Fiber Optic Bi-Directional Communication

An interesting feature of optical fibers is that light traveling in one direction is largely unaffected by light traveling in the opposite direction along the same fiber. This makes sense when you think about it. If you were to shine two torches at each other, their beams wouldn't interfere with one another.

The ability of light to travel in both directions along optical fibers without interfering allows us to use them for bi-directional communications. That said, the loading and unloading of the signals at each end is more involved because both ends of the fiber must be connected to both a transmitter and a receiver. In telecommunication, this is usually managed by a device called a circulator. However, circulators for plastic fiber systems are expensive (defeating the purpose of using plastic in the first place). A cheaper alternative involves using two optical couplers but the trade-offs include increased losses and cross-talk.

Recall that an optical coupler is a 4-port device with the ports usually denoted alphabetically from A to D. recall also that a signal injected in to one port is literally split and becomes available on the two ports at the opposite end of the coupler (though one port's output is significantly stronger than the other). For example, a signal injected in port A is split between port D (the strong path) and port C (the weak path). Importantly, the optical coupler is a bi-directional device. So, a signal injected in to ports C or D is split between ports A and B and this is true even if a signal is connected to ports a and/or B at the same time. It's this property that allows us to use optical couplers to implement bi-directional fiber optic communications

Figure 1 below show the basic implementation of bidirectional fiber optic communications between two stations using optical couplers

As you can see, the transmitter (Tx) of station 1 is connected to the channel via the weak path of its optical coupler (that is, from port B to D). this transmitted signal is connected to receiver (Rx) at station 2 via strong path of its optical coupler (that is, from port B to path of its optical coupler (that is, from port d to B) and this signal is directed to station 1 receiver via its optical coupler's its strong path (that is, from port D to A).

The fact that the two signal travel through a weal path of one of the optical couplers is responsible for the higher losses involved in this method of loading and unloading the signals (compared with using a circulator).

Also, recall from your investigations into the operation of the coupler modules in experiments 10, that the input signal to an optical coupler is actually split three ways not just two. A small amount of light is reflected to the port on the same end as the input. For example, a signal injected in port A results in a very small signal on the output of port B. this is responsible for the cross-talk mentioned earlier and may need to be managed.