

Open eXchange Data Format Specification

Version 1.4

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Welcome to OpenXDF

The Consortium would like to thank everyone that has participated in the OpenXDF forums and everyone who has given us direct feedback over the past couple of years. Your constructive criticism and insights have contributed greatly to the development of OpenXDF, XDFviewer, and maXimus.

Changes in Version 1.0

Packaging, Compression, and Encryption

Previous versions of the specification allowed for proprietary compression and encryption with the understanding that such methods would render the file unusable by other systems.

It became obvious that using OpenXDF to exchange data between research and clinical institutions would require standardized and secure methods of encrypting sensitive information for transport. This version of the specification introduces the ability to secure OpenXDF files using strong, password-based TwoFish encryption.

Experience with OpenXDF in the field highlighted the utility of being able to store sections of an OpenXDF header separately. This version of the specification introduces packaging sections that provide details on how to use ZIP with DEFLATE to package and compress multiple OpenXDF headers, and other types of files, into a single file that all compatible systems will be able to handle.

XML

This version of the specification explicitly restricts the OpenXDF headers to UTF-8 or UTF-16 encoding to ensure maximal compatibility between XML parsers.

Data Storage

Previous versions included a number of artificial limitations left over from the original development. Sample size, sample frequency, and frame length are no longer constrained, and OpenXDF now includes the ability to specify the byte order of multi-byte samples.

Montages

Since the specification no longer includes limitations on sampling frequencies, the specification now includes a minimal set of sampling frequencies for the high- and low-frequency filter types. The specification also includes a new notch filter requirement.

Previous versions of the specification included a “Type” tag for channels in the montage. This generated a lot of confusion in the forums since the type names listed were proprietary. In addition, there was some confusion over how to display events like the XDFviewer using the channel type.

This version of the specification uses standard names for the channel types and includes a table that specifies how event types relate to channel types.

Patient Information

The patient information section now includes a significant amount of additional information.

Video

OpenXDF now includes support for referencing video associated with a record.

American Academy of Sleep Medicine Guidelines

OpenXDF now includes support for the new AASM guidelines.

Changes in Version 1.1

XML

§2.1.1.3 of the specification now explicitly requires that systems read and write values using the POSIX locale defined in IEEE 1003.1, 2004 when not governed by any other requirements. This requirement specifically addresses an issue that arises when exchanging OpenXDF files between systems using locale settings with conflicting decimal symbols ("9.345" vs. "9,345").

Changes in Version 1.2

XML

§2.1.1.4 of the specification now requires systems that read and write OpenXDF files retain any well-formed, unrecognized tag's location within the hierarchy, namespace, name, and contents, and write the tag and its contents back out verbatim.

Event Display

§3.1.13 is now an optional guideline for consistent event display.

Changes in Version 1.3

Encryption

§2.1.1.2 of the specification now suggests using a random sequence of bytes securely-generated at the time of encryption as the Initialization Vector for encryption instead of a freshly-generated UUID. While UUIDs are unique and avoid the problem of reusing a key-IV pair, UUIDs are not cryptographically secure.

Changes in Version 1.4

Corrected formatting errors.

Level 3.PSG

§2.3.2 of the specification no longer includes RERA's as a defined event and replaces them with Flow Limitations.

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1 Introduction

The fundamental motivation behind OpenXDF is to provide the medical community with an open standard for the exchange of time-series data such as electroencephalograph (EEG), electrocardiogram (ECG), and oximetry signals. The OpenXDF standard also serves as a vehicle for the lightweight exchange of patient- and domain-specific metadata, such as patient demographics and polysomnography scoring information, with or without signal data.

At its most basic level, an OpenXDF file is a XML-based header file that provides all of the information necessary to interpret a signal data file. This abstraction allows OpenXDF serve more advanced functions such as being a superset to existing formats (§2.1.1.5); allowing multiple signal data files, possibility of different formats, to coexist as a single unit; and metadata exchange.

1.1 Conventions

A byte is a single octet of bits.

The cardinality of an XML tag is a constraint on the number of times a tag may occur within a given context. A "required" tag shall occur exactly once within a context while an "optional" tag may occur at most once within a context. The specification will express the cardinality of a tag that may occur more than once within a context using interval notation.

Figure 1 illustrates the formatting used for XML and code blocks. Blue text indicates an example value.

```
<xdf:OpenXDF>
  <xdf:EpochLength> 30 </xdf:EpochLength>
  <xdf:SessionContinuity> false </xdf:SessionContinuity>
  <xdf:DataFiles />
</xdf:OpenXDF>
```

Figure 1 – Example XML Block

1.2 Organization

OpenXDF is a tiered framework designed to allow standardized and custom specializations of the format while enforcing a common foundation that provides a high-level of compatibility between unrelated systems.

OpenXDF Level 1 defines the absolute minimum requirements for a functional OpenXDF file.

OpenXDF Level 2 defines advanced features common to most specialties.

OpenXDF Level 3 defines specializations of the standard. Level 3 standards contain the name of the specialization to which they apply. "Level 3.PSG," for instance, is the standard polysomnography specialization.

2 Implementation Standards

2.1 Level 1

2.1.1 System Requirements

2.1.1.1 Packaging

Systems may package and/or compress one or more OpenXDF headers, as well as any secondary files such as a patient photo, into a single file using the ZIP file format and the DEFLATE compression algorithm.

When packaged in a ZIP file, systems shall store the main OpenXDF header in the root of the package and name it "header.xdf." Later sections will discuss when it is appropriate to package multiple OpenXDF headers and secondary files together, and discuss how to organize the package in a standard way.

2.1.1.2 Encryption

Systems may encrypt OpenXDF headers or packages using TwoFish in Cipher Feedback (CFB) mode. When encrypting with TwoFish, systems shall use SHA-256 to hash a plain text, UTF-8 encoded password into a 256-bit encryption key and use SHA-512 to calculate a 512-bit checksum of the original file.

While TwoFish is a 128-bit block cipher, TwoFish operates as a stream cipher in CFB mode eliminating the need for a padding scheme to align the input on 128-bit boundaries.

Cipher feedback shall be primed with a 128-bit initialization vector (IV). Since the IV must be public, the IV should be a random sequence of bytes securely-generated at the time of encryption to avoid security issues related to using the same key-IV pair more than once.

Encrypted files shall begin with the OpenXDF encryption header shown in Figure 2. All fields are big endian and aligned on 1-byte boundaries.

```
OpenXDFEncryptionHeader
{
/* identifies an encrypted OpenXDF header/package; set to 0x53584446. */
  UInt32 Magic;
/* size of the header; set to 96 bytes. */
  UInt32 HeaderSize;
/* the cipher feedback initialization vector. */
  UInt8 InitializationVector[16];
/* SHA-512 hash of the original file. */
  UInt8 Checksum[64];
/* Application-specific data. */
  UInt64 ApplicationData;
}
```

Figure 2 – OpenXDF Encryption Header

Systems shall only apply encryption after packaging/compression.

2.1.1.3 XML and Entities

Reading systems shall employ an XML parser that adheres to the W3C XML version 1.0 standard. XDFviewer and maXimus use Microsoft's free XML Core Services (MSXML) 4.0 to implement a Simple API for XML (SAX) parser. There are also several open-source, cross-platform parsers available such as eXpat and libxml.

Likewise, writing systems shall write OpenXDF files in a manner that conforms to the XML version 1.0 standard and shall only use UTF-8 or UTF-16 encoding to ensure maximum compatibility between XML parser implementations.

When not governed by the XML specification, UTF-8/-16, or any specific requirements in this specification (such as the use of ISO-8601 for date/time values), systems shall read and write values using the POSIX locale defined in chapter 7 of IEEE 1003.1, 2004.

Systems shall be backward and forward compatible with all versions of the OpenXDF specification starting with version 1.0.

If this specification does not explicitly indicate the order of list items using a timestamp, epoch number, etc., systems shall rely on the order in which list items appear in the header. For instance, if "A1" precedes "C3" in the source list of a signal data file, then "A1" precedes "C3" in the signal data file.

Unless otherwise specified, all values are case-insensitive. For instance, "C3" is the same electrode as "c3."

2.1.1.4 Unrecognized and Custom Tags

In addition to the standard tags, implementers may also use custom tags. Custom tags shall include an implementation-specific namespace. Custom tags shall not use the "xdf" namespace.

Reading systems may safely ignore well-formed, but unrecognized, tags. For instance, a system designed to only understand Level 1 OpenXDF may safely ignore Level 2 tags or custom tags from another implementation.

Systems that read and write OpenXDF files, however, shall retain any well-formed, unrecognized tag's location within the hierarchy, namespace, name, and contents, and write the tag and its contents back out verbatim.

2.1.1.5 Data Frames

A data frame is a collection of signal data blocks, aligned on 1-byte boundaries, where each signal data block contains the same duration of data. The signal data blocks shall be stored in the same order as their sources in the signal data file's source list.

While OpenXDF does not constrain the length of a frame, implementers should carefully consider read performance and display requirements when choosing a frame length. A short frame length may force a reading system to fetch samples using a large number of small disk operations, while a long frame length may impose limits on epoch length and display time bases.

For many systems, a one-second frame length provides a good mix of disk access efficiency and display flexibility.

Figure 3 illustrates a typical frame:

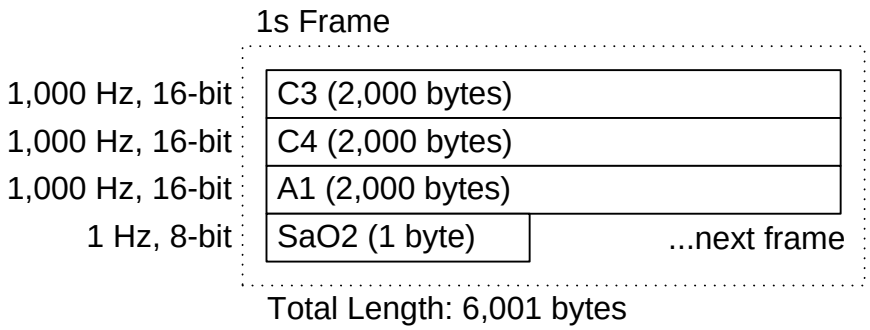


Figure 3 – Example Data Frame

2.1.1.6 Digital and Physical Ranges

While not a specific requirement of this specification, implementers should pay particular attention to digital and physical ranges.

OpenXDF and EDF effectively treat signals as though they have no unit. The EDF header includes a text field for specifying the unit of a signal. The field is not reliable, however, since it can contain any arbitrary unit or no unit at all. A signal's unit value in OpenXDF is simply a convenience for dealing with voltage signals.

Signals without a unit require some care when deciding their physical and digital ranges.

Consider a signal that has a physical range of [-5 millibars, 5 millibars]. In EDF, it is possible to specify "mbar" in the unit field and rely on reading systems to scale the value on the screen appropriately. Doing this, however, assumes that the reading system understands "mbar." The reading system may only recognize "mb" or not recognize millbars at all.

Now consider a system that is able to display one unit per pixel vertically on the screen at a sensitivity of one. Without any knowledge of the above signal's unit, the reading system would simply display the signal with a vertical range of only 10 pixels at a sensitivity of one and less than two pixels at the nominal sensitivity of seven.

If instead, the signal's range is [-5000 microbars, 5000 microbars], the logical equivalent to the same range expressed in millibars, the reading system would display the signal with a vertical range of 10,000 pixels at a sensitivity of one since the unit of sensitivity is microbars-per-pixel instead of millibars-per-pixel.

2.1.2 Header Requirements

An OpenXDF header file begins with the standard XML declaration including the XML version and text-encoding scheme as shown in Figure 4. As specified in §2.1.1.3, the encoding shall either be UTF-8 or UTF-16.

```
<?xml version="1.0" encoding="utf-8" ?>
```

Figure 4 – XML Declaration

2.1.2.1 xdf:OpenXDF Entity

The xdf:OpenXDF entity, shown in Figure 5, immediately follows the XML declaration and is the root element of an OpenXDF header. The xdf:OpenXDF entity declares the "xdf" namespace as well as any custom namespaces required by the header.

```
<xdf:OpenXDF  xmlns:xdf="http://www.openxdf.org/xdf"
              xmlns:custom="organization/custom"
              xmlns:...
              >
  <xdf:EpochLength> 30 </xdf:EpochLength>
  <xdf:SessionContinuity> false </xdf:SessionContinuity>
  <xdf:DataFiles />
</xdf:OpenXDF>
```

Figure 5 – xdf:OpenXDF Entity; Level 1

xdf:EpochLength	
Data Type:	UInt8
Cardinality:	Optional
Default:	See Description
Description:	Epoch (page) length in seconds. This value shall be a common integer multiple of the frame lengths specified by the data files. An OpenXDF file shall not specify an epoch length that would force a system to display partial frames in an epoch. The system shall treat an invalid value as an error and stop processing the file. If a header does not specify this value, the system shall choose a value that is a common integer multiple of the frame lengths specified in the data files and is between 10 and 60 seconds. If any one of the frame lengths exceeds 60 seconds, the epoch length shall be the least common integer multiple of the frame lengths. The system shall treat the failure to determine a valid epoch length as an unrecoverable error.

xdf:SessionContinuity	
Data Type:	Boolean
Cardinality:	Optional
Default:	False
Description:	Indicates how systems shall calculate epoch numbers across sessions. If this value is true, systems shall take the time between sessions into account when calculating epoch numbers. For example, consider Session A and Session B, and an epoch length of 30 seconds. If Session A is one hour long, Session B begins one hour after Session A ends and this value is true, the first epoch of Session B would be 241 instead of 121.

xdf:DataFiles	
Data Type:	List of DataFile entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of signal data files referenced by the header.

2.1.2.2 xdf:DataFile Entity

```
<xdf:DataFile>
  <xdf:File> EXAMPLE.RAWDATA </xdf:File>
  <xdf:FrameLength> 1 </xdf:FrameLength>
  <xdf:Endian> big </xdf:Endian>
  <xdf:Sources />
  <xdf:Sessions />
</xdf:DataFile>
```

Figure 6 – xdf:DataFile Entity; Level 1

xdf:File	
Data Type:	Text
Cardinality:	Required
Default:	No default
Description:	The signal data file name. To avoid path convention issues across platforms, systems should avoid absolute and/or complex paths such as UNC paths and URLs. Systems shall attempt to translate between Windows and POSIX conventions where possible.

xdf:FrameLength	
Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	The data frame length in seconds. Systems shall treat a value less than or equal to zero as an unrecoverable error. See §2.1.1.5.

xdf:Endian	
Data Type:	Endian
Cardinality:	Optional
Default:	“little”
Description:	Specifies the byte order of multi-byte samples.

xdf:Sources	
Data Type:	List of Source entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of sources in the signal data file.

xdf:Sessions	
Data Type:	List of Session entities; [1, +∞)
Cardinality:	Required
Default:	No default
Description:	Defines a list of recording sessions in the signal data file. Sessions shall be disjoint across all DataFile entities specified in the header.

2.1.2.3 xdf:Source Entity

```
<xdf:Source>
  <xdf:Ignore> false </xdf:Ignore>
  <xdf:SourceName> C3 </xdf:SourceName>
  <xdf:Signed> true </xdf:Signed>
  <xdf:SampleWidth> 2 </xdf:SampleWidth>
  <xdf:SampleFrequency> 1000 </xdf:SampleFrequency>
  <xdf:DigitalMax> 32767 </xdf:DigitalMax>
  <xdf:DigitalMin> -32768 </xdf:DigitalMin>
  <xdf:PhysicalMax> 3200 </xdf:PhysicalMax>
  <xdf:PhysicalMin> -32600 </xdf:PhysicalMin>
  <xdf:DigitalToVolts> 0.09765774 </xdf:DigitalToVolts>
  <xdf:Unit> 0.000001 </xdf:Unit>
</xdf:Source>
```

Figure 7 – xdf:Source Entity

xdf:Ignore

Data Type:	Boolean
Cardinality:	Optional
Default:	False
Description:	Indicates whether systems shall ignore the source. Headers shall specify the SourceName, SampleWidth, and SampleFrequency for ignored sources. The SampleWidth and SampleFrequency values may be arbitrary as long as their product equals the correct number of bytes in a frame to skip.

xdf:SourceName

Data Type:	Text
Cardinality:	Required
Default:	No default
Description:	A name that uniquely identifies this source within this DataFile entity. Systems shall treat any subsequent sources with a duplicate name as though their ignore flags are set to true.

xdf:Signed

Data Type:	Boolean
Cardinality:	Optional
Default:	True
Description:	Indicates whether samples are signed or unsigned.

xdf:SampleWidth

Data Type:	UInt8
Cardinality:	Required
Default:	No default
Description:	Sample size in bytes. Systems shall support sample sizes up to the integer size of their target architectures. For example, 32-bit systems shall support up to 32-bit (4 byte) samples, but are not required to support larger samples. If a system encounters a sample size it does not support, the system shall treat the source as though xdf:Ignore is true. Systems shall treat a value of zero as an unrecoverable error.

xdf:SampleFrequency

Data Type:	UInt16
Cardinality:	Required
Default:	No default
Description:	The sampling frequency, in Hz, for this source. Systems shall treat a value of zero as an unrecoverable error.

xdf:DigitalMax

Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	Maximum value of the digital signal. See §2.1.1.6.

xdf:DigitalMin

Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	Minimum value of the digital signal. See §2.1.1.6.

xdf:PhysicalMax

Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	Maximum value of the physical signal. See §2.1.1.6.

xdf: PhysicalMin

Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	Minimum value of the physical signal. See §2.1.1.6.

xdf:DigitalToVolts	
Data Type:	Floating-point
Cardinality:	Optional
Default:	1.0
Description:	Specifies a multiplier that systems may use to convert the digital range of a non-Voltage signal to Volts. Consider an amplifier with a DC input that outputs 0.01V increments represented by signed, 8-bit samples. The full range of the input is: [-128, 127] = [-1.28V, 1.27V]. Now consider a CPAP machine that outputs 0V to 1V representing 0 cmH2O, 30 cmH2O. To display the data properly, the OpenXDF source would need a physical min and max of 0 and 30 respectively, and a digital min and max would be 0 and 100 respectively. In this case, the xdf:DigitalToVolts value would 0.01.

xdf:Unit	
Data Type:	Floating-point
Cardinality:	Optional
Default:	0.0
Description:	Specifies the unit of a calibrated physical signal as a factor of Volts. For instance, 0.001 represents millivolts. For non-Voltage signals, this value shall be 0.0.

2.1.2.4 xdf:Session Entity

```
<xdf:Session>
  <xdf:Offset> 1000 </xdf:Offset>
  <xdf:Length> 7201200 </xdf:Offset>
  <xdf:StartTime> 2008-07-015T22:00:00.250-04:00 </xdf:StartTime>
</xdf:Session>
```

Figure 8 – xdf:Session Entity; Level 1

xdf:Offset	
Data Type:	UInt64
Cardinality:	Required
Default:	No default
Description:	Specifies the offset, in bytes, from the beginning of the signal data file to the start of the session data.

xdf:Length	
Data Type:	UInt64
Cardinality:	Required
Default:	No default
Description:	Specifies the length, in bytes, of the session's signal data.

xdf:StartTime	
Data Type:	Date/Time
Cardinality:	Required
Default:	No default
Description:	Specifies session's start date and time.

2.2 Level 2

2.2.1 System Requirements

A level 2 compliant system shall adhere to all requirements in §2.1.1 and introduces the following requirements.

2.2.1.1 Packaging

Systems may package patient photos into a package directory named "photos." The names of the photos may be arbitrary as long as they are unique within the "photos" directory. For maximum compatibility, systems should store patient photos as JPEGs.

2.2.1.2 Montaging

When implementing a montage interface, systems shall provide the user with a ground source. Systems shall always refer to this implied ground source as "GND" and shall not include it in the source list. The ground source shall always be zero, i.e. GND – C3 is equivalent to 0 – C3.

Systems shall provide the minimal sets of low- and high-frequency filters specified in §3.1.5 and §3.1.6 respectively. These filters shall support the following discrete set of sampling frequencies (in Hz) typically used in PSG and EEG studies:

1	5	10
25	50	100
200	250	256
500	512	1,000
10,000		

Systems should also provide both 50 Hz and 60 Hz notch filters for sampling frequencies in the above set greater than or equal to 200 Hz.

Systems shall ignore filter settings for signals sampled at frequencies outside of the system's supported set. Implementers may choose how to handle invalid filter cutoff frequency and signal sampling frequency combinations. For instance, an implementer may choose to use a null filter to zero a channel if the montage specifies a 53 Hz low-frequency filter on a 25 Hz signal. Likewise, an implementer may choose to use an identity filter if the montage specifies a 35 Hz high-frequency filter on a 25 Hz signal.

2.2.2 Header Requirements

A level 2 compliant format shall adhere to all requirements in §2.1.2 and introduces the following requirements.

2.2.2.1 Instantaneous Event

The *Instantaneous Event* entity is the common basis for events that do not have duration.

```
<Instantaneous Event>
  <xdf:Time> 2008-07-015T22:05:00.123-04:00 </xdf:Time>
</Instantaneous Event>
```

Figure 9 – *Instantaneous Event*

xdf:Time	
Data Type:	Date/Time
Cardinality:	Required
Default:	No default
Description:	Specifies the date and time at which the event occurred.

2.2.2.2 Non-instantaneous Event

The *Non-instantaneous Event* entity is the common basis for events that have duration.

```
<Non-instantaneous Event>
  <!-- Instantaneous Event Information -->
  <xdf:Duration> 5 </xdf:Duration>
</Non-instantaneous Event>
```

Figure 10 – *Non-instantaneous Event*

xdf:Duration	
Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	Specifies the duration of the event.

2.2.2.3 Staff

The *Staff* entity is the common basis for information about staff members.

```
<Staff Member>
  <xdf:FirstName> Joe </xdf:FirstName>
  <xdf:LastName> Technician </xdf:LastName>
  <xdf:MiddleName> Bob </xdf:MiddleName>
  <xdf:ID> 1515 </xdf:ID>
  <xdf:WorkPhone> 1|352|555-0000|312 </xdf:WorkPhone>
  <xdf:Pager />
  <xdf:Fax />
  <xdf:CellPhone />
  <xdf:Email> joebob@sleeplab.com </xdf:Email>
  <xdf:Specialty />
  <xdf:Title1> RPSGT </xdf:Title1>
  <xdf:Title2 />
  <xdf:Title3 />
</Staff Member>
```

Figure 11 – *Staff*

xdf:FirstName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The staff member's first name.

xdf:LastName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The staff member's last name.

xdf:MiddleName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The staff member's middle name.

xdf:ID

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The staff member's organizational ID.

xdf:WorkPhone

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The staff member's work phone number.

xdf:Pager	
Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The staff member's pager number

xdf:Fax	
Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The staff member's fax number

xdf:CellPhone	
Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The staff member's cell phone number.

xdf:Email	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The staff member's email address.

xdf:Specialty	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The staff member's specialty.

xdf:Title1	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form staff member title.

xdf:Title2	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form staff member title.

xdf:Title3	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form staff member title.

2.2.2.4 xdf:OpenXDF Entity

```
<xdf:OpenXDF xmlns:xdf="http://www.openxdf.org/xdf"
             xmlns:custom="organization/custom"
             xmlns:...
             >
  <!-- Level 1 Information -->
  <xdf:PatientInformation />
  <xdf:NoteLog />
  <xdf:Video />
</xdf:OpenXDF>
```

Figure 12 – xdf:OpenXDF Entity; Level 2

xdf:PatientInformation	
Data Type:	PatientInformation entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about the patient.

xdf:NoteLog	
Data Type:	List of Note entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a global list of annotations.

xdf:Video	
Data Type:	Video entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about associated video clips.

2.2.2.5 xdf:DataFile Entity

```
<xdf:DataFile>
  <!-- Level 1 Information -->
  <xdf:Montages />
  <xdf:RevMontages />
</xdf:DataFile>
```

Figure 13 – xdf:DataFile Entity; Level 2

xdf:Montages	
Data Type:	List of Montage entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of montages used during recording.

xdf:RevMontages	
Data Type:	List of Montage entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of display montages used during review. Unlike recording montages, it is generally acceptable to only keep the last used review montage.

2.2.2.6 xdf:Session Entity

```
<xdf:Session>
  <!-- Level 1 Information -->
  <xdf:SyncMarkers />
</xdf:Session>
```

Figure 14 – xdf:Session Entity; Level 2

xdf:SyncMarkers	
Data Type:	List of SyncMarker entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of data synchronization markers.

2.2.2.7 xdf:Montage Entity

```
<xdf:Montage>
  <xdf:EffectiveTime> 2008-07-15T22:00:00.250-04:00 </xdf:EffectiveTime>
  <xdf:Channels />
</xdf:Montage>
```

Figure 15 – xdf:Montage Entity

xdf:EffectiveTime	
Data Type:	Date/Time
Cardinality:	Required
Default:	No default
Description:	The date and time at which the montage took effect.

xdf:Channels	
Data Type:	List of Channel entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of channels.

2.2.2.8 xdf:Channel Entity

```
<xdf:Channel>
  <xdf:G1> C3 </xdf:G1>
  <xdf:G2> A2 </xdf:G2>
  <xdf:Label> C3/A2 </xdf:Label>
  <xdf:Sensitivity> 7 </xdf:Sensitivity>
  <xdf:HF> 0.531 </xdf:HF>
  <xdf:LF> 35 </xdf:LF>
</xdf:Channel>
```

Figure 16 – xdf:Channel Entity; Level 2

xdf:G1

Data Type:	Text
Cardinality:	Optional
Default:	"GND"
Description:	Specifies the source to which systems shall reference G2.

xdf:G2

Data Type:	Text
Cardinality:	Optional
Default:	"GND"
Description:	Specifies the G2 source for the channel.

xdf:Label

Data Type:	Text
Cardinality:	Optional
Default:	The system shall choose a default label that includes the names of the sources specified by G1 and G2.
Description:	Specifies a label for the channel.

xdf:Sensitivity

Data Type:	Sensitivity
Cardinality:	Optional
Default:	0
Description:	Specifies the channel sensitivity.

xdf:LF

Data Type:	Low Frequency Filter
Cardinality:	Optional
Default:	0
Description:	Specifies the low frequency filter for the channel.

xdf:HF	
Data Type:	High Frequency Filter
Cardinality:	Optional
Default:	0
Description:	Specifies the high frequency filter for the channel.

2.2.2.9 xdf:PatientInformation Entity

```
<xdf:PatientInformation>
  <xdf:FirstName> Tim </xdf:FirstName>
  <xdf:LastName> Newnan </xdf:LastName>
  <xdf:MiddleName> John </xdf:MiddleName>
  <xdf:ID> 111-22-3333 </xdf:ID>
  <xdf:DOB> 1979-04-22 </xdf:DOB>
  <xdf:Gender> male </xdf:Gender>
  <xdf:Weight> 200 </xdf:Weight>
  <xdf:WeightUnits> lb </xdf:WeightUnits>
  <xdf:Height> 71 </xdf:Height>
  <xdf:HeightUnits> in </xdf:HeightUnits>
  <xdf:DominantHand> right </xdf:DominantHand>
  <xdf:Street> 111 Magnolia Place </xdf:Street>
  <xdf:City> Gainesville </xdf:City>
  <xdf:State> FL </xdf:State>
  <xdf:Country> United States </xdf:Country>
  <xdf:ZipCode> 32608 </xdf:ZipCode>
  <xdf:HomePhone> 1|352|555-0001 </xdf:HomePhone>
  <xdf:WorkPhone> 1|352|555-0002|312 </xdf:WorkPhone>
  <xdf:EmergPhone />
  <xdf:Fax />
  <xdf:Pager />
  <xdf:CellPhone />
  <xdf:Email />
  <xdf:Codes> 327.23, 333.94 </xdf:Codes>
  <xdf:Comments> This is a comment. </xdf:Comments>
  <xdf:TestDescription> Tested for sleep disorders. </xdf:TestDescription>
  <xdf:Medication> Ambien, Coumadin </xdf:Medication>
  <xdf:Interpretation> Patient had abnormal sleep. </xdf:Interpretation>
  <xdf:Recommendations> Patient needs CPAP. </xdf:Recommendations>
  <xdf:FollowupPlans> Will followup with CPAP study. </xdf:FollowupPlans>
  <xdf:PatientOpinion> Patient concerned about CPAP tolerance. </xdf:PatientOpinion>
  <xdf:Physician />
  <xdf:Technician />
  <xdf:Referring />
  <xdf:Ordering />
  <xdf:Reading />
</xdf:PatientInformation>
```

Figure 17 – xdf:PatientInformation Entity

xdf:FirstName	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient's first name.

xdf:LastName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient's last name.

xdf:MiddleName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient's middle name.

xdf:ID

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient's organizational ID.

xdf:DOB

Data Type:	Date
Cardinality:	Optional
Default:	No default
Description:	The patient's date of birth.

xdf:Gender

Data Type:	Gender
Cardinality:	Optional
Default:	No default
Description:	The patient's gender.

xdf:Weight

Data Type:	Floating-point
Cardinality:	Optional
Default:	0.0
Description:	The patient's weight.

xdf:WeightUnits

Data Type:	Weight Unit
Cardinality:	Optional
Default:	"lb"
Description:	Weight measurement unit.

xdf:Height

Data Type:	Floating-point
Cardinality:	Optional
Default:	0.0
Description:	The patient's height.

xdf:HeightUnits

Data Type:	Height Unit
Cardinality:	Optional
Default:	“in”
Description:	Height measurement unit.

xdf:DominantHand

Data Type:	Dominant Hand
Cardinality:	Optional
Default:	No default
Description:	The patient’s dominant hand.

xdf:Street

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient’s street address.

xdf:City

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient’s city of residence.

xdf:State

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient’s state of residence.

xdf:Country

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient’s country of residence.

xdf:ZipCode

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient’s postal code.

xdf:HomePhone

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The patient’s home phone number.

xdf:WorkPhone

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The patient's work phone number.

xdf:EmergPhone

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The patient's emergency contact phone number.

xdf:Fax

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The patient's fax number.

xdf:Pager

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The patient's pager number

xdf:CellPhone

Data Type:	Phone Number
Cardinality:	Optional
Default:	No default
Description:	The patient's cell phone number.

xdf:Email

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The patient's email address.

xdf:Codes

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Defines a comma-separated list of diagnosis codes.

xdf:Comment

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form comment.

xdf:TestDescription

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form description of the test.

xdf:Medication

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Defines a comma-separated list of medications.

xdf:Interpretation

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form interpretation of the test.

xdf:Recommendation

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form recommendations

xdf:FollowupPlans

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form follow-up plans

xdf:PatientOpinion

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form patient opinion about the test.

xdf:Physician

Data Type:	Staff entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about the patient's primary physician.

xdf:Technician

Data Type:	Staff entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about the technician that ran the test.

xdf:Referring	
Data Type:	Staff entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about the patient's referring physician.

xdf:Ordering	
Data Type:	Staff entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about the physician that ordered the test.

xdf:Reading	
Data Type:	Staff entity
Cardinality:	Optional
Default:	No default
Description:	Specifies information about the physician that read the test.

2.2.2.10 xdf:Note Entity

```
<xdf:Note>
  <!-- Instantaneous Event Information -->
  <xdf:NoteText> Lights-out </xdf:NoteText>
</xdf:Note>
```

Figure 18 – xdf:Note Entity

xdf:NoteText	
Data Type:	Text
Cardinality:	Required
Default:	No default
Description:	Free-form annotation.

2.2.2.11 xdf:Video Entity

```
<xdf:Video>
  <xdf:VideoClips />
  <xdf:NoteLog />
</xdf:Video>
```

Figure 19 – xdf:Video Entity

xdf:VideoClips	
Data Type:	List of VideoClip entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of associated video clips.

xdf:NoteLog	
Data Type:	List of Note entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of video annotations.

2.2.2.12 xdf:VideoClip Entity

```
<xdf:VideoClip>
  <!-- Non-instantaneous Event Information -->
  <xdf:ClipFile> video/clip1.wmv </xdf:ClipFile>
  <xdf:ClipComment> Seizure Event </xdf:ClipComment>
</xdf:VideoClip>
```

Figure 20 – xdf:VideoClip Entity

xdf:ClipFile	
Data Type:	Text
Cardinality:	Required
Default:	No default
Description:	The video clip file name. To avoid path convention issues across platforms, systems should avoid absolute and/or complex paths such as UNC paths and URLs. Systems shall attempt to translate between Windows and POSIX conventions where possible.

xdf:ClipComment	
Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	Free-form comment.

2.2.2.13 xdf:SyncMarker Entity

```
<xdf:SyncMarker>
  <!-- Instantaneous Event Information -->
  <xdf:SyncDelta> 0.0012 </xdf:SyncDelta>
</xdf:SyncMarker>
```

Figure 21 – xdf:SyncMarker Entity

xdf:SyncDelta	
Data Type:	Floating-point
Cardinality:	Required
Default:	No default
Description:	Indicates acquisition device drift in seconds. A positive value indicates that the acquisition device was running faster than its nominal sampling rate. A negative value indicates that the acquisition device was running slower than its nominal sampling rate.

2.3 Level 3.PSG

2.3.1 System Requirements

A level 3.PSG compliant system shall adhere to all requirements in §2.2.1 and introduces the following requirements.

2.3.1.1 Packaging

Systems may package scoring results into secondary headers under a package directory named "scoring." The file names of the secondary headers may be arbitrary but shall be unique within the "scoring" directory. Each secondary header may contain one or more scorers; however, the scorer IDs shall be unique across all secondary headers in the package.

2.3.2 Header Requirements

A level 3.PSG compliant format shall adhere to all requirements in §2.2.2 and introduces the following requirements.

2.3.2.1 Respiratory Event

The *Respiratory Event* entity is the common basis for classified respiratory events.

```
<Respiratory Event>
  <!-- Non-instantaneous Event Information -->
  <xdf:Class> obstructive </xdf:Class>
</Respiratory Event>
```

Figure 22 – *Respiratory Event* Entity

xdf:Class	
Data Type:	Respiratory Class
Cardinality:	Required
Default:	No default
Description:	Specifies the respiratory event class.

2.3.2.2 xdf:OpenXDF Entity

```
<xdf:OpenXDF xmlns:xdf="http://www.openxdf.org/xdf"
             xmlns:custom="organization/custom"
             xmlns:...
             >
  <!-- Level 2 Information -->
  <xdf:ScoringResults />
</xdf:OpenXDF>
```

Figure 23 – xdf:OpenXDF Entity; Level 3.PSG

xdf:ScoringResults	
Data Type:	ScoringResults entity
Cardinality:	Optional
Default:	No default
Description:	Specifies scoring results.

2.3.2.3 xdf:Channel Entity

```
<xdf:Channel>
  <!-- Level 2 Information -->
  <xdf:Type> Pressure </xdf:Type>
</xdf:Channel>
```

Figure 24 – xdf:Channel Entity; Level 3.PSG

xdf:Type	
Data Type:	Channel Type
Cardinality:	Optional
Default:	No default
Description:	Channel type

2.3.2.4 xdf:ScoringResults Entity

```
<xdf:ScoringResults>
  <xdf:EpochInformation>
  <xdf:Scorers>
</xdf:ScoringResults>
```

Figure 25 – xdf:ScoringResults Entity

xdf:EpochInformation	
Data Type:	List of Epoch entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of scorer-independent epoch information.

xdf:Scorers	
Data Type:	List of Scorer entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of scorers.

2.3.2.5 xdf:Epoch Entity

```
<xdf:Epoch>
  <xdf:EpochNumber> 546 </xdf:EpochNumber>
</xdf:Epoch>
```

Figure 26 – xdf:Epoch Entity

xdf:EpochNumber	
Data Type:	UInt32
Cardinality:	Required
Default:	No default
Description:	Specifies the epoch number to which this information applies.

2.3.2.6 xdf:Scorer Entity

```
<xdf:Scorer>
  <xdf:ScorerID> 9BC7C81D-9D2D-4685-B08E-0B334F858299 </xdf:ScorerID>
  <xdf:FirstName> Alice </xdf:FirstName>
  <xdf:LastName> de Scorer </xdf:LastName>
  <xdf:SleepStages />
  <xdf:Apneas />
  <xdf:Hypopneas />
  <xdf:FlowLimitations />
  <xdf:Desaturations />
  <xdf:Microarousals />
  <xdf:Snores />
  <xdf:LegMovements1 />
  <xdf:LegMovements2 />
  <xdf:NoteLog />
</xdf:Scorer>
```

Figure 27 – xdf:Scorer Entity

xdf:ScorerID	
Data Type:	UUID
Cardinality:	Required
Default:	No default
Description:	Specifies a universally unique ID for the scorer.

xdf:FirstName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The scorer's first name.

xdf:LastName

Data Type:	Text
Cardinality:	Optional
Default:	No default
Description:	The scorer's last name.

xdf:SleepStages

Data Type:	List of SleepStage entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of sleep stages.

xdf:Apneas

Data Type:	List of Apnea entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of apneas.

xdf:Hypopneas

Data Type:	List of Hypopnea entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of hypopneas.

xdf:FlowLimitations

Data Type:	List of FlowLimitation entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of flow limitations.

xdf:Desaturations

Data Type:	List of Desaturation entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of O2 desaturations.

xdf:Microarousals

Data Type:	List of Microarousal entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of microarousals.

xdf:Snores	
Data Type:	List of Snore entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of snores.

xdf:LegMovements1	
Data Type:	List of LegMovement entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of leg movements on the first leg channel

xdf:LegMovements2	
Data Type:	List of LegMovement entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of leg movements on the second leg channel

xdf:NoteLog	
Data Type:	List of Note entities; [0, +∞)
Cardinality:	Optional
Default:	No default
Description:	Defines a list of scorer-dependent annotations.

2.3.2.7 xdf:SleepStage Entity

```
<xdf:SleepStage>
  <xdf:EpochNumber> 342 </xdf:EpochNumber>
  <xdf:Stage> R </xdf:Stage>
</xdf:SleepStage>
```

Figure 28 – xdf:SleepStage Entity

xdf:EpochNumber	
Data Type:	UInt32
Cardinality:	Required
Default:	No default
Description:	The epoch number to which this sleep stage applies.

xdf:Stage	
Data Type:	Sleep Stage
Cardinality:	Optional
Default:	"N"
Description:	Specifies the sleep stage for this epoch.

2.3.2.8 xdf:Apnea Entity

```
<xdf:Apnea>
  <!-- Respiratory Event Information -->
</xdf:Apnea>
```

Figure 29 – xdf:Apnea Entity

2.3.2.9 xdf:Hypopnea Entity

```
<xdf:Hypopnea>
  <!-- Respiratory Event Information -->
</xdf:Hypopnea>
```

Figure 30 – xdf:Hypopnea Entity

2.3.2.10 xdf:FlowLimitation Entity

```
<xdf:FlowLimitation>
  <!-- Respiratory Event Information -->
</xdf:FlowLimitation>
```

Figure 31 – xdf:FlowLimitation Entity

2.3.2.11 xdf:Desaturation Entity

```
<xdf:Desaturation>
  <!-- Non-instantaneous Event Information -->
</xdf:Desaturation>
```

Figure 32 – xdf:Desaturation Entity

2.3.2.12 xdf:Microarousal Entity

```
<xdf:Microarousal>
  <!-- Non-instantaneous Event Information -->
</xdf:Microarousal>
```

Figure 33 – xdf:Microarousal Entity

2.3.2.13 xdf:Snore Entity

```
<xdf:Snore>
  <!-- Non-instantaneous Event Information -->
</xdf:Snore>
```

Figure 34 – xdf:Snore Entity

2.3.2.14 xdf:LegMovement Entity

```
<xdf:LegMovement>
  <!-- Non-instantaneous Event Information -->
</xdf:LegMovement>
```

Figure 35 – xdf:LegMovement Entity

3 Data Types

3.1.1 Fundamental Data Types

Type	Range
Boolean	{ “true”, “false” }
(S/U)Int8	(S)igned/(U)nsigned 8 bits
(S/U)Int16	(S)igned/(U)nsigned 16 bits
(S/U)Int32	(S)igned/(U)nsigned 32 bits
(S/U)Int64	(S)igned/(U)nsigned 64 bits
Floating-point	Platform specific.

3.1.2 Endian Type

The Endian type describes the byte order of a multi-byte value. Little endian values proceed from the least-significant byte to the most significant, whereas big endian values proceed from the most-significant byte to the least significant. The Endian type may be one of the following values:

“big”	“little”

3.1.3 Date/Time Type

A date/time value shall adhere to the following subset of ISO 8601.

A time shall be qualified with a date; however, a date does not have to include a time. If a date does not include a time, the time shall default to 00:00:00 UTC.

Dates always include four-digit years and leading zeros on the month and day. A dash (“-”) separates the year, month, and day.

Systems shall pay particular attention to the ability to represent arbitrary dates using ISO 8601. Systems may not rely on an internal date/time representation that uses a starting epoch or is limited in range to the near future.

A date and the character “T” shall precede time values. Systems shall always specify time values in 24-hour format with leading zeros on the hour, minute, and second. Fractions of a second may be expressed using a decimal point (“.”) after the seconds. A colon (“:”) separates the hour, minute, and second.

Systems shall support up to one microsecond precision.

Time zone offsets start with “+” or “-” character followed by the offset in hours and minutes with leading zeros and separated by a “:”. Using “Z” instead of a time zone offset indicates Coordinated Universal Time (UTC). If a time does not include either an offset or a “Z” character, the time zone shall default to UTC.

```
“2008-07-15” ..............................00:00:00 +000 ms AM UTC, July 15, 2008
“2008-07-15T22:00:00.000250” ..............10:00:00 +250 us PM UTC, July 15, 2008
“2008-07-15T22:00:00.000250Z” .............10:00:00 +250 us PM UTC, July 15, 2008
“2008-07-15T22:00:00.250-04:00” ...........10:00:00 +250 ms PM EDT/CST, July 15, 2008
```

Figure 36 – Example Date/Time Values

3.1.4 Sensitivity Type

Traditionally, this value would specify the sensitivity in uV / mm. Systems shall interpret this value as simply a divider. A sensitivity of zero indicates that the system should zero the channel.

Systems shall support the following values typically used in PSG and EEG studies:

0	1	2
3	5	7
10	15	20
30	40	50
75	80	100
150	200	

3.1.5 Low Frequency Filter Type

Systems shall support the following low frequency cutoffs (in Hz) typically used in PSG and EEG studies and specified by the AASM:

0.032	0.053	0.1
0.159	0.3	0.531
1.592	5.305	10
15.916	53.052	

Some of these values represent the typical set of low-frequency filter time constants, which are: 5s, 3s, 1s, 0.3s, 0.1s, 0.03s, and 0.003s.

$$\tau = \frac{1}{2 \cdot \pi \cdot f_{cutoff}}$$

Figure 37 – Time Constant / Cutoff Frequency Relationship

3.1.6 High Frequency Filter Type

Systems shall support the following high frequency cutoffs (in Hz) typically used in PSG and EEG studies:

15	30	35
60	70	100

3.1.7 Gender Type

Gender may be one of the following values:

“male”	“female”

3.1.8 Weight Unit Type

The weight unit may be one of the following values:

“lb”	“kg”

3.1.9 Height Unit Type

The height unit may be one of the following values:

“in”	“cm”

3.1.10 Dominant Hand Type

The dominant hand may be one of the following values:

“left”	“right”

3.1.11 Phone Number Type

The phone number type is a text value that contains the country code, area code, subscriber number, and extension separated by the pipe (“|”) character.

```
“1|352|555-0000|312” ......................+1 (352) 555-0000 x312
“39|06|12345678|312” .......................+39 06 12345678 x312
“44|20|12345678|312” .......................+44 20 12345678 x312
```

Figure 38 – Example Phone Numbers

3.1.12 UUID Type

The UUID type is a Universally Unique Identifier that adheres to RFC 4122.

```
“9BC7C81D-9D2D-4685-B08E-0B334F858299”
“873491BA-5A2C-407F-B608-A02DA601D076”
“B63CA4D8-F74F-4DD3-A9A3-82E0D1E4F517”
```

Figure 39 – Example UUIDs

3.1.13 Channel Type

The channel type serves two purposes. First, it indicates where reading systems should display each type of event. Second, it serves as a hint for computer scoring system as to how the system should interpret the channel. The channel type may be one of the following values:

“Central”	“Occipital”	“Frontal”
“EOG1”	“EOG2”	“EKG1”
“EKG2”	“EKG3”	“Chin”
“Leg1”	“Leg2”	“Therm.” (Thermister)
“Press.” (Pressure Transducer)	“C.Flow” (CPAP Flow)	“Chest” (Chest Effort)
“Abdomen” (Abdominal Effort)	“SaO2”	“Snore”
“Body” (Body Position)	“Pulse”	“EtCO2”
“RR” (R-to-R Interval)	“pH”	“BP” (Blood Pressure)
“PTT” (Pulse Transit Time)	“CPAP” (CPAP Pressure)	

Reading systems should display events according to the following rules:

Event Type	Channel Type

Apneas	Systems should display apneas on the Thermister channel. If a Thermister channel is not present in the montage, systems may display apneas on the Pressure channel if present.
Hypopneas	Systems should display hypopneas on the Pressure channel. If a Pressure channel is not present in the montage, systems may display hypopneas on the Thermister channel if present.
Flow Limitations	Systems should display flow limitations on the Chest channel.
Leg Movements	Systems should display leg movements on either the Leg1 or Leg2 channel depending on the leg movement list in which the event exists (xdf:LegMovements1 or xdf:LegMovements2).
Snores	Systems should display snores on the Snore channel.
Desaturations	Systems should display desaturations on the SaO2 channel.
Microarousals	Systems should display microarousals on any available EEG or EOG channel (Central, Occipital, Frontal, EOG1, or EOG2).

3.1.14 **Sleep Stage Type**

The sleep stage type may be one of the following values:

"1" / Stage 1 or AASM N1	"2" / Stage 2 or AASM N2	"3" / Stage 3 or AASM N3
"4" / Stage 4 or AASM N3	"R" / REM	"A" / Infant Active
"T" / Infant Transitional	"Q" / Infant Quiet	"W" / Wake
"M" / Movement	"L" / Lights-on	"TR" / Tech-in-Room
"N" / No-data	"NR" / AASM Infant Non-REM	

3.1.15 **Respiratory Class Type**

The respiratory class may be one of the following values:

"obstructive"	"mixed"	"central"

4 Putting It All Together: A Full Example

```
<?xml version="1.0" encoding="utf-8" ?>
<xdf:OpenXDF  xmlns:xdf="http://www.openxdf.org/xdf"
              xmlns:custom="http://www.example.org/custom">
  <xdf:EpochLength> 30 </xdf:EpochLength>
  <xdf:SessionContinuity> false </xdf:SessionContinuity>
  <xdf:PatientInformation>
    <xdf:FirstName> Tim </xdf:FirstName>
    <xdf:MiddleName> John </xdf:MiddleName>
    <xdf:LastName> Newnan </xdf:LastName>
    <xdf:ID> 111-22-3333 </xdf:ID>
    <xdf:DOB> 1979-04-22 </xdf:DOB>
    <xdf:Gender> male </xdf:Gender>
    <xdf:Weight> 200 </xdf:Weight>
    <xdf:WeightUnits> lb </xdf:WeightUnits>
    <xdf:Height> 71 </xdf:Height>
    <xdf:HeightUnits> in </xdf:HeightUnits>
    <xdf:DominantHand> right </xdf:DominantHand>
    <xdf:Street> 111 Magnolia Place </xdf:Street>
    <xdf:City> Gainesville </xdf:City>
    <xdf:State> FL </xdf:State>
    <xdf:Country> United States </xdf:Country>
    <xdf:ZipCode> 32608 </xdf:ZipCode>
    <xdf:HomePhone> 1|352|555-0001 </xdf:HomePhone>
    <xdf:WorkPhone> 1|352|555-0002|313 </xdf:WorkPhone>
    <xdf:EmergPhone />
    <xdf:Fax />
    <xdf:Pager />
    <xdf:CellPhone />
    <xdf:Email />
    <xdf:Codes> 327.23, 333.94 </xdf:Codes>
    <xdf:Comment> This is a comment. </xdf:Comment>
    <xdf:TestDescription> Tested for sleep disorders. </xdf:TestDescription>
    <xdf:Medication> Ambien, Coumadin </xdf:TestDescription>
    <xdf:Interpretation> Patient had abnormal sleep. </xdf:Interpretation>
    <xdf:Recommendation> Patient needs CPAP. </xdf:Recommendation>
    <xdf:FollowupPlans> Will followup with CPAP study. </xdf:FollowupPlans>
    <xdf:PatientOpinion> Patient concerned about CPAP tolerance. </xdf:PatientOpinion>
    <xdf:Physician />
    <xdf:Technician>
      <xdf:FirstName> Joe </xdf:FirstName>
      <xdf:MiddleName> Bob </xdf:MiddleName>
      <xdf:LastName> Technician </xdf:LastName>
      <xdf:ID> 1515 </xdf:ID>
      <xdf:WorkPhone> 1|352|555-0000|312 </xdf:WorkPhone>
      <xdf:Pager />
      <xdf:Fax />
      <xdf:CellPhone />
```

```
      <xdf:Email> joebob@sleeplab.com </xdf:Email>
      <xdf:Specialty />
      <xdf:Title1> RPSGT </xdf:Title1>
      <xdf:Title2 />
      <xdf:Title3 />
    </xdf:Technician>
    <xdf:Referring />
    <xdf:Ordering />
    <xdf:Reading />
  </xdf:PatientInformation>
  <xdf:NoteLog>
    <xdf:Note>
      <xdf:Time> 2008-07-15T22:05:00.123-04:00 </xdf:Time>
      <xdf:NoteText> Lights-out </xdf:NoteText>
    </xdf:Note>
    <xdf:Note>
      <xdf:Time> 2008-07-15T22:15:00.639-04:00 </xdf:Time>
      <xdf:NoteText> Lights-on </xdf:NoteText>
    </xdf:Note>
  </xdf:NoteLog>
  <xdf:Video>
    <xdf:VideoClips>
      <xdf:VideoClip>
        <xdf:Time> 2008-07-15T22:00:00.250-04:00 </xdf:Time>
        <xdf:Duration> 20 </xdf:Duration>
        <xdf:ClipFile> video/clip1.wmv </xdf:ClipFile>
        <xdf:ClipComment> Seizure Event </xdf:ClipComment>
      </xdf:VideoClip>
    </xdf:VideoClips>
    <xdf:NoteLog />
  </xdf:Video>
  <xdf:DataFiles>
    <xdf:DataFile>
      <xdf:File> EXAMPLE.RAWDATA </xdf:File>
      <xdf:FrameLength> 1 </xdf:FrameLength>
      <xdf:Endian> big </xdf:Endian>
      <xdf:Sources>
        <xdf:Source>
          <xdf:Ignore> false </xdf:Ignore>
          <xdf:SourceName> C3 </xdf:SourceName>
          <xdf:SampleWidth> 2 </xdf:SampleWidth>
          <xdf:Signed> true </xdf:Signed>
          <xdf:SampleFrequency> 1000 </xdf:SampleFrequency>
          <xdf:DigitalMax> 32767 </xdf:DigitalMax>
          <xdf:DigitalMin> -32768 </xdf:DigitalMin>
          <xdf:PhysicalMax> 3200 </xdf:PhysicalMax>
          <xdf:PhysicalMin> -3200 </xdf:PhysicalMin>
          <xdf:DigitalToVolts> 0.09765774 </xdf:DigitalToVolts>
```

```
      <xdf:Unit> 0.000001 </xdf:Unit>
    </xdf:Source>
    <xdf:Source>
      <xdf:Ignore> false </xdf:Ignore>
      <xdf:SourceName> C4 </xdf:SourceName>
      <xdf:SampleWidth> 2 </xdf:SampleWidth>
      <xdf:Signed> true </xdf:Signed>
      <xdf:SampleFrequency> 1000 </xdf:SampleFrequency>
      <xdf:DigitalMax> 32767 </xdf:DigitalMax>
      <xdf:DigitalMin> -32768 </xdf:DigitalMin>
      <xdf:PhysicalMax> 3200 </xdf:PhysicalMax>
      <xdf:PhysicalMin> -3200 </xdf:PhysicalMin>
      <xdf:DigitalToVolts> 0.09765774 </xdf:DigitalToVolts>
      <xdf:Unit> 0.000001 </xdf:Unit>
    </xdf:Source>
    <xdf:Source>
      <xdf:Ignore> false </xdf:Ignore>
      <xdf:SourceName> A1 </xdf:SourceName>
      <xdf:SampleWidth> 2 </xdf:SampleWidth>
      <xdf:Signed> true </xdf:Signed>
      <xdf:SampleFrequency> 1000 </xdf:SampleFrequency>
      <xdf:DigitalMax> 32767 </xdf:DigitalMax>
      <xdf:DigitalMin> -32768 </xdf:DigitalMin>
      <xdf:PhysicalMax> 3200 </xdf:PhysicalMax>
      <xdf:PhysicalMin> -3200 </xdf:PhysicalMin>
      <xdf:DigitalToVolts> 0.09765774 </xdf:DigitalToVolts>
      <xdf:Unit> 0.000001 </xdf:Unit>
    </xdf:Source>
    <xdf:Source>
      <xdf:Ignore> false </xdf:Ignore>
      <xdf:SourceName> Pressure </xdf:SourceName>
      <xdf:SampleWidth> 2 </xdf:SampleWidth>
      <xdf:Signed> true </xdf:Signed>
      <xdf:SampleFrequency> 1000 </xdf:SampleFrequency>
      <xdf:DigitalMax> 32767 </xdf:DigitalMax>
      <xdf:DigitalMin> -32768 </xdf:DigitalMin>
      <xdf:PhysicalMax> 3200 </xdf:PhysicalMax>
      <xdf:PhysicalMin> -3200 </xdf:PhysicalMin>
      <xdf:DigitalToVolts> 0.09765774 </xdf:DigitalToVolts>
      <xdf:Unit> 0.000001 </xdf:Unit>
    </xdf:Source>
    <xdf:Source>
      <xdf:Ignore> false </xdf:Ignore>
      <xdf:SourceName> SaO2 </xdf:SourceName>
      <xdf:SampleWidth> 1 </xdf:SampleWidth>
      <xdf:SampleFrequency> 1 </xdf:SampleFrequency>
      <xdf:DigitalMax> 100 </xdf:DigitalMax>
      <xdf:DigitalMin> 0 </xdf:DigitalMin>
```

```
        <xdf:PhysicalMax> 100 </xdf:PhysicalMax>
        <xdf:PhysicalMin> 0 </xdf:PhysicalMin>
        <xdf:DigitalToVolts> 0.01 </xdf:DigitalToVolts>
      </xdf:Source>
    </xdf:Sources>
    <xdf:Sessions>
      <xdf:Session>
        <xdf:Offset> 1000 </xdf:Offset>
        <xdf:Length> 9601200 </xdf:Length>
        <xdf:StartTime> 2008-07-15T22:00:00.250-04:00 </xdf:StartTime>
        <xdf:SyncMarkers>
          <xdf:SyncMarker>
            <xdf:Time> 2008-07-15T22:00:10.250-04:00 </xdf:Time>
            <xdf:SyncDelta> 0.0012 </xdf:SyncDelta>
          </xdf:SyncMarker>
        </xdf:SyncMarkers>
      </xdf:Session>
    </xdf:Sessions>
    <xdf:Montages>
      <xdf:Montage>
        <xdf:EffectiveTime> 2008-07-15T22:00:00.250-04:00 </xdf:EffectiveTime>
        <xdf:Channels>
          <xdf:Channel>
            <xdf:G1 />
            <xdf:G2> C3 </xdf:G2>
            <xdf:Label> GND/C3 </xdf:Label>
            <xdf:Sensitivity> 7 </xdf:Sensitivity>
            <xdf:LF> 0.531 </xdf:LF>
            <xdf:HF> 35 </xdf:HF>
            <xdf:Type />
          </xdf:Channel>
          <xdf:Channel>
            <xdf:G1> C4 </xdf:G1>
            <xdf:G2> A1 </xdf:G2>
            <xdf:Label> A1/C4 </xdf:Label>
            <xdf:Sensitivity> 7 </xdf:Sensitivity>
            <xdf:LF> 0.531 </xdf:LF>
            <xdf:HF> 35 </xdf:HF>
            <xdf:Type> Central </xdf:Type>
          </xdf:Channel>
          <xdf:Channel>
            <xdf:G1 />
            <xdf:G2> Pressure </xdf:G2>
            <xdf:Label> GND/Pressure </xdf:Label>
            <xdf:Sensitivity> 7 </xdf:Sensitivity>
            <xdf:LF> 0.159 </xdf:LF>
            <xdf:HF> 15 </xdf:HF>
            <xdf:Type> Pressure </xdf:Type>
```

```
            </xdf:Channel>
            <xdf:Channel>
              <xdf:G2> SaO2 </xdf:G2>
              <xdf:Label> SaO2 </xdf:Label>
              <xdf:Sensitivity> 10 </xdf:Sensitivity>
              <xdf:LF />
              <xdf:HF />
              <xdf:Type> SaO2 </xdf:Type>
            </xdf:Channel>
          </xdf:Channels>
        </xdf:Montage>
      </xdf:Montages>
      <xdf:RevMontages />
    </xdf:DataFile>
  </xdf:DataFiles>
  <xdf:ScoringResults>
    <xdf:EpochInformation />
    <xdf:Scorers>
      <xdf:Scorer>
        <xdf:ScorerID> 9BC7C81D-9D2D-4685-B08E-0B334F858299 </xdf:ScorerID>
        <xdf:FirstName> Alice </xdf:FirstName>
        <xdf:LastName> de Scorer </xdf:LastName>
        <xdf:SleepStages>
          <xdf:SleepStage>
            <xdf:EpochNumber> 1 </xdf:EpochNumber>
            <xdf:Stage> W </xdf:Stage>
          </xdf:SleepStage>
          <xdf:SleepStage>
            <xdf:EpochNumber> 2 </xdf:EpochNumber>
            <xdf:Stage> 1 </xdf:Stage>
          </xdf:SleepStage>
          <xdf:SleepStage>
            <xdf:EpochNumber> 3 </xdf:EpochNumber>
            <xdf:Stage> 1 </xdf:Stage>
          </xdf:SleepStage>
          <xdf:SleepStage>
            <xdf:EpochNumber> 4 </xdf:EpochNumber>
            <xdf:Stage> R </xdf:Stage>
          </xdf:SleepStage>
        </xdf:SleepStages>
        <xdf:Apneas>
          <xdf:Apnea>
            <xdf:Time> 2008-07-15T22:14:32.543-04:00 </xdf:Time>
            <xdf:Duration> 10.8 </xdf:Duration>
            <xdf:Class> Obstructive </xdf:Class>
          </xdf:Apnea>
        </xdf:Apneas>
        <xdf:Hypopneas />
```

```
        <xdf:Desaturations />
        <xdf:Microarousals>
          <xdf:Microarousal>
            <xdf:Time> 2008-07-15T22:12:14.873-04:00 </xdf:Time>
          </xdf:Microarousal>
        <xdf:Snores />
        <xdf:LegMovements1 />
        <xdf:LegMovements2 />
        <xdf:FlowLimitations />
        <xdf:NoteLog />
        <custom:CustomSpikeEvents>
          <custom:CustomSpikeEvent>
            <xdf:Time> 2008-07-15T22:06:24.683124-04:00 </xdf:Time>
          </custom:CustomSpikeEvent>
        </custom:CustomSpikeEvents>
        <custom:CustomRespiratoryEvents>
          <custom:CustomRespiratoryEvent>
            <xdf:Time> 2008-07-15T22:10:00-04:00 </xdf:Time>
            <xdf:Duration> 15.2 </xdf:Duration>
            <custom:LowestSaO2> 82 </custom:LowestSaO2>
          </custom:CustomRespiratoryEvent>
        </custom:CustomRespiratoryEvents>
      </xdf:Scorer>
    </xdf:Scorers>
  </xdf:ScoringResults>
</xdf:OpenXDF>
```

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