

# Lab 7.1.2

## Waveform Decoding

### Part 1 – Reading the Waveform

First, a quick description of the process used by the 10/100 Mbps versions of Ethernet to transmit a frame. In Figure 1, the fields present in a simple 802.3 Ethernet frame are shown.

Preamble	SFD	Destination	Source	Length Type	Data	Pad	FCS
7	1	6	6	2	46 to 1500		4

Figure 1 - Basic 802.3 Ethernet frame fields.

Manchester encoding relies on the direction of the edge transition in the middle of the timing window to determine the binary value for that bit period.

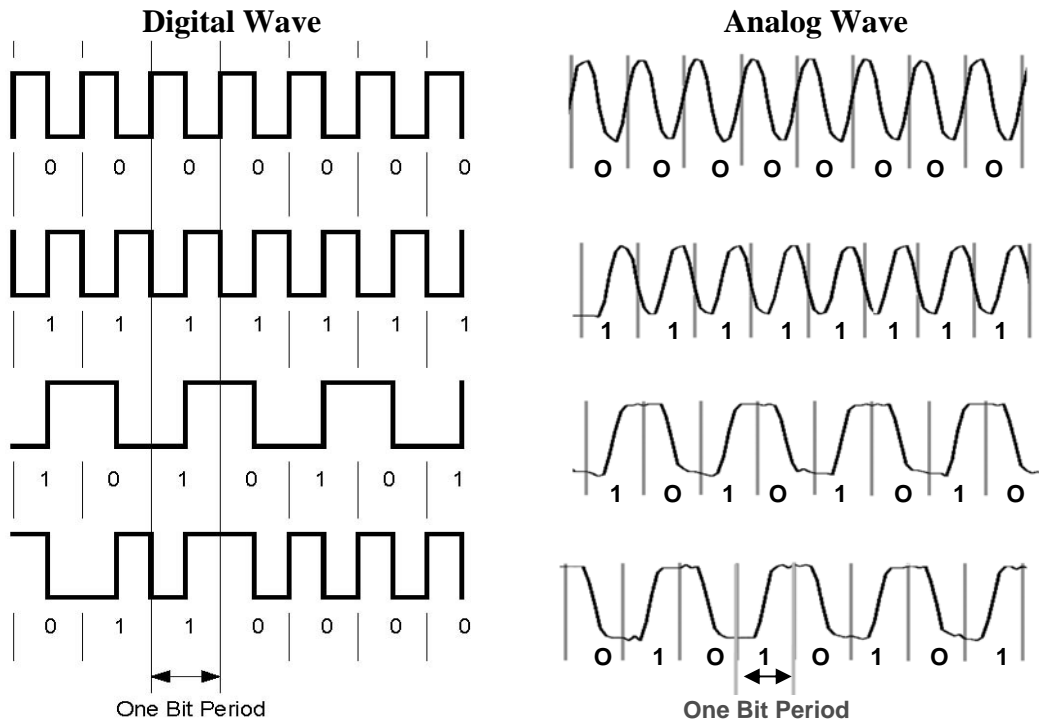


Figure 2

In the encoding example in Figure 2 there is one timing window highlighted vertically through all four waveform examples and labeled as one bit period. The top waveform has a falling edge in the center of the timing window, so it is interpreted as a binary 0.

Depending on how you view it the second waveform is 180 degrees out of phase, or it is shifted half of one bit period to the side. It is otherwise identical. The result is that in the center of the timing window for the second waveform there is a rising edge, which is interpreted as a binary 1.

Instead of a repeating sequence of the same binary value in the third waveform example there is an alternating binary sequence. In the first two examples the signal must transition back between each bit period, so that it can make the same-direction transition each time in the center of the timing window. With alternating binary data, there is no need to return to the previous voltage level in preparation for the next edge in the center of the timing window.

The fourth waveform example is random data which allows us verify that whenever there is a wide separation between two transitions then both edges are in the center of a timing window and represent the binary value for that timing window.

After encoding the binary into Manchester, the physical layer transmits the resulting signal onto the attached medium.

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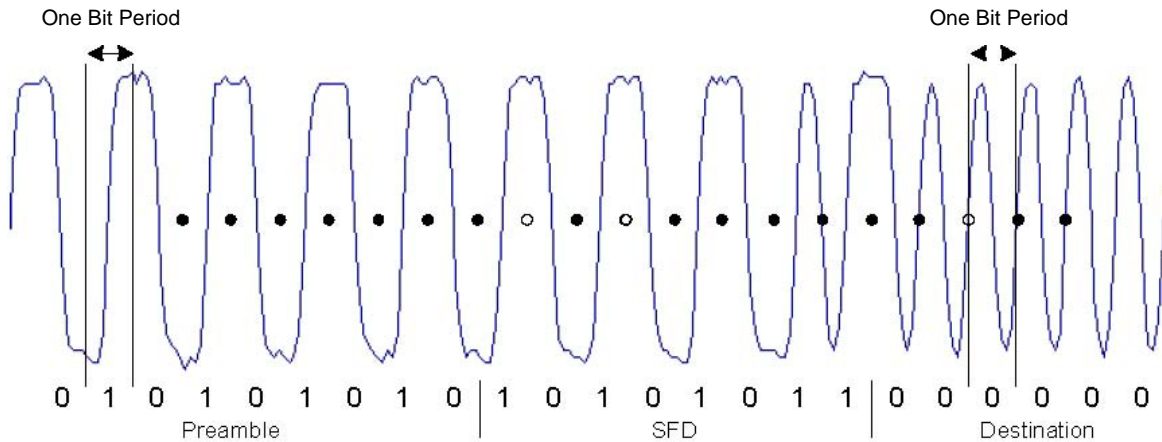


Figure 3

In Figure 3 two vertical lines were drawn to clearly delineate timing periods. In the center of both marked timing periods is an edge transition. Black dots have been added at the boundaries of some other timing periods to aid in decoding the binary data. The decoded binary is shown below the waveform along with the Ethernet field boundaries.

## Part 2 – Reading the Waveform

To transmit the frame, it must be passed from the MAC Layer to the physical layer. Ethernet encoding rules specify that each octet is transferred least-significant bit (LSB) first from the MAC Layer to the physical layer, so the bits are reordered on a per-octet basis - Figure 4. The FCS field is not reordered.

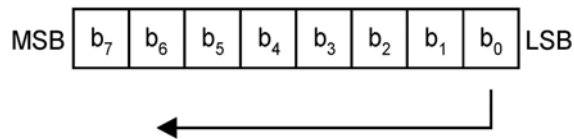


Figure 4

Conceptually, this is easiest to grasp as simply turning each octet over as shown below. The change is most identifiable in the Start of Frame Delimiter (SFD) octet – Figure 5.

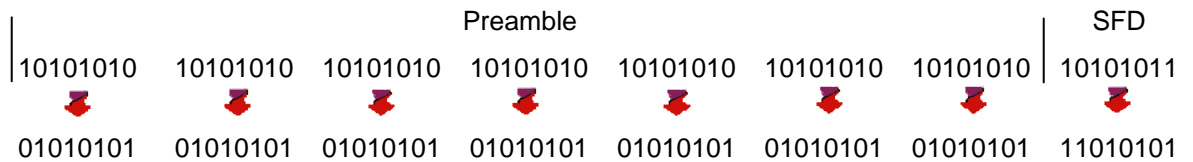


Figure 5

If sample data were shown for the first few fields in a frame, it might appear as follows. Each field is delineated above the sample hexadecimal data for that field, and appears as it might be seen at the MAC Layer – Figure 6.

Preamble	SFD	Destination	Source	Length/Type
55 55 55 55 55 55 55	D5	00 C0 17 A0 02 35	00 80 20 56 33 D4	08 06

Figure 6

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### Part 3 – Decoding the Waveform

1. Locate the boundaries of the timing windows. On your lab sheet there are faint timing marks. Compare the locations of those timing marks with the Manchester encoding examples shown in Figure 2 and the section of decoded waveform in Figure 3. After a short time lean back and look at the spacing of the time windows. Notice that despite how the waveform has narrow and wide spaced sections, your timing windows are all evenly spaced.
2. This step is only possible after you have found and marked some of the timing window boundaries. Now mark the direction of the wave in the center of the timing window.
3. Go back and write the binary value below each arrow. Remember, if the wave is going up in the center it represents a 1. If the wave is going down in the center it represents a 0.
4. Look for the Start of Frame Delimiter (SFD), which appears at the end of the initial stretch of widely spaced waveform edges. There will be a change in the pattern, and you should have decoded a binary 11 right where the waveform pattern changed. Draw a vertical line through the waveform along the timing mark to the right of the binary 11 pattern, and before the next timing window. That line separates the end of the SFD from the beginning of the Destination Address. Count back to the left eight bits and draw another vertical line on the left clocking line for the eighth bit. That line marks the start of the SFD (includes the binary 11) and the beginning of the previous field. Refer back to Figure 1 to obtain the number of octets required for each Ethernet field. For example, the SFD in Figure 1 is shown with the number one below it. That indicates one octet, or eight binary bits. Count bits as indicated by Figure 1 until you have drawn vertical lines between each of the Ethernet fields leading up to the Data field. You might want to make small marks along the way for each octet division, as you will find that useful in the next step.
5. Convert the binary back to hexadecimal. But wait—there is a trick! Remember that the MAC Layer reordered the bits before handing them to the physical layer. You have to reverse that before converting back to binary. Most people perform the conversion incorrectly the first time. See Figure 5 for a quick refresher on what happened.
6. Identify the Destination MAC Address. This is written in hexadecimal. See figure 6 for a quick refresher.
7. Identify the Source MAC Address. Written the same as the destination MAC.
8. Identify the Layer 3 protocol contained in the Length/Type field. This step is performed after all of the Ethernet header information has been marked into the correct fields and converted back into hexadecimal. If the conversion was not done correctly, the next operation will result in the wrong answer for the next step.
9. If the value in the Length/Type field is less than 0600 then in most cases the contents of the Data field are decoded per the 802.2 protocol. If the value is less than 0600 then the field indicates Length.
10. If the value in the Length/Type field is equal to or greater than 0600, then in most cases the contents of the Data field are decoded per the Ethernet II protocol. If the value is equal to or greater than 0600 then the field indicates Type.
11. If your Length/Type field indicated a Type, then you will be able to look up the value to learn which protocol is next in the Data field. <http://www.rfc-editor.org/rfc-index.html>

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