

ENGINEERING NOTE

MOVITRAC

Synchronizing Variable Speed Drives

Many applications require that two or more independent drives be synchronized. For example, two conveyor lines each carrying a different subassembly may have to be synchronized so that both subassemblies arrive simultaneously at the final assembly station. If these drives were not synchronized, the subassemblies would not arrive simultaneously at final assembly and thus would slow down production throughput. With less human labor input and the trend to more automated factories and higher production, the need for synchronization is expanding.

Traditionally, synchronization has been achieved mechanically. However, with the advent of sophisticated industrial electronics, electronic synchronization is now possible. In many cases electronic synchronization is more economical and offers more flexibility than does mechanical synchronization.

Mechanical Synchronization

Typically mechanical synchronization involves a single drive motor that is connected to multiple driven machines via various line shafts, couplings, miter gear units, belts, sheaves, chains, sprockets, etc.

As the number of driven pieces of equipment increases, the amount of mechanical parts required to achieve synchronization increases tremendously. Additionally as the distances from the drive motor to the driven equipment increases, mechanical synchronization may be impractical.

But there are many applications where mechanical synchronization is the preferred method. A roller conveyor for transporting pallets with several "live" rollers could use mechanical synchronization of the "live" rollers very efficiently. The live rollers can be interconnected to the drive motor via gears or chains and sprockets mounted on the axle of each live roller fairly easily. Providing a drive motor for each live roller and electronic synchronizing each motor may be too "sophisticated".

Electronic Synchronization

Electronic synchronization involves independent variable speed drives that are electronically forced to operate in synchronism. Electronic synchronization is often simpler to install than mechanical synchronization since the majority of the mechanical parts have been eliminated and in many cases is more economical. Additionally the speeds of the independent drives can be ratioed very easily via thumbwheel or potentiometer adjustments.

Two methods of electronic synchronization are used, one is termed analog synchronization and the other absolute synchronization.

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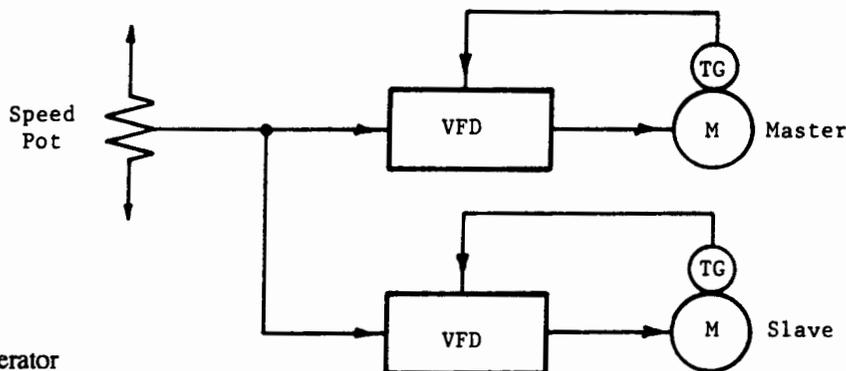
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1. Analog Synchronization

The underlying principle in analog synchronization is that the same speed command signal is supplied to each drive.



M-Motor
TG-Tachometer Generator
VFD-Variable Frequency Drive

In this example, the slave motor speed is varied by the Slave Movitrac which is referenced by the same potentiometer voltage as the Master Movitrac. Connected in this manner, any adjustment made on the speed potentiometer will change the speed of the master and slave motors by the same degree. Typically to further enhance stability and provide more accurate synchronization, both drives are supplied with a tachometer generator for closed loop speed control. The closed loop speed control will minimize any speed fluctuations on each drive due to load changes.

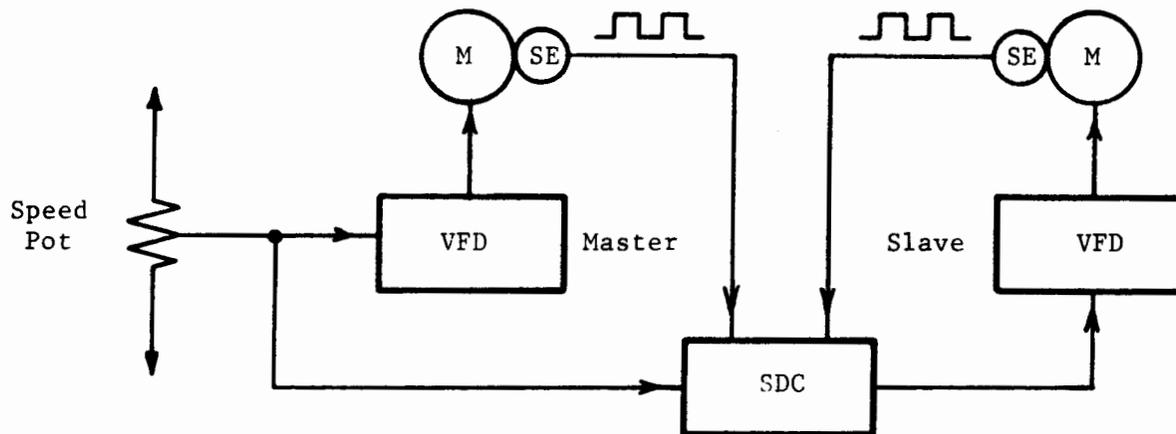
However with analog synchronization, the actual speed difference between the master and slave can only be kept, at best, within a range of ± 0.5 to 1%. With this speed differential, over a period of time the two drives will gradually "drift" away from true synchronization. As long as this small speed differentiation can be accommodated or compensated for by manually "resynchronizing" the drives occasionally, the analog synchronization method of electronic synchronization is more economical than absolute electronic synchronization.

2. Absolute Synchronization (Electronic Line Shafting)

In absolute synchronization the remaining error of the analog synchronization is fully compensated for, providing an exact match of the two drive motor shafts with respect to speed and angular position.

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M-Motor
SE-Shaft Encoder
VFD-Variable Frequency Drive
SDC-Synchronous Drive Controller

In this example, the master shaft encoder transmits any motion of the master motor shaft to the SDC. The slave shaft encoder does the same for the slave motor. The incoming pulses are counted by a differential counter and a digital number of the count difference is continuously calculated. This number is then converted to an analog error signal. By adding this error signal, which can be positive or negative, to the slave drives reference voltage, the slave motor will be additionally accelerated or decelerated, and therefore the slave motor shaft is forced to follow error-free to any motion of the master motor shaft.

Anytime two or more independent drives must be exactly matched in speed and shaft angular position, the absolute synchronization method will achieve this.

As shown above, the electronic synchronization methods offer more flexibility than the mechanical method and in many cases is more economical and practical. Although the electronic methods are shown with speed adjustment via a manual speed pot, standard process signals for automatic speed adjustment can be easily accommodated by suitable selection of converters. Additionally by monitoring the speed of any shaft, material, etc., the gearmotors can be synchronized to the process and not only to each other.