SECTION A - AURORA COMMUNICATION

The bitstream provided contains a generic communication module implementing the Aurora protocol on the **SFP00 and SFP02** channels. The characteristics of this protocol are as follows:

- Aurora lanes : 1
- Encoding: 8b/10b
- Lane Width : 4 bytes
- Interface : Framing
- Dataflow Mode : Duplex
- Flow Control : None
- Line Rate : 2 Gbps
- Scrambler/Descrambler: No
- Endianess: Little endian
- CRC: Yes

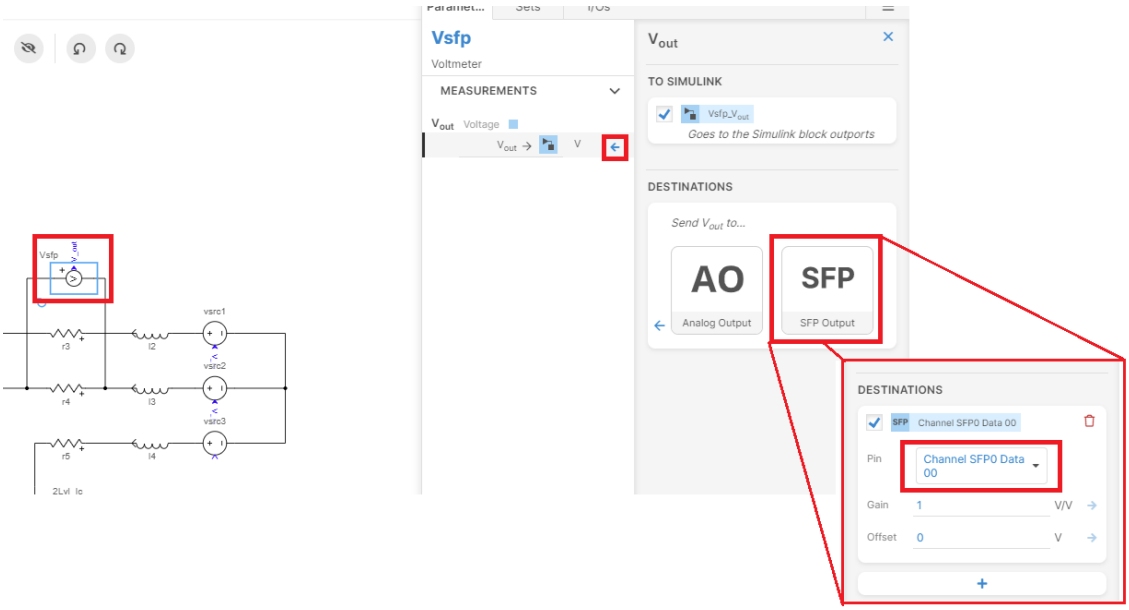
It is implemented as a custom feature in the firmware.

1 - AURORA TRANSMISSION ON PORT SFP00

The communication on CH00 is directly connected to the FPGA-Based solver eHS. When designing a circuit using the Schematic Editor tool, measurements from the schematic can be mapped to data transmitted on the Aurora link. Similarly, data received from the link can be mapped to controlled voltage or current sources in the schematic. Data in both directions is made using single-precision floating-point format. The maximum frame size in each direction is 32 words of 32 bits.

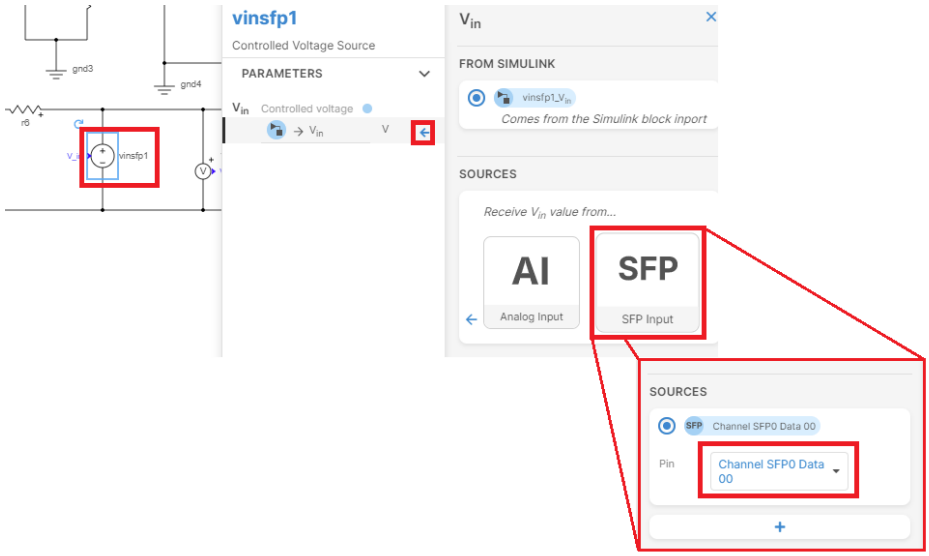
1.1 - DATA TRANSMISSION

Each measurement in the circuit can have a destination added as “SFP Output”. Once selected, an index on the transmitted frame can be selected. Each index can be selected only once in the circuit schematic.



1.2 - DATA RECEPTION

Data received on the frame can be used to drive controlled current or voltage sources in the schematic, by specifying the corresponding index on the received frame.

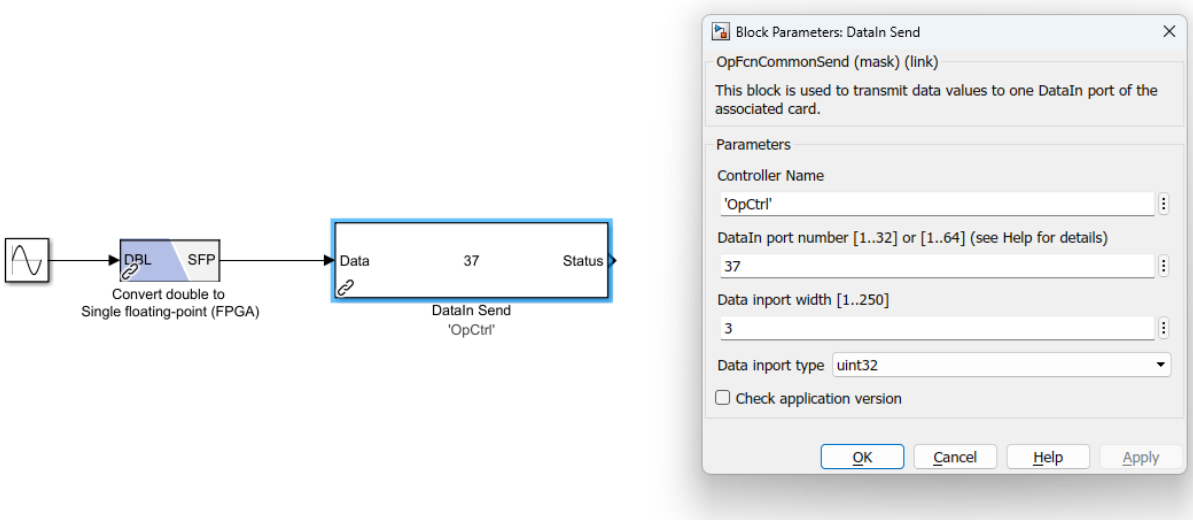


2 - AURORA TRANSMISSION ON PORT SFP02

The communication on CH02 is directly connected to communication ports available in the RT-LAB Simulink model, or HYPERSIM model. In the following sections, we will assume that the model is based on RT-LAB, although the same concepts apply to the HYPERSIM environment.

2.1 - DATA TRANSMISSION

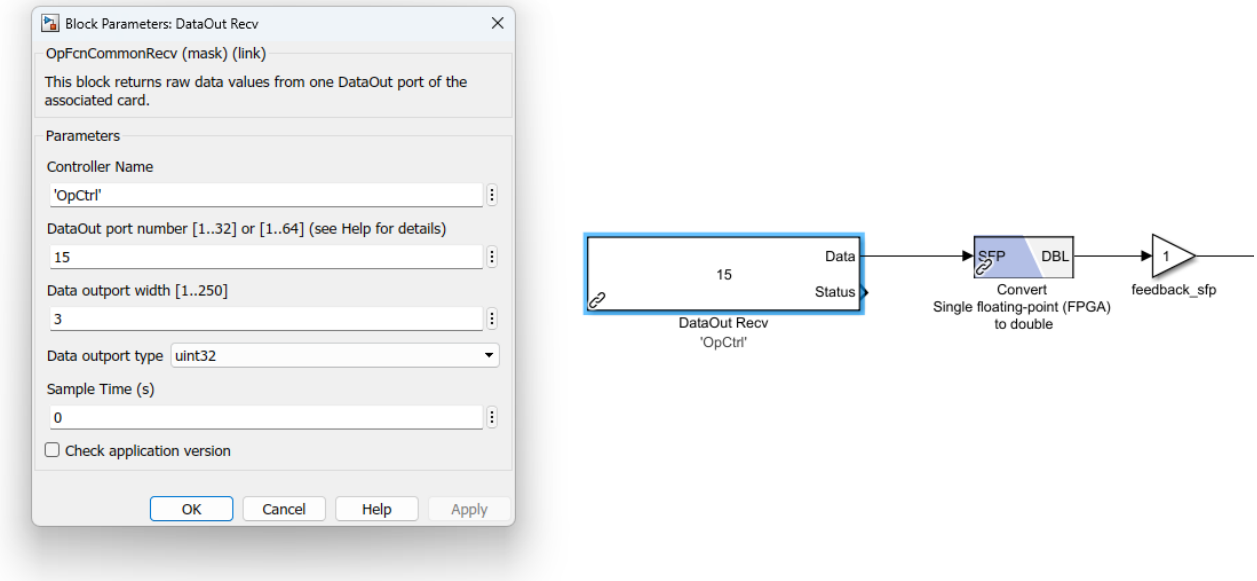
The data sent to the Aurora protocol is configured by adding elements to the “DataIn Send” port 37:



The data total number of data sent to the Aurora link is determined by the “Data inport width” parameter of this communication port. In the example above, each transmitted frame will have a size of 3 words of 32 bits. It is possible to increase this size, up to a maximum of 250 words of 32 bits. Within these words, it is possible to have mixed type of signals (e.g. float, unsigned or signed types up to 32 bits). In the example above, a 3-phase sinewave is converted into single-precision floating-point, before being transmitted on Aurora, with a sampling time equal to the simulated model time step size. The frame size cannot be modified from one frame to another during a simulation.

2.2 - DATA RECEPTION

The data is received from the “DataOut Recv” port 21. The “Data outport width” parameter should correspond to the maximal frame size expected to be received during the simulation. The last completely received frame at the end of a simulation step will be transmitted to the model at the beginning of the following step. It is possible to increase this size, up to a maximum of 250 words of 32 bits. Within these words, it is possible to have mixed type of signals (e.g. float, unsigned or signed types up to 32 bits).



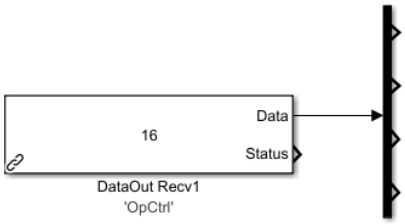
In the example above, 3 single-precision floating-point values are received from Aurora, before being made available to the model at the output of the “Convert Single floating-point (FPGA) to double” block.

If that frame size does not correspond to the value assigned to the “Vector size” parameter, this behavior is applied:

- If the frame was longer than the value of the “Vector size” parameter, the words exceeding the vector size are dropped.
- If the frame was shorter than the value of the “Vector size” parameter, the missing words in the received frame are padded with data of value 0 in the reception of the model from the firmware.

3 - AURORA LINK STATISTICS

The Aurora link statistics can be read from “DataOut Recv” port 16, where each received signal has the unsigned integer 32-bit format:



The signification of each signal is as follows:

Table 1: Aura link statistics info

Output index	Bits	Signal name	**Expected value**	**Description**
1	0-7	NbDataPerFrame	1-250	Number of 32-bit words in the last received frame, offset by -1. E.g. if 3-word frames are received, the value read would be 2.
	16	ChannelUp	1	Aurora Status port indicating a successful lane initialization.
	17	LaneUp	1	Aurora Status port indicating a successful lane initialization.
	18	FrameError	0	Aurora Status port indicating a Frame Error. Frames with no data, consecutive Start of Frame symbols, and consecutive End of Frame symbols are considered as Frame Error.
	19	SoftError	0	Aurora Status port indicating a Soft error has been detected in the incoming serial stream, such as an 8b/10b decoding error.
	20	HardError	0	Aurora Status port indicating that the Aurora core has detected a hard error. The core monitors each MGT for hardware errors such as buffer overflow/underflow and loss of lock.
	21	FIFOOverflowError	0	Aurora status port indicating the communication interface detect a FIFO Overflow occurrence.
	22	CRCError	0	Aurora status port indicating a CRC error has been detected.
2	0-31	TimeBetweenFrames	100-8000000	Provides the elapsed time between successive frames, as a count of 5-ns clock ticks, offset by -1. E.g. if frames are received every 100us, the value read would be 19999.
3	0-31	NbFrameErrors	0	Indicates the number of Frame Error since the start of the simulation
4	0-31	NbReceivedFrames	0-4294967295	Indicates the number of frames received since the beginning of the simulation.

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