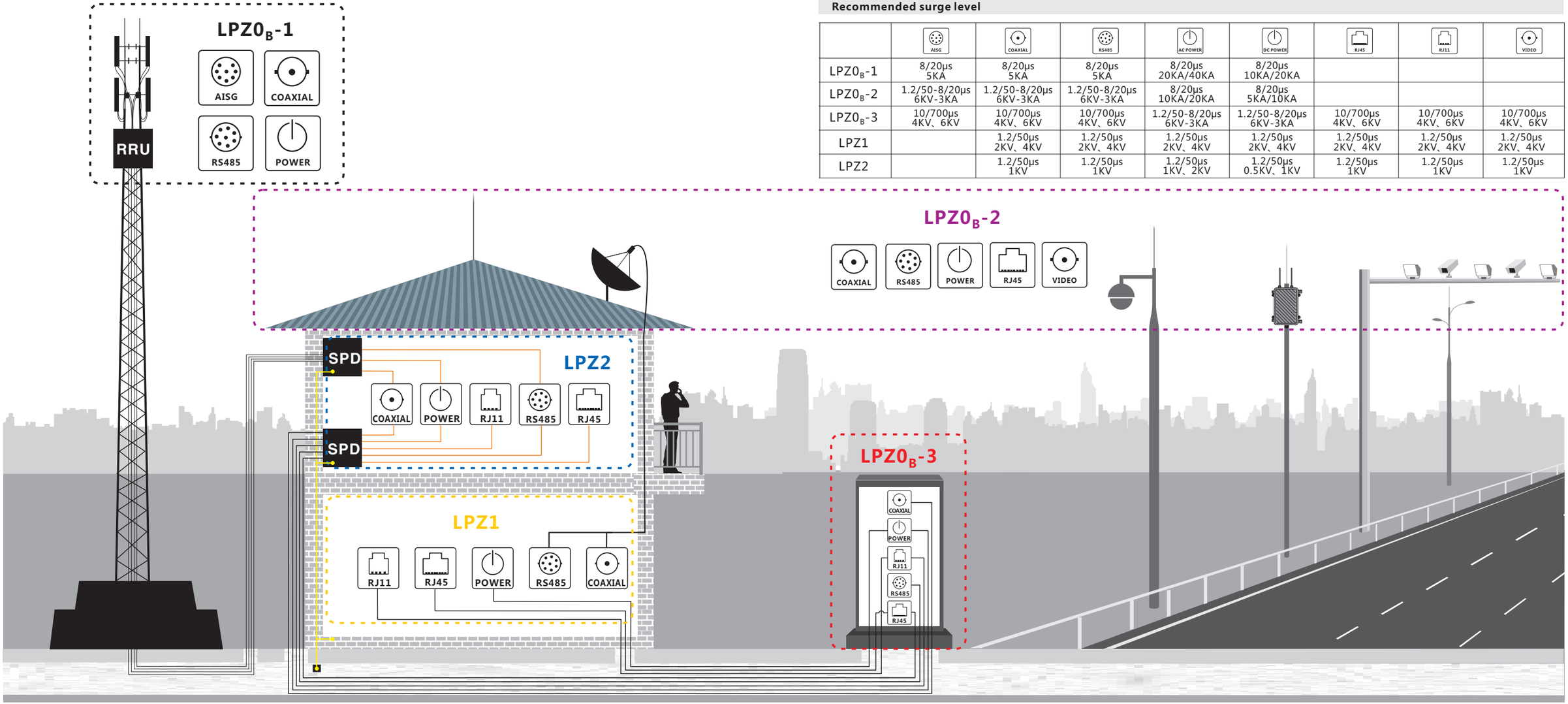


Recommended surge level

	AISG	COAXIAL	RS485	AC POWER	DC POWER	RJ45	RJ11	VIDEO
$LPZ0_B$-1	8/20μs 5KA	8/20μs 5KA	8/20μs 5KA	8/20μs 20KA/40KA	8/20μs 10KA/20KA			
$LPZ0_B$-2	1.2/50-8/20μs 6KV-3KA	1.2/50-8/20μs 6KV-3KA	1.2/50-8/20μs 6KV-3KA	8/20μs 10KA/20KA	8/20μs 5KA/10KA			
$LPZ0_B$-3	10/700μs 4KV、6KV	10/700μs 4KV、6KV	10/700μs 4KV、6KV	1.2/50-8/20μs 6KV-3KA	1.2/50-8/20μs 6KV-3KA	10/700μs 4KV、6KV	10/700μs 4KV、6KV	10/700μs 4KV、6KV
LPZ1		1.2/50μs 2KV、4KV	1.2/50μs 2KV、4KV	1.2/50μs 2KV、4KV	1.2/50μs 2KV、4KV	1.2/50μs 2KV、4KV	1.2/50μs 2KV、4KV	1.2/50μs 2KV、4KV
LPZ2		1.2/50μs 1KV	1.2/50μs 1KV	1.2/50μs 1KV、2KV	1.2/50μs 0.5KV、1KV	1.2/50μs 1KV	1.2/50μs 1KV	1.2/50μs 1KV

$LPZ0_B$-1 Application environment on telecom transmission tower

$LPZ0_B$-2 Outdoor cabinet on rooftops (high speed aerial included)

$LPZ0_B$-3 General outdoors, walls, hanging bars

LPZ1 OTHER areas inside buildingexcept $LPZ0_B$ classification defined, e. g. passageway, weak current wells, switching room, basement, inside room

LPZ2 To be provided with good line-to-ground connection system and the specific room with primaryprotection, e.g. inside building,generator room or outdoor container-style mini generator room etc.

AC

AC(Alternating current)

Is an electric current in which the flow of electric charge periodically reverses direction, whereas in direct current (DC, also dc), the flow of electric charge is only in one direction. AC is the form in which electric power is delivered to businesses and residences, and it is the form of electric power that consumers typically use when they plug kitchen appliances, televisions and electric lamps into a wall socket. A common example of DC power is a battery cell in a flashlight. The abbreviations AC and DC are often used to mean simply alternating and direct, as when they modify current or voltage.

The usual waveform of alternating current in most electric power circuits is a sine wave. In certain applications, different waveforms are used, such as triangular or square waves. Audio and radio signals carried on electrical wires are also examples of alternating current. These types of alternating current carry information encoded (or modulated) onto the AC signal, such as sound (audio) or images (video). These currents typically alternate at higher frequencies than those used in power transmission.

The world voltage profiles:

The interior world generally has two kinds of electricity used by the voltage, ac 100 v to 130v, respectively, with two types of AC 220 ~ 240 v.
100 v ~ 130 v low voltage are classified, such as the United States, Japan, and the ship's voltage, pay attention to safety;
220 ~ 240 v is known as the high pressure, including the China of 220 v and 230 v of the British and most European countries, pay attention to the energy conversion efficiency.
Use 220 ~ 230 v voltage, also have the use of 110 ~ 110 v voltage, such as Sweden and Russia.
100v AC: Japan, South Korea
110 ~ 130v AC: Taiwan, China, the United States, Canada, Mexico, panama, Cuba, Lebanon and other 30 countries
220 ~ 230v AC: China, Hong Kong (200 v), UK, Germany, France, Italy, Australia, India, Singapore, Thailand, the Netherlands, Spain, Greece, Austria, the Philippines, Norway, about 120 countries

DC

DC(Direct current)

Is the unidirectional flow of electric charge. Direct current is produced by sources such as batteries, power supplies, solar cells, or dynamos. Direct current may flow in a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams. The electric current flows in a constant direction, distinguishing it from alternating current (AC). A term formerly used for this type of current was galvanic current.
The abbreviations AC and DC are often used to mean simply alternating and direct, as when they modify current or voltage. Direct current may be obtained from an alternating current supply by use of a rectifier, which contains electronic elements (usually) or electromechanical elements (historically) that allow current to flow only in one direction. Direct current may be converted into alternating current with an inverter or a motor-generator set.

Direct current is used to charge batteries and as power supply for electronic systems. Very large quantities of direct-current power are used in production of aluminum and other electrochemical processes. It is also used for some railways, especially in urban areas. High-voltage direct current is used to transmit large amounts of power from remote generating sites or to connect alternating current power grids.

There are several kinds of the dc voltage level:

1.2 v rechargeable battery
1.5 v batteries
3 v power requirement of the remote control
5v of the SCM needs
6 volt motor vehicle power supply
9 volt digital table class needs
12 v for many occasions
24 v car use
48 v electric vehicle
Some other unusual

DSL

DSL (Digital Subscriber Line)

The rise of the Internet, people through telephone dial-up Internet, speed is slow, can not meet the growing needs of users.

DSL Chinese name is a digital subscriber line, is a telephone line for the transmission of media transmission technology combination. DSL technical support for symmetric and asymmetric transmission mode of transmission in the public telephone network subscriber loop transmission, solved the bottleneck problem that often occurs in the network service providers and end users of the "last mile". As the DSL access scheme does not need to transform the telephone lines, it can make full use of a large number of telephone users can already lay the loop, greatly reducing the overhead. Therefore, the use of copper line to provide high-speed Internet access, more popular with users, the various aspects of attention, has been widely used in some countries and regions.

category	Name	velocity	Transmission distance	advantage
Symmetrical DSL	HDSL	N×64kbps Various velocity	Within 3.6 km	Compared with the traditional T1/E1 technology, the most prominent advantage is that the deployment cost is low, and the installation is convenient.
	SDSL	Rate range from 160kbps to 2.084Mbps	0.4mm twisted pair on the maximum transmission distance of up to 3 km or more	Compared with SDSL, HDSL can save a pair of twisted pair, so the deployment is more simple and convenient.
	MVL	128kbps	Effective transmission distance of up to 7 km	Using a pair of twisted pair to achieve high speed data access, the deployment cost and power consumption are relatively low, and can be carried out with high density,
	IDSL	128kbps	Effective transmission distance of up to 7 km	IDSL can provide 128kbps services
Asymmetric DSL	ADSL	Up to 8Mbps of the high-speed downlink rate, and the uplink rate of 1Mbps	Effective transmission distance of up to 5 to 3 km	Make full use of the existing PSTN telephone network, only in line at both ends of the installation of ADSL equipment can provide users with high-speed broadband services, no need to re wiring, and thus greatly reduce the cost of service
	RADSL	Downlink transmission rate between 640kbps to 12Mbps, the uplink transmission rate is between 128kbps to 1Mbps	Effective transmission distance of up to 5 to 3 km	The data transmission can be realized by using a pair of twisted pair wires, which can support synchronous and asynchronous transmission.
	VDSL	Maximum can achieve the transmission rate of 58Mbps	In the case of less than 1.5 km of the user loop length, 13Mbps or higher access rates can be provided	VDSL actually can be regarded as the next generation of ADSL technology, its average transmission rate can be 5 to 10 times higher than the ADSL.

POE

POE (Power Over Ethernet)

POE refers to the existing Cat.5 Ethernet cabling infrastructure does not make any changes in the situation, for some IP based terminal (such as IP telephony, wireless LAN access point AP network camera, etc.) for the transmission of data signals at the same time, can also provide DC power supply technology for this kind of equipment. POE technology can ensure the normal operation of the existing network while ensuring the normal operation of the existing structure, and reduce the cost to the maximum extent.

Standard

In order to regulate and promote the development and application of POE in June 2003, IEEE 802.3 working group established the IEEE 802.3af standard, as an extension of the Ethernet standard, power supply, power supply network for transmitting and receiving all the detailed provisions.
IEEE 802.3af standard is a new standard Ethernet power supply system based on POE, which based on the IEEE 802.3 increased by standard direct power line, is to extend the existing Ethernet standard, is the first international standard on power distribution.
In October 2009, the 802.3at IEEE standard should be born to the needs of high power terminals, in the basis of compatible with 802.3af standards, to provide greater power supply needs to meet the new needs.

The main power characteristic parameters of POE :

(1) Voltage between 44 ~ 57V, the typical value is 48V.
(2) Maximum allowable current is 550mA and the maximum starting current is 500mA.
(3) Typical operating current is 10 ~ 350mA, the overload detection current is 350 ~ 500mA.
(4) Under no-load condition, the maximum current is 5mA.
(5) For PD equipment to provide 3.84 to 12.95W three level of electrical power request, the maximum not more than 13W.

The difference between Poe and POE+:

(1) POE+ maximum power support up to 25.5W, part of the factory products can support the 50W, and Poe can get the power of 25.4W;
(2) POE maximum support current is 350mA, POE+ maximum support current is 600mA;
(3) POE+ added a power management mode;

COAXIAL

CVBS

CVBS

CVBS is a widely used standard, also called baseband video or RCA video, is the (US) National Television Standards Committee (NTSC) TV signal of traditional image data transmission method. Composite video contains color difference (hue and saturation) and brightness (light) information.

The signal standard bandwidth is 6MHz. In composite video, the interference of color difference and luminance information is inevitable, especially when the signal is weak. CVBS is the first generation of video display output (the second generation is S-VIDEO, the third generation is VGA, the fourth generation is DVI, the fifth generation is HDMI).
(1) CVBS (AV interface or Video interface), Audio and Video separate transmission
(2) CVBS transmit the mixed video signal (Y and C) with the sound signal.
(3) Close transmission, Used Simulation waveform to transmit data

Advantage:
Audio and Video signals are separately transmitted, Reduce the video and audio mutual interference.

Disadvantage:
CVBS transmit the mixed video signal will cause quality loss.

COAXIAL

SDI

SDI(Serial digital interface)

Is a family of digital video interfaces first standardized by SMPTE(The Society of Motion Picture and Television Engineers) in 1989.For example, ITU-R BT.656 and SMPTE 259M define digital video interfaces used for broadcast-grade video. A related standard, known as high-definition serial digital interface (HD-SDI), is standardized in SMPTE 292M; this provides a nominal data rate of 1.485 Gbit/s.

Additional SDI standards have been introduced to support increasing video resolutions (HD, UHD and beyond), frame rates, stereoscopic (3D) video, and color depth. Dual link HD-SDI consists of a pair of SMPTE 292M links, standardized by SMPTE 372M in 1998; this provides a nominal 2.970 Gbit/s interface used in applications (such as digital cinema or HDTV 1080P) that require greater fidelity and resolution than standard HDTV can provide.

These standards are used for transmission of uncompressed, unencrypted digital video signals (optionally including embedded audio and time code) within television facilities; they can also be used for packetized data. Coaxial variants of the specification range in length but are typically less than 300 meters . Fiber optic variants of the specification such as 297M allow for long-distance transmission limited only by maximum fiber length or repeaters. SDI and HD-SDI are usually available only in professional video equipment because various licensing agreements restrict the use of unencrypted digital interfaces, such as SDI, prohibiting their use in consumer equipment.

COAXIAL

AHD

AHD

AHD technology used the Y/C signal separation and filtering technology which can effectively reduce the noise in high frequency and have the better image. It can transmit long distance (500 m) with high-definition video signal. Compared with the traditional analog products, AHD image quality has a qualitative upgrade; the highest definition can be equivalent to the 1080P.

Three format:
AHD-L definition (TVL)
Far higher than the traditional analog 960H,
AHD-M definition (TVL)
Equivalent to the 720P level,
AHD-H definition (TVL)
Equivalent to the full HD 1080P level,

Characteristic:
(1) Advanced color separation, clear signal filtering, 3D noise reduction technology, higher image quality,
(2) The transmission can reach 500 meters with 75-3 coaxial line,
(3) Zero time delay data , real time performance, high fidelity
(4) The good compatibility including D1 ,960H signal and so on
(5) The design for OSD menu is easy to operate.
(6) The cheap price with analog HD quality .
(7) The open standard which is easy to do the market promotion

COAXIAL

TVI

TVI (Transport Video Interface)

In the security industry, is a kind of high definition video transmission based on coaxial cable. In China, hikvision has launched HDTVI chip, TVI camera Joanne is also about to launch.

TVI, a new generation of connected transmission system architecture, a new generation of brightness and chroma separation, signal processing circuit, HD to 720P, 1080P, DVR mixed use of 720P and 1080P signals, can use the original coaxial cable, no need to change the original line, and can adapt to the engineering with twisted pair compatibility stronger.

TVI can also use coaxial cable 75-3 (5C2V) two-way transmission of mega pixel high-definition video signal, the transmission distance of up to 500m, no delay, no compression, low loss, high performance of video transmission.
At the same time, the TVI market is completely open, break the traditional restrictions, compatible with any TVI products in the market, the chip provided by the third party manufacturers, chip has stable supply capacity, is no longer fixed manufacturer restrictions, users have more choices on hd.

HDMI

HDMI (High definition multimedia interface)

Is a digital video / audio interface technology, is a special type of image transmission for digital interface, which can transmit audio and video signals at the same time, the maximum data transmission speed is 4.5GB/s. HDMI can be paired with broadband digital content protection (HDCP) to prevent unauthorized copying of copyright video content. The longest transmission can be 30 meters, to ensure the normal of sound and image. HDMI 1.4 version of the cable a total of 5 types, the standard way of marking: Standard HDMI Cable; Standard HDMI Cable with Ethernet; Standard Automotive HDMI Cable; High Speed HDMI Cable; High Speed HDMI Cable with Ethernet.

Advantage:

HDMI relative to existing analog video interfaces such as composite, S-Video, and component video:

(1) quality: HDMI is a digital interface, since all analog connections (such as component video or S-video) require no loss in the conversion from analog to digital, so it can provide the best video quality. This difference is particularly evident at higher resolutions, such as 1080p. Digital video will be clearer than component video, found in eliminating the component video softness and smearing. This text such as small, high contrast details of the difference will be to maximize.

(2) ease of use: HDMI integrates video and multi-channel audio in a single cable, eliminating the cost, complexity, and confusion of the multi cable used in the current A/V system. This is especially useful when upgrading or adding devices.

(3) High Intelligence: HDMI supports two-way communication between video sources (such as DVD players) and DTV to implement new features such as auto configuration and one touch play. Through the use of HDMI equipment is connected to the monitor automatically the most efficient transmission format (such as 480p vs 720p, 16:9 vs 4:3) eliminates the need for consumers to scroll through all formatting options to guess the best viewing format.

(4) high clear content ready: Support for HDCP HDMI devices to access advanced high-definition content, bring us some comfort. HD-DVD and Blu-ray have the high definition movie delay starting image resisting marking (also called content protection mark), to help minimize due to potential problems caused by the conversion, but is expected to start this sign in a few years, Means that the future of high-definition movies will not be able to play through an unprotected interface, such as analog components.

RS485

RS232, RS422, RS485 Difference

RS232, RS422, RS485 is the electrical standard, the main difference is that the logic of how to express.

RS232 12V /-12V said the logic 1, logic 0, full duplex, at least 3 lines of communication (RX, TX, GND), said that because of the use of absolute voltage logic, because of the interference, the wire resistance and other reasons, not far communication distance, speed can be tens of meters.

RS422, launched in RS232, using the TTL differential logic level said, is two voltage difference logic, RS422 is defined as full duplex, so at least 4 lines of communication (generally more additional ground wire), a driver can drive up to 10 receivers (i.e. the receiver load for 1/10 units) a relationship, communication distance and communication speed, short distance in general can use the high-speed communication rate is low when it is used for long distance communication, generally up to hundreds of kilometers.

RS485, launched in RS422, most inherited 422, the main difference is that RS485 is half duplex, and a drive capability of the drive can be driven at least 32 receivers (i.e. the receiver for 1/32, when the unit load) receiver using higher impedance can drive more receiver. So now most of the full duplex 485 driver / receiver is the standard: RS422/485, because the full duplex RS485 driver / receiver can be used in the RS422 network.

Characteristic:

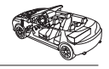
(1) RS-485 electrical characteristics: the use of differential signal negative logic, logic "0" to the difference between the two lines - (2~6) V said; logic "1" to the difference between the two lines is + (2~6) V. The interface signal level is lower than the RS-232-C, and it is not easy to damage the chip of the interface circuit, and the level is compatible with the TTL level, and can be conveniently connected with the TTL circuit.

(2) RS-485 data maximum transmission rate of 10Mbps.

(3) RS-485 interface is a combination of a balanced driver and a differential receiver, and the ability to resist common mode interference is enhanced, that is, anti noise interference is good.

The maximum communication distance of 4 RS-485 is about 1219m, the maximum transmission rate is 10Mbps, the transmission rate and the transmission distance is inversely proportional to the transmission rate of 100KbpS, it can achieve maximum communication distance, if need to transport a longer distance, need to add 485 repeaters. RS-485 bus generally supports 32 nodes, if the use of a special 485 chips, you can reach 128 or 256 nodes, the maximum can support to 400 nodes.

CAN



CAN(Controller Area Network)

As industrial measurement and control technology and production automation technology advances, the traditional RS - 232, RS - 485 and CCITTV. 24 communication technologies cannot meet the needs of modern industrial control, and field bus (Fieldbus), with its low price, reliable performance, and gradually become a new kind of communication technology in the field of industrial measurement and control. Field bus is used in production field, between microcomputer-based measuring control equipment to realize the bidirectional serial multi-node digital communication system, is a kind of open, digital, multipoint communication bottom control network. Brings together computer technology, network communication technology and automatic control technology (3 c) field bus technology, developed in the 1980 s, and gradually in the manufacturing and process industries, transportation, building automation system has been widely attention and application. Fieldbus basically has the following several types: [1-3] foundation fieldbus (FF), Lon Works, ProfiBus, CAN, HART, and which CAN namely controller local area network (LAN) because of the high performance, high reliability and unique design is more and more attention, already formed the international standard, is recognized as one of the most promising fieldbus.

The main features of CAN bus:

(1) CAN work for many, any node on the network at any time you can take the initiative to send information to other nodes, regardless of master-slave, flexible

(2) CAN order of precedence network nodes can be arranged to meet and coordinate their different real-time requirements

(3) Adopting nondestructive bus arbitration technology more, send information at the same time, in order of priority communications, saves bus arbitration conflicts between, avoid paralysis

(4) From point to point, point to multipoint, and global broadcast message

(5) Communication speed of up to 1M bps (40m), the longest transmission distance up to 10km (rate for 5kbps)

(6) Network nodes are currently up to 110, packet identifier 2 032 (CAN2.0A), extended (CAN2.0B) virtually unlimited message marker

(7) Short frame data structures, transmission time is short, strong anti-jamming ability, good error detection effect

(8) Communication medium can be used twisted pair, coaxial cable, or fiber

(9) Network nodes in the case of error severity can automatically turn off the output function from the network

(10) Realize the standardization and normalization (ISO11898)

USB

USB (Universal Serial Bus)

USB Is an external bus standard, for the specification of computer and external equipment connection and communication. Is the application of interface technology in the field of PC. ‘Plug and play ‘and hot swap function for USB interface support device. USB is at the end of 1994 by Intel, Compaq, IBM, Microsoft and other companies jointly proposed.

USB version	Transmission rate	Rate designation	Maximum output current	Launch date
USB1.0	1.5Mbps(192KB/s)	Low-Speed	5V/500mA	January 1996
USB1.1	12Mbps(1.5MB/s)	Full-Speed	5V/500mA	September 1998
USB2.0	480Mbps(60MB/s)	High-Speed	5V/500mA	April 2000
USB3.0	5Gbps(500MB/s)	Super-Speed	5V/900mA	November 2008
USB 3.1Gen 2	10Gbps(1280MB/s)	Super-speed+	20V/5A	December 2013

USB devices will be a large number of applications, mainly with the following advantages:

1 Can be hot swap.
2 Easy to carry.
3 Standardization.
4 Can connect multiple devices.

Difference between USB3.0 and USB2.0:

(1) distinguishes from the base color:
USB2.0 interface base is generally black or white.
USB3.0 interface base is usually blue;
Distinguished from the U disc pin socket:
USB 2 is a 4 pin, and USB 3 uses a 9 pin, the pin is more than USB2.0.

(2) distinguish between transmission speeds:
This method requires the use of tools, in theory, the rate of USB 2.0 is 480 Mbps, and USB 3.0 can reach 4.8 Gbps.

(3) Observe the contact
This approach is more cautious, USB 2.0 only with 4Pin metal contact, while USB 3.0 is the 9pin touch. Front 4Pin is consistent with USB 2.0; the rear 5pin is exclusive for USB 3.0

(4) observation marking
USB 3.0 logo "SS" represents the "Super Speed", in the USB 3.0 interface part will have the identity. In addition, the USB 3.0 cable due to an increase of 5 routes, it will also be slightly thicker than the USB 2.0 cable.

ITU-T K.20 (JUN 2016) Resistibility of telecommunication equipment installed in a telecommunication centre voltages and overcurrents

Applicable tests for external ports

Test type	No. of pairs simultaneously tested	Test connection	Primary protection	Port type							
				Symmetric port		Coaxial port		Dedicated power feed port		Mains power port	
				Basic	Enhanced	Basic	Enhanced	Basic	Enhanced	Basic	Enhanced
Lightning Voltage	Single	Transverse/ differential	No	1KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	1KV,0Ω 1.2/50 - 8/20μs	1.5KV,0Ω 1.2/50 - 8/20μs	1KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	2.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs
		Port to earth	No	1KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	n. a.		1KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	2.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs
		Port to external port	No	n. a.		n. a.		n. a.		2.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs
		Coordination/ Transverse/ differential	Yes	4KV,25Ω 10/700μs	4KV,25Ω 10/700μs	4KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs	4KV,25Ω 10/700μs	4KV,25Ω 10/700μs	6KV,0Ω 1.2/50 - 8/20μs	10KV,0Ω 1.2/50 - 8/20μs
		Coordination/ Port to earth	Yes	4KV,25Ω 10/700μs	4KV,25Ω 10/700μs	n. a.		4KV,25Ω 10/700μs	4KV,25Ω 10/700μs	6KV,0Ω 1.2/50 - 8/20μs	10KV,0Ω 1.2/50 - 8/20μs
		Coordination/ Port to external port	Yes	n. a.		n. a.		n. a.		6KV,0Ω 1.2/50 - 8/20μs	10KV,0Ω 1.2/50 - 8/20μs
	Multiple	Port to earth	No	1.5KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	n. a.		n. a.		n. a.	
		Port to external port	No	n. a.		n. a.		n. a.		n. a.	
		Port to earth	Yes	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		n. a.		n. a.	
		Port to external port	Yes	n. a.		n. a.		n. a.		n. a.	
	Unshielded twisted pair (UTP) Ethernet	Port to earth	No	n. a.		n. a.		n. a.		n. a.	
		Transverse	No	600V,10Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	n. a.		n. a.		n. a.	
		Voltage impulse test	No	2.5KV,5Ω 1.2/50 - 8/20μs	6KV,5Ω 1.2/50 - 8/20μs	2.5KV,5Ω 1.2/50 - 8/20μs	6KV,5Ω 1.2/50 - 8/20μs	n. a.		n. a.	
		Power over Ethernet(PoE)	No	600V,10Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	600V,10Ω 1.2/50 - 8/20μs	1.5KV,5Ω 1.2/50 - 8/20μs	n. a.		n. a.	
	Shielded twisted pair (STP) Ethernet	Port to earth	No	2.5KV,10Ω 1.2/50 - 8/20μs	6KV,10Ω 1.2/50 - 8/20μs	2.5V,10Ω 1.2/50 - 8/20μs	6KV,5Ω 1.2/50 - 8/20μs	n. a.		n. a.	
		Shield test	No	1.5KV,10Ω 1.2/50 - 8/20μs	6KV,10Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	6KV,10Ω 1.2/50 - 8/20μs	n. a.		n. a.	
Lightning Current	Single	Port to earth	No	1KA/wire, 0Ω, 8/20μs	5KA/wire, 0Ω, 8/20μs	n. a.		1KA/wire, 0Ω,8/20μs	5KA/wire, 0Ω,8/20μs	n. a.	
		Port to external port	No	n. a.		n. a.		n. a.		n. a.	
		Differential	n. a.	n. a.		1 KA, 8/20μs	5 KA 8/20μs	n. a.		n. a.	
		Shield to earth	n. a.	n. a.		4KA(Note 1), 2KA (Note 2) 8/20μs	20KA(Note 1), 5KA (Note 2) 8/20μs	n. a.		n. a.	
		Shield to external port	n. a.	n. a.		n. a.		n. a.		n. a.	
	Multiple	Port to earth	No	1 kA/wire, Limited to 6 kA, R = 0 , 8/20μs	5 kA/wire, Limited to 30 kA,R = 0 , 8/20μs	n. a.		n. a.		n. a.	
		Port to external port	No	n. a.		n. a.		n. a.		n. a.	
Insulation	Multiple	Port to earth	n. a.	2500V,5Ω 1.2/50 - 8/20μs	6000V,5Ω 1.2/50 - 8/20μs	n. a.		n. a.		n. a.	
Power induction and earth Potential rise	Single	Transverse	No	600V, 600Ω,0.2s	600V, 600Ω,0.2s	Under study		600V, 600Ω,0.2s	600V, 600Ω,0.2s	n. a.	
		Port to earth	No	600V, 600Ω,0.2s	600V, 600Ω,0.2s	n. a.		600V, 600Ω,0.2s	600V, 600Ω,0.2s	Under study	Under study
		Port to external port	No	n. a.		n. a.		n. a.		n. a.	
		Coordination Transverse	Yes	600V, 600Ω,0.2s	1500V, 600Ω,0.2s	Under study		600V, 600Ω,0.2s	1500V, 600Ω,0.2s	n. a.	
		Coordination Port to earth	Yes	600V, 600Ω,0.2s	1500V, 600Ω,0.2s	n. a.		600V, 600Ω,0.2s	1500V, 600Ω,0.2s	n. a.	
		Coordination Port to external port	Yes	n. a.		n. a.		n. a.	n. a.	n. a.	
Neutral potential rise	Single	Port to earth	No	n. a.		n. a.		n. a.		600V, 200Ω,1.0s	1500V, 200Ω,1.0s
		Port to external port	No	n. a.		n. a.		n. a.		600V, 200Ω,1.0s	1500V, 200Ω,1.0s
Main power contact	Single	Transverse	No	230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	n. a.		230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	n. a.	
		Port to earth	No	230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	n. a.		230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	230V,10,20, 40,80,160, 300,600 and 1000Ω, 15min	n. a.	
		Port to external port	No	n. a.		n. a.		n. a.		n. a.	

NOTE 1 – Equipment designed to be connected to antennas/equipment exposed to direct lightning currents, e.g., connected to antennas/equipment mounted on a tower.NOTE 2 – Applicable equipment not covered by Note 1.

Applicable tests for internal ports

Test type	Primary protection	Unshielded			Shielded cable			POE		Floating d.c.power interface		Earthed d.c.power interface	
			Basic	Enhanced		Basic	Enhanced	Basic	Enhanced	Basic	Enhanced	Basic	Enhanced
Lightning	No	Unshielded cable with symmetric pairs	500V,10Ω 1.2/50μs –8/20μs	1KV,10Ω 1.2/50μs –8/20μs	Shielded cable to earth	500V,0Ω 1.2/50μs –8/20μs	1.0KV,0Ω 1.2/50μs –8/20μs	600V,10Ω 1.2/50μs –8/20μs	1KV,10Ω 1.2/50μs –8/20μs	500V,0Ω 1.2/50μs –8/20μs	1KV,0Ω 1.2/50μs –8/20μs	500V,0Ω 1.2/50μs –8/20μs	1KV,0Ω 1.2/50μs –8/20μs
					USB shielded cable to earth	100V,0Ω 1.2/50μs –8/20μs	150V,0Ω 1.2/50μs –8/20μs						
		UTPEthernet portrated impulse voltage test	2.5KV,5Ω 1.2/50μs –8/20μs	6KV,5Ω 1.2/50μs –8/20μs	STP Ethernet simultaneousport to earth	1KV,0Ω 1.2/50μs –8/20μs	1.5KV,0Ω 1.2/50μs –8/20μs						
					UTP Ethernet portrated impulse voltage test	2.5KV,5Ω 1.2/50μs –8/20μs	6KV,5Ω 1.2/50μs –8/20μs						
		Floating d.c. power interface	500V,0Ω 1.2/50μs –8/20μs	1KV,0Ω 1.2/50μs –8/20μs	Floating d.c. power interface	500V,0Ω 1.2/50μs –8/20μs	1KV,0Ω 1.2/50μs –8/20μs						

ITU-T K.21 (JUN 2016) Resistibility of telecommunication equipment installed in customer premises to voltages and overcurrents

Applicable tests for external ports

Test type	No. of pairs simultaneously tested	Test connection	Primary protection	Port type							
				Symmetric port		Coaxial port		Dedicated power feed port		Mains power port	
				Basic	Enhanced	Basic	Enhanced	Basic	Enhanced	Basic	Enhanced
Lightning Voltage	Single	Transverse/ differential	No	1.5KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	1KV,0Ω 1.2/50 - 8/20μs	1.5KV,0Ω 1.2/50 - 8/20μs	1.5KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	2.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs
		Port to earth	No	1.5KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		1.5KV,25Ω 10/700μs	6KV,25Ω 10/700μs	2.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs
		Port to external port	No	1.5KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		1.5KV,25Ω 10/700μs	6KV,25Ω 10/700μs	2.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs
		Coordination/ Transverse/ differential	Yes	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	4KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	6KV,0Ω 1.2/50μs– 8/20μs	10KV,0Ω 1.2/50μs– 8/20μs
		Coordination/ Port to earth	Yes	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	6KV,0Ω 1.2/50μs– 8/20μs	10KV,0Ω 1.2/50μs– 8/20μs
		Coordination/ Port to external port	Yes	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	6KV,0Ω 1.2/50μs– 8/20μs	10KV,0Ω 1.2/50μs– 8/20μs
	Multiple	Port to earth	No	1.5KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	n. a.		n. a.		n. a.	
		Port to external port	No	1.5KV,25Ω 10/700μs	1.5KV,25Ω 10/700μs	n. a.		n. a.		n. a.	
		Port to earth	Yes	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		n. a.		n. a.	
		Port to external port	Yes	4KV,25Ω 10/700μs	6KV,25Ω 10/700μs	n. a.		n. a.		n. a.	
	Unshielded twisted pair (UTP) Ethernet	Port to earth	No	n. a.		n. a.		n. a.		n. a.	
		Transverse	No	600V,10Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	n. a.		n. a.		n. a.	
		Voltage impulse test	No	2.5KV,5Ω 1.2/50 - 8/20μs	6KV,5Ω 1.2/50 - 8/20μs	n. a.		n. a.		n. a.	
		Power over Ethernet (PoE)	No	600V,10Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	n. a.		n. a.		n. a.	
	Shielded twisted pair (STP) Ethernet	Shield test	No	1.5KV,10Ω 1.2/50 - 8/20μs	6KV,10Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	6KV,10Ω 1.2/50 - 8/20μs	n. a.		n. a.	
		Port to earth	No	1.5KV,0Ω 1.2/50 - 8/20μs	6KV,0Ω 1.2/50 - 8/20μs	1.5KV,10Ω 1.2/50 - 8/20μs	6KV,10Ω 1.2/50 - 8/20μs	n. a.		n. a.	
Lightning Current	Single	Port to earth	No	1KA/wire,0Ω ,8/20μs	5KA/wire,0Ω ,8/20μs	n. a.		1KA/wire,0Ω ,8/20μs	5KA/wire,0Ω ,8/20μs	n. a.	
		Port to external port	No	1KA/wire,0Ω ,8/20μs	5KA/wire,0Ω ,8/20μs	n. a.		1KA/wire,0Ω ,8/20μs	5KA/wire,0Ω ,8/20μs	n. a.	
	Multiple	Port to earth	n. a.	1 kA/wire, Limited to 6kA,R = 0 ,8/20μs	5 kA/wire, Limited to 30 kA,R = 0 ,8/20μs	n. a.		n. a.		n. a.	
		Port to external port	n. a.	1 kA/wire, Limited to 6kA,R = 0 ,8/20μs	5 kA/wire, Limited to 30 kA,R = 0 ,8/20μs	n. a.		n. a.		n. a.	
		Differential	n. a.	n. a.		1 kA, 8/20μs	5 kA 8/20μs	n. a.		n. a.	
		Shield to earth	No	n. a.		1 kA, 8/20μs	5 kA 8/20μs	n. a.		n. a.	
		Shield to external port	No	n. a.		4kA(Note 1), 2kA (Note 2) 8/20μs	20kA(Note 1), 5kA (Note 2) 8/20μs	n. a.		n. a.	
Insulation	Multiple	Port to earth	n. a.	2.5V,5Ω 1.2/50 - 8/20μs	6KV,5Ω 1.2/50 - 8/20μs	n. a.		n. a.		n. a.	
Power induction and earth Potential rise	Single	Transverse	No	600V,600Ω ,0.2s	600V,600Ω ,0.2s	Under study		600V,600Ω ,0.2s	600V,600Ω ,0.2s	n. a.	
		Port to earth	No	600V,600Ω, 0.2s	600V,600Ω, 0.2s	n. a.		600V,600Ω, 0.2s	600V,600Ω, 0.2s	Under study	Under study
		Port to external port	No	600V,600Ω, 0.2s	600V,600Ω, 0.2s	n. a.		600V,600Ω, 0.2s	600V,600Ω, 0.2s	Under study	Under study
		Coordination Transverse	Yes	600V,600Ω, 1s	1.5KV,200Ω ,2s	Under study		600V,600Ω, 1s	1.5KV,200Ω ,2s	n. a.	
		Coordination Port to earth	Yes	600V,600Ω, 1s	1.5KV,200Ω ,2s	n. a.		600V,600Ω, 1s	1.5KV,200Ω ,2s	n. a.	
		Coordination Port to external port	Yes	600V,600Ω, 1s	1.5KV,200Ω ,2s	n. a.		600V,600Ω, 1s	1.5KV,200Ω ,2s	n. a.	
Neutral potentialrise	Single	Port to earth	No	n. a.		n. a.		n. a.		600V 200Ω,1s	1500V 200Ω,1s
		Port to external port	No	n. a.		n. a.		n. a.		600V 200Ω,1s	1500V 200Ω,1s
Main power contact	Single	Transverse	No	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	n. a.		230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	n. a.	
		Port to earth	No	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	n. a.		230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	n. a.	
		Port to external port	No	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	n. a.		230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	230V,10,20,40, 80,160, 300, 600 and 1000Ω,15min	n. a.	

NOTE 1 – Equipment designed to be connected to antennas/equipment exposed to direct lightning currents, e.g., connected to antennas/equipment mounted on a tower.NOTE 2 – Applicable equipment not covered by Note 1.

Applicable tests for internal ports

Test type	Primary protection	Unshielded cable			Shielded cable			PoE		Floating d.c. power interface		Earthed d.c. power interface	
			Basic	Enhanced		Basic	Enhanced	Basic	Enhanced	Basic	Enhanced	Basic	Enhanced
Lightning	No	Unshielded cable with symmetric pairs	1KV,10Ω 1.2/50μs– 8/20μs	1.5KV,10Ω 1.2/50μs– 8/20μs	Shielded cable to earth	1KV,0Ω 1.2/50μs– 8/20μs	1.5KV,0Ω 1.2/50μs– 8/20μs	600V,10Ω 1.2/50μs– 8/20μs	1KV,10Ω 1.2/50μs– 8/20μs	1KV,0Ω 1.2/50μs– 8/20μs	1.5KV,0Ω 1.2/50μs– 8/20μs	1KV,0Ω 1.2/50μs– 8/20μs	1.5KV,0Ω 1.2/50μs– 8/20μs
					USB shielded cable to earth	100V,0Ω 1.2/50μs– 8/20μs	150V,0Ω 1.2/50μs– 8/20μs						
		UTP Ethernet portrated impulse voltage	2.5KV,5Ω 1.2/50μs– 8/20μs	6KV,5Ω 1.2/50μs– 8/20μs	STP Ethernet simultaneous port to earth	1KV,0Ω 1.2/50μs– 8/20μs	1.5KV,0Ω 1.2/50μs –8/20μs						
					Floating d.c. power interface	1KV,0Ω 1.2/50μs– 8/20μs	1.5KV,0Ω 1.2/50μs– 8/20μs						

GR1089-2:(2010) Electromagnetic Compatibility (EMC) and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

First-Level Lightning Surge

Surge Test Number	Port Types	Test Description	Min.Peak Open-CircuitVoltage (Volts)	Min. Peak Short-Circuit Current per Conductor (Amperes)	Surge Maximum Rise/Minimum Decay Timefor Voltage and Current(μs)	Value of External Non-Inductive Resistors	Repetitions Each Polarity	Test Connections
1	1,3,3b/5b,5	Multiport OSP Test	±1000	25	10/360	N/A	5	Up to 24conductors
1.1	3b/5b	Short Loop OSP Interface	±1000	25	10/360	N/A	5	A
1.2	3b/5b	Short Loop OSP Interface - with Secondary Protectors	±Vs	25(at 1000 V)	10/360	N/A	5	A
2	1,3,5	OSP Interface	±100 to ±1000	10(at 100 V)to 100(at 1000 V)	10/1000	N/A	5 at each voltage increment	A
2.1	1,3,5	Extended OSP Interface	±100 to ±2000	10(at 100 V)to 100(at 2000 V)	10/1000	N/A	5 at each voltage increment	A
2.2	1,3,5	OSP Interface–with SecondaryProtectors	±Vs	100(at 1000 V)	10/1000	N/A	5	A
3	1,3,3b/5b,5	Gas Tube Interaction Test	±4000	SeeFigure 4-6	10/700 voltage 5/310 current	25	5	(A5 and A6) orB
4	3,5	Inductive Kick Test for OSP Interfaces	±2500	500	2/10	N/A	10	See Figure 4-1
5	3,3b/5b,5	Fast Rise Time Test for Remote OSP Interfaces	±1000	200	2/10	N/A	5	A
6	3,5	Higher Ground Resistancefor Remote OSP Interfaces – Longitudinal	±1000	100	10/1000	N/A	5	A5, A6
7	3,5	High Lightning ExposureTest for Remote OSP Inter faces	±400 to ±4000	50 (at 400 V) to 500(at 4000 V)	10/250	N/A	5 at each voltage increment	B
8	2,3a/5a,4,4a	Intra-Building with up to 2 Pairs per Port (Metallic)	±800	100	2/10	N/A	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	A1, A2, A3,A4
8.1	2,3a/5a,4,4a	Intra-Building with Secondary Protectors up to 2 Pairs per Port (Metallic)	±Vs	100 (at 800 V)	2/10	N/A	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	A1, A2, A3,A4
9	2,4,4a	Intra-Building with up to 2 Pairs per Port (Longitudinal)	±1500	100	2/10	N/A	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
9.1	2,4,4a	Intra-building with Secondary Protectors up to 2 Pairs per Port (Longitudinal)	±Vs	100 (at 1500 V)	2/10	N/A	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
10	2,3a/5a,4,4a	Alternative Intra-Building for up to 2 Pairs per Port (Metallic)	±800	400	1.2/50-8/20	6	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	A1, A2, A3,A4
10.1	2,3a/5a,4,4a	Alternative Intra-Building with Secondary Protectors up to 2 Pairs per Port (Metallic)	±Vs	Vs/2	1.2/50-8/20	6	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	A1, A2, A3,A4
11	2,4,4a	Alternative Intra-Building up to 2 Pairs per Port (Longitudinal)	±1500	750	1.2/50-8/20	10	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
11.1	2,4,4a	Alternative Intra-Building Undervoltage up to 2 Pairs per Port(Longitudinal)	±Vs	Vs/2	1.2/50-8/20	10	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
12	2,3a/5a,4,4a	Intra-Building for 3 or 4 Pairs per Port (Metallic)	±800	400	1.2/50-8/20	6	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	Test per Figure 4-10
12.1	2,3a/5a,4,4a	Intra-Building with Secondary Protectors, 3 or 4 Pairs per Port (Metallic)	±Vs	Vs/2	1.2/50-8/20	6	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	Test per Figure 4-10
13	2,4,4a	Intra-Building 3 or 4 Pairs per Port (Longitudinal)	±1500	750	1.2/50-8/20	20	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
13.1	2,4,4a	Intra-Building Undervoltage 3 or 4 Pairs per Port (Longitudinal)	±Vs	Vs/2	1.2/50-8/20	20	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
14	2,3a/5a,4,4a	Intra-Building for > 4 Pairs per Port(Metallic)	±800	400	1.2/50-8/20	6	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	Test per Figure 4-10
14.1	2,3a/5a,4,4a	Intra-Building with Secondary Protectors, > 4 Pairs per Port (Metallic)	±Vs	Vs/2	1.2/50-8/20	6	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	Test per Figure 4-10
15	2,4,4a	Intra-Building for > 4 Pairs per Port(Longitudinal)	±1500	750	1.2/50-8/20	40	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
15.1	2,4,4a	Intra-Building with Secondary Protectors for > 4 Pairs per Port(Longitudinal)	±Vs	Vs/2	1.2/50-8/20	40	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	B
16	2,3a/5a,4,4a	Intra-Building for Paired Shielded Cables	±1500	750	1.2/50-8/20	2	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	See Figure 4-12
17	2,3a/5a,4,4a	Intra-Building for Coaxial	±1500	750	1.2/50-8/20	2	Repetitions each polarity may be 5 on 1 sample, or 1 on 3 samples.	See Figure 4-13
18	4a	Customer Side ONT Interfaces	±1000	100	10/1000	N/A	5	A5, A6
19	6	Antenna Port Test	±600	300	1.2/50-8/20	N/A	5	Center conductor to shield
19.1	6	Antenna Port with Secondary Protector Test	±Vs	300(at 600 V)	1.2/50-8/20	N/A	5	Center conductor to shield
20	7	AC Power Port Test with External SPD	±2000	1000	1.2/50-8/20	N/A	5	Phase to neutral, phase to ground, neutral to ground
21	7	AC Power Port Test with External SPD	±6000	3000	1.2/50-8/20	N/A	5	Phase to neutral, phase to ground, neutral to ground
21.1	7	AC Power Port with Secondary Protector	±Vs	3000(at 6000 V)	1.2/50-8/20	N/A	5	Phase to neutral, phase to ground, neutral to ground
22	8a	Tower Mounted Transceiver Fed with Remote DC Power Test (Longitudinal)	±6000	Minimum peak short-circuit current per port is 3000 A.	1.2/50-8/20	N/A	5	See Figure 4-15. Feed and return to shield simultaneously
23	3a/5a,8b	Voltage Limiting for Intra-Site Cell Site Ports (Longitudinal)	±2500	Minimum peak short-circuit current per port is 5000 A.	8/20current	N/A	5	B

1=CO OSP Cable Ports, 2=CO Intra-building Cable Ports, 3=CO Intra-building Cable Ports, 3a/5a=Non-CO Intra-Building Ports, 3b/5b=Short Reach OSP Cable Ports, 4=Intra-Cell Site Cable Ports, 4a=Customer-Side Optical Network Terminals (ONTs) and Intelligent Network Interface Devices (iNIDs) Cable Ports, 5=OSP Site OSP Cable Ports, 6=Antenna Ports, 7=AC Power Ports, 8a=DC Power to Antenna, 8b=Intra-Cell Site DC Power

Second-Level Lightning Surge

Surge Test Number	Port Types	Test Description	Min.Peak Open-Circuit Voltage(Volts)	Min. Peak Short-Circuit Current per Conductor (Amperes)	Surge Maximum Rise/Minimum DecayTimefor Voltageand Current(μs)	Repetitions Each Polarity	Test Connections
1	1,3,5	Inductive Kick Test for OSP Interfaces	±5000	500	2/10	1	See Figure 4-1
2	7	Lightning to AC Power Port	±6000	3000	1.2/50-8/20	1	Phase conductors to neutral, phase conductors to ground, neutral conductor to ground
2.1	7	Lightning to AC Power Port With Secondary Protectors	±Vs	3000(at 6000 V)	1.2/50-8/20	1	Phase conductors to neutral, phase conductors to ground, neutral conductor to ground

1=CO OSP Cable Ports, 3=CO Intra-building Cable Ports, 5=OSP Site OSP Cable Ports, 7=AC Power Ports,

ISO7637-2:2011 Road vehicles --Electrical disturbances from conduction and coupling--Part 2: Electrical transient conduction along supply lines only

Examples of test pulse severity levels for nominal 12V and 24V system

Test pulse[a]	Selected test level[b]	Test pulse severity level,Us[c,d] (V)						Min.number of pulses or test time	Burst cycle/pulse repetition tim[e]	
		IV		III		I/II				
		12	24	12	24	12	24		min.	max.
1		-150	-600	-112	-450	-75	-300	500Pulses	0.5s	e
2a		+112	+112	+55	+55	+37	+37	500Pulses	0.2s	5s
2b		+10	+20	+10	+20	+10	+20	10Pulses	0.5s	5s
3a		-220	-300	-165	-220	-112	-150	1h	90ms	100ms
3a		+150	+300	+112	+220	+75	+150	1h	90ms	100ms

a: Test pulses as in 5.6
b: Values agreed between vehicle manufacturer and equipment suppller.
c: The amplitudes are the values of Us as defined for each test pulse in 5.6.
d: The former levels I and II are revised because they did not ensure sufficient immunity in subsequent road vehicles'design.
e: The maximum pulse repetition time shall be chosen such that it is the minimum time for the DUT to be correctly initialized before the application of the next pulse and shall be ≥0.5S.

ISO16750-2:2010 Road vehicles -- Environmental conditions and testing for electrical and electronic equipment -- part 2: electrical loads

Starting profile values for systems with 12V and 24V nominal voltage

Parameter		Level						
		I		II		III		IV
		12V	24V	12V	24V	12V	24V	12V
Voltage V	U_{S6}	8(-0.2)	10(-0.2)	4.5(-0.2)	8(-0.2)	3(-0.2)	6(-0.2)	6(-0.2)
	U_S	9.5(-0.2)	20(-0.2)	6.5(-0.2)	15(-0.2)	5(-0.2)	10(-0.2)	6,5(-0.2)
Duration ms	t_f	5(±0.5)	10(±1)	5(±0.5)	10(±1)	5(±0.5)	10(±1)	5(±0.5)
	t_6	15(±1.5)	50(±5)	15(±1.5)	50(±5)	15(±1.5)	50(±5)	15(±1.5)
	t_7	50(±5)	50(±5)	50(±5)	50(±5)	50(±5)	50(±5)	50(±5)
	t_8	1000(±100)	1000(±100)	10000(±1000)	1000(±100)	1000(±100)	1000(±100)	10000(±1000)
	t_r	40(±4)	40(±4)	100(±10)	100(±10)	100(±10)	40(±10)	100(±10)
Minimum functional status		A[a]	A[e]	B[a]	B[e]	B[a]	B[e]	A[a]
		A[b]	B[f]	B[b]	C[f]	C[b]	C[f]	B[b]
		B[c]	B[g]	C[c]	C[g]	C[c]	C[g]	C[c]
		B[d]	B[h]	C[d]	C[h]	C[d]	C[h]	C[d]

a: $U_S$min = 6 V; $U_S$max = 16 V (see Table 1, Code A).
b: $U_S$min = 8 V; $U_S$max = 16 V (see Table 1, Code B).
c: $U_S$min = 9 V; $U_S$max = 16 V (see Table 1, Code C).
d: $U_s$min = 10.5 V; $U_s$max = 16 V (see Table 1, Code D).
e: $U_S$min = 10 V; $U_S$max = 32 V (see Table 2, Code E).
f : $U_S$min = 16 V; $U_S$max = 32 V (see Table 2, Code F).
g: $U_S$min = 22 V; $U_S$max = 32 V (see Table 2, Code G).
h: $U_s$min = 18 V; $U_s$max = 32 V (see Table 2, Code H).

Pulse for test A in systems with 12 V and 24 V nominal voltage

Parameter	Type of system		Minimum test requirements
	U_N=12V	U_N=24V	
U_s[a] (V)	79≤U_S≤101	151≤U_S≤202	10 pulses at intervals of 1 min
R_i[a] (Ω)	0.5≤R_i≤4	1≤R_i≤8	
t_d (ms)	40≤t_d≤400	100≤t_d≤350	
t_d (ms)	$10(^{0}_{-5})$	$10(^{0}_{-5})$	

a: If not otherwise agreed, use the higher voltage level with the higher value for internal resistance, or use the lower voltage level with the lower value for internal resistance.

IEC61000-4-5:2014 Electromagnetic compatibility (EMC) –Part 4-5: Testing and measurement techniques – Surge immunity test

Installation class	Test levels (kV)																			
	AC power supply and a.c. I/O				DC power supply and d.c. I/O				Unsymmetrical operated circuits/lines[a,d,e]				Symmetrical operated circuits/lines[a,d,e]				Shielded circuits/lines[a,d,f]			
	External ports[a]		Internal ports[a,d]		External ports[a]		Internal ports[a,d]		External port		Internal port		External port		Internal port		External port		Internal port	
	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground
0	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
1	/	0.5	/	/	/	/	/	/	/	/	/	0.5	/	/	/	0.5	/	/	/	/
2	0.5	1.0	/	/	/	/	/	/	/	/	0.5	1.0	/	/	/	1.0	/	/	/	0.5
3	1.0	2.0	1.0	2.0	/	/	/	/	/	/	1.0	2.0	/	/	/	2.0	/	/	/	2.0
4	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	/	4.0[b]	/	4.0[b]	/	4.0[b]	/	4.0[b]
5	[c,b]	[c,b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	2.0[b]	4.0[b]	/	4.0[b]	/	4.0[b]	/	4.0[b]	/	4.0[b]

a: No test is advised if the cable length is shorter than or equal to 10 m.
b: Where the port is always intended to be used with specified primary protection, testing is performed with the primary protection in place to ensure coordination with the protection elements. If primary protection is required to protect the interface but not provided, testing is also performed at the maximum let through level of the specified primary protection and with a typical primary protector.
c: Depends on the class of the local power supply system.
d: The testing of intra-system ports is generally not required.
e: Line-to-line surges (transverse) may occur in networks where SPDs (surge protective devices) with connection to ground are used for protection. Such surges are outside the scope of this standard. This phenomenon can however be simulated by applying common mode surges through the defined primary protection elements.
f: The testing of ports connecting to antennas is outside the scope of this standard.

IEC61000-4-4:2012 Electromagnetic compatibility (EMC) – Part 4-4:Testing and measurement techniques – Electrical fast transient/burst immunity test

Open circuit output test voltage and repetition frequency of the impulses

Level	Power ports, earth port (PE)		Signal and control ports	
	Voltage peak kV	Repetition frequency kHz	Voltage peak kV	Repetition frequency kHz
1	0.5	5 or 100	0.25	5 or 100
2	1	5 or 100	0.25	5 or 100
3	2	5 or 100	1	5 or 100
4	4	5 or 100	2	5 or 100
X[a]	Special	Special	Special	Special

The use of 5 kHz repetition frequency is traditional, however, 100 kHz is closer to reality. Product committeesshould determine which frequencies are relevant for specific products or product types.

With some products, there may be no clear distinction between power ports and signal ports, in which case it is up to product committees to make this determination for test purposes.

a: "X" can be any level, above, below or in between the others. The level shall be specified in the dedicatedequipment specification.

IEC61000-4-2:2008 Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

Contact discharge		Air discharge	
Level	Test voltage KV	Level	Test voltage KV
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15
x[a]	Special	x[a]	Special

a:"x" can be any level, above, below or in between the others. The level shall be specified in thededicated equipment specification. If higher voltages than those shown are specified, special test equipment may be needed.

UL60950-1:2013 Information Technology Equipment – Safety – Part 1: General Requirements

Test voltages for eletric strength tests based on peak working voltages part 1

Grade of insulation	Points of application (as appropriate)						
	PRIMARY CIRCUIT to BODY PRIMARY CIRCUIT to SECONDARY CIRCUIT between Parts in PRIMARY CIRCUIT					SECONDARY CIRCUIT to BODY between independent SECONDARY CIRCUITS	
	WORKING VOLTAGE VPEAK OR DC					WORKING VOLTAGE V	
	U≤210Vpeak or d.c.[2]	210V < U≤420V peak or d.c.[3]	420 < U≤ 1.41KVpeak or d.c.	1.41KV < U≤ 10KVpeak or d.c.[4]	10KV < U≤ 50KVpeak or d.c.	U≤42.4Vpeak or 60V d.c.	42.4V peak or 60Vd.c. < U≤10KVpeak or d.c.[5]
	Test voltage , volts r.m.s.[1]						
FUNCTIONAL	1000	1500	See Va in table 5B , Part2	See Va in table 5B , Part2	1.06U	500	See Va in table 5B , Part2
BASIC , SUPPLEMENTARY	1000	1500	See Va in table 5B , Part2	See Va in table 5B , Part2	1.06U	no test	See Va in table 5B , Part2
REINFORCED	2000	3000	3000	See Vb in table 5B , Part2	1.06U	no test	See Vb in table 5B , Part2

1) For WORKING VOLTAGES exceeding 10KV peak or d.c. in SECONDARY CIRCUITS , the same test voltage as for PRIMARY CIRCUITS apply。
2) Use this column for unearthed DC MAINS SUPPLIES up to and including 210V d.c.。
3) Use this column for unearthed DC MAINS SUPPLIES over 210V d.c. up to and including 420V d.c.。
4) Use this column for unearthed DC MAINS SUPPLIES over 420 V d.c.。
5) Use these columns for d.c. derived within the equipment from an AC MAINS SUPPLIES , or for DC MAINS SUPPLIES that are earthed within the same building。

Equipment V Ports

Trade	Equipment	Port								
		RJ11	RJ45	RS485	AC	DC	HDMI	USB	Coaxial	ECGcable
Telecommunication	xDSL moden	●	●			●				
	Cable moden		●			●			●	
	Telephone	●								
	Splitter	●								
	Router		●			●				
	RRU		●	●	●	●				
	Corded Phone	●								
	Cordless Phone	●				●				
	IP Phone	●				●				
	Micro Power Cell Base Station	●	●		●	●				
	VoIP Telephone Adapter	●								
	Wireless LAN Access Point		●		●	●				
	BBU		●	●	●	●				
	Telephone switchboard	●			●					
	Network switch		●		●					
	NXU IAD VOIP PSTN	●	●		●	●				
Consumer Electronics	Television		●		●		●	●	●	
	Personal computer		●		●	●	●	●		
	Printer	●	●		●			●		
	Set top box		●		●		●	●	●	
	Digital Multimedia Broadcast Receiver				●	●	●	●	●	
	Digital Still and Video Camera				●	●	●	●		
	DVD Player and Recorder				●	●	●	●		
	LCD Projector		●		●	●	●	●		
	LCD TV		●		●	●	●	●		
Industrial	LED driver				●	●				
	POS	●	●			●				
	Parking management		●	●	●	●				
	Outdoor LED Lighting				●					
	Power Line Network			●	●					
	Power Supply				●					
	Satellite Radio				●	●				
	SMPS Embedded				●					
	SMPS External				●					
	Clothes Dryer				●					
	Dishwasher				●					
	Electric Inductive Cooktop				●					
	Electric Range Oven				●					
	Electric Resistive Cooktop				●					
	Gas Cooktop				●					
	Gas Range Oven				●					
	Microwave Oven				●					
	Range Hood				●					
	Refrigerator				●					
	Room AC				●					
	Solar Power System (Residential)			●	●					
	Washing Machine				●					
Security	Camera		●	●	●	●	●	●	●	
	NVR/DVR		●	●	●		●	●	●	
Medical	ECG monitor				●					●
Automobile	Navigator					●		●		
	Body control system					●				
	Audio and video entertainment system					●	●			
	Automobile air-condition					●				
	Display instrument					●				