

Industrial Fiberscope

Operating Manual



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Introduction

Thank you for purchasing a GE Inspection Inspection Technologies industrial fiberscope. We value your business and appreciate you choosing us as your remote visual inspection provider.

Our family of fiberscopes includes standard models ranging in diameter from 2.4mm to 8.4mm, and non-articulating fiberscopes as small as 0.5mm diameter. Where possible, models incorporate ultra-thin fiber technology, to provide the highest quality imaging, and use wear-resistant metallic outer braids or polyurethane-coated tungsten for increased durability.

By following the use and care instructions in this guide, you will be rewarded with years of dependable, trouble-free service. Please read these instructions completely before use.

Warnings and Precautions

The following precautions will help you to use your fiberscope safely and prolong its life.

- Do not bend or twist the articulating section at the end of the insertion tube by hand. Always use the articulation controls to move the tip.
- Whenever inserting or withdrawing the fiberscope, first adjust the articulation controls to the relaxed neutral position to straighten the tip. Ensure the articulation lock is released, so the tip is free to bend as needed.
- Never apply excessive force when inserting or withdrawing the fiberscope. The flexible bending section is vulnerable to tension and compression forces and may be damaged.
- Never try to force articulation knobs beyond their mechanical stops.
- Keep protective caps on all glass surfaces when the system is not in use.
- Protect the fiberscope from unnecessary moisture, heat, dust and shock.
- Never leave the scope unattended when it is connected to an operating light source.
- Do not leave the fiberscope connected to an operating light source for extended periods of non-inspection time.
- Never use the instrument to observe within a human or animal body.
- Never insert the fiberscope into areas of live voltage.
- Use only recommended accessories (page 18), because other components may lead to unpredictable performance.

System Description

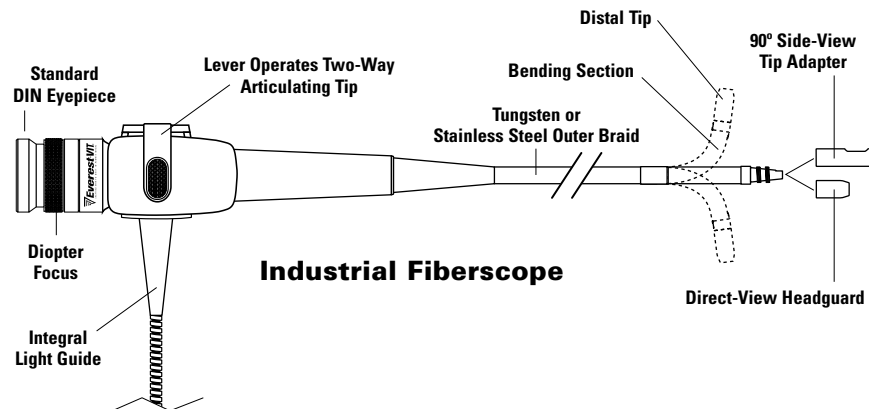
Fiberscopes consist of two separate and different fiber-optic bundles running through a protective insertion tube that has viewing optics on the distal end and an eyepiece on the other. One fiber bundle is designed to carry light from a light source to the viewing tip and is called the Illumination Bundle or Light Guide. The other is designed to carry an image from the viewing tip to the eyepiece and is called the Imaging Bundle or Image Guide. One end of each bundle terminates in the distal tip with the purpose of illuminating and capturing an image, while the opposite ends terminate separately, the Imaging Bundle in the eyepiece and the Illumination Bundle in the light guide connector. Imaging performance is primarily dependent on the quality of these fibers and lens sets.

Below is a description of the functional components of a fiberscopes.

Imaging System

The imaging system includes the eyepiece optics, the fiber-optic imaging bundle, and the distal lens set.

The eyepiece magnifies the image carried back by the imaging bundle for viewing by the human eye. On most models the eyepiece includes a diopter focus adjustment so different users can adjust the lens set to their particular vision prescription and use the fiberscope without glasses. All GE Inspection Technologies' eyepieces are of standard "DIN" design and therefore compatible with standard eyepiece attachments such as camera couplers.



Imaging System (continued)

The imaging bundle is a continuous strand of flexible glass fibers that carry the image from the distal tip back to the eyepiece. The high-resolution image of GE Inspection Technologies' fiberscopes is due primarily to the extremely small diameter and high light transmission efficiency of our imaging fibers.

The distal lens set is a combination of precision micro lenses that capture images and focus them into the small imaging bundle. Many GE Inspection Technologies fiberscope models are equipped with a special distal section that accepts an additional lens set that changes the direction of view from forward to side. This side-view tip adapter enables the same scope to be used as either a forward-viewing scope or side-viewing scope. A direct, forward-viewing tip is provided with the fiberscope. The side-viewing tip is available as an optional accessory.

Illumination System

The illumination system includes a fiber-optic light guide that carries light from a light source to the target area and any distal lenses that may focus or spread the light as it is projected.

Almost all GE Inspection Technologies models use a single, continuous fiber-optic bundle that extends from the distal tip through the insertion tube and out to a light source. Others use an internal fiber-optic bundle up to the scope body and then connect to an external light guide that extends to the light source. The continuous bundle design has the highest efficiency and is therefore the preferred method. A detachable light guide design is less expensive to repair and sometimes used on very short length models where transmission efficiency is not as critical.

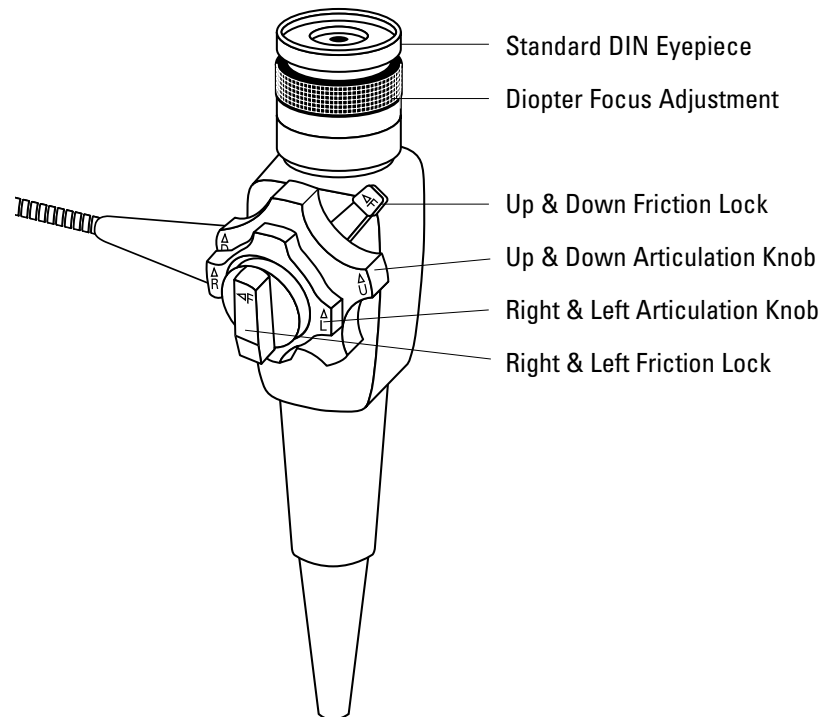
Models with a "U" in the model number prefix contain a special illumination bundle made of quartz fibers. These fibers provide optimum performance for transmitting ultraviolet light to the inspection area and are intended for use in applications where fluorescent dyes need to be stimulated with ultraviolet light.

Articulation System

Articulation refers to the ability of the operator to “steer” the fiberscope tip. GE Inspection Technologies’ fiberscopes are either 4-way articulating with a set of knob controls, 2-way articulating with a lever control, or non-articulating.

Articulation is accomplished by a set of steel cables that extend from the distal section back to the scope body, and an articulating collar assembly in the bending section. The cables push and pull the articulating collars together or apart in order to “steer” the viewing tip in a desired direction. The operator uses the knob or lever control on the scope body to push and pull the proper cables. Both articulation control devices include a locking mechanism should the operator want the tip to stay where pointed instead of returning toward the neutral forward direction.

4-way Articulating Models



Fiberscope Body

The body, or hand-piece, is the control section of the fiberscope and is designed to facilitate one-hand operation of the articulation controls while looking in the eyepiece. This leaves the operator's other hand free to push, pull and rotate the flexible insertion tube. Both hands work together to position the distal section and point the viewing tip toward the area to be inspected.

Insertion Tube

The insertion tube is most of the working length of the fiberscope and is constructed to be durable and flexible at the same time. Its flexibility allows it to be snaked through equipment bends in order to reach to areas not accessible by rigid borescopes or other inspection instruments. Its durable construction protects the optical fiber bundles and houses the articulation cables. All models have a stainless steel monocoil at their center for resistance to accidental crushing, and most incorporate a steel outer braid or tungsten braid.

Bending Section

The bending, or articulation, section connects the insertion tube to the distal viewing section and houses the articulating collar assembly. This is most flexible part of the scope, allowing the tip to be pointed in almost any direction. Its need for flexibility however makes it the most vulnerable part of the scope, and it can not tolerate the same rough handling as the insertion tube, although its outer braid does provide protection from sliding over rough surfaces.

Distal Section

The distal section houses the termination points of both the illumination fiber bundle and imaging bundle. The distal section also contains the precision micro lenses that focus images into the imaging bundle. All of these components are positioned in careful orientation so as to provide the highest possible imaging performance. Scope models are available with forward-viewing tips, side-viewing tips, or interchangeable tips that use both forward and side-viewing tip adapters.

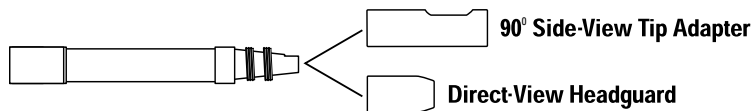
System Setup

Setup consists only of installing the desired tip adapter (for models equipped for interchangeable tips), focusing the eyepiece to your eye, making a few checks to ensure the fiberscope is operating properly, and plugging the light guide into an available light source.

To Change the Tip Adapter

1. Unscrew the tip until it clears both sets of threads. Store in tip adapter case.
2. Screw on the new tip until it completely clears the first set of threads.
3. Rotate the tip on the scope until the keyed flat finds the flat on the scope distal section.
4. Slide the tip down to the second set of threads and screw on until finger-tight.

DO NOT USE ANY TOOLS OTHER THAN YOUR HAND TO TIGHTEN THE TIP OR DAMAGE MAY RESULT!



Focus the Eyepiece

To focus the eyepiece optics for your eye, simply rotate the focus knob while looking into the eyepiece. The viewing tip of the fiberscope should be pointed at a small object with sharply defined edges. Typed text on white paper is a recommended target for this adjustment.

Check Operation

Before using the fiberscope it is a good practice to check for any visible damage as well as operation of the tip articulation and clarity of the image. Look for any sign of penetration or crushing of the insertion tube, bending neck or distal section that might indicate damage to the imaging system, or other damage that might compromise performance. Check for adequate tip articulation by rotating the control knobs or moving the control lever. Look through the eyepiece to ensure the fiberscope is providing a good image (connect light guide to a light source for this check). If damage is found or performance inadequate, return the scope to the Service Center for evaluation and repair.

Plug Into a Light Source

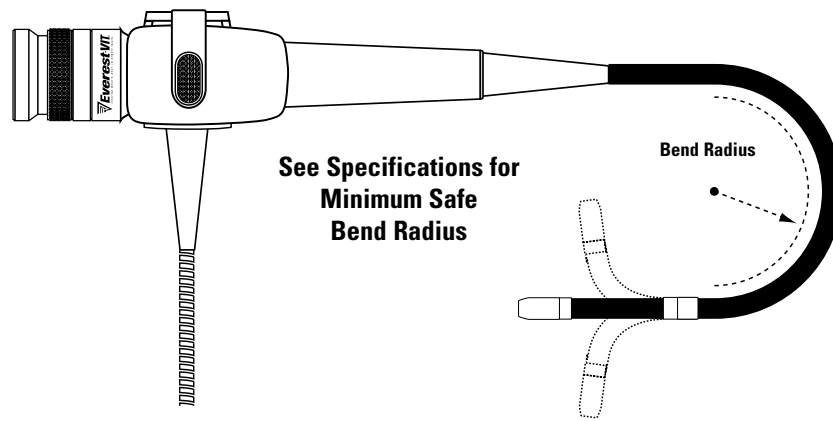
Insert the light guide connector into the light guide socket of an GE Inspection Technologies or other compatible light source. Turn the light source on, wait about 30 seconds for the lamp to reach peak intensity, and check to ensure a bright light is projected from the viewing tip of the fiberscope. The fiberscope is now ready to use.

Operation

To effectively perform a fiberscope inspection, you must be familiar with the internal design of the equipment you are inspecting and also be familiar with the operation of the fiberscope. Inside the equipment your vision will be limited to the scope's field-of-view, so you must be able to visualize the location of the fiberscope and its orientation to the area to be inspected.

Holding the Fiberscope

Hold the fiberscope body in one hand in a way that is comfortable and allows you to both look into the eyepiece and actuate the articulation control. Use the other hand to hold the insertion tube and guide it toward the inspection area. Be sure not to bend the insertion tube or bending section into a tighter bend radius than noted in the specifications. This will cause damage to the imaging and illumination fibers.



Inserting the Fiberscope

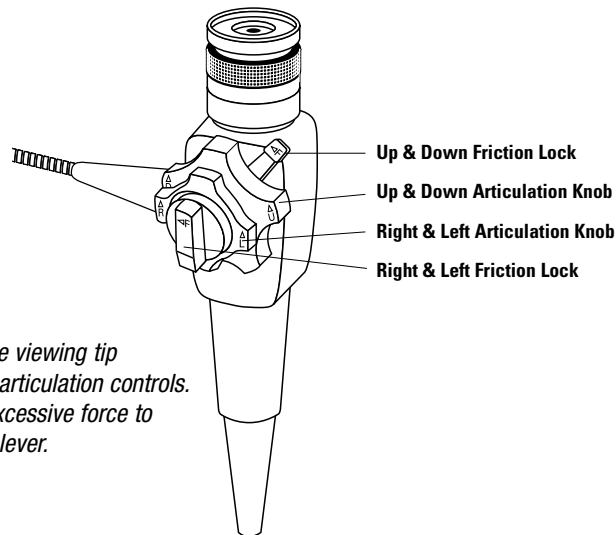
Before inserting the fiberscope into equipment, ensure that the bending section is straight and the articulation lock is not engaged. The tip should move freely when the articulation controls are moved. With the tip in the forward neutral position, slowly begin to insert the scope into the equipment. Look into the eyepiece to see where the scope is pointed as you guide the tip to the inspection area. If a bend must be negotiated, articulate the tip in the direction of the bend so as to keep the tip from buckling. If the scope is hindered while maneuvering around objects or bends, rotate the tube back and forth while moving it forward. This kind of movement helps to overcome snags on equipment edges. Continue guiding the scope forward until the target area is visible in the eyepiece.

Articulating the Viewing Tip

To articulate the tip, either rotate the knob controls or move the lever, depending on which model you are using. In the dual knob configuration, one knob controls right/left movement and the other controls up/down. In the lever configuration, the lever controls up/down movement, but can be used to achieve right/left by rotating the insertion tube 90 degrees before moving the lever.

Both articulation control devices include a friction lock mechanism. Use this friction lock to fix the tip in the direction to which you articulate. You can also apply the lock loosely before articulating, and then lock it down tightly after the tip is in the final viewing position.

4-way Articulating Model



CAUTION: Never bend the viewing tip by hand. Always use the articulation controls.

CAUTION: Never apply excessive force to the articulation knobs or lever.

Withdrawing the Fiberscope

When the inspection is completed, carefully withdraw the fiberscope. **Be sure to release all articulation locks prior to withdrawal in order to prevent damage to the articulation system.** Move the articulation controls back and forth to ensure they are in the loose neutral position and the tip is free to bend as needed during withdrawal. Pull out the scope slowly, and be ready to catch the viewing tip when it exits to prevent slapping and possible damage to the tip optics. If the scope snags on equipment edges, try rotating the tube back and forth.

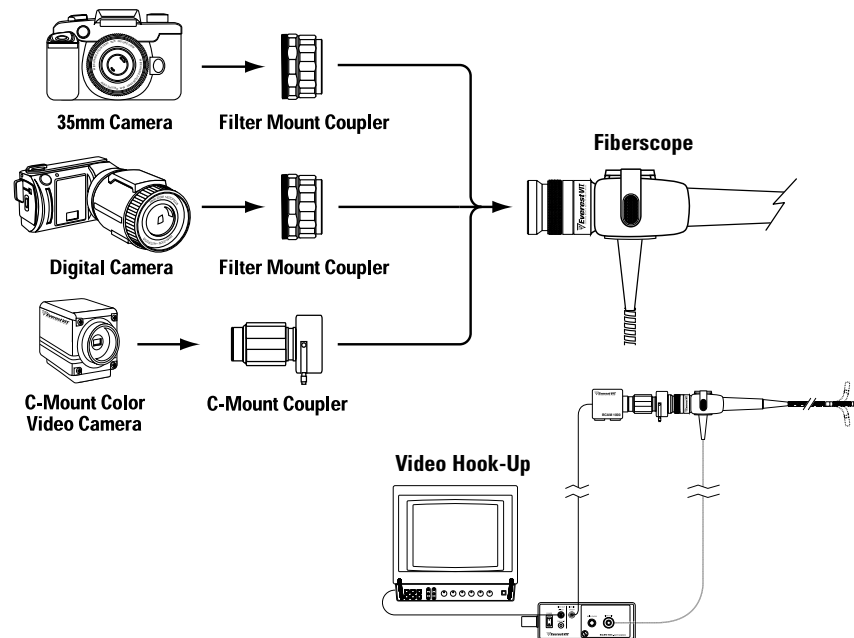
Using Cameras with the Fiberscope

Borescope video cameras, still 35mm cameras and digital cameras can be used with fiberscopes to document inspection images on videotape, 35mm film or digital data storage devices. See your local GE Inspection Technologies Sales Representative to determine which is best for you. Each requires an optical coupler to attach the camera to the fiberscope eyepiece. The right coupler depends on the camera being used.

Borescope Video Cameras usually have a standard “c-mount” fitting which requires a c-mount coupler. These couplers can have different focal lengths which determine the screen magnification of the fiberscope image, which in turn can impact image brightness. The right coupler will depend on the diameter of the scope being used and the available light on the target surface. You may want to have more than one of these couplers to optimize performance on each inspection.

35mm SLR Cameras require a threaded coupler that will screw on to the lens of the specific camera being used. The diameter of the threads must match the lens thread diameter, so have this diameter information available when selecting the threaded coupler.

Digital Cameras must have a similar lens thread to the 35mm SLR cameras in order to be used with fiberscopes. As with the 35mm SLR camera, have the thread diameter available when selecting the threaded coupler.



User Care and Maintenance

User maintenance on a fiberscope can be summed up in two parts: keeping the scope clean, and storing it properly when not being used. Care of the fiberscope during use is also important and will affect frequency of repair.

Cleaning the Fiberscope:

After each use, clean and dry the fiberscope to prevent corrosion and long-term exposure to residual chemicals.

1. Clean the insertion tube with soapy water, then rinse and dry.
2. Clean the glass surfaces in the viewing tip, light guide connector and eyepiece with a soft cloth and an alcohol/water solution. Common household glass cleaners will work as well (Windex®, etc.).
3. Clean the fiberscope body with a damp cloth. DO NOT immerse the body in water; it is not watertight.

Packing and Storing the Fiberscope:

When packing the fiberscope, take care to:

- Ensure all articulation locks are released.
- Replace protective cap on the eyepiece.
- If equipped with a detachable tip adapter, secure in its protective case.
- Secure entire scope length in storage cut-out before closing case lid.
- If stored outside of case, do not coil the tube in a smaller diameter than is designed into case storage section.

CAUTION! Do not let case lid fall on insertion tube.

Store the system in its carrying case away from water, high humidity, high temperature, direct sunlight, dust, salinity, chemicals, x-rays, vibration and shock.

User tips for longer scope life

- Do not move or twist the bending section at the end of the insertion tube by hand.
- When inserting or withdrawing the scope, articulate the tip to the relaxed forward position and ensure the friction lock is released.
- Never apply excessive force when inserting or withdrawing the tube.
The tip may be caught, and strong tensile force can damage the bending neck.
- Never try to force articulation knobs beyond their mechanical stops.
- Keep protective caps on all glass surfaces when the scope is not in use.
- Protect the fiberscope from unnecessary moisture, heat, dust and shock.
- Do not leave the fiberscope connected to an operating light source for long periods of non-inspection time.
- Clean the fiberscope after every use.

Troubleshooting

The following troubleshooting hints should help you to solve some performance problems on site. If a problem is not solved using these suggestions, call the Service Center at the number listed under the SERVICE section and arrange to return your fiberscope for evaluation and repair. ***Never attempt to disassemble the fiberscope.***

If Image is Not Clear and Sharp...

- Object may be out of focus. Try adjusting eyepiece diopter focus or moving the viewing tip farther or closer to the object.
- If using a detachable tip adapter, the tip may not be properly attached. Detach tip adapter and reinstall.
- Lenses or glass windows may be dirty. Clean glass surfaces on viewing tip and eyepiece with alcohol and cotton swab (or soft cloth). Also clean detachable tips if being used.
- Light may be insufficient. Increase light source intensity or move viewing tip closer to object. Clean tip of light guide connector.
- If using a c-mount camera, and Moire fringes appear (patterns of curved line distortion), try rotating the camera slightly with respect to the eyepiece.

If Articulation is Difficult...

- Articulation locks may be fully or partially engaged. Release locks.
- Articulation cable movement may be hindered by bends in the insertion tube. Keep tube as straight as possible during inspection.
- Viewing tip movement may be blocked due to its position inside equipment. Try to reposition tip by rotating tube or moving tip forward or backward.

Do Not Apply Excessive Force on Articulation Controls!

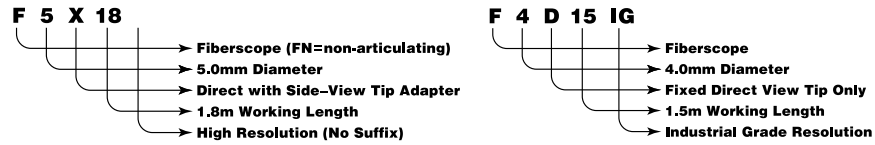
If Image is Not Bright Enough...

- Light source intensity may be at a low setting. Turn to maximum intensity.
- Viewing tip may be too far from object. Move tip closer to object.
- If using a detachable tip adapter, the tip may not be properly attached. Detach tip adapter and reinstall.
- Lenses or glass windows may be dirty. Clean glass surfaces on viewing tip, light guide connector and eyepiece with alcohol and cotton swab (or soft cloth). Also clean detachable tips if being used.
- Light source lamp may have degraded performance. Install new lamp.
- Light source capacity may be insufficient for application. Try higher intensity light source.

System Specifications

Model Number Explanation

The model number on your fiberscope indicates its specific characteristics. Here are two examples that show the methodology:



OPTICAL

Direction of View	Fixed Direct, Fixed Side, or Direct with Side-view Tip Adapter
Field of View	
2.4mm \emptyset models	60°
3.2, 4.0, 5.0, 6.0 8.4 \emptyset models	45°
0.5, 1.5mm \emptyset models	70°
1.0mm \emptyset models	55°
Depth of Field	
2.4, 3.2, 4.0 mm \emptyset models	5 mm (0.20 in.) to infinity
5.0, 6.0 8.4 \emptyset models	6 mm (0.24 in.) to infinity
Distal Focus	Fixed focus lens set

MECHANICAL

Insertion Tube Bend Radius	
2.4 - 6.0 mm \emptyset models	1.25 in.
8.4 mm \emptyset models	1.5 in.
13.6 mm \emptyset models	2.0 in.
Articulation	
Sub-2.4 mm \emptyset models	Non-articulating
2.4 mm \emptyset models	130° Up/Down
3.2 - 6.0 mm \emptyset models	120° Up/Down
8.4 mm \emptyset models	120° Up/Down; 120° Right/Left
Tube Construction	
2.4, 3.2, 4.0, 5.0 mm \emptyset models	Stainless steel monocoil inside watertight PVC and stainless steel outer braid
6.0, 8.4 mm \emptyset models	Stainless steel monocoil inside watertight PVC and polyurethane-coated tungsten outer braid
Integral Light Guide (2.4 mm \emptyset models and larger)	Fiber-optic, 2.0 m length

ENVIRONMENTAL

Operating Temperature	-18° to 77° C (0° to 170° F)
Watertight	
Insertion Tube	up to 1 atm/1 bar (14.7psig); approx. 30 ft. water depth
Handpiece	splashproof only
Fluid resistance (insertion tube)	Water, 5% salt water, aviation fuel, gasoline, machine oil, light oil, hydraulic fluids

Warranty

GE Inspection Technologies warrants the industrial fiberscopes to be free of defects in material and workmanship and to perform in accordance with the manufacturer's specifications when subject to normal use and service for a period of one year from the date of purchase. GE Inspection Technologies will either repair or replace components found to be defective or at variance from the manufacturer's specifications within this time at no cost to the customer. It shall be the purchaser's responsibility to return the instrument to the authorized service center.

This warranty does not cover breakage or failure due to tampering, misuse, neglect, accidents, improper installation, modification, shipping, or to improper maintenance, service, and cleaning procedures. This warranty is also void if the instrument is not used in accordance with the manufacturer's recommendations or if required service is performed by anyone other than an GE Inspection Technologies authorized agent. No other express or implied warranty is given.

Service

To obtain service for your system, call one of the Service Centers below. If the problem cannot be corrected over the phone, you will be given a return authorization number for shipment to the service center.

ALWAYS contact a GE Inspection Technologies Service Center for a Return Materials Authorization Number (RMA) prior to returning any products for service or repair.

USA

GE Inspection Technologies
Product Service Dept.
4619 Jordan Road North Dock
Skaneateles Falls, NY 13153

Tel: 315-685-4142
Fax: 315-685-2920
Email: rvi-service@ge.com

Germany

GE Inspection Technologies
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72379 Hechigen

Tel: +49-7471-9882 20
Fax: +49 7471-9882 30
Email: rvi-infoeuropa@ge.com

Hong Kong

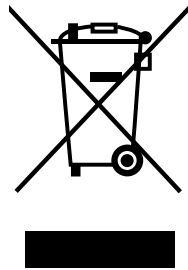
GE Inspection Technologies
Unit 1602, 16/F Sing Pao Building
101 King's Road
North Point, Hong Kong

Tel: +852-2877-0801
Fax: +852-2877-0868
Email: rvi-infohongkong@ge.com

Accessories

Part Number	Description
Scope Accessories	
FT5S50	Side-view detachable tip adapter for 5 mm models
FT6S50	Side-view detachable tip adapter for 6 mm models
FT8S50	Side-view detachable tip adapter for 8 mm models
FA103-W	Light guide adapter to connect to Richard Wolf light sources.
FA103-0 or LGAF-LO	Adaptor to connect fiber-optic light guide to ELSV-60 or ACMI or Olympus light source (included with fiberscope)
RA103	Rubber Eyecup for eyepiece
Light Sources	
ELSV-60	60W Solarc® light source with convenient single power/video cable connection to C-Mount color video camera.
ELS-24DC	24W Solarc® light source
ELS-24DC KIT	ELS-24DC 24W Solarc® light source with AC adapter, 12V PowerBar™ battery and charging system, and operational carry pouch with shoulder strap.
ELSV-24	120W UV/white switchable light source
FLS-200UV	200W high intensity UV/white switchable light source
Borescope Cameras	
CAM-V101 SET	C-Mount color video camera
CAM-DS104	Digital camera kit
CAM-SLR	35mm SLR camera kit
FA103-A	Light guide adapter for ACMI and Olympus light sources (included with fiberscope)
FA103-0	Light guide adapter for Olympus light sources
MON-LCD-8	8-inch SVGA LCD monitor
MON-LCD-12	12-inch SVGA LCD monitor
XA216	VGA Head-mounted Viewer by MicroOptical

Environmental Compliance



The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Visit www.ge.com/inspectiontechnologies for take-back instructions and more information about this initiative.

Customer Support Centers

North/South America

4619 Jordan Road
Skaneateles Falls, NY 13153
Tel: 888-332-3848
315-685-4142
Email: rvi-info@ge.com

Europe

Lotzenäcker 4
72379 Hechingen
Germany
Tel: +49 (0) 7471 9882 0
Email: rvi-infoeuropa@ge.com

Asia/Pacific

Unit 1602, 16/F Sing Pao Building
101 King's Road
North Point
Hong Kong
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Email: rvi-infohongkong@ge.com

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