Entertainment Services and Technology Association

ESTA

American National Standard
E1.31- 2009
Entertainment Technology – Lightweight streaming protocol for transport of DMX512 using ACN

CP/2006-1020r3

[inside front cover]

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E1.31 — 2009
Entertainment Technology
Lightweight streaming protocol for transport of DMX512 using ACN

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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 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 for the benefit of the entertainment industry.

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[CP] Custom-market Producer
[MP] Mass-market Producer
[DR] Dealer or Rental company
[U] User
[G] General Interest

Table of Contents

1 Introduction

1.1 Scope

This standard describes a mechanism to transfer DMX512-A [DMX] packets over a TCP/IP network using a subset of the ACN protocol suite. It covers data format, data protocol, data addressing, and network management.

1.2 Overview and Architecture

This standard can be used to transfer DMX512-A [DMX] packets of all START Codes via an ANSI E1.17 [ACN] supported network. A simple packet wrapper approach is used whereby the DMX512-A [DMX] data is encapsulated in a wrapper following the ACN packet structure. The ACN standard wrapper is carried in UDP [UDP] packets when used on TCP/IP networks. In the future, this use of the ACN wrapper and packet structure will also allow E1.31 to be carried over other networks supported by ACN.

The wrapper is structured such that it is both compatible and meaningful to the ANSI E1.17 [ACN] standard. Readers are referred to the ANSI E1.17 [ACN] standard, particularly the “ACN Architecture” and “Device Management Protocol” documents for more information. The “Root Layer Protocol” used in this standard is described in the “ACN Architecture” document.

This standard uses multicast addressing to provide a mechanism to partition traffic for distinct universes of DMX512-A [DMX] data. Direct unicast of DMX512-A [DMX] data is also supported.

1.3 Appropriate use of this standard

This standard uses a non-reliable transport mechanism to stream packets of data from multiple controllers to multiple receivers over the ACN network. Like DMX512-A [DMX] over EIA-485 media, there is no acknowledgement and therefore no assurance that all packets have been received.

1.4 Classes of data appropriate for transmission

This standard, E1.31, is intended to define a method to carry DMX512-A [DMX] style data over IP Networks, including Ethernet IP Networks. It is designed to carry repetitive control data from one or more controllers to one or more receivers. This protocol is intended to be used to control dimmers, other lighting devices, and related nonhazardous effects equipment.

1.5 Compliance

Compliance with this standard is strictly voluntary and the responsibility of the implementer. Markings and identification or other claims of compliance do not constitute certification or approval by the E1 accredited standards committee.

2 Normative References

[DMX] ANSI E1.11 Entertainment Technology – USITT DMX512-A Asynchronous Serial Digital Data Transmission Standard for controlling lighting equipment and accessories.

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[ACN] ANSI E1.17 Entertainment Technology – Architecture for Control Networks

This standard is maintained by ESTA.

[RDM] ANSI E1.20 Entertainment Technology – Remote Device Management over DMX512 networks.

This standard is maintained by ESTA.

[UTF8] The Unicode Consortium. The Unicode Standard, Version 5.0.0, defined by:
The Unicode Standard, Version 5.0 (Boston, MA, Addison-Wesley, 2007. ISBN 0-321-48091-0)

[UDP] RFC 0768 UDP User Datagram Protocol

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[IGMP2] RFC 2236 IGMPv2 Internet Group Management Protocol Version 2.

This standard is maintained by the IETF.

[IGMP3] RFC 3376 Internet Group Management Protocol, Version 3

This standard is maintained by the IETF.

[ASIPM] RFC 2365 Administratively Scoped IP Multicast.

This standard is maintained by the IETF.

[UUID] RFC 4122 P. Leach, M. Mealling, and R. Salz. *A Universally Unique IDentifier (UUID) URN Namespace*. July 2005.

This standard is maintained by the IETF.

3 Definitions

3.1 Octet: An eight bit byte within a data packet.

3.2 Universe: A set of up to 512 data slots identified by universe number. Note: In E1.31 there may be multiple sources for a universe. See also Slot.

3.3 Universe Number: Each packet contains a universe number identifying the universe it carries. From an ACN perspective, a receiving device has some number of properties whose value is addressed by the combination of a universe number and a data slot number. From an historical perspective, a receiving device consumes some number of DMX512 [DMX] data slots.

3.4 Slot: A slot is a sequentially numbered octet in a DMX512 [DMX] packet. A single Universe contains a maximum of 513 Slots, starting at slot 0. Slot 0 is the DMX512 [DMX] START Code. Slots 1 through 512 are data slots.

3.5 Source: A stream of data packets for a universe is said to be sent from a *source*. A *source* is uniquely identified by a number in the header of the packet (see field CID in Table 1). A *source* may output multiple streams data, each for a different universe. Also, multiple *sources* may output data for a given universe.

3.6 Active Data Slots: When translating ANSI E1.11 DMX512-A [DMX] to E1.31, the active data slots are defined as ranging from data slot 1 to the maximum data slot in the most recently received packet with the corresponding START Code. Devices originating E1.31 shall define their active data slots using the *DMP First Property Address* and *DMP Property Count* fields shown in Table 1.

4 Protocol Packet Structure Summary

E1.31 is a protocol that lives within the suite of protocols defined by the ANSI E1.17 [ACN] standard. The ACN standard provides a method for layering protocols and for using a simple repeating message structure throughout. The lowest layer ACN protocol is called the Root Layer Protocol (RLP), which wraps E1.31 as well as other protocols such as Session Data Transport (SDT). It is not necessary to implement or understand these other protocols to use E1.31 to send DMX512 [DMX] data over ACN.

> The repeating message structure is called the Protocol Data Unit (PDU) format which is fully defined in “Section 2.2 Protocol Data Units and Blocks – The Standard ACN Message Format” and “Section 2.4 PDU Fields” of the “ACN Architecture Document” of ANSI E1.17 [ACN].

E1.31 defines an outer layer PDU wrapper that specifies the sequence number of a packet and that carries a block of data (all PDUs carry a block of data). This data block contains a nested PDU containing a single message of the Device Management Protocol of ANSI E1.17 [ACN] to carry DMX512 [DMX] data. Each PDU contains a length field which equals the length of the entire PDU including its header and data block information.

Table 1 describes the E1.31 packet format on UDP [UDP].

Octet	Field Size	Field Name	Field Description	Field Contents
Root Layer (See Section 5)				
0, 1	2	Preamble Size	Define RLP Preamble Size.	0x0010
2,3	2	Post-amble Size	RLP Post-amble Size.	0x0000
4-15	12	ACN Packet Identifier	Identifies this packet as E1.17	0x41 0x53 0x43 0x2d 0x45 0x31 0x2e 0x31 0x37 0x00 0x00 0x00
16-17	2	Flags and Length	Protocol flags and length	Low 12 bits = PDU length High 4 bits = 0x7
18-21	4	Vector	Identifies RLP Data as 1.31 Protocol PDU	0x00000004
22-37	16	CID	Sender's CID	Sender's unique ID
E1.31 Framing Layer (See Section 6)				
38-39	2	Flags and Length	Protocol flags and length	Low 12 bits = PDU length High 4 bits = 0x7
40-43	4	Vector	Identifies 1.31 data as DMP Protocol PDU	0x00000002
44-107	64	Source Name	User Assigned Name of Source	UTF-8 [UTF-8] encoded string, null-terminated
108	1	Priority	Data priority if multiple sources	0-200, default of 100
109-110	2	Reserved	Reserved	Transmitter Shall Send 0 Receivers Shall Ignore
111	1	Sequence Number	Sequence Number	To detect duplicate or out of order packets.
112	1	Options	Options Flags	Bit 7 = Preview_Data Bit 6 = Stream_Terminated
113-114	2	Universe	Universe Number	Identifier for a distinct stream of DMX Data
DMP Layer (See Section 7)				
115-116	2	Flags and Length	Protocol flags and length	Low 12 bits = PDU length High 4 bits = 0x7
117	1	Vector	Identifies DMP Set Property Message PDU	0x02
118	1	Address Type & Data Type	Identifies format of address and data	0xa1
119-120	2	First Property Address	Indicates DMX START Code is at DMP address 0	0x0000
121-122	2	Address Increment	Indicates each property is 1 octet	0x0001
123-124	2	Property value count	Indicates 1+ the number of slots in packet	0x0001 -- 0x0201
125-637	1-513	Property values	DMX512-A START Code + data	START Code + Data

Table 1: E1.31 Packet Format

All packet contents shall be transmitted in network byte order (big endian).

5 E1.31 use of the ACN Root Layer Protocol

E1.31 shall use the ACN Root Layer Protocol as defined in the ANSI E1.17 [ACN] “ACN Architecture” document. The fields described here are for E1.31 on UDP [UDP]. Alternative Root Layer Protocol (RLP) content may be defined by further standards in order to transport E1.31 on other protocols.

5.1 Preamble Size

Transmitters shall set the Preamble Size to 0x0010. Receivers of UDP [UDP] based E1.31 shall discard the packet if the Preamble Size is not 0x0010. The preamble contains the preamble size field, the post-amble size field, and the ACN packet identifier and has a length of 0x10 octets.

5.2 Post-amble Size

There is no post-amble for RLP used over UDP [UDP]; therefore the Post-amble Size is 0x0. Transmitters shall set the Post-amble Size to 0x0000. Receivers of UDP based E1.31 shall discard the packet if the Post-amble Size is not 0x0000.

5.3 ACN Packet Identifier

The ACN Packet Identifier shall contain the following sequence of hexadecimal characters 0x41 0x53 0x43 0x2d 0x45 0x31 0x2e 0x31 0x37 0x00 0x00 0x00.

Receivers shall discard the packet if the ACN Packet Identifier is not valid.

5.4 Flags & Length

The Root Layer's Flags & Length field is a 16-bit field with the PDU length encoded in the low 12 bits and 0x7 in the top 4 bits.

```
  7   6   5   4   3   2   1   0
+-------------------------------+
| flags=0x7     |  length-hi    |
+-------------------------------+
| length-lo                     |
+-------------------------------+
```

Figure 1: RLP Flags and Length

The RLP PDU length is computed starting with octet 16 and counting all octets in the packet through the last Property Value provided in the DMP layer (Octet 637 for a full payload). This is the length of the RLP PDU.

5.5 Vector

Transmitters shall set the Root Layer's Vector to 0x0000004. Receivers shall discard the packet if the received value is not 0x00000004. This value indicates that the root layer PDU is wrapping an E1.31 framing layer PDU.

5.6 CID (Component Identifier)

The Root Layer contains a CID. The CID shall be a UUID (Universally Unique Identifier) [UUID] that is a 128-bit number that is unique across space and time compliant with RFC 4122 [UUID]. Each piece of equipment should maintain the same CID for its entire lifetime (e.g. by storing it in read-only memory). This means that a particular component on the network can be identified as the same entity from day to day despite network interruptions, power down and so on. However, in some systems there may be situations in which volatile components are dynamically created “on the fly” and in these cases the controlling process can generate CIDs as required. The choice of UUIDs for CIDs allows them to be generated as required without reference to any registration process or authority. As with all E1.31 packet contents, the CID shall be transmitted in network byte order (big endian).

6 E1.31 Framing Layer Protocol

6.1 Flags & Length

The E1.31 Flags & Length field is a 16-bit field with the PDU length encoded in the low 12 bits and 0x7 in the top 4 bits.

```
  7   6   5   4   3   2   1   0
+-------------------------------+
| flags=0x7     |  length-hi    |
+-------------------------------+
| length-lo                     |
+-------------------------------+
```

Figure 2: E1.31 Flags and Length

The E1.31 framing layer PDU length is computed starting with octet 38 and continuing through the last property value provided in the DMP PDU (octet 637 for a full payload). This is the length of the E1.31 framing layer PDU.

6.2 Vector

Transmitters shall set the E1.31 Layer's Vector to 0x0000002. Receivers shall discard the packet if the received value is not 0x00000002. This value indicates that the E1.31 framing layer is wrapping a DMP PDU.

6.3 Source Name

A user assigned name provided by the source of the packet for use in displaying the identity of a source to a user. There is no mechanism, other than user configuration of sources, to ensure uniqueness of this name. The source name shall be null terminated. If the source component implements ACN discovery as defined in EPI 19 [ACN] then this name shall be the same as the UACN field specified in EPI 19 [ACN].

6.4 Priority

A receiver conforming to this standard may receive data for the same universe from multiple sources that may be distinguished by examining the CID in the packet. (This is a situation that cannot occur in conventional DMX systems.)

The Priority field is an unsigned one octet field. The value is used by receivers in selecting between multiple sources of data for a given universe number. Sources that do not support variable priority shall transmit a priority of 100. No priority outside the range of 0 to 200 shall be transmitted on the network. Priority increases with numerical value, i.e., 200 is a higher priority than 100.

For a given universe number, an E1.31 receiver shall treat data from packets with the highest priority as the definitive data for that universe.

6.4.1 Multiple Sources at Highest Priority

It is possible for there to be multiple sources, all transmitting data at the highest currently active priority level for a given universe. When this occurs, receivers must handle these sources in some way.

A receiver which is only capable of processing one source of data will encounter a *sources exceeded* condition when two or more sources are present.

Many devices are capable of combining, merging or arbitrating between the candidate sources by some algorithm (see below), but such algorithms frequently limit the number of concurrent sources which can be handled due to resource limitations, or encounter situations where there are still multiple candidate sources meeting some specified condition, and then, once again, a *sources exceeded* condition arises which requires resolution.

6.4.2 Discussion of Merge and Arbitration Algorithms

A process of combining data from multiple sources to produce a definitive result is called a merge. A process which selects between candidate sources based on some additional selection criterion is called arbitration.

The single most common merging algorithm, which is usually appropriate to lighting intensity data (e.g. dimmer inputs), is to take the highest (numerically largest) level present from any of the candidate sources slot by slot throughout the universe - so-called Highest Takes Precedence (HTP) merging. A variation of this uses DMX512 START Code DDh (see [DMX] and http://www.esta.org/tsp/working_groups/CP/DMXAlternateCodes.php) to indicate slot-by-slot priority before merging the highest priority data for each slot on an HTP basis.

For other devices such as movement axes in automated luminaires, HTP is often highly inappropriate. In this case, it is common to accept only one candidate source, but arbitration criteria may be applied e.g. based on information in the Source Name field.

6.4.3 Discussion of Resolution of Sources Exceeded Condition

Resolution is required when the number of sources exceeds limitations of the algorithm or of resources available. In the simplest case with no merging or arbitration, this occurs when there is more than one source (at highest active priority).

One resolution mechanism is to stop accepting data from any source. Other mechanisms may choose one or more from the candidate sources by some overload selection scheme.

Designers are very strongly discouraged from implementing resolution algorithms that generate different results from the same source combination on different occasions, because this can make *sources exceeded* conditions hard to detect, makes networks very hard to troubleshoot and may cause unexpected results at critical times. For example, an arbitration scheme which accepts the first source detected at the active highest priority and rejects any subsequent ones will produce results dependent on the order in which equipment is initialized and the vagaries of packet timing, and is not recommended.

6.4.4 Requirements for Merging and Arbitrating

The ability of devices to merge or arbitrate between multiple sources at highest active priority shall be declared in user documentation for the device.

If merging or arbitration is implemented, the maximum number of sources which can be correctly handled shall be declared in user documentation for the device.

If merging or arbitration is implemented the algorithm used shall be declared in user documentation for the device.

6.4.5 Requirements for *Sources Exceeded* Resolution

The resolution behavior of equipment under *sources exceeded* conditions shall be declared in user documentation for the device.

Receiving devices conforming are strongly recommended to indicate a *sources exceeded* condition by some means easily detected at the device, e.g., by a flashing indicator, or obvious status message.

Receiving devices may additionally indicate a *sources exceeded* condition by other means such as remote indication initiated by a network message. This is particularly appropriate for devices which may be hard to access.

6.4.6 Requirements for Devices with Multiple Operating Modes

Receiving devices which have multiple configurations available to select between different methods for merging and/or *Sources Exceeded* resolution, shall meet the rules above for each configuration separately. Any configurations in which the device is not compliant with this standard should be clearly declared as such, but are otherwise beyond the scope of this specification.

6.5 Sequence Number

In a routed network environment it is possible for packets to be received in a different order to the one in which they were sent. The sequence number allows receivers or diagnostic equipment to detect out of sequence or lost packets.

Sources shall maintain a sequence for each universe they transmit. The sequence number for a universe shall be incremented by one for every packet sent on that universe.

6.6 Options

This bit-oriented field is used to encode optional flags that control how the packet is used.

Preview_Data: Bit 7 (most significant bit)

This bit, when set to 1, indicates that the data in this packet is intended for use in visualization or media server preview applications and shall not be used to generate live output.

Stream_Terminated: Bit 6

This bit is intended to allow E1.31 transmitters to terminate transmission of a stream without waiting for a timeout to occur and to indicate to receivers that such termination is not a fault condition.

When set to 1, this bit indicates that the source of the data for the universe specified in this packet has terminated transmission of that universe. Three packets containing this bit set to 1 shall be sent by transmitters upon terminating sourcing of a universe. Upon receipt of a packet containing this bit set to a value of 1, a receiver shall enter network data loss condition. Any property values in these packets shall be ignored.

Bits 0 through 5 of this field are reserved for future use and shall be transmitted as 0 and ignored by receivers.

6.7 Universe

The Universe is a 16-bit field that defines the universe number of the data carried in the packet. Universe values shall be limited to the range 1 to 63999. Universe value 0 and those between 64000 and 65535 are reserved for future use. See Section 8 for more information.

6.8 Framing Layer Operation and Timing - Transmitter Requirements

6.8.1 Transmission Rate

E1.31 sources shall not transmit packets for a given universe number at a rate which exceeds the maximum refresh rate specified in E1.11, for a data packet with the same slot count. Note that E1.11 [DMX] places special restrictions on the maximum rate for alternate START Code packets in Section 8.5.3.2 of that document.

6.8.2 Null START Code Transmission Requirements

In order to avoid unnecessary usage of network bandwidth, transmission of redundant Null START Code data is minimized. For a given universe number, transmitting devices shall transmit Null START Code data only when that data changes, with the following exceptions:

1. Three packets containing the non-changing data shall be sent before the initiation of transmission suppression.

2. Thereafter, a single keep-alive packet shall be transmitted at intervals of between 800mS and 1000mS. Each keep-alive packet shall have identical content to the last Null START Code data packet sent with the exception that the sequence number shall continue to increment normally.

These requirements do not apply to alternate START Code data.

6.9 Framing Layer Operation and Timing - Receiver Requirements

6.9.1 Network Data Loss

Network data loss condition is a condition that is defined as either the absence of reception of E1.31 packets from a given source for a period of 2.5 seconds or the receipt of a packet containing the Options field, bit 6 set to value of 1 (see Section 6.6 Options). Data loss is specific to a universe (see the Universe field in Table 1), so data loss may exist for one universe from a source and not for other universes provided by that same source.

When a data loss condition arises, a source specific universe is considered disconnected.

6.9.2 Sequence Numbering

Receivers that do not support sequence numbering of packets shall ignore the contents of this field.

Having first received a packet with sequence number A, a second packet with sequence number B arrives. If, using signed 8-bit binary arithmetic, B – A is less than or equal to 0, but greater than -20 then the packet containing sequence number B shall be deemed out of sequence and discarded.

> Note: This algorithm allows the sequence stream from a source to jump by large amounts without undue delay, as in the case of a reset, without allowing packets received slightly out of order to cause flicker or interfere with predictive algorithms found in many moving light fixtures.

For receivers supporting sequence numbering, packets shall be processed in the order received unless they are discarded according to the above algorithm.

7 DMP Layer Protocol

In DMP terms the DMX packet is treated at the DMP layer as a set property message for an array of up to 513 one-octet virtually addressed properties. A restriction of E1.31 is that the array shall always begin at property zero corresponding in DMX nomenclature to START Code. This allows E1.31 implementations which do not process DMP generically to treat much of the DMP header content as fixed values.

7.1 Flags & Length

The DMP Layer's Flags & Length field is a 16-bit field with the PDU length encoded in the low 12 bits and 0x7 in the top 4 bits.

```
  7   6   5   4   3   2   1   0
+-------------------------------+
| flags=0x7     |  length-hi    |
+-------------------------------+
| length-lo                     |
+-------------------------------+
```

Figure 3: DMP Flags and Length

The DMP layer PDU length is computed starting with octet 115 and continuing through the last property value provided in the DMP PDU (octet 637 for a full payload). This is the length of the DMP PDU.

7.2 Vector

The DMP Layer's Vector shall be set to 0x02, which indicates a DMP Set Property message by transmitters. Receivers shall discard the packet if the received value is not 0x02.

7.3 Address Type and Data Type

Transmitters shall set the DMP Layer's Address Type and Data Type to 0xa1. Receivers shall discard the packet if the received value is not 0xa1.

7.4 First Property Address

Transmitters shall set the DMP Layer's First Property Address to 0x0000. Receivers shall discard the packet if the received value is not 0x0000.

7.5 Address Increment

Transmitters shall set the DMP Layer's Address Increment to 0x0001. Receivers shall discard the packet if the received value is not 0x0001.

7.6 Property Value Count

The DMP Layer's Property Value Count is used to encode the number of DMX512-A [DMX] Slots (including the START Code slot).

7.7 Property Values (DMX512-A Data)

The DMP Layer's Property values field is used to encode the DMX512-A [DMX] START Code and data.

The first octet of the property values field shall be the DMX512-A [DMX] START Code.

The remainder of the property values shall be the DMX512-A data slots. This data shall contain a sequence of octet data values that represent a consecutive group of data slots, starting with slot 1, from a DMX512-A packet. The number of data slots encoded in the frame shall not exceed the DMX512-A limit of 512 data slots.

Processing of Alternate START Code data shall be compliant with ANSI E1.11 [DMX] Section 8.5.3.3 - Handling of Alternate START Code packets by in-line devices.

8 Operation of E1.31 in IPv4 Networks

8.1 Assignment of IP Addresses

E1.31 compliant equipment requiring an IP address shall conform to EPI-29 (Revised Rules for Allocation of Internet Protocol Version 4 Addresses to ACN Hosts) of ANSI E1.17 [ACN] for IP-address assignment.

8.2 Association of Multicast Addresses and Universe

This standard uses network multicast addressing in order to direct DMX512-A universes to their specified destination. Universes may be sent directly between network devices using unicast addressing, however no discovery mechanism is specified in this standard to support the dynamic determination of such addresses.

Addressing and partitioning of multicast traffic is achieved by setting the least significant two bytes of the multicast IP address to the desired universe number. Multicast addresses corresponding to the top 256 universes are reserved by the IANA for scope relative addressing; therefore E1.31 devices shall not transmit on these top 256 addresses. If these reserved universes are used in the future, they must be transmitted unicast. Additionally, E1.31 devices shall not use universe number 0 as it is reserved for future use. Also, Universe numbers between 64000 and 65535 are reserved for future use and shall not be used by E1.31 devices except as specified in future standards designed to coexist with E1.31 and which specifically call for the use of these universes.

Controllers can thus transmit data to the required universes without prior knowledge of the network topology. Equally, responders can listen to a predetermined IP address for data representing a specific universe.

An operating mode shall be provided where E1.31 controllers shall transmit universes on the multicast address as defined in Table 2. E1.31 receivers of a universe shall subscribe to the multicast address defined in Table 2. Note: The identity of the universe shall be determined by the universe number in the packet and not assumed from the multicast address. An E1.31 receiver shall also respond to 1.31 data received on its unicast address.

8.3 Multicast Subscription

Transmitters and Receivers shall use IGMP V2 [IGMP2] or IGMP V3 [IGMP3]. IGMP is used to communicate multicast address usage to network routers.

This requirement is placed on transmitters because many switches or routers do not handle incoming multicast packets well unless the source has advertised in this manner.

8.4 Allocation of Multicast Addresses

Multicast addresses are from the IPv4 Local Scope and will be managed by routers in conformance with RFC 2365 [ASIPM].

The multicast IP address is defined in Table 2 below:

IP Address Byte	Value
1	239
2	255
3	Universe – Hi byte
4	Universe – Lo byte

Table 2: Universe - IP mapping

When multicast addressing is used, the UDP destination Port shall be set to the standard ACN-SDT multicast port (5568). For unicast communication the ACN-SDT multicast port shall be used by default, but methods for configuration and use of alternative ports may be provided.

9 Translation between DMX512-A and E1.31

9.1 DMX512-A to E1.31 Translation

Devices performing translation of incoming DMX512-A [DMX] data to E1.31 network data are subject to the requirements of this Section.

9.1.1 Boot Condition

A DMX512-A [DMX] to E1.31 translator shall not transmit E1.31 packets for a given universe until it has received at least one valid (properly formed) DMX512-A [DMX] input packet for that universe.

9.1.2 Temporal Sequence

A DMX512-A [DMX] to E1.31 translator shall transmit packets in the order in which they are received from the DMX512-A [DMX] source.

9.1.3 Loss of Data

Upon detection of loss of data as defined in DMX512-A [DMX], a transmitter shall terminate transmission in accordance with Section 6.6.

9.2 E1.31 to DMX512-A Translation

9.2.1 General

Devices performing translation of incoming E1.31 network data to DMX512-A [DMX] data are subject to the requirements of this Section.

9.2.2 Loss of Data

An operating mode shall be provided, whereupon detection of loss of data, as defined in Section 6.9.1, for all sources of a universe, a transmitter shall immediately stop transmitting DMX512-A [DMX] packets. In addition, a transmitter may supplement this required mode with alternative operating modes, for example, such as those implementing a hold-last-look feature by continuously retransmitting the last valid packet.