

Implementation of
ENV 1064:1993

Medical informatics — Standard communication protocol — Computer-assisted electrocardiography

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National foreword

This Draft for Development is identical with the European prestandard ENV 1064:1993 *Medical informatics — Standard communication protocol — Computer-assisted electrocardiography*, prepared by CEN whose members have committed themselves to making it available in an appropriate form. In the UK the Draft for Development is the form now chosen for ENVs in the information technology area.

This Draft for Development is published under the direction of the Information Technology Systems Standards Policy Committee whose Technical Committee IST/35 has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any queries on interpretation, or proposals for change, and to keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

NOTE International and European Standards, as well as overseas standards, are available from Customer Services, Publications, BSI, Linford Wood, Milton Keynes, MK14 6LE.

After two years this ENV will be reviewed by CEN members with a view to its:

- conversion into a European Standard (which would be implemented in the UK as a British Standard);
- extension once for a further two years;
- replacement by a revised ENV (which would be published in the UK as a revised Draft for Development);
- withdrawal.

The future of this Draft for Development is therefore bound to that of the ENV and the Draft for Development will not be reviewed separately.

This publication is not to be regarded as a British Standard.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ENV title page, pages 2 to 120 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Descriptors: Medicine, data processing, information interchange, medical equipment, electrocardiographs, data transfer, data transmission, protocols

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Medical informatics — Standard communication protocol — Computer-assisted electrocardiography

Informatique médicale — Protocole de communication standard pour l'électrocardiographie assisté par ordinateur

Medizinische Informatik — Standardkommunikationsprotokoll — Computergestützte Elektrokardiographie

This European Prestandard (ENV) was approved by CEN on 1993-06-01 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard (EN).

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This communications protocol for computerized electrocardiography has been worked out within the Advanced Informatics for Medicine (AIM) Project NR 1015, entitled “A standard communications protocol for computerized electrocardiography” (SCP-ECG).

The SCP-ECG project was executed from June 1989 until December 1990, with the support of DGXIII/F of the European Commission.

The preparation of this standard was undertaken by Project Team 007 of CEN/TC 251 “Medical Informatics” and covered by the European Commission order voucher BC-IT-215.

The European Prestandard has been approved for submission to the formal vote by CEN/TC 251 during its 11th plenary meeting on 26th of January 1993.

This European Prestandard was submitted for formal vote by the CEN Central Secretariat to the members of CEN/CENELEC on 1993-03-29 with the deadline of 1993-06-01. The result of the formal vote was positive.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to announce the existence of this European Prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

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0 Introduction

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. It is 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 interconnectivity of 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 the present document. The primary aim of this standard is to ensure that ECG reports and data from any vendor's computerized ECG recorder can be transmitted 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.

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

1 Scope and field of application

The present 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. The current 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. The current Standard also does not address exercise ECG recordings. The clinical need for transmission of these specialized recordings is indeed very low and has therefore not been considered in this Standard.

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 present standard is confined to the first of these three stages.

Reference databases and standards for the other stages, i.e. ECG measurement and diagnostic programs, are outside the scope of the present document. They have been defined in the European Project entitled "Common Standards for Quantitative Electrocardiography" (abbreviated CSE) with support of the Medical and Public Health Research Programmes of Directorate General (DG) XII of the European Community (EC). References to this work are given in Subclause 2.2.

The present 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.

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

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

A minimum set of control and query messages for cart-to-cart and cart-to-host interchange are defined in Chapter 7.

A low-level transport protocol for the exchange of data between an ECG cart and a host based on an enhanced X-Modem protocol is defined in Chapter 8. If an RS-232 interface is used then the enhanced X-Modem Protocol can be used.

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 the current Standard.

2 Normative references

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-8859-1, *Information Processing — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1 (1986) complement to the ISO 2022 Standard shall be used as the default character set in the Standard defined in the current Document*.

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*.

IEC 62D(CO6), *Performance Requirements for Single Channel and Multichannel Electrocardiographs, 1977*.

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*.

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*.

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

CSE project

project supported by DG XII of the European Commission aiming at the development of Common Standards for (Quantitative) Electrocardiography

3.1.3

interpretive device

device (cart, computer) analyzing the ECG signal

3.1.4

median beat

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

3.1.5

message

a textual body of information

3.1.6

overreading

the process whereby a cardiologist reviews the computer based interpretation of an ECG in order to verify the report after making changes to the text

3.1.7

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

3.1.8

residual data

the remaining original ECG data after “proper” subtraction with the Median cycle. The adjective “proper” refers to accurate beat alignment

3.1.9

rhythm data

the full original ECG data

3.1.10

section

an aggregate of data elements related to one aspect of the electrocardiographic recording, measurement or interpretation

3.1.11

universal statement codes

ECG interpretation codes described in Annex B of this document

3.2 Description of other technical terms related to this standard

See Glossary in Annex F.

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	American 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 5.8.1)
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
CSE	Common Standards for Quantitative Electrocardiography
CR	Carriage Return (control character)
CRC	Cyclic Redundancy Check
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 Program/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 "Median Beat" used in this document should not be interpreted in the strict statistical sense. It is any of an averaged beat, a "Median Beat", a selected or any other representative single cycle taken from the total ECG recording. This "Median 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. 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 Annex C.

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.

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 5.4.4, tag 14) and section numbers 128 to 1023 uniquely define the content of these 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.

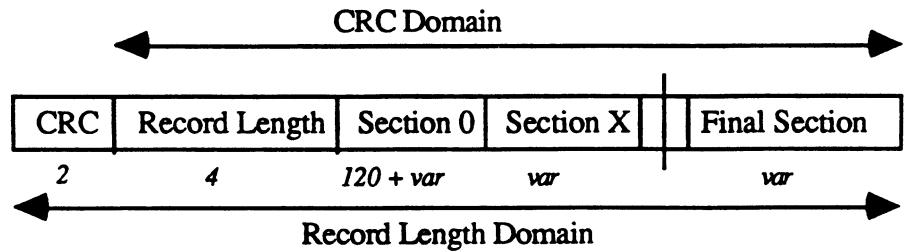
5.2.3 Inclusion of sections 2–11 (see 5.2.7 and 5.2.8) are optional. Any SCP-ECG data record shall contain Section 0 (Pointers) and Section 1 (Header). No consistency checking among the presence of different sections is assumed. Specifically, if any of sections 8, 9, or 11 is present, it is not assumed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

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

- 1) The 2-byte checksum is calculated as a CRC-CCITT, the algorithm of which is described in 8.3.5, and is calculated over the entire range starting with the first byte following the checksum 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

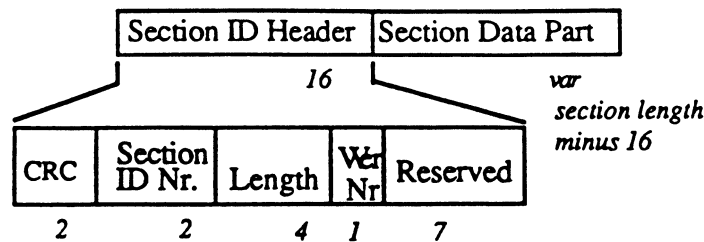
Any section shall start with a “Section ID Header” (16 bytes) defined below:

Bytes	Contents
1-2	16 bit CRC-CCITT Checksum over the entire section except these 2 bytes.
3-4	Section ID number as defined in 5.2.2 (see also paragraph 5.3.1.1).
5-8	Section length in bytes <u>including</u> the “Section ID Header” (see 5.3.1.2).
9	Version Number of the Section
10-16	Reserved.

Each section shall have a Protocol Version Number (see byte 9) which may be used to specify different levels of compatatibily with the Standard when this is updated in the future (see Annex E).

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 MEDIANS ARE ENCODED)
Optional	(Section 5) ENCODED MEDIAN DATA IF MEDIANS ARE STORED
Optional	(Section 6) “RESIDUAL SIGNAL” AFTER MEDIAN SUBTRACTION IF MEDIANS 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) STATEMENT CODES RESULTING FROM THE INTERPRETATION

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

Section nr. Contents

- (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 median 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 median 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 medians are encoded, then this Section shall identify the position of these medians relative to the “residual” signal contained in Section 5 below. This section is **optional**.
- (5) Median ECG complexes for each lead are encoded if the originating device has generated those complexes. This section is **optional**.
- (6) This section contains the “residual” signal that remains for each lead after the median QRS complexes have been subtracted, or if no medians have been subtracted, the entire rhythm signal. This section is **optional**.
- (7) This section contains global measurements for each 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 for the legal document 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 overreading physician (or device) are defined in the “Header section” (Section 1). The data contained in this section should enable a similar device of the same manufacturer to exactly re-compile Sections 8 and 11. 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 B). 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.

5.3.0 The section starts with a “Section ID Header” as defined in 5.2.7.

5.3.1 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 defined by the SCP-ECG protocol shall be provided in the pointer section. Use the special codes defined in 5.3.1.2 and 5.3.1.3 for the pointer field for any optional section not included in an SCP-ECG data record.
- Manufacturer specific sections may be added by appending pointer fields for these sections to the pointer section.
- 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 5.3.1.1)
- b) A Section Length (see 5.3.1.2)
- c) An Index to the Section (see 5.3.1.3)

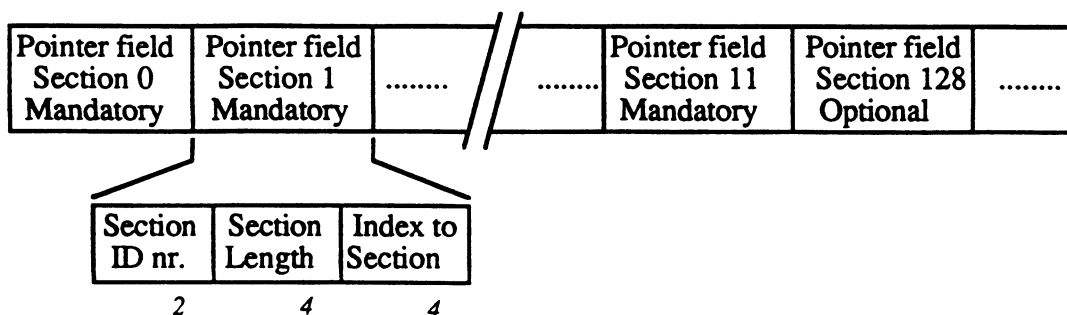
5.3.1.1 The Section Identification number is stored in two bytes containing the section number, as listed in 5.2.2. Section ID numbers 0 through 11 are currently defined in this SCP-ECG protocol, numbers 12 through 127, as well as numbers above 1023 are reserved for future use, numbers 128 through 1023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

5.3.1.2 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 32 kbytes. If a section is not included in the SCP-ECG record the length shall be set to 0.

5.3.1.3 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 checksum). 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 preceded by the Checksum (2 bytes) and the Record Length (4 bytes).

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

5.3.2 Pointer section data part overview



5.4 Specification of the header information — patient data/ECG acquisition data — Section 1

5.4.0 The section shall start with a “Section ID Header” as defined in 5.2.7.

5.4.1 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.

5.4.2 Basic methodology

5.4.2.1 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:

	Tag	Parameter
(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 unique patient identification:

(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

5.4.2.2 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.
- 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 **5.4.2.5**).

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

5.4.2.3 A maximum of one instance of any field defined in **5.4.4** is allowed to be included in the “Header” section, except for the following fields listed below:

<u>Tag</u>	<u>Value description</u>	<u>Max. instances</u>
10	Drugs	no limit
13	Diagnosis or referral indication	no limit
30	Free text	no limit
32	History diagnostic codes	no limit

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

5.4.2.5 Maximum and reasonable length of free text fields

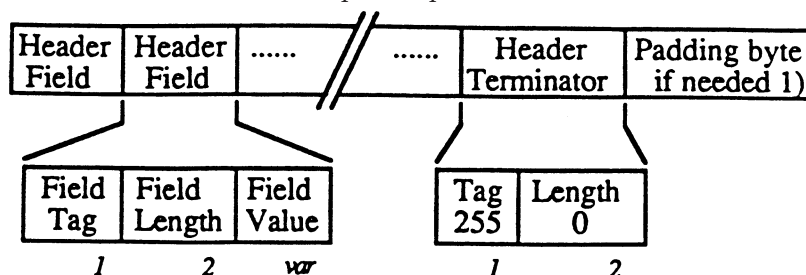
In order to facilitate the implementation of the protocol a maximum field length, i.e. **64** (except for tag 13 and tag 30, where the limit is 80) and reasonable values for the length of the different free text fields have been determined, as shown in the table below. Having no limit on the variable length free text fields makes it difficult to design a receiver. Dissenting implementors of the Protocol are free to accept more characters if they wish to. However, the Standard allows the receiver to ignore any characters past 64 (80 for tags 13 and 30).

Section	Tag	Contents	Instance > once	Reasonable Length
2	0	Last Name	—	40
2	1	First Name	—	40
2	2	Patient Identification Number	—	40
2	3	Second Last Name	—	40
2	10	Drugs	yes	40 (1)
2	13	Diagnosis or Referral Indication	yes	80 (1)
2	14	Acquiring Device Identification Number	—	40
2	15	Analyzing Device ID Number	—	40
2	16	Acquiring Institution Description	—	40
2	17	Analyzing Institution Description	—	40
2	18	Acquiring Department Description	—	40
2	19	Analyzing Department Description	—	40
2	20	Referring Physician	—	60
2	21	Overreading Physician	—	60
2	22	Technician Description	—	40
2	23	Room Description	—	40
2	30	Free Text Field	yes	80 (1)
2	31	ECG Sequence Number	—	12
2	32	Medical History Data	yes	80

NOTE:

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

5.4.3 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.

5.4.4 Specification of the defined parameters

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>																				
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><th><u>Byte</u></th><th><u>Contents</u></th></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. If all 3 bytes are zero, then age is not specified.</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>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>	<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. If all 3 bytes are zero, then age is not specified.	<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																					
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<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><th><u>Byte</u></th><th><u>Contents</u></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) If all 4 bytes are zero, then date-of-birth is not specified.</td></tr></table>	<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) If all 4 bytes are zero, then date-of-birth is not specified.												
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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. If all 3 bytes are zero, then height is not specified.</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>	<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. If all 3 bytes are zero, then height is not specified.	<u>Value</u>	<u>Unit</u>	0	Unspecified	1	Centimeters	2	Inches	3	Millimeters				
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1	Centimeters																					
2	Inches																					
3	Millimeters																					

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>																														
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. If all 3 bytes are zero, then weight is not specified.</td></tr></table> <table><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></td><td></td></tr><tr><td>1</td><td>Kilogram</td><td>3</td><td>Pound</td></tr><tr><td>2</td><td>Gram</td><td>4</td><td>Ounce</td></tr></table>	<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. If all 3 bytes are zero, then weight is not specified.	<u>Value</u>	<u>Unit</u>	<u>Value</u>	<u>Unit</u>	0	Unspecified			1	Kilogram	3	Pound	2	Gram	4	Ounce								
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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></table> <table><tr><th><u>Value</u></th><th><u>Sex</u></th><th><u>Value</u></th><th><u>Sex</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>Sex</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>Sex</u>																													
1	Male	0	Not Known																													
2	Female	9	Unspecified																													
9	1	Race (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: Race indication defined as:</td></tr></table> <table><tr><th><u>Value</u></th><th><u>Race</u></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>	<u>Byte</u>	<u>Contents</u>	1	Binary: Race indication defined as:	<u>Value</u>	<u>Race</u>	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><u>Byte</u></th><th><u>Contents</u></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>7 - Beta Blockers</td></tr><tr><td>1 - Digitalis</td><td>8 - Psychotropic</td></tr><tr><td>2 - Antiarrhythmic</td><td>9 - Calcium Blockers</td></tr><tr><td>3 - Diuretics</td><td>10 - Antihypotensive</td></tr><tr><td>4 - Antihypertensive</td><td>11 - Anticholesterol</td></tr><tr><td>5 - Antianginal</td><td>12 - ACE- Inhibitors</td></tr><tr><td>6 - Antithrombotic</td><td></td></tr><tr><td>13-99 Reserved</td><td></td></tr><tr><td>100 - Not taking drugs</td><td>101 Drugs, but unknown type</td></tr><tr><td>102 - Other medication</td><td>103-255 Manufacturer specific codes</td></tr></table>	<u>Byte</u>	<u>Contents</u>	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	7 - Beta Blockers	1 - Digitalis	8 - Psychotropic	2 - Antiarrhythmic	9 - Calcium Blockers	3 - Diuretics	10 - Antihypotensive	4 - Antihypertensive	11 - Anticholesterol	5 - Antianginal	12 - ACE- Inhibitors	6 - Antithrombotic		13-99 Reserved		100 - Not taking drugs	101 Drugs, but unknown type	102 - Other medication	103-255 Manufacturer specific codes
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100 - Not taking drugs	101 Drugs, but unknown type																															
102 - Other medication	103-255 Manufacturer specific codes																															

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 3 ->*** 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 3-***. 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**

The following list is optional and by far complete. The list could be much improved.

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 - Lorcainide

CLASS 3**DIURETICS**

- 0 - Unspecified
- 1 - Thiazide
- 2 - Furosemide (Lasix)
- 3 - Potassium Chloride

CLASS 4**ANTIHYPERTENSIVE**

- 0 - Unspecified
- 1 - Clonidine
- 2 - Prazosin
- 3 - Hydralazine

CLASS 5**ANTIANGINAL**

- 0 - Unspecified
- 1 - Isosorbide
- 2 - Calcium Blockers
- 3 - Nitrates

CLASS 6**ANTITHROMBOTIC AGENTS**

- 0 - Unspecified
- 1 - Aspirin
- 2 - Coumadin
- 3 - Heparin
- 4 - Warfarin
- 5 - Streptokinase
- 6 - t-PA

CLASS 7**BETA BLOCKERS**

- 0 - Unspecified
- 1 - Propranolol
- 2 - Corgard
- 3 - Atenolol
- 4 - Metoprolol
- 5 - Pindolol
- 6 - Acebutolol

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

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>																																																				
11	2	Systolic blood pressure (Binary) <table><tr><th><u>Byte</u></th><th><u>Contents</u></th></tr><tr><td>1-2</td><td>Binary: Systolic blood pressure in mmHg.</td></tr></table>	<u>Byte</u>	<u>Contents</u>	1-2	Binary: Systolic blood pressure in mmHg.																																																
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<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: <table><tr><th><u>Byte</u></th><th><u>Contents</u></th></tr><tr><td>1-2</td><td>Binary: Institution number</td></tr><tr><td>3-4</td><td>Binary: Department number</td></tr><tr><td>5-6</td><td>Binary: Device ID</td></tr><tr><td>7</td><td>Binary: Device type</td></tr><tr><th><u>Value</u></th><th><u>Type</u></th></tr><tr><td>0</td><td>Cart</td></tr><tr><td>1</td><td>System (or Host)</td></tr><tr><td>8</td><td>Binary: Manufacturer code, permissible codes are: <table><tr><td>0 - Unknown</td><td>10 - Okin</td></tr><tr><td>1 - Burdick</td><td>11 - Quinton</td></tr><tr><td>2 - Cambridge</td><td>12 - Siemens</td></tr><tr><td>3 - Compumed</td><td>13 - Spacelabs</td></tr><tr><td>4 - Datamed</td><td>14 - Telemed</td></tr><tr><td>5 - Fukuda</td><td>15 - Hellige</td></tr><tr><td>6 - Hewlett-Packard</td><td>16 - ESA-OTE</td></tr><tr><td>7 - Marquette Electronics</td><td>17 - Schiller</td></tr><tr><td>8 - Mortara Instruments</td><td>18 - Picker-Schwarzer</td></tr><tr><td>9 - Nihon Kohden</td><td>19 - Elettronica-Trentina</td></tr><tr><td></td><td>20 - Zwœnitz</td></tr></table></td></tr><tr><td></td><td></td><td>21-99 Reserved</td></tr><tr><td></td><td></td><td>100 - Other</td></tr><tr><td></td><td>9-14</td><td>Text characters: Text model description. 5 bytes of text and NULL terminator</td></tr><tr><td></td><td>15</td><td>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. The protocol revision number shall be updated with each revision in any section in the CSE/CTS Coordinating Center.</td></tr></table>	<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: Manufacturer code, permissible codes are: <table><tr><td>0 - Unknown</td><td>10 - Okin</td></tr><tr><td>1 - Burdick</td><td>11 - Quinton</td></tr><tr><td>2 - Cambridge</td><td>12 - Siemens</td></tr><tr><td>3 - Compumed</td><td>13 - Spacelabs</td></tr><tr><td>4 - Datamed</td><td>14 - Telemed</td></tr><tr><td>5 - Fukuda</td><td>15 - Hellige</td></tr><tr><td>6 - Hewlett-Packard</td><td>16 - ESA-OTE</td></tr><tr><td>7 - Marquette Electronics</td><td>17 - Schiller</td></tr><tr><td>8 - Mortara Instruments</td><td>18 - Picker-Schwarzer</td></tr><tr><td>9 - Nihon Kohden</td><td>19 - Elettronica-Trentina</td></tr><tr><td></td><td>20 - Zwœnitz</td></tr></table>	0 - Unknown	10 - Okin	1 - Burdick	11 - Quinton	2 - Cambridge	12 - Siemens	3 - Compumed	13 - Spacelabs	4 - Datamed	14 - Telemed	5 - Fukuda	15 - Hellige	6 - Hewlett-Packard	16 - ESA-OTE	7 - Marquette Electronics	17 - Schiller	8 - Mortara Instruments	18 - Picker-Schwarzer	9 - Nihon Kohden	19 - Elettronica-Trentina		20 - Zwœnitz			21-99 Reserved			100 - Other		9-14	Text characters: Text model description. 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. The protocol revision number shall be updated with each revision in any section in the CSE/CTS Coordinating Center.
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		21-99 Reserved																																																				
		100 - Other																																																				
	9-14	Text characters: Text model description. 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. The protocol revision number shall be updated with each revision in any section in the CSE/CTS Coordinating Center.																																																				

16 Binary: SCP-ECG Protocol Compatibility Level (one byte)
Detailed specifications are given in Annex D (see D.4)

17 Binary: Language Support Code (one byte)
This bit map indicates the supported character sets:

<u>Bit</u>	<u>Contents</u>	
	<u>Reset (0)</u>	<u>Set (1)</u>
0	ASCII only	/ Other sets supported
1	Latin-1 only	/ Other sets supported
2	Single byte sets only	/ Multiple byte sets supported
3-7	Reserved	

18 Binary: Capabilities of the ECG Device (one byte bit map)
This bit map indicates the supported functions:

<u>Bit</u>	<u>Contents</u>	
	<u>Reset (0)</u>	<u>Set (1)</u>
0-3	Reserved	Reserved
4	No printing	Can print ECG reports
5	No analysis	Can interpret ECG
6	No storage	Can store ECG records
7(MSB)	No acquisition	Can acquire ECG data

19 Binary: AC Mains Frequency Environment (one byte)
0 = Unspecified
1 = 50 Hz
2 = 60 Hz

20-35 Character String: Internet Address (15 bytes+NULL)
(format: 255.255.255.255)
The string has to be NULL terminated.

36 Binary: Length of the string for Program Revision Number

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

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>
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.

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>								
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	Overreading Physician (Text characters) This field provides a text description of the overreading 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><u>Byte</u></th><th><u>Contents</u></th></tr><tr><td>1</td><td>Binary: Level of emergency. 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>	<u>Byte</u>	<u>Contents</u>	1	Binary: Level of emergency. 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.				
<u>Byte</u>	<u>Contents</u>									
1	Binary: Level of emergency. 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.									
25	4	Date of Acquisition (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: 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>	<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)									
26	3	Time of Acquisition (Binary) This field has the following format: <table><tr><th><u>Byte</u></th><th><u>Contents</u></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.	<u>Byte</u>	<u>Contents</u>	1	Binary: Hours (range 0 – 23)	2	Binary: Minutes (range 0 – 59)	3	Binary: Seconds (range 0 – 59)
<u>Byte</u>	<u>Contents</u>									
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.								

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>																																																						
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																																												
0	— 60 Hertz notch filter																																																							
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	History Diagnostic 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. Byte 0 is used to designate the Diagnostic Code Table which is applied. In case this byte is equal to zero (0) then the following set of codes apply: <table><tr><th><u>Value</u></th><th><u>Contents</u></th></tr><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><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></table>	<u>Value</u>	<u>Contents</u>	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	60	Neurological disease	65	Alimentary disease	70	Renal disease	80	Pre-operative general surgery	81	Post-operative general surgery	90	General medical
<u>Value</u>	<u>Contents</u>																																																							
0	Diagnoses or clinical problems not specified																																																							
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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																																																							
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

The missing numbers in the series from 1 to 100 have been reserved for future extension of some categories.

<u>TAG</u>	<u>LENGTH</u>	<u>VALUE (Parameter data)</u>
255	0	None (demographic section terminator)

5.5 Specification of the huffman tables — Section 2

5.5.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

5.5.1 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.

5.5.2 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 median 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.

5.5.3 The following basic values are use:

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

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

<u>Byte</u>	<u>Contents</u>																		
1-2	Number of Huffman Tables defined (if 19999 then the default Table, defined in C.2.7, 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: <table> <tr> <td>1 byte —</td><td>Number of bits in prefix</td></tr> <tr> <td>1 byte —</td><td>Number of bits in entire code</td></tr> <tr> <td>1 byte —</td><td>Table mode switch</td></tr> <tr> <td></td><td><u>Value</u> <u>Content</u></td></tr> <tr> <td></td><td>0 Switch to another Huffman table</td></tr> <tr> <td></td><td>1 Huffman coding if # of bits in prefix ≥ # of bits entire code</td></tr> <tr> <td></td><td>1 Original data if # of bits in prefix < # of bits entire code</td></tr> <tr> <td>2 bytes —</td><td>Base value represented by base code (in AVM units).</td></tr> <tr> <td>4 bytes —</td><td>Base code — 1st bit in code represented by least significant bit of the 4 byte area.</td></tr> </table>	1 byte —	Number of bits in prefix	1 byte —	Number of bits in entire code	1 byte —	Table mode switch		<u>Value</u> <u>Content</u>		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	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 byte —	Number of bits in prefix																		
1 byte —	Number of bits in entire code																		
1 byte —	Table mode switch																		
	<u>Value</u> <u>Content</u>																		
	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																		
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.																		

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

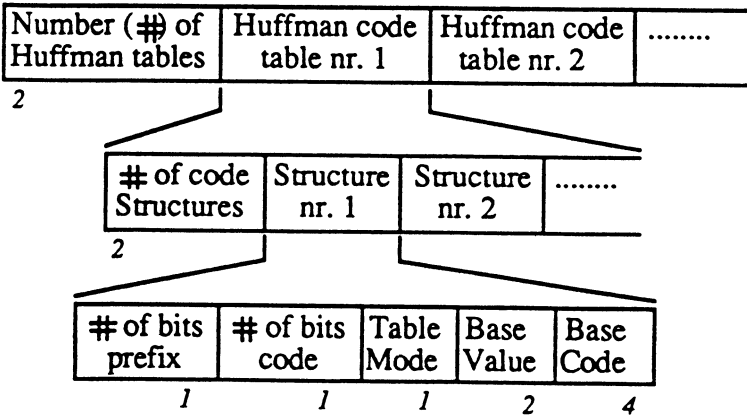
Note that this represents the following coded values:

- 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.

5.5.6 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.

5.5.7 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:

5.6.0 If present, the section shall start with a “Section ID Header” as defined in **5.2.7**.

5.6.1 The section data part is defined below:

Byte	Contents
1	Number of leads enclosed
2	Flag byte: Bit 0 (LSB) Set = Medians used Reset = No medians used Bit 1 Reserved Bit 2¹⁾ Set = Leads all simultaneously recorded Reset = Leads not all simultaneously recorded. Bits 3 -> 7¹⁾ The number of simultaneously recorded leads.

- 3-11 Detail for first lead (see **5.6.2**)
 12-20 Detail for second lead (see **5.6.2**)

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: Leads 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.

5.6.2 The detailed information for each lead is as follows:

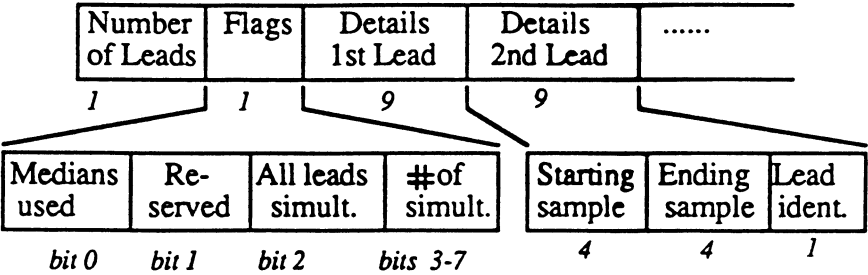
Byte	Contents
1-4	(Unsigned) Starting sample number
5-8	(Unsigned) Ending sample number
9	Lead identification. The following numbering scheme shall be used:
1-I ²⁾	21-Left Arm 41 - V3R-cal 61 - III
2-II	22-Right Arm 42 - V4R-cal 62 - aVR
3-V1	23-Left Leg 43 - V5R-cal 63 - aVL
4-V2	24-I ²⁾ 44 - V6R-cal 64 - aVF
5-V3	25-E 45 - V7R-cal 65 - -aVR ⁴⁾
6-V4	26-C 46 - X-cal
7-V5	27-A 47 - Y-cal
8-V6	28-M 48 - Z-cal
9-V7	29-F 49 - CC5-cal
10-V2R	30-H 50 - CM5-cal
11-V3R	31-I ²⁾ -cal 51 - Left Arm-cal
12-V4R	32-II-cal 52 - Right Arm-cal
13-V5R	33 - V1-cal 53 - Left Leg-cal
14-V6R	34 - V2-cal 54 - I-cal ²⁾
15-V7R	35 - V3-cal 55 - E-cal
16-X ³⁾	36 - V4-cal 56 - C-cal
17-Y ³⁾	37 - V5-cal 57 - A-cal
18-Z ³⁾	38 - V6-cal 58 - M-cal
19-CC5	39 - V7-cal 59 - F-cal
20-CM5	40 - V2R-cal 60 - H-cal
0	- Unspecified lead
66 -> 99	- Reserved for future expansion ⁴⁾
100 -> 255	- Manufacturer specific

5.6.3 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 **5.8.1**) 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.

5.6.4 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 1) should not be confused with the Frank electrode I (eye; lead ID 24).
- ³⁾ Leads X, Y and Z can be recorded by any orthogonal system, such as the Frank or McFee lead system. Unipolar leads X+, X-, Y+, Y-, Z+ and Z- can be given manufacturer specific codes.
- ⁴⁾ Extensions of the lead numbering scheme shall eventually be done in future revisions of the Protocol in the CSE Coordinating Center in Leuven, Belgium.

5.7 Specification of QRS locations — Section 4

If present, this section defines the locations and width of the various QRS complexes. For a detailed description see Annex C.

5.7.0 The section shall start with a “Section ID Header” as defined in 5.2.7.

5.7.1 QRS location definition

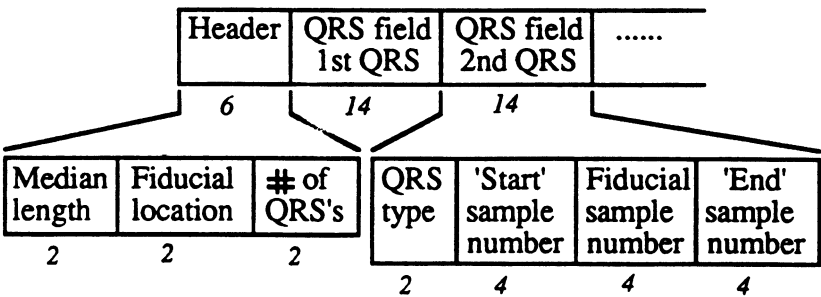
The header area of the Section data part defines certain quantities that are common to all medians. The remaining data indicates the location of the QRS's relative to the “residual” signal. The Section data part header area has the following contents:

Byte	Contents
1-2	Length of Median data in milliseconds
3-4	(Unsigned) Sample number of the fiducial (QRS trigger point) relative to the beginning of the median ECG cycle. The first sample is numbered 1.
5-6	Total number of QRS complexes within the entire ECG record.

5.7.2 The following information on QRS locations is stored:

1-2	QRS type of 1st QRS (0 - ??, 0 = dominant type QRS)
3-6	(Unsigned) Sample number on residual data for start of 1st QRS ¹⁾ addition ²⁾ .
7-10	(Unsigned) Sample number on residual data for location of fiducial point from 1st.QRS
11-14	(Unsigned) Sample number on residual data for end of 1st QRS ¹⁾ addition ²⁾ .
15-16	QRS type of 2nd QRS
etc.	

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



NOTE:

¹⁾ Bytes 3-6 and 11-14 bound the protected area of the QRS complexes, as specified and illustrated in Annex C. These locations are abbreviated in Annex C as QB(k) and QE(k), respectively.

²⁾ There is no reason for subtraction of the dominant “Median Cycle” from the non-dominant QRS complexes, because this does not increase the compression ratio. The contrary may occur due to higher “signal activity” after such subtraction.

5.8 Specification of the median encoded data — Section 5

5.8.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

5.8.1 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 median data 1 = First difference ¹⁻⁴⁾ data used for median data 2 = Second difference ¹⁻³⁾ data used for median 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) – 0	D2(1) = D1(1) – 0 = X(1)
X(2)	D1(2) = X(2) – X(1)	D2(2) = D1(2) – D1(1) = X(2) – 2*X(1)
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:

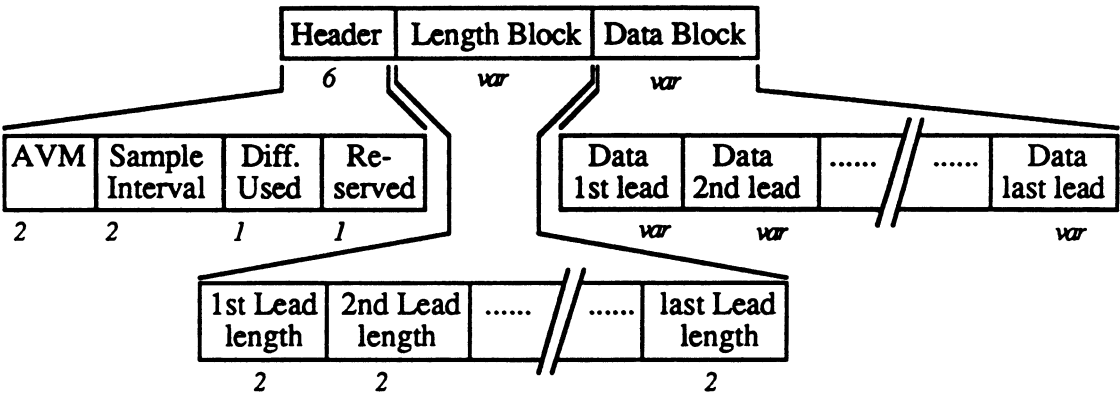
Sample Number	N	1	2	3	4	5	6	7	8
Sample Value	X(n)	10	12	1	15	18	22	20	15
1st Difference	D1(n)	—	2	1	2	3	4	− 2	− 5
Encoded data		10	2	1	2	3	4	− 2	− 5

5.8.2 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 median data for first encoded lead
3-4	(Unsigned) Number of bytes in compressed median data for second encoded lead
etc.	

5.8.3 The encoded median 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.

5.8.4 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 medians have been subtracted (see 5.6.1, byte 2),
- or
- ii) the residual signal after medians have been subtracted.

5.9.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

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

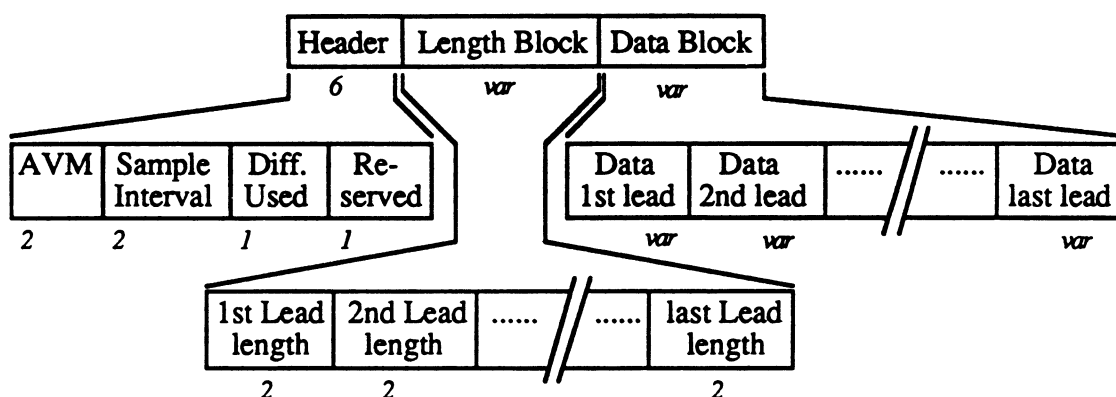
Byte	Contents
1-2	Multiplier for amplitude value (AVM). This operates as follows: The Amplitude Value Multiplier is expressed in nano Volt (1×10^{-9} Volt). Example: 1250 -> 1 amplitude quantum = 1.250 μ V 2441 -> 1 amplitude quantum = 2.441 μ V
3-4	The sample time interval for this section in microseconds (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	Reserved for future use.

5.9.2 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 rhythm data for first encoded lead
3-4	(Unsigned) Number of bytes in compressed rhythm data for second encoded lead
etc.	

5.9.3 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.

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



5.10 Specification of the global measurements — Section 7

This section contains global measurements for each beat type or QRS contained in the record and a list of pacemaker spikes in the record. If measurements are sent for each QRS, then the first measurement block should contain “global or average” measurements.

5.10.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

5.10.1 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 (e.g. Q wave) was not present in the corresponding lead

These codes shall replace the measurement data when appropriate.

5.10.1.1 Global ECG measurement data:

Byte	Contents
1	This byte contains the number of QRS types if medians are used, otherwise the number of QRS's + 1. It refers to the number of measurement block needed to store the global measurements. The “extra” record (+1) is used to store the global measurements for the entire ECG, whereas the other are used to store measurements for each specific beat, for the programs which compute no “median” beat.
2	The number of possible pacemaker spikes for which location times 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 the first (dominant) QRS type or global value if medians are not used (see 5.10.2).
23-38	Measurements for the second QRS type or first QRS (see 5.10.2).
etc.	

5.10.1.2 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) (Unsigned 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) (Unsigned integer)
etc.	

NOTES:

¹⁾ Time and amplitude of these pacemaker spikes shall be given as unsigned quantities, which gives a range of 0-65.635 seconds and 0-65.35 mV, respectively.

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

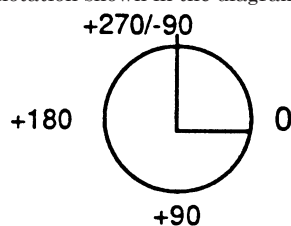
5.10.2 The format of the measurement block for each complex is:

<u>Byte</u>	<u>Contents</u>
1-2	P onset (milliseconds from beginning of median complex) ¹⁾
3-4	P offset (milliseconds from beginning of median complex) ¹⁾
5-6	QRS onset (milliseconds from beginning of median complex) ¹⁾
7-8	QRS offset (milliseconds from beginning of median complex) ¹⁾
9-10	T offset (milliseconds from beginning of median complex) ¹⁾
11-12	P axis in the frontal plane (– 90 -> 270 angular degrees, 999 if undefined) ²⁾
13-14	QRS axis in the frontal plane (– 90 -> 270 angular degrees, 999 if undefined) ²⁾
15-16	T axis in the frontal plane (– 90 -> 270 angular degrees, 999 if undefined) ²⁾

NOTES:

¹⁾ If no median complex is computed then the time from the beginning of the ECG record shall be given in milliseconds.

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



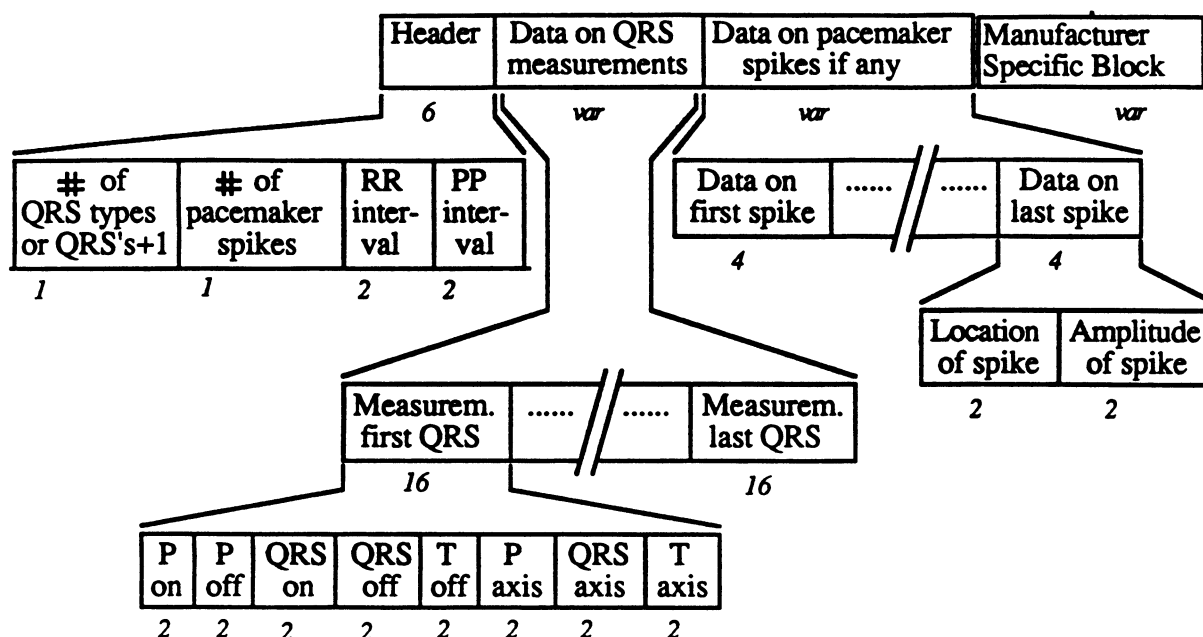
³⁾ If no P wave is present, e.g. due to atrial fibrillation then the code 19999 shall be given.

5.10.3 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 this block shall be derived from the info given in the header of the data section i.e. (Number of QRS types times 16) + (Number of pacemaker spikes times 4) + 1. The end shall be given in the Section ID Header by the total length of the section.

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



5.11 Specifications for the storage of full text electrocardiographic interpretive statements — Section 8

This section contains a text version of the legal document representing the latest diagnostic interpretation of the ECG, including all overreadings, if performed.

5.11.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

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

5.11.2 Header:

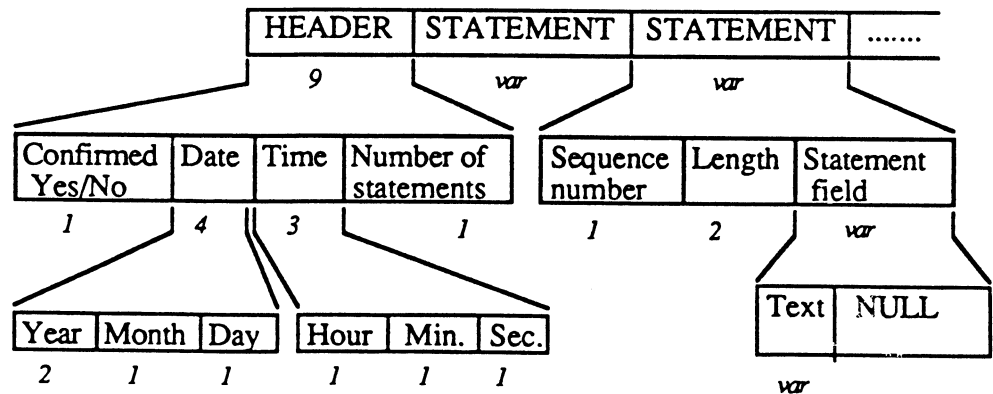
Byte	Contents
1	Binary: Confirmed/Non confirmed report:
	<u>Value</u> <u>Type</u>
	0 Non Confirmed report
	1 Confirmed report
	2 Overread but not yet confirmed report
2-3	Binary: Year (Full integer notation, as in 1990)
4	Binary: Month (range 01 – 12; 01 = January)
5	Binary: Day (range 01 – 31)
6	Binary: Hours (range 00 – 23)
7	Binary: Minutes (range 00 – 59)
8	Binary: Seconds (range 00 – 59)
9	Binary: Number of statements in this section

5.11.3 Statement data:

Byte	Contents
1	Binary: Statement sequence number.
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.

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

5.11.5 The section data part lay-out:



5.12 Specifications for storing manufacturer specific interpretive statements and data related to the overreading trail — Section 9

This section is reserved for manufacturer specific diagnostic statements of the analyzing device and overreading trail of the interpretation. The source of the analyzing device and the name of the overreading physician (or device) are defined in the “Header Section” (Section 1).

5.12.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

5.12.1 The structure and format of the data part of this section are manufacturer specific.

5.13 Specification of the lead measurement block — Section 10

This section contains the measurements of each recorded lead separately. The mandatory measurements and their format are listed below. A manufacturer specific area, and escape codes for special conditions have been provided.

5.13.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

5.13.1 The lead measurement section data part shall consist of one record for each measured lead. Each record shall consist of four fields:

- a) Lead identifier as in the “Lead Definition Part” of Section 3 (Binary; 1 byte),
- b) Length (unsigned integer) of record in bytes, excluding bytes 1-3 (Binary; 2 bytes)
- c) Up to 50 basic measurements (signed integers) (Binary fields; 2 bytes each),
- d) Manufacturer measurement area, starting from byte 104 on (Binary). No specific guidelines are included for the lay-out or format of this block.

5.13.2 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 measurement program
- 19999 (decimal) - Measurement not found because wave (e.g. Q wave) was not present in the corresponding lead

5.13.3 The Header of the data part of this Section contains the number of leads for which a measurement block is transmitted and the length of this block (each in binary, 2 bytes).

5.13.4 Each lead measurement block shall consist of:

Byte	Contents
1-2	Lead ID
3-4	Length of record
5-6	P-duration (ms) (total P-duration, including P+ and P– components)
7-8	PR-interval (ms)
9-10	QRS-duration (ms)
11-12	QT-interval (ms)
13-14	Q-duration (ms)

15-16	R-duration (ms)
17-18	S-duration (ms)
19-20	R'-duration (ms)
21-22	S'-duration (ms)
23-24	Q-amplitude (μV)
25-26	R-amplitude (μV)
27-28	S-amplitude (μV)
29-30	R'-amplitude (μV)
31-32	S'-amplitude (μV)
33-34	J-point-amplitude (μV) (amplitude of the J-point = amplitude of end of QRS)
35-36	P(+)-amplitude (μV)
37-38	P(-)-amplitude (μV)
39-40	T(+)-amplitude (μV)
41-42	T(-)-amplitude (μV)
43-44	ST-slope ($\mu\text{V/s}$)
45-46	P morphology description, as defined below
47-48	T morphology description, as defined below
49-50	Iso-electric segment at onset of QRS (in ms) (Segment I) ¹⁾
51-52	Iso-electric segment at the end of QRS (in ms) (Segment K) ¹⁾
53-54	Intrinsicoid deflection (in ms)
55-56	Quality code reflecting ECG recording conditions, as defined below
57-58	ST-amplitude at the J-point plus 20 ms
59-60	ST-amplitude at the J-point plus 60 ms
61-62	ST-amplitude at the J-point plus 80 ms
63-104	Reserved for future use ²⁾
105-***	Manufacturer specific block for measurement results

5.13.4.1 The P and T morphology description codes (Bytes 45 – 48) are defined as follows:

Value Contents

0	unknown	
1	positive	
2	negative	
3	positive/negative	
4	negative/positive	
5	positive/negative/positive	
6	negative/positive/negative	
7	notched M-shaped	
8	notched W-shaped	

5.13.4.2 The Quality Code (Bytes 55-56) is defined as follows:

2 binary bytes per lead, consisting of 8 two-bit-fields. Each two-bit pair represents the noise level in one of four classes.

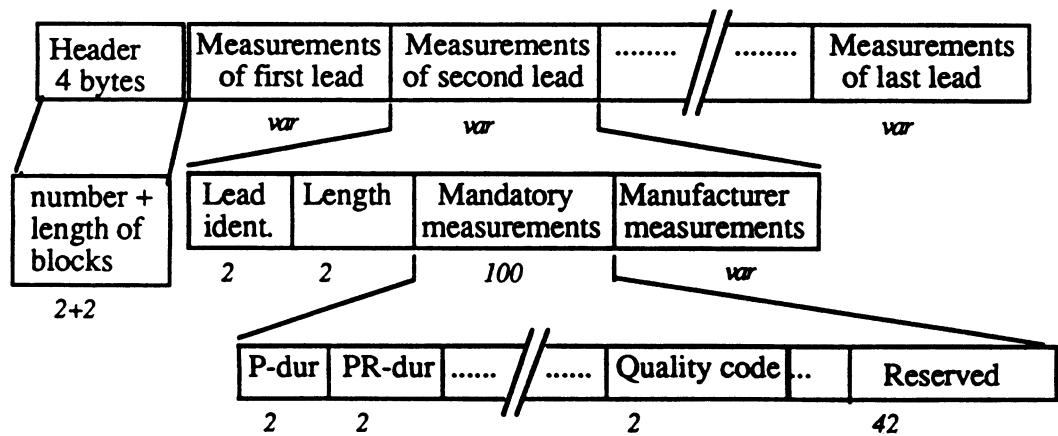
The least significant bit of byte 55 is defined as bit 0.

The most significant bit of byte 56 is defined as bit 15.

<u>Bit</u>	<u>Contents</u>	<u>Level</u>	<u>Class</u>
0-1	AC (mains) noise	0	none/no
2-3	overrange	1	moderate/yes
4-5	wander	2	severe
6-7	tremor or muscle artifact	3	unknown
8-9	spikes or sudden jumps		

- 10-11 electrode loose or off
- 12-13 pacemaker
- 14-15 interchanged lead

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



NOTES:

- ¹⁾ For the definition of the iso-electric segments I and K see European Heart Journal 1985; vol. 6, pages 815–825. Briefly, “I” is the interval between the global onset of QRS derived from all simultaneously recorded leads and the onset of QRS in a specific lead. Conversely, “K” is the time between the end of QRS in a specific lead and the global end of QRS.
- ²⁾ Bytes 63-104 have to be set to zero and need to be transmitted if a manufacturer specific measurement block is included.
- ³⁾ All measurements have to be expressed as signed integers. The amplitudes of the Q, S, S', T(–) and P(–) waves shall be expressed as negative integers, as well as the J-point amplitude and J + 20, J + 60 and J + 80 amplitudes, when they are negative. Note that the J-point (J) is the same as the QRS-end location.

5.14 Specifications for the storage of the universal ECG interpretive statement codes — Section 11

This section contains the most recent interpretation and overreading data, coded according to the Universal Statement Codes and Coding Rules, defined in Annex B.

The data contained in this section shall be consistent with the data in Sections 8 and 9.

5.14.0 If present, the section shall start with a “Section ID Header” as defined in 5.2.7.

5.14.1 Structure and format definition:

- Data shall be stored on a statement-by-statements basis. There are three types of statements possible:
 - 1) Universal Statement Codes (as defined in Annex B)
 - 2) Full Text (as used in Section 8)
 - 3) Statement Logic (identifying logical relationships between statements)

To store the three types of statements, three separate statement fields were defined.

— Only one field of type “Statement Logic” is allowed to identify the logical relationships between statements of the other types. If no “Statement Logic” type field is included in the section, it is assumed that all statements are equally valid, and have no “special” relationship to each other, except for what is declared in the statement. The number of fields of the types “Universal Statement Codes” and “Full Text” are not restricted.

5.14.2 The lay-out of the data part of this section is presented in **5.14.3**, and is explained below:

5.14.2.1 Header:

<u>Byte</u>	<u>Contents</u>						
1	Binary: Confirmed/Non confirmed report: <table> <tr> <th><u>Value</u></th><th><u>Type</u></th></tr> <tr> <td>0</td><td>Non Confirmed report</td></tr> <tr> <td>1</td><td>Confirmed report</td></tr> </table>	<u>Value</u>	<u>Type</u>	0	Non Confirmed report	1	Confirmed report
<u>Value</u>	<u>Type</u>						
0	Non Confirmed report						
1	Confirmed report						
2-3	Binary: Year (Full integer notation, as in 1990)						
4	Binary: Month (range 01 – 12; 01 = January)						
5	Binary: Day (range 1 – 31)						
6	Binary: Hours (range 0 – 23) (time is always local time)						
7	Binary: Minutes (range 0 – 59)						
8	Binary: Seconds (range 0 – 59)						
9	Binary: Number of statements in this section						

5.14.2.2 Statement data:

<u>Byte</u>	<u>Contents</u>														
1	Binary: Statement sequence number. Each statement has been given a sequence number to allow easy binding by the Type 3 logical operands.														
2-3	Binary: Statement field length (number of bytes in the statement, starting with the statement field type byte, and including the NULL terminator.)														
4-***	Statement field: <table> <tr> <th><u>Byte</u></th><th><u>Contents</u></th></tr> <tr> <td>1</td><td>Binary: Statement field type <table> <tr> <th><u>Value</u></th><th><u>Type</u></th></tr> <tr> <td>1</td><td>Coded statement type, using the Universal Statement Codes</td></tr> <tr> <td>2</td><td>Full text type, as used in Section 8</td></tr> <tr> <td>3</td><td>Statement logic type, as described below.</td></tr> </table></td></tr> <tr> <td>2-...</td><td>Data depending on the field type, terminated by NULL (0).</td></tr> </table>	<u>Byte</u>	<u>Contents</u>	1	Binary: Statement field type <table> <tr> <th><u>Value</u></th><th><u>Type</u></th></tr> <tr> <td>1</td><td>Coded statement type, using the Universal Statement Codes</td></tr> <tr> <td>2</td><td>Full text type, as used in Section 8</td></tr> <tr> <td>3</td><td>Statement logic type, as described below.</td></tr> </table>	<u>Value</u>	<u>Type</u>	1	Coded statement type, using the Universal Statement Codes	2	Full text type, as used in Section 8	3	Statement logic type, as described below.	2-...	Data depending on the field type, terminated by NULL (0).
<u>Byte</u>	<u>Contents</u>														
1	Binary: Statement field type <table> <tr> <th><u>Value</u></th><th><u>Type</u></th></tr> <tr> <td>1</td><td>Coded statement type, using the Universal Statement Codes</td></tr> <tr> <td>2</td><td>Full text type, as used in Section 8</td></tr> <tr> <td>3</td><td>Statement logic type, as described below.</td></tr> </table>	<u>Value</u>	<u>Type</u>	1	Coded statement type, using the Universal Statement Codes	2	Full text type, as used in Section 8	3	Statement logic type, as described below.						
<u>Value</u>	<u>Type</u>														
1	Coded statement type, using the Universal Statement Codes														
2	Full text type, as used in Section 8														
3	Statement logic type, as described below.														
2-...	Data depending on the field type, terminated by NULL (0).														

5.14.2.3 Statement type:

Type 1: This type shall contain one coded statement optionally followed by one or more modifiers, according to the Universal Statement Codes. The coded statement and modifiers shall each occupy one data part terminated by a NULL (0). The data parts are of variable length and the number of data parts is not restricted. The only restriction is the total length of all data parts together, which is 65535 bytes maximum.

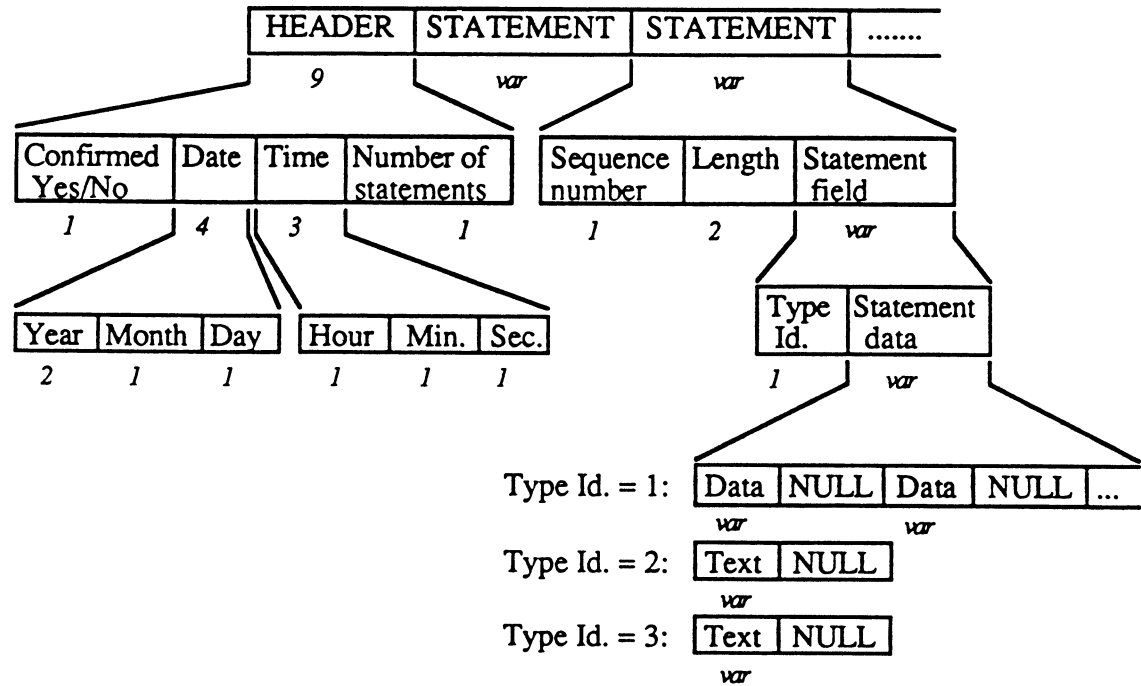
Type 2: This type has one data part containing only text characters, and is NULL (0) terminated.

Type 3: This type has one data part containing only text characters, and is NULL (0) terminated. The contents of this field identifies the logical relationships between statements by using logical operands acting on statements referred to by their sequence number.

Example: “(1+2);3”

with “+” = or, “;” = and, “(...)” marking precedence this means: statement nr. 1 OR statement nr. 2. AND statement nr. 3.

5.14.3 Lay-out of the data part of Section 11:



6 Minimum requirements for encoding and compression of the electrocardiographic signal data

6.0 Scope and field of application

As described in the **General Scope and Field of Application (Clause 1)** of the present standard, ECGs are taken in routine clinical practice with the patient being at rest, during defined periods of exercise or over long-term periods during regular daily activity, i.e. during ambulatory (so-called Holter) monitoring or in intensive care-units for cardiac arrhythmia monitoring. Recommendations for compression of data from long-term ECG recordings have been excluded from the present document. The specifications for encoding and compression described in this document are restricted to the routine resting electrocardiogram.

6.1 Introduction

ECG recordings made at rest have typically a length of 10 seconds. If digitized within accuracy limits recommended by the International Committees on Electrocardiology of AHA, AAMI, CSE and others, namely 500 samples/s and maximum 5µV/LSB, for each ECG lead per second 1,000 bytes of data is obtained with 16 bits/samples. This results in 80,000 bytes of data for a standard 12-lead 10-second ECG. (In this case, redundancy of limb leads which can be reconstructed from lead I and lead II has already been removed.)

Although less than medical imaging, electrocardiography thus results in large amounts of digital data compared to other medical data such as patient history, diagnostic codes and biomedical laboratory data. Although technology has nowadays significantly increased the available capacity and transmission speed, data reduction is still desirable, if not an economic necessity especially when transmission is performed over the normal telephone network.

Indeed, there are two compelling reasons to compress digital ECG data:

- 1. to reduce the (magnetic) storage requirements for medical databases and hospital information systems,
- 2. to reduce the time (and telephone expense) of ECG data transmission.