

# YASKAWA AC Drives

## Wire Drawing Applications

## Market Overview

This document provides a general market overview and is intended to familiarize the reader with the benefits of using AC drives in wire drawing applications.

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# 1 Preface

Yaskawa manufactures products used as components in a wide variety of industrial systems and equipment. The selection and application of Yaskawa products remain the responsibility of the equipment manufacturer or end user. Yaskawa accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any Yaskawa product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All systems or equipment designed to incorporate a product manufactured by Yaskawa must be supplied to the end user with appropriate warnings and instructions as to the safe use and operation of that part. Any warnings provided by Yaskawa must be promptly provided to the end user.

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### ◆ Intended Audience

This document is intended to familiarize the reader with the benefits of AC drives in wire drawing applications and also provide a general market overview.

## 2 Wire Drawing Market Overview

### ◆ Wire Drawing Introduction

The process of wire drawing has in effect changed very little over the years. It uses a combination of a die and/or a series of dies to draw wire to a selected gauge. Drawn wire is in many applications beyond what we normally would think like electrical wire and TV cables. For example, springs of any kind are made of drawn wire; as well as re-bar used for construction world-wide. Paper clips and staples are made from thin drawn wire. Spokes on wheels, wire brushes, metal handles are made from drawn wire as well. There are literally thousands of finished products that rely on drawn wire. To satisfy this ever growing need, many millions of miles of wire are drawn by metal working companies annually. For this reason wire drawing, although unchanged in process for many years, is an extremely cost sensitive and competitive market. In turn, the companies that make wire drawing equipment and the process equipment around wire drawing are very in tune to any productivity or efficiency advantage they can get. One of those primary advantages is to use an AC drive. AC drives are much more efficient, use less parts, and allow for more productivity than traditional designs.

A common diagram shown below illustrates the wire drawing process. If multiple dies are used, they are linked together serially until the required cross section is reached. It is vitally important to keep continuous and know tension and speed on the wire as it travels through the machine. This ensures a consistent cross section.

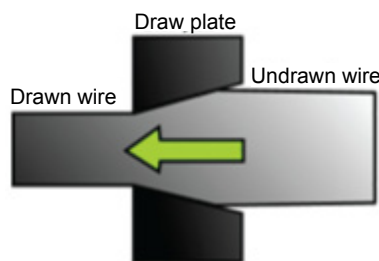


Figure 1 Wire Drawing

### ◆ Science Behind the Wire Drawing

Metallurgy is the study of metal and metal processes. There is a defined rate of change of metal characteristics based on tension and strength over a range of temperatures when the metal is being manipulated. Wire drawing is a metal working process used to reduce the cross section of wire by pulling it through a series of dies. This process is a type of forging. Forging is the plastic, or permanent, changing of a metal shape. Forging can be performed at hot, warm or cold temperatures. Since, metals have different characteristics at varying temperatures; it is possible to change the characteristics of the metal itself as the temperature rises. When wire is drawn, it is drawn at room temperature. At that point, it is being 'cold worked' forged. Cold working a metal is term used for plastically deforming at ambient room temperature without changing the characteristics of the metal. When the wire is drawn, the metal does not change characteristics, it only changes shape.

### ◆ The Wire Drawing Process

The process itself is actually quite simple. To begin the wire drawing process, a spool of wire is placed at beginning of the machine on a spool. In order to feed it through the machine, the end of wire must be cut or flattened. It is fed through the machine and through a series of dies to achieve its final cross sectional area. The end of the machine usually has a spool or coiler so the finished product is a coil of wire at the desired cross sectional area. The end process may also be a barrel packer where a barrel is placed and the coiled wire is spooled directly into the barrel using a turntable.

It is vitally important the temperature of the machinery does not get too hot (primarily caused by the energy released while deforming of the metal) and the wire has a constant tension and speed as it moves through the series of dies. Historically this was achieved solely by mechanical means. However, DC drives began to be used to operate the motors at certain levels depending on the metal and cross section required. As technology improved, software was added for winder applications which kept the material moving at the proper speed and tension to ensure a good product. This removed some of the mechanics and transferred it to electronic technology. With the introduction of high-performance/ high efficiency AC drives with powerful processors for software, mechanical dependency on the machinery is greatly diminished.

### ◆ Drives and the Wire Drawing Process

As discussed above, AC drives can be used for a wide range of functions on a wire drawing machines as they are very similar to a winder. Electronic Line Shaft, vector controls and serial communications are used on many of these modern machines.

### ■ Definition of Electronic Lineshaft Software

**Note:** This section is taken directly from the ELS Manual for VSG114815.

*. . . Electronic Line shaft Software allows one or more A1000 driven motors to be synchronized to a master encoder signal. The master encoder provides a pulse reference to the follower that results in the follower commanding its motor to maintain a specific shaft position. The follower drive monitors the pulse feedback from the master encoder and its own encoder. The follower will then compensate for any position errors by adjusting its motor's output speed, resulting in near perfect alignment between the system master and the follower motor. There is no accumulation of position error, so alignment will always be maintained. . .*

On a wire drawer, a main drive is used and the rest are follower drives. The software definition states further:

*. . . The follower also possesses an electronic gearing feature. This allows the follower to operate at a ratio of the master as though the two were mechanically coupled through belts or gearing. This software includes "Enhanced" Modbus communications. The registration control feature allows the follower drive to accept a registration mark from the moving product and regulate its angular position. This is used for special applications such as packaging machines, flying cutoffs, label . . .*

ELS (-047) software is ideal for a wire drawer as it's winder like characteristics requires the wire to move at a known and continuous tension and speed. It must continually adjust for error and tracking.

The introduction of AC drives not only provided very good performance, it gave the user the advantage of not rely on mechanical parts, which are subject to wear. Therefore preventative maintenance and routine tear downs are significantly reduced.

### ■ Challenges of the wire drawing application include:

- Fast process times.
- High torque and speed control.
- Quick accelerations to a speed and deceleration to zero speed again without losing tension.
- Varied speed ranges and torque requirements depending on material.
- Process can suffer from very little downtime.
- Due to speed, issues with the process can cause large amounts of scrap and lost revenue.

### ■ Cutters

Many companies that provide wire drawing equipment also provide peripheral equipment. After drawing the wire, there are requirements to cut to a certain length. The A1000 with Electronic Line Shaft performs this function very well. There is a closed-loop main drive and a follower drive after the cutting wheel. The main drive must maintain accurate tension and speed in conjunction with the follower drive.

### ■ Barrel Packers

A wire barrel packer is an assembly that may be placed directly off the wire drawer or coiled wire may be brought over to a different station. In the barrel packing function, a barrel is placed on a rotating turn table. Wire is continuously fed into the bottom of the barrel and recoiled. There are usually two motors on a barrel packer, one for laying out the wire and one for spinning the turn table. As this process is much slower and not dependant on tension but only moderately for speed, a small open loop drive is coupled with a closed loop vector drive for the turntable. There is a turntable only version of this assembly as well. In that case only a single AC drive is installed.

### ■ Coilers and Spoolers

Spoolers are often found at the end of wire drawing machines. Coilers are separate machines that coil wire and end products of various gauges and strengths. Their sole purpose is to wind, or spool the final product for shipment. Coilers can be used to wind very large cable at high speeds and have gone as high as 1000 HP. Spoolers seems to be smaller and do not go above 50 HP. Although they perform the same function, spoolers look to be smaller than coilers, and are referred to as such in the industry.

■ Application Requirements

Wire Applications	Voltages	HP Range	Duty	Software
Wire Drawing	230/460/575V	5-100hp	Continuous Heavy Duty; 40 deg C N1; Enclosed	Electronic Lineshaft
Coilers	230/460/575V	50-1000hp	Continuous Heavy Duty; 40 deg C N1; Enclosed	
Barrel Packers	230/460/575V	20-40hp	Continuous Heavy Duty; 40 deg C N1; Enclosed	
Cutters	230/460/575V	5-75hp	Continuous Heavy Duty; 50 deg C N1; Enclosed	Electronic Lineshaft

■ Drive Functions Appropriate for Wire Drawing Process

The functions that can be applied while operating a wire drawer, coiler and spooler are very similar to a winder. AO.AFD.68 table displays the features and benefits of using an AC drive in the winding application.

Drive Products	Features	Benefits
A1000 or G7 Drives	PID Control Mode	Line velocity control and diameter consistency can be achieved using the drives PID Mode with dancer position sensors, velocity sensors or diameter sensors.
	Cooling Fan On/Off Control	Controlling the number of times the drive fan is switched on and off increases the lifespan of the cooling fan and reduces the need for maintenance.
	Flux Vector Control and Torque Control Mode	Both torque and constant tension control are possible by using Closed loop Vector Control and Torque Control Mode.
	Zero Servo Mode	The Zero Servo Function in Closed Loop Flux Vector keeps the wire from becoming slack, eliminating the need for a mechanical brake.
	Kinetic Energy Braking (KEB)	KEB braking function can decelerate the application to stop without damaging the load, even when a power outage occurs. Simply coasting to stop can cause the wire to build-up or break.
	Torque Detection	Undertorque Detection senses wire breaks so that the drive can automatically stop the application immediately.
	Software options	Profibus, Modbus, Modbus RTU, Ethernet and Ethernet TCP/IP
	Electronic Lineshaft Software	CIMR-AUXAXXXXAA-047 software

## 3 References

The documents and websites listed in *Table 1* can be used as supplemental information to this Application Note. Yaskawa manuals can be downloaded from [www.yaskawa.com](http://www.yaskawa.com).

**Table 1 References**

<b>Item</b>	<b>Description</b>	<b>Type</b>
AO.AFD.68	Application Overview Winding	App. Note
TM.A1000SW.064	Electronic Lineshaft with Alignment A1000 Drive Software Technical Manual	Other
<a href="http://www.yaskawa.com">www.yaskawa.com</a>	Website of Yaskawa America, Inc. Information on products can be found here, including technical manuals, training material, and other application notes.	



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MANUAL NO. AO.AFD.76

Published in U.S.A. February 2013 13-2