
**Health informatics — Medical
waveform format —**

**Part 3:
Long term electrocardiography**

*Informatique de santé — Forme d'onde médicale —
Partie 3: Électrocardiographie de longue durée*



STANDARDSISO.COM : Click to view the full PDF of ISO/TS 22077-3:2015



COPYRIGHT PROTECTED DOCUMENT

© ISO 2015, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	2
5 Encoding format	3
5.1 Primary description	3
5.1.1 Sampling attributes	3
5.1.2 Frame attributes	4
5.1.3 Waveform class	4
5.2 Data alignment	5
5.2.1 Data encoding	5
5.2.2 Recorder encoding	6
5.2.3 Scanner encoding	9
5.3 Lead name	12
5.4 Lead calculation	13
5.5 Filter information	14
5.5.1 Description of filter-processed data	14
5.5.2 Description of filter use information	15
5.6 Unique identifier	15
6 Measurement information	15
6.1 Measurement date/time	15
6.2 Patient information	15
6.2.1 Patient name	15
6.2.2 Patient ID	16
6.2.3 Age and date of birth	16
6.2.4 Gender	16
6.2.5 Comment	17
Annex A (informative) MFER Conformance statement	18
Annex B (informative) Waveform encoding	19
Annex C (informative) Example of waveform coding	21
Annex D (informative) Reference table of coding scheme	25
Bibliography	29

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).

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).

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 ambulatory ECG examination is widely utilized in the clinical field. This rule applies for long-term waveform description such as ambulatory ECG, monitoring waveforms, etc. Recently, EMR, or Electronic Medical Records, becomes commonly used and it strongly requires Ambulatory ECG examination for the therapeutic purpose. However, new digitalized data of Ambulatory ECG recorder cannot be used among different manufacturers scanner. This Technical Specification intends that MFER encoded data for ambulatory ECG is analysed by other scanner and these are also interoperable on EMRs.

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.

STANDARDSISO.COM : Click to view the full PDF of ISO/TS 22077-3:2015

Health informatics — Medical waveform format —

Part 3: Long term electrocardiography

1 Scope

This Technical Specification defines the application of medical waveform format encoding rules (MFER) to describe long-term electrocardiogram waveforms measured in physiological laboratories and health care clinics. It covers electrocardiograms such as bipolar 2, 3-lead, 12-lead that are measured by medical equipment such as Holter electrocardiograph and patient physiological monitors that are compatible with the medical waveform format Encoding rules (MFER) Technical Specification (ISO 22077-1).

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, *Medical waveform format — Part 1: Encoding rules*

3 Terms and definitions

3.1

recorder

recording equipment worn or carried by the patient including associated electrodes and cables for recording or recording and analysing heart action potentials

Note 1 to entry: Some recorders can record not only ECG but also non-invasive blood pressure measured automatically, SpO₂, and respiratory waveform.

3.2

scanner

equipment that retrieves ECG waveforms from the recorder and analyses and edits ECG waveforms provided by the recorder to determine the presence of abnormal heart rhythms such as arrhythmia

3.3

patient event

information or event for analysing the ECG.

EXAMPLE For example, they may have chest pain, dizziness, or palpitations, etc. Pushing a “patient event” switch located on the recorder allows for recording ECG waveforms with the time of occurrence.

3.4

heart beat

ECG cycle, comprising the P, QRS and the ST-T wave

3.5

dominant beat

typical heart beat used for measurement and analysis

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

3.6

average beat

typical heart beat used for measurement and analysis

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

3.7

abstract waveform

one heartbeat of P-QRS-T, extracted by each lead for analyzing and editing

3.8

low battery

<information>battery voltage is low and exchange of battery is required

3.9

leads off

<information> electrodes are disconnected

3.10

out of range

<information in patient monitoring system>poor condition on the radio field

3.11

pacing pulse

pulsed waveform from artificial pacemaker

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)
SpO2	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	Sampling rate unit	1	1 000 Hz		Override
		Exponent (10th power)	1		10 ⁻¹²⁸ ~+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 of least significant bit for ECG waveform sampled (generally, digitized) ([Table 3](#)).

Table 3 — Sampling resolution

MWF_SEN			Data length	Default	Encoding range/remarks	Duplicated definitions
12	0Ch	Sampling resolution unit	1	See Table 6	—	Override
		Exponent (10th power)	1		10-128~+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 attributes 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 of sequences

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

5.1.3 Waveform class

Long-term ECG waveform is grouped based on instruments and purpose, as shown in Table 8.

Table 8 — Waveform class

MWF_WFM		Date length	Remarks	Duplicated definitions
08	08h	2		Override
		Str ≤ 32	Waveform encoding	

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

For types of waveforms ([Tables 9 to 10](#)), 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 — Long-term ECG waveform-1

Major classification	Type	Value	Waveform descriptions	Remarks
Electrocardiogram	ECG_LTERM	2	Long-term ECG	Ambulatory ECG Patient monitoring system ECG

- It is recommended that ECG classified into the type ECG_LTERM is used when it takes over 30 min for measurement, because application system such as viewer may have different display format for each waveform type. However, this recommendation is not a requirement.
- In addition, extracted waveforms which are used in the long-term ECG are shown in [Table 10](#). These waveforms shall be extracted after being analysed and edited, and then shall be used for scanning.

Table 10 — Long-term ECG waveform-2

Major classification	Type	Value	Waveform descriptions	Remarks
Electrocardiogram	ECG_BEAT	9	Dominant beat extracted waveform	Extracted waveform for one beat by ambulatory ECG Write comment Average, Median, Dominant

5.2 Data alignment

Data alignment recommended by ambulatory ECG standard shall be prescribed. Data alignment should be simple as much as possible in order to prevent troubles caused by the complication which may result in some limitation of interoperability by using complicated format.

5.2.1 Data encoding

In long-term ECGs, the recorder for recording ECG waveforms, the scanner for analysing and editing ECG waveforms, and the electronic medical record for referring waveforms shall be encoded in the most appropriate format respectively in accordance with MFER.

- Recorder encoding: The recorder encodes ECG waveforms on the assumption that it processes the data in real time. The data encoded by the recorder shall be regarded as the original data (original ECG). This encoding format is defined in view of the risk of sudden disconnection of battery or other record media in patient's daily life. Furthermore, encoding of information including pacemaker spike and patient event shall be also prescribed.
- Scanner encoding: In the scanner encoding, information derived from analysing and editing the long-term ECG data recorded by the recorder shall be added to the original data. This encoding format is defined in view of reading MFER file with the scanner, and the secondary information, including heart beat code or event strip created by the scanner, shall be encoded in this format. This format also shall be used to output data from the scanner to the host system such as electronic medical record in accordance with MFER.

5.2.2 Recorder encoding

In recorder encoding, the following points should be noted:

- In view of sudden disconnection of battery or other record media, the data recorded by the time of the disconnection should be kept to allow for reading data in a proper format.
- Information on patient event or body movement should be in the same way as ECG and respiratory waveforms, so that every user can read data without any difficulty.

5.2.2.1 Encoding of waveforms

In recorder encoding, waveforms shall be encoded according to MWF_WAV (1Eh), and shall consist of lead, status and stopper. [Figure 1](#) shows one minute waveform data, and it is an example of waveform data recorded using leads called CM5 and NASA.

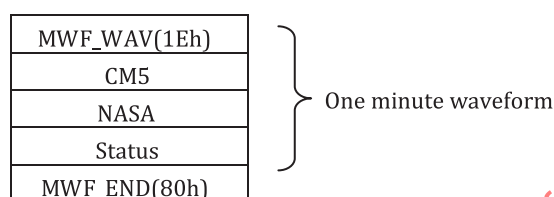


Figure 1 — Encoding of waveform

MWF_END (80h) tag shall be encoded at the end of the file as a stopper.

In encoding waveforms, it is practical to use a multiple frame.

It is practical to use multiple frames to encode waveforms. Frames are usually created in the order that waveforms are generated, and then the frames shall be aligned to create waveforms.

Frame 1		Frame 2		Frame 3
Header -1	Wave body	Header -2	Wave body	Header-3

Figure 2 — Multiple frame configurations

In encoding successive waveforms with the multiple frames, waveforms encoded with frames later than Frame 2 are usually the same with pre-encoded condition or status in Frame 1. For example, the sampling frequency and waveform code are usually the same. In such case, according to MFER, the header is frequently omissible.

5.2.2.2 Encoding format for pacemaker spike and patient event

Pacemaker spike and patient event shall be encoded by data type MWF_DTP (0Ah) "16-bit status".

Table 11 — Waveform information (status)

MWF_DTP	Data length	Default	Remarks	Duplicated definitions
10	0Ah	1	N.A.	Override

Table 12 — Definition of data type

Value	Data type
4	16-bit status

Pacemaker information shall be encoded with 16-bit status.

Table 13 — Definition of status

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Information	Value
0	Pacing	0: none 1: Pacing
1	Reserved	
2	Ventricular pacing	0: none 1: Ventricular pacing
3	Atrial pacing	0: none 1: Atrial pacing
4	Reserved	
5	Low battery	0: none 1: Battery changing
6	Leads off	0: none 1: Electrode disconnection
7	Radio field strength	0: none 1: Out of range
8	Patient event 1	0: none 1: patient event 1
9	Patient event 2	0: none 1: patient event 2
10 - 12	Body position	000: none 001: Standing/Seating 010: Supine 011: Right lateral decubitus 100: Left lateral decubitus 101: Prone 110: Reserved 111: Reserved
13	Reserved	
14	Reserved	
15	Reserved	

Patient event 1 is defined on the assumption that the recorder event key is held down in ambulatory ECGs. In the patient monitoring system, this corresponds with the “nurse call” in the transmitter. Patient event 2 can be used as medical information. It is recommended that its practical use is defined by each user.

5.2.2.3 Encoding of event information

Said “event information” includes every information except waveform information. Patient event is defined as “Status” in 5.2.2.2 of this rule. Value of body movement, blood pressure, and SpO2 shall be encoded as patient event.

Table 14 — Reference pointer

MWF_RPT		Data length	Default	Remarks	Duplicated definitions
69	45h	Data type	1		Possible
		Reference pointer	Str < 256	URL	

Table 15 — Data type

Data type	Value
External data	0
MFER data	1

Event information shall be encoded using the reference pointer MWF_RPT (45) in a number of formats. Some examples are shown below:

a) **MWF_EVT (41h)**

Figure 3 illustrates the encoding of patient event in event information by using the reference pointer MWF_RPT (45h). It is recommended that MWF_END (80h) is used to encode not only waveforms but also event information.

Using MWF_EVT (41h), patient event shall be defined as character string.

File name : HolterECG.mwf	
:	Data type : 1 Reference pointer file: //PatEvt.mwf
:	
MWF_RPT(45h)	
MWF_WAV(1Eh)	
CM5	
NASA	
CM5	
NASA	
MWF_END(80h)	
End tag	

Figure 3 — Definition of event**Table 16 — Event**

MWF_EVT		Data length	Encoding range / remarks	Duplicated definitions
65	41h	Waveform recognition pointcode	2	Multiple definitions available
		Starting time (point)	4	
		Duration	4	
		Event information	Str < 256	

b) **MWF_VAL (42h)**

Figure 4 illustrates the encoding of patient event in event information by using the reference pointer MWF_RPT (45). It is recommended that MWF_END (80h) is used to encode not only waveforms but also event information.

This rule only applies to irregular measurements such as non-invasive blood pressure (NIBP). By using MWF_VAL (42h), NIBP shall be defined as measurement value.

File name : HolterECG.mwf	
:	
:	
MWF_RPT(45h)	Data type : 1
	Reference pointer file://NIBP_data.mwf
MWF_WAV(1Eh)	
CM5	
NASA	
CM5	
NASA	
MWF_END(80h)	End tag

File name : NiBP_data.mwf	
:	
:	
MWF_VAL(42h)	Encoding N IBP as MWF_VAL
Encoding of measurement value	Encoding of time point and measurement value
MWF_END(80h)	End tag

Figure 4 — Definition of measurement value

Table 17 — Measurement value

MWF_VAL		Data length	Encoding range/remarks	Duplicated definition
66	42h	Value code	2	Multiple definitions available
		Time point	4	
		Value	Str ≤ 32	

5.2.3 Scanner encoding

The scanner encoding format after analysing and editing shall be prescribed.

5.2.3.1 Encoding of MFER interpretation code and beat annotation

Interpretation code and beat annotation shall be encoded with the event tag.

Table 18 — Encoding of interpretations

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

Interpretation code format shall be defined as follows:

Table 19 — Interpretation code format

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	Interpretation code												Possibility

Interpretation code shall consist of number starts with 4244. See [Table 20](#).

Each possibility bit code means as follows:

- 0: Undesignated (No need to be defined or specified)
- 1: In case the possibility of the applicable finding is unlikely
- 2: Suspicious
- 3: Strongly suspicious

5.2.3.2 Interpretation

When the applicable interpretation is encoded throughout the whole frame, the definition shall be made in the root definition region. Both starting time and duration shall not be used when the event information is not used. In the case that event information is used, “0 (zero)” shall be used for both starting time and duration.

5.2.3.3 Beat-to-beat waveform classification

The time when the relevant heart beat is observed shall be designated as starting time, and the duration shall not be used. In the case that event information is used, “0 (zero)” shall be used for the duration.

5.2.3.4 Waveform classification in the given period

Relevant regional time shall be designated by using the starting time and duration in order to encode abnormal waveforms, for example, atrial fibrillation.

5.2.3.5 Simultaneous encoding of event code and event information

Event code and event information shall be used simultaneously. Alternatively, event code = 0 and event information shall be encoded. See the example below.

E.g. Event information shall be encoded with “interpretation text^code system (manufacturer name)^abbreviation or code” (in case of encoding plurality of event information, use “&”). In encoding with MFER code MWF_ECGL_VE_ISO(4496) and adding event information defined in SCP-ECG, the event information shall be encoded as follows:

ventricular premature complex^SCP-ECG^VPC

Table 20 — Interpretation code

Reference ID	CODE		Interpretation (English)
	DEC	HEX	
MWF_ECG_UNDFD	4224	1080	Unclassified
MWF_ECGL_NOR_BEAT	4228	1084	Normal beat
MWF_ECGL_WPW_BEAT	4232	1088	Wolff-Parkinson-White syndrome type beat

Table 20 (continued)

Reference ID	CODE		Interpretation (English)
	DEC	HEX	
MWF_ECGL_BBB_BEAT	4236	108C	Bundle branch block beat
MWF_ECGL_JUC_BEAT	4240	1090	Junctional beat
MWF_ECGL_SUP_BEAT	4244	1094	Supraventricular beat
MWF_ECGL_SBBB_BEAT	4248	1098	Supraventricular beat with Bundle branch Block
MWF_ECGL_SWPW_BEAT	4252	109C	Supraventricular beat with WPW
MWF_ECGL_AVC_BEAT	4256	10A0	Aberrant Ventricular Conduction
MWF_ECGL_VENT_BEAT	4260	10A4	Ventricular beat
MWF_ECGL_FUS_BEAT	4264	10A8	Fusion beat
MWF_ECGL_VENTESP_BEAT	4268	10AC	Ventricular escape beat
MWF_ECGL_IDORHM_BEAT	4272	10B0	Idioventricular rhythm
MWF_ECGL_UNDFD_BEAT	4276	10B4	Undefined beat
MWF_ECGL_UNDFD_L_BEAT	4280	10B8	Learning beat
MWF_ECGL_UNDFD_C_BEAT	4284	10BC	Calibration beat
MWF_ECGL_A_PACE_BEAT	4288	10C0	Atrial paced beat
MWF_ECGL_V_PACE_BEAT	4292	10C4	Ventricular paced beat
MWF_ECGL_D_PACE_BEAT	4296	10C8	Dual paced beat
MWF_ECGLPAC_F_BEAT	4300	10CC	Paced fusion beat
MWF_ECGL_ART_1_BEAT	4304	10D0	Artefact
MWF_ECGL_ART_2_BEAT	4308	10D4	Artefact
MWF_ECGL_BRADY	4480	1180	Bradycardia
MWF_ECGL_TACHY	4484	1184	Tachycardia
MWF_ECGL_PAUSE	4488	1188	Pause
MWF_ECGL_PROLONG	4492	118C	Prolong
MWF_ECGL_VE_ISO	4496	1190	VE Isolated
MWF_ECGL_VE_COU	4500	1194	VE Couplet
MWF_ECGL_VE_RUN	4504	1198	VE Run
MWF_ECGL_VT	4508	119C	Ventricular Tachycardia
MWF_ECGL_RONT	4512	11A0	R on T
MWF_ECGL_VENT_BIGE	4516	11A4	Ventricular Bigeminy
MWF_ECGL_VENT_TRI	4520	11A8	Ventricular Trigeminy
MWF_ECGL_SVE_ISO	4524	11AC	SVE Isolated
MWF_ECGL_SVE_COU	4528	11B0	SVE Couplet
MWF_ECGL_SVE_RUN	4532	11B4	SVE Run
MWF_ECGL_PARO_S_TACHY	4536	11B8	Paroxysmal Supraventricular Tachycardia
MWF_ECGL_SUP_BIGE	4540	11BC	Supraventricular Bigeminy
MWF_ECGL_SUP_TRI	4544	11C0	Supraventricular Trigeminy
MWF_ECGL_A_FIB	4548	11C4	Atrial Fibrillation
MWF_ECGL_A_FLUTTER	4552	11C8	Atrial Flutter
MWF_ECGL_A_F_F	4556	11CC	Atrial Flutter/Fibrillation
MWF_ECGL_ST_ELE	4560	11D0	ST Elevation

Table 20 (continued)

Reference ID	CODE		Interpretation (English)
	DEC	HEX	
MWF_ECGL_ST_DEP	4564	11D4	ST Depression
MWF_ECGL_CAP_FAIL	4568	11D8	Capture Failure
MWF_ECGL_UNDER_SENS	4572	11DC	Under Sensing
MWF_ECGL_OVER_SENS	4576	11E0	Over Sensing

5.3 Lead name

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. As the lead code is encoded by the number 0-127, extra attention would be required in the case of complying with other rules such as SCP-ECG. Lead code later than 4160 is defined in the long-term ECG standard. For more detailed lead name other than the definition in the long-term ECG standard, see [Annex D](#).

Table 21 — 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	b	—	—
11	V3R	61	III
12	V4R	62	aVR
13	V5R	63	aVL
14	V6R	64	aVF
15	V7R	65	-aVR ^a
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	—	—

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

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

Table 21 (continued)

Code	Lead	Code	Lead
33	CB5	—	—
34	CB6	—	—
^a -aVR lead shall not be encoded according to MFER. The users (viewer) should make a calculation to derive -aVR when required. ^b Although V2R (10) is defined in other rules such as SCP-ECG, the definition shall not be used in MFER.			

Table 22 — Lead name-2

Code	Lead	Remarks
4160	Status	In case status including body position is encoded
4161	Body position	In case body position is encoded as successive waveforms
4162	Body movement	
4163	Respiratory	In case method for respiratory measurement is not specified (including snoring)
160	Impedance respiratory waveform	
143	Blood pressure	In case method for NiBP measurement is not specified
175	SPO2	
4166	ECG1	These shall be used in case lead name is not definite
4167	ECG2	
4168	ECG3	
4169	ECG4	

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 should be practiced to prevent occurrence of arithmetic waveform distortion.

Table 23 — Lead calculation operation table (derivation from leads I and II)

Lead name	Arithmetic operation	Computation (right hand potential R; left hand potential L; and left foot potential F)
III	II - I	III = F - L = (F - R) - (L - R), where II = F - R, 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 24 — Lead calculation operation table (derivation from leads I and III)

Lead name	Calculation formula	Calculation (right hand potential R; left hand potential L; and left foot potential F)
II	III + I	$II = F - R = (F - L) + (L - R)$, where $III = F - L$, $I = L - R$
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 25 — Lead calculation operation table (derivation from leads II and III)

Lead name	Calculation formula	Calculation (right hand potential R; left hand potential L; and left foot potential F)
I	II - III	$I = L - R = (F - R) - (F - L)$, where $II = F - R$, $III = F - L$
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	$(II + III)/2$	$aVL = F - (R + L)/2 = \{(F - R) + (F - L)\}/2 = (II + III)/2$
-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 26 — Filter information

MWF_FLT	Data length	Duplicated definitions
17	Str < 256	Possible

Table 27 — Filter description example

Filter function	Abbreviation	Example	Meaning
Filter information only	None	Hum filter ON	Ham filter (not specified) is used. More specific information shall be provided by adding power supply frequency information.
High pass filter	HPF	HPF = 0.05	Characteristics unspecified 0.05 Hz low frequency cutoff (high-pass) filter is used.
Low pass filter	LPF	LPF = 150^second order Butterworth filter	Butterworth second characteristics 150 Hz high frequency cutoff (low-pass) filter is used.
Band elimination filter	BEF	BEF = 50^Hum filter	50 Hz ham filter is used. Cutoff characteristics uncertain.

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 $1/(2\pi \times 3 \text{ s})$ approximately 0,05 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 28 — 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.

6.1 Measurement date/time

This tag encodes the examination/measurement date/time or the data acquisition date/time ([Table 29](#)).

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

Table 29 — Measurement time

MWF_TIM			Data length	Default	Remarks	Duplicated definitions
133	85h	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	
		Milli-sec	2		0 – 999	
		Micro-sec	2		0 – 999	

6.2 Patient information

6.2.1 Patient name

Patient name should be encoded as follows.

Family name^first name^middle name

Table 30 — Patient name

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

6.2.2 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 31 — Patient ID

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

6.2.3 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 32 — Age and date of birth

MWF_AGE				Data length	Default	Remarks	Duplicated definitions
131	83h	Age	Years	1	None		Override
			Days	2			
		Birth date	Year	2			
			Month	1			
			Day	1			

6.2.4 Gender

Patient gender may be encoded.

Table 33 — Gender

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

Table 34 — Gender code

Gender	Value
Unclear	0
Male	1
Female	2
Unspecified	3

6.2.5 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 35 — Comment

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

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 A (informative)

MFER Conformance statement

A.1 Conformance statement

Each implementer should provide a specification sheet of their MFER waveform format using the conformance statement below (Table A.1). Use of non-default values should be identified clearly. If the extension capabilities of the MFER description are used, an additional sheet with these 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
Note									

Annex B (informative)

Waveform encoding

B.1 Recording example

With ambulatory ECG recorder, it is impossible to know exactly when the measurement is finished. Therefore, when encoding waveforms, the waveform information shall be encoded regularly (e.g. every 1 min) to prevent users from reading data improperly by MWF_END (80h) when they add information. As MWF_END (80h) indicates that there is no other MFER encoding after MWF_END (80h), this tag should be written at the end of the file.

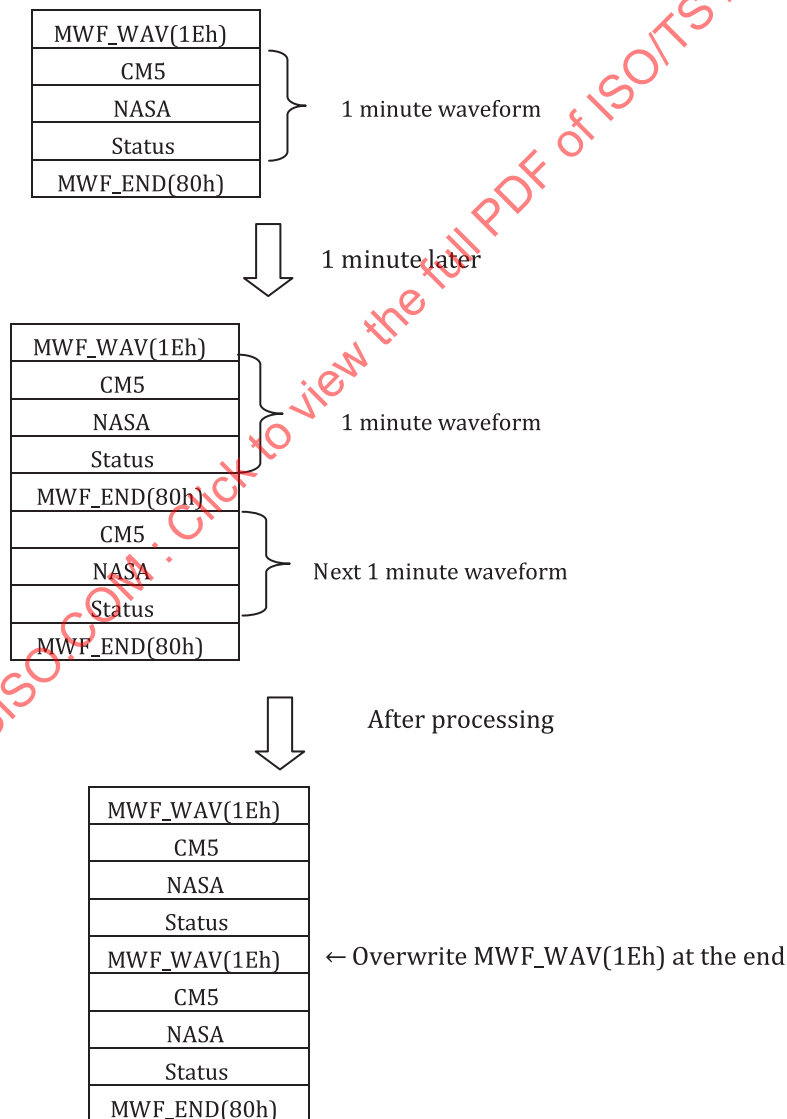


Figure B.1 — Encoding of waveform

The data updating shall be made in the order shown below in encoding by the recorder:

1. Additionally encode waveform data
2. Encode MWF_END(80h)
3. Encode new waveform data to MWF_END(80h) which indicates an ending point of the last data

MWF_WAVE(1Eh) shall be written for every predetermined time. In such event, as data such as sampling or sequence encoded in the first place shall remain, the ECG data are recognized as a successive waveform.

STANDARDSISO.COM : Click to view the full PDF of ISO/TS 22077-3:2015

Annex C (informative)

Example of waveform coding

C.1 Example of waveform coding

The table below shows examples of the encoding of two-channel ambulatory ECG with status information (pacemaker spike, patient event, etc.) and body movement. The waveform should be divided into several blocks (1 block is 30 s), and sampling frequency is 125 Hz. The body movement should be encoded for every second.

According to the example of waveform coding, tags should be outputted in the following order:

Table C.1 — Example of waveform coding

Tag name		Code				Descriptions
		Tag No (HEX)	Length (DEC)	Data (HEX)		
1	MWF_PRE	40	32	4d 46 52 20		MFR
				4c 6f 6e 67 20 54 65 72 6d 20 45 43 47 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		Long-term ECG
2	MWF_BLE	01	1	01		Little endian
3	MWF_TXC	03	6	55 54 46 2d 38 00		Character encoding scheme is UTF-8
4	MWF_MAN	17	53	4e 69 68 6f 6e 4b 6f 68 64 65 6e 5e 52 41 43 2d 33 31 30 33 5e 56 65 72 20 30 31 2d 30 36 20 50 5e 33 31 30 33 30 30 30 30 30 32 30 30 35 30 37 31 35 30 32 00		Information on manufacturer or model name
5	MWF_WFM	08	1	02		Waveform type = Long-term ECG
6	MWF_TIM	85	11	Year	d7 07	2007/01/23 13:31:00, 0, 0
				Month	01	
				Day	17	
				Hour	0d	
				Minute	1f	
				Second	00	
				Milli-second	00 00	
				Micro-second	00 00	
7	MWF_AGE	83	7	Years	16	Age = 22 years old
				Days	fe 1f	Age by day = 8 190 days old
				Birth date [y]	c0 07	Birth date = 1984/11/23
				Birth date [M]	0b	
				Birth date [D]	17	

Table C.1 (continued)

Tag name		Code			Descriptions
		Tag No (HEX)	Length (DEC)	Data (HEX)	
8	MWF_PNM	81	42	4d 61 72 6b 20 53 6d 69 74 68 00	Mark Smith
9	MWF_PID	82	11	31 31 32 33 37 30 30 30 35 31 00	ID = 1123700051
10	MWF_SEX	84	1	01	Gender = Male
11	MWF_SEN	0c	4	Measure 00	Electrical potential = 5 micro-V 5×10^{-6} V
				Exponent part fa	
				Data 05 00	
12	MWF_IVL	0b	4	Measure 01	Interval = 8 milli-second 8×10^{-3} sec.
				Exponent part fd	
				Data 08 00	
13	MWF_BLK	04	4	a6 0e 00 00	Block length = 30 s 3 750 samples Sampling interval $\times$ Recording time
14	MWF_DTP	0a	1	00	Data type 16 bit signed integer
15	MWF_CHN	05	1	04	The number of channel = 4 • ECG1 • ECG2 • Status information • Body movement information
16	MWF_SEQ	06	4	01 00 00 00	The number of sequence = 1
17	MWF_ATT	3f 00	4	MWF_LDN 09	Waveform type = ECG1
				Length 02	
				Data 46 10	
18	MWF_ATT	3f 01	4	MWF_LDN 09	Waveform type = ECG2
				Length 02	
				Data 47 10	
19	MWF_ATT	3f 02	7	MWF_LDN 09	Waveform type = status
				Length 02	
				Data 40 10	
				MWF_DTP 0a	Data type = 16 bit status
				Length 01	
				Data 04	