

American National Standard



ANSI/AAMI EC71:2001/ (R)2013

Standard communications
protocol for computer-
assisted electrocardiography

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Particular care should be taken in applying a product standard to existing devices and equipment, and in applying a recommended practice to current procedures and practices. While observed or potential risks with existing equipment typically form the basis for the safety and performance criteria defined in a standard, professional judgment must be used in applying these criteria to existing equipment. No single source of information will serve to identify a particular product as "unsafe". A voluntary standard can be used as one resource, but the ultimate decision as to product safety and efficacy must take into account the specifics of its utilization and, of course, cost-benefit considerations. Similarly, a recommended practice should be analyzed in the context of the specific needs and resources of the individual institution or firm. Again, the rationale accompanying each AAMI standard and recommended practice is an excellent guide to the reasoning and data underlying its provision.

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Standard communications protocol for computer-assisted electrocardiography

Developed by
Association for the Advancement of Medical Instrumentation

Approved 11 May 2001 and reaffirmed 19 September 2013 by
American National Standards Institute, Inc.

Abstract: This standard specifies the content and structure of information for interchange between digital electrocardiographs (ECG carts) and computer ECG management systems, as well as other computer systems where ECG-related data can be stored. Standard data formats are specified for demographics, ECG rhythm data, reference beats, global measurements, and interpretation. Practical compression of the ECG rhythm data is also standardized. This standard also specifies the two-way digital transmission of remote requests and results between digital ECG carts and heterogeneous computer systems (hosts). It specifies conventions required for cart-to-host and cart-to-cart interchange of patient data. Compliance with this standard is defined separately for data format, query messaging, and data transport.

Keywords: electromedical equipment, diagnostic, monitoring, communications protocol, computer-assisted ECG, ECG

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Committee representation

Association for the Advancement of Medical Instrumentation

Electrocardiograph (ECG) Committee

This standard was developed by the ECG/Standard Communications Protocol (SCP) Working Group of the AAMI ECG Committee. Committee approval of the standard does not necessarily imply that all committee members voted for its approval.

The **AAMI ECG Committee** has the following members:

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David Mortara, PhD

Members: James J. Bailey, MD, National Institutes of Health
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NOTE—Participation by federal agency representatives in the development of this standard does not constitute endorsement by the federal government or any of its agencies.

Foreword

This document represents work carried out by the Standard Communications Protocol Working Group of the AAMI Electrocardiograph (ECG) Committee, based on CEN's prENV 1064, "Standard Communications Protocol for Computer-Assisted Electrocardiography".

Development of a universal ECG transmission protocol was first started during a series of discussions involving computerized electrocardiograph manufacturers (principal participants included Marquette Electronics, Mortara Instruments, Hewlett-Packard, Compumed, Burdick, and Siemens) and the United States Veterans Administration in 1986 and 1987. The results of these discussions, the so-called "Universal Protocol," were used as the starting point in AIM's SCP-ECG Project.

In 1989, the Advanced Informatics for Medicine (AIM) Project Nr 1015, entitled "A standard communications protocol for computerized electrocardiography" (SCP-ECG) was initiated. The project team consisted of six main SCP-ECG partners (J.L.Willems, Leuven; Chr. Zywietz, Hannover; P. Rubel, Lyon; J. H. van Bommel, Rotterdam; R. Degani, Padova and P. W. Macfarlane, Glasgow) and representatives from manufacturers of computerized electrocardiographs (including Cardionics, Elettronica-Trentina, ESA-OTE Biomedica, Fukuda-Denshi, Hellige, Hewlett-Packard, Marquette Electronics, Medis, Mortara Instruments, Mortara-Rangoni, Nihon-Kohden, Picker-Schwarzer, Schiller, Siemens-Elema [also representing Burdick]) and a number of program developers, as well as users from different universities. The resulting document, prENV 1064 was prepared by the members of Project Team 007 of CEN/TC 251 (J.L.Willems, Project Team Leader; P. Rubel & Chr. Zywietz, Core Team; and Extended Team members R. Bedini, K. Hedström, P. W. Macfarlane, C. Monroe, F. Pincirolì, L. Rystrom, and S. Scheirman) and draft version 1.0 was published February 9, 1993.

The current draft proposal represents the contents of ENV 1064, updated to incorporate the comments and changes recommended by the AAMI SCP-ECG WG. Over the course of three meetings, the first January 27, 1997 in Washington, DC, the second April 24-25 in Palm Coast, Florida, the third June 7, 1997, in Washington DC, the AAMI SCP-ECG Working Group discussed and proposed changes to the CEN prENV 1064 document. These changes, captured in Revision 1.0 of the AAMI draft, reflected the findings of the WG members during implementation of the protocol, and were intended to address shortcomings and inconsistencies in the original document. Comments were reviewed by the AAMI SCP-ECG WG members and the parent AAMI ECG Committee members, and Revision 1.1 of the draft, incorporating these recommendations, was presented to CEN on August 19, 1997. Over the course of three more AAMI SCP-ECG WG meetings in Orlando, Florida, November 6-7, 1997, Keystone, Colorado, April 23-24, 1998, and Cleveland, Ohio, September 12-13 1998, a new version of the then labeled Annex D (Compliance) was prepared and refined. This, plus additional changes resulting from comments on the earlier version, comprised Revision 1.2 of this draft. Revision 1.2 was reviewed at an AAMI-SCP WG meeting in Boston, Massachusetts on June 5, 1999, and recommended changes, including the reordering of the Annexes so that all normative annexes precede any informative annexes, were incorporated into Revision 1.3, dated September 11, 1999.

Current voting members of the AAMI SCP-ECG WG are: Stacy Gehman, Industry Co-Chair, Quinton Instrument Co.; Robert Bain, Johns Hopkins Hospital; Alan Berson, NIH NHLBI; Damon Coffman, Instrumedix; Matthew Connell, Burdick; David Geraghty, Fukuda Denshi America; Charles Ho, FDA/CDRH; Peter W. Macfarlane, Univ. of Glasgow; Charles Monroe, Hewlett-Packard; Shankara Reddy, GE Marquette Medical Systems; Johann-Jakob Schmid, Schiller AG; Ward Silver, Physio Control; Christoph Zywietz, Medical School of Hannover.

Other participating members of the WG include: Stig Andersson, Siemens-Elema; James Bailey, NIH; Eric Brinster, Quinton Instrument Co.; Fabrizio Conforti, Elettronica Trentina; Steve Duke, Physio Control; Ronald Fischer, Medical School of Hannover; Kurt Hedstrom, Siemens-Elema; Ed Jones, GE Marquette Medical Systems; Kevin Katzenmaier, 3M Health; Gary Laube, Burdick; Cesare Malossi, Elettronica Trentina; Gordon Neff, Datascope; Paul Rubel, INSERM; Eugene Salber, Braemar; Glenn Sherman, Instrumedix; Katherine Stankus, Spacelabs Medical.

The AAMI-SCP Working Group gratefully acknowledges the extensive work of Charlie Monroe, of Hewlett-Packard, as editor of the AAMI-WG version of the SCP document.

Note: Participation by the United States of America Food and Drug Administration representatives in the development of this standard does not constitute endorsement by the United States federal government or any of its agencies.

Introduction and field of application

The electrocardiogram (ECG) is a recording of voltage changes transmitted to the body surface by electrical events in the heart muscle, providing direct evidence of cardiac rhythm and conduction, and indirect evidence of certain aspects of myocardial anatomy, blood supply and function. During its propagation to the surface, extracardiac tissues may intervene and influence the ECG.

Electrocardiography has been used for many years as a key, non-invasive method in the diagnosis and early detection of coronary heart disease, which is the leading cause of mortality in Western countries. In 1993, it was estimated that more than 100 million standard ECGs are recorded yearly in the European Community (EC) for routine diagnostic and screening purposes at an estimated cost of more than 1.2 billion ECU per year.

Almost all newer electrocardiographs nowadays use digital recording, interpretation and communication techniques. These stand-alone, microcomputer based machines can be connected to each other, and to larger minicomputer based management servers for long-term storage and serial comparison. To this end, various manufacturers have used different techniques.

It is in the general public interest for users not to be restricted in their options by incompatible technical features and services of different systems. ECG processing is increasingly being integrated with various other data processing in health care. This evolution shall have considerable impact on the storage and communication of ECG data. There are many different end-users who for different purposes (support of patient care, management, research and education) want to obtain a copy of the signal data, of the interpretive report and/or measurement results. Being one of the very first systems for medical decision support, computerized ECG interpretation stretches from departments of cardiology in hospitals, to general practitioners in primary care and health care centers. In life-threatening acute myocardial infarction, ECGs are being used in ambulances by paramedical personnel to assess the necessity for administering thrombolytic agents, with long-distance monitoring whenever possible.

To enable the exchange of information between various systems it was of utmost importance that a standard communications protocol for computer-aided electrocardiography (SCP-ECG) had to be established, as defined in this document. The primary aim of this standard is to specify a data format and means for transmitting ECG reports and data from any vendor's computerized ECG recorder on a direct connected serial line to any other's vendor central ECG management system. The same standard should also allow standardized transmission of digitized ECG data and results between various computer systems.

Under the standard communication protocol (SCP) the contents and format of the ECG waveform data and the measurements from ECG devices of different manufacturers are not expected to be identical. As a result, the determination of the suitability of a device and/or system for any particular application remains with the user/purchaser. The following possible uses of ECG records require special attention:

- Serial comparison of ECGs and interpretations
- Plot formats of ECGs
- Maintaining audit trail of edits
- Bi-directional communication and remote query.

The user is cautioned to make sure that the data contents and format of the waveform data, measurements, and the interpretive statements meet his or her specific needs. If more than one type of ECG devices and/or database management systems are interconnected, the user is also advised to verify with the manufacturers that the data from different systems are compatible with each other and with the user's needs.

In order to understand this standard, the reader needs some basic understanding of electrocardiology, electrocardiography and signal processing.

This standard relates to the conventional recording of the electrocardiogram, i.e. the so-called standard 12-lead electrocardiogram and the vectorcardiogram (VCG). Initially, the electric connections used for recording the ECG were made to the limbs only. These connections to the right arm (RA), left arm (LA), left leg (LL) and right leg (RL) were introduced by Einthoven. The electrical variations detected by these leads are algebraically combined to form the bipolar leads I, II, and III. Lead I, for example records the difference between the voltages of the electrodes placed on the left arm and the right arm. The unipolar electrocardiographic leads (aVR, aVL, aVF and the precordial leads V1 to V6) were introduced much later, starting in 1933. In these leads, potentials are recorded at one location with respect to a level which does not vary significantly in electrical activity during cardiac contraction. The "augmented" limb lead potentials are recorded with reference to the average potential of (L+F), (R+F) and (L+R) respectively. The unipolar chest leads are recorded with reference to the average potential of (RA+RL+LL)/3 which is called the Wilson "central terminal" (CT). In vectorcardiography recordings are made of three mutually perpendicular leads, running parallel to one of the rectilinear

coordinate axes of the body. The axes are the X-axis going right to left, the Y-axis with a top to bottom orientation, and the Z or front to back axis.

In some research centers, so-called body surface maps are obtained by placing many (from 24 to 124 or even more) closely spaced electrodes around the torso. This standard has not been designed to handle transmission of such recordings, although future extensions could be made to this end. The standard has also not been designed to transmit specialised recordings of intracardiac potentials or of the so-called Holter or other long-term ECG recordings made for monitoring cardiac rhythm. This standard also does not address exercise ECG recordings.

ECG computer processing can be reduced to 3 principal stages:

1. Data acquisition, encoding, transmission and storage;
2. Pattern recognition and feature extraction, i.e. ECG measurement;
3. Diagnostic classification.

In each of these stages there are important needs for standardization and quality assurance testing. The scope of the standard is confined to the first of these three stages.

The various data sections that shall be transmitted by means of the standard ECG communications protocol are defined in Clause 5 of this Standard.

Minimum requirements for data encoding and compression are defined in Clause 6.

The compliance categories defined in ANNEX B provide users and manufacturers of ECG devices and/or systems with a relatively simple codification of SCP-ECG related features and information content that may be provided by a specific device. Compliance is defined separately for data format, query messaging, and data transport. Four Data Format Categories have been defined based on information content as follows:

Category	Data Sections Required ¹	Content Description
I	0, 1, 7, 8	Demographics, global measurements and interpretation
II	0, 1, 2, 3, 6, (7), (8)	Demographics and ECG rhythm data ²
III	0, 1, 2, 3, 5, (7), (8)	Demographics and reference beats ²
IV	0, 1, 2, 3, 4, 5, 6, (7), (8)	Demographics, ECG rhythm data, and reference beats ²

Note 1: All devices stating a SCP-ECG Data Format Category import data sections 0, 1, 7, 8. All Categories may have additional sections added (e.g. 9, 10, 11). A device may export at more than one Category. Manufacturer specific data shall be optionally included only in manufacturer specific fields, bytes and data blocks that have been defined in the standard. Reserved, unspecified and undefined fields, bytes or data blocks will not be used for manufacturer specific data.

Note 2: (7) and (8) mean that these data sections are optional for export.

For a particular device, a SCP-ECG compliance statement lists Data Format Category(ies) for export (i.e. acquiring and making available a SCP-ECG record) and import (i.e. accepting, and making available to a user, a SCP-ECG record). A device may also state its ability to transfer (i.e. making available a SCP-ECG record without changing its data format, for example, exporting a record that was previously imported). (These terms are precisely defined in ANNEX B for the purpose of this standard).

Clause 7 specifies query messaging, and Clause 8 specifies data transport. A device should state one of three options: "Query Messaging and Data Transport not supported", "Query Messaging supported", or "Query Messaging and Data Transport supported". It is recognized that other mechanisms for transfer of a SCP-ECG formatted file exist. This standard neither restricts nor supports use of any mechanism other than SCP-ECG Query Messaging and Data Transport defined in Document Clauses 7 and 8.

The selection and definition of ECG specific high-level syntaxes for transfer of messages and data between host-to-hosts, such as EDIFACT or ASN.1, are beyond the scope of this standard.

Standard communications for computer assisted electrocardiography

1 Scope

This standard covers the two-way digital transmission of remote requests and results between digital electrocardiographs (ECG carts) and heterogeneous computer systems (hosts). It documents the common conventions required for the cart-to-host as well as cart-to-cart interchange of specific patient data (demographic, recording...), ECG signal data, ECG measurement and ECG interpretation results.

This standard specifies the content and structure of the information which is to be interchanged between digital ECG carts and computer ECG management systems (ECG DBMS), as well as other computer systems where ECG data can be stored. It enables any two such systems to establish a logical link for communicating ECG related data in a standard and interpretable form.

2 Normative references

CCITT Blue Book, ed. 1988, Volume VIII.2., Recommendations for X.25 and Specifications for the CCITT-CRC Calculations

CCITT Blue Book, ed. 1988, Volume VIII.1., Specifications for the V series, including XMODEM

GB 2312-80 Code of Chinese Graphic Character Set for Information Interchange - Primary Set

ISO 2022 Information Processing - ISO 7-bit and 8-bit coded character sets- With code extension techniques (1986) . For all text fields the limited conformance to the ISO 2022 standard shall be applied, as described in ANNEX A.

ISO-8859 Information Processing - 8-bit single-byte coded graphic character sets.

ISO 2375 Data processing - Procedure for registration of escape sequences.

ISO 646 Information processing - ISO 7-bit coded character set for information interchange

ISO 4873 Information processing - ISO 8-bit code for information interchange – Structure and rules for implementation.

ISO 6429 Information processing - ISO 7-bit and 8-bit coded character sets – Additional control functions for character-imaging devices.

ISO 60646 Unicode

IEC 601-1 Safety of Medical Electrical Equipment, Part 1. General Requirements - 1979

IEC 601-2 The Particular Requirements for Safety, Part 2. (Electrocardiographs), 62D(CO17) –1979

JIS X0201-1976 Code for Information Interchange

JIS X0208-1998 Code of the Japanese Graphic Character Set for Information Interchange

JIS X0212-1990 Code of the Supplementary Japanese Graphic Character Set for Information Interchange

KS C5601-1987 Code for Information Interchange

3 Definitions

3.1 Description of terms specific to this standard

3.1.1 Acquiring Cardiograph: Cardiograph recording the original ECG signal.

3.1.2 Bimodal Compression: The use of low pass filtering and sample decimation outside of a protected zone containing the QRS complex, with no decimation or filtering within the protected zone, is called bimodal compression, and is indicated by 5.9.2 byte 6.

3.1.3 Confirming: The process whereby a trained and experienced cardiologist reviews the computer-generated (or overread) interpretation of an ECG in order to confirm the computer-generated (or overread) interpretation or to make the final changes to the interpretation text. The confirmed ECG is the final clinically acceptable version for diagnosis and treatment.

3.1.4 CSE Project: Project supported by DG XII of the European Commission aiming at the development of Common Standards for (Quantitative) Electrocardiography.

3.1.5 Interpretive Device: Device (cart, computer) analyzing the ECG signal.

3.1.6 Message: A textual body of information.

3.1.7 Overreading: The process whereby a cardiologist or a cardiology fellow reviews the computer-generated interpretation of an ECG in order to verify the accuracy or to make changes to the interpretation text. An overread ECG is generally not the final clinically acceptable version for diagnosis and treatment. Usually, the Overreading process precedes the Confirming process.

3.1.8 Record: The entire data file which has to be transmitted, including the ECG data and associated information, such as patient identification, demographic and other clinical data.

3.1.9 Reference Beat: Reference/representative ECG cycle computed through any (but not specified) algorithm. This comprises the P, QRS and the ST-T waves.

3.1.10 Residual Data: The remaining original ECG data after "proper" subtraction of the reference beat. The adjective "proper" refers to accurate beat alignment.

3.1.11 Rhythm Data: The full original ECG data, or the decompressed and reconstructed ECG data at reduced resolution. (Rhythm data is typically 10 seconds in length.)

3.1.12 Section: An aggregate of data elements related to one aspect of the electrocardiographic recording, measurement or interpretation

3.1.13 Universal Statement Codes: ECG interpretation codes described in ANNEX D of this document.

3.2 Description of other technical terms related to this standard

See Glossary in ANNEX E.

3.3 Description of general medical informatics terms

See Vocabulary of Medical Informatics Terms developed by Project Team 001 of CEN/TC 251.

4 Abbreviations

AAMI	Association for the Advancement of Medical Instrumentation
AC	Alternating Current
A/D	Analog to Digital
AHA	American Heart Association
AIM	Advanced Informatics for Medicine Programme of the European Commission Directorate General XIII
ANSI	American National Standards Institute
AVM	Amplitude Value Multiplier (see 5.8.2)
ASCII	American Standard Code for Information Interchange

ASN.1	Abstract Syntax Notation One
BS	Backspace (control character)
CCITT	International Telegraph and Telephone Consultative Committee
CEC	Commission of the European Communities
CEN	Comité Européen de Normalisation - European Committee for Standardisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CR	Carriage Return (control character)
CRC	Cyclic Redundancy Check
CSE	Common Standards for Quantitative Electrocardiography
CTS	Conformance Testing Service
DG	Directorate General (of the European Commission)
EC	European Community
ECG	Electrocardiogram
ECU	European Currency Unit
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
EN	Européenne Norme (European Standard)
ENV	Européenne Norme Voraugabe (European Pre-standard)
ESC	Escape (control character)
FF	Form Feed (control character)
HT	Horizontal Tab (control character)
ICD	International Classification of Diseases
ID	Identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IMIA	International Medical Informatics Association
ISO	International Organization for Standardisation
JIS	Japanese Industrial Standard
LAN	Local Area Network
LF	Line Feed (control character)
LSB	Least significant bit
MSB	Most significant bit
OSI	Open Systems Interconnection
PT	Project Team
PTT	Post, Telegraph and Telephone Administration
RMS	Root Mean Square
SCP	Standard Communications Protocol

SCP-ECG	Standard Communications Protocol for Computerized Electrocardiography
TC	Technical Committee
TCP/IP	Transmission Control Protocol/ Internet Protocol
VCG	Vectorcardiogram
VT	Vertical Tab (control character)
WG	Working Group

5 Definition of the data contents and format within the standard ECG communications protocol

The data record which is to be interchanged shall be divided into different sections. The contents and format of each of these sections are defined in this document.

5.1 General considerations

5.1.1 All text data (character strings) shall comply to the limited conformance requirements of ISO 2022, described in ANNEX A. Latin-1 (ISO-8859-1) shall be the default character set.

5.1.2 All character strings shall be NULL terminated (not part of ISO 2022).

5.1.3 For all signed binary values 2's-complement coding shall be applied.

5.1.4 All single and multiple byte binary values are regarded as unsigned integers, if not otherwise specified.

5.1.5 Binary values spanning more than 1 byte shall be transmitted in ascending order of significance (the least significant byte is transmitted first, the most significant byte last).

5.1.6 Consecutive bytes are numbered from left to right (starting with 1). Bits of a byte are numbered from right to left (0 = LSB, 7 = MSB).

5.1.7 The first byte in the record (i.e. the first byte of the Checksum) is defined as Byte 1.

5.1.8 ECG samples are indexed and numbered starting with sample number 1. Sample index 0 is not used in the present document. The sample index is a ones-based 16-bit index. The first sample starts at time 0. The second sample is at time 0+2 ms in case of 500 samples/s sampling rate.

5.1.9 Sections are numbered starting from 0 (the Pointer Section) to 32767.

5.1.10 The term "Reference Beat" used in this document refers to an ECG complex which is chosen as representative of a class of such complexes. No specific statistical meaning is implied by this term; for example, it may be an averaged beat, a "Median Beat", a selected or any other representative single cycle taken from the total ECG recording. This "Reference Beat" does include the P-wave if present (not in case of atrial fibrillation), the ST-T segment and the T wave of this beat.

An ECG may have multiple reference beats. The term "Beat type" used in this document refers to any one of an ordered list of reference beats, starting with reference beat type 0 (zero). Reference beat type 0 is, by definition, the reference beat used for classification of the ECG, and for reference beat subtraction, if reference beat subtraction is used in compression. The ordering of the list of reference beats does not imply a temporal sequence within the rhythm data.

The term "Rhythm Data" is used to indicate the ECG recording over the entire recording time, usually 10-seconds in most recorders. A description of these terms and of the recommended data compression methodology, including numerical examples and the methods for conformance testing on the minimum requirements of data compression and signal distortion are given in Clause 6, ANNEX C, and ANNEX B.

Reference Beat type 0 data in 5.8 are intended to be used for display, (re)analysis and, if reference beat subtraction has been used for data compression, for Rhythm Data reconstruction.

5.1.11 All indexes or pointers to a field are defined in bytes and are ones-based (start at 1) if not otherwise specified.

5.1.12 One KByte = 1024 bytes.

5.2 Specifications for the data structure

5.2.1 All sections shall start on an odd index (even offset) boundary. This implies that all sections shall contain an even number of bytes. A padding byte has to be added to the end of any section otherwise containing an odd number of bytes.

Padding bytes shall always be set to NULL. Blocks of data within a section may contain either odd or even numbers of bytes. Padding occurs only at the end of a section if needed.

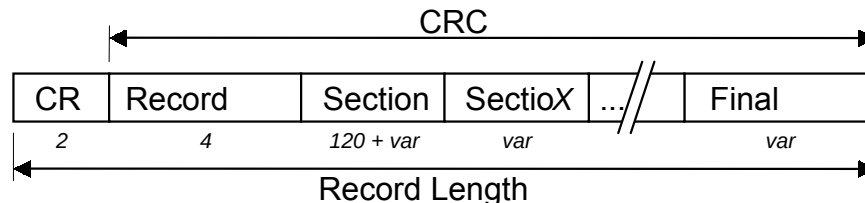
5.2.2 All sections are given Identification numbers. Section ID numbers 0 through 11 are currently defined in the SCP-ECG protocol, numbers 12 through 127, as well as numbers above 1024 are reserved for future use. Numbers 128 to 1023 are for manufacturer specific sections. The combination of the manufacturer code (see 5.4.5, tag 14) and section numbers 128 to 1023 uniquely define the content of the manufacturer-specific sections. There are no specific rules for the lay-out and format of these sections. However, use of the structure defined in 5.2.7 is recommended.

5.2.3 Inclusion of sections 2 - 11 (see 5.2.7 and 5.2.8) are optional. Any SCP-ECG data record shall contain Section 0 (Pointers) and Section 1 (Header). No consistency checking among the presence of different sections is assumed. Specifically, if any of sections 8, 9, or 11 is present, it is not assumed that all three shall be present.

5.2.4 The ECG record starts with a 6-byte record header, consisting of a 2-byte CRC followed by a 4-byte record length. These are defined as follows:

- 1) The 2-byte cyclic redundancy check (CRC) is calculated as a CRC-CCITT, the algorithm of which is described in 8.4.5, and is calculated over the entire range starting with the first byte following the CRC and ending with the last byte in the record.
- 2) The 4-byte record length denotes the number of bytes in the total record, including the 6 bytes of this record header.

5.2.5 Record overview:



5.2.6 The sequence order of the sections of a record is free, with the exception of Section 0 (zero) which shall immediately follow the record header. However, a maximum of one instance of any section is allowed in a SCP-ECG data record

5.2.7 Each section consists of:

- 1) A Section Identification Header (Section ID Header)
- 2) A Section Data Part.

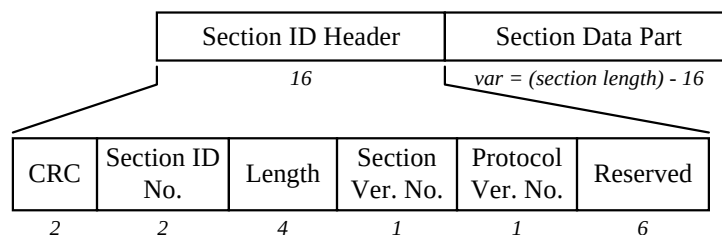
Any section shall start with a "Section ID Header" (16 bytes) defined below:

Bytes	Contents
1-2	16 bit CRC-CCITT over the entire section except these 2 bytes.
3-4	Section ID number as defined in 5.2.2 (see also paragraph 5.3.2.1).
5-8	Section length in bytes <u>including</u> the "Section ID Header" (see 5.3.2.2).
9	Version Number of the Section
10	Version Number of the Protocol (see 5.4.5 tag 14, byte 15).
11-16	Reserved (for data section 0 see 5.3.1).

Each section shall have a Section Protocol Version Number (see bytes 9 and 10) which may be used to specify different levels of compatibility with the Standard when this is updated in the future (see ANNEX B). For data sections 1-11, Section Version Numbers (byte 9) shall be the Protocol Version under which the section was approved. For data sections 12-1023, Section Version shall refer to the manufacturer's version for that section, independent of the Protocol version.

5.2.8 Reserved fields shall always be set to NULL (zero)

5.2.9 Section lay-out overview:



5.2.10 The numbers in italic in the lay-out overviews (in 5.2.5, 5.2.9 and below) indicate the length in bytes of the corresponding field or indicated block (*var* = variable length).

5.2.11 A global overview of the SCP-ECG data structure is presented in the Table below:

Mandatory	2 BYTES – CHECKSUM - CRC - CCITT OVER THE ENTIRE RECORD (EXCLUDING THIS WORD)
Mandatory	4 BYTES – (UNSIGNED) SIZE OF THE ENTIRE ECG RECORD (IN BYTES)
Mandatory	(Section 0) POINTERS TO DATA AREAS IN THE RECORD
Mandatory	(Section 1) HEADER INFORMATION - PATIENT DATA/ECG ACQUISITION DATA
Optional	(Section 2) HUFFMAN TABLES USED IN ENCODING OF ECG DATA (IF USED)
Optional	(Section 3) ECG LEAD DEFINITION
Optional	(Section 4) QRS LOCATIONS (IF REFERENCE BEATS ARE ENCODED)
Optional	(Section 5) ENCODED REFERENCE BEAT DATA IF REFERENCE BEATS ARE STORED
Optional	(Section 6) "RESIDUAL SIGNAL" AFTER REFERENCE BEAT SUBTRACTION IF REFERENCE BEATS ARE STORED, OTHERWISE ENCODED RHYTHM DATA
Optional	(Section 7) GLOBAL MEASUREMENTS
Optional	(Section 8) TEXTUAL DIAGNOSIS FROM THE "INTERPRETIVE" DEVICE
Optional	(Section 9) MANUFACTURER SPECIFIC DIAGNOSTIC AND OVERREADING DATA FROM THE "INTERPRETIVE" DEVICE
Optional	(Section 10) LEAD MEASUREMENT RESULTS
Optional	(Section 11) UNIVERSAL STATEMENT CODES RESULTING FROM THE INTERPRETATION

5.2.12 The following remarks apply to the data areas identified above:

<u>Section</u>	<u>Contents</u>
(0)	This section contains pointers to the start of each of the following sections. This section is mandatory .
(1)	This section contains information of general interest concerning the patient (e.g. patient name, patient ID, age, etc.) and the ECG (acquisition date, time, etc.). This section is mandatory .
(2)	This section contains all of the Huffman tables used in the encoding of rhythm (or "residual signal") and reference beat data. The tables shall be referenced by Sections 5 and 6 by their numerical order in this section. Thus, when reference is made in the reference beat encoding section to table 2, this shall refer to the second table defined in Section 2. This section is optional .
(3)	This section specifies which ECG leads are contained within the record. This section is optional .
(4)	If reference beats are encoded, then this Section shall identify the position of these reference beats relative to the "residual" signal contained in Section 6 below. This section is optional .
(5)	Reference beats for each lead are encoded if the originating device has identified those complexes. This section is optional .
(6)	This section contains the "residual" signal that remains for each lead after the reference beats have been subtracted, or if no reference beats have been subtracted, the entire rhythm signal. This section is optional .
(7)	This section contains global measurements for each reference beat type or for each QRS contained in the record and a list of possible pacemaker spikes in the record. This section is optional .
(8)	This section contains the latest actual text of the diagnostic interpretation of the recorded ECG data, including all overreadings if performed. Only the text of the most recent interpretation and overreading shall be included in this section. No manufacturer specific codes should be used in the text. Mnemonic codes as listed in the Universal statement codes may be used if necessary. The data contained in this section shall be consistent with the data in Section 9 and Section 11. This section is optional .
(9)	This section contains the manufacturer specific diagnostic statements of the analyzing device and overreading trails of the interpretations. The source of the analyzing device and the name of the latest confirming physician (or device) are defined in the "Header section" (Section 1). This section is optional .
(10)	A set of basic measurements and manufacturer specific measurements (if any) for each recorded lead are presented in this section. This section is optional .
(11)	This section contains the most recent interpretation and overreading data, coded according to the Universal Statement Codes and Coding rules (ANNEX D). The data contained in this section shall be consistent with the data in Sections 8 and 9. This section is optional .

5.3 Specification of the pointer section – Section 0

The purpose of this section is to store pointers to the remaining Sections in the record. All sections are given identification numbers, as listed in paragraph 5.2.2.

5.3.1 The section starts with a "Section ID Header" as defined in 5.2.7. Bytes 11-16 of the Section ID Header shall contain the six-character ASCII string: "SCPECG".

5.3.2 To provide a flexible way of section management, the data part of the pointer section is defined as follows :

- One pointer field for each section 0 - 11 defined by SCP-ECG protocol shall be provided in the pointer section, whether the optional sections are present or not. For any optional section not included in a SCP-ECG data record, the special codes defined in 5.3.2.2 and 5.3.2.3 for the pointer field shall be used.
- Manufacturer specific sections, if present, shall have a pointer field in section 0.
- The first pointer field included in this section shall be the field for section 0 (this section)

Each pointer field contains three parts:

- a) A Section Identification (see 5.3.2.1)
- b) A Section Length (see 5.3.2.2)
- c) An Index to the Section (see 5.3.2.3)

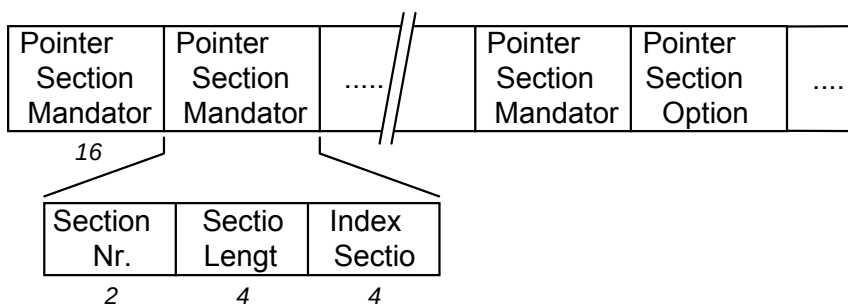
5.3.2.1 The Section Identification number is stored in two bytes containing the section number, as listed in 5.2.2. Section ID numbers 0 through 11 are currently defined in this SCP-ECG protocol, numbers 12 through 127, as well as numbers above 1023 are reserved for future use, numbers 128 through 1023 are codes for manufacturer specific sections.

5.3.2.2 The length in bytes of a section (= an even number, see 5.2.1) is presented in this unsigned 4 byte integer field part. The length includes the "Section ID Header" bytes (see 5.2.7). The 4 byte integer is necessary to allow sections to be larger than 65535 (64K – 1)bytes. For data Sections 2 - 11 a pointer field must be included. If no data is transmitted for any of these sections, set the section length to 0.

5.3.2.3 An index to the first byte of a section shall be presented in this unsigned 4 byte integer field part. The index is calculated relative to the start of the record, i.e. byte 1 of the record (first byte of the CRC). For example, if Section 11 begins at an offset of 128,900 bytes from the beginning of the ECG record, the index to Section 11 would be set to 128,901. The 4 byte integer is necessary to allow an SCP-ECG record to be larger than 32 kbytes. If a section is not included in the SCP-ECG record the index shall be set to NULL (0). The index to Section 0 shall always be set to 7, since Section 0 is always preceeded by the Checksum (2 bytes) and the Record Length (4 bytes).

5.3.2.4 The pointer fields shall be in numerical order. However, the sections themselves do not necessarily have to follow in numerical order.

5.3.3 Pointer section data part overview



5.4 Specification of the header information – Patient data / ECG acquisition data – Section 1

5.4.1 The section shall start with a "Section ID Header" as defined in 5.2.7.

5.4.2 Introduction to the Section data part

The following layout details the format that should be used to transmit patient demographic and ECG administrative data as part of the standard (SCP-ECG) communications protocol for digital ECG data.

5.4.3 Basic methodology

5.4.3.1 It is recognized that, although a large number of parameters may be transmitted, most devices will only send a subset of that number. As a result, it was agreed that the format of the patient demographic area should be made flexible.

Each parameter shall be stored in a separate field. Including a field in this section shall be optional, with the single provision that the following parameters (1 -> 4) SHALL be present:

	<u>Tag</u>	<u>Parameter</u>
(1)	2	Patient ID (used as primary key in the ECG management database)
(2)	14	ID of the Acquiring Device
(3)	25	Date of Acquisition
(4)	26	Time of Acquisition

In addition, the SCP-ECG Working Group highly recommends the following parameters for uniquely identifying the patient and time of acquisition:

(5)	0	Patient Last Name
(6)	1	Patient First Name
(7)	5	Patient Date of Birth (the date of birth shall in principle be given AD)
(8)	8	Patient Sex
(9)	15	ID of the Analyzing Device
(10)	34	Date Time Zone

5.4.3.2 Flexibility is achieved by identifying each field by:

- One leading specification byte, referred to as "*tag*", indicating the contents of the parameter field.
- A 2-byte unsigned integer, referred to as "*length*", containing the length of the *field value* in bytes, allowing variable length text entries and use of multiple byte character sets (as the Japanese character set). The NULL terminator character of a text string shall be included to calculate the field length. For example, for the last name "Menuel" the length shall be listed as 7, the NULL included. A length field value of 0 is allowed, which is equivalent to "not defined".
- Zero or more parameter bytes, referred to as "*value*", containing the actual parameter data.

The field *tag* (1 binary byte) permits a total of 255 different field types to be defined (0 -> 254; 255 is used as terminator), of which 55 (200-254) are reserved for use by an individual manufacturer. Any field identified by a value of 200-254 is not defined within the specification of this protocol and permits a manufacturer to define its own set of fields.

The field *length* (2 binary bytes) shall contain the actual length of the field *value*. The *tag* and *length* bytes (first 3 bytes of any field) are not included in the field length. The maximum possible length of each field *value* is 65535 bytes (unsigned 2 bytes). However, for practical reasons the maximum length of a field shall not exceed 64 bytes, except for the free text items (see 5.4.3.5).

The field *value*, containing the actual parameter data, can be of any combination of binary bytes and text characters.

5.4.3.3 A maximum of one instance of any field defined in 5.4.5 is allowed to be included in the "Header" section, except for the following fields listed below:

Tag	Value description	Max. instances
10	Drugs	no limit
13	Diagnosis or referral indication	no limit
30	Free text	no limit
32	History diagnostic codes	no limit
35	Free-text Medical History	no limit

5.4.3.4 The first 16 characters of the patient identification number shall be unique.

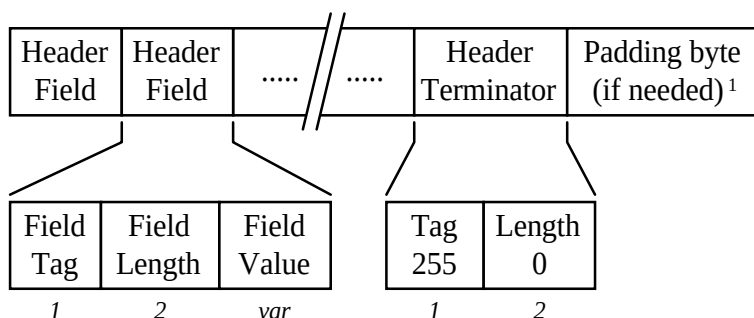
5.4.3.5 Maximum and reasonable length of free text fields

In order to facilitate the implementation of the protocol a maximum field length, i.e. 64 (except for tag 13, tag 30, and tag 35, where the limit is 80) and reasonable values for the length of the different free text fields have been determined, as shown in the table below.

Section	TAG	CONTENTS	Instance > once	Reasonable Length
1	0	Last Name	-	40
1	1	First Name	-	40
1	2	Patient Identification Number	-	40
1	3	Second Last Name	-	40
1	10	Drugs	yes	40 (1)
1	13	Diagnosis or Referral Indication	yes	80 (1)
1	14	Acquiring Device Identification Number	-	40
1	15	Analyzing Device ID Number	-	40
1	16	Acquiring Institution Description	-	40
1	17	Analyzing Institution Description	-	40
1	18	Acquiring Department Description	-	40
1	19	Analyzing Department Description	-	40
1	20	Referring Physician	-	60
1	21	Latest Confirming Physician	-	60
1	22	Technician Description	-	40
1	23	Room Description	-	40
1	30	Free Text Field	yes	80 (1)
1	31	ECG Sequence Number	-	12
1	35	Free-text Medical History	yes	80

NOTE:

1) Multiple instances are allowed for these fields, each with 40 or 80 characters, NULL terminated.



5.4.4 An overview of the "Header" section data part is presented below.

NOTE:

1) Padding bytes (if any) should be set to zero. This applies to all sections, but will not be shown in all the following diagrams.

5.4.5 Specification of the defined parameters

TAG	LENGTH	VALUE (Parameter data)																				
0	length	Last name (Text characters) This shall also be used to transmit the entire name if the originating unit does not explicitly determine a first name.																				
1	length	First name (Text characters)																				
2	length	Patient ID (Text characters)																				
3	length	Second Last name (Text characters) The field value may be defined as appropriate for the country or area the ECG-device is used. For instance in the USA this field may hold the Family member prefix code, in France it may contain the patient's maiden name, and in Portugal as well as in Spain and several Latin American countries, the second last name of the patient.																				
4	3	Age (Binary) This field has the following format : <table><tr><td><u>Byte</u></td><td><u>Contents</u></td></tr><tr><td>1-2</td><td>Binary: Age in units as indicated in byte 3</td></tr><tr><td>3</td><td>Binary: Units of age as defined below.</td></tr><tr><td><u>Value</u></td><td><u>Unit</u></td></tr><tr><td>0</td><td>Unspecified</td></tr><tr><td>1</td><td>Years</td></tr><tr><td>2</td><td>Months</td></tr><tr><td>3</td><td>Weeks</td></tr><tr><td>4</td><td>Days</td></tr><tr><td>5</td><td>Hours</td></tr></table> If all 3 bytes are zero, then age is not specified.	<u>Byte</u>	<u>Contents</u>	1-2	Binary: Age in units as indicated in byte 3	3	Binary: Units of age as defined below.	<u>Value</u>	<u>Unit</u>	0	Unspecified	1	Years	2	Months	3	Weeks	4	Days	5	Hours
<u>Byte</u>	<u>Contents</u>																					
1-2	Binary: Age in units as indicated in byte 3																					
3	Binary: Units of age as defined below.																					
<u>Value</u>	<u>Unit</u>																					
0	Unspecified																					
1	Years																					
2	Months																					
3	Weeks																					
4	Days																					
5	Hours																					
5	4	Date - of - birth (Binary) This field has the following format : <table><tr><td><u>Byte</u></td><td><u>Contents</u></td></tr><tr><td>1-2</td><td>Binary: Year (Full integer notation, as in 1990)</td></tr><tr><td>3</td><td>Binary: Month (range 01 - 12; 01 = January)</td></tr><tr><td>4</td><td>Binary: Day (range 01 - 31)</td></tr></table> If all 4 bytes are zero, then date-of-birth is not specified.	<u>Byte</u>	<u>Contents</u>	1-2	Binary: Year (Full integer notation, as in 1990)	3	Binary: Month (range 01 - 12; 01 = January)	4	Binary: Day (range 01 - 31)												
<u>Byte</u>	<u>Contents</u>																					
1-2	Binary: Year (Full integer notation, as in 1990)																					
3	Binary: Month (range 01 - 12; 01 = January)																					
4	Binary: Day (range 01 - 31)																					

TAG	LENGTH	VALUE (Parameter data)																						
6	3	Height (Binary) This field has the following format : <table><tr><th><u>Byte</u></th><th><u>Contents</u></th></tr><tr><td>1-2</td><td>Binary: Height in units as indicated in byte 3</td></tr><tr><td>3</td><td>Binary: Units of height as defined below.</td></tr><tr><th><u>Value</u></th><th><u>Unit</u></th></tr><tr><td>0</td><td>Unspecified</td></tr><tr><td>1</td><td>Centimeters</td></tr><tr><td>2</td><td>Inches</td></tr><tr><td>3</td><td>Millimeters</td></tr></table> If all 3 bytes are zero, then height is not specified.	<u>Byte</u>	<u>Contents</u>	1-2	Binary: Height in units as indicated in byte 3	3	Binary: Units of height as defined below.	<u>Value</u>	<u>Unit</u>	0	Unspecified	1	Centimeters	2	Inches	3	Millimeters						
<u>Byte</u>	<u>Contents</u>																							
1-2	Binary: Height in units as indicated in byte 3																							
3	Binary: Units of height as defined below.																							
<u>Value</u>	<u>Unit</u>																							
0	Unspecified																							
1	Centimeters																							
2	Inches																							
3	Millimeters																							
7	3	Weight (Binary) This field has the following format: <table><tr><th><u>Byte</u></th><th><u>Contents</u></th></tr><tr><td>1-2</td><td>Binary: Weight in units as indicated in byte 3</td></tr><tr><td>3</td><td>Binary: Units of weight as defined below.</td></tr><tr><th><u>Value</u></th><th><u>Unit</u></th><th><u>Value</u></th><th><u>Unit</u></th></tr><tr><td>0</td><td>Unspecified</td><td>3</td><td>Pound</td></tr><tr><td>1</td><td>Kilogram</td><td>4</td><td>Ounce</td></tr><tr><td>2</td><td>Gram</td><td></td><td></td></tr></table> If all 3 bytes are zero, then weight is not specified.	<u>Byte</u>	<u>Contents</u>	1-2	Binary: Weight in units as indicated in byte 3	3	Binary: Units of weight as defined below.	<u>Value</u>	<u>Unit</u>	<u>Value</u>	<u>Unit</u>	0	Unspecified	3	Pound	1	Kilogram	4	Ounce	2	Gram		
<u>Byte</u>	<u>Contents</u>																							
1-2	Binary: Weight in units as indicated in byte 3																							
3	Binary: Units of weight as defined below.																							
<u>Value</u>	<u>Unit</u>	<u>Value</u>	<u>Unit</u>																					
0	Unspecified	3	Pound																					
1	Kilogram	4	Ounce																					
2	Gram																							
8	1	Sex (Binary) This has the following format: <table><tr><th><u>Byte</u></th><th><u>Contents</u></th></tr><tr><td>1</td><td>Binary: Sex indication defined as:</td></tr><tr><th><u>Value</u></th><th><u>Sex</u></th><th><u>Value</u></th><th><u>Meaning</u></th></tr><tr><td>1</td><td>Male</td><td>0</td><td>Not Known</td></tr><tr><td>2</td><td>Female</td><td>9</td><td>Unspecified</td></tr></table>	<u>Byte</u>	<u>Contents</u>	1	Binary: Sex indication defined as:	<u>Value</u>	<u>Sex</u>	<u>Value</u>	<u>Meaning</u>	1	Male	0	Not Known	2	Female	9	Unspecified						
<u>Byte</u>	<u>Contents</u>																							
1	Binary: Sex indication defined as:																							
<u>Value</u>	<u>Sex</u>	<u>Value</u>	<u>Meaning</u>																					
1	Male	0	Not Known																					
2	Female	9	Unspecified																					

TAG	LENGTH	VALUE (Parameter data)																												
9	1	Race (Binary) This has the following format: <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Binary: Race indication defined as:</td></tr><tr><td></td><td><table><tr><th>Value</th><th>Race</th></tr><tr><td>0</td><td>Unspecified</td></tr><tr><td>1</td><td>Caucasian</td></tr><tr><td>2</td><td>Black</td></tr><tr><td>3</td><td>Oriental</td></tr><tr><td>4-9</td><td>Reserved</td></tr><tr><td>10-255</td><td>Other (manufacturer specific)</td></tr></table></td></tr></table>	Byte	Contents	1	Binary: Race indication defined as:		<table><tr><th>Value</th><th>Race</th></tr><tr><td>0</td><td>Unspecified</td></tr><tr><td>1</td><td>Caucasian</td></tr><tr><td>2</td><td>Black</td></tr><tr><td>3</td><td>Oriental</td></tr><tr><td>4-9</td><td>Reserved</td></tr><tr><td>10-255</td><td>Other (manufacturer specific)</td></tr></table>	Value	Race	0	Unspecified	1	Caucasian	2	Black	3	Oriental	4-9	Reserved	10-255	Other (manufacturer specific)								
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10	length	Drugs (Two binary and Text characters) Each drug entered in the patient demographic area shall be described by the following structure: <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Drug code table indicator. If Byte 1 is set to 0 then the following table applies</td></tr><tr><td>2</td><td>Class code</td></tr><tr><td>3</td><td>Specific drug code within the specified class</td></tr><tr><td>4-***</td><td>Text description of the drug (optional).</td></tr></table> The following classes are defined : <table><tr><td>0 - Unspecified</td><td>5 - Antianginal</td></tr><tr><td>1 - Digitalis</td><td>6 - Anti thrombotic</td></tr><tr><td>2 - Antiarrhythmic</td><td>7 - Beta Blockers</td></tr><tr><td>3 - Diuretics</td><td>8 - Psychotropic</td></tr><tr><td>4 - Antihypertensive</td><td>9 - Calcium Blockers</td></tr><tr><td>10 – Antihypotensive</td><td>100 – Not taking drugs</td></tr><tr><td>11 – Anticholesterol</td><td>101 – Drugs, but unknown type</td></tr><tr><td>12 – ACE- Inhibitors</td><td>102 – Other medication</td></tr><tr><td>13-99 Reserved</td><td>103-255 – Manufacturer specific codes</td></tr></table> Note (1): A class code of 0 is always followed by a drug code of 0, indicating that the drug is undefined within this document, and that the text in bytes 4–*** is the only description available. Note (2): A non-zero class code together with a drug code of 0 always indicates that a drug of that particular class has been applied, but that it is either unknown or not defined within this document. Even if a non-zero class and drug code are applied, a text description of the drug may also be sent in bytes 4–***. There are no standardized naming conventions. Note (3): There is no limit on the number of drugs which can be coded. Note (4): Within each class subcode 9 shall be used for “other”.	Byte	Contents	1	Drug code table indicator. If Byte 1 is set to 0 then the following table applies	2	Class code	3	Specific drug code within the specified class	4-***	Text description of the drug (optional).	0 - Unspecified	5 - Antianginal	1 - Digitalis	6 - Anti thrombotic	2 - Antiarrhythmic	7 - Beta Blockers	3 - Diuretics	8 - Psychotropic	4 - Antihypertensive	9 - Calcium Blockers	10 – Antihypotensive	100 – Not taking drugs	11 – Anticholesterol	101 – Drugs, but unknown type	12 – ACE- Inhibitors	102 – Other medication	13-99 Reserved	103-255 – Manufacturer specific codes
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13-99 Reserved	103-255 – Manufacturer specific codes																													
		The following list is optional and by far incomplete. The list could be much improved.																												

TAG	LENGTH	VALUE (Parameter data)
10 , <i>cont.</i>		CLASS 1: DIGITALIS PREPARATION 0 – Unspecified 1 – Digoxin-Lanoxin 2 – Digitoxin-Digitalis CLASS 2: ANTIARRHYTHMIC 0 – Unspecified 1 – Dysopyramide 2 – Quinidine 3 – Procainamide 4 – Lidocaine 5 – Phenytoin 6 – Dilantin 7 – Amiodarone 8 – Tocainide 9 – Other 10 – Encainide 11 – Mexilit/Mexilitine 12 – Flecainide 13 – Lorcaïnide CLASS 3: DIURETICS 0 – Unspecified 1 – Thiazide 2 – Furosemide (Lasix) 3 – Potassium Chloride CLASS 4: ANTIHYPERTENSIVE 0 – Unspecified 1 – Clonidine 2 – Prasozin 3 – Hydralazine CLASS 5: ANTIANGINAL 0 – Unspecified 1 – Isosorbide 2 – Calcium Blockers 3 – Nitrates CLASS 6: ANTITHROMBOTIC AGENTS 0 – Unspecified 4 – Warfarin 1 – Aspirin 5 – Streptokinase 2 – Coumadin 6 – t-PA 3 – Heparin CLASS 7: BETA BLOCKERS 0 – Unspecified 4 – Metoprolol 1 – Propranolol 5 – Pindolol 2 – Corgard 6 – Acebutolol 3 – Atenolol CLASS 8: PSYCHOTROPIC 0 – Unspecified 1 – Tricyclic antidepressant 2 – Phenothiazide 3 – Barbiturate CLASS 9: CALCIUM BLOCKERS 0 – Unspecified 1 – Nifedipine 2 – Verapamil CLASS 10: ANTIHYPOTENSIVE 0 – Unspecified 1 – Asthmatic drug 2 – Aminophylline 3 – Isuprel CLASS 11: ANTICHOLESTEROL 0 – Unspecified 1 – Colestid 2 – Lovastatin 3 – Simvastatin 4 – Fibrates CLASS 12: ACE- INHIBITORS 0 – Unspecified 1 – Captopril
11	2	Systolic blood pressure (Binary) <u>Byte</u> <u>Contents</u> 1-2 Binary: Systolic blood pressure in mmHg.

TAG	LENGTH	VALUE (Parameter data)
12	2	Diastolic blood pressure (Binary) <u>Byte</u> <u>Contents</u> 1-2 Binary: Diastolic blood pressure in mmHg.
13	length	Diagnosis or Referral indication (Text characters) This field contains a text description of the patient's diagnosis or the referral indication.
14	length	Machine ID Acquiring Device (Binary bytes and Text characters) This field uniquely identifies the device that acquired the ECG. It uses the following generic data structure for device characterization, which is also used in Tag 15: <u>Byte</u> <u>Contents</u> 1-2 Binary: Institution number 3-4 Binary: Department number 5-6 Binary: Device ID 7 Binary: Device type <u>Value</u> <u>Type</u> 0 Cart 1 System (or Host) 8 Binary: set equal to 255 - see Manufacturer character string at end of tag 14. Note: Legacy devices used this byte to specify a Manufacturer code. These codes shall no longer be used except for identifying legacy files. For historical purposes the assigned codes were as follows: 0 – Unknown 11 - Quinton 1 – Burdick 12 - Siemens 2 – Cambridge 13 - Spacelabs 3 – Compumed 14 - Telemed 4 – Datamed 15 - Hellige 5 – Fukuda 16 - ESA-OTE 6 – Hewlett-Packard 17 - Schiller 7 – Marquette Electronics 18 - Picker-Schwarzer 8 – Mortara Instruments 19 - Elettronica-Trentina 9 – Nihon Kohden 20 - Zwönitz 10 – Okin 21-99 Reserved 100 - Other 9-14 Text characters: Text model description. Up to 5 bytes of text and NULL terminator
		15 Binary: SCP-ECG protocol revision number (the decimal point shall be deleted; version 1.0 becomes 10; the revisions shall as far as possible be backward compatible). This number shall exactly refer to the written document describing the actual protocol revision. 16 Binary: SCP-ECG Protocol Compatibility Level (one byte). Detailed specifications are given in ANNEX B (see B.3).

TAG	LENGTH	VALUE (Parameter data)																																																																																																																																																																																																															
14, cont.		17 Binary: Language Support Code (one byte). This bit map indicates the supported character sets: <table><thead><tr><th>Bit 0</th><th>Bit 1</th><th>Bit 2</th><th>Bit 3</th><th>Bit 4</th><th>Bit 5</th><th>Bit 6</th><th>Bit 7</th><th>Meaning</th></tr></thead><tbody><tr><td>0</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>8-bit ASCII-only</td></tr><tr><td>1</td><td>0</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>ISO-8859-1 Latin-1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>ISO-8859-2 Latin-2 (Central and Eastern European)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>ISO-8859-4 Latin-4 (Baltic)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>ISO-8859-5 Cyrillic</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>ISO-8859-6 Arabic</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>ISO-8859-7 Greek</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>ISO-8859-8 Hebrew</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>ISO-8859-11 Thai</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>ISO-8859-15 Latin-9 (update to Latin-1, also called "Latin-0")</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>Unicode (ISO-60646)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>JIS X0201-1976 (Japanese)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>JIS X0208-1997 (Japanese)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>JIS X0212-1990 (Japanese)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>GB 2312-80 (Chinese)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>KS C5601-1987 (Korean)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>Reserved</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>Reserved</td></tr><tr><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>0</td><td>1</td><td>Reserved</td></tr><tr><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>1</td><td>0</td><td>Reserved</td></tr><tr><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>1</td><td>1</td><td>Reserved (except for following entry)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>Manufacturer-Specific</td></tr></tbody></table>	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Meaning	0	x	x	x	x	x	x	x	8-bit ASCII-only	1	0	x	x	x	x	x	x	ISO-8859-1 Latin-1	1	1	0	0	0	0	0	0	ISO-8859-2 Latin-2 (Central and Eastern European)	1	1	0	1	0	0	0	0	ISO-8859-4 Latin-4 (Baltic)	1	1	0	0	1	0	0	0	ISO-8859-5 Cyrillic	1	1	0	1	1	0	0	0	ISO-8859-6 Arabic	1	1	0	0	0	1	0	0	ISO-8859-7 Greek	1	1	0	1	0	1	0	0	ISO-8859-8 Hebrew	1	1	0	0	1	1	0	0	ISO-8859-11 Thai	1	1	0	1	1	1	0	0	ISO-8859-15 Latin-9 (update to Latin-1, also called "Latin-0")	1	1	1	0	0	0	0	0	Unicode (ISO-60646)	1	1	1	1	0	0	0	0	JIS X0201-1976 (Japanese)	1	1	1	0	1	0	0	0	JIS X0208-1997 (Japanese)	1	1	1	1	1	0	0	0	JIS X0212-1990 (Japanese)	1	1	1	0	0	1	0	0	GB 2312-80 (Chinese)	1	1	1	1	0	1	0	0	KS C5601-1987 (Korean)	1	1	1	0	1	1	0	0	Reserved	1	1	1	1	1	1	0	0	Reserved	x	x	x	x	x	x	0	1	Reserved	x	x	x	x	x	x	1	0	Reserved	x	x	x	x	x	x	1	1	Reserved (except for following entry)	1	1	1	1	1	1	1	1	Manufacturer-Specific
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		18 Binary: Capabilities of the ECG Device (one byte bit map) This bit map indicates the supported functions: <table><thead><tr><th>Bit</th><th>Contents</th></tr></thead><tbody><tr><td></td><td><table><thead><tr><th>Reset (0)</th><th>Set (1)</th></tr></thead><tbody><tr><td>0-3</td><td>Reserved</td></tr><tr><td>4</td><td>No printing</td></tr><tr><td>5</td><td>No analysis</td></tr><tr><td>6</td><td>No storage</td></tr><tr><td>7(MSB)</td><td>No acquisition</td></tr></tbody></table></td></tr></tbody></table>	Bit	Contents		<table><thead><tr><th>Reset (0)</th><th>Set (1)</th></tr></thead><tbody><tr><td>0-3</td><td>Reserved</td></tr><tr><td>4</td><td>No printing</td></tr><tr><td>5</td><td>No analysis</td></tr><tr><td>6</td><td>No storage</td></tr><tr><td>7(MSB)</td><td>No acquisition</td></tr></tbody></table>	Reset (0)	Set (1)	0-3	Reserved	4	No printing	5	No analysis	6	No storage	7(MSB)	No acquisition																																																																																																																																																																																															
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		20-35 Reserved for future use. 36 Binary: Length of the string for Analysing Program Revision Number. Byte 36 must be equal to or greater than 1. The character strings following byte 36 are required. If a particular character string is empty, a single NULL is required to be present.																																																																																																																																																																																																															

TAG	LENGTH	VALUE (Parameter data)						
14, cont.		37-** Character String: Analysing Program Revision Number. The string has to be NULL terminated. **-** Character string: Serial number of the Acquisition Device. The character string has to be NULL terminated **-** Character string: Acquisition device system software identifier. The character string has to be NULL terminated. **-** Character string: Acquisition device SCP implementation software identifier (maximum 24 characters plus NULL terminator). The character string has to be NULL terminated. **-** Character string: Manufacturer of the Acquisition Device. Contains the Manufacturer's registered trade name. The character string has to be NULL terminated						
15	length	Machine ID Analyzing Device (Binary bytes and Text characters) This field uniquely identifies the device that analyzed the ECG (if other than the acquiring cardiograph). The format of this field is identical to that utilized by parameter 14 above.						
16	length	Acquiring Institution Description (Text characters) This field provides a text description of the Institution where the ECG was acquired.						
17	length	Analyzing Institution Description (Text characters) This field provides a text description of the Institution where the ECG was analyzed.						
18	length	Acquiring Department Description (Text characters) This field provides a text description of the Department where the ECG was acquired.						
19	length	Analyzing Department Description (Text characters) This field provides a text description of the Department where the ECG was analyzed.						
20	length	Referring Physician (Text characters) This field provides a text description of the referring physician.						
21	length	Latest Confirming Physician (Text characters) This field provides a text description of the latest confirming physician.						
22	length	Technician Description (Text characters) This field provides a text description of the technician.						
23	length	Room Description (Text characters) This field provides a text description of the room where the ECG was recorded.						
24	1	Stat Code (Binary) <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Binary: Level of emergency.</td></tr><tr><td>0</td><td>Value 0 refers to "routine" and higher values to increasing levels of emergency as defined by the user. For this codes in the range of 1 to 10 are recommended.</td></tr></table>	Byte	Contents	1	Binary: Level of emergency.	0	Value 0 refers to "routine" and higher values to increasing levels of emergency as defined by the user. For this codes in the range of 1 to 10 are recommended.
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TAG	LENGTH	VALUE (Parameter data)										
25	4	Date of Acquisition (Binary) This field has the following format: <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1-2</td><td>Binary: Year (Full integer notation, as in 1990)</td></tr><tr><td>3</td><td>Binary: Month (range 01 - 12; 01 = January)</td></tr><tr><td>4</td><td>Binary: Day (range 01 - 31)</td></tr></table>	Byte	Contents	1-2	Binary: Year (Full integer notation, as in 1990)	3	Binary: Month (range 01 - 12; 01 = January)	4	Binary: Day (range 01 - 31)		
Byte	Contents											
1-2	Binary: Year (Full integer notation, as in 1990)											
3	Binary: Month (range 01 - 12; 01 = January)											
4	Binary: Day (range 01 - 31)											
26	3	Time of Acquisition (Binary) This field has the following format: <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Binary: Hours (range 0 - 23)</td></tr><tr><td>2</td><td>Binary: Minutes (range 0 - 59)</td></tr><tr><td>3</td><td>Binary: Seconds (range 0 - 59)</td></tr></table> The time of acquisition shall be expressed as local time in the Time Zone of acquisition (see tag 34).	Byte	Contents	1	Binary: Hours (range 0 - 23)	2	Binary: Minutes (range 0 - 59)	3	Binary: Seconds (range 0 - 59)		
Byte	Contents											
1	Binary: Hours (range 0 - 23)											
2	Binary: Minutes (range 0 - 59)											
3	Binary: Seconds (range 0 - 59)											
27	2	Baseline Filter (Binary; 2 bytes) This field contains the "cut-off" frequency (-3 db) of the high pass baseline filter in units of (1/100) Hertz.										
28	2	Low-pass Filter (Binary; 2 bytes) This field contains the "cut-off" frequency (-3 db) of the low pass filter in units of Hertz.										
29	1	Filter Bit Map (Binary; 1 byte) This field indicates if other filters have been used during the processing of the ECG. The definition of these bits are: <table><tr><td>0</td><td>- 60 Hertz notch filter</td></tr><tr><td>1</td><td>- 50 Hertz notch filter</td></tr><tr><td>2</td><td>- Artifact filter</td></tr><tr><td>3</td><td>- Baseline filter</td></tr><tr><td>4 - 7</td><td>- Undefined</td></tr></table> If all bits are zero then the filter setting was not specified	0	- 60 Hertz notch filter	1	- 50 Hertz notch filter	2	- Artifact filter	3	- Baseline filter	4 - 7	- Undefined
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1	- 50 Hertz notch filter											
2	- Artifact filter											
3	- Baseline filter											
4 - 7	- Undefined											
30	length	Free Text Field (Text characters) This field permits free text comments to be carried along with the ECG.										
31	length	Sequence Number (Text characters) ECG sequence number.										
32	length	Medical History Codes (Binary) This field contains a description of the patient's clinical problems and diagnoses. There is no limit on the number of diagnoses. Each diagnosis shall be represented by one byte.										

TAG	LENGTH	VALUE (Parameter data)																																										
		Byte 0 is used to designate the Medical History Code Table which is applied. In case this byte is equal to zero (0) then the following set of codes apply: <table><thead><tr><th>Value</th><th>Contents</th></tr></thead><tbody><tr><td>0</td><td>Diagnoses or clinical problems not specified</td></tr><tr><td>1</td><td>Apparently healthy</td></tr><tr><td>10</td><td>Acute myocardial infarction</td></tr><tr><td>11</td><td>Myocardial infarction</td></tr><tr><td>12</td><td>Previous myocardial infarction</td></tr><tr><td>15</td><td>Ischemic heart disease</td></tr><tr><td>18</td><td>Peripheral vascular disease</td></tr><tr><td>20</td><td>Cyanotic congenital heart disease</td></tr><tr><td>21</td><td>Acyanotic congenital heart disease</td></tr><tr><td>22</td><td>Valvular heart disease</td></tr><tr><td>25</td><td>Hypertension</td></tr><tr><td>27</td><td>Cerebrovascular accident</td></tr><tr><td>30</td><td>Cardiomyopathy</td></tr><tr><td>35</td><td>Pericarditis</td></tr><tr><td>36</td><td>Myocarditis</td></tr><tr><td>40</td><td>Post-operative cardiac surgery</td></tr><tr><td>42</td><td>Implanted cardiac pacemaker</td></tr><tr><td>45</td><td>Pulmonary embolism</td></tr><tr><td>50</td><td>Respiratory disease</td></tr><tr><td>55</td><td>Endocrine disease</td></tr></tbody></table>	Value	Contents	0	Diagnoses or clinical problems not specified	1	Apparently healthy	10	Acute myocardial infarction	11	Myocardial infarction	12	Previous myocardial infarction	15	Ischemic heart disease	18	Peripheral vascular disease	20	Cyanotic congenital heart disease	21	Acyanotic congenital heart disease	22	Valvular heart disease	25	Hypertension	27	Cerebrovascular accident	30	Cardiomyopathy	35	Pericarditis	36	Myocarditis	40	Post-operative cardiac surgery	42	Implanted cardiac pacemaker	45	Pulmonary embolism	50	Respiratory disease	55	Endocrine disease
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32, cont.		<table><thead><tr><th>Value</th><th>Contents</th></tr></thead><tbody><tr><td>60</td><td>Neurological disease</td></tr><tr><td>65</td><td>Alimentary disease</td></tr><tr><td>70</td><td>Renal disease</td></tr><tr><td>80</td><td>Pre-operative general surgery</td></tr><tr><td>81</td><td>Post-operative general surgery</td></tr><tr><td>90</td><td>General medical</td></tr><tr><td>100</td><td>Other</td></tr><tr><td>128-255</td><td>Manufacturer specific</td></tr></tbody></table> The missing numbers in the series from 1 to 100 have been reserved for future extension of some categories.	Value	Contents	60	Neurological disease	65	Alimentary disease	70	Renal disease	80	Pre-operative general surgery	81	Post-operative general surgery	90	General medical	100	Other	128-255	Manufacturer specific																								
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TAG	LENGTH	VALUE (Parameter data)																								
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6	XYZ leads derived from standard 12-lead ECG																									
7-255	Undefined now. Reserved for later use																									
34	length	DateTime Zone The contents of this tag identify the global time zone in which the acquired data was obtained, thus allowing the date/time value specified by tags 25 and 26 to be converted to any Time Zone (e.g. UTC). The following parameter bytes of this tag provide three ways to indicate Time Zone. <table><thead><tr><th>Byte</th><th>Name</th><th>Type</th><th>Notes</th></tr></thead><tbody><tr><td>1-2</td><td>Offset</td><td>signed integer</td><td>Time Zone specified as an offset from UTC in minutes. [Note 1]</td></tr></tbody></table>	Byte	Name	Type	Notes	1-2	Offset	signed integer	Time Zone specified as an offset from UTC in minutes. [Note 1]																
Byte	Name	Type	Notes																							
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TAG	LENGTH	VALUE (Parameter data)			
		3-4	Index	unsigned byte	Time Zone specified by a manufacturer-defined mapping (until a consensus mapping is defined using bytes 1-1000) using this value as a lookup-table index. [Note 2]
			<u>Value</u>	<u>Meaning</u>	
			0	Index not used	
			1-1000	= Reserved for future use	
			1001 – 32766	= Manufacturer-specific	
			32767	= Reserved	
34, <i>cont.</i>		<u>Byte</u>	<u>Name</u>	<u>Type</u>	<u>Notes</u>
		5-x	Description	Text String	Time Zone specified by a null-terminated string. [Note 3]
		<u>Note 1</u> - Allowable values for Offset are -780 through 780 (i.e., +/-13 hours) and hexadecimal 0x7FFF. 0x7FFF indicates that the field is not initialized or is unused. If the Offset field contains an allowed value other than 0x7FFF, the Index and Description fields are considered redundant and may be ignored <u>Note 2</u> - The Index value specifies Time Zone only if the Offset value is 0x7FFF. An Index value of zero indicates that the field is not used or not initialized. Use of this byte as presently defined is manufacturer specific. <u>Note 3</u> - The Description field specifies Time Zone only if the Offset value is 0x7FFF. This string should be in the format of the TZ environment variable as standardized by Posix (Unix). Reference: 'C/C++' language subroutine name tzset(), environment variable "TZ", and associated data structures. The Description field must be 1 byte at a minimum (i.e., the null terminator. <u>Note 4</u> - If Time Zone is not defined for the device, Tag 34 may be omitted from the data record. Similarly, an instance of Tag 34 containing values for the Offset = 0x7FFF, Index = 0, and Description = null terminator is also allowed if Time Zone is not defined.			
35	length	Free Text Medical History This field permits free text for entering the medical history.			
255	0	None (demographic section terminator).			

5.5 Specification of the Huffman tables – Section 2

5.5.1 If present, the section shall start with a "Section ID Header" as defined in 5.2.7.

5.5.2 The scheme for signal compression presented below is based on the Huffman method of encoding. This method is not the only one possible, but is the recommended one.

5.5.3 This Section of the ECG record contains the definition of the Huffman Code Tables that were used to encode the ECG. The provision of a number of tables permits optimum encoding of the data (e.g. the reference beats and rhythm data will probably use different tables). It shall be assumed that the encoded data within each entity shall be encoded using Table # 1 (i.e. the first Table defined within this Section). Escape codes should be provided within each Table to enable a change to another Table.

5.5.4 The following basic values are used:

- i) The fundamental sample time, as defined in the section containing the coded data (i.e. Section 5 "Reference Beat data" and Section 6 "Rhythm data").
- ii) The fundamental unit of ECG amplitude, as defined in the section containing the coded data (i.e. Section 5 "Reference Beat data" and Section 6 "Rhythm data").

5.5.5 The structure of the data part of this Section is then as follows :

Byte	Contents								
1-2	Number of Huffman Tables defined (if 19999 then the default Table, defined in C.2.7.4, is used)								
3-4	Number of code structures in Table # 1.								
5-???	The structures defining each code in Table # 1. Each structure has the following layout : 1 byte - Number of bits in prefix 1 byte - Number of bits in entire code 1 byte - Table mode switch <table><tr><th>Value</th><th>Content</th></tr><tr><td>0</td><td>Switch to another Huffman table</td></tr><tr><td>1</td><td>Huffman coding if # of bits in prefix = # of bits entire code</td></tr><tr><td>1</td><td>Original data if # of bits in prefix < # of bits entire code</td></tr></table> 2 bytes - Base value represented by base code (in AVM units). 4 bytes - Base code - 1st bit in code represented by least significant bit of the 4 byte area. ???+1 - ???+2 Number of structures in Table # 2. ???+3 - **** Structures representing Table # 2. etc.	Value	Content	0	Switch to another Huffman table	1	Huffman coding if # of bits in prefix = # of bits entire code	1	Original data if # of bits in prefix < # of bits entire code
Value	Content								
0	Switch to another Huffman table								
1	Huffman coding if # of bits in prefix = # of bits entire code								
1	Original data if # of bits in prefix < # of bits entire code								

5.5.6 The Huffman codes have been defined to permit a single structure described above to specify a series of consecutive amplitude values. The "prefix" mentioned above is common to all of the codes describing the consecutive values - the remaining bit field changes by 1 LSB in incrementing through the indicated range.

Structures that define the Huffman code for just one value shall have no remainder and hence the prefix length shall equal the total code length.

An example byte structure of the Huffman code is then:

	MSB				LSB			
Received Bvte 1 ---	P1	P2	P3	P4	C1	C2	C3	C4
Received Bvte 2 ---	C5	C6	P5	P6	P7	C7	C8	C9
Received Bvte 3 ---	C10	C11	P8	P9	P10	C12	C13	C14

etc.

Note that this represents the following coded values:

P1	P2	P3	P4	C1	C2	C3	C4	C5	C6
----	----	----	----	----	----	----	----	----	----

- 4 bit prefix with total code length of 10.

P5	P6	P7	C7	C8	C9	C10	C11
----	----	----	----	----	----	-----	-----

- 3 bit prefix with total code of 8.

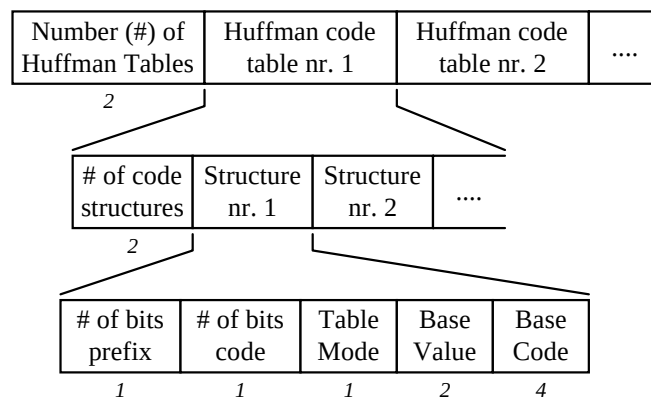
P8 P9 P10 C12 C13 C14

- 3 bit prefix with total code length of 6.

It shall be seen that the "picking" of bits in a given byte proceeds from the most significant bit to the least significant bit and that the bytes are processed in the order received.

5.5.7 Escape codes - i.e. codes that shall dictate a change of Huffman Table - shall include a zero (0) value for the "Table mode switch". The "Base Value" shall then contain the number of the Table to which a switch is desired.

5.5.8 An overview of the data part of this section is presented below.



5.6 Specification of the ECG lead definition – Section 3

This section defines the leads that are transmitted, together with some general administrative information, thus:

5.6.1 If present, the section shall start with a "Section ID Header" as defined in 5.2.7.

5.6.2 The section data part is defined below:

<u>Byte</u>	<u>Contents</u>
1	Number of leads enclosed
2	Flag byte :
Bit 0 (LSB)	Set = Reference beat subtraction used for compression Reset = Reference beat subtraction not used for compression
Bit 1	Reserved
Bit 2 ¹⁾	Set = Leads all simultaneously recorded Reset = Leads not all simultaneously recorded.
Bits 3 -> 7 ¹⁾	The number of simultaneously recorded leads.
3-11	Detail for first lead (see 5.6.3)
12-20	Detail for second lead (see 5.6.3) etc.

EXAMPLE: Three leads are recorded simultaneously: e.g. first leads I, aVF, V2; second leads X, Y, Z, etc. Lead details should be listed in above listed order: Lead I in the first segment (3-11), Lead aVF in the second segment (12-20), Lead V2 in the third segment (21-29), Lead X in the fourth segment (30-38), etc.

5.6.3 The detailed information for each lead is as follows :

Byte	Contents
1-4	(Unsigned) Starting sample number
5-8	(Unsigned) Ending sample number
9	Lead identification. The following numbering scheme shall be used:

Lead Identification Table:

1	= I ²⁾
2	= II
3	= V1
4	= V2
5	= V3
6	= V4
7	= V5
8	= V6
9	= V7
10	= V2R
11	= V3R
12	= V4R
13	= V5R
14	= V6R
15	= V7R
16	= X ³⁾
17	= Y ³⁾
18	= Z ³⁾
19	= CC5
20	= CM5
21	= Left Arm
22	= Right Arm
23	= Left Leg
24	= I ²⁾
25	= E
26	= C
27	= A
28	= M
29	= F
30	= H
31	= I ²⁾ -cal
32	= II-cal
33	= V1-cal
34	= 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
51	= Left Arm-cal
52	= Right Arm-cal
53	= Left Leg-cal
54	= I-cal ²⁾
55	= E-cal
56	= C-cal
57	= A-cal
58	= M-cal
59	= F-cal
60	= H-cal
61	= III
62	= aVR

63 = aVL
 64 = aVF
 65 = -aVR
 66 = V8
 67 = V9
 68 = V8R
 69 = V9R
 70 = D (Nehb – Dorsal)
 71 = A (Nehb – Anterior)
 72 = J (Nehb – Inferior)
 73 = Defibrillator lead: anterior-lateral
 74 = External pacing lead: anterior-posterior
 75 = A1 (Auxiliary unipolar lead 1)
 76 = A2 (Auxiliary unipolar lead 2)
 77 = A3 (Auxiliary unipolar lead 3)
 78 = A4 (Auxiliary unipolar lead 4)
 79 = V8-cal
 80 = V9-cal
 81 = V8R-cal
 82 = V9R-cal
 83 = D-cal (cal for Nehb – Dorsal)
 84 = A-cal (cal for Nehb – Anterior)
 85 = J-cal (cal for Nehb – Inferior)⁴⁾

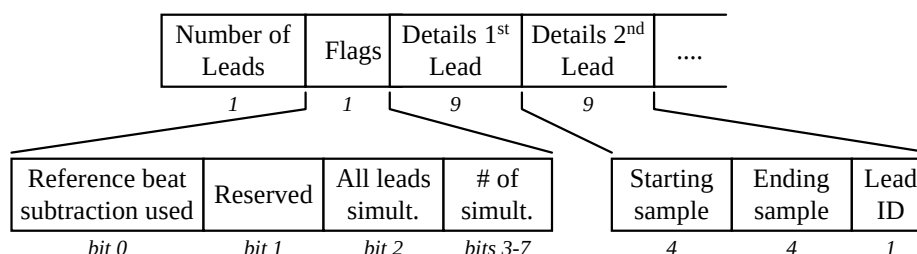
0 - Unspecified lead
 86 -> 99 - Reserved for future expansion⁴⁾
 100 -> 255 - Manufacturer specific

5.6.4 The sample numbering shall start with sample number 1 and refers to all leads recorded simultaneously. In order to convert these values to time, the sampling rate of the proper data section (see 5.8.2) should be consulted.

For example, if 8 leads (I, II, V1 to V6) are recorded simultaneously over 10 seconds at 500 samples/s and stored this way, then each lead begins with sample number 1 and ends with sample number 5000.

If the leads are recorded in groups of three, for example over 2.5 seconds at 500 samples/s, then leads I,II,and III begin with sample number 1 to sample 1250, and leads aVR, aVL, and aVF begin with sample number 1251.

5.6.5 An overview of the data part of this section is presented below.



NOTES:

- 1) In case not all leads are recorded simultaneously, the leads shall be presented in groups corresponding to those recorded simultaneously.
- 2) The Einthoven lead one (coded with the Roman I; lead ID's 1 and 31) should not be confused with the Frank electrode I (eye; lead ID's 24 and 54).
- 3) Leads X, Y and Z can be recorded by any orthogonal system, such as Frank or McFee lead systems, etc. Clause 5.4.5 tag 33 may be used to define the lead system used.
- 4) Extensions of the lead numbering scheme may be done in future revisions of the protocol.

5.7 Specification of QRS locations, reference beat subtraction zones, and protected areas – Section 4

If present, this section defines the locations and width of the various QRS complexes. For a definition of reference beats, beat types, and the significance of reference beat type 0, see 5.1.10. For a detailed description of the overall process, see ANNEX C.

5.7.1 The section shall start with a "Section ID Header" as defined in 5.2.7

5.7.2 QRS location definition

The header area of the Section data part defines certain quantities that are common to the type 0 reference beat for all leads. The remaining data indicates the reference beat type and location of each QRS relative to the "residual" signal. The Section data part header area has the following contents :

Byte	Contents
1-2	Length of reference beat type 0 data in milliseconds. Note: The number of samples N is obtained by dividing the length L of the reference beat (in milliseconds) by the sample time interval SI (in microseconds, see clause 5.9.2, bytes 3-4) using the following equation: $N = \text{truncation} [(1000 \mu\text{s/ms} * L) / SI]$. The manufacturer shall assign a length (in bytes 1-2) such that when this equation is used, the intended number of samples in the reference beat is obtained. For example, 1000 ms of data at 2000 μs per sample results in an N of 500 samples.
3-4	(Unsigned) Sample number of the fiducial (QRS trigger point) relative to the beginning of reference beat type 0. This location is abbreviated as fcM in ANNEX C. The first sample is numbered 1.
5-6	Total number of QRS complexes within the entire ECG record.

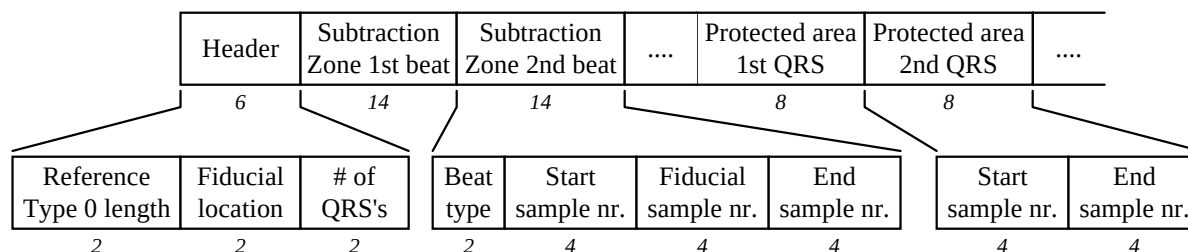
5.7.3 The following information on location of reference beat subtraction zones is stored, consisting of one block of 14 bytes for each QRS complex. The total number of blocks is equal to the number of QRSs stored in 5.7.2 bytes 5-6.

1-2	Beat type of 1st QRS (see 5.1.10 for definition of "Beat type")
3-6	(Unsigned) sample number ¹⁾ on residual data for the start of subtraction/addition of reference beat 0 for 1st QRS, if the QRS is of type 0, otherwise a value of 0 (zero). ^{2,3)}
7-10	(Unsigned) sample number ¹⁾ on residual data for location of fiducial point for 1 st QRS. ⁴⁾ This location is abbreviated as fc(1) in ANNEX C.
11-14	(Unsigned) sample number ¹⁾ on residual data for end of subtraction/addition of reference beat 0 for 1st QRS, if the QRS is of type 0, otherwise a value of 0 (zero). ^{2,3)}
15-16	Beat type of 2nd QRS
etc.	

5.7.4 The following information on location of protected areas (QRS complexes) is stored, consisting of one block of 8 bytes for each QRS complex. The total number of blocks is equal to the number of QRSs stored in 5.7.2 bytes 5-6.⁴⁾

1-4	(Unsigned) sample number ¹⁾ on residual data for the start of the protected area of the 1st QRS. This location is abbreviated as QB(1) in ANNEX C.
5-8	(Unsigned) sample number ¹⁾ on residual data for the end of the protected area of the 1st QRS. This location is abbreviated as QE(1) in ANNEX C.
9-12	(Unsigned) sample number ¹⁾ on residual data for the protected area of the start of the 2nd QRS. This location is abbreviated as QB(2) in ANNEX C.
13-16	(Unsigned) sample number ¹⁾ on residual data for the end of the protected area of the 2nd QRS. This location is abbreviated as QE(2) in ANNEX C.
etc.	

5.7.5 An overview of the data part of this section is presented below.



NOTES:

- 1) All sample numbers in this clause refer to the original samples before processing them for decimation and/or compression. The first sample of the original data is numbered 1.
- 2) If bytes 1-2 indicate reference beat type 0, then bytes 3-6 and 11-14 bound the area around the QRS for reference beat type 0 subtraction or addition, as specified and illustrated in ANNEX C. These locations are abbreviated in ANNEX C as SB(k) and SE(k), respectively.
- 3) If bytes 1-2 indicate a reference beat type other than 0, then reference beat subtraction is not used, in which case bytes 3-6 and 11-14 contain 0 (zero).
- 4) Clauses 5.7.3 and 5.7.4 may also be used to indicate location of the protected zones in case bimodal compression is used but not reference beat subtraction. In this case, 5.7.3 bytes 3-6 and 11-14 shall be set to zero.

5.8 Specification of the encoded type 0 reference beat data – Section 5

This section provides details of reference beat type 0. For a definition of reference beats, reference beat types, and the significance of reference beat type 0, see 5.1.10. For a detailed description the overall process see ANNEX C.

5.8.1 If present, the section shall start with a "Section ID Header" as defined in 5.2.7.

5.8.2 The section data part begins with a header that has the following format:

Byte	Contents
1-2	Multiplier for amplitude value (AVM). This operates as follows: The Amplitude Value Multiplier is expressed in nano Volt ($1 * 10^{-9}$ V). Example: 1250 -> 1 amplitude quantum = 1.250 μ V 2441 -> 1 amplitude quantum = 2.441 μ V
3-4	The sample time interval for this section in microseconds ($1 * 10^{-6}$ s). Example: 4000 -> 250 samples/s. 1250 -> 800 samples/s.
5	This value indicates the encoding of the sample data as follows: 0 = Real (zero difference) data used for reference beat 0 data 1 = First difference ¹⁻⁴⁾ data used for reference beat 0 data 2 = Second difference ¹⁻³⁾ data used for reference beat 0 data
6	Reserved.

NOTES:

1) Difference data are defined as:

(Sample value(difference) for time [t]) – (Sample value(difference) for time [t-1])

Original data	First differences	Second differences
X(1)	D1(1)=X(1)	D2(1)=X(1)
X(2)	D1(2)=X(2)-X(1)	D2(2)=X(2)
X(3)	D1(3)=X(3)-X(2)	D2(3)=D1(3)-D1(2)=X(3)-2*X(2)+X(1)
X(4)	D1(4)=X(4)-X(3)	D2(4)=D1(4)-D1(3)=X(4)-2*X(3)+X(2)

So the general formula for the first difference is as follows:

$$D1(n) = X(n) - X(n-1)$$

The general formula for the second difference is as follows:

$$D2(n) = X(n) - 2*X(n-1) + X(n-2)$$

Decoding of the 2nd difference data is performed using the following formula:

$$X(n) = D2(n) + 2*X(n-1) - X(n-2)$$

2) For the first 2 samples in each lead, second differences are not computed in the SCP-ECG Protocol. The original value amplitudes of these samples shall be retained. The first sample value shall similarly be retained in the encoded data stream using 1st differences.

3) An example of the encoded results using 2nd differences is given in the table below for a series of 8 sample data:

Sample Number:	N	1	2	3	4	5	6	7	8
Sample Value:	X(n)	10	12	13	15	18	22	20	15
2nd Difference:	D2(n)	-	-	-1	1	1	1	-6	-3
Encoded data:		10	12	-1	1	1	1	-6	-3

4) An example of the encoded results using 1st differences is given in the table below using the same series of 8 sample data:

Sample Number:	N	1	2	3	4	5	6	7	8
Sample Value:	X(n)	10	12	13	15	18	22	20	15
1st Difference:	D1(n)	-	2	1	2	3	4	-2	-5
Encoded data:		10	2	1	2	3	4	-2	-5

5.8.3 The section data part contains the byte lengths of the encoded leads. Its format is as follows:

Byte Contents

1-2 (Unsigned) Number of bytes in compressed reference beat 0 data for first encoded lead

3-4 (Unsigned) Number of bytes in compressed reference beat 0 data for second encoded lead

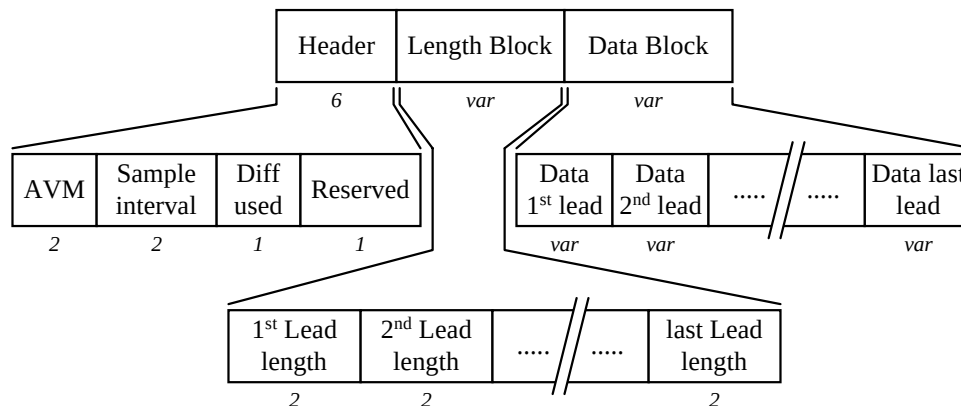
etc.

5.8.4 The encoded reference beat 0 data then follows. If Section 2 has been provided, the data is coded as a series of Huffman codes taken from Section 2. The leads are encoded in the order specified in Section 3. If Section 2 is not provided, ECG data (either differenced or non-differenced) shall be formatted as signed, two-byte integers.¹⁾

NOTE:

1) Other formats may be accommodated by providing a “dummy” Huffman table with one code structure. The number of bits in the prefix must be set to zero. The number of bits in the entire code must be set to the desired number of bits per sample.

5.8.5 An overview of the data part of this section is presented below.



5.9 Specification of the rhythm data – Section 6

This section contains either:

- (i) the entire ECG rhythm data, if no reference beats have been subtracted (see 5.6.2, byte 2), or
- (ii) the residual signal after reference beats have been subtracted.

5.9.1 If present, the section shall start with a "Section ID Header" as defined in 5.2.7.

5.9.2 The section data part begins with a header that has the following format :

<u>Byte</u>	<u>Contents</u>
1-2	Multiplier for amplitude value (AVM). This operates as follows: The Amplitude Value Multiplier is expressed in nano Volt ($1 * 10^{-9}$ Volt). Example: 1250 -> 1 amplitude quantum = 1.250 μ V 2441 -> 1 amplitude quantum = 2.441 μ V
3-4	The sample time interval for this section in microseconds ($1 * 10^{-6}$ s). Example: 4000 -> 250 samples/s. 1250 -> 800 samples/s.
5	This value indicates the encoding of the sample data as follows: 0 = Real (zero difference) data used for rhythm data 1 = First difference data used for rhythm data 2 = Second difference data used for rhythm data
6	This value indicates how rhythm data is compressed, as follows: 0 = bimodal compression not used 1 = bimodal compression used.

Note: If bimodal compression is used, the protected region sample time interval is as in 5.8.2, but AVM is as in 5.9.2 Bytes 1-2. Outside the protected region, AVM and sample time interval are as in 5.9.2 bytes 1-2 and 3-4.

5.9.3 The section data part contains the byte lengths of the encoded leads. Its format is as follows:

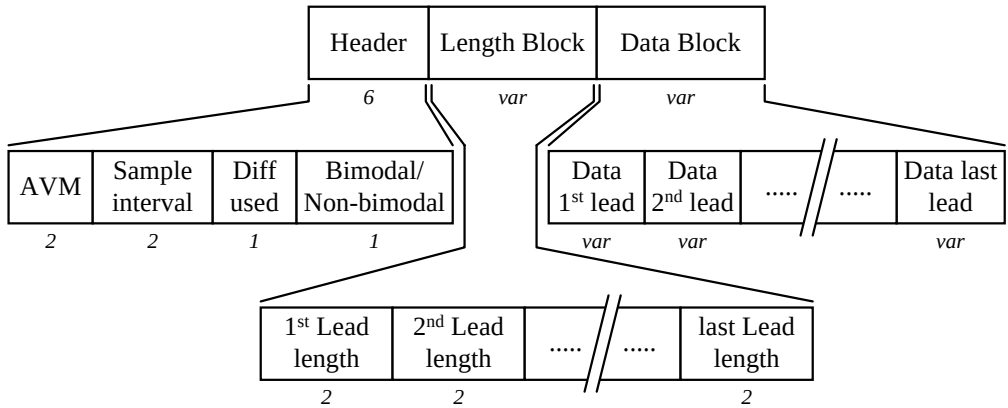
<u>Byte</u>	<u>Contents</u>
1-2	(Unsigned) Number of bytes in compressed rhythm data for first encoded lead
3-4	(Unsigned) Number of bytes in compressed rhythm data for second encoded lead
etc.	

5.9.4 The rhythm data then follows. If Section 2 has been provided, the data is coded as a series of Huffman codes taken from Section 2. The leads are encoded in the order specified in Section 3. If Section 2 is not provided, ECG data (either differenced or non-differenced) shall be formatted as signed, two-byte integers.¹⁾

NOTE:

1) Other formats may be accommodated by providing a "dummy" Huffman table with one code structure. The number of bits in the prefix must be set to zero. The number of bits in the entire code must be set to the desired number of bits per sample.

5.9.5 An overview of the data part of this section is presented below.



5.10 Specification of the global measurements – Section 7

This section contains either global measurements for each reference beat type or for each QRS in the record, and a list of pacemaker spikes in the record. If measurements are provided for each QRS, then the first measurement block shall contain global measurements of beat type 0. The term “global” refers to measurements taken across all leads of the ECG, but not necessarily representing more than one individual beat. See clause 5.1.10 for a discussion of beat types.

5.10.1 If present, the section shall start with a "Section ID Header" as defined in 5.2.7.

5.10.2 The section data part contains global ECG measurement data and pacemaker spike measurement data if any.

Special codes, as defined in the CSE Project, have been reserved to indicate:

29999 (decimal) – Measurement not computed by the program

29998 (decimal) – Measurement result not found due to rejection of the lead by the measurement program

19999 (decimal) – Measurement not found because wave was not present (e.g. P wave during atrial fibrillation).

These codes shall replace the measurement data when appropriate.

5.10.2.1 Global ECG measurement data:

<u>Byte</u>	<u>Contents</u>
1	This byte contains either the number of reference beat types or the number of QRS's + 1 (compare to 5.10.2.4 byte 1). This byte refers to the number of measurement blocks stored, where the first block (bytes 7-22) always contain measurements for reference beat type 0. If this byte contains the number of reference beat types (i.e., it is not equal to 5.10.2.4 byte 1 plus 1), then each subsequent block contains the global measurements for each subsequent reference beat type. If this byte contains the number of QRS's + 1, then the subsequent blocks contain the measurements for each individual beat in sequence.
2	The number of pacemaker spikes for which location times are sent.
3-4	Average RR interval in milliseconds for all QRS's
5-6	Average PP interval in milliseconds for all QRS's
7-22	Measurements for reference beat type 0 (see 5.10.3).
23-38	Measurements for reference beat type 1, or for first QRS (see byte 1).
etc.	

5.10.2.2 Pacemaker spike measurement data (if any):

<u>Byte</u>	<u>Contents</u>
1 - 2	1 st spike time in milliseconds from start of rhythm record (Unsigned integer)
3 - 4	1 st spike amplitude in microvolts ($1 * 10^{-6}$ V) (Signed integer)
5 - 6	2 nd spike time in milliseconds from start of rhythm record (Unsigned integer)
7 - 8	2 nd spike amplitude in microvolts ($1 * 10^{-6}$ V) (Signed integer)
etc.	

NOTES:

1) Time and amplitude of these pacemaker spikes shall be given as signed quantities, which gives a range of 0-65.535 seconds and ± 32.767 mV, respectively.

2) The time resolution for the pacemaker spikes shall be less than or equal to 2 ms.

5.10.2.3 Pacemaker Spike Information

For each pacemaker spike identified in 5.10.2.1, byte 2, and in 5.10.2.2, this section shall contain one 6-byte block providing additional information about the pacemaker spike. The order of the blocks corresponds to the order of the spikes identified in 5.10.2.2.

<u>Byte</u>	<u>Contents</u>
1	Spike type of Pacemaker Spike #1: 0 Unknown 1 Spike triggers neither P-wave nor QRS 2 Spike triggers a QRS 3 Spike triggers a P-wave 4-127 Reserved 128-254 Manufacturer-specific 255 No spike type analysis performed
2	Source of Pacemaker Spike #1: 0 Unknown 1 Internal 2 External 3-255 Reserved
3-4	Index of triggered QRS Complex for Pacemaker Spike #1: 0 No link 1 Link to QRS #1 first QRS complex 2 Link to QRS #2 second QRS complex - etc.
5-6	Pulse width in microseconds – 0 is unknown or uncomputed (unsigned).

5.10.2.4 QRS type information

This section identifies the reference beat type for each QRS complex in the ECG. Complexes are addressed in order. Reference beat types are numbered according to their appearance in the Global ECG measurement data section (5.10.2.1).

<u>Byte</u>	<u>Contents</u>
1-2	Number of QRS complexes.
3	Reference beat type of first QRS complex (0-??).
4	Reference beat type of second QRS complex (0-??).
	etc.

5.10.2.5 Additional Global measurements

This section provides for additional measurements beyond those defined in 5.10.2.1. It is placed here so as not to render inoperable any implementations of previous versions of the protocol.

<u>Byte</u>	<u>Contents</u>
1-2	Ventricular rate, in beats per minute (unsigned integer).
3-4	Atrial rate, in beats per minute (unsigned integer).
5-6	QT corrected (milliseconds) (unsigned integer).
7	Formula type used for HR correction:

- 0 Unknown or unspecified
- 1 Bazett
- 2 Hodges
- 3-127 Reserved
- 128-254 Manufacturer specific
- 255 Measurement not available

8-9 Number of bytes in tagged fields which follow (zero if no tagged fields).

10- Tagged fields, as follows. Valid Tags are 0 - 254, tag 255 is a terminator. Each tag has at least a one byte tag identifier and a one byte length specifier (tag 255 length is 0).

TAG	LENGTH	VALUE (Parameter data)												
0	5	QT_{end} All-lead Dispersion (Binary) QT Intervals measured in milliseconds, from QRS onset to T wave offset. All ECG leads are used in measurement. Valid values are 0 – 254 (milliseconds); 255 = measurement not provided. <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Dispersion = maximum QT interval – minimum QT interval.</td></tr><tr><td>2</td><td>Heart rate corrected Dispersion: Max–Min.</td></tr><tr><td>3</td><td>Dispersion = standard deviation of the QT intervals.</td></tr><tr><td>4</td><td>Heart rate corrected Dispersion: standard deviation.</td></tr><tr><td>5</td><td>Heart rate correction formula. (See definition of byte 7 for valid values.)</td></tr></table>	Byte	Contents	1	Dispersion = maximum QT interval – minimum QT interval.	2	Heart rate corrected Dispersion: Max–Min.	3	Dispersion = standard deviation of the QT intervals.	4	Heart rate corrected Dispersion: standard deviation.	5	Heart rate correction formula. (See definition of byte 7 for valid values.)
Byte	Contents													
1	Dispersion = maximum QT interval – minimum QT interval.													
2	Heart rate corrected Dispersion: Max–Min.													
3	Dispersion = standard deviation of the QT intervals.													
4	Heart rate corrected Dispersion: standard deviation.													
5	Heart rate correction formula. (See definition of byte 7 for valid values.)													
1	5	QT_{peak} All-lead Dispersion (Binary) QT Intervals measured in milliseconds, from QRS onset to T wave peak. All ECG leads are used in measurement. Valid values are 0 – 254 (milliseconds); 255 = measurement not provided. <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Dispersion = maximum QT_{peak} interval – minimum QT_{peak} interval.</td></tr><tr><td>2</td><td>Heart rate corrected Dispersion: Max–Min.</td></tr><tr><td>3</td><td>Dispersion = standard deviation of the QT_{peak} intervals.</td></tr><tr><td>4</td><td>Heart rate corrected Dispersion: standard deviation.</td></tr><tr><td>5</td><td>Heart rate correction formula. (See definition of byte 7 for valid values.)</td></tr></table>	Byte	Contents	1	Dispersion = maximum QT _{peak} interval – minimum QT _{peak} interval.	2	Heart rate corrected Dispersion: Max–Min.	3	Dispersion = standard deviation of the QT _{peak} intervals.	4	Heart rate corrected Dispersion: standard deviation.	5	Heart rate correction formula. (See definition of byte 7 for valid values.)
Byte	Contents													
1	Dispersion = maximum QT _{peak} interval – minimum QT _{peak} interval.													
2	Heart rate corrected Dispersion: Max–Min.													
3	Dispersion = standard deviation of the QT _{peak} intervals.													
4	Heart rate corrected Dispersion: standard deviation.													
5	Heart rate correction formula. (See definition of byte 7 for valid values.)													
2	5	QT_{end} Precordial Dispersion (Binary) QT Intervals measured in milliseconds, from QRS onset to T wave offset. Precordial ECG leads only are used in measurement. Valid values are 0 – 254 (milliseconds); 255 = measurement not provided. <table><tr><th>Byte</th><th>Contents</th></tr><tr><td>1</td><td>Dispersion = maximum QT interval – minimum QT interval.</td></tr><tr><td>2</td><td>Heart rate corrected Dispersion: Max–Min.</td></tr><tr><td>3</td><td>Dispersion = standard deviation of the QT intervals.</td></tr><tr><td>4</td><td>Heart rate corrected Dispersion: standard deviation.</td></tr><tr><td>5</td><td>Heart rate correction formula. (See definition of byte 7 for valid values.)</td></tr></table>	Byte	Contents	1	Dispersion = maximum QT interval – minimum QT interval.	2	Heart rate corrected Dispersion: Max–Min.	3	Dispersion = standard deviation of the QT intervals.	4	Heart rate corrected Dispersion: standard deviation.	5	Heart rate correction formula. (See definition of byte 7 for valid values.)
Byte	Contents													
1	Dispersion = maximum QT interval – minimum QT interval.													
2	Heart rate corrected Dispersion: Max–Min.													
3	Dispersion = standard deviation of the QT intervals.													
4	Heart rate corrected Dispersion: standard deviation.													
5	Heart rate correction formula. (See definition of byte 7 for valid values.)													

TAG	LENGTH	VALUE (Parameter data)												
3	5	QT_{peak} Precordial Dispersion (Binary) QT Intervals measured in milliseconds, from QRS onset to T wave peak. Precordial ECG leads only are used in measurement. Valid values are 0 – 254 (milliseconds); 255 = measurement not provided. <table><thead><tr><th>Byte</th><th>Contents</th></tr></thead><tbody><tr><td>1</td><td>Dispersion = maximum QT_{peak} interval – minimum QT_{peak} interval.</td></tr><tr><td>2</td><td>Heart rate corrected Dispersion: Max–Min.</td></tr><tr><td>3</td><td>Dispersion = standard deviation of the QT_{peak} intervals.</td></tr><tr><td>4</td><td>Heart rate corrected Dispersion: standard deviation.</td></tr><tr><td>5</td><td>Heart rate correction formula. (See definition of byte 7 for valid values.)</td></tr></tbody></table>	Byte	Contents	1	Dispersion = maximum QT _{peak} interval – minimum QT _{peak} interval.	2	Heart rate corrected Dispersion: Max–Min.	3	Dispersion = standard deviation of the QT _{peak} intervals.	4	Heart rate corrected Dispersion: standard deviation.	5	Heart rate correction formula. (See definition of byte 7 for valid values.)
Byte	Contents													
1	Dispersion = maximum QT _{peak} interval – minimum QT _{peak} interval.													
2	Heart rate corrected Dispersion: Max–Min.													
3	Dispersion = standard deviation of the QT _{peak} intervals.													
4	Heart rate corrected Dispersion: standard deviation.													
5	Heart rate correction formula. (See definition of byte 7 for valid values.)													
4 - 254	(none)	Reserved												
255	0	None (section terminator).												

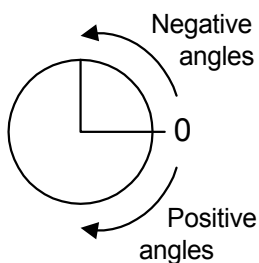
5.10.3 The format of the measurement block for each reference beat type or for each individual QRS.

Byte	Contents
1-2	P onset ¹
3-4	P offset ¹
5-6	QRS onset ¹
7-8	QRS offset ¹
9-10	T offset ¹
11-12	P axis in the frontal plane (angular degrees, 999 if undefined) ²
13-14	QRS axis in the frontal plane (angular degrees, 999 if undefined) ²
15-16	T axis in the frontal plane (angular degrees, 999 if undefined) ²

NOTES:

1) If the measurement block contains measurements for a reference beat type, then measurements for onset/offset are given in milliseconds from the beginning of the reference beat. If the measurement block contains measurements for an individual beat, then measurements for onset/offset are given in milliseconds from the beginning of the ECG record. Wave durations and intervals can be computed from wave or interval offset minus onset.

2) For the axes (P, QRS, T) in the frontal plane the convention shown in the diagram below shall be used.

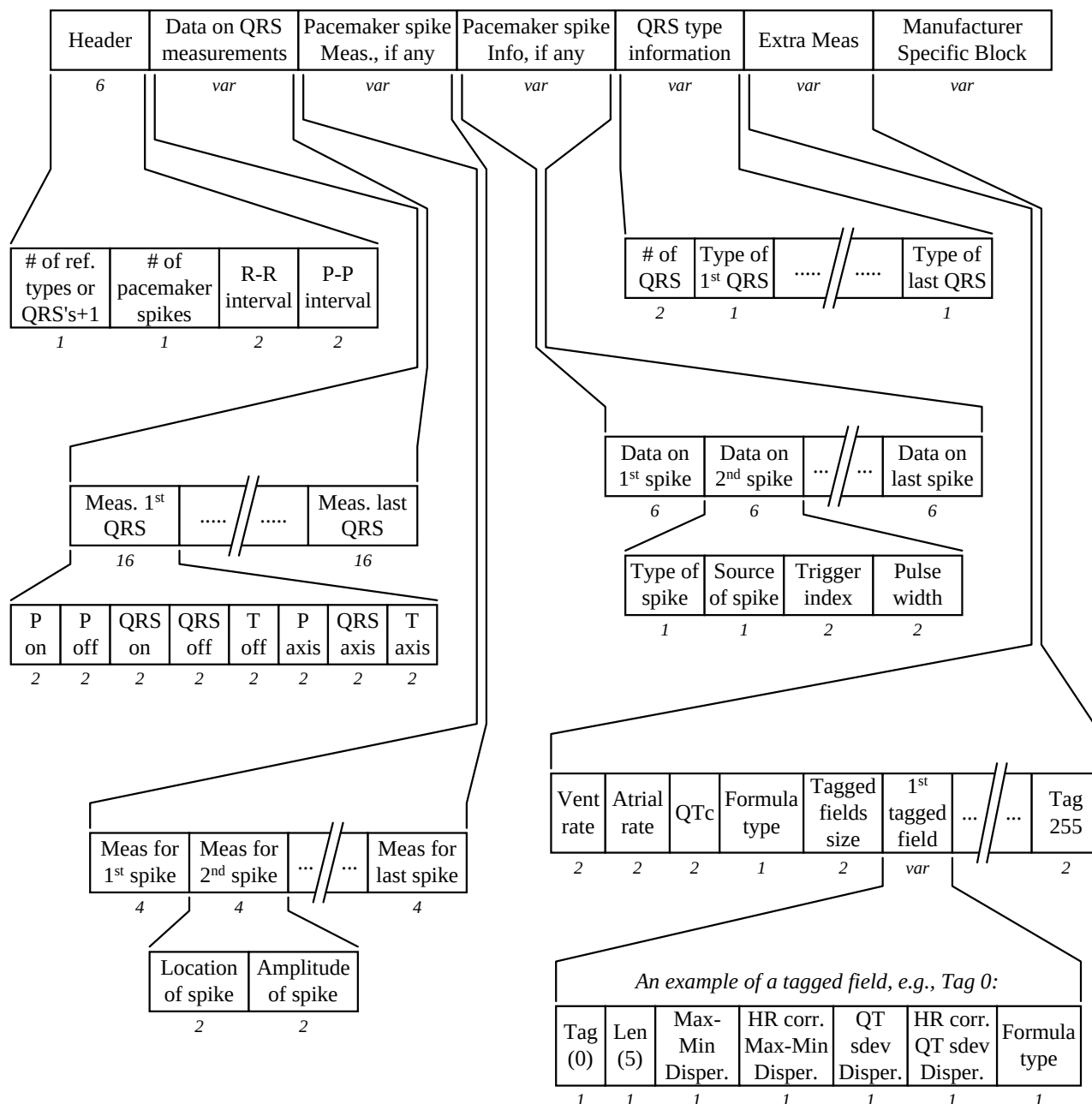


5.10.4 Manufacturer specific global measurement block

A block with variable length for manufacturer specific global measurements can be added to this section, after the data on pacemaker spikes.

The start of the manufacturer specific block (counting from the beginning of the Section ID Header) shall be derived from the information given for the global ECG measurement data. For example, if the measurement blocks contain global measurements for each reference beat type, the start of the manufacturer specific block will be 16 (i.e., 5.2.7) + 6 + (Number of reference beat types times 16) + (Number of pacemaker spikes times 4) + (Number of pacemaker spikes times 6) + (2 + Number of QRSs) + (9 + the number of bytes in tagged global measurements) + 1. The end shall be given in the Section ID Header by the total length of the section, including the Section ID Header (see Section 5.2.7).

5.10.5 An overview of the data part of Section 7 is presented below.



5.11 Specifications for the storage of full text electro-cardiographic interpretive statements – Section 8

This section contains a text version of the latest diagnostic interpretation of the ECG

5.11.1 If present, the section shall start with a "Section ID Header" as defined in 5.2.7.

5.11.2 The data portion of this section includes a data header followed by multiple statements.

5.11.3 Header:

Byte	Contents
------	----------

1	Binary: Confirmed/Nonconfirmed report:
---	--

Value	Type
-------	------

0	Original report (not overread)
---	--------------------------------

1	Confirmed report
---	------------------

2	Overread report, but not confirmed
---	------------------------------------

2-3	Binary: Year (Full integer notation, as in 1990)
-----	--

4	Binary: Month (range 01 - 12; 01 = January)
---	---

5	Binary: Day (range 01 - 31)
---	-----------------------------

6	Binary: Hours (range 00 - 23)
---	-------------------------------

7	Binary: Minutes (range 00 - 59)
---	---------------------------------

8	Binary: Seconds (range 00 - 59)
---	---------------------------------

9	Binary: Number of statements in this section
---	--

5.11.4 Statement data:

Byte	Contents
------	----------

1	Binary: Statement sequence number, starting with 1.
---	---

2-3	Binary: Statement field length (number of bytes in the statement, starting with the first byte following, and including the NULL terminator)
-----	--

4-***	Statement body: text terminated by NULL.
-------	--

5.11.5 No codes are allowed in the statements, unless accompanied by descriptive text.

5.11.6 The section data part lay-out:

