Calculating Tap Weights from De-emphasis Values

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1.0 What's Going On

In order to understand this calculation, it is first necessary to understand how tap weights get added together in a data waveform, and therefore where the resulting de-emphasis value came from.

Consider that a data waveform is the sum of contributions from individual bits. The contribution due to an individual bit is called the pulse response. Figure 1 shows the pulse response from a two tap equalizer.

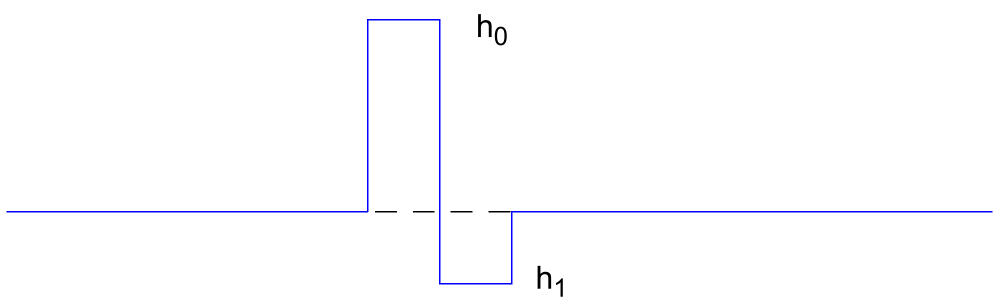

FIGURE 1. Pulse response due to two tap equalizer

In Figure 1, the magnitude of h_0 is usually greater than of h_1, and is considered to be the main tap. The response with amplitude h_1 occurs after the main response, and is often called the first post-cursor tap response. h_0 is usually positive and h_1 is usually negative. Note that Figure 1 is the pulse response when the data bit is a one. When the data bit is a zero, the pulse response is inverted.

In summary, the equalizer tap weights can be read directly from the ***pulse*** response.

In contrast, the de-emphasis value is read directly from the ***step*** response. A step response is generated by a long sequence of zeros followed by a long sequence of ones. Figure 2 shows how this step response is built up from a sequence of pulse responses.

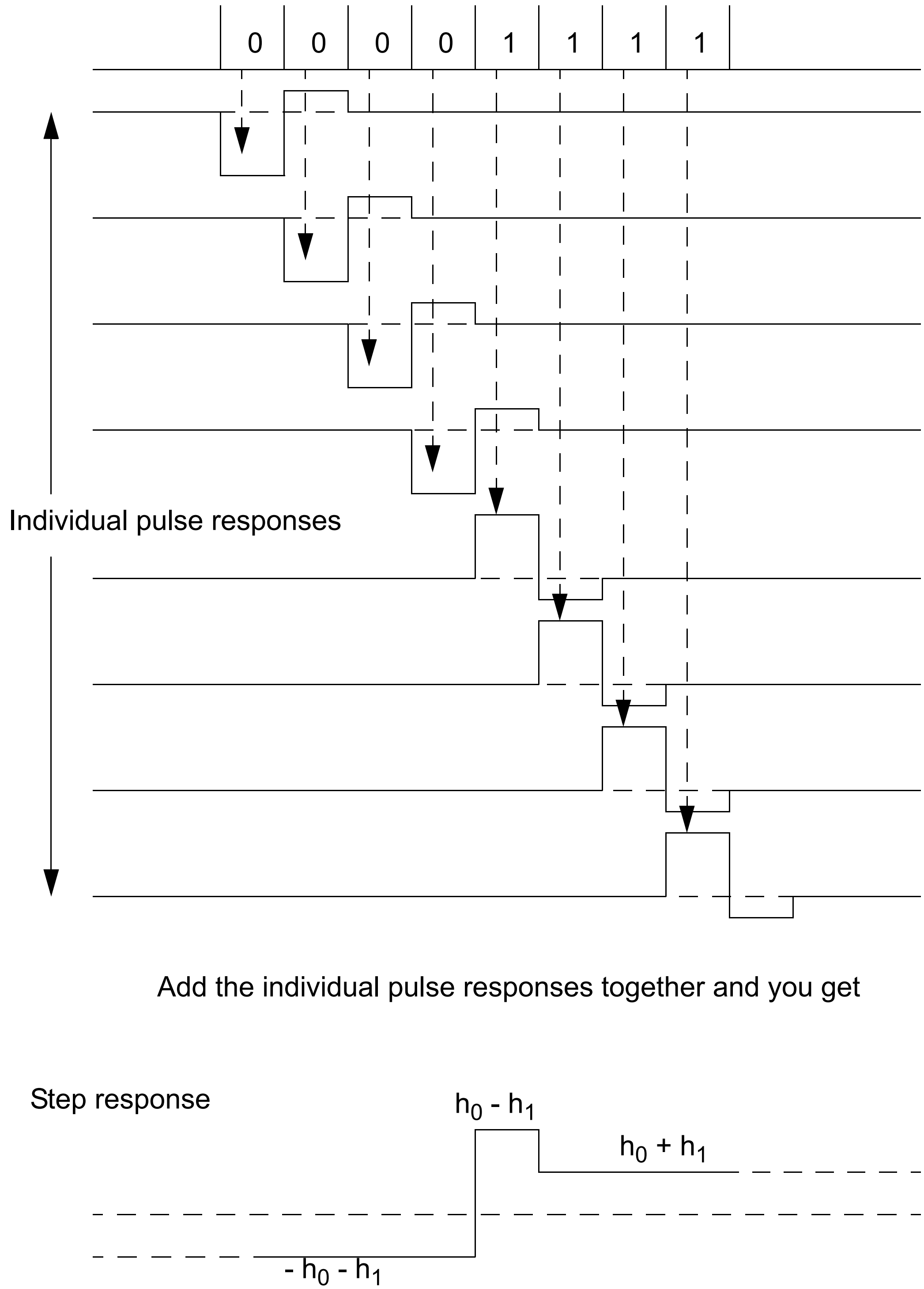

FIGURE 2. Construction of a step response from individual pulse responses

2.0 The Equations

Given a two tap equalizer with tap weights h_0 and h_1, and assuming that h_0 is positive and h_1 is negative, then the maximum output level is proportional to

$$v_{max} \propto h_0 - h_1 \qquad \text{(EQ 1)}$$

and the minimum output level is proportional to

$$v_{min} \propto h_0 + h_1 \qquad \text{(EQ 2)}$$

If the de-emphasis level is a expressed in decibels, then

$$a = 20\log\left(\frac{v_{max}}{v_{min}}\right) \qquad \text{(EQ 3)}$$

$$\frac{h_0 - h_1}{h_0 + h_1} = 10^{a/20} \qquad \text{(EQ 4)}$$

Normalizing *vmax* to one,

$$h_0 = 1 + h_1 \qquad \text{(EQ 5)}$$

$$1 + 2h_1 = 10^{-a/20} \qquad \text{(EQ 6)}$$

$$h_0 = \frac{10^{-a/20} + 1}{2} \qquad \text{(EQ 7)}$$

$$h_1 = \frac{10^{-a/20} - 1}{2} \qquad \text{(EQ 8)}$$

For example, if a = 3.5dB, then h_0 = 0.834 and h_1 = -0.166.