

产品目录 PRODUCT CONTENTS

一、矿物绝缘电缆简述	Instruction for Mineral Insulated Cable (MI Cable)	13
二、矿物绝缘电缆结构图	MI cable structure diagram	13
三、电缆主要性能	Main performance of cable	14
四、电缆抗火灾能力	Fire resistance	16
五、电缆抗过载能力	Overload resistance	17
六、电缆价格性能比	Cable price/performance ratio	18
七、生产流程	Flow chart	20
八、电缆设计、订货型号及表示方法	Cable design, ordering model and expression methods	21
九、应用、设计注意事项	Notices for application and design	22
十、“分支”型矿物绝缘电缆	“Branch” type MI cable	23
十一、适用的电气线路	Suitable electrical lines	25
十二、主要应用场所	Main application occasions	27
十三、附表 (产品性能数据)	Attached table (performance data)	28
十四、电缆附件	Accessory	36
十五、电缆附件结构参数	Accessory Structure and parameters	39
十六、电缆敷设和安装	Laying and installation	42
十七、矿物绝缘电缆制造标准	Manufacturing standard of MI cable	47
十八、矿物绝缘电缆的特性标准	Performance standard of MI cable	47
十九、矿物绝缘电缆的应用标准	Application standard of MI cable	47
二十、附件及安装方法	Accessories and installation methods	48

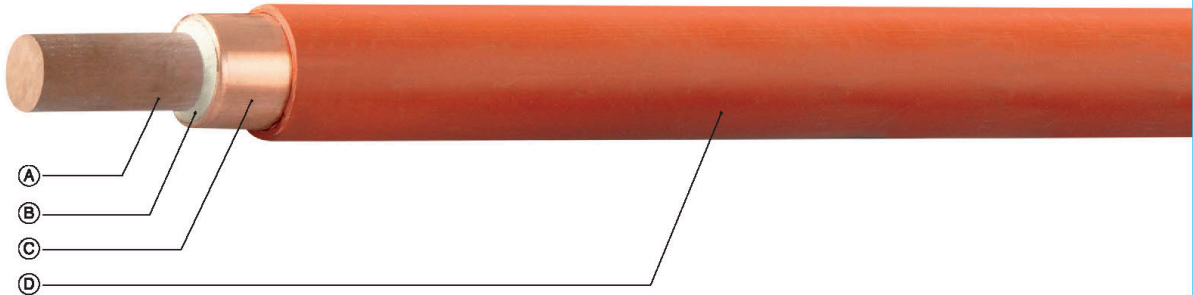
一、矿物绝缘电缆简述 Instruction for Mineral Insulated Cable (MI Cable)

矿物绝缘电缆国内又称防火电缆或氧化镁电缆，国外简称MI电缆。该电缆最早于1895年瑞士人研制开发，并取得专利，1934年法国率先将该项新技术转化为生产。矿物绝缘电缆的出现是对传统电缆的创新，特别是在一些重要场所和关键电气线路中发挥的作用，使塑料电缆望尘莫及。因而英国、澳大利亚、加拿大等工业发达国家均相继开始生产矿物绝缘电缆，但主要仅用于建筑业及重要的工业设施。而中国涉及较迟，直至1968年才开始由上海电缆研究所对该产品进行研制开发。由于该产品用材和结构的特殊性，使得其具有传统有机绝缘电缆所无法比拟的电气性能、机械性能、耐环境性能和环保性能。随着该产品不断推广人们对安全要求越来越高，矿物绝缘电缆也越来越为人们所认同，现已广泛应用于基础工业及民用建设中。

Mineral insulated cable is also called fireproof cable or copper-conductor copper sheathed magnesia insulated cable in China, known as MI cable abroad. In 1895, Swiss researched and developed this cable and received the patent. In 1934, this new technology was converted into the production for the first time in France. The emergence of MI cable demonstrates the innovation of traditional cable, especially, its effect in the some important areas and electric circuits, it leaves the plastic cable in the dust. Accordingly, U.K., Australia and Canada began to produce the MI cable gradually, but, the cable was applied to building industry and key industrial facilities at that time. And, China was relatively late to involve in the field of this cable, until Shanghai Cable Research Institute was engaged in the research and development of this product in 1968. Due to the particularity of product material and structure, it has high electric property, mechanical performance, environment resistance and environmental protection that the traditional organic insulation cable does not have. With the continuous promotion of this product, people require higher demands for the safety, it is recognized by more and more people, and now, it has been widely applied to the basic industry and civil construction.

二、矿物绝缘电缆结构图 MI cable structure diagram

- ① 铜导体 Copper conductor
- ② 矿物绝缘材料 (氧化镁) mineral insulated (magnesia)
- ③ 铜护套 Copper sheath
- ④ 防腐保护外套 (可选用) Anticorrosion outer sheath (optional)



矿物绝缘电缆以高导电率的铜导体、矿物（氧化镁）绝缘、无缝铜管护套为基本结构组成，当电缆用于对铜有腐蚀的场合时，最外层可加一层塑料外套（可选择）。

裸电缆连续工作温度可达250℃，在950℃~1000℃时可持续供电3小时，短时间或非常时期可接近铜的熔点1083℃工作（氧化镁熔点为2800℃）。

MI cable is composed of high-conductivity copper conductor, mineral (magnesium-oxide) insulator and seamless copper-tube sheath, if the cable is used in the locations where the copper will be eroded, it may be added with plastic sheath (optional) at the outermost layer.

The continuous working temperature of bare cable reaches 250℃, it can supply the power for 3 hours continuously at 950℃~1,000℃, in addition, it can work at copper melting point of 1,083℃ in short time or unusual time (melting point of magnesia: 2,800℃)



三、电缆主要性能 Main performance of cable

3.1 耐火性能 Fire-resistive performance

电缆不但自身无法燃烧，更不会引发火源。即使在着火的情况下，电缆仍可正常工作。而且只要火焰温度低于铜的熔点温度，火情消除后，电缆无需更换，仍可继续使用。更换护套和芯线材料耐火更佳，可在油气环境下使用。

Never does the cable burn by itself, or does it cause the source of fire. Even in fire condition, it can still work normally. And, as long as the flame temperature is lower than the melting point of copper, the cable can be used continuously without change after the fire is removed. It would have better fire-resistive performance if the sheath and conductor material are changed, it can be used in oil gas environment.

3.2 过载保护能力强 Strong overload protection

线路过载时，塑料电缆会因过电流或过电压而引发绝缘发热老化或击穿；而对于矿物绝缘电缆，只要发热达不到铜的熔点温度，电缆不会受损。即使瞬间击穿，击穿点处氧化镁既便熔化仍为氧化镁，过载消除后，电缆性能不会产生变化，仍可继续正常使用。

When the circuit has the over load, the plastic cable will come across the aging of insulation or break-down for heat due to the over current or over voltage; while, MI cable has no loss only the heating temperature is not higher than the copper melting point. Even if the instantaneous breakdown occurs, the magnesia at the breakdown point still is magnesia after being melted at a high temperature. After the over load is removed, the cable has no change in performance, it can work normally and continuously.

3.3 载流量大 Large current carrying capacity

由于电缆绝缘材质及结构的特殊性，使得矿物绝缘电缆具有较大的载流能力。传输相同的电流流量，若选用矿物绝缘电缆可比塑料类电缆减小1到2个截面等级或更大。

Because of the particularity of insulated material and structure, MI cable has a quite large current carrying capacity. If transmitting the same current capacity, MI cable could be one to two or more cross sections less than plastic cable.

3.4 工作温度高 High working temperature

由于绝缘层氧化镁的熔点温度远高于铜的熔点温度，因而裸电缆最高正常工作温度可达250℃，短期可在接近铜的熔点温度1083℃下继续运行。

Because the melting point of magnesia at the insulating layer is far higher than the melting point of copper, the max normal working temperature of bare cable can reach as high as 250℃, and, it can work continuously under the copper melting point of 1,083℃ in a short time.

3.5 防水、防腐、防爆 Waterproof, anticorrosion and explosion-proof property

由于电缆采用无缝铜管作护套，导体、绝缘及护套三者间是致密压实体。因而使其不但具有防止水、潮气、油及一些化学物质的侵害，而且具有阻止可燃性油蒸汽、气体和火焰的蔓延。

The cable adopts the seamless copper tube as the sheath, it is very compact among the conductor, insulation and sheath, so, the cable not only has the function of resisting the water, dampness, oil, chemical substance, etc., also can prevent the spreading of combustible oil vapor, gas and flame.

3.6 屏蔽性能优越 Excellent shielding property

电缆铜护套是最佳的屏蔽保护层，既可防止电缆本身对其它线缆的干扰，又可阻止外界电磁场对自身的干扰。

The cable copper sheath is the best shield, it not only can prevent other cables being interfered by this cable, but also can prevent this cable being by external electromagnetic field.

3.7 抗辐射能力强 Strong radiation resistance

由于电缆组成材料均为无机物，因而在经受核辐射后，电缆的电气及机械性能不会产生任何变化。

As the material of cable is inorganic, the electric and mechanical performance of cable can not be changed after suffering from the nuclear radiation.

3.8 使用寿命长 Long service life

由于电缆由无机材料组成，因而不会老化，其使用期限最低达数百年以上。

The cable is made of inorganic material, therefore, it is not aged, its service life reaches hundreds of years at least.

3.9 外径小、重量轻 Small outer diameter and light weight

和同载流量塑料电缆相比，矿物绝缘电缆外径，重量要减少很多，既可减小占用空间，又便于安装。

Compared with the plastic cable of same current-carrying capacity, the outer diameter of MI cable and the weight of that are reduced much, in terms of these, the cable can reduce the occupied space and is easily installed.

3.10 环保、安全 Environmental protection and safety

电缆组成材料均为无机物，不含任何有机物。因而电缆即使处于1000℃以上加热中，也不会产生丝毫的烟雾，更无卤素及毒性气体。该电缆是能真正实现绿色环保，无“二次灾害”的安全型产品。

The material of cable is inorganic, without any organic matter. Therefore, even if the cable is heated with 1, 000℃ above, it can't produce halogen, smoke, or poisonous gas. This cable can really realize the green environmental protection, it is the safety product without secondary damage.

3.11 机械强度高 High mechanical strength

电缆结构密实、坚固耐用，可承受外力的挤压、撞击、弯曲、压扁等，在电缆压扁至原来电缆外径的1/3~2/3时，仍可继续安全的正常使用。

Due to compact, firm and durable structure, it can withstand the external extrusion, collision, bend or bruising, although the cable is changed by 1/3~2/3 of the original shape due to crushing, it still can be used normally.

3.12 弯曲性能 Bending performance

电缆经充分退火后，具有一般塑料电缆所无法相比的可弯曲性。最小弯曲半径仅为电缆外径的2~6倍，如果需重复、多次弯曲时，需要用喷灯加热弯曲部分，避免电缆破裂。

After the cable is annealed fully, its high flexural property is incomparable for plastic cable. The min bending radius is two to six times smaller than cable outer diameter. What's more, if it required to be bent repeatedly, please use blow lamp for hot bending parts, preventing cracking of cable.

3.13 良好的接地 Perfect earthing

对于矿物绝缘电缆来说，不需要独立的接地导线，因为电缆的铜护套已起到接地导线的作用，并可提供极好的低接地电阻，与有机电缆相比，它可以节省一根地线。

MI cable need not the individual earthing conductor, because the copper sheath of cable has take the effect of earthing conductor, and provides extremely good low earthing resistance. Comparing with the organic cables, it saves an earth wire.



四、电缆抗火灾能力 Fire resistance

4.1 电缆在火焰中应有条件

无论是在工厂还是建筑物中，电气线路的安全性至关重要。据国家有关部门统计，在火灾起因中，由于电气引起的火灾占30%以上。而由电缆引起的火灾又占电气火灾的30%以上。因而要求电缆不但要有抗外在火焰破坏的能力，而且要有自身不会产生和传播火源的特性，防止老化。由于矿物绝缘电缆构成材料均为无机物，绝缘体氧化镁不会老化，由它构成的线路，也不会导致火情的发生和传播。如一旦由其它原因引发火灾，该电缆在火烧中不仅能受熊熊大火的考验，还会受到其它坠物的不断冲击和消防笼头水的喷淋。此时，电缆在不产生烟雾和毒性气体的同时，还能保证消防设备的正常启动、火情扑灭及人员的撤离，是评价该线路抗火灾能力的关键。

4.1 Essential conditions of cable in the flame

Whether in the factory or in the building, the security of electric circuit is of paramount importance. According to the statistics from some relevant departments, more than 30% of fires are caused by the electric cause, and more than 30% of which are caused by cable. Accordingly, on one hand, the cable must have the ability to resist the destroy from external flame, on the other hand, the cable must have the character that it should not produce or transmit fire source, and should be able to anti aging. Since the material of MI cable is inorganic, the insulator magnesias would not age, the circuit consisted by MI cable would not cause or transmit fire. Once the fire is caused for other reasons, the cable should be able to withstand the test of fire and the continuous impact of other precipitations as well as the fire hydrant spraying. While not producing the smoke and poisonous gas, the cable can guarantee the normal start of fire fighting equipment, extinction of fire, and evacuation of personnel that is the key to evaluate the fire resistance of circuit.

4.2 耐火性能试验方法 Fire-resistive performance test method

试验项目Test item	GB/T19216	BS 6387	IEC 60331
耐火试验 Resistance to fire alone	750°C 90min	C级(protocol C) 950°C 180min	750°C 90min
耐火与喷淋试验 Resistance to fire with water	无 Without	W级(protocol C) 650°C 15min	无Without
耐火与冲击试验 Resistance to fire with mechanical shock	830°C 120min	Z级(protocol C) 950°C 15min	830°C 试验时间等级(time class): 30、60、90、120min



耐火试验Fire-resistive test



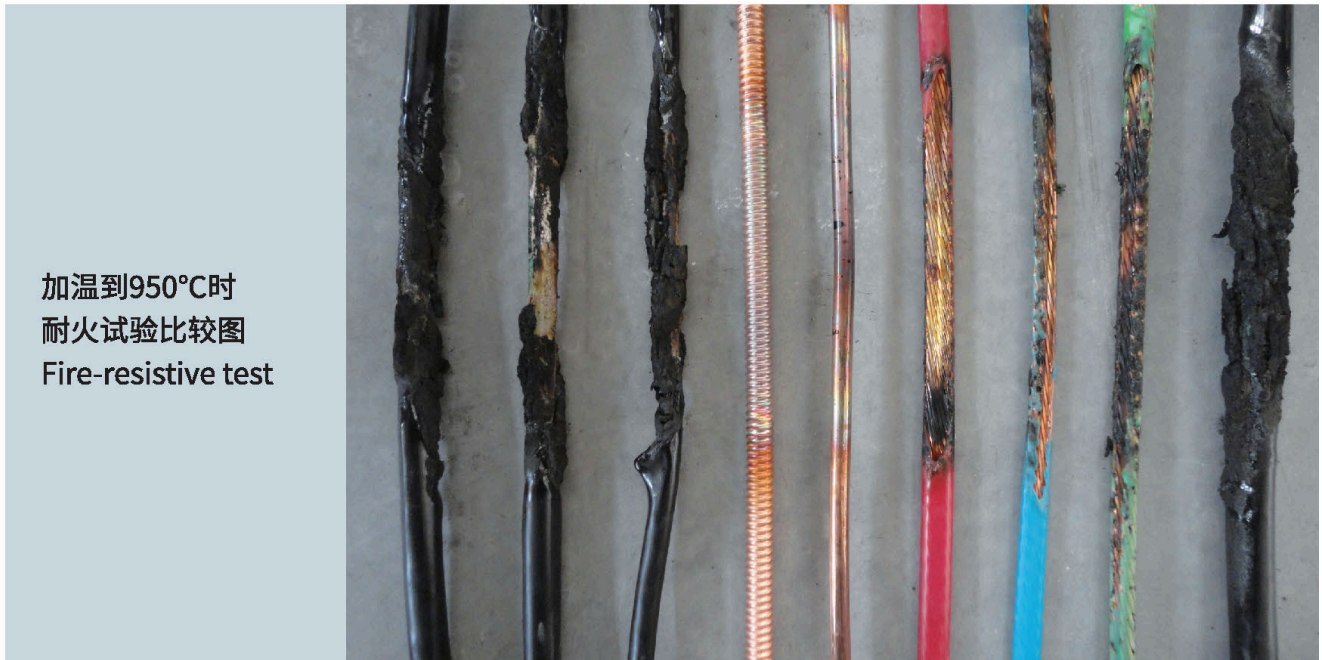
喷淋试验Water spray test



冲击试验Impact test

补充：包括英国BS6387标准在内试验要求均不严格，BS6387要求3种试验分别在三个新试样上分别进行与火灾实际情况不符，且BS6387：2013标准仅适用于电缆外径20mm及以下电缆。对于电缆外径超过20mm，则BS8491：2008标准的试验要求为所有试验在一根电缆上完成，在830+40-0°C下，冲击：每10分钟1次，连续30、60、120分钟，然后喷水 5秒后等30秒，再喷5秒等30秒，需要完成5次。英国地铁公司电缆火灾安全试验要求，所有试验在一根试样上完成，试验条件更加苛刻，950°C3小时，每十分钟用钢棒冲击一次，用水喷淋15分钟(钢棒仍在冲击)然后试样在冲击点处进行180°弯曲，再进一步进行机械冲击，最后试样浸水进行额定电压的试验，这种要求只有矿物绝缘电缆才能满足要求。

Supplement: all the test requirements including S6387 are not strict enough, S6387 requires that 3 types of tests to be carried out on three new samples respectively, BS6387:2013 standard is only applicable to cables with outer diameter of 20mm and below. For the cable outer diameter more than 20mm, the BS8491:2008 standard test requires that all tests be completed on one cable. Under 830+40-0°C, the impact: 1 times per 10 minutes, 30, 60, 120 minutes, then 30 seconds after the water spray 5 seconds, and 5 seconds for 30 seconds, and 5 times. which is inconformity with the actual fire condition, cable fire safety test of British Underground Corporation requires that all the tests should be carried out on one sample, the test conditions are more rigorous, 950°C for 3 hours, use steel bar to impact once every 10min, spray with water for 15min (steel bar keeps striking), then bend the sample for 180° at the struck point, make further mechanical shock, at last, dip the sample in water, and implement test of rated voltage, only mineral insulated cable is able to satisfy this kind of requirements.



4.3 电缆防火能力

从前述内容看，只有英国地铁公司的电缆火灾安全性能的要求，才是电缆在火灾中经受的真正的耐火性能考验。因为电缆在火烧中并非不受外界的干扰，它会受到消防水、火烧脱落物及其它重物的不断冲击，而且是在同一线路上。而有机（塑料）电缆耐火性能是靠导体和绝缘间的云母包带实现的，塑料耐火电缆一经火烧，云母和绝缘将分别形成硬壳及碳壳。碳壳一遇消防水将导电，云母硬壳遇水或其它重物的冲击将脱落。公安部四川消防研究所及英国消防研究所对矿物绝缘电缆及塑料类耐火电缆进行了模拟实体火灾对比试验，试验证明，能够满足英国地铁公司耐火安全要求的只有矿物绝缘电缆。

4.3 Fire-proof capability

According to the forementioned contents, only the fire safety performance requirements for cables issued by British Underground Corporation can help the cable undergo the real fire-resistive test. It is impossible that the same cable has no outside interference, it will be impacted constantly by the fire fighting water, falling material or other heavy objects. And, the realization of the fire resistance of organic (plastic) material depends on the mica tape between the conductor and insulator, once the plastic fire-resistance cable is burned, the mica and insulator will form the hard shell and carbon shell respectively. Hereinto, the carbon shell will conduct the electricity immediately if sprayed by the fire fighting water, and the mica hard shell will come off if sprayed by the water or impacted by the heavy objects. Sichuan Fire Research Institute of Ministry of Public Security and UK Fire Research Institute performed the test of the cable performance when simulating the real fire for MI cable and plastic fire-resistance cable, the test proved that only the mineral insulated cable meets the requirements specified by British Underground Corporation on fire-resistive performance.

五、电缆抗过载能力 Overload resistance

试验条件：试验均选用具有相同额定载流量规格的不同类别电缆，所有试验电缆并联，试验电缆同时联接到可调变压器。

试验方法：逐渐加大电流变压器的输出电压，从而改变通过被试验电缆的电流，直至电流过载后观察电缆的状况。

试验结论：由下面试验效果图，可以看出在对电缆加载过电流后，试验中部分电缆因电能转换为热能，而使电缆自身产生火源。从试验结果也可得出，只有矿物绝缘电缆不会因为过载而出现电气故障，更不会出现火情。

Test condition: The test adopts the cables that have the same rated current carrying capacity but different categories, all tested cables are connected in parallel, and connected to the adjustable transformer simultaneously.

Test methods: Increase the output voltage of current transformer gradually, to change the current passing the tested cable, and then, watch the cable status after the current overload occurs.

Test conclusion: As shown in following test efficiency diagram, we can know that after the over-current is applied to the cable, some tested cables produce the fire source by itself because its electric energy is converted into the thermal energy. Meanwhile, the test result shows that even if over load occurs, MI cable hasn't the electric fault or doesn't cause the fire.



矿物绝缘电缆

Mineral insulated cable



矿物绝缘电缆 Mineral Insulated Cable	
无卤低烟阻燃耐火电缆 LSZH flame-retardant and fire resistive cable	
高阻燃电缆 High flame-retardant cable	
耐火电缆 Fire resistive cable	

电缆过载试验Cable overload test

六、电缆价格性能比 Cable price/performance ratio

6.1 性能比较 Comparison of the performance

比较性能 Comparing the performance		矿物绝缘电缆 BTTZ型 Mineral Insulated Cable BTTZ type	普通阻燃耐火电缆 ZN-YJV型 Common flame-retardant and fire resistive cable ZN-YJV type	无卤低烟耐火电缆 WDZN-YJY型 LSZH fire resistive cable WDZN-YJY type
电缆规格 Cable spec.		4× (1×120)	4×150+1×70	4×150+1×70
敷设条件 Layout conditions		可明敷、不用桥架或穿管 Surface wiring is available, without tray or pipeline	需封闭桥架或穿管保护 Need enclosed tray or pipeline protection	需封闭桥架或穿管保护 Need enclosed tray or pipeline protection
使用寿命 Service life		100年以上 Over 100 years	20~40年 20~40 years	20~40年 20~40 years
阻燃性能 Flame-retardant performance		无法燃烧 No combustion	C类阻燃 CAT-C flame retardance	可达A类阻燃 CAT-A flame retardance
耐火能力 Fire-resistive capability	耐火性能 Fire-resistive performance	950°C180min	750°C90min且电缆价格将有较大提高 Cable may be burned at 750°C for 90min, its price will be increased greatly.	
	喷淋试验 Water spraying test	达到试验要求 Meeting the test requirements	不能通过该项试验 Fail to pass this test	
	机械冲击 Mechanical impact	达到试验要求 Meeting the test requirements	不能通过该项试验 Fail to pass this test	
耐温性能 Temperature resistance performance		正常为250°C最高可达1000°C Normal: 250°C; max: 1,000°C	最高为90°C，短路时仅为250°C Max: 90°C; short circuit: 250°C	
环保性能 Environmental protection performance		无烟、无卤、无毒 No smoke, halogen or poison	燃烧中产生大量烟雾、毒气 Producing a great number of sm- oke and poisonous gas in burning	燃烧中有少量烟雾及毒性气体 Producing little smoke or poi- sonous gas in burning
占用空间 Occupying the space		Φ40.6mm	Φ55mm	Φ65mm

6.2 价格比较

在同样使用环境下进行价格比较：

电缆均传输相同的载流量; 矿物绝缘电缆铜护套替代接地线芯

6.2 Comparison of the price

Comparing the price in the same service environment

Both cables transmit the same current carrying capacity; the copper sheath of MI cable takes the place of earthing core.

比较项目 Comparison of the item	矿物绝缘电缆 BTTZ型 Mineral Insulated Cable BTTZ type	普通阻燃耐火电缆 ZN-YJV型 Common flame-retardant and fire resistive cable ZN-YJV type	无卤低烟耐火电缆 WDZN-YJY型 LSZH fire resistive cable WDZN-YJY type
电缆规格 Cable spec.	4×(1×120)	4×150+1×70	4×150+1×70
载流量ACurrent carrying capacity	380	360	365
每米价格百分比Price per meter (percentage)	100%	95%	102%

6.3 比较结论

- a. 电缆寿命长，可避免因塑料电缆使用年限给工程造成的二次投资。
- b. 电缆外径小,比塑料电缆节约很大的布线空间，更便于设计、安装。
- c. 电缆敷设方式简单，可以明敷不用穿管，可再为工程节约造价。
- d. 电缆耐高温而且防爆、耐腐、防水、防磁、耐机械损伤（包括动物啃咬）、不会老化、载流量大、过载能力强等，其中任一项性能的效果均远优于塑料电缆。
- e. 该电缆是真正的绿色、安全产品  
与目前最为“环保”的无卤低烟塑料电缆相比，矿物绝缘电缆不但在电性能及机械性能方面有较大提高，而且真正实现了无卤、无烟、无毒，彻底消除了无卤低烟塑料电缆中残留的毒素。
- f. 该电缆已不再是主要用于消防系统  
由于其优越的性能价格比而成为替代无卤低烟电缆、耐火电缆、阻燃电缆、母线槽（容量为3000A及以下）等产品的发展方向。
- g. 该产品的性能价格比远优于其它任何一种电缆。

6.3 Conclusion

- a. With long service life, it can avoid the secondary investment for project for the service life of plastic cable.
- b. With small outer diameter, it can save large of wiring space compared with the plastic cable, easily designed and installed.
- c. With simple layout, it can be exposed laid out without in pipeline, so it saves construction price for the project.
- d. With performances of high temperature resistant, flame-retardant, explosion-proof, corrosion resistant, waterproof, anti-magnet, mechanical damage resistance (including the animal biting), anti aging, large current carrying capacity, high overload capacity, etc., any one item is far better than the plastic cable.
- e. This cable is the real green and safe product.  
Compared with LSZH plastic cable that is the most environmental-protection at present, MI cable not only is improved greatly in the electric performance and mechanical performance, but also can realize the halogen free, no smoke and no toxicity, it completely eliminates the residual toxin in the LSZH plastic cables.
- f. This cable is not the main fire control system any more.  
Owning to the excellent performance/price ratio, it will take the place of LSZH cable, fire-resistive cable, flame-retardant cable, bus slot (3,000A and below) gradually.
- g. The performance/price ratio of product surpasses any kind of cables.



七、生产流程 Flow chart



1. 瓷柱压制

2. 瓷柱烧结

3. 电缆装配

4-5. 电缆拉伸

6-7. 电缆退火

8. 浸水试验

9. 产品检测

10. 成品

1. Ceramic column extrusion

2. Ceramic column sintering

3. Cable assembly

4-5. Cable stretching

6-7. Cable annealing

8. Immersion inspection

9. Product testing

10. End products

八、电缆设计、订货型号及表示方法 Cable design, ordering model and expression methods

等级 Class	型号 Model	名称 Name	截面 Section (mm <sup>2</sup> )	芯数 Core	额定电压 Rated voltage (V)
轻型 Light-duty	BTTQ	轻型铜芯铜护套矿物绝缘电缆 Light-duty copper sheathed mineral insulated cable with copper conductor	1.0-4.0	2-7	500 (500/500)
	BTTVQ	轻型铜芯铜护套防腐外套矿物绝缘电缆 Light-duty copper sheathed mineral insulated cable with copper conductor and anticorrosion sheath			
	BTTYQ	轻型铜芯铜护套无卤低烟外套矿物绝缘电缆 Light-duty copper sheathed mineral insulated cable with copper conductor and non-halogen low-smoke sheath			
重型 Heavy-duty	BT TZ	重型铜芯铜护套矿物绝缘电缆 Heavy-duty copper sheathed mineral insulated cable with copper conductor	1-400	1-19	750 (750/750)
	BTTVZ	重型铜芯铜护套防腐外套矿物绝缘电缆 Heavy-duty copper sheathed mineral insulated cable with copper conductor and anticorrosion sheath			
	BTTYZ	重型铜芯铜护套无卤低烟外套矿物绝缘电缆 Heavy-duty copper sheathed mineral insulated cable with copper conductor and non-halogen low-smoke sheath			

注：1. 截面为25mm<sup>2</sup>以上的电缆均由单芯电缆组成，具体规格表示方法详见附表1。  
Notes: 1. Cables whose sectional areas are 25mm<sup>2</sup> above are made up of single-core cables, refer to table 1 for detailed expression methods of specification.

表示方法：  
例一：截面为1.5mm<sup>2</sup>，3芯轻型铜芯铜护套矿物绝缘电缆  
表示为：BTTQ 3×1.5  
例二：截面为300mm<sup>2</sup>，4芯重型铜芯铜护套矿物绝缘电缆  
表示为：BT TZ 4× (1×300)  
例三：截面为35mm<sup>2</sup>，4芯重型铜芯铜护套防腐外套矿物绝缘电缆  
表示为：BTTVZ 4× (1×35)

Expression methods  
eg.1: Sectional area is 1.5mm<sup>2</sup>, 3-core light-duty copper sheathed mineral insulated cable with copper conductor, can be expressed as BTTQ 3×1.5  
eg.2: Sectional area is 300mm<sup>2</sup>, 4-core heavy-duty copper sheathed mineral insulated cable with copper conductor, can be expressed as BT TZ 4× (1×300)  
eg.3: Sectional area is 35mm<sup>2</sup>, 4-core heavy-duty copper sheathed mineral insulated cable with copper conductor and anticorrosion sheath, can be expressed as: BTTVZ 4× (1×35)



九、应用、设计注意事项 Notices for application and design

1. 设计应用时，矿物绝缘电缆与普通塑料电缆相比，布线方式更简单，占用空间更小，敷设方式更多样，只是型号不同而已。
2. 电缆明敷在建筑物空间，并有美观要求的场所时，应设计成裸的，也可根据场合要求外套选用不同颜色的塑料或无卤低烟料。
3. 有氨及氨气或其它对铜有腐蚀作用的环境下，应设计成有塑料外护套的电缆。
4. 带有塑料外套的电缆可同其它塑料类电缆共同敷设在同一桥架、电缆沟、电缆隧道或人能触及的场所，但该裸电缆应单独敷设，否则会对其他塑料等有机电缆造成影响。
5. 电缆无需穿金属管，单芯电缆不允许单独穿管，特殊场合必须穿金属管的线路，单芯电缆必须每组回路拼紧后再穿管，而且应设计成有塑料外护套的电缆。
6. 由于该电缆载流能力大，建议提高一个截面等级设计选用，35mm²及以上可提高二个截面等级使用。
7. 由于该电缆铜护套可以作接地线用，建议以四芯矿物绝缘电缆用于三相五线制线路。
8. 当考虑到整个线路需减少采用中间联接时，可将截面为25mm²及以下的多芯电缆，设计成单芯电缆（根数等于多芯电缆的芯数），或将大规格单芯电缆设计成小规格单芯电缆双拼或多拼联接，这样都可以使电缆长度成倍增加。
9. 当某线路路径较长，而在整个线路中有需用矿物绝缘电缆的部位，也有用普通塑料电缆的部位时，则可通过转接箱予以转换。
10. 电缆可用分支箱分支矿物绝缘电缆。

1. When comparing with the general plastic cables, the MI cable is simpler in layout, occupies less space, has more layout methods, and they are different in model expression.
2. When the cables are exposed laid out in buildings where should be beautiful in appearance, it should be designed into bare type, also plastics of different colors or LSZH material is available for sheath according to the location.
3. It should be designed into the one with the plastic outer sheath when it is intended for environment with ammonia and ammonia gas or other matters that would erode copper.
4. The cable with plastic sheath can be laid out with other plastic cables in the same bridge tray, cable duct, cable tunnel or other touchable occasions, but this bare cable should be laid out separately, otherwise, it would affect other plastic or other organic cables.
5. The cable need not to be set in metal pipe, single-core cable is not allowed to be set in pipe alone, when it must be set in metal pipe for special occasions, the each circuit group of single-conductor cables should be arranged together compactly before being set in the pipe, and should be designed into the one with the plastic outer sheath.
6. As the cable has high current carrying capacity, it is advised to upgrade a sectional area class for designing and using, and that of exceeding and including 35mm² can be used by upgrading two sectional area classes.
7. As the copper sheath of cable can be used as ground wire, it is advised to use four-core MI cable for three-phase five-wire systems.
8. When considering that the whole line should employ less intermediate connection, just design the multi-core cables whose sectional area is 25mm² and below into single-core cables (cable number equals to the core number of multi-core cable), or design the large-specification single-core cable into small-specification single-core cable in doubled or more connection, so the cable length can be exponentially increased.
9. When a transmission route is rather long, and it requires both MI cable and general plastic cable, then transmitting box can be used for transition.
10. Cable branching box can be use to branch the mineral insulated cables.

11. 国标GB/T 50169-2016 《电气装置安装工程接地装置施工及验收规范》于2017年4月1日开始实施。该标准的4.1.8“严禁利用金属软管、管道保温层的金属外皮或金属网、低压照明网络的导线铅皮以及电缆金属护层作为接地线”。我就BTTZ电缆的铜护套可以作为接地线使用提出的疑虑，作如下答疑和说明。  
国标GB/T 2951.1-2008《电缆外护层 第1部分：总则》在3.1条对电缆的外护层定义为：包覆在电缆金属套、非金属套或组合套外面，保护电缆免受机械损伤和腐蚀或具其他特种作用的保护覆盖层。国家机械行业标准JB/T 5268.1-2011《电缆金属套 第1部分：总则》在3.1条对电缆金属套定义为：包覆在绝缘芯或缆芯上用金属材料制成的密封套。3.5铜套：用铜或铜合金制成的密封套。因此，很明显BTTZ电缆的铜护套不是《验收规范》所指的电缆金属护层，而是电缆金属套。  
为了区别电缆金属护层和电缆的铜护套，我们根据GB/T 2951.1-2008和JB/T 5268.1-2011这二个标准的具体内容，对电缆金属护层和电缆金属套的名称、定义、结构和作用等方面不同点作如下列表：

- 电气装置的接地线要求有足够的机械强度和接地电阻等重要指标来保证接地线路的可靠有效，而电缆的电缆金属护层没有这些指标来考核，因此被严禁作为接地线。
- GB/T 13033标准对BTTZ电缆的铜护套，规定了厚度和外径，从而确定了其截面，且考核电缆铜护套的直流电阻，因此他具备了电缆外导体的所有性质。加之有弯曲试验和压扁试验要求，对铜护套的机械强度得到了保证。因此BTTZ电缆的铜护套完全可以作为接地线。
- 中国建筑标准设计研究院编制，中华人民共和国住房和城乡建设部批准的《国家建筑标准设计图集 09D101-6 矿物绝缘电缆敷设》第33页中“2.电缆主要特性（8）接地”的原文内容为：“对于该电缆来说，一般不需要单独的接地导线，因为电缆的铜护套已起到了接地导线的作用，且有极好的低接地电阻，比其他绝缘电缆可节约一根接地导线”。这为矿物绝缘电缆铜护套可以作为接地线的设计选型、安装敷设、工程验收中提供了国家标准和技术法规的依据。

序号	项目	GB/T 50169的电缆金属护层	GB/T 13033电缆的铜护套
1	名称	金属护层	铜护套
2	定义	保护电缆免受机械损伤等作用的保护覆盖层	包覆在绝缘芯或缆芯上用铜或铜合金制成的密封套
3	结构	包覆在电缆金属套、非金属套或组合套外面	包覆在绝缘层外
4	材料	GB/T 2951.表1均为金属带材或金属丝	铜管
5	作用	无或损坏金属护层电缆照样运行	无或损坏铜护套电缆不能够运行
6	性能指标	有结构尺寸，但无金属护层机械强度，无直流电阻值	有结构尺寸（截面）和直流电阻值
7	英文术语	Metal protective coverings	Copper sheaths



11. The national standard GB/T 50169-2016 “Specification for construction and acceptance of grounding devices for electrical installations” was put into effect in April 1, 2017. The standard 4.1.8 “strictly prohibits the use of metal hose, pipe insulation layer metal or metal mesh, lead skin of low voltage lighting network and cable metal shield as grounding wire.” Our company’s doubts about the use of copper sheath of BTTZ cable as grounding wire are given as follows: The national standard GB/T 2951.1-2008 “first parts of the cable outer shield: general” is defined as the outer protective layer of the 3.1 cable: covering the cable metal sleeve, the non metal sleeve or the combination sleeve to protect the cable from the mechanical damage and corrosion or other special protective cover layers. The national machinery industry standard JB/T 5268.1-2011 “first parts of cable metal sleeve: general principle” is defined as a sealing sleeve made of metal material on insulated core or cable core in the 3.1 article. 3.5 copper sleeve: sealed sleeve made of copper or copper alloy. Therefore, it is obvious that the copper sheath of the BTTZ cable is not the cable metal sheath as the acceptance specification, but the cable metal bushing. In order to distinguish the copper sheath of the cable metal shield and cable, we make the following list of the name, definition, structure and function of the cable metal shield and the cable metal sleeve according to the specific contents of the two standards of GB/T 2951.1-2008 and JB/T 5268.1-2011.

Number	Project	GB/T 50169 Cable metal shield	GB/T 13033 Copper sheath of cable
1	Name	Metal shield	Copper sheath
2	Definition	Protection of cable from mechanical damage Protective cover layer	Coating of copper on insulated core or cable core A sealing sleeve made of a copper alloy.
3	structure	Coated in cable metal sleeve, The outside of a nonmetal sleeve or a combination sleeve	Cover the insulating layer
4	Material Science	GB/T 2951. Table 1 are all Metal strip or wire	copper pipe
5	Effect	Non or damaged metal shield Cable operation	No or damaged copper sheath The cable is not able to run
6	performance index	Structure size, but no metal shield Mechanical strength, no DC resistance	Structure size (section) And DC resistance value
7	English terminology	Metal protective coverings	Copper sheaths

The grounding wire of the electrical device requires sufficient mechanical strength and grounding resistance to ensure the reliability and effectiveness of the grounding line, and the cable metal shield is not tested by these indicators, so it is strictly prohibited as a grounding wire.

The GB/T 13033 standard specifies the thickness and outer diameter of the copper sheath of the BTTZ cable, thus determining its cross section and assessing the DC resistance of the cable copper sheath, so that he has all the properties of the outer conductor of the cable. With the requirements of bending test and flattening test, the mechanical strength of copper sheath is guaranteed. Therefore, the copper sheath of BTTZ cable can be used as grounding wire.

China Institute of architecture standard design, the thirty-third page of “2. cable main characteristics (8) grounding” in thirty-third pages of “09D101-6 mineral insulated cable laying” approved by the Ministry of housing and urban and rural construction of the Ministry of housing and urban and rural construction, the original content of “2. cable main characteristics (8) grounding” is: “for this cable, there is no need for individual grounding guide.” The wire, because the copper sheath of the cable has played the role of the grounding wire, and has an excellent low grounding resistance, saving a grounding wire more than other insulated cables. “。 The copper sheath of mineral insulated cable can provide the basis for national standard and technical regulation for the design, installation, installation and acceptance of the grounding

十、“分支”型矿物绝缘电缆 “Branch” type MI cable

**10.1 分支电缆**

BTTZ系列矿物绝缘电缆，可以采用预制分支电缆，实现树干式配电（见右图），其单芯和多芯电缆均可制作预制分支电缆。

BTTZ预制分支电缆由厂家根据现场需求，实地测量确定联接体位置、主干电缆及分支电缆的长度，在厂家加工生产。

BTTZ预制分支电缆解决了该系列电缆只能使用分支箱进行分线的局限。大幅节省现场安装时间、节约安装空间，改善了分支箱气密性、水密性差的问题。

**10.1 Branch cable**

BTTZ mineral insulated cable series, can be used in a prefabricated branch cable, trunk type distribution (see right-hand chart), the single core and multicore cables are prefabricated branch cable can be made up.

BTTZ prefabricated branch cable by manufacturer according to the requirements of field measurements to determine the connection position, length of main cable and branch cable, in factory production.

BTTZ prefabricated branch cable solved the series cable branch box can only be used for the limits of the line. Greatly save installation time, save installation space, improve the problem of poor branch box air tightness, water tightness.



电缆规格表

型号	芯数	导体标称截面积 (mm²)	
		主干电缆	分支电缆
FZ-BTTZ FZ-BTTVZ FZ-BTTYZ	1 芯 2-4 芯	6 ~ 300 4 ~ 25	1.5 ~ 150 1.5 ~ 25

**产品表示方法**

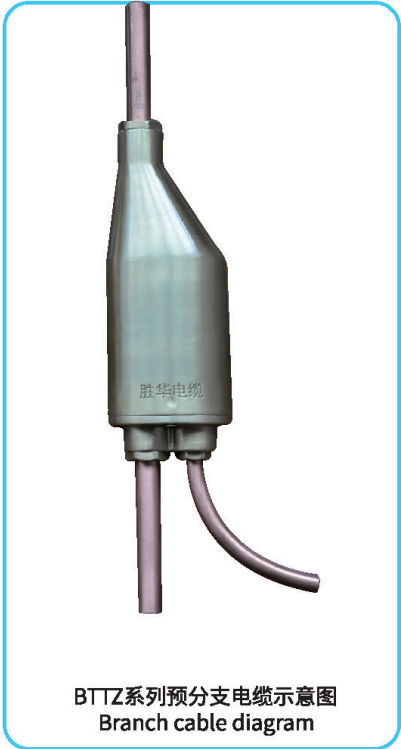
示例1：矿物绝缘预制分支电缆，额定电压为750V，单芯，主干电缆标称截面120mm²、分支电缆为35mm²；  
表示为：FZ-BTTZ 1\*120/1\*35-750

示例2：无卤低烟外套矿物绝缘预制分支电缆，额定电压为750V,主干电缆标称截面4\*25mm²、分支电缆为4\*10mm²；  
表示为：FZ-BTTYZ 4\*25/4\*10-750

**Product presentation**

Example 1: mineral insulated prefabricated branch cable, rated voltage of 750 v, single core, nominal section 120 was the trunk cable, branch cable was 35;  
Expressed as: FZ-BTTZ 1\*120/1\*35-750

Example 2: low smoke zero halogen coat mineral insulated prefabricated branch cable, rated voltage of 750 v, nominal section 4 \* 25 was the trunk cable, branch cable is 4 \* 10 was;  
Expressed as: FZ-BTTYZ 4\*25/4\*10-750





# 矿物绝缘电缆

Mineral insulated cable

## 10.2 分支箱

“分支”型矿物绝缘电缆由主干线、分支线和分支箱组成，其施工方便、安装简单，且分支点可根据工程现场需要作适量调整，而无需定位测量和安装。其在工厂及建筑工程中的广泛应用，不但可提高电气安全性，而且使工程造价大为降低。分支箱可进行“T”联接和“十”字联接，在主动力线路中替代母线槽，可节约造价。在水平线路敷设中采用分支型，则可以转换电缆走向。

型号规格表示方法示例：

三相五线制供电系统中，铜护套做为地线，四根主电缆截面为185mm<sup>2</sup>，支线截面为16mm<sup>2</sup>，表示为：

FZ-BTTZ 4 (1×185) / 4 (1×16)

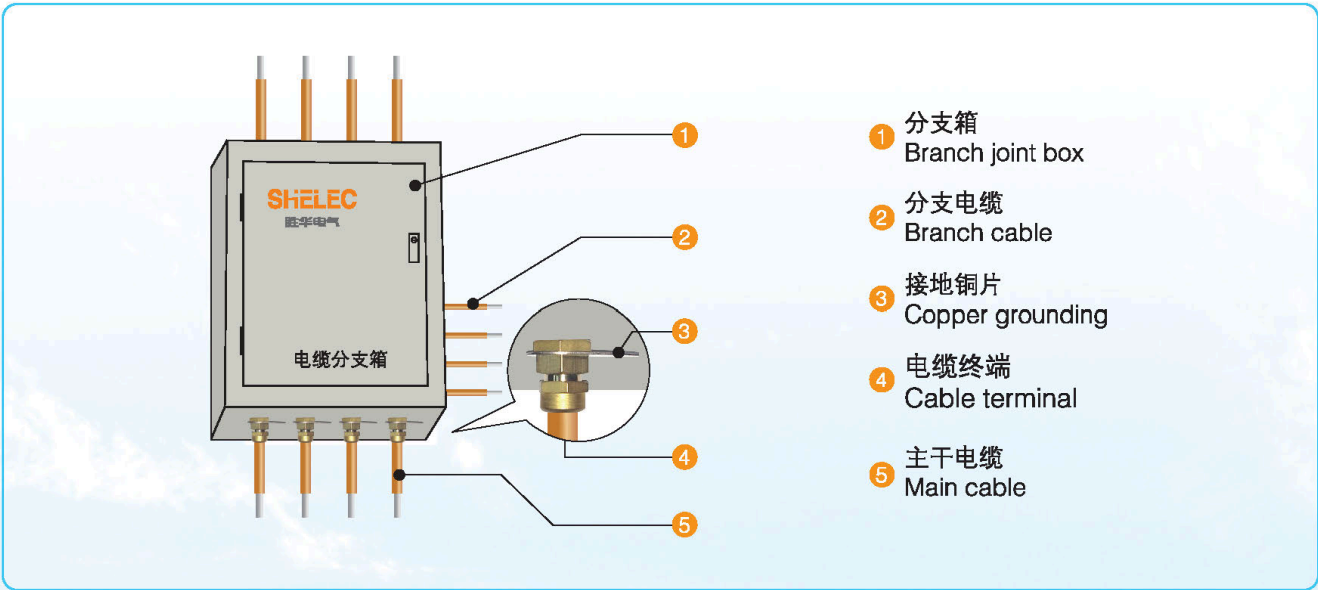
## 10.2 Branch box

“Branch” type MI cable is composed of trunk line, branch line and branch box, it is convenient in construction, simple in installation, and the branch point can be adjusted appropriately according to the on-site condition, need not location survey or installation. Its wide application in factory engineering and constructional works not only improves the electrical safety, but also cuts down the construction cost considerably. Branch box is able to make “T” shaped connection and “+” shaped connection, replacing the bus duct in main power line can cut down the cost. In horizontal layout, the cable’s wiring direction can be changed by employing the branch type cable.

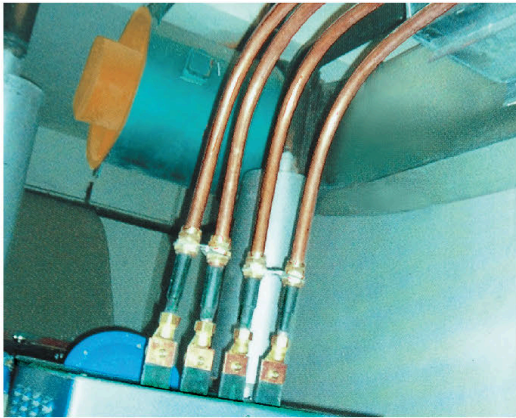
Example for model and specification expression:

In three-phase five-wire power supply system, copper sheath is used as earth wire, sectional area of four pieces of cable is 185mm<sup>2</sup>, branch line is 16mm<sup>2</sup>, it can be expressed as:

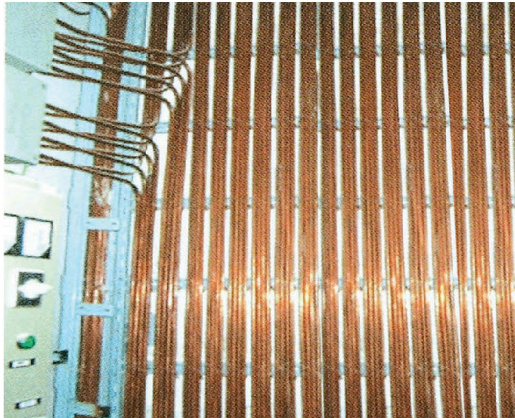
FZ-BTTZ 4 (1×185) / 4 (1×16)



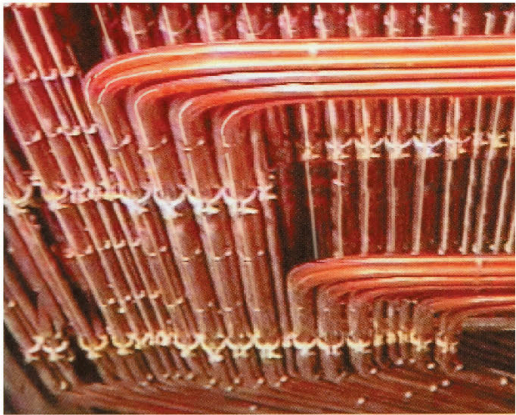
## 十一、适用的电气线路 Suitable electrical lines



消防线路 Fire lines



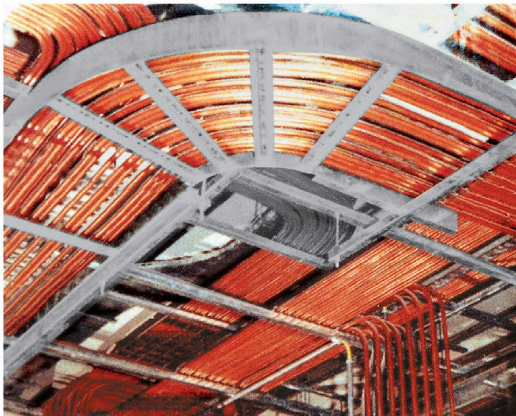
主动力分支线路  
Main power branch lines



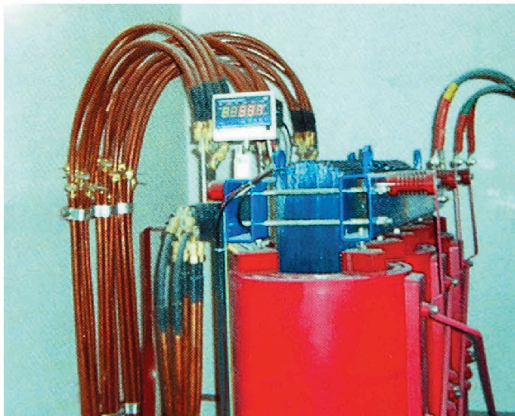
密集线路 Dense lines



照明线路 Illumination circuits

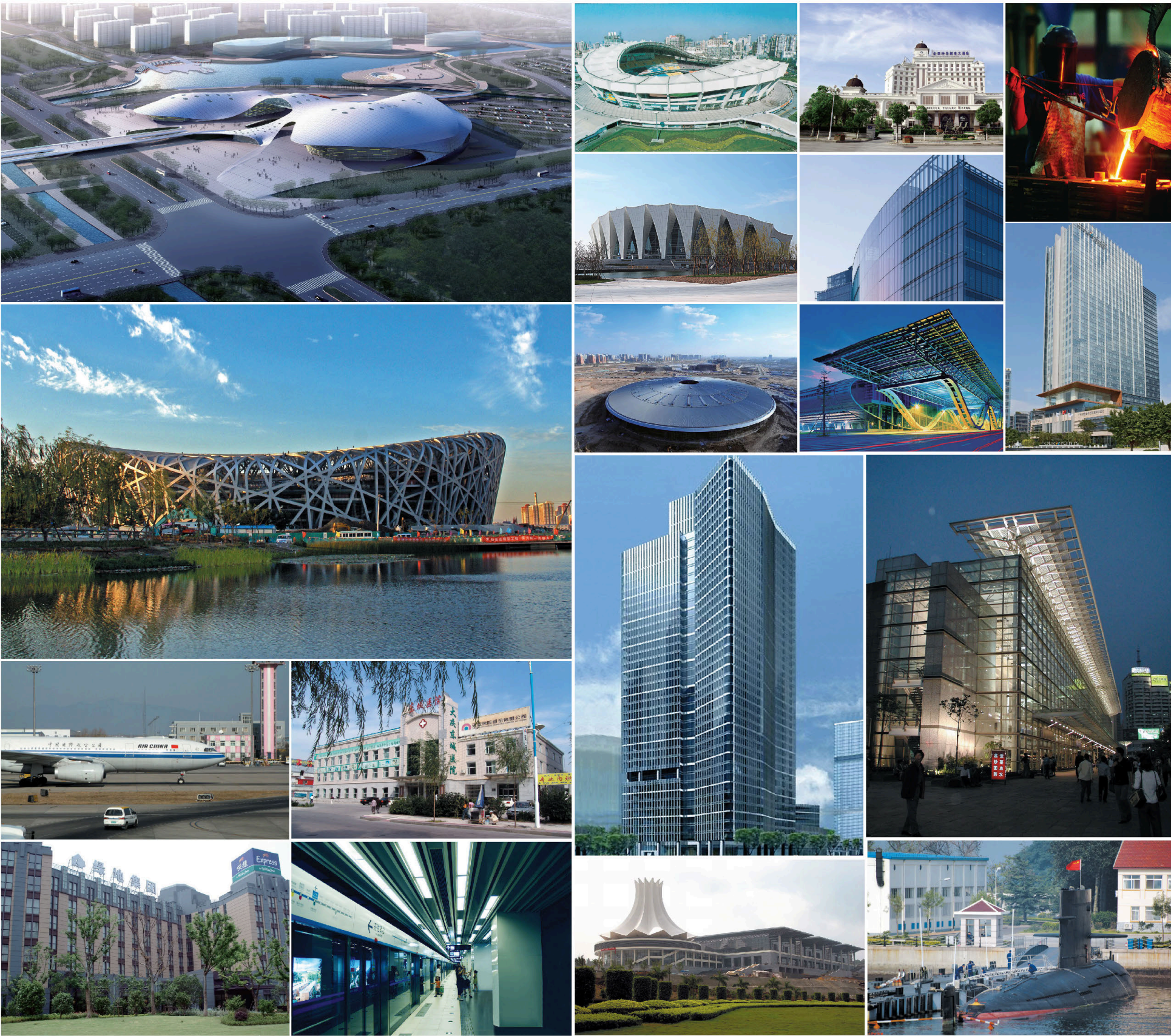


化工、冶金、防爆系统电气线路  
Electrical lines for chemical industry, metal-lurgy and explosion-proof system



电厂及电站输配电线路  
Transmission and distribution lines for power plants and power stations





十二、主要应用场所 Main application occasions

A. 公共建筑 Public buildings

- 公共娱乐场所 Public entertainment places
- 高层建筑 High-rise buildings
- 宾馆饭店 Hotels
- 医院、学校、机关 Hospitals, schools, government units
- 百货商场、仓库 Department stores, warehouses
- 国家纪念馆和历史性建筑物 National memorials and buildings of historic interest
- 银行、邮电大楼 Banks, postal buildings
- 图书馆、博物馆、展览馆 Libraries, museums, exhibition halls
- 机场航站楼、车站、港口 Airport terminal buildings, stations, ports
- 电力调度楼、电信大楼 Power dispatching buildings, telecommunication buildings

B. 高温场合 High-temperature situations

- 冶金工业 Metallurgical industry
- 焦炭行业 Coke industry
- 船舶工业 Shipbuilding industry
- 钢铁工业 Iron and steel industry
- 玻璃工业 Glass industry
- 其它高温场合的输配电线路 Transmission and distribution lines in other high-temperature situations

C. 危险场所 Hazardous locations

- 石油化工工业 Petrochemical industry
- 炼油厂、加油站及油库 Refinery, filling station and oil house
- 制漆和颜料工业 Paint making and pigment industry
- 化学工业 Chemical industry
- 核电站 Nuclear power station
- 海上石油平台 Offshore oil platform
- 天然气、煤气输送和压缩站 Natural gas, gas transportation and compression plant
- 医药工业 Medical industry
- 矿业、造纸业 Mining, paper industry
- 军事工业 Military industry

D. 地下场所 Underground buildings

- 地铁 Underground railways
- 地下仓库 Underground warehouses
- 隧道 Tunnels
- 地下广场 Underground squares

E. 运输和交通枢纽 Transportation and traffic junction



十三、附表 (产品性能数据) Attached table (performance data)

说明：附表1-附表8中的载流量均摘自IEC364-5-523《建筑物电气装置 第五篇：电气设备的选择和安装 第523节：布线系统 载流量》。  
Remark: current-carrying capacities in attached table 1-attached table 8 are excerpted from IEC364-5-523 Electrical installations of buildings-Part 5: Selection and erection of electrical equipment-Section 523: Current-carrying capacities in wiring systems.

附表1 500V及750V级铜芯铜护套矿物绝缘电缆主要工程数据  
Attached table 1 Main engineering data of copper-conductor copper sheathed mineral insulated cables of class 500V and 750V

导体芯数和 标准截面 Core number of conductor and nominal sectional area		电缆外径 Overall diaemeter of cable		额定载流量 Current Ratings		铜护套 横截面积 Cross section size of copper sheath	成品电缆最大 长度(仅供参考) Max length of finished cables (only for reference)		近似重量 Approximate weight	
							传统工艺 Traditional craft	现代工艺 Modern technology	裸电缆 Bare cable	防腐外套电缆 Cable with anticorrosion outer sheath
	mm <sup>2</sup>	mm	mm	A	A	mm <sup>2</sup>	m	m	kg/km	kg/km
BTTQ 轻载电缆 Light-duty cable	2×1.0	5.1	6.4	17.5	19.5	6.0	150		104	125
	2×1.5	5.7	7.0	22.5	25	7.1	150		130	153
	2×2.5	6.6	7.9	30	33	9.4	150		179	205
	2×4.0	7.7	9.2	40	44	12.1	150		248	287
	3×1.0	5.8	7.1	15	16.5	7.6	150		135	159
	3×1.5	6.4	7.7	19	21	8.9	150		168	193
	3×2.5	7.3	8.8	25	28	10.7	150		224	261
	4×1.0	6.3	7.6	14.5	16	8.8	150		161	187
	4×1.5	7.0	8.3	19	21	10.2	150		202	230
	4×2.5	8.1	9.6	25	28	12.8	150		278	319
	7×1.0	7.6	9.1	10	11	11.6	250		233	271
	7×1.5	8.4	9.9	12.5	14	13.3	200		291	333
BTTZ 重载电缆 Heavy-duty cable	7×2.5	9.7	11.2	17	19	17.4	160		407	455
	1×1.5	4.9	6.2	30	33	5.8	900	1000	97	117
	1×2.5	5.3	6.6	39	43	6.4	800	1000	116	137
	1×4.0	5.9	7.2	51	56	7.7	850	1000	135	170
	1×6.0	6.4	7.7	63	69	8.9	700	1000	180	206
	1×10	7.3	8.8	81	90	10.7	580	1000	245	278
	1×16	8.3	9.8	107	119	13.2	490	1000	320	371
	1×25	9.6	11.1	139	154	17.0	370	900	440	502
	1×35	10.7	12.2	168	187	20.2	350	750	555	637
	1×50	12.1	13.6	207	230	24.7	310	700	736	831
	1×70	13.7	15.2	251	279	30.9	260	600	981	1088

续附表1 Attached table 1

型号 Model	导体芯数和 标准截面 Core number of conductor and nominal sectional area	电缆外径 Overall diaemeter of cable		额定载流量 Current Ratings		铜护套 横截面积 Cross section size of copper sheath	成品电缆最大 长度(仅供参考) Max length of finished cables (only for reference)		近似重量 Approximate weight	
		裸电缆 Bare cable	防腐外套电缆 Cable with anticorrosion outer sheath	防腐外套电缆 Cable with anticorrosion outer sheath	裸电缆 Bare cable		传统工艺 Traditional craft	现代工艺 Modern technology	裸电缆 Bare cable	防腐外套电缆 Cable with anticorrosion outer sheath
	mm <sup>2</sup>	mm	mm	A	A	mm <sup>2</sup>	m	m	kg/km	kg/km
BTTZ 重载电缆 Heavy-duty cable	1×95	15.4	17.4	300	333	36.7	200	500	1280	1403
	1×120	16.8	18.8	344	382	42.6	180	450	1500	1701
	1×150	18.4	20.4	388	431	49.5	150	350	1840	2054
	1×185	20.4	22.9	434	482	58.1	105	300	2260	2496
	1×240	23.3	25.8	483	537	70.1	90	220	2965	3470
	1×300	26.0	28.6	795	883	86.7	64	200	3680	3852
	1×400	30.0	32.8	948	1053	110.8	50	150	4950	5007
	2×1.5	7.9	9.4	23.5	26	12.5	330	1000	230	270
	2×2.5	8.7	10.2	32	36	14.6	260	1000	284	327
	2×4.0	9.8	11.3	42	47	17.6	305	900	365	413
	2×6.0	10.9	12.4	54	60	20.9	230	750	465	512
	2×10	12.7	14.2	74	82	26.7	170	700	640	695
	2×16	14.7	16.2	98	109	34.1	170	600	855	941
	2×25	17.1	19.1	128	142	43.4	120	450	1160	1299
	3×1.5	8.3	9.8	20	22	13.6	330	1000	260	302
	3×2.5	9.3	10.8	27	30	16.1	290	900	335	378
	3×4.0	10.4	11.9	36	40	19.3	270	750	435	477
	3×6.0	11.5	13.0	46	51	23.1	190	700	530	593
	3×10	13.6	15.1	62	69	30.3	140	600	775	833
	3×16	15.6	17.6	83	92	38.1	115	500	1090	1140
	3×25	18.2	20.2	108	120	47.4	110	350	1440	1564
	4×1.5	9.1	10.6	20.5	23	15.8	260	900	312	358
	4×2.5	10.1	11.6	27	30	18.5	255	750	415	444
	4×4.0	11.4	12.9	36	40	22.9	215	700	510	574
	4×6.0	12.7	14.2	46	51	26.7	235	600	670	719
	4×10	14.8	16.3	61	68	34.4	180	550	870	997
	4×16	17.3	19.3	80	89	45.8	120	400	1265	1455
	4×25	20.1	22.6	104	116	56.0	90	300	1785	1956
	7×1.5	10.8	12.3	14	15.5	20.7	300		444	496
	7×2.5	12.1	13.6	19	21	24.7	220		562	620
	10×1.5	13.5	15.0	12.5	13.5	26.0	250		638	703
	10×2.5	15.2	17.2	17	19	29.7	200		836	924
	12×1.5	14.1	15.6	11.5	13	32.2	250		706	774
	12×2.5	15.6	17.6	15.5	17	38.1	200		907	997
	19×1.5	16.6	18.6	10	11	41.6	200		982	1077



附表2 500V及750V级铜芯铜护套矿物绝缘裸或防腐外护套电缆，允许人接触的

铜护套温度：70℃/环境温度：30℃(沿墙、楼板、线槽、穿管)

Attached table 2 Copper-conductor copper sheathed mineral insulated bare cable or cable with anticorrosion sheath of class 500V and 750V, touchable temperature of copper sheath: 70℃/ambient temperature: 30℃ (along the walls, floors, line ducts, pipes)

载流量A Current carrying capacity A				
导体标称截面积 Nominal sectional area of conductor mm <sup>2</sup>		载流量A Current carrying capacity A		
		两根导体(单相)两芯或单芯电缆 Two pieces of conductor (single-phase) two-core or single-core cable	三根导体 (三相) Three pieces of conductor (three-phase)	
			多芯或单芯电缆 三角形排列 Multi-core or single-core cable Triangle arrangement	单芯电缆 平列 Single-core cable Side-by-side arrangement
		1	2	3
(轻载)500V Light-duty 500V	1.5	23	19	21
	2.5	31	26	29
	4	40	35	38
(重载) 750V Heavy-duty 750V	1.5	25	21	23
	2.5	34	28	31
	4	45	37	41
	6	57	48	52
	10	77	65	70
	16	102	86	92
	25	133	112	120
	35	163	137	147
	50	202	169	181
	70	247	207	221
	95	296	249	264
	120	340	286	303
	150	388	328	346
	185	440	371	392
	240	514	434	457
	300	782	748	879
	400	940	893	1032

注：1. 对于单芯电缆，回路中各电缆的铜护套在两端连接在一起。  
2. 对于易触及的裸电缆，表列数值应乘以0.9。  
Notes: 1. For single-core cables, copper sheaths are connected on the two ends.  
2. For touchable bare cables, the listed data should be multiplied by 0.9.

附表3 500V及750V级铜芯铜护套矿物绝缘裸电缆，不允许人接触的

铜护套温度：105℃/环境温度：30℃(沿墙、楼板、线槽、穿管)

Attached table 3 Copper-conductor copper sheathed mineral insulated bare cable of class 500V and 750V, untouchable temperature of copper sheath: 105℃/ambient temperature: 30℃ (along the walls, floors, line ducts, pipes)

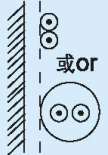
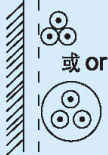
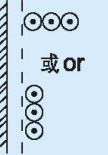
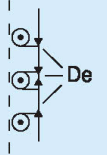
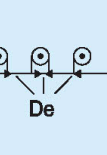
载流量A Current carrying capacity A				
导体标称截面积 Nominal sectional area of conductor mm <sup>2</sup>		载流量A Current carrying capacity A		
		两根导体(单相)两芯或单芯电缆 Two pieces of conductor (single-phase) two-core or single-core cable	三根导体 (三相) Three pieces of conductor (three-phase)	
			多芯或单芯电缆 三角形排列 Multi-core or single-core cable Triangle arrangement	单芯电缆 平列 Single-core cable Side-by-side arrangement
		1	2	3
(轻载)500V Light-duty 500V	1.5	28	24	27
	2.5	38	33	36
	4	51	44	47
(重载) 750V Heavy-duty 750V	1.5	31	26	30
	2.5	42	35	41
	4	55	47	53
	6	70	59	67
	10	96	81	91
	16	127	107	119
	25	166	140	154
	35	203	171	187
	50	251	212	230
	70	307	260	280
	95	369	312	334
	120	424	359	383
	150	485	410	435
	185	550	465	492
	240	643	544	572
	300	973	947	964
	400	1230	1136	1146

注：1. 对于单芯电缆，回路中各电缆的铜护套在两端连接在一起。  
2. 成组电缆不需要乘校正系数。  
Notes: 1. For single-core cables, copper sheaths are connected on the two ends.  
2. Group cables need not to be multiplied by correction coefficient.



附表4 500V及750V级铜芯铜护套矿物绝缘裸或防腐外护套电缆，允许人接触的

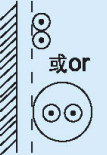
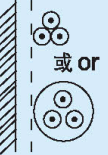
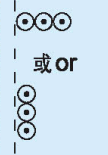
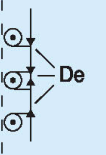
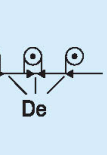
铜护套温度：70℃/环境温度：30℃(自由空气)  
Attached table 4 Copper-conductor copper sheathed mineral insulated bare cable or cable with anticorrosion sheath of class 500V and 750V, touchable temperature of copper sheath: 70℃/ambient temperature: 30℃ (Free air)

载流量A Current carrying capacity A						
导体标称截面积 Nominal sectional area of conductor mm <sup>2</sup>	两根导体(单相) 两芯或单芯电缆 Two pieces of con- ductor (single-phase) two-core or single- core cable		三根导体 (三相) Three pieces of conductor (three-phase)			
			多芯或单芯电缆 三角形排列 Multi-core or single-core cable Triangle arrangement	单芯电缆 平列 Single-core cable Side-by-side arrangement	单芯电缆 垂直有间隙 Single-core cable Vertical with clearance	单芯电缆 水平有间隙 Single-core cable Horizontal with clearance
						
	1	2	3	4	5	
(轻载)500V	1.5	25	21	23	26	29
Light-duty	2.5	33	28	31	34	39
500V	4	44	37	41	45	51
(重载) 750V Heavy-duty 750V	1.5	26	22	26	28	32
	2.5	36	30	34	37	43
	4	47	40	45	49	56
	6	60	51	57	62	71
	10	82	69	77	84	95
	16	109	92	102	110	125
	25	142	120	132	142	162
	35	174	147	161	173	197
	50	215	182	198	213	242
	70	264	223	241	259	294
	95	317	267	289	309	351
	120	364	308	331	353	402
	150	416	352	377	400	454
	185	472	399	426	446	507
	240	552	466	496	497	565
	300	812	758	789	792	889
	400	965	913	933	938	1058

注：1. 对于单芯电缆，回路中各电缆的铜护套在两端连接在一起。  
2. 对于易触及的裸电缆，表列数值应乘以0.9。  
Notes: 1. For single-core cables, copper sheaths are connected on the two ends.  
2. For touchable bare cables, the listed data should be multiplied by 0.9.

附表5 500V及750V级铜芯铜护套矿物绝缘裸电缆，不允许人接触的

铜护套温度：105℃/环境温度：30℃(自由空气)  
Attached table 5 Copper-conductor copper sheathed mineral insulated bare cable of class 500V and 750V, untouchable temperature of copper sheath: 105℃/ambient temperature: 30℃ (Free air)

载流量A Current carrying capacity A						
导体标称截面积 Nominal sectional area of conductor mm <sup>2</sup>	两根导体(单相) 两芯或单芯电缆 Two pieces of con- ductor (single-phase) two-core or single- core cable		三根导体 (三相) Three pieces of conductor (three-phase)			
			多芯或单芯电缆 三角形排列 Multi-core or single-core cable Triangle arrangement	单芯电缆 平列 Single-core cable Side-by-side arrange- ment	单芯电缆 垂直有间隙 Single-core cable Vertical with clear- ance	单芯电缆 水平有间隙 Single-core cable Horizontal with clear- ance
						
	1	2	3	4	5	
(轻载)500V	1.5	31	26	29	33	37
Light-duty	2.5	41	35	39	43	49
500V	4	54	46	51	56	64
(重载) 750V Heavy-duty 750V	1.5	33	28	32	35	40
	2.5	45	38	43	47	54
	4	60	50	56	61	70
	6	76	64	71	78	89
	10	104	87	96	105	120
	16	137	115	127	137	157
	25	179	150	164	178	204
	35	220	184	200	216	248
	50	272	228	247	266	304
	70	333	279	300	323	370
	95	400	335	359	385	441
	120	460	385	411	441	505
	150	526	441	469	498	565
	185	596	500	530	557	629
	240	697	584	617	624	704
	300	1012	945	973	1026	1098
	400	1197	1129	1161	1209	1312

注：1. 对于单芯电缆，回路中各电缆的铜护套在两端连接在一起。  
2. 成组电缆不需要乘校正系数。  
Notes: 1. For single-core cables, copper sheaths are connected on the two ends.  
2. Group cables need not to be multiplied by correction coefficient.



附表6 500V及750V级铜芯铜护套矿物绝缘电缆空气中（环境温度不等于30℃时）的校正系数， 应用于空气中敷设的电缆的载流量  
Attached table 6 Correction coefficient of copper-conductor copper sheathed mineral insulated cable of class 500V and 750V in the air (ambient temperature not equal to 30℃), can be applied to the current-carrying capacity of cables laid out in the air.

环境温度℃ Environment temperature℃	防腐护套裸电缆， 允许人接触70℃ Bare cable with anticorrosion sheath, touchable 70℃	裸电缆 不允许人接触105℃ Bare cable Untouchable 105℃
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	0.87	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

附表7 500V及750V级铜芯铜护套矿物绝缘电缆多回路或多根芯电缆成组校正系数,在应用于线管中或线槽中的电缆以及明敷电缆束时参照额定值  
Attached table 7 When is applied to cables in line pipes or line ducts as well as exposed laying cable bunch, refer to the rated value for the group correction coefficient of multi circuits of copper-conductor copper sheathed mineral insulated cable of class 500V and 750V or multi-core cable.

项 Item	电缆的排列 Arrangement of cable	校正系数 Correction coefficient											
		回路或多芯电缆的数量 Quantity of circuit or multi-core cable											
		1	2	3	4	5	6	7	8	9	12	16	20
1	成束明敷暗敷或封闭 在线管或线槽内 Exposed laying in bunch or enclosed in line pipe or line duct	1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.45	0.41	0.38
2	单层敷设在墙上、楼板或 无孔托盘上 Lay out single layer on wall, floor or hole-free tray	1.00	0.85	0.79	0.73	0.75	0.72	0.72	0.71	0.70	0.70	0.70	0.70
3	单层直接敷设在木制 楼板上 Lay out single layer on wooden floor directly	0.95	0.81	0.72	0.68	0.66	0.64	0.63	0.62	0.61	0.61	0.61	0.61
4	单层敷设在垂直或 水平的托盘上 Lay out single layer on verti- cal or horizontal tray	1.0	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72	0.72	0.72	0.72
5	单层敷设在梯型支撑 或夹板等 Lay out single layer on lad- der type support or plywood	1.0	0.87	0.82	0.80	0.80	0.79	0.79	0.78	0.78	0.78	0.78	0.78

注：1. 表列系数适用于相同负载的均匀成组电缆。  
2. 相邻电缆之间的水平间隙大于二倍电缆总直径时，不需要乘降低系数。  
Notes: 1. The listed coefficients are suitable for uniform group cables that are same in load.  
2. When horizontal clearance between two adjacent cables is larger than two times of overall diameter of cable, it need not to be multiplied by the reduction coefficient.



十四、电缆附件 Accessory

电缆附件包括：终端、接线端子、接地片、中间连接器等

Accessory includes terminals, wiring terminals, grounding strip, intermediate connector etc.

14.1 终端

安装在矿物绝缘电缆末端的一个完整端部，包括一个封端和一个填料函或者一个组合的封端/填料函装置。每根电缆都需安装终端。

终端的表示方法：铜芯铜护套矿物绝缘电缆终端，额定电压750V，适用于单芯4mm²电缆。

表示为：ZA-750 1×4

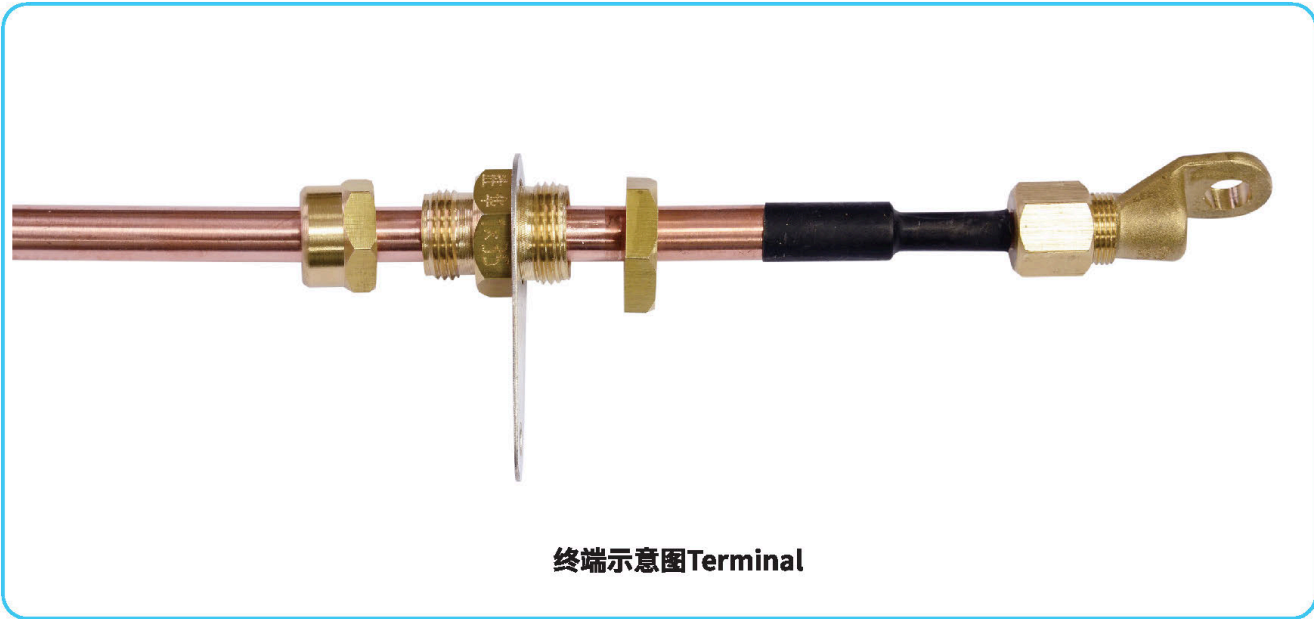
- 1) 终端封端：由一种隔潮密封的部件组成。包括黄铜密封罐、密封罐盖板、终端密封料、导体外露部分绝缘管。
- 2) 终端填料函：主要是用于连接电缆和开关柜、分支箱，它包括填料函本体、压缩环、填料函螺母、锁紧螺母。

14.1 Terminals

MI cables must be provided with terminals which include one seal and one gland or one combined seal/gland.

Indication of terminals: Example: A 4mm² single-core copper core and sheath MI cable terminal is indicated as ZA-750 1×4

- 1) Seal: It is made up of moisture proof sealing part, including abrass pot, a stub cap, sealing material and outer insulating sleeve.
- 2) Gland: It is used to connect the cable and switch board. Which includes a gland body, acompressing ring, a gland back nut and a lock nut.



14.2 接线端子

用于连接导体和控制柜接线柱或电源。压装型端子它由压装螺母、压装斜垫及端子本体等构成。接线端子有二种形式，其一、压装型接线端子，适用于35mm²以上电缆的连接，其二、压接型接线端子，适用于6-25mm²电缆的连接。小规格电缆4mm²及以下可以不带接线端子。

14.2 Cable connector terminals

It is used to connect conductor and terminal of control board or power source.Pressing type terminal is made up of back nut, pressing pad, terminal body. There are two types of terminals: pressure connector terminal used for more than 35mm² MI cables; compression connector terminal used for 6-25mm² cables. Those MI cables not exceeding 4mm² can carry no terminals.



14.3 接地片

电缆铜护套用作接地时或与电缆铜护套连接的其它电气设备的接地，需要采用接地片

14.3 Copper grounding plate

Copper grounding plate should be introduced when copper sheath or other electric equipments connected.

电缆附件的选配方法(不带中间连接器附件) Selection of cable accessory (no intermediate connector accessory)

电缆 Cable	封端 Termination seal			填料函 Gland	接线端子 Cable connector terminals	接地片 Copper grounding plate
	黄铜密封罐 Brass pot	密封料 Brass material	芯线绝缘套管 Insulated sleeve of core			
单芯 Single core	-	-	按表7 See table 7	按表2 See table 2	按表4/5 See table 4/5	按表6 See table 6
多芯 Multi core	按表3 See table 3	按密封电缆使用温度选择 Select according to operating temperature of sealed cable	按表7 See table 7	按表2 See table 2	按表5 See table 5	按表6 See table 6

备注：根据实际需要选配电缆附件 Select the cable accessories according to your need.

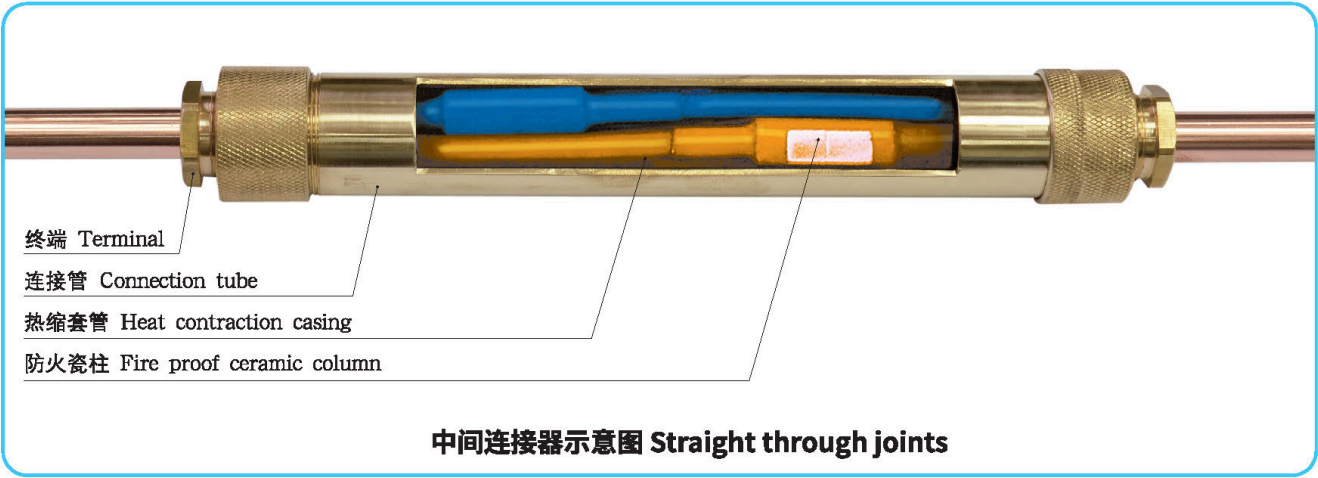


14.4 中间连接器附件

当电缆长度达不到要求时需要采用中间连接器，它是将两种相同规格的电缆连接起来成为一根电缆的装置，在需联接的电缆两头端部各装上终端，芯线用压接管连接在两电缆终端间，卡上带内螺纹的黄铜套管拧紧，多芯电缆需套热塑套管或陶瓷柱，单芯电缆可套也可不用套管。

14.4 Straight through joints

Intermediate connector will be required when the cable length can not reach the requirements, which connects two cables of same specifications into one cable. Two ends of cables that are needed connecting should be mounted with the terminal respectively, the core wire is jointed between two cable terminals with the compression pipe, the threaded brass sleeve on the card is tightened up. Multi-core cable needs the plastic sleeve or porcelain post for covering, and the single-core cable needs the sleeve or not.



中间连接器附件 Intermediate connector accessory

表1 Table 1		
型号 Models	电缆型号 Cable modes	适用电缆规格 Specifications of applicable cable
ZAL-I	BTTZ BTTVZ	1×1-1×35、2×1-2×6、3×1-3×4、4×1-4×2.5
	BTTQ BTTVQ	1×1-1×4、2×1-2×4、3×1-3×2.5、4×1-4×2.5、7×1-7×2.5
ZAL-II	BTTZ BTTVZ	1×50-1×95、2×10-2×16、3×6-3×16、4×4-4×10、7×1-7×4、10×1.5-10×2.5、12×1.5-12×2.5
ZAL-III	BTTZ BTTVZ	1×120、1×150、2×25、3×25、4×16、19×1.5
ZAL-IV	BTTZ BTTVZ	1×185、1×240、4×25
ZAL-V	BTTZ BTTVZ	1×300、1×400

十五、电缆附件结构参数 Accessory Structure and parameters

终端 Terminals

表2 终端填料函 Table 2 terminal gland

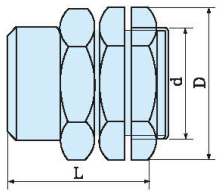
表2 Table 2						
	型号 Model	D (mm)	d (mm)	L (mm)	电压等级 Voltage class	适用的电缆规格 Specifications of applicable cable
	ZA-I	M20	24	34	750V 500V	1×1-1×35、2×1-2×6、3×1-3×4、4×1-4×2.5 1×1-1×4、2×1-2×4、3×1-3×2.5、4×1-4×2.5、7×1-7×2.5
	ZA-II	M25	29	37	750V	1×50-1×95、2×10-2×16、3×6-3×16、4×4-4×10、7×1-7×4、10×1.5-10×2.5、12×2.5
	ZA-III	M32	36	38	750V	1×120、1×150、2×25、3×25、4×16、19×1.5
	ZA-IV	M40	45	42	750V	1×185、1×240、4×25
	ZA-V	M42	46	56	750V	1×300、1×400

表3 封端密封罐 Table 3 seal tank for end

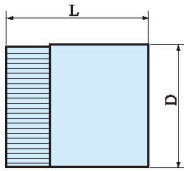
表3 Table 3					
	密封罐规格 Model of seal tank	D (mm)	L (mm)	电压等级 Voltage class	适用的电缆规格 Specifications of applicable cable
	20	14.8	17	750V 500V	1×1-1×35、2×1-2×6、3×1-3×4、4×1-4×2.5 1×1-1×4、2×1-2×4、3×1-3×2.5、4×1-4×2.5、7×1-7×2.5
	25	21.2	25	750V	1×50-1×95、2×10-2×16、3×6-3×16、4×4-4×10、7×1-7×4、10×1.5-10×2.5、12×2.5
	32	26.8	32	750V	1×120、1×150、2×25、3×25、4×16、19×1.5
	40	33.2	40	750V	1×185、1×240、4×25
	50	36.5	50	750V	1×300、1×400

表4 压装型接线端子 Table 4 pressing installation-type wiring terminal

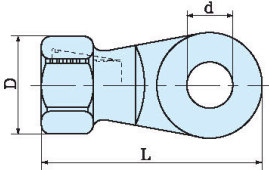
表4 Table 4						
	型号 Model	L (mm)	D (mm)	d (mm)	电压等级 Voltage class	适用的电缆规格 Specifications of applicable cable
	YZ-I	52.5	22	8	750V	1×35
	YZ-II	52.5	22	10.5	750V	1×50 1×95
	YZ-III	72	27	12	750V	1×120 1×150
	YZ-IV	88	32	14	750V	1×185 1×240
	YZ-V	101	40	16	750V	1×300 1×400



表5 压装型接线端子(铜鼻子) Table 5 pressing connection-type wiring terminal (copper fastener)

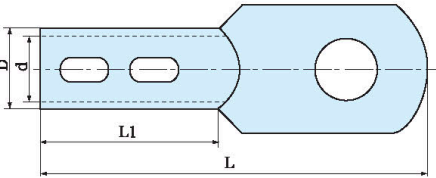
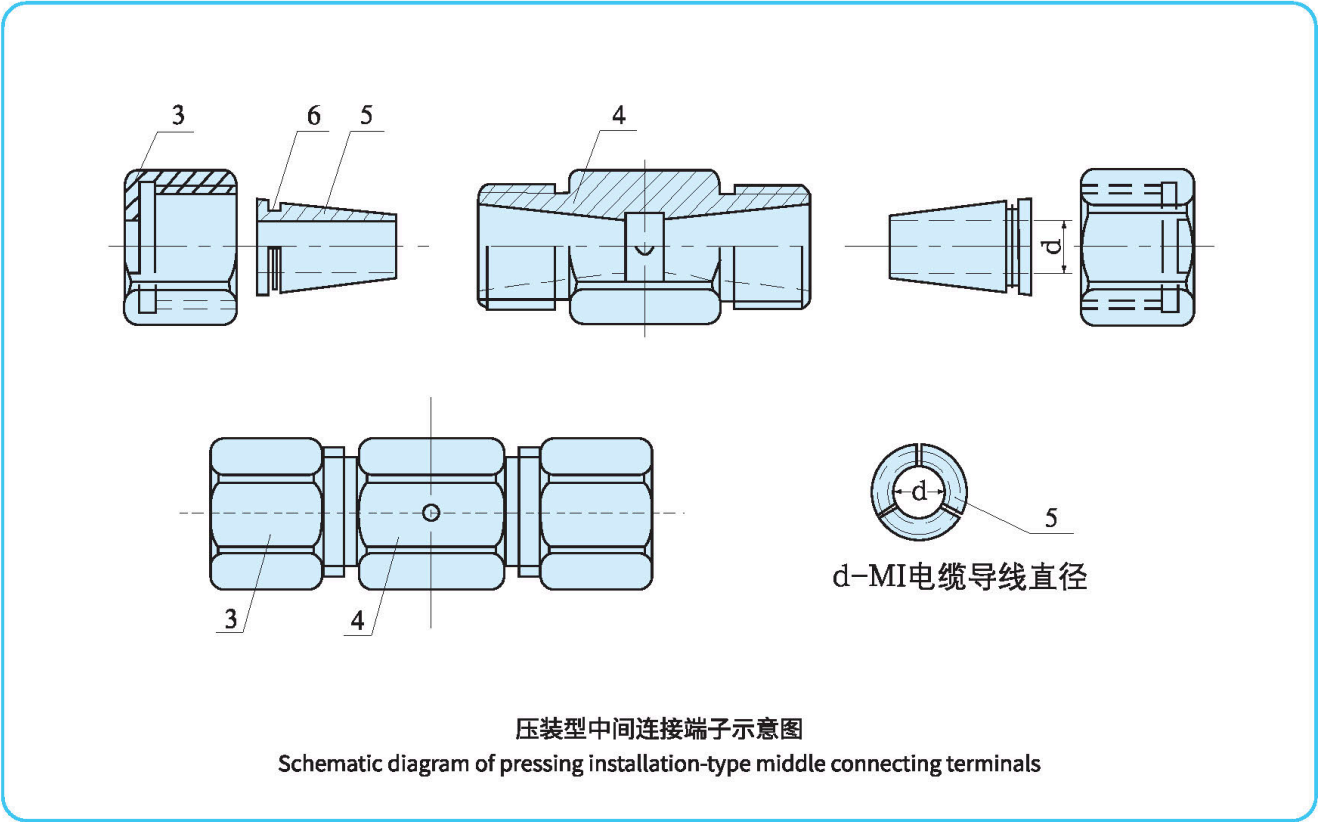
表5 Table 5				
	导体截面mm <sup>2</sup> Cross section of conductors mm <sup>2</sup>	端子型号 Terminal model	d (mm)	D (mm)
	6	DT-4	2.8	5
	10	DT-6	3.5	6
	16	DT-10	4.5	8
	25	DT-16	6	9

表6 接地铜片 Table 6 copper grounding strip

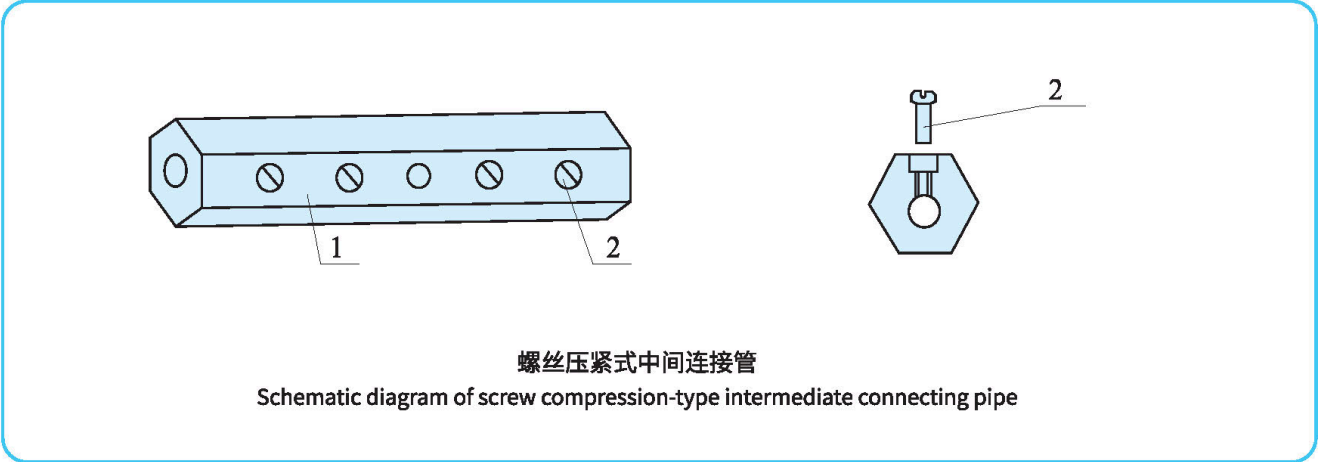
表6 Table 6

	型号 Model	D1 (mm)	D2 (mm)	d (mm)	电压等级 Voltage class	适用的电缆规格 Specifications of applicable cable
	I	20.5	30	6	750V	1×1-1×35、2×1-2×6、3×1-3×4、4×1-4×2.5
					500V	1×1-1×4、2×1-2×4、3×1-3×2.5、 4×1-4×2.5、7×1-7×2.5
	II	25.5	35	6	750V	1×50-1×95、2×10-2×16、3×6-3×16、 4×4-4×10、7×1-7×4、10×1.5-10×2.5、12×2.5
	III	32.5	48	8	750V	1×120、1×150、2×25、3×25、4×16、19×1.5
	IV	40.5	56	8	750V	1×185、1×240、4×25
	V	42.5	58	8	750V	1×300、1×400



B、压接型中间连接端子：(铜鼻子)，在市场上有标准件。主要适用于1.5-4mm<sup>2</sup>的电缆导体连接。  
B. pressing connection-type middle connecting terminal: (copper fastener), has standard unit in the market. It is mainly applicable to connection of cbale conductors with specifications of 1.5-4mm<sup>2</sup>.

C、螺丝连接型中间连接端子：主要适用于1.5-25mm<sup>2</sup>的电缆导体连接。  
C. Screw connection-type middle connecting terminal: it is mainly applicable to connection of cable conductors with specifications of 6-25mm<sup>2</sup>





电缆分支

矿物绝缘分支电缆是我公司最近开发的一个新品，通过电缆分支接线箱，解决了矿物绝缘电缆的分支问题，也就是所谓的“T”联接和“十”字联接。

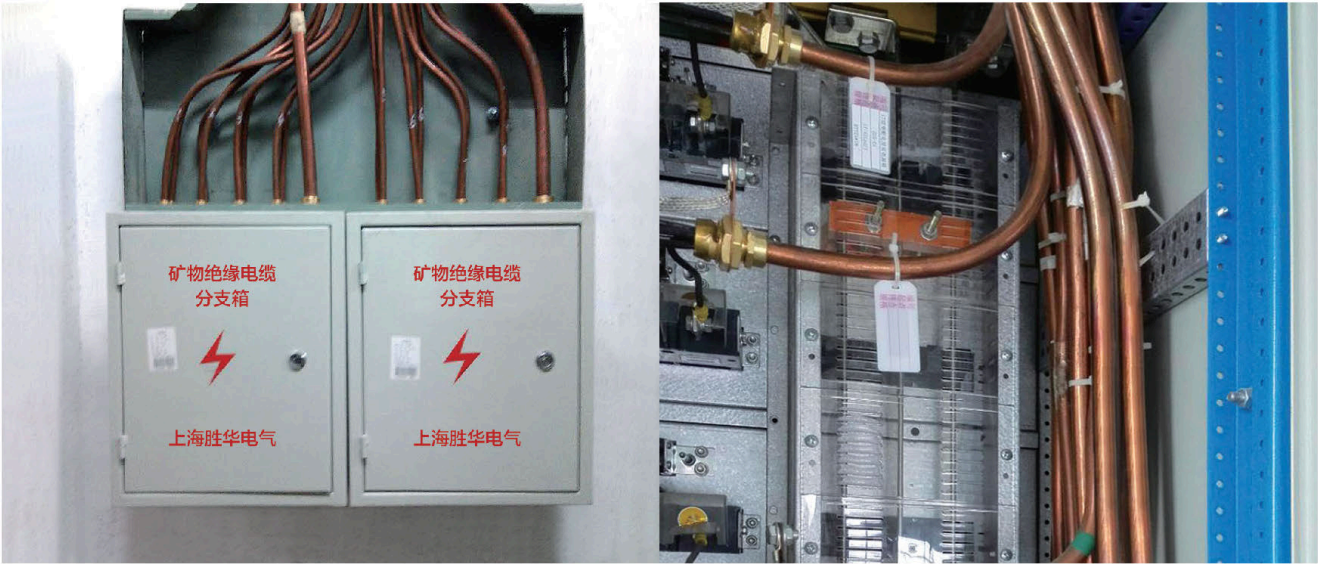
矿物绝缘电缆分支接线箱的选用：根据用户要求提供。

Cable branching

Mineral-insulated branch cable is product newly developed by our company. By adopting the branch connecting box, it solves the branching problem of mineral-insulated cables that is “T” shaped connection and “十” shaped connection. Selection of the branch connecting box for mineral-insulated cables: the branch connecting box will be provided according to user’s requirements.

分支接线盒的型号规格 Model & specifications of branch connecting box

型号 Model	外形尺寸(长×宽×高) Overall dimension (length×width×height) mm	电缆主干进线规格 Specifications of main cable wires
MI-FZ-I	360×230×140	35及以下 35and the following
MI-FZ-II	360×230×140	1×50-1×95
MI-FZ-III	360×310×140	1×120-1×150
MI-FZ-IV	410×340×160	1×185-1×240
MI-FZ-V	450×400×180	1×300-1×400



十六、电缆敷设和安装 Laying and installation

16.1 矿物绝缘电缆敷设的一般要求 General requirements on laying of mineral-insulated cables

- (1) 矿物绝缘电缆敷设见国家建筑标准设计：矿物绝缘电缆敷设99D163(中国建筑标准设计研究所出版)
- (1) Refer to the Mineral Insulated Cable Layout 99D163(issued by China Architecture Design and Research Institute) that specifies the national building standard design for the layout of mineral insulated cable
- (2) 电缆在敷设前，均应检查电缆是否完好，绝缘电阻是否达到标准要求。
- (2) Before laying of cables, cables shall be checked if they are complete and if insulation resistances reach standard requirements.

(3) 电缆敷设时，其固定点之间的间距，除支架敷设在支架处固定外，其余可按下表推荐的数值固定。

(3) When laying cables, for the distance between fixed points, except the laying of supported in fixed at the support, the remaining can be fixed according to the number recommended in following form.

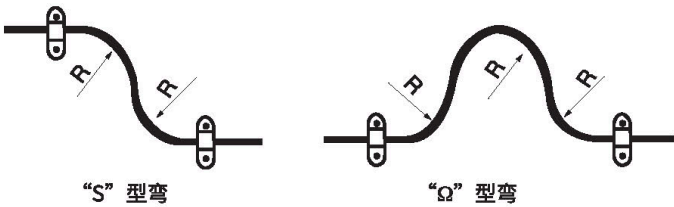
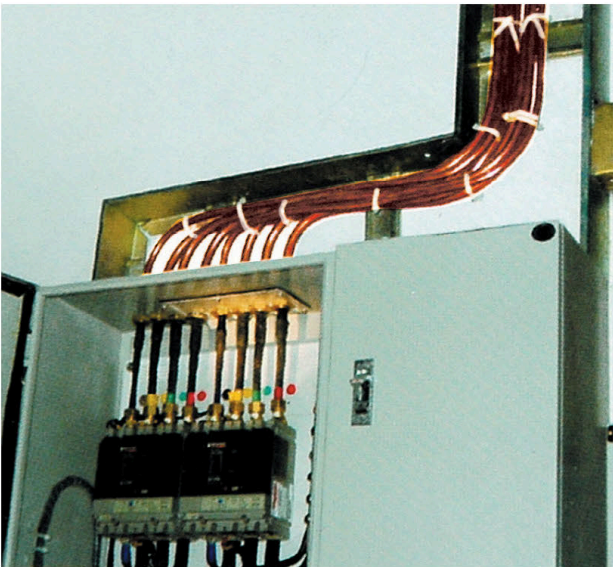
电缆外径(mm)Cable diameter		表2 Table 2		
固定点之间的最大距离 The maximum distance between fixed points	水平Level	D<9	9≤D<15	D≥15
	垂直Vertical	600	900	1500
		800	1200	2000

在明敷部位，如果相同走向的电缆大、中、小规格都有，从整齐、美观方面考虑，可按最小规格电缆标准要求固定，也可分档距离固定。当电缆倾斜敷设时，电缆与垂直方向成30°及以下时，按垂直间距固定；大于 30°时，按水平间距固定。

On the obvious laying positions, if cables with large, middle and small specifications all exist, considering from the orderly and beautiful aspects, they can be fixed by adopting specifications of the cables with the smallest specifications and they can also be fixed with space separation. When laying cables slantwise, if the angle between the cable and vertical direction is equivalent to or less than 30°, the cables will be fixed according to vertical space, if this angle exceeds 30°,the horizontal space with be based on.

- (4) 电缆敷设时，在转弯处、中间连接器两侧，有条件固定的应加以固定。
- (5) 计算敷设电缆所需长度时，应考虑留有1%的余量。
- (6) 对电缆在运行中可能遭受到机械损伤的部位，应采取适当的保护措施。
- (7) 单芯电缆敷设时，应逐根敷设，待每组布齐并矫直后，再作排列绑扎，绑扎间距以1-1.5m为宜。
- (8) 电缆在对铜护套有腐蚀作用的环境中敷设时，或在部分埋地或穿管敷设时，应采用聚氯乙烯外护套或低烟无卤外护套。
- (9) 布线过程中，电缆锯断后应立即对其端部进行临时性密封。
- (10) 电缆全长均为直线敷设或联接用电器可能产生振动时，要在允许的场合设置膨胀环。

- (4) When laying cables, joints and two sides of middle connectors shall be fixed if with proper conditions.
- (5) When calculating the length required for laying cables, 1% tolerance shall be considered to be left.
- (6) For positions that may suffer from mechanical damage during the running of cables, proper protective measures shall be taken.
- (7) When laying single-core cables, they shall be laid separately, and after each group is wired orderly,then they can be arranged for binding, and suiform binding space shall be 1-1.5m.
- (8) When laying cables in an environment that has corrosion effect on copper sheaths, or part of cables are embedded under the ground, or when they are laid by penetraing the tubes.External protective sleeves made of polyvinyl chloride or halogen-free external protective sleeves with low smoke shall be adopted.
- (9) During the wiring process, temporal seal shall be carried out for the ends of cables when they are sawed up.
- (10) When the whole cables are laid straightly or electrical appliances may produce vibration, expansion rings shall be set on allowable occasions.





(11) 一般矿物绝缘电缆无需穿管敷设，而且是有磁性的金属管时单芯电缆必须同一回路一起穿越。特殊场合必须穿管的不允许单独穿越。

(12) 对于大截面单芯电缆，用于交流电网络时应采取涡流消除措施，在交变电流作用下，铜护套上会形成横向涡流，会造成能量损耗。当线路负荷特别大而需要两组以上的电缆时，可按图1 a.b的形式排列两组或多组电缆，但每组之间要留有两倍电缆外径的距离，而且每组电缆接线位置应相同。此外，在电缆进配电箱、柜时，为固定电缆需在箱柜的板面上打孔，同样为防止电缆在进箱、柜的铁皮面上产生旋涡，在箱柜板面上应按图2所示的方式开孔，或加垫非磁性材料的隔板固定电缆，一般采用铝母线或铜母线加工制作、打孔，当采用扁钢或角钢制作支架时，这时也应参照上述方法开孔，以防涡流产生。

(13) 大截面单芯电缆用于交流网络时，由于交流磁场的作用，铜护套上会产生感应电势，如果电缆两端接地形成回路就会产生与芯线电流相反的纵向电流，而且相当严重，消除方法除同回路电缆紧靠一起外，另外也可以使两根相邻电缆形成回路来消除。

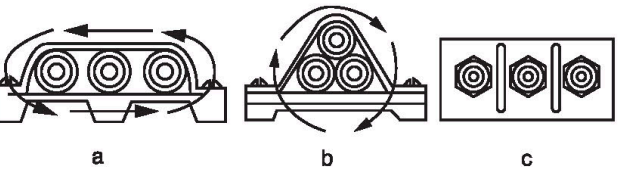


图1、涡流的产生及其消除措施示意图  
Figure 1. schematic diagram of production of vortex and its

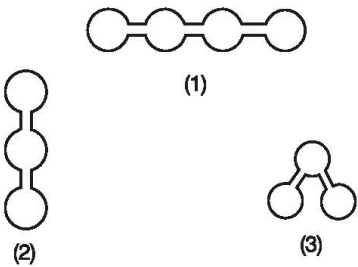


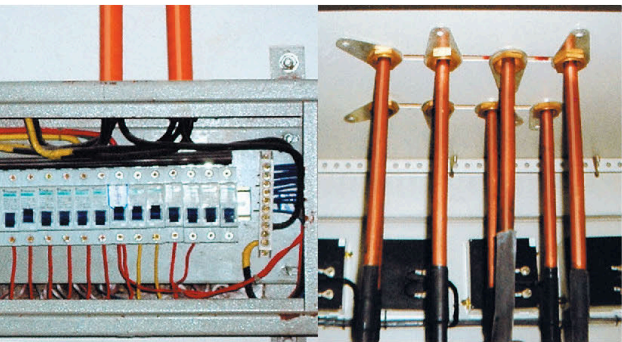
图2、电气箱、柜进线孔示意图  
Figure 2. schematic diagram of wiring holes of electric box and cabinet

(14) 单芯电缆敷设时，推荐按表5中列出的电缆排列方法进行敷设，且每路电缆之间留有不少于电缆外径2倍的间隙，如不留间隙则应考虑载流量减少系数。

(11) General mineral-insulated cables need not be laid by penetrating the tubes, on special occasions when penetration of tubes is required, please refer to the belon form(independent penetration of metal tubes is not allowed for single-core cables).

(12) For single-core cables with large sections, vortex elimination measures shall be taken when used in A.C power grid. Under the effect of alternating current, horizontal vortex will be formed on the copper sheaths and therefore cause energy consumption. When the load of lines is extremely big and over two groups of cables are required, two groups of cables or more can be arranged according to form a and b in diagram 1, however, space over two times of the external diameter of the cables shall be left for each group and the wiring position of each group of wires shall be the same. Iaddition, when cables enter the distribution box and rdistribution cabient, holes shall be drilled on the panel of box and cabinet in order to fix cables, likewise, in order to prevent vortex produced on the iron surface when cables enter the box and cabinet, holes shall be drilled on the panel of the box and cabinet as showed in diagram 2 or fix cables with baffles made of nonmagnetic materials. It usually adopts aluminium or copper generatrix for machining and boring. When making supports by adopting flat bar or angle bar, the above method shall also be referred to for drilling holes to prevent the appearance of vortex.

(13) When the single-core cable of large cross section is used for AC network, the copper sheath will produce the inductive electric potential due to the effect of AC magnetic field. If the earthing of two ends of cable forms the loop, much longitudinal current is produced opposite to the core wire current, this current is eliminated by forming the loop between two neighbored cables besides closing the cables that are same in loop.



(14) When laying single-core cables, it is recommended that they shall be laid by adopting the arrangement methods of wires listed in form 5, and space that is no less than two times of the external diameter of the cables shall be left between each line of cables. If space is not left, the coefficient of current carrying capacity shall be considered to be reduced.

电缆排列方法 Arrangement methods of cables.

表5 Table 5

敷设方式 Laying method	三相三线 Three-phase three-wire	三相四线 Three-phase four-wire
单路电缆 Single-line cables		
两路平行电缆 Two-line parallel cables		
三路或多路平行电缆 Three-line or multi-line parallel cables		

16.2 电缆附件的制作 Manufacturing of cable accessories

电缆终端的制作步骤:

- (1) 用专用割刀在距电缆末端20cm处割出一痕线，用斜口钳剥除铜皮，并用干布清除氧化镁粉
- (2) 将密封罐拧在电缆铜护套上
- (3) 用喷灯火焰驱除电缆末端处的潮气
- (4) 在密封罐中填加密封料并压实、盖上密封盖压紧
- (5) 将热收缩套管套在线芯上
- (6) 测试绝缘电阻

具体详见本公司的安装施工手册

The manufacturing process of cable terminal:

- (1) Use a special shear to cut a line in the place 20cm from the cable end, a pair of diagonal cutting pliers to strip off copper sheet and clear magnesia powder with dry cloth.
- (2) Fastened sealed tank onto the copper sheath of the cables
- (3) Use blowtorch flame to dry humidity in the cable end
- (4) Stuff sealed material in the sealed tank, press tightly and put on the cover
- (5) Put heat contraction casings on the cable core
- (6) Test insulation resistances

The details can be seen in the installation and construction manual of our company.





中间连接制作步骤

- (1) 制作终端绝缘密封
  - (2) 制作线芯绝缘
  - (3) 安装中接端子
  - (4) 制作中接端子绝缘
  - (5) 安装中间连接器
- 具体详见本公司的安装施工手册

Procedures of middle connecting manufacturing

- (1) Manufacturing terminal insulation seals
  - (2) Manufacturing conductor core insulators
  - (3) Installing middle connecting terminals
  - (4) Manufacturing middle connecting terminal insulators
  - (5) Installing middle connectors
- The details can be seen in the installation and construction manual of our company.

16.3 安装施工注意事项 Point for attention in installation and construction

- 1、由于电缆的绝缘材料在空气中易吸潮，施工时应做好防潮，当发现潮气进入端部，可剪去受潮段，也可用火焰喷灯直接对电缆受潮段加热驱潮、直到用500V兆欧表检测电缆的绝缘电阻达到100MΩ以上才能进行安装终端和中间连接器。
- 2、在终端和中间连接器的安装过程中，要多次及时测量电缆的绝缘电阻值，因安装时电缆受潮，或金属碎屑未清除干净，均可造成绝缘不合格。
- 3、电缆的终端应牢固地固定在电缆和电气设备上，利用铜护套作接地线时，应接地可靠。
- 4、矿物绝缘电缆，吸潮以后膨胀成为氢氧化镁，阻止了潮气进一步进入。
- 5、在桥架T形弯、L型弯、穿越墙洞、电气竖井、进出配电箱等弯曲度大、空间狭小处敷设时要按照工厂安装说明的弯曲方法和力度进行冷弯,以免在操作中损伤电缆铜护套。
- 6、根据设计图纸绘制“电缆敷设走向图”，认真核对电缆的根数、规格、长度、走向、中间接头位置及与其他管道交叉的间距等。敷设时应在专用的电缆放线架上进行，逐根放线、逐路捆扎、做到横平竖直。在处理中间接头、终端头时要留足操作余量。在穿钢管及桥架的转角、分支等处，要按照事先排布好的顺序平滑均匀地过渡，避免交叉和重叠，电缆平行敷设时，如有多个中间连接器，其位置应相互错开。

- 1. For the insulationg materials of cables,protection against humidity shall be well done on construction. If it is found that the ends are humid,the humid ends can be cut, or flame-thrower lamps can be used to heat the humid ends. Until insulating resistance reaches 100MΩor more tested by 500V mega-meter,terminals and middle connectors can be installed.
- 2. In the installation process of terminals and middle connectors,insulating resistance of cables shall be tested for many times in time, for cables become humid on construction or metal crumb is not cleared off ,insulation may be not qualified.
- 3. The terminals of cables shall be fixed tightly on the cables or electric appliance. When using a copper sheath as an earth connector,it is reliable that it shall be connected to the earth.
- 4. Because it is easy for magnesia powder of mineral-insulated cables to become humid,it will bulge into magnesium hydroxide after being humid.So humidity is prevented from further entry.
- 5. When laying in the places of large curves and small space such as T-shape curve and L-shape curve of bridge,traversing a wall hole,a electric silo and a distribution tank,they shall be chilly curved in accordance to the curving methods and degree of installation instruction less copper sheath of cables is destroyed in the process.
- 6. Cable Layout is drafted according to a design drawing .The number, specification,length,trend,location of middle connectors as well as space between crossed tubes etc. shall be checked carefully.While laying,they shall be carried out one by one in special cable drum rack and bundled one by one. Besides,they shall be done horizontally and vertically.When handling with middle connectors and terminals,operation space shall be sufficiently left. While traversing the curves of branches of steel tubes or bridge, order shall be arranged to transit smoothly,and cross and repeat shall be avoided. When laying cables horizontally,middle connectors shall be staggered if there are many.

- (5) 在桥架T形弯、L型弯、穿越墙洞、电气竖井、进出配电箱等弯曲度大、空间狭小处敷设时要按照工厂安装说明的弯曲方法和力度进行冷弯，以免在操作中损伤电缆铜护套。
- (6) 根据设计图纸绘制“电缆敷设走向图”，认真核对电缆的根数、规格、长度、走向、中间接头位置及其他管道交叉的间距等。敷设时应在专用的电缆放线架上进行，逐根放线、逐路捆扎、做到横平竖直。在处理中间接头、终端头时要留足操作余量。在穿钢管及桥架的转角、分支等处，要按照事先排布好的顺序平滑均匀地过渡，避免交叉和重叠电缆平行敷设时，如有多个中间连接器，其位置应相互错开。

- (5) When laying in the places of large curves and small space such as T-shape curve and L-shape curve of bridge, traversing a wall hole, a electric silo and a distribution tank, they shall be chilly curved in accordance to the curving methods and degree of installation instruction less copper sheath of cables is destroyed in the process.
- (6) Cable layout is drafted according to a design drawing. The number, specification, length, trend, location of middle connectors as well as space between crossed tubes etc. shall be checked carefully. While laying, they shall be carried out one by one in special cable drum rack and bundled one by one. Besides, they shall be done horizontally and vertically. When handling with middle connectors and terminals, operation space shall be sufficiently left. While traversing the curves or branches of steel tubes or bridge, order shall be arranged to transit smoothly, and cross and repeat shall be avoidd. When laying cables horizontally, middle connectors shall be staggered if there are many.

十七、 矿物绝缘电缆制造标准 Manufacturing standard of MI cable

GB/T13033-2007 额定电压750V及以下矿物绝缘电缆及终端  
IEC60702-2002额定电压不超过750V的矿物绝缘电缆及其终端  
BS6207-2001 额定电压750V及以下矿物绝缘电缆

GB/T13033-2007 mineral insulated cable with a rated voltage not exceeding 750V and its terminals  
IEC60702-2002 mineral insulated cable with a rated voltage not exceeding 750V and its terminals  
BS6207-2001 mineral insulated cable with a rated voltage not exceeding 750V

十八、 矿物绝缘电缆的特性标准 Performance standard of MI cable

BS6387： 2013用于火灾条件下保持电路完整的电缆的性能标准（英国）  
GA306.1~306.2-2001 公安部消防标准  
IEC60332-3电缆在火焰条件下的燃烧试验  
GB/T18380-2008 电缆或光缆在火焰条件下的燃烧试验  
BS6387： 2013 performance requirements for cable required to maintain circuit integrity under fire conditions Britain  
GA306.1~306.2-2001 Fire standard of Ministry of Public Security  
IEC60332-3 Test during flame combustion of cable  
GB/T18380-2008 Tests on electric and optical fibre cables under fire conditions

十九、 矿物绝缘电缆的应用标准 Application standard of MI cable

GB50045-2005高层民用建筑设计防火规范  
GB50016-2006建筑设计防火规范  
JGJ16-2008民用建筑电气设计规范  
GB50217-2007电力工程电缆设计规范  
GB50045-2005 Code for Fire Protection Design of High-Rise Civil Buildings  
GB50016-2006 Code for Fire Protection Design of Buildings  
JGJ16-2008 Code for Electrical Design of Civil Building  
GB50217-2007 Code for Design of Cables of Electric Works



矿物绝缘电缆敷设时可参照  
《矿物绝缘电缆敷设施工》手册  
Refer to manual on the left for the lay-out of mineral insulated cable



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二十、附件及安装方法 Accessories and installation methods

终端 Terminal

电缆在通电使用前，需采用一种永久性的终端将电缆与电气设备相接。终端有两种作用：一是使电缆绝缘材料（氧化镁）与外界隔离起密封用途，二是将电缆连接到开关柜或用设备上起固定作用。因而终端由二部份构成：

- 密封部分：一般由黄铜罐（或热收缩管）、罐盖、密封材料和导体的绝缘套管所组成。
- 压盖部分：一般由压盖本体、压缩环和压盖螺母所组成。

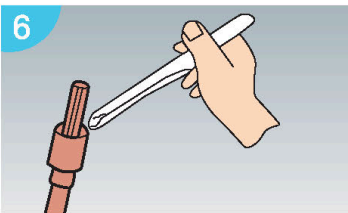
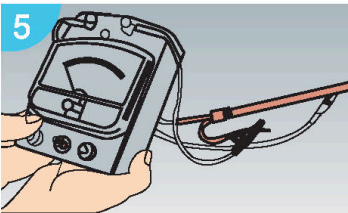
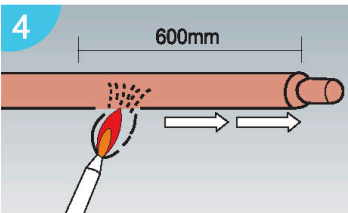
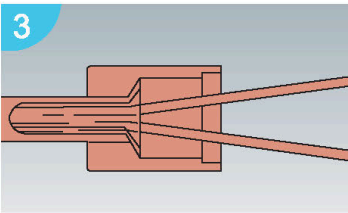
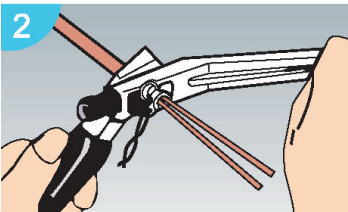
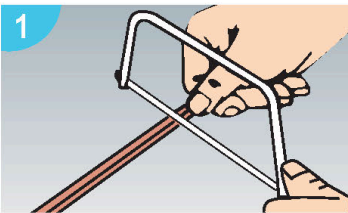
Before energizing and using the cable, a permanent terminal is required to connect the cable with the electric equipment. The terminal has two functions: one is the isolation of cable insulating material (magnesium oxygen) from the external, the other is the fixing of connection between the cable and switchgear or electric equipment. So, the terminal is made up of two parts:

- Sealing part: made up of brass pot (or thermal-shrinkable tube) , pot cover, sealing material and insulating sleeving of conductor.
- Cover part: made up of cover body, compression ring and cover screw.

安装施工方法 Installation & construction methods

- ① 将电缆按所需长度先用管子割刀在上面割一道痕线（图1、铜护套不能割断），再用斜口钳将护套铜皮夹在钳口之间按顺时针方向扭转，以一步步地夹住护套铜皮的边并以较小角度进行转动剥离，直至割痕处（图2）。
- ② 用清洁的干布彻底清除外露导线上的氧化镁绝缘料，然后将束头套在电缆上，并将黄铜封杯垂直拧在电缆护套铜皮上(图3)。开始时应用手束拧，并用束头在封杯上滑动来检查封杯的垂直度。确认垂直后再用管丝钳夹住封杯的滚花座继续进行安装，直至护皮一端低于封杯内局部螺纹处。
- ③ 从约距电缆敞开端600mm处用喷灯火焰加热电缆，并将火焰不断地移向电缆敞开端，以便将水分排除干净，切记只可向电缆敞开端移动火焰，否则将会把水分驱向电缆内部（图4）。
- ④ 用欧姆表分别测量一下芯与芯、芯与护套之间的绝缘电阻，若测量结果达到要求，则可以在封口杯内注入封口膏(图5)。注意封口膏应从一侧逐渐加入，不能太快，以便将空气排尽。等封口膏加满，再压上杯盖，接着用热缩套管把线芯套上，并热缩（图6）。最后用欧姆表再测量一下绝缘电阻，如果绝缘偏低，则重新再做一次。

- ① Make a line on the cable with a knife according to the required length (Fig. 1 The copper sheath can't be cut off) , clamp the copper sheath skin and make the torsion with the diagonal cutting nippers, to clamp the copper sheath skin side, rotate and peel off with a small angle to the cutting trace (Fig.2)
- ② Completely clean the magnesium oxygen insulating material of exposed conductor with the clean dry cloth, cover the bunched head on the cable, tighten the brass sealing cup to the cable copper sheath skin vertically (fig.3). At the beginning, tighten it with the hands, then, examine the verticality of sealing cup by the sliding of bunched head on the sealing cup. After ensuring the verticality, clamp the knurled base of sealing cup with the screw clamp to go on installation, till the one end of sheathed skin is lower than the partial thread of inside of sealed cup.
- ③ Heat the cable from the opening terminal 600mm with the flame of blowtorch, move the flame to the opening terminal of cable step by step, clear away the water, remember that you only move the flame to the opening terminal of cable, otherwise, the water would enter into the inside of cable (Fig. 4)
- ④ Measure the insulation between the cores and between the core and sheath with the ohm meter respectively, if the measured result reaches the requirements, fill the sealing cup with the sealing compound (Fig.5). Put the sealing compound into from one side generally, not too fast, so as to exhale the air completely. After filling with the sealing compound, press it with the cup cover, put the wire core into the thermal-shrinkable sleeving, and then, perform the thermal-shrinkage operation (Fig.6) . At last, measure the insulation resistance with the ohm meter, if the resistance is on the low side, repeat abovementioned operation.



52	企业法人营业执照
53	CQC产品认证证书
54	质量管理体系认证证书
55	环境管理体系认证证书
56	职业健康安全管理体系认证证书
57	知识产权管理体系认证证书
58	计算机软件著作权登记证书
59	高新技术企业证书
59	科技进步奖证书
60-61	中国船级社工厂认可证书
62	浦东新区企业研发机构证书
62	测量管理体系认证证书
63	上海专精特新证书
63	上海浦东新区科学技术奖
64	军队装备入网证书
64	中建三局2020年度优秀物资供应商
65	AAA级信用企业证书
65	守合同重信用企业证书
66	质量检测国家标准合格产品证书
66	中国建筑学会建筑电气分会特殊贡献奖
67	全国工业产品生产许可证
68	上海市高新技术成果转化项目证书
69	专利证书
70	燃烧性能等级证书
71-80	检验报告
81	防爆合格证
82-86	部分工程业绩
87	质量保证方案及确保质量的技术组织措施