

# POWERTEC

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## **Application Note 040201: Electronic Line Shaft Application for Chain Systems**

**Concept:** Utilize multiple drives to run a single chain conveyor for the purpose of distributing chain stress.

### **Problems:**

1. When drives are connected mechanically to the same load there cannot be ANY change in velocity between drives that is not corrected for in some way. Any change will result in one or more drives being in current limit thus creating high local loading and binding the system.
2. No velocity controlled or Electric Line Shaft (ELS) system will run successfully on a long chain conveyor with changes in vertical elevation without some method of compensating the distribution of slack points in the system due to tolerance accumulation.
3. Current sharing is desired in such a drive system but current control alone cannot assure stable operation of all drives and will result in binding of the system because one drive still has to regulate the speed of the entire system and if it is unloaded due to slack the current regulated drives will overdrive the master.

**Solution:** The requirements for such a system are accuracy and a means of load distribution that is consistent with the fact that you cannot push a chain. One drive in the system is designated the Master Drive and it is set up to simply operate at a commanded speed, using controlled ramps

accelerating up to speed and decelerating down to speed. It must also provide an accurate output of its speed and load for use elsewhere. Additional drives must follow the master in a VERY accurate digital lineshaft, but the slave drives must be set to a SLIGHTLY faster following ratio. Typical ratios of slave following are 1.005:1 (one half of one percent). This is the reason the lineshaft must be very accurate since the overspeed required is very small but must be consistent. This overspeed is necessary to assure that all slaves recover any long-term developed slack in front of that drive. Since it is possible that any single drive will try to increase its speed, attempting to pull all drives behind it, therefore overloading that drive, current to the drive must be limited in order to prevent one drive from pulling too much. Since it is desired that all drives (including the master) pull an equal part of the load, each slave must have the current limited, but if the slaves are simply current limited at some arbitrary level of current, this will not assure each drive will run at the same load AND speed. If the master drive current is used as the current limit value for each slave drive, then all system requirements are met. The very close reference following assures that all slaves will run at the same speed as the master, except for a very slightly faster ratio. If any chain slack develops in back of a drive, that drive will run at a very slightly faster speed than the master, slowly pulling the slack out until other slaves distribute the slack in the system, but not so rapidly as to push the chain in front. During this time, the load on that slave will drop to near zero until the slack is recovered, but the other drives will continue to pull as the slack distributes around the full length of the chain. If at any time, the master drive becomes lightly loaded, the current output of the master will drop. The slaves will then be limited to a lower current and will not be able to pull on the chain as much, forcing the master drive to pick up more load to maintain chain speed. If the master drive becomes heavily loaded, the master current will increase, thereby giving the slaves a higher current limit (remember they are trying to run slightly faster

than the master) and will pull harder on the chain, equaling the current required by the master.

Summary: The system design will result in the master drive running at a constant speed (it's current limit is set to maximum rated current) and the slaves running at a constant current, which is the same current as the master. The requirements for the system to work is a very accurate digital line shaft, and the ability to set current limit on the slave drives from an external source. Additionally, the line shaft cannot be allowed to accumulate error in the slaves. In other words, when the slaves are in current limit, the line shaft system must stop accumulating position error and pick up the line shaft following position only when coming out of current limit. There are very few line shaft systems that allow for this that also provide the accuracy needed. Simply velocity following will not work because the error at low speeds is unacceptable. The line shaft must be capable of shaft-position (pulse-by-pulse) accuracy all the way to zero speed. Almost any system can be made to run acceptably at high speeds, but the starting and low speed operation is where the need for this accuracy is required.

The Powertec Genesis drives and Digimax ratio following system does provide for this functionality. Additionally, the new Powertec Flexmax drive system will also provide this accuracy and functionality. This satisfactory operation has been proven in multiple drives on the same chain up to 7000 feet in length