NRD E 60GHz

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NRD E 60GHz
(BPF) NRD E NRD E
BPF
BPF 3
BPF:0.3dB 5 BPF:0.5dB

, NRD E , ,

60GHz wideband bandpass filter using NRD guide E-plane resonators

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Abstract A novel structure of bandpass filter using NRD guide E-plane resonators is proposed. The NRD guide E-plane resonator is constructed by inserting metal foils in the E-plane of NRD guide. Simulation, fabrication and handling of the filter are very easy because each resonator is separated by simple metal foils. Chebyshev response bandpass filters are designed based on the theory of direct-coupled resonator filters and fabricated at 60GHz. Simulated and measured filter performances agreed well with the design specifications. Insertion losses of the fabricated filters were found to be around 0.3dB for 3-pole filter and 0.5dB for 5-pole bandpass filter, respectively.

Keywords bandpass filter, NRD guide E-plane resonator, millimeter wave integrated circuits, millimeter wave

1.

NRD (Nonradiative Dielectric waveguide)
[1]-[3]
(BPF) [4]-[7]
NRD BPF
[8]-[10]
[8][9]

NRD H
BPF[10] NRD
NRD E
NRD E
3 ы ʊ

2. NRD E

NRD E 1 NRD

2

60GHz 2.25mm

ε_r=2.04

PTFE a=2.25mm b=2.50mm

[1] NRD

55GHz 66.6GHz NRD E

PTFE a/2 E M

2

L

Ansoft HFSS Ver.8.5

f_0 Q Q_u

60GHz

M 3.0mm

L f_0

2

(f_0=0.702L^2-8.03L+80.99) LSM_{01} λ_g/2

f_0

f_0=60.5GHz L

3.84mm 58x10^6 S/m

36.5x10^6 S/m PTFE 2x10^{-4}

L=3.84mm Q_u

Q_u 2100

3. 3 BPF

f_0=60.5GHz, 3dB Δf=2GHz,

RW=0.1dB 3 BPF

[11]

3 BPF 3

Q Q_e=Q_{ei}=Q_{eo}=36.67 k_{ij}=k_{12}=k_{23}=0.02586

3.1. 外部 Q

NRD E Q Q_e

4

3.0mm

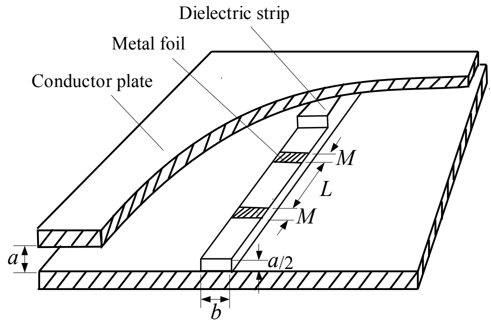
s_e w_e

Q HFSS S

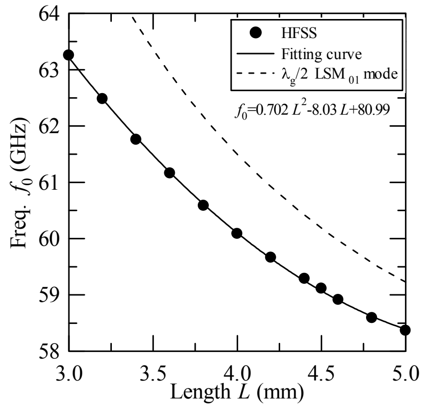
[11]

$$Q_e = Q_L = f_0/\Delta f_{3dB}$$

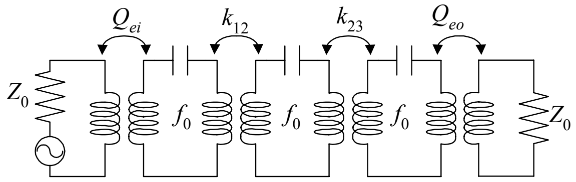
$$\because \frac{1}{Q_L} = \frac{1}{Q_u} + \frac{1}{Q_{ei}} + \frac{1}{Q_{eo}}, \quad Q_u = Q_{eo} = \infty$$



1 NRD E



2 L f_0



3 3 BPF

Q_{ei}/Q_{eo} / Q Q_L Q

Q_u Q Q_u

Q_{eo}

s_e w_e Q

f_0 5

L f_0=60.5GHz L=4.40mm

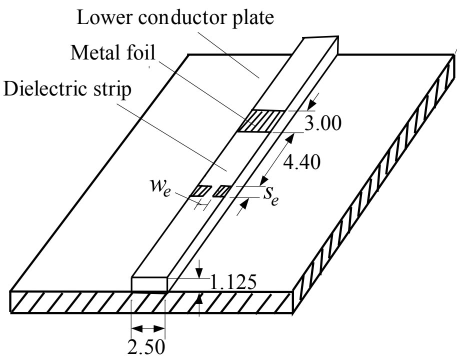
5(b) w_e 0

L

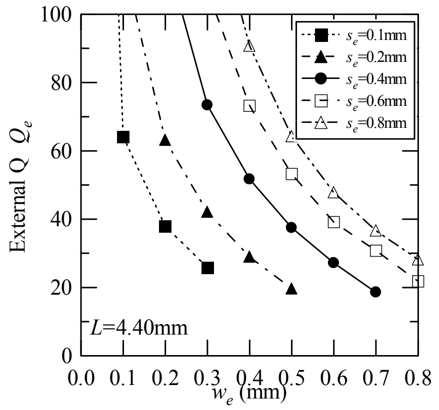
s_e=0.60mm, w_e=0.60mm

3.2. 結合係数 *k*

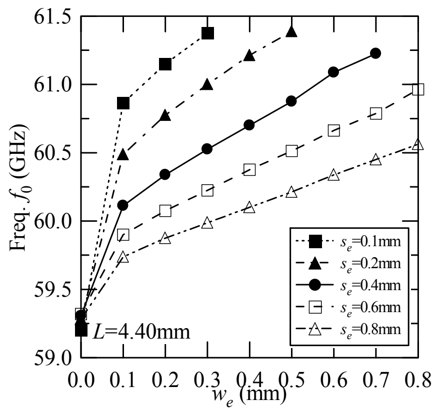
NRD E



4 Q

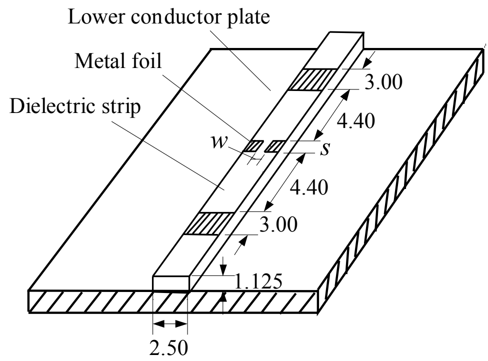


(a) Q Q_e

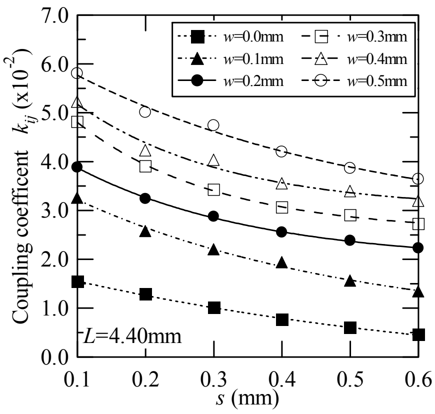


(b) f_0

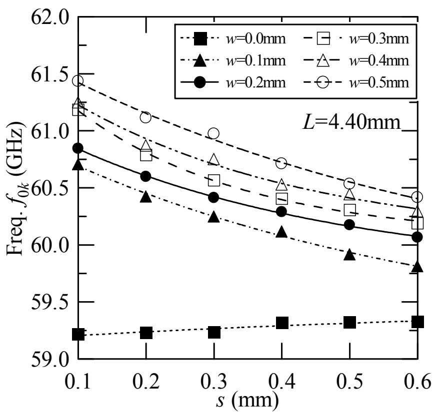
5 Q



6 k



(a) k_{ij}



(b) f_{0k}

7 k_{ij}

6 2 , f_{0h}

, f_{0l}

3.0mm s w

s w k_{ij} f_{0k} 7

k_{ij} f_{0k} HFSS S L f_{0k}=60.5GHz

[11] L=4.40mm 7(a) w

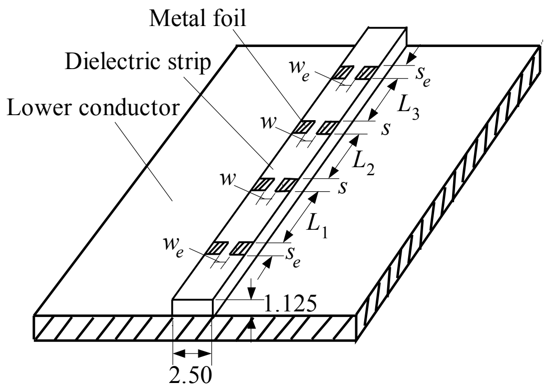
s

$$k_{ij} = \frac{\left|f_{0h}{}^2 - f_{0l}{}^2\right|}{\left|f_{0h}{}^2 + f_{0l}{}^2\right|} , \qquad f_{0k} = \sqrt{f_{0h} \cdot f_{0l}}$$

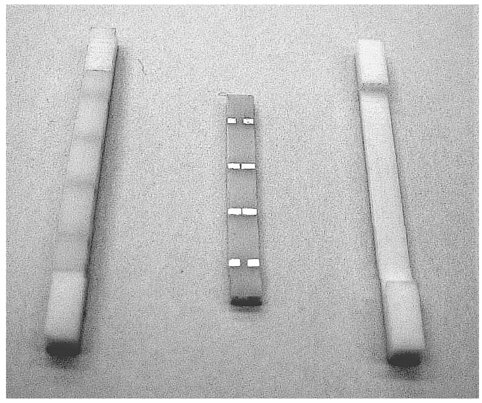
w

s

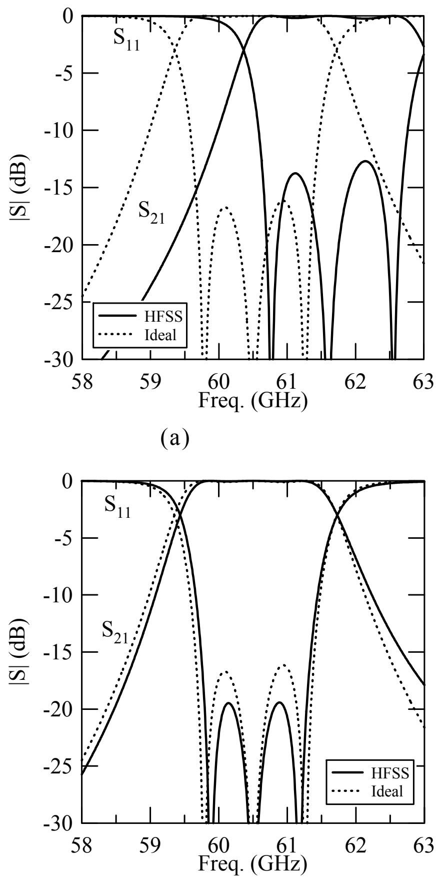
k_{ij} i j , f_{0k} Q



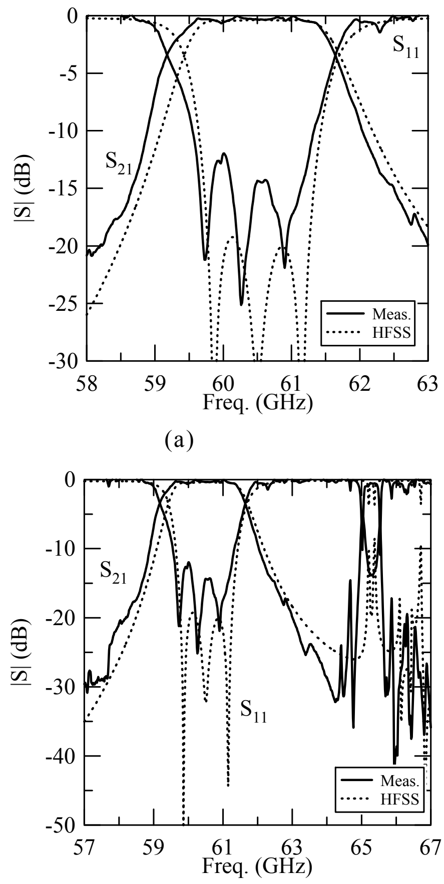
8 3 BPF



(a) (b) (c)
10 3 BPF



(b)
9 3 BPF



(b)
11 3 BPF

1
2 2 3 s
w s=0.50mm, w=0.20mm

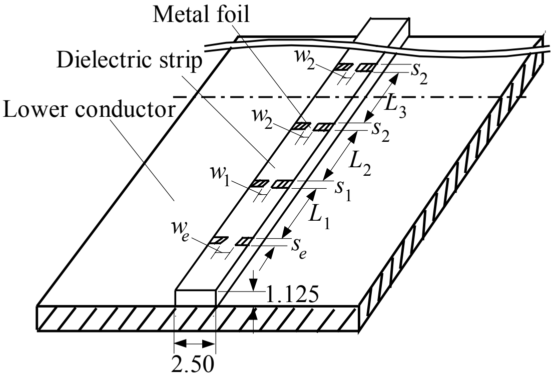
3.3. フィルタ構造の設計

3 BPF 8
BPF
L_1=L_3=4.40mm, L_2=4.20mm, s_e=0.60mm, w_e=0.60mm, s=

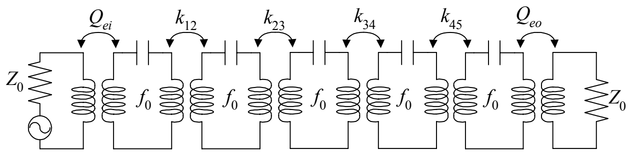
0.50mm, w=0.20mm 3
BPF HFSS 9(a)
3
3

61.5GHz 1GHz

Agilent ADS2004A HFSS



12　5　BPF



13　5　BPF

[12]　3　BPF
9(b)

L_1=L_3=4.94mm, L_2=4.68mm, s_e=0.60mm, w_e=0.70 mm, s=0.50mm, w=0.20mm

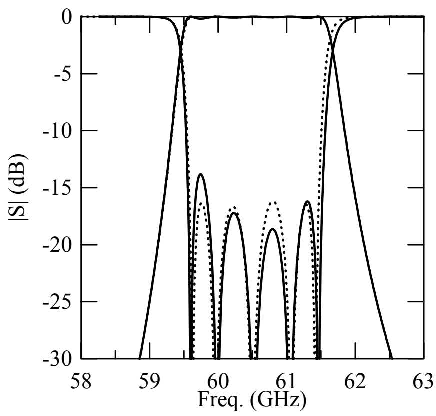
3.4. 試作及び測定

3　BPF　NC
/　NC

PTFE　2
NRD

L　0.2mm
3　BPF　10
-　,
-NRD
[13]　NRD
WR-15
NRD　25
11(a)
HFSS

f_0　Δf,
I.L.　f_0=60.41GHz, Δf=2.40GHz, *I.L.*=0.26dB
NRD　E
Q　1800　Q　2
HFSS　Q_u
11(b)　2　65GHz



4.　5　BPF

f_0=60.5GHz,　3dB　Δf=2GHz,　RW= 0.1dB　5　BPF　3
5　BPF　12
13

Q $Q_e=Q_{ei}=Q_{eo}=36.84$ $k_{ij}=k_{12}=$ $k_{45}=0.02482$, $k_{23}=k_{34}=0.01892$

4.1. フィルタ構造の設計

2 3

$L_1=L_5=4.94$mm, $L_2=L_4=4.68$mm, $L_5=4.78$mm, $s_e=0.60$mm, $w_e=0.70$mm, $s_1=0.50$mm, $w_1=0.20$mm, $s_2=0.60$mm, $w_2=0.20$mm

HFSS

3.3 ADS

5 BPF

14 HFSS

, $L_1=L_5=4.94$mm, $L_2=L_4=4.55$mm, $L_5=4.41$mm, $s_e=0.60$mm, $w_e=0.70$mm, $s_1=0.50$mm, $w_1=0.20$mm, $s_2=0.70$ mm, $w_2=0.15$mm

4.2. 試作及び測定

5 BPF 3.4

PTFE

L 0.2mm

5 BPF 25

15(a)

HFSS

f_0 Δf, $I.L.$

$f_0=60.53$GHz, $\Delta f=2.11$GHz, $I.L.=0.54$dB

15(b) 3 BPF

2

65GHz

5.

NRD E 60GHz 3 5

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