Ring Loaded Mach-Zehnder

File name: `Loaded MZ.apc`

This example shows how to use chromatic dispersion, scan and sweep functions. The circuit is shown in Fig. 1: a Mach Zehnder interferometer loaded with a phase-shifter ring resonator. To act as an interleaver with symmetrical transfer function on the Bar and Cross ports the unbalance must be one half the length of the ring. The default values are: length of the ring L_r=500 μm, unbalance ΔL=250 μm and ring coupling coefficient K_R equal to 8/9 in order to have a maximally flat in-band characteristic. A group index equal to 2.0 for the straight waveguides and equal to 2.01 for the ring at the wavelength 1.55 μm are assumed. The Free Spectral Range is FSR=c/(2.01L_r-2ΔL)=594 GHz. The symmetrical characteristic deteriorates moving away from the central wavelength mainly because of the slightly different dispersion of the two arms of the interferometer. The two directional couplers of the Mach-Zehnder are assumed wavelength independent with a power coupling ratio equal to 0.5.

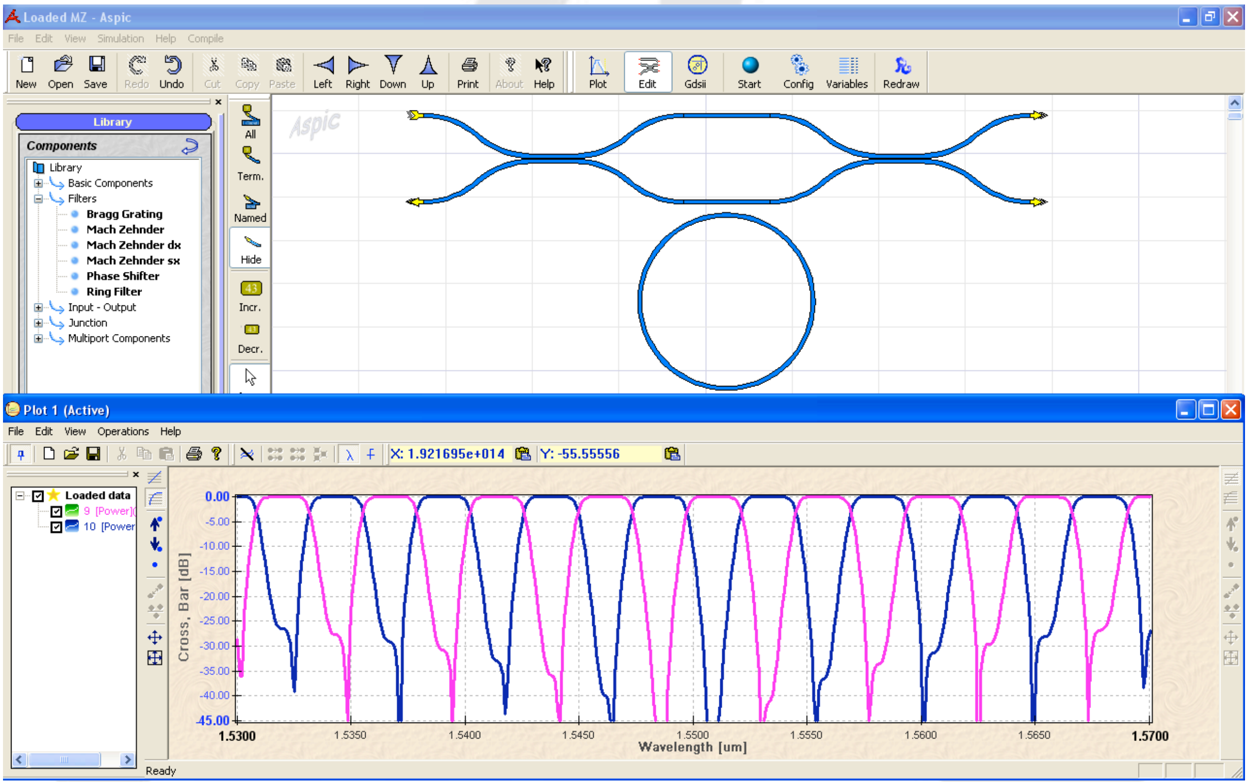

Fig. 1 – The ring loaded Mach-Zehnder and its bar and cross intensity transfer function.

The transfer function of this device is simply given by the squared cosine response of the phase shift difference accumulated in the two arms of the Mach Zehnder. Fig. 2 shows the two phase shifts and hence the reason of the third-order symmetrical and squared intensity characteristic. The phase of the upper arm varies linearly with the frequency whereas the phase shift induced by the lower arm is distorted by the phase shifter. The intensity response varies very rapidly where the phase jumps and remains almost flat otherwise. The difference between the two contributions increases by 2π each free spectral range and the characteristic assumes the nice shape shown in Fig. 1. If K_R=8/9 a maximum flatness is achieved whereas for lower values a ripple appears. Clearly, if

K_R=1 a simple unbalanced Mach Zehnder with a sinusoidal transfer function with the same FSR is obtained, as shown in Fig. 3a.

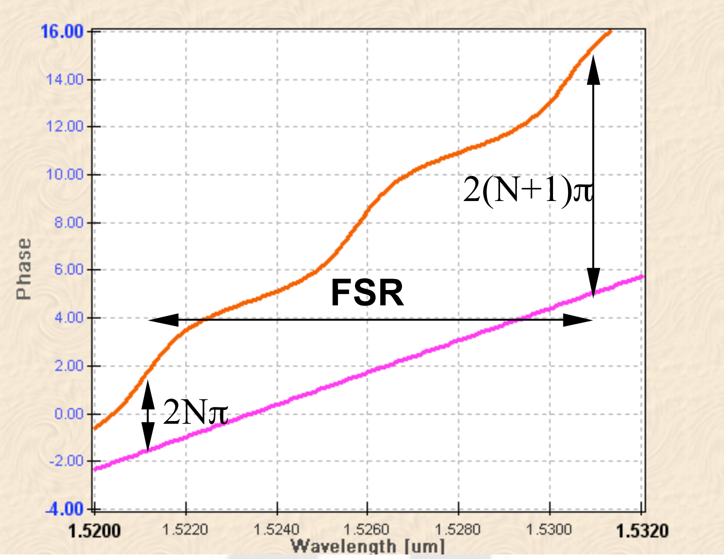

Fig. 2 – Phase shift induced in the two arms of the Mach-Zehnder

The extinction ratio (or rejection) near the central wavelength is higher than 45 dB but decreases rapidly if the two directional couplers are not ideals. Fig. 3b shows the minimum bar output for the five values of K_1=0.3; 0.4; 0.5; 0.6; 0.7 as a function of K_2. The valued used in the scan are visible by expanding the output variable in the left panel of the plot window. Each curve can be selected, edited, exported and deleted as usual.

The value used for a variable is that one specified in the "*Variables Table*" unless a *Scan* or a *Sweep* function is used. In this case the values are calculated in the range specified in the "*Config*" panel.

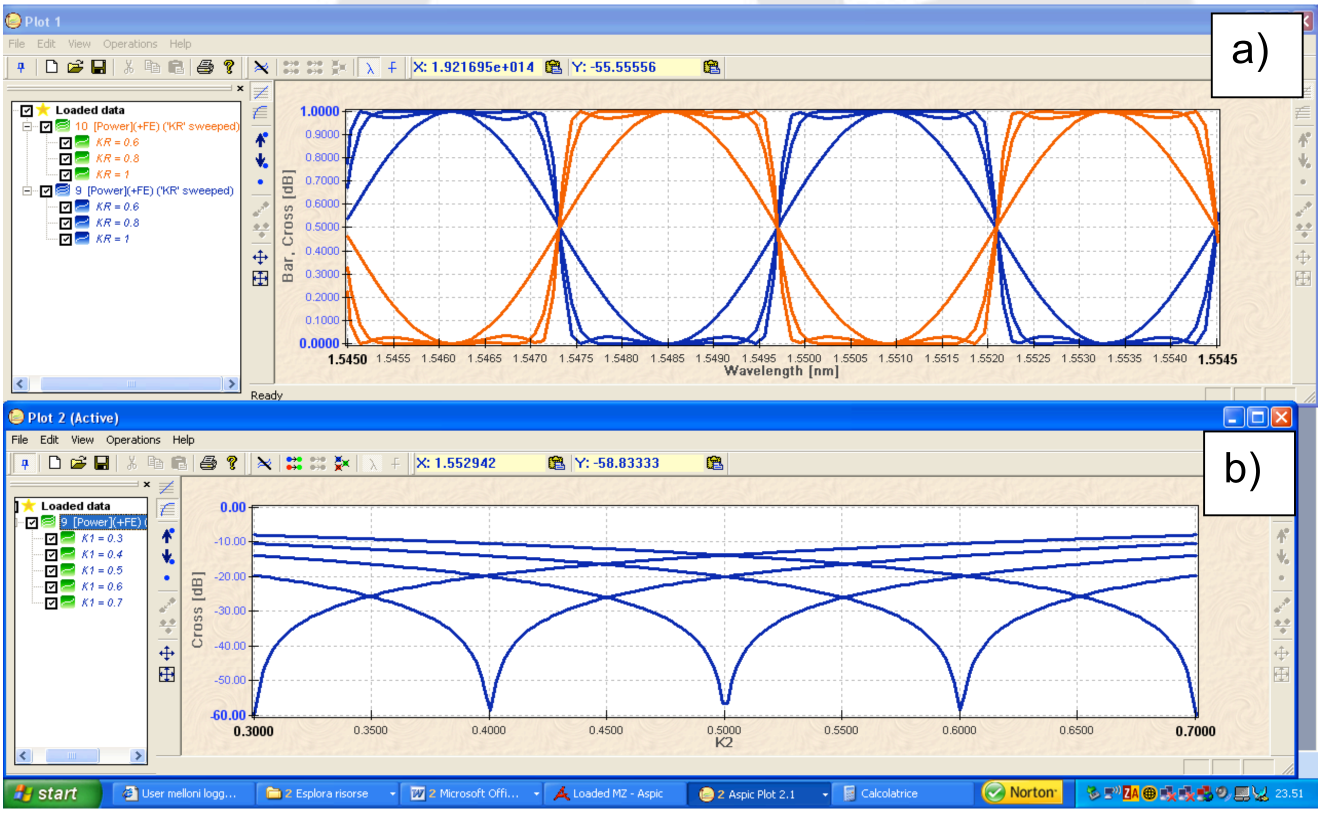

Fig. 3 – a) Bar and cross transfer function for K_R=0.6, 0.8 and 1. b) Extinction ratio for K_1 and K_2 in the range 0.3 to 0.7.