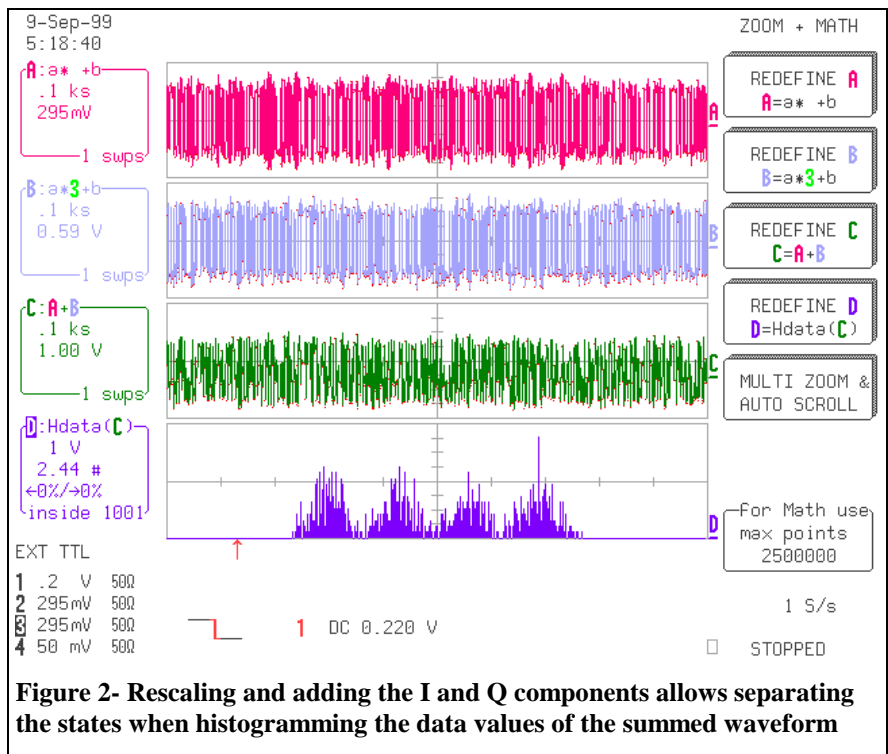
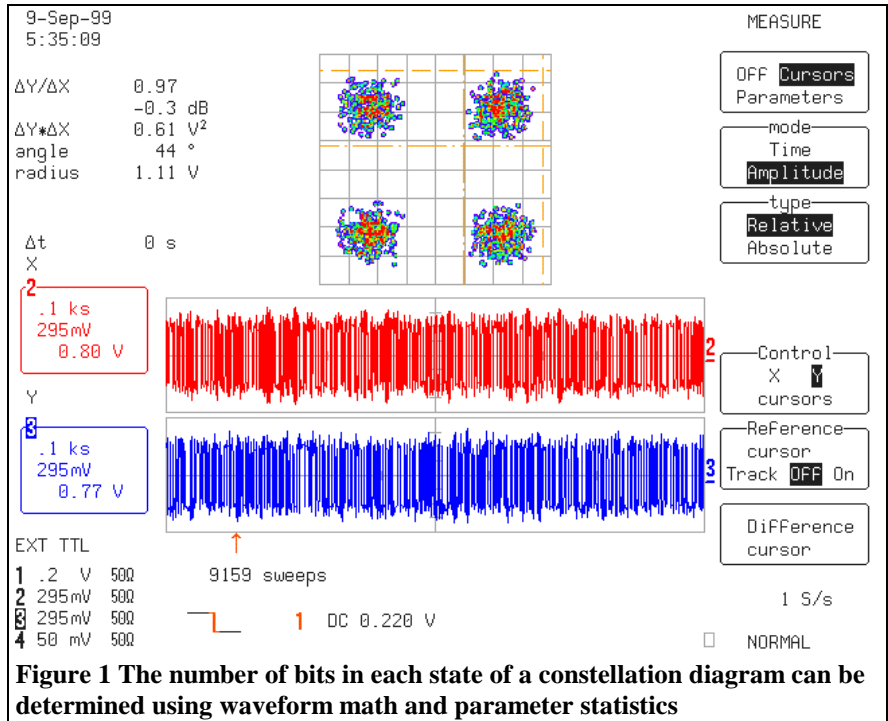


Histogram Constellation Diagrams

Determine The Statistical Population Of Each State

Constellation diagrams graphically represents the states of an encoded serial communications signal. It is often required to determine the number of values(statistical population) in each state. Figure 1 shows an example of a constellation diagram for a CDMA signal. This diagram is created by acquiring the "I" and "Q" waveform components of the CDMA signal, using the CDMA symbol clock as the external clock, and displaying them as an X-Y plot. The spectral mapping of the color graded analog persistence display provides a qualitative indication of the relative number of events contained in each state.

The quantitative analysis of the number of events in each state requires a series of simple math operations shown in figure 2. The "I" and "Q" waveforms are scaled by a constant value and added. For example, if we simply added the components the difference between a "01" and a "10" state would be lost. But if, as in this case, we multiply the "Q" component (Channel 3) by 2 the overlapping states are separated as shown in the histogram of the data values in the lower trace in figure 2. The states, normally represented as



"0+0=0", "0+1=1", "1+0=1", and "1+1=2" are now mapped to "0+0=0", "0+1=1", "2+0=2", and "2+1=3". For more com-



plex encoding other scaling factors may be chosen to achieve the same separation. For example, multiplying the “I” and “Q” components of a 16QAM signal by 3 and 5, respectively, separates the 16 possible states.

The histogram of the data values can be interpreted numerically using any of the 18 histogram parameters available in the statistical analysis package. Figure 3 shows the use of total population (totp), which shows the total number of measured values in the histogram, and maximum population (maxp) which shows the number of events in the highest bin.

Applying the parameter gating cursors allows the user to read the number of events in each state as shown in figure 4. The histogram was first stored to one of the 4 internal memories so that placement of the parameter gating cursors will not cause the scope to recalculate the histogram. The total population now reads the number of events between the cursors which are bracketing the state with the highest amplitude value (the “11” state). The bin with the maximum population is still contained within the cursors so its value remains unchanged.

The ability to combine external clocking, analog persistence, long acquisition memory

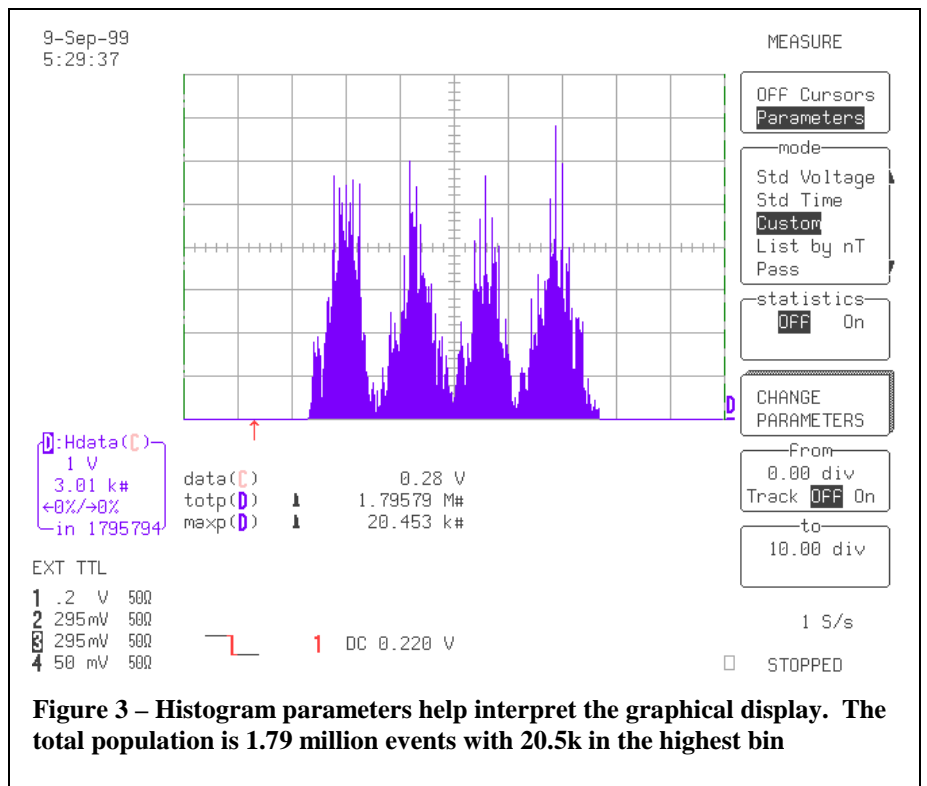


Figure 3 – Histogram parameters help interpret the graphical display. The total population is 1.79 million events with 20.5k in the highest bin

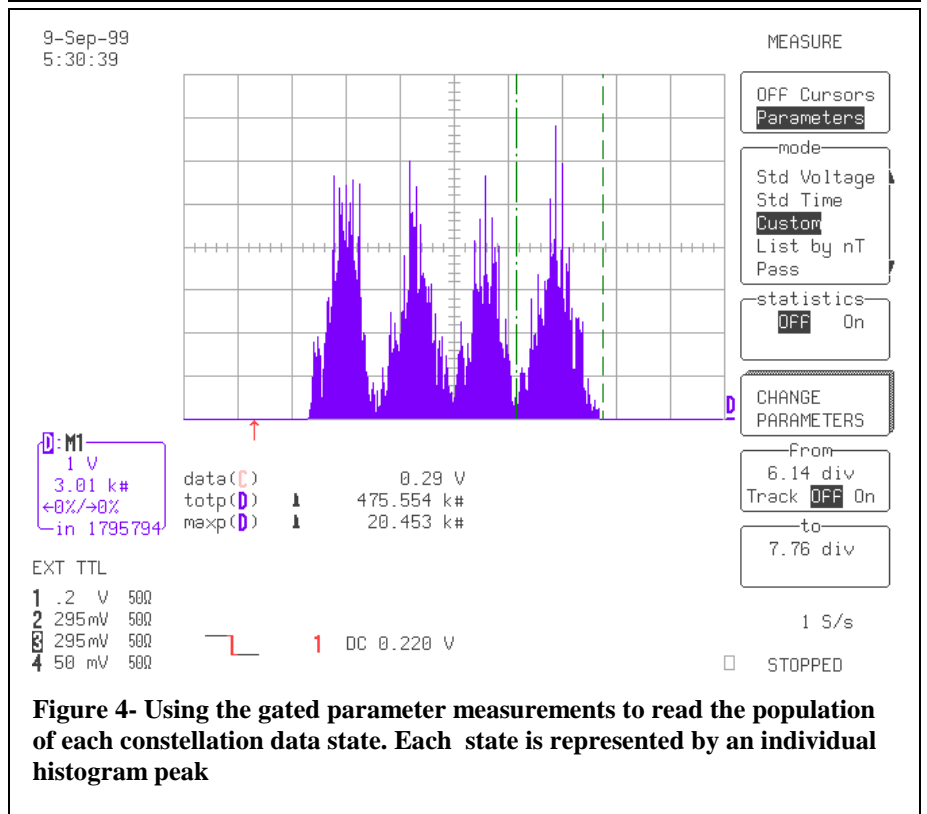


Figure 4- Using the gated parameter measurements to read the population of each constellation data state. Each state is represented by an individual histogram peak

and chained math operations allows accurate quantitative data to be extracted from what

used to be a qualitative measurement.

