APPLICATION NOTE 44B

More Information and Easier Pulse Analysis With the Model 185A 1000 mc Oscilloscope

The large, bright display and extreme dynamic range plus the wide bandwidth, fast sweep speeds and high degree of sweep magnification of the ⓗⓟ Model 185A Oscilloscope make it ideal for detailed pulse analysis and viewing intermittent signals. For example, the 185A dramatically reverses the trend toward smaller displays and low sensitivities at high frequencies by providing 10 mv/cm sensitivity (up to 3 mv/cm with the vernier control) and a full 10 cm display over its entire frequency range. Furthermore, the oscilloscope presents a true indication of a portion of the display even when the vertical amplifier is overloaded up to 60 screen diameters. Compare the 60:1 overload capability of the 185A with a maximum overload capability of 4 - 6:1 of conventional oscilloscopes which have a maximum sensitivity of 50 mv/cm in the 30 mc region, 100 mv/cm from 50 - 100 mc and several volts/cm at 500 mc. With conventional oscilloscopes maximum height at 30 mc is usually 4 - 5 cm and as little as 1 cm at higher frequencies.

Extremely wide vertical and horizontal dynamic range permit unusually large magnification of a minute signal. The horizontal axis freatures 100X magnification and the delay control brings any portion of the horizontal trace to center screen. The vertical axis can accommodate signals from 200 mv/cm to 3 mv/cm (using the vernier), a range of approximately 60:1, and you can bring any portion of the amplified signal on screen with the vertical position control. The combined expansion horizontally and vertically means that a portion of a pulse that occupies only 1/6000th of the screen initially, can fill the entire 10 centimeter by 10 centimeter screen. Three examples follow which illustrate uses of the 185A Oscilloscope.

Sections A and B of this note show how you can measure jitter and overshoot quickly and easily by using the exceptional capability of the 185A for vertical and horizontal expansion. Section C demonstrates that the 185A presents useful information on semi-periodic signals even though the display is synthesized from a large number of recurrences of the actual pulse or pulse train.

A. Capability of Extremely Fast Sweep Speeds Simplifies Jitter and Pulse Analyses.

Figure 1* illustrates a medium speed pulse on the screen of the 185A. Assume you want to measure the amount of jitter between the pre-trigger being used to synchronize the 185A and the trailing edge of the test pulse. Assume, also, that you wish to investigate the discontinuity on the trailing edge of the pulse which is circled in figure 1.

Pulse Details:	Rise Time	≈	40 ns
	Decay Time	≈	30 ns
	Amplitude	=	1.4 volts

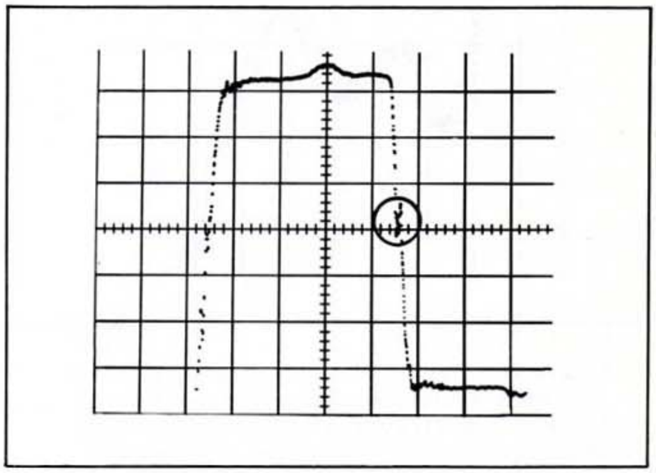

Figure 1. Medium Speed Pulse on 185A (Sweep Time 100 ns/cm; Vertical Sensitivity 200 mv/cm)

Figure 2 shows the trailing edge of the pulse with the sweep expanded 10 times.

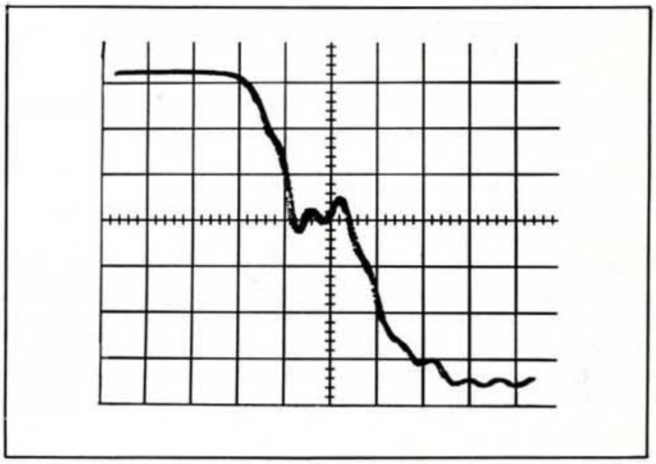

Figure 2. Trailing Edge of Pulse Shown in Figure 1 with Sweep Expanded 10 Times (Sweep Time 10 ns/cm; Vertical Sensitivity 200 mv/cm)

* All photographs here were taken with an ⓗⓟ Model 196A Oscilloscope Camera using Polaroid Type 47 film, speed 3000 with the Camera set at f4.4, 1 sec.

Notice that the discontinuity circled in figure 1 is now clearly defined as a "ringing" with a period of about 5 ns. Jitter of about 1 ns causes a widening of the trace to 1 mm.

Figure 3 shows an additional 4X magnification in each direction, giving a total of 40X sweep expansion and 4X vertical expansion from the original pulse.

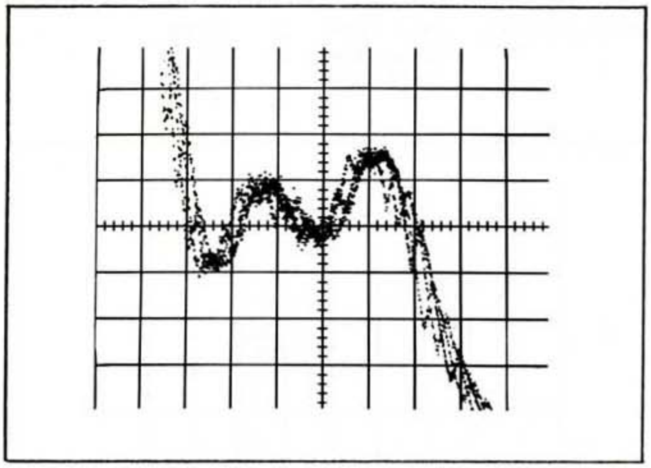

Figure 3. Portion of Trailing Edge of Pulse in Figure 1 with Sweep Expanded 40 Times, Vertical Sensitivity Increased 4 Times--note clear presentation of jitter on trailing edge (Sweep Time 2.5 ns/cm; Vertical Sensitivity 50 mv/cm)

Now you can see that the trace has jitter of about 1-1/2 ns. The amplitude of the disturbance is approximately 130 mv.

B. <u>Vertical Expansion up to 60 Diameters without Overload Increases the Usefulness of the 185A in Analyzing Pulse Detail such as Overshoot</u>

Figure 4 shows a fast rise pulse being viewed with the 185A using the 187A-76C 10:1 divider.

Pulse Amplitude: approximately 2 volts;
Pulse Width: approximately 200 ns.

Total size of the pulse in this picture is about the same as it might appear on conventional oscilloscopes. Remember, figure 4 shows the largest possible presentation of the test pulse that you can get on conventional oscilloscopes without going to external magnification. But here is what you can do with the 185A!

Assume you wish to view the overshoot phenomena circled in the figure 4 in greater detail. In figure 5, after the first horizontal and vertical expansion, the pulse fills the entire screen.

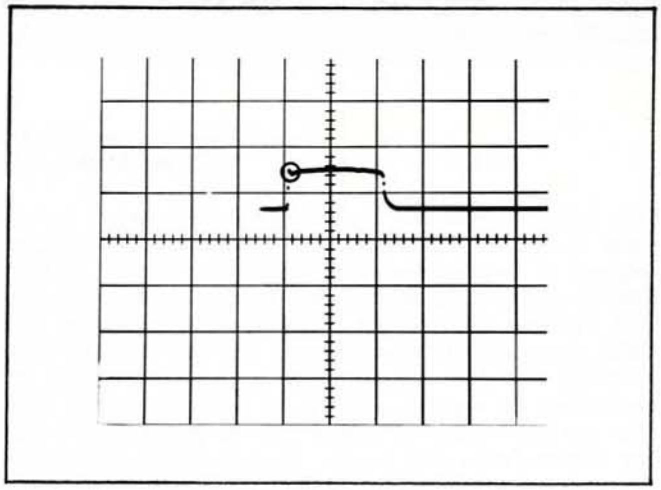

Figure 4. Fast Rise Pulse on 185A (Sweep Time 100 ns/cm; Vertical Sensitivity 2 v/cm 200 mv/cm range plus 187A-76C 10:1 divider)

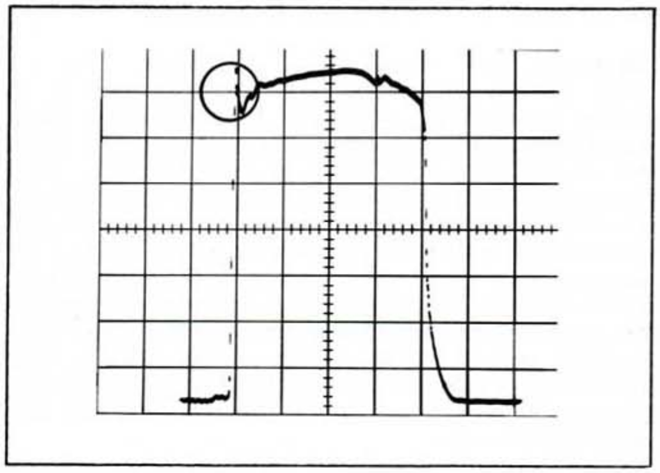

Figure 5. Same Pulse as Figure 4 with Sweep Expanded 2 Times and Vertical Sensitivity Increased (Sweep Time 50 ns/cm; Vertical Sensitivity 300 mv/cm 50 mv/cm plus vernier and 187A-76C 10:1 divider)

Notice the overshoot in the circled area (figure 5) as the detail begins to emerge.

Figure 6 illustrates the corner of the leading edge of the pulse as the magnification is further increased.

Now you can estimate that the period of the "ringing" is about 2 ns. This might indicate, for example that some portion of the test circuit is resonant at 500 mc.

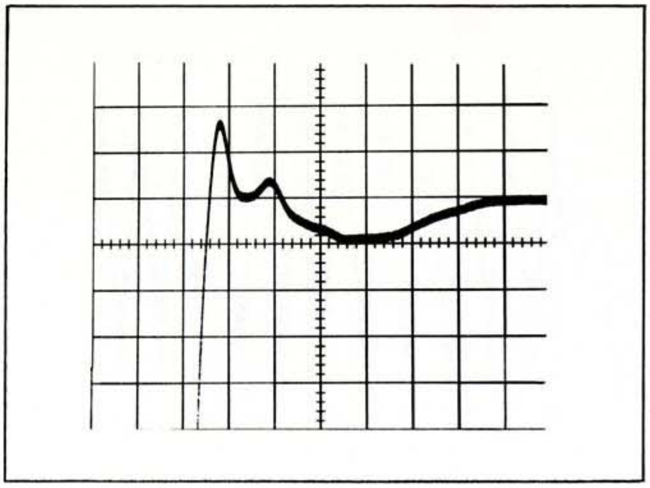

Figure 6. Portion of Pulse in Figure 4.
(Sweep Time 2 ns/cm;
Vertical Sensitivity 100 mv/cm)

Figure 7 illustrates the final magnification as the overshoot phenomena, scarcely visible in figure 4, now fills the entire screen.

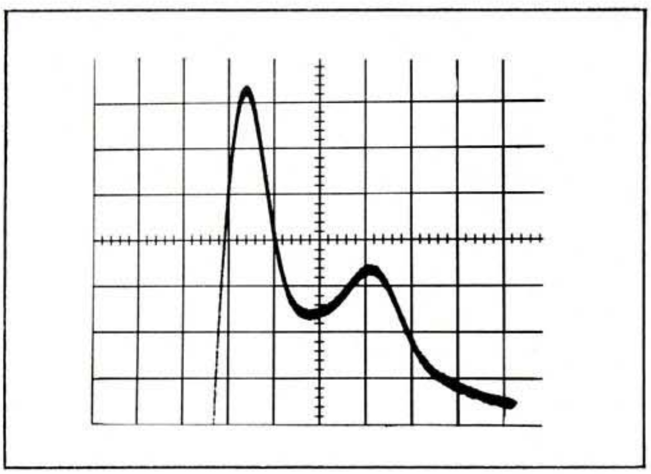

Figure 7. Portion of Pulse in Figure 4
(Sweep Time 2 ns/cm;
Vertical Sensitivity 30 mv/cm)

C. It is Easy to Determine the Proportion of Time a Pulse is Intermittent by Estimating the Relative Number of Dots on the Waveform and the Baseline Under the Waveform

Each "sample" plotted on the 185A screen represents true instantaneous signal amplitude because of a unique feedback system used in the 185A. As a result, the display gives useful information even on signals that are not 100% periodic.

Figure 8 shows the 185A presentation of a semi-periodic pulse train.

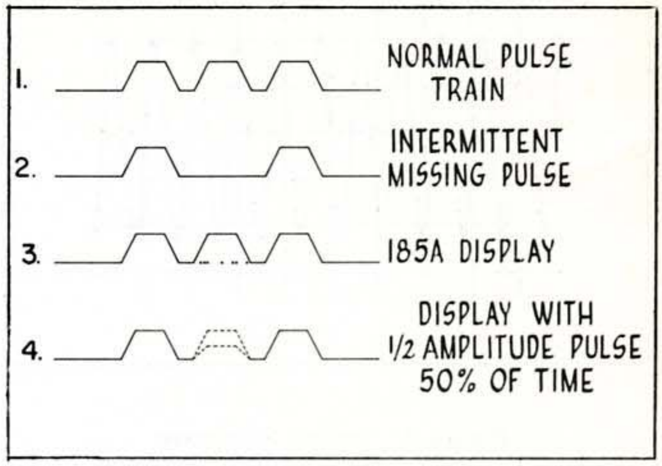

Figure 8. Presentations with Semi-Periodic Signals

On line 1 of figure 8 a normal pulse train is shown. Line 2 shows the pulse train as it occurs occasionally with the center pulse missing. Line 3 shows the presentation as it appears on the 185A. The center pulse is heavily outlined in its "normal" position and a scattering of dots on the baseline indicate that the pulse is occasionally missing. The relative number of dots on the wave (which can be estimated) compared with the number on the baseline indicates the proportion of time the pulse is missing. Line 4 illustrates the presentation with a half amplitude pulse occurring 50% of the time.

Conventional oscilloscopes indicate the missing pulses by allowing the base line to strike through. The relative brightness of the wave and baseline indicate the relative frequency of occurrences. You can see that the presentation in the form of relative number of dots is actually easier to interpret than an estimation of relative brightness of wave and baseline as other oscilloscopes present it.

Figures 9 and 10 show another example of the 185A presentation with a semi-periodic signal. Figure 9 is the photograph of a 450 mc sine wave on a 185A. The oscilloscope is synchronized by means of the H01 184A Synchronizing Trigger Unit. (Refer to Application Note 44A, figure 6 for a block diagram of the synchronizing method.) Figure 10 shows the same wave with 30% 400 cps amplitude modulation. Since the 400 cps modulating frequency is not harmonically related to the rf signal which synchronizes the oscilloscope, the modulating signal changes the amplitude of the 450 mc carrier to create the characteristic presentation of a randomly modulated carrier shown in the picture. The display is almost identical to the presentation on a "conventional" oscilloscope monitoring an amplitude modulated carrier.

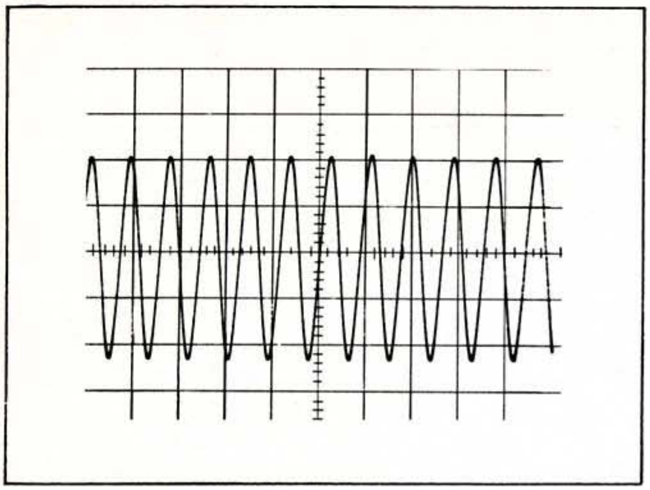

Figure 9. 450 mc Sine Wave
(Sweep Time 2.5 ns/cm;
Vertical Sensitivity 200 mv/cm)

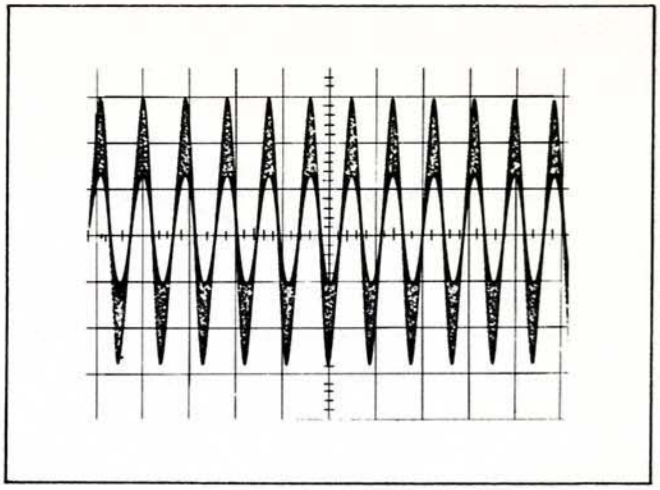

Figure 10. Same Signal as Figure 9 with
30% 400 cycle Amplitude Modulation
(Sweep Time 2.5 ns/cm;
Vertical Sensitivity 200 mv/cm)