



Testbericht

Dok. Nr.: PL140665
Datum: 19.01.2015
Seite: 1 von 21

Movement test

Pfäffikon, 19.01.2015

Projekt: RADOX MFH-S B




PL140665

Offered for:
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	Testbericht PL140665	Dok. Nr.: PL140665 Datum: 19.01.2015 Seite: 2 von 21
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III. Table of Contents

1. Scope	4
2. Applicable Documents	4
3. Overview Test Results	4
Introduction	5
3.1 Objective	5
3.2 Test Method	5
3.3 Requirements	5
4. Test Specimens	5
5. Test Equipment	5
5.1 Equipment Description	5
5.2 Test Set-Up	6
6. Conclusion	8
7. Test Results	9
7.1 RADOX MFH-S B 3x0.5 mm ²	9
7.2 RADOX MFH-S B 5x1.5mm ²	10
7.3 RADOX MFH-S B 12x2x0.75 mm ²	11
7.4 RADOX MFH-S B 2x2x2.5 mm ²	12
7.5 RADOX MFH-S B 16x(2x1.5) mm ²	13
7.6 Table resistor increase per chanel	14
8. Appendix	15



1. Scope

This test report documents the movement test of five different RADOX MFH-S B cables

2. Applicable Documents

This document must be read in conjunction with the documents listed below:

Doc. Ref.	Title	Issue
STD 586 610 N (e)	Radox MFH-S B Multi Core Cables 0.5 mm ² – 6 mm ²	04.11.2014

Table 1 list of the applicable document

3. Overview Test Results

The product family RADOX MFH-S B is able to withstand more than 1'000'000 (one Million) cycles in a drag chain.

Restricting the number of cycles is the bending radius. According this test Huber + Suhner defines the maximum achievable drag chain moving cycles in relation with the bending radius.

Product range	Bending Radius up to 100k Cycles	Bending Radius up to 500k Cycles	Bending Radius up to 1'000k Cycles
Cables with diameter ≤ 12mm	6x Cable Dia	10x Cable Dia	12x Cable Dia
Multi-Core cables with diameter > 12mm	8x Cable Dia	10x Cable Dia	12x Cable Dia
Twisted pairs cable with diameter > 12mm	8x Cable Dia	12x Cable Dia	14x cable Dia

Movements in colder environment will reduce the lifetime.

To get more safety in the cable lifetime, Huber + Suhner advises to increase the bending Radius.

Introduction

3.1 Objective

To expand the field of operation of this cable family it is important to experience how they resist against movements.

3.2 Test Method

The samples are fitted into cable drag chains with different bending radius. While the cable drag-machine drags them for- and backwards, the resistance of the screens and conductors gets monitored. Avoiding any friction, if possible

3.3 Requirements

More than one million cycles

4. Test Specimens

H+S Art. Nr.	Sample description	Bendingradius 1	Bendingradius 2
85002705	Radox MFH-S B 3x0.5mm ²	45 (8 x D)	90 (15 x D)
85002708	Radox MFH-S B 12x2x0.75 mm ²	90 (6 x D)	160 (10 x D)
85003089	Radox MFH-S B 5x1.5 mm ²	45 (5 x D)	90 (10 x D)
85003101	Radox MFH-S B 2x2x2.5 mm ²	90 (5 x D)	160 (10 x D)
85018446	Radox MFH-S B 16x(2x1.5) mm ²	160 (6.5 x D)	280 (11 x D)

Table 2 List of the samples

Take the cable outer diameter D from the technical data sheet (annex). The cable diameter get multiplied by a factor, which shows the hardness grade of the test situation of each sample. Like that, the influence of the different bending radius of the same sample gets possible to compare.

5. Test Equipment

5.1 Equipment Description

Manufacturer	Type	Serialnumber	Device description	Next calibration
H&S Pfäffikon	3	-	Cable drag machine	-
Fluke	325	16040080	Multimeter	Juni 2015
Resistomat	2318	140531	Mili-Ohm measure device	Juni 2015
LX Instruments	325	1099058	Datalogger and multiplexer	März 2015

Table 3 List of the test equipment



5.2 Test Set-Up

Chanel	Group	Sample	Bendingradius / mm
1	1 C	3x0.5 mm ²	45
2	2 CMS		
3	1 C	5x1.5 mm ²	45
4	2 CMS		
5	1 C	3x0.5 mm ²	90
6	2 CMS		
7	1 C	2x2x2.5 mm ²	90
8	2 MS		
9	1 C	12x2x0.75 mm ²	90
10	2 C		
11	3 C		
12	Mainscreen		
13	2 C	16x(2x1.5) mm ²	160
14	2 GS		
15	3 GS		
16	3 C		
17	1 C		
18	1 GS		
19	4 C		
20	4 GS		
21	1 C	16x(2x1.5) mm ²	280
22	1 GS		
23	2 C		
24	2 GS		
25	3 GS		
26	3 C		
27	4 C		
28	4 GS		
29	Mainscreen		
30	1 C	2x2x2.5 mm ²	160
31	2 MS		
32	1 C	12x2x0.75 mm ²	160
33	2 C		
34	3 C		
35	Mainscreen	12x2x0.75 mm ²	160
36	Mainscreen	16x(2x1.5) mm ²	160
37	1 C	5x1.5 mm ²	90
38	2 CMS	5x1.5 mm ²	90

Table 4 List of Channels: C= Conductor, GS = Groupscreen, MS = Mainscreen & LMS = L+HS in series



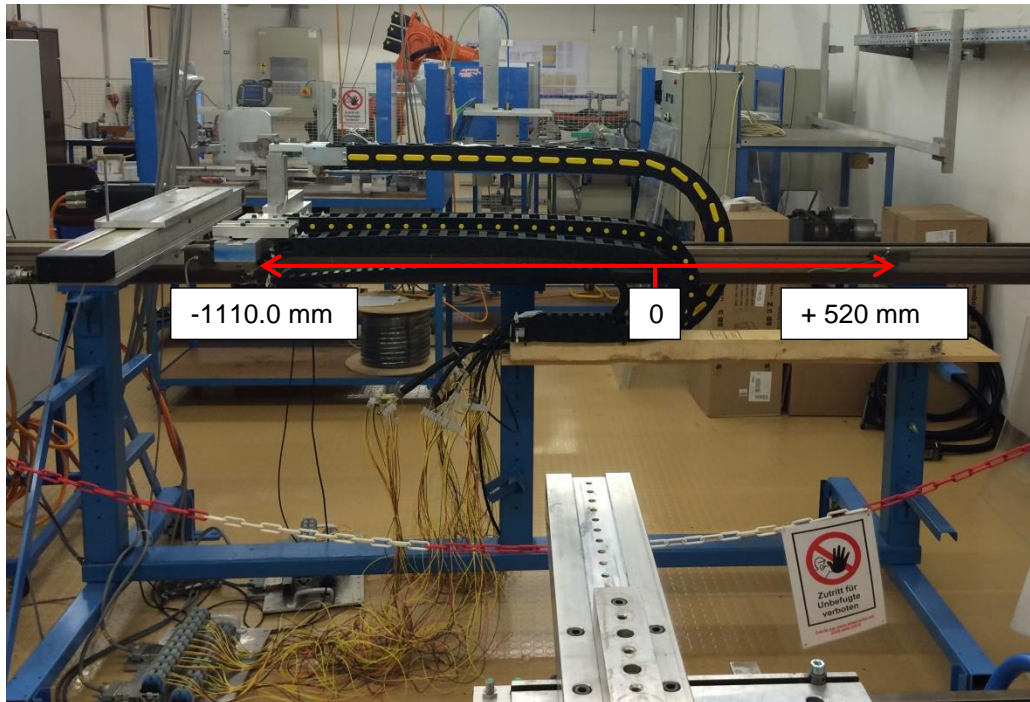


Figure 1 test set-up movement test. The slide at position bottom dead center (BDC)

The reference point, where the drag machine starts the program, is marked in the illustration as zero (0). One movement includes the range from the reference point (0) to the bottom dead center (-1110.0 mm), rewards to the top dead center (+520 mm) and finally back to the reference point (0).

The computer counts the movements, using a sensor and stops the test as soon the desired value is obtained.



6. Conclusion

Nr.	Type	Bendingradius	Calculation of radius	Cycles	Status
85002705	Radox MFH-S B 3x0.5mm ²	(45) 48 mm	8.3 x D _{cable}	1'000'000	Max.movements
85002705	Radox MFH-S B 3x0.5mm ²	(90) 100 mm	17.4 x D _{cable}	1'000'000	Max.movements
85003089	Radox MFH-S B 5x1.5 mm ²	(45) 48 mm	5.4 x D _{cable}	60'000	Screen fault
85003089	Radox MFH-S B 5x1.5 mm ²	(90) 100 mm	11.2 x D _{cable}	1'000'000	Max.movements
85002708	Radox MFH-S B 12x2x0.75 mm ²	(90) 100 mm	6.4 x D _{cable}	92'000	Jacket crack
85002708	Radox MFH-S B 12x2x0.75 mm ²	160 mm	10.3 x D _{cable}	330'000	Jacket crack
85003101	Radox MFH-S B 2x2x2.5 mm ²	(90) 100 mm	7.3 x D _{cable}	92'000	Jacket crack
85003101	Radox MFH-S B 2x2x2.5 mm ²	160 mm	11.7 x D _{cable}	330'000	Jacket crack
85018446	Radox MFH-S B 16x(2x1.5) mm ²	160 mm	6.7 x D _{cable}	92'000	Jacket crack
85018446	Radox MFH-S B 16x(2x1.5) mm ²	280 mm	11.7 x D _{cable}	1'000'000	Max.movements

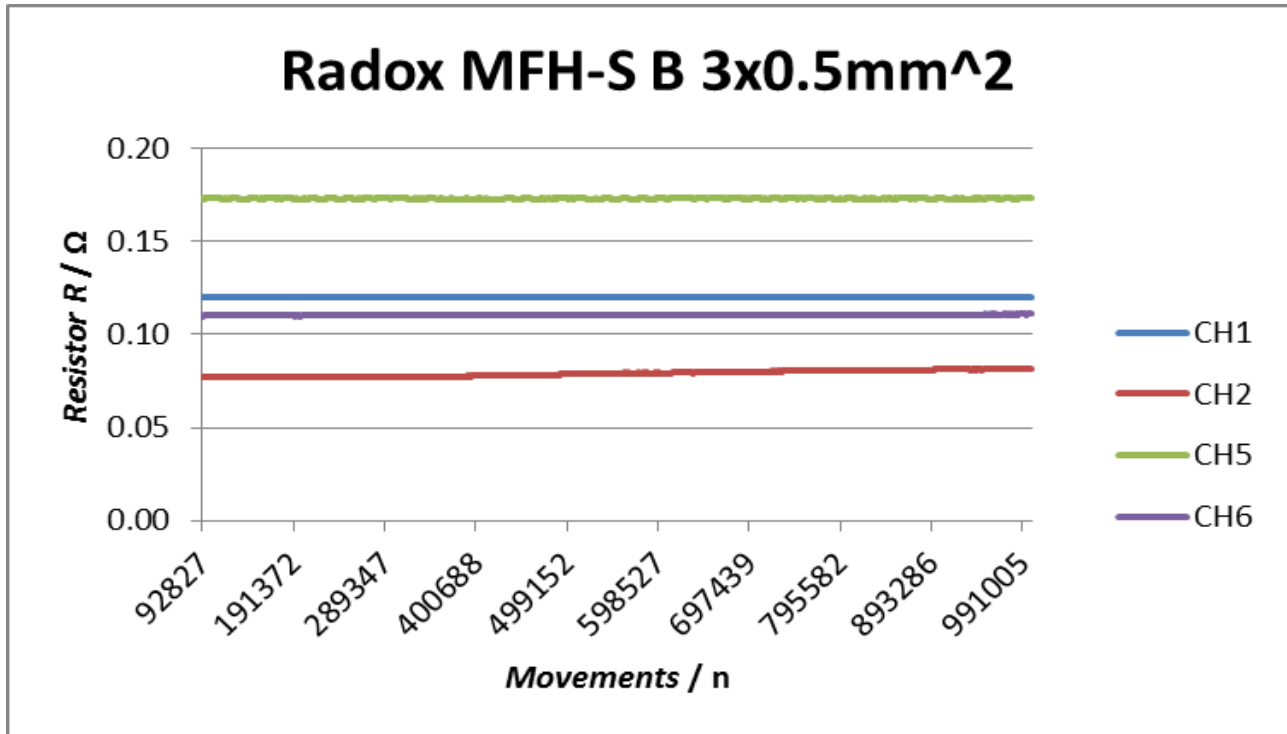
Table 5 Summary of the test results

The resistances of the conductors are higher than in the reality. The cables are connected to the logging cables of the four conductor measuring circuit by luster terminals. This increases the resistance data. According to that, the increase of the resistance can only be declared as a function of time in percent.



7. Test Results

7.1 RADOX MFH-S B 3x0.5 mm²

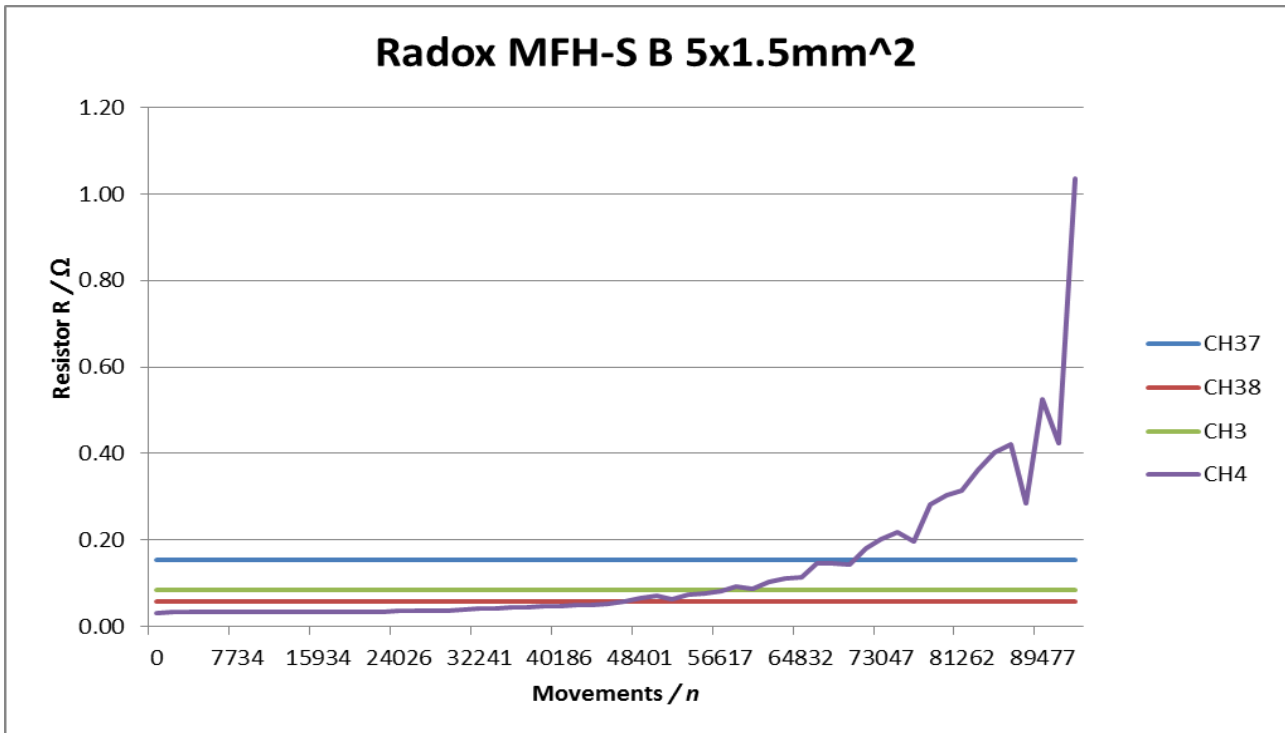


Graph 1 Maximum resistor increase (CH2) of 2 % during 1 MM cycles

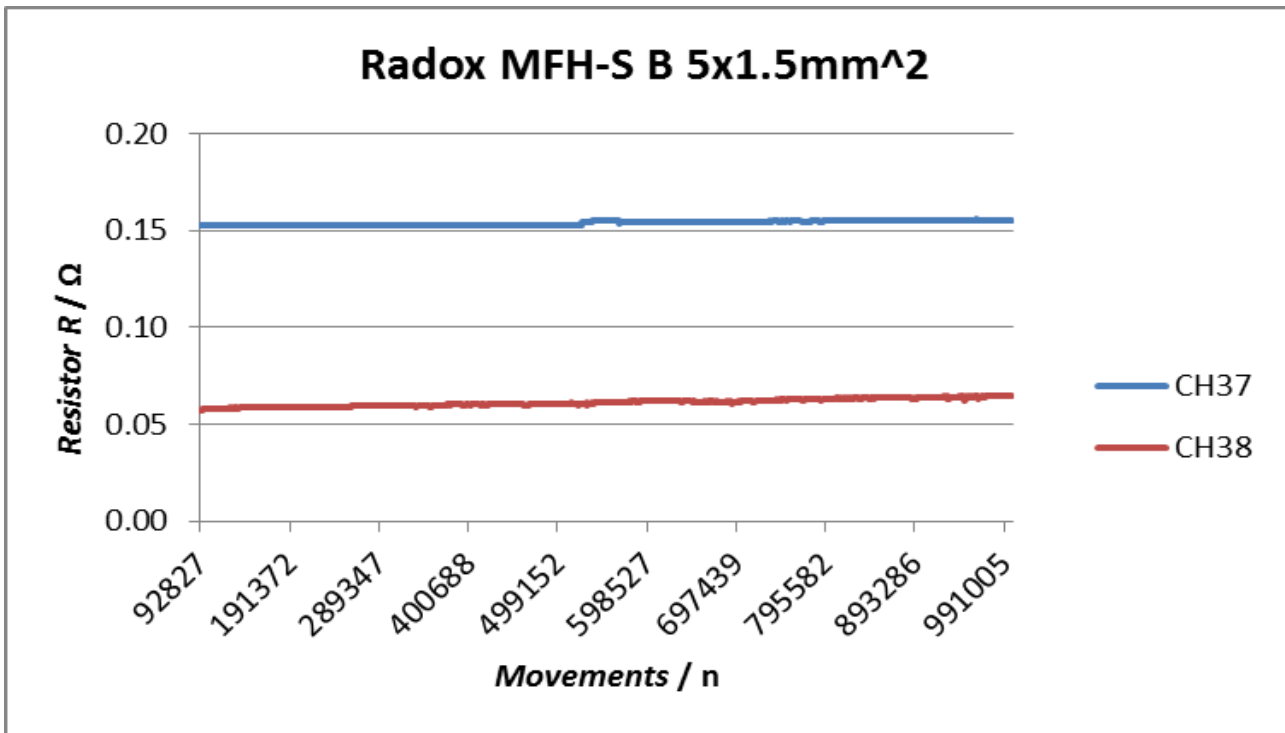




7.2 RADOX MFH-S B 5x1.5mm²



Graph 2 Resistor increase of CH4 (screen)

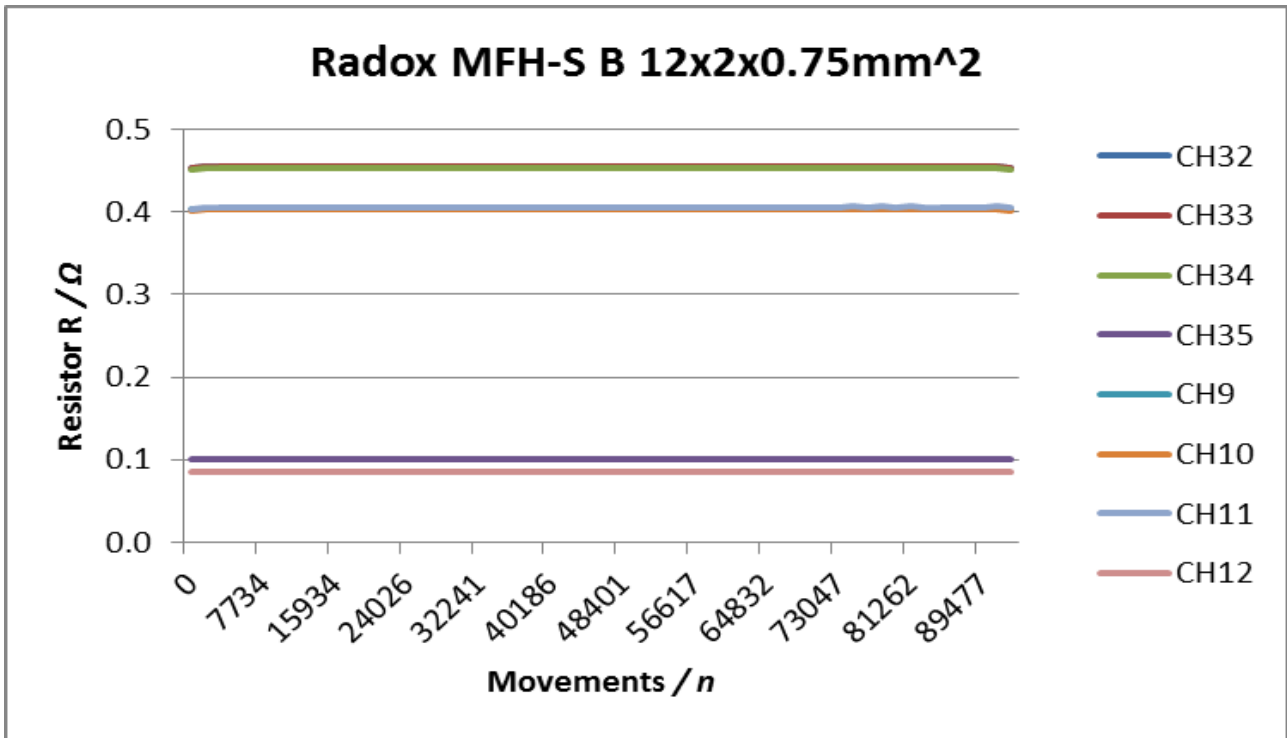


Graph 3 CH 37 & CH 38 reach 1 MM movements (R_{CH36} 113 % after 1 MM cycles)

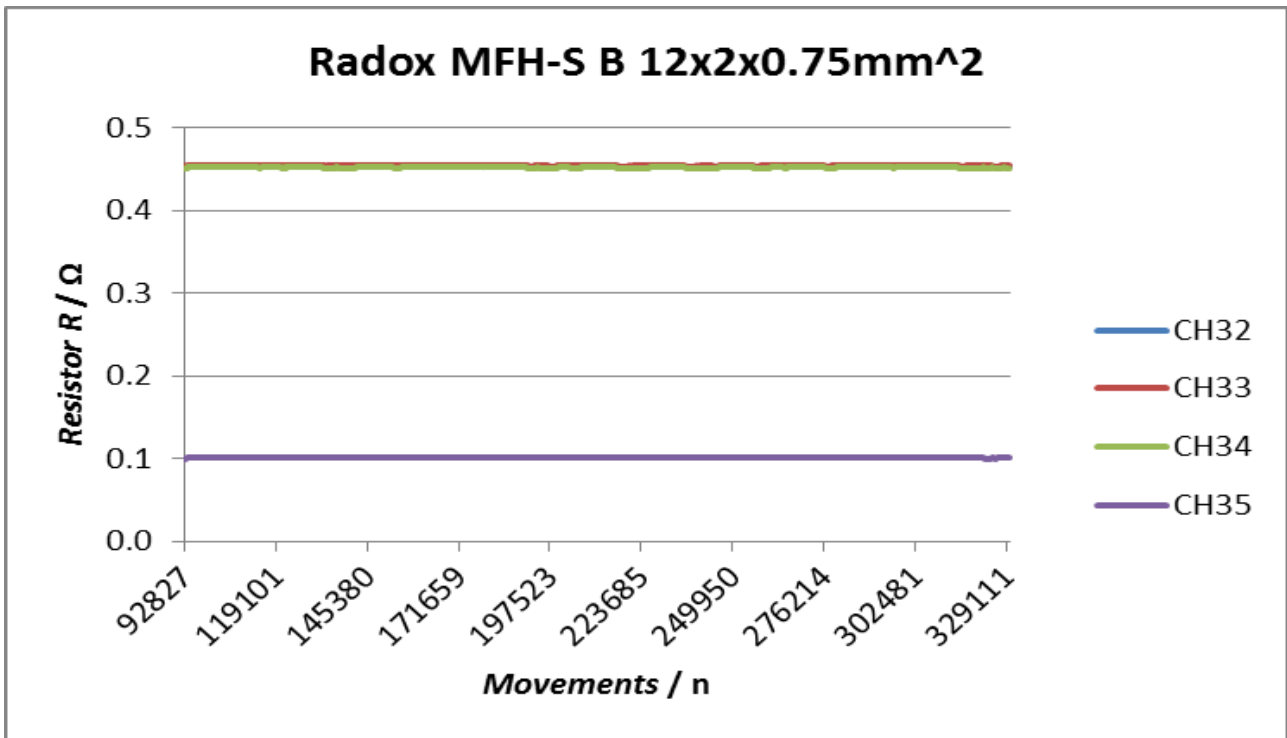




7.3 RADOX MFH-S B 12x2x0.75 mm²



Graph 4 Sample 12x2x0.75 mm², until jacket crack of r = 90 mm

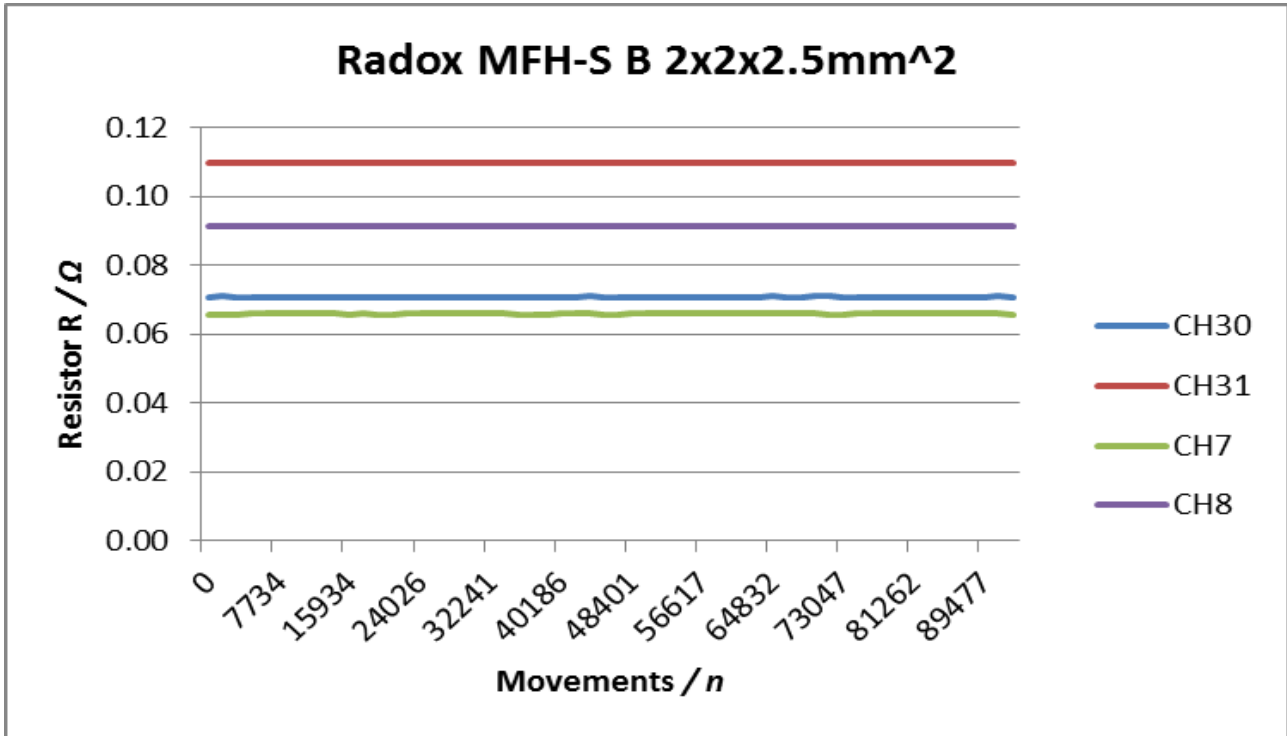


Graph 5 crack of cable sheath of 12x2x0.75 mm², r = 160 mm, after 330'000 cycles

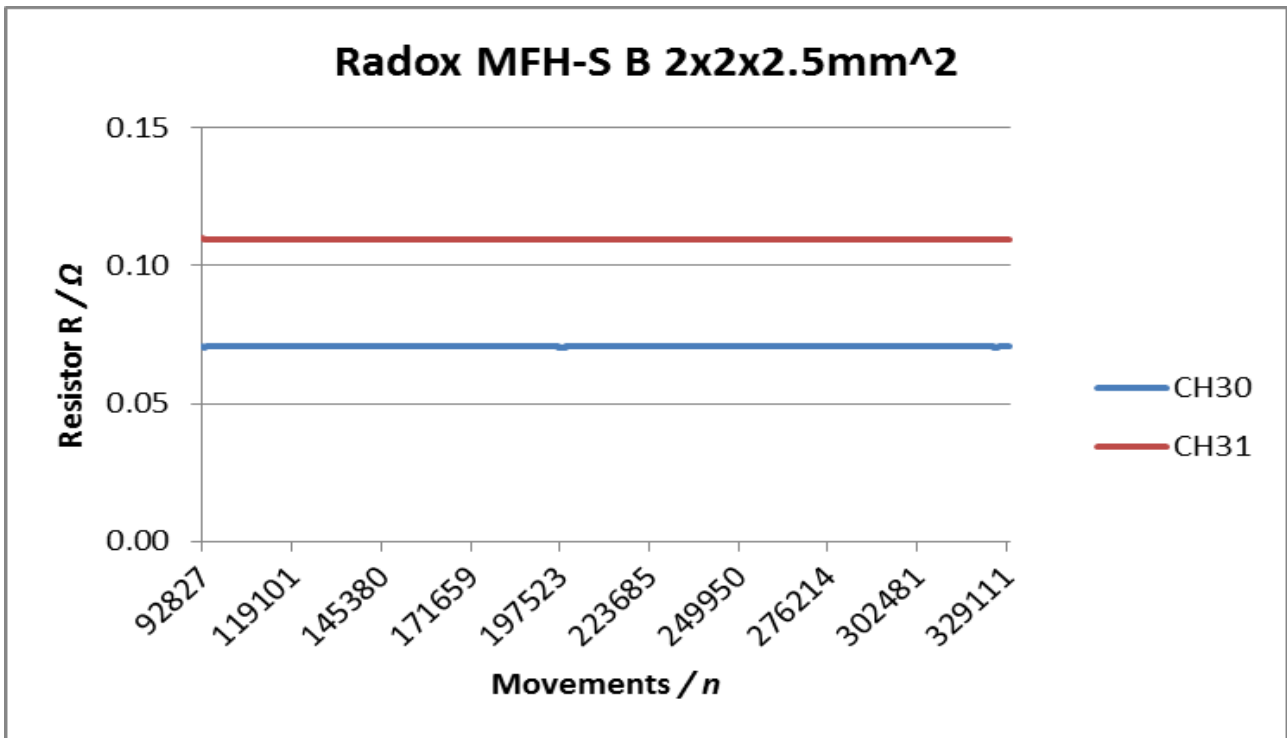




7.4 RADOX MFH-S B 2x2x2.5 mm²



Graph 6 Values of 2x2x2.5 mm² until crack in cable sheath of r = 90 mm

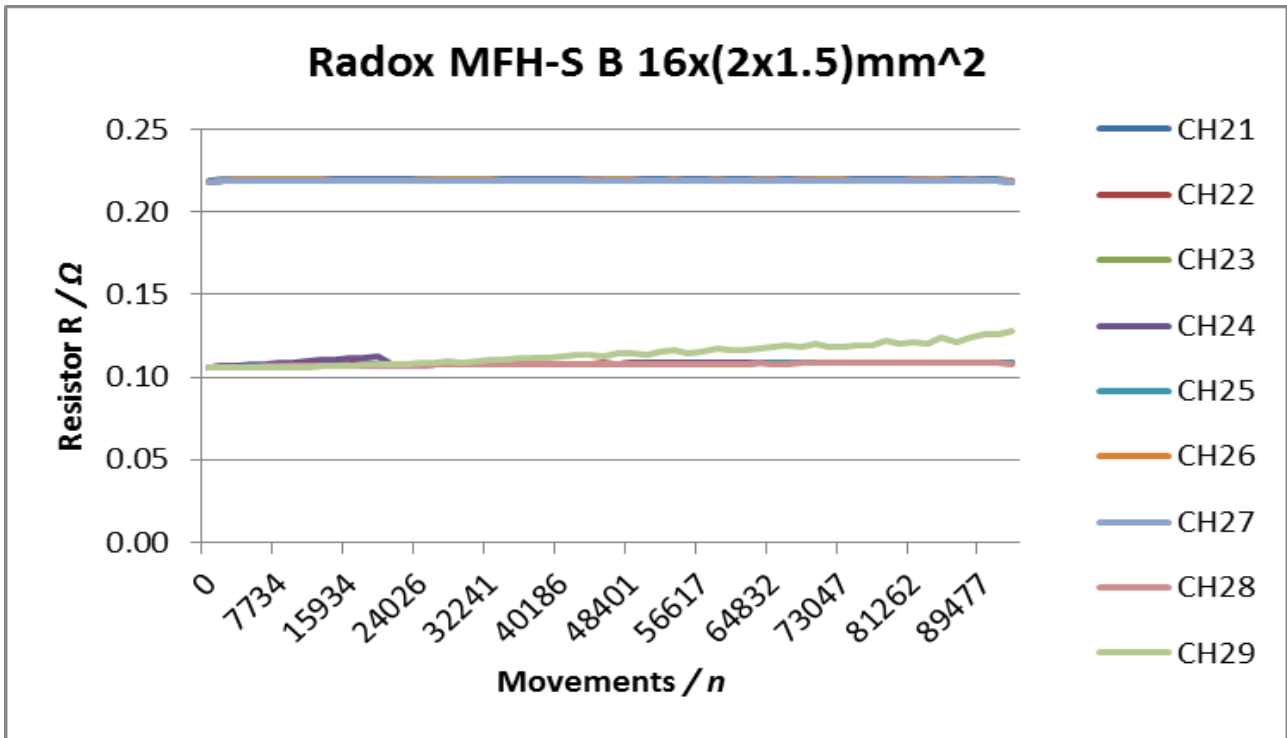


Graph 7 Values of 2x2x2.5 mm², r = 160 mm, until crack on cable sheath

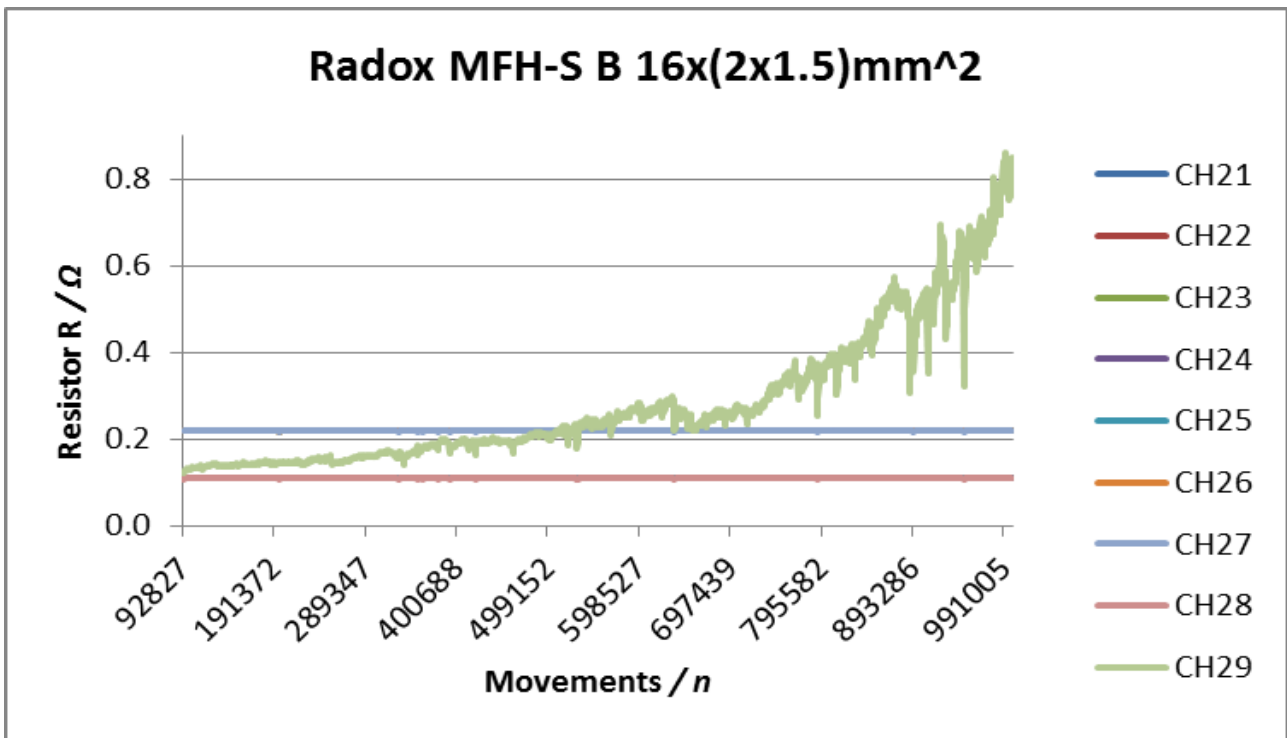




7.5 RADOX MFH-S B 16x(2x1.5) mm²



Graph 8 16(2x1.5) mm², r = 160, until crack on cable sheath



Graph 9 16(2x1.5) mm², r = 280 mm, until 1 MM cycles





7.6 Table resistor increase per chanel

Chanel	Resistor increase	Chanel	Resistor increase
1	< 1%	20	< 1%
2	6 %	21	< 1%
3	< 1%	22	< 1%
4	275 % bei 60'000 Zykl.	23	< 1%
5	< 1%	24	< 1%
6	< 1%	25	< 1%
7	< 1%	26	< 1%
8	< 1%	27	< 1%
9	< 1%	28	< 1%
10	< 1%	29	704 % (200 % nach 541810 Zykl.)
11	< 1%	30	< 1%
12	< 1%	31	< 1%
13	< 1%	32	< 1%
14	1 %	33	< 1%
15	< 1%	34	< 1%
16	< 1%	35	< 1%
17	< 1%	36	30 %
18	1 %	37	2 %
19	7 %	38	13 %

Table 6 Resistor increase in percent





8. Appendix



Figure 2 crack on cable sheath of $16(2 \times 1.5) \text{ mm}^2$, bending radius 160 mm

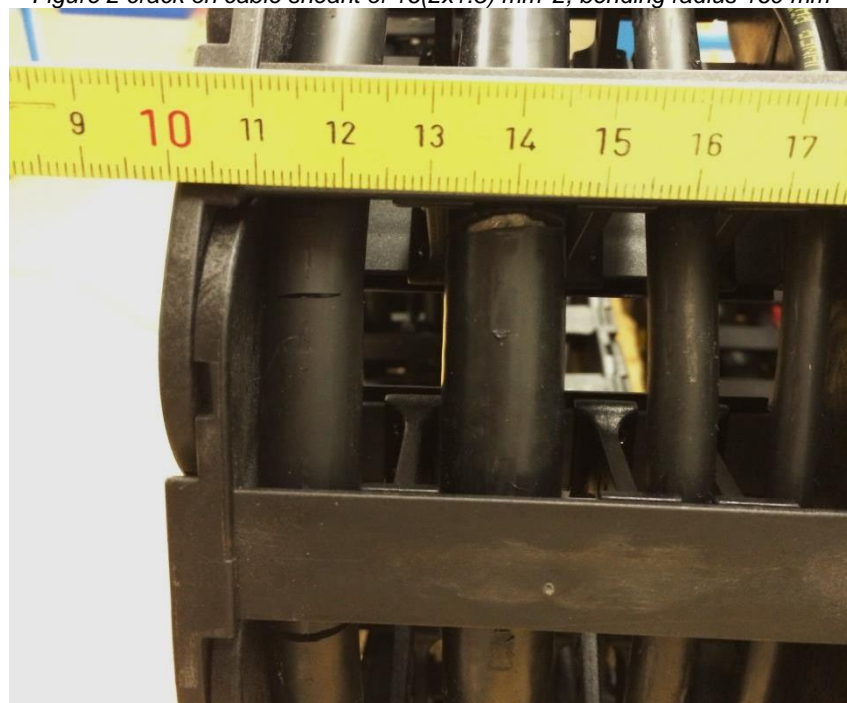



Figure 3 crack in cable sheath of $12 \times 2 \times 0.75 \text{ mm}^2$ and $2 \times 2 \times 2.5 \text{ mm}^2$ (f.l.t.r), bending radius 90 mm



	Testbericht PL140665	Dok. Nr.: PL140665 Datum: 19.01.2015 Seite: 16 von 21
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RADOX MFH-S B

Multi Core Cables 0.5mm² - 6mm²

General Properties

Mud, diesel fuel, oil, ozone, hydrolysis and weather resistant. Excellent flexibility, light weight, halogen free, flame retardant, easily strippable.

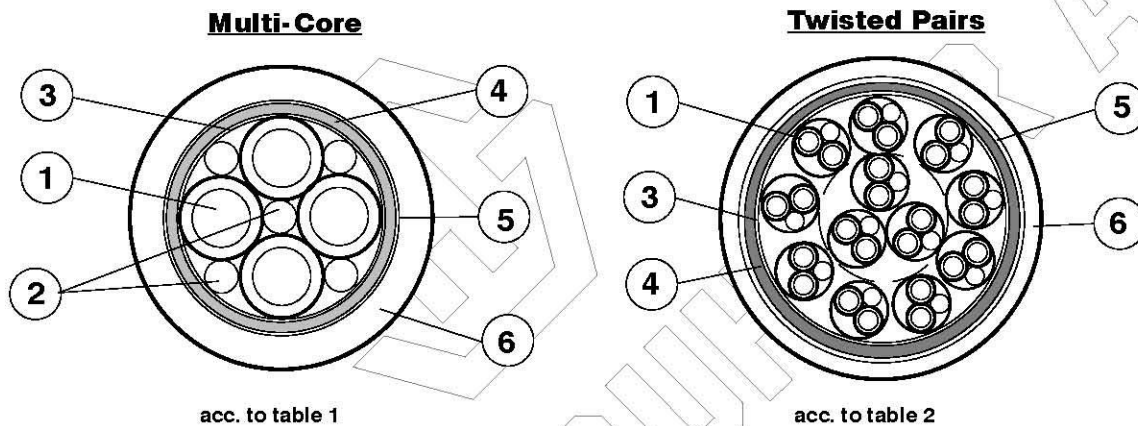
Application

Highly flexible cable for fixed and free installations of power, control and lighting applications in harsh environments like diesel engines, ships, oil rigs and other offshore units.

Resistant to oil and drilling fluids according to NEK TS 606.

Suitable for moving cable Carriers; flexible up to - 40 °C and - 50 °C for fixed installation.

General Composition of cables :



- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Cores RADOX type MA14 Pair screen (optional) Drain wire (optional) 2. Center und Fillers (optional) 3. Wrapping 4. Screen 5. Wrapping 6. Sheath | <p>Conductor: stranded tin plated copper
 Insulation: RADOX TI301
 Colours: see table 1-2
 Plastic laminated Al-tape
 Stranded tin plated copper</p> <p>RADOX 125 REC</p> <p>Tape</p> <p>Tin plated copper braid, coverage density: ≥ 90%</p> <p>Tape</p> <p>RADOX Elastomer S FH (SHF2, SHF mud), colour : black
 D : see table 1-2</p> |
|---|---|

Cable marking: HUBER+SUHNER RADOX MFH- S B 0.6/1 KV n x mm² SHF2 SHF MUD 90C

IEC 60332- 1-2 IEC 60332- 3- 22 00000000- %%%-%- ##- @@@@
└─── Week - Year
└─── Production lot number
└─── Item number

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RADOX MFH-S B

Multi Core Cables 0.5mm² - 6mm²

Technical data:

Rated voltage a.c. U_0/U	600/1000	V
Max. voltage a.c. U_{0m}/U_m	720/1200	V
Max. voltage d.c. conductor to earth	900	V
Max. voltage d.c. conductor to conductor	1800	V
Test voltage a.c.	3 500	V
Test voltage d.c.	8 400	V
Max. rated conductor temperature normal operation IEC 60092	90	°C
Temperature index of insulation TI/20kh	> 145	°C
Temperature index of sheath TI/20kh	> 120	°C
Max. storage temperature	40	°C
Min. installation and handling temperature	- 40	°C
Min. storage temperature	- 50	°C
Min. bending radius	fixed installation	$D \leq 12$ mm 3 x D
		$D > 12$ mm 4 x D
	free movement	$D \leq 12$ mm 5 x D
		$D > 12$ mm 6 x D

The cables pass the following fluid tests

Drilling fluid resistance for SHF mud	Fulfilled	NEK TS 606, 4.1.1
Mineral oil type IRM 903	7 d / 100 °C	NEK TS 606, 4.1.2
Calcium bromide brine (45 % w/w CaBr ₂ / H ₂ O)	56 d / 70 °C	NEK TS 606, 4.1.2
Base oil EDC 95- 11	56 d / 70 °C	NEK TS 606, 4.1.2

Drilling fluid resistance	Fulfilled	IEC 60092- 360
Mineral oil type IRM 902	24 h / 100 °C	IEC 60811- 2- 1, 10
Mineral oil type IRM 902	7 d / 100 °C	IEC 60092- 360, An. C
Mineral oil type IRM 903	7 d / 100 °C	IEC 60092- 360, An. C
Calcium bromide brine (45 % w/w CaBr ₂ / H ₂ O)	56 d / 70 °C	IEC 60092- 360, An. D

The cables pass the following fire tests

Fire protection in ships	Fulfilled	IEC 60092- 350 + DNV 827.11
Vertical flame spread of a single cable	$50 < L \leq 540$ mm	IEC 60332- 1- 2
Vertical flame spread of bunched cables	$L \leq 2.5$ m	IEC 60332- 3- 22 Cat. A
Smoke density	$T \geq 70$ %	IEC 61034- 2
Corrosivity of combustion gases	$pH \geq 4.3, C \leq 10$ µS/mm	IEC 60754- 2
Amount of halogen acid gas	$HCl+HBr+HJ \leq 0.5\%$	IEC 60684- 2, 45.1
Content of fluorine	$HF \leq 0.1$ %	IEC 60684- 2, 45.2
Toxicity	Fulfilled	IMO FTP Code 2010, An.1 Pt.2, 2.4.2



RADOX MFH-S B

Multi Core Cables 0.5mm² - 6mm²

Fire protection on railway vehicles, Level of protection 1 - 4

		DIN 5510
Vertical flame spread	$50 < L \leq 540$ mm	EN 60332- 1- 2
Vertical flame spread, bunched, $D \leq 6$ mm	$L \leq 1.5$ m	EN 50305, 9.1.2
Vertical flame spread, bunched, $6 < D < 12$ mm	$L \leq 2.5$ m	EN 60332- 3- 25 (EN 50305, 9.1.1)
Vertical flame spread, bunched, $D \geq 12$ mm	$L \leq 2.5$ m	EN 60332- 3- 24
Smoke density	$T \geq 60$ %	EN 61034- 2
Corrosivity of combustion gases	$\text{pH} \geq 4.3$, $C \leq 10$ $\mu\text{S}/\text{mm}$	EN 50267- 2- 2
Amount of halogen acid gas	$\text{HCl} + \text{HBr} \leq 0.5\%$	EN 50267- 2- 1
Content of fluorine	$\text{HF} \leq 0.1$ %	EN 60684- 2, 45.2
Toxicity	$\text{ITC} \leq 6$	EN 50305, 9.2

Fire protection on railway vehicles, hazard level

	HL1 - HL3	EN45545
Vertical flame spread	$50 < L \leq 540$ mm	EN 60332- 1- 2
Vertical flame spread, bunched, $D \leq 6$ mm	$L \leq 1.5$ m	EN 50305, 9.1.2
Vertical flame spread, bunched, $6 < D < 12$ mm	$L \leq 2.5$ m	EN 50305, 9.1.1 (EN 60332- 3- 25)
Vertical flame spread, bunched, $D \geq 12$ mm	$L \leq 2.5$ m	EN 60332- 3- 24
Smoke density	$T \geq 70$ %	EN 61034- 2
Toxicity	$\text{ITC} \leq 6$	EN 50305, 9.2

Applicable standards :

DNV 827.11	Type approval programme - Lightweight electric cables
IEC 60092- 350	General construction and test methods of cables for shipboard and offshore applications
NEK TS 606	Cables for offshore installation, halogenfree and/or mud resistant

Approvals :

DNV : Certificate E- 12873



RADOX MFH-S B

Multi Core Cables 0.5mm² - 6mm²

Table 1, Multi Core Cables:

Cable type n x mm ²	Conductor n x diameter mm	Core colours	Pair screen	Drain wire	R ₂₀ max conductor Ω / km	Cable diameter mm	Cable weight nom kg/100m	Overall screen cross section mm ²	H+S Article
3 x 0.5	19 x 0.18	bk, bu, bn	-	-	40.1	5.75±0.3	6.34	2.11	85002705
4 x 0.5	19 x 0.18	bk, bu, bn, gy	-	-	40.1	6.1±0.3	7.05	2.11	85002932
3 x 0.75	19 x 0.23	bk, bu, bn	-	-	26.7	6.3±0.3	7.7	2.11	85002979
4 x 0.75	19 x 0.23	bk, bu, bn, gy	-	-	26.7	6.7±0.3	8.9	2.38	85025142
5 x 0.75	19 x 0.23	bk, bu, bn, gy, light bu	-	-	26.7	7.35±0.3	10.9	2.9	85003007
7 x 0.75	19 x 0.23	bk, bu, bn, gy, light bu, wh, og	-	-	26.7	8.35±0.3	14.1	3.43	85003052
12 x 0.75	19 x 0.23	wh num	-	-	26.7	9.55±0.3	18.8	3.96	85002706
14 x 0.75	19 x 0.23	wh num	-	-	26.7	10.2±0.4	21.6	4.0	85027796
16 x 0.75	19 x 0.23	wh num	-	-	26.7	10.7±0.4	24.0	4.22	84135032
24 x 0.75	19 x 0.23	wh num	-	-	26.7	12.7±0.4	34.2	5.55	85028542
25 x 0.75	19 x 0.23	wh num	-	-	26.7	12.9±0.4	33.6	5.94	85003059
30 x 0.75	19 x 0.23	wh num	-	-	26.7	13.5±0.4	39.7	6.34	84135033
37 x 0.75	19 x 0.23	wh num	-	-	26.7	14.8±0.4	50.0	9.98	85002707
50 x 0.75	19 x 0.23	wh num	-	-	26.7	17.1±0.5	64.8	11.64	84118582
3 x 1.5	37 x 0.23	bk, bu, bn	-	-	13.7	7.45±0.3	11.8	2.9	85003088
4 x 1.5	37 x 0.23	bk, bu, bn, gy	-	-	13.7	8.1±0.3	13.8	3.17	85025144
5 x 1.5	37 x 0.23	bk, bu, bn, gy, light bu	-	-	13.7	8.9±0.3	16.8	3.96	85003089
7 x 1.5	37 x 0.23	bk, bu, bn, gy, light bu, wh, og	-	-	13.7	10.1±0.4	21.7	4.0	85027763
12 x 1.5	37 x 0.23	wh num	-	-	13.7	11.9±0.4	31.4	5.55	85003092
3 x 2.5	37 x 0.29	bk, bu, bn	-	-	8.21	8.6±0.3	15.6	2.9	85025146
4 x 2.5	37 x 0.29	bk, bu, bn, gy	-	-	8.21	9.45±0.3	19.4	3.7	85026777
4 G 2.5	37 x 0.29	gnye, bn, bk, gy	-	-	8.21	9.45±0.3	19.4	3.7	85025147
5 G 2.5	37 x 0.29	gnye, bu, bn, bk, gy	-	-	26.7	10.5±0.4	23.7	4.36	85018986
19 x 2.5	37 x 0.29	wh num	-	-	8.21	17.9±0.5	73.4	10.9	85027823
8x2.5 + 2x0.75	0.29 / 0.23	wh num	-	-	26.7	15.3±0.5	47.7	9.98	85019021



RADOX MFH-S B

Multi Core Cables 0.5mm² - 6mm²

Table 2, Twisted Pairs:

Cable type n x mm ²	Conductor n x diameter mm	Core colours	Pair screen	Drain wire	R ₂₀ max conductor Ω / km	Cable diameter mm	Cable weight nom kg/100m	Overall screen cross section mm ²	H+S Article
4 x 2x 0.5	19 x 0.18	wh num	-	-	40.1	9.25±0.3	14.6	3.7	85028903
5 x 2x 0.5	19 x 0.18	wh num	-	-	40.1	9.75±0.3	16.4	3.96	85018695
10 x 2 x 0.5	19 x 0.18	wh num	-	-	40.1	12.8±0.4	26.1	5.94	85018794
14 x 2 x 0.5	19 x 0.18	wh num	-	-	40.1	14.1±0.4	34.8	9.98	85018853
21 x 2 x 0.5	19 x 0.18	wh num	-	-	40.1	17.7±0.5	51.1	11.64	85025951
2 x 0.75	19 x 0.23	bk, bu	-	-	26.7	6.3±0.3	7.0	2.11	85002975
(2 x 0.75)	19 x 0.23	bk, bu	yes	-	26.7	6.3±0.3	7.42	2.11	85016844
2 x (2 x 0.75)	19 x 0.23	bk, bu, bn, gy	yes	yes	26.7	9.5±0.3	15.7	3.96	85018684
4 x (2 x 0.75)	19 x 0.23	wh num	yes	yes	26.7	10.5±0.3	21.3	4.75	85018685
4 x 2 x 0.75	19 x 0.23	wh num	-	-	26.7	10.4±0.4	18.6	3.96	85025307
8 x 2 x 0.75	19 x 0.23	wh num	-	-	26.7	14.6±0.4	37.9	9.98	85003074
8 x (2 x 0.75)	19 x 0.23	wh num	yes	yes	26.7	15.4±0.4	41.1	6.34	85016458
12 x 2 x 0.75	19 x 0.23	wh num	-	-	26.7	15.6±0.5	43.9	9.98	85002708
12 x (2 x 0.75)	19 x 0.23	wh num	yes	yes	26.7	17.1±0.5	54.0	11.64	85016479
16 x (2 x 0.75)	19 x 0.23	wh num	yes	yes	26.7	18.7±0.5	66.5	13.3	* 85018686
5 x 2 x 1.0	19 x 0.26	wh num	-	-	20.0	12.1±0.4	26.1	5.55	85018964
2 x 1.5	37 x 0.23	bk, bu	-	-	13.7	7.15±0.3	10.0	2.38	85003086
(2 x 1.5)	37 x 0.23	bk, bu	yes	-	13.7	7.1±0.3	10.1	2.11	85016845
2 x (2 x 1.5)	37 x 0.23	bk, bu, bn, gy	yes	yes	13.7	11.7±0.3	24.6	5.15	85018688
4 x (2 x 1.5)	37 x 0.23	wh num	yes	yes	13.7	12.8±0.3	33.6	5.94	85018689
8 x (2 x 1.5)	37 x 0.23	wh num	yes	yes	13.7	19.5±0.5	72.4	13.86	* 85018690
12 x (2 x 1.5)	37 x 0.23	wh num	yes	yes	13.7	20.9±0.4	87.4	14.96	* 85018691
16 x (2 x 1.5)	37 x 0.23	wh num	yes	yes	13.7	24.0±0.5	122.2	16.63	* 85018446
2 x 2.5	37 x 0.29	bk, bu	-	-	8.21	8.2±0.3	13.6	2.64	85003100
(2 x 2.5)	37 x 0.29	bk, bu	yes	-	8.21	8.25±0.3	13.6	2.11	85016525
2 x 2 x 2.5	37 x 0.29	bk, bu, bn, gy	-	-	8.21	13.7±0.4	28.7	5.55	85003101
2 x (2 x 2.5)	37 x 0.29	bk, bu, bn, gy	yes	yes	8.21	13.9±0.4	33.0	5.15	85016533
3 x 4	56 x 0.30	bk, bu, bn	-	-	4.8	9.8±0.3	22.0	3.7	* 85026490
2 x 2 x 4	56 x 0.30	bk, bu, bn, gy	-	-	4.8	16.6±0.5	46.8	9.98	* 85016574
2 x 6	84 x 0.30	bk, bu	-	-	3.2	10.7±0.4	24.4	4.36	* 85019004
2 x 2 x 6	84 x 0.30	bk, bu, bn, gy	-	-	3.2	18.9±0.5	58.9	13.3	* 85016580
3 x 6	84 x 0.30	bk, bu, bn	-	-	3.2	11.3±0.4	30.1	4.22	* 85026510

* certification pending