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CUSTOM HYBRID CONNECTORS SOLVE MANY INTERCONNECT DILEMMAS

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CONTENT

ABSTRACT 2

HISTORICAL INTERFACES 3

MILITARY APPLICATIONS 3

COMMERCIAL APPLICATIONS 3

HYBRID CIRCULAR CONNECTORS 4

- Test and Measurement 4
- Industrial and Outdoor 4
- Medical Technology 5

CUSTOM HYBRID CABLE SOLUTIONS 6

CONCLUSION 6

ABSTRACT

Oftentimes when developing or assembling a product or system, multiple input / output interfaces are required. Power, communication signals, sensor interfaces, and in some cases fluid and gas connections all take up space individually, and can result in a connection real estate challenge as well as a cable management nightmare. This paper discusses how it is possible to combine several interface types into a unitized or modular interface as a means of reliably simplifying connections and saving space. It also addresses the issue of interconnecting devices that are signal compatible, but which have physically incompatible interface connectors from different manufacturers, so that no off-the-shelf cable can satisfy the need. The solution – custom hybrid cables.

HISTORICAL INTERFACES

Separable electrical connector interfaces evolved slowly over many decades starting as single pins and sockets or spring contacts to pads. Contact theory and electrical requirements initially defined contact sizes, which in turn defined the physical characteristics of the interfaces. Electrically isolating materials – insulators – were needed to protect the user from potentially dangerous voltages, and to provide physical structure to support the electrical interface. It is these insulators that allowed multiple contacts to be assembled into the first multipole unitized connectors. Originally these were designed to be the "hot" and "neutral" lines of the relevant power supply. Over time, signal lines were added and numerous connector package designs evolved. Connectors designed for one function were adapted to support both power and low-level signals. D-Subminiature connectors are a good example of this and are among the earliest standardized hybrid connectors supporting high power plus signal lines (Figure 1).

Fig 1. D-subminiature connector

MILITARY APPLICATIONS

Hundreds of other designs evolved over time, but in harsh industrial and military environments more was needed. Military engineers worked with connector manufacturers and developed several standards for connectors that were adapted to work in harsh environments. Resistance to shock, vibration, fluid ingress, and temperature extremes were the drivers behind this work. MIL DTL-5015 standard for "circular, threaded electrical connectors", and MIL-DTL-38999 standard, which added "miniature, high density, quick disconnect" to the foregoing, were developed, along with many other standards. As space constraints became apparent and streamlining the connection process was of interest, power, coaxial and fiber optic interfaces were combined in these connectors. Such hybrid solutions are exemplified in Figure 2 – on the left, power and signals are combined; and on the right, coax and signals.

Fig 2. MIL–Spec connectors

COMMERCIAL APPLICATIONS

Manufacturers serving the commercial market were on board as well, realizing that the combining of multiple interfaces solves a number of problems for a system designer. It can reduce the total number of connections to an enclosure, saving space as well as reducing the possibility of incorrect connections. It can also save time by reducing the number of cable connections a user would need to make in setting up a portable system. There are probable cost reductions too, as every input / output interface requires a connector housing and mounting space on the enclosure. With a hybrid connector, the housing and mounting spaces are consolidated into one.

HYBRID CIRCULAR CONNECTORS

ODU is a manufacturer that serves both the military and commercial markets. The company has addressed the need for hybrid connectors in several of its products through most of its product families, each with their own advantages. In the simplest form, ODU AMC®, ODU AMC® High-Density, ODU MEDI-SNAP® and ODU MINI-SNAP® product lines can support multiple contact sizes within the same connector, thus allowing those connectors to carry both signals and power for USB® and other high speed interfaces. There are also versions of ODU MEDI-SNAP® and ODU MINI-SNAP® products that support fluid interfaces in conjunction with traditional electrical signals (Figure 3).

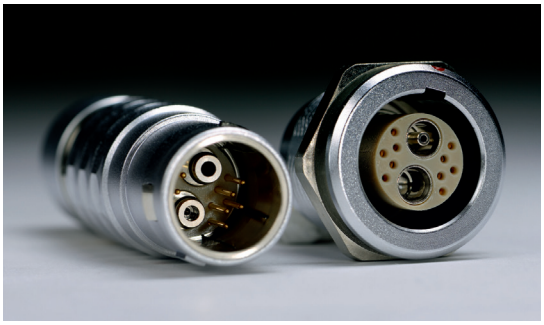

Fig 3. ODU MINI-SNAP® hybrid connector & receptacle

Other hybrids pioneered by ODU include fiber optics, single-mode and multi-mode, expanded beam and plastic optical fiber, all of which have been implemented in the ODU MINI-SNAP® and the ODU AMC® Series T product lines. In one particular application requiring a high-density solution, the ODU AMC® Series T family was used for an enhanced expanded beam fiber optic solution with up to 12 fibers (Figure 4).

The following examples are actual customer applications, for which ODU developed unique hybrid custom connectors and cables:

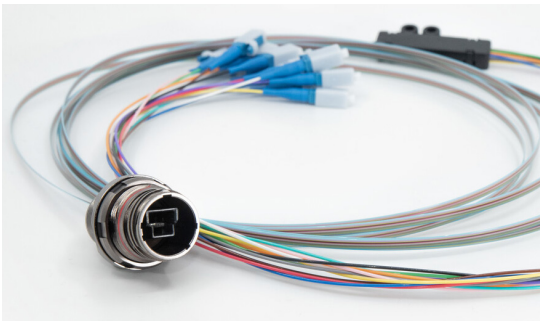

Fig 4. EBP fiber optic cable

Test and Measurement

In this example, the customer's field personnel needed to perform mobile analytics and monitoring of gas flow in harsh environmental conditions. The implementation required a hybrid cable carrying both electrical signals and gases.

ODU developed a solution using custom ODU MINI-SNAP® connectors with properties that include a high number of push-pull mating cycles (up to 5,000) and high impermeability (IP68) against rain, dust and dirt.

Industrial and Outdoor

This application required the combination of GPS location monitoring along with control of fertilizer distribution, in a system designed for use on mobile agricultural equipment. The environmental challenges here were similar to the preceding application, but with the addition of strong vibration and high levels of electromagnetic interference.

Again, ODU engineers overcame these challenges with custom designed ODU MINI-SNAP® connectors carrying both data and signals. The resulting cable is capable of supporting data transmission rates up to 100 Mbits / sec – the fast Ethernet standard.

Medical Technology

The third application example was for an interface capable of carrying control signals, power and air-supply to a professional dental cleaning device. The primary challenge in this case was the high-power requirement – 8.5 kW at 1.25 kV AC. ODU engineers developed a hybrid solution based on the ODU MEDI-SNAP® Size 3.5 (Figure 5), which not only met the requirements, but was also low weight thanks to the connector's plastic housing.

Fig 5. ODU MEDI-SNAP® size 3.5

MODULAR HYBRID CONNECTORS FOR DIVERSE APPLICATIONS

In many cases the circular connector approach is inadequate to meet a user's needs because it cannot be expanded to accommodate all the interface types the user wants to integrate. In addition, each user-specified hybrid circular connector must be custom designed and built to order by the manufacturer. In response, ODU developed their ODU-MAC® series of products. These product lines are modularly assembled connectors where components are stacked together in a supporting frame. The frames are of various sizes depending on their use and the number of modules required.

Fig 6. ODU-MAC® assemblies for automatic mating

The user can define their needs as a list of required modules, and the connector can be built to meet those requirements. Module options include, but are not limited to signals, high current, high voltage, high-speed standards (e.g., USB® 3.2, HDMI® and Ethernet), RF coax, fiber optics and fluids. Custom contacts have also been developed for many applications. Furthermore, there are options for automatic and manual docking.

For automatic docking, the two connector frame halves typically do not have a housing hood, but are mounted to the system enclosures (Figure 6). This is useful for automatic or robotic test systems, or where two systems are stacked together with no cabling between them.

For manual mating, a hood is used to cover the frame and provide a cabling strain relief support (Figure 7). The operator physically plugs the two halves together by manual force, often with the aid and mechanical advantage of levers or spindles, which overcome the potentially high combined insertion and withdrawal forces from the multitude of connection interfaces.

These ODU-MAC® hybrid interfaces, along with the availability of non-magnetic ODU contacts, have led ODU to be the leader in MRI plug in applications. The ability to combine many interfaces into a unitized and hybridized block simplifies the connecting process, guarding against mistakes, and solving wire management issues.

Fig 7. ODU-MAC® assemblies for manual mating

CUSTOM HYBRID CABLE SOLUTIONS

If a connector manufacturer is limited to just producing connectors, it cannot provide a complete solution for many customers. What's needed is a rapid turnaround service which offers a wide variety of available high-quality plugs, sockets and cables, plus highly experienced engineers who can choose or develop the right set of connectors and cables to create an ideal custom solution for the client. And there's one more important requirement: The same vendor must be able to produce its custom cable assemblies in a timely manner and in whatever volume the client needs. Its ability to meet all these requirements is what distinguishes ODU from many of its competitors.

CONCLUSION

This whitepaper has illustrated the need for custom hybrid connectors and cables, as a means of solving space limitations, wiring complexities and cost issues when interconnecting multiple disparate systems. ODU is a leader in the field, with capabilities that range from the smallest circular connector, supporting signal and power, up through test platforms that support a wide range of interfaces. The ability to accommodate an extensive variety of interfaces into a hybrid and scalable modular connector is a key strength of the company, and ODU's engineers are always up to the challenge of delivering the best hybrid solution for any given customer application.

FIND OUT MORE

Get in touch with us:
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The contact arrangement of an ODU data transmission connector differs from a standard data transmission connector due to the robust ODU specific design. However, the ODU design meets the electrical specifications of the respective standard data transmission protocol.

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