



DKAN0004A

Introduction to Embedded Ethernet Components

04 September 2009

Introduction

This application note provides an entry level discussion of embedded Ethernet components. It includes a broad overview of the possible hardware implementations and software requirements to meet the IEEE 802.3 Ethernet specification.

Application

Hardware

Figure 1 shows the block diagram of an Ethernet endpoint.

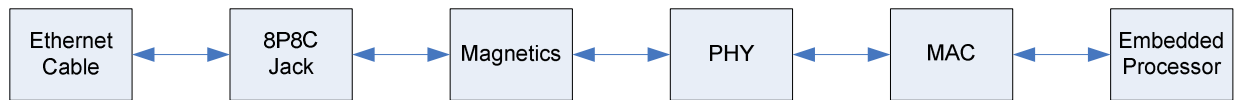


Figure 1. Ethernet Block Diagram

Ethernet typically uses an 8-conductor twisted pair cable, such as CAT5e or CAT6, and 8P8C plugs (often incorrectly referred to as RJ45). Figure 2 shows a CAT5e cable and termination. An 8P8C jack provides a mechanical connection between the embedded device and network.



Figure 2. CAT5e Cable with 8P8C Plug

The magnetic components physically isolate the device from the network. They provide EMI suppression while delivering the signal without distortion. The magnetic components are available separately or integrated within the jack, as shown in Figure 3.



Figure 3. 8P8C Jack with Integrated Magnetic Components

The PHY is the physical layer. It includes a transceiver and codec that interfaces the Media Access Controller (MAC) to a physical medium, such as fiber optic or copper cable. The PHY's internal circuitry is predominantly an analog circuit which is why it remains a separate device in most applications.

The MAC is the data communications sub-layer that implements the Carrier-Sense Multiple Access / Collision Detection (CSMA/CD) protocol. It stores a unique serial number called the MAC address. Other network devices use the MAC address to route information to the embedded device.

The embedded processor stores and executes the TCP/IP stack. Some embedded processors have an integrated MAC and PHY, as shown in Figure 4. This is the most integrated solution, which requires the least board space.

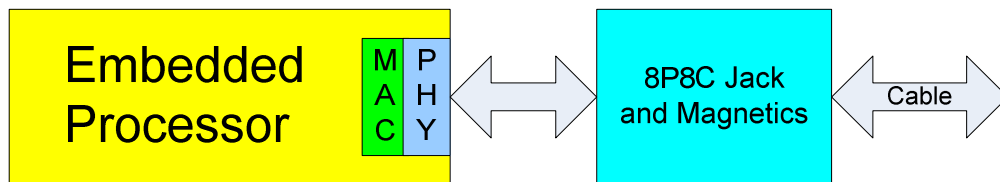


Figure 4. Integrated MAC and PHY

Figure 5 shows an integrated MAC. This is a common solution, but an external PHY device is required. The MAC and PHY must have compatible interfaces. The MII, or Media Independent Interface is one interface used to connect an Ethernet MAC to a PHY.

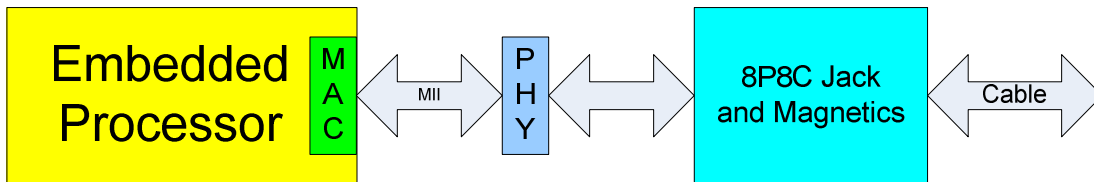


Figure 5. Integrated MAC and External PHY

Figure 6 illustrates an external MAC and PHY. The embedded processor uses a standard interface, such as SPI, to communicate with the MAC. An existing design can incorporate Ethernet using this topology.

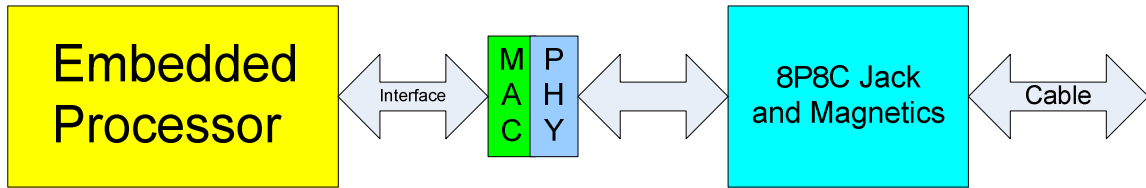


Figure 6. External MAC and PHY

Software

The software implements a TCP/IP stack. It is provided by the embedded processor supplier or a third party software supplier. The TCP/IP stack is a layered set of software protocols. Each layer contains one or more protocols that perform the specific functions necessary for communication between layers and devices. Figure 7 is a reference model of the stack.

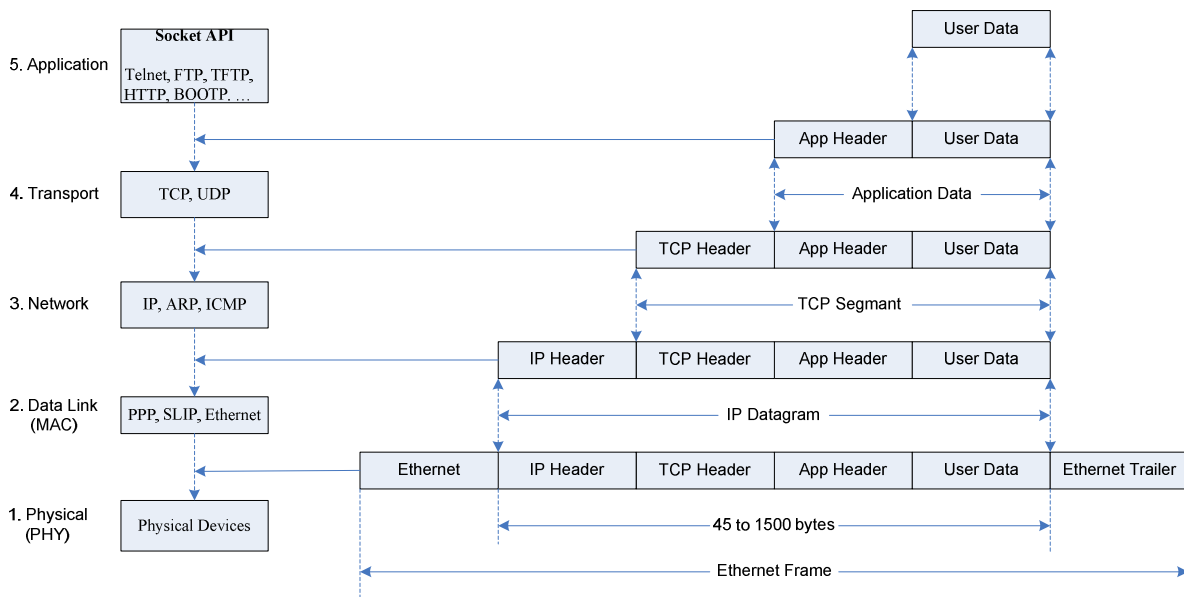


Figure 7. TCP/IP Layer Reference Model

The TCP/IP stack application layer defines the system’s functionality. It needs to include the protocols required by the embedded application. For example, if the application requires webpage hosting, then the TCP/IP stack must support the HTTP protocol. Table 1 shows the typical protocols required for some common applications. Definitions of some popular protocols are provided in the Appendix.

Table 1. TCP/IP Application Protocols

Application	Protocols
File Transfer	FTP
Email	SMTP, POP3, IMAP
Webpage	HTTP, HTTPS
Terminal Access	Telnet, SSH

Modules

Modules provide a completed solution. When choosing a module, ensure its software supports the desired functionality. Figure 8 illustrates an Ethernet module.

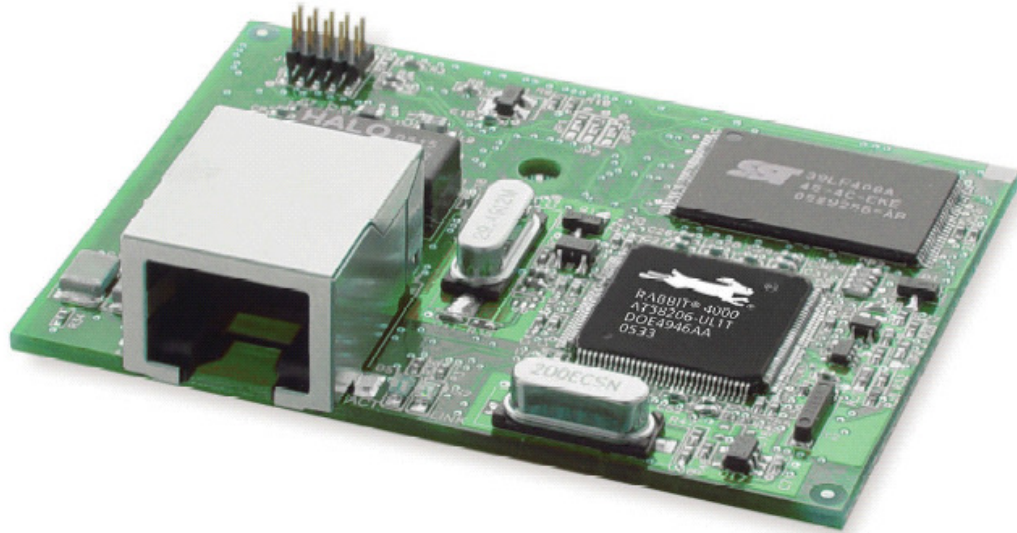


Figure 8. RCM4000 Ethernet Module

Conclusion

This application note provides a basic introduction to embedded Ethernet and all the critical pieces needed to develop an Ethernet enabled product. For additional information about embedded Ethernet, see the following documents:

Additional Information

AN1120: Ethernet Theory of Operation. Microchip Technology. 2008

AN731: Embedding PICmicro Microcontrollers in the Internet. Microchip Technology. 18 January 2002

AN418: Remote Application Update for the RCM33xx. Rabbit Semiconductor

AN417: Secure Embedded Web Application Kit 2.0. Rabbit Semiconductor

AN0134: eZ80 Remote Access. ZiLOG. March 2003

AN0160: A Serial-to-TCP Gateway for the eZ80AcclaimPlus! Connectivity ASSP. ZiLOG. July 2008

AN0207: The eZ80F91 as a Mail Server. ZiLOG. July 2008

Appendix: Protocol Definitions

These protocol definitions are from dictionary.die.net, accessed on September 4, 2009.

DHCP: Dynamic Host Configuration Protocol - A protocol that provides a means to dynamically allocate IP addresses to computers on a local area network. The system administrator assigns a range of IP addresses to DHCP and each client computer on the LAN has its TCP/IP software configured to request an IP address from the DHCP server. The request and grant process uses a lease concept with a controllable time period.

DNS: Domain Name System - A general-purpose distributed, replicated, data query service chiefly used on Internet for translating hostnames into Internet addresses. Also, the style of hostname used on the Internet, though such a name is properly called a fully qualified domain name. DNS can be configured to use a sequence of name servers, based on the domains in the name being looked for, until a match is found.

FTP: File Transfer Protocol - A client-server protocol which allows a user on one computer to transfer files to and from another computer over a TCP/IP network. Also the client program the user executes to transfer files.

HTTP: Hypertext Transfer Protocol - The client-server TCP/IP protocol used on the World-Wide Web for the exchange of HTML documents. It conventionally uses port 80.

HTTPS: HyperText Transmission Protocol, Secure - A variant of HTTP used by Netscape for handling secure transactions. "https" is a unique protocol that is simply SSL underneath HTTP. You need to use "https://" for HTTP URLs with SSL, whereas you continue to use "http://" for HTTP URLs without SSL. The default "https" port number is 443, as assigned by the Internet Assigned Numbers Authority.

IMAP: Internet Message Access Protocol - A protocol allowing a client to access and manipulate electronic mail messages on a server. It permits manipulation of remote message folders (mailboxes), in a way that is functionally equivalent to local mailboxes.

PPP: Point to Point Protocol - The protocol defined in RFC 1661, the Internet standard for transmitting network layer datagrams (e.g. IP packets) over serial point-to-point links.

POP3: Post Office Protocol 3 - POP3 allows a client computer to retrieve electronic mail from a POP3 server via a (temporary) TCP/IP or other connection.

SMTP: Simple Mail Transfer Protocol - A protocol defined in STD 10, RFC 821, used to transfer electronic mail between computers, usually over Ethernet. It is a server to server protocol, so other protocols are used to access the messages.

SSH: Secure Shell Remote Protocol - ssh is intended to replace rlogin and rsh, and provide secure encrypted communications between two untrusted hosts over an insecure network. X11 connections and arbitrary TCP/IP ports can also be forwarded over the secure channel.

Telnet: Telnet Remote Protocol - The Internet standard protocol for remote login. Runs on top of TCP/IP. Defined in STD 8, RFC 854 and extended with options by many other RFCs. Unix BSD networking software includes a program, telnet, which uses the protocol and acts as a terminal emulator for the remote login session.

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