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RECENT DEVELOPMENTS IN VEHICLE EMISSIONS TEST INSTRUMENTATION

Vehicle manufacturers and engine developers are fighting an ongoing battle to optimise performance, fuel economy and emissions. Although the last two are largely related, the emissions have to comply with standards such as Euro 5 (and Euro 6 from 2014) in Europe, and the EPA Phase 3A standards in the USA. Taking into account the global markets, differing standards for petrol (gasoline) and diesel cars, and the further standards for light commercial vehicles and lorries (trucks) and buses, the situation is highly complex.

Emissions are measured during standardised emissions test cycles; not only are the tests expensive to run but, if the targets are not met, the costs involved in further development of engine hardware, catalytic converters or engine control maps can be very high. All of this points towards the need for high-quality instrumentation that is accurate, reliable and easy to use.

The latest standards lay down limits for carbon monoxide (CO), total hydrocarbon (THC), non-methane hydrocarbon (NMHC), nitrogen oxides (NO_x) and particulate matter (PM). In a state-of-the-art engine or chassis dynamometer, instrumentation for measuring these values - as well as the dozens of other test parameters - is typically connected to a data acquisition system and control PC via a CAN (controller area network) bus. Compared with traditional hard-wired instrumentation, the use of CAN offers numerous benefits. For instance, it is quicker and easier to make the physical connections, and the risk of wiring errors is greatly reduced. In addition, the sensors can be connected directly without the need for signal conditioning, and CAN offers good immunity to electromagnetic interference. Overall, CAN makes it simpler and quicker to implement far more sophisticated instrumentation systems, thereby enabling engine developers and dynamometer operators to get a more detailed picture of the engine's behaviour.

CAN has also become an industry standard in engine and chassis dynamometers, where the protocol's inherent characteristics and its compatibility with the engine- or vehicle-installed systems make it a logical choice.

CAN communications are integrated as standard in state-of-the-art instrumentation such as the ECM Lambda 5220 that takes fast measurements of Lambda, air-fuel ratio (AFR), Φ (equivalence ratio) and $\%O_2$ (oxygen). Easy and quick to set up, calibrate and use, this analyser is suitable for developing and testing all sizes of internal combustion engine operating with any fuel, including hydrogen. With a response time of less than 150ms, the CAN interface and a facility that enables the analyser to be turned on and off by a signal from the vehicle's ignition switch, the Lambda 5220 can be used in the loop during development of real-time emissions control strategies. In addition, the Lambda 5220 incorporates pressure compensation that corrects for errors due to exhaust back pressure, altitude changes and barometric pressure changes; this feature is particularly important for pre-turbo and diesel applications.

As well as being compatible with Bosch and NTK wideband sensors, the Lambda 5220 can be used with ECM's own wideband sensors that are factory-calibrated. Importantly, the calibration data is stored on a chip in the sensor's connector, which enables the sensor to be air-calibrated in the field from the Lambda 5220. Also, should a sensor become damaged or need to be changed for any other reason, the stored calibration data makes sensor changeovers far quicker and easier.

A related instrument is the ECM NOx 5210, a versatile NOx, Lambda and $\%O_2$ analyser for use with diesel, lean burn, HCCI and gas turbine engines. Two versions are available, the NOx 5210t for engines that can operate rich, lean and at stoichiometric, and the NOx 5210g for engines that operate lean of stoichiometric - which covers most diesel engines and gas turbine engines. As with the Lambda 5220, the sensors' calibration data is stored in a memory chip in the connector. A fast response time and the built-in CAN capability mean that the NOx 5210 is also suitable for use in the loop during development of real-time emissions control strategies.

Where there is a need for compact, ruggedised modules rather than the more traditional style of instrumentation, products are available such as ECM's LambdaCAN Module, a wideband Lambda, AFR and $\%O_2$ measurement module with a CAN interface. In terms of its capabilities, this is similar to the Lambda 5220 - with features such as pressure compensation and compatibility with sensors having a calibration memory chip - but the compact, rugged and sealed modular design makes it particularly useful for mounting in

vehicles. Although there is no display on the module, all parameters can be accessed via the test system's host PC or, indeed, via any other display connected to the CAN bus, such as the dashCAN two-channel display unit that connects to the CAN bus for displaying data from any two instruments. If individual cylinders are being monitored, up to 16 of the LambdaCAN modules can be multiplexed.

Just as the LambdaCAN is a compact alternative to the Lambda 5220, the NOxCAN is a ruggedised NOx, Lambda and $\%O_2$ analyser module that can be used instead of the NOx 5210 when there is a need for a ruggedised instrument without an integral display.

While the foregoing has focused on instruments for measuring emissions, it should be remembered that CAN-compatible instrumentation is available for other essential parameters such as air flow, fuel flow, temperatures and pressures, enabling dynamometer operators to assemble complete test instrumentation systems based around a CAN bus. As mentioned earlier, the beauty of CAN lies in the simplicity and ease with which complex and sophisticated systems can be created, yet there is just one cable to be connected to the data acquisition system and control PC

ECM instruments are available in the UK from Labcell Ltd. Datasheets can be downloaded from the company's website at www.labcell.com, or telephone 01420 568150 or email mail@labcell.com for more information or to request a demonstration.

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