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THE EFFECT OF PULSE SHAPE IN RASTER DOT
ALPHA-NUMERIC CRT PRESENTATIONS ON
SPOT LUMINANCE AND LUMINANCE DISTRIBUTION

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CRT
APPLICATION AND
REFERENCE NOTES

THE EFFECT OF PULSE SHAPE IN RASTER DOT
ALPHA-NUMERIC CRT PRESENTATIONS ON
SPOT LUMINANCE AND LUMINANCE DISTRIBUTION

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
A. PURPOSE	2
B. PRELIMINARY NOTES, EQUATIONS AND ASSUMPTIONS	3
C. THEORETICAL DISCUSSION	6
D. NUMERICAL ANALYSIS OF A TRIANGULAR PULSE	10
E. COMPARISON OF THE EFFECTS ON THE SPOT DISTRIBUTION IN RECTANGULAR AND TRIANGULAR PULSING	18
F. PULSES OF ARBITRARY FORM	21
G. CONCLUSIONS	22
H. REFERENCES	23

A. PURPOSE

These notes provide means of analyzing the effect of pulse shape on the written spot configuration and its relative brightness in raster-dot displays. The observations noted and the application of the methods described will provide the equipment designer with better insight into pulse shape limitations, observed spot size, spot shapes and their luminance distributions as well as variations resulting from changes in the applied drive-voltage levels in a particular tube design. The subject discussed is becoming increasingly important due to the demands for higher resolution and increased writing speeds.

It will be shown that after the luminance and line width characteristics of a given CRT design in terms of the drive voltage have been established, the spot shape and its luminance distribution can be synthesized for any pulse shape at a given set of operating conditions.

B. PRELIMINARY NOTES, EQUATIONS AND ASSUMPTIONS

It has previously been demonstrated (Ref 1) that if ideal rectangular drive pulses are applied the highlight luminance of a written spot can only approach that of a written line (in a given tube under identical operating conditions) if spot roundness is sacrificed. Under conditions of constant writing speed, complete spot roundness is theoretically only possible with an infinitesimal pulse width which would reduce the highlight luminance essentially to zero. Reference 1 suggested a compromise pulse equivalent of a 2.5σ width of the written line at the same drive level. It was shown that this would reduce the highlight luminance by about 20% and provide a reasonably round written spot under conditions of proper spot separation.

In general, pulses used in raster dot writing are not rectangular and as a result more sophisticated analytical approaches become necessary. The following material will first treat the theoretical equations applicable to arbitrary pulse shapes for isolated spots. A triangular pulse shape will then be used to illustrate the method suggested and to provide performance comparisons between rectangular and triangular pulse shapes.

To simplify the discussion the following assumptions and conditions are made:

1. The spatial beam current density distribution at the screen is a Solid Gaussian Distribution.
2. There is little or no phosphor saturation.
3. The luminance response to beam current density is assumed to be instantaneous rather than possessing finite rise and decay times. This assumption does not affect the validity of the analysis.

4. The term "instantaneous luminance values" as used in these notes designates the integrated instantaneous luminance values at the given repetition rate and writing speed and for the drive level and location relative to the beam center applying at that instant. Values used may be expressed relative to the time or the spacial domain.
5. Variations due to phosphor or glass surface granularities are ignored.
6. The spot motion is horizontal at a constant writing speed.
7. The σ values given are those associated with the perpendicular luminance cross-section of a fully written line at a given drive level.
8. The σ_s values are normalized values corresponding to the perpendicular luminance cross-section of a fully written line at the maximum drive level used in the applied pulse.
9. Undelected spot grid cut-off reference is used.
10. Deflection defocusing phenomenon are neglected.
11. The analysis applies to the center of the tube face.

Because of its basic importance to this subject. the maximum or highlight luminance across a single, well separated CRT line as given in Reference 1 is repeated here:

$$L_H = \rho_o E'_{vs} T \eta_s \frac{\sqrt{\pi}}{S} r_{(e^{-1})} N = \rho_o E'_{vs} T \eta_s \frac{\sqrt{\pi}}{S} \frac{r_{(1-e^{-1})}}{.67726} N \quad <1$$

where:

L_H ----- is the highlight luminance in Fl.

ρ_o ----- is the maximum beam current density within the beam in A/cm².

E'_{vs} ----- is the effective view screen voltage in Volts (actual view screen voltage relative to the cathode minus the screen breakthrough voltage).

T ----- is the transmission of the glass faceplate as a decimal fraction.

η_s ----- is the phosphor screen efficiency in Fl/Watt/cm².

S ----- is the writing speed in inches/sec.

$r_{(e^{-1})}$ -- is the spot radius at the e^{-1} level of the Gaussian in cm.

$r_{(1-e^{-1})}$ is the shrinking raster spot radius in cm.

N ----- is the repetition rate in Hz.

Equation 1 will remain the same for all consistent dimensional systems.

The minimum pulse width necessary to duplicate the full luminance of the written line using a rectangular pulse is 6σ (Ref. 1).

In the time domain, this value is given by:

$$T_1 = (3.132 \text{ d/S}) \text{ sec} \quad <2$$

Where T_1 is the pulse width, d is the SRM (Shrinking Raster Method) line width and 3.132 is the multiplier to extend the SRM line width to the 6σ level line width.

In the time domain, the compromise rectangular pulse width is given by:

$$T_2 = (1.305 \text{ d/S}) \text{ sec} \quad <3$$

Normalized values will be used whenever possible. It is suggested that the reader review Reference 1 to obtain a general overview on the subject of the Raster Dot Display concept.