1325 Northmeadow Parkway, S-130
Roswell, GA 30076
Phone (770) 772-0400
e-mail: sales.us@br-automation.com

Latest developments in Multi-axis technology

Multi-axis versus single axis servo drive systems

Abstract

Today's industrial machinery is becoming increasingly electrical. Mechanical transmission components that drive motion within the machine are being replaced with electric servo motors and drives. It started with a single stand-alone servo axis replacing a DC or AC drive on the machine. The benefits were quickly realized in the performance of the feedback driven system over the classic open-loop architecture. But the trend continued from there. Additional sections of the machine, such as mechanical cams and gears, became targets for their replacement expense and dynamic nature due to wear-and-tear. So, additional single axis servo systems were added. And the benefits were further realized with more powerful motion controllers able to handle the additional axes. But, from the drive or amplifier perspective, these advancements in technology came with a high price tag for the machine builder. 3-phase starters, contacts, filters, chokes, capacitors, and resistors had to be considered for each single axis drive system. Each additional servo axis offered little for the machine builder except possibly the volume discount from the vendor. Today, multiple-axis servo drive systems are what's "hot" (but as we'll see, hopefully not too hot). This article compares multi-axis servo systems to the classic single axis servo drive.

Limitations of Single Axis drive systems

There is one universal limiting factor to power electronics – heat. Transistors in electric servo drives, often referred to as Insulated Gate Bipolar Transistors (IGBTs), can switch on and off at rates around 20 kHz or higher. When this happens, components heat up quickly. In order to dissipate this energy and avoid overheating of the drives, this heat must be dissipated quickly and efficiently. When single axis servo drives are utilized, there are space requirements to consider in the electric panel. There is typically a minimum mounting distance for other components around the servo drive so that heat can be exchanged to its surroundings without heating up the nearby components. As additional single axis servo drives are added, space in the cabinet begins to suffer. And space is an expensive aspect of control cabinet design. So what is the machine builder to do? This is a good example of where looking at a multi-axis servo drive system could be beneficial. Here's how.

1325 Northmeadow Parkway, S-130
Roswell, GA 30076
Phone (770) 772-0400
e-mail: sales.us@br-automation.com

The future in Motion Control – Multi-Axis drive systems

Image 1: Drives at their most economical! This new multi-axis ACOPOSMulti system eliminates the need for fans or air conditioners in the switching cabinet thus offering the highest degree of efficiency for multi-axis machines that are commonly used in the plastics, packaging, print, and textile industries.

A multi-axis servo drive system can allow for direct side-by-side mounting of the drives with no clearance between the units. This is necessary in order to simplify the wiring of the 24VDC control voltage and 750VDC bus power bus between the units. When they are butted-up against each other, these bus cables can be easily attached, secured, and hidden from the operator of the machine. But, with this compact mounting design, the heat generated must go somewhere. There are 3 choices, and these options have to be considered when sizing up the system. They are wall mounting, feed-through mounting, and cold plate mounting. The least efficient and simplest to implement is the wall mounting. This involves natural convection through the back of the drives into the cabinet in which they are mounted. The second choice, feed-through mounting, requires a hole to be cut into the back of the cabinet. The drives are then mounted with heat sinks out the back of the cabinet. These IP65 rated heat sink units allow easy dissipation into the cooler air outside. The third option for heat dissipation in multi-axis servo systems is forced water or oil cooling. This so-called cold plate mounting circulates cooled water or oil over the mounting plate of the drives and acts as a radiator. This is the most efficient method of heat dissipation. With these choices, the machine builder has a clean way of dissipating heat and minimizing cabinet space with the multi-axis servo system.

1325 Northmeadow Parkway, S-130
Roswell, GA 30076
Phone (770) 772-0400
e-mail: sales.us@br-automation.com

Efficient use of Energy

So far we have discussed the normal operation of any servo system with the heat generated from its internal electronics. If you add in the duty cycle of the machine, you run into more heat issues. Quick deceleration or dynamic braking, for example, can create large amounts of energy that must be disposed of quickly as well. This generated energy is pumped back onto the DC bus internal to the drive. This DC bus, which is created when 3 phase input power to the servo drive is converted into a DC power by means of a voltage rectifier, should maintain a range of 750VDC plus 10%. If the generated energy increases the DC voltage above this threshold, the servo drive could be damaged and will shut down. In stand alone servo drive applications, the choice is simple. If the application threatens to increase the DC bus above the threshold, an external resistor or capacitor unit must be used. These items can be costly ($500 or more), require additional panel space, and, in the case of resistors, waste resources by burning off unused power. The multi-axis servo system offers a better alternative.

Machines running multiple servo axes often have different requirements for all of the axes at any given time. During a standard cycle of the machine, chances are that some servos are accelerating or using energy while others are decelerating or generating energy. Taken individually, these axes are inefficient with their power use. Taken together, these axes can pool their resources by means of the multiple axis, modular servo drive design. In this multi-axis servo system, there is one power supply that provides the DC bus for all of the servo axes. Incidentally, there is only 1 set of contactors, 1 choke, and 1 filter necessary as well, resulting in obvious cost savings. But because there is one DC bus, some of the servo axes can be pulling energy from the bus while others are adding energy back onto it. This sharing of the bus is much more efficient than the using external power components on an individual drive basis. An additional feature to look for is regeneration of power back onto the 3 phase line. If the bus does go too high above the nominal 750VDC, a circuit will enable internally in the power supply which switches power from the DC bus back to the 3-phase AC power line, with a clean power factor rating approaching 1. This feature has cost benefits to the machine builder in the form of less power components and to the end user in savings of power consumption.

1325 Northmeadow Parkway, S-130
Roswell, GA 30076
Phone (770) 772-0400
e-mail: sales.us@br-automation.com

Integrated Safety

Having discussed heat and energy issues, we come to another major benefit of the multi-axis servo drive system over the individual servo drive -- safety. It is important to get diagnostic information from the drive system when it is not working properly. These diagnostics come in the form of errors or warnings and it is important to know this information to keep the machine running safely. In order to get this information, 24VDC needs to be applied to the control logic of the drives. The same voltage is applied to all other vital electronic components of the machine – the PLC, the PC, the I/O, etc. If power is lost or interrupted with a single axis drive system, there is very little the drive can do to keep this 24VDC voltage supply the brains of the machine. With the multi-axis servo drive system, this becomes possible. The energy on the 750VDC bus can be used to keep the 24VDC logic working for a significant time. It's hard to say exactly how long this can be maintained. That is a result of where in the cycle the power has been lost, how many 24VDC devices are being supplied, and numerous other factors. But the fact remains that the multi-axis system can supply the important electrical components of the machine longer than an individual drive system can.

Image 2: Today, safety on machines is limited to E-stop buttons. So the only possible safety reaction is switching off the machine. The future looks different with "Integrated Safety". ACOPOSmulti is based on ETHERNET Powerlink. The activation of functions such as safely limited speed is done directly over the network. Wiring these safety-related signals to the drive is now a thing of the past.

1325 Northmeadow Parkway, S-130
Roswell, GA 30076
Phone (770) 772-0400
e-mail: sales.us@br-automation.com

Conclusion

Putting it all into perspective, we see that the multi-axis servo drive system is certainly the wave of the future. As more axes are added to each piece of machinery, the cost per axis for the machine builder decreases. And the amount of diagnostics and troubleshooting ability for the end customer increases. It is truly a win-win for industrial machine builders and the product producers. This trend will continue for years to come, as companies will improve their productivity well beyond their expectations.

Errol Neider
Regional Sales Manager
B&R Industrial Automation Corp.