

Technical Note 064

Six digital inputs for (6) preset speeds

Using the Constant speed source to start the ACH580

The ACH580 has an additional three Constant frequency selection points and the new Constant speed start source that make programming the Constant frequency applications very easy. The Constant speed start source in the Start/stop/direction group will be used to simplify the starting of the drive. When the request for a Constant frequency is made to the drive this feature provides the start command and eliminates the need for the extra interlock and DI to start the drive. This feature was developed to provide for easier integration with package unit controllers and thermostat controllers and is an advantage when retrofitting to OEM designs.

This technical note will use the Constant speed start source with the Constant frequency reference points using the *28.21 Constant frequency function > Const freq mode > Separate mode*. The Separate mode will be used instead of the Packed mode. This design approach will eliminate the need to use intermediate relay logic to convert the multiple fan speed requests to the three DI inputs needed to support the truth table logic in the Packed mode for Constant frequency control.

In the Separate mode, the six discrete selection points are paired: one to one, to the Constant frequency value fields.

- Constant frequency selection parameters: 28.22, 28.23, 28.24, 28.25, 28.46, and 28.47.
- Constant frequency value field parameters: 28.26, 28.27, 28.28, 28.29, 28.30, and 28.31.

The Constant frequency value fields are programmed to hold the actual frequency reference values in Hertz (Hz) that the drive will use to create the desired motor/fan speeds. The selection parameters are in turn associated with the activation points (DIs) that are wired from the unitary controller/thermostat contacts to the drive's digital inputs making the fan speed requests.

In the ACH580 you have the standard low voltage digital inputs and the option to add more DIs using the expansion board. Any of the six Constant frequency selection points can be associated to any of the standard six low voltage digital inputs, DI1 to DI6, or to any of the six 120-volt capable digital inputs, DI7 to DI12, using the CHDI-01 expansion card.

The Constant speed start source

Parameter *20.03 Ext1 In1 source [40] Constant speed*

- Any requested Constant frequency "Starts" the drive.
- Does not require a separate DI input to be associated as the Ext1 start source. Saves a DI point.

Starting the VFD using the Constant speed start source will also depend on selecting the Constant frequency references in Group 28.

Remember, that in HVAC applications the predominate operating mode for the drive is Scaler mode, not Vector mode. In Scaler the units are in Hertz (Hz) not RPM. So, even though the start source says "speed" it will be controlling to "frequency" values.

The Constant speed start source combined with the six Constant frequency selection points in the Separate mode will eliminate the intermediate relays needed to translate the inputs for the traditional Packed mode. In addition, the option to wire directly to the drive's DIs using the unitary controller/thermostat's 24 VAC source or using the drive's 24 VDC through the controller's dry contacts, will simplify the wiring and interlocks. When the integration is using the 24 VAC signals from the control logic contacts directly to the drive's DIs the interposing or isolating relays are often eliminated.

In the next section we will look at two possible integration circuits between the RTU's unitary controller/thermostat and the drive controlling the fan speed. One with interposing relays (dry contacts) between the unitary controller/thermostat and the drive's DIs using the drive's 24 VDC power source. The second design will be wiring the switched 24 VAC voltages from the unitary controller/thermostat directly to the drive using the unitary controller's 24 VAC source. In both cases we will be programming using the Group 28 Constant frequency, Separate mode.

Controller integration wiring with interposing relays and 24 VDC sourced from the drive.

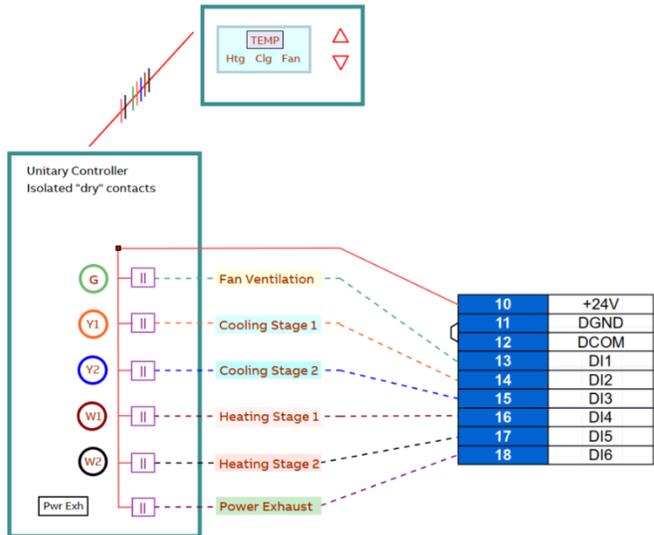
The existing controllers may have interface relays that replicate the thermostat signals. The G, Y1, Y2, W1, W2 symbols represent the traditional control logic for the fan, cooling, and heating modes. When the logic for the mode is true the associated N.O. contacts will be closed. Only one of the requests should be true at a given time.

Prior to the ACH580 the only way to interface with the VFD was using the Packed logic solution. This required a set of intermediate relays be added to create the contact closures to support the three DI truth table.

In this diagram the drive sources the 24 VDC. The circuit as drawn assumes dry contacts (interposing relays) at the unit controller are energized by the thermostat logic.

From the perspective of the unitary controller the 24 VDC is considered (and should be marked) an external source.

The unit "Safeties" are not shown here, but if they are present you will need to add DIs. The CHDI-01, I/O card has an additional (6) voltage capable DIs, 120 VAC.



Controller integration wiring with a 24 VAC source, direct

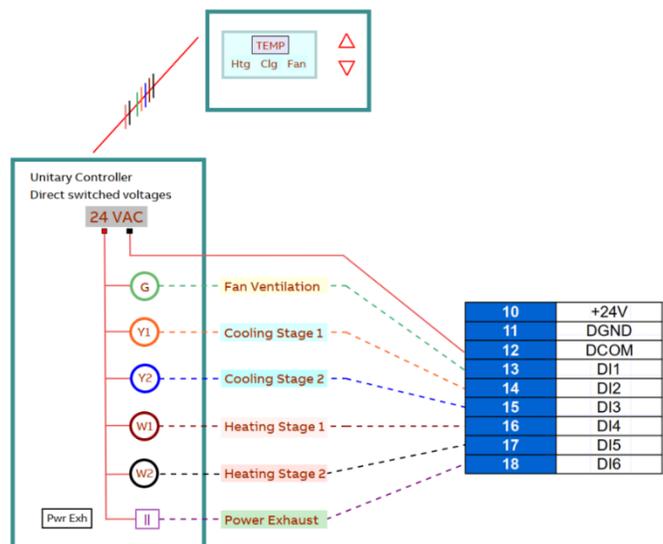
In this diagram, the control voltage is from a 24 VAC from a CPT at the unit. The G, Y1, Y2, W1, W2 symbols represent the traditional control logic for the fan, cooling, and heating modes. When the logic for the mode is true the control voltage will be switched to the corresponding drive digital input.

The DI circuit can receive the 24 VAC signal directly. In this case the interposing relays are not needed, and the control circuits can be wired directly to the unitary controller/thermostat.

The 24 VAC voltage would be switched by the unitary controller/thermostat contacts, to the DI's and then pass back to the CPT neutral through DCOM.

The safeties for the unit are not shown, as in the integration shown above. Additional DIs can be added using the CHDI-01 expansion card.

Note: In some designs the control voltage can be 120 VAC and may require using the CHDI voltage capable digital input points as the main interface.



When using 24 VAC as the source through the digital input circuit there is always the potential that the DI circuit can see the zero crossing of the alternating current wave form and interpret the input as being Off. Depending on the application this can cause intermittent operation for the control that depends on that DI status. If you add Off delays to your DIs to buffer the status and avoid the zero crossing effect, programming a minimum time Off delay time of 0.01 seconds is recommended.

Programming examples using the ACH580 Constant frequency Separate mode

This next section will be providing programming examples for a roof top packaged unit with VFD fan control. It will be integrating the drive’s Constant frequency references with the package unit’s unitary/thermostat control and interface relays. The design is based on a 24 VDC circuit.

The program and parameter selection examples are designed to sequence the fan speeds to support RTU system modes and the Cooling and Heating stages.

RTU system modes will be:

- Ventilation
- Cooling mode with two stages (Stage 1 cooling and Stage 2 cooling)
- Heating mode with two stages (Stage 1 heating and Stage 2 heating)
- and a Power Exhaust mode.

Roof top packaged unit programming parameters:

The program will be using the *External 1 (Ext1) [40] Constant speed* as the start source.

The following is a list of the likely programming for the drive. A comprehensive understanding of how the packaged unit operates and the unique fan speeds required to run the equipment safely is required. The final program will need to be adjusted to meet the fan/motor speeds required by the unit’s sequence of operation.

20.03 Ext1 In1 source	[40]	Constant speed	
21.03 Stop mode	[1]	Ramp	
28.71 Freq ramp set selection	Acc/Dec time 1	(default)	
28.73 Deceleration time 1	180 seconds	(adjustable to provide effective flow across the coils)	
28.21 Constant frequency function	[0]	Separate (default)	
28.22 Constant frequency sel1	DI1	Min. Fan Speed	
28.23 Constant frequency sel2	DI2	1st Stage Cooling	
28.24 Constant frequency sel3	DI3	2nd Stage Cooling	
28.25 Constant frequency sel4	DI4	1st Stage Heating	
28.46 Constant frequency sel5	DI5	2nd Stage Heating	
28.47 Constant frequency sel6	DI6	Powered Exhaust	
28.26 Constant frequency 1	30 Hz	(50%) of motor/fan speed	
28.27 Constant frequency 2	42 Hz	(70%)	“
28.28 Constant frequency 3	57 Hz	(95%)	“
28.29 Constant frequency 4	36 Hz	(60%)	“
28.30 Constant frequency 5	58 Hz	(95%)	“
28.31 Constant frequency 6	60 Hz	(100%)	“

!! CAUTION !! Make sure you understand the Minimum speed and flow requirements for warm air across the coil during stages of Cooling. Yes... slowing the fan down saves energy. Slowing it down too much freezes coils or in the heating mode can create high heat conditions. Select appropriate flow rates. Blow down and/or purge the system coils to remove the cold air or hot air before the fan shuts down .

In most RTU control designs if the continued air flow is required the manufacturer will have added a time delay relay (TDR) to the fan speed request circuit. The TDRs would be adjusted to the Off delay time needed to move the conditioned air through the system and remove the cooling or heating temperatures from the coils.

Programming a continued air flow using the drive

When programming a continued air flow across the coils using the drive functions there are a couple of approaches. As shown above, the simplest way would be to change the stop method from Coast to Ramp and set the Decel time. When using the ramp to stop method you will need to appreciate that the fan speed is gradually reducing and the face velocity through the coils is also falling off. At some point the flow across the coil is no longer effective in removing the cooling or heating energy from the system. You will want to review the lowest fan speed and confirm the deceleration ramp time needed to effectively reduce the temperature in the system to a safe level.

The actual ramp time is based on the frequency reference value at the time the drive is stopped, the deceleration time and, of course, zero Hz. At nominally 50% speed (30 Hz) the Ramp to stop time will be about 50% of the full Decel Ramp time. The flow rate will be effective for the first portion of that time as the ramp goes to zero Hz.

In this application the Ventilation mode frequency setting also serves as minimum frequency. So... What about minimum frequency? Will it be able to maintain a higher fan speed during the Decel ramp? Unfortunately, no. The Minimum frequency would only apply if the drive is started and running in Auto or in Hand. Once all the Constant frequency requests are withdrawn the drive is no longer started, it is stopping. When the ramp time expires the drive will stop. Setting Minimum frequency would still be a good idea to protect the system in Hand mode, but in Auto once the drive is stopped the ramp time is the only support for continued air flow through the system.

Using Off delays

Another option is to use "Off delays" to ensure that the ventilation mode remains on for a minimum amount of time and maintain an effective flow rate. Assuming the Off delay needs to occur on the way down add the Off delay to the Ventilation digital input activation point and use the DI delayed status for the selection point. Re-sequencing the order of the selection points will be required so the delay does not occur on the way up.

If the operation sequence requires it, you may need to add the Off delay to the lower stages of both Cooling and Heating before going to Ventilation only. The unit controller sequence will determine where and when to add the Off delay so make sure you understand the sequence and order of the different modes.

Also, confirm if the unit control could be just shut off during any mode, manually or by time clock. Will the unit have any orderly shutdown? Will the flows be effective to remove the heating or cooling energy to safe levels? The Off delay built into the DI for the last active mode will control the fans continued air flow.

Adding the DI OFF delay timers

How to add the OFF delays and resequencing the selection points to support the "on the way down" sequence is shown below to give you another opportunity to reason your way through how the conflict rule works with the sel point order. Remember the sel# and Constant frequency# are linked. If two requests are in conflict the lower # wins. The [Technical Note 055](#) is a good review if you are not familiar with the conflict rule with Constant frequency references.

Below is a restated set of parameter values that could be used to provide DI OFF delay values to blow down the lower stages of Cooling and Heating before dropping into Ventilation only mode. The DI points will be associated with the sel points in reverse order. The drive Constant frequency values are also reversed. On the way up the higher stage selection wins and there is no delay. On the way down with the lower stage mode sequencing to the Ventilation mode, the delayed status of the lower stage's DI has to time out before the drive drops down to the Ventilation mode frequency reference. When DI1 for the Ventilation mode is removed the DI1 delayed status maintains the continued air flow for the programmed DI1 OFF delay time.

Parameters settings

10.06 DI1 OFF delay	120 seconds	(adjustable)
10.08 DI2 OFF delay	90 seconds	(adjustable)
10.12 DI4 OFF delay	90 seconds	(adjustable)
20.03 Ext1 In1 source	[40] Constant speed	
28.21 Constant frequency function	[0] Separate	(default)
28.22 Constant frequency sel1	DI6	Powered Exhaust
28.23 Constant frequency sel2	DI5	2nd Stage Heating

28.24 Constant frequency sel3	DI4 delayed status	1st Stage Heating
28.25 Constant frequency sel4	DI3	2nd Stage Cooling
28.46 Constant frequency sel5	DI2 delayed status	1st Stage Cooling
28.47 Constant frequency sel6	DI1 delayed status	Ventilation Only, Min. Fan Speed
28.26 Constant frequency 1	60 Hz	(100%) of motor/fan speed
28.27 Constant frequency 2	58 Hz	(95%) “
28.28 Constant frequency 3	36 Hz	(60%) “
28.29 Constant frequency 4	57 Hz	(95%) “
28.30 Constant frequency 5	42 Hz	(70%) “
28.31 Constant frequency 6	30 Hz	(50%) “

Setting the DI delayed status for the DI OFF delay timers.

The *Constant frequency sel2*, *Constant frequency sel4* and the *Constant frequency sel6* points will be programmed to use the DI’s delayed status. The *DI2 OFF delay*, *DI4 OFF delay* and *DI6 OFF delay* times are set using parameters 10.06, 10.08 and 10.12. The delayed status is selected when you associate the DI points in the Group 28 Constant frequency sel2 and sel4 parameters.

- 28.24 Constant frequency sel3 > Other > 10 standard DI, RO > 10.02 delayed status >3 DI4 [10.02.03 DI4].*
- 28.46 Constant frequency sel5 > Other > 10 standard DI, RO > 10.02 delayed status >1 DI2 [10.02.01 DI2].*
- 28.47 Constant frequency sel6 > Other > 10 standard DI, RO > 10.02 delayed status >0 DI1 [10.02.00 DI1].*

Summary

The six programmable Constant frequency references provide flexibility when integrating to the OEM unitary controllers and thermostats. The Constant speed start source can be used to conserve valuable I/O points when connecting to the package unit’s controls. The direct integration of the controller/thermostat to the drive can eliminate the need for interposing or isolating relays. In addition, using the Separate mode with programmable Constant frequency references can eliminate the intermediate relays previously needed to support the Packed truth table logic.

The programming examples and the parameter settings will provide a good starting point for developing programs for the packaged unit integrations. When integrating to the unit controls a comprehensive understanding of how the unit operates, the flow rates required for each of the modes, and the number and progression of the controlled stages is needed.

If TDRs are not part of the design, programming Ramp to stop settings, and possibly Off delays, may be needed to provide for effective and safe operation of the equipment. The overall sequence of operation needs to be accurate including the correct sequencing of the operational modes and timing of continued air flow through the system when it shuts down.

The ACH580 Group 28 Constant frequency reference chain offers multiple features in support of Constant frequency programming. The Separate mode with the six programmable Constant frequency references provides the flexibility need to program and control today’s commercial packaged AHU and RTU systems.