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Advantages of AC Servo Drives vs. DC Servo Drives

AC servo drives (also known as brushless servos, or brushless DC servos) were introduced to the market in the mid-1980s. Since their introduction, they have widely replaced DC servo drives in those machine tool and positioning applications where performance is the main criteria. The AC servo drive uses the same basic transistor electronics and control circuitry as the (PWM) DC servo drive, the difference in the overall system performance is related to the design of the motor.

In a DC motor, the permanent magnets are located on the stator (motor frame) and the armature windings are located on the rotor. Motor current is passed from the motor frame to the rotor via a commutating ring and motor brush arrangement. The commutator also serves to align (commutate) the armature relative to the permanent magnets in order to produce maximum motor torque. Speed feedback from the motor to the drive is typically a DC tachogenerator, which like the motor itself has an armature winding and commutator/ brush construction.

In a AC motor, the permanent magnets are located on the rotor and the armature winding are on the stator. Motor current is commutated by the drive electronics based on feedback provided by a rotor position indicator mounted on the motor shaft. Speed feedback from the motor to the drive is realized via a three phase AC tachogenerator, which is similar in construction to that of the motor.

The AC motor owes its superior performance over the DC motor to its basic design. These advantages include:

- **Rotor Inertia-** Since the rotor of a DC motor contains the armature windings it has a much higher inertia compared to that of an AC motor which contains permanent magnets. For motors of similar torque rating, this can be a difference of up to a factor of 4 in favor of the AC motor. This means that an AC motor can accelerate much faster than a DC motor of the same torque rating.

- **Motor Size-** Since the armature windings of an AC motor are located on the stator which is next to the frame of the motor, the heat generated by the motor's armature current can be radiated to the ambient via the motor frame. In a DC motor, the armature current runs in the rotor which is not in good thermal contact with the ambient. Because both motors utilize permanent magnets to generate the motor field, motor torque is directly proportional to motor current. It is typical that an AC motor will have an advantage of 50% higher motor (torque) rating than a DC motor of the same dimension.

- **Torque rating at high speed-** The commutator ring and brush system in a DC motor becomes less efficient as motor speed increases which in many cases requires that the motor current, and therefore torque, be decreased at higher speeds. The AC motors, which are commutated electronically, have no such limitation.

- **Brush Maintenance-** The commutator ring and brush system found in the DC motor (and tachogenerator) require regular service which in many cases is avoided because of the difficulty in accessing the brushes due to the motor's mounting location. The brush life is shortened in many industrial environments such as oil based coolants. The AC motors have no brushes to change, and are therefore "maintenance free".

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