INSTRUCTION MANUAL

Serial Number 20537

OSCILLOSCOPE CAMERA SYSTEM

3-inch Cameras And Accessories

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WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

CONTENTS

Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

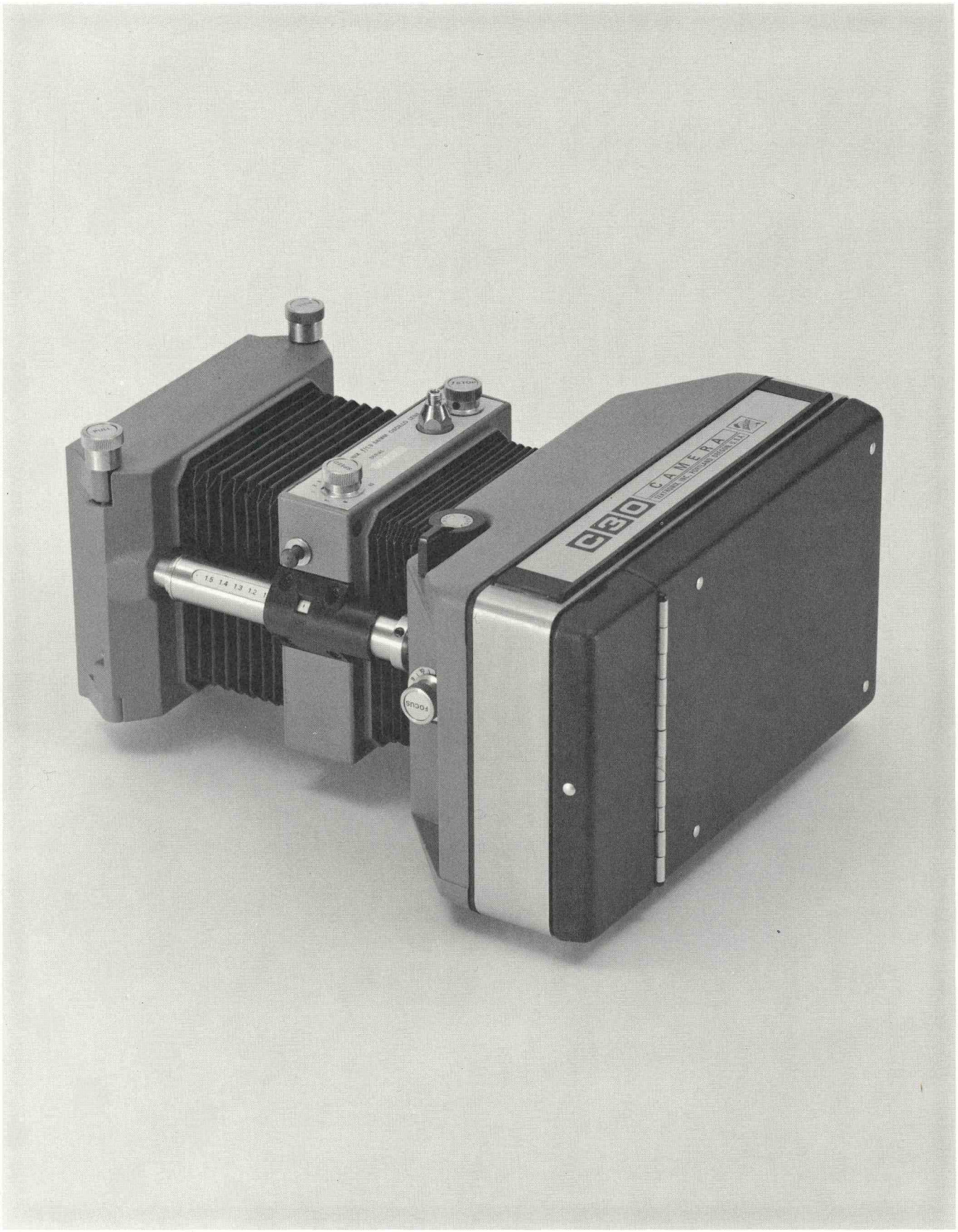


Fig. 1-1. Type C-30 Camera.

SECTION 1

CHARACTERISTICS

General Description

The Tektronix Type C-30 Camera has been specifically designed for photographing oscilloscope displays. The optical system of the camera permits photographs to be made directly from the oscilloscope screen so the image is not reversed.

The camera provides many new convenience features. Slide-on type mounting is used so that the camera can easily be mounted or removed. Swing-away hinges allow the camera to be swung out of the way either to the left or right so the crt display can be conveniently viewed.

The design of the Type C-30 Camera makes available a wide range of object-to-image (MAG) ratios while the Polaroid[1] Land Pack Film Back makes available quickly either black and white or color pictures.

MAIN FRAME

Focusing

Focusing to compensate for slight differences between oscilloscopes is accomplished by means of a focus knob on the left side. Once the Focus knob has been set, it may be locked in position with the Focus Lock knob. This will prevent accidentally changing the focus of the camera.

Mounting

Additional bezels are available for mounting the camera on Tektronix oscilloscopes other than the Types 422 and 453, which do not require an additional bezel. The special bezels have a groove which permits the Type C-30 Camera to be conveniently attached or removed by sliding the camera into the groove on the bezel.

Optical System

Photographs taken directly from oscilloscope screen with no reversal. Object-to-image ratio may be varied from 1:0.7 to 1:1.5 in ten steps.

Viewing

The camera may be swung away from the crt either to the left or right on its swing-away hinges to provide display viewing.

Size

See Fig. 1-2.

Weight

4 lbs., 10 oz.

[1] **Registered trademark of the Polaroid Corporation.**

[2] **No bezel is required to mount the Type C-30 Camera on a Type 422 or 453 oscilloscope.**

[3] **For Type 565 and RM565 oscilloscopes use Tektronix Part No. 016-0243-00.**

LENS

Lens and Shutter Settings

Both lens and shutter setting can be made from the top of the shutter box. X Synchronization contact connections are available on the bottom of the shutter box.

Shutter Speeds

(T), (B), and seven shutter speeds from 1 to 1/50 X Synchronization.

f Stops

1.9, 2.8, 4, 5.6, 8, 11 and 16.

Object-To-Image Ratios

1 to 1.5, 1.4, 1.3, 1.2, 1.1, 1, 0.9, 0.85 , 0.8 and 0.7.

POLAROID LAND PACK FILM BACK

Black and white, or color film is available for the Pack Film Back. Picture size is $3\frac{1}{4} \times 4\frac{1}{4}$. 100-Series Polaroid Land Film Packs are used with this camera back.

BEZELS[2]

Tektronix Part No.

016-0241-00 For Types 310, 310A, 316, RM16, 317, RM17 and 360 oscilloscopes.

016-0242-00 For Types 321 and 321A oscilloscopes.

016-0243-00 For 500-Series oscilloscopes.

016-0244-00 For 560-Series oscilloscopes.[3]

Optional Accessories

The use of a portra lens will enable the Type C-30 camera to be used for photographing, for example, test setups.

The depth of field when using the portra lens will vary with the f stop and magnification settings used. Generally, at f/1.9 there will be very little depth of field; while at f/16, the depth of field will allow quite a wide range of distance to be accommodated, depending upon the picture sharpness required.

TABLE 1-1

Subject Area Covered With Portra Lens

Type C-30 Object-to-Image (MAG) Ratio	Effective Magnification With Portra Lens	Total Distortion Per-centage	Subject Area Covered
0.7	0.140	—2.7	22 inch diameter circuit (380 in^2)
1.0	0.377	—2.3	8 × 10 inch rectangle (80 in^2)
1.5	0.770	—1.0	3.75 × 4.75 inch rectangle (18 in^2)

Portra lens composite: +4 —11.25 = 7.25 diopters.

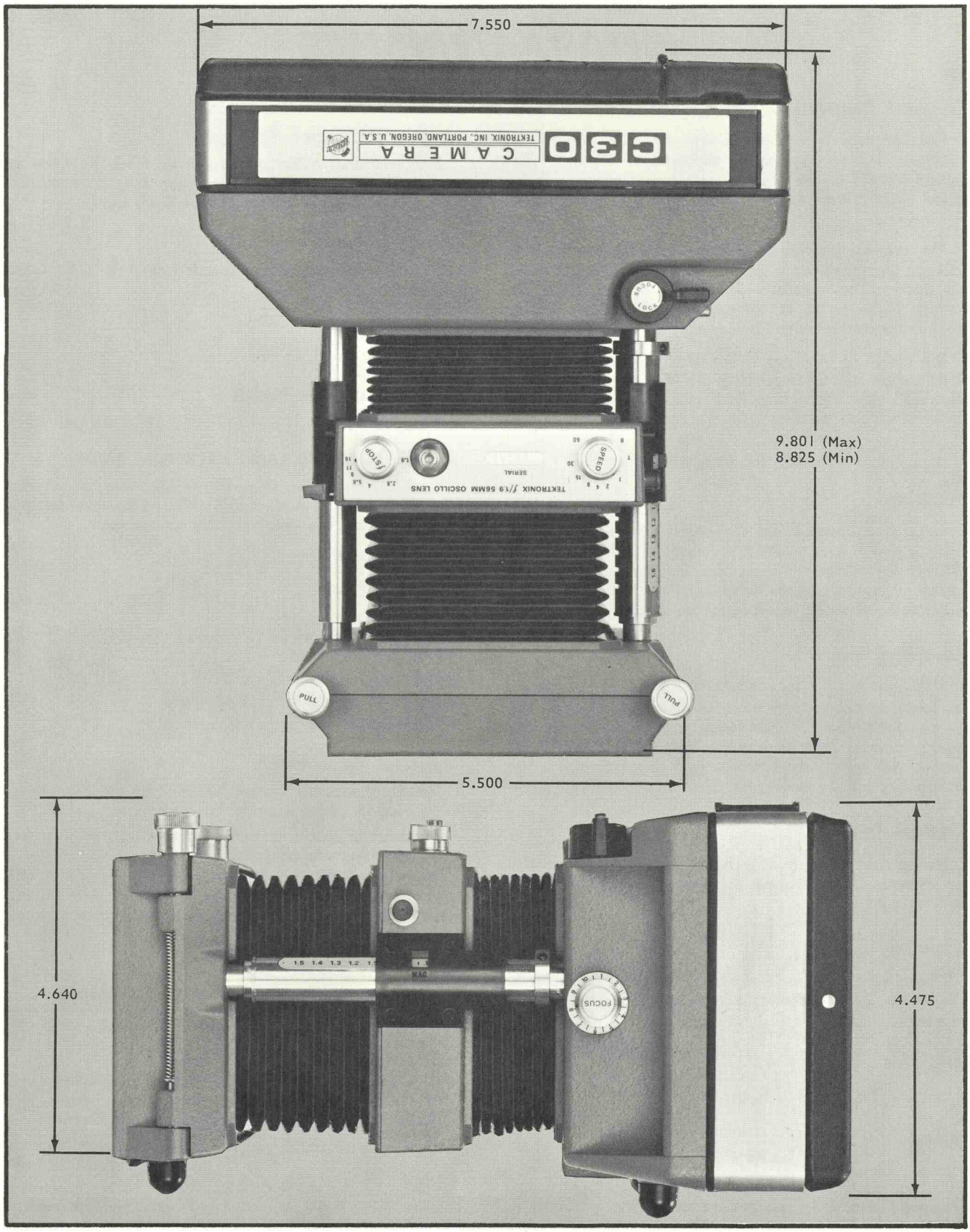


Fig. 1-2. Dimensions of the Type C-30 Camera.

SHUTTER ACTUATOR MODEL 2 OR 3

The Shutter Actuator System Model 2 or 3 is a rotary solenoid-operated shutter release control. The Shutter Actuator has been designed to be used with the Tektronix Camera systems.

The Shutter Actuator System permits electrical triggering of the camera shutter. It can also be used to trip more than one camera shutter simultaneously, through the use of more than one Shutter Actuator System tied to the same remote switching control.

The power supply is intended to be attached to the Polaroid Pack Film Back by using the Power Supply Mounting Bracket Tektronix Part No. 122-0713-00), or the power supply may be set on an object near the camera.

Electrical Characteristics

Power Supply

Line Voltage—115 (230) volts, 50 to 400 Hz, or 115 (230) volts dc.

Fuse—$\frac{1}{2}$ amp slow-blow type for 115-volt operation, 0.3 amp slow-blow for 230-volt operation.

Shutter Actuator

Input Voltage—115 (230) volts dc.

Peak Current—1 amp for 115-volt operation, $\frac{1}{2}$ amp for 230 volt.

Holding Current—0.13 amp for 115-volt operation, 0.067 amp for 230 volt.

System Delay

The length of time for the shutter to become fully open after the MOMENTARY-OFF-MAINTAIN switch has been operated is approximately 20 to 25 milliseconds, depending upon the type of shutter used.

Mechanical Characteristics

Power Supply

Finish—aluminum box is finished in textured black vinyl paint. The front panel is anodized aluminum.

Dimensions—$4\frac{1}{16}$ inches long X $3\frac{1}{16}$ inches wide X $3\frac{1}{8}$ inches deep.

Weight—approximately $15\frac{3}{4}$ oz.

Power Supply Mounting Bracket

Finish—cold rolled steel bracket is finished in textured black vinyl paint.

Shutter Actuator Solenoid

Finish—Die-cast case is finished in black. The name plate is anodized anluminum.

Dimensions—$2\frac{1}{2}$ inches long X $2\frac{1}{16}$ inches wide X $1\frac{3}{4}$ inches deep.

Weight—approximately $10\frac{3}{4}$ oz.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

MAIN FRAME

Mounting the Camera

To mount the camera on a Type 422 or 453 oscilloscope, remove the foot from the support casting by unscrewing it. Insert either the Type 422 or 453 light seal and re-install the foot to hold the light seal in place. For most photographic work, it is recommended that any mesh or light filters also be removed from the oscilloscope.

The camera now can be mounted to the oscilloscope by sliding the camera into the grove on the Type 422 or 453 oscilloscope bezel. The camera can be removed at any time by lifting it off the oscilloscope bezel. The hinge system of the support casting permits the camera to be swung open either to the left or right by lifting the opposite hinge pin and swinging the camera away from the support casting, or the support casting may be detached from the camera completely by lifting both hinge pins simultaneously.

Slide on mounting has been incorporated to provide a fast and easy method of camera mounting or removal, particularly when one camera is used with several oscilloscopes. If, however, a more secure attachment is required between the bezel and the oscilloscope it can be obtained by tightening the two set screws (mounting lock adjustments) located in the support casting with a $^{5}/_{64}$ hexagonal wrench.

To obtain access to the two set screws (mounting lock adjustments) it is necessary to swing the camera away from the support casting. The camera may be swung away in either direction or removed completely, which ever is the most convenient. The two set screws are located in the half-round boss on each side of the support casting next to the light seal groove.

The two set screws need only be adjusted in a clockwise direction a small amount to effectively lock the support casting onto the bezel.. To remove the support casting from the bezel after locking it on, it will be necessary to loosen both set screws by turning them in a counterclockwise direction until the support casting will slide off the bezel easily.

Special Mounting Information

Special mounts (bezels) are used to attach the Type C-30 Camera to oscilloscopes other than the Types 422 or 453. The bezels take the place of the normal graticule cover on these oscilloscopes.

To mount the 321-321A bezel, first remove the graticule cover from the oscilloscope by removing phillips head screw (321A only) located on the lower part of the cover, then lift out on the lower part of the cover and pull down. For most photographic work it is recommended that any mesh or light filters also be removed from the oscilloscope.

Check the oscilloscope external graticule for scratches and be sure it is clean. Place the external graticule in the cutout for it on the oscilloscope so that the scribed side is toward the CRT and the illumination slots are down.

Engage the two ears on the top of the bezel into the top of the front panel, i. e., reverse the graticule cover removal procedure. After the bezel is in place reinstall the phillips screw to hold the bezel firmly to the oscilloscope. Make certain that the groove in the bezel runs across the top and down each side of the bezel. Mount the camera by sliding it into the groove on the special bezel.

NOTE

It will be necessary to drill and tap a hole in the front panel of the Type 321 for a 4-40 phillips head screw. The special mounting bezel should be used as the template.

To mount the bezel on other oscilloscopes, first remove the graticule cover from the oscilloscope by unscrewing the four knurled nuts. For most photographic work it is recommended that any mesh or light filters also be removed from the oscilloscope.

Check the oscilloscope external graticule or crt protector plate for scratches and be sure that it is clean. Place the external graticule, if one is to be used, on the graticule studs so that the scribed side is toward the crt and the clear illumination slots (if there is a choice) are up.

Place the bezel on the graticule studs. Use the four graticule nuts supplied to attach the bezel to the oscilloscope The new graticule nuts are slotted so that a screwdriver or coin can be used to tighten them. Make certain that the groove in the bezel runs across the top and down each side of the bezel. Mount the camera by sliding it into the groove on the special bezel.

LENSES

Adjusting the Lens Aperture

The f STOP selector (see Fig. 2-1) is used to select the lens opening. The dial is calibrated in f-stop numbers with a black dot to indicate the setting.

The lens setting to be used for a particular picture depends on several factors. Whenever possible, use of f-stop numbers lower than f/4 should be avoided if an external graticule is to be used. As in all cameras, the best depth of field is obtained at the smallest openings (largest f-stop numbers). This is important in all oscilloscope cameras since the trace and an external graticule cannot simultaneously be brought into focus when the f-stop number is lower than f/4. In applications where an external graticule is used and it is necessary to use the lens wide open, special techniques can be used to obtain a satisfactory picture with both the trace and the external graticule in focus. These techniques are described in Section 4 of this manual.

Additional information on selecting lens openings for particular applications is given in the Photographic Techniques section of this manual.

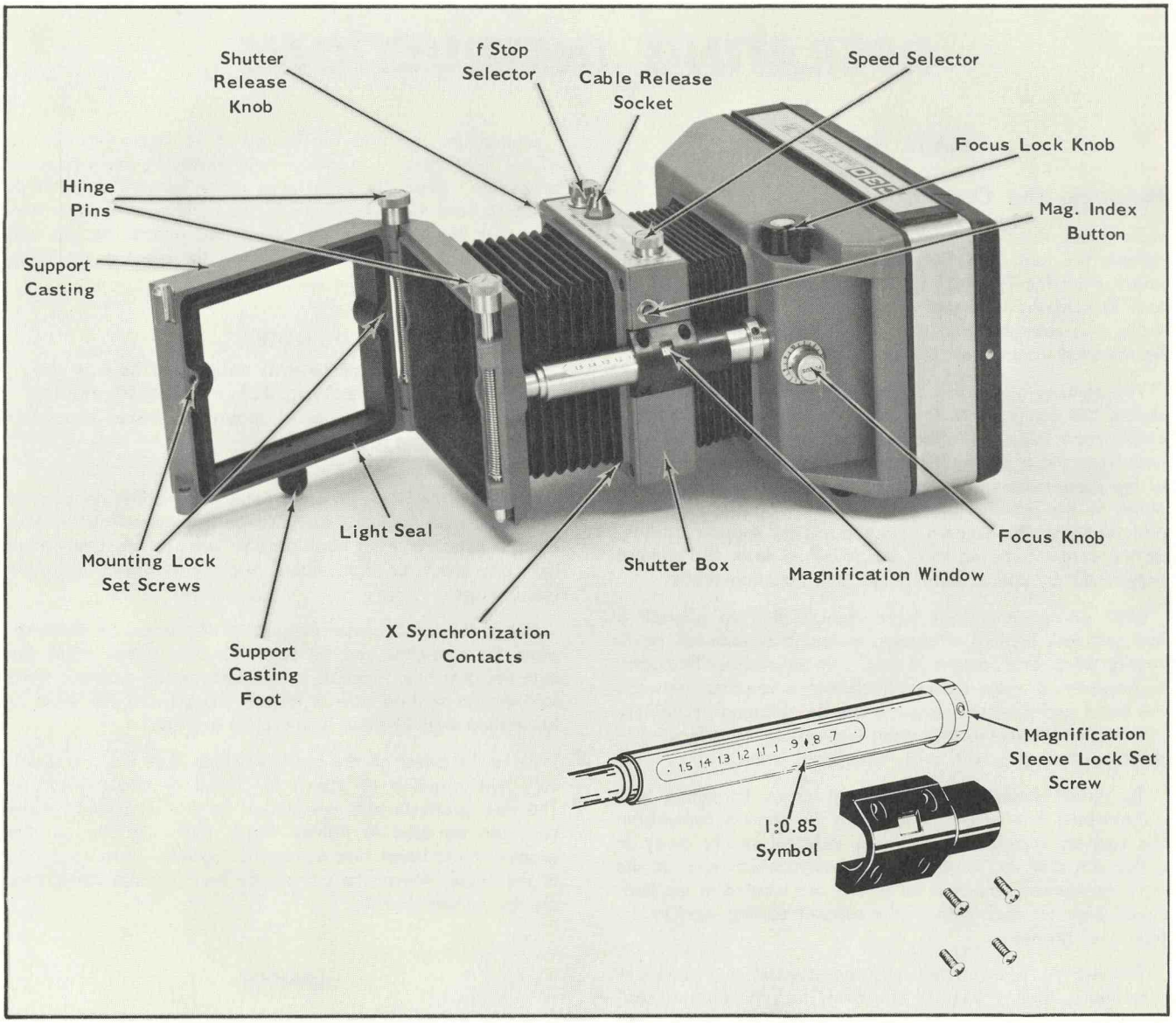


Fig. 2-1. Type C-30 Camera controls and their functions.

Selecting the Shutter Speed

The camera shutter speed is selected by means of the SPEED selector (see Fig. 2-1). Numbers shown on the dial are actually the reciprocals of the shutter speeds. For example, when the SPEED selector is set at 30, the shutter is open 1/30 second. As with the aperture setting, many factors determine the shutter speed used for a particular picture. Care must be taken that the right combination of lens opening and shutter speed is chosen so that the desired results may be obtained. More information on selecting the shutter speed is contained in the Photographic Techniques section of this manual.

Releasing the Shutter

The SHUTTER RELEASE knob is located on the right side of the shutter box. When the SHUTTER RELEASE knob is pressed, the shutter mechanism is actuated. In all positions of the SPEED selector except (T) and (B) the shutter mechanism operates independently of the time that the SHUTTER RELEASE knob is held down. In the (B) position of the SPEED selector, the shutter remains open as long as the SHUTTER RELEASE knob is held down. When the control is released, the shutter closes. In the (T) position of the SPEED selector, the shutter is opened the first time the knob is pressed. It is then necessary to press the SHUTTER RELEASE knob a second time in order to close the shutter.

The shutter can also be operated using a shutter release cable. The shutter release cable is connected to the cable release socket located on top of the shutter box.

CAUTION

Do not attempt to force the SHUTTER RELEASE LEVER.

Setting Lens Object-to-Image (MAG) Ratio

Several object-to-image (MAG) ratios are available for use with the Type C-30 Camera.

On the left side of the shutter box and above the guide rod is the MAGnification button. Just below the MAG Index button is a window which has the image number, of the object-to-imake ratio for which the Type C-30 Camera is set, centered in it.

To change the magnification ratio, depress the MAG Index button and slide the shutter housing along the guides until the desired image number appears in the window under the MAG Index button. Release the button, then gently move the shutter housing until it engages the detent for that particular image number.

NOTE

When setting the camera for an object-to-image ratio of 1:0.85 the number 0.85 will not appear in the window; instead, a ♦ will appear. DO NOT loosen the set screw which secures the magnification sleeve lock ring. This is a factory adjustment used solely to compensate for lens magnification tolerances. The magnification sleeve lock ring is located adjacent to the rear casting on the left guide, i.e., the guide which has the image numbers imprinted on it.

It will be necessary to refocus the camera after changing the object-to-image ratio. Focusing instructions will be found under Polaroid Land Pack Film Camera Back in this section of the manual.

POLAROID LAND PACK FILM CAMERA BACK

Focusing the Camera with the Focusing Plate

To use the Focusing Plate, the Polaroid Land Pack Film Camera Back must be opened and the Focusing Plate inserted where the film normally rests. Refer to the paragraphs under Loading and Exposing the Polaroid Land Film Pack for directions on how to open the camera back.

When the Focusing Plate has been properly installed it should appear as shown in Fig. 2-2 with the half-moon cut-out on the right and the plastic inserts resting firmly against the front of the exposure window.

To install the Focusing Plate, insert the two ears on the left end of the Focusing Plate against the left end of the exposure window. With nothing more than finger pressure, push the Focusing Plate to the left and insert the right end of the Focusing Plate into the exposure window. Release the pressure on the Focusing Plate and allow it to rest against the right end of the exposure window. Press the Focusing Plate forward until all four plastic inserts are resting firmly against the front of the exposure window.

To remove the Focusing Plate, insert a finger into the half-moon cut-out on the right and pull outward.

When focusing the camera, be sure to set the Lens for maximum aperture (f/1.9) and set the SPEED selector on (T). Obtain a sharply focused trace on the crt using the oscilloscope focus and astigmatism controls. Then secure the

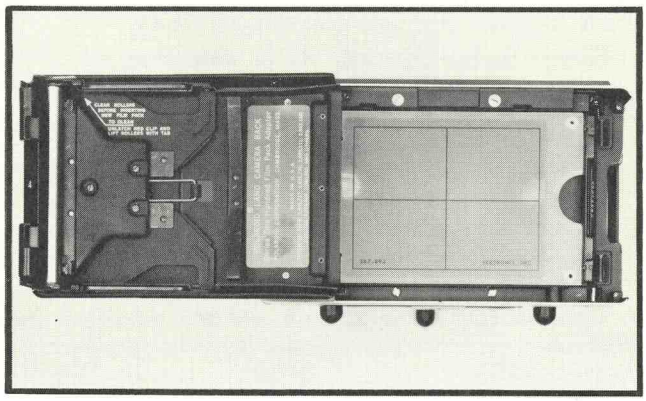


Fig. 2-2. Focusing Plate installed in Pack Film Camera Back.

camera in place against the oscilloscope. Open the camera shutter and observe the image on the Focusing Plate. Turn the FOCUS LOCK knob fully clockwise, then adjust the FOCUS knob on the side of the camera to produce a sharply focused image of the oscilloscope trace on the Focusing Plate.

After focusing the camera, turn the FOCUS LOCK knob counterclockwise to insure that the camera focus cannot be changed accidentally.

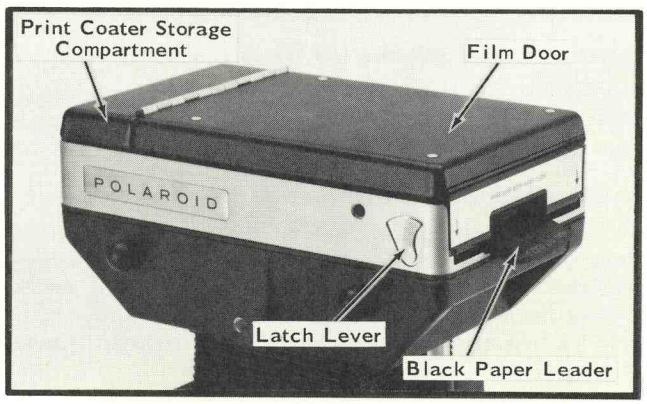


Fig. 2-3. Polaroid Land Pack Film Camera Back.

Loading and Exposing the Polaroid Land Film Pack

When the film box is opened, the instruction sheet and print coater should be saved.

To open the camera back for loading, push the LATCH LEVER on the bottom of the camera back (near the tripod socket), counterclockwise. The door should have opened slightly. Swing the door out until it is fully open.

Remove the empty film container from the camera back by lifting up and pulling it out from under the door hinge.

The processing rollers in the camera back should be inspected and cleaned if necessary. Directions inside the door indicate how to release the stainless steel rollers from their

normal position in the camera back. A damp cloth may be used to clean the rollers. It is important to keep these rollers clean to spread the developing reagent evenly.

Remove the film pack from the foil wrapper by tearing the wrapper at the indicated point. When you unwrap the film, be careful to handle the film pack by the edges only.

Insert the film pack under the back door hinge and push it toward the hinge and forward into the film plane until it snaps into place. Be sure that the indicated side of the film pack is correctly oriented toward the lens. The black paper leader should be allowed to hang over the right end of the camera back.

Close the door by squeezing it until both sides snap shut. Make sure the black paper leader is extending outside the camera back.

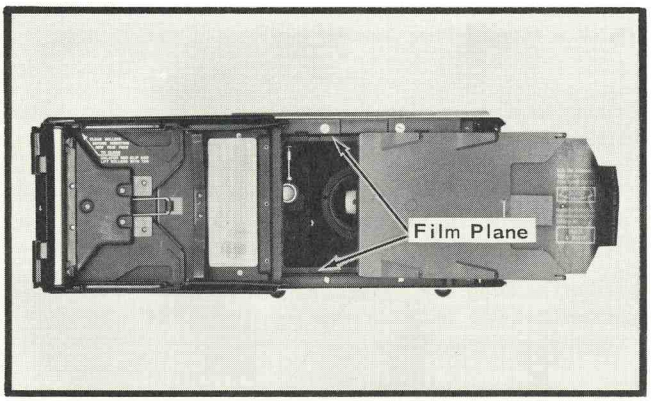


Fig. 2-4. Installing Film Pack into camera back.

Close the lens shutter, or the first exposure will be fogged. Pull the black paper leader all the way out. The camera is now ready for the first picture.

Advancing and Developing the Film

After taking the picture, pull the white tab which extends from the camera back completely out of the camera back, i.e., until the white tab separates from the film in the camera. Pulling the white tab does two things: first, it positions the positive and negative sheets together and second, it causes the yellow tab (marked "PULL") to pop out.

NOTE

Do not pull another white tab if the yellow tab is already extending from the camera back.

Next pull the yellow tab. This causes the positive and negative sheets to be pulled between and through the processing rollers, spreading the developing reagent between the two sheets to start the development process.

Pull the yellow tab completely out of the camera back in one smooth, fairly rapid motion. Pull about as hard and rapidly as you might pull down a window shade; not slowly and hesitantly.

Wait the recommended development time. Follow the directions in the instruction sheet for development times. The development time varies for different types of film, and even the development times for a particular film is subject to change.

When the development time is up, peel the print away from the negative rapidly. Do not let the print fall back on the damp negative.

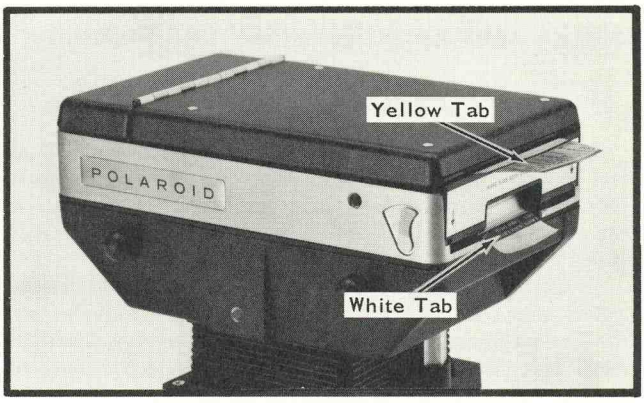


Fig. 2-5. Positive and negative sheets ready to be pulled out of camera back.

Coat each print as soon as possible after separating it from the negative, using the Polaroid Print Coater.

When using the Print Coater, apply along the entire length of the print, including edges, borders, and corners, with 6 to 8 firm overlapping strokes. For the last two or three pictures in each film pack press the coater down hard against a non-image surface for a moment to release extra liquid, then spread the liquid smoothly across the print as before.

Storage Of Print Coater

The print coater can be stored in the compartment just to the left of the film loading door (rear of camera back towards you). To open the compartment, grasp the black cover area to the left of the hinge and lift up. It the compartment is difficult to open, pry with your fingernails between the black cover and the aluminum casting on the left side of the body.

Portra Lens (Optional Accessory)

The portra lens is attached to the normal Type C-30 lens by inserting the portra lens into the three plastic clips located around the front of the normal lens. Access to the front of the camera lens is obtained through the opening in the support casting. When attaching the portra lens to the camera lens, the lettering on the portra lens must be facing away from the camera lens.

When the portra lens is not in use it may be stored in its storage clip which can be mounted in the camera back.

To attach the plastic storage clip into the camera back, open the camera back and remove the film container, then remove the bottom left (viewed looking toward the lens) rear-bellows screw. Attach the storage clip using the screw supplier with the clip, making sure in mounting the storage clip that none of the clip extends into the exposure window area.

SHUTTER ACTUATOR MODEL 2 OR 3

Mounting

Power Supply Model 2 or 3 and Power Supply Mounting Bracket

Grasp the power supply so the front panel is toward you and the top of the power supply down. With the power supply in this position, remove the two bottom screws. Lay the mounting bracket on the supply so the flat surface

of the bracket is against the supply and the plastic knob is toward you. Line up the slots in the bracket so they are over the holes in the power supply from which the two bottom screws were just removed. When the slots and screw holes are lined-up, re-insert the two bottom screws through the slots into the power supply cabinet. Do not tighten the screws at this time.

Power Supply Model 2 or 3 is mounted on a camera back by inserting the screw supplied with the Power Supply Mounting Bracket through the proper hole in the bracket and into the tripod socket on the bottom of the camera back. The proper hole for mounting the Power Supply Mounting Bracket to the camera back is shown in Fig. 2-6.

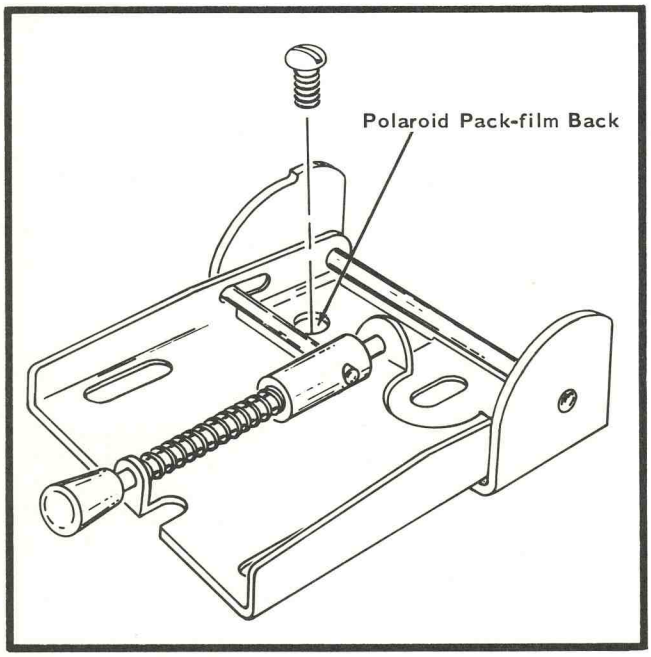


Fig. 2-6. Selecting proper mounting hole in Power Supply Mounting Bracket.

After securing the Power Supply Mounting Bracket to the camera back, push the power supply toward the camera back until the rubber feet rest against the camera back. The two bottom screws holding the bracket to the power supply are now tightened.

When it is necessary to open the camera back, the power supply may be rotated out of the way. The power supply is unlocked from its position by pulling back the plastic knob. Keep the knob pulled back (away from the camera back) and rotate the power supply out and down. Release the knob and allow the power supply to rotate into its down position. After the camera back is closed again, the power supply is rotated back to normal position by pushing the power supply up and in toward the camera. The power supply locks into position automatically.

Shutter Actuator Solenoid

Loosen both of the Shutter Actuator solenoid set screws found between the main part of the body and the knurled nut. The set screws should be loosened only enough to allow the knurled nut to turn freely.

Hold the Shutter Actuator solenoid directly above the cable release socket on the shutter box. Turn the knurled nut to screw the Shutter Actuator solenoid onto the cable release socket or, as an alternative method, loosen the set screws enough to permit the knurled nut to be removed from the Shutter Actuator solenoid body. The knurled nut is then screwed onto the cable release socket. After screwing the nut onto the cable release socket, remount the Shutter Actuator body onto the knurled nut; then it is necessary to tighten one or both of the set screws that retain the knurled nut.

Operating Controls and Connectors

ACTUATOR (Indicator Lamp)	Lights when the Shutter Actuator solenoid is energized. The lamp will stay lit as long as the actuator is held energized. The lamp is an indicator that the shutter is open if the shutter is set on (B). The lamp is not, however, an indicator that the shutter is open if the shutter is set on (T).
ON-OFF POWER	Turns the line voltage to the power supply on or off. Indicator lamp lights when line voltage is applied to the power supply.
MOMENTARY-OFF-MAINTAIN	Causes the Shutter Actuator solenoid to be energized in the MOMENTARY or MAINTAIN positions. The MOMENTARY is a spring return to OFF position while the MAINTAIN position allows the Shutter Actuator solenoid to be held in the energized position indefinitely.
REMOTE	**Model 3**—Applying 24 Vdc to the + and — pins of the REMOTE connector will energize an internal relay whose normally open contacts are connected across the MOMENTARY-OFF-MAINTAIN switch. The energizing of the internal relay will cause its normally open contacts to close, which will simulate holding the MOMENTARY-OFF-MAINTAIN switch in its MOMENTARY position. As long as 24 Vdc is applied to the + and — pins of the REMOTE connector the Shutter Actuator solenoid will remain energized.

NOTE

Voltage polarity should be observed when several Shutter Actuator units are being triggered simultaneously from the same 24 Vdc source.

REMOTE 115 (230) VDC + and — Pin Jacks	**Model 2**—Shorting the + and — pin jacks together causes the Shutter Actuator solenoid to energize. It is possible by connecting a switch between these two pin jacks to energize the Shutter Actuator solenoid from a remote location.

WARNING

When the ON-OFF switch is ON, the MOMENTARY-OFF-MAINTAIN switch is OFF and the line-power and the Shutter Actuator solenoid are connected to the power supply; LETHAL VOLTAGE appears between the REMOTE 115 (230) VDC + and — pin jacks.

Power Cord	The power cord to the power supply is permanently attached.
ACTUATOR 115 (230) VDC 1A (.5A)	Receptacle into which the connector from the Shutter Actuator solenoid connects to obtain power to operate the Shutter Actuator solenoid.

Operating Shutter Actuator Model 2 or 3

NOTE

To prevent a misleading display on the oscilloscope, the leads of the Shutter Actuator system should not be interwound with the input leads to the oscilloscope. Maximum separation of the leads is recommended since there is a magnetic field present when the Shutter Actuator solenoid is energized.

Repetitive Waveforms

Mount the Shutter Actuator solenoid and power supply on the camera as described under Mounting, then mount the camera on the oscilloscope.

1. Apply line voltage to the power supply after connecting the Shutter Actuator solenoid to the power supply, then set the SPEED selector to (B).

2. Energize the Shutter Actuator solenoid by turning the ON-OFF switch to ON and the MOMENTARY-OFF-MAINTAIN switch to MAINTAIN.

3. Focus the camera.

4. After focusing the camera, return the MOMENTARY-OFF-MAINTAIN switch to OFF.

To photograph a repetitive waveform, using any shutter setting other than (T) or (B), first obtain a stable display of the desired waveform on the crt. Second, with the camera back ready for exposure, push the MOMENTARY-OFF-MAINTAIN switch to MOMENTARY and release.

To photograph a repetitive waveform using a shutter setting of (T), the MOMENTARY-OFF-MAINTAIN switch must be pushed twice to the MOMENTARY position. The first time the switch is operated to MOMENTARY, the shutter will open. The second operation will close the shutter.

To photograph a repetitive waveform using a shutter setting of (B), the MOMENTARY-OFF-MAINTAIN switch must be held in the MOMENTARY position for the desired exposure time and then released.

Non-repetitive Waveforms

Mount and focus the camera system as outlined above under Repetitive Waveforms.

When pohotographing a non-repetitive waveform using a shutter setting of (T), set the oscilloscope for single sweep operation so the display, when presented, will not have jitter. Push the MOMENTARY-OFF-MAINTAIN switch to MOMENTARY and release. Wait for the waveform to occur, then push the MOMENTARY-OFF-MAINTAIN switch to MOMENTARY again and release. This last action closes the shutter.

When using a shutter setting of (B) to photograph a non-repetitive waveform, set the oscilloscope for single sweep operation. Then set the MOMENTARY-OFF-MAINTAIN switch to MAINTAIN. After the waveform has occurred, the MOMENTARY-OFF-MAINTAIN switch is set to OFF to close the shutter.

NOTE

The Shutter Actuator System Model 2 or 3 may be left in the MAINTAIN (energized) position for an indefinite period without damaging the equipment.

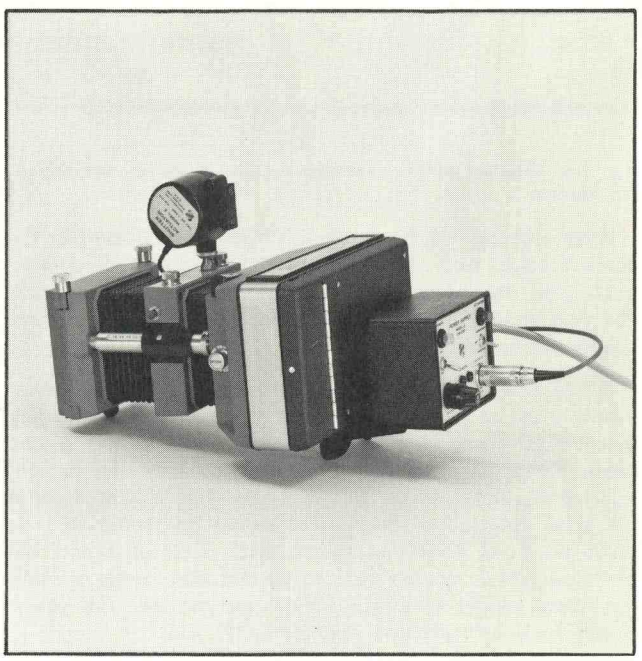


Fig. 2-7. Mounting the Shutter Actuator on the Type C-30 Camera.

SECTION 3

PHOTOGRAPHIC TECHNIQUES

CAMERA-OSCILLOSCOPE CONSIDERATIONS

Writing Rate

Writing Rate is a figure of merit which roughly describes the ability of a particular camera system mounted on a particular oscilloscope to photograph fast moving traces. The writing rate figure expresses the maximum spot rate (usually in centimeters per microsecond) which can be photographed satisfactorily.

The faster the oscilloscope spot moves, the dimmer the trace becomes. This is because the electron beam strikes each point on the phosphor coating for a shorter period of time. A camera system and oscilloscope which have a high writing rate are required for low repetition rate displays at the fast oscilloscope sweep rates.

Figure 3-1 shows one way in which writing rate can be calculated. A single trace of a damped sine wave is displayed. The frequency of the damped waveform is such that the rapidly rising and falling portions of the first cycle or two fail to photograph. The writing rate of the system is found as follows: Starting from the left, find the first rapidly rising or falling portion of the damped sine wave which is photographed in its entirety. Let D represent the vertical distance in centimeters between the peaks which are connected by this portion. If D is three or more times as great as the horizontal distance occupied by one cycle (so that the horizontal component of velocity is small compared to the vertical component), the maximum writing rate in centimeters per microsecond is given approximately by:

$$\text{Maximum writing rate} = 3.14\,Df$$

where f is the frequency of the damped wave in megahertz.

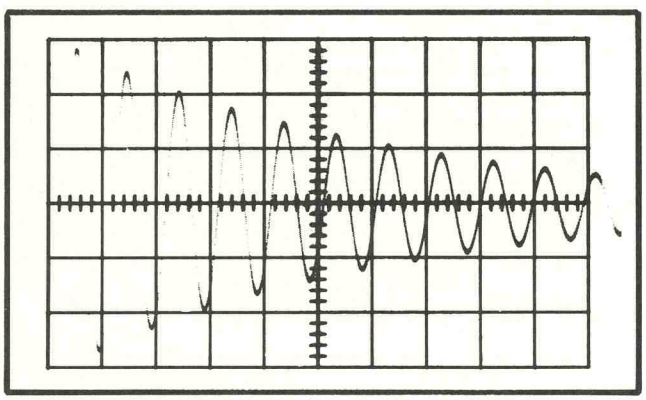


Fig. 3-1. A single-shot damped sinusoidal waveform which can be used to measure the maximum writing rate of an oscilloscope-camera combination.

It is inadvisable to speak of the absolute writing rate of an oscilloscope or camera, because so many variables are involved. Among the variables which must be considered are the speed of the camera lens, the type of crt phosphor, the type of film, the crt accelerating potential, the camera lens, and development time of the film.

It is possible to compare the effectiveness of two films by measuring their writing rate under the same conditions. In other words, you can determine which of the two films is the more effective under those particular conditions without being able to assign a specific value to either film.

The rated ASA speed of a film doesn't tell you much about its effectiveness in recording single oscilloscope traces. This is because the ASA speed rating is measured for 1/50 second exposure to light of normal daylight and spectral characteristics, while the very short exposures of fast crt traces are several orders of magnitude smaller and have various spectral distributions. There is usually some relationship between ASA rating and maximum writing rate, however. Thus it would be safe to assume that a film with a very high ASA speed rating would probably have a higher maximum writing rate than a film with a lower ASA speed rating.

CRT SELECTION

Selecting the Crt Phosphor

There are a great number of phosphor types presently available to the purchaser of a cathode-ray oscilloscope. Each of these phosphors has certain advantages and disadvantages compared to the others. There is no one phosphor which is best for all applications. Of the many types of phosphors available, five are most commonly in use. They are the P1, P2, P7, P11 and P31. Other phosphor types are usually restricted to special applications. Since the P1, P2, P7, P11 and P31 phosphors are the ones most commonly used, information contained in this portion of the manual will primarily concern these phosphors.

For low sweep rate or repetitive-sweep applications where a high writing rate is not required, practically any type of phosphor is satisfactory. It is only for single-sweep or low-repetition-rate applications at the fast sweep rates where selection of the crt phosphor is important. In low-repetition-rate applications at the fast sweep rates, use of the proper phosphor can mean the difference between getting a good photograph and not getting one at all.

Probably the most important single characteristic of a phosphor for photographic purposes is the color of its emitted light. A blue or violet fluorescence has the highest actinic value and this is most suitable for photographic work. In general, it can be stated that (all other things being equal) the shorter the wavelength of the visible peak emitted light, the better the phosphor for photographic applications.

Most users of oscilloscopes are concerned not only with photographing the oscilloscope trace but in observing it directly as well. For such applications it is important to have a phosphor which gives good results in both types of applications. This frequently results in the choice of a phosphor such as P2 or P31 where the emitted light has a large

TABLE 3-1

Common Phosphor Table

Phosphor Type	[1]Writing Rate P11 used as the standard.	[2]Relative Brightness Representative of 10 kV aluminized screens.	Wavelength of Peak Radiant Energy.	Decay Time in ms to 10% of initial value.	Color	
					Fluorescense	Phosphorescense
P1	35% as fast	150	520 nanometers	25	Yellowish-Green	Yellowish-Green
P2	70% as fast	230	510 nanometers	.32	Bluish-Green	Green
P7	95% as fast	128	450 nanometers	.34	Blue-White	Yellow-Green
P11	100%	100	450 nanometers	.38	Purplish-Blue	Purplish-Blue
P31	75% as fast	390	530 nanometers	.34	Green	Green

[1]To achieve the writing rate comparisons the shutter of the test camera was left open five seconds to make use of the available light.
[2]Taken with a Spectra Brightness Spot Meter, which incorporates a C.I.E. Standard Eye Filter.

enough actinic value to give a good writing rate and also has sufficient persistence to permit easy viewing.

It has been observed that the P11 phosphor has the highest comparative writing rate of any common phosphor and is thus best for photographic work. The medium short persistence of the phosphor is somewhat undesirable for general purpose work but the disadvantages of this are slight. Type P11 should be chosen whenever the ultimate in photographic ability is required. Type P11 emits a medium short-duration purplish-blue light.

Since the Type P2 and P31 phosphors appear to be best for combined general purpose and photographic applications, they are standard on most Tektronix oscilloscopes. Type P11 is standard on some Tektronix oscilloscopes where extremely rapid sweeps make it possible to obtain maximum benefit from the advantages of this phosphor. Other phosphors can be obtained on any of the Tektronix oscilloscopes.

FILM SELECTION

Selecting the Proper Film

For most oscilloscope work you will find Polaroid Land film the most convenient. This film permits you to see the picture very soon after taking it and makes it unnecessary to expose part or all of the film before developing it.

The following table of Polaroid film types gives a brief outline of the available emulsions. The film recommended or films having equivalent characteristics may be used.

TABLE 3-2

Polaroid Land Pack Film Types

Film Type	Approximate ASA Rating	Picture Size	Remarks
107[2]	3000	3¼ x 4¼	Panchromatic type which yields a paper type print on a plastic backing material. Requires coating.
108[3]	75	3¼ x 4¼	Color film which yields a paper type print on a plastic backing material. Requires no coating.

[2]Development time 10 seconds.
[3]Development time 50-60 seconds.

HELPFUL TECHNIQUES WITH POLAROID LAND FILM

General

Several types of spray-on matte finishes are available which will enable you to make pencil or pen notes directly on the Polaroid prints. The spray can be obtained from any store handling art or photographic supplies.

Another method of note marking is to use an ink eraser to rub the emulsion off the areas to be written on. Pen or pencil is then used to write the data on the print.

Still another method of note marking is to scratch the desired data onto the print with a sharp pointed instrument. The data should be scratched onto the print before it is coated.

For greater contrast on Polaroid prints, use a slightly longer development time. A decrease in development time, on the other hand, will normally increase writing rate, with however, a consequent lowering of print contrast. Shorter time will sometimes bring up waveform details not otherwise visible.

A method which sometimes produces very good results with Polaroid Land films is prefogging. In prefogging, the film is exposed to a predetermined amount of light for a definite period. The intensity of the light and the period of the exposure are so chosen that the film is brought right to the threshold of being exposed. A lesser amount of light is then required to expose the film. The prefogging technique can produce an increase in maximum writing rate of two or more times depending on film type, film condition, the nature of the prefog light and other variables. Prefogging results in a slightly foggy background on the photographs and somewhat less contrast. This is a small price to pay for a large increase in writing rate, however.

Postfogging is very similar to prefogging. The difference is that the film is exposed to the controlled light source after the exposure, rather than before. Postfogging produces very nearly the same increase in writing rate as prefogging.

Storage of Film

Do not open a flim package until it is to be used. The vapor tight packaging will protect the film against high humidities. Under high humidity conditions film should be exposed and processed as soon as possible.

Do not store open packages of film in damp basements, ice boxes, or refrigerators because of the high humidities in these places. If it is desirable to refrigerate an open package of film, it should be placed inside a can or jar which can be tightly sealed to keep out the moisture.

When storing film, the temperature in the area should be about 70°F. If a cool storage place is not available the film may be stored in a refrigerator. Film may be stored for 2 months at 75°F, 6 months at 60°F, and 12 months at 50°F. The storage area should be at 40% to 60% relative humidity. To avoid moisture condensation on cold film surfaces the unopened packages of film should be allowed about 30 minutes to 2 hours to come up to room temperature before opening after they have been removed from cold storage.

Open packages of film should be kept away from chemical fumes, x-ray, and radioactive materials. Open packages of film should also be in an area with a humidity between 40% and 60%, with 40% preferred. Polaroid film can be used at temperatures from about 40°F to 100°F. However, open film will keep longer in a temperature of 90°F at 50% humidity than it will in a temperature of 70°F at 80% humidity.

The developed film should ideally be stored in an area with a temperature between 60°F and 80°F with a humidity not over 60%.

NOTES

SECTION 4

PICTURE TAKING

Photographing Repetitive Signals

The following procedure can be used as a guide to obtain an exposure.

1. Position the external graticule, if the oscilloscope has one, for the white lines.

2. Mount the camera bezel on the oscilloscope if the oscilloscope is other than a Tektronix Type 422 or 453.

3. Obtain the signal and adjust the controls for the desired display.

4. Attach the camera to the bezel and secure the camera against the oscilloscope.

5. Adjust the focus, astigmatism and intensity controls for a sharp trace.

6. Set the f STOP selector for the largest lens opening (smallest f-stop number) and carefully focus the camera on the trace or halfway between the trace and graticule in the case where an external graticule is to be used.

NOTE

When using an external graticule and both a clear trace and external graticule are desired, the camera should be focused halfway between the trace and the external graticule.

7. Set the intensity to midrange, scale illumination three-quarters clockwise, SPEED selector to 1/4 second and f STOP selector to f/5.6. The above control settings should be reasonably close for most film around 3000 ASA rating and a waveform with a frequency near 1 kHz.

Photographing Single-Sweep Displays

Single-sweep displays are formed when the oscilloscope spot sweeps across the screen only once. The actual exposure time is thus determined not by the shutter speed setting, but by the duration of the sweep plus phosphor persistence, provided the shutter is open sufficiently long. In one type of single-sweep photography, the graticule exposes the film for the time set by the shutter while the spot on the screen exposes the film for only the duration of the sweep. It is therefore not usually possible to adjust the trace and graticule for the same intensity and obtain good pictures, since the effective exposure times for the two are different.

Success in obtaining good photographs of single-sweep displays will come only with experience. A few tips, however, may reduce the amount of experimenting required.

1. Use steps 1 through 6, under Photographing Repetitive Signals, to set up the camera.

2. Select a shutter speed which is of a longer time than the event which is to be photographed.

3. Use the highest practical intensity without causing defocus of the trace.

4. Where practical, use f-stops higher than f/4 if an external graticule is used. This will permit both trace and external graticule to be in focus.

It should be remembered that since the shutter speed has already been determined, the selection of lens opening will determine how well the trace photographs. In single-sweep applications you must make your camera settings for the trace intensity and duration. You cannot use the graticule illumination as a reference.

Picture Troubles

If the trace is too wide (defocused due to high light intensity) on the picture, this may be corrected by either using a higher f-stop number or a faster shutter speed. If the defocused trace cannot be cured by using either a higher f-stop number or a faster shutter speed, the camera needs to be refocused.

No image appears on the picture

1. Inoperative shutter mechanism.

Image just barely appears on a picture

1. Use higher intensity and scale illum settings.

2. Use a slower SPEED selector setting.

3. Set the f STOP selector for a smaller number.

4. Use a film with a higher ASA rating.

5. Prefogging or postfogging may help. Refer to the section on Photographic Techniques.

Light streaks on picture

1. Light leaks in bellows between shutter box and camera back. See local Tektronix Representative about repair.

2. Light seal between camera and oscilloscope faulty.

3. Dirty rollers in camera back.

4. Film pack was handled too roughly during loading.

Fogging on picture

1. Scale illum control is set too high.

2. Light-struck or bad film.

3. Film was exposed to light during loading.

Either trace or external graticule in focus, with the other out of focus

1. Use f-stop numbers larger than f/4 when photographing an external graticule.

2. Camera needs to be refocused because of an object-to-image ratio change.

Some portions of photographed signal appear brighter than others

1. Use an exposure which is long enough to allow several sweeps to occur.

Eliminating Parallax and Focusing Difficulties

The Tektronix oscilloscopes with the internal "no parallax" graticule and variable edge-lighting, will have no parallax problems and hence no focusing difficulties.

The fact that on some oscilloscopes the trace and graticule are not in the same plane results in some parallax. This also makes it impossible to obtain good focus simultaneously on both the trace and graticule at f-stop numbers below f/4. Both of these difficulties can be eliminated where necessary by either of two methods.

The first method involves double exposing the film. First set up the oscilloscope display as usual and focus the camera on the trace. Turn down the graticule intensity to minimum and make the first exposure of the trace only. Then turn up the graticule to its former brightness and set the camera lens for its smallest lens opening (largest f-stop number). Readjust the camera shutter speed to compensate for the smaller lens opening. Turn down the oscilloscope trace and make a second exposure of the graticule only. The resulting photograph, due to the greater depth of field when making the graticule exposure, will have no parallax between graticule and trace and will have both the graticule and trace in proper focus. Care must be taken in using this method that the position of the film for the second exposure is the same as for the first exposure.

The second method involves double exposing the film. First set up the oscilloscope display as usual and focus the camera on the trace. Turn down the graticule intensity to minimum and make the first exposure of the trace only. Then turn up the graticule to its former brightness and refocus the camera on the graticule. Turn down the oscilloscope trace and make a second exposure of the graticule only. The resulting photograph, due to refocusing between exposures, will have no parallax between graticule and trace and will also have both the graticule and trace in proper focus. Care must be taken in using this method that the position of the film for the second exposure is the same as for the first exposure.

Effects of Camera Magnification on Exposure

The camera or lens object-to-image ratio is the ratio of the object size to the image size. For example, a 1:1 setting is one whose object is the same size as the image. The object-to-image ratio of the camera lens has a definite effect on the exposures obtained.

The object-to-image ratio affects the amount of light which will fall on a given point of the film. The smaller the image on the film, the greater the intensity of the light. Therefore the larger the object-to-image ratio, the less time required to obtain a good exposure on the film. With a 1:0.7 setting slightly less exposure time is required to photograph a display than is required with a 1:0.9 setting. The difference in the exposure time required between the various settings is so slight, however, that it can usually be ignored.

It is important to note that a slightly better writing rate can be obtained with a larger object-to-image ratio than with a small object-to-image ratio. Here again, the difference is fairly small unless there is a wide difference in the ratio.

Reciprocity

Decreasing the f-stop number by one unit (e.g. from f/8 to f/5.6) doubles the area through which light can pass and expose film in the camera. Theoretically, such a decrease in the f-stop number requires that the exposure time be halved to produce the same exposure as obtained previously. This results in what is known as the Law of Reciprocity. The Reciprocity Law works quite well for medium intensity light at medium shutter speeds. The law fails, however, for very short exposures from bright light or for very long exposures from dim light. It is only for exposures in the range of approximately 1/250 second to 1 second that the Reciprocity Law can be used.

SECTION 5
OPTICAL AND ELECTRICAL DESCRIPTION

C-30

Object-To-Image Ratio Determination

The object-to-image ratio of the camera lens system depends on the focal length of the lens and on the object and image distances. When it is desired to obtain a given magnification with a particular lens, both the object and image distances and the focal length of the lens determine the magnification. The magnification of a lens is given by the formula:

$$m = \frac{f}{s - f} = \frac{s^1}{s}$$

where m is the magnification, s is the object distance, s^1 is the image distance, and f is the focal length of the lens. The image distance is determined by the lens focal length and the object distance by the following relationship:

$$s^1 = \frac{sf}{s - f} = sm$$

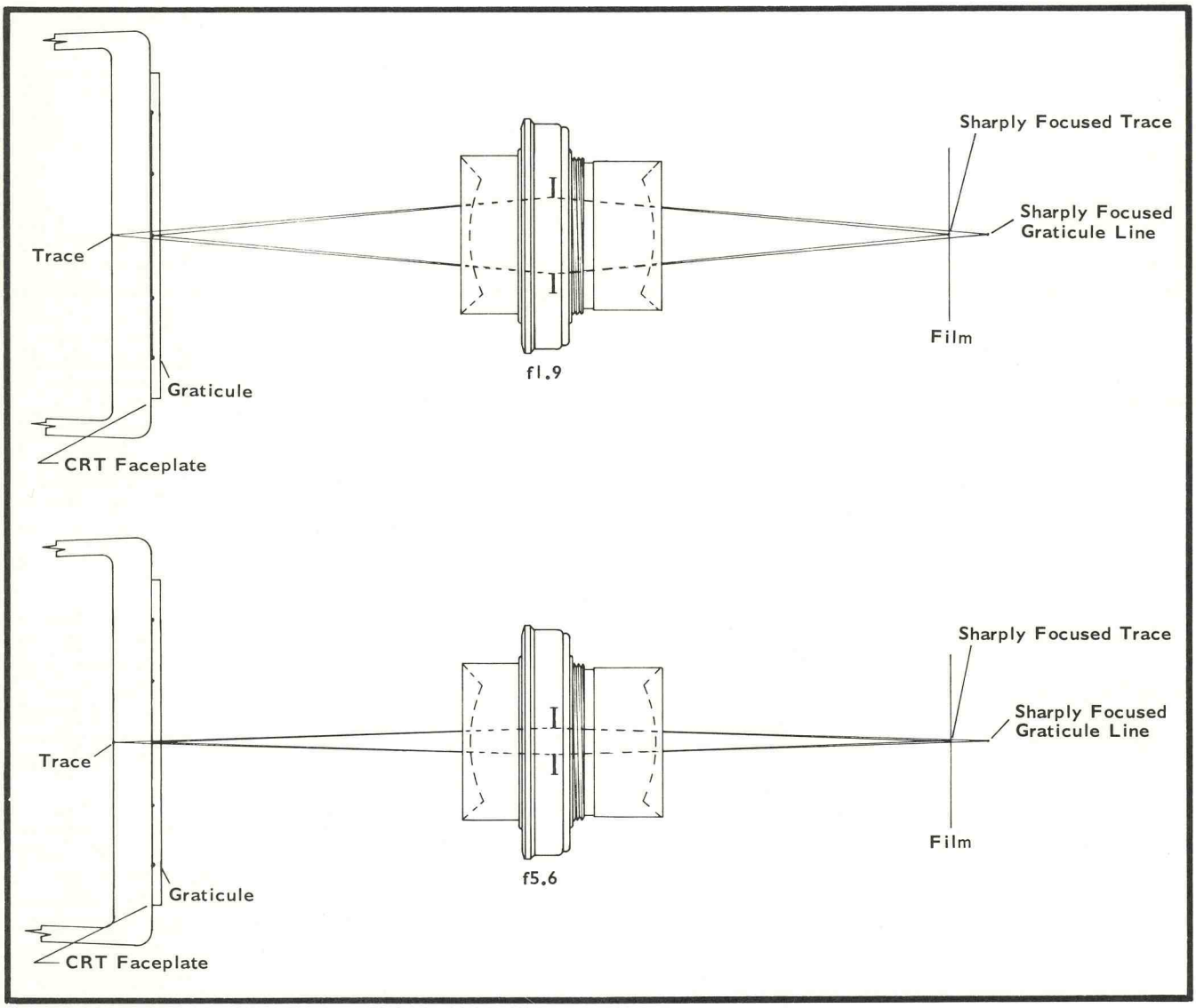


Fig. 5-1. Depth of field for different aperture settings. In the upper drawing, a small f-stop number permits light rays through the outer extremities of the lens to converge rapidly to focus on the film. When the object distance is changed slightly, the image on the film is defocused quite rapidly due to the sharp convergence of the light rays. In the lower drawings the same lens is shown but with a larger f-stop number. Rays through the outer extremities of the lens now converge much more slowly to the image on the film. When the object distance is changed slightly the image is defocused much more slowly due to the slower convergence of the rays.

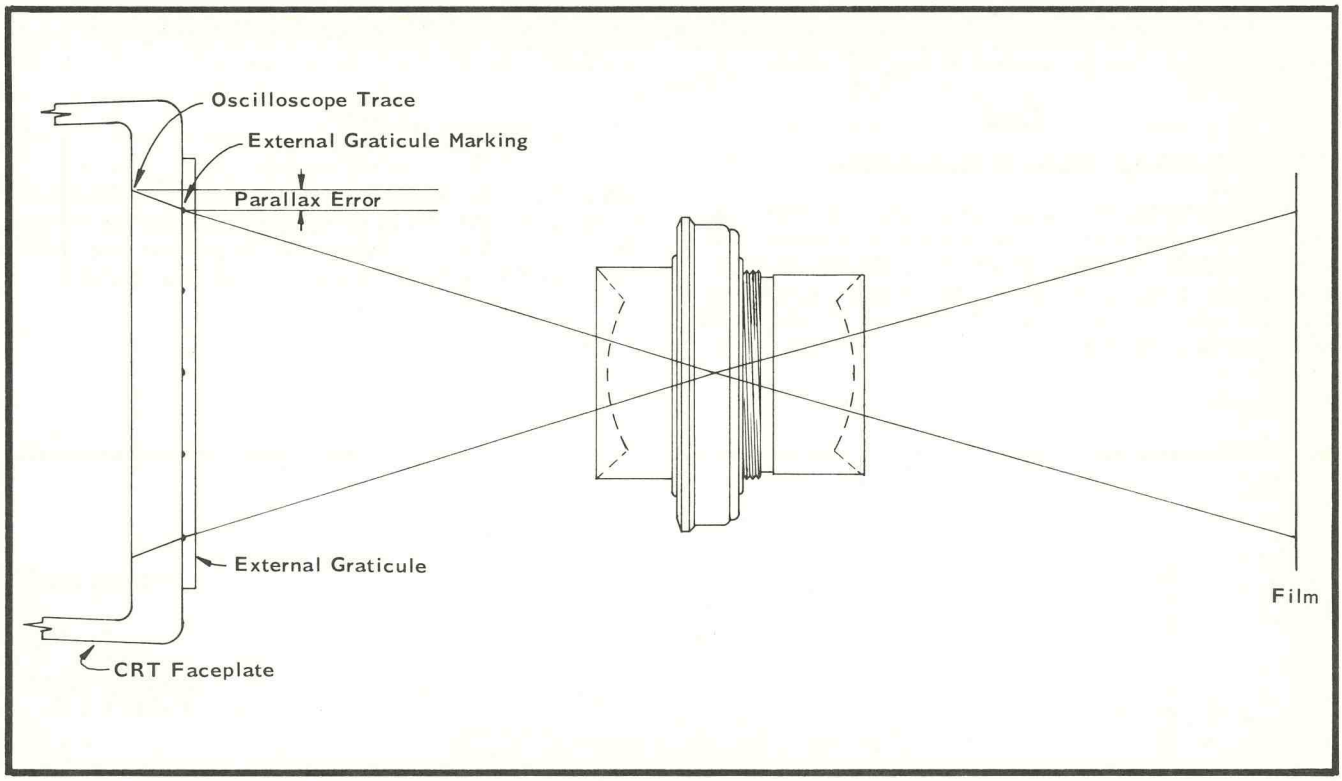


Fig. 5-2. The fact that the oscilloscope trace and external graticule lines are not in the same plane introduces a certain amount of parallax error as can be seen from the illustration. The oscilloscope trace is actually higher than the external graticule line; however, on the film both appear to be at the same level.

f STOP Determination

The f-stop value for a particular camera lens system is found by dividing the focal length of the system by the diameter of the limiting aperture. Thus:

$$\text{f-stop value} = \frac{f}{a}$$

where f is the focal length of the lens and a is the diameter of the limiting aperture. Two means are available for increasing the speed of a lens (decreaasing the f-stop value). These are (a) decreasing the focal length of the lens, and (b) increasing the diameter of the limiting aperture.

Depth of Field and Parallax

One characteristic of all lenses is that as the f-stop value is decreased, the depth of field for that lens is also decreased. This result occurs regardless of whether the f-stop value is decreased by shortening the focal length or by increasing the diameter of the limiting aperture. This is demonstrated in Fig. 5-1. An f/1.9 lens aperture is shown in the upper drawing. It can be seen that the rays from the object on the axis which pass through the extremities of the lens opening converge sharply to the image on the film. This means that if the object is moved slightly, the image will be moved slightly away from the film shown in the drawing. This will result in the image becoming out of focus due to the wide divergence of the rays. Since a slightly different object distance will result in the image being out of focus, the lens is said to have a low depth of field.

The lower drawing of Fig. 5-1 shows the same lens with the aperture reduced. This results in a value of f/5.6 for the lens system. A construction similar to the upper drawing shows that the light rays through the outer extremities of the lens now converge much more slowly to the film. Thus it is possible to change the object distance by a much greater amount before the image is defocused by the same amount. This lower lens system thus has a better depth of field than the upper lens system.

Depth of field is extremely important in lens systems designed to photograph oscilloscope displays. The low depth of field of an f/1.5 or f/1.9 lens aperture means that care must be taken to properly focus the image. This characteristic makes it difficult to obtain proper focus simultaneously on two objects in different planes. Thus the oscilloscope trace when pictured with an external graticule (which are in different planes) cannot be simultaneously brought into proper focus at f-stops values less than f/4. In order to increase the depth of field of the lens system sufficiently to permit both the external graticule and oscilloscope trace to be in focus, it is necessary to increase the f-stop value of the lens by decreasing the size of the aperture. Whenever possible, the large f-stop values should be used.

The characteristic by which the depth of field decreases as the f-stop value is decreased explains why the camera must be focused at the smallest f-stop values of the lens.

Fig. 5-2 shows another effect of the external graticule not being in the same plane as the oscilloscope trace. Because the trace is farther from the camera, parallax occurs which makes displayed signals appear smaller than they really are in both the horizontal and vertical directions. This effect can either be eliminated by using the internal graticule crt's, or compensated for by increasing the vertical and horizontal gain of the oscilloscope when using a crt which has an external graticule.

SHUTTER ACTUATOR MODEL 2 or 3

Circuit Description

Line voltage is applied to a bridge rectifier made up of D2, D3, D4 and D5. The rectified output voltage is then applied to the Shutter Actuator solenoid via pins 1 and 3 of J19.

Closing SW9 causes the Shutter Actuator solenoid to start energizing. As the actuator energizes, its plunger trips SW19, thus connecting pins 1 and 6 of J19 together and causing B15 to light. After SW19 has been tripped, the current path for the actuator is through the parallel combination of R10, R11, R12 and R13 and pin 2 of J19. R10, R11, R12 and R13 reduce the dc output voltage of the power supply to allow the actuator to remain energized indefinitely without damage.

D12 has been installed to suppress the arc which will occur when SW19 switches. Pin 4 of J19 grounds the Shutter Actuator solenoid and power supply cases to the third wire ground.

NOTES

SECTION 6

CAMERA SYSTEM MAINTENANCE

General Care of the Camera System

The Camera System should be given the same care as other precision optical devices. Care should be taken in handling the various mechanisms to asure that they are not damaged. The equipment should be kept covered when not in use to prevent dust accumulating on or in it.

Lenses

In order to obtain maximum use from your camera, care should be taken that the lenses are kept clean. When lenses require cleaning, remove the loose dust on the lenses with a soft camel-hair brush. Fingerprints and other smudges can be removed with clean, high-quality lens tissue. Be careful that you do not scratch the lenses when cleaning them.

NOTE

The front and rear lenses may be cleaned by attaching the cleaning materials to a long rod. The rod is then inserted through either the front opening or the camera back opening to reach the lens to be cleaned.

Do not attempt to disassemble the lenses. The lens assemblies are sealed, therefore dirt should not get on the inner surfaces of the lenses.

Special lubricants have been added to the shutter during manufacture which makes further lubrication unnecessary during its lifetime. It is essential that neither oil or graphite be used on the shutter, as either may ruin it. It the shutter acts sluggish, it may be the result of continuous wear or extreme atmospheric conditions. Dust should present no problems, since the shutter is sealed inside the lens system.

Camera Back

The Polaroid film back used with the Type C-30 Camera should be inspected after each batch of film is exposed and before more film is put in the camera. Any reagent on the rollers or other parts of the back should be removed immediately using a moist rag. If reagent is left on the rollers of the back, it may ruin some of the pictures.

Electrical Visual Inspection

You should visually inspect the entire electrical instrument every few months for possible circuit defects. These defects may include such things as loose or broken connections, scorched wires or resistors, or broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent defects. It is essential that you determine the cause of overheating before replacing heat-damaged parts in order to prevent further damage.

Component Replacement

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance, and rating required.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered directly from your Tektronix Field Engineer or Field Office. See Parts Ordering Information preceding Section 7.

Soldering

Metal Terminals. When soldering metal terminals (e.g., interconnecting plug pins, switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. The soldering iron should have a 40- to 75-watt rating with a $\frac{1}{8}$ inch wide chisel-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

3. If a wire extends beyond the solder point, clip the excess close to the joint.

4. Clean the flux from the solder joint with a flux-remover solvent to maintain good environmental characteristics.

NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

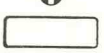
PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
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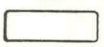	Control, adjustment or connector.

SECTION 7

MECHANICAL PARTS LIST

FIG. 1 STANDARD C-30

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	348-0048-00			3	FOOT, rubber, black
-2	426-0285-01			1	CASTING, support
-3	377-0143-00			2	INSERT, locking
	- - - - - -			-	mounting hardware for each: (not included w/insert)
-4	213-0006-00			1	SCREW, set, 8-32 x 3/16 inch, HSS
-5	124-0178-00			1	STRIP, light seal, 1/8 x 3/16 x 15 inches long
-6	214-0647-00			2	ASSEMBLY, hinge pin & knob
	- - - - - -			-	each assembly includes:
-7	334-0966-03			1	TAG, knob (PULL)
	- - - - - -			-	mounting hardware for each: (not included w/assembly)
-8	214-0626-00			1	SPRING
-9	210-1009-00			1	WASHER, flat, 0.200 ID x 0.312 inch OD
-10	354-0290-00			1	RING, retaining
-11	214-0646-00			3	SPRING, auxiliary lens retainer
	- - - - - -			-	mounting hardware for each: (not included w/spring)
-12	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
-13	334-0966-00			1	TAG, knob (SPEED)
-14	334-0966-01			1	TAG, knob (F STOP)
-15	366-0340-02			1	KNOB, black—FOCUS LOCK
	- - - - - -			-	knob includes:
	213-0004-00			2	SCREW, set, 6-32 x 3/16 inch, HSS
-16	334-0969-00			1	TAG, knob (FOCUS LOCK)
-17	334-0968-00			1	TAG, name plate
-18	366-0339-02			1	KNOB—FOCUS
	- - - - - -			-	knob includes:
	213-0048-00			1	SCREW, 4-40 x 1/8 inch, HSS
-19	334-0966-02			1	TAG, knob (FOCUS)
-20	210-1015-00	X263		1	WASHER, spring tension, 0.254 ID x 0.500 inch OD
					STANDARD ACCESSORIES
-21	354-0279-00			1	RING, light seal (422)
	354-0280-00			1	RING, light seal (453)
-22	387-0893-00			1	PLATE, focus
	070-0527-00			2	MANUAL, instruction (not shown)
					OPTIONAL ACCESSORIES
	016-0246-00			1	ASSEMBLY, auxiliary lens (not shown) (see data sheet)

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.