Level:
BASE

FIBRE OPTIC ROTARY JOINTS

Basic Operating Principles

Fibre Optic Rotary Joints (FORJs) allow a user to send and receive data at Gbit rates across a rotating interface at a much lower error/loss rate than conventional electrical brush technology. They are normally used by converting electrical communication signals to optical signals by use of media convertors. A two-channel signal (send and receive) can be superimposed onto one fibre optic channel, through use of a bidirectional transceiver, and sent through a fibre optic rotary joint without interference from electromagnetic radiation or suffering from the effects of electrical contact noise [1].

The functionality of fibre-optic technology is broad, ranging from strain and temperature sensing to medical imaging and to information technology communication. This brief article focusses on the most common application that we at BGB see our fibre product range being used in: Optical digital data transmission.

Fibre-optic data transmission has largely displaced electrical signal transmission methods at rotating interfaces through the use of Fibre-Optic Rotary Joints (FORJs) where data-rate, data-fidelity, longevity and space claim are critical. FORJs are couplers that allow the transmission of light and therefore high-speed digital data between rotating and stationary parts of equipment or machines. They can rotate continuously through 360° allowing complete freedom of rotation of the rotor side of an application.

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Basic Operating Principles

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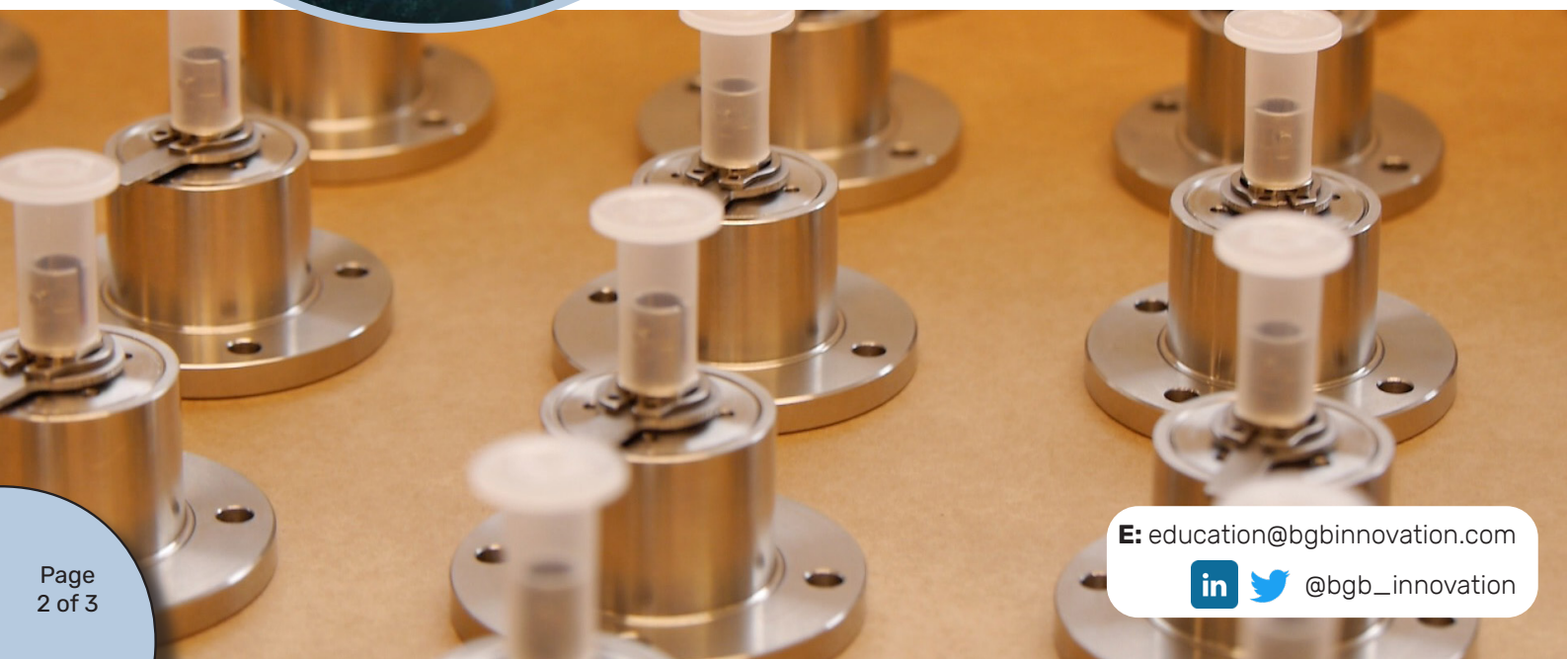
In most static fibre-optic installations an isolated send and receive communication channel is achieved by using two (duplex) fibre cables alongside each other. However, in rotating applications, the complexity of sending signals along two off-axis fibre cores across a rotating interface can drive the cost up significantly.

Thankfully, due to the physical properties of light, fibre-optic and FORJ communication systems support two-way (bidirectional) communication along one fibre. In this case, one communication channel will operate at one wavelength, e.g. 1310nm, and the other will operate at another, e.g. 1550nm, down the same fibre. Therefore, the number of parts and complexity of parts can be reduced, keeping cost low. This process is known as wavelength division multiplexing and is not limited to two signal channels.

In fact, multiple signals can be pushed down the same fibre so long as they have different wavelengths and transceivers that can sense those wavelengths in isolation.



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FORJs with up to 20 fibre cores are common and readily available but single channel FORJs are by far the most popular. In most applications it is less complex and less costly to perform data interpretation and interrogation on the rotary side of an application and pass information through a single channel than to try to pass multiple off-axis channels through a rotating axis.

FORJs provide a long service life of up to 50M revolutions [2], limited by bearings alone rather than electrical contacts that wear and must be replaced. Signal fidelity is excellent, with signal drop-out and loss being near zero [3]. As an optical, rather than electrical, union the unit suffers no issues through high or fast varying local electro-magnetic fields making it an excellent choice where Electro-Magnetic Immunity (EMI) is required. Furthermore, it is ideal for use in volatile environments where electric arcing must be supressed or avoided.

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[1] J. M. Senior, "Optical Fiber Communications Principles and Practice," Pearson Prentice Hall, 2009.
[2] BGB Engineering, FORJ Product Portal, BGB Engineering, 2022.
[3] BGB Engineering, Customer Specific Internal Testing.

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