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VOKA

CORE IDENTIFICATION ACCORDING TO DIN VDE 0815

► **Installation cables**
J-Y(St)Y ... Lg J-Y(St)Y ... BMK J-Y(St)Yh ... Lg

PAIR

The colour of the a-core of the first (tracer) pair is red in every layer, in all other pairs it is white.
The colour of the b-core is blue, yellow, green, brown and black in continuous repetition as follows:

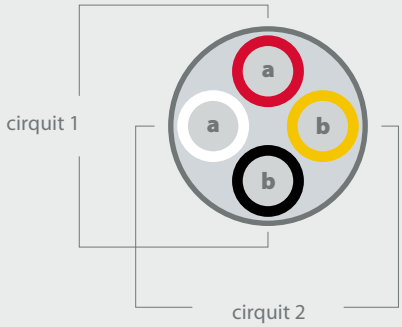
Ongoing no. of the pair																			colour of B-cores
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	blue
2	7	12	17	22	27	32	37	42	47	52	57	62	67	72	77	82	87	92	97	yellow
3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	green
4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94	99	brown
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	black

► **Installation cables**
J-Y(St)Y ... Lg

STAR-QUAD

In installation cable J-Y(St)Y … Lg
with 2 pairs as star quad:

in circuit 1	the colour of the a-core is red, the colour of the b-core is black
in circuit 2	the colour of the a-core is white, the colour of the b-core is yellow



► **Installation cables**
J-YY ... Bd, J-HH ... Bd, J2Y(St)Y ... Bd, J-Y(St)Y ... Bd, J-H(St)H ... Bd

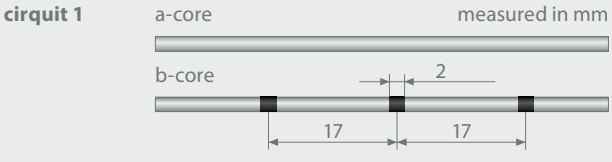
IDENTIFICATION BY RINGS

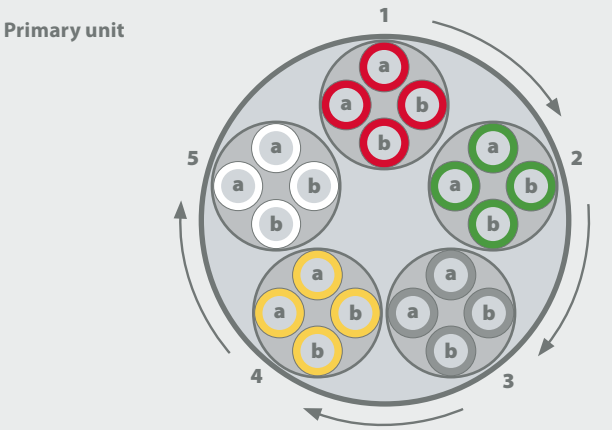
The cores of a quad are marked with black rings. The cores of the five star quads of the primary bunch are coloured as follows:

quad 1: basic colour red
quad 2: basic colour green
quad 3: basic colour grey
quad 4: basic colour yellow
quad 5: basic colour white

The tracer bunch is identified by a red plastic spiral in every layer. The other bunches have a white spiral. The quads of a primary bunch are counted in the order of the basic colours.

In cables with more than five star quads the primary and main bunches are counted in the same direction, starting with the tracer bunch of the first inner layer and continuing throughout all layers to the outside.





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CORE IDENTIFICATION ACCORDING TO DIN VDE 0815

► **Installation cables for industrial electronics**

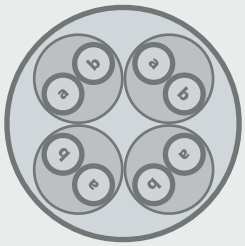
JE-Y(St)Y **JE-Y(St)Yv** **JE-Y(St)YY** **JE-YCY** **RD-Y(St)Y**
JE-LIYCY **JE-LiYY** **JE-LiY(St)Y**
JE-LiHCH **JE-LiHH** **JE-H(St)H** **JE-HCH**

PAIR

Basic colours of insulating covers in installation cables with 2 pairs as star quads

cirquit	1		2	
core	a	b	a	b
basic colour	blue	red	grey	yellow

PAIRS FORMED TO UNITS



Basic colours of insulating covers of bunch pairs

cirquit	1		2		3		4	
core	a	b	a	b	a	b	a	b
basic colour	blue	red	grey	yellow	gren	brown	white	black

To distinguish individual bunches, cores must be identified by smear-resistant coloured rings or bunches by spirals of plastic tape with printed bunch number.

When applying the ring identification to distinguish the bunches, the coloured cores must be identified according to table 2 above and picture 1 on the right. The dimensions in picture 1 should be observed to ensure clear distinction of the bunches. A slight blurring at the edge of the ring identification and a minor misalignment of the 2 semirings are permitted.

IDENTIFICATION BY RINGS

IDENTIFICATION OF BUNDLES BY RING GROUPS

Unit no.	Ring colour	Ring group: units of 4 cores	Ring group: units of 8 cores/ 4 pairs	spiral colour
1	pink	I	I	
2		I	II	
3		II	III	
4		II	IIII	
5	orange		I	
6			II	
7			III	
8			IIII	
9	violet		I	
10			II	
11			III	
12			IIII	

Unit no.	Ring colour	Ring group: units of 4 cores	Ring group: units of 8 cores/ 4 pairs	spiral colour
13	pink		I	blue
14			II	
15			III	
16			IIII	
17	orange		I	red
18			II	
19			III	
20			IIII	

In cables with more than 12 bunches additional bunches are identified^ by a coloured plastic spiral. The counting of bunches starts with the inner layer and continues in the same direction throughout all layers to the outside.

CORE IDENTIFICATION ACCORDING TO DIN VDE 0816

Outdoor telecommunication cables
► **A-2Y(L)2Y … Bd, A2YF(L)2Y**

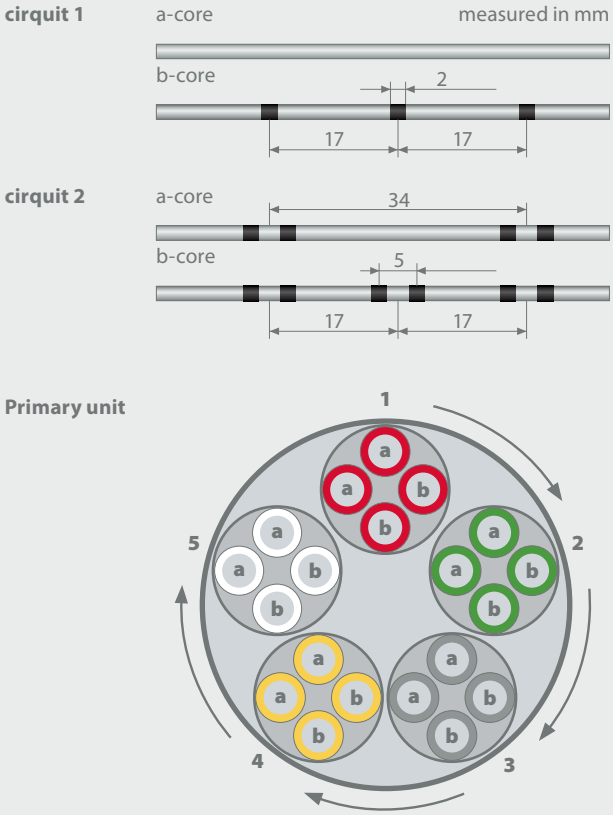
The cores of a quad are marked with black rings. The cores of the five star quads of a primary bunch are coloured as follows:

quad 1: basic colour red
quad 2: basic colour green
quad 3: basic colour grey
quad 4: basic colour yellow
quad 5: basic colour white

The tracer bunch is identified by a red plastic spiral in every layer. The other bunches have a white spiral. The quads of a primary bunch are counted in the order of the basic colours.

In cables with more than five star quads the primary and main bunches are counted in the same direction, starting with the tracer bunch of the first inner layer and continuing throughout all layers.

IDENTIFICATION BY RINGS



CORE IDENTIFICATION ACCORDING TO DIN VDE 0813

► **Switchboard cables**
S-Y(St)Y

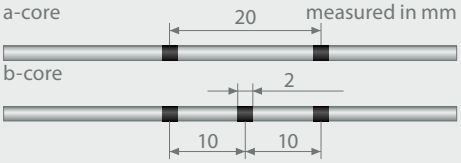
Identification of a-core and b-core by basic colour and ring colour.

Ongoing no. of stranding element					Basic colour of core	Ring colour of the a-core
1	2	3	4	5	a white b white c red d pink e black	blue
6	7	8	9	10		yellow
11	12	13	14	15		green
16	17	18	19	20		brown
21	22	23	24	25		black
26	27	28	29	30	a grey b grey c red d pink e black	blue
31	32	33	34	35		yellow
36	37	38	39	40		green
41	42	43	44	45		brown
46	47	48	49	50		black

Ring colour of the b-core				
blue	yellow	green	brown	black

PAIR

IDENTIFICATION BY RINGS



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CORE IDENTIFICATION ACCORDING TO DIN 47100

Electronic control cables and computer cables
► **LIYY and LIYCY**

The first colour is the basic core colour.
If cores are multi-coloured, identification is composed of one basic colour and one contemporary colour.
Counting from the outside to the inside continuing throughout all layers.

CORE STRANDING

(cables with 4 cores are stranded in the colour order white, yellow, brown, green)

Core	Colour	Core	Colour	Core	Colour	Core	Colour	Core	Colour
1	white	19	whitepink	37	greyblue	55	greypink	73	pinkgreen
2	brown	20	pinkbrown	38	pinkblue	56	redblue	74	yellowpink
3	green	21	whiteblue	39	greyred	57	whitegreen	75	pinkgreen
4	yellow	22	brownblue	40	pinkred	58	browngreen	76	yellowblue
5	grey	23	whitered	41	greyblack	59	whiteyellow	77	greenred
6	pink	24	brownred	42	pinkblack	60	yellowbrown	78	yellowred
7	blue	25	whiteblack	43	blueblack	61	whitegrey	79	greenblack
8	red	26	brownblack	44	redblack	62	greybrown	80	yellowblack
9	black	27	greygreen	45	white	63	whitepink	81	greyblue
10	violet	28	yellowgrey	46	brown	64	pinkbrown	82	pinkblue
11	greypink	29	pinkgreen	47	green	65	whiteblue	83	greyred
12	redblue	30	yellowpink	48	yellow	66	brownblue	84	pinkred
13	whitegreen	31	greenblue	49	grey	67	whitered	85	greyblack
14	browngreen	32	yellowblue	50	pink	68	brownred	86	pinkblack
15	whiteyellow	33	greenred	51	blue	69	whiteblack	87	blueblack
16	yellowbrown	34	yellowred	52	red	70	brownblack	88	redblack
17	whitegrey	35	greenblack	53	black	71	greygreen		
18	greybrown	36	yellowblack	54	violet	72	yellowgrey		

PAIRED STRANDING

Pair		Core	Colour	Pair		Core	Colour	Pair	Core	Colour	Pair	Core	Colour
1	45	a b	white brown	12	56	a b	whitered brownred	23	a b	white brown	34	a b	whitered brownred
2	46	a b	green yellow	13	57	a b	whiteblack brownblack	24	a b	green yellow	35	a b	whiteblack brownblack
3	47	a b	grey pink	14	58	a b	greygreen yellowgrey	25	a b	grey pink	36	a b	greygreen yellowgrey
4	48	a b	blue red	15	59	a b	pinkgreen yellowpink	26	a b	blue red	37	a b	pinkgreen yellowpink
5	49	a b	black violet	16	60	a b	greenblue yellowblue	27	a b	black violet	38	a b	pinkgreen yellowblue
6	50	a b	greypink redblue	17	61	a b	greenred yellowred	28	a b	greypink redblue	39	a b	greenred yellowred
7	51	a b	whitegreen browngreen	18	62	a b	greenblack yellowblack	29	a b	whitegreen browngreen	40	a b	greenblack yellowblack
8	52	a b	whiteyellow yellowbrown	19	63	a b	greyblue pinkblue	30	a b	whiteyellow yellowbrown	41	a b	greyblue pinkblue
9	53	a b	whitegrey greybrown	20	64	a b	greyred pinkred	31	a b	whitegrey greybrown	42	a b	greyred pinkred
10	54	a b	whitepink pinkbrown	21	65	a b	greyblack pinkblack	32	a b	whitepink pinkbrown	43	a b	greyblack pinkblack
11	55	a b	whiteblue brownblue	22	66	a b	blueblack redblack	33	a b	whiteblue brownblue	44	a b	blueblack redblack

CORE IDENTIFICATION ACCORDING TO DIN VDE 0293

IDENTIFICATION OF CORES IN MULTICORE CABLES

Number of cores	Cables **with** green-yellow marked core (protection core) **Code "J"**					Cables **without** green-yellow marked core (protection core) **Code "O"**				
	protection core	Active core				Active core				
2	–					blue	brown			
3	green-yellow	blue	brown			-	brown	black	grey	
4	green-yellow	–	brown	black	grey	blue	brown	black	grey	
5	green-yellow	blue	brown	black	grey	blue	brown	black	grey	black

COLOUR CODES

CODE FOR COLOUR IDENTIFICATION

acc. to IEC 757 colour	Code old	Code new	RAL
black	sw	BK	9005
white	ws	WH	9010
blue	bl	BU	5015
red	rt	RD	3000
brown	bn	BN	8003
grey	gr	GY	7001
yellow	ge	YE	1021
green	gn	GN	6018
violet	vio	VT	4005
green-yellow	gnge	GNYE	6018/1021
orange	org	OG	2003
pink	rs	PK	3015
darkblue	dbl		5010
darkbrown	dbn		8014
transparent	tr		-
ultramarine blue	ubl		5002

COLOUR CODE FOR VEHICLE CABLES

No. of cores	Core colours
1	rd
2	wh, bk
3	wh, bk, bn
4	wh, bk, bn, ye
5	wh, bk, bn, ye, gn
6	wh, bk, bn, ye, gn, rd
7	wh, bk, bn, ye, gn, rd, bu
8	wh, bk, bn, ye, gn, rd, bu, vt

COLOUR CODE FOR YR-CABLES

Cores	Core colours
2 x 0,8	bk, bu
3 x 0,8	bk, bu, bn
4 x 0,8	bk, bu, bn, ye
5 x 0,8	bk, bu, bn, ye, gn
6 x 0,8	bk, bu, bn, ye, gn, vt
8 x 0,8	bk, bu, bn, ye, gn, vt, wh, og
10 x 0,8	bk, bu, bn, ye, gn, vt, wh, og, tr, gy
12 x 0,8	bk, bu, bn, ye, gn, vt, wh, og, tr, gy, rd, lbu
14 x 0,8	bk, bu, bn, ye, gn, vt, wh, og, tr, gy, rd, lbu, cog, lgn
16 x 0,8	bk, bu, bn, ye, gn, vt, wh, og, tr, gy, rd, lbu, cog, lgn, lrd, lye

COLOUR CODE FOR YYSCH-CABLES

Cores	Core colours
2 x 0,6	ye, bn
3 x 0,6	ye, gn, bn
4 x 0,6	ye, gn, bn, bk
5 x 0,6	ye, gn, bn, bk, bu
6 x 0,6	ye, gn, bn, gy, pk, wh
10 x 0,6	wh, bk, hbu, bn, gn, ye, gy, pk, bu, rd
16 x 0,6	1st layer: wh, bk, lbu, bn, gn
	2nd layer: ye, lgy, pk, bu, rd, tr, gy, vt, lgn, og, elf
26 x 0,6	core: wh, bk + 2 drain wires
	1st layer: lbu, bn, gn, ye, lgy, pk, bu, rd, tr
	2nd layer: gy, vt, lgn, og, elf, whbu, whye, whgn, whbn, whbk, rdbu, rdye, rdgn, rdbn, rdbk

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STRAND CONSTR. & CONDUCTOR RESISTANCE ACC. TO VDE 0295

CONSTRUCTION OF STRANDED WIRES

Cross-section mm²	1 Stranded wires VDE 0295 Class 2	2 Multi-stranded wires	3 Fine-stranded wires VDE 0295 Class 5	4 Fine-stranded wires VDE 0295 Class 6	5	6	7
0,14				18 x 0,10	18 x 0,10	36 x 0,07	72 x 0,05
0,25			14 x 0,16	32 x 0,10	32 x 0,10	65 x 0,07	128 x 0,05
0,34		7 x 0,25	19 x 0,16	42 x 0,10	42 x 0,10	88 x 0,07	174 x 0,05
0,38		7 x 0,27	12 x 0,21	21 x 0,16	48 x 0,10	100 x 0,07	194 x 0,05
0,5	7 x 0,30	7 x 0,30	16 x 0,21	28 x 0,16	64 x 0,10	131 x 0,07	256 x 0,05
0,75	7 x 0,37	7 x 0,37	24 x 0,21	42 x 0,16	96 x 0,10	195 x 0,07	384 x 0,05
1,0	7 x 0,43	7 x 0,43	32 x 0,21	56 x 0,16	128 x 0,10	260 x 0,07	512 x 0,05
1,5	7 x 0,52	7 x 0,52	30 x 0,26	84 x 0,16	192 x 0,10	392 x 0,07	768 x 0,05
2,5	7 x 0,67	19 x 0,41	50 x 0,26	140 x 0,16	320 x 0,10	651 x 0,07	1290 x 0,05
4	7 x 0,85	19 x 0,52	56 x 0,31	224 x 0,16	512 x 0,10	1040 x 0,07	
6	7 x 1,05	19 x 0,64	84 x 0,31	192 x 0,21	768 x 0,10	1560 x 0,07	
10	7 x 1,35	49 x 0,51	80 x 0,41	320 x 0,21	1280 x 0,10	2600 x 0,07	
16	7 x 1,70	49 x 0,65	128 x 0,41	512 x 0,21	2048 x 0,10		
25	7 x 2,13	84 x 0,62	200 x 0,41	800 x 0,21	3200 x 0,10		
35	7 x 2,52	133 x 0,58	280 x 0,41	1120 x 0,21			
50	19 x 1,83	133 x 0,69	400 x 0,41	705 x 0,31			
70	19 x 2,17	189 x 0,69	356 x 0,51	990 x 0,31			
95	19 x 2,52	259 x 0,69	485 x 0,51	1340 x 0,31			
120	37 x 2,03	336 x 0,67	614 x 0,51	1690 x 0,31			
150	37 x 2,27	392 x 0,69	765 x 0,51	2123 x 0,31			
185	37 x 2,52	494 x 0,69	944 x 0,51	170 x 0,41			
240	61 x 2,24	627 x 0,70	1225 x 0,51	1905 x 0,41			
300	61 x 2,50	790 x 0,70	1530 x 0,51	2385 x 0,41			
400	61 x 2,89		2035 x 0,51				
500	61 x 3,23		1768 x 0,61				

The number of wires in columns 3 to 7 is free from obligation.

The VDE 0295 only lays down the maximum diameter of the single wire and the maximum resistance which is related to the cross-section.

ELECTRIC RESISTANCE OF CONDUCTORS

Cross-section mm²	Tinned wires		Bare wires	
	Class 1/2	Class 5/6	Class 1/2	Class 5/6
0,14		142		138
0,25		82		79
0,34		59		57
0,38		46		44
0,5	36,7	40,1	36	39
0,75	24,8	26,7	24	26
1	18,2	20	18,1	19,5
1,5	12,2	13,7	12,1	13,3
2,5	7,56	8,21	7,41	7,98
4	4,7	5,09	4,61	4,95
6	3,11	3,39	3,08	3,3
10	1,84	1,95	1,83	1,91
16	1,16	1,24	1,15	1,21

Cross-section mm²	Tinned wires		Bare wires	
	Class 1/2	Class 5/6	Class 1/2	Class 5/6
25	0,734	0,795	0,727	0,78
35	0,529	0,565	0,524	0,554
50	0,391	0,393	0,387	0,386
70	0,27	0,277	0,268	0,272
95	0,195	0,21	0,193	0,206
120	0,154	0,164	0,153	0,161
150	0,126	0,132	0,124	0,129
185	0,1	0,108	0,0991	0,106
240	0,0762	0,0817	0,0754	0,0801
300	0,0607	0,0654	0,0601	0,0641
400	0,0475	0,0495	0,047	0,0486
500	0,0369	0,0391	0,0366	0,0384

STRAND CONVERSION AWG

AWG No.	Construction of strands acc. to AWG concentric	Construction of strands acc. to VDE bunched	Solid wire acc. to AWG or VDE mm	Conductor cross-section mm²	Conductor resistance Ω/km	Copper indes
28				0,08	216	0,80
28	**7x0,127**		**0,321**	0,09		0,89
28		10x0,10		0,08		0,79
28		10x0,12		0,11		1,13
VDE			**0,40**	0,13		1,26
26			**0,405**	0,13	130	1,28
26	**7x0,160**			0,14		1,41
26		18x0,10		0,14		1,41
VDE			**0,50**	0,20		1,96
24			**0,511**	0,21	87	2,05
24	**7x0,203**			0,23		2,27
24	**19x0,127**			0,24		2,41
24		11x0,16		0,22		2,21
24		14x0,15		0,25		2,47
23			**0,574**	0,259	66,5	2,30

AWG No.	Construction of strands acc. to AWG concentric	Construction of strands acc. to VDE bunched	Solid wire acc. to AWG or VDE mm	Conductor cross-section mm²	Conductor resistance Ω/km	Copper indes
VDE			**0,60**	0,28		2,83
22			**0,644**	0,33	53	3,25
22	**7x0,254**			0,35		3,55
22	**19x0,160**			0,38		3,82
22		7x0,25		0,34		3,44
20			**0,812**	0,52	33	5,03
20	**7x0,320**			0,56		5,63
20	**19x0,203**			0,61		6,15
20		7x0,32		0,56		5,63
18			**1,024**	0,82	20	8,23
18	**7x0,404**			0,90		8,97
18	**19x0,254**			0,96		9,63
18		19x0,26		1,00		10,09
16			**1,290**	1,31	13	13,07
16	**7x0,510**			1,43		14,30
16	**19x0,320**			1,53		15,28
16		30x0,25		1,47		14,73

Conversion AWG (28-16) into Metric Dim.: In US-American areas of influence and in the computer industry it is customar to define the dimensions of copper wires and strands in AWG(American Wire Gauge). The table shows bunched strands and wires acc. To VDE (regular typeface) in comparison with concentric AWG strands and AWG solid wires (boldface).

CARRYING CAPACITY OF EUROPALLETS • J-Y(ST)Y

	Rings	J-Y(St)Y ... 0.6	J-Y(St)Y ... 0.8
1 x 2	100 m	10000 m	10000 m
	250 m	14000 m	10000 m
2 x 2	100 m	10000 m	6000 m
	250 m	10000 m	7500 m
3 x 2	100 m	5500 m	4000 m
	250 m	7500 m	5000 m
4 x 2	100 m	5500 m	3000 m
	250 m	7500 m	4000 m
5 x 2	100 m	4500 m	3000 m
	250 m	7500 m	4000 m
6 x 2	100 m	4000 m	3000 m
	250 m	5000 m	4000 m
8 x 2	100 m	3000 m	3000 m
	250 m	5000 m	3000 m
10 x 2	100 m	3000 m	3000 m
	250 m	4000 m	2000 m
12 x 2	100 m	3000 m	
	250 m	4000 m	
16 x 2	100 m	3000 m	
	250 m	2500 m	
20 x 2	100 m	2500 m	
	250 m	3000 m	
24 x 2	100 m	2000 m	
	250 m		

	Coils	J-Y(St)Y ... 0.6	J-Y(St)Y ... 0.8
1 x 2	500 m	6000 m	6000 m
	1000 m	12000 m	10000 m
2 x 2	500 m	6000 m	6000 m
	1000 m	12000 m	10000 m
3 x 2	500 m	6000 m	6000 m
	1000 m	10000 m	4000 m
4 x 2	500 m	12000 m	5000 m
	1000 m	10000 m	4000 m
5 x 2	500 m	12000 m	5000 m
	1000 m	10000 m	2000 m
6 x 2	500 m	12000 m	5000 m
	1000 m	4000 m	
8 x 2	500 m	5000 m	2000 m
	1000 m	4000 m	
10 x 2	500 m	5000 m	1000 m
	1000 m	4000 m	

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CARRYING CAPACITY OF EUROPALLETS • NYM

dimension	Rings 50 m	Rings 100 m	one-way drums
1 x 1,5	5000	10000	6000
1 x 2,5	5000	10000	6000
1 x 4	5000	7200	6000
1 x 6	5000	4800	6000
1 x 10	5000	4800	6000
1 x 16	3600	4200	3000
2 x 1,5	5000	4800	6000
2 x 2,5	3600	4200	5000
2 x 4	2100	3000	
2 x 10	1000	3000	
2 x 16	750	1000	
3 x 1,5	6000	6000	6000
3 x 2,5	4800	4800	3000
3 x 4	1500	2000	2000
3 x 6	1500	1500	1000
3 x 10	1000	1000	1000
3 x 16	500	1000	500

dimension	Rings 50 m	Rings 100 m	one-way drums
4 x 1,5	4800	4800	4000
4 x 2,5	3600	3600	3000
4 x 4	1500	2000	1000
4 x 6	1500	1500	1000
4 x 10	750	1000	1000
4 x 16	500	1000	500
4 x 25	500		500
4 x 35	500		500
5 x 1,5	4800	4800	3000
5 x 2,5	3000	3000	2000
5 x 4	1250	1000	1000
5 x 6	1000	1000	1000
5 x 10	500	1000	500
5 x 16	500	1000	500
5 x 25	500		500
7 x 1,5	2100	3600	3000
10 x 1,5	2100	3000	2000
12 x 1,5	1500	2000	1000

CARRYING CAPACITY OF EUROPALLETS • DATA CABLE

type	packing	Simplex		Duplex		size
		packing size	pcs/ pallet	packing size	pcs/ pallet	
UTP 5e	box	14 inch	36	na	na	80 x 120
	500 m	EW 40	12	EW 50	10	80 x 120
	1000 m	EW 50	10	EW 60	4	80 x 120
FTP 5e	box	16 inch	18	na	na	100 x 120
	500 m	EW 40	12	EW 60	4	80 x 120
	1000 m	EW 50	10	EW 76	2	80 x 120
UTP Cat 6	box	16 inch	18	na	na	80 x 120
	500 m	EW 50	10	EW 60	4	80 x 120
	1000 m	EW 60	4	EW 76	2	80 x 120
FTP Cat 6	box	20 inch	12	na	na	80 x 120
	500 m	EW 50	10	EW 60	4	80 x 120
	1000 m	EW 60	4	NG 9		80 x 120
U/STP Cat 6	500 m	EW 50	10	EW 60	4	80 x 120
	1000 m	EW 60	4	NG 9		80 x 120
S/STP Cat 6	500 m	EW 50	10	EW 60	4	80 x 120
	1000 m	EW 60	4	NG 9		80 x 120
SLAN 600	500 m	EW 50	10	EW 60	4	80 x 120
	1000 m	EW 60	4	NG 9		80 x 120
xLAN 1000	500 m	EW 50	10	EW 60		80 x 120
	1000 m	EW 60	4	NG 9		80 x 120
xLAN 1200	500 m	EW 50	10	EW 76	2	80 x 120
	1000 m	EW 76	2	NG 9		80 x 120

VOKA LAN – STRUCTURED CABLING OF BUILDINGS

WHY STRUCTURED CABLING?

The fast development of modern business-oriented data processing creates increasingly higher requirements on information-technical interconnection of building complexes, and today cabling becomes an equally important component of infrastructure as e.g. electricity and water supply, telephone or heating.

Structured and service-neutral cabling gains more and more importance for meeting the requirements of progressive information and communication service connection. As a consequence different organisations and committees have been dealing with standardisation of application-independent networks for many years. Results of this are the today known standards such as EN 50173-1 or ISO/IEC 11801 2nd ed., which describe a universally usable cabling system.

This provides the user with the key advantage of adapting applications to the needs and not to existing infrastructure. As a result a future-oriented and future-proof application is warranted.

STRUCTURE OF MODERN BUILDING CABLING

The structured cabling of buildings consists of three areas:

Primary area (Campus Backbone)
It includes the inter-building connection from the site distributor **(1)** to the individual building distributors **(2)** using fibre-optic cables.

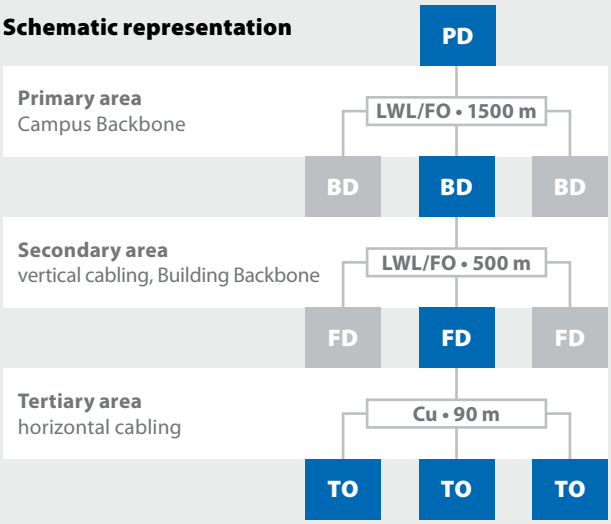
Secondary area
(vertical cabling, Building Backbone)
It includes the connection from the building distributors **(2)** to the storey distribution boards **(3)** using balanced copper cables or fibre-optic cables.

Tertiary area (horizontal cabling)
It includes the area-covering connection from the storey distribution board **(3)** to the workplace sockets **(4)** using balanced copper cables.

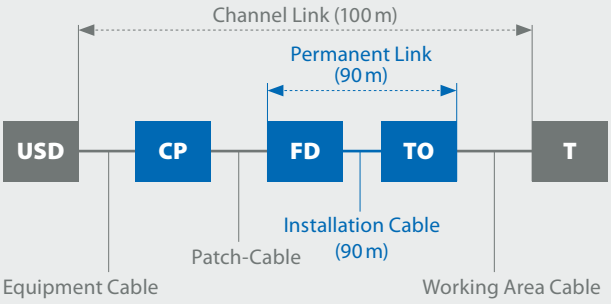
PD plant main distributor
BD building distributor
FD floor distributor
TO technical outlet (wall outlet)

The connection for data transmission from the storey distribution board up to the main site distributor is mainly established using fibre-optic cables. Contrary to this, the phone connection to the site distributor is established using copper technology.

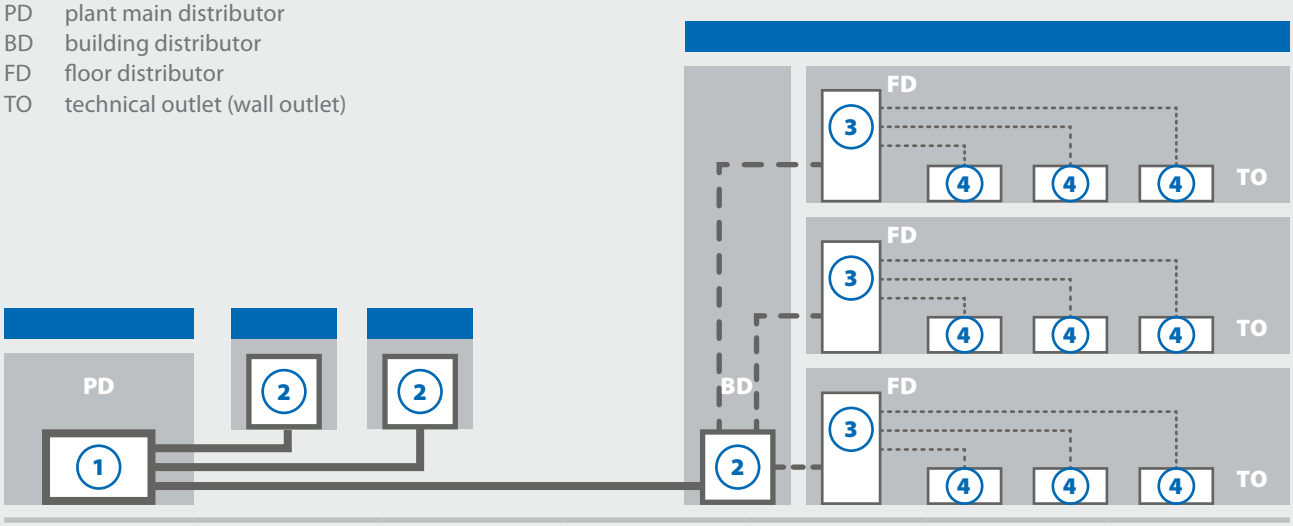
Schematic representation



Channel and permanent link



USD user specific device
CP connection point
TO technical outlet
T terminal



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VOKA LAN - CLASSIFICATION AND APPLICABLE STANDARDS

REQUIREMENTS ON THE TELECOMMUNICATION CABLE

Accordinhg to the international standard ISO/ IEC 11801 the requirements of cables are divided into three categories: , 4 and 5. In the 2nd edition of ISO/ IEC 11801 additional categories are specified: Category 6 for bandwidhts up to 250 MHz and Category 7 for bandwidths up to 600 MHz.

Classification and requirements

For data cables in the tertiary and secondary area.

Attenuation (db / 100m)

Frequency (MHz)		1	4	8	10	16	20	31,25	62,5	100	200	250	300	600	1000
Cat 3	ISO/IEC 11801	2,6	5,6	8,5	9,8	13,1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cat 3/120 Ω	ISO/IEC 11801	f.f.s.	f.f.s.	f.f.s.	f.f.s.	f.f.s.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cat 5	EN 50288	2,0	4,1	5,8	6,5	8,2	9,3	11,7	17,0	22,0	N/A	N/A	N/A	N/A	N/A
Cat 5e	EN 50288	2,1	4,0	–	6,3	8,0	9,0	11,4	16,5	21,3	N/A	N/A	N/A	N/A	N/A
Cat 5/120 Ω	ISO/IEC 11801	1,8	3,6	–	5,2	6,2	7,0	8,8	12,5	17,0	N/A	N/A	N/A	N/A	N/A
Cat 5/150 Ω	ISO/IEC 11801	f.f.s.	2,2	–	3,6	4,4	4,9	6,9	9,8	12,3	N/A	N/A	N/A	N/A	N/A
Cat 6A	EN50288	2,1	3,8	–	5,9	7,5	8,4	10,5	15,0	19,1	27,6	31,1	34,3	N/A	N/A
Cat 6	EN50288	2,1	3,8	–	6,0	7,6	8,5	10,7	15,5	19,9	29,1	33,0	N/A	N/A	N/A
Cat 7A	EN50288	2,1	37	–	5,8	7,3	8,2	10,3	14,6	18,5	26,5	29,7	32,7	47,1	61,9
Cat 7	EN50288	2,0	3,7	–	5,9	7,4	8,3	10,4	14,9	19,0	27,5	31,0	34,2	50,1	N/A

NEXT (db)

Frequency (MHz)		1	4	8	10	16	20	31,25	62,5	100	200	250	300	600	1000
Cat 3	ISO/IEC 11801	41	32	27	26	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cat 4	ISO/IEC 11801	56	47	42	41	38	36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cat 5	ISO/IEC 11801	62	53	48	47	44	42	40	35	32	N/A	N/A	N/A	N/A	N/A
Cat 5/120 Ω	ISO/IEC 11801	f.f.s.	58	–	53	50	49	46	41	38	N/A	N/A	N/A	N/A	N/A
Cat 5/150 Ω	ISO/IEC 11801	f.f.s.	58	–	53	50	49	46	41	38	N/A	N/A	N/A	N/A	N/A
Cat 5e	EN 50288	62,3	53,3	51,8	47,3	44,3	42,8	39,9	35,4	32,3	N/A	N/A	N/A	N/A	N/A
Cat 6A	EN 50288	75,3	66,3	–	60,3	57,2	55,8	52,9	48,4	45,3	40,8	39,3	38,1	N/A	N/A
Cat 6	EN 50288	75,3	66,3	–	60,3	57,2	55,8	52,9	48,4	45,3	40,8	39 ,3	N/A	N/A	N/A
Cat 7A	EN 50288	78,0	78,0	–	78,0	78,0	78,0	78,0	78,0	75,4	70,9	69,4	68,2	63,7	N/A
Cat 7	EN 50288	78,0	78,0	–	78,0	78,0	78,0	78,0	75,5	72,4	67,9	66,4	65,2	60,7	N/A

INSTALLATION CABLES AND CONNECTORS - OVERVIEW AND CLASS II

ISO / IEC downwards compatibility of improved Cat 7A- connectors in combination with Cat 8- Installtion cables. (S/FTP, shielded)

		Connectors					
		Cat 5	Cat 6	Cat 6A	Cat 7	Cat 7A	improved Cat 7A
Installation Cables	Cat 5	Class D	Class D	Class D	Class D	Class D	Class D
	Cat 6	Class D	Class E	Class E	Class E	Class E	Class E
	Cat 6A	Class D	Class E	Class EA	Class EA	Class EA	Class EA
	Cat 7	Class D	Class E	Class EA	Class F	Class F	Class F
	Cat 7A	Class D	Class E	Class EA	Class F	Class FA	Class FA
	Cat 8	Class D	Class E	Class EA	Class F	Class FA	Class II

VOKA LAN – CLASSIFICATION AND APPLICABLE STANDARDS

STANDARDS FOR THE DIGITAL TELECOMMUNICATION

	ISO/IEC-Standards International guidelines, in Europe only informative (ISO is a worldwide standardized committee)	
ISO/IEC 11801	2nd edition: Information technology, generic cabling for customer premises cabling	
IEC 61156-1	**Multicore and symmetrical pair/quad cables for digital communications** Generic specification	
IEC 61156-**2**	Horizontal floor wiring	Sectional specification
IEC 61156-**2-1**		Blank detail specification
IEC 61156-**2-2**		Capability approval - Sectional specification
IEC 61156-**3**	Work area wiring	Sectional specification
IEC 61156-**3-1**		Blank detail specification
IEC 61156-**3-2**		Capability approval - Sectional specification
IEC 61156-**4**	Riser cable	Sectional specification
IEC 61156-**4-1**		Blank detail specification
IEC 61156-**4-2**		Capability approval - Sectional specification
	Symmetrical pair/quad cables for digital communications with transmission characteristics up to 600 MHz	
IEC 61156-**5**	Horizontal floor wiring	Sectional specification
IEC 61156-**5-1**		Blank detail specification
IEC 61156-**5-2**		Capability approval - Sectional specification
IEC 61156-**6**	Work area wiring	Sectional specification
IEC 61156-**6-1**		Blank detail specification
IEC 61156-**6-2**		Capability approval - Sectional specification
IEC TS 61873	State of art for symmetrical pair/ quad cables with transmission characteristics beyond category 5	

	CENELEC-Standards European guidelines
EN 50173-1	Information technology - Generic cabling systems (similar to ISO/IEC 11801)
HD 608	**Symmetric pair/quad and multicore cables for digital communications** Generic specification
EN 50167	Sectional specifications for screened floor cables
EN 50168	Sectional specifications forscreened work area and patch cord cables
EN 50169	Sectional specifications forhorizontal and building backbone cables
EN 50288-1	**Multi-element metallic cables used in analogue communication and control** Generic specification
EN 50288-**2-1**	Sectional specification for screened Horizontal and building backbone cables up to 100MHz
EN 50288-**2-2**	Sectional specification for screened work area and patch cord cables up to 100MHz
EN 50288-**3-1**	Sectional specification for unscreened Horizontal and building backbone cables up to 100MHz
EN 50288-**3-2**	Sectional specification for unscreened work area and patch cord cables up to 100MHz
EN 50288-**4-1**	Sectional specification for screened Horizontal and building backbone cables up to 600MHz
EN 50288-**4-2**	Sectional specification for screened work area and patch cord cables up to 600MHz
EN 50288-**5-1**	Sectional specification for screened Horizontal and building backbone cables up to 250MHz
EN 50288-**5-2**	Sectional specification for screened work area and patch cord cables up to 250 MHz
EN 50288-**6-1**	Sectional specification for unscreened Horizontal and building backbone cables up to 250MHz
EN 50288-**6-2**	Sectional specification for unscreened work area and patch cord cables up to 250 MHz
EN 50288-**9-1**	Sectional specification for screened Horizontal and building backbone cables up to 1000 MHz
EN 50288-**10**	Sectional specification for screened Horizontal and building backbone cables up to 500 MHz
EN 50288-**11**	Sectional specification for unscreened Horizontal and building backbone cables up to 500 MHz
EN 55022	Limits and methods of measurement of radio disturbance characteristics of information technology equipment.

	US-Standards
TIA/EIA-568.C	Commercial Building; Telecommunication cabling standard
TSB-36	Technical systems bulletin. Additional cable specification for unshielded twisted pair cables
TSB-67	Transmission performance specifications for field testing of unshielded twisted pair cabling systems

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VOKA LAN – PLANNING AND INSTALLATION ADVICES

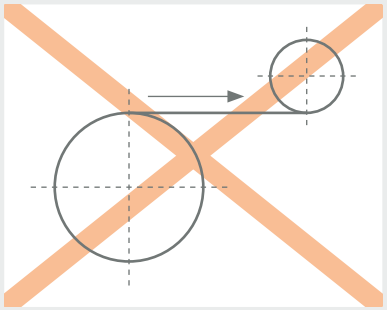
PLANNING ADVICES

- Fibre-optic cables (FOC) are recommended for establishing the PRIMARY area, whereby the site distributor is usually star-connected to the individual building distributors
- The SECONDARY area can be established using both fibre-optic and copper cables (FOC is recommended), and the structure can be star- or ring-connected.
- The TERTIARY area is designed as star connection consisting of copper cables. 4 pairs covered with a foil screen and having a conductor diameter of 0.51 mm are the minimum recommendation.
- In order to cover future applications and requirements as well, cables with individual pair screening and an overall braid screen should be preferred. (higher near-end-crosstalk attenuation and better EMC behaviour)
- Halogen-free cables are recommended for buildings with a high concentration of material goods or persons.
- When selecting the cable type, the system reserves should be designed for an application period of 10-15 years.
- It is also important that all contained components are either screened or unscreened. Existing standards are for facilitation and safety and should be observed.
- In the TERTIARY area sufficiently dimensioned cable runs are to be planned due to the high cable density in this section.

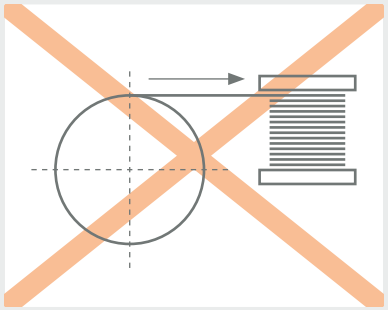
INSTALLATION ADVICES

- In the tertiary area a maximum cable length of 90 m between the storey distribution boards and the workplace sockets should be observed.
- Attention should also be paid to the grounding balance. The grounding potential difference between any grounding points may not exceed 1 V.
- It is to consider that in combined cable runs energy and telecommunication cables are to be separated by a metallic middle web.
- The cables should be used in closed and dry rooms, and the cable runs should be protected against aggressive chemicals and rodents.
- At storey breakthroughs a subsequent fire barrier is necessary to protect the riser.

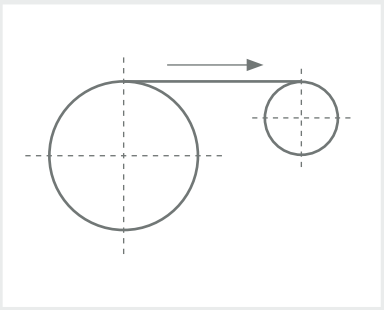
INSTALLATION GUIDELINES



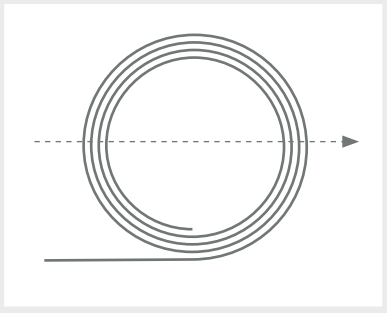
Do not unwind cables from the drum against their original running direction.



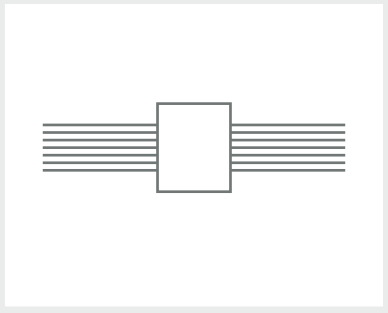
Deflecting the cables is also impermissible.



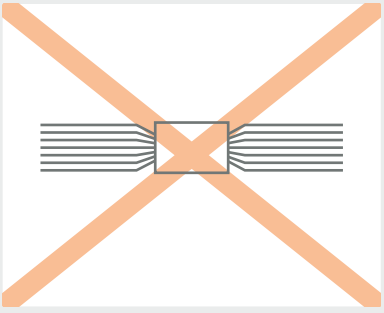
The drum should always be laid horizontally, perhaps on a balancing stand, to avoid mechanical loads.



Cable coils should always be placed in a vertical position and unrolled on the floor to avoid a deflecting effect.
If there is not enough space for unwinding the required length, a sufficient bending must be observed when feeding back the cable.



A cable bunch should always lie stretched to avoid potential jammings during installation. If e.g. several cables are layed parallel in cable trays, it is recommended to bunch them using a cable tie or insulating tape.



Crushing the individual cables is to avoid when assembling them into bunches.

VOKA LAN – PLANNING AND INSTALLATION ADVICES

TENSILE LOAD DURING AND AFTER INSTALLATION

Data cables should be subjected to the lowest possible mechanical loads. In relevant standards 5 daN/qmm² Cu conductor are indicated as maximum permissible traction. Depending on the number of pairs and the overall screen construction, the maximum tensile load values are as follows:

Coductor dimension	Ø NW (mm)	without braid		with braid	
		2 Pairs	4 Pairs	2 Pairs	4 Pairs
AWG 26/7	7x0,16	30 N	60 N	70 N	100 N
AWG 24	0,51	50 N	90 N	90 N	150 N
AWG 23	0,57	-	-	130 N	190 N
Ø 0,6	0,6	70 N	120 N	160 N	240 N
AWG 22	0,64	80 N	150 N	170 N	250 N

Attention should be paid to the fact that cables should not be pulled too strong when bending them around sharp corners or edges. A too strong mechanical load can affect the transmission characteristics.

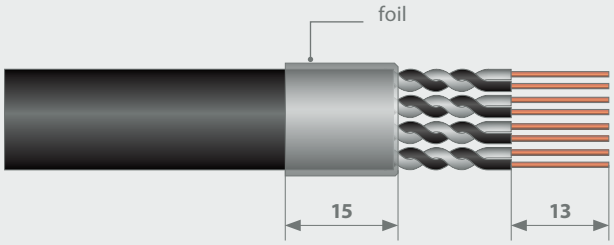
The minimum bending radius may not deceed the octuple cable diameter. Under installed conditions.

The radius can be reduced to the quadruple cable diameter. In both development and production of **VOKA-LAN** cables care is taken to achieve the most solid and compact cable construction so that substantial losses of transmission parameters do not occur, even if these installation guidelines cannot be observed due to local conditions.

VOKA LAN – INSTRUCTIONS FOR CONNECTION

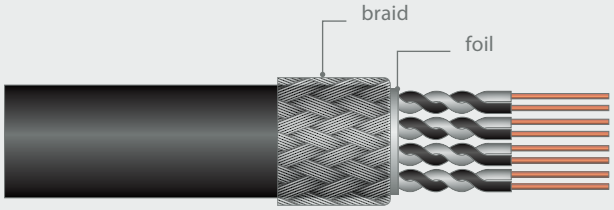
SCREENED CABLES (FOIL)

The cable ends are to be stripped approx. 10 cm. Then the individual pairs can be straightened corresponding to the pin connection and cut to the required length. The dismantled cable length should be as short as possible to maintain the original twisting. For cable types with aluminium-clad plastic foil care should be taken that the coloured (usually the outer) side is non-conducting. The foil is to be folded back approx. 15 mm over the sheath (so that the conducting side is outside) and fixed with the drain wire. According to EN 50173 maximum untwisting of the pairs may be 13 mm for contacting.



SCREENED CABLES (FOIL + BRAID)

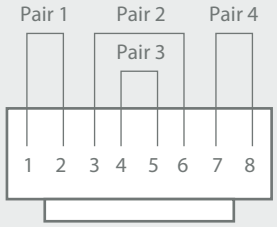
The screen should always be applied as largely as possible. A possibly present drain wire is only to be used for fixing and not for exclusive contacting. The braid is the only component to be folded back, the foil is not required for screen continuity and can be cut off.



PIN CONNECTION

The combination of pins and pairs is described in the applicable standards as follows:

See installation guidelines of the respective component manufacturer for corresponding pair application to the connection system.



Norm	Pair 1	Pair 2	Pair 3	Pair 4
ISO/IEC 11801 EN 50173	Pair numbers and colours are not defined			
EIA/TIA-568-B.2 (T568A) EIA/TIA-568-B.2 (T568B)	whbu-bu	whor-or	whgn-gn	whbn-bn

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VOKA LAN – FIRE BEHAVIOUR, FIRE PROPAGATION AND CALORIFIC POTENTIAL

The European standards EN 50167, EN 50168 and EN 50169 require not only screens but also halogen-free outer sheaths for data cables. Consideration and adherence to these standards is particularly recommended for public facilities like hospitals, schools and airports. Moreover, the use of halogen-free cables is reasonable for buildings with a high concentration of persons or material goods.

Cables with PVC sheath
PVC standard materials can propagate flames under fire conditions, and in combination with moisture (e.g. extinguishing water) they can generate hydrochloric acid (HCl) by splitting off hydrogen chloride gas. In addition, burning PVC (polyvinyl chloride) causes strong smoke development, and corrosive damages to buildings and equipment can often reach a degree far more severe than the actual fire damages.

All **VOKA-LAN and X-LAN-data cables** are manufactured in compliance with fire propagation behaviour according to IEC 60332-1, manufacturing in accordance with the stricter IEC 60332-3 is possible on demand.

Cables with halogen-free sheath
For these cables materials are used, which do not contain halogens (e.g. chlorine) and do not release corrosive gases under fire conditions. The content of toxic gases is also reduced to a minimum, and smoke development and flame propagation are barely present or possible. Designation notes on the cable are e.g. the abbreviations FRNC or LSOH.

In detail these designations have the following meaning:

FR flame-retardant (inhibiting flame propagation)
NC non-corrosive (no corrosive constitutents)
LS low-smoke (low smoke development)
OH zero-halogen (halogen-free)

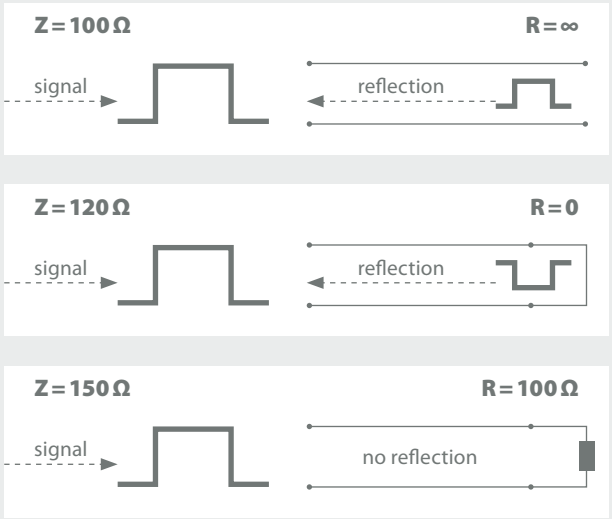
Using these materials is safety-relevant because free vision in corridors and escape routes is maintained. This, however, requires the use of such materials for other products as well, e.g. for energy cables or cable routing ducts.

All our data cables can be supplied with these halogen-free and flame-retardant sheath materials upon request. Additional costs for these versions are inevitable, but they are very low and therefore virtually non-existant if utmost importance is ascribed to safety.

Calorific potential (kWh/m), (MJ/m)
There are many different combustible installations or products in every building. Some of them are cables and wires, which, although perhaps concealed in intermediate ceilings or ducts, can represent a substantial component, especially in adminstration buildings. These cables have most different energy (calorific) values and can increase the total calorific potential of a building significantly. This fact should already be considered at the planning stage in order to minimise the fire load amounts.

VOKA LAN – KEY CABLE PARAMETERS

Characteristic impedance – Z (Ω)
Characteristic impedance describes the terminal resistance of the cable without any line reflections, i.e. the total electrical power fed into a cable by a signal source is transmitted to the output impedance, only reduced by the cable attenuation. The main function of a data cable is to transfer electrical pulse groups. The higher the data bitrate is required, the higher the frequency bandwidth of the transmission channel (e.g. cable) is to be selected. The output and input impedance values of devices connected to the cable are to be the same as of the cable itself (= adapted). Otherwise transmission can be incorrect due to impulse distortions. The characteristic impedance of balanced cables for telecommunications is standardised according to EN 50173-1 bzw. ISO/IEC 11801:



Attenuation – α (dB)
The cable attenuation reduces the incoming signal amplitude at the output and thereby, among other things, limits the applicable free cable length. Ohmic loss resistances in longitudianal direction are generated depending on the conductor material and cross-sectional area. Additionally the skin effect (current displacement) reduces the effective conductor cross-section depending on the frequency increase. The frequency-dependence of the selected core insulation material causes additional capacitive loss resistances between conductors. The cable attenuation, which is usually indicated for a reference length of 100 m, defines the transmission ratio between send and receive level.

Near-End Crosstalk Attenuation – NEXT (dB)
Crosstalk describes the unintended crossing of signal energy into an adjacent circuit. In this case the electromagnetic field generated by the useful signal of a pair of cores creates a spurious signal in an adjacent pair at the same cable end (NEAR END). The near-end crosstalk attenuation (NEXT) results from the performance ratio "power input at the disturbing pair" to „power output at the disturbed pair" at the same cable end.

FAR-End Crosstalk Attenuation – FEXT (dB)
The electromagnetic field of the useful signal at the input of a pair of cores creates a spurious signal on the output side (FAR END) of an adjacent pair. The far-end crosstalk attenuation (FEXT) results from the performance ratio „power input at the disturbing pair" to „power output at the disturbed pair" at the.

ELFEXT (dB)
ELFEXT (Equal-Level Far-End Crosstalk) describes the difference between FEXT and attenuation and could also be designated as Far-End ACR. ELFEXT is a calculated value defining the ratio between crosstalk interference level and receive level.

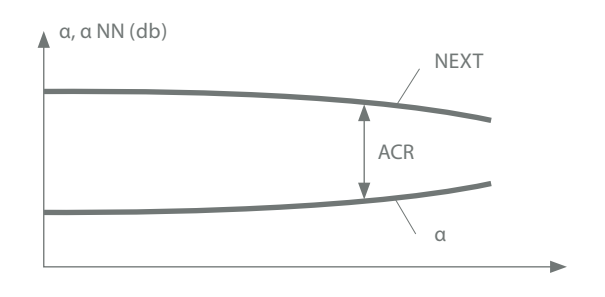
$$ELFEXT_{(f)} = FEXT_{(f)} - \alpha_{(f)}$$

Power Sum NEXT – PSNEXT (dB)
Power sum NEXT is the total near-end crosstalk power sum, i.e. the amount of all spurious signals coupled into a pair of conductors. For twin cables PSNEXT is equal to NEXT. For cables with more than two pairs the difference increases continuously due to the fact that the spurious signals of all adjacent pairs of cores are coupled into one pair of conductors.

Attenuation to Crosstalk Ratio – ACR (dB)
ACR is a characteristic variable for basic transmission quality rating of a cable. It describes the ratio between the strength of the incoming useful signal and the disturbing noise signal of an adjacent pair of cores.

$$ACR_{(f)} = NEXT_{(f)} - \alpha_{(f)}$$

It is important that the useful signal is always stronger than the noise signal, which is indicated by a positive ACR value. At the highest transmission frequency the recommended ACR value of a LINK should be ≥ 4 dB.



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VOKA LAN – KEY CABLE PARAMETERS

Return Loss – RL (dB)
If different characteristic impedance values or inhomogeneities occur within a cable system (e.g. between the cable and a component), the fed signal energy at this disturbing point is partially reflected (=backscatter). Return loss is the ratio between fed and backscattered energy and reflects the homogeneity of a cable or a transmission path.These reflections should be minimised in order to ensure faultless transmission.

Delay Skew (ns)
Delay Skew describes the difference between signal transit times in the indidviual pairs of a cable (caused by different twisting lengths of the pair). This value - it should be as low as possible - is important for multistage transfer methods because the transit time difference is to be balanced by the receiver.

Nominal Velocity of Propagation – NVP (%)
This value indicates the propagation speed of the electrical signal in the cable. Expressed in %, this value is related to light speed in vacuum. The NVP value is also required for length determination of installed cables.

$$\text{NVP} = \frac{\text{expansion speed of the signal}}{\text{speed of liht in vacuum}} \times 100\,\%$$

NVP = 77 % expresses a transit time of approx. 0,33/NVP = 4,2 ns/m

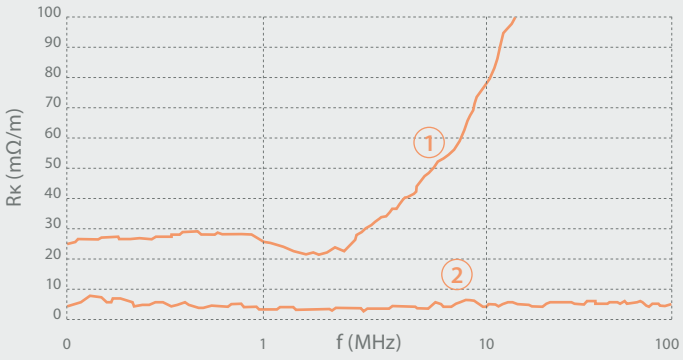
Transfer impedance – Rк (Ω/m)
Electromagnetic compatibility (EMC) gains more and more significance along with increasing transmission frequencies in data cables. In order to protect cables against unwanted noise influence and surrounding electrical equipment against interfering transmissions of cables respectively, for today's data cables more and more attention is paid to a sufficient field screen.

Each current-carrying conductor creates an electromagnetic field. The magnetic field of a pair of cores is to a large extent compensated by twisting the cores, while the electric field is compensated by applying a foil and/or braid screen. The transfer impedance (coupling resistance) is frequency-dependent and increases linearly with the cable length. It is indicated in mΩ/m; the value should be as low as possible. The lower the transfer impedance, the more efficient is the screening effect and thus contributes substantially to the EMC value optimisation of an overall system.

The selection and quality of the earthing point, which should be as low-ohmic as possible for the entire frequency range, is also important for the screening effect.

Using a double screen (foil and overall screen) results in better screening effects especially in the higher frequency range.

The transfer impedance can describe the effectiveness of the cable screen: the lower its value the better the screening effect.



1 Aluminium foil screen
2 Aluminium foil screen and copper braid

BASIC MATERIAL PROPERTIES

material	code	VDE	temperature range (°C)	tensile strength (N/mm^2)	elongation (%)	density (g/cm^3)	volume resistance ($\Omega x cm$)
Polyvinylchloride	PVC	Y	-30 … +70	10 … 25	150 … 300	1,2 … 1,5	10^{12} … 10^{15}
Polyvinylchloride, heat resistant	PVC	Y	-20 … +90	10 … 25	150 … 300	1,3 … 1,4	12^{12} … 10^{15}
Polyvinylchloride, cold resistant	PVC	Y	-40 … +70	10 … 25	150 … 300	1,4 … 1,5	10^{12} … 10^{15}
Polyvinylchloride, flame resistant	PVC	Y	-30 … +70	10 … 25	150 … 250	1,3 … 1,6	10^{12} … 10^{15}
High pressure polyethylene	HDPE	2Y	-50 … +70	20 … 30	500	0,95 … 0,98	10^{17}
Low pressure polyethylene	LDPE	2Y	-50 … +100	30	800	0,918 … 0,935	10^{17}
Polyamide	PA	4Y	-40 … +80	50 … 180	200 … 300	1,10 … 1,15	10^{14}
Polybutylen terephtalate	PBTP	-	-60 … +110	50 … 100	50 … 300	1,3	10^{16}
Polytetrafourethylene	PTFE	5Y	-190 … +260	14 … 40	240 … 400	2,0 … 2,3	10^{18}
Tetraflourethylene-hexaflour-propylene copolymer	FEP	6Y	-100 … +200	20 … 25	250 … 350	2,0 … 2,3	10^{18}
Ethylen-tetraflourethylen	ETFE	7Y	-100 … +150	40 … 50	100 … 300	1,6 … 1,8	10^{16}
Polypropylene	PP	9Y	-50 … 90	30 … 50	300	0,91	10^{17}
Polyurethane	PUR	11Y	-40 … +100	30 … 45	300 … 600	1,15 … 1,20	10^{12}
Thermoplastic polyolefin elastomer	TPE	12Y	-70 … +125	3 … 25	280 … 650	0,9 … 1,2	10^{12}
Silicone rubber	SI	2G	-60 … +180	5 … 10	200 … 350	1,2 … 1,3	10^{15}
Ethylene propylen ruber	EPM/EPDM	3G	-30 … +125	5 … 20	200 … 450	1,3 … 1,6	10^{14}
Ethylen vinyl acetate	EVA	4G	-30 … +125	5	200	1,3 … 1,5	10^{13}
Chloropren-rubber	CR	5G	-40 … +100	25	450	1,4 … 1,7	10^{13}
Flame retardant Polyethylene	FRPE	H	-30 … +70	5 … 10	100 … 150	1,4 … 1,6	10^{13}

material	code	Shore-Hardness A.D	resistance to weathering (t)	fuel resistance	oil resistance	flammability
Polyvinylchloride	PVC	70 … 95	moderate	moderate	good	self-extinguishing
Polyvinylchloride, heat resistant	PVC	70 … 95	moderate	moderate	good	self-extinguishing
Polyvinylchloride, cold resistant	PVC	70 … 95	moderate	moderate	good	self-extinguishing
Polyvinylchloride, flame resistant	PVC	80 … 90	moderate	moderate	good	not flammable
High pressure polyethylene	HDPE	60 … 62	good	poor	moderate	flammable
Low pressure polyethylene	LDPE	43 … 50	moderate	poor	moderate	flammable
Polyamide	PA	60 … 70	good	moderate	good	flammable
Polybutylen terephtalate	PBTP	80 (D)	good	good	good	flammable
Polytetrafourethylene	PTFE	55 … 65	very good	very good	very good	not flammable
Tetraflourethylene-hexaflour-propylene copolymer	FEP	55 … 60	very good	very good	very good	not flammable
Ethylen-tetraflourethylen	ETFE	70 … 75	very good	very good	very good	not flammable
Polypropylene	PP	55 … 60	moderate	moderate	moderate	flammable
Polyurethane	PUR	80 … 100	very good	good	good	self-extinguishing
Thermoplastic polyolefin elastomer	TPE	50 … 90	very good	good	very good	flammable
Silicone rubber	SI	40 … 80	very good	poor	moderate	high ignition temperature
Ethylene propylen ruber	EPM/EPDM	65 … 85	good	poor	poor	flammable
Ethylen vinyl acetate	EVA	70 … 80	good	poor	poor	flammable
Chloropren-rubber	CR	55 … 70	very good	poor	good	self-extinguishing
Flame retardant Polyethylene	FRPE	45 … 50	good	moderate	moderate	self-extinguishing

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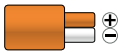
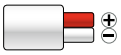
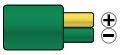
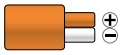
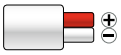
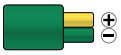
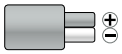
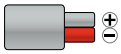
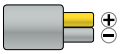
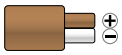
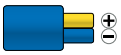
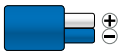
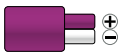
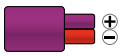
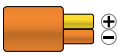
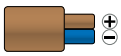
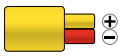
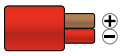
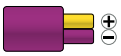
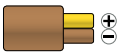
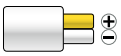
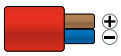
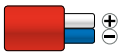
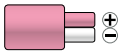
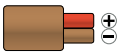
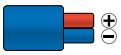
INTERNATIONAL IDENTIFICATION COLOURS FOR TEMPERATURE MEASUREMENT TECHNOLOGY

THERMOCOUPLES

Type	Pole	Material	EU DIN 43722	GER DIN 43714	USA ANSI MC 96.1	FR NF C42-324	GB BS 4937 / 1843
R	+	Platinum- 13% Rhodium					
	−	Platinum					
S	+	Platinum- 10% Rhodium					
	−	Platinum					
B	+	Platinum- 30% Rhodium					
	−	Platinum- 6% Rhodium					
J	+	Iron					
	−	Copper-Nickel					
T	+	Copper					
	−	Copper-Nickel					
E	+	Nickel-Chrome					
	−	Copper-Nickel					
K	+	Nickel-Chrome			 	  	 
	−	Nickel					
N	+	Nickel-Chrome-Silicon					
	−	Nickel-Silicon					
U	+	Copper					
	−	Copper-Nickel					
L	+	Iron					
	−	Copper-Nickel					

Source: Reckmann GmbH Mess + Regeltechnik

CODES

Cable type	
TE	thermocouple
THL	thermoline

Construction	
Li	strand
ed	solid conductor

Core insulation	
2G	silicone insulation
5Y	PTFE foil
8Y	polyimide foil
Gf	mica foil
Gu	E-glass lapped (use of glass fibre yarn with temperature range up to 350°C)
Gl	E-glass braided
R	R-glass (use of special glass fibre yarn with temperature range up to 750°C)
RGu	R-glass lapped
RGl	R-glass braided
U	eco-friendly impregnation
B	cores coloured or with (coloured) tracer thread (only for multi-wired cables and stranded cores)
J	protective earth wire

core stranding (only at thermocouples and thermolines)	
ov	oval stranding
vs	stranded

Outer braid	
S	steel wire braid
VA	stainless steel braid

(Coloured) tracer thread	
Kf	(coloured) tracer thread
X	second (coloured) tracer thread crossed to first (coloured) tracer thread

PRODUCT DESCRIPTION FOR SINGLE-CORE CONNECTION CABLES

Li Gl U 0,75²Ni Kf-rt

- Strand
- E-glass braided
- Eco-friendly impregnation
- Conductor: cross-section in mm²/material
- Tracer thread/colour

Li RGl U 0,75²Ni Kf-rt

- Strand
- R-glass braided
- Eco-friendly impregnation
- Conductor: cross-section in mm²/material
- Tracer thread/colour

Li 2G Gl U 0,75²Ni Kf-rt

- Strand
- Silicone insulation
- E-glass braided
- Eco-friendly impregnation
- Conductor: cross-section in mm²/material
- Tracer thread/colour

*without (coloured) tracer thread = complete colouring: only colour (to be indicated)

Construction of strand	
0,22²	7 x 0,20 mm²
0,35²	11 x 0,20 mm²
0,50²	16 x 0,20 mm²
0,75²	24 x 0,20 mm²
1,00²	32 x 0,20 mm²
1,00²	7 x 0,44 mm²
1,50²	30 x 0,25 mm²
1,50²	48 x 0,20 mm²
2,00²	40 x 0,25 mm²
2,50²	49 x 0,25 mm²
2,50²	84 x 0,20 mm²
4,00²	84 x 0,25 mm²
6,00²	126 x 0,25 mm²
10,00²	203 x 0,25 mm²

Colours	
nt	natural-coloured (ecru)
ws	white
sw	black
bl	blue
rt	red
bn	brown
gr	grey
ge	yellow
gn	green
or	orange
rs	pink
gg	green/yellow

Conductor material	
Cu	copper
Cu-vn	optical nickel-plated copper
Cu-vn-pf	non-porous nickel-plated copper
Cu-vs	silver-coated copper
Cu-vz	tinned copper
Ni	nickel

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CODES

PRODUCT DESCRIPTION FOR MULTI-CORE CONNECTION CABLES

One conductor material

Li Gl U S J B 3x0,75²Ni Kf-rt

Strand*/E-glass braided

Eco-friendly impregnation/
steel wire braid/protective earth wire/coloured core

Conductor material
Number of conductors/cross-section in mm²/material

Tracer thread/colour

Two conductor materials

Li Gl U S J B 2x0,75²Ni + 1x1,00²Cu-vn Kf-rt

…
Conductor material 1
Number of conductors/cross-section in mm²/material

Conductor material 2
Number of conductors/cross-section in mm²/material

Tracer thread/colour

Two conductor materials and one thermocouple (TE)

TE Li Gl U S J B 2x0,75²Ni + 1x1,00²Cu-vn + 2x0,35² Typ J sw 2xKf-rt-X

Thermocouple
Strand/E-glass braided
Eco-friendly impregnation/steel wire braid/
protective earth wire/coloured cores
Conductor material 1: number/cross-section in mm²/material
Conductor material 2: number/cross-section in mm²/material
Thermocouple (TE): number/cross-section in mm²/element type/colour
Colour identification outer braid: number/Tracer thread/colour/shape description (parallel or crossed)

PRODUCT DESCRIPTION FOR THERMOCOUPLEE UND THERMOLEITUNGEN (examples)

Single cores twice lapped • oval stranding

TE Li Gu Gu ov 2x0,20² Typ K gn

Thermocouple
Strand*
Insulation 1: E-glass lapped
Insulation 2: E-glass lapped
Construction: ovale stranding*
Construction of conductor

Single cores lapped and braided • stranded

TE Li Gu Gl vs 2x0,50² Typ K gn

Thermocouple
Strand*
Insulation 1: E-glass lapped
Insulation 2: E-glass braided
Construction: stranded
Conductor

Single cores lapped and braided • stranded • outer steel wire braid

TE Li Gu Gl vs S 2x0,50² Typ K gn

Thermocouple
Strand*
Insulation 1: E-glass lapped
Insulation 2: E-glass braided
Construction: stranded
Steel wire braid*
Conductor: number/cross-section (mm²/strand) bzw. diameter (mm/solid conductor)/element type*/colour identification

Strand*	only if strand is required, else solid conductor
Oval stranding*	2 conductors parallel, replace with »STR« when stranding
Steel wire braid*	iron braid, replace with »SS« in stainless steel braids
Element type*	thermocouple (thermopair); with addition "X" thermoline

CODES

CODE FOR HARMONIZED CABLES ACC. TO DIN 57 292/ VDE 0292

1	2	3	4	5	6	7	8	9

1 Identification according designation

H	harmonized designation
A	national type

2 nominal voltage U_0/U

03	300 / 300V
05	300 / 500V
07	450 / 750V

3 Insulation

V	PVC
R	natural and/ or synthetic rubber
S	silicone rubber

4 Sheath

V	PVC
R	natural and/ or synthetic rubber
N	chloroprene rubber
J	glass fibre braid
T	textile braid

5 Particularities in construction

H	flat, divisible cable
H2	flat, non-divisible cable

6 Conductor

U	solid
R	multi-wired
K	fine-wired for fixed installation
F	fine-wired for flexible installation
H	extra fine-wired
Y	tinsel wire

7 Number of cores

8 Protective conductor

X	without protective conductor
G	with protective conductor

9 Nominal conductor cross-section in mm²

EXAMPLES FOR CODE DESIGNATION

PVC-sheathed wire 2,5 mm² greenyellow **H07V-U 2,5 gnye**

Light tough-rubber sheathed wires
3 cores, 1,5 mm²,
with protective conductor green-yellow **H05RR-F 3G1,5**
2cores, 1,5 mm²,
without protective conductor **H05RR-F 2X1,5**

PCV-sheathed wire
round, 4 cores, 2,5 mm² **H05VV-F 4G2,5**

CODE FOR POWER CABLES ACC. TO VDE 0276

1	2	3	4	5	–	6	7	x	8	9	10

1 Identification

N	VDE standard
X	in resemblance to VDE

2 Type of conductor

A	aluminiun conductor
-	copper conductor

3 Insulation

Y	PVC
2X	cross-linked PE (VPE)

4 Concentric conductor, screen

C	concentric copper conductor (helical)
CW	concentric copper conductor (wave-form)

5 Sheath

Y	PVC
2Y	PE

6 Protective conductor

O	without protective conductor
J	with protective conductor

7 Number of cores

8 Nominal conductor cross-section in mm²

9 Conductor

R	circular conductor
S	sector-shaped conductor
E	solid-wired
M	multi-wiredConductorquerschnitt (mm²)

10 Nominal voltage
U_0/U

EXAMPLES FOR CODE DESIGNATION

Power cable acc. to standard, insulation and sheath from PVC, with green-yellow core, 3 cores, nominal cross-section 16 mm², solid circular conductor, nominal voltage 0,6/1 kV

NYY-J 3 x 16 RE 0,6/1 kV

Power cables acc. to standard, aluminium conductor, insulation and sheath from PVC, with protective conductor, 3 cores, with wave-form concentric conductor, nominal crosssection 25 mm², solid sector-shaped conductor, nominal voltage 0,6/ 1kV

NACWY-J 3 x 25 SE 0,6/1kV

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CODES

CODE FOR TELECOMMUNICATION LINES

1 Basic Type

A	outdoor cable
G	mining cable
J	installation cable
S	switchboard cable
T	distribution cable

2 Additional Information

B	lightning protection
J	induction protect.
E	electronics

3 Insulation

Y	PVC
2Y	PE
02Y	Foam-PE
02YS	Foam-Skin PE
5Y	PTFE
6Y	FEP
7Y	ETFE
9Y	PP
09YS	Foam-Skin PP

4 Construction over conductor stranding

F	petroleum jelly filling
L	aluminium sheath
C	copper braid
D	copper spinning
(L)	aluminium tape
(St)	metal foil screen (Al/PE)
(mS)	magnetic screen
(Z)	strain bearing element
(K)	copper tape screen

5 Sheath

Y	PVC
Yv	PVC reinforced
Yw	PVC heat resistant
2Y	PE
H	halogen-free flame retardant
LSOH	low smoke zero halogen
FRNC	flame retardent non corrosive
F2	PVC flame ret. IEC 332.3 (LOI>30)
FR	PVC flame retardent IEC 332.3

6 number of stranding elements

7 Stranding element

1	Single conductor
2	Pair
3	Triple
4	Quad
5	Five

8 Nominal conductor cross-section in mm²

9 Stranding element

St 0	star-quad (in general)
St I	star-quad (tele-comm. cable)
St III	star-quad (local cable)
St IV	star-quad for transmission up to 120 kHz
St V	star-quad for transmission up to 550 kHz
St VI	star-quad for transmission up to 17 MHz
TF	carrier frequency
P	paired
Kx	coaxial pair
DM	Dieselhorst-Martin-quad
PimF	pair in metal foil
VimF	quad in metal foil

10 Type of stranding

Lg	layer-stranding
Bd	unit stranding

EXAMPLES FOR CODE DESIGNATION

200 paired outdoor telephone cable for local grids, foam-skin PE-sheathed, composite layer sheath from coated aluminium tape and PE outer sheath, star-quad unit stranding, conductor diameter 0,4 mm

A-02YS(L)2Y
200x2x0,4 STIII Bd

CODE FOR CONTROL CABLES

1 Identification

N	VDE standard
(N),X	in resembl. to VDE

2 Insulation

Y	PVC
X	cross-linked, thermoplastic synthetic materials
G	elastomers
HX	cross-linked, halogen-free materials
2Y	PE

3 Type of cable

A	insulation cable
D	solid cable
AF	flexible stranded cable
F	flexible cable for fittings
L	flourescent tube cable
LH	direct line, minor mechanical stress
MH	direct line, medium mechanical stress
SH	direct line,heavy mechanical stress
SSH	direct line, specific stress
SL	control cable/ welding cable
S	control cable
LS	control cable with minor mechanical stress
FL	flat flexible cable
Si	silicone cable
Z	flat twin flexible cord
GL	glass fibre yarn
Li	bunched conductor acc. to VDE 0812
LiF	bunched conductor acc. to VDE 0812, extra fine stranded

4 Particularities

T	support wire
Ö	enhanced oil-resistance
U	flame-resistant
w	heat resistant
FE	insulation integrity
C	copper wired braid
D	copper wire helically winded
S	steel wired braid

5 Sheath

Y	PVC
X	crosslinked, thermoplastic synthetic materials
G	elastomers
H	halogen-free materials
PUR	polyurethane

6 Core identification

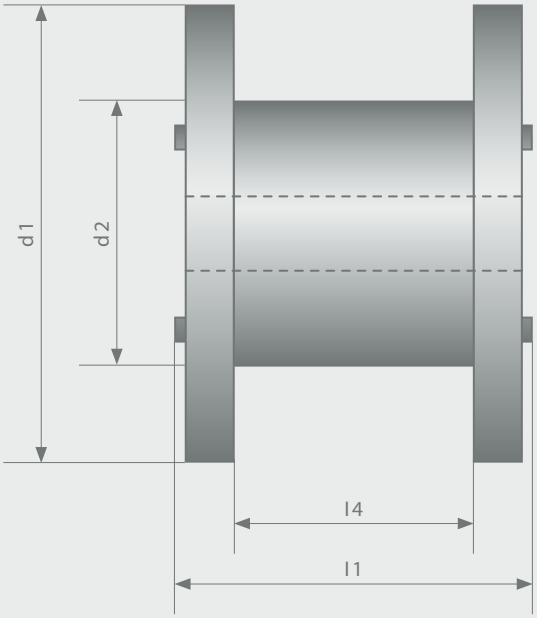
O	without protective conductor
J	with protective conductor
Z	cores with number-printing
B	cores with colour-coding

7 Number of cores

8 Nominal conductor cross-section in mm²

KTG CABLE DRUMS

DRUM-TABLE



Nominal size of drum	d1 flange diameter	d2 core diameter	l1 width overall	l4 width internal	approx. drum weight	Max. carrying capacity	surcharge pledged amount
	mm	mm	mm	mm	kg	kg	EUR
Plastic drums							
050	500	150	456	404	4	100	17,38
070	710	355	510	400	15	250	52,92
080	800	400	510	400	16	350	68,77
090	900	450	680	560	23	400	92,03
100	1000	500	704	560	32	500	108,39
Wooden drums							
051	500	150	470	410	8	100	16,36
071	710	355	520	400	25	250	35,53
081	800	400	520	400	31	400	44,99
091	900	450	690	560	47	750	57,78
101	1000	500	710	560	71	900	82,57
121	1250	630	890	670	144	1700	155,18
141	1400	710	890	670	175	2000	186,88
161	1600	800	1100	850	280	3000	305,24
181	1800	1000	1100	840	380	4000	396,25
Wooden drums with iron hooping							
120	1250	630	890	670	165	170	177,16

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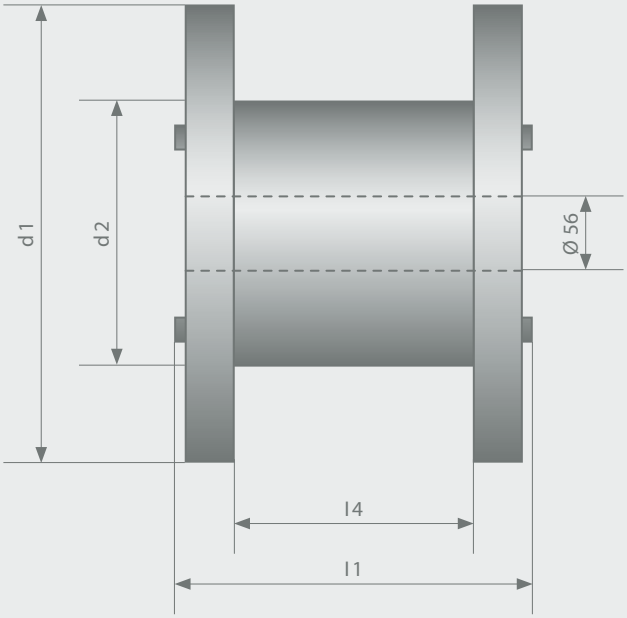
KTG CABLE DRUMS

CAPACITY (Windable cable length in meters)

Cable Ø mm	Nominal size of KTG-cable drum													Cable Ø mm
	051	071	081	091	101	121	141	161	181	201	221	251	281	
3	5324													3
4	2466													4
5	1578													5
6	1508	2328	3080	5679										6
7	1105	1706	2257	4165	5286									7
8	844	1303	1724	3183	4040									8
9	665	1026	1358	2510	3186									9
10	537	829	1097	2029	2576	5038								10
11	443	683	904	1674	2125	4157	5296							11
12	371	573	758	1404	1782	3488	4444							12
13	315	487	644	1194	1516	2967	3780							13
14	271	418	554	1028	1304	2555	3255	5595						14
15	235	364	481	893	1134	2222	2831	4868	5639					15
16	206	319	422	784	995	1950	2484	4274	4959					16
17	182	281	373	693	880	1724	2197	3781	4380					17
18	162	250	331	617	783	1536	1957	3368	3902	5287				18
19		224	297	553	701	1376	1753	3019	3498	4740				19
20		202	267	498	632	1240	1580	2722	3153	4274	5949			20
21		179	238	444	565	1112	1419	2448	2836	3845	5357			21
22		160	212	398	507	1002	1279	2211	2563	3474	4845	5857		22
23		143	191	359	458	906	1159	2006	2325	3153	4401	5322		23
24		128	172	324	414	823	1053	1826	2118	2871	4012	4854		24
25		115	155	294	376	750	961	1669	1935	2624	3670	4443		25
26		104	140	267	342	685	879	1529	1774	2406	3368	4079	5869	26
27			128	243	313	625	807	1406	1631	2212	3100	3757	5409	27
28			116	223	287	577	742	1296	1504	2039	2861	3469	4998	28
29			106	204	263	532	685	1197	1390	1885	2647	3211	4630	29
30				187	242	491	633	1109	1288	1746	2454	2980	4300	30
31				172	223	454	587	1029	1196	1612	2281	2771	4002	31
32				159	206	424	545	957	1112	1508	2125	2582	3732	32
33				147	191	391	507	892	1037	1406	1982	2411	3487	33
34				136	177	364	472	833	968	1313	1853	2255	3265	34
35				126	164	340	441	779	906	1228	1735	2112	6061	35
36				117	153	317	412	730	848	1150	1627	1982	2875	36
37				108	142	296	386	684	796	1079	1529	1863	2704	37
38				101	133	277	362	643	748	1014	1438	1753	2548	38
39					124	260	339	605	704	954	1354	1653	2403	39
40					116	244	319	570	663	899	1277	1560	2270	40
41					108	229	300	537	625	848	1206	1473	2146	41
42					101	216	283	507	591	801	1140	1394	2032	42
43						203	267	479	558	757	1079	1320	1926	43
44						192	252	453	528	716	1022	1251	1827	44
45						181	238	429	500	678	969	1187	1736	45
46						171	225	407	474	643	920	1128	1650	46
47						161	213	386	450	610	874	1072	1570	47
48						153	202	367	428	579	813	1020	1495	48
49						145	192	331	406	551	791	971	1425	49
50						137	182	315	387	524	753	926	1360	50

NON-RETURNABLE DRUMS

DRUM-TABLE



Nominal size of drum	d1 flange diameter	d2 core diameter	l4 width internal	l1 width overall	Flange thick	approx.drum weight	Cub
	mm	mm	mm	mm	mm	kg	m²
Plywood drums							
040	400	150	404	420	8	3,3	0,05
050	500	150	404	420	8	3,5	0,11
060	600	150	404	420	8	6,0	0,15
076	755	315	396	420	12	9,3	0,25
Wooden drums							
70	710	355	400	510	36	20,0	0,26
80	800	400	400	510	36	24,0	0,33
90	900	450	500	600	36	44,0	0,49
90	900	450	560	650	36	44,0	0,53
100	1000	500	500	600	36	48,0	0,60
100	1000	500	560	650	35	48,0	0,65
120	1200	600	600	725	46	67,0	1,04
140	1400	710	710	896	60	136,0	1,76
160	1600	800	900	1080	70	167,0	2,76
180	1800	1000	900	1120	70	275,0	3,63
200	2000	1250	1120	1350	70	343,0	5,40
2200	2200	1400	1220	1450	90	632,0	7,02
2500	2500	1600	1220	1450	90	681,0	9,06

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NON-RETURNABLE DRUMS

CAPACITY (Windable cable length in meters)

Cable Ø mm	Nominal size of drum												Cable Ø mm
	EW40	EW50	EW60	EW76	NG8	NG9	NG10	NG12	NG14	NG16	NG18	NG20	
2	5737												2
3	2550	6181	9615										3
4	1434	3477	5409	6246									4
5	756	1833	2851	3998	4800								5
6	525	1273	1980	2776	3300	5300							6
7	386	935	1454	2040	2400	3900							7
8	295	700	1100	1562	1800	2900							8
9	233	566	880	1200	1400	2300	2700						9
10	176	425	662	928	1100	1700	2100						10
11		352	547	767	900	1400	1800						11
12		295	460	644	780	1200	1500	2600					12
13		252	392	549	660	1000	1200	2200					13
14		217	338	473	570	900	1100	1900					14
15		189	294	412	500	780	950	1600	2700				15
16				363		660	850	1400	2400				16
17				321		570	750	1300	2100				17
18				286		500	670	1100	1900				18
19				257			600	1000	1700				19
20				232			500	940	1500	2200	3300		20
21								850	1400	2000	3000		21
22								780	1200	1800	2700		22
23								700	1100	1600	2500		23
24								650	1000	1500	2300		24
25								600	950	1400	2000		25
26								560	900	1300	1900		26
27								500	850	1200	1800		27
28									750	1100	1700		28
29									700	1000	1600		29
30									680	980	1500		30
31									600	900	1400	2000	31
32									550	850	1300	1970	32
33									500	800	1200	1850	33
34										750	1100	1750	34
35										700	1150	1650	35
36										680	1000	1550	36
37										640	980	1450	37
38										600	930	1400	38
39										580	890	1300	39
40										550	840	1250	40
41										520	800	1200	41
42										500	760	1150	42
43											730	1100	43
44											700	1000	44
45											660	990	45
46											640	950	46
47											610	910	47
48											580	870	48
49											560	840	49
50											530	800	50

PROPERTIES AND TEST SPECIFICATIONS

BEHAVIOUR UNDER FIRE CONDITIONS

The flammability of cables and wires is judged in accordance with a variety of standards.

Flame resistance acc. to
- DIN VDE 0482 Part 332-1
- EN 60332-1
- IEC 60332 Part 1

Flame resistance describes the property of a cable to resist to flame propagation. This property is demonstrated by testing the flammability.

The test is conducted on single cores or cables vertically secured and exposed to a standard test flame for a specified time period of 60 s.

The test is cosidered to be passed where flaming of the specimen ceases of its own accord within a determined length.

Flame retardent acc. to
- DIN VDE 0482 Part 332-2
- EN 60332-3
- IEC 60332 Part 3

Contrary to flame resistance a cable is designated as flame-retardant if it is capable of retarding flame propagation after a flaming period of 20 min. For this practice-oriented test a cable bunch attached to a vertically arranged ladder is used. The test is considered to be passed where flaming of the specimens ceases of its own accord after a flaming period of 20 min.

CORROSIVE GASES

Combustion gases developing during fire are very problematic. They can be extremely toxic and very dangerous for people and animals. In combination with extinguishing water these combustion gases also generate aggressive reaction products (acids), which can cause serious damages to facilities and buildings.

The test for **corrosiveness of combustion gases is conducted** acc. to
- DIN VDE 0482 Part 267
- EN 50267
- EN 60754

The pH-value and conductivity are to be determined in order to judge the corrosiveness of developing gases. This test also allows the detection of very small amounts of halogen-free components. The combustion of synthetic materials, e.g. PVC, causes dense smoke development and a drastic deterioration of visibility conditions. As a consequence escape routes may be impassable, and the work and rescue efforts of fire brigades become more difficult.

The **density of smoke** developing under fire conditions is judged acc. to
- DIN VDE 0482 Part 1034
- IEC 61034

This test method allows smoke density measurement of burning cables under practice-oriented conditions.

The smoke density of various materials is determined by means of comparative testing . A photometric system equipped with a light source (100 W) and a selenium photocell records the light obscuration caused by developing smoke.

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PROPERTIES AND TEST SPECIFICATIONS

INSULATION INTEGRITY

Many conventional cables show malfunctions due to melting of synthetic materials under fire conditions. As a consequence short circuits cause downtimes of neccessary equipment. Applicable constructive measures and the use of appropriate materials can help maintain the insulation integrity of a cable for a certain time period. Testing is conducted acc. to

- DIN VDE 0472 Part 814
- DIN VDE 0482 Part 200
- EN 50200

This test method determines the insulation integrity of cables and insulated wires under direct fire exposure. Cables tested in accordance with this standard are marked with **FE 180** behind the abbreviated construction designation, whereas **FE** is the abbreviation for fire exposure, not for functional endurance.

The specimen of a single cable is secured above the burner in a horizontal position and connected to a voltage source (power cables and insulated wires are tested at 400 V, telecommunication cables and wires at 110 V). Metallic screens are connected together and earthed.

The burner is to be ignited, and the flame is to be adjusted to a temperature of at least 750°C by means of a temperature sensor. The energised specimen is then to be lowered into the flame, and a timer is to be started.

Unless otherwhise specified in the relevant product specifications, the test period shall be 180 min.

The test shall be cosidered to be passed where no short circuit or current flow interruption occurs within the scheduled duration.

FUNCTIONAL ENDURANCE

The test of insulation integrity **FE** s not to be mistaken for the test of **functional endurance E acc. to DIN 4102-12**. In this case an entire cable system is tested instead of a single cable. Cable systems are cables and wires (power cables and lines, installation cables for telecommunication and information processing systems) together with their corresponding connection elements, cable trays and mountings.

The necessity of functional endurance is required by law, which, among other things, stipulates a functional endurance of at least 30 min (E 30) for

- fire alarm systems
- security lighting and
- passenger lift systems

Furthermore, functional endurance over a period of 90 min is required for

- extinguishing water pumps
- ventilation systems
- smoke outlets and
- fire brigade lifts

The test is generally conducted by an officially recognised testing centre. The test stand is to be in accordance with DIN 4102 Part 2 and must have a minimum lenght of 3 m accordingly. The test temperature follows the standard temperature-time curve.

Several test specimens from each cable construction with integrated functional endurance are to be tested, namely

- power cables
  2 specimens 4 x 1,5 and 2 specimens 4 x 50 or greater
- telecommunication cables
  2 specimens of the smallest permissible number of cores or pairs

The test specimens are to be suspended using practical means, applied to supporting structures provided for this purpose or attached directly to the ceiling or wall. The Test voltage is to be 400 V for power cables and 110 V for telecommunication cables.

Functional endurance is proven where no short circuit or current flow interruption occurs in the cable system throughout the fire test. The following classes are distinguished depending on the measured duration of functional endurance:

E30 >30 minutes
E60 >60 minutes
E90 >90 minutes

CUSTOMISED SPECIAL CABLES

Applications
- Energy transmission
- Data transmission
- Telecommunication
- Control

Requirements
- Heat-resistant up to 90°C
- Cold-resistant up to -40°C
- Oil-resistant acc. to DIN VDE 0472 Part 803
- Fuel-resistant
- Flame-resistant acc. to DIN EN 50265
- Flame-resistant acc. to IEC 60332.3 Cat. A, B, C
- Insulation integrity
- Functional endurance

Construction elements

Conductor
- solid
- multi-wired
- bare
- tinned

stranding elements
- cores
- pairs
- triple
- quad

Individual screening stranding elements
- plastic-laminated aluminium foil
- braid

Stranding
- in bunches
- in layers

Collective screening
- plastic-laminated aluminium foil
- copper tape
- tinned or bare copper wire braid
- galvanised steel wire braid
- galvanised steel tape

Materials
Insulating and sheathing materials are selected acc. to requirements and mechanical properties, e. g.:

Sheath
- PE
- Foam-Skin PE
- PP
- TPE

Insulation
- PVC
- PE
- TPE
- PUR

VOKA KABEL GMBH – GENERAL

Price basis
Price quotations apply for 1000 m of cable. Current prices are calculated according to quotations of the non-ferrous metalworking industry using electrolytic copper for conducting purposes (DEL notice), valid on the day after order receipt, plus purchase costs.

Copper price
Cables and wires are sold at daily copper prices (DEL). DEL is the stock exchange listing for German electrolytic copper for conducting purposes, that is 99.5 % pure copper. DEL is indicated in EUR/100 kg.

Copper index
Copper index describes the copper weight of each article. If the listed copper index is 68, the corresponding cable contains 68 kg of copper in a length of 1000 m.

Copper addition
The copper addition (EUR/km) is calculated as follows:

$$ca = \text{copper index (kg/km)} \times \frac{(\text{DEL} + 1\%\ \text{purchase costs}) - \text{copper basis}}{100}$$

VAT
Prices are calculated excluding VAT. It will be charged additionally according to the fiscal regulations currently in force.

Pricing term
Carriage-free for a net merchandise value of EUR 1.500,- or more, or free station at the place of use respectively. If the net merchandise value is less than EUR 1.500,-, freight costs will be charged upon consultation.

Inland payment terms
2 % discount within 14 days, 30 days net, copper addition strictly net.

Divergences in measurement, weight, quantity and construction
Divergences related to raw materials or production remain reserved. Trade-customary over- or under- deliveries are permitted.

Short lengths
We reserve the right to deliver up to 10 % of the ordered quantity in short lengths.

Dimensions meter marking
The meter marking is a guide value and not calibration-capable. It does not serve for verifying the delivered length indicated by the cable manufacturer. Only calibrated measuring instruments are to be used for this purpose.

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CE-IDENTIFICATION

General terms
The Single European Market requires a variety of regulations regarding free commodity exchange. Several EC directives for reducing technical trade barriers were enacted to take different national guidelines into account, e.g.:

- Construction Products Directive
- Machinery Directive
- EMC Directive
- Low-voltage Directive etc.

EC Low-voltage Directive
Cables and wires fall within the scope of the Low-voltage Directive 2006/95/EC of the European Parlament and the Council from 12. December 2006 on the harmonisation of the laws of Member States relating to Electrical Equipment designed for use within certain voltage limits.

certificate of conformity
The manufacturer is required to verify products regarding compliance with existing standards and specifications. The EC certificate of conformity certifies this inspection. It contains:
- name and adress of the manufacturer
- equipment description
- reference to harmonised standards
- reference to specifications forming the basis of conformity
- year of CE symbol identification

VOKA issues this certificate of conformity for cables and wires falling within the scope of the Low-voltage Directive on demand.

CE identification
The CE identification certifies the conformity of a product with the corresponding EC directives. The requirement for CE marking is in effect since January 1st, 1997, and relates to all electrical equipment falling within the scope of the Low-voltage Directive.

Identification is made by the manufacturer, thus declaring that all directives applicable to the product are observed.

VOKA applies the CE symbol using either ink-jet printing on the cable or label marking.

ENVIRONMENT PROTECTION

In product manufacturing we refrain from using hazardous substances according to Directive 2002/95/EC - RoHS. We use only lead-free materials in order to protect our environment. Cable residues, pilot and rejection products are mainly refurbished at our production sites. Residues of synthetic materials are re-employed in the production process. Furthermore we use recyclable materials for all our packaging and support materials.

Our reverse service for wooden drums can also help you contribute to environment protection. We return your empty wodden drums at no charge for you, and we can use them repeatedly at steady quality without wasting valuable resources.

For drum return please contact:

KTS GmbH
Celler Str. 18
08525 Plauen
Tel: +49 (0) 3741-522007
Fax: +49 (0) 3741-522018

You can also contact us directly:

E-mail: info@kts-kabeltrommelservice.de
Internet: www. kts-kabeltrommelservice.de

GENERAL EXPLANATIONS

DEFINITIONS

ACR: (Attenuation to Cross-talk Ratio) The difference between attenuation and cross-talk, measured in decibels.

Adapter: Device to join different plug types.

AM: Amplitude modulation

Analogue signal: An electrical signal which varies continuously not having discrete values.

ANSI: American National Standards Institute.

AWG: American Wire Gauge, a wire diameter specification.

Backbone: The part of the network that carries the heaviest traffic. It is the main trunk cable from which all connections to the network are made.

Back-scattering technique: A technique for measurement of length, reflection and attenuation in a data cable. Only a small part of the signal is reflected to the source and will be analized.

Balun: A transformer device used to convert unbalanced coaxial signals to balanced signals.

Baud: Unit of data transmission speed meaning bits per second (100 baud = 100 bits/s).

Bit: The smallest unit of information in a binary system. Represents either a one or a zero (1/0).

Bit-rate: Transmission velocity of a binary signal.

Breakout cable: Each fibre of these cables has a separate strain relief (e.g. kevlar) and a separate sheath. Two or more of these sheathed fibres are cabled together and covered with a common sheath. In contrast, Mini-Breakout cables will not have separate strain relief or sheath.

Bridge: An interconnecting device for local area networks at the OSI Data Link Layer.

Byte: A group of bits (normally 8 bits in length).

CATV: Community area television.

CCTV: Closed-circuit television.

Channel: The end-to-end transmission path connecting any two points at which application specific equipment is connected. Equipment and work area cables are included in the channel.

Coding: A mechanical device at a plug-in connection system, which guarantees a connection at the correct side or which prevents inserting a plug into a bush of the same type of plug, but which is assigned to another application.

Concentrator: A device serving as a wiring hub into star-to-pology network. Sometimes refers to a device containing multiple modules of a network equipment.

Controller: A unit for the control of input and output operations.

Cross-talk: Unwanted transfer of energy from one circuit to another. Cross-talk typically occurs between adjacent circuits.

Data rate: Measure for the rate, in which data will be transferred over medium, indicated in bit/s or bps.

Decibel (dB): Unit for measuring relative strength (ratio) of two signals.

Dielectric: Insulation material between the conductors.

Digital signal: The binary (1/0) output of a computer or terminal. In data communications, an alternating, non-continuous (pulsating) signal.

EIA: Electronic Industries Association.

Electromagnetic interference: Irradiation of malfunctions during the signal transmission caused by electromagnetic fields.

EMC: Electro-Magnetic-Compatibilty. The ability of a system to minimize radiated emmissions and maximize immunity from external noise sources.

FDDI: Fibre distributed data interface.

Fibre optics: Light transfer by a glass fibre for data or signal transmission.

Fire load: Calorific value of the combustible components of a cable in kWh/m or MJ/m.

Flame retardant: In case of fire, fire forwarding will be delayed (FR).

Frequency: Number of oscillation periods of a signal for each unit of time.

FRNC: Flame retardant, non corrosive.

Full-duplex: A circuit or device permitting transmission in two directions at the same time.

Gain: The increase of a voltage or a current to a reference value.

GND: Ground.

Half duplex (HDX techniques): Half duplex transmission of a channel in both directions, either to be able to transmit or to receive, at the same point of time.

Halogen free: No halogenides (e.g. chlorine) in use. Halogen free cables are used with increased fire protection request regarding protection of individuals or because of high real value concentrations. They do not develop corrosive gases in case of fire (=non-corrosive), and the released amount of toxic gases is substantially lower than with PVC materials.

Hybrid cable: Consists of at least two different types of cables with a common sheath (e.g. FO and copper cables).

IEEE: Institute of Electrical and Electronic Engineers.

IEEE802: Designing project of IEEE for LAN standards. Indoor cable: Cables used for applications within buildings.

Interface: The region, where two systems or a major and a minor system meet and interact with each other.

Impedance: The combined effect of resistance, inductance and capacitance on a transmitted signal. Impedance varies at different frequencies.

ISDN: Integrated Services Digital Network. A carrier-provided service that allows simultaneous accomodation of a variety of switched digital data and voice transmission.

ISO: International Standardisation Organization

Insulation resistance: The higher is the resistance of a material, the better suitable is the material for insulations. The unit is (Ωm); for cables and cords of the derived units (MΩkm) or (GΩkm).

LAN: Local area network, a local data network, e.g. in a building.

Level: A measure of the difference between a quantity or value and an established reference.

Link: An end-to-end transmission path provided by the cabling infrastructure.

Loss: The part of energy applied to a system, that dissipated and performs not useful.

LS0H: Low smoke, zero halogen.

MAN: Metropolitan area network, region network, connection of several LANs, e.g. within a city.

Master: A central station, which can check directly different stations (remote).

MAU:(1) Multi-station access unit in reference to Token-Ring. (2) Medium attachment unit in reference to Ethernet. A wiring concentrator used in local area networks. A device, that allows terminals, PCs, printers and other devices to be connected in a star-based configuration to Token-Ring or Ethernet-LANs.

Multiplexer (MUX): A device allowing two or more signals to pass over and share a common transmission path simultaneously.

Network: (1) An interconnected group of nodes. (2) A series of points, nodes or stations connected by communication channels; the collection of equipment through which connections are made between data stations.

NEXT: Near end cross-talk.

NVP: Nominal Velocity of Propagation.

OTDR (Optical Time Domain Reflectometer): An instrument, that allows the characterisation of a fibre by the analysis of back-scattered light.

Outdoor cable: Cables, which are designed for under–earth or duct applications.

Patch cable: A flexible piece of cable, terminated at both ends with plugs. Used for interconnecting circuits on a patch board.

Peak: The maximum instantaneous value of a varying current or voltage.

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GENERAL EXPLANATIONS

Pigtail: An approx. 1,5m long, single core FO-cable, with unilateral manufactured plug.

Port: In- or output of a data channel in network.

Primary-Cabling: A connection of the individual building distributors building-spreading at the plant area.

Protocol: A formal set of conventions governing the formatting and relative timing of message exchange between two communication systems.

Pulse: A voltage or current, which changes from one value to another and then back to the original value in a limited period of time.

Quartz glass: One in amorphous, thus not cristalline form, glassily solidified for melt from silicon oxide.

Receiver: An electronic device, that receives signals. In a fibre optic system it converts light energy into electrical energy.

Redundancy: This means, that there exists more than one single connection to realize data transmission between two network nodes.

Remote: Remote terminals are workstations, which are usually installed at another place than the central computer.

Repeater: A device, which automatically amplifies, restores or reshapes signals to compensate for distortion and/or attenuation prior to retransmission.

Resistance: In dc circuits, the opposition a material offers to current flow, measured in ohms. In ac circuits, resistance is the real component of impedance, and may be higher than the value measured in dc. It is determined by the quality of copper and the cross-section of the conductor. It rises linear with the cable length and is decisive for the attenuation.

Return loss: Noise or interference caused by impedance discontinuities along the transmission line at various frequencies.

Router: Connecting device for two LANs, which also can be different (e.g. Ethernet and Token-Ring). It could also be used to connect LANs and WANs.

Secondary-Cabling: Cable and connecting hardware that comprise the main and intermediate cross-connects, as well as cable runs between telecommunication closets, equipment rooms and entrance facilities.

Segment: Within a LAN, a connected part of a cable is called a segment.

Server: Computer in LANs, which handles with special functions in the network (e.g. file servers or printer servers).

Shield: A tape, serve or braid of metal, usually copper, aluminium or other conductive material, placed around or between electric circuits, cables or their components, to prevent signal leakage or interference.

Signal: Any visible or audible indication, which can convey information. Also, the information conveyed through a communication system.

Single-ended: Unbalanced, such as grounding one side of a circuit of transmission line.

Skin-effect: The tendency of alternating current to travel only on the surface of a conductor, if its frequency increases.

Splice: A permanent joint, joining two optical fibres.

Star-quad: Cable element, which consists of four cores twisted with each other, whereby the opposite cores form a transmission path (side circuit).

STP: Shielded twisted pair.

STQ: Shielded twisted quad.

Tertiary-Cabling: Horizontal connection of the floor distributor with the telecommunication outlet at the workstation.

TIA: Telecommunications Industries Association.

Token: A special signal, which runs continuously in the ring network. If a station wants to transmit, it has to take the token out of the ring, transmit the data and continue to send the token again.

Topology: The physical or logical architecture of connections and nodes of a network (star-, ring- and bus configurations).

TPDDI: Twisted Pair Distributed Data Interface.

Transmitter: An electronic device for sending signals.

Transition point: A location in the horizontal cabling subsystem where flat undercarpet cabling connects to round cabling.

UHF: Ultra high frequency (from 300 MHz up to 3 GHz).

UTP: Unshielded twisted pair.

UTQ: Unshielded twisted quad.

Velocity of light: v0 = 2, 998 x 108 m/sec.

VHF: Very high frequency (from 30 MHz up to 300 MHz).

WAN:Wide area network.

Wavelength: The distance between successive peaks or nodes of a wave. Work area cable: A cable assembly used to connect equipment to the telecommunication outlet in the work area

GENERAL TERMS AND CONDITIONS VOKA-KABEL GMBH

Status 04/2012

1. Scope

1.1 The following conditions apply to any business relations with our customers (hereinafter referred to as "the Purchaser") as far as they are entrepreneurs in terms of § 14 German Civil Code, legal entities of public law or special funds under public law. The conditions apply particularly to contracts on the sale and/or the delivery of movable goods, regardless of whether we produce the goods or purchase them from subcontractors. The present conditions in their respective version also provide the master agreement to future contracts on the sale and/or the delivery of movable goods with the same Purchaser, excluding the necessity to refer to them in each particular case.

1.2 The Purchaser's General Terms and Conditions of Purchase are hereby expressly vetoed. They shall in no case be mandatory to us, even if we do not expressly contradict them at the conclusion of a contract. The sales terms below apply, even if we implicitly execute the Purchaser's order despite being aware of adverse or divergent conditions.

2. Sales terms

2.1 Any order of goods by the Purchaser shall be deemed a binding contractual offer. Unless otherwise indicated in the order, we shall be entitled to accept this contractual offer within 8 business days upon receipt. Acceptance shall be effected by means of order acknowledgement. Orders shall not be regarded as accepted until they have been confirmed by us. Our sales agents act as negotiators, not as contracting representatives.

The Purchaser shall not be permitted to assign claims arising out of the contractual relationship established with us to any third parties.

2.2 Prices indicated in our order acknowledgement shall prevail to the account of services rendered.

2.2.1 The price basis of any order acknowledgement is formed by the price list valid on the respective day of acknowledgement in correspondence with the metal quotation agreed upon (usually 1 day after order receipt). If the metal quotation is omitted on that day, the subsequent metal quotation shall apply.

2.2.2 If we have received a purchase offer in the form of an order we are able to finally acknowledge including the scheduled delivery date (cleared order), we shall calculate the price according to the price list and metal quotation agreed upon. Any final order acknowledgement requires clarification of the customer, the customer's address, the address for invoicing and delivery, the order content stating article quantities and types to be delivered, discounts, delivery requests or delivery dates respectively and special conditions, where applicable.

2.2.3 For business to be processed within 4 months after contract conclusion we shall be entitled to increase prices agreed upon with regard to a short-term change in the metal quotation. The reason for this is that significant variations compared to prices indicated in the order acknowledgement may arise due to the daily redefinition of the metal quotation.

2.2.4 The metal quotation forms the basis of the raw material calculation or the raw material accounting respectively. It is calculated on the basis of the quotation of the non-ferrous metalworking industry for electrolytic copper wire bars for conducting purposes (DEL notice) plus incurred purchase costs. The DEL notice is published in the business section of leading daily newspapers.

2.2.5 If stocking up on metal and procurement on DEL notice is impossible or not ensured at full volume, we shall account for the actual metal procurement prices plus purchase costs incurred.

2.2.6 For delivery ex distribution centre prices of the price list valid on the date of distribution and the metal quotation (DEL notice or metal procurement price) on the date of distribution shall apply.

2.2.7 If copper is provided to the supplier by the Purchaser, we shall charge the hollow price. The copper shall be consigned to the supplier's control no later than 5 weeks prior to the acknowledged delivery date.

2.3 Our prices are based on the cost conditions of raw material market procurement costs stated to us at the time of order acknowledgement. If these cost conditions change, we shall be entitled to implement a subsequent price adjustment or, as the case may be, to rescind from the aggregated or remaining order, provided that we notify the Purchaser immediately after the changed conditions have become known to us and, in case of rescission, return payments already received from the Purchaser.

2.4 Call orders

If call-off delivery is agreed, the Purchaser undertakes to determine and communicate the time of complete delivery within an appropriate period of one month maximum from the date of order acknowledgement. This shall also apply in case of delivery arrangements for certain acceptance dates. Unless a separate agreement on call-off dates is concluded, call orders shall always be delivered within 3 months from the date of order acknowledgement. If the Purchaser does not adhere to the call commitment, we shall be entitled to sue for acceptance and payment. After expiration of the call commitment the prices of the company Vogtländisches Kabelwerk GmbH, valid at the time of delayed calls, shall apply to further call arrangements.

3. Delivery terms

3.1 Our delivery commitment implies that we are able to stock up with raw materials necessary for the order on raw material quotations prevailing on the date of order acknowledgement. If this precondition is not given, paragraph 2.3 of our General Terms and Conditions shall apply.

3.2 Periods and dates of delivery are always approximated statements. Any delivery period shall start with the despatch of our written order acknowledgement and the delivery date stated therein at the earliest, but, however, not prior to the provision of documents to be procured or materials to be provided by the Purchaser and the observance of payment terms agreed upon.

3.3 The delivery period shall be deemed observed after the delivery item has left our factory or warehouse or if the readiness for shipment is communicated prior to its expiration.

3.4 If subsequent changes or amendments of the delivery contract are agreed, a new delivery period shall be agreed at the same time if the original period cannot be observed due to the changes or amendments. The new delivery period shall not start prior to the despatch of our new order acknowledgement.

3.5 Events of force majeure shall authorise us to delay performance of services for an appropriate period of time or to rescind because of contractual parts not yet fulfilled, provided that we notify the Purchaser immediately after these conditions have become known to us and, in case of rescission, return payments already received from the Purchaser. Strike, lockout, mobilisation, war, embargo, ban on exports and imports, shortage of raw materials and fuels, fire, traffic blockage, interruption of operations or transport as well as similar conditions, even if such conditions occur on the part of upstream suppliers, shall be deemed equivalent to force majeure. Indemnity claims of the Purchaser shall be excluded in cases of force majeure, provided that neither intent nor an act of culpable negligence occurred on our part. This limitation of liability shall not apply to damages resulting from injuries inflicted to the body, life or health.

3.6 The aforementioned conditions shall not even be covered by us if they occur during a current event of default. We shall notify the Purchaser of the beginning and end of such impediments at earliest convenience.

3.7 Delivery commitments and delivery periods shall only be agreed reserving correct and due receipt of the subcontractor's deliveries. If this is not ensured, we shall be entitled to rescind from the contract without compensation, provided that we notify the Purchaser immediately after these conditions have become known to us and, in case of rescission, return payments already received from the Purchaser. We shall not assume any risk of procurement.

3.8 If any delivery period is exceeded, the Purchaser shall be committed to grant an appropriate grace period to us, which may not fall below three weeks.

3.9 After expiration of any acceptance period in accordance with the provision stipulated under paragraph 2.4 of these General Terms and Conditions we shall no longer be committed to deliver. In this case we reserve the discretionary decision to rescind from the contract, to demand advance payment or to condition our delivery on adequate collateral. This shall also apply in the case of conditions becoming known to us, which justify doubts about the Purchaser's creditworthiness, particularly if the Purchaser does not pay promptly or immediately despite dunning letter and overdue claims.

3.10 We reserve the right to deliver up to 10 % of the order quantity in excess or short lengths. Divergences related to raw materials or production remain reserved. Customary excess or short lengths shall be permitted.

3.11 Orders on special services shall exclusively be delivered in manufacturing lengths according to the production conditions.

3.12 Shipping charges

We deliver free to the door for a net merchandise value of € 1500,- or more (on metal basis) or free station of the recipient respectively, this shall apply to inland shipment (mainland). In case of international shipment we deliver free German border. We shall charge additional freight for small orders with a net merchandise value of less than € 1500,- (on metal basis).

3.13 Packaging charges

Packaging shall be free of charge for a net merchandise value of 250,- EUR or more. Packaging shall be charged at cost price if the value is less than 250,- EUR.

3.13.1 Returnable drums and barrels belonging to VOKA and loaned to the Purchaser with our deliveries shall be charged separately. Barrels and drums shall be taken back and credited with 2/3 of the charged value if they are in a good and reusable condition. Any delivery of stillages and euro-pallets shall be effected on exchange. In case of occurring exchange delays to be covered by the Purchaser, costs arising out of this shall be charged to the Purchaser.

3.13.2 KTG drums (flange diameter 50 to 280 cm) for cables and wires are the property of Kabeltrommel GmbH & Co. KG (KTG), Cologne, and shall be provided to the Purchaser according to KTG's conditions on the transfer of cable drums.

3.13.3 We shall not grant any freight reimbursement for the collection of goods.

3.13.4 The Purchaser shall indemnify the supplier from the obligation to accept returnable products according to § 4 of the Packaging Directive.

4. Payment terms

4.1 Invoicing shall be made upon delivery. We shall be entitled to assign claims arising out of our business connection.

4.2 Invoices issued to the Purchaser shall be payable as indicated in the invoice.

4.3 Invoices accounting a total amount of less than 25,- EUR shall be payable strictly net.

4.4 In the event of non-compliance with the payment terms indicated in the invoice or paragraph 4.3 respectively, the Purchaser shall be on default. During the default period we shall be entitled to add interest in the amount of the legal default interest rate currently in force to the invoice amount. The right to enforce further damages, particularly proven increased interest rates, shall remain unaffected thereof. The default consequences shall arise automatically, i.e. independent from the enforcement of default. In the event of default all our accounts receivable, including bills accepted but not yet discharged, shall become due in cash immediately. The Purchaser shall no longer be entitled to sell goods being in our ownership or co-ownership (see clause 6 Retention of title) and shall be committed to provide adequate collateral to us. We reserve the same right in the event of reasonable doubts regarding the Purchaser's creditworthiness. In this case we shall furthermore be entitled to condition the delivery of other goods on the provision of adequate collateral and/or cash in advance.

4.5 Payment shall principally be made in the form of cash payment or postal order. Bill and bill/cheque payments shall only be accepted within a period of 10 days from the invoice date and under reserve, and they require our explicit consent. They shall be considered as payments only after they have been discharged by the acceptor and we have consequently been exonerated of the endorser's liability with the result of the retention of title remaining in force for our benefit until the discharge of the bill. Any payment shall be made with the effect of discharging the debt and exclusively to the bank indicated in the invoice, to which we have assigned our claims arising out of our business connection.

4.6 The Purchaser shall only be entitled to offset or retain payments if the Purchaser's counterclaim(s) is/are not disputed and legally ascertained. The retention arising out of the same contractual relationship shall, however, remain unaffected thereof.

4.7 Our regional agents do not hold any power for collection.

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GENERAL TERMS AND CONDITIONS VOKA-KABEL GMBH

Stand 12/2011

5. Transfer of risk

Any risk shall be transferred to the Purchaser after the Purchaser has been notified by us that the goods are reported to be ready for collection or shipment, but no later than on the date on which the goods have left our factory or have been taken over by the Purchaser in our factory. This shall also apply in the event of carriage-free delivery and if the goods are shipped by us upon request of the Purchaser. In the event of shipment being delayed at the Purchaser's request or due to reasons attributable to the Purchaser, the risk shall be transferred to the Purchaser for the duration of the delay.

6. Retention of title

6.1 We reserve the title to the property in goods supplied until full payment of any accounts, including accounts accruing in the future, arising out of the business connection, even if payments referring to particularly identified accounts are made. In the event of open account the reserved property shall be deemed collateral to our current account balance claims.

6.2 Goods subject to retention of title may only be sold according to the rules of business transactions. This shall no longer apply in the event of the Purchaser being on default. The Purchaser shall not be entitled to pledge or assign goods as collateral. Pledging on the part of any third parties shall immediately be notified to us.

6.3 Any manipulation, processing or connection of our goods performed by the Purchaser shall in any case be made for us without the event of liabilities accruing to us. In the event of processing, manipulation or connection to other items not under our ownership, we reserve the right of co-ownership to the new item in an amount resulting from the ratio of the invoice value of processed, manipulated or connected goods subject to retention of title to the value of the new item.

6.4 For collateral purposes the Purchaser shall fully assign to us all claims against any third parties, including any current account balance claims on an open item basis, attributable to the Purchaser in connection with the use of goods subject to retention of title, particularly through resale, manipulation and processing or due to another legal cause (e.g. unlawful act) in the amount of the invoice value of our goods. Any assignment shall act as collateral to any of our claims and particularly to indemnity claims raised against the Purchaser. The Purchaser shall be entitled to collect assigned claims prior to our revocation. In the event of default or other indications of the Purchaser's financial difficulties, the direct debit authorisation shall expire without express revocation.

6.5 If the total realisable value of existing collateral exceeds our claims by more than 10 %, we shall in this extent be committed to release collateral selected by us on the Purchaser's request.

6.6 In the event of default, the Purchaser shall upon our request be committed to furnish particulars suitable for the enforcement of our rights of retention of title, in particular to issue a statement on goods subject to retention of title and their destination.

6.7 If the Purchaser fails to accomplish the Purchaser's commitments arising out of the mutual business connections, the Purchase's right to own goods subject to retention of title shall expire. We shall in such cases be entitled to take back goods subject to retention of title. We shall also be entitled to enter the Purchaser's company grounds or other premises for the purpose of taking possession of goods subject to retention of title. Taking back goods subject to retention of title shall constitute rescission from the contract. We shall be entitled to commercialise goods subject to retention of title after their return. Proceeds resulting from the valorisation shall be reduced by reasonable valorisation costs and then be offset against amounts owed by the Purchaser.

7. Warranty

Unless other directives or references based on special written agreements are to be observed and become an integral part of the contract, we deliver subject to and in accordance with the requirements stipulated by the regulations of the Association for Electrical, Electronic and Information Technologies (VDE).

7.1 The Purchaser's claims for defects shall only be in force if the Purchaser duly observes the Purchaser's obligation stipulated by § 77 HGB (Code of Commercial Law) to inspect the goods and give notice of defects. The Purchaser shall conduct factual and functional inspection and testing of incoming goods immediately upon receipt and by reference to our shipping documents. The Purchaser cannot be exonerated of the obligation to perform inspection. Costs incurring to the Purchaser due to processing of goods without prior inspection shall always be borne by the Purchaser.

7.2 Shortfall quantities and/or apparent defects shall only be warranted upon written notice of the complaint specifying the order and delivery note data and within a period of 10 workdays after distribution.

7.3 If apparent defects have not been contested within the aforementioned period, any claims of the Purchaser in this respect shall be excluded.

7.4 Unapparent defects emerging in the course of time shall immediately be communicated to us by the Purchaser.

7.5 The return of goods necessary in the event of defect requires our prior consent. In this respect the legal regulation on the taxing of costs applies. Returns made without our prior consent shall not require our acceptance. In this case the Purchaser shall solely bear the total costs of return.

7.6 In the event of supplementary performance in the form of a new delivery due to a justified notice of defects, the provisions on the delivery period apply accordingly. We require an appropriate period of time of at least three weeks to be granted to us for rectifying the defects in the form of subsequent improvement.

7.7 The presence of a defect shall constitute the following rights to the Purchaser:

7.7.1 In the event of defectiveness, the Purchaser shall first of all have the right to demand supplementary performance from us. Any supplementary performance can according to the Purchaser's choice be effected by means of removal of the defect or delivery of new goods. We reserve the right to refuse the form of supplementary performance chosen by the Purchaser if it would only be possible at disproportional cost.

7.7.2 In the event of failed efforts to provide supplementary performance, we reserve the additional right to undertake further supplementary performance according to the conditions indicated under 7.7.1 and within an appropriate period of time. The Purchaser shall have the right to rescind from the contract or to abate the purchase price only if even the repeated supplementary performance has failed.

7.7.3 Claims of the Purchaser due to expenditures required for the purpose of supplementary performance, particularly for carriage, route, labour and material costs, shall be excluded insofar as the expenditures are increasing in case the delivery item has subsequently been transferred to a location other than the Purchaser's establishment, unless the transfer corresponds to its intended use.

7.7.4 Unless the defect has been fraudulently concealed by us, the warranty period shall principally last one year from the date of delivery of the goods. The Purchaser shall in any case furnish proof of the defect being already present on delivery.

7.7.5 Warranty claims shall principally be excluded if inappropriate modifications, repairs or other interventions have been performed by the Purchaser or any third parties without absolute necessity and the contested defect was caused or may have been caused in this way.

8. Rights in tools

The Purchaser or any third parties shall not acquire any rights (transitional right, rights of use etc.) by reimbursing portions of the costs for tools. In the event of industrial property rights of third parties being infringed due to deliveries according to drawings or other information provided by the Purchaser, the Purchaser shall indemnify us against any claims thereto.

9. Liability

9.1 Unless otherwise specified in these General Terms and Conditions including the provisions below, we shall be liable for any breach of contractual and non-contractual obligations according to the relevant legal regulations.

9.2 Unless none of the regulations below applies, we shall in the event of damages – for whatever legal reason – principally be liable only in case of malice and culpable negligence:

In the event of ordinary negligence we shall only be liable:

a) for damages resulting from injuries to the body, life or health;

b) for damages resulting from the violation of an integral contractual obligation (i.e. an obligation of such importance that its accomplishment facilitates due execution of the contract in the first place and its observance is and may regularly be trusted by the contractual partner); in this case our liability shall, however, be limited to the reimbursement of the predictable damage typically occurring.

9.3 The limitation of liability according to subparagraph 9.2 shall not apply if we have fraudulently concealed any defect or have assumed warranty for the quality of the goods. The same shall apply to claims of the Purchaser according to the Product Liability Law.

10. Export regulations

If a national Purchaser exports goods abroad, the Purchaser is committed to verify whether the exported goods are subject to restrictions of the German Foreign Trade and Payments Act. The exporter of the goods bears the sole responsibility for observing the respective export regulations. This also applies to the provisions of US foreign trade legislation. We shall in no case assume any warranty that products supplied by us comply with such regulations.

11. Place of jurisdiction

As far as the customer is a merchant in accordance with the Code of Commercial Law, a legal entity of public law or a special fund under public law, our company headquarters shall be the exclusive place of jurisdiction for any legal action taken against us.

In the event of legal action against the Purchaser, we shall also be entitled to bring legal proceedings before a court locally competent for the headquarters or a subsidiary of the Purchaser.

12. Applicable law

12.1 These General Terms and Conditions and any legal relationships between us and the Purchaser shall exclusively be governed by the law of the Federal Republic of Germany.

12.2 The UN Convention on Contracts for the International Sale of Goods (CISG) shall be excluded.

13. Final provisions

In the event of any regulation under these General Terms and Conditions being void or becoming unenforceable, the effectiveness of the other conditions shall remain unaffected thereof. In this case both parties shall be committed to introduce an effective and enforceable clause, corresponding as far as possible to the economic and non-material goals within the legal restrictions, in place of the void and unenforceable clause.