11.May.2001

Technical Manual
for Chip Multilayer Antenna

Application: 2.4GHz Wireless
Bluetooth™

Multilayer Products Department

Murata Manufacturing Co., Ltd.

Chip Antenna is a special component to change characteristics and this requires a different matching circuit by the condition of your usage (i.e. size of PCB / the position of antenna / feeding position …) and it is difficult to offer standard product to you.

So, we prepared the below 8 different kinds of standard chip antennas which have different frequency and these will cover conditions of various customer's usage and applications of 2.4GHz.

Please evaluate and find the best chip antenna out of these chip antennas.

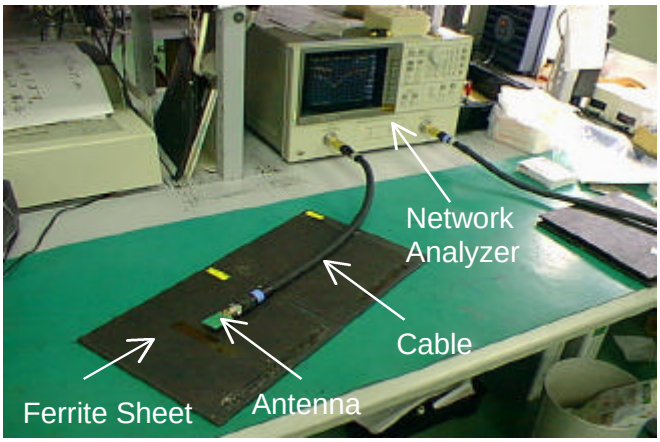
This application manual was prepered to offer advice of chip antenna's usage and technical information and this will be helpful for you to design your PCB and matching circuit.

Center Frequency [MHz]	New Part Number	Old Part Number
2780	LDA 92 2G78 20D -204	LDA 8220D 2780A
2870	LDA 92 2G87 20D -206	LDA 8220D 2870A
2970	LDA 92 2G97 20D -208	LDA 8220D 2970A
3050	LDA 92 3G05 20D -210	LDA 8220D 3050A
3150	LDA 92 3G15 20D -193	LDA 8220D 3150A
3240	LDA 92 3G24 20D -194	LDA 8220D 3240A
3350	LDA 92 3G35 20D -195	LDA 8220D 3350A
3500	LDA 92 3G50 20D -215	LDA 8220D 3500A

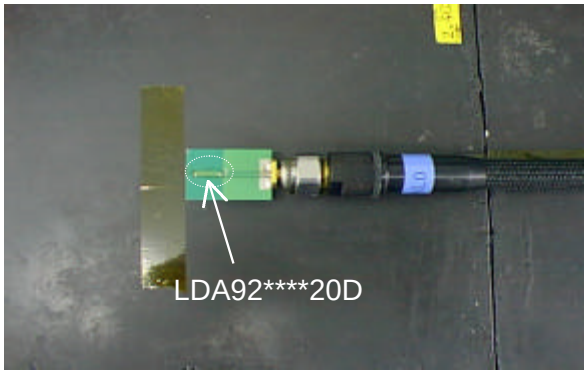
1. Standard f0 of LDA92****20D for 2.45GHz-Band

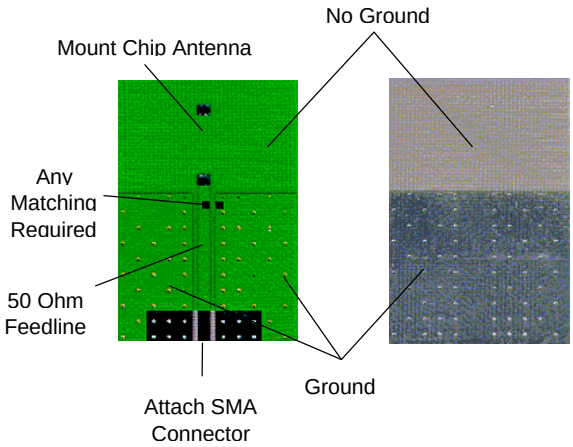
1-1. Measurement System

Chip antenna f0 is measured by using a PCB as shown below and a network analyzer.
A ferrite sheet is spread under the PCB to reduce outside influences.



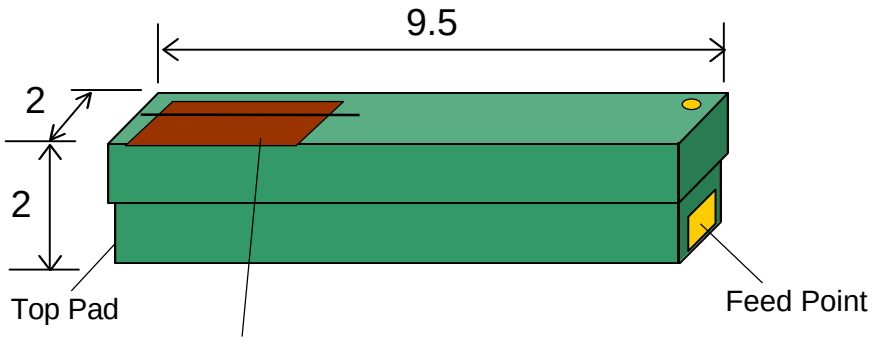
Measurement System for
Chip Antenna



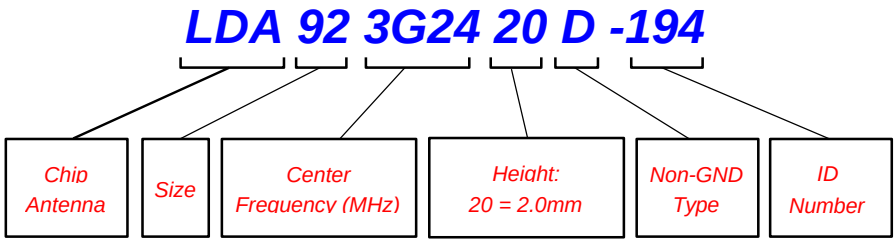


Standard PCB for LDA92****20D
(*Note: This PCB is not optimized for good gain performance.)

1-2. Standard f0 of LDA92****20D



Appearance



Part Number

Center Frequency [MHz]	New Part Number	Old Part Number
2780	LDA 92 2G78 20D -204	LDA 8220D 2780A
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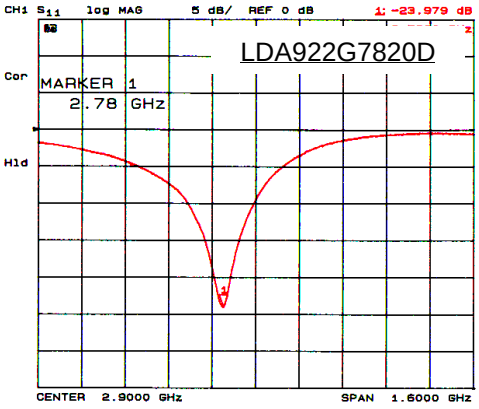
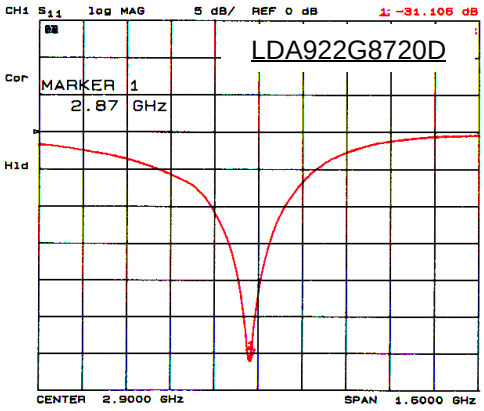
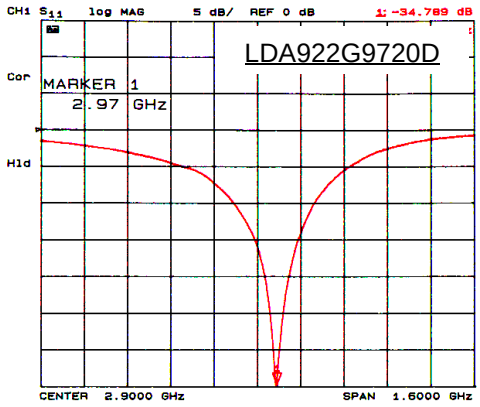
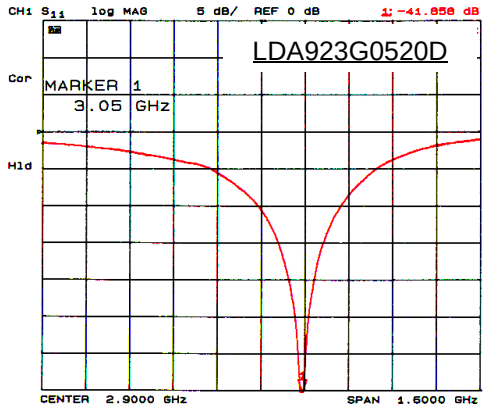
3500	LDA 92 3G50 20D -215	LDA 8220D 3500A

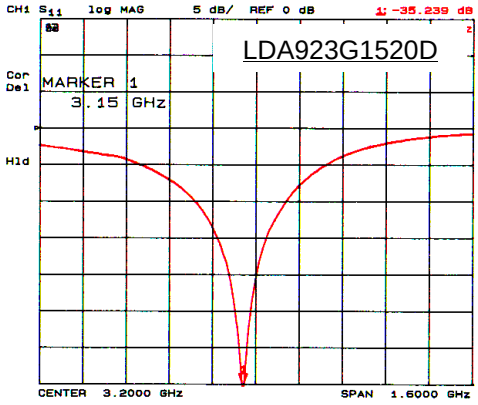
Standard f0 of LDA92****20D for 2.45GHz-Band

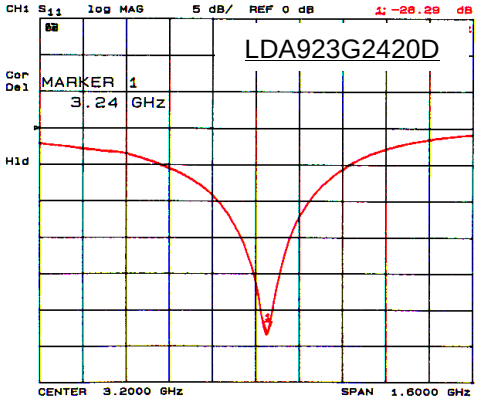


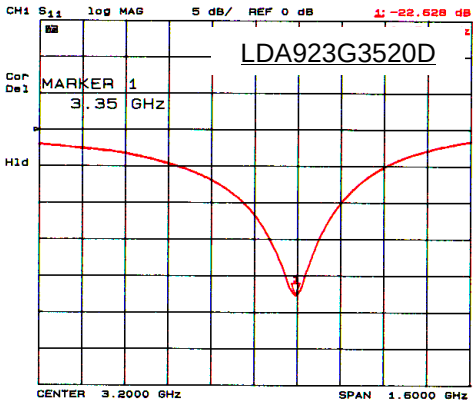


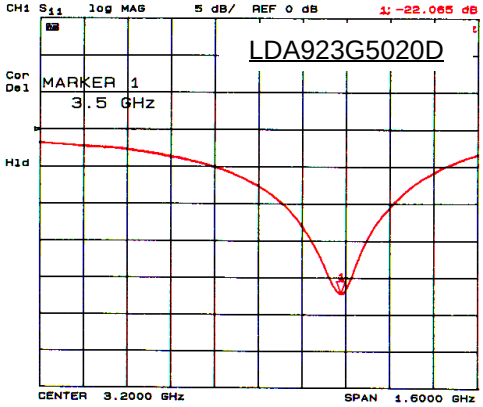








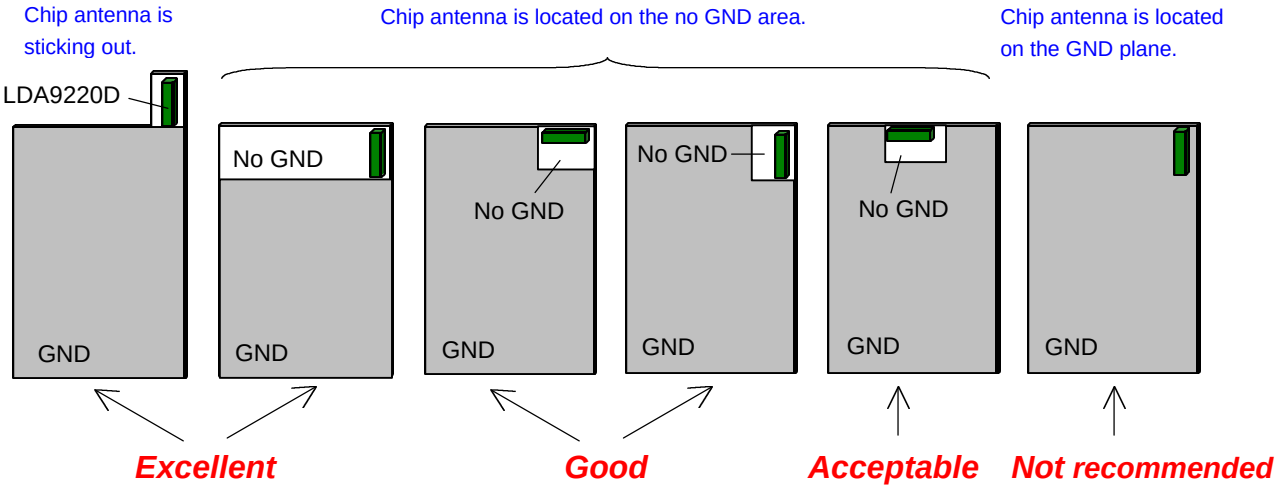




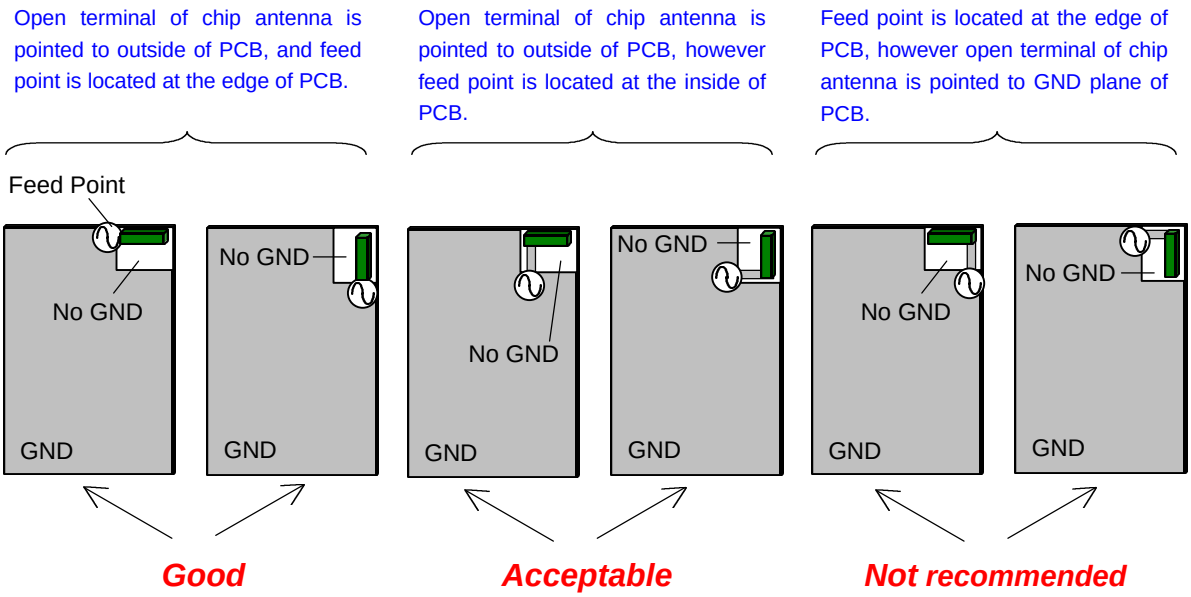
Return Loss of Standard LDA92****20D

2. Suitable PCB Condition of LDA92****20D

2-1. Chip Antenna Position

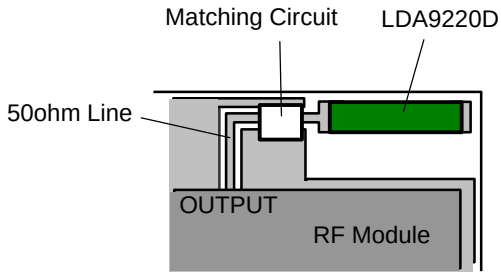


2-2. Antenna Direction & Feed Point Position



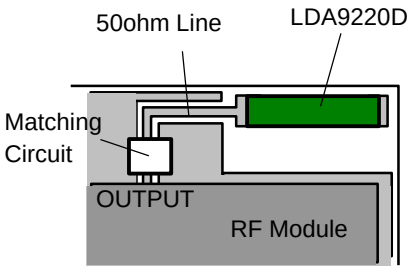
2-3. Matching Circuit Position

Matching Circuit is located at the top of 50ohm line that is nearest place from chip antenna.



Good

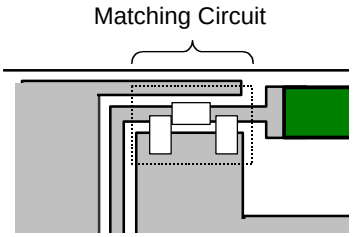
Matching Circuit is located at the top of 50ohm line that is farthest place from chip antenna.



Acceptable

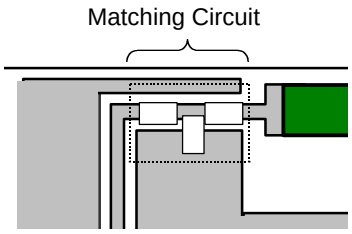
2-4. Structure of Matching Circuit

(Shunt-Series-Shunt)



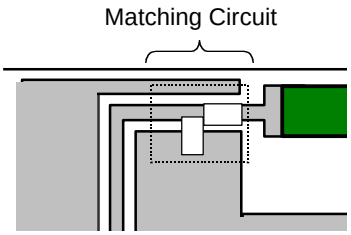
Good

(Series-Shunt-Series)



Good

(Series-Shunt)

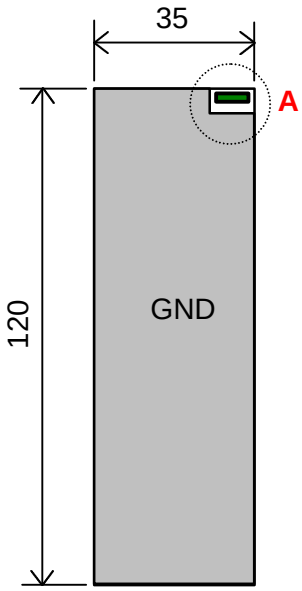


Acceptable

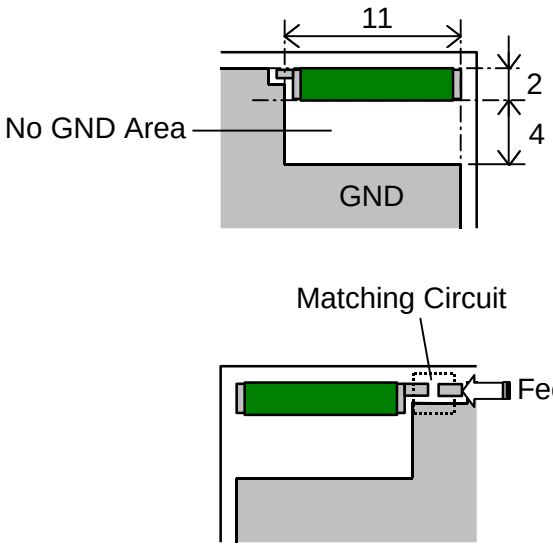
(*Note: When series components are not needed, 0-ohm resistance is needed to mount there.)

2-5. Actual Mock-up PCB

(1) Cellular Phone Size



(Close-up of **A** area)

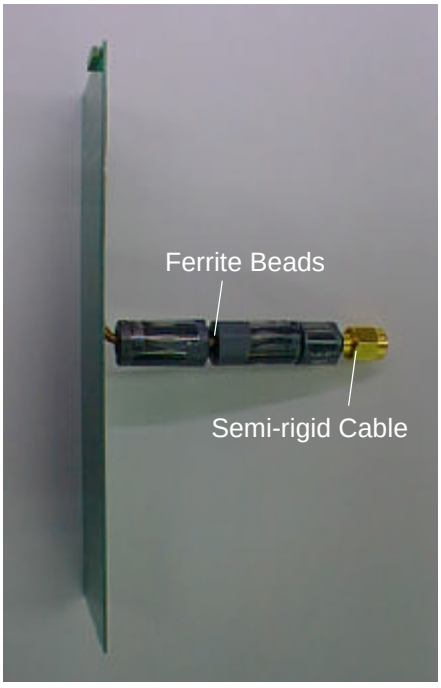


Board Thickness : 0.8
Board Material : FR-4

(unit : mm)

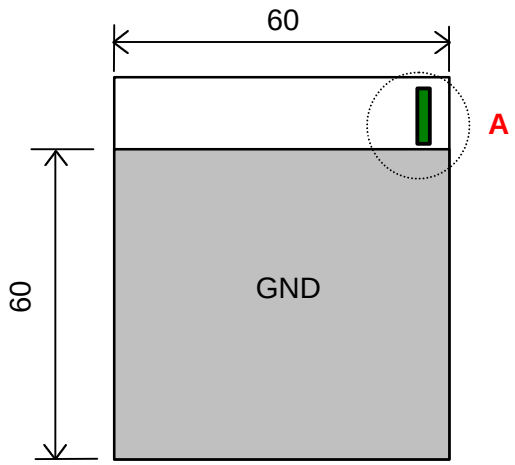
Semi-rigid cable should be soldered to GND plane and be extended away from the center of the PCB. And typically, ferrite beads are affixed to the part of the cable that extends away from PCB.

(Top View)

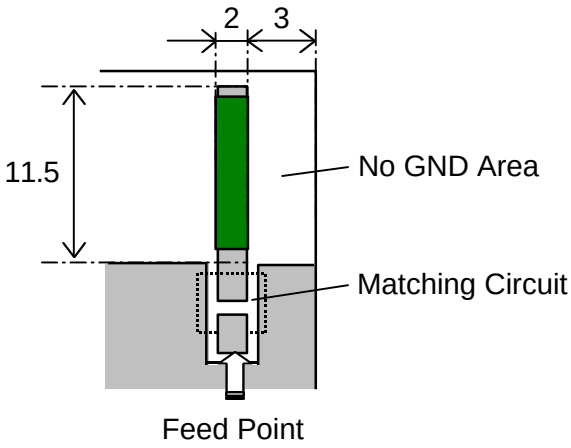


(Side View)

(2) Ideal Size for 2.45GHz-Band



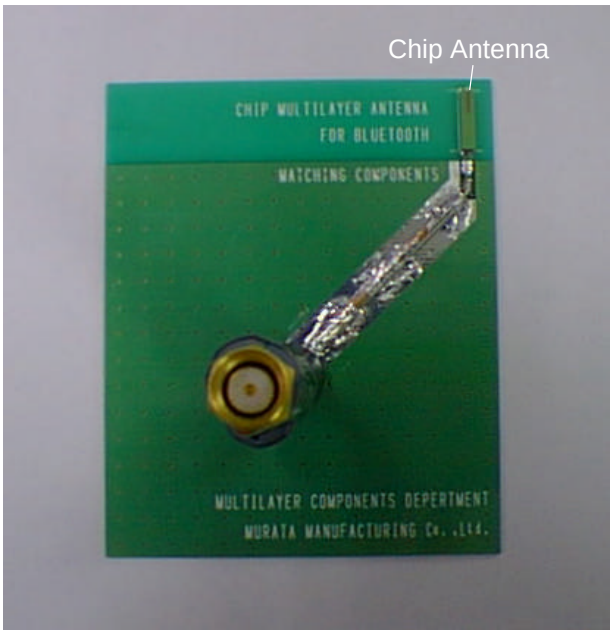
(Close-up of **A** area)



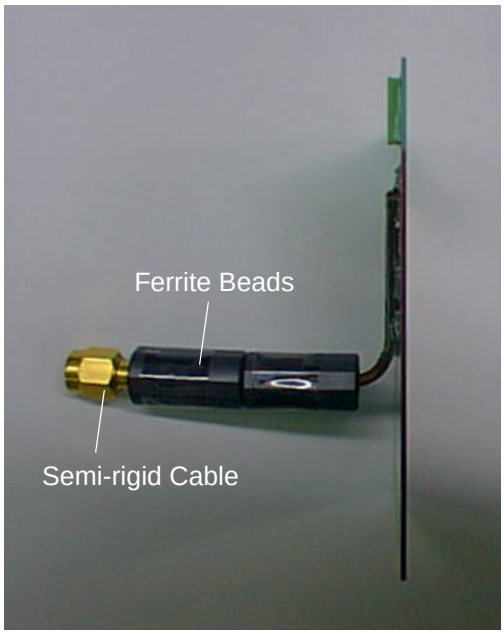
Board Thickness • 0.8
Board Material • FR-4

(unit: mm)

Semi-rigid cable should be soldered to GND plane and be extended away from the center of the PCB. And typically, ferrite beads are affixed to the part of the cable that extends away from PCB.



(Top View)



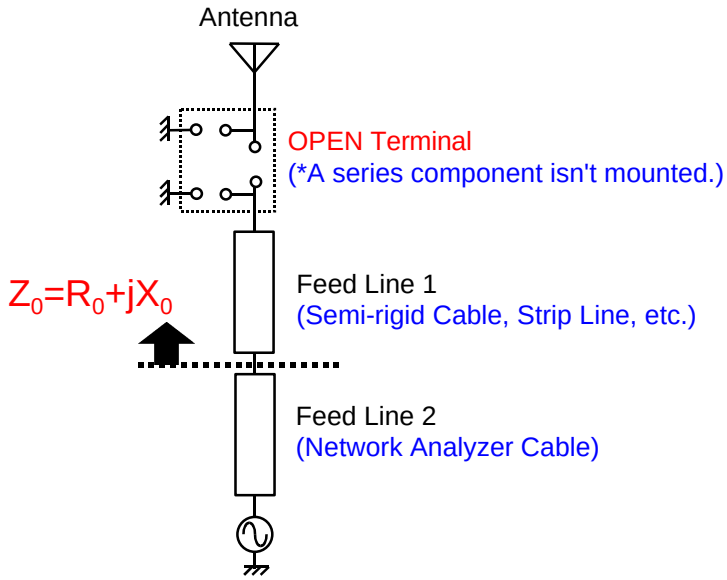
(Side View)

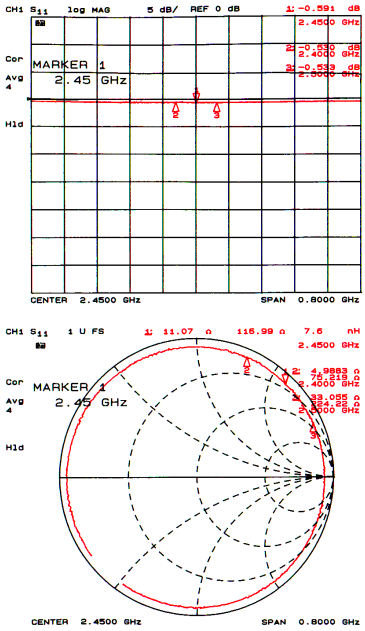
3. Impedance Matching and Frequency Adjustment

3-1. Preparation of Impedance Matching

(Step 1) The Beginning

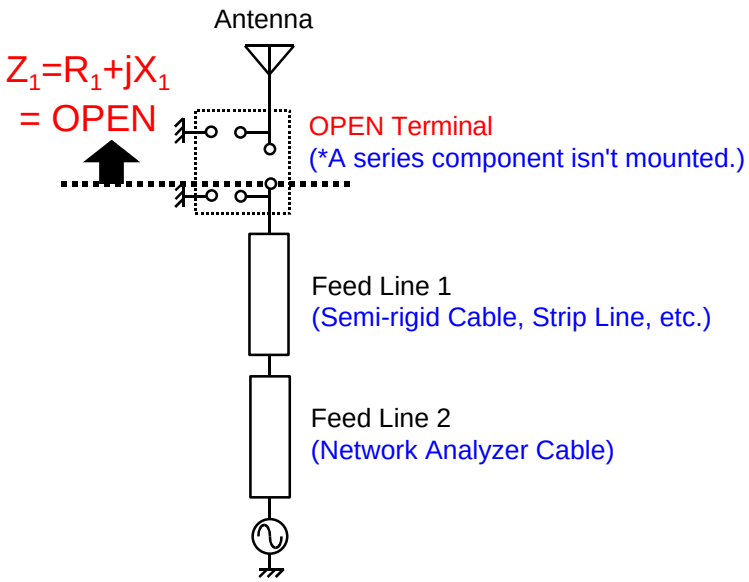
Network analyzer is usually calibrated at the top of cable. So the smith chart can't show correct impedance of the chip antenna because of inclusion of semi-rigid cable impedance,etc..

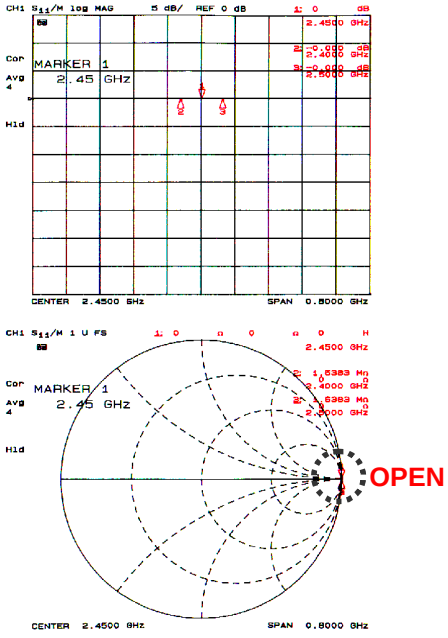




(Step 2) Electrical Delay Adjustment

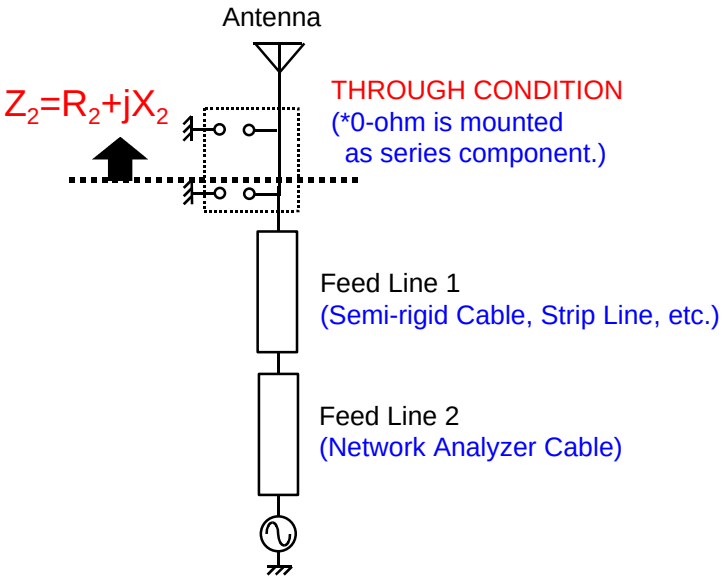
Electrical delay should be set on the network analyzer using open terminal as shown below.

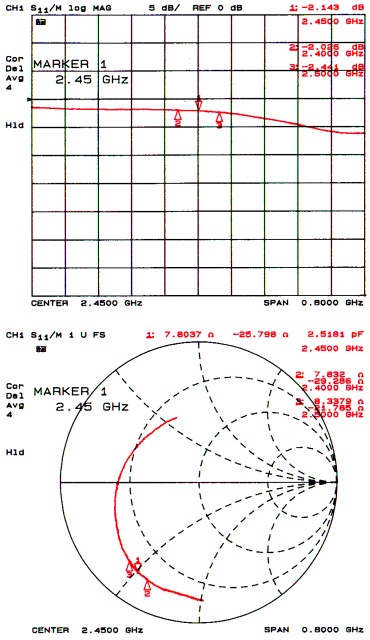




(Step 3) Correct Impedance of Chip Antenna

After electrical delay adjustment, the antenna system can be tested exactly on a calibrated network analyzer as shown below.

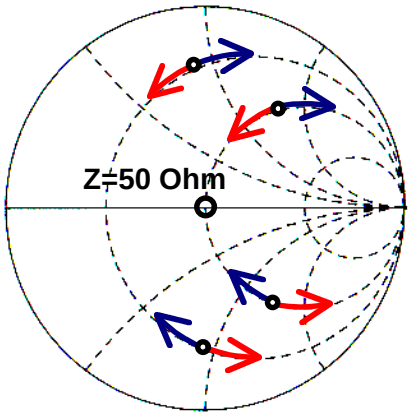




3-2. Smith Chart

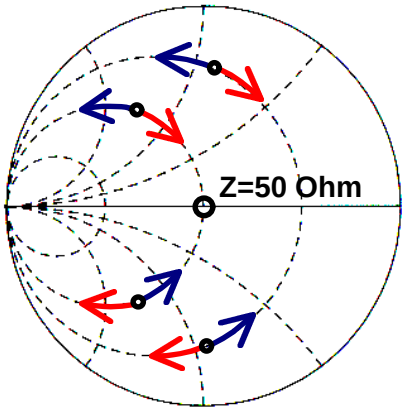
The smith chart view can be used to match the antenna impedance to 50ohm. Using series and shunt components, the point of 2.45GHz shoud be moved to the point of Z=50ohm.

(Impedance Chart)



	Value	Shift
Series C	Small	Large
	Large	Small
Series L	Small	Small
	Large	Large

(Admittance Chart)

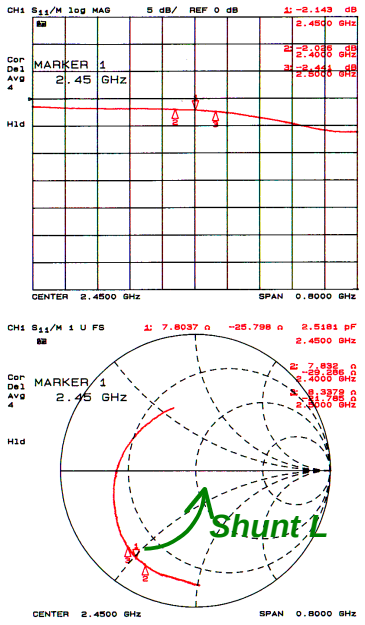


	Value	Shift
Shunt C	Small	Small
	Large	Large
Shunt L	Small	Large
	Large	Small

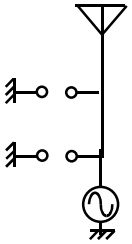
3-3. Adjustment of Impedance

(Ex1). The mock-up PCB of celler phone size shown in page 7 is used. Initial impedance is lower than 50ohm. Mostly the chip antenna impedance shows lower impedance than 50ohm like this.

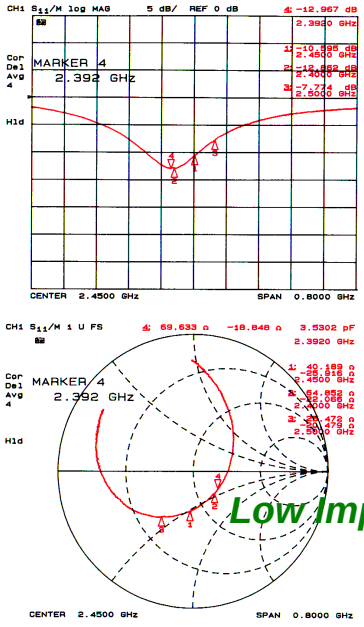
1. The Beginning



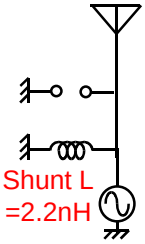
f_0=3240MHz
(LDA923G2420D)



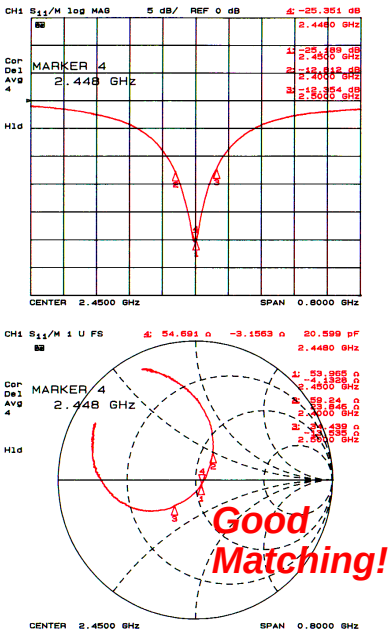
2. with Shunt L=2.2nH



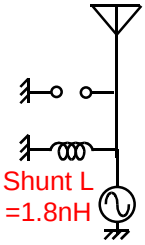
f_0=3240MHz
(LDA923G2420D)



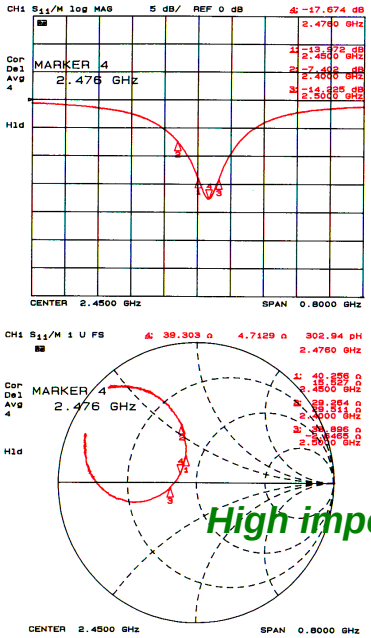
3. with Shunt L=1.8nH



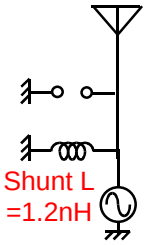
f_0=3240MHz
(LDA923G2420D)



4. with Shunt L=1.2nH

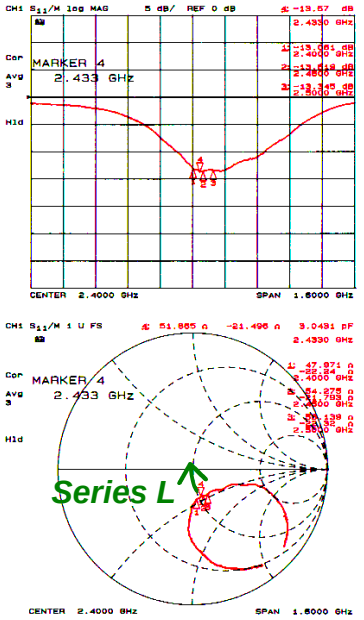


f_0=3240MHz
(LDA923G2420D)

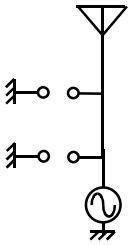


(Ex2). The mock-up PCB of ideal size shown on page 8 is used. Initial impedance is higher than 50ohm. This is a rare case.

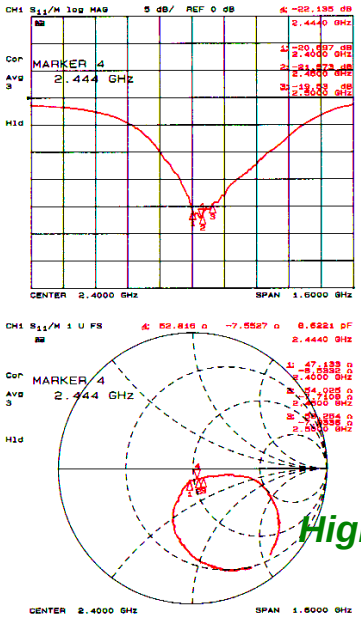
1. The Beginning



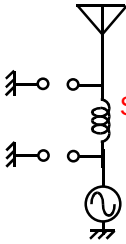
f_0=2780MHz
(LDA922G7820D)



2. with Series L=2.2nH

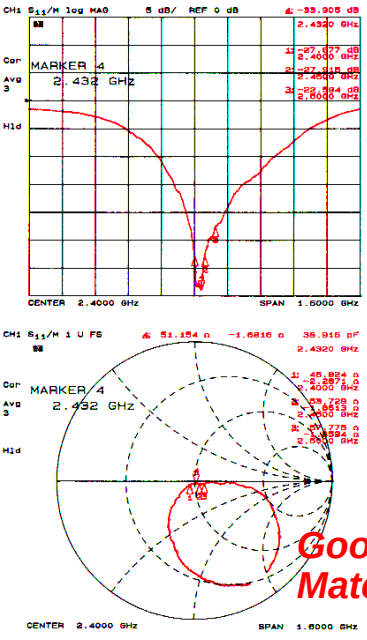


f_0=2780MHz
(LDA922G7820D)

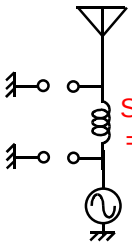


High Impedance

3. with Series L=2.7nH

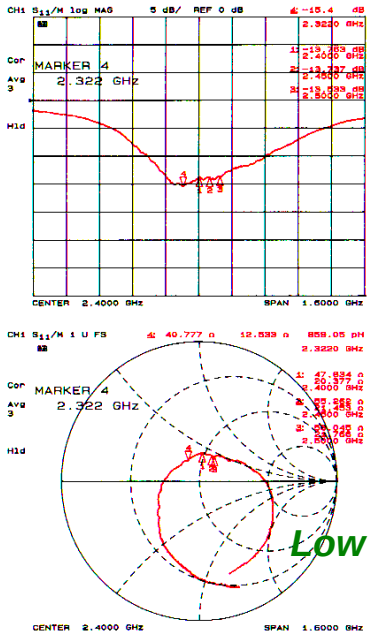


f_0=2780MHz
(LDA922G7820D)

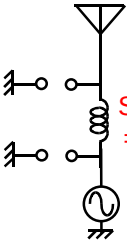


Good Matching!

4. with Series L=3.9nH



f_0=2780MHz
(LDA922G7820D)

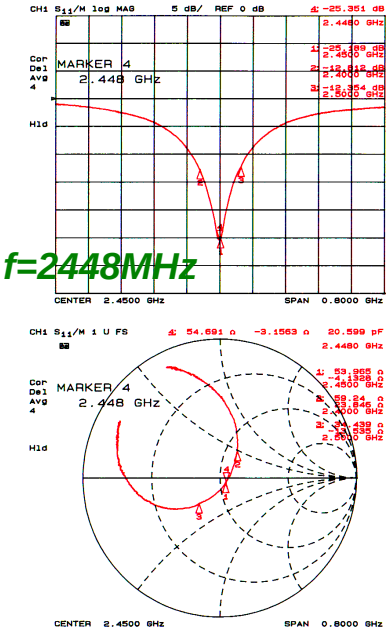


Low Impedance

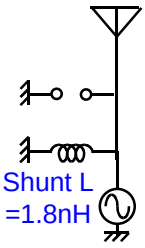
3-4. Adjustment of Resonant Frequency

(Ex1) The mock-up PCB of celler phone size shown in page 7 is used.
Firstly, chip antenna f0 is changed as rough adjustment.
Then there is some possibility that the impedance is changed a little, so it should be rematched again.

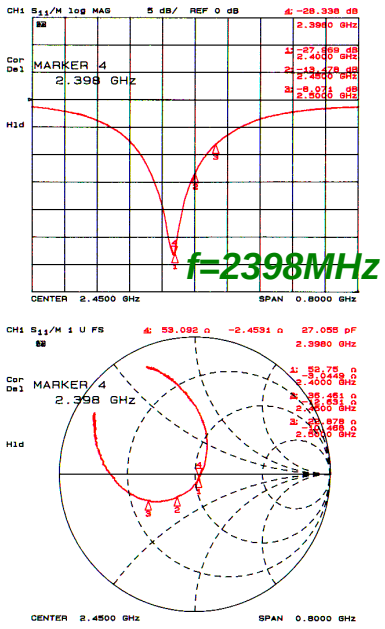
1. The Beginning (f0=3240MHz)



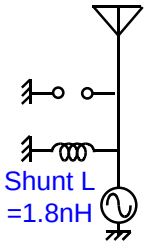
f_0=3240MHz
(LDA923G2420D)



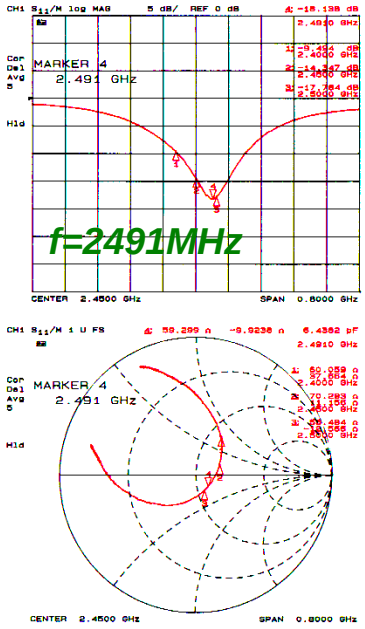
2. f0=3150MHz



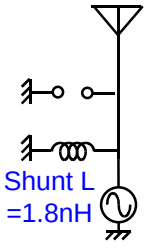
f_0=3150MHz
(LDA923G1520D)



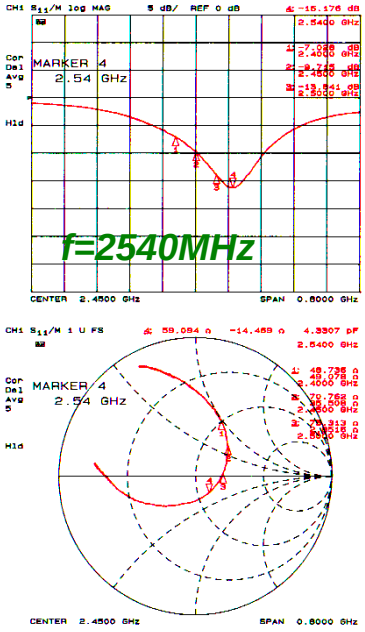
3. f0=3350MHz



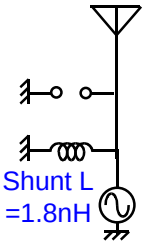
f_0=3350MHz
(LDA923G3520D)



4. f0=3500MHz

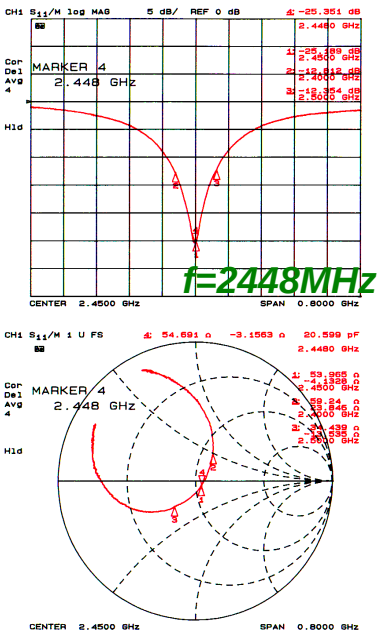


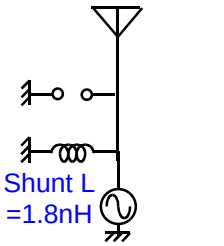
f_0=3500MHz
(LDA923G5020D)



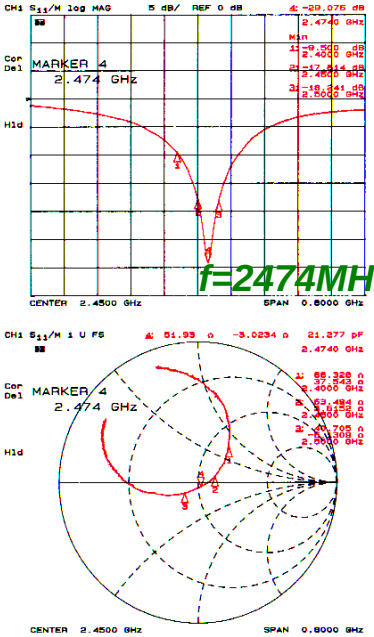
Next, by inserting series component resonant frequency can be shifted widely and be adjusted more exactly (fine adjustment). Typical data is shown below and all result is summarized in table on next page.

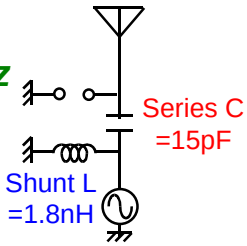
5. The Beginning (f0=3240MHz)



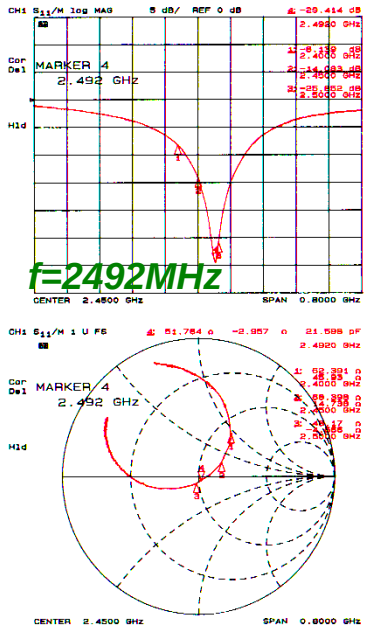


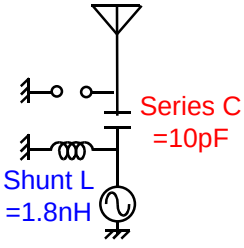
6. f0=3240MHz, Series C=15pF



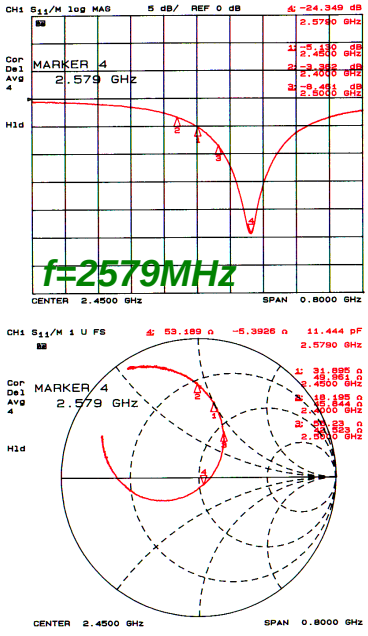


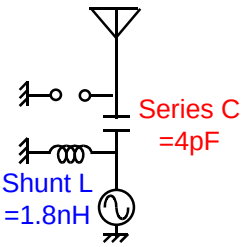
7. f0=3240MHz, Series C=10pF



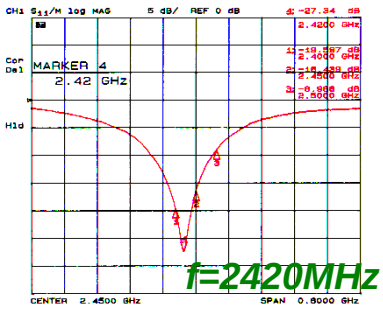


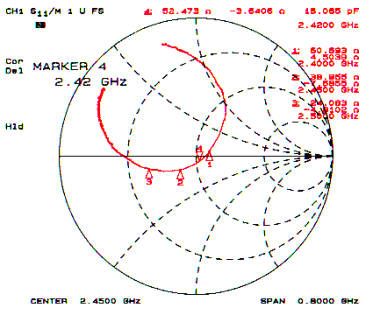
8. f0=3240MHz, Series C=4pF

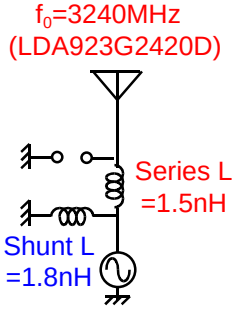




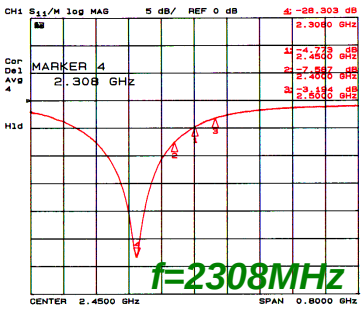
9. f0=3240MHz, Series L=1.5nH

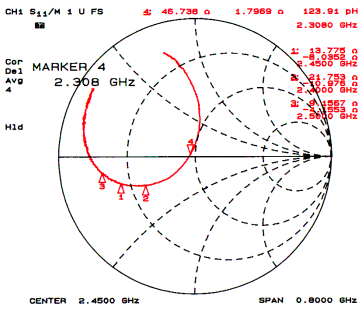


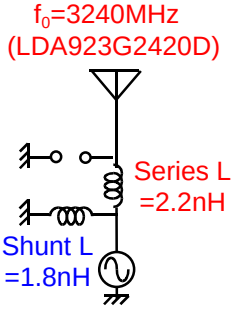




10. f0=3240MHz, Series L=2.2nH







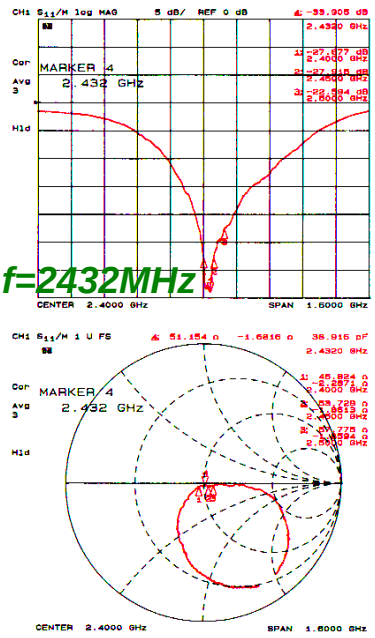
Summary

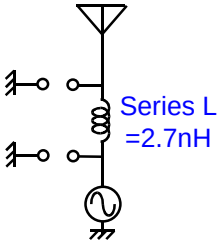
Chip Ant. F0 [MHz]	3240								
Shunt (near Ant.)	-	-	-	-	-	-	-	-	-
Series	2.2(nH)	1.8(nH)	1.5(nH)	0 (ohm)	15 (pF)	10(pF)	7(pF)	4(pF)	2(pF)
Shunt (near F.P.)	1.8(nH)	1.8(nH)	1.8(nH)	1.8(nH)	1.8(nH)	1.8(nH)	1.8(nH)	1.8(nH)	1.8(nH)
Peak Frequency [MHz]	***2308***	***2397***	***2420***	***2448***	***2474***	***2492***	***2516***	***2579***	***2679***
VSWR of peak Frequency	1.08	1.05	1.09	1.11	1.07	1.07	1.13	1.13	1.06

Chip Ant. F0 [MHz]	3150			3350		
Shunt (near Ant.)	-	-	-	-	-	-
Series	0 (ohm)	47(pF)	16(pF)	0 (ohm)	36(pF)	16(pF)
Shunt (near F.P.)	1.8(nH)	1.8(nH)	1.8(nH)	1.5(nH)	1.5(nH)	1.5(nH)
Peak Frequency [MHz]	***2398***	***2429***	***2445***	***2495***	***2529***	***2552***
VSWR of peak Frequency	1.08	1.03	1.03	1.15	1.11	1.11

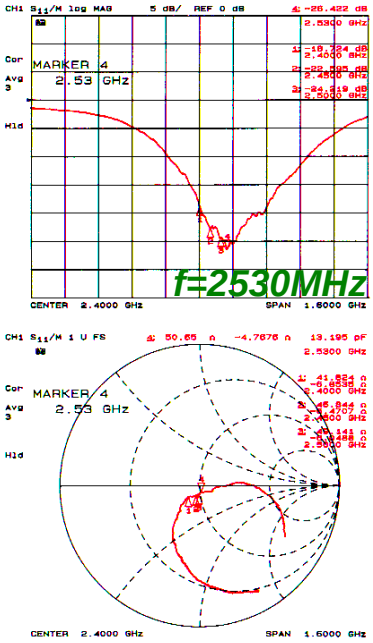
(Ex2) The mock-up PCB of ideal size shown in page 8 is used.
Firstly, chip antenna f0 is changed as rough adjustment.
Then there is some possibility that the impedance is change a little, so it should be rematched again.

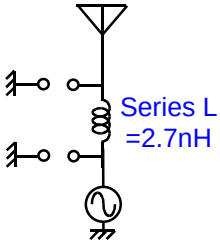
1. The Beginning (f0=2780MHz)



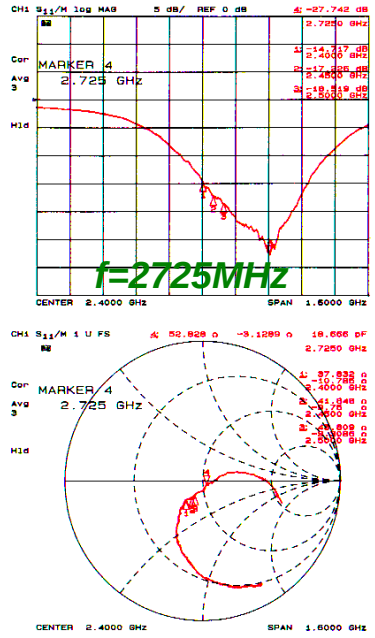


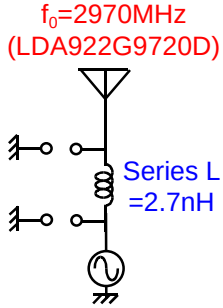
2. f0=2870MHz





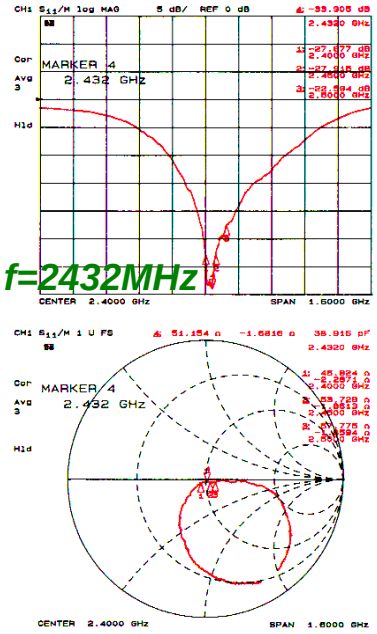
3. f0=2970MHz

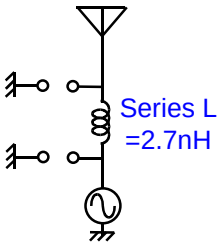




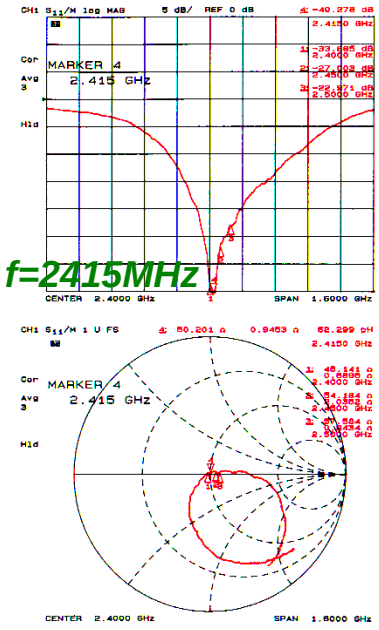
Next, by inserting series component resonant frequency can be shifted widely and adjusted more exactly (fine adjustment). Typical data is shown below and all result is summarized in table on next page.

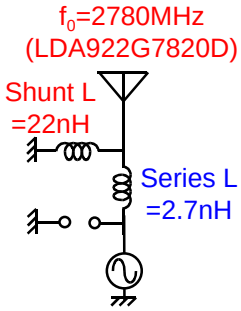
4. The Beginning (f0=2780MHz)



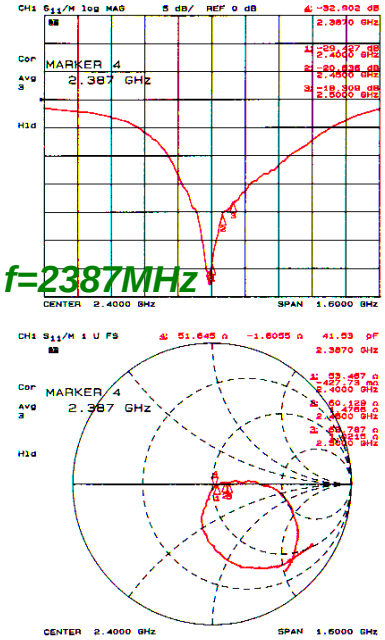


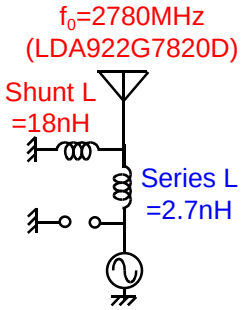
5. f0=2780MHz , Shunt L=22nH



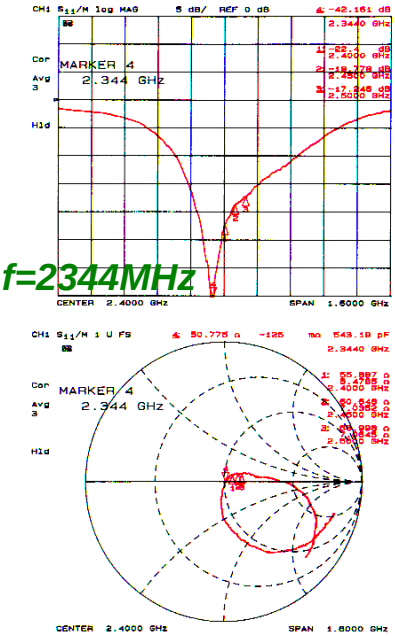


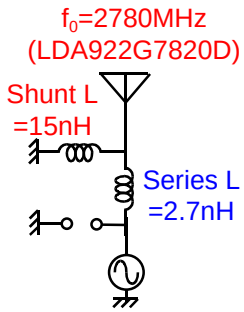
6. f0=2780MHz , Shunt L=18nH



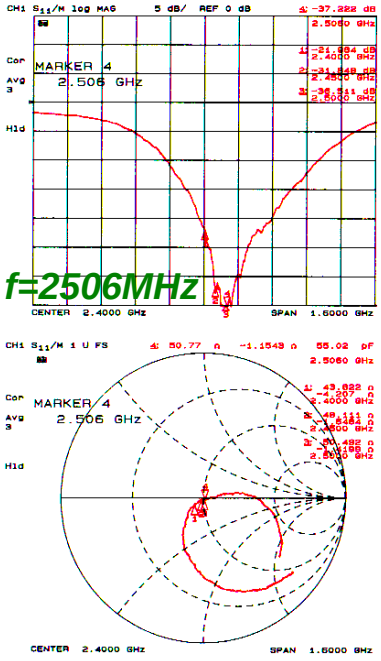


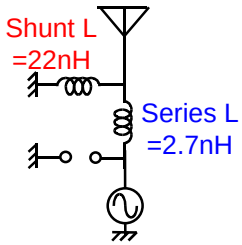
7. f0=2780MHz , Shunt L=12nH



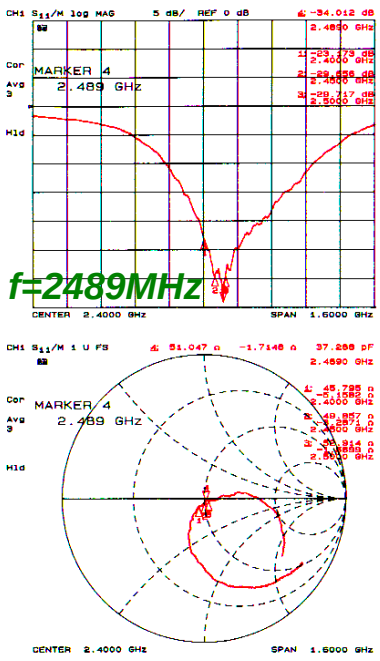


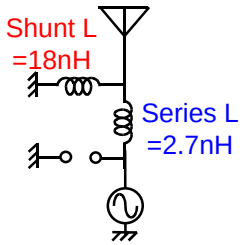
7. f0=2870MHz , Shunt L=22nH





8. f0=2870MHz , Shunt L=18nH





Summary

Chip Ant. F0 [MHz]	2780				2870				2970			
Shunt (near Ant.)	15(nH)	18(nH)	22(nH)	-	15(nH)	18(nH)	22(nH)	-	15(nH)	18(nH)	22(nH)	-
Series	2.7(nH)	2.7(nH)	2.7(nH)	2.7(nH)	2.7(nH)	2.7(nH)	2.7(nH)	2.7(nH)	3.3(nH)	3.3(nH)	3.3(nH)	3.3(nH)
Shunt (near F.P.)	-	-	-	-	-	-	-	-	-	-	-	-
Peak Frequency [MHz]	***2344***	***2387***	***2415***	***2432***	***2448***	***2489***	***2506***	***2530***	***2556***	***2582***	***2660***	***2690***
VSWR of peak Frequency	1.02	1.05	1.02	1.04	1.01	1.04	1.03	1.10	1.00	1.01	1.00	1.03