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Tektronix®
COMMITTED TO EXCELLENCE

C-5C
CAMERA
With Options

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
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Serial Number _____




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WARNING

THE REMAINING PORTION OF THIS TABLE OF CONTENTS LISTS THE SERVICING INSTRUCTIONS. THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

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OPERATORS SAFETY SUMMARY

The general safety information in this summary is for both operating personnel and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

TERMS

In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

As Marked on Equipment

CAUTION indicates either a personal injury hazard not immediately accessible as you read the marking or a hazard to property, including the equipment itself.

PRECAUTIONS

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an atmosphere of explosive gases unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary

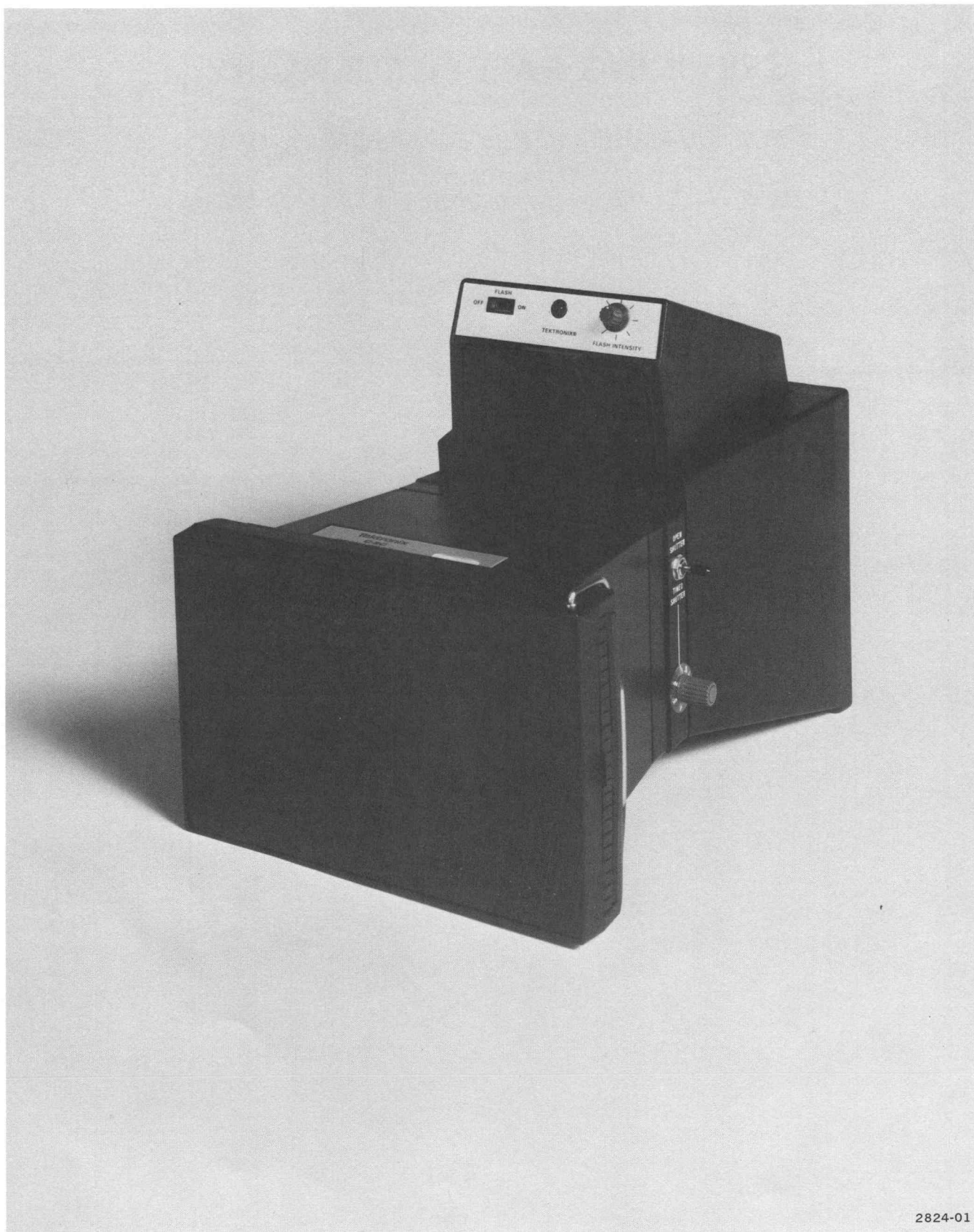
Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, replacing components, or soldering.



2824-01

The C-5C Camera.

GENERAL INFORMATION

INTRODUCTION

The TEKTRONIX C-5C is a lightweight, general-purpose camera with a Polaroid-type CB101 back. It features a battery-operated electronic shutter with fixed focus and an f/16 aperture opening. The camera can be mounted on most models of Tektronix oscilloscopes and small monitors. An interchangeable lens-shutter assembly and spacer section provide an object-to-image ratio (magnification factor) of either 1:0.67 or 1:0.85. With these ratios, photographs taken on instruments with either an 8- by 10-centimeter or 9.8- by 12.2-centimeter display cover the usable area of the film surface. The camera's major sections are high-impact resistant, injection-molded plastic.

The standard C-5C Camera is shipped with an adapter hood that permits mounting directly to a TEKTRONIX 577, 600-series, 1420-series and 5100-series instrument. Attached on top of the adapter hood is the battery-operated Graticule Flash Unit. A viewing door which can be opened to observe the instrument crt without removing the camera is also provided. A listing of other camera adapters and equipment for which they are used is found in the Options section of this manual and in the Accessories listing at the end of the Replaceable Mechanical Parts list.

SPECIFICATION

The optical characteristics presented in Table 1-1 are valid only if the camera is operating at an ambient temperature between 0° and +50° C (+32° and +122° F). Electrical characteristics listed in Table 1-2 are valid when the camera has been adjusted within an ambient temperature between +20° and +25° C (+68° and +77° F) for at least 10 minutes. Power requirements, environmental characteristics, and physical characteristics of the camera are listed in Tables 1-3, 1-4, and 1-5 respectively.

Table 1-1

Optical Characteristics

Characteristics	Performance Requirements	Supplemental Information
Relative Aperture	Fixed at f/16.	
Focal Length	58 mm nominal.	
Object-to-Image Ratio (Magnification Factor)	1:0.67 or 1:0.85 within $\pm 5\%$.	Changeable by repositioning the lens-shutter assembly in one of two possible positions.
Geometric Distortion	$\pm 1\%$ or less.	
Resolving Power	At least 6 lines/mm at center. At least 3 lines/mm at corner.	

Table 1-2

Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
Timed Shutter Mode	Shutter speed continuously variable from 0.1 through 5 seconds $\pm 20\%$.	Minimum shutter time interval must have been adjusted to 0.1 second with the camera at ambient temperature between $+20$ to $+25^{\circ}$ C for at least 10 minutes.
Minimum Time Interval	0.1 second $\pm 20\%$.	
Open Shutter Mode	Shutter opens on actuation and closes on actuation at any time interval greater than 0.1 second.	
Graticule Flash Unit		
Recycle Time	2 seconds nominal.	
Energy Input	Adjustable from 0.04 to 0.2 joules.	

Table 1-3

Power Requirements

Characteristics	Performance Requirements	Supplemental Information
Batteries		Tektronix does not provide batteries with the camera.
Size	AA.	
Type	Alkaline.	
Number of Cells	4.	
Nominal Cell Voltage	1.5 V.	

Table 1-4

Environmental Characteristics

Characteristics	Description
Temperature	
Operating	0° to +50° C (+32° to +122° F).
Nonoperating	–55° to +75° C (–67° to +167° F) with film and batteries removed.
Humidity	
Operating	0 to 75 % relative humidity at +50° C (122° F).
Altitude	
Operating	4,500 m (15,000 ft).
Nonoperating	15,000 m (50,000 ft).
Vibration	15 minutes along each of the three major axes at a total displacement of 0.025 inch p-p with frequency varied from 10 to 55 to 10 Hz in one-minute sweeps. Held for 10 minutes at each resonant point, or if none, at 55 Hz.
Shock	Three shocks at 50 g, one-half sine, 10 milliseconds duration in each direction along each major axis. Total of 18 shocks.
Transportation	Qualifies under National Safe Transit Committee Pre-Shipment Test Procedures 1A-B-1 and 2.

Table 1-5

Physical Characteristics

Characteristics	Description
Camera with Graticule Flash Unit	
Weight	1.1 kg (2.5 lb).
Length, Width, and Height	See Figure 1-1.

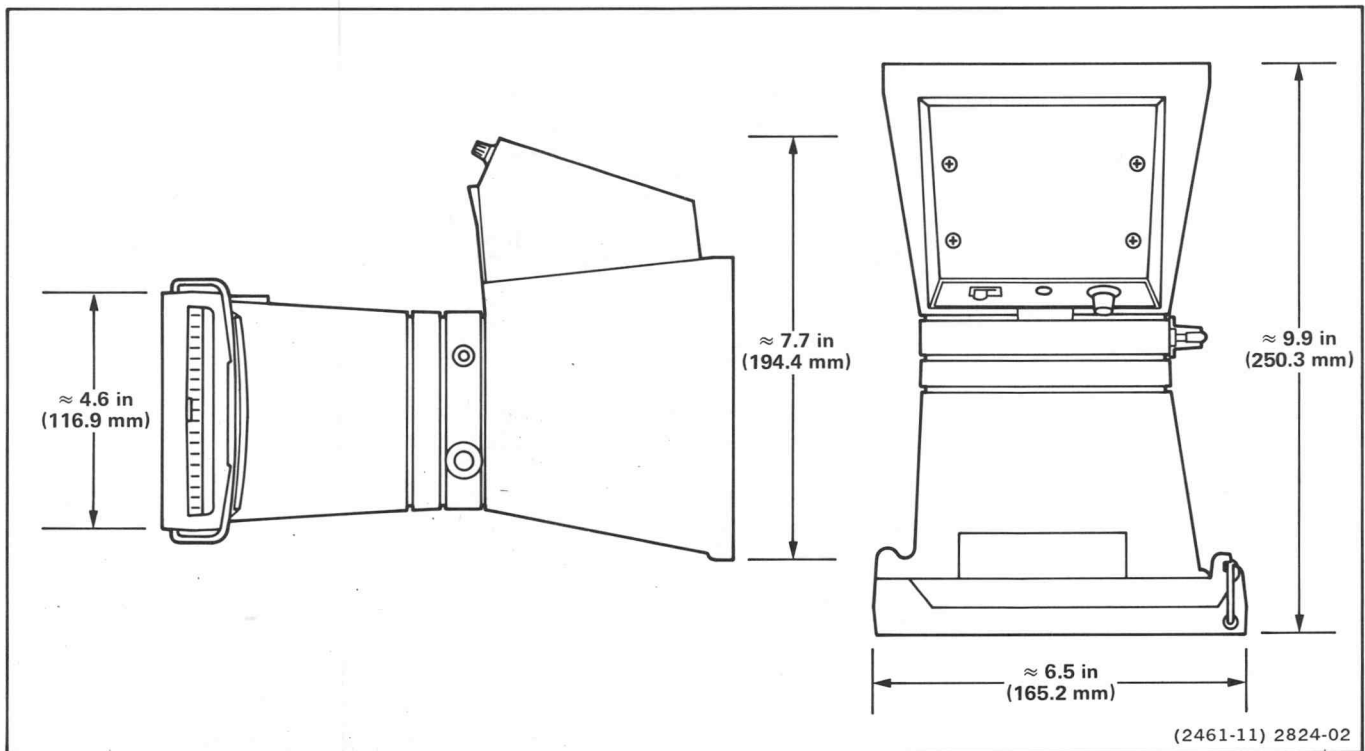


Figure 1-1. Dimensional drawing.

OPERATING INSTRUCTIONS

This section of the manual is intended to familiarize the operator with use of the C-5C Camera to record crt traces. Included is a description of controls, information for installing batteries, mounting the camera to the instrument, focusing instructions, film loading and developing information, photographic techniques, film selection criteria, and additional useful operating information.

The C-5C Camera is shipped in a carton along with its standard accessories. At installation time, save the shipping carton and packaging materials for reuse should reshipment become necessary. Refer to the end of the Maintenance section for repackaging instructions.

DESCRIPTION OF CONTROLS

Refer to Figure 2-1 for location of camera and flash unit controls.

- ① **Shutter Switch**—Actuates the camera shutter and Graticule Flash Unit when manually operated. This switch has two positions, TIMED SHUTTER and OPEN SHUTTER.

TIMED SHUTTER—When the switch is pushed to the TIMED SHUTTER position, shutter speed is automatically controlled by the camera's variable timing circuitry.

OPEN SHUTTER—When the switch is pushed to the OPEN SHUTTER position, the shutter opens and remains open until the switch is manually returned to its center position.

- ② **Shutter Speed Control**—Determines the time period that the shutter remains open to admit light for exposing film when the shutter switch is pushed to the TIMED SHUTTER position. It is continuously variable from approximately 0.1 through 5 seconds.
- ③ **Viewing Door**—Opens to permit direct viewing of the crt display.
- ④ **FLASH Switch**—Turns the Graticule Flash Unit on and off.
- ⑤ **Ready Indicator**—Blinks when the Graticule Flash Unit is ready for operation. When the indicator is continuously illuminated, the Graticule Flash Unit is in the recharging condition.
- ⑥ **FLASH INTENSITY Control**—Varies the intensity of the flash tube light.

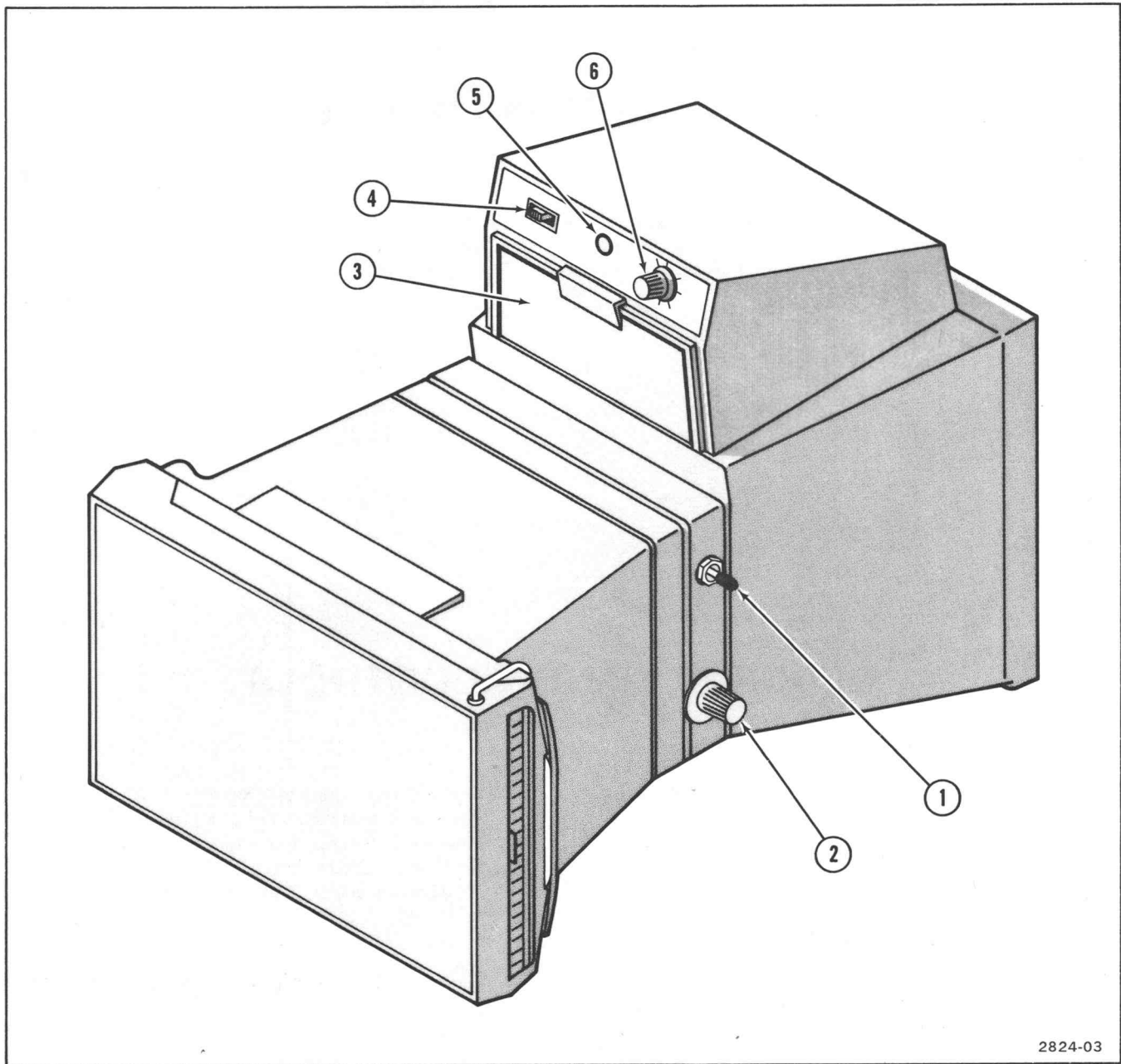


Figure 2-1. Camera controls.

PREPARATION FOR USE

INSTALLING THE BATTERIES

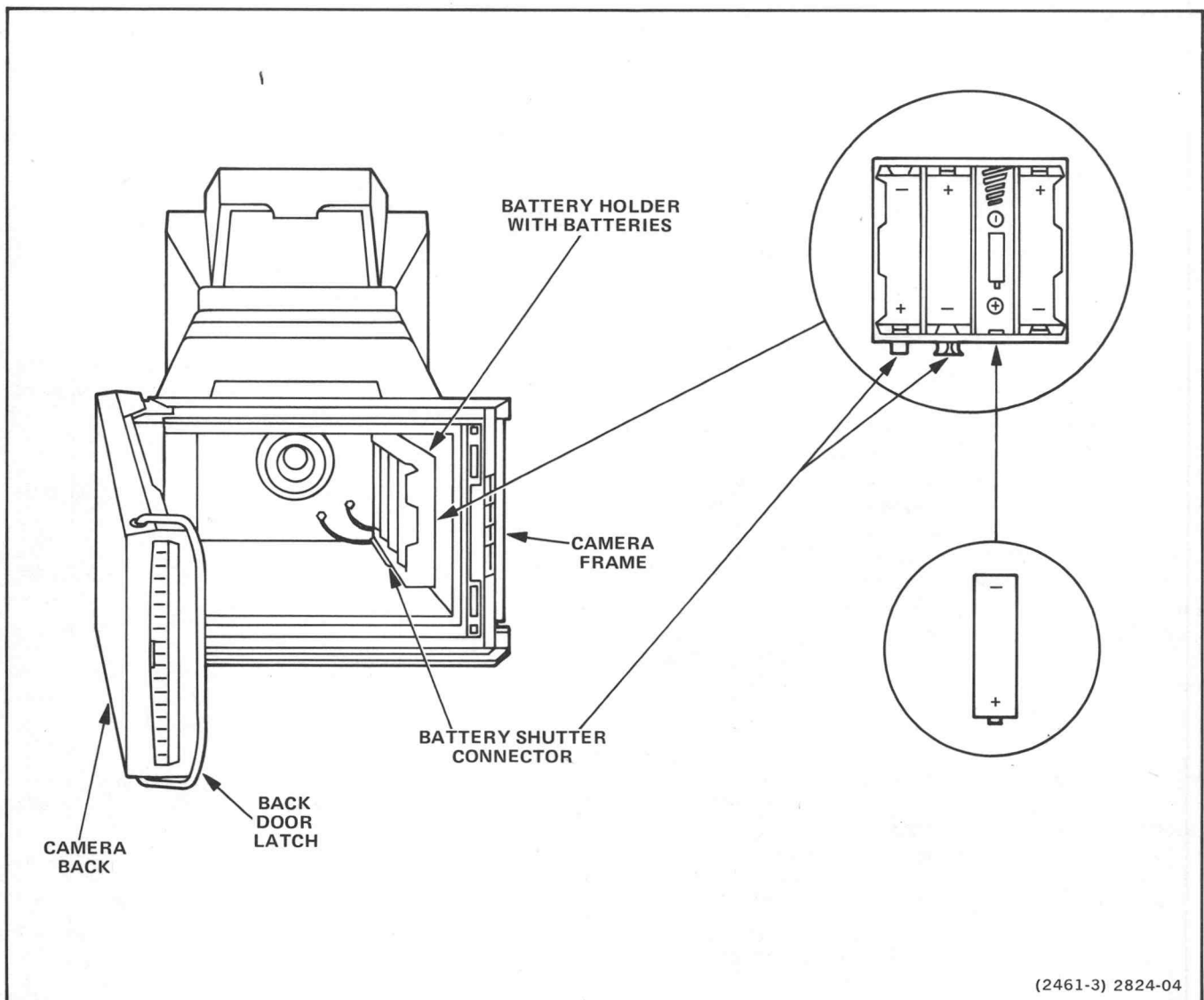
NOTE

Tektronix does not provide batteries for the C-5C Camera. Alkaline type, size AA power cells or equivalent should be used.

Four 1.5-volt batteries, providing a total output of 6 volts, are required to operate the shutter and Graticule Flash Unit. The batteries are inserted into the battery

holder located inside the camera frame. To remove and replace the batteries and battery holder, use the following procedure and refer to Figure 2-2.

1. Ensure that the shutter switch is in its center (off) position.
2. Open the camera back by releasing the back door latch.
3. Pull the battery holder away from the camera frame by separating the pressure-sensitive fasteners.



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Figure 2-2. Installing the batteries.

4. Unplug the battery shutter connector from the holder terminals, exercising care to prevent damage to wires or connector.
5. To remove a battery from the battery holder, pry the positive-terminal end of the battery upward and away from the holder. The battery should then snap out of the holder.

CAUTION

Observe positive-negative polarities when inserting batteries into the battery holder. This information is imprinted in the battery slots of the holder.

6. To replace a battery, position the flat end (negative terminal) against the spring in the battery holder. Push the battery towards the spring and downward into the holder. The battery should snap firmly into the slot.
7. Securely snap the battery shutter connector onto the holder terminals.
8. Position the battery holder against the camera frame, with the terminals facing downward. Push the fasteners together until the holder adheres to the camera frame.

CHANGING THE MAGNIFICATION FACTOR

The magnification factor is determined by the position of a movable spacer in relation to the lens-shutter assembly. When the spacer is located between the camera back and lens-shutter assembly, the magnification factor is 1:0.85. When the spacer is located in front of the lens-shutter assembly, the magnification factor is 1:0.67. Your choice of magnification factor will depend on the size of the screen display. Table 2-1 lists the recommended magnification factor for common screen display sizes. To change the magnification factor, refer to Figure 2-3 and perform the following procedure.

Table 2-1
Recommended Magnification Factors

Screen Display Size (cm)	Magnification Factor	Spacer Location
8 X 10	0.85	Between camera frame and lens-shutter assembly.
9.8 X 12.2	0.67	Between adapter hood and lens-shutter assembly.

1. Unplug the battery shutter connector from the battery holder terminals (located inside the camera frame; see Figure 2-2).

WARNING

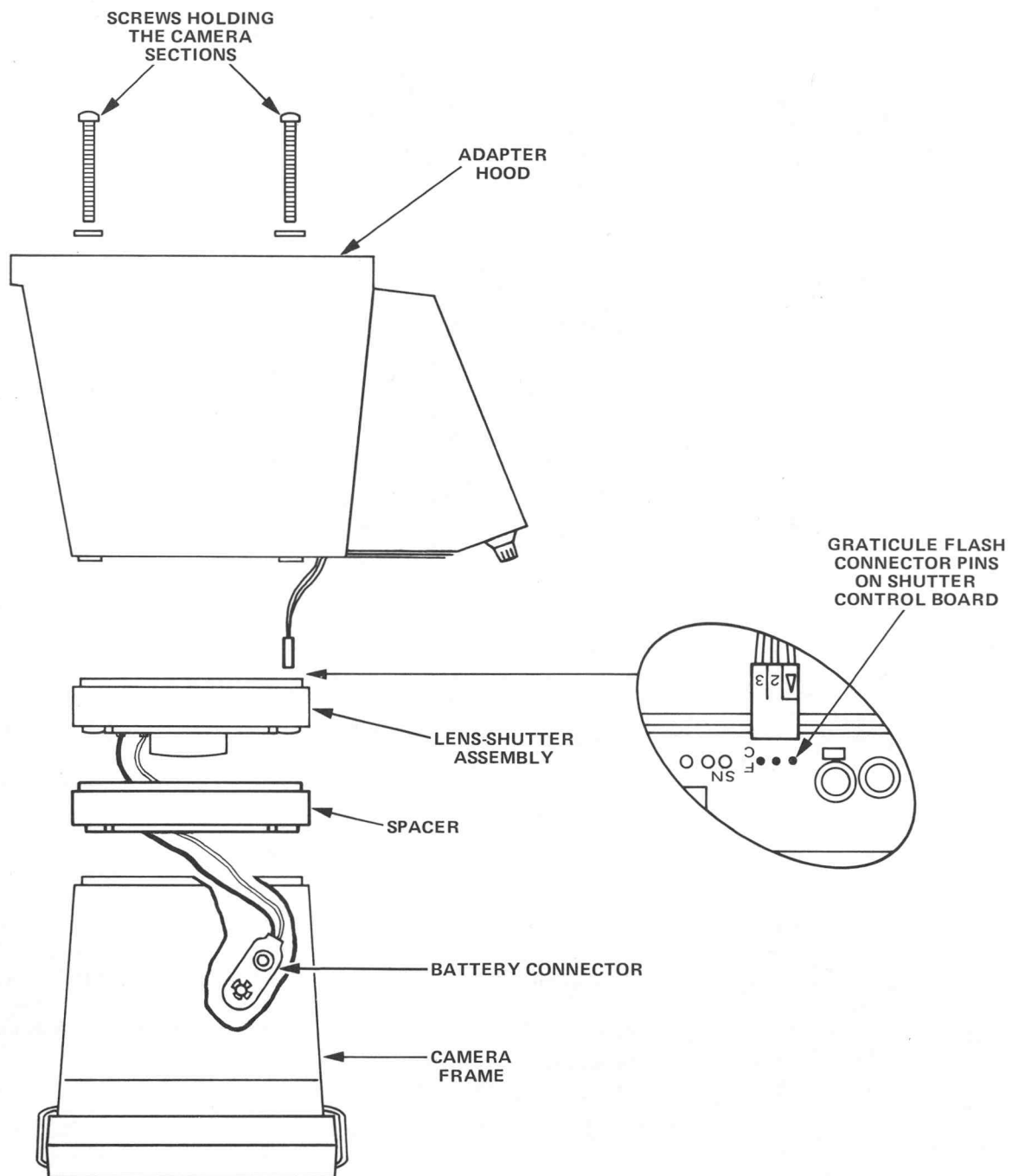
The Graticule Flash Unit has no operator-serviceable parts. Refer all servicing to qualified service personnel.

2. Unplug the Graticule Flash Unit connector from the shutter control board. Note which side the flag is located on the connector.
3. Place the camera on its back with the adapter hood facing upward.

CAUTION

When the four screws are removed in the next step, sections of the camera are unsecured. Careless handling could cause an assembly to fall free and be damaged.

4. Remove the four screws and washers holding the camera sections together (located inside the adapter hood).
5. Carefully lift the adapter hood off the camera.
6. Carefully lift the lens-shutter assembly and spacer off the camera frame.
7. Reassemble the lens-shutter assembly and spacer onto the camera frame to achieve the desired magnification factor (refer to Table 2-1).
8. Carefully replace the adapter hood onto the camera and secure the assemblies with the four screws.
9. Plug the Graticule Flash Unit connector onto the shutter control board, ensuring correct orientation of the connector flag.
10. Snap the battery connector onto the battery holder terminals.



2824-07

Figure 2-3. Changing the magnification.

MOUNTING THE CAMERA

Mounting the Standard C-5C Camera

CAUTION

To prevent the camera from falling free and being damaged, DO NOT let go of the camera until it is securely attached to the instrument.

To mount the camera, set the inside front lip of the camera adapter hood down into the groove on the top of the instrument bezel. Then, let the bottom of the adapter swing down until it rests tightly against the bezel.

To remove the camera, swing the bottom part of the camera adapter out and away from the instrument bezel. Then, lift the camera up and away from the groove on the top of the bezel.

Mounting the C-5C Camera Option 1 and Option 2

The mounting procedures for Option 1 and Option 2 are identical to the standard C-5C Camera.

Mounting the C-5C Camera Option 3

To mount the Option 3 camera, set the top lip of the adapter hood up into the groove located on the underside of the top part of the oscilloscope bezel. Then, let the adapter hood swing down into the bezel. When the bottom part of the hood touches the instrument, let the adapter drop vertically down into the small notch in the upper side of the bottom part of the bezel. Ensure that the adapter is on the right side of the guide that protrudes out of the front panel.

To remove the camera, lift the adapter hood up until the bottom lip is clear of the oscilloscope bezel. Swing the bottom of the adapter out and away from the bezel. Then pull the camera down and away from the groove on the underside of the top part of the bezel.

INSTALLING PACK FILM

The following procedure, when used with Figure 2-4, describes how to install pack film in the camera.

1. Release the camera door latch and open the film door.
2. Remove the empty film container (if applicable) by lifting up on the pack film tab and pulling to the right.
3. Clean the rollers if necessary.

NOTE

For the camera to operate properly, the processing rollers in the film back must be clean. Check these rollers each time film is inserted. Instructions for removal of the rollers are displayed inside the film door. The Maintenance section of this manual also contains roller removal instructions.

4. Open the film box and carefully remove the foil-wrapped pack film. Retain the instruction sheet and print coater.
5. Remove the film pack from the foil, handling the pack only by its edges.
6. Insert the film pack into the film plane, pushing it to the left and down until it snaps into place. Ensure that the black paper leader is hanging over the right end of the camera back and that the numbered white tabs are not caught between the film pack and film plane.
7. Close the film door, ensuring that the black paper leader and numbered white tabs are outside the door. Swing the door latch into place until it snaps into the locked position.
8. Pull the black paper leader completely out. This will expose the first white film tab. The camera is now ready for taking the first picture. The numeral on each white film tab indicates the sequential number of the picture that is ready for exposure.

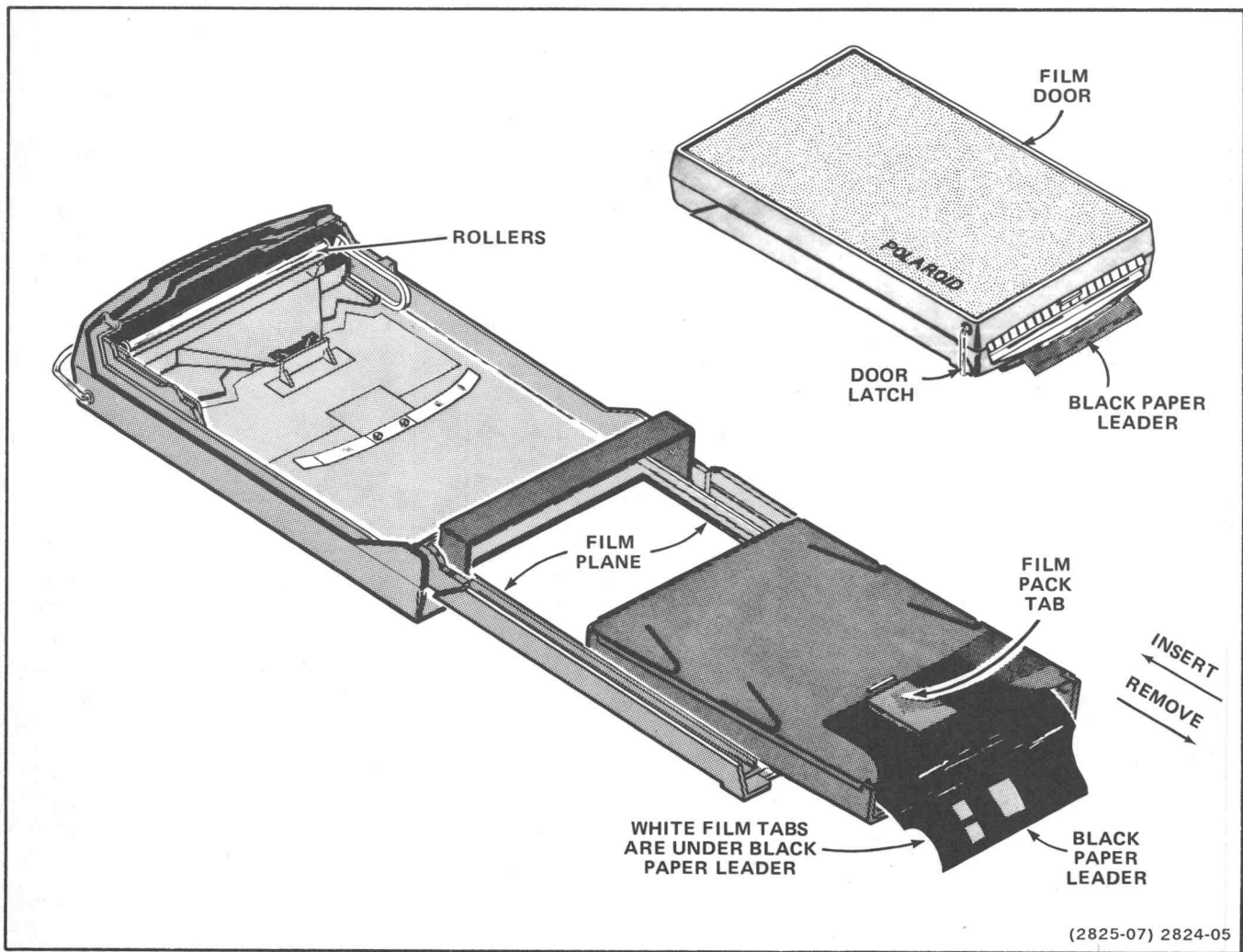


Figure 2-4. Installing the pack film.

USING THE CAMERA

GRATICULE FLASH UNIT

WARNING

Under no circumstance should a test instrument be operated without a crt light filter when no other implosion shield is provided. Check the appropriate instrument manual for information relating to crt implosion.

Before using the Graticule Flash Unit, remove any colored light filter from the front of the instrument crt and replace it with a clear light filter. The effectiveness of

graticule flash illumination is severely degraded when the flash unit is used with colored crt light filters. A clear filter may also provide improved photographic reproduction and contrast with reduced crt intensity settings.

If your instrument was not provided with a clear light filter accessory, contact your local Tektronix representative or refer to your Tektronix Products Catalog.

The following procedure describes how to operate the Graticule Flash Unit.

1. Set the FLASH INTENSITY control to midrange. Additional adjustment may be required to determine the optimum setting for graticule reproduction.
2. Set the FLASH switch to ON and wait for the Ready indicator to begin blinking.

NOTE

If the Ready indicator does not begin blinking within six to seven seconds, the batteries may be weak and may require replacement. If battery replacement does not restore normal operation, the Graticule Flash Unit may require repair.

3. When the Ready indicator begins blinking, close the viewing door and actuate the camera shutter.
4. Advance and develop the film.

NOTE

Failure to turn the Graticule Flash Unit off when not in use will shorten battery life due to circuit leakage current.

5. Set the FLASH switch to OFF when finished taking pictures.

DEVELOPING THE PACK FILM

After a picture is taken, advance and develop each exposure as follows (see Figure 2-5):

1. Pull the white tab completely out of the film back. A yellow tab with black arrows should appear.

NOTE

If the yellow tab does not appear after the white tab is pulled, take the camera to a darkened area, open the film back, and carefully remove the yellow tab that failed to pop out.

2. Smoothly pull the yellow tab completely out of the film back using one continuous motion.

NOTE

Development time for Type 084 film is approximately 15 seconds at an ambient temperature of 70° F or above. A slightly longer development time generally provides greater print contrast. Shorter development time will decrease print contrast, but may improve photographed details not otherwise visible. Refer to a later paragraph on Film Selection and accompanying Table 2-2 for specifications on other films.

3. Wait for the proper development time. Follow the directions contained in the film instruction sheet for proper development times under various conditions.

WARNING

Many developing solutions contain a caustic substance which may cause chemical burns. If you accidentally get the solution on your skin, wipe it off immediately and wash the area thoroughly as soon as possible. Be extremely careful to keep the solution away from your eyes and mouth.

4. When the development time is up, carefully peel the print away from the negative. Do not allow the print to touch the damp negative after the two have been separated.
5. Prints that require coating should be coated as soon as possible after separation from the negative. Use six to eight overlapping strokes to apply the print coater along the entire length of the print, including edges, borders, and corners.

PICTURE TROUBLE

No Image on Picture

1. Use a slower shutter speed setting.
2. Use a film with a higher ASA rating.

Light Streaks on Picture

1. If light leaks between the camera frame and spacer or the lens-shutter assembly, check that the various camera sections are properly secured.
2. Rollers in the Polaroid camera back may be dirty.
3. Polaroid film pack was handled too roughly during loading.

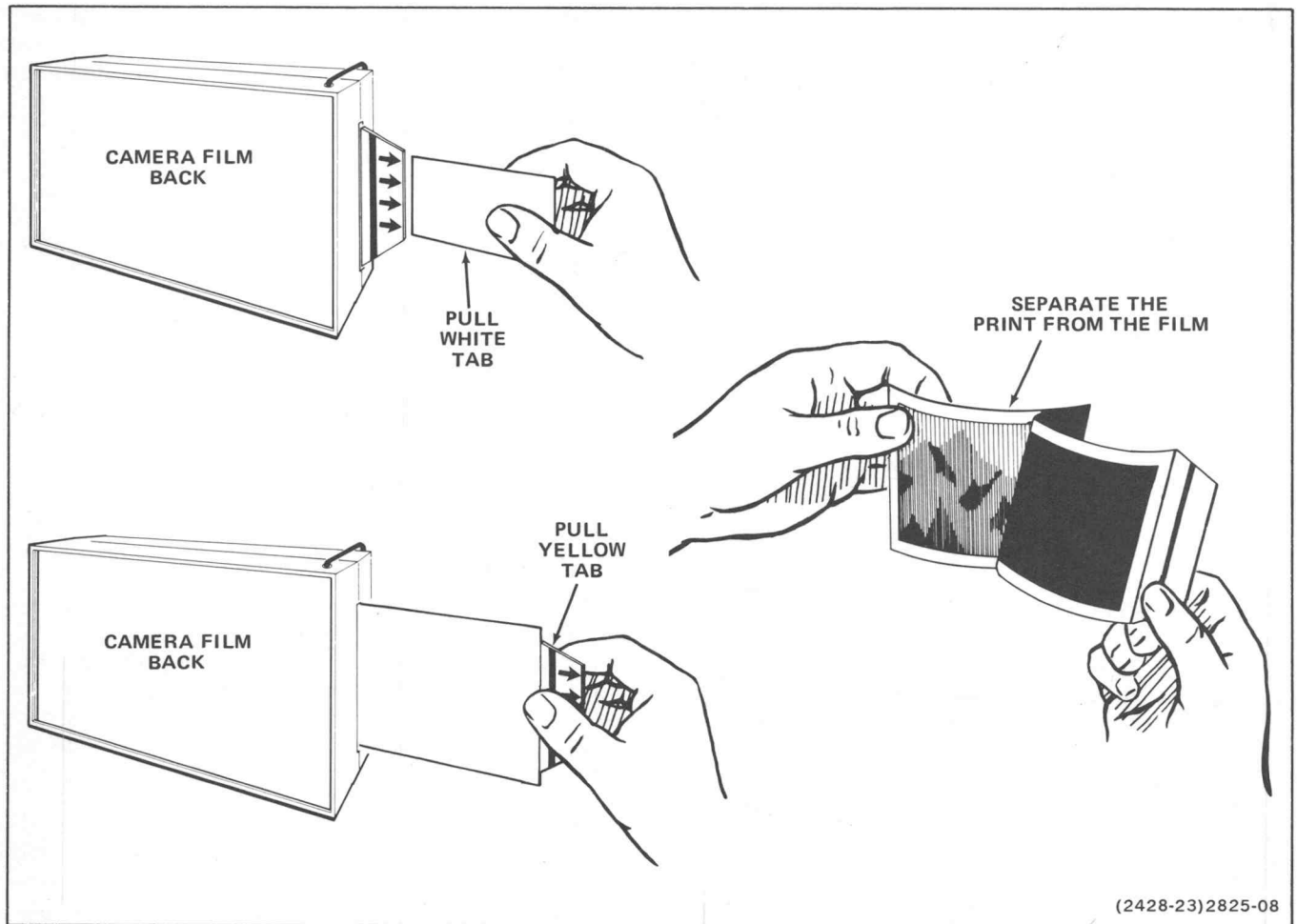


Figure 2-5. Developing the pack film.

Table 2-2
Commonly Used Polaroid Film for the C-5C Camera

Film Type	ASA Equivalent Speed	Development Time (Seconds at 75° F)	Format	Resolution (Line Pairs/mm)	Characteristics	CRT Recording Uses					
						Repetitive	Stored	TV Type (Gray Scale)	Scintillation Type Medical	Graphics Alpha-Numeric	Single Sweep
611 ^a	200	45	Positive Print	20	Low Contrast, wide gray scale			X			
665	75	30	Positive Print	20-25	Medium Contrast, wide gray scale	X	X	X			
107	3,000	15	Negative	160-180	Medium Contrast	X	X				X
084 ^b	3,000	15	Positive Print	20	Medium Contrast	X	X	X	X		
667 ^{a,b}	3,000	30	Positive Print	16	Medium Contrast	X	X	X	X		
108 ^{a,c}	75	60	Positive Print	15-17	Color—Balanced for 5500° K	X		X			
668 ^{a,c}	75	60	Positive Print	15-17	Color—Balanced for Electronic Flash	X		X			

^aNo coating required.^bPreferred for oscilloscope photography.^cAlthough the C-5C Camera lens is not achromatic, it will give satisfactory color results in most situations.

Fogging on Picture

1. Instrument scale illumination control may be set too high.
2. Light-struck or bad film.
3. Film was exposed to light during loading.

Some Portions of Photographed Signal Appear Brighter Than Others

Use an exposure time long enough to allow several sweeps to occur.

FILM SELECTION

For most crt trace-recording uses, Polaroid films are likely to be most convenient. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. Several types of Polaroid film are available in packs. These pack films are 3 1/4 by 4 1/4 inches and provide an actual image size of 7.3 by 9.5 centimeters. Refer to Table 2-2 for the films most commonly used with the C-5C Camera.

HELPFUL TECHNIQUES WITH FILM

Making Notes

NOTE

Polaroid recommends that spray-on matte finishes not be used as a method of note marking on self-coating Polaroid film.

Several types of spray-on matte finishes are available which will enable you to make pencil or pen notes directly on non-self-coating Polaroid prints only. They can be obtained from any art or photographic supply store.

Another method of note marking on non-self-coating Polaroid prints is to use an ink eraser to rub the emulsion off the areas to be written on. A pen or pencil can then be used to write data on the print.

For self-coating Polaroid prints, rub the emulsion off the areas to be written on with a damp cloth, being careful that the emulsion area removed is remote from the waveform area.

Still another method 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. If data is to be scratched onto a self-coating Polaroid print, it must be done within 10 to 15 seconds after the print is separated from the negative.

Contrast

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

Continuous Tone (Gray Scale) Display

Photographing a continuous tone (gray scale) display requires a technique different from that used for trace recording. In trace recording, it is necessary to record two levels of intensity—white for trace and graticule, black or gray for the background. In gray scale photography, it is important to record a whole range of tones that may be only slightly different from one another.

A common problem when taking photographs of a continuous tone display is that the print develops with a loss of detail in the dark and light areas. A contributing factor relates to the difference between the human eye and film print reproduction. The eye is extremely sensitive with a wide dynamic range that accommodates (within one scene) brightness intensity ranges approaching 1000:1. Polaroid Type 084 and 667 films have a usable range of approximately 15:1. Polaroid Type 611 has a wide brightness intensity range and is recommended for gray scale photography.

There is quality gray scale tonal rendition when the film print renders information in both the darkest and lightest area of display presentation. Crt photography allows adjustment of camera shutter speed and instrument contrast to produce an acceptable photograph. Adjusting the instrument so that the display appears low in contrast (washed out) will merge the brightness (light intensity) of the display for better film reproduction. This adjustment compresses the display brightness within the recordable range of the film. Generally, this process will require experimentation to produce satisfactory results.

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

THEORY OF OPERATION

This section of the manual contains a functional description of the circuitry used in the C-5C Camera. The standard camera contains two circuit boards, the shutter control board and graticule flash board. Schematic diagrams provided in the Diagrams section of this manual are keyed to each circuit board description by numbered diamond symbols. A functional block diagram for each circuit board is also provided in this section. For optimum understanding of the circuit being discussed, refer to both the appropriate schematic diagram and functional block diagram.

SHUTTER CONTROL BOARD

1

The shutter control board contains timing circuitry to operate the camera shutter and provides an X-Sync command for the Graticule Flash Unit. The functional block diagram for this board is shown in Figure 3-1.

Shutter Circuit

Integrated circuit U1277 is a dual, retriggerable-resettable, monostable multivibrator. When triggered, each section produces an output pulse whose width is determined by its respective timing circuit. Shutter Timing circuit U1277A controls the time that the shutter remains

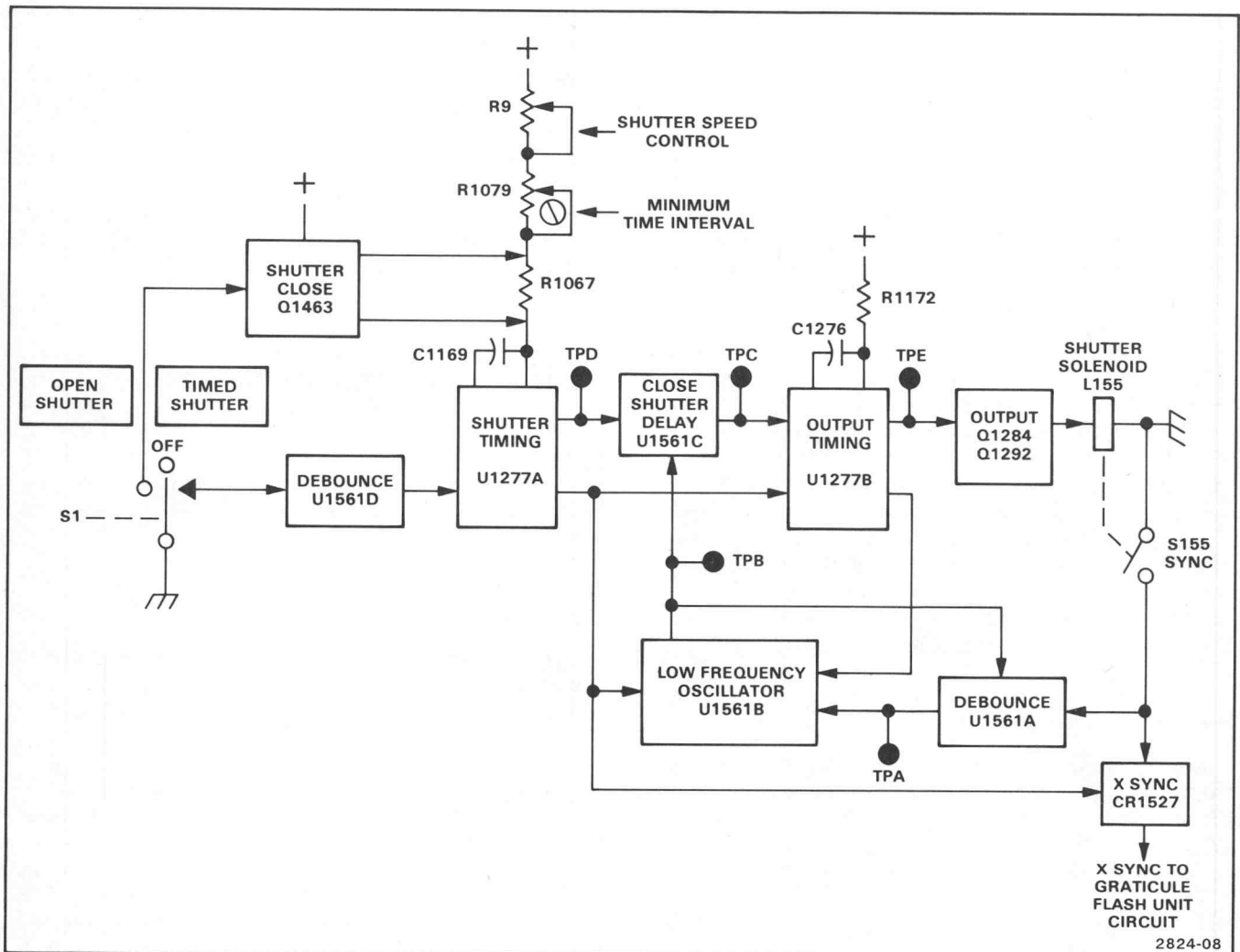


Figure 3-1. Shutter block diagram.

Theory of Operation—C-5C Camera

open. Minimum Time Interval potentiometer R1079 is used to calibrate minimum time, while Shutter Speed control R9 externally adjusts shutter timing between 0.1 and 5 seconds. Output Timing circuit U1277B, when triggered, provides an output pulse to Shutter Solenoid L155. The width of the output pulse is approximately 40 ms as determined by R1172 and C1276.

Debounce Circuits

To minimize the bounce effect when switches S1 and S155 contacts first close, debounce circuits consisting of R-C networks and Schmitt input gates are employed.

Test Point Conditions

Before shutter activation, the quiescent operating state at each test point is as follows:

TPA — Low
TPB — High
TPC — Low
TPD — Low
TPE — Low

Timed Shutter Mode

With shutter switch S1 set to TIMED SHUTTER, a logic low is generated at the input of its Debounce circuit. This input is inverted by U1561D and triggers U1277A, discharging C1169. Pin 7 of U1277A goes low, triggering U1277B. The output of Close Shutter Delay circuit U1561C remains low and unchanged. Test Point E then goes high, turning on Output transistors Q1284 and Q1292. The action energizes solenoid L155, opening the shutter. When the shutter opens, S155 closes and the X-Sync pulse is transmitted to the Graticule Flash Unit through R1528, causing it to fire. When the shutter timing cycle ends, C1169 is recharged and U1277A pin 7 goes high. Test Point D goes low and is coupled through the delay network consisting of R1426, C1416, R1509, and C1512 to U1561C pin 9. With U1561C pin 9 low, Test Point C goes high, triggering U1277B and closing the shutter.

Open Shutter Mode

With S1 set to OPEN SHUTTER, U1277A is triggered through CR1473 and the Debounce network. Timing capacitor C1169 is prevented from charging by CR1370. Capacitor C1160 is discharged by CR1470, turning on Q1463. When S1 is returned to its center (off) position, C1169 charges through Q1463 and R1067. Transistor Q1463 remains on until C1160 is charged through R1159 and R1164.

Low Frequency Oscillator

The Low Frequency Oscillator consists of U1561B, C1150, and R1539. This circuit ensures that if the camera shutter is opened by means other than the timing circuit, it will return to a closed position before picture taking.

When new batteries are installed, the shutter may cycle. The Low Frequency Oscillator also ensures that the shutter will be in a closed position after new batteries are installed.

The following conditions allow the oscillator to trigger U1277B and close the shutter:

- The timing circuits are in their quiescent state. If either TPD or TPE is high, the oscillator is inhibited by CR1543 or CR1488.
- Shutter Solenoid L155 is open (switch S155 is closed).

With S155 closed, a low at U1561A causes TPA to change state from low to high, causing TPB to go low and TPC to go high. This will trigger U1277B and close the shutter. Pin 9 of U1277B discharges C1550 through CR1488 and causes TPB to return to a high state. This will ensure that TPB remains high when TPE is high, allows sufficient time for L155 to disengage, and permits S155 and TPA to return to their quiescent states. If S155 is still closed, the cycle is repeated.

GRATICULE FLASH BOARD



The graticule flash board contains circuitry which provides the voltage levels and control circuits to operate the Graticule Flash Unit. The functional block diagram for this board is shown in Figure 3-2.

Converter

Transistor Q40 and transformer T45 form the Blocking Oscillator that operates as a flyback type of dc-to-dc converter that produces a charging voltage of up to 500 volts.

When power is applied to the flash unit, Q40 is biased on by T45 and R42. Current flow through Q40 and pins 1 and 6 of T45 create a magnetic field that induces a positive feedback voltage through pin 2 of T45 to Q40. Current through Q40 continues to increase until the core of T45 saturates. At this point the feedback voltage ceases. Current through Q40 then starts to decrease, and the magnetic field

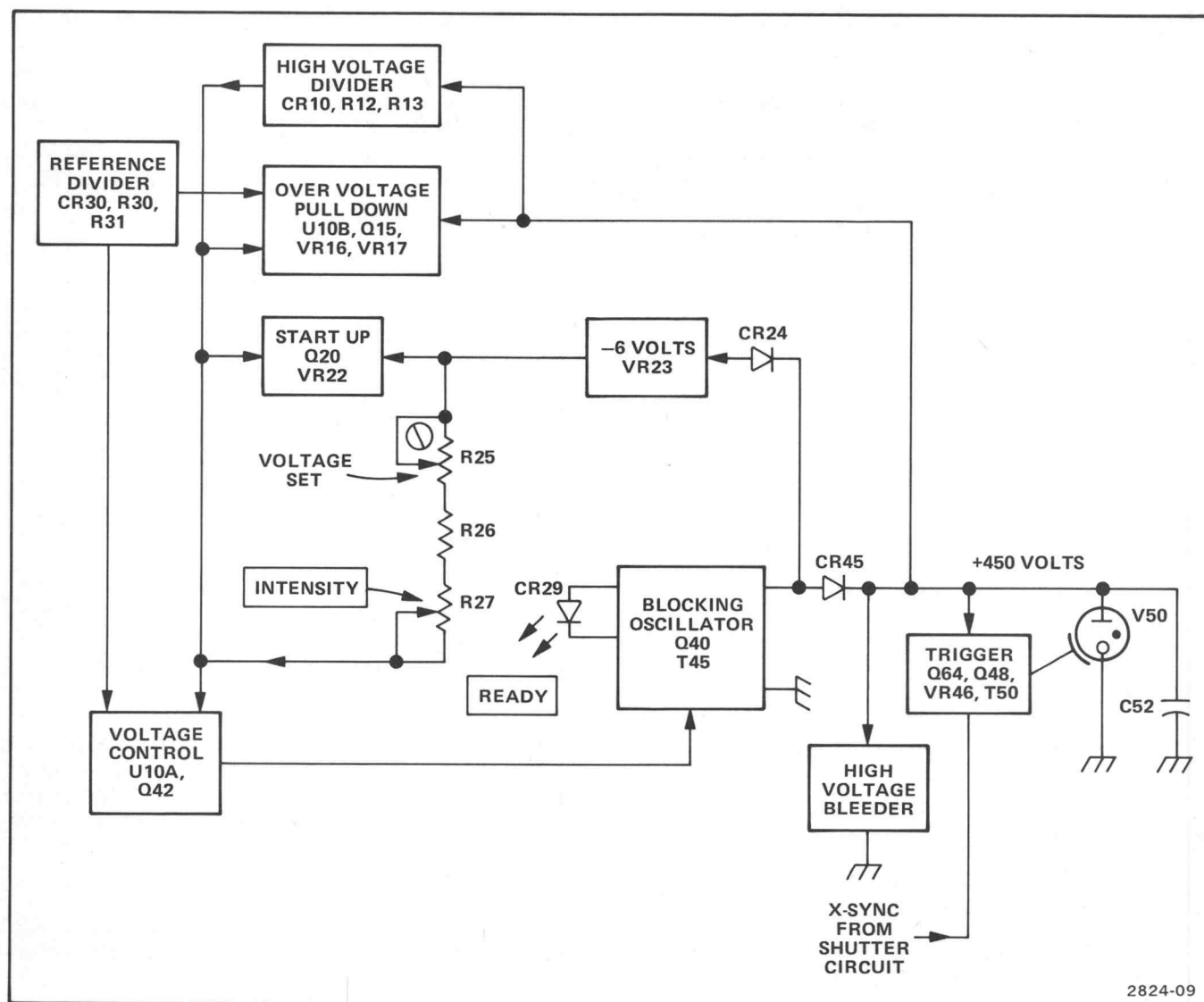


Figure 3-2. Graticule flash block diagram.

of T45 begins to collapse. As the field collapses, a negative-feedback voltage at pin 2 of T45 turns off Q40. With Q40 off, a high flyback voltage is induced in all windings of T45. High voltage at pin 7 of T45 is rectified for the charging circuit by CR45 and for the Intensity Control circuit by CR24. To protect Q40, high voltage at pin 2 of T45 is shunted to ground through CR40.

The Blocking Oscillator cycle of the converter is repeated until stopped by the Intensity Control circuit. Once stopped, the cycle starts again only when a charge voltage is needed (after a flash or when required by the Intensity Control circuit).

With power applied, C65 charges to the supply voltage through R65, R67 and R48. This charge is used later in triggering the flash.

Charging

The high voltage rectified by CR45 charges C46 and C52. The charge level on C52 (between 200 and 450 volts) determines the flash intensity of V50. This level is determined by the length of time the converter operates, which is controlled by the Intensity Control circuit. As the high voltage (rectified by CR24) charges C24, a negative voltage is developed. This voltage is limited to -6.2 volts by VR23 and is used as a reference voltage for the FLASH

INTENSITY control. The voltage across VR23 is summed (through R25, R26, and R27) with a positive voltage from C52 (through R12 and R13) at pin 3 of U10A. Resistor R25 sets the maximum voltage level that may be applied to C52, while R27 controls the voltage at C52 to between 200 and 450 volts. Pin 1 of U10A remains low while voltage is developing across C52. When voltage on pin 3 of U10A exceeds the voltage on pin 2 (set by CR30 at about +0.6 volt), pin 1 goes high. This causes Q42 to be biased on, grounding the base of Q40 and turning it off. With Q40 off, C52 slightly discharges, causing pin 1 of U10A to again go low, turning Q40 on. This cycle continually repeats, maintaining a selected voltage on C52, until the unit is triggered.

When the FLASH switch is first set to ON, there is no negative voltage on the anode of VR22, and Q20 is turned on. With Q20 on, pin 3 of U10A is held below pin 2 of U10A, causing pin 1 of U10A to be low. With pin 1 low, Q40 remains on until the voltage at the anode of VR22 is approximately -6.2 volts, turning Q20 off.

Ready Indicator

The Ready indicator (CR29) blinks at the same frequency as the charging cycle. Reverse voltage protection of CR29 is provided by CR28, while R28 determines the current level through CR29.

Intensity Control

The Intensity Control circuit consists of U10B, Q15, R17, VR16, and VR17. It causes the voltage on C52 to be lowered if the FLASH INTENSITY control is turned down. Pin 6 of U10B is referenced at about +0.3 volt to pin 2 of U10A. Pin 5 of U10B is common to pin 3 of U10A, causing

pin 7 of U10B to be low. If the FLASH INTENSITY control is adjusted to a lower level, pin 1 of U10A goes high. This biases Q42 on, turning Q40 off. Pin 7 of U10B goes high, turning Q15 on. This causes the voltage level on C52 (through VR16, VR17, and R17) to decrease until the voltage on pin 5 is lower than pin 6 of U10B. Pin 7 of U10B then goes low, turning Q15 off. U10A takes control, repeating the charging cycle at the new voltage setting.

Trigger

Assume that C46 and C52 are charged to the charging voltage, C65 is charged to the supply voltage (battery), and the Ready indicator is blinking to show that the flash unit is ready to operate.

When the shutter is actuated, a short circuit is applied across the X-SYNC and GND terminals, turning Q64 on through CR62 and R62. This causes C65 to discharge through R48 and R65, which applies a positive gate to Q48. This gate turns on Q48, which discharges C46 through the primary of T50, a high-turns-ratio transformer. The output of T50 is a 4- to 6-kilovolt pulse which triggers V50. This causes C52 to discharge through V50, creating a flash.

Capacitors C46 and C52 discharge during the flash time and ready the unit for recharging. As soon as the momentary short circuit across the X-SYNC and GND terminals is removed and the flash terminated, C65, C46, and C52 begin to recharge.

As a safety factor, whenever the unit is turned off, S60 connects R60 across C52 to discharge any potential that may be on C52.

CALIBRATION

INTRODUCTION

This section contains a Performance Check and an Adjustment Procedure for the shutter and graticule flash circuit boards. The Performance Check is used to verify camera electrical performance characteristics, while the Adjustment Procedure is used to restore the camera to its original electrical performance specification.

LIMITS AND TOLERANCES

The limits and tolerances given in these procedures are valid for a calibrated instrument having a 10-minute warm-up period and when performed in an ambient temperature between 20° and 25° C. All limits and tolerances given are for the C-5C Camera and do not include test equipment error or tolerances. Except when listed as Specification Performance Requirements in Section 1, the limits and tolerances appearing in these procedures are not camera specifications.

TEST EQUIPMENT REQUIRED

Test equipment required to make the Performance Check and to accomplish the Adjustment Procedure are listed in Table 4-1. The capabilities of the test equipment listed are the minimum required to check camera performance. If alternate equipment is used, it must meet or exceed the specification of the listed equipment.

Table 4-1
Test Equipment Required

Description	Minimum Specification	Purpose	Examples
1. Precision DC Voltmeter with Two Test Leads	Range, 0 to ± 1000 V; accuracy, within 0.1%. Digital voltmeter must have at least 3 1/2-digit readout.	Check voltage levels.	TEKTRONIX DM 502 Digital Multimeter (operates in a TM 500-series Power Module).
2. Oscilloscope	Vertical bandwidth, dc to 15 MHz; horizontal sweep speed, minimum 0.5 s/div within 3%.	Display shutter pulse and waveform conditions.	TEKTRONIX T921 Oscilloscope.
3. Photometer Probe	Range, 0.001 to 1999 fc; resolution, 0.0001 fc; accuracy, 5%.	Check and adjustment of electronic shutter.	TEKTRONIX J6501 Illuminance Probe.
4. Constant-intensity Light Source	Dc source.	Provide light for shutter check.	Incandescent lamp.
5. Coaxial Cable	Impedance, 50 Ω ; length, 42 in; connectors, bnc.	Signal interconnection.	Tektronix Part 012-0057-01.
6. Nylon Alignment Tool	To fit variable resistors.	Adjust timing and voltages.	Tektronix Part 003-0675-00.
7. Photometer Probe-to-bnc Adapter	Assembled using example parts per Figure 4-1.	Signal interconnection.	Tektronix Part 131-0458-00 (Cinch DA-15-S) female 15-pin connector. Tektronix Part 200-0787-00. (Cinch DA-51210-1) connector cover. Tektronix Part 131-0955-00 female chassis mount bnc connector.

PERFORMANCE CHECK

The Performance Check permits verification of the camera's applicable electrical specifications without making internal adjustments. Included are the procedures for checking minimum shutter speed and Graticule Flash Unit charging voltage.

1. Minimum Shutter Speed Check

- a. Assemble the photometer probe-to-bnc connector as shown in Figure 4-1 and connect the test setup as illustrated in Figure 4-2.

- b. Rotate the Shutter Speed control fully counterclockwise to 0.1.

- c. Set test oscilloscope controls as follows:

Vertical (both channels if applicable)

Volts/Division (Channel 1)	10 ms
Volts/Division Variable	In detent
Position	To center trace
Coupling (Channel 1)	DC
Display Mode	Channel 1

Time Base	
Time/Division	20 ms
Magnification	X1
Position	Midrange

Trigger

Source	Internal
Mode	Auto
Slope	+
Level	Midrange

- d. Set bottom of the crt trace two divisions below the center horizontal graticule line.

- e. Set camera Shutter switch to OPEN SHUTTER.

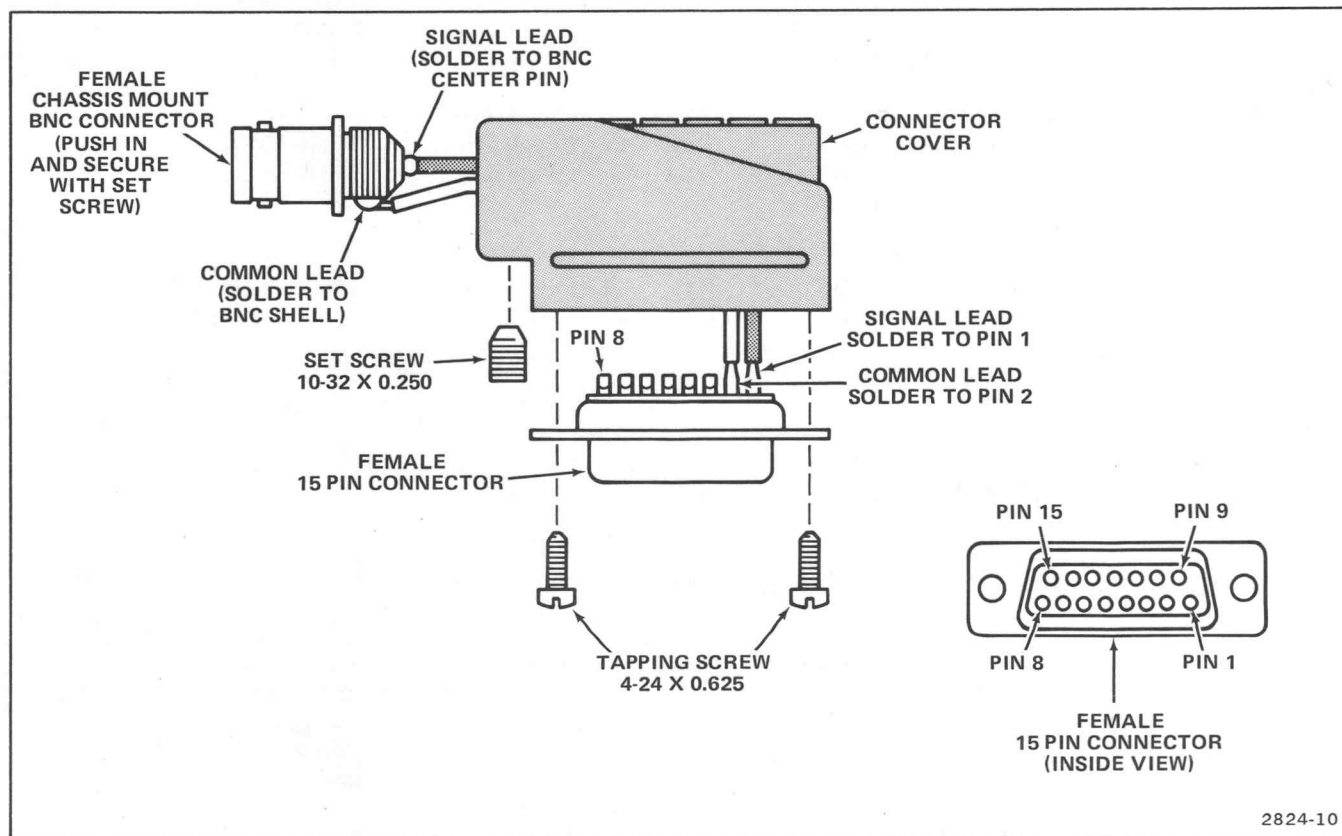
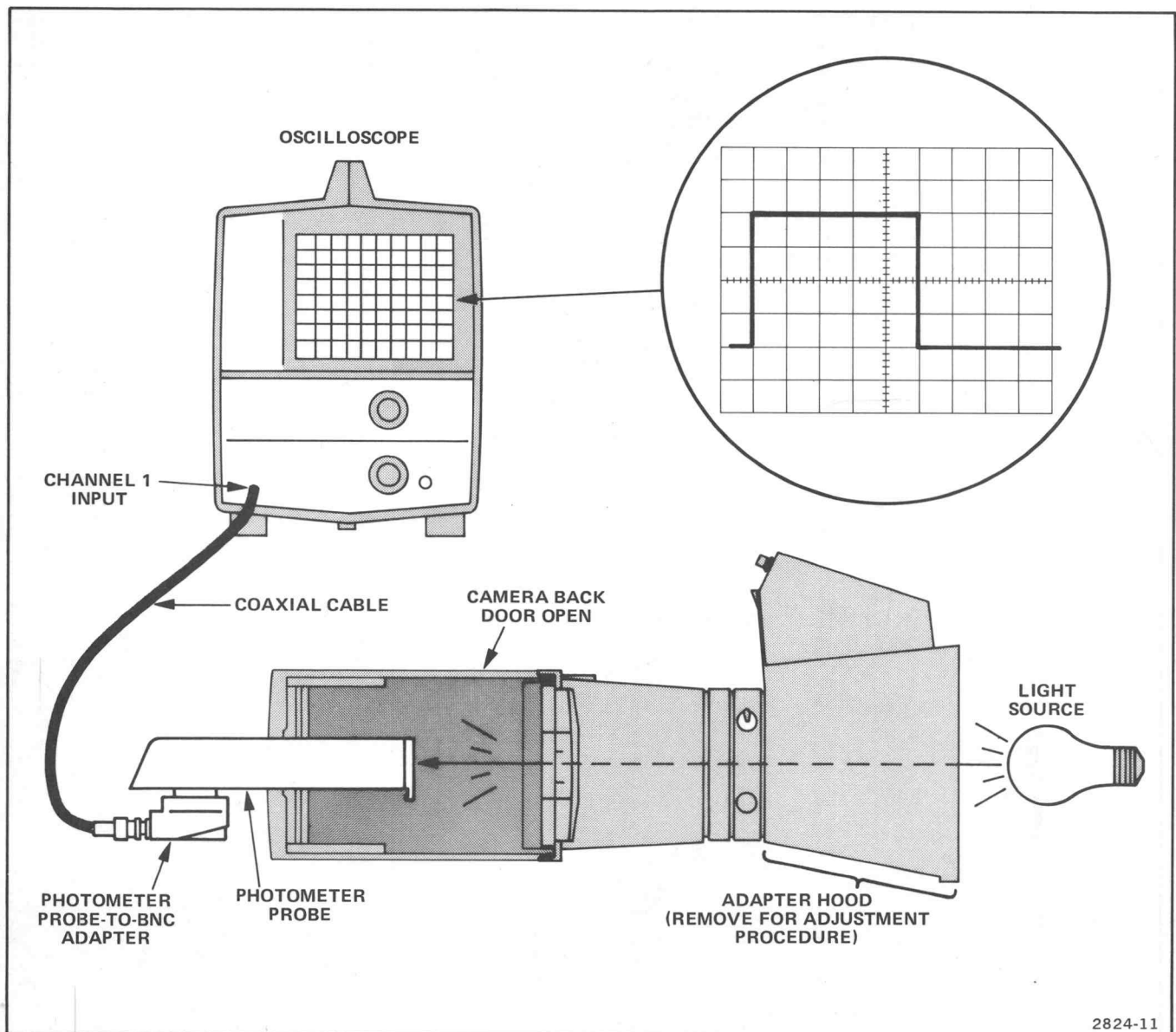


Figure 4-1. Assembling the photometer probe-to-bnc adapter.



2824-11

Figure 4-2. Test setup for minimum shutter speed check.

- f. Adjust the distance between the photometer probe and light source until the top of the crt trace is two divisions above the center horizontal graticule line. Total vertical display should be four divisions.
 - g. Set oscilloscope Trigger Mode to Normal.
 - h. Push Shutter switch down to TIMED SHUTTER several times while adjusting the oscilloscope Trigger Level control for a stable display.
 - i. CHECK — that the waveform pulse width is five divisions at midpoint of the vertical display. See Figure 4-2 for waveform display. If the expected waveform is not obtained, perform the Minimum Shutter Speed adjustment procedure.
2. Graticule Flash Unit Charging Voltage Check
 - a. At the Graticule Flash Unit set the FLASH switch to OFF.
 - b. Pull off and set aside the FLASH INTENSITY knob.

WARNING

Potentially dangerous high voltages exist on the flash unit circuit board when it is operating. **DO NOT** touch any components when removing the flash unit circuit board.

CAUTION

When the screws are removed in the next step, the flash unit circuit board will fall free. To prevent possible damage to components and wires, support the assembly with your hand under the flash unit reflector plate when removing the screws.

- c. Remove the four screws on top of the Graticule Flash Unit.

- d. When the reflector plate and circuit board fall down onto your hand, carefully pull them down and out of the Graticule Flash Unit housing, through the front of the adapter, only as far as the flash unit cable permits.

- e. Set the voltmeter to DC Volts and Range to 1 kilo-volt.

- f. Connect the black test lead from the voltmeter Low input and the red test lead from the High input across C52 on the flash unit circuit board as shown in Figure 4-3.

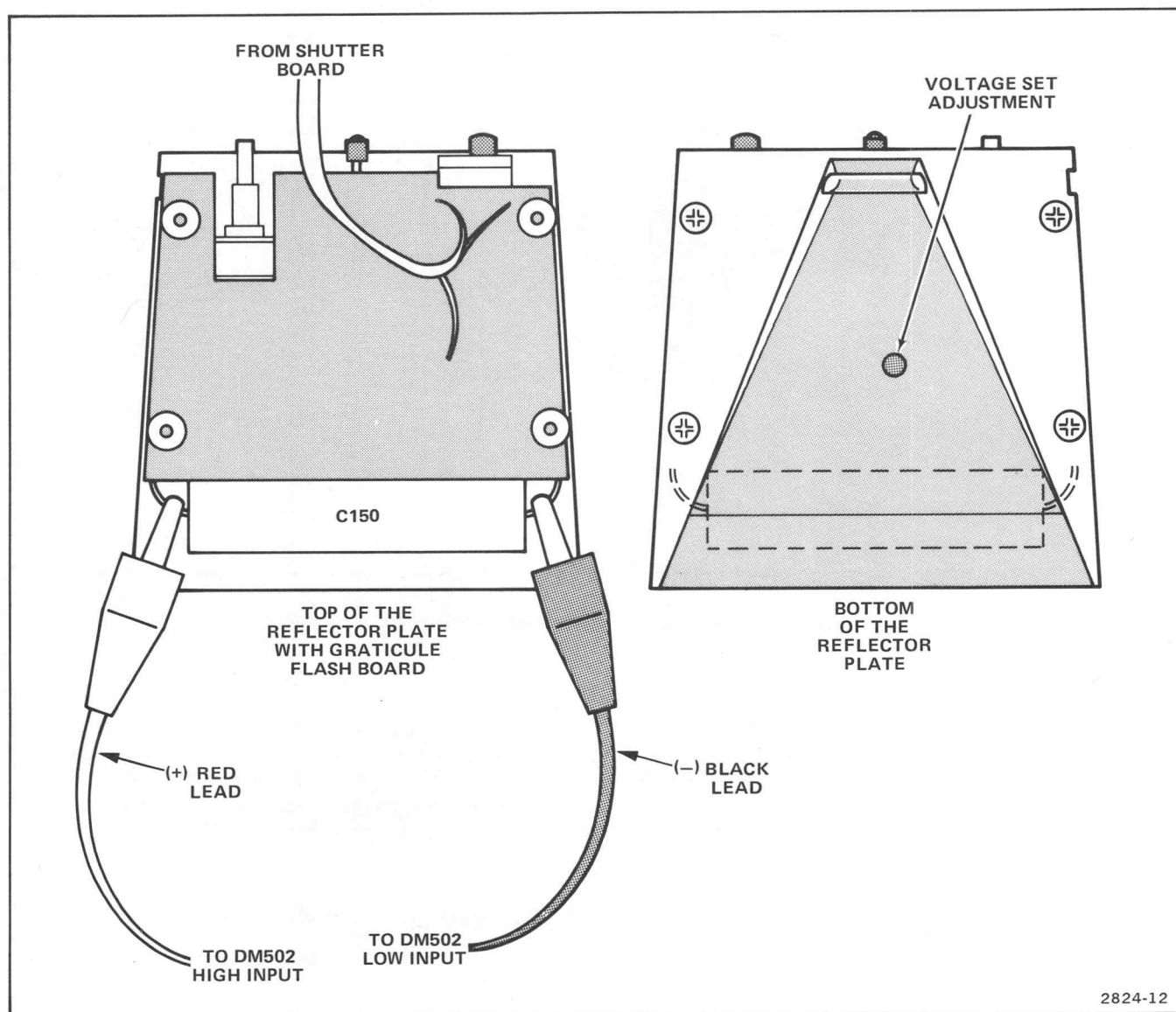


Figure 4-3. Test setup for graticule flash unit charging voltage check and adjustment.

- g. At the Graticule Flash Unit set the FLASH switch to ON.
- h. CHECK — that the charging voltage is +450 volts. If the charging voltage is not +450 volts, perform the Graticule Flash Unit Charging Voltage adjustment procedure.
- i. Replace the circuit board and reflector plate assembly into the Graticule Flash Unit housing, secure with the four screws, and replace the FLASH INTENSITY knob.

ADJUSTMENT PROCEDURE

Adjustment is generally required after a repair has been made to the instrument or whenever completion of a Performance Check procedure reveals a deficiency. It may also be required after long time intervals in which normal aging of components can affect instrument accuracy. Before making any adjustments, carefully read each applicable procedure.

The Adjustment Procedure permits restoration of the shutter control and graticule flash circuits to the original performance specification. Do not make any adjustment unless it is essential to satisfy a performance parameter.

While performing the procedure, any fault discovered should be corrected before continuing. This procedure is not intended for use as a troubleshooting guide. For troubleshooting information refer to the Maintenance section.

1. Adjust Minimum Shutter Speed

- a. Place the camera on its back with the adapter hood facing upward.
- b. Unplug the Graticule Flash Unit connector from the shutter circuit board. Note which side the flag is located on the connector.

CAUTION

When the four screws are removed in the next step, sections of the camera are unsecured. Careless handling could cause an assembly to fall free.

- c. Remove the four screws and washers holding the camera sections together (located inside the adapter hood).
- d. Carefully lift off the adapter hood.

- e. Replace the four screws and washers to secure the remaining sections of the camera together.
- f. Assemble the photometer probe-to-bnc adapter as shown in Figure 4-1 and connect the test setup as illustrated in Figure 4-2.
- g. Rotate the Shutter Speed control fully counterclockwise to 0.1.
- h. Set test oscilloscope controls as follows:

Vertical (both channels if applicable)

Volts/Division (Channel 1)	10 ms
Volts/Division Variable	In detent
Position	To center trace
Coupling (Channel 1)	DC
Display mode	Channel 1

Time Base

Time/Division	20 ms
Magnification	X1
Position	Midrange

Trigger

Source	Internal
Mode	Auto
Slope	+
Level	Midrange

- i. Set bottom of the crt trace two divisions below the center horizontal graticule line.
- j. Set camera Shutter switch to OPEN SHUTTER.
- k. Adjust the distance between the photometer probe and light source until the top of the crt trace is two divisions above the center horizontal graticule line. Total vertical display should be four divisions.
- l. Set oscilloscope Trigger Mode to Normal.
- m. Push Shutter switch down to TIMED SHUTTER several times while adjusting the oscilloscope Trigger Level control for a stable display.
- n. ADJUST — Minimum Time Interval R1079 for a waveform pulse width of five divisions at the mid-point of the vertical deflection while pushing the Shutter switch down repeatedly to TIMED SHUTTER. Use the nylon alignment tool for this adjustment. Refer to Figure 4-4 for the location of R1079.
- o. Disconnect the test setup and reassemble the adapter hood onto the camera.

2. Adjust Graticule Flash Unit Charging Voltage

- a. At the Graticule Flash Unit set the FLASH switch to OFF.
- b. Pull off and set aside the FLASH INTENSITY knob.

WARNING

Potentially dangerous high voltages exist on the flash unit circuit board when it is operating. DO NOT touch any components when removing the flash unit circuit board.

CAUTION

When the screws are removed in the next step, the flash unit circuit board will fall free. To prevent possible damage to components and wires, support the assembly with your hand under the flash unit reflector plate when removing the screws.

- c. Remove the four screws on top of the Graticule Flash Unit.
- d. When the reflector plate and circuit board fall down onto your hand, carefully pull them down and out of the Graticule Flash Unit housing, through the front of the adapter, only as far as the flash unit cable permits.
- e. Set the voltmeter to DC Volts and Range to 1 kilovolt.
- f. Connect the black test lead from the voltmeter Low input and the red test lead from the High input across C52 on the flash unit circuit board as shown in Figure 4-3.

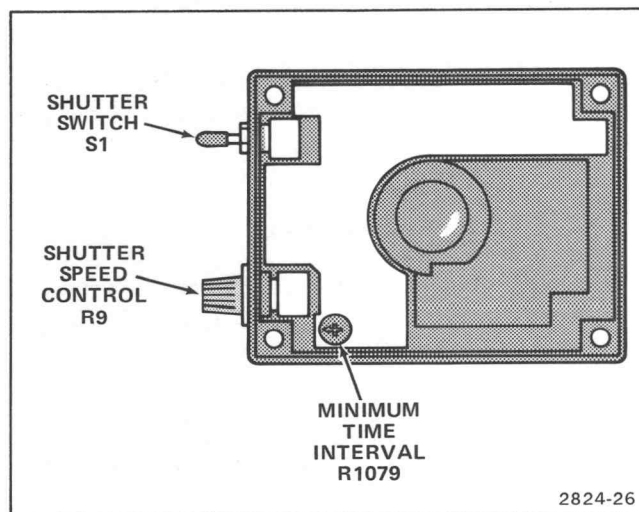


Figure 4-4. Location of minimum time control adjustment.

- g. Using the nylon alignment tool, rotate Voltage Set R25 (on reverse side of the circuit board) fully counterclockwise. Refer to Figure 4-3 for the location of R25.
- h. Rotate FLASH INTENSITY control R27 fully clockwise.
- i. At the Graticule Flash Unit set the FLASH switch to ON.
- j. ADJUST — R25 for a +450-volt reading on the voltmeter.
- k. CHECK — that the Ready indicator is blinking.
- l. Push the Shutter switch down to TIMED SHUTTER, causing the flash unit lamp to flash.
- m. CHECK — that the voltage recharges to +450 volts and that the Ready indicator illuminates continuously while the voltage is recharging.
- n. Set the FLASH switch to OFF.
- o. Disconnect the test setup.
- p. Replace the circuit board and reflector plate assembly into the Graticule Flash Unit housing, secure with the four screws, and replace the FLASH INTENSITY knob.

MAINTENANCE

INTRODUCTION

This section of the manual contains preventive and corrective maintenance instructions for the various mechanical and electrical components and a troubleshooting procedure for the electrical circuits of the camera.

STATIC-SENSITIVE COMPONENTS

CAUTION

Static discharge can damage any semiconductor component in this camera.

This camera contains electrical components that are susceptible to damage from static discharge. See Table 5-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kilovolt to 30 kilovolts are common in unprotected environments.

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together, whenever possible, with shorting wire or conductive plastic foam.
6. Pick up components by the body, never by the leads.

7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction-type or antistatic wick-type desoldering tools.

Table 5-1

Relative Susceptibility to
Static Discharge Damage

Semiconductor Classes	Relative Susceptibility Levels ^a
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs (most sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFET	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (least sensitive)	9

^aVoltage equivalent for levels:

1 = 100 to 500 V	4 = 500 V	7 = 400 to 1000 V (est)
2 = 200 to 500 V	5 = 400 to 600 V	8 = 900 V
3 = 250 V	6 = 600 to 800 V	9 = 1200 V

Voltage discharged from a 100-pF capacitor through a resistance of 100 ohms.

PREVENTIVE MAINTENANCE

The C-5C Camera is designed to provide long, trouble-free operation if given the same care as other precision optical devices. When performing any preventive maintenance on the camera, care should be taken in handling the various mechanical and electrical components to ensure that they are not damaged.

CLEANING

Camera Surfaces

Clean the exterior plastic surfaces with a soft lint-free cloth or a cotton-tipped applicator dampened with warm water. If necessary, use a mild soap solution. Interior surfaces may be cleaned by dusting with a dry, lint-free cloth or soft brush.

Lenses

To obtain optimum results from your camera, always keep the external lens surfaces clean. When required, remove loose dust with a soft camel-hair brush. Fingerprints and other smudges can be removed with clean, high-quality lens tissue. Avoid scratching the lenses while cleaning.

The front and rear lens surfaces may be cleaned by attaching the cleaning materials to a thin rod. The rod can then be inserted through either the front opening or the back opening of the camera to reach each side of the lens to be cleaned.

Camera Back Rollers

The C-5C Camera back contains two stainless steel rollers used in processing exposed film. These rollers may collect a buildup of film-developing solution and therefore should be inspected each time a new film pack is inserted. If required, clean the rollers before inserting new film.

Instructions for cleaning the rollers are found inside the camera back door. Should these instructions be missing or faded, the rollers can be cleaned by using a damp cloth or cotton-tipped applicator to remove any deposits.

The rollers can be removed by lifting the rear of the roller assembly up and out of the camera back. To replace the assembly, set the rollers down into the camera back. Then gently push the rear of the roller assembly down into the camera back until the small plastic retaining latch on the roller assembly catches and holds the rollers in place.

Circuit Boards

Clean circuit boards as often as operating conditions require. Accumulations of dirt and dust on circuit boards and wires can cause arcing and short circuits, resulting in damage to components or camera failure. Remove circuit board dust before it builds up sufficiently to cause arcing and short circuiting during periods of high humidity. Dust is best removed from the circuit boards with dry, low-pressure air (approximately nine pounds per square inch). Dirt clinging to surfaces may be removed with a soft camel-hair brush or a soft lint-free cloth dampened with a mild detergent and water solution. Use a cotton-tipped applicator for cleaning in narrow spaces.

Visual Inspection

Inspect the camera interior occasionally for broken connections, improperly seated semiconductors, damaged or improperly installed circuit boards, heat-damaged components, and similar indications. If heat-damaged components are found, determine the cause of excessive heat and take measures to prevent recurrence of such damage.

Lubrication

The potentiometers used in the C-5C Camera are permanently sealed and the toggle switch is installed with proper lubrication. Therefore, periodic lubrication is not recommended, and only rarely should lubrication be necessary.

Semiconductor Checks

Periodic checks of the semiconductor devices are not recommended. The best check of semiconductor performance is actual operation in the camera.

Adjustment After Repair

Conduct the Performance Check after any electrical component has been replaced. If adjustment is found to be necessary, perform the appropriate Adjustment Procedure. The Performance Check and Adjustment Procedure are contained in Section 4, Calibration.

TROUBLESHOOTING

Preventive maintenance performed on a regular basis should reveal most potential problems before a camera malfunctions. However, should troubleshooting be required, the following information is provided to facilitate location of a fault. In addition, the technical material presented in the Theory of Operation and Diagrams sections of this manual may be helpful while troubleshooting.

RECOMMENDED TROUBLESHOOTING EQUIPMENT

The following equipment, or the equivalent, may be useful when troubleshooting the C-5C Camera.

Multimeter

Description: Voltmeter, input impedance of 10 megohms and a range from 0 to at least 1000 volts dc; accuracy, within 0.1%. Ohmmeter, 0 to 20 megohms. Test probes should be insulated to prevent accidental shorting.

Purpose: Checking voltage and resistance.

Test Oscilloscope

Description: Frequency response, dc to 15 MHz; deflection factor, 5 millivolts to 5 volts per division. A 10X, 10-megohm voltage probe should be used to reduce circuit loading.

Purpose: Checking operating waveforms.

TROUBLESHOOTING AIDS

Troubleshooting Chart

Troubleshooting charts are provided to aid in locating and isolating problem areas. The shutter control circuit troubleshooting chart is contained in Figure 5-1, and the graticule flash circuit troubleshooting chart in Figure 5-2.

Diagrams

Complete circuit diagrams are located on the foldout pages in the Diagrams section. The component number and electrical value of each component are shown on each diagram (see the first page of the Diagrams section for definitions of reference designators used to identify components). Each main circuit is assigned a series of component numbers to assist in identifying circuit location. Important voltages and waveforms are also shown on the diagrams. A heavy line encloses the circuitry that is mounted on a circuit board.

Color Codes and Markings

Resistors used in the camera are either composition or precision metal-film resistors. They are color-coded with the EIA color code (some metal-film resistors may have the value printed on the body). Refer to Figure 5-3 for color-coding definition.

The capacitance value of common disc and some small electrolytic capacitors is marked on the side of the component body.

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot.

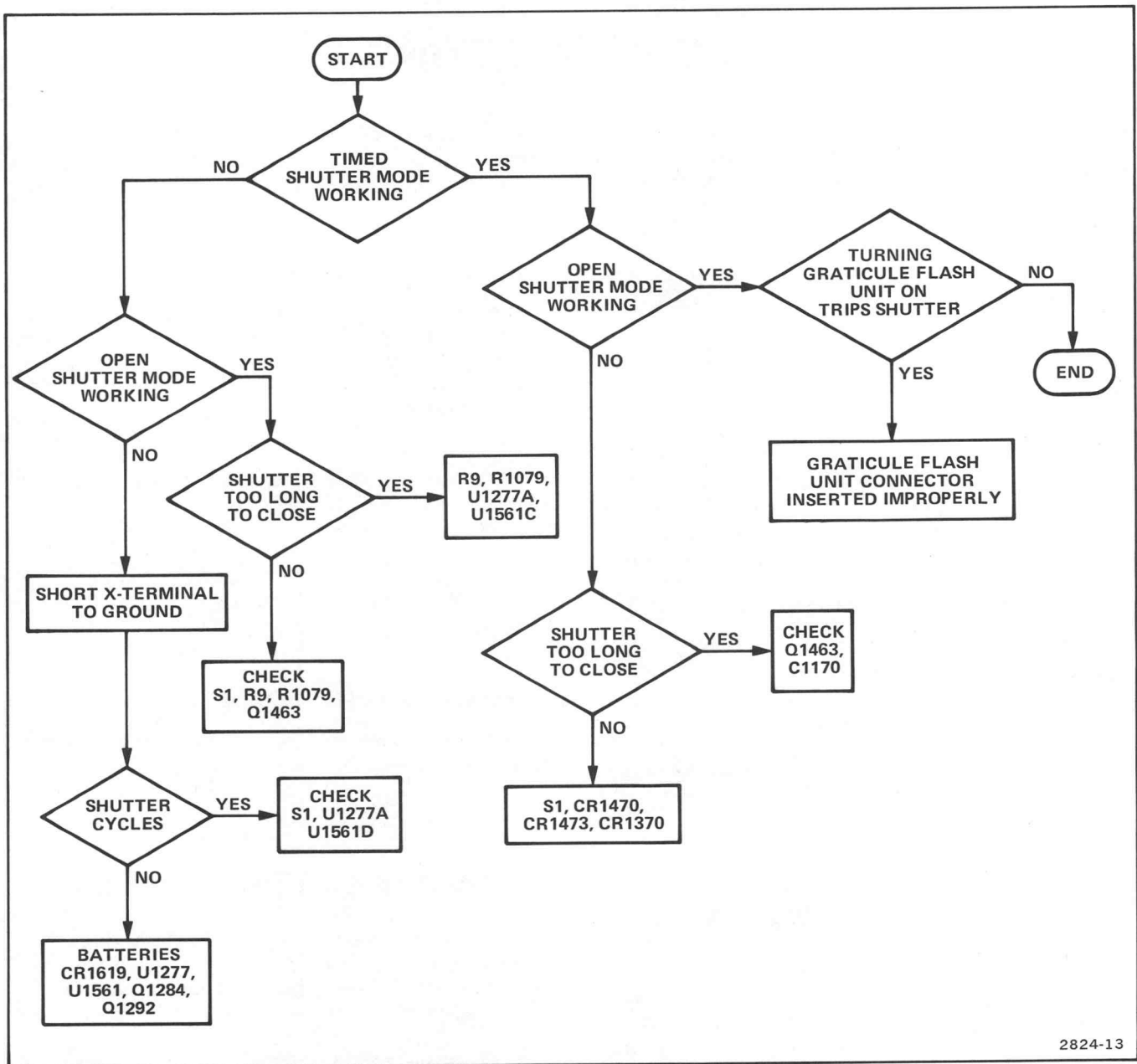
Semiconductor Lead Configuration

Figure 5-4 shows the lead configuration of semiconductor devices used in the camera.

TROUBLESHOOTING TECHNIQUES

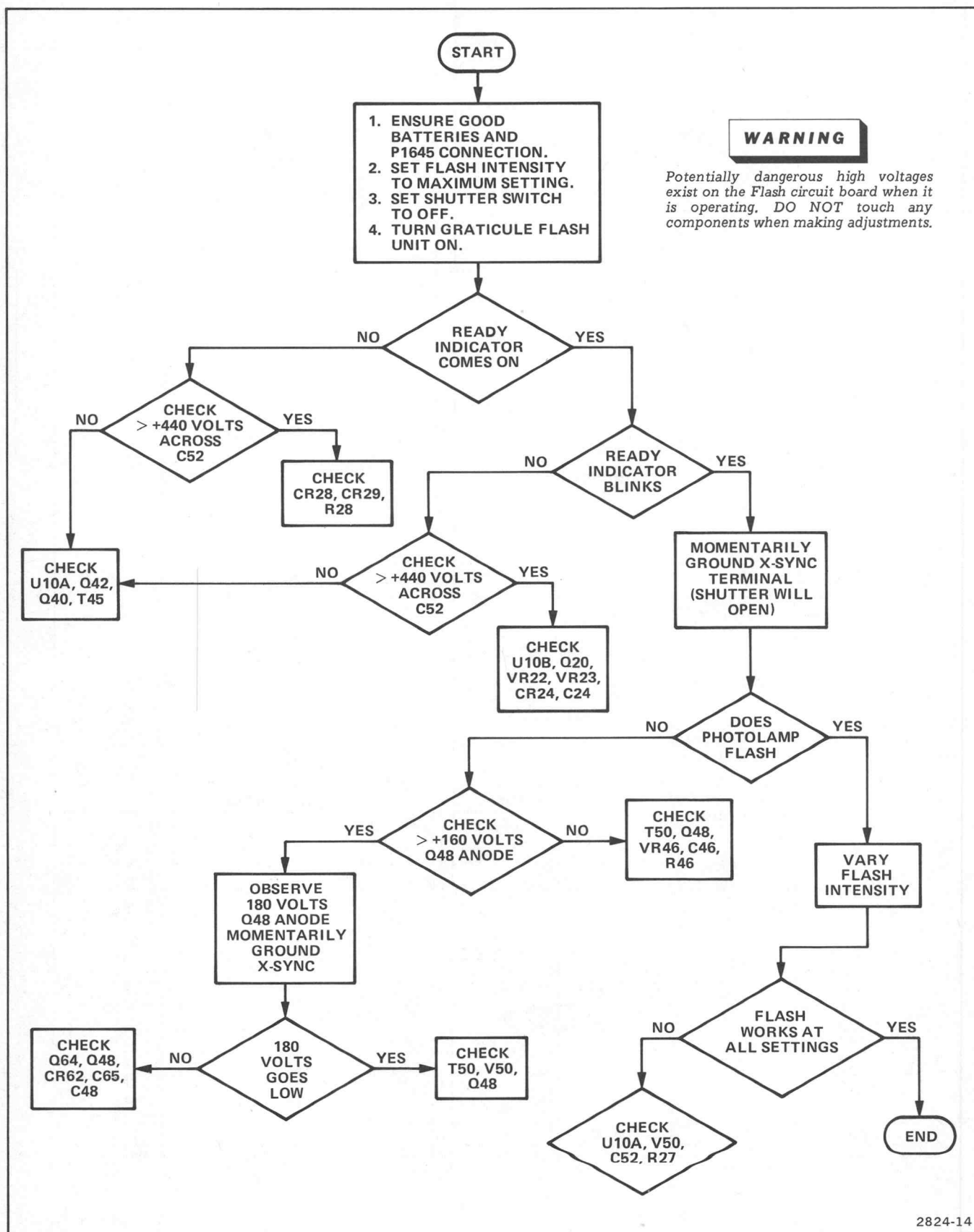
The following checklist is arranged to enable checking of basic functions before performing detailed troubleshooting. Starting at the beginning may help you to save time in locating a fault.

1. Check the control settings. Refer to the Operating Instructions section of the manual to determine correct control settings and indications.
2. Check the performance of the C-5C Camera by going through the Performance Check in Section 4. If the camera does not meet a specification requirement, perform the Adjustment Procedure in Section 4.
3. Perform a visual inspection. This may reveal broken connections, damaged components, semiconductors not firmly mounted, damaged circuit boards, or other clues.



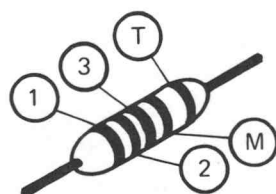
2824-13

Figure 5-1. Shutter control troubleshooting chart.

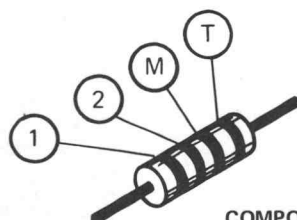


2824-14

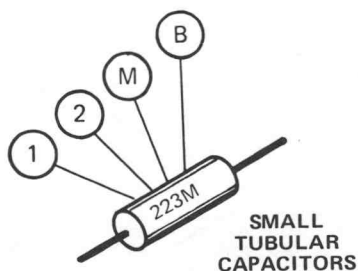
Figure 5-2. Graticule flash troubleshooting chart.



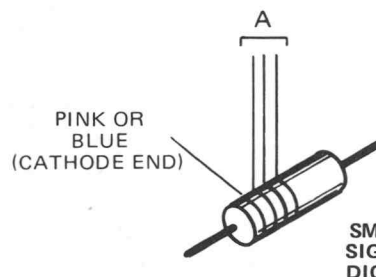
METAL-FILM RESISTORS



COMPOSITION RESISTORS



SMALL TUBULAR CAPACITORS



SMALL SIGNAL DIODES

(A) COLORS IDENTIFY SIGNIFICANT DIGITS IN TEKTRONIX PART NUMBER (E.G. BROWN, GRAY, GREEN STRIPES INDICATE PART NUMBER 152-0185-00)

(B) TOLERANCE; F=±1%, J=5%, K=10%, M=20%

(1) (2) and (3) 1ST, 2ND, AND 3RD SIGNIFICANT FIGS.

(T) AND/OR (TC) COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS;

(M) MULTIPLIER (T) TOLERANCE;

(TC) TEMPERATURE COEFFICIENT.

COLOR	SIGNIFICANT FIGURES	RESISTORS (Ω)		CAPACITORS (pF)		
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE	
					Over 10 pF	Under 10 pF
BLACK	0	1	---	1	±20%	±2 pF
BROWN	1	10	±1%	10	±1%	±0.1 pF
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	---
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	±3%	---
YELLOW	4	10^4 or 10 K	±4%	10^4 or 10,000	+100% -9%	---
GREEN	5	10^5 or 100 K	±½%	10^5 or 100,000	±5%	±0.5 pF
BLUE	6	10^6 or 1 M	±¼%	10^6 or 1,000,000	---	---
VIOLET	7	---	±1/10%	---	---	---
GRAY	8	---	---	10^{-2} or 0.01	+80% -20%	±0.25 pF
WHITE	9	---	---	10^{-1} or 0.1	±10%	±1 pF
GOLD	—	10^{-1} or 0.1	±5%	---	---	---
SILVER	—	10^{-2} or 0.01	±10%	---	---	---
NONE	—	---	±20%	---	±10%	±1 pF

2168-22 (1982-31)

Figure 5-3. Color code for resistors and capacitors.

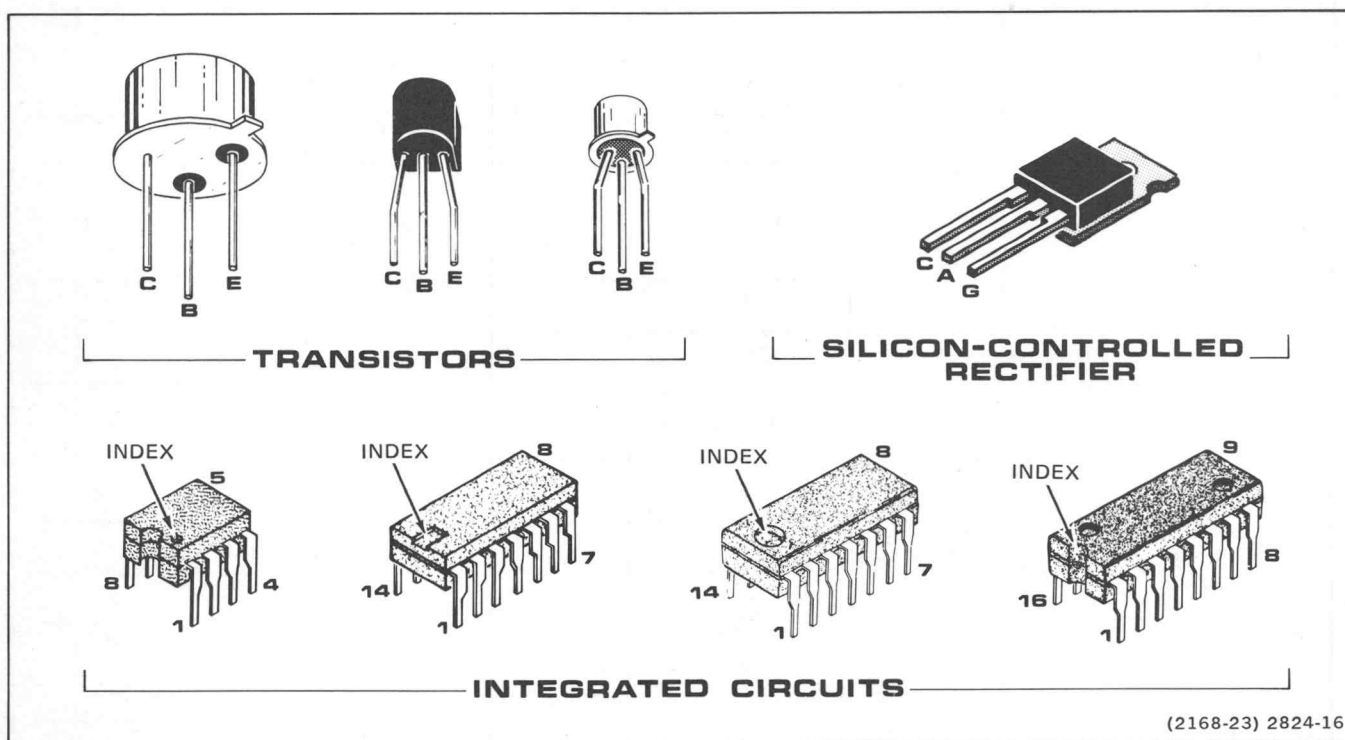


Figure 5-4. Lead configuration for semiconductor devices.

4. Isolate the fault to a particular circuit. To isolate a fault, note its symptom; the symptom often identifies the circuit in which the trouble is located.
5. Incorrect operation of all circuits often indicates trouble in the battery pack. Check first for correct voltage readings from the battery pack. A defective component elsewhere in the camera can appear as a battery problem and may affect operation of other circuits.
6. Check the timing of the TIMED SHUTTER and OPEN SHUTTER modes. Figure 5-5 shows the timing diagram for these modes.
7. Check the oscillator by shorting the X-Terminal. The shutter will operate continually until the short is removed. Figure 5-6 shows the timing diagram for the shutter circuit with X-Terminal shorted.

8. Check graticule flash circuit voltages and waveforms. These are located on the graticule flash circuit diagram. Often a defective component can be located by checking for correct voltages and waveforms in a circuit.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly in each camera. To obtain operating conditions similar to those used to take these readings, see the voltage and waveform setup procedure in the Diagrams section. Individual deviations should be noted on schematics for future reference.

WARNING

To prevent electrical shock or circuit damage, disconnect batteries before any component or assembly is removed or replaced.

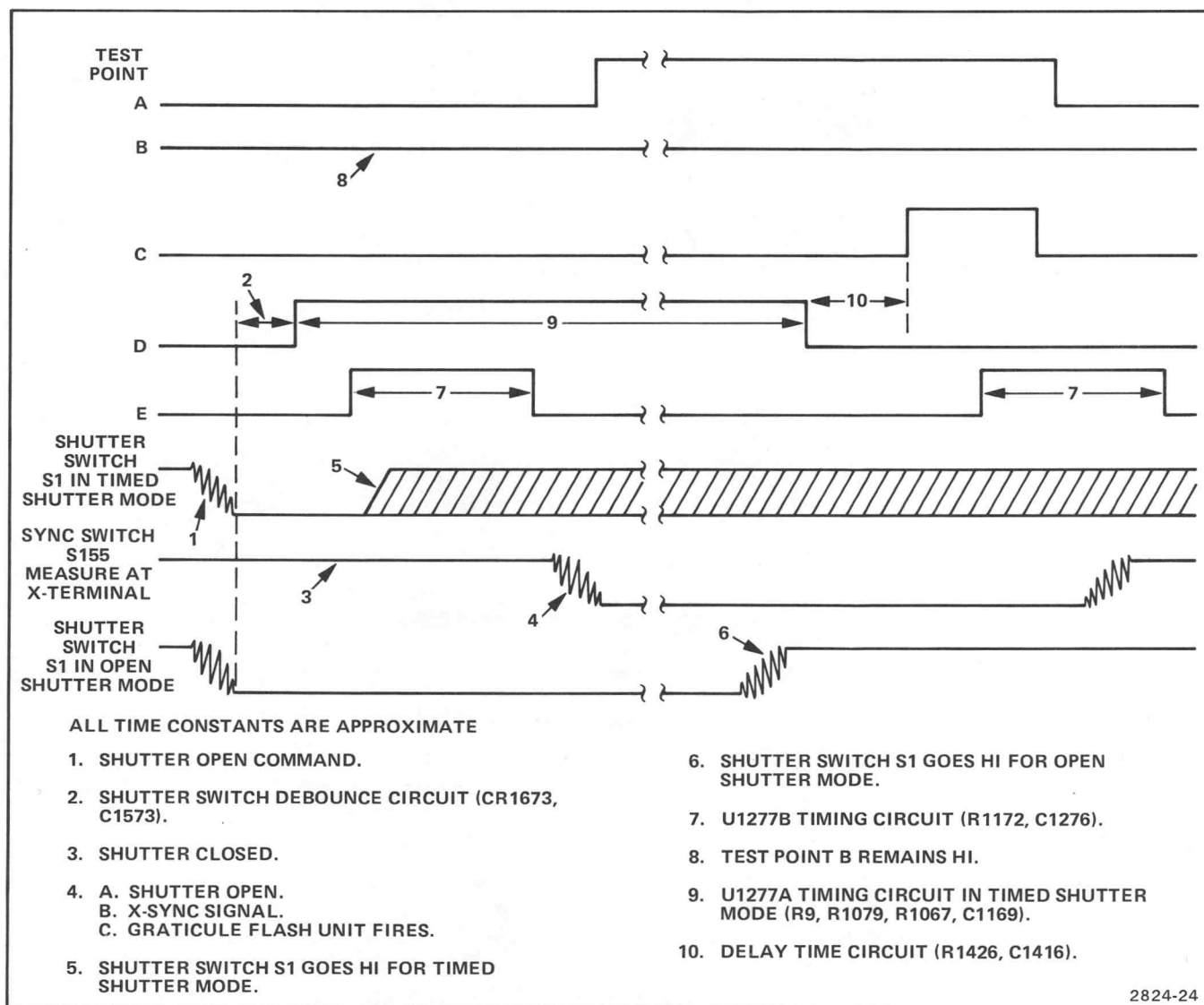


Figure 5-5. Timing diagram for timed shutter and open shutter modes.

9. Check individual components. Remember, the best check of semiconductors and capacitors is actual operation in a circuit. If a component is suspect, substitute a new one. Before checking integrated circuits, read the part in the Theory of Operation section which explains that particular circuit.

CAUTION

When checking capacitors with an ohmmeter, do not exceed the voltage rating of the capacitor. Some ohmmeters use a 30-volt source.

Check resistors for discoloration. Disconnect one end from the circuit and check with an ohmmeter. Refer to the Replaceable Electrical Parts list for the tolerance of resistors used in the C-5C Camera. Resistors normally need not be replaced unless the measured value varies widely from the specified value.

Check inductor continuity with an ohmmeter (it may be necessary to disconnect one end of the inductor).

Check capacitors for leakage. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter (on the highest scale) after disconnecting one end of the capacitor from the circuit. Ensure that you do not exceed the voltage rating of the capacitor (some ohmmeters use a 30-volt source). The resistance reading should be high after initial charge of the capacitor. An open capacitor can also be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

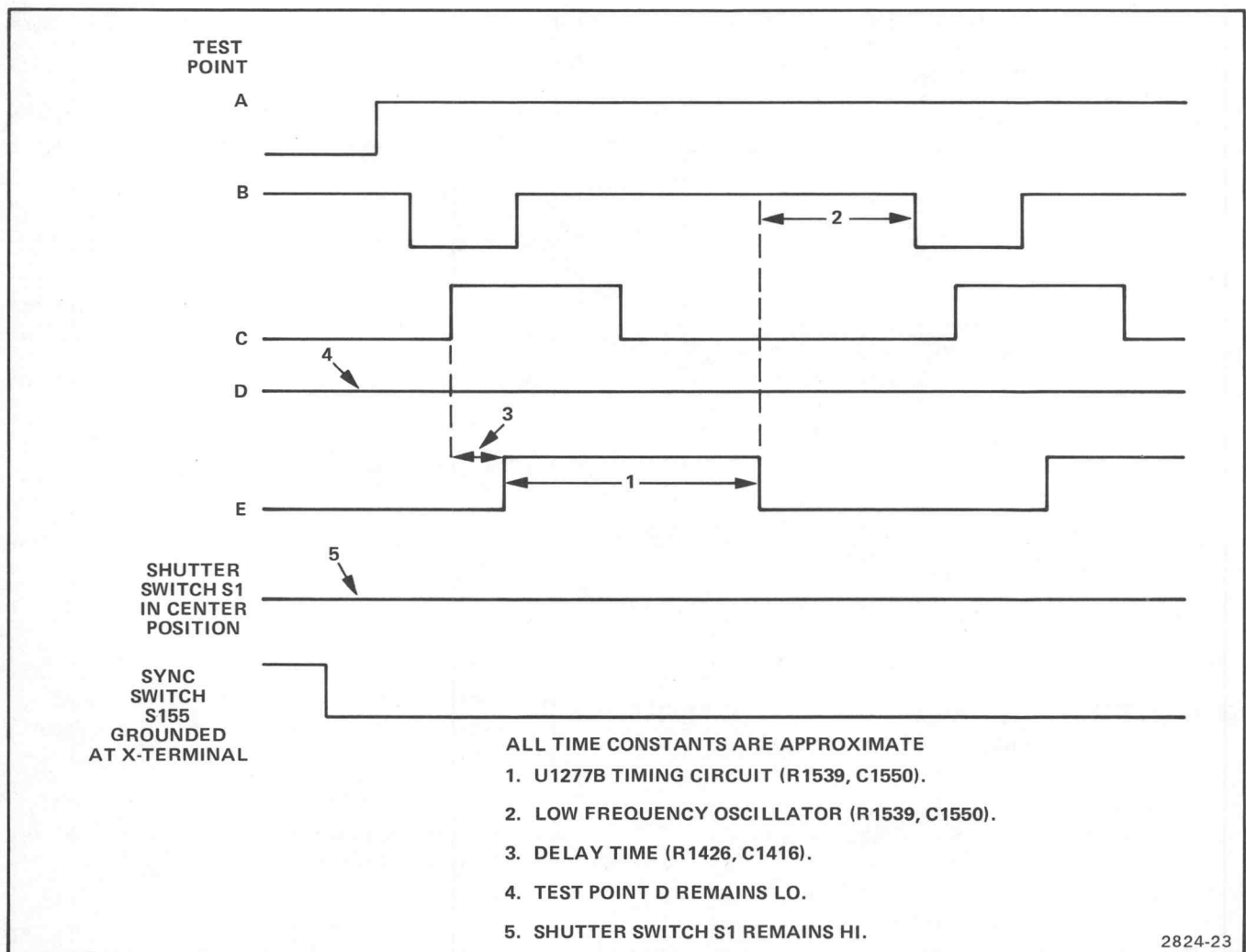


Figure 5-6. Timing diagram with X-Terminal shorted to ground.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and camera repair. Special techniques and procedures required to replace components in the C-5C Camera are described in this part of the manual. If it is necessary to ship your camera to a Tektronix Service Center for repair or service, refer to the repackaging instructions at the end of this section.

OBTAINING REPLACEMENT PARTS

Standard Parts

Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the Replaceable Electrical and Mechanical Parts lists for the proper value, rating, tolerance, and description.

NOTE

Physical size and shape of a component may affect camera performance. Always use direct-replacement components, unless it is known that a substitute will not degrade performance.

Special Parts

In addition to the standard electronic components, special parts used in the C-5C Camera are manufactured

or selected by Tektronix, Inc. to meet specific performance requirements or are manufactured for us in accordance with our specifications (see Cross Index—Manufacturers Code Number to Manufacturer in Replaceable Electrical Parts list). Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., it is imperative that all of the following information be included to ensure receiving the proper parts.

1. Camera type and option.
2. Camera serial number.
3. A description of the part (if electrical, include the circuit number).
4. Tektronix part number.

ADAPTER HOOD AND LENS-SHUTTER ASSEMBLY REMOVAL

To remove the adapter hood and lens-shutter assembly, refer to Figure 2-3 and perform the following procedure.

1. Unplug the battery connector from the battery holder (located inside the camera frame; see Figure 2-2).
2. Unplug the Graticule Flash Unit connector from the shutter control board. Note which side the flag is located on the connector.
3. Place the camera on its back with the adapter hood facing upward.

CAUTION

When the four screws are removed in the next step, sections of the camera are unsecured. Careless handling could cause an assembly to fall free and be damaged.

4. Remove the four screws and washers holding the camera sections together (located inside the adapter hood).

5. Carefully lift the adapter hood off the camera.

6. Carefully lift the lens-shutter assembly off the camera.
7. The lens-shutter assembly and adapter hood can be replaced by performing the reverse of this procedure.

SHUTTER CONTROL BOARD REMOVAL

To remove the shutter control board, perform the following procedure.

1. Remove the lens-shutter assembly.
2. Disconnect the batteries.
3. Disconnect the three leads and two connectors from the shutter control board, noting their location.

NOTE

The mounting screw near the Shutter Timing control secures the red battery lead to the rear of the lens-shutter housing.

4. Remove the three screws and holding nuts on the shutter control board (see Figure 5-7).

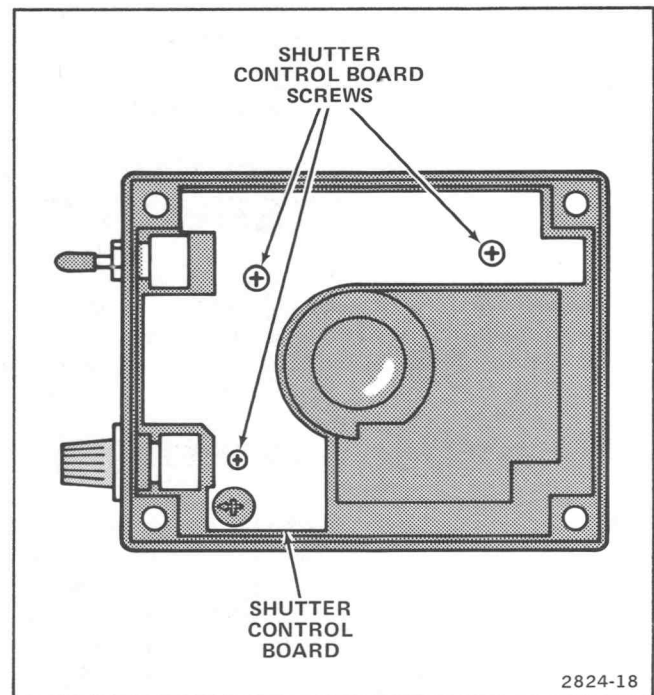


Figure 5-7. Removal of shutter control board.

5. Remove the shutter control board.
6. The shutter control board can be replaced by reversing the order of this procedure.

OPTICAL LENS REMOVAL

To remove the front, middle, and rear optical lenses, perform the following steps.

NOTE

When removing the lenses, use a high-quality lens tissue to prevent scratching lens surfaces.

Remove Front and Middle Lens

1. Remove three front lens holding screws as shown in Figure 5-8A.
2. Place a lens tissue over the loose front lens assembly.
3. Carefully turn the lens-shutter assembly over and allow the front and middle lenses, holding ring, and adapter to fall into your hand.
4. Replace the front and middle lens assembly in correct sequence (refer to Figure 5-8B).
5. Secure the front and middle lens assembly with the three front lens holding screws.

Remove Rear Lens

1. Remove three rear lens holding screws as shown in Figure 5-8C.
2. Place a lens tissue over the loose rear lens assembly.
3. Carefully turn the lens-shutter assembly over and allow the rear lens and holding ring to fall into your hand.
4. Replace the rear lens assembly in correct sequence (refer to Figure 5-8B).
5. Secure the rear lens assembly with the three rear lens holding screws.

SHUTTER ASSEMBLY REMOVAL

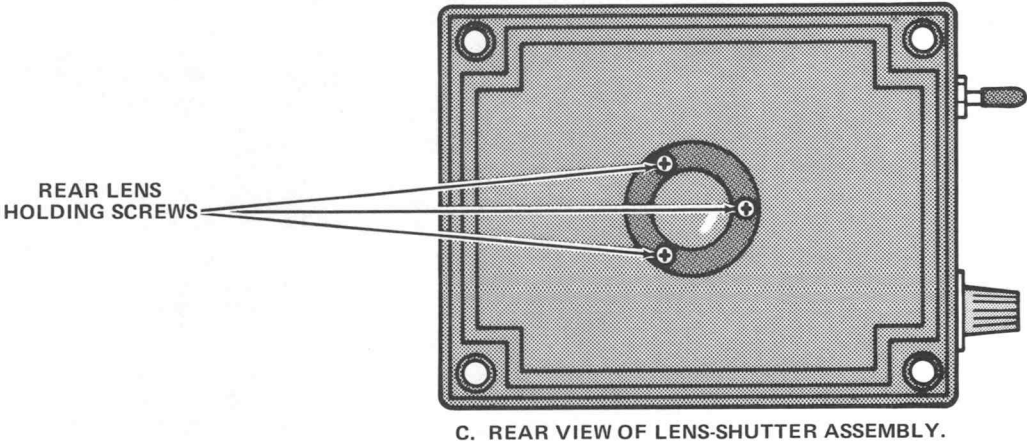
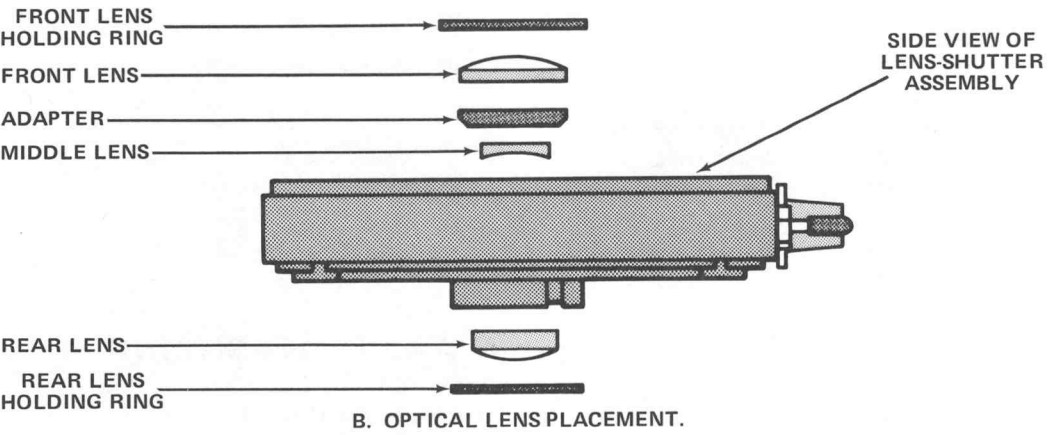
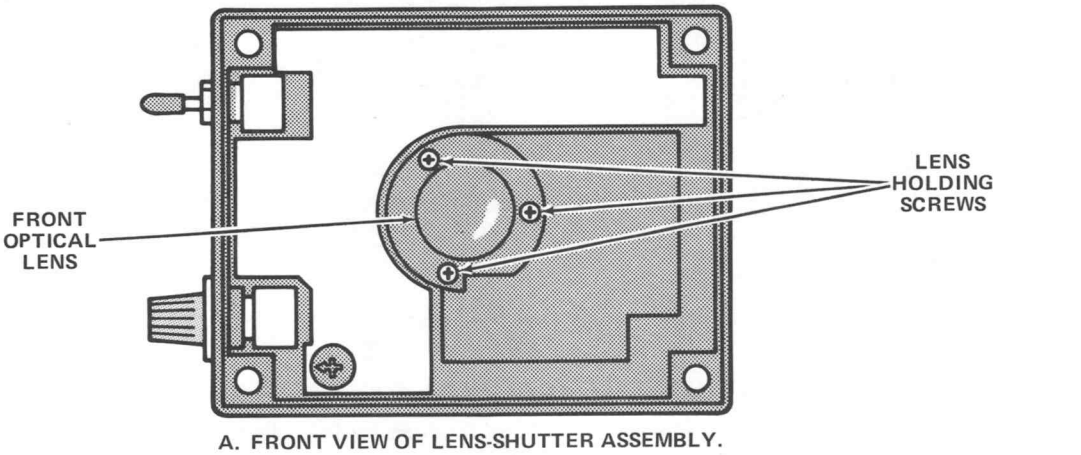
To remove the shutter assembly, perform the following procedure.

1. Remove the adapter hood and lens-shutter assembly from the camera.
2. Remove the four screws holding the shutter cover in place (shown in Figure 5-9) and lift out both the cover and optical lens assembly.
3. Remove the shutter control board.
4. Remove the remaining screw holding the shutter and battery leads in place.
5. Disconnect the three leads from the shutter control board, noting their location.
6. Lift out the shutter assembly.
7. To reinstall the shutter assembly and shutter cover, reverse the foregoing procedure.

GRATICULE FLASH UNIT REMOVAL

To remove the Graticule Flash Unit from the adapter hood perform the following procedure.

1. Remove the adapter hood from the camera.
2. Unplug the Graticule Flash Unit connector from the shutter control board.
3. Remove the three screws securing the flash unit to the adapter hood and let the front part of the flash unit (where screws are inserted) drop down. Refer to Figure 5-10 for location of the three screws that secure the flash unit to the adapter hood.
4. Pull the Graticule Flash Unit straight out of the adapter hood.
5. The Graticule Flash Unit may be replaced by reversing the order of this procedure.



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Figure 5-8. Removal of optical lenses.

GRATICULE FLASH BOARD REMOVAL

The following procedure describes how to remove the graticule flash board from the Graticule Flash Unit. Refer to Figure 5-10.

1. Remove the adapter hood from the camera.
2. Unplug the Graticule Flash Unit connector from the shutter control board.
3. Pull off the FLASH INTENSITY knob.

CAUTION

When the screws are removed in the next step, the circuit board will fall free. To prevent possible damage to components and wires, support the circuit board with your hand under the flash unit when removing the screws.

4. Remove the four screws on top of the Graticule Flash Unit and let the end of the circuit board and reflector plate assembly opposite the FLASH INTENSITY knob drop down into your hand.

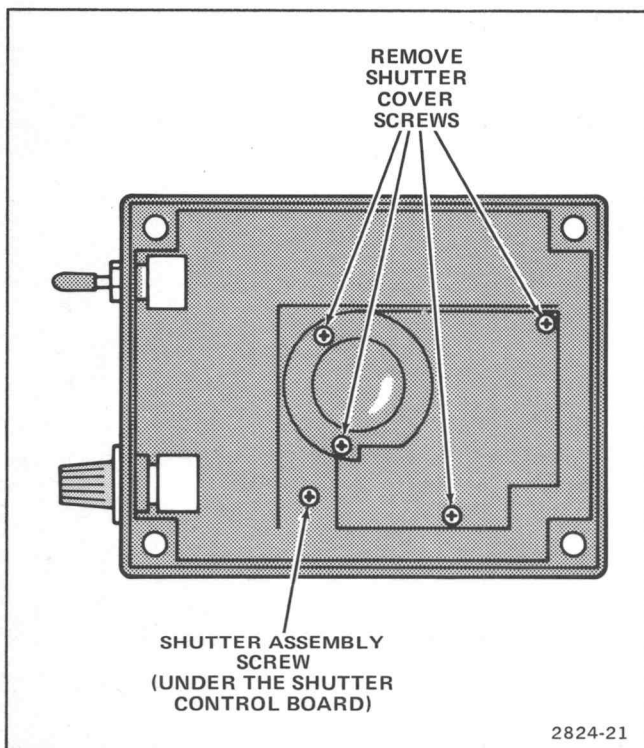


Figure 5-9. Removal of shutter assembly.

5. Pull the graticule flash board and reflector plate down and out of the Graticule Flash Unit housing.
6. For access to both sides of the graticule flash board, remove the four screws on top of the deflector plate and separate the circuit board and plate. For complete circuit board removal, unsolder the flash tube light.
7. The graticule flash board can be replaced by performing the reverse of this procedure. Ensure that the graticule flash connector cable is in the reflector plate slot to avoid pinching the wires.

COMPONENT REMOVAL AND REPLACEMENT

WARNING

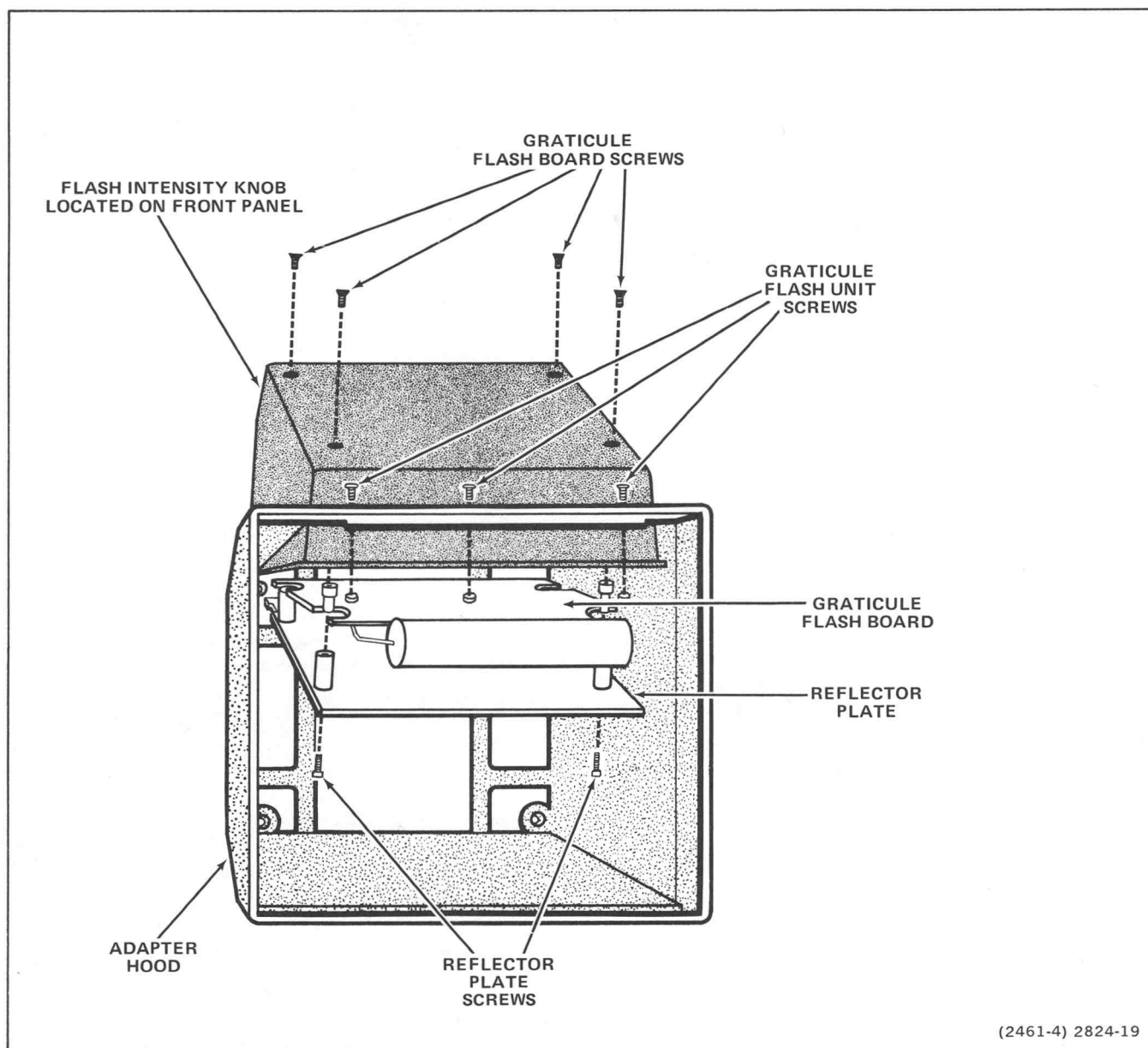
To prevent electrical shock or damage to the camera, disconnect the batteries before replacing any components.

In order to replace parts soldered to the circuit boards in your C-5C Camera, the appropriate board should first be removed from the camera. Refer to preceding board removal procedures for detailed instructions. Refer to the following paragraphs discussing Soldering Techniques before attempting component replacement.

Soldering Techniques

For soldering, use ordinary 60/40 solder and a 15-watt pencil-type soldering iron. Using a soldering iron with a higher wattage rating on etched circuit boards can cause the etched circuit wiring to separate from the board base material. Use the following techniques to replace a component on an etched circuit board.

1. Grip component lead with long-nose pliers. Touch soldering iron to lead at solder connection. Do not lay iron directly on the board.
2. When solder begins to melt, gently pull lead out. This operation should leave a clear hole in the board. If it does not, the hole can be cleared by reheating the solder and placing a sharp object (e.g., a toothpick) into the hole to clear it. A static-free vacuum-type desoldering tool or solder wick also can be used for this purpose.



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Figure 5-10. Removal of graticule flash unit and graticule flash board.

3. Bend leads of the replacement component to fit holes and spacing on the board. If component is replaced while circuit board is mounted in the camera, cut leads so they protrude just through the board. Insert leads into the holes in the board, with the component firmly seated against the board (or as originally positioned). If it does not seat properly, heat the solder and gently press the component into place.

4. Touch iron to the connection and apply a small amount of solder to make a firm solder joint. To protect heat-sensitive components, hold the lead

between the component body and the solder joint with a pair of long-nosed pliers or other heat-sinking tool.

5. Clip any excess lead that protrudes through circuit board (if not cut in step 3).

6. Clean area around the solder connection with flux-remover solvent and air dry.

Semiconductor Replacement

Replacement semiconductors should be of the original types or direct replacements. Lead configurations of the semiconductors used in the camera are shown in the Troubleshooting portion of this section. Some plastic-case transistors have lead configurations which do not agree with those shown. If a replacement transistor is made by a manufacturer other than the original, check the manufacturer's basing diagram for correct basing.

Replacement of semiconductors may affect the adjustment of the C-5C Camera. After replacing semiconductors, especially if using parts other than those listed in the Replaceable Electrical Parts list, check the camera to ensure that performance has not been degraded. Refer to the Performance Check procedure in Section 4 of this manual.

Interconnecting Cable and Pin Connector Replacement

Most interconnecting cable assemblies (cables and connectors) are factory assembled. They must be replaced only as a complete unit.

Some cables have multi-connector holders. It is possible for pin connectors to become dislodged from the plastic holders. If this happens, the connector can be reinstalled as follows (see Figure 5-11).

1. Bend grooved portion of holder away from cable as shown.

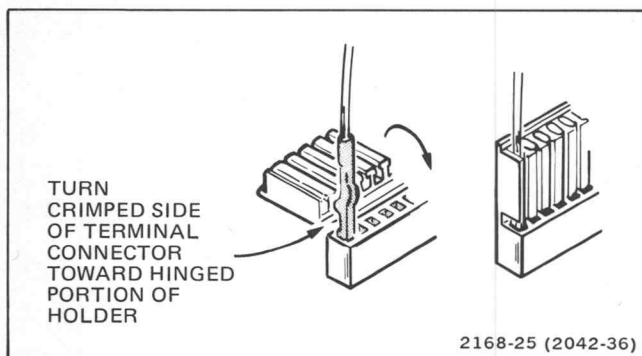


Figure 5-11. Pin connector replacement.

2. Reinsert connector into its hole in the plug-in portion of the holder.

Some cables have wires soldered directly to board pads and to plug connections. It is important to note and remember wire positions when removing and replacing these cable assemblies.

INSTRUMENT REPACKAGING

Should reshipment become necessary, reuse the original carton in which your camera was shipped. If original packaging is unfit for use or is not available, repackage the camera as follows.

1. Obtain a corrugated cardboard carton having inside dimensions of no less than six inches more than camera dimensions; this will allow for cushioning. Use a carton having a test strength of at least 200 pounds.
2. Surround the camera with protective polyethylene sheeting.
3. Cushion the camera on all sides by tightly packing dunnage or urethane foam between carton and camera, allowing three inches on all sides.
4. Seal carton with shipping tape or industrial stapler.

Required Reshipment Information

If the camera is to be shipped to a Tektronix Service Center for service or repair, before packaging, attach a tag containing the following information.

1. Owner's name and address, with the name of an individual at your firm that can be contacted.
2. Complete camera serial number.
3. Description of the services required.

OPTIONS

Your camera may be equipped with one or more camera options. A brief description of each option is given below. For further information relating to camera options and optional purchases, see your Tektronix Products Catalog or contact your local Tektronix representative.

OPTION 1

The C-5C Option 1 is a C-5C Camera without the Graticule Flash Unit. A viewing door is provided on the top of the adapter in place of the Graticule Flash Unit. The Option 1 camera can be mounted on instruments listed in Section 1 of this manual. For mounting instructions see Mounting the Camera in Section 2.

OPTION 2

The C-5C Option 2 is a C-5C Camera without the Graticule Flash Unit. It contains an adapter hood that allows camera mounting on TEKTRONIX 432, 434, 455, 460-series, 475 and 475A instruments. A viewing door is provided on the top of the adapter in place of the Graticule Flash Unit. For mounting instructions see Mounting the Camera in Section 2.

OPTION 3

The C-5C Option 3 is a C-5C Camera with a Graticule Flash Unit and an adapter hood that mounts on TEKTRONIX T900-series (except T922R) instruments. For mounting instructions see Mounting the Camera in Section 2.

REPLACEABLE ELECTRICAL PARTS

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 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.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICON	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-6315-00		CKT BOARD ASSY:SHUTTER CONTROL	80009	670-6315-00
C1160	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	56289	503D475G035AS
C1169	290-0301-00		CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
C1276	283-0249-00		CAP.,FXD,CER DI:0.068UF,10%,50V	72982	8131N075 C 683K
C1416	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C1512	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C1550	283-0203-00		CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131N075 E474M
C1573	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C1616	283-0204-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C1626	290-0755-00		CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C1633	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	56289	503D475G035AS
C1634	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C1642	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C1682	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
CR1370	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1470	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1473	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1488	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1489	152-0066-00		SEMICON D DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR1527	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1543	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1618	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1619	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
Q1463	151-0188-00		TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1284	151-0190-00		TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1292	151-0625-02		TRANSISTOR:SILICON,PNP	03508	D45H11
R1067	321-0261-00		RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R1079	311-1748-00		RES.,VAR, NONWIR:TRMR,15K OHM,0.50W	73138	91-96-0
R1159	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1164	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1172	315-0684-00		RES.,FXD,CMPSN:680K OHM,5%,0.25W	01121	CB6845
R1277	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1383	315-0360-00		RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
R1385	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R1426	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1471	315-0560-00		RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
R1490	315-0473-00		RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1509	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1518	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1528	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1539	315-0564-00		RES.,FXD,CMPSN:560K OHM,5%,0.25W	01121	CB5645
R1542	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1543	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1673	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1689	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
U1277	156-1152-01		MICROCIRCUIT,DI:PRCN RETRIGGERABLE	80009	156-1152-01
U1561	156-0961-02		MICROCIRCUIT,DI:QUAD 2-INP NAND ST	80009	156-0961-02
CHASSIS PARTS					
R9	311-1996-00		RES.,VAR, NONWIR:CKT BD,500K OHM,10%,0.50W	01121	WP4G040S504UZ
S1	260-1986-00		SWITCH,TOGGLE:SPDT,0.4VA,20V MAX	80009	260-1986-00

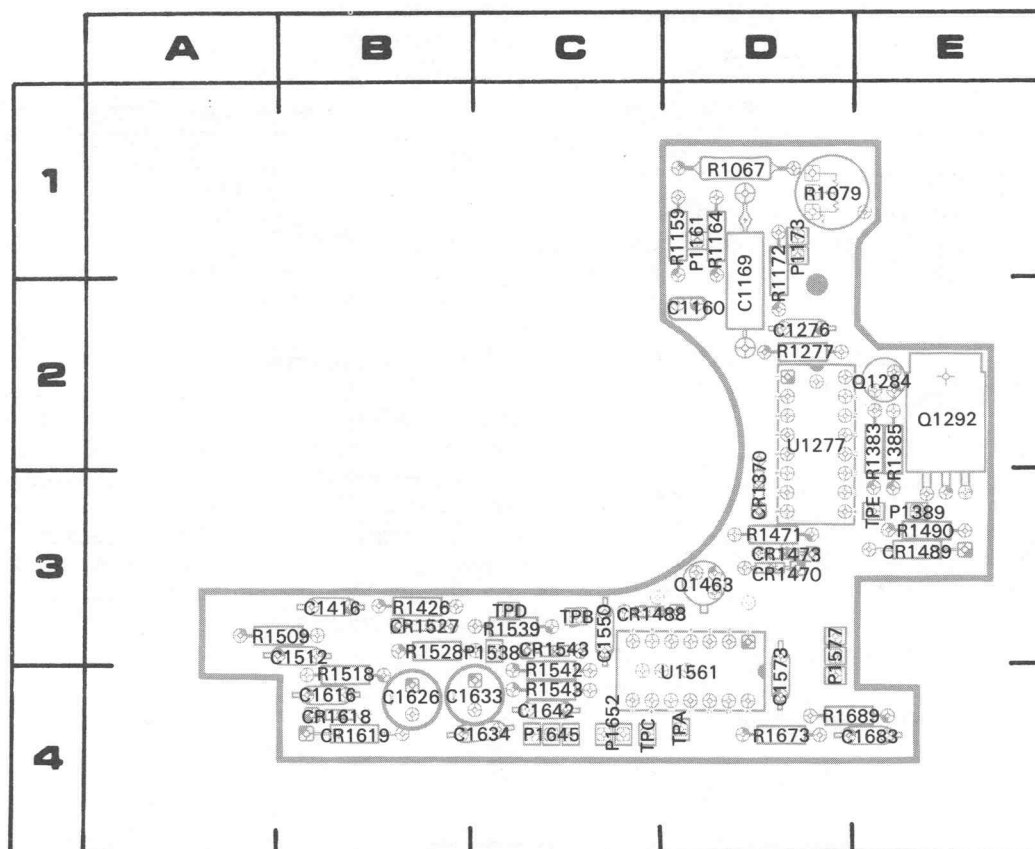


Figure 8-1. Shutter control board component locations.

SHUTTER CONTROL DIAGRAM 1

PARTIAL A1 ASSY					
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C1160	2B	2D	Q1292	3H	2E
C1169	2D	2D	Q1463	2C	3D
C1276	2G	2D			
C1276	2G	2D	R1067	2D	1D
C1416	3E	3B	R1079	2D	1D
C1512	2E	3B	R1159	2B	1D
C1550	5C	3C	R1164	1B	1D
C1573	3C	4D	R1172	2G	1D
C1616	3H	4B	R1277	3G	2D
C1626	2H	4B	R1383	2H	2E
C1633	2I	4C	R1385	3G	2E
C1634	5B	4C	R1426	2E	3B
C1642	6H	4C	R1471	2B	3D
C1683	3B	4E	R1490	2H	3E
			R1509	3E	3B
CR1370	2C	3D	R1518	2E	4B
CR1470	2B	3B	R1528	4H	3B
CR1473	3B	3D	R1539	5D	3C
CR1488	4E	3C	R1542	5D	4C
CR1489	2I	3E	R1543	5F	4C
CR1527	4G	3B	R1673	2C	4D
CR1543	4C	3C	R1689	2B	4E
CR1618	3E	4B			
			TPA	5C	4D
P1161	2I	1D	TPB	5F	2C
P1173	1D	1D	TPC	2F	4C
P1389	2I	3E	TPD	2D	3C
P1538	4I	3C	TPE	2G	3E
P1577	2A	4D			
P1645	3I	4C	U1277A	3D	2D
P1652	5I	4C	U1277B	3G	2D
			U1561B	5D	4D
Q1284	3H	2E	U1561C	3F	4D
CHASSIS MOUNTED PARTS					
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
BT160	1J	CHASSIS	S1	3A	
L155	2I		S155	3I	
R9	1D				



 **Static Sensitive Devices**
See Maintenance Section

SHUTTER CONTROL

VOLTAGE AND WAVEFORM CONDITIONS

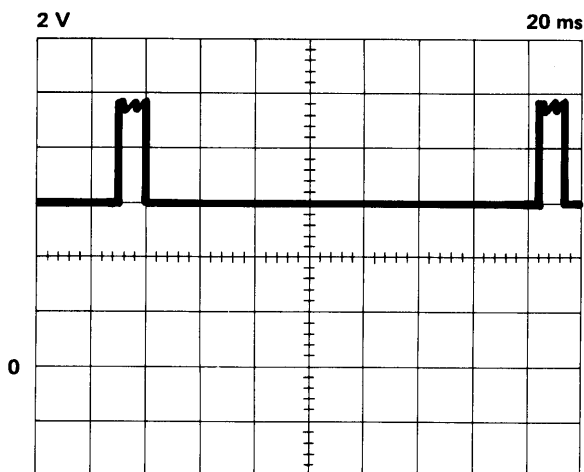
WARNING

Potentially dangerous high voltages exist on the Flash circuit board when it is operating. DO NOT touch connections or components when the unit is operating. Disconnect the batteries and discharge C52 and C46 before replacing circuit board parts.

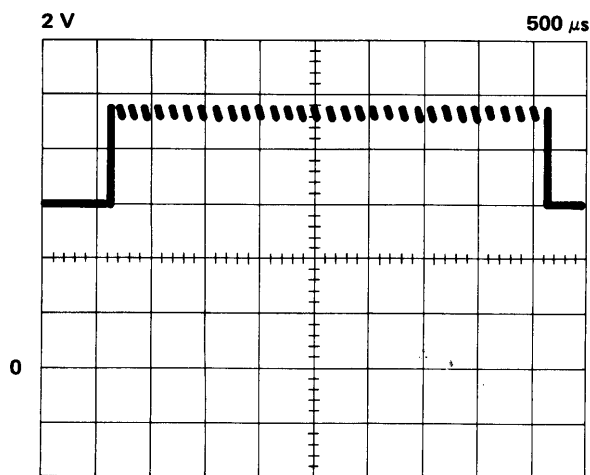
Common Measurement Conditions

1. All measurements are between the test point and ground.
2. Accomplish the following set-up procedures before making voltage or waveform measurements:
 - a. Connect a 2 M Ω resistor across C52.
 - b. Set the FLASH INTENSITY control fully clockwise.
 - c. Set R25 for a charge voltage of +450 V dc.
 - d. Connect the probe to test point 1A and 1B.
3. Test oscilloscope is dc coupled and internally triggered. Vertical deflection and sweep ranges are shown on the waveforms.
4. Turn the flash unit on and push the camera shutter down to TIMED SHUTTER several times to activate the circuit and test waveforms.
5. Voltage measurements may vary as much as 20%.

1 A



1 B

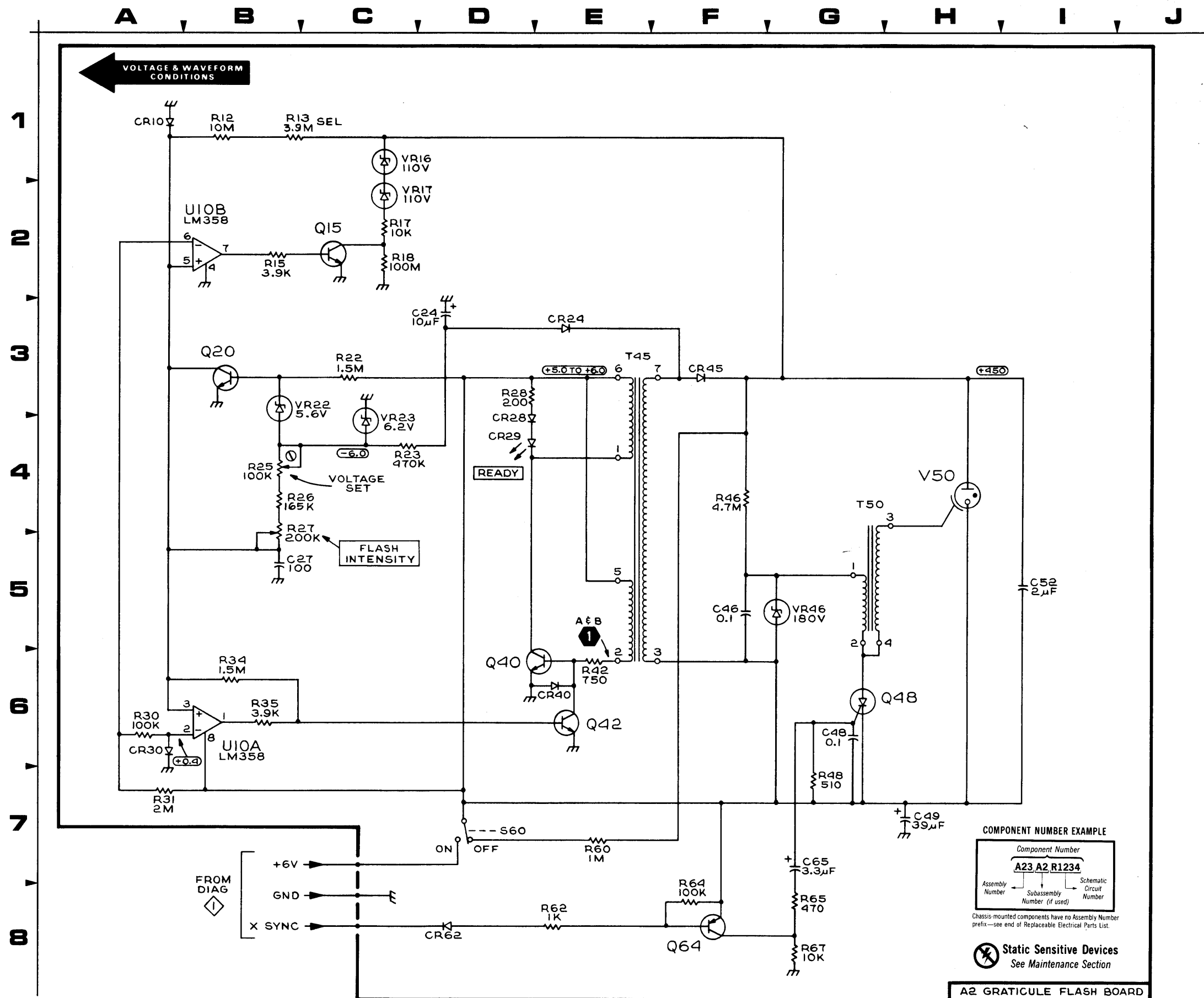


GRATICULE FLASH DIAGRAM 2

PARTIAL A2 ASSY					
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C24	3D	4B	R23	4C	3B
C27	5B	2C	R25	4B	3C
C46	5F	3B	R26	4B	3C
C48	6G	3C	R27	4B	2C
C49	7H	2B	R28	3D	2B
C52	5I	4B	R30	6A	3B
C65	7G	3D	R31	7A	3B
			R34	6B	2C
CR10	1A	2C	R35	6B	2C
CR24	3E	2B	R42	6E	3A
CR28	4D	2B	R46	4F	3D
CR29	4D	1B	R48	7G	3C
CR30	6A	3B	R60	7E	2B
CR40	6E	3A	R62	8E	3B
CR45	3F	2B	R64	8F	3B
CR62	8D	3B	R65	8G	3D
			R67	8G	3C
Q15	2C	4C			
Q20	3B	3C	T45	3E	2A
Q40	6D	3A	T50	4G	3D
Q42	6E	3B			
Q48	6H	4D	U10A	6B	2B
Q64	8F	3C	U10B	2B	2B
R12	1B	2C	VR16	1C	2C
R13	1B	2C	VR17	2C	3C
R15	2B	3B	VR22	3C	3C
R17	2C	3C	VR23	4C	3C
R18	2C	3C	VR46	5G	3C
R22	3C	3C			
CHASSIS MOUNTED PARTS					
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
S60	7D		V50	4H	

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION
BT160	1	1J	S1	1	3A
L155	1	2I	S60	2	7D
R9	1	1D	S155	1	3I



REPLACEABLE MECHANICAL PARTS

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 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.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component

Attaching parts for Assembly and/or Component

Detail Part of Assembly and/or Component

Attaching parts for Detail Part

Parts of Detail Part

Attaching parts for Parts of Detail Part

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ----- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

#	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
ACTR	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ADPTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ALIGN	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
AL	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
ASSEM	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSY	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ATTEN	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
AWG	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
BD	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BRKT	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRS	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRZ	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BSHG	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
CAB	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAP	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CER	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CHAS	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CKT	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
COMP	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
CONN	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
COV	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
CPLG	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CRT	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
DEG	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DWR	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

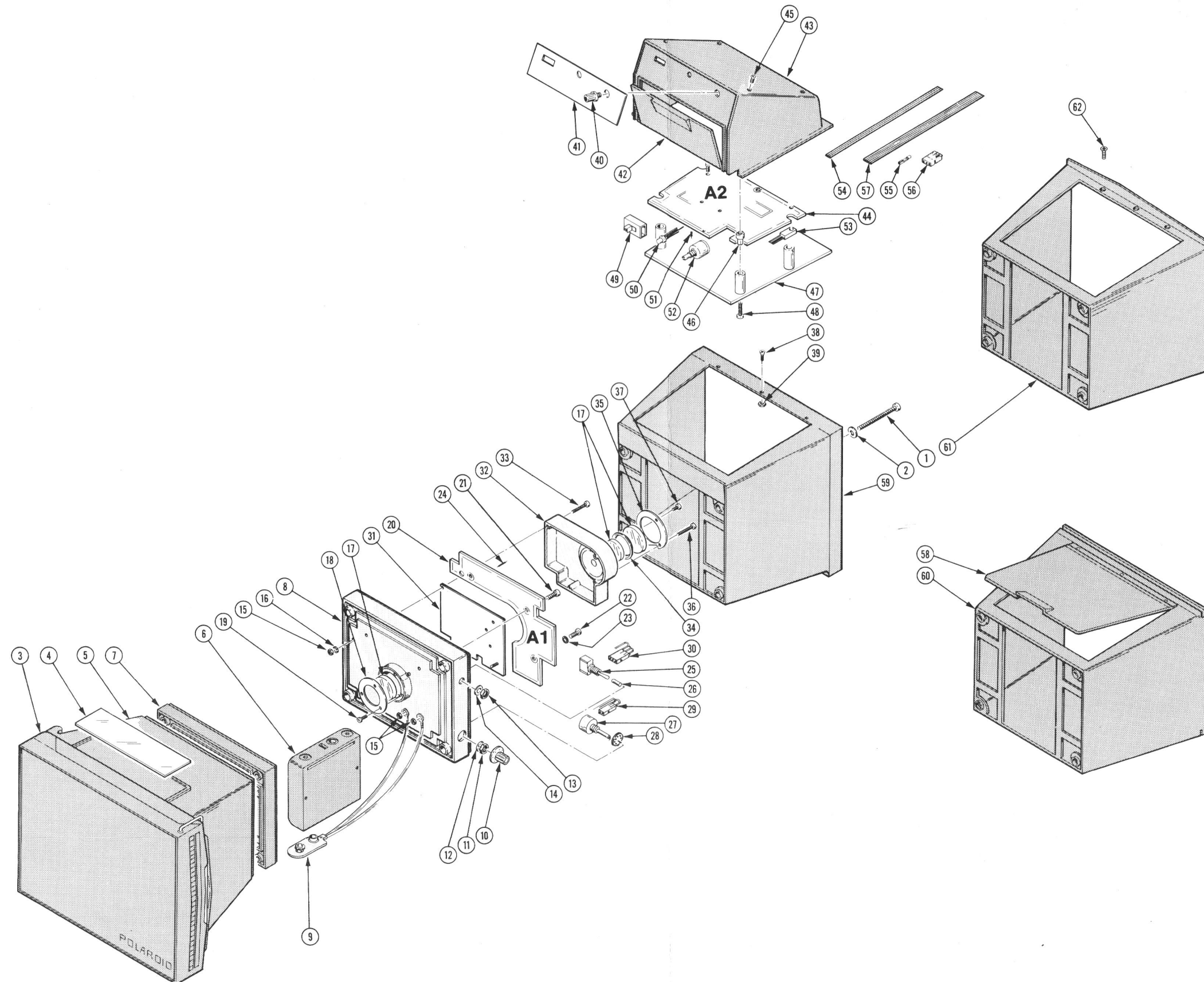
Mfr. Code	Manufacturer	Address	City, State, Zip
07322	MINNESOTA RUBBER CO.	3630 WOODDALE AVENUE	MINNEAPOLIS, MN 55416
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
09353	C AND K COMPONENTS, INC.	103 MORSE STREET	WATERTOWN, MA 02172
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
13103	THERMALLOY COMPANY, INC.	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS, TEXAS 75234
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
47904	POLAROID CORPORATION	750 MAIN STREET	CAMBRIDGE, MA 02139
53387	MINNESOTA MINING AND MFG. CO., ELECTRO PRODUCTS DIVISION	3M CENTER	ST. PAUL, MN 55101
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
76381	MINNESOTA MINING AND MFG. CO.	3M CENTER	ST. PAUL, MN 55101
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
93907	CAMCAR SCREW AND MFG. CO.	600 18TH AVE.	ROCKFORD, IL 61101

Replaceable Mechanical Parts—C-5C Camera

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-	426-1294-05		1		FRAME,LT SHIELD:W/CAMERA BACK (ATTACHING PARTS)	80009	426-1294-05
-1	211-0530-00		4		SCREW,MACHINE:6-32 X 1.75 INCH,PNH STL	83385	OBD
-2	210-0870-00		4		WASHER,FLAT:0.14 ID X 0.312 INCH OD STL	12327	OBD
	-----				- - - * - - -		
			-		. FRAME ASSY INCLUDES:		
-3	122-0989-00		1		. BACK,CAMERA:POLAROID CB	47904	CB-101
-4	334-3698-00		1		. PLATE IDENT:		
	252-0683-00		FT		. FSTNR TAPE,HOOK:1.0 W,NYLON,W/ADH BACK	76381	SJ3503
	252-0684-00		FT		. FSTNR TAPE PILE:1.0 W,NYLON,W/ADH BACK	53387	SJ3527
-5	426-1294-03		1		. FRAME,LT SHIELD:	80009	426-1294-03
-6	352-0511-00		1		. HOLDER,BATTERY:	07322	MR-8220
-7	361-0771-02		1		SPACER,MGF:LENS/SHUTTER	80009	361-0771-02
-8	380-0470-09		1		HOUSING LENS:W/SHUTTER	80009	380-0470-09
-9	131-1160-01		1		. CLIP,ELECTRICAL:BATTERY,W/TERMINAL LUGS	80009	131-1160-01
-10	366-1704-01		1		. KNOB:GY,0.127 ID X 0.392 OD X 0.4 H,W/SKIRT	80009	366-1704-01
-11	210-0583-00		1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BBS	73743	2X20319-402
-12	210-0046-00		1		. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-13	210-0562-00		1		. NUT,PLAIN,HEX.:0.25-40 X 0.312 INCH,BRS	73743	2X20224-402
-14	210-0940-00		1		. WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-15	210-0405-00		4		NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
-16	210-0001-00		2		WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-17	122-1009-00		1		LENS SET,CAMERA:	80009	122-1009-00
-18	343-0738-00		1		RETAINER,LENS:REAR (ATTACHING PARTS)	80009	343-0738-00
-19	213-0805-00		3		SCREW,TPG,TF:2-28 X 0.188,PLASTITE,PNH	93907	OBD
	-----				- - - * - - -		
-20	-----		1		. CKT BOARD ASSY:SHUTTER CONTROL(SEE A1 EPL) (ATTACHING PARTS)		
-21	213-0119-00		2		. SCR,TPG,THD FOR:4-24 X 0.375 INCH,PNH STL	83385	OBD
-22	211-0081-00		1		. SCREW,MACHINE:2-56 X 0.562,PNH STL	83385	OBD
-23	210-0001-00		1		. WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
	-----				- - - * - - -		
-24	131-0608-00		11		. . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-25	-----		1		. . SWITCH,TOGGLE:(SEE S1 EPL)		
-26	200-1295-00		1		. . CAP.,SW HANDLE:BLACK	09353	8968-2
-27	-----		1		. . RES.,VAR,NONWIR:(SEE R9 EPL)		
-28	210-0046-00		1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-29	175-5104-00		1		CA ASSY,SP,ELEC:2,22 AWG,3.0 L	80009	175-5104-00
	352-0169-01		1		. CONN BODY,PL,EL:2 WIRE BROWN	80009	352-0169-01
-30	175-2632-00		1		CA ASSY,SP,ELEC:3,22 AWG,3.0 L	80009	175-2632-00
	352-0161-00		1		. HLDR,TERM CONN:3 WIRE BLACK	80009	352-0161-00
-31	386-4275-00		1		PLATE,SHTR ASSY:	80009	386-4275-00
-32	200-2174-00		1		COVER,SHUTTER: (ATTACHING PARTS)	80009	200-2174-00
-33	211-0003-00		2		SCREW,MACHINE:2-56 X 0.875 INCH,PNH,STL	83385	OBD
	-----				- - - * - - -		
-34	361-0903-00		1		SPACER,LENS:0.097 THK,BRASS	80009	361-0903-00
-35	343-0739-00		1		RETAINER,LENS:FRONT (ATTACHING PARTS)	80009	343-0739-00
-36	211-0100-00		1		SCREW,MACHINE:2-56 X 0.750 INCH,PNH,STL	83385	OBD
-37	213-0805-00		1		SCREW,TPG,TF:2-28 X 0.188,PLASTITE,PNH	93907	OBD
	-----				- - - * - - -		
	016-0642-00		1		FLASH UNIT: (ATTACHING PARTS)	80009	016-0642-00
-38	211-0062-00		3		SCREW,MACHINE:2-56 X 0.312 INCH,RDH STL	83385	OBD
-39	210-0405-00		3		NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
	-----				- - - * - - -		
			-		. FLASH UNIT INCLUDES:		
-40	366-1035-00		1		. KNOB:GY,0.126 ID X 0.307 OD X 0.562 H	80009	366-1035-00
-41	334-2708-00		1		. MARKER,IDENT:MKD ON/OFF BRIGHT/DIM	80009	334-2708-00
	334-2770-00		1		. MARKER,IDENT:MKD CAUTION	80009	334-2770-00
-42	200-1932-00		1		. DOOR,CRT VIEW:W/FLASH PLASTIC	80009	200-1932-00
-43	380-0469-00		1		. HOUSING,FLASH:	80009	380-0469-00
-44	-----		1		. CKT BOARD ASSY:GRATICULE FLASH(SEE A2 EPL) (ATTACHING PARTS)		
-45	211-0119-00		4		. SCREW,MACHINE:4-40X0.25" 100 DEG,FLH,STL	83385	OBD
-46	129-0599-00		4		. SPACER,POST:0.422 L,4-40 THD,AL,0.312 OD	80009	129-0599-00
	-----				- - - * - - -		

Replaceable Mechanical Parts—C-5C Camera

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-47	378-0846-01		-		. . CKT BOARD ASSY INCLUDES:		
			1		. . REFLECTOR, LIGHT: W/MARKING (ATTACHING PARTS)	80009	378-0846-01
-48	211-0014-00		4		. . SCREW, MACHINE: 4-40 X 0.50 INCH, PNH STL	83385	OBD
-49			1		. . SWITCH, SLIDE: (SEE S60 EPL)		
-50			1		. . LAMP: (SEE CR29 EPL)		
	352-0360-01		1		. . HOLDER, LED: 212/214	80009	352-0360-01
-51	131-0608-00		3		. . TERMINAL, PIN: 0.365 L X 0.25 PH, BRZ, GOLD PL	22526	47357
-52			1		. . RES., VAR, NONWIR: (SEE R27 EPL)		
-53			1		. . SCR: (SEE Q48 EPL)		
	386-1130-00		1		. . INSULATOR DISC: TRANSISTOR, NYLON	13103	7717-15N
	198-3952-00		1		. . WIRE SET, ELEC:	80009	198-3952-00
-54	175-0826-00		FT		. . WIRE, ELECTRICAL: 3 WIRE RIBBON	80009	175-0826-00
-55	131-0707-00		3		. . CONNECTOR, TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
-56	352-0161-00		1		. . HLDR, TERM CONN: 3 WIRE BLACK	80009	352-0161-00
	198-3068-00		1		. . WIRE SET, ELEC:	80009	198-3068-00
-57	175-0828-00		1		. . WIRE, ELECTRICAL: 5 WIRE RIBBON	08261	OBD
-58	200-1933-00		1		. . DOOR, CRT VIEW: WITHOUT FLASH	80009	200-1933-00
			-		. (OPTION 1 AND 2 ONLY)		
-59	016-0357-01		1		ADAPTER HOOD:	80009	016-0357-01
			-		(STANDARD AND OPTION 1 ONLY)		
-60	016-0359-01		1		ADAPTER HOOD:	80009	016-0359-01
			-		(OPTION 2 ONLY)		
-61	016-0358-01		1		ADAPTER HOOD:	80009	016-0358-01
			-		(OPTION 3 ONLY)		
					(ATTACHING PARTS)		
-62	211-0088-00		3		SCREW, MACHINE: 2-56 X 0.281" 82 DEG, FLH STL	77250	OBD
					- - - - *		



C-5C Camera

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
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STANDARD ACCESSORIES

070-2824-00

1 MANUAL, TECH: INSTRUCTION

80009 070-2824-00

@

C-5C Camera

ACCESSORIES

