Entertainment Services and Technology Association

DRAFT

BSR E1.27-2, Entertainment Technology - Standard for Permanently Installed Control Cables for Use with ANSI E1.11 (DMX512-A) and USITT DMX512/1990 Products

Foreword

(This foreword is not part of draft American National Standard E1.27-2.)

This standard describes the types of permanently installed cable used to interconnect products that comply with ANSI E1.11-2004, Entertainment Technology – USITT DMX512-A: Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories, or that comply with USITT DMX512/1990.

In 2003, the Control Protocols Working Group of ESTA's Technical Standards Program authorized the formation of a DMX512 Cabling Task Group. Writing an American National Standard for the permanently installed cables was one of the projects assigned to this task group. This document is the result.

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1 General

1.1 Scope

This Standard is intended to provide for maximum interoperability in the use of equipment connected in permanently installed entertainment lighting applications. To accomplish this intent the Standard defines acceptable cable and connector types, and the ways in which they may be used.

Entertainment lighting uses both EIA-485/EIA-485-A and EIA/TIA-568 Category 5 and higher cabling systems for data connection between equipment. There are significant differences between the two cables. In order to avoid confusion arising from the differences in specification of the two cable types this Standard has separate sections for cables designed specifically for EIA-485 signals and Category 5 and higher cable.

Category 5 cable is also known as Class D cable under ISO/IEC standard 11801. Research by the ESTA CPWG determined that Category 5, 5e, 6, and 6a cables would all be suitable for use with DMX512. Since control over future revisions of ANSI/EIA/TIA-568 and ISO/IEC 11801 is beyond the scope of this standard, ANIS/EIA/TIA-568 Category cables shall be the controlling standard with respect to future developments. Cable, Equipment, and System Manufacturers, and Engineers, System Integrators, and Installers subject to ISO/IEC standards should consider references to Category 5 or higher cable as referencing comparable cable described by ISO/IEC standards.

This Standard applies to entertainment lighting systems that are permanently installed, regardless of the nature of the facility. Connection of portable and temporary equipment are not covered by this standard, and applications that may limit the interoperability of entertainment lighting control systems for the sake of cost are also beyond the scope of this Standard. Connection of proprietary control systems, which may co-exist with equipment covered by this Standard, is also beyond the scope of this Standard.

1.2 Appropriate uses

This Standard is intended for those involved in the design, manufacture, installation, and use of entertainment lighting systems. Applications of permanently installed entertainment lighting vary widely, including conventional theatre, theme parks, churches, convention centers, and themed retail. Control systems for these venues continue to grow in complexity and this Standard is intended to ensure that permanent installations are compatible with the widest possible range of equipment.

1.3 Compliance

Compliance with this Standard is strictly voluntary and the responsibility of the Specifier, System Manufacturer and installer. Disclosures and identification or other claims of compliance do not constitute certification or approval by the E1 Accredited Standards Committee. See clause 7 for disclosure requirements.

2 Normative references

ANSI/TIA/EIA-568-B-2001	Commercial Building Telecommunications Cabling Standard
ANSI/TIA/EIA-568-B.2-1-2002	Commercial Building Telecommunications Cabling Standard - Part 2 - Addendum 1 - Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling
ANSI/TIA/EIA-485-A-1998	Electrical Characteristics of Generators & Receivers for Use in Balanced Digital Multipoint Systems

This standard will be referred to as EIA-485-A in this document.

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Telecommunications Industry Association
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http://www.tiaonline.org/

Note: EIA-485-A is compatible with: ISO/IEC 8482:1993 Information Technology - Telecommunications and information exchange between systems - Twisted pair multipoint interconnections.

IEEE 802.3 CSMA/CD Access Method and Physical Layer Specifications

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854
USA
http://standards.ieee.org/getieee802/802.3.html

ISO/IEC 11801-2002 Information technology - Generic cabling for customer premises

IEC
International Electrotechnical Commission
PO Box 131
3 rue de Varembe
CH-1211 Geneva 20
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www.iec.ch

ISO
International Organization for Standardization
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USITT DMX512/1990 Digital Data Transmission Standard for Dimmers and Controllers
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6443 Ridings Rd.
Syracuse, NY 13206-1111
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+1-800-938-7488 +1-315-463-6463 Fax +1-315-463-6525
http://www.usitt.org

ANSI E1.11-2004 - Entertainment Technology - USITT DMX512-A - Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories
ANSI E1.20-2006-Remote Device Management
Entertainment Technology and Services Association
875 Sixth Avenue, Suite 1005
New York, NY 10001
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3 Definitions

3.1 Access Controlled: A location secured through use of a door, gate, or other physical means to ensure that only persons allowed to adjust equipment have access to it.

3.2 Cable Manufacturer: Any individual or company who manufactures cable and or cable assemblies which meet the requirements of this standard.

3.3 Category 5 or higher: As of the date of publication of this standard, this includes ANSI/EIA/TIA-568 Category 5, 5e, 6, and 6a and their comparable cables as defined by ISO/IEC standards. Cables of similar construction and designed for similar application defined by future revisions of ANSI/EIA/TIA-568 are also included in this definition.

3.4 Circuit common: The common reference (zero volt supply) of the transmitter or receiver circuitry.

3.5 Common: see Data Link, Signal Common, and Circuit Common.

3.6 Data link: The physical connection between transmitting and receiving devices.

3.7 Data link common: The connection to circuit Common at the point of interconnection of the product.

3.8 Data link segment: The part of a data link between any two devices on that link.

3.9 Earth ground: The common, zero potential available from the mains electricity supply and usually connected to the metal chassis of equipment. Earth Ground is referred to as Earth in Europe and Ground in the USA.

3.10 Equipment Manufacturer: Any individual or company who designs, produces or supplies devices connecting to cabling systems which meet the requirements of this standard

3.11 Isolated: A circuit topology in which the output is completely electrically disconnected from the input.

3.12 Readily Accessible: Equipment or parts of equipment that may be accessed by users without the use of tools.

3.13 Receiver (receiving device): A piece of equipment that accepts a signal.

3.14 Specifier: An individual or organization responsible for determining equipment and connection of equipment for a given installation.

3.15 System Manufacturer: Any individual or company who produces installation drawings of systems designed which meet the requirements of this standard.

3.16 Termination (electrical): The use of a terminator at the end of a data link.

3.17 Termination (physical): The connection of a wire to a device.

3.18 Terminator: A device that is designed to minimize unwanted signal reflections on a data link.

3.19 Transmitter (transmitting device): A piece of equipment that produces a signal.

4 Cable types

In permanent installations, DMX512-A cables may be either one of two basic cable types: cables specified for use with EIA-485/EIA-485-A or EIA-422, and cables specified as EIA/TIA568 Category 5 or higher.

DMX512-A defines types of Enhanced Functionality that use bidirectional communication. Systems intended for use with EF protocols should use cables designed for bidirectional communication signals.

Considerations for systems using both cable types are detailed in Clause 6.

Uses of either cable type for anything other than ANSI E1.11 (DMX512-A) or USITT DMX512/1990 are beyond the scope of this standard.

4.1 EIA-485 cable

Unless specifically qualified for use in entertainment lighting control systems by a competent specifier, system integrator or Cable Manufacturer based on the characteristics described in 4.1.1 through 4.1.3, cable shall be of a type designed for EIA-485/EIA-485-A or EIA-422 applications.. Cables that are not fully specified by the Cable Manufacturer for all characteristics described in 4.1.1 through 4.1.3 shall not be used.

Requirements for specific voltage ratings, insulation types, jacket materials and other characteristics vary with location and application, and are beyond the scope of this Standard. Installations complying with this standard should comply with local requirements.

4.1.1 Construction

Cable shall consist of a minimum of two twisted conductor pairs, with shielding of individual pairs or overall shielding of multiple pairs, or both. Cables incorporating individually shielded pairs shall have the shields insulated from each other. Cables with an overall braided shield and integral drain wire are preferred. Cables of any type with an integral drain wire are preferred over those without an integral drain wire.

4.1.2 Impedance

The characteristic impedance of each conductor pair used for data transmission shall be within the range of 100 to 120 ohms. Due to the characteristic impedance of 120 Ohms in EIA-485 systems, 120 Ohms is preferred.

4.1.3 Capacitance

Capacitance between conductors within a shield shall not exceed 65 pF/m (19.8 pF/ft). Capacitance between any conductor and the shield shall not exceed 115 pF/m (35 pF/ft).

4.2 Category cable

As stated in Clause 1 and defined in Clause 3, references to Category cable include equivalent Class cables as defined by ISO/IEC standards.

Category cable shall meet the requirements of at least EIA/TIA-568 Category 5. Category cable meeting the requirements of a category higher than Category 5 is permissible. Note: the nominal impedance of these cables when used at DMX512 transmission speeds is 115 Ohms, making for a trivial impedance mismatch with cables described in clause 4.1 operated at the same data rates.

Requirements for specific voltage ratings, insulation types, jacket materials and other characteristics vary with location and application, and are beyond the scope of this Standard. Installations complying with this standard should comply with local requirements.

4.2.1 Electromagnetic Emissions from Category cable

Where legal restrictions on electromagnetic emissions require use of shielding a shielded cable shall be used.

5 Connectors

5.1 User connection points

Five-pin XLR connectors shall be used for all user connection points, with the exception of Patch Bays as defined by E1.11 and described in 5.1.1. Other connector types shall not be used. Connection points for controllers and other transmitting devices shall utilize male connectors. Connection points for receiving devices shall utilize female connectors.

5.1.1 Allowable use of RJ-45 Patch Bays

RJ-45 Patch Bays shall comply with all of the applicable requirements of E1.11, and the use of a Patch Bay with RJ-45 connectors that complies with E1.11 does not relieve the system specifier or installer from the requirement to use 5-pin XLRs for all other user connection points. Patch Bays are generally located in an access controlled equipment room to provide the ability to cross-connect a large number of data links without buffering, and shall not be used for direct connection of portable equipment.

5.1.1.1 Electromagnetic Emissions from RJ-45 Patch Bays

Where legal restrictions on electromagnetic emissions require use of shielding the RJ-45 connector shall be of a type that provides for uninterrupted shielding.

5.1.2 Alternate Connectors

Since even the smallest commonly available junction boxes are of sufficient size to accommodate a 5-pin XLR, the E1.11 concession for use of an alternate connector shall not apply.

5.2 Internal connectors

Internal connectors are those that provide a data link termination point that is not readily user accessible on permanently installed equipment. Termination may be by direct soldering of wires, set screw or other compression type termination, or insulation displacement. Direct termination of a permanently installed cable on a male RJ-45 shall not be allowed.

Internal connectors shall be numbered as described in Clause 6.4, Table 1 or Table 2 as determined by cable being terminated.

Internal connections may be co-located within a single enclosure, or may have intervening runs of permanently installed cable.

6 Installation

Cable shall be installed to provide a point-to-point two pair and common connection between each device on a data link. When multiple DMX512-A or DMX512/1990 universes exist within a single cable, a cable type that allows for complete electrical isolation between universes shall be used.

Conduit should be used for the entire length of any cable. Either metallic or nonmetallic conduit provides mechanical protection for cables. Properly earthed metallic conduit may provide some shielding, but should not be relied upon for any effective shielding at DMX512 data transmission rates. Nonmetallic conduit does not provide any shielding.

6.1 Cable Preparation

Shields and drain wires exposed by the process of preparing the cable for termination shall be insulated from accidental contact with earth ground. Shields from individually shielded pairs shall be insulated from accidental contact with each other.

6.2 Splices

Any splices shall comply with 6.1 and shall be made using devices, materials, and methods appropriate to the transmission of high speed digital data. Splices shall provide data path integrity for all data pairs of each data link, and shall be insulated from accidental contact with earth ground, shields, or data lines.

6.3 Multiple cable types

Where more than one cable type exists within a single installation care shall be taken to ensure that characteristics of jointly terminated or spliced cables match. Where it is not possible to match cable types exactly the use of active buffering is recommended.

6.4 Physical Termination

The data link common and both pairs of each data link shall be terminated at each device on the data link in accordance with Table 1 or Table 2 based on cable type. Where devices do not provide termination points for all wires the unterminated wires shall be spliced through for all devices in the middle of a data link, and shall be protected from damage or accidental contact with earth ground, shields, or data lines at each end. Unterminated wires at the end of a data link shall not be cut off. No more than two data link segments shall be terminated on a single set of termination points.

Physical terminations shall be made in a manner that prevents stresses on the conductors, termination points, connector assembly, and cable. The conductors shall not be the means of support for any device.

Table 1 Conductor Termination of EIA-485 type cables

Conductor	XLR pin number or equivalent
Shield	1
Pair 1 Complement (Data 1 -)	2
Pair 1 True (Data 1 +)	3
Pair 2 Complement (Data 2-)	4
Pair 2 True (Data 2+)	5

Note to Table 1: The color coding of wires varies by Cable Manufacturer and cable type.

Table 2 Conductor Termination of ISO/IEC Category 5 cables

Wire color	Function	XLR Pin Number or equivalent
white/orange	Pair 1 true (Data 1 +)	3
orange	Pair 1 complement (Data 1 -)	2
white/green	Pair 2 true (Data 2 +)	5
green	Pair 2 complement (Data 2 -)	4
blue	Not assigned	
white/blue	Not assigned	
white/brown	Data link common (common reference) for Pair 1 (0 V)	1
brown	Data link common (common reference) for Pair 2 (0 V)	1

6.5 Acceptable use of unassigned wires

Wires not assigned in Table 2 shall not be terminated in a manner where they connect to any pin of the 5-pin XLR and shall comply with one and only one of the uses described in Clause 6.5.1 through 6.5.3. Unassigned wires shall not be used in any manner other than those described in Clause 6.5.1 through 6.5.3.

6.5.1 Unassigned wires unused

Where the unassigned wires are not used for any purpose the requirements of clause 6.4 shall not apply to the unassigned wires. Unused wires shall be capped and turned back against the cable jacket.

6.5.2 Unassigned wires used for signaling

Where the unassigned wires are used for any type of signal the requirements of clause 6.4 shall apply to the unassigned wires. Signals carried by the unassigned wires shall not cause any measurable interference on the pairs used for DMX512 data. Signals shall not exceed a nominal 24 VDC or 24 Vrms relative to Data Link Common and shall not exceed 1 W in power. Signals terminating on the same device as a 5-pin XLR shall not connect to any pin of the 5-pin XLR.

6.5.3 Unassigned wires used for low power transmission

Where the unassigned wires are used for power transmission the requirements of clause 6.4 shall apply to the unassigned wires. Power carried by the unassigned wires shall be within the limits of IEEE 802.3 Clause 33. Equipment utilizing the low voltage power supply may or may not comply with the detection and operational requirements of IEEE 802.3 Clause 33. Power supply failure shall not adversely affect transmission of DMX512 data over the data link, although it may affect data on the output side of isolated transmitters powered from that power supply. Power supply noise shall not cause any measurable interference on the pairs used for DMX512 data. Power supply wires terminating on the same device as a 5-pin XLR shall not connect to any pin or the shell of the 5-pin XLR.

6.6 Isolation between data links

Data links that are deliberately isolated from each other within devices shall maintain electrical isolation throughout each data link.

6.7 Protection of installed cable

6.7.1 Mechanical

Cables should be protected against physical damage along their entire length. Specific protection techniques are beyond the scope of this standard, but may include conduit, trunking, or raceways.

Requirements for specific protection techniques and materials vary with location and application, and are beyond the scope of this Standard. Installations complying with this standard should comply with local requirements.

6.7.2 Electrical

Cables should be protected against electrical damage and from transmitting electrical damage to connected devices. Earthed metal conduit or separate grounding wires for earth grounding of devices may be used to provide a separate grounding path. Under no circumstance shall any cable conductor or shield be connected to earth ground except at the transmitter as described in the E1.11 Preferred Topology. In practice the transmitter grounding is likely to occur inside equipment, and connection of the Data Link Common to earth ground as part of cabling infrastructure will be unnecessary. Equipment Manufacturers should specify their earth grounding scheme in product documentation.

6.7.3 Earth Grounding of Shielded Cables

Where legal restrictions on electromagnetic emissions require use of shielding, the shield of the cable required in 4.2.1 shall be terminated according to those requirements. If there is any possibility that co-terminating the shield and Data Link Common of a cable with a separate Data Link Common conductor and shield conductor will create a ground loop on the Data Link Common the two conductors shall not co-terminate.

6.8 Maximum Run Length

It is beyond the scope of this standard to determine a maximum run length that will apply to all possible installations. Factors that reduce the maximum run length include the number of EIA-485 units loads on the data link, the number of splices in the data link, the strength of the data link transmitter(s), and proximate sources of interference. Use of bidirectional communication protocols such as ANSI E1.20 Remote Device Management may also affect the maximum useful run length.

6.9 Electromagnetic Interference

While requirements for specific installations are beyond the scope of this Standard, system specifiers, manufacturers, integrators, and installers should ensure that electromagnetic interference does not reduce DMX512 signal quality. This may include use of shielded cable where not otherwise required, earth grounded metallic conduit, design practices that provide sufficient separation of DMX512 cables from sources of interference, and other techniques and technologies.

7 Marking of E1.27-2 Compliant Components

Panels provided for the connection of portable equipment shall be marked to indicate compliance with this standard. Panels, connectors, assemblies, or devices not complying with this standard shall not have the marks described in 7.1 appear anywhere.

7.1 Acceptable marks

Marks indicating compliance with this standard shall be one of the following:

A) A text label stating “ANSI E1.27-2”.

B) A symbol consisting of the number 5 with five horizontal lines to the left and right sides of the character.

7.2 Placement of compliance marks

Marks indicating compliance with this standard should appear in a user discernable place and shall appear somewhere on the assembly. Marks shall be of sufficient size to be clearly readable in the marking process used.

7.3 Proper Termination marks

Devices including a 5-pin XLR shall include a label or other mark somewhere on the device showing the wire termination required to ensure that signals appear on the pins of the XLR as defined by this standard.

7.4 Category Cable marks

Installations using Category Cable should include a run length mark. Both ends of the cable should be marked in a permanent manner with the total length of the run. Standard lengths printed on the cable jacket should not be considered adequate since they do not tell the user how long that particular segment is.

7.5 Other marking

Marks not related to compliance with this standard may be used in addition to the required marks.