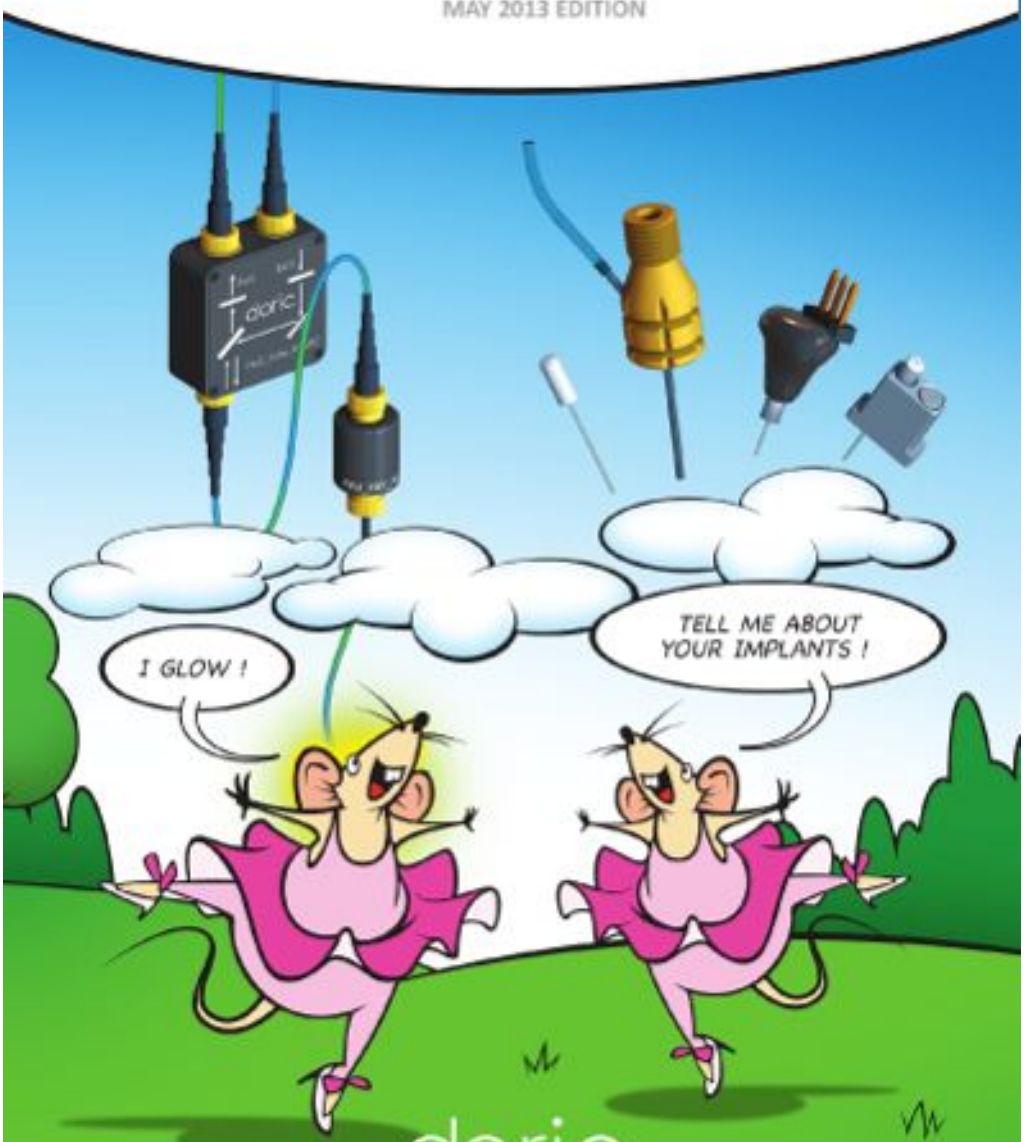
OPTOGENETICS HARDWARE CATALOG

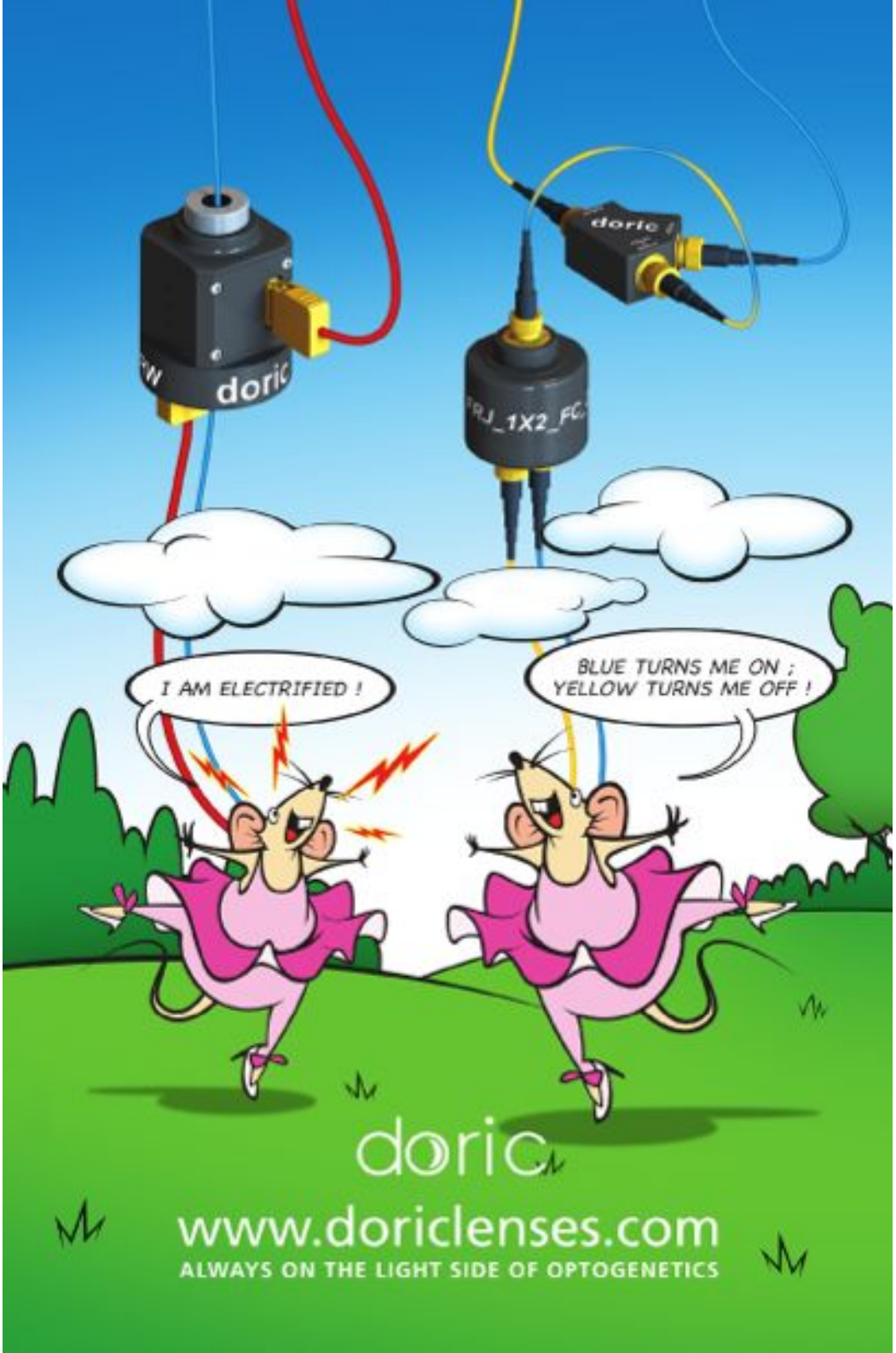
MAY 2013 EDITION



doric

www.doriclenses.com

ALWAYS ON THE LIGHT SIDE OF OPTOGENETICS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I AM ELECTRIFIED !
BLUE TURNS ME ON ;
YELLOW TURNS ME OFF !
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ALWAYS ON THE LIGHT SIDE OF OPTOGENETICS

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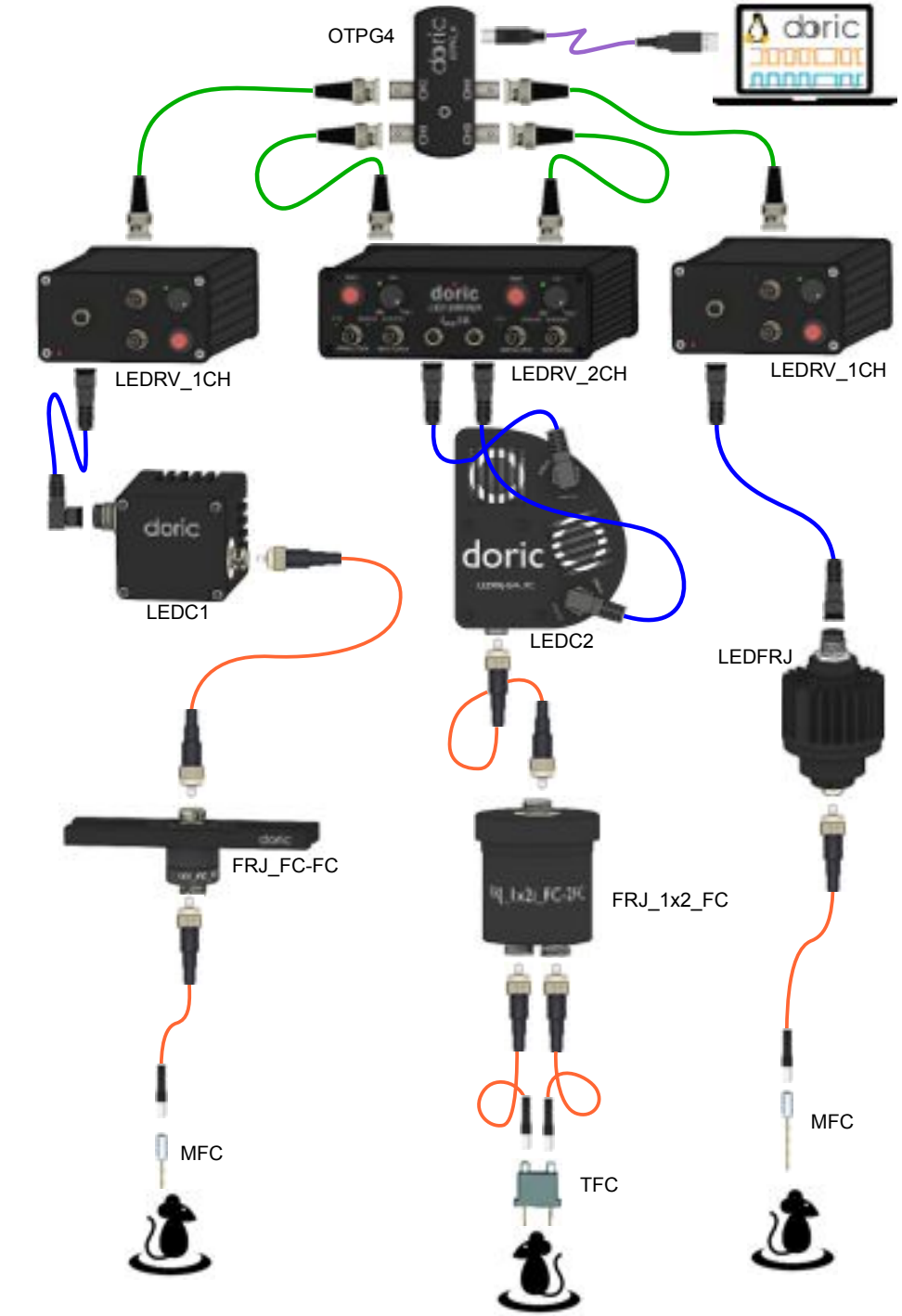
Optogenetics products catalog overview

Optogenetics is a scientific method, as a matter of fact, the Method of the Year 2010 according to Nature Methods magazine, that enables control of targeted cell functions using light stimulation and genetically encoded light-sensitive proteins. Currently, the most popular method of optical stimulation in optogenetics research is to send the light, from a laser or an LED source, along an optical fiber to the brain of a laboratory animal, typically mouse or rat. As time goes by, this simple optical link is evolving into more complex circuitry, resembling an early fiber-optic telecommunication network. This fiber-to-the-brain (FTTB) network consists of fiber coupled light sources and their drivers, light shutters or modulators, rotary joints for in vivo experiments, beam-splitters, fiber-optic patch cords, variety of fiber-optic cannulas with implantable fibers and the list goes on. And that network is not using only optical signals. It is actually a hybrid network monitoring interaction of tissue with light, electrical signals and different fluids. The applications where the optical fiber is used to illuminate neurons, cells and other tissues and to collect laser-induced fluorescence, back-scatter etc. are becoming common. The use of the optogenetics method is no more limited to neurons and is being applied to other cell types, e.g., heart muscle cells.

Due to an ever growing demand for new products and customization, we have outlined the optogenetics product road map that states what is being produced, what we anticipate that customers might need and where we are focusing our R&D efforts. We are trying hard to educate ourselves about those needs and we do invite you, our customer, to suggest or discuss with us further expansions of that road map.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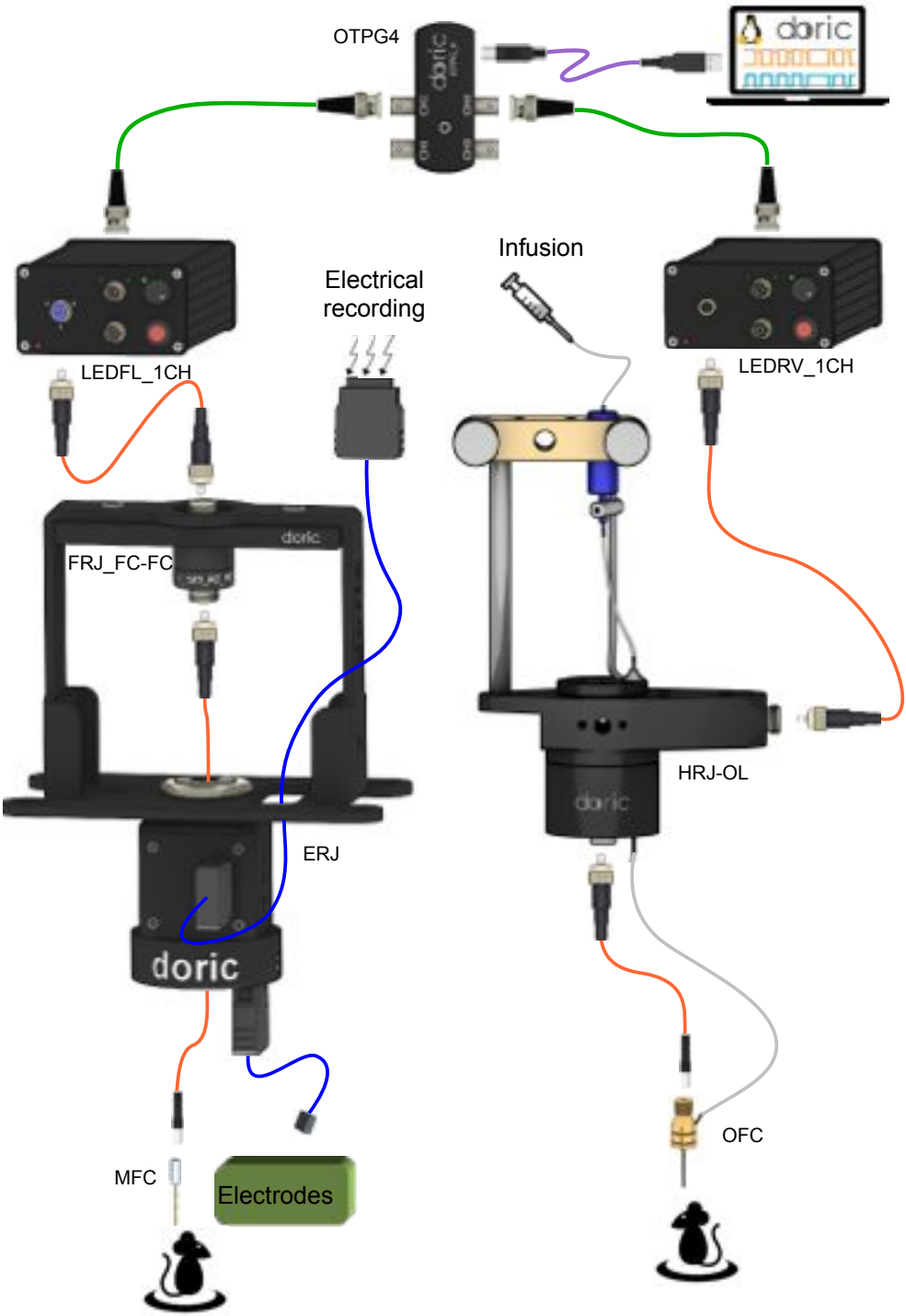
LEDRV_2CH
LEDRV_1CH
LEDC1
LEDC2
LEDFRJ
FRJ_FC-FC
FRJ_1x2_FC
MFC
TFC
MFC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doric
Infusion
Electrical recording
LEDFL_1CH
LEDRV_1CH
FRJ_FC-FC
HRJ-OL
ERJ
doric
MFC
Electrodes
OFC

Products road map

Optogenetics TTL Pulse generators

TTL	4ch	8ch

Light sources

LED Light sources	Single	Dual	Triple	Quadruple	8 LEDs
Driver	✓	✓	N/A	✓	
Connectorized modules	✓	✓	✓	✓	
LED Light-sources	✓	✓	✓	✓	✓
LED+Fiber-optic cannula	✓	✓	N/A	N/A	N/A
LED + Rotary Joint	✓	✓	✓	✓	

Connectorized splitters/combiners

	Intensity division	Wavelength division	Fluorescence
Doric Mini Cubes	✓	✓	✓
Multiple intensity splitters	✓	N/A	N/A
Multiple spectral splitters	N/A	✓	✓

Rotary joints

Fiber-optic Rotary joints	Intensity division	Wavelength division/combining	Fluorescence/Imaging
1x1 passive	N/A	N/A	F
1x1 high RPM	N/A	N/A	F/I
1x2	✓	✓	N/A
2x1	N/A	Inverted 1x2 ✓	✓
1x4	✓	✓	N/A
4x1	N/A	Inverted 1x4 ✓	✓
2x2	Wavelenth combination +Intensity splitting		
nxn			
Electrical Rotary joints passive	6 channels		12 channels
Hybrid Rotary Joint OL (optic, liquid)	Optic 1x1, Fluid 1 to 6 (22,25 ga)		Optic 1x2 wavelength or intensity splitting, fluid 1 to 6 (20-25 ga)

Patch cords			
Fiber-optic Patch cords	Mono fiber	Dual fiber	Branching fiber patch cord
	✓	✓	✓

Cannulas			
Fiber-optic cannula	Mono fiber	Dual fiber	Two ferrule
Ferrule 1.25	✓		✓
Ferrule 2.5	✓	✓	
M3	✓		
M2	✓		
Rectangular Magnetic	✓		✓
Hybrid Cannulas	Optical & fluid	Optical & electrical	Optical, electrical & fluid
M3	✓	✓	development
Rectangular Magnetic	✓	✓	development

Stereotaxic tools

Stereotaxic tools	Holder 1.25mm	Holder 2.5mm
Ferrule 1.25	✓	
Ferrule 2.5		✓
M3 adapter	✓	✓
M2 adapter	✓	✓
Magnetic receptacle	✓	

Optogenetics TTL Pulse generator

Optogenetics TTL Pulse Generator 4 channels

The optogenetics methods use light pulses to modulate the activity of genetically engineered light sensitive cells like neurons or others. Long gone are the days when sending of a continuous streak of blue light along the optical fiber to the mice brain would make him running and provoke worldwide scientific sensation. Today's optogenetics experiments require light pulse trains that correlate not only to muscle contraction but to number of other tissue events, monitoring and measurements. LEDs and laser diodes are the light sources well-suited to modulation by TTL pulse generators. In order to facilitate vertical integration of our optogenetics hardware, we have developed TTL pulse generator that seamlessly integrates with the rest of our optognetics product portfolio. The pulse train parameters and its triggering are specified via open source software and its graphical interface. The pulse generator needs to be connected to computer with USB cable and with BNC cable to Doric or any other LED driver. Currently the pulse amplitude is fixed at 5V. However, the next generation of Doric LED drivers, expected later in the year, will allow for manual amplitude setting.
Four channel TTL pulse generator can drive up to four LED drivers or LED sources. However, this number is if some of the channels are used as triggers. Example: Four channels pulse generator can control pulsing of two LED sources with Channel 1 and Channel 2 while Channels 3 and 4 are used as triggers.

The pulse programming is done using freeware that can be downloaded from our website.

ORDERING CODE: OTPG_□

Number of channels: 4 or 8

Related products: LED drivers 1 to 4, Branching Fiber Patch cords (1xN) and LED fiber-optic light sources 1 to 8 channels.

Fiber-coupled light sources

The fiber optic circuits are driven by light and hence the need to couple the light sources into the optical fiber. The most common sources used to couple the light into the fibers are the laser diodes and LEDs, while the miniature incandescent lamps are used only when broad and smooth spectrum is needed. The incandescent lamps can be used as primary sources from which different spectral bands and profiles can be extracted.

The light sources like LEDs or laser diode require specific drivers that are either integrated within the light source or they are made and sold separately. We offer stand alone LED drivers for one or several diodes, or connectorized LEDs packages for up to 4 different wavelength LEDs and the fiber-optic light-sources that integrate up to four connectorized LED(s) with their respective drivers within one box.

Our drivers can be used within wide range of inputs, 100–240 VAC, 50-60 Hz. The power cord terminations or plugs toward wall socket are selected to match the destination country standard.

LED drivers

Depending of the number of channels, our LED drivers support manual CW operation of up to four independent high brightness LED modules. For each driver's channel, there is a BNC connector that allows independent TTL or analog modulation of respective LED with an input amplitude from 0 to 5V and the frequency of up to 10kHz. Another BCN connector gives feedback of the LED signal with an oscilloscope. To avoid potential LED damage, the maximum current is factory limited to 1A or to customer selected maximum value. When drivers are used for implantable LEDs the maximum current is limited to 0.35 A or 0.5 A.

ORDERING CODE: LEDRV_□CH_□□□□

Number of channels 1, 2 or 4

I_{max} (mA) 350, 500, 1000

For each LED channel, there is a M8-4pin female receptacle on the front panel of the LED driver. The electrical connection to our LEDs is via 1.5 meter long cable with corresponding M8-4pin male and female connectors.

Two channel LED driver

Two channel LED driver powers-up one or two single LED modules of our *dual connectorized high brightness LED* module. To put it simply, this driver is like two single channel drivers in one box.

The four channel LED driver provides tunable DC current to four individual LEDs or clusters of two, three or four diodes combined into single optical output. The 4 channel LED driver is more silent and more compact by volume per channel than its 1 and 2 channel brethren.

Four channel LED driver

Connectorized single LED

Connectorized High brightness single LED

Our robust and compact modules couple high brightness LEDs into different types of optical fibers via FC receptacle that allows change or replacement of the fiber-optic patch cord. The novelty is an optimized heat sink design with active cooling that enhances LED's longevity as well as thermal and spectral stability.
Our micro-optic approach provides maximum coupling possible efficiency and is well-suited for coupling LEDs into multimode optical fibers.The coupling efficiency depends on LED emitter size, fiber core diameter and fiber's numerical aperture. The factory testing of the optical coupling is with 1 mm plastic optical fiber. Refer to *Table 1* for detailed LED specifications.

The module features M8-4pin male connector. The electrical connection to our LED driver is via 1.5 meter long cable with corresponding M8-4pin male and female connectors normally provided with the driver.

ORDERING CODE: LEDC1-B_FC

LED Color code
Other colors from Table 1 available as custom product
Receptacle code
FC is stock item, SMA available as custom product.

Connectorized dual LEDs

This package combines the light from two LEDs of different color into a single output fiber and uses patent pending regular pentagon mirrors configuration. The coupling efficiency for respective colors is nearing those of our single LED sources. Refer to *Table 1* for details. The LEDs are driven independently from each other via two M8 connectors when connected to any of our drivers like two Single channel LED drivers, Two Channel LED driver or Four channel LED driver. The electrical connection to our LED drivers is via two 1.5 meter long cables with corresponding M8-4pin connectors.

ORDERING CODE : LEDC2-B/A_FC

LED Color Codes
Other colors from Table 1 available as custom product

Receptacle code
FC is stock item, SMA available as custom product.

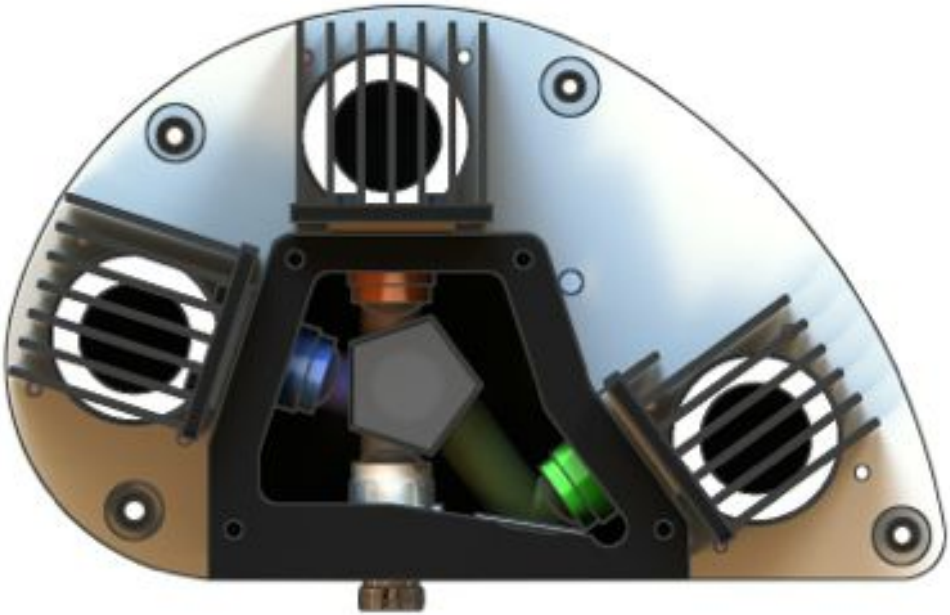
Connectorized 3 LED clusters

Using three LEDs of different emissions spectrum coupled to the same optical fiber adds new light firing capabilities to Optogenetics toolbox. The package uses compact and efficient patent pending regular pentagon mirror configuration. The LEDs are driven independently from each other via our Four Channel LED driver.

ORDERING CODE : LEDC3-B/G/A_FC

LED Color Codes
Other colors from Table 1 available as custom product

Receptacle code
FC is stock item, SMA available as custom product.



Connectorized 4 LED clusters

Using four spectrally different LEDs coupled to the same optical fiber further enhances light firing capabilities to Optogenetics toolbox. The package uses compact and efficient patent pending regular pentagon mirror configuration.

ORDERING CODE : LEDC4-U/B/G/A_FC

LED Color Codes
Other colors from Table 1 available as custom product

Receptacle code
FC is stock item, SMA available as custom product.

LED Fiber-optic Light-sources

To operate pigtailed or connectorized LEDs, one needs appropriate drivers. We offer fiber-ready LEDs and LED drivers as separate packages that need to be connected with electrical cables. However, for those who prefer *plug and play* approach, we have introduced the fiber-optic LED light-sources featuring the driver and connectorized LED within a same box. While preserving all functionalities of the LED drivers and connectorized LEDs, our fiber-optic LED sources offer simplicity of one box design, improved thermal management, patented coupling assembly and more informative and user-friendly interface.

Single LED fiber-optic light-source

When only one color LED source is needed, this union of LED driver and connectorized LED is the least expensive and most compact option that provides full control over CW operation and modulation of the light signal.

Single LED fiber-optic light-source

ORDERING CODE: LEDFL_B_FC

LED Color code
Other colors from *Table 1 available as custom product*

Receptacle code
FC is stock item, SMA available as custom product.

Dual LED fiber-optic light-source

When two LEDs of different colors need to be coupled into one fiber, one can use two channel LED driver and connectorized dual LED or this Dual LED fiber-optic source which, as a single package, provides unsurpassed simplicity, patented coupling assembly, low cost and space saving option.

LEDFL2

ORDERING CODE: LEDFL_B/A_FC

LED Color Codes
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.

4 LED fiber-optic light-source

This is our top of the line light source that provides unprecedented light coupling efficiency based on our patented regular pentagon assembly of dichroic filters. Each LED has independent current modulation and can work in analog, digital and manual mode. The output of all LEDs is combined into one fiber connector.

ORDERING CODE: LEDFL_U/B/G/A_FC

LED Color Codes
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.

Four channel LED fiber-optic light source

Multiple fiber-optic light sources

This product consists of 2 to 8 independent LED light sources, each with its own fiber-optic connector, CW amplitude knob and TTL modulation port.

8 blue LED fiber-optic light-source

The device can be used with a wide range input voltage 100-240 (V) AC, 50-60 Hz.

ORDERING CODE: LEDFL_2A_FC

LED Color Codes
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.

ORDERING CODE: LEDFL_8B_FC

LED Color Codes
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.

Application: The product can be used to illuminate fiber cannula arrays up to 1x8

Single LED + Fiber-optic cannula

We have developed an assembly where the LED is the integral part of the fiber-optic cannula thus providing an lightweight optical source attached to the head of the animal suitable for deep brain illumination. The protruding optical fiber is implanted into the skull.

In order to keep the assembly small and light there is no heatsink. To limit the heat generation, only medium brightness LEDs are used. Maximum current should be limited to 150mA.

LED + Fiber-optic cannula

The electrical connector is so called Header with 3 positions 0.050” gold wire Male Pins (Sullins part # GRPB031VWVN-RC).

ORDERING CODE : LFC-B_□□□□□-□□□_□□□

LED color code
B or A are stock items
Other colors from *Table 1 available as custom product*

Fiber-optic code
200-0.53 for glass fiber 200 um core - NA=0.53
240-0.63 for plastic fiber 240 um core - NA=0.63

Fiber length “L” (mm)

Accessories

Due to the lack of standard use of those implants, we provide 3 wires 15 cm long (or longer if needed) electrical cable with stripped wires on an end and Female socket connector header (Sullins part # LPPB032CFFN-RC) on the other end.

LEDs + FRJ

It is a common practice to connect LED light sources or connectorized LEDs with rotary joints via fiber-optic patch cord. If that patch cord has uncoated fiber ends, which is often the case due to the extra cost and complexity, at least 8% of the light is lost to Fresnel reflection, not to mention other possible connection losses. One way of getting around this avoidable loss is to integrate the LED or LEDs within the fiber-optic rotary joint, thus eliminating that fiber patch cord all-together. That is exactly what we did by joining our legendary fiber-optic rotary joint and equally well known LED sources.

LED+FRJ

The surface of LED emitters is typically larger than the diameter of the optical fibers commonly used in optogenetics experiments and that leads to more uniform optical coupling. All our LED assemblies with integrated rotary joints have M8 connectors for each LED in the package.

Single Led + Fiber-optic Rotary Joint

ORDERING CODE: LEDFRJ-B_FC

LED Color code
B or A are stock items
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.

Dual Led + Fiber-optic Rotary Joint

This patent pending assembly is perfect for light activation of Channelrhodopsin-2 (ChR2) with 473 nm blue light and Halorhodopsin inhibition with 589 nm yellow light. However, other LED wavelength combinations are also possible as long as they are not overlapping.

ORDERING CODE: LEDFRJ-B/A_FC

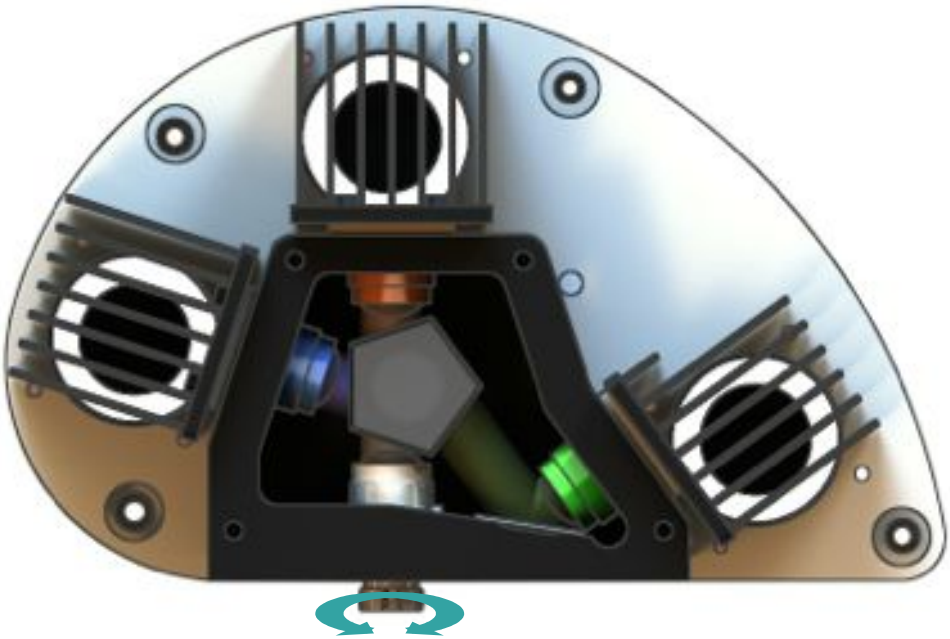
LED Color Codes
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.

3 Leds + Fiber-optic Rotary Joint

Combining three different colors is very old problem and has been tried in numerous ways when synthesizing the “white light” or making high quality color cameras. With new type of opsins emerging on a daily bases, it is very likely that a new wavelengths will be needed within standard activation set. This patent pending assembly provides possibility to combine three distinct wavelengths and couple them to rotating optical fiber.

ORDERING CODE: LEDFRJ-B/G/A_FC

LED Color Codes
Other colors from *Table 1 available as custom product*
Receptacle code
FC is stock item, SMA available as custom product.



4 LEDs + Fiber-optic Rotary Joint

Using four spectrally different LEDs coupled to the same optical fiber further enhances light firing capabilities to Optogenetics toolbox. The package uses compact and efficient patent pending regular pentagon mirror configuration.

ORDERING CODE: LEDFRJ-U_B_G_A_FC

LED Color Codes
Other colors from *Table 1 available as custom product*

Receptacle code
FC is standard, SMA available as custom product.

LED specifications

Table 1: LED color code and main specifications

LED				FIBER OUTPUT POWER @1000mA			
Color	**Code**	**Wavelength**	**Bandwidth FWHM**	**core 200µm NA = 0.48**	**core 240µm NA = 0.63**	**core 400µm NA = 0.48**	**core 960µm NA = 0.50**
Near UV	**385**	385 nm	15 nm	2.0 mW	2.2 mW	8.0 mW	25 mW
	U	405nm	-	-	-	-	-
Royal	**Y**	455 nm	25 nm	3.0 mW	3.5 mW	16 mW	65 mW
Blue	**B**	465 nm	25 nm	5.0 mW	5.6 mW	22 mW	80 mW
Cyan	**C**	505 nm	30 nm	2.0 mW	2.2 mW	8.0 mW	25 mW
Green	**G**	515 nm	35 nm	2.0 mW	2.2 mW	8.0 mW	25 mW
Amber	**A**	595 nm	20 nm	0.8 mW	1.0 mW	3.0 mW	12 mW
Orange	**H**	625 nm	20 nm	3.5 mW	3.5 mW	13 mW	35 mW
Red	**R**	635 nm	20 nm	3.5 mW	4.0 mW	16 mW	40 mW
Infrared	**850**	850 nm	45 nm	3.0 mW	3.0 mW	16 mW	20 mW
Infrared	**940**	940 nm	35 nm	2.0 mW	2.0 mW	9.0 mW	20 mW
White	**W45**	4500 K	250 nm	2.5 mW	3.0 mW	8.0 mW	35 mW
White	**W55**	5500 K	250 nm	3.5 mW	4.0 mW	12 mW	55 mW

Splitters/Combiners with fiber-optic connectors

As fiber optics is finding wider use in microscopy, optogenetics and life sciences in general, it is becoming increasingly popular to use wavelength and intensity division or combination of the light within fiber optic circuits. The beam-splitters have been used in optics for many years and almost exclusively within the parallel beam of light and at 45 degrees angle of incidence. Since the light coming out of the optical fiber is divergent, it needs to be made parallel or collimated before the beam-splitters can be used. For combining or splitting of the light output from optical fibers requires good collimation lenses, beam-splitters with steep transition curves and precision positioning to get efficient coupling. Inspired by microscopy cubes and the need for user friendly beam-splitting in the fiber-optics applications, we have developed a family of *doric mini cubes and multiple splitters*, that integrate beam-splitting glass plates, collimation lenses and fiber-optic receptacles, all in small and convenient connectorized packages. Apart from shrinking the size of the cubes we have introduced higly efficient beam-splitters with unprecedented balance of the s and p polarization reflection curve based on our patent pending low angle of incidence design.

Doric Mini Cubes: Intensity division

This mini cube contains a beam splitter that separates a beam in two output beams with equal power. This cube can be effectively used only as a splitter.

The receptacles can be chosen between FC, SMA or M3. The output receptacles are typically of the same type but can be different if needed.

Doric Mini cube
Intensity Division

ORDERING CODE: DMC_1x2i_VIS_FC

VIS for 450 to 650 nm
Other ranges *available as custom product*

Input receptacle code

FC is standard, SMA available as custom product.

The angle of incidence of light to partially dichroic mirror inside standard, intensity division Doric mini cubes is 22.5 degrees that helps better control s and p polarization.

Doric Mini Cubes: Wavelength division

The wavelength division mini cube contains a dichroic mirror that combines or separates different wavelengths. Consequently, the cube can be used as a splitter, a combiner or to separate excitation and fluorescence wavelengths. This version of mini cube has no other filters except a dichroic mirror. However, the sensitivity of fluorescence measurements of the doric mini cube can be increased if narrow band filters for excitation and fluorescent channel are added. Externally, this is done by adding *Connectorized U-Brackets* with *desired filters* to respective channels. If the specific filters are put inside the cube, it becomes *Fluorescence Mini Cube*.

Doric Mini cube for separation of 470nm and 590nm - standard version

ORDERING CODE: DMC_1x2w_470/590_FC

Wavelength 1 (nm)

Wavelength 2 (nm)

Receptacle code
FC is standard, SMA available as custom product.

Beam combiner *Beam splitter* *Separation of excitation and fluorescence beams*

Doric Mini Cube – Wavelength division

The angle of incidence of light to the dichroic mirror found inside standard Doric mini cubes is 22.5 degrees. That helps better control of s and p polarization. For customers using traditional dichroic filters made for 45 degrees angle of incidence, we can make use of them in a custom product as shown on this picture. Call us for details.

Example of custom assembly - Doric mini cube for separation of 470 nm and 530 nm band

Fluorescence Mini Cube

For more precise fluorescence measurements we have devised a cube that incorporates dichroic splitter, the narrow band pass filters for excitation light and corresponding filter for fluorescent spectrum, all within the same cube. The LED sources typically have broader spectrum and filtering the input with narrow band filter is highly recommended. The same applies to fluorescence detection channel where the appropriate long pass filter greatly improves signal to noise ratio.

Fluorescence mini cube

ORDERING CODE: FMC_1x2f_□□□/□□□-□□□_FC

Excitation Wavelength (nm)

Fluorescent Wavelength Range (nm)
Minimum – Maximum

Receptacle code
FC is standard, SMA available as custom product.

Light Intensity Distributor

The fiber coupled laser sources typically offer high intensity within relatively small fiber diameter. When running several simultaneous in-vivo experiments with those types of sources, it makes perfect sense to use the light distributor which is basically an intensity splitter. By doing this, the required number of modulation channels, drivers and optical sources can be reduced. Our patent pending Light intensity distributor provides compact, connectorized package with low insertion and polarization dependent loss (PDL), ideal for multimode fibers.

Light intensity distributor

ORDERING CODE: **LID**_1x4_VIS_FC
or **LID**_1x3_VIS_FC

Receptacle code
FC is standard, SMA available as custom product.

VIS stands for visible wavelength range from 450 to 650 nm. Other ranges *available as custom product.* The expected intensity percentage in each channel is typically slightly less than 100 divided by the number of channels.

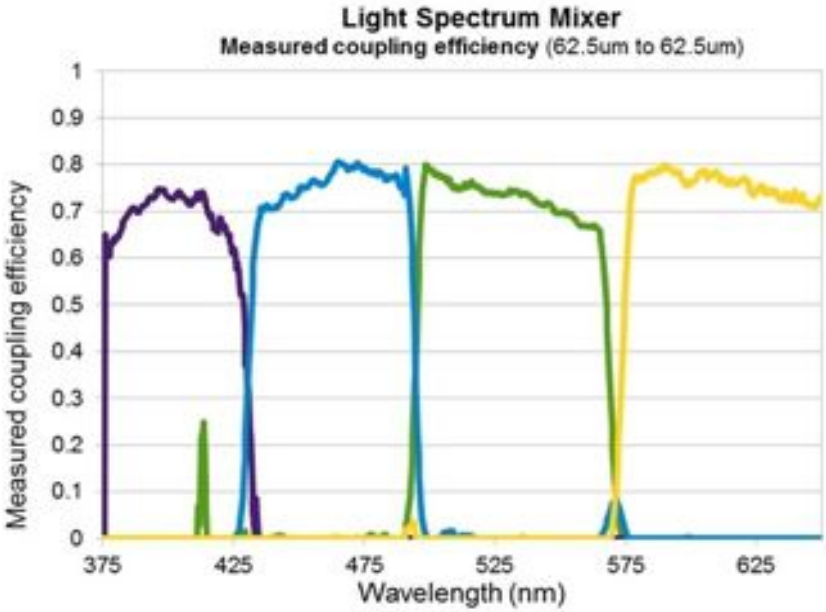
NB Our standard products assume the use of identical fiber diameters, receptacles and equal intensity for each channel. However, this can be customized if needed at extra cost.

The main difference between Doric Mini Cube and Light Intensity Distributor is the angle of incidence to dichroic mirror which is in the later case 18 degrees. The small angle of reference minimizes differences between the s and p polarization and improves the compactness of the assembly.

Light Spectrum Mixer

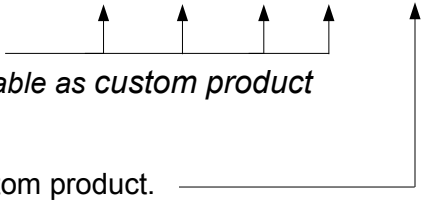
For in-vivo optogenetics experiments there is a need to illuminate the tissue with specific pulses of spectrally different light using the same fiber. To put it simply, the light from different fiber coupled LEDs or lasers needs to be combined into one beam and coupled to an optical fiber leading to fiber-optic implant or cannula. Our patent pending light spectrum mixer provides compact, connectorized package with highly efficient coupling and low polarization dependent loss (PDL), ideal for multimode fibers.

Light spectrum mixer



The same device can be used in the opposite direction as a light spectrum separator. The concept of spectrum mixer or splitter is analog to concept of wavelength division multiplexing and demultiplexing in optical telecommunication.

ORDERING CODE: LSM_1x4_405/470/530/590_FC
or **LSM**_1x3_ 470/530/590_FC



Center wavelengths (nm)
Other LED or laser wavelengths *available as custom product*

Receptacle code
FC is standard, SMA available as custom product.

NB Our standard products assume the use of identical fiber diameters and identical receptacle codes. However, this can be customized if needed at extra cost.

The main difference between Doric Mini Cube and Light Spectrum Mixer is the angle of incidence to dichroic mirror which is in the later case 18 degrees. The small angle of reference minimizes differences between the s and p polarization and improves the compactness of the assembly.

NA converter

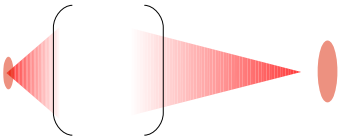
The Lagrange invariant can be defined as a product of numerical aperture and diameter of the optical fiber. With a lens system that re-images the light from one fiber end to the other, one can change the light cone converging toward the other fiber (NA) and create different spot size. However, the product of NA and spot diameter or Lagrange invariant remains the same as its name implies.

NA converter

When coupling multimode fibers with different diameter and/or numerical aperture (NA) the following situations can be encountered:

-Input fiber with smaller diameter and smaller NA couples well with output optical fiber with larger diameter and NA. Common connectors like FC/PC, SMA and others can be used. However, in the opposite direction the connection is very lossy.

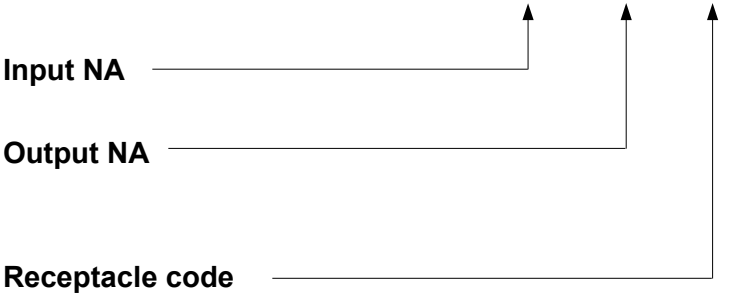
-The coupling between optical fibers of similar values of Lagrange invariant but different NA and core diameters cannot be butt-coupled without introducing a significant loss in both directions. However, their coupling can be effectively optimized using a lens system with the appropriate magnification. Then, the connection has a high transmission in both directions. For the lab situations where different types of fibers have to be connected, these NA converters can be effective match makers. They can also be used to increase the filling of the fiber's NA resulting in larger illuminating cone on the other end of the fiber.


Lagrange invariant - 2X magnification

Example:

If input fiber has 0.48 NA and 100 um core diameter, the lens system with 2X magnification will reduce the NA on the other side of converter to 0.24 and increase the spot size to 200 um.

ORDERING CODE: NAC_□□□_□□□_FC



FC is standard, SMA available as custom product.

Output NA equals Input NA divided by Magnification.

Connectorized U-Bracket

Sometimes it is necessary to attenuate the light signal or to filter its spectrum within a fiber-optic link. A simple connectorized U-bracket allows setting the desired intensity attenuation or spectral filtering by inserting the appropriate mini filter from the mini filter set. To state the obvious, it is necessary that NAs and diameters of input and output fibers are of the same or similar type unless some loss is tolerated. The NA of the fibers should be less than the NA of the collimating lenses.

Connectorized U-bracket and filter insert

ORDERING CODE: CUB_0.5_FC

Max fiber NA

Receptacle type
FC is standard, SMA available as custom product.

U-Bracket Inserts

The inserts can be fitted with attenuating filters or spectral filters made from a variety of glass materials. As a matter of fact, any filter can be fitted to our standard filter holder and its characteristics or code can be engraved on its body. In this way you can build your set using off the shelf and custom filters.

Attenuating or spectral filter insert

The narrow band filters can be useful for filtering fluorescence excitation spectrum or for the fluorescence light.

ORDERING CODE: UBI_□□□□□_□□□□□

Glass type or Filter glass manufacturer
e.g. Semrock, Omega, Chroma, Schott

Manufacturer part number

or Attenuation (% or dB)

Examples: UBI_Semrock_FF01-474/23-25, UBI_Chroma_ET470/40x

Fiber-optic Rotary Joints

The fiber-optic rotary joint optically connects the fiber-optic tips within the fiber receptacle on the fixed side and on the rotating side of the joint. It consists of high precision bearings and a lens system which allow a rotation-insensitive optical power transfer between the fiber tips. In some optogenetics experiments, the optical fiber is connected to the mouse head and when the mouse moves inside confined space, the rotary joint releases the twisting of the optical fiber. The nomenclature that we use for this product is FRJ_mXn where m represents the number of input fibers on the fixed side and n represents the number of output fibers on the rotating side.

1x1 Fiber-optic Rotary Joint

Basic, most popular type of the rotary joint. It consists of a body, two bearings, two collimating lenses and of a receptacle on each side. When connectors are inserted in receptacles the fiber tips are in the focal planes of the respective collimating lenses. Between the lenses the beam is parallel. Typically used with optical fibers with core diameter of 200µm and NA of up to 0.5.

1x1 fiber-optic rotary joint FC output

ORDERING CODE: FRJ_1x1_FC-FC

Intput Receptacle Code
FC is stock item, SMA available as custom product

Output Receptacle Code
FC and M3 are stock items, SMA available as custom product.

1x2 Fiber-optic Rotary Joints

1x2 fiber-optic rotary joints have a single fiber receptacle on the fixed side and two fiber receptacles on the rotating side. These rotary joints are used to send light coming from a single optical fiber to two points on the moving target via separate optical fibers.

There are two distinct versions of this product, one for the intensity division and the other for the wavelength division of light. Each version can be further customized if needed.

Intensity division

The intensity division rotary joints send half of the input light into each of the two output receptacles. The input receptacle is typically the FC type while output receptacles can be any of M3, SMA or FC types.

The rotary joint with FC receptacle on input side and M3 receptacles on the rotating side is small and compact and meets the low rotation torque requirements of some optogenetics experiments. The rotary joint with FC or SMA output connectors is somewhat larger. The fiber patch cords with corresponding connectors should be used to connect to rotary joints. The other side of those patch cords can be fitted with the M3 connectors, magnetic connectors or with a fiber ferrule that connect to fiber-optic cannula. For more information on the matching patch cords for rotary joints, see the patch cord section.

1x2 fiber-optic intensity rotary joint

ORDERING CODE: FRJ_1x2i_FC-2FC_□□□

Input Receptacle Code
FC is standard, SMA available as custom product.
Output Receptacle Code (same for both fibers)
FC and M3 are stock items, SMA available as custom product.
Numerical Aperture
0.22 or 0.5

Wavelength division

The wavelength division rotary joints split the spectral band originating from the input receptacle and send each band to the corresponding rotating fiber receptacles. In some optogenetics experiments, they can be used for example to separate the 473-488 nm blue light (ON signal) and the 590 nm orange light (OFF signal).

The rotary joint with FC receptacle on input side and M3 receptacles on the rotating side is small and compact and meets the low rotation torque requirements of some optogenetics experiments. The rotary joint with FC output receptacles is somewhat larger. The fiber patch cords with corresponding connectors should be used to connect to rotary joints. On the output side, the loose ends of the fibers can be terminated with the M3 connectors, magnetic connectors or with a fiber ferrule that connect to the fiber-optic cannula. For more information on the matching patch cords for rotary joints, see patch cord section.

1x2 fiber-optic rotary joint wavelength division

ORDERING CODE:

FRJ_1x2w_473/590_FC-2FC_□□□

Wavelengths (nm)

Input Receptacle Code
FC is stock item, SMA and M3 available as custom product

Output Receptacle Code (same for both fibers)
FC and M3 are stock items, SMA available as custom product.

Numerical Aperture
0.22 or 0.5

Interestingly enough, the wavelength division 1x2 rotary joint can be used in the opposite direction as spectral combiner. In optogenetics stimulation applications that means combining activation and silencing fiber coupled light sources on a static part of the rotary joint and delivering those beams to single rotating fiber on the other side of the joint.

2x1 fiber-optic rotary joint combines two different wavelengths

Shared Light Path 2x2 FRJ

The simplest form of 2x2 rotary joint is used to mix two spectrally different sources on the fixed side and to do intensity split on the rotating side. This is an excellent tool for bilateral optogenetics stimulation, be it for activation or silencing. This tool is designed for people wanting to combine two laser sources or one laser and one LED source. Those wanting to combine two LEDs of different colors are better served with Dual LED + FRJ or LEDFRJ-B/A_FC and Branching patchcord.

U *4x1 fi*

2wx2i fiber-optic rotary joint

ORDERING CODE: FRJ_2wx2i_473/590_2FC-2FC

Wavelengths (nm)

Input Receptacle Code
FC is stock item, SMA available as custom product
Output Receptacle Code (same for both fibers)
FC and M3 are standard, SMA available as custom product.

Separate Light Path 2x2 FRJ

In some cases there is a need for rotary joint that connects two arbitrary fiber-optic types on the stationary side of rotary joint with their respective counterparts on the rotating side. The examples of such applications are plentiful and here are some of them:

2x2 fiber-optic rotary joint

- In vivo fluorescence measurements where one path is used for excitation light while the other path is used by collecting fiber with high diameter and high NA,

- Concurrent optogenetics experiments of two different brain centers having different illumination modulation,

- Increasing the power of LED illumination, e.g. amber, by combining two fiber coupled LEDs over strategically positioned fiber-optic cannulas and the list goes on.

This innovative patent pending technology offers unprecedented possibilities for laser or LED based optogenetics lighting and other applications requiring compact and low loss dual channel fiber-optic rotary joint.

ORDERING CODE: FRJ_2x2_VIS_2FC-2FC

Wavelength range VIS, IR, ...

Input Receptacle Code
FC is stock item, SMA available as custom product
Output Receptacle Code (same for both fibers)
FC and M3 are standard, SMA available as custom product.

1x4 Fiber-optic Rotary Joints

These joints are used to send the light coming from a single optical fiber to 4 different points on the moving animal via separate optical fibers.

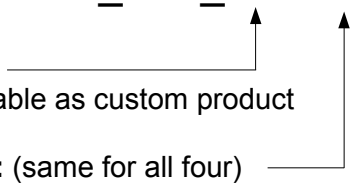
There are two distinct versions of this product, one featuring the intensity division and the other the intensity and wavelength division of light. Each version can be further customized if needed.

Intensity division

The purely intensity division rotary joint sends one quarter of the input light into each of four output receptacles. Its input receptacle is typically FC or SMA, while the output receptacles can be M3, SMA or FC types. However, due to the torque limitations in some optogenetics experiments, we strongly recommend the use of M3 version over bulkier FC and SMA versions.

The fiber patch cords with corresponding connectors should be used to connect to rotary joints. On the output side, the loose ends of the fibers can be terminated with the M3 connectors, magnetic connectors or with a fiber ferrule that connect to fiber-optic cannula. For more information on the matching patch cords for 1x4 fiber-optic rotary joint see patch cord section.

ORDERING CODE: FRJ_1x4i_FC-4FC



Input Receptacle Code:
FC is standard, SMA available as custom product

Output Receptacle Code: (same for all four)
FC and M3 are stock items, SMA available as custom product.

4x1 Fiber-optic Rotary Joints

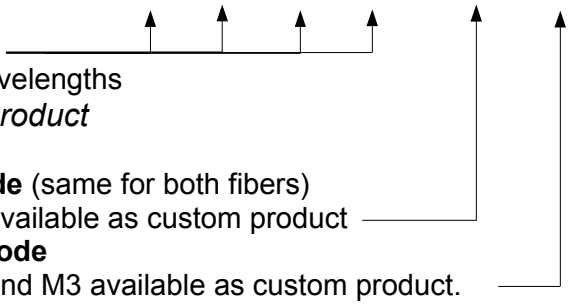
4x1 fiber-optic rotary joints have four fiber receptacles on the fixed side and one fiber receptacle on the rotating side. They are used to combine spectrally different light beams coming from up to four optical fibers and to couple those beams to rotating fiber on the other side of the joint.

Unlike 1x4 FRJ which has intensity division version, the 4x1 FRJ has only the version that combines different wavelengths.

For more information on the matching patch cords for 4x1 fiber-optic rotary joint, see patch cord section.

ORDERING CODE:

FRJ_4wx1_405/470/530/590_4FC-FC



Wavelengths (nm)
Other LED or laser wavelengths
available as custom product

Input Receptacle Code (same for both fibers)
FC is standard, SMA available as custom product
Output Receptacle Code
FC is standard, SMA and M3 available as custom product.

Numbers ofter the slash represent center wavelength (nm) for the corresponding spectral band. Other LED or laser wavelengths available as custom product.+

Technical specifications of fiber-optic rotary joints

The principal motivation behind the development of our fiber-optic rotary joints is to provide optogenetics research labs with simple and inexpensive passive tools for connecting light sources with freely moving laboratory animals via optical fibers. Consequently, the main parameter to consider is the torque needed to move the joint or the resistance to the rotation of the joint. Typically smaller devices will have smaller torque.

The numerical aperture of the connecting fibers can affect the overall transmission of the joints and we recommend that appropriate fibers be used if the best transmission results are to be obtained. Additionally, the transmission and its variation during rotation are influenced by the fiber diameter. The specs shown below relate to 200µm diameter fibers.

FRJ	Torque	NA	Weight	ODmax	Length	Transmission (T)
FRJ_FC-FC	7µN.m	0.48	18g	17mm	30mm	> 80%
FRJ_1x2i/w_FC-2M3	9µN.m	0.22	22g	19mm	36mm	> 2x35% *
FRJ_1x4i/w_FC-4M3	16µN.m	0.22	38g	28mm	40mm	~ 4x16% *
FRJ_1x2i/w_FC-2FC	14µN.m	0.22	117g	40mm	60mm	> 2x35% *
FRJ_1x4i/w_FC-4FC	30µN.m	0.22	275g	60mm	70mm	~ 4x15% *

* : valid for intensity division

For all fiber-optic rotary joints, the variation of the power with the angular position of the joint is lower than 5% per channel.

Electrical rotary joint

Electrical rotary joint - 12 channels

The electrical rotary joints have been used for in-vivo electrophysiology recordings for many years. The arrival of optogenetics created the need for electrophysiological recordings of the optical stimulation of the tissue. That requires certain degree of opto-electrical hybridization of cannulas, connecting cables and rotary joints. The electrical rotary joint with the through hole is optogenetics-ready if its through hole diameter is larger than the diameter of fiber-optic connector on either end of the patch cord that connects fiber-optic rotary joint and fiber-optic cannula implant. If this is the case, the electrical and fiber-optic rotary joints can be used in tandem. With this in mind, we have developed passive electrical rotary joint with low torque of 0.9 mNm and 1.8 mNm for 6 and 12 electrical contacts respectively that can be used either purely for electrophysiology, or, when combined with fiber-optic rotary joints, for electrophysiological recordings of optogenetically induced events.

The joints have 7.5 mm through hole that is sufficiently large to allow passing of M3 connector or ferrule/sleeve type connectors across.
The joint also comes equipped with accessories for attaching our standard 1x1 or 1x2 fiber-optic rotary joints.

Notes:

-The fiber patch cord must have at least one end with connectors or ferrules that are less than through hole diameter.

-The number of electrical contacts does not necessarily equals the number of recording channels as some of them might be used by electronics on a head stage.

ORDERING CODE: ERJ_□□_HRW-HRW

# of electrical contacts:
6, 12

Fixed side connector type:
HRW for HARWIN M80-826***12*** or ***06*** standard
WIR for 30 cm long leads custom

Rotating side connector type:
HRW for HARWIN M80-826***12*** or ***06***, WIR for 30 cm long leads

Related products: 1x1 and 1x2 Fiber-optic rotary joints, Branching Fiber Patch cords (1xN)

ERJ and FRJ used in tandem

Hybrid Rotary Joints (optical, liquid and electrical)

To better understand the flow of ions in biological tissue or within a single cell, the scientist use electrophysiological recordings to monitor optogenetically marked and stimulated tissue while administering various liquids to the observation site. For in-vivo experiments, one needs the hybrid rotary joints that combines some or all functions of the fiber-optic, electrical and liquid rotary joints within one instrument. For us, each of the possible combinations of these functions is a product category on its own.

Fiber-optic & Liquid rotary joint

The optogenetics method provides the possibility to directly observe the influence of different drug solutions on cell processes. To enable in-vivo observations of those interactions, we have developed hybrid optical/liquid rotary joints that allows optical connection and liquid delivery via up to six tubes within rotating part of the rotary joint. This joint couples to any type of the liquid swivels from Instech Solomon. It incorporates a holder for liquid swivel and corresponding interchangeable metal tubes for insertion of plastic tubing. It is possible to exchange tubing and prevents cross-contamination when changing liquid solutions.

Fiber-optic and liquid rotary joint

ORDERING CODE: HRJ-OL_FC-FC

Optical Channel Input Receptacle Code
FC is stock item, SMA available as custom product
Optical Channel Output Receptacle Code
FC are stock items, SMA or M3 available as custom products.

NB the liquid swivel and the plastic tubing are not included.

Related products: Optic & Fluid cannula, Branching Fiber Patch cords (1xN)

Fiber-optic & Electrical rotary joint

By combining light stimulation and electrophysiological recordings in optogenetics experiments, one can observe correlation of electrical pulses with light stimulation. At this stage, most of research is focused on combining the comb of electrodes with a single illuminating fibers or one fiber one electrode. To facilitate this kind of in vivo experiments, we have developed passive low torque hybrid rotary joints with number of electrical channels and one optical channel with FC connectors on both ends. This product is more compact than combination of electrical rotary joint and 1x1 fiber-optic rotary joint where the fiber is passed through central hole of the electrical joint.

Fiber-optic & electrical rotary joint

ORDERING CODE:

HRJ-OE_FC-FC_□□_HRW-HRW

Optical Input Receptacle Code
FC is stock item, SMA is custom product

Optical Output Receptacle Code
FC is stock item, SMA and M3 available as custom products.

# of electrical channels
6,12

Fixed side connector type
HRW for HARWIN M80-826***12*** or ***06*** *depending on # of channels*
WIR for 30 cm long leads

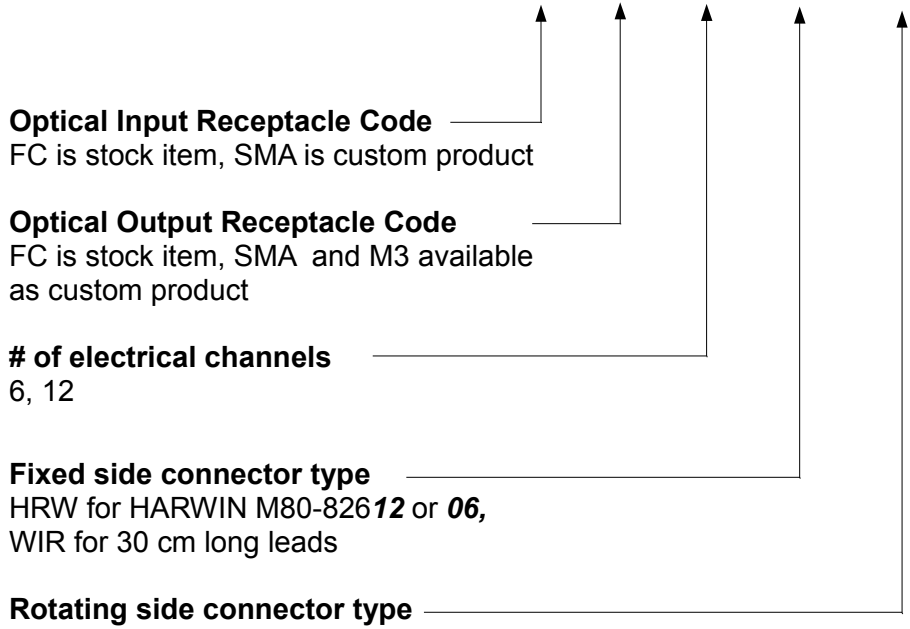
Rotating side connector type
HRW for HARWIN M80-826***12*** or ***06*** *depending on # of channels*
WIR for 30 cm long leads

Related products: Branching Fiber Patch cords (1xN)

Optical, Liquid & Electrical rotary joint

ORDERING CODE:

HRJ-OLE_FC-FC_□□_HRW-HRW



Optical Input Receptacle Code
FC is stock item, SMA is custom product

Optical Output Receptacle Code
FC is stock item, SMA and M3 available as custom product

# of electrical channels
6, 12

Fixed side connector type
HRW for HARWIN M80-826***12*** or ***06,***
WIR for 30 cm long leads

Rotating side connector type
HRW for HARWIN M80-826***12*** or ***06***,
WIR for 30 cm long leads

Assisted Hybrid Rotary Joints

So far, we spared no effort to reduce friction in our rotary joints for in-vivo brain research involving small animals like mice and rats. However, the increased complexity level of today's optogenetics experiments requires evermore optical, electrical and liquid channels to be linked to animal's brain and, at certain point, there is no choice but to use assisted rotation joints.

Assisted Fiber-optic & Electrical rotary joint

By combining light stimulation and electrophysiological recordings in optogenetics experiments, one can observe their correlation. At this stage, most of research is focused on combining single illuminating fiber with either one electrode or comb of electrodes. Each electrode requires at least one slip ring, where each ring has the braking effect on the rotary joint. Our assisted rotary joint removes this impediment to rotation regardless of the number of electrical channels. The standard joint comes with 12 electrical channels and one optical channel and FC connectors on both ends. This product is more compact than combination of electrical rotary joint and 1x1 fiber-optic rotary joint where the fiber is passed through central hole of the electrical joint.

Assisted Fiber-optic & electrical rotary joint

Contact us to discuss possibilities for more electrical or optical channels.

ORDERING CODE:

AHRJ-OE_FC-FC_12_HRW-HRW

Optical Input Receptacle Code
FC is stock item, SMA, M3 optional

Optical Output Receptacle Code
FC is stock item, SMA and M3 optional

# of electrical channels

Fixed side connector type
HRW for HARWIN M80-82612
WIR for 30 cm long leads

Rotating side connector type
HRW for HARWIN M80-82612
WIR for 30 cm long leads

Related products: Branching Fiber Patch cords (1xN)

Connectorized Mechanical Shutter Adapter

The modulation of light signal is very important for optogenetics experiments. The light sources, like LEDs or laser diodes are well-suited for direct electrical modulation, while some popular laser types require external modulation via mechanical shutters or acousto-optic modulators. However, mechanical shutters are gaining popularity with laser based optogenetics set-ups as they are better suited for use multimode fibers.

Connectorized Machenical Shutter Adapter -SRS

The inconvenience of mechanical shutters is that they require parallel beam of light and subsequent coupling into optical fiber can be tricky and unstable. To facilitate the use of mechanical shutters we are providing connectorized adapters for major shutter brands like SRS475 and Uniblitz.

These assemblies provide relatively inexpensive alternative to acousto-optic modulators. We can supply the adapter only or connectorized SR475 or Uniblitz xxx shutter head with or w/out their respective Shutter Controllers.

ORDERING CODE: CMSA-SR475_FC-FC

Shutter type

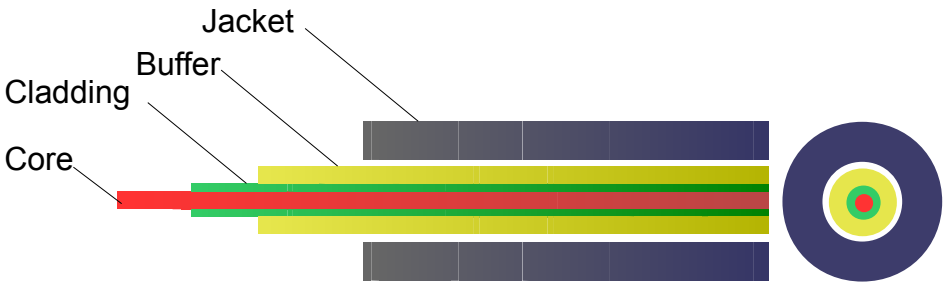
Optical Input Receptacle Code
FC is stock item, SMA is custom product

Optical Output Receptacle Code
FC is stock item, SMA and M3 available as custom products.

Fiber-optic cables for optogenetics

A fiber-optic patch cord connects two distant fiber optic ends and uses the same type of fiber and connections as the tips of the respective fibers it connects. In the context of optogenetics experiments with the rotary joint, a fiber optic patch cord is needed to connect the light source and the rotary joint and yet another patch cord to connect the rotary joint and the fiber-optic cannula.

Structure of a patch cord



The **core** and the **cladding** are two layers that make up the lightguide. However, the light travels inside the core of the fiber-optic, barely or not inside the cladding. For this reason, interconnected fiber-optics should have the same core diameter. Different cladding diameters have no influence on the coupling efficiency.

The **buffer** is a protective layer that tightly encircles the cladding. For patch cords, we usually recommend the use of another protective layer, called **jacket**, which is a loose tube covering the previously mentioned layers of the cable.

Table 2: Termination codes for patch cords

Description	Picture	Termination code
FC connector		**FC**
SMAconnector		**SMA**
Zirconia ferrule OD=1.25mm		**ZF1.25**
Zirconia ferrule OD=1.25mm with flange		**ZF1.25(F)**
Metal ferrule OD=1.25mm		**MF1.25**
Zirconia ferrule OD=2.5mm		**ZF2.5**
Zirconia ferrule OD=2.5mm with flange		**ZF2.5(F)**
Metal ferrule OD=2.5mm		**MF2.5**
Rectangular magnetic connector		**RMC**
M3 connector		**CM3**
M3 connector – peek plastic		**CM3(P)**
M2 connector		**CM2**

Table 3: Plastic optical fibers

Core	Cladding	Outer diameter		Numerical Aperture	Fiber-optic code
		Buffer	Jacket		
240	250	1000	-	0.50	**240/250/1000-0.50**
480	500	1000	-	0.50	**480/500/1000-0.50**
960	1000	2200	-	0.50	**960/1000/2200-0.50**
1480	1500	3000	-	0.50	**1480/1500/3000-0.50**

Unless otherwise specified, the patch cords are black.

Table 4: Silica multimode optical fibers

Core	Cladding	Outer diameter		Numerical Aperture	Fiber-optic code
		Buffer	Jacket		
50	125	250	900	**0.22**	**50/125/900-0.22**
62.5	125	250	900	**0.27**	**62.5/125/900-0.27**
100	110	125	900	**0.22**	**100/110/900-0.22**
100	110	125	900	**0.37**	**100/110/900-0.37**
100	110	500	900	**0.44**	**100/110/900-0.44**
105	125	250	900	**0.22**	**105/125/900-0.22**
200	220	240	900	**0.22**	**200/220/900-0.22**
200	240	400	900	**0.22**	**200/240/900-0.22**
200	220	245	900	**0.37**	**200/220/900-0.37**
200	230	500	900	**0.37**	**200/230/900-0.37**
200	230	500	900	**0.39**	**200/230/900-0.39**
200	230	500	900	**0.48**	**200/230/900-0.48**
200	220	500	900	**0.53**	**200/220/900-0.53**
300	330	370	900	**0.22**	**300/330/900-0.22**
300	330	650	1000	**0.37**	**300/330/1000-0.37**
400	440	480	900	**0.22**	**400/440/900-0.22**
400	430	730	1100	**0.37**	**400/430/1100-0.37**
400	430	730	1100	**0.39**	**400/430/1100-0.39**
400	430	730	1100	**0.48**	**400/430/1100-0.48**
400	440	475	900	**0.53**	**400/440/900-0.53**

For better fiber protection, we also offer larger jackets made of PVC tubing. In this case, we use the following color convention, or we can use the black jacket if preferred. Metal jacket or jackets made of other materials are also available on request.

Table 5: Alternative jackets for patch cords

Jacket color	Fiber core diameter (µm)	Alternative fiber-optic codes	
		PVC jacket OD 2mm	PVC jacket OD 3mm
Red	50	**50/125/2000-0.22**	**50/125/3000-0.22**
Green	100 or 105	**100/□□□/2000-□□□ or 105/125/2000-0.22**	**100/□□□/3000-□□□ or 105/125/3000-0.22**
Dark blue	200	**200/□□□/2000-□□□**	**200/□□□/3000-□□□**
Light blue	300	**300/□□□/2000-□□□**	**300/□□□/3000-□□□**
Orange	400	**400/□□□/2000-□□□**	**400/□□□/3000-□□□**
Yellow	600	**600/□□□/2000-□□□**	**600/□□□/3000-□□□**

Mono Fiber Patch cords

The simplest form of the patch cord is a piece of fiber with buffer coating and two ferrules on its ends. So far, the most popular fiber in optogenetics research is a fiber with 200 µm core diameter and NA=0.22.

Mono fiber-optic patch cord

ORDERING CODE:

MFP_□□□/□□□/□□□-□□□_□□□_□□□-□□□

Fiber-optic code
See *Table 3*, *Table 4* and *Table 5* for available codes

Fiber length (m)
From ferrule tip to ferrule tip

Termination code : End 1
See *Table 2* for available codes

Termination Code: End 2
See *Table 2* for available codes

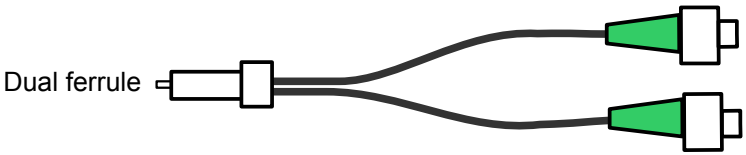
However, it is important to mention that diameter of the fiber and its numerical aperture limit the useful collection angle and coupling into the fiber. Therefore, if higher coupling from sources like LEDs into optical fiber of specific diameter is needed, please select higher NA fiber and follow it all the way through to the fiber optics cannula.

Dual Fiber Patch cords

A dual fiber patch cord has two fiber-optic strands within the jacket, where the fiber ends are inserted into mono or dual fiber ferrules or connectors.

Some dual fiber patch cords were especially designed to easily bring the light from the two optical channels of the 1x2 rotary joint into a dual fiber cannula.

There are several types of dual fiber patch cords, depending on the type of connectors and cannulas used.



Dual fiber patch cord

ORDERING CODE:

DFP_□□□/□□□/□□□-□□□_□□□_□□□-□□□

Fiber-optic code
See *Table 3* and *Table 4* for available codes

Fiber length (m)
(From ferrule tip to ferrule tip)

Termination code : Single connector side
See *Table 6* for available codes

Termination Code: Two connectors side
See *Table 2* for available codes

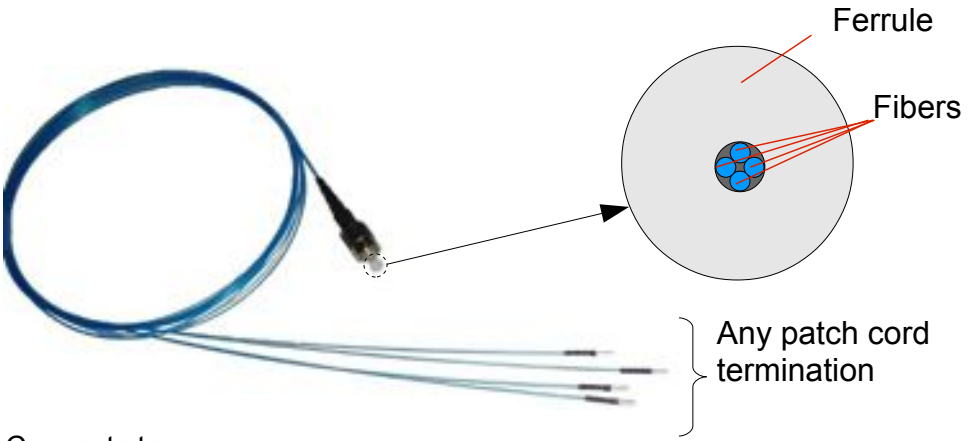
Table 6: Termination codes for patch cords for dual fiber patch cord (single connector side)

Description	Picture	Termination code
Dual ferrule with pitch 0.7mm -Titanium		**DF0.7**
Dual ferrule with pitch 1.0mm - Titanium		**DF1.0**
Dual ferrule with pitch 1.2mm - Titanium		**DF1.2**
Dual ferrule with pitch 1.5mm -Titanium		**DF1.5**

Branching Fiber Patch cords (1xN)

A branching fiber patch cord consists of multiple single fiber patch cords that are at one end joined within one connector and its ferrule, while the loose side of the patch cords ends with mono fiber ferrules or connectors.

We offer fiber-optic patch cords that branch from one input to N output connectors. These patch cords have a single FC or SMA connector on bundled fibers end, and FC, SMA, M3, zirconia or metal ferrule for each fiber on the other end. The optical power entering the fiber bundle is divided between the channels.



Connects to:
»Fiber with a larger core diameter
»LED source

ORDERING CODE:

BFP(□)_□□□/□□□/□□□-□□□_□□□_□□□-□□□

Number of branches

Fiber-optic code
See *Table 3* and *Table 4* for available codes

Fiber length (cm)
(From one ferrule tip to another ferrule tip)

Termination code : Single connector side
See *Table 2* for available codes

Termination Code: Multiple connectors side
See *Table 2* for available codes

Example: Branching Fiber Patch Cord with two fibers

BFP_2_200/220/900_0.53_100_FC_2xZF1.25

Fiber-optic Cannula

Mono fiber-optic cannula Rectangular magnetic

A fluid cannula is an assembly of a metal tube and a fluid tube receptacle, used for administering fluids when metal tube is inserted into the body. A venous cannula is inserted into a vein to obtain blood samples or to deliver medicines. The body of a cannula has a form that easily connects to or disconnects from the plastic tubing. The plastic tubing can be disconnected while the cannula remains attached to the body surface with the hollow needle (tube) inserted into the body for the later use. Similar to those fluid cannulas, biomedical and optogenetics applications need fiber-optic cannulas to introduce the laser or LED light into the body tissue. As an example, illuminating the neurons within the mouse brain with the blue or orange light has become an essential tool for studying the processes within genetically modified photosensitive neurons. In early days of optogenetics, researchers used a fluid cannula to insert the optical fibers into the brain tissue, where the metal tube was guiding the fiber to the neurons. After the experiment, the optical fiber was removed from the cannula only to be reinserted later. The optical fiber removal and re-entry could lead to infections and clogging of the fluid cannula.

Optic & Fluid Cannula - M3

With some exceptions, the fiber-optic cannula is typically used without the metal tube of the fluid cannula. It consists of a fiber-optic ferrule with some sort of fiber-optic receptacle on one side and the implantable fiber protruding from the other side. When the fiber-optic cannula is fixed to the body and the fiber implanted, the light can be delivered to the tissue and the fluorescence or scatter from the tissue can be captured. In these experiments, it is imperative that the connection between the delivery fiber and the cannula is light, small and simple to connect and disconnect. For a mono fiber delivery, the connection between the ferrules of the light delivery fiber patch cord and the fiber-optic cannula is achieved, in its simplest form, via

fiber-optic sleeve. The connector type connection is preferred but it is not always applicable. In some optogenetics experiments it is necessary to introduce two or more implantable fibers within a small, precise distance. Those applications call for the dual fiber-optic cannula that is easily connected to the matching delivery fibers.

The concept of fiber-optic cannulas with different optical fibers, receptacle types and fiber terminations is bound to be further fragmented. So far we carry *Mono fiber cannulas*, *Dual fiber cannulas, Two ferrules cannulas and hybrid cannulas*. In effect, we are developing hybrid cannulas that transmit combination of light, liquid and electrical signals. Tables 7, 8 and 9 show different possibilities possible with each canula type.

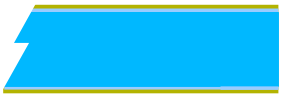
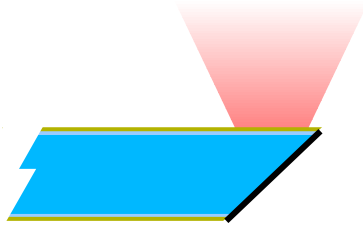
Table 7: Silica multimode optical fibers

Core (µm)	Outer diameter (µm)	Numerical Aperture	Buffer color	Outer Layer	Fiber-optic code
50	70	**0.22**	yellow	Polymide buffer	**50/70-0.22**
100	125	**0.22**	yellow	Polymide buffer	**100/125-0.22**
100	125	**0.37**	yellow	Polymide buffer	**100/125-0.37**
100	150	**0.44**	clear	Silicone buffer	**100/150-0.44**
200	240	**0.22**	yellow	Polymide buffer	**200/240-0.22**
200	260	**0.22**	clear	Silicone buffer	**200/260-0.22**
200	230	**0.37**	clear	Hard polymer cladding	**200/230-0.37**
200	245	**0.37**	yellow	Polymide buffer	**200/245-0.37**
200	230	**0.48**	clear	Hard polymer cladding	**200/230-0.48**
200	245	**0.53**	blue	Hard polymer cladding	**200/245-0.53**
300	370	**0.22**	yellow	Polymide buffer	**300/370-0.22**
300	330	**0.37**	clear	Hard polymer cladding	**300/330-0.37**
400	480	**0.22**	yellow	Polymide buffer	**400/480-0.22**
400	430	**0.37**	clear	Hard polymer cladding	**400/430-0.37**
400	430	**0.48**	clear	Hard polymer cladding	**400/430-0.48**
400	475	**0.53**	clear	Hard polymer cladding	**400/475-0.53**

Table 8: Plastic optical fibers

Core	Outer diameter	Numerical Aperture	Buffer color	Fiber-optic code
240	250	0.63	clear	**240/250-0.63**
480	500	0.50	clear	**480/500-0.50**

Table 9: Fiber-optic termination codes for cannulas

Termination code	Description	Drawing	Specifications
FLT	Flat tip		
Axx	Angled tip		Standard angles: 45°; 60° Other angles on request (max 60°)
Bxx	Bi prism tip		Standard angles: 45°; 60° Other angles on request (max 60°)
Cxx	Conical tip		Rounded tip thickness: ~ 0.1x to 0.2x core diameter Standard angles: 45°; 60° Other angles on request (max 60°)
MA45	Mirror tip at 45°		

Note: Axx, Bxx, Cxx and Rxx are offered to facilitate the insertion of the fiber-optic in the tissue. However, they have little influence on the light spread.

Mono Fiber-optic Cannula

The mono fiber-optic cannula is an assembly of a bare optical fiber, a fiber ferrule and a receptacle or a sleeve. One side of the ferrule is polished while the implantable part of the fiber protrudes from the opposite end of the ferrule. The ferrule is placed within receptacle or sleeve to allow connecting to the fiber-optic patch cord. The protruding fiber can be implanted into the body while the ferrule or the receptacle is attached to the skin. When the cannula is connected with the patch cord, it is possible to send the light signals to and from the tissue close to fiber tip. It is imperative for in-vivo optogenetics applications that the fiber-optic cannula allows for efficient, plug and play type connection with the fiber-optic patch cord.

A receptacle is a mechanical holder that defines the positions of the fiber tip and guides the connecting ferrule to the optical coupling position. For mono fiber-optic cannulas we offer Zirconia sleeves as the simplest form of receptacle, M2, M3 and rectangular magnetic receptacles. For more information refer to receptacle section.

N.B.: Zirconia sleeves are ordered separately.

The tolerance on the length of protruding fiber is better than 0.1mm.

ORDERING CODE: MFC_□□□/□□□-□□□_□□□_□□□_□□□

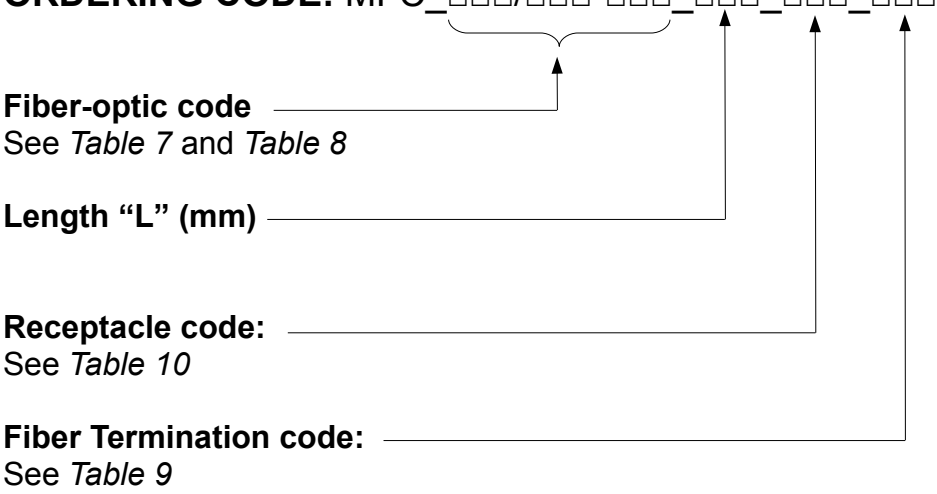


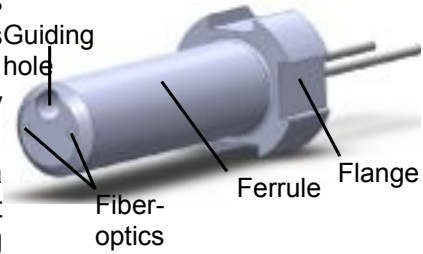
Table 10: Receptacle codes for mono fiber-optic cannula

Description	Picture	Termination code
Zirconia ferrule OD 1.25mm		**ZF1.25**
Metal ferrule OD 1.25mm		**MF1.25**
Zirconia ferrule OD 2.5mm		**ZF2.5**
Metal ferrule OD 2.5mm		**MF2.5**
Receptacle with M2 thread Titanium		**RM2**
Receptacle with M3 thread Titanium		**RM3**
Receptacle with M3 thread Peek plastic		**RM3(P)**
Rectangular Magnetic Receptacle Titanium		**RMR**

See receptacle section for details on mass and dimensions.

Dual Fiber-optic Cannula

A dual fiber-optic cannula provides two implantable fibers at a precise distance within a single ferrule. The tolerance on the protrusion for each fiber is less than 0.1 mm. These cannulas are perfectly suited for the applications where two brain centers close to each other are simultaneously optically stimulated or controlled.



The positioning of one mono fiber cannula at a time with the stereotaxic equipment has greater likelihood of 3D positioning errors (lateral and depth). Additionally, the diameter of the ferrules limits the minimum distance between the fiber tips. With dual fiber-optic cannula the insertion of the fiber is faster (single shot), the distance between the fiber tips is predefined and the protrusion depth is assured. The cannula includes a guiding hole to insure precise alignment when connecting to a dual fiber-optic connector (equipped with a guiding pin). The dual fiber cannula can be made for any distance in 0.7 to 1.7 mm range. If larger distances between the brain centers need to be covered, please refer to *Two Ferrules Cannulas*.

Our dual fiber-optic cannula has a typical transmission higher than 75% for each fiber.

ORDERING CODE: DFC_□□□/□□□-□□□_□□□_□□□_□□□

Fiber core diameter (µm)
See *Table 7* and *Table 8*

Length "L"(mm)
See convention in *Table 11*

Receptacle code:
See *Table 11*

Fiber Termination code:
See *Table 9* for available codes

Table 11: Receptacle codes for dual fiber cannula

“Pitch” = Distance between the fibers (mm)	Picture	Receptacle code
0.7		**DF0.7**
1.0mm		**DF1.0**
1.2mm		**DF1.2**
1.5mm		**DF1.5**
Select distance (x) in 0.7 mm – 1.7 mm range		**DFx**

Two Ferrules Cannula

The two ferrules cannula provides two implantable fibers, each within its own ferrule, at a precise distance exceeding 1.7 mm. The tolerance on the protrusion for each fiber is less than 0.1 mm. These cannulas are perfectly suited for the applications where two brain centers at a distance larger than 1.7 mm from each other are optically stimulated or controlled. The positioning of one mono fiber cannula at a time with the stereotaxic equipment has greater likelihood of 3D positioning errors (lateral and depth). With two ferrules cannula the insertion of the fiber is faster (single shot), the distance between the fiber tips is predefined and the protrusion depth is assured.

Two types of receptacles are currently available for the two ferrule cannula (see pictures on next page). They both consist of precision machined holders that house zirconia ferrules and determine the spacing between the ferrules centers. First type of two ferrule cannula connects to a pair of patch cords terminated with ferrules 1.25mm by using two zirconia sleeves (ID 1.25mm). In the other case, the holder also includes a pair of magnets, so that the cannula can connect to a pair of rectangular magnetic connectors.

The two ferrules cannula can be made for distances larger than 1.7 mm. For shorter distances between the brain centers, please refer to *Dual fiber-optic Cannulas*.

ORDERING CODE: TFC_□□□/□□□-□□□_□□□_□□□_□□□

Fiber-optic code
See *Table 7* and *Table 8*

Length of fiber "L"(mm)

Receptacle code:
See *Table 12*

Fiber Termination code:
See *Table 9* for available codes

NOTE : Unless otherwise specified, an aluminum housing and 1.25mm zirconia ferrules are being used.

Table 12: Termination codes for two ferrules cannula

Center-to-center distance between ferrules (mm)	Picture	Termination code
Sleeve connection		
2.0 mm		**TF2**
2.5 mm		**TF2.5**
3.0 mm		**TF3**
3.5 mm		**TF3.5**
4.0 mm		**TF4**
Other (x)		**TFx**
Magnetic connection		
3mm		**TM3**
4mm		**TM4**
Other (x)		**TMx**

Fiber-optic Cannula Arrays

Basically this product can be described as a loose fiber optic bundle

with FC/PC connectors on loose end and V-groove based fiber-optic cannula array on the other end.

ORDERING CODE:

FCA1x8_□□□/□□□-□□□_□□□_□□□_□□□_□□□

Fiber-optic code
See *Table 7* and *Table 8*

Protrusion of fiber "L"(mm)

Fiber-optic pitch (um):
See *Table 12*

Overall fiber length (mm)

Termination Code for Multiple connectors side
See *Table 2* for available codes

Hybrid Cannula

As convergence of different techniques for cell monitoring (optogenetics, electrophysiology) and fluid administration gathers speed, we are determined to facilitate this trend by providing photonics hardware products such as new hybrid cannula types.

Optic & Fluid Cannula

The basic idea behind the optogenetics is the introduction of the virus born proteins like channelrhodopsin-2 to targeted cells or neurons and the illumination of the same through fiber optic tip. So far this has been a two step process with two different cannulas with inherent imprecision. Led by a request from Brain Science Institute, RIKEN in Japan, we have designed a hybrid cannula with a metal tube that guides the optical fiber and restricts liquid delivery around the fiber tip. The design of the hybrid cannula in one version is based on an M3 receptacle, a metal tube and a side hole to receive liquid injection tube. In other incarnations of hybrid cannula we use our rectangular magnetic receptacle and similar side opening for receiving the injection tube. If users want to target the cells around the fiber tip, the length of the tube and the length of the fiber have to be the same.
All our mono fiber-optic cannulas have a typical transmission higher than 80%.

ORDERING CODE:

OFC_□□□/□□□-□□□_□□□_□□□_□□□

Fiber-optic code
See *Table 7* and *Table 8*

Length “L” (mm)
See convention in *Table 13*

Receptacle code
See *Table 13* for available codes

Fiber Termination code
See *Table 9* for available codes

More information on www.optogenetics-at-doric.com.

Table 13: Receptacle codes for Optic & Fluid Cannula

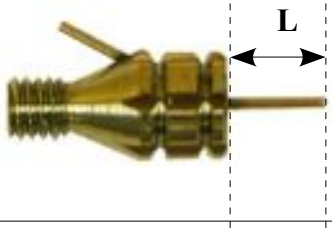
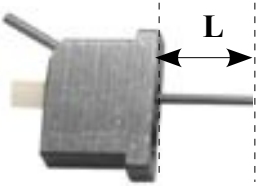
Description	Picture	Termination code
Receptacle with M3 thread		**RM3**
Rectangular Magnetic Receptacle		**RMR**

Table 14: Technical specifications of fiber-optic cannulas

Part	Mass [mg]	Max OD [mm]	Length [mm]
1.25mm ferrules			
Zirconia ferrule 1.25mm	50	1.25	6.5
Zirconia ferrule with MU flange	120	2.5	12
Metal ferrule 1.25mm	50	1.25	6.5
2.5mm ferrules			
Zirconia ferrule 2.5mm	350	2.5	10.5
Zirconia ferrule 2.5mm with FC flange	Not measured	4.5	16
Metal ferrule 2.5mm	400	2.5	10 or 12.5
Dual ferrule 2.5mm	Not measured	4.0	10 + 1.5 (pin)
Sleeves			
Zirconia sleeve ID=1.25mm	20	1.6	6
Zirconia sleeve ID=2.5mm	80	3.2	12
M2			
M2 receptacle - titanium	?	2	6
M2 receptacle - plastic	?	2	6
M2 screw - titanium	?	4	3.2
M2 screw - plastic	?	4	3.2
M2 protective cap	?	4	2.5
M3			
M3 receptacle - titanium	300	4	7.6
M3 receptacle - plastic	100	4	7.6
M3 screw - titanium	90	4	4.5
M3 screw - plastic	30	4	4.5
M3 protective cap	40	4	4.5
Rectangular magnetic			
Rectangular Magnetic receptacle	180	5x2	~8
Rectangular Magnetic connector	150	5x2	5
Cannula assemblies			
1.25mm Zirconia ferrules (x2) + sleeve	120	1.6	13
1.25mm metal ferrules (x2) + sleeve 1.25	120	1.6	13
2.5mm Zirconia ferrule (x2) + sleeve 2.5mm	780	3.2	21
2.5mm metal ferrules (x2) + sleeve 2.5mm	880	3.2	21

Dual ferrule (x2) + sleeve 2.5mm	Not measured	4.5	20
M3 receptacle titanium + M3 screw titanium + Zirconia ferrule with flange	500	4	~11
M3 receptacle plastic + M3 screw plastic + Zirconia ferrule with MU flange	250	4	~11
Rectangular magnetic receptacle + Rectangular magnetic connector	330	5x2	10

Receptacles for optogenetics

Connecting a fiber-optic cannula and a fiber-optic patch cord requires matching the receptacle on the cannula side and the connector on the patch cord end. The receptacle is the female part of the fiber-optic connection that contains a centered fiber tip, guides the connecting ferrule to the optical coupling positions and fastens it in place. In fiber optics, there are many different types of receptacles. However, here we show only those specific to our optogenetics products like Zirconia sleeve, M3 and rectangular magnetic receptacles. Other receptacle types like SMA, FC/PC are too big to be used for fiber-optic cannulas.

Zirconia sleeve as receptacle

The simplest form of receptacle consists of an implantable fiber glued in a Zirconia or a metal ferrule inserted in a Zirconia sleeve. The matching ferrule from the patch cord side is simply inserted in the sleeve.

Connecting 1.25mm ferrules with Zirconia sleeve

Connecting dual ferrules with Zirconia sleeve

Two versions of Zirconia sleeve receptacles are available:

Inner diameter	Outer diameter	Length
1.25 mm	1.6 mm	6.8 mm
2.5 mm	3.2 mm	11.4 mm

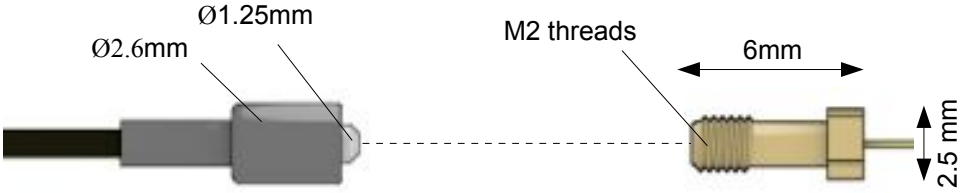
Zirconia sleeve

ORDERING CODE : SLEEVE_ZR_□□□

Inner diameter(mm)

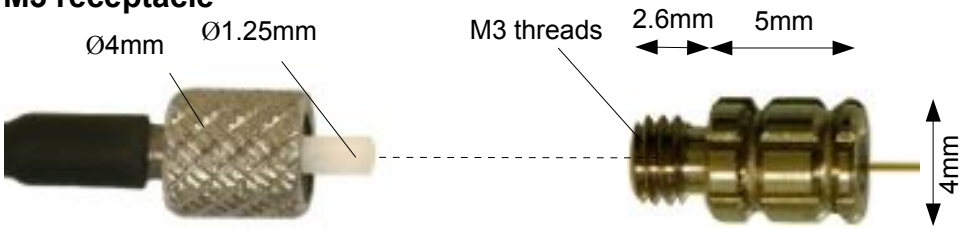
1.25, 2.50

M2 receptacle



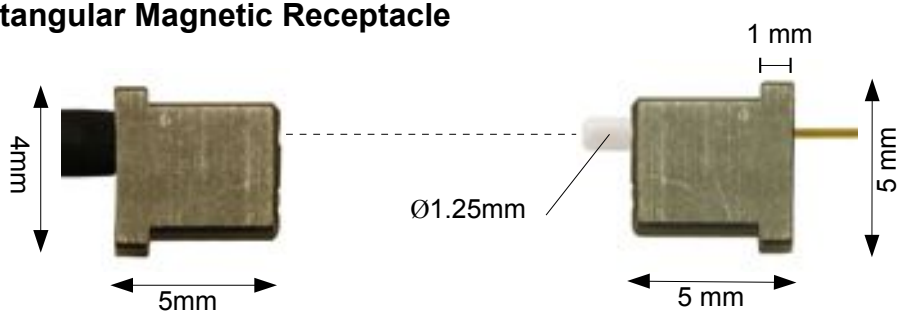
M2 connector *M2 receptacle*

M3 receptacle



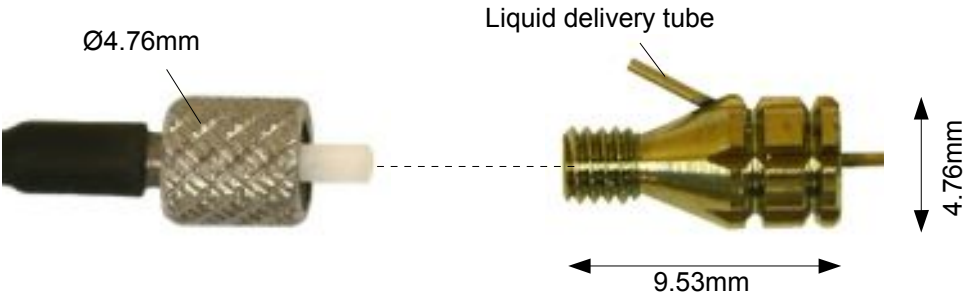
M3 connector *M3 receptacle*

Rectangular Magnetic Receptacle



Rectangular magnetic connector *Rectangular magnetic receptacle*

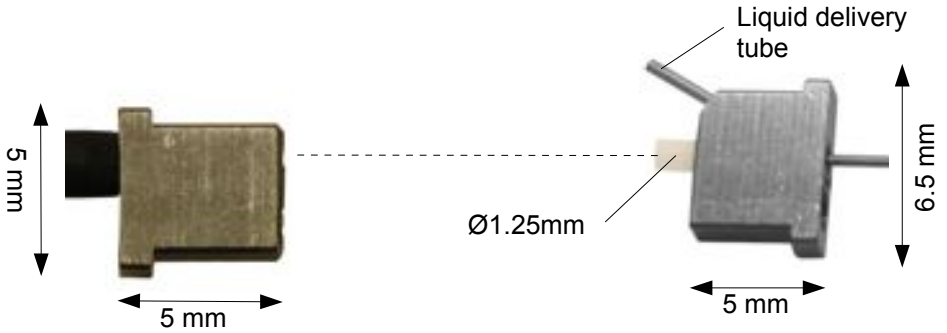
Optic and Fluid Cannula with M3 receptacle



Optic connector – M3

Optic & fluid receptacle – M3

Optic and Fluid Cannula with rectangular magnetic receptacle



Optic & fluid connector Rectangular magnetic

Optic & fluid receptacle Rectangular magnetic

Stereotaxic holders and adapters

Stereotaxic arm (1) is valued for its positioning precision. However, when it comes to positioning the fiber-optic cannula, some of the precision is lost when attaching or detaching the cannula to the arm. To simplify the implantation of the cannula and maintain the precision, we have developed a stereotaxic cannula holder (2) and fiber-optic cannula adapters(3) for attaching our M3 cannulas to the stereotaxic arm.

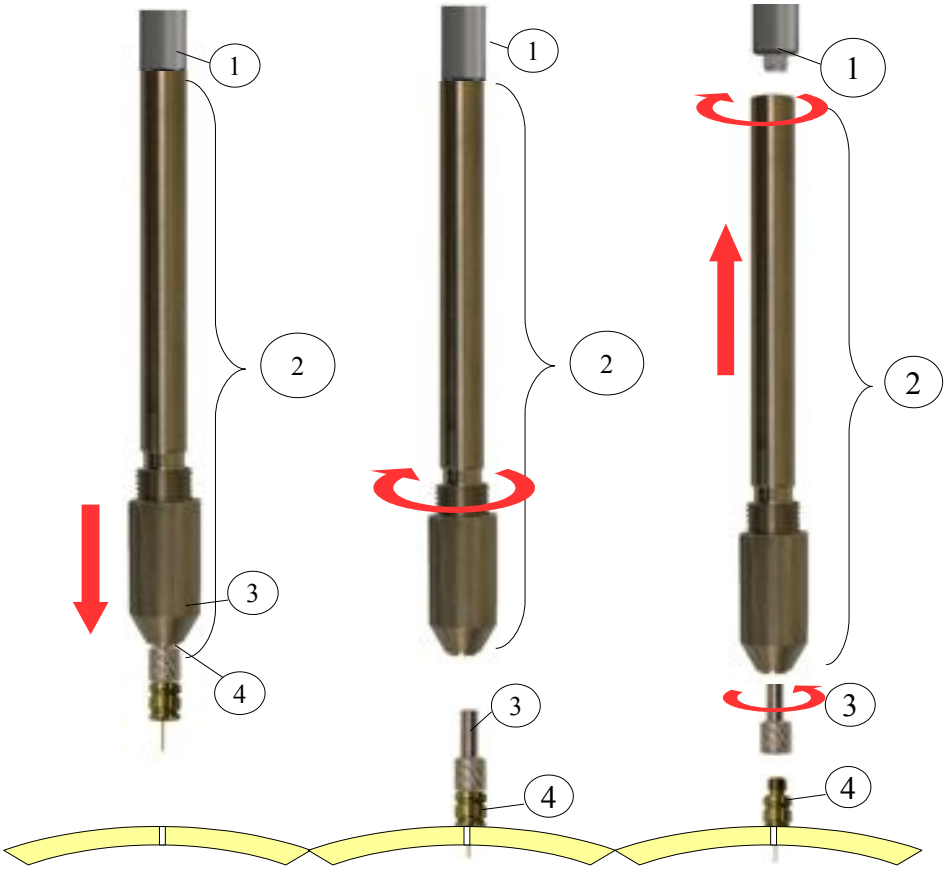


Fig a: Cannula implantation

Fig b: Stereotaxic arm detachment

Fig c: Adapter and holder detachment

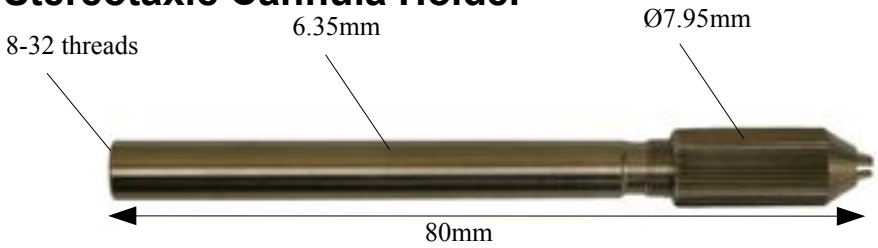
1 Stereotaxic arm

2 Stereotaxic cannula holder

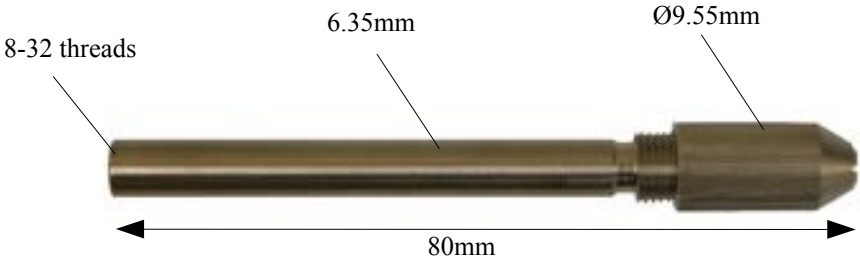
3 Fiber-optic cannula adapter

4 Cannula

Stereotaxic Cannula Holder



Stereotaxic holder 1.25



Stereotaxic holder 2.5

ORDERING CODE : SCH_□□□

Ferrule diameter (mm)
2.50, 1.25

M3 or M2 receptacle adapter

Fiber-optic cannula adapter – 2.5mm

Fiber-optic cannula adapter – 1.25mm

ORDERING CODE : FCA_□□□_□□□

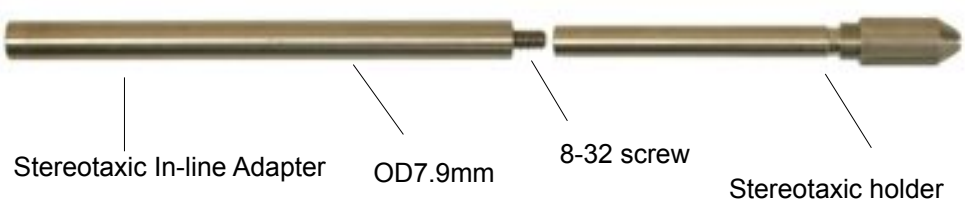
Attachment diameter
2.50, 1.25
Receptacle adapter
RM2, RM3

Adapters for Stereotaxic holder

We offer adapters to attach our stereotaxic holders on stereotaxic frames that use 7.9 mm diameter rods as standard. We can offer other adapters on request.

In-line adapter

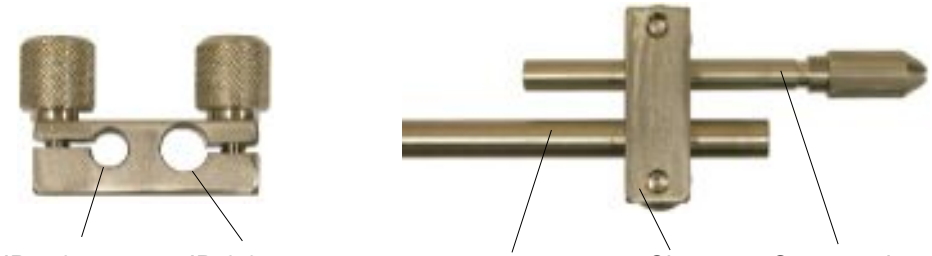
This adapter consists of a 7.9mm diameter rod, with 8-32threads at one end, and 4-40 threads at the other end.



ORDERING CODE : SIA_7.9

Clamp

This adapter is a double clamp, designed to hold a 7.9mm diameter rod on one side and a 6.35mm diameter rod on the other side.



ORDERING CODE : SCL_7.9

Accessories

Table 15: Mating adapters

Description	Picture	Code
Zirconia sleeve ID1.25mm		**SLEEVE_ZR_1.25**
Zirconia sleeve ID2.5mm		**SLEEVE_ZR_2.5**
Bronze sleeve ID1.25		**SLEEVE_BR_1.25**
Bronze sleeve ID2.5		**SLEEVE_BR_2.5**
FC/FC mating adapter		**ADAPTER_FC**
SMA/SMA mating adapter		**ADAPTER_SMA**
M3/M3 mating adapter		**ADAPTER_M3**

Table 16: Dust caps

Description	Picture	Compatibility	Code
SMA receptacle cap		Assemblies that include SMA receptacles: • Mini cubes • Fiber-optic rotary joints	**CAP_SMA**
FC receptacle cap		Assemblies that include FC receptacles: • Mini cubes • Fiber-optic rotary joints	**CAP_FC**
Ferrule 2.5 cap		• Cannulas or patch cords with ferrules OD2.5mm (MF2.5, ZF2.5, DFxx) • FC connectors	**CAP_Ferrule_2.5**
Ferrule 1.25 cap		• Cannulas or patch cords with ferrules OD1.25mm (MF1.25, ZF1.25) • M3 connectors • Rectangular magnetic connectors	**CAP_Ferrule_1.25**
M3 receptacle cap		Assemblies that include M3 receptacles: • Mini cubes • Fiber-optic rotary joints • Cannulas with M3 receptacles (RM3)	**CAP_M3**

All products listed in the table are supplied with dust caps.

M3 connectors

M3 connectors offer a secured, light and small connection for multimode fibers. The standard material of the flange and the screw is titanium. Alternative to titanium is the peek plastic.

M3 connector - parts included: ferrule, screw, strain relief

ORDERING CODE: CM3_□□□

Ferrule inner diameter (µm)
125, 127, 230, 235, 245, 330

ORDERING CODE: CM3P_□□□

Ferrule inner diameter (µm)
125, 127, 230, 235, 245, 330
The letter P indicate that peek plastic is used instead of titanium.

Table 17: Holders for fiber-optic rotary joints

Description	Picture	Code
Holder for • FRJ_1x1		**Holder_FRJ_small**
Holder for • FRJ_1x2 • FRJ_1x4		**Holder_FRJ_large**
Holder for ERJ, FRJ_1x2, FRJ_1x4 or combination of ERJ + FRJ		**Holder_ERJ**

All 1x2 and 1x4 fiber-optic rotary joints are supplied with their respective holders.

Description	Picture	Code
Cleaver		**Cleaver**

Cables

Description	Picture	Code
M8 male / M8 female, 1.5m long	  	**Cable_M8-M8**

Optogenetics kits

Until recently, the optogenetics hardware was sold mainly in a modular fashion or at component level. However, for your convenience, we have introduced kits that contain necessary bits and pieces to perform certain class of experiments. Those kits simplify ordering process and represent a better deal than buying the same components individually.

Optogenetics beginner's kit

The beginner's kit is made up of the single channel LED driver, a single blue LED diode and rotary joint assembly (LED+FRJ), four types 0.5 m long mono fiber patch cords and 10 fiber-optic implant cannulas for each patch cord type and one dual branching patch cord for bi-lateral activation. On top of all this, there are zirconia sleeves of 1.25 mm and 2.5 mm inner diameter and a cleaver. This is what we believe to be the basic photonics hardware required to perform optogenetics experiments with freely moving animals.

Optogenetics Beginner's Kit	**Item code**	**Qty**
Single channel LED driver	LEDRV_1CH_1000	1
Single Blue Led + Fiber-optic Rotary Joint	LEDFRJ-B_FC	1
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-ZF1.25(F)	1
Cannula	MFC_200/245-0.53_50_ZF1.25_FLT	10
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-ZF2.5	1
Cannula	MFC_200/245-0.53_50_ZF2.5_FLT	10
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-CM3	1
Cannula	MFC_200/245-0.53_50_RM3_FLT	10
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-RMC	1
Cannula	MFC_200/245-0.53_50_RMR_FLT	10

Branching Fiber Patch Cord	BFP(2)_200/220/900_0.53_100_FC_2xZF1.25(F)	2
Zirconia sleeves 1.25 mm	SLEEVE_ZR_1.25	10
Zirconia sleeve 2.5 mm	SLEEVE_ZR_2.5	10
Cleaver		1

ORDERING CODE: OBK

N.B.: The length of fiber-optic implant is 50mm and can be cleaved to desired length by user. The length of fiber protruding from cannula and length of the patch cord can be changed to whatever length suits your experiment.

Optogenetics intermediary level kit

The intermediary kit is made up of a blue and amber dual LED fiber-optic source and a rotary joint, all within a single box that can be conveniently placed on the top of the cage. In addition, four 0.5 m long fiber-optic patch cords are provided to match 4 different types of fiber-optic implant (cannula) sets with 5 cannulas in each set. This photonics hardware enables light activation and silencing in optogenetics experiments with freely moving animals.

ORDERING CODE: OIK

N.B.: The length of fiber-optic implant is 50mm and can be cleaved to desired length by user. Alternatively you may indicate the desired fiber length.

Optogenetics Intermediary Kit	**Item code**	**Qty**
Two channel LED driver	LEDRV_2CH_1000	1
Dual Led + Fiber-optic Rotary Joint Blue and amber LED light source with fiber-optic rotary joint	LEDFRJ-B_A_FC	1
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-ZF1.25(F)	1
Cannula	MFC_200/245-0.53_50_ZF1.25_FLT	10

Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-ZF2.5	1
Cannula	MFC_200/245-0.53_50_ZF2.5_FLT	10
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-CM3	1
Cannula	MFC_200/245-0.53_50_RM3_FLT	10
Mono Fiber Patch cord	MFP_200/220/900-0.53_0.5_FC-RMC	1
Cannula	MFC_200/245-0.53_50_RMR_FLT	10
Branching Fiber Patch Cord	BFP(2)_200/220/900_0.53_100_FC_2xZF1.25(F)	2
Zirconia sleeves 1.25 mm	SLEEVE_ZR_1.25	10
Zirconia sleeve 2.5 mm	SLEEVE_ZR_2.5	10
Cleaver		1

Optogenetics professional kit

The professional kit includes the latest photonics hardware required to perform optogenetics experiments with freely moving animals. Basically, we have added electrical rotary joint with 12 electrical contacts to our intermediary kit.

ORDERING CODE: OPK

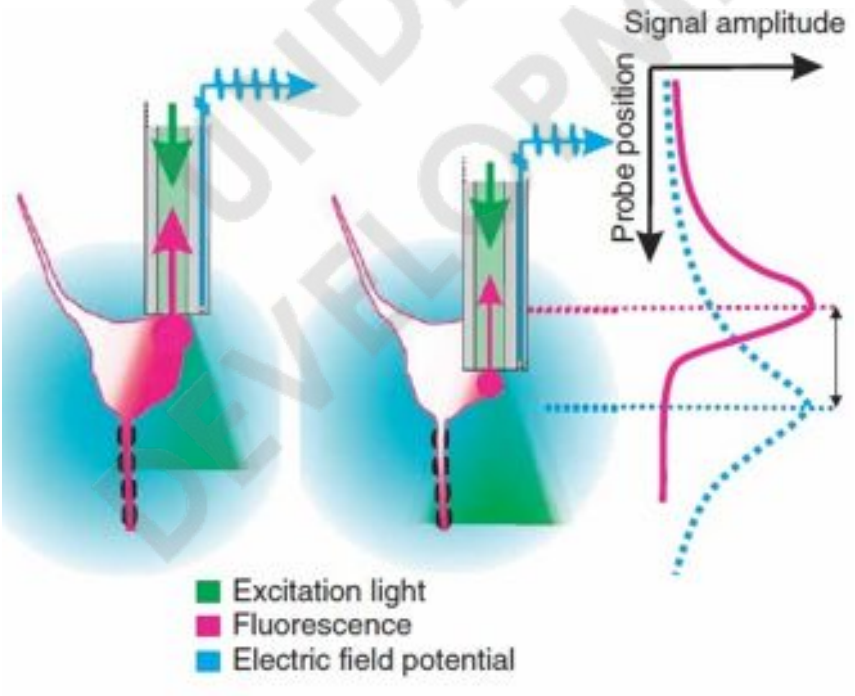
N.B.: The length of fiber-optic implant is 50mm and can be cleaved to desired length by user. Alternatively you may indicate the desired fiber length.

Optogenetics Professional Kit **Item code**	**Qty**
Two channel LED driver LEDRV_2CH_1000	1
Dual Led + Fiber-optic Rotary Joint LEDFRJ-B/A_FC Blue and amber LED light source with fiber-optic rotary joint	1
Electrical Rotary Joint ERJ_12_HRW-HRW	1
Mono Fiber Patch cord MFP_200/220/900-0.53_0.5_FC-ZF1.25(F)	1
Cannula MFC_200/245-0.53_50_ZF1.25_FLT	10
Mono Fiber Patch cord MFP_200/220/900-0.53_0.5_FC-ZF2.5	1
Cannula MFC_200/245-0.53_50_ZF2.5_FLT	10
Mono Fiber Patch cord MFP_200/220/900-0.53_0.5_FC-CM3	1
Cannula MFC_200/245-0.53_50_RM3_FLT	10
Mono Fiber Patch cord MFP_200/220/900-0.53_0.5_FC-RMC	1
Cannula MFC_200/245-0.53_50_RMR_FLT	10
Branching Fiber Patch Cord BFP(2)_200/220/900_0.53_100_FC_2xZF1.25(F)	2

Zirconia sleeves 1.25 mm	SLEEVE_ZR_1.25	10
Zirconia sleeve 2.5 mm	SLEEVE_ZR_2.5	10
Cleaver		1

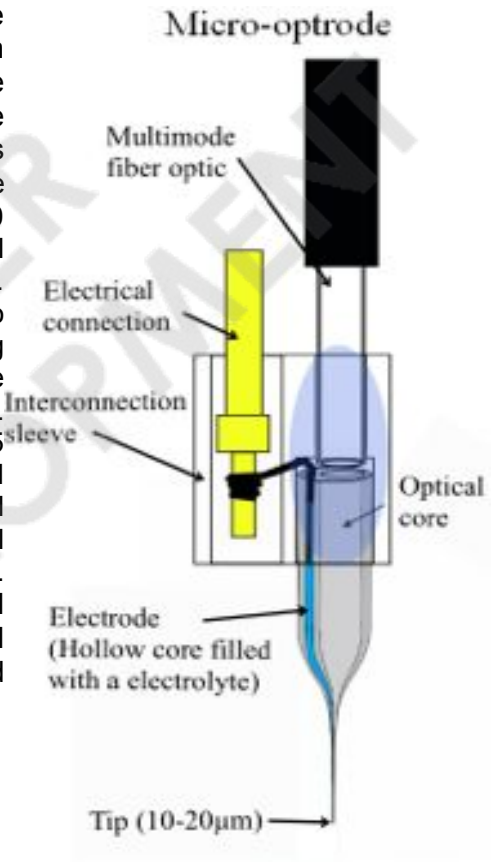
Single-cell fiber-optrode cannula kit

Doric Lenses presents a first commercially available kit for single-cell activity recording with fiber-optrodes. These optrodes allow for in-vivo single-cell combined electrophysiological recordings and optical excitation and monitoring. The opto-electrical interface area is a tip of the fiber-optrode that is made smaller than the cell itself to assure sufficient spatial resolution.



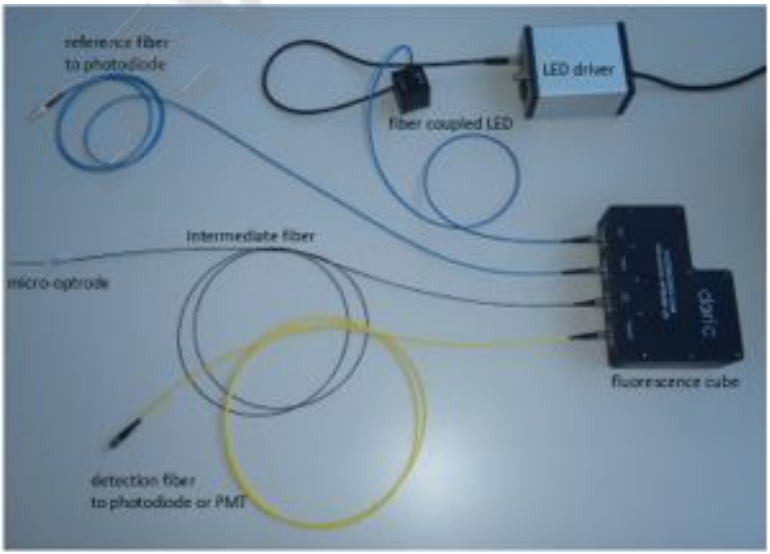
Source: LeChasseur et al., Nat. Methods. 8, 319–325, 2011

The fiber-optrode probe is made from a dual-core optical fibre with one core filled with electrolyte serving as an electrode while the high-index glass core guides excitation and fluorescent light. The initial dual-core optical fiber has 900 µm outer diameter, 500 µm optical guiding core and 100 µm hollow core. One end of that fiber is pulled to smaller diameter to create a long taper that can be cut to diameter size that fits the targeted cell size. Typically this diameter is around 15 µm. The custom designed hybrid connector assures good optical coupling and proper electrical connection with fiber-optrode probe. This technique[1] has great potential for single cell identification, local fluorescence monitoring and optogenetics applications.



ORDERING CODE: SFK

Single-cell Fiber-optrode Cannula Kit	Item code	Qty
Single LED fiber-optic light-source	LEDFL_B_FC	1
Low-noise GFP Fluorescence cube		1
Fiber-optic patch cord connection to light source		1
Fiber-optic patch cord connection to reference photodiode		
Fiber-optic patch cord connection to fluorescence detector		1
Fiber-optic patch cord connection to fiber-optrode cannula		1
Fiber-optrode cannula		2
Fiber-optrode probe Piece of dual-core optical fiber with 900 um diameter with one end pulled to 15 um diameter		100



Contact us for more information on measurement and assembly procedure.