Three-phase roller table motors

for low voltage
with squirrel-cage rotor
Product specification

Series A21O, A20O, ARC, ARB

Introduction

Roller table motors are special driving elements for the rolling mill industry. Particularly in case of working and conveying roller tables, these motors are subject to extremely hard electrical and mechanical requirement. This fact results from the very different modes of operation and cases of load with their variants such as continuous duty, intermittent duty and short-time as well as starting duty, electrical braking duty and reversing duty.

The motors must be up to operative overloads (e.g. blockings caused through jammed rolled material). VEM roller table motors of the classical type series ARB 22 - 65 have proved their functional efficiency and operational reliability for decades under partially extreme environmental conditions.

Starting from these expieriences, VEM has developed various variants of roller tabele motors adapted to the conditions of the modern drive engineering in the frequency converter operation.

The winding of these motors are specially designed for the converter feeding.

Application in the run-out roller table

In contrast to the classical roller table design with a soft torque characteristic curve and long blocking periods, the roller table motors designed for converter feeding have a hard torque characteristic curve being typical of double-squirrel-cage rotors. So, a correct synchronism with varying loads will be obtained in case of group drives. That's the condition for a good rolling quality.

For the mechanical design are available the robust constructions in grey cast iron of the type series K21R / K20R with horzontal / vertical cooling ribs in non-ventilated design, the type series A21O / A20O or the construction of the type series ARB and ARC basing on ring-type ribbed housings.

Geared roller table motors
Approach roller table rocker bar furnace

Converter-controlled working roller table

In case of converter feeding, the operating speeds can be adapted to the drive requirement perfectly.

As the control ranges are mainly in the lower frequency range, we recommend a project-oriented winding adaption and the application of frequency converters with automatic voltage increase of field-oriented control.

The enclosed operating data sheets have been worked out for the rough project planning. They are basing on the mode of operation S3-25% duty cycle and on the arrangement of the winding in temperature class F. A delivery in temperature class H is possible as an option. It can be used, particularly in case of the mode of operation S5, for raising the switching frequency.

Standards and regulations

The motors comply with the relevant standards and regulations and specifically with the following:

Title	DIN EN / DIN VDE	IEC
Rotating electrical machines, rating and performance	DIN EN 60034-1/11.95	IEC 34-1 IEC 85
Rotating electrical machines, methods for determining losses and efficiency	VDE 0530 p. 2	IEC 34-2
Totally enclosed three-phase induction motors with squirrel-cage rotor, type IM B3	DIN 42673	(IEC 72)
Totally enclosed three-phase induction motors with squirrel-cage rotor, type IM B5, B35 and B14	DIN 42677	(IEC 72)
Rotating electrical machines, terminal markings and direction of rotation	DIN VDE 0530 p. 8	IEC 34-8
Rotating electrical machines, symbols for types of construction and mounting arrangements	DIN EN 60034-7	IEC 34-7
Rotating electrical machines, built-in thermal protection	-	IEC 34-11
Rotating electrical machines, methods of cooling	DIN EN 60034-6	IEC 34-6
Rotating electrical machines, classification of degrees of protection provided by enclosures	DIN VDE 0530 p. 5	IEC 34-5
Rotating electrical machines, mechanical vibrations of certain machines	DIN EN 60034-14	IEC 34-14
Cylindrical shaft ends for rotating electrical machines	DIN 748 p. 3	IEC 72
Rotating electrical machines, Noise limits	DIN EN 60034-9	IEC 34-9
Rotating electrical machines, starting performance	DIN EN 60034-12	IEC 34-12
IEC standard voltages	DIN IEC 38	IEC 38

Furthermore, VEM motors comply with various foreign regulations which have been adapted to IEC 34-1

NF C 51	France	NBNC 51-101	Belgium
ÖVE M10	Austria	CEI 2-3, V1	Italy
SS 426 0101	Sweden	NEK-IEC 34-1	Norway
SEV 3009	Switzerland	BS 5000	United Kingdom of Great Britain
		BS 4999	

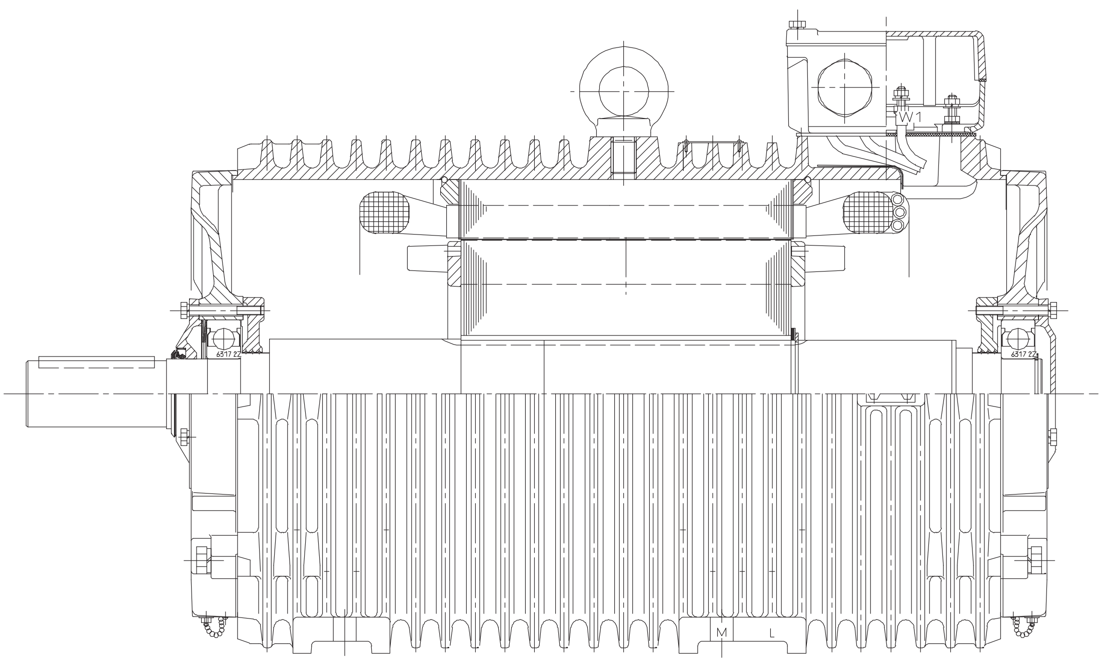
With these standards and regulations, the following limits for temperature rise are valid:

Regulations	Temperature of cooling air	Permissible limits of temperature rise in K (measured by resistance method) Insulation class				
	°C	A	E	B	F	H
DIN EN 60034-1/ 11.95	40	60	75	80	105	125
IEC 34-1	40	60	75	80	105	125
Great Britain BS	40	60	75	80	105	125
Italy CEI	40	60	70	80	105	125
Sweden SEN	40	60	70	80	105	125
Norway NEK	40	60	-	80	105	125
Belgium NBN	40	60	75	80	105	125
France NF	40	60	75	80	105	125
Switzerland SEV	40	60	75	80	105	125

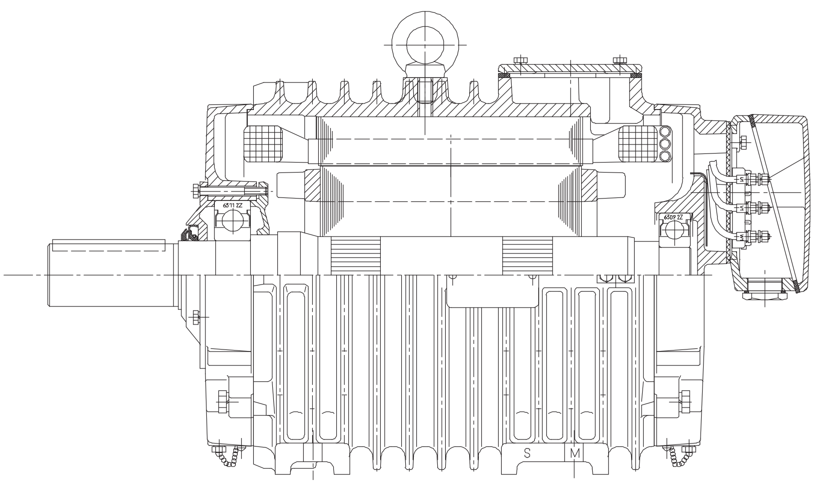
Design versions

Generally, the motors are delivered in a robust grey cast iron version. In case of the easy type series A21O, A20O, the housings are provided with horizontal / vertical cooling ribs and in case of the heavy type series ARB, ARC, they are provided with ribs arranged across the axial direction. The housings have a high mechanical resistance and a very good thermal capacity. In case of the type series A21O, A20O, the terminal box can be executed on the top, right or left, analogous to the standard motor series K21R, K20R. In case of the type series ARB the terminal box is placed on the right and in case of the type series ARC it can be delivered as an option so that it is arranged on the non-driving side at the top or at the non-driving side end-shield.

Shaft height	Series	Material for Housing	End-shields	Feet	Foot mounting
132 up to 280	A21O, W/A21O, W	Grey cast iron			Bolt-on
315					Cast-on
355	A22O, W				
132 up to 250	ARC				Bolt-on
280 up to 355	A20O, W				Cast-on
22 up to 65	ARB				Bolt-on



Sectional drawing series ARC, terminal box on top



Sectional drawing series ARC, terminal box on the end-shield N-end

Cooling

The motors are designed in type of cooling IC 410, non-ventilated, with surface cooling.

Vibration behaviour

The permissible vibration intensities of electric motors are specified in DIN EN 60034-14.
The vibration intensity stage N (normal) is achieved or bettered by VEM motors in the basic version. The vibration intensity stages R (reduced) and S (special) are available at extra charge and depending on the type. Please consult the manufacturer.

All rotors are dynamically balanced with the half key inserted. This balancing is documented on the rating plate with the letter H after motor No., balancing with full key inserted on request, designation in then F after motor No.

Bearing arrangement / Bearing lubrication

VEM motors are equipped with bearings from excellent manufacturers. The bearings have a nominal service life of at least 20.000 h for maximum permissible load conditions. Without additional axial loading, for coupling service the nominal bearing service life is 40.000 h.

The bearing types are seen from the bearing arrangement tables.

Use of cylindrical roller bearings

Using cylindrical roller bearings (heavy bearing arrangement), relatively high radial forces or masses can be accepted at the motor shaft end, e.g. belt drives, pinions or heavy couplings.
The minimum radial force at the shaft end must be at least a quarter of the permissible one. Account must be taken of permissible shaft end loading. Both these values are found in the diagrams.

Important to note:
Radial forces below the minimum value can lead to bearing damage within a few hours. Test runs in no-load state are only permissible for a short period.

Bearing and shaft end loads

Due to the international standardization of asynchronous motors, the dimensioning of bearings and shaft is only variable within close limits, therefore, VEM has selected a design optimum.

Permissible shaft end loads

The size of the permissible shaft end loading is determined by the following principle:

- permissible bending of the shaft
- shaft end fatigue strength
- bearing service life

A nominal bearing service life of 20.000 hours is taken as a basis.

The following is pre-set as a loading scheme:
F_r = radial shaft end loading
F_a = axial shaft end loading
l = shaft end length
x = distance of application point of F_r from the shaft shoulder

The type-related data for the permissible axial shaft end load F_a and the permissible radial shaft end load $F_{r0,5}$ (at the application point x : l = 0,5) , $F_{r1,0}$ (at the application point x : l = 1.0), for the basic version and for heavy bearing arrangement and in horizontal and vertical types of mounting are found in the tables.
The given permissible loads are valid for practically vibration-free motor mounting and defined load action planes.

The loads F_r and F_a depend generally on the used transmission members, i.e. on the axial and radial forces arising from these transmission members and their weights.

The calculation of forces is done by using formulas of mechanics, e.g. for belt pulleys:

$$F_r = 2 \cdot 10^7 \cdot \frac{P}{n \cdot D} \cdot c$$

with

F_r = radial force in N
P = motor output in kW (transmission output)
n = nominal motor speed
D = belt pulley diameter in mm
c = pre-tension factor as stated by the belt manufacturer

In practice F_r does not always act at x : l =0,5. The conversion of permissible radial force within the range of x : l = 0,5 up to x : l =1,0 can be done by linear interpolation.

If the calculated shaft loading exceeds the permissible ones, then the drive members must be changed. Among others, this will be:

- selection of a larger belt pulley diameter
- use of V-belts instead of flat belts
- selection of other pinion diameter or skew angle of the toothed wheel
- selection of other coupling versions

Generally, care must be taken that the resulting load application point of F_r is not outside the shaft end.

Paint finish

Normal finish

- Adapted for group of climates "world wide" according to IEC 721-2-1
  Non-weather-protected locations, open-air conditions, in aggressive atmospheres (chemical industries, sea environments), short-time up to 100 % relative humidity at temperatures up to +35 °C, continuously up to 98 % relative humidity at temperatures up to +30 °C.

Finish system
- prime coat plastic resin / zinc phosphate, layer thickness ≥ 30 µm
- second coat on separate-application base, layer thickness 30 ≥ µm
- finish coat 2K (separate-application) polyurethane varnish, layer thickness ≥ 30 µm

Standard colour:
RAL 7031 blue grey

Further special coating systems
- version for excessive thermal stresses
- version for excessive chemical and radiation stresses
- systems on customer's request

Shaft ends

According to IEC 34-7, the definition of the motor ends is as follows:
D-end (DS):
Drive end of the motor
N-Seite (NS):
Non-driving end (opposite to the drive end)

Centre holes according to DIN 332, sheet 1 and 2, Form DS.

For sizes 56 – 112, keys and key-ways are according to DIN 6885 sheet 1, Form B, and for the sizes 132 - 355 according to DIN 6885 sheet 1, Form A. Key length for sizes 132 – 355 are according to DIN 748 p. 3 Draft. Dec. 91.

Thread for press-on and dismantling devices:

Shaft end diameter	thread
for 9 mm	M3
for 11 mm	M4
for 14 mm	M5
for 19 mm	M6
for 22 mm	M8
for 24 mm	M8
for 28 mm	M10
> 28 up to 38 mm	M12
> 38 up to 50 mm	M16
> 50 up to 85 mm	M20
> 85 up to 130 mm	M24

The motors are always supplied with the key fitted.

The second shaft end can transmit the full power rating with coupling output. The power transmission capability by belt, chain or pinion drive for the second shaft end is available on request. The drive elements used, such as pulleys or couplings, are to be balanced with a balance grade of at least G 6.3 according to DIN ISO 1940, p. 1, with half key inserted.

Design voltage and frequency

In the basic version, motors are supplied for the following design parameters:

230/400 V Δ/Y	50 Hz
400/690 V Δ/Y	50 Hz
690 V Δ	50 Hz
460 V Δ	60 Hz

The motor can run without changing the design output on mains in which the voltage at the design frequency diverges by ± 5 % from the nominal value (design voltage range A), in these mains the frequency can diverge by ± 2 % from the nominal value.
The above standard voltages according to DIN IEC 38 are taken as the design point.
Special voltages and frequencies on request.

Design voltage range, design frequency range

(special version)

Motors to be used for mains voltage as specified in DIN IEC 38 with the total tolerance of ± 10 % are to be selected according to the corresponding design voltage listed in the technical tables. The design voltage range limited by U_U and U_O is also given there.
When the motors are connected to voltages between 95 % and 105 % of the design voltage range – this corresponds to the mains voltage value according to DIN IEC 38 with ± 10 % - already at the voltage range limits of range A (see DIN EN 60034-1/11.95) and without taking into account the permissible tolerances, the maximum permissible temperature rise of the stator winding may be exceeded by approx. 10 K.

Design output

The design output applies for continuous operation as specified in DIN EN 60034-1/11.95, at a coolant temperature of 40 °C and an altitude above sea level of ≤ 1000 m, design frequency 50 Hz and design voltage. The series K11R/K21R and K10R / K20R have thermal reserves which permit, depending on types, the following overloads in continuous operation:
- up to 10 % above the rated output at 40 °C coolant temperature or
- rated output up to 50 °C coolant temperature
- rated output at an installation altitude of up to 2.500 m above sea level

These conditions apply only alternatively, when both apply, the output must be reduced.

Motor torque

The design torque in Nm given at the motor shaft is calculated by

$$M = 9550 \cdot \frac{P}{n}$$

with P = design output in kW
n = speed in rpm

In the Motor selection data tables, starting torque, pull-up torque and pull-out torque are given as multiples of design torque.
If the voltage deviates from its design point, the torques change about quadratically. The classified characteristics of torque behaviour are given in the Motor selection data tables.

Ambient temperature

All VEM motors in the basic version can be used at ambient temperatures from -35 °C up to +40 °C.

Overload capacity

In compliance with DIN EN 60034-1, all motors can be exposed to the following overload conditions:
- 1,5 times the rated current for 2 min,
- 1,6 times the rated torque for 15 s (1,5 times for $I_A / I_N > 4,5$)

Both conditions apply to design voltage and design frequency.

Design efficiency and design power factor

Efficiency η and power factor cos φ are stated in the Motor selection data lists .

Restarting with residual field and phase opposition

Restarting after mains failure against a 100 % residual field is possible for all motors.

Motor protection

The following motor protection versions are available as an option:
- motor protection with PTC thermistor sensors in the stator winding
- bimetallic temperature sensor as NC contact or NO contact in the stator winding
- resistance thermometer for monitoring the winding or bearing temperature on request

Special duties

In the catalogue are additionally specified motor selection data for the project planning of special duty types such as S3, S5, S9. The selection must be done according to the effective torque M_{eff} (in which must be included the maximum torque M_{max}).
In addition is to be checked that the maximally required impact torque must be lower than or equal to the maximum torque.
Special duty types, as intermittent, short-time duty or electrical braking procedures are possible on request.

Tolerances - electrical parameters

According to DIN EN 60034-1/11.95 the following tolerances are permissible:

Efficiency (indirect calculation)	-0,15 (1-η) for $P_N \leq 50$ kW -0,1 (1-η) for $P_N > 50$ kW
Power factor	$\frac{1-\cos\varphi}{6}$ at least 0,02 maximum 0,07
Slip (at rated load and operating temperature)	$\pm$ 20 % for $P_N \geq$ 1kW
Starting current (in the planned starting connection)	+ 20 % without restrictions downwards
Starting torque	- 15 % and + 25 %
Pull-up torque	- 15 %
Pull-out torque	- 10 % (after the application of this tolerance M_K/M at least 1,6)
Moment of inertia	$\pm$ 10 %
Noise level (sound pressure level)	+ 3 dB (A)

These tolerances are permissible for the values assured for three-phase asynchronous motors, taking the necessary manufacturing tolerances and material variations of the raw material into account.

The standard contains the following notes on this:

1. A guarantee for all or any of the values shown in the table is not mandatory. In tender, the guaranteed value for which permissible deviations should apply must be expressly specified. The permissible variations must correspond to those stated in the table.
2. ”Guarantee”: In some countries, a distinction is drawn between guaranteed values and typical or declared values.
3. If a permissible deviation applies only in one direction then the value in other direction is not limited.

Tolerances - mechanical parameters

Dimensional short sign acc. to DIN 42939	Meaning of the dimension	Fit or tolerance
a	Spacing of feet fixing holes in axial direction	• 1 mm
a_1	Diameter or width across corners of attachment flange	- 1 mm
b	Spacing of feet fixing holes across axial direction	• 1 mm
b_1	Diameter of flange spigot	up to diameter 230 mm j6 up to diameter 250 mm h6
d, d_1	Diameter of the cylindrical shaft end	up to diameter 48 mm k6 from diameter 55 mm m6
e_1	Pitch circle diameter of attachment flange	• 0,8 mm
f, g	Maximum width of the motor (without terminal box)	+ 2 %
h	Shaft height (lower edge foot to shaft centre line)	up to 250 mm -0,5 > 250 mm -1
k, k_1	Overall length of the motor	+ 1 %
p	Overall height of the motor (lower edge foot, housing or flange to highest point of the motor)	+ 2 %
s, s_1	Diameter of fixing holes of foot of flange	+ 3%
t, t_1	Lower edge shaft end to upper edge key	+ 0,2 mm
u, u_1	Key width	h9
w_1, w_2	Centre of first attachment hole to shaft end shoulder	• 3,0 mm
	Distance shaft shoulder – flange face, fixed bearing D-end	• 0,5 mm
	Distance shaft shoulder – flange face	• 3,0 mm
	Motor weight	-5 up to +10 %