
IFO
INDUSTRIAL FIBER OPTICS
Educational Catalog
2020

INDUSTRIAL FIBER OPTICS

Educational Catalog

Industrial Fiber Optics
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Laser Classifications

All manufacturers of lasers used in the United States, must conform to regulations administered by the Center for Devices and Radiological Health (CDRH), a branch of the U.S. Department of Health and Human Services. CDRH categorizes lasers as follows:

Class	Description
I	A laser or laser system which does not present a hazard to skin or eyes for any wavelength or exposure time. Exposure varies with wavelength. For ultraviolet, .2 to .4 µm exposure is less than from .8 nW to .8 µW. Visible light exposure varies from .4 µW to 200 µW, and for near IR, the exposure is < 200 µw. Consult CDRH regulations for specific information.
II	Any visible laser with an output less than 1 mW of power. Warning label requirements — yellow caution label stating maximum output of 1 mW. Generally used as classroom lab lasers, supermarket scanners and laser pointers
IIIa	Any visible laser with an output over 1 mW of power with a maximum output of 5 mW of power. Warning label requirements — red danger label stating maximum output of 5 mW. Also used as classroom lab lasers, in holography, laser pointers, leveling instruments, measuring devices and alignment equipment.
IIIb	Any laser with an output over 5 mW of power with a maximum output of 500 mW of power and all invisible lasers with an output up to 400 mW. Warning label requirements — red danger label stating maximum output. These lasers also require a key switch for operation and a 3.5-second delay when the laser is turned on. Used in many of the same applications as the Class IIIa when more power is required.
IV	Any laser with an output over 500 mW of power. Warning label requirements—red danger label stating maximum output. These lasers are primarily used in industrial applications such as tooling, machining, cutting and welding. Most medical laser applications also require these high-powered lasers.

Product Index

Laser Safety

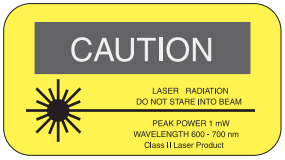
All lasers sold by Industrial Fiber Optics emit a visible beam of low power red light. No infrared, ultra-violet, x-ray or other non-visible radiation is emitted from these products.

With outputs of a thousandths of a watt, these low-power lasers cannot be used to burn, cut or drill. Even so, you should use caution, because the beam is concentrated. It could become focused to a pinpoint within the human eye. ***Never look directly into the laser beam or stare at its bright reflections — just as you should avoid staring at the sun or other very bright light sources.***

Federal Regulations

The U.S. Department of Health, Education and Welfare regulates and classifies all laser products sold in the United States. Industrial Fiber Optics lasers comply fully with laser performance standards established by Center for Devices and Radiological Health (CDRH) Regulation 21, parts 1040.10 and 1040.11, Code of Federal Regulations.

All lasers described in this brochure fall within the limitations of Class II and Class IIIa of CDRH standards.



Class II Laser Labeling

Class II lasers may not exceed 1 milliwatt of output power, and must contain a pilot light and a beam attenuator. An example of the "warning logotype" label used for Class II lasers is shown on the left.

Class IIIa Laser Labeling

Class IIIa lasers have an output power limitation between 1 and 5 milliwatts, and require a pilot light and a beam attenuator. The "warning logotype" label required for this classification of laser is shown on the left.

Additional References

For more information about lasers and laser standards, contact your local U.S. Department of Health, Education and Welfare office, or write to the agency's headquarters at 1390 Piccard Dr., Rockville, MD 20850.

For U.S. guidelines on laser classifications and health standards, refer to the American National Standards Institute specifications governing lasers and laser safety. The guidelines are published by the Laser Institute of America, 12424 Research Parkway, Suite 130, Orlando, FL 32826.

Lasers!

Industrial Fiber Optics is a leading American manufacturer of low power educational lasers. We began making diode lasers in the early '90s as a preferred alternative to helium neon lasers, for communication demonstrations. From the early days our classic design was bright blue, see-through, impact-resistance acrylic enclosures (see photo at right). The color alone appealed to students interested in laser technology. We call this characteristic design our CT (for Cerulean Tech) laser series.

In 2004 we acquired the educational laser line from Metrologic Instruments, long a major player in that market. Metrologic sold to us because of our commitment to the educational business and our high quality. (Metrologic now focuses on laser bar code scanning and related technology.) Since purchasing the Metrologic line, we have upgraded, improved many of the products and rewritten instruction manuals while retaining the conventional packaging that made these lasers so durable.

Our catalog includes a green laser pointer in a Class II power level; two kit versions of a full-size diode lasers; and a self-contained, battery-powered diode pumped solid state laser which is also a Class II power level. All of these products deliver exceptional value to the educational market while also serving as top-quality technical instruments.

If you have any old or non-working Metrologic products, please contact our customer service department and we will do our best to repair or get replacement parts for you.

Laser Product Line Includes

- Diode communications lasers
- Full line of helium-neon lasers (CT series)
- Laser pointers (Class II and IIIa)
- Metrologic lasers

Laser Selection

Attempting to compare all the makes and models of lasers in today's market can be confusing at best. In general, helium neon lasers are the preferred choice if long coherence length and wavelength stability are needed for optical interferometric experiments. Diode lasers are the best choice for communications or fiber optic experiments.

Questions? Industrial Fiber Optics' technical staff will be happy to help you select the correct laser for your specific needs. Monday through Friday, 7 a.m. to 4 p.m., Mountain Standard Time, call (480) 804-1227, or e-mail info@i-fiberoptics.com

ML 800 Series

The ML 800 series of laser is a tried and true laser design. Originally designed and manufactured by Metrologic, we are very productive at Industrial Fiber Optics to continue producing this outstanding line of lasers. Designed with a sturdy metal enclosure and along the lines of classic laser design with integrated power supply this laser is an excellent choice for an industrial or educational application.

Features

- Hard seal laser tubes for long dependable life
- Shock resistant mountings
- Durable extruded aluminum housing that protects laser tube and power supply components
- Two-year limited warranty
- Solid-state power supply mounted on durable printed circuit board
- Standard 1/4-20 camera-type threaded hole in bottom of chassis for tripod or optical bench mounting
- Mechanical slide shutter over front aperture to block beam without having to turn off power supply (as required by CRDH)
- Rear end caps with power switch and indicators lamps, fuse holder, and line cord with 3 prong grounded plug
- Full-length rubber strips on the underside to prevent scratching and slipping on polished surfaces
- Labels and safety features to meet all U.S. CDRH regulations
- Integrated power supply
- Power requirements 105 – 125 VAC 60 Hz

Front view of the ML 800 series shows the mechanical beam stop and threaded optical mounts.

ML 800 .5 mW Laser

Class II CDRH Classification

The most economical laser in the classic ML 800 series

ML 810 .8 mW Laser

Class II CDRH classification

With output power of .8 mW, the ML 810 is our most popular model in the 800 series for any engineering or educational lab. Its beam width is visible in a normal or semi-dark room when conducting most optical experiments.

Characteristics

Operating

Temperature ..... -20 to 50 °C

Optical

Wavelength ..... 632.8 nm
Polarization ..... random
Model ..... TEM_{00}
Beam diameter ..... < 1 mm
Beam divergence ..... < 2 milliRadians

Storage

Chassis dimensions ..... 24 x 7.2 x 7.2 cm

ML 820, ML 840 and ML 850 have been discontinued. Suggested replacements are IF HN20 for ML 820 and IF HN50 for ML 850, described on page 4.

Modulated Helium Neon Lasers

Industrial Fiber Optics' Classic ML 868 and ML 869 modulated helium-neon lasers contain all features of the standard product line, but they also can be modulated by varying their beam intensity. These lasers are capable of up to 15% intensity variations at rates up to one MHz. They are unquestionably the best red light-producing lasers in the product line.

Features

- Smallest beam diameter and lowest beam diameter of the ML 800 series
- Output beam ranges from 85% to 100% of full power during modulation
- Lasers accept modulation signals from 50 Hz to 1 MHz, although video signals of higher bandwidth (such as color TV) will not be transmitted
- Effective signal transmission distance up to several hundred feet without a beam collimator. With collimator and detector, range increases to thousands of feet
- 3.5 mm phone jack accepts audio input signals at 100 mV peak-to-peak level and 8 kΩ impedence
- Two-year limited warranty

ML 868 .8 mW Laser

Class II CDRH Classification

The modulated ML 868 can do so much more than ordinary lasers! For example: Connect a microphone to this laser and send voice signals over the beam to a distant receiver. Or pulsate the transmission with a signal generator, reflect it from a distant mirror and measure the speed of light with a receiver and oscilloscope.

ML 869A 1.5 mW Laser

Class IIIa CDRH Classification

The ML 869 provides nearly twice the optical power of the ML 868, greatly increasing the maximum useful distances for any experiment or demonstration. Increased brightness also helps students make better holograms. Small movements or vibrations are less likely to blur the picture with the ML 869's shorter exposure time.

Characteristics

Operating

Temperature ..... 0 to 50 °C

Optical

Wavelength ..... 632.8 nm
Polarization ..... random
Model ..... TEM_{00}
Diameter ..... .66 mm
Beam divergence..... 1.25 milliRadians

Storage

Chassis dimensions ..... 32.8 x 7.2 x 7.2 cm

Helium Neon Lasers

Industrial Fiber Optics is pleased to include the expansion of its dependable and versatile helium neon lasers to include the 5 mW powerhouse. Within our standard product line we offer modulated and unmodulated models to choose from with powers ranging from .5 to 3.5 milliwatts. These lasers have the same great features as our diode lasers. You will easily recognize this laser as it is packaged it in a brilliant blue acrylic housing which is extremely durable and visually appealing to both industrial and educational users. The helium neon laser with its narrow and stable wavelength stability and long coherence length is ideal for:

- Holography and interferometry
- Voice communication
- Diffraction
- Single and double slit experiments

In addition, this laser can be used to conduct regular laser, optics and fiber optic experiments which demonstrate properties such as:

- Refraction
- Reflection
- Tyndall's light-guiding-in-water experiments
- Scattering of light
- Critical angle determination in materials
- Convergence and divergence of lenses
- Polarization of light
- Measurement of Brewster's angle

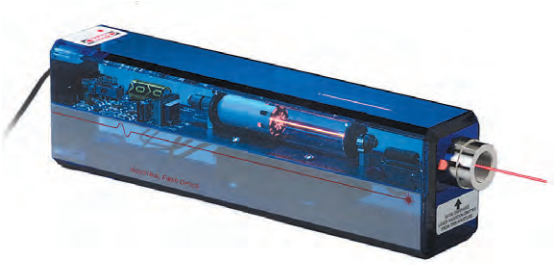
Models

Stock No.*	Class[1]	Modulatable	Power Level
IF-HN05	II	No	.5 milliwatts
IF-HN08	II	No	.8 milliwatts
IF-HN08M	II	Yes[2]	.8 milliwatts
IF-HN15M	IIIa	Yes[2]	1.5 milliwatts
IF-HN20	IIIa	No	2.5 milliwatts
IF-HN50	IIIa	No	5.0 milliwatts

* 220-VAC 50 Hz power adapters available upon request

1 Laser classifications as defined by the Center for Devices and Radiological Health

2 Electrical input is industry-standard 3.5 mm audio jack



Features

- Hard-seal laser tube for long dependable life
- Fool-proof mechanical beam stop
- Bright laser pilot light
- Impact-resistant, see-through, two-tone blue acrylic case
- Tamper-resistant screws for safety
- Threaded mount for holding lenses, filters and diffraction gratings
- Tripod mount—¼ - 20 thread
- Rubber feet on chassis bottom for adhesion on slick lab surfaces
- Full-color operator's manual with safety information and common experiments
- Labeling and safety requirements compliant with U.S. CDRH regulations
- Standard 3.5 mm audio input jack (modulatable models)
- 110- and 220-VAC electrical voltage options
- 2-year warranty

Characteristics

Operating

Analog bandwidth ..... 600 Hz to 20 kHz
Temperature ..... 0 to 40° C

Optical

Wavelength ..... 632.8 nanometers
Polarization ..... random
Mode ..... TEM_{00}
Beam diameter ..... < 1 millimeter
Beam divergence ..... < 2 milliradians

Storage*

Chassis dimensions ..... 5.8 × 7 × 36.7 cm
Weight ..... 820 grams

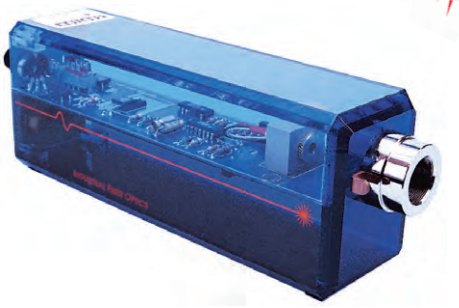
* Excluding 3.5 and 5.0 mW models

Diode Lasers

Industrial Fiber Optics offers two basic models of lab-sized (semiconductor) diode lasers. Our RL series of diode lasers is ideal for conducting voice and audio optical transmission experiments as well as common laser and optical experiments. Electrical connections for the analog and digital inputs are the industry-standard, durable banana jacks. In addition, the analog input has a 3.5 mm audio jack for audio and microphone inputs. This laser is also the only product on the market which features an externally-adjustable internal electronic amplifier with a variable gain from 1 to 50. This feature makes it suitable for low-voltage microphone inputs and higher amplitude signals from AM/FM radios.

Features

- Semiconductor laser diode for long dependable life
- All solid-state electronic design
- Analog and digital modulation capabilities
- Internal overdrive protection on inputs
- Fool-proof mechanical beam stop
- Linear polarized light beam
- Impact-resistant, see-through, two-tone blue acrylic case
- Tamper-resistant screws for safety
- Threaded mounts for holding lenses, filters and diffraction gratings
- Tripod mount—¼ - 20 thread
- Rubber feet on chassis bottom for adhesion on slick lab surfaces
- Full-color operator's manual with safety information and common procedures
- Labeling and safety requirements compliant with U.S. CDRH regulations
- 110- and 220-VAC electrical voltage options
- 4-year limited warranty



Industrial Fiber Optics' VL series lasers offer wider electrical modulation bandwidth capabilities. They are suitable for video laser transmission and conducting standard voice and audio transmission experiments. Analog and digital inputs for these lasers are industry-standard RCA phono jacks.

Applications

- Voice and AM/FM radio transmission
- Laser leveling experiments
- Light shows
- Bar code scanning
- Particle counting
- Refraction & reflection measurements
- Polarization experiments
- NTSC Video transmission (IF-VL only)

Characteristics

Polarization	linear
Beam diameter	2 millimeter
Beam divergence	2 milliradians
Chassis dimensions	5.6 × 7.5 × 22 cm
Weight	400 grams
Operating temperature	0 to 40° C

Models

Stock Number	Class[1]	Wavelength (nanometers)	Optical Power (mW)	Digital Bandwidth	Analog Bandwidth	Comments
IF-RL08-635	II	635	0.8	1-500 kHz	1-500 kHz	*Alternative to conventional HeNe lasers*
IF-RL30-635	IIIa	635	3.0	1-500 kHz	1-500 kHz	*A very bright modulatable laser for long-distance requirements*
IF-VL08-635	II	635	0.8	1-20 MHz	1-10 MHz	*Least expensive laser for transmitting video[2] signals*
IF-VL30-635	IIIa	635	3.0	1-20 MHz	1-10 MHz	*Brightest laser for transmitting digital and video[2] information*

1 Laser classifications as defined by the Center for Devices and Radiological Health (CDRH) 2 Picture signals from color televisions, video cameras and camcorders

Diode Laser Pointer (modulatable and rechargeable)

The ML268 incorporates the best features of full- or lab-sized lasers in a convenient hand-size design only slightly larger than conventional pen-sized laser pointers. The laser is suitable for use in lectures and AV shows, transmitting video pictures over a laser beam, or as a lab laser for optical experimentation and demonstration. (Metrologic Instruments produced this laser until 2004. IFO redesigned and now manufactures an improved version.)

Features

ML 268

- Rechargeable nickel-cadmium batteries
- Small size conveniently fits the palm of the hand for use as a laser pointer
- High-quality beam as found in full-size lab lasers (improved over the original Metrologic design)
- Highly visible red beam
- 3-position power switch with a momentary switch for continuous or intermittent use
- Standard RCA-type phone jack accepts camcorder/VCR video signals or high-level audio signals; an amplifier circuit permits use of microphone or other low-level audio sources
- Tough impact-resistant metal chassis and end caps with durable powder coatings

The ML268 operates directly from a 110-VAC-to- 9-VDC power adapter/charger, or from internal rechargeable batteries. When fully charged the batteries typically provide two hours of continuous operation. The optical beam can be electrically modulated via a standard audio RCA-type jack. The internal circuitry is electrically compatible with NTSC color video signals from a camcorder or VCR, or audio signals from low-impedance sources.*

The solid-state visible laser diode and miniaturized electronic components make this the smallest modulated educational laser on the market. Two decades since its introduction, this laser pointer remains an innovative product with outstanding performance.

Characteristics

Optical Power (typical)	0.9 mW
Wavelength	650 nm
Electrical bandwidth	20 Hz To 4 MHz
Electrical input impedance (RCA jack)	~6.2 kΩ
Beam diameter	3.0 mm
Divergence	1.1 milliRadians
Housing (L x W x H)	14.0 x 3.2 x 3.2 cm

Laser includes 115- to-9 volt power adapter and full-color manual

* With an additional amplifier circuit to amplify/buffer high-impedance audio sources, the ML268 can also be used for an optical audio transmission link.

ML 268 Optical Receiver

45-725

This two-channel audio/video receiver is a simple companion accessory to the ML 268. It combines a photodetector and amplifier circuit to convert electrically modulated optical beams to an electrical signal. The output is available on standard RCA audio/video jacks. When used with a suitably modulated laser the receiver provides an NTSC color composite video optical transmission link. (The receiver is also capable of demodulating audio signals from modulated Class IIIa or lower power lasers, but the recovered audio signals are small. An amplified speaker will deliver suitable audio volume). Powered by a 9-volt battery.

Helium-Neon Laser Project Kit

Industrial Fiber Optics invites you to build your own helium-neon laser. In this all-component kit, you'll find everything you need, including schematics and step-by-step assembly instructions. This low-cost laser can be assembled in three or four hours. It is ideal for the student laboratory, classroom demonstrations, laser shows and holography instruction. Features of the completed kit are identical to those of the IFO ML 800 series. Optical characteristics are also very similar (see ML 800 specifications on page 2 of this catalog). This kit is an appropriate challenge for those who have previously assembled simple electronic kits—and it adds a very functional laser to your tools.

Kit comes complete with hard-seal helium-neon tube, printed circuit board, electrical components, switch, fuse, laser tube mounts, transformer, high-voltage electrical wire, 3-prong electrical line cable, durable extruded aluminum housing and metal end caps with powder coating, screws, CDRH laser labels, assembly instructions, schematic, parts list and operating instructions. Does not include soldering iron or solder. (Some soldering experience is recommended for this project.)

ML 801

Characteristics

Power (typical)	0.5 mW
Wavelength	632.8 nm
Polarization	random
Beam diameter	0.48 mm
Beam divergence	1.7 milliRadians
Dimensions	27.9 x 7.2 x 7.4 cm

Diode Laser Kit

For more adventurous electronics hobbyists, Industrial Fiber Optics now offers a semi-conductor diode laser in kit form. It has the same features as our RL series diode lasers shown on page 5. The completed laser is perfect for conducting a wide variety of voice, audio optical transmission and laser experiments. The easy-to-follow circuit schematic and assembly instructions create a captivating and dynamic class project in the basics of semi-conductor laser construction and operation. The completed laser is capable of audio transmission using a microphone, CD or AM/FM radio.

Kit contains printed wiring board, electronic components, switches, laser diode, laser diode mount, collimating lens, impact-resistant acrylic enclosure (not shown) with end cap, beam shutter, CDRH labels, power adapter and step-by-step assembly guide, circuit schematic and parts list. Does not include soldering iron or solder. (We recommend some soldering experience and understanding of simple schematics to complete this project.)

IF RL08-K

Characteristics

Power (typical)	0.8 mW
Wavelength	635 nm
Polarization	linear
Beam diameter	3.20 mm
Beam divergence	2.0 milliRadians
Chassis dimensions	22 x 5.6 x 7.5 cm

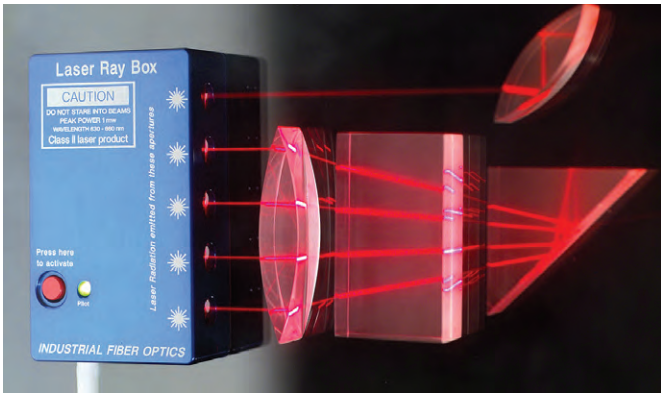
Laser Ray Box

Compact and powerful, the Laser Ray Box produces five parallel and sharply defined light beams ideal for demonstrating optical ray analysis and viewing. Five side-by-side 1mW diode lasers 1.6 cm apart create beams that are 650 nm in wavelength for high visibility (readily seen even in a typical well-lit room). With its commanding visual effects, the Laser Ray Box will easily and dramatically demonstrate the following light behaviors when used with the appropriate optics:

- Light bending due to refraction
- Focusing effects of refractive optics
- Reflections from mirrors
- Fresnel reflections from non-coated lens surfaces
- Monochromatic character of laser light
- Total internal reflection

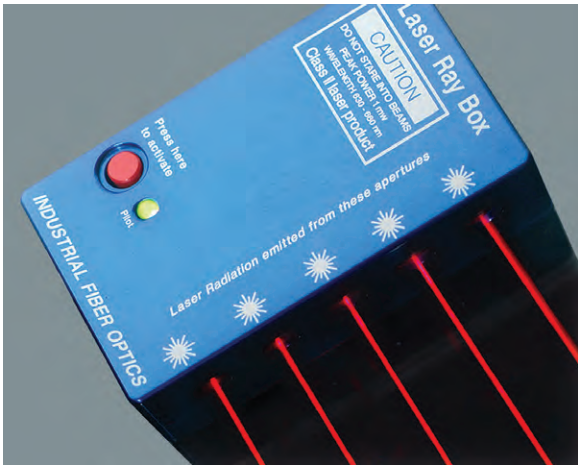
The bottom of the Laser Ray Box has a magnetized surface for easy adherence to both horizontal and vertical metal surfaces such as steel white or chalk boards for classroom optical demonstrations.

Power to energize the lasing elements is provided by an internal NiCd cell that is charged with the VAC-to-DC power adapter provided.



Models

Stock No.	Description
IF 550	Laser Ray Box
IF 583	Laser Ray Box with foam-lined container



Features

- Bright green pilot light for safety
- Laser engraved permanent labeling
- Labeling and safety requirements compliant with U.S. CDRH regulations
- Magnetic strip for adhesion to vertical surfaces
- Rechargeable, long life NiCad battery
- 1-year warranty
- Full-color operations manual with safety information and equipment set-up
- Linearly polarized light beam

Characteristics

Operating

Input voltage, max ..... 12 volts
Input current ..... 75 milliamperes
Temperature ..... 0 to 40° C

Optical

Wavelength ..... 650 nanometers
Polarization ..... linear
Output power, max ..... .95 milliwatts
Beam diverted into rays

Storage

Chassis dimensions ..... 11 × 6 × 2 cm
Weight ..... 400 grams

This device is rated as a Class II laser product by CDRH regulations because no single beam exceeds 1 mW of visible laser radiation or light.

Laser Pointers

Industrial Fiber Optics offers, for educational use, laser pointers that produce either green or red light. The pointers are CDRH-compliant and bear all required regulatory labels. Our product line is unique because we offer CDHR Class II power levels that most companies do not. (Class II lasers have a maximum peak power of 1 milliwatt [mW] in the visible range—the highest class rating that many school systems permit.)

The table on the right compares brightness perceived by the human eye in response to various laser wavelengths of the same radiometric optical power. As shown, green light appears much brighter to the human eye than does red. Our 532 nm Class II green laser pointer, therefore, is an excellent solution for teachers who must comply with specific school regulations, but who wish to offer vivid optical demonstrations that Class II red light pointers cannot provide.

Wavelength nanometers (nm)	Brightness Perceived by the Human Eye
670 (red)	1 (reference)
650	3.4 x reference
635	7.2 x reference
632.8 (HeNe gas)	7.9 x reference
532 (green)	28.2 x reference

Lifetime: > 3,000 hours
Warranty: 6 months
Batteries: 2 AAA

Green Light

Red Light

Deluxe Red Light

Class Power (mW)	Stock Number	Wavelength (nm)
Class IIIa < 5	IF 565	532
Class II < 1	IF 563	645
Class IIIa < 5	IF 560	645
Class IIIa < 5	IF 564	532

Laser Pointer Education Kit

This economical kit is packaged so each student has his/her personal optics kit to study important concepts of light, color, and light waves using standard laser pointers. The multi-use kit is a collection of 15 demonstrations and nine experiments that require a few supplemental items found in a common science or physics lab.

Activities include:

- Understanding color and color filters
- Scanning bar codes
- Investigating ophthalmology and paired muscle balance
- Exploring specular and diffused reflection
- Understanding reflection of light
- Measuring the index of refraction
- Calculating the wavelength of a laser beam
- Studying polarization of light

The kit contains a holographic diffraction grating; 2 polarized filters; two front surface mirrors; short and long focal length lenses; cylindrical lens; solar cell; rectangular prism; vinyl cap for mounting lenses to pointers; color filter set (red, blue, and green); and instruction guide. All are contained in a sturdy plastic hinged case.

Models

Stock No.	Description
45-211	Standard kit
45-311	Kit w Class IIIa 650 nm Pointer
45-315	Kit w Class IIIa 635 nm Pointer
45-317	Kit w Class II Green Pointer
45-318	Kit w Class II 650 nm pointer

Laser Optics Lab

The Laser Optics Lab contains more than 30 optical components and accessories for demonstrating the principles of optics in basic courses of physics and physical science. When used in conjunction with any HeNe laser,* the lab enables instructors to provide students an exciting and easily grasped learning experience in lasers and optics.

Sampling of Experiments

- Investigate reflection, refraction and critical angle.
- Measure wavelengths of light using the techniques of Young, Michelson and Lloyd.
- Construct optical levers to detect and measure miniscule movements that are almost imperceptible to the human eye.
- Test a lens for defects, collimate light and evaluate a person's visual perception skills.
- Capture light in an arcing water jet or a optical fiber and investigate fiber optics phenomena.
- View a hologram, observe interference rings and measure diffraction patterns with a ruler.
- Determine the index of refraction of a liquid or transparent solid by measuring bending in the intense laser beam as it enters or leaves the material.
- Study characteristics of light: wavelength, interference, diffraction and polarization.

One key aspect of this lab is its simple optical bench system that consists of metal components and carriers magnetically attached to a steel optical table. Experiment set-up is easy, intuitive.

Included is a 68-page, fully-illustrated instruction guide that contains 34 optical, light and laser experiments. All experiments were developed by teachers and thoroughly tested in classrooms. Each experiment contains detailed instructions and illustrations to guide students to successful completion of each demonstration or activity. Experiments demonstrate the refractive, diffractive and other wave properties of light using the unique and visually dramatic characteristics of an HeNe laser. In addition to guiding the student through exercises in light and optics, the booklet also explains the theory of laser operation, aspects of laser construction and laser safety.

Laser Optics Lab includes three lenses, four mirrors, coated beam splitter, equilateral prism, optical beam spreader, air wedge, transmission hologram, diffraction mosaic, diffraction grating, fiber optic light guide, pair of glass interference plates, polarizing and color filters. The lab also contains an optics bench system consisting of metal component carriers, steel optical table, magnetic strips and a 68-page full-color instruction and experiment guide.

Complete lab and manual:
45-600

Manual alone:
45-700

** Diode lasers or pointers are adequate for completing some of these experiments, but they will produce less-than-adequate results in some experiments that require a very narrow optical spectrum.*

Physical Optics Lab

With Industrial Fiber Optics Physical Optics Lab, the study of image processing and Fourier transforms of optical formations can be practical studies for most high school and undergraduate physics classes. By adding any HeNe laser.* This product enables instructors to provide turnkey exercises to give students an efficient and exciting learning experience in lasers and optics. Using this unique collection of laser accessories with the instruction booklet can show students:

Sampling of Experiments

Complete lab and manual: **45-688**

Manual alone: **45-788**

- How double exposures, or even multiple exposures, on photographic slides can be separated into individual photographs
- How noise or other unwanted information can be eliminated from a transparency
- How diffraction patterns can be manipulated to form new images through the process of spatial filtering
- How to create a continuous tone photo from a half-tone (newspaper) photo
- How optical noise is removed from a laser beam by a spatial filter
- How optical components are manipulated to produce a collimated (parallel) beam of light
- How to create and compare Fresnel and Fraunhofer diffraction patterns
- How spatial frequency information is displayed in a Fraunhofer diffraction pattern
- How physical optics can serve as an excellent introduction to the study of Fourier series and Fourier transforms in optics and math courses

Included is the 63 page, fully-illustrated instruction guide containing six activity modules structured to develop an experimental setup for demonstrating Fourier Transformation. The manual represents a series of optical laboratory activities typically not covered by introductory physics courses in high schools and universities. The goal of the activity series is to demonstrate Fourier Transformation in a way that bridges the gap between mathematical theory and real world application. Manual also includes information on laser safety, optical and Fourier Transforms and additional reference materials.

The Physical Optics Lab contains four mounted lenses, 8 magnetic mounts with magnetic tape, two mounted front surface mirrors, nine steel "L" mounts (to hold optical components), one 50 micron pinhole, a +15 mm focal lens in threaded cell, two mylar viewing screen, a set of 21 transparencies, a instruction booklet, and a padded carrying case. Also the manual contains valuable appendices on optical theory.

One key aspect of this lab is its simple optical bench system that consists of metal components and carriers magnetically attached to a steel optical table. Mounting system allows for x, y, and z axis positioning of all lenses and mirrors. Experiment set-up is easy, intuitive. The lab's cost also is exceptionally low when compared to that of many conventional optical rails and benches.

Suggested helium neon lasers to use with this lab:

IF HN08

ML 811

** Diode lasers or pointers are adequate for some of the experiments, but will produce poor results for some of the experiments requiring very narrow optical spectrum.*

Michelson Interferometer

Industrial Fiber Optics' Michelson Interferometer Kit is the first truly inexpensive kit that faithfully re-creates the time-honored Michelson Interferometer. The Michelson Interferometer was/is a classic device that splits a beam of monochromatic light into two parts that travel along different optical paths, then are merged to produce interference fringes.

The fringes shift or change shape noticeably whenever one of the optical components in either optical path moves, even almost unperceptibly. They also shift when the effective length of one optical path changes slightly with respect to that of the second. These shifts make it possible to measure ultra changes of a medium's index of refraction, microscopic movements of components as well as the fundamental principle for items such as the laser ring gyroscope.

Before the advent of lasers with a visible beam, the alignment of interferometer components was very difficult to achieve under ordinary laboratory conditions. Now, using the brilliant red beam of an inexpensive Industrial Fiber Optics laser pointer, alignment can be achieved in just a few seconds.

The kit contains a set of optical components, optical table, mountings for easy assembly and a comprehensive instruction manual.

The manual includes additional exercises:

- Measuring the diameter of a human hair
- Measuring the coefficient of linear expansion of different metals
- Detecting vibrations using the interferometer as a seismograph
- Confirming the historic Michelson/Morely experiment that demonstrated the speed of light is not affected by the motions of planet earth through space

This kit includes steel optical table, U-shaped carriers, L-shaped carriers, magnetic strips, beam splitter, small mirrors, short focal-length lens, laser pointer holder and instruction guide.

(Laser pointer shown is not include in standard kit.)

Models

Stock No.	Description
45-940	Michelson Interferometer with Class IIIa 655 mm Pointer
45-941	Michelson Interferometer with Class IIIa 635 mm Pointer
45-942	Michelson Interferometer without laser pointer

WBS Laser Communication Projects

The WBS Laser Communications Project is the ultimate educational laser project and contains the last laser you1ll need to purchase. Why? Because of it contains a versatile laser with very wide electrical modulation capability. The digital audio jack accommodates as low as 100 Hz for laser audio communication experiments and a RF video jack capable of frequencies as high as 70 megahertz for simultaneous transmission of color video picture and sound. With such fantastic versatility, this one laser can perform all of the following dynamic optical communication demonstrations:

- Voice communication
- AM/FM radio transmission
- Video from camcorder
- RF video from VCR
- Digital line-of-sight computer links

In addition, this laser in these projects can be used to conduct regular laser, optics and fiber optic experiments which demonstrate properties such as:

- Refraction and reflection
- Light shows
- Tyndall's light-guiding-in-water experiments
- Speed of light measurement
- Critical angle determination in materials
- Convergence and divergence of lenses
- Polarization of light
- Measurement of Brewster's angle
- Perimeter security using laser beams

Models

As a special package offer, Industrial Fiber Optics will combine the WBS Laser with a free optical RF video receiver, interconnecting cables, power adapters and an instruction booklet for setting up a VCR-to-Laser-to-Receiver-to-TV link as a group package.

IF UL08-635X

Industrial Fiber Optics also will offer the WBS Laser as a complete laser communication package with the items above, as well as a microphone, AM/FM radio, patch cords and an audio receiver.

IF UL08-635Y

Features

- Semiconductor lasing element and all solid-state electronic design for a long dependable life
- Bright 635 nanometer wavelength laser beam
- Standard electrical input jacks
- Electrical overdrive protection on all inputs
- High visibility, fool-proof mechanical beam stop
- Linear polarized light beam
- Tamper-resistant screws for safety
- Impact-resistant, see-through, two-tone blue acrylic case
- Threaded mount for holding lenses, filters and diffraction gratings
- Tripod mount—¼ - 20 thread
- Rubber feet on chassis bottom for adhesion on smooth surfaces
- Full-color operator's manual with safety information and common experiments
- 4-year limited warranty

Characteristics (Lasers)

Operating

Analog bandwidth ..... 100 to 70 MHz
Temperature ..... -20 to 50º C

Optical

Wavelength ..... 635 nm
Polarization ..... linear
Output power ..... 0.8 mw
Beam diameter, max ..... 3.2 mm
Beam divergence, max ..... 2 milliradians

Storage

Weight ..... 400 grams
Chassis dimensions ..... 5.6 × 7.5 × 22 cm

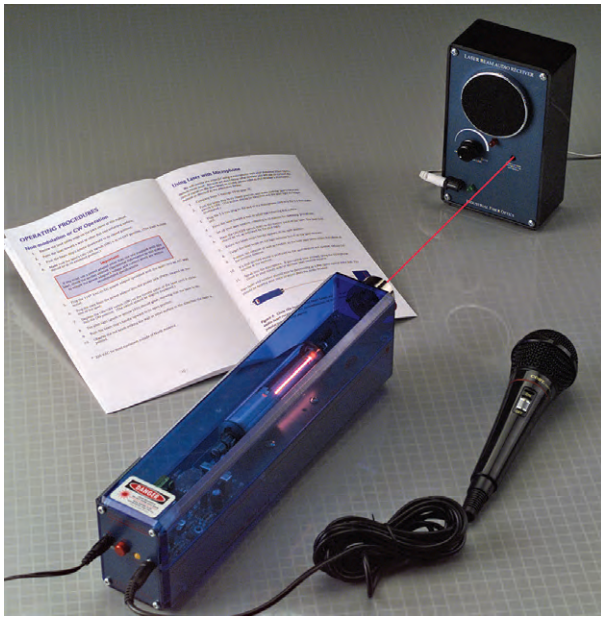
Laser Audio Transmission Project

Wow your students with a visual demonstration of sound being transmitted over light waves from a laser beam. Simple and easy to set up, this state-of-the-art equipment package is a breeze to use. Simply insert the microphone into the jack at the rear of the laser, plug in the VAC-to-DC power adapters and aim the laser beam at the audio receiver's optical detector. Then talk, sing, hum or create almost any imaginable sound into the microphone. Equipment set-up is less than five minutes and the sounds are sent across the room and recreated within nanoseconds.

Students will be amazed that somehow voices are electronically and optically relayed from one remote point to another and converted back into sounds—without benefit of a "hard connector" in-between.

The project's audio receiver features total solid state design, adjustable volume control, self-contained and durable surface-mount electronics design, 110 VAC operation, and impact-resistant enclosure. Inside the receiver are the sensitive optical semiconductor detector, amplifier, power conditioning electronics and 10 cm (4 in.) speaker.

Package includes a choice of diode or helium neon laser, audio receiver, high-sensitivity electronic microphone, instruction manuals and two 110-VAC-to-DC power adapters. Also included is 3 meters of fiber optic cable for demonstrating the light- and information-carrying abilities of optical fiber.



Available with the general purpose .8 mW Class II Helium modulatable neon laser.

IF 511

With the smaller and highly linear .8 mW 635 nm Class II Diode Laser

IF 512

Laser Audio Receiver

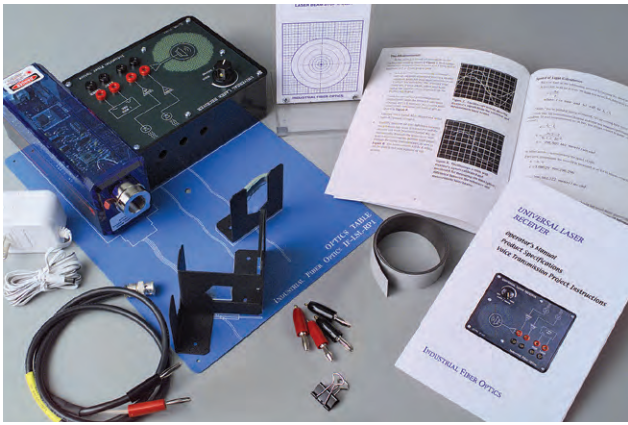
Receiver for detecting light from any visible or infrared laser beam and converting modulated light signals to sound. (Shown in top right of photo above.)

Features:

IF 513

- 110 VAC operation
- 100 mm (4 inch) internal speaker
- Adjustable volume control
- 100 to 15 kHz detection frequency range

Laser Speed of Light Receiver Project



In the last few years, lasers have become invaluable tools in thousands of scientific, medical and communications applications. This project, in several individual experiments, demonstrates a laser's unique ability to perform a variety of tests with deceptive ease.

Activities include:

- Measuring the speed of light
- Transmitting & receiving audible signals using light as the transport medium
- Transmitting and detecting black-and-white video signals using light.

Complete Kit with Laser **IF 546**

The modulated laser included with this kit can also be utilized for hundreds of other classroom and real-life projects. The instruction manual contains detailed instructions and diagrams that describe equipment set-up, as well as a historical journey into efforts to measure the speed of light. This is a great opportunity to learn not only about new technology, but also the very human history behind it.

Included in the kit are a .8 mW diode laser, optical beam splitter, first-surface mirror, converging lens, optics mounts, microphone, electronic control/receiver box with 2-channel receiver and 1 MHz oscillator, 110 VAC-to-DC power adapter, optics table and step-by-step instruction book. Not included but required for operation are a modulated laser, video camera and monitor and a dual-channel 40 MHz oscilloscope. We will substitute 220 VAC adapters upon request.

Characteristics

Specifications

CDRH Classification	Class II
Polarization	Linear
Laser Emission Color	Red
Laser Mode	TEM_{00}

Operating

Input Voltage	12 - 18 V
Input Current	60 - 125 mA
Wavelength	635 nm
Optical Output Power, Nominal	0.8 mW
Power, (min/max)	.7 / .9 mW
Beam Diameter	4 mm
Beam Divergence	1.00 mRad
Digital Modulation	20 MHz
Analog Modulation	100 - 10 M Hz to MHz

Mechanical

Operating Temperature	0 to 40 ° C
Housing	5.6 X 7.5 X 2 cm

Digital Laser Power Meter

The model 45-545A digital laser power meter is a multi-purpose instrument with the degree of accuracy required for many research applications and CDRH compliance measurements. This unit features settings for standard and peak/hold radiometric measurements and percentage mode for calibrating/measuring to user-defined standards. The meter employs a low-power LCD with large, 12 mm-high numerals.

In standard and peak/hold radiometric modes, the meter's four ranges display full-scale readings of 19.99 µW, 199.9 µW, 1.999 mW and 19.99 mW.

The detector head is black anodized aluminum for durability, 25 mm in diameter and 30 mm in depth.
A 0.5 m retractable, shielded cable electrically connects the detector head to the meter's internal electronics. A snap-mount on the side chassis secures the head when not in use. Optical sensor and filters in shock-resistant mounts are located inside the head.

An analog signal, proportional to the optical power on the detector, is available from a BNC output terminal. It may be used to drive strip chart recorders, oscilloscopes and other devices. Analog output ranges from 0 to +2 volts. Signals up to 100 kHz can be detected and amplified by the optical detector and internal circuitry. (This allows the meter to demodulate audio signals from lasers in educational demonstrations.)

Calibration is within 5 percent of full scale at intensity stabilized 635 nm diode laser light. For monochromatic light of other wavelengths within 500 to 950 nm, a built-in radiometric filter corrects to within 20 percent of standard. A chart in the manual lists nominal response from 450 to 950 nm.

Features

- Easy-to-read digital readout
- Zero offset adjustment to compensate for ambient light
- Provides peak readings for scanned laser beams
- Has a ratiometric mode in 100 percent offset control; displays readings directly as percentages
- Detachable detector head with threaded mounting hole for use on a ringstand or optical bench
- Calibration charts and instruction guide included
- Dual-powered (110 VAC or two 9V batteries for portability)

Characteristics

Operating

Display resolution	3½ digits
Calibration Accuracy 635 nm	5 %
Temperature	10 to 30° C
Battery lifetime	> 15 hours

Optical

Detector Active Area	1 cm^2
Maximum Optical Input Power	100 mw
Aperture Diameter	7 mm
Acceptance Angle	30°

Storage

Size	20 x 914 x 9 cm
Weight	1 kg
Temperature	-10 to 50° C

Industrial Fiber Optics' quality control department calibrates each meter and affixes a certificate of calibration to the meter housing. Calibration traceable to NTSC standards.

For more information about operating modes, calibration and specifications, please review the instruction guide for this product on our web site.

45-545A

Digital Photometer

(Optical Power Meter)

A versatile and economical classroom tool for measuring power levels of laser beams, demodulating optical signals for audio applications and solar experiments. Photometers are essential equipment in any principles-of-technology or in-school research program. The battery power, portability and adjustable height detector of this model offer particular flexibility.

The photometer is powered by two standard 9-volt batteries and offers four digital measurement scales from 20 microwatts through 20 milliwatts. Output to two industry-standard banana jacks is a conditioned electrical voltage that is directly proportional to light incident upon the photodetector with a frequency range up to 10 kHz. (The analog output can be connected to a strip chart recorder for solar monitoring, to an oscilloscope for observing time-dependent optical signals or to an amplified speaker for voice transmission.) The photometer also will act as an audio receiver to demodulate laser signals, which are also output to industry-standard banana jacks.

Features

- Large easy-to-read digital display
- Four measurement scales from 20 microwatts to 20 milliwatts
- Large active area detector
- Sensitive to visible and IR light
- Battery operation for portability (100-plus hours operation)
- Momentary switch for long battery life
- Adjustable detector height
- Impact resistant enclosure
- All solid state detector and electronic design

IF PM

Optional Range model: 199 µW, 1.999 mW, 19.99 mW, and 199.9 mW

(Photometer comes complete with storage container, metal optical stand for the detector, instruction manual and batteries.)

Characteristics

Operating

Input power ..... Two 9-volt batteries
Accuracy* ..... ± 10%
Ranges (4) ..... 19.99 µW, 199.9 µW
..... 1.999 mW, 19.99 mW
Temperature ..... 10 to 30° C

Optical

Detector active area ..... 1 cm^2
Wavelength sensitivity** ..... 450 to 950 nm
Maximum optical input ..... 100 mW

Storage

Control/Display Unit ..... 16 × 9.5 × 6.5 cm
Detector Assembly/Stand ..... 16.5 × 5 cm
Weight ..... 750 grams

* Calibrated at 632.8 nanometers

** Special response curve of photodector can be seen on our web site

Laser Safety Signs

Readily visible warning signs are recommended by the FDA in any area where lasers may be operating. Be proactive in promoting safety. No lab area should be without proper warning signs.

Sturdy laminated plastic signs, for Class II and Class IIIa lasers, measure 18 × 25 cm.

Class IIIa
IF 140020

Class II
IF 140021

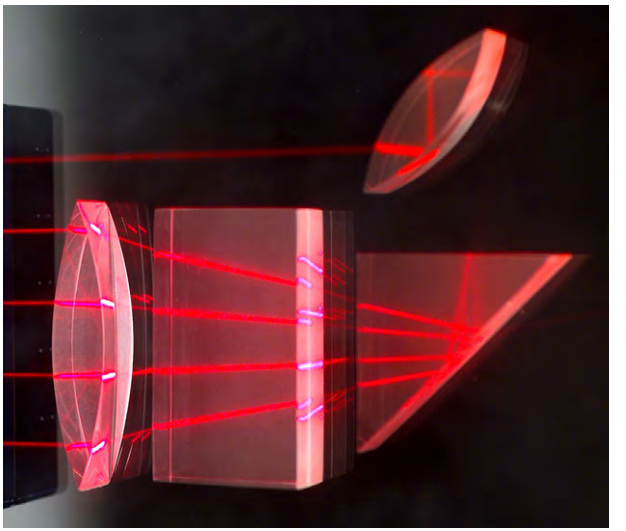
Cylindrical Lens Set

High quality acrylic lenses designed for use with the Laser Ray Box. Specially formulated material allows the visualization of laser beams traveling through optical element. Allows the direct observation of refraction, Fresnel Reflections and internal reflection within the optical element itself. Set includes four 20 mm thick optical elements.

Optical Elements

- Double convex, 50 mm, focal length 50 mm
- Double convex, 76 mm, focal length 100 mm
- Right Angle Prism, 70 mm, on oblique side
- Rectangular Block, 70 mm × 28 mm

IF 551



Light Ray Viewing Kit

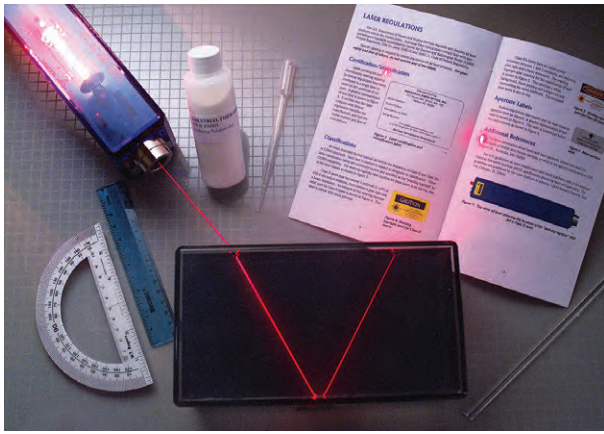
The Light Ray Viewing Kit is a small "liquid laboratory." When used with any of our lasers it creates underwater light ray patterns and diagrams that constitute the basics of all introductory optic studies. In a complementary series of activities in the accompanying instruction guide, students can observe, and more readily understand, principles and equations.

Activities include:

- Snell's Law
- Total internal reflection
- Equal angles of incidence and reflection
- Determining critical angle

IF 548

Set-up for each experiment requires less than five minutes and costs only a few pennies. ("Just add water!") Project equipment includes impact-resistant observation tank; four ounces of scattering solution; first-surface mirror; stirring rod; ruler; protractor; and eight full-color instruction guides. Suitable for grades 6 and above.



Project equipment includes: impact-resistant observation tank; four ounces of scattering solution; first-surface mirror; stirring rod; ruler; protractor; and a full-color instruction guide

Does not include laser shown in picture above.

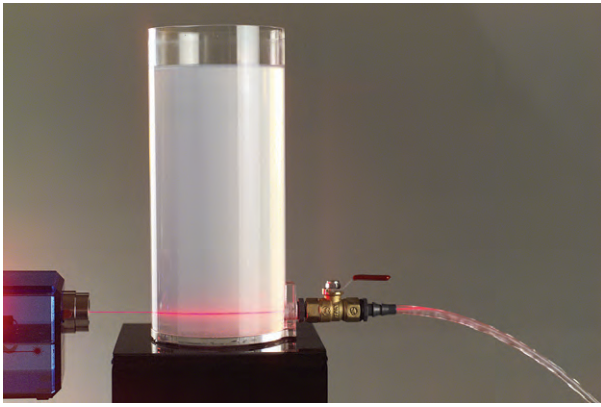
Consumables:

Four ounces scattering solution .....**IF 850005**

Tyndall's Historical Experiment — Laser Style

Recreate the historical experiment demonstrating the fundamental concept that lead to transmitting light through optical fiber. In 1870, before the skeptical British Royal Society, Irish researcher John Tyndall successfully demonstrated how light could be guided in a stream of falling water. It was the first recorded observation of light being guided by "total internal reflection" and it still is a visually fascinating experiment today. Using modern components, demonstrate this basic principle of light's behavior when it enters a constricting optical channel.

IF 514



A visible-light laser with optical power of .5 mW or greater is required for use, but not included.

Laser Beam Stop

An inexpensive apparatus for ensuring and practicing safe laser usage in the classroom. The apparatus acts as a diffuse surface to avoid any specular reflections. One side is matte white for maximum visibility and the other side is matte black for maximum absorption. Applicable to all Class II, IIIa and IIIb laser beams. Acrylic base with rubber feet for stability and adhesion.

IF LBS1

Beam Stop dimensions are 3 x 4 in.

Photonics Wall Chart

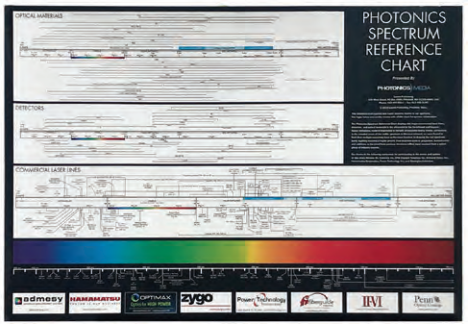
Our Photonics Wall Chart is the perfect visual aid for easily and accurately studying the characteristics of lasers, opto-electronics and light.

In four vibrant colors it portrays:

14 0005

- The linear full-color visible light spectrum
- Commercial laser emission spectra
- A chart of the complete photonic electromagnetic spectrum
- Photodetector spectrum detection ranges

Laminated in heavy plastic for durability, this is a superb complement to any science class or laser curriculum. Dimensions are 56 x 82.5 cm (22 x 32 in).

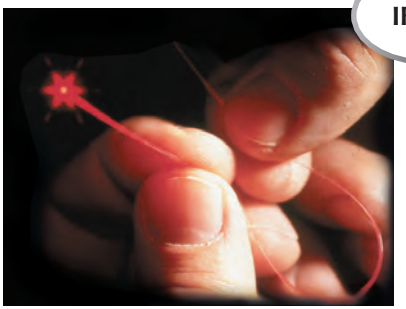


Laser-to-Fiber Adapter with Fiber

With lasers and fiber optics classes frequently being taught together it is often desirable to direct light from a laser beam into an optical fiber. With this component, mating optical fibers to the standard optical mounts of many educational helium neon (HeNe) and diode lasers (Industrial Fiber Optics, Laser Master, Metrologic, Scientific Laser Connection) is easy. Threads on the fiber adapter are 32 threads per inch and 3/4-inch in diameter.

Included: 1.5 meters of unjacketed 2000 µm core plastic fiber with factory-tooled and polished termination.

IF LFA



Fiber Optic Rod

A specially formulated acrylic waveguide for demonstrating the basics of fiber optics when used with a visible light laser. To illustrate, merely align the end of the rod at an angle and watch the laser light rays "bouncing" down the acrylic bar. Ideal for inexpensive but dramatic demonstrations of Snell's Law and total internal reflection in action.

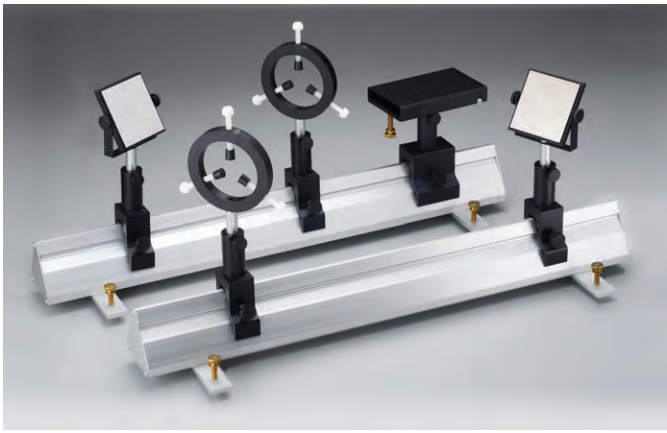
IF ACR

Optic Rail

Industrial Fiber Optics' Optical Rail Kit is an uncomplicated and economical system for conducting basic experiments with optical components and lasers. Designed for classroom use, the bench is easy to set up and requires little or no training, making students' laboratory time more productive. The kit includes mounts that permit use with most lasers, light sources, mirrors, lenses, gratings and filters. It's perfect for any introductory science or physics laboratory or hobbyists.

All components are fabricated from aluminum and anodized for durability and longevity. The mirror and lens holders are black powder coated to reduce stray reflections. All treads and mounts utilize SAE ¼-20 so users can create their own mounts and fixtures as desired.

The Optical Rail Kit comes complete with mounting accessories for performing a multitude of optical and laser experiments with lenses, mirrors and lasers. Replacement components and additional accessories to enhance capabilities are available from Industrial Fiber Optics.



45-225

The Optical Rail Kit includes: two 0.6 meter benches, two leveling- base sets, two end cap sets with attachment screws, two ring mounts for holding lenses, two adjustable mirror holders, four standard pin-carriers with pins, adjustable laser holder and heavy-duty pin carrier with pin. (See components list below for more detailed descriptions of individual components.)

Replacement Components

Optical Rails*
Extruded and anodized aluminum optical rails.
Two .6 m rails **45-202**
One 1 m rail **45-201**

Leveling Base Set
One set required for each rail. **45-221**

End Cap Set
One set required for each rail. Includes attachment screws. **45-221**

Standard Pin Carrier
Solid aluminum and black powder coated for reduction of specular reflections. Includes adjustment and locking screw with standard pin. **45-212**

* Custom lengths available upon request

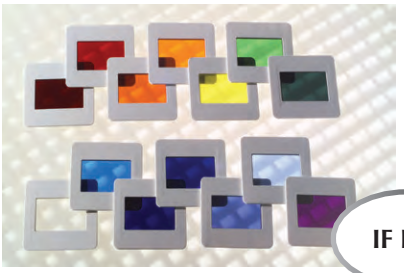
Heavy-duty Pin Carrier
Same as standard pin carrier, but with greater depth for stability. For use with laser holder. Includes adjustment and locking screw with standard pin. **45-212**

Pin Set
Set of three 60 mm pins for standard and heavy duty pin-carriers. Can be screwed together to extend length. **45-214**

Laser Holder/Adjuster
Holder for mounting, tilting and positioning lab-sized lasers on optical rails. Black anodized aluminum construction. Includes thumbscrew for tilt. **45-208**

Ring Mount
Black anodized aluminum mount for cylindrical components 6 to 50 mm in diameter. Includes three brass adjustment screws and cushioned tips. **45-122**

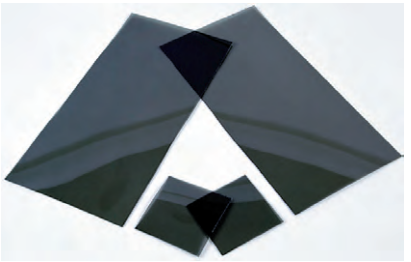
Mirror Holder
Black anodized 75 × 75 mm aluminum mounting plate to which mirrors can attached; 360 degree vertical and horizontal rotation. Includes support and mounting screw that attaches to standard pin and carrier. **45-209**



IF FS4

Deluxe Filter Set

Contains 14 different colors of filter in 35 mm slide mounts. Colors are light blue, medium blue, daylight blue, dark blue, golden amber, medium green, light green, green-blue, light red, medium purple, orange, medium yellow, medium red and frost. All filters are individually mounted on plastic mounts as shown.



Polarizing Film

A general-purpose linear polarizing film for use with visible and near-infrared light. Thickness is .75 mm. Extinction ratio is greater than .01%. Useful for reducing glare, conducting optical experimentation and increasing contrast in sensors. Film is easily cut, punched or drilled and is resistant to heat, impact and abrasion.

Size (mm)	Quantity	Stock Number
50 × 50	2	IF PF1
50 × 50	100	IF PF2
100 × 200	2	IF PF3
475 × 625	1	IF PF4

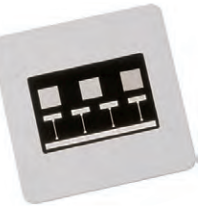
RGB Filter Set

A set of three individual colored filters mounted in standard 35 mm slide holders. Ideal for use in optical transmission measurements, solar monitoring and exploration, attenuation of laser beams and demonstrations of laser light's monochromacity. Set includes one red, blue and green filter.

IF FS1

Diffraction Mosaic

The diffraction mosaic is a precision array of seven different slots/grids designed for use in performing laser double- and multiple-slit diffraction experiments. The mosaic contains four double-slits and three multiple-slit arrays on an opaque film with clear apertures. Double-slit separations range from 45 to 100 µm in width. The gratings are 25, 50 and 100 lines/mm. The mosaic is inexpensive and mounted in easy-to-use 35 mm slide holder. Includes12-page full-color guide for conducting and understanding light diffraction experiments.



IF 508

Unbreakable Mirrors

An inexpensive solution to the problem of glass mirror breakage in classrooms. Substrate is acrylic with an aluminum coating for the reflecting surface. Ideal for younger students.

Size (inches)	Stock Number
2.5 × 3	IF AM1
5 × 7	IF AM2
10 × 12	IF AM3

Fiber Optic Splicing & Connector Module

The Fiber Optic Connector and Splicing Module is an ideal hands-on training curriculum for industrial technology and vocational education studies in two of the most sought after industry technical skills today—splicing a fiber optic cable and installing of fiber optic connectors in the field.

Features

- Comprehensive and challenging activities
- Complete self-contained curriculum
- Color-coded activity tabs
- Low cost per student
- Uses safe, large-core 1000 µm plastic fiber
- Full 4-color instructor and student manuals
- Step by step instructions
- Many graphic illustrations add clarity to instructions
- Removable and photo-copyable sheets in the Instructor's Manual
- Stand-alone curriculum capability

IF 505

Included in the Activites

- Advance reading assignments.
- Actual hands-on, step-by-step procedures for assembling components, then testing them for degree of technical performance. Discussions of applicability to real-world environments such as communications systems put the procedures in industry perspective.
- Assessment of the strengths and shortcomings of various components as system requirements change.
- Worksheets/quizzes that test students' knowledge as well as their ability to apply that knowledge to conceptual situations.
- Homework assignments (using Internet or library resources).

The comprehensive Instructor's Manual that comes with the module also includes answers to quiz and worksheet questions and a description of replacement parts, which are consumed or worn down in activities.

Activities

- Equipment and Component Familiarization
- Methods for Installing a Fiber Connector
- Methods for Splicing Fiber Cable

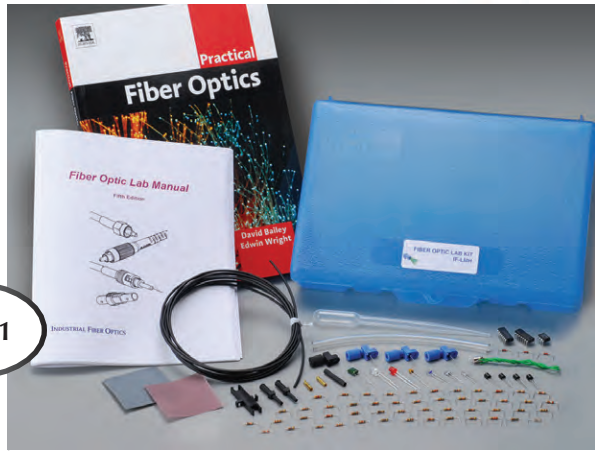
The module is fully compatible with both the plastic and glass versions of the Fiber Optic Demonstration System. (In addition, this module is also compatible with a product manufactured for Scientific Laser Connection, which is referred to as Module 2.)

(The Fiber Optic Connector and Splicing Module includes the following items: fiber inspection microscope, hot knife and stand, fiber optic crimping tool, Professional fiber cutter, stainless steel polishing puck, polishing slurry, Micro-strip fiber stripper, glass polishing plate, tool box, 2 ounces index-matching gel, 2000 grit sandpaper, 3 µm polishing film, 2 ST® mating sleeves, set of two interconnecting fibers, 4 ounces isopropyl alcohol, two Student manuals, one Instructor's manual, 15 2-meter lengths of 1000 µm-core plastic fiber, 15 fiber splices and 30 ST® fiber connectors).

Consumables Kit:

15 2-meter 1000 µm core plastic fibers, 15 fiber splices, 30 ST® fiber connectors, 40 µm and 3 µm polishing film.....**IF 528**

Intermediate Fiber Optic Classroom & Lab Course

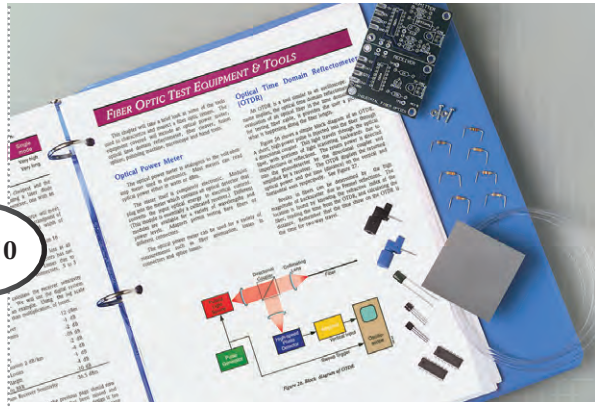


IF SC11

An intermediate fiber optics curriculum, for vocational and trade schools, industrial arts and university levels. Courses can be tailored in length from 10 to 15 weeks. Recommended prerequisites: a basic understanding of electronics and mathematics. Course includes a text for classroom or lecture, lab course containing a comprehensive series of student experiments, and lab kit with all required components.

Part One of the classroom text places fiber optics into perspective as a transmission medium and describes its advantages over other media. Part Two examines fiber sources, detectors, and connectors, in contrast to the distinctly different characteristics of their electronic counterparts. Part Three explains in detail how fiber optic systems are designed and assembled. It covers link system design, installation, special fiber optic hardware, applications and equipment.

Fiber Optic Minicourse



IF MC10

A short course covering the basic concepts of fiber optic communications and industrial applications, intended as a supplement to other more general electronics classes. Class length is variable, to meet instructors' time constraints: five to ten 1-hour periods, plus two 2-hour experimental sessions.

The course begins with "The History of Fiber Optics," followed by sections describing fiber optic communications systems and their individual components. Also included are a list of additional reading references and a helpful fiber optic glossary. Experimental sessions involve students in assembling and testing a fully functional fiber optic digital communication link with separate transmitter and receiver modules.

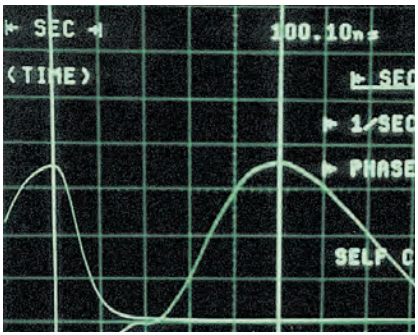
Course comes complete with a full-color classroom manual and kit containing all required electronic components, including printed wiring boards, fiber optic LED, photodetector and cable. No prior fiber optics experience or special tools are needed for assembly and demonstration. *(Minimum order of 50.)*

Speed of Light Apparatus

With Industrial Fiber Optics' Speed of Light Apparatus, measuring the speed of light is now easy and quite accurate. Such was not the case for many centuries. The famed Galileo—after he attempted to measure the speed of light with an unlikely arrangement of lanterns and flags on tall towers—decided that light must travel at infinite speed. Later, Armande Fizeau used an elaborate mechanism with mirrors, lens and a huge rotating cogwheel to determine if the speed of light was, in fact, not infinite. He got close. After many years we now know light does not travel at infinite speed, but rather 299,792.4562 meters per second in a vacuum.

With the proper combination of electronics, electro-optics and fiber optics this once-difficult measurement is simple and can be conducted in any lab or classroom. All that's needed is a 60 × 100 cm table, 110 VAC electrical power, oscilloscope and the Speed of Light Apparatus.

To conduct this experiment, first apply 110 VAC power to the oscilloscope and Speed of Light Apparatus, then connect oscilloscope probes to apparatus test points. After calibration, the oscilloscope monitors the reference and delayed pulses, the time delay is measured and the speed of light calculated.



A typical oscilloscope display depicts the reference signal and the delayed optical signal through optical fiber (100 ns of delay through 20 meters of optical fiber.)

Kit version **IF SLK**

Assembled version **IF SLA**

An integral part of the Speed of Light Apparatus is an easily understood full-color, often lighthearted manual. It begins by tracing the early steps of technical pioneers in their quest to understand light. The manual also includes detailed step-by-step set-up and measurement instructions and examples with equations for calculating the speed of light. In addition, assembly instructions are included for those who purchase this as a kit.

Features

- All solid-state transmitter/receiver design
- Low-voltage electronics operation
- Fiber optic delay requires no optical alignment
- Safe, visible LED light source
- Quick set-up and measurement
- Impact-resistant, protective enclosure
- Rubber feet on chassis bottom for adhesion on smooth surfaces
- Contained light beam is ideal for small areas
- 28-page full-color manual with step-by step assembly, operation instructions and sample oscilloscope displays

(The apparatus consists of an electronics circuit board in protective plastic enclosure, two fiber optic cables, test connections for all outputs and a 110 VAC-to-DC power adapter. The optical fibers terminate in simple collet/cinch connectors for easy assembly and efficient coupling. A 20 MHz oscilloscope is required.) Adapters for 220 VAC will be furnished upon request.

Just for Kids! - Adventures in Fiber Optics Kit

Welcome to the fascinating world of fiber optic technology!

Not long ago fiber optics was little more than a laboratory curiosity. Physicists and scientists in research labs were the only people doing much work in this field.

IF E60

In the last 20 years all that has changed. From its obscure beginnings in the back of a lab, fiber optics has become an important and rapidly changing technology. It employs many of the world's brightest scientists and business people.

With this kit anyone can follow the exploits of famous experimenters such as Galileo, Franklin, Tyndall and Gould, begin to explore fiber optics starting with the very basics and learn more about the fascinating potential of fiber optical technology. Requires no electronics or optics experience.

The kit is suggested for ages 10 and above. It contains materials and an instruction manual to complete five unique projects and 20 exciting experiments such as:

- Bending a Light Guide
- Fluorescence
- Tyndall's Prestigious Light-in-Water Experiment
- Special Fiber Optic Lighting
- Art of Polishing Glass
- Making Your Own Image Conduit
- Creating a Holiday Ornament

Kit items include penlight, rubber light hood, six different optical fiber types, Ulexite image transfering rock, three coherent fiber optic components, color gel filters, lens, star/constellation map, polishing film and other miscellaneous components.

Complete exciting fiber optic projects:

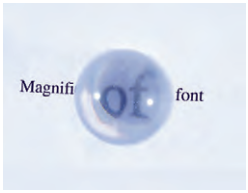


Image Magnifier

Lighted Constellation Map

Fiber Optic Wand

Fluorescent Holiday Wreath

Optical Voice Link

This Industrial Fiber Optics kit "favorite" may have earned more high grades and scholastic honors for student science projects than any other. For students and experimenters alike, the Optical Voice Link is the ideal introduction for an electronics hobbyist first learning about the marvels, mysteries and science of light transmission through optical fiber. There is something fascinating, indeed, about hearing your own voice, after it has been converted into light and then coupled into, through, and out of an optical fiber.

Kit
IF OVL10-K
Assembled Version
IF OVL10-A

Duplex Kit
IF OVL20-K
Assembled Version
IF OVL20-A

The Optical Voice Link is suitable for science projects; home projects for the hobbyist; short audio fiber optic curricula for schools; inexpensive classroom demonstrations; hands-on industrial training; and voice transmission in critical electrical isolation applications.

(Kit includes: printed wiring boards, switches, electronics, microphone, 8-ohm speaker, three meters of plastic fiber optic cable, and an uncomplicated tutorial and step-by-step assembly instruction manual. No prior fiber optics experience, special tools or training are needed to build, use and enjoy the multiple applications of this kit. Some experience with soldering is recommended for completion of the unassembled version.)

Features

- High-quality audio circuits
- On-board microphone
- Visible LED optimized for plastic optical fiber
- 9-volt battery operation
- High-quality multilayer PCBs
- Plastic optical fiber with simple terminations
- Extendable to 20 meters
- 32-page full color instruction booklet

Educational Communication Kit

IF E22

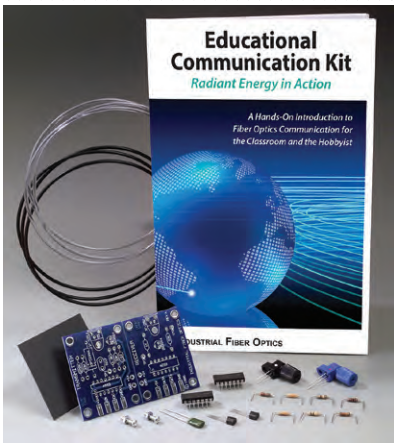
This is our most popular kit, providing students the opportunity to examine fiber optic communication technology at its basics. It's a great hands-on educational product as well as an opportunity for the serious investigator/ experimenter to explore fiber optic technology inexpensively. The Communication Kit is an easy-to-assemble, digital link for experimenting and beginner science projects. (This digital link also can be used to construct high-voltage isolation for telephones, modems and computers.)

Kit contains red LED and photodetector, one meter of optical fiber, printed wiring boards, polishing film, oscillator chip, electronic components and instruction booklet. Suitable for students in grades 9 and above.

Features

- Visible fiber optic source and detector
- Built-in oscillator for testing and demos
- TTL and CMOS logic-compatible inputs and outputs
- Low-voltage operation
- Utilizes plastic optical fiber with simple terminations
- 32-page comprehensive booklet covering assembly, schematics, experiments, fiber optic fundamentals and circuit operation.

We recommend some soldering experience for assembly



Fiber Optics
Lab Course and Lab Kit

The Lab Course is a 68-page guide which contains nine fascinating fiber optics experiments. Lab Course in now in its 5th edition which has full-color illustrations throughout. With the Lab Course, instructors can avoid having to create their own fiber optics or opto-electronics experiments and thus spend more time with their students. Do-it-yourself experimenters will learn valuable practical experience about fiber optics. Each of the nine experiments contains activities which use state-of-the-art opto-electronic components. Along with learning about unique fiber optics procedures, these activities later can be used in dealing with practical, real-world situations. Experiments begin with the basic physics and progress toward solutions for design and circuit problems.

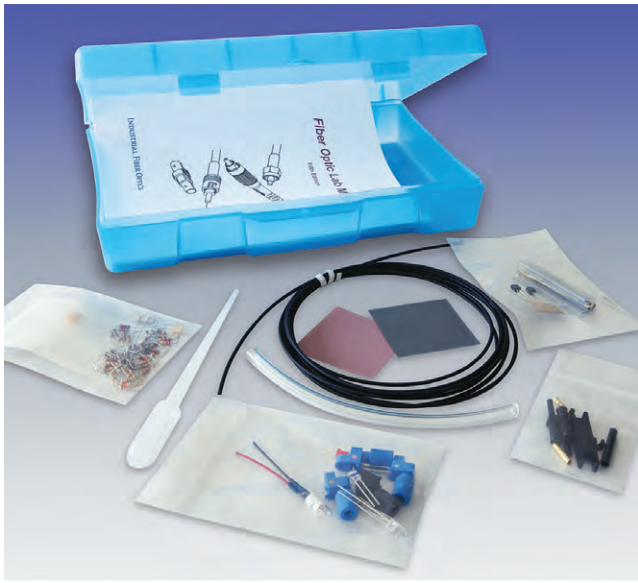
Lab Kit contains all the fiber optic and electronic components required to complete the experiments in the Lab Course manual. (Lab Kit contains optical light pipe, fiber optic cable, splices, connectors and polishing film, with LEDs, photodetectors, transmitter and receiver electronics. No special tools or training required.)

Lab Course with Lab Kit **IF LMH**

Industrial Fiber Optics also has available a 26-page answer guide for the Lab Manual containing tables of typical experimental data derived in our labs, plus answers to all questions and homework assignments.

Answer Guide **IF LMA**

Answer guide can be downloaded at no charge from our web site.



Experiments includes:

- Making a light guide
- Fiber optic cable transmission
- Characteristics of connectors and splices
- Index-matching procedures
- Speed of opto-electronic devices
- Fiber optic transmitter
- Receiver design
- Fiber termination techniques

Lab Course **IF LM** (manual alone)

Lab course manual can be downloaded at no charge from our web site.

Fiber Optic A/D Kit

An premier kit for high school and technical instructors who require the ability to demonstrate analog and digital fiber optics communications principles with a single, economical product. When assembled, the kit provides a unique arrangement of dual-purpose analog and digital transmitter and receiver modules. The transmitter features an on-board microphone for an audio analog signal source and a built-in 15 Hz oscillator for digital signals. It also has input connections for external analog and CMOS-compatible signals. The receiver also incorporates a dual-purpose analog/digital design with a power amplifier driving a 10 cm speaker, digitized circuitry for signals and flashing LED. Unlike other fiber optic kits, this one requires no oscilloscope and is powered by two 9-volt batteries, eliminating the need for external power supplies.

IF 545

The only accessories required but not included are a soldering iron, tools needed for assembly of the kit, and two 9-volt batteries. Economical for both individual students and group projects. A detailed component list can be found on the Industrial Fiber Optics web site.

The kit includes:

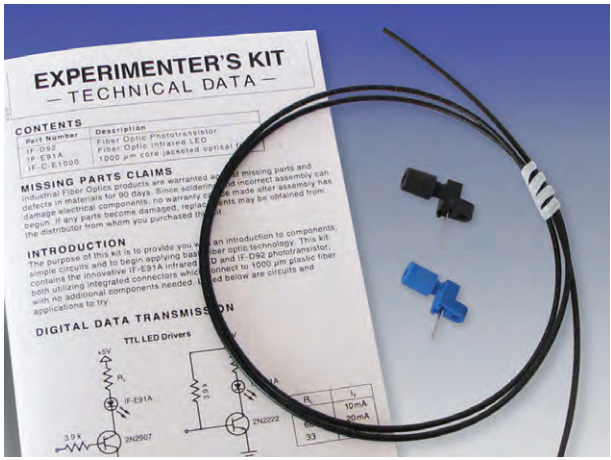
- Transmitter and receiver printed wiring boards
- All required electronic circuit components
- Plastic fiber optic cable and connectors
- Complete instructions on how to assemble components and complete all projects
- Full-color 40 page instruction manual

Experimenter's Kit

Our least expensive basic kit—ideal for designing experiments, original science projects and short-distance optical isolation applications.

Included are one meter of 1000 µm plastic optical fiber, matched IR LED and photodetector (IF E91A and IF D92, respectively) with integral fiber optic connectors, instructional design information and application hints.

IF E10



Magic Optic Rock (TV stone)

Nature created its own fiber optic material long before scientists even dreamed of today's highly refined optical fiber. It is a rare, naturally-occurring mineral called ulexite. The stones are composed of thousands of tiny, parallel, hairlike crystals that transfer an image just like the coherent faceplates and light guides described elsewhere in this catalog. Ulexite often is known by the name of TV stone because of its image-transferring properties. Stones are approximately ½ inch (13 mm) thick and ¾ × ¾ inches (19 × 19 mm) across the face.

IF C-FOR

Fluorescent Fiber Kit

Demonstrate the properties of fluorescence in a single kit. For demonstrating the light-guiding properties of optical fiber without the need for messy powders or liquids. Fluorescent material is embedded in plastic optical fiber for easy and safe use. Includes lengths of red and green fluorescent fiber and clear undoped fiber.

IF 567

Kit contents include: red-colored 1 mm (.04 inch) diameter optical fiber; green-colored 1 mm (.04 inch) diameter optical fiber*; clear optical fiber 1 mm (.04 inch) diameter optical fiber*; 3 mm (1/8 inch) black tubing, 15 cm (6 inches) long; and an instruction guide.*

* Other fiber diameters may be substituted for the 1 mm fluorescent fiber.

Fiber Assortment Kits

An economical assortment of six different types of fibers that would be very costly if purchased individually. Assortment may include glass fibers, jacketed and unjacketed plastic fibers, multi-fiber light guides and coherent fiber bundles. An exceptional value!

IF FGB

Twelve different types of fibers and samples like those in the kit above, plus the addition of fluorescent fibers, fiber optic "TV" stone and coherent light guides.

IF FGB2

* IF FGB2 feature in picture

Optical Sample Kit

A kit expressly created for teachers wanting to demonstrate fiber optics in a classroom and anyone beginning to experiment or develop fiber optic products. Each kit contains an assortment of fiber core diameters and construction. The Optical Sample Kit whose contents are listed below includes fibers and fiber lengths commonly used for illumination projects and model airplane, auto and railroad building.

Jacketed		Unjacketed	
Diameter	Length (m)	Diameter	Length (m)
1000 µm	1.5	250 µm	1.5
1500 µm	.6	500 µm	.6
2000 µm	.6	750 µm	.6
16 × 265 µm bndl	.3		
32 × 265 µm bndl	.3		
48 × 265 µm bndl	.3		
64 × 265 µm bndl	.3		

Optical Fiber

For schools and teachers, the challenge is often how to be able to teach the basics principles of science, physics and technology with economical budgets, a shortage of time and to do so safely. Nothing replaces lectures and books like students being able to visualize things for themselves. With optical fiber sometimes being perceived as an exotic technology it is often thought impossible to bring this technology or samples to the classroom and that is not far from true.

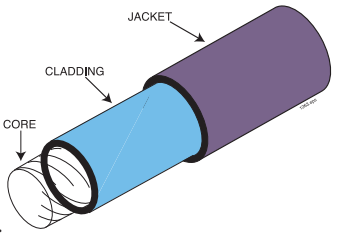
Industrial Fiber Optics offers a variety of plastic optical fibers that are simple and safe letting the student focus on the more intriguing aspects of light technology. The fibers listed below are made from common plastic materials that can be found in any home. They are easily cut using a single-edge razor blade and are ideal for projects such as:

- Demonstration of light principles
- Optical communication devices
- Visual displays and lighting

Optical Fiber Materials:

Optical fiber is manufactured from silica (highly refined glass) or polymer (plastic). Each has advantages for various applications, but glass fiber when it breaks can produce dangerous and nearly invisible small glass shards. Polymer fiber is more flexible, easily trimmed, and safer to handle. For these reasons Industrial Fiber Optics provides this exclusively in its educational kits and is what we recommend for the classroom environment.

A typical fiber cable (depicted in figure) consists of a specially formulated acrylic core, Teflon®-like coating and a polyethylene jacket.



Bare Fiber Strands

Diameter (mm)	Stock Number
.25	IF C U250
.50	IF C U500
.75	IF C U750
1.0	IF C U1000
1.5	IF C U1500
2.0	IF C U2000
3.0	IF C U3000

Fiber Cable

(jacketed)

Diameter core/jacket (mm)	Stock Number
.50/1.0	810115
1.0/2.2 *	IF C E1000
1.5/3.0	IF C E1500
2.0/3.3	IF C E2000

* Cable that is used in most of the educational kits we produce and the most common industry used product.

Fluorescent Fiber

1 mm diameter

Color	Stock Number
Red	IF 810087
Green	IF 810087

Fiber Bundles

Fiber number/ diameter (mm)	Stock Number
16/.265	IF C LG16
32/.265	IF C LG32
48/.265	IF C LG48
64/.265	IF C LG64

For complete engineering specifications on the fibers above, visit our web site: www.i-fiberoptics.com.

Please Visit our Website
www.i-fiberoptics.com