

Design a microstrip ring hybrid for a $50\ \Omega$ system with a design frequency of 2 GHz on Rogers RT/duroid 5880 (1 oz. copper, 1.574 mm board thickness). Draw a fully-labeled top view sketch of design.

Per section 7.8 and Figure 7.42a, we will need $Z_0 = 50\ \Omega$ and $\sqrt{2} Z_0 = \sqrt{2}(50) = 70.71\ \Omega$ microstrips.

The Rogers RT/duroid 5880 datasheet only gives $\epsilon_r = 2.20$ (no graph versus frequency).

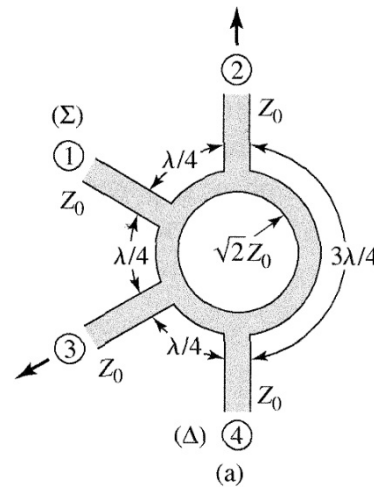


FIGURE 7.42 Three types of hybrid junctions. (a) A ring hybrid, or *rat-race*, in microstrip line or stripline form.

$$Z_0 = 50\ \Omega$$

From Rogers MWI at 2 GHz on Rogers RT/duroid 5880 (1 oz. copper, 1.574 mm thick)-
 $W_{50} = 4.9\ \text{mm}$. Started with 'Synthesis Width' option and changed to 'Analytical' option to get closer values for $50\ \Omega$, only went to one decimal place for width.

Program Design Type Information

Microstrip

Transmission Line Information

Impedance = 50.06 ohms
Effective dk = 1.8915

Dielectric Loss is = 0.19471 dB/m
Conductor loss is = 0.33774 dB/m
Total loss is = 0.53245 dB/m

Dielectric Q Factor is 1285.
Conductor Q Factor is 856.8
Total Q Factor for transmission line is 514.1

Wavelength on transmission line:
1 wavelength = 0.108 meters
1/2 wavelength = 0.054 meters
1/4 wavelength = 0.027 meters
1/8 wavelength = 0.013 meters

Open Single End Fringing = 0.7489 mm
Skin depth in copper is = 1.476e-6 meters

All material names are licensed, registered trademarks of Rogers Corporation

Material Name	Bulk Dk	Df	TC Dk	Ti
RT/duroid 5870	2.33	0.0012	-115	0.
RT/duroid 5880	2.2	0.0009	-125	0.
RT/duroid 5880LZ	1.96	0.0019	22	0.
RT/duroid 6002	2.94	0.0012	12	0.
RT/duroid 6010LM	10.7	0.0023	-425	0.
RT/duroid 6035HTC	3.6	0.0013	-66	1.
RT/duroid 6202	2.94	0.0015	13	0.
TMM3	3.45	0.002	37	0.
TMM4	4.7	0.002	-15.3	0.
TMM6	6.3	0.0023	-11	0.
TMM10	9.8	0.0022	-38	0.

Material Properties

Material: RT/duroid 5880 Thickness (H): 1.574 mm

Dk: 2.2 Df: 0.0009 Thermal Cond.: 0.2 W/K*m

☒ use z-axis Bulk Dk values
☐ Dk values for a specific frequency
☐ Dk values for characteristic impedance

Conductor Parameters

Thickness (T): 0.0013 microns Surface Area Index: 3.7

1oz ED Avg Nodule Size (microns): 0.2

Conductivity: $5.813 \times 10^7\ \text{S/m}$

Surface Roughness (RMS): 2.1 microns

Roughness loss model: Hall-Huray

Copper roughness values:
☒ Optimum for accuracy
☐ Actual measurement

☒ Analytical ☐ Synthesis Width Impedance: 50 Ohms Frequency: 2 GHz

Calculate Generate Tables and Files: None

ROGERS CORPORATION
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English Metric
Circuit Parameters
Conductor Width (W): 4.9 mm
Space (S): 0.2286 mm Length: 25.4 mm

$$Z_0 = 70.71 \, \Omega$$

From Rogers MWI at 2 GHz on Rogers RT/duroid 5880 (1 oz. copper, 1.574 mm thick)-
 $W_{71} = 2.807 \, \text{mm} \approx 2.8 \, \text{mm}$ and $\epsilon_{r,e} = 1.8299$. Started with $W_{50} = 4.9 \, \text{mm}$ and used the 'Analytical' option to get width value by trial-n-error.

Use (3.193) to get $v_p = c / \sqrt{\epsilon_{r,e}} = 2.9979 \times 10^8 / \sqrt{1.8299} \Rightarrow v_{p,71} = 2.216 \times 10^8 \, \text{m/s}$.

$\lambda_{71} = v_{p,71} / f = 2.216 \times 10^8 / 2 \times 10^9 = 110.8086 \, \text{mm} \Rightarrow 3\lambda_{71}/4 = 83.1 \, \text{mm} \text{ \& } \lambda_{71}/4 = 27.7 \, \text{mm}$.

Microstrip

Transmission Line Information

Conventional Microstrip
 Using 1.574 mm RT/duroid 5880 circuit materials.
 Conductor width = 2.807 mm

Impedance = 70.71 ohms
 Effective dk = 1.8299

Dielectric Loss is = 0.18429 dB/m
 Conductor loss is = 0.37895 dB/m
 Total loss is = 0.56324 dB/m

Dielectric Q Factor is 1336.
 Conductor Q Factor is 751.1
 Total Q Factor for transmission line is 480.8

Wavelength on transmission line:
 1 wavelength = 0.110 meters
 1/2 wavelength = 0.055 meters
 1/4 wavelength = 0.027 meters
 1/8 wavelength = 0.013 meters

Material Properties

Material Name	Bulk Dk	Df	TC Dk	T
RT/duroid 5870	2.33	0.0012	-115	0
RT/duroid 5880	2.2	0.0009	-125	0
RT/duroid 5880LZ	1.96	0.0019	22	0
RT/duroid 6002	2.94	0.0012	12	0
RT/duroid 6010LM	10.7	0.0023	-425	0
RT/duroid 6035HTC	3.6	0.0013	-66	1
RT/duroid 6202	2.94	0.0015	13	0
TMM3	3.45	0.002	37	0
TMM4	4.7	0.002	-15.3	0
TMM6	6.3	0.0023	-11	0
TMM10	9.8	0.0022	-38	0

Conductor Parameters

Thickness (T) 0.0013 microns
 Surface Area Index 3.7
 Roughness loss model Hall-Huray
 Avg Nodule Size (microns) 0.2
 Conductivity $5.813 \times 10^7 \, \text{S/m}$
 Surface Roughness (RMS) 2.1 microns

Material Properties

Material RT/duroid 5880 Thickness (H) 1.574 mm
 Dk 2.2 Df 0.0009 Thermal Cond. 0.2 W/K*m
☒ use z-axis Bulk Dk values
☐ Dk values for a specific frequency
☐ Dk values for characteristic impedance

Analytical
☐ Synthesis Width
☐ Synthesis Space

Impedance 50 Ohms
 Frequency 2 GHz
 Calculate

Generate Tables and Files
 None

Freq. Range 1 to 30 GHz

☒ Display results of only one calculation

