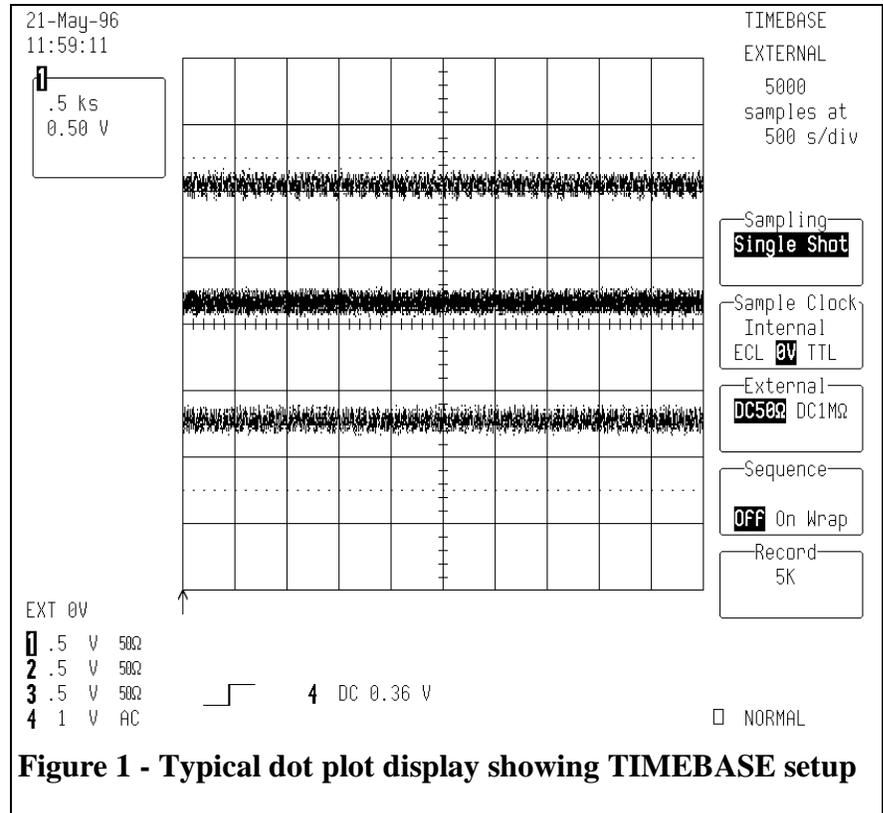


# Dot Plot Displays

## Externally Clock Oscilloscope To Analyze PRML Channels

A classic technique for characterizing the sampling performance of Partial Response Maximum Likelihood (PRML) disk drive channels is the dot plot display shown in figure 1. The analog read signal is applied to an input channel of the oscilloscope and the waveform is sampled using the disk drive's sampling clock. The samples are then displayed using persistence mode to show a history of multiple samples. Since the PRML waveforms have known sample amplitudes it is easy to see the effects of improper sample timing and additive noise on the sampling process.

LeCroy oscilloscopes are able to produce dot plot displays because they include the ability to externally clock the internal digitizers using a user supplied signal. As can be seen from the TIMEBASE menu in figure 1 the oscilloscope accepts 3 different external clock signal levels: ECL (-1.3V), TTL (+1.5V) or the zero crossing of an analog signal as an input. The input impedance level can be set to 50Ω or 1 MΩ. Triggering occurs on the on the rising edge of the signal. The transition times of the external clock signal should be less than 10 ms.



**Figure 1 - Typical dot plot display showing TIMEBASE setup**

In external sampling the oscilloscope time base is set by the user in terms of the total number of samples set in the RECORD field of the TIMEBASE menu. This is also shown in figure 1. Record lengths of from 50 to the maximum memory length (2 M in L versions) can be selected in multiples of 1, 2, or 5. *It is important to note that the oscilloscope will automatically revert to internal sampling if the TIME/DIV knob is used.*

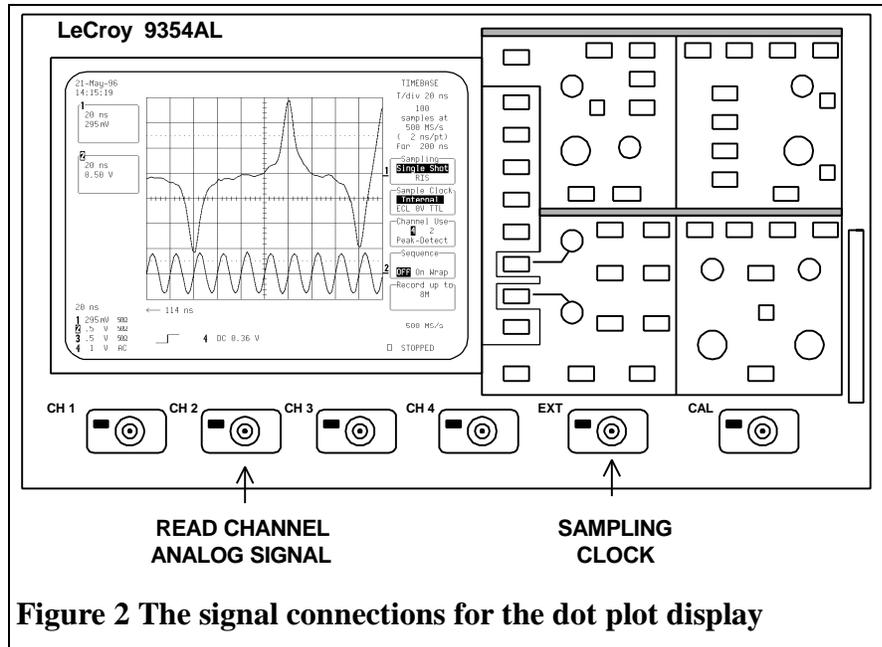
The measurement requires access to the read channel ana-

log waveform as well as the drive's sampling clock. Figure 2 shows how these signals would be connected to a typical LeCroy oscilloscope for the standard external clock input. Note that the timing of the sampling clock may need to be trimmed to assure that the signal waveforms are sampled at the correct time. This is usually accomplished by trimming the length of the coaxial cable connecting the sampling clock output to the oscilloscope's ext trigger/sampling input.

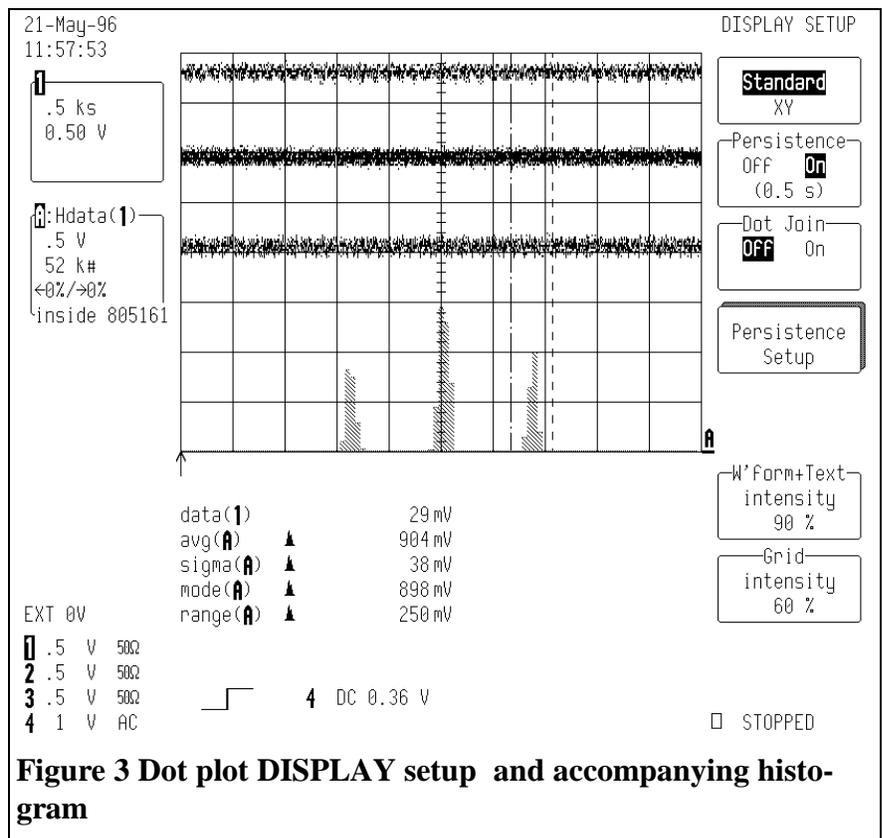
In addition to the signal connections and TIMEBASE menu settings remember that the DISPLAY menu must be used to select the PERSISTENCE display mode and turn DOT JOIN off as shown in figure 3.

The dot plot is a qualitative display. By combining the dot plot with LeCroy's optional histogramming capability it is possible to quantify the waveform. In figure 3, the lower trace is the histogram of the data parameter of the input channel. The measurement parameter readout under the histogram display provides direct reading of the mean, standard deviation (sigma), mode and range (thickness) of the signal voltages represented by the upper line in the dot plot.

LeCroy oscilloscopes combine the familiarity of traditional dot plot displays with the digital precision of automatic measurement parameters and histogram displays. The combination is a powerful tool for analyzing the performance of PRML channel drives.



**Figure 2** The signal connections for the dot plot display



**Figure 3** Dot plot DISPLAY setup and accompanying histogram