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Application Note AN-03

Pressure Tolerant Solutions

Electronics Design Group

FOCAL
TECHNOLOGIES

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1.0 Introduction

Focal's subsea multiplexer cards are typically installed in pressure housings that maintain the electronics at a one atmosphere pressure. Although this is a common and well proven configuration, it does usually require a relatively expensive enclosure including the pressure housing, seals, endcaps, and an array of subsea connectors or penetrators for connection to external devices. In ROV systems, in particular, the external devices can be cameras, sonars, sensors, and various control systems, all of which need to be connected to the multiplexer for combining the signals onto a high speed optical link to the surface.

Typically the multiplexer is installed in a pressure housing that is already required for other electronics. In some system configurations, though, the cost of an enclosure can be avoided by installing the multiplexer in an existing oil-filled compartment, such as a junction box, where the multiplexer will be exposed to the same ambient pressure as the vehicle, roughly 1.5 psi per meter depth. Focal has developed a full range of pressure tolerant multiplexer cards and components for these applications with typical depth ratings of 4000 m (6000 psi).

2.0 Tradeoffs

Although significant equipment cost can be saved by eliminating pressure housings and associated components, the total cost of operating with pressure tolerant components needs to be carefully considered:

1. Maintenance: Installing and servicing cards in oil filled boxes can be difficult and messy compared to air filled housings. Accessing the cards to reconfigure modes of operation via switch settings, for example, inherently requires some drainage of pressure compensating fluids.
2. Life: Pressure tolerant components see significantly more stress at 6000 psi than regular components at 15 psi, so component lifetimes are expected to be less in the long term. Focal conducts life tests on pressure tolerant components to establish reasonable baselines for component life. The standard one year warranty applies to all pressure tolerant cards.
3. Availability: Since cards and critical components, such as optical transceivers, need to be tested and qualified for operation at depth, the range of options for pressure tolerant products is somwhat less than for standard products. Focal can qualify new configurations per customer requests, but obviously this requires additional time versus using off-the-shelf products.

Pressure tolerant solutions tend to be suitable for cost-sensitive configurations of small to mid-size vehicles where installation of a multiplexer would otherwise forc

3.0 Pressure Tolerant Process

Focal has been developing pressure tolerant electronics assemblies since 2004. Generally, pressure tolerant cards are modified remote (subsea) versions of standard cards that are paired with standard non-pressure-tolerant versions of the cards at the console (surface) end of the system. The pressure tolerant cards are otherwise functionally identical to standard cards with respect to specifications on electrical input/output signals, possible switch configurations, diagnostics, etc. Optical components, such as transceivers and couplers, do exhibit a small reduction in perfornance at pressure, typically 1-3 dB, but this is incorporated in the specifications and overall system design. Optical power budgets with most pressure tolerant cards are greater than 20 dB.

Over the years, Focal has established multiple test protocols for pressure tolerant components:

1. Design testing validates new products, processes, or configurations and includes extensive temperature cycling, pressure cycling, life testing (cycling and soaking), and review and testing of material compatibility with common oils, e.g. Tellus 32, used in pressure compensation systems.

2. Part screening ensures subassemblies, such as optical transceivers and couplers, are fully compliant with pressure tolerant specifications before they are installed in complete stack assemblies. Part screening includes temperature cycling, rapid pressure cycling, and pressure soaks.

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Fiber optic transceivers are critical components for pressure tolerant applications, and Focal has successfully conducted extensive life testing on several solutions.