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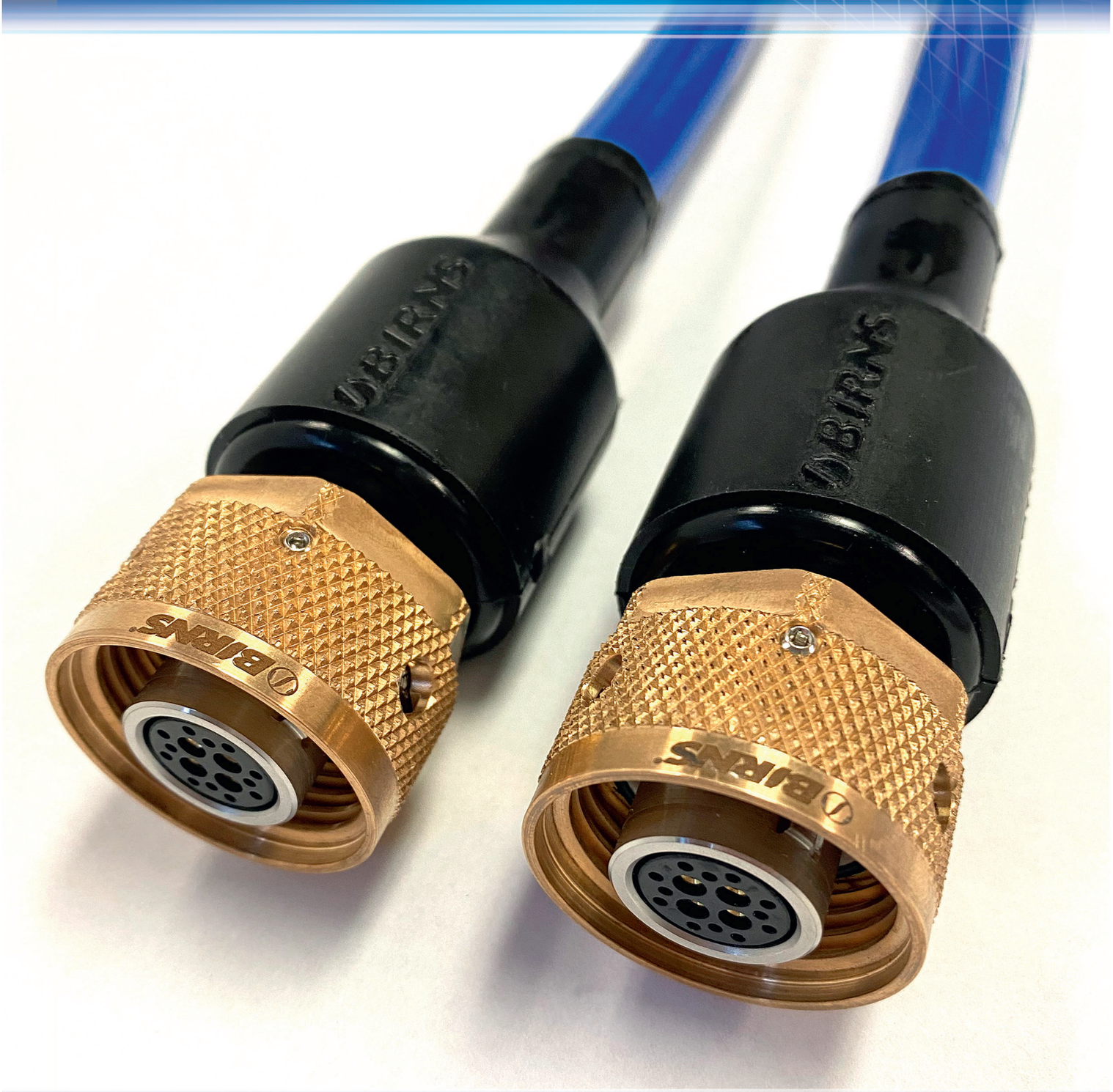

CONNECTORS/CABLES/WINCHES; OFFSHORE RENEWABLES/OFFSHORE TECHNOLOGY

Subsea Ethernet connecti

By Amy Brown, chief marketing officer, BIRNS, Inc., Oxnard, California, USA

BIRNS develops new ultra-high speed connectivity solution in answer to industry demands for true gigabit data transfer from extreme depth systems

Today's subsea cable assemblies are relied upon to provide data, signal and power rates at incredibly high speeds. This need for speed advances as the technology of extreme depth subsea systems continuously becomes more sophisticated and innovative. BIRNS, Inc. was recently asked to develop a connectivity solution with ~10G/s (gigabits/second) data transfer speed capability for new advanced deep submergence AUVs and other systems that require extremely high data throughput rates. While most commercially available published subsea connectivity Ethernet speeds average around only 1G/s, BIRNS developed a unique cable assembly that produced, at pressure, consistent data transfer rates of a remarkable 9.4± 0.1G/s. The testing was capped at this level, limited only by the technology available to test such speeds. Extensive performance testing proved that data consistently transmitted at this rate over the entire range of pressures from 0 to 8700 PSI/600 bar (6000-metre equivalent depth).

The latest subsea applications require ultra-fast and reliable onboard connectivity to support real-time data streaming and download capability, for everything from high-definition video streaming and monitoring to sonar digital downloads.

Special termination protocols were developed for BIRNS' exclusive 52A-278 cable constructed for Cat 8.2 use

From defence reconnaissance and mapping applications to marine geoscience acoustic Doppler current profiler (ADCP), light detection and ranging (LiDAR), seafloor imaging, broad area surveying and inspection, these systems can require incredibly high bandwidth data delivery rates, and often necessitate quick post-

tivity at 9+ gigabits per second

mission access to huge amounts of payload and vehicle management data. BIRNS provided a groundbreaking solution with its six-kilometre rated cable assembly with exclusive 52A-278 cable constructed for Cat 8.2 use: a double ended assembly with two BIRNS Millennium 3M-16 cable plugs (CPs) with 12 22-AWG data contacts and four 16 AWG contacts for power.

EARLY ETHERNET ADVANCES

Ethernet as a system for connecting computers was first developed in 1973, and by 1985 it had become an IEEE standard. The name Ethernet came from the inventor Robert Metcalf, as an homage to the old "luminiferous ether" theory which was once thought to explain the propagation of electromagnetic waves through space. The industry standard then went on to develop to include speeds of Ethernet (10Mbp/s), Fast Ethernet (100Mbp/s) and Gigabit Ethernet (1G/s). A more current Ethernet standard is 10-gigabit Ethernet, 10 times faster than the former Gigabit Ethernet, and is commonly used in enterprise computing systems. In comparison, use of Cat 5 cable provides typically 1G/s. Wired connections at and above these speeds were formerly only cost effective in high performance computing and data centres but are now available for subsea system data applications, thanks to the new BIRNS cable assembly technology.

EXCLUSIVE BIRNS CABLE

Connectivity this advanced requires a unique approach to cabling, and the result was a highly complex cable which nonetheless had an external diameter of only ø19.1mm (ø0.750 inches) and a bend radius of 191mm (7.5 inches). Straight conductors cause, and are susceptible to, EMI (electromagnetic interference) from electrical and magnetic fields arising from current flow. EMI degrades signal and in

The cable assembly is attached to flanged receptacles mounted inside a high pressure hydrostatic test chamber

The unit is prepared to be subjected to the pressure equivalent of six kilometres depth for an hour as part of the testing, with Cat 8 high-speed data cables connected outboard of the tank

severe cases can lead to total data loss. However, when wires (especially balanced lines with matched impedance) are twisted together as a twisted pair, effects of noise currents and external magnetic fields are lowered. Metallic shielding (screening) around the pairs provides a barrier to external EMI and an electrical path for the removal of spurious induced currents. Thus, BIRNS 52A-278 cable's exclusive design included construction to Cat 8.2 requirements, with five 15 AWG (1.5mm^2) 600V conductors and four 300V-capable balanced twisted shielded pairs, individually screened with 100% coverage shielding to protect against EMI and provide the data rates required. These were bundled together in a central water blocked core with triple-layer 100% coverage overall screen, a 1.0mm (0.040-inch) TPE core jacket and a 2.4mm (0.095-inch) thick outer jacket of pressure extruded polyurethane. The BIRNS team developed exclusive new proprietary termination protocols to further reduce loss and increase bandwidth for this unique cabling.

OVERMOULDING

BIRNS has a NAVSEA PRO-020 certified overmoulding facility – one of the few approved by the US Navy for the manufacturing of outboard cables for naval submarines. BIRNS has been creating bespoke solutions for the world's most demanding environments since 1954, and has invested heavily in advanced technology and protocols for its cable assembly overmoulding. This overmoulding process occurs after termination of the assembly, and seals the connector and cable interface, provides strain relief, precludes discontinuous bending, and adds elastomeric mechanical strength to the junction. It forms a powerful chemical bond able to withstand the demanding subsea environment. The team engineered a new custom mould for the 3M-16 assembly, providing secure and repeatable polyurethane cable sealing to the cable jacket, while strengthening the integrity of the assembly and its requisite data delivery properties.

TESTING

The demonstration of these groundbreaking data transfer rates under pressure was conducted by connecting the cable assembly to flanged receptacles mounted inside a 15,000 PSIG (1000 Barg) hydrostatic test chamber. Data transfer rates were tested for one minute starting at zero pressure and at every 1000 PSIG (69 Barg) up to the test pressure 8700 PSIG (600 Barg). While the unit was held at test pressure for one hour at 8700 PSIG, the following transfer rates were met: 3.975 terabytes over 3600 seconds, with an average of 1.1 gigabytes transferred per second. Once the one-hour peak pressure

hold and its coextensive data transfer test was complete, the pressure was then reduced to atmospheric (zero PSIG/Barg) and a final one-minute transfer rate test was conducted. While still submerged at zero PSIG/Barg, the assembly then passed IR testing at 500VDC with a minimum resistance threshold of 300MΩ.

LOOKING TO THE FUTURE

The company expects that the BIRNS Millennium 3M-16 cable assemblies with its exclusive cable most likely have higher data rates than the ones already confirmed. However, the ability to reliably test beyond 9.4± 0.1G/s is limited by the current computer technology that is commercially available. BIRNS currently uses a 3000MHz cable certifier which certifies links up to Cat 8.2, including Transverse Conversion Loss (TCL) and DC Resistance Unbalance (the unequal resistance between two wires in a twisted pair) measurements.

Part of a double-ended assembly with two BIRNS Millennium 3M-16 cable plugs that provides data transfer rates of 9.4± 0.1G/s

Ten-plus gigabits per second is extremely high – for reference, one can watch a 4K ultra streaming movie with just 25Mbp/s. But huge data downloads require blistering speed. The BIRNS team is always pushing the limits to expand present technology, and looks forward to the opportunity to expand even beyond the groundbreaking data rates and performance characteristics already achieved. It is exciting to consider what else might be discovered as a result, from the benthic to the abyssal zones, and what that can mean for the developers of and performance by complex subsea vehicles and other advanced systems in the future.