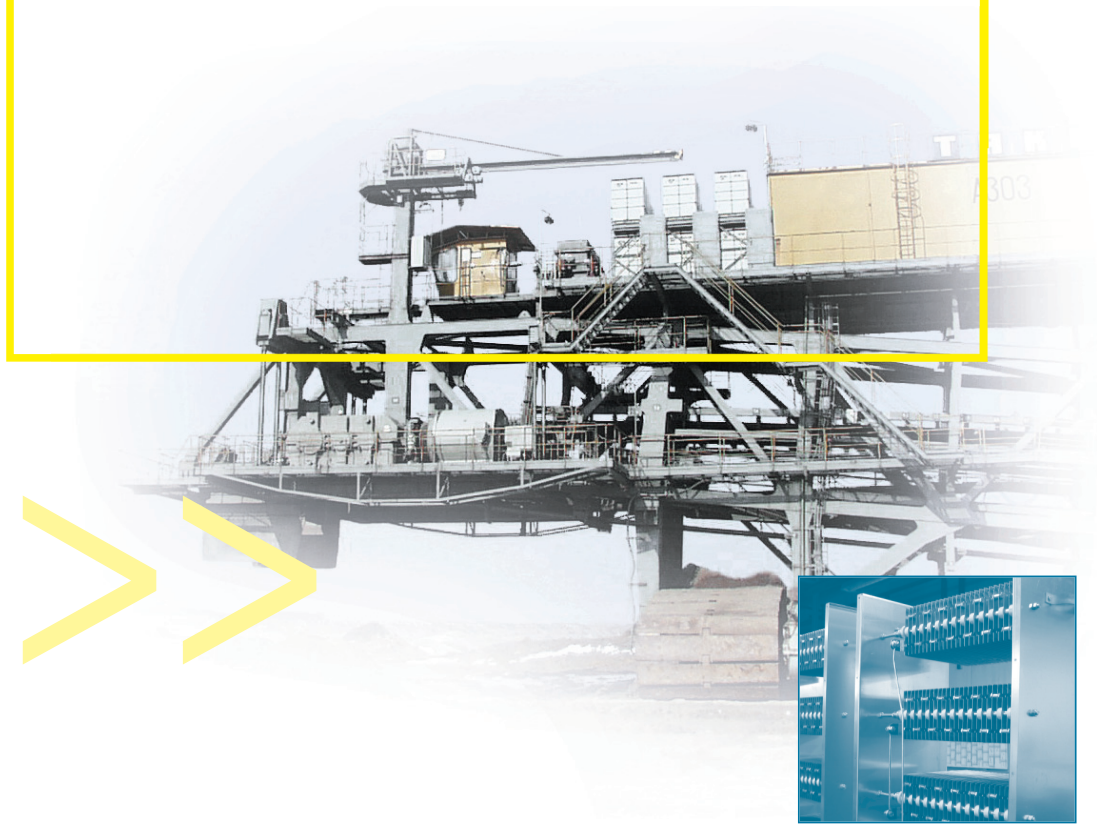
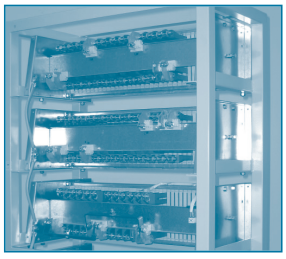
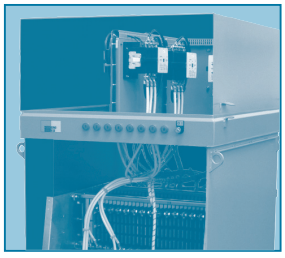
Oil cooled motor starters

MOTORSTARTERS

High torque – low current







GINO ESE

General

Oil-cooled resistor starter 3PA3

for three-phase motors with slip-ring rotor up to 12,800 kW

General, application

3PA3 starters are stepped resistor starters with contactors and cast iron 3PR3 resistors in a housing filled with insulating oil.

Oil-cooled starters save the heat that forms during the starting process and slowly release it through their surface. Therefore, they are particularly suited for high-performance drives that are not frequently started.

The design combines the advantages of a resistor starter with those of a more economical heat carrier (oil) and a high protection class for applications in difficult environments.

Robust power contactors guarantee high operational reliability and long service lives combined with low maintenance. All parts in motion are mounted outside of the oil filling and therefore easy to maintain.

Designs

- Simple starter with stator contactor for low voltage machines up to 640 kW
- Simple starter without stator contactor for low and medium-voltage machines up to 6400 kW
- Twin starter without stator contactor for low and medium voltage machines up to 12800 kW
- Starter with plain steel plate tank
- Starter with finned tank for higher starting frequency
- Starter with additional water cooling for high starting frequency

Basic accessories

- Stator contactor and thermal overcurrent relay for drives up to 640 kW, size 1 to 3
- Water cooling size 52 to 56
- Auxiliary switches required for the customer's control, wired to terminals
- Temperature monitoring,
  warning at 100°C,
  tripping at 130°C
- Control voltage 230 V – 50/60 Hz
- Step contactors, PLC alternatively timers for starting steps
- Short circuit contactor(s)
- Cable inlets, connection directly to the short circuit contactor
- Oil level indicator
- Painting RAL 7035

Extras

- Control transformer for different control voltage
- Electronic blocking control during starting
- Cable cover to increase the protection class to IP 55
- Oil level control
- No. of starts monitor
- Oil tank with cooling fins
- Local control and position pointer
- Anti-condensation heating
- Rotor voltage > 2000 V
- Controller for brush lifting device
- Terminal box for rotor cable
- Torque-dependent start
- Communication and visualization via PROFIBUS (www.profibus.com)

Standards and regulations

3PA3 starters comply with

- DIN VDE 0660 Regulations for low-voltage switchgear
- DIN 46062 Starters for direct current and alternating current slip-ring motors
- IEC 60947-4-1 Low voltage switchgear, contactors and motor starters

They conform with the Low Voltage Directive 73/234 EWG of the EC.

According to DIN 50010, T1 the starters are suited for installation in

- closed locations
- roofed locations
- outdoor locations

Protection

IP54 as per DIN 40050 / IEC 144

Ambient temperature

-25 ... +45°C, higher temperatures on request

Altitude

Up to 1000 m above sea level, higher altitudes on request

To be provided by the customer

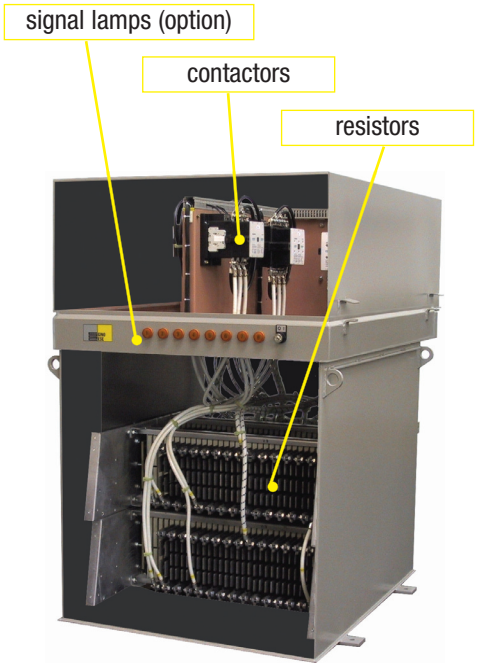
- Plane foundation
- Oil catch basin
- Stator contactor or circuit breaker
- Line-side short circuit protection
- Thermal motor protection above size 3
- Supply and filling in of the oil fill

Oil fill

For the oil fill, use acid-free insulating oil as specified by DIN 51370, DIN VDE 0370.

- ESSO Univolt 56
- Shell Diala D
- Energol JS R
- BP JSH-A

Starter transport is only admissible without oil fill.



Selection and technical data

Order number 3PA3 ①②0-③④⑤⑥⑦-M.. accessories M10 to M… or full text

- Selection according to starter load factor f

Model Order no. 3PA3 ①②	Motor rating kW at starting load				Rotor current A ③ Characteristic			Technical starter data					
	Half load starting f=0.7	Fan starting f=1	Full load starting f=1.4	Heavy load starting f=2.0	1	2 [1)]	3[2)]	Rotor voltage up to V	Maximum starter energy $W_{a\ max}$ kJ	Starting time ta[3)] s	Starting number z	Starting frequency h_a 1/h	Starter positions[4)]
Single starter without stator contactor, order supplement ④ = A													
01	200	140	100	70	150	250	-	1320	8000	18	6	2.0	6
02	450	315	225	155	250	450	630	1500	20000	20	5	1.10	7
03	640	450	320	225	250	450	630	1500	26000	20	5	1.10	7
04	900	630	450	315	450	630	-	1500	29000	20	4	1.10	7
05	1260	880	630	440	450	630	1100	1500	48600	36	3	0.45	8
06	1800	1250	900	625	630	1100	1600	2000	69000	36	3	0.40	8
07	2500	1750	1250	875	630	1100	1600	2000	106000	36	3	0.40	8
08	3600	2500	1800	1250	1100	1600	-	2000	149000	40	3	0.30	9
09	5000	3500	2500	1750	1100	1600	-	2000	220000	40	3	0.30	11
10	6400	4500	3200	2250	1100	1600	-	2000	283000	40	3	0.30	12
Twin starter without stator contactor, order supplement ④ = A													
40	2 x 3600	2 x 2500	2 x 1800	2 x 1250	2 x 1100	2 x 1600	-	2000	2 x 149000	40	3	0.3	9
41	2 x 5000	2 x 3500	2 x 2500	2 x 1750	2 x 1100	2 x 1600	-	2000	2 x 220000	40	3	0.3	11
42	2 x 6400	2 x 4500	2 x 3200	2 x 2250	2 x 1100	2 x 1600	-	2000	2 x 283000	40	3	0.3	12
Starter with water cooling, without stator contactor, order supplement ④ = A													
52	1260	880	630	440	450	630	-	1500 [5)]	53100	36	3	2.2	8
54	2500	1750	1250	875	630	1100	-	2000	112700	36	3	3.3	8
56	5000	3500	2500	1750	1100	1600	-	2000	230400	40	3	3	11

- Selection according application

Model Order no. 3PA3 ①②	Motor rating kW at starting load										Rotor current A ③ Characteristic			Technical starter data				
	Vertical mill w/o load f=0,7		pump f=0,9		Fan f=1,0		Ball mill f=1,3		Crusher f=1,8		1	2 [1)3)]	3[2)3)]	Rotor voltage up to V [7)8)]	Maximum starter energy W_{a_max} kJ	Starting number z	Starting frequency h_a 1/h	Starter positions[4)]
	P/kW	t_a/s	P/kW	t_a/s	P/kW	t_a/s	P/kW	t_a/s	P/kW	t_a/s								
Single starter without stator contactor, order supplement ④ = A																		
01	380	10	300	10	130	20	210	10	110	14	150	250	-	1320	8000	6	2,00	6
02	1100	10	890	10	350	23	510	12	250	18	250	450	630	1500	20000	5	1,10	7
03	1500	10	960	12	400	26	670	12	290	20	250	450	630	1500	26000	5	1,10	7
04	2100	10	1200	14	560	26	930	12	400	20	450	630	-	1500	29000	4	1,10	7
05	3900	12	2300	16	1100	29	1600	16	780	23	450	630	1100	1500	48600	3	0,45	8
06	4100	16	2800	18	1300	36	2000	18	980	26	630	1100	1600	2000	69000	3	0,40	8
07	5600	18	4400	18	1800	40	2700	20	1400	29	630	1100	1600	2000	106000	3	0,40	8
08	7900	18	5500	20	2300	44	3800	20	1700	32	1100	1600	-	2000	149000	3	0,30	9
09	10500	20	7100	23	3100	48	4900	23	2300	36	1100	1600	-	2000	220000	3	0,30	11
10	11700	23	8100	26	3600	52	5600	26	2600	40	1100	1600	-	2000	283000	3	0,30	12
Double starter without stator contactor, order supplement ④ = A																		
40	12300	23	8500	26	3800	52	5900	26	2800	40	2 x 1100	2 x 1600	2000	298000	3	0,3	9	3800
41	16100	26	11200	29	5200	56	7100	32	3400	48	2 x 1100	2 x 1600	2000	440000	3	0,3	11	5200
42	16800	32	13100	32	6300	60	7300	40	4000	52	2 x 1100	2 x 1600	2000	566000	3	0,3	12	6300
Starter with water cooling, without stator contactor, order supplement ④ = A																		
52	3200	16	2500	16	1100	32	1700	16	1000	20	450	630	1500 [6)]	53100	3	2,2	8	3200
54	6000	18	4600	18	1900	40	2900	20	1400	29	630	1100	2000	112700	3	3,3	8	6000
56	11000	20	7400	23	3200	48	5100	23	2100	40	1100	1600	2000	230400	3	3,0	11	11000

Technical data, starter for water cooling with service wate r pump voltage 3/400 V – 50 Hz (different voltage upon request)					
Model 3PA3 ①②	Pump rating kW	Cooling capacity kW	Cooling water inlet temperature °C	Cooling water requirement m³/h	Piping connection	Pressure drop bar
52	0.37	11	≤ 20	0.7	R1/2"	0.35
54	1.1	33.5	≤ 20	1.8	R1/2"	0.5
56	2.2	71.5	≤ 20	3.1	R1"	0.7

1) Standard workshop setting if no other specification is made
2) For rotor current of 630 A; rotor voltage max. 2000 V
3) This version is approx. 3% heavier
4) Other voltages on request
5) Multi-step starter with binary control on request
6) if rotor current > 1600 A, choose twin starter
7) if motor rating > 5000 kW; high voltage type
8) Water quality; service water

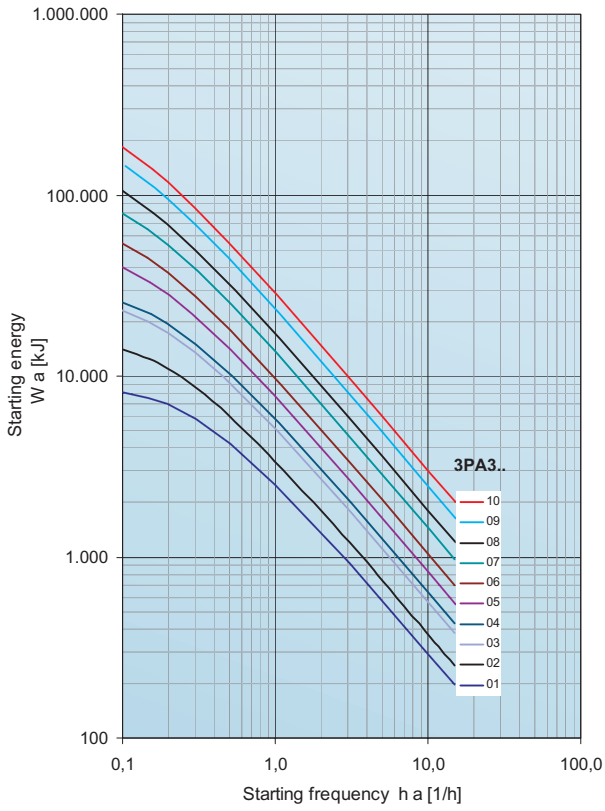
Order supplements, items ④⑤⑥⑦ and accessories

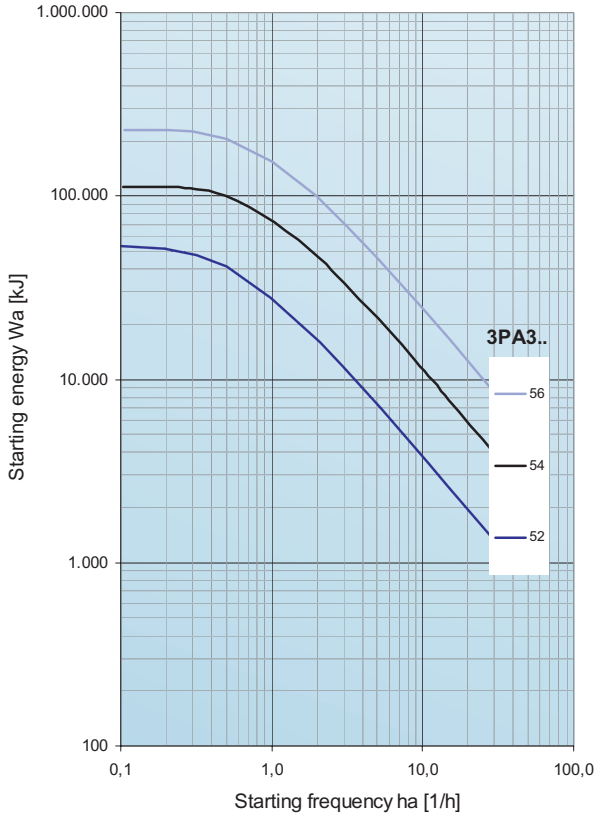
Starter with stator contactor , nominal voltage up to 690V, order supplement ④				
Model 3PA3 ①②	Contactor nominal current A	Adjusting range over-current relay A	Fusing up to A	Order sup-plement ④
Model w/o stator contactor			-	A
01	170	63 - 90	250	K
		80 - 110	315	B
		110 - 135	315	C
		125 - 200	355	D
02	400	125 - 200	355	E
		200 - 320	500	F
		320 - 500	500	G
03	630	320 - 500	630	H
		400 - 630	630	J

Starter factor , order supplement ⑤		
from	to	⑤
0.35	0.45	A
0.45	0.56	B
0.56	0.71	C
0.71	0.90	D
0.90	1.12	E
1.12	1.42	F
1.42	1.80	G
1.80	2.25	H
2.25	2.75	J
2.75	3.60	K
3.60	4.50	L
4.60	5.65	M
5.65	7.15	N
7.15	9.00	P
9.00	11.25	Q
11.25	14.25	R
14.25	18.00	S

Starting time, order supplement ⑥⑦	
(ta) = sec	⑥⑦
10	10
12	12
14	14
16	16
18	18
20	20
23	23
26	26
28	28
32	32
36	36
40	40
44	44
48	48
52	52
56	56
60	60
65	65
70	70
80	80

Accessoires , order supplement M..	
M10	Different control voltage with built-in control transformer, indicate desired control voltage in full text
M20	Electronic blocking control, protects the drive during starting
M30	Cable cover as protection against mechanical damage to starter feed cables and to increase protection to class IP55
M40	Level control, tripping function: changeover contact wired to terminals
M45	Monitoring the number of starts
M50	Oil tank with cooling fins, increases starting frequency by factor 3.8
M60	Local control and position pointer
M65	Anti-condensate heating for control cabinet
M70	Rotor voltage] 2000 V
M80	Brush lifting device control
M82	Terminal box for rotor cables
M85	Torque-dependent start
M90	Communication and visualization via industrial bus system





Small starter glossary

During starting, energy is taken from the grid. Half of it is used for acceleration, the other half is converted into heat in the starter.

In terms of heat balance, the starter can be compared to a tank with a hole at the bottom:

If the tank is filled with water (energy) from a vessel and if this vessel can be emptied three times into the tank, for example, then you must wait until the water from one vessel fill has drained through the hole.

The amount of water added is equivalent to the starting energy W_a, the filling volume of the tank to the maximum admissible starting energy until reaching the final temperature and the draining volume to the starting frequency.

The value for the starting frequency indicates the energy volume at operating temperature that is transferred at hourly rates through the starter surface – like the flow through the drain hole measured at hourly intervals.

The starter energy listed in the tables relates to a limiting temperature rise of 75 K and/or a limit temperature of 110°C at +45°C ambient temperature.

Definitions

Starter energy Wa
Energy which is converted into heat in the starter during the starting operation.

Number of starts z
Permissible number of starts in succession with starting time ta and time interval 2ta until reaching operating temperature.

Starting time ta
Duration of the starting process in seconds.

Starting load factor f
ratio of the mean starting load to the starter duty rating.

Starter duty factor ka
Factor for the starter calculated by dividing 1.4 times the starter duty rating of the motor by the starting load factor.

Rotor duty factor k
Calculated using the rotor data for standstill voltage and rated rotor current of the motor.

Starting frequency
Number of starts per hour at operating temperature

Starting steps n
Number of resistor steps of the starter.

Starting positions n+1
Number of switching positions during starting.

Equations

$$Wa = 0.5f \cdot P \cdot ta \text{ [kJ]}$$

$$z = \frac{Wa_{max}}{Wa}$$

Drive with constant load torque

$$ta = \frac{i \cdot n^2}{91200 \cdot (f - \frac{M_L}{M_N}) \cdot P} \text{ [s]}$$

Drive with square law load torque and f= 1

$$ta = \frac{i \cdot n^2}{91200 \cdot 0.67 \cdot P} \text{ [s]}$$

Half load starting	f = 0,7	M_{max}/M_n ca.1.0
Fan starting	f = 1,0	M_{max}/M_n ca.1.4
Full load starting	f = 1,4	M_{max}/M_n ca.1.7
Heavy starting	f = 2,0	M_{max}/M_n ca.2.5

$$ka = \frac{1.4k}{f}$$

$$k = \frac{u_2}{i_2 \cdot \sqrt{3}}$$

Wa_{max} = total starting energy admissible for the starter [kJ]
Wa = starting energy per start [kJ]
ta = starting time [s]
i = moment of inertia of the rotating masses related to the motor shaft [kgm²].

Conversion from speed n_x to motor speed n

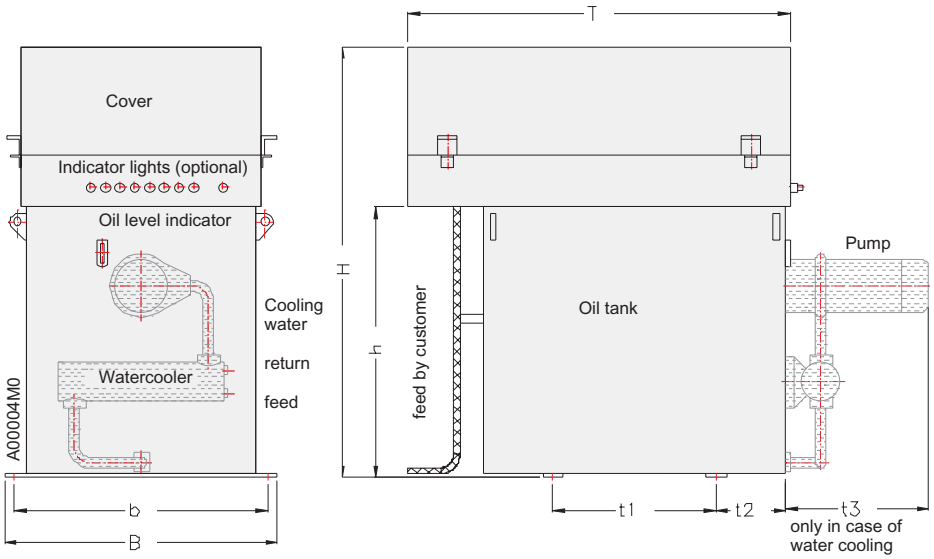
$$i_n = i_x \cdot (\frac{n^2}{n_x^2}) \text{ [kgm²]}$$

Conversion from straight accelerated masses to moment of inertia:

$$i_n = 91.2 \cdot m(\frac{v}{n})^2 \text{ [kgm²]}$$

m = mass [kg]
v = mass speed [m/s]
M_L = load moment
M_N = nominal moment
N = nominal drive speed [min^{-1}]
P = motor rating [kW]
i_2 = rated rotor current [A]
u_2 = rotor standstill voltage [V]

Dimensions and Weights



Dimensions and weights										
3PA3 Model	B	H	T	b	h	t1	t2	t3	Weight w/o oil ca. kg	Oil volume ca. l
Simple starter										
01	380	900	766	350	474	280	122		100	60
02	560	870	1101	510	439	430	202		215	145
03	560	1155 /1225 [1]	962 / 1067 [1]	510	684	430	178		282	185
04	560	1255	962	510	784	430	178		255	205
05	836	1257	1169	776	766	500	213		400	355
06	951	1327	1221	891	836	580	223		480	500
07	1048	1600	1221	988	1109	640	202		720	775
08	1048	1630	1641	988	1139	820	322		1020	1080
09	1118	1940	1706	1058	1449	860	334		1430	1600
10	1118	2000	2136	1058	1509	1100	429		1690	2060
Double starter										
40	2 x 3PA308, in parallel								2040	2 x 1080
41	2 x 3PA309, in parallel								2860	2 x 1600
42	2 x 3PA310, in parallel								3380	2 x 2060
Starter with water cooling										
52	836	1307	1169	776	816	500	213	424	470	383
54	1048	1650	1221	988	1179	640	202	424	800	812
56	1118	1990	1706	1058	1499	860	334	424	1560	1660

[1] Size 03 with stator co tactor

ÖKWA_engl_06/2010

subject to technical changes 2010

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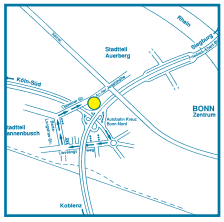

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