Editorial

Importance Of Lighting For ADAS Functions
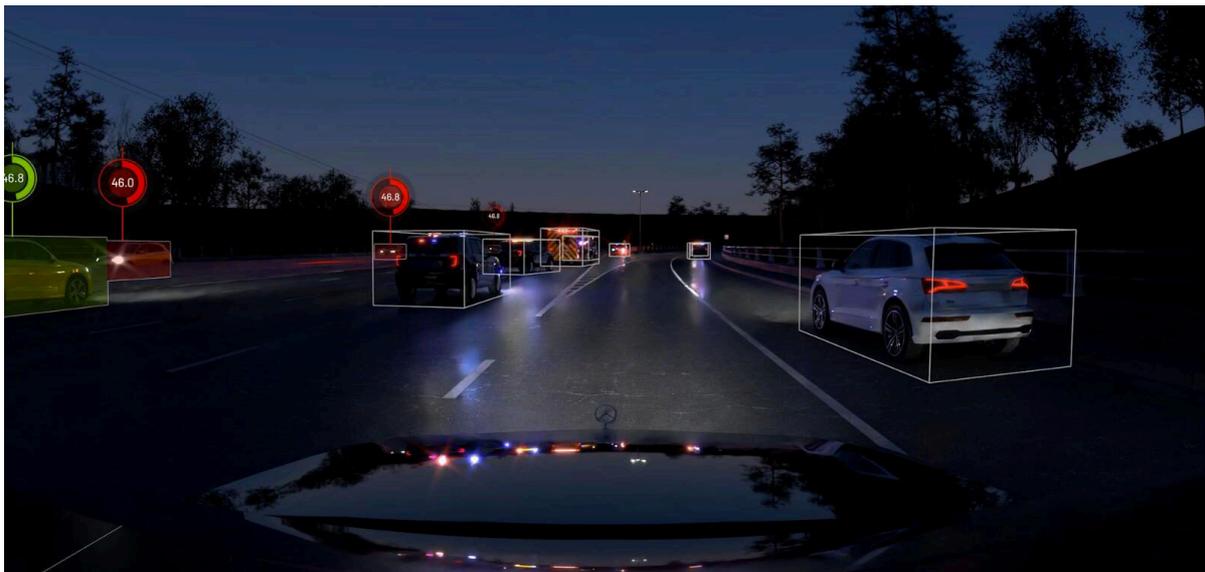
Lighting obviously supports ADAS, but where's the boundary between the two? Is lighting actually an integral part of ADAS? Legacy automakers have separate departments for lighting and ADAS. Some lighting functions have one foot in each realm—especially those involving camera detection inputs to software, like automatic high/low beam selection and ADB. In cases like that, specification and software development can be shared between the teams. It's the same in legacy tier-1 suppliers, some of the most well-known of which have an ADAS business unit and a separate lighting unit. This isn't always the case, though; some new EV makers have combined lighting and ADAS teams.

At DVN, we have always gathered—and as a lighting engineer, I have long worked with both communities. Three years ago, we extended the DVN community to the lidar realm with dedicated newsletter, membership, and events. Eric Amiot leads the DVN-Lidar business unit, with senior advisers Alain Servel, Martin Booth, and Luc Bourgeois.

Lidar technology is more mature today than it was at the start of DVN-Lidar. New technologies are emerging, like HD radar and IR cameras, and we're seeing L^{2+} ADAS and L^{3-4} AD applications becoming mainstream. That is why we have decided to extend the scope of DVN Lidar to become **DVN Sensing & Application**. The focus is on sensors—all kinds of them—and there'll be more about vehicle applications, whether they are AD or ADAS.

Our first event will be dedicated to a single function: AEB (automated emergency braking), which will become mandatory in 2029 in USA as specified in new FMVSS № 127. The regulation requires AEB systems to function at faster vehicle speeds compared to Europe and EuroNCAP specification. Scenarios are different, including a night scenario in low beam conditions. Is a visible-light camera enough, or will it take additional sensors like regular or High Definition (HD) radar, or an InfraRed (IR) camera? do we need sensor fusion? Do we need to improve low beam performance to improve front camera detections? These are just some of the new questions facing the lighting and ADAS community. This will be the focus on our AEB event in Detroit on 9-10 April this Spring.

Today's DVNewsletter is dedicated to AEB as specified in FMVSS 127 and EuroNCAP. We bring you expert insight and analysis, new technical solutions, and interviews with Magna and Mobileye experts.

Please feel free to **contact me** if you'd like to receive the DVN Sensing & Application newsletter. And **online registration** for the AEB event in April is open!

Sincerely yours,

Paul-Henri Matha
DVN Chief Executive Officer and Lighting General Editor
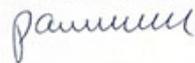
In Depth Lighting Technology

Why is AEB a Lighting Community Topic?

Night AEB testing with dummies (IIHS image)

We are used to working on AEB requirements by Euro NCAP. This has never been much of a topic for the lighting community. Tests include car to pedestrian, car to bicycle, and car to motorcyclist, with maximum speed 60 km/h. ⅔ of the points are obtained by day, and the others by night. The night tests include street lights and low beams. Camera detection isn't a big issue with street lights helping, and so low beam performance is not crucial.

Only one night test was done without streetlight, but with high beams on, with maximum speed 60 km/h for AEB and 80 km/h for front collision warning and emergency steering support. The detection task doesn't call for a wide high beam, because the pedestrian is in front of the car. With a normal high beam with a range of 150 metres, you have time to detect and decelerate to avoid a collision.

	CPFA	CPNA	CPNCO	CPLA		CPTA				CPRA/CPRC	
Section	7.2.1	7.2.2	7.2.3	7.2.4		7.2.5				7.2.6	
Type of test	AEB			AEB	FCW/ESS	AEB				AEB	
VUT speed [km/h]	10-60			20-60	50-80	10,15,20		10		4,8	
VUT direction	Forward			Forward		Farside turn		Nearside turn		Rearward	
Target speed [km/h]	8	5		5	5	5				0	5
Target direction	Coming from Farside	Coming from Nearside		Forward		Coming from Opposite direction	Coming from Same direction	Coming from Opposite direction	Coming from Same direction	Standing, Direction facing selected by lab	Coming from nearside
Impact location [%]	50	25,75*	50	50	25	50				25,50,75	50
Dummy Articulation	Yes – as per test speed			Yes		Yes				Articulated dummy in 'off' position	Yes
Lighting condition	Day/Night			Day/Night		Day				Day	
Vehicle lights (night)	Low beam			High beam		N/A				N/A	
Streetlights (night)	Streetlights			No streetlights		N/A				N/A	

From Euro NCAP 2023 protocol
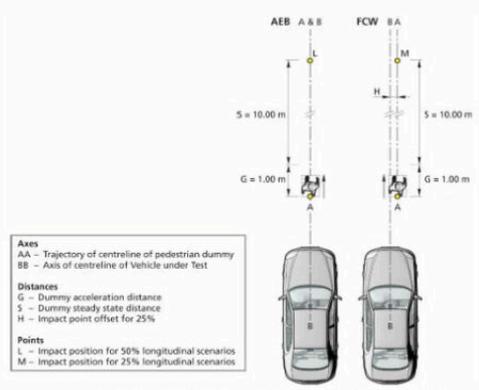
In terms of lighting, the main difference with FMVSS 127 is pedestrian detection by night (vehicle detection at night is easier because vehicles have their own lights, or at least retro-reflectors). Speeds are similar, but the night scenarios are without any streetlight, and with low beam as well as high beam. And there are crossing scenarios, not just longitudinal pedestrian movement.

TABLE 2 TO S8.1.1—TEST PARAMETERS WHEN APPROACHING A PEDESTRIAN

	Direction	Overlap	Obstructed	Speed (km/h)		Lighting condition
				V_{SV}	V_P	
Pedestrian Crossing Road.	Right	25	No	Any 10–60	5	Daylight
	Right	50	No	Any 10–60	5	Daylight Lower Beams Upper Beams
	Left	50	No	Any 10–60	8	Daylight
	Right	50	Yes	Any 10–50	5	Daylight
Stationary Pedestrian ..	Right	25	No	Any 10–55	0	Daylight Lower Beams Upper Beams
Pedestrian Moving Along the Path.	Right	25	No	Any 10–65	5	Daylight Lower Beams Upper Beams
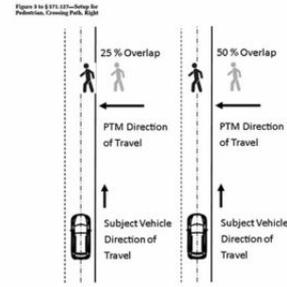
From FMVSS 127

100-metre high beam range and a vehicle speed of 60 km/h, that's a 6-second preview (time to collision). A pedestrian moving at 5 km/h would have moved 10 metres over those 6 seconds. So to detect the pedestrian, the car would need a high beam spanning ±5 degrees—and the U.S. high beam spread requirement is much wider, so all should be fine.

The low-beam scenario is the tough one. Where's the pedestrian? Coming from the right side or the left side? How can I be sure it is a pedestrian? What is the camera's reaction time? How to avoid false detection and false braking? Should we change the low beam pattern to put even more light out to the sides and on the left than they already do (which is contributing to increasingly loud and voluminous glare complaints)? 1g deceleration—maximum brake force—at 60km/h is equivalent to a movement distance around 30 metres, not including reaction time. Camera reaction time (by night for vehicle recognition + high beam to low beam switch) in SAE J3069 was estimated at 2.5 seconds (NHTSA believes 1 second). At 60 km/h, this means another 40 metres. Pedestrian detection should then be done at 70 metres—longer if the vehicle is to brake smoothly; who wants a car decelerating automatically at 1G? The test seems passable with low beam if there's enough light in the right zone.

In their rationale, NHTSA describes tests showing some vehicles have succeeded in fulfilling all the tests, and some others failed at 20 km/h. NHTSA interprets this as meaning their regulation is feasible with current sensor setups, even if vehicles have not been developed to fulfil the requirements.

Table 22: Pedestrian AEB Performance
2023 Test Results Summary

	Dir.	Overlap	Obst.	Speed (km/h)		Lighting Condition	Pathfinder	Ioniq 5	Corolla Hybrid	iX xDrive50	F150 Lighting	CX-90
				V_{SV}	V_P							
Pedestrian Crossing Road	Right	25%	No	Any 10 - 60	5	Daylight	50	40	60	50	60	60
	Right	50%	No	Any 10 - 60	5	Daylight	60	60	60	60	60	60
				Any 10 - 60		Lower Beams	60	50	60	60	50	60
				Any 10 - 60		Upper Beams	60	50	60	60	60	60
	Left	50%	No	Any 10 - 60	8	Daylight	50	50	60	60	60	60
	Right	50%	Yes	Any 10 - 50	5	Daylight	40	40	50	50	50	40
Stationary Pedestrian	Right	25%	No	Any 10 - 55	0	Daylight	55	55	55	55	55	55
				Any 10 - 55		Lower Beams	20	50	55	55	30	55
				Any 10 - 55		Upper Beams	55	55	55	55	55	55
Pedestrian Moving Along the Path	Right	25%	No	Any 10 - 65	5	Daylight	50	60	65	65	65	65
				Any 10 - 65		Lower Beams	-	60	65	40	40	60
				Any 10 - 65		Upper Beams	-	60	65	65	65	65

If ADB was clearly mentioned in the test scenario, it would have been easier to detect the pedestrian from the side for sure. But it is not written like that. Good headlamps and close collaboration between lighting and ADAS teams will be key to meet FMVSS 127's requirements. It is our chance to collaborate more closely.

Driver Assistance News

NHTSA's New AEB Rule is Live. How Was It Shaped?

NHTSA published their final rule on AEB in the U.S. Federal Register this past 26 November, enacting new Federal Motor Vehicle Safety Standard № 127, with effect from 27 January 2025. New vehicles built from 1 September 2029 (the 2030 models) will have to be equipped with AEB systems. The only exception is vehicles "produced by small-volume manufacturers, final-stage manufacturers, and alterers"; those will have an additional year, and will have to be equipped with compliant systems starting on 1 September 2030 (the '31 models).

The deadline to file a petition for reconsideration was 10 January—which has already passed, and NHTSA's response to them is visible at the linked Federal Register publication. The Alliance for Automotive Innovation; Toyota; VW, and Scuderia Cameron Glickenhaus (who describe themselves as "a boutique manufacturer of exotic high-performance racing and road cars") filed petitions for reconsideration. Hyundai sent NHTSA a letter commenting on the proposed rule, which the agency treated as though it were a petition for reconsideration. A further petition was sent in by Autotalks, who say they make chipsets for "advanced, secure V2X communication". However, it was submitted after the deadline, so NHTSA are treating it as its own start-from-scratch petition for rulemaking.

Some contested points of the proposed regulation were granted. In summary:

- petitioners wanted explicit definitions for terms "operate" and "imminent" as used in the standard. NHTSA declined to do so, on grounds that "imminent" is used in its ordinary plain meaning, and the language of the regulation already defines how the system must "operate". The agency did decide to adjust the language of the standard with regard to "imminent", in recognition that the specified performance test doesn't look at AEB activation timing.
- The agency found, after reviewing the petitions, that one of their test scenarios inadvertently made parts of the standard more stringent than intended; the

relevant language has been adjusted.
- NHTSA also adjusted the language of the standard to clarify the specifications for the forward collision warning visual and audible signals.

Other contested points were denied. Petitioners wanted NHTSA to ease up on the requirement that an AEB-equipped vehicle make no contact with the lead vehicle or pedestrian. Specifically, they wanted contact to be allowed at or below 10 km/h. NHTSA said no, on grounds that the no-contact requirement is feasible and meets the need for safety. Petitioners asked that multiple test runs be permitted to achieve the no-contact performance—for example, no contact on five out of seven runs could be considered a pass. NHTSA said no to this, too, on the same grounds: the standard as put forth is feasible and meets the need for safety.

Petitioners also wanted more specificity on fault-indicator warning lights; NHTSA declined to provide it, saying the rule as written meets the legal requirements for Federal Motor Vehicle Safety Standards. Another rejection: petitioner requests to be permitted to provide a control by which the driver could disable the system. One petitioner—it was the "boutique manufacturer of exotic high-performance racing and road cars"—asked that AEB not be required on cars with manual transmissions; NHTSA said there's no need for any such an exemption, because manual-transmission vehicles with AEB are already a thing. The same petitioner wanted the rule relaxed for small-volume makers like themselves; NHTSA said no and referred to existing provisions by which very low-volume car makers can petition on a case-by-case basis for relief from specific requirements. And at least one petitioner said NHTSA failed to fully consider the costs involved with equipping vehicles with AEB; NHTSA's response: "Yes, we did".

The final rule is thorough and detailed. It includes stringent system performance requirements, system configuration and self-check requirements, and two different false-activation tests. Have a close look at the Federal Register publication linked at the start of this article; give it a good read-through. We're all going to have to be conversant with it in a few short years!

Technologies for Next Generation AEB

By Martin Booth & Luc Bourgeois, DVN Sensing & Applications Senior Advisers

AEB systems (advanced emergency braking) started appearing in the early 2010s. They have improved over time as the technology has evolved, and they've become capable of handling a wide variety of road scenes. Euro NCAP ratings have made them essential for achieving a 5-star safety score. And the European GSR-2 (general safety regulation requires all new vehicles sold in Europe to have AEB since July 2024.

The most common perception configurations for these AEBs are:

- A single perception technology: camera or radar. This setup meets the performance and robustness level required by GSR2 as of July 2024, and can achieve up to 4 stars in the 2023 Euro NCAP protocol.
- Dual perception technologies: camera *and* radar, and real-time fusion of their information. This allows for a 5-star Euro NCAP rating, and gives the highest level of performance and robustness. This means detecting and avoiding collisions with moving or stationary vehicles, partially or fully in the path, up to about 65 km/h. The same goes for vulnerable road users—pedestrians, cyclists, and motorcyclists.

It is evident that AEB has been developed primarily for urban and peri-urban scenarios. Statistics show vehicles with AEB have about 40 per cent fewer accidents than those without. A typical set of scenarios to evaluate AEB for Euro NCAP includes:

Car to Car:

- Approaching a car crossing a junction
- Approaching a car head-on
- Turning across the path of an oncoming car
- Approaching a stationary car
- Approaching a slower-moving car
- Approaching a braking car

Pedestrian:

- Car reversing into adult or child
- Adult crossing a road into which a car is turning
- Child running from behind parked vehicles
- Adult along the roadside

Cyclist:

- Approaching cyclist crossing from behind parked vehicles
- Turning across path of an oncoming cyclist
- Approaching a crossing cyclist
- Approaching a cyclist along the roadside

Motorcyclists:

- Approaching a stationary motorcyclist
- Approaching a braking motorcyclist
- Turn across the path of an oncoming motorcyclist

After this initial phase of deploying AEB for over 15 years, we are now seeing an increase in the expected performance of AEBs with the Euro NCAP 2030 vision and FMVSS 127 from NHTSA for 2029, which will likely lead to an evolution in perception technologies and AEB systems.

FMVSS 127 requires an AEB system to avoid high-speed collisions: 100 km/h for stationary objects! This implies a need for long-range radar or lidar. The standard also requires systems to avert collisions with pedestrians during day and night up to 72 km/h without external lighting of the driving scene. This means the car must have a lighting system capable of illuminating the driving scene well enough to support that AEB performance, or it must be equipped with perception technology that guarantees pedestrian detection at night—lidar or infrared cameras.

To quantify the additional performance required of AEB by 2029, let's consider the case of avoiding collisions with stationary vehicles up to 100 km/h and compare it to the current situation of AEB which avoid collisions up to an average of 65 km/h.

Under optimal adhesion conditions ($\mu = 1$), it takes approximately 25 metres to stop a vehicle traveling at 65 km/h by applying a deceleration of 1 g. In these same $\mu=1$ adhesion conditions, it will take about 50 metres to stop a vehicle traveling at 100 km/h (10 metres for braking system reaction time + 40 metres of deceleration at 1g).

Consequently, full braking must be applied approximately 1.8 seconds before impact, compared to 1.2 seconds today. This increase of 0.6 seconds is a challenge for the detection system's performance, especially for its ability to keep from generating false positives that could lead to unintended braking.

So, the new performance requirements for AEB raise questions about the sensors' performance and the best ways to fuse their information, while avoiding severe false positives.

Advance engineering phases are under way at suppliers and automakers to choose new configurations, and we will soon see the selections and compromises that ensure a favourable risk-benefit ratio to achieve the traffic accident reduction goals set by Euro NCAP and FMVSS 127.

NHTSA projects that the new standard will save at least 360 lives a year and prevent at least 24,000 injuries annually. A lot of those accidents occur at nighttime or other low visibility conditions.

The new standard requires cars to be able to stop and avoid contact with a vehicle in front of them at speeds up to 100 km/h, and apply the brakes automatically at up to 130 km/h when a collision with a lead vehicle is imminent. Pedestrians have to be avoided at up to 72 km/h, in both day and night conditions.

Today's AEB systems typically use a camera and some sort of image processor plus an 'AI' detection algorithm—often part of the L^2 driver assist system, using the same components. However, visible light camera-based systems do not perform well at night, or in fog, direct sunlight and other challenging weather conditions. The 0.2 lux requirement of the NHTSA mandate makes a stop from 45mph difficult (including the time to detect and classify objects)—vehicle headlights can only illuminate so far ahead.
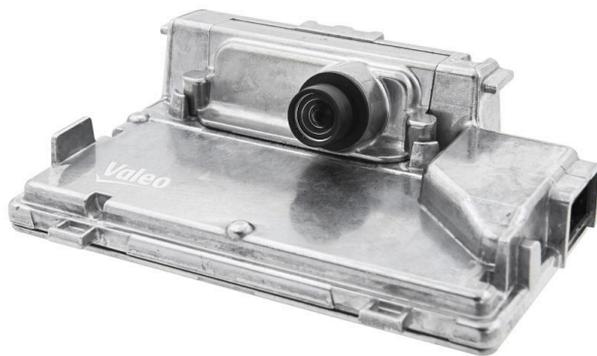
Valeo front camera AEB system

According to Teledyne Flir, in VSI Labs test reports, only one of eight 2023-'24 U.S.-spec vehicles tested was able to pass all of the FMVSS 127 tests with the existing camera and radar sensors—which shows the general inadequacy of existing sensor suites to meet the new requirements.

RCCG colour filter arrays, deep trench isolation, composite metal grids, and other advanced CMOS processing techniques, along with advanced image processing, improve low-light sensor performance and dynamic range, but still do not offer an ideal solution.
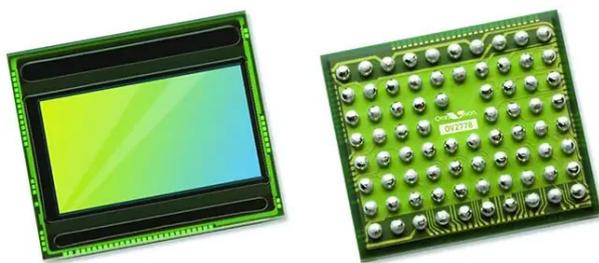
CMOS image sensor

Mobileye believe it possible to meet the new requirements with a camera-only approach, but this will depend strongly on vehicle headlight design and 'AI' processing capability.

Shortwave infrared (SWIR) sensors from vendors like Sony use an InGaAs photodiode layer bonded to a CMOS silicon substrate with the readout circuits. Achieving fine-pitch bonding (and therefore smaller pixels) is key to improved resolution. Single cameras that cover both the visible spectrum and SWIR are possible, but expensive. New CQD (colloidal quantum dot)-based sensors from companies like SWIR Vision Systems promise significant cost reduction by using more standard CMOS processing techniques, but SWIR may be more appropriate for in-cabin sensing, since the wavelength does not give significantly better detection capabilities than visible light in fog. SWIR also requires active illumination, which presents cost and power challenges for long-range detection.

Tri-Eye also have a CMOS-based HD SWIR sensor allowing 2D imaging and 3D mapping of the road in all visibility conditions, at much lower cost than lidar. It uses a 1,135-nm laser illuminator and need no InGaAs detector.

TriEye SWIR camera

Lidar also has the potential to overcome cameras' night vision performance limitations, because it uses active illumination. Costs in China are dropping, starting to approach $200 on the way down, but lidar units are still considered too expensive for standalone AEB systems today. As more auto automakers use lidar for L^3 driving (or L^2 in China), the lidar units can also be used for the AEB function. In fact, AEB is the main lidar function in China today.

FMCW lidar has the advantage of being able to instantaneously measure speed and distance, and has better adverse-weather performance versus ToF lidars. Perception accuracy is much better than camera systems, and lidar is better at classifying irregular objects. It also can reduce false activations, for example on steep slopes or with metal plates on the ground. Swiss-Re did a study on collision avoidance in cars with and without lidar, and found an improvement of at least 25 per cent with lidar enabled.

HD radar resolution is also improving, making this a promising alternative to lidar as a second sensor for L^{2+} driving and potentially the AEB function. HD radar also is not affected by lighting or weather conditions. New radars with air-waveguide antennas have a range of up to 300m and can detect objects like motorcycles at close to those distances. These 4D radars not only scan the horizontal plane, but also measure the height of objects using a 2D array of antennas, which helps reduce false positives from things like manhole covers. Two corner radars can offer a 250° field of view. Lidar can still outperform radar in many small-object detection scenarios, though, with a 10× improvement in angular resolution.

Another possible solution is the FIR (far infrared) or thermal camera. Traditionally these have been expensive and so confined to defence and surveillance applications, but improved microbolometer sensor technologies have allowed for cost reductions and better resolutions.

The Owl Thermal Ranger, for example, provides 1-megapixel resolution over the full LWIR spectrum at 120 fps, and doesn't rely on active illumination. A chip stack allows the readout logic (ROIC) to be placed directly under the sensor, and an FPGA is typically used today for the digital logic. The Owl camera also does not need a traditional ISP; those functions can be performed in the ROIC and allows for shutterless operation.

Thermal cameras do not need lasers, scanning systems, or optical alignment. Owl believes a VGA-resolution thermal camera should cost under $90 by 2029 when the U.S. AEB mandate goes into effect, and an HD camera at < $250. Size is also smaller than lidar units, and total power can be less than 3W. Owl CEO Chuck Gershman told DVN his company "see a huge increase in interest in thermal cameras from the automakers since the new NHTSA regulation came out, and believe this will be an optimum solution for next generation ADAS designs".

Owl Thermal Camera

Thermal cameras traditionally required expensive germanium glass lenses to transmit the FIR wavelengths. Newer chalcogenide glass materials and wafer-scale moulding technology from companies like Umicore are also making significant strides in cost reduction here.
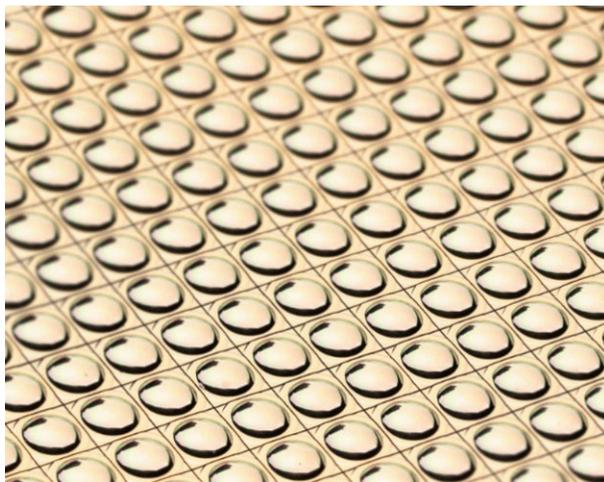
Umicore Tessella™ Lens Array

September 2024, VSI labs completed FMVSS 127 PAEB testing equipped with Teledyne FLIR's latest automotive thermal camera and Prism™ 'AI' perception software. The LWIR camera could see multiple times further down the road than the headlights could illuminate, giving improved detection, less false positives and slower deceleration. LWIR is better at detecting the objects you want to brake for versus camera, radar or lidar, including animals on the road and works better than lidar in fog and heavy rain.

Flir Thermal camera (above), standard camera (below)

There are also unique integration challenges with lidar and IR cameras. Standard windshield glass does not transmit FIR wavelengths, so automotive windshield manufacturers like Saint-Gobain have developed glass with a special crystal area for the FIR camera—allowing standard and IR cameras to be mounted side-by-side.

It still remains to be seen what the optimum AEB solution will be. A camera-only solution with appropriate headlight design and 'AI' processing capability may be able to meet the standard. A low-cost SWIR or FIR (thermal) camera may be better for standalone applications, though, if the automaker is also providing L^3 driving—then a camera + HD radar or camera + lidar solution may be a reasonable choice.

In all cases, the 'AI' software and processing to do pedestrian and other object detection and sensor fusion is also a key part of the overall solution. Processing (object detection and classification) at the sensor can reduce latency and improve scalability, but this is maybe more cost effective in the central computer, where sensor fusion is also done.

Owl, for example, can provide ROS outputs of classified objects inside the camera module, which lowers main-ECU performance and power requirements.

DVN Interview: Mobileye AEB Chief Shimon Solodkin

DVN: What is Mobileye's view on what kind of hardware and software will be needed for the FMVSS 127 AEB regulation?

Shimon Solodkin: Mobileye's current camera-based systems demonstrate strong performance in nighttime AEB scenarios, including with only a single front-facing camera. For FMVSS 127, achieving compliance largely depends on the overall system design, including headlamp optimisation on the automaker side. Our current assumption is that a single camera shows very good performance against FMVSS performance metrics. Mobileye's camera-based solution leverages advanced image processing and 'AI' algorithms achieve high accuracy for pedestrian and vehicle detection, even in challenging low-light conditions, without requiring additional sensors. Additional sensors beyond cameras would add cost and complexity barriers that could limit widespread adoption.

DVN: Are LWIR thermal cameras a better solution?

S.S.: Mobileye believes optimizing the capabilities of forward-facing cameras, combined with robust 'AI' processing, offers a more cost-effective and scalable solution for meeting regulatory requirements.

DVN: How about HD radar?

S.S.: Radar's resolution for detecting smaller objects or differentiating pedestrians from other obstacles is less precise than camera-based systems on their own. Mobileye integrates radar with cameras in some configurations to enhance redundancy and performance, especially for higher levels of autonomy.

DVN: Lidar is still expensive; how does HD radar compare?

S.S.: The imaging radar solution we are preparing to bring to market demonstrates the potential to reduce the need for surround lidar in advanced systems, offering cost advantages to automakers without sacrificing performance. However, we believe Mobileye's camera-based solutions will be capable of meeting regulatory requirements without the need for the added cost and complexity of imaging radar or lidar. Imaging radar and lidar become more relevant as automakers deploy more advanced automated systems, such as eyes-off highway driving.

DVN: What should the 'AI' component of an AEB system look like?

S.S.: 'AI' models for driver assistance applications are most efficiently deployed on purpose-built hardware optimized for 'AI'-specific workloads. Mobileye's EyeQ family of SoCs are designed from the ground up to deliver high-performance, low-power processing tailored for ADAS and autonomous capabilities. Our processors can handle the demands of multi-sensor fusion, including both cameras and radar, with enough computational power to enable real-time object detection and classification.

As an example for 'AI' integration, the EyeQ6L harnesses a deep learning dynamic neural network (DNN). When combining the additional computational resources EyeQ6L offers with new 'AI' integrations, this unlocks powerful capabilities, like Neural Network Semantic Segmentation (NSS), our pixel segmentation DNN, and pairs it with advanced classifiers, which enables "pathways". Pathways are in reference to a novel algorithm that introduces center paths for all lanes in the image simultaneously. There are also multiple new sensing products, such as advanced, any-object detection and enriched semantic information of vulnerable road users and vehicles alike.

DVN: What is the optimal sensor set for L^{2+} including AEB?

S.S.: By 2027, we anticipate L^{2+} capabilities, such as eyes-on/hands-off highway autopilot, will be offered as a premium option by most global automakers. Mobileye's scalable architecture supports both cost-effective base configurations and enhanced systems with additional sensors for L^{2+} to L^3 functionality. For these requirements, our Surround ADAS solution, using front, rear, and parking cameras linked through a single EyeQ6H, provides robust safety and driver-assist features with a simpler sensor configuration and lighter computing load, making it a cost-effective option for mass market vehicles. At the premium end, Mobileye SuperVision™ delivers robust, hands-free L^{2+} functionality in defined domains through 11 cameras for 360-degree coverage, as well as an HD Map and Mobileye's RSS driving policy model, using two EyeQ6H—building on the economies of scale enabled through Surround ADAS.

DVN: How does camera detection of objects differ from human perception?

S.S.: "Perception" is the key term—humans perceive objects, the environment and key driving tasks in many ways that surpass even the most advanced camera systems. However, cameras have the advantage of never being distracted or fatigued from sensing what's around the vehicle. Our long history with camera-based safety systems proves that technology working together with humans saves lives and reduces crashes.

DVN: Are there requirements on low beam performance for good AEB performance?

S.S.: Yes, there are minimum requirements already defined in headlamp regulations. Mobileye works with automakers to align headlamp design and sensor performance to meet these standards effectively.

DVN: What would an optimum low beam look like as far as sensors are concerned?

S.S.: FMVSS 108 defines the maximum allowable illumination for low beam performance, which serves as a key benchmark for AEB nighttime performance. Mobileye is actively collaborating with automakers to strike the right balance between optimizing illumination for sensor performance and ensuring compliance with FMVSS 108.

DVN: In a camera system, what is the time span for object detection?

S.S.: Our front-camera system is capable of detecting objects at ranges of hundreds of metres during daytime conditions. In low-illumination scenarios, such as those specified under FMVSS 127, detection range is more constrained due to the more limited visibility provided by low beams. However, the nighttime breaking scenarios outlined do not require extremely long detection distances for AEB to be effective. Detecting an object as close as 40 metres is sufficient to ensure safe braking under such conditions.

DVN: What do you think about low beam for distant pedestrian detection under streetlights?

S.S.: Detection with low beams under street lighting has been a standard part of NCAP testing for several years. We don't see this as a significant challenge, as current systems on the market have consistently demonstrated strong performance at speeds up to 60 km/h as required by NCAP. We work frequently with automakers to ensure low-beam headlights provide enough light for robust camera sensing in these situations at a variety of speeds.

DVN Interview: Magna's Jeffrey McWilliams

Jeffrey McWilliams is Magna Electronics' Marketing and Communications Manager, and spoke with us on Magna's views about the new US requirements for AEB.

DVN: What is Magna's view on what kind of hardware and software will be needed for the FMVSS 127 AEB regulation?

Jeffrey McWilliams: Regular cameras, such as RCCB, are generally sufficient for the AEB component of FMVSS 127, but their adequacy for the PAEB part is uncertain. Compliance with FMVSS 127 is not the sole criterion; the system must also not pose an unreasonable risk to motor vehicle safety.

For robust performance, these camera systems should ideally be supplemented by radar. Even with this supplementation, there may still be challenges at night, particularly with detecting stopped vehicles in traffic lanes that lack taillight illumination.

SWIR technology's effectiveness for PAEB would necessitate active illumination. The primary issue is not SWIR itself, but the active illumination systems required. To avoid interference from other light sources in the same wavelength, gating is necessary. Alternatives to SWIR exist, such as regular CMOS FPAs, which are sensitive in the NIR spectrum (< 1,000 nm). Although the quantum efficiency diminishes with longer wavelengths, CMOS FPAs are a viable alternative. However, careful configuration of the illumination is required to ensure it meets eye-safe class 1 standards, a domain in which we hold patents.

A single forward-facing camera might suffice for L^2 automation and meet nighttime AEB specifications, but a more comprehensive solution, potentially involving supplementary radar and advanced illumination technologies, will likely be necessary to ensure robust performance and compliance with safety regulations.

DVN: Are LWIR thermal cameras a better solution?

Jeffrey McWilliams: LWIR thermal cameras offer significant benefits in darkness for detecting objects with distinct heat signatures. However, they are not without drawbacks.

The cost of LWIR thermal cameras in the automotive industry is a critical consideration. While the target is generally to reduce costs, the real issue is the cost of alternative solutions to comply with FMVSS 127, including the risk of recalls. Regular FPAs are inexpensive but may not perform adequately in darkness, potentially leading to inadvertent braking. Lidar solutions, although viable, are currently more expensive. Other active systems, such as gated imaging, present interesting options but may not yet match the cost-effectiveness of thermal cameras. As thermal camera volumes scale up, their costs are expected to decrease, especially with solutions optimized for augmenting AEB/PAEB systems to meet nighttime PAEB mandates. Our thermal product is specifically targeted for this purpose.

One of the primary applications of thermal sensors is to meet pedestrian AEB requirements as standalone sensors. However, in practice, they serve as additional sensors that support the existing technology in the vehicle. This integration provides a more comprehensive and real-world aspect to the functional safety of the vehicle. By enhancing the capabilities of current ADAS systems, thermal sensors contribute to a more reliable and effective safety mechanism, ensuring better protection for pedestrians and other road users.

In terms of power consumption, thermal cameras are passive sensors and thus have low power consumption. In contrast, active solutions, including imaging radar, consume more power than thermal cameras.

DVN: How about HD radar?

Jeffrey McWilliams: All sensors have their strengths and weaknesses. Magna believes that a complementary sensor suite, such as a combination of HD radars and thermal sensors, provides the best system-wide solution. HD radars show significant improvements over traditional radars and can meet almost all AEB cases. They excel at distinguishing small objects in all weather conditions, providing range and velocity information. Although identifying pedestrians near guardrails can be challenging for some HD radars, Magna has resolved this issue. Additionally, classifying nearly motionless pedestrians is difficult, but multi-modal systems, where thermal sensors augment radar data, can fully classify pedestrians.

DVN: Lidar is still expensive, but will it be a better approach for AEB systems?

Jeffrey McWilliams: The question of whether lidar is a better approach for AEB systems should focus on the cost to comply with the regulation rather than a subjective definition of "better." Lidar remains relatively expensive, with US/EU vendors pricing it around $500 and Chinese vendors potentially offering it at half the cost. In contrast, thermal sensors can already achieve a price point significantly below $500 even in low volumes. Additionally, lidar, as an active system, consumes more power compared to thermal sensors. Therefore, considering both cost and power consumption, thermal sensors are likely a more cost-effective solution for AEB systems.

DVN: What should the 'AI' component of an AEB system look like?

Jeffrey McWilliams: The AEB solution requires more than just the sensor; it also necessitates a robust perception stack, which includes machine learning components. The placement of this perception stack—whether in the camera/radar/lidar module or in central compute—depends on various factors and the automaker's approach.

The processing requirement, measured in TOPS (trillion operations per second), is linked to sensor resolution but is not the only factor to consider. Thermal imaging can achieve PAEB with lower resolution compared to other imaging alternatives, while high-resolution radar currently has lower resolution. The specific compute requirements for high-resolution radar should be addressed by the radar team.

Thermal perception can be implemented in multiple ways: on shared hardware in a Central Computing Unit (CCU), on a dedicated system-on-chip in a standalone ECU or within the thermal camera itself, creating a standalone thermal sensor like our thermal product.

DVN: Will the AEB system be a separate domain, or will it always be part of the L^2 or L^3 driving system?

Jeffrey McWilliams: The AEB system, mandated by FMVSS 127 for all light vehicles starting in September 2029, is not dependent on any SAE classification for L^2, L^3, or L^4 driving systems. While some may include AEB within ADAS, AEB/PAEB functions are typically hidden from the driver until triggered by an event. Therefore, it is not appropriate to bundle them with ADAS or any level of automated driving system. However, all ADAS will also need to comply with FMVSS 127. Functional partitioning and system design depend on the automaker's preference and implementation. AEB and ADAS (including L^{2+} and L^3 are related features derived from inputs originating from a common set of sensors and are likely implemented on common hardware. It is unlikely that AEB will occupy a distinct domain, separate from other driving assistance functions. However, safety analysis will be required to demonstrate the robustness and integrity of AEB independently from these others.

Lighting News

Arteb and MIND: a strategic partnership for the future of automotive lighting

Arteb celebrated another milestone in its trajectory by signing a strategic agreement with MIND, reinforcing their commitment to bringing technologies to Brazil and meeting the growing demands of the automotive sector.

Under the leadership of Emerson de Paula Silva, COO of Arteb, and Jarbas Enzenberg, Director of Engineering and Laboratory, this partnership strengthens their position as a reference in innovation and quality in the market.

Arteb team thanks the MIND team, represented by Hossein Nafari, and all the partners who made this achievement possible.

Elba new CEO

On January 13th, 2025, Mr. Dan Dogojie has been appointed as CEO – General Manager of ELBA, replacing Mr. Florin Tulcan, who will continue his activity being member of ELBA's Board of Administration.

Mr. Dan Dogojie has a solid experience of over 10 years in ELBA and previous position was as Plant Manager – Elba Automotive.

His extensive knowledge of Elba company and automotive industry will ensure the continuation of Elba successful collaboration.

H-Great is strengthening Automotive LED development and production

China's H-Great will supply Geely Automobile

Having accumulated high-performance LED design and sealing technology for nearly 10 years, H-Great entered the automotive LED market and became a supplier to major automakers ahead of other companies. The company's LEDs are used in various types of lighting such as headlamps, taillamps, and interior lamps, as well as in-vehicle displays.

H-Great is facing head-on a market with great potential and is proceeding with the development of automotive LEDs and expanding its product lineup. Mass production of backlight LEDs was achieved at an early stage. The company's unique eutectic bonding technology is used in the headlamp LEDs to effectively suppress temperature rises. Additionally, the power consumption of tail lamps and daytime running lamps (DRLs), which affect the vehicle's cruising range, has been reduced by 30%.

According to the company's chief technology officer (CTO), Yang Zhilong, because automotive LEDs require high reliability and performance, overseas LED manufacturers have dominated the market until now.

H-Great has entered into a strategic alliance with major automaker Geely Automobile, and a model equipped with Geely's smart LEDs is scheduled to roll off the production line by the end of this year.

Brightek UPP: COLORbrate the Colours Within Seconds

In automotive lighting, below are the possible Challenges in RGB LED Calibration:

- Non-linear Brightness Adjustments: Adjusting LED brightness isn't straightforward. When designers modify current levels to change brightness, RGB components don't respond in a predictable, linear way. This can lead to colour inconsistencies, especially when brightness varies.
- Temperature-Induced Colour Shift: LEDs are sensitive to temperature changes. In automotive environments, where temperatures vary widely, LED colours tend to shift, compromising intended colours and uniformity.
- Module Surface Effects: RGB LEDs emit light through various module surfaces, and different surface materials can alter the perceived colour. When multiple LEDs interact with various textures, it's difficult to maintain a uniform appearance.
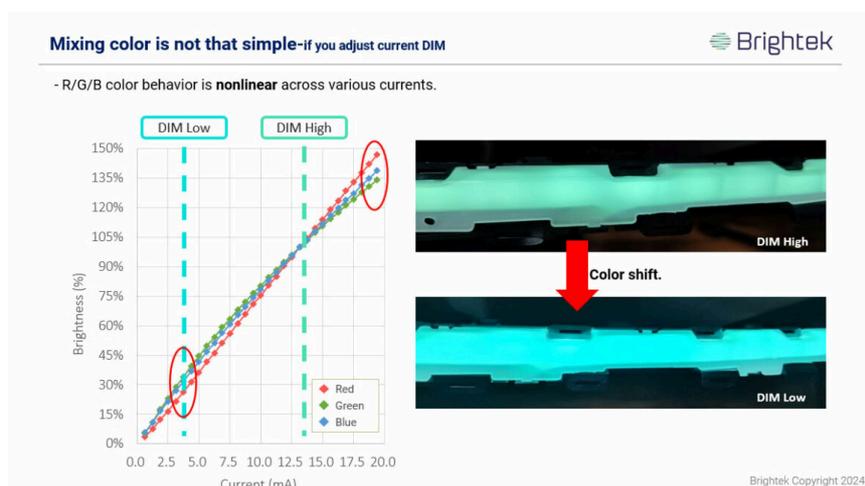
Brightek's Ultimate PWM Program (UPP) software is aiming to achieve rapid, reliable colour calibration by transforming the complex task of RGB LED alignment into a streamlined process. Rather than relying on time-consuming manual adjustments, UPP uses an advanced algorithm that converts the X/Y axis on a CIE colour system into precise Pulse Width Modulation (PWM) settings, enabling highly accurate colour adjustments across LEDs.

This conversion process is critical for achieving uniform colour output across multiple LEDs on the same surface or light bar. By mapping each LED's colour precisely to the target coordinates on the chromaticity scale, UPP try to ensure every LED displays the same colour—even if LEDs have slight variations in manufacturing, as per Brightek states, with an impressive 99% accuracy.

How UPP Calibrates Colours?

- Converting Chromaticity Coordinates to PWM: UPP translates the X/Y values on a CIE colour coordinate into corresponding PWM signals. PWM allows the software to control the RGB intensity levels precisely
- Uniform Colour Across All LEDs: Once the PWM settings are calibrated, every LED on the same surface or light bar will display a consistent colour, even if individual LEDs naturally emit light with subtle variations.
- Adaptable for Complex Installations: For Automotive Lighting where LEDs often interact with different surfaces, materials, and module designs, UPP's PWM-based approach can be a good solution.

UPP aim to bring designers below benefits:

- Save Time: UPP's swift calibration process, by using Brightek superb EVO 3838 ICLED, is 5X faster than traditional methods
- Achieve Greater Precision: With high-fidelity algorithms, UPP delivers 99% accuracy in seconds using EVO 3838 ICLED
- Ensure Long-Term Reliability: Managing both brightness and temperature-induced colour shifts

Maximize Accuracy, Minimize Time

EVO iCLed Accelerates Calibration Time and Perfect Your Colors

Performance Index	EVO	Other Brand Smart LED
Total Colors Calibrated	256	256
Total Calibration Duration	29 min 47 sec	2 hours 31 min
PWM Tunning Accuracy	99.06 %	42.54 %
Average Regression Count	0.19	11.49
Total Regression Count	48	2942
Total Calibration Retries	0	92

CIE1931 — LED RGB — sRGB
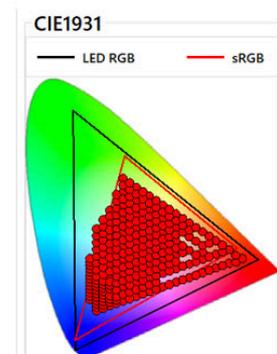
5X Faster, 99%+ Accuracy

General News

San'an increases its production capacity as demand for its microLED chips is strong

China-based San'an Optoelectronics is experiencing increased demand for its microLED wafers, and the company is expanding its production capacity. San'an currently has the capacity to produce 250 6" microLED wafers per month, and by the end of the quarter, it will be increasing its capacity to 1,400 monthly wafers.

San'an also has passed Samsung's audit and microLED validation tests for its latest chips, and the company is now entering into Samsung's supply chain for the company's large-area tiled Wall microLED TVs.

San'an produces its microLED wafers at its $1.8 billion mini-LED and micro-LED production centre in Hubei. The company has been developing microLED technologies for years. In 2018 it was reported that San'an and Samsung signed a long-term agreement to co-develop Micro-LED displays. In 2020 Sanan signed an R&D joint-project agreement with CSoT.

To go further …

BMW 7 Series ADAS Sensor Suite

Take a look at this online video describing the BMW 7 Series' sensor suite.