



# SNS COLLEGE OF TECHNOLOGY

Coimbatore-35  
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

### OPTICAL AND MICROWAVE ENGINEERING

III YEAR/ VI SEMESTER  
1

#### UNIT 1 – MICROWAVE PASSIVE DEVICES

TOPIC – Hybrid Rings

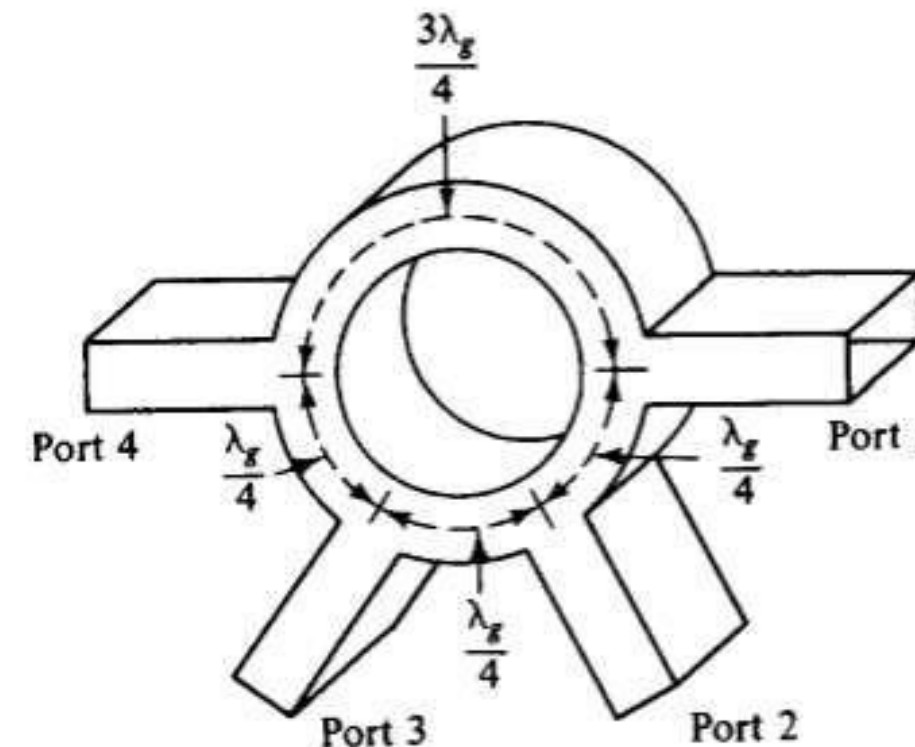


# Hybrid Ring



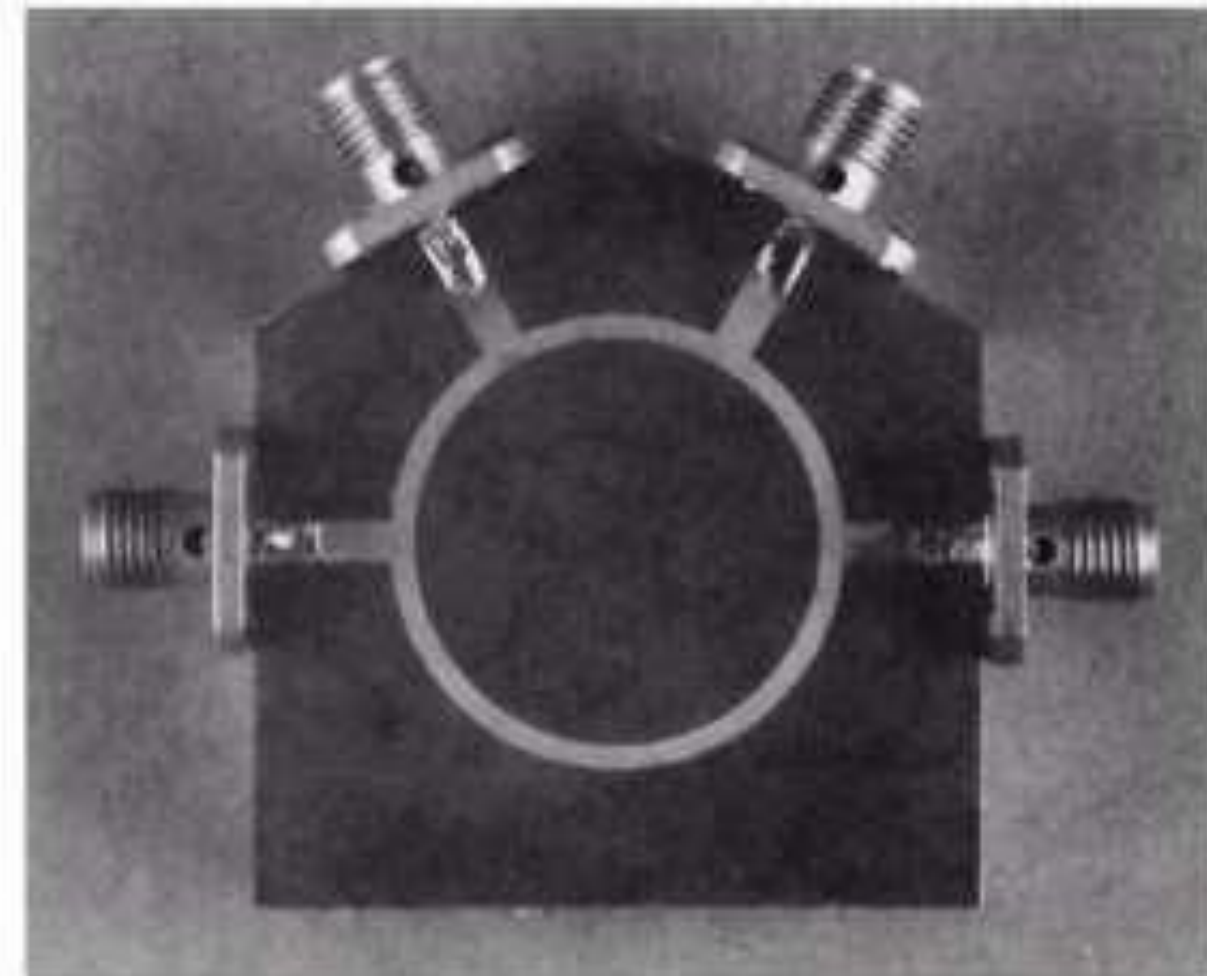
- A hybrid ring consists of an annular line of proper electrical length to sustain standing waves, to which four arms are connected to a proper intervals by means of series or parallel junctions.
- Figure shows hybrid ring with series junctions.
- The hybrid ring has characteristics similar to that of Magic Tee. When a wave is fed in to port 1 it will appear at port 3 because the difference of phase shifts for waves travelling in clock wise is  $180^\circ$ . So the waves are cancelled at port 3.
- The same reason for the waves fed in to port 2 will not emerge at port 4 and so on.
- The S Matrix for hybrid Ring is as shown

$$\mathbf{S} = \begin{bmatrix} 0 & S_{12} & 0 & S_{14} \\ S_{21} & 0 & S_{23} & 0 \\ 0 & S_{32} & 0 & S_{34} \\ S_{41} & 0 & S_{43} & 0 \end{bmatrix}$$





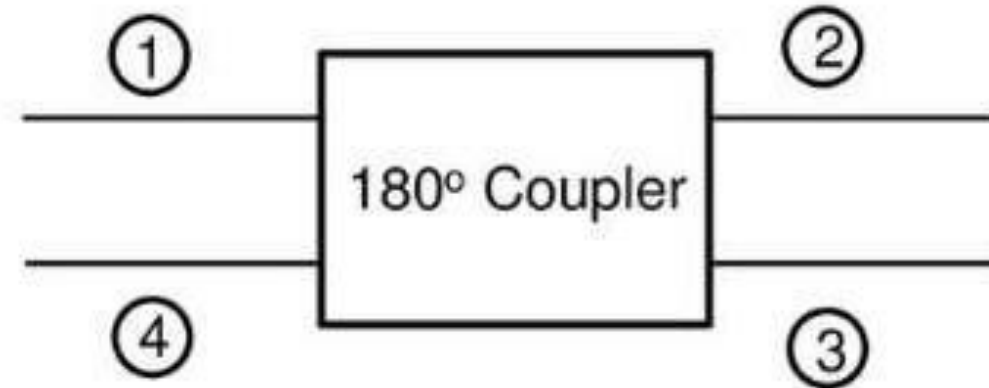
# Rat Race Ring Coupler







# Rat Race Coupler



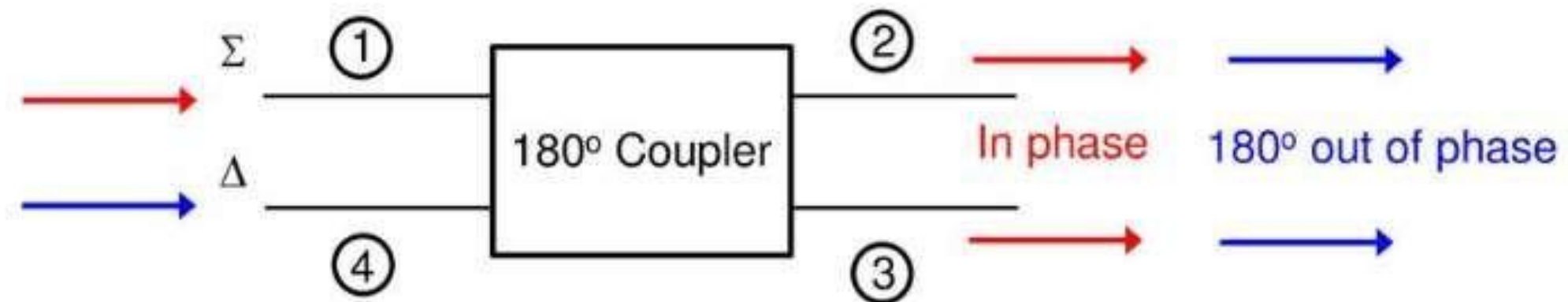
$$[S] = \frac{-j}{\sqrt{2}} \begin{bmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & -1 \\ 1 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 \end{bmatrix}$$

- The rat race is a lossless 4-port (the  $S$  matrix is unitary).
- All four ports are matched.
- The device is reciprocal (the  $S$  matrix is symmetric).
- Port 4 is isolated from port 1, and ports 2 and 3 are isolated from each other.



# Rat Race Coupler

The rat race can be used as a splitter:



**Note:** A matched load is usually placed on port 4.

- The signal from the “sum port”  $\Sigma$  (port 1) splits evenly between ports 2 and 3, in phase. This could be used as a power splitter (alternative to Wilkinson).

$$S_{21} = S_{31}$$

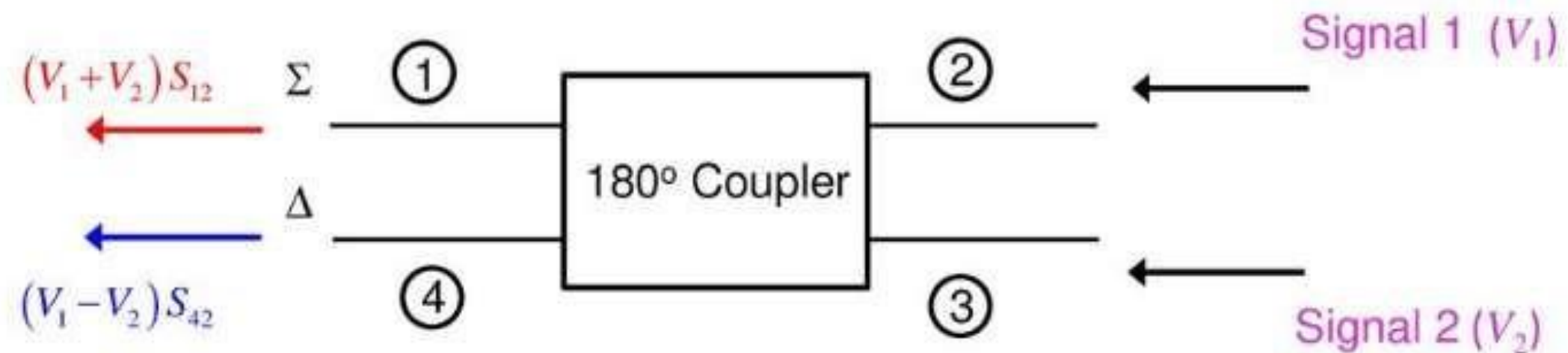
- The signal from the “difference port”  $\Delta$  (port 4) splits evenly between ports 1 and 2, 180° out of phase. This could be used as a balun.

$$S_{24} = -S_{34}$$



# Rat Race Coupler

The rat race can be used as a combiner:



- The signal from the sum port  $\Sigma$  (port 1) is the sum of the input signals 1 and 2.

$$S_{12} = S_{13}$$

- The signal from the difference port  $\Delta$  (port 4) is the difference of the input signals 1 and 2.

$$S_{42} = -S_{43}$$



**THANK YOU**