
# SpaceWire Router ASIC

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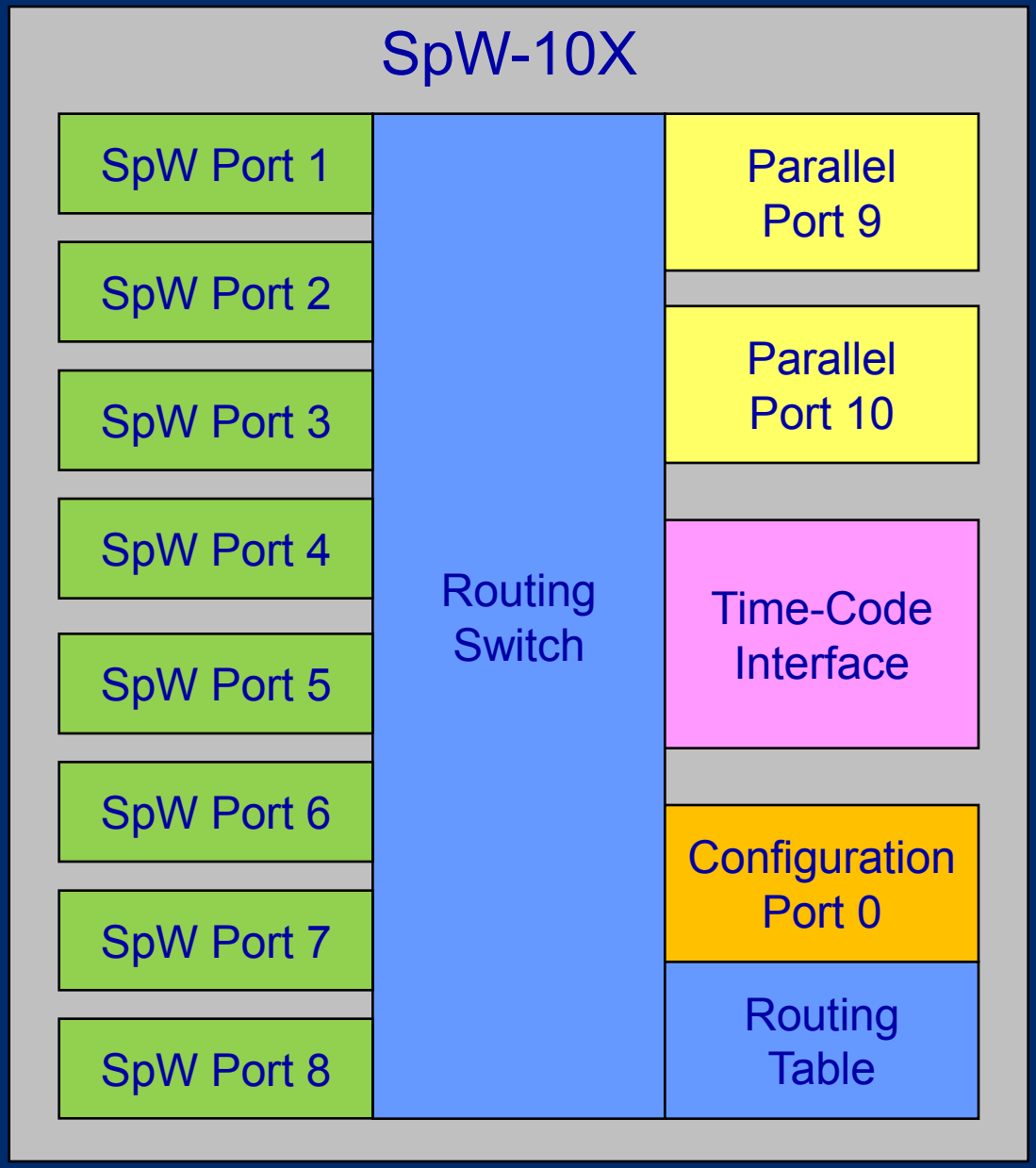
# SpW-10X Architecture




# SpaceWire Ports

- SpaceWire compliant
- Data Signalling Rate
  - 200 Mbits/s maximum
  - Selectable 2 – 200 Mbits/s
- Each SpaceWire port can run at a different speed
- LVDS drivers and receivers on chip
  - Avoids size, mass, cost of external LVDS chips
- Receiver auto-start mode
- Power control
  - Each SpaceWire port can be completely disabled
    - including clock tree
  - LVDS can be tri-stated with auto-enable
  - Links can be held disconnected until there is data to send


# Parallel Ports

- Parallel ports to support connection to
  - Processors
  - Simple logic
- 8-bit data + control/data flag
- FIFO type interface
- Operate at speed of SpaceWire links
  - i.e. 200 Mbits/s


# Routing Switch

- Switches packet being received to
- Appropriate output port
- SpaceWire and Parallel ports treated the same
- Non-blocking
  - If the required output port is not being used already
  - Guaranteed to be able to forward packet
  - Rapid packet switching times
  - Low latency
- 3.2 Gbits/s maximum throughput
- Worm-hole routing


# Configuration Port

- Used to configure router device
  - Routing tables
  - Link speeds
  - Power states
  - Etc
- Used to read router status
- RMAP Remote Memory Access Protocol
- Used for reading and writing configuration port registers
- Router can be configured over
  - Any SpaceWire port
  - Any Parallel port


# Time-Code Port

- Sends and receives time-codes
- Tick-in
  - Internal time-counter incremented and time-code sent
  - Or
  - Value on the time-code input port is sent as a time-code
- Tick-out
  - Indicates valid time-code received
  - Value of time-code on time-code output port

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# Status/Configuration Interface

- On power up holds some configuration information
- Thereafter provides status according to four address lines
- 0-10: Port status
  - 0: Configuration port
  - 1-8: SpaceWire port
  - 9-10: Parallel port
- 11: Network discovery
  - Return port
  - This is a router
- 12: Router control
  - Enables and timeouts
- 13: Error active
- 14: Time-code
- 15: General purpose
  - Contents of general purpose register
  - Settable by configuration command


# Router ASIC Performance

- ASIC
  - Implementation in Atmel MH1RT gate array
  - Max gate count 519 kgates (typical)
  - 0.35 µm CMOS process
- Radiation tolerance
  - 100 krad
  - SEU free cells to 100 MeV
  - Used for all critical memory cells
  - Latch-up immunity to 80 MeV/mg/cm$^2$
- Performance
  - SpaceWire interface baud-rate 200 Mbits/s
  - LVDS drivers/receivers integrated on-chip
- Power
  - 5 W power with all links at maximum data rate
  - Single 3.3 V supply voltage
- Package
  - 196 pin ceramic Quad Flat Pack 25 mil pin spacing

# ESA SpaceWire Router Performance

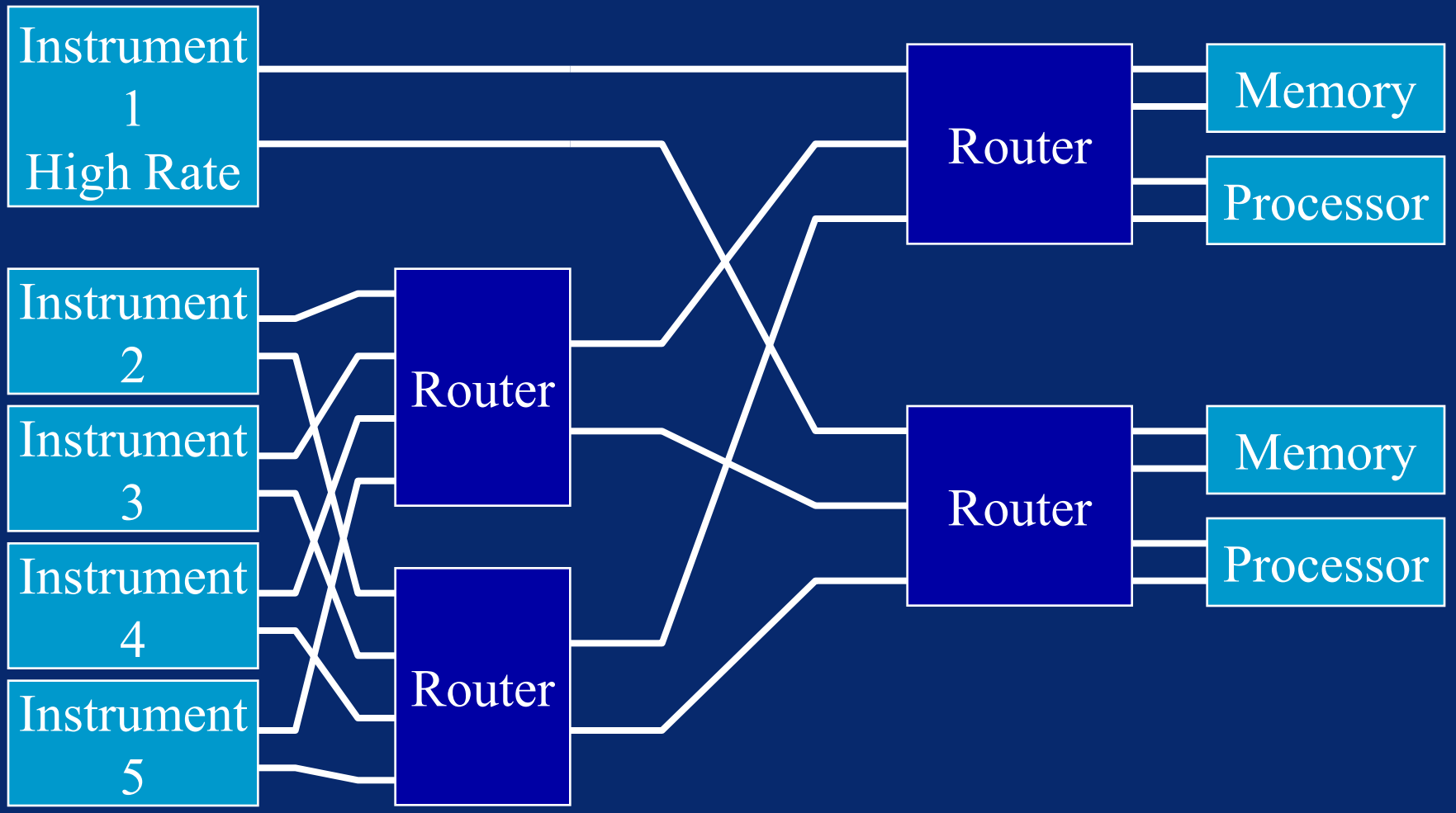
**SpaceWire Router Latency and Jitter Measurements (Bit rate = 200Mbits/s)**

| Description | Symbol | Value | Units |
|---|---|---|---|
| Switching Latency | $T_{SWITCH}$ | 133.3 | ns, max |
| Router Latency – SpaceWire to SpaceWire port | $T_{SSDATA}$ | 546.6 | ns, max |
| Router Latency – SpaceWire to External port | $T_{SEDATA}$ | 316.6 | ns, max |
| Router Latency – External to SpaceWire port | $T_{ESDATA}$ | 363.3 | ns, max |
| Router Latency – External to External port | $T_{EEDATA}$ | 166.6 | ns, max |
| Time-code Latency – SpaceWire to SpaceWire port | $T_{SSTC}$ | 409.3 | ns, max |
| Time-code Latency – SpaceWire to External port | $T_{SETC}$ | 316.6 | ns, max |
| Time-code Latency – External to SpaceWire port | $T_{ESTC}$ | 359.9 | ns, max |
| Time-code Jitter | $T_{TCJIT}$ | 116.6 | ns, max |

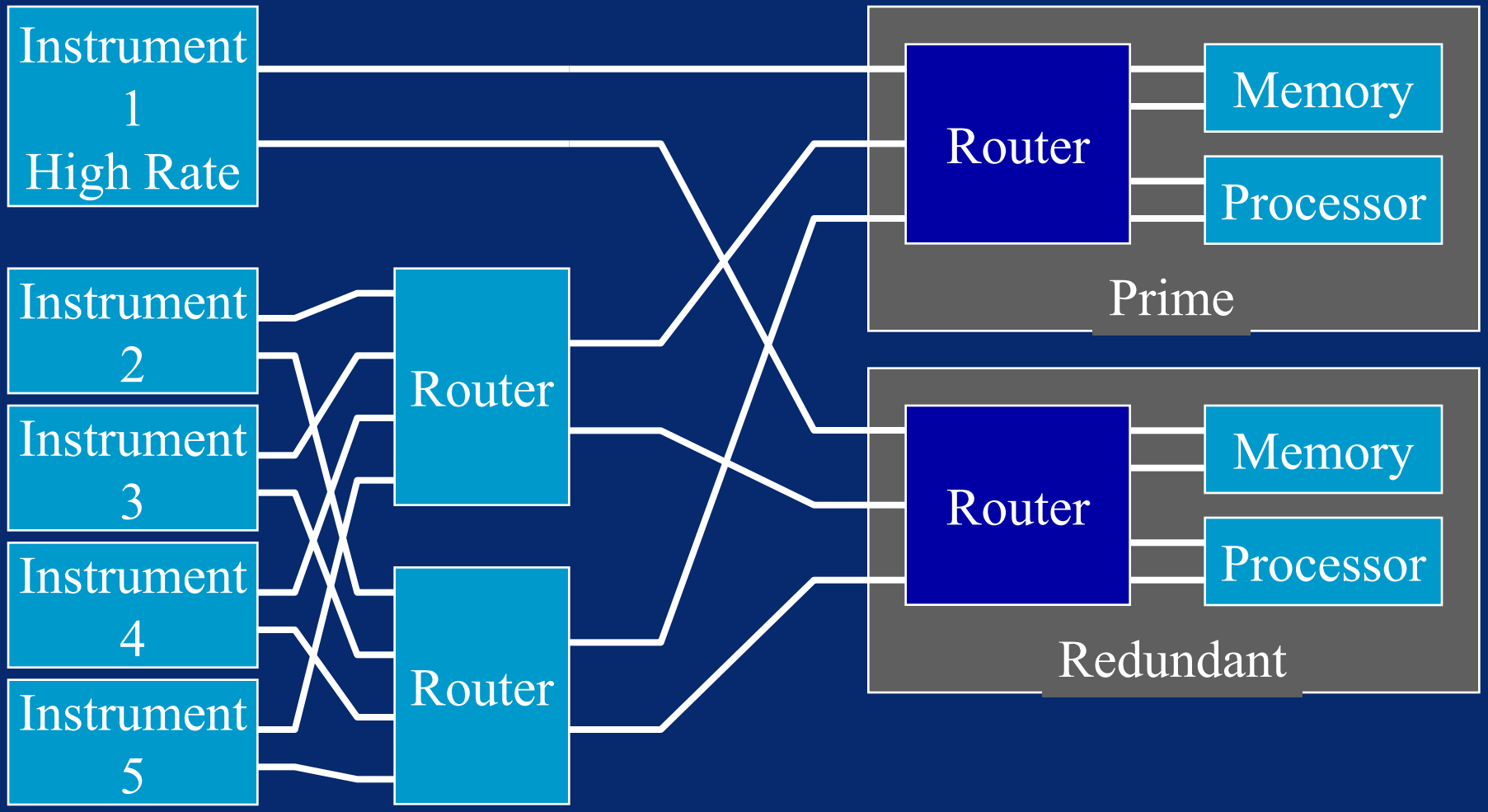
[1] Note all figures are worst case

Above figures derived from simulation

# Applications – Standalone Router



# Applications – Embedded Router



# Applications – Node Interface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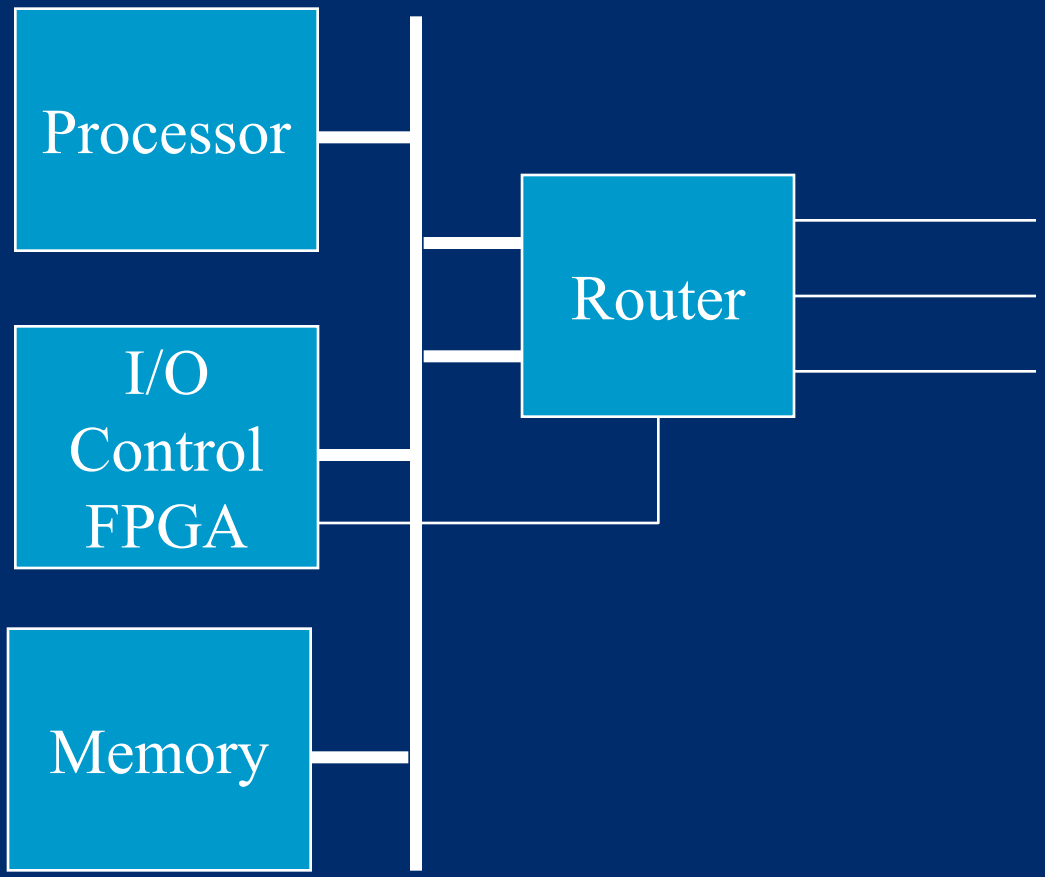


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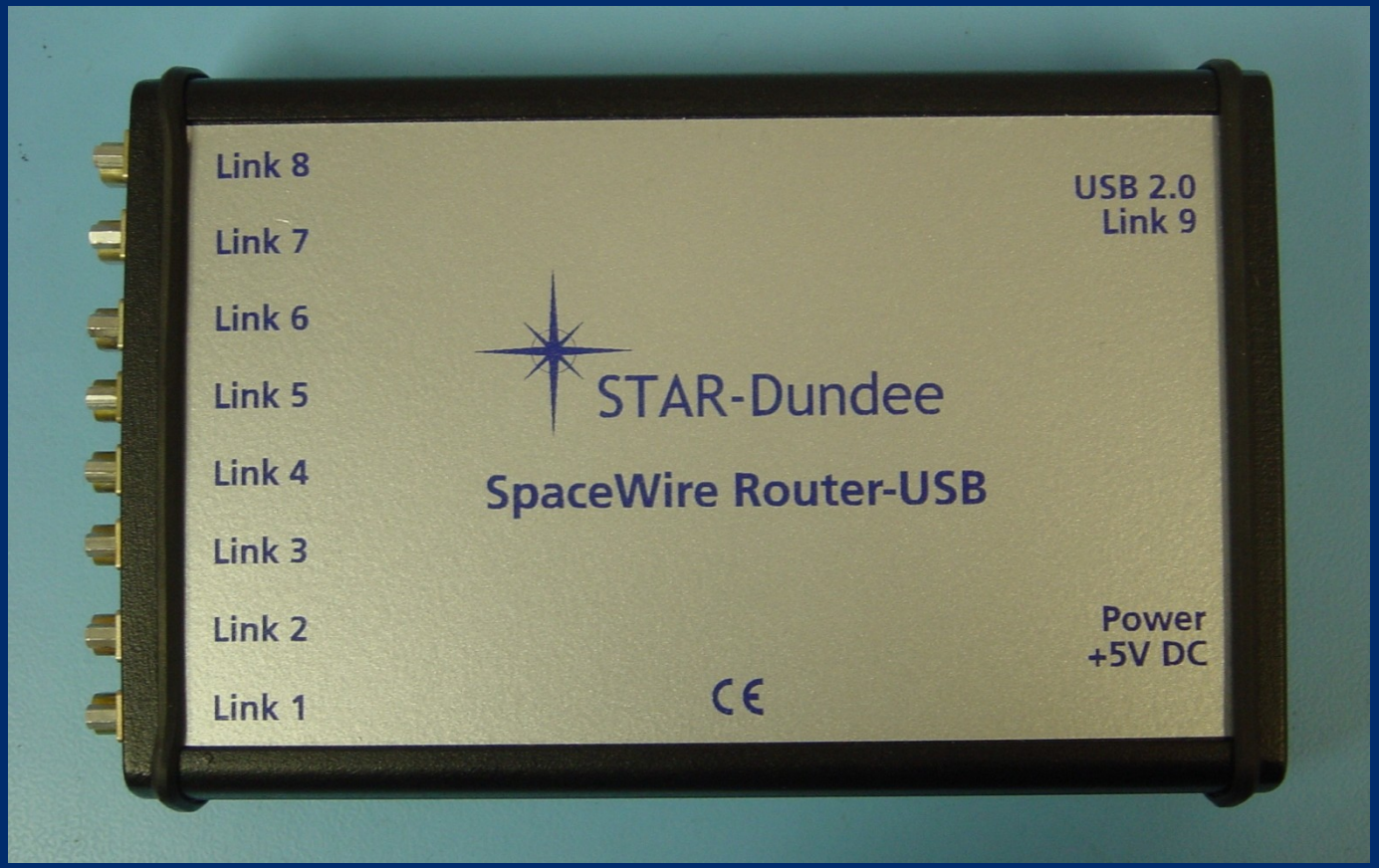
# Router Prototype Implementations



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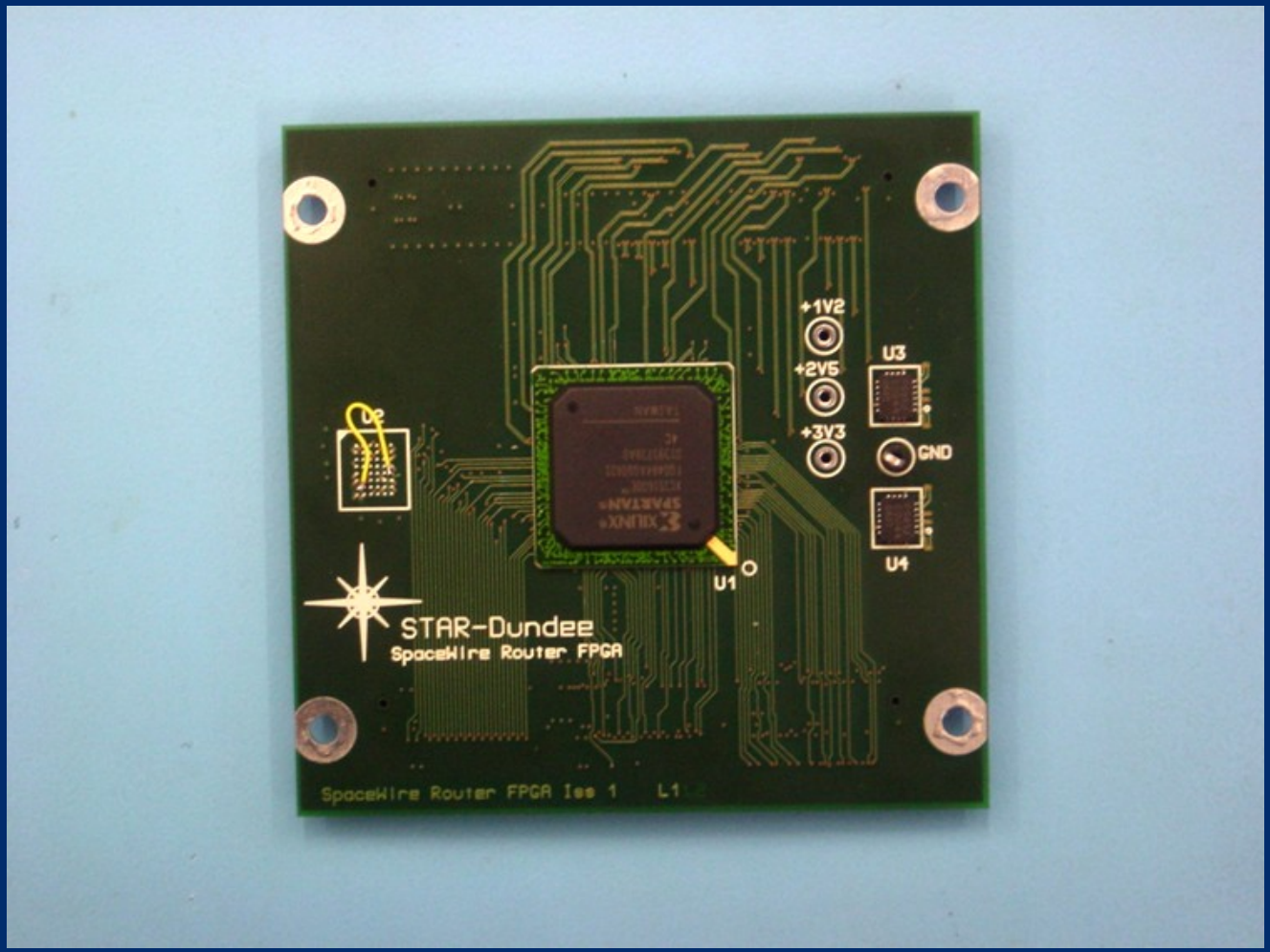

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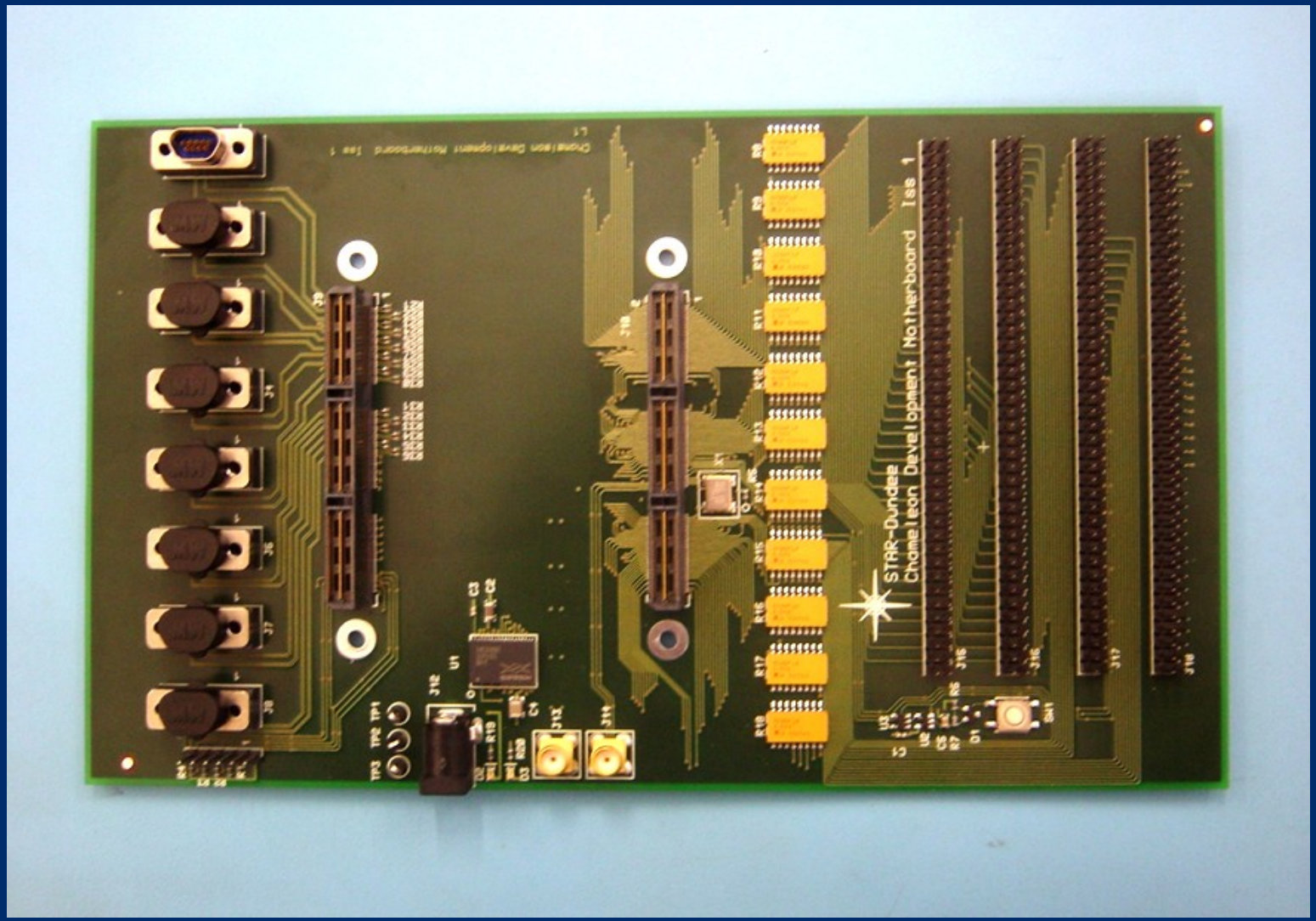


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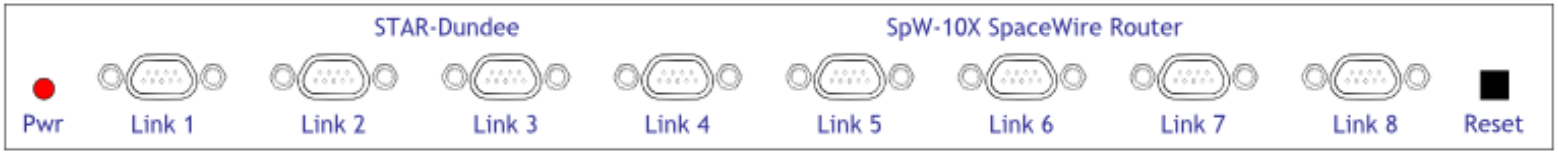
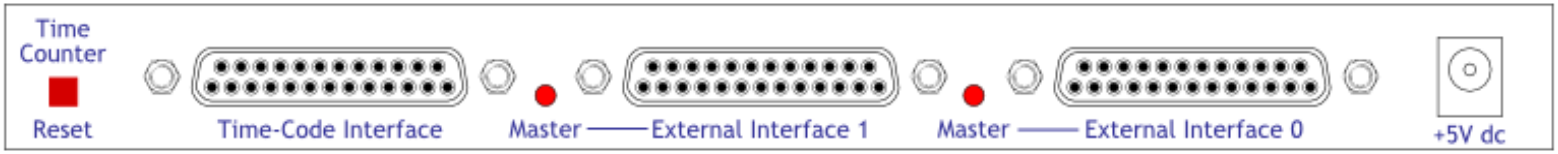
# SpW-10X Development System




- Boxed
- 6U Rack Mount

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# Team

- University of Dundee
  - Design and Testing
- Austrian Aerospace
  - Independent VHDL Test Bench
  - Transfer to ASIC technology
- Astrium GmbH
  - Functional Testing
- Atmel
  - ASIC Manufacture
- STAR-Dundee
  - Support and Test Equipment


# Conclusions

- ESA router has extensive capabilities
- Suitable for a wide range of applications
- Independently tested
- Extensively validated
- Full range of support services available
  - Evaluation boards
  - 6U and boxed
- Prototypes due November 2007
- Atmel AT7910E