INTERNATIONAL STANDARD

IEC 62056-21

First edition
2002-05

Electricity metering – Data exchange for meter reading, tariff and load control –

Part 21: Direct local data exchange

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING – DATA EXCHANGE FOR METER READING, TARIFF AND LOAD CONTROL –

Part 21: Direct local data exchange

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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The provider of the maintenance service has assured the IEC that he is willing to provide services under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the provider of the maintenance service is registered with the IEC. Information may be obtained:

Manufacturer's identification, item 12) of 6.3.2: from

The FLAG Association, UK
www.dlms.com/flag

Enhanced identification character, item 24) of 6.3.2: from

DLMS User Association
Geneva / Switzerland
www.dlms.ch

International Standard IEC 62056-21 has been prepared by IEC Technical Committee 13: Equipment for electrical energy measurement and load control.

This first edition IEC 62056-21 cancels and replaces the second edition of IEC 61107 published in 1996 and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
13/1271/FDIS	13/1277/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annexes A, B and E form an integral part of this standard.

Annexes C and D are for information only.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

IEC TC 13 has the task of preparing standards for data exchange for the purposes of meter reading, tariff and load control, and consumer information using various alternative communication media, with reference to ISO and ITU standards.

Meter data exchange can be local or remote. This part of IEC 62056 is restricted to local data exchange, whereas remote data exchange is covered by other standards of the IEC 62056 series.

ELECTRICITY METERING – DATA EXCHANGE FOR METER READING, TARIFF AND LOAD CONTROL –

Part 21: Direct local data exchange

1 Scope

This part of IEC 62056 describes hardware and protocol specifications for local meter data exchange. In such systems, a hand-held unit (HHU) or a unit with equivalent functions is connected to a tariff device or a group of devices.

The connection can be permanent or disconnectable using an optical or electrical coupling. An electrical interface is proposed for use with a permanent connection, or when more than one tariff device needs to be read at one site. The optical coupler should be easily disconnectable to enable data collection via an HHU.

The protocol permits reading and programming of tariff devices. It is designed to be particularly suitable for the environment of electricity metering, especially as regards electrical isolation and data security. While the protocol is well-defined, its use and application are left to the user.

This standard is based on the reference model for communication in open systems. It is enhanced by further elements such as an optical interface, protocol controlled baud rate switchover, data transmission without acknowledgement of receipt. The protocol offers several modes for implementation in the tariff device. The HHU or equivalent unit acts as a master while the tariff device acts as a slave in protocol modes A to D. In protocol mode E, the HHU acts as a client and the tariff device acts as a server.

As several systems are in practical use already, particular care was taken to maintain compatibility with existing systems and/or system components and their relevant protocols.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050-300:2001, *International Electrotechnical Vocabulary (IEV) – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 62051:1999, *Electricity metering – Glossary of terms*

IEC 62056-42:2002, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 42: Physical layer services and procedures for connection oriented asynchronous data exchange*

IEC 62056-46:2002, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC-protocol*

IEC 62056-53:2002, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM application layer*

ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange*

ISO/IEC 1155:1978, *Information processing – Use of longitudinal parity to detect errors in information messages*

ISO/IEC 1177:1985, *Information processing – Character structure for start/stop and synchronous character-oriented transmission*

ISO/IEC 1745:1975, *Information processing – Basic mode control procedures for data communication systems*

ISO/IEC 7480:1991, *Information technology – Telecommunications and information exchange between systems – Start-stop transmission signal quality at DTE/DCE interfaces*

ITU-T Recommendation V.24 (2000), *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*

ITU-T Recommendation V.28 (1993), *Electrical characteristics for unbalanced double-current interchange circuits*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purpose of this part of IEC 62056 the terms and definitions given in IEC 60050-300 and IEC 62051, as well as the following apply:

3.1.1
tariff device
fixed data collection unit, normally linked or combined with an electricity meter, acting as a server

3.1.2
master
central station. Station which takes the initiative and controls the data flow

3.1.3
slave
station responding to requests of a master station. The tariff device is normally a slave station

3.1.4
client
a station, asking for services, normally the master station

3.1.5
server
a station, delivering services. The tariff device (e.g. the meter) is normally the server, delivering the requested values or executing the requested tasks

3.2 Abbreviations

HHU hand-held unit

4 Physical properties

4.1 Electrical current loop interface

a) Type of signal

20 mA current loop

Absolute limits:

Open-circuit voltage: max. 30 V d.c.

Loop current: max. 30 mA

Table 1 – Electrical interface

Current	**Send (TX)**	**Receive (RX)**
Zero, no loop current, SPACE	≤2,5 mA	≤3 mA
One, 20 mA loop current, MARK	≥11 mA	≥9 mA
Voltage drop	**Send (TX)**	**Receive (RX)**
One, 20 mA loop current, MARK	≤2 V	≤3 V
Maximum open-circuit voltage during operation		30 V d.c.

b) Power supply

On the tariff device side the interface is passive. The HHU supplies the necessary power.

c) Connections

Via terminals or suitable connectors. Polarity errors can prevent communication, but shall not harm the devices.

d) Circuit arrangements in two-wire configuration (one slave station)

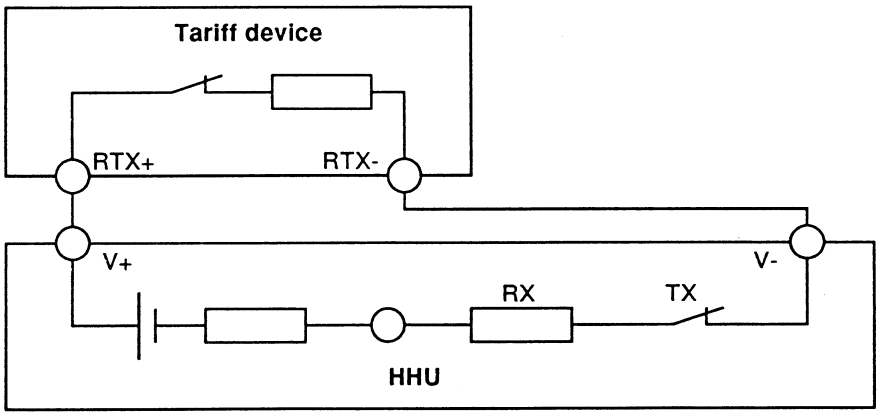


Figure 1a – Circuit diagram of a two-wire single slave configuration

e) Circuit arrangements in two-wire configuration (multiple slave stations)

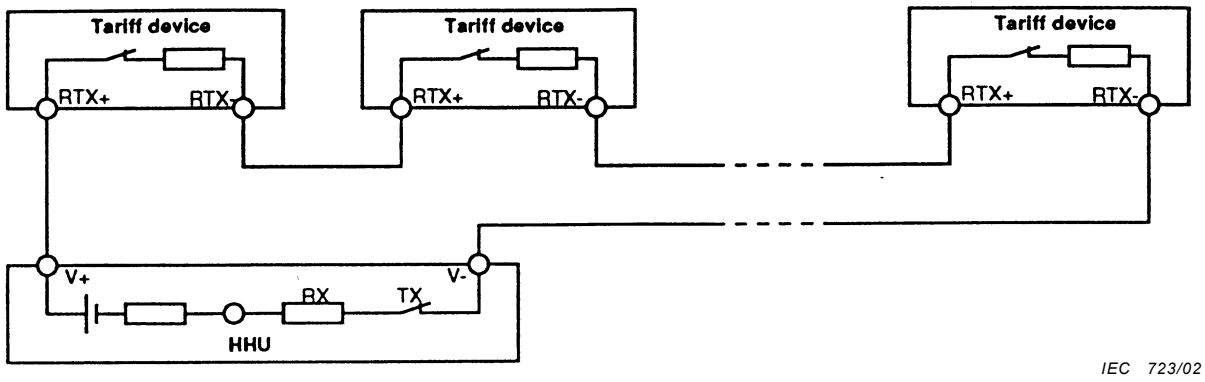


Figure 1b – Circuit diagram of a two-wire multiple slave configuration

f) Circuit arrangements in four-wire configuration (one slave station)

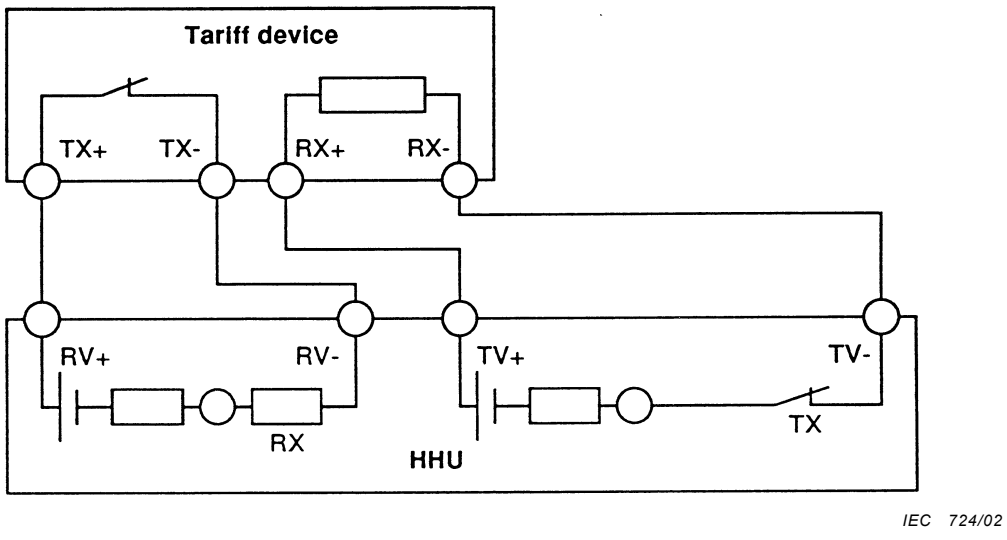


Figure 1c – Circuit diagram of a four-wire single slave configuration

g) Circuit arrangements in four-wire configuration (multiple slave stations)

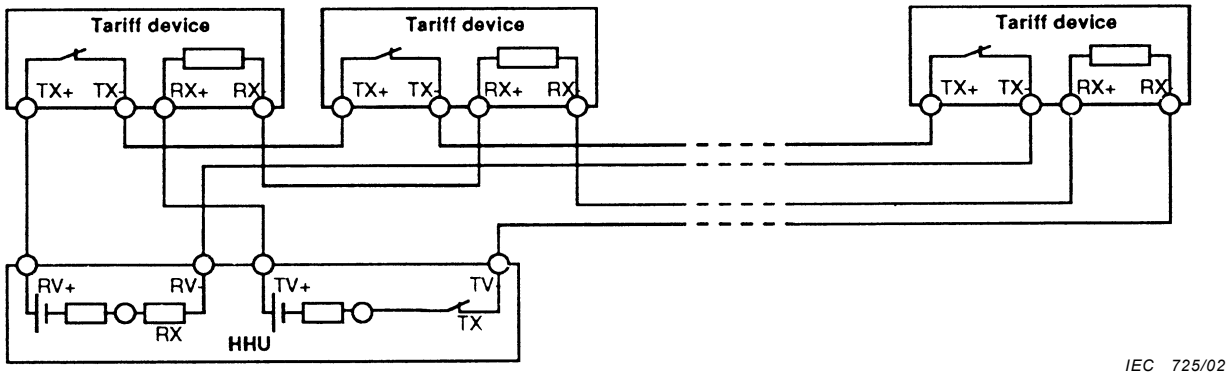


Figure 1d – Circuit diagram of a four-wire multiple slave configuration

Figure 1 – Circuit diagrams

If a nominal voltage of the master station (HHU) of 26 V is assumed, eight slave stations (tariff devices) can be connected in series.

4.2 Electrical interface V.24/V.28

Relevant ITU-T recommendations apply:

ITU-T Recommendation V.24: only circuits No. 102 (Signal ground), 103 (Transmitted data) and 104 (Received data) are used.

ITU-T Recommendation V.28: The electrical characteristics of the interchange circuits shall be according to the ITU-T V.28 Recommendation. These enable signalling rates up to 20 kbit/s.

4.3 Optical interface

4.3.1 Construction of the reading head

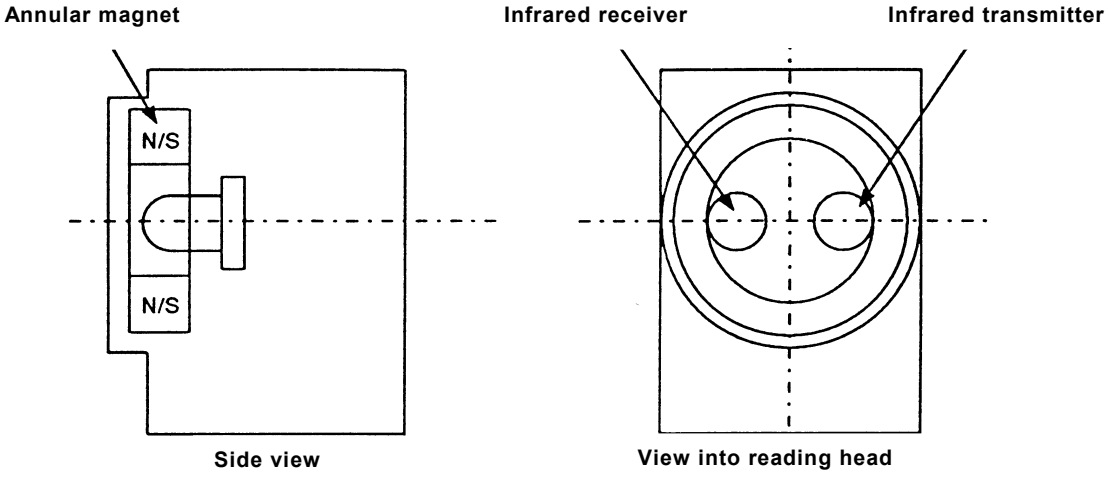


Figure 2a – Arrangement of components

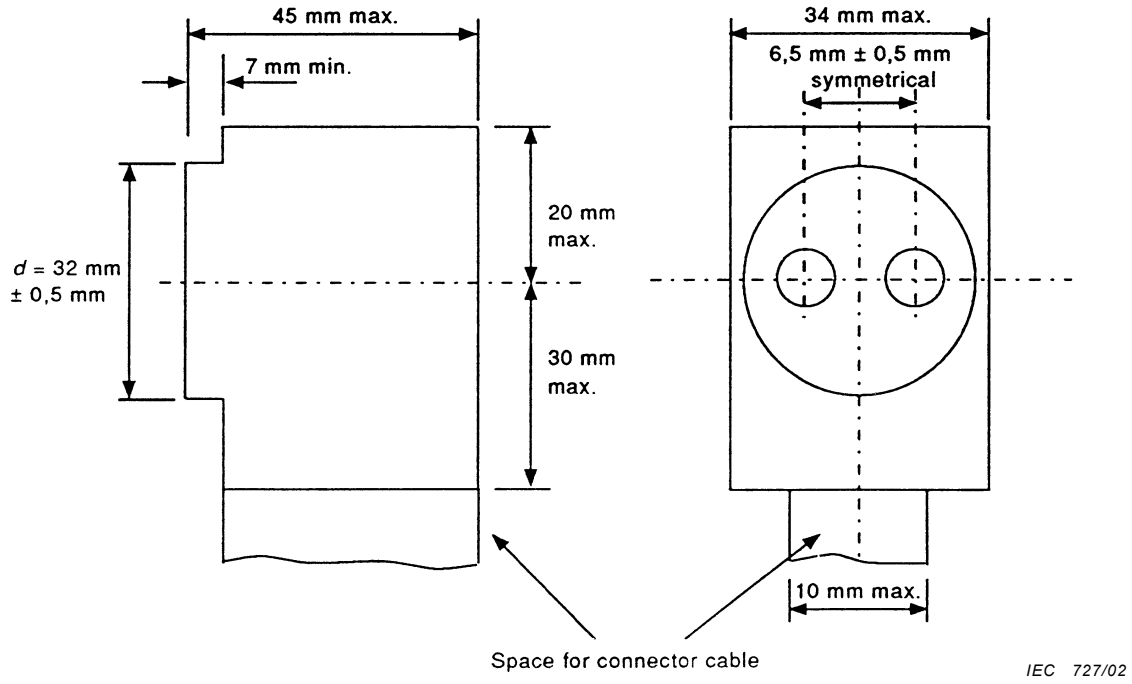


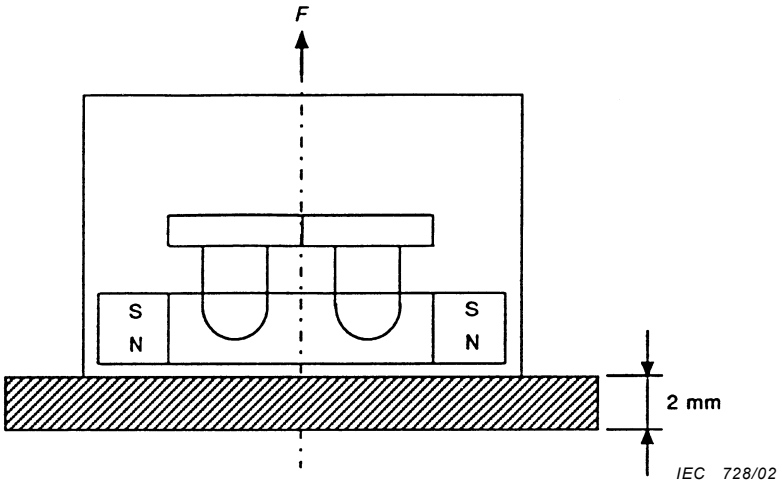
Figure 2b – Dimensions

Figure 2 – Construction of the reading head

4.3.2 Characteristic data of the magnet

Cohesion force

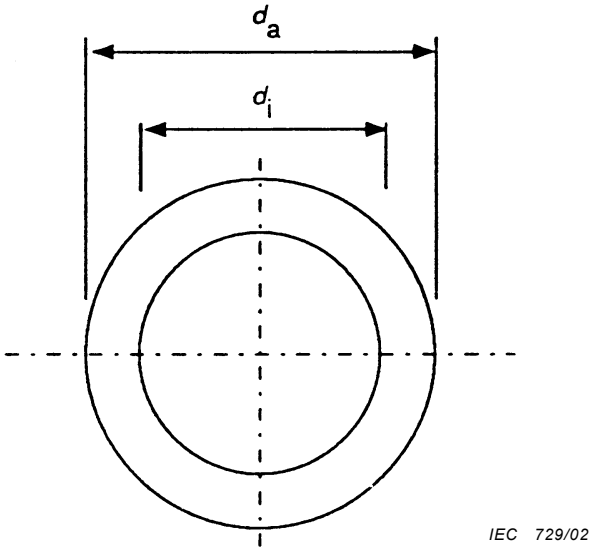
The cohesion force *F* is defined as the perpendicular pulling force measured when the magnet is positioned on a bright 2 mm thick deep-drawing steel plate St 12, minus the weight of the reading head itself.



Cohesion force

F ≥5 N in contact with the steel plate; F > 1.5 N at a distance of 2 mm from the steel plate.

Figure 3a – Cohesion force



Internal diameter d_i = 13 mm ± 1 mm; External diameter d_a = 28 mm minimum

Magnetization: axial, north pole directed towards the tariff device.

Figure 3b – Dimensions

Figure 3 – Characteristic data of the magnet

4.3.3 Arrangement of components in the tariff device

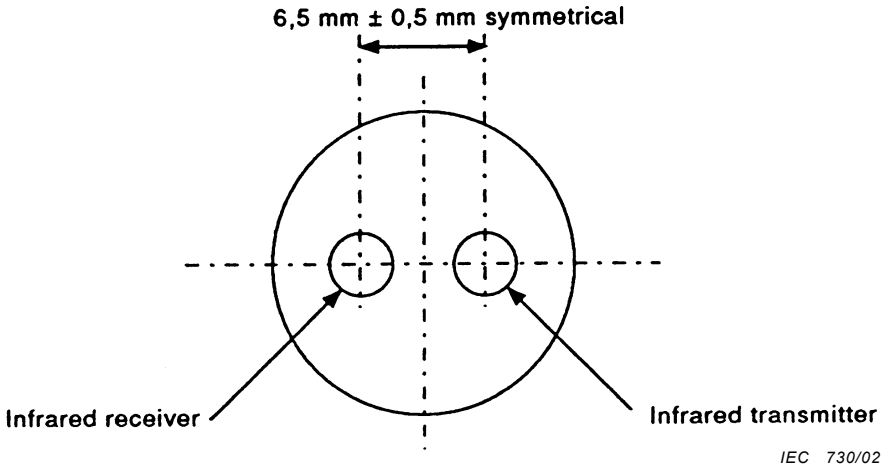


Figure 4 – View into optical port

4.3.4 Alignment

Although no mechanical alignment is specified, optimum data transfer is achieved (under test conditions) when the reading head is in the correct position (cable downwards), the infrared receiver in the tariff device is aligned directly opposite the infrared transmitter in the reading head, and the infrared receiver in the reading head is directly opposite the infrared transmitter in the tariff device.

Slight variations to this position should not affect performance significantly, but for larger variations, degradation of the optical characteristics can occur.

4.3.5 Optical characteristics

4.3.5.1 Wavelength

The wavelength of the radiated signals in both directions is between 800 nm and 1 000 nm (infrared).

4.3.5.2 Transmitter

The transmitter in the tariff device, as well as in the reading head, generates a signal with a radiation strength $E_{e/T}$ over a defined reference surface (optically active area) at a distance of a_1 = 10 mm (±1 mm) from the surface of the tariff device or the reading head.

The following limiting values apply:

ON-condition (ON = SPACE = Binary 0): $500 \leq E_{e/T} \leq 5\,000$ µW/cm²

OFF-condition (OFF = MARK (quiescent state) = Binary 1): $E_{e/T} \leqq 10$ µW/cm²

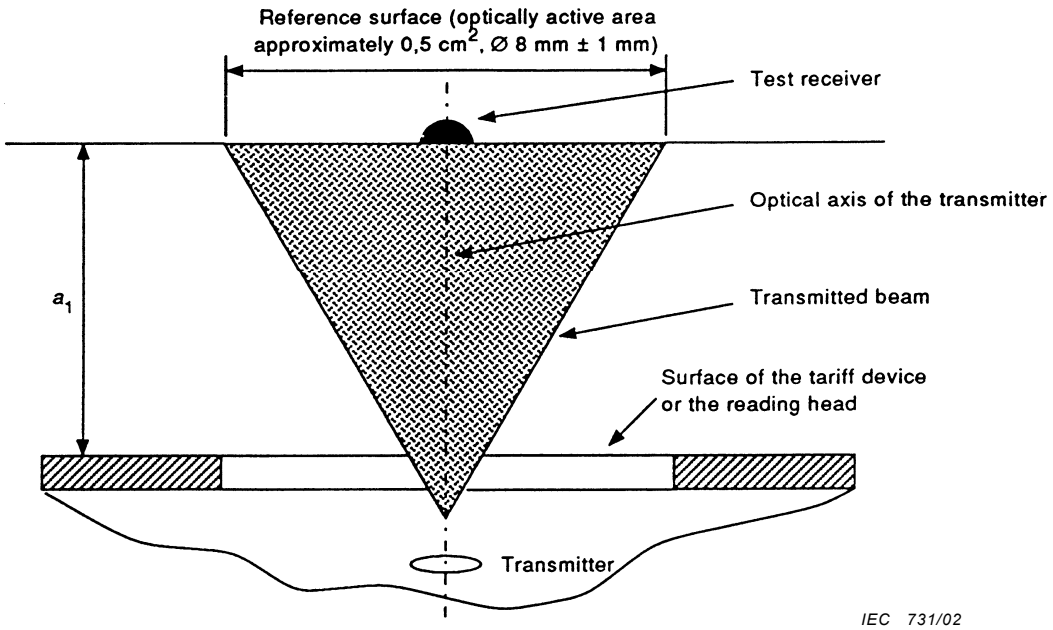


Figure 5 – Test arrangement for the transmitter

4.3.5.3 Receiver

A transmitter which is positioned at a distance a_2 = 10 mm (±1 mm) on the optical axis from the receiver in the tariff device or the reading head generates a signal with a radiation strength $E_{e/R}$ over a defined reference surface (optically active area).

The following limiting values apply:

ON-condition: receiver definitely ON at $E_{e/R} \geq 200$ µW/cm² (ON = SPACE = Binary 0)

OFF-condition: receiver definitely OFF at $E_{e/R} \leq 20$ µW/cm² (OFF = MARK (quiescent state) = Binary 1)

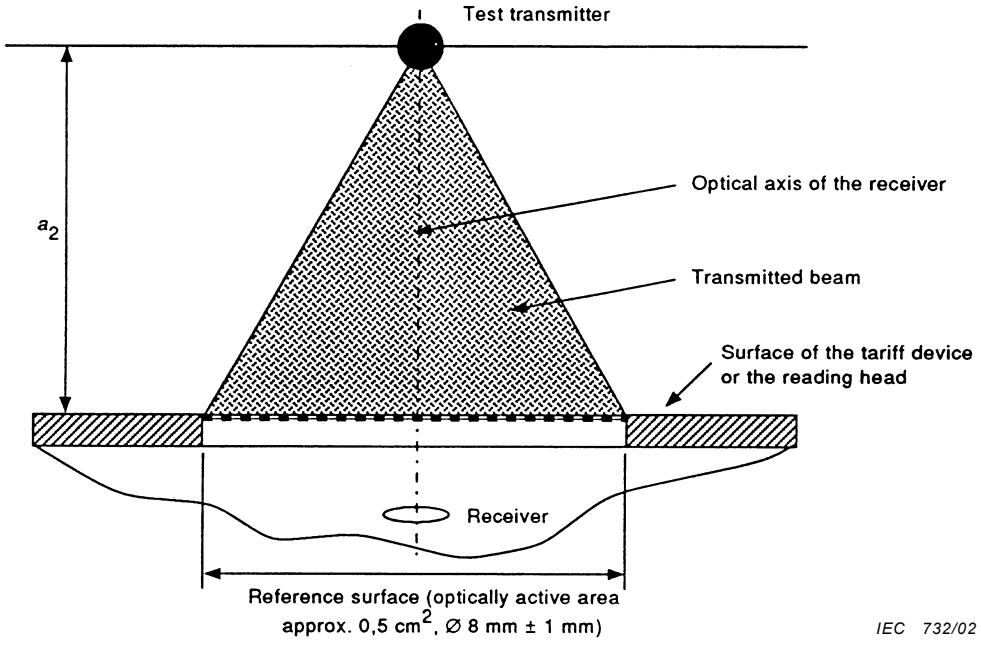


Figure 6 – Test arrangement for the receiver

4.3.5.4 Environmental lighting condition

The optical path (data transmission) shall not be affected by surrounding light with an intensity of up to 16 000 lux (light composition comparable with daylight, including fluorescent light).

4.3.5.5 Environmental temperature condition

The reference temperature is 23 °C ± 2 °C.

5 Character transmission

5.1 Type of transmission

Asynchronous serial bit (Start – Stop) transmission according to ISO/IEC 1177:1985, half-duplex.

5.2 Transmission speed

Initial baud rate – 300

Standard baud rates – 300, 600, 1 200, 2 400, 4 800, 9 600, 19 200

Special baud rate – as desired.

NOTE The maximum speed may be limited by the reading head or the optical port or the ITU-T Recommendation V.28 limitations in the tariff device.

5.3 Signal quality

According to ISO/IEC 7480:1991:

– category 1 for the transmitter;
– category A for the receiver.

5.4 Character format

Character format according to ISO/IEC 1177:1985.

(1 start bit, 7 data bits, 1 parity bit, 1 stop bit).

NOTE Protocol mode E (see 6.4.5) may use byte transparency, 1 start bit, 8 data bits, 1 stop bit (e.g. see Annex E).

5.5 Character code

Character code according to ISO/IEC 646:1991, international reference version. For local use, a national replacement code can be used.

NOTE Protocol mode E (see 6.4.5) may use byte transparency.

5.6 Character security

With parity bit, even parity according to ISO/IEC 1177:1985.

NOTE Protocol mode E (see 6.4.5) may use byte transparency, specific security may be used.

6 Data transmission protocol

6.1 General

The protocol offers five alternative protocol modes, which can be used by the tariff device: A, B, C, D and E. Mode selection is a subset of ISO/IEC 1745, basic mode control procedures.

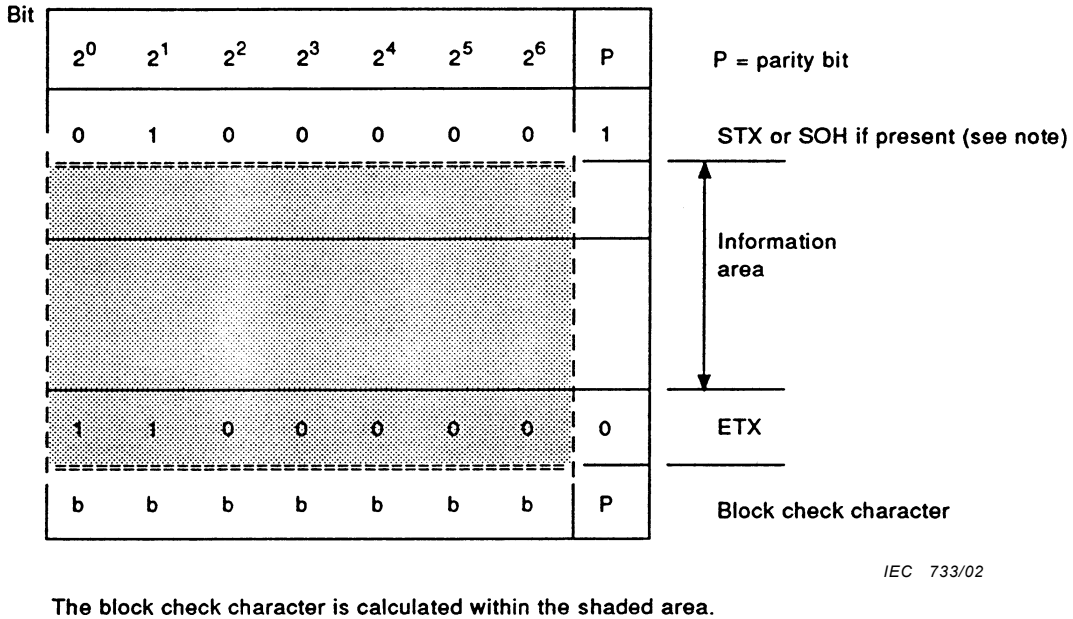
Data exchange is bi-directional in protocol modes A, B, C and E and is always initiated by the HHU with a transmission of a request message. In protocol modes A to C, the HHU acts as a master and the tariff device acts as a slave. In protocol mode E, the HHU acts as a client and the tariff device acts as a server. These protocol modes permit meter reading and programming. Protocol mode E may be a transparent binary mode.

Data exchange is unidirectional in protocol mode D and permits readout only. The information flows from the tariff device to the HHU. Data transmission is initiated, for example by operating a push button or other sensor on the tariff device.

The protocol mode used by the tariff device is indicated to the HHU by the identification message. Protocol modes A to D are identified by the baud rate identification character (see item 13 in 6.3.3) while protocol mode E is identified by an escape sequence (see items 23 and 24 in 6.3.2). Protocol mode E enables to use various protocols, one of them being the METERING HDLC protocol as described in Annex E.

6.2 Calculation of the block check character

The readout of data may be performed without block check character. Whenever used, the block check character shall comply with ISO/IEC 1155:1978.



NOTE The scope of the block check character BCC is as specified in ISO/IEC 1745:1975, and is from the character immediately following the first SOH or STX character detected up to and including the ETX character which terminates the message. The calculated BCC is placed immediately following the ETX.

Figure 7 – Setting up a block check character (example according to ISO/IEC 1155)

6.3 Message definitions

Explanations of message contents see 6.3.14.

6.3.1 Request message

Opening message from the HHU to the tariff device. The device address is optional.

I	?	Device address	!	CR	LF
1)	9)	22)	2)	3)	3)

6.3.2 Identification message

Answer of a tariff device. Fields 23) and 24) are optional, they are part of field 14).

I	X	X	X	Z	\	W	Identification	CR	LF
1)	12)	12)	12)	13)	23)	24)	14)	3)	3)

6.3.3 Acknowledgement/option select message

Negotiation of advanced features (only used in protocol mode C and E).

ACK	V	Z	Y	CR	LF
4)	10)	13)	11)	3)	3)

6.3.4 Data message (except in programming mode)

Normal response of a tariff device, for example the full data set (not used in protocol mode E).

STX	Data block	!	CR	LF	ETX	BCC
5)	15)	2)	3)	3)	6)	8)

6.3.5 Acknowledgement message

If appropriate, see also flow charts in the annexes.

ACK
4)

6.3.6 Repeat-request message

If appropriate, see also flow charts in the annexes.

NAK
16)

6.3.7 Programming command message

Used for programming and block oriented data transfer, see also 6.5.

SOH	C	D	STX	Data set	ETX	BCC
17)	18)	19)	5)	20)	6)	8)

6.3.8 Programming command message using optional partial blocks

Used for long messages, see also 6.5 and flow charts in the annexes (only in protocol mode C).

SOH	C	D	STX	Data set	EOT	BCC
17)	18)	19)	5)	20)	7)	8)

6.3.9 Data message (programming mode)

Used for block oriented data transfer, see also 6.5 and flow charts in the annexes.

STX	Data set	ETX	BCC
5)	20)	6)	8)

6.3.10 Data message (programming mode) using optional partial blocks

Used for long messages of block oriented data transfer, see also 6.5 and flow charts in the annexes (only in protocol mode C).

STX	Data set	EOT	BCC
5)	20)	7)	8)

6.3.11 Error message (programming mode)

Used for block oriented data transfer, see also flow charts in the annexes.

STX	Error message	ETX	BCC
5)	21)	6)	8)

6.3.12 Break message (programming mode)

Used for block oriented data transfer, see also flow charts in the annexes.

SOH	B	0	ETX	BCC
17)	18)	19)	6)	8)

6.3.13 Block message (other protocols)

Block messages are used in conformance with the protocol selected, as specified in "other protocol", see 6.4.5 and Annex E.

6.3.14 Explanations of message contents

1) Start character "/" (forward oblique, code 2FH).
2) End character "!" (exclamation mark, code 21H).
3) Completion character (CR, carriage return, code 0DH; LF, line feed, code 0AH).
4) Acknowledge character (ACK, acknowledge, code 06H).
5) Frame start character (STX, start of text code 02H) indicating where the calculation of BCC shall start from. This character is not required if there is no data set to follow.
6) End character in the block (ETX, end of text, code 03H).
7) End character in a partial block (EOT, end of text block, code 04H).
8) Block check character (BCC), if required, in accordance with the characters 5) and 6). Items 5) and 6) do not apply when the data block is transmitted without check characters.
9) Transmission request command "?" (question mark, code 3FH)
10) Protocol control character (see 6.4.5.2).
11) Mode control character (see 6.4.5.3).
12) Manufacturer's identification comprising three upper case letters except as noted below:

    If a tariff device transmits the third letter in lower case, the minimum reaction time t_r for the device is 20 ms instead of 200 ms. Even though a tariff device transmits an upper case third letter, this does not preclude supporting a 20 ms reaction time.

    These letters shall be registered with the administrator: The FLAG Association (see the foreword).

13) Baud rate identification (for baud rate changeover)

    The request message, the identification message and the acknowledgement/option select message are transmitted at the initial rate of 300 Bd (except protocol mode D). The baud rate of the data message depends on the baud rate determined by the protocol.

    a) Protocol mode A (without baud rate changeover)

       Any desired printable characters except "/", "!" and as long as they are not specified for protocol mode B or protocol mode C.

    b) Protocol mode B (with baud rate changeover, without acknowledgement/option select message)

       A - 600 Bd

       B - 1 200 Bd

       C - 2 400 Bd

       D - 4 800 Bd

       E - 9 600 Bd

       F - 19 200 Bd

       G, H, I - reserved for later extensions.

    c) Protocol mode C and protocol mode E (with baud rate changeover, with acknowledgement / option select message or other protocols)

       0 - 300 Bd

       1 - 600 Bd

       2 - 1 200 Bd

       3 - 2 400 Bd

4 - 4 800 Bd
5 - 9 600 Bd
6 - 19 200 Bd
7, 8, 9 - reserved for later extensions.

d) Protocol mode D (data transmission at 2 400 Bd)
Baud rate character is always 3.

14) Identification, manufacturer-specific, 16 printable characters maximum except for "/" and "!". "\" is only allowed as an escape character, see 23) and 24).

15) Data block with the measured values (see syntax diagram for normal reading). All printable characters may be used in the data block, as well as line feed and carriage return, except for "/" and "!".

16) Repeat request character (NAK, negative acknowledge, code 15H).

17) Start-of-header character (SOH, start-of-header, code 01H).

18) Command message identifier

P - Password command
W - Write command
R - Read command
E - Execute command
B - Exit command (break)

Other characters are reserved for future use.

19) Command type identifier (signifies the variant of the command)

Values:

a) for password P command

0 - data is operand for secure algorithm
1 - data is operand for comparison with internally held password
2 - data is result of secure algorithm (manufacturer-specific)
3-9 - reserved for future use.

b) for write W command

0 - reserved for future use
1 - write ASCII-coded data
2 - formatted communication coding method write (optional, see Annex C)
3 - write ASCII-coded with partial block (optional)
4 - formatted communication coding method write (optional, see Annex C) with partial block
5 - reserved for national use
6-9 - reserved for future use.

c) for read R command

0 - reserved for future use
1 - read ASCII-coded data
2 - formatted communication coding method read (optional, see Annex C)
3 - read ASCII-coded with partial block (optional)
4 - formatted communication coding method read (optional, see Annex C) with partial block
5,6 - reserved for national use
7-9 - reserved for future use.

d) for execute E command

0-1 - reserved for future use

2 - formatted communication coding method execute (optional, see Annex C)

3-9 - reserved for future use.

e) for exit B command

0 - complete sign-off

1 - complete sign-off for battery operated devices using the fast wake-up method

2-9 - reserved for future use.

20) Data set

This provides the address and data for the message (see 6.5).

The following applies to command messages:

a) The password command

The address and unit fields are empty (devoid of any characters).

b) The write command

Where the value represents a data string, the address is the start location to which the data is to be written. The unit field is left empty.

c) The read command

Where a data string is to be read, the address is the start location from which data is read.

The value represents the number of locations to be read including the start location. The unit field is left empty.

d) The execute command

It requests that a device executes a predefined function.

e) The exit command

No data set is required when the command type identifier is 0.

21) Error message

This consists of 32 printable characters maximum with exception of (,), *, / and !. It is bounded by front and rear boundary characters, as in the data set structure. This is manufacturer-specific and should be chosen so that it cannot be confused with data, for example starting all error messages with ER.

22) Device address, optional field, manufacturer-specific, 32 characters maximum. The characters can be digits (0...9), upper-case letters (A...Z), or lower case letters (a...z), or a space ( ). Upper and lower case letters, and the space character are unique*. Leading zeros shall not be evaluated. This means that all leading zeros in the transmitted address are ignored and all leading zeros in the tariff device address are ignored (i.e. 10203 = 010203 = 000010203). When both the transmitted address and the tariff device address contain only zeros, regardless of their respective lengths, the addresses are considered equivalent. As a missing address field is considered as a general address (/ ? ! CR LF), the tariff device shall respond. The tariff device shall be able to evaluate the complete address as sent by an external device, even if the internal programmed address is shorter or longer in length.

NOTE 1 * Upper and lower case letters, and the space character must match and their combination may be used only once.

NOTE 2 The device identification number can be used as an address to avoid reading of, or writing to, wrong devices.

23) Sequence delimiter (backslash code 5CH), optional field. This character is always followed by a one character field 24). This field is part of the maximum 16 character wide identification field 14). Multiple pairs 23)/24) are allowed.

24) Enhanced baud rate and mode identification character (optional field). This field is part of the 16 character wide identification field 14). W must be registered with the administrator: The DLMS User Association (see the foreword). For details see 6.4.5.1.

6.4 Communication modes

6.4.1 Protocol mode A

Protocol mode A supports bidirectional data exchange at 300 baud without baud rate switching. This protocol mode permits data readout and programming with optional password protection.

6.4.1.1 Overview

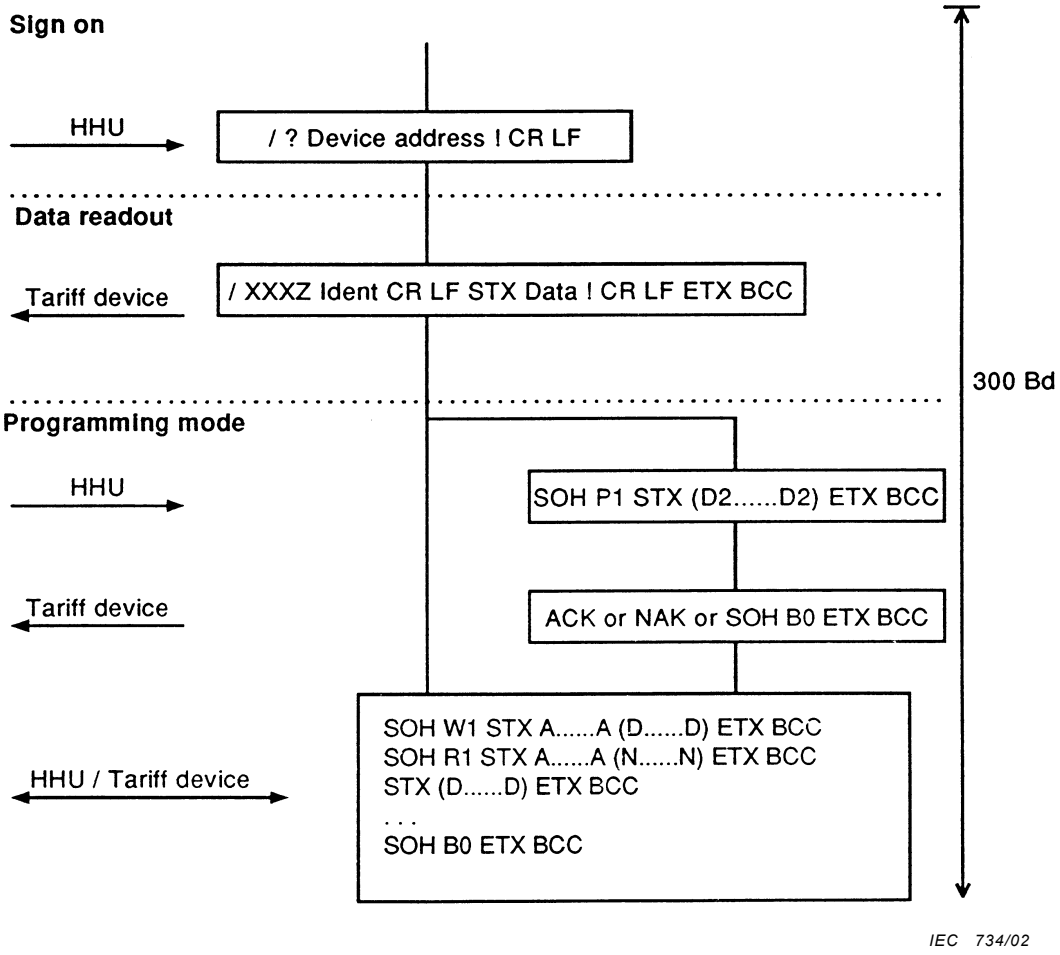


Figure 8 – Diagram protocol mode A

6.4.1.2 Data readout

The tariff device transmits the data message immediately following the identification message.

6.4.1.3 Switch to programming mode

Programming mode can be entered immediately following completion of the data readout by sending any command message, including a password command message.

6.4.1.4 Data readout with optional switch to programming mode

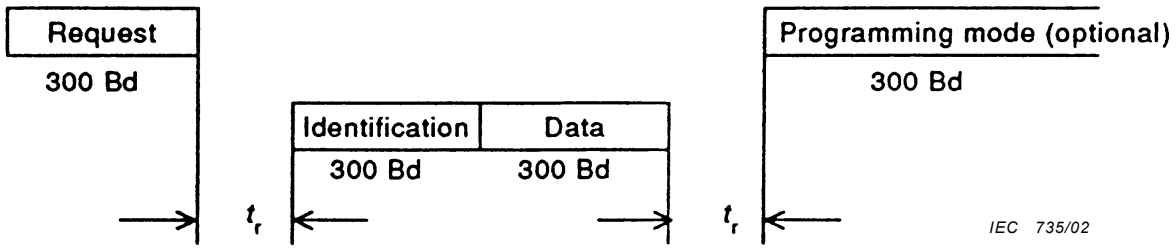


Figure 9 – Transmission protocol for protocol mode A

6.4.1.5 Reaction and monitoring times

The time between the reception of a message and the transmission of an answer is:

(20 ms) 200 ms ≤ t_r ≤ 1 500 ms (see item 12) of 6.3.14).

The time between two characters in a character sequence is:

t_a < 1 500 ms

6.4.1.6 End of data readout transmission

The data transmission is complete after the data message has been transmitted by the tariff device. An acknowledge signal is not provided for.

The HHU can retransmit a request if the transmission was faulty.

6.4.2 Protocol mode B

Protocol mode B supports bidirectional data exchange with baud rate switching. This protocol mode permits data readout and programming with optional password protection.

6.4.2.1 Overview

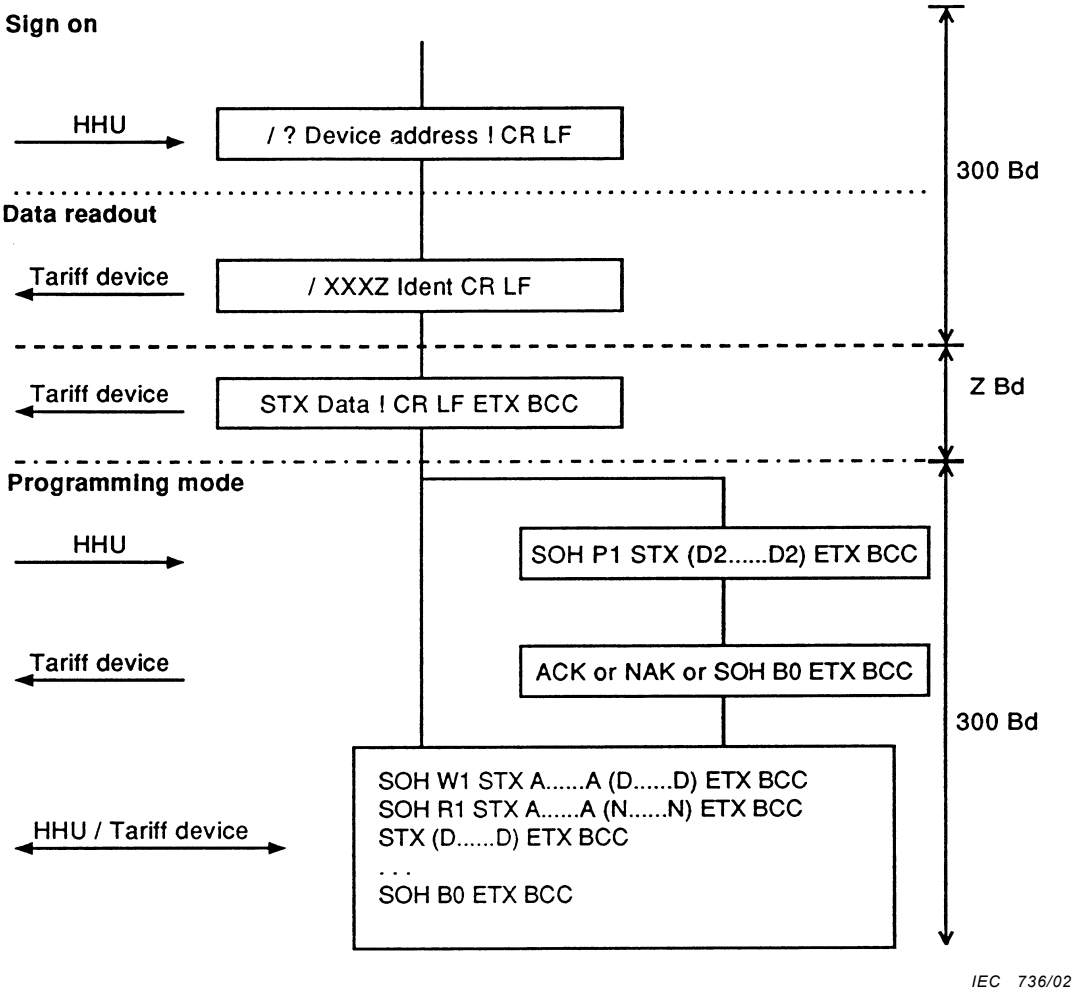


Figure 10 – Diagram protocol mode B

6.4.2.2 Data readout

After transmitting the identification message, the tariff device briefly interrupts the transmission. During the interval the tariff device and the HHU switch over to the baud rate prescribed in the identification message. Following this the tariff device transmits the data message at the new baud rate.

6.4.2.3 Switch to programming mode

Programming mode can be entered immediately following completion of the data readout by sending any command message by the HHU at 300 baud, including a password command message.

6.4.2.4 Data readout with optional switch to programming mode

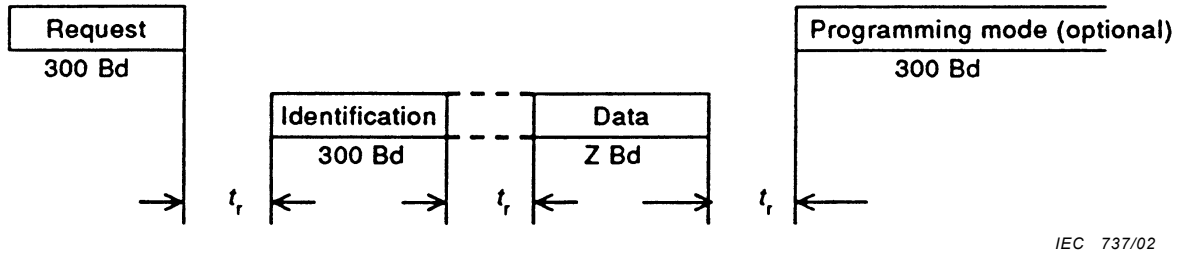


Figure 11 – Transmission protocol for protocol mode B

6.4.2.5 Reaction and monitoring times

The time between the reception of a message and the transmission of an answer is:

(20 ms) 200 ms ≤ t_r ≤ 1 500 ms (see item 12) of 6.3.14.

The time between two characters in a character sequence is:

t_a < 1 500 ms

6.4.2.6 End of data readout transmission

The data transmission is complete after the data message has been transmitted by the tariff device. An acknowledge signal is not provided for.

The HHU can retransmit a request if the transmission was faulty.

6.4.3 Protocol mode C

Protocol mode C supports bidirectional data exchange with baud rate switching and permits data readout, programming with enhanced security and manufacturer-specific modes.

6.4.3.1 Overview

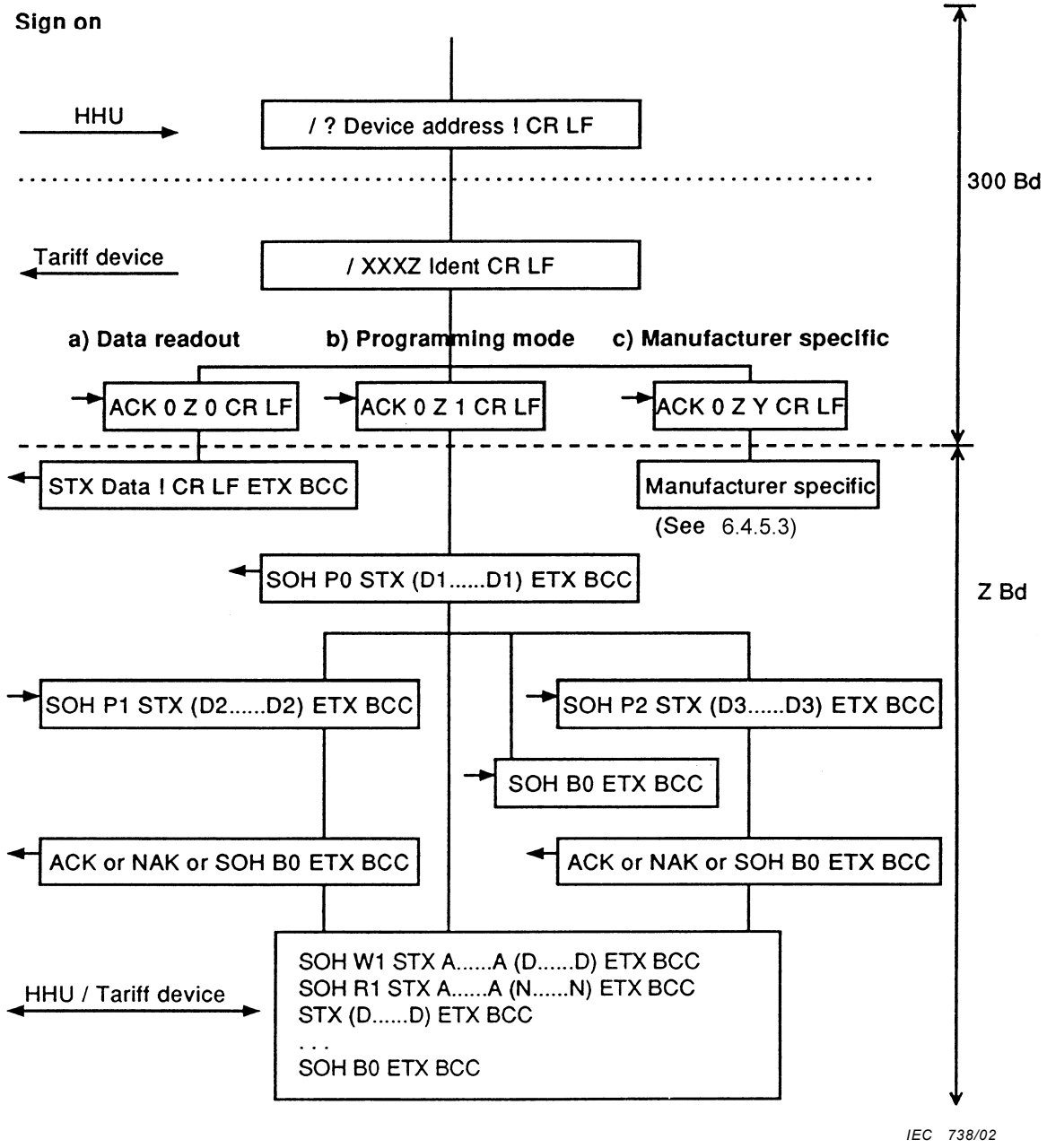


Figure 12 – Diagram protocol mode C

W (Write) will be followed by ACK or NAK or an error message.

R (Read) will be followed by a data message or NAK or an error message as reply.

Termination occurs following SOH B0 ETX BCC (without NAK response), or by timeout (see Annex A, note 1).

See also Annex A.

After the identification message has been transmitted, the tariff device waits for the acknowledge/option select message from the HHU. This may be a request for data readout, a switch to programming mode, or a switch to manufacturer-specific operation.

6.4.3.2 Data readout mode

In the case of ACK 0 Z 0 CR LF the tariff device will respond with a predefined data set in the format defined in 6.5 ("Syntax diagrams - Readout mode - Data message"). The data set may be empty for those tariff devices not designed to read data in this manner.

The communication will proceed at 300 Bd (initial baud rate) if:

– the "Z" character in the acknowledgement/option select message is 0; or

– an incorrect or unsupported acknowledgement/option select message is sent or received; or

– no acknowledgement/option select message is sent or received.

The communication will only switch to Z baud if the Z characters in the identification response and the acknowledgement/option select message are identical.

6.4.3.3 Switch to programming mode

In the case of ACK 0 Z 1 CR LF the tariff device will switch to programming mode. Further communication will proceed at 300 Bd (the initial baud rate) if:

– the Z character in the acknowledgement/option select message is 0.

The communication will switch to Z baud if the Z character in the identification response and the acknowledgement/option select message are identical. If the acknowledgement/option select message is inconsistent or determined to be in error by the tariff device, then communication will proceed at 300 Bd in the data readout mode. Programming will not be entered.

6.4.3.4 Switch to manufacturer-specific operation

Manufacturer's own options may be obtained by selecting Y to take values between 6 and 9 in the sequence ACK 0 Z Y CR LF.

Data readout mode (fallback mode, corresponds to protocol mode A, data readout)

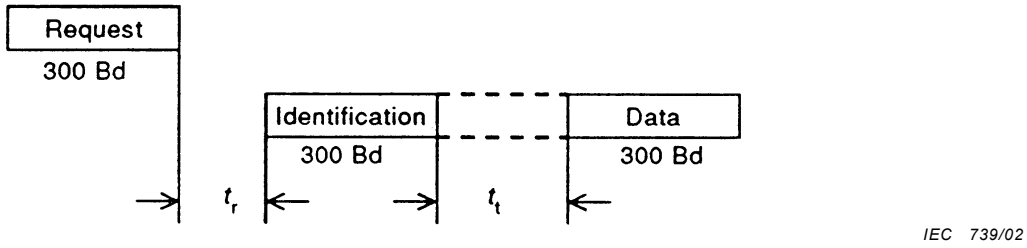


Figure 13 – Transmission protocol for protocol mode C giving data readout without acknowledgement from the HHU

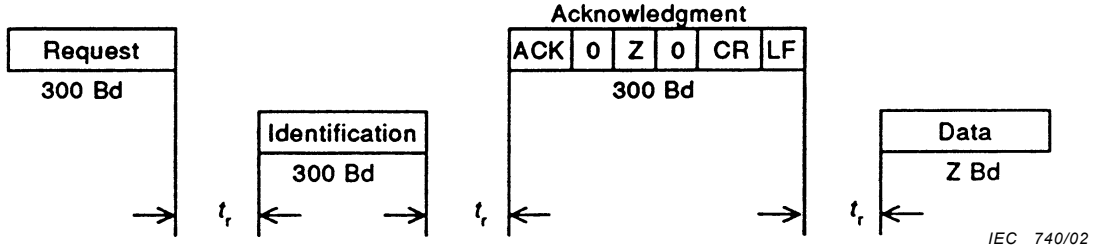


Figure 14 – Transmission protocol for protocol mode C giving data readout with confirmation of the suggested baud rate

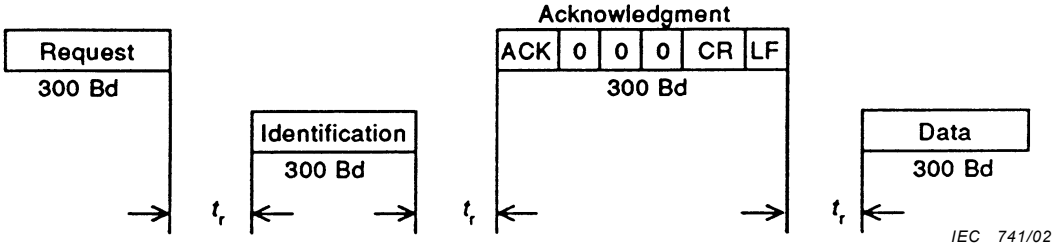


Figure 15 – Transmission protocol for protocol mode C giving data readout with rejection of the suggested baud rate

6.4.3.5 End of data readout transmission

The data transmission is complete after the data message has been transmitted by the tariff device. An acknowledge signal is not provided for. The HHU can transmit a repeat request if the transmission was faulty.

6.4.3.6 Reaction and monitoring times

The time between the reception of a message and the transmission of an answer is:

(20 ms) 200 ms ≤ t_r ≤ 1 500 ms (see item 12) of 6.3.14).

If a response has not been received, the waiting time of the transmitting equipment after transmission of the identification message, before it continues with the transmission, is:

1 500 ms < t_t ≤ 2 200 ms

The time between two characters in a character sequence is:

t_a < 1 500 ms

6.4.3.7 Programming mode

This mode is entered as prescribed. In order to permit access, certain security measures may have to be undertaken.

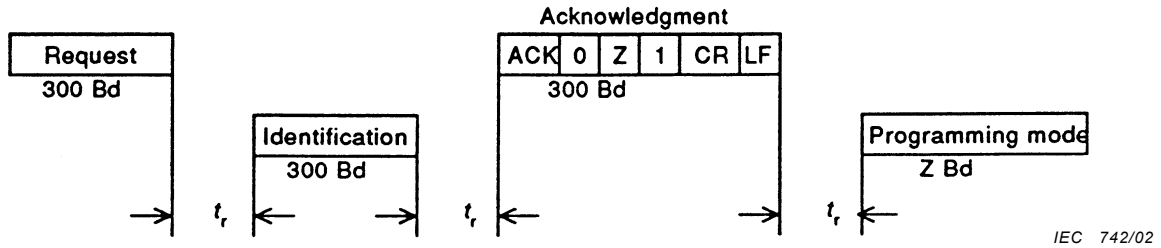


Figure 16 – Transmission protocol for protocol mode C. Switching to programming mode with acceptance of the suggested baud rate

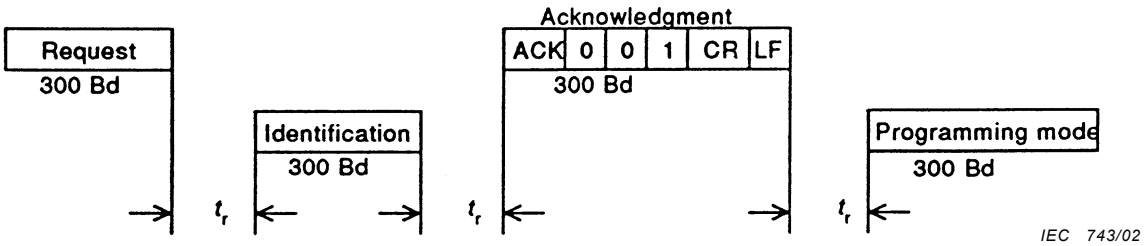


Figure 17 – Transmission protocol for protocol mode C. Switching to programming mode with rejection of the suggested baud rate

6.4.3.8 Levels of access - system security

See Annex D.

6.4.4 Protocol mode D

Protocol mode D supports unidirectional data exchange at a fixed baud rate of 2400 baud and permits data readout only.

6.4.4.1 Overview

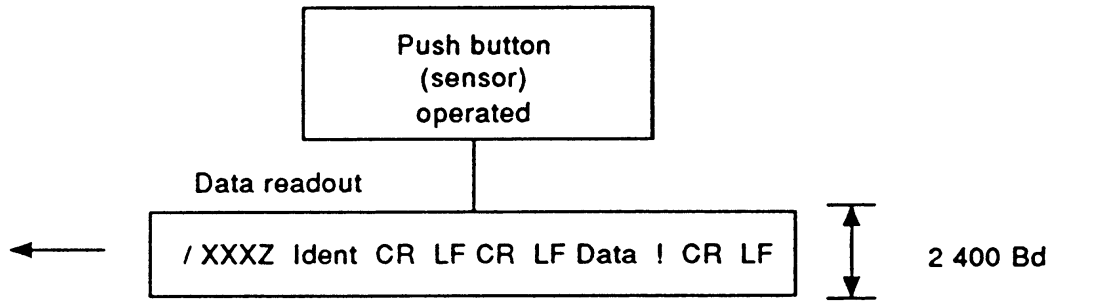


Figure 18 – Diagram protocol mode D

6.4.4.2 Data readout

The tariff device transmits the data message at 2 400 Bd immediately following the activation of a push button or other sensor on the tariff device.

/	X	X	X	3	Identification	CR	LF	CR	LF	Data	!	CR	LF

2 400 Bd

IEC 745/02

Figure 19 – Transmission protocol for protocol mode D

The time between two characters in a character sequence is:

t_a < 1 500 ms

6.4.4.3 End of transmission

The data transmission is complete after the data message has been transmitted by the tariff device. An acknowledgement signal is not provided for.

6.4.5 Protocol mode E (other protocols)

The identification message (server's response to the initial request message of a client) includes an identification field, which may be up to 16 characters long. Within this identification string, one or more escape sequences, consisting of an escape character "\" and one following identifying character (see 6.4.5.1), advise the client that enhanced capabilities are available. The protocol control characters define details to enter protocol modes C or E.

6.4.5.1 Usage of escape character "W" in protocol mode E (item 24 in 6.3.2)

Enhanced baud rate and mode identification character (optional field, defining protocol mode E)

0-1 - reserved for future applications.

2 - binary mode (HDLC), see Annex E.

3-9 - reserved for future applications.

Other printable characters with exception of /, \ and !: manufacturer-specific use.

6.4.5.2 Usage of protocol control character "V" in protocol mode C and E (item 10 in 6.3.3)

0 - normal protocol procedure.

1 - secondary protocol procedure.

2 - HDLC protocol procedure, see Annex E.

3-9 - reserved for future applications.

6.4.5.3 Usage of mode control character "Y" in protocol modes C and E (item 11 in 6.3.3)

0 - data readout.

1 - programming mode.

2 - binary mode (HDLC), see Annex E.

3-5 and A-Z - reserved for future applications.

6-9 - manufacturer-specific use.

6.4.6 Entering programming mode (unknown tariff device)

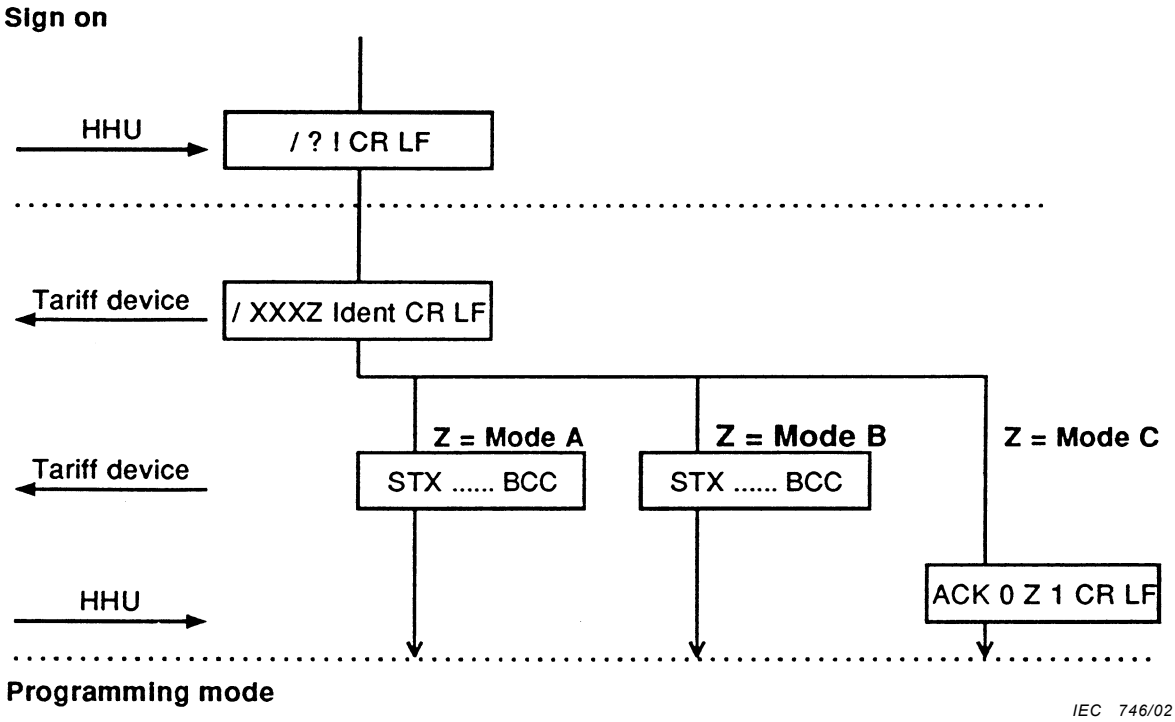


Figure 20 – Diagram for entering programming mode

NOTE 1 For full details, see relevant subclauses.

NOTE 2 The request message is sent without address as this is for an unknown tariff device.

NOTE 3 The value returned by the tariff device in the Z character of the identification message determines which protocol mode the tariff device operates in (see item 13) in 6.3.14).

NOTE 4 This method should not be used if more than one device is connected to the communication channel.

NOTE 5 Protocol mode E (for other protocols, see Annex E) may need to handle programming in its own context

6.4.7 Partial block communication (optional, only in protocol mode C)

Partial blocks are identified using the command type identifier issued from the HHU set to 3 or 4, corresponding to "unformatted" and "formatted" coding respectively; for example R3 means "partial block read, unformatted", and R4 means "partial block read, formatted". Partial block communication can be used for read and write commands.

All partial block data messages are tagged with the EOT character, except for the last partial block data message which is tagged with ETX to indicate to the receiving unit that the current message completes the partial block data transfer. The length of partial block data messages is not defined and can be variable.

When writing using partial block data messages, whether unformatted or formatted, the address field within the data set is sent only in the first command message. This indicates the start of a partial block transfer. The addresses for the subsequent command messages will not be sent, as the data within the command messages are considered to be one continuous block.

When using partial blocks, ACK is sent from the receiving unit to indicate that the last partial block data message was received correctly and the next partial block data message can be sent. NAK is sent from the receiving unit to indicate that the last partial block data message was not correctly received and should be repeated.

The master device (for example HHU) can decide to abort a partial block transfer by issuing a new command message. This can be used to discontinue the communication when the tariff device has difficulty receiving telegrams and continues to respond with NAKs or when the master device has difficulty receiving the data messages from the tariff device.

Table 2 – Read, Write and Execute commands

	Normal	With partial blocks
Unformatted	W1/R1	W3/R3
Formatted	E2/W2/R2	W4/R4

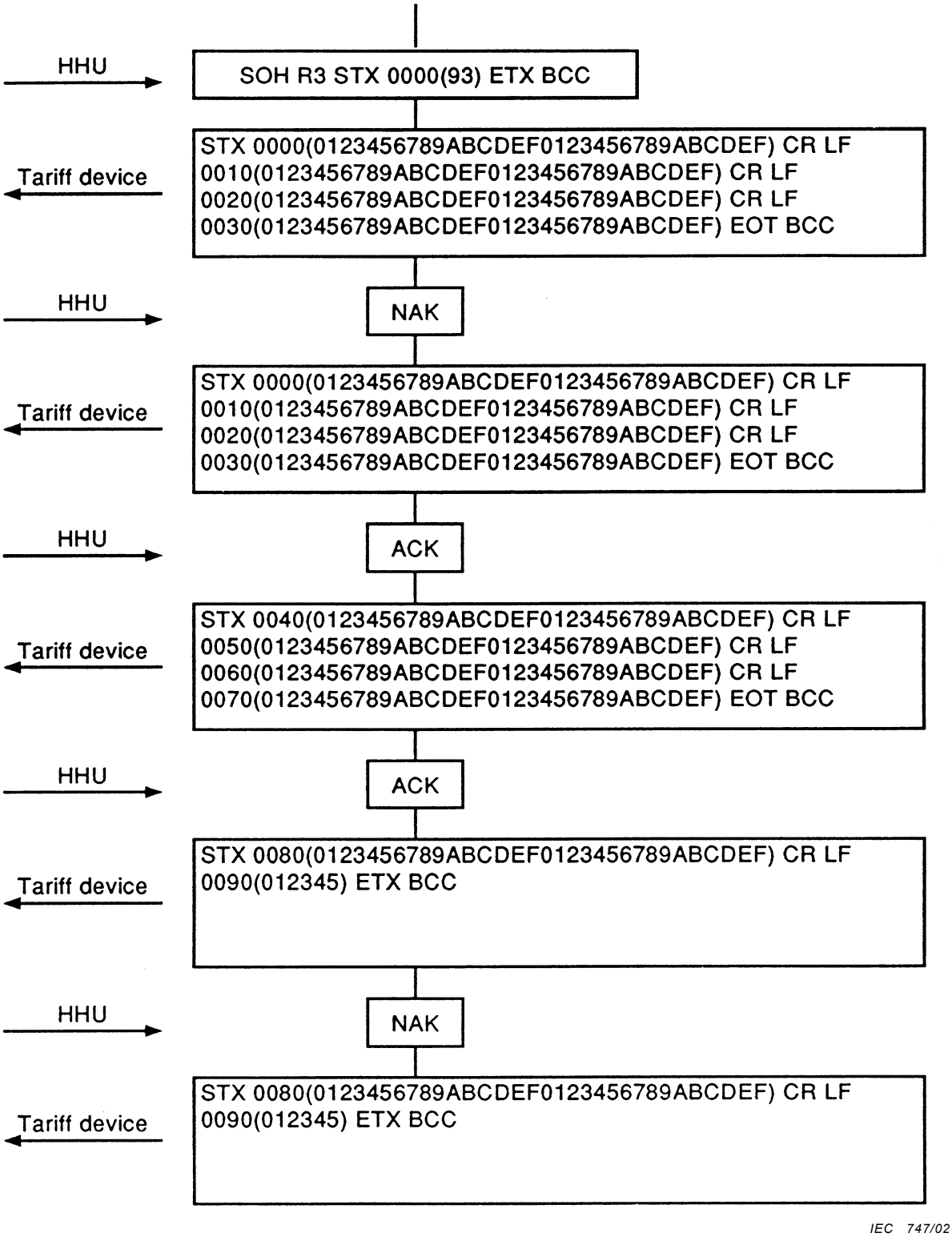


Figure 21 – Example of a partial block unformatted read

Example of a partial block unformatted read. In this case, the tariff device is creating partial block data messages with 48 bytes each (16 bytes per data line) except for the last data message. The first and last data messages had to be repeated.

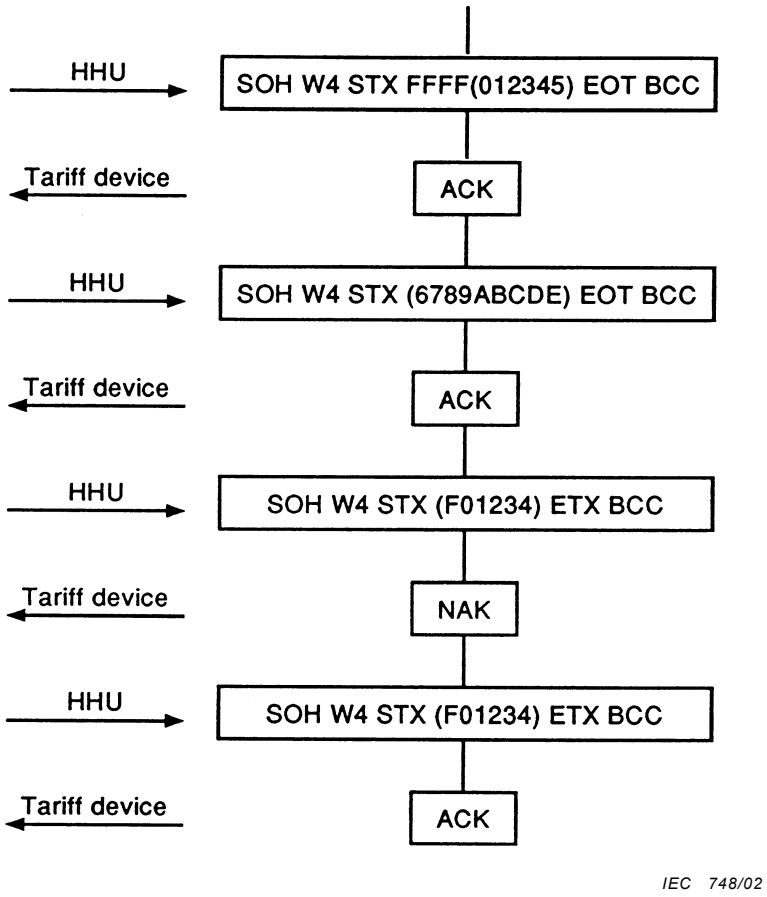


Figure 22 – Example of a partial block formatted write

Example of a partial block formatted write. In this case, the HHU is creating partial block data messages of variable length. The third data message had to be repeated. Note that the formatted code (in this example FFFF) is sent from the HHU only once. This is used to indicate the first block and is therefore not repeated in the subsequent blocks.

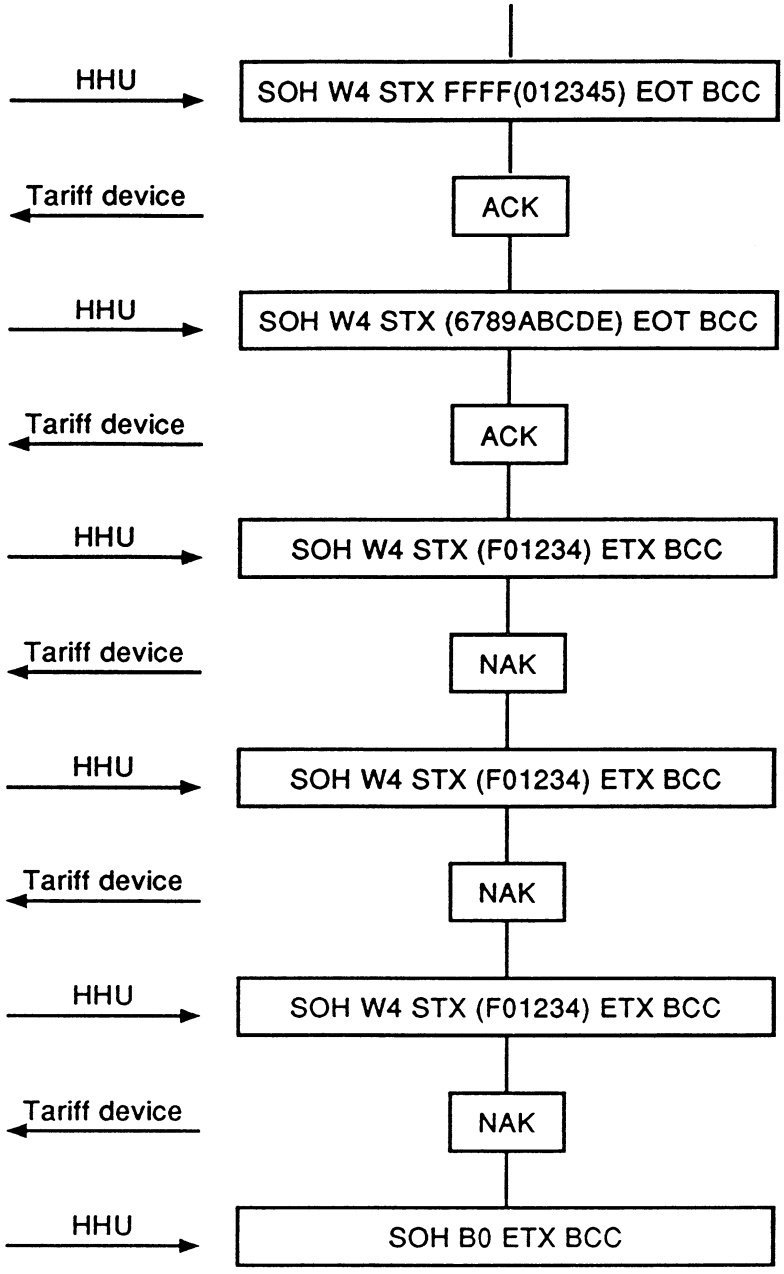


Figure 23 – Example of a partial block formatted write (with errors)

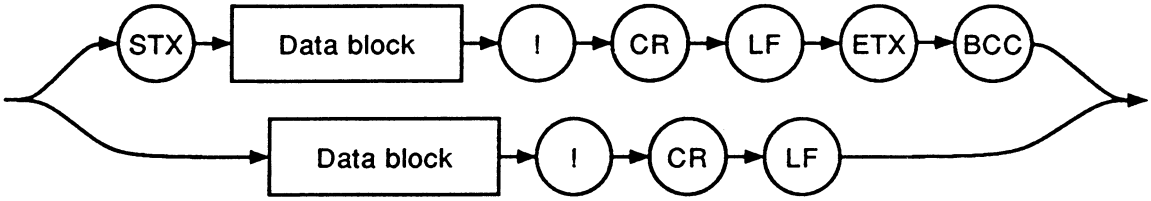
Example of a partial block formatted write with repeated communication errors. In this example, after three retries, the HHU decided to abort the communication.

6.5 Syntax diagrams

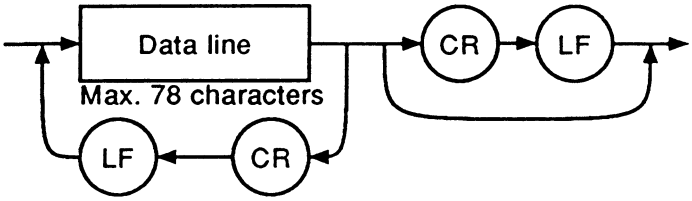
The following syntax diagrams provide help in order to interpret the definitions of the preceding subclauses relating to protocol modes A, B, C and D.

6.5.1 Readout mode

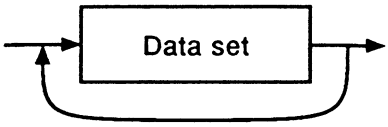
Data message:



Data block:



Data line:



Data set:

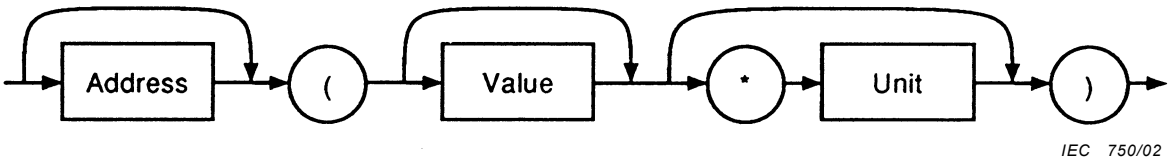


Figure 24 – Syntax diagrams – readout mode

A data block consists of a sequence of data lines separated by the characters CR, carriage return, code ASCII 0DH and LF, line feed, code 0AH. A data line consists of one or more data sets. A data set contains, in general, an identification number or address, the value, the unit and various boundary characters. A data line should be not longer than 78 characters* including all boundary, separating and control characters. The sequence of the data sets or data lines is not fixed.

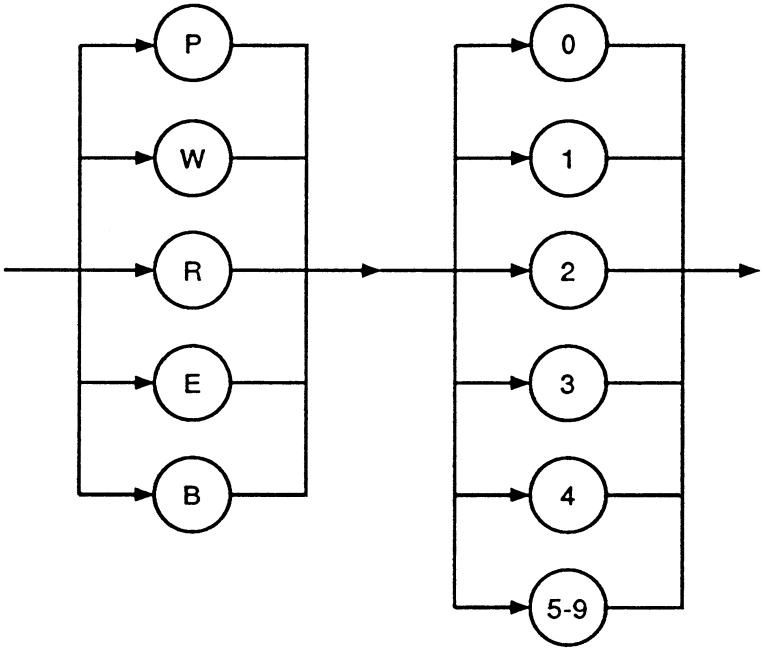
NOTE * For mode D, the data lines need not be separated by CR LF characters. In this case, security check information can be embedded as the last character(s) in the data block.

6.5.2 Programming mode

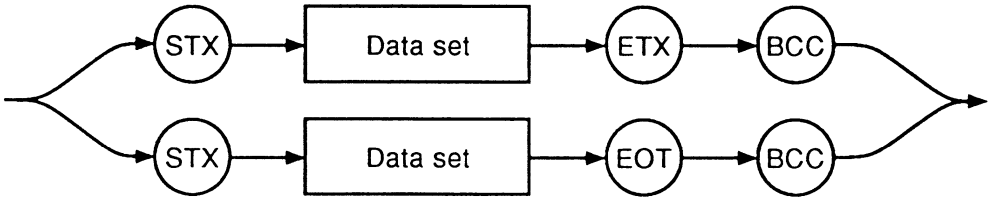
COMMAND

Command message:

Command identifier:



Data message:



Data set:

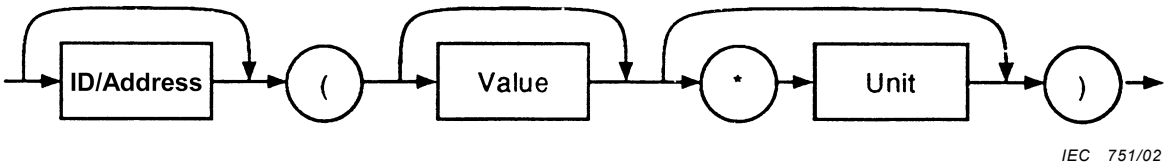
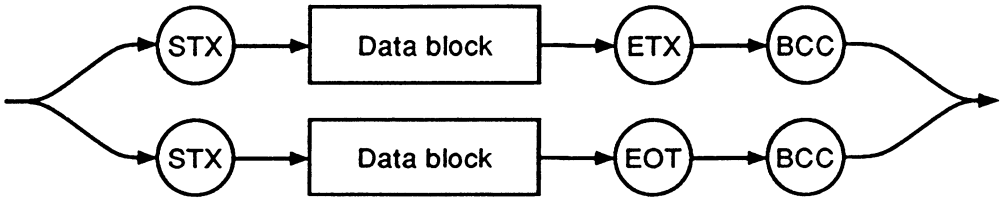


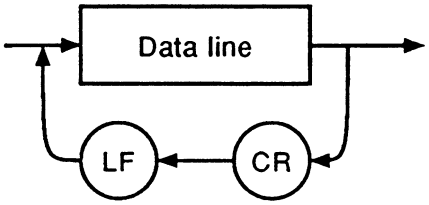
Figure 25 – Syntax diagrams – programming mode – command

ANSWER

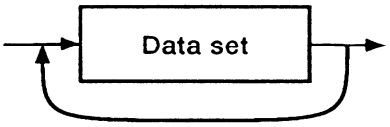
Data message:



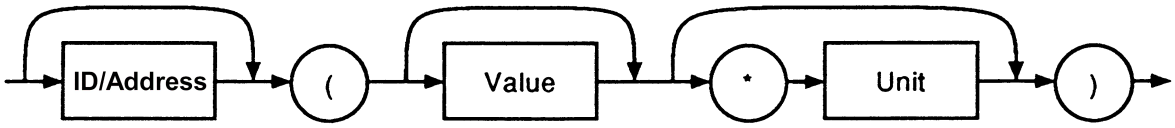
Data block:



Data line:



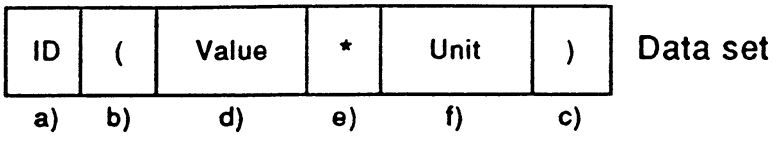
Data set:



IEC 752/02

Figure 26 – Syntax diagram – programming mode – answer

6.6 Data set structure



IEC 753/02

Figure 27 – Data set structure

a) Identification number or address: 16 printable characters maximum with the exception of (,), /, and !. The identification string is the code given to the value and is taken from the identification code in the glossary system of the equipment concerned.

b) Front boundary character of the data information (.

c) Rear boundary character of the data information).

d) Value: 32 printable characters maximum with the exception of (,), *, / and !. For decimal values, only points (not commas) shall be used and shall be counted as characters.

e) The separator character "*" between value and unit is not needed if there are no units.

f) Unit: 16 printable characters maximum except for (,), / and !.

NOTE 1 Remarks regarding items a), e) and f): to reduce the quantity of data, the identification code a) and/or the unit information e) and f) can be dispensed with, provided that an unambiguous correlation exists. For example, the identification code or the unit information is not necessary for a sequence of similar values (sequence of historical values) on condition that the evaluation unit can clearly establish the identification code and unit of the succeeding values from the first value of a sequence.

NOTE 2 Remarks regarding programming mode, protocol mode C: item a), the identification number may be used as an address; item d), the value portion may contain up to 128 characters.

Annex A
(normative)

Flow chart for direct local data exchange protocol, protocol mode C

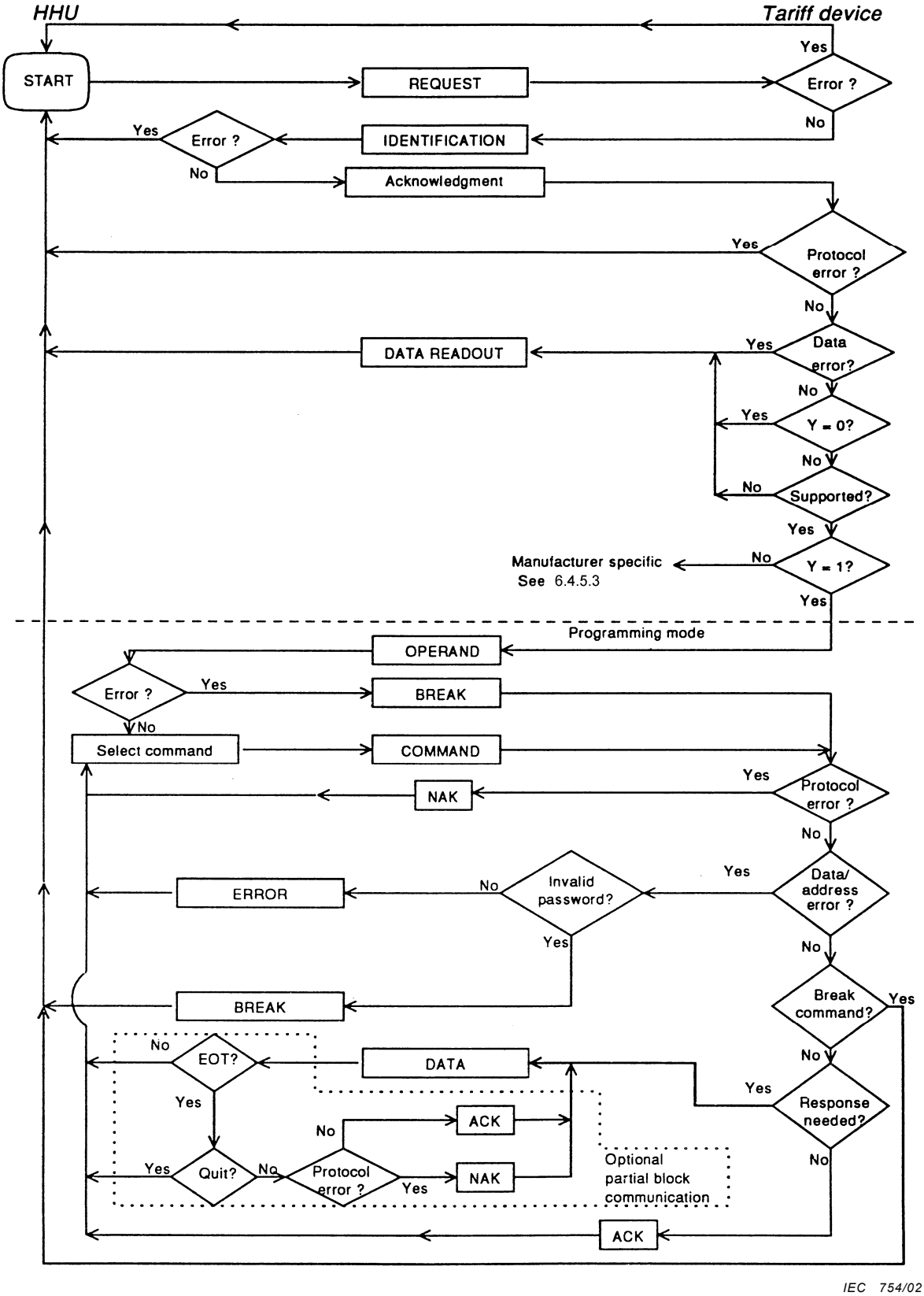


Figure A.1 – Flow chart for direct local data exchange protocol, protocol mode C

Key to protocol mode C flow diagram

Message formats

For a complete message format definition, see 6.3.

REQUEST	/ ? Device Address ! CR LF
IDENTIFICATION	/ XXX Z Ident CR LF
ACKNOWLEDGEMENT	ACK 0 Z Y CR LF
DATA READOUT	STX DATA ! CR LF ETX BCC
OPERAND	SOH P 0 STX (d . . . d) ETX BCC
	SOH P 0 STX (d . . . d) EOT BCC
COMMAND	SOH C D STX a . . a (d . . . d) ETX BCC
	optionally: SOH C D STX a . . a (d . . . d) EOT BCC
DATA	STX (d . . d) ETX BCC
	optionally: STX (d . . d) EOT BCC
ERROR	STX (e . . e) ETX BCC
BREAK	SOH B 0 ETX BCC

NOTE 1 The inactivity time-out period for the tariff device is 60 s to 120 s after which the operation moves from any point to the start.

NOTE 2 A break message can be issued at any point. Operation then moves to the start after finishing the current operation.

NOTE 3 ACK and NAK are used for error diagnosis at the command protocol level, with the following definition:

ACK is returned from a tariff device, if the command meets protocol requirements, and a successful operation is performed within the tariff device (e.g. memory write).

NAK is returned from a tariff device, if the command does not meet protocol requirements.

If the command meets protocol requirements but is not executed due to tariff device functionality (e.g. memory write protect, illegal command, etc.) an error message is returned.

ACK and NAK are also used as "continue" and "repeat last partial block" commands issued by the receiving device when in partial block mode (command type = 3 or 4).

NOTE 4 All other error diagnosis is done by time-out, i.e. if the tariff device does not respond within 1 500 ms of a command, there has been an error and the HHU should take appropriate action.

NOTE 5 A protocol error occurs when a parity, or the BCC, or the message syntax is incorrect.

NOTE 6 An address/data error occurs when the received address or command is unknown or the data set structure or content is incorrect. In this case, the command cannot be carried out.

NOTE 7 An error refers to any type of error (protocol, address/data, etc.).

NOTE 8 The diagram does not explicitly indicate the partial block write method. See 6.4.7 for further details.

Annex B
(normative)

Wake-up methods for battery-operated tariff devices

B.1 Provision for battery-operated tariff devices

In order to make the optical interface work with battery-operated tariff devices, it is necessary to send a preliminary wake-up message from the HHU to the tariff device.

The wake-up message is a string of NUL characters (code 00H) during 2,1 s to 2,3 s.

Between two NUL characters of this message a maximum delay time of 5 ms is allowed.

After the last character of the wake-up message, the HHU shall wait 1,5 s to 1,7 s until the request message can be sent.

Transmission speed for the start procedure is 300 Bd. Then the data communication can continue in mode A, B, C, or E.

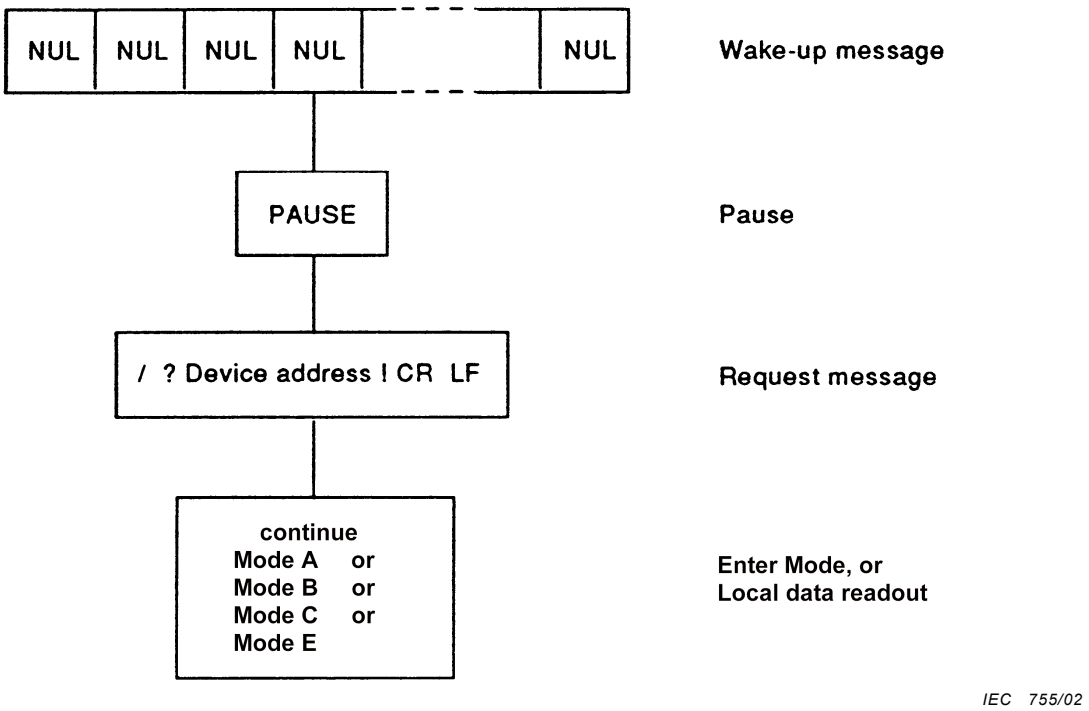


Figure B.1 – The start sequence for battery-operated devices

End of transmission

A data transmission is complete after the data message has been transmitted by the tariff device. An acknowledge signal is not provided for.

If the transmission was faulty the HHU shall wait at least 1,5 s until a repeat wake-up message can be sent.

B.2 Provision for battery-operated tariff devices fast wake-up method

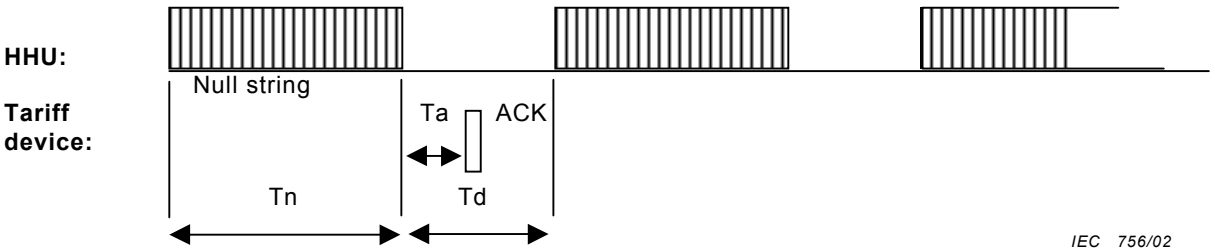
In order to make the optical interface work with battery-operated tariff devices, it is necessary to send a preliminary wake-up message from the HHU to the tariff device.

The fast wake-up message is a string of NUL characters (code 00H), an intermittent null string comprising 0,5 s of null characters, followed by a wait period of two characters + 20 ms. During a wait period, if the tariff device detects null activity and is ready to proceed with a sign-on protocol, the tariff device responds with an ACK character at the baudrate of the detected null string.

After transmission of the ACK character, the tariff device shall be ready to receive an ident request within 200 ms, at the baudrate of the detected null string. When the HHU receives an ACK character, it will terminate transmission of null strings and transmit an ident request message 200..1500 ms after the ACK receipt.

A recommended minimum time of 4,5 s is made for the HHU to transmit the intermittent null string wakeup.

The baudrate of the wake-up can be at any valid baudrate specified in 5.2. Then the data can continue in protocol mode A, B, C or E.



Parameter	Time
Tn min	500 ms
Tn max	600 ms
Td min	20 ms + two characters
Td max	Td min + 20 ms
Ta min	10 ms

Figure B.2 – Diagram for the start sequence of battery-operated devices by fast wake-up mode

End of transmission

The data transmission is complete after the data message has been transmitted by the tariff device. An acknowledge signal is provided for by the SOH B1 ETX BCC which requires the tariff device to transmit an ACK before the tariff device terminates the communication session. This provides feedback to the HHU that the tariff device has accepted and will execute the sign-off command.

If the transmission was faulty, the HHU shall wait at least 1,5 s until a repeat wake-up message can be sent.

Annex C
(informative)

Formatted codes

C.1 General

This annex defines a data protocol for accessing metering devices within the framework of this standard (protocol mode E is excluded). The protocol is designed to allow access to all information within a given metering device. The protocol can be viewed on two levels. The first level defines a data structure that can be applied to various metering applications. This requires the decomposition of data into items such as channels, data types, registers and tariffs. The second level defines the content of these categories, that is the unit of measurement recorded in register 0; whether it is kilowatt-hours or cubic meters of water. Eight different data categories have been defined in which to organise metering data. These are: Register, Seasonal, Load profile, Group, Variable, Parameter, Extended function and Manufacturer-specific. An additional category has been reserved for future applications.

Reading and writing are supported using the R2/R4 and W2/W4 commands in programming mode in the form of programming command messages. Additionally, execute commands, such as trigger a seasonal cumulation, are supported using the E2 programming command messages. All formatted commands have the syntax of command messages. In order to simplify processing within the metering unit, the coding method uses a four digit hex code, an associated mnemonic, and a data field. Within the command message, the code field corresponds to the data set "address field", and the data field corresponds to the data set "value field". The mnemonic is a general purpose one, in that it does not refer to any particular application, electrical metering, gas metering, etc. A set of mnemonics could be generated for a specific application for clarity as the need arises. The data field follows the syntax for data set structure. Some codes require a predefined data field format. These are listed explicitly. The last section defines how the coding scheme is applied to electricity metering applications. In the rest of this annex, reference will only be made to R2 and W2, although in most cases an R4 or W4 command could be used.

C.2 Channels

Channels play a specific part in coding. They are the link between the first and second levels of coding. This is accomplished by defining channel types, of which there can be a limitless number. A type is assigned to each channel used in a metering unit, be it water, gas, heat or electricity. This depends on the data being stored within that channel. When assigning channels within a metering unit, the designation may or may not refer to physical channels. In the case of a metering unit that registers the electrical energy, water and gas usage at a particular installation, the channel designation could logically be applied to each item resulting in three channels. But in a single electricity meter, where the device may measure various kinds of information, such as kWh, kW and kVA, the data may all be accessed as one logical channel, even though the information is delivered to the metering device on different physical channels. The channel type only plays a role in the following data categories: Register, Season, Load profile and Group. The other data categories, Extended function, Variable, Parameter, and Manufacturer-specific, do not require the channel to be specified, and are therefore not defined by the channel type, but are available independent of channel type. The following diagram is an example of the use of channel types.

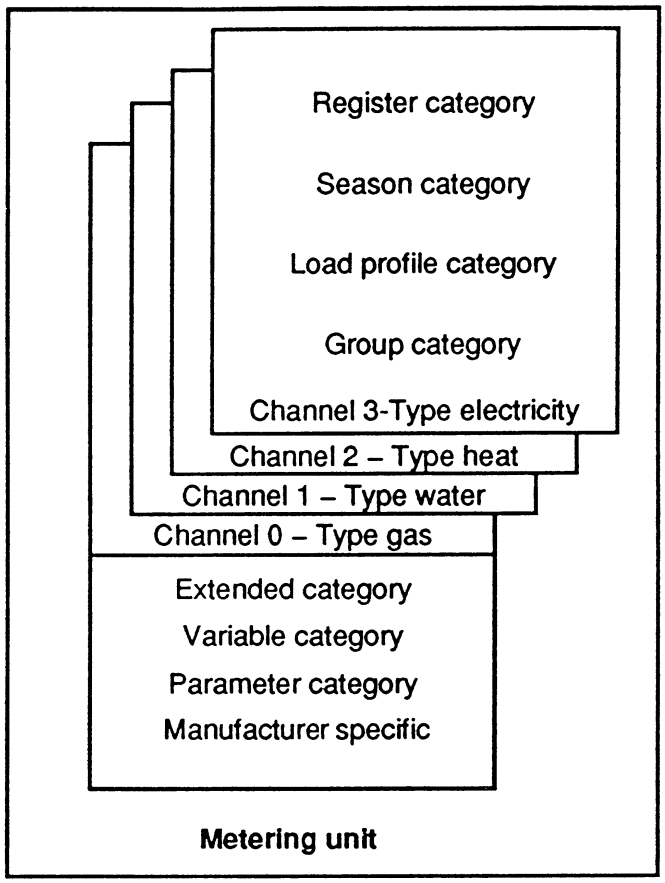


Figure C.1 – Example of channel types

Here, channels 0, 1, 2, and 3 are being used to collect information on gas, water, heat and electricity usage respectively. This does not mean that channel 3 is always electricity or that channel 1 is always water; the channel assignment is arbitrary. What is important is to know the channel type present on each channel.

Channel types allow for future expansion in the case where a new type of metering is desired, or when a particular type has no more free registers to define, and a new type of measurement is desired. This could occur when a new type of electrical measurement is desired, but all the registers for an available channel type have already been defined. It is also feasible that when a new channel type is defined, the whole register/tariff structure could also be redefined to better describe the application.

Instead of trying to include the channel type information in the identification message, a set of commands is supported in the parameter category that allows the user to question the meter as to which type is to be found on which channel.

C.3 Formatted reading and writing (commands R2, R4, W2, and W4)

For the R2 and W2 commands, the various codes can normally be used for formatted reading or writing. When used for reading, the data field in the read command shall be left blank except where noted. In this case, the parentheses, (), shall remain to retain protocol integrity. Returned information is in the form of data messages. Although preferred, the metering device is not required to send decimal point or unit information within the returned data set. If the information is not included in the returned data set, then provision shall be made so that this information can be accessed using other device independent commands.

Time/date stamps are considered an integral part of a single data record and are included when accessing data records that have associated with them such information. They have the form (YY-MM-DD) or (YY-MM-DD hh:mm). In this case, the time and date stamp will be included as a new data set within the same data line as follows:

STX 0401 (0000.00*kW)(93-12-31 12:53) ETX BCC

When writing data, only available in the Register, Variable, and Parameter categories, the form of the data shall be compatible with the data set structure. When information is not explicitly sent by the programming device, the receiving unit may assume certain items, like units or decimal points or leading zeros. Writing the value 0 to a particular data record is the same as erasing or resetting the record. The preferred method in this case is to send a write command with an empty data field () which is defined as resetting the addressed information. Because programming historical data is not considered a desired feature, write commands used in the Season, Group or Load profile data categories are defined as erase commands.

C.4 Coding capabilities

The coding scheme allows up to eight CHANNELS of data (each can have a different channel type), 64 REGISTERS per channel, each with four DATA TYPES and 16 TARIFFS per type. See clause C.2 for expansion capabilities. Throughout the rest of this annex, words in CAPITALS will have specific meanings as defined in the various subclauses.

The eight major data categories are shown below with the associated code areas. Within each data category, further division is used when possible to create a smart code and to make the creation of new codes possible.

Code	*Data category*
0xxx	Register
:	
7xxx	
8xxx	Season
9xxx	Load profile
Axxx	Group
Bxxx	Extended function
Cxxx	Variable
Dxxx	Parameter
Exxx	RESERVED
Fxxx	Manufacturer-specific

C.4.1 Register data category

C.4.1.1 Register coding

The REGISTER data category provides read and write access to all measurement data records excluding seasonal (memory or stored value) and load profile data.

Code (binary)				
0ccc	xxxx	xxxx	xxxx	ccc = CHANNEL (000 = channel 0)
0xxx	ddxx	xxxx	xxxx	dd = DATA TYPE
				00 = 0
				01 = 1
				10 = 2
				11 = 3
0xxx	xx r r	r r r r	xxxx	r r r r r = REGISTER
				00 0000 = Register 0
				00 0001 = Register 1
				00 0010 = Register 2
				00 0011 = Register 3
				00 0100 = Register 4
				00 0101 = Register 5
				00 0110 = Register 6
				00 0111 = Register 7
				00 1000 = Register 8
				:
				11 1111 = Register 63
0xxx	xxxx	xxxx	t t t t	t t t t = TARIFF

There are 64 REGISTERS reserved for each CHANNEL. Using the DATA TYPE field, each REGISTER can be interpreted in up to four different ways. The validity of a particular DATA TYPE depends on the information being measured. Note that the DATA TYPE does not appear in the command mnemonic when it is 0. When reading from the REGISTER category, the predefined code that was transmitted to the metering unit is returned from the metering unit as the ID field of the returned data set. This is most important when groups of registers are read in the group category in order to distinguish between the individual registers. When writing registers, an ACK is returned only if the message has been accepted and processed successfully, otherwise an error message will be returned.

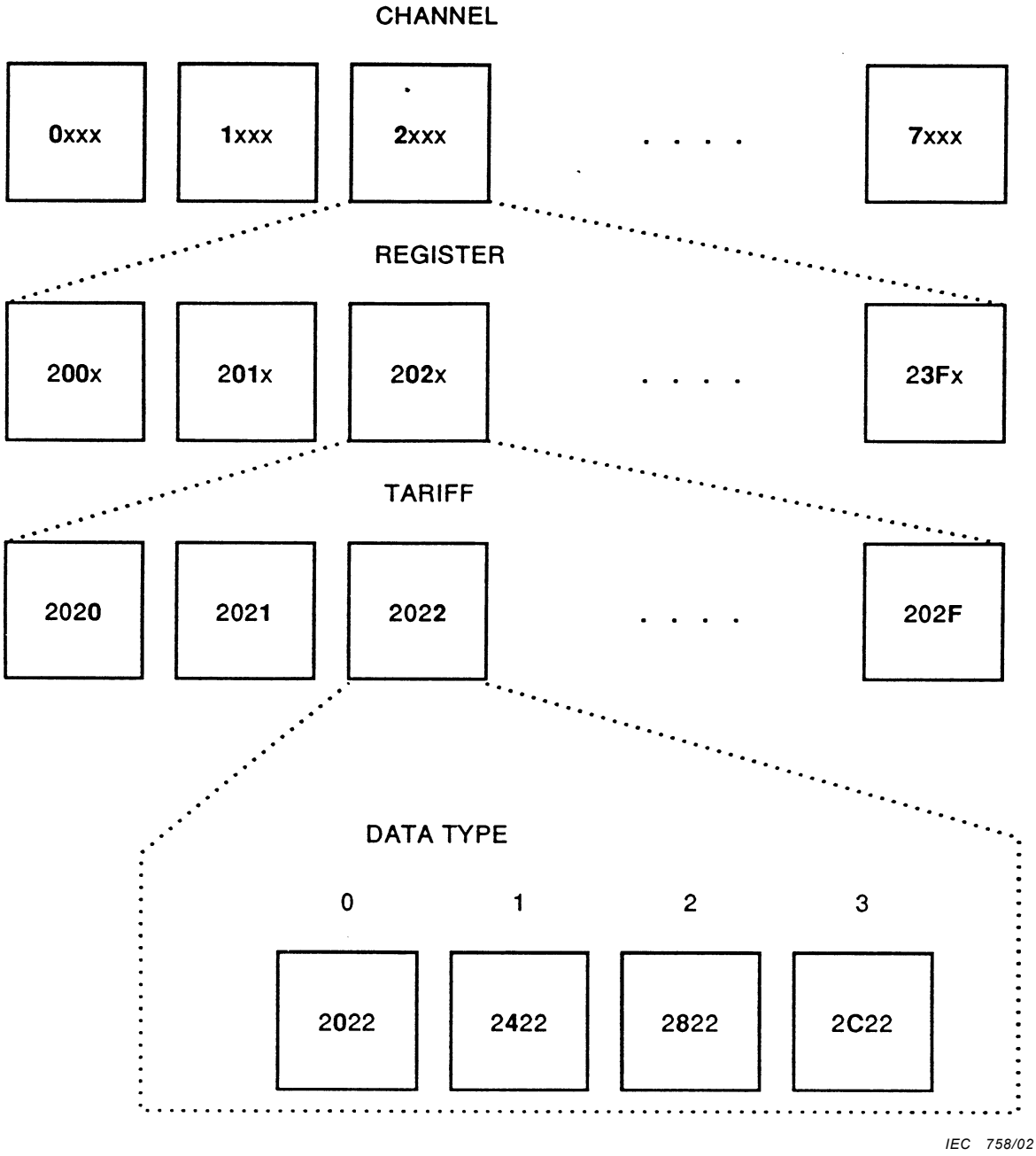


Figure C.2 – Register coding diagram

C.4.1.2 Register examples

Code	*Mnemonic*	*Data*	*Function and data form*
0000	c0_r0_t0	-	Channel 0 Type 0 Register 0 Tariff 0
0001	c0_r0_t1	-	Channel 0 Type 0 Register 0 Tariff 1
0002	c0_r0_t2	-	Channel 0 Type 0 Register 0 Tariff 2
0003	c0_r0_t3	-	Channel 0 Type 0 Register 0 Tariff 3
0004	c0_r0_t4	-	Channel 0 Type 0 Register 0 Tariff 4
0021	c0_r2_t1	-	Channel 0 Type 0 Register 2 Tariff 1
0022	c0_r2_t2	-	Channel 0 Type 0 Register 2 Tariff 2
0023	c0_r2_t3	-	Channel 0 Type 0 Register 2 Tariff 3

0024	c0_r2_t4	-	Channel 0 Type 0 Register 2 Tariff 4
0010	c0_r1_t0	-	Channel 0 Type 0 Register 1 Tariff 0
0410	c0_t1_r1_t0	-	Channel 0 Type 1 Register 1 Tariff 0
0810	c0_t2_r1_t0	-	Channel 0 Type 2 Register 1 Tariff 0
0012	c0_r1_t2	-	Channel 0 Type 0 Register 1 Tariff 2
0013	c0_r1_t3	-	Channel 0 Type 0 Register 1 Tariff 3
0014	c0_r1_t4	-	Channel 0 Type 0 Register 1 Tariff 4
0080	c0_r8_t0	-	Channel 0 Type 0 Register 8 Tariff 0
0081	c0_r8_t1	-	Channel 0 Type 0 Register 8 Tariff 1
0082	c0_r8_t2	-	Channel 0 Type 0 Register 8 Tariff 2
0083	c0_r8_t3	-	Channel 0 Type 0 Register 8 Tariff 3
0084	c0_r8_t4	-	Channel 0 Type 0 Register 8 Tariff 4
1xxx	-	-	Channel 1
2xxx	-	-	Channel 2
3xxx	-	-	Channel 3
4xxx	-	-	Channel 4
5xxx	-	-	Channel 5
6xxx	-	-	Channel 6
7xxx	-	-	Channel 7

C.4.2 Season data category

C.4.2.1 Season coding

The Season data category allows read access to the seasonal data (memory or stored value) using the R2 command, and erase access using the W2 command. The same fields are used as in the Register data category, but they are shifted one hex digit to the right, causing the tariff number to be defined in the data field. Additionally, the data field is used to specify which season location(s) is(are) to be addressed and the access type. The youngest, or most recently stored, season location is assigned a season number of 0. Using this coding scheme, every season location is individually addressable, or groups of registers may be accessed. In the Season data category, the ID field returned from the metering unit consists of the code and data field that was used in the read command. This results in an eight digit ID field. In order to conserve time and storage in a reading device, the code portion of the ID field does not need to be repeated if it has not changed since the last time it was sent. This means that when reading single seasonal records, the returned ID will always contain eight digits but when reading multiple seasonal records, only the first season record within a block of records shall contain the code field as long as the code applies to all other records within the block.

Refer to the examples in C.4.2.2. When writing (erasing) registers, an ACK will be returned only if the message has been accepted and processed successfully, otherwise an error message will be returned. The following code and data descriptions define this scheme.

Code (binary)				
1000	xccc	xxxx	xxxx	ccc = CHANNEL
1000	xxxx	ddxx	xxxx	dd = DATA TYPE
				00 = 0
				01 = 1
				10 = 2
				11 = 3

1000	xxxx	xxr r	r r r r	r r r r r r = REGISTER
				00 0000 = Register 0
				00 0001 = Register 1
				00 0010 = Register 2
				:
				11 1111 = Register 63

Data field (binary)

t t t t	xxxx	xxxx	xxxx	t t t t = TARIFF
xxxx	ssss	ssss	xxxx	ssss ssss = SEASON number
				00h - FFh
xxxx	xxxx	xxxx	aaaa	aaaa = ACCESS
				0000 = Single Record
				0001 = All Seasons
				0010 = All Tariffs (and all Seasons)
				0011 = All Registers (Tariffs & Seasons)
				0100 = All Types (Register, Tariffs, Seasons)
				0101 = All Channels (Types, Reg., Tar., Seasons)
				0110 = RESERVED
				:
				1111 = RESERVED

The ACCESS codes have the following definitions:

- single record – only the specified SEASON will be accessed;
- all SEASONS – all SEASONS under the specified record will be accessed regardless of the SEASON number used in the command;
- all TARIFFS – all TARIFFS and all SEASONS of the specified CHANNEL, REGISTER and DATA TYPE will be accessed;
- all REGISTERS – all season locations of the specified CHANNEL and DATA TYPE will be accessed;
- all DATA TYPES – all season locations of the specified CHANNEL will be accessed;
- all CHANNELS – all season locations will be accessed.

C.4.2.2 Season read examples (R2)

Code	*Mnemonic*	*Data*	*Function and data form*
8000	c0_r0_t1_m00	1000	Channel 0 Type 0 Register 0 Tariff 1 Season 0
	Returned ID:	*80001000*	*(Channel 0 Type 0 Reg. 0 Tariff 1 Season 0)*
8000	c0_r0_t1_m01	1010	Channel 0 Type 0 Register 0 Tariff 1 Season 1
	Returned ID:	*80001010*	*(Channel 0 Type 0 Reg. 0 Tariff 1 Season 1)*
8040	c0_t1_r0_t1_m01	1010	Channel 0 Type 1 Register 0 Tar. 1 Season 1
	Returned ID:	*80401010*	*(Channel 0 Type 1 Register 0 Tar. 1 Season 1)*
8080	c0_t2_r0_t1_m01	1010	Channel 0 Type 2 Register 0 Tar. 1 Season 1
	Returned ID:	*80801010*	*(Channel 0 Type 2 Register 0 Tar. 1 Season 1)*
8000	c0_r0_t1_mff	1FF0	Channel 0 Type 0 Reg. 0 Tar. 1 Season 255
	Returned ID:	*80001FF0*	*(Channel 0 Type 0 Reg. 0 Tar. 1 Seas. 255)*

8002	c0_r2_t1_m*	1001	Channel 0 Type 0 Reg. 2 Tar. 1 All Seasons
	Returned IDs	*80021001*	*(Channel 0 Type 0 Reg. 2 Tariff 1 Season 0)*
	if present:	1011	(Channel 0 Type 0 Reg. 2 Tariff 1 Season 1)
		1021	(Channel 0 Type 0 Reg. 2 Tariff 1 Season 2)
		1031	(Channel 0 Type 0 Reg. 2 Tariff 1 Season 3)
		1041	(Channel 0 Type 0 Reg. 2 Tariff 1 Season 4)
		:	
		1FF1	(Channel 0 Type 0 Reg. 2 Tar. 1 Seas. 255)

Note that only the first record contains the code field from the read command.

8000	c0_r*	1003	Channel 0 All Registers
	Returned IDs	*80000003*	*(Channel 0 Type 0 Reg. 0 Tariff 0 Season 0)*
	if present:	*0013*	*(Channel 0 Type 0 Reg. 0 Tariff 0 Season 1)*
	:		
	0FF3		*(Channel 0 Type 0 Reg. 0 Tar. 0 Seas. 255)*
	1003		*(Channel 0 Type 0 Reg. 0 Tariff 1 Season 0)*
	:		
	1FF3		*(Channel 0 Type 0 Reg. 0 Tar. 1 Seas. 255)*
	: :		
	F003		*(Channel 0 Type 0 Reg. 0 Tar. 15 Seas. 0)*
	:		
	FFF3		*(Channel 0 Type 0 Reg. 0 Tar. 15 Seas. 255)*
	80010003		*(Channel 0 Type 0 Reg. 1 Tariff 0 Season 0)*
	0013		*(Channel 0 Type 0 Reg. 1 Tariff 0 Season 1)*
	:		
	0FF3		*(Channel 0 Type 0 Reg. 1 Tar. 0 Seas. 255)*
	80011003		*(Channel 0 Type 0 Reg. 1 Tariff 1 Season 0)*
	1013		*(Channel 0 Type 0 Reg. 1 Tariff 1 Season 1)*
	:		
	1FF3		*(Ch. 0 Type 0 Register 1 Tariff 1 Season 255)*
	: :		
	F003		*(Ch. 0 Type 0 Register 1 Tariff 15 Season 0)*
	:		
	FFF3		*(Ch. 0 Type 0 Reg. 1 Tariff 15 Season 255)*
	80020003		*(Ch. 0 Type 0 Register 2 Tariff 0 Season 0)*
	: : :		
	80030003		*(Ch. 0 Type 0 Register 3 Tariff 0 Season 0)*
	: : :		
	803F0003		*(Ch. 0 Type 0 Register 63 Tariff 0 Season 0)*
	0013		(Ch. 0 Type 0 Register 63 Tariff 0 Season 1)
	:		
	0FF3		(Ch. 0 Type 0 Reg. 63 Tariff 0 Season 255)
	: :		
	F003		(Ch. 0 Type 0 Register 63 Tariff 15 Season 0)
	:		
	FFF3		(Ch. 0 Type 0 Register 63 Tar. 15 Season 255)

Note that, in this example, each unique code (8000, 8001, ... , 803F) appears only once and at the beginning of the block of associated records. It may also be repeated.

8001	c0_r1_t2_m00	2000	Channel 0 Type 0 Register 1 Tariff 2 Season 0
8001	c0_r1_t3_m00	3000	Channel 0 Type 0 Register 1 Tariff 3 Season 0
8001	c0_r1_t4_m00	4000	Channel 0 Type 0 Register 1 Tariff 4 Season 0
81xx	-	-	Channel 1
82xx	-	-	Channel 2
83xx	-	-	Channel 3
84xx	-	-	Channel 4
85xx	-	-	Channel 5
86xx	-	-	Channel 6
87xx	-	-	Channel 7

C.4.2.3 Season erase examples (W2)

Code	*Mnemonic*	*Data*	*Function and data form*
8000	er_c0_r0_t1_m00	1000	Channel 0 Type 0 Register 0 Tar. 1 Season 0
8000	er_c0_r0_t1_m01	1010	Channel 0 Type 0 Register 0 Tar. 1 Season 1
8040	er_c0_t1_r0_t1_m01	1010	Channel 0 Type 1 Register 0 Tar. 1 Season 1
8000	er_c0_r0_t1_mff	1FF0	Channel 0 Type 0 Register 0 Tar. 1 Season 255
81xx	-	-	Channel 1
82xx	-	-	Channel 2
83xx	-	-	Channel 3
84xx	-	-	Channel 4
85xx	-	-	Channel 5
86xx	-	-	Channel 6
87xx	-	-	Channel 7
8000	er_c0_r0_t1_m*	1001	Ch. 0 Type 0 Register 0 Tariff 1 All Seasons
8000	er_c0_r0_t*	0002	Channel 0 Type 0 Register 2 All Tariffs
8000	er_c0_r*	0003	Channel 0 Type 0 All Registers
8000	er_c0_*	0004	Channel 0 All Data Types
8000	er_c*	0005	All Channels

C.4.3 Load profile data category

C.4.3.1 Load profile coding

The Load profile data category allows read access to the load profile records using the R2 command and erasure of records using the W2 command. This category reserves load profile capabilities for each of the 64 available REGISTERS. The code field is used to specify the CHANNEL and REGISTER number. The data field is used to specify the actual records requested. This is in the form of start and end dates. When addressing load profile data, a distinction is made between data records and status records. Generally, a status record is any record that does not have the same units as the register being accessed. This includes time/date records and status flag records. Using the LOAD PROFILE Access field, the user can distinguish between these records. In addition, the user can indicate that all REGISTERS be accessed regardless of the one defined in the command. The code field is defined below.

Code (binary)				
1001	xccc	xxxx	xxxx	ccc = CHANNEL
1001	xxxx	l lxx	xxxx	l l = LOAD PROFILE Access
				00 = Data + Status records for specified register only
				01 = Data + Status records for all registers
				10 = Data records for all registers
				11 = Status records for all registers
1001	xxxx	xxr r	r r r r	r r r r r r = REGISTER
				00 0000 = Register 0
				00 0001 = Register 1
				00 0010 = Register 2
				00 0011 = Register 3
				:
				11 1111 = Register 63

When specifying dates to be addressed, the data field is formatted as follows:

(YYMMDDyymmdd)

where YYMMDD refers to the start date and yymmdd refers to the end date of the period to be read. When the two dates are the same, or only the start date is defined, a single day is selected. The end date must be later than the start date. A day is defined as all records stored within the period 00:00:01 to 24:00:00 of any given day. When no date is specified, the complete load profile array is addressed. This applies to reading and erasing. The load profile data is transmitted chronologically with the oldest record first and the most recent record last.

In order to ensure that the returned load profile records are uniquely identifiable and understandable, the tariff unit shall indicate to which REGISTER the data records refer. For example, a unit with load profile records available for REGISTER 0 and REGISTER 4, in response to a read command requesting all REGISTERS (i.e. 9040), the unit shall indicate which records in the returned data refer to REGISTER 0 and which to REGISTER 4. In addition, if records are read without timing information, or the provided information does not allow a chronological reconstruction of the load profile records, the unit shall include data messages which allow such chronological reconstruction. These data messages have the form (YY-MM-DD hh:mm).

These requirements also apply to reading load profile data with an execute command.

C.4.3.2 Load profile examples

Code	*Mnemonic*	*Data*	*Function and data form*
9000	c0_r0	911201911201	Channel 0 Register 0 Day 91-12-1
9000	c0_r0	911201911231	Ch. 0 Register 0 Day 91-12-1 to 91-12-31
9000	c0_r0	911202	Channel 0 Register 0 Day 91-12-2
91xx	-	-	Channel 1
92xx	-	-	Channel 2
93xx	-	-	Channel 3
94xx	-	-	Channel 4
95xx	-	-	Channel 5
96xx	-	-	Channel 6
97xx	-	-	Channel 7
9040	c0_r*	930101930131	Channel 0 All Reg. Day 93-01-01 to 93-01-31
Returned Registers		Channel 0 Register 0	
if present:		Channel 0 Register 1	
		Channel 0 Register 2	
		:	
		Channel 0 Register 63	

C.4.4 Group data category

C.4.4.1 Group coding

In contrast to the Register data category, the Group data category allows access to ranges of Register records instead of individual records. Reading, using R2, and erasing, using W2, of a group of records is supported. The user can specify wild cards to indicate which ranges of data records to operate on. The coding is as follows:

Code	*(binary)*			
1010	bbbb	xxxx	xxxx	bbbb = GROUP Access type 0000 = Register Wild card mask 0001 = RESERVED : 1111 = RESERVED
1010	0000	qqqq	xxxx	qqqq = WILD CARD Indicators

Group Commands are interpreted as follows. The requested records are specified using the data field. This field is simply the code field as defined in the Register category. That is, the data field always defines a single specific data record within the metering unit. The coding used has defined fields, for example CHANNEL. Each of these fields can be designated as fixed or wild. This is accomplished using the q parameters in the Group code. Beginning from left to right, each parameter is assigned a bit q in the WILD CARD field. These bits are assigned as follows:

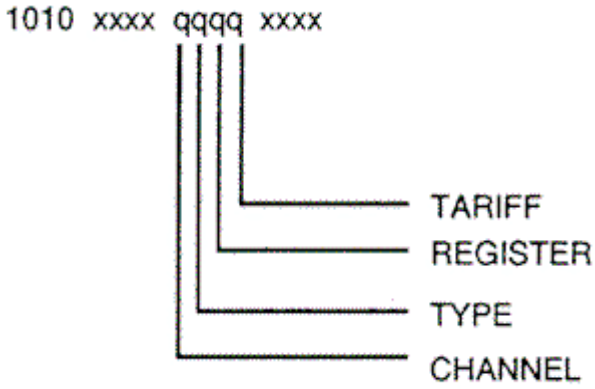


Figure C.3 – Bit assignment for group data

A one in the corresponding bit position indicates that a field takes on all possible values. A zero indicates that the field is fixed. In this way, wild cards can be assigned so that all CHANNEL 1 registers are read, or all REGISTER 1 records on a particular channel will be erased, and so on.

C.4.4.2 Group read examples (R2)

Code	Mnemonic	Data	Function and data form
A000	gr_c0_r0_t0	0000	Group read Channel 0 Type 0 Reg. 0 Tariff 0

NOTE This is the same as simply reading the Ch. 0 Type 0 Register 0 Tariff 0 in the Register category (Code = 0000).

A080	gr_c*_r0_t0	0000	Group read Ch. * Type 0 Register 0 Tariff 0

This command reads from all eight CHANNELS all records with REGISTER 0, TYPE 0 and TARIFF 0. In this case, the command data field could be 0000, 1000, 2000 ... 6000 or 7000 and the command still has the same meaning. Since the channel field is considered a wild card, varying it has no meaning.

A040	gr_*_c0_t0	0000	Group read Channel 0 All Types Register 0 Tariff 0

This command reads from CHANNEL 0 all DATA TYPES from REGISTER 0 and TARIFF 0.

A020	gr_c0_r*_t0	0000	Group Read Ch. 0 Type 0 Register * Tariff 0

This command reads from CHANNEL 0 all REGISTERs with TYPE 0 and TARIFF 0.

A010	gr_c0_r0_t*	0000	Group Read Ch. 0 Type 0 Register 0 All Tariffs

This command reads all records from CHANNEL 0, TYPE 0, REGISTER 0, regardless of TARIFF.

C.4.4.3 Group erase examples (W2)

Code	Mnemonic	Data	Function and data form
A010	ge_c0_r0_t*	0000	Group Erase Ch. 0 Type 0 Register 0 Tariff *

This command erases from CHANNEL 0, TYPE 0, REGISTER 0, all TARIFFs.

A0FF	ge_*	0000	Group erase all wild

This command erases all data records in the Register category.

C.4.5 Extended function

The extended function category reserves 4k worth of pages for further expansion.

C.4.6 Variable data category

C.4.6.1 Variable coding

Variable data includes values or parameters that are dynamic in nature and represent a state within a metering unit. This includes such items as time, date and days since last cumulation. Data format in this group is explicit and shall be followed. Some data fields can contain variable length data. These are indicated by a trailing + sign. If the data length received by a metering unit is not what is expected, the unit can decide what course of action to pursue, i.e. truncation, ignoring, error message, etc. In this group, the coding is not as smart as in previous categories.

Code (binary)				
1100	t t t t	xxxx	xxxx	t t t t = Variable TYPE 0000 = Time and Date Related Items 0001 = Data Related Items 0010 = RESERVED : 1111 = RESERVED
1100	xxxx	vvvv	vvvv	vvvv vvvv = VARIABLE Identifier

C.4.6.2 Variable data examples

Code	*Mnemonic*	*Data*	*Function and data form*
C000	time_date	yymmddhhmmss	Time and Date (decimal)
C001	time_date_cal	yymmddhhmmsswwn	Time, Date, Week and Day (decimal) ww = week number (1 - 53) n = day of week (1 = Monday)
C002	day_season	ddddss	Day Counter and Season Number dddd = day counter in days ss = season number
C003	time_date_cals	yymmddhhmmsswwnz	Time, Date, Week, Day and Summer as C001 with z = summer time flag (1 = active)
C004	day_count	d+ or d+.d	Day Counter (decimal) i.e. ddd or ddd.d
C006	last_com_date	yy-mm-dd hh:mm	Last Programming Mode Communication Date & Time Stamp (Time is optional)
C100	c0_cum_counter	n+	Ch. 0 Cumulation Counter (decimal)
C107	c7_cum_counter	n+	Ch. 7 Cumulation Counter (decimal)
C110	c0_fail_count	n+	Ch. 0 Power Fail Counter (decimal)
C111	c1_fail_count	n+	Ch. 1 Power Fail Counter (decimal)

C117	c7_fail_count	n+	Ch. 7 Power Fail Counter (decimal)
C120	c0_over_count	n+	Ch. 0 Overvoltage Counter (decimal)
C127	c7_over_count	n+	Ch. 7 Overvoltage Counter (decimal)
C130	c0_under_count	n+	Ch. 0 Undervoltage Counter (decimal)
C137	c7_under_count	n+	Ch. 7 Undervoltage Counter (decimal)
C140	battery_time	n+	Battery Hour Counter (decimal)
C150	error	n+	Error Code
C151	rev_run	n+	Reverse-Running Flag

C.4.7 Parameter data category

C.4.7.1 Parameter data coding

Parameter data includes values or parameters that are static in nature and represent the programming or configuration of a unit. These include such items as channel type identification, identification numbers and passwords. Data format in this group is explicit and shall be followed. Some data fields can contain variable length data. These are indicated by a trailing + sign. If the data length received by a metering unit is not what is expected, the unit can decide what course of action to pursue, i.e. truncation, ignoring, error message, etc. One method of preventing ambiguity would be to perform a formatted read of the data record first to obtain its internal dimensions.

Code (binary)

1101	t t t t	xxxx	xxxx	t t t t = Parameter TYPE 0000 = General Data Items 0001 = Communications 0010 = Configuration 0011 = RESERVED : 1111 = RESERVED
1101	xxxx	pppp	pppp	pppp pppp = PARAMETER Identifier

C.4.7.2 Parameter data examples

Code	*Mnemonic*	*Data*	*Function and data form*
D000	id_1	n+	Identification Number 1
D001	id_2	n+	Identification Number 2
			:
D00F	id_par	n+	Parameter Set ID
D007	id_8	n+	Identification Number 8
D010	season1_length	n+	Season 1 Length in Days
			:
D01F	season16_length	n+	Season 16 Length in Days
D104	pass4_1	pppp	4 Character Password 1
D114	pass4_2	pppp	4 Character Password 2
			:
D174	pass4_8	pppp	4 Character Password 8
D105	pass5_1	ppppp	5 Character Password 1
D106	pass6_1	pppppp	6 Character Password 1
D107	pass7_1	ppppppp	7 Character Password 1
D108	pass8_1	pppppppp	8 Character Password 1
D110	address	n+	32 Character Address

D200	ctype0	n+	Channel 0 Type
D201	ctype1	n+	Channel 1 Type
D202	ctype2	n+	Channel 2 Type
D203	ctype3	n+	Channel 3 Type

C.4.8 Manufacturer-specific coding

Each manufacturer can use this region in the code space for their own purposes. The manufacturer is free with regard to coding and data format.

Code (binary)

1111 xxxx xxxx xxxx

C.5 Formatted execution (command E2)

Formatted execution allows the user to request that a device executes a predefined function, such as season change or cold start. The coding method allows for parameters to be passed using the data field. When the command requires no parameters then the parentheses are left empty. The code categories are shown below.

Code category

0xxx Execute

1xxx RESERVED

:

Exxx

Fxxx Manufacturer-specific

C.5.1 Execute coding

The Execute category defines codes that cause the unit to perform a specific function. The coding is as follows:

Code (binary)

0000 ssss xxxx xxxx ssss = Execution SET
0000 = General commands
0001 = Test/calibration
0010 = RESERVED
:
1111 = RESERVED

0000 xxxx cccc cccc cccc cccc = Execution COMMAND

Execution examples

Code	*Mnemonic*	*Data*	*Function and data form*
0000	long_readout	0000	Long Readout
0000	short_readout	0001	Short Readout
0000	register_readout	0002	Register Readout
0000	season_readout	0003	Season Readout
0000	lp_readout	0004	Load Profile Readout
0000	var_readout	0005	Variable Readout
0000	par_readout	0006	Parameter Readout
0001	season_change	-	Perform a season change (cumulation)
0002	cold_start	-	Perform a cold start (initialise)
0003	cum_input_reset	-	Neutralize Cumulation Inputs

0100	rcr_test	-	Activate Ripple-Control-Unit Self-Test
0101	cal_on	-	Calibration Mode On
0102	cal_off	-	Calibration Mode Off

In the above table, many different readouts are defined. They contain information based on the following five data areas as defined in this annex: Register, Season, Load Profile, Variable and Parameter. The following table indicates which data categories are transmitted in response to which commands.

Long Readout	Register + Season + Load Profile
Short Readout	Register + Season
Register Readout	Register
Season Readout	Season
Load Profile Readout	Load Profile
Variable Readout	Variable
Parameter Readout	Parameter

The Long Readout corresponds to the data that would be sent in a Data Readout "data message" for a meter with load profile. The Short Readout corresponds to the data that would be sent in a Data Readout "data message" for a meter without load profile. In all readouts, the data which the meter sends is identified using the formatted codes as defined in this annex.

In order to ensure that the readouts are self-contained, that is, all the relevant information is present in order to uniquely identify and understand the data, the meter shall include the channel type record for all channels present. For an electricity meter with only one channel (channel 0), the data set "D200(x)" shall be present in the readout where x represents the channel type designation for electricity. For example, in a meter with a gas channel (on channel 1) and a heat channel (on channel 5), the data set would contain the channel type identification "D201(y)" and the channel type identification "D205(z)" where y and z represent the channel type designation for gas and heat respectively.

C.5.2 Manufacturer-specific coding

Each manufacturer can use this region in the code space for their own functions. The manufacturer is free with regard to coding and data format.

Code (binary)			
1111	xxxx	xxxx	xxxx

C.6 Electricity metering: channel type 0

The following definitions are for the electricity metering channel type.

Code (binary)				
0ccc	xxxx	xxxx	xxxx	ccc = CHANNEL (000 = channel 0)
0xxx	ddxx	xxxx	xxxx	dd = DATA TYPE
				00 = Current Value = Energy
				(i.e. Energy-Tariff 1 with units kWh)
				01 = Integrated = Demand
				(i.e. Demand-Tariff1 with units kW)
				10 = Sum of Integrated = Cumulative Demand
				(i.e. Cumulative Demand 1 with units kW)
				11 = RESERVED

0xxx xxr r r r r r xxxx r r r r r r = REGISTER
see below
0xxx xxxx xxxx t t t t t t t t = TARIFF
0000 = Total
0001 = Tariff 1
0010 = Tariff 2
:
1111 = Tariff 15

REGISTER coding (binary):

00 0000 = Register 0 = |+Ai| + |+Ac|

00 0001 = Register 1 = |–Ai| + |–Ac|

00 0010 = Register 2 = |+Rc|

00 0011 = Register 3 = |–Rc|

00 0100 = Register 4 = |+Ri|

00 0101 = Register 5 = |–Ri|

00 0110 = Register 6 = (|+Ai| +|+Ac|) + (|–Ai| + |–Ac|)

00 0111 = Register 7 = (|+Ai| + |+Ac|) – (|–Ai| + |–Ac|)

00 1000 = Register 8 = |+Ri| + |+Rc|

00 1001 = Register 9 = |–Ri| + |–Rc|

00 1010 = Register 10 = |+Ri| + |–Rc|

00 1011 = Register 11 = |+Ri| – |–Rc|

00 1100 = Register 12 = |–Ri| + |+Rc|

00 1101 = Register 13 = |–Ri| – |+Rc|

00 1110 = Register 14 = |+Ri| + |–Ri|

00 1111 = Register 15 = |+Ri| – |–Ri|

01 0000 = Register 16 = |+Rc| + |–Rc|

01 0001 = Register 17 = |+Rc| – |–Rc|

01 0010 = Register 18 = |+Ri| + |–Ri| + |+Rc| + |–Rc|

01 0011 = Register 19 = |+Ri| – |–Ri| + |+Rc| – |–Rc|

01 0100 = Register 20 = |+Ri| – |–Ri| – |+Rc| + |–Rc|

01 0101 = Register 21 = $\text{sqrt}((|+Ai| + |+Ac|)^2 + |+Ri|^2)$

01 0110 = Register 22 = $\text{sqrt}((|-Ai| + |–Ac|)^2 + |+Rc|^2)$

01 0111 = Register 23 = $\text{sqrt}((|-Ai| + |–Ac|)^2 + |–Ri|^2)$

01 1000 = Register 24 = $\text{sqrt}((|+Ai| + |+Ac|)^2 + |VRc|^2)$

01 1001 = Register 25 = $\text{sqrt}((|+Ai| + |+Ac|)^2 + (|+Ri| + |–Rc|)^2)$

01 1010 = Register 26 = $\text{sqrt}((|-Ai| + |–Ac|)^2 + (|+Rc| + |–Ri|)^2)$

01 1011 = Register 27 = $\text{sqrt}((|+Ai| + |+Ac| + |–Ai| + |–Ac|)^2 + (|+Ri| + |+Rc| + |–Ri| + |–Rc|)^2)$

01 1100 = Register 28 = $\text{sqrt}((|+Ai| + |+Ac|)^2 + (|+Ri| + |–Rc|)^2) – \text{sqrt}((|–Ai| + |–Ac|)^2 – (|+Rc| + |–Ri|)^2)$

01 1101 RESERVED

:

11 1111 RESERVED

For the description in this clause, the measurement plane is considered to have two axes, real and imaginary. The real axis is denoted A and the imaginary axis R. Positive (+) is considered to the right or up and negative (–) considered to the left or down. The reference for the measurement plane is considered the current vector which is fixed on the +A half axis. The momentary voltage vector is used to designate the current energy transfer and has phase angle ϕ in relation to the current vector. Phase angle ϕ is zero when the current and voltage are coincident, and is positive in the counter clockwise direction. The four quadrants are numbered 1 to 4 counterclockwise from the positive real axis.

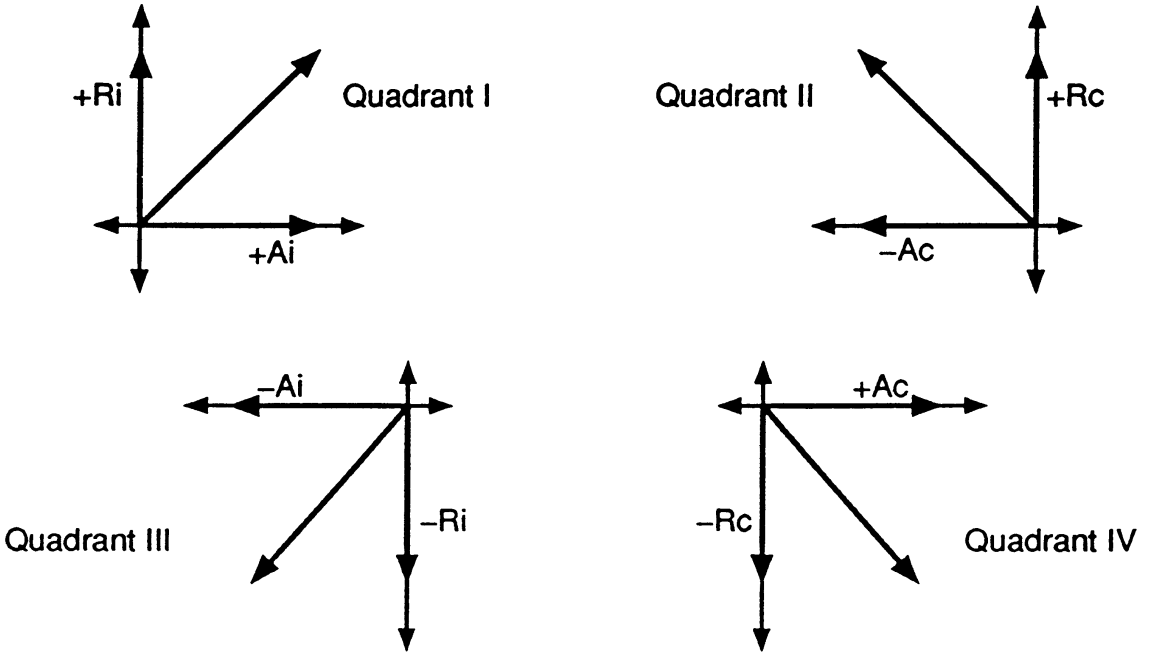
When the vector denoting the momentary voltage in relation to the momentary current is in the first quadrant, +Ai represents the real component of energy consumption and +Ri the imaginary or reactive component of energy consumption.

When the voltage vector is in the second quadrant, –Ac represents the real component of energy consumption and +Rc the imaginary or reactive component of energy consumption.

When the voltage vector is in the third quadrant, –Ai represents the real component of energy consumption and –Ri the imaginary or reactive component of energy consumption.

When the voltage vector is in the fourth quadrant, +Ac represents the real component of energy consumption and –Rc the imaginary or reactive component of energy consumption.

When the voltage vector is coincident with the +R or –R half-axes, then no real component is present, and the imaginary or reactive component of the energy consumption is considered to be of the same type as the last measured reactive component. Note that all measurement components are functions of time and could therefore be designated as such, i.e. +Ai(t). As such, the equations for the vector sums are only correct for instantaneous values. The individual register values cannot be used at a later point in time to calculate other register totals, i.e. Register-X <> sqrt(Register-Y^2 + Register-Z^2).



Quadrant	Real component	Reactive component
1	+Ai	+Ri
2	–Ac	+Rc
3	–Ai	–Ri
4	+Ac	–Rc

NOTE For reference vector, see previous page.

Figure C.4 – Vector diagrams for quadrants I to IV

Annex D
(informative)

Levels of access – system security

In order to restrict access to the tariff device, different levels of security are defined. Any or all of these may be used by a tariff device.

Access level 1

Requires only a knowledge of this protocol to gain access.

Access level 2

Requires one or more passwords to be correctly entered.

Access level 3

Requires operation of a sealable button or manipulation of certain data with a secret algorithm to gain access.

Access level 4

Requires physical entry into the case of the tariff device and effecting a physical change, such as making/breaking a link or operation of a switch, before further communications access is allowed.

Annex E
(normative)

METERING HDLC protocol using protocol mode E for direct local data exchange

The protocol stack as described in IEC 62056-42, IEC 62056-46 and IEC 62056-53 shall be used.

The switch to the baud rate Z shall be at the same place as for protocol mode C. The switch confirm message, which has the same structure as the acknowledgement/option select message, is therefore at the new baud rate, but still with parity (7E1). After the acknowledgement, the binary mode (8N1) will be established.

As the server acknowledgement string is a constant in the server's program, it could be easily possible to switch to the baud rate and the binary mode (Z Bd. 8N1) at the same time. The characters ACK 2 Z 2 CR LF shall be replaced by their 8 bit equivalents by adding the correct parity bit in order to simulate their 7E1 equivalents. This alternative method is not visible to the client, both have an equivalent behaviour (see also Figure E.4).

A client which is not able to support protocol HDLC mode E (W=2) will answer in a protocol mode as defined by Y (normally protocol mode C).

The enhanced capability of the server (tariff device) is communicated with the escape sequence "\W" which is part of the meter identification string (see items 14), 23) and 24) in 6.3.14).

E.1 Overview

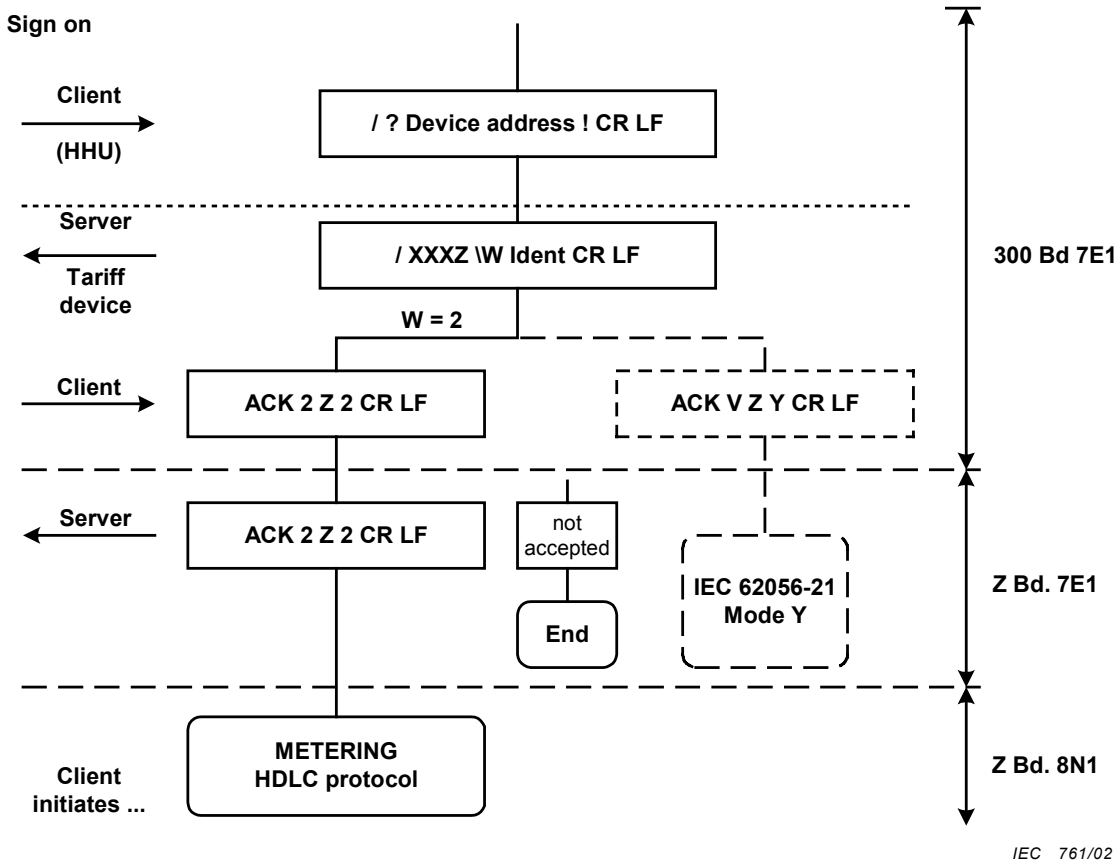


Figure E.1 – Entering protocol mode E (HDLC)

E.2 Readout mode and programming mode

These modes are handled within the higher layers of the protocol. After having established a transparent channel, the "METERING HDLC protocol" takes care of the correct data handling, and a DLMS based application handles access rights, read only or read/write access, etc. Necessary procedures are described in IEC 62056-42, IEC 62056-46 and IEC 62056-53. The flow chart and the changeover to HDLC for the direct local data exchange protocol, protocol mode E, is shown below.

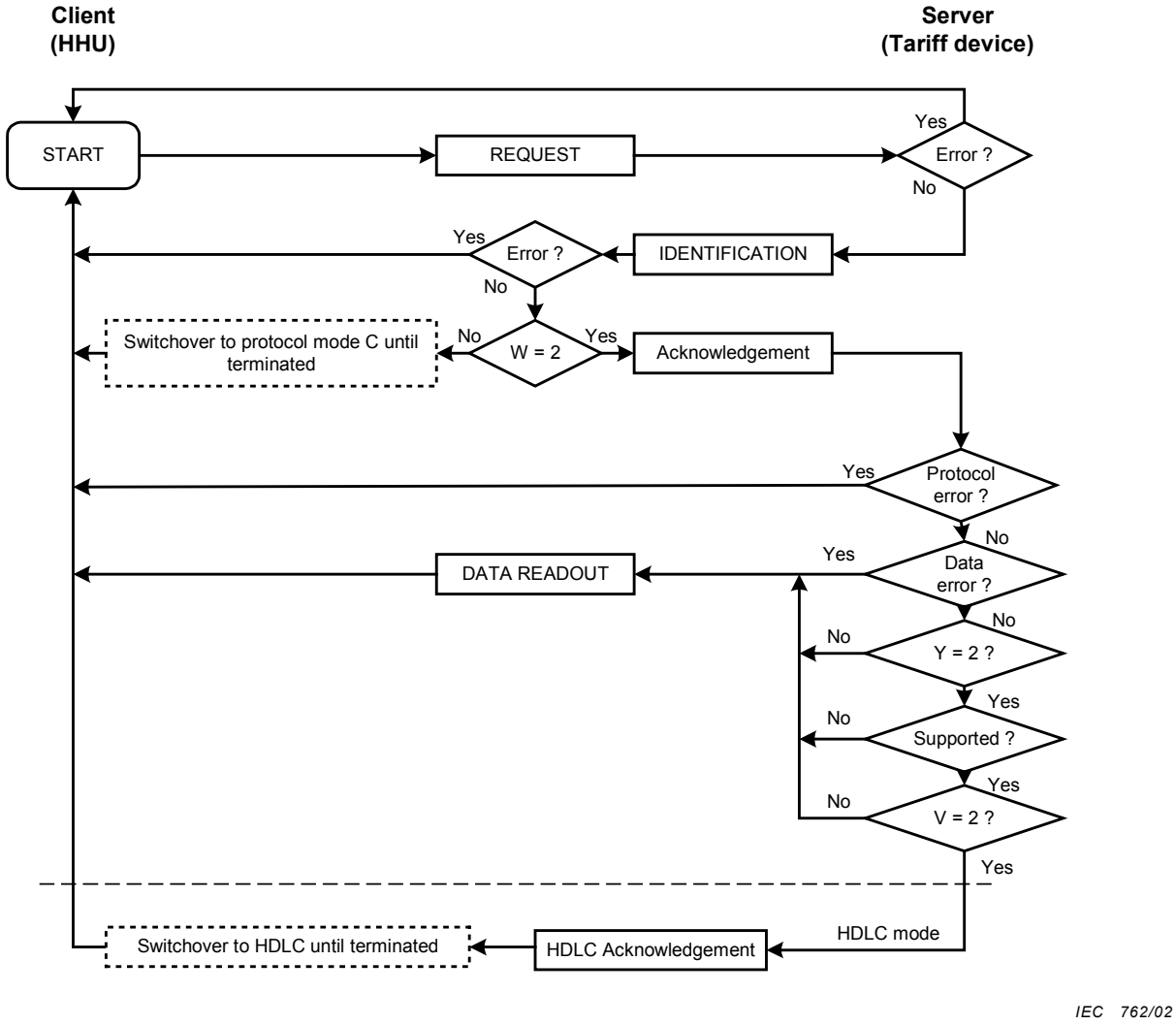


Figure E.2 – Flow chart and switchover to METERING HDLC in protocol mode E

E.3 Key to protocol mode E flow diagram

Message formats

REQUEST	/ ? Device Address ! CR LF
IDENTIFICATION	/ XXX Z Ident CR LF
Acknowledgement	ACK 2 Z 2 CR LF

DATA READOUT (fall back data readout mode A) STX DATA ! CR LF ETX BCC

NOTE The inactivity time-out period for the tariff device is 60 s to 120 s after which the operation moves from any point to the start.

E.4 Physical layer – Introduction

The framework is equivalent to "Physical layer services and procedures for connection oriented asynchronous data exchange" (see IEC 62056-42).

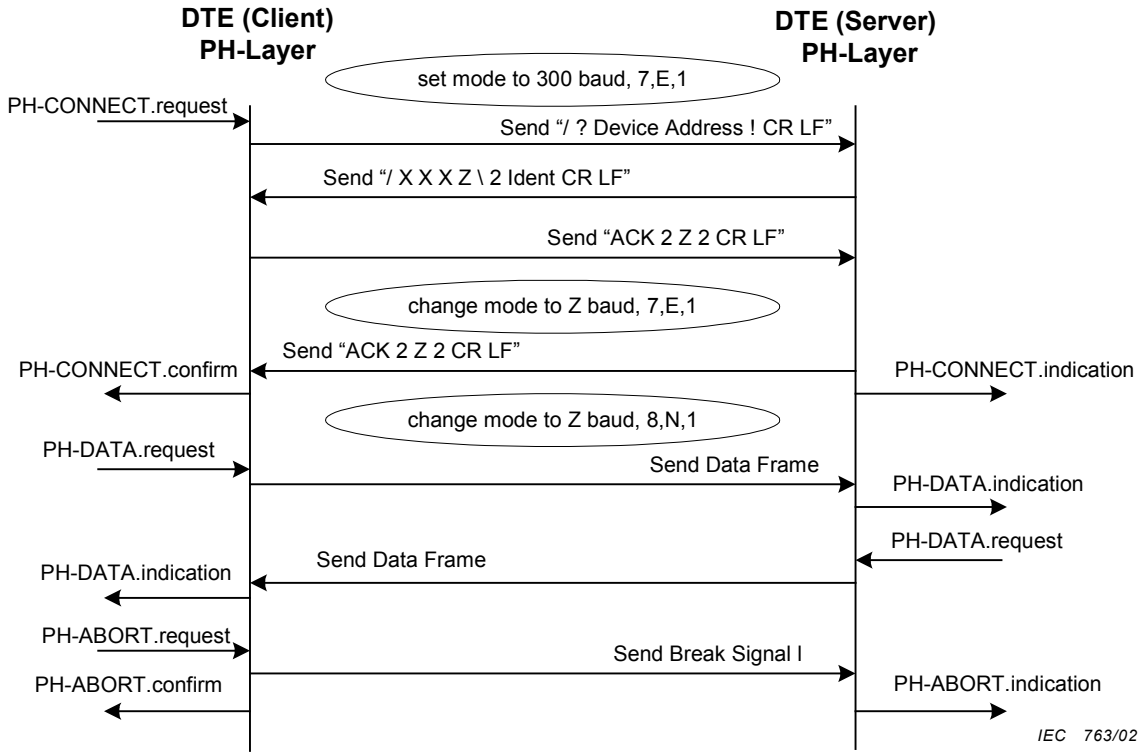


Figure E.3 – Physical layer primitives

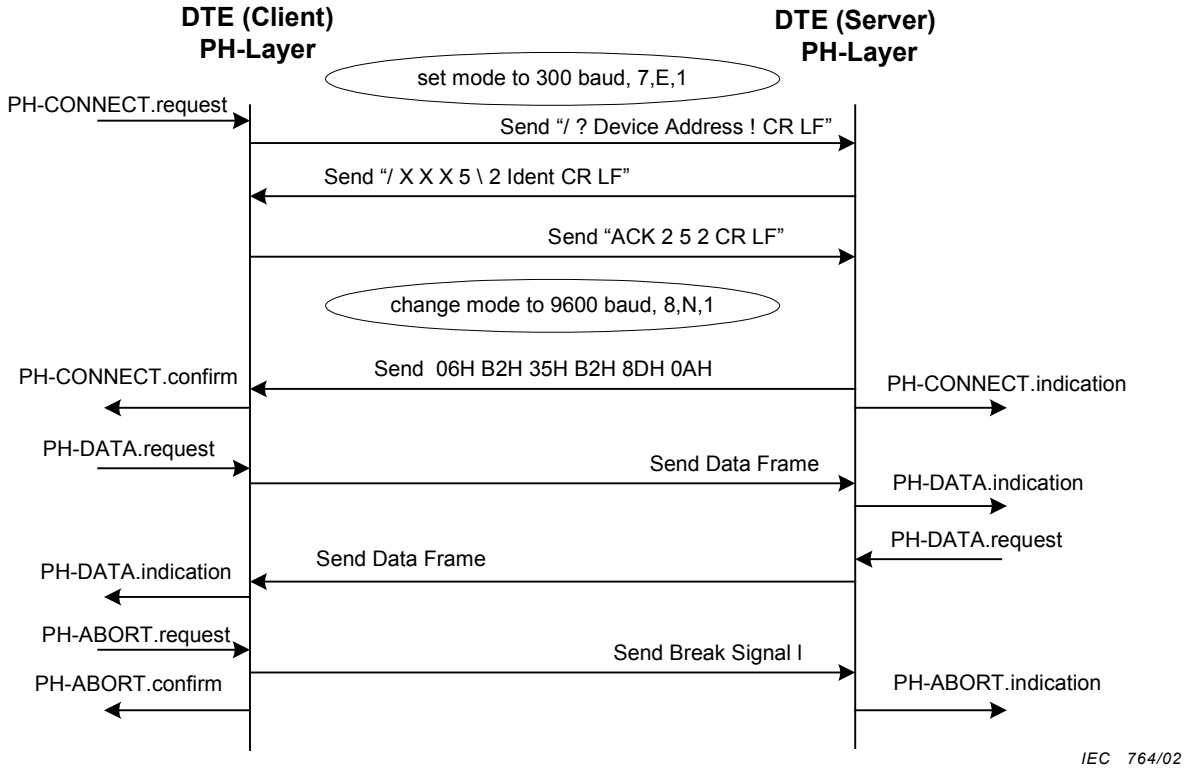


Figure E.4 – Physical layer primitives, simplified example with one mode change only

E.5 Physical layer primitives

PH-CONNECT.request

Once the PH-CONNECT.request primitive has been invoked with this connection type, the PH-Layer entity will start to establish the connection according to the procedure described above. The device address is passed via the PhConnType parameter. For this purpose, a mapping of the Lower MAC address to the device address (item 22), 6.3.14) has to be specified. Note, that a PH-CONNECT.request cannot be initiated by the server (tariff device).

PH-CONNECT.confirm

After receiving the ACK 2 Z 2 CR LF or other, for example NAK message from the server (tariff device), the PH-CONNECT.confirm primitive is invoked with the appropriate result parameter.

Messages:

ACK 2 Z 2 CR LF the metering device has entered the METERING HDLC protocol mode E

Other response the PH-CONNECT.request failed

PH-CONNECT.indication

After the server's PH-Layer has acknowledged the METERING HDLC protocol mode E, it indicates this to the MAC-sublayer by invoking the PH-CONNECT.indication primitive. During HDLC operation, timeouts, etc. are following HDLC rules.

PH-ABORT.request

The PH-Layer entity aborts the connection.

NOTE BREAK is only local to the client, the server does not respond, timeout is used. Timeouts for HDLC are defined in IEC 62056-46.

PH-ABORT.confirm

Since the client will never receive a response from the server, the PH-Layer entity always has to confirm the PH-ABORT.request.

NOTE BREAK is only local to the client, the server does not respond, timeout is used. Timeouts for HDLC are defined in IEC 62056-46.

PH-ABORT.indication

Detecting BREAK, the server PH-Layer entity resets its state machine to the initial state and invokes the PH-ABORT.indication service to indicate the termination of the connection.

E.6 Data link layer

The details are defined in IEC 62056-46.

Bibliography

IEC 62056-61:2002 *Electricity metering – Data exchange for meter reading, tariff and load control – Part 61: Object Identification System (OBIS)*

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ISO/IEC 7498-2:1989, *Information processing systems – Open systems interconnection – Basic reference model – Part 2: Security architecture*

ISO/IEC 7498-3:1997, *Information technology – Open systems interconnection – Basic reference model – Part 3: Naming and addressing*

ISO/IEC 7498-4:1989, *Information processing systems – Open systems interconnection – Basic reference model – Part 4: Management framework*

ISO/IEC 13239:2000, *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures*

Index

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.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ❑
librarian ❑
researcher ❑
design engineer ❑
safety engineer ❑
testing engineer ❑
marketing specialist ❑
other.....

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ❑
consultant ❑
government ❑
test/certification facility ❑
public utility ❑
education ❑
military ❑
other.....

Q4 This standard will be used for: *(tick all that apply)*

general reference ❑
product research ❑
product design/development ❑
specifications ❑
tenders ❑
quality assessment ❑
certification ❑
technical documentation ❑
thesis ❑
manufacturing ❑
other.....

Q5 This standard meets my needs: *(tick one)*

not at all ❑
nearly ❑
fairly well ❑
exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ❑
standard is incomplete ❑
standard is too academic ❑
standard is too superficial ❑
title is misleading ❑
I made the wrong choice ❑
other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness.....
quality of writing.....
technical contents.....
logic of arrangement of contents .....
tables, charts, graphs, figures.....
other .....

Q8 I read/use the: *(tick one)*

French text only ❑
English text only ❑
both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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