INTERNATIONAL STANDARD

ISO 22077-3

First edition
2023-08

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 22077-3:2023

Reference number
ISO 22077-3:2023(E)

© ISO 2023

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2023 – All rights reserved

Contents

Page

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This first edition of ISO 22077-3 cancels and replaces ISO/TS 22077-3:2015, which has been technically revised.

The main changes are as follows:

— Clause 3 has been updated;

— editorial corrections.

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

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

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Introduction

The long-term electrocardiography (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, became commonly used and it strongly requires long-term ECG examination for the therapeutic purpose. However, new digitalized data of long-term ECG recorder cannot be used among different manufacturers scanner. This document intends that MFER encoded data for long-term ECG is analysed by other scanner and these are also interoperable on EMRs.

This document defines the detailed rules for electrocardiography waveform format that is encoded according to the medical waveform format encoding rules (MFER). In addition to electrocardiography waveform format encoding, there are rules for other waveforms such as standard 12-lead ECG, stress ECG, etc. that are contained in other MFER documents.

About MFER

Medical waveforms such as ECG, electroencephalography (EEG), 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, vectorcardiography (VCG), EEG with ECG, blood pressure with ECG, sleep polysomnography (PSG), etc. MFER can describe not only ECG for physiological examinations conducted in intensive care unit (ICU) and operating room acute care contexts, but also EEG, respiration waveform, and pulse.

— **Implementation:** 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.

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

— **Separation between supplier and consumer of medical waveforms:** the MFER specification concentrates on data format instead of paper-based recording. For example, recorded ECG is processed by filter, data alignment, and other parameters, so that the ECG waveform can be easily displayed using an application viewer. However, the ECG recordings displayed as images are 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 is supported such as filtering, view alignment, etc. In this way, the medical waveform described in MFER can be used for multiple purposes.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

1) HL7 is the registered trademark of Health Level Seven International. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

2) DICOM is the registered trademark of the National Electrical Manufacturers Association for its standards publications relating to digital communications of medical information. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

3) IEEE is a registered trademark of Institute of Electrical and Electronics Engineers, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

© ISO 2023 – All rights reserved

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

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

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Health informatics — Medical waveform format —

Part 3:
Long-term electrocardiography

1 Scope

This document defines the application of medical waveform format encoding rules (MFER) to describe long-term electrocardiography waveforms measured in physiological laboratories and health care clinics. It covers electrocardiography 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 MFER documents encoding rules (see ISO 22077-1).

2 Normative references

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

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

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

3.1.1
recorder
equipment worn or carried by the patient with the intention of recording and analysing heart action potentials

3.1.2
scanner
equipment that retrieves ECG waveforms from the heart recorder and analyses, edits the information received to determine the presence of abnormal heart rhythms and reports

3.1.3
patient ECG recording event
manual marking of clinical information during ECG recording

Note 1 to entry: There shall be a “patient ECG recording event” switch on the recorder. It can be pushed to mark and timestamp a clinical event affecting the assessment of the ECG waveform. For example, the patient can have chest pain, dizziness or palpitation. Pushing a “patient ECG recording event” switch located on the recorder allows for recording ECG waveforms with the time of occurrence.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

3.1.4
dominant beat
primary heart beat extracted from typical beats for each lead in a period of long-term ECG

Note 1 to entry: The dominant beat is used for measurement and analysis of ECG in the period and easily viewing the change of ECGs for each period.

Note 2 to entry: In general, it is the typical heart beat excepting extrasystole or drifts of baseline.

3.1.5
average beat
beat waveform constructed from the average value of each temporal point in ECG across a number of beats

3.1.6
median beat
beat waveform constructed from the median value of each temporal point in ECG across a number of beats

3.1.7
leads off
disconnected electrodes

3.2 Abbreviated terms

CDA	Clinical Document Architecture
DBMS	Data Base Management system
DICOM	Digital Imaging and Communication in Medicine
ECG	Electrocardiography
EEG	Electroencephalography
EMR	Electronic Medical Record
HL7	Health Level Seven
ICU	Intensive Care Unit
IEEE	Institute of Electrical and Electronic Engineers
MFER	Medical waveform Format Encoding Rules
NIBP	Non-Invasive Blood Pressure
PSG	Sleep Polysomnography
SCP-ECG	Standard communication protocol — Computer-assisted electrocardiography (ISO 41064)
SpO_2	Saturation of Peripheral Oxygen
VCG	Vectorcardiography
XML	Extensible Markup Language

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

4 Encoding format

4.1 Primary description

4.1.1 General

This document provides the encoding of long-term ECG waveforms. It also supports encoding other ECG waveforms such as ambulatory ECG and real-time physiological monitoring. In addition, along with the ECG waveform encoding, the encoding of waveform recognition information, measurement information, interpretation information, etc. is provided, but these are all optional functions and depend on each implementation concept. For instance, interpretation codes or measurement values are described by other standard including HL7 CDA, XML, and DBMS, etc. with waveforms decoding MFER. However, in all instances, when implementing a device, apply the requirements as listed in ISO 22077-1.

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

4.1.2 Sampling attributes

4.1.2.1 General

Sampling attributes including sampling rate and resolution are given in Tables 1 to 4.

4.1.2.2 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		$10^{-128 \text{ to } +127}$	
		Mantissa	≤ 4		e.g. unsigned 16-bit integer	

The unit can 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	—

4.1.2.3 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 4	—	Override
		Exponent (10th power)	1		$_{10}$ -128 to +127	
		Mantissa	≤ 4		e.g. unsigned 16-bit integer	

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Table 4 — Sampling units

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

4.1.3 Frame attributes

4.1.3.1 General

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

4.1.3.2 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

4.1.3.3 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

4.1.3.4 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

4.1.4 Waveform class

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

Table 8 — Waveform class

MWF_WFM		Data 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.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

For types of waveforms (Tables 9 and 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
Electrocardiography	ECG_LTERM	2	Long-term ECG	Ambulatory ECG Patient monitoring system ECG

a) 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 can have different display format for each waveform type.

b) In addition, extracted waveforms that 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
Electrocardiography	ECG_BEAT	9	QRS waveform	Extracted waveform for one beat by long-term ECG Write comment Average, Median, Dominant beat

4.2 Data alignment

4.2.1 General

Data alignment recommended by long-term ECG standard shall be specified. Data alignment should be as simple as possible in order to prevent troubles caused by the complication which can result in some limitation of interoperability by using complicated format.

4.2.2 Data encoding

In long-term ECGs, the recorder for recording ECG waveforms, the scanner for analysing and editing ECG waveforms, and the EMR for referring waveforms shall be encoded in the most appropriate format 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 specified.

— 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.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

4.2.3 Recorder encoding

4.2.3.1 General

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 in order to read 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.

4.2.3.2 Encoding of waveforms

In recorder encoding, waveforms shall be encoded in accordance with 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. CM5 and NASA are part of the lead shown in Tables 21, D.1, and D.2.Examples of status are shown in Table 22.

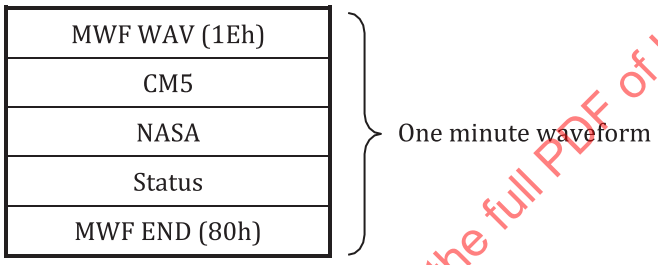

Figure 1 — Encoding of waveform

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

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

Figure 2 shows the structure of multiple frame configurations.

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 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.

4.2.3.3 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”, as shown in Tables 11 and 12.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Table 11 — Waveform information (status)

MWF_DTP		Data length	Default	Remarks	Duplicated definitions
10	0Ah	1	—	—	Override

Table 12 — Definition of data type

Value	Data type
4	16-bit status

Pacemaker information shall be encoded with 16-bit status, as shown in Table 13.

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 ECG recording event 1	0: none 1: patient ECG recording event 1
9	Patient ECG recording event 2	0: none 1: patient ECG recording 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 ECG recording event 1 is defined on the assumption that the recorder event key is held down in long-term ECGs. In the patient monitoring system, this corresponds with the “nurse call” in the transmitter. Patient ECG recording event 2 can be used as medical information. Its practical use should be defined by each user.

4.2.3.4 Encoding of event information

Said “event information” includes every information except waveform information. Patient event is defined as “Status” in 4.2.3.3 of this rule. Value of body movement, blood pressure, and SpO_2 shall be encoded as patient event.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

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 (45h) in a number of formats, as shown in Tables 14 and 15. This tag indicates an external file pointer represented as a hyperlink. 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). MWF_END (80h) should be used to encode not only waveforms but also event information.

Using MWF_EVT (41h), patient event shall be defined as character string, as shown in Table 16.

File name : HolterECG.mwf

: :	
MWF_RPT (45h)	Data type : 1 Reference pointer file://PatEvt.mwf
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 point code	2	—	Multiple definitions available
		Starting time (point)	4	Number of data values acquired at the sampling interval defined in the root definition	
		Duration	4		
		Event information	Str < 256	—	

b) **MWF_VAL (42h)**

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Figure 4 illustrates the encoding of patient event in event information by using the reference pointer MWF_RPT (45h). MWF_END (80h) should be 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, as shown in Table 17.

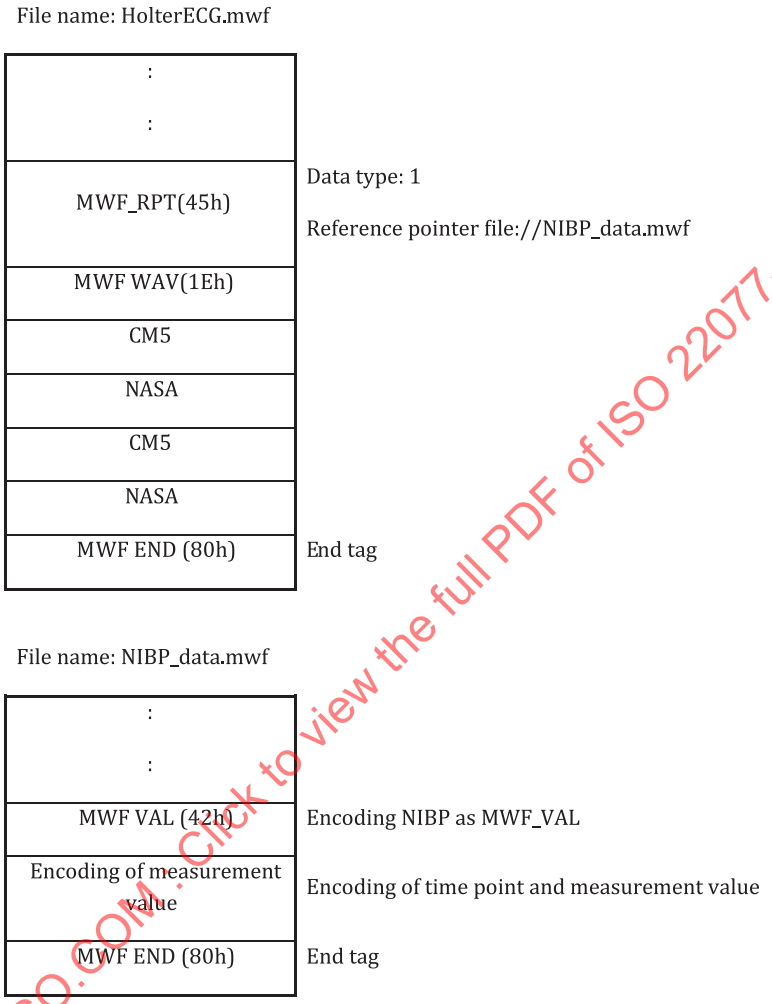

Figure 4 — Definition of measurement value

Table 17 — Measurement value

MWF_VAL			Data length	Encoding range/remarks	Duplicated definitions
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 ("^")	

4.2.4 Scanner encoding

4.2.4.1 General

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

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

4.2.4.2 Encoding of MFER interpretation code and beat annotation

Interpretation code and beat annotation shall be encoded with the event tag, as shown in Table 18.

Table 18 — Encoding of interpretations

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

Interpretation code format shall be defined in Table 19:

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 a number starting with 4224. 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

4.2.4.3 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.

4.2.4.4 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.

4.2.4.5 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.

4.2.4.6 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.

For example, Event information is encoded with “interpretation text^code system (manufacturer name)^abbreviation or code” (in case of encoding plurality of event information, use “&”). In encoding

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

with MFER code MWF_ECGL_VE_ISO (4496) and adding event information defined in SCP-ECG, the event information is 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
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

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Table 20 *(continued)*

Reference ID	CODE		Interpretation (English)
	DEC	HEX	
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
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

4.3 Lead name

Lead name means the waveform code used in long-term ECGs, as shown in Table 21. This code shall be used in 12-lead ECG and/or Vector lead ECG. As the lead code is encoded by a number between 0 and 127, extra attention would be required in the case of conforming with other rules such as SCP-ECG. Lead code later than 4160 is defined in the long-term ECG standard, as shown in Table 22. 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)

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.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Table 21 *(continued)*

Code	Lead	Code	Lead
32	CB4	—	—
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	SpO_2	—
4166	ECG1	These shall be used in case lead name is not definite
4167	ECG2	
4168	ECG3	
4169	ECG4	

4.4 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, as shown in Tables 23, 24, and 25:

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	aVF = F–(R+L)/2 = {(F–R)+(F–L)}/2 = (II+III)/2 = II–I/2
-aVR	Inverted aVR	

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

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	aVF = F–(R+L)/2 = {(F–R)+(F–L)}/2 = {(III+I)+III}/2 = III+I/2
-aVR	Inverted 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	III+ I	I = L–R = (F–R)– (F–L), where II = F–R, III = F–L
aVR	– I – III/2	aVR = R–(L+F)/2 = {(R–L)+(R–F)}/2 = {– (II–III)–II}/2 = –II+III/2
aVL	(I – III)/2	aVL = L–(R+F)/2 = {(L–R)+(L–F)}/2 = {(II–III)–III}/2 = –III+II/2
aVF	III + I/2	aVF = F–(R+L)/2 = {(F–R)+(F–L)}/2 = (II+III)/2
-aVR	Inverted aVR	

Sampled ECG data for all leads shall be completely synchronized.

4.5 Filter information

4.5.1 General

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

4.5.2 Description of filter-processed data

Description is made on the filter information processed for the data described by MFER, as shown in Tables 26 and 27.

Table 26 — Filter information

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

Table 27 — Filter description example

Filter function	Abbreviation	Example	Meaning
Filter information only	None	Hum filter ON	Hum 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 characteristics150 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:

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

By High-pass Filter = 1/ωT, the lower cutoff frequency of time constant of 3 s is described by 1/(2π × 3 s) approximately 0,05 Hz.

4.5.3 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 can be used to indicate that the ECG was measured by an electrocardiograph, printed on recording paper underwent the relevant filter processing, and can be utilized for diagnosis.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Annex A
(informative)

MFER conformance statement

Each implementer should provide a specification sheet of their MFER waveform format using the conformance statement in 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											

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Annex B
(informative)

Waveform encoding

With long-term 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 MWR_END (80h), this tag should written at the end of the file.

Figure B.1 shows one-minute waveform data, and it is an example of waveform data recorded using leads called CM5 and NASA.

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

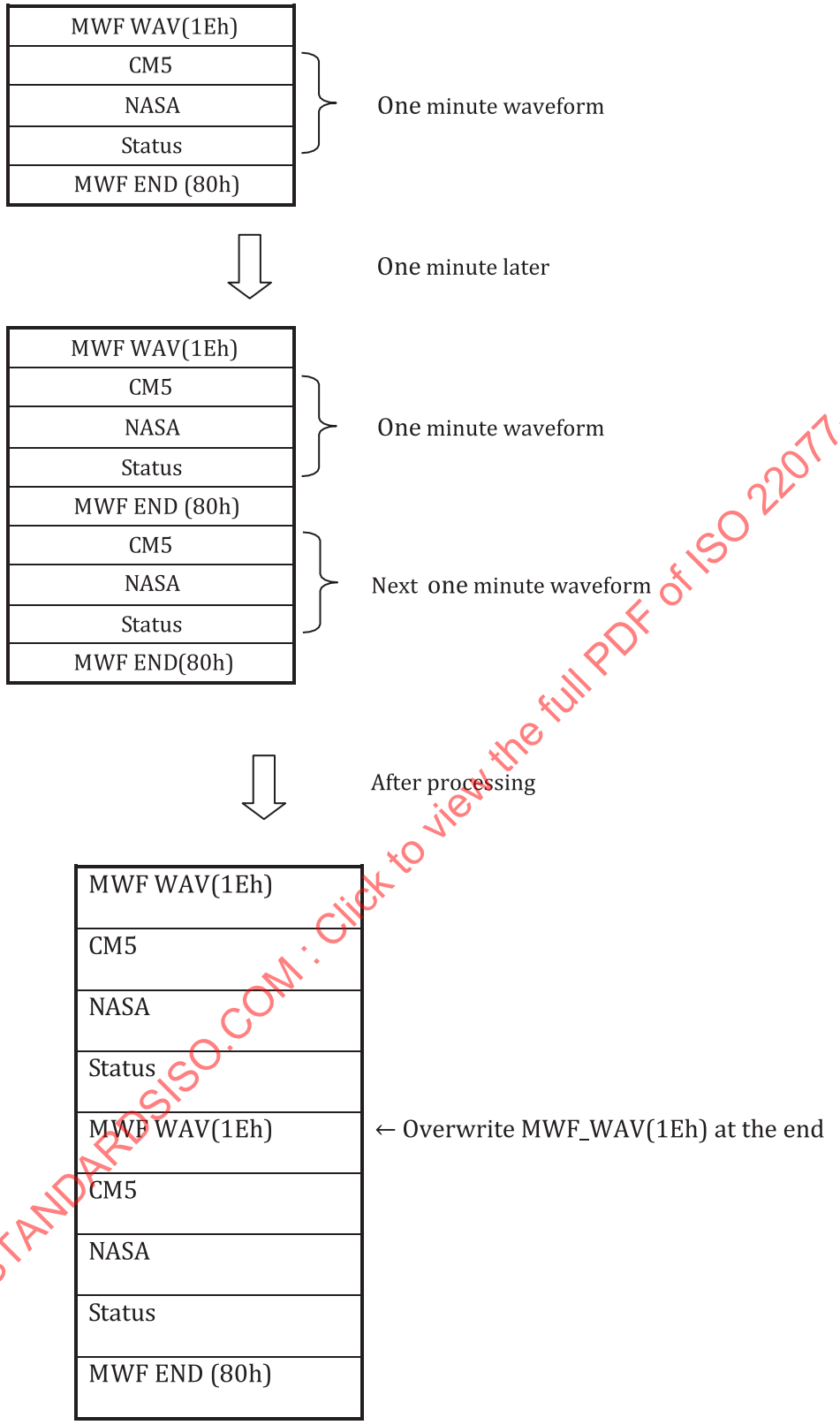

Figure B.1 — Encoding of waveform

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);

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

3. encode new waveform data to MWF_END(80h) that 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 22077-3:2023

© ISO 2023 – All rights reserved

Annex C
(informative)

Example of waveform encoding

The table below shows examples of the encoding of two-channel long-term 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 order following in Table C.1..

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		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 Age by day = 8 190 days old Birth date = 1984/11/23
				Days	fe 1f	
				Birth date [Y]	c0 07	
				Birth date[M]	0b	
				Birth date[D]	17	
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

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Table C.1 *(continued)*

Tag name		Code				Descriptions
		Tag No (HEX)	Length (DEC)	Data (HEX)		
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 × 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	

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved

Table C.1 *(continued)*

Tag name		Code					Descriptions
		Tag No (HEX)	Length (DEC)	Data (HEX)			
20	MWF_ATT	3f 03	21	MWF_LDN	09		Waveform type = body movement
				Length	02		
				Data	42 10		
				MWF_IVL	0b		Interval = 1 000 milliseconds $1\ 000 \times 10^{-3}$ sec..
				Length	4		
				Data	Measure	01	
					Exponent part	fd	
					Data	E8	
						03	
						00	
						00	
				MWF_BLK	04		Block length = 30 s
				Length	02		30 samples
				Data	1e 00		Sampling interval × Recording time
				MWF_DTP	0a		Data type = 16-bit unsigned integer
				Length	01		
				Data	01		
21	MWF_WAV	1e	84	00 00 58 20			Data length shall be designated as 4 bytes. Data length = 22 560 bytes
			Waveform information	ECG1	xx xx xx xx		3 750 samples × 2 (byte)
				ECG2	xx xx xx xx		3 750 samples × 2 (byte)
				Status	xx xx xx xx		3 750 samples × 2 (byte)
				Body movement	xx xx xx xx		30 samples × 2 (byte)
22	MWF_WAV	1e	84	00 00 58 20			Data length shall be designated as 4 bytes. Data length = 22 560 bytes
			Waveform information	ECG1	xx xx xx xx		3 750 samples × 2 (byte)
				ECG2	xx xx xx xx		3 750 samples × 2 (byte)
				Status	xx xx xx xx		3 750 samples × 2 (byte)
				Body movement	xx xx xx xx		30 samples × 2 (byte)
•							
•							
•							

STANDARDSISO.COM : Click to view the full PDF of ISO 22077-3:2023

© ISO 2023 – All rights reserved