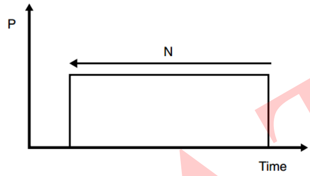
4.7 Duty types

The duty types are indicated by S1...S10 according to IEC 60034-1 and VDE 0530 Part 1. The outputs given in the catalogs are based on continuous running duty, S1, with rated output.
In the absence of an indication of the rated duty type, continuous running duty is assumed when considering motor operation.

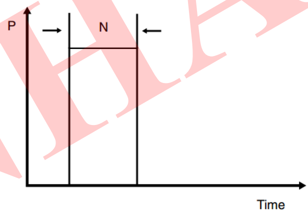
S1 Continuous running duty

Operation on constant load of sufficient duration for thermal equilibrium to be reached.
Designation S1.



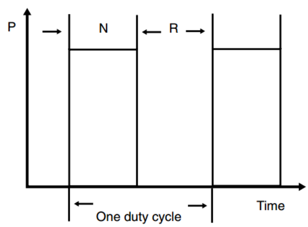
S2 Short-time duty

Time shorter than that required to reach thermal equilibrium, followed by a rest and a de-energized period of sufficient duration to allow motor temperature to reach ambient termperature or cooling temperature. 10, 30, 60, and 90 minutes are recommended for the rated duration of the duty cycle.
Designation for example S2 60 min.



S3 Intermittent duty

A sequence of identical duty cycles, each including a period of operation at constant load, a rest and a de-energized period. The duty cycle is too short for thermal equilibrium to be reached. The starting current does not significantly affect temperature rise. Recommended values for the cyclic duration factor are 15, 25, 40, and 60 percent. The duration of one duty cycle is 10 min.
Designation for example S3 25 %.

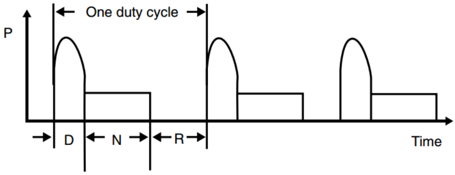


$$\text{Cyclic duration factor} = \frac{N}{N+R} \times 100\ \%$$

Explanation of symbols used in this and the following figures

P = output power
D = acceleration
N = operation under rated condition
F = electrical braking
V = operation of no load
R = at rest and de-energized
P_N = full load

S4 Intermittent duty with starting

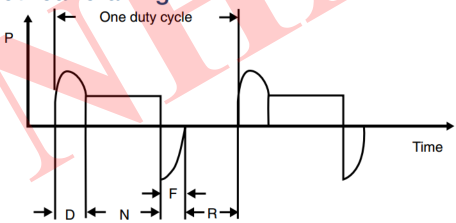


A sequence of identical duty cycles, each cycle including a significant period of starting, operation at constant load, a rest and a de-energized period.
The cycle-time is too short for thermal equilibrium to be reached. In this duty type, the motor is brought to rest by the load or by mechanical braking which does not thermally load the motor.
The following parameters are required to fully define the duty type: the cyclic duration factor, the number of duty cycles per hour (c/h), the moment of inertia of the load (J_L) and the moment of inertia of the motor (J_M).

Designation for example S4 25 % 120 c/h J_L = 0.2 kgm^2 J_M = 0.1 kgm^2.

$$\text{Cyclic duration factor} = \frac{D + N}{D + N + R} \times 100\ \%$$

S5 Intermittent duty with starting and electrical braking

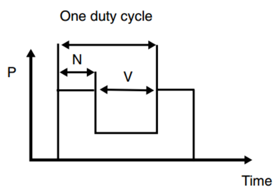


A sequence of identical duty cycles, each cycle consisting of a significant starting period, a period of operation at constant load, a period of rapid electric braking, a rest and a de-energized period.
The duty cycles are too short for thermal equilibrium to be reached. The following parameters are required to fully define the duty type: the cyclic duration factor; the number of duty cycles per hour (c/h), the moment of inertia of the load (J_L) and the moment of inertia of the motor (J_M).

Designation for example S5 40 % 120 c/h J_L = 2.6 kgm^2 J_M = 1.3 kgm^2.

$$\text{Cyclic duration factor} = \frac{D + N + F}{D + N + F + R} \times 100\ \%$$

S6 Continuous operation periodic duty

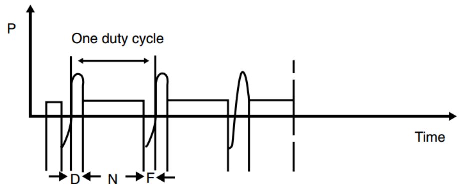


A sequence of identical duty cycles, each cycle consisting of a period at constant load and a period of operation at no-load. The duty cycles are too short for thermal equilibrium to be reached.
Recommended values for the cyclic duration factor are 15, 25, 40, and 60 percent. The duration of the duty cycle is 10 min.

Designation for example S6 40 %. Cyclic duration factor $= 100\ \% \times \frac{N}{N + V}$

S7 Continuous operation periodic duty with electrical braking

A sequence of identical duty cycles, each cycle consisting of a starting period, a period of operation at constant load, and a period of braking. The braking method is electrical braking such as counter-current braking. The duty cycles are too short for thermal equilibrium to be reached.

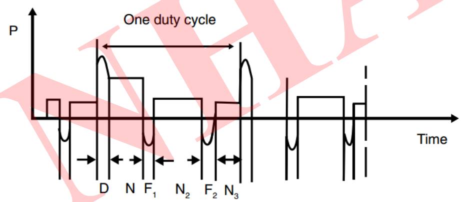


The following parameters are required to fully define the duty type: the number of duty cycles per hour (c/h), the moment of inertia of the load (J_L), and the moment of inertia of the motor (J_M).

Designation for example S7 500 c/h J_L = 0.08 kgm^2 J_M =0.08 kgm^2.

S8 Continuous-operation periodic duty with related load speed changes

A sequence of identical duty cycles, each cycle consisting of a starting period, a period of operation at constant load corresponding to a predetermined speed, followed by one or more periods of operation at other constant loads corresponding to different speeds. There is no rest or a de-energized period. The duty cycles are too short for thermal equilibrium to be reached.



This duty type is used for example by pole-changing motors. The following parameters are required to fully define the duty type: the number of duty cycles per hour (c/h), the moment of inertia of the load (J_L), the moment of inertia of the motor (J_M), and the load, speed, and cyclic duration factor for every operation speed.

Designation for example S8 30 c/h J_L = 63.8 kgm^2 J_M = 2.2 kgm^2.

24 kW	740 r/min	30%
60 kW	1460 r/min	30%
45 kW	980 r/min	40%

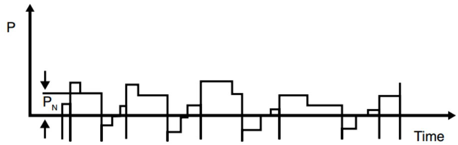
$$\text{Cyclic duration factor 1} = \frac{D + N_1}{D + N_1 + F_1 + N_2 + F_2 + N_3} \times 100\ \%$$

$$\text{Cyclic duration factor 2} = \frac{F_1 + N_2}{D + N_1 + F_1 + N_2 + F_2 + N_3} \times 100\ \%$$

$$\text{Cyclic duration factor 3} = \frac{F_2 + N_3}{D + N_1 + F_1 + N_2 + F_2 + N_3} \times 100\ \%$$

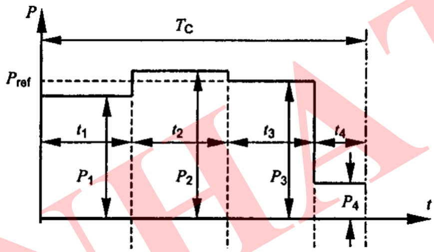
S9 Duty with non-periodic load and speed variations

A duty in which, generally, load and speed vary non-periodically within the permissible operating range. This duty includes frequently applied overloads that may greatly exceed the full loads. For this duty type, suitable full load values should be taken as the basis of the overload concept.



S10 Duty with discrete constant loads and speeds

A duty consisting of a specific number of discrete values of load (or equivalent loading) and if applicable, speed, each load/speed combination being maintained for sufficient time to allow the machine to reach thermal equilibrium. The minimum load within a duty cycle may have the value zero (no-load or de-energized and at rest).



The appropriate designation is S10, followed by the per-unit quantities plΔt for the respective load and its duration, and the per-unit quantity TL for the relative thermal life expectancy of the insulation system. The reference value for the thermal life expectancy is the thermal life expectancy at rating for continuous running duty and permissible limits of temperature rise based on duty type S1. For a time de-energized and at rest, the load shall be indicated by the letter r.

Example: S10 plΔt = 1.1/0.4; 1/0.3; 0.9/0.2; r/0.1 T_L = 0.6

The value of T_L should be rounded to the nearest multiple of 0.05.

For this duty type a constant load appropriately selected and based on duty type S1 shall be taken as the reference value ('P_{ref}' in the figure) for the discrete loads.

Note: The discrete values of load will usually be equivalent loading based on integration over a period of time. It is not necessary that each load cycle be exactly the same, only that each load within a cycle be maintained for sufficient time for thermal equilibrium to be reached, and that each load cycle is capable of being integrated to give the same relative thermal life expectantly.