KME ITALY SpA

HANDBOOK OF

ELECTRIC CABLES - MICO

Fourth issue - 1998

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GENERAL INTRODUCTION

The quality of an electric installation depends on its correspondence to the norms, on technical ability of installer and planner, but also on the behaviour of electrical devices, both in standard and critical conditions.

It's up to norm emitter defining minimum condition under which some devices must work; certification Institutes must verify this conditions to be satisfied during real manufacture; both complex and easy (therefore less critical) structured devices must be subjected to this general rule.

MICO cable (Mineral Insulated Cable) belongs to electric cables class, as to say a standard and every-day use product class; on the other hand safety problems hardly concern just electric conduits, because of their characteristic of passing through different environments; so the research of new solutions becomes real significant also in this undervalued field, but vital for the working of a wide range of safety devices that are necessary during particular situations when reliability becomes critical and unreplaceable.

MICO CABLE: WITH MINERAL INSULATION

In the following section will be made a detailed description of dimensional and electric characteristics of the cable, on the contrary this introduction means to list all general principles that suggest MICO installation.
MICO is qualified from Italian norms as **FIRE RESISTANT**, as to say manufactured in order to pass the test described in CEI 20-36 norm and this fact is verified from IMQ when it certifies the correspondence to CEI 20-39/1 manufacturing norm where tests of CEI 20-36 norm are required.
CEI 20-36 norm has been emitted to simulate fire conditions and to prove which cables pass this event.
During this test a cable sample lays over a burner and it's warmed up to 750℃ for 3 hours, at one end the cores are separated, at the other they are supplied with rated voltage and protected by 3 A fuses.
If no fuse switch off, the cable is "Fire Resistant" qualified.

Other countries have harder firetests than this: in U.K. the cable, supplied with rated voltage and protected by 3 A fuses, must be warmed by a flame up to 950℃ for 3 hours, then it's quickly cooled by water spray and, at last, must be mechanically stressed while it's bended following a "**S**" shape.
This test simulate the action of sprinklers or pumps during a fire and the drop of structures which can hit the cable if it's laid without protection: when a cable passes this test, it's qualified **CWZ** (BS 6387 norm).
It's not up to us to state that this test is much harder than CEI 20-36 norm: during this latter, the cable is supported by 2 metal rings above the burner and it doesn't move, so even if the insulator carbonizes, it remains between the conductors and keeps the insulation high; during the first one the cable is water sprinkled and beaten by a little metal bar, so insulator cracks and conductors are no longer insulated.
MICO cables pass both firetest in CEI 20-36 norm and CWZ test in BS 6387 norm, where temperature goes up to 950℃, simulating temperatur es that can be reached during a fire.

On the contrary Australian standard requires the cable to be warmed up to 1050℃ inside a furnace and then cooled by water sprinkling; differently from all the others, here the cable must be tested togheter with all fixing systems at sight like channels, clips, clamps: there is the clear willing to test a complete installation system in a real situation and not a series of separate devices which could pass the test, if lonely, but could cause some troubles once they are installed.

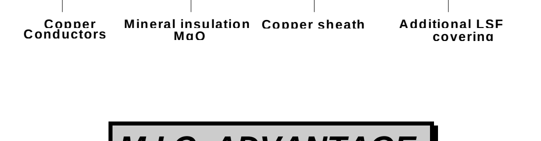
It's needless to point out that MICO cables pass also this test but it's important to understand that, though the normative interpretations are different, their aim is the same: defining a representative test simulating fire effects, as realistic as it can, and verifing the effects on complete conduit, more exactly on "**At sight Conduit System**"; less critical are the problems related to walled up cables, because in this case fire resistance is given from wall structure and from its REI.

Even Firemen had tested MICO cables to verify their structural fire behaviour following the time-temperature curve of circular letter nr. 91 on 14 September 1961.
DM 30.11.1983 states that "Fireproof Compartment" is "the building part with predetermined fire resistant building materials as boundaries and organized to answer to fire prevention needs", so if MICO cables go through a fireproof compartment, they must keep the same characteristics and peculiarities and behave themselves like all the other materials making up fireproof compartment wall.
This test has been performed at Research and Test Center of Home Office - Capannelle (Roma),where it's been declared that our cable behaves itself like a building structural component (REI 90).

So we have a great number of examples where MICO cable has been proved in most different and unfavourable conditions, anyway obtaining always good results because of its structure; therefore its performance wouldn't be discussed but what we'd like to point out is that MICO cable offer a complete and already avalaible solution for any installation requiring at sight layout: in fact we can say that MICO cable is a **complet conduit more than a simple electric cable**.
This statement could seem quite riskly, especially if we think about standard conduit definition: "Group made up by one or more electric conductors and by all the components assuring their insulation, support, fixing and their eventual mechanical protection" (CEI 64-8/2 norm, section 26.1); but, analysing the previous definition, MICO cable, laid at sight with its copper clips, matches all these requires and moreover it's characterized by a fire resistance which has been verified during many and different conditions.

We have noticed that norm Institutes best worry is to make a test to simulate fire conditions the best they can, so to foresee the performance of the cable and to be sure that cables passing this test assure their working also under real condition.
Waiting for a different norms agreement to find a compromise between manufacturer and safety needs, a real solution is already avalaible: MICO cable offer absolutely great performances and anticipates future development.

MICO: MINERAL INSULATED CABLE



M.I.C. ADVANTAGE

For its exclusive manufacturing method, MICO cable following properties allow this conduit to be a sure and lasting solution and assure unique performances wherever it's used:

- MICO doesn't deteriorate with age (because insulator doesn't oxidize);
- its current capacity is higher than other cables with equal cross-section (because it doesn't stand high temperature);
- resists to overload and short circuit current without being damaged (because it doesn't stand high temperature);
- doesn't propagate the flame (because it doesn't burn);
- doesn't propagate the fire(because it doesn't burn);
- doesn't produce toxic or corroding smokes or gases (because it doesn't burn);
- keep on working during the fire (because it doesn't burn).

Further good qualities due to cable geometry can join to above mentioned thermal nature advantages:

- outer sheath acts like protection conductor (therefore this latter is concentric, with all relative advantages);
- concentric protection conductor sorround active conductors avoiding any electric arc outside the cable, preventing them to be touched or mechanically damaged.

Each time a conductor element tries to access the internal part of the cable, this causes a short circuit and the following protection devices switch on.
The external sheath of the copper cable and the highly pressed mineral insulator make up a greatly resistant screen towards external mechanical stress..
To assure it, it's enough to hammer the cable and verify sheath integrity; such mechanical properties make the cable "autonomous" because it can be directly externally laid , with no need of protection tubes.
Coaxial configuration of M.I.C. gives another, generally unknown but very important, advantage.
In TN systems, as to say the ones supplied with their own transformer room, for an earth damage anywhere in the electric installation, the following condition must be satisfied: $U_0 / Z_S > I_a$ where U_O is a.c. rated voltage (V_{eff} between phase and earth), I_a is the current which makes protection devices switch on within 5 seconds and Z_S è is the damage ring impedance (CEI 64-8 norm, art. 413.1.3).
Impedance Z_S is composed by a resistive and a reactive component: this latter is minimized for coaxial configuration.
This means that with MICO is easier to satisfy this condition, especially when the installation is very wide.

It's not enough: during earth damage the voltage on the masses is lower than ordinary cables, because the concentric protection conductor show a lower reactance than phase conductor.
At last, we can sum up further advantages of MICO cable this way:

- it cannot start a fire or cause indirect contacts (because the conductors are screened from sorrounding environment by concentric protection conductor);
- it doesn't need protective tube (because its mechanical resistance is similar to a metallic tube one);
- it has minimum damage ring impedance and minimum contact voltage (because it's a coaxial cable).

The pleasant aesthetical look is another advantage of M.I.C., that is common to all copper objects.
In places where it's not allowed to break the walls to embed the conduit, for example in monumental buildings, the copper sheath cable is the ideal solution, while a zinc plated steel tube or a metal or PVC channel would be aesthetically unacceptable.

MANUFACTURING PROCESS

It's interesting to summariza the manufacturing process of MICO cable, to give users the chance to clearly appreciate the properties of its materials, which grant different characteristics from traditional insulation cables.
Starting to analyse material components, the starting assembly is made with large diameter, continous and weldless copper tubes, and one or more copper rods; their relative proportion is the same they will have later on, when the cable is finished.
Magnesium Oxide powder, after a previous complex treatment, is such compressed to form small cylindrical blocks, with a central lenghtwise hole to allow the right numbers of connectors to be pushed in.

This manufacturing method assures a high degree of precision and uniformity of insulator thickness between conductors and between conductors themselves and the outer sheath.
After above mentioned components assembly, the tube is drawn, step by step with the necessary intermediate annealing, until we obtain the same cable dimensions imposed by the manufacturing norm.
After the coiling of the cables, the last action is an annealing to normalize internal mechanical stresses and to assure the most suitable and uniform handy characteristics.

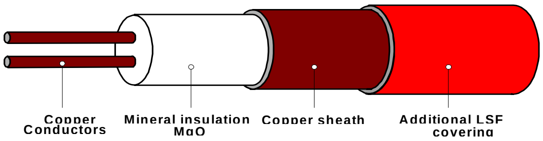
FIRST SECTION

DIMENSIONAL AND ELECTRIC CHARACTERISTIC

GENERAL CHARACTERISTICS

Mineral Insulated Cables are formed by:

- outer, continous and weldless sheath, made by a DHP copper tube, with melting point of 1083℃;
- Magnesium Oxide insulator, hardly compressed, with melting point of 2800℃;
- annealed conductors in ETP 99,9 electrolitic copper wire, with melting point of 1083℃.



Power M.I. cables made by E.M. are supplied, on request, with an additional LSF (with polyolefin base) outer covering, conforming to CEI 20-22 standard, with low emission of opaque flue gases and cianoalogenidrici gas according to CEI 20-37 & CEI 20-38 norms (see attached IMQ certificates).

The covering can be necessary in one of the following cases:

- to garantee protection to the copper sheath in corrosive enviroment;
- if copper sheath of the cable is used as PEN conductor;
- to make easier the identification of the circuit by the color;
- for aestethical reasons (in rooms with particular requirements);
- when cables must be laid underground or directly put under plaster.

CORRESPONDENCE TO THE MANUFACTURING NORMS

M.I. Cables made by KME ITALY are in conformity with the following manufacturing norms:

- ITALY CEI 20-39/1 - 1995 / **IMQ** certificate (see enclosed);
- U.K. BS 6207 - 1995 / **BASEC** certificate;
- GERMANY DIN VDE 0284-1 - 1995 / **VDE** certificate.

The following tables and the attached IMQ certificates refer to the above mentioned norms that are the national acknowledgements of the harmonized document CENELEC HD 586.1 S1 / 1994; among different type tests, these norms provide for conformity to the CEI 20-36 norm (IEC 331).
For this reason M.I.C. is classified “fireproof”
Procedures to verify the production quality conform to what it’s required by UNI/EN 29000 & UNI/EN 29002 norms (see attached)

For what concerns the essential security requirements, our M.I.C. conforms to the “low voltage” norm Nr. 72/23/EEC modified with Nr. 90/683/EEC. Therefore starting from Jan. 1st 1997, the cables packing has CE mark, as required by the above mentioned norm.

DIMENSIONAL CHARACTERISTICS

Nominal diameter over copper sheath

Rated Voltage	Cross-Section mm²	***Nominal diameter over copper sheath* (mm) ± 0,05**						
		1 cond	2 cond	3 cond	4 cond	7 cond	12 cond	19 cond
500 V	1		5,1	5,8	6,3	7,6		
	1,5		5,7	6,4	7,0	8,4		
	2,5		6,6	7,3	8,1	9,7		
	4		7,7					
750 V	1,5	4,9	7,9	8,3	9,1	10,8	14,1	16,6
	2,5	5,3	8,7	9,3	10,1	12,1	15,6	
	4	5,9	9,8	10,4	11,4			
	6	6,4	10,9	11,5	12,7			
	10	7,3	12,7	13,6	14,8			
	16	8,3	14,7	15,6	17,3			
	25	9,6	17,1	18,2	20,1			
	35	10,7						
	50	12,1						
	70	13,7						
	95	15,4						
	120	16,8						
	150	18,4						
	185	20,4						
	240	23,3						
	300	26,0						
	400	30,0						

Nominal conductors diameter

Cross-section (mm²)	1	1,5	2,5	4	6	10	16	25	35
Diameter (mm)	1,13	1,38	1,78	2,26	2,76	3,57	4,51	5,64	6,68

Cross-section (mm²)	50	70	95	120	150	185	240	300	400
Diameter (mm)	7,98	9,44	11,00	12,36	13,82	15,35	17,48	19,54	22,56

Mean copper sheath thickness

Rated Voltage	Cross-Section mm²	***Mean copper sheath thickness* (mm) - 10%**						
		1 cond.	2 cond.	3 cond.	4 cond.	7 cond.	12 cond.	19 cond.
500 V	1		0,41	0,45	0,48	0,52		
	1,5		0,43	0,48	0,50	0,54		
	2,5		0,49	0,50	0,54	0,61		
	4		0,54					
750 V	1,5	0,41	0,54	0,56	0,59	0,65	0,76	0,84
	2,5	0,42	0,57	0,59	0,62	0,69	0,81	
	4	0,45	0,61	0,63	0,68			
	6	0,48	0,65	0,68	0,71			
	10	0,50	0,71	0,75	0,78			
	16	0,54	0,78	0,82	0,86			
	25	0,60	0,85	0,87	0,93			
	35	0,64						
	50	0,69						
	70	0,76						
	95	0,80						
	120	0,85						
	150	0,90						
	185	0,94						
	240	0,99						
	300	1,08						
	400	1,17						

Nominal insulation thickness (MgO)

Rated Voltage	Cross-Section mm²	***Nominal insulation thickness* (mm) -0,1÷+20%**						
		1 cond.	2 cond.	3 cond.	4 cond.	7 cond.	12 cond.	19 cond.
500 V	1		0,65	0,75	0,75	0,75		
	1,5		0,65	0,75	0,75	0,75		
	2,5		0,65	0,75	0,75	0,75		
	4		0,65					
750 V	1,5	1,3	1,3	1,3	1,3	1,3	1,3	1,3
	2,5	1,3	1,3	1,3	1,3	1,3	1,3	
	4	1,3	1,3	1,3	1,3			
	6	1,3	1,3	1,3	1,3			
	10	1,3	1,3	1,3	1,3			
	16	1,3	1,3	1,3	1,3			
	25	1,3	1,3	1,3	1,3			
	35	1,3						
	50	1,3						
	70	1,3						
	95	1,3						
	120	1,3						
	150	1,3						
	185	1,4						
	240	1,6						
	300	1,8						
	400	2,1						

Cable weight without additional covering

Rated Voltage	Cross-section mm²	*Cable weight without additional covering* (kg/m)						
		1 cond	2 cond	3 cond	4 cond	7 cond	12 cond	19 cond
500 V	1		0,100	0,128	0,150	0,237		
	1,5		0,120	0,158	0,190	0,285		
	2,5		0,176	0,210	0,265	0,395		
	4		0,240					
750 V	1,5	0,093	0,212	0,242	0,298	0,409	0,685	0,870
	2,5	0,113	0,260	0,311	0,367	0,550	0,835	
	4	0,141	0,342	0,399	0,472			
	6	0,172	0,427	0,507	0,623			
	10	0,235	0,582	0,728	0,861			
	16	0,319	0,845	0,980	1,225			
	25	0,443	1,138	1,370	1,752			
	35	0,573						
	50	0,764						
	70	1,005						
	95	1,270						
	120	1,570						
	150	1,883						
	185	2,315						
	240	3,020						
	300	3,760						
	400	5,006						

Cable weight with additional LSF covering

Rated Voltage	Cross-Section mm²	*Cable weight with additional LSF covering* (kg/m)						
		1 cond	2 cond	3 cond	4 cond	7 cond	12 cond	19 cond
500 V	1		0,121	0,151	0,175	0,272		
	1,5		0,143	0,184	0,218	0,322		
	2,5		0,202	0,243	0,301	0,437		
	4		0,274					
750 V	1,5	0,110	0,243	0,274	0,333	0,455	0,746	0,968
	2,5	0,130	0,298	0,352	0,411	0,602	0,927	
	4	0,164	0,385	0,444	0,521			
	6	0,198	0,474	0,556	0,677			
	10	0,268	0,636	0,786	0,923			
	16	0,356	0,907	1,069	1,326			
	25	0,485	1,238	1,476	1,895			
	35	0,619						
	50	0,816						
	70	1,063						
	95	1,358						
	120	1,668						
	150	1,990						
	185	2,460						
	240	3,186						
	300	3,936						
	400	5,199						

Commercial Lenght

Rated Voltage	Cross-Section mm²	***Commercial Lenght*** **± 5% (m)**						
		1 cond	2 cond	3 cond	4 cond	7 cond	12 cond	19 cond.
500 V	1		1800♦	1500♦	1200♦	800		
	1,5		1400♦	1100♦	900♦	600		
	2,5		1100♦	900♦	700♦	500		
	4		800♦					
750 V	1,5	1500	750	670	560	385	210	150
	2,5	1300	610	520	445	310	175	
	4	1050	480	420	350			
	6	1200	370	345	270			
	10	950	280	245	205			
	16	730	205	180	145			
	25	540	150	135	110			
	35	440						
	50	350						
	70	275						
	95	215						
	120	185						
	150	155						
	185	125						
	240	98						
	300	80						
	400	80						

♦ For prompt delivery 100 metres coils are ready in warehouse.

Internal coils diameter

Rated Voltage	Cross-Section mm²	**Internal coils diameter (mm)**						
		1 cond	2 cond	3 cond	4 cond	7 cond.	12 cond.	19 cond.
500 V	1		1150	1150	1150	1150		
	1,5		1150	1150	1150	1150		
	2,5		1150	1150	1150	1150		
	4		1150					
750 V	1,5	1150	1150	1150	1150	1450	1450	1450
	2,5	1150	1150	1150	1450	1450	1450	
	4	1150	1150	1450	1450			
	6	1150	1450	1450	1450			
	10	1150	1450	1450	1450			
	16	1150	1450	1450	1450			
	25	1150	1450	1450	1450			
	35	1450						
	50	1450						
	70	1450						
	95	1450						
	120	1450						
	150	1450						
	185	1450						
	240	1450						
	300	1450						
	400	1450						

LSF additional covering thickness

diameter over copper sheath		**covering thickness**	
from	to (included)	minimum	average
mm	mm	mm	mm
-	7	0,45	0,65
7	15	0,54	0,75
15	20	0,75	1,00
20	-	0,96	1,25

ELECTRICAL CHARACTERISTICS

Nominal conductor resistance

Cross-Section (mm²)	1	1,5	2,5	4	6	10	16	25	35
Nominal resistance at 20 ℃ (ohm/km)	17,241	11,494	6,896	4,310	2,835	1,724	1,077	0,690	0,492
Maximum resistance at 20 ℃ (ohm/km)	18,100	12,100	7,410	4,610	3,080	1,830	1,150	0,727	0,524

Cross-Section (mm²)	50	70	95	120	150	185	240	300	400
Nominal resistance at 20 ℃ (ohm/km)	0,344	0,246	0,181	0,143	0,115	0,093	0,072	0,057	0,043
Maximum resistance at 20 ℃ (ohm/km)	0,387	0,268	0,193	0,153	0,124	0,101	0,0775	0,0620	0,0465

If it is necessary, the electrical conductor resistance value, measured at a temperature different from 20 ℃, can be corrected using the following re lation:

$$\mathbf{R20} = \cdot \frac{254{,}5}{234{,}5 + t} \cdot \frac{1000}{L}$$

dove:

t is the cable temperature (℃) during the resistance measurement;
$\mathbf{R_{20}}$ is the cable electric resistance at 20 ℃ (ohm/km);
L is the cable length (m);
$\mathbf{R_t}$ is the cable electric resistance measured at the temperature **t**

Nominal copper sheath resistance

Rated Voltage	Cross-Section mm²	***Nominal copper sheath resistance* (Ω/km)**						
		1 cond	2 cond	3 cond	4 cond	7 cond	12 cond	19 cond
500 V	1		2,855	2,279	1,964	1,491		
	1,5		2,422	1,931	1,689	1,293		
	2,5		1,833	1,614	1,344	0,990		
	4		1,419					
750 V	1,5	2,981	1,381	1,266	1,093	0,832	0,541	0,414
	2,5	2,677	1,184	1,068	0,934	0,697	0,458	
	4	2,238	0,979	0,892	0,753			
	6	1,931	0,824	0,746	0,645			
	10	1,614	0,645	0,569	0,502			
	16	1,310	0,505	0,453	0,388			
	25	1,016	0,397	0,364	0,308			
	35	0,852						
	50	0,697						
	70	0,558						
	95	0,470						
	120	0,405						
	150	0,348						
	185	0,300						
	240	0,248						
	300	0,204						
	400	0,163						

Nominal copper sheath cross-section

Rated Voltage	Cross-Section mm²	***Nominal copper sheath cross-section* (mm²)**						
		1 cond	2 cond	3 cond	4 cond	7 cond	12 cond	19 cond
500 V	1		6,04	7,56	8,77	11,56		
	1,5		7,12	8,92	10,21	13,33		
	2,5		9,40	10,68	12,82	17,42		
	4		12,14					
750 V	1,5	5,78	12,49	13,62	15,77	20,73	31,85	41,59
	2,5	6,44	14,56	16,14	18,46	24,73	37,64	
	4	7,70	17,61	19,34	22,90			
	6	8,93	20,93	23,11	26,74			
	10	10,68	26,74	30,28	34,36			
	16	13,16	34,11	38,07	44,42			
	25	16,96	43,39	47,37	56,01			
	35	20,23						
	50	24,73						
	70	30,89						
	95	36,69						
	120	42,59						
	150	49,48						
	185	57,47						
	240	69,39						
	300	84,55						
	400	105,97						

Copper sheath maximum resistance

Rated Voltage	Cross-Section mm²	***Copper sheath maximum resistance* (Ω/km)**						
		1 cond	2 cond	3 cond	4 cond.	7 cond.	12 cond.	19 cond.
500 V	1		3,950	3,150	2,710	2,060		
	1,5		3,350	2,67	2,330	1,780		
	2,5		2,530	2,230	1,850	1,360		
	4		1,960					
750 V	1,5	4,130	1,900	1,750	1,510	1,150	0,744	0,570
	2,5	3,710	1,630	1,470	1,290	0,959	0,630	
	4	3,090	1,350	1,230	1,040			
	6	2,670	1,130	1,030	0,887			
	10	2,230	0,887	0,783	0,690			
	16	1,810	0,695	0,622	0,533			
	25	1,400	0,546	0,500	0,423			
	35	1,170						
	50	0,959						
	70	0,767						
	95	0,646						
	120	0,556						
	150	0,479						
	185	0,412						
	240	0,341						
	300	0,280						
	400	0,223						

Copper sheath minimum cross-section

Rated Voltage	Cross-Section mm²	***Copper sheath minimum cross-section* (mm²)**						
		1 cond	2 cond.	3 cond	4 cond	7 cond.	12 cond	19 cond.
500 V	1		4,360	5,470	6,360	8,370		
	1,5		5,140	6,450	7,400	9,680		
	2,5		6,810	7,730	9,320	12,670		
	4		8,790					
750 V	1,5	4,170	9,070	9,850	11,420	14,990	23,170	30,240
	2,5	4,640	10,580	11,730	13,360	17,980	27,360	
	4	5,580	12,770	14,010	16,570			
	6	6,450	15,250	16,740	19,430			
	10	7,730	19,430	22,020	24,980			
	16	9,520	24,810	27,720	32,340			
	25	12,320	31,570	34,480	40,760			
	35	14,730						
	50	17,98						
	70	22,48						
	95	26,680						
	120	31,000						
	150	35,990						
	185	41,850						
	240	50,560						
	300	61,570						
	400	77,310						

Light duty multi-core cables (500 V): resistance, reactance & impedance

cable type	Resistance R (Ω/km)			Reactance X (Ω/km)	Impedance Z (Ω/km)		
	30 ℃	70 ℃	105 ℃		30 ℃	70 ℃	105 ℃
2L1	18,811	21,656	24,145	0,088	18,811	21,656	24,145
2L1,5	12,575	14,477	16,141	0,083	12,576	14,477	16,141
2L2,5	7,701	8,866	9,885	0,079	7,702	8,866	9,885
2L4	4,479	5,157	5,749	0,075	4,480	5,157	5,749
3L1	18,811	21,656	24,145	0,091	18,811	21,656	24,145
3L1,5	12,575	14,477	16,141	0,086	12,576	14,477	16,141
3L2,5	7,701	8,866	9,885	0,079	7,702	8,866	9,885

Above indicated values are valid also for multi-core cables with 4 & 7 conductors

Heavy duty two-core cables (750 V): resistance, reactance & impedance

cable type	Resistance R (Ω/km)			Reactance X (Ω/km)	Impedance Z (Ω/km)		
	30 ℃	70 ℃	105 ℃		30 ℃	70 ℃	105 ℃
2H1,5	12,575	14,477	16,141	0,101	12,576	14,478	16,142
2H2,5	7,701	8,886	9,885	0,094	7,702	8,866	9,885
2H4	4,791	5,516	6,150	0,088	4,792	5,516	6,150
2H6	3,200	3,685	4,109	0,083	3,201	3,686	4,110
2H10	1,902	2,190	2,441	0,079	1,904	2,191	2,442
2H16	1,195	1,376	1,534	0,075	1,198	1,378	1,536
2H25	0,756	0,870	0,970	0,073	0,759	0,873	0,973

Above indicated values are valid also for all the other types of multi-core cables (with 3, 4 ,7, 12 & 19 conductors).

Single-core triplet cables: resistance, reactance & impedance

cable type	Resistance R (Ω/km)			Reactance X (Ω/km)	Impedance Z (Ω/km)		
	30 ℃	70 ℃	105 ℃		30 ℃	70 ℃	105 ℃
1H1,5	12,576	14,478	16,142	0,139	12,577	14,478	16,142
1H2,5	7,702	8,866	9,885	0,128	7,703	8,867	9,886
1H4	4,792	5,516	6,15	0,120	4,793	5,518	8,650
1H6	3,202	3,686	4,109	0,112	3,204	3,687	4,111
1H10	1,903	2,190	2,442	0,104	1,906	2,193	2,444
1H16	1,196	1,377	1,535	0,098	1,200	1,380	1,538
1H25	0,757	0,871	0,971	0,093	0,763	0,876	0,975
1H35	0,546	0,628	0,700	0,089	0,554	0,635	0,706
1H50	0,404	0,465	0,518	0,085	0,413	0,473	0,525
1H70	0,281	0,323	0,360	0,083	0,293	0,333	0,369
1H95	0,204	0,234	0,260	0,080	0,219	0,247	0,272
1H120	0,163	0,186	0,207	0,078	0,180	0,202	0,221
1H150	0,133	0,152	0,169	0,077	0,154	0,170	0,185
1H185	0,109	0,123	0,137	0,076	0,133	0,145	0,157
1H240	0,086	0,096	0,106	0,076	0,115	0,123	0,131
1H300	0,076	0,084	0,092	0,075	0,107	0,113	0,119
1H400	0,075	0,063	0,069	0,075	0,095	0,099	0,103

Single-core cables laid side by side: resistance, reactance & impedance

cable	Resistance R(Ω/km)									Reactance X (Ω/km)			Impedance Z(Ω/km)								
	30 °C			70 °C			105 °C						30 °C			70 °C			105 °C		
type	R	S	T	R	S	T	R	S	T	R	S	T	R	S	T	R	S	T	R	S	T
1H1,5	12,61	12,57	12,53	14,51	14,47	14,44	16,18	16,14	16,10	0,160	0,139	0,161	12,61	12,57	12,54	14,52	14,48	14,44	16,18	16,14	16,10
1H2,5	7,740	7,702	7,665	8,905	8,866	8,829	9,924	9,885	9,848	0,149	0,128	0,150	7,742	7,703	7,667	8,906	8,867	8,831	9,925	9,886	9,850
1H4	4,831	4,792	4,755	5,555	5,516	5,480	6,189	6,150	6,113	0,140	0,120	0,142	4,833	4,793	4,757	5,557	5,517	5,482	6,190	6,151	6,115
1H6	3,241	3,202	3,166	3,725	3,686	3,649	4,148	4,109	4,073	0,132	0,112	0,135	3,244	3,204	3,168	3,727	3,687	3,652	4,150	4,111	4,075
1H10	1,942	1,903	1,867	2,229	2,190	2,154	2,481	2,442	2,406	0,124	0,104	0,127	1,946	1,905	1,871	2,233	2,193	2,158	2,484	2,444	2,409
1H16	1,236	1,196	1,161	1,416	1,377	1,341	1,574	1,535	1,499	0,117	0,098	0,121	1,242	1,200	1,167	1,421	1,380	1,347	1,579	1,538	1,504
1H25	0,797	0,757	0,722	0,911	0,871	0,836	1,011	0,971	0,935	0,112	0,093	0,117	0,805	0,762	0,731	0,918	0,876	0,844	1,017	0,975	0,943
1H35	0,587	0,546	0,512	0,669	0,628	0,594	0,74	0,700	0,665	0,107	0,089	0,113	0,597	0,553	0,524	0,677	0,634	0,604	0,748	0,706	0,675
1H50	0,446	0,404	0,371	0,506	0,464	0,431	0,558	0,517	0,483	0,103	0,085	0,110	0,457	0,413	0,387	0,516	0,472	0,445	0,568	0,524	0,496
1H70	0,323	0,280	0,249	0,364	0,322	0,290	0,401	0,359	0,326	0,099	0,083	0,108	0,338	0,292	0,271	0,378	0,333	0,309	0,413	0,368	0,343
1H95	0,246	0,203	0,172	0,276	0,233	0,201	0,302	0,259	0,227	0,096	0,080	0,106	0,264	0,218	0,202	0,292	0,246	0,227	0,317	0,271	0,250
1H120	0,206	0,161	0,132	0,229	0,185	0,155	0,249	0,206	0,175	0,093	0,078	0,105	0,226	0,179	0,169	0,248	0,201	0,187	0,267	0,220	0,203
1H150	0,177	0,132	0,104	0,195	0,151	0,122	0,212	0,168	0,138	0,090	0,077	0,104	0,199	0,153	0,147	0,216	0,169	0,160	0,231	0,185	0,172
1H185	0,154	0,107	0,083	0,168	0,122	0,096	0,181	0,135	0,108	0,086	0,077	0,104	0,177	0,132	0,133	0,190	0,144	0,141	0,202	0,156	0,150
1H240	0,132	0,083	0,063	0,142	0,095	0,072	0,152	0,104	0,081	0,082	0,077	0,104	0,155	0,113	0,122	0,166	0,122	0,127	0,175	0,130	0,132
1H300	0,122	0,073	0,056	0,130	0,082	0,062	0,137	0,090	0,068	0,078	0,076	0,103	0,145	0,105	0,117	0,153	0,112	0,121	0,161	0,118	0,124
1H400	0,104	0,054	0,038	0,110	0,061	0,042	0,115	0,067	0,046	0,077	0,076	0,103	0,129	0,094	0,110	0,136	0,098	0,112	0,142	0,102	0,114

Single-core cables laid at the __distance of a diameter__: *resistance, reactance & impedance*

cable	**Resistance R**(Ω/km)									**Reactance X**			**Impedance Z(Ω/km)**								
	30 ℃			70 ℃			105 ℃			**(Ω/km)**			30 ℃			70 ℃			105 ℃		
type	R	S	T	R	S	T	R	S	T	R	S	T	R	S	T	R	S	T	R	S	T
1H1,5	12,61	12,57	12,54	14,52	14,48	14,44	16,18	16,14	16,10	0,203	0,182	0,205	12,61	12,57	12,54	14,52	14,48	14,44	16,18	16,14	16,10
1H2,5	7,743	7,703	7,767	8,907	8,867	8,831	9,925	9,886	9,850	0,192	0,171	0,194	7,745	7,705	7,670	8,907	8,867	8,831	9,927	9,888	9,852
1H4	4,833	4,793	4,728	5,557	5,518	5,482	6,191	6,151	6,115	0,183	0,163	0,186	4,837	4,796	4,762	5,560	5,520	5,485	6,194	6,154	6,118
1H6	3,244	3,203	3,169	3,727	3,687	3,652	4,150	4,111	4,075	0,175	0,156	0,179	3,248	3,207	3,174	3,731	3,691	3,656	4,154	4,114	4,079
1H10	1,946	1,905	1,870	2,232	2,192	2,157	2,484	2,443	2,408	0,167	0,148	0,171	1,953	1,911	1,878	2,239	2,197	2,164	2,489	2,448	2,414
1H16	1,24	1,199	1,165	1,420	1,379	1,345	1,578	1,537	1,502	0,160	0,141	0,165	1,250	1,207	1,177	1,429	1,386	1,355	1,586	1,543	1,511
1H25	0,803	0,760	0,728	0,916	0,874	0,841	1,015	0,973	0,940	0,154	0,136	0,161	0,817	0,772	0,746	0,928	0,884	0,856	1,026	0,983	0,954
1H35	0,593	0,550	0,519	0,674	0,632	0,600	0,745	0,703	0,671	0,150	0,132	0,157	0,611	0,566	0,543	0,690	0,645	0,620	0,760	0,716	0,689
1H50	0,453	0,409	0,379	0,512	0,469	0,438	0,564	0,521	0,490	0,145	0,129	0,154	0,475	0,429	0,410	0,532	0,486	0,465	0,583	0,537	0,514
1H70	0,332	0,287	0,259	0,372	0,328	0,299	0,408	0,364	0,334	0,140	0,126	0,152	0,360	0,313	0,301	0,398	0,351	0,336	0,431	0,385	0,367
1H95	0,257	0,210	0,185	0,285	0,239	0,212	0,310	0,265	0,237	0,136	0,123	0,150	0,289	0,244	0,239	0,315	0,269	0,260	0,339	0,292	0,281
1H120	0,217	0,170	0,147	0,239	0,193	0,168	0,259	0,213	0,186	0,133	0,121	0,149	0,253	0,209	0,209	0,273	0,228	0,224	0,291	0,245	0,238
1H150	0,190	0,142	0,121	0,207	0,160	0,137	0,222	0,176	0,151	0,129	0,120	0,147	0,227	0,185	0,190	0,243	0,199	0,201	0,257	0,213	0,211
1H185	0,169	0,120	0,105	0,182	0,134	0,116	0,194	0,146	0,126	0,123	0,199	0,147	0,205	0,168	0,179	0,218	0,178	0,187	0,194	0,146	0,126
1H240	0,148	0,100	0,141	0,158	0,110	0,097	0,167	0,118	0,103	0,116	0,117	0,145	0,183	0,153	0,168	0,194	0,160	0,173	0,203	0,166	0,178
1H300	0,139	0,093	0,085	0,147	0,099	0,088	0,154	0,105	0,092	0,112	0,115	0,143	0,172	0,146	0,162	0,182	0,151	0,166	0,190	0,156	0,170
1H400	0,120	0,075	0,069	0,126	0,079	0,071	0,131	0,83	0,073	0,108	0,115	0,142	0,155	0,135	0,152	0,163	0,139	0,160	0,170	0,142	0,159

Voltage drop in single-core triplet cables

cable type	Voltage drop (mV/Am)					
	cos φ = 1			cos φ = 0,8		
	30 °C	70 °C	105 °C	30 °C	70 °C	105 °C
1H1,5	21,780	25,080	27,960	17,570	20,210	22,510
1H2,5	13,340	15,360	17,120	10,800	12,420	13,830
1H4	8,300	9,550	10,650	6,760	7,770	8,650
1H6	5,550	6,380	7,120	4,550	5,220	5,810
1H10	3,300	3,790	4,230	2,740	3,140	3,490
1H16	2,070	2,380	2,660	1,760	2,010	2,230
1H25	1,310	1,510	1,680	1,150	1,300	1,440
1H35	0,950	1,090	1,210	0,850	0,960	1,060
1H50	0,700	0,810	0,900	0,650	0,730	0,810
1H70	0,490	0,560	0,620	0,480	0,530	0,580
1H95	0,350	0,400	0,450	0,370	0,410	0,440
1H120	0,280	0,320	0,360	0,310	0,340	0,370
1H150	0,230	0,260	0,290	0,260	0,280	0,310
1H185	0,190	0,210	0,240	0,230	0,250	0,270
1H240	0,150	0,210	0,180	0,200	0,250	0,230
1H300	0,130	0,150	0,160	0,180	0,190	0,210
1H400	0,099	0,110	0,120	0,160	0,170	0,170

Voltage drop in single-core cables laid side by side

cable type	voltage drop (mV/Am)					
	cos φ = 1			cos φ = 0,8		
	30 °C	70 °C	105 °C	30 °C	70 °C	105 °C
1H1,5	21,780	25,080	27,960	17,570	20,210	22,510
1H2,5	13,340	15,360	17,120	10,800	12,420	13,830
1H4	8,300	9,550	10,650	6,760	7,770	8,650
1H6	5,550	6,380	7,120	4,550	5,220	5,810
1H10	3,300	3,790	4,230	2,740	3,140	3,490
1H16	2,070	2,380	2,660	1,760	2,010	2,230
1H25	1,310	1,510	1,680	1,150	1,300	1,440
1H35	0,950	1,090	1,210	0,850	0,960	1,060
1H50	0,700	0,810	0,900	0,650	0,730	0,810
1H70	0,490	0,560	0,620	0,480	0,530	0,580
1H95	0,350	0,400	0,450	0,370	0,410	0,440
1H120	0,280	0,320	0,360	0,310	0,340	0,370
1H150	0,230	0,260	0,290	0,260	0,280	0,310
1H185	0,190	0,210	0,240	0,230	0,250	0,270
1H240	0,150	0,210	0,180	0,200	0,250	0,230
1H300	0,130	0,150	0,160	0,180	0,190	0,210
1H400	0,099	0,110	0,120	0,160	0,170	0,170

Voltage drop in single-core cables laid at the distance of a diameter

cable type	Voltage drop (mV/Am)					
	cos φ = 1			cos φ = 0,8		
	30 °C	70 °C	105 °C	30 °C	70 °C	105 °C
1H1,5	21,790	25,080	27,960	17,630	20,270	22,570
1H2,5	13,340	15,360	17,130	10,870	12,480	13,890
1H4	8,300	9,560	10,660	6,830	7,830	8,710
1H6	5,550	6,390	7,120	4,620	5,290	5,870
1H10	3,300	3,800	4,240	2,810	3,210	3,560
1H16	2,060	2,390	2,670	1,830	2,080	2,290
1H25	1,320	1,520	1,690	1,210	1,370	1,510
1H35	0,960	1,100	1,220	0,920	1,030	1,130
1H50	0,720	0,820	0,910	0,720	0,800	0,880
1H70	0,510	0,580	0,640	0,550	0,610	0,660
1H95	0,380	0,430	0,470	0,440	0,480	0,520
1H120	0,310	0,350	0,380	0,380	0,420	0,440
1H150	0,260	0,290	0,320	0,340	0,370	0,390
1H185	0,230	0,250	0,270	0,310	0,330	0,350
1H240	0,200	0,210	0,220	0,280	0,300	0,310
1H300	0,180	0,190	0,200	0,270	0,280	0,290
1H400	0,150	0,160	0,170	0,240	0,250	0,260

Voltage drop in Light duty multi-core cables (500 V)

cable type	Voltage drop (mV/Am)					
	cos φ = 1			cos φ = 0,8		
	30 °C	70 °C	105 °C	30 °C	70 °C	105 °C
2L1	37,620	43,310	48,290	30,200	34,760	38,740
2L1,5	25,150	28,950	32,280	20,220	23,260	25,930
2L2,5	15,400	17,730	19,770	12,420	14,280	15,910
2L4	8,960	10,310	11,500	7,260	8,340	9,290
3L1	32,580	37,51	41,820	26,160	30,100	33,550
3L1,5	21,780	25,080	27,960	17,510	20,150	22,460
3L2,5	13,340	15,360	17,120	10,750	12,370	13,780

Above indicated values are valid also for multi-core cables with 4 & 7 conductors.

Voltage drop in Heavy duty multi-core cables (750 V)

cable type	Voltage drop (mV/Am)					
	cos φ = 1			cos φ = 0,8		
	30 °C	70 °C	105 °C	30 °C	70 °C	105 °C
2H1,5	25,150	28,950	32,280	20,240	23,280	25,950
2H2,5	15,400	17,730	19,770	12,430	14,300	15,930
2H4	9,580	11,030	12,300	7,770	8,930	9,940
2H6	6,401	7,370	8,220	5,220	6,000	6,670
2H10	3,800	4,380	4,880	3,140	3,600	4,000
2H16	2,390	2,750	3,070	2,000	2,290	2,540
2H25	1,510	1,740	1,940	1,300	1,480	1,640

Above indicated values are valid also for all the other types of multi-core cables (with 3, 4 ,7, 12 & 19 conductors).

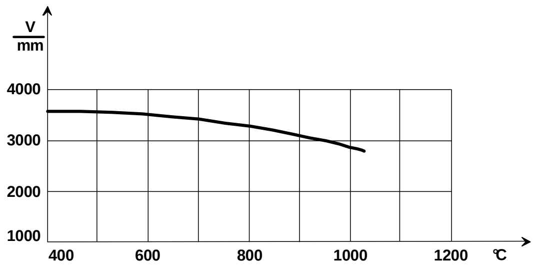
INSULATION CHARACTERISTICS

Thermal conductivity

As we know, an electric insulator is a thermal insulator too; so in ordinary cables the electric insulator interferes with heat diffusion outwards and, therefore, under the same current flow, the temperature of a standard cable is higher than a M.I.C.
In fact, Magnesium Oxide is an exception to this general rule: it's an excellent electric insulator and a good thermal conductor; these 2 characteristics allow MgO to insulate the conductors and to easily transmit outwards the heat produced by Joule effect.
Thermal conductivity of Magnesium Oxide increases with its density, resulting from compression ratio; the **KME ITALY** manufacturing process gives a density of 2,0 g/cm^3 to which corrisponds a thermal conductivity of 2,36 w/m ℃.

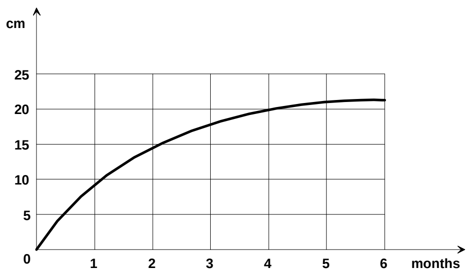
DIELECTRIC STRENGTH

Insulator dielectric strength decreases with temperature increase, as shown in the following diagram; we can quite ignore this decrease at temperatures lower than 1000 ℃.



RESISTANCE TO HUMIDITY

Magnesium Oxide, used in M.I.C. as electric insulator, is hygroscopic, so enviroment humidity decreases its insulation resistance; the latter, measured by a Megaohmeter at 500 V, must be more than 100 MΩ.
Anyway, if a cable end is open, humidity goes inside only for few centimetres; the following diagram shows the depth of humidity penetration in relation to the time of exposure of a cable with unsealed ends.



Therefore humidity can easily be removed cutting approx. 100 mm of cable from both ends without heating, or heating the cable in order to push humidity itself towards the open ends.
To avoid humidity absorption, all cable coils are temporarily sealed both on factory exit and during the storing; every cable used in an electric wiring system must be protected by suitable terminations.

TEMPERATURE LIMITS

Magnesium Oxide insulation is stable and it doesn't suffer any agening as temperature grows up to the melting point of 2800℃; so the theoretic al temperature limit of M.I.C. is determined by the copper melting point (external sheath and conductors): 1083 ℃.
Up to this temperature cables are totally inert to flame and they don't produce any kind of toxic, corrosive or opaque flue gas; hardly temperature during a fire goes over 1000℃.
But it would be better not to use M.I.C. where temperature, in continous exercise, goes over 250 ℃.
In fact, over this temperature, the external oxidation of the copper sheath is so fast to decrease its thickness in a short time; the following table shows the theoretical reduction of the sheath thickness in relation to both time and temperature.

Sheath thickness reduction (μ m)	250 ℃	400 ℃	800 ℃
	years	years	hours
25,4	2,57	0,0583	0,259
50,8	10,30	0,2330	1,040
127,0	64,30	1,4600	6,480
254,0	257,00	5,8300	25,900

M.I.C. BEHAVIOUR IN SHORT CIRCUIT CONDITION

In relation to the above mentioned values we can approx. obtain the time in which the copper sheath thickness assumes a lower value than 10% in comparison with its nominal value
In short circuit condition the electric cables can suffer mechanical damages (due to electrodynamic forces developing between conductors) and thermal damages (extreme heating); the electrodynamic forces created by a short circuit don't damage multi-core cables, which are structurally quite strong; on the contrary single-core cables laid side by side on platform can suffer violent shifting and they can cause or suffer damages.
In this case, it's a good habit to fix the cables to their support by brackets at short distance (about 1 m).
An electric conductor must resist also thermal troubles; its dimension (section) must be choosen so as a short circuit current "I" can flow through the cable for a time "t", less than 5 seconds, in which automatic protection devices must switch on and temperature must not go over a fixed limit (CEI 64-8/434.3.2); this current value can be determined by the following formula:

$$\mathbf{I = S \cdot K \cdot \frac{1}{\sqrt{t}}}$$

where:

S = conductor cross-section (mm²);
K = factor whose value depends on the material of the protection conductor, of the insulator and other parts and on starting and final temperature; this factor is calculated by the following formula (CEI 64-8 appendix B, chapter 54):

$$\mathbf{K = \sqrt{\frac{Qc \cdot (B+20)}{\rho 20} \cdot Ln\left(1 + \frac{\theta f - \theta 0}{B + \theta 0}\right)}}$$

where:

Q_C = thermal capacity per volume unit of the conductor (J/℃ mm ^{3})
B = inverse of temperature coefficient of resistivity at 0℃ for the conductor(℃);
ρ_{20} = conductive material resistivity at 20 ℃;
θ_o = conductor starting temperature (℃);
θ_f = conductor final temperature(℃).
B, **Q_C** e **ρ_{20}** values can be derived from the following table:

material	B	Q_C	ρ_{20}
Copper	235	3,45 * 10 $^{-3}$	17,241 * 10 $^{-6}$
Alluminium	228	2,50 * 10 $^{-3}$	28,264 * 10 $^{-6}$
Lead	230	1,45 * 10 $^{-3}$	214,000 * 10 $^{-6}$
Steel	202	3,80 * 10 $^{-3}$	138,000 * 10 $^{-6}$

CEI 64-8 norm art. 434.3.2 provides for copper conductors the following values of “K” with relative values of maximum temperatures allowed during ordinary working and during short circuit in relation to the insulator peculiarity:

Conductor type	K	Ordinary working (℃)	short circuit (℃)
PVC insulated copper conductors	115	70	160
within reach & LSF external sheath MIC	115	70	160
standard plastic insulated copper conductors	135	60	200
butyl rubber insulated copper conductors	135	85	220
within reach & bare MIC	135	70	200
EPR and XLPE insulated copper conductors	143	90	250
out of reach & bare MIC	200	105	500

Therefore cable minimum cross-section value, in relation to the short circuit current and to the switch time of protection devices, can be evalueted by the following formula:

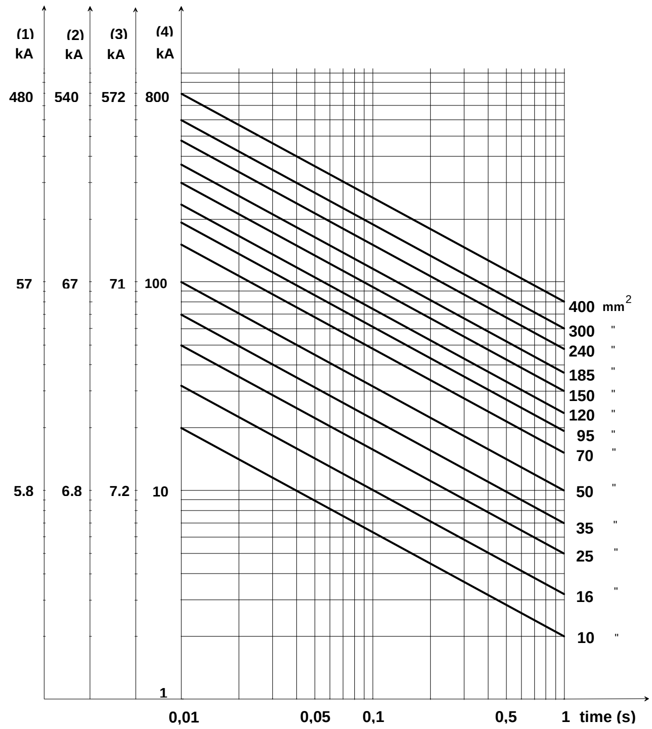
$$S = \frac{I \cdot \sqrt{t}}{K}$$

The following tables show the value of minimum section to be used with a bare & within reach M.I.C. and the correspondent value of section for other types of cable, in relation to 2 diferent switching times of protection devices.

Short circuit period = 0,01 s					
insulator	Minimum cross-section (mm²) for a short circuit current (kA) corresponding to				
	5	10	15	25	35
Mineral (k=200)	2,5	6	10	16	25
EPR (k=143)	4	10	16	25	25
butyl rubber (k=135)	4	10	16	25	35
PVC (k=115)	6	10	16	25	35

Short circuit period = 1 s					
insulator	Minimum cross-section (mm²) for a short circuit current (kA) corresponding to				
	5	10	15	25	35
Mineral (k=200)	25	50	95	150	185
EPR (k=143)	35	70	120	185	300
butyl rubber (k=135)	50	95	120	185	300
PVC (k=115)	50	95	150	240	400

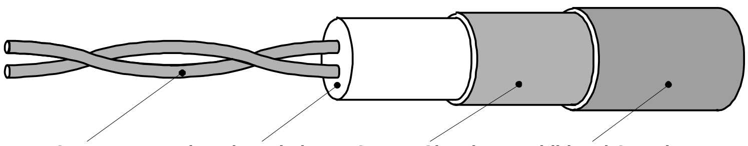
The tables show how M.I.C. allows, in relation to thermal stress due to short circuit, to use conductors with considerably lower cross-section than all the other ; the following diagram let us fastly calculate the minimum cable cross-section, according to short circuit current value and its duration.



(1) k = 115 for PVC insulated copper conductors & for M.I.C. with LSF outer covering;
(2) k = 135 for ordinary or butyl rubber insulated copper conductors & bare and within reach M.I.C.;
(3) k = 143 for ethylene - propylene or reticulated propylene rubber insulated copper conductors;
(4) k = 200 for bare and out of reach M.I.C.

“TWISTED” MINERAL INSULATED CABLES

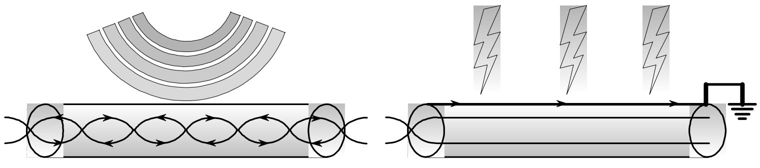
With the same manufacturing technology process it’s possible to supply a “twisted” Light duty M.I.C. (300/500), type **2T1,5** with additional LSF outer covering, red-coloured with low emission of opaque flue gas (CEI 20-37 e CEI 20-38).



The above cable is manufactured and tested in conformity with CEI 20-39/1 and can be sealed and installed like all the other M.I.C.; in fact its dimensional and electric characteristics, its terminations and fittings are the same indicated in previous pages for cable type 2L1,5.
Further characteristics are:

Nominal capacity between conductors at 1 kHz	164,5 pF/m
Nominal capacity between a conductor and copper screen at 1 kHz	243, 5 pF/m
Nominal capacity between 2 conductors and copper screen at 1 kHz	384,4 pF/m
Inductance (loop) at 10 MHz	436,0 μH/m
Attenuation at 1 MHz	- 19,0 dB/km
Attenuation at 10 MHz	- 52,0 dB/km
Nominal characteristic impedance	50 Ω
Twist frequency per metre	20

For what we stated above and because of its copper sheath, which is an excellent electrostatic screen at low impedance, the twisted M.I.C. notably reduces electromagnetic interferences and signal noises in modern integrated management systems of security.



such as:

- **fire alarms systems;**
- **security phone systems;**
- **data transmission systems;**
- **etc. ....**

As all the other M.I.C., the twisted cable has the peculiarity of keeping working even in critical enviroment conditions, such as fire with mechanical stress and water sprinkling.

Red coloured 2T1,5/LSF cable can be supplyed in standard coils of 100 metres or multiple of length.

On request also 2T1/LSF type of cable is avalaible.

CURRENT CAPACITY

M.I.C. capacity values are indicated in CEI -UNEL 35024/2-1997 norm, based on CENELEC R064001(1991) Report; This norm must be applied to fixed electric installations whose main characteristics are described in CEI 64-8 norm, part 5.

The Iz (A) M.I.C. capacity, in a particular condition of installation, can be deduced from the following formula:

$$I_z = I_0 \times k_1 \times k_2$$

where:
I_0 = capacity in air at 30 °C related to preseen insta llation method, deduced from tables **I** & **II**;
k_1 = correction factor for room temperature different from 30 °C (table **III**);
k_2 = correction factor for many bundled layered circuits (tables **IV - V** or **VI**).

bundle and layer definitions are:

Layer: group of circuits made with cables laid side by side, spaced or not, put in horizontal or vertical position; layered cables are installed on wall, platform, ceiling, floor or ladder tray.

NOTES
- many layers one upon the others on the same support (for example a platform) are to be considered a bundle;
- 2 single-core cables, belonging to different circuits, are spaced when their distance is more than 2 times the outer diameter of the bigger cross-section cable;
- 2 multi-core cables are spaced when their distance is more than the outer diameter.

Bundle: group of many circuits made with not spaced and not layered cables.

NOTE
- We specify that the maximum temperature mentioned in the respective tables refers to metal sheath and not to conductors: in particular installations, cables thermal computation can be made using method reported in CEI 20-21 norm, presuming conductors and metal sheath to be at the same temperature.

The number of conductors to be considered is the number of conductors where really current flows. For capacity computation, three-phase system is supposed to be balanced.

Table 1 and 2 capacities are defined for maximum working temperature, indicated below each table.

Capacity values are based on a room temperature of 30°C. For different ones, these values must be multiplied by the proper correction factors, that can be deduced from table III.

When many circuits are installed in the same bundle and they are put in one or more horizontal or vertical spaced layer, capacity must be multiplied by the proper correction factors shown in tables IV - V or VI of CEI UNEL 35024/2-1997 norm.

When two or more conductors are connected in parallel in the same system phase or pole, it's necessary to take particular precautions in order to assure current to be equally divided between them; these precautions are respected if:

a - conductors have the same cross-section;
b - conductors have approx. the same length and they are not shunted to other circuits;
c - all conductors in parallel belong to single-core or multi-core cables transposed along the course.

For single - core not transposed cables, triplet or laid, with conductors of section > 50 mm^2, it's necessary to take particular installation precautions for what concerns phases spacing and their best sequence.

Table I/1

***single-core H (750 V) M.I.C.* bare**, exposed to touch or covered with thermoplastic material (metal sheath maximum temperature 70℃). For bare cables we must multiply by 0,9. Cables sheaths are connected to the ends.

cable type	triplet cables in air	laid side by side cables in air		horizontal spaced cables in air		vertical spaced cables in air		laid cables in air, fixed on wall or ceiling		triplet cables in air, fixed on wall or ceiling
	13-14 15-16 *	13-14 15-16 *		14 15-16 *		14 15-16 *		11 11A *		11 11A *
	3 cables	2 cables	3 cables	2 cables	3 cables	2 cables	3 cables	2 cables	3 cables	3 cables
	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1H1,5	22	26	26	26	32	26	28	25	23	21
1H2,5	30	36	34	36	43	36	37	34	31	28
1H4	40	47	45	47	56	47	49	45	41	37
1H6	51	60	57	60	71	60	62	57	52	48
1H10	69	82	77	82	95	82	84	77	70	65
1H16	92	109	102	109	125	109	110	102	92	86
1H25	120	142	132	142	162	142	142	133	120	112
1H35	147	174	161	174	197	174	173	163	147	137
1H50	182	215	198	215	242	215	213	202	181	169
1H70	223	264	241	264	294	264	259	247	221	207
1H95	267	317	289	317	351	317	309	296	264	249
1H120	308	364	331	364	402	364	353	340	303	286
1H150	352	416	377	416	454	416	400	388	346	327
1H185	399	472	426	472	507	472	446	440	392	371
1H240	466	552	496	552	565	552	497	514	457	434

Table II/1

multi-core H (750 V) e L (500 V) M.I.C. bare, exposed to touch or covered with thermoplastic material (metal sheath maximum temperature 70℃). For bare cables we must multiply by 0,9.

nominal conductor cross section	cable in air, spaced from wall or ceiling or on platform		cable in air, fixed on wall or ceiling	
	13-14-15-16 *		11-11A *	
mm²	2 cables	3 cables	2 cables	3 cables
serie	(A)	(A)	(A)	(A)
500 V				
1,5	25	21	23	19
2,5	33	28	31	26
4	44	37	40	35
750 V				
1,5	26	22	25	21
2,5	37	30	34	28
4	47	40	45	37
6	60	51	57	48
10	82	69	77	65
16	109	92	102	86
25	142	120	133	112

* Installation methods taken from 3rd edition of CEI 64-8/5 norm, table 52 C

Table I/2

single-core H (450/750 V) M.I.C. bare, not exposed to touch (metal sheath maximum temperature 105℃). - Correction factor for bundle is not required.

cable type	triplet cables in air	laid side by side cables in air		horizontal spaced cables in air		vertical spaced cables in air		laid cables in air, fixed on wall or ceiling		triplet cables in air, fixed on wall or ceiling
	13-14 15-16 *	13-14 15-16 *		14 15-16 *		14 15-16 *		11 11A *		11 11A *
	3 cables	2 cables	3 cables	2 cables	3 cables	2 cables	3 cables	2 cables	3 cables	3 cables
	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1H1,5	28	33	32	33	40	33	35	31	30	26
1H2,5	38	45	43	45	54	45	47	42	41	35
1H4	50	60	56	60	70	60	61	55	53	47
1H6	64	76	71	76	89	76	78	70	67	59
1H10	87	104	96	104	120	104	105	96	91	81
1H16	115	137	127	137	157	137	137	127	119	107
1H25	150	179	164	179	204	179	178	166	154	140
1H35	184	220	200	220	248	220	216	203	187	171
1H50	228	272	247	272	304	272	266	251	230	212
1H70	279	333	300	333	370	333	323	307	280	260
1H95	335	400	359	400	441	400	385	369	334	312
1H120	385	460	411	460	505	460	441	424	383	359
1H150	441	526	469	526	565	526	498	485	435	410
1H185	500	596	530	596	629	596	557	550	492	465
1H240	584	697	617	697	704	697	624	643	572	544

Table II/2

multi-core H (750 V) e L (500 V) M.I.C. bare, not exposed to touch (metal sheath maximum temperature 105℃). Correction factor for bundle is not required

nominal conductor cross section mm²	cable in air, spaced from wall or ceiling or on platform		cable in air, fixed on wall or ceiling	
	13-14-15-16 *		11-11A *	
	2 cables	3 cables	2 cables	3 cables
type	(A)	(A)	(A)	(A)
500 V				
1,5	31	26	28	24
2,5	41	35	38	33
4	54	46	51	44
750 V				
1,5	33	26	32	26
2,5	45	35	42	35
4	60	47	55	47
6	76	59	70	59
10	104	81	96	81
16	137	107	127	107
25	179	140	166	140

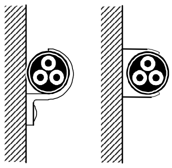
* Installation methods taken from 3rd edition of CEI 64-8/5 norm, table 52 C

Table III

Correction factor **k_1** for room temperature different from 30 °C

room temperature	bare cable or covered by thermoplastic material exposed to touch	bare cable not exposed to touch
°C	70 °C	105 °C
10	1,26	1,14
15	1,20	1,11
20	1,14	1,07
25	1,07	1,04
35	0,93	0,96
40	0,85	0,92
45	0,76	0,88
50	0,67	0,84
55	0,57	0,80
60	0,45	0,75
65	-	0,70
70	-	0,65
75	-	0,60
80	-	0,54
85	-	0,47
90	-	0,40
95	-	0,32

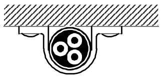
APPENDIX A

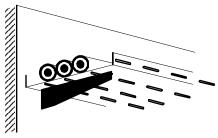


Mineral Insulated Cables can be:

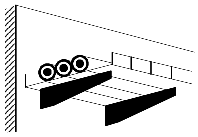
- installed close to the wall (or spaced from it)

- fixed to the ceiling, or

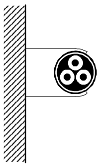




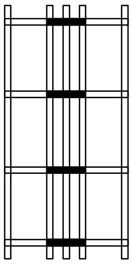
- to holed platform



- to brackets



- fixed by clamps



- to platform with cross bars