Power interfaces standardisation, a path towards more recurrent space equipment

some lines over the next ECSS E ST 20 20C

F. Tonicello, ESA-ESTEC, TEC-EPM
Noordwijk
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Power Interface Standardisation as a path to a *path towards more recurrent space equipment*

1. Introduction
2. Scope
3. Covered Perimeter
4. Attitude
5. ECSS E ST 20 20 C
    a. Schedule and deliverables (phase 1)
    b. Work plan
    c. Status
    d. Some outcome (@present!)
6. Conclusions

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ECSS on Power Interface Standardisation, introduction

Opposite to a number of equipment that can be bought “off the shelf” (e.g. reaction wheels, sensors, S-band transponders, …), power related ones are in general very much customised to each specific mission.

Also the number of power unit suppliers is quite large, given birth across Europe to a number of units with ***similar*** functions and performances but ***no or very limited reusability***.

So the introduction of some rationalisation would be clearly beneficial to all actors, allowing reduction of the non-recurring costs and the delays of each procurement, and a well-defined frame inside which to develop the future products.

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ECSS on Power Interface Standardisation, introduction, brief chronology

The **Technical Dossier** produced in the frame of the harmonisation process for Electrical Power Management and Distribution (PMD) in 2013, second semester, identifies the standardisation of Power interfaces as an important objective.

At a **workshop** on this subject organised by TEC-EPM in **October 2012**, a large consensus was achieved among the participants, representing most of the industrial and institutional actors in the domain, that this activity should be initiated and that they were willing to contribute.

A NWIP has been therefore submitted to ECSS in 2013 for the production of a power interface standard (ECSS-E-ST-20-20C), aimed at providing such requirements.

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ECSS on Power Interface Standardisation, scope

The ECSS TA agreed to split the activity in **two** phases:

a. **Phase 1**: Standardisation of interfaces in LCL (Latching Current Limiter) based power distribution networks.

The reasons is that this topic is the one felt most urgent by the community, as clearly expressed at the workshop, and the one where a consensus between participants has the largest probability to be achieved.

b. **Phase 2** (after successful completion of phase 1): Other power interfaces

Main bus, Battery, Solar Array, signal interfaces to power units

Specific interfaces: Pyrotechnic or similar devices activation chain, DNEL strategy and implementation, battery to PCU power and sensing interfaces with associated battery management functionalities, etc.

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ECSS on Power Interface Standardisation, scope

Additional inputs came from Harmonisation meetings with Eurospace and Delegations: the WG should focus on the "big" perspective

a. Mapping of current and future systems needs
b. Joint study of existing interface definitions
c. Agreement on common interface definition per class of application

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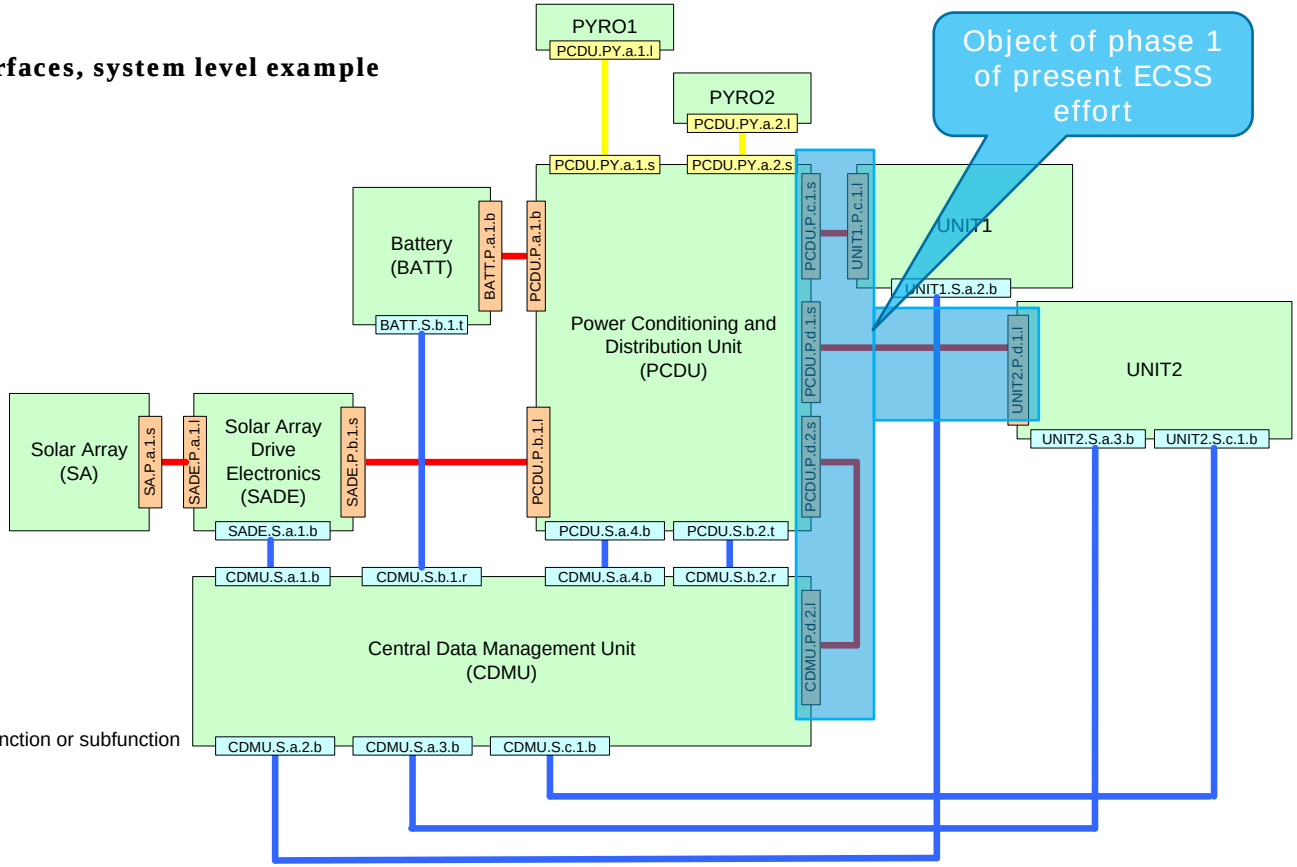
ECSS on Power Interface Standardisation, scope

Standardisation of electrical interfaces, system level example



Element1 (E1) — Element1 (abbreviated E1) – it can be a unit, function or subfunction

Power line

Signal line

Pyro line

APS.P.a.1.s — **APS** element, Interface **P** (power), interface type **a**, interface instance **1**, source side **s**

TMTC.S.b.2.r — **TMTC** element, Interface S (signal), interface type **b**, interface instance **2**, receiver side **r**

PCDU.PY.g.3.l — **PCDU** element, Interface **PY** (pyro), interface type **g**, interface instance **3**, load side **l**

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ECSS on Power Interface Standardisation, covered perimeter

1. ESA and national institutional programmes, i.e. chiefly Earth Observation, Navigation and Science.
    a. GEO telecom are left aside for now, since they obey to a totally different industrial logic, and domains like manned spaceflight or launchers have different specificities.

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ECSS on Power Interface Standardisation, attitude

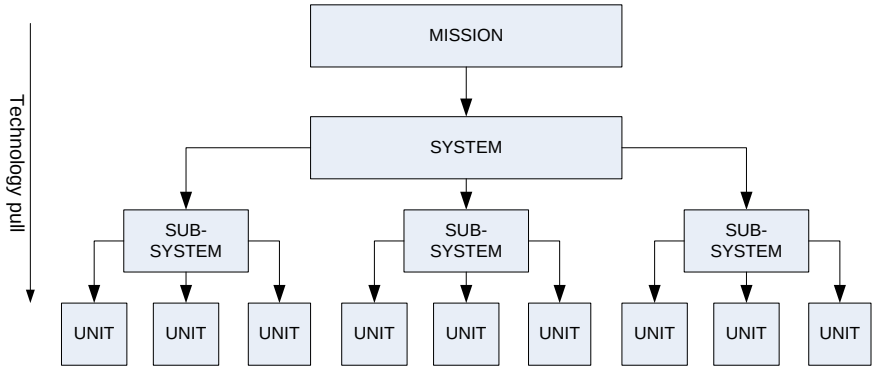

Figure 1, Technology pull

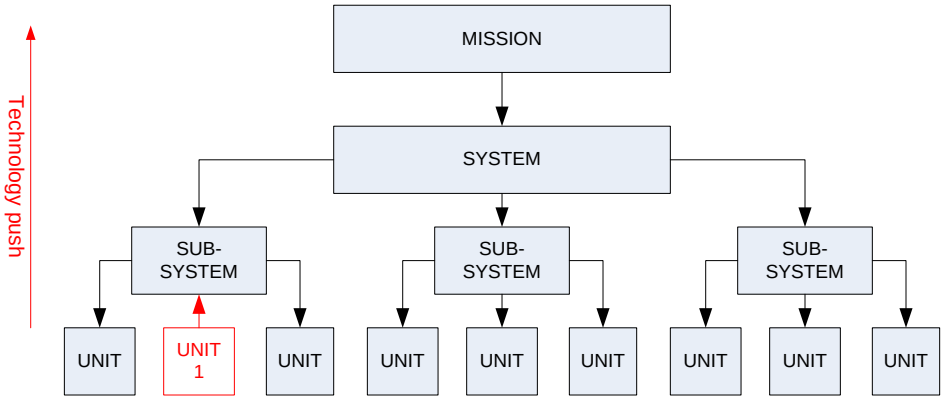

Figure 2, Technology Push

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ECSS on Power Interface Standardisation, attitude

1. No unique top-down or bottom-up flow
2. Appreciate system issues and subsystem/unit design issues at the same time
3. Iterate system-subsystem-unit-subsystem-system

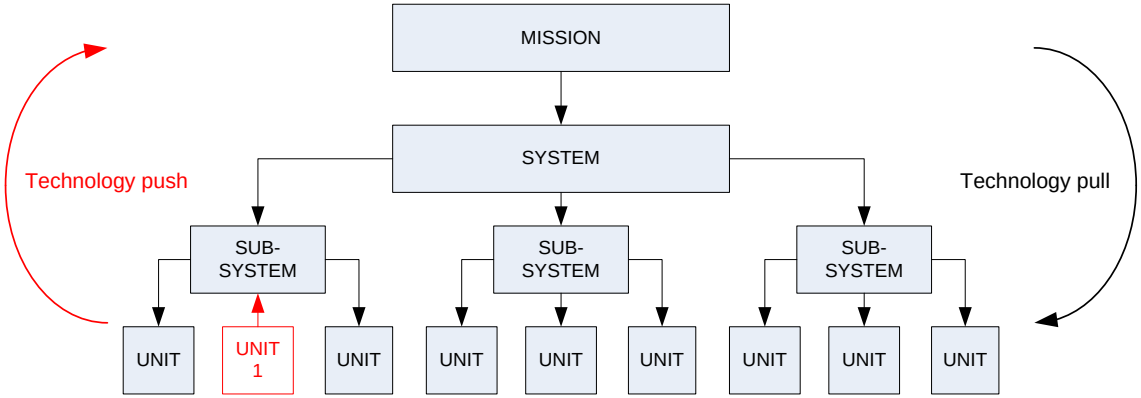

Figure 1, Technology push-pull

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ECSS on Power Interface Standardisation, attitude

1. System / prime

a. Specify the *discrete* world of existing opportunities as much as possible, and not the *continuous* world of possible new design

b. Assess the *product specification*, do not produce *customer specification* upfront

c. Facilitate reuse

d. Specify only what you need

2. Unit manufacturer

a. Recognise that the level of optimisation requested is on the system (general level) more than on the detail (particular level)

b. Be responsible of the *product specification*, do not expect passively the *customer specification*

c. Design for *flexibility and reuse* (including design for manufacturing, testability

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ECSS on Power Interface Standardisation, WG composition, schedule and deliverables (phase 1)

1. WG composition: Airbus D&S, Thales Alenia Space, OHB, TERMA, ETCA, Selex ES, ESA
2. Start of work: December 2013
3. Agreed duration: 12+1 months
4. Meetings in person: 7 (at ESTEC)
5. Deliverables:
    a. draft standard (covering phase 1 work) at 12 months; final version at 13 months
    b. draft handbook (covering phase 1 work) at 12 months; final version at 13 months
6. MoM and AIL at each meeting

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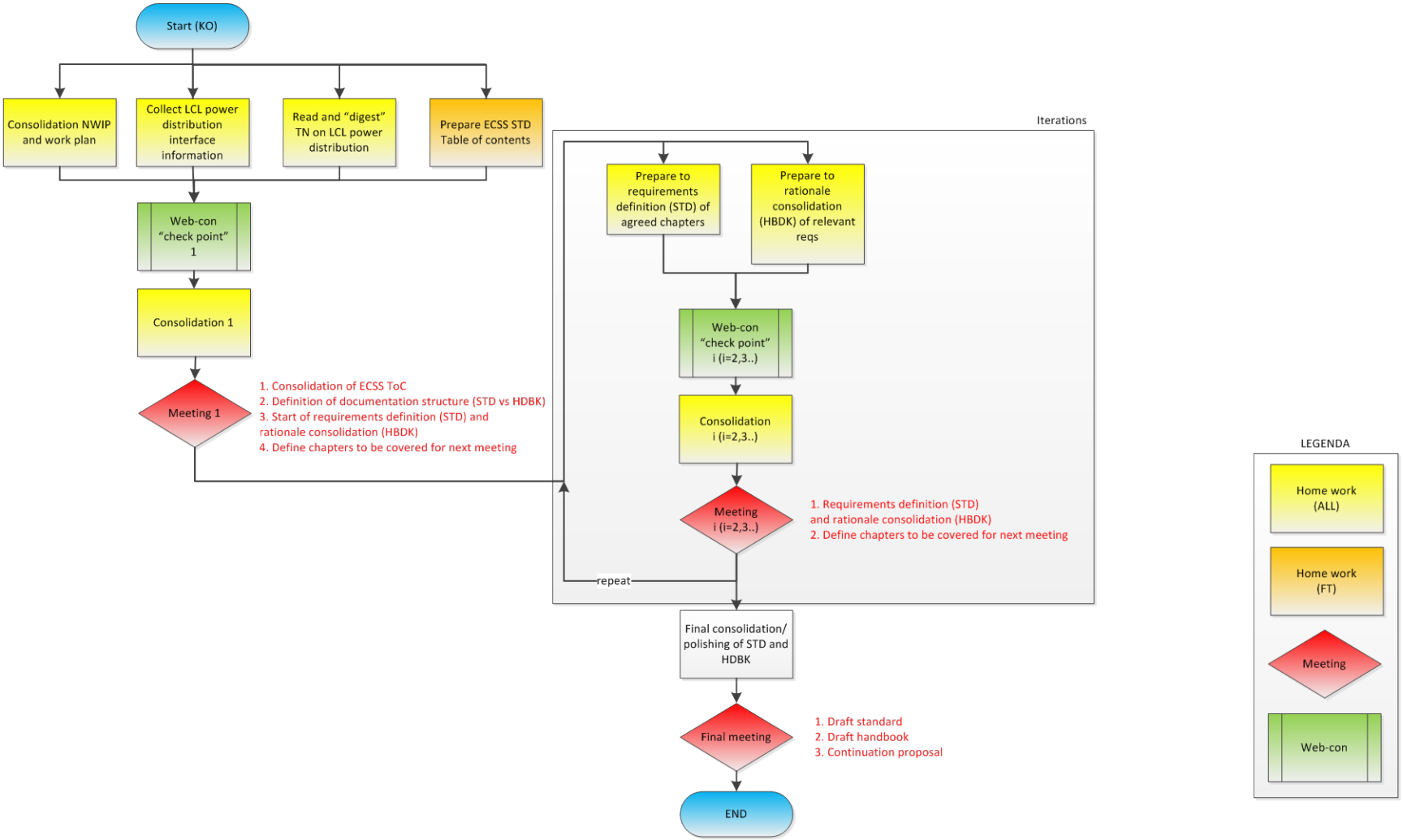
ECSS on Power Interface Standardisation, work plan



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ECSS on Power Interface Standardisation, status

STD drafting

a. **Source, functional requirements** => done, few items subject of open AI's
b. **Load, functional requirements** => done
c. **Source, performance requirements** =>done, few items subject of open AI's
d. **Load, performance requirements** => partially covered, full coverage expected Oct 2014

HDBK drafting

a. Based on a "digested" TN from ESA (subject of a previous workshop with industry)
b. Content agreed by the WG
c. To be made compliant with ECSS formal drafting rules

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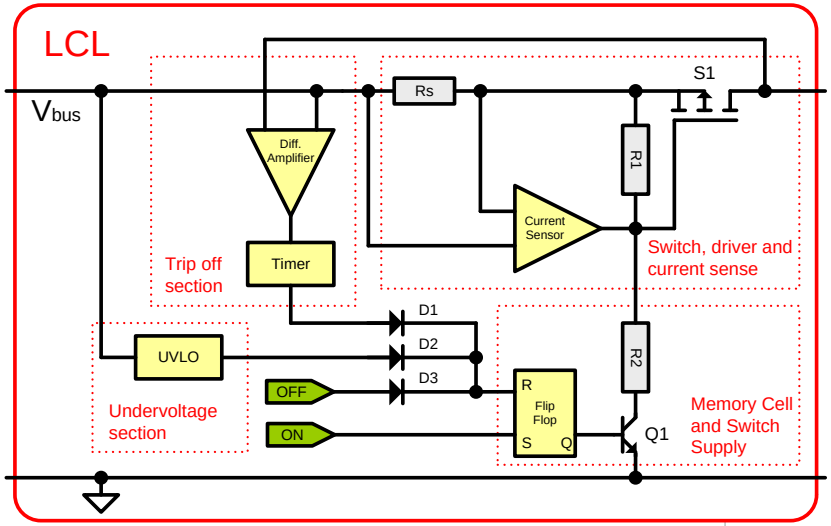
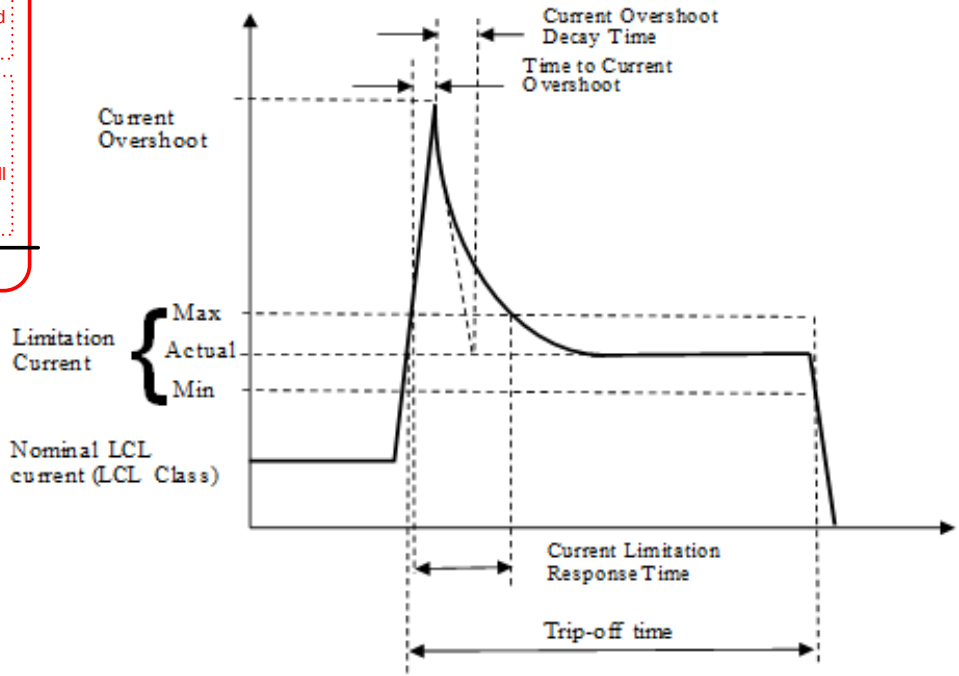
ECSS on Power Interface Standardisation, some outcome

Block and Time diagram of an LCL first…





ECSS on Power Interface Standardisation, some outcome

Agreement on **reference standard main bus** (unregulated, regulated) **features specifications**:

Power Bus type :		28V regulated bus	50V regulated bus	28V unregulated bus	50V unregulated bus	Power distribution has to…
Nominal DC Bus Voltage	Min	28-1%	50-1%	22	32	work nominal
	Max	28+1%	50+1%	38	52	work nominal
Abnormal DC Bus voltage range	Min	N/A	N/A	0	0	survive, no specific performance required
	Max (tolerance)			40	55	survive, no trip off unless overload results, rating of components respected
	Max (emission)			38	52	work nominal because equal to nominal limits
Nominal Bus ripple voltage	Max	According to ECSS E ST 20C		Up to +- 500 mVpp in the range 30 Hz to 50 MHz.	Up to +- 500 mVpp in the range 30 Hz to 50 MHz.	work nominal
Nominal Bus voltage transients	Max	According to ECSS E ST 20C		±1.4V for load steps of 50%, max 2ms duration, with dI/dt=1A/us	±2.5V for load steps of 50%, max 2ms duration, with dI/dt=1A/us	work nominal
Abnormal Bus voltage transients	Max	0 to 34V max	0 to 60V max	Within Power Bus abnormal DC limits		survive

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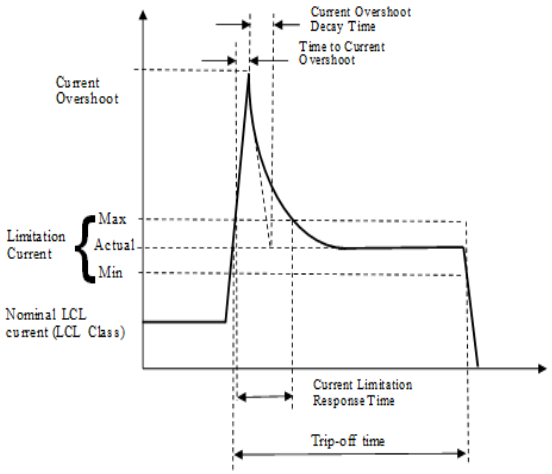
ECSS on Power Interface Standardisation, some outcome

Definition of standard power distribution elements (LCL and RLCL) **classes** for all spacecraft users (platform and payload)

provisional result @02Oct2014:



RLCLs

Class	**0.5**	**0.5**	**0.5**	**1**	**1**	**1B**	**1A**	**2B**	**2A**	**2B**	**2A**	**2**
Bus voltage [V]	28V	38V	52V	28V	38V	52V	52V	28V	28V	38V	38V	52V
Class current [[A]	0.5	0.5	0.5	1	1	1	1	2	2	2	2	2
Trip off min [ms]	10	10	10	10	10	6	4	10	4	10	4	4
Trip off max [ms]	20	20	20	20	20	12	8	20	8	20	8	8

Vdrop 1% OVERALL AGREED

LCLs

Class	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**4**	**4**	**4A**	**4B**	**5**	**5**	**5**	**6**	**6**	**6**	**8**	**8**	**8**	**10**	**10**	**10**
Bus voltage [V]	28V	38V	52V	28V	38V	52V	28V	38V	52V	28V	38V	52V	52V	28V	38V	52V	28V	38V	52V	28V	38V	52V	28V	38V	52V
Class current [[A]	1	1	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6	8	8	8	10	10	10
Trip off min [ms]	10	10	10	10	10	6	6	6	4	6	6	2	4	4	4	2	2	2	2	2	2	2	1.5	1.5	1.5
Trip off max [ms]	20	20	20	20	20	12	12	12	8	12	12	4	8	8	8	4	4	4	4	4	4	4	3	3	3

Vdrop 1% OVERALL AGREED

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ECSS on Power Interface Standardisation, CONCLUSIONS

The path for (power) interface specifications is set…

ECSS effort starts to deliver interesting results…

Indeed, interface specification is the first step towards recurrent equipment availability.

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