

## The Next Generation Connector

This paper describes a new harsh environment fiber optic connector system designed primarily for use on military shipboard and avionics platforms. The Next Generation Connector (NGCon) system is an emerging product family consisting of connectors, backshells and terminus specifications. Included herein is an account of the origins of the NGCon connector system from its inception along with a detailed description of the hardware design.

This high channel count fiber optic connector system will offer the tightest mechanical tolerances in the most rugged and versatile packaging available on the market today. The NGCon incorporates best practices learned during the evolution of many military fiber optic programs over the last several decades. New and upgraded military platforms that incorporate harsh environment fiber optic systems will benefit from the use of the NGCon and its exceptional tight tolerance design.

NGCon resulted from a collaboration of the Naval Sea Systems Command (NAVSEA), Naval Air Systems Command (NAVAIR) and the Defense Logistics Agency (DLA), formerly DSCC, to create a single standard product for shipboard and aerospace requirements. Their combined efforts established a working group comprised of representatives from NAVSEA, NAVAIR, DLA, fiber-optic connector manufacturers and several major defense contractors. Since the beginning of the collaboration, Amphenol Fiber Systems International (AFSI) has been a major contributor to the development of the NGCon specification and design. Once the specification is complete and in service, the industry members of the working group will provide DLA with a multi-source supply chain to ensure vendor interoperability and part interchangeability.

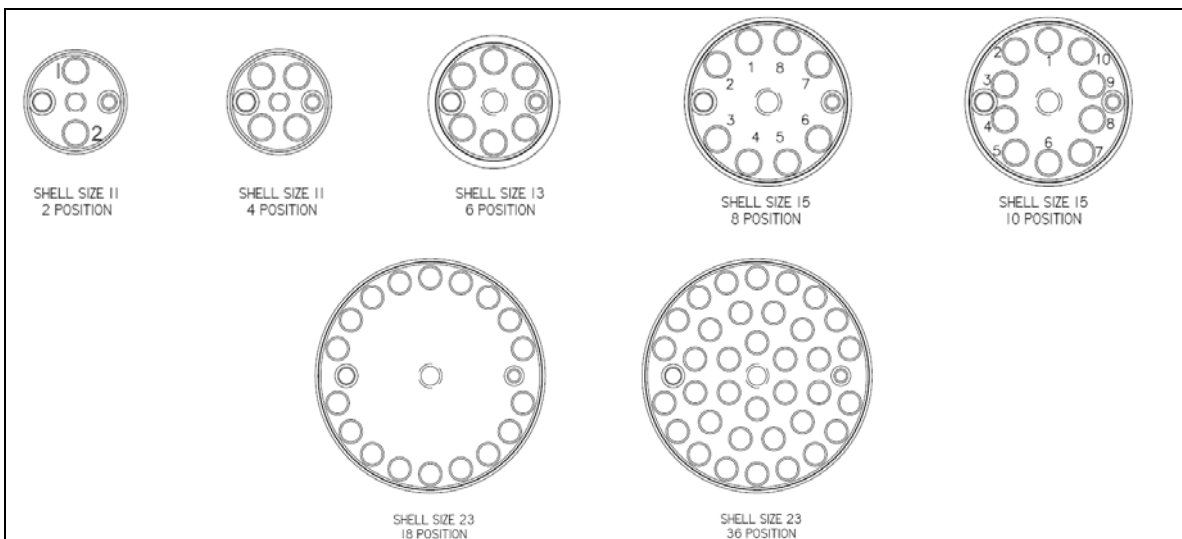
This connector family includes innovations such as rear-release genderless contacts, wide temperature range and high-density packaging as shown in *Picture 1*. Designated to become the new shipboard and aerospace standard for fiber optic interconnect technology, NGCon combines proven technology from MIL-PRF-28876 and MIL-DTL-38999 military connector specifications. The connector family military designation is MIL-PRF-64266, which is available in four shell sizes as depicted in *Table 1*. The terminus channel arrangements, as seen in *Picture 2*, vary from two in shell 11 to thirty-six channels in shell 23. Receptacles are available in Jam Nut and Wall Mount configurations.



**Picture 1**  
**NGCon 36-Channel**  
**Jam Nut Receptacle and Plug**

Shell Size	Shell Size Designator	Insert Channels
11	B	2, 4
13	C	6
15	D	8, 10
23	H	36

**Table 1**  
**Shell Sizes and Channels**



**Picture 2**  
**Insert Arrangements**

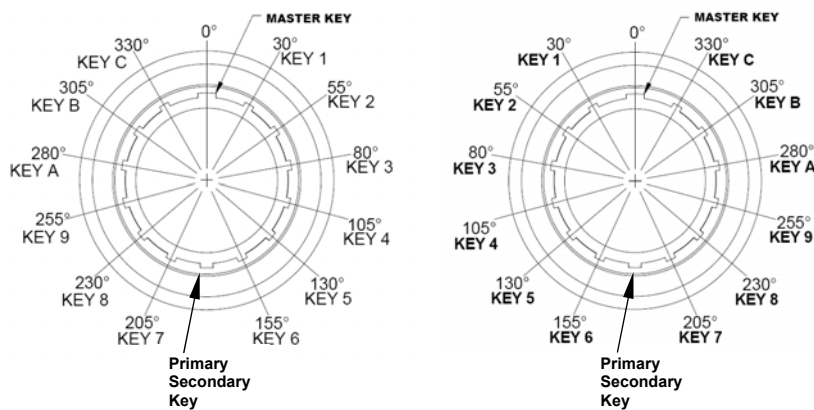
The NGCon specification focuses on improving performance, maintainability and commonality at a reduced cost. Performance enhancements include lower insertion loss values. As delineated in *Table 2*, when compared to the current military standard optical connectors M28876 and M38999, the NGCon connector system improves initial insertion loss by 0.25 dB for single mode and as much as 0.50 dB for multimode performance. It incorporates the extended temperature

range of -55°C to +165°C from M38999. NGCon uses an easily removable alignment sleeve retainer (ASR) and a single genderless terminus to improve maintainability and also to allow full and open access in both the plug and receptacle to the termini end-face for cleaning and inspection. Common tools and processes for termination and cable assembly ensure uniformity across the supplier base. This commonality of parts, processes and tooling saves money and allows the end-user to maintain a single training regimen and tool set.

Fiber Type	NGCon		M28876		M38999	
	Initial	Verification	Initial	Verification	Initial	Verification
SM 9 / 125	0.50	0.75	0.75	1.25	0.75	1.25
MM 62.5 / 125	0.50	0.75	0.75	1.25	1.0	1.50

**Table 2**  
**Insertion Loss Comparisons (dB)**

In addition to the extended temperature range, high-density packaging and removable ASR, the NGCon includes a ratcheting plug, a full-mate indicator, a double-start thread and twelve keying options. The ratcheting plug locking mechanism ensures that the coupling nut will not back-off during shock or vibration and that it will maintain full-thread engagement during the harshest environmental conditions. The addition of a receptacle full-mate indicator guarantees full engagement of the connector, precluding the need for torque on the coupling nut. The connector double start thread used in conjunction with a master and secondary alignment key ensures proper connector alignment prior to mating. Twelve keying options, as shown in *Figure 1* (1-9 and A-C), make the NGCon the most configurable multi-channel harsh environment connector with a two-fold increase in key options from both the M28876 and M38999 connector families.



**Figure 1**  
**Key Options**

A removable ASR, as shown in *Picture 3*, is a key feature of the NGCon. The ASR holds split zirconia ceramic alignment sleeves sandwiched in a metallic

housing. Use of split ceramic alignment sleeves enables the most accurate and repeatable mechanical alignment possible, facilitating exceptional optical performance. The ASR can be used in either the plug or the receptacle, effectively doubling the available keying options from twelve to twenty-four. Threaded alignment pins hold the ASR together, making it fully serviceable in the field.



**Picture 3**  
**Alignment Sleeve Retainer (ASR)**

The NGCon terminus, shown in *Picture 4*, is a rear release stainless steel design that utilizes a beryllium copper retaining clip, a ceramic ferrule, a front sealing o-ring and a  $3.25 \pm 0.25$  pound spring. The durable heat-treated retaining clip ensures repeatable and consistent performance over the terminus life cycle. The use of high precision 1.25 mm ceramic ferrules enables the best optical performance available on the market today. The o-ring seals the ferrule cavity from moisture penetration. The strong spring force ensures inelastic fiber compression for optimal signal performance over the shock, vibration and temperature requirements. This single genderless terminus design eliminates the need for a separate pin or socket contact, simplifying stocking requirements and reducing cost.

The MIL-PRF-29504 specification, which describes the NGCon terminus, has three designations:

- MIL-PRF-29504/18 Non-keyed, genderless, PC / UPC terminus
- MIL-PRF-29504/19 Dummy terminus
- MIL-PRF-29504/20 Keyed, genderless, APC terminus



**Picture 4**  
**NGCon Terminus**  
**M29504/18**

The APC version of the terminus is equipped with an alignment key and enables an 8° angle polish for low back reflection applications. Use of the dummy terminus keeps the connector seal intact when no optical fiber is present for termination. The specified terminus configurations, shown in *Table 3*, accommodate fiber sizes from 125 microns to 175 microns; custom fiber sizes are available from AFSI upon request.

## NGConn Termini

COTS PRODUCT	Military P/N	Temp Range	Ferrule ID	Fiber ID TOL	Fiber Size
<b>M29N0XXX</b>	<b>PC M29504/18</b>	<b>-55C /+165C Dash Number</b>	<b>Size in μm</b>	<b>Tolerance</b>	<b>Size in Microns</b>
M29N0204	M29504/18	-204	125.0	+1/-0	< 9/125
M29N0205	M29504/18	-205	125.5	+1/-0	< 9/125
M29N0206	M29504/18	-206	126.0	+1/-0	< 9/125
M29N0201	M29504/18	-201	125.0	+1/-0	9/125
M29N0202	M29504/18	-202	125.5	+1/-0	9/125
M29N0203	M29504/18	-203	126.0	+1/-0	9/125
M29N0226	M29504/18	-226	126.0	+1/-0	50/125, 62.5/125
M29N0227	M29504/18	-227	127.0	+1/-0	50/125, 62.5/125
M29N0242	M29504/18	-242	142.0	+1/-0	100/140
M29N0245	M29504/18	-245	145.0	+1/-0	100/140
M29N0256	M29504/18	-256	156.0	+3/-0	62.5/125/155
M29N0257	M29504/18	-257	157.0	+3/-0	62.5/125/155
M29N0273	M29504/18	-273	173.0	+3/-0	100/140/172
M29N0275	M29504/18	-275	175.0	+3/-0	100/140/172
<b>COTS PRODUCT</b>	<b>Military P/N</b>	<b>Temp Range</b>	<b>Ferrule ID</b>	<b>Fiber ID TOL</b>	<b>Fiber Size</b>
<b>M29N0XXX</b>	<b>APC M29504/20</b>	<b>-55C /+165C Dash Number</b>	<b>Size in μm</b>	<b>Tolerance</b>	<b>Size in Microns</b>
M29N0404	M29504/20	-404	125.0	+1/-0	< 9/125
M29N0405	M29504/20	-405	125.5	+1/-0	< 9/125
M29N0406	M29504/20	-406	126.0	+1/-0	< 9/125
M29N0401	M29504/20	-401	125.0	+1/-0	9/125
M29N0402	M29504/20	-402	125.5	+1/-0	9/125
M29N0403	M29504/20	-403	126.0	+1/-0	9/125
M29N0426	M29504/20	-426	126.0	+1/-0	50/125, 62.5/125
M29N0427	M29504/20	-427	127.0	+1/-0	50/125, 62.5/125
M29N0442	M29504/20	-442	142.0	+1/-0	100/140
M29N0445	M29504/20	-445	145.0	+1/-0	100/140
M29N0456	M29504/20	-456	156.0	+3/-0	62.5/125/155
M29N0457	M29504/20	-457	157.0	+3/-0	62.5/125/155
M29N0473	M29504/20	-473	173.0	+3/-0	100/140/172
M29N0475	M29504/20	-475	175.0	+3/-0	100/140/172
<b>COTS PRODUCT</b>	<b>Military P/N</b>	<b>Temp Range</b>	<b>Ferrule ID</b>	<b>Fiber ID TOL</b>	<b>Fiber Size</b>
<b>M29N2000</b>	<b>Dummy M29504/19</b>	<b>-55C /+165C Dash Number</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
M29N2000	M29504/19	-500			

**Table 3**  
**Specified Terminus Configurations**  
(Example: M29504/18-202 for SM 9/125 +1/-0)

The NGCon backshells are stand-alone configurations. The backshell attachment coupling mechanism conforms to the M38999 Series III design specification by using anti-rotation teeth and metric threads. Any Series III backshell of similar shell size will fit on an NGCon plug or receptacle connector. Likewise, any NGCon backshell of similar shell size will fit on an M38999 Series III plug or receptacle.

The NGCon backshell specification incorporates numerous flexible configurations that correlate closely with M38999 implementations for use with myriad applications. Configurations are identified for light, medium and heavy-duty applications. The designs include options for simplex cable and multi-fiber cable construction, which accommodate conduit, convoluted tubing, braided shielding and Kevlar strength member termination. Additional specified configurations include EMI protection and stowage. Most configurations are available in three angular arrangements of straight, 45-degree and 90-degree termination options or with a split backshell alternative if required. The multitude of NGCon backshell designs allows many configurable options for multiple end user requirements. *Table 4* depicts the specified configurations of the NGCon connector and backshell product family.

<b>SPECIFIED NGCon CONFIGURATIONS (preliminary)</b>		
<b>Military</b>	<b>AFSI</b>	<b>Description</b>
M64266/01	NG01	Receptacle, Flange Mount
M64266/02	NG02	Plug
M64266/03	NG03	Receptacle, Jam Nut
M64266/04	NG04	Backshell Heavy Duty Straight
M64266/05	NG05	Backshell Heavy Duty 45
M64266/06	NG06	Backshell Heavy Duty 90
M64266/07	NG07	Backshell Light Duty Straight
M64266/08	NG08	Backshell EMI
M64266/09	NG09	Alignment Sleeve Retainer
M64266/10	NG10	Dust Cap, Plug
M64266/11	NG11	Dust Cap, Receptacle
M64266/12	NG12	BS Simplex Convolute, Straight, 45, 90
M64266/13	NG13	BS Simplex Banded, Straight, 45, 90
M64266/14	NG14	BS Simplex Straight, 45, 91
M64266/15	NG15	BS Non-environ, Simplex Convolute, Straight 45, 90
M64266/16	NG16	BS Non-environ, Simplex Banded, Straight, 45, 90
M64266/17	NG17	Stowage Receptacle
M64266/19	NG19	BS Clam Simplex Convolute, Straight, 45, 90
M64266/20	NG20	BS Clam Simplex Banded, Straight, 45, 90
M64266/21	NG21	BS Clam Simplex Straight, 45, 90

**Table 4**  
**Specified Configurations**

A limited and common tool set simplifies assembly and maintenance of NGCon backshells and connectors, which easily accommodate field service requirements and allow for unified and common training across multiple supplier product offerings. AFSI offers in-house or on-location training as required. In addition, AFSI offers a complete line of tooling and tool kits for NGCon including:

- Termination kit
- Test kit
- Cleaning kit
- Consumables kit

In conclusion, the NGCon system encompasses designs for connectors, terminus and backshells. It combines proven technology from 28876, 38999 and fiber optic best practices with innovations including rear-release genderless contacts, high-density packaging and multiple keying options. The terminus and connector tight mechanical tolerances ensure precise mechanical alignment and minimal optical attenuation during multiple mating cycles in the most extreme environmental conditions. The design of the NGCon connector allows easy maintenance with the incorporation of an ASR for full terminus end-face access. A multitude of backshell configurations enables the user to choose a wide variety of cabling options to fit every possible need. Using the available tool kits in conjunction with the proper training will guarantee accurate cable termination, test and cleaning.

The NGCon system is the ideal solution for the rugged high bandwidth needs of military air, sea and aerospace applications.



### **Company Overview**

Amphenol Fiber Systems International (AFSI), a division of Amphenol, provides reliable and innovative fiber optic interconnect solutions that withstand the harsh environments of military (ground systems, avionics, shipboard), energy and broadcast applications. After more than 18 years in business, AFSI maintains its position as a global leader in fiber optic interconnect components and systems such as termini, M28876, 38999 assemblies, MIL-ST, TFOCA and the TFOCA-II<sup>®</sup> connector, which AFSI developed and patented. AFSI has delivered millions of fiber optic connectors in more than 34 countries. Whenever there is a need for superior cost-effective fiber optic systems and products that will stand up to demanding operating environments, you can rely on AFSI for engineering know-how, top-quality products and expert technical support.

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Tom has 25 years experience in the telecommunications and defense electronics industries. He is responsible for the qualified naval shipboard fiber optic product line. Prior to joining AFSI, he held a variety of engineering and engineering management positions at Texas Instruments Missile Systems, Alcatel and Tycom Optical Transmissions Systems. In addition, Tom is a former detachment commander and platoon leader in the Texas Army National Guard. Tom graduated from Texas A&M University with a Bachelor of Science in Electrical Engineering. He is a certified Project Management Professional and a Six Sigma Green Belt.

**Alan Sherman, Aerospace Market Manager**

Alan has over 30 years experience in the connector industry. He has the world-wide responsibility for the sale of AFSI product to the Airframe and Avionics markets for both commercial and military applications. Prior to joining AFSI, Alan held a number of Application Engineering and Sales Management positions at AMP Inc, Tri-Star Electronics and Kings Electronics. Alan graduated from Queens College (NY) with a Bachelors Degree in Mathematics. He is a member of many trade organizations and committees including IICIT, AFCEA, ARINC, SAE and AUVSI.