

## AppNote 7 - SpiNNaker Links

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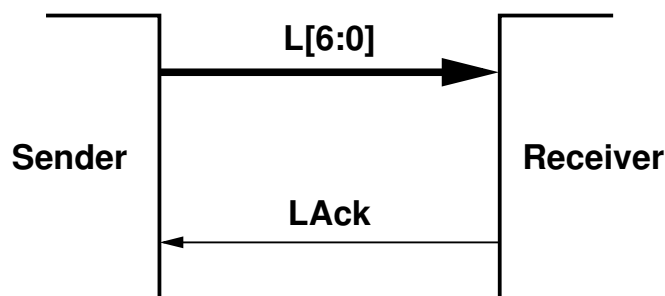
*Steve Temple - 3 Apr 2012 - Version 1.00*

### Introduction

A SpiNNaker chip has 6 bidirectional inter-chip links which are used to connect the chips together to provide a packet-switched network facility. Each link comprises 2 independent unidirectional links, an input link and an output link. The links convey data in packet form using a self-timed 2-of-7 protocol. This note describes the protocol used by the link hardware and its electrical characteristics.

### 2-of-7 Self-timed Coding

Each unidirectional link consists of 7 data wires  $L[6:0]$  and an acknowledge wire  $LAck$ . Data symbols are sent from Sender to Receiver using transition signalling on the data wires where a transition on 2 of the 7 wires conveys a symbol which represents 4 bits of information. A transition on the acknowledge wire signals that the receiver has received the symbol and the sender may transmit another one.



Sixteen data symbols encode the values 0 to 15 and a seventeenth (EOP) symbol encodes *end of packet*. The SpiNNaker chip I/O drivers use LVCMOS voltages and thresholds. The logic levels 0 and 1 are represented by voltages of 0V and 1.8V respectively. Following chip reset, the data wires of the output link go to logic 0 and the acknowledge wire of the input link goes to logic 1.

The links run at around 50 Msymbols/s and the cycle time for each symbol is therefore around 20ns.

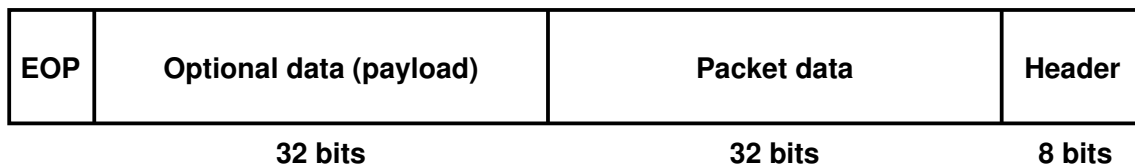
### Symbol Coding

Note that a symbol is encoded using transitions on  $L[6:0]$  so the table below represents the state of the wires only after the first symbol has been sent. Two consecutive symbols of the same value return the wires to the state they were in before the first symbol was sent. Therefore the table should be interpreted as 0=*no transition*, 1=*transition*.

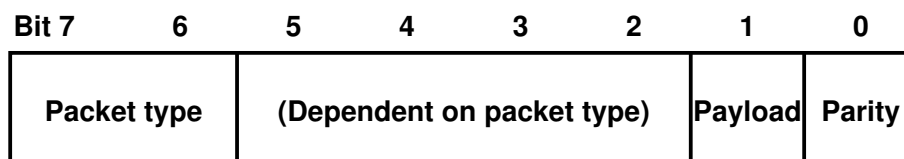
Value	L[6]	L[5]	L[4]	L[3]	L[2]	L[1]	L[0]
0	0	0	1	0	0	0	1
1	0	0	1	0	0	1	0
2	0	0	1	0	1	0	0
3	0	0	1	1	0	0	0
4	0	1	0	0	0	0	1
5	0	1	0	0	0	1	0
6	0	1	0	0	1	0	0
7	0	1	0	1	0	0	0
8	1	0	0	0	0	0	1
9	1	0	0	0	0	1	0
10	1	0	0	0	1	0	0
11	1	0	0	1	0	0	0
12	0	0	0	0	0	1	1
13	0	0	0	0	1	1	0
14	0	0	0	1	1	0	0
15	0	0	0	1	0	0	1
EoP	1	1	0	0	0	0	0

## Packet Format

Data sent on the links is formed into packets of 40 or 72 bits. The 40-bit packets are conveyed as 10 data symbols followed by an EOP symbol and 72-bit packets are conveyed as 18 data symbols followed by an EOP symbol.



Packets have an 8 bit header field followed by either 32 or 64 bits of data. The header contains various control bits some of which have fixed function and others whose function depends on the type of the packet. Two bits, the Payload and Parity bits, are relevant to the low level transmission of packets.



The Payload bit is set in long (72-bit) packets and clear in short (40-bit) packets. The Parity bit ensures that the entire packet (excluding EOP) has odd parity.

The first symbol in a packet is header bits [3:0] and the last symbol is EOP.

## Link Connector

On the SpiNNaker test PCBs each bidirectional link appears on a 34 way sub-miniature header plug. The input side of the link consists of inputs  $Lin[6:0]$  and output  $LinAck$ . The output side of the link has outputs  $Lout[6:0]$  and input  $LoutAck$ .

The placement of signals on the connectors is such that direct inter-board links can be made with 34-way ribbon cables. Alternate signals in the ribbon are interleaved with ground wires to improve signal integrity.

Pin	Signal	Pin	Signal
1	GND	2	Lin[6]
3	GND	4	Lin[5]
5	GND	6	Lin[4]
7	GND	8	Lin[3]
9	GND	10	Lin[2]
11	GND	12	Lin[1]
13	GND	14	Lin[0]
15	GND	16	LinAck
17	GND	18	GND
19	LoutAck	20	GND
21	Lout[0]	22	GND
23	Lout[1]	24	GND
25	Lout[2]	26	GND
27	Lout[3]	28	GND
29	Lout[4]	30	GND
31	Lout[5]	32	GND
33	Lout[6]	34	GND

## Connector Parts

The PCB mounted header plugs and ribbon cable mounted sockets are from Toby Electronics ([www.toby.co.uk](http://www.toby.co.uk)) and the ribbon cable is from Farnell ([www.farnell.com/uk](http://www.farnell.com/uk)). It is convenient to buy 68-way cable and split it. Part numbers are:

Toby C42-34-BS1-G – 1.27mm pitch micro straight PCB mount IDC box header

Toby A32-34-CGB1-G – 1.27mm pitch IDC micro cable sockets

Farnell 1207470 – Amphenol Spectra-Strip - 193.3003.068 - Ribbon cable, 68 way

### Change log:

- 1.00 - 03apr12- ST - initial release - comments to [temples@cs.man.ac.uk](mailto:temples@cs.man.ac.uk)