

# STAR-Dundee

## Supporting SpaceWire Applications

### SpaceWire Link Analyser Mk2

The SpaceWire Link Analyser Mk2 is designed specifically to support the testing and debugging of SpaceWire systems. It provides a rich set of test functionality in a single instrument; helping hardware and software engineers at all stages of SpaceWire related system development: feasibility, breadboard, engineering model, qualification model and flight model. Furthermore, it is an invaluable tool during spacecraft system integration and test, making the SpaceWire network traffic visible with minimal intrusion on the spacecraft systems. Building on STAR-Dundee's proven and widely used SpaceWire Link Analyser and SpaceWire Monitor tools, the Link Analyser Mk2 is ready to help discover and solve tricky problems well before they can have significant impact on cost and schedule.

Expanding on the knowledge and experience gained from the successful Link Analyser, the Link Analyser Mk2 has a more powerful hardware platform with greater onboard memory capacity to provide an enhanced and extended set of trace, analysis and triggering functions.

#### New features with the Link Analyser Mk2:

- RMAP, emerging standard and custom protocol analysis.
- 2000 times more memory, storing up to 16 million events.
- External triggers and logic analyser interfaces for cross triggering and synchronisation with external EGSE equipment.
- Software API for script automation and coordination with EGSE test equipment.
- Support for multiple Link Analyser Mk2 devices connected to a single PC.
- 19" rack mountable.



SpaceWire Link Analyser Mk2 front view



SpaceWire Link Analyser Mk2 rear view

#### Key Features

The Link Analyser Mk2 comprises a SpaceWire interface unit and software running on a host PC. The interface unit connects to the host PC using a USB 2.0 cable and is powered via a 5V power brick.

#### Principal Software features include:

- **Link level trace:** Monitoring, tracing and recording traffic at the link level. Used to confirm link start-up, flow-control, data transfer, and error recovery.

Time from Trigger	Time Delta	End A Event	End A Error	End A Delta	End B Event	End B Error	End B Delta
538 ns	50 ns	W0LL			W0SA0 (03)		50 ns
588 ns	40 ns	W0LL		40 ns	W0SA0 (04)		40 ns
640 ns	50 ns	W0LL			W0SA0 (05)		50 ns
700 ns	60 ns	W0LL		110 ns	W0SA0 (06)		40 ns
760 ns	40 ns	W0LL			W0SA0 (07)		50 ns
820 ns	60 ns	W0LL		100 ns	W0SA0 (08)		50 ns
880 ns	40 ns	W0LL		40 ns	W0SA0 (09)		40 ns
940 ns	50 ns	W0LL			W0SA0 (0A)		50 ns
1000 ns	20 ns	W0LL			EOP		20 ns
0 ns	110 ns	W0SA0 (03)		110 ns	W0LL		110 ns
40 ns	40 ns	W0SA0 (04)		40 ns	W0LL		40 ns
100 ns	50 ns	W0SA0 (05)		50 ns	W0LL		110 ns
150 ns	50 ns	W0SA0 (06)		50 ns	W0LL		40 ns
190 ns	40 ns	W0SA0 (07)		40 ns	W0LL		80 ns
230 ns	20 ns	W0SA0 (08)		20 ns	W0LL		50 ns
270 ns	50 ns	W0SA0 (09)		50 ns	W0LL		50 ns
320 ns	50 ns	W0SA0 (0A)		50 ns	W0LL		110 ns
380 ns	40 ns	W0SA0 (0B)		40 ns	W0LL		380 ns
380 ns	20 ns	EOP		20 ns	W0LL		380 ns
760 ns	380 ns	W0LL		6,30464621 s	W0SA0 (0C)		6,30464563 s
6,3046466 s	50 ns	W0LL		60 ns	W0SA0 (0D)		50 ns

Example link level display

- **Packet level trace:** Monitoring, tracing and recording of SpaceWire packets. Used to monitor the flow of packets exchanged across a SpaceWire link, the response of a system to packet errors, and the control of SpaceWire systems using control packets.

Delta	End A	End A Delta
	Header: 03	
	Cargo Size: 62 bytes	210 ns
	EOP	12,270 µs
	Header: 03	210 ns
	FD 00 C1 53 24 1D 13 3B	190 ns
	D4 C9 E9 D3 AB DC 21 F0	1,600 µs
	90 D6 E4 6D 3A 4C 14	1,600 µs
	5C D9 72 0A DB 3E 31 21	Expand All
	7C 91 4E 3F 4C 17 B2 5F	Collapse All
	87 40 2B 93 50 AE B0 5B	Expand Packet
	6B 5A 17 58 27 49 3A 69	Collapse Packet
	14 9F AC 00 00 00	
	EOP	
	Header: 03	210 ns
	Cargo Size: 62 bytes	190 ns

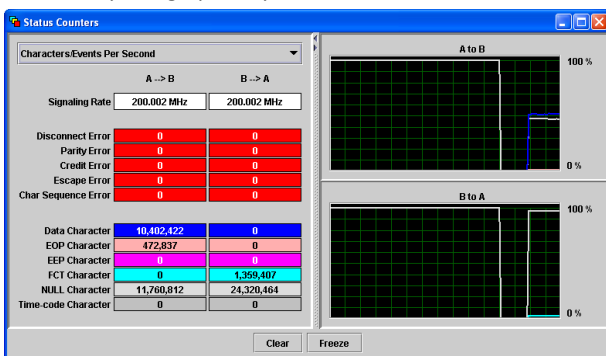
Detail of packet level display

- **RMAP analysis:** Display of RMAP transactions in a readily understandable form with each field of the protocol data unit clearly identified, simplifying RMAP analysis immensely.

Time From...	Time ...	End A	End A Delta	End B	End B Delta
0 ns		(PID=1) Header: RMAP Command			
		Path Address: 04			
		Target Address: FE			
		Instruction: Read Command			
		Increment Target			
		Key: 20			
		Reply Path: 00 00 01 03			
		Initiator Address: FA			
		Transaction ID: 1592			
		Extended Address: 00			
		Address: 00000001			
		Data Length: 000004			
4,080 µs	4,080 µs	EOP (4,080 µs @ 5,147 Mbytes/s)	4,080 µs		
5,620 µs	1,540 µs			(PID=1) Header: RMAP Reply	
		Path Address: 03			
		Target Address: FA			
		Instruction: Read Reply			
		Increment Target			
		Status: Success			
		Initiator Address: FE			
		Transaction ID: 1592			
		Data Length: 000004			
		Data:			
		00 00 00 00			
8,520 µs	2,900 µs	EOP (2,900 µs @ 5,207 Mbytes/s)	2,900 µs		
1,0046 ms	996,08 µs	(PID=2) Header: RMAP Command	1,00052...		
		Path Address: 04			

Interpreting RMAP transactions

- **Custom protocol analysis:** The format of protocol data units for additional end user protocols running over SpaceWire can be displayed in a similar manner to the RMAP protocol upon request to STAR-Dundee.
- **Emerging standard protocols:** As new SpaceWire standard protocols become available the Link Analyser Mk2 software will be updated to display these new protocols.
- **Large trace memory:** The large memory is capable of the real-time recording of millions of SpaceWire characters flowing in each direction for later analysis.
- **Search recorded characters:** Recorded characters can be searched for specific patterns or for particular events.
- **Selective tracing:** Filtering allows only relevant characters to be recorded which both extends trace length and improves readability during debugging.
- **Event-trace trigger:** Recording of events is started by a trigger condition, which can be a specific event (e.g. disconnect, EEP, external trigger), after a character sequence (e.g. EOP plus header/address of a packet), or after a specific sequence of events. Pre- and post- event triggering are supported with the trigger position being indicated on the traffic display.
- **Unobtrusive monitoring:** The LVDS signals are buffered by the SpaceWire Link Analyser Mk2 to ensure the unit is transparent to the SpaceWire link being analysed.
- **Statistical monitoring of link traffic:** Monitoring and display of the level of traffic flowing through the SpaceWire link. Statistical information is gathered continuously and the display updated every second. Information is presented both numerically and graphically.



Statistical monitoring of link traffic

- **Fault injection:** The SpaceWire Link Analyser Mk2 allows disconnect and parity errors to be injected in the monitored link. These faults can be used to validate the system level operation in the event of various failures.
- **Device identification:** When multiple Link Analyser Mk2 devices are connected to a single PC, each instance of the software is differentiated by displaying the serial number of the associated device. Similarly, the SpaceWire port LEDs of a device can be flashed on demand identifying one Link Analyser Mk2 from another when mounted together.
- **Save to file:** Recorded characters can be dumped to file in various formats, allowing the trace information to be stored for future reference, shared with others or loaded in to external software.

#### External equipment support features include:

- **External triggers:** Two triggers are provided on the front panel of the Link Analyser Mk2. One provides a trigger output signal, which is asserted when the Link Analyser Mk2 triggers. This can be used to trigger oscilloscopes, logic analysers, or other test equipment to make measurements concurrent

with the recording by the Link Analyser Mk2. The other provides a trigger input, which can be used to trigger data recording by the Link Analyser Mk2.

- **Logic analyser interface:** To support testing and debugging of equipment using SpaceWire interfaces, a 38pin Mictor logic analyser connector is provided on the rear panel of the Link Analyser Mk2. The SpaceWire traffic in each direction of the link is decoded into a set of characters which are provided on the logic analyser connector. This capability allows a range of logic analysers to be used to analyse SpaceWire systems, dramatically simplifying the debugging of complex systems using SpaceWire interfaces. (A second connector is reserved for future use.)
- **19" rack mountable:** Readily mounted in a 1U high, 19" rack alongside other STAR-Dundee products using STAR-Dundee's rack mounting kit. Up to four Link Analyser Mk2s can be mounted on a 1U shelf.
- **Traffic visibility:** The Link Analyser Mk2 provides multi-colour LEDs on each of the SpaceWire interfaces. These provide an immediate indication of the status of the SpaceWire link.
- **USB 2.0 interface:** This provides a high speed connection to a host PC or laptop to configure and control the Link Analyser Mk2, and provide the monitor and analysis displays.

#### Host PC and Software support:

- **Application Programming Interface:** For EGSE purposes the collection and analysis of the operation of the SpaceWire links often needs to be automated and coordinated with the operation of other test equipment. To support this, the Link Analyser Mk2 is provided with an API for C.
- **Ease of use:** The user interface has been designed with SpaceWire users in mind, with context sensitive help available at all times. Information can be entered and displayed in SpaceWire terms rather than as raw signals.

#### Specifications

Size: 110 x 30 x 112 mm (excluding feet).

Power: +5V DC, power brick supplied.

SpaceWire Ports:

- ECSS-E50-12A and ECSS-E-ST-50-12C compliant.
- Maximum Speed: 200 Mbits/s each port.
- USB 2.0: High Speed 480 Mbits/s.

Trigger input and output: SMB connectors with +3.3V signal level and 5V tolerances.

Trace Memory:

- Capacity for up to 16 million events.
- ±100% post/pre-triggering.

API: C language.

Analysis software included: Operates under Windows (Windows 10, 8, 7, Vista, XP, 2000) and Linux (2.6 kernels).

#### Application Notes

Application notes are available that describe how the Link Analyser Mk2 can be used to debug FPGA, hardware and application software, test system response to SpaceWire link errors, and integrate with spacecraft EGSE equipment.

(See <http://www.star-dundee.com> for application notes.)