



Acoustic Vehicle Alerting System (AVAS) for Detectability of E- scooters

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Research Team

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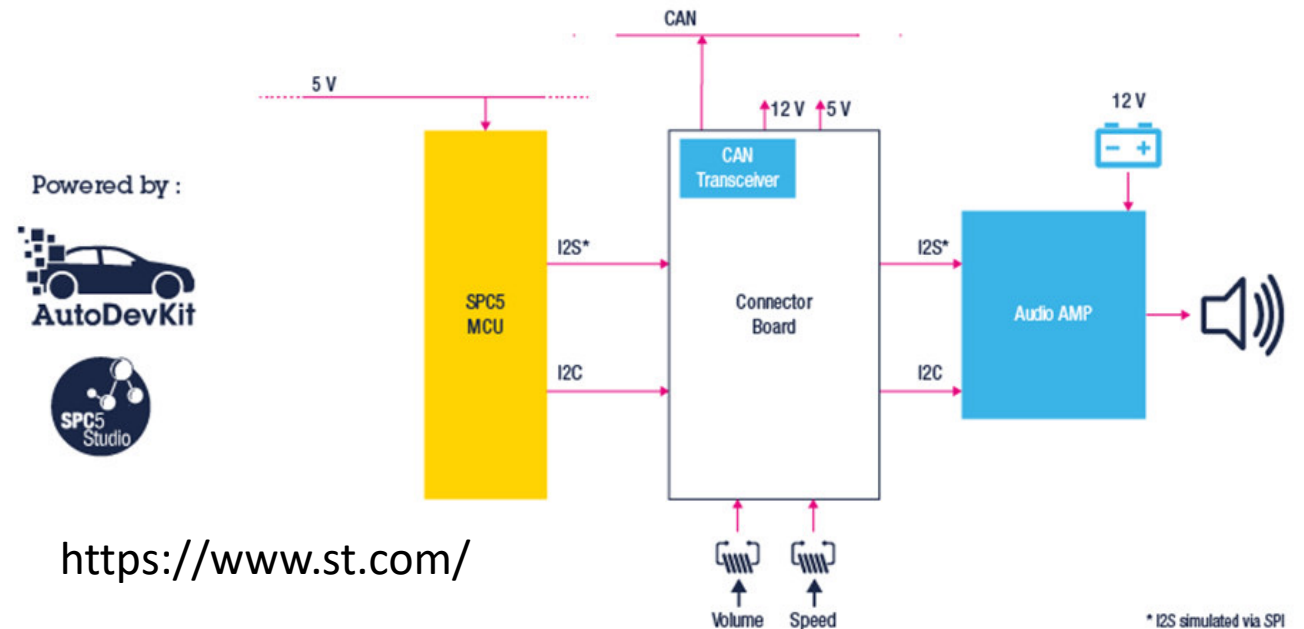
AVAS: Why is it needed?

- Audible detection to ensure safety of both rider and pedestrians
 - Evidence suggest AVAS is needed to avoid potential collisions with pedestrians.
- Especially sensitive groups:
 - Blind or partially sighted people.
 - Hearing impaired people.
 - Are AVAS the solution?



Technical Challenges

- Signal generation: PWL, frequency range, frequency content (tones), directivity.
 - Continuous vs. event-based acoustic signal; signal as a function of speed.
- Constraints: Integration with e-scooter hardware and software



Regulatory Challenges

- AVAS regulation for transport vehicles. Optimised for e-scooters?
 - UNECE 138.01 (2017) - Europe
 - FMVSS No. 141 (2016) - US

https://doi.org/10.1121/AT.2020.16.4.20	Europe	United States	
Speed range (forward motion)	Up to 20 km/h (± 1 km/h)	Up to 30 km/h (+2km/h)	
Reverse	6 km/h (± 2 km/h)	0 km/h (stationary)	
Minimum third-octave levels for nonadjacent bands	Mandatory	Mandatory	
Frequency range	160 Hz to 5,000 Hz At least 2 nonadjacent 1/3 bands (at least one below/within 1.6kHz)	4 Nonadjacent one-third octave bands spanning no fewer than 9 bands from 315 Hz to 5,000 Hz	2 Nonadjacent one-third octave bands from 315 Hz to 3,150 Hz
Sound while vehicle is stationary	Not mandatory	Mandatory	
Pitch shifting	Mandatory	Not mandatory	

Regulatory Challenges

One-Third Octave-Band Center Frequency (Hz)	Minimum A-Weighted SPL (dB)	A-Weighted Band Sum (dB)	Example of Measured Alert Signal
315	47		47
400	47		47
500	47		55*
630	47		46
800†	47†		46†
1,000	47	57	46
1,250	47		55*
1,600	47		46
2,000	47		45
2,500	47		45
3,150	47		44

Other Challenges

- Balance between vehicle awareness and annoyance/preference.
- Noticeability as a function of ambient sound
- How can we make the sounds noticeable:
 - Level/frequency shifting
 - Roughness
 - Pulses (amplitude modulation)
 - Tonality patterns.
- Questions:
 - How to increase noticeability without compromising community annoyance?
 - How to avoid disharmonic modulations (due to different types of AVAS in operation)?

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Results will be reported after July 2021.



Questions?

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