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# Design of $5\times20=100$Gbps Based Optical AP-DCDM Network

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**Abstract**: Multiplexing is a technique that increases channel capacity and reduces the cost of overall system. In this paper five user Absolute Polar Duty Cycle Division Multiplexing (APDCDM) is done in electrical domain. Here each user generates different RZ duty cycle pulses and data rate of 20Gbps, the 100Gbps signal is transmitted through a Standard Single Mode Fibre. It has been observed that at the signal is successfully transmitted up to 75 Km distance and Q-factor also calculated as 15dB.

**Keywords**: APDCDM, BER, Q-factor.

## I. INTRODUCTION

Multiplexing is one of the fundamental necessities in today's digital communications. Multiplexing allows multiple users (or data inputs) to share the bandwidth of the transmission medium. In existing systems, the medium is normally shared based on time slot (TDM), carrier frequency (FDM) or spectrum coding (CDM). The goals of all multiplexing techniques are to support as many users at as high speed and at the lowest cost possible [3]. However, for multiplexing high number of users with high data rates, high speed multiplexer and de-multiplexer are required. At higher speeds clock recovery is another essential issue which limit the conventional multiplexing techniques.

Realizing these problems the design of five users Absolute Polar Duty Cycle Division Multiplexing (APDCDM) based Optical communication system has been proposed in this paper. The absolute polar duty cycle division multiplexing is a variant of DCDM. APDCDM require less bandwidth and less energy for transmission as compared to DCDM technique. It is based on having each channel modulated with a unique RZ duty cycle. In this technique each multiplexing user transmits bit '0' with zero volts and for the case of bit one, the odd users transmit with +A volts and the even users transmit with –A volts. Based on the linear distribution of duty cycle, the $i^{th}$ multiplexing user transmits bit 1 within $T_i$ second which is calculated as:

$$T_i = \frac{i\times T_S}{(n+1)}$$

Where, 'n' represents number of multiplexing users.

For example, assigning the duty cycle value for 5 users using DCDM technique:

For the 1st user = $T_s/6$.
For the 2nd user = $2T_s/6$.
For the 3rd user = $3T_s/6$.
For the 4th user = $4T_s/6$.
For the 5th user = $5T_s/6$.

## II. SIMULATION SETUP

**Transmitter Section-** There are five user define Bit Sequence Generators (BSG), the output of BSGs are modulated by Return to Zero (RZ) pulse generators. The odd users (i.e. user-1, user-3 & user-5) generate positive pulse whereas even users (i.e. user-2 & user-4) generate positive pulse. The RZ pulse generator modulates duty cycle of input signal as shown in figure-1. The RZ-PG1 modulates 15%, RZ-PG2 modulates 30%, RZ-PG3 modulates 45%, RZ-PG4 modulates 60%, and RZ-PG5 modulates 75%. The last 25% is used for guard band purpose, to avoid symbol overlapping in communication system.

**Table 1: Setup parameter for five user APDCDM system**

| S.No. | Setup parameter | Quantity |
|---|---|---|
| **Transmitter section-** | | |
| 1 | No. of bit sequence generators | 5 |
| 2 | No. Pulse Generators (RZ) | 5 |
| 3 | Bit rates, Gbps | 20 |
| 4 | Absolute Polar Circuit | 1 |
| 5 | Operating wavelength, nm/THz | 1550 |
| 6 | Launched power, mw | 2 |
| 7 | Length of OFC, km | 100 |
| **Receiver Section-** | | |
| 1 | EDFA, m | 5 |
| 2 | Gaussian LPF, cut off frequency | $0.75\times$ bit rate |


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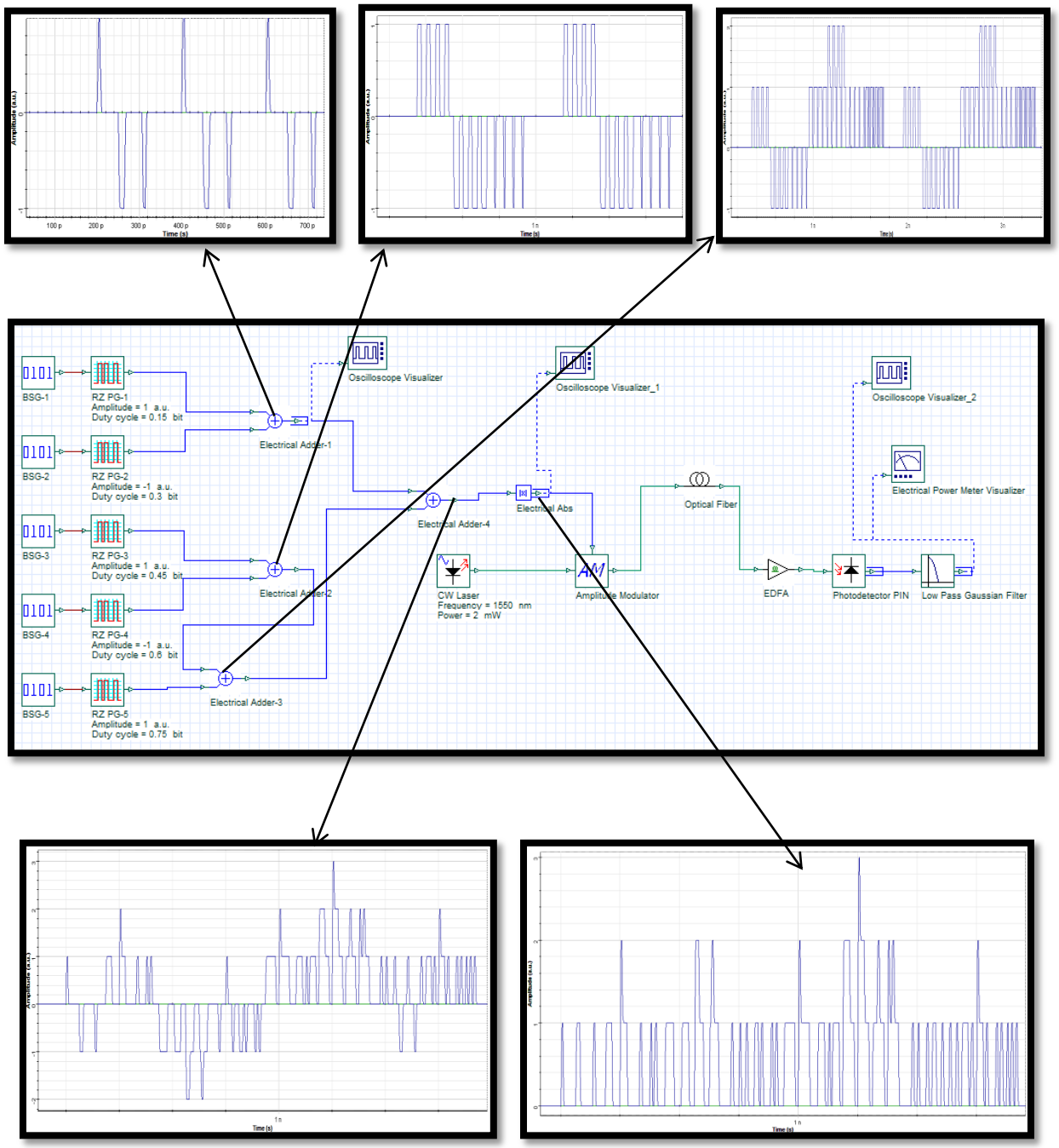


Fig. 1: Simulation setup for $5 \times 20 = 100$ Gbps WDM Optical Network

The output of RZ pulse generators are electrically multiplexed using Electrical adder. The electrical adder-1, adds data of user-1 and user-2, electrical adder-2, adds data of user-2 and user-3, electrical adder-3, adds data of user-5 and output of electrical adder-2, electrical adder-4, adds output of electrical adder-1 and electrical adder-3. The output of electrical adder-4 is final output of five users; then this signal is passed through the absolute polar circuit which converts negative signal into positive signals, this is known as Absolute Polar Duty cycle Division Multiplexing. Now the multiplexed signal is converted in optical signal by modulating the continuous wave (CW) laser (light source) and transferred through an optical fiber.

**Receiver Section-** The optical signal is received and amplified by EDFA. Then this signal is detected by a PIN detector which converts the optical signal in electrical signal and low pass filter (LPF) is used to eliminates the unwanted high frequency noise that produced in optical fiber. The measuring devices like electrical power meter and oscilloscopes are also used for analysis of five user APDCDMsystem.


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## III. RESULTS

### I. Q-factor (dB) & BER versus Length-

Figure-2, shows Q-factor (dB) & BER versus length graph for five user APDCDM system at the data rate of 100Gbps. The multiplexed data is transmitted through a SSMF of 100km length; the BER is successfully maintained up to 75km and Q-factor also calculated as 15dB.

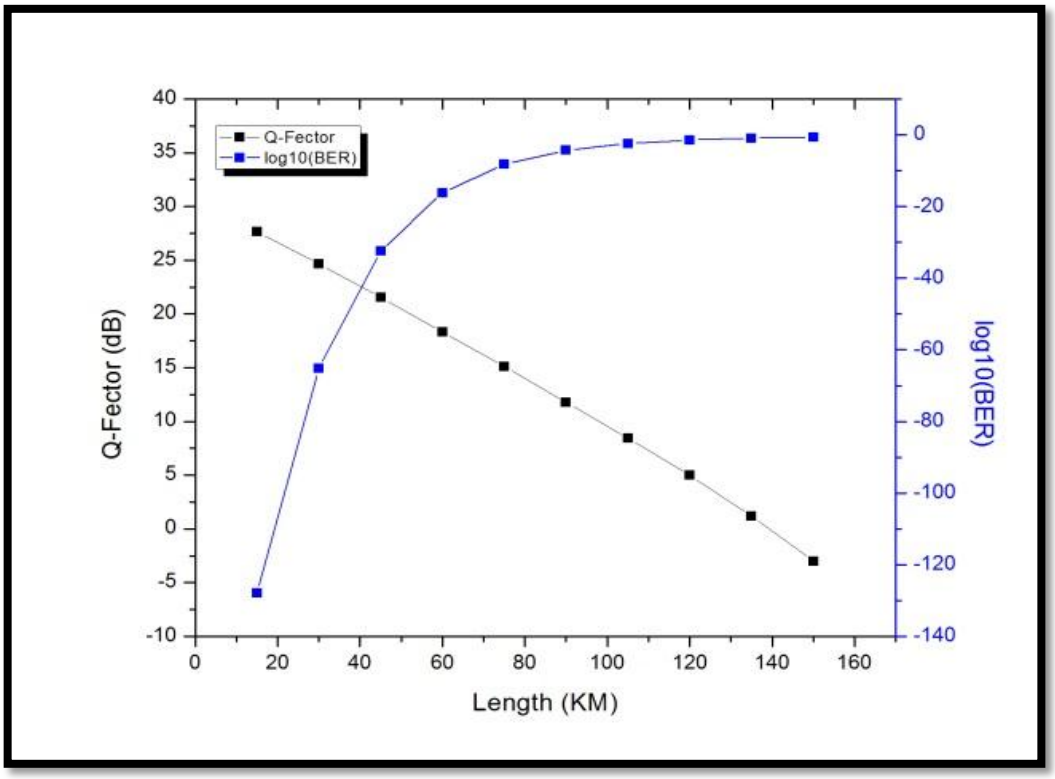


Fig. 2: Q-factor (dB) & Log BER Vs Length for five user APDCDM

## IV. CONCLUSION

The five user Absolute Polar Duty Cycle Division Multiplexing (APDCDM) based optical communication has been designed successfully. The 100Gbps multiplexed signal is transmitted on this network and data is successfully transmitted up to 75 km distance based on standard BER and Q-factor also calculated as 15dB.

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