CHAPTER 7

7.0 CONCLUSIONS

The main objective of this thesis is to design a communication system that

- Uses a single coherent light source.
- Increases the number of communication channels in PSK communication system.
- Makes use of coherence property for increasing the number of channels through manipulation of optical path lengths (OPL).

For all of the above, different schemes were developed in five different designs. Here, a brief discussion of the achievements and how further improvements can be made ensues.

In all optical two-channel PSK communication, using a single light source it was shown that two different channels can be used for information transfer using single light source. In this design two polarization planes are used for different channels. Since orthogonal plane polarized light wave do not interfere with each other so outputs from both channels are clean with no interference between them. In this design a unique decoding system is developed. The detailed explanation has been given in chapter 4.

An all optical single channel, two-way communication system, utilising a single light source shows it is possible to design a two-way communication system was also designed. This means it is possible to have one central office with a strong light source, which is easy to maintain, while the other side does not need to have light source at all. This is a big advantage over the existing system, which requires two light sources for a two-way communication. In this communication system two orthogonal plane polarized lightwaves

are used. One plane-polarized light is for sending the signal while the other one is to receive the signal. Since both plane polarized light wave are orthogonal they do not interfere with each other.

In the design of a single channel two-way communication system, without a time delay unit, the light wave is split three times which makes the returning signal very weak but coherence length problem can be rid of so this design provides us a choice between a weak return signal without a time delay and strong return signal with time delay unit. If the communication is over a long distance then it is better to choose a stronger return signal with a time delay because the light wave will be attenuated over the long distance. But the use of a stronger light source will then produce non-linear effects, which in turn degrades the quality of the return signal. Similarly if the communication system is over a short distance then a system without a delay unit can be selected because of overall low attenuation and it also makes the system simpler.

In an all optical two-channel, two-way communication system using a single light source, the light wave is divided into two parts one of which becomes the reference while the other part is divided again into two equal orthogonal plane polarized light waves. Both orthogonal plane polarized light waves are coded with signals. On the other side, away from the light source both orthogonal plane polarized light waves interfere with a portion of a reference light wave and in this way signals are decoded. Remaining portion of the light wave is again divided and a similar procedure is repeated and new signals, which are

encoded on the other side of the light source, are decoded on the light source side. In this way two-way two-channel communication is established.

In all these four designs the coherence length has been maintained. If the path length of any two light waves is not within the coherence length they will not interfere with each other to produce characteristics interference on the surface of the photo-detector. In other words signal decoding will be difficult. But it also creates a possibility of transmitting more channels over the same path, with the same light wave but using different coherence lengths. This property is exploited in "coherence length dependent multi-channel PSK communication system, using a single light source. In this design it has been shown that as long as the path length difference for different signals is more then the coherence length of the light sources the signal will not interfere with one another.

Besides increasing the number of channels the systems have three main advantages over other systems.

i. Most laser diodes produce phase noise. This phase noise can increase the bit error rate. But in the above systems the effect of phase noise is reduced to nil, because the reference light wave and the signal carrying light wave are both derived from the same source. If any phase noise is produced it will effect the signal carrying light wave as well as the reference light wave and there will be net zero effect on the performance of the system the to the phase noise. In other words the system is independent of phase noise generated by the light source.

ii. Most laser diodes also produce frequency jitter and frequency shift. This also causes an increase in bit error rate. This change in frequency is usually due to change in temperature. In the system studies the effect of frequency is not taken in account because the reference and the signal carrying light waves both come from the same source.

iii. The third advantage is that when two polarized light pass through conventional single mode fibre (SMF) their relative angle between the planes of polarization remains un-changed over few kilometer length [5], which warrants conventional single mode fibre for use in PSK communication. In other words there is no extra cost of laying new polarization maintaining fibre. Long lengths of SMF may mix two polarization due to impurity therefore the PSK system is well suited for LAN communications.

7.1 Further Work

In the pursuit of PSK communication with and without using EDFA, a number of areas have been identified which would require further extensive research. The PSK communication system designed in the course of this work is not very efficient as far as power of the light wave is concerned. Usually more than 75% of power is wasted. Because each time a signal is divided by non-polarized beam splitter 50% power is wasted and same thing happened at transmitting and receiving side of the signal. If efficient polarization maintaining fiber couplers are used then a major portion of the light source can be saved. More work need to be done for studying the behavior of SMF with respect to plane of polarization. Though there are polarization maintaining fiber couplers

available but expensive and difficult to make. Implementation of PSK communication is more difficult than ASK communication, because PSK communication requires polarization maintaining fiber (PMF) which is expensive and difficult to splice and also light source should have very narrow line width.

For long distance PSK communication a high power light-source is needed because PMF also usually have higher loss. High power light sources create non-linear effects, which in turn limit PSK communication. We have studied multi-channel PSK communication using different path lengths for different channels, which is larger than the source coherence length. But detailed study of data transfer rate and path length difference is needed. We also suggest that EDFA should be used for long distance PSK communication. Similarly polarization-maintaining wavelength multiplexer (WDM) has to be studied because the degree of polarization maintaining of such WDM's may not be same for all wavelengths.

7.2 References

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