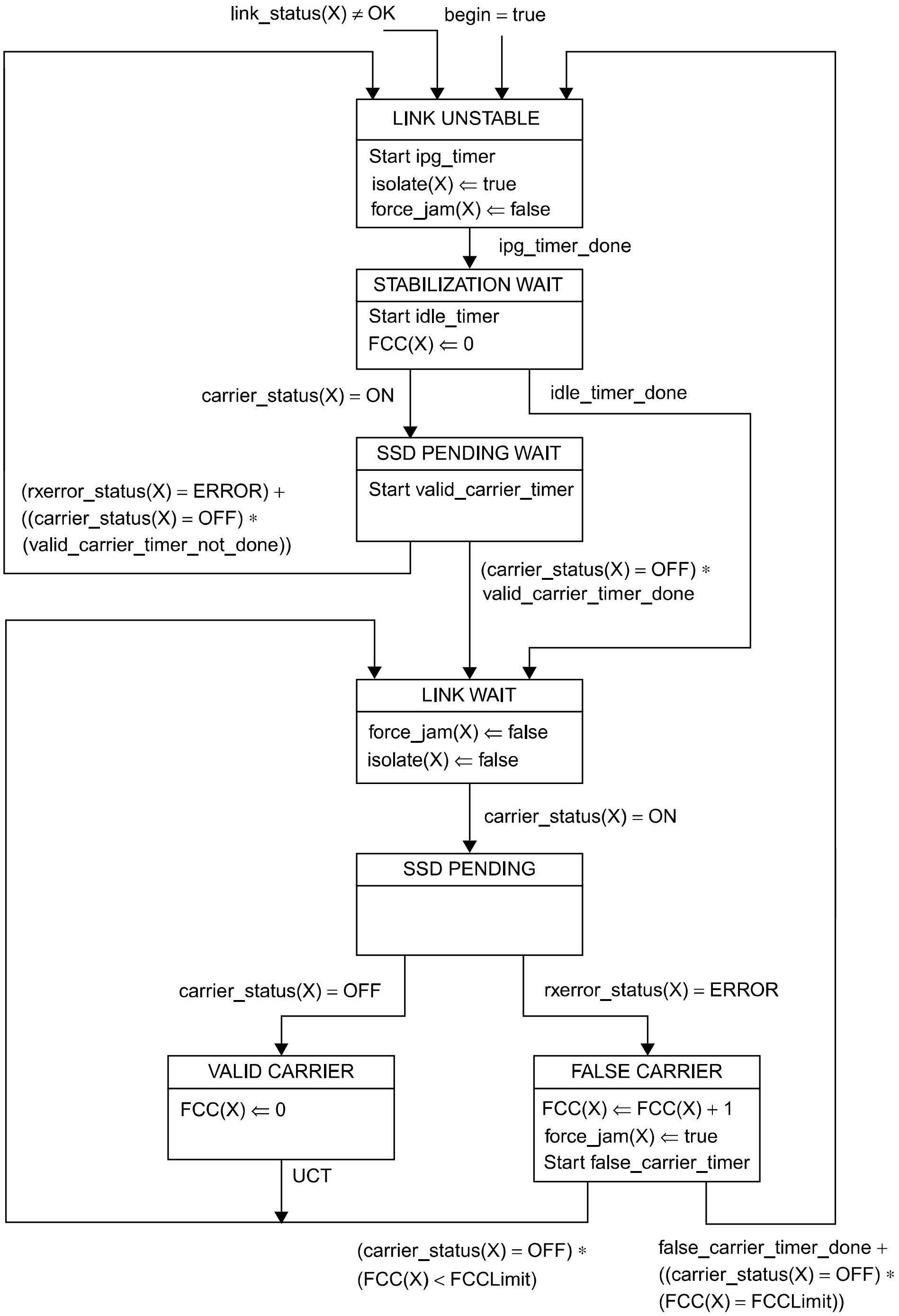

Figure 27-9—100BASE-X carrier integrity monitor state diagram for port X

27.4 Repeater electrical specifications

27.4.1 Electrical isolation

Network segments that have different isolation and grounding requirements shall have those requirements provided by the port-to-port isolation of the repeater set.

27.5 Environmental specifications

27.5.1 General safety

All equipment meeting this standard shall conform to IEC 950: 1991.

27.5.2 Network safety

This subclause sets forth a number of recommendations and guidelines related to safety concerns; the list is neither complete nor does it address all possible safety issues. The designer is urged to consult the relevant local, national, and international safety regulations to ensure compliance with the appropriate requirements.

LAN cable systems described in this subclause are subject to at least four direct electrical safety hazards during their installation and use. These hazards are as follows:

a) Direct contact between LAN components and power, lighting, or communications circuits.
b) Static charge buildup on LAN cables and components.
c) High-energy transients coupled onto the LAN cable system.
d) Voltage potential differences between safety grounds to which the various LAN components are connected.

Such electrical safety hazards must be avoided or appropriately protected against for proper network installation and performance. In addition to provisions for proper handling of these conditions in an operational system, special measures must be taken to ensure that the intended safety features are not negated during installation of a new network or during modification or maintenance of an existing network. Isolation requirements are defined in 27.5.3.

27.5.2.1 Installation

Sound installation practice, as defined by applicable local codes and regulations, shall be followed in every instance in which such practice is applicable.

27.5.2.2 Grounding

The safety ground, or chassis ground for the repeater set, shall be provided through the main ac power cord via the third wire ground as defined by applicable local codes and regulations. It is recommended that an external PHY to the repeater should also be mechanically grounded to the repeater unit through the power and ground signals in the MII connection and via the metal shell and shield of the MII connector if available.

If the MDI connector should provide a shield connection, the shield may be connected to the repeater safety ground. A network segment connected to the repeater set through the MDI may use a shield. If both ends of the network segment have a shielded MDI connector available, then the shield may be grounded at both ends according to local regulations and ISO/IEC 11801: 1995, and as long as the ground potential difference between both ends of the network segment is less than 1 V rms. The same rules apply towards an inter-repeater link between two repeaters. Multiple repeaters should reside on the same power main; if not, then it is highly recommended that the repeaters be connected via fiber.

WARNING—It is assumed that the equipment to which the repeater is attached is properly grounded and not left floating nor serviced by a “doubly insulated ac power distribution system.” The use of floating or insulated equipment, and the consequent implications for safety, are beyond the scope of this standard.

27.5.2.3 Installation and maintenance guidelines

During installation and maintenance of the cable plant, care should be taken to ensure that uninsulated network cable connectors do not make electrical contact with unintended conductors or ground.

27.5.3 Electrical isolation

There are two electrical power distribution environments to be considered that require different electrical isolation properties:

a) *Environment A.* When a LAN or LAN segment, with all its associated interconnected equipment, is entirely contained within a single low-voltage power distribution system and within a single building.
b) *Environment B.* When a LAN crosses the boundary between separate power distribution systems or the boundary of a single building.

27.5.3.1 Environment A requirements

Attachment of network segments via repeater sets requires electrical isolation of 500 V rms, one-minute withstand, between the segment and the protective ground of the repeater unit.

27.5.3.2 Environment B requirements

The attachment of network segments that cross environment B boundaries requires electrical isolation of 1500 V rms, one-minute withstand, between each segment and all other attached segments and also the protective ground of the repeater unit.

The requirements for interconnected electrically conducting LAN segments that are partially or fully external to a single building environment may require additional protection against lightning strike hazards. Such requirements are beyond the scope of this standard. It is recommended that the above situation be handled by the use of nonelectrically conducting segments (e.g., fiber optic).

It is assumed that any nonelectrically conducting segments will provide sufficient isolation within that media to satisfy the isolation requirements of environment B.

27.5.4 Reliability

A two-port repeater set shall be designed to provide a mean time between failure (MTBF) of at least 50 000 hours of continuous operation without causing a communications failure among stations attached to the network medium. Repeater sets with more than two ports shall add no more than 3.46×10^{-6} failures per hour for each additional port.

The repeater set electronics should be designed to minimize the probability of component failures within the repeater electronics that prevent communications among other PHYs on the individual segments. Connectors and other passive components comprising the means of connecting the repeater to the cable should be designed to minimize the probability of total network failure.

27.5.5 Environment

27.5.5.1 Electromagnetic emission

The repeater shall comply with applicable local and national codes for the limitation of electromagnetic interference.

27.5.5.2 Temperature and humidity

The repeater is expected to operate over a reasonable range of environmental conditions related to temperature, humidity, and physical handling (such as shock and vibration). Specific requirements and values for these parameters are considered to be beyond the scope of this standard.

It is recommended that manufacturers indicate in the literature associated with the repeater the operating environmental conditions to facilitate selection, installation, and maintenance.

27.6 Repeater labeling

It is required that each repeater (and supporting documentation) shall be labeled in a manner visible to the user with these parameters:

a) Crossover ports appropriate to the respective PHY should be marked with an X.
b) The repeater set class type should be labeled in the following manner:
   1) Class I: a Roman numeral "I" centered within a circle.
   2) Class II: a Roman numeral "II" centered within a circle.

Additionally it is recommended that each repeater (and supporting documentation) also be labeled in a manner visible to the user with at least these parameters:

a) Data rate capability in Mb/s
b) Any applicable safety warnings
c) Port type, i.e., 100BASE-TX and 100BASE-T4
d) Worst-case bit time delays between any two ports appropriate for
   1) Start-of-packet propagation delay
   2) Start-of-collision Jam propagation delay
   3) Cessation-of-collision Jam propagation delay

27.7 Protocol Implementation Conformance Statement (PICS) proforma for clause 27, Repeater for 100 Mb/s baseband networks[26]

27.7.1 Introduction

The supplier of a protocol implementation that is claimed to conform to IEEE Std 802.3u-1995, Repeater for 100 Mb/s baseband networks, shall complete the following Protocol Implementation Conformance Statement (PICS) proforma.

27.7.2 Identification

27.7.2.1 Implementation identification

Supplier	
Contact point for enquiries about the PICS	
Implementation Name(s) and Version(s)	
Other information necessary for full identification—e.g., name(s) and version(s) for machines and/or operating systems; System Names(s)	
NOTES 1—Only the first three items are required for all implementations; other information may be completed as appropriate in meeting the requirements for the identification. 2—The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g., Type, Series, Model).	

27.7.2.2 Protocol summary

Identification of protocol standard	IEEE Std 802.3u-1995, Repeater for 100 Mb/s baseband networks
Identification of amendments and corrigenda to this PICS proforma that have been completed as part of this PICS	
Have any Exception items been required? No [ ] Yes [ ] (See clause 21; the answer Yes means that the implementation does not conform to IEEE Std 802.3u-1995.)	
Date of Statement	

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[26] *Copyright release for PICS proformas* Users of this standard may freely reproduce the PICS proforma in this annex so that it can be used for its intended purpose and may further publish the completed PICS.

27.7.3 Major capabilities/options

Item	Feature	Subclause	Status	Support	Value/Comment
*FXP	Repeater supports 100BASEFX connections	27.1.2.2	O		
*TXP	Repeater supports 100BASETX connections	27.1.2.2	O		
*T4P	Repeater supports 100BASET4 connections	27.1.2.2	O		
*CLI	Repeater meets Class I delays	27.1.1.3	O		
*CLII	Repeater meets Class II delays	27.1.1.3	O		
*PHYS	PHYs capable of detecting non 100BASE-T signals	27.3.1.5.2	O		

In addition, the following predicate name is defined for use when different implementations from the set above have common parameters:

*XP:FXP or TXP

27.7.4 PICS proforma tables for the Repeater for 100 Mb/s baseband networks

27.7.4.1 Compatibility considerations

Item	Feature	Subclause	Status	Support	Value/Comment
CC1	100BASE-FX port compatible at the MDI	27.1.2.2	FXP:M		
CC2	100BASE-TX port compatible at the MDI	27.1.2.2	TXP:M		
CC3	100BASE-T4 port compatible at the MDI	27.1.2.2	T4P:M		
CC4	Internal segment compatibility	27.1.2.2.1	M		Internal port meets clause 29 when repeater management implemented

27.7.4.2 Repeater functions

Item	Feature	Subclause	Status	Support	Value/Comment
RF1	Signal Restoration	27.3.1	M		
RF2	Data Handling	27.3.1	M		
RF3	Received Event Handling	27.3.1	M		
RF4	Collision Handling	27.3.1	M		
RF5	Error Handling	27.3.1	M		
RF6	Partition	27.3.1	M		
RF7	Received Jabber	27.3.1	M		

27.7.4.3 Signal restoration function

Item	Feature	Subclause	Status	Support	Value/Comment
SR1	Output amplitude as required by 100BASE-FX	27.3.1.1.1	FXP:M		
SR2	Output amplitude as required by 100BASE-TX	27.3.1.1.1	TXP:M		
SR3	Output amplitude as required by 100BASE-T4	27.3.1.1.1	T4P:M		
SR4	Output signal wave-shape as required by 100BASE-FX	27.3.1.1.2	FXP:M		
SR5	Output signal wave-shape as required by 100BASE-TX	27.3.1.1.2	TXP:M		
SR6	Output signal wave-shape as required by 100BASE-T4	27.3.1.1.2	T4P:M		
SR7	Output data timing as required by 100BASE-FX	27.3.1.1.3	FXP:M		
SR8	Output data timing as required by 100BASE-TX	27.3.1.1.3	TXP:M		
SR9	Output data timing as required by 100BASE-T4	27.3.1.1.3	T4P:M		

27.7.4.4 Data-Handling function

Item	Feature	Subclause	Status	Support	Value/Comment
DH1	Data frames forwarded to all ports except receiving port	27.3.1.2.1	M		
DH2	Data frames transmitted as appropriate for 100BASE-FX	27.3.1.2.1	FXP:M		
DH3	Data frames transmitted as appropriate for 100BASE-TX	27.3.1.2.1	TXP:M		
DH4	Data frames transmitted as appropriate for 100BASE-T4	27.3.1.2.1	T4P:M		
DH5	Code Violations forwarded to all transmitting ports	27.3.1.2.2	M		
DH6	Code Violations forwarded as received	27.3.1.2.2	O.1		
DH7	Received Code Violation forwarded as /H/ or as received	27.3.1.2.2	XP:O.1		
DH8	Received Code Violation forwarded as bad_code or as received	27.3.1.2.2	T4P:O.1		
DH9	Code element substitution for remainder of packet after received Code Violation	27.3.1.2.2	M		

27.7.4.5 Receive Event-Handling function

Item	Feature	Subclause	Status	Support	Value/Comment
RE1	scarrier_present detect implemented	27.3.1.3.1	M		
RE2	Repeat all received signals	27.3.1.3.1	M		
RE3	Preamble encoded as required by 100BASE-FX	27.3.1.3.2	FXP:M		
RE4	Preamble encoded as required by 100BASE-TX	27.3.1.3.2	TXP:M		
RE5	Preamble encoded as required by 100BASE-T4	27.3.1.3.2	T4P:M		
RE6	Start-of-packet propagation delay, Class I repeater	27.3.1.3.3	CLI:M		
RE7	Start-of-packet propagation delay, Class II repeater	27.3.1.3.3	CLII:M		

Item	Feature	Subclause	Status	Support	Value/Comment
RE8	Start-of-packet variability for 100BASE-FX input port	27.3.1.3.4	FXP:M		7.0 BT
RE8	Start-of-packet variability for 100BASE-TX input port	27.3.1.3.4	TXP:M		7.0 BT
RE9	Start-of-packet variability for 100BASE-T4 input port	27.3.1.3.4	T4P:M		8.0 BT

27.7.4.6 Collision-Handling function

Item	Feature	Subclause	Status	Support	Value/Comment
CO1	Collision Detection	27.3.1.4.1	M		Receive event on more than one port
CO2	Jam Generation	27.3.1.4.2	M		Transmit Jam message while collision is detected
CO3	Collision-Jam Propagation delay, Class I repeater.	27.3.1.4.3	CLI:M		SOP + SOJ ≤ 140 BT
CO4	Collision-Jam Propagation delay, Class II repeater with any port T4	27.3.1.4.3	CLII:M		SOP + SOJ ≤ 67 BT
CO5	Collision-Jam Propagation delay, Class II repeater, all TX/FX ports	27.3.1.4.3	CLII:M		SOP ≤ 46, SOJ ≤ 46 BT
CO6	Cessation of Collision Propagation delay, Class I repeater	27.3.1.4.4	CLI:M		EOJ ≤ SOP
CO7	Cessation of Collision Propagation delay, Class II repeater	27.3.1.4.4	CLII:M		EOJ ≤ SOP

27.7.4.7 Error-Handling function

Item	Feature	Subclause	Status	Support	Value/Comment
EH1	Carrier Integrity function implementation	27.3.1.5.1	XP:M		Self-interrupt of data reception
EH2	False carrier count for Link Unstable detection	27.3.1.5.1	XP:M		False carrier count in excess of FCCLimit
EH3	False carrier count reset	27.3.1.5.1	XP:M		Count reset on valid carrier
EH4	False carrier timer for Link Unstable detection	27.3.1.5.1	XP:M		False carrier of length in excess of false_carrier_timer
EH5	Jam message duration	27.3.1.5.1	XP:M		Equals duration of false carrier event, but not greater than duration of false_carrier_timer
EH6	Link Unstable detection	27.3.1.5.1	XP:M		False Carrier count exceed FCCLimit or False carrier exceeds the false_carrier_timer or power-up reset
EH7	Messages sent to repeater unit in Link Unstable state	27.3.1.5.1	XP:M		Inhibited sending messages to repeater unit
EH8	Messages sent from repeater unit in Link Unstable state	27.3.1.5.1	XP:M		Inhibited sending output messages

Item	Feature	Subclause	Status	Support	Value/Comment
EH9	Monitoring activity on PMA interface in Link Unstable state	27.3.1.5.1	XP:M		Continue monitoring activity at PMA interface
EH10	Reset of Link Unstable state	27.3.1.5.1	XP:M		No activity for more than ipg_timer plus idle_timer or Valid carrier event of duration greater than valid_carrier_timer preceded by Idle of duration greater than ipg_timer
EH11	Block flow of non-100 Mb/s signals	27.3.1.5.2	PHYS:M		

27.7.4.8 Partition function

Item	Feature	Subclause	Status	Support	Value/Comment
PA1	Partition function implementation	27.3.1.6	M		Self-interrupt of data reception
PA2	Consecutive collision count for entry into partition state	27.3.1.6	M		Consecutive collision in excess of CCLimit
PA3	Consecutive collision counter incrementing	27.3.1.6	M		Count incremented on each transmission that suffers a collision
PA4	Consecutive collision counter reset	27.3.1.6	M		Count reset on successful collision
PA5	Messages sent to repeater unit in Partition state	27.3.1.6	M		Inhibited sending messages to repeater unit
PA6	Messages sent from repeater unit in Partition state	27.3.1.6	M		Continue sending output messages
PA7	Monitoring activity on PMA interface in Partition state	27.3.1.6	M		Continue monitoring activity at PMA interface
PA8	Reset of Partition state	27.3.1.6	M		Power-up reset or Detecting activity for greater than duration no_collision_timer without a collision

27.7.4.9 Receive Jabber function

Item	Feature	Subclause	Status	Support	Value/Comment
RJ1	Receive Jabber function implementation	27.3.1.7	M		Self-interrupt of data reception
RJ2	Excessive receive duration timer for Receive Jabber detection	27.3.1.7	M		Reception duration in excess of jabber_timer
RJ3	Messages sent to repeater unit in Receive Jabber state	27.3.1.7	M		Inhibit sending input messages to repeater unit
RJ4	Messages sent from repeater unit in Receive Jabber state	27.3.1.7	M		Inhibit sending output messages
RJ5	Reset of Receive Jabber state	27.3.1.7	M		Power-up reset or Carrier no longer detected

27.7.4.10 Repeater state diagrams

Item	Feature	Subclause	Status	Support	Value/Comment
SD1	Repeater core state diagram	27.3.2.2	M		Meets the requirements of figure 27-2
SD2	Receive state diagram for port X	27.3.2.2	M		Meets the requirements of figure 27-3
SD3	100BASE-TX and 100BASE-FX Transmit state diagram for port X	27.3.2.2	XP:M		Meets the requirements of figure 27-4
SD4	100BASE-T4 Transmit state diagram for port X	27.3.2.2	T4P:M		Meets the requirements of figure 27-5
SD5	Repeater data-handler state diagram	27.3.2.2	M		Meets the requirements of figure 27-6
SD6	Receive timer for port X state diagram	27.3.2.2	M		Meets the requirements of figure 27-7
SD7	Repeater partition state diagram for port X	27.3.2.2	M		Meets the requirements of figure 27-8
SD8	Carrier integrity monitor for port X state diagram	27.3.2.2	M		Meets the requirements of figure 27-9

27.7.4.11 Repeater electrical

Item	Feature	Subclause	Status	Support	Value/Comment
EL1	Port-to-port isolation	27.4.1	M		Satisfies isolation and grounding requirements for attached network segments
EL2	Safety	27.5.1	M		IEC 950: 1991
EL3	Installation practices	27.5.2.1	M		Sound, as defined by local code and regulations
EL4	Grounding	27.5.2.2	M		Chassis ground provided through ac mains cord
EL5	2-port repeater set MTBF	27.5.4	M		At least 50 000 hours
EL6	Additional port effect on MTBF	27.5.4	M		No more than 3.46×10^{-6} increase in failures per hour
EL7	Electromagnetic interference	27.5.5.1	M		Comply with local or national codes

27.7.4.12 Repeater labeling

Item	Feature	Subclause	Status	Support	Value/Comment
LB1	Crossover ports	27.6	M		Marked with an X
LB2	Class I repeater	27.6	CLI:M		Marked with a Roman numeral I centered within a circle
LB3	Class II repeater	27.6	CLII:M		Marked with Roman numerals II centered within a circle
LB4	Data Rate	27.6	O		100 Mb/s
LB5	Safety warnings	27.6	O		Any applicable
LB6	Port Types	27.6	O		100BASE-FX, 100BASE-TX or 100BASE-T4
LB7	Worse-case start-of-packet propagation delay	27.6	O		Value in Bit Times
LB8	Worse-case start-of-collision-Jam propagation delay	27.6	O		Value in Bit Times
LB9	Worse-case Cessation-of-Collision Jam propagation delay	27.6	O		Value in Bit Times

28. Physical Layer link signaling for 10 Mb/s and 100 Mb/s Auto-Negotiation on twisted pair

28.1 Overview

28.1.1 Scope

Clause 28 describes the Auto-Negotiation function that allows a device to advertise enhanced modes of operation it possesses to a device at the remote end of a link segment and to detect corresponding enhanced operational modes that the other device may be advertising.

The objective of the Auto-Negotiation function is to provide the means to exchange information between two devices that share a link segment and to automatically configure both devices to take maximum advantage of their abilities. Auto-Negotiation is performed using a modified 10BASE-T link integrity test pulse sequence, such that no packet or upper layer protocol overhead is added to the network devices (see figure 28-1). Auto-Negotiation does not test the link segment characteristics (see 28.1.4).

The function allows the devices at both ends of a link segment to advertise abilities, acknowledge receipt and understanding of the common mode(s) of operation that both devices share, and to reject the use of operational modes that are not shared by both devices. Where more than one common mode exists between the two devices, a mechanism is provided to allow the devices to resolve to a single mode of operation using a predetermined priority resolution function. The Auto-Negotiation function allows the devices to switch between the various operational modes in an ordered fashion, permits management to disable or enable the Auto-Negotiation function, and allows management to select a specific operational mode. The Auto-Negotiation function also provides a Parallel Detection function to allow 10BASE-T, 100BASE-TX, and 100BASE-T4 compatible devices to be recognized, even though they may not provide Auto-Negotiation.

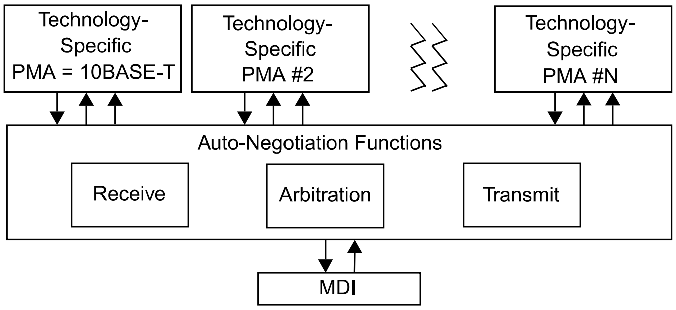


Figure 28-1—High-level model

The basic mechanism to achieve Auto-Negotiation is to pass information encapsulated within a burst of closely spaced link integrity test pulses that individually meet the 10BASE-T Transmitter Waveform for Link Test Pulse (figure 14-12). This burst of pulses is referred to as a Fast Link Pulse (FLP) Burst. Each device capable of Auto-Negotiation issues FLP Bursts at power up, on command from management, or due to user interaction. The FLP Burst consists of a series of link integrity test pulses that form an alternating clock/data sequence. Extraction of the data bits from the FLP Burst yields a Link Code Word that identifies the operational modes supported by the remote device, as well as some information used for the Auto-Negotiation function's handshake mechanism.

To maintain interoperability with existing 10BASE-T devices, the function also supports the reception of 10BASE-T compliant link integrity test pulses. 10BASE-T link pulse activity is referred to as the Normal Link Pulse (NLP) sequence and is defined in 14.2.1.1. A device that fails to respond to the FLP Burst sequence by returning only the NLP sequence is treated as a 10BASE-T compatible device.

28.1.2 Application perspective/objectives

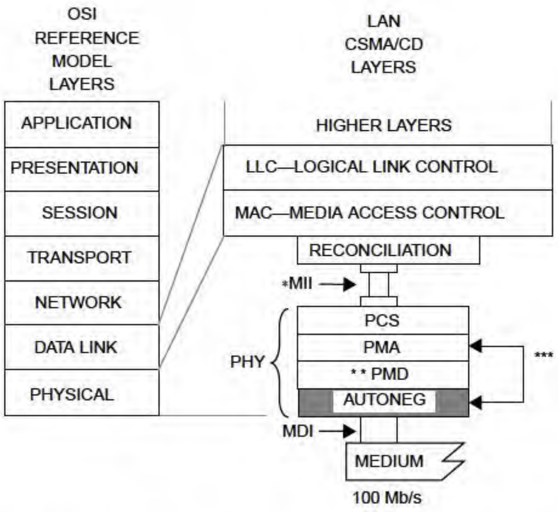
The Auto-Negotiation function is designed to be expandable and allow IEEE 802.3 compatible devices using an eight-pin modular connector to self-configure a jointly compatible operating mode. Implementation of the Auto-Negotiation function is optional. However, it is highly recommended that this method alone be utilized to perform the negotiation of the link operation.

The following are the objectives of Auto-Negotiation:

a) Must interoperate with the IEEE 802.3 10BASE-T installed base.
b) Must allow automatic upgrade from the 10BASE-T mode to the desired "High-Performance Mode."
c) Requires that the 10BASE-T data service is the Lowest Common Denominator (LCD) that can be resolved. A 10BASE-T PMA is not required to be implemented, however. Only the NLP Receive Link Integrity Test function is required.
d) Reasonable and cost-effective to implement.
e) Must provide a sufficiently extensible code space to
    1) Meet existing and future requirements.
    2) Allow simple extension without impacting the installed base.
    3) Accommodate remote fault signals.
    4) Accommodate link partner ability detection.
f) Must allow manual or Network Management configuration to override the Auto-Negotiation.
g) Must be capable of operation in the absence of Network Management.
h) Must not preclude the ability to negotiate "back" to the 10BASE-T operational mode.
i) Must operate when
    1) The link is initially electrically connected.
    2) A device at either end of the link is powered up, reset, or a renegotiation request is made.
j) The Auto-Negotiation function may be enabled by automatic, manual, or Network Management intervention.
k) Completes the base page Auto-Negotiation function in a bounded time period.
l) Will provide the basis for the link establishment process in future CSMA/CD compatible LAN standards that use an eight-pin modular connector.
m) Must not cause corruption of IEEE 802.3 Layer Management statistics.
n) Operates using a peer-to-peer exchange of information with no requirement for a master device (not master-slave).
o) Must be robust in the UTP cable noise environment.
p) Must not significantly impact EMI/RFI emissions.

28.1.3 Relationship to ISO/IEC 8802-3

The Auto-Negotiation function is provided at the Physical Layer of the OSI reference model as shown in figure 28-2. Devices that support multiple modes of operation may advertise this fact using this function. The actual transfer of information of ability is observable only at the MDI or on the medium. Auto-Negotiation signaling does not occur across either the AUI or MII. Control of the Auto-Negotiation function may be supported through the Management Interface of the MII or equivalent. If an explicit embodiment of the MII is supported, the control and status registers to support the Auto-Negotiation function shall be implemented in accordance with the definitions in clause 22 and 28.2.4. If a physical embodiment of the MII management is not present, then it is strongly recommended that the implementation provide control and status mechanisms equivalent to those described in clause 22 and 28.2.4 for manual and/or management interaction.



MDI = MEDIUM DEPENDENT INTERFACE
MII = MEDIA INDEPENDENT INTERFACE
AUTONEG = AUTO-NEGOTIATION

PCS = PHYSICAL CODING SUBLAYER
PMA = PHYSICAL MEDIUM ATTACHMENT
PHY = PHYSICAL LAYER DEVICE
PMD = PHYSICAL MEDIUM DEPENDENT

* MII is optional for 10 Mb/s DTEs and for 100 Mb/s systems and is not specified for 1 Mb/s systems.
** PMD is specified for 100BASE-X only; 100BASE-T4 does not use this layer.
*** AUTONEG communicates with the PMA sublayer through the PMA service interface messages PMA_LINK.request and PMA_LINK.indicate.

Figure 28-2—Location of Auto-Negotiation function within the ISO reference model

28.1.4 Compatibility considerations

The Auto-Negotiation function is designed to be completely backwards compatible and interoperable with 10BASE-T compliant devices. In order to achieve this, a device supporting the Auto-Negotiation function must provide the NLP Receive Link Integrity Test function as defined in figure 28-17. The Auto-Negotiation function also supports connection to 100BASE-TX and 100BASE-T4 devices without Auto-Negotiation through the Parallel Detection function. Connection to technologies other than 10BASE-T, 100BASE-TX, or 100BASE-T4 that do not incorporate Auto-Negotiation is not supported.

Implementation of the Auto-Negotiation function is optional. For CSMA/CD compatible devices that use the eight-pin modular connector of ISO/IEC 8877: 1992 and that also encompass multiple operational modes, if a signaling method is used to automatically configure the preferred mode of operation, then the Auto-Negotiation function shall be used in compliance with clause 28. If the device uses 10BASE-T compatible link signaling to advertise non-CSMA/CD abilities, the device shall implement the Auto-Negotiation function as administered by this specification. All future CSMA/CD implementations that use an eight-pin modular connector shall be interoperable with devices supporting clause 28. If the implementor of a non-CSMA/CD eight-pin modular device wishes to assure that its operation does not conflict with CSMA/CD devices, then adherence to clause 28 is recommended.

While this Auto-Negotiation function must be implemented in CSMA/CD compatible devices that utilize the eight-pin modular connector, encompass multiple operational modes, and offer an Auto-Negotiation mechanism, the use of this function does not mandate that the 10BASE-T packet data communication service must exist. A device that employs this function must support the 10BASE-T Link Integrity Test function through the NLP Receive Link Integrity Test state diagram. The device may also need to support other technology-dependent link test functions depending on the modes supported. Auto-Negotiation does not perform cable tests, such as detect number of conductor pairs (if more than two pairs are required) or cable performance measurements. Some PHYs that explicitly require use of high-performance cables, may require knowledge of the cable type, or additional robustness tests (such as monitoring CRC or framing errors) to determine if the link segment is adequate.

28.1.4.1 Interoperability with existing 10BASE-T devices

During Auto-Negotiation, FLP Bursts separated by 16 ± 8 ms are transmitted. The FLP Burst itself is a series of pulses separated by 62.5 ± 7 µs. The timing of FLP Bursts will cause a 10BASE-T device that is in the LINK TEST PASS state to remain in the LINK TEST PASS state while receiving FLP Bursts. An Auto-Negotiation able device must recognize the NLP sequence from a 10BASE-T Link Partner, cease transmission of FLP Bursts, and enable the 10BASE-T PMA, if present. If the NLP sequence is detected and if the Auto-Negotiation able device does not have a 10BASE-T PMA, it will cease transmission of FLP Bursts, forcing the 10BASE-T Link Partner into the LINK TEST FAIL state(s) as indicated in figure 14-6.

NOTE—Auto-Negotiation does not support the transmission of the NLP sequence. The 10BASE-T PMA provides this function if it is connected to the MDI. In the case where an Auto-Negotiation able device without a 10BASE-T PMA is connected to a 10BASE-T device without Auto-Negotiation, the NLP sequence is not transmitted because the Auto-Negotiation function has no 10BASE-T PMA to enable that can transmit the NLP sequence.

28.1.4.2 Interoperability with Auto-Negotiation compatible devices

An Auto-Negotiation compatible device decodes the base Link Code Word from the FLP Burst, and examines the contents for the highest common ability that both devices share. Both devices acknowledge correct receipt of each other’s base Link Code Words by responding with FLP Bursts containing the Acknowledge Bit set. After both devices complete acknowledgment, and optionally, Next Page exchange, both devices enable the highest common mode negotiated. The highest common mode is resolved using the priority resolution hierarchy specified in annex 28B. It may subsequently be the responsibility of a technology-dependent link integrity test function to verify operation of the link prior to enabling the data service.

28.1.4.3 Cabling compatibility with Auto-Negotiation

Provision has been made within Auto-Negotiation to limit the resulting link configuration in situations where the cabling may not support the highest common capability of the two end points. The system administrator/installer must take the cabling capability into consideration when configuring a hub port’s advertised capability. That is, the advertised capability of a hub port should not result in an operational mode that is not compatible with the cabling.

28.2 Functional specifications

The Auto-Negotiation function provides a mechanism to control connection of a single MDI to a single PMA type, where more than one PMA type may exist. Management may provide additional control of Auto-Negotiation through the Management function, but the presence of a management agent is not required.

The Auto-Negotiation function shall provide the Auto-Negotiation Transmit, Receive, Arbitration, and NLP Receive Link Integrity Test functions and comply with the state diagrams of figures 28-14 to 28-17. The Auto-Negotiation functions shall interact with the technology-dependent PMAs through the Technology-Dependent Interface. Technology-dependent PMAs include, but are not limited to, 100BASE-TX and 100BASE-T4. Technology-dependent link integrity test functions shall be implemented and interfaced to only if the device supports the given technology. For example, a 10BASE-T and 100BASE-TX Auto-Negotiation able device must implement and interface to the 100BASE-TX PMA/link integrity test function, but does not need to include the 100BASE-T4 PMA/Link Integrity Test function. The Auto-Negotiation function shall provide an optional Management function that provides a control and status mechanism.

28.2.1 Transmit function requirements

The Transmit function provides the ability to transmit FLP Bursts. The first FLP Bursts exchanged by the Local Device and its Link Partner after Power-On, link restart, or renegotiation contain the base Link Code Word defined in 28.2.1.2. The Local Device may modify the Link Code Word to disable an ability it possesses, but will not transmit an ability it does not possess. This makes possible the distinction between local abilities and advertised abilities so that multimode devices may Auto-Negotiate to a mode lower in priority than the highest common local ability.

28.2.1.1 Link pulse transmission

Auto-Negotiation's method of communication builds upon the link pulse mechanism employed by 10BASE-T MAUs to detect the status of the link. Compliant 10BASE-T MAUs transmit link integrity test pulses as a mechanism to determine if the link segment is operational in the absence of packet data. The 10BASE-T NLP sequence is a pulse (figure 14-12) transmitted every 16 ± 8 ms while the data transmitter is idle.

Auto-Negotiation substitutes the FLP Burst in place of the single 10BASE-T link integrity test pulse within the NLP sequence (figure 28-3). The FLP Burst encodes the data that is used to control the Auto-Negotiation function. FLP Bursts shall not be transmitted when Auto-Negotiation is complete and the highest common denominator PMA has been enabled.

FLP Bursts were designed to allow use beyond initial link Auto-Negotiation, such as for a link monitor type function. However, use of FLP Bursts beyond the current definition for link startup shall be prohibited. Definition of the use of FLP Bursts while in the FLP LINK GOOD state is reserved.

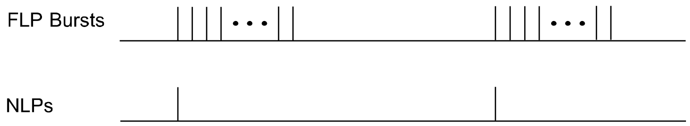


Figure 28-3—FLP Burst sequence to NLP sequence mapping

28.2.1.1.1 FLP burst encoding

FLP Bursts shall be composed of link pulses meeting the requirements of figure 14-12. A Fast Link Pulse Burst consists of 33 pulse positions. The 17 odd-numbered pulse positions shall contain a link pulse and represent clock information. The 16 even-numbered pulse positions shall represent data information as follows: a link pulse present in an even-numbered pulse position represents a logic one, and a link pulse absent from an even-numbered pulse position represents a logic zero. Clock pulses are differentiated from data pulses by the spacing between pulses as shown in figure 28-5 and enumerated in table 28-1.

The encoding of data using pulses in an FLP Burst is illustrated in figure 28-4.

28.2.1.1.2 Transmit timing

The first pulse in an FLP Burst shall be defined as a clock pulse. Clock pulses within an FLP Burst shall be spaced at 125 ± 14 µs. If the data bit representation of logic one is to be transmitted, a pulse shall occur 62.5 ± 7 µs after the preceding clock pulse. If a data bit representing logic zero is to be transmitted, there shall be no link integrity test pulses within 111 µs of the preceding clock pulse.

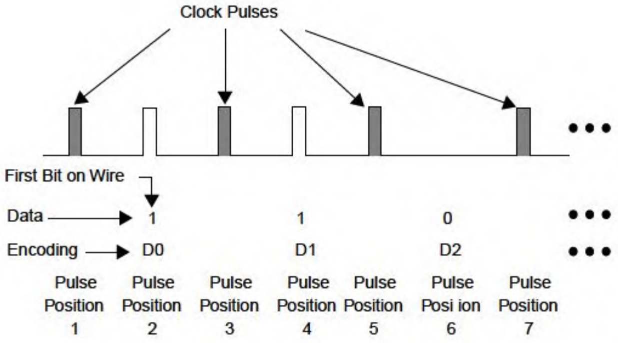


Figure 28-4—Data bit encoding within FLP Bursts

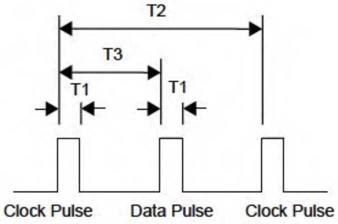


Figure 28-5—FLP Burst pulse-to-pulse timing

The first link pulse in consecutive FLP Bursts shall occur at a 16 ± 8 ms interval (figure 28-6).

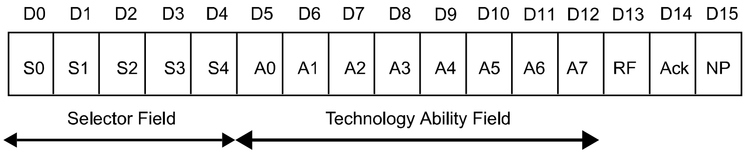
Figure 28-6—FLP Burst to FLP Burst timing

Table 28-1—FLP Burst timing summary

#	Parameter	Min.	Typ.	Max.	Units
T1	Clock/Data Pulse Width (figure 14-12)		100		ns
T2	Clock Pulse to Clock Pulse	111	125	139	µs
T3	Clock Pulse to Data Pulse (Data = 1)	55.5	62.5	69.5	µs
T4	Pulses in a Burst	17		33	#
T5	Burst Width		2		ms
T6	FLP Burst to FLP Burst	8	16	24	ms

28.2.1.2 Link Code Word encoding

The base Link Code Word (base page) transmitted within an FLP Burst shall convey the encoding shown in figure 28-7. The Auto-Negotiation function may support additional pages using the Next Page function. Encodings for the Link Code Word(s) used in Next Page exchange are defined in 28.2.3.4. In an FLP Burst, D0 shall be the first bit transmitted.



D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
S0	S1	S2	S3	S4	A0	A1	A2	A3	A4	A5	A6	A7	RF	Ack	NP

Figure 28-7—Base page encoding

28.2.1.2.1 Selector Field

Selector Field (S[4:0]) is a five bit wide field, encoding 32 possible messages. Selector Field encoding definitions are shown in annex 28A. Combinations not specified are reserved for future use. Reserved combinations of the Selector Field shall not be transmitted.

28.2.1.2.2 Technology Ability Field

Technology Ability Field (A[7:0]) is an eight bit wide field containing information indicating supported technologies specific to the selector field value. These bits are mapped to individual technologies such that abilities are advertised in parallel for a single selector field value. The Technology Ability Field encoding for the IEEE 802.3 selector is described in annex 28B.2. Multiple technologies may be advertised in the Link Code Word. A device shall support the data service ability for a technology it advertises. It is the responsibility of the Arbitration function to determine the common mode of operation shared by a Link Partner and to resolve multiple common modes.

NOTE—While devices using a Selector Field value other than the IEEE 802.3 Selector Field value are free to define the Technology Ability Field bits, it is recommended that the 10BASE-T bit be encoded in the same bit position as in the IEEE 802.3 selector. A common bit position can be important if the technology using the other selector will ever coexist on a device that also offers a 10BASE-T mode.

28.2.1.2.3 Remote Fault

Remote Fault (RF) is encoded in bit D13 of the base Link Code Word. The default value is logic zero. The Remote Fault bit provides a standard transport mechanism for the transmission of simple fault information. When the RF bit in the Auto-Negotiation advertisement register (register 4) is set to logic one, the RF bit in the transmitted base Link Code Word is set to logic one. When the RF bit in the received base Link Code Word is set to logic one, the Remote Fault bit in the MII status register (register 1) will be set to logic one, if the MII management function is present.

The Remote Fault bit shall be used in accordance with the Remote Fault function specifications (28.2.3.5).

28.2.1.2.4 Acknowledge

Acknowledge (Ack) is used by the Auto-Negotiation function to indicate that a device has successfully received its Link Partner’s Link Code Word. The Acknowledge Bit is encoded in bit D14 regardless of the value of the Selector Field or Link Code Word encoding. If no Next Page information is to be sent, this bit shall be set to logic one in the Link Code Word after the reception of at least three consecutive and consistent FLP Bursts (ignoring the Acknowledge bit value). If Next Page information is to be sent, this bit shall be set to logic one after the device has successfully received at least three consecutive and matching FLP Bursts (ignoring the Acknowledge bit value), and will remain set until the Next Page information has been loaded into the Auto-Negotiation Next Page register (register 7). In order to save the current received Link Code Word, this must be read from the Auto-Negotiation link partner ability register (register 6) before the Next Page of transmit information is loaded into the Auto-Negotiation Next Page register. After the COMPLETE ACKNOWLEDGE state has been entered, the Link Code Word shall be transmitted six to eight (inclusive) times.

28.2.1.2.5 Next Page

Next Page (NP) is encoded in bit D15 regardless of the Selector Field value or Link Code Word encoding. Support for transmission and reception of additional Link Code Word encodings is optional. If Next Page ability is not supported, the NP bit shall always be set to logic zero. If a device implements Next Page ability and wishes to engage in Next Page exchange, it shall set the NP bit to logic one. A device may implement Next Page ability and choose not to engage in Next Page exchange by setting the NP bit to a logic zero. The Next Page function is defined in 28.2.3.4.

28.2.1.3 Transmit Switch function

The Transmit Switch function shall enable the transmit path from a single technology-dependent PMA to the MDI once a highest common denominator choice has been made and Auto-Negotiation has completed.

During Auto-Negotiation, the Transmit Switch function shall connect only the FLP Burst generator controlled by the Transmit State Diagram, figure 28-14, to the MDI.

When a PMA is connected to the MDI through the Transmit Switch function, the signals at the MDI shall conform to all of the PHY’s specifications.

28.2.2 Receive function requirements

The Receive function detects the NLP sequence using the NLP Receive Link Integrity Test function of figure 28-17. The NLP Receive Link Integrity Test function will not detect link pass based on carrier sense.

The Receive function detects the FLP Burst sequence, decodes the information contained within, and stores the data in rx_link_code_word[16:1]. The Receive function incorporates a receive switch to control connection to the 100BASE-TX or 100BASE-T4 PMAs in addition to the NLP Receive Link Integrity Test function, excluding the 10BASE-T Link Integrity Test function present in a 10BASE-T PMA. If Auto-Negotiation detects link_status=READY from any of the technology-dependent PMAs prior to FLP Burst detection, the autoneg_wait_timer (28.3.2) is started. If any other technology-dependent PMA indicates link_status=READY when the autoneg_wait_timer expires, Auto-Negotiation will not allow any data service to be enabled and may signal this as a remote fault to the Link Partner using the base page and will flag this in the Local Device by setting the Parallel Detection Fault bit (6.4) in the Auto-Negotiation expansion register. If a 10BASE-T PMA exists above the Auto-Negotiation function, it is not permitted to receive MDI activity in parallel with the NLP Receive Link Integrity Test function or any other technology-dependent function.

28.2.2.1 FLP Burst ability detection and decoding

In figures 28-8 to 28-10, the symbol “t_0=0” indicates the event that caused the timers described to start, and all subsequent times given are referenced from that point. All timers referenced shall expire within the range specified in table 28-8 in 28.3.2.

The Receive function shall identify the Link Partner as Auto-Negotiation able if it receives 6 to 17 (inclusive) consecutive link pulses that are separated by at least flp_test_min_timer time (5–25 µs) but less than flp_test_max_timer time (165–185 µs) as shown in figure 28-8. The information contained in the FLP Burst that identifies the Link Partner as Auto-Negotiation able shall not be passed to the Arbitration function if the FLP Burst is not complete. The Receive function may use the FLP Burst that identifies the Link Partner as Auto-Negotiation able for ability matching if the FLP Burst is complete. However, it is not required to use this FLP Burst for any purpose other than identification of the Link Partner as Auto-Negotiation able. Implementations may ignore multiple FLP Bursts before identifying the Link Partner as Auto-Negotiation able to allow for potential receive equalization time.

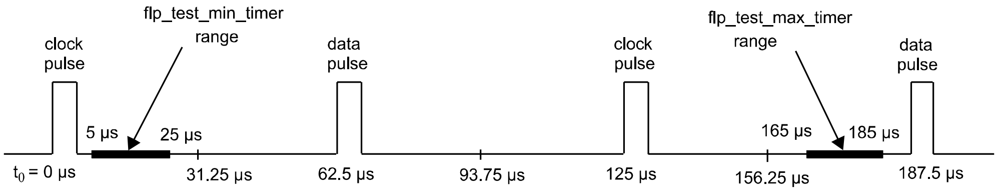


Figure 28-8—FLP detect timers (flp_test_min/max_timers)

The Receive function captures and decodes link pulses received in FLP Bursts. The first link pulse in an FLP Burst shall be interpreted as a clock link pulse. Detection of a clock link pulse shall restart the data_detect_min_timer and data_detect_max timer. The data_detect_min/max_timers enable the receiver to distinguish data pulses from clock pulses and logic one data from logic zero data, as follows:

a) If, during an FLP Burst, a link pulse is received when the data_detect_min_timer has expired while the data_detect_max_timer has not expired, the data bit shall be interpreted as a logic one (figure 28-9).
b) If, during an FLP Burst, a link pulse is received after the data_detect_max_timer has expired, the data bit shall be interpreted as a logic zero (figure 28-9) and that link pulse shall be interpreted as a clock link pulse.

As each data bit is identified it is stored in the appropriate rx_link_code_word[16:1] element.

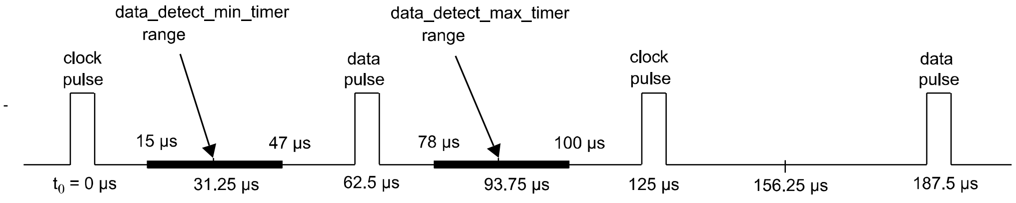
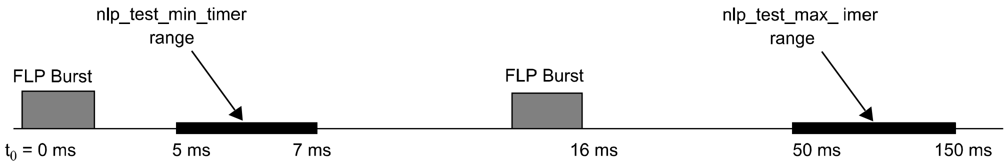


Figure 28-9—FLP data detect timers (data_detect_min/max_timers)

FLP Bursts conforming to the nlp_test_min_timer and nlp_test_max_timer timing as shown in figure 28-10 shall be considered to have valid separation.

28.2.2.2 NLP detection

NLP detection is accomplished via the NLP Receive Link Integrity Test function in figure 28-17. The NLP Receive Link Integrity Test function is a modification of the original 10BASE-T Link Integrity Test function (figure 14-6), where the detection of receive activity will not cause a transition to the LINK TEST PASS state during Auto-Negotiation. The NLP Receive Link Integrity Test function also incorporates the Technology-Dependent Interface requirements.



NOTE—The reference for the starting of the nlp_test_min_timer is from the beginning of the FLP Burst, as shown by t_0, while the reference for the starting of the nlp_test_max_timer is from the expiration of the nlp_test_min_timer.

Figure 28-10—FLP Burst timer (nlp_test_min/max_timers)

28.2.2.3 Receive Switch function

The Receive Switch function shall enable the receive path from the MDI to a single technology-dependent PMA once a highest common denominator choice has been made and Auto-Negotiation has completed.

During Auto-Negotiation, the Receive Switch function shall connect both the FLP Burst receiver controlled by the Receive state diagram, figure 28-15, and the NLP Receive Link Integrity Test state diagram, figure 28-17, to the MDI. During Auto-Negotiation, the Receive Switch function shall also connect the 100BASE-TX and 100BASE-T4 PMA receivers to the MDI if the 100BASE-TX and/or 100BASE-T4 PMAs are present.

When a PMA is connected to the MDI through the Receive Switch function, the signals at the PMA shall conform to all of the PHY's specifications.

28.2.2.4 Link Code Word matching

The Receive function shall generate ability_match, acknowledge_match, and consistency_match variables as defined in 28.3.1.

28.2.3 Arbitration function requirements

The Arbitration function ensures proper sequencing of the Auto-Negotiation function using the Transmit function and Receive function. The Arbitration function enables the Transmit function to advertise and acknowledge abilities. Upon indication of acknowledgment, the Arbitration function determines the highest common denominator using the priority resolution function and enables the appropriate technology-dependent PMA via the Technology-Dependent Interface (28.2.6).

28.2.3.1 Parallel detection function

The Local Device detects a Link Partner that supports Auto-Negotiation by FLP Burst detection. The Parallel Detection function allows detection of Link Partners that support 100BASE-TX, 100BASE-T4, and/or 10BASE-T, but do not support Auto-Negotiation. Prior to detection of FLP Bursts, the Receive Switch shall direct MDI receive activity to the NLP Receive Link Integrity Test state diagram, 100BASE-TX and 100BASE-T4 PMAs, if present, but shall not direct MDI receive activity to the 10BASE-T or any other PMA. If at least one of the 100BASE-TX, 100BASE-T4, or NLP Receive Link Integrity Test functions establishes link_status=READY, the LINK STATUS CHECK state is entered and the autoneg_wait_timer is started. If exactly one link_status=READY indication is present when the autoneg_wait_timer expires, then Auto-Negotiation shall set link_control=ENABLE for the PMA indicating link_status=READY. If a PMA is enabled, the Arbitration function shall set link_control=DISABLE to all other PMAs and indicate that Auto-Negotiation has completed. On transition to the FLP LINK GOOD CHECK state from the LINK STA-

TUS CHECK state the Parallel Detection function shall set the bit in the link partner ability register (register 5) corresponding to the technology detected by the Parallel Detection function.

NOTES

1—Native 10BASE-T devices will be detected by the NLP Receive Link Integrity Test function, an integrated part of the Auto-Negotiation function. Hence, Parallel Detection for the 10BASE-T PMA is not required or allowed.

2—When selecting the highest common denominator through the Parallel Detection function, only the half-duplex mode corresponding to the selected PMA may automatically be detected.

28.2.3.2 Renegotiation function

A renegotiation request from any entity, such as a management agent, shall cause the Arbitration function to disable all technology-dependent PMAs and halt any transmit data and link pulse activity until the break_link_timer expires (28.3.2). Consequently, the Link Partner will go into link fail and normal Auto-Negotiation resumes. The Local Device shall resume Auto-Negotiation after the break_link_timer has expired by issuing FLP Bursts with the base page valid in tx_link_code_word[16:1].

Once Auto-Negotiation has completed, renegotiation will take place if the Highest Common Denominator technology that receives link_control=ENABLE returns link_status=FAIL. To allow the PMA an opportunity to determine link integrity using its own link integrity test function, the link_fail_inhibit_timer qualifies the link_status=FAIL indication such that renegotiation takes place if the link_fail_inhibit_timer has expired and the PMA still indicates link_status=FAIL or link_status=READY.

28.2.3.3 Priority Resolution function

Since a Local Device and a Link Partner may have multiple common abilities, a mechanism to resolve which mode to configure is required. The mechanism used by Auto-Negotiation is a Priority Resolution function that predefines the hierarchy of supported technologies. The single PMA enabled to connect to the MDI by Auto-Negotiation shall be the technology corresponding to the bit in the Technology Ability Field common to the Local Device and Link Partner that has the highest priority as defined in annex 28B. This technology is referred to as the Highest Common Denominator, or HCD, technology. If the Local Device receives a Technology Ability Field with a bit set that is reserved, the Local Device shall ignore that bit for priority resolution. Determination of the HCD technology occurs on entrance to the FLP LINK GOOD CHECK state. In the event that a technology is chosen through the Parallel Detection function, that technology shall be considered the highest common denominator (HCD) technology. In the event that there is no common technology, HCD shall have a value of “NULL,” indicating that no PMA receives link_control=ENABLE, and link_status_[HCD]=FAIL.

28.2.3.4 Next Page function

The Next Page function uses the standard Auto-Negotiation arbitration mechanisms to allow exchange of arbitrary pieces of data. Data is carried by optional Next Pages of information, which follow the transmission and acknowledgment procedures used for the base Link Code Word. Two types of Next Page encodings are defined: Message Pages and Unformatted Pages.

A dual acknowledgment system is used. Acknowledge (Ack) is used to acknowledge receipt of the information; Acknowledge 2 (Ack2) is used to indicate that the receiver is able to act on the information (or perform the task) defined in the message.

Next Page operation is controlled by the same two mandatory control bits, Next Page and Acknowledge, used in the Base Link Code Word. Setting the NP bit in the Base Link Code Word to logic one indicates that the device is Next Page Able. If both a device and its Link Partner are Next Page Able, then Next Page exchange may occur. If one or both devices are not Next Page Able, then Next Page exchange will not occur and, after the base Link Code Words have been exchanged, the FLP LINK GOOD CHECK state will be entered. The Toggle bit is used to ensure proper synchronization between the Local Device and the Link Partner.

Next Page exchange occurs after the base Link Code Words have been exchanged. Next Page exchange consists of using the normal Auto-Negotiation arbitration process to send Next Page messages. Two message encodings are defined: Message Pages, which contain predefined 11 bit codes, and Unformatted Pages. Unformatted Pages can be combined to send extended messages. If the Selector Field values do not match, then each series of Unformatted Pages shall be preceded by a Message Page containing a message code that defines how the following Unformatted Pages will be interpreted. If the Selector Field values match, then the convention governing the use of Message Pages shall be as defined by the Selector Field value definition. Any number of Next Pages may be sent in any order; however, it is recommended that the total number of Next Pages sent be kept small to minimize the link startup time.

Next Page transmission ends when both ends of a link segment set their Next Page bits to logic zero, indicating that neither has anything additional to transmit. It is possible for one device to have more pages to transmit than the other device. Once a device has completed transmission of its Next Page information, it shall transmit Message Pages with Null message codes and the NP bit set to logic zero while its Link Partner continues to transmit valid Next Pages. An Auto-Negotiation able device shall recognize reception of Message Pages with Null message codes as the end of its Link Partner's Next Page information.

28.2.3.4.1 Next Page encodings

The Next Page shall use the encoding shown in figures 28-11 and 28-12 for the NP, Ack, MP, Ack2, and T bits. The 11-bit field D10–D0 shall be encoded as a Message Code Field if the MP bit is logic one and an Unformatted Code Field if MP is set to logic zero.

D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	T	Ack2	MP	Ack	NP

Message Code Field

Figure 28-11—Message Page encoding

D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
U0	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	T	Ack2	MP	Ack	NP

Unformatted Code Field

Figure 28-12—Unformatted Page encoding

28.2.3.4.2 Next Page

Next Page (NP) is used by the Next Page function to indicate whether or not this is the last Next Page to be transmitted. NP shall be set as follows:

logic zero = last page.
logic one = additional Next Page(s) will follow.

28.2.3.4.3 Acknowledge

As defined in 28.2.1.2.4.

28.2.3.4.4 Message Page

Message Page (MP) is used by the Next Page function to differentiate a Message Page from an Unformatted Page. MP shall be set as follows:

logic zero = Unformatted Page.
logic one = Message Page.

28.2.3.4.5 Acknowledge 2

Acknowledge 2 (Ack2) is used by the Next Page function to indicate that a device has the ability to comply with the message. Ack2 shall be set as follows:

logic zero = cannot comply with message.
logic one = will comply with message.

28.2.3.4.6 Toggle

Toggle (T) is used by the Arbitration function to ensure synchronization with the Link Partner during Next Page exchange. This bit shall always take the opposite value of the Toggle bit in the previously exchanged Link Code Word. The initial value of the Toggle bit in the first Next Page transmitted is the inverse of bit 11 in the base Link Code Word and, therefore, may assume a value of logic one or zero. The Toggle bit shall be set as follows:

logic zero = previous value of the transmitted Link Code Word equalled logic one.
logic one = previous value of the transmitted Link Code Word equalled logic zero.

28.2.3.4.7 Message Page encoding

Message Pages are formatted pages that carry a single predefined Message Code, which is enumerated in annex 28C. Two-thousand and forty-eight Message Codes are available. The allocation of these codes will be controlled by the contents of annex 28C. If the Message Page bit is set to logic one, then the bit encoding of the Link Code Word shall be interpreted as a Message Page.

28.2.3.4.8 Message Code Field

Message Code Field (M[10:0]) is an eleven bit wide field, encoding 2048 possible messages. Message Code Field definitions are shown in annex 28C. Combinations not specified are reserved for future use. Reserved combinations of the Message Code Field shall not be transmitted.

28.2.3.4.9 Unformatted Page encoding

Unformatted Pages carry the messages indicated by Message Pages. Five control bits are predefined, the remaining 11 bits may take on an arbitrary value. If the Message Page bit is set to logic zero, then the bit encoding of the Link Code Word shall be interpreted as an Unformatted Page.

28.2.3.4.10 Unformatted Code Field

Unformatted Code Field (U[10:0]) is an eleven bit wide field, which may contain an arbitrary value.