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BSI Standards Publication

# Health informatics — Medical waveform format

## Part 2: Electrocardiography

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**National foreword**

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# ISO/TS 22077-2

First edition  
2015-08-01

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## Health informatics — Medical waveform format —

### Part 2: Electrocardiography

*Informatique de santé — Forme d'onde médicale —  
Partie 2: Electrocardiographie*



Reference number  
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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 215, *Health informatics*.

ISO/TS 22077 consists of the following parts, under the general title *Health informatics — Medical waveform format*:

- *Part 1: Encoding rules*
- *Part 2: Electrocardiography*
- *Part 3: Long term electrocardiography*

## Introduction

The standard 12-lead electrocardiogram (ECG) is one of the most widely used medical waveforms in clinical sites. In particular, the increased usage of electronic medical records provides the environment in which these ECGs can be accurately utilized; however, it is essential that to address the therapeutic requirements, ECG use is not constrained to specific machine types and manufacturers. Furthermore, there is great interest in the various kinds of patient information contained in ECGs that are extensively studied and shared between health care providers.

This Technical Specification defines the detailed rules for electrocardiogram waveform format that is encoded according to the medical waveform format encoding rules (MFER). In addition to electrocardiogram waveform format encoding, there are rules for other waveforms such as long-term ECG (Holter ECG), stress ECG, etc. that are contained in other MFER technical specifications. Please refer to those specifications for additional information.

### About MFER

Medical waveforms such as electrocardiogram, electroencephalogram, and blood pressure waveforms are widely utilized in clinical areas such as physiological examinations, electronic medical records, medical investigations, research, education, etc. Medical waveforms are used in various combinations and document types according to the intended diagnostic purpose. For example, ECG waveforms are utilized extensively in the clinical arena, with resting 12-lead ECG being used the most. A cardiologist makes diagnoses using 10 s to 15 s ECG waveform measurements; however, longer periods are sometimes required to recognize patient heart conditions such as arrhythmia. Also, there are many other methods using ECG such as Holter ECG, physiologic monitoring ECG, stress ECG, intracardiac ECG, VCG, EEG with ECG, blood pressure with ECG, PSG, etc. MFER can describe not only ECG for physiological examinations conducted in ICU and operating room acute care contexts, but also EEG, respiration waveform, and pulse.

### Simple and easy

MFER is a specialized representation for medical waveforms that removes unnecessary coded elements (“tags”) for waveform description. For example, a standard 12-lead ECG can be described simply only using a common sampling condition and the lead condition, making waveform synchronization and correct lead calculation much easier.

### 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, DICOM, IEEE, 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 is 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 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 can support 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 2: Electrocardiography

### 1 Scope

This Technical Specification defines the application of medical waveform format encoding rules (MFER) to describe standard electrocardiogram waveforms measured in physiological laboratories, hospital wards, clinics, and primary care medical checkups. It covers electrocardiograms such as 12-lead, 15-lead, 18-lead, Cabrera lead, Nehb lead, Frank lead, XYZ lead, and exercise tests that are measured by inspection equipment such as electrocardiographs and patient monitors that are compatible with MFER.

Medical waveforms that are not in the scope of this Technical Specification include Holter ECG, exercise stress ECG, and real-time ECG waveform encoding used for physiological monitors.

### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *Health informatics — Medical waveform format — Part 1: Encoding rules*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **dominant beat**

typical heart beat used for measurement and analysis in standard 12-lead ECG

Note 1 to entry: In general, it is the primary heart beat excepting extrasystole or drifts of baseline.

#### 3.2

##### **average beat**

typical heart beat used for measurement and analysis in standard 12-lead ECG

Note 1 to entry: This is averaged for waveforms excluding abnormal beats for each lead.

#### 3.3

##### **median beat**

typical heart beat used for measurement and analysis in standard 12-lead ECG

Note 1 to entry: This is a waveform with the median value of waveforms excluding the abnormal beats for each lead.

#### 3.4

##### **tag**

identifier code for a semantic concept

## 4 Symbols and abbreviated terms

CEN	Comité Européen de Normalization/European Committee for Standardization
DBMS	Data Base Management system
DICOM	Digital Imaging and Communications in Medicine
ECG	Electrocardiogram
EEG	Electroencephalogram
EHR	Electronic Health Record
GPS	Global Positioning System
HL7	Health Level Seven
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
JIS	Japanese Industrial Standard
LSB	Least significant bit
MFER	Medical waveform Format Encoding Rules
MSB	Most significant bit
OID	Reference to the ISO standard
SAS	Sleep Apnea Syndrome
SCP-ECG	Standard Communications Protocol for Computerized Electrocardiography (ISO IS 11073-91064)
SpO <sub>2</sub>	Saturation of Peripheral Oxygen
UID	Reference to the ISO standard
UUID	Reference to the ISO standard
VCG	Vectorcardiogram
XML	Extensible Markup Language

## 5 Encoding format

### 5.1 Primary description

MFER provides encoding of Long-term ECG waveforms but since MFER is used *mutatis mutandis* for encoding of ECG waveforms such as ambulatory ECG, patient monitor system, etc., In addition, together with encoding of ECG waveforms, encoding of information of recognition for waveform, measurement information, interpretation information, etc. is provided, but these are all optional functions and are dependent on each implementation concept. For instance, interpretation code or measurement value might be described by other standard such as HL7, XML, DBMS, etc. with waveforms decoding MFER. However, in all instances, when implementing a device, apply the requirements as listed in ISO 22077-1.

### 5.1.1 Sampling attributes

Sampling attributes including sampling rate and resolution are given in [Tables 1](#) to [4](#).

#### 5.1.1.1 MWF\_IVL (0Bh): Sampling rate

This tag indicates the frequency or sampling interval for the medical waveform is sampled ([Table 1](#)).

**Table 1 — Sampling rate**

MWF_IVL		Data length	Default	Encoding range/remarks	Duplicated definitions	
11	0Bh	Unit	1	1 000 Hz	—	Override
		Exponent (10th power)	1		10 <sup>-128</sup> ~+127	
		Mantissa	≤4		e.g. unsigned 16-bit integer	

The unit may be frequency in hertz, time in seconds, or distance in meters ([Table 2](#)).

**Table 2 — Sampling rate unit**

Unit		Value	Remarks
Frequency	Hz	0	Including power
Time interval	s	1	—

#### 5.1.1.2 MWF\_SEN (0Ch): Sampling resolution

This tag indicates the resolution, minimum bits, the medical waveform sampled (generally, digitized) ([Table 3](#)).

**Table 3 — Sampling resolution**

MWF_SEN		Data length	Default	Encoding range/remarks	Duplicated definitions	
12	0Ch	Unit	1	See <a href="#">Table 4</a>	—	Override
		Exponent (10th power)	1		10 <sup>-128</sup> ~+127	
		Mantissa	≤4		e.g. unsigned 16-bit integer	

**Table 4 — Sampling units**

Unit		Value	Default	Remarks
Voltage	Volt	0	0,000 001 V	—

### 5.1.2 Frame attributes

A frame is composed of data blocks, channels and sequences.

#### 5.1.2.1 MWF\_BLK (04h): Data block length

This tag indicates the number of data sampled in a block ([Table 5](#)).

**Table 5 — Data block length**

MWF_BLK	Data length	Default	Remarks	Duplicated definitions	
04	04h	≤4	1	—	Override

### 5.1.2.2 MWF\_CHN (05h): Number of channels

This tag indicates the number of ECG channels ([Table 6](#)). If a previously specified channel attribute is reset to the root definition including Default, the number of channels should be specified before each definition of the channel attribute. The number of channels cannot be specified within the definition of a channel attribute.

**Table 6 — Number of channels**

MWF_CHN		Data length	Default	Remarks	Duplicated definitions
05	05h	≤4	1	—	Override

### 5.1.2.3 MWF\_SEQ (06h): Number of sequences

This tag indicates the number of sequences ([Table 7](#)). If the number of sequences is not designated, it depends on the data block length, the number of channels and the number of waveform data values that are defined for the specified frame.

**Table 7 — Number if sequences**

MWF_SEQ		Data length	Default	Remarks	Duplicated definitions
06	06h	≤4	Depends on waveform data length	—	Override

## 5.1.3 Waveform

The waveform class and type, waveform attributes and waveform data are encoded as follows.

### 5.1.3.1 MWF\_WFM (08h): Waveform class

Waveforms such as standard 12-lead ECG and monitoring ECG are grouped based on instruments and purpose, as shown in [Table 8](#).

**Table 8 — Waveform class**

MWF_WFM		Data length	Default	Remarks	Duplicated definitions
08	08h	2	Non-specific waveform	—	Override
		Str ≤ 32	Waveform description	—	

As a general rule, each type of waveform is described in a separate specification.

For types of waveforms ([Table 9](#)), numbers 1 to 49151 (BFFFh) are reserved. Numbers 49152 to 65535 can be used privately, but it is recommended to add these to the MFER specification rather than rely on private extensions.

**Table 9 — Standard 12-lead ECG waveforms**

Waveform kind	Type	Value	Waveform description	Remarks
Electrocardiogram	ECG_STD12	1	Standard 12-lead ECG	Standard 12-lead ECG including general ECG in short-term recording.
	ECG_BEAT	9	QRS beat	In general, one heart beat waveform extracted from standard 12-lead ECG recording. Write comment Average, Median, Dominant
	ECG_DRV	12	Derived lead	Derived ECG from Frank vector leads, EASI lead, etc.

### 5.1.3.2 MWF\_LDN (09h): Waveform attributes (lead name, etc.)

This is the waveform code used in 12-lead ECGs and vector lead ECGs. Because the lead code is encoded by 0 to 127, care should be taken when other standards such as SCP-ECG, etc. are followed. Since part of these code spaces overlap, the present table shall be followed in all MFER applications.

Since in this specification, the code for the lead name is encoded by 127 or less, the codes specified in systems such as SCP-ECG shall require conversion. However, in the present lead code table, leads which are not used in standard 12-lead ECG are defined and, in general, will not need to be replaced.

**Table 10 — Definition of waveform attributes**

MWF_LDN		Data length	Default	Description range, remarks	Duplicated definition
09	09h	Waveform code	Undefined	Data length = 2, if waveform information is encoded	Override
		Waveform information		Str ≤ 32	

The present code supports 12-lead electronic cardiogram waveforms. In this Technical Specification, it is recommended to encode leads using MFER waveform information, rather than those specified in other standards.

In addition, this Technical Specification extends the 12-lead names for humans to include ECG lead names for animals. When other leads for animals are used, such as CV5RL, CV6LL, CV6LU, and V10, they should be specified by waveform information.

**Table 11 — Lead name**

Code	Lead	Code	Lead
1	I	—	—
2	II	—	—
3	V1	—	—
4	V2	—	—
5	V3	—	—
6	V4	—	—
7	V5	—	—
8	V6	—	—
9	V7	—	—

**Table 11** (continued)

Code	Lead	Code	Lead
10	b	—	—
11	V3R	61	III
12	V4R	62	aVR
13	V5R	63	aVL
14	V6R	64	aVF
15	V7R	65	-aVR <sup>a</sup>
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	—	—
<sup>a</sup> aVR lead shall not be encoded according to MFER. The users (viewer) should mke a calculation to derive -aVR when required. <sup>b</sup> Although V2R (10) is defined in other rules such as SCP-ECG, the definition shall not be used in MFER.			

Code and information can be added to the type of waveform. If a waveform is required to be reconfigured, as in the case of deriving leads III and aVF from leads I and II, the codes should always be specified. The codes should be taken into special consideration as they have a function to specify some processing, as in the case of deriving other limb leads from leads I and II or deriving a waveform based on the lead name. See [Annex D](#) for the definition of waveform attributes.

As the lead names are defined depending on the class of waveform, the lead subsets are not called out for each class of waveform in MFER. Thus, caution should be taken in encoding lead names.

For waveform codes, numbers 1 to 49151 (BFFFh) are already reserved. Numbers 49152 to 65535 can be used privately but it is recommended to add these to the MFER specification rather than rely on private extensions.

### 5.1.3.3 MWF\_WAV (1Eh): Waveform data

The entire set of waveform data should be strictly aligned as defined in Frame attributes. If the waveform data are compressed, the data alignment may depend on the compression method, but the waveform data after un-compressing should be aligned according to the definition. Refer to [Annex B](#).

If waveform data are different from what is defined in frame information, they may be discarded depending on application processing. MFER behaviour is undefined in this case.

## 5.1.4 Channel

### 5.1.4.1 MWF\_ATT (3Fh): Channel attributes (channel definition)

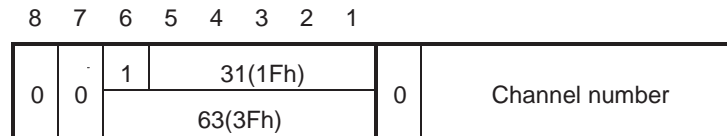
This tag defines the attributes for each channel (see [Table 12](#)). Before this definition, the channel number shall be specified using the values in [Table 6](#).

**Table 12 — Channel attributes**

MWF_ATT		Data length	Default	Remarks	Duplicated definitions
63	3Fh	Depends on definition	—	—	Override

NOTE Channel definition for each channel is encoded with a special context tag of P/C = 1 and tag number of 1Fh. That is, the type number is P/C + tag number encoded with 3Fh and identifies the attribute of the relevant channel.

For the tag of the channel attribute definition, context mode is selected with P/C (bit 6 = 1).



**Figure 1 — Number of channel**

The data length includes all the range of the channel attribute definition ([Figure 2](#)).

Tag		Data length	Group of definition									
3Fh	Channel number	All definition	Channel attribute			Channel attribute			—	Channel attribute		
			T	L	V	T	L	V	—	T	L	V

**Figure 2 — Definition of channel attributes**

Tag		Data length	Group of definition									
3Fh	Channel number	80h	Channel attribute			Channel attribute			—	End-of-contents		
			T	L	V	T	L	V	—	00	00	

**Figure 3 — Definition of channel attributes with indefinite length**

## 5.2 Data alignment

This Technical Specification supports many ECG alignment styles according to [Annex B](#), allowing for complicated alignment formats that could result in processing issues. It is recommended that formats be simplified as much as possible in order to maximize interoperability.

## 5.3 Abstract waveform

This example is in principle the same as the 12-lead ECG, but one heartbeat of P-QRS-T is extracted and expressed. The abstract waveform is processed in three ways: extraction as dominant beat, averaged beat and median beat. These depend on the system concept and measurement method. The abstract waveform should be clearly stipulated in implementation specifications, but all leads may be encoded by abstract waveform of MFER.

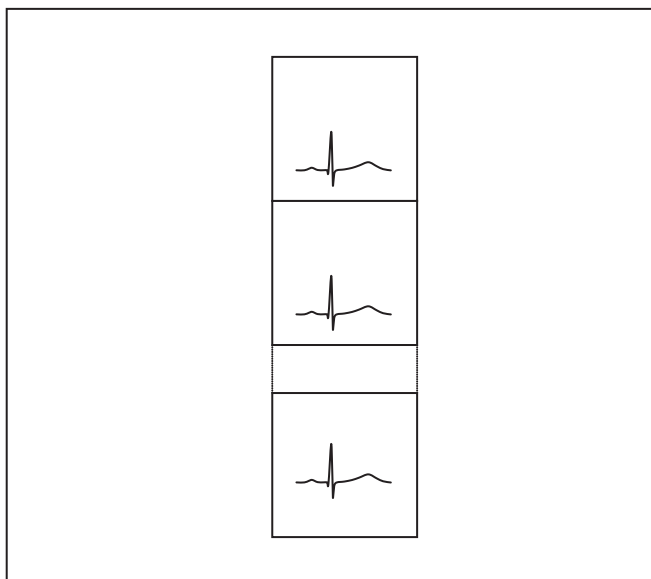


Figure 4 — Abstract waveform

#### 5.4 Lead calculation

Recent electrocardiographs frequently adopt systems to record limb leads by Leads I and II only. In such event, Leads III, aVR, aVL, and aVF shall be found by calculation. Derivation shall be performed by the following operation:

In implementing lead calculation, thorough consideration shall be given to aspects such as A/D conversion method, phase deviation or electrode disconnection, and care must be practiced to prevent occurrence of arithmetic waveform distortion.

Table 13 — Lead calculation operation table (calculation from leads I and II)

Lead name	Calculation operation	Computation (right arm potential R; left arm potential L, left foot potential F)
III	II - I	III = F-L = (F-R) - (L-R) where, II = F - R and I = L - R
aVR	- (I + II)/2	aVR = R-(L+F)/2 = {(R-L)+(R-F)}/2
aVL	I - II/2	aVL = L-(R+F)/2 = {(L-R)+(L-F)}/2 = (I-III)/2 = I-II/2
aVF	II - I/2	aVL = F-(R+L)/2 = {(F-R)+(F-L)}/2 = (II+III)/2 = II-I/2
-aVR	Negative number of aVR	

Table 14 — Lead calculation operation table (calculation from leads I and III)

Lead name	Calculation operation	Computation (right arm potential R; left arm potential L, left foot potential F)
II	III+ I	II = F-R = (F-L)+ (L-R) where, III = F - L and I = L - R
aVR	- I - III/2	aVR = R-(L+F)/2 = {(R-L)+(R-F)}/2 = {-I-(III+I)}/2 = -I-III/2
aVL	(I - III)/2	aVL = L-(R+F)/2 = {(L-R)+(L-F)}/2 = (I-III)/2
aVF	III + I/2	aVL = F-(R+L)/2 = {(F-R)+(F-L)}/2 = {(III+I)+III}/2 = III+I/2
-aVR	Negative number of aVR	



**Table 15 — Lead calculation operation table (calculation from leads II and III)**

Lead name	calculation operation	Computation (right arm potential R; left arm potential L, left foot potential F)
I	II - III	$I = L - R = (F - R) - (F - L)$ where, $II = F - R$ and $III = F - L$
aVR	$-II + III/2$	$aVR = R - (L + F)/2 = \{(R - L) + (R - F)\}/2 = \{- (II - III) - II\}/2 = -II + III/2$
aVL	$-III + II/2$	$aVL = L - (R + F)/2 = \{(L - R) + (L - F)\}/2 = \{(II - III) - III\}/2 = -III + II/2$
aVF	$(II + III)/2$	$aVF = F - (R + L)/2 = \{(F - R) + (F - L)\}/2 = (II + III)/2$
-aVR	Negative number of aVR	

Sampled ECG data for all leads shall be completely synchronized.

## 5.5 Filter information

When filter information is described in MFER, it is classified in two cases: filter-processed data and non-filtered use information.

### 5.5.1 Description of filter-processed data

Description is made on the filter information processed for the data described by MFER.

**Table 16 — Filter information**

MWF_FLT		Data length	Duplicated definitions
17	11h	Str < 256	Possible

**Table 17 — Filter description example**

Filter function	Abbreviation	Example	Meaning
Filter information only	None	Hum filter ON	Hum filter (characteristics, etc. not specified) used.
High-frequency pass filter	HPF	HPF = 0,05	Indefinite characteristics 0,05 Hz low frequency cutoff (high-pass) filter used.
Low-frequency pass filter	LPF	LPF = 150^secondary Butterworth filter	Butterworth secondary characteristics 150 Hz high frequency cutoff (low-pass) filter used.
Band elimination filter	BEF	BEF = 50^Hum filter	50 Hz Hum filter used. Cutoff characteristics not known.

In ECG, high-pass (low frequency cutoff) filter is frequently described by the time constant, but in MFER, it is recommended to describe it by frequency. For example, the low frequency cutoff filter, which has the primary Butterworth characteristics shown by frequently used CR, is described by the following:

By High-Pass Filter =  $1/\omega T$ , the lower cutoff frequency of time constant of 3 s is described by  $1/(2\pi \times 3 \text{ s}) \approx 0,05 \text{ Hz}$ .

### 5.5.2 Description of filter use information

In this case, MFER ECG data has not been subject to filter processing, and the fact that a specific filter is used is stipulated only. For example, this information may be used to indicate that the ECG was measured by an electrocardiograph, printed on recording paper underwent the relevant filter processing and may be utilized for diagnosis.

## 5.6 Unique identifier

This tag indicates UID (Unique Identifier).

**Table 18 — Unique identifier**

MWF_UID		Length	Default value	Remarks	Override
135	87h	Str ≤ 64	No		No

Definition of the Object Identifier is not in the scope of MFER. This is designated with OID, UUID.

## 6 Measurement information

Of information generated during measuring ECG, information that would exert effect on the authenticity of ECG and validity of waveforms is encoded. For example, it is possible to encode waveform display information and power supply frequency that do not exert effect on generation of ECG waveform measurement but that are required to reproduce the condition at the time of measurement. The descriptions in this chapter are recommended to be implemented in accordance to local conventions whenever possible.

Refer to [Annex C](#).

### 6.1 Measurement date/time

This tag encodes the examination/measurement date/time or the data acquisition date/time ([Table 19](#)).

The date/time is an important object stored using MFER. Care should be taken to ensure it is accurate.

**Table 19 — Measurement time**

MWF_TIM		Data length	Default	Remarks	Duplicated definitions	
133	85 h	Year	2	None	1900 – 2100	Override
		Month	1		1 – 12	
		Day	1		1 – 31(1 – 30, 1–28, 29)	
		Hour	1		0 – 23	
		Minute	1		0 – 59	
		Second	1		0 – 59	
		Millisecond	2		0 – 999	
		Microsecond	2		0 – 999	

### 6.2 Measurement time (classification point)

The measurement time (classification point) is encoded by MWF\_EVT format.

**Table 20 — Event**

MWF_EVT		Data length	Encoding range/remarks	Duplicated definition	
65	41h	Event code	2	Number of samples acquired at the sampling interval defined in the root definition	Possible
		Starting time (point)	4		
		Duration	4		
		Event information	Str < 256		

When the recognition point of ECG waveform is shown ([Figure C.1](#)), it is encoded by the event code. When the recognition point in an ECG waveform is encoded by the root definition, it applies to all leads. When it is in a channel definition (each channel), the recognition point shall only apply to that channel.

By specifying the lead inside the channel definition, the recognition point of each lead may be encoded. If the waveform is not encoded using MFER, then the lead should be specified in the channel definition.

### 6.3 Measurement value

The measurement value is encoded by MWF\_VAL.

**Table 21 — Measurement value**

MWF_VAL		Data length	Encoding range/remarks	Duplicated definition	
66	42h	Value code	2	Multiple definitions available	
		Time point	4		Number of data values sampled is encoded.
		Value	Str ≤ 32		Value is encoded with a character string with unit ("^").

### 6.4 Measurement information classification

#### 6.4.1 Observation event

Events that have actually occurred, such as clinical observations, can be encoded by the use of MWF\_EVT.

**Table 22 — Event information**

MWF_EVT		Data length	Encoding range/remarks	Duplicated definition	
65	41h	Event code	2	Possible	
		Starting time (point)	4		Number of data values acquired at the sampling interval defined in the root definition.
		Duration	4		
		Event information	Str < 256		

#### 6.4.2 Waveform ancillary information

Information that may possibly exert an effect on the waveform, such as power supply frequency, shall be encoded using MWF\_INF.

**Table 23 — Waveform ancillary information**

MWF_INF		Data length	Encoding range/remarks	Duplicated definition	
21	15h	Ancillary information code	2	Possible	
		Starting time (point)	4		Number of data values acquired at the sampling interval defined in the root definition.
		Duration	4		
		Waveform information	Str < 256		

#### 6.4.3 Recording/display condition

Though no influence is exerted on the waveform encoded in MFER, MWF\_CND shall be used to encode information on lead combinations used when the ECG was measured. This encoding is used when recording and display conditions should be reproduced, for example, in electronic medical records, in order to improve, authenticity.

**Table 24 — Recording/display, etc. information**

MWF_CND		Data length	Remarks	Duplicated definition
68	44h	Recording/display condition	2	Possible
		Description code 1	2	
		Description code 2	2	
		Starting point	4	
		Duration	4	
		Descriptive information	Str < 256	

#### 6.4.3.1 Waveform display example

Recording lead combinations used when ECG is measured are encoded by MWF\_CND.

Tag: MWF\_CND

Recording/display condition: MWF\_ECG\_LEADS (65030)

Description code 1: channel No. 1 -

Description code 2: lead name

Starting point: record starting point

Duration: Relevant recording time

#### 6.4.3.2 Recording sensitivity display example

The recording sensitivity used at the time of recording is encoded.

### 6.5 Power supply frequency

The power supply frequency may be encoded. In general, the electrocardiograph has an AC interference elimination filter, but recording without filter processing and adding encoding of power supply frequency can eliminate AC interference by secondary processing.

### 6.6 Electrode condition

This may be specified when electrodes are disconnected. In particular, in the event that lead composition is performed, the derivation operation will not be performed accurately, a possible situation that should be thoroughly taken into account in implementation.

### 6.7 Calibration waveform

Encoding can be performed when calibrated waveform is implemented.

### 6.8 Artefact contamination

This code can be used to indicate that artefact and noise get mixed at the time of measuring ECG.

## 6.9 Automatic interpretation code, etc.

The Interpretation code is used for an automatic analysis system, but in the event that this function may be represented using another protocol such as HL7, it that protocol should be used.

### 6.9.1 MFER interpretation code and heart beat code encoding rules

Interpretation statements code and beat annotation can be encoded using the event tag.

**Table 25 — Automatic interpretation code**

MWF_EVT		Data length	Encoding range/remarks	Duplicated definitions
65	41h	Interpretation statements code	2	Possible
		Starting time (point)	4	
		Duration	4	
		Interpretation statements descriptive information	Str < 256	

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	Interpretations statements code											Question	

**Figure 5 — Composition of interpretation statements code**

The interpretation statements code is composed with 128 - 8191.

The question bit code means:

- 0: Undesignated (finalization or designation is not particularly needed)
- 1: In the event that there is little possibility of rendering an opinion
- 2: When there is any question
- 3: When there is strong question,

and is able to designate the following supplementation:

a) Interpretation code

When the applicable opinion is encoded throughout the whole frame, definition shall be made in the root definition region. In the event that no event information is used, both starting time and duration are not used. In the case that event information is used, “zero” shall be employed for both starting time and duration.

b) Waveform classification for each heart beat

The time of the position of the applicable heart beat shall be designated as the starting time and no duration time is used. When the event information is used, the duration shall be set to “zero” and the event information is used.

c) **Waveform classification within the period**

For example, transient bundle branch block, etc. are encoded, using the starting time and duration, the relevant regional time shall be specified.

d) **When waveform classification is encoded simultaneously with event information, event code and event information can be specified at the same time, or the event code = 0 and the event information may be encoded.**

**6.10 Patient information**

**6.10.1 Patient name**

Patient name should be as follows.

Family name^first name^middle name

**Table 26 — Patient name**

MWF_PNM		Data length	Default	Remarks	Duplicated definition
129	81h	Str ≤ 128	None		Override

**6.10.2 Patient ID**

The patient identifier may be encoded. Management of patient identifiers is outside the scope of the MFER specification. It is recommended to encode a patient ID as follows:

Patient ID^Local ID^Temporary ID.

If the above format is not provided, then the available identifier shall be used for all applications.

**Table 27 — Patient ID**

MWF_PID		Data length	Default	Remarks	Duplicated definition
130	82h	Str ≤ 64	None		Override

**6.10.3 Age and date of birth**

Age of the patient and date of birth may be encoded. The patient age is based on the date of examination or waveform acquisition.

**Table 28 — Age and date of birth**

MWF_AGE			Data length	Default	Remarks	Duplicated definition
131	83h	Age	Years	1	None	Override
			days	2		
		Date of birth	Year	2		
			Month	1		
			Day	1		

**6.10.4 Gender**

The gender of the patient may be encoded.

**Table 29 — Gender**

MWF_SEX		Data length	Default	Remarks	Duplicated definition
132	84h	1	Unclear		Override

**Table 30 — Gender code**

Gender	Code
Unclear	0
Male	1
Female	2
Unspecified	3

### 6.11 Comment

Memos and comments may be encoded. Information that does not exert a direct effect on waveform may be encoded (e.g. patient movement).

[Reference] Information that exerts effect on waveform may be encoded by ancillary information (MWF\_INF).

**Table 31 — Comment**

MWF_NTE		Data length	Default	Remarks	Duplicated definitions
22	16h	Str < 256			Possible

Only one comment shall be encoded within 255 characters; however, multiple comments may be included as required. Each comment may be read by a viewer, whether or not the comment has any user specified meaning.. By using multiple instances of comments, longer comments may be accommodated.





## Annex B (informative)

### Waveform alignment

**NOTE** In this section, the term “channel” is used differently from the “channel attributes” of the frame referred to in MFER Part 1 according to traditional electrocardiography. Care must be taken to avoid any misunderstanding in its interpretation. For example, a 3-channel ECG has a different meaning from the channel attributes of the MFER frame.

#### B.1 1-channel ECG

This model describes the oldest type of 1-channel electrocardiograph, where an ECG is recorded by measuring over one lead. For each lead, the frame is encoded and the waveform length is variable. Waveforms may be viewed in chronological order, but the format should be properly changed for display or recording as is the case with the realignment to 3x4 leads of [Figure B.2](#). This encoding is old-fashioned as an electrocardiograph but is still popularly used for a biological information monitor, for example.

##### B.1.1 1-channel ECG recording

ECG is recorded frame by frame and relevant lead waveform is not ensured of temporal continuation. Consequently, time-phase that bestrides leads, for example, RR interval, has no meaning.

I	II	III	aVR	aVL	. . . . .
---	----	-----	-----	-----	-----------

**Figure B.1 — 1-channel ECG**

##### B.1.2 3-channel realignment of waveforms recorded in 1-channel ECG

In this case, 1-lead ECGs that are shown in 1-channel ECG of [Figure B.1](#) are realigned into 3x4 leads. In such events, the waveform phase between channels is not compensated and there is no synchronism in each heartbeat.

I	aVR		V1	V4
II		aVL	V2	
III		aVF	V3	

**Figure B.2 — Realignment to 3x4 leads**

### B.1.3 6-channel realignment of waveforms recorded in 1-channel ECG

This is a case in which 1-lead ECG shown in 1-channel ECG of [Figure B.1](#) is realigned into 6x2 leads. In such event, the waveform phase between channels is not compensated and there is no synchronism in each heartbeat.

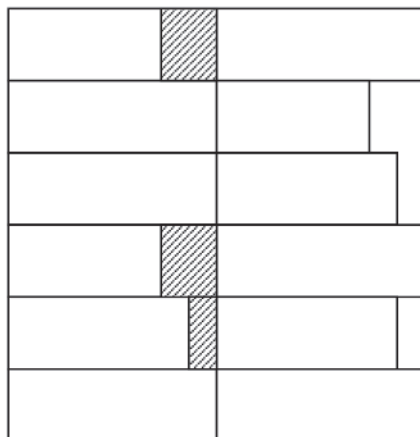


Figure B.3 — Realignment to 6x2 leads

## B.2 Multichannel ECG

This is a model to represent 2-channel, 3-channel, and other ECGs. No synchronism is achieved in waveform phases between groups.

This information does not indicate the actual recording image such as multiplex mode recording, alternate mode recording, as prescribed in ISO 22077-1.

### B.2.1 3-channel ECG

In this model, there is no time synchronism between groups, for example, I, II, and III and aVR, aVL, and aVF groups.

I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Figure B.4 — 3-channel ECG

### B.2.2 Realignment of 3-channel ECG to 6x2 lead ECG

In this case, too, there is no time synchronism between groups, either, same as [B.2.1](#).

I		V1
II		V2
III		V3
aVR		V4
aVL		V5
aVF		V6

**Figure B.5 — 6x2 lead realignment**

### B.2.3 In case where calculating leads are used

It is possible to calculate from Limb Lead I and Lead II by other limb lead composition.

I	V1
II	V2
III or calculated III	V3
calculated aVR	V4
calculated aVL	V5
calculated aVF	V6

**Figure B.6 — Realignment of calculated 6x2 leads**

## B.3 Multichannel simultaneous recording ECG

In general, 8 leads of I, II, V1, V2, V3, V4, V5, and V6 are encoded by MFER to exchange and retain messages, and when they are used for display or recording, other limb leads are found by derivation (see 5.4). In this format, a method of simultaneously recording 9 leads (I, II, III, V1, V2, V3, V4, V5, and V6 are simultaneously recorded and aVR, aVL, and aVF are arithmetically found) and 12 leads (I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, and V6) is used. This information does not indicate actual recording images such as multiplex recording, alternate mode recording, etc. prescribed in ISO 22077-1.

NOTE Besides deriving other leads found from two leads of I and II, other leads can be derived from Leads I and III or Leads II and III (see [Table 13](#)).

### B.3.1 8-lead ECG

The ECG consists of 2 channels limb leads (in general, Leads I and II) and 6 channels chest leads from V1 through V6. The remaining limb leads (III, aVR, aVL, and aVF) can be found by lead composition (refer to [Table 13](#)). However, limb leads are able to be used in other combinations, for example, combinations of Leads II and III and Leads III and I [see [Table 13](#)].

I
II
V1
V2
V3
V4
V5
V6

**Figure B.7 — 8-lead ECG**

### B.3.2 9-lead ECG

I
II
III
V1
V2
V3
V4
V5
V6

**Figure B.8 — 9-lead ECG**

### B.3.3 12-lead simultaneous ECG

All 12-lead ECGs are simultaneously recorded.

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

**Figure B.9 — 12-lead ECG**

### B.3.4 12-lead full synchronizing ECG at the time of use

In ECGs encoded in [B.1](#) and [B.2](#), remaining Leads III, aVR, aVL, and aVF are found by calculation (refer to [Table 13](#)).

I
II
Lead III
Lead aVR
Lead aVL
Lead aVF
V1
V2
V3
V4
V5
V6

**Figure B.10 — Calculated 12-lead synchronization display**

### B.3.5 6x2 lead composition synchronization ECG

In this display, there is a method to display all leads fully synchronized and a method to display temporal misalignment, that is, to display Lead I (group) followed by Lead V1 (group) (from II and III, other leads can be found or from Leads I and III, other waveforms can be found by calculations).

I	V1
II	V2
Lead III	V3
Lead aVR	V4
Lead aVL	V5
Lead aVF	V6

**Figure B.11 — Calculation type 6x2 leads**

### B.3.6 3x4+1 leads are displayed by calculated leads

I	Lead aVR	V1	V4
II	Lead aVL	V2	V5
Lead III	Lead aVF	V3	V6
II			

**Figure B.12 — Figure 13 3x4+1 leads**

### B.3.7 Lead-reassigned 12-lead ECG display 1

This is to reassign 12-lead ECG waveforms in the order of vector with directions taken into account.

Lead aVL
I
Lead (- aVR)
II
Lead aVF
Lead III
V1
V2
V3
V4
V5
V6

**Figure B.13 — Reassigned 12-lead ECG**

### B.3.8 6x2 lead composition synchronization ECG

In this display, there is a method to display all leads fully synchronized and a method to display temporal misalignment, that is, to display Lead I (group) followed by Lead V1 (group) (from II and III, other leads may be found or from Leads I and III, other waveforms may be found by calculations).

Lead aVL	V1
I	V2
Lead -aVR	V3
II	V4
Lead aVF	V5
Lead III	V6

**Figure B.14 — Lead-reassigned 12-lead ECG display 6x2 display**

### B.3.9 Free format

In addition, this format describes an optional time with optional lead combinations. In this example, optional combinations of a total of 3 leads of Lead II, Lead V1, and Lead aVF are recorded for an optional time.

II
V1
aVF

**Figure B.15 — Free format**

### B.3.10 Extended lead

When extended lead is lead-designated, extended display is enabled by the above display and the display that conforms to multichannel ECG (possibility of failure of time-phase coincidence).

I	V1	V2(V1R)
II	V2	V1(V2R)
Lead III	V3	V3R
Lead aVR	V4	V4R
Lead aVL	V5	V5R
Lead aVF	V6	V6R

**Figure B.16 — Extended lead example**

I	V1	—
II	V2	—
Lead III	V3	—
Lead aVR	V4	V7
Lead aVL	V5	V8
Lead aVF	V6	V9

**Figure B.17 — Extended lead 1**



I	V1	—
II	V2	—
Lead III	V3	—
Lead aVR	V4	V3R
Lead aVL	V5	V4R
Lead aVF	V6	V5R

**Figure B.18 — Extended lead 2**

## Annex C (informative)

### Encoding of waveform recognition point and measurement values

#### C.1 General

Waveform recognition points (classification point) may be encoded with event tag (MWF\_EVT), which is categorized as Level 2 as defined in ISO 22077-1.

##### C.1.1 Waveform recognition point

The ECG waveform recognition points are shown in [Figure C.1](#), and each point is encoded with the event tag of MFER coding. In the case that the recognition point is encoded in the root definition, the recognition points affect all leads of the beat. On the other hand, if the recognition points are in the channel definition, they only apply to beats in that channel.

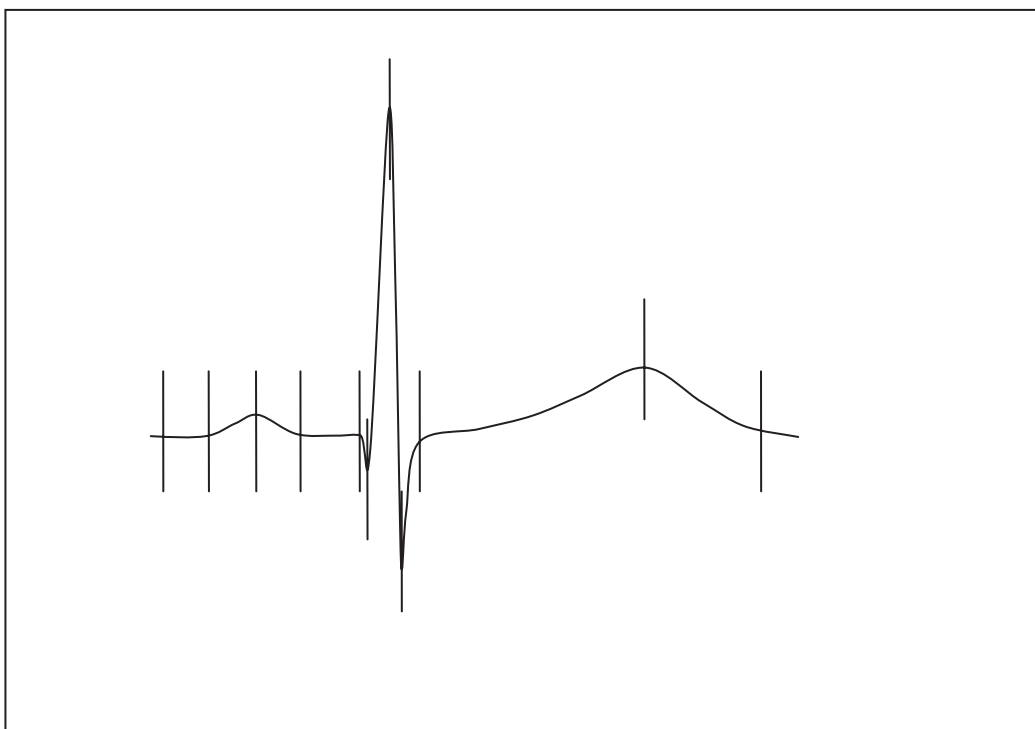


Figure C.1 — Waveform recognition point

##### C.1.2 Encoding for recognition point

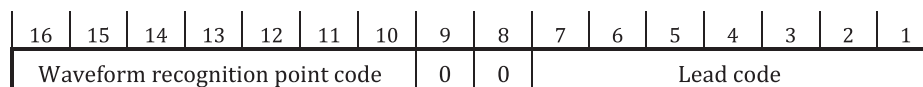
The waveform identification point is encoded with an event tag (MWF\_EVT). The episode code such as P wave, QRS, etc. is represented on the waveform recognition code of the MWF\_EVT.

The start point of the episode such as P onset, QRS onset, etc. is described on the starting time position of the MWF\_EVT. In the case of single point representation such as peak point, only the starting time position is used. If this is the case and supplement information is used, the duration shall be zero.

The end point is described by start point and duration, namely the end point is presented by start point + duration period. If there is specific information for the recognition point, the information can be described on the supplementary part in a text string.

**Table C.1 — Event**

MWF_EVT		Data length	Encoding range/remarks	Duplicated definitions	
65	41h	Event code	2	Waveform recognition point code	Possible
		Starting time (point)	4	Number of data values acquired at the sampling interval defined in the root definition	
		Duration	4		
		Interpretation statements descriptive information	Str < 256		



**Figure C.2 — Waveform recognition point code bit**

Lead code designation can be encoded as channel information when the channel coincides with the entity but in the 12-lead ECG, it is encoded by [Figure C.2](#).

### C.1.3 Group definition

When the waveform recognition points are identified as the same heart beat such as a P-QRST-T, the beat is indicated using bracketing by group definition (MWF\_SET). Since this tag is P/C = 1(bit 6), the group definition implies the context mode.

**Table C.2 — Group definition**

MWF_SET	Data length	Default	Remarks	Duplicated definitions
103	67h	Depends on definition		Not possible within scope

The group definition means that all recognition points are related to each other. For example, a P wave activity generates the following QRS contraction, and QRS and T wave are same beat phenomenon. Therefore, when some events should be described at same time, these events can be grouped as same beat.



**Figure C.3 — Example of P-QRS-T Group**

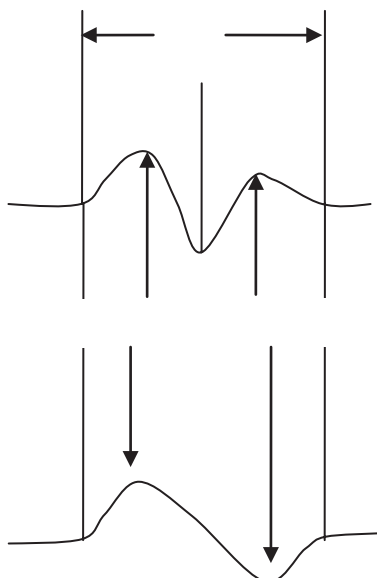


Figure C.4 — P wave

#### C.1.4 Classification code

Each classified point is represented in [Table C.3](#) on the first element of MWF\_EVN.

Table C.3 — Classification code

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_DOMT	55808	DA00	Dominant beat
MWF_ECG_AVBEAT	56320	DC00	Averaging beat
MWF_ECG_P_WAVE	35328	8A00	P wave
MWF_ECG_P2_WAVE	35840	8C00	P2 wave
MWF_ECG_P1_PEAK	36352	8E00	P wave first peak
MWF_ECG_P2_PEAK	36864	9000	P wave second peak
MWF_ECG_PP_WAVE	37376	9200	P' wave (Retrograde)
MWF_ECG_PP2_WAVE	37888	9400	P'2 wave
MWF_ECG_PP1_PEAK	38400	9600	P' wave first peak
MWF_ECG_PP2_PEAK	38912	9800	P' wave second peak
MWF_ECG_QRS_COMPLEX	41472	A200	QRS complex
MWF_ECG_QRS_PEAK	41984	A400	QRS peak
MWF_ECG_Q_WAVE	43008	A800	Q wave
MWF_ECG_Q_PEAK	43520	AA00	Q wave peak
MWF_ECG_R_WAVE	44032	AC00	R wave
MWF_ECG_R_PEAK	44544	AE00	R wave peak
MWF_ECG_R2_WAVE	45056	B000	R' wave
MWF_ECG_R2_PEAK	45568	B200	R' wave peak
MWF_ECG_R3_WAVE	46080	B400	R'' wave
MWF_ECG_R3_PEAK	46592	B600	R'' wave peak

**Table C.3 (continued)**

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_S_WAVE	47104	B800	S wave
MWF_ECG_S_PEAK	47616	BA00	S wave peak
MWF_ECG_S2_WAVE	48128	BC00	S' wave
MWF_ECG_S2_PEAK	48640	BE00	S' wave peak
MWF_ECG_S3_WAVE	49152	C000	S'' wave
MWF_ECG_S3_PEAK	49664	C200	S'' wave peak
MWF_ECG_QRS_NOTCH	50176	C400	Notch
MWF_ECG_DELTA	42496	A600	Delta
MWF_ECG_T_END	51712	CA00	T wave end
MWF_ECG_T_PEAK	52224	CC00	T wave peak
MWF_ECG_T2_END	52736	CE00	T' wave end
MWF_ECG_T2_PEAK	53248	D000	T' wave peak
MWF_ECG_U_END	53760	D200	U wave end
MWF_ECG_U_PEAK	54272	D400	U wave peak
MWF_ECG_STJ	50688	C600	ST-j
MWF_ECG_ST	51200	C800	ST
WMF_ECG_J_WAVE	39424	9A00	J wave
MWF_ECG_H_WAVE	40448	9E00	His bundle wave
MWF_ECG_FIDUCIAL	33792	8400	Fiducial point
MWF_ECG_ISOLECTRIC	33280	8200	Isoelectric point
MWF_ECG_UN_PACING	34048	8500	Pacing pulse (unknown)
MWF_ECG_A_PACING	34304	8600	Atrial pacing pulse
MWF_ECG_V_PACING	34816	8800	Ventricular pacing pulse
MWF_ECG_CAL	55296	D800	Calibration

### C.1.5 Measurement value (measurement value with no lead designation)

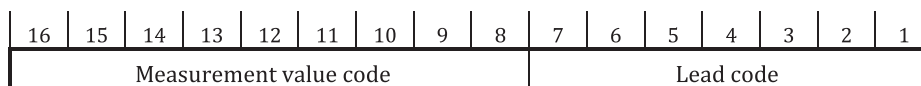
[Table C.4](#) shows the values measured by total leads.

**Table C.4 — Measurement value (no lead designation) code table**

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_HEART_RATE	32769	8001	Heart rate
MWF_ECG_VPC_MIN	32778	800A	VPC rate per min
MWF_ECG_VPC_HOUR	32780	800C	VPC rate per hour
MWF_ECG_TIME_PD_RR	32770	8002	RR interval
MWF_ECG_ANGLE_P_FRONT	32772	8004	P wave axis
MWF_ECG_ANGLE_QRS_FRONT	32774	8006	QRS axis
MWF_ECG_ANGLE_T_FRONT	32776	8008	T wave axis
MWF_ECG_ANGLE_T_PP	32782	800E	PP interval

### C.1.6 Measurement value (allowed to designate for each lead)

In the event that the measurement value differs for each lead and all leads are standardized, the measurement value shall be specified. In the event that Leads III and aVL are values found from lead composition, the measurement value can be described by designating the virtual channel, but to be simple, it can be encoded by the present rules (lead name designation). In the case of lead code 0, it is interpreted to be no lead designation. Where still more detailed description is required, it is found by operation from the waveform classification point and sampling information.



**Figure C.5 — Measurement value code composition**

**Table C.5 — Measurement value table for each lead**

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_TIME_PD_P	57472	E080	P width
MWF_ECG_AMPL_P1	57600	E100	P1 amplitude
MWF_ECG_AMPL_P2	57728	E180	P2 amplitude
MWF_ECG_TIME_PD_PQ	57856	E200	PQ interval
MWF_ECG_AREA_P_WAV	59776	E980	P Area
MWF_ECG_TIME_PD_Q	57984	E280	Q duration
MWF_ECG_AMPL_Q	58112	E300	Q amplitude
MWF_ECG_TIME_PD_QRS	58240	E380	QRS duration
MWF_ECG_TIME_PD_R	59904	EA00	R duration
MWF_ECG_AMPL_R	58368	E400	R amplitude
MWF_ECG_TIME_PD_R2	60032	EA80	R2 duration
MWF_ECG_AMPL_R2	59392	E800	R2 amplitude
MWF_ECG_TIME_PD_S	60160	EB00	S duration
MWF_ECG_AMPL_S	58496	E480	S amplitude
MWF_ECG_TIME_PD_S2	60288	EB80	S2 duration
MWF_ECG_AMPL_S2	59520	E880	S2 amplitude
MWF_ECG_AMPL_STj	58624	E500	STj
MWF_ECG_AMPL_ST	58752	E580	ST
MWF_ECG_ST_MIN	60416	EC00	STmin
MWF_ECG_AMPL_T	58880	E600	T amplitude
MWF_ECG_AMPL_T2	60544	EC80	T2 amplitude
MWF_ECG_TIME_PD_QT	59008	E680	QT interval
MWF_ECG_TIME_PD_QT_CORR	59136	E700	QTc interval
MWF_ECG_TIME_PD_VAT	59264	E780	Ventricular activation time
MWF_ECG_AMPL_ST_SLOPE	59648	E900	ST-slope
MWF_ECG_AMPL_ST1	60672	ED00	ST-amplitude at the J-point plus 20 ms (μV)
MWF_ECG_AMPL_ST2	60800	ED80	ST-amplitude at the J-point plus 40 ms (μV)

**Table C.5 (continued)**

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_AMPL_ST3	60928	EE00	ST-amplitude at the J-point plus 60 ms ( $\mu\text{V}$ )
MWF_ECG_AMPL_ST4	61056	EE80	ST-amplitude at the J-point plus 80 ms ( $\mu\text{V}$ )
MWF_ECG_AMPL_ST5	61184	EF00	ST-amplitude at the J-point plus 1/16 average R-R interval ( $\mu\text{V}$ )
MWF_ECG_AMPL_ST6	61312	EF80	ST-amplitude at the J-point plus 1/8 average R-R interval ( $\mu\text{V}$ )

### C.1.7 Event mark

In the case that the event marks that are prepared by an electrocardiograph are encoded, the present code is used and the meaning is explained by either attaching the applicable specifications (comment tag, etc.) or by including event information.

**Table C.6 — Event mark**

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_MARK 0	61184	EF00	Mark 0
MWF_ECG_MARK 1	61185	EF01	Mark 1
MWF_ECG_MARK 2	61186	EF02	Mark 2
MWF_ECG_MARK 3	61187	EF03	Mark 3
MWF_ECG_MARK 4	61188	EF04	Mark 4
MWF_ECG_MARK 5	61189	EF05	Mark 5
MWF_ECG_MARK 6	61190	EF06	Mark 6
MWF_ECG_MARK 7	61191	EF07	Mark 7

### C.1.8 Measurement (recording) information

Calibration waveform, information that occur during measurement of ECG and information with artefacts may be encoded in MFER records. To encode this information, when the MFER waveform is processed, they are encoded using MWF\_EVT. The MFER waveform is not directly processed but when various kinds of information that are generated at the time of measurement are encoded, they are explained by ancillary information MWF\_INF. Detailed information is encoded by the waveform information section.

**Table C.7 — Recording condition**

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_CAL	65025	FE01	Calibration
MWF_ECG_NOISE	65026	FE02	Artefact/Noise
MWF_ECG_FILTER	65027	FE03	Filter
MWF_ECG_EDOFF	65028	FE04	Electrode OFF
MWF_ECG_PWR	65029	FE05	Power line frequency
MWF_ECG_LEADS	65030	FE06	Measurement leads combination

**Table C.7** (continued)

Reference ID	CODE		English name
	DEC	HEX	
MWF_ECG_SENS	65031	FE07	Measurement sensitivity



## Annex D (informative)

### Reference table of coding scheme

#### D.1 Lead name

In [Annex C](#), the coding scheme of the present rule and SCP-ECG shall be described.

According to this specification, codes for lead name shall be encoded by a number smaller than 127. Therefore, some SCP-ECG codes need to be converted. In this coding scheme table, those leads that are not used in standard 12-lead ECG are defined, and do not typically need to be converted.

**Table D.1 — Waveform Lead name**

MWF_LDN		Data length	Default	Encoding range · remarks	Duplicated definitions	
09	09h	Waveform code	≤2	Unidentified	In encoding waveform information, the data length = 2	Override
		Waveform information	Str ≤ 32			

The present code indicates the code correspondence of ECG 12-lead waveform. According to the present rule, it is recommended that the lead that is not used in the standard ECG should be encoded by waveform information. When using EASI derivation leads, the derivation lead name such as “EASI” should be specified, as well as the lead name code.

In addition, there are ECG leads called CV5RL, CV6LL, CV6LU, and V10, which are not for humans but for animals. In case other leads other than these 4 leads for animals are used, they should be used by waveform information.

**Table D.2 — Lead code**

CODE	Reference ID		SCP-ECG	Remarks
	MFER			
0	CONFIG	MWF_ECG_LEAD_CONFIG		CONFIG shall be used when using only waveform information.
1	I	MWF_ECG_LEAD_I	I	When these leads are used in the display or the other purpose, they shall be represented as like “lead II”.
2	II	MWF_ECG_LEAD_II	II	
3	V1	MWF_ECG_LEAD_V1	V1	
4	V2	MWF_ECG_LEAD_V2	V2	
5	V3	MWF_ECG_LEAD_V3	V3	
6	V4	MWF_ECG_LEAD_V4	V4	
7	V5	MWF_ECG_LEAD_V5	V5	
8	V6	MWF_ECG_LEAD_V6	V6	
9	V7	MWF_ECG_LEAD_V7	V7	
10	—	—	V2R	According to MFER, V2R shall be used as V1.

Table D.2 (continued)

CODE	Reference ID		SCP-ECG	Remarks
	MFER			
11	V3R	MWF_ECG_LEAD_V3R	V3R	When these leads are used in the display or the other purpose, they shall be represented as like "lead V3R".
12	V4R	MWF_ECG_LEAD_V4R	V4R	
13	V5R	MWF_ECG_LEAD_V5R	V5R	
14	V6R	MWF_ECG_LEAD_V6R	V6R	
15	V7R	MWF_ECG_LEAD_V7R	V7R	
16	X	MWF_ECG_LEAD_X	X	According to MFER, leads other than vector-lead or monitor ambulatory ECG-lead such as 12-lead ECG shall be prescribed separately.
17	Y	MWF_ECG_LEAD_Y	Y	
18	Z	MWF_ECG_LEAD_Z	Z	
19	CC5	MWF_ECG_LEAD_CC5	CC5	
20	CM5	MWF_ECG_LEAD_CM5	CM5	
21	—	—	LA	
22	—	—	RA	
23	—	—	LL	
24	—	—	I	
25	—	—	E	
26	—	—	C	
27	—	—	A	
28	—	—	M	
29	—	—	F	
30	—	—	H	
31	NASA	MWF_ECG_LEAD_NASA	I-cal	
32	CB4	MWF_ECG_LEAD_CB4	II-cal	
33	CB5	MWF_ECG_LEAD_CB5	V1-cal	
34	CB6	MWF_ECG_LEAD_CB6	V2-cal	
35	—	—	V3-cal	
36	—	—	V4-cal	
37	—	—	V5-cal	
38	—	—	V6-cal	
39	—	—	V7-cal	
40	—	—	V2R-cal	
41	—	—	V3R-cal	
42	—	—	V4R-cal	
43	—	—	V5R-cal	
44	—	—	V6R-cal	
45	—	—	V7R-cal	
46	—	—	X-cal	
47	—	—	Y-cal	
48	—	—	Z-cal	
49	—	—	CC5-cal	
50	—	—	CM5-cal	

Table D.2 (continued)

CODE	Reference ID		SCP-ECG	Remarks
	MFER			
51	—	—	LA-cal	
52	—	—	RA-cal	
53	—	—	LL-cal	
54	—	—	I-cal	
55	—	—	E-cal	
56	—	—	C-cal	
57	—	—	A-cal	
58	—	—	M-cal	
59	—	—	F-cal	
60	—	—	H-cal	
61	III	MWF_ECG_LEAD_III	Lead III	When these leads are used in the display or other purpose, they shall be represented as like "Lead III".
62	aVR	MWF_ECG_LEAD_AVR	aVR	
63	aVL	MWF_ECG_LEAD_AVL	aVL	
64	aVF	MWF_ECG_LEAD_AVF	aVF	
65	—	—	-aVR	According to MFER, -aVR shall not be used, and the user should use the negative number of aVR instead.
66	V8	MWF_ECG_LEAD_V8	V8	When these leads are used in the display or other purpose, they shall be represented as like "Lead V8R".
67	V9	MWF_ECG_LEAD_V9	V9	
68	V8R	MWF_ECG_LEAD_V8R	V8R	
69	V9R	MWF_ECG_LEAD_V9R	V9R	
70	Nehb-D	MWF_ECG_LEAD_NEHB_D	D (Nehb-Dorsal)	
71	Nehb-A	MWF_ECG_LEAD_NEHB_A	A (Nehb-Anterior)	
72	Nehb-J	MWF_ECG_LEAD_NEHB_J	J (Nehb-Interior)	
91	MCL	MWF_ECG_LEAD_MCL	MCL	
92	—	—	MCL1	
93	—	—	MCL2	
94	—	—	MCL3	
95	—	—	MCL4	
96	—	—	MCL5	
97	—	—	MCL6	
98	—	—	CC	
99	—	—	CC1	
100	—	—	CC2	
101	—	—	CC3	

**Table D.2 (continued)**

CODE	Reference ID		SCP-ECG	Remarks
	MFER			
102	—	—	CC4	
103	—	—	CC6	
104	—	—	CC7	
105	—	—	CM	
106	—	—	CM1	
107	—	—	CM2	
108	—	—	CM3	
109	—	—	CM4	
110	—	—	CM6	
111	CV5RL	MWF_ECG_LEAD_CV5RL	—	
112	CV6LL	MWF_ECG_LEAD_CV6LL	—	
113	CV6LU	MWF_ECG_LEAD_CV6LU	—	
114	V10	MWF_ECG_LEAD_V10	—	

NOTE At recording, Lead -aVR is not encoded by MFER. It shall be processed by taking a negative number of aVR on the user side (viewer, etc.).

NOTE In SCP-ECG, etc., V2R(10) is defined but in MFER, it is not used.

## Annex E (informative)

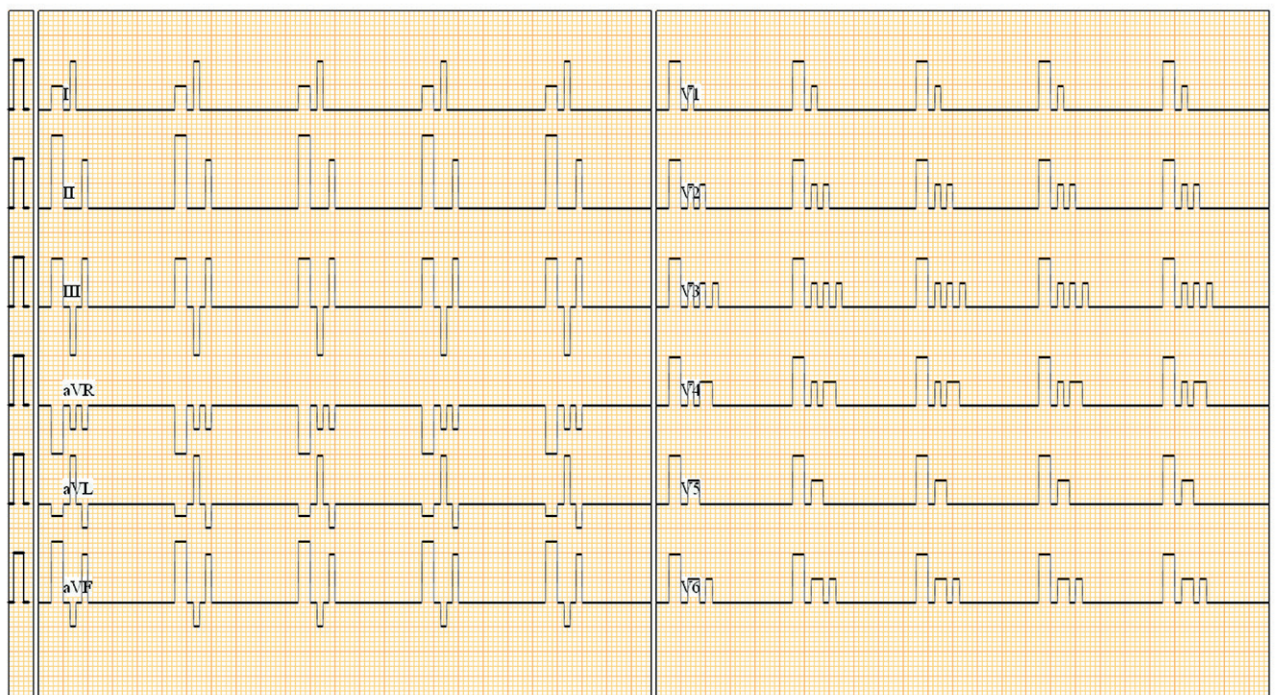
### Waveform verification rule between ECG provider and user

#### E.1 General

This rule is for verification between ECG provider and user. The waveform should include a checking pattern of timing, width, and shape for each lead such as illustrated in [Figure E.1](#).

#### E.2 Waveform example

The checking waveform shall be encoded in accordance with the sampling conditions, waveform data alignment conditions and other provider's specifications. The waveform shall include timing information for interval and width, waveform shape for each lead, amplitude, and so on. User shall confirm the correct reproduction of the waveform that is calculated limb leads III, aVR, aVL, aVF with I and II, correctly displayed chest leads, and confirm timing such as interval and width and amplitude.



**Figure E.1 — ECG checking format example**

## Bibliography

- [1] ISO 11073-91064, *Health informatics — Standard communication protocol — Part 91064: Computer-assisted electrocardiography*
- [2] ISO/IEEE 11073-10101, *Health informatics — Point-of-care medical device communication — Part 10101: Nomenclature*
- [3] ISO/IEEE 11073-10102, *Health informatics — Point-of-care medical device communication — Part 10102: Nomenclature — Annotated ECG*









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