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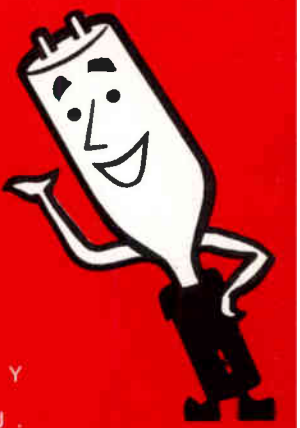
RCA Tube Tips



A NEWSLETTER TO THE BROADCASTING INDUSTRY
RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

The Importance of Vidicon Dark Current

According to R. G. Neuhauser, camera-tube-design engineer of the RCA Electron Tube Division, anyone whose responsibility it is to obtain optimum performance from vidicon cameras will find it extremely helpful to familiarize himself with certain characteristics of the vidicon.

The most important set-up value of a vidicon from the standpoint of its performance in a camera is its dark current—that is, the current which flows in the signal-electrode circuit when the vidicon is operated with no light on its photosurface. The importance of the dark current lies in the fact that its value determines the vidicon's sensitivity, uniformity of background, and lag (tendency of moving objects to smear). The sensitivity increases as the dark current is increased, at the expense of increased lag and decreased uniformity of background.

When two or more vidicons of the same type are set up so that they have the same sensitivity, uniformity of background, and lag characteristics, their signal-electrode voltages may differ by as much as three to one, but their dark currents will be identical. Similarly, if these vidicons are set up so that their dark currents are equal, they will have remarkably similar sensitivities, background uniformity, and lag characteristics, although their signal-electrode voltages may differ by as much as three to one. This variation in the amount of signal-electrode voltage required to produce equal dark currents in vidicons of the same type is due to normal differences in photosurface thickness from tube to tube. Although any vidicon will operate over a three-to-one range of signal voltage, its dark current and, therefore, its performance in a given application will vary widely over this range. To obtain optimum performance from a vidicon in a given application, the signal-electrode voltage must be very carefully adjusted to provide the proper value of dark current for the application. Similarly, when two or more vidicons must perform identically in a given application—that is, have the same sensitivity, uniformity of background, and lag characteristics—they must be operated not at the same signal-electrode voltage, but at the same value of dark current. The proper value of dark current depends on the type of service in which the tube is to be used.

The dark current of a vidicon is affected by temperature, as well as by signal-electrode voltage. The performance of a vidicon is also determined by the signal-output current which, in turn, depends on the amount

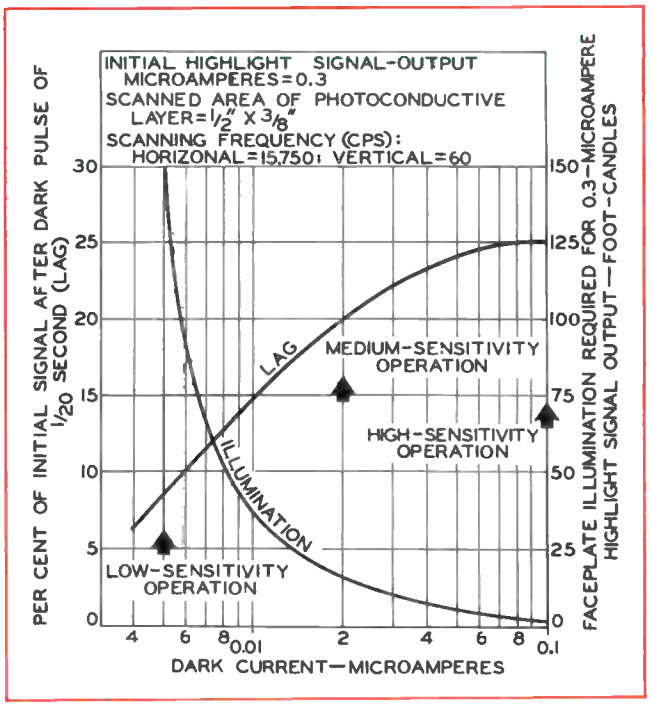


Figure 1. Faceplate illumination requirements and lag characteristics of vidicons, as functions of dark current.

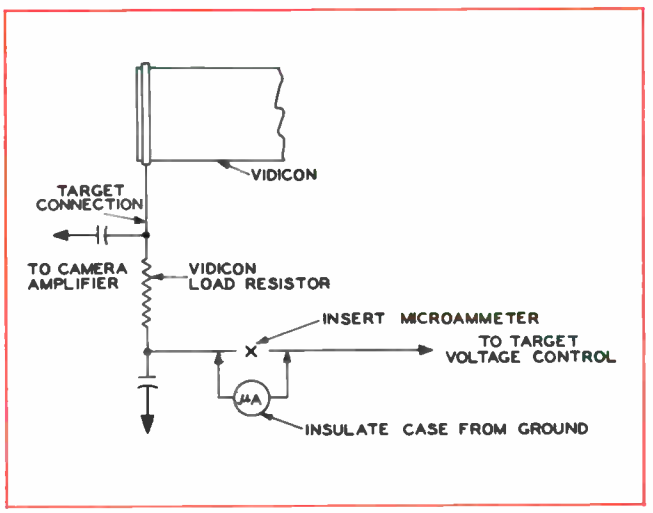


Figure 2. Circuit used to measure the signal-electrode current of a vidicon camera tube.

of light on the photosurface as well as on the signal-electrode voltage. The lag at low signal-output currents is generally severe.

Vidicon service is divided into three general types or modes, called the "low-," "medium-," and "high-dark-current" modes, corresponding, respectively, to operation with dark currents of approximately 0.005, 0.02, and 0.1 microampere as shown in Figure 1. The "low-dark-current" mode is characterized by low sensitivity, requiring faceplate-illumination levels of about 200 foot-candles, by perfect uniformity of background, and by negligible lag. It is used for film-pickup work or outdoor pickup in bright sunlight, and requires the lowest signal-electrode voltage. The "medium-dark-current" mode is the one most frequently used and provides a good balance between sensitivity, lag, and background uniformity. The lag is usually satisfactory for most applications, and the background is substantially uniform, being just below the flare point for the RCA-6198 and -6326 vidicons. The signal-electrode voltage required for this mode of operation is approximately double that required for the "low-dark-current" mode.

The "high-dark-current" mode is used when maximum sensitivity is required. The sensitivity under these conditions is two to three times greater than that obtainable in the "medium-dark-current" mode. The 6198 and 6326 vidicons have pronounced edge flare at a dark-current level of approximately 0.1 microampere and, therefore, are not generally operated in this mode. RCA's 6198-A and 6326-A vidicons, however, have a fairly uniform dark-current characteristic at the 0.1-microampere level and, therefore, may be operated in the "high-dark-current" mode with good results. Lag in this mode, however, is higher and may result in noticeable smearing of moving objects and in a tendency towards long-lasting "image-burn." The signal-electrode voltage required for the "high-dark-current" mode of operation is about 50% higher than that required for the "medium-dark-current" mode, or three times that required for the "low-dark-current" mode.

Because dark current is the principal consideration in setup and operating adjustments for vidicons, facilities for the measurement of this current should be provided in all vidicon camera installations. The most suitable instrument for this purpose is a multirange microammeter having a full-scale sensitivity of 0.01 microampere or less, such as the RCA WV-84B Ultra-Sensitive DC Microammeter. This instrument should be connected in the lead to the signal electrode, as shown in Figure 2.

To measure the dark current, set up the vidicon to produce a picture under normal conditions of light and lens opening for the mode of operation employed—i.e., adjust the scanning width and height to the proper values, and adjust the vidicon beam so that it just discharges the picture highlights. Then cap the lens and read the signal-electrode current. Next, cut off the vidicon beam and read the signal-electrode (circuit-leakage) current. The difference between the two readings is the true dark current of the vidicon. Adjust the signal-electrode voltage to obtain the desired value of vidicon dark current.

If an accurate microammeter, such as the RCA WV-84B, is not available, the following method can be used to determine the proper dark-current levels for the 6198 and the 6326 vidicons. With camera scanning properly adjusted and the raster centered on the tube faceplate, cap the lens and adjust the signal-electrode voltage until the corners of the picture seen on the monitor begin to turn light. Record the signal-electrode voltage at this point. The dark current at this point is about 0.02 microampere, which is the optimum value for most industrial uses and live-scene pickups. If the highest possible sensitivity is desired, the signal-electrode voltage safely can be increased 50%, provided one is willing to pay the price of non-uniform background and a tendency toward image retention. Where maximum uniformity of background and low lag is required, as in film-pickup work, the signal-electrode voltage should be reduced to one-half the value at which the flare in the corners started to appear. The dark current at this point will be approximately 0.005 microampere.

The dark currents of the 6198-A and the 6326-A vidicons cannot be estimated as easily as those of the 6198 and 6326, because the photo-surface used in the "A" versions does not tend to flare at the edges. However, a general unevenness of background occurs in these tubes at dark current of about 0.1 microampere. This value of dark current is the highest that should be used when the 6198-A and 6326-A are adjusted for maximum sensitivity.

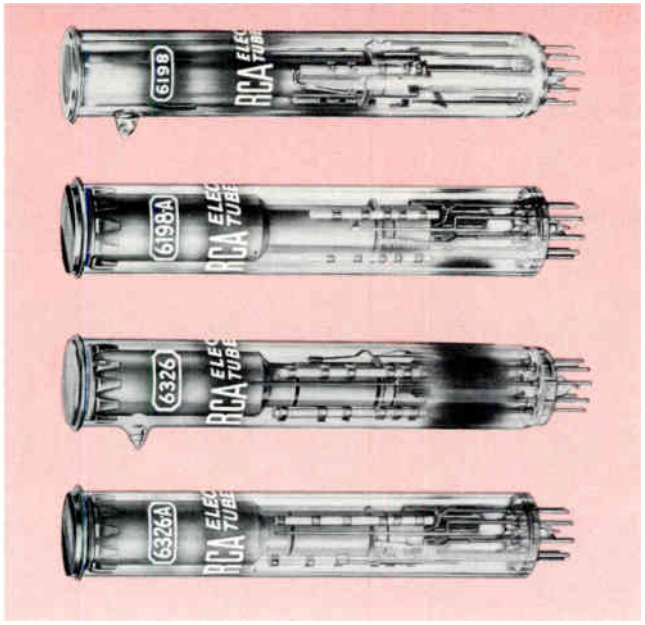
In some vidicon cameras in which metering facilities are not provided, a calibration signal is made available which may be substituted for the vidicon signal. This signal usually corresponds to a vidicon signal-output current of about 0.3 microampere. Once the level of this calibration signal has been established on the waveform cathode-ray oscilloscope, it can be used to measure the signal-output current and relative dark current by comparing the amplitude of both the dark current and the signal current above the zero-current level.

Non-uniformities in wave shape of the dark current signal may make accurate measurement difficult, but adequate determination of approximate level is readily made.

Because the dark current of a vidicon increases with temperature, adjustments made when the camera is first turned on may have to be changed as the temperature rises to its stable operating value. The effects of dark-current drift with increasing temperature will be noticeable either as flare or as an increase in pedestal height or setup in the signal. Readjustment of the signal-electrode voltage will restore pedestal and flare to original conditions.

Another major consideration affecting the performance of a vidicon is the value of signal-output current.

RCA's WV-84B Ultra-Sensitive DC Microammeter



The signal-output current is the difference between the signal-electrode current developed in the dark and the total current developed during pickup. Excessive signal-output currents result in loss of resolution while low values result in unnecessary lag or smearing of moving objects. For best performance, the peak value of the signal-output current should be 0.3 to 0.4 microampere.

The average signal-output current can be measured by the same method used to measure the dark current. Peak signal-output current is somewhat more difficult to measure. A good approximation can be obtained by the use of the current meter and video-waveform monitor oscilloscope. Focus the camera on a plain white card or wall, or on the open film gate of the projector, and measure the resulting signal-electrode current, which is approximately equal to the peak signal-output current. Also record the height of the resulting trace on the oscilloscope screen above the position of the trace with the lens capped. The oscilloscope can then be used to compare the peak signal-electrode current developed during any scene with the equivalent-peak value produced by the uniformly bright scene. After these measurements have been made, the video gain of the camera should be kept constant and light level controlled to maintain the peak signal value constant at the level observed on the oscilloscope.

The fact that the lag depends upon the signal-output current as well as on the dark current may introduce problems in certain applications. For example, if the light level on the tube is fixed, it is sometimes possible to reduce the lag by increasing the signal-electrode voltage so as to obtain both higher signal-output and dark currents. In these instances, there will be an optimum signal-electrode voltage where the lag will be at a minimum. Note that the curves of Figure 1 are given for constant signal-output level.

A common fault in vidicon camera setup is the practice of increasing the signal-output current just to a point where a satisfactory signal-to-noise ratio is attained. This practice usually results in a signal output that is too low to assure best performance from the standpoint of lag.

Chief Engineers Relate Long Life and Excellent Performance Records of RCA Broadcast Tubes

Recent reports from several radio and television broadcasters point up the long life and excellent performance records of RCA tubes in radio and TV broadcast service.

In letters received by TUBE TIPS:

T. C. Kenney, chief engineer, KDKA, Pittsburgh, Pa., wrote: ". . . I thought you might be interested in receiving a copy of our tube report which we furnish to our Headquarters Engineering Division each month.

"The tubes that I am primarily calling to your attention are the four 5671's (two with 61,240 hours and two with 86,789 hours of service) which we use in the modulator and power amplifier of our transmitter. I might state that the tubes are just as good today as they were when just put into service."

D. R. Taylor, chief engineer, KOLN-TV, Lincoln, Neb., wrote: "It may be of interest to you to know what tube life has been on the RCA-6166 tubes in our RCA TT-50AH transmitter. This transmitter was placed in operation about three years ago. One tube failed recently and was removed from service after 19,498 hours of operation. It was one of the original tubes purchased with the transmitter."

Mr. Taylor said that two other RCA-6166's had been retired at 18,620 hours and 17,000 hours, respectively. He added, "Still another 6166 is still in service and has 16,514 hours to date. The average life for 18 tubes that have been removed from service is 9,297 hours. We are very pleased with this tube life."

Ed Risk, chief engineer, KSD-TV, St. Louis, Mo., indicated that he had just removed his last original RCA-5762 power tube from the 25-kilowatt audio section of his station's television transmitter after 30,236 hours of operation.

Gil Voiles, chief engineer, WIBW, Topeka, Kans., made comments regarding two RCA-892-R power triodes. The tubes, it was reported, operated for 53,829 and 53,379 hours.These tubes were original equipment in WIBW's RCA BTA-5F AM transmitter which was purchased by the station in 1950. (According to H. C. Vance, Manager, Sales Engineering, Distributor Products, RCA Electron Tube Division, these operating periods for the 892-R types are believed to be a new life record.)

Hugo Bondy, chief engineer, WAGA-TV, Atlanta, Ga., reported on an RCA-5762 which was retired from service after 27,000 hours.

* * *

As the article above indicates, TUBE TIPS is most interested in reporting on instances where RCA tubes are establishing or surpassing operational life records in radio and television broadcast service. If you know of any new or unusual operational tube life stories about RCA tubes used in radio or TV broadcast equipment, please send such information to Harvey Slovik, Editor, TUBE TIPS, RCA, 415 S. 5th St., Harrison, N. J.

Radio and TV Broadcasters Invited to RCA IRE-NARTB Exhibits

RCA products of interest to radio and television broadcasters will be on display at the IRE Show, March 24th through 27th in the New York Coliseum, and at the NARTB Convention, April 27th through May 1st in the Statler-Biltmore Hotel, Los Angeles. The RCA Electron Tube Division, in conjunction with other services of the Radio Corporation of America, cordially invites all broadcasters to visit the two RCA exhibits.

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