2	Reserved	-	-	Reserved
5	1	U Current Offset	1F8 - 208	1FF	Modification not recommended
	2	W Current Offset	1F8 - 208	1FF	Modification not recommended
	3	Dead Zone	0 - 70	16	Modification not recommended
	4	Current Phase Offset	0 - FF	40	Modification not recommended
6	1	Reserved	-	-	Reserved
	2	Reserved	-	-	Reserved

	3	Reserved	-	-	Reserved
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Function Setting Description

The function setting is an eight-bit register controlled by the parameter 1.1 in Function Selection.

Each bit of the register controls one function of FASTEC Drive. Their descriptions are as follows.

Bit	Function	0	1
7	Baud Rate	1200	4800
6	Braking Current	Low	High
5	Reserved	-	-
4	Reserved	-	-
3	Parity	Odd	Even
2	Error Message Sending Set	Send after stop	Send when occurring
1	Under Voltage Protection	No	Yes
0	Reverse	Forward	Reverse

Error Message Description

Error messages can be obtained from FASTEC Drive by 2 methods

1. Using the Setter
2. Checking the pulse signal from ports 1 and 2 of FASTEC Drive’s control interface.

The error messages are as follows:

Fault	Error Message	Pulse from Port 1 and 2	Potential Cause
Communication failure	01	1 pulse, repeat after 2s	<ul style="list-style-type: none"> ● Control interface failure; ● Hardware failure.
Power module failure	02	2 pulses, repeat after 2s	<ul style="list-style-type: none"> ● Power module fail; ● Overcurrent protection activated.
Overvoltage	04	3 pulses, repeat after 2s	<ul style="list-style-type: none"> ● Line voltage exceeds limits;

			<ul style="list-style-type: none"> ● 1.7's value is too low.
Overload	08	4 pulses, repeat after 2s	<ul style="list-style-type: none"> ● The required motor current is too high; ● 1.4's value is too low.
Phase lost	10	5 pulses, repeat after 2s	<ul style="list-style-type: none"> ● One phase of the motor is not properly connected.
Undervoltage	24	6 pulses, repeat after 2s	<ul style="list-style-type: none"> ● The line voltage is too low; ● 1.7's value is too high³.
I/O failure	-	7 pulses, repeat after 2s	<ul style="list-style-type: none"> ● The I/O interface is faulty.
Over temperature	80	8 pulses, repeat after 2s	<ul style="list-style-type: none"> ● Drive ventilation is not sufficient; ● Drive's fan is not working properly; ● 1.6 is too low
Current sensor error	18, 88, 98	9 pulses, repeat after 2s	<ul style="list-style-type: none"> ● Current sensor failure; ● Motor cable is not connected properly.

To clear an error message and to restart the drive:

1. Resolve the fault.
2. If the ALM pulse is still on, tap the ON/OFF button of the Setter to clear the error message

V/F Configuration Process

FASTEC Drive is configured into V/F mode as follows:

1. Complete the motor drive system setup and plug in the Setter;
2. Power on the Drive and long-press the *set* button twice to enter the parameter editing mode. When in editing mode, the SET LED will be on;
3. Press *set* to navigate through different parameter groups and use the + and - button to choose different parameters within the groups. Use the *Enter* button to start and finish a

³ Parameter 1.7 is used as the protection threshold for overvoltage. In the meantime, 0.5*parameter 1.7 is the undervoltage protection threshold when the drive is not running and 0.25*parameter 1.7 is the undervoltage protection threshold when the drive is running.

parameter edit and the + and - button to change the parameter's value. The following changes can be made:

Parameters	Value	Note
2.1 Rated frequency	Motor plate rated frequency	Normally 50Hz. Sometimes 60Hz
2.2 Rated voltage	0.9 * motor plate rated voltage	For IEC motors, use the delta connection rated voltage. Usually 220V. Does not apply to NEMA motors.
2.3 Low-Speed Frequency	5	Use the default value unless the starting torque is too large or too small
2.4 Low-Speed Voltage	20	Use the default value unless the starting torque is too large or too small
3.1 KP-N	0	
3.2 KI-N	0	
3.3 KP-U	0	
3.4 KI-U	0	

4. After finishing the parameter editing, tap the *ON/OFF* button to exit.
5. Use the + and - button to set the output frequency and the *ON/OFF* button to run the motor. If the performance meets requirements, keep the motor running for about 5s. After 5s, ports 2 and 3 will have a 12V signal output indicating that the drive has memorised the speed setting.
6. Stop the motor with the *ON/OFF* button. Power off the Drive and unplug the Setter. Apply the control signal to the Drive. If configuration is correctly completed, the Drive control signals will run the motor.

SLVC Configuration Process

SLVC mode is used when higher motor speed control or higher starting torque accuracy is needed. To run the motor with SLVC, motor parameters recognition is required.

Following are the steps for running the motor parameters recognition process:

1. Complete the motor drive system setup and plug in the Setter;
2. Decouple the load from the motor shaft. If that is not possible, then some mechanical components can remain attached to the motor shaft providing that no further load is connected. For example, with a pulley transmission, the wheel attached to the motor shaft can remain providing the belt or pulley is detached.
3. Long press the *set* button twice to get to the following display:



Fig 7.

4. Tap the *Enter* button and then the *ON/OFF* button, FASTEC Drive will automatically initiate the motor parameters recognition process;
5. The motor parameters recognition will last for roughly 2 mins. When the process is complete, the Setter will display parameter 2.8 shown as follows (The 2.8's value varies for different motors);

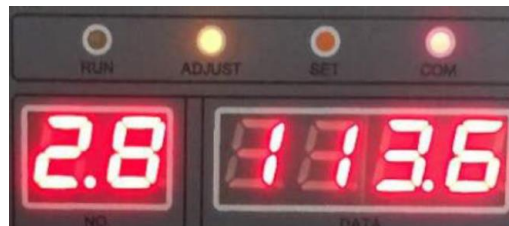


Fig 8.

6. Input the motor rated voltage and frequency and the low-speed voltage and frequency values as for the V/F configuration. Use the default PI controller values (3.1 - 3.4).
Normally, 3.1 and 3.2 will not need to be changed. 3.3 and 3.4 re-adjusted to increase or decrease the speed loop response performance. If the speed adjustment is not fast enough, then 3.3 and 3.4 should be increased. If the speed adjustment is too fast and causing an overshoot, then 3.3 and 3.4 should be decreased.
7. Use the + and - button to set the output frequency and the *ON/OFF* button to run the motor. If the performance meets requirements, allow the motor to run for approximately 5s. Ports 2 and 3 will have a 12V signal output indicating that the drive has memorized the speed setting.
8. Stop the motor with the *ON/OFF* button. Power off the Drive and unplug the Setter.
Apply the control signal to the Drive. If configuration is correctly completed, the Drive control signals will run the motor.

I/O Control Configurations

The basic I/O configuration is provided in the section control Interface Installation. This section will provide information about I/O Control. The I/O control includes two functions which are JOG and ON/OFF. In either function, the motor will run at the memorized speed set during the V/F or SLVC configuration. The two functions are available at the same time so the motor control can be flexible.

With the JOG function, the user can send a constant signal to the FWD or REV port, i.e., close the respective relay, and the motor will start and run at the preset speed until the signal at FWD or REV is removed. When the motor runs, the 12V output signal will be activated at ports 2 and 3. The relationships between signals in this function are described in the following chart.

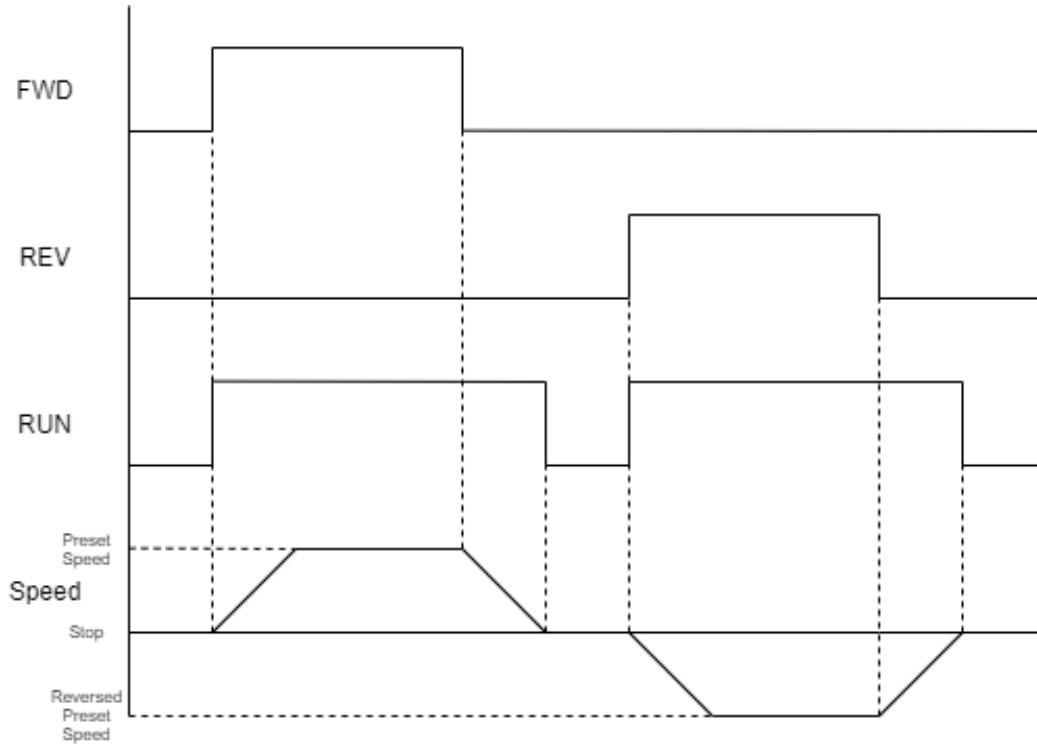


Fig 9.

Using the ON/OFF function, the user can send an edge signal to either FWD or REV to set the direction and then send an edge signal to the ON/OFF port to start the motor. A 12V output signal sent by ports 2 and 3 will indicate that setting the direction and running the motor has been successful. While running, an edge signal sent to the opposite direction port, either FWD or REV can alter the motor direction. The motor will first stop and then start to run in the other direction. An edge signal sent to the ON/OFF port again will stop the motor and the 12V output signal from ports 2 and 3 will be removed. The relationships between signals in this function are shown in the following chart.

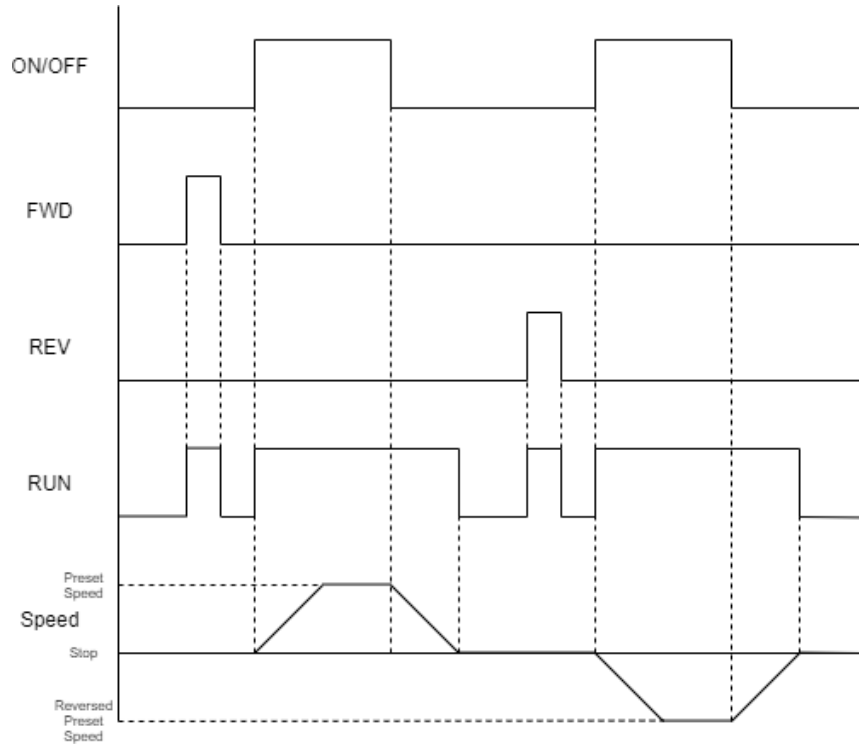


Fig 10.

PTP Communication Configuration

PTP communication is used to allow the user needs to control the motor speed while the motor is running. It is needed when FASTEC Drive is integrated into an automation system.

For more information about FASTEC Drive’s PTP communication function, please contact Fastec for more details.