

## WP0199

### Dodge® synchronous drive components: HT500 drive or chain drive

Dodge Customer/Order Engineering

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Thirty years ago who could have imagined a day when synchronous drives could replace chain drives in high torque applications? With new materials, construction, and designs, synchronous drive systems are now in a situation where they can not only replace equivalent sized chain drives, but can outperform them. This is applicable to a wide range of applications and can even yield a cost advantage in the long run. Synchronous drives also provide engineers with a wider range of choices.

Chain drives are one of the oldest known forms of power transmission. They date back thousands of years. The great Leonardo da Vinci designed chains that were used in Europe during 1580's. However, its real development took place during the 1800s when it was used on bicycles. Chain drives were also used on the plane designed by the Wright brothers. However, the development of roller chain drives has stagnated in recent decades due to development of both v-belt and synchronous belt drives.

The development of synchronous drives began around 1945. When they were invented, synchronous drives became known as timing belt drives as they synchronized, or timed, the movement of the bobbin and needle in a sewing machine. Development of synchronous drives continues to this day. ABB's Dodge drives have kept up with the advancement of these drives over the years. The Dyna-Sync (trapezoidal tooth profile timing belt drive) was introduced in 1965, HTD (curvilinear profile) in 1990, HT150 in 1995 and HT200 in 2000 (modified curvilinear profile), HTR and HTRC (RPP profile) in 2009, and now the HT500 (modified curvilinear profile high HP drive) in 2014. HT500 belts contain carbon fiber cords and are one of the highest HP belts available today for industrial applications.

Originally, rubber timing belts were reinforced with steel to prevent elongation. Later, these belts were reinforced with fiberglass. Fiberglass corded belts, like the HT200 are still the most commonly used type of belt. For more demanding load applications, belts with a polyurethane body and Kevlar cording were introduced. With introduction of HT500, fiberglass cords and Kevlar cords are replaced with carbon cords offering many advantages such as;

- Greater power density
- Greater flex fatigue resistance
- Greater modulus
- Greater environmental resistance

Power density allows for more compact drives, reduction in weight, cost, and overhung load. For example, a 20mm wide HT500 14M belt can do the same job as a 157mm wide HT200. Carbon cording also has better flex fatigue resistance than steel, fiberglass and Kevlar cords. Greater flex fatigue resistance leads to greater belt life. Having a higher modulus means HT500 belts will not stretch like other materials and thus keeps the pitch constant regardless of the load, helping the HT500 belt to transmit consistent torque. Unlike the Kevlar cording used in the first generation of high horsepower belts, the carbon cords used in the HT500 will not swell or stretch when exposed to water or oils. Thus, the HT500 can be used successfully in more types of applications.

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Obviously, the HT500 offers significant advantages over other types of synchronous drives. But what about chain drives? Three major design aspects need to be considered when trying to replace a chain drive with a synchronous drive:

1. Belt load carrying capacity
2. Size of the drive package
3. Cost

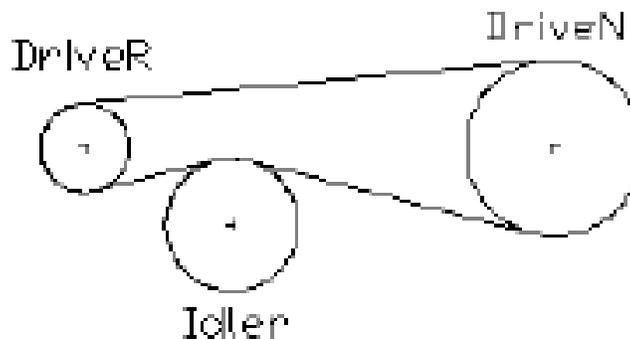
With previous generations of synchronous belts, the size of a drive had to be increased significantly to achieve the required load carrying capacity of a chain drive. Either the sprocket had to be larger in diameter and/or the width of the drive had to increase to accommodate a larger belt. Carbon cording, like that used in the HT500, has dramatically increased the load carrying capability. This increase in capacity makes it possible to replace roller chain width for width in chain sizes 35 to 180 and higher, as illustrated in Table 1 below.

Chain Size	35	40	50	2/40	60	3/40	2/50	2/60	80	3/50	100	3/60	2/80	120	2/100	140
Width in mm	12.7	17.0	21.1	31.5	26.4	45.7	39.4	49.3	33.5	57.4	40.9	72.1	62.7	50.8	76.7	54.4
HT500 SPKTS																
8M-12																
8M-21																
8M-36																
8M-62																
14M-20																
14M-37																
14M-68																

**Table 1.** Chain and belt drives of comparable diameters at 10/100/500 RPM. Chain ratings per American Chain Association

Based on the above table, an 8M-12 HT500 belt, which is 12mm in width, meets or exceeds the load capability of 35 chain (12.7mm) to 50 chain (21.1mm).

Another problem faced while trying to replace chain drives with synchronous drives is the length of the belt based on the center distance. Whereas the length of a chain can be lengthened or shortened by adding or removing the links, the same is not possible with synchronous belts where lengths are fixed. This problem may be overcome by using a heavy-duty backside idler on synchronous drive systems whereby allowing the synchronous drive to fit into the desired center distance. See Figure 1 below.



**Figure 1.** Heavy Duty Backside Idler

The last issue to consider when trying to replace chain drives with synchronous drives is cost. The initial cost of installing a synchronous drive is typically higher than that of a chain drive. However, taking into account longer belt and sprocket life and elimination of the need for lubrication and re-tensioning, the TCO cost can be actually lower.

While the above considerations must be taken into account, synchronous drives do offer some real advantages over chain drives, including:

- Higher speed capability
- No lubrication
- Higher speed ratios
- Increased belt and sprocket life

Synchronous drives can operate up to 10,000 feet per minute with MTO sprockets. While some engineered roller chain drives can reach speeds of up to 10,000 feet per minute depending on the pitch size, they do so with expensive forced oil lubrication systems. In fact, all chain drives will require some form of lubrication from oil drip lubrication, to oil bath lubrication, to the forced oil lubrication systems mentioned above. Synchronous belt drives operate without the need for any type of lubrication. With synchronous belt drives, speed ratios of up to 10:1 can be achieved while chain drives are typically limited to 5:1 – 7:1. Also, compared to standard roller chain drives, HT500 belts can last up to 3X longer and the sprocket up to 10X longer.

HT500 drives offer numerous advantages over chain drives. They can be more compact, operate at higher speeds with larger speed ratios, have a longer life, and are almost maintenance free requiring no re-tensioning and no lubrication, and they can do so at a lower TCO cost.

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