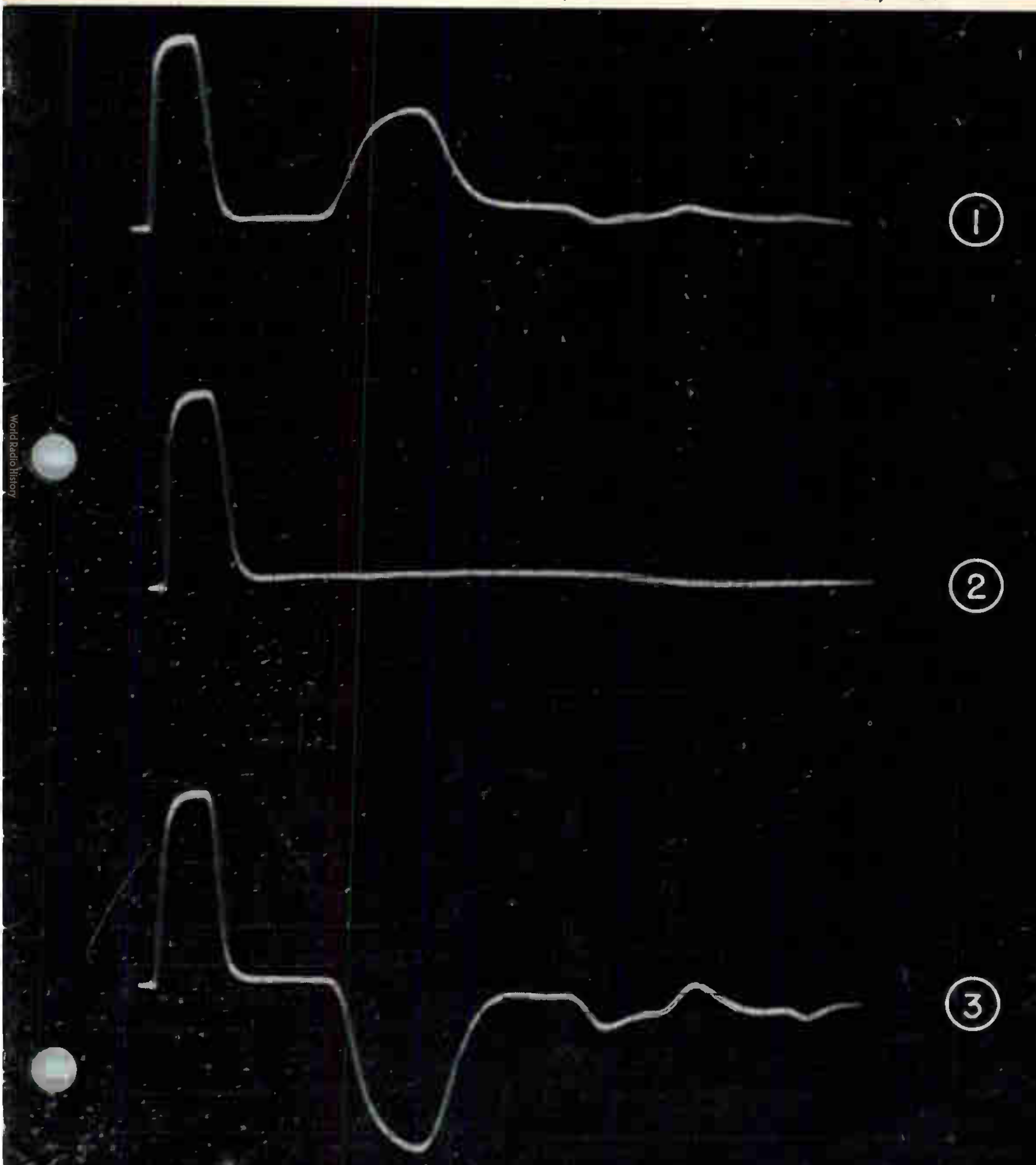
THE

OSCILLOGRAPHER

Vol. 12, No. 4 OCT.-DEC., 1951



TRANSMISSION LINE TERMINATION

See Page 2

Oops . . . . . . Sorry!

As some of our more acute readers may have noted, this issue of the Oscillographer is somewhat late. The cause of this extended delay of publication was the result of a truly incredible series of circumstances. Production stoppages, material shortages, turnover of personnel, marriages of members of the staff, and the births of various and sundry children all combined to hurl monkeywrench after monkeywrench into the well oiled, precision machine that is the Du Mont Oscillographer. Had the doughty Portia had such a flock of tribulations thrust upon her, she unquestionably would have left off her incessant facing of life and gone screaming over the horizon.

Now, however, things are looking up. New sources of supply and a new production schedule will, we trust, eliminate the mechanical problems. As for the human element, we feel that the staff is now fairly well stabilized, with all but one of the eligible bachelors married off, and, at this writing, no more wee bundles in the offing.

So much for the alibies. You may have noted that this issue of the Oscillographer is Volume 12, Number 4, October-December, 1951. Reference to your last copy, will show that the Volume and Number sequence remains unbroken, while the date has simply been advanced one year. The next issue of the Oscillographer, to be mailed on January 20, 1952, will thus be Volume 13, Number 1.

Our policy in future issues will be the same as always: to report the latest developments in techniques and equipment for cathode-ray oscillography and related fields. Articles presently scheduled for publication in forthcoming issues include

(*Continued on Page* 12)

THE
OSCILLOGRAPHER

A publication devoted exclusively to the cathode-ray oscillograph, providing the latest information on developments in equipment, applications, and techniques. Permission for reprinting any material contained herein may be obtained by writing to the Editor at address below.

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Neil Uptegrove - Editor

ON THE COVER

Shown on the cover is a multiple exposure illustrating the proper termination of a transmission line. Trace 1 indicates that the output impedance of the line exceeds its characteristic impedance, while trace 3 indicates that the output impedance of the line is less than the characteristic impedance. Trace 2 shows the terminating impedance matched to the characteristic impedance. These oscillograms were recorded from a Du Mont Type 303 Cathode Ray Oscillograph with a Du Mont Type 295 Oscillograph-record Camera. The excellent high-frequency response of the Type 303, as well as its high sensitivity, make the instrument well suited for studies, such as this, where faithful reproduction of high-speed pulses is required.

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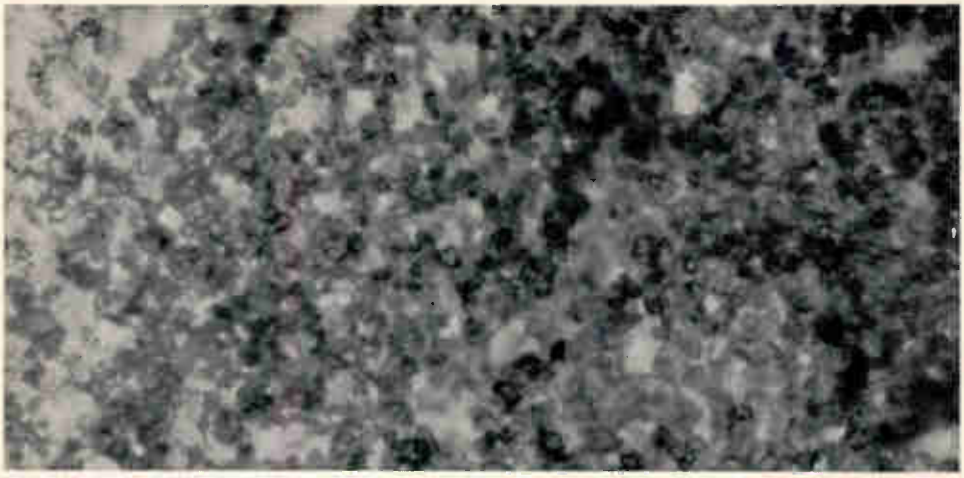

Figure 1. Photomicrograph of Type P11 screen phosphor at 150X magnification. An understanding of the basic qualities of standard screen materials is of considerable aid in realizing the fullest potentialities of the cathode-ray oscillograph.

RTMA SCREEN PHOSPHORS

A Review of the Characteristics of the Standard Screen Materials And their Application to Oscillography

If the full capabilities of the cathode-ray oscillograph are to be realized, it is important that a cathode-ray tube with the proper screen material be selected to satisfy the requirements of a given application. To aid in the selection of the most suitable phosphor, this article contains a brief discussion of phosphors presently used in oscillographic work. As a supplement to this discussion, a table on the following page lists all the presently standard RTMA phosphors and some of their more important characteristics.

Common Oscillographic Phosphors

While many of the RTMA phosphors were developed specifically for oscillographic applications, only five of them are currently in general use: the P1, P2, P5, P7, and P11. Other RTMA phosphors either find little application in oscillography, or, like the Type P3, have been made obsolete by more recent developments.

The P15 phosphor is not found in general oscillographic work. However, with the possibility that it will find broader application in the future, a description of it here is not out of place.

Type P1

The P1 phosphor is probably the most commonly used for general-purpose oscillography, where the usual application is the visual observation of repetitive phenomena. The P1 is an efficient screen material, producing a relatively brilliant green trace at low accelerating potentials. The spectral distribution of the light output of the P1 screen lies in the region of maximum sensitivity of the human eye. Thus good contrast may be obtained, even under unfavorable conditions of ambient light. The P1 screen is also relatively efficient for photographic recording. Satis-

TABLE I — STANDARD RTMA PHOSPHORS

Screen	Persistence	Composition	Fluorescence	Phosphorescence	Applications
P1	Medium	Zinc orthosilicate	Green	Green	Visual observation. High efficiency of P1 screen results in bright traces at relatively low accelerating potentials.
P2	Long or short	Zinc sulphide	Blue-green	Yellow-green	General purpose screen for oscillographs employing accelerating potentials of 4,000 volts or more. By filtering, either short-persistence blue component, or long-persistence yellow component may be selected. High efficiency for high-speed single transients. Not recommended for use at less than 4000 volts acceleration.
P3	Medium	Zinc Beryllium silicate	Yellow	Yellow	General oscillographic use. Not as efficient as P1. Persistence has exponential decay that is chiefly of interest in television.
P4	Medium	Zinc sulphide and zinc beryllium silicate	White	White	Used primarily for television picture tubes.
P5	Short	Calcium tungstate	Blue	Blue	Used primarily for photography on continuous-motion film for frequencies above 200 kc. Not as actinic as P11.
P6	Medium	Zinc sulphide and a complex compound of zinc and calcium sulphide	White	White	Developed chiefly for use in color television.
P7	Long or short	Zinc sulphide cascaded on zinc and calcium sulphide	Blue-white	Yellow	Developed originally for radar. Similar in characteristics to P2 screen, but has longer persistence. Useful for radar, integrating noise, and repetitive phenomena and low speed transients.
P8	Same as P7	(Reserved by British as being confidential during World War II)			
P9	Long	Calcium phosphate	White	White	Very long persistence with high definition, developed primarly for radar applications.
P10	Nearly permanent	Potassium chloride	Magenta on White	Magenta on White	Used chiefly for radar. Pattern erased by infra-red irradiation.
P11	Short	Zinc sulphide	Blue	Blue-green	Used primarily for oscillographic recording; has higher visual and photographic efficiency than P5, but should not be used for continuous-motion recording of frequencies above 200 kc because persistence of P11 is slightly greater than P5.
P12	Long	Zinc magnesium fluoride	Orange	Orange	Used primarily for fire-control radar for scanning rates of from 4 to 16 scans per second.
P13	Discontinued		Red	Red	Also developed for fire-control and radar.
P14	Long	Zinc sulphide cascaded on zinc and calcium sulphide	White	Orange	Developed for radar operating at a scanning rate of about 1 scan per second. Also for moving-target indication.
P15	Very Short	Zinc oxide	Blue-green	Blue-green	Shortest persistence presently available. Used primarily in flying-spot scanners or for high-resolution, high-frequency continuous motion recording. Not as actinic as P11.

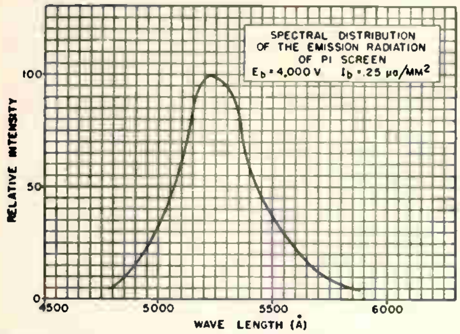

Figure 2. Graph showing spectral distribution of light output of Type P1 phosphor.

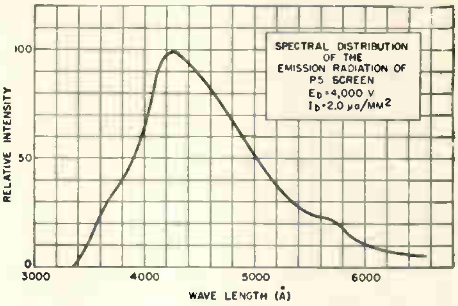

Figure 4. Graph of spectral distribution of the light output of the Type P5 phosphor.

factory oscillograms may be obtained of repetitive or transient phenomena, when there is no need for moving-film photography.

Type P2

The P2 phosphor is the most versatile screen material available for oscillographs operating with an accelerating potential of 4000 volts or more. The P2 is a dual-purpose screen, having a blue green fluorescence of short persistence and a yellow-green phosphorescence of long persistence. The blue component has high photographic efficiency; and persistence of this component is sufficiently short that in almost all instances, it may be used satisfactorily for continuous-motion recording applications.

The persistence of the yellow component is, on the other hand, sufficiently long that visual observation of single transients and repetitive phenomena of low rates is possible. In most photographic applications, the yellow component serves to increase the photographic-writing-rate capabilities of the instrument. In continuous-motion recording, where the long-persistence phosphorescence would cause blurring, the yellow component may be eliminated by the use of a standard blue filter, such as the Du Mont Type 2560-B Color Filter. However, the P2 will not offer as satisfactory performance in continuous-motion-recording applications as a short-persistence phosphor. In cases where it is desired, the blue "flash" may be removed from the yellow component by means of a yellow filter, such as the Du Mont Type 2560-C. This practice is advantageous when visual observation of this screen over protracted periods is necessary.

When used at higher accelerating potentials, the P2 screen offers characteristics not unlike those of the P1 phosphor. This

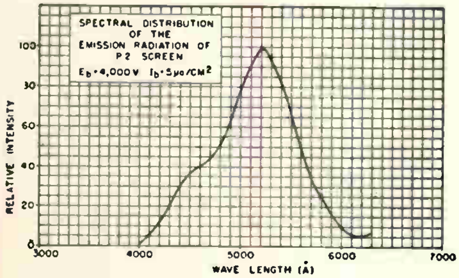

Figure 3. Graph showing spectral distribution of light output of Type P2 phosphor.

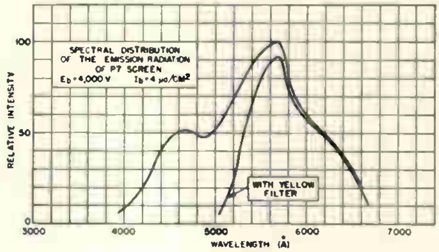

Figure 5. Graph of spectral distribution of the light output of the Type P7 phosphor.

similarity between the P1 and P2 screens may be greatly increased by the use of a standard green filter such as the Du Mont Type 2560-A.

Type P5

The P5 phosphor produces a blue trace of very short persistence and high photographic efficiency. While the persistence of the P5 is somewhat shorter than that of the P11 screen, the efficiency of the P5 phosphor is lower. Thus the P5 screen is recommended only for those few applications where the shorter persistence is absolutely necessary. In practice, the chief oscillographic application requiring this shorter persistence is the continuous-motion recording of signals containing frequency components above approximately 200 kc.

Type P7

The P7 screen, like the P2, is a dual-purpose one, producing a short-persistence blue fluorescence and a long-persistence yellow phosphorescence. As in the case of the P2 phosphor, either component may be eliminated by means of filtering. The Du Mont Types 2560-B and 2560-C filters are recommended. The P7 serves over a broad range of oscillographic applications, including visual observation, as well as photographic recording, of recurrent or transient phenomena. The P7 is more efficient than the P2 at accelerating potentials of less than 5000 volts and so is used primarily with instruments of low or medium accelerating potentials.

Type P11

The P11 phosphor produces a blue trace of high photographic efficiency. Its persistence is sufficiently short for the great majority of recording applications, and except for the very few applications where the slightly shorter persistence of the P5 is required, the P11 is recommended as the most practical short-persistence screen for general-purpose oscillography.

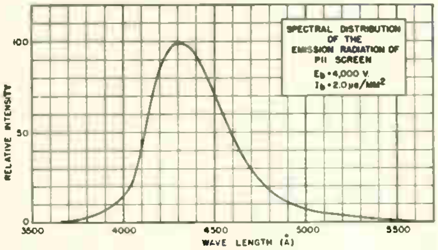

Figure 7. Graph showing spectral distribution of the light output of the Type P11 phosphor.

Type P15

The P15 screen has the shortest persistence of any phosphor presently available. It produces a light blue-green trace at higher accelerating potentials, and tends to become somewhat more yellow as the accelerating potential is decreased. The P15 has a decay time* of less than 1.5 microsecond under normal operating conditions. Decay times of less than one microsecond are possible under special operating conditions. The P15 phosphor is used primarily in the scanning generator of flying-spot scanners, although there are a few oscillographic applications where the very short persistence of the P15 screen may be required. Chief among these applications is high-resolution, high-frequency continuous-motion recording. The P15 screen phospor is not generally recommend for use at lower accelerating potentials.

Recommended Screens

It will be noticed in the Du Mont Catalog of Cathode-ray Equipment, that generally only two or three of the commonly used oscillographic phosphors are listed as standard with each cathode-ray oscillograph. For example, the Du Mont Type 304-H is listed as standard only with the Types P1, P7, and P11 screens, while the Du Mont Type 250-AH is cataloged as standard only with the Types P2 and P11 screens. In view of the operating characteristics of the oscillographs concerned, the reasoning behind these selections of screens will be apparent. As stated above, the P7 screen is more efficient at lower accelerating potentials and writing rates than is the P2, while at higher potentials,

* Decay time is defined in this instance as the time required for the light output to drop to 30% of its initial value.

DU MONT SPECIAL CATHODE-RAY TUBES

The complete line of Du Mont RTMA-registered tube types is carefully engineered to provide the broadest possible coverage over the entire range of general oscillographic applications. In some instances, however, the requirements of highly specialized applications may be beyond the capabilities of RTMA-registered tube types. In such cases the Du Mont line of Special Cathode-ray Tubes provides the answer.

Some Typical Special Tubes

Typical of the Du Mont Special Cathode-ray Tubes is the Du Mont Type K1098P-. This is a 5-inch, flat-faced electrostatically focused and deflected cathode-ray tube containing four independent electron-gun and deflection structures in a single glass envelope. Thus four related or unrelated phenomena may be displayed on a single cathode-ray screen. Each electron beam may be independently controlled, while common accelerator and intensifier electrodes are used to accelerate all four electron beams. All deflection-electrode leads are brought out through a ring socket on the neck of the tube to facilitate connection. Deflection electrode structures are carefully shielded from each other to minimize interaction.

Figure 1. Type K1098P-, containing four wholly independent electron-gun and deflection-electrode structures.

A maximum accelerating potential of 6000 volts may be applied to the Type K1098P-.

Figure 2. Type K1101P- for ultra-high-speed oscillography. Frequencies as high as 1000 megacycles may be displayed with this tube.

Another member of the Du Mont line of Special Cathode-ray Tubes is the Type

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and writing rates the converse is true. Thus, in the Type 304-H, operated with an acceleration of 3000 volts, the P7 is recommended, and in the Type 250-AH, operating with an acceleration of 13,500 volts, use of the P2 is indicated. The P1 is not listed as standard with the Type 250-AH, since, at high accelerating potentials, the P2 offers the characteristics needed for visual observation that are found in the P1 phosphor. In both cases, the P11 screen is recommended, since the P11 is generally the most satisfactory of the short-persistence phosphors, regardless of the acceleration.

Du Mont can supply virtually any of the standard RMA phosphors with any cathode-ray tube. However, the phosphors listed as standard with each oscillograph in the Du Mont Catalog are those which have proved themselves most satisfactory for the instrument in question, and which provide the best performance over the range of applications for which that instrument was designed. It is only in the most unusual circumstances that a phosphor other than those recommended for use with the instrument is required.

For additional information on screen phosphors, we refer the reader to "Luminescent Screens for Cathode-ray Oscillography" by R. Feldt, in Volume 11, Number 2 of the Oscillographer (April-June, 1949). For additional information on screen phosphors with relation to photographic recording, see "Techniques of Photo-recording" by H. P. Mansberg in Volume 12, Number 2 of the Oscillographer (April-June, 1950).

The Polaroid-Land Process As Applied to Photo-recording

Introduction

The Polaroid-Land photographic process, by means of which a finished, positive print is obtained in 60 seconds after exposure, is gaining importance rapidly in the field of oscillograph recording. Several oscillograph record cameras, such as the new Du Mont Type 297, operating on the Polaroid-Land principle have now been made commercially available.

The Polaroid-Land process differs in several respects from conventional photographic processes, and an understanding of the basic photographic principles involved should aid in obtaining optimum results in oscillographic recording by this medium.

The Process

The Polaroid-Land photographic process, is sometimes known as a soluble silver complex process. It involves the simultaneous development of both positive and negative images in adjacent layers of photographic material, the positive image being formed from the unexposed silver halide grains of the negative image. The adjacent layers, in the Polaroid-Land process, consist of a paper negative coated with the conventional silver halide emulsion, and a positive printing paper coated with crystals of metallic sulfide. Attached to the printing paper, at the head of each frame, is a small air-tight "pod" which contains a chemical reagent and plasticizer. After exposure of the paper negative, the negative-emulsion surface and the positive-printing surface are pulled together and pressed firmly between steel rollers. Thus the pod is broken, and the jellied reagent is spread evenly in a thin film between the adjacent layers. The exposed grains of silver halide in the negative emulsion are thereby developed into metallic silver, while the unexposed silver halide grains are dissolved. These unexposed grains diffuse out of the negative emulsion into the immediately adjacent positive-printing surface. Sulfide crystals on the printing surface cause the silver solution to precipitate as a positive image on the printing surface. The entire process requires about 60 seconds at normal room temperatures. Since any excess developer is trapped and resealed, it is not generally possible for the operator to come into contact with the reagent during the normal operation of the camera. However, if occasion to examine the reagent arises, caution should be observed, since the chemicals employed will stain clothing permanently.

Recording Material

Polaroid-Land film, Type 41 (black and white), is available at most photographic supply stores. A single loading packet contains enough material for eight 3¼ by 4¼ frames. As was pointed out previously in the *Oscillographer**, with the Du Mont Type 297 Oscillograph-record Camera, it is possible to make a number of evenly spaced exposures on a single frame.

Recording of Stationary Patterns

The technique of recording stationary patterns by the Polaroid-Land process does not differ materially from conventional recording techniques. Average exposures for Du Mont cathode-ray oscillographs are shown in Table I. Exposure is by no means critical, but it should be borne in mind that the Polaroid-Land Film Type 41 is, for oscillographic applications, somewhat slower than conventional emulsions. For best results in a particular application, several test exposures should be made to determine the correct aperture setting and exposure time.

Transient Recording

Generally speaking, the Polaroid-Land process, with presently available materials, does not lend itself to the recording of high-speed single transients. For transients of medium and low speeds, the photographic techniques do not differ from those for conventional recording materials, once the slower emulsion speed of the

*See the "Oscillographer", Vol. 12, No. 3, July-September, 1950, page 11, Figure 9.

TABLE I
AVERAGE EXPOSURE GUIDE FOR DU MONT CATHODE-RAY OSCILLOGRAPHS
(Polaroid-Land Process)

Du Mont Oscillograph Type No.	Cathode-ray Tube	Accelerating Voltage	Diaphragm Setting	Exposure Time (Secs)
208-B	5LP11-A	1400	5.6	1
241	5JP11-A	1500	5.6	1
247-A+263-B	5RP11-A	11,500	11	½
248	5JP11-A	4000	8	½
248-A+263-B	5RP11-A	12,000	11	½
250-A	5CP11-A	3200	11	1
250-AH+263-B	5RP11-A	13,700	16	½
256-D or 256-E	5CP11-A	4000	8	½
274-A	5BP11-A	1000	4	1
275-A	5CP11-A	3000	11	1
279	5SP11	4500	8	½
280-A	5XP11	11,900	11	½
288-A	5XP11	20,000	16	½
281-A	5RP11-A	8000	16	1
281-A+263-B	5RP11-A	14,000	16	½
281-A+286-A	5RP11-A	29,000	22	½
294-A	5XP11	12,000	11	½
303	5YP11	3000	8	1
304	5CP11-A	1780	8	1
304-H or 304-HR	5CP11-A	3000	11	1

*Average exposures with stationary pattern of ten sinewave cycles on screen and medium intensity settings.

Polaroid-Land Film Types 40 and 41; development time: 1 min.
Type 297 Camera using Blue-Reflecting Dichroic Mirror
Object—Image Ratio: 2.25.

NOTE: For approximate exposures for other phosphors, mutliply the above exposures by the following factors:
P1 — 4 times P2 — 5 times P7 — 2 times

Polaroid-Land recording material is taken into consideration.

Presensitizing the Film

It is possible to increase the photographic-writing-rate capabilities of the Type 41 Polaroid-Land film to a considerable degree by presensitizing the frame before the recording is made. The function of presensitizing is to raise the operating point of the film characteristic above the toe of the H and D curve,* thereby increasing the contrast of the photographic image.

The recommended procedure for presensitizing Polarioid-Land Material, Type 41, is as follows:

1. Place the extension barrel opening of the Type 297 Oscillograph-record camera, loaded with the film to be presensitized, against a sheet of white opal glass, which is six inches in front of a 25-watt, frosted incandescent lamp.

2. Expose for 1/25 of a second at f/2.8.

An improvement of photographic-writing-rate capabilities by a factor of as much as 8 may be obtained by presensitizing in this manner.

Reproducing the Polaroid-Land Recording

The Polaroid-Land process does not ordinarily yield a negative suitable for reproduction, as do conventional photographic processes.

A common procedure for obtaining reproductions is to have the Polaroid-Land print photo-copied. The photo-copy nega-

(*Continued on Page* 12)

*See "Oscillographer", Vol. 12, No. 2, April-June, 1950, page 7.

THE DU MONT TYPE 334-A
Cathode-ray Oscillograph

Figure 1. Du Mont Type 334-A Cathode-ray Oscillograph.

Announcement has been made of the Du Mont Type 334-A, a small, compact, and highly portable oscillograph intended for general field engineering. Since it includes a wide-band vertical-deflection amplifier, the Type 334-A is particularly well suited for such applications as setting up and maintaining microwave relay links and field radar systems, trouble shooting electronic computers, terminating transmission cables, and television field work. This light weight instrument is also very useful as a piece of airborne test equipment, and a special cable is included with the instrument for connection to the 110-volt, 400-cycle outlet of the aircraft.

The Type 334-A is equipped with a wide range of driven, as well as recurrent sweeps, enabling use of the instrument as a synchroscope. Quantitative analysis of high-frequency phenomena is facilitated by internally generated timing markers indicating intervals of one microsecond.

A Type 2AP1 Cathode-ray Tube is employed in the Type 334-A, and is operated at an overall acceleration of 800 volts. Under this condition, the tube produces a fine trace with excellent resolution. The pattern is viewed through a calibrated magnifier, and a variable intensity illumination system renders the calibration lines visible at the viewer's discretion.

A complete set of probes and cable-assemblies is included with the Type 334-A (See Figure 3). Two input probe assemblies are supplied. One of these, marked SIGNAL INPUT, is matched to the characteristics of the SIGNAL INPUT, and both may be used interchangeably at the EXT SYNC jack. Two identical ten-foot coaxial patching cords, having connectors at both ends, are also provided for connection to signal sources having suitable jacks. Two patching cords are supplied to facilitate direct connection to the deflection plates of the Type 334-A. A 15-foot POWER CORD is also supplied terminating in a connector which attaches to the supply outlets commonly found in aircraft.

The Type 334-A and cables are supplied in a sturdy metal carrying case.

Figure 2. Right-side view of the Type 334-A is shown at top; the left-side view, at bottom.

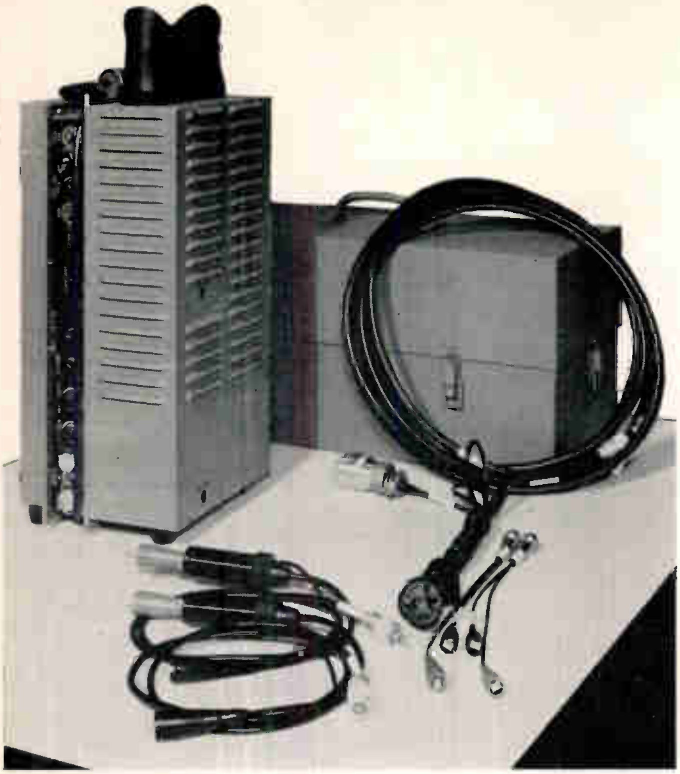

Figure 3. The Du Mont Type 334-A Cathode-ray Oscillograph is supplied complete with a set of connecting cables and input probes, as well as a sturdy, metal carrying case.

SPECIFICATIONS

CATHODE-RAY TUBE: Type 2AP1. 800 volts overall accelerating potential.
VERTICAL DEFLECTION: Deflection Factor through amplifier (full gain), 0.1 rms volt/inch; through input probe and amplifier (full gain), 1.0 rms volt/inch. INPUT IMPEDANCE to amplifier, 'low' position, 62 ohms; 'high' position, 430,000 ohms paralleled by 30 $\mu\mu f$ (includes three attenuator positions of 0, 20 and 40 db); to probe, 4 megohms paralleled by 12 $\mu\mu f$. DELAY NETWORK, ½ μsec signal delay terminated by 10 step signal attenuator with total of 20 db attenuation in 2 db steps. SINUSOIDAL FREQUENCY RESPONSE: Within 5% at 100 cps and 1 mcps; Within 30% at 40 cps and 2.5 mcps.
LINEAR TIME BASE: provides recurrent sweeps or driven sweeps; recurrent sweeps in three ranges, 'fast' 5000 to 50,000 cycles per second, 'medium' 250 to 5000 cycles per second, 'slow' 10 to 250 cycles per second; driven sweeps in three ranges, 'fast' 5 to 8 μsec duration, 'medium' 20 to 50 μsec duration, 'slow' 120 to 280 μsec duration. SYNCHRONIZATION from vertical-deflection signal, or externally connected signal of 2 to 100 volts; input impedance, 400,000 ohms paralleled by 40 $\mu\mu f$; TIMING SIGNAL, internally developed 1.0 μsec pulses.
POWER SOURCE: Type 334-A is designed to operate from 115 $\pm$10 volts at any frequency between 50 and 1200 cycles per second; power consumption, 90 watts at 60 cycles.
PHYSICAL CHARACTERISTICS: Instrument housed in metal cabinet provided with carrying handle and protective cover. Overall dimensions, 9″ (22.9 cm.) height x 8″ (20.3 cm.) width x 20¾″ (52.7 cm.) depth including 3″ eyeshade; weight 29 lbs. (13 kg.)

Cat. No.	*Type No.*	*Description*
1577-E	334-A	Cathode-ray Oscillograph for 115-volt ($\pm$10 volts) 50-1200-cycle operation, with Type 2AP1 Cathode-ray tube.

POLAROID-LAND PROCESS

(*Continued from Page* 9)

tive then may be used to make any number of prints. It is possible, however, to fix the Polaroid-Land negative permanently and use this paper negative for printing additional recordings. The most satisfactory process for fixing the paper negative is as follows:

1. Make the first exposure in the normal manner. Initiate development by pulling out the film tab.

2. While the processing of the first print is underway, the next frame may be exposed. One minute after the first frame has been exposed, darken the room, or throw an opaque cloth over the top of the camera. Open the picture door, peel off the first print, and immediately close the picture door. The negative of the first print thereby remains in the camera, and will not fog so long as it is not exposed to light.

3. When the processing of the second print is to be initiated, pull out the tab (the negative of the first print) in a darkened room or under a cloth, and immediately after tearing this negative off, immerse it in a tray or jar of hypo. A concentrated hypo solution, such as Kodak Rapid Fixer Solution, is recommended. This paper negative should remain in the fixing solution for approximately two minutes. (Meanwhile the next recording may be exposed).

4. After fixing for 2 minutes, the paper negative may be washed and dried in the conventional manner.

The negative obtained may be subsequently printed by the Ozalid process, or it may be contact-printed on standard photographic paper. In the latter case, a soft or medium paper such as Azo #2 should be selected. Place the emulsion side of the paper negative in contact with the emulsion of the printing paper, and expose through the paper negative. Process the contact print in the conventional manner.

Clarity of the contact print may be improved by rubbing the back of the paper negative with oil or melted wax to increase its transparency. Similarly, the Polaroid-Land print itself may be used to make contact-printed reproductions. Again oil or melted wax may be used to make the original print more transparent. The oiled Polaroid-Land print may also be contact-printed upon conventional photographic film, yielding a transparent photographic negative, from which any number of reproductions may be made by conventional printing techniques.

OOPS . . . SORRY

(*Continued from Page* 2)

such subjects as: Techniques for quantitative measurements with the cathode-ray oscillograph; D-C amplifiers and their relation to oscillography; Distributed amplification as applied to the oscillograph; and a comprehensive article on the use of transducers and interpretation of non-electrical phenomena by means of the oscillograph.

These subjects reflect, however, only our opinion of what is of interest and import to the reader. Thus we invite you to write, making any suggestions on what material you would like to see in the Oscillographer. The comments and suggestions received in the past have been of inestimable assistance in guiding the Oscillographer. However, it is only by a continuing stream of such comment that we will be able to achieve our goal, that of making the Oscillographer a publication of ever increasing value to those interested in cathode-ray oscillography.

DU MONT SPECIAL CATHODE-RAY TUBES

(Continued from Page 7)

K1101P-, a 5-inch flat-faced, electrostatically focused and deflected tube intended for ultra-high-speed oscillography. The Type K1101P- employs a multi-band post accelerator and may be operated at accelerating potentials as high as 37,000 volts to provide the very high light output and short electron transit time necessary for the display of ultra high-speed phenomena.

Deflection-plate connections are located on the neck of the tube to minimize deflection-electrode capacitances. The tube may be used to display frequencies as high as 1000 megacycles.

Type K1080P-

The Du Mont Type K1080P- is a 7-inch magnetically focused and deflected cathode-ray tube which may be operated at accelerating potentials of up to 30,000

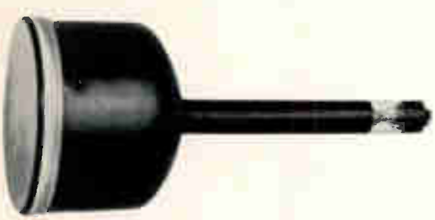

Figure 3. Type K1080P- provides very high light output and excellent resolution.

volts. Thus very high light output is achieved with extremely small spot size and excellent resolution. The face plate of the Type K1080P- is carefully manufactured to conform to a uniform standard of curvature and thickness. The Du Mont Type K1080P- is intended primarily for such applications as in fly-spot scanners where high light output, excellent resolution, and an optically uniform face plate are required.

The Du Mont Type K1065P- is a 3 inch flat-faced, electrostatically focused, and deflected tube. It employs a post accelerator intensifying electrode and provides very high vertical sensitivity at accelerating potentials up to 5000 volts. Deflection-plate connections are brought out through the neck to minimize interelectrode capacitance. The Type K1065P-, only slightly over 10 inches in length, is in-

Figure 4. Type K1065P- is a compact tube providing high light output and high deflection sensitivity.

tended for applications where excellent resolution and sensitivity are required, and where space is at a premium.

Specification Sheets

These tubes are merely representative of the many in the line of Du Mont Special Cathode-ray Tubes. Specification sheets on these and other typical examples of Du Mont Special Cathode-ray Tubes are now available and may be obtained by requesting Bulletin TDL-1 from Allen B. Du Mont Laboratories, Inc. at the address given on Page 2.

Figure 5. Specification sheets describing these and other typical Du Mont Special Cathode-ray Tubes are now available.

RELATING TRANSIENT- AND AMPLITUDE-RESPONSE CURVES WITHOUT COMPUTATION

Amplitude and transient response of any "black box" can be estimated the one from the other fairly accurately with the help of a few general rules and the set of sample curves shown in Fig. 1.

When inspecting the plot of an amplitude response note:

the frequency range, e.g. to 3 db down;

the steepness of cutoff, down to perhaps 10 db, in proportion to the whole transmitted frequency range.

When inspecting the transient response (to a square-wave input) note:

the time of rise T_r from 10% to 90% of the final height; the rounding or ringing at the toe and the top of the rise; the degree of assymmetry of the rise relative to its midpoint.

For strict prediction of the transient response, both the amplitude and the phase response must be taken into account. However, to simplify matters, the phase distortion will here be taken as negligible; but there are simple symptoms to show when appreciable phase distortion makes corrections necessary. The rules are then:

1. For similar amplitude responses, the transient rise time T_r is inversely proportional to bandwidth:

$$T_r = \frac{K}{f_c}$$

2. Among systems of equal bandwidth, that without phase distortion gives the steepest transient rise.

3. Transient responses without phase distortion are symmetrical about the midpoint of the rise. Phase distortion causes assymmetry, rounding of one corner (usually the toe) and ringing at the other (usually the top); the more distortion, the worse.

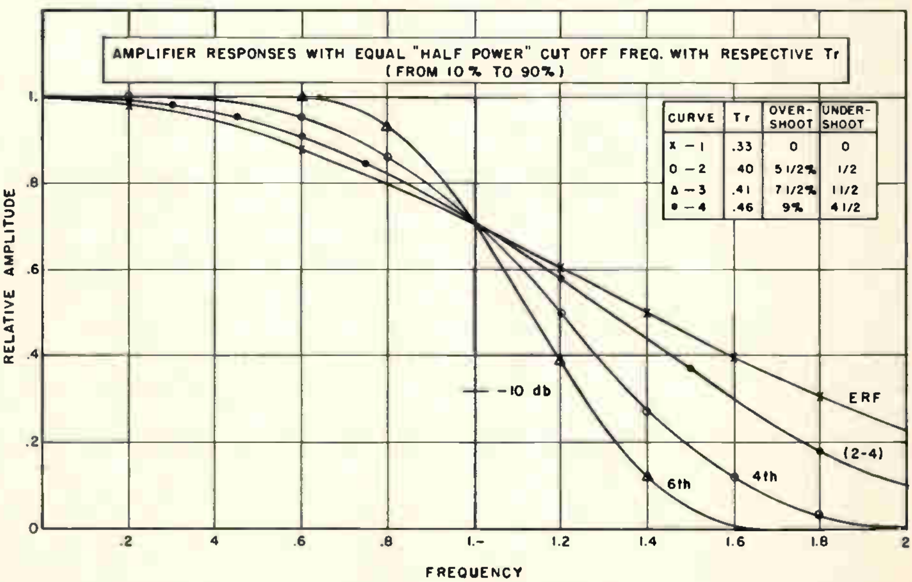

Figure 1. Amplitude-response curves having the same nominal cutoff frequency. Tabulated values give the over- and under-shoot to be expected with each amplifier.

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4. Without phase distortion, the steeper the cutoff of the amplitude response relative to the total bandwidth, the sharper, or the more ringing, will be the corners of the transient response.

5. Amplitude response beyond 10 db attenuation contributes very little to the steepness or shape of the transient response.

6. To correlate transient response rise time T_r and bandwidth, see Fig. 1, assuming negligible phase distortion. Note that in practical amplifier and filter networks, the steeper the cutoff the more severe is generally the phase distortion within the transmitted range of frequencies, and the more does T_r suffer compared with the curves shown. Fig. 1 shows five representative amplitude response curves, all having the same nominal cutoff frequency (3 db point) f_c but differing in the steepness of their cutoff. The table then gives the percentage overshoot and following undershoot of the corresponding transient responses and the constant K relating bandwidth f_c and rise time T_r according to the equation:

$$T_r = \frac{K}{f_c}$$

When going gradually from one amplitude response to the next, the corresponding overshoot and the constant K will also change gradually, permitting simple interpolation.

— H. E. KALLMANN

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