396 Dual Color Sensitometer

Operation Manual

x-rite
FCC
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Canada
CAN ICES-3 (A) / NMB-3 (A)

Calibratable Sensitometer
Designed and manufactured to comply with the calibration requirements described in DIN V 6868-55.
CE DECLARATION

Hereby, X-Rite, Incorporated, declares that this 396 Series is in compliance with the essential requirements and other relevant provisions of Directive(s) EMC 2004/108/EC and RoHS 2011/65/EU (Category 9).

Instructions for disposal: Please dispose of Waste Electrical and Electronic Equipment (WEEE) at designated collection points for the recycling of such equipment.

Proprietary Notice

The information contained in this manual is derived from patent and proprietary data of X-Rite, Incorporated. This manual has been prepared solely for the purpose of assisting in the use and general maintenance of this instrument.

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Limited Warranty

X-Rite warrants this Product against defects in material and workmanship for a period of twelve (12) months from the date of shipment from X-Rite’s facility, unless mandatory law provides for longer periods. During such time, X-Rite will either replace or repair at its discretion defective parts free of charge.

X-Rite’s warranties herein do not cover failure of warranted goods resulting from: (i) damage after shipment, accident, abuse, misuse, neglect, alteration or any other use not in accordance with X-Rite’s recommendations, accompanying documentation, published specifications, and standard industry practice; (ii) using the device in an operating environment outside the recommended specifications or failure to follow the maintenance procedures in X-Rite’s accompanying documentation or published specifications; (iii) repair or service by anyone other than X-Rite or its authorized representatives; (iv) the failure of the warranted goods caused by use of any parts or consumables not manufactured, distributed, or approved by X-Rite; (v) any attachments or modifications to the warranted goods that are not manufactured, distributed or approved by X-Rite. Consumable parts and Product cleaning are also not covered by the warranty.

X-Rite’s sole and exclusive obligation for breach of the above warranties shall be the repair or replacement of any part, without charge, which within the warranty period is proven to X-Rite’s reasonable satisfaction to have been defective. Repairs or replacement by X-Rite shall not revive an otherwise expired warranty, nor shall the same extend the duration of a warranty.

Customer shall be responsible for packaging and shipping the defective product to the service center designated by X-Rite. X-Rite shall pay for the return of the product to Customer if the shipment is to a location within the region in which the X-Rite service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations. Proof of purchase in the form of a bill of sale or receipted invoice which
is evidence that the unit is within the Warranty period must be presented to obtain warranty service. Do not try to dismantle the Product. Unauthorized dismantling of the equipment will void all warranty claims. Contact the X-Rite Support or the nearest X-Rite Service Center, if you believe that the unit does not work anymore or does not work correctly.

THESE WARRANTIES ARE GIVEN SOLELY TO BUYER AND ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR APPLICATION, AND NON-INFRINGEMENT. NO EMPLOYEE OR AGENT OF X-RITE, OTHER THAN AN OFFICER OF X-RITE, IS AUTHORIZED TO MAKE ANY WARRANTY IN ADDITION TO THE FOREGOING.

IN NO EVENT WILL X-RITE BE LIABLE FOR ANY OF BUYER’S MANUFACTURING COSTS, OVERHEAD, LOST PROFITS, GOODWILL, OTHER EXPENSES OR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES BASED UPON BREACH OF ANY WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT TORT, OR ANY OTHER LEGAL THEORY. IN ANY EVENT OF LIABILITY, X-RITE’S MAXIMUM LIABILITY HEREUNDER WILL NOT EXCEED THE PRICE OF THE GOODS OR SERVICES FURNISHED BY X-RITE GIVING RISE TO THE CLAIM.

This agreement shall be interpreted in accordance with the laws of the State of Michigan and jurisdiction and venue shall lie with the courts of Michigan as selected by X-Rite, Incorporated.
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1. Getting Started

Unpacking and Inspection

After removing the instrument from the shipping carton, inspect for possible damage. If any damage has occurred during shipping, immediately contact the transportation company. Do not proceed with installation until the carrier’s agent has inspected the damage.

If damage is not evident, check to make sure that the following items are included:

- Sensitometer
- Getting Started Manual
- Certificate of Calibration
- Registration Card
- Important Notice

Your instrument was packaged in a specially designed carton to assure against damage. If reshipment is necessary, the instrument should be packaged in the original carton. If the original carton is not available, contact X-Rite at: 1-888-826-3044 or 1-616-803-2100 to have a replacement shipped to you.
Instrument Description

The 396 Sensitometer is a battery operated, dual color, single sided exposure sensitometer, designed for quality control of cine and X-ray processing systems. It produces a repeatable stepped exposure on applicable film.

Its ease of operation enables anyone with little instruction to expose repeatable sensitometry strips, with either blue or green exposing light—simulating the light from blue and green intensifying screens.

Advanced low-power circuitry allows a long battery life without sacrificing performance. Replacement battery is a 9-volt alkaline type.
Applying Power

The sensitometer is shipped from the factory with the 9v alkaline battery installed and the power switch in the “Off” (left) position. When you are ready to use, slide the switch to the “On” (right) position. The power switch is located on the front of the instrument.

Your sensitometer is designed to operate from a 9v alkaline battery for approximately one year.

For optimum battery life, turn off the instrument when not in use.

When the battery is low, the circuit will not allow any exposures to occur. Should your unit become inoperative, replace the battery first. Refer to Section Four to see battery replacement procedure. If this does not rectify the problem, refer the instrument to X-Rite or an authorized service center for proper servicing.

There are no user serviceable components in the sensitometer.
2. Application and Procedures

Sensitometer Monitoring For Process Control

The sensitometer exposes film with a known quantity of light through a 21-step light modulator. The maximum light is emitted from Step No. 21. Each successive step emits approximately 70.7% of the light emitted from the step adjacent to it (.15 log exposure). The processed film responds to this exposure in a predictable manner. A plot of optical density—measured on the processed film—against relative log exposure values is known as the D-Log E curve. Figure One shows the response of a typical radiographic film to exposure with the sensitometer. The portion of the curve that changes most with variations in processing is called the “straight line portion” of the curve.

It is not necessary to plot D-Log E Curves to monitor automatic processors in normal laboratory environments. A simpler method is to record the three parameters from the D-Log E Curve which contain most of the data.

The following three parameters on the curve should be monitored to give pertinent processing data.

- **Base+Fog:** Step No. 1 on the D-Log E Curve is called Base+Fog the least exposed portion of the film. It is the base support density plus any silver emulsion density developed in the area where negligible exposure should occur.

- **Mid Density (Speed Index):** The density step on the exposed film that has a density closest to but not less than 1.20D. This step is a direct indicator of film speed. Variations in processor conditions are monitored on this step.
• **Density Difference (Contrast Index):** This is a calculation of the slope in the straight-line portion of the D-Log E Curve. Choose the High Density (HD) step as the step closest to 2.20D. The Low Density (LD) step is chosen as the step closest to but not lower than 0.45D. The Contrast Index or Density Difference is the difference between HD and LD.

**FIGURE 1. D-Log E Curve**

Optical density versus relative log exposure for typical radiographic film.
Selection and Use of Film
The film selected to monitor a given processor should be representative of the film used with that processor.

Scheduling Sensitometric Control
Every processor in use should have a separate control chart plotted to monitor its behavior. The more frequent the data points, the better the control feedback. A control film should be run at start-up of the processor and at least once a day. Use sensitometry whenever trouble is suspected, or a change has been made to the process.

Processing Procedure

1. Allow the processor temperature and chemistry to reach equilibrium when starting up the processor before processing film.

2. Films should be processed immediately after being exposed. Any delay between exposure and processing should be consistent from film to film.

3. Run a full width film for cleanup at start-up.

4. Orient the film into the processor in a consistent manner—making sure the film is inserted per processor manufacturer's specification.
5. After processing of film is complete, record the date, time, and processor identification number on the film in the designated areas.

**Manual Data Recording Procedure**

**Establishing Normal Mid Density, Density Difference, and Base+Fog**

The normal mid density (speed index), density difference (contrast index), and base+fog values are established on a representative film, when the processor is considered to be operating in an optimum fashion.

Run several film samples and determine the average values for mid density, density difference, and base+fog, using a transmission densitometer. Step wedge areas are as uniform as is possible to produce. There are, however, some errors at the edges of the step area. Therefore, always measure density at the center of the step. Use a 2mm aperture to give best repeatability.

Record the following data on a process control record:

- **Developer Temperature** - Temperature of developer solution in processor during processing
- **Normal Base+Fog** - Step number one density, the least exposed step on the wedge.
- **Normal Mid Density (Speed Index)** - The density step on the exposed film that has a density closest to but not less than 1.20D. The step number should remain the same for a given processor and film type.
- **Normal Density Difference (Contrast Index)** - Choose the High Density (HD) step as the step closest to 2.20D. The Low Density (LD) step is chosen as the step closest to but not lower than 0.45D.
NOTE: Monitor subsequent films on the same steps selected for normal density difference.

- **Date** - Month - Day – Year
- **Processor Number** - Processor identification
- **Emulsion Number** - Film batch identification
- **Developer Type** - Developer vendor identification
- **Fixer Type** - Fixer vendor identification
- **Film Type** - Film vendor identification
- **Exposure Color** - Exposure light (blue or green)
- **Developer Replenisher Rate** - The rate of developer replenishment
- **Fixer Replenisher Rate** - The rate of fixer replenishment
- **Processing Time** - Film process time, input-to-output

A box of film should be set aside from regular stock for exclusive sensitometer use. New film stock will require re-establishment of normal values because small density changes are possible between film batches.

**Daily Plotting of Data on Process Control Record**
Plot the Mid Density (Speed Index), Density Difference (Contrast Index), Base+Fog, and Developer Temperature results on the process control record each time a control film is developed. Record data immediately so that it is not lost or changed.
Automatic Data Recording Procedure Using the 391 Densitometer

When the X-Rite 391 densitometer is used to measure process control films, it will automatically calculate and store the values for: mid density (speed index), density difference (contrast index), and base+fog. The unit will also store up to 32 measurements of film data for twelve processors.

Printing Process Control Records

The 391 densitometer will printout the process control record when interfaced to a printer (see below).
Processor Troubleshooting

When troubleshooting out of tolerance processor conditions, use Mid Density (Speed Index) as the primary guide. This is the most predictable indicator for all film types. Base+Fog is predictable, but is the least sensitive. Density Difference (Contrast Index) reacts predictably for a given set of film conditions but may vary from film to film.

Listed below is a chart showing Mid Density and Base+Fog reactions to common processor problem conditions.

As Control Records become more complete for a given film, the relationships between Density Difference and Processor Conditions will become apparent. Always note the reason for out-of-tolerance processor condition on the Control Record.

**NOTE:** When out-of-tolerance conditions are noticed, always verify results with another test film before making any processor adjustments.

<table>
<thead>
<tr>
<th>Mid Density</th>
<th>Base+Fog</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>High or Normal</td>
<td>Developer temperature too high.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developer over replenished.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improper safe lighting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improper solution mix.</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>Low or Normal</td>
<td>Developer temperature too low.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developer under replenished.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inadequate developer circulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improper solution mix.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contaminated developer.</td>
</tr>
</tbody>
</table>
3. Using the Sensitometer

Setting Exposure Color
Optimum sensitometric control occurs when the proper color light exposes the film. Expose with the same color emitted from the intensifying screen recommended by the film manufacturer for the film being exposed. For example, when using blue emitting intensifying screen—expose in “BLUE” position. Slide the color switch on the front of the unit to the left for “BLUE” or to the right for “GREEN.”

NOTE: The exposure time should be set in accordance with the manufacturers requirements. See Adjusting Exposure Setting.

Adjusting Exposure Setting
The sensitometer can be adjusted for seven different exposure times. The factory preset exposure setting is #3. If different exposure times are required, refer to the chart on the next page or on the bottom of unit for the switch position requirements. Each exposure setting moves the mid density (speed index) on the film one
step. The dipswitch used to adjust the exposure time is located on the bottom of the unit.

<table>
<thead>
<tr>
<th>Exposure Setting</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>2</td>
<td>I</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>3</td>
<td>O</td>
<td>I</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>4</td>
<td>O</td>
<td>O</td>
<td>I</td>
<td>O</td>
</tr>
<tr>
<td>5</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>O</td>
</tr>
<tr>
<td>6</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>I</td>
</tr>
<tr>
<td>MAX</td>
<td>O</td>
<td>O</td>
<td>I</td>
<td>I</td>
</tr>
</tbody>
</table>

Exposing Film

IMPORTANT NOTES:

- Film must be inserted all the way to the back of the unit in order to be exposed properly.

- The sensitometer is calibrated to expose screen-type films normally used for general radiography to an approximate density of 1.0D + Base + Fog on Step No. 11.

- If the X-Rite 390 or 391 Densitometer is used to measure film strips, the sensitometric exposure must meet the following criteria:
- The exposure must have a gamma of .7 or greater on steps 7 through 15. (increasing density increments of at least .11D).
- The film must have at least 1.25 inch of clear leader at both ends of the exposure. The use of 8" x 10" or 18cm x 24cm film is recommended.

Expose the selected film as follows:

1. Select exposure color—blue or green.
2. Adjust exposure setting if required.
3. Insert the film—emulsion side down—with the back edge against the stop, and the film centered in the unit.
4. Press the cover down and hold firmly until the beeper has sounded. Always press down in the center of the cover.
5. Allow cover to raise and remove the film immediately.

6. Develop the film in the processor to be monitored (refer to Section 2).

7. Record data on film immediately after development (refer to Section 2).
4. General Maintenance

Repair Information
The 396 Instrument is covered by a one-year limited warranty—excluding alkaline battery—and should be referred to the factory for repair within the warranty period. Attempts to make repairs within this time frame may void the warranty.

X-Rite provides a factory repair service to their customers. Because of the complexity of the circuitry, all repairs should be referred to the factory.
X-Rite will repair any 396 past warranty. The customer shall pay shipping cost to the factory, and the instrument shall be submitted in the original carton, as a complete, unaltered unit.

Calibration/Recertification
X-Rite sensitometers are calibrated at exposure setting “3” at the factory. The exposure of Step 11 is adjusted to match factory standard instruments maintained by X-Rite.

A certificate of calibration is provided with each instrument, along with a calibration sticker that is initialed and dated by the Quality Assurance Inspector. Because calibration requires a master instrument for comparison, sensitometers do not have user accessible calibration adjustments. X-Rite offers a recertification program to verify sensitometer calibration. Recertification is recommended every 12 months and can be arranged through X-Rite’s Customer Service Department.
Cleaning the Instrument

Your instrument requires very little maintenance to achieve years of reliable operation. The following cleaning procedures should be performed from time to time.

General Cleaning
The exterior of the instrument may be wiped clean with a cloth dampened in water or a mild cleaner, whenever required.

NOTE: DO NOT use any ketone solvents to clean the unit, this will cause damage to the cover.

Cleaning the Step Tablet
The step tablet should be cleaned of dust and lint periodically to maintain consistent exposures.
Clean the tablet with lens tissue or a lint-free cloth.
Replacing the Battery

A low battery condition prevents exposures from occurring. Always Replace The Battery before referring the unit for service.

1. **Turn Power Switch “Off”** and remove battery access cover.
2. Disconnect old 9-Volt battery from the circuit and discard appropriately.
3. Connect a new **9 Volt Alkaline** battery to the circuit—recognizing proper polarity—and insert into the compartment.
4. Reinstall battery access cover and turn power “On.”
5. Technical Specifications

**Design Conformance:** A.N.S.I. PH2.9-1974*

**Unit-to-Unit Repeatability:** ±.02 Log Exposure

**Exposure Stability:** ±.02 Log Exposure per year

**Temperature Sensitivity:** ±.02 Log Exposure from 59°F (15°C) - 86°F (30°C)

**Light Modulation:** 21-Step Wedge, 0.15D per step

**Blue Color Peak Wavelength:** 460nm ±10nm

**Green Color Peak Wavelength:** 510nm ±10nm

**Warm-up Time:** Instantaneous

**Recycle Time:** 2 Seconds

**Supply Voltage:** 9-Volt alkaline battery

**Current:** 300mA

**Frequency Range:** 50/60Hz

**Ambient Temp.:** 25°C

**Operating Temp.:** 15°C to 35°C

**Relative Humidity:** Not to exceed 75%

**Installation Category:** II

**Usage:** Indoor Only

**Altitude:** 2000m

**Pollution Degree:** 2

**Dimensions:** 7.0in. (17.78cm) W x 3.75in. (9.50cm) D x 2.3in (5.84cm) H

**Weight:** 9 lbs. (.410kg.)

* American National Standards Institute compliance except as noted.

This instrument may be covered by one or more patents. Refer to the instrument for actual patent numbers.

Specifications and design subject to change without notice.