Application Note LM20/25
Physical Layer Link Signaling for 100baseTX and 10baseT Networks
(Updated 9-9-98)

Introduction

IEEE 802.3u is the most widely recognized and accepted standard used in the design and installation of 100baseT (Fast Ethernet) Local Area Networks. Compliance by manufacturers to the standard is voluntary and many of the new features specified in the standard have been defined only as optional requirements. The IEEE 802.3u standard maintains equipment interoperability even with variation in LAN product capabilities by including a Physical Layer signaling scheme. Signaling is used as a handshake between two connected pieces of LAN equipment (Link Partners) and is accomplished by exchanging a burst of pulses called Fast Link Pulses (FLPs) that form a Link Code Word. The Link Code Word describes the capabilities and fault status of the transmitting equipment which is compared to the capabilities of the receiving equipment. A Link is then established based on the highest common mode of operation. The process of establishing a Link by exchanging Link Code Words is called Auto-negotiation and must be completed prior to any data being transmitted.

Link Partner Signaling

Fast Ethernet Link Partners exchange bursts of Fast Link Pulses that form a Link Code Word. The Link Code Word consists of 16 encoded data bits that provide detailed information about the transmitting equipment. The first word transmitted is the base Link Code Word which identifies the type of message being sent, the capabilities of the Link Partner, equipment fault status, received Link Code Word acknowledgment and support for additional Link Code Word information called Next Page. Once the Link Partners have exchanged the base Link Code Word, the capabilities are compared and a Link is established based on the highest common mode of operation. The following is the operating mode priority from highest to lowest:

1. 100baseTX Full Duplex
2. 100baseT4
3. 100baseTX Half Duplex
4. 10baseT Full Duplex
5. 10baseT Half Duplex

Additional information may be exchanged between Link Partners that support the Next Page function. Next Page information is typically vendor specific for the equipment.

Pre-IEEE 802.3u Equipment

A significant amount of Fast Ethernet equipment was installed in the field prior to the IEEE 802.3u standard being finalized. Some of this equipment does not support the FLP scheme of handshaking but instead establishes a Link by continuously transmitting an "idle" data packet using the Fast Ethernet MLT-3 waveform. This form of Link Signaling is called Parallel Detection. When a Link Partner that supports Auto-negotiation receives a Parallel Detection signal, it will

disable its FLP bursts and transmit the same Parallel Detection waveform to setup the Link. Equipment that does not support Auto-negotiation must be configured to exactly match the mode of operation as the Link Partner or else no Link can be established and the equipment will report that there is no connection to the network.

10baseT Equipment

Standard Ethernet (10baseT) uses a signaling scheme based on a single pulse called a Normal Link Pulse (NLP). The NLP is transmitted continuously by the Link Partners every 8 to 24 milliseconds, except during data transmission, to maintain the Link. Recently 10baseT equipment that use the FLP method of establishing a Link have been introduced. These new products support Auto-negotiation by exchanging Link Code Words and can automatically select half duplex or full duplex modes based on the highest common mode of operation.

Fixed/Commanded Operating Modes and an Ambiguous Duplex Mode

Many types of LAN equipment allow the user to set the speed (10Mbs or 100Mbs) and duplex mode (half of full) of an individual port or device. The IEEE 802.3u standard does not specify what type of Link Signaling should be used when a port or device is commanded to a specific operating mode. Testing of various equipment has shown that the Parallel Detection waveform or the NLP are commonly used to establish Links when the equipment is configured to a commanded operating mode. The Parallel Detection waveform and NLP are specific regarding the speed of the Link but are ambiguous as to which duplex mode has been selected. Link problems can occur when one Link Partner is configured for full duplex operation and the other Partner is set for Auto-negotiation and the Parallel Detection or NLP Link signals are used. The Auto-negotiating Link Partner will correctly set the Link speed but will assume a half duplex mode based on the ambiguous signal type. The Link will perform poorly or will be disabled due to high error rates and excessive collisions. Links that use Parallel Detection/NLP signaling should use one of the following configurations (both Link Partners have same speed capability):

1. Both Link Partners in Auto-negotiation Mode.
2. Both Link Partners in Full Duplex Mode.
3. One Link Partner in Half Duplex Mode and one Link Partner in Auto-negotiation Mode.
4. Both Link Partners in Half Duplex Mode.

LanMaster 20/25 Uses

The LanMaster Models 20 and 25 are designed to detect FLPs, NLPs and Parallel Detection (MLT-3) waveforms. They also decode the Link Code Word contained in an FLP burst and displays the configuration and fault information of the Link Partner. The Model 20 and 25 are used for the following:

- New Installations/Moves, Adds and Changes/Troubleshooting

  Identify live outlets in multi-outlet wall plates
  Certify operating modes of connected equipment are compatible
  Confirm Network Interface Card is functioning

Verify transmit-receive pairs are assigned correctly (LAN or NIC polarity)
Provide a "No Link" indication for Links with reversed pairs
Identify equipment with fault conditions

- Network Management

Determine configuration of equipment prior to upgrading
Identify dead drops for re-assignment

LanMaster 20/25 Testing

Link Continuity - The FLP, NLP or MLT-3 signal is received from the far-end equipment and the corresponding capability LED(s) is illuminated.
Outlet or Cable Transmit/Receive Polarity - The 3,6 wire pair is scanned for signals and when detected the "LAN" indicator is lit showing a connection to a network device other than a Network Interface Card. If no signals are present, the 1,2 wire pair is scanned for signals and when detected the "NIC" indicator is illuminated showing connection to a node/ work station. If no signals are detected on either pair the "NO LINK" indicator is lit.
Reversed Pair - If the positive and negative wires within a wire pair have been reversed, the "NO LINK" indicator will illuminate even when Link signals are present. This feature prevents users from connecting equipment to a Link that gives a proper Link pulse but fails to operate when installed due to a reversed pair. This feature is for use with equipment that supports FLP or NLP signaling.
Equipment Configuration - The Link Code Word from the far-end equipment is decoded and the capabilities are displayed by the operating mode indicators. When more than one operating modes are displayed the far-end equipment is capable of Auto-negotiation.
Fault Detection - The Link Code word from the far-end equipment is decoded and when the fault bit is set the "FAULT" indicator is illuminated.