

Entertainment Services and  
Technology Association



American National Standard  
E1.27-2 - 2009  
Entertainment Technology -  
Recommended Practice for Permanently  
Installed Control Cables for Use  
with ANSI E1.11 (DMX512-A) and USITT  
DMX512/1990 Products

[inside front cover]

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CP/2006-1011r5.1  
(CP/2006-1011r5 with editorial corrections)

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The Control Protocols Working Group, which authored this Standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. ESTA is committed to developing consensus-based standards and recommended practices in an open setting. Future Control Protocols Working Group projects will include updating this publication as changes in technology and experience warrant, as well as developing new standards and recommended practices for the benefit of the entertainment industry.

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## Foreword

(This foreword is not a normative part of ANSI E1.27-2–2009.)

This recommended practice 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 that would be a recommended practice for permanently installed cables was one of the projects assigned to this task group. This document is the result.

Task Group Chair: John David Butler, Integrated Theatre.

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## 1 General

### 1.1 Scope

This Recommended Practice is intended to provide for maximum interoperability in the use of equipment connected in permanently installed entertainment lighting applications. To accomplish this intent the Recommended Practice 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 Recommended Practice 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 Recommended Practice, 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 Recommended Practice 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 Recommended Practice, and applications that may limit the interoperability of entertainment lighting control systems for the sake of cost are also beyond the scope of this Recommended Practice. Connection of proprietary control systems, which may co-exist with equipment covered by this Recommended Practice, is also beyond the scope of this Recommended Practice.

### 1.2 Appropriate uses

This Recommended Practice is intended for those involved in the design, manufacture, installation, and use of entertainment lighting systems.

### 1.3 Compliance

Compliance with this Recommended Practice 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 ESTA. See clause 7 for disclosure requirements.

### 1.4 Local Requirements and Regulations

Cabling installations covered by this Recommended Practice are frequently also covered by local regulations which may place restrictions on cable construction, connection or installation for reasons of safety, electromagnetic compatibility or other reasons. Such local regulations may be statutory requirements or may be included in the system specification. All such regulations are entirely beyond the scope of this Recommended Practice and compliance with this Recommended Practice has no bearing on compliance with any other such 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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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

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

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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

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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..

**3.3 Category 5 or higher:** As of the date of publication of this Recommended Practice, 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 and Circuit Common, also known as Signal 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.

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

**3.12 Readily Accessible:** Equipment or parts or 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 as well as some or all of the equipment used in the systems.

**3.16 System Integrator:** Any individual or company who primarily produces the installation drawings of systems and not the equipment used in the systems

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

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

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

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

**3.21 User Connection Point:** A part of a system where ends users may readily connect to a data link.

## 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.

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

DMX512-A defines types of Enhanced Functionality that use bidirectional communication. Systems intended for use with EF protocols should use cables with consistent characteristics throughout the system.

### 4.1 EIA-485 cable

Cable should be of a type designed for EIA-485/EIA-485-A or EIA-422 applications. Some cables designed for digital data applications other than EIA-485 may be acceptable, as determined by the cable characteristics described in 4.1.1 through 4.1.3.

Cables should be fully specified by the Cable Manufacturer for all characteristics described in 4.1.1 through 4.1.3.

#### 4.1.1 Construction

Cable should consist of a twisted conductor pair or pairs, with shielding of individual pairs or overall shielding of multiple pairs, or both. Cables incorporating individually shielded pairs should have the shields insulated from each other. Cables with an 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 should 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 should not exceed 65 pF/m (19.8 pF/ft). Capacitance between any conductor and the shield should 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 should 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 Recommended Practice. Installations complying with this Recommended Practice should comply with local requirements.

## **5 Connectors**

### **5.1 User connection points**

Five-pin XLR connectors should 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 should not be used. Connection points for controllers and other transmitting devices should utilize male connectors. Connection points for receiving devices should utilize female connectors.

#### **5.1.1 Allowable use of RJ-45 Patch Bays**

RJ-45 Patch Bays should comply with all of the applicable requirements of E1.11, and the use of a Patch Bay with RJ-45 connectors that complies with E1.11-2004 Clause 7.3 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 should not be used for direct connection of portable equipment.

#### **5.1.2 Electromagnetic Emissions from RJ-45 Patch Bays**

Local regulations may require the use of RJ-45 connectors which provide for uninterrupted shielding. See 1.4.

#### **5.1.3 Alternate Connectors**

Since even the smallest commonly available junction boxes are of sufficient size to accommodate a 5-pin XLR, the E1.11-2004 Clause 7.1.2 concession for use of an alternate connector should 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 should not be allowed.

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

## **6 Installation**

Cable should be installed to provide a point-to-point one or 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 electrical isolation between universes should be used. Cables allowing crosstalk between universes within that cable may cause undesirable system operation. Using a cable with shielding of individual pairs or cable with different lay lengths for different pairs will minimize crosstalk between universes.

While conduit provides for mechanical protection of cables, and properly earthed metallic conduit may provide some shielding, it 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 should be insulated from accidental contact with earth ground. Shields from individually shielded pairs should be insulated from accidental contact with each other.

## 6.2 Splices

Any splices should comply with 6.1 and should be made using devices, materials, and methods appropriate to the transmission of high speed digital data. Splices should provide data path integrity for all data pairs of each data link, and should 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 should 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 one or both pairs of each data link should be terminated at each device on the data link in accordance with Table 1 or Table 2 based on cable type. No more than two data link segments should be terminated on a single set of termination points.

Physical terminations should be made in a manner that prevents stresses on the conductors, termination points, connector assembly, and cable. The conductors should 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 should not be terminated in a manner where they connect to any pin of the 5-pin XLR and should comply with one and only one of the uses described in Clause 6.5.1 through 6.5.3.

Unassigned wires should 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 should not apply to the unassigned wires. Unused wires should be capped and turned back against the cable jacket and securely fastened to the 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 should apply to the unassigned wires. Signals carried by the unassigned wires should not cause any measurable interference on the pairs used for DMX512 data. Signals should not exceed a nominal 24VDC or 24Vrms relative to Data Link Common and should not exceed 1W in power injected into the cable. Signals terminating on the same device as a 5-pin XLR should 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 should apply to the unassigned wires. Power carried by the unassigned wires should 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 should 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 should not cause any measurable interference on the pairs used for DMX512 data. Power supply wires, other than those connected to Data Link Common, terminating on the same device as a 5-pin XLR should 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 should be wired to 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 Recommended Practice, 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 Recommended Practice. Installations complying with this Recommended Practice 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 should 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.

## 6.8 Maximum Run Length

It is beyond the scope of this Recommended Practice to determine a maximum run length that will apply to all possible installations. Factors that affect the maximum run length include the number of EIA-485 unit 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.

A properly selected and installed DMX512 cable should provide acceptable signal strength for runs of 300m (1000ft). Please note that the technical requirements, such as run-length and topology for other networking technologies, such as Ethernet, should be considered if using the installed cable for another networking technology in the future is anticipated.

## 7 Marking of E1.27-2 Compliant Components

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

Patch panels described in 5.1.1 should be clearly marked to differentiate RJ-45 connectors used for DMX512 from RJ-45 connectors used for other purposes.

### 7.1 Acceptable marks

Marks indicating compliance with this Recommended Practice should be a text label stating “ANSI E1.27-2”.

### 7.2 Placement of compliance marks

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

### 7.3 Proper Termination marks

Devices including a 5-pin XLR connector should 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 Recommended Practice.

### 7.4 Category Cable marks

Installations using Category Cable should include a run length mark.

### 7.5 Other marking

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