

Amphenol Pcd

Matching performance to requirements - modern connectors break the barriers to enhanced system performance.

BEVERLY, February 21, 2017 -- In today's commercial & military aerospace world, engineers are challenged to incorporate more functionality in less space, without increasing weight, sacrificing performance, payload, or range. Whether it's increasing the capability of a guidance system, improving the functionality of an avionics sensor, or adding local intelligence to a remote system or subsystem (IOT), wired interconnects continue to play a key role; and finding the connector with the right combination of performance, size and weight can be a daunting task.

The temptation is to fall back onto tried and true connectors that have worked in the past. Often these are 1960's era M38999 metal circular or M24308 D-Subminiature style connectors. While functional & proven, these tend to be overkill for the task at hand, or overly complex with performance far in excess of the requirements. This paper will look at how new, plated plastic connectors measure up to traditional metal connectors, in a specific application context and how matching connector performance to application requirements helps engineers meet their performance envelope.

Defining the requirements is key to selecting the connector with the "right stuff". A design engineer needs to look at application level requirements as well as the electrical requirements to accurately gauge what type of performance is required from the interconnect. Using a simplified & stylized example for illustration purposes, a problem statement for a connector to support a sensor package for use in a Light Support Aircraft or Low Altitude UAV might read as follows:



Electrical Requirements

- Qty 2 28 v dc, 3 amps continuous, with a 6 Mhz AC carrier, on 20 awg wire, shielded
- Qty 2 RS485 twisted pair communications, on 24 awg wire, unshielded style
- Qty 2 power returns, with 20 awg wire, unshielded, milspec style
- Qty 4 active low digital control signals, with 24 awg wire, unshielded milspec style

Application Requirements

- Wire harness will use a milspec wire with a stainless steel braid for EMI protection.
- Used in an unpressurized, non-temperature controlled area of an airframe, but not directly exposed to the external environment.
- Operational altitude not to exceed 10k – 15k feet.
- Connection will be made & unmade infrequently, for maintenance, test and upgrades.
- The connector is routed through a roughly 1" diameter opening during installation.
- Minimize weight – this is a Low Altitude, Long Endurance UAV or light aircraft, after all.

Breaking these down individually, we need a connector that can support:

- 6x 24 awg and 4x 20 awg, milspec contacts.
- Shielding termination will be needed on the power lines, to protect the 6 Mhz carrier signal from stray noise. 6 Mhz base frequencies & fundamentals means shielding below 100Mhz. Factoring in the possible data bandwidth, shield performance below 1Ghz is of interest.
- Not being exposed to the "outside world" means little or no impact risk.
- Sealing will be required, as there could be condensation, and possibly immersion. Exposure to flight line chemicals and fuels is possible.
- Since mating & unmating is infrequent, we don't need to worry about high mating cycles. 100-200 cycles should be sufficient.
- Low altitude use limits temperature range, probably not exceeding -25C to +125C

- Choose 0.750" diameter max, to comfortably fit through 1.0" hole.
- For Shock & Vibration considerations, let's assume a light support aircraft means a Restricted or Utility Aircraft type (crop duster, for example) at 12,500lbs, with takeoff & landing speeds in the 60 mph – 100 mph range. Shock should not exceed 100G's, and vibration should be minimal – say 15G sinusoidal.

Based on these considerations, how do these several popular connectors compare? Using published specifications, we'll compare key specifications of the legacy M24308 D-Subminiature (DSUB), M38999 Circular Connector (M38999), Amphenol Aerospace's more modern 2M Series circular connector (2M), and a connector typical of plated plastic connectors, Amphenol PCD's Pegasus Series (Pegasus). Table 1 lists the application requirements above, and whether these connectors meet, don't meet, or exceed the requirements. For selection purposes, this could be converted to a weight selection matrix.

Table 1 – Connector Comparison

		Requirements \ PN	M24308 DSUB M24308/2-2F 15 position	M38999 Circular TV-01-DT-1398-P TV-06-DT-1398-S	2M 2M803-001C-9-210-P 2M803-003C-9-210-S	Pegasus SJS860910P SJS860900P
inline or flange mount		cabling, panel	meets	meets	meets	meets
number of positions		10	meets	meets	meets	meets
max voltate (dc)		28v	meets	meets	meets	meets
max current (dc)		3 amps	meets	meets	meets	meets
max operating freq		6 Mhz	meets	meets	meets	meets
wire awg support		20 awg & 24 awg	meets	meets	meets	meets
shield termination		braid to backshell	does not meet**	does not meet**	meets	meets
Sealing		IP67	does not meet**	exceeds	exceeds	meets
Fluid Immersion		not required	does not meet**	exceeds	exceeds	exceeds
Chemical Resistance		short duration	does not meet**	exceeds	exceeds	exceeds
Mating Cycles		100 min, 250 preferred	exceeds	exceeds	exceeds	meets
Altitude Rating		10k - 15k feet max	does not meet	exceeds	exceeds	exceeds
Temperature Range		-25C to +125C	meets	exceeds	exceeds	exceeds
Shock		100 G	does not meet	exceeds	exceeds	exceeds
Vibration		15 G sinusoidal	does not meet	exceeds	exceeds	exceeds
Size	plug	0.750" max	1.49" wide	1.157"	0.745"	0.714"
	receptacle	outer diameter	1.49" wide	1.093"	0.830"	0.740"
Weight	plug	minimized	7.6 grams	34 grams	9.2 grams	3.3 grams
	receptacle		8.9 grams	56 grams	9.6 grams	3.2 grams

Notes: does not meet** additional accessories can be added to the connector to meet requirement, but at additional cost, size & weight

As can be seen in Table 1, Connector Comparison, the legacy DSUB does not meet the requirements. While the DSUB easily meets the electrical specifications, it does not meet the environmental specifications, size, or weight requirements. The M38999 easily meets or exceeds all the requirements except for the braid termination, size, and weight. Adding a backshell to address the braid termination further compounds the size and weight penalty.

This makes perfect sense when one considers that the DSUB was conceived as a general purpose, non-environmentally sensitive connector, and the M38999 as a general purpose connector for rugged & harsh environments. The key word here is "general purpose". Since neither the DSUB, nor M38999 were designed with a specific task in mind, they are either over designed or under designed for any particular task. In fact, both the DSUB and M38999 were designed before the terms SWAP and "light weight" became catchwords. Hence while they can both be made to work in many applications, they are often not the ideal choice.

The newer connectors, the **2M** and **Pegasus** styles, fare much better. The 2M was designed to address the size & weight issues inherent in the M38999, and it does a good job. The connector is smaller, and

much lighter. However, it still suffers from being “general purpose”, in that it was designed to cover a wide range of applications, and not specifically aerospace. So while the 2M meets or exceeds all the electrical and mechanical criteria, it still comes with a weight penalty, relative to the plastic connectors.

The **Pegasus Series** is a much better choice for this application. Purposefully designed for Commercial and Military aerospace avionics applications, the Pegasus Series provides a much better fit to the requirements. The Pegasus Series is able to meet all of the environmental requirements “as is”. Pegasus is environmentally sealed, unlike the DSUB. Pegasus has the temperature, chemical, shock and vibration performance of the M38999, but has an integrated braid termination area, unlike the M38999, and is a fraction of the size and weight of either.

The Pegasus is smaller and lighter than the 2M. Pegasus achieves this size and weight savings over the 2M Series by having a simpler design architecture, as well as being completely made of plastic, with its lower specific density.

Weight comparison of ULTEM plastic to Steel & Aluminum

Connector	Housing Material	Specific Gravity	Specific Density in lbs per cubic foot	vs Pegasus
Pegasus	ULTEM CRS5011	1.28	79.9	
2M	Aluminum	2.55 - 2.80	159.1	2x
M38999, DSUB	Stainless Steel	7.8 – 7.9	486.7	6x

Of course there are limitations to plastic connectors. A plastic connector may not be a good choice where direct impacts from tools, soldiers' boots, and loose equipment or debris are common. Use in applications with very high mating cycles, such as radio headsets, user video, network, and power, may also not be appropriate, as the plastic will wear faster than metal.

The avionic sensor application described here was chosen specifically to highlight where a light weight, high performance, EMI shielded plastic connector, such as Pegasus, could be used. Similar applications would be power and signal distribution for UAV electric fan motor power; cabin monitor and surveillance camera systems; door and flap motor actuators and controls; tail, wing or warning lights; and wheel well, cargo or cabin lights. These applications require moderate pin counts, are disconnected infrequently for scheduled maintenance, are protected from direct impacts, and require the higher shock, vibration, temperature, and EMI shielding typically addressed by metal connectors.

So when you are evaluating connectors, be sure consider all you options. A modern, lightweight, high performance, EMI shielded plastic connector like Amphenol PCD's Pegasus has the “right stuff” for many of today's aerospace applications.

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About Amphenol Pcd

Amphenol Pcd, a subsidiary of Amphenol Corporation, is one of the world's leading suppliers of interconnect products for Military, Commercial Aerospace and Industrial applications. Located north of Boston in Beverly, Massachusetts, the company designs and manufactures a wide range of products - System Attachments, Junction Modules, Relay Sockets, Terminal Blocks, Rectangular & Circular connectors, and Cable Assemblies & Adapters. Each product is made and engineered with the highest quality standards in the industry. With facilities in North America and Asia, Amphenol Pcd products are chosen by hundreds of OEMs around the world, reliant on Amphenol's technical excellence, global network of distributors, and cost-effective solutions for custom systems.