# TECHNICAL SPECIFICATION

# ISO/TS 22077-5

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# Health informatics — Medical waveform format —

## Part 5:
## Neurophysiological signals



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# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 215, *Health informatics*.

A list of all parts in the ISO 22077 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.



 

# Introduction

Neurophysiological signals are used to monitor and assess an individual's brain activity for a wide array of clinical examinations including sleep polysomnography (PSG), determination of brain death, evoked potentials (EP), and electromyography (EMG).

Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain. It is typically non-invasive, with multiple electrodes placed along the scalp (see Figures B.1 and B.2). Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations (popularly called "brain waves") that can be observed in EEG signals. EEG is most often used to diagnose epilepsy, which causes abnormalities in EEG readings. It is also used to diagnose sleep disorders, coma, encephalopathies, and brain death.

PSG examinations include monitoring the condition of the body during sleep at night. Confirmed diagnosis of sleeping disorders and sleeping respiratory disorders is supported by recording neurophysiological signals through electrodes. By measuring brain waves, eye movements, electromyogram movements, etc., the depth of sleep (sleep stage), quality, presence or absence of midwake arousal, respiration by breathing, snoring, oxygen saturation, etc., can be assessed.

To correctly interpret neurophysiological changes, medical device systems need to capture these data, along with additional waveforms such as the respiration, SpO2, EOG (eye movement). Healthcare providers and clinical specialists who perform these examinations greatly benefit from interoperability – having all the examination data recorded in a single standardized package or file that can be safely and securely managed and exchanged.

The purpose of this document is to describe the heterogeneous neurophysiological waveforms and related data that can be normalized to a standard semantic representation and format and persisted in a single package. The specification also supports the time synchronization of these waveforms and related parametric data so that the clinician receiving the data package is able to better assess the patient's condition throughout the examination period.

**About Medical waveform Format Encoding Rules (MFER)**

The MFER standards address several challenges that are not limited to either EEG waveforms or the neurophysiological assessments that are the main subject of this document:

— **Simple and easy implementation:** application of MFER is very simple and is designed to facilitate understanding, easy installation, trouble-shooting, and low implementation cost.

— **Using with other appropriate standards:** it is recommended that MFER only describes medical waveforms. Other information can be described using appropriate standards such as HL7®[1)], DICOM®[2)], IEEE®[3)], etc. For example, clinical reports that include patient demographics, order information, medication, etc. are supported in other standards such as HL7® Clinical Document Architecture (CDA). By including references to MFER information in these documents, implementation for message exchange, networking, database management that includes waveform information becomes simple and easy.

— **Separation between supplier and consumer of medical waveforms:** the MFER specification concentrates on data format instead of paper-based recording. For example, recorded ECG/EEG are processed by filter, data alignment, and other parameters, so that the ECG waveform can be easily displayed using an application viewer. However, it is not as useful for other purposes such as data

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processing for research investigations. A design goal of MFER is that a waveform is described in raw format with as complete as possible recording detail. When the waveform is used, appropriate processing of the data are supported like filtering, view alignment and so on. In this way, the medical waveform described in MFER can be used for multiple purposes.

— **Product capabilities are not limited:** standards often support only a minimum set of requirements, so the expansion of product features can be greatly limited. MFER can describe medical waveform information without constraining the potential features of a product. Also, medical waveform display must be very flexible, and thus MFER has mechanisms supporting not only a machine-readable coded system for abstract data, but also human-readable representation.

The MFER specification supports both present and future product implementations. MFER supports the translation of stored waveform data that was encoded using other standards, enabling harmonization and interoperability. This capability supports not only existing waveform format standards but can be extended to support future formats as well.

# Health informatics — Medical waveform format —

# Part 5:
# Neurophysiological signals

## 1 Scope

This document specifies a heterogeneous format of neurophysiological waveform signals to support recording in a single persistent record package as well as interoperable exchange. The document focuses on electroencephalography (EEG) waveforms created during EEG examinations. Specific provision is made for sleep polysomnography examinations (PSG), brain death determination, evoked potentials (EP), and electromyography (EMG) studies.

This document is intended for neurophysiology.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 22077-1:2015, *Health informatics — Medical waveform format — Part 1: Encoding rules*

ISO/TS 22077-3:2015, *Health informatics — Medical waveform format — Part 3: Long term electrocardiography*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22077-1:2015 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

## 4 Symbols and abbreviated terms

| | |
|---|---|
| CO2 | Carbon dioxide |
| DC | Direct Current |
| DICOM | Digital Imaging and Communication in Medicine |
| ECG | Electrocardiography |
| EEG | Electroencephalography |
| EMG | Electromyography |
| EOG | Electrooculography |

| | |
|---|---|
| EP | Evoked potentials |
| HPF | High-frequency pass filter |
| IEEE | Institute of Electrical and Electronic Engineers |
| LOINC®[4)] | Logical Observation Identifiers Names and Codes |
| LPF | Low-frequency pass filter |
| MFER | Medical waveform Format Encoding Rules |
| PSG | Polysomnography |
| SEP | Somatosensory evoked potential |
| SNOMED-CT®[5)] | Systematized Nomenclature of Medicine-Clinical Terms |
| SpO2 | Saturation of peripheral oxygen |

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# 5 General

## 5.1 Overview of the rules

All MFER content (see ISO 22077-1:2015, 4.2.2), including the file header and waveform data, should be encoded based on the encoding rules that are composed of the tag, length and value (TLV), 3-tuple as shown in Figure 1.

| Tag (T) | Data length (L) | Value (V) |
|---|---|---|

**Figure 1 — Data unit**

- The tag (T) consists of one or more octets and indicates the attribute of the data value.
- The data length (L) is the length of data values indicated in one or more octets.
- The value (V) is contents which are indicated by tag (T); e.g. attribute definition, waveform data, etc.

In order to make effective use of this document, a MFER conformance statement is provided in Annex A and sample waveform description are provided in Annex C.

## 5.2 Configuration of waveform data

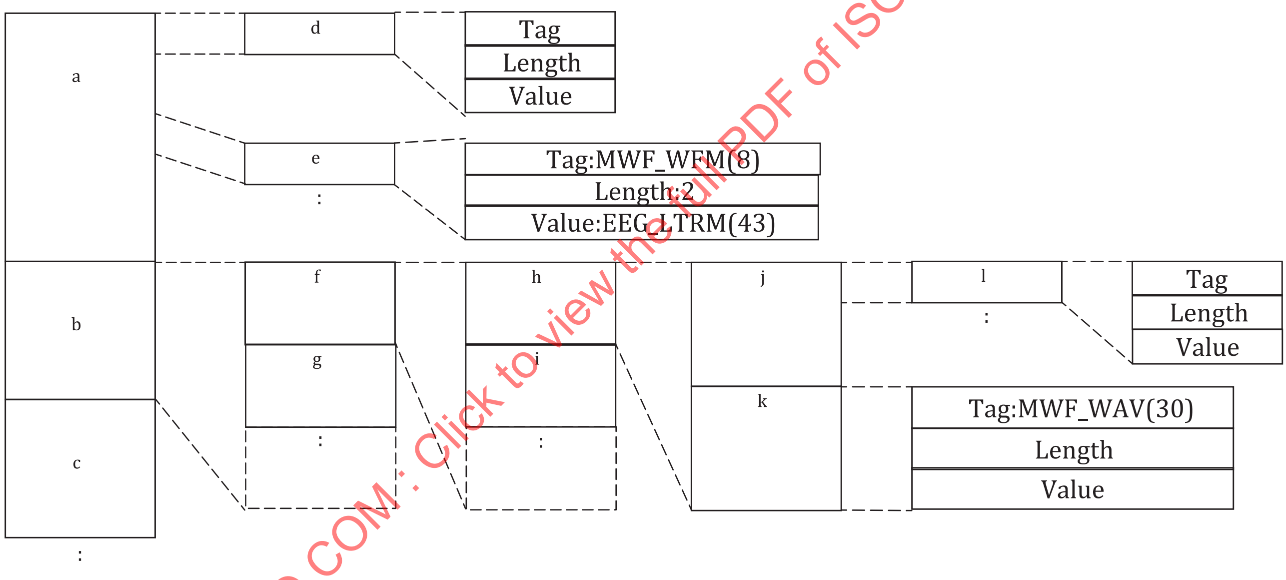
Medical waveform data described in accordance with the MFER is an aggregate of waveform frame data that consists of a header section (encoding detailed information about the waveform) and a waveform data section (main data of waveform). See Figure 2. The header and waveform data are encoded based on the encoding rules that are composed of TLV (Tag - Data length - Value). One MFER waveform file can include several waveforms. The content of an MFER waveform file is sequentially interpreted from the beginning of the file, and a single file can contain multiple waveform definitions. Given the sequential precedence processing for an MFER file, a waveform definition applies until another definition with the same tag is encountered. In this case, the subsequent definition replaces the preceding definition for the same waveform.

Additionally, the definition for one waveform can be used, by reference, to define additional waveforms in the MFER file. For example, a 60 channel EEG might only require four core waveform specifications, with the other channels referring to the same definition, providing simplification of the overall file complexity.

When there are several waveforms in a MFER waveform file, each waveform can be located anywhere in the file; however, in the specification of data generated during EEG and other examinations, waveform frames should be located as shown in Figure 2 to enhance usability and avoid erroneous interpretation:

— The information about EEG examination and others should be described before description of waveform [i.e. in (a) and (d) content should be included before (e)]. For this document, the waveform class definition(s) (MWF_WFM) are for neurophysiological signals and should be set to one of the appropriate values defined in Table 2.

— The same type waveforms should be described in a sequential, contiguous manner, and located chronologically in the file.




**Key**

a EEG examination
b waveform (type #1)
c waveform (type #2)
d Explanation about neurophysiological signals
e explanation (waveform class)
f waveform #1 of type #1
g waveform #2 of type #1
h frame #1 of waveform #1
i frame #2 of waveform #1
j header
k waveform data
l explanation about frame

**Figure 2 — Waveform data configuration**

## 5.3 Time synchronization

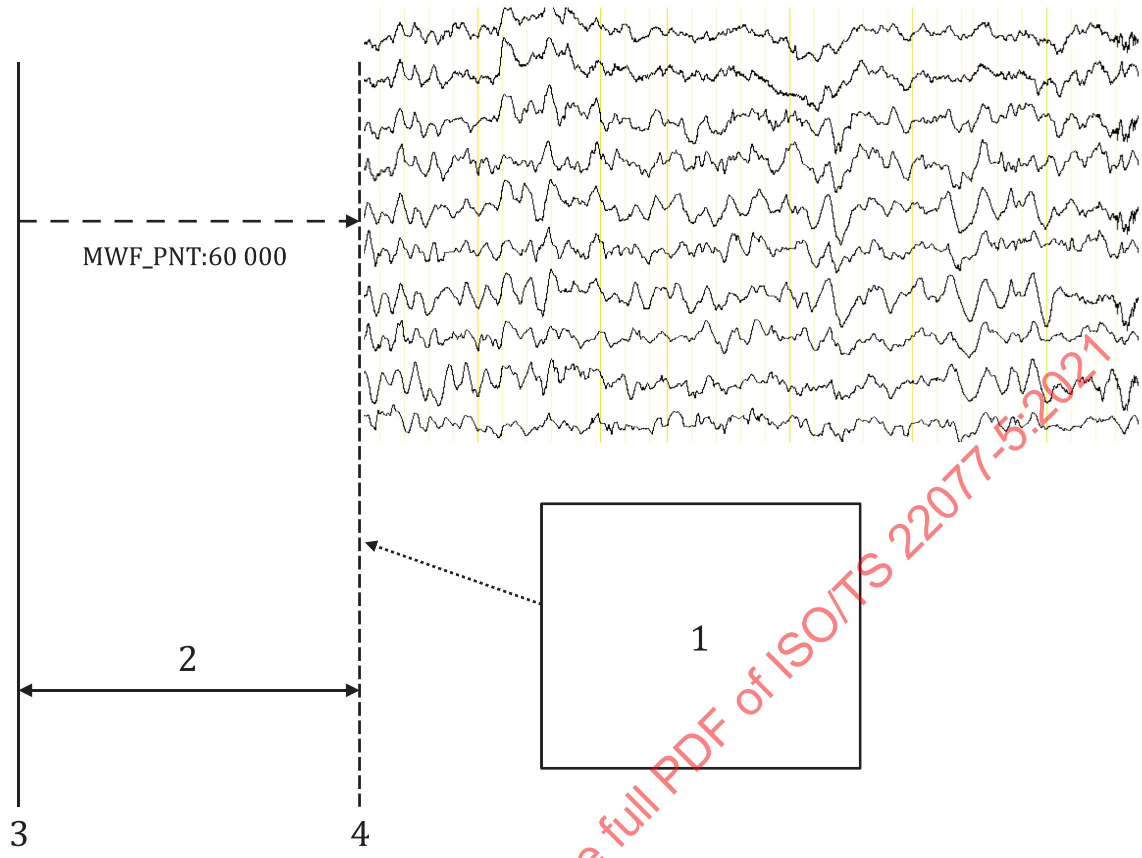
In EEG examination data, several types of neurophysiological signals and biomedical data, such as SpO2 or respiration may be described together in the same MFER file, requiring support for time synchronization between the waveform streams and these parametric observations. In addition, it is necessary to capture the state of the photic stimulator at the time the data was acquired.

NOTE For EEG examinations, photic stimulators are used to investigate anomalous brain activity triggered by specific visual stimuli, such as flashing lights or other patterns.

The reference time used for synchronization starts counting from the beginning of the examination period. The data recording system shall establish the reference time for each data point using the recorded examination time. The reading system can then establish synchronization between data points by correlating the acquisition time for each data point.

The reference time of waveforms such as EEGs are described using the pointer tag (MWF_PNT). The reference time of events such as photic stimulator information (stimulator period, frequency, mode, duration, etc.) is described using "starting time" item of the event tag (MWF_EVT). The reference time of measurements such as heart rate and respiration rate are described using the "time point" item of the value tag (MWF_VAL). Reference time is indicated as a data pointer that depends on the sampling rate of the waveform frame. The waveform reader system may also achieve data synchronization using pointers of different sampling rate.

For example, in Figure 3, if the sampling interval of a photic stimulator event is 1 second and the sampling interval of EEG waveform is 1 ms, then the point of photic stimulator event becomes 60 s and the point of EEG waveform becomes 60 000 samples at the time of the start of the photic stimulator.




**Key**

1 Event information
tag: MWF_EVT
code: <photic Stimulator>
starting time: 60 s

2 60 s

3 start of examination

4 stimulator begin

**Figure 3 — Time synchronization**



# 6 Waveform encoding

## 6.1 General

### 6.1.1 Application of EEG studies

This set of medical waveform format encoding rules (MFER) is aimed at ensuring that the waveforms collected during EEG studies, including PSG examinations, are encoded together with the needed contextual and descriptive information of the EEG examination. The waveforms recorded during EEG studies include “full disclosure waveform” (i.e. comprehensive continuous waveform data covering the entire period of the exam), and “intermittent record waveform” (i.e. waveform records in short segments of particular interest during the exam). Intermittent waveforms are also commonly described as, e.g. “one shot”, “window”, “snapshot”, “snippet”.

### 6.1.2 Full disclosure waveforms

This form is used when encoding all EEG waveforms during examinations, including the resting period, and the loading period such as photic stimulation. This not only includes encoding of waveform signals from all leads used in the examination but also encoding of a subset of waveforms selected from multiple leads. Note that for full disclosure waveform recording, encoding waveforms for the entire period of the examination within one frame (see Figure 2) significantly reduces the MFER file complexity and simplifies reading of the EEG content.

Encoding of full disclosure waveform shall be done in accordance with ISO 22077-1. The waveform class of these waveforms include EEG_REST (40), EEG_EP (41), EEG_LTRM (43) and others.

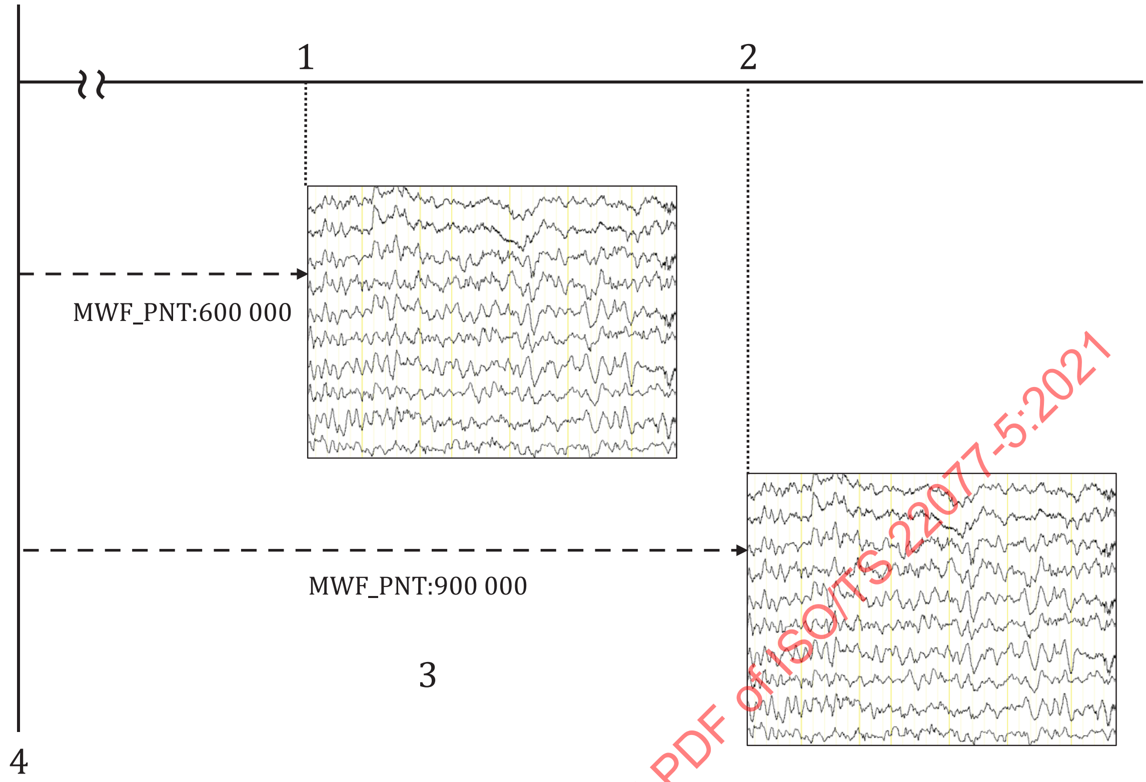
### 6.1.3 Intermittent record waveforms

Intermittent recording of waveforms is used when encoding the waveforms of EEG, etc., using interval records to capture shorter periods of interest during the examination such as resting, photic stimulation, hyperventilation periods or one-shot records taken at random during the examination.

The point of time when the record concerned was taken during the test shall be encoded with using the pointer tag (MWF_PNT).

For example, in Figure 4, if the sampling interval is 1 ms, then the point of information event (point #1) becomes 600 s and the point of EEG waveform becomes 600 000 samples at the time of the start of the examination.

Using the same sampling interval, the point of information event (point #2) becomes 900 s and the point of EEG waveform becomes 9 000 000 samples at the time of the start of the examination.




**Key**

1 600 s after examination starting

2 900 s after examination starting

3 sampling interval 1 ms

4 start of examination

**Figure 4 — Intermittent record waveform**



## 6.2 Waveform class

### 6.2.1 General

The waveform class indicates that this waveform data represents a neurophysiological signal. Furthermore, the waveform class indicates the kind of waveform that is included in the MFER data. The format is given in Table 1.

**Table 1 — Waveform class**

| MWF_WFM | | Data length | Default | Remarks | Duplicated definitions |
|---|---|---|---|---|---|
| 08 | 08h | 2 | Non-specific waveform | — | Override |
| | | Str ≤ 32 | Waveform description | — | Override |
| NOTE 1 See ISO 22077-1:2015, 5.1.3. | | | | | |
| NOTE 2 See ISO 22077-1:2015, 4.3.3.2 and 4.3.3.3. | | | | | |

### 6.2.2 Waveform Class for EEG, PSG, EP, EMG

#### 6.2.2.1 General

Each waveform class shall identify its Type based on Table 2 below.

**Table 2 — Classification of waveforms**

| Classification | Type | Value | Description | Remarks |
|---|---|---|---|---|
| Electrocardiography | ECG_LTERM | 2 | Long-term ECG | Holter ECG, monitoring ECG |
| Electroencephalography (Neurophysiological signal) | EEG_REST | 40 | Resting EEG | Includes surgical monitoring EEG |
| | EEG_EP | 41 | Evoked EEG | ABR<br>SEP |
| | EEG_CSA | 42 | Frequency analysis | Reserved for future use. |
| | EEG_LTRM | 43 | Long-term EEG | Sleeping EEG |
| | EMG | 44 | Electromyography | — |
| | EOG | 45 | Electrooculography | — |
| Respiratory | RESP | 46 | Respiratory | Impedance resitatory, air-flow, Snore asnd others |
| NOTE 1 See ISO 22077-1:2015, section 5.1.3 [Waveform for general waveform type definitions (40) through (43)]. | | | | |
| NOTE 2 EMG, EOG and RESP are uniquely defined in this document. | | | | |

The following subsections provide additional detail for each of the waveforms identified in Table 2, except those reserved for future use, such as EEG_CSA.

#### 6.2.2.2 EEG_REST, EEG_LTRM

Electroencephalography (EEG) is a diagnostic technique recording the electrical activity of the brain. Usually the electrodes are placed on the surface of the skull; special techniques use implanted electrodes as well (see Annex B).

EEG data are used to diagnose epilepsy, to monitor encephalopathy, for anaesthesia and coma state determination, and within sleep studies.

In clinical procedures, an EEG is typically is recorded for 20 minutes to 60 minutes using electrodes placed on the patient's scalp. Long term monitoring (e.g. to monitor epilepsy) may last from 6 hours to several days. In both cases, video and audio recordings are often made as well.

Electrical potentials are in the range of 1 µV to 500 µV.

In sleep medicine, polysomnography (PSG), also called a "sleep study", is an examination for diagnosing sleep disorders. EEG data captured during PSG examinations are used as the primary indicator for sleep stages, arousal, and wakefulness, but it is also used to aid in the diagnosis of parasomnia and nocturnal epilepsy. Additional physiological parameters are recorded during sleep in order to identify sleep stages, measure brain function, monitor respiratory control, and monitor patient movement and body position.

A polysomnography consists of several measured quantities, with the most relevant for this document:

— brain activity (EEG);

— eye movements (EOG);

— activity of skeletal muscles (EMG).

Additionally, some of the following parameters are recorded:

— electrical activity of the heart (ECG);

— changes in blood oxygen levels (pulse oximetry);

— respiratory parameters like nasal and oral airflow via pressure transducers in front of nostrils and mouth or chest and abdominal expansion during breathing (via belts);



— sound recordings to measure snoring.

Data acquisition is done via a multichannel recording unit which samples sensors attached to different parts of the patient's body. Study duration is typically up to 8 hours. Channel selection varies somewhat between labs.

In many cases a video is taken to show the person's movements during sleep, as well as audio recordings.

#### 6.2.2.3 EMG, EEG_EP

Electromyography (EMG) is a diagnostic technique recording the electrical activity of skeletal muscles. The electrical potential of the muscle cells changes on activation, due to a patient's movement or triggered by external stimulation. The data are used to detect neuromuscular abnormalities or to monitor muscular activity. In polysomnography, electromyography is used to measure the muscle tension and movement.

Two different techniques are used. Surface EMG assesses muscle function by recording electrical potentials from muscle at the skin surface. Intramuscular EMG uses needle electrodes inserted through the skin into the muscle, often in combination with surface electrodes as reference.

Within polysomnography, only surface EMG is used.

Measured values are in the range of 50 µV to 30 mV.

#### 6.2.2.4 EOG

Electrooculography (EOG) is a diagnostic technique to record eye movement, which is an important measure for classification of the sleep stage, for example slow-rolling eye movements in less deep sleep stages and rapid, irregular eye movements indicating the REM phase.

Typically, two electrodes are used to measure the eye movement. They are placed above or below the outer canthus of the eyes.

Measured values and sampling rates are approximately in the same range as EEG.

#### 6.2.2.5 RESP

Respiratory are parameters like nasal and oral airflow via pressure transducers in front of nostrils and mouth or chest and abdominal expansion during breathing (via belts).

## 6.3 Waveform attributes (lead names)

### 6.3.1 Waveform code

Lead name means the waveform code that is one of waveform attributes. The format is as in Table 3.



**Table 3 — Definition of waveform attributes**

| MWF_LDN | | | | Data length | Default | Remarks | Duplicated definitions |
|---|---|---|---|---|---|---|---|
| 09 | 09h | Waveform code | | 2 | undefined | Data length = 2,<br>if waveform information is encoded | Override |
| | | Waveform information | | Str ≤ 32 | | — | Override |

NOTE 1 See ISO 22077-1:2015, Table 11 for general specifications.

### 6.3.2 EEG

Since the EEG becomes bipolar, it is described as follows.

Generation of waveform codes by combination of electrodes (see Figure 5).

| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | – negative electrode (G1) | | | | | | + positive electrode (G2) | | | | | | | |

NOTE See ISO 22077-1:2015, Figure 8 for additional specifications.

**Figure 5 — Generation of waveform code by combination of electrodes**

Waveform codes can be generated by combination of electrode codes, as shown in Table 4 and Table 5. The electrode code is given in Annex B (additional specifications are in ISO 22077-1:2015, Table 14).

**Table 4 — Electrode code**

| Name | Abbreviation | Electrode code |
|---|---|---|
| Left front polar | FP1 | 12 |
| Right front polar | FP2 | 13 |
| Left ear | A1 | 74 |
| Right ear | A2 | 75 |

**Table 5 — Example of waveform code generation**

| Lead | – electrode | + electrode | Waveform code |
|---|---|---|---|
| FP1 - A1 | 12 | 74 | 17994(464A) |
| FP2 - A2 | 13 | 75 | 18123(46CB) |

### 6.3.3 PSG, EOG, EMG, EP, RESP

Waveform codes can be generated by parameters of PSG, EOG, EMG, EP, RESP as shown in Table 6.

**Table 6 — Waveform code**

| Code | Lead | Remarks |
|---|---|---|
| 31 | Pulse | — |
| 175 | SpO2 | — |
| 4161 | Body position | — |
| 4162 | Body movement | — |
| 4180 | Impedance respiratory | — |
| 4181 | Airflow | Nostril and Mouth Respiration |
| 4182 | Snore | — |
| 4183 | Rib Cage movement | — |
| 4184 | Abdominal movement | — |
| 4185 | Leg movement(Left) | — |
| 4186 | Leg movement(Right) | — |
| NOTE 1 See ISO 22077-1:2015, Tables 10 and 22 for additional electrode code specifications. | | |
| NOTE 2 Leads (4180) and following are newly defined in this document. | | |

**Table 6** *(continued)*

| Code | Lead | Remarks |
|---|---|---|
| 4187 | EMG1 | — |
| 4188 | EMG2 | — |
| 4189 | EMG3 | — |
| 4190 | EMG4 | — |
| 4191 | EOG(Left eye movement) | — |
| 4192 | EOG(Right eye movement) | — |
| 4193 | EOG3 | — |
| 4194 | EOG4 | — |
| 4195 | CO2 | — |
| 4196 | DC1 | DC input channel 1 |
| 4197 | DC2 | DC input channel 2 |
| 4198 | DC3 | DC input channel 3 |
| 4199 | DC4 | DC input channel 4 |

NOTE 1 See ISO 22077-1:2015, Tables 10 and 22 for additional electrode code specifications.

NOTE 2 Leads (4180) and following are newly defined in this document.



### 6.3.4 ECG

Encoding of ECG waveform attribute is done in accordance with the long-term ECG specification, ISO/TS 22077-3:2015, Annex D. Lead name means the waveform code used in long-term ECGs. This code shall be used in 12-lead ECG and/or Vector lead ECG. The lead code is encoded by the number 0 to 127 in Table 7.

Lead code later than 4160 is defined in the long-term ECG standard such as Table 8. For more detailed lead name other than the definition in the long-term ECG standard, see ISO/TS 22077-3.

**Table 7 — Lead name-1**

| Code | lead | Code | Lead |
|---|---|---|---|
| 1 | I | — | — |
| 2 | II | — | — |
| 3 | V1 | — | — |
| 4 | V2 | — | — |
| 5 | V3 | — | — |
| 6 | V4 | — | — |
| 7 | V5 | — | — |
| 8 | V6 | — | — |
| 9 | V7 | — | — |
| 10 | (V2R) [a] | — | — |
| 11 | V3R | 61 | III |
| 12 | V4R | 62 | aVR |
| 13 | V5R | 63 | aVL |
| 14 | V6R | 64 | aVF |

[a] Although V2R (10) is defined in other rules such as SCP-ECG, the definition shall not be used in MFER.

[b] -aVR lead shall not be encoded according to MFER. The users (viewer) should make a calculation to derive –aVR when required.

NOTE 1 See ISO/TS 22077-3:2015, Table 21.

**Table 7** *(continued)*

| Code | lead | Code | Lead |
|---|---|---|---|
| 15 | V7R | 65 | -aVR [b] |
| 16 | X | 66 | V8 |
| 17 | Y | 67 | V9 |
| 18 | Z | 68 | V8R |
| 19 | CC5 | 69 | V9R |
| 20 | CM5 | 70 | D(Nehb Dosal) |
| — | — | 71 | A(Nehb Anterior) |
| 31 | NASA | 72 | J(Nehb Inferior) |
| 32 | CB4 | — | — |
| 33 | CB5 | — | — |
| 34 | CB6 | 91 | MCL |

[a] Although V2R (10) is defined in other rules such as SCP-ECG, the definition shall not be used in MFER.

[b] -aVR lead shall not be encoded according to MFER. The users (viewer) should make a calculation to derive –aVR when required.

NOTE 1 See ISO/TS 22077-3:2015, Table 21.

**Table 8 — Lead name-2**

| Code | Lead | Remarks |
|---|---|---|
| 4166 | ECG1 | These shall be used in case lead name is not defined. |
| 4167 | ECG2 | |
| 4168 | ECG3 | |
| 4169 | ECG4 | |

NOTE 1 See ISO/TS 22077-3:2015, Table 22 for additional specifications.

## 6.4 Sampling attributes

### 6.4.1 General

"Sampling interval (MWF_IVL)" and "Sampling resolution (MWF_SEN)" should be described in accordance with ISO 22077-1. If multiple types of waveform are present, the sampling attributes described immediately before description of their waveform data are used. See 5.3 for additional use information.

### 6.4.2 MWF_IVL (0Bh): Sampling rate

This tag indicates the frequency or interval the medical waveform is sampled (see Table 9).

**Table 9 — Sampling rate**

| MWF_IVL | | | Data length | Default | Encoding range/re-marks | Duplicated definitions |
|---|---|---|---|---|---|---|
| 11 | 0Bh | Sampling rate unit | 1 | 1 000 Hz | - | Override |
| | | Exponent($10^{th}$ power) | 1 | | $10^{-128 \sim +127}$ | |
| | | Mantissa | ≤4 | | e.g. signed 16-bit integer | |

The unit can be frequency in Hertz, time in seconds or distance metres (see Table 10).

**Table 10 — Sampling rate unit**

| Unit | | Value | Remarks |
|---|---|---|---|
| Frequency | Hz | 0 | Including power |
| Time interval | s | 1 | — |
| Distance | m | 2 | — |

### 6.4.3 MWF_SEN (0Ch): Sampling resolution

This tag indicates the resolution of least significant bit, medical waveform sampled (generally, digitized) (see Table 11).

**Table 11 — Sampling resolution**

| MWF_SEN | | | Data length | Default | Encoding range/ remarks | Duplicated definitions |
|---|---|---|---|---|---|---|
| 12 | 0Ch | Sampling resolution unit | 1 | See Table 12 | | Override |
| | | Exponent($10^{th}$ power) | 1 | | $10^{-128\sim+127}$ | |
| | | Mantissa | ≤4 | | e.g. signed 16-bit integer | |

**Table 12 — Sampling units**

| Unit | | Value | Default | Remarks |
|---|---|---|---|---|
| Voltage | V | 0 | 0,000 001 V | — |
| Pressure | mm Hg(Torr) | 1 | — | — |
| | Pa | 2 | — | — |
| | cm $H_2O$ | 3 | — | — |
| | mm Hg/s | 4 | — | — |
| Ratio | % | 7 | — | Include volume fraction (%) |
| Flow rate, flow, volume | l | 19 | — | — |
| | l/s | 20 | — | — |
| | l/min | 21 | — | — |

Sampling attributes shall conform to ISO 22077-1:2015, Tables 2, 3, 4 and 5.

## 6.5 Frame attributes

"Data block length (MWF_BLK)", "Number of channels (MWF_CHN)" and "Number of sequences (MWF_SEQ)" should be described in accordance with ISO 22077-1. If multiple types of waveform are present, the frame attributes described immediately before description of their waveform data are used.

Frame attributes shall conform to ISO 22077-1:2015, Table 6.

## 6.6 Pointer

This tag indicates the waveform data pointer, which is represented by the sampling rate of the root level, in the frame. If no pointer is designated, the pointer of the first frame is initialized as zero. The pointer for the next frame is deemed to be a value adding the number of data length of the virtual root level channel in the previous frame.

Pointer references shall conform to ISO 22077-1:2015, Table 28.

In electrocardiogram test, the pointer can be used to indicate the position of waveform in the examination.



The format is provided in Table 13.

**Table 13 — Pointer**

| MWF_PNT | | Data length | Default | Remarks | Duplicated definitions |
|---|---|---|---|---|---|
| 07 | 07h | ≤4 | Zero or pointer of previous frame | — | Override |

## 6.7 Filter

"Filter information (MWF_FLT)" should be described in accordance with ISO 22077-1. Table 14 and Table 15 provide the format and some examples.

Filters shall conform to ISO/TS 22077-3:2015, Tables 26 and 27.

Neurophysiological signal often uses special filters to eliminate the influence of various artefacts during examination. Because some filters cause distortion or delay of neurophysiological signal waveform, a clear description of attenuation rate, delayed time, etc. is recommended if care is deemed necessary.

In electroencephalography, HPF and LPF have the following settings.

HPF: 0.001, 0.003, 0.03, 0.1, 0.3, 0.6, 1.0, 2.0, 5.0, 10 s

LPF:15, 30, 35, 60, 70, 120, 300, 600, 1 200, 3 000 Hz

**Table 14 — Filter information**

| MWF_FLT | | Data length | Default | Remarks | Duplicated definitions |
|---|---|---|---|---|---|
| 17 | 11h | Str ≤ 128 | unused | — | Possible |

**Table 15 — Filter description example**

| Filter function | Abbreviation | Example | Meaning |
|---|---|---|---|
| Filter information only | None | Hum filter ON | Hum filter (characteristics, etc. not specified). Combining line frequency information can provide specific filter information. |
| High-frequency pass filter | HPF | HPF=0,5^delay time=1 023 ms | Indefinite characteristics 0,5 Hz low frequency cut-off (high-pass) filter used.<br>Delay time is 1 023 ms. |
| Low-frequency pass filter | LPF | LPF=150^secondary Butterworth filter | Butterworth secondary characteristics 150 Hz high frequency cut-off (low-pass) filter used. |
| Band elimination filter | BEF | BEF=50^Hum filter | 50 Hz Hum filter used. Cut-off characteristics not known. |

# 7 Event information

## 7.1 General

The event information as EEG, PSG, EOG, EMG and EP should be described using with "Event (MWF_EVT)" and " Value (MWF_VAL)".

Event information shall conform to ISO 22077-1:2015, Table 32.

## 7.2 Measurement status – related events

Measurement status-related events such as photic stimulation and hyperventilation, etc. is described as event. The format is Table 16. Events include those listed in Table 17.

**Table 16 — Measurement-related events**

| MWF_EVT | | | Data length | Encoding range/Remarks | Duplicated definitions |
|---|---|---|---|---|---|
| 65 | 41h | Event code | 2 | See Table 17 | Multiple definitions available |
| | | Starting time (point) | 4 | Number of samples acquired at the sampling interval defined in the root definition. | |
| | | Duration | 4 | | |
| | | Event information | Str ≤ 256 | See Table 17 | |
| NOTE 1 See ISO 22077-1:2015, 4.3.3.2. | | | | | |

**Table 17 — Measurement-related event code**

| Reference ID | CODE | | Event | Explanation/ Event information |
|---|---|---|---|---|
| | DEC | HEX | | |
| MWF_CAL | 4701 | 125D | Calibration | — |
| MWF_EVENT1 | 4702 | 125E | Event1 | — |
| MWF_EVENT2 | 4703 | 125F | Event2 | — |
| MWF_PHOTO_STIM | 4704 | 1260 | Photic stimulation | — |
| MWF_HYPERVENT | 4705 | 1261 | Hyperventilation | — |
| MWF_IMP_CHECK | 4706 | 1262 | Skin-Electrode Impedance Check | — |
| MWF_RESET | 4707 | 1263 | Reset | — |
| MWF_EYES_OPEN | 4708 | 1264 | Eye open | — |
| MWF_EYES_CLOSED | 4709 | 1265 | Eye closed | — |
| MWF_EYE_MOVEMENT | 4710 | 1266 | Eye movement | — |
| MWF_BODY_MOVMENT | 4711 | 1267 | Body movement | — |
| MWF_EMG | 4712 | 1268 | EMG | — |
| MWF_ARTTIFACT | 4713 | 1269 | Artifact | — |
| MWF_NOISE | 4714 | 126A | Noise | — |
| MWV_WAKING | 4715 | 126B | Waking | — |
| MWF_APNEA | 4716 | 126C | Apnea | — |
| MWF_HYPOPNEA | 4717 | 126D | Hppopnea | — |
| MWF_NREM1 | 4718 | 126E | Stage1 Non-REM | See Reference [5] |
| MWF_NREM2 | 4719 | 126F | Stage2 Non-REM | |
| MWF_NREM3 | 4720 | 1270 | Stage3 Non-REM | |
| MWF_REM | 4721 | 1271 | Stage REM | |
| MWF_LIGHTS_ON | 4722 | 1272 | Turn on the lights in the room | — |
| MWF_LIGHTS_OFF | 4723 | 1273 | Turn off the lights in the room | — |
| NOTE 1 See ISO 22077-1:2015, Table 32 for additional specifications. | | | | |

# Annex A
(informative)

# MFER conformance statement

Each implementer should provide a specification sheet of their specific MFER waveform format as a conformance statement (Table A.1). Use of non-default values should be identified clearly. If the extension part of the MFER description is used, an additional sheet with other optional extensions should also be provided.

**Table A.1 — Conformance statement template**

| **MFER specification** | | | **Frame** | / | **Ver.** | | |
|---|---|---|---|---|---|---|---|
| Producer | Manufacturer | | Date | | Model | | |
| | Author | | Edited date | | | | |
| Waveform title | | | Specification | | | | |
| Preamble | | | Endianity | •Default(big endian) •Big endian •Little endian | | | |
| Version | .. | Character | | | | | |
| Sampling attributes | Sampling rate | Unit | | Exponent | | Mantissa | |
| | Sampling resolution | Unit | | Exponent | | Mantissa | |
| Data type | •Default •( ) | NULL | •Not used •( ) | Offset value | •Not used •( ) | | |
| Frame number | | Block | | Channel | | Sequence | |

| **Channel No.** | **Lead or Waveform** | **Condition** | **Remarks** |
|---|---|---|---|
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| Note | | | |
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# Annex B
(informative)

# EEG electrode code

## B.1 Electrode positioning

Small metal discs or electrodes that are placed on the scalp in specific positions in accordance to established positioning schemes. The manner in which pairs of electrodes are connected to each amplifier of the EEG machine is called a montage. Each montage will use one of three standard recording derivations:

**common reference** Each amplifier records the difference between a scalp electrode and a reference electrode. The same reference electrode is used for all channels. Electrodes frequently used as the reference electrode are A1, A2, the ear electrodes, or A1 and A2 linked together.

**average reference** Activity from all the electrodes are measured, summed together and averaged before being passed through a high value resistor. The resulting signal is then used as a reference electrode and connected to input 2 of each amplifier and is essentially inactive. All EEG systems will allow the user to choose which electrodes are to be included in this calculation.

**bipolar** These sequentially link electrodes together usually in straight lines from the front to the back of the head or transversely across the head. For example, the first amplifier can have electrodes FP1 and F3 connected to it and the second amplifier F3 and C3 connected to it.

The 10–20 system or International 10–20 system is an internationally recognized method to describe and apply the location of scalp electrodes in the context of an EEG examination, e.g. polysomnography (see Figure B.1). These positions are identified by the recordist who measures the head using the International 10/20 System. Electrode positioning relies on taking measurements between certain fixed points on the head. The electrodes are then placed at points that are 10 % and 20 % of these distances.

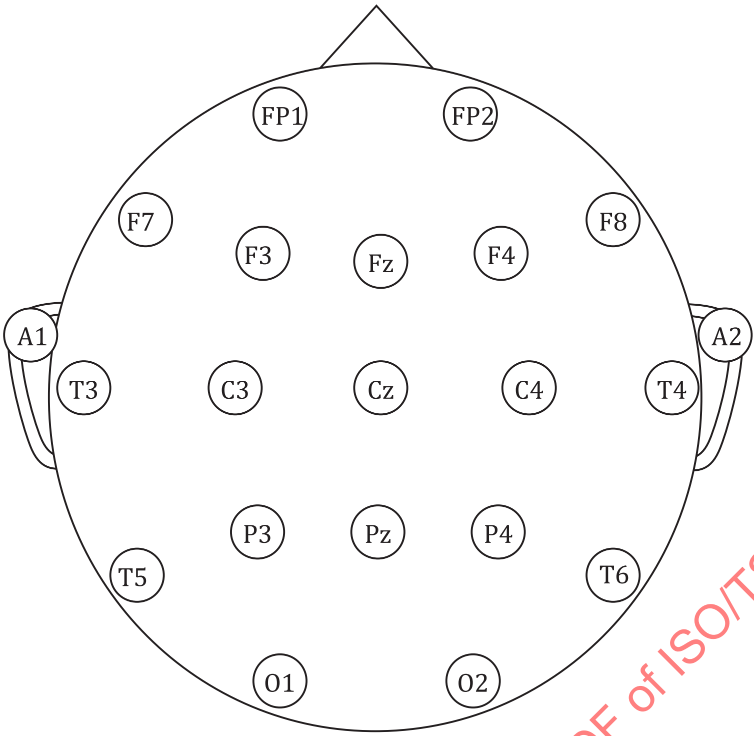


**Figure B.1 — The 10-20 system**

When recording a more detailed EEG with more electrodes, extra electrodes are added using the 10 % division, which fills in intermediate sites halfway between those of the existing 10–20 system (see Figure B.2).

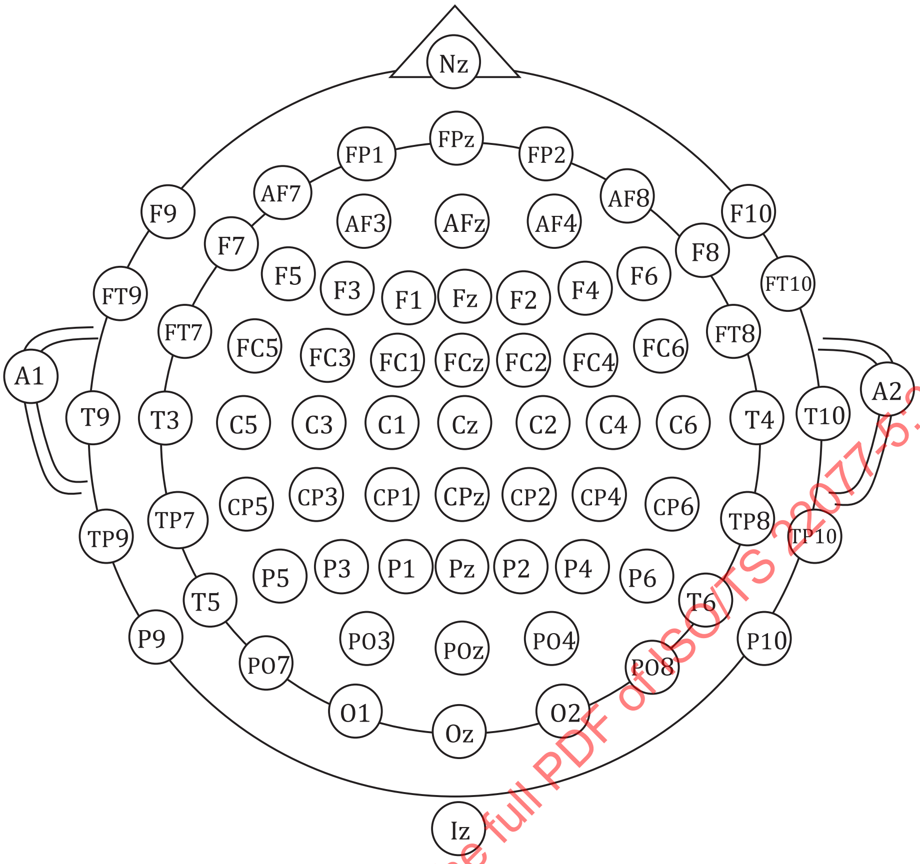


**Figure B.2 — Higher-resolution systems**

## B.2 Electrode code

The electrode code is given as Table B.1.

**Table B.1 — EEG electrode code names**

| Name | Abbreviation | Electrode code | IEEE 11073-10101 Part::Code |
|---|---|---|---|
| Undefined | U | 0 | |
| Nasion | Nz | 1 | 7::996 |
| Front polar | Fpz | 2 | 7::1000 |
| Anterior frontal | AFz | 3 | 7::1004 |
| Frontal | Fz | 4 | 7::1008 |
| Front central | FCz | 5 | 7::1012 |
| Central | Cz | 6 | 7::1016 |
| Centro parietal | CPz | 7 | 7::1020 |
| Parietal | Pz | 8 | 7::1024 |

NOTE 1 See Reference [4] for the related DICOM waveform specification.

NOTE 2 IEEE 11073-10101 is the most suitable mapping, while LOINC® or SNOMED-CT® can be added in the future as needed.

NOTE 3 According to ACNS (American Clinical Neurophysiology Society) Guideline 2, ACNS 2016 prefers T7 to T3, T8 to T4, P7 to T5, and P8 to T6. IEEE 11073-10101 is described as T3, T4, T5, and T6, the same as this standard. See Reference [6].

**Table B.1** *(continued)*

| Name | | Abbreviation | Electrode code | IEEE 11073-10101 Part::Code |
|---|---|---|---|---|
| Parieto-occipital | | POz | 9 | 7::1028 |
| Occipital | | Oz | 10 | 7::1032 |
| Inion | | Iz | 11 | 7::1036 |
| Front polar | Left | FP1 | 12 | 7::1041 |
| | Right | FP2 | 13 | 7::1042 |
| Frontal | Left | F1 | 14 | 7::1049 |
| | Right | F2 | 15 | 7::1054 |
| Front central | Left | FC1 | 16 | 7::1089 |
| | Right | FC2 | 17 | 7::1094 |
| Central | Left | C1 | 18 | 7::1129 |
| | Right | C2 | 19 | 7::1134 |
| Centro parietal | Left | CP1 | 20 | 7::1153 |
| | Right | CP2 | 21 | 7::1158 |
| Parietal | Left | P1 | 22 | 7::1177 |
| | Right | P2 | 23 | 7::1182 |
| Occipital | Left | O1 | 24 | 7::1209 |
| | Right | O2 | 25 | 7::1214 |
| Anterior frontal | Left | AF3 | 26 | 7::1217 |
| | Right | AF4 | 27 | 7::1222 |
| Frontal | Left | F3 | 28 | 7::1057 |
| | Right | F4 | 29 | 7::1062 |
| Front central | Left | FC3 | 30 | 7::1097 |
| | Right | FC4 | 31 | 7::1102 |
| Central | Left | C3 | 32 | 7::1137 |
| | Right | C4 | 33 | 7::1142 |
| Centro parietal | Left | CP3 | 34 | 7::1161 |
| | Right | CP4 | 35 | 7:1166 |
| Parietal | Left | P3 | 36 | 7::1185 |
| | Right | P4 | 37 | 7::1190 |
| Parieto-occipital | Left | PO3 | 38 | 7::1233 |
| | Right | PO4 | 39 | 7::1238 |
| Frontal | Left | F5 | 40 | 7::1065 |
| | Right | F6 | 41 | 7::1070 |
| Front central | Left | FC5 | 42 | 7::1105 |
| | Right | FC6 | 43 | 7::1110 |
| Central | Left | C5 | 44 | 7::1145 |
| | Right | C6 | 45 | 7::1150 |

NOTE 1 See Reference [4] for the related DICOM waveform specification.

NOTE 2 IEEE 11073-10101 is the most suitable mapping, while LOINC® or SNOMED-CT® can be added in the future as needed.

NOTE 3 According to ACNS (American Clinical Neurophysiology Society) Guideline 2, ACNS 2016 prefers T7 to T3, T8 to T4, P7 to T5, and P8 to T6. IEEE 11073-10101 is described as T3, T4, T5, and T6, the same as this standard. See Reference [6].

**Table B.1** *(continued)*

| Name | | Abbreviation | Electrode code | IEEE 11073-10101 Part::Code |
|---|---|---|---|---|
| Centro parietal | Left | CP5 | 46 | 7::1169 |
| | Right | CP6 | 47 | 7::1174 |
| Parietal | Left | P5 | 48 | 7::1193 |
| | Right | P6 | 49 | 7::1198 |
| Anterior frontal | Left | AF7 | 50 | 7::1225 |
| | Right | AF8 | 51 | 7::1230 |
| Frontal | Left | F7 | 52 | 7::1073 |
| | Right | F8 | 53 | 7::1078 |
| Front temporal | Left | FT7 | 54 | 7::1113 |
| | Right | FT8 | 55 | 7::1118 |
| Temporal | Left | T3 | 56 | 7::1249 |
| | Right | T4 | 57 | 7::1254 |
| Temporo parietal | Left | TP7 | 58 | 7::1273 |
| | Right | TP8 | 59 | 7::1278 |
| Post temporal | Left | T5 | 60 | 7::1257 |
| | Right | T6 | 61 | 7::1262 |
| Parieto occipital | Left | PO7 | 62 | 7::1241 |
| | Right | PO8 | 63 | 7::1246 |
| Frontal | Left | F9 | 64 | 7::1081 |
| | Right | F10 | 65 | 7::1086 |
| Front temporal | Left | FT9 | 66 | 7::1121 |
| | Right | FT10 | 67 | 7::1126 |
| Temporal | Left | T9 | 68 | 7::1265 |
| | Right | T10 | 69 | 7::1270 |
| Temporo parietal | Left | TP9 | 70 | 7::1281 |
| | Right | TP10 | 71 | 7::1286 |
| Parietal | Left | P9 | 72 | 7::1201 |
| | Right | P10 | 73 | 7::1206 |
| Ear | Left | A1 | 74 | 7::1289 |
| | Right | A2 | 75 | 7::1290 |
| Anterior temporal | Left | T1 | 76 | 7::1297 |
| | Right | T2 | 77 | 7::1298 |
| Pharyngeal | Left | Pg1 | 78 | 7::1305 |
| | Right | Pg2 | 79 | 7::1306 |
| Sphenoidal | Left | Sp1 | 80 | 7::1313 |
| | Right | Sp2 | 81 | 7::1314 |
| Reference | | Ref | 100 | |
| Reference 2 | | Ref2 | 101 | |

NOTE 1 See Reference [4] for the related DICOM waveform specification.

NOTE 2 IEEE 11073-10101 is the most suitable mapping, while LOINC® or SNOMED-CT® can be added in the future as needed.

NOTE 3 According to ACNS (American Clinical Neurophysiology Society) Guideline 2, ACNS 2016 prefers T7 to T3, T8 to T4, P7 to T5, and P8 to T6. IEEE 11073-10101 is described as T3, T4, T5, and T6, the same as this standard. See Reference [6].

**Table B.1** *(continued)*

| Name | Abbreviation | Electrode code | IEEE 11073-10101<br>Part::Code |
|---|---|---|---|
| Non Specific Electrode | EEG | 127 | |

NOTE 1 See Reference [4] for the related DICOM waveform specification.

NOTE 2 IEEE 11073-10101 is the most suitable mapping, while LOINC® or SNOMED-CT® can be added in the future as needed.

NOTE 3 According to ACNS (American Clinical Neurophysiology Society) Guideline 2, ACNS 2016 prefers T7 to T3, T8 to T4, P7 to T5, and P8 to T6. IEEE 11073-10101 is described as T3, T4, T5, and T6, the same as this standard. See Reference [6].

# Annex C
(informative)

# Example of waveform encoding

## C.1 Electroencephalography (EEG)

Table C.1 is a sample describing the EEG. The sampled EEG waveform is for 30 minutes and it has 12ch EEG waveforms and 1ch ECG waveform. Photic stimulator for 15 seconds is given 10 minutes and 20 minutes after the start of the examination.

**Table C.1 — Example of encoding electroencephalography**

| Tag name | | Code | | | | Descriptions |
|---|---|---|---|---|---|---|
| | | Tag No (HEX) | Length (DEC) | Data (HEX) | | |
| 1 | MWF_PRE | 40 | 32 | 4d 46 52 20 | | MFR |
| | | | | 50 6f 6c 79 73 6f 6d 6e 6f 67 72 61 70 68 79 20 20 20 20 20 20 20 20 20 20 20 20 20 20 | | Polysomnography |
| 2 | MWF_BLE | 01 | 1 | 00 | | Big endian |
| 3 | MWF_TIM | 85 | 11 | Year | 07 e4 | The examination date and time: 2020/02/05 13:31:20, 0, 0 |
| | | | | Month | 02 | |
| | | | | Day | 05 | |
| | | | | Hour | 0d | |
| | | | | Minute | 1f | |
| | | | | Second | 14 | |
| | | | | Milli-second | 00 00 | |
| | | | | Micro-second | 00 00 | |
| 4 | MWF_AGE | 83 | 7 | Years | 23 | Age: 35 years old |
| | | | | Days | 33 07 | Age in days: 13 063 days old |
| | | | | Birth date [Y] | 07 c0 | Date of birth: 1984/05/01 |
| | | | | Birth date[M] | 05 | |
| | | | | Birth date[D] | 01 | |
| 5 | MWF_SEX | 84 | 1 | 01 | | Male |
| 6 | MWF_WFM | 08 | 2 | 00 2b | | Long-term EEG (EEG_LTRM) |
| 7 | MWF_DTP | 0a | 1 | 00 | | Data type: Signed 16 bits integer |
| 8 | MWF_IVL | 0b | 4 | Unit | 01 | Sampling interval: 1 s |
| | | | | Exponent | 00 | |
| | | | | Mantissa | 00 01 | |
| 9 | MWF_PNT | 07 | 4 | 00 00 00 00 | | Pointer: 0 s |

**Table C.1** *(continued)*

| Tag name | | Code | | | | Descriptions |
|---|---|---|---|---|---|---|
| | | Tag No (HEX) | Length (DEC) | Data (HEX) | | |
| 10 | MWF_EVT | 41 | 24 | Event code | 12 60 | Event: Photic stimulator (4704) |
| | | | | Starting time | 00 00 02 58 | Starting time: 600 s |
| | | | | Duration | 00 00 00 0f | Duration: 15 s |
| | | | | Event information | 46 72 65 71 75 65 6e 63 79 3d 38 5e 48 7a | Information: Frequency=8^Hz |
| 11 | MWF_EVT | 41 | 24 | Event code | 12 60 | Event: Photic stimulator (4704) |
| | | | | Starting time | 00 00 04 b0 | Starting time: 1 200 s |
| | | | | Duration | 00 00 00 0f | Duration: 15 s |
| | | | | Event information | 46 72 65 71 75 65 6e 63 79 3d 38 5e 48 7a | Information: Frequency=8^Hz |
| 12 | MWF_IVL | 0b | 4 | Unit | 01 | Sampling interval: $1 \times 10^{-3}$ s = 1 ms |
| | | | | Exponent | fd | |
| | | | | Mantissa | 00 01 | |
| 13 | MWF_SEN | 0c | 4 | Unit | 00 | Sampling resolution: $10 \times 10^{-6}$ volt = 10 micro volt |
| | | | | Exponent | fa | |
| | | | | Mantissa | 00 0a | |
| 14 | MWF_BLK | 04 | 4 | 00 1b 77 40 | | Data block length: 1 800 000 samples |
| 15 | MWF_CHN | 05 | 1 | 0c | | Number of channels: 12 |
| 16 | MWF_SEQ | 06 | 4 | 00 00 00 01 | | Number of sequences: 1 |
| 17 | MWF_ATT | 3f 00 | 4 | MWF_LDN | 09 | Channel 1 attribute |
| | | | | Length | 02 | negative electrode: FP1(12) |
| | | | | Data | 46 4a | positive electrode: A1(74) |
| 18 | MWF_ATT | 3f 01 | 4 | MWF_LDN | 09 | Channel 2 attribute |
| | | | | Length | 02 | negative electrode: FP2(13) |
| | | | | Data | 46 cb | positive electrode: A2(75) |
| 19 | MWF_ATT | 3f 02 | 4 | MWF_LDN | 09 | Channel 3 attribute |
| | | | | Length | 02 | negative electrode: F3(28) |
| | | | | Data | 4e 4a | positive electrode: A1(74) |
| 20 | MWF_ATT | 3f 03 | 4 | MWF_LDN | 09 | Channel 4 attribute |
| | | | | Length | 02 | negative electrode: F4(29) |
| | | | | Data | 4e cb | positive electrode: A2(75) |
| 21 | MWF_ATT | 3f 04 | 4 | MWF_LDN | 09 | Channel 5 attribute |
| | | | | Length | 02 | negative electrode: C3(32) |
| | | | | Data | 50 4a | positive electrode: A1(74) |
| 22 | MWF_ATT | 3f 05 | 4 | MWF_LDN | 09 | Channel 6 attribute |
| | | | | Length | 02 | negative electrode: C4(33) |
| | | | | Data | 50 cb | positive electrode: A2(75) |
| 23 | MWF_ATT | 3f 06 | 4 | MWF_LDN | 09 | Channel 7 attribute |
| | | | | Length | 02 | negative electrode: P3(36) |
| | | | | Data | 52 4a | positive electrode: A1(74) |

**Table C.1** *(continued)*

| Tag name | | Code | | | | Descriptions |
|---|---|---|---|---|---|---|
| | | Tag No (HEX) | Length (DEC) | Data (HEX) | | |
| 24 | MWF_ATT | 3f 07 | 4 | MWF_LDN | 09 | Channel 8 attribute |
| | | | | Length | 02 | negative electrode: P4(37) |
| | | | | Data | 52 cb | positive electrode: A2(75) |
| 25 | MWF_ATT | 3f 08 | 4 | MWF_LDN | 09 | Channel 9 attribute |
| | | | | Length | 02 | negative electrode: O1(24) |
| | | | | Data | 4c 4a | positive electrode: A1(74) |
| 26 | MWF_ATT | 3f 09 | 4 | MWF_LDN | 09 | Channel 10 attribute |
| | | | | Length | 02 | negative electrode: O2(25) |
| | | | | Data | 4c cb | positive electrode: A2(75) |
| 27 | MWF_ATT | 3f 0a | 4 | MWF_LDN | 09 | Channel 11 attribute |
| | | | | Length | 02 | negative electrode: T3(56) |
| | | | | Data | 5c 4a | positive electrode: A1(74) |
| 28 | MWF_ATT | 3f 0b | 4 | MWF_LDN | 09 | Channel 12 attribute |
| | | | | Length | 02 | negative electrode: T4(57) |
| | | | | Data | 5c cb | positive electrode: A2(75) |
| 29 | MWF_FLT | 11 | 11 | 48 50 46 3d 30 2e 35 33 5e 48 7a | | Filter: HPF=0,53^Hz |
| 30 | MWF_FLT | 11 | 10 | 4c 50 46 3d 31 32 30 5e 48 7a | | Filter: LPF=120^Hz |
| 31 | MWF_PNT | 07 | 4 | 00 00 00 00 | | Pointer: 0 ms |
| 32 | MWF_WAV | 1e | 84 (hex) | 02 93 2e 00 | | Data length is designated as 4 bytes.<br>Data length: 43 200 000 bytes<br>In this case, the data value section uses 128 octets or more, the most significant bit is set. |
| | | | Wave-form informa-tion | ch.1: FP1-A1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.2: FP2-A2 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.3: F3-A1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.4: F4-A2 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.5: C3-A1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.6: C4-A2 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.7: P3-A1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.8: P4-A2 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.9: O1-A1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.10: O2-A2 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.11: T3-A1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| | | | | ch.12: T4-A2 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| 33 | MWF_WFM | 08 | 2 | 00 02 | | Long-term ECG (ECG_LTERM) |
| 34 | MWF_DTP | 0a | 1 | 00 | | Data type: Signed 16 bits integer |
| 35 | MWF_IVL | 0b | 4 | Unit | 01 | Sampling interval: $1 \times 10^{-3}$ s = 1 ms |
| | | | | Exponent | fd | |
| | | | | Mantissa | 00 01 | |



 

**Table C.1** *(continued)*

| Tag name | | Code | | | | Descriptions |
|---|---|---|---|---|---|---|
| | | Tag No (HEX) | Length (DEC) | Data (HEX) | | |
| 36 | MWF_SEN | 0c | 4 | Unit | 00 | Sampling resolution: 10 × $10^{-6}$ volt = 10 micro volt |
| | | | | Exponent | fa | |
| | | | | Mantissa | 00 0a | |
| 37 | MWF_BLK | 04 | 4 | 00 1b 77 40 | | Data block length: 1 800 000 samples |
| 38 | MWF_CHN | 05 | 1 | 01 | | Number of channels: 1 |
| 39 | MWF_SEQ | 06 | 4 | 00 00 00 01 | | Number of sequences: 1 |
| 40 | MWF_ATT | 3f 00 | 4 | MWF_LDN | 09 | Channel 1 attribute |
| | | | | Length | 02 | ECG1(4166) |
| | | | | Data | 10 46 | |
| 41 | MWF_FLT | 11 | 10 | 48 50 46 3d 30 2e 35 5e 48 7a | | Filter: HPF=0,5^Hz |
| 42 | MWF_FLT | 11 | 9 | 4c 50 46 3d 33 35 5e 48 7a | | Filter: LPF=35^Hz |
| 43 | MWF_PNT | 07 | 4 | 00 00 00 00 | | Pointer: 0 ms |
| 44 | MWF_WAV | 1e | 84 (hex) | 00 36 ee 80 | | Data length is designated as 4 bytes.<br>Data length: 3 600 000 bytes<br>In this case, the data value section uses 128 octets or more, the most significant bit is set. |
| | | | Wave-form informa-tion | ch.1: ECG1 | xx xx xx xx .... | 1 800 000 samples × 2(byte) |
| 45 | MWF_END | 80 | | | | |

## C.2 Polysomnography (PSG)

Table C.2 is a sample describing the PSG. The sampled PSG waveform is for 8 hours. It has EEG, EOG, EMG, ECG, respiration and others. The sampling frequency of the EEG, EOG, EMG and ECG waveforms is 1 000 Hz, and that of respiration and other waveforms is 250 Hz.

**Table C.2 — Example of encoding polysomnography**

| Tag name | | Code | | | Descriptions |
|---|---|---|---|---|---|
| | | Tag No (HEX) | Length (DEC) | Data (HEX) | |
| 1 | MWF_PRE | 40 | 32 | 4d 46 52 20 | MFR |
| | | | | 50 6f 6c 79 73 6f 6d 6e 6f 67 72 61 70 68 79 20 20 20 20 20 20 20 20 20 20 20 20 20 | Polysomnography |
| 2 | MWF_BLE | 01 | 1 | 00 | Big endian |

**Table C.2** *(continued)*

| Tag name | | Code | | | | Descriptions |
|---|---|---|---|---|---|---|
| | | Tag No (HEX) | Length (DEC) | Data (HEX) | | |
| 3 | MWF_TIM | 85 | 11 | Year | 07 e4 | The examination date and time: 2020/02/05 13:31:20, 0, 0 |
| | | | | Month | 02 | |
| | | | | Day | 05 | |
| | | | | Hour | 0d | |
| | | | | Minute | 1f | |
| | | | | Second | 14 | |
| | | | | Milli-second | 00 00 | |
| | | | | Micro-second | 00 00 | |
| 4 | MWF_AGE | 83 | 7 | Years | 23 | Age: 35 years old<br>Age by day: 13 063 days old<br>Date of birth: 1984/05/01 |
| | | | | Days | 33 07 | |
| | | | | Birth date [Y] | 07 c0 | |
| | | | | Birth date[M] | 05 | |
| | | | | Birth date[D] | 01 | |
| 5 | MWF_SEX | 84 | 1 | 01 | | Male |
| 6 | MWF_WFM | 08 | 2 | 00 2b | | Long-term EEG (EEG_LTRM) |
| 7 | MWF_DTP | 0a | 1 | 00 | | Data type: Signed 16 bits integer |
| 8 | MWF_IVL | 0b | 4 | Unit | 01 | Sampling interval:<br>$1 \times 10^{-3}$ s = 1 ms |
| | | | | Exponent | FD | |
| | | | | Mantissa | 00 01 | |
| 9 | MWF_SEN | 0c | 4 | Unit | 00 | Sampling resolution:<br>$10 \times 10^{-6}$ volt = 10 micro volt |
| | | | | Exponent | Fa | |
| | | | | Mantissa | 00 0a | |
| 10 | MWF_BLK | 04 | 4 | 01 b7 74 00 | | Data block length:<br>28 800 000 samples |
| 11 | MWF_CHN | 05 | 1 | 03 | | Number of channels: 3 |
| 12 | MWF_SEQ | 06 | 4 | 00 00 00 01 | | Number of sequences: 1 |
| 13 | MWF_ATT | 3f 00 | 4 | MWF_LDN | 09 | Channel 1 attribute |
| | | | | Length | 02 | negative electrode: F3(28) |
| | | | | Data | 4e 4b | positive electrode: A2(75) |
| 14 | MWF_ATT | 3f 01 | 4 | MWF_LDN | 09 | Channel 2 attribute |
| | | | | Length | 02 | negative electrode: C3(32) |
| | | | | Data | 50 4b | positive electrode: A2(75) |
| 15 | MWF_ATT | 3f 02 | 4 | MWF_LDN | 09 | Channel 3 attribute |
| | | | | Length | 02 | negative electrode: O1(24) |
| | | | | Data | 4c 4b | positive electrode: A2(75) |
| 16 | MWF_FLT | 11 | 11 | 48 50 46 3d 30 2e 35 33 5e 48 7a | | Filter: HPF=0,53^Hz |
| 17 | MWF_FLT | 11 | 10 | 4c 50 46 3d 31 32 30 5e 48 7a | | Filter: LPF=120^Hz |
| 18 | MWF_PNT | 07 | 4 | 00 00 00 00 | | Pointer: 0 ms |