

## 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 200 $\mu$ m and NA of up to 0.5.

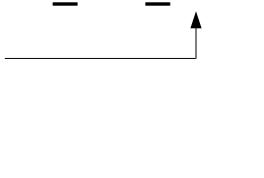


*1x1 fiber-optic rotary joint FC output*

### ORDERING CODE: FRJ\_1x1\_FC-FC

#### Input 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 available as custom product

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

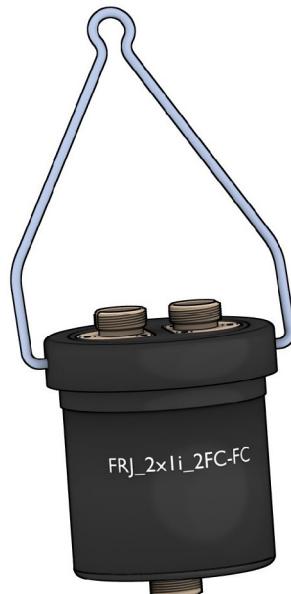
**Numerical Aperture** \_\_\_\_\_  
0.22 or 0.5

## 2x1 Fiber-optic Rotary Joints

2x1 fiber-optic rotary joints have two fiber receptacles on the fixed side and one fiber receptacle on the rotating side. These rotary joints are used to combine spectrally different light beams coming from two optical fibers and to couple those beams to rotating fiber on the other side of the joint.

Unlike 1x2 FRJ which has intensity and wavelength division versions, the 2x1 FRJ has only the wavelength division or combination version.

The 2wx1 fiber-optic rotary joint can be used for optogenetics stimulation, activation or silencing. For more information on the matching patch cords for 2x1 fiber-optic rotary joint, see patch cord section.



*2x1 fiber-optic rotary joint  
combines two different  
wavelengths*

## ORDERING CODE:

FRJ\_2wx1\_473/590\_2FC-FC\_□□□

**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.

**Numerical Aperture** \_\_\_\_\_

0.22 or 0.5

## 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.



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:

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.

Simultaneous illumination of two different brain centers with different light pulse trains of the same or different wavelengths.

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 many other applications requiring compact and low loss dual channel fiber-optic rotary joint.



*2x2 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.

***Under construction***

*4x1 fiber-optic rotary joint intensity division with FC outputs*

### 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.

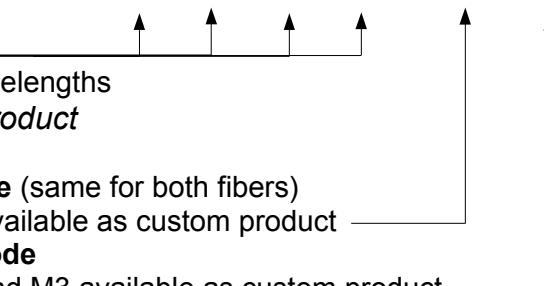
For more information on the matching patch cords for 4x1 fiber-optic rotary joint, see patch cord section.

### 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 after 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 200 $\mu$ m diameter fibers.

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

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.

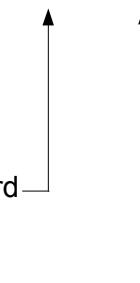


*Electrical rotary joint - 12 channels*

## ORDERING CODE: ERJ\_□□\_HRW-HRW

# of electrical contacts: \_\_\_\_\_

6, 12



Fixed side connector type:

HRW for HARWIN M80-82612 or **06** standard

WIR for 30 cm long leads custom

Rotating side connector type: \_\_\_\_\_

HRW for HARWIN M80-82612 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 M80-82612 or **06** depending on # of channels  
WIR for 30 cm long leads

**Rotating side connector type** \_\_\_\_\_  
HRW for HARWIN M80-82612 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

## 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 laser types require external modulation via mechanical shutters or acousto-optic modulators.

Recently we have connectorized 3 mm aperture SR475 shutter head from Stanford Research Systems Inc with an add-on accessory . The assembly provides relatively inexpensive alternative to acousto-optic modulators. We can supply the adapter only or connectorized SR475 shutter head with or w/out SR470 Laser Shutter Controller.

### ORDERING CODE: CMSA-SR475\_FC-FC

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.

