Introducing the next-generation of rain light sensing

Automatic wipers have become virtually ubiquitous in high-end vehicles, but how can manufacturers circumvent the challenge of false wipes? Sam Maddalena, Melexis’ Optoelectronics Business Unit Manager, explains.

A popular feature in most modern premium vehicles and in many medium-class models in Europe and Asia, the rain light sensor’s initial uptake can be attributed to its status as a comfort function. Subsequently it also has been viewed as an important safety device, as the correct wiper speed ensures good visibility in all conditions. Car manufacturers also view the rain light sensor’s location behind the rear-view mirror as ideal for a cluster of sensors, such as humidity, sun position and ambient temperature. Many rain light sensors already assess light levels, relaying that information to an ECU to enable automatic headlight control. This feature is also seen primarily as a comfort function, with an ECU taking over the decision from the driver to illuminate headlights in changing weather conditions, during dawn and dusk driving, or at the entrances and exits to tunnels.

The rain light sensor is an opto-electronic system that generally consists of LEDs, photodiodes, a microcontroller and the necessary control circuitry. An optical sensor with a near infrared, light emitting diode located just behind the rear-view mirror sends an infrared beam onto the back side of the windscreen. If there’s no rain on the glass, the windscreen reflects 100% of this NIR light back into a receiving photodiode, but when rain falls on the glass, the difference in the amount of reflected light allows the rain intensity to be calculated.

While the rain light sensor system works well in lab conditions, the sun is a major disturbance factor in commercially available systems. For example, when the driver navigates round a roundabout, the sun can swiftly cross the windscreen from side to side, creating an optical effect that results in false wipes. On a dry windscreen, the wiper will make an unpleasant sound and if it happens too often, the wipers will quickly degrade.

Until now, it has been a considerable challenge for manufacturers of rain light sensors to avoid disturbance from the sun. Either the system has to ignore signals or wait to do a double or triple check, making the system less responsive. Among the alternatives is a delicate optical system with special waveguides to monitor the raindrops, which is both complicated to integrate and expensive.
A solution is to enable the system to split the sun component from the rain component, thus allowing it to differentiate between rain and an errant sun signal. Melexis’ latest rain light interface chip, the MLX75308, achieves this and more. With connections to both rain and ambient light sensors, as well as special compensation techniques, the Melexis chip can determine when a sun signal occasionally confuses the rain sensor, allowing the ECU to make the appropriate decision.

Since its inception, the rain light sensor has come to inhabit a common area of vehicle real-estate. It can always be found mounted just behind the rear-view mirror, in the best place to monitor oncoming rain and adjust wiper speed accordingly, without compromising the driver’s field of vision. The Melexis rain sensor interface chip sits next to the microcontroller for the rain light sensor module. The rain light sensor module is connected to one of the vehicle’s ECUs for controlling comfort and safety systems. The MLX75308 provides communication control and power to the LEDs that emit the IR beam into the windscreen, the photodiodes that receive that light, as well as photodiodes that detect general ambient light conditions. Melexis interface IC acts as the master, splitting the signals and sending them over SPI to the microcontroller, as and when needed. This removes much of the computational burden from the microcontroller and makes the system design much easier.

Individual manufacturers often have their own dedicated rain sensing algorithms. For example, some manufacturers favor a more relaxed rate of wiping, prioritizing that over a perfectly clear windscreen. Other manufacturers will activate the wipers at the slightest suggestion of rain. Some manufacturers always run with the headlights on, whilst others will only active the headlights in precise ambient light conditions. By presenting the signal data to the microcontroller on-demand and in a digital form, Melexis MLX75308 enables Tier 1 and OEMs to implement their own algorithms on the microcontroller to determine exactly how this data should be handled.

Contrasting with the individuality of rain sensing algorithms is the demand from OEMs for a rain sensing system that works across different car platforms. This means that the system needs to be flexible enough to cope with a wide variety of windscreen angles (windscreens span 40° to 90° angles) and different shades of windscreen tinting, from those that are very black to those that are crystal clear. Sensor interfaces need the additional bandwidth to cope with multiple sensors, enabling high-end manufacturers to integrate sensors that will cover a larger area of the windscreen in order to sense the slightest raindrop. The rain light system also needs to work over an exceptionally high current range – from picoamps to milliamps – as the difference between sensing ambient light on a bright day and the limited light levels when driving at night result in multiple orders of magnitude difference in incoming current levels. Melexis’ MLX75308 is programmable, versatile and offers a high dynamic range, enabling it to cope with the full spectrum of light levels, windscreen angles and shades of glass.
When integrating rain light sensors, other design criteria include size and performance. The MLX75308 is being made available in a new generation leadless QFN package, measuring just 4 x 4mm. With external led drivers, the MLX75308 interface lets automotive designers choose the drivers that best suit their system. So if space is at a premium, for example, then strong LED drivers will enable the use of very small photodiodes.

Looking to the future, Melexis is working on a second generation of rain light interface that offers higher integration and a smaller PCB footprint. This will use integrated LED drivers, at the expense of lower light power levels.

Beyond that, the idea of integrating a cluster of sensors with the rain light sensor is appealing. Indeed, additional sensors are only an incremental cost, as the power and local interconnect network (LIN) connections are already present. One of the sensors that could be added is a Contactless Temperature Sensor using FIR (Far InfraRed) to serve applications like automatic air-conditioning or automatic windshield defogging. Both comfort applications that are becoming increasingly popular in many countries.

Melexis has raised the performance bar when it comes to rain light sensing. With its combination of optical and automotive mixed signal design expertise, the company has tackled a long-held technical challenge for today’s automotive manufacturers in an easy-to-integrate and cost effective way.