**Physical layer**

From Wikipedia, the free encyclopedia

[Jump to navigation](https://en.wikipedia.org/wiki/Physical_layer#mw-head) [Jump to search](https://en.wikipedia.org/wiki/Physical_layer#searchInput)

|  |  |
| --- | --- |
|  |  |
| **This article has multiple issues.** Please help [**improve it**](https://en.wikipedia.org/w/index.php?title=Physical_layer&action=edit) or discuss these issues on the [**talk page**](https://en.wikipedia.org/wiki/Talk:Physical_layer). *(*[*Learn how and when to remove these template messages*](https://en.wikipedia.org/wiki/Help:Maintenance_template_removal)*)*   |  | | --- | | This article **needs additional citations for** [**verification**](https://en.wikipedia.org/wiki/Wikipedia:Verifiability). *(October 2009)* |  |  | | --- | | This article's [**lead section**](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Lead_section) **contains information that is not included elsewhere in the article**. *(August 2018)* | | | |

|  |
| --- |
| [**OSI model**](https://en.wikipedia.org/wiki/OSI_model) **by** [**layer**](https://en.wikipedia.org/wiki/Abstraction_layer) |
| 7.  [Application layer](https://en.wikipedia.org/wiki/Application_layer)[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| 6.  [Presentation layer](https://en.wikipedia.org/wiki/Presentation_layer)[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| 5.  [Session layer](https://en.wikipedia.org/wiki/Session_layer)[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| 4.  [Transport layer](https://en.wikipedia.org/wiki/Transport_layer)[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| 3.  [Network layer](https://en.wikipedia.org/wiki/Network_layer)[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| 2.  [Data link layer](https://en.wikipedia.org/wiki/Data_link_layer)[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| 1.  Physical layer[[show]](https://en.wikipedia.org/wiki/Physical_layer) |
| * [v](https://en.wikipedia.org/wiki/Template:OSI_model) * [t](https://en.wikipedia.org/wiki/Template_talk:OSI_model) * [e](https://en.wikipedia.org/w/index.php?title=Template:OSI_model&action=edit) |

In the seven-layer [OSI model](https://en.wikipedia.org/wiki/OSI_model) of [computer networking](https://en.wikipedia.org/wiki/Computer_network), the **physical layer** or **layer 1** is the first and lowest layer. This layer may be implemented by a [PHY](https://en.wikipedia.org/wiki/PHY) chip.

The physical layer defines the means of transmitting raw [bits](https://en.wikipedia.org/wiki/Bit)[[1]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-1) over a physical [data link](https://en.wikipedia.org/wiki/Data_link) connecting network [nodes](https://en.wikipedia.org/wiki/Node_(networking)). The [bitstream](https://en.wikipedia.org/wiki/Bitstream) may be grouped into code words or symbols and converted to a physical [signal](https://en.wikipedia.org/wiki/Signal) that is transmitted over a [transmission medium](https://en.wikipedia.org/wiki/Transmission_medium). The physical layer provides an electrical, mechanical, and procedural interface to the transmission medium. The shapes and properties of the [electrical connectors](https://en.wikipedia.org/wiki/Electrical_connector), the frequencies to broadcast on, the [line code](https://en.wikipedia.org/wiki/Line_code) to use and similar low-level parameters, are specified by the physical layer.



**Contents**

* [1 Role](https://en.wikipedia.org/wiki/Physical_layer#Role)
* [2 Physical signaling sublayer](https://en.wikipedia.org/wiki/Physical_layer#Physical_signaling_sublayer)
* [3 Relation to the Internet Protocol](https://en.wikipedia.org/wiki/Physical_layer#Relation_to_the_Internet_Protocol)
* [4 List of services](https://en.wikipedia.org/wiki/Physical_layer#List_of_services)
* [5 Technologies](https://en.wikipedia.org/wiki/Physical_layer#Technologies)
* [6 See also](https://en.wikipedia.org/wiki/Physical_layer#See_also)
* [7 References](https://en.wikipedia.org/wiki/Physical_layer#References)
* [8 External links](https://en.wikipedia.org/wiki/Physical_layer#External_links)

**Role**

The physical layer consists of the [electronic circuit](https://en.wikipedia.org/wiki/Electronic_circuit) transmission technologies of a network.[[2]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-Fundamentals_of_Sensor_Network_Programming-2) It is a fundamental layer underlying the higher level functions in a network, and can be implemented through a great number of different hardware technologies with widely varying characteristics.[[3]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-3)

Within the semantics of the OSI model, the physical layer translates logical communications requests from the [data link layer](https://en.wikipedia.org/wiki/Data_link_layer) into hardware-specific operations to cause transmission or reception of electronic (or other) signals.[[4]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-4)[[5]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-5) The physical layer supports higher layers responsible for generation of logical [data packets](https://en.wikipedia.org/wiki/Network_packet).

**Physical signaling sublayer**

In a network using [Open Systems Interconnection](https://en.wikipedia.org/wiki/Open_Systems_Interconnection) (OSI) architecture, the *physical signaling sublayer* is the portion of the physical layer that[[6]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-FS1037C-6)[[7]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-7)

* interfaces with the data link layer's [medium access control](https://en.wikipedia.org/wiki/Medium_access_control) (MAC) sublayer,
* performs [symbol](https://en.wikipedia.org/wiki/Symbol_(data)) encoding, [transmission](https://en.wikipedia.org/wiki/Transmission_(telecommunications)), reception and decoding and,
* performs [galvanic isolation](https://en.wikipedia.org/wiki/Galvanic_isolation).

**Relation to the Internet Protocol**

The [Internet protocol suite](https://en.wikipedia.org/wiki/Internet_protocol_suite), as defined in [RFC 1122](https://tools.ietf.org/html/rfc1122) and [RFC 1123](https://tools.ietf.org/html/rfc1123), is a high-level networking description used for the Internet and similar networks. It does not define an equivalent layer that deals exclusively with hardware-level specifications and interfaces, as this model does not concern itself directly with physical interfaces. Several [RFCs](https://en.wikipedia.org/wiki/Request_for_Comments) mention a *physical layer* and *data link layer*, but that is in the context of [IEEE](https://en.wikipedia.org/wiki/Institute_of_Electrical_and_Electronics_Engineers) protocols. [RFC 1122](https://tools.ietf.org/html/rfc1122) and 1123 do not mention any physical layer functionality or physical layer standards.

**List of services**

|  |  |
| --- | --- |
|  | This section **is in** [**list**](https://en.wikipedia.org/wiki/MOS:LIST) **format, but may read better as** [**prose**](https://en.wikipedia.org/wiki/MOS:PROSE). You can help by [converting this section](https://en.wikipedia.org/w/index.php?title=Physical_layer&action=edit), if appropriate. [Editing help](https://en.wikipedia.org/wiki/Help:Editing) is available. *(October 2017)* |

The major functions and services performed by the physical layer are:

* Bit-by-bit or [symbol-by-symbol](https://en.wikipedia.org/wiki/Symbol_rate) delivery[[8]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-8)
* Providing a standardized interface to a physical [transmission medium](https://en.wikipedia.org/wiki/Transmission_medium), including[[9]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-9)[[10]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-10)
  + Mechanical specification of [electrical connectors](https://en.wikipedia.org/wiki/Electrical_connector) and [cables](https://en.wikipedia.org/wiki/Electrical_cable), for example maximum cable length
  + Electrical specification of [transmission line](https://en.wikipedia.org/wiki/Transmission_line) [signal level](https://en.wikipedia.org/wiki/Signal_level) and [impedance](https://en.wikipedia.org/wiki/Electrical_impedance)
  + Radio interface, including [electromagnetic spectrum](https://en.wikipedia.org/wiki/Electromagnetic_spectrum) [frequency allocation](https://en.wikipedia.org/wiki/Frequency_allocation) and specification of [signal strength](https://en.wikipedia.org/wiki/Signal_strength), analog [bandwidth](https://en.wikipedia.org/wiki/Bandwidth_(signal_processing)), etc.
  + Specifications for [IR](https://en.wikipedia.org/wiki/Infrared) over [optical fiber](https://en.wikipedia.org/wiki/Optical_fiber) or a wireless IR communication link
* [Modulation](https://en.wikipedia.org/wiki/Modulation)
* [Line coding](https://en.wikipedia.org/wiki/Line_coding)
* [Bit synchronization](https://en.wikipedia.org/wiki/Bit_synchronization) in synchronous [serial communication](https://en.wikipedia.org/wiki/Serial_communication)
* [Start-stop signalling](https://en.wikipedia.org/wiki/Start-stop_signalling) and [flow control](https://en.wikipedia.org/wiki/Flow_control_(data)) in [asynchronous serial communication](https://en.wikipedia.org/wiki/Asynchronous_serial_communication)
* [Circuit switching](https://en.wikipedia.org/wiki/Circuit_switching)
* [Multiplexing](https://en.wikipedia.org/wiki/Multiplexing)
  + Establishment and termination of [circuit switched](https://en.wikipedia.org/wiki/Circuit_switched) connections
* [Carrier sense](https://en.wikipedia.org/wiki/Carrier_sense) and [collision detection](https://en.wikipedia.org/wiki/CSMA/CD) utilized by some level 2 [multiple access methods](https://en.wikipedia.org/wiki/Multiple_access_method)
* [Equalization](https://en.wikipedia.org/wiki/Equalization_(communications)) filtering, [training sequences](https://en.wikipedia.org/wiki/Training_sequence), [pulse shaping](https://en.wikipedia.org/wiki/Pulse_shaping) and other [signal processing](https://en.wikipedia.org/wiki/Signal_processing) of physical signals
* [Forward error correction](https://en.wikipedia.org/wiki/Forward_error_correction)[[11]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-11) for example bitwise convolutional coding
* [Bit-interleaving](https://en.wikipedia.org/wiki/Bit-interleaving) and other [channel coding](https://en.wikipedia.org/wiki/Channel_coding)

The physical layer is also concerned with:[[12]](https://en.wikipedia.org/wiki/Physical_layer#cite_note-12)

* [Bit rate](https://en.wikipedia.org/wiki/Bit_rate)
* [Point-to-point](https://en.wikipedia.org/wiki/Point-to-point_(telecommunications)), multipoint or [point-to-multipoint](https://en.wikipedia.org/wiki/Point-to-multipoint) line configuration
* Physical [network topology](https://en.wikipedia.org/wiki/Network_topology), for example [bus](https://en.wikipedia.org/wiki/Bus_network), [ring](https://en.wikipedia.org/wiki/Ring_network), [mesh](https://en.wikipedia.org/wiki/Mesh_network) or [star network](https://en.wikipedia.org/wiki/Star_network)
* [Serial](https://en.wikipedia.org/wiki/Serial_communication) or [parallel](https://en.wikipedia.org/wiki/Parallel_communication) communication
* [Simplex](https://en.wikipedia.org/wiki/Simplex_communication), [half duplex](https://en.wikipedia.org/wiki/Duplex_(telecommunications)#Half-duplex) or [full duplex](https://en.wikipedia.org/wiki/Duplex_(telecommunications)#Full-duplex) transmission mode
* [Autonegotiation](https://en.wikipedia.org/wiki/Autonegotiation)

**Technologies**

|  |  |
| --- | --- |
|  | This section **does not** [**cite**](https://en.wikipedia.org/wiki/Wikipedia:Citing_sources) **any** [**sources**](https://en.wikipedia.org/wiki/Wikipedia:Verifiability). Please help [improve this section](https://en.wikipedia.org/w/index.php?title=Physical_layer&action=edit) by [adding citations to reliable sources](https://en.wikipedia.org/wiki/Help:Referencing_for_beginners). Unsourced material may be challenged and [removed](https://en.wikipedia.org/wiki/Wikipedia:Verifiability#Burden_of_evidence). *(October 2018) (*[*Learn how and when to remove this template message*](https://en.wikipedia.org/wiki/Help:Maintenance_template_removal)*)* |

The following technologies provide physical layer services:

* [1-Wire](https://en.wikipedia.org/wiki/1-Wire)
* [ARINC 818](https://en.wikipedia.org/wiki/ARINC_818) Avionics Digital Video Bus
* [Bluetooth](https://en.wikipedia.org/wiki/Bluetooth) physical layer
* [CAN bus](https://en.wikipedia.org/wiki/CAN_bus) (controller area network) physical layer
* [DSL](https://en.wikipedia.org/wiki/Digital_subscriber_line)
* [EIA](https://en.wikipedia.org/wiki/Electronic_Industries_Alliance) [RS-232](https://en.wikipedia.org/wiki/RS-232), [EIA-422](https://en.wikipedia.org/wiki/EIA-422), [EIA-423](https://en.wikipedia.org/wiki/RS-423), [RS-449](https://en.wikipedia.org/wiki/RS-449), [RS-485](https://en.wikipedia.org/wiki/RS-485)
* [Etherloop](https://en.wikipedia.org/wiki/Etherloop)
* [Ethernet physical layer](https://en.wikipedia.org/wiki/Ethernet_physical_layer) Including [10BASE-T](https://en.wikipedia.org/wiki/10BASE-T), [10BASE2](https://en.wikipedia.org/wiki/10BASE2), [10BASE5](https://en.wikipedia.org/wiki/10BASE5), [100BASE-TX](https://en.wikipedia.org/wiki/100BASE-TX), [100BASE-FX](https://en.wikipedia.org/wiki/100BASE-FX), [100BASE-T](https://en.wikipedia.org/wiki/100BASE-T), [1000BASE-T](https://en.wikipedia.org/wiki/1000BASE-T), [1000BASE-SX](https://en.wikipedia.org/wiki/1000BASE-SX) and other varieties
* [G.hn](https://en.wikipedia.org/wiki/G.hn)/[G.9960](https://en.wikipedia.org/wiki/G.9960) physical layer
* [GSM](https://en.wikipedia.org/wiki/GSM) [Um air interface](https://en.wikipedia.org/wiki/Um_air_interface) physical layer
* [IEEE 802.15.4](https://en.wikipedia.org/wiki/IEEE_802.15.4) physical layers
* [IEEE 1394 interface](https://en.wikipedia.org/wiki/IEEE_1394_interface)
* [IRDA](https://en.wikipedia.org/wiki/Infrared_Data_Association) physical layer
* [ISDN](https://en.wikipedia.org/wiki/Integrated_Services_Digital_Network)
* [ITU](https://en.wikipedia.org/wiki/International_Telecommunication_Union) Recommendations: see [ITU-T](https://en.wikipedia.org/wiki/ITU-T)
* [I²C](https://en.wikipedia.org/wiki/I%C2%B2C), [I²S](https://en.wikipedia.org/wiki/I%C2%B2S)
* [LoRa](https://en.wikipedia.org/wiki/LoRa)
* [Low-voltage differential signaling](https://en.wikipedia.org/wiki/Low-voltage_differential_signaling)
* [Mobile Industry Processor Interface](https://en.wikipedia.org/wiki/Mobile_Industry_Processor_Interface) physical layer
* [Modulated ultrasound](https://en.wikipedia.org/wiki/Modulated_ultrasound)
* [Optical Transport Network](https://en.wikipedia.org/wiki/Optical_Transport_Network) (OTN)
* [SMB](https://en.wikipedia.org/wiki/System_Management_Bus)
* [SONET/SDH](https://en.wikipedia.org/wiki/Synchronous_optical_network)
* [SPI](https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus)
* T1 and other [T-carrier](https://en.wikipedia.org/wiki/T-carrier) links, and E1 and other [E-carrier](https://en.wikipedia.org/wiki/E-carrier) links
* Telephone network [modems](https://en.wikipedia.org/wiki/Modems) — [V.92](https://en.wikipedia.org/wiki/V.92)
* [TransferJet](https://en.wikipedia.org/wiki/TransferJet) physical layer
* [USB](https://en.wikipedia.org/wiki/USB) physical layer
* Varieties of [802.11](https://en.wikipedia.org/wiki/802.11) [Wi-Fi](https://en.wikipedia.org/wiki/Wi-Fi) physical layers
* [Visible light communication](https://en.wikipedia.org/wiki/Visible_light_communication) co-ordinated under [IEEE 802.15.7](https://en.wikipedia.org/wiki/IEEE_802.15#IEEE_802.15.7:_Visible_Light_Communication)
* [X10](https://en.wikipedia.org/wiki/X10_(industry_standard))

**See also**

* [Clock recovery](https://en.wikipedia.org/wiki/Clock_recovery)
* [Data transmission](https://en.wikipedia.org/wiki/Data_transmission)
* [Digital modulation](https://en.wikipedia.org/wiki/Digital_modulation)
* [Intrinsic safety](https://en.wikipedia.org/wiki/Intrinsic_safety)
* [Line code](https://en.wikipedia.org/wiki/Line_code)
* [Pulse shaping](https://en.wikipedia.org/wiki/Pulse_shaping)
* [Bit synchronization](https://en.wikipedia.org/wiki/Bit_synchronization)
* [Channel model](https://en.wikipedia.org/wiki/Channel_model)

**References**

 *Gorry Fairhurst (2001-01-01).* [*"Physical Layer"*](https://web.archive.org/web/20090618154921/http:/www.erg.abdn.ac.uk/users/gorry/course/phy-pages/phy.html)*. Archived from* [*the original*](http://www.erg.abdn.ac.uk/users/gorry/course/phy-pages/phy.html) *on 2009-06-18.*

  *Iyengar, Shisharama (2010).* [*Fundamentals of Sensor Network Programming*](https://books.google.com/books?id=UD0h_GqgbHgC&printsec=frontcover&dq=network%2B+guide+to+networks&src=bmrr#v=onepage&q&f=false)*. Wiley. p. 136.*

  [*"The Physical Layer | InterWorks"*](https://interworks.com/blog/bfair/2011/07/30/physical-layer/)*. InterWorks. 2011-07-30. Retrieved 2018-08-14.*

  *Shaw, Keith (2018-10-22).* [*"The OSI model explained: How to understand (and remember) the 7 layer network model"*](https://www.networkworld.com/article/3239677/lan-wan/the-osi-model-explained-how-to-understand-and-remember-the-7-layer-network-model.html)*. Network World. Retrieved 2019-02-15.*

  [*"(PDF) DATA COMMUNICATION & NETWORKING"*](https://www.researchgate.net/publication/288180515_DATA_COMMUNICATION_NETWORKING)*. ResearchGate. Retrieved 2019-02-15.*

   This article incorporates [public domain material](https://en.wikipedia.org/wiki/Copyright_status_of_works_by_the_federal_government_of_the_United_States) from the [General Services Administration](https://en.wikipedia.org/wiki/General_Services_Administration) document: [*"Federal Standard 1037C"*](http://www.its.bldrdoc.gov/fs-1037/fs-1037c.htm)*.*

  [*"physical signaling sublayer (PLS)"*](https://web.archive.org/web/20101227170125/http:/tiaonline.org/market_intelligence/glossary/index.cfm?term=%26%23TC%5DSR%3FN%0A)*. Archived from* [*the original*](http://www.tiaonline.org/market_intelligence/glossary/index.cfm?term=%26%23TC%5DSR%3FN%0A) *on 2010-12-27. Retrieved 2011-07-29.*

  *Shekhar, Amar (2016-04-07).* [*"Physical Layer Of OSI Model: Working Functionalities and Protocols"*](https://fossbytes.com/physical-layer/)*. Fossbytes. Retrieved 2019-02-15.*

  *Bayliss, Colin R.; Bayliss, Colin; Hardy, Brian (2012-02-14).* [*Transmission and Distribution Electrical Engineering*](https://books.google.com/books?id=cLwO-Hh6_VEC&printsec=frontcover&dq=The+physical+layer+Providing+a+standardized+interface+to+a+physical+transmission+medium,+including++Mechanical+specification+of+electrical+connectors+and+cables,+for+example+maximum+cable+length+Electrical+specification+of+transmission+line+signal+level+and+impedance+Radio+interface,+including+electromagnetic+spectrum+frequency+allocation+and+specification+of+signal+strength,+analog+bandwidth,+etc.+Specifications+for+IR+over+optical+fiber+or+a+wireless+IR+communication+link&hl=en&sa=X&ved=0ahUKEwjx3fKs6b3gAhUq6KYKHQ0gCXAQ6AEIKDAA#v=onepage&q&f=false)*. Elsevier.* [*ISBN*](https://en.wikipedia.org/wiki/ISBN_(identifier))[*9780080969121*](https://en.wikipedia.org/wiki/Special:BookSources/9780080969121)*.*

  [*"CCNA Certification/Physical Layer - Wikibooks, open books for an open world"*](https://en.wikibooks.org/wiki/CCNA_Certification/Physical_Layer)*. en.wikibooks.org. Retrieved 2019-02-15.*

  *Bertsekas, Dimitri; Gallager, Robert (1992).* [*Data Networks*](https://archive.org/details/isbn_9780132009164)*. Prentice Hall. p.*[*61*](https://archive.org/details/isbn_9780132009164/page/61)*.* [*ISBN*](https://en.wikipedia.org/wiki/ISBN_(identifier))[*0-13-200916-1*](https://en.wikipedia.org/wiki/Special:BookSources/0-13-200916-1)*.*

* 1.  *Forouzan, Behrouz A.; Fegan, Sophia Chung (2007).* [*Data Communications and Networking*](https://books.google.com/books?id=bwUNZvJbEeQC&printsec=frontcover&dq=The+physical+layer+is+also+concerned+with:++Bit+rate+Point-to-point,+multipoint+or+point-to-multipoint+line+configuration+Physical+network+topology,+for+example+bus,+ring,+mesh+or+star+network+Serial+or+parallel+communication+Simplex,+half+duplex+or+full+duplex+transmission+mode+Autonegotiation&hl=en&sa=X&ved=0ahUKEwishIeD6b3gAhUB06YKHRP4CfAQ6AEIMDAB#v=onepage&q&f=false)*. Huga Media.* [*ISBN*](https://en.wikipedia.org/wiki/ISBN_(identifier))[*9780072967753*](https://en.wikipedia.org/wiki/Special:BookSources/9780072967753)*.*

**External links**

* [Physical Layer (Layer 1)](http://www.tcpipguide.com/free/t_PhysicalLayerLayer1.htm)
* [10G Layer 1 Walkthrough](http://fmad.io/blog-10g-ethernet-layer1-overview.html)
* 5G Layer 2 Walltrough

[Categories](https://en.wikipedia.org/wiki/Help:Category):

* [OSI model](https://en.wikipedia.org/wiki/Category:OSI_model)