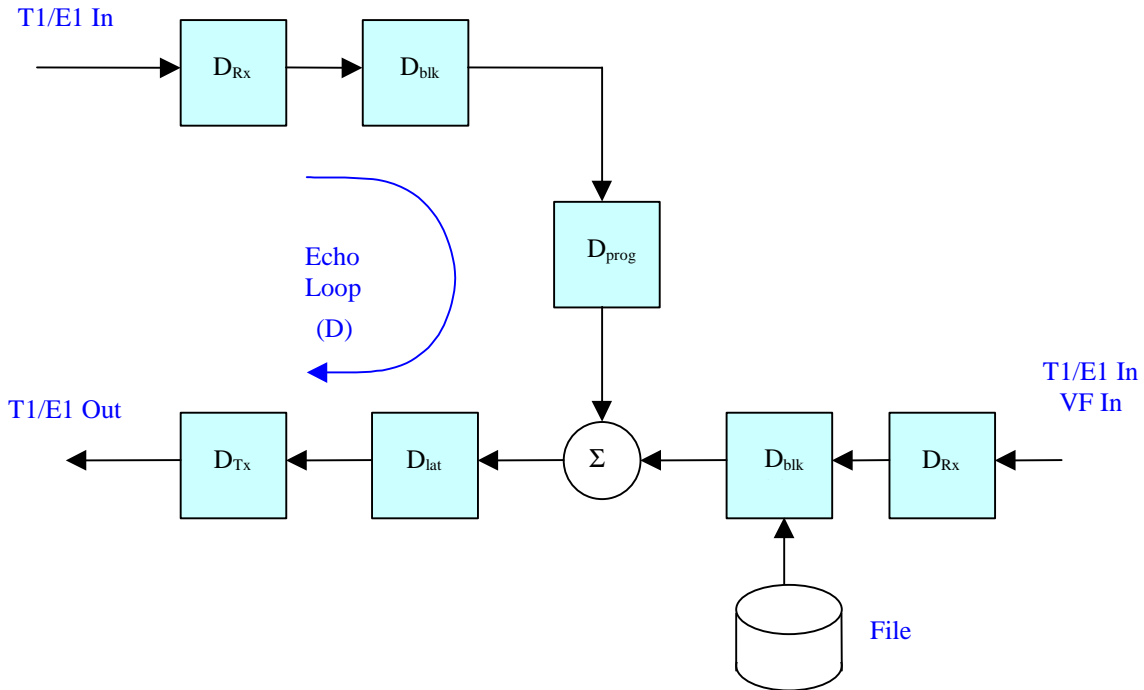


Understanding Delay in the Delay/Attenuate Application

Understanding the various sources of delay when using GL cards is essential in understanding the relationships between the various signals that may interact in the Delay/Attenuate application.



D : Requested delay = Echo Loop delay.

D_{Rx} : Receive hardware buffering = 1 superframe.

D_{Tx} : Transmit hardware buffering = 1 superframe.

D_{blk} : Response time or *processing blocksize*. User-defined. Default = 1 superframe.

D_{lat} : Transmit latency: User-defined. Default = 2 superframes.

D_{prog} : Residual or *programmed* delay = Requested delay minus Processing, Latency, and hardware delays.

D: Requested Delay

This is just the total echo path delay.

D_{Rx} and D_{Tx} : Hardware Buffering Delay

The GL Card uses a double-buffering system on both input and output. This introduces a delay of one superframe (multiframe) upon input and one superframe (multiframe) upon output. This delay is fixed by the architecture of the card. Because the output of the Delay/Attenuate application is linked to the input, the hardware delay will effectively be that of the longest superframe involved in the echo loop.

D_{blk}: Response Time Delay (*Processing Blocksize Delay*)

The Delay/Attenuate application operates on signal data in blocks. This results in an additional source of delay referred to as block delay, or more commonly as response time delay. It is called response time delay because the worst case response time of an application cannot be shorter than the processing block size. Due to hardware buffering, the block size cannot be shorter than 1 superframe (multiframe). The default processing block size is two superframes.

D_{lat}: Transmit Latency Delay

Because Windows is a multitasking system, and because execution of the echo path requires a non-infinitesimal length of time to complete, transmit data is generally queued in advance of its actual transmission. This guarantees that the application will be able to transmit an uninterrupted signal train at the cost of a small delay interval. By thinking carefully about a receive-process-transmit operation and the various delays encountered, a transmit latency of at least one superframe is required. The default latency is two superframes.

D_{prog}: Residual or *Programmed* Delay

The Delay/Attenuate application subtracts the delay values discussed above from the value you specify as the desired loop delay to calculate the delay D_{prog} to be used internally by the program. Note that the various sources of delay described above results in the following relationship:

$$D_{\text{prog}} = D - (D_{\text{Rx}} + D_{\text{blk}} + D_{\text{lat}} + D_{\text{Tx}})$$

Given that the Delay/Attenuate application views hardware delay as that of the largest superframe involved in any of its hardware sources or destinations, the above relationship becomes:

$$D_{\text{prog}} = D - [2 * \max(D_{\text{Rx}}, D_{\text{Tx}}) + D_{\text{blk}} + D_{\text{lat}}].$$

D_{min}: Minimum Achievable Delay.

This processing architecture results in a minimum achievable loop delay. This minimum delay is the value of D when D_{prog} has been reduced to zero. From the above formula, this is

$$D_{\text{min}} = D_{\text{Rx}} + D_{\text{blk}} + D_{\text{lat}} + D_{\text{Tx}}.$$

Timing Relationships of Mixed Signals.

You can use the above diagram to calculate the relationship between signals traversing the echo loop and signals being mixed in from other sources in the Delay/Attenuate application.

- For mixed signals arriving on a T1/E1 timeslot, notice that the Rx Hardware Buffer Delay and the Response Time Delay occur on both the echo path and the mixed signal path and therefore cancel each other out. The mixed signal also experiences the transmit latency and the transmit hardware buffering delay. The net result is that the echo path signal is delayed with respect to the mixed signal by D_{prog} .
- For mixed signals originating from a file or from a noise generator, no Rx Hardware Buffer Delay is incurred. However, such signals still incur Response Time Delay. The net result is that the echo path signal will be delayed with respect to the mixed signal by $D_{\text{prog}} + D_{\text{Rx}}$.
- For mixed signals arriving via the VF input, the signals are inserted directly into the Receive Hardware Buffer. Therefore, the effect is exactly as if the signals arrived on a T1/E1 timeslot.