Recycling and Bulk Materials | iSeries FUs

Contents:

i550 cabinet IP20 / NEMA Open Type

i550 protec IP66 / NEMA 4X

i550 motec IP66 / NEMA 4X

1 Introduction

This guide provides assistance in selecting and configuring Lenze iSeries VFDs for typical machines used in recycling and bulk material applications. The focus is on field-proven parameter sets for conveyor belts, screening drums, crushing and shredding machines, and mixers, as well as their implementation in the EasyStarter PC tool. For additional functions, such as the mapping of various fieldbuses, please refer to the Lenze product documentation or the help texts for the Lenze VFD PC tool EasyStarter.

Recycling and bulk material plants often consist of a chain of conveyors, screening/crushing stages, and mixing/dosing units. From a drive technology perspective, robust start/stop features, resonance avoidance, and process-reliable torque control are crucial.

Application	Objective	Key Parameters (Summary)
Conveyor belt	Protect mechanical components, belt monitoring	Ramps, S-ramp, skip frequency, load detection
Screen Drum	Smooth operation, avoid resonance	Long ramps, min. speed, skip frequency
Mixer	Torque & Process Quality	Vector/SLVC, Torque, PID, Dynamics, Reverse
Crusher / Grinder	Prevent blockages, Ensure high torque	Vector Control, Torque Limit, Reverse, Dynamics

2 General Settings

2.1 Conveyor Belt – Parameters (Recommendation)

Parameter	Description	Value (Recommendation)	Note
P300.000	motor control	6 – U/f (open loop)	Robust, easy commissioning
P210,000	Minimum frequency	~5 Hz	Stable startup
P211.000	Maximum frequency	~50 Hz	Depends on the application
P220.000	Acceleration time 1	10–20 s	Smooth belt start-up
P221.000	Delay time 1	10–20 s	Gentle stop
P226.001	S-ramp	30–50%	Jerk reduction
P303.xxx	skip frequency	1–3 zones	Avoid Resonances
P710.xxx	Load detection	Enable	Detect belt break / idle

2.2 Screen Drum – Parameters (Recommendation)

Parameter	Description	Value (Recommen-dation)	Note
P300.000	motor control	6 – V/f Control	High inertia
P210,000	Minimum Frequency	10–15 Hz	Stable continuous operation
P211.000	Maximum frequency	40–50 Hz	Depends on the application
P220,000	Acceleration time 1	20–60 s	Very long ramps
P221.000	Delay time 1	20–60 s	Protect the mechanics
P226.001	S-ramp	~50%	Smooth operation
P303.xxx	skip frequency	2–3 zones	Avoid resonance ranges

2.3 Mixer – Parameters (Recommendation)

Parameter	Label	Value (Recommendation)	Note
P300.000	motor control	8 – Sensorless	High dynamics & torque
motor	Motor Data	Nameplate + ID Run	Essential for Good Control
P210.000	Minimum Frequency	0–5 Hz	Process-dependent
P211.000	Maximum frequency	50–60 Hz	Process-dependent
P220.000	Acceleration time 1	3–10 s	Set dynamics
P221.000	Delay time 1	3–10 s	Set dynamics
P600 ff.	PID control	Optional activation	Process control

2.4 Crusher/Grinder – Parameters (Recommendation)

Parameter	Description	Value (Recommendation)	Note
P300.000	motor control	8 – Sensorless	High dynamics & torque
motor	Motor Data	Nameplate + ID Run	Required for high torque
P210.000	Minimum frequency	5–10 Hz	Prevents standstill under load
P211.000	Maximum frequency	40–60 Hz	Application-dependent
P220.000	Acceleration time 1	3–10 s	Fast response
P221.000	Delay time 1	3–10 s	Dynamic braking
P226.001	S-ramp	20–40%	Mechanical protection

2.5 Fan – Parameters (Recommendation)

Parameter	Description	Value (recommendation)	Note
P300.000	motor control	6 – V/f control / ECO Mode	Energy-efficient, ideal for square loads
P210,000	Minimum frequency	10–20 Hz	Safe operation, no flow interruption
P211.000	Maximum frequency	50–60 Hz	Full power
P220,000	Acceleration time 1	5–20 s	Gentle ramp-up
P221.000	Delay time 1	5–20 s	No mechanical stress
P226.001	S-ramp	20–40%	Smooth operation
P305.000	Switching frequency	Low (e.g., 2–4 kHz)	Improved efficiency

2.6 Checklist (Easy Starter)

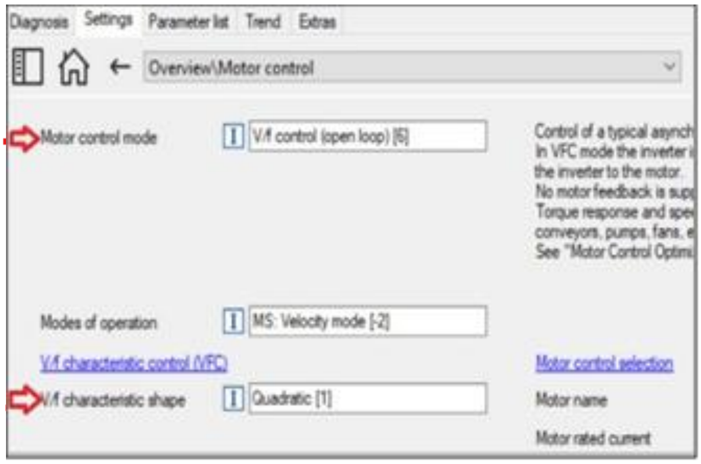
Step	Action	Details	Goal / Benefit
1	Record motor nameplate data	Enter voltage, current, frequency, speed, and cos ϕ in full	Basis for correct control
2	Motor Identification (ID Run)	For sensorless/vector control: Perform and verify Energized ID	Optimal torque & control quality
3	Set limit values	Min/Max frequency, current and torque limits, thermal protection	Protection of motor and drive
4	Setting Ramps & S-Ramp	Set acceleration/deceleration, activate S-ramp; extend for high inertia	Minimize mechanical wear, ensure smooth operation
5	Define skip fre-quencies	Identify and block resonance ranges based on measurements or experience	Avoid vibrations
6	Activate monitoring	Set load detection; learn threshold values for idle and loaded operation	Process reliability
7	Test Run & Fine-Tu-ning	Use Trend/Scope (speed, current, torque) and optimize	Optimal System Behavior

2.7 General Settings in Easy Starter

Motor Control Mode

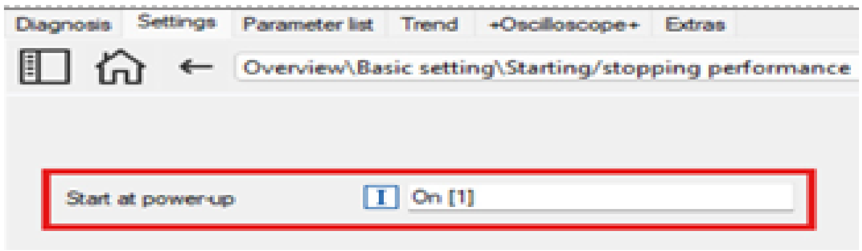
For simple and energy-efficient motor control, Lenze recommends the following motor control settings:

For AC induction motors, set “Motor Control Mode” (**P300.000**) to “U/f- Control (**open-loop**) [6]” and “U/f Characteristic Curve Shape” (**P302.000**) to “Quadratic [1].”



Start-up on Power-On

A common requirement is for the drive to start upon power- , provided the RUN command is already present. Normally, the drive must first power up and then receive a RUN command to avoid an error. The drive can be programmed to start during startup by setting “Start on Startup” (0x2838:002 – P203:002) = [1] to On.

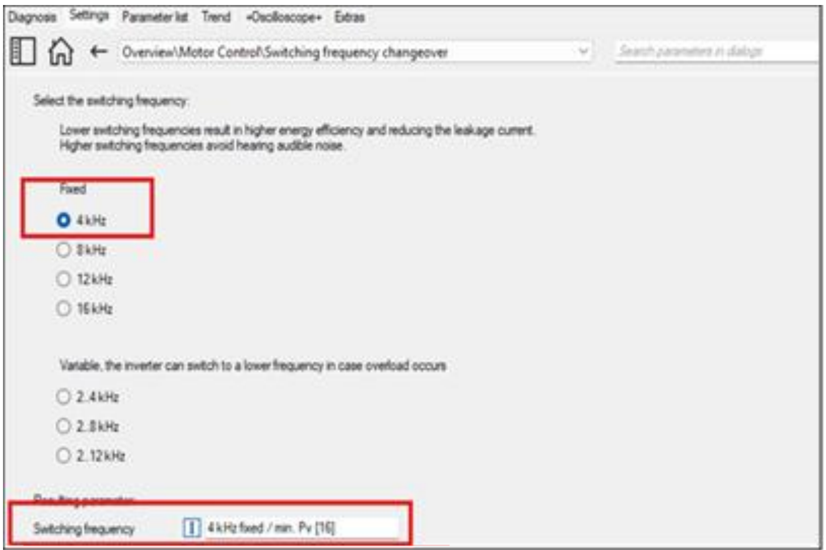


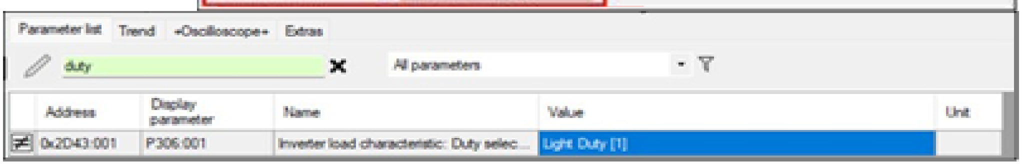
Light Duty Mode

The “light duty” operating mode is generally available for i5x0 cabinets ≥ 3 kW with IP21/31 (NEMA 1) drives, but not for IP66 and IP55 drives. The default setting is heavy duty, but it can also be configured to light duty, which allows for a continuously higher current with the same drive. This helps the customer select a smaller inverter.

To use light duty mode, the drive must use a switching frequency of 4 kHz (0x2939:000 – **P305:000** Switching Frequency).

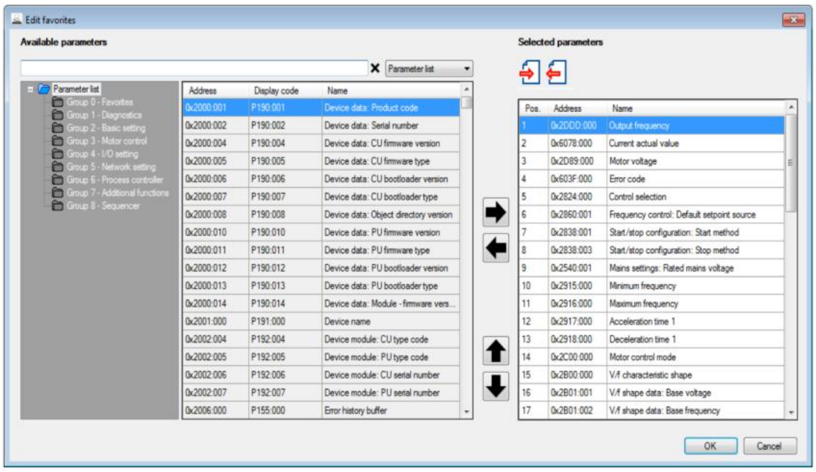
Next, enable the load characteristic curve: Set the “Inverter Load Characteristic Curve: Overload Selection” (0x2D43:001 – **P306:001**) to “Light Duty” [1].





Optimizing the End-User Experience (Favorites)

In Easy-Starter, select the 5–10 most important parameters in your preferred order in the “ ” favorites menu.

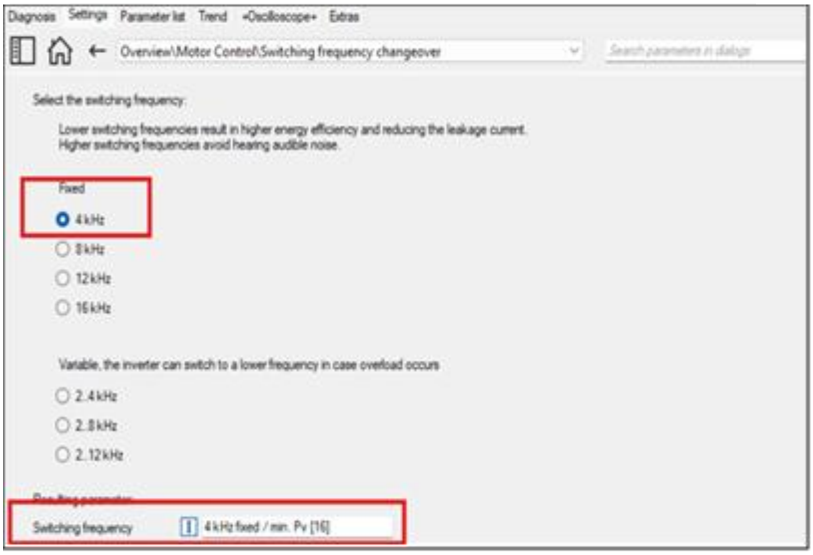


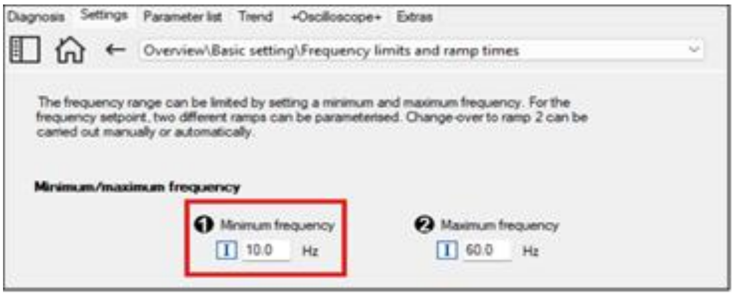
Optimizing Leakage Current

The i500 drives generally have low leakage currents. In principle, the i5x0 drives can be operated up to 11 kW on a 30 mA RCD; see the respective product documentation for details. Using short motor cables and removing the IT screws (available on i5x0 control cabinet inverters) can further reduce the leakage current.

The following settings can also help minimize leakage current:

1. Set the “Switching Frequency” (0x2939:000 – **P305:000**) to the lowest possible setpoint frequency.



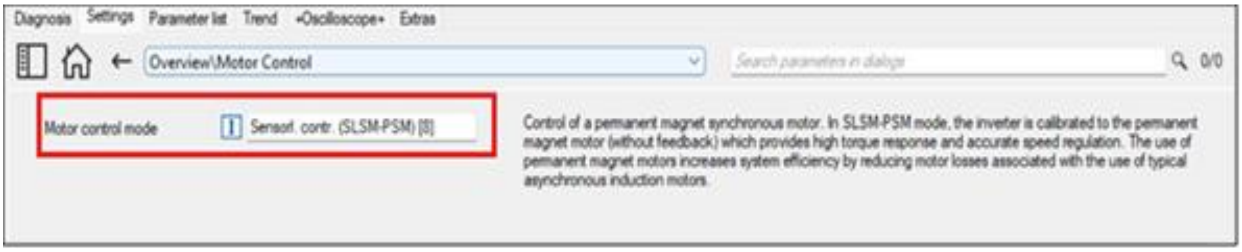


2. Set the "Minimum Frequency" (0x2915:000 – **P210:000**) to 15 to 20 Hz. This ensures that the motor does not run below this speed during startup.

3. Set the fastest possible acceleration time. This measure reduces the risk of tripping during speed-up. "Acceleration Time 1" (0x2917:000 - **P220:000**).
4. Use the shortest possible motor power cables.
5. Ensure there is a good ground connection. The motor power cables should be shielded and terminated on the drive side.
6. Check with the motor manufacturer regarding the grounding requirements on their website.

3 Support for PM motor control

Lenze offers a very powerful and flexible PM motor control method called "SLSM-PSM." Parameter 0x2C00:**000-P300:000** [Motor Control Mode] with selection [8] SLSM-PSM. This selection works best at carrier frequencies of 8 kHz.



The most important thing is to select the correct method for low speeds: 0x2C13:000 with the two options:

[1] - Carrier-based [Default setting]

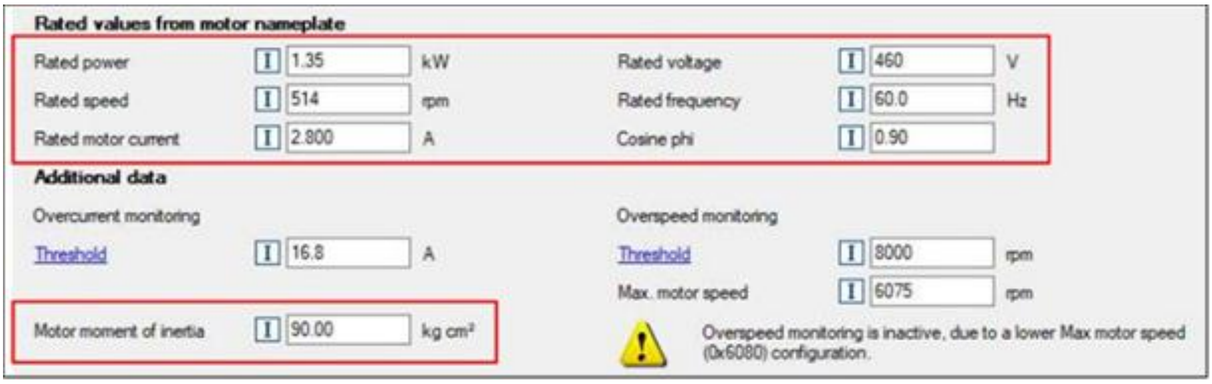
This is Lenze's unique method for supporting dynamic and precise motor control even at low speeds, with a possible rated torque of up to 200%. It is particularly easy to use and highly effective with Lenze IE5 motors. It is recommended for dynamic applications but is not suitable for every motor.

[2] = i/f-based

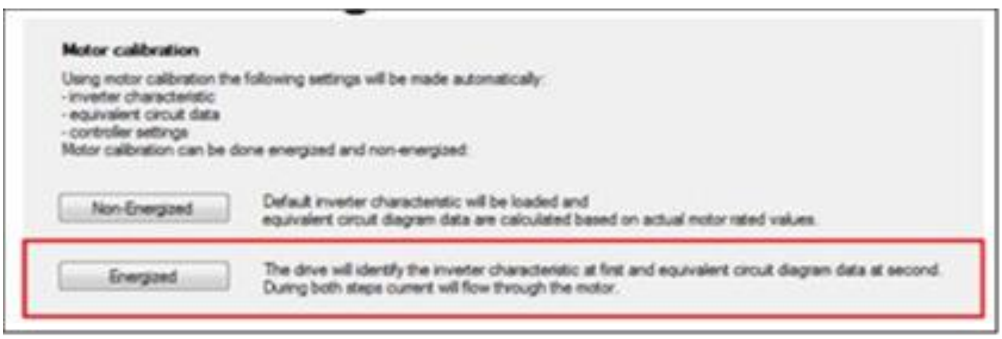
i/f-based is the recommended universal method for any motor and is commonly used in the market because it is easy to operate and offers good performance.

Basic Steps for Commissioning

1. Entering the Motor Nameplate Data



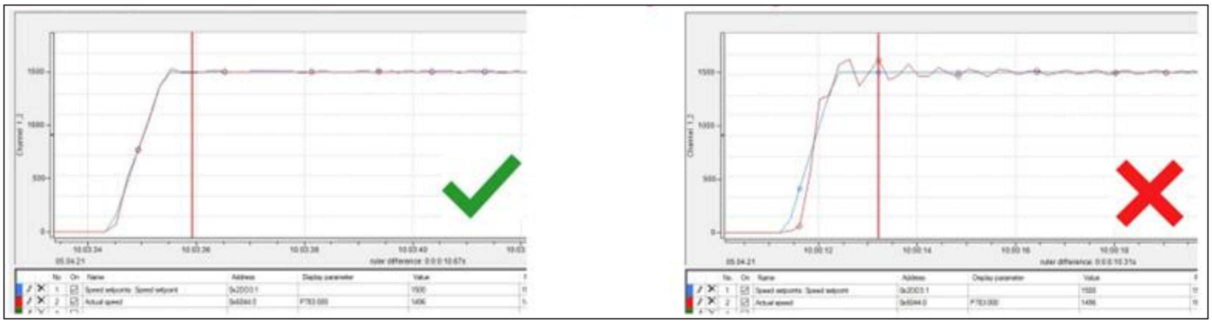
2. Perform Calibration Under Voltage



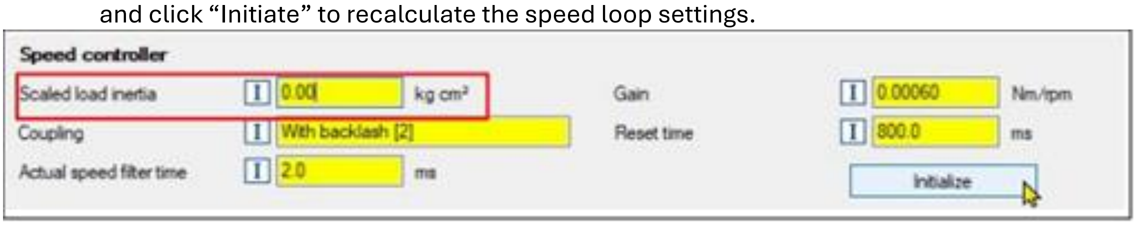
3. Check the inductance values Ld and Lq and determine the deviation. If the deviation is less than 5–10%, set “SLSM Low-Speed Method” (0x2C13:000) to i/f-based [2]; otherwise, leave “Carrier Based” [1] selected

4. Configure a trend or curve that records the “Speed Setpoint” (0x2DD#:001) against the “Actual Speed” (0x6044:000–P783:000). Attempt to run the motor up to the rated/application speed.

If the motor does not start or is unable to reach the set speed, you may need to adjust the low-speed range; see **“Notes on Adjusting the Low-Speed Range [Not Observable]”** at the end of this manual.

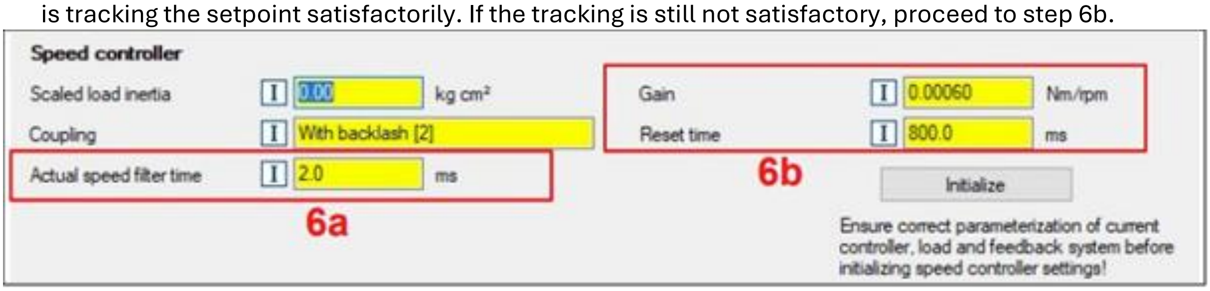


5. If the actual speed is not tracking the setpoint satisfactorily for the application, set the load inertia and click “Initiate” to recalculate the speed loop settings.

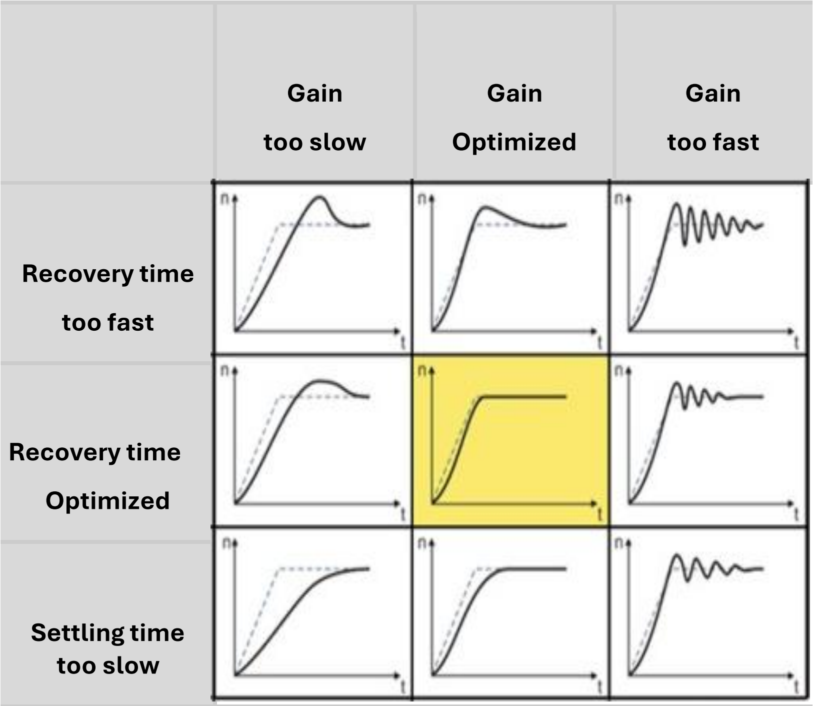


If the actual speed still does not track the setpoint satisfactorily for the application, check the trend again. Begin by manually tuning the speed loop as described in Step 6.

6. Adjust the manual speed controller settings:
a) Increase the filter time for the actual speed [to 4.0…5.0 ms] and check the trend to see if the actual speed is tracking the setpoint satisfactorily. If the tracking is still not satisfactory, proceed to step 6b.



b) Adjust the gain and settling time of the speed controller according to the guidelines in the following graph. In general, adjustments to the gain and settling time are made in increments of +/- 10–30%. After each adjustment, check the trend to see the effects and determine whether the actual speed is following the setpoint satisfactorily. Once the tracking is satisfactory, you are done.



Recommendation for range optimization at low speed [not noticeable]

0x2C13:000 [SLSM long-term method] = <u>[1] - Carrier-based [DEFAULT SETTING]</u>

- If the motor hums but does not start or takes longer than the set time to accelerate, it may be necessary to increase the RF feed amplitude [0x2C10:001]. Increase 0x2C10:001 in 10% increments to achieve satisfactory startup/acceleration.
- Set the HF feed range to a value lower than the application's lowest continuous or long-term operating speed, but not lower than required for the application. This ensures that long-term/continuous operation takes place in the (perceptible) high-speed range.
- Some applications/motors achieve better performance with faster acceleration in the low-speed range. If necessary, use 0x291B:000 [Auto-change.thresh.ramp2] to automatically switch from acceleration ramp time 1 to ramp time 2.

"SLSM Low-Speed- ing Method" (0x2C13:000) <u>= [2] = i/f-based</u>

- The most common problem in the low-speed range in this mode is instability and/or stalling during the transition from the low-speed range to the high-speed range. This is typically caused by the input current being too high. An adjustment (typically a reduction) of the low-speed current values "Acceleration Current" (0x2C12:001) and "Standstill Current" (0x2C12:002) is usually necessary, especially in applications with variable or quadratic torque profiles.
- Adjusting "Acceleration Current" (0x2C12:001) and "Standstill Current" (0x2C12:002) in this mode is a balancing act. Current values higher than necessary lead to instability during the transition to the high-speed range. Lower current values can cause problems when starting and operating the application in the low-speed range if high torque is required there.
- In this mode, a higher transition point is typically advantageous. The default value [10%] should only be reduced if absolutely necessary for the application. Increasing it to 20–30% can improve stability, provided the application allows it.

4 PID – Temperature and Pressure Control

Proportional-Integral-Derivative (PID) control is a closed-loop control method used to monitor a process variable such as pressure or temperature. In this process, the fan, for example, must adjust its speed to maintain this variable at a constant value.

Common applications that require PID control include heating, cooling, and pressure control.
First, a suitable analog sensor is installed in the system. This can be a pressure sensor, a temperature sensor, or another type of sensor.

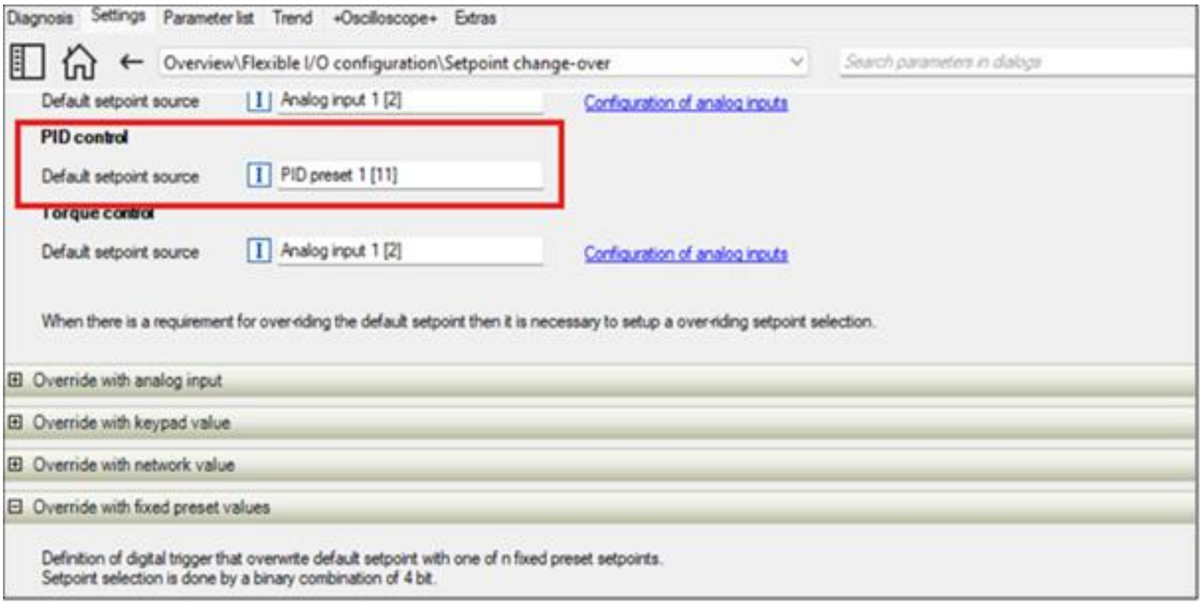
PID applications are classified as either “forward-acting” or “reverse-acting.” This term refers to the fan’s relationship to the monitored process variable. If an increase in fan speed leads to an increase in the monitored process variable (e.g., direct pressure), it is a “forward-acting” PID application. If an increase in fan speed results in a decrease in the process variable (e.g., a fan supplying cooling air until the monitoring temperature is reached), this is a “reverse-acting” process.

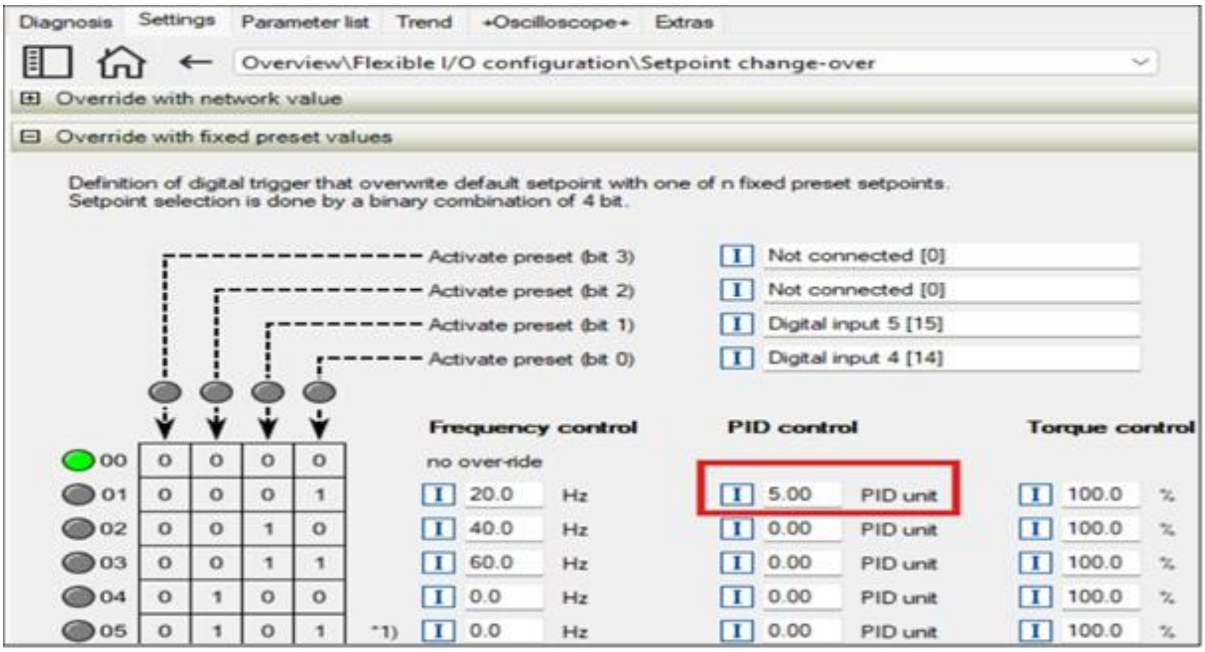
Set Operating Mode
Set the operation mode (0x4020:001 - **P600:001**) to either “Normal Operation [**1**]” or “Reverse Operation [**2**]” depending on the application.

Program the drive’s analog input
Next, we need to program which analog input of the drive is to be used as the monitored process variable. Set the “PID Process Variable” (0x4020:002 - **P600:002**) to either “Analog Input 1 [**1**]” or “Analog Input 2 [**2**]”.

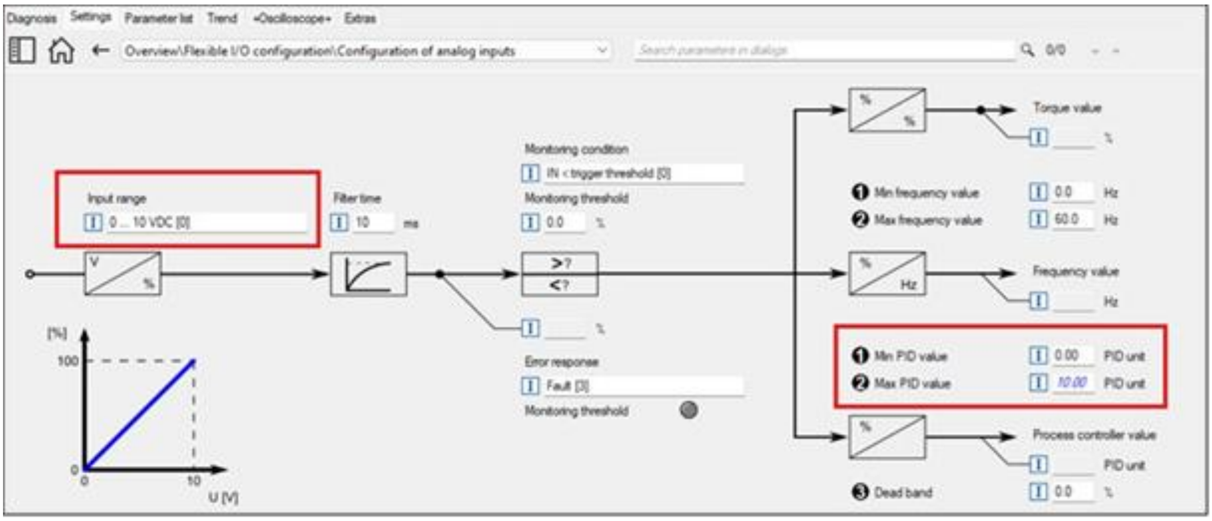
Programming the Setpoint Source

Next, we need to configure the drive for the setpoint source. The setpoint is the value to which the drive is supposed to adjust the monitored process variable. Setpoint sources can be the keyboard, an analog signal (which must not be the same analog input as the monitored process variable), or a predefined internal setpoint. Set "Default Setpoint Source" (0x2860:002 – **P201:002**) to one of the following options as needed: "Keypad [**1**]," "Analog Input 1 [**2**]," "Analog Input 2 [**3**]," or "PID Setpoint 1 [**11**]." If you use "PID Setpoint 1 [**11**]" as the setpoint, make sure to also program the desired setpoint in "Setpoint 1" (0x4022:001 – **P451:001**).





Please note that the setpoint is specified in user-defined PID units, which in turn are configured in the analog input channel configuration for the monitored process variable. Set both the "Min. PID Value" (0x263x:004 - **P43x:004**) and the "Max. PID Value" (0x263x:005 - **P43x:005**) to match the signal range of the analog sensor used to monitor the process variable. Enter this value in PID units (for example, if the sensor was 0–10 VDC = 0–10 PSI, set 0x263x:004 - **P43x:004 = 0** and 0x2363x:005 - **P43x:005 = 10**).

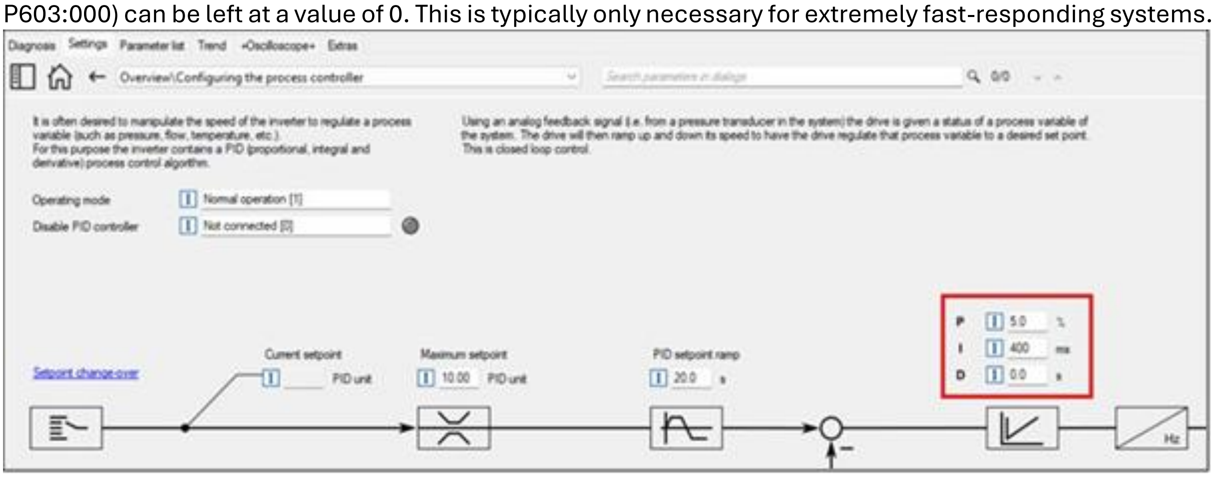


PID Optimization

The PID control loop must then be optimized for the application while the system is running. A common approach to PID optimization is as follows:

1. To disable the I-component, set the settling time for the I-component in “PID I-Component” (0x4049:000 - P602:000) to 6000 ms. With this setting and the default setting for “PID D-Term” (0x404A:000 - P603:000), the process controller operates as a P controller.
2. Increase the gain of the P component incrementally in “PID P Component” (0x4048:000 - P601:000) until the system becomes unstable (oscillates).
3. Reduce the gain again until the system is stable once more (no longer oscillates).
4. Reduce the gain by an additional 15%.
5. Set the settling time for the I-component in “PID I-Component” (0x4049:000 - P602:000). When making this setting, note that a settling time that is too low can lead to overshoot, especially with large steps in the control error.
6. Optional: Set the gain of the D-component in “PID D-component” (0x404A:000 - P603:000).

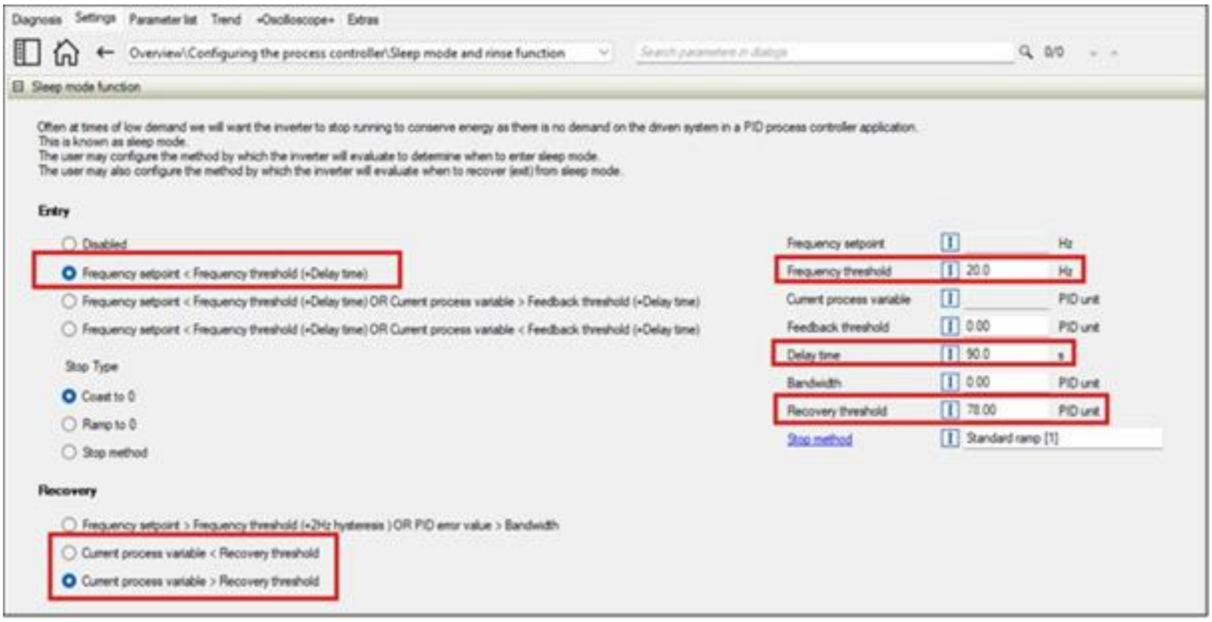
When making this setting, note that the D-component is very sensitive to electrical interference in the feedback loop as well as to digitization errors. For most systems, the “PID D-component” (0x404A:000 - P603:000) can be left at a value of 0. This is typically only necessary for extremely fast-responding systems.



The idle function (also called “process controller idle”) causes the drive to stop as soon as the process variable remains unchanged, even though the drive’s output falls below a certain frequency for a specified period of time. An example of this is a fan in a warehouse. At 3:00 a.m., the outside temperature in the warehouse has dropped below the setpoint, so the drive should stop the fan to save energy.

The “PID Sleep Mode: Activation” (0x4023:001 - **P610:001**) should be set to “Output Frequency < Threshold [**1**]” for a fan. The “Frequency Threshold” (0x4023:003 - **P610:003**) must be set to a low value that is just below the minimum airflow required for the application. A “delay time” (0x4023:005 - **P610:005**) must be entered. Select a value that ensures the application’s fan is shut off. If the time is too short, the application may “flutter.”

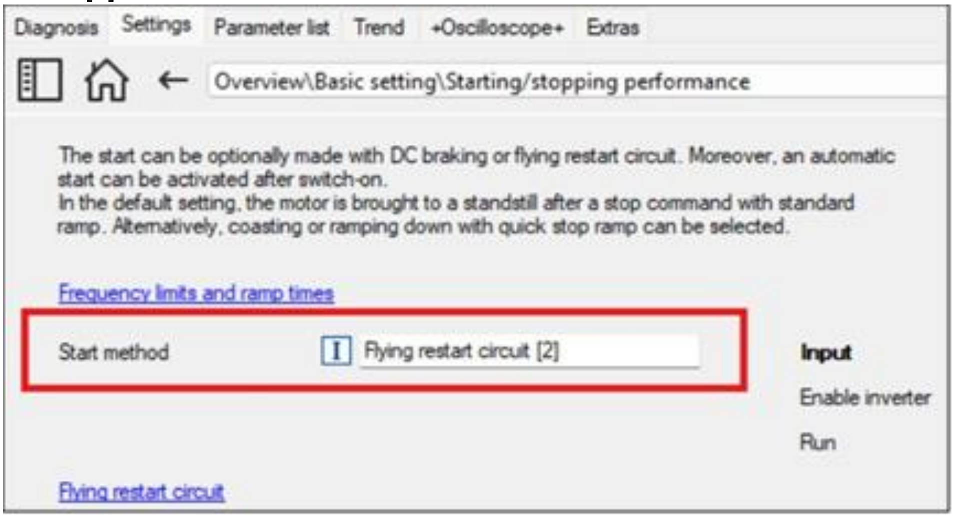
The fan application is typically restored when the monitored process variable either falls (in a normally acting PID application, e.g., heating) or rises (in a reverse-acting PID application, e.g., cooling) and falls outside a tolerance window. Set “Termination” (0x4023:006 - **P610:006**) to either “PVar < Termination Threshold [**1**]” for normally acting PID applications or to “PVar > Termination Threshold [**2**]” for inversely acting PID applications.
Finally, set the “Termination Threshold” (0x4023:008 - **P610:008**) to the maximum value that the application can tolerate as a deviation for the monitored process variable. This value is entered in user-defined PID units and is scaled. (i.e., if the process setpoint is 70° and a maximum increase to 78° could be tolerated, enter 78°).



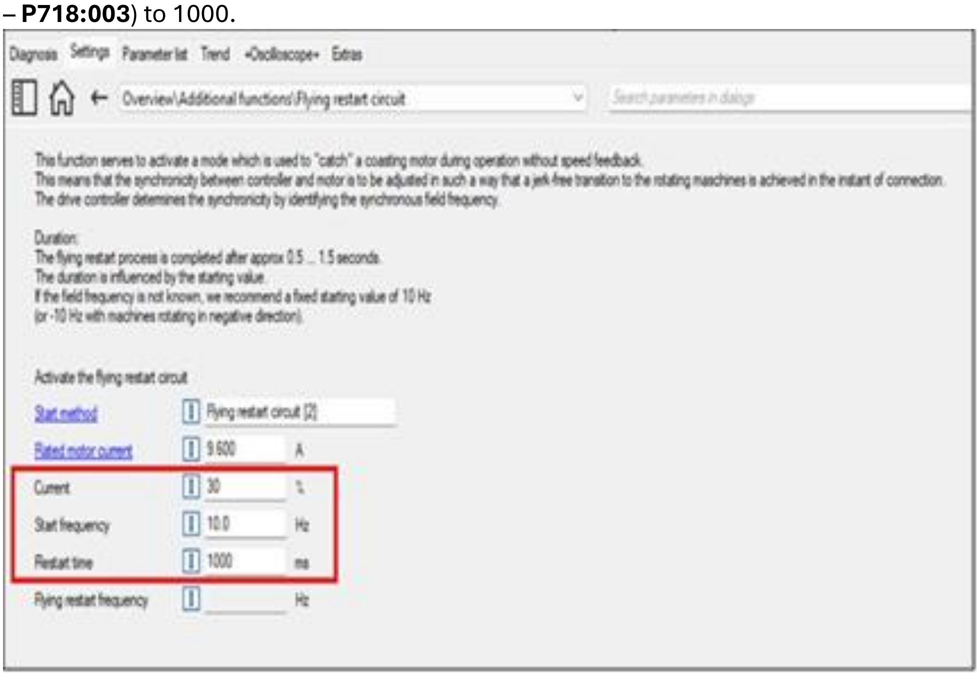
5 Flying Restart (“Windmill” Effect)

Idling fans are subject to “windmill” operation due to drafts. Therefore, their startup must be controlled. The i500 Series drives feature a catch algorithm that detects and records the motor speed and transitions the motor to normal operation.

To configure the drive for a catch-up alarm, set “Start Method” (0x2838:001 – **P203:001**) = “Flying Restart Circuit [2]”



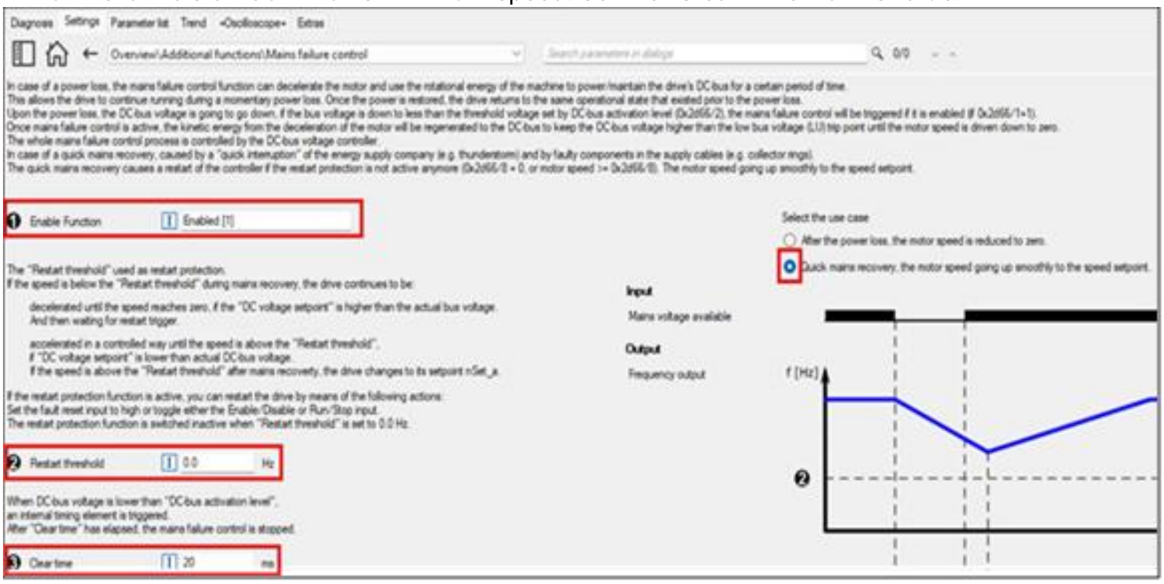
The flying restart circuit should be configured so that operation is as smooth as possible. The applied current should be a small fraction of the motor’s rated current. A good starting value is 30%. Set “Current” (0x2BA1:001 – **P718:001**) to 30. Normally, the start frequency is unknown. In this case, Lenze recommends starting the search at 10.0 Hz. Set “Start Frequency” (0x2BA1:002 – **P718:002**) to 10.0. The restart process can take approximately 0.5–1.5 seconds. A good starting value is 1000 ms. Set “Restart Time” (0x2BA1:003 – **P718:003**) to 1000.



6 Bypass in the Event of a Brief Power Outage

In fan applications, it is often preferable for a drive to maintain control at the expense of fan speed rather than having to perform a fly-start due to a brief power outage. i500 Series drives can utilize the momentum of a fan to regenerate power and thus maintain control during a brief power outage.
Setup is as follows:

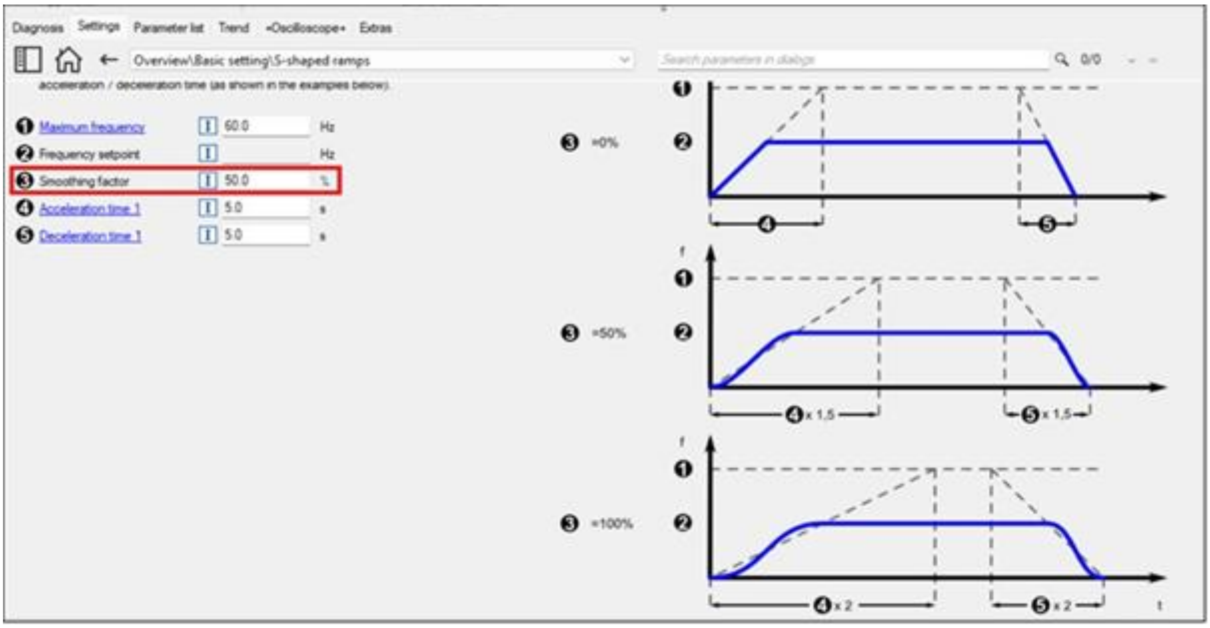
1. Set “Enable Function” (0x2D66:001 – **P721:001**) to Enabled [**1**].
2. Since we want both a bypass and automatic recovery, select the application scenario “Rapid power restoration; motor speed increases smoothly to the setpoint speed” and set the “Restart Threshold” (0x2D66:008 – **P721:008**) to 0.0 Hz to disable restart protection and allow the drive to restart automatically.
3. The “Clear Time” (0x2D66:007 – **P721:007**) must be set to define the maximum duration for which the bypass should be maintained. This value should be set to a value appropriate for the torque of the rotating fan. The larger and faster the fan, the longer this value can be set. To determine the correct setting, run the drive at its normal rated speed, disable the fan, and use a stopwatch to measure the time it takes for the fan to slow down to its minimum speed. Set the “Clear Time” to this value.



4. Set the DC voltage setpoint (0x2D66:005 – P721:005) to 95% so that the drive attempts to maintain 95% of the DC bus nominal voltage.
5. The setpoint ramp (0x2D66:006 – P721:006) defines the rate at which the drive attempts to raise the bus voltage back to the setpoint. This value should be set to one-tenth of the clear time (0x2D66:007 – P721:007).
6. Set the DC bus activation level (0x2D66:002 – P721:002) to 72% for 120-V and 230-V drives, and to 82% for 400/480-V and 480-V/600-V drives.

7 Minimizing Motor Load, Jerk, and Overshoot in High-Inertia Applications

Jerk and speed overshoots can be minimized in drives with high inertia by using S-shaped acceleration/deceleration ramps. However, this extends the drive's total acceleration/deceleration times. To use S-shaped ramps, simply program the "smoothing factor" (0x291E:001 – **P226:001**). 50% is a good starting point for smoothing in drives with high inertia.



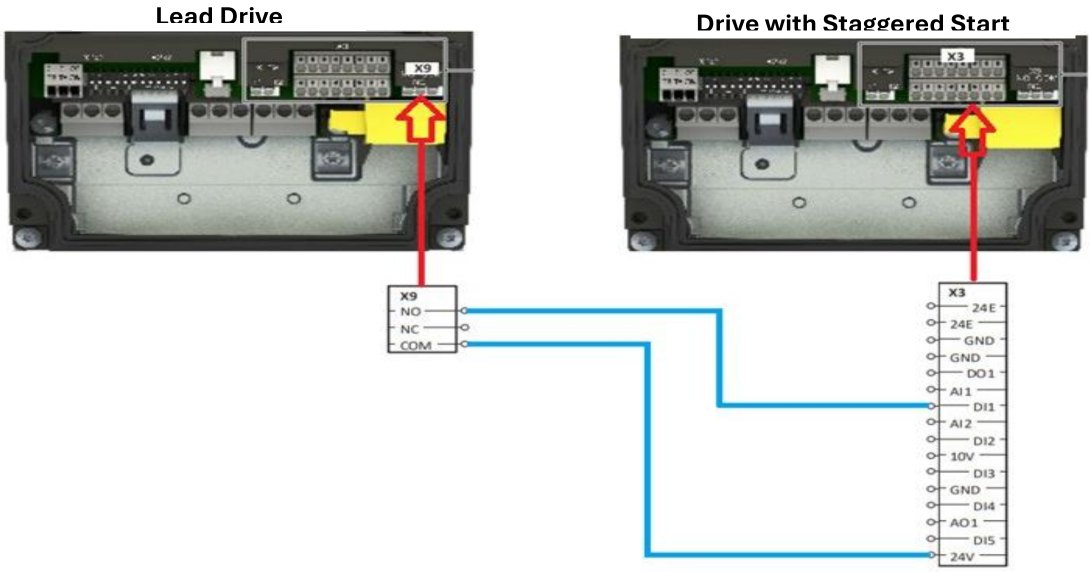
The i500 Series drives also feature a second acceleration/deceleration ramp that can be triggered automatically when the drive exceeds a frequency threshold. This is useful for gradually accelerating at low speeds and high inertia while enabling a faster response at or near the rated speed.

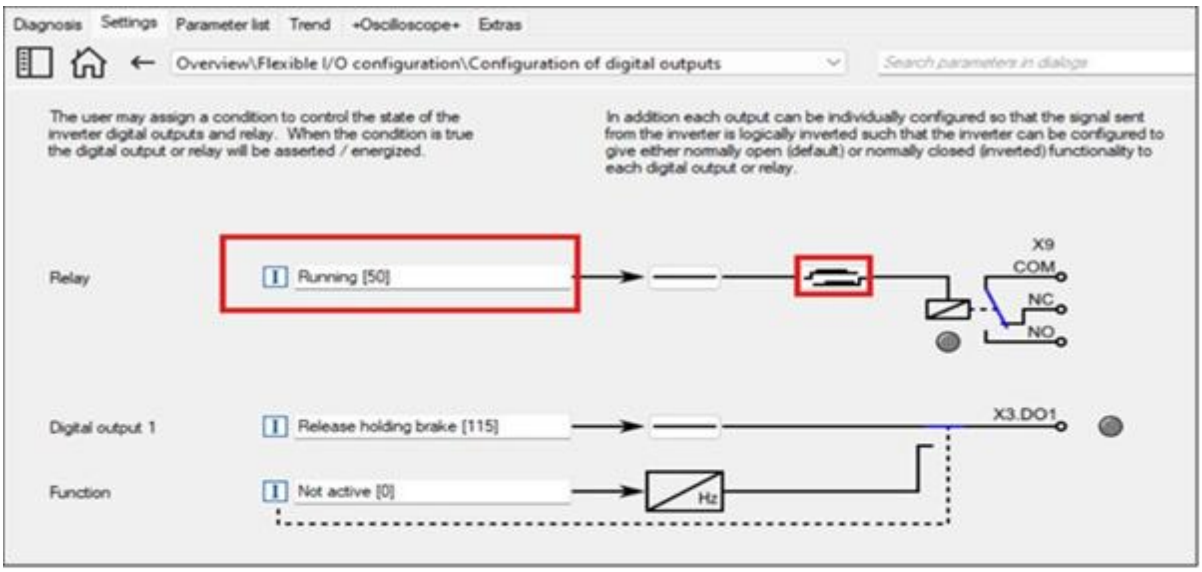
To configure this option, first program the second acceleration/deceleration ramp in “Acceleration Time 2” (0x2919:000 – **P222:000**) and “Delay Time 2” (0x291A:000 – **P223:000**). Next, program the frequency “Auto-change.thresh.ramp2” (0x291B:000 – **P224:000**).

8 Staggered Start of System Drives Without a PLC

Sometimes it is necessary to reduce the power demand on the utility grid during system startup. This can be achieved by staggering the drive starts in the application. To achieve this without a higher-level controller, use the relay output of one drive to trigger the start of the next drive by programming a turn-on delay for the relay.

Wire the relay output of the lead drive so that it triggers the input of the following drive, which is configured as a RUN command.



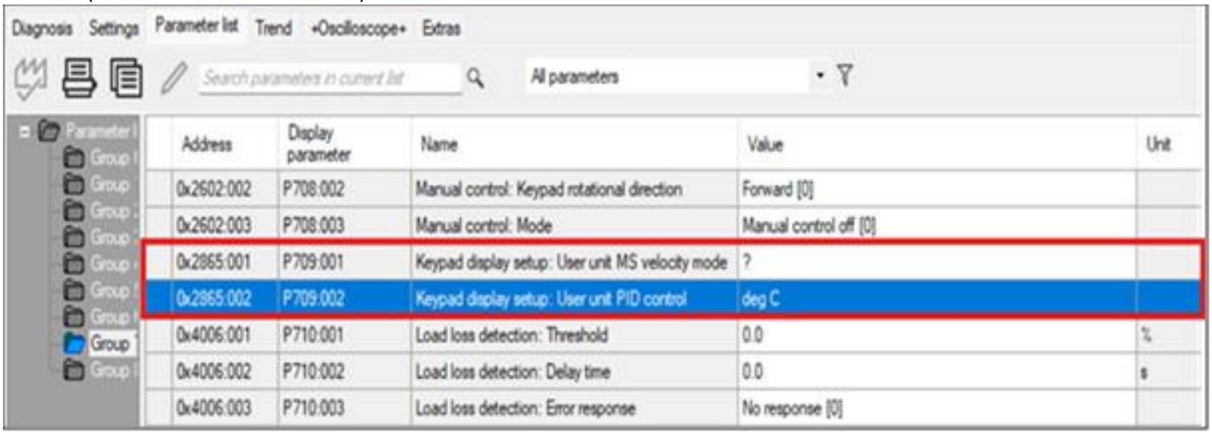


Next, configure the relay output so that it turns on when the drive is running by setting “Relay” (0x2634:001 – **P420:001**) = Running **[50]**.

9 Control Units with Keypad

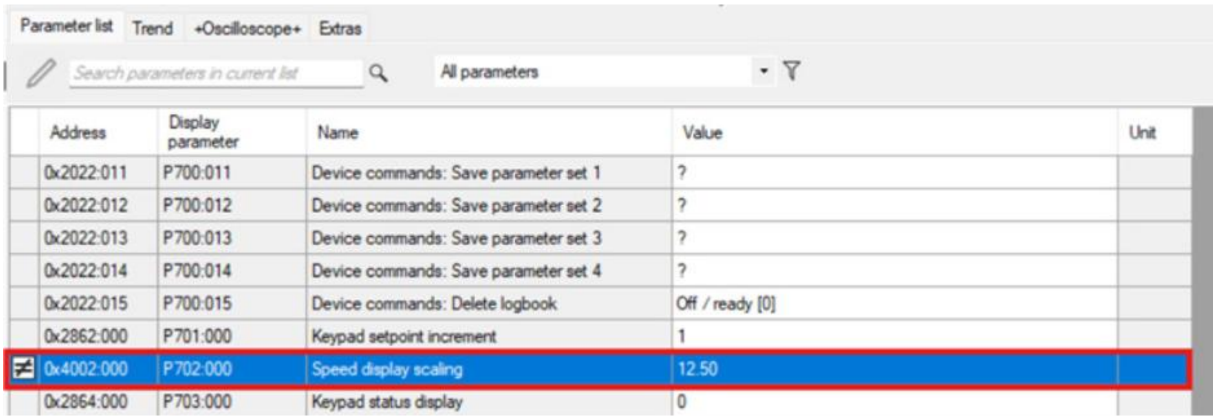
The legend on the operating screen of the i500 Cabinet and i500 Protec series drives can be changed to any six ASCII characters to customize the display for the specific application (e.g., "°F," "°C," "ft/sec," etc.). If the drive is in PID mode, set the legend under "User Unit PID Control" (0x2865:002 – **P709:002**).

If the drive is in speed mode, set the legend in "User Unit for MS Speed Mode" (0x2865:001 – **P709:001**).



Address	Display parameter	Name	Value	Unit
0x2602:002	P708:002	Manual control: Keypad rotational direction	Forward [0]	
0x2602:003	P708:003	Manual control: Mode	Manual control off [0]	
0x2865:001	P709:001	Keypad display setup: User unit MS velocity mode	?	
0x2865:002	P709:002	Keypad display setup: User unit PID control	deg C	
0x4006:001	P710:001	Load loss detection: Threshold	0.0	%
0x4006:002	P710:002	Load loss detection: Delay time	0.0	s
0x4006:003	P710:003	Load loss detection: Error response	No response [0]	

In speed mode, also program a multiplier using "Speed Display Scaling" (0x4002:000 – **P702:000**) to convert Hz to the desired units (i.e., if 50 Hz corresponds to 750 cm/sec, enter a value of 15.0).



Address	Display parameter	Name	Value	Unit
0x2022:011	P700:011	Device commands: Save parameter set 1	?	
0x2022:012	P700:012	Device commands: Save parameter set 2	?	
0x2022:013	P700:013	Device commands: Save parameter set 3	?	
0x2022:014	P700:014	Device commands: Save parameter set 4	?	
0x2022:015	P700:015	Device commands: Delete logbook	Off / ready [0]	
0x2862:000	P701:000	Keypad setpoint increment	1	
0x4002:000	P702:000	Speed display scaling	12.50	
0x2864:000	P703:000	Keypad status display	0	

10 Disclaimer

This guide is for informational purposes only. Although we have made every effort to ensure the accuracy of the information, we cannot guarantee that it is free of errors or omissions. Users are advised to verify all information before relying on it. We assume no liability for any loss or damage resulting from reliance on this guide.