

5-4 Ethernet Link Object

Class Code: F6_{hex}

5-4.1 Scope

The Ethernet Link Object maintains link-specific counters and status information for a Ethernet 802.3 communications interface. Each device shall support exactly one instance of the Ethernet Link Object for each Ethernet IEEE 802.3 communications interface on the module. Devices may use an Ethernet Link Object instance for an internally accessible interface, such as an internal port for an embedded switch, Refer to Chapter 6 (Device Profiles) for additional information on multi-port EtherNet/IP devices.

5-4.2 Revision History

Since the initial release of this object class definition changes have been made that require a revision update of this object class. The table below represents the revision history.

Table 5-4.1 Revision History

Revision	Reason for Object Definition Update
1	Initial revision of this object definition
2	Add Instance Attribute 6, Interface Control
3	Add new instance attributes 7-10 providing support for multiple port Ethernet devices

5-4.3 Attributes

5-4.3.1 Class Attributes

The Ethernet Link Object shall support the following class attributes.

Table 5-4.2 Class Attributes

Attribute ID	Need in Implementation	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
1	Required	Get	Revision	UINT	Revision of this object	The current value assigned to this attribute is three
2	Conditional ¹	Get	Max Instance	UINT	Maximum instance number of an object currently created in this class level of the device	The largest instance number of a created object at this class hierarchy level
3	Conditional ¹	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device	The number of object instances at this class hierarchy level
4 thru 7	These class attributes are optional and are described in Volume 1, Chapter 4.					
¹ Required if the number of instances is greater than 1.						

An error reading the Class Revision attribute implies this is a revision 1 only implementation.

5-4.3.2 Instance Attributes

The Ethernet Link Object shall support the following instance attributes.

Table 5-4.3 Instance Attributes

Attr ID	Need in Implementation	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
1	Required	Get	Interface Speed	UDINT	Interface speed currently in use	Speed in Mbps (e.g., 0, 10, 100, 1000, etc.)
2	Required	Get	Interface Flags	DWORD	Interface status flags	Bit map of interface flags. See section 5-4.3.2.1
3	Required	Get	Physical Address	ARRAY of 6 USINTs	MAC layer address	See section 5-4.3.2.3
4	Conditional ¹	Get	Interface Counters	STRUCT of:		See section 5-4.3.2.4
			In Octets	UDINT	Octets received on the interface	
			In Ucast Packets	UDINT	Unicast packets received on the interface	
			In NUCast Packets	UDINT	Non-unicast packets received on the interface	
			In Discards	UDINT	Inbound packets received on the interface but discarded	
			In Errors	UDINT	Inbound packets that contain errors (does not include In Discards)	
			In Unknown Protos	UDINT	Inbound packets with unknown protocol	
			Out Octets	UDINT	Octets sent on the interface	
			Out Ucast Packets	UDINT	Unicast packets sent on the interface	
			Out NUCast Packets	UDINT	Non-unicast packets sent on the interface	
			Out Discards	UDINT	Outbound packets discarded	
			Out Errors	UDINT	Outbound packets that contain errors	

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Attr ID	Need in Implementation	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
5	Optional	Get	Media Counters	STRUCT of:	Media-specific counters	See section 5-4.3.2.5
			Alignment Errors	UDINT	Frames received that are not an integral number of octets in length	
			FCS Errors	UDINT	Frames received that do not pass the FCS check	
			Single Collisions	UDINT	Successfully transmitted frames which experienced exactly one collision	
			Multiple Collisions	UDINT	Successfully transmitted frames which experienced more than one collision	
			SQE Test Errors	UDINT	Number of times SQE test error message is generated	
			Deferred Transmissions	UDINT	Frames for which first transmission attempt is delayed because the medium is busy	
			Late Collisions	UDINT	Number of times a collision is detected later than 512 bit-times into the transmission of a packet	
			Excessive Collisions	UDINT	Frames for which transmission fails due to excessive collisions	
			MAC Transmit Errors	UDINT	Frames for which transmission fails due to an internal MAC sublayer transmit error	
			Carrier Sense Errors	UDINT	Times that the carrier sense condition was lost or never asserted when attempting to transmit a frame	
			Frame Too Long	UDINT	Frames received that exceed the maximum permitted frame size	
			MAC Receive Errors	UDINT	Frames for which reception on an interface fails due to an internal MAC sublayer receive error	
6	Optional	Set	Interface Control	STRUCT of:	Configuration for physical interface	See section 5-4.3.2.6
			Control Bits	WORD	Interface Control Bits	
			Forced Interface Speed	UINT	Speed at which the interface shall be forced to operate	Speed in Mbps (10, 100, 1000, etc.)
7	Optional	Get	Interface Type	USINT	Type of interface: twisted pair, fiber, internal, etc	See section 5-4.3.2.7
8	Optional	Get	Interface State	USINT	Current state of the interface: operational, disabled, etc	See section 5-4.3.2.8

Attr ID	Need in Implementation	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
9	Optional	Set	Admin State	USINT	Administrative state: enable, disable	See section 5-4.3.2.9
10	Conditional ²	Get	Interface Label	SHORT_STRING	Human readable identification	See section 5-4.3.2.10

¹ The Interface Counters attribute is required if the Media Counters attribute is implemented.

² Required if number of instances is greater than 1.

5-4.3.2.1 Interface Flags

The Interface Flags attribute contains status and configuration information about the physical interface and shall be as follows:

Table 5-4.4 Interface Flags

Bit(s):	Called:	Definition
0	Link Status	Indicates whether or not the Ethernet 802.3 communications interface is connected to an active network. 0 indicates an inactive link; 1 indicates an active link. The determination of link status is implementation specific. In some cases devices can tell whether the link is active via hardware/driver support. In other cases, the device may only be able to tell whether the link is active by the presence of incoming packets.
1	Half/Full Duplex	Indicates the duplex mode currently in use. 0 indicates the interface is running half duplex; 1 indicates full duplex. Note that if the Link Status flag is 0, then the value of the Half/Full Duplex flag is indeterminate.
2-4	Negotiation Status	Indicates the status of link auto-negotiation 0 = Auto-negotiation in progress. 1 = Auto-negotiation and speed detection failed. Using default values for speed and duplex. Default values are product-dependent; recommended defaults are 10Mbps and half duplex. 2 = Auto negotiation failed but detected speed. Duplex was defaulted. Default value is product-dependent; recommended default is half duplex. 3 = Successfully negotiated speed and duplex. 4 = Auto-negotiation not attempted. Forced speed and duplex.
5	Manual Setting Requires Reset	0 indicates the interface can activate changes to link parameters (auto-negotiate, duplex mode, interface speed) automatically. 1 indicates the device requires a Reset service be issued to its Identity Object in order for the changes to take effect.
6	Local Hardware Fault	0 indicates the interface detects no local hardware fault; 1 indicates a local hardware fault is detected. The meaning of this is product-specific. Examples are an AUI/MII interface detects no transceiver attached or a radio modem detects no antennae attached. In contrast to the soft, possible self-correcting nature of the Link Status being inactive, this is assumed a hard-fault requiring user intervention.
7-31	Reserved	Shall be set to zero

5-4.3.2.2 Interface Speed

The Interface Speed attribute shall indicate the speed at which the interface is currently running (e.g., 10 Mbps, 100 Mbps, 1 Gbps, etc.) A value of 0 shall be used to indicate that the speed of the interface is indeterminate. The scale of the attribute is in Mbps, so if the interface is running at 100 Mbps then the value of Interface Speed attribute shall be 100. The Interface Speed is intended to represent the media bandwidth; the attribute shall not be doubled if the interface is running in full-duplex mode.

5-4.3.2.3 Physical Address

The Physical Address attribute contains the interface's MAC layer address. The Physical Address is an array of octets. The recommended display format is "XX-XX-XX-XX-XX-XX", starting with the first octet. Note that the Physical Address is not a settable attribute. The Ethernet address shall be assigned by the manufacturer, and shall be unique per IEEE 802.3 requirements. **Devices with multiple ports but a single MAC interface (e.g., a device with an embedded switch technology) may use the same value for this attribute in each instance of the Ethernet Link Object. The general requirement is that the value of this attribute shall be the MAC address used for packets to and from the device's own MAC interface over this physical port.**

5-4.3.2.4 Interface Counters

The Interface Counters attribute contains counters relevant to the receipt of packets on the interface. These counters shall be as defined in RFC 1213 "MIB-II Management Information Base". The Interface Counters are a conditional attribute; they shall be implemented if the Media Counters attribute is implemented. **Multi-port devices with a single MAC interface (e.g., device with an embedded switch) shall maintain counter values in one of three ways:**

1. **In each instance, count the MAC frames sent/received by the device itself over the port represented by that instance (i.e., each physical interface counts the MAC frames sent/received over that interface). This is the preferred solution.**
2. **Use counter values of 0 for those instances that correspond to the external switch ports; count MAC frames in the instance that corresponds to the internal device interface**
3. **Use the same counter values for all instances, counting MAC frames sent/received by the device itself**

5-4.3.2.5 Media Counters

The Media Counters attribute contains counters specific to Ethernet media. These counters shall be as defined by RFC 1643, "Definitions of Managed Objects for Ethernet-Like Interface Types". If this attribute is implemented the Interface Counters shall also be implemented. **Instances that refer to internal interfaces may set the values of the Interface Counters to 0.**

Note: some underlying hardware or system implementations may not provide all of the Media Counters. In the case of fiber media, some of the counters do not apply (e.g., collision counters). Devices shall use values of 0 for counters that are not implemented.

5-4.3.2.6 Interface Control

The Interface Control attribute is a structure consisting of Control Bits and Forced Interface Speed and shall be as follows:

5-4.3.2.6.1 Control Bits**Table 5-4.5 Control Bits**

Bit(s):	Called:	Definition
0	Auto-negotiate	0 indicates 802.3 link auto-negotiation is disabled. 1 indicates auto-negotiation is enabled. If auto-negotiation is disabled, then the device shall use the settings indicated by the Forced Duplex Mode and Forced Interface Speed bits.
1	Forced Duplex Mode	If the Auto-negotiate bit is 0, the Forced Duplex Mode bit indicates whether the interface shall operate in full or half duplex mode. 0 indicates the interface duplex should be half duplex. 1 indicates the interface duplex should be full duplex. Interfaces not supporting the requested duplex shall return a GRC hex 0x09 (Invalid Attribute Value). If auto-negotiation is enabled, attempting to set the Forced Duplex Mode bits shall result in a GRC hex 0x0C (Object State Conflict).
2-15	Reserved	Shall be set to zero

5-4.3.2.6.2 Forced Interface Speed

If the Auto-negotiate bit is 0, the Forced Interface Speed bits indicate the speed at which the interface shall operate. Speed is specified in megabits per second (e.g., for 10 Mbps Ethernet, the Interface Speed shall be 10). Interfaces not supporting the requested speed should return a GRC hex 0x09 (Invalid Attribute Value).

If auto-negotiation is enabled, attempting to set the Forced Interface Speed shall result in a GRC hex 0x0C (Object State Conflict).

5-4.3.2.7 Interface Type

The Interface Type attribute shall indicate the type of the physical interface. Table 5-4.6 shows the Interface Type values. This attribute shall be stored in non-volatile memory.

Table 5-4.6 Interface Type

Value	Type of interface
0	Unknown interface type.
1	The interface is internal to the device, for example, in the case of an embedded switch.
2	Twisted-pair (e.g., 10Base-T, 100Base-TX, 1000Base-T, etc.)
3	Optical fiber (e.g., 100Base-FX)
4-256	Reserved.

5-4.3.2.8 Interface State

The Interface State attribute shall indicate the current operational state of the interface. Table 5-4.7 shows the Interface State values. This attribute shall be stored in volatile memory.

Table 5-4.7 Interface State

Value	Interface State
0	Unknown interface state
1	The interface is enabled and is ready to send and receive data
2	The interface is disabled
3	The interface is testing
4-256	Reserved.

5-4.3.2.9 Admin State

The Admin State attribute shall allow administrative setting of the interface state. Table 5-4.8 shows the Admin State values. This attribute shall be stored in non-volatile memory.

Table 5-4.8 Admin State

Value	Admin State
0	Reserved
1	Enable the interface
2	Disable the interface. If this is the only CIP communications interface, a request to disable the interface shall result in an error (status code 0x09).
3-256	Reserved.

5-4.3.2.10 Interface Label

The Interface Label attribute shall be a text string that describes the interface. The content of the string is vendor specific. For internal interfaces the text string should include “internal” somewhere in the string. The maximum number of characters in this string is 64. This attribute shall be stored in non-volatile memory.

5-4.4 Common Services**5-4.4.1 All Services**

The Ethernet Link Object shall provide the following common services.

Table 5-4.9 Common Services

Service Code	Need in Implementation		Service Name	Description of Service
	Class	Instance		
0x01	Optional	Optional	Get_Attribute_All	Returns a predefined listing of this objects attributes (See the Get_Attribute_All response definition in section 5-4.4.2)
0x0E	Conditional	Required	Get_Attribute_Single	Returns the contents of the specified attribute.
0x10	n/a	Conditional	Set_Attribute_Single	Modifies a single attribute.