

Distribution automation using distribution line carrier systems —

Part 5-2: Lower layer profiles — Frequency shift keying (FSK) profile

ICS 29.240.20; 33.200; 35.100.05

National foreword

This British Standard reproduces verbatim IEC 61334-5-2:1998 Technical report type 2 and implements it as the UK national standard. A type 2 report means that it is still under technical development and there is the possibility but not immediately of an agreement on a formal standard. If any reader of this foreword have any suggestions on changes that should be considered could they inform the secretary of PEL/57.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power system control and communications, which has the responsibility to:

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

A list of organizations represented on this committee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC standards normally include an annex which lists normative references to international publications with their corresponding or European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the CEI IEC title page, pages ii to vi, pages 1 to 32 and a back cover.

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

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 December 1998

© BSI 07-1999

ISBN 0 580 30956 8

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
National foreword	Inside front cover
Foreword	v
Text of CEI IEC 61334-5-2	1

**RAPPORT
TECHNIQUE
TECHNICAL
REPORT**

**CEI
IEC**

61334-5-2

Première édition
First edition
1998-05

**Automatisation de la distribution à l'aide de
systèmes de communication à courants porteurs –**

**Partie 5-2:
Profils des couches basses –
Profil FSK (modulation par déplacement
de fréquence)**

**Distribution automation using
distribution line carrier systems –**

**Part 5-2:
Lower layer profiles –
Frequency shift keying (FSK) profile**



Numéro de référence
Reference number
CEI/IEC 61334-5-2:1998

Contents

	Page
Foreword	v
1 General	1
1.1 Scope and object	1
1.2 Normative references	1
1.3 Acronyms	1
2 The lower layer profile structure	3
2.1 MAC sublayer	3
2.2 PLS sublayer	3
2.3 MAU	3
3 MAC sublayer	3
3.1 Overview	3
3.2 Classes of service	4
3.2.1 Class of service in connection oriented (CO) mode	4
3.2.2 Class of service in connectionless (CL) mode	7
3.3 MAC services	9
3.4 MAC to LLC interfaces	9
3.4.1 MA_Data.request	9
3.4.1.1 Function	9
3.4.1.2 Structure	9
3.4.1.3 Use	9
3.4.2 MA_Data.indication	9
3.4.2.1 Function	9
3.4.2.2 Structure	10
3.4.2.3 Use	10
3.4.3 MA_Data.confirm	10
3.4.3.1 Function	10
3.4.3.2 Structure	10
3.4.3.3 Use	10
3.5 MAC to Physical layer interfaces	10
3.6 MAC to Layer Management Interface	10
3.6.1 Function	10
3.6.2 Structure	10
3.6.3 Use	11
3.7 MAC frame format	11
3.8 MAC frame	11
3.9 Elements of the MAC frame	12
3.9.1 Preamble	12
3.9.2 Flag	12
3.9.3 Address	12
3.9.4 Control	12
3.9.4.1 Repetition Style 1	12
3.9.4.2 Repetition Style 2	13
3.9.5 Repetition	15
3.9.6 Information	15
3.9.7 Frame Checking Sequence (FCS)	15
3.10 MAC invalid frame	15
3.11 MAC procedures	15
3.11.1 MACph procedures	16
3.11.1.1 Transmit a frame	16
3.11.1.2 Receive a frame	16

	Page	
3.11.1.3	Detection of the AC phase delay	16
3.11.2	MACre procedures	16
3.11.3	MAC repetition procedures Style 1	17
3.11.3.1	Service_Class = 1	17
3.11.3.2	Service_Class = 2	18
3.11.4	MAC repetition procedures Style 2	19
3.12	Repetition management	21
3.13	MAC state transition	21
3.13.1	State transition table for the operation Style 1	21
3.13.2	State description	23
3.13.3	Event descriptions	23
3.13.4	Actions description	24
3.13.5	Notation used in the transition table	24
4	PLS sublayer	24
4.1	PLS service specification	24
4.1.1	General description of the service	24
4.1.2	Detailed specification of the service	25
4.1.2.1	Ph_Data.request	25
4.1.2.2	Ph_Data.confirm	25
4.1.2.3	Ph_Data.indication	25
4.1.2.4	Ph_ZC.indication	26
4.2	Frame structure and synchronization	26
4.2.1	Frame structure	26
4.2.2	Frame synchronization	26
4.3	MI characteristics	26
4.3.1	General description of the characteristics	26
4.3.2	Detailed description of the signals	27
4.3.2.1	Transmit Data (TD)	27
4.3.2.2	Receive Data (RD)	27
4.3.2.3	Mode Control (MC)	27
4.3.2.4	Bit Clock (BC)	27
4.3.2.5	Zero Crossing (ZC)	27
4.4	Description of the procedures	27
4.4.1	PLS component state descriptions	28
4.4.2	PLS component event descriptions	28
4.4.3	PLS component action descriptions	28
5	MAU	29
5.1	General	29
5.2	General characteristics	29
5.2.1	Modulation rate	29
5.2.2	Frequency range	29
5.2.3	Optional interchange circuits	30
5.3	MV modem characteristics	30
5.3.1	Nominal input-output impedance	30
5.3.2	Load impedance	30
5.3.3	Nominal signal output power	30
5.3.4	Nominal signal frequency band (BN)	30
5.3.5	Transmission mask	30

	Page
5.3.6 Carrier stabilization	31
5.3.7 Input sensitivity	31
5.3.8 Input dynamic range	31
5.3.9 Bit error rate	31
5.3.10 Recovered clock jitter	31
5.4 LV modem characteristics	31
5.4.1 Frequency bands	31
5.4.2 Input-output impedance	31
5.4.3 Load impedance	31
5.4.4 Transmission mask	31
5.4.5 Signal frequency stabilization	31
5.4.6 Input sensitivity	31
5.4.7 Input dynamic range	31
5.4.8 Bit error rate	31
5.4.9 Recovered clock jitter	32
Figure 1 — Profile structure	2
Figure 2 — Protocol layers in repetition process	4
Figure 3 — Service class 0	5
Figure 4 — Service class 1	5
Figure 5 — Service class 2	6
Figure 6 — Service class 1	7
Figure 7 — Service class 2	8
Figure 8 — Example of the transmitting frame using two repeaters in Service_Class 2 for both repetition Style 1 (RS _n , where n = 1) and Style 2 (RS _n , where n = 2)	17
Table 1 — Initiating station MAC state transition table for the operation Style 1	22
Table 2 — End and repeater station MAC state transition table for the operation Style 1	23
Table 3 — PLS component state transitions	29

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.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example “state of the art”.

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 61334-5-2, which is a technical report of type 2, has been prepared by IEC technical committee 57: Power system control and associated communications.

The text of this technical report is based on the following documents:

Committee draft	Report on voting
57/272/CDV	57/301/RVC

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

This document is issued in the type 2 technical report series of publications (according to G.3.2.2 of part 1 of the IEC/ISO Directives) as a “prospective standard for provisional application” in the field of frequency shift keying (FSK) profile for distribution automation using distribution line carrier systems because there is an urgent requirement for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the IEC Central Office.

A review of this type 2 technical report will be carried out not later than three years after its publication, with the options of extension for a further three years or conversion to an International Standard or withdrawal.

1 General

1.1 Scope and object

This technical report of type 2 describes a lower layer profile that includes the medium access control (MAC) sublayer, the physical signalling (PLS) sublayer and the mains attachment units (MAU), with the purpose of giving a contribution to build up a set of standards for effective communication on MV and LV network for distribution line carrier (DLC) systems.

This profile uses the FSK modulation technique that offers the advantages of low cost implementation, robustness and immunity against noise and interferences. Furthermore, the transmission quality is predictable knowing few parameters of the transmission medium. Using standard electrical signal interface to the modem, the profile is effective for different modulation techniques.

Different technical approaches in developing communication for DLC systems are in progress. As a consequence, at present different low level profiles are feasible with acceptable results in terms of performance and cost-effectiveness. In many cases, the differences amongst solutions are minor and it is possible to find a common root. This report describes a low level profile that assembles some common experience.

According to the structure of the open system interconnection model, the low level profile should present a standard interface to the logical link control (LLC) sublayer and consists of sublayers such as the MAC sublayer, PLS and MAU, that present well-defined interface to each other.

The MAC sublayer here described interfaces both the LLC connectionless (CL) (see IEC 61334-4-32) and the LLC connection oriented (CO) (see IEC 61334-4-33).

The use of the MAC in the two cases is different due to the frame length and the frame sequence on the medium. To improve the efficiency of the communication, different classes of service are given. The proper use of the class of service and related parameters allow users control of the transfer and waiting time of the processes involved in the transmission.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61334. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61334 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 60495:1993, *Single sideband power-line carrier terminals*.

IEC 61334-3-1:—, *Distribution automation using distribution line carrier systems — Part 3-1: Mains signalling requirements — Frequency bands and output levels*¹⁾.

IEC 61334-3-21:1996, *Distribution automation using distribution line carrier systems — Part 3-21: Mains signalling requirements — MV phase-to-phase isolated capacitive coupling device*.

IEC 61334-4-32:1996, *Distribution automation using distribution line carrier systems — Part 4-32: Data communication protocols — Data link layer — Logical link control (LLC)*.

IEC 61334-4-33:—, *Distribution automation using distribution line carrier systems — Part 4-33: Data communication protocols — Data link layer — Logical link control — Connection oriented protocol*¹⁾.

ISO/IEC 3309:1993, *Information technology — Telecommunications and information exchange between systems — High-level data link control (HDLC) procedures — Frame structure*.

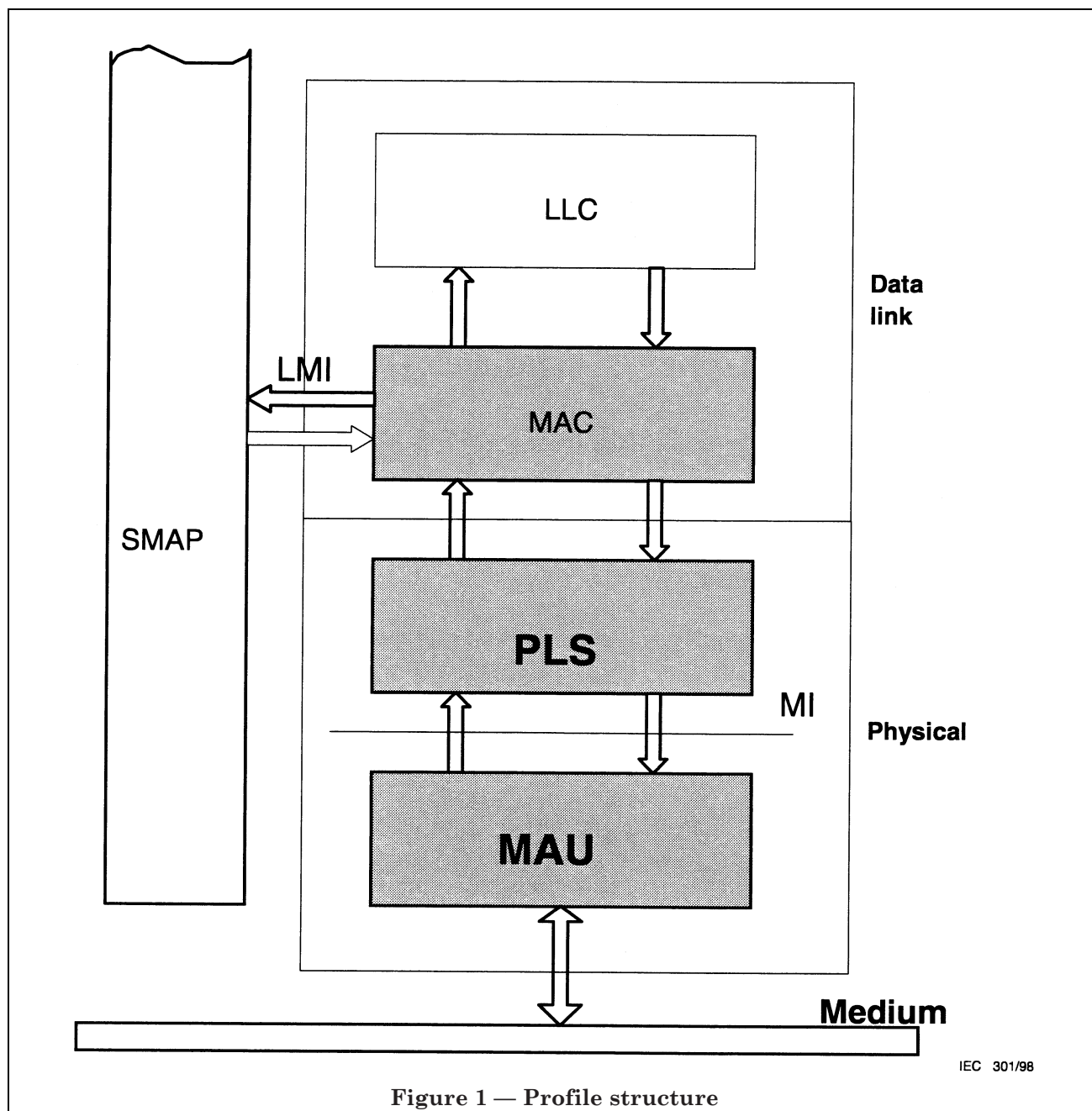
ITU-T Recommendation V.24:1996, *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*.

1.3 Acronyms

PLS	Physical Signalling Sublayer
MAU	Mains Attachment Unit
MAC	Medium Access Control

¹⁾ To be published.

MI	MAU Interface
LLC	Logical Link Control sublayer
DL	Data Link layer
Ph	Physical layer
SMAP	System Management Application Process
LMI	Layer Management Interface
LME	Layer Management Entity
SDU	Service Data Unit
PDU	Protocol Data Unit



2 The lower layer profile structure

The profile model is shown in Figure 1 and consists of a MAC sublayer, a physical signaling sublayer and a mains attachment unit.

2.1 MAC sublayer

The MAC sublayer presents interfaces to the LLC sublayer and provides the access to the physical medium to exchange data units between peer entities.

Typical functions of the MAC sublayer are to delimit the protocol data units into frames, providing synchronization and error detecting.

Peculiar function is to detect in a data exchange the correlation between the phases of the power line voltage of the transmitting and receiving stations.

The MAC sublayer implements a repetition mechanism to overcome transmission problems due to attenuation of stationary waves.

2.2 PLS sublayer

The PLS sublayer provides services to the MAC sublayer to transfer physical data unit between peer entities connected through the MAU to the physical medium.

The PLS sublayer is intended to be independent of the physical characteristics and implementation of the MAU. The MI between PLS and MAU allows the use of different modems or modulation devices.

The service primitives at the MI may correspond to exchanged signals, when the modem exists as a circuit or independent part.

2.3 MAU

The MAU transforms the data units received from the PLS into signals suitable to be transmitted on the medium and vice versa.

Circuits devoted to synchronization and to detect the zero-crossing of the mains phase are included in the MAU and the relative information transits at the interface to the PLS as proper signals.

The MAU corresponds to the modem, if it exists as a physical unit, or to the modulation function.

In the case of LV, the MAU contains also the coupling device to the power line. In the case of MV, the coupling device is outside the MAU (see IEC 61334-3-21).

3 MAC sublayer

3.1 Overview

The MAC sublayer provides services to the LLC sublayer to exchange data units between peer entities with reference to ISO — OSI architecture.

The MAC functions may be grouped in MACre and MACph.

The functions provided by the MACre are the following:

- interface to LLC;
- repetition control.

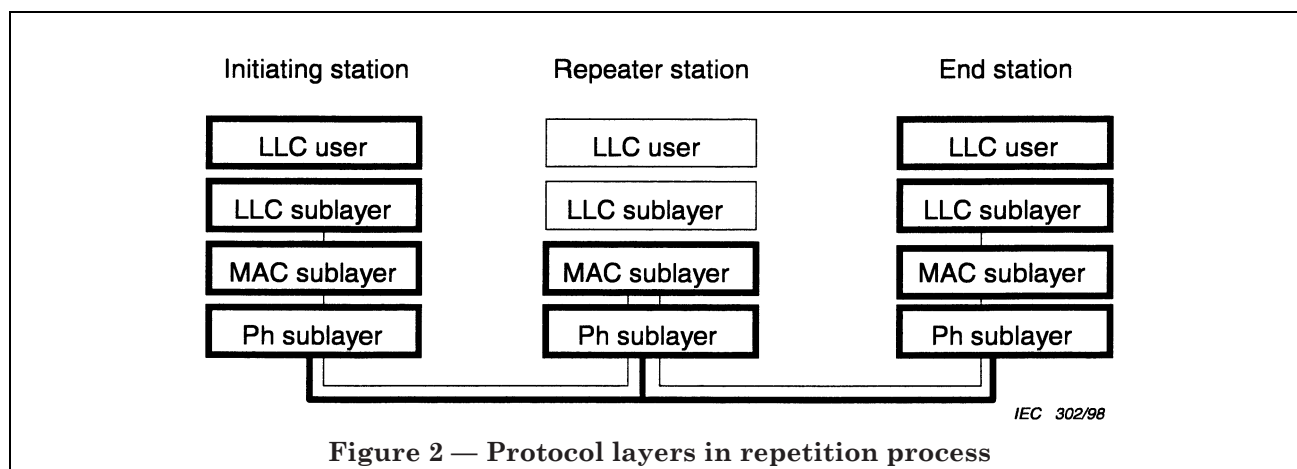
The functions provided by the MACph are the following:

- encapsulating the frame to be transmitted;
- frame filtering the frames to be received on the address basis (individual or group);
- detecting the frame errors or the line status;
- detecting the correlation between the AC phase of the transmitting and receiving stations.

When the LLC sublayer requests the transmission of data to a destination station (called end station), if necessary the MACre sublayer activates the repetition procedures setting the intermediate repeaters.

When a remote station operates as repeaters, the highest functions involved in the transmission are the MACre's ones.

The scheme of the stations and the layers involved in a repetition process is shown in Figure 2.



3.2 Classes of service

Different classes of service are provided to support a connection oriented LLC (CO-LLC) and a connectionless LLC (CL-LLC).

The classes of service are as follows:

- 0, 1 and 2 to support the CO-LLC mode;
- 1 and 2 to support the CL-LLC mode; each class includes the subclasses A, B, C, etc.

Classes 0 and 1 are used to transmit information not requesting an answer. Class 2 is used to transmit information requesting an answer. Each class defines the supervisory time (waiting time) for the initiating station, for the repeaters and for the end station to take control of the line.

The class of service is given by the service class parameters associated to the service primitive. These parameters originate in the LLC layer or come from the upper layer as link class parameters. The subclasses A, B, C, etc. allow a different set-up of the service class parameters.

3.2.1 Class of service in connection oriented (CO) mode

The following Service_Class values are used by the CO-LLC mode procedures:

- 0: Service_Class “confirm after transmission”: the MAC sublayer generates the confirmation at the end of the transmission by the Physical layer (see Figure 3);
- 1: Service_Class “postponed confirmation”: the confirmation is postponed until the complete transmission, including repetition steps, is carried out (see Figure 4);
- 2: Service_Class “round-trip delayed confirmation”: the MAC sublayer starts a timer as long as the round trip delay, needed for the remote station to transmit an LLC frame back, including the repetition steps, if any (see Figure 5).