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Whitepaper

Accelerated growth of common DC Bus drive applications

AC drive systems for variable speed motors are experiencing accelerated growth thanks to several predominant trends in manufacturing including higher levels of automation and efficiency. Along with the expansion of system-type drive installations for industrial machinery is the increased adaption of what is termed “Common DC Bus” design for AC drive systems. This approach offers users several advantages for applications with multiple AC drives especially when they are in a coordinated system typical for motion control and production lines.

Although a common DC bus configuration is not new and took rise along with the DC to AC drive migration in the 1990s, there are increased implementations across many different industries. This whitepaper will look at the main advantages with use of common DC bus configuration for AC drive systems and why they are increasingly the choice for implementation to meet today’s needs.

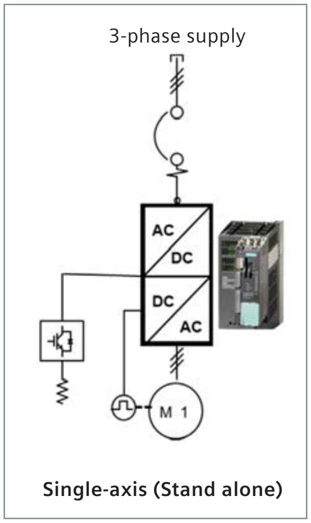
The majority of variable speed AC drives make two power conversions in their design. Incoming AC power is rectified to DC and then the DC is inverted into a pulse width modulated 3-phase AC waveform that can control many different types of AC motors. This unitarily adapted and proven design principle has an impediment for many applications—for example, when the motor needs to stop or change torque direction from motoring to regenerating, the inertia energy needs to be addressed.

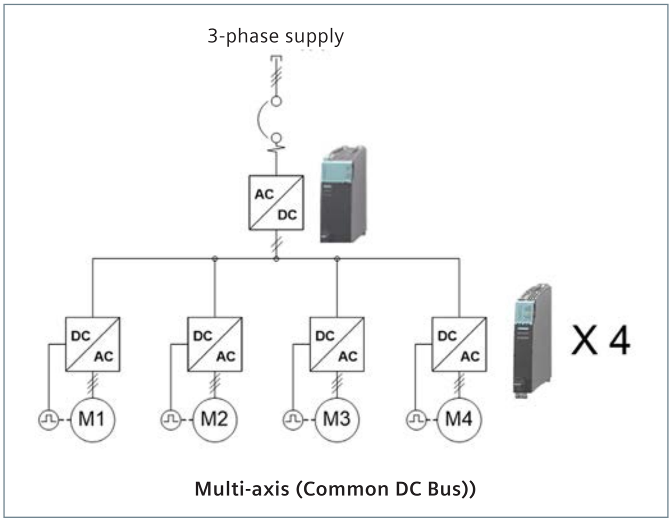
In a low-inertia or a simple pump application, stopping the motion can be as easy as turning off the AC drive and coasting down or setting a mechanical brake. For most system-type applications, there are more demanding needs with fast stopping, quick direction changes, and overhauling loads that increase the complexity of the solution.

The most widely found solution in AC drives is to use dynamic braking which incorporates a switching device and resistor to dissipate the energy into heat. In addition to the added components, the biggest undesirable effect in DB braking is the wasting of energy into heat to get rid of the regenerative power. Cost-effectively recovering this regenerative power is an increasing concern and plays well into the design of a common DC bus drive system that typically consist of a single unit for the AC to DC conversion, and multiple DC to AC motor inverter units all commonly connected to the DC bus.

Figure 1 (left):
Example with DB braking

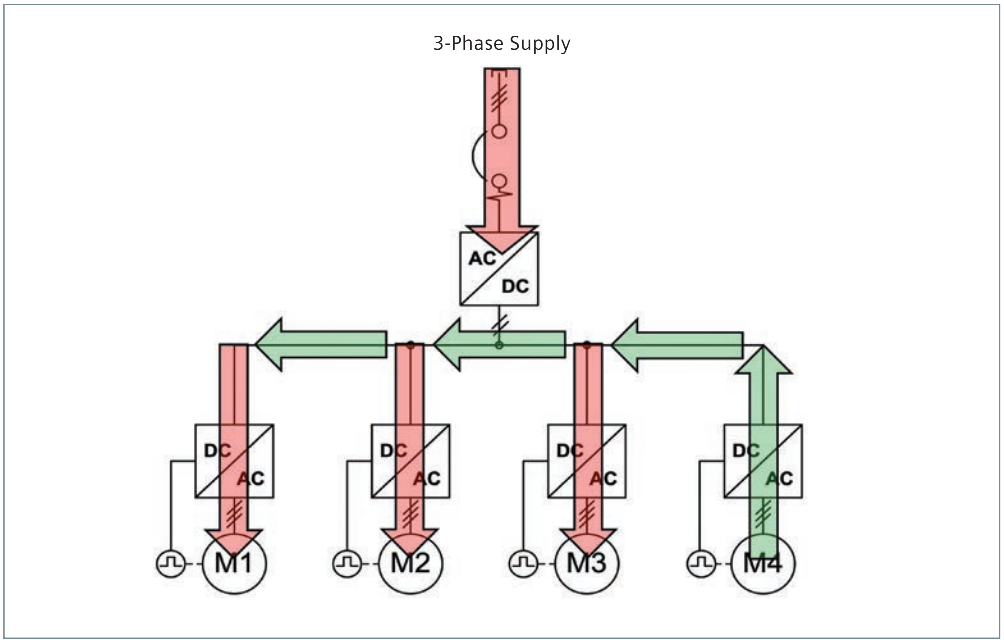
Figure 2 (right):
Example with four motor inverters





When regenerative power is fed back to the drive through the motor inverter, the DC bus voltage rises and can cause a fault condition if not addressed. In a stand-alone drive, it is very typical to use dynamic braking to dissipate the energy as stated previously. In a common DC bus drive system, the regenerative energy sent back can be utilized to power other motoring axis through the shared DC bus design. This can eliminate the wasting of energy and reduces the supply power, which can be substantial in many applications such as unwinders and hoists that have considerable regenerative load cycles or motion profiles with fast and frequent deceleration characteristics.

Figure 3:
Recovery of regenerative power in the DC bus



In a common DC bus system, if conditions exist where more power is being regenerated than can be used by the motoring axis, then dynamic braking can also be used — but in such applications, a line regenerative system can be a better solution. Line regenerative systems can feed power back onto the power supply albeit at a substantial cost. Due to the hardware cost of line regeneration, stand-alone drives rarely utilize this technology, but with the economy of scale in using multi-axis common DC bus system, the adder of one common hardware component is more neglectable. In addition, due to what is termed the coincidence factor on sizing the AC to DC feed on common DC bus applications, this single feed is typically sized much less than the sum of the rated loads making this functionality more economical.

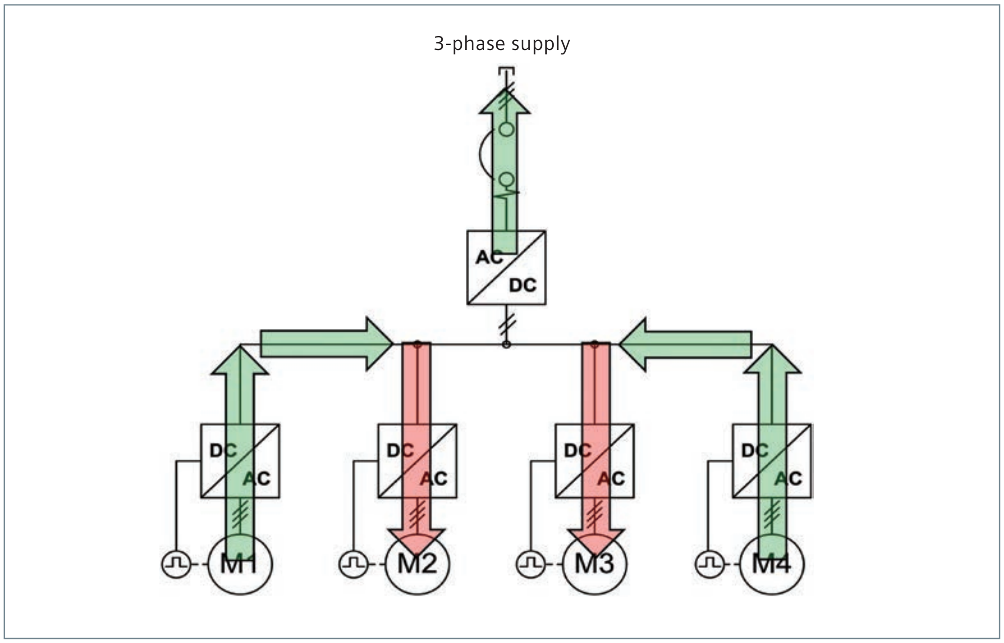


Figure 4
Recovery of regenerative power to power feed

In comparison to several stand-alone drives, each with its own line components versus a multi-axis system with one set of line components, additional savings are clearly found in the reduction of hardware components, cabinet space, wiring and other cost factors. With modern increases in computing power, a single processor can now operate multiple inverter sections further reducing cost and allowing flexibility in the separation of power components from control electronics in the cabinet layout now popular with arc flash mitigation.

Power storage devices such as batteries and ultra-capacitors are an emerging trend added in with drive systems. These devices typically connect to DC power, making common DC bus drive systems well positioned for this trend, as well as the go to solution when efficiency and power storage is paramount. In recent years, addressing the needs for power dip ride through or the ability to buffer peak loads in production machinery without oversizing the complete system have bolstered the growth of common DC bus drive systems.

Conclusion

Common DC bus drive systems offer a number of advantages in size, cost, efficiency and ease of adapting to power regenerative capability or power storage. When implementing a common DC bus drive system, it is important to use a product that has been designed for this capability. Connecting the DC bus of AC drives not designed for this configuration can lead to disastrous results and unsafe conditions. Additionally, observe the ampacity limits of the DC bus and any group fusing requirements in the drive manuals and make sure the product you select has been listed for common DC bus connection in the product certifications.

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