ORIGINAL ARTICLES

Determination of Internal Gain in Optical Cross Add and Drop Multiplexer (OXADM) Device

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ABSTRACT

ICT is changing the world that people live in. With the increasing of application and needs in ICT nowadays, a high-efficiency device that performs the reliable and effective functions and can give satisfaction to customers is required. Towards this demand, OXADM offers high security features that can switch signals to alternative routes in case of failure occurs to the network. OXADM is asymmetrical device that offers functions U-turn that forms a directional signal to the East and West orientation. However, due to the asymmetric architecture causes both directions have different insertion loss values. Therefore internal amplifier gain value can be used and is determined by obtaining the intersection of the pass through signal and a directional signal to the West. This paper studied the method of determining the gain of the internal amplifier of the easiest way and tested on different data transmission rates start at 1.25 GHz, 2.5 GHz and 5 GHz. Value obtained is the internal amplifier’s gain for OXADM that is suitable for every transmission rates.

Key words:

Introduction

The OXADM can also provide survivability through restoration against failure by means of dedicated and shared protection that can be applied in WDM ring metropolitan network and network migration without restructuring the existing network configuration (Ab-Rahman et al., 2006a) (Ab-Rahman and Shaari, 2006b). With the excellence, multifunctional, and flexible features, it is expected to be key issue to be discussed amongst the researcher and manufacturer soon. We include in this section the exact specification of OXADM, insertion loss for every function of device, crosstalk, return loss and storage and operating temperature. However, the loss is different for each OXADM operations, particularly when the ring protection switch for directional orientation to the West and to the East by 12 dB and 10 dB respectively as shown in Table 1. With the inclusion of internal gain is to ensure that the two signals has equal amplitude of the pass through signal. Uniformity in the signal at each output is important in the management OXADM node for a ring network. This makes it easy to set the amplifiers in the network.

The both signal must have same output power level for ease of network management

Fig. 1: Uniformity in the signal at each output is important in the management OXADM node for a ring network. This can be achieved by comparing with pass through signal and internal gain to control the signal amplitude.

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Table 1: The specification of OXADM prototype device. Insertion loss of ring protection function (bold) is higher than pass through and other routing functions.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Operation</th>
<th>Values</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion loss</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pass Through</td>
<td></td>
<td>Ideal</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Actual</td>
<td>dB</td>
</tr>
<tr>
<td>Add</td>
<td>0.037</td>
<td>4</td>
<td>dB</td>
</tr>
<tr>
<td>Drop</td>
<td>0.037</td>
<td>3</td>
<td>dB</td>
</tr>
<tr>
<td>Single Path Exchange</td>
<td>0.051</td>
<td>6</td>
<td>dB</td>
</tr>
<tr>
<td>Double Path Exchange</td>
<td>0.051</td>
<td>6</td>
<td>dB</td>
</tr>
<tr>
<td>Linear Protection</td>
<td>0.051</td>
<td>6</td>
<td>dB</td>
</tr>
<tr>
<td>Multiplex Protection</td>
<td>0.051</td>
<td>6</td>
<td>dB</td>
</tr>
<tr>
<td>Ring Protection (To East)</td>
<td>NA</td>
<td>10</td>
<td>dB</td>
</tr>
<tr>
<td>Ring Protection (To West)</td>
<td>NA</td>
<td>12</td>
<td>dB</td>
</tr>
<tr>
<td>Crosstalk</td>
<td></td>
<td>&gt; 60</td>
<td>dB</td>
</tr>
<tr>
<td>Return Loss</td>
<td></td>
<td>&gt; 40</td>
<td>dB</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-20 to +70</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-40 to +85</td>
<td></td>
<td>°C</td>
</tr>
</tbody>
</table>

The preamplifier, post amplifier and internal amplifier in device are important and need to be managed properly. The internal gain ensure the output power for every operation of OXADM is at the same amplitude. Thus this enable to extend the function of OXADM node in ring and mesh optical network to perform the function of survivability and migration with assistance of preamplifier and post amplifier (Ab-Rahman and Shaari, 2007a)(Ab-Rahman et al., 2007b)(Ab-Rahman et al., 2011b). A good configuration of amplifiers used can extend the achievable distance by the network and ensure the signal received at the user end with high quality assurance (Ab-Rahman, 2009c). Morever OXADM can also perform the multifunctional devices such as multiplexer, demultiplex, OADM, OXC and etc (Ab-Rahman, 2011a). Signal uniformity is important when the OXADM used in other application to replace the original device and uninterrupted the system performance.

This paper studied the method of determining the gain of the internal amplifier of the easiest way and tested on different data transmission rates start at 1.25 GHz, 2.5 GHz and 5 GHz. Value obtained is the internal amplifier’s gain for OXADM that is suitable for every transmission rates. The technique is similar to identify the suitable injection signal in drop and add operation of OXADM as reported in (Ab-Rahman and Shaarani, 2009).

Internal Amplifier Gain:

The purpose of the simulation study is to obtain the optimum value for the internal amplifier gain for ring protection towards the west signal at different transmission rates. Simulation was conducted on three different data transmission rates of 1.25 Gbps, 2.5 Gbps and 5 Gbps. The ideal value of internal gain for each data transmission rate has to be determined. Sensitivity of the photoreceiver is set at -25 dBm (1530 nm) at a rate of 2.5 Gbps data transmission (Thermal noise = 3.1347 x 10-23 W/Hz).

Gain value for the internal amplifier for the operation of a ring of protection towards west signal at 1.25 Gbps is 5 dB which provides the same level of magnitude of the pass through operation signal (output power = -22.84 dB). This is based on the intersection on both the graph as shown in Figure 2.

![Fig. 2: Calculating the internal gain by defining the insertion point with pass through signal at 1.25 Gbps transmission rate from received power view.](image)
Effect of internal amplifier gain at 1.25 Gbps BER performance is shown in Figure 3. The internal gain value of 5.5 dB gives a BER measurement the same value and satisfaction for both the operational (BER <1x10^-47).

The ideal gain for the internal amplifier for the ring protection scheme (towards the west signal) at 2.5 Gbps is 5 dB which provides the same level of magnitude of the pass through operation signal (output power = -22.98 dB). This is based on the intersection on both the graph as shown in Figure 4. This value is similar to the results obtained in Figure 2.

Fig. 3: Calculating the internal gain by defining the insection point with pass through signal at 1.25 Gbps transmission rate from BER performance view.

Fig. 4: Calculating the internal gain by defining the insection point with pass through signal at 2.5 Gbps transmission rate from received power view.

Fig. 5: Calculating the internal gain by defining the insection point with pass through signal at 2.5 Gbps transmission rate from BER performance view.
Fig. 6: Calculating the internal gain by defining the insertion point with pass through signal at 5 Gbps transmission rate from received power view.

Effect of internal amplifier gain at 2.5 Gbps to BER performance is shown in Figure 5. The internal gain of 5.5 dB gives a BER measurement the same value and satisfaction for both the operational (BER < 1x10^-19).

The ideal gain for the internal amplifier for the ring protection scheme (towards the west signal) at 5 Gbps is 5 dB which provides the same level of magnitude of the pass through operation signal (output power = -23.37 dB). This is based on the intersection on both the graph as shown in Figure 6. This value is similar to the results obtained in Figure 2 and Figure 4.

Fig. 7: Calculating the internal gain by defining the insertion point with pass through signal at 5 Gbps transmission rate from BER performance view.

Despite the increase in the data transmission rate depreciate the measured BER performance, but based on observations in Figure 7 shows the intersection of two main operational OXADM occurs at 5.5 dB (BER < 1x10^-2). However, if the BER performance is to increase the sensitivity of the value should be lowered or increase the value of the gain of the amplifier used (Saleh and Teich, 1991) (Ab-Rahman et al., 2008g)(Ab-Rahman et al., 2009b).

From observations based on Figure 2 to Figure 7 it can be concluded that the appropriate value of the internal amplifier is at 5.5 dB for BER values standardized with the pass through signal operations and other operations for all data transmission rates. However, the optimum value that can be used is 5 dB.

Reference