ECSS Change Request / Document Improvement Proposal

1. Originator's name: David Jameux

Organization: ESA/ESTEC

e-mail: david.jameux@esa.int

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 7 March 2011

1. General 3
1.1 Structure of the document 3
1.2 Careful revision of some definitions 4
1.3 Streamlining references to other standards 5
2. Physical layer requirements 5
3. Time-code distribution 6
4. Introduction of new backward compatible features 7
4.1 Introduction of interrupt/signalling codes 7
4.2 Introduction of simplex and/or half-duplex mode(s) 7
5. Miscellaneous 8
5.1 Virtual channels 8
5.2 Update state machine 8
5.3 Router timeout 9
5.4 Specification of host interface 10
6. Other errors to be corrected 10
Annex 1: Change Requests collected from the SpaceWire Community 27
A.1 General 27
A.1.1 Structure of the document 27
A.1.2 Alignment with OSI model and general computer networks terminology 28
A.1.2.1 Clarify definition of “nodes” 28
A.1.2.2 Add routing capability to nodes 28
A.1.2.3 Protocol description formalism 28
A.1.3 Streamlining references to other standards 31
A.2 Physical layer description reduced specification of to electrical signals 32
A.2.1 Physical channel (cable assembly) 32
A.2.1.1 Cables 33
A.2.1.2 Connectors 36
A.2.1.3 New shielding and grounding schemes 37
A.2.2 Backplanes 39

A.3 Character level (Physical layer) - Data rate....40
A.3.1 Minimum data rate....40
A.3.2 Starting data rate....40
A.3.3 Maximum data rate....41
A.3.4 Data rate negotiation....41
A.4 Update behaviour of nodes/terminals....41
A.4.1 Add configuration port in nodes....41
A.4.2 Nodes shall discard packets with unexpected destination address....43
A.4.3 Add routing capability to nodes....44
A.5 Time-code master: one or more?....47
A.6 Introduction of backward compatible signalling codes....48
A.6.1 Backward compatibility with Time-codes....48
A.6.2 Interrups+ACK scheme....48
A.6.3 Multi-purpose signalling scheme (allowing time codes and interrupts and more)....50
A.7 Introduce broadcast/multicast....54
A.8 Introduction of simplex and/or half-duplex....54
A.9 Miscellaneous....55
A.9.1 Virtual channels....55
A.9.2 High time-synchronisation resolution option....56
A.9.3 Increase error detection capability at character level....57
A.9.4 Requirement on Regional Addressing....58
A.9.5 Update state machine....58
A.9.6 After “reset” the time-counter shall be set to zero....59
A.9.7 Switching arbitration algorithm....60
A.9.8 Router timeout....61
A.9.9 State of the link interface during the spilling of a packet....62
A.9.10 Over specification of host interface....62
A.9.11 Credit count error protection....63
A.10 Editorial comments....64
A.11 Inputs to the SpW Handbook....67

NOTE: In the column “7. Justification” of the tables below, the references in brackets […] refer to the Change Request numbers in “Annex 1: Change Requests collected from the SpaceWire Community”

1. General

1.1 Structure of the document

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
1	Whole document	all	Re-write the standard according to the current ECSS drafting rules. Revisit the whole document so that each clause contains only a single requirement and that each requirement expresses a single need. Remove hanging clauses. Clearly separate informative and normative material Remove a number of ambiguities raised by the SpW users (mainly the Working Group).	As reported in [0] and [1]: A number of ambiguities identified by the SpW Working Group may lead to different implementations and limit the interoperability of unit/device vendors.	*Proposed change approved.*
2	Whole document	all	Introduce new backward compatible features raised by the SpW users (mainly the Working Group).	As reported in [86], [48], [51], [52], [53], [54], [55], [46], [47], 49], [61], and [62]: These additional features are considered necessary for the deployment of SpaceWire networks by the SpaceWire community.	***PROPOSED DISPOSITION*** *The principle of introducing new backwards compatible features is approved. The disposition of the proposed individual new features is handled in the respective Change Requests*

1.2 Careful revision of some definitions

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
3	Whole document	all	Clarify definition and behaviour of “nodes” and review all node-related requirements. The term node should be only used as abstract end point (terminal) of the network and not for a physical unit. Introduce a different term (e.g. device) for electronic modules or units in the network which can contain one or more SpaceWire interfaces. Introduce a single configuration ports for devices and the permission to contain a routing capability.Remove a number of ambiguities raised by the SpW users (mainly the Working Group).	As reported in [3], [4], [94], [95], [98] and [100]: Some requirements in ECSS-E-ST-50-12C refer to the term “node” as some electronic module or unit comprising one or several SpW interfaces while other requirements refer to the term “node” as the SpW interface itself as a terminal of the network. This has been creating a lot of confusion, specifically when trying to define other protocols operating on top of SpaceWire. Amongst the related confusion is the Time-code usage in particular and time distribution in general, which is severely impacted by the definition of a “node”. Another source of confusion is whether a packet with unexpected destination address shall be discarded, since RMAP does not follow this rule. Moreover, the design of SpaceWire higher level protocols such as Plug-And-Play require a clear definition of items to be discovered in a SpW network, and the assignment of a configuration port to each of these items. At last, some discussion in the SpW WG is ongoing whether aligning the definition of nodes to the one of routers (with e.g. the possibility for nodes to switch characters/packets) would clarify this definition and help supporting PnP.	Clarify the terms “port”, “link”, interface”, “router”, “node”, “end-point”, etc. w.r.t. SpaceWire as part of the revision of the standard.
4	Whole document	all	Carefully improve the protocol description and consistency formalism (clear layering) and precise the use of some terms (e.g. switching instead of routing) and clearly describing for each protocol “level” the description of syntax, synchronisation, semantics; and include a description of the Service Access Points.	As reported in [2], [11], and [99]: SpW does not involve routing (OSI layer 3) but only switching (OSI layer 2). In literature the term Wormhole switching is widely used as a synonymous of wormhole routing. However, the development of SpaceWire higher level protocols in general and the SOIS stack in particular involves routing. The use of this term at SpW level therefore may create confusion. Moreover, the ECSS-E-ST-50-12C Standard mixes for each protocol “level” the description of syntax, synchronisation, semantics; and it does not describe the Service Access Points. The advantage is that it facilitates the first reading/understanding of the major features of SpaceWire but it also increases the risk of ambiguities when it comes to detailed understanding and implementation	Keep the overall layering as it is but remove any kind of (minor) mixing/overlap between layers in the current standard and clearly define Service Access Points.

1.3 Streamlining references to other standards

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
5	2 3.2	14 15	Streamline references to other standards	As reported in [5], [6], and [22]: Some of the normative references must be removed or updated. The related terms and definitions must then be updated.	Remove references to ECL, PECL and 1355-1995, especially in the normative parts of the standard. Keep the description of the DS encoding as part of the SpaceWire standard, unless it is shown that a better description can be found elsewhere. *Note: The issue of the connector and the soldering and crimping standards is still open. This issue might disappear if the new standard does not specify manufacturing processes anymore (see section 2. Physical layer requirements).*

2. Physical layer requirements

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
6	5 & 6	31 to 51	Update the way the Physical channel is specified. (cable assembly or backplanes)	As reported in [39], [40], [13], [33], [12], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], and [32]: The specification of the SpW cable assembly (cable and connector) in terms of mechanical and physical properties is far too detailed in ECSS-E-ST-50-12C. In the past there have been a number of cases where the specified cable construction did not meet the mission needs (e.g. cable to heavy or too stiff or too high loss, etc). There is a general consensus in the SpW community that only the electrical, physical parameters of the cable assembly (e.g. Differential Impedance, Signal Skew, Return Loss, Insertion Loss, Near-end Crosstalk, Far-end Crosstalk, etc.) should be specified. The exact physical parameters and their values still need to be defined. Similarly, the SpW community would like to keep the existing connector (submicro-D) for SpW but generally recognise that several connectors have to be allowed, in order to avoid too many mismatches with mission needs. At least one other connector was identified. Moreover, the shielding scheme must be redesigned to allow intermediate connectors and improve EMC. Some new scheme has been proposed and will soon be validated through breadboarding. At last, SpaceWire links are often used within a unit or electronic box. The current SpaceWire standard contains some requirements on PCB and backplane tracking but no requirements on backplane connectors or backplane construction.	Specify only the type and pin allocation of the connector; and electrical properties of the cable assembly. Consider one or two additional complementary connector types for inclusion in the standard.

3. Time-code distribution

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
7	7 & 8		Clarify time distribution	As reported in [44], [45] , [59], [69], [72], [73], [74], [75], [76], [77], [78], [79], [84], and [85]: Some clarification is required regarding the specification of the time distribution. The time distribution and the time interface are defined in 8.12 and 7.7. Some of the requirements are ambiguous and not well structured. This is in particular the case when it comes to the handling of error cases. There is for example a lot of debate within the SpW community whether only one or multiple nodes can issue Time-codes and whether they are then considered time masters.	***PROPOSED DISPOSITION*** Clarify the time-code distribution. The requirements concerning the time distribution should be at only one place in the document.

4. Introduction of new backward compatible features

4.1 Introduction of interrupt/signalling codes

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (14)	6. Changes	7. Justification	8. Disposition
8	7 & 8	52 to 86	Introduce Interrupt distribution codes or more general low-latency signalling codes	As reported in [86], [48], [51], [52], [53], [54], [55], [46], [47], and [49]: A possible use of one reserved state of the two “control bits” of the SpW standard to allow low-latency distribution of interrupts across SpW networks was presented to the SpW Working group several times. The technical solution was discussed thoroughly and improved. Some optimisation of this technique allowing low-latency distribution of any kind of signalling code, included but not limited to interrupts and time codes, was recently presented to the SpW Working group. Once validated by ESA through breadboarding, the feature will be ready for introduction into the new release of the standard.	***PROPOSED DISPOSITION*** Include the Distributed Interrupts or more general low latency signalling codes as a new feature in the revised standard. For this, one or more of the three reserved states of the two control bits shall be used.

4.2 Introduction of simplex and/or half-duplex mode(s)

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (14)	6. Changes	7. Justification	8. Disposition
29	8	57	Introduce simplex and/or half-duplex mode(s).	As reported in [61] and [62]: For many high speed payload data applications only a simplex connection from the instrument to the memory is required. In these cases the back channel provided by SpaceWire is often seen as unnecessary complexity and cable mass. It has been proposed to modify the SpaceWire codec and the state machine to support simplex operation. Also the possibility of a half-duplex SpaceWire implementation has been suggested.	***PROPOSED DISPOSITION*** Not to introduce simplex and half-duplex in the update of the SpaceWire standard unless more detailed explanations on the technical solution and on the impact on the current SpaceWire standard are provided very soon.

5. Miscellaneous

5.1 Virtual channels

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
9	Whole document	all	Remove all text related to virtual channels	As reported in [87], [88], and [97]: In several sections, ECSS-E-ST-50-12C hints at the possibility to implement “virtual channels” with Logical Addresses. This has created a lot of confusion amongst users and is not intrinsically part of SpaceWire but left to users (at application level).	*Proposed change approved.*

5.2 Update state machine

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
10	8.5	63	Change state diagram.	As reported in [65], [66], and [67]: During the implementation of the SpaceWire codec some inconsistencies in the transitions described in the state diagram have been identified. a) The transition from Started to ErrorReset is impossible when gotNULL condition is set. b) The transition from Connecting to Run shall be applied only after sending FCT to channel. These inconsistencies will have to be corrected by making some slight modifications of the standard text and state diagrams.	

5.3 Router timeout

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
12	10	89 to 106	Add timeout to router specification (TBC)	As reported in [90], and [91]: If a router stops receiving data due to an internal failure the packet is stuck and can block some paths in the network. It is difficult to detect and recover this situation from outside the routers. An effective method to recover from this failure condition is to introduce a timeout inside the routing switches which removes the stuck packet from the link after a certain period of time without movement. This feature is important to avoid failure propagation through the network and to allow local failure recovery without the need to power cycle the network. The details on how this optional time out should be specified still have to be defined.	Introduce a requirement into the SpaceWire standard for a selectable timeout in each router. The possible values for these programmable time outs still have to be discussed and agreed. One of these possible values is infinity (i.e. it must be possible to disable the timeout). Routers do not have to implement all possible values for the timeout.

5.4 Specification of host interface

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
13	Whole document	all	Update the host interface description so as to limit its specification to the minimum required. The host interface specification should only contain the type of signals but not the exact format.	As reported in [58], [70], and [71]: It has been agreed at SpW Working Group level that the host interface description overlaps somehow with implementation requirements.	***PROPOSED DISPOSITION*** Specify the use of 8-bits+control bit as Service Access Point to the SoW link interface; and that EEP and EOP are defined by the control bit set to 1 and the lsb data bit is 0 (EOP) or 1 (EEP) Add a note that recalls that an adaptation layer can be connected to this SAP to provide a higher level host interface.

6. Other errors to be corrected

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
14	Figure 4-1	26	Correct figure [voltage values indicated in the upper picture of Figure 4-1 appear to be wrong]	Indeed, if the voltage across the input resistor of 100 Ohm is 350mV, then the voltage indicated on the right of the arrows are wrong. I think it is not +250mV +400mV typical but +125mV +200mV typical. There is a ratio 2 between both values.	Change +250mV +400mV respectively to +125mV +200mV in Figure 4-1.

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
15	7.2	52	Add specification in text that parity is sent first, then control bit and lastly data starting from the LSB	Currently it is only indicated in the figure with an arrow in what order the characters are transmitted. Only the data bit transmission order is explicitly specified in the text.	*Proposed change approved.*
16	Figure 7-2	53	An explicit requirement should refer to the figures as the definition of the characters. Also the transmission order of the bits should be explicitly stated.	Currently the figure is only referenced from a NOTE which is not according to ECSS drafting rules.	Add an explicit requirement defining the characters regardless of the figures. Add also an explicit requirement defining the transmission order of the bits.
17	7.4a	54	Remove.	It is already specified for both data characters and control characters in clauses 7.2 and 7.3 where a parity bit should be included. This clause should only specify how it is used.	*Proposed change approved.*
18	7.7d	56	Remove and clarify in 8.12.2	Specified in 8.12.2 since only one node or router is allowed to be time-master. It is not appropriate to have time distribution specifications in this section as it should only specify the signal interface. 8.12.2 specifies that “only a single link interface shall manage the distribution of time”. This should be worded as it does not make sense if a router is used as the time master.	***PROPOSED DISPOSITION*** *Proposed change approved. Time-code distribution should be described only in one place. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
19	8.12.2 e		Remove	Already specified in 8.3 p, q, r, s.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
20	8.12.2 f	84	Remove.	This clause is actually not as clear as it seems. It specifies that a time-master entity shall not try to transmit a time-code unless it has first checked that the link interface in question is in the run-state. Nowhere is a requirement written that says that a transmitter shall only transmit time-codes in the run-state. Clauses 8.3 p,q, r and s have some requirements. 8.4.2 on page 60 also have some relevant text but it is descriptive. 8.5.2.7 a states what is actually needed as a requirement but only as a NOTE which is thus descriptive. The part in the NOTE should be made an explicit requirement and this clause (8.12.2 f) should be removed.	***PROPOSED DISPOSITION*** *Clarify that Time-codes can only be sent in the Run state. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
21	8.12.2 g	84	Replace with the following: When a Time-code is received on a node or router the following shall be done: 1. Compare the time-count value of the time-code with the local time-counter. 2. If the time-count value of the Time-code is one more modulo 64 than the current time-counter value the time-counter is updated and the updated value is transmitted on all link interfaces except the one it was received on. 3. If the time-count value of the Time-code is equal to the current time-counter value nothing is done. If the time-count value of the Time-code is neither one more modulo 64 nor equal to the time-counter value the time-counter should be updated with the received value.	Previously the information in this replacement clause was spread out into several other clauses. I specify why these clauses should be removed and replaced with this one in the removal change requests for those clauses. It should also be specified explicitly that the calculations are done modulo 64. It is also specified that the node or router should send the time-code to all the ports except the one it was received on. The node or router at the originating port should already be updated but this is not a necessary requirement since even if the time-code is transmitted on the originating port it will not be propagated. This requirement could therefore perhaps be removed to ease implementation. The downside is that an unnecessary time-code is transmitted.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
22	8.12.2 h	84	Remove	It is sufficient to state that it shall be checked that the time-count is one more than the time-counter value which is done in other clauses. This clause does not add any information.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
23	8.12.2 i	84	Remove in favour of new 8.12.2.g	As it is now it is not verifiable on its own since it specifies a situation when the procedure in the current 8.12.2 g does not apply.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
24	8.12.2 j	84	Remove in favour of new 8.12.2.g	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g. The relevant information from this clause is included in the new clause 8.12.2 g.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
25	8.12.2 k	84	Remove in favour of new 8.12.2.g	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
26	8.12.2 l	85	Remove in favour of new 8.12.2.g	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
27	8.12.2 n	85	Remove in favour of new 8.12.2.g	This clause specifies the circumstances under which a time-code or the time-counter is considered invalid. The next clause (o) specifies what shall be done if the time-code is considered invalid but it is left to the implementer to determine which of the two cases apply.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
28	8.12.2 o	85	Remove in favour of new 8.12.2.g	This clause is not individually verifiable. It violates the procedure specified in the current 8.12.2 g. The actual behavior has not been changed in the proposed 8.12.2 g but it could be argued that one change should be made. The current specification results in that after a time-code is lost it would take the number of additional time-code transmissions equal to the number of hops in the network until the complete network is synchronized again. This is probably not desirable. It is not good to leave this issue open for implementations to handle individually as it is currently.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Hiroki Hihara, Address: 10, Nisshin-cho 1-chome, Fuchu, Tokyo 183-8551, Japan

Organization: NEC TOSHIBA Space Systems, Ltd. / SpaceWire User's Group, Japan.

e-mail: h-hihara@bc.jp.nec.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-02-20

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
CR-E-ST-50-12C_01 SEQH-DG-T-10103-1	8.12.2 m	85	After reset or disconnect-reconnect (state machine in ErrroReset state) the time-counters in time master nodes and end nodes, excluding routers, shall be set to zero and any control-flag outputs shall be set to zero. (under-lined words are to be added for changes)	Time-Counter Since SpaceWire routers are connected to multiple nodes, its internal time-counter does not have to be initialized after reset or disconnect-reconnect occurs in one port. - The statement "After reset or disconnect□reconnect (state machine in ErrorReset state) the time□counter shall be set to zero and any control□flag outputs shall be set to zero." would not be suitable for router use. - Since a router accommodates several SpaceWire links, the internal counter, which is described as "the router's time- counter" in term k and l, should not be reset. In other words, one reset operation on a link should not have influence on other links.	The revised text shall express that the intention is not to reset time counters if a single SpW interface is reset but only if a whole device (node or router) is reset.
CR-E-ST-50-12C_02 SEQH-DG-T-10103-2	8.3e	58	Proposed addition is as follows on 8.3 e.; 3. Credit count in the transmitter and the receiver might be checked, or the flow control could be re-established within upper protocol layers.	FCT Due to some reasons, FCT transmission sometimes vanishes ("dead lock" in other words). One major cause of FCT disappearance is considered as the discrepancies of credit counters between an initiator and a target. - Transmission error is considered in current specification, whereas some specific case, in that the credit counter in sending end becomes less than the one in receiving end due to some reason, has to be considered. - Strictly speaking, a credit counter in a receiving end, which corresponds to 8.3.c is not specified explicitly.	*Proposed change discarded* Document the issue and possible workarounds into the SpaceWire Handbook.

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

1. Originator's name: Pinsard

Organization: CEA

e-mail: frederic.pinsard@cea.fr

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 19/02/2010

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
CR-E-ST-50-12C_03	7.7	54	i. high time-synchronisation resolution option: On the transmitter part: • When a high resolution synchronisation is needed a jitter-correction Time-Code could be sent just after the usual Time-Code that carries the six-bit time. • This jitter-correction Time-Code is built as follow: - the two control flags are set to One in order to avoid any confusion with any other use of the Time-Code - The Four lowest bits are equal to the number M of bits sent between the Tick-In signal assertion and the output on Dout of the first data-control flag bit of the Time-Code (ESC data-control flag bit) - The two left bits are reserved for future use and shall both be set to zero. On the receiver part: • A synchronisation signal shall be asserted after a number (64 minus M) of receiver bits from the arrival of the first data-control flag bit of the Time-Code (ESC data-control flag bit). See example below:	To improve the time synchronisation the following requirement could be added to the SpaceWire standard in section 7.7 time interface The implementation of this requirement is low resource consuming and will allow SpaceWire to be use were high accuracy synchronisation is needed (better than 10µs)	*Proposed change discarded for SpaceWire Revision.D but kept as input to SpaceWire 2*

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Jennifer Larsen

Organization: Aeroflex Colorado Springs

e-mail: Larsen@aeroflex.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 02/24/2010

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
	10.5.2	101	Request that the state in which the SpaceWire link interface should be in during the spilling of a packet be defined.	Assume a large packet is being spilled on a SpW port. What state should the link halt in? Section 10.5.2 states that if an error is detected by either the source or destination node that the packet will be “spilled” if the pack being spilled is quite large it could take some time to rid the link of the error packet. f. Then goes on to state “the link shall not restart after an error until some N-Chars are read...” it does not state the state the SpW link should be in while/after the packet is spilled. Should the link be in the ErrorWait state? Ready state and not send data until some N-Chars are received? (per section 8.5 figure 8-2)	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Francois Bonnet

Organization: CNES

e-mail: francois.bonnet@cnes.fr

2. ECSS Document number: ECSS-E-ST-50-12C (31 July 2010)

3. Date of CR: 3 March 2010

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
CR-E-ST-50-12C_04	4.3.2 Figure 4-1	26	Figure 4-1: LVDS signalling levels I think that the first scheme of this figure is wrong. Indeed, if the voltage across the input resistor of 100 Ohm is 350mV, then the voltage indicated on the right of the arrows are wrong. I think it is not +250mV +400mV typical but +125mV +200mV typical. There is a ratio 2 between both values.		***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#14 (same change requested)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date:

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
1	8.12.2 b	84	Replace with the following: At any moment in time there shall be only a single node or router, the time-master, managing the distribution of time. NOTE The node or router can use different link interfaces to transmit the time-codes. This allows for redundancy if a link is broken. NOTE It is a allowed to switch the time mastery between different nodes or routers.	It is neither suitable nor feasible to restrict the time-code source to be a single link-interface. As there shall be only one time-counter in a node or router they shall be considered the source of the time-codes not a specific link interface. Redundancy is a desired feature in a SpaceWire network and thus it should be allowed for different link interfaces on different nodes or routers to handle the distribution of time as long as they are designed on system level not to do it at the same time.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
2	8.12.2 c	84	Remove.	How a time-code is transmitted is clear from clause 7. This section should only specify how time is distributed that is how the time-counter is changed and how the value is propagated on a network.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
3	8.12.2 d	84	Replace with the following: To distribute time the time-master shall do the following: 1. The time-counter is incremented by one. 2. The control flags are set to zero. 3. A time-code is constructed from the new time-counter value and the control flags. The resulting time-code is transmitted on all link interfaces in the time-master.	Original description was not clear about where a time counter was located but indicated that one should be located in each link interface. This seems not to be what was actually intended from the beginning since other descriptive parts (8.4.2) of the standard indicate that when tick in is asserted then the time-code presented on a time-code input should be transmitted. This also seems to be in line with existing codec implementations such as the UoD codec. In my view the most reasonable thing to do is to entirely skip the talk of TICK_IN and similar signals in this section and only talk about what the clause title says that is: time distribution. It is specified how the time-	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date:

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
				counter is updated and to where the new time-count shall be sent. It should not specify how the time-code is transmitted. Clause 7 specifies a signal interface for time-codes. If one is present then a time-code should be transmitted as indicated there. Other implementations perhaps have the time distributer integrated in the link interface and does not need an external interface. Thus it is unnecessary to refer to specific signals here.	
4	8.12.2 e	84	Remove	Specified in 8.3 p, q, r, s.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-03-02

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
1	8.12.2 f	84	Remove.	This clause is actually not as clear as it seems. It specifies that a time-master entity shall not try to transmit a time-code unless it has first checked that the link interface in question is in the run-state. Nowhere is a requirement written that says that a transmitter shall only transmit time-codes in the run-state. Clauses 8.3 p,q, r and s have some requirements. 8.4.2 on page 60 also have some relevant text but it is descriptive. 8.5.2.7 a states what is actually needed as a requirement but only as a NOTE which is thus descriptive. The part in the NOTE should be made an explicit requirement and this clause (8.12.2 f) should be removed.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
2	8.12.2 g	84	Replace with the following: When a Time-code is received on a node or router the following shall be done: 4. Compare the time-count value of the time-code with the local time-counter. 5. If the time-count value of the Time-code is one more modulo 64 than the current time-counter value the time-counter is updated and the updated value is transmitted on all link interfaces except the one it was received on. 6. If the time-count value of the Time-code is equal to the current time-counter value nothing is done. 7. If the time-count value of the Time-code is neither one more modulo 64 nor equal to the time-counter value the time-counter should be updated with the received value.	Previously the information in this replacement clause was spread out into several other clauses. I specify why these clauses should be removed and replaced with this one in the removal change requests for those clauses. It should also be specified explicitly that the calculations are done modulo 64. It is also specified that the node or router should send the time-code to all the ports except the one it was received on. The node or router at the originating port should already be updated but this is not a necessary requirement since even if the time-code is transmitted on the originating port it will not be propagated. This requirement could therefore perhaps be removed to ease implementation. The downside is that an unnecessary time-code is transmitted.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-03-02

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
3	8.12.2 h	84	Remove.	It is sufficient to state that it shall be checked that the time-count is one more than the time-counter value which is done in other clauses. This clause does not add any information.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
4	8.12.2 i	84	Introduce information to 8.12.2 g as specified in other change request.	As it is now it is not verifiable on its own since it specifies a situation when the procedure in the current 8.12.2 g does not apply.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-03-02

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
1	8.12.2 j	84	Remove. Information contained in new 8.12.2 g.	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g. The relevant information from this clause is included in the new clause 8.12.2 g.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
2	8.12.2 k	84	Remove. Information contained in new 8.12.2 g	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
3	8.12.2 l	85	Remove. Information contained in new 8.12.2 g	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
4	8.12.2 m	85	After reset the time-counter shall be set to zero.	It is not feasible to reset the time-counter when each individual link enters error-reset. Then the whole time distribution will be disturbed just because one link had a disturbance. It should instead only be specified that the time-counter shall be zero after reset/startup. The control flags do not need to be specified here since only the count is relevant to the time-distribution.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#CR-E-ST-50-12C_01/SEQH-DG-T-10103-1 (time counter value after reset)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-03-03

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
1	8.12.2 n	85	Remove. Information is contained in new 8.12.2 g.	This clause specifies the circumstances under which a time-code or the time-counter is considered invalid. The next clause (o) specifies what shall be done if the time-code is considered invalid but it is left to the implementer to determine which of the two cases apply.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
2	8.12.2 o	85	Remove. Information is contained in new 8.12.2 g.	This clause is not individually verifiable. It violates the procedure specified in the current 8.12.2 g. The actual behaviour has not been changed in the proposed 8.12.2 g but it could be argued that one change should be made. The current specification results in that after a time-code is lost it would take the number of additional time-code transmissions equal to the number of hops in the network until the complete network is synchronized again. This is probably not desirable. It is not good to leave this issue open for implementations to handle individually as it is currently.	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
3	8.5.2.7 a	67	Make the NOTE a requirement instead. 8.5.2.7c The receiver is enabled. 8.5.2.7d The transmitter is enabled to send Time-codes, FCTs, N-Chars and NULLs.	It is not specified in a requirement anywhere in the standard that the transmitter should be enabled to transmit all four character in the run-state. This is only written in descriptive text (and in the state diagram figure which is only referenced from descriptive text).	***PROPOSED DISPOSITION*** *Proposed change approved. The change will be implemented as part of the disposition to CR#10 (Change state diagram).*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-07-01

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
1	10.2.3 i	97	Define larger or remove requirement completely.	This is not a requirement as larger is not defined which breaks the ECSS standardization rules.	*Remove clause 10.2.3i.*
2	7.7d	56	Should be removed	Specified in 8.12.2 since only one node or router is allowed to be time-master. It is not appropriate to have time distribution specifications in this section as it should only specify the signal interface.	***PROPOSED DISPOSITION*** *(same CR as CR#18)* *Proposed change approved. Time-code distribution should be described only in one place. The change will be implemented as part of the disposition to CR#7 (Clarify time-code distribution)*
3	7.2	52	Add specification in text that parity is sent first, then control bit and lastly data starting from the LSB	Currently it is only indicated in the figure with an arrow in what order the characters are transmitted. Only the data bit transmission order is explicitly specified in the text.	***PROPOSED DISPOSITION*** *(same CR as CR#15)* *Proposed change approved.*
4	7.3	53	An explicit requirement should refer to the figures as the definition of the characters. Also the transmission order of the bits should be explicitly stated.	Currently the figure is only referenced from a NOTE which is not according to ECSS standardization rules.	***PROPOSED DISPOSITION*** *(same CR as CR#16)* Add an explicit requirement defining the characters regardless of the figures. Add also an explicit requirement defining the transmission order of the bits.

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

ECSS Change Request / Document Improvement Proposal

1. Originator's name: Marko Isomäki

Organization: Aeroflex Gaisler

e-mail: marko@gaisler.com

2. ECSS Document number: ECSS-E-ST-50-12C

3. Date: 2010-07-01

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
1	7.4a	54	Remove	It is already specified for both data characters and control characters in clauses 7.2 and 7.3 where a parity bit should be included. This clause should only specify how it is used.	***PROPOSED DISPOSITION*** *(same CR as CR#17)* *Proposed change approved.*
2	7.6	55	The clause should specify everything without an explicit data width or require that everyone uses 8-bits+control bit. EEP and EOP could be specified with saying that the control bit is 1 and the lsb data bit is 0 (EOP) or 1 (EEP).	It seems unnecessary to have a lot of requirements for a specific implementation. It is better to write the requirement in general terms. Otherwise it should be specified that everyone MUST use 8-bit width.	***PROPOSED DISPOSITION*** Specify the use of 8-bits+control bit as Service Access Point to the SoW link interface; and that EEP and EOP are defined by the control bit set to 1 and the lsb data bit is 0 (EOP) or 1 (EEP); and add a note that recalls that an adaptation layer can be connected to this SAP to provide a higher level host interface. *The change will be implemented as part of the disposition to CR#13 (Specification of host interface)*

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

Annex 1: Change Requests collected from the SpaceWire Community

A.1 GENERAL

A.1.1 Structure of the document

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
0 [Süß]	Whole document	all	**Revisit the whole document** so that clauses contain only requirements and Notes do not contain any requirement **Remove ambiguities** raised by the SpW users (mainly the Working Group) **Introduce new backward compatible features** raised by the SpW users (mainly the Working Group)	Re-write the standard according to the new ECSS writing rules Ambiguities have lead to different implementations and difficult interoperability of unit/device vendors. These new features are considered necessary for the deployment of SpaceWire networks by the SpaceWire community.	
1 [Parkes ECSS-E-ST-50-12C changes.ppt slide 2]	Whole document	all	**Separate informative and normative material**		

A.1.2 Alignment with OSI model and general computer networks terminology

A.1.2.1 Clarify definition of “nodes”

A.1.2.2 Add routing capability to nodes

A.1.2.3 Protocol description formalism

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
2 [Jameux RC 1]	Whole docu ment	all	**Replace all references to routing and routers with switching and switches.**	SpW does not involve routing (OSI layer 3) but only switching (OSI layer 2).	
3 [Süß SpaceWire Nodes - June 2010]	3.2.46	19	**Change definition of node:** according to attached file "SpaceWire Nodes - ISC, Jun 2010, Süss.pdf"	Aligning the definition of nodes to the one of routers to clarify this definition, support PnP, and allow routing in nodes.	
4 [Seynin - SpaceWire Standard Evolution.Sheyn in.ppt slide 11]	3.2.46	19	**Clarify definition of node**	Many SpW nodes implementations have more than one link (for fault-tolerance, for throughput improvement, etc.). It isn’t covered in the standard, how the links and the node should operate (same/different LA, common/separate time-code register(s), etc.)	
11 [Ferrer - spw new version albert comments.ppt slide 14]	4.6	31	**Clarify Wormhole routing/switching:**	In literature the term Wormhole switching is widely used as a synonymous of wormhole routing. A reference to this other term could be included.	
94 [Süß - SpaceWire Standard Evolution - Nov.	10.3	100	**Add routing capability to nodes.**	Whether or not to include the optional routing function described under option C as part of the definition of the SpaceWire node has been controversially discussed during	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
2008]				previous SpaceWire working group meetings. For example the draft SpaceWire-PnP Protocol Definition [3] states that nodes are expected to have no routing function: "packets arriving at any port on a node will be consumed by the node." On the other hand there exist already some devices like the SMCS332SpW (AT7911E) which include such a routing function between the SpaceWire ports of the node. Similar, the Golden Gate ASIC developed by BAE [5], which can be used to connect up to four SpaceWire interfaces through a PCI bus to the host processor, also contains a routing function between the SpaceWire ports. There have been also a number of computer boards developed which make use of the SpW-10X router (AT7910E) to interface to the SpaceWire network. The SpW-10X provides two external ports that are effectively FIFO interfaces to inject and retrieve SpaceWire packets into and form the network. These examples make clear that nodes with integrated routing function are a concept which is actually widely used. During a discussion it was proposed that these cases could be regarded as a node being attached to a router. Conceptually this could establish again the clear distinction between the routing and the network access point function in the Space Wire network. But as this connection is part of a SpaceWire network there should be one or several	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
				SpaceWire links between the router and this node. This is certainly not the case in the examples provided above and the reason is that implementing such a very short SpaceWire link is inefficient when the connection has to be made on a board or even in a chip. In addition it would also require a duplication of the configuration port zero. Conceptually this may be even be welcome but it will result in additional implementation effort. More significantly this separation of the node and the router function would also require a duplication of the local time counter. One belonging to the router and one belonging to the node. If the router and the node are attached to each other this duplication does not make sense. Furthermore, the routing capability within a node allows useful network topologies as shown in Figure 2 (b). In some scenarios, a ring topology meets the requirements in terms of bandwidth and redundancy without requiring external routing devices. The topology shown in Figure 2 (a) requires more harness, the powering of more devices and links that may not provide any advantage when for instance a simple chain of sensors is considered. On the contrary, the extra devices increase the complexity of failure cases and error recovery mechanisms. SpaceWire should not be constrained to certain network topologies and exclude other	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				technologies which are widely used. Finally it needs to mentioned that the presented node definition does allow the implementation of simple nodes with only a single link, nodes with several links without routing or nodes with several links with routing only between certain links. All these cases are a possible subset of the wider definition.	
99 [Jameux RC 2]	Whole docu ment	all	**Improve description of each protocol "level" according to telecommunication and computer networks standards**	The ECSS-E-ST-50-12C Standard mixes for each protocol "level" the description of syntax, synchronisation, semantics; and it does not describe the Service Access Points. Advantage: Facilitates first understanding of the major features of SpaceWire Disadvantage: Increases the risk of ambiguities when it comes to details	

A.1.3 Streamlining references to other standards

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
5 [Gasti RC 1.1]	3.2.55	19	**Remove section**	The PECL technology is no more used in the manufacturing of LVDS receivers and transceivers.	
6 [Gasti RC 1.3]	4.1	24	**Remove "SpaceWire takes… those differences"** All reference and misleading clarifications to IEEE Standard 1355-1995 shall put in annex.	Section 1 providing the normative reference and section 4.3.2 related to SpW LVDS are referring to ANSI/TIA/EIA-644 and not IEEE	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				Standard 1355-1995.	
22 [Gasti RC 1.2]	5.3.1a	38	**Replace with:** The SpaceWire connectors shall be a nine contact micro-miniature D-type with solder contacts, as ESCC3401/071 or ESCC No. 3401/029 or crimp contacts ESCC reference shall be added for crimp contacts	ESA project are using ESCC No. 3401/029 02B9SFR113E Microminiature MDM Flying leads as there is no qualified nine contact micro-miniature D-type with solder contacts based on ESCC3401/071. Moreover, ESA preferred part list does not include a nine contact micro-miniature D-type with solder contacts based on ESCC3401/071.	

A.2 PHYSICAL LAYER DESCRIPTION REDUCED SPECIFICATION OF TO ELECTRICAL SIGNALS

A.2.1 Physical channel (cable assembly)

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
39 [Parkes ECSS-E-ST-50-12C changes.ppt slide 18]	6.6.4	46	**Change:** Define skew and jitter in terms of acceptable eye pattern at receiver		
40 DS - 23 sept. 10 15:36 in ECSS-E-ST-50-12C for SpW	6.6.4.1	47		EMC/EMI: The skew generates a comb of nearly constant emission lines from the frequency bit rate up to about 1GHz and then very	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
Evolutions internal review_JI_DSannoted.pdf				aggressive in term of EMI. This is particularly a problem when LVDS signals cover a long distance inside a unit. Low frequency bit rates are even more aggressive because of the increase of the frequency overlap with low-level signals.	
13 [Parkes ECSS-E-ST-50-12C changes.ppt slides 3-11]	5.2	33	**Change cable and cable assembly:** Remove inner shields - May be a cross-talk issue Connect inner shields together and to outer shield - Will reduce stiffness, size and weight - Will not degrade electrical performance Include drain wire Connect to pin 3 at both ends - Prevents “bulk-head” problem - Simplifies and improves grounding arrangement	Connect to ground at one end only Provides a ground reference for differential pair 100 Mbit/s signals 1 ns edges 1 GHz signals Inner shield effective for around 150 mm	
33 DS - 23 sept. 10 15:21 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSannoted.pdf	5.5.2. 1a	43		For transmitted bit rates much lower than 200Mb/sec, the LVDS frequency bandwidth can be limited using a pair of capacitive load at the transmitter output terminals. This method is particularly useful to reduce EMI on low-level signals within a unit.	

A.2.1.1 Cables

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
12 [Süß - SpaceWire Standard Evolution - Nov. 2008]	5.2	33	**Re-write paragraph:** specify not the construction but some physical and electrical parameters. These could comprise parameters like Differential Impedance, Signal Skew, Return Loss, Insertion Loss, Near-end Crosstalk (NEXT) and Far-end Crosstalk (FEXT)	The standard provides a very detailed and rigid specification on the construction of the cable. It specifies e.g. wire type and size of the conductors but also of the shield, filler, binder and jacket material. This kind of specification can be directly given to a cable manufacturer who can based on this produce a cable compliant to the standard, which is able to transmit the signal over a length of 10 m and support a data rate of 200 Mbps. The disadvantage is that this cable may be too heavy and rigid for some short connections and too lossy for distances beyond 10 m. Some different cable constructions have been proposed in the past.	
14 [Ilstad – comment p33 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI.pdf]	5.2	33		With regards to the SpaceWire Cable construction, a draft standardisation text for SpaceWire WG evaluation will be one of the outputs from the ongoing Low Mass SpaceWire cable activity. At present several alternative cable constructions are being evaluated in addition to alternative connectors for the cable assembly. As mentioned above in the comment, section 5.2 should rather specify electrical parameters than the cable construction itself to allow more freedom for different constructions to be applied according to user needs. The downside of this approach may be that a range of cables needs qualification which can be a costly and lengthy procedure. At present a one of the solutions that seems most appropriate is to remove the outer shield while terminating inner shields at both ends to chassis. Pin 3 is then left unconnected at both sides as the electronics inside a box is also grounded to chassis to	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				follow good EMC rules.	
15 [Nomachi - SpaceWire-modification_request.v1 - Masaharu Nomachi.ppt slide 2]	5.2.2.1a	34	**Remove.**	Thick signal wire such as 24 AWG is required for launch vehicle application.	
16 [Nomachi - SpaceWire-modification_request.v1 - Masaharu Nomachi.ppt slide 2]	5.2.1b	34	**Remove.**	Thick signal wire such as 24 AWG is required for launch vehicle application.	
17 [Ilstad – comment p36 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI.pdf]	5.2.4	36	This section should be considered removed.	If electrical performance parameters, including EMC/EMI levels, are specified that cables must adhere to, then cables can be constructed in various ways depending on length, data rate and slew rate of the driver or particular environmental requirements.	
18 DS - 23 sept. 10 14:38 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSannoted.pdf	5.2.4.8	37	Could be used for the shielding introduction then a. should talk about 4 individually screened twisted pairs.	Outer shield No more needed.	
19 DS - 23 sept. 10 14:39 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSan	5.2.4.11	37	To be removed.	Unjustified	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
noted.pdf					
20 [Parkes ECSS-E-ST-50-12C changes.ppt slides 12-14]	5.2.4.15	34	**Change:** Make cable signal skew specification much tighter E.g. Factor of 5 - 0.02 ns per m - 150 mm per ns - 3mm length difference per m of cable	Cable attenuation Include larger wire gauge cores for reduced attenuation i.e. have a least two different cables Larger, heavier long distance (20 m) E.g. 26 AWG Smaller, lighter short distance (5 m) E.g. 28 AWG or 30 AWG? Higher Speed SpaceWire 400 Mbits/s plus Principal limitation is connector impedance mismatch (and cable attenuation) Need connector with 100 ohm differential impedance up to 2 or 3 Gbps	

A.2.1.2 Connectors

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
21 [Süß - SpaceWire Standard Evolution - Nov. 2008]	5.3	38	**Insert:** [additional connector types should be included in the standard?]	A nine-pin micro-miniature D-type is specified as the SpaceWire connector. It is compact and available for space use. The differential impedance of the D-type connectors does not match the 100 Ω of the cables and the termination. Still in practice the distortion introduced by it is acceptable in most cases. Other connectors like a 4-way twinax connector [2][3][4] or circular 13 pin 38999 Series II connector [6] have been proposed	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				and investigated.	

A.2.1.3 New shielding and grounding schemes

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
23 DS - 23 sept. 10 14:42 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSan noted.pdf	5.3.4	39	Pin 3 is useless		
24 DS - 23 sept. 10 14:44 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSan noted.pdf	5.3.5	40	5.3.5 Individual shield connection Each twisted pair shield shall be connected to the connector backshell over 360°. The backshell shall be a fully closed metallic enclosure. The rest of this paragraph is unjustified and should be removed.		
25 [Ilstad – comment p40 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI.pdf]	5.3.5b &c	40	Both 5.3.5 b. and c. should be adapted depending on recommendation outcomes from the Low Mass SpaceWire activity.	Point c. is in not correctly specified. If a connection via resitor and capacitor is to be used, then it should be done at the opposite end of the inner shield connection (pin3). As it is written here it can be misunderstood that the connection from pin3 to inner shield should go via resistor and capacitor - a useless thing to do.	
26 [Süß - SpaceWire Standard	5.4	41	**Change:** [A connection of the inner shield on both sides with	The micro-miniature D-type connector has nine signal contacts. Eight are used for the 4	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
Evolution - Nov. 2008]			the possibility to implement a controlled capacitive decoupling on one side behind the plug could be investigated as a solution.]	twisted pair cables and one is used to terminate the inner shields at end of the cable from which the signals are being driven. The inner shields are isolated from one another. This feature can be useful to prevent loops in the grounding design and the symmetrical arrangement avoids the problem of having to know which end of the cable is which during installation. A problem occurs when the cable is broken into several parts due to bulk head connectors which are often used in larger structures. This leads to the situation that the inner shields on both sides of the bulkhead are not connected to the ground of either side.	
27 [Ilstad – comment p41 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI.pdf]	5.4	41	Final recommendation pending results from Low Mass SpaceWire activity.		
28 DS - 23 sept. 10 14:53 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSannoted.pdf	5.4.3	41	The whole paragraph should fit with the new implementation: - individual shielded twisted pairs - shields 360° terminated in the metallic backshell.		
29 DS - 23 sept. 10 14:57 in ECSS-E-ST-50-12C for SpW Evolutions	5.4.3d &e	41	d. Shields bonded via <10mΩ impedance connection e. Backshell to main body via <10mΩ impedance connection		

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
internal review_JI_DSannoted.pdf					
30 [Ilstad – comment p42 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI.pdf]	Figure 5-3	42	Inner shield grounding scheme is due for revision. Recommendations pending results from Low Mass SpaceWire activity.		
31 DS - 23 sept. 10 15:01 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSannoted.pdf	Figure 5-3	42	To be redrawn	- no more ground pin - shields connected to the main body via a backshell free of aperture.	

A.2.2 Backplanes

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
32 [Süß - SpaceWire Standard Evolution - Nov. 2008]	5.5	43	**Insert:** [Add requirements on backplane connectors or backplane construction.]	SpaceWire links are often used within a unit or electronic box. The current SpaceWire standard contains some requirements on PCB and backplane tracking but no requirements on backplane connectors or backplane construction.	

A.3 CHARACTER LEVEL (PHYSICAL LAYER) - DATA RATE

A.3.1 Minimum data rate

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
36 [Parkes ECSS-E-ST-50-12C changes.ppt slide 16]	6.6.1	46	**Change:** Increase minimum data rate to 4 Mbits/s Allows time for both ends to respond to speed change Possible extension to low data rate start-up E.g. 1 Mbits/s or 2 Mbit/s Required modification to state machine time-out times		

A.3.2 Starting data rate

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
41 [Seynin - SpaceWire Standard Evolution.Sheynin.ppt slide 6]	6.6.5	47	**Change:** We restart a link at its regular rate at once.	When the link is running at regular rate of hundreds of Mb/s, to restart the link starting at 10 Mb/s after every detected error and then moving to the regular for this link rate causes unreasonable delays, gaps in information flow.	

A.3.3 Maximum data rate

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
37 [Parkes ECSS-E-ST-50-12C changes.ppt slide 17]	6.6.2	46	**Change:** Define maximum data rate to be 200 Mbits/s using existing specified cables and connectors		

A.3.4 Data rate negotiation

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
38 [Seynin - SpaceWire Standard Evolution.Sheynin.ppt slide 6]	6.6.3	46	**Change:** Introduce two-side procedure to agree on rates.	duplex link rate matching procedure by negotiation and/or by sequence of attempts is required.SpaceWire is a standard with smooth, continuous rates scale and lack of a two-side procedure to agree on rates looks as a flaw in the standard	

A.4 UPDATE BEHAVIOUR OF NODES/TERMINALS

A.4.1 Add configuration port in nodes

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
95 [Süß - SpaceWire Standard Evolution - Nov. 2008]	10.3	100	**Add configuration port in nodes.**	Every SpaceWire routing switch has one internal configuration port with address zero. It can be used to configure the routing switch and to obtain status information. This is an important feature for network discovery and PnP. It showed to be a problem that this port zero is only present in routing switches and not in nodes. The update of the definition will align the SpaceWire Node addressing with the SpaceWire Routing Switch addressing. An internal configuration port with address 0 will be introduced for nodes but normal SpaceWire packets starting with a logical address (32 – 254) will be passed to the next layer as before. With the described modification, the concept of node is tied to a single configuration port which can be accessed from all SpaceWire links which belong to this node. In this port zero configuration space, among others, information about all links belonging to the node can be found. […] The processing of a SpaceWire packet by a node following this definition is shown in Figure 1. The packet may have some leading bytes containing a path address. As specified in [2] this is followed by the logical address and the PID bytes and the payload of the packet. The node will start by analysing the first byte of the packet. A. If the leading byte is a zero the packet will be routed to the configuration port for processing. The second byte would be expected to be one valid logical address of	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				the node or the default logical address 254. The later is especially the case if a node is to be discovered and the logical address is not yet known by the sending node. The following handling of packet will be made in accordance with the Protocol Identifier (PID), which could for example indicate that it is a RMAP packet, a PnP packet or any other protocol supported by the node. It is important for network discovery that the node remembers the SpaceWire link through which it received the packet addressing the configuration port so that any reply to an interrogation packet is returned through the same link of the node. B. If the leading byte corresponds to one of the Logical Addresses (LA) of the node the packet is forwarded to the host system. The PID and the rest of the packet may be analysed by hardware or software and may then be provided to the application level software for further processing.	

A.4.2 Nodes shall discard packets with unexpected destination address

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
98 [Parkes ECSS-E-ST-50-12C changes.ppt slide 21]	10.5.4 .3	103	**Change** [Packet with unexpected destination address shall be discarded] **with** [Packet with unexpected destination address can be discarded]	Conflict with RMAP which responds to invalid addresses	
100 [Jameux RC 3]	10.5.4 .3.a	103	**Remove**	A requirement cannot be based on the criteria "a packet arrives at a node with an unexpected destination address" since "unexpected destination address" is not defined for a node.	

A.4.3 Add routing capability to nodes

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
94 [Süß - SpaceWire Standard Evolution - Nov. 2008]	10.3	100	**Add routing capability to nodes.**	Whether or not to include the optional routing function described under option C as part of the definition of the SpaceWire node has been controversially discussed during previous SpaceWire working group meetings. For example the draft SpaceWire-PnP Protocol Definition [3] states that nodes are expected to have no routing function: "packets arriving at any port on a node will be consumed by the node." On the other hand there exist already some devices like the SMCS332SpW (AT7911E) which include such a routing	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
				function between the SpaceWire ports of the node. Similar, the Golden Gate ASIC developed by BAE [5], which can be used to connect up to four SpaceWire interfaces through a PCI bus to the host processor, also contains a routing function between the SpaceWire ports. There have been also a number of computer boards developed which make use of the SpW-10X router (AT7910E) to interface to the SpaceWire network. The SpW-10X provides two external ports that are effectively FIFO interfaces to inject and retrieve SpaceWire packets into and form the network. These examples make clear that nodes with integrated routing function are a concept which is actually widely used. During a discussion it was proposed that these cases could be regarded as a node being attached to a router. Conceptually this could establish again the clear distinction between the routing and the network access point function in the Space Wire network. But as this connection is part of a SpaceWire network there should be one or several SpaceWire links between the router and this node. This is certainly not the case in the examples provided above and the reason is that implementing such a very short SpaceWire link is inefficient when the connection has to be made on a board or even in a chip. In addition it would also require a duplication of the configuration port zero.	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
				Conceptually this may be even be welcome but it will result in additional implementation effort. More significantly this separation of the node and the router function would also require a duplication of the local time counter. One belonging to the router and one belonging to the node. If the router and the node are attached to each other this duplication does not make sense. Furthermore, the routing capability within a node allows useful network topologies as shown in Figure 2 (b). In some scenarios, a ring topology meets the requirements in terms of bandwidth and redundancy without requiring external routing devices. The topology shown in Figure 2 (a) requires more harness, the powering of more devices and links that may not provide any advantage when for instance a simple chain of sensors is considered. On the contrary, the extra devices increase the complexity of failure cases and error recovery mechanisms. SpaceWire should not be constrained to certain network topologies and exclude other technologies which are widely used. Finally it needs to mentioned that the presented node definition does allow the implementation of simple nodes with only a single link, nodes with several links without routing or nodes with several links with routing only between certain links. All these cases are a possible subset of the wider definition.	

A.5 TIME-CODE MASTER: ONE OR MORE?

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
44 [Süß SpaceWire Nodes - June 2010]	7.3	52	**Change:** [support multi Time-Code master]	Only one node in a SpaceWire network should provide the active TICK_IN signal which triggers the broadcast of the Time-Codes. This is to avoid collisions of Time-Codes within the network. For fail safety and redundancy reasons it can be useful to have simultaneous Time-Codes from different time masters in a system. This could be implemented by using the two remaining reserved states of the control flags.	
45 [Parkes ECSS-E-ST-50-12C changes.ppt slide 19]	7.3	53	**Change:** Remove (c) note 2 and part of (d)	SpW-WG reserved time-codes NASA use multiple time-codes Both violate the existing standard	
69 [Isomaki RC1.1]	8.12.2 b	84	**Replace with the following:** At any moment in time there shall be only a single node or router, the time-master, managing the distribution of time. NOTE The node or router can use different link interfaces to transmit the time-codes. This allows for redundancy if a link is broken. NOTE It is a allowed to switch the time mastery between different nodes or routers.	It is neither suitable nor feasible to restrict the time-code source to be a single link-interface. As there shall be only one time-counter in a node or router they shall be considered the source of the time-codes not a specific link interface. Redundancy is a desired feature in a SpaceWire network and thus it should be allowed for different link interfaces on different nodes or routers to handle the distribution of time as long as they are designed on system level not to do it at the same time.	

A.6 INTRODUCTION OF BACKWARD COMPATIBLE SIGNALLING CODES

A.6.1 Backward compatibility with Time-codes

A.6.2 Interrups+ACK scheme

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
86 [Sheynin Distributed Interrupts in SpaceWire Networks - Dec 2006]	8.12.2	86	**Insert:** [attached file 8.13 Interrupts distribution (normative).pdf]	Introduction of Distributed Interrupts	
48 [Sheynin Distributed Interrupts in SpaceWire Networks - Dec 2006]	Figure 7-2	53	**Replace figure with the one attached here.**	Introduction of Distributed Interrupts	
51 [Sheynin Distributed Interrupts in SpaceWire Networks - Dec 2006]	7.3c	53	**Replace with:** The other three control codes (Time-Code, Interrupt-Code and Interrupt_Acknowledge-Code) shall be formed from ESC followed by a single data character.	Introduction of Distributed Interrupts	
52 [Sheynin Distributed Interrupts in SpaceWire Networks - Dec 2006]	7.3c	53	**Insert:** NOTE 3. The Interrupt-Code and Interrupt_Acknowledge-Code are used to distribute real-time interrupt signals from nodes that are sources of	Introduction of Distributed Interrupts	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
			interrupts to nodes that can do interrupt processing procedures (see subclause 8.13). Interrupt/ Interrupt_Acknowledge-codes can eliminate system-wide sideband signals for low latency control signals distribution.		
53 [Sheynin Distributed Interrupts in SpaceWire Networks - Dec 2006]	7.3d	53	**Replace with:** (C6=0, C7=0)	Introduction of Distributed Interrupts	
54 [Sheynin Distributed Interrupts in SpaceWire Networks - Dec 2006]	7.3e	53	**Insert:** Five bits of interrupt information shall be held in the least significant five bits of the Interrupt-Code (I0-I4) and the three most significant bits (C5=0. C6=0, C7=1) shall contain control flags that are distributed isochronously with the Interrupt-Code. NOTE The Interrupt-Code is used to distribute interrupt request information and control flags (C5=0, C6=0, C7=1) isochronous with the Interrupt-Code distribution.	Introduction of Distributed Interrupts	
55 [Sheynin Distributed Interrupts in	53		**Insert:** Five bits of interrupt acknowledge	Introduction of Distributed Interrupts	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
SpaceWire Networks - Dec 2006]			information shall be held in the least significant five bits of the Interrupt_Acknowledge-Code (I0-I4) and the three most significant bits (C5=1, C6=0, C7=1) shall contain control flags that are distributed isochronously with the Interrupt_Acknowledge-Code. NOTE The Interrupt_Acknowledge-Code is used to distribute interrupt acknowledge information and control flags (C5=1, C6=0, C7=1) isochronous with the Interrupt_Acknowledge-Code distribution.		

A.6.3 Multi-purpose signalling scheme (allowing time codes and interrupts and more)

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
46 [Ferrer - spw new version albert comments.ppt slide 8]	7.3	52	**Redefine Time-Codes:** Proposal to define Time-Codes as a type of ESC+Data character sequence. This special sequence can be called "escape data characters" or "signalling codes" or "escape codes".	Current definition states: "The Time-Code is used to distribute system time information and control flags isochronous with the time-code distribution." If Time-Codes are going to be used for other purposes the definition must be changed. Escape codes are very important because	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
				they can bypass the flow control mechanism. - In case of packet blocking they can still be sent They have minimum latency and jitter. They can contain minimum information They are limited - If possible, some values should be reserved for future SpW development If possible, same control code should imply same behaviour. Mandatory functions of theses codes should be very simple to implement in hardware.	
47 [Ferrer - spw new version albert comments.ppt slides 11, 19 and 20]	7.3	52	Restrict 64-bit Time-code scheme to <T6,T7>=<0,0> and use the other three combinations to implement Signalling codes, a number of them maybe dedicated to time distribution, others to interrupt distribution, etc.	Point 1. The current Time-Code scheme does not provide the possibility to 'instantly' distribute any form of absolute time across the SpaceWire network (because the "time information value" is limited to 64 values). It provides 'instant signalling' (with some latency that can be negligible for low time-accuracy applications and bounded for high time-accuracy applications) of: - a state (provided by one of the 64 possible "time information" values, usually value 0) - an incremental tick (the fact that the value is incremented with 1) Any implementation that is trying to use the value of the Time-code to provide time information will be always limited (e.g. the epoch of a scheduled communication cycle will have to be 64 although the control loop might require any number of communications within a loop; the epoch will have to be very short (in the order of tens of microseconds) in order to allow frequent time synchronisation	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				points, although control loops vary from 1microsecond for advanced robotics to 100ms or 125ms for spacecraft control); and physical values such as 100ms are not easily divided by 64) and therefore very application specific. Point 2. From the point of view of the information theory, this information can be coded on 2 bits: state and tick (e.g. the reset state is <0x> where x is either 0 or 1 depending on its previous value; and any following tick is <1x> where x is either 0 or 1 depending on its previous value; in other word, a time-code is in fact <b1, b2> where b1 is 0 in case of state reset and 1 in tick increment mode; and b2 is always flipping to indicate a new time-code) Point 3. The 'instant signalling' of state+tick can be used to distribute time-codes but also interrupts or any kind of low-latency signal Given these three points, and keeping the ESC+data character scheme, we could define not "Time-codes" but "Signalling codes". As explained above, each Signalling code requires 2 bits. This leaves 6 bits that allow defining 64 Signalling codes. A number of them can be used as time codes (allowing by the way the distribution of more than one time scheme; e.g. a 50us time scheme as well as a 1ms time scheme and a 125ms time scheme). A number of them can be dedicated to interrupt distribution (with no acknowledgement since this kind of signalling	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				usually does not require any; or Signalling code <N,s,f> (where N is the 6-bit Signalling code label while s is the state bit and f is the flipping bit) can be the interrupt and Signalling code <N+1, s,f> can be the interrupt acknowledgement if the latter is really required). The only problem of this Signalling code scheme is that it is not backward compatibility with SpaceWire 1.0. But, if we consider that, in practice, all existing implementations of SpaceWire Time-codes are using <00> as the two most significant bits ("control flags" T6 and T7), we can keep this and implement the Signalling code concept with <01>, <10> and <11> as only possible values for T6 and T7. This leaves 2^4*3=48 possible Signalling codes.	
49 [Ferrer - spw new version albert comments.ppt slide 11]	Figure 7-2	53	**Requirements on the introduction of side-band interrupt signalling based on control codes:** Proposed interrupt codes use Escape+data characters to broadcast a value to the network. Two problems must be solved 1. Avoid a spurious value to be broadcasted 2. Avoid infinite transmission due to loops Timeout requires configuration and a counter in the routers for each possible value . Proposal: A different control codes (or any other bit change) must be received each time to enable the value to be broadcasted. (requires 64 bits per port) Interrupts distribution could be designed so that its implementation supports other uses. (rename to signalling codes)		

A.7 INTRODUCE BROADCAST/MULTICAST

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
93 [Seynin - SpaceWire Standard Evolution.Seynin.ppt slide 12]	10.2.7	99	**Insert** Broadcast/multicast modes in SpaceWire interconnections	In the standard it is limited to router-to-node.It can be extended for router-to-router for some interconnection topologies, (e.g. tree) and accurate routing tables writing	

A.8 INTRODUCTION OF SIMPLEX AND/OR HALF-DUPLEX

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
61 [Süß - SpaceWire Standard Evolution - Nov. 2008]	8	57	**Add simplex and/or half-duplex mode.**	For many high speed payload data applications only a simplex connection from the instrument to the memory is required. In these cases the back channel provided by SpaceWire is often seen as unnecessary complexity and cable mass. It has been proposed to modify the SpaceWire codec and the state machine to support simplex operation [11], [12]. Also the possibility of a half-duplex SpaceWire implementation has been suggested [13]. It remains to be investigated what consequences these changes will have for the backwards compatibility of SpaceWire and if they should be included in the update of the standard.	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
62 [Seynin - SpaceWire Standard Evolution.Sheynin.ppt slide 11]	8	57	**Add** simplex SpaceWire	Using two new signals – tx_simplex_enabled and rx_simplex_enabled two types of the simplex mode link operation – transmitting simplex or receiving simplex. Transmitting:transmitter sends data for N*12,8 microseconds. Reconnecting:transmitter goes to Connecting State and sends only NULL symbols on the frequency 10MHz for 12,8*K microseconds.	

A.9 MISCELLANEOUS

A.9.1 Virtual channels

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
87 [Parkes ECSS-E-ST-50-12C changes.ppt slide 22]	Figure 10-3	93	**Remove "virtual channel"**	Remove all text related to virtual channels	
88 [Parkes ECSS-E-ST-50-12C changes.ppt slide 22]	10.1.2 .8	93	**Remove section**	Remove all text related to virtual channels	
97 [Parkes ECSS-E-ST-50-12C	10.5.4 .3 NOTE	103	**Remove section**	Remove all text related to virtual channels	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
changes.ppt slide 22]	1				

A.9.2 High time-synchronisation resolution option

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
60 [Pinsard - CR1.1]	7.7h	56	**Insert:** i. high time-synchronisation resolution option: On the transmitter part: · When a high resolution synchronisation is needed a jitter-correction Time-Code could be sent just after the usual Time-Code that carries the six-bit time. · This jitter-correction Time-Code is built as follow: - the two control flags are set to One in order to avoid any confusion with any other use of the Time-Code - The Four lowest bits are equal to the number M of bits sent between the Tick-In signal assertion and the output on Dout of the first data-control flag bit of the Time-Code (ESC data-control flag bit) - The two left bits are reserved for future use and shall both be set to zero. On the receiver part: · A synchronisation signal shall be	To improve the time synchronisation the following requirement could be added to the SpaceWire standard in section 7.7 time interface The implementation of this requirement is low resource consuming and will allow SpaceWire to be use were high accuracy synchronisation is needed (better than 10µs).	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
			asserted after a number (64 minus M) of receiver bits from the arrival of the first data-control flag bit of the Time-Code (ESC data-control flag bit). See example in attached file "high time-synchronisation resolution option - example.pdf"		

A.9.3 Increase error detection capability at character level

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
56 [Ferrer - spw new version albert comments.ppt slides 4-6]	8.5.1	64	**Add other error types** In Figure 8.2 ("RxErr = Disconnect error OR Parity error OR Escape error (ESC followed by EOP or EEP or ESC).")	Parity bit covers SpW character. It can detect a change on a single bit But errors can be produced by - Unexpected jitter, noise or interferences - Simultaneous Data/Strobe transitions may occur - One or more bits may be added Parity error may not detect these errors. Up to now, the behaviour depends on SpW Codec implementation. The standard should push implementers to detect as many types of error as possible and to disconnect for each of them. A Bit Error Rate (BER) of 10exp(12) implies an error every 2.78 hours in a single 100Mbit/s link. (GOES-R NASA project)	

A.9.4 Requirement on Regional Addressing

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
92 [Isomaki RC5.1]	10.2.3 i	97	**Define larger or remove requirement completely.**	This is not a requirement as larger is not defined which breaks the ECSS standardization rules.	

A.9.5 Update state machine

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
65 [Süß - SpaceWire Standard Evolution - Nov. 2008]	8.5	63	**Change state diagram.**	During the implementation of the SpaceWire codec some inconsistencies in the transitions described in the state diagram have been identified [10]. a) The transition from Started to ErrorReset is impossible when gotNULL condition is set. b) The transition from Connecting to Run shall be applied only after sending FCT to channel. These inconsistencies will have to be corrected by making some slight modifications of the standard text and state diagrams.	
66 [Seynin - SpaceWire Standard Evolution.Seynin.ppt slide 10]	8.5	63	**Add requirement** "always to send FCT before going to the RUN state"	An only sending node can never set a connection	
67 [Isomaki RC4.3]	8.5.2.7a		**Make the NOTE a requirement instead:** 8.5.2.7c The receiver is enabled. 8.5.2.7d The transmitter is enabled to send Time-codes,	It is not specified in a requirement anywhere in the standard that the transmitter should be enabled to transmit all four character in the run-state. This is	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
	NOTE		FCTs, N-Chars and NULLs.	only written in descriptive text (and in the state diagram figure which is only referenced from descriptive text).	

A.9.6 After “reset” the time-counter shall be set to zero

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
80 [Isomaki RC3.4]	8.12.2 m	85	**Replace with the following:** After reset the time-counter shall be set to zero.	It is not feasible to reset the time-counter when each individual link enters error-reset. Then the whole time distribution will be disturbed just because one link had a disturbance. It should instead only be specified that the time-counter shall be zero after reset/startup. The control flags do not need to be specified here since only the count is relevant to the time-distribution.	
81 [Parkes ECSS-E-ST-50-12C changes.ppt slide 20]	8.12.2 m	85	**Replace with the following:** After reset the time-counter shall be set to zero.	This is incorrect and stops time-codes working briefly after a link disconnect.	
82 [Hihara RC1.1]	8.12.2 .m		After reset or disconnect-reconnect (state machine in ErrroReset state) the time-counters in time master nodes and end nodes, excluding routers, shall be set to zero and any control-flag outputs shall be set to zero.	Since SpaceWire routers are connected to multiple nodes, its internal time-counter does not have to be initialized after reset or disconnect-reconnect occurs in one port. - The statement “After reset or disconnect- reconnect (state machine in ErrorReset state) the time- counter shall be set to	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				zero and any control- flag outputs shall be set to zero." would not be suitable for router use. - Since a router accommodates several SpaceWire links, the internal counter, which is described as "the router's time- counter" in term k and l, should not be reset. In other words, one reset operation on a link should not have influence on other links.	
83 [Nomachi - SpaceWire-modification_request.v1 - Masaharu Nomachi.ppt slide 2]	8.12.2 m	85	**Change:** [This specification would be applied for time master node only.This specification would be applied for end nodes (reserved counters in receivers), excluding non-time master routers.]	The statement "After reset or disconnect- reconnect (state machine in ErrorReset state) the time- counter shall be set to zero and any control- flag outputs shall be set to zero." would not be suitable for router use. Since a router accommodates several SpaceWire link, the internal counter, which is described as "the router's time- counter" in term k and l, should not be reset. In other words, one reset operation on a link should not have influence on other links.	

A.9.7 Switching arbitration algorithm

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
89 [Ferrer - spw new version	10.1.2 .9.6	96	**Inconsistency:** last paragraph of section 10.1.2.9.6:		

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
albert comments.ppt slide 11]			"In the event of several packets competing for a set of links, subclause 10.2.5 specifies the means of arbitration when an output port becomes available, giving access to the newly freed output port to the packet with the highest priority destination address" Section 10.2.5 "SpaceWire routing switches shall provide a means of arbitrating between input ports requesting the same output port." -> Does not oblige the use of a specific arbitration algorithm		

A.9.8 Router timeout

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
90 [Süß - SpaceWire Standard Evolution - Nov. 2008]	10.2	96	**Add router timeout.**	If a router stops receiving data due to an internal failure the packet is stuck and can block some paths in the network. It is difficult to detect and recover this situation from outside the routers. An effective method to recover from this failure condition is to introduce a timeout inside the routing switches which removes the stuck packet from the link after a certain period of time.	
91 [Parkes ECSS-E-ST-50-12C changes.ppt slide 23]	10.2	96	**Add:** [Add router time-out requirements]		

A.9.9 State of the link interface during the spilling of a packet

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
96 [Larsen RC1.1]	10.5.2	101	**Request** that the state in which the SpaceWire link interface should be in during the spilling of a packet be defined.	Assume a large packet is being spilled on a SpW port. What state should the link halt in? Section 10.5.2 states that if an error is detected by either the source or destination node that the packet will be "spilled" if the pack being spilled is quite large it could take some time to rid the link of the error packet. f. Then goes on to state "the link shall not restart after an error until some N-Chars are read..." it does not state the state the SpW link should be in while/after the packet is spilled. Should the link be in the ErrorWait state? Ready state and not send data until some N-Chars are received? (per section 8.5 figure 8-2).	

A.9.10 Over specification of host interface

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
58 [Isomaki RC6.2]	7.6	55	**The clause should specify everything** without an explicit data width or require that everyone uses 8-bits+control bit. EEP and EOP could be specified with saying that the control bit is 1 and the lsb data bit is 0 (EOP) or 1 (EEP).	It seems unnecessary to have a lot of requirements for a specific implementation. It is better to write the requirement in general terms. Otherwise it should be specified that everyone MUST use 8-bit width.	
70 [Isomaki RC1.2]	8.12.2 c	84	**Remove**	How a time-code is transmitted is clear from clause 7. This section should only specify how time is distributed that is how the time-counter is changed and how the value is propagated on a network.	
71 [Isomaki	8.12.2	84	**Replace with the following:** To distribute time the time-master shall do the following:	Original description was not clear about where a time counter was located but indicated that one	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
RC1.3]	d		1. The time-counter is incremented by one. 2. The control flags are set to zero. 3. A time-code is constructed from the new time-counter value and the control flags. The resulting time-code is transmitted on all link interfaces in the time-master.	should be located in each link interface. This seems not to be what was actually intended from the beginning since other descriptive parts (8.4.2) of the standard indicate that when tick in is asserted then the time-code presented on a time-code input should be transmitted. This also seems to be in line with existing codec implementations such as the UoD codec. In my view the most reasonable thing to do is to entirely skip the talk of TICK_IN and similar signals in this section and only talk about what the clause title says that is: time distribution. It is specified how the time-counter is updated and to where the new time-count shall be sent. It should not specify how the time-code is transmitted. Clause 7 specifies a signal interface for time-codes. If one is present then a time-code should be transmitted as indicated there. Other implementations perhaps have the time distributer integrated in the link interface and does not need an external interface. Thus it is unnecessary to refer to specific signals here.	

A.9.11 Credit count error protection

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
63 [Hihara RC1.2]	8.3e2	58	**Insert:** 3. Credit count in the transmitter and the receiver might be checked, or the flow control could be re-established within upper protocol layers.	Due to some reasons, FCT transmission sometimes vanishes(“dead lock” in other words). One major cause of FCT disappearance is considered as the discrepancies of credit counters between an initiator and a target. - Transmission error is considered in current specification, whereas some specific case, in that	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
				the credit counter in sending end becomes less than the one in receiving end due to some reason, has to be considered. - Strictly speaking, a credit counter in a receiving end, which corresponds to 8.3.c is not specified explicitly.	
64 [Nomachi - SpaceWire-modification_request.v1 - Masaharu Nomachi.ppt slide 4]	8.3e2	58	**Change:** [Is additional state transition required for continuous SpaceWire communication ?]	Many people experience the state in which FCT transmission vanishes when some error occurs.	

A.10 EDITORIAL COMMENTS

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
8 [Bonnet RC1.1]	Figure 4-1	26	**Correct figure** [voltage values are wrong]	Indeed, if the voltage across the input resistor of 100 Ohm is 350mV, then the voltage indicated on the right of the arrows are wrong. I think it is not +250mV +400mV typical but +125mV +200mV typical. There is a ratio 2 between both values.	
9 [Ilstad – comment p26 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI.pdf]	Figure 4-1	26	**Do NOT correct figure**	Actually this figure is correct and in line with EIA/TIA-644 specification. The figure indicates the minimum voltage threshold a receiver must adhere to to change state. if the differential signal is less than +/- 100mV then behaviour of the receiver is not guaranteed.	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
42 [Ferrer - spw new version albert comments.ppt slide 3]	Figure 6-2	48	**Replace figure with the one attached here.**		
43 [Isomaki RC5.3]	7.2	52	**Add specification in text** that parity is sent first, then control bit and lastly data starting from the LSB	Currently it is only indicated in the figure with an arrow in what order the characters are transmitted. Only the data bit transmission order is explicitly specified in the text.	
50 [Isomaki RC5.4]	Figure 7-2	53	**An explicit requirement should refer to the figures** as the definition of the characters. Also the transmission order of the bits should be explicitly stated.	Currently the figure is only referenced from a NOTE which is not according to ECSS standardization rules.	
57 [Isomaki RC6.1]	7.4a	54	**Remove.**	It is already specified for both data characters and control characters in clauses 7.2 and 7.3 where a parity bit should be included. This clause should only specify how it is used.	
59 [Isomaki RC5.2]	7.7d	56	**Remove**	Specified in 8.12.2 since only one node or router is allowed to be time-master. It is not appropriate to have time distribution specifications in this section as it should only specify the signal interface.	
68 [Nomachi - SpaceWire-modification_request.v1 - Masaharu Nomachi.ppt slide 2]	8.11.2		**Change:** [The definition for duration (727-1000ns) should be clarified..]	[see also figure attached]	
72 [Isomaki RC1.4]	8.12.2 e		**Remove**	Specified in 8.3 m, n.	
73 [Isomaki RC2.1]	8.12.2 f	84	**Remove**	This clause is actually not as clear as it seems. It specifies that a time-master entity shall not try to transmit a time-code unless it has first checked that the link interface in question is in the run-state. Nowhere is a requirement written that says that a transmitter shall only transmit time-codes in	

Dispositions:
Accept and implement the change as proposed
Refer the proposed change to the TA for disposition
Refine the proposed change for implementation (incl. justification)
Reject the proposed change (incl. justification for rejection

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				the run-state. Clauses 8.3 p,q, r and s have some requirements. 8.4.2 on page 60 also have some relevant text but it is descriptive. 8.5.2.7 a states what is actually needed as a requirement but only as a NOTE which is thus descriptive. The part in the NOTE should be made an explicit requirement and this clause (8.12.2 f) should be removed.	
74 [Isomaki RC2.2]	8.12.2 g84		**Replace with the following:** When a Time-code is received on a node or router the following shall be done: 1. Compare the time-count value of the time-code with the local time-counter. 2. If the time-count value of the Time-code is one more modulo 64 than the current time-counter value the time-counter is updated and the updated value is transmitted on all link interfaces except the one it was received on. 3. If the time-count value of the Time-code is equal to the current time-counter value nothing is done. If the time-count value of the Time-code is neither one more modulo 64 nor equal to the time-counter value the time-counter should be updated with the received value.	Previously the information in this replacement clause was spread out into several other clauses. I specify why these clauses should be removed and replaced with this one in the removal change requests for those clauses. It should also be specified explicitly that the calculations are done modulo 64. It is also specified that the node or router should send the time-code to all the ports except the one it was received on. The node or router at the originating port should already be updated but this is not a necessary requirement since even if the time-code is transmitted on the originating port it will not be propagated. This requirement could therefore perhaps be removed to ease implementation. The downside is that an unnecessary time-code is transmitted.	
75 [Isomaki RC2.3]	8.12.2 h	84	**Remove**	It is sufficient to state that it shall be checked that the time-count is one more than the time-counter value which is done in other clauses. This clause does not add any information.	
76 [Isomaki RC2.4]	8.12.2 i	84	**Remove in favour of new 8.12.2.g**	As it is now it is not verifiable on its own since it specifies a situation when the procedure in the current 8.12.2 g does not apply.	
77 [Isomaki RC3.2]	8.12.2 j	84	**Remove in favour of new 8.12.2.g**	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g. The relevant information from this clause is included in the new clause 8.12.2 g.	
78 [Isomaki RC3.2]	8.12.2 k	84	**Remove in favour of new 8.12.2.g**	This clause is not individually verifiable since it violates the procedure specified in the current	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
				8.12.2 g.	
79 [Isomaki RC3.3]	8.12.2 l	85	**Remove in favour of new 8.12.2.g**	This clause is not individually verifiable since it violates the procedure specified in the current 8.12.2 g.	
84 [Isomaki RC4.2]	8.12.2 n	85	**Remove in favour of new 8.12.2.g**	This clause specifies the circumstances under which a time-code or the time-counter is considered invalid. The next clause (o) specifies what shall be done if the time-code is considered invalid but it is left to the implementer to determine which of the two cases apply.	
85 [Isomaki RC4.2]	8.12.2 o	85	**Remove in favour of new 8.12.2.g**	This clause is not individually verifiable. It violates the procedure specified in the current 8.12.2 g. The actual behavior has not been changed in the proposed 8.12.2 g but it could be argued that one change should be made. The current specification results in that after a time-code is lost it would take the number of additional time-code transmissions equal to the number of hops in the network until the complete network is synchronized again. This is probably not desirable. It is not good to leave this issue open for implementations to handle individually as it is currently.	

A.11 INPUTS TO THE SPW HANDBOOK

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
7 DS - 23 sept. 10 13:17 in ECSS-E-ST-50-12C for SpW Evolutions	4.2.2	24		Differential characteristic impedance matched Remark: LVDS is not impedance matched in Common Mode (CM). That means the LVDS	

4. Number	5. Location of deficiency clause (e.g. 3.1	page 14)	6. Changes	7. Justification	8. Disposition
internal review_JI_DSan noted.pdf				is vulnerable to CM voltage exceeding a certain threshold at receiver inputs. ex: ±0.8 Volt from DC to about 10kHz. Above 10kHz the shield becomes effective but the ability of the receiver to reject CM voltage disturbance decreases when increasing the frequency. A good immunity to external CM disturbances is usually expected above 10kHz, thanks to the shield, but not documented. That's the meaning of "good" in the last point ! rather an expectation instead of a valid/measurable requirement.	
10 DS - 23 sept. 10 13:45 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSan noted.pdf	4.3.2	27		See DS's previous note. This declaration has a very limited practical extent. Probably a very good immunity for space application but not documented. It is suspected the LVDS being particularly susceptible to conducted ESD tests (bit flip) due to signal clipping at the receiver ports. Comparatively RS422 and RS232 offer a much higher immunity to offending CM voltage.	
33 DS - 23 sept. 10 15:21 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSan noted.pdf	5.5.2. 1a	43		For transmitted bit rates much lower than 200Mb/sec, the LVDS frequency bandwidth can be limited using a pair of capacitive load at the transmitter output terminals. This method is particularly useful to reduce EMI on low-level signals within a unit.	
34 [Parkes ECSS-E-ST-50-12C changes.ppt	6.2	44	**Change:** Add clarification that the 100 k ohm input impedance is for the receiver chip only	Recommended practice with LVDS	

4. Number	5. Location of deficiency clause (e.g. 3.1)	page (e.g. 14)	6. Changes	7. Justification	8. Disposition
slide 15]			If does not include bias resistors used for prevention of noise induced switching when input is open circuit.		
35 DS - 23 sept. 10 17:59 in ECSS-E-ST-50-12C for SpW Evolutions internal review_JI_DSannoted.pdf	6.2	44	High PCB ground plane to unit chassis inductance		