PHOTONIC INTEGRATED CIRCUITS FOR AVIONICS
NETWORK ACCESS AND BACKBONE NETWORK INTERFACE
WDM LAN APPLICATIONS

M. Beranek, N. Peterson and M. Hackert
Naval Air Systems Command
Patuxent River, Maryland

M. Mašanović, L. Johansson and D. Renner
Freedom Photonics
Santa Barbara, California

Introduction
The SAE AS5659 Wavelength Division Multiplexed (WDM) Local Area Network (LAN) standard defines network access (NAI) and backbone network (BNI) optical interfaces [1]. NAI and BNIs provide optical connection to and within the backbone network, respectively. The backbone network is comprised of optical network elements (ONEs). ONEs include optical multiplex and optical transport layers. Client adaptation elements (which include electrical signal adaptation, electrical multiplex and optical channel layers) interface to ONEs via NAI. ONEs interface to one another via BNI.

Before AS5659 was published, the BNI, NAI, and ONE functions were described using other nomenclature [2–5]. These functions included protocol conversion, optical mux/demux, splitting and combining, amplification, add/drop, broadcasting, routing and switching. In 2007, bi-directional add-drop multiplexer, tunable laser transmitter, tunable filter, and tunable wavelength converter devices were suggested as key enabling components for WDM local area networking in a military avionics systems [6]. Now that AS5659 is published, we provide descriptions of photonic integrated circuit (PIC) and planar lightwave circuit (PLC) components for future digital WDM LAN avionics NAI and BNI applications.

Tunable Lasers and Transmitters
Freedom Photonics is currently developing compact widely tunable transmitters for avionic applications [7]. These incorporate a widely tunable laser and a high speed interferometric modulator. Figure 1 shows a schematic and picture of the tunable Tx on submount together with tuning and 10 Gbps waveform data. Also shown is a compact TOSA style package incorporating the tunable laser transmitter PIC.

![Figure 1](image1.jpg)

Figure 1 – From left: Schematic of Tx PIC, Tx on submount, wide >50nm tuning range, Optical 10Gbps eye diagram, Compact TOSA tunable Tx package.

Tunable Wavelength Converter
The tunable wavelength converter was previously reported [8] and is described here for completeness (Figure 2). This device converts input wavelengths to output wavelengths with > 20 dB dynamic range over a >32 nm C-band wavelength tuning range. The receiver comprises an 18 GHz PIN photodiode and Electro-Absorption Modulator (EAM) driver. The tunable transmitter PIC comprises a widely tunable laser, Semiconductor Optical Amplifier (SOA) and MZ modulator.

![Figure 2](image2.jpg)

Figure 2 – From left: Wavelength Converter (WC) schematic, WC package, -with detail, 2.5Gbps response at 20°, 100°C.
WDM LAN Node

Very compact WDM LAN node architectures have been implemented in a silicon photonics platform (Figure 3). The first generation (left) incorporated an AWG based mux/demux. The second generation (center) incorporated MZ based switches. The drop and through 10 Gbps performance is displayed in Figure 3 (right).

Figure 3 – First generation AWG based WDM LAN node (left), Second generation MZ switch based WDM LAN node (center), Drop and through performance of second generation node (right).

Wavelength multiplexing and demultiplexing has also been implemented using AWG technology on a PLC platform. This platform is also low loss and well suited for both WDM LAN node and printed circuit board-level optical signal distribution. Figure 4 shows an example PLC design incorporating AWG mux/demux with a response as shown in the figure.

Figure 4 – Detail AWG (left), Response from integrated AWG mux/demux filter (right).

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References