

Clean Power VFD

AN008 – Enhance Control & Reduce Mechanical Stress with Multiple Ramps

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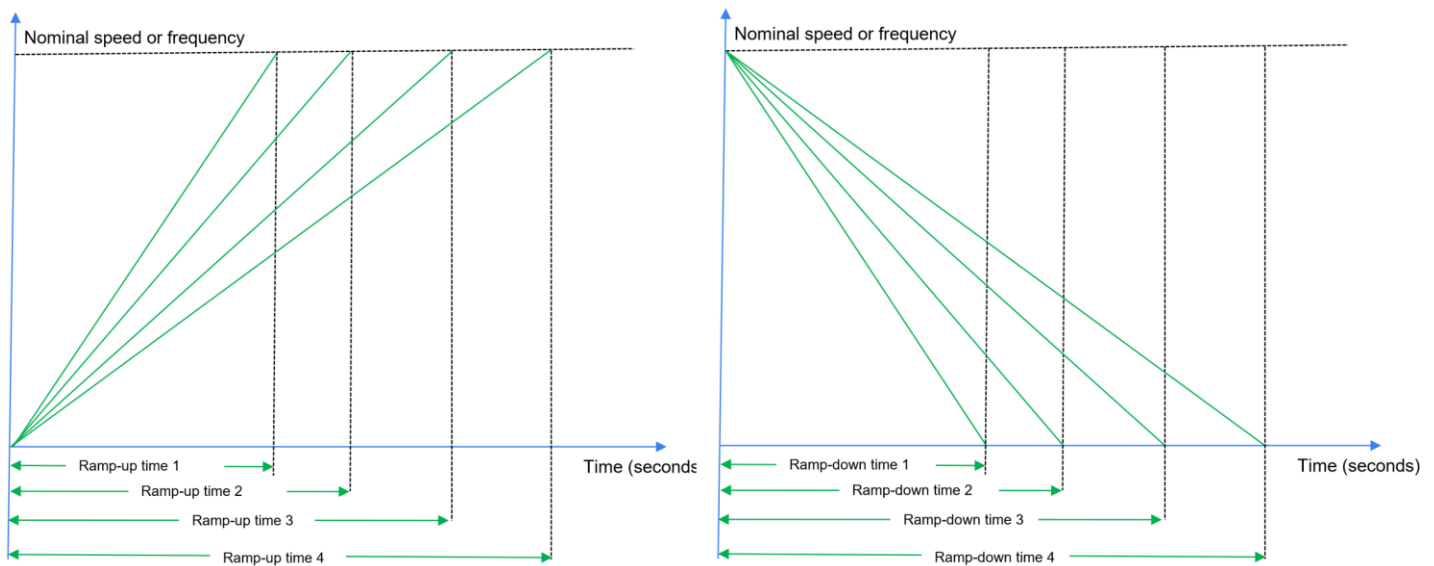
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Application overview

The Clean Power VFD supports multiple acceleration and deceleration ramps which provide enhanced control over motor speed profiles, allowing for smoother operation, reduced mechanical stress, and improved energy efficiency. This application note explores the use cases, benefits, and implementation of the Clean Power VFD with up to four acceleration and four deceleration ramps.



Use Cases

Material Handling Systems

- **Scenario:** A conveyor system requires different speed profiles when starting and stopping to accommodate varying load conditions.
- **Solution:** Using multiple ramps, the VFD can apply a gentle acceleration for light loads and a steeper ramp for heavy loads, preventing mechanical shock and ensuring smooth movement.
- **Example:**
 - When starting an empty conveyor, a slow acceleration ramp is used to avoid excessive strain on the belt and motor.
 - When starting a heavily loaded conveyor, a faster acceleration ramp is applied to ensure the system reaches the desired speed quickly without causing unnecessary delays in material transport.
 - For unloading or buffering zones, different deceleration ramps are used to control material flow, preventing sudden stops that could cause materials to shift or jam.
 - Adaptive control allows the system to switch dynamically between acceleration and deceleration ramps based on real-time load conditions, improving efficiency and reducing wear and tear on the conveyor system.

Centrifugal Pumps and Fans

- **Scenario:** A pump system needs to gradually ramp up to prevent water hammer effects and avoid sudden pressure spikes.
- **Solution:** Different acceleration ramps can be configured based on system pressure, while deceleration ramps can be used to ensure control stopping without cavitation.
- **Example:**
 - When starting the pump, a slow acceleration ramp is used to allow pressure to build up gradually, preventing sudden pressure surges that could damage pipelines and valves.
 - During normal operation, a moderate acceleration ramp can be employed when increasing flow demand to optimize energy consumption while maintaining system stability.
 - A slow deceleration ramp is used for normal shutdown to gradually reduce pressure, prevent cavitation and ensure a smooth stop.
 - The ability to select and switch between these ramps dynamically allows the pump system to adapt to varying load conditions and operating requirements, enhancing efficiency and equipment longevity.

Benefits

- **Enhanced Process Control:** Multiple ramps allow for customized motor control, improving system performance.
- **Reduced Mechanical Stress:** Smooth transitions reduce wear on mechanical components, extending equipment lifespan.
- **Energy Efficiency:** Optimal acceleration and deceleration profiles minimize energy spikes and improve overall efficiency.
- **Increased Safety:** Gradual speed changes enhance operational safety by preventing sudden starts and stops.
- **Flexibility in Applications:** The ability to configure different ramps for varying load conditions makes the VFD suitable for diverse industries.

Implementation guides

Software Compatibility

Please make sure to update your Clean Power VFD's firmware to version 2024.14.00 or later to enable multiple acceleration and deceleration ramps.

You can find the link to download the firmware in the latest release notes on the [SmartD Help Center](#).

Step-by-step instructions

Step-by-step instructions on configuring the Clean Power VFD's multiple acceleration and deceleration ramps.

Step-by-step mobile configuration				
<p>Configuration is complete. Pair/Transfer the configuration to the VFD (2) Clean Power VFD or save the configuration.</p> <p>Motor controls</p> <p>Motor control mode: Velocity V/f (rpm) (default)</p> <p>Allow reverse: Enabled (default)</p> <p>Ramp up: 2 s</p> <p>Ramp down: 5 s</p> <p>Normal stop mode behaviour: Ramp down (default)</p> <p>Buttons: Save, Transfer</p>	<p>Ramp up</p> <p>Please enter motor ramp up (acceleration) configuration.</p> <p>Ramp up provides smooth acceleration, bringing the motor to full speed in a preset time.</p> <p>Ramp type: Linear ramp</p> <p># Duration (s)</p> <p>R1: 20</p> <p>Motor frequency ramp up time duration graph showing Nominal frequency (Hz) vs Acceleration time (s).</p> <p>Buttons: Done</p>	<p>Ramp up</p> <p>Please enter motor ramp up (acceleration) configuration.</p> <p>Ramp up provides smooth acceleration, bringing the motor to full speed in a preset time.</p> <p># Duration (s) Enabled</p> <p>R1: 20</p> <p>R2: 30</p> <p>R3: 40</p> <p>R4: 10</p> <p>Motor frequency ramp up time duration graph showing multiple ramps (R1, R2, R3, R4).</p> <p>Buttons: Done</p>	<p>Configuration is complete. Pair/Transfer the configuration to the VFD (2) Clean Power VFD or save the configuration.</p> <p>Motor controls</p> <p>Allow reverse: Enabled (default)</p> <p>Seamless direction change: Enabled</p> <p>Spinning direction priority: Raise alarm (default)</p> <p>Ramp up: 20 s (default)</p> <p>R1: 20 s, R2: 30 s, R3: 40 s, R4: 10 s</p> <p>Ramp down: 20 s (default)</p> <p>Normal stop mode behaviour: Ramp down (default)</p> <p>V/f low speed torque compensation: Disabled (default)</p> <p>Motor automatic restart: Default</p> <p>Buttons: Save, Pair VFD</p>	<ul style="list-style-type: none"> • Open the Advanced Configuration and expand the Motor controls section. • Click on the pencil of the Ramp up • Click on the + sign of the ramp definition table. • Enter the ramp duration in seconds (0.1 to 3600). • The new acceleration ramps will be added to the ramps graph. • Click Done. • The ramp durations are displayed in the Configuration screen.
<p>Configuration is complete. Pair/Transfer the configuration to the VFD (2) Clean Power VFD or save the configuration.</p> <p>Motor controls</p> <p>Allow reverse: Enabled (default)</p> <p>Seamless direction change: Enabled</p> <p>Spinning direction priority: Raise alarm (default)</p> <p>Ramp up: 20 s, R2: 30 s, R3: 40 s, R4: 10 s</p> <p>Ramp down: 20 s (default)</p> <p>Normal stop mode behaviour: Ramp down (default)</p> <p>V/f low speed torque compensation: Disabled (default)</p> <p>Motor automatic restart: Default</p> <p>Buttons: Save, Pair VFD</p>	<p>Ramp down</p> <p>Please enter the motor ramp down (deceleration) configuration.</p> <p>Ramp down configuration provides smooth deceleration, bringing the motor to full stop in a preset time.</p> <p>Ramp type: Linear ramp</p> <p># Duration (s)</p> <p>R1: 20</p> <p>Motor frequency ramp up time duration graph showing Nominal frequency (Hz) vs Deceleration time (s).</p> <p>Buttons: Done</p>	<p>Ramp down</p> <p>Please enter the motor ramp down (deceleration) configuration.</p> <p>Ramp down configuration provides smooth deceleration, bringing the motor to full stop in a preset time.</p> <p># Duration (s) Enabled</p> <p>R1: 20</p> <p>R2: 1</p> <p>R3: 30</p> <p>Motor frequency ramp up time duration graph showing multiple ramps (R1, R2, R3).</p> <p>Buttons: Done</p>	<p>Configuration is complete. Pair/Transfer the configuration to the VFD (2) Clean Power VFD or save the configuration.</p> <p>Motor controls</p> <p>Allow reverse: Enabled (default)</p> <p>Seamless direction change: Enabled</p> <p>Spinning direction priority: Raise alarm (default)</p> <p>Ramp up: 20 s, R2: 30 s, R3: 40 s, R4: 10 s</p> <p>Ramp down: 20 s (default)</p> <p>R1: 20 s, R2: 1 s, R3: 30 s</p> <p>Normal stop mode behaviour: Ramp down (default)</p> <p>V/f low speed torque compensation: Disabled (default)</p> <p>Motor automatic restart: Default</p> <p>Buttons: Save, Pair VFD</p>	<ul style="list-style-type: none"> • Open the Advanced Configuration and expand the Motor controls section. • Click on the pencil of the Ramp down • Click on the + sign of the ramp definition table. • Enter the ramp duration in seconds (0.1 to 3600). • The new deceleration ramps will be added to the ramps graph. • Click Done. • The ramp durations are displayed in the Configuration screen.
<ul style="list-style-type: none"> • Click on Save. • Click on Transfer or Pair to connect and transfer the configuration to the VFD. 				

Ramp selection

Ramp selection by Digital Input:

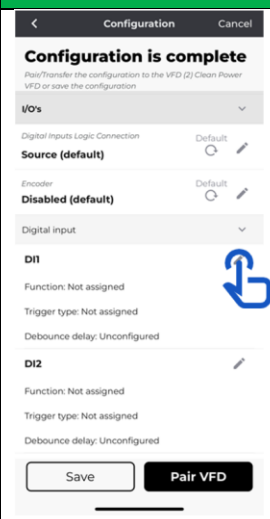
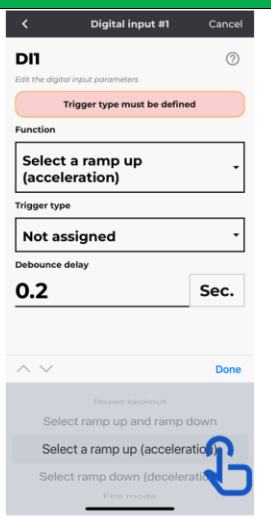
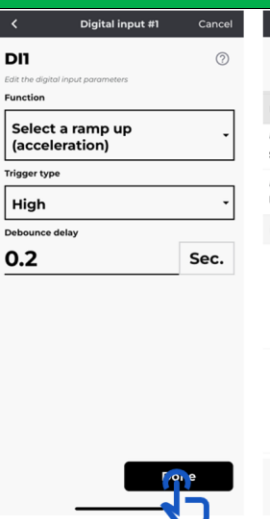
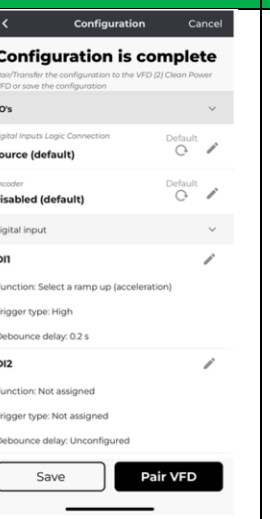

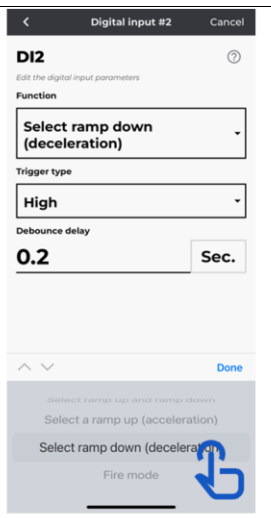
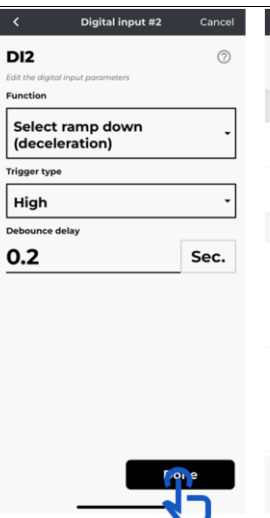
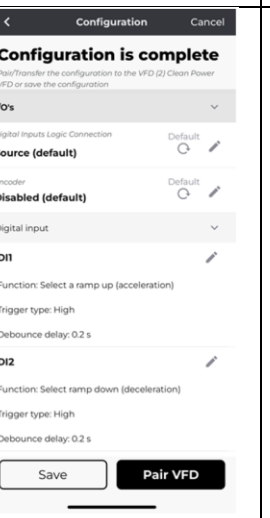
When using digital inputs to select which acceleration or deceleration ramp to use, the digital input(s) must be configured.

Known Limitations:

Please note that currently, the Clean Power VFD can only assign one digital input for selecting the ramp up and/or ramp down, ONLY 2 acceleration ramps and 2 deceleration ramps can be defined when using I/O.

When DI = 0 → Select ramp 1, and when DI = 1 → Select ramp 2.

Please follow the instructions below to configure the Clean Power VFD's digital input(s) for ramp selection:

Step-by-step mobile configuration				
				<ul style="list-style-type: none"> • Open the Advanced Configuration and expand the I/Os section. • Click on the pencil of the selected DI. • Click on the Function. • Scroll down and click on Select a ramp up (acceleration). • Select the Trigger Type. • Click Done. • The Select ramp up function is displayed for the selected DI on the Configuration screen.
				<ul style="list-style-type: none"> • Open the Advanced Configuration and expand the I/Os section. • Click on the pencil of the selected DI. • Click on the Function. • Scroll down and click on Select a ramp down (deceleration). • Select the Trigger Type.. • Click Done. • The Select ramp down function is displayed for the selected DI on the Configuration screen.
<ul style="list-style-type: none"> • Click on Save. • Click on Transfer or Pair to connect and transfer the configuration to the VFD. 				

Ramp selection by Modbus TCP:

The registers below allow you to select which acceleration ramp or deceleration ramp to be used within the 4 presets.

Modbus TCP Register	Holding Address
SmartD Motor Controller / SetPoints.rampUpCurveIndex	16#041B (1051 decimal)
SmartD Motor Controller / SetPoints.rampDownCurveIndex	16#041C (1052 decimal)

Ramp selection by BACnet IP:

The BACnet objects below allow you to select which acceleration ramp or deceleration ramp to be used within the 4 presets.

BACnet object name	Object Id
SmartD Motor Controller,SetPoints.rampUpCurve	MV21
SmartD Motor Controller.SetPoints.rampDownCurve	MV22

Test the system**Safety precautions:**

- Ensure proper grounding of all electrical components.
- Make sure to have safety barriers and equipment to protect test personnel.
- Make sure that an emergency stop is available.
- Verify that the motor and load are correctly rated for the VFD.

Pre-test setup:

- Make sure that the multiple ramps are configured based on application requirements,

Baseline performance testing procedure:

- Run the system with the default acceleration ramp (Ramp up 1) and deceleration ramp (Ramp down 1).
- Measure parameters such as torque, speed variation and mechanical stress.
- Identify any potential issues such as excessive vibration, overheating, or unstable speed transitions.

Incremental ramp adjustment testing procedure:

- Test each acceleration ramp individually by gradually increasing speed from zero to the desired operating level.
- Observe and document response times, load adaptation, and energy efficiency.
- Repeat the process for each deceleration ramp, note stopping behavior and impact on the load.

Load variation testing procedure:

- Introduce different load conditions (e.g., varying conveyor loads or changing pump pressures).
- Test how each ramp responds to these changes and adjust accordingly to optimize the transitions.
- Monitor for any unwanted effects such as mechanical wear, excessive power consumption, or instability.

Final Optimization and Documentation:

- Fine-tune acceleration and deceleration parameters for the best performance.
- Document optimal ramp settings for different load scenarios.
- Save and export your configuration.

Conclusion

Defining multiple acceleration and deceleration ramps on the Clean Power VFD ensures superior control, efficiency, and safety for a wide range of industrial applications. Proper implementation ensures optimal system performance, reduced downtime, and improved operational reliability.

For further information, and detailed specifications, or to initiate an implementation in your operations, please visit our website: <https://smartd.tech/> or contact us at +1-866-776-2783

Let SmartD help you achieve operational excellence and improve system reliability with cleaner, more efficient power solutions.