

System components

Couplings

Siemens Integrated Drive Systems

Overview

Integrated drive portfolio:

The core elements of a fully integrated drive system are frequency converters, motors, couplings and gear units. Siemens offers all the required components in top manufacturing quality from a single source, perfectly integrated – operating perfectly together, for all power classes.

As a standard solution or tailored to individual requirements. No other provider on the market is able to offer a comparable portfolio. All Siemens drive components are optimally harmonized and coordinated to each other so that they interact ideally in every application.

Siemens Integrated Drive Systems turn simple drive components into real systems. Drive technology based on IDS ensures maximum productivity, energy efficiency and reliability in every automation environment and over the entire product lifecycle.

FLENDER couplings – part of the drive system

A drive system comprises individual machines, including motor and gearbox; couplings connect these components and frequently ensure the connection to the driven load.

The coupling can perform other tasks in addition to the transmission of rotary motion and torque, such as:

- Compensation for **shaft misalignment** with low restorative forces
- Influencing of intrinsic torsional frequency and **damping**
- **Overload**: Interruption or limitation of torque
- **Electrical** insulation, noise insulation
- Function in **explosive environments**

Couplings are frequently planned after the machines to be connected have already been selected. Thanks to a large number of different coupling assembly options, specified boundary conditions for installation space and connection geometry can be met from the catalog standard. The coupling also performs secondary functions, such as the provision of brake disks or brake drums for operational or holding brakes, devices to record speed or the addition of chain wheels or belt pulleys.

Because of the environment, the coupling has to meet a large number of additional requirements. Couplings must be as suitable for use in a potentially explosive environment as for use at a high or low ambient temperature. The environment may be defined as chemically aggressive or be subject to laboratory conditions or requirements of food manufacture.

Standard construction types of Siemens FLENDER couplings for SIMOTICS FD motors

Type	Description
N-EUPEX	Flexible cam coupling <ul style="list-style-type: none"> • Universally implementable, damping coupling for compensation of shaft misalignment • Suitable for plug-in installation and easy assembly with three-part design Rated torque: 19 ... 62000 Nm
N-BIPEX	Flexible claw coupling <ul style="list-style-type: none"> • Universal usage, damping shaft coupling to offset shaft misalignment • Compact design • Suitable for plug-in assembly Rated torque: 12 ... 4650 Nm
RUPEX	Flexible pin and bush coupling <ul style="list-style-type: none"> • Fail-safe, damping universal coupling for medium to very high torques with a good misalignment range • Compact design, low weights and mass moments of inertia • Suitable for plug-in assembly Rated torque: 200 ... 1300000 Nm
ZAPEX	Gear couplings <ul style="list-style-type: none"> • Double-jointed coupling compensates for angular, parallel and axial misalignment • Long-term lubrication through design measures and the use of special seals • Small dimensions • Can be used for high shock loads Rated torque: 1300 ... 7200000 Nm
ARPEX	All-steel couplings <ul style="list-style-type: none"> • Zero-backlash, torsionally rigid coupling • For compensating radial, angular, and axial shaft misalignment by means of two flexible lamella packages made of stainless spring steel • Easy installation thanks to compact lamella packages Rated torque: 92 ... 1450000 Nm

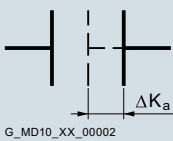
Overview (continued)Shaft misalignment

Shaft misalignment is the result of displacement that occurs during assembly and operation and, where machines constructed with two radial bearings each rigidly coupled, will cause high loads being placed on the bearings. Elastic deformation of base frame, foundation and machine housing will lead to shaft misalignment which cannot be prevented, even by precise alignment. Furthermore, because individual components of the drive train heat up differently during operation, heat expansion of the machine housings causes shaft misalignment.

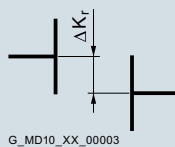
Poorly aligned drives are often the cause of seal, rolling bearing or coupling failure.

Alignment should be carried out by specialist personnel in accordance with the Siemens operating instructions.

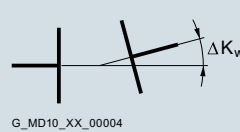
Depending on the direction of the effective shaft misalignment, a distinction is made between:



Axial misalignment



Radial misalignment



Angular misalignment

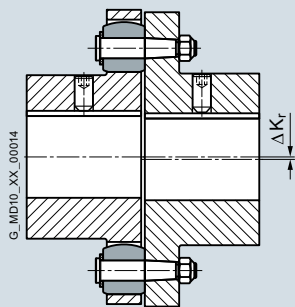
The couplings can be subdivided into the following groups:

- **Single-joint couplings – N-EUPEX, N-BIPEX, and RUPEX series**

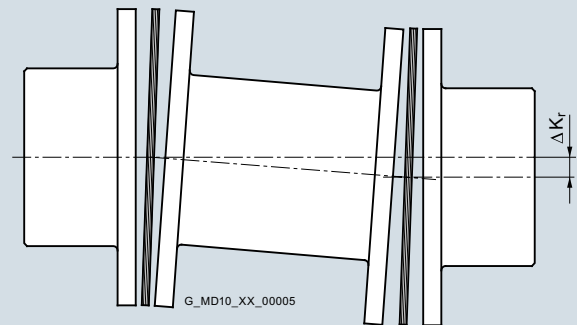
Couplings with flexible elements mainly made of elastomer materials. Shaft misalignment results in deformation of the elastomer elements. The elastomer elements can absorb shaft misalignment as deformations in an axial, radial and angular direction. The degree of permissible misalignment depends on the coupling size, the speed of rotation and the type of elastomer element. Single-joint couplings do not require an adapter and are therefore short versions.

- **Two-joint couplings – ARPEX and ZAPEX series**

Two-joint couplings are always designed with an adapter. The two joint planes are able to absorb axial and angular offsets; radial offset is achieved by the distance between the two joint planes and the angular shift of the joint planes. The permitted angular misalignment per joint level is frequently about 0.5°. The permitted shaft misalignment of the coupling can be adjusted via the length of the adapter. If there are more than two joint levels, it is not possible to define the position of the coupling parts relative to the axis of rotation. (The less frequently used parallel-crank couplings are an exception)



Example: RUPEX coupling



Example: ARPEX coupling

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Overload

Overload conditions are operating conditions that go beyond the limit loads of the coupling. Overload conditions may occur under non-standard operating conditions, e.g. drive blockage, short circuit or supply fluctuations, as well as under standard operating conditions, e.g. when starting or braking. Particularly in the case of high mass moments of inertia of the driven machine, torques that are a multiple of the motor starting torque may become effective during direct starting or star-delta starting.

Overload conditions may damage not only the coupling but also the entire drive train. Frequently, overload conditions can be avoided through design measures; SIRIUS soft starters or SINAMICS frequency converters are suitable for considerably reducing starting torques of induction motors. If drive blockages or overloads of the driven machine cannot be ruled out, torque limiting coupling designs can prevent damage to the drive train.

Coupling behavior under overload conditions

Coupling behavior under overload where the torque is considerably above the limits of use of the coupling concerned is determined by the engineering design of the coupling series.

The ZAPEX, ARPEX, N-EUPEX, N-BIPEX and RUPEX coupling series can withstand overloads until the breakage of metal parts. These coupling series are designated as fail-safe. Coupling types which can withstand overload, i.e. fail-safe types, are used e.g. in crane systems. In case of coupling breakage due to overloads, the splintering metal parts may cause injury to persons and property damage!

The N-EUPEX DS coupling series throws overload.

The elastomer element of these couplings is irreparably damaged without damage to metal parts when subjected to excessive overload. These coupling series are designated as non-fail-safe, but can be fitted with a fail-safe device. This component enables emergency operation, even after the rubber element of the coupling has been irreparably damaged.

Damping

On drives which are prone to torsional and bending vibrations, measurements or calculations such as natural frequency calculations, torsional vibration simulation or bending vibration calculations are necessary for verifying safe dimensioning of the drive train and preventing damage.

The drive train may, depending on complexity, be regarded as a two-mass vibration-generating system or N-mass vibration-generating system. The vibration-generating masses are defined by the rotating bodies and the couplings by the coupling stiffnesses and shaft stiffnesses. The effect of torsional vibration excitations on the behavior of the system is calculated.

Torsional vibration excitations may occur during the starting of an induction motor, during a motor short circuit or in diesel engine drives. Bending vibrations may be critical if the coupling is insufficiently balanced and/or at an operating speed close to the critical speed.

The details needed for calculating the torsional vibration are specified in the coupling catalog:

- Dynamic torsional stiffness
- Damping (specification of the damping coefficient ψ or Lehr's damping $D = \psi/4\pi$)
- Mass moment of inertia of the coupling halves

Electrical insulation

A particularly efficient and economical measure for reducing bearing currents is to use an electrically isolating coupling. The range of couplings comprises suitable couplings in leakage-current-isolated versions for the various drive scenarios.

Version for potentially explosive atmospheres

Wherever a potentially explosive environment cannot be ruled out, the machinery used must meet special conditions in order to prevent the outbreak of fire as far as possible. Within the European Union, Directive 2014/34/EU applies to these applications. This directive harmonizes the individual states' legal requirements for explosion prevention and clearly defines the procedure for testing and circulating machines and parts.

Whether or not a machine is used in a potentially explosive environment, the manufacturer is required under EC Machinery Directive 2006/42/EC to assess and as far as possible prevent hazards which may arise from his product.

The operator has an obligation to ascertain whether an environment is potentially explosive. Details of this are laid down in Directive 1999/92/EC. The manufacturer is responsible for ensuring that the product is safe as defined in the EC Machinery Directive and conforms to Directive 2014/34/EU, if the EX requirement is specified by the operating company.

The drive train mostly comprises individual pieces of equipment which are put together to form a subassembly. If the individual pieces of equipment, such as motor, coupling, gearbox or driven machine conform to Directive 2014/34/EU, the manufacturer of the overall unit can limit the risk assessment to the additional hazards which arise from the combination of different individual pieces of equipment. The hazards which can arise from the individual pieces of equipment are assessed by the relevant suppliers.

Directive 94/9/EC of March 23, 1994 has been replaced since April 20, 2016 by Directive 2014/34/EU of the European Parliament and the Council of February 26, 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.

The coupling series suitable for use in potentially explosive environments are marked EX in Catalog MD 10.1.

FLENDER couplings are to be rated as components according to the new EC Machinery Directive 2006/42/EC. Therefore, Siemens does not issue a declaration of incorporation for these products.

Overview (continued)

Assignment of coupling types to SIMOTICS FD motors

Motors					
Air-cooled – enclosed version		Water-cooled		Air-cooled – open version	
Self-ventilation	Forced ventilation	Water-jacket cooling	Heat exchanger	Self-ventilation	Forced ventilation
Cooling method IC411	Cooling method IC416	Cooling method IC71W	Cooling method IC86W	Cooling method IC01	Cooling method IC06
1LM1/1MM1	1LQ1/1MQ1	1LH1/1MH1	1LN1/1MN1	1LL1	1LP1
Applications					
Pumps, fans, compressors	Conveyor belts, paper machines, rolling mills	Extruders, rollers, winches	Propeller drives, bow thrusters	Compressors, fans	Lifting, holding, closing gear
Industry assignments					
W&WW, energy, chemicals, O&G	Paper, steel, mining, cement	Marine, plastics, textile, paper, steel	Marine, steel, plastics	Energy, steel	Cranes
Coupling assignments					
N-EUPEX	RUPEX	ARPEX	ARPEX	RUPEX	RUPEX
N-BIPEX	ARPEX	ZAPEX	ZAPEX	ARPEX	
RUPEX	ZAPEX				
ARPEX					

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FLENDER couplings – the right coupling for any application		N-EUPEX	N-BIPEX	RUPEX	ZAPEX	ARPEX ARP-6	ARPEX ARS - ARC
Characteristics		Flexible coupling			Torsionally rigid coupling		
		Cam coupling	Claw coupling	Pin-and-bush coupling	Gear coupling	All-steel coupling	All-steel coupling
Properties		Fail-safe, torsionally flexible, damping	Fail-safe, torsionally flexible, damping	Fail-safe, torsionally flexible, damping	Fail-safe, torsionally rigid, double-cardanic	Fail-safe, torsionally rigid, double-cardanic	Fail-safe, torsionally rigid, double-cardanic
Rated torque	Nm	19 ... 62000	12 ... 4650	200 ... 1300000	1020 ... 7200000	100 ... 17000	170 ... 1450000
Perm. peripheral speed	m/s	36	45	40/60	60	100	55/100
Temperature in area of application	°C	-50 ... +100	-50 ... +100	-50 ... +100	-20 ... +80	-40 ... +280	-40 ... +280
Perm. angular misalignment • at 1500 rpm	°	0.1	0.5/0.4/0.3	0.2	0.5 - 1	0.7	0.7/0.4/0.3/0.2
Versions							
• with clamping hub		–	–	○	–	○	●
• with adapter		●	–	○	●	●	●
• with brake disk/ drum		●	–	●	●	○	○
• with sliding hub		○	–	○	○	○	○
Vertical installation		●	●	●	●	● / ○	● / ○
• with axial play limitation		–	–	●	●	–	○
• as clutch coupling		–	–	○	●	–	○
• as shear pin coupling		–	–	○	○	–	○
Leakage current insulation		–	●	○	●	○	○
• in accordance with API 610/ API 671		–	– / ●	– / ●	–	API 610 (671)	–
• in accordance with Directive 2014/34/EU		●	●	●	●	●	●
Service							
Maintenance interval		Annual visual inspection	Annual visual inspection	Annual visual inspection	Annual visual inspection	Maintenance-free ¹⁾	Maintenance-free ¹⁾
Wear parts, radially expandable		●	–	●	–	●	●
Installation outlay		Low	Low	Low	High	High	High

○ Optionally available

● Available in standard program

– Not possible

For additional information about FLENDER couplings
see [Catalog MD 10.1](#).

¹⁾ An annual visual inspection is recommended.