ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-81

LOCAL AREA NETWORKS
CSMA/CD BASEBAND

PHYSICAL LAYER

2nd Edition – March 1984

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BRIEF HISTORY

Open Systems Interconnection standards are intended to facilitate homogeneous interconnection of heterogeneous information processing systems. This Standard is within the framework for the co-ordination of standards for Open Systems Interconnection which is defined by ISO 7498. It is based on the practical experience of ECMA Member Companies world-wide, and the results of their active standardization bodies in Europe and the USA. It represents a pragmatic and widely based consensus.

This Standard is one of a series of standards to be developed and published by ECMA in the field of Local Area Networks. These ECMA standards refer to several LAN techniques:

- Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- Token Techniques (Bus, Ring)

This 2nd Edition of Standard ECMA-81 was adopted by the General Assembly of ECMA on December 13, 1983

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1. GENERAL

1.1. Scope

For the purpose of compatible interconnection of data processing equipment via a local area network using the carrier sense multiple access collision detection technique (CSMA/CD) at 10 Mbit/s, this Standard ECMA-81 :

- defines the services provided at the conceptual interface between the Physical Layer and the Link Layer above it (see section 3);
- specifies the electrical characteristics of the connection between Data Terminal Equipment and the cable defined in Standard ECMA-80 (see section 5).

Physical frame protocol characteristics are outside the scope of this Standard, and are defined in Standard ECMA-82.

1.2. References

ISO 7498	Data Processing - Open Systems Interconnection - Basic Reference Model
IEEE Standard 802.3	CSMA/CD Access Method and Physical Layer Specifications
ECMA-72	Transport Protocol
ECMA-80	Local Area Networks - CSMA/CD Baseband - Coaxial Cable System
ECMA-82	Local Area Networks - CSMA/CD Baseband - Link Layer
ECMA-TR/14	Local Area Networks Layers 1 to 4 Architecture and Protocols

1.3. Definitions

For the purpose of this Standard the following definitions apply :

1.3.1. Baseband Transmission Mode

A technique whereby information is directly encoded on and conveyed by the transmission medium, such that at any time only one information signal can be present without disruption.

1.3.2. Coaxial Cable

A two-conductor (centre conductor, shield), concentric, constant impedance transmission line.

1.3.3. Collision

The result of multiple transmissions overlapping in the physical channel, resulting in corrupted data and necessitating retransmissions.

1.3.4. Carrier Sense Multiple Access with Collision Detection

CSMA/CD is the generic term for a class or link management procedure used by the local area network.

1.3.5. Link Layer

The Link Layer provides the functional and procedural means for data transmission between access points (LSAPs) on the same local area network.

1.3.6. Phase Encoding

A means by which separate date and clock signals can be combined into a single, self-synchronizable data stream, suitable for transmission on a serial channel.

1.3.7. Data Terminal Equipment (DTE)

The source and sink for all communication on the network. This includes all equipments attached to the medium, including the means of connection to the medium.

1.3.8. Preamble

A sequence of encoded bits generated by the Link Layer which the Physical Layer transmits before each frame to allow synchronization of clocks and other Physical Layer circuitry at DTEs on the network.

1.3.9. Transmission

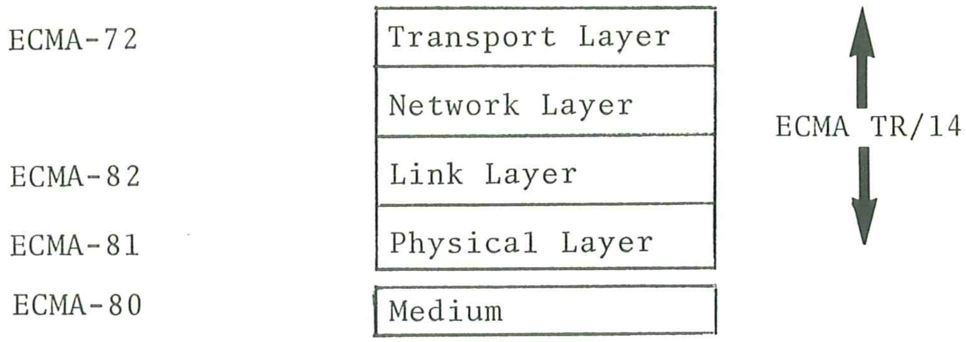
A series of bits on the medium, at the beginning of which the receiver synchronizes, and during which the receiver is not required to re-synchronize. A transmission is delimited by silence before and after the transmission.

1.4. Conformance

Equipment conforming to this Standard shall implement all of the requirements specified in sections 4 and 5. There are no conformance requirements for the services defined in section 3.

2. GENERAL DESCRIPTION

ECMA-TR/14 discusses the relationship between this Standard and other ECMA Standards for local area network interconnection. This relationship is illustrated diagrammatically below.



The Physical Layer provides the means for communication between Link Layer entities.

It is anticipated that a future standard will define connection of a Data Terminal Equipment (DTE) to the medium by means of a media access unit (MAU). In this Standard, the MAU is considered as a functional part of the DTE, and is not explicitly visible.

Standards ECMA-80, ECMA-81 and ECMA-82 constitute together a subset of Standard IEEE 802.3.

3. PHYSICAL LAYER SERVICES

3.1. Signal Error Indication

The Physical Layer asserts a Signal Error Indication for the Link Layer whenever the Physical Layer detects a signal quality error on the medium. This function is primarily a means of indicating the presence of a collision on the medium (see section 4.5.).

3.2. Input Data Indication

The Physical Layer sends an Input Data Indication containing one bit of data to the Link Layer whenever the Physical Layer receives a data bit from the medium.

3.3. Carrier Indication

The Physical Layer asserts a Carrier Indication for the Link Layer when the Physical Layer is giving an Input Data Indication or a Signal Error Indication to Link Layer.

3.4. Output Data Request

The Physical Layer sends an Output Data Request to the Link Layer whenever the Physical Layer requires another bit to transmit on the medium. This request is sent once per bit time.

3.5. Output Complete Indication

The Link Layer sends an Output Complete Indication to the Physical Layer in response to an Output Data Request from the Physical Layer, when the Data Link Layer has no more data to output.

3.6. Output Data Response

The Link Layer sends an Output Data Response containing one bit of data to the Physical Layer in response to an Output Data request from the Physical Layer, when the Data Link Layer has data to output.

3.7. Output Request

The Link Layer sends an Output Request to the Physical Layer when the Link Layer wishes to output data.

3.8. Optional Services

3.8.1. Activate Physical Request

The Link Layer sends an Activate Physical Request to the Physical Layer when the Link Layer wishes to activate (turn on) the Physical Layer.

3.8.2. Deactivate Physical Request

The Link Layer sends a Deactivate Physical Request to the Physical Layer when the Link Layer wishes to deactivate (turn off) the Physical Layer.

3.8.3. Set Monitor Mode Request

The Link Layer sends a Reset Monitor Mode Request to the Physical Layer when the Link Layer wishes to take the Physical Layer out of Monitor Mode and into Normal Mode.

4. PHYSICAL LAYER FUNCTIONS

4.1. Encoding and Decoding Functions

4.1.1. Encoding Function

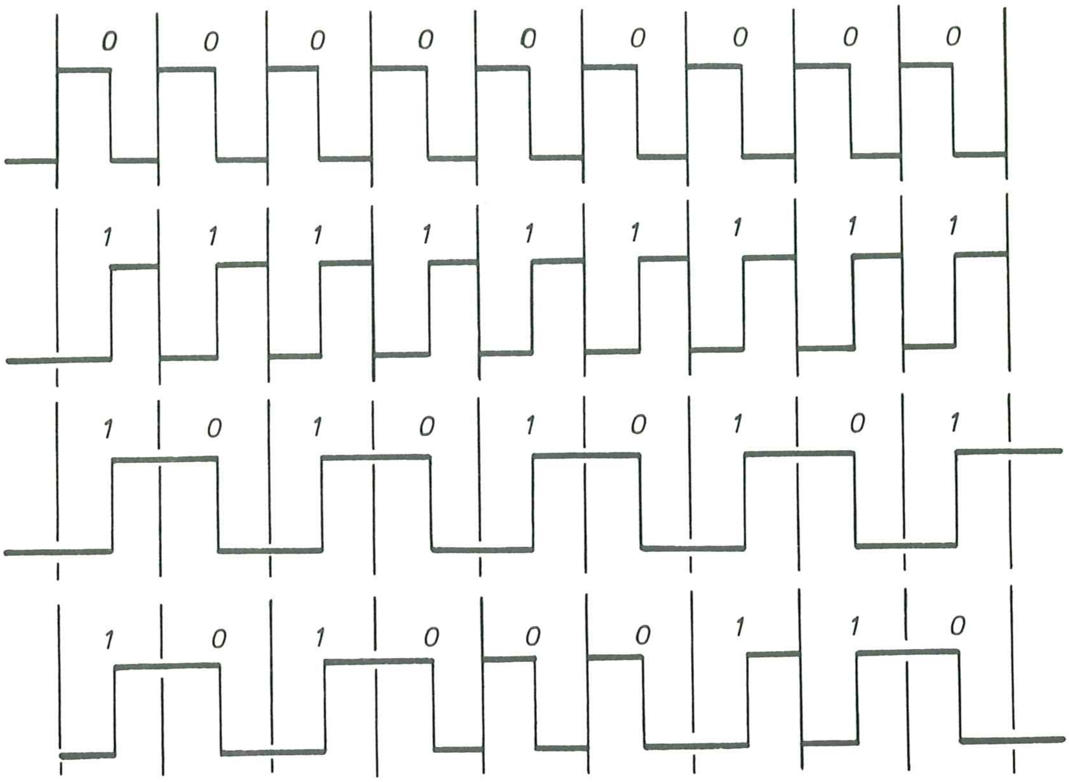
The encoder shall use the Manchester Phase-Encoding technique, to translate physically separate signals of clock (synchronization) and data into a single, self-synchronizable serial bit stream, suitable for transmission on the medium.

Manchester Phase-Encoding is defined as encoding where :

- a positive going transition shall be made at the centre of each bit cell containing a ONE,
- a negative going transition shall be made at the centre of each bit cell containing a ZERO,
- a transition shall be made at each bell boundary between consecutive bit cells containing the same value.

Examples of this encoding are illustrated below.

The encoder shall provide the defined output for the first, and all subsequent bits presented to its input. All information submitted for encoding shall appear at the output of the encoder for transfer to the transmit function (see 4.2.).



Examples of Manchester Phase-Encoding

4.1.2. Recovery of Data Timing

Recovery of timing information implicit in the encoded data is easily accomplished at the receiving side because of the wealth of transitions guaranteed to be in the encoded waveform, independent of the data sequence.

A phase-locked loop or equivalent mechanism shall be used to extract timing information from the self-synchronized serial bit stream.

4.1.3. Decoding Function

The decoder is used to separate the incoming phase encoded bit stream into data stream and a clock signal (see Appendix A for phase distortion and jitter characteristics).

4.1.4. Signalling Rate

The signalling rate shall be 10 Mbit/s $\pm$ 0,01%. Other signalling rates are for future study.

4.2. Transmit Function

The Transmit Function shall allow the transmission of serial data bit streams on the medium defined in Standard ECMA-80.

At the start of a frame transmission, no more than 3 bit cells of information shall be lost. The fourth bit cell shall be transmitted onto the medium with the correct timing and signal level.

The Transmit Function shall output on the medium signals whose levels and waveforms meet the requirements of section 5.1.3.

4.3. Receive Function

The Receive Function shall allow the reception of serial data bit streams over the medium defined in Standard ECMA-80.

At the start of receiving a frame from the medium, no more than 5 full bit cells of information shall be received from the medium and not transmitted to the data decoder.

In addition it is permissible for the first bit cell sent to the data decoder to contain invalid data, however all successive bit cells of the frame shall be valid.

4.4. Carrier Sense Function

The Carrier Sense Function indicates the presence of a signal transmission attempt on the medium. The Carrier Indication is asserted for the Link Layer (see 3.3.) when transmission on the medium is detected regardless of whether the DTE concerned is itself transmitting at that time. The Carrier Sense Function shall assert the Carrier Indication within 2 bit times of reception of transmission.

The Carrier Indication shall be removed when the end of transmission on the medium is detected. The Carrier Sense Function shall remove the Carrier Indication between 1,3 and 1,6 bit times after the end of transmission.

4.5. Signal Error Detection Function

The Physical Layer shall send a Signal Error Indication (see 3.1.) to the Link Layer when a collision on the medium is detected.

A collision occurs when more than one DTE is transmitting on the medium.

The Physical Layer shall send the Signal Error Indication when it detects that more than one DTE is transmitting on the medium.

The Signal Error Indication shall be presented no more than 9 bit cell times after the signal (e.g. DC average) on the medium equals or exceeds that produced by 2 (or more) DTEs transmitting concurrently, under the condition that the DTE detecting collision presence is transmitting.

The indication shall be removed within 20 bit cells after the end of multiple transmission on the medium.

The Signal Error Detection Function is not required to be able to sense an abnormal (e.g. open) medium, but may do so in some implementations.

4.6. Jabber Function

The Physical Layer shall provide a Jabber Function, which is a self interrupt capability to inhibit transmit data from reaching the medium. The Jabber Function will terminate a transmission in a minimum time of 20 ms and a maximum time of 150 ms.

If the transmission is in excess of this duration the Jabber Function shall inhibit further data output from reaching the medium. Reset of the Jabber Function is either achieved manually or alternatively arranged to be dependent upon the removal of the output data stream.

4.7. Signal Error Detection Test Function

The Physical Layer shall implement an automatic test to indicate to the Link Layer the operational status of the Signal Error Detection Function.

The Signal Error Detection Function shall assert a Signal Error Indication to the Link Layer after between 6 and 16 bit times following each transmission.

The Signal Error Indication shall be removed by the Signal Error Indication Test Function after being asserted for 10 ± 5 bit times.

The methods used to simulate a collision during this test will be implementation dependent. However, as much as possible of the Signal Error Detection Function shall be tested.

Under no circumstances shall the Signal Error Detection Test Function cause undefined transmissions to be generated by the medium.

4.8. Monitor Function (Optional)

Upon receipt of the Set Monitor Request or as the result of independent action within the Physical Layer, the Physical Layer shall, within 20 ms, disable the Transmit Function in such a way as to prevent the transmission of signals on the medium and prevent any abnormal loading by the disabled transmitter on the medium itself.

The purpose of this function is to prevent a malfunctioning active component (e.g. transmit driver) from affecting the normal operation of the network.

The Monitor Function shall not interact with the Receive Function.

5. ELECTRICAL CHARACTERISTICS

5.1. DTE to Cable Connection

In this specification, negative current is defined as current into the DTE (out of the centre conductor of the cable).

The connection between the DTE and the cable shall have the following characteristics.

5.1.1. Input Impedance

The shunt capacitance presented to the cable by the directly attached DTE circuitry (not including the means of attachment to the cable) should not exceed 2 pF. The magnitude of the pulse reflection due to the DTE circuitry and the mechanical connector shall be not greater than that produced by a 4 pF capacitance when measured with a waveform of amplitude 0V to - 2V and rise and fall times of 25 ns.

The resistance presented to the cable shall be greater than 100 kOhm.

These conditions shall be met in the POWER OFF State, and the POWER ON not transmitting state.

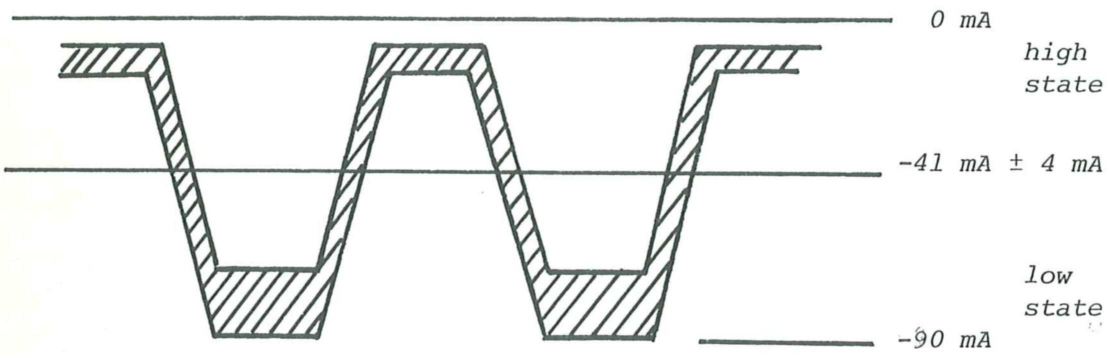
The shunt resistance presented to the coaxial cable by the DTE circuitry when it is transmitting shall be greater than 20 kOhm over the voltage range of 0V to - 4 V.

5.1.2. Bias Current

Current flow between the cable and a DTE shall be in the range + 2 uA to - 25 uA in the POWER OFF state, and the POWER ON not transmitting state.

5.1.3. Cable Signalling Levels

The signal on the cable due to a single DTE as measured at the DTE's transmitter is composed of an AC component and an offset component. Expressed in terms of current, the composite signal immediately adjacent to the DTE connection (prior to splitting the current flow in each direction) shall have an offset component (average dc current including the effects of time distortion) in the range -37 mA to -45mA, and an ac component from ± 28 mA up to the offset value. This is illustrated below.



Driver Current Signal Levels

The DTE shall meet the specified current signal levels regardless of the number of DTEs transmitting simultaneously.

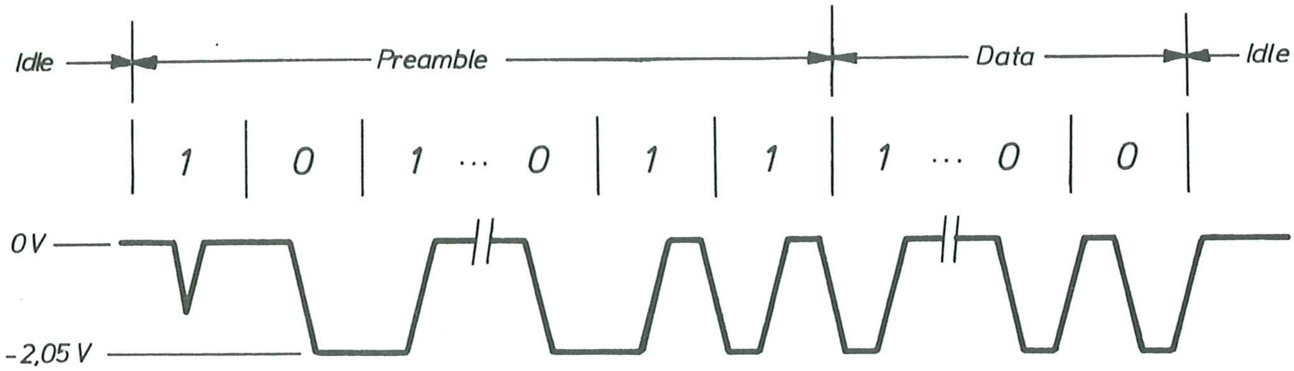
The DTE shall sink no more than -25uA when the voltage on the cable centre conductor falls to -7V or less when the DTE is transmitting.

The actual current measured at a given point on the cable is a function of the transmitted current and the cable loss to the point of measurement. Negative current is defined as current out of the center conductor of the cable (into the DTE). The 10% to 90% rise/fall times shall be 25 ns ± 5 ns at 10 Mbit/s. Harmonic content generated from a 10 MHz fundamental periodic output shall meet the following requirements :

- Second and Third Harmonics : each at least 20 dB below fundamental.
- Fourth and Fifth Harmonics : each at least 30 dB below fundamental.
- Sixth and Seventh Harmonics : each at least 40 dB below fundamental.

- All Higher Harmonics : each at least 50 dB below fundamental.

The following figure illustrates typical waveforms present on the cable; it does not define a requirement. Voltages given are nominal, measured on a terminated cable at a point adjacent to a transmitting DTE connection. They are derived from the cable signalling levels specified above and the characteristic impedance of the cable defined in Standard ECMA-80.



5.1.4. Transmit Signal

Section 5.1.3. specifies the current level from the DTE to the coaxial cable. Since the coaxial cable proceeds in two directions from the DTE, the current into the coaxial cable is actually half the current measured from the DTE.

The phase distortion of the transmitted signal at the DTE connection shall not exceed ± 3,5 ns for any data pattern.

The output level on the coaxial trunk cable shall return to the quiescent state within a nominal 8 bit times following the cessation of the output data stream. The exact time is dependent upon cable parameters.

5.1.5. Receive Signal

The phase distortion of the received signal at the DTE connection shall not exceed ± 10,5 ns for any data pattern. Care should be taken in the design of the receiver in order to minimize any additional phase distortion it may introduce to the received signal before it is conveyed to the Decoding Function specified in 4.1.3.

5.1.6. Receive Collision Detection Threshold

A Signal Error (specified in section 4.5.) may be detected when the average received signal voltage is more negative than the threshold range of -1,492V max. and -1,629 V min. when measured with respect to the coaxial cable shield.

A DTE that implements this receive threshold shall be considered to have carried out Receive Mode collision detection. Receive Mode collision detection indicates that a non-transmitting DTE has the capability to detect collisions between two or more DTE's.

5.2. DTE Electrical Characteristics

5.2.1. Electrical Isolation

An adequate isolation shall be provided between the DTE and the coaxial cable, as specified in Standard ECMA-80.

5.2.2. Reliability

Connectors and other components comprising the means of connecting the DTE to the cable should be designed to minimize the probability of total network failure. The DTE-to-Cable Connection should be designed to provide at least 1 million hours of continuous operation within the network without causing communication failure among other DTEs attached to the local network medium.

It should be noted that a fault condition which causes a DTE to draw in excess of 2 mA may cause communication failure among other DTEs.

5.2.3. Common Mode Current Shunt

A shunt shall be provided for high frequency common mode currents between the coaxial cable shield(s) and the DTE signal earth (ground). The impedance of this shunt shall be less than 15 Ohm between 3 MHz and 30 MHz, and greater than 300 kOhm at 50 Hz.

APPENDIX A

NETWORK PHASE DISTORTION AND JITTER BUDGET

Phase distortion and Jitter components within the Network are as follows :

Transmit Signal	± 3,5 ns	(Note A1)
Coaxial Cable Segment	± 7,0 ns	
SNR on Cable	± 6,0 ns	(Note A2)
	± 16,5 ns	(Note A3)

Note A1 - Total figure for data encoded, transmission circuitry and means of local interconnection between these functions.

Note A2 - Value based on 5:1 Signal to Noise Ratio (SNR) measured as peak signal : peak noise in all Network data transmission paths.

Note A3 - A figure of 18 ns is recommended to accommodate a design margin for implementation dependent considerations.