Fault diagnosis of electrical drives

Electrical drives are basic components in a multitude of devices, processes, machinery and vehicles, and in the large areas of mechanical power and process engineering, manufacturing, transportation and precision mechanical devices. Their power ranges from a few mW to hundreds MW.

The most important types of electrical motors can be divided into:

(i) DC motors
   - series-wound motors
   - shunt-wound motors
   - permanent-field motors
(ii) Three-phase AC motors
    - induction motors (asynchronous motors)
    - synchronous motors
(iii) Single-phase AC motors
    - commutator motors (universal motors)
    - squirrel-cage motors.

Table 3.1 gives an overview of some basic types, illustrating torque characteristics and corresponding control inputs. As static and dynamic models of the various electrical motors are required for model-based fault detection, the reader is referred to well-known basic books on electrical drives such as [3.3], [3.13], [3.18], [3.19], [3.20].

In the following, some case studies are described for DC motors with brushes and for AC motors. Further types of electrical motors will be considered in Chapter 4 for electrical actuators.

3.1 Direct-current motor (DC)

3.1.1 Structure and models of a DC motor

A permanently excited DC motor with a rated power of \( P = 550 \text{ W} \) at rated speed \( n = 2500 \text{ rpm} \) is considered, [3.6]. This DC motor has a two-pair brush commuta-
### Table 3.1. General survey of electrical motors with small power, [3.9]

<table>
<thead>
<tr>
<th>motor</th>
<th>DC shunt-wound motor</th>
<th>DC series-wound motor</th>
<th>three-phase asynchronous motor</th>
<th>three-phase synchronous motor (DC excitation of rotor)</th>
<th>single-phase (universal motor)</th>
<th>single-phase asynchronous motor with condensator</th>
<th>single-phase asynchronous motor (Ferraris motor)</th>
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<tbody>
<tr>
<td>circuit diagram</td>
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<tr>
<td>manipulated variables</td>
<td>( \Delta U_A ) armature voltage</td>
<td>( \Delta I_E ) excitation current</td>
<td>( \Delta \omega ) frequency</td>
<td>( \Delta U ) voltage</td>
<td>( \Delta \omega ) frequency</td>
<td>( \Delta U ) voltage</td>
<td>( \Delta U_{St} ) manipulated voltage</td>
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<td>( \Delta I_E )</td>
<td>( \Delta R_i )</td>
<td>( \Delta R )</td>
<td>( \Delta U )</td>
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**Note:** The table and figures are placeholders for the actual content. The actual images and text should be provided for a complete representation.