Autoclass II v160

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Goal of Autoclass

Autoclass is a classification mechanism that allows a PD to communicate its effective maximum power consumption to the PSE. This happens in such a way that the PSE will be able to set the power budget to the effective maximum PD power including the effective channel losses.

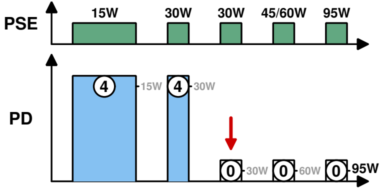
Goal: $P_{PSE\_BUDGET} = P_{PD}$ + actual channel loss + minimal margin

This will allow more efficient use of the PSU since only the effectively used power needs to be budgeted. This feature is not offered by the current classification scheme or by LLDP.

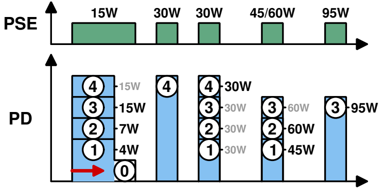
Previous presentations: ➠yseboodt_1_0913.pdf , ➠yseboodt_3_1114.pdf

Autoclass schemes

4,4,0,0,0 Autoclass



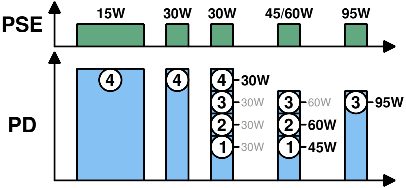
Partial class current Autoclass



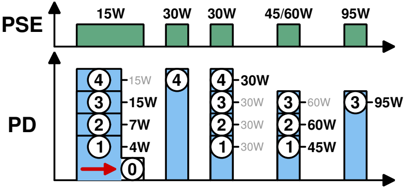
PSE knows it is Autoclass because the third finger is zero. PSE will offer highest amount of power available. PD knows how much that is due to power demotion. PD cannot indicate desired power.

PSE knows it is Autoclass due to partial class current in the first long finger. PD can indicate maximum desired power. PSE will offer up to that amount (or less, with power demotion).

Partial current Autoclass Classification



Fixed power L1 classification



Autoclass L1 classification

A PD indicates it is Autoclass by switching to class 0 current levels in the tail of the first long finger. Subsequently it will use the same classification scheme as fixed power PDs. This gives the PSE an indication of the *maximum desired power*, greatly speeding the time it takes to power up all PDs in multiport systems, since the Autoclass PD does not 'block' the maximum power budget the PSE can deliver during the Autoclass procedure.

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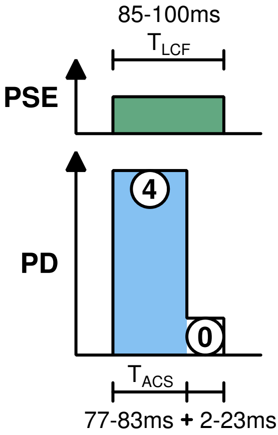
Partial class current

A PD indicates it wants to perform Autoclass by dropping I_{Class} to class 0 current level after T_{ACS} has elapsed of the long first finger.

PSEs can optionally detect this partial class current if they support Autoclass. If not, the behavior will be identical to fixed power classification.

Class currents 1,2 and 3 will have (TBD) defined behavior in PD and PSE for possible future use.



Class 0 (1st finger) is not possible for Autoclass PDs.

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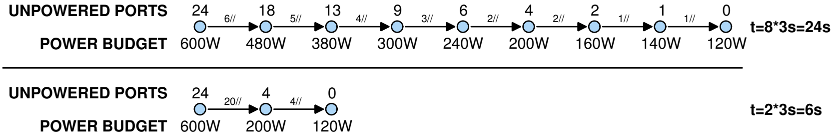
Multiport startup speed

With the (4,4,0,0,0) Autoclass scheme[1], multiport startup can be slow because the PSE would allocate initially 90W to every PD.

Example: a 24 port PSE with a 600W PSU and all 20W Autoclass PDs connected, assume Autoclass takes 3 seconds. It would take the system **24 seconds** to power up all PDs. But, if the PD could indicate maximum power consistent with the fixed power classes, startup would only take **6 seconds**.



[1] abramson_01_1114.pdf

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PSE/PD synchronisation

Autoclass requires the PSE and PD to have a common time reference, since power measurement and maximum power consumption need to coincide.

For PSEs the transition from POWER_UP to POWER_ON state is well defined and suitable. For PDs the crossing of $V_{Port\_PD(min)}$ threshold will be used as time reference.

PD implementors will need to measure/design for the worst case startup time between this reference point ($V_{Port\_PD(min)}\uparrow$) and the PD being able to turn on the load to maximum. Any undesired power spikes or inrush currents must have occured before T_{AUTO_PD1}.

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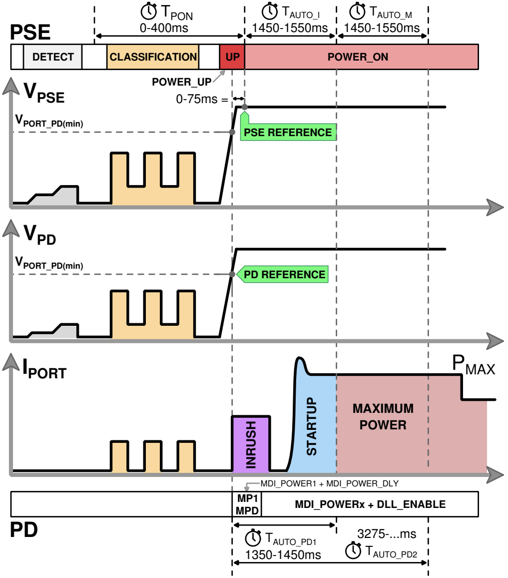
Synchronisation diagram

PSE starts T_{AUTO_I} timer after reaching POWER_ON state.

PD starts T_{AUTO_PD1} and T_{AUTO_PD2} timers after crossing the minimum Vport threshold. This is between 0-75ms before T_{AUTO_I} starts.

Total Autoclass time takes maximum 3.1s for PSEs and 3.275s for PDs.

Note: T_{PON} and other parameters may still change due to 4P-ID.



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Timing parameters

$\mathbf{T_{AUTO\_I}}$: Time after reaching POWER_ON during which the PSE ignores power consumption of the PD. Useful for when inrush power is greater than maximum power consumption, or to cover high power secondary inrush events.

$\mathbf{T_{AUTO\_M}}$: Time after T_{AUTO_I} during which the PSE measures the power consumption of the PD.

$\mathbf{T_{AUTO\_PD1}}$: Time after crossing $V_{Port\_PD(min)}$ during which the PD needs to prepare maximum load condition. This includes PD inrush time + mandatory T_{Inrush} + PD startup time.

$\mathbf{T_{AUTO\_PD2}}$: Time after crossing $V_{Port\_PD(min)}$ until which the PD must maintain maximum power consumption.

Autoclass timing is a balance between ease of use (long timings = more applications can meet startup speed requirements) versus speed of classification. A total Autoclass time of 3 seconds is a reasonable balance.

Causes for increased power consumption

After Autoclass is completed several effects can cause an increase in PSE power delivered:

- Increased cable temperature (higher resistance)
- Lowered V_{PSE} (causes higher current, more cable loss)
- PD effects (temperature dependence, efficiency vs V_{PD})

Examples at 51W PD power level:

Cause	**Effect P_{PSE}**
V_{PSE} drops from 57V to 50V with 12.5Ω cable	+4.5%
R_{ch} increase from 10.3Ω (20°C) to 12.5Ω (65°C)	+3.5%
V_{PSE} 57V $\rightarrow$ 50V and R_{ch} 10.3Ω $\rightarrow$ 12.5Ω	+6.7%
V_{PSE} 55V $\rightarrow$ 53V and R_{ch} 10.3Ω $\rightarrow$ 11.3Ω	+2.2%

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Minimum power margin

To avoid unexpected power cycles the PSE should allocate a minimum power margin to allow for these effects. We cannot use worst case corners as this will take away the benefits of Autoclass, the aim should be to set the minimum margin to cover the common case. PSEs can always select or be configured for higher margin.

PSEs implementing Autoclass should allocate **minimum 5%** more power than the value measured during T_{AUTO_M} to account for temperature differences causing a variation in the total power consumption.

Note: Adding the margin should not cause the PSE to allocate more power than defined for the corresponding class in table 33-8.

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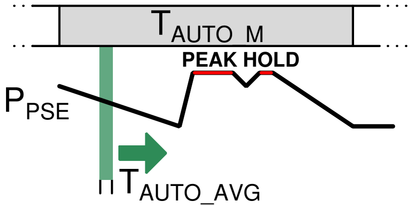
Measurement method

The measurement method should be specified to avoid interoperability issues with PDs that do not present a clean DC load during T_{AUTO_M}. A rolling average of 150ms-300ms(TBD) combined with peak & hold allows for flexible PD implementations.



Example of PD that is not drawing clean DC power.

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Minimum Allocated Power

Defining a minimum Autoclass power level gives the PD designer a safe minimum allocated power in case the load cannot be turned on (eg. fault). Using this minimum power the PD can signal the error condition, without risking power disconnect due to accidental measurement at no/partial-load.

A minimum power of 4W (Class 1) seems reasonable:

- Cable loss on worst case 4-pair cable is only 40mW (0.1%).
- Applications below this power level are unlikely to be able to trigger a reliable maximum load.
- LLDP is a better suited mechanism to inform the PSE of actual power usage for these power levels.

Autoclass & LLDP

Next to physical layer Autoclass, LLDP can be used to (re-)trigger or cancel Autoclass. Triggering Autoclass via LLDP is a solution for PDs that cannot meet the startup timing requirements of physical layer Autoclass. Cancelling Autoclass allows the PD to return to the maximum power level it advertized over L1.

LLDP can also be used to override the results obtained by L1 Autoclass: increase or decrease allocated power.

LLDP proposal: ➠yseboodt_4_0115.pdf

Summary

Topics dealt with in this presentation:

1. Comparison of Autoclass schemes
2. Partial class current to communicate maximum power and achieve fast startup
3. Partial class current timings
4. Synchronization on POWER UP to ON for PSE and $V_{PD(min)}$ for PD
5. Timing for PSEs ($Auto_I$, $Auto_M$) and PDs ($Auto_{PD1}$, $Auto_{PD2}$)
6. Minimum power margin of 5%
7. Measurement method (average over 0.15-0.3s + peak & hold)
8. Minimum power of 4W (PSE)
9. Autoclass & LLDP

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