Abstract: Electric motors are the backbone of industrial drive technology. Without them automated production processes would for example not exist.

Motors deployed can have a capacity ranging from a few watts up to several kW and even MW. The control technology of these motors is relatively simple when they have a constant speed. It is, however, often necessary to regulate motor speed, for example fans in large ventilation and air-conditioning systems which regulate the flow of air via the RPM.

Speed control of units having higher performance (traction control of trains, drive motors on boats and electric busses) is achieved using IGBT semi-conductors, which have the feature that with a very small control power they can control large loads. The signals for IGBT control are transferred, dependent upon installation and voltage requirements, using plastic optical fibres (POF).

This whitepaper considers the following options with respect to reconfiguration of the POF transmission path.

The focus here is on simplified installation, time-saving in service actions and the use of active optical cables (AOC), which make an optical line redundant.

Advantages achieved by way of "electrical connection - optical transmission" can be best used in industrial environments.

State-of-the-art:

In order to control a three-phase motor, six IGBT driver boards are necessary (two IGBTs per phase); the driver boards are connected using plastic optical fibres with the control electronics. The POF fibres provide for interference-free and galvanically-isolated signal transmission.

In particular in the case of locomotives, IGBTs are installed in a redundant configuration such that if one fails, the controller board can transfer the function to the redundant component and therefore maintain system function. As a consequence there is a duplication of the optical transmission lines.

Block diagram (optical transmission lines in red):

The connection between the controller and IGBT board is achieved by way of separate POF assemblies. The electro-optical conversion takes place on the PCBs in the transceivers, the optical contacts provide the connection.
Whitepaper

New options in IGBT control: electrical connection – optical transmission

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Whitepaper

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to the fibres. The optical power budget is sufficient to realise one or two connectors in the transmission line.

The make-up of the POF lines can be done on site - although, in order to achieve appropriate reliability / quality of the fibre surfaces, the preference is for pre-fabricated cables.

Controller board with 16 optical duplex channels and star distribution to individual IGBT driver boards:

Problems in current applications

Due to the use of separate transmission and receiving elements, controller boards require a great deal of space which makes them unnecessarily large. In addition, both insulation as well as servicing require attention to be paid to the various POF fibres being correctly positioned/connected. The allocation to the IGBTs must be correct and transmitters/receivers must not be confused.

The optical elements used as standard are designed for industrial applications by having extended temperature ranges and higher vibration capacities, but only offer simplified strain relief for the fibres. In addition, the optical interface must be very carefully protected against contamination, and when unplugged it is absolutely vital to remember to use protective inserts.

A further disadvantage is the retrospective mounting of the optical elements on the controller board, since these are not generally reflow capable.

HARTING – the solution:

The solution developed by HARTING - working in collaboration with leading rail vehicle manufacturers - moves the controller board transceiver into a plug-in module and integrates the optical interface: electrical connection - optical transmission is the new transmission principle.

HARTING has adopted tried-and-trusted solutions from the DIN 41612 series for the electrical plugs and system casing.

A particularly interesting point is the die cast zinc casing which is able to satisfy the higher requirements of the rail market with respect to robustness and EMV. It also offers the option of inserting the cable either straight or angled and therefore also integrates the best kink protection and tension relief for the fibres.

The conductor card in the DIN casing can if required also include the series resistors and the support capacitors, in order to ensure the optical elements are optimally controlled and to exclude any interference.

The Active-Optical POF module means customers have the option of simultaneous contacting up to 16 optical channels in a very small space. Installation and servicing are much simplified, hand-in-hand with time savings.

The HARTING range is complemented by pre-fabricated systems which can be prepared and tested in accordance with customer requirements.
HARTING Active Optical POF module:

Summary and outlook:

The HARTING system supports data rates of up to 50 Mbit/s, although 10 Mbit/s is often sufficient, since the transmission elements as installed stand out because of their particularly high slope steepness. The supply voltage can be either 3.3 volts or 5 volts.

Depending on customer requirements, the transmission/receiving elements can be sourced from various manufacturers, and in an ideal case only the circuit board needs to be new.

In present applications IGBT driver boards remain unchanged, which simplifies the changeover to the new system when redesigning of the controller board.

In the future the principles applied to the controller board can be transferred to the IGBT driver board, and here again a bidirectional optical plug-in and electrical transmission could be achieved with the help of a compact D-sub casing. This means double-sided active optical cable can be used to control IGBTs in an industrial environment.

Active-Optical-Cable Assembly:

About HARTING / contact:

The HARTING technology group uses its in-house skills to develop tailor-made solutions and products in the fields of electric, electronic and optical connection, transmission and network technologies, production, mechatronics and software production as well as connectors for energy and data transmission such as in mechanical engineering, machine construction, rail engineering, wind power systems, factory automation and in the telecommunications sector.

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The author has been a member of the HARTING technology group since 1997. He initially worked as a development engineer for fibre-optic transmission systems, later working as market manager for power supplies and energy management. Since 2002 he has been responsible product manager for fibre optic solutions at HARTING Electronics.

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