NEXT GENERATION EXPANDED BEAM CONNECTORS FOR HARSH ENVIRONMENTS

In the morning of October 27 1981, a Soviet submarine ran aground in the Swedish archipelago. An event that became world news and suddenly put Sweden into an international crisis situation.

This event brought to light the use of fiber optics in sonar equipment and was the start of the Swedish Armed Forces (SAF) development of its own fiber optic competence. Later, the Swedish Defence Material Administration (FMV) chose expanded beam technology as the technology of choice for field tactical communication, because of its unique and reliable functionality in harsh environments. This became the start of Micropol, a company specializing in passive fiber optics for extreme conditions.

FALCON™ - The smallest expanded beam connector on the market.

High ambitions in R&D

In the 1980s, as the SAF initiated their plans for wider usage of fiber optic field cables and rugged connectors, Micropol founder Anders Andersson became a key person. He had a background from the Swedish Royal Airforce and had founded Micropol after working with fiber optics since the archipelago incident. Micropol became a trusted development partner.

– The Army's non-standard and demanding specifications for harsh conditions ranges from extreme heat to melting and freezing snow. The equipment needs to be resistant to damage, abrasion, deformation and breakage. It should handle mud and sand particles that find their way between the connectors, says Mikael Andersson, R&D Director at Micropol.

One example of successful progress is the fiber optic technology developed for the FALCON connector, launched in 2013. It is used by the SAF in all applications where rugged components are a requirement. FALCON is the smallest 12 channel expanded beam connector on the market that fulfill the beam diameter specified in MIL-DTL-83526. Tested to meet the world's toughest specifications and with very low insertion and return loss.

Mikael Andersson,
R&D Director at Micropol

Why low insertion loss matters

The insertion loss for FALCON is <1.2 dB, compared to the NATO standard which is <2.5 dB. Simply put, the lower the insertion loss, the more connectors can be used without losing signal. As a result, the FALCON allows for more connectors In a serial communication line, than competition.

– Micropol has, through years of research and development, tested different simulations for how the lens should be designed to obtain as low loss (IL) as possible and a minimum back reflection (RL). We have experimented with different geometries and materials with different refractive index to be able to create the ultimate lens for an expanded beam connector. This is now the standard lens in the current FALCON connector, says Mikael Andersson.

Experiments have also been carried out with an anti-reflex coating on the lens so that the light continues in the transmission direction in the connector and with minimum back reflection. This is extremly important when transmitting 10Gbit or more.

Testing according to international requirements and standards

For the SAF, it is essential their fiber optical tactical systems are designed for use in any scenario on a global scale. FMV is unique in having specified the optical performance on such a level, that a maximum of connectors can be serially used with a minimum loss of communication. For this reason, FMV performs a series of comparative quality tests to ensure that all technical equipment meets their high standard requirements.

Facts about FALCON:

- Insertion loss <1.2 dB vs. NATO standard <2.5 dB
- Temperature range from -57°C to +85°C (+100°C optional)
- The only 12-channel junior connector in the world with standard size collimated light beam

Environmental test of optical connectors

Several qualifying tests has been performed by FMV, with four brands of expanded beam optical connectors. The aim was to expose the connectors for temperature cycling and different endurance tests with the purpose to verify the connector's resistance to the specified environmental they were exposed to.

As an example, temperature cycling according to IEC 60068-2-14 Na was performed, see table 1. As FMV's approval criterion was ≤1.0 dB in each part, connector "D" (FALCON, developed by Micropol) was the only connector to meet the requirement. Even If the test standard specifies temperatures between -40°C and +55°C, FALCON is qualified to temperatures up to 100°C, as the sole expanded beam connector in the world to withstand this temperature.

Vibration and shock tests performed on the Falcon, were similar in result. A number of vibration and shock test were carried out according to e.g. IEC-60068-2-6-Fc, all with acceptable results. An example is presented in Table 2 which illustrate the attenuation during a 30G physical impact test.

In 2018, FMV published a Certificate of Conformity (CoC), confirming the use of the FALCON connector in the Swedish field tactical communication system. The CoC concludes that FALCON is compatible to any other brand on the market and as such also offering interoperability to the NATO standard. Furthermore, the CoC summarizes the overall performance to be better than specification regarding e.g. attenuation values and attenuations of reflection (Ref. Certificate of Conformity, FMV, 2018).

Facts about Micropol Fiberoptic AB:

- Micropol is a Swedish company, established in 1988
- Technology leaders in passive fiber optics
- Business areas: Defence & Security, Industry, Telecom and MedTech
- 2100 m^2 production facility, including clean room production
- Certified according to ISO 9001:2015
- 28 employees, whereof 20 in production
- Annual turnover 60 MSEK

Cycle No.	Temp °C	Brand and attenuation dB			
		ConnA	ConnB	ConnC	ConnD
1	-40	1,20	0,88	0,84	0,81
	+55	1,05	0,99	1,06	0,84
2	-40	1,19	0,89	0,81	0,83
	+55	1,06	0,97	1,13	0,85
3	-40	1,17	0,93	0,85	0,83
	+55	1,03	0,99	1,06	0,85
4	-40	1,19	0,88	0,84	0,82
	+55	1,10	1,04	1,07	0,84
5	-40	1,14	0,88	1,12	0,82
	+55	1,02	1,00	1,05	0,85
6	-40	1,14	0,90	0,85	0,83
	+55	1,00	0,96	1,08	0,85
7	-40	1,19	0,88	0,93	0,81
	+55	1,00	0,95	1,07	0,84
8	-40	1,15	0,85	0,79	0,83
	+55	0,99	0,96	1,07	0,84
9	-40	1,10	0,84	0,81	0,82
	+55	1,01	0,93	1,04	0,84
10	-40	1,10	0,88	0,77	0,82
	+55	0,98	0,91	1,01	0,84
	+20	1,08	0,87	0,83	0,84

Table 1. From "Environmental test of optical connectors" (2014) Ref. IEC 60068-2-14 Na. Basic environmental testing procedures. Part 2: Tests - Test N: Change of temperature.

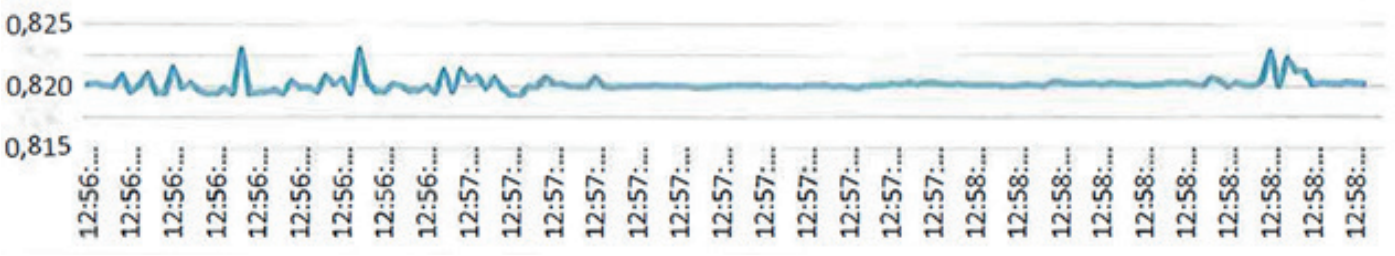

Table 2.From "Environmental test of optical connectors" (2014)
Attenuation changes during the physical impact test on the Y-axis (30G)