Clean Power VFD

AN006 – Simple HVAC Fan & Damper Control using Digital Inputs and Relays

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Application overview

This application note provides a step-by-step guide to implement HVAC fan and damper control using the Clean Power VFD's embedded Damper functionality. It covers how to wire and configure Clean Power VFD.

HVAC Fan & Damper Control

In HVAC systems, damper integration with VFDs is a common approach to achieve precise control of airflow and maintain energy efficiency. This setup typically involves VFDs controlling fan motors while dampers regulate the airflow within ductwork, allowing the system to adjust to fluctuating heating, cooling, and ventilation demands.

This combination of VFD and damper integration in HVAC is a widely adopted strategy for reducing operating costs, enhancing control, and improving the overall sustainability of building systems.

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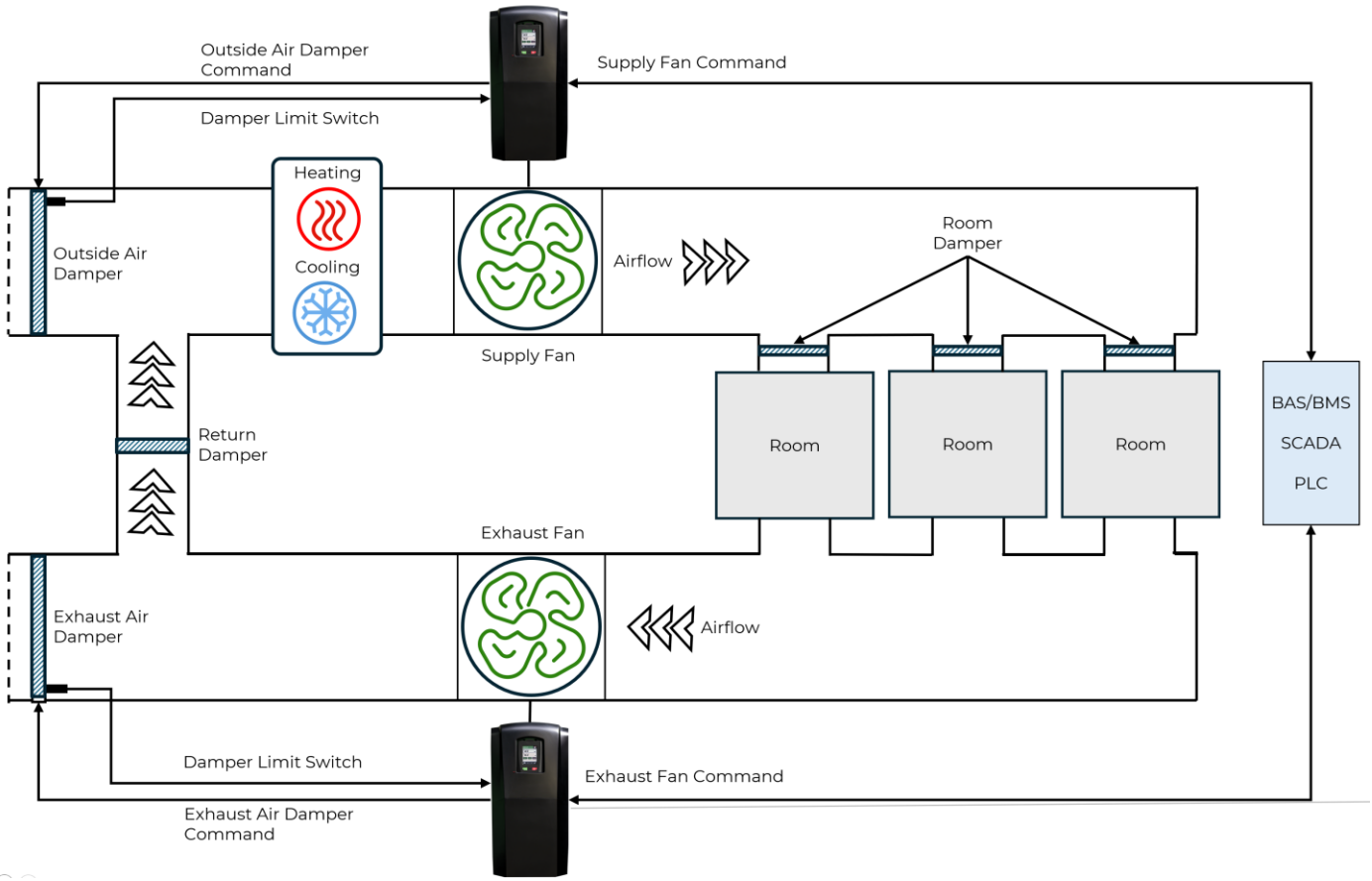
Implementation guides

Software Compatibility

Please make sure to update your Clean Power VFD's firmware to version 2025.04.00 or later to use the fan & damper control functionality.

You can find the link to download the firmware in the latest firmware release notes on the SmartD Help Center.

Key Aspects of Damper and VFD Integration



Control and Communication

VFDs can be programmed to operate in response to signals from the building automation system (BAS), programmable logic controller (PLC), sensors, or directly from the dampers. For example, as the damper opens to increase airflow, the VFD adjusts the fan speed to meet the demand. Similarly, if the damper closes, the VFD slows the fan motor down, conserving energy.

Often, a PID loop is used to control the fan speed based on input from pressure or airflow sensors, ensuring consistent airflow and reducing unnecessary energy use. Usage of embedded PID is not covered in this application note.

Pressure Control

Many HVAC systems are designed to maintain a certain static pressure within the ducts. As dampers open and close, this pressure can vary. The VFD adjusts fan speed to maintain optimal static pressure, enhancing comfort while avoiding excessive strain on components.

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Using VFDs and dampers together provides better control over pressure fluctuations, reducing the likelihood of air leaks and duct damage.

Energy Efficiency
Integrating VFDs with dampers can significantly reduce energy consumption in HVAC systems. By modulating fan speed according to the actual demand, energy wastage from fans running at full speed is minimized.

Energy savings are especially notable in variable air volume (VAV) systems, where demand for airflow varies throughout the day. The VFD reduces motor speed in line with the reduced airflow requirements when certain zones or areas require less ventilation.

Reduced Wear and Tear
With dampers and VFDs working together, the system avoids unnecessary strain on motors and fans, as it operates only at the required speed. This leads to less wear on the components, potentially extending their operational lifespan.

Additionally, VFDs provide smoother ramp-up and ramp-down, reducing sudden changes in fan speed that could otherwise cause mechanical stress on the HVAC system.

Enhanced Control Options
The integration allows for advanced HVAC zoning, where dampers control airflow to specific areas while the VFD modulates fan speed according to demand. This setup supports precise temperature and ventilation control in different zones.

It is also possible to link VFD control to environmental or occupancy sensors, enabling further energy savings by reducing airflow in unoccupied areas.

Applications in HVAC Systems

Commercial Buildings: VFD-damper integration is common in large commercial buildings where varying airflow is needed across multiple zones.

Industrial Facilities: In spaces where ventilation requirements fluctuate, this integration helps maintain air quality and regulate temperature effectively.

Data Centers: Precise airflow control is critical for temperature-sensitive environments like data centers, where VFD-damper setups ensure reliable cooling at optimal efficiency.

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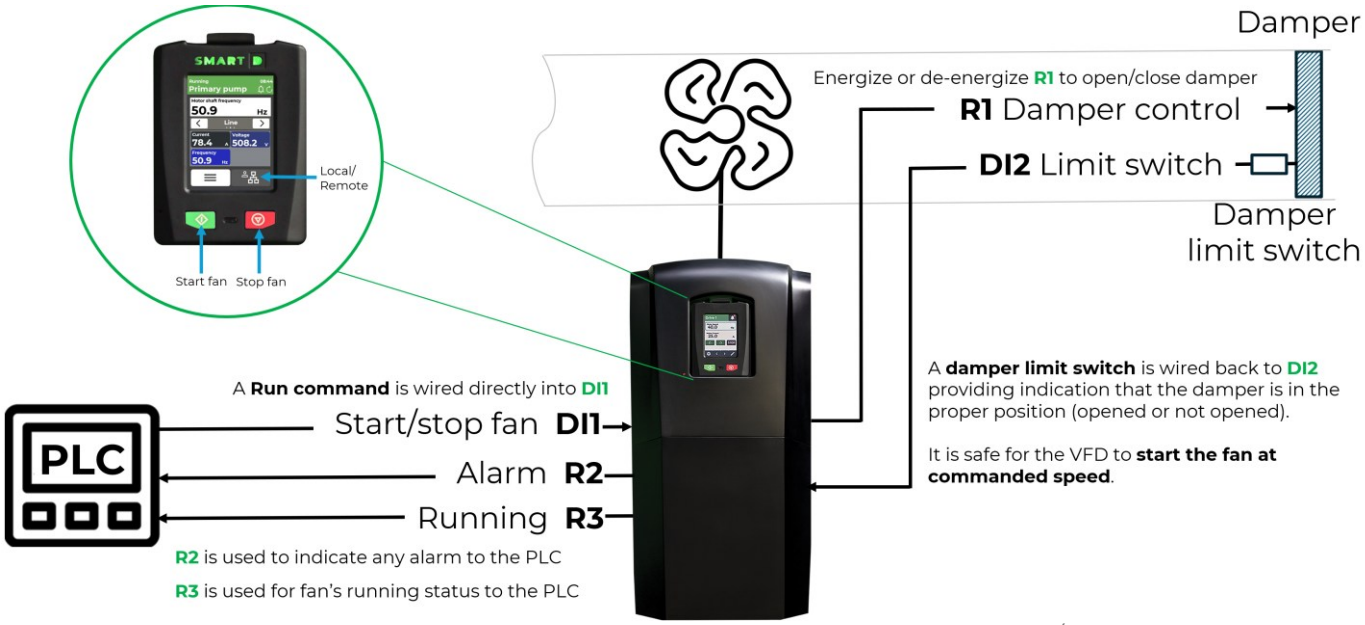
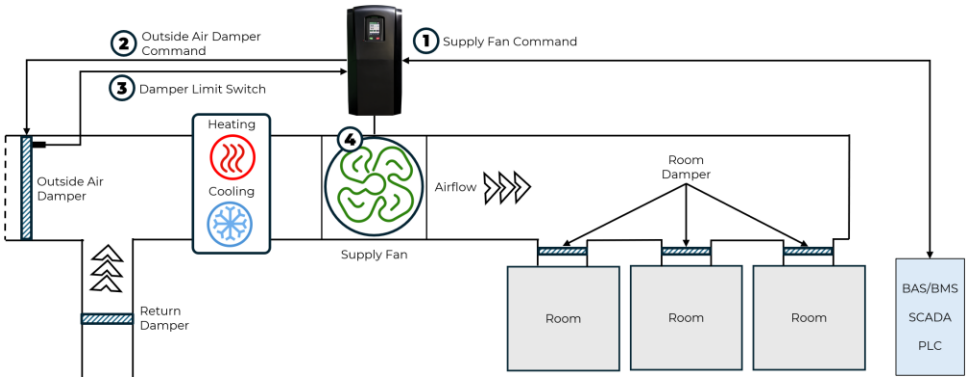
Simple Fan & Damper Start Sequence using I/O

The Clean Power VFD provides natively the damper control logic using I/O, reducing cost that is associated with external control hardware and software.



Wiring example of simple fan and damper control with I/O

Start fan and damper control with I/O



(1) The fan command is wired directly into one of the VFD's digital inputs. The digital input indicates a start fan command.
(2) The VFD uses the configured relay to energize the relay to open the damper.
(3) The damper limit switch is wired back to another VFD's digital input providing indication that the damper is in the proper position, and it is safe to start the fan.
(4) On the damper opened indication, the VFD brings the fan to the specified speed.

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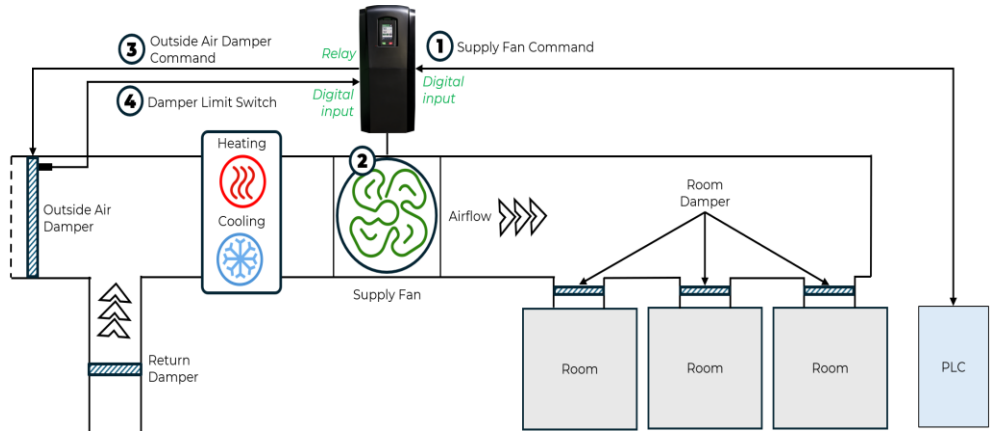
Stop fan and damper control with I/O



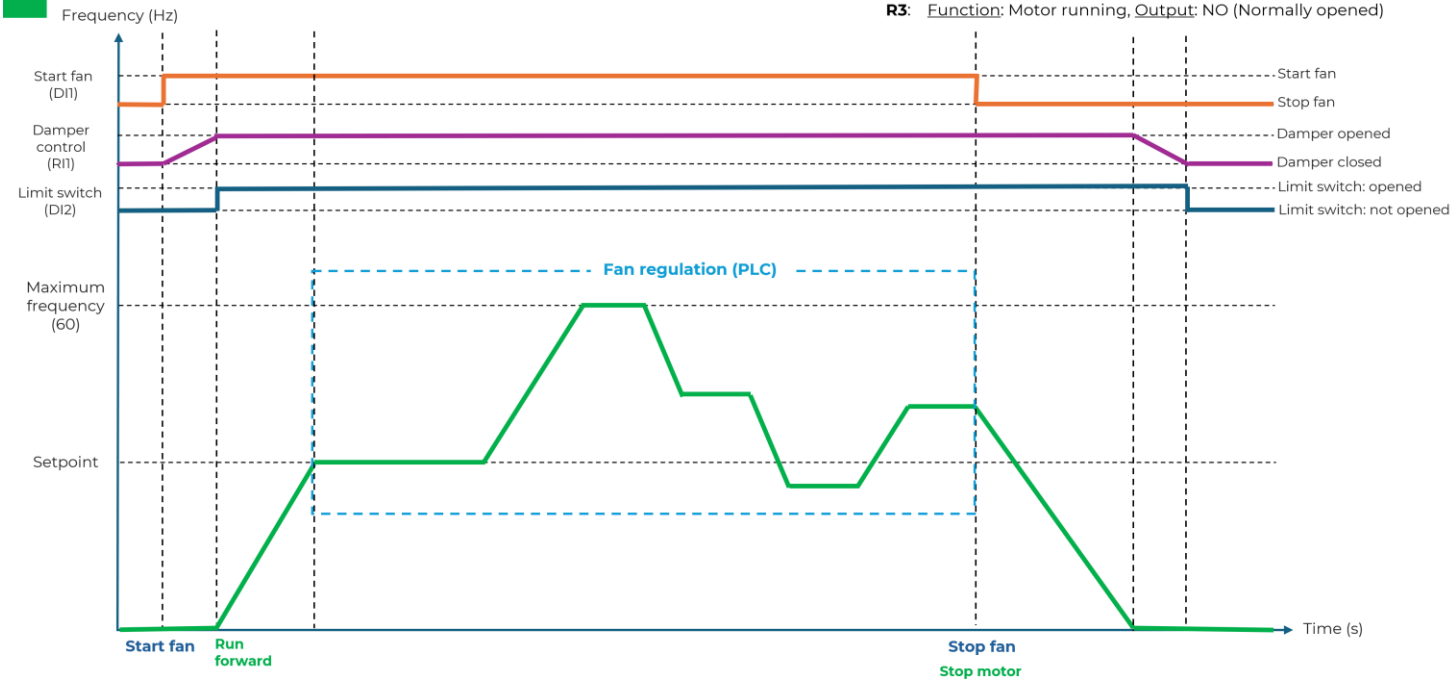
(1) The fan command digital input indicates a stop fan command.
(2) The VFD decelerates and stops the fan.
(3) Once the fan is stopped, the VFD uses the configured relay to de-energize the relay to close the damper.
(4) The damper limit switch indicates that the damper is closed.

Fan and Damper Control using I/O Sequence Diagram

The flow diagram #1 provides the control sequence from the fan command from the digital input DI1 to start or stop the fan, the relay R1 to open the damper and the damper limit switch feedback wired to digital input DI2 to indicate the damper position.

Fan and Damper Control Example Using I/O

Configuration:
DI1: Function: **Fan & damper control**, Trigger type: High
DI2: Function: **Damper limit switch**, Trigger type: High
R1: Function: **Damp control**, Output: NC (Normally closed)
R2: Function: Any alarm above minor, Output: NO (Normally opened)
R3: Function: Motor running, Output: NO (Normally opened)



Flow diagram 1

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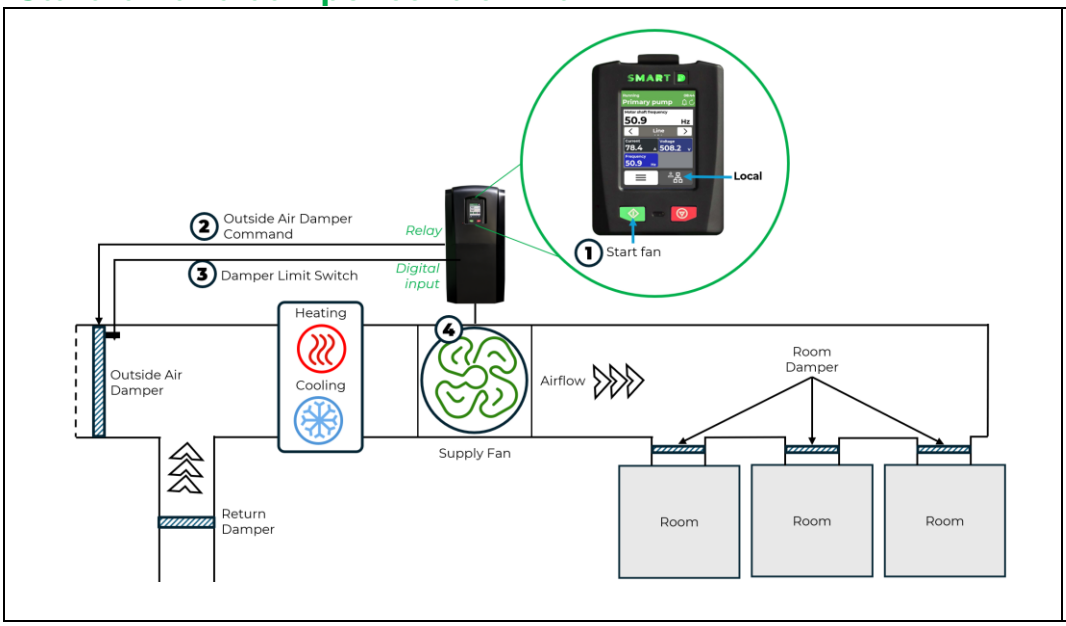
Manual Fan & Damper Start Sequence using HMI

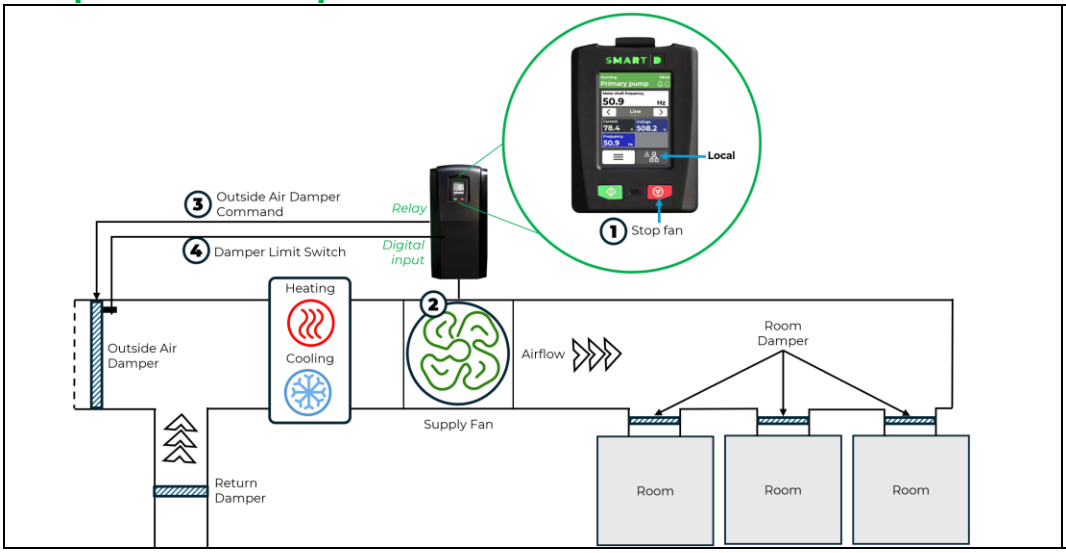
When the Clean Power VFD is in local control mode, the HMI's Start and Stop buttons can be used to perform the same fan and damper control sequence.

Start fan and damper control with HMI



(1) Pressing on the HMI's Start button issues a start fan command.
(2) The VFD uses the configured relay to energize the relay to open the damper.
(3) The damper limit switch is wired back to another VFD's digital input providing indication that the damper is in the proper position, and it is safe to start the fan.
(4) On the damper opened indication, the VFD brings the fan to the specified speed.

Stop fan and damper control with HMI



(1) Pressing on the HMI's Stop button issues a stop fan command.
(2) The VFD decelerates and stops the fan.
(3) Once the fan is stopped, the VFD uses the configured relay to de-energize the relay to close the damper.
(4) The damper limit switch indicates that the damper is closed.

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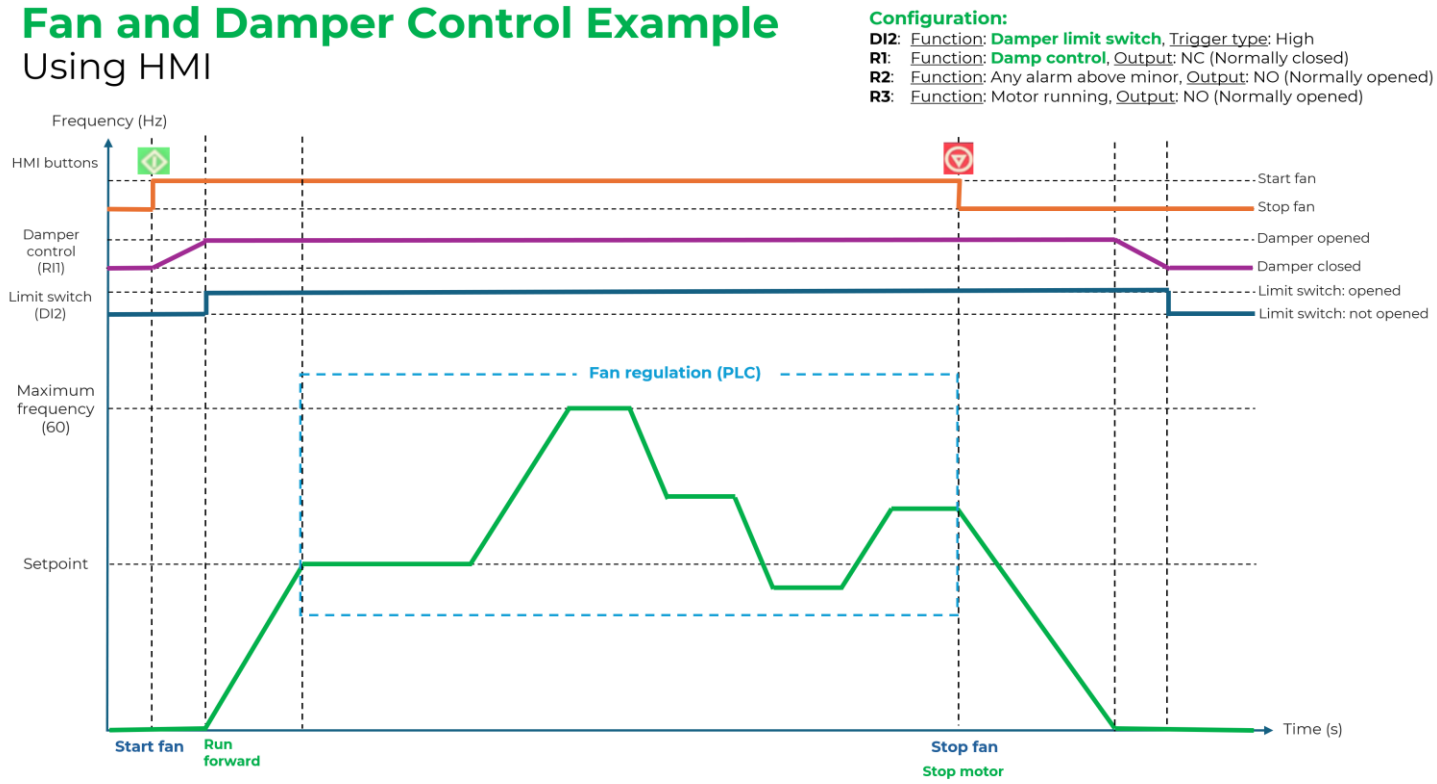
Fan and Damper Control using HMI Sequence Diagram

The flow diagram below provides the control sequence from the fan command from HMI's Start button to start the fan and the Stop button to stop the fan, the relay R1 to open the damper and the damper limit switch feedback wired to digital input DI2 to indicate the damper position.



Flow diagram 2

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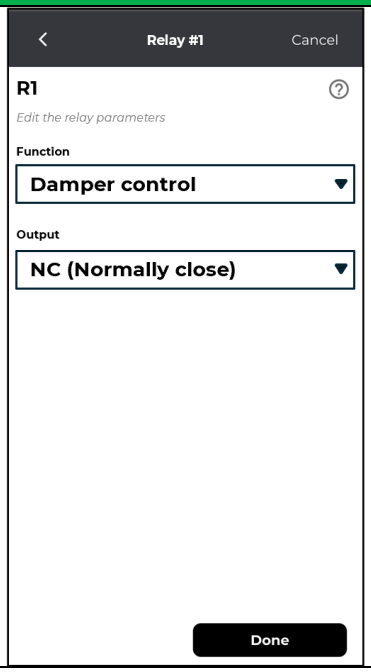
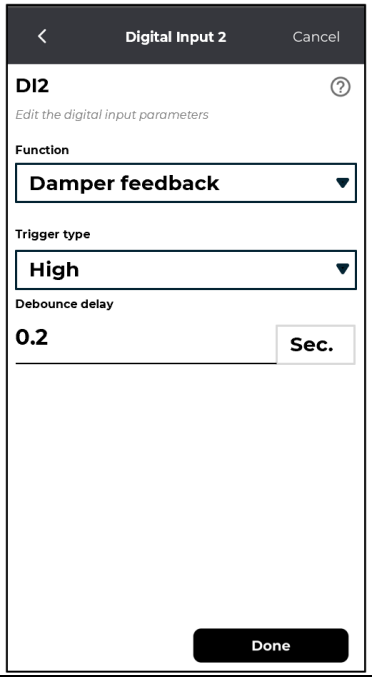
Clean Power VFD I/O Configuration

The Clean Power VFD automatically enables the fan and damper control features when:

- a relay output is assigned for damper control.
- a digital input is assigned for damper limit switch feedback

Both relay and digital input must be assigned to enable the native fan and damper control feature.

Step-by-step mobile configuration	
Assign a relay for damper control • Navigate and click on the **I/O's** configuration • Scroll down and click on **Relay** configuration • Select **R1** and click on the pencil • Select **Damper control** in the Function • Select **NC (Normally closed)** output type • Click on Done	
Assign a digital input for damper limit switch feedback • Navigate and click on the **I/O's** configuration • Scroll down and click on **Digital Input** configuration • Select **DI2** and click on the pencil • Select **Damper feedback** in the Function • Select **High** as output type • Click on Done	

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Test the system

Please follow the steps below to test the fan and damper control implementation:

1. **Verify control connection:** Make sure that all control cables are securely connected to the VFD's inputs and outputs.
2. **Verify the VFD's configuration:** Confirm that a relay is assigned for damper control, and a digital input is assigned for damper feedback.
3. **Manual testing with HMI:** Put the VFD to local control mode and press on the Start button to validate that the start fan and damper control sequence is working. Press on the Stop button to validate that the stop fan and damper control sequence is working.
4. **Test with I/Os:** Switch to remote I/O control, activate the configured DI to issue the start fan command and validate that the start fan and damper control sequence is working. Deactivate the configured DI to issue the stop fan command and validate that the stop fan and damper control sequence is working.

Conclusion

This application note has outlined the substantial benefits and enhanced performance capabilities provided by SmartD Technologies' Clean Power VFD.

By leveraging its advanced control algorithms and maintaining optimal motor function, the Clean Power VFD ensures superior efficiency, reliability, and sustainability in motor control applications.

We encourage industries looking to upgrade or install new motor control systems to consider the Clean Power VFD for its exceptional benefits.

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

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