Chapter 5

Conclusion

5.1 Conclusions of This Research

PD frequency response measurement system using gain-controlled EDFA based on the MZM technique has successfully performed first at NTC Telecommunications Research Laboratory, Department of electrical engineering, Faculty of engineering, Chiang Mai University. The system uses a standard MZM for two-tone stimulus signal generation instead of a high extinction ratio MZM as the originally proposed. Previous study shows that its extinction ratio performance is sufficiently large for acceptable frequency response error. The optical couplers are used to direct the optical signal into different measurements instead of the costly optical switch as the originally proposed. The uses of couplers enable faster automated measurement, where it takes shorter time to obtain stable reading as the modulation frequency is swept. The insertion losses of the optical couplers through each port pair is considered and taken into the frequency response ratio formula.

In this work, we demonstrate the use of gain-controlled EDFA to compensate the two-tone lightwave level to improve SNR of the converted RF signal. The effects of EDFA on the PD frequency response are studied. The amplified two-tone signal is kept constant broad frequency range. The best input optical power for an MZM is obtained at 13dBm. The best constant two-tone stimulus signal level amplified by an EDFA is obtained at higher than 3dBm. The converted RF extinction ratio more than 38 dB is achieved. By using gain-controlled EDFA, the optical power sensor discrepancies can be limited due to constant optical power level. The RF power sensor error can also be decreased due to higher PD generated photocurrent level. The frequency response curve fluctuation is decreased to under ±0.1dB when two-tone power is controlled by EDFA. It should be noted that power imbalance of the two-tone due to the EDFA is about ±0.03dB, and the ASE noise gives error in κ less than ±0.046dB.

The automated measurement using computer control is achieved by using LabVIEW programming. The measurement system can perform automatically which is faster and more precise. Moreover, the null point biasing control of an MZM for two-tone generation is also successfully developed where the bias point is determined from analyzing the harmonic components of the converted RF spectrum instead of optical spectrum. The bias voltage resolution is achieved up to 0.001V as high as the limit of the programmable power supply. Therefore, the null bias voltage is achieved with great accuracy. In other words, the highest suppression ratio performance of an MZM can be reached.

5.2 Problems and Obstacles

The test frequency range of the measurement system should be more than the bandwidth of a photodiode under test, however in our setup, it is limited by the RF generator.

5.3 Suggestions and Guidelines for Further Research

5.3.1 If the EDFA can also be controlled by computer, this will be useful for fully automatic control system. It enables simple characterization if another EDFA models will be used such as high-gain EDFA.

5.3.2 For the null point finding mechanism, from figure 4.12, consideration by the average RF power by an RF power sensor may be possible which requires further study. This will enables the lower cost measurement system where it no needs for a costly RF spectrum analyzer.

5.4 The Future Uses of the Research Results

5.4.1 The test frequency range of this technique can fully extended as high as possible by using gain-controlled EDFA.

5.4.2 The developed PD response measurement system can be used for further study to improve the drawbacks to make this technique perfectly.

5.4.3 Calibrated PD by using this system can be used to measure the laser diode (E/O) frequency response.

5.4.4 The measurement system can be applied for the laser diode (E/O) frequency response measurement which can be used for further research.