Technical Note 204

Multiple motors controlled by a single drive

Guidance on how to implement

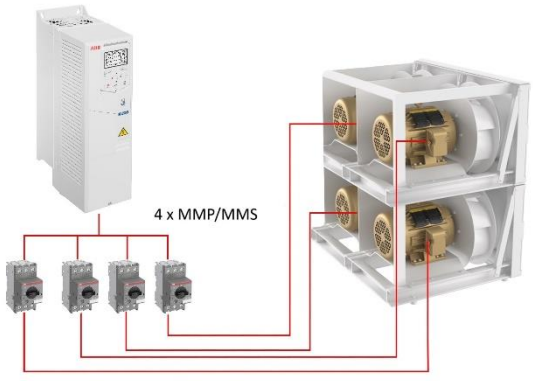
The majority of applications in the HVACR industry have variable speed drives (VSDs, VFDs) applied to motors on a one-to-one basis. In some instances, there may be a strategic reason or advantage to use one drive to control multiple motors. Applying drive technology this way is possible but requires extra considerations from the designer & installer compared to using one to one. Using one drive for multiple motors means the motors connected will all operate at the same speed. System control schemes should not actively stage (connect or disconnect) individual motors from the output of the drive while running. Common multiple motor applications include fan arrays or jet fans in a smoke ventilation system, as these can be controlled at the same speed and ramp up and down together to achieve the desired output for the system. This technical note contains guidance on how to implement this type of control for **induction motors only.**

Sizing the drive

When sizing a drive for a motor it is advised to always cover the current rating and check kW or HP. Technical Note 016 can also be referenced for more details on drive sizing. In this scenario all the motors that are to be connected to the drive need to be considered. In most multiple motor applications the motors tend to be the same size in terms of power rating. However, this doesn't have to be the case, and the motors can be different power sizes. All the motors do need to be rated for the same voltage. Once the combined full load current ratings of each motor have been added together, the next step would be to add up the combined kW or HP rating for all the motors. Then check to ensure that the drive can meet both the total full load current rating as well as the total kW or HP rating required to operate all the motors in the application.

Motor protection devices

Connecting multiple motors to one drive also requires individual overload protection devices to be installed for each motor. When using one drive per one motor the drive provides overload protection but when connecting multiple motors to a single drive this is not the case. The recommended devices to provide overload and short circuit protection in these applications would be a manual motor protector (MMP) or also known as a manual motor starter (MMS). This can provide the necessary overload protection for each individual motor in case of an issue with a single motor in the system. Note that in the event of a low impedance short in the motor, that the drive is likely to sense the issue and fault offline before a MMP opens. While technically fuses can be used on the output side of the drive, fuses are not recommended for motor protection. The use of fuses increases the chance of having only a single phase opening to individual motor. An MMP opens all three phases to the motor, to fully disconnect the motor. An aux contact on each MMP is recommended for monitoring status.



Cable distances

The drive and motor both have maximum recommended cable lengths which should be listed in manufacturer manuals. When calculating cable distances for this type of system it is important to remember to include the sum of all the motor cable lengths when checking against the recommendations for the drive. For the motor's considerations, the cable length to check would be the individual cable run for each motor rather than the sum of all motor cables. The location of where protection devices and the drive are installed are important as this can have a significant impact on the cable lengths. For example, installing the protection devices close to the motors can help reduce the total motor cable length (from the drive's perspective) if the drive is installed in a cabinet some distance away. The distance between the drive and motor is also very important to know as filtering may be required to protect the motor and drive if it is longer than the recommended distance. Using a dV/dt filter can reduce voltage levels in these cases.

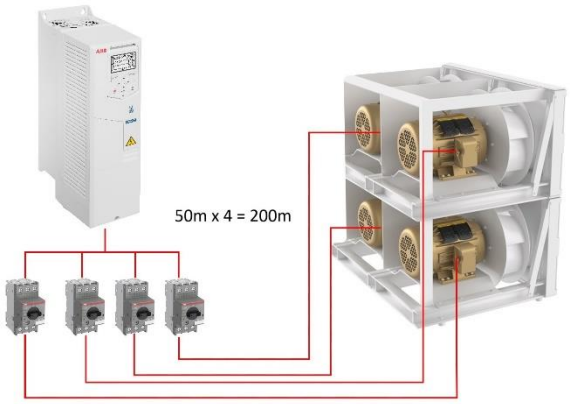


ABB HVACR drives commissioning

The next sections cover items that need to be considered when commissioning the ABB ACH580 drive on these types of systems and also some of the features in the drives that support the user during setup. While the ACH580 is used as the example, many of these concepts apply to other drives.

Control mode of Scalar vs Vector

For a multi-motor system Scalar control mode should be selected. Upon selecting multi-motor during first start assistant on the ACH580, it will change the control mode to scalar automatically. The reason for this is Vector control utilizes data from the motor ID run and controls the flux within the motor which is not feasible when there are multiple motors connected to the drive. Vector is a control mode used for applications where high accuracy is required along with larger torque control variation and when using multi-motors supported by a single drive, these applications tend not to have these requirements.

Start methods

There are two possible starting methods recommended for use with a multi-motor system. These methods are flying start or constant time pre-magnetization. The default starting mode for an ACH580 is flying start which is appropriate for most applications. There are some benefits to using constant time start mode when having a single drive support a multi-motors application which will be outlined below. Technical Note 049 provides additional details on fan array starting methods.

Flying start control mode sends pulses of energy to the motor and monitors the back EMF to determine the rotation and speed of the motor. The drive will then try to catch the spinning load by outputting a proportionate amount of voltage and frequency based on the approximate speed. In a system with multiple motors the same logic applies but the drive uses an average of the back EMF signal and tries to catch the spinning loads. The possible issue here is the motors could be free spinning at slightly different speeds which may result in one or more of the motors being too far outside from this average EMF value causing those motors to draw more current, which could result in an overcurrent fault on the drive. This however is not common in many applications and most multi-motor applications controlling fans operate without any problems with the flying start method.

Constant time start mode is a more effective start mode when connecting multiple motors. This is especially true when controlling fans in HVACR where the fan can be rotating even with no power applied. This start method uses pre-magnetization which will bring the motors to a complete stop before ramping up to setpoint. The reason this start mode is preferred is that it will bring any free spinning motors to a complete stop and reduce the potential for any overcurrent issues when the drive tries to catch multiple spinning motors.

Stop methods

The ACH580 can be configured for either coast to a stop or ramp to a stop operation. There are independent stop mode parameters (**21.03 stop mode** and **20.45 start interlock stop mode**) for the traditional start/stop method and for the stop method when a safety (start interlock) is opened. For single motor applications, typically fan applications are configured to coast to a stop while pump applications are configured to ramp to a stop. However, with multiple motor applications, ramp to a stop is often recommended for both pump and fan applications when possible. The advantage to the ramp method is that the drive maintains full control of all the motors while ramping down. Maintaining control of all the motors is especially helpful in situations where there are brief power disturbances, such as those caused by a generator transfer event.

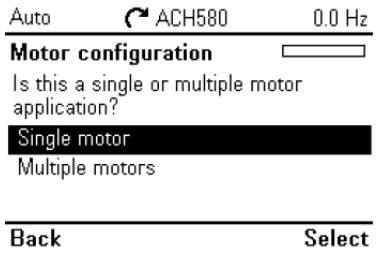
As an example, consider a generator transfer test scenario that has a short delay between utility and generator power. The local controller has backup power from a UPS, thus the start command remains constant to the drive. However, there is an interposing relay (with no UPS power) between a safety (i.e. high duct static pressure) and the start interlock input on the drive. During the short period of no power, the interposing relay opening causes the drive to believe the safety has opened. In this example, with the start interlock stop mode programmed to ramp, the drive keeps control of the motors and does not need to go through one of the previously described start methods.

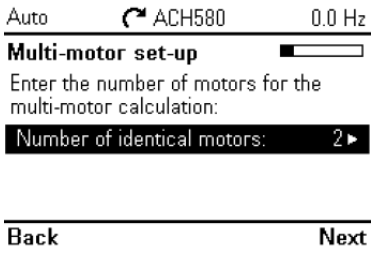
Energy optimizer

Energy optimizer is automatically disabled through the ABB first start assistant or motor nominal values assistant when using multiple motors. Energy optimizer helps save energy when the drive is operating in scalar mode set with parameter **99.04 motor control mode** by controlling the motor flux and optimizing, where possible, the output voltage to the motor. When there are multiple motors connected to the drive it cannot accurately control the flux and optimize the voltage output to suit a multiple motor application.

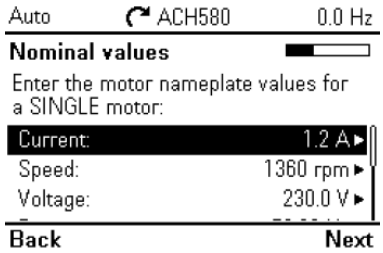
First start assistant / Primary settings

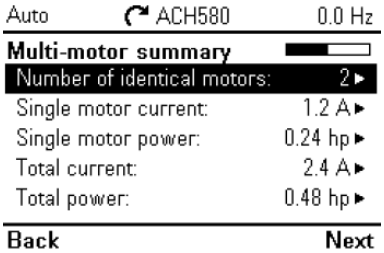
When using an ABB ACH580 drive there are setup assistants which helps the user when commissioning a drive with multiple motors connected. The first start assistant's motor configuration, and also the motor nominal values assistant, both allow selection of multiple motors as shown on the screens below. The first start assistant can also be accessed through primary settings if required as the drive may have initially been powered up before commissioning. By selecting the multiple motors option, the screen will display some different options compared to when setting up a single motor configuration. The following screen asks for the number of identical motors which are being connected to the drive.



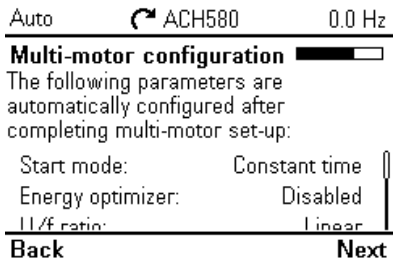


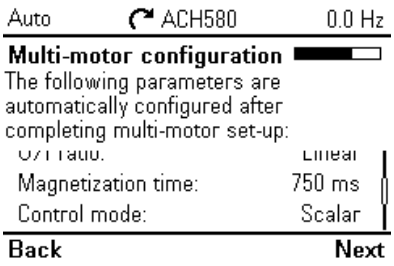
The next screen that follows asks for the user to enter the motor nameplate value for one of the motors that are being connected to the drive. The drive then calculates the total current and power before displaying them on a multi-motor summary screen.

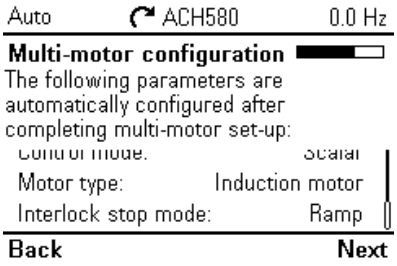




To complete the multi-motor setup part of the first start assistant, the below screen will be displayed which shows the items which the drive has automatically configured based on the choice of a multi-motor system. These items have been covered earlier in this technical note in more detail, but the below screens show a summary. Note that the assistant changes the interlock stop mode to ramp but the traditional stop mode is not adjusted in this assistant. Using the assistant is extremely helpful in avoiding potential issues with drive settings that may be missed during commissioning stage, as most drives have default settings for one drive to one motor systems.







Summary

Using a single drive to control multiple motors is common in fan arrays and jet fans in ventilation systems for HVACR applications. Drive sizing, protection device selection, cable distance calculation & drive commissioning all need to be done differently than when looking at a single drive to single motor system. Using an ABB ACH580 drive can greatly simplify the commissioning of these applications using primary settings to select the optimum settings required to reduce any issues upon startup and operation.