Varying beam thickness in CRT display systems

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Though computer-driven CRT displays have many programable parameters, including intensity, blinking, and dashed- or dotted-line generation, beam thickness is not among them, except indirectly through the display's brightness control. Thickness variability can, however, be provided if the control circuit shown is inserted in the display's stroke vector generator. The circuit superimposes equal-amplitude sine and cosine waves on the generator's X- and Y-deflection ramp signals.

When the CRT beam is stationary, the sine and cosine waves produce a circle. As this circle is moved by the generator ramp signals, a straight line with the thickness of the circle's diameter is displayed. The thickness of the stroke can be programed through digital control of the sine and cosine wave amplitudes.

Since a circle is symmetrical, the stroke thickness will be independent of the slope of the stroke. The circles, however, must be closely spaced to prevent ragged edges from being produced in the display. The frequency of the sine and cosine waves, therefore, must be high enough to complete a full circle before the generator ramp signals displace the beam by a distance that is equal to the diameter of the cathode-ray spot.

The stroke vector generator must be the constant-rate type, so that the velocity at which the beam moves over the CRT screen is constant, no matter the length and slope of the stroke being generated. The beam displacement rate for only an X or Y increment is then equal to the displacement rate for any combination of X and Y increments. If the displacement is in either the X or Y direction alone, the corresponding ramp slope will be maximum.

To find the minimum signal frequency of the sine and cosine waves, the maximum X or Y ramp signal slope must be known, as well as the X and Y deflection sensitivity, and the cathode-ray-spot diameter. Suppose these values are 0.01 volt per microsecond, 1 centimeter per volt, and 0.01 cm, respectively. This means that a 0.01-cm displacement can be produced by a 0.01-V signal in 1 μs (for a slope of 0.01 V/μs). The period of a full sine or cosine cycle must then be 1 μs at most, making the minimum signal frequency equal to 1 megahertz. For this case, the maximum stroke thickness is limited to 2.5 millimeters; beyond this, the circles become conspicuous.

In the thickness control circuit given, a 1-MHz sine wave is employed as the reference input to a three-bit digital-to-analog converter, permitting the sine-wave amplitude to be digitally controlled. The phase splitter then produces the sine and cosine waves, which are superimposed on the vector generator's X and Y ramp signals by a pair of op-amp summers. These summing amplifiers drive the X and Y inputs of the CRT display, producing straight-line segments the thickness of which can be varied digitally. □

Controlling display thickness. Circuit converts CRT beam thickness to a digitally programable display parameter. Beam thickness is controlled by superimposing sine and cosine waves to create a circle with a diameter that can be varied in response to a digital input.