Duty cycle guide
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IEC (the International Electrotechnical Commission) uses different duty cycles designations to describe electrical motor operating conditions.

The term duty defines the load cycle to which the machine is subjected, including, if applicable, starting, electric braking, no-load and rest de-energized periods, and including their durations and sequence in time.

The duty type S1 can be defined as operation at a constant load maintained for sufficient time to allow the machine to reach thermal equilibrium.

For a motor suitable to this duty type, the rating at which the machine may be operated for an unlimited period is specified. This class of rating corresponds to the duty type whose appropriate abbreviation is S1.

A complete designation provides the abbreviation of the duty type followed by an indication of the duration of the duty (S2 40 minutes).

The duty type S2 can be defined as operation at constant load for a given time, less than that required to reach thermal equilibrium, followed by a time de-energized and at rest of sufficient duration to re-establish the equilibrium between the machine temperature and that of the coolant temperature.

For a motor suitable to this duty type, the rating at which the machine, starting at ambient temperature, may be operated for a limited period is specified. This class of rating corresponds to the duty type whose appropriate abbreviation is S2.

A complete designation provides the abbreviation of the duty type followed by an indication of the duration of the duty (S2 40 minutes).
The duty type S3 is defined as a sequence of identical duty cycles, each including a time of operation at constant load and a time de-energized and at rest. The contribution to the temperature-rise given by the starting phase is negligible.

A complete designation provides the abbreviation of the duty type followed by the indication of the cyclic duration factor (S3 30%).

The duty type S4 is defined as a sequence of identical duty cycles, each cycle including a significant starting time, a time of operation at constant load and a time de-energized and at rest.

A complete designation provides the abbreviation of the duty type followed by the indication of the cyclic duration factor, by the moment of inertia of the motor JM and by the moment of inertia of the load JL, both referred to the motor shaft (S4 20% JM = 0.15 kg m² JL = 0.7 kg m²).

The duty type S5 is defined as a sequence of identical duty cycles, each cycle consisting of a starting time, a time of operation at constant load, a time of electric braking and a time de-energized and at rest.

A complete designation refers to the duty type and gives the same type of indication of the previous case.

The duty type S6 is defined as a sequence of identical duty cycles, each cycle consisting of a time of operation at constant load and a time of operation at no-load. There is no time de-energized and at rest.

A complete designation provides the abbreviation of the duty type followed by the indication of the cyclic duration factor (S6 30%).
**S7 Continuous-operation periodic duty with electric braking**

The duty type S7 is defined as a sequence of identical duty cycles, each cycle consisting of a starting time, time of operation at constant load and a time of electric braking. There is no time de-energized and at rest.

A complete designation provides the abbreviation of the duty type followed by the indication of both the moment of inertia of the motor JM and the moment of inertia of the load JL (S7 JM = 0.4 kg m² JL = 7.5 kg m²).

**S8 Continuous-operation periodic duty with related load/speed**

The duty type S8 is defined as a sequence of identical duty cycles, each consisting of a time of operation at constant load corresponding to a predetermined speed of rotation, followed by one or more times of operation at other constant loads corresponding to different speeds of rotation.

A complete designation provides the abbreviation of the duty type followed by the indication of the moment of inertia of the motor JM and by the moment of inertia of the load JL, together with the load, speed and cyclic duration factor, for each speed condition (S8 JM = 0.7 kg m² JL = 8kgm2 25kW 800rpm 25% 40kW 1250rpm 20% 25 kW 1000 rpm 55%).

**S9 Duty with non-periodic load and speed variations**

The duty type S9 is defined as a duty in which generally load and speed vary non-periodically within the permissible operating range. This duty includes frequently applied overloads which may greatly exceed the reference load.

For a motor suitable to this duty type, the rating at which the machine may be operated non-periodically is specified. This class of rating corresponds to the duty type whose appropriate abbreviation is S9.

**S10 Duty with discrete constant loads and speeds**

The duty type S10 is defined as the operation characterized by a specific number of discrete values of load maintained for a sufficient time to allow the machine to reach thermal equilibrium. The minimum load during a duty cycle may have value zero and be relevant to a no-load or rest condition.

A complete designation provides the abbreviation of duty type followed by the indication of both the moment of inertia of the motor JM and by the moment of inertia of the load JL, together with the load, speed and cyclic duration factor, for each speed condition (S10 JM = 0.7 kg m² JL = 8kgm2 25kW 800rpm 25% 40kW 1250rpm 20% 25 kW 1000 rpm 55%).

**Figure 10** - Duty with discrete constant loads and speeds; Duty type S10

- $\Delta T_0$: Starting/accelerating time
- $\Delta T_s$: Operation time at constant load
- $\Delta T_f$: Time of electric braking
- $\Delta T$: Time de-energized and at rest