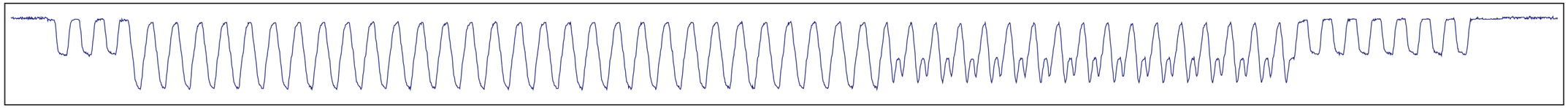
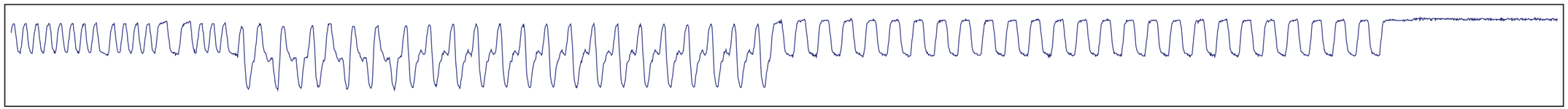
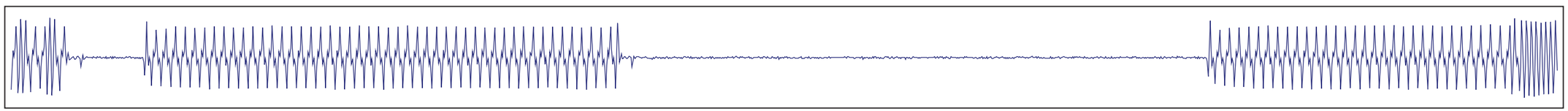
All graphics were captured using a digital storage oscilloscope in a lab environment. The 10BASE-T example is a little more jagged than the others because the sampling rate on the oscilloscope was more coarse than the other graphics. tThe signal samples provided are for concept illustration and should not be scaled because the timing interval is not constant.



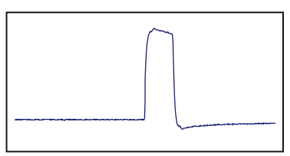
This graphic shows a preamble collision captured on 10BASE2. The lab setup had two transmitting stations attached to the same coax cable segment. The beginning part of the signal is transmitted between zero volts and -1 volt. When the collision starts, the signal exceeds the collision detection threshold of about -1.5 volts. Note that the collision pattern changes partway through the collision. That is apparently when the second station discovered the collision and switched from transmitting preamble and instead transmitted the jam signal. Both preamble and jam often appear as a repeating binary 1, 0 pattern. The event ended when the signal returned to zero volts.



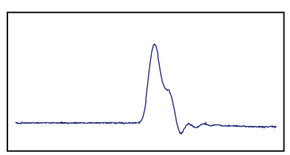
This graphic shows a mid-frame collision measured on 10BASE2. The lab setup had the two transmitting stations separated by a repeater. Both transmitting stations listened to the cable and found it idle before beginning a new transmission. The delay introduced by the repeater, plus normal latency on the cable and in-station delays, caused the collision to begin a short way into the first station's transmission. Note that the near station immediately began transmitting jam, then stopped after the jam signal had been sent. The second station, being farther away, continued transmitting jam for a short time after the first station, and then also stopped. The event ended when the signal returned to zero volts.



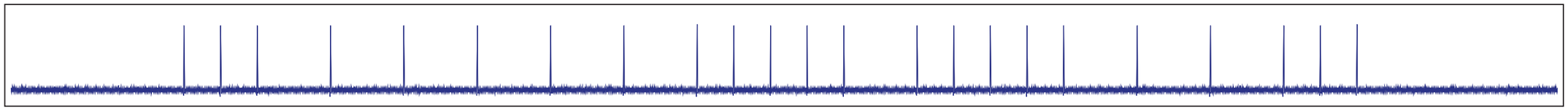
This graphic shows the end of a 10BASE-T transmission, followed by a jam signal caused by a repeater with SQE enabled. The second repeater forwarded the transmission, and then sent the SQE heartbeat pulse back to the first repeater to indicate a successful transmission. SQE is not supposed to be enabled between repeaters to prevent this. The first repeater is required to generate a jam signal if the received transmission is too short. After the end of the first signal, this graphic shows the repeater forwarding a jam signal to all ports to prevent any other station from transmitting until the collision domain is clear. After a short delay (the interframe gap), the graphic shows another legal transmission beginning.



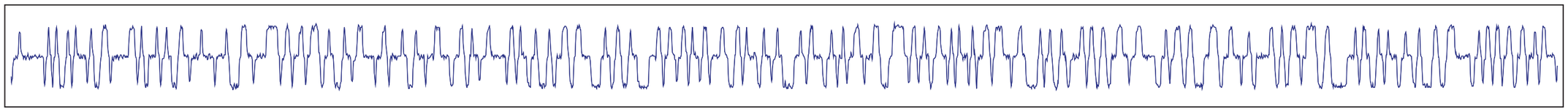
NLP Link Pulse measured on twisted pair coming from a 10/100 capable network adapter.



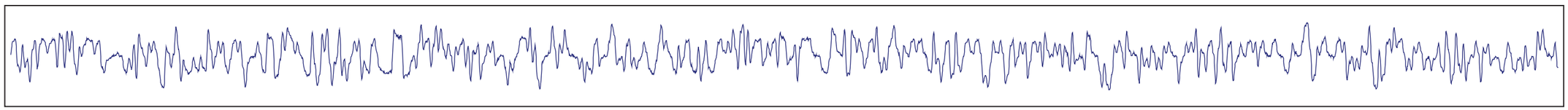
NLP Link Pulse measured on twisted pair coming from a 10/100/1000 switch. One might expect the relatively clean (square) signal in the left graphic from a device capable of Gigabit Ethernet, but the shaping of this signal is intentional and relates to pre-emphasis.



This graphic shows an FLP AutoNegotiation link word. (Each pulse is the same as an NLP pulse, only there could be as many as 33 pulses in a group.) The 17 clocking pulses are evenly spaced. Pulses appearing between the clocking pulses indicate a binary zero. Lack of a pulse between the clocking pulses indicates a binary zero. The link word presents 1000 0001 1011 0001 in binary, though further work is required to decode the meaning. This is the Auto-Negotiation base page.



This graphic shows a sample 100BASE-TX signal. The signal is MLT-3 encoded, and a scrambling process is involved to increase the transition density. The signal may be hand-decoded, but doing so requires the descrambler key to be aligned properly with the data before decoding begins. The signal voltage shown represents +1 volts, zero volts, and -1 volts.



This graphic shows a sample of one of four channels required for a 1000BASE-T link. The signal is 4D-PAM5 encoded, and a scrambling process is involved to increase the transition density. Because the same symbol (transmitted simultaneously on four wire pairs) may arrive at up to 50ns apart at the end of 100 meters of twisted pair, it is all but impossible to hand-decode Gigabit Ethernet. Furthermore, the signal voltage shown represents some 17 different voltage levels between +1 volts and -1 volts, due in part to the constant collision resulting from both link partners transmitting simultaneously on the same four wire pairs.