

APRIL 1979



TEPAC ENGINEERING BULLETIN No. 21

CRT CONSIDERATIONS FOR RASTER DOT ALPHA NUMERIC PRESENTATIONS

**FORMULATED BY
EIA TUBE ENGINEERING PANEL ADVISORY COUNCIL**

NOTICE

EIA Engineering Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or non-member of EIA from manufacturing or selling products not conforming to such Standards and Publications, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than EIA members, whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by EIA without regard to whether or not their adoption may involve patents on articles, materials, or processes. By such action, EIA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Recommended Standard or Publication.

Published by

ELECTRONIC INDUSTRIES ASSOCIATION
Engineering Department
2001 Eye Street, N.W.
Washington, D.C. 20006

Published in U.S.A.

TEPAC ENGINEERING BULLETIN NO.21

CRT CONSIDERATIONS FOR
RASTER DOT ALPHA NUMERIC
PRESENTATIONS

FREDERICK G. OESS
Member, TEPAC JT-20 Committee



Documents
Document Sharing Hub

-1-

CRT CONSIDERATIONS FOR
RASTER DOT ALPHA NUMERIC
PRESENTATIONS

By

Frederick G. Oess, Dir. of Display Tube Engineering
Clinton Electronics Corporation, Rockford, Ill.

ABSTRACT

The purpose of this article is to describe some of the major CRT parameters and how they relate to each other, as well as the data presentation method provided by Clinton Electronics Corporation's tube data sheets. The stress is on optimization of raster-dot, alpha-numeric displays, based on tubes using unipotential focus lenses and magnetic deflection.

PRELIMINARY NOTES

The general forms of CRT data sheets, as they have evolved over the years, provide the monitor designer with very useful information on mechanical dimensions of the tube, maximum electrical operating levels for the various electrodes, inter-electrode capacitance values, etc. Their shortcoming, however, lies in the failure to describe more fully the total operating conditions in terms of spot size and light output over the useful operating range of the tube. What is offered, at best, is a typical set of operating conditions at some single fixed Grid #2 voltage (V_{G2}) and final anode voltage (E_{Vs}). Under given conditions of writing speed, repetition rate and drive, the tube is specified to provide a certain minimum value of integrated raster luminance at a given maximum line width, usually measured in terms of

shrinking raster values. This has resulted in the following types of actions by most monitor designers:

1. Straightforward use of the stated "typical" operating conditions without any attempt to optimize the tube performance in terms of the desired display.
2. The blind acceptance of a fixed Grid #2 voltage, and thereby a great deal of performance variation from unit to unit due to the normally expected cutoff variations from tube to tube.
3. The design of systems on the basis of a few sample tubes from a single tube run, and the resulting bitter disappointment in the operating parameters when the full range of tube variability is experienced during subsequent production.
4. A conscientious effort, at some design-time expense, to obtain additional information from the tube designer.

Further difficulties arise when such specifications are copied and subsequently sent out for quotation by other tube manufacturers. It should be noted that it is quite possible to develop a great number of tube designs which will meet such a specification at the given "typical" operating conditions, but all of these designs will deviate considerably from the original tube (and each other) once these "typical" conditions are changed. If an identical tube replacement is required, such specifications are inadequate, even to the point of being useless. Only exact electron optical "copies" will provide identical performance characteristics.

Displays providing alpha-numeric data presentation by the raster-dot method have generally grown out of the less expensive standard monochrome TV tubes and associated circuit technology. In recent years, however, demands for improved performance have forced a considerable degree of sophistication, applying increased pressure on both circuit and tube designers. Since today monitors of the raster-dot type represent, by far, the largest share of the market for display CRTs, the need for better engineering communications between tube and monitor designer is essential. The establishment of a meaningful specification format is one form such communication can take.



The other important factor involves conveyance by the tube designer of some very basic information about tube operating theory.

THEORETICAL AND DESIGN CONSIDERATIONS

This article will explain the advantage of a means of describing the operating parameters of any common type of CRT, in terms of its most basic form. Furthermore, the writer will attempt to clarify some fundamental tube parameters relationships, thereby providing a clearer understanding of what can be done to maximize tube performance. For the sake of clarity and brevity, the discussion will be mainly based on tubes using gun designs with a preaccelerator or buffer anode (G2), a unipotential focusing lens and no limiting apertures. However, the methods of data presentation described are generally applicable to magnetic and electro-static deflection tubes, using either unipotential, bipotential or magnetic focus, with or without limiting apertures. Figure 1 shows a schematic of a gun with typical electrode voltage ranges. The general form of the electron beam is indicated in Figure 2. Also noted are the parameters which shall subsequently be referred to. In the latter figure the radial dimensions are greatly exaggerated to better illustrate the relationships involved.

To simplify the theoretical discussion, this analysis of CRTs uses the cathode as the reference potential. The cathode (K) provides a continuous source of electrons which form a space charge cloud in front of the emitter surface. The emitted electrons have Maxwellian thermal velocity distributions in both axial and radial directions. These distributions limit the attainable spot size in any CRT. The purpose of Grid #1 (G1) is to constrict the field penetration of Grid #2 (G2) into the cathode space, thereby permitting the amount of current drawn from the space charge cloud to be controlled. The combination of the foregoing elements constitutes the triode generator, or simply the triode. For a given G2 voltage (V_{G2}), the negative voltage on the G1 necessary to provide visual extinction of the undeflected spot is called the spot cutoff. In any CRT, the optimum cathode current, I_C , can be readily calculated from one of the following formulae:

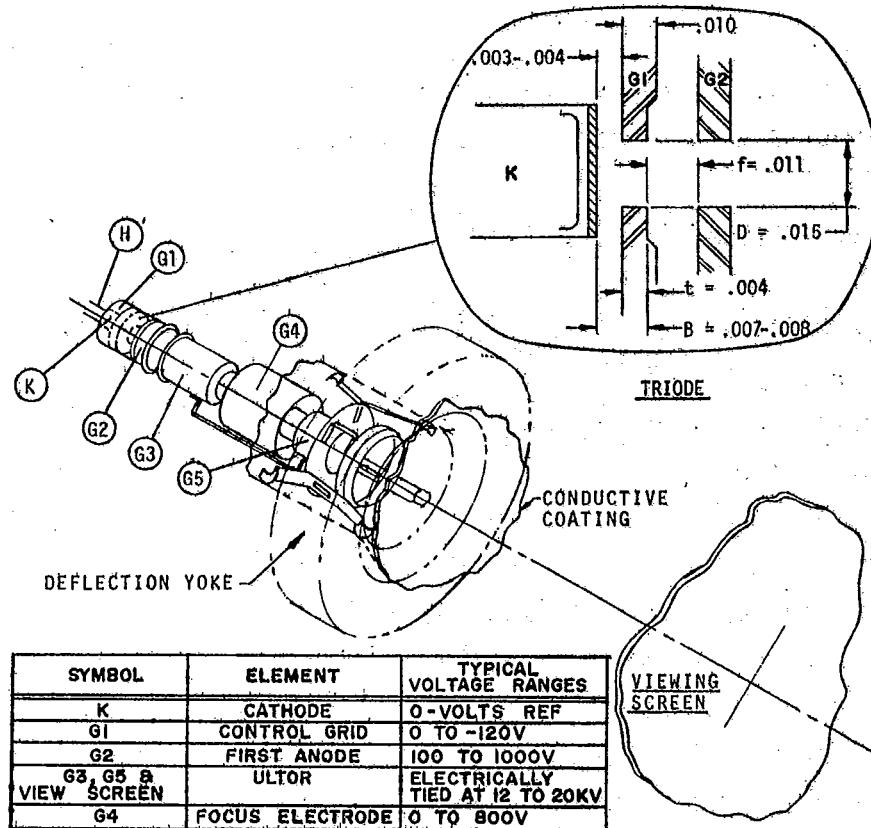
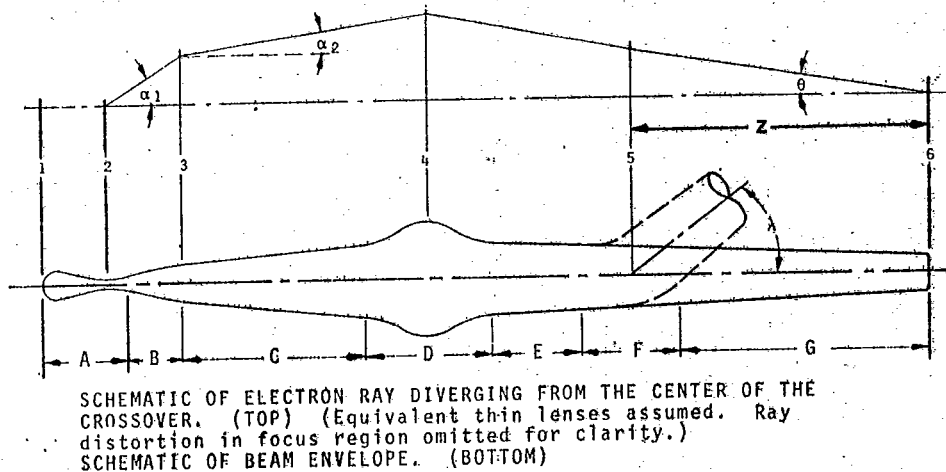


Figure 1 CRT Schematic



SECTOR	DESCRIPTION	ELECTRON VELOCITY	STATION	DESCRIPTION
A	TRIODE AREA	LOW	1	CATHODE
B	GRID 2 DRIFT SPACE	INCREASED	2	CROSSOVER
C	GRID 3 DRIFT SPACE	HIGH	3	G2-G3 LENS
D	FOCUS AREA	LOWER	4	FOCUS LENS
E	ANODE DRIFT SPACE	HIGH	5	DEFL. CENTER
F	DEFLECTION REGION	HIGH	6	VIEW SCREEN
G	ANODE DRIFT SPACE	HIGH		

Figure 2 Electron Beam

$$I_C = K V_D^\psi V_C^{(1.5-\psi)} \mu A \quad <1$$

$$\psi = 3e^{.28\gamma^{2.3}}$$

$$\gamma = |V_D|/|V_C|$$

$$I_C = K V_D^{3.0} V_C^{-1.5} \quad <2$$

$$I_C = K V_D^{3.5} V_C^{-2.0} \quad <3$$

Where:

K - the modulation constant is a design function of the triode. Its value varies from about 3 to 4.5 with 3.5 being a conservative level in tubes designed for raster-dot applications.

V_C - the cutoff voltage is the negative voltage on G1 necessary to just extinguish the undeflected spot.

V_D - the drive is the positive operating voltage of G1 relative to its cutoff value.

ψ - is a variable exponent.

γ - is the grid drive fraction.

The above relationships are further clarified in Figure 3.

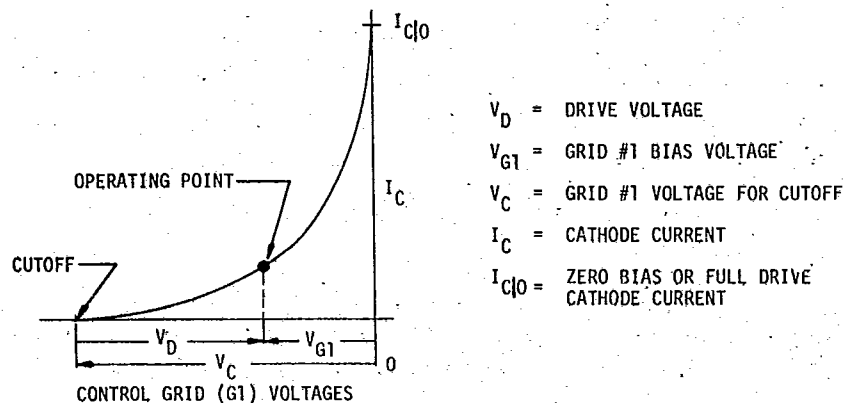


Figure 3 Triode Performance Characteristic