



# STAR-Dundee

## Supporting SpaceWire Applications

### SpaceWire PCI Mk2

The SpaceWire PCI Mk2 is the latest development of STAR-Dundee's widely used SpaceWire PCI interface board. It provides three SpaceWire interfaces with efficient host software support for the rapid sending and receiving of SpaceWire packets straight into host PC memory. In addition a hardware packet generator and checker are provided for the ultimate in high-speed packet processing.

Using the proven STAR-Dundee PCI platform, and taking account of feedback from spacecraft engineers, the PCI Mk2 provides the essential capabilities now demanded of SpaceWire test equipment, including: Packet Generation, Packet Checking, Time Code Master and high speed data transfer.

The SpaceWire PCI Mk2 is suitable for all stages of SpaceWire equipment development: initial SpaceWire evaluation, instrument simulation, control system simulation, unit testing, integration support, and EGSE.

#### Key Features

**Three SpaceWire interfaces:** Each fully compatible with the SpaceWire standard and able to operate at up to 200 Mb/s. An LED for each link indicates its status.

**Powerful SpaceWire routing capabilities:** Incorporating STAR-Dundee's advanced SpaceWire routing technology, the PCI Mk2 is able to route packets between SpaceWire ports and between those ports and the PCI interface. Path and logical addressing are supported along with a router configuration port. This allows SpaceWire routing technology to be explored using the PCI Mk2 and makes switching of SpaceWire traffic very easy.

**SpaceWire interface mode:** In addition to the router mode which provides full routing capabilities, the PCI Mk2 also includes an interface mode, which allows packets to be transmitted and received independently on each of the SpaceWire links. Traffic received on the SpaceWire links is automatically passed to software, with no routing required. Due to its simplicity, this mode can be very useful when first using SpaceWire.

**Packet generation:** A hardware packet generator can generate any length packet with a specific header and predefined data. The packet information is downloaded from a host PC into dual-port memory. This information is then used by the packet generator to form the required SpaceWire packets.

**Packet checking:** A hardware packet checker receives packets and checks their contents against a template held in the dual-port memory.

**Extensive API:** Developed after many years spent supporting users of SpaceWire interface boards, the Mk2 API provides a common API to all of STAR-Dundee's Mk2 products, enhancing reusability of the application software. The extensive functionality of the API makes it very easy to develop SpaceWire related application software. Example application programs relieve further the pressure on development schedule. The API provides access to all the functionality of the PCI Mk2 providing the high performance data transfer capabilities often needed for SpaceWire system simulation and testing purposes.

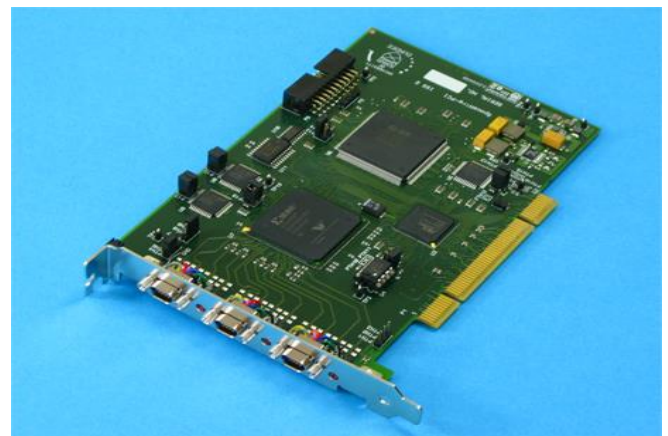
**Software drivers:** High performance drivers for the SpaceWire PCI Mk2 board are supplied with the board for Windows and versions of the Linux operating system. QNX and VxWorks drivers are available separately, enabling the PCI Mk2 to provide SpaceWire capability for real-time systems.

**Field upgradability:** The SpaceWire PCI Mk2 supports field upgradeability of the board functionality. Any upgrades or requested customisations can be downloaded from the STAR-Dundee website and installed quickly and efficiently.

**Common board formats:** The SpaceWire PCI Mk2 design is available in three different board configurations: PCI, cPCI and PMC. With the core circuitry being identical, this allows easy migration of user application software from one platform to another.

**Ease of use:** The SpaceWire PCI Mk2 is easy to use, enabling spacecraft system and software engineers to rapidly develop the simulation, test and EGSE equipment they need.

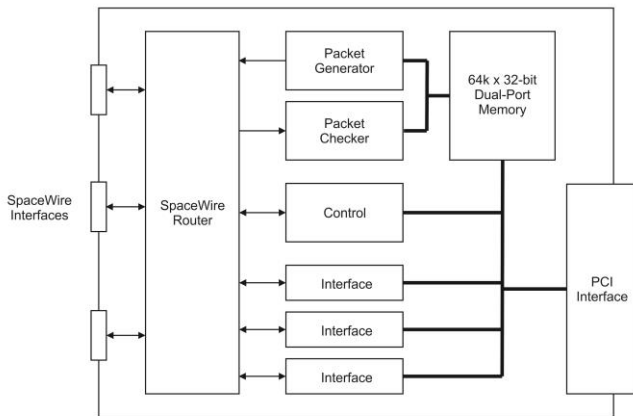
**First class support:** As with all of STAR-Dundee's products, a year's support and maintenance is included with the SpaceWire PCI Mk2. This support is provided directly from the team that developed each product so that we can respond quickly with answers to customer questions, give assistance with application development, and resolve any problems quickly.



SpaceWire PCI Mk2

## Overview

A block diagram of the SpaceWire PCI Mk2 board is shown below.



SpaceWire PCI Mk2 Block Diagram

The three SpaceWire interfaces of the SpaceWire PCI Mk2 are each fully compliant to the SpaceWire standard and operate at up to 200 Mbits/s. They are connected to a SpaceWire router so that packets from one SpaceWire port can be routed to another SpaceWire port or into the host PC via the PCI interface. There are three independent channels from the SpaceWire router to the PCI interface, so traffic flowing over one port cannot block traffic for another port. In addition there is a separate control channel, so that the host PC is always able to access the control, configuration and status space of the PCI Mk2 regardless of the data flow.

The SpaceWire router contained in the PCI Mk2 has support for path and logical addressing, group adaptive routing, watch-dog timing, power on request, and disable on silence. It includes a configuration port (port 0) for setting routing tables, configuring the SpaceWire links and monitoring their status.

The PCI interface is 32 bits wide and can operate at 33 MHz. It contains a DMA controller for rapid transfer of data to and from the SpaceWire PCI Mk2 board.

A hardware packet generator and checker are included on the SpaceWire PCI Mk2 to automatically generate and check SpaceWire packets at high speed without using host computer resources. The packets to be generated are stored in a dual-port memory on the PCI Mk2 board. Packets of any length can be generated with a separate header and cargo as required. The speed of packet data generation and the gap between packets can be controlled. This makes the implementation of instrument simulation systems very simple.

The packet checker receives an incoming packet and checks it against a template held in the dual-port memory. At the same time the incoming packet can be stored in the dual-port memory. Any mismatches can be flagged to the host computer. The packet checker is very useful for the automatic testing of packets from high data-rate instruments. The instrument can be configured and controlled from the host PC via the PCI interface and SpaceWire router, while data packets are checked by the packet checker.

The SpaceWire PCI Mk2 includes support for fault injection. Parity errors, credit errors, escape errors, data corruption and EEP termination of packets can all be carried out automatically or on demand.

## Application Programming Interface

A full API is provided to allow all functions of the SpaceWire PCI Mk2 to be controlled from user application software. A variety of programming languages are supported, including C.

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

A key feature of the API is that it not only provides functionality to send and receive packets, but also functions required when testing equipment. For example, the API makes it simple to send packets terminated with an EEP, and to determine the end of packet marker of received packets. It simplifies the process of sending a stream of traffic (for example, from a file), and receiving a stream of traffic. If these streams were to include time-codes in the middle of packets, the position of these time-codes would be maintained by the API. This allows traffic streams to be recorded accurately and replayed, so multiple test runs will be consistent.

The API is provided with extensive documentation and examples, which can be used as a basis for new applications.

A compatibility API is provided, allowing existing software written for earlier STAR-Dundee SpaceWire PCI devices to be used with the SpaceWire PCI Mk2. This reduces the time and effort required to migrate to the PCI Mk2, while also allowing the user to take advantage of its enhanced capability set.

## Specifications

API:

- C (See website for current list of supported languages.)

Software:

- Application software included.
- Source code examples provided.

Supported Platforms:

- Windows drivers (Windows 10, 8, 7, Vista, XP), 32 and 64bit.
  - Linux (4.x, 3.x and 2.6 Kernels).
  - QNX and VxWorks drivers available separately.
- (See website for current list of supported platforms.)

PCI Interface:

- 32-bit, 33 MHz.

Size:

- Standard PCI board approximately 165 mm long (excluding front panel bracket).

Power:

- +3.3V DC, supplied via PCI connector

SpaceWire Ports:

- Compliant to ECSS-E50-12A and ECSS-E-ST-50-12C.
- Number of SpaceWire Ports: 3
- Maximum Speed: 200 Mbits/s
- Data-Strobe skew tolerance: tested on all units to  $\pm 2$  ns at data rate of 200 Mbits/s
- Connectors: 9-pin micro-miniature D-type
- LVDS signalling: Using Xilinx LVDS

EMC:

- The SpaceWire PCI Mk2 board is sold as a component for inclusion in a computer unit. EMC certification is the responsibility of the user.