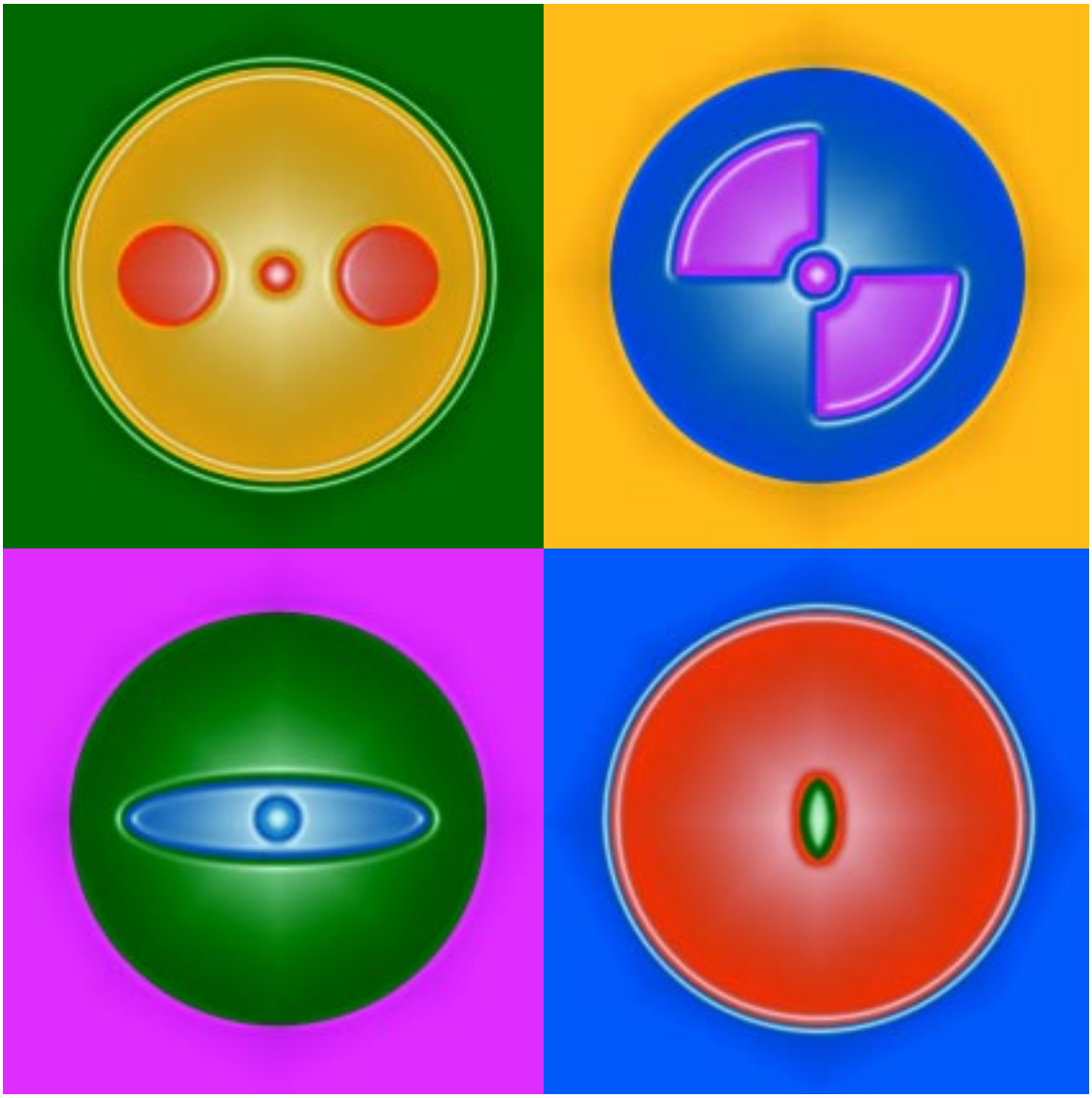
PM Splicing with Ericsson



ERICSSON

Automated PM Splicing

Bowtie PM fiber

By combining its POL (*Polarization Observation by Lens-effect tracing*) method of fiber alignment with its standard FSU series machines, Ericsson creates a PM (*Polarization Maintaining*) splicer that offers effective rotational alignment for all types of PM fibers, as well as, the convenience of automated splicing.

The following pages describe this unique rotational alignment method as part of an introduction to PM splicing with Ericsson.

Panda PM fiber

PM Fiber

PM fiber comes in four main types--Panda, Bowtie, Elliptical jacket and Elliptical core--all of which are illustrated on this page. The various types represent different methods of achieving the same goal: namely to suppress the cross-coupling of power between two perpendicularly polarized modes. PM fiber is used in any system where control of polarization is necessary, such as in coherent communications systems and interferometric sensors.

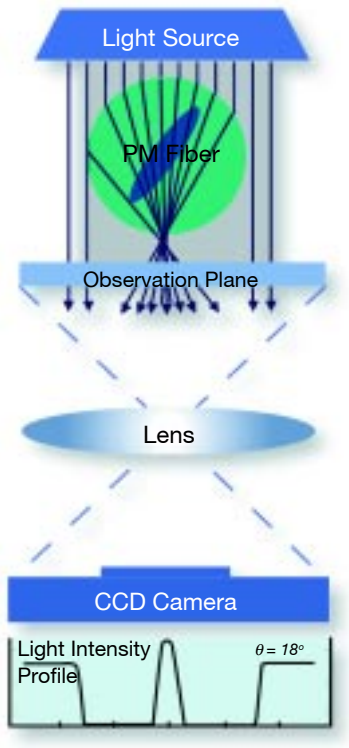
However, in order to build such systems one must first be able to splice PM fiber such that its polarization maintaining properties are preserved. The measure of these properties is the extinction ratio, which is the logarithmic ratio of the power along the two principal axes. Typically, PM fiber is manufactured with an extinction ratio of around 25-45 dB. In order to get an extinction ratio over 30 dB when splicing, one must be able to splice the fibers with less than 1.5° of rotational misalignment.

Elliptical Jacket PM fiber

Elliptical Core PM fiber

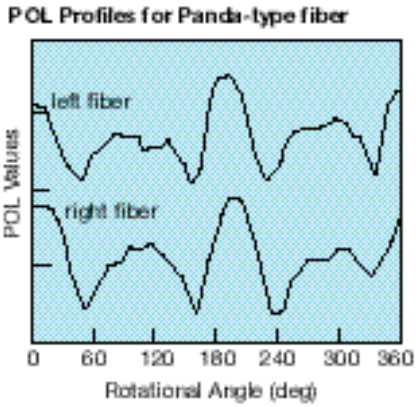
A number of active and passive alignment methods have been developed for PM fiber splicing. However, active alignment methods have often been costly and tedious; whereas, passive alignment techniques have often suffered from being fiber type specific or excluding extinction ratio estimation. Ericsson's POL method overcomes all of these limitations, allowing for cost-effective splicing of all sorts of PM fiber (as well as, D-shaped, V-shaped, twin-core and multicore fiber) and providing the tools needed for reliable extinction ratio estimation.

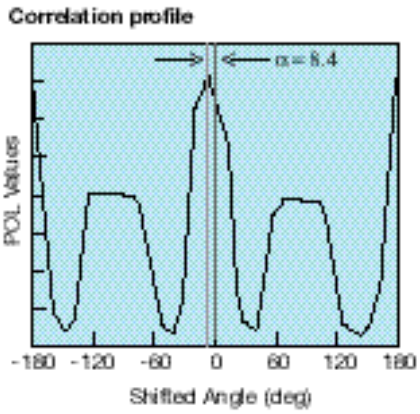
POL Method



POL Set-up

The POL Method takes advantage of the fact that when a fiber is illuminated from the side, it acts as a cylindrical lens that offers a measurable light intensity profile. Since, in the case of PM fiber, this light intensity profile changes during rotation, it is possible to analyze 360° worth of light intensity profiles for a given fiber and arrive at a new profile--a POL profile--that indicates the fiber's exact rotational orientation. The POL profile for each PM fiber type has its own characteristic form; however, the curves are similar, and more importantly, mathematically comparable (see adjacent diagram). Additionally, since POL profiles include a large number of data points and information from an entire rotation, they are relatively noise insensitive.





FSU 995 PM

What is needed then to orient two fibers with respect to each other are rotators that can turn each of the fibers at least 360°, side-view illumination, cameras to record light intensity profiles (see above diagram), and programmed algorithms to calculate the POL profiles and compare them. All of this has been integrated into the FSU 995 PM.

With an automatic splicer like the FSU 995 PM, splicing PM fibers is as easy and reliable as ordinary fiber splicing. It takes only 2-3 minutes from fiber loading to a finished splice when splicing PM fiber with the FSU PM.

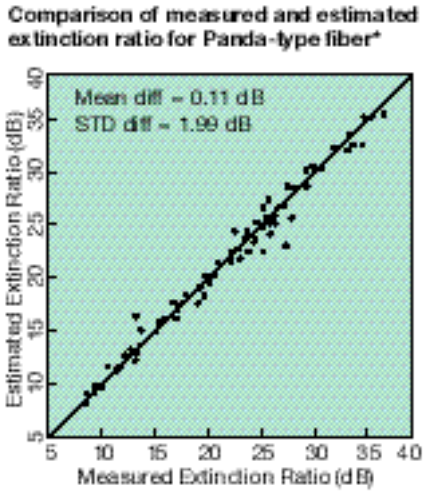
FSU 995 PM

Additionally, the FSU 995 PM has features such as Ericsson's hot image estimation technique and real time control. Thus, by choosing the FSU 995 PM, one gets not only a cost-effective PM splicer, but also a powerful, versatile splicer for ordinary splicing, as well as, for handling more complex applications, such as attenuator making and tapering.

Extinction Ratio Estimation

The extinction ratio quantifies the degree to which light is polarized along one axis, and thus represents to what extent the PM fiber is indeed maintaining polarization. In this sense, measuring the extinction ratio after PM splicing is roughly analogous to measuring the power loss after ordinary splicing: they both give you an indication of how successful the splicing was.

The POL method employed by Ericsson in the FSU 995 PM gives an impressive mean extinction ratio of 32.2 dB (with 2.73 dB standard deviation). In addition, the splicer automatically makes an extinction ratio estimation after each splice, which gives an accurate evaluation when compared to measured values (see adjacent graph).



*The low extinction ratios were obtained by intentionally setting the angle-offset to 0 - 22 degrees.

In order to estimate the extinction ratio, the FSU 995 PM re-rotates the spliced fibers 360 degrees and calculates new POL profiles to determine the post-splicing angular offset. This latter value is then used to calculate the estimated extinction ratio.

Fiber Preparation

Ericsson EUC-12 Ultrasonic cleaner

Ericsson offers all the tools you need to effectively prepare PM fibers for splicing (see also list on following page). In addition to the EUC 12 Ultrasonic cleaner and the EFC-11/PM Fiber cleaver shown here, there are special fiber fixtures, vacuum grooves and strippers, all designed to make PM splicing quick and easy.

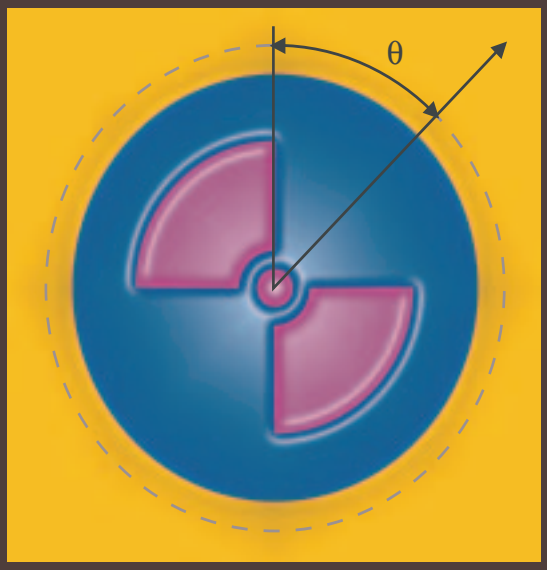
It is particularly important to ensure good cleaving of PM fibers, since imperfectly cleaved fiber end-faces can exert torsional force on each other during splicing, causing them to twist out of rotational alignment. With the Ericsson EFC-11/PM cleaver in your splicing arsenal, you can avoid this reduction of polarization.

Ericsson EFC-11/PM Fiber cleaver

Technical Data-PM Splicing

PM Stripper	For 80 and 125 µm fiber, and both short and long strip lengths
EFC-11/PM Fiber cleaver*	Cleaves with a diamond blade with a life of greater than 18,000-20,000 cleaves
EUC 12 Ultrasonic cleaner*	Cleans with an ultrasonic frequency of 51-55 Hz
Vacuum grooves	For PM fiber with cladding 80-125 µm (125-400 µm coating)
Ceramic v-grooves	(optional, for short strip length) For PM fiber with cladding 80-125um (125-900um coating)
Applicable fibers	80-125 µm cladding, 160-900 µm coating
Fiber fixtures	For PM fiber with coating 400 and 900 µm
PM Heat shrink oven	Plug-in device for all sorts of heat-shrinkable sleeves for PM fiber
FSU 995PM	**An all-purpose fusion splicer* specially equipped with rotators for precise alignment of PM fibers**
Alignment methods	Azithumal: POL method Axial: Hot core alignment with real time control
Extinction ratio	32.2 dB (Mean, STD 2.73), up to 40 dB for certain types
Splice losses	Typical values 0.02 dB
Power supply	90-264 V AC, 50-60 Hz, 13.2 V DC
Monitor	3” high resolution LCD monitor
Video output	1 V p-p positive, 75 Ohms/CCIR
Operating environment	0-40 °C, 0-95% RH (non-condensing)
Size/Weight	37 x 36.2 x 18 cm (WxDxH) 8.15 kg (power supply and other accessories not included)
Carrying case	Rugged cabin-sized case with space for accessories 54.5 x 42.5 x 25.5 cm (WxDxH)

*In addition to PM splicing applications, these tools are perfectly suited to other splicing procedures and are compatible with a wide range of non-PM fibers, including, in the case of the EUC cleaner, ribbon fiber.



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