

# STAR-Dundee

## SpaceWire and SpaceFibre Expertise

### SpaceWire Brick Mk4

The SpaceWire Brick Mk4 is a USB 3.0 to SpaceWire interface device that is suitable for use in all stages of SpaceWire equipment development: initial SpaceWire evaluation, instrument simulation, control system simulation, unit testing and integration support.

The SpaceWire Brick Mk4 provides two SpaceWire interfaces, support for high speed data transfer, the capability to inject various types of errors on demand, the ability to transmit and receive time-codes and act as a time-code master, and comes complete with highly optimised host software for low latency transmission of SpaceWire packets directly to and from the host PC.



SpaceWire Brick Mk4

Expanding on the 15 years of knowledge and experience gained with the original SpaceWire-USB Brick, the Brick Mk2 and the Brick Mk3, the SpaceWire Brick Mk4 has enhanced FMECA protection. The use of STAR-Dundee's powerful software stack, STAR-System, makes it simple to migrate from the Brick Mk2 or Brick Mk3 to the Brick Mk4. The Brick Mk4 is backwards compatible with the Brick Mk3, including all the features present in the Brick Mk3 and adding the following:

- Enhancements to FMECA protection.
- Grounding stud on the rear panel.
- New power status LED.



SpaceWire Brick Mk4 Rear Panel

### Key Features

**Two SpaceWire interfaces:** Each fully compatible with the SpaceWire standard. Tri-colour LEDs for each link indicate status and packet transfer activity. The SpaceWire links have been tested running at 300 Mbit/s using a 2 metre STAR-Dundee lab cable, and at 200 Mbit/s using a 10-metre lab cable. Configurable transmit clock speeds allow the speed of each link to be set independently.

**Improved hardware design:** The new case design includes a grounding stud on the rear panel to provide a solid connector to ground any equipment to the Brick Mk4's ground along with an LED to indicate the power status. The hardware is designed to prevent any single failure causing damage to equipment interfaced to the SpaceWire or Trigger ports. A FMECA report is available under NDA and provides further details on this protection.

**Error injection:** Parity errors, escape errors and credit errors can all be injected on demand or in sequence with transmitted packets. Transmitted packets can also be terminated with an EEP.

**Operating modes:** The SpaceWire Brick Mk4 can operate in one of two modes: interface mode (the default mode) or router mode.

**Interface mode:** In interface mode, packets can be transmitted and received on each of the SpaceWire links concurrently. Traffic received on the links is automatically passed to software through independent channels. Traffic transmitted from software can be sent out of each link using its corresponding channel. Using this mode it is straightforward to connect to equipment under test or to provide an emulation of some SpaceWire flight equipment on a network. Due to its simplicity, this mode is also very useful when first using SpaceWire.

**Router mode:** In router mode the Brick Mk4 is able to route packets between SpaceWire ports and between those ports and the USB port. Path and logical addressing are supported along with a router configuration port, allowing SpaceWire routing technology to be explored. Port routing options mean that traffic from one port can be automatically routed to another.

**Triggering:** The front panels of the Brick Mk4 have two general purpose bi-directional SMB triggers which can be used for device synchronisation, triggering of SpaceWire packets and errors, or event signalling between cards or external equipment.

**Packet Timestamping:** A start and end of packet timestamp can be recorded for each received packet at sub microsecond resolution. The elapsed time epoch is set using the software API and the timestamp seconds increment can be synchronised with a pulse input on one of the SMB triggers or by a hardware prescaler.

**USB compatibility:** The device is a standard USB 3.0 device. It can also be used in USB 2.0 or 1.1 ports, provided they can deliver 500mA power.

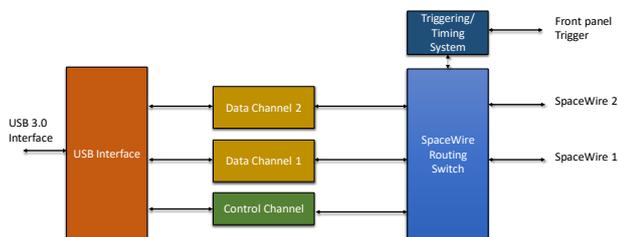
**USB powered:** The Brick Mk4 is powered over the USB port and requires no additional power source. This makes it very easy to connect to a laptop and debug problems in any location. Note that the Brick Mk4 can be used with USB hosts and powered hubs but not with bus powered hubs because they cannot provide enough power.

**RMAP support:** In addition to the other APIs, the Brick Mk4 includes an API to build RMAP packets to be transmitted, and to interpret RMAP packets which have been received.

**Rack Mountable:** The Brick Mk4 can be rack mounted alongside other STAR-Dundee products using the Rack Kit Mk2.

## Hardware Overview

A block diagram of the SpaceWire Brick Mk4 is shown below.



**SpaceWire Brick Mk4 Hardware Overview**

The SpaceWire interfaces of the Brick Mk4 are each fully compliant to the SpaceWire standard. They are connected to a SpaceWire router so that packets from one SpaceWire port can be routed to the other SpaceWire port or into the host PC via the USB interface. There are two independent channels from the SpaceWire router to the USB interface, so traffic flowing over one port cannot block traffic for another port. There is also a separate control channel, so that the host is always able to access the control, configuration and status space of the Brick Mk4, regardless of the data flow.

The SpaceWire router contained in the Brick Mk4 supports path and logical addressing, group adaptive routing, watch-dog timeouts and link management including power on request and disable on silence. It includes a configuration port (port 0) for setting routing tables, configuring the links and monitoring their status.

The USB interface is compliant to the USB 3.0 standard, which provides lower latency and higher speed transfers than previous USB versions, allowing rapid transfer of data to and from host software to the SpaceWire Brick Mk4. The device can also be used in USB 2.0 and 1.1 ports. All power is provided by the USB port, and no additional power source is required. This makes it very easy to connect a Brick Mk4 to a laptop, and debug problems in the field.

The SpaceWire Brick Mk4 includes support for fault injection on each of the SpaceWire links. Parity errors, escape errors and various forms of credit errors can all be injected on demand, while transmitted packets can be terminated with an EEP.

## Included Software

The SpaceWire Brick Mk4 hardware is supported by STAR-Dundee's software stack, STAR-System, providing a consistent programming interface for accessing all STAR-Dundee's most recent, and future, router and interface devices.

**Software drivers:** High performance drivers for the SpaceWire Brick Mk4 are supplied for Windows and Linux. STAR-System is regularly updated to support the latest versions of both operating systems.

**Software applications:** Example command line applications are provided with source code to demonstrate common tasks, and to test a device's throughput and latency. GUI applications are also provided to support the configuration of devices, the transmission and reception of packets and time-codes, and to inject errors.

## Application Programming Interface

A full API is provided to allow all functions of the SpaceWire Brick Mk4 to be controlled from user application software. A variety of programming languages are supported, while a version is also available separately for LabVIEW.

The API is common across several STAR-Dundee products, and is consistent for each programming language and platform. This simplifies software development and allows migration of software from one device to another and from one platform to another, improving software reuse and reducing the risk of schedule delays.

A key feature of the API is that it not only provides functionality to transmit and receive packets, but also provides the functions required when testing equipment. For example, the API makes it simple to inject errors, to transmit packets terminated with an EEP, and to determine the end of packet marker of received packets. All APIs are provided with extensive documentation and examples, which can be used as a basis for new applications.

## Usability

**Ease of use:** The SpaceWire Brick Mk4 is easy to use, enabling spacecraft electronics and software engineers to rapidly develop the simulation, test and EGSE equipment they need.

**Field upgradability:** The SpaceWire Brick Mk4 supports field upgradability of its functionality. Upgrades can be downloaded from the STAR-Dundee website and installed quickly and efficiently.

**First class support:** As with all of STAR-Dundee's products, a year's support and maintenance is included with the Brick Mk4. Support is provided by the team that developed the product allowing us to respond quickly to technical questions, give assistance with application development, and resolve any problems quickly.

## Specifications

Part Number	326
Size	85 x 66 x 19 mm (approx.)
Power	Powered via USB cable
API	C, C++, Python (LabVIEW available separately)
Software	<ul style="list-style-type: none"> <li>Application software included</li> <li>Source code examples provided</li> </ul>
Platforms	<ul style="list-style-type: none"> <li>Windows (11 and 10)</li> <li>Linux (6.x, 5.x, 4.x and 3.x kernels)</li> </ul>
SpW Ports	<ul style="list-style-type: none"> <li>Compliant to ECSS-E50-12A, ECSS-E-ST-50-12C, ECSS-E-ST-50-12C Rev.1, and provides support for RMAP (ECSS-E-ST-50-52C)</li> <li>Number of SpaceWire Ports: 2</li> <li>Maximum Speed: 300 Mbit/s</li> <li>Data-Strobe skew tolerance: tested on all units to <math>\pm 2</math> ns at a data rate of 200 Mbit/s</li> <li>Connectors: 9-pin micro-miniature D-type</li> </ul>
USB Ports	<ul style="list-style-type: none"> <li>USB 3.0</li> <li>Backwards compatible with USB 2.0 and 1.1</li> </ul>
SMB Ports	<ul style="list-style-type: none"> <li>5V tolerant level or edge triggered input buffer</li> <li>3.3V output buffer with active high/low and programmable pulse width options</li> </ul>
EMC	CE/FCC certified

All information provided is believed to be accurate at time of publication. Please contact STAR-Dundee for the most recent details. © 2023 STAR-Dundee Ltd.



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