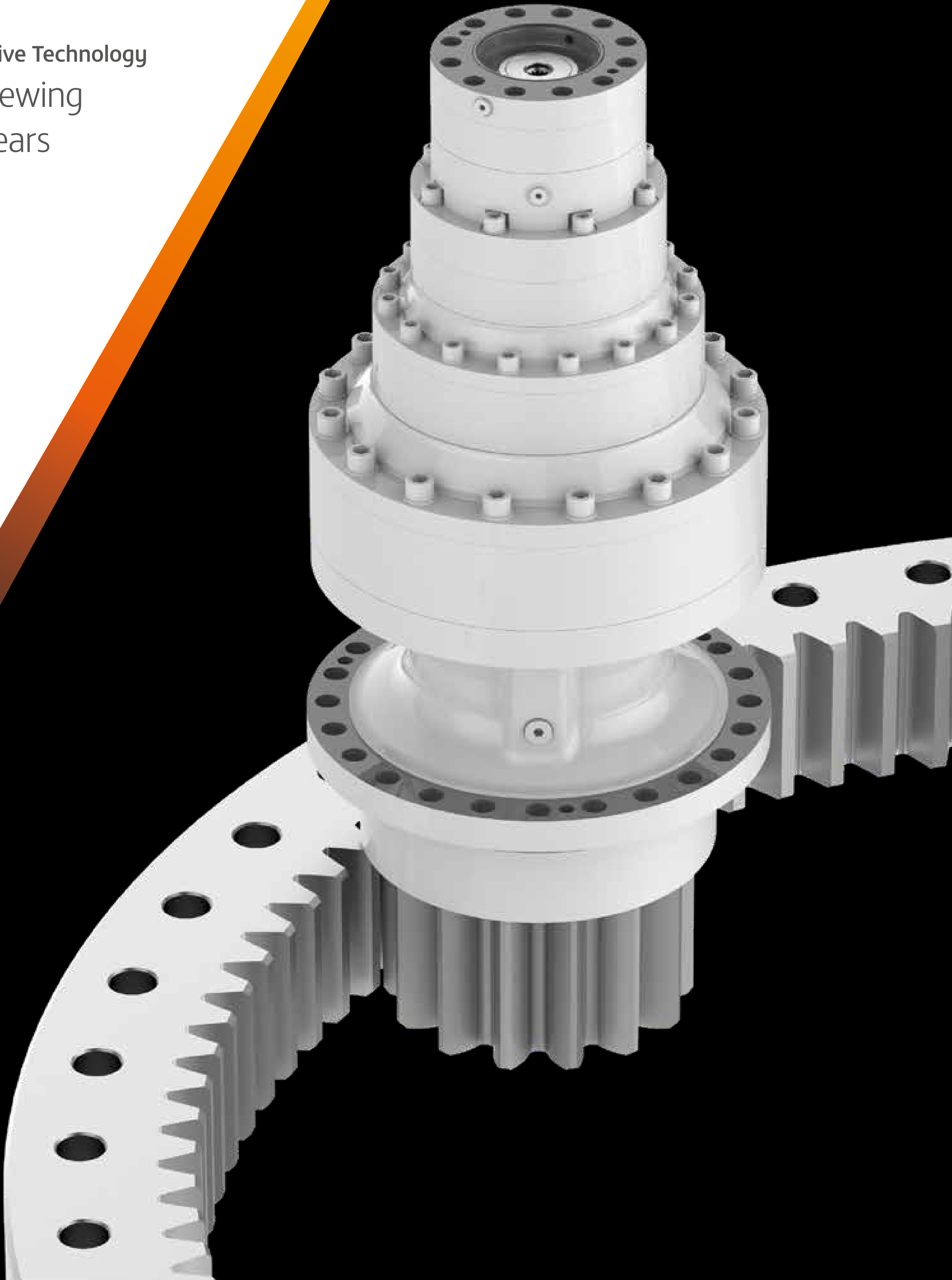
ZOLLERN

Solid metals. Fine solutions.

Drive Technology

Slewing gears



The ZOLLERN Group
ZOLLERN is one of the pioneers in the metal industry. At several locations in Europe, North America and Asia, 2,400 employees develop, produce and service a wide range of high-quality metal products. ZOLLERN supplies sophisticated solutions for a wide range of applications with its business areas of drive technology, investment casting, sand casting and forging, mechanical engineering elements and steel profiles.

Contents Page

ZOLLERN slewing gears
Powerful and cost-effective

ZOLLERN slewing gears
have proved their value with high performance in demanding operation and under the toughest operating conditions. Their stand-out advantages and special characteristics are

- Compact design
- Long service life
- Modular gear design
- Easy maintenance
- High efficiency
- Practical shape

With the ready-to-install unit from ZOLLERN, cost-effective solutions are possible even in tight spaces.

Fields of application
- Truck-mounted and mobile cranes
- Ship and on-board cranes
- Shipyard and port cranes
- Container gantry cranes
- Construction-site cranes and conveying equipment
- Loading and warehouse cranes
- Cable and hydraulic excavators
- Offshore cranes
- Wind turbines
- Tunnel drilling machines

The slewing gear planetary gears are also used in ZOLLERN rope winches, industrial gears, free-fall winches and travel drives.
ZOLLERN drives consist of design- and system-compatible gear components.

High-performance series
For demanding applications


Wind turbine


Hydraulic excavator


Mobile crane


Tunnel drilling machine


Ship crane

Standard series

Size	3.19	3.20	3.22	3.24	3.25
Typical drive unit class according to FEM	M3	M4	M6	M2	M5

Tower crane

Lattice boom crane

Oil platform

Bucket wheel excavator

3.26	3.27	3.28	3.29
M4	M6	M7	M8

Modular gear design

Input designs

Bevel gear

Hydraulic

Design of planetary gear

2-stage

3-stage

Housing types and Pinion design

Bottom flange »FU«

Electric

Free shaft

Our advantages for you
- Flexible customer connection
- Adaptable to all common motors

4-stage

5-stage

Our advantages for you
- Gearing designed according to ISO 6336
- Modular gear design
- Finely graduated gear ratios combined from standard serial parts
- High torque density
- Weight-optimized and compact design
- Harmonious torque step over the entire series

Top flange »FO«

Our advantages for you
- Design using finite element method
- Tension and weight-optimized design
- Single-part shaft pinion
- Pinion design according to standard series
- Quenched and tempered quality steels
- Ground tooth flanks
- Optimized tooth shape
- Tip relief
- Asymmetrical crowning

» ZOLLERN slewing gears are specially designed for applications in wind turbines as well as in the shipping, port and offshore industries. «

Output torques

Preliminary gear selection
In order to determine the right gear size for the application, the loading, duration (T) and load spectrum must first be known.
The F.E.M. (Fédération Européenne de la Manutention Section I; Rules for the design of hoisting appliances; 3rd edition 1998) differentiates between the following loads:

- Load I: crane operating with no wind
- Load II: crane operating with wind
- Load III: crane under extraordinary loads

The maximum output torques given in the technical data relate to the load spectrum L2, operating class T5 and a reference speed of 15 rpm for load case II.

If the rotating mechanism is classified in a different drive unit class then it is possible to preselect the correct gear size by converting the required maximum torque using the operating factor K. ZOLLERN application engineers then take care of the individual design.

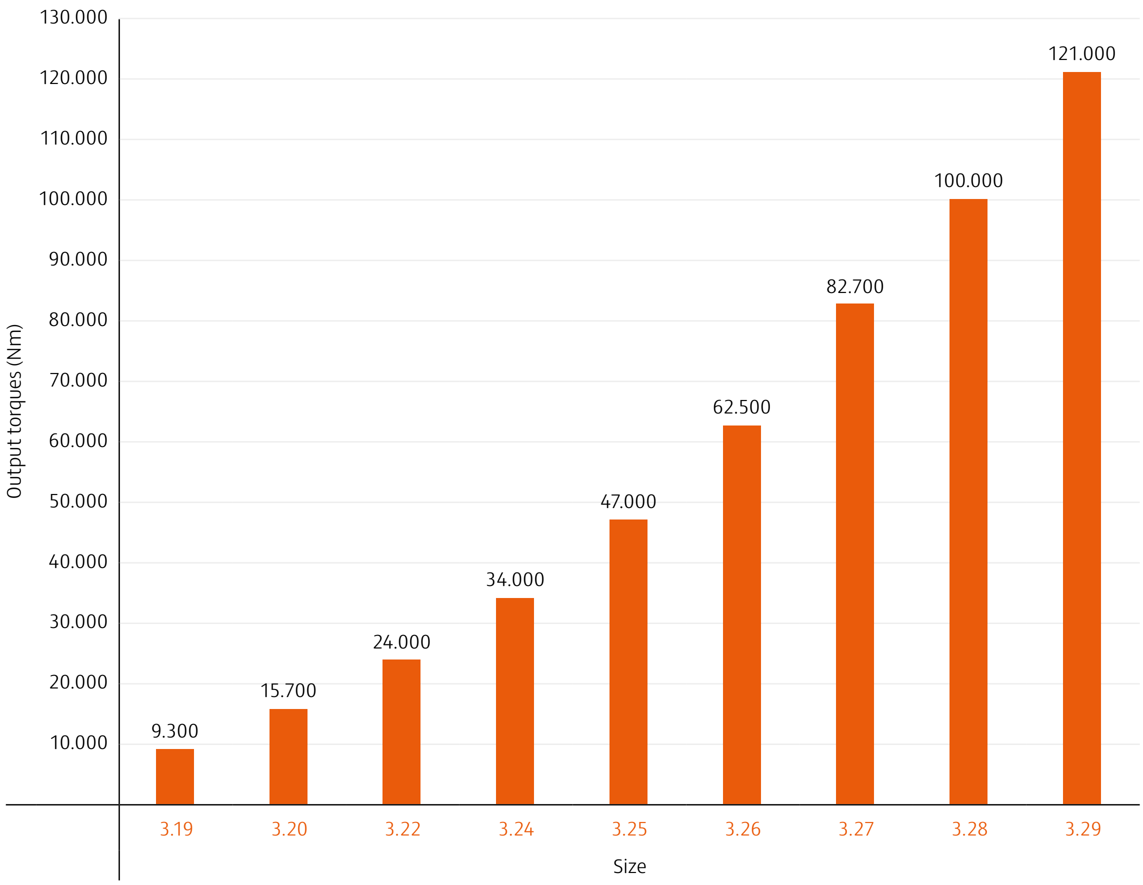
Calculation of the corrected torque

$$T_c = T \cdot K$$

T = required torque
T_c = corrected torque
K = operating factor (according to the operating class and the spectrum class from the table on page 11)
$T_{dyn\ perm}$ = dynamically permitted torque according to catalogue for class M5-L2-T5

The following must apply for selection of the gear size:
$T_c \leq T_{dyn\ perm}$

If the operating spectrum or speed deviate from this, the correct gear size is determined individually.



» ZOLLERN slewing gears are known for their strong performance under tough conditions in the construction machinery industry. «

Operating factor K for slewing gears

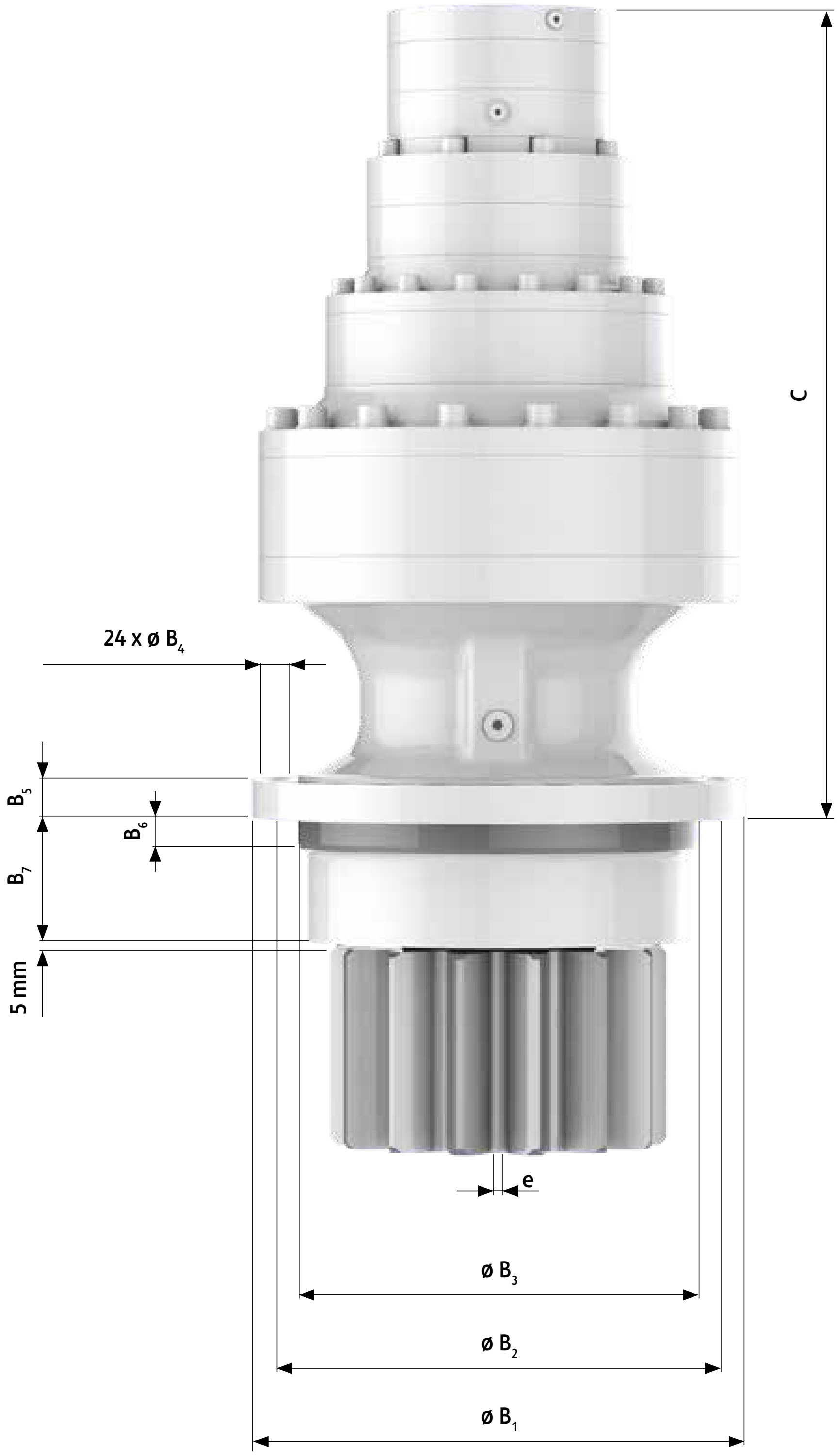
	Description	T2	T3	T4	T5	T6	T7	T8
Operating class	Mean operating time per day in h calculated over 1 year	over 0.25 to 0.5	over 0.5 to 1	over 1 to 2	over 2 to 4	over 4 to 8	over 8 to 16	over 16
	Service life in h 8 years, 200 days/year	400 to 800	800 to 1,600	1,600 to 3,200	3,200 to 6,300	6,300 to 12,500	12,500 to 25,000	25,000 to 50,000
Load spectrum		Drive unit class operating factor K						
L1 Light	Maximum load only as an exception, otherwise light load	M1 0.91	M2 0.94	M3 0.97	M4 0.99	M5 1.02	M6 1.08	M7 1.17
L2 Medium	Roughly equal shares of low, medium and high loads	M2 0.92	M3 0.95	M4 0.98	M5 1.00	M6 1.09	M7 1.16	M8 1.23
L3 Heavy	Loads are always close to the maximum load	M3 0.95	M4 1.01	M5 1.08	M6 1.15	M7 1.21	M8 1.27	M8 1.33
L4 Very heavy	Always maximum load	M4 1.19	M5 1.26	M6 1.31	M7 1.36	M8 1.41	M8 1.46	M8 1.52

Gear ratios the model series

// 2-stage	// 3-stage	// 4-stage	// 5-stage
17	46	199	**1,397**
22	61	236	1,529
26	**72**	**279**	**1,676**
29	**84**	**322**	1,764
35	**94**	**362**	**1,811**
	108	**418**	**1,934**
	130	**435**	**2,089**
	144	**501**	**2,173**
	154	**542**	**2,347**
	177	555	**2,507**
		650	**2,708**
		676	**2,817**
		720	**3,009**
		780	**3,250**
		864	**3,380**
		922	3,598
		1,064	**3,900**
		1,178	**4,056**
			4,680

Preferred series in **bold type**

Technical data
»Bottom flange« design (FU)



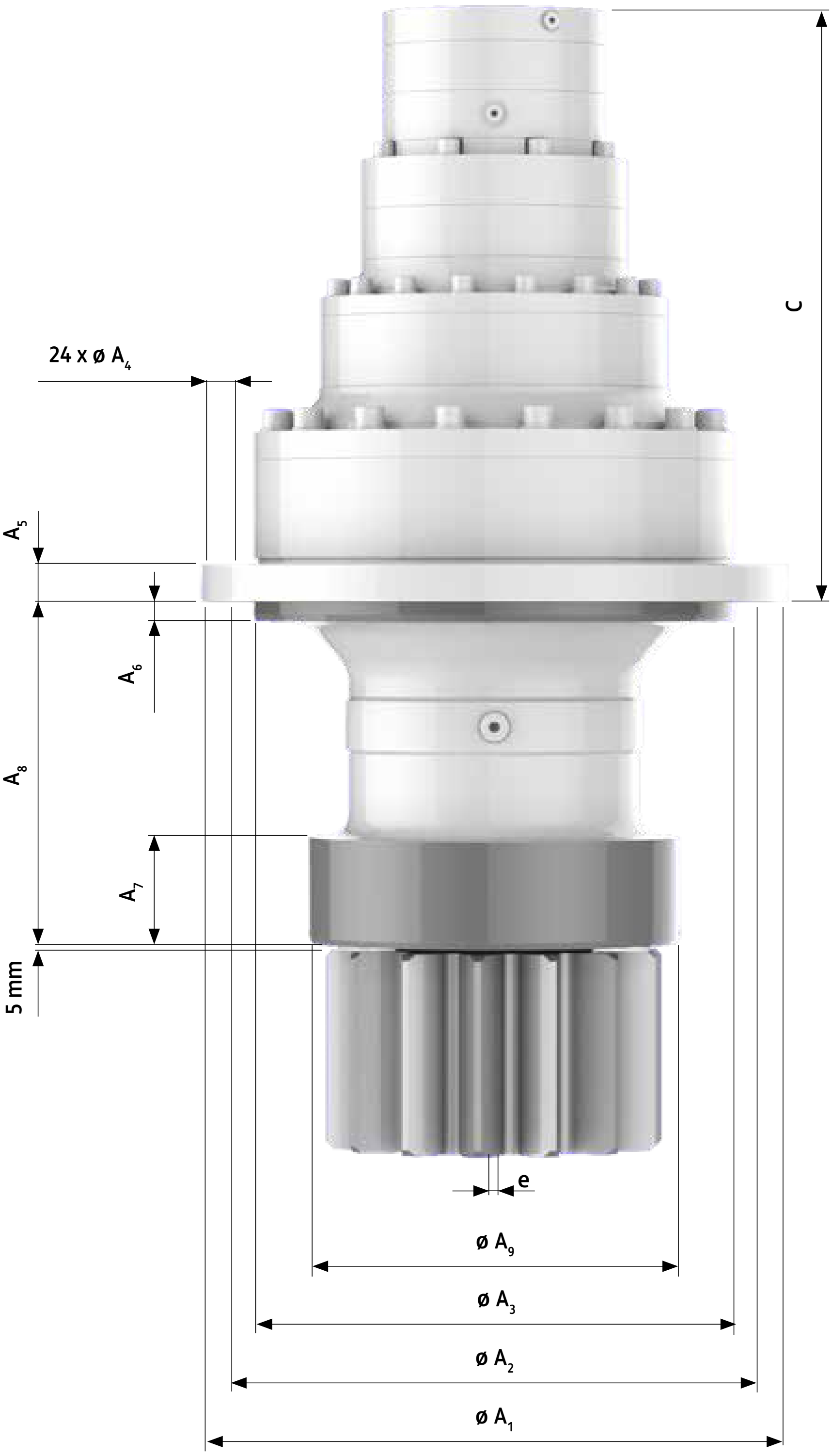
Size	Torques[1]		Main gear dimensions							Gear dimensions C		Eccen-tricity	Output pinion				Total weight	Relief (see S. 16)
»FU«	Tdyn. zul	Tstat	ø B_1	ø B_2 ±0,2	ø B_3 h7	B_4[2]	B_5	B_6	B_7	2 stages	3 stages	e	m_n	z	b	x	3 stages	B_{10}
	(Nm)	(Nm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)			(mm)		(kg)	(mm)
3.19	9.300	11.250	260	235	210	Ø 13,5	20	15	55	395	464	2,5	10	12	90	0,5	100	275
3.20	15.700	19.000	282	258	230	Ø 13,5	20	15	70	419	488	2,5	12	13	110	0,5	135	297
3.22	24.000	29.000	326	296	265	Ø 17,5	25	15	72	457	530	2,5	14	13	130	0,5	195	341
3.24	34.000	41.000	368	330	295	Ø 17,5	25	20	90	536	623	2,5	16	13	140	0,5	285	383
3.25	47.000	57.000	400	362	325	Ø 22	30	20	100	530	616	2,5	16	14	150	0,5	340	415
3.26	62.500	79.000	437	400	365	Ø 22	30	20	100	629	728	2,5	18	13	170	0,5	445	452
3.27	82.700	100.000	480	435	395	Ø 26	40	20	110	675	780	2,5	20	13	180	0,5	580	495
3.28	100.000	127.000	510	450	410	Ø 26	40	25	140	754	867	2,5	20	14	200	0,5	730	525
3.29	121.000	158.000	565	510	460	Ø 26	40	25	174	765	881	2,5	22	14	200	0,5	895	580

[1] Output torques according to FEM Section I M5/L2/T5 at n_{out} = 15 rpm

The stated output torques may vary in the case of design according to the specifications of classification organisations or if the gear ratios or pinion gearing deviate from the preference series.

[2] Strength class 10.9 for DIN EN ISO 4762 fixing bolts and 300HV (DIN EN ISO 7092) washers

Technical data
»Top flange« design (FO)



Size	Torques[1]		Main gear dimensions									Gear dimensions C		Eccen-tricity	Output pinion				Total weight	Relief (see S. 16)
»FO«	Tdyn. zul (Nm)	Tstat (Nm)	ø A_1 (mm)	ø A_2±0,2 (mm)	ø A_3 h7 (mm)	A_4[2] (mm)	A_5 (mm)	A_6 (mm)	A_7 (mm)	A_8 (mm)	ø A_9 h7 (mm)	2 stages (mm)	3 stages (mm)	e (mm)	m_n	z	b (mm)	x	3 stages (kg)	A_{10} (mm)
3.19	9.300	11.250	320	290	250	Ø 13,5	20	8	45	165	180	285	354	2,5	10	12	90	0,5	100	335
3.20	15.700	19.000	355	325	285	Ø 13,5	20	8	50	190	225	299	368	2,5	12	13	110	0,5	135	370
3.22	24.000	29.000	395	365	320	Ø 17,5	25	8	60	205	250	324	397	2,5	14	13	130	0,5	195	410
3.24	34.000	41.000	430	400	355	Ø 17,5	25	10	75	255	280	371	458	2,5	16	13	140	0,5	285	445
3.25	47.000	57.000	475	440	390	Ø 22	30	10	85	280	300	385	471	2,5	16	14	150	0,5	340	490
3.26	62.500	79.000	515	475	430	Ø 22	30	10	90	330	330	399	498	2,5	18	13	170	0,5	445	530
3.27	82.700	100.000	575	525	465	Ø 26	40	10	100	355	360	430	535	2,5	20	13	180	0,5	580	590
3.28	100.000	127.000	600	550	500	Ø 26	40	15	110	395	375	499	612	2,5	20	14	200	0,5	730	615
3.29	121.000	158.000	660	600	550	Ø 26	40	15	125	425	410	514	630	2,5	22	14	200	0,5	895	675

[1] Output torques according to FEM Section I M5/L2/T5 at n_{out} = 15 rpm
The stated output torques may vary in the case of design according to the specifications of classification organisations or if the gear ratios or pinion gearing deviate from the preference series.

[2] Strength class 10.9 for DIN EN ISO 4762 fixing bolts and 300HV (DIN EN ISO 7092) washers

// Pin wheel lengths »A_8« for top flange »TF«

Size	min. length A_8	max. length A_8	165	170	180	190	200	205	210	220	230	240	250	255	260	270	280	290	300	330	355	375	395	400	425	450	475	500	550	600	650	700	750	800	850	900	950	1.000
3.19	165	800	■	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•				
3.20	190	1.300				■	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.22	205	1.300						■	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.24	255	1.300												■	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.25	280	1.300															■	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.26	330	1.300																		■	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.27	355	1.700																			■	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.28	395	1.700																					■	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.29	425	1.700																							■	•	•	•	•	•	•	•	•	•	•	•	•	•

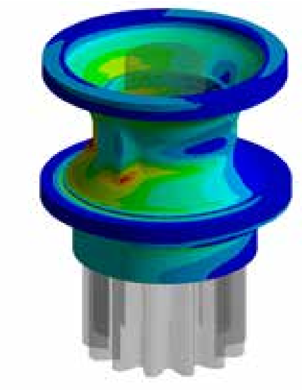
■ Preferred series

Model series

ZOLLERN's standard range of slewing gears already include an impressive array of standard features.

Parking brake
The parking brake is a spring action disc brake (failsafe). It is hydraulically released. The holding brake is not an operating brake and can only be operated at standstill.

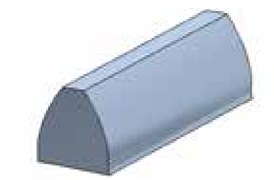
Output pinion
The configuration of gearbox and pinion toothing depends on the selection of the pitch diameter of the pinion tooth system. For optimum pinion tooth system, see table, pages 13, 15.



Output housing
All output housings in the standard range are made from spheroidal graphite cast iron and are configured for optimum weight and friction using finite elements.

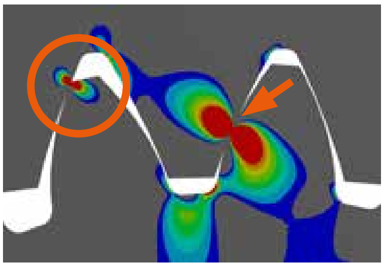
// Without ZOLLERN optimization

Pinion tooth flank | **Meshed tooth flanks**



Standard tooth flank

When the output pinion is under load, the shaft and tooth are deformed. This deformation can lead to meshing interference and edge wear.

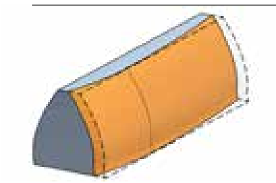


Meshing interference and edge wear

// With ZOLLERN optimization

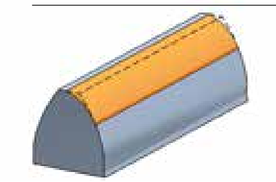
The pairing of output pinion and ring gear is calculated depending on the specific application. Shaft deformation and deflection of the output pinion are considered under load.

Pinion tooth flank | **Meshed tooth flanks**



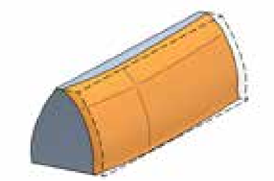
Asymmetric crowning

In order to compensate for shaft deformation and deflection, the tooth flank is corrected with asymmetric crowning in the angle of the flank, appropriate to the torque. This prevents edge wear and ensures optimum load distribution.



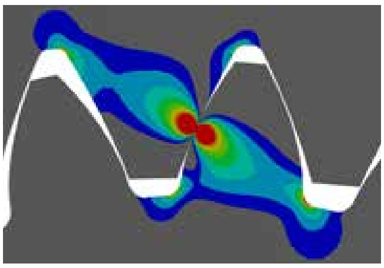
Tip relief

In addition, the tooth deformation under load is calculated and the tooth flank is corrected by means of tip relief. This prevents the ring gear from meshing too early.



ZOLLERN optimization

Using tooth flank corrections, crowning and tip relief significantly increases the service life of the output pinion and ring gear. Significantly narrower tooth crown widths can be used.

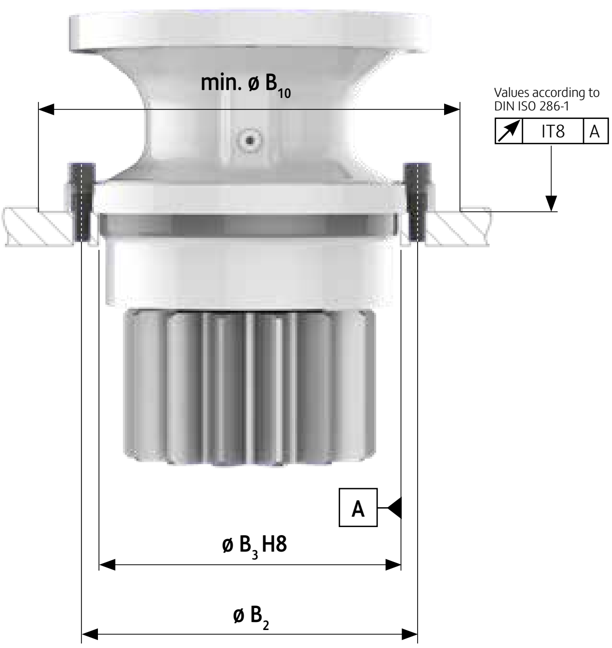


Optimum meshing

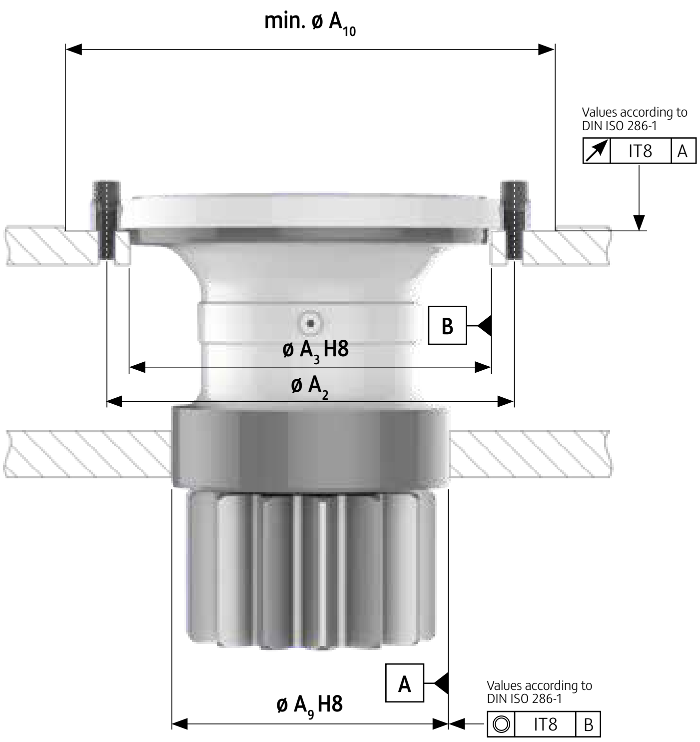
Installation instructions and connection design

To ensure perfect functioning and optimal power transmission between the gear and the driven mating gear, the gears require a connection design that is resistant to bending and twisting. This requires conformance with the shape and position tolerances described below.

Top flange »FU«



Bottom flange »FO«



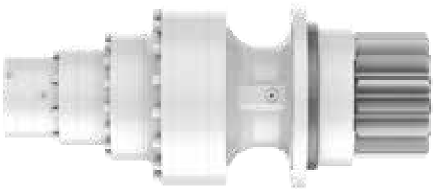
// Fixing bolts for steel construction (customer connection)

Fixing holes for steel construction according to DIN-EN 20273-m	Thread size	⌖ A
ø 11.0	M 10	0.4
ø 13.5	M 12	0.6
ø 17.5	M 16	0.6
ø 22.0	M 20	0.8
ø 26.0	M 24	0.8

Possible installation positions

Position Output pinion

Bottom



Horizontal

Top

Corrosion protection
Standard C3 coating, "high" protection duration (epoxy resin), colour RAL 9002 (grey-white).

Packing for storage and transport
Internal preservation of gear for two-year storage.

Lubricant
Gear oil: mineral oil
Pinion toothing: To achieve the full service life, the tooth flanks must always have an adequate grease film. Determine the type of lubricant to be used in consultation with the ring gear manufacturer.

Options (available on request)

- Service brake
- Manual brake control
- Electric drive with asynchronous or torque motor
- Sensors for position recognition
- Speed measurement
- Temperature monitoring
- Supported torque arm for torque monitoring
- Splined output pinion
- Case-hardened pinion for top requirements
- Synthetic oil

Lubrication recommendation

	Labelling according to DIN 51 502	Labelling according to ISO 6743-6	Minimum standard of the lubricant
Gear oil	CLP	ISO-L CKC (or CKD)	DIN 51 517 T3: CLP 220 and ISO 12925-1: CKC / CKD 220
First oil change	200 operating hours after commissioning		
Subsequent oil changes	every 1,000 operating hours, at least every twelve months		

Attention
Gear oils based on mineral oil and PAO must not be mixed with synthetic gear oil based on polyglycol. Do not mix greases with different soap bases.

Operating conditions
The slewing gears are designed for use in the central European region. Permitted oil temperature (in operation) -20°C to +70°C and/or ambient temperature (out of operation) at least -30°C.

Data necessary for the design

Company/address ________ Date ________

Responsible department ________ Contact ________ Enquiry No. ________

Phone ________ Fax ________ E-mail ________

Requirement / number of units ________ For use with (e.g. truck-mounted, on-board, offshore or port mobile crane, construction-site crane, wind turbine) ________ For use as (e.g. slewing gear, swivel gear, pitch gear) ________

// Operating data - design criteria

(all values relate to the output of the slewing gear)

Output/design

Dynamic load

Output torque M_{dyn} ________ (Nm)

Speed on output n_{out} ________ (rpm)

M_{dyn} corresponds with $S_{M\ max\ II}$ according to FEM Section I

Installed power P ________ (kW)

Static load

Output torque M_{stat} ________ (Nm)

Design according to FEM Section I

Drive unit class	Load spectrum	Operating class
❑ M	❑ L	❑ T

Approval by classification organisation

❑ ABS ❑ DNV•GL

❑ LRS ❑ RMRS ❑ Other________

Alternative design

Spectrum	M_{dyn} (Nm)	n_{out} (rpm)	Time share (%)
1			
2			
3			
4			
			100 %

Calculated service life in h ________ (hours)

Safety factor against ________ (–)

❑ Yield strength ❑ Breakdown

at ❑ M_{dyn} ❑ M_{stat} ________ (Nm)

// Technical data

Output pinion

Module m ________ (mm)

Number of teeth z ________

tooth width b ________ (mm)

Profile shift coefficient x ________

Standard x=0.5 for output gear

❑ Shaft pinion (standard)

❑ Splined output pinion

❑ Hardened and grinded tooth flanks

❑ Case-hardened and grinded tooth flanks

Ring gear, tooth flanks

❑ soft ❑ hardened

Ring gear data

z ________

b ________ (mm)

x ________

❑ Inner gearing

❑ External gearing

Gear ratio

i ________ ± ________ %

Gear attachment

❑ Bottom flange ❑ Top flange

Output unit, length ________ (mm)

Position output pinion

Orientation Output gear

❑ bottom ❑ top ❑ horizontal

// Hydro motor drive

Make ________

Type ________

Available displacement Q ________ (l/min)

Available differential pressure Øp ________ (bar)

// Electric motor drive

Make ________

Type ________

Output ________ (kW)

Speed ________ (rpm)

Control (BF; On/Off, gentle start...)

Voltage, current type ________

Tightening torque M_A ________ (Nm)

Tilting torque M_K ________ (Nm)

Duty cycle ED ________ (%)

Start-ups per hour ________

// Brake

Parking brake

❑ yes ❑ no

Design

❑ Spring-pressure disc brake

❑ with add. backstop ❑ brake motor

❑ Disc brake ❑ Drum brake

Actuation

❑ hydraulic min. release pressure ________ (bar)

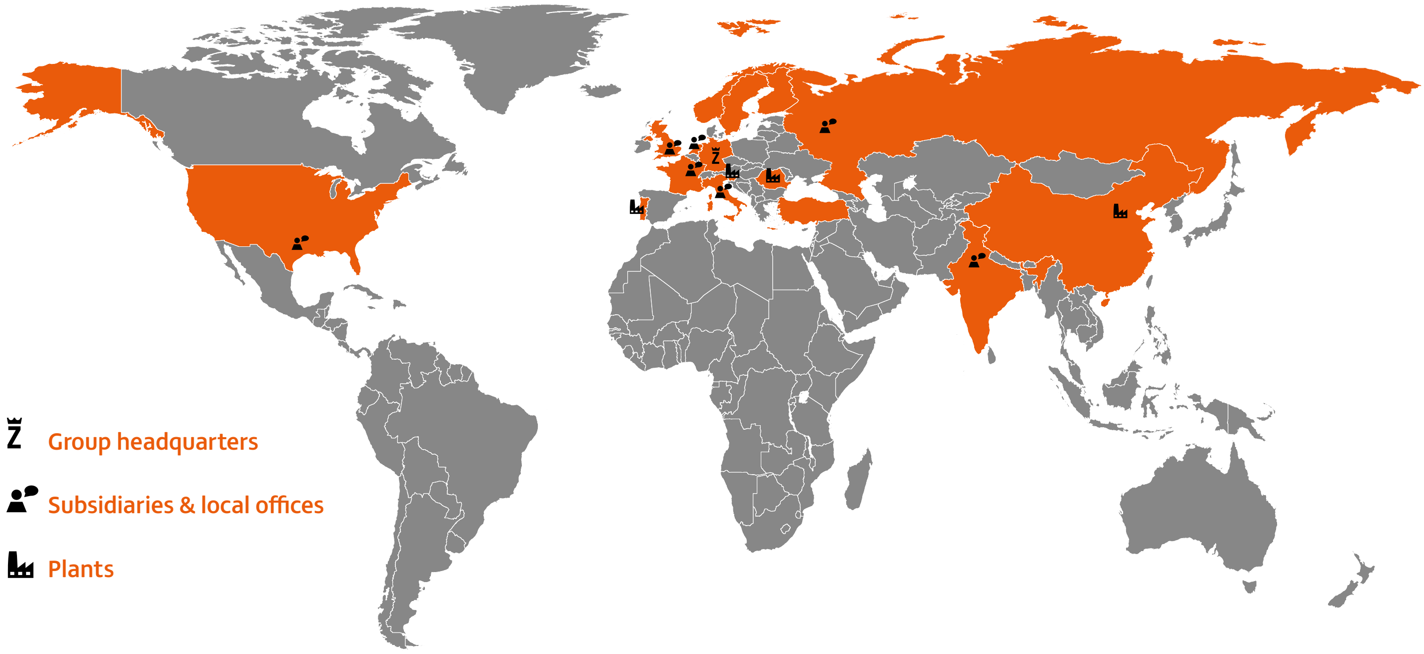
❑ electric/magnetic max. release pressure ________ (bar)

Expected back-pressure ________ (bar)

// Other

// Scope of supply

❑ Motor
❑ Load holding valve
❑ Brake on input
❑ Coupling
❑ Motor lantern
❑ Torque arm
❑ Incremental shaft encoder
❑ Hydraulic aggregate
❑ Hydraulic control
❑ Acceptance
❑ Certificates



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