# The Effect of First Pre-Amplifier Gain to the BER Performance in Restored Metro Ring Network

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**Summary**
The main objective of this simulation study is to observe the profile effects of first pre-amplification and to the value of output power and bit error rate (BER) performance in the restored metropolitan ring network using 1:1 linear protection scheme. Three profiles are introduced and studied, its effects on BER performance and output power are compared. We observed the first gain value gives the significant effect to the initial BER value. As a result we propose the BER improvement by optimizing the value of gain based on the load line analysis in our previous publication [6]. The OptiSystem simulation is used to obtain the desired research objective and analysis the results elsewhere.

***Key words:***
*EDFA, gain, first amplifier, BER, ring network, restoration*

## 1. Introduction

OXADM provides a linear protection scheme to implement the dedicated protection in ring network as implemented by OADM and OXC [1,2]. In path switching, restoration of traffic is handled by the source node and the destination node. Dedicated protection normally activates when one of transmission line breakdown. When a link failure occurs within the ring, the signal will be switch to the alternative route as illustrated in Figure 1 [5]. The restoration is significant for ensuring signal flows continuously. The device is compatible with types of link usage 1:1 and 1+1 [3,4]. The accumulation feature will support the shared protection to be performed in case of two different set of wavelengths going to east and west links. The restoration in 1+1 can be called as multiplex protection [5].

Figure 1 depicted the activation of dedication protection when failure occurs between Node 2 and Node 3. The affected node will switch the signals to protection route. The switching performed within the optical layer will be able to achieve high speed restoration against the failure/degradation of cables, fibers, and optical amplifiers. It is important to avoid huge losses of data and great influence upon a large number of users over a wide area.

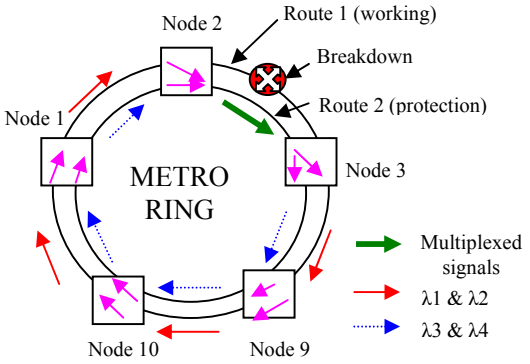


Fig.1 1:1 linear protection mechanism in metro ring network. When a link failure occurs within the ring, the affected is switched over to the protection path.

## 2. Preamplifier First Gain Effect

This section studies the effect of preamplifier first gain to the total performance of restored optical ring network. For detail observation, we introduce three gain profiles (B, D and E) and compare the results in term of output power and BER performance. Figure 2 shows output power measured at every node for three determined first gain value. The value for three gain profiles is given as:

Profile B = 1 dB
Profile D = 4 dB
Profile E = 7 dB

Optical ring network consist of 10 nodes with 600 km parameter were set up and the simulation is carry out using OptiSystem Software. The failure occurs between Node 1 and Node 2 in which the first node is activated to divert the signal to protection line. Meanwhile the second divert back the signal to the original line. The study of first preamplifier effect is preliminary and important in aiming to get a good profile to compensate system losses and ensure the signal can be sent farer and network is able to be extended. The profile of amplifier gain was already studied and the result can be found in [5,6] with good suggestion to extending the network length.

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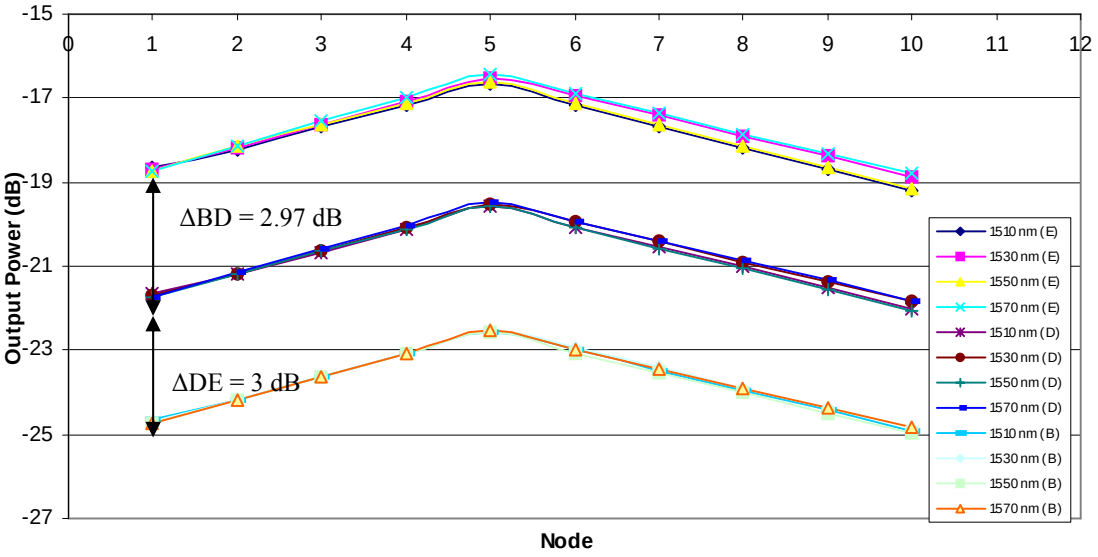


Fig. 2. The output power measured at every node for three profiles (B, D and E). The different is about 3 dB.

From Figure 2, we observed that the increment of first gain will effect to output power in the system. 3 dB different can be observed at every measured nodes. The system was measured at OC-48 with the span is 60 km.

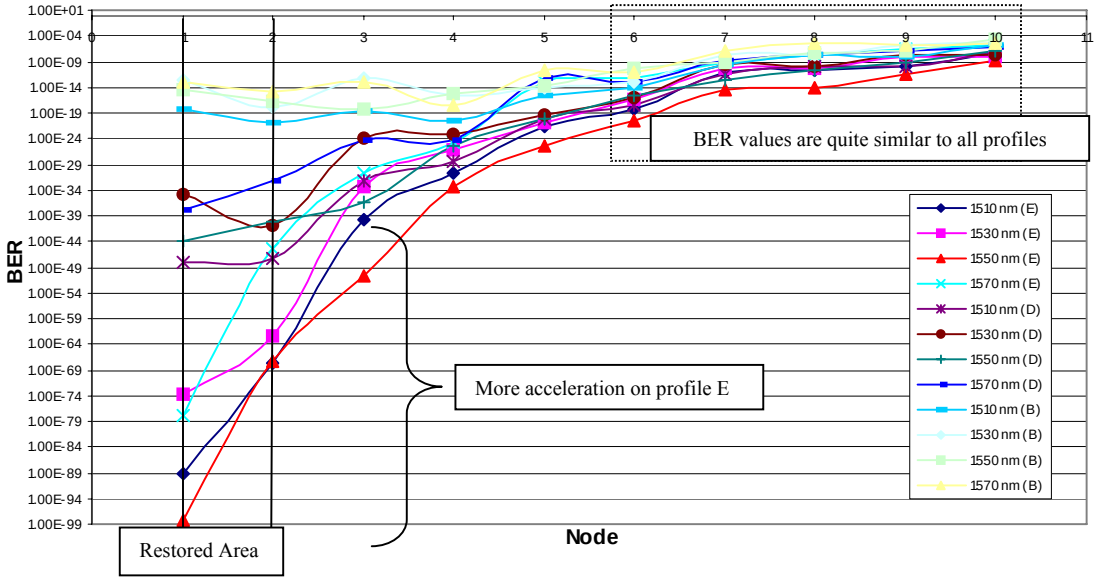


Fig. 3 BER performance for three measured profile indicates the first pre-amp gain give the instantaneous effect to the initial values. The 1:1 linear protection scheme is activated at node 2.

Figure 3 and 4 show the BER performance for three different first pre-amp profiles that measured at every node with parameter 600 km ring network. The initial BER values are positioned at different point. Profile E with gain 7 dB gives the minimum reading which is 2.84 x $10^{74}$ at 1510 nm. The values then increase with the increment of distance untill achieve at node 5. The BER profile at Node 6 till the end are overlapped because all profile used the same gain values. Here we can conclude that the gain profile give the significant effect to the system BER performance. We observed the Profile B give the consistent values as compare to other profile but profile E is the best position for initial BER value . The increment of

output power resulting from the first gain only affect the starting value but not for the whole BER profile. Therefore, the optimization for the whole gain value is needed to achieved the stabilization of BER performance at every node in restored ring network.

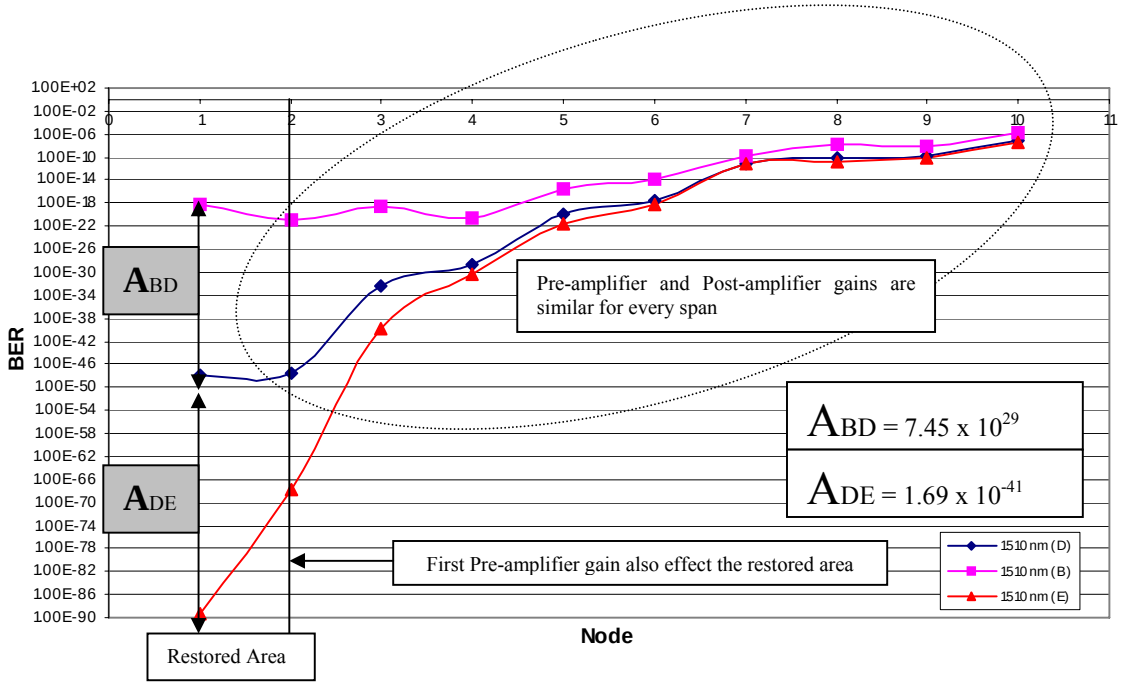


Fig. 4. The detail observation for BER profile extracted from Figure 3 for B, D and E group at wavelength 1510 nm. The profile is looked overlapped to each other towards the end due to the same gain values used.

## 4. Conclusions

From this study, it can be concluded that the first preamplifier gain may affects the BER performance in the recovered area. Any changes in the power level can be compensated or improved by amplifier gain. Optimizing the values can improve by extending the maximum length that can be achieved at minimum BER [5]. Therefore, an optical amplifier configuration is vital to obtain a stable BER performance profile (slow decrement rate) in the secured optical ring network design [6]. The ideal amplifier gain value is determined by the system's load value as shown in [6]. The connection between BER performance and amplification gain is in the form of Gaussian negative. Hence, an area called extreme high/active is created where the increase in gain value will deteriorate the value of this BER performance. Therefore, research on amplification value profile is very important in order to avoid the BER profile in the ring network to be in the extreme high/active area.

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