Innovative Lighting Concept for Next Generation Train

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Next Generation Train
2035 Hamburg Dammtor ready for departure

streamlined double deck cab car; single wheels; electric drive 18 MW; 400 km/h;
aerodynamic + magnetic braking, distance 8 km; performance 100,000 km/month
Next Generation Train
Topics and Goals

1. Increasing the certified train speed to 400 km/h
2. Halving the specific energy consumption (compared to ICE-3\(^1\) at 300 km/h)
3. Noise reduction
4. Increase of passenger comfort
5. Improvement of driving safety
6. Reduction of wear and life cycle costs
7. Cost-efficient design: by modularization and system integration
8. Increasing efficiency of development and permission processes

\(^1\) ICE – InterCity Express
Lighting: systematic investigation

Technical aspects
- Standards
- Illuminance calculation
- Energy consumption
- Interior design

Comfort
- Lighting comfort evaluations
- Passenger satisfaction

Economical aspects
- Price history
- Price trend
- Sensitivity analysis
- LCC

Passenger room lighting
Light sources

OLED = Organic Light Emitting Diode

series of thin nm-layers:
• substrate (plastic, glass, foil)
• transparent Indium Tin Oxide (ITO) – anode
• amorphous layers of organic semiconductor
• Metal cathode

OLED - layers can be spread over very large areas, making them ideal as two-dimensional light sources
Light sources

OLEDs

- Homogeneous, non-glare and area light
- Dimmable neutral white light (4 000 K)
- Excellent colour rendering (CRI\textsuperscript{1} up to 90)
- Efficient OLED modules (> 50 lm/W)
- Slim form factor (< 2.5 mm) and low weight
- Low surface heating (typ. T = 40°C)

- Limited in size (max. 145 x 145 mm)
- Service life only 15 000 h (ca. 2 years in trains)
- Still expensive (ca. 60 €/module = 600 €/klm)

\textsuperscript{1} CRI – Color Rendering Index
NGT lighting concept

- an energy-efficient, compact, comfortable and low-maintenance lighting system had to be developed within the NGT project
Calculation method: DIALux

- well-established software for light planning in buildings and outdoor spaces
- free software
- import of CAD\(^1\) data
- import of OLED specifications
- photorealistic visualizations

the model of NGT was developed and validated within the project

\(^1\) CAD – Computer-aided Design
Model validation
Experiment Design

- Measuring points according to EN 13272 – standard in model and in full-size mock-up

- 136 measuring points on lower deck
- 54 measuring points on upper deck
Model validation
Experiment results

- average difference of 4.5% on lower deck (LD)
Model validation
Experiment results

• average difference of only 0.5% on upper deck (UD)
Lighting concept for NGT
Lower deck (second class)

- 302 Tridonic® ‘Lureon REP 20w5-40 DC’ modules
- 634 Watt total
→ 12.2 W/passenger
(ICE$^1$ 23.2 W/passenger)
→ 48% power saving

$^1$ ICE – InterCity Express
Lighting concept for NGT
Upper deck (first class)

• 349 Tridonic® ‘Lureon REP 20w5-40 DC’ modules

• 733 Watt total $\rightarrow$ 15.6 W/passenger (ICE$^1$ 33.5 W/passenger) $\rightarrow$ 47% power saving

$^1$ ICE – InterCity Express
Summary

- innovative passenger area lighting for double-decker cars has been developed within the Next Generation Train project

- technical, economical and comfort aspects of the lighting were investigated

- due to the use of innovative illuminants (OLEDs) energy-efficient, compact, comfortable and low-maintenance lighting according to EN 13272- Standard is possible

- modular system allows realizing a lot of design ideas and smart lighting control

Outlook

- combined control (centrally + individually)

- lighting control using Railway Customer Card (RCC)
THANK YOU FOR YOUR ATTENTION!
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