Allen-Bradley

AC Drives

Load Sharing Applications for AC Drives

Rockwell Automation

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Overview

Load sharing is a term used by many to describe a system where multiple drive and motor sets are coupled and used to run one mechanical load. In the strictest sense, load-sharing means that the amount of torque applied to the load from each motor is prescribed and carried out by each drive and motor set.

Identifying Load Sharing Applications

The first step in addressing the needs of an application with multiple motors is to determine if the motors are required to work together to share the load. Load sharing involves multiple motors and drives powering the same process. Each drive and motor set must contribute its proportional share of power to the driven load.

Multiple motors that are run from a single drive is not load sharing because torque control of individual motors is not possible. Motors that are controlled by separate drives without any interconnection are also not sharing the load. The lack of interconnection defeats any possible comparison and error signal generation that is required to compensate for differences in the load that is applied to any single drive and motor set.

Control Topologies

Three categories are Droop, Torque Follower, and Speed Trim Follower.

Control Topologies

Three categories of load sharing techniques will be presented, each having unique characteristics. The subtle differences will be addressed to better identify how to implement each to ensure a successful application. The categories are Droop, Torque Follower, and Speed Trim Follower.

Droop

This is the simplest form of load sharing to set up and, therefore, the least precise and less flexible. The precision of this control is dependent on three factors, the drives control algorithm, the motor characteristics, and the type of load being controlled.

Since a volts/hertz drive does not have the ability to run in “torque mode”, a more loose interpretation of the term “load sharing” is sometimes used. Load sharing on a volts/hertz drive is much less controllable and to a large extent dependent on the motor and type of load coupling. Since a loaded induction motor has “slip” as an inherent characteristic, load sharing is a natural response to loading.

When two motors are coupled to the same load each will slip according to its portion of load, forcing load to be picked up by the other motor. In this regard, a high slip motor is better for load sharing applications. However in a general sense, the slip of a motor is representative of its efficiency rating. High slip motors tend to have high starting torque but have low efficiency. Though high efficiency motors will slip when loaded, they may not have enough slip at full load to achieve a reasonable degree of load sharing. For this reason many drives offer a feature called “Droop”.

The Droop feature enhances the natural slip of the motor by reducing the output frequency in proportion to load current. Ideally it is only the torque-producing component of the load current that determines the droop. The amount of droop can usually be programmed in the drive in hertz or % speed.

Torque Follower

This type of load sharing requires a drive having the capability of operating in “torque mode”, such as the 1336 IMPACT™ drive. If speed regulation is required, one of the drives may be in “speed mode” (called the “Master”). Keep in mind that a drive in speed mode is really still in torque mode. While in speed mode the speed regulator provides a torque command output. This torque command output can be distributed to the other drives on the system (called the “Slaves” or “Torque Followers”). This torque signal may be scaled at the master output or the slave input to divide the load sharing in any ratio desired. In this case, it is possible to have drive and motor sets of varying horsepower sizes each pulling load to the extent of their capability. For example, a 100 horsepower and a 75 horsepower drive and motor set each running at 86% of its power rating could power a system requiring 150 horsepower. The ratio of load sharing can be adjusted such that each motor and drive set pulls a proportional amount of load under all conditions.

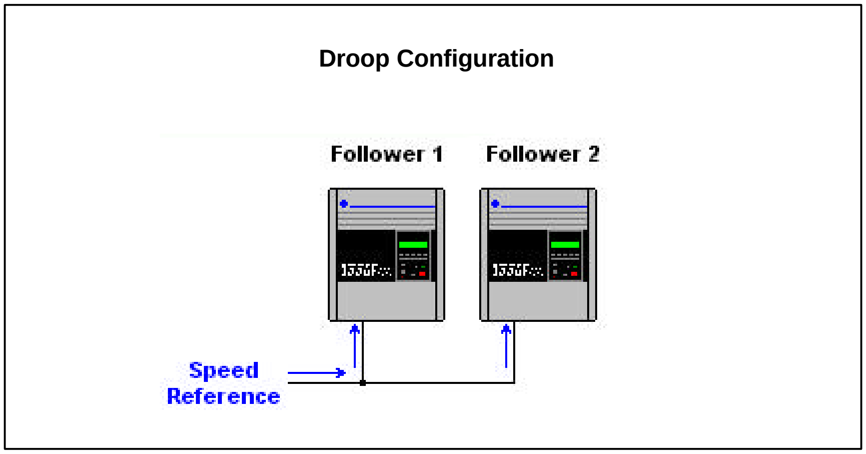
Speed Trim Follower

This configuration requires drives that can produce an internal torque reference or estimate torque current. Master and follower drives are operated in speed regulation mode and receive the same speed reference. Interconnection of the drives is necessary so that torque references may be compared. The torque reference of the master drive is sent to the follower drives. Each follower drive compares its own torque reference with that of the master drive. The output of the comparator is an error signal that trims the speed of the follower.

Configurations

Droop

The master and follower drive(s) receive the same speed reference and no interconnection of the drives is required. The speed of the motors will be dependent on the load and amount of droop that is programmed at full load current.



Advantages

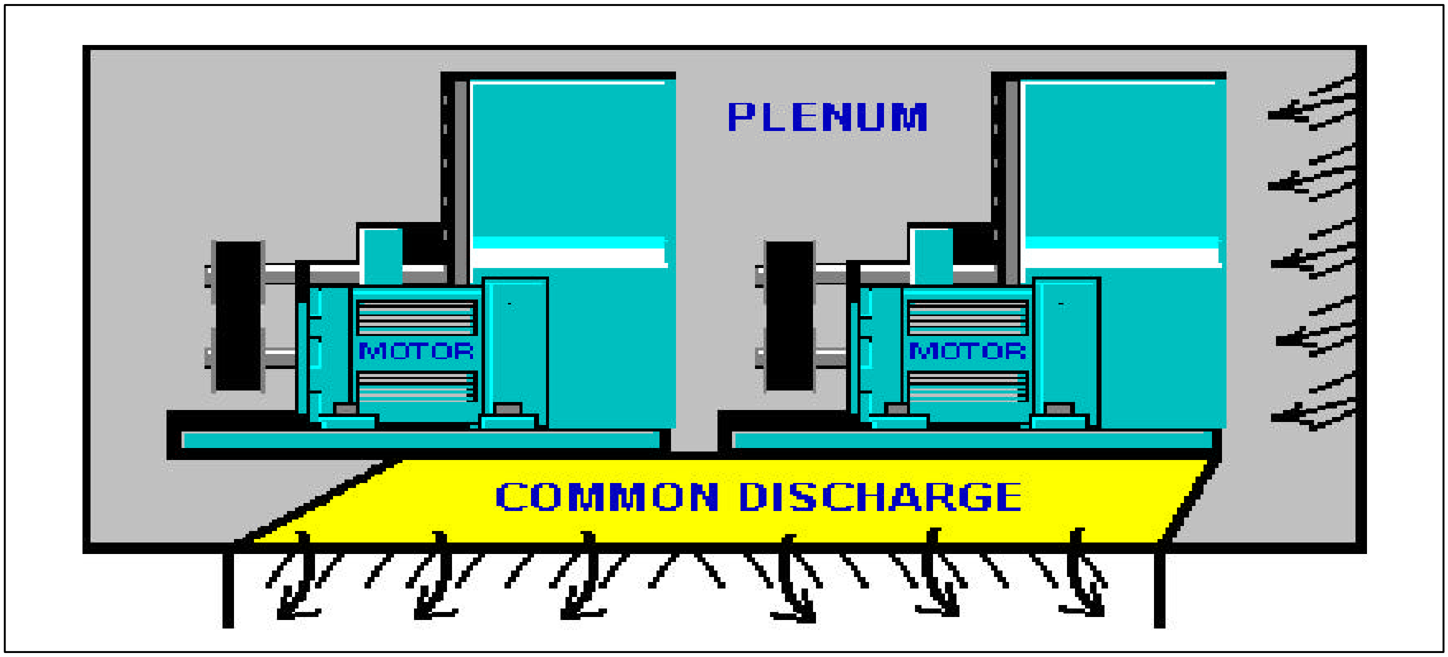
- *Simple*
- *No extra wiring for interconnection*
- *High performance drive not required*
- *No runaway condition with load loss*

Disadvantages

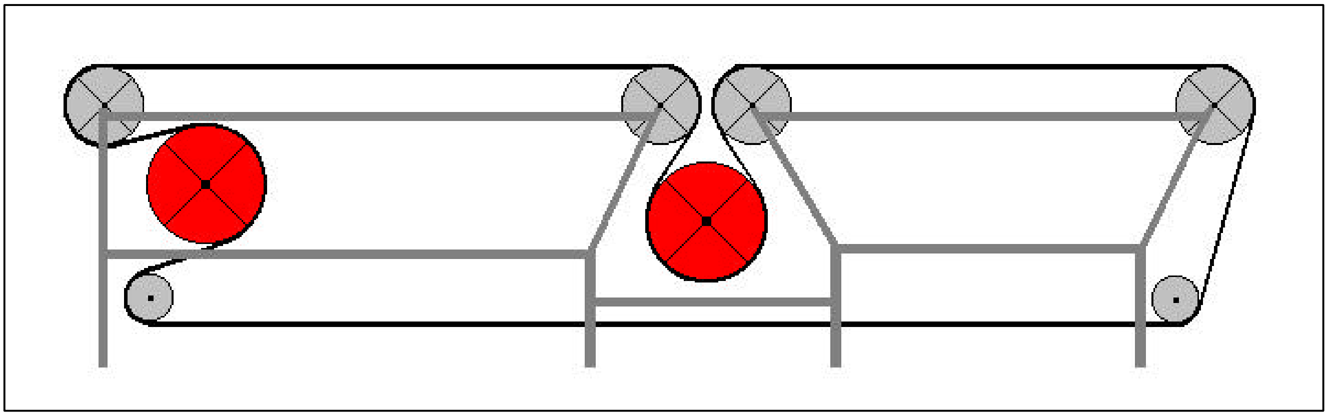
- *Poor speed regulation*
- *Limited speed range*
- *Sharing of load not precise*

Droop Applications

Air handling units with a common discharge.



Continuous belt conveyor with multiple driven rolls.

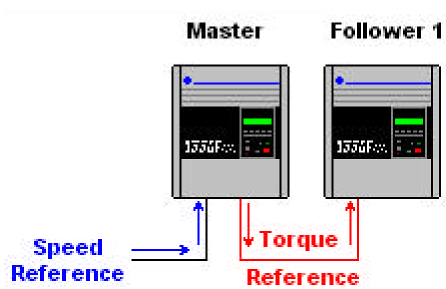


In both examples, the speed regulation is not critical.

Torque Follower

The master drive is operated in speed regulation. The follower drive(s) are operated in torque regulation mode. Interconnection of the drives is required. The torque reference of the master drive is sent to the follower drives and used as the command.

Torque Follower Configuration



Advantages

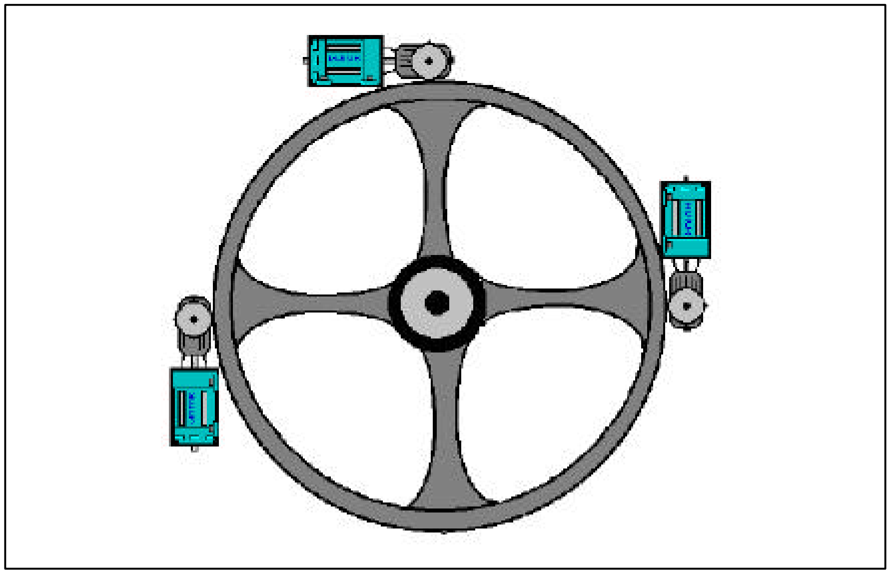
- *Precise load sharing (act as one)*
- *Operation over the entire speed range*
- *Minimum torque mode helps prevent runaway*

Disadvantages

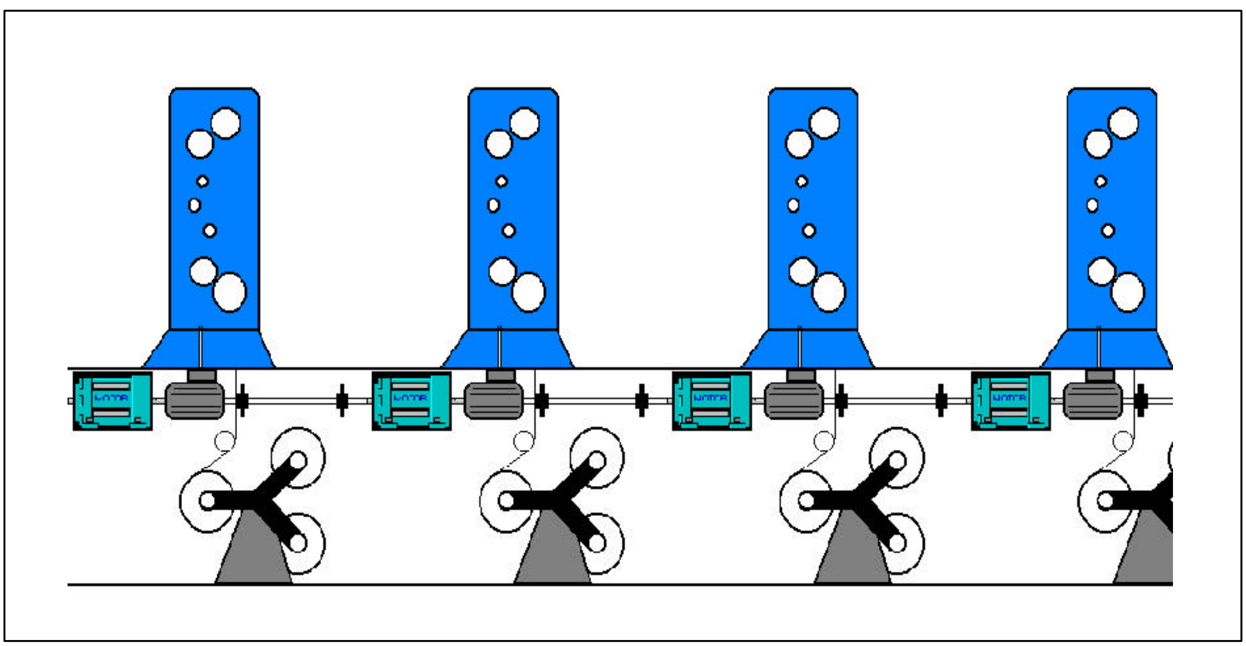
- *Requires a torque regulating drive*
- *Interconnection required*
- *Load loss runaway if torque regulation only*

Torque Follower Applications

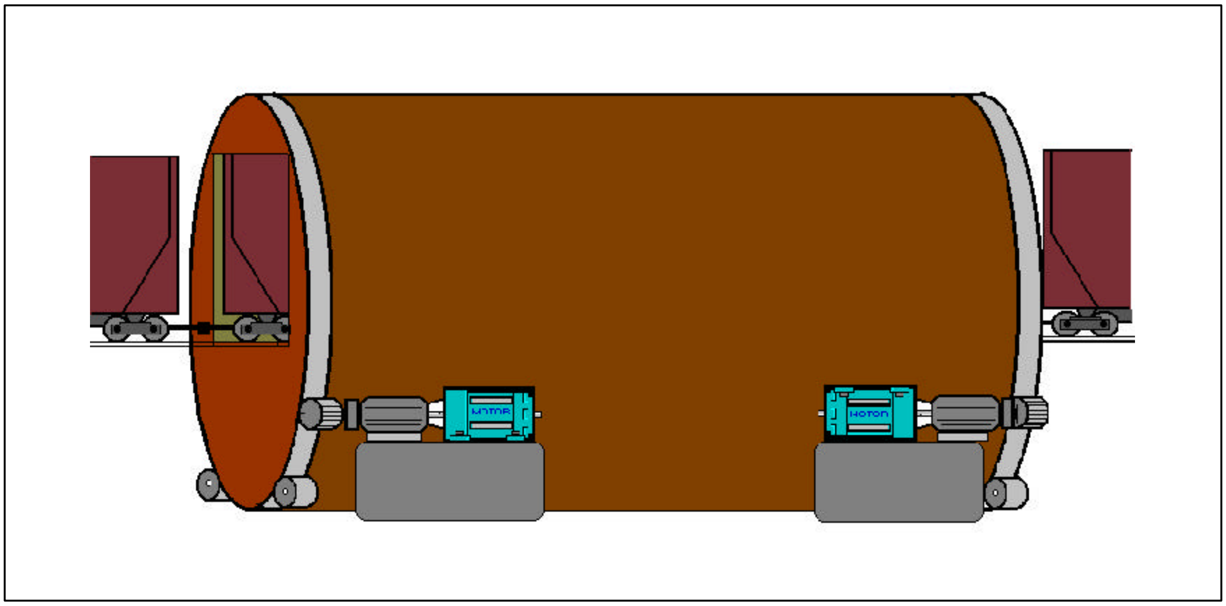
Large diameter bull gear with multiple drives.



Printing presses with inline drive shaft.



Coal car dumper, Cement kiln, Separator drum.

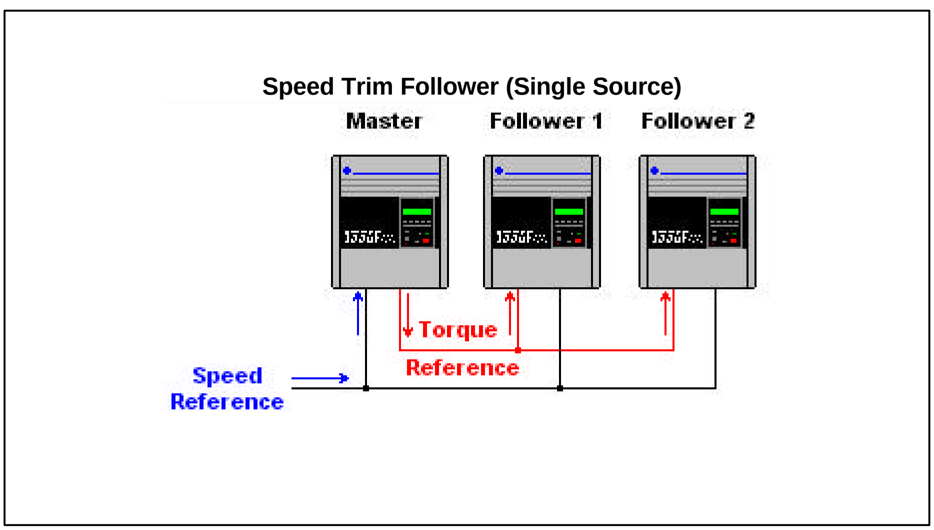


In all examples, the coupling between the motors is rigid and speed regulation is critical.

Speed Trim Follower

The master drive is operated in speed regulation. The follower drive(s) are operated in speed regulation mode with a speed trim. The trim is a function of the comparing of torque commands of the master and follower drives.

Two types of configurations can be used; one uses a single source (master drive) for a torque reference comparison. The follower drives compare the masters drive torque reference to their own internal value to create the error signal for speed trimming.



Load Sharing Applications for AC Drives

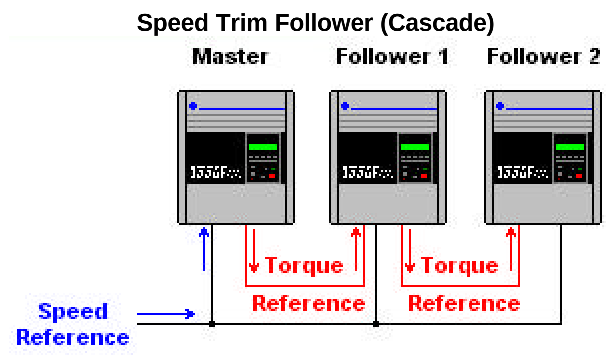
The second configuration cascades the torque reference comparison. The first follower compares the master to its internal value. The second follower compares follower 1 and its internal value.

Advantages

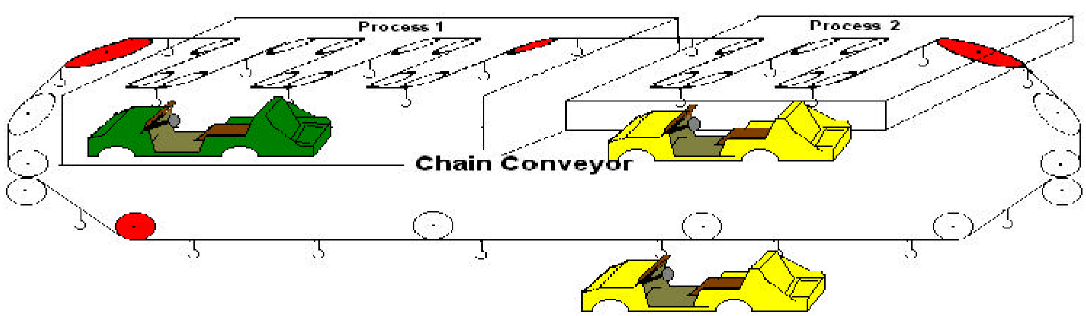
- *Continuous automatic compensation*
- *Operation over the entire speed range*
- *Trim feature built into drive*
- *Speed regulation*

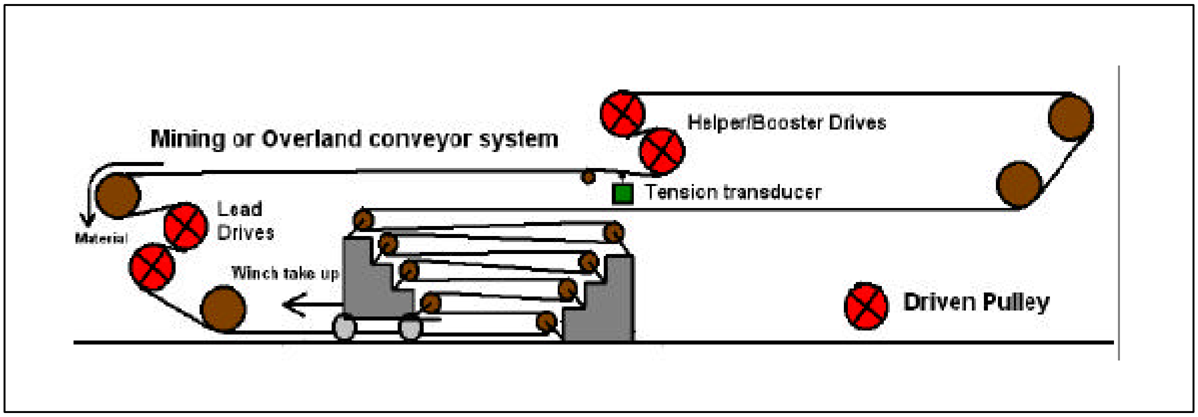
Disadvantages

- *Requires high performance drive for precision*
- *Requires interconnection wiring*



Speed Trim Follower Applications





In these examples, the coupling between motors has a very high potential for oscillation; therefore, the automatic compensation inherent with the speed trim is best suited to these types of applications.

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