

LTCC Filter Technology Solution

RF MORECOM
COREA



Contents

LTCC Process Advantage

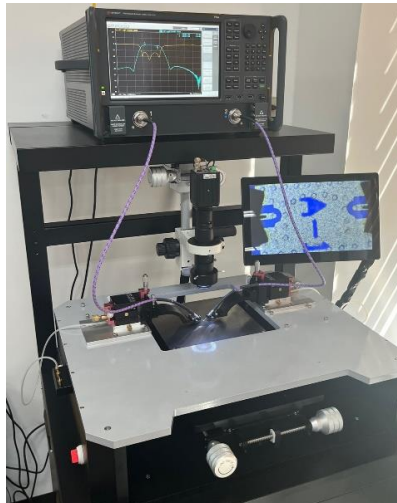
High Quality Measuring System

Filter performances

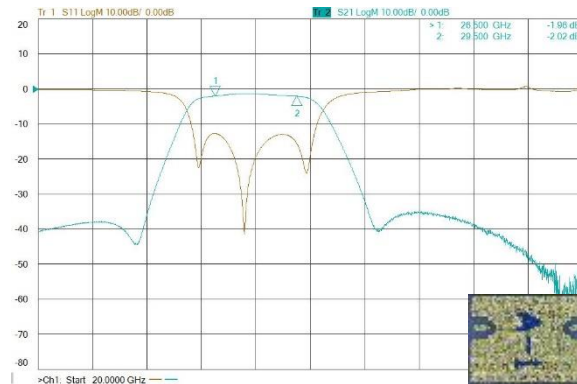
Advanced LTCC Filter

High Frequency Measuring System

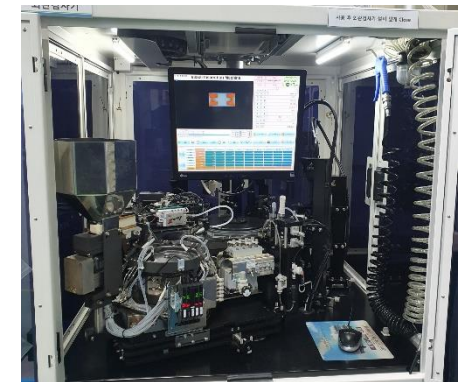
- Build a measurement base from DC to 72GHz
- Automated characteristic test system through RF characteristic handler equipment
- Characteristic evaluation and appearance inspection of product through appearance test machine
- Various measurement solutions, including handler, characteristic test jig, and probe methods



Network Probe-Station



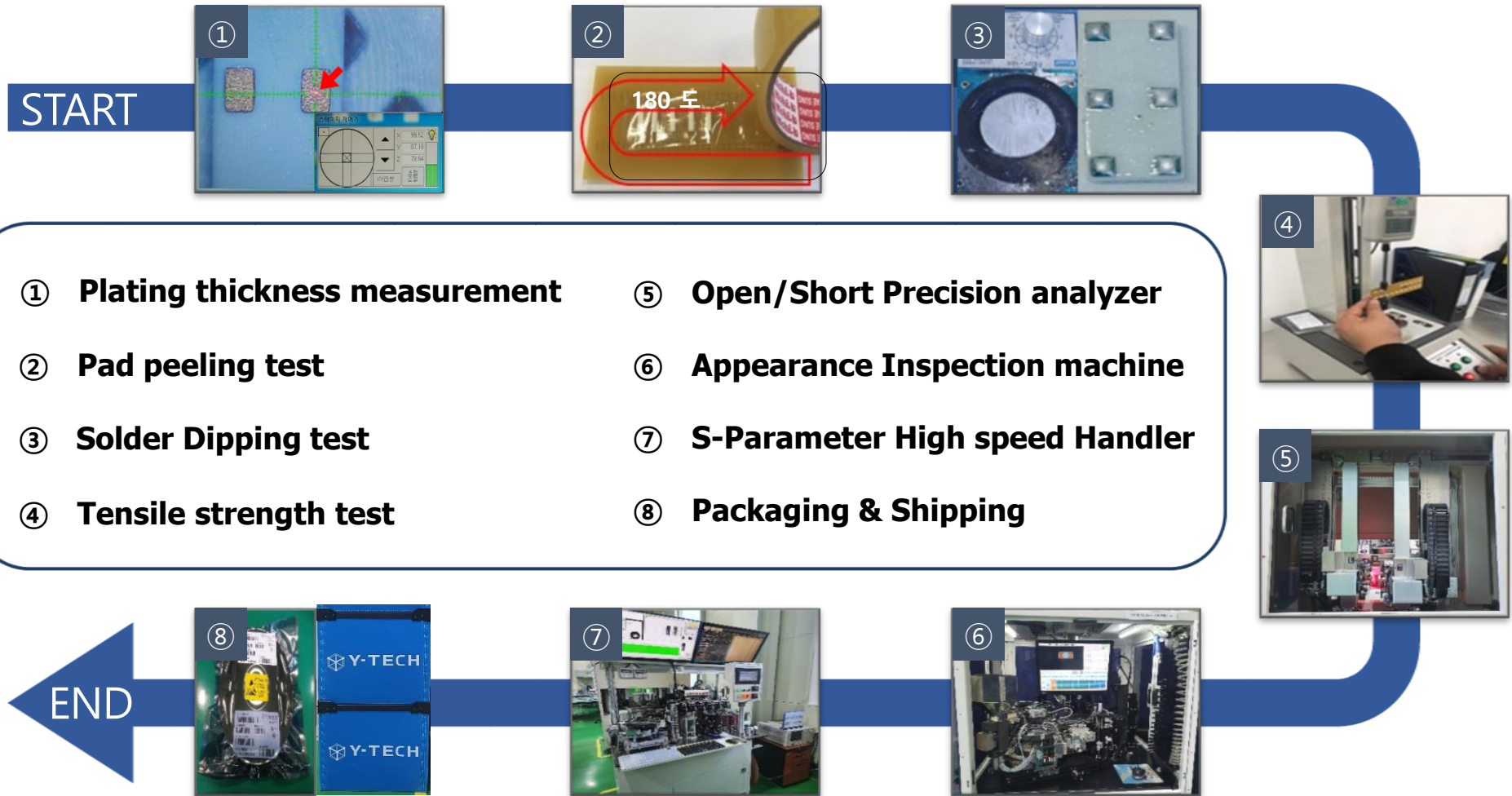
28GHz BPF Data



Automated appearance/characteristic check machine

Advanced LTCC

Quality Measuring System



Advanced LTCC Filter

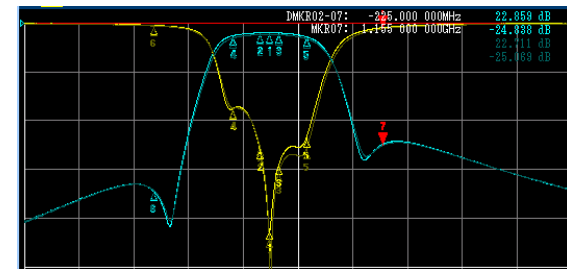
Quality Measuring System (Reliability check)

No.	Test Item	Condition	Read Out
1	High Temperature Storage Life	125°C	125hrs
2	Low Temperature Storage Life	-45°C	250hrs
3	Temperature Humidity Storage	85°C / 90% R.H.	125hrs
4	Temperature Cycling	-55~125°C / 15min / 15min	500Cycles
5	Thermal shock	85°C/-40°C 30min each	72Cycles

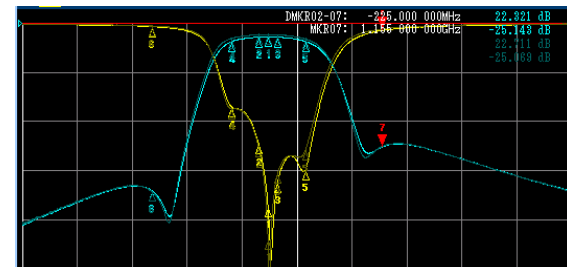
< TcF Test [-40°C ~ 125°C] >

- Secure -40 °C ~ 12 °C Filter operation environment functional stability.
- Band shift doesn't occur when the temperature changes.
- Small deviation occurred within Insertion Loss : 0.3dB

TcF Test	-40°C	Room Temp.	125°C
Insertion Loss	-1.96dB	-2.30dB	-2.78dB



< -40°C characteristic deviation from room temperature >



< 125°C characteristic deviation from room temperature >

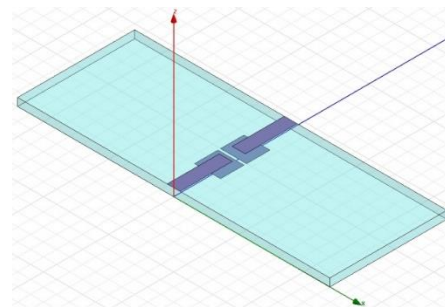
Advanced LTCC Filter

Diversity of Filter Development Experience

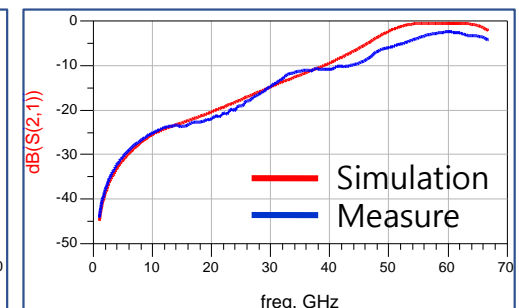
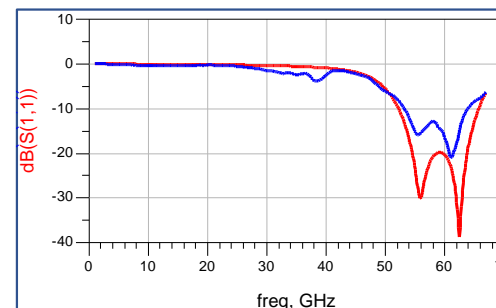
- Study and Develop of LTCC Filter with various partners and study institute
- 5G & mm-wave Filter Production Experience
- Attached a Filter Spec sheet

Number	ITEM	Center Frequency
1	BPF	1GHz
2	BPF	770MHz 805MHz 947MHz
3	BPF	3.5GHz
4	BPF	3.8GHz
5	BPF	3.55GHz 3.62GHz 3.84GHz
6	BPF	28GHz 4Type
7	BPF	38GHz 2Type
8	Diplexer	2.40-2.50GHz 4.90-5.95GHz
9	LPF	700MHz LPF 800MHz LPF 900MHz LPF

<LTCC(Er 5.9) End-Coupled 60GHz Filter>



	Simulation	Measured
Insertion Loss	-0.6dB	-2.5dB
Bandwidth (>-10dB Return Loss)	13.5GHz (52.3~65.8)	10.75 (53.25~64)



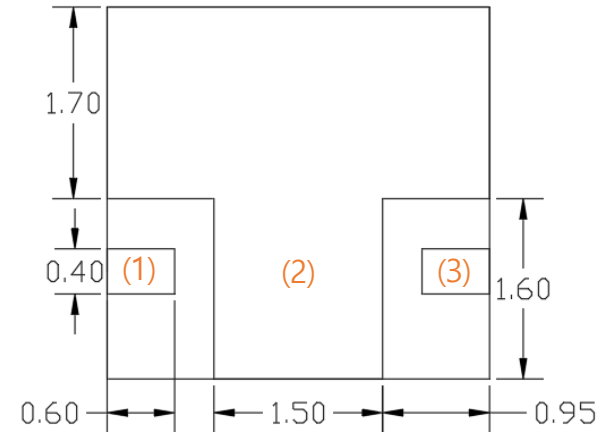
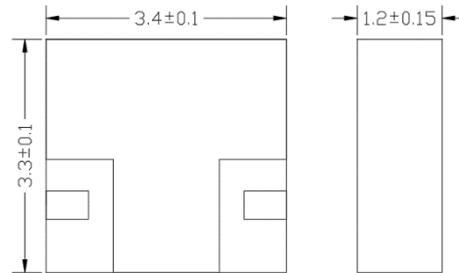
LTCC Filter

Low Pass Filter

1. 900MHz LPF

Shapes and Dimension

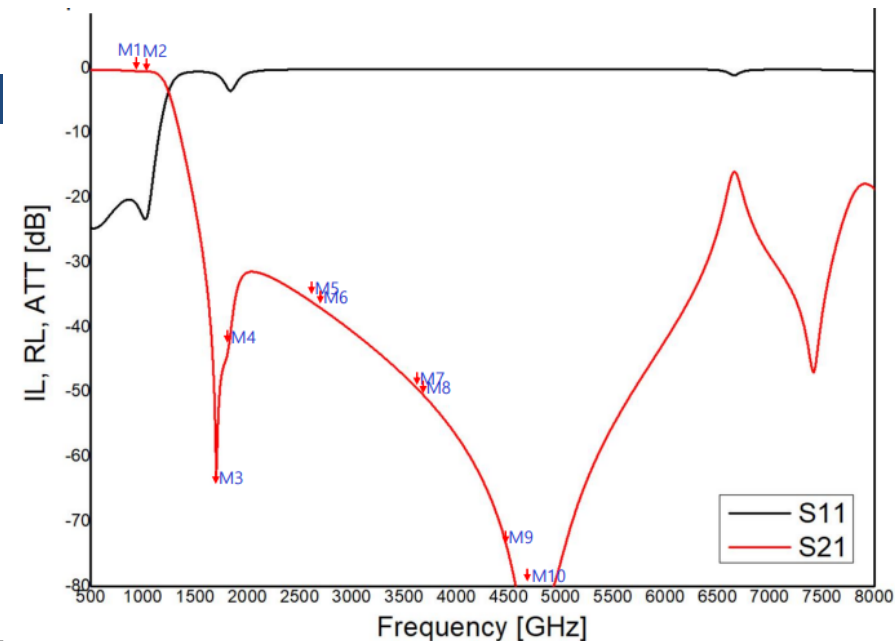
Parameter	Value [mm]
X	3.4 ± 0.1
Y	3.3 ± 0.1
T	1.2 ± 0.1



Terminal Function	
(1)	Input / Output
(2)	GND
(3)	Input / Output

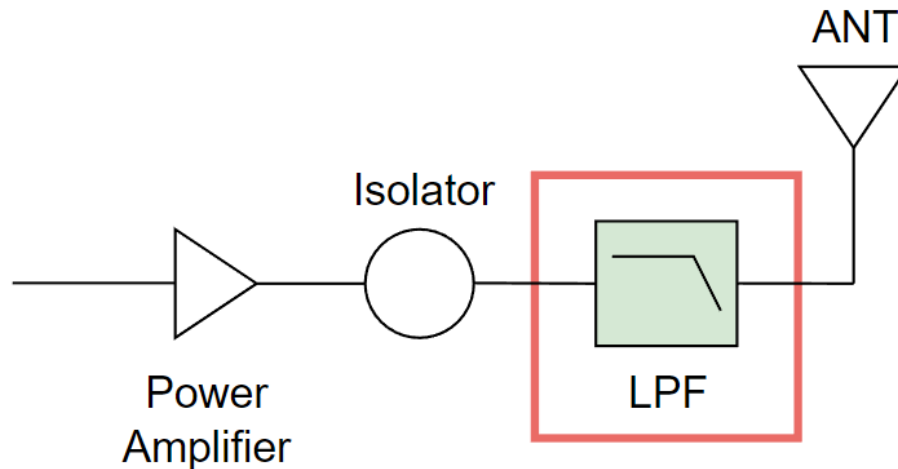
Specifications

Electrical Parameter	Achieved Value	Units
Nominal Center Frequency(f_0)	915	MHz
Pass Band Range (B.W.)	$f_0 \pm 15$	MHz
Insertion Loss in B.W.	Max. 0.5	dB
VSWR in B.W.	Max. 1.6	dB
Attenuation	30 @ 3 X f_0	dB
	40 @ 4 X f_0	dB
	40 @ 5 X f_0	dB
Input Power	Max. 2	W
Characteristic impedance	50	Ω



1. 900MHz LPF

■ Application (Block Diagram)



■ Product Features

LPF_900MHz

Appliance	RF wireless charger
Function	Remove a harmonic of the electricity amp to allow the system to achieve spread spec
Customer	CPE/Data Link, etc
Competitor	TDK, Murata
Advantage	1) Customer optimization development 2) Subminiature and High power (more than 10W) 3) Low loss filter

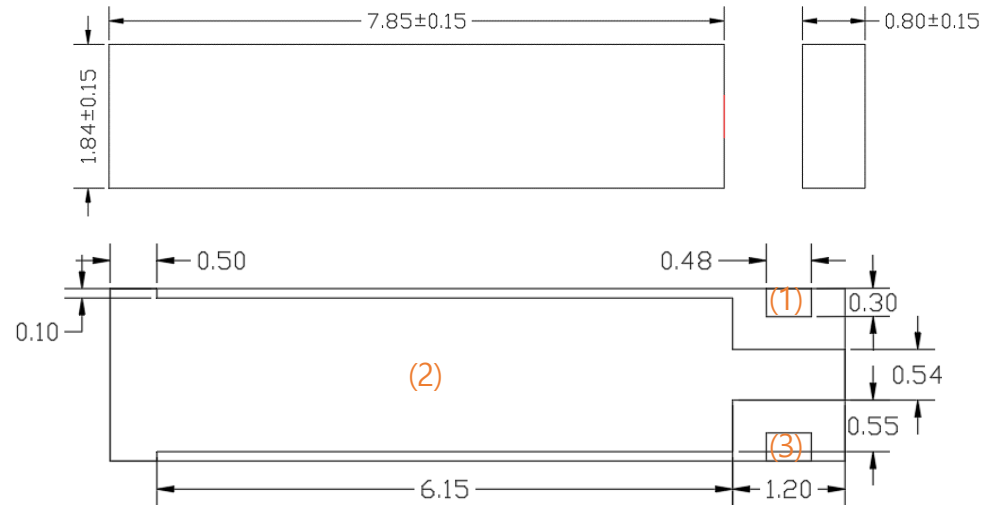
LTCC Filter

Band Pass Filter

2-1. 770MHz BPF

Shapes and Dimension

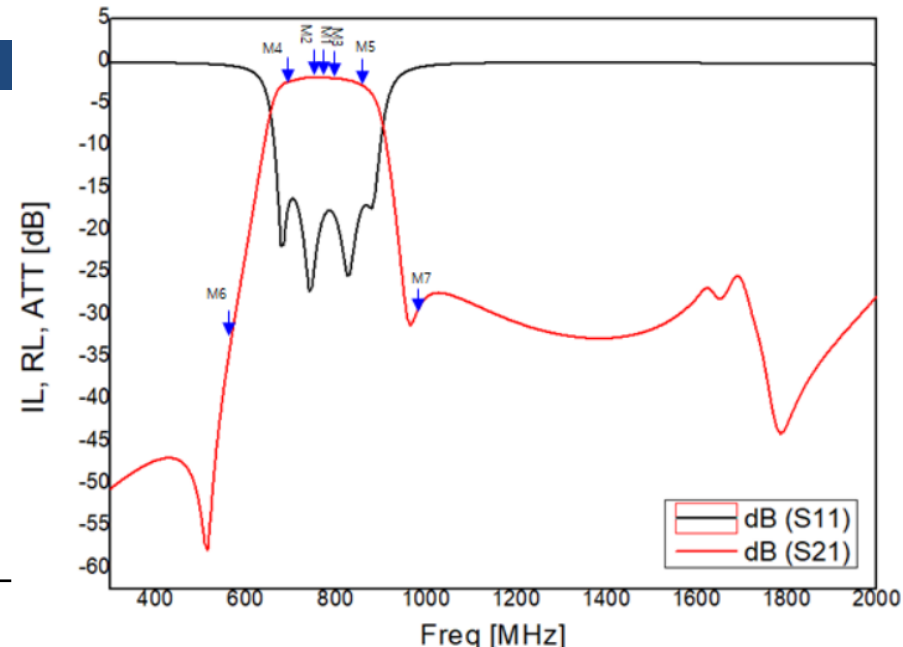
Parameter	Value [mm]
X	7.85 ± 0.15
Y	1.84 ± 0.15
T	0.80 ± 0.15



Terminal Function
(1) Input / Output
(2) GND
(3) Input / Output

Specifications

Electrical Parameter	Achieved Value	Units
Nominal Center Frequency(f_0)	770	MHz
Pass Band Range (B.W.)	1) B.W. 1 : $f_0 \pm 15$	MHz
	2) B.W. 2 : $f_0 \pm 75$	
Insertion Loss in B.W. 1,2	3) B.W. 1 : Max. 2.9	dB
	4) B.W. 2 : Max. 3.9	
Ripple in B.W. 1,2	5) B.W. 1 : Max. 0.4	dB
	6) B.W. 2 : Max. 1.2	
Attenuation	Min. 20 @ DC – 563MHz	dB
	Min. 20 @ 983 – 2000MHz	
Return Loss in B.W. 1,2	Min. 13	dB
Power Capacitor	Max. 1000	mW
Characteristic impedance	50	Ω



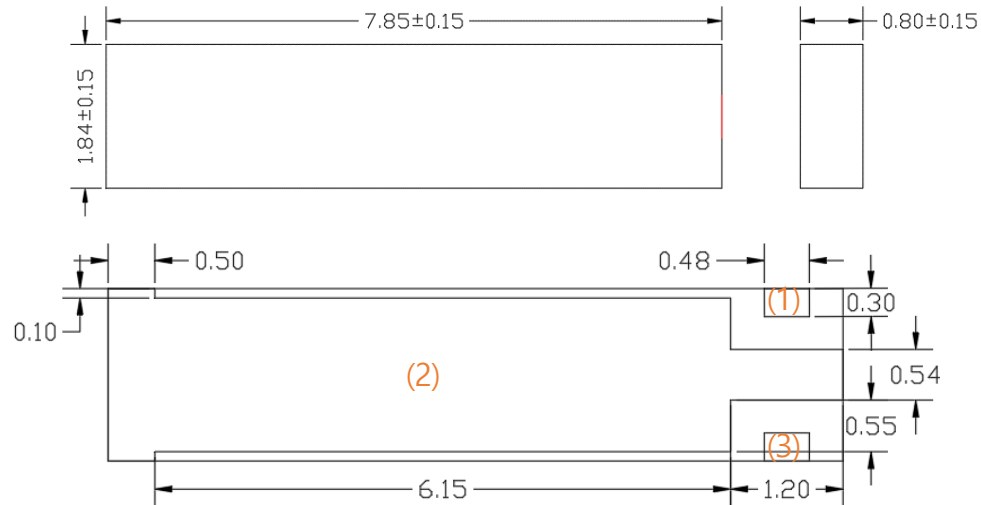
LTCC Filter

Band Pass Filter

2-2. 805MHz BPF

Shapes and Dimension

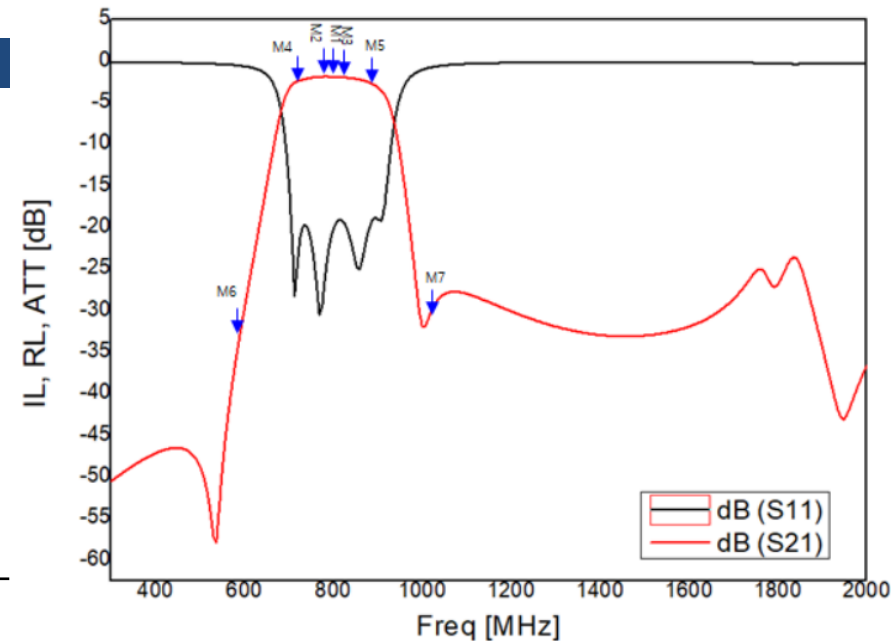
Parameter	Value [mm]
X	7.85 ± 0.15
Y	1.84 ± 0.15
T	0.80 ± 0.15



Terminal Function
(1) Input / Output
(2) GND
(3) Input / Output

Specifications

Electrical Parameter	Achieved Value	Units
Nominal Center Frequency(f_0)	805	MHz
Pass Band Range (B.W.)	1) B.W. 1 : $f_0 \pm 15$ 2) B.W. 2 : $f_0 \pm 75$	MHz
Insertion Loss in B.W. 1,2	3) B.W. 1 : Max. 2.9 4) B.W. 2 : Max. 3.9	dB
Ripple in B.W. 1,2	5) B.W. 1 : Max. 0.4 6) B.W. 2 : Max. 1.2	dB
Attenuation	Min. 20 @ DC – 586MHz	dB
	Min. 20 @ 1016 – 2000MHz	dB
Return Loss in B.W. 1,2	Min. 13	dB
Power Capacitor	Max. 1000	mW
Characteristic impedance	50	Ω



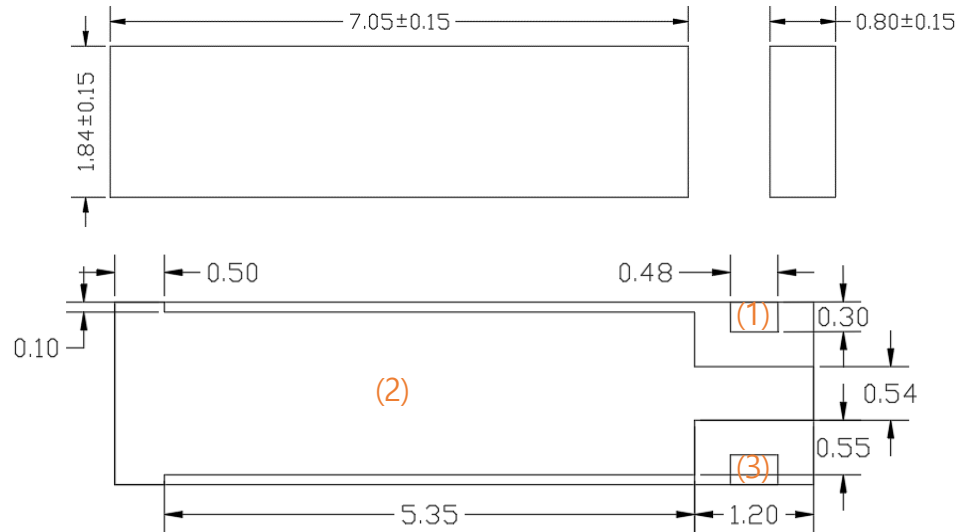
LTCC Filter

Band Pass Filter

2-3. 947MHz BPF

■ Shapes and Dimension

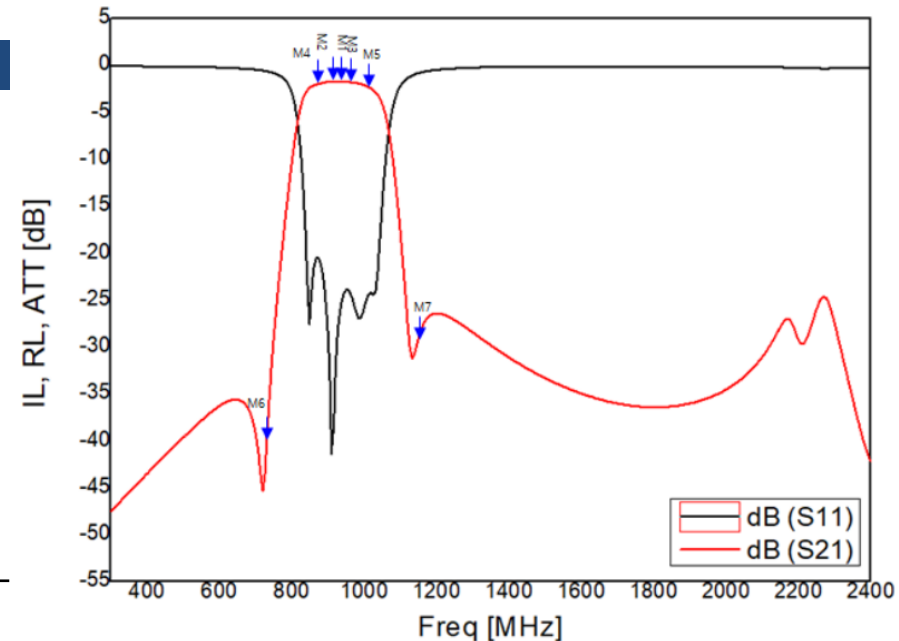
Parameter	Value [mm]
X	7.05 ± 0.15
Y	1.84 ± 0.15
T	0.80 ± 0.15



Terminal Function
(1) Input / Output
(2) GND
(3) Input / Output

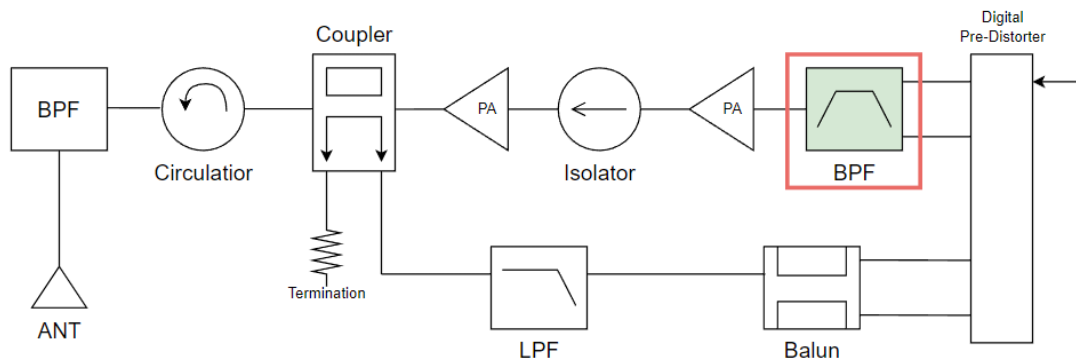
■ Specificatipons

Electrical Parameter	Achieved Value	Units
Nominal Center Frequency(f_0)	947	MHz
Pass Band Range (B.W.)	1) B.W. 1 : $f_0 \pm 15$	MHz
	2) B.W. 2 : $f_0 \pm 75$	
Insertion Loss in B.W. 1,2	3) B.W. 1 : Max. 2.9	dB
	4) B.W. 2 : Max. 3.9	
Ripple in B.W. 1,2	5) B.W. 1 : Max. 0.4	dB
	6) B.W. 2 : Max. 1.2	
Attenuation	Min. 20 @ DC – 730MHz	dB
	Min. 20 @ 1150 – 2000MHz	
Return Loss in B.W. 1,2	Min. 13	dB
Power Capacitor	Max. 1000	mW
Charavertistics impedance	50	Ω



2-1,2,3 BPF 3Type Features & Application

■ Application (Block Diagram)



■ Product Features

BPF_770, 805, 947MHz

Appliance

5G Base station

Function

Random noise cancellation from digital stage
→ **Protect PA**

Customer

CPE/FEM/Data link, etc

Competitor

TDK, Murata, Partron

Advantage

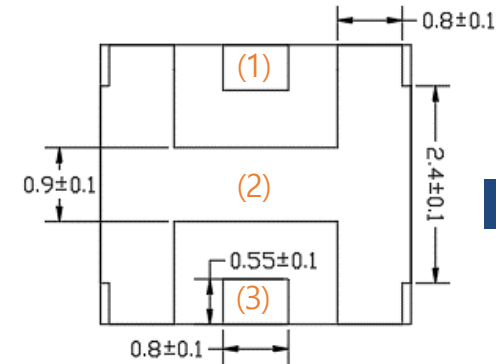
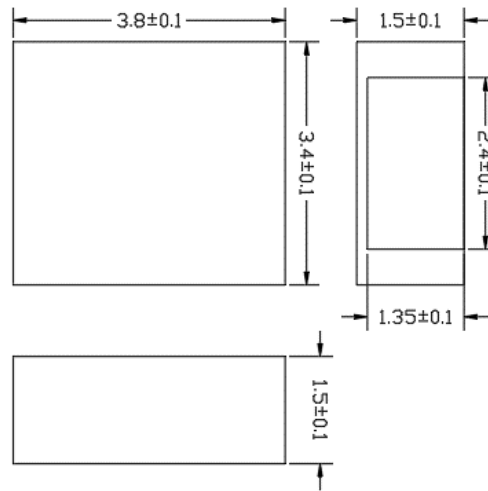
1) Small size
(1/4~1/2 smaller)

2) Price competitiveness

3. 3.5GHz BPF

Shapes and Dimension

Parameter	Value [mm]
X	3.80 ± 0.10
Y	3.40 ± 0.10
T	1.50 ± 0.10

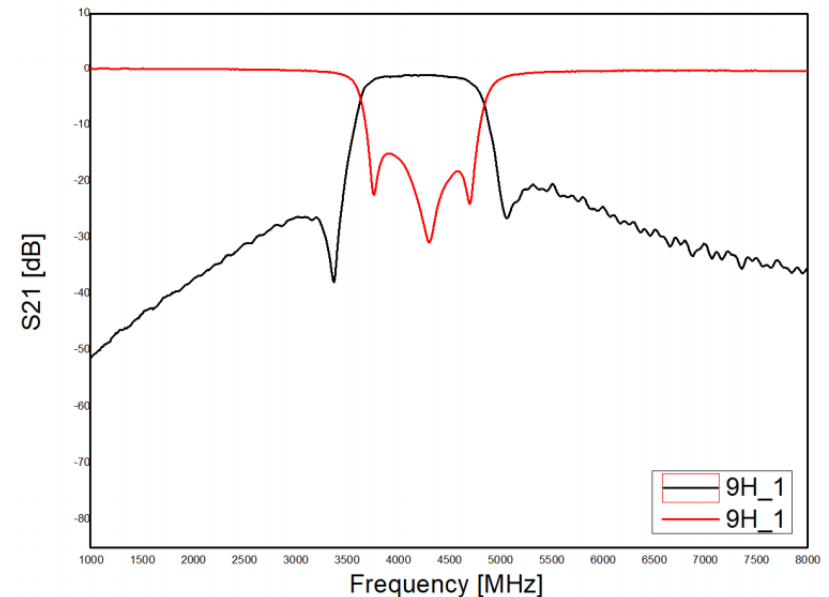


Terminal Function

- (1) Input / Output
- (2) GND
- (3) Input / Output

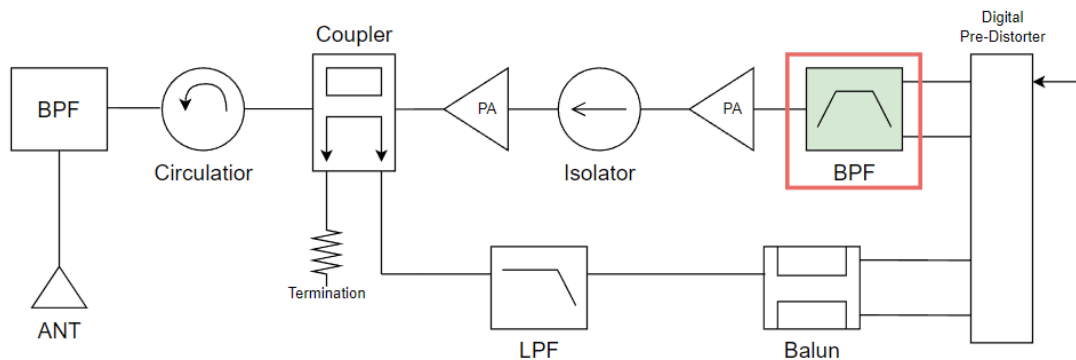
Specifications

Electrical Parameter	Achieved Value	Units
Pass band	3.4 – 4.3	GHz
Insertion Loss	MAX. 1.3	dB
Return Loss	MIN. 14	dB
Ripple	MIN. 1.2	dB
Attenuation	20 @ DC – 3.1	dB
	20 @ 4.6 – 10	dB
Mechanical Parameter	Achieved Value	Units
Dimensions(W x L x H)	3.80 x 3.40 x 1.50	mm
Storage Temperature	-40 to +85	°C



3. 3.5GHz BPF

- Application (Block Diagram)



- Product Features

BPF_3.5GHz

Appliance

5G Base station

Function

Random noise cancellation
from digital stage
→ Protect PA

Customer

BTS, Data link, etc.

Competitor

TDK, Murata, Partron

Advantage

- 1) Small size
(1/4~1/2 smaller)
- 2) Price competitiveness

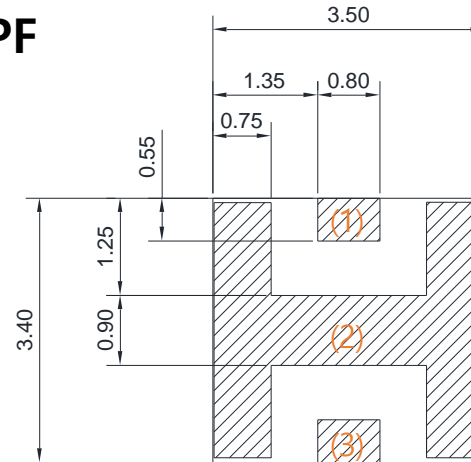
LTCC Filter

Band Pass Filter

4. Sub-6GHz : 3.8GHz BPF

Shapes and Dimension

Parameter	Value [mm]
X	3.50 ± 0.10
Y	3.60 ± 0.10
T	1.23 ± 0.10

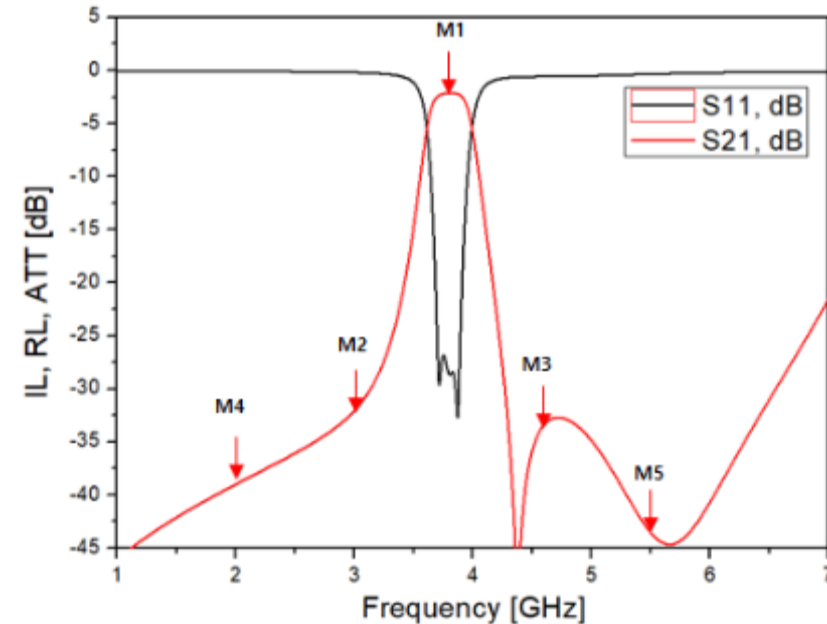


Terminal Function

- (1) Input / Output
- (2) GND
- (3) Input / Output

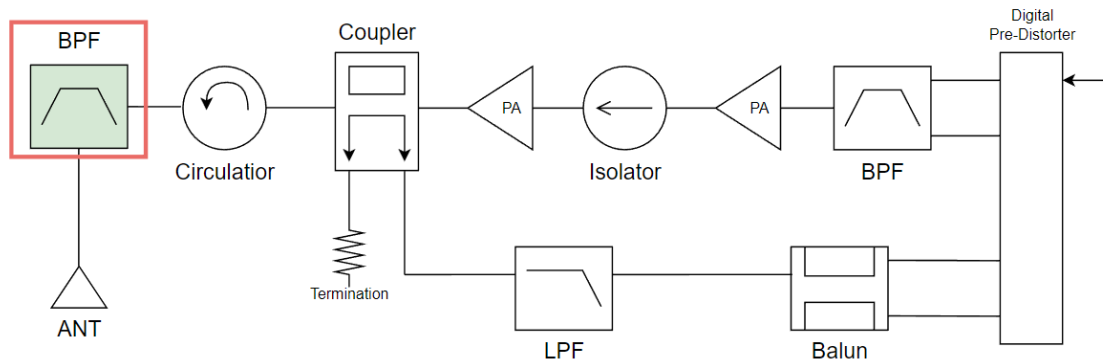
Specifications

Electrical Parameter	Achieved Value	Units
Nominal Center Frequency(f_0)	3.8	GHz
Pass Band Range (B.W.)	1) B.W. 1 : $f_0 \pm 12$	MHz
	2) B.W. 2 : $f_0 \pm 100$	
Insertion Loss in B.W. 1,2	3) B.W. 1 : Max. 2.6	dB
	4) B.W. 2 : Max. 3.2	
Ripple in B.W. 1,2	5) B.W. 1 : Max. 0.3	dB
	6) B.W. 2 : Max. 0.8	
Attenuation	Min. 33 @DC – 2.1GHz	dB
	Min. 25 @2.1 – 3.1GHz	dB
	TBD Min. @3.62GHz	dB
Return Loss in B.W. 1,2	TBD Min. @3.98GHz	dB
	Min. 27 @4.6 – 5.5GHz	dB
	Min. 10	dB
Power Capacity	Max. 1000	mW



4. Sub-6GHz : 3.8GHz BPF

■ Application (Block Diagram)



■ Product Features

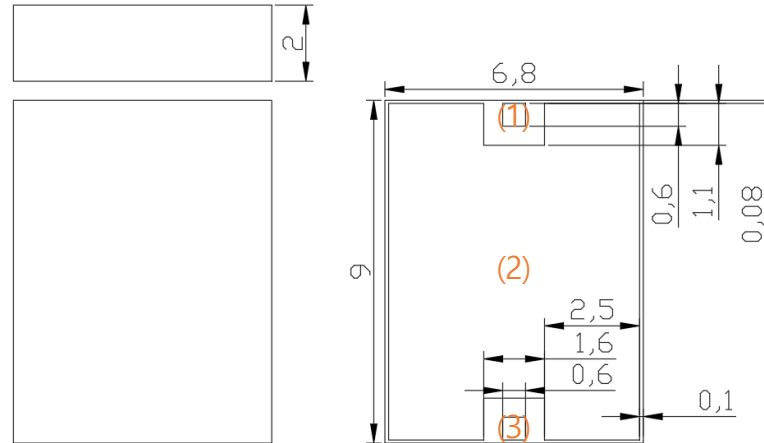
BPF_3.8GHz

Appliance	5G CPE and Repeater
Function	Frequency filters to meet domestic and international radio specification
Customer	BTS makers and Repeater companies
Competitor	TDK, Murata
Advantage	1) Performance and development responsiveness 2) Price and Size

5. 6GHz BPF

Shapes and Dimension

Parameter	Value [mm]
X	9.0 ± 0.10
Y	6.8 ± 0.10
T	2.0 ± 0.10

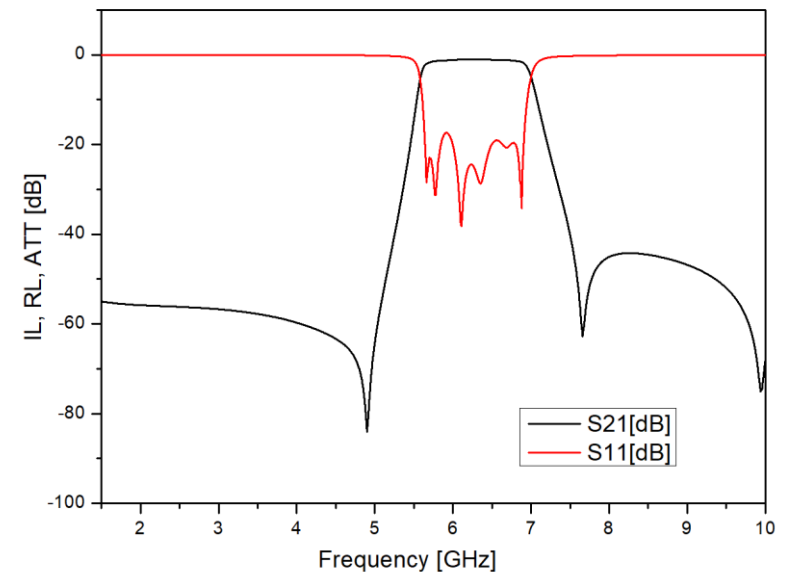


Terminal Function

- (1) Input / Output
- (2) GND
- (3) Input / Output

Specifications

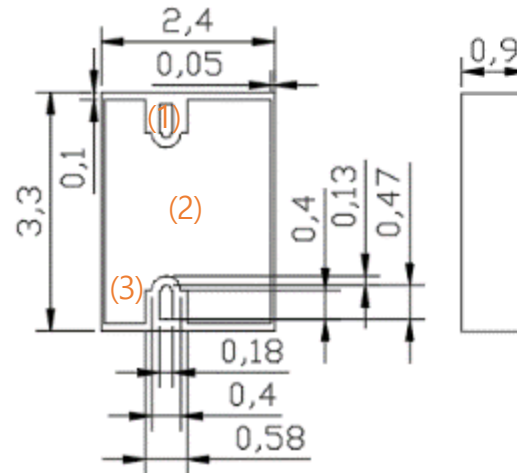
Electrical Parameter	Achieved Value	Units
Nominal Center Frequency(f_0)	6.3	GHz
Pass Band Range (B.W.)	$f_0 \pm 600$	MHz
Insertion Loss in B.W. 1,2	Typ. 1.8dB / Max. 2.1	dB
	Min. 50 @DC – 4.50GHz	dB
	Min. 40 @4.50 – 5.00GHz	dB
Attenuation	Min. 15 @5.00 – 5.46GHz	dB
	Min. 15 @7.25 – 8.00GHz	dB
	Min. 40 @8.00 – 9.00GHz	dB
Return Loss in B.W.	Min. 15	dB
Impedance	50	Ω



6. 5G : 28GHz BPF

■ Shapes and Dimension

Model	A	B	C	D
Dimension	Value [mm]			
X	2.4	2.4	3.5	2.4
Y	3.3	3.3	7.4	4.35
T	0.9	0.9	0.9	0.9



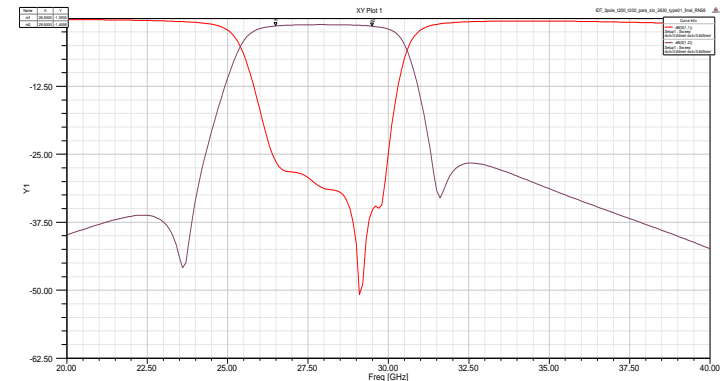
Terminal Function

- (1) Input / Output
- (2) GND
- (3) Input / Output

■ Specificatipons

Electrical Parameter	Simulation Value	Units
Pass Band Range (B.W.)	26.5 – 29.5	GHz
Insertion Loss in B.W.	1.45	dB Max.
Attenuation	30	dB Min. @24GHz
Return Loss in B.W.	10	dB Min.
Characteristics impedance	50	Ω

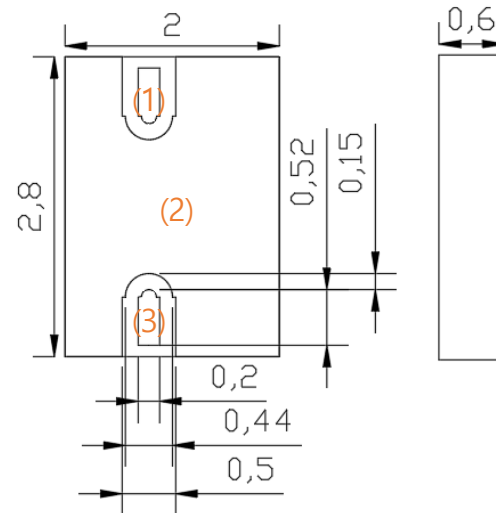
<Model A>



7. 5G : 38GHz BPF

Shapes and Dimension

Model	A	B
Dimension	Value [mm]	
X	2.0	1.36
Y	2.8	2.8
T	0.6	0.6



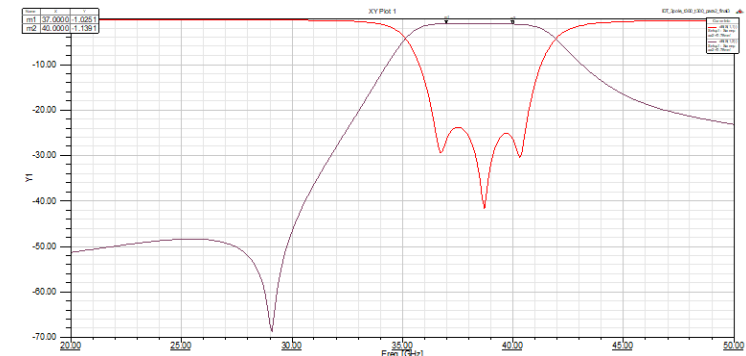
Terminal Function

- (1) Input / Output
- (2) GND
- (3) Input / Output

Specificatipons

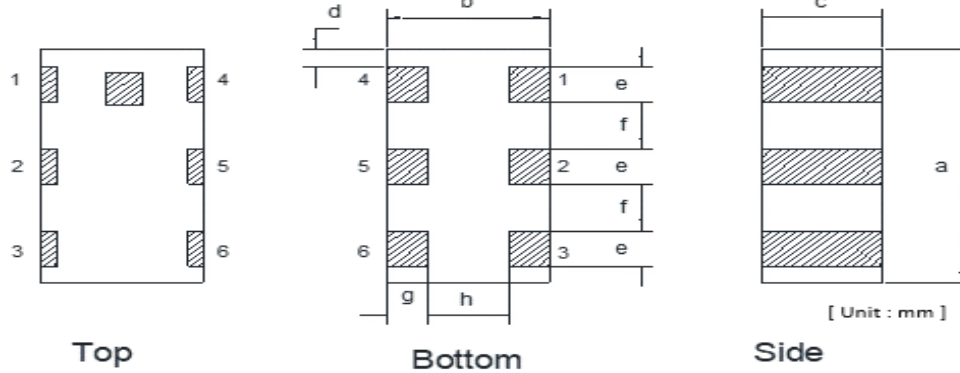
Electrical Parameter	Simulation Value	Units
Pass Band Range (B.W.)	37 – 40	GHz
Insertion Loss in B.W.	1.25	dB Max.
Attenuation	30	dB Min. @33GHz
Return Loss in B.W.	20	dB Min.
Characteristics impedance	50	Ω

<Model A>



8. Diplexer

Shapes and Dimension



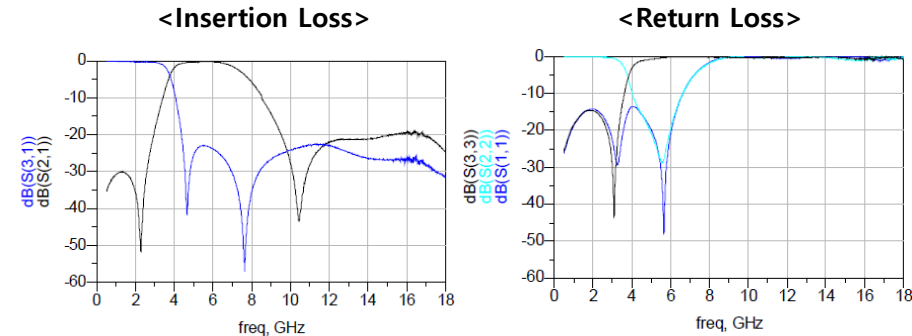
Specifications

• Electrical Parameter	Lower Freq.	Higher Freq.	Units
Pass Band	2.4 – 2.5	4.9 – 5.95	GHz
Insertion Loss	0.5 max.	0.6 max.	dB
Pass Band VSWR	2.0 max.	2.0 max.	dB
Return loss	10	10	dB
Attenuation	21 min. (@4.90-5.00GHz)	27 min. (@0.82-2.17GHz)	dB
	21 min. (@5.00-5.95GHz)	30 min. (@2.40-2.50GHz)	
	30 min. (@7.20-7.50GHz)	20 min. (@9.80-11.9GHz)	
Isolation	21min. (@4.9 – 6.95GHz)	30 min. (@4.9 – 6.95GHz)	dB
• Mechanical Parameter	Achieved Value	Units	
Dimensions(W x L x H)	1.6 x 0.8 x 0.6	mm	
Storage Temperature	-40 to +85	°C	
Operating Temperature	-40 to +85	°C	

Item	size	Item	size
a	1.6 ± 0.1	e	0.2
b	0.8 ± 0.1	f	0.3
c	Max 0.6	g	0.15
d	0.2	h	0.5

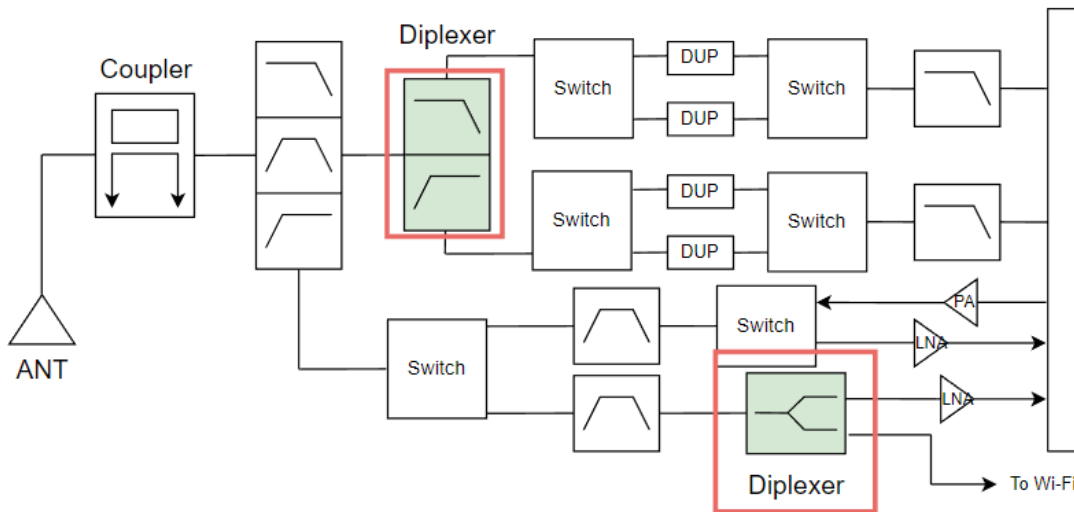
port	exposition	port	exposition
1	Lower Freq. Port	4	GND
2	GND	5	Common Port
3	Higher Freq. Port	6	GND

Electrical Characteristics



7. Diplexer

- Application (Block Diagram)



- Product Features

Diplexer

Appliance

WiFi Module

Function

Multiple frequencies coming from an antenna separate frequencies for the application or synthesize them to use one antenna

Customer

Seongji Industry, Broadcom

Competitor

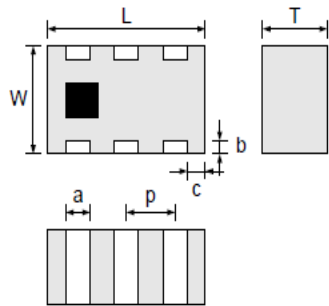
TDK, Murata

Advantage

- 1) Performance and Price
- 2) Development responsiveness

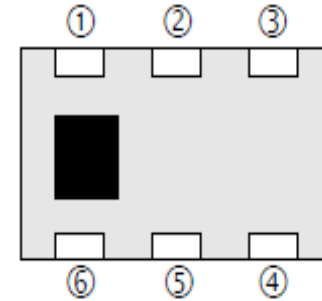
9. Balun

Shapes and Dimension



L	W	T	a
1.60±0.15	0.8±0.10	0.60±0.10	0.30±0.10
b	c	p	
0.30 +0.10/-0.20	0.10±0.10	0.55±0.10	

NOTE : Dimensions in mm

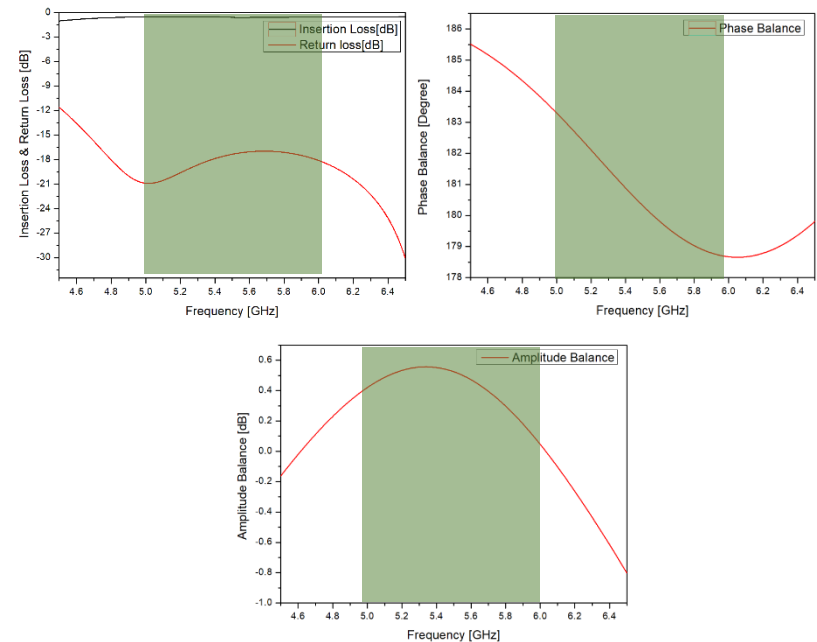


- ① N. C.
- ② GND
- ③ Balanced Port1
- ④ Balanced Port2
- ⑤ GND or DC
- ⑥ Unbalanced Port

Specifications

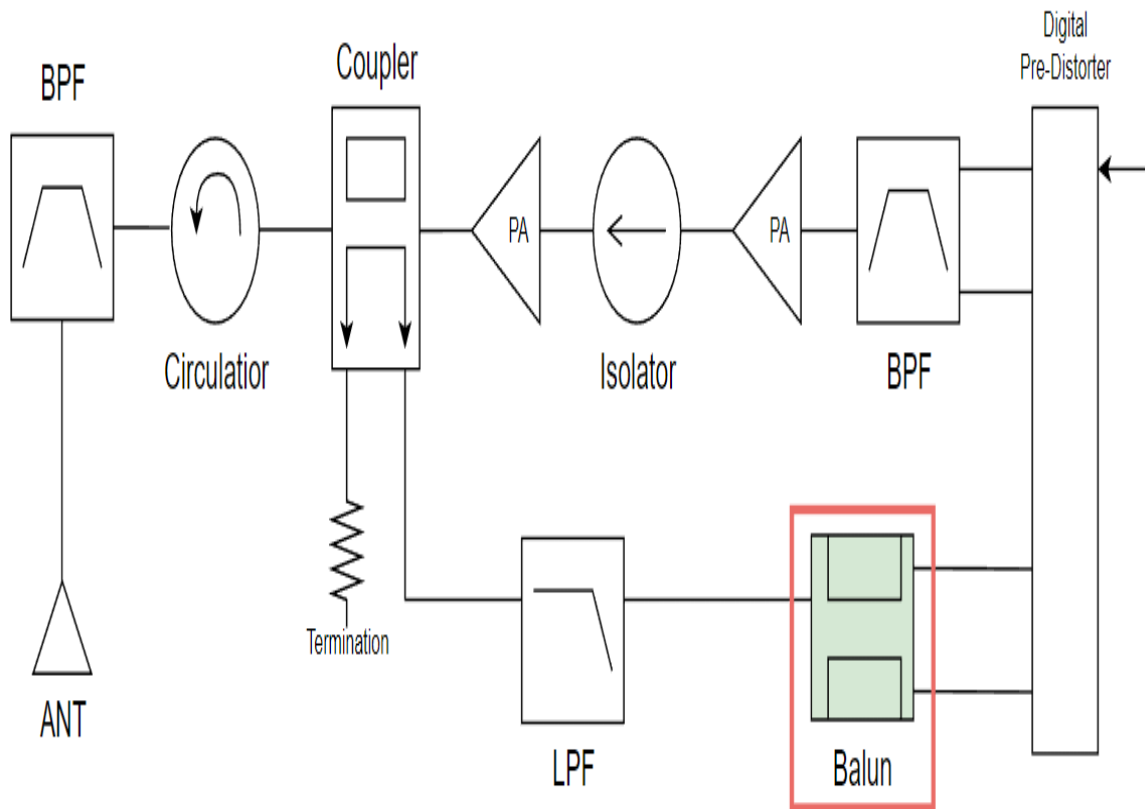
Electrical Parameter	Achieved Value	Units
Frequency of Operation	4.9 – 5.9	GHz
Balanced impedance	100	Ω
Unbalanced impedance	50	Ω
Insertion loss	Max 1.2	dB
Return loss	Min 10	dB
Phase balance	170 - 190	degree
Amplitude balance	±2	dB
Mechanical Parameter	Achieved Value	Units
Dimensions(W x L x H)	1.6 x 0.8 x 0.6	mm
Storage Temperature	-40 o +85	°C
Operating Temperature	-40 to +85	°C

Electrical Characteristics



8. Balun

Application (Block Diagram)



Product Features

Balun

Appliance

WLAN, Home RF

Function

Convert balance signal and unbalance signal according to function, balance at feed part of antenna

Customer

Seongji Industry

Competitor

TDK, CHILISIN

Advantage

- 1) Performance and Price
- 2) Development responsiveness