

## Positioning Overview

The PowerFlex 525 drive includes a simple position regulator which can be used in a variety of position applications without the need for multiple limit switches or photo-eyes. This can be used as a stand-alone controller for simple applications (up to 8 positions) or in conjunction with a controller for more flexibility.

Please note that this is not intended to replace high end servo controllers or any application that needs high bandwidth or very high torque at low speeds.

## Common Guidelines for All Applications

The position regulator can be configured for operation appropriate for a variety of applications. Certain parameters will need to be adjusted in all cases.

[P047](#) [Speed Reference1] must be set to 16 “Positioning”.

[A535](#) [Motor Fdbk Type] must be set to match the feedback device. Positioning mode must use [A535](#) [Motor Fdbk Type] option 4.

### [A535](#) [Motor Fdbk Type] Options

**0 “None”** indicates no encoder is used. This can not be used for positioning.

**1 “Pulse Train”** is a single channel input, no direction, speed feedback only. This should not be used for positioning. The Single Channel selection is similar to a Pulse Train, but uses the standard encoder scaling parameters.

**2 “Single Chan”** is a single channel input, no direction, speed feedback only. This should not be used for positioning. Single channel uses the standard encoder scaling parameters.

**3 “Single Check”** is a single channel input with encoder signal loss detection. The drive will fault if it detects that the input pulses do not match the expected motor speed. This should not be used for positioning.

**4 “Quadrature”** is a dual channel encoder input with direction and speed from the encoder. This may be used for positioning control.

**5 “Quad Check”** is a dual channel encoder with encoder signal loss detection. The drive will fault if it detects that the encoder speed does not match the expected motor speed.

[A544](#) [Reverse Disable] should be set to 0 “Rev Enabled” to allow bidirectional movement necessary for position control.

[P039](#) [Torque Perf Mode] default setting is 1 “SVC”. However, any mode can be used to improve the low speed torque for positioning applications. For best results, tune the application first. The autotune routine can be completed to further improve the drive-motor performance.

[A550](#) [Bus Reg Enable] default setting is 1 “Enabled”. If the deceleration time is too short, the drive may overshoot the desired position. For best results, a longer deceleration time may be necessary. [A550](#) [Bus Reg Enable] can be disabled to provide precise stopping movements, but the deceleration time will need to be manually tuned so that it is long enough to avoid F005 “OverVoltage” faults.

[A437](#) [DB Resistor Sel] default setting is 0 “Disabled”. If improved deceleration performance is required a Dynamic Brake resistor can be used. If used, this parameter should be set to the appropriate setting for the resistor selected.

[P035](#) [Motor NP Poles] must be set to match the number of motor poles on the motor driven by the PowerFlex 520-series drive.

[A536](#) [Encoder PPR] must be set to match the number of pulses per revolution of the encoder used (i.e., 1024 PPR Encoder).

[A559](#) [Counts Per Unit] sets the number of encoder counts that will be used to define one position unit. This allows the encoder positions to be defined in terms of units important to the application. For example, if 1cm of travel on a conveyor belt requires 0.75 turns of the motor, the motor encoder is 1024 PPR, and the Motor Feedback type is set to Quadrature, then this parameter would need to be set to  $(4 \times 1024 \times 0.75) = 3072$  counts for one cm of travel. Then all other positions could be setup in units of “cm”.

[A564](#) [Encoder Pos Tol] indicates the desired position tolerance for the system. This will determine how close the drive must be to the commanded position before the drive will indicate “At Home” or “At Position” in units of raw encoder pulses. This has no effect on the actual positioning control of the motor.

## Positioning Operation

Parameter [A558](#) [Positioning Mode] must be set to properly match the desired operation of the positioning function.

### [A558](#) [Positioning Mode] Options

**0 “Time Steps”** uses Step Logic times. This mode ignores the Step Logic settings and moves through the steps (Step 0 to Step 7 and back to Step 0) based on the times programmed into [L190...L197](#) [Stp Logic Time x]. This can be used when the desired position is based only on time. In addition, this mode only accepts absolute positions in a positive direction from “home”. This option provides an easy way to implement a simple positioning program or to test the basic positioning setup. For additional flexibility one of the other settings should be used.

**1 “Preset Input”** directly commands movement to any step based on the status of the digital inputs programmed for “Preset Freq”. This setting ignores the Step Logic Commands settings and instead the drive will move directly to whatever step is currently commanded by [A410...A425](#) [Preset Freq x] and [L200...L214](#) [Step Units x]. This is useful when an application needs direct access to any position step based on discrete inputs. This mode moves in the forward direction from Home and is an absolute move.

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**IMPORTANT** Advanced Step Logic options such as incremental move are not available in this mode.

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**2 “Step Logic”** provides a highly flexible mode of operation. This can be used to move through the steps (Step 0 to Step 7 and back to Step 0) or can jump to a different step at any time based on time or the status of digital inputs or communication commands. In this mode the drive always starts at Step 0 of the Step Logic profile.

**3 “Preset StpL”** is identical to 2 “Step Logic” except the drive will use the current status of the Preset Inputs to determine which Step Logic step to begin. This only affects the initial step. After start, the drive will move through the steps in the same manner as if setting 2 was selected.

**4 “StpLogic-Lst”** is identical to 2 “Step Logic” except the drive will use the step prior to its last stop command to determine which Step Logic step to begin. This only affects the initial step. After start, the drive will move through the steps in the same manner as if setting 2 was selected. This allows a process to be stopped and then restarted at the position where it stopped.

In all position modes, the following parameters will control the characteristics at each step:

[L200](#), [L202](#), [L204](#), [L206](#), [L208](#), [L210](#), [L212](#) and [L214](#) [Step Units x] are the number value to the left of the decimal (whole number) of the 8 positions desired for an application, beginning with Step 0 (L200) and continuing with each step until Step 7 (L214). For example, enter 2 into this parameter if you would like a commanded position of 2.77.

L201, L203, L205, L207, L209, L211, L213 and L215 [Step Units F x] are the number value to the right of the decimal (the portion less than 1) of the 8 positions desired for an application, beginning with Step 0 (L201) and continuing with each step until Step 7 (L215). For example, enter 0.77 into this parameter if you would like a commanded position of 2.77.

[A410](#)...[A417](#) [Preset Freq x] are the parameters that define the maximum frequency the drive will run at during the corresponding step. For example, if [Preset Freq 2] is set to 40 Hz, the drive will accelerate to 40 Hz maximum when moving to Position 2.

Frequency Source	Step Source	Position Source
<a href="#">A410</a> [Preset Freq 0]	<a href="#">L180</a> [Stp Logic 0]	<a href="#">L200</a> [Step Units 0]
<a href="#">A411</a> [Preset Freq 1]	<a href="#">L181</a> [Stp Logic 1]	<a href="#">L202</a> [Step Units 1]
<a href="#">A412</a> [Preset Freq 2]	<a href="#">L182</a> [Stp Logic 2]	<a href="#">L204</a> [Step Units 2]
<a href="#">A413</a> [Preset Freq 3]	<a href="#">L183</a> [Stp Logic 3]	<a href="#">L206</a> [Step Units 3]
<a href="#">A414</a> [Preset Freq 4]	<a href="#">L184</a> [Stp Logic 4]	<a href="#">L208</a> [Step Units 4]
<a href="#">A415</a> [Preset Freq 5]	<a href="#">L185</a> [Stp Logic 5]	<a href="#">L210</a> [Step Units 5]
<a href="#">A416</a> [Preset Freq 6]	<a href="#">L186</a> [Stp Logic 6]	<a href="#">L212</a> [Step Units 6]
<a href="#">A417</a> [Preset Freq 7]	<a href="#">L187</a> [Stp Logic 7]	<a href="#">L214</a> [Step Units 7]

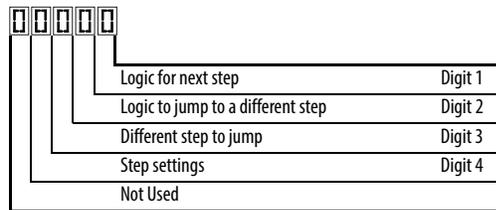
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**IMPORTANT** The default value for [A410](#) [Preset Freq 0] is 0.00 Hz. This value needs to be changed or the drive will not be able to move during Step 0.

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[L190](#)...[L197](#) [Stp Logic Time x] are the parameters that define the time the drive will remain in each corresponding step if that step is time-based. For example, if [L192](#) [Stp Logic Time 2] is set to 5.0 seconds and that step is time-based, the drive will remain in Step 2 for 5.0 seconds. Note that this is the total time in that step, not the time at that position. Therefore, it will include the time needed to accelerate, run, and decelerate to that position.

[L180](#)...[L187](#) [Stp Logic x] are the parameters that allow additional flexibility and control various aspects of each step when a positioning mode is selected that utilizes the Step Logic functions. Note that in Positioning mode these parameters have a different function than when used for normal velocity Step Logic. Each of the 4 digits controls one aspect of the each position step. The following is a listing of the available settings for each digit:



**Velocity Control Settings (Digit 4)**

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

**Positioning Settings (Digit 4)**

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Direction From Home	Type of Command
0	Accel/Decel 1	Off	FWD	Absolute
1	Accel/Decel 1	Off	FWD	Incremental
2	Accel/Decel 1	Off	REV	Absolute
3	Accel/Decel 1	Off	REV	Incremental
4	Accel/Decel 1	On	FWD	Absolute
5	Accel/Decel 1	On	FWD	Incremental
6	Accel/Decel 1	On	REV	Absolute
7	Accel/Decel 1	On	REV	Incremental
8	Accel/Decel 2	Off	FWD	Absolute
9	Accel/Decel 2	Off	FWD	Incremental
A	Accel/Decel 2	Off	REV	Absolute
b	Accel/Decel 2	Off	REV	Incremental
C	Accel/Decel 2	On	FWD	Absolute
d	Accel/Decel 2	On	FWD	Incremental
E	Accel/Decel 2	On	REV	Absolute
F	Accel/Decel 2	On	REV	Incremental

**Settings (Digit 3)**

Setting	Description
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

**Settings (Digit 2 and 1)**

Setting	Description
0	Skip Step (Jump Immediately)
1	Step Based on [Stp Logic Time x]
2	Step if "Logic In 1" is Active
3	Step if "Logic In 2" is Active
4	Step if "Logic In 1" is Not Active
5	Step if "Logic In 2" is Not Active
6	Step if either "Logic In 1" or "Logic In 2" is Active
7	Step if both "Logic In 1" and "Logic In 2" are Active
8	Step if neither "Logic In 1" nor "Logic In 2" is Active
9	Step if "Logic In 1" is Active and "Logic In 2" is Not Active
A	Step if "Logic In 2" is Active and "Logic In 1" is Not Active
b	Step after [Stp Logic Time x] and "Logic In 1" is Active
C	Step after [Stp Logic Time x] and "Logic In 2" is Active
d	Step after [Stp Logic Time x] and "Logic In 1" is Not Active
E	Step after [Stp Logic Time x] and "Logic In 2" is Not Active
F	Do Not Step/Ignore Digit 2 Settings

**TIP** Use the Wizard in Connected Components Workbench to simplify setup instead of manually configuring the parameters.

Note: Incremental move commands will cause the drive to move the amount specified based on the current position. Absolute commands are always with reference to "Home".

[A565](#) [Pos Reg Filter] provides a low pass filter at the input of the position regulator.

[A566](#) [Pos Reg Gain] is a single adjustment for increasing or decreasing the responsiveness of the position regulator. For faster response, the filter should be reduced and/or the gain should be increased. For smoother response with less overshoot, the filter should be increased and/or the gain should be reduced. In general, the gain will have a larger effect on most systems than the filter.

## Homing Routine

This drive supports incremental encoders only. Therefore, when the drive powers up it will reset the current position to zero. If this is known to be correct the position routine can be started without further adjustment. However, in most applications the drive will need to be “homed” after each power-up and prior to starting the position routine.

This can be accomplished in one of the following two ways:

1. Manual Homing—Program the following drive parameters:

[t062](#), [t063](#), [t065...t068](#) [DigIn TermBlk xx] = 37 “Pos Redefine”

Program one of the digital inputs to 37 “Pos Redefine”. Then, move the system into the home position with a run command, a jog command, or by manually moving the system into the home position. Then, toggle the “Pos Redefine” input. This will set the drive to “Home” at its current position and [d388](#) [Units Traveled H] and [d389](#) [Units Traveled L] are set to zero. Alternately, the “Pos Redefine” bit in [A560](#) [Enh Control Word] can be toggled instead of utilizing a digital input.

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**IMPORTANT** The “Pos Redefine” input or bit must be returned to inactive before starting the position routine. Otherwise the drive will continuously read a position of “0” (home) and the position routine will not function correctly.

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2. Automatic Homing to Limit Switch—Program the following drive parameters:

[t062](#), [t063](#), [t065...t068](#) [DigIn TermBlk xx] = 35 “Find Home”  
Program one of the digital inputs to 35 “Find Home”.

[t062](#), [t063](#), [t065...t068](#) [DigIn TermBlk xx] = 34 “Home Limit”  
Program one of the digital inputs to 34 “Home Limit”. Normally, the “Home Limit” input would be wired to a proximity switch or photo-eye and will indicate the system is in the home position.

[A562](#) [Find Home Freq] sets the frequency the drive will use while it is moving to the home position during the automatic homing routine.

[A563](#) [Find Home Dir] sets the direction the drive will use while it is moving to the home position during the automatic homing routine.

To begin the automatic homing routine, activate the “Find Home” input and then initiate a valid start command. The drive will then ramp to the speed set in [A562](#) [Find Home Freq] and in the direction set in [A563](#) [Find Home Dir] until the digital input defined as “Home Limit” is activated. If the drive passes this point too quickly it will then reverse direction at 1/10th [A562](#) [Find Home Freq] to the point where the Home Limit switch reactivates. Approximately one second after the routine finds home the drive will stop. Alternately, the “Find Home Freq” and/or “Home Limit” bits in [A560](#) [Enh Control Word] can be activated instead of utilizing a digital input. The inputs or bits should be returned to inactive after the routine is complete.

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**IMPORTANT** After the position is reached the drive will stop. If the Find Home is removed before the homing is complete, the drive will begin running the position routine without the proper home. In this case Home will not be reset and the position will be in relation to the power up position.

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## Encoder and Position Feedback

[d376](#) [Speed Feedback] indicates the measured speed feedback or the calculated speed feedback when no feedback device is selected. Parameter [d376](#) [Speed Feedback] is the number value to the left of the decimal (whole number) and [d377](#) [Speed Feedback F] is the value to the right of the decimal (the portion less than 1).

[d378](#) [Encoder Speed] indicates the measured speed of the feedback device. This is useful if the encoder is not used for motor speed control. However, the encoder must be used for some purpose in order for [d378](#) [Encoder Speed] to indicate a value. Parameter [d378](#) [Encoder Speed] is the number value to the left of the decimal (whole number) and [d379](#) [Encoder Speed F] is the number to the right of the decimal (the portion less than 1).

[d388](#), [d389](#) [Units Traveled x] indicate the current position of the system in terms of units away from Home. Parameter [d388](#) [Units Traveled H] is the number value to the left of the decimal (whole number) and [d389](#) [Units Traveled L] is the number to the right of the decimal (the portion less than 1).

[d387](#) [Position Status] indicates the status of the positioning functions. The indication bits are:

**Bit 0 “Dir Positive”** indicates the current direction the drive has moved from Home.

**Bit 1 “At Position”** indicates whether the drive is at its commanded position. If the drive is within [A564](#) [Encoder Pos Tol] of the commanded position, this bit will be active.

**Bit 2 “At Home”** indicates whether the drive is at Home. If the drive is within [A564](#) [Encoder Pos Tol] of “Home”, this bit will be active.

**Bit 3 “Drive Homed”** indicates whether the drive has been homed since power-up. This bit will be active once the drive has been homed either manually or automatically. It will remain active until the next power down.

## Use Over Communications

If 8 steps are not adequate for the application or if dynamic program changes are required, many of the positioning functions can be controlled through an active communication network. The following parameters will allow this control.

### [C121](#) [Comm Write Mode]

Repeated writes to parameters over a communication network can cause damage to the drive EEPROM. This parameter allows the drive to accept parameter changes without writing to the EEPROM.

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**IMPORTANT** Parameter values set prior to setting 1 “RAM only” are saved in RAM.

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### [C122](#) [Cmd Stat Select]

Selects velocity-specific or position/fibers-specific Command and Status Word bit definitions for use over a communication network.

### [A560](#) [Enh Control Word]

This parameter allows many of the positioning functions to be completed through parameter control using an explicit message. This allows the operation over communications instead of with hardware inputs. The bits have the same functions as the digital input options of the same name. Options relating to positioning are:

**Bit 0 “Home Limit”** indicates the drive is at the home position.

**Bit 1 “Find Home”** causes the drive to find home at the next start command. Deactivate this bit after completing the homing routine.

**Bit 2 “Hold Step”** overrides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released.

**Bit 3 “Pos Redefine”** resets the home position to the current position of the machine. Deactivate this bit after completing the homing routine.

**Bit 4 “Sync Enable”** holds the existing frequency when A571 [Sync Time] is set to enable speed synchronization. When this bit is deactivated the drive will accelerate to the new commanded frequency based on A571 [Sync Time].

**Bit 5 “Traverse Dis”** disables the traverse function when this bit is active.

**Bit 6 “Logic In 1”** provides an identical function and is logically ORed with setting 24 “Logic In 1” for [t062](#), [t063](#), [t065...t068](#) [DigIn TermBlk xx]. It can be used to move through the Step Logic functions (speed or position) using comms control without requiring actual digital input transitions.

**Bit 7 “Logic In 2”** provides an identical function and is logically ORed with setting 25 “Logic In 2” for [t062](#), [t063](#), [t065...t068](#) [DigIn TermBlk xx]. It can be used to move through the Step Logic functions (speed or position) using comms control without requiring actual digital input transitions.

#### [L200...L214](#) [Step Units x]

All of the position steps can be written to while the drive is running. The changes will take place at the next move. For example, if step 0 is over-written while the drive is moving to step 0, the drive will move to the previous commanded position at step 0. The next time the drive is commanded to return to step 0 it will proceed to the new position. One possible use of this capability is when an application requires full control of the movement by a controller external to the drive. The Step Logic program might be written to jump from step 0 back to step 0 when Input 1 is active. The controller could write any desired position to step 0 and then toggle the input 1 bit of [A560](#) [Enh Control Word] to cause the drive to move to the new position. This allows almost unlimited flexibility and can be used with absolute or incremental moves.

## Setup Notes

The RA computer tool (Connected Components Workbench) can make setup of the positioning functions much easier. Refer to the latest versions for additional tools or wizards which can aid in the setup.