

Half-Duplex SpaceWire

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Rationale

Some applications are symmetric

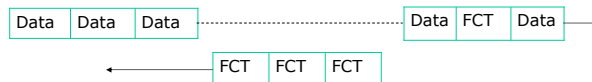
- Data stores
- Router-to-router connections (sometimes)

Some applications are asymmetric

- Sources of data
 - sensors
- Sinks of data
 - actuator
 - data-downlink

Half-duplex operation

Each end of a link takes it in turns to send data and control

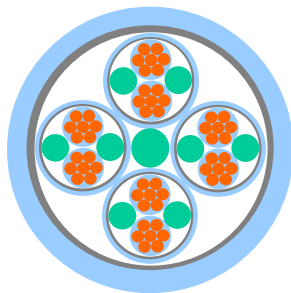


Wires can be re-used

- We require half the number of wires
- Mass may be more than halved

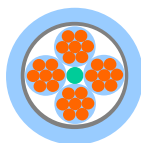
Operation need not be symmetric but can dynamically adjust to the required asymmetry
 The reverse flow is still available for configuration, control, etc.

SpaceWire Cables



Full-duplex: 80g/m

Conductor size:
 28awg (7*36awg)



Half-duplex: 26g/m

Cable capacities / mass

Gore™ already produce a range of aerospace cables configured as shown and intended for Data-Strobe encoding (for IEEE-1394 applications).

These offer a range of capacities, for a range of masses:

Wire gauge (awg)	Mass (g/m)	Max length @100Mb/s (m)	Max length @500Mb/s (m)
30	22	21	9
28	26	27	12
26	35	33	18
24	50	45	22
22	63	53	30

Performance



Half-duplex has, at most, half the total performance of full-duplex – but we would expect uni-directional traffic rates to be comparable in both cases.

Half-duplex also has the overhead of turnaround time which will reduce its performance.

Allowing 500ns for each turnaround we can calculate the expected data rates. A fixed turnaround period will have more impact at higher data rates (it represents more bit periods) – hence we show figures for a range of raw bit rates.

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Performance - predicted



All figures: Mb/s

Raw bit rate	10	20	50	100	200
Full-duplex Bidirectional	15.2	30.4	76.0	152.0	304.0
<i>Half-duplex Bidirectional</i>	<i>7.5</i>	<i>14.8</i>	<i>36.1</i>	<i>69.3</i>	<i>128.7</i>
Full-duplex Unidirectional	8.0	16.0	40.0	80.0	160.0
<i>Half-duplex Unidirectional</i>	<i>7.3</i>	<i>14.4</i>	<i>34.3</i>	<i>63.6</i>	<i>111.4</i>

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Performance – and measured



All figures: Mb/s

Raw bit rate	10	20	50	100	200
Full-duplex Bidirectional	15.2	30.4	76.0	152.0	304.0
<i>Half-duplex Bidirectional</i>	<i>7.5</i>	<i>14.8</i>	<i>36.1</i>	<i>69.3</i>	<i>128.7</i>
				73.2	
Full-duplex Unidirectional	8.0	16.0	40.0	80.0	160.0
<i>Half-duplex Unidirectional</i>	<i>7.3</i>	<i>14.4</i>	<i>34.3</i>	<i>63.6</i>	<i>111.4</i>
				70.5	

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Findings



- Half-duplex can be implemented
- Half-duplex performs as expected
- CODECS can be compatible with full-duplex
 - Able to detect a full/half-duplex other-end and operate in the correct mode
 - Only a few changes to the CODEC

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Changes to the SpW Standard



- Physical level: Add 2-pair, low mass cable
Add different connector (?)
- Signal level: Allow bi-directional data
- BLVDS (?)
- Character level: No change
- Exchange level: Extend state machine
Define turnaround
- Packet level: No change
- Network level: No change
- Application level: No change

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Conclusions



Whilst retaining all the features and benefits offered by SpaceWire – with no change to the user-level functionality or interface ...

Half-duplex SpaceWire offers a unidirectional data rate similar to full-duplex SpaceWire and reduces cable mass by 66%.

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