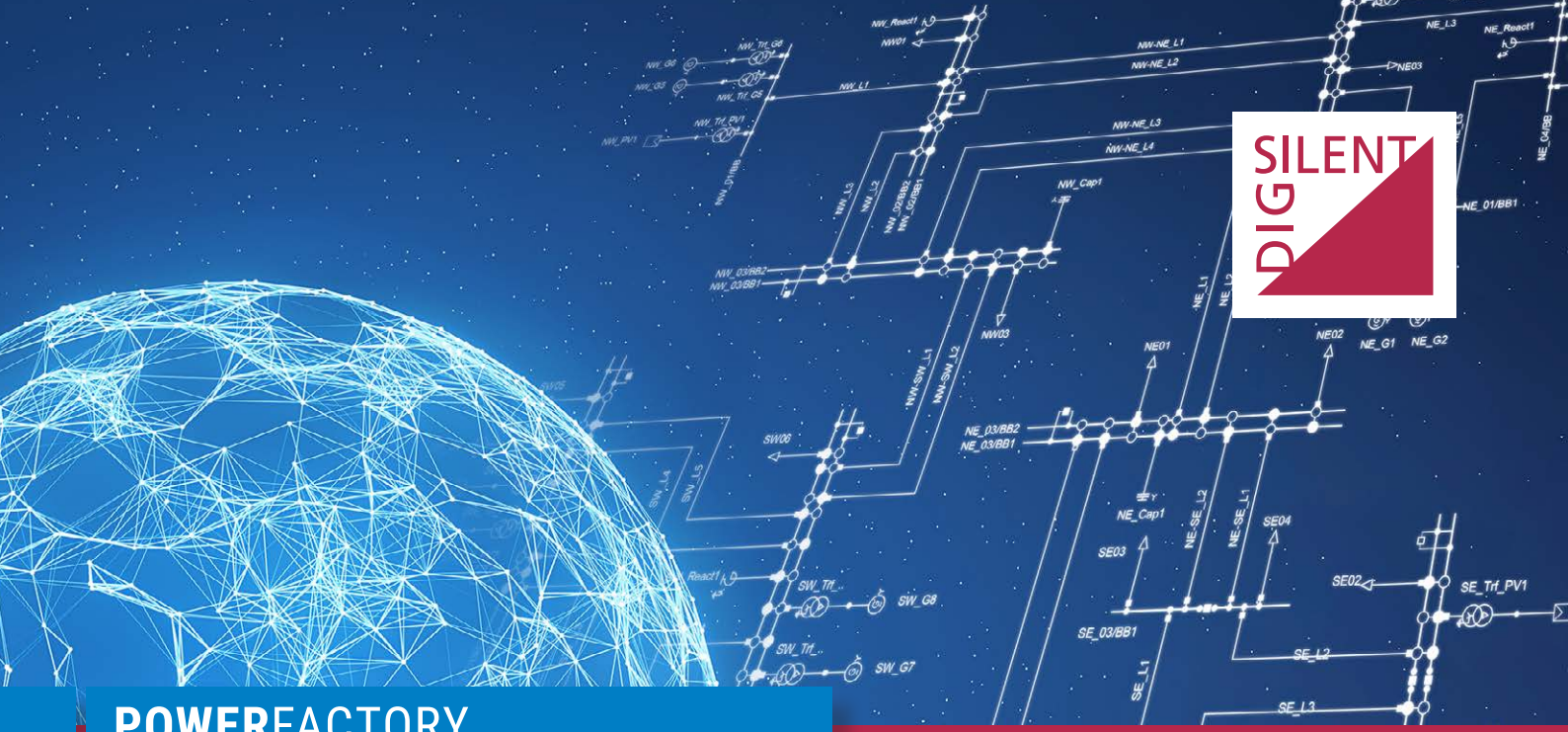

POWERFACTORY

PowerFactory 2021

Technical Reference

Motor Driven Machine

ElmMdm

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 General Description of the Motor Driven Machine Models **1**

2 MDM Type 1 **2**

3 MDM Type 3 **3**

4 MDM Type 5 **5**

A Input / Output Signals for Dynamic Models **6**

List of Figures **7**

List of Tables **8**

1 General Description of the Motor Driven Machine Models

Three types of motor driven machine (MDM) models are available in *PowerFactory*:

- MDM Type 1
- MDM Type 3
- MDM Type 5

All types of MDM models can be used in conjunction with an asynchronous or synchronous motor. Typical connections in a composite frame are shown below in Figure 1.1 for both asynchronous and synchronous motor configurations.

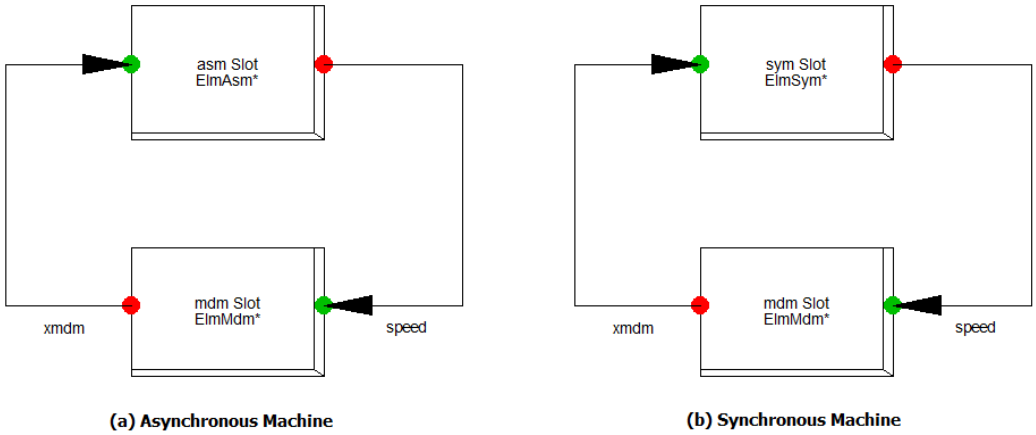

Figure 1.1: Typical composite frame for a motor driven machine

The input of the motor driven machine is the speed of the motor, $xspeed$ in p.u., and its output is the MDM-Torque, $xmdm$ in p.u. .

The motor driven machine models are dynamic models and can only be used during time-domain calculations, e.g. RMS or EMT simulations. Therefore, all data necessary can be found on the RMS-/EMT simulation pages (RMS and EMT simulations use the same data).

2 MDM Type 1

The MDM Type 1 model approximates a variable torque load where the torque is proportional to a user-defined power of speed. This MDM model can represent, for example, a quadratic torque load such as a centrifugal pump, fan or blower (Figure 2.1).

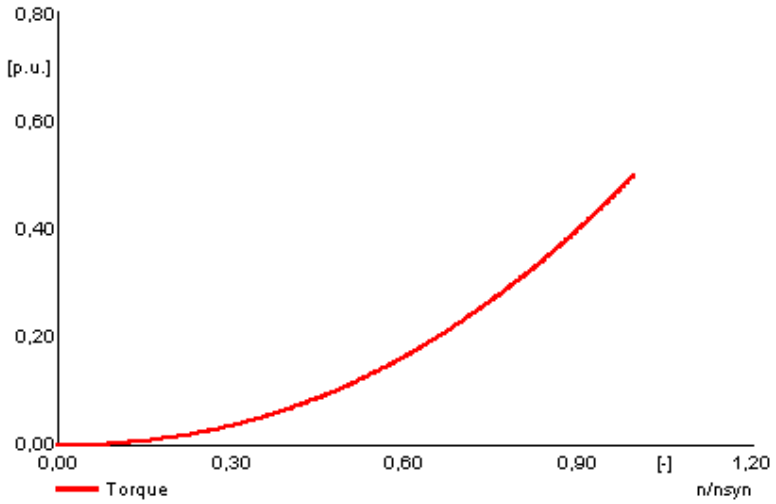

Figure 2.1: Example of the Torque-Speed Characteristic of the MDM Type 1 Model

The MDM Type 1 torque $xmdm$ is calculated as follows:

$$xmdm = mdmlp \cdot xspeed^{(mdmex-1)} \tag{1}$$

where:

- $xspeed$ is the speed of the machine in p.u.
- $mdmlp$ is a user-defined proportional factor of the MDM characteristic in p.u.
- $mdmex$ is a user-defined exponent of the MDM characteristic in p.u.

3 MDM Type 3

The MDM Type 3 model is an extension of the type 1 model, providing more flexibility by allowing the user to model the load as a U-shaped characteristic (Figure 3.1) with a standstill torque, minimum torque and torque at synchronous speed.

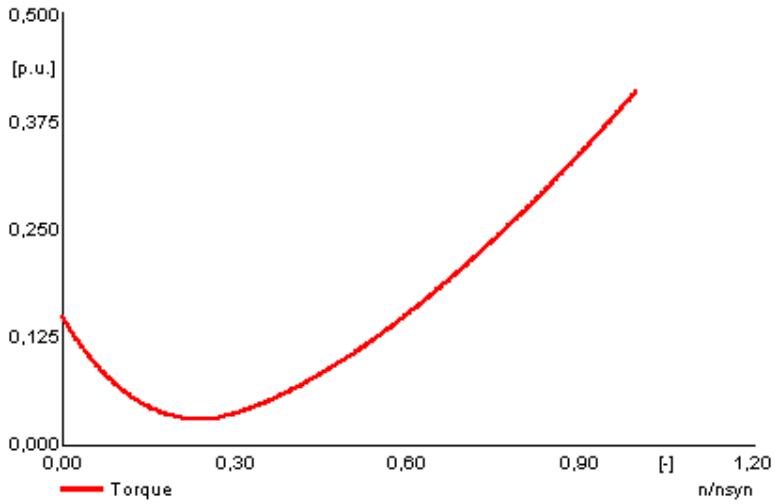

Figure 3.1: Example of the Torque-Speed Characteristic of the MDM Type 3 Model

The MDM Type 3 torque $xmdm$ is calculated as follows:

$$xmdm = \begin{cases} xkmm + (alf1 - xkmm)\left(\dfrac{|xspeed| - (1 - slipm)}{slipm}\right)^{exp1}, & \text{if } slip \leq slipm \\ xkmm + (alf2 - xkmm)\left(\dfrac{(1 - slipm) - |xspeed|}{1 - slipm}\right)^{exp2}, & \text{if } slip > slipm \end{cases} \quad (2)$$

where:

- $alf1$ is the torque at synchronous speed in p.u.
- $alf2$ is the user-defined standstill torque in p.u.
- $xkmm$ is the user-defined minimum torque at $slip_m$ in p.u.
- $xspeed$ is the speed of the machine in p.u.
- $slip = 1 - xspeed$ is the slip of the machine in p.u.
- $slipm$ is the user-defined slip at minimum torque in p.u.
- $exp1$ and $exp2$ are user-defined exponents for the polynomial functions in p.u.

The torque at synchronous speed $alf1$ will be calculated from initial conditions if the machine is running. Otherwise, $alf1$ will be taken from the user-defined input data for motor start-up simulations.

To calculate the exponent $exp1$ from a given point of the curve $(torque, speed)$, the following

equation can be used:

$$exp1 = \frac{\ln(torque - xkmm)}{\ln\left(\frac{speed - (1 - slipm)}{1 - (1 - slipm)}\right)} \tag{3}$$

4 MDM Type 5

The MDM Type 5 model has a user-defined torque-speed characteristic. The curve points $(torque, speed)$ of the characteristic are entered in a table (example is shown in Figure 4.1) and the resulting values are interpolated. The load will be calculated from initial conditions, if the machine is running, or from the user-defined input data for motor start-up.

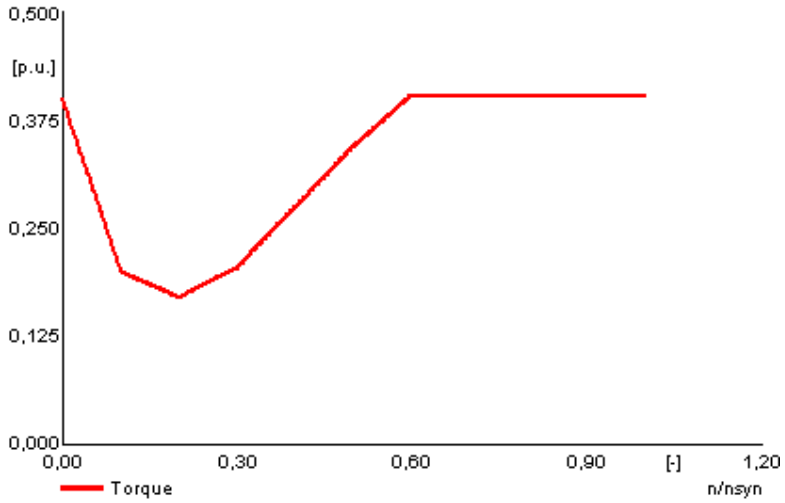

Figure 4.1: Example of the Torque-Speed Characteristic of the MDM Type 5 Model

The MDM Type 5 torque $xmdm$ is calculated as follows:

$$xmdm = torque(xspeed) + xspeed \cdot (Load - 1) \tag{4}$$

where:

- $xspeed$ is the speed of the machine in p.u.
- $torque(xspeed)$ is the user-defined torque interpolated from the input table data in p.u.
- $Load$ is a user-defined constant load value in p.u.

The user-defined value for the parameter $Load$ is used only for motor start-up. If the machine is running this parameter is being calculated from the initial conditions and the user-entered value is ignored.

A Input / Output Signals for Dynamic Models

Figure A.1: Input / Output Definition

Table A.1: Dynamic Model Variables (signals)

Parameter	Description	Unit
xspeed	Speed of asynchronous / synchronous machine	p.u.
xmdm	Torque output of motor driven machine	p.u.

List of Figures

1.1 Typical composite frame for a motor driven machine 1

2.1 Example of the Torque-Speed Characteristic of the MDM Type 1 Model 2

3.1 Example of the Torque-Speed Characteristic of the MDM Type 3 Model 3

4.1 Example of the Torque-Speed Characteristic of the MDM Type 5 Model 5

A.1 Input / Output Definition 6

List of Tables

A.1 Dynamic Model Variables (signals) 6