Regular readers will be aware of our coverage of the application markets for compound semiconductors, in particular those in the automotive sector where the high radiance, robustness and low-cost of LEDs ensures their consideration in many on-board systems. However, LEDs are also starting to make other contributions peripheral to the vehicle itself. Here we look at the high-performance end of vehicle technology to show how LEDs are improving not only the safety but also the enjoyment of motor sport.

Motor racing to give green light to exploit the advantages of LEDs

III-Vs Review has often covered the illumination aspects of LEDs (see the article on Lumileds in Issue 3, p44-47). However, peripheral lighting is also just one of a growing number of applications for LEDs, in particular for motor vehicles. For example, white LEDs are being adopted for backlighting instrument panel displays as well as reversing lamps and soon interior courtesy lights.

It seems that high-brightness LEDs of all colours are penetrating markets previously dominated by older forms of lighting such as incandescents as well as early-generation LEDs. Examples include blue LEDs on the PlayStation 2 (their first major application as individual status indicator lamps), multi-colour LEDs on Christmas trees and, most recently, a rock concert that I attended where the band had had their guitars fitted with ultra-bright LEDs to add impact to their performance!

Application to motor racing

Always at the leading edge of technology in electronics and otherwise, Formula 1 motor racing is now using LED illumination at Grand Prix tracks around the world. Although huge TV screens using multi-colour arrays of high-brightness LEDs are now commonplace at such outdoor spectator events, there are other ways that the LED’s unique mix of characteristics ensures further penetration into this high-profile sport.

Here we look at one application which is already in place, plus a further prospective application. These firstly add to the enjoyment of spectators as well as enhancing the safety of the drivers and track-side workers. They also provide improvements in performance, reliability and energy efficiency.

Colour purity

Colour purity is a very important characteristic for the acceptability of new light sources. Sony most likely opted for blue LEDs on its PS2 games console only because it conforms with the blue colour theme of the unit. Other LED colours are cheaper and function equally well, but Sony was more interested in the colour rather than the impact on the overall cost of the unit.
Even though today’s racing drivers rely on radio communications, other signals (such as flags waved by track-side marshals) are still in use to warn of local hazards. These are simple so that they are easy to see as well as being unambiguous in their meaning:

- blue - allow a faster car to pass;
- yellow - no overtaking due to local hazard (e.g. a stationary car);
- green - the track is clear;
- red - race halted;
- black - return to the pits.

Over the years drivers have seen much use of most colours, but only a few have been shown the black flag (and several of these drivers claimed to have not seen it).

This highlights one of the main problems confronting the race organiser. The signals must be seen in all weather conditions (ranging from bright sunlight to rain) to someone travelling at speeds of over 150 mph (240 km/hr). Not surprisingly, for some time the use of flags waved by track-side marshals has been under scrutiny.

Money is usually no object in F1 so it has been surprising that a high-tech alternative has not been implemented already. After two fatal accidents involving flag marshals in the past two seasons, there is hope that a better system is about to be introduced which will make full use of the special characteristics of LEDs. The new system combines sensors, fibre optics and on-board displays with computer software and is now poised for full-scale deployment at 20 tracks worldwide.

**MIDC on track**

The new system - called Marshalling Information Display Control system (MIDC) - works with a new transponder-based communications system and could be in place as soon as the Formula 1 technical committee gives the green light.

The system debuted in the Orange Arrows F1 cars at the season-opening Australian Grand Prix in Melbourne and worked very well. The drivers could quickly and easily see track status via LEDs on the top of the instrument panel in the cockpit.

McLaren has also trialed the system, with the MIDC tricolour LED warning system placed in front of the driver’s steering wheel (see Figure 1). It is readily visible yet faired-in to minimise aerodynamic drag.

**Transponders and fibre optics**

The system creates a marshalling map showing race-control track status at all points of the circuit. Loops are set up around the track which detect signals from transponders on each car to sense the position of every car on the track at all times.

A fibre-optic communications ring links all parts of the track to the main control centre. What is special about the new system is that the controller rapidly processes the data and then feeds status information back to the teams and their drivers. This can appear simply as an easily-noticed single lamp lighting up on the instrument panel.

**Alert status**

Currently, if an accident occurs at a particular part of the track, the Formula 1 Operations Management system (FOM) alerts track-side marshals who then show a flag accordingly (for example, a yellow flag held still to caution of a hazard - e.g. a car stationary at the side of the track - or waved to tell drivers to slow down).

In the new system this would be indicated by a yellow LED in the cockpit of each car as the driver approaches the hazard (constant for caution; flashing to slow down). When the car is past the hazard, the light would extinguish. Since the track is segmented into zones which are each 200 m in length, the hazard zones can be designated precisely.

Previously, there has been much controversy about whether or not a driver had seen the waved flags. With the new system the driver’s...
Automotive applications: the fastest-growing sector of the LED market

According to a market analysis from the 2nd edition of the report "A Strategic Study of the Worldwide Semiconductor Optoelectronic Component Industry: Market Prospects to 2005" by Reed Electronics Research, UK, the worldwide market for LEDs is growing at a double-digit rate and should exceed US$3.2bn by 2005 (see graphics).

The automotive sector is one of the fastest-growing application areas for LEDs of all types. The market share will grow from 15% in 2000 to 20% in 2005. This is being boosted in two principal areas:

- Replacement of existing components, principally filament lamps, for internal and external lighting functions.
- New applications which exploit the unique mix of characteristics of LEDs, e.g. display panel backlighting, extra stop-lamps, roadside signalling, etc.

Unlike traditional incandescent lamps, LEDs are robust and reliable enough to provide, for the first time, "fit-for-life" functionality. In particular, despite adverse conditions such as vibration and temperature, sealed lighting units featuring bright, low-power LEDs have a high enough Mean Time Between Failure to outlast the projected lifetime of most vehicles.

If the race has to be stopped then the FOM can switch on a red lamp in each car. A black flag — shown to a driver who has committed a major misdemeanour — is at the moment less obvious to implement but they are working on it! This could perhaps be signalled by flashing all the lights in a sequence.

To avoid failures the system has numerous back-up procedures. This may eventually mean that the current use of a safety car (sent out on to the track while debris is cleared etc) can be eliminated too.
The two fatal accidents to track-side marshals are believed to have been due partly to the track-side signalling. Apertures are made in the safety fence to allow flags to be held out. In a freak incident at the Australian GP, a marshal was killed by a detached wheel passing through such an aperture. With the new system, these can perhaps be eliminated and the integrity of the fencing will be complete (there will always be the need for marshals to gain access to the track to attend a stricken car, but this can perhaps be done via special gates).

The MIDC system looks set to provide an overdue improvement in track-side safety for marshals. Also, it will assist drivers, their teams and race officials in the running of the race, reduce controversial racing incidents (such as drivers not seeing waved flags), and eliminate confusion over the precise positioning of cars when collisions occur.

Opportunities in sponsorship
As already noted, LED-based track-side multi-colour displays show all the racing action at many parts of a circuit. These would not be possible using any other illumination system and are both efficient and easy to operate. Of course, they also provide numerous opportunities for advertising, extending even to LED-display-equipped airships beaming down messages to the spectators below.

Advertising has become an all-important financial supporter of motor racing, none more so than in the USA. The racing car's surface area is almost saturated with sponsors, but even this provides an opportunity for further market exploitation of LEDs.

A UK-based company, Adflash Ltd, has developed 'WheelFX'. As one commentator remarked, it is a system that might "have fans wondering if they are seeing things". Debuted at the Lehigh Valley Grand Prix US Champ Car race at the Nazareth Speedway, PA, USA on May 4-6, the wheels of the Newman-Haas cars driven by Cristiano da Matta and Christian Fittipaldi were used to display the logos of the team's principal sponsors: Kmart, Texaco/Havoline and Toyota (see Figure 2).

Through some clever proprietary exploitation of the stroboscopic phenomenon, LEDs fitted to the rotating inner rims of the wheels constantly display a static image on the rotating face of the wheel, regardless of the speed.