BRS36ANT00001(WFI GPS)

KZWLSLSVS0001 (LTE)

Antenna Performance Evaluation

-LTE Main/Aux

-WiFi Main/Aux

-GPS

Date of Report: 2023/ 02 / 07

Department: WCB , Auden Techno Corp.

Prepared by: Derek Yen

Document/Report Information

Project Name	**Venus plus**
Topics	**Antenna Performance Evaluation**
Date of Report	**2023/ 02 / 07**
Report Revision	**Rev06**
Dept.	**WCB, Auden Techno Corp.**
Antenna Type	**WiFi Main: PIFA Antenna ,WiFi Aux: PIFA Antenna , LTE Aux: PIFA Antenna ,LTE Main: PIFA Antenna**
Revised by	**Bryant Huang**

Report History

Date	Report Rev.	Project Stage	Description
2022/07/14	Rev00	EVT	1. All Antennas Performance.
2022/08/01	Rev01	EVT	1. LTE Main, WiFi main, WifI aux, GPS performance optimization.
2022/08/12	Rev02	EVT	1. LTE Aux and WiFi main performance Evaluation.
2022/10/11	Rev03	DVT1	1. LTE Aux performance with factory sample and finetune.
2022/10/13	Rev04	DVT1	1. Check LTE Main, Wi-Fi, GPS antenna performance in DVT1 device. 2. Fine tune Wi-Fi antenna in DVT1 device.
2022/11/23	Rev05	DVT1	1. LTE main performance debug with spk.
2023/02/07	Rev06	DVT1	1. All Antennas Performance.

Outline

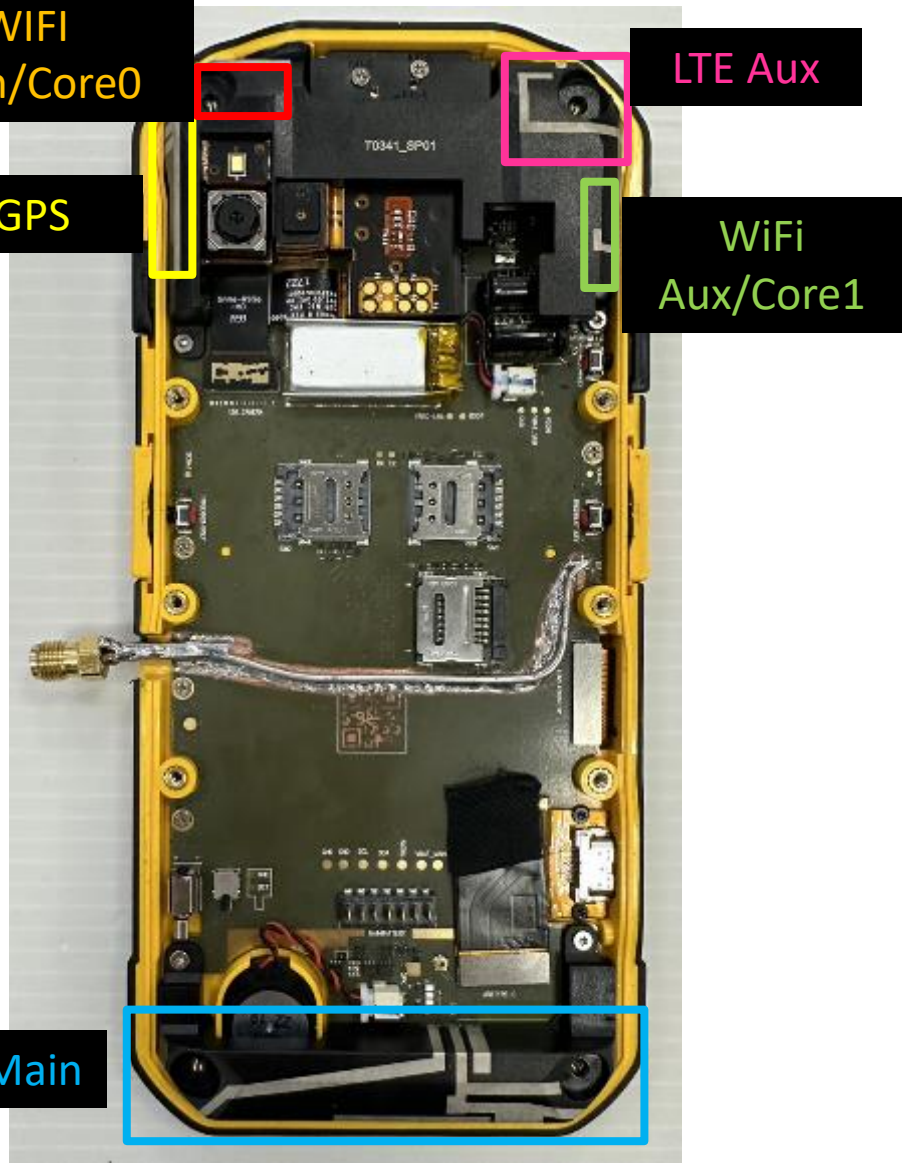
- Platform and Fixture Introduction
- Pictures of Antenna pattern
- Antenna Solution and Performance
  - LTE Main
  - LTE Aux
  - WIFI Main/Aux
  - GPS Ant.
- Conclusion

Pictures of Device

Front view

Back view

Pictures of Device



Outline

- Platform and Fixture Introduction
- Pictures of Antenna pattern
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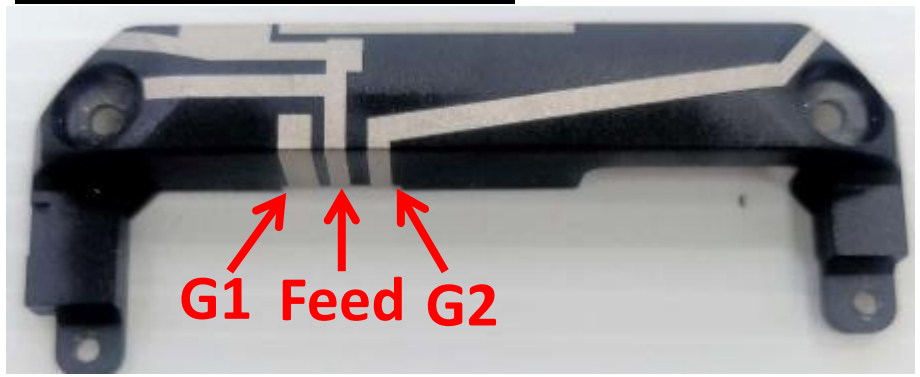
  - LTE Main
  - LTE Aux
  - WIFI Main/Aux
  - GPS Ant.
- Conclusion

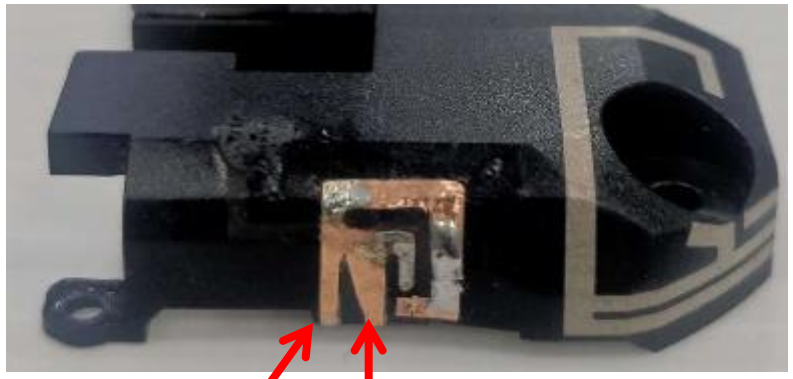
Pictures of Antenna

LTE Main antenna



WIFI Main/Core0 antenna

WIFI Aux/Core1 antenna



GPS antenna

Outline

- Platform and Fixture Introduction
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- Antenna Solution and Performance
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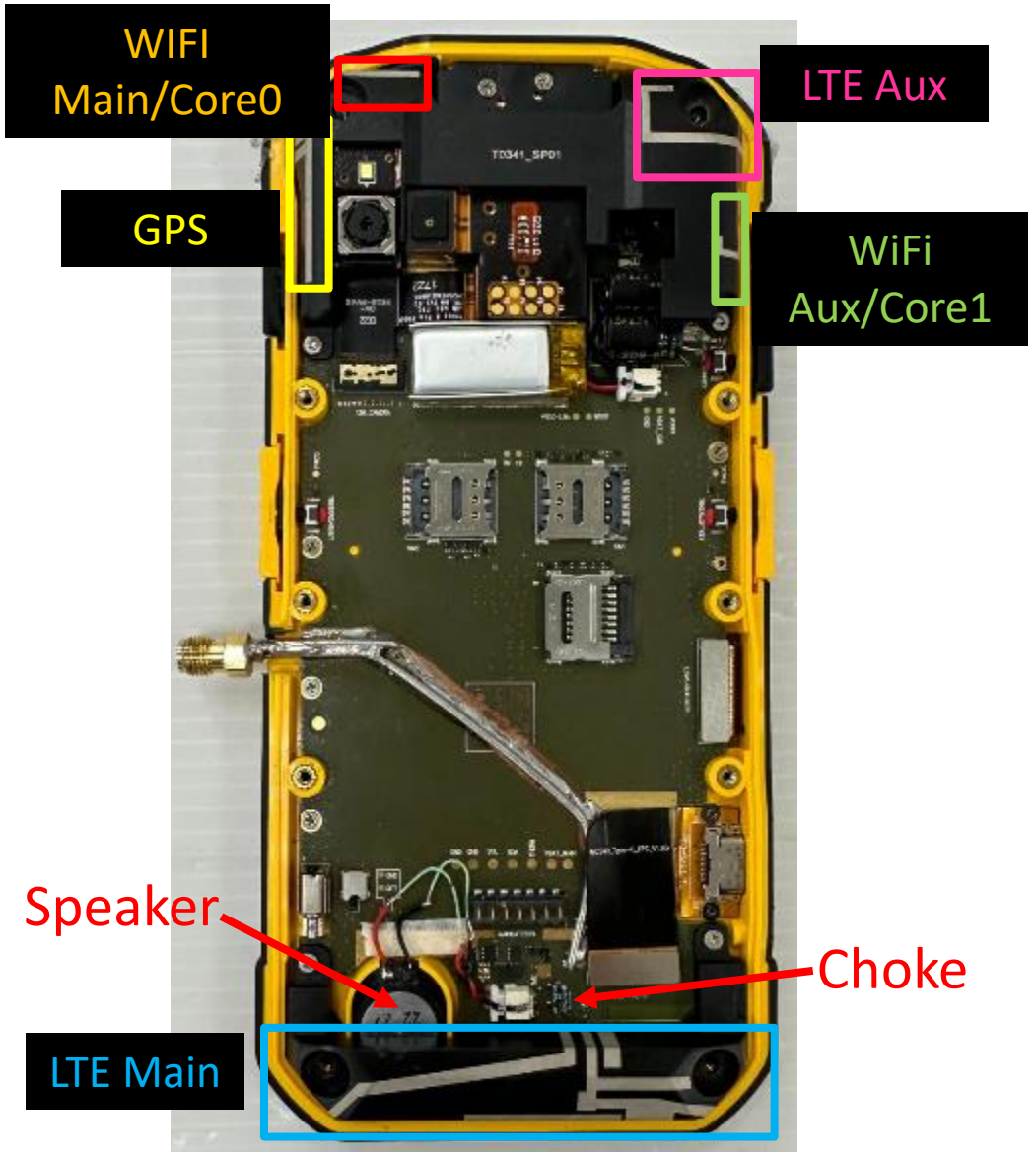
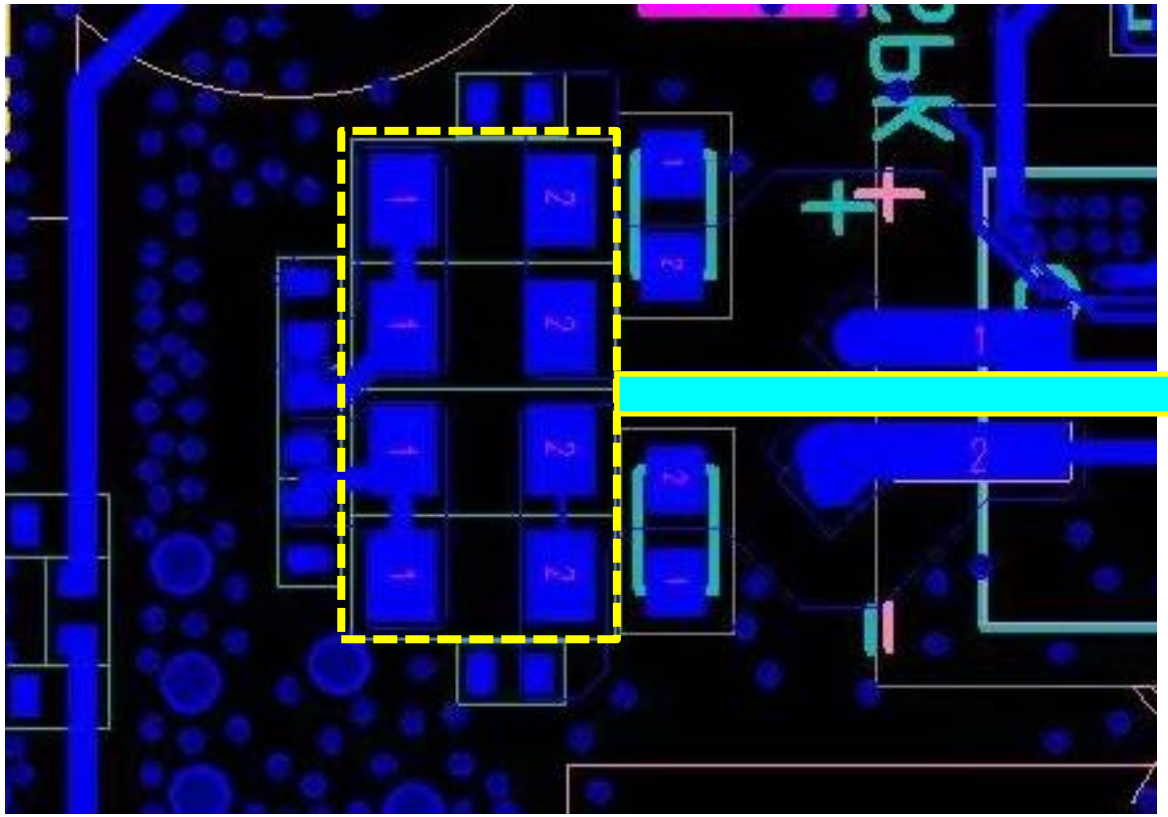
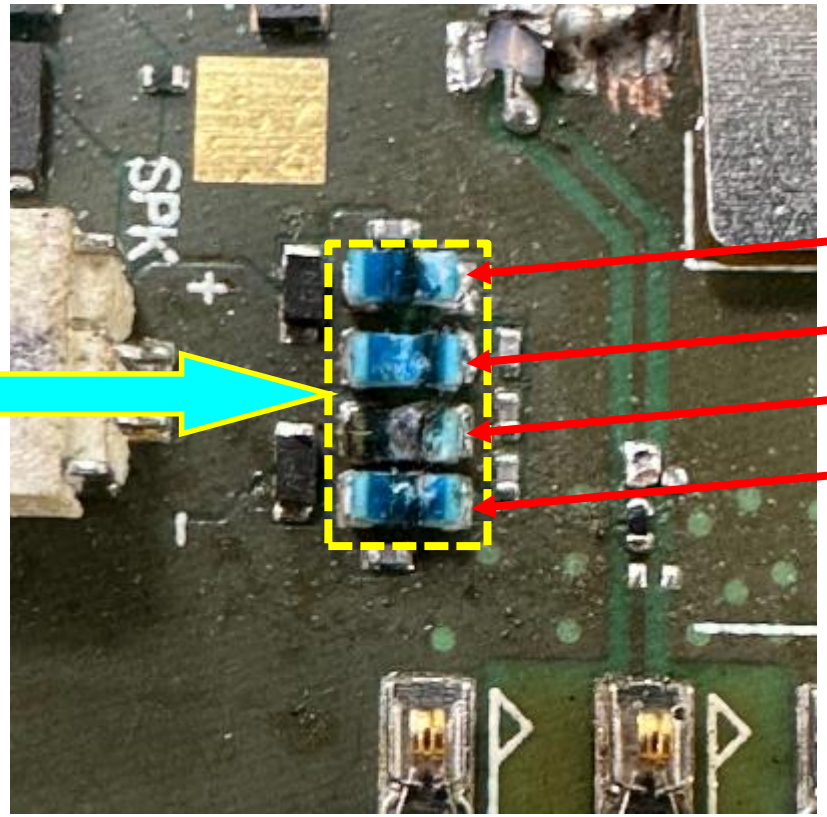
  - LTE Aux
  - WIFI Main/Aux
  - GPS Ant.
- Conclusion

Pictures of Device

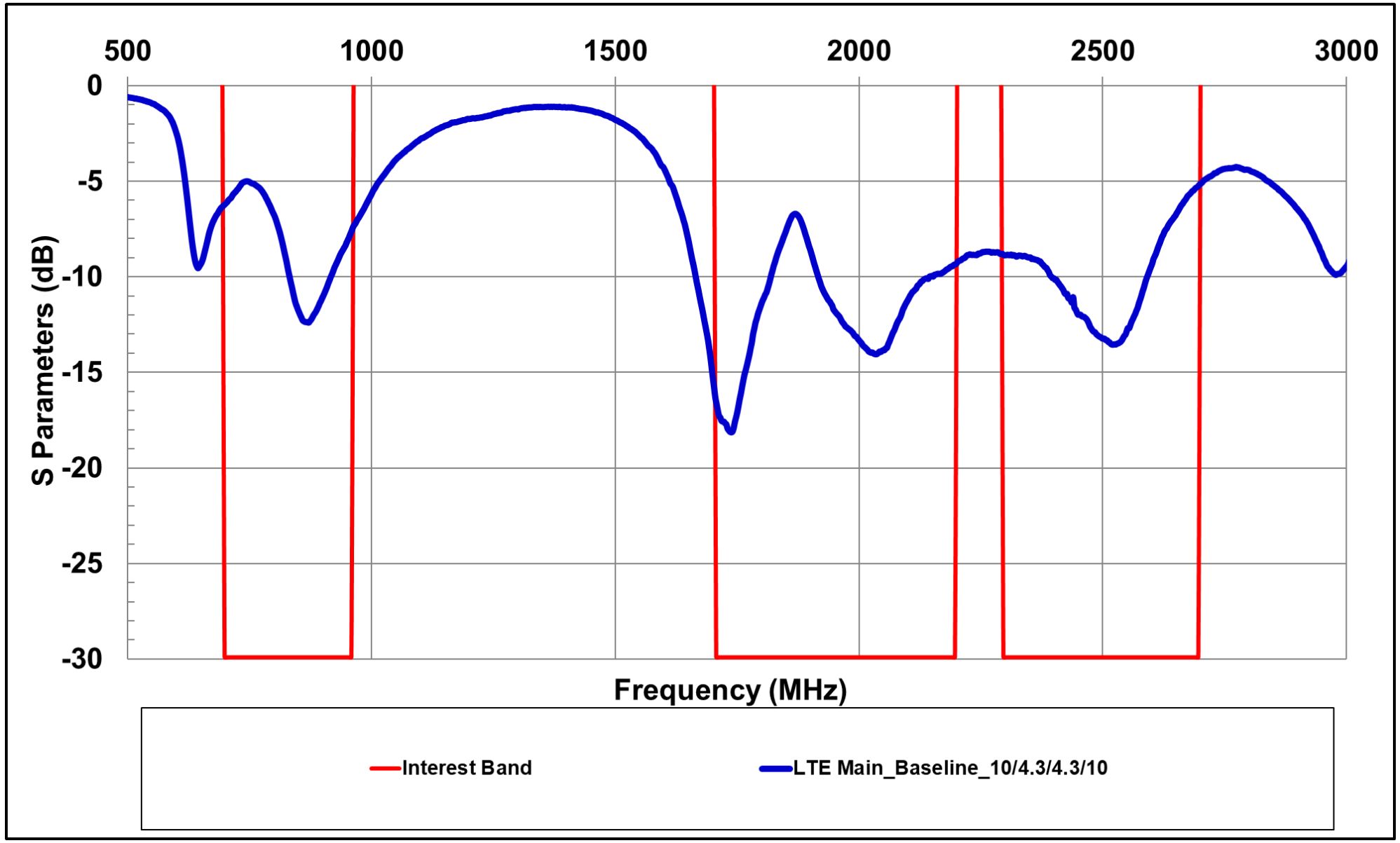


Choke status





S11_LTE Main Antenna



Efficiency_LTE Main antenna_Low Band

Conditions	Cond.00			
Date	2022/11/15			
Report Rev.	Rev04			
Antenna	LTE Main			
Project Stage	DVT1 Terminal			
Detail	1. Baseline 2. 10nH/4.3nH/4.3nH/10nH 3. PIFA+coupling type			
Chamber	Auden GTS 2800			
MHz	Spec	MHz	Avg. Gain (dB)	Peck. Gain(dBi)
698	-4.0	698	-3.0	1.4
703	-4.0	703	-3.1	1.4
704	-4.0	704	-3.2	1.4
707	-4.0	707	-3.3	1.4
710	-4.0	710	-3.4	1.3
716	-4.0	716	-3.8	0.9
726	-4.0	726	-3.6	0.7
728	-4.0	728	-3.6	0.6
734	-4.0	734	-3.5	0.5
737	-4.0	737	-3.6	0.5
740	-4.0	740	-3.5	0.5
746	-4.0	746	-3.5	0.5
748	-4.0	748	-3.5	0.5
751	-4.0	751	-3.6	0.3
756	-4.0	756	-3.6	0.1
758	-4.0	758	-3.7	0.1
777	-4.0	777	-3.9	-0.3
781	-4.0	781	-3.9	-0.3
782	-4.0	782	-3.9	-0.3
787	-4.0	787	-4.0	-0.4
791	-4.0	791	-4.0	-0.2

Conditions	Cond.00			
Date	2022/11/15			
Report Rev.	Rev04			
Antenna	LTE Main			
Project Stage	DVT1 Terminal			
Detail	1. Baseline 2. 10nH/4.3nH/4.3nH/10nH 3. PIFA+coupling type			
Chamber	Auden GTS 2800			
MHz	Spec	MHz	Avg. Gain (dB)	Peck. Gain(dBi)
803	-4.0	803	-4.3	-0.1
806	-4.0	806	-4.4	-0.3
821	-4.0	821	-4.5	-0.2
824	-4.0	824	-4.5	-0.1
832	-4.0	832	-4.3	0.0
837	-4.0	837	-4.1	0.5
847	-4.0	847	-3.9	0.5
849	-4.0	849	-3.8	0.5
862	-4.0	862	-3.5	1.0
869	-4.0	869	-3.3	1.1
880	-4.0	880	-3.1	1.4
882	-4.0	882	-3.0	1.4
894	-4.0	894	-2.8	1.4
898	-4.0	898	-2.8	1.4
915	-4.0	915	-2.8	1.5
925	-4.0	925	-3.0	1.3
943	-4.0	943	-3.2	1.2
960	-4.0	960	-3.7	0.8

Efficiency_LTE Main Antenna_Middle and High Band

Conditions	Cond.00			
Date	2022/11/15			
Report Rev.	Rev04			
Antenna	LTE Main			
Project Stage	DVT1 Terminal			
Detail	1. Baseline 2. 10nH/4.3nH/4.3nH/10nH 3. PIFA+coupling type			
Chamber	Auden GTS 2800			
MHz	Spec	MHz	Avg. Gain (dB)	Peck. Gain(dBi)
1710	-3.5	1710	-2.7	2.6
1733	-3.5	1733	-2.8	3.1
1745	-3.5	1745	-3.0	2.9
1748	-3.5	1748	-3.0	2.9
1755	-3.5	1755	-3.1	2.7
1780	-3.5	1780	-3.6	2.3
1785	-3.5	1785	-3.7	2.2
1805	-3.5	1805	-4.0	2.1
1843	-3.5	1843	-4.1	1.0
1850	-3.5	1850	-4.0	1.3
1880	-3.5	1880	-3.6	2.2
1910	-3.5	1910	-3.5	2.5
1920	-3.5	1920	-3.6	2.2
1930	-3.5	1930	-3.5	2.3
1950	-3.5	1950	-3.5	1.8
1960	-3.5	1960	-3.4	1.7
1980	-3.5	1980	-3.5	1.4
1990	-3.5	1990	-3.6	1.3
2110	-3.5	2110	-3.3	1.8
2133	-3.5	2133	-2.7	2.2
2140	-3.5	2140	-2.6	2.3

Conditions	Cond.00			
Date	2022/11/15			
Report Rev.	Rev04			
Antenna	LTE Main			
Project Stage	DVT1 Terminal			
Detail	1. Baseline 2. 10nH/4.3nH/4.3nH/10nH 3. PIFA+coupling type			
Chamber	Auden GTS 2800			
MHz	Spec	MHz	Avg. Gain (dB)	Peck. Gain(dBi)
2155	-3.5	2155	-2.4	2.5
2170	-3.5	2170	-2.3	2.3
2200	-3.5	2200	-2.2	2.7
2300	-3.5	2300	-2.6	2.6
2305	-3.5	2305	-2.6	2.6
2310	-3.5	2310	-2.5	2.7
2315	-3.5	2315	-2.5	2.7
2350	-3.5	2350	-2.5	2.5
2355	-3.5	2355	-2.5	2.4
2360	-3.5	2360	-2.6	2.2
2400	-3.5	2400	-2.8	1.5
2402	-3.5	2402	-2.8	1.5
2442	-3.5	2442	-2.6	2.1
2494	-3.5	2494	-2.5	2.5
2500	-3.5	2500	-2.5	2.5
2535	-3.5	2535	-2.6	2.5
2570	-3.5	2570	-2.7	2.6
2620	-3.5	2620	-3.2	2.6
2655	-3.5	2655	-3.8	1.9
2690	-3.5	2690	-4.0	1.5

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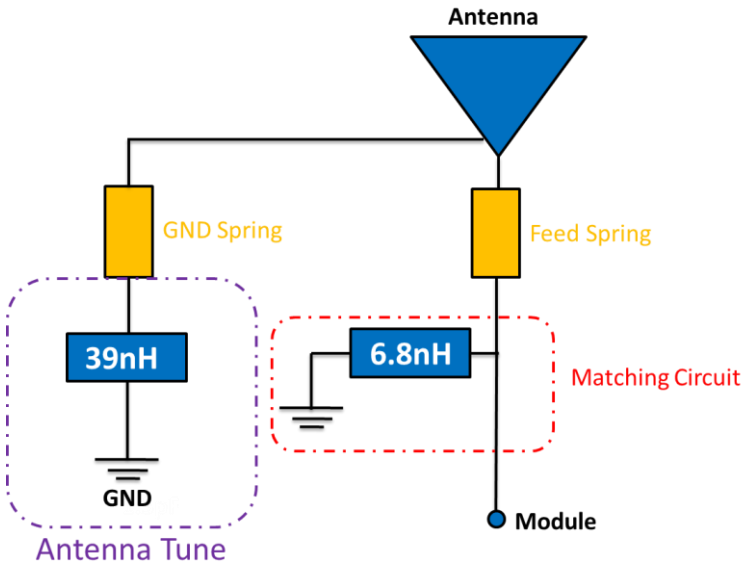
LTE Aux Working Mode

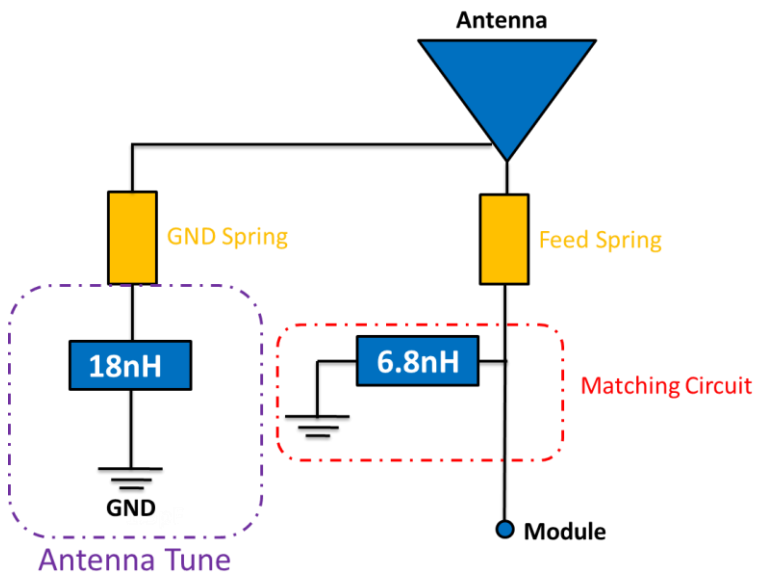
WWAN Aux antenna

Tune1 for 728~821MHz and M/HB



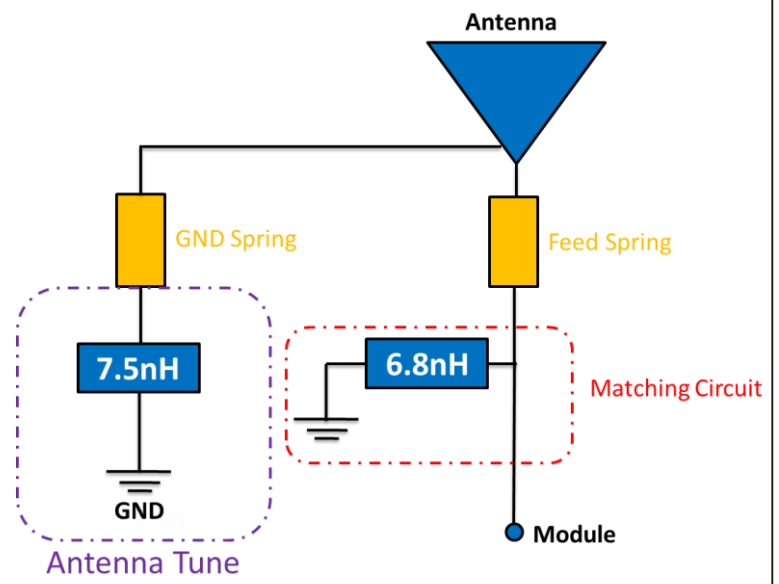
WWAN Aux antenna

Tune2 for 824~894MHz

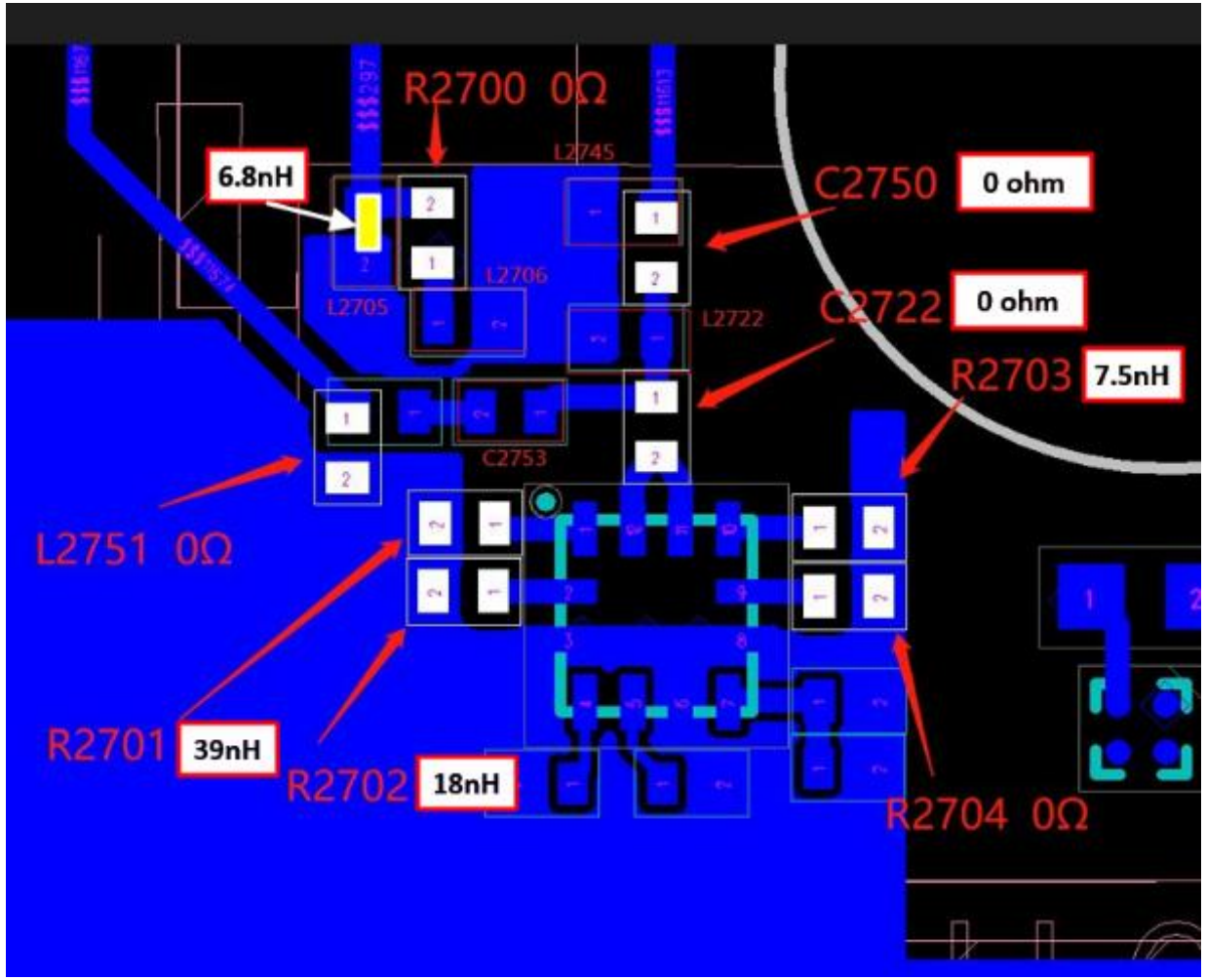


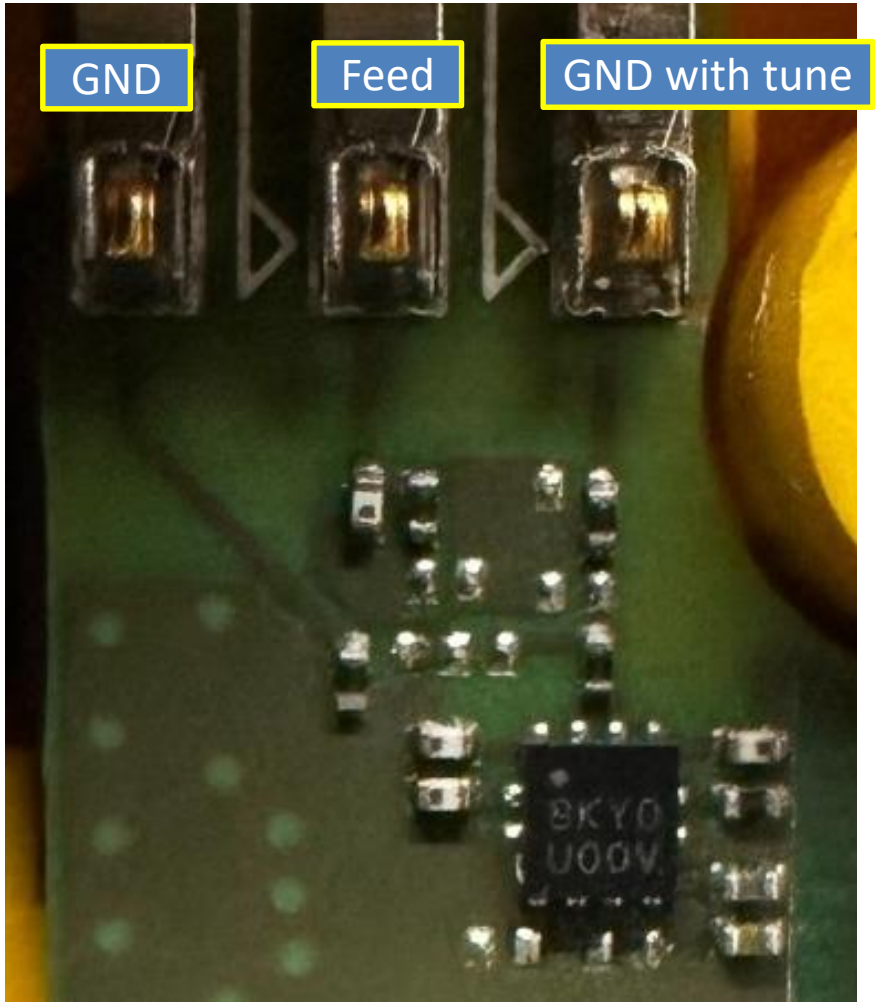
WWAN Aux antenna

Tune3 for 898~925MHz

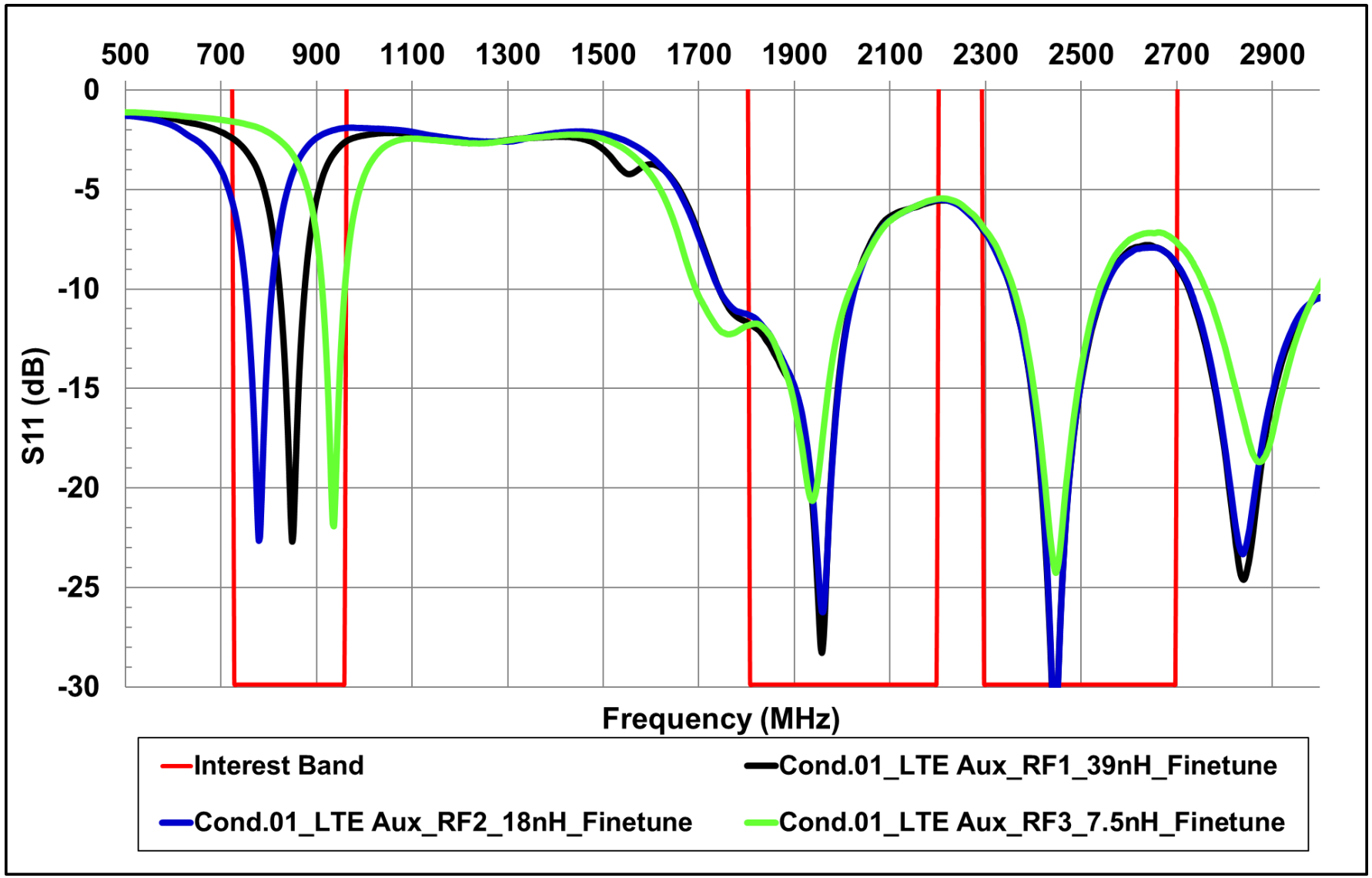


LTE Aux PCB Layout





LTE Aux_S11


500
700
900
1100
1300
1500
1700
1900
2100
2300
2500
2700
2900
0
-5
-10
-15
-20
-25
-30
S11 (dB)
Frequency (MHz)
Interest Band
Cond.01_LTE Aux_RF1_39nH_Finetune
Cond.01_LTE Aux_RF2_18nH_Finetune
Cond.01_LTE Aux_RF3_7.5nH_Finetune

LTE Aux_Efficiency_Low Band

- LTE Aux antenna use switch to cover low band.

Conditions		Cond.01			Cond.01			Cond.01		
Date		2022/10/7			2022/10/7			2022/10/7		
Report Rev.		Rev03			Rev03			Rev03		
Antenna		LTE Aux			LTE Aux			LTE Aux		
Project Stage		DVT1			DVT1			DVT1		
Detail		1. Feed_p6.8nH. 2. RF1_39nH. 3. Finetune. 4.PIFA+Coupling Type.			1. Feed_p6.8nH. 2. RF2_18nH. 3. Finetune. 4.PIFA+Coupling Type.			1. Feed_p6.8nH. 2. RF3_7.5nH. 3. Finetune. 4.PIFA+Coupling Type.		
Chamber		Auden GTS 2800			Auden GTS 2800			Auden GTS 2800		
MHz	Spec	MHz	Avg. Gain (dB)	Peak. Gain(dBi)	MHz	Avg. Gain(dB)	Peak. Gain(dBi)	MHz	Avg. Gain(dB)	Peak. Gain(dBi)
698	-8.0	698	-10.9	-7.8	698	-15.0	-11.8	698	-19.1	-16.0
703	-8.0	703	-10.2	-7.1	703	-14.5	-11.3	703	-18.6	-15.4
704	-8.0	704	-10.1	-7.1	704	-14.4	-11.2	704	-18.5	-15.4
707	-8.0	707	-9.8	-6.8	707	-14.1	-10.9	707	-18.3	-15.2
710	-8.0	710	-9.6	-6.7	710	-13.9	-10.8	710	-18.1	-15.1
716	-8.0	716	-9.4	-6.6	716	-13.7	-10.7	716	-18.1	-15.2
726	-8.0	726	-8.8	-6.0	726	-13.1	-10.0	726	-17.6	-14.6
728	-8.0	728	-8.7	-5.9	728	-13.1	-10.0	728	-17.6	-14.6
734	-8.0	734	-8.5	-5.6	734	-12.9	-9.8	734	-17.5	-14.4
737	-8.0	737	-8.4	-5.5	737	-12.8	-9.6	737	-17.4	-14.4
740	-8.0	740	-8.3	-5.3	740	-12.6	-9.5	740	-17.4	-14.2
746	-8.0	746	-8.0	-5.0	746	-12.4	-9.2	746	-17.2	-13.9
748	-8.0	748	-7.9	-4.9	748	-12.3	-9.2	748	-17.2	-14.0
751	-8.0	751	-7.8	-4.8	751	-12.2	-9.1	751	-17.1	-14.0
756	-8.0	756	-7.7	-4.7	756	-12.0	-8.9	756	-16.9	-13.8
758	-8.0	758	-7.6	-4.7	758	-11.9	-8.9	758	-16.9	-13.7
777	-8.0	777	-7.2	-4.3	777	-10.7	-7.9	777	-15.9	-13.0
781	-8.0	781	-7.0	-4.1	781	-10.4	-7.5	781	-15.7	-12.6
782	-8.0	782	-7.0	-4.1	782	-10.4	-7.4	782	-15.6	-12.5
787	-8.0	787	-7.1	-4.1	787	-10.1	-7.1	787	-15.4	-12.2
791	-8.0	791	-7.1	-4.1	791	-9.8	-6.9	791	-15.2	-12.1
803	-8.0	803	-7.4	-4.5	803	-9.2	-6.3	803	-14.7	-11.8
806	-8.0	806	-7.5	-4.6	806	-9.1	-6.1	806	-14.6	-11.7
821	-8.0	821	-8.3	-5.5	821	-8.5	-5.6	821	-14.0	-11.1
824	-8.0	824	-8.5	-5.6	824	-8.4	-5.4	824	-13.9	-10.9
832	-8.0	832	-9.0	-6.0	832	-8.1	-5.0	832	-13.5	-10.4
837	-8.0	837	-9.3	-6.3	837	-7.9	-4.9	837	-13.2	-10.2
847	-8.0	847	-9.9	-6.8	847	-7.7	-4.6	847	-12.8	-9.5
849	-8.0	849	-10.1	-6.9	849	-7.7	-4.5	849	-12.7	-9.4
862	-8.0	862	-11.0	-8.0	862	-7.7	-4.6	862	-11.9	-8.7
869	-8.0	869	-11.3	-8.1	869	-7.8	-4.5	869	-11.2	-7.8
880	-8.0	880	-11.8	-8.5	880	-8.0	-4.6	880	-10.1	-6.6
882	-8.0	882	-11.9	-8.6	882	-8.1	-4.6	882	-9.9	-6.4
894	-8.0	894	-12.3	-8.8	894	-8.5	-5.0	894	-8.9	-5.2
898	-8.0	898	-12.6	-9.0	898	-8.7	-5.2	898	-8.6	-4.8
915	-8.0	915	-13.4	-9.8	915	-9.7	-6.1	915	-7.4	-3.6
925	-8.0	925	-14.0	-10.3	925	-10.4	-6.9	925	-7.0	-3.2
943	-8.0	943	-14.8	-11.4	943	-11.6	-8.2	943	-6.7	-3.1
960	-8.0	960	-15.5	-12.2	960	-12.6	-9.2	960	-7.2	-4.0

LTE Aux_Efficiency_Middle & High Band

- LTE Aux antenna use switch(RF1) to support MB/HB.

Conditions	Cond.01
Date	2022/10/7
Report Rev.	Rev03
Antenna	LTE Aux
Project Stage	DVT1
Detail	1. Feed_p6.8nH. 2. RF1_39nH. 3. Finetune. 4.PIFA+Coupling Type.
Chamber	Auden GTS 2800

MHz	Spec	MHz	Gain (dB)	Peak. Gain(dBi)
1710	-7.0	1710	-9.4	-4.9
1733	-7.0	1733	-8.9	-4.3
1745	-7.0	1745	-8.6	-3.8
1748	-7.0	1748	-8.5	-3.8
1755	-7.0	1755	-8.4	-3.6
1780	-7.0	1780	-7.9	-3.0
1785	-7.0	1785	-7.8	-2.9
1805	-7.0	1805	-7.6	-2.8
1843	-7.0	1843	-6.8	-2.4
1850	-7.0	1850	-6.8	-2.5
1880	-7.0	1880	-6.7	-2.4
1910	-7.0	1910	-6.8	-2.0
1920	-7.0	1920	-6.9	-1.7
1930	-7.0	1930	-6.8	-1.3
1950	-7.0	1950	-7.0	-1.2
1960	-7.0	1960	-7.2	-1.6
1980	-7.0	1980	-7.7	-2.4
1990	-7.0	1990	-8.0	-2.8
2110	-7.0	2110	-7.7	-2.6
2133	-7.0	2133	-7.6	-2.7
2140	-7.0	2140	-7.5	-2.8

Conditions	Cond.01
Date	2022/10/7
Report Rev.	Rev03
Antenna	LTE Aux
Project Stage	DVT1
Detail	1. Feed_p6.8nH. 2. RF1_39nH. 3. Finetune. 4.PIFA+Coupling Type.
Chamber	Auden GTS 2800

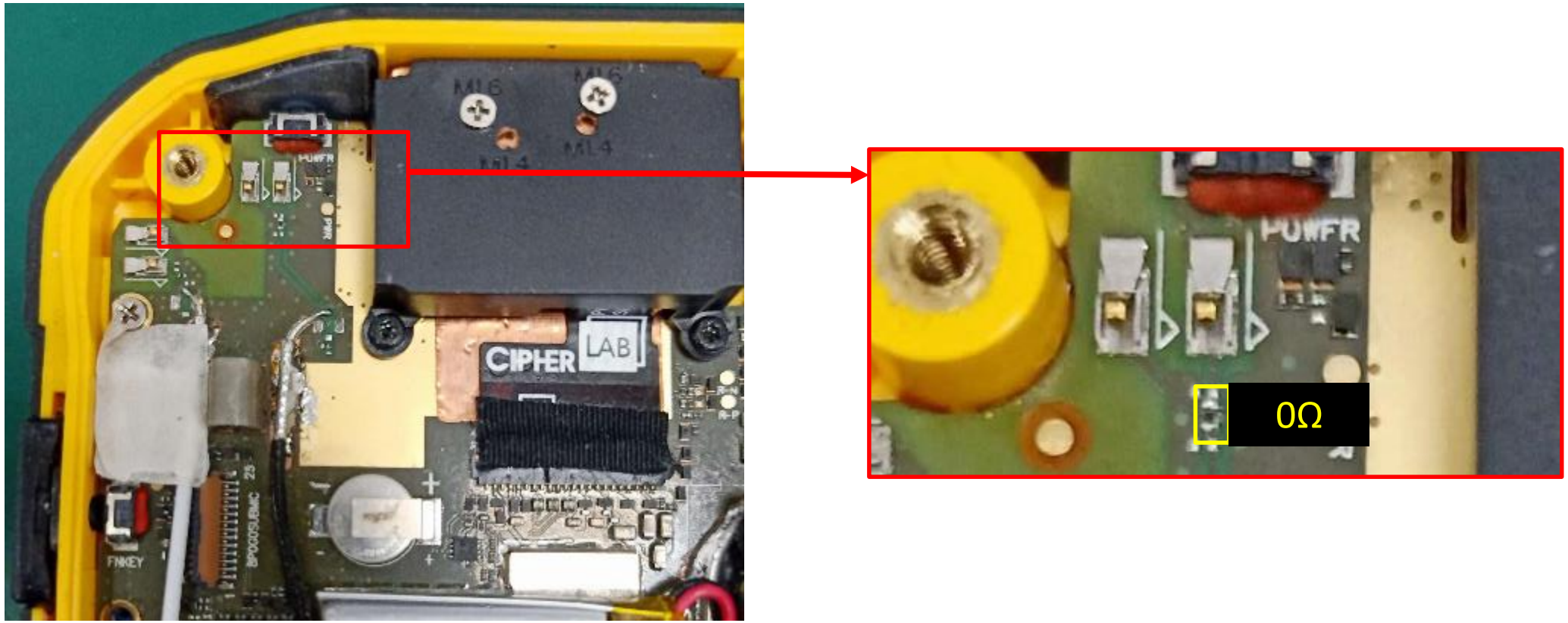
MHz	Spec	MHz	Gain (dB)	Peak. Gain(dBi)
2155	-7.0	2155	-7.4	-2.7
2170	-7.0	2170	-7.4	-3.0
2200	-7.0	2200	-7.1	-2.9
2300	-7.0	2300	-5.4	-1.2
2305	-7.0	2305	-5.3	-1.0
2310	-7.0	2310	-5.1	-0.8
2315	-7.0	2315	-5.0	-0.7
2350	-7.0	2350	-4.2	-0.2
2355	-7.0	2355	-4.2	-0.2
2360	-7.0	2360	-4.2	-0.2
2400	-7.0	2400	-3.9	0.2
2402	-7.0	2402	-4.0	0.1
2442	-7.0	2442	-3.7	0.6
2494	-7.0	2494	-3.9	0.6
2500	-7.0	2500	-3.9	0.5
2535	-7.0	2535	-4.2	0.1
2570	-7.0	2570	-4.5	-0.1
2620	-7.0	2620	-5.0	-0.8
2655	-7.0	2655	-5.1	-1.0
2690	-7.0	2690	-5.0	-0.5

Outline

- Platform and Fixture Introduction
- Pictures of Antenna pattern
- Antenna Solution and Performance
  - LTE Main
  - LTE Aux
  - WIFI Main/Aux
  - GPS Ant.
- Conclusion

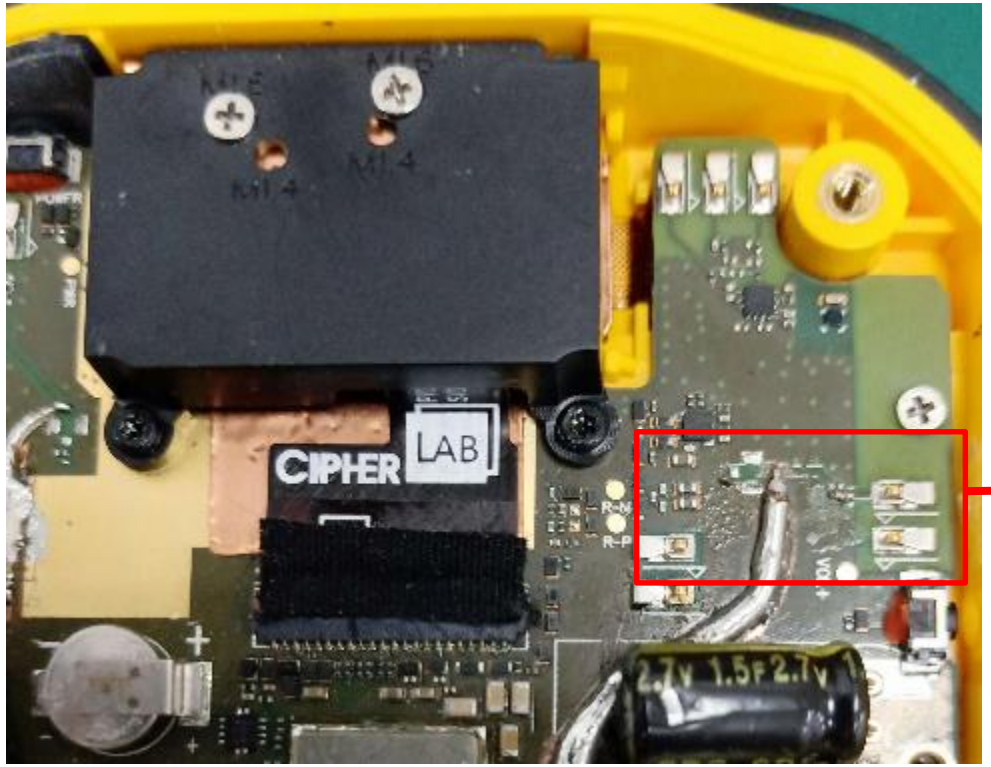
Solution of WIFI Main/Core0 Antenna

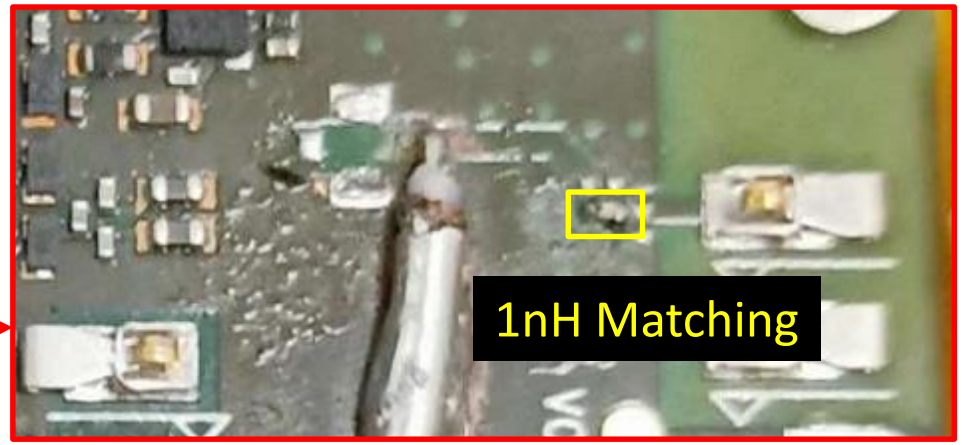
因高頻諧振頻偏，原matching替換成0歐姆後特性有改善。



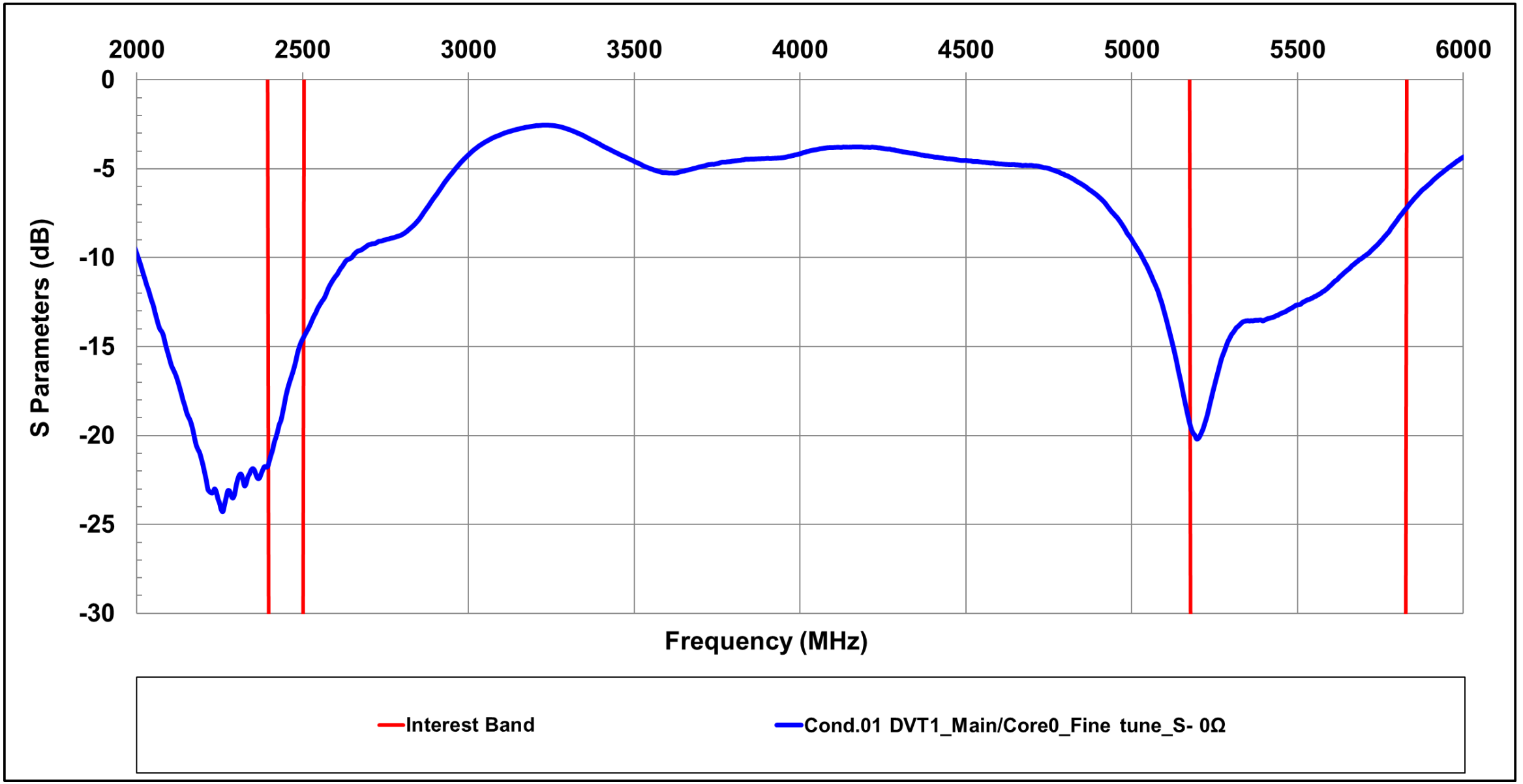
Solution of WIFI Aux/Core1 Antenna

因高頻特性不佳，電路串1nH優化。

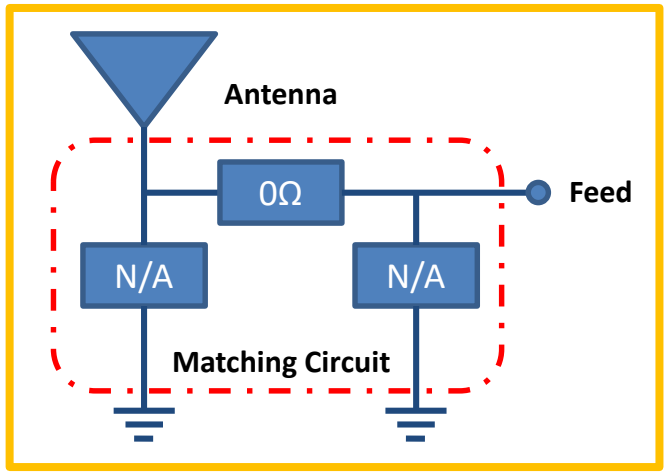




S11_WiFi Main/Core0 Antenna

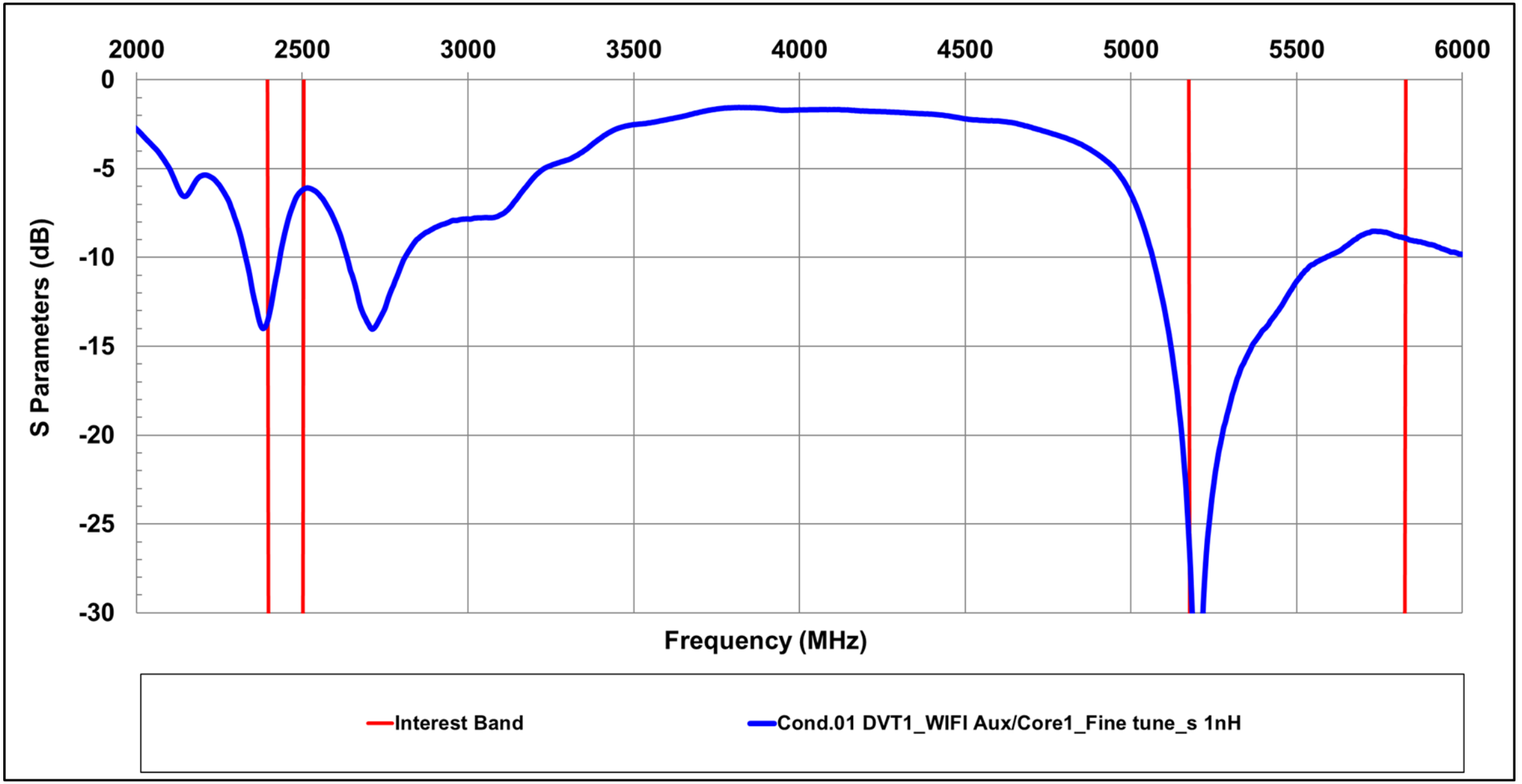


Efficiency_WiFi Main/Core0 Antenna

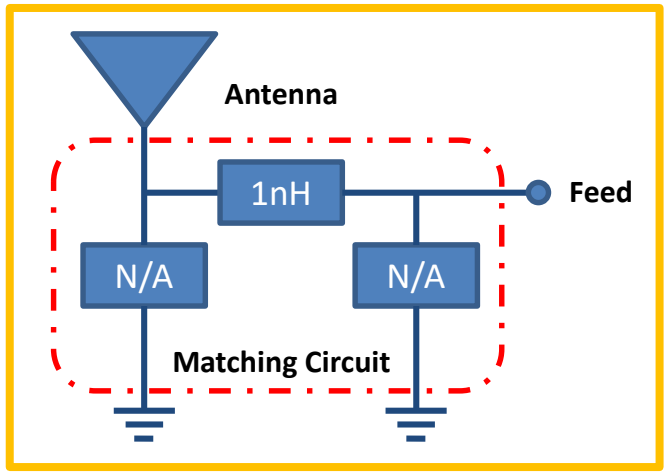


Conditions	Cond.01			
Date	2022/10/13			
Report Rev.	Rev04			
Antenna (Rev.)	WIFI Main/Core0			
Project Stage	DVT1			
Detail	*Fine tune. *S-0歐姆			
Chamber	Auden GTS2800			
MHz	Spec	MHz	Avg. Gain(dB)	Peak. Gain(dBi)
2402	-3.0	2402	-3.5	1.8
2442	-3.0	2442	-4.0	1.7
2484	-3.0	2484	-4.8	0.3
5150	-3.0	5150	-6.1	-0.8
5250	-3.0	5250	-4.6	1.1
5350	-3.0	5350	-4.2	2.1
5470	-3.0	5470	-4.6	1.5
5725	-3.0	5725	-4.9	1.0
5785	-3.0	5785	-5.1	1.3
5875	-3.0	5875	-4.6	1.9

S11_WiFi Aux/Core1 Antenna



Efficiency_WiFi Aux/Core1 Antenna

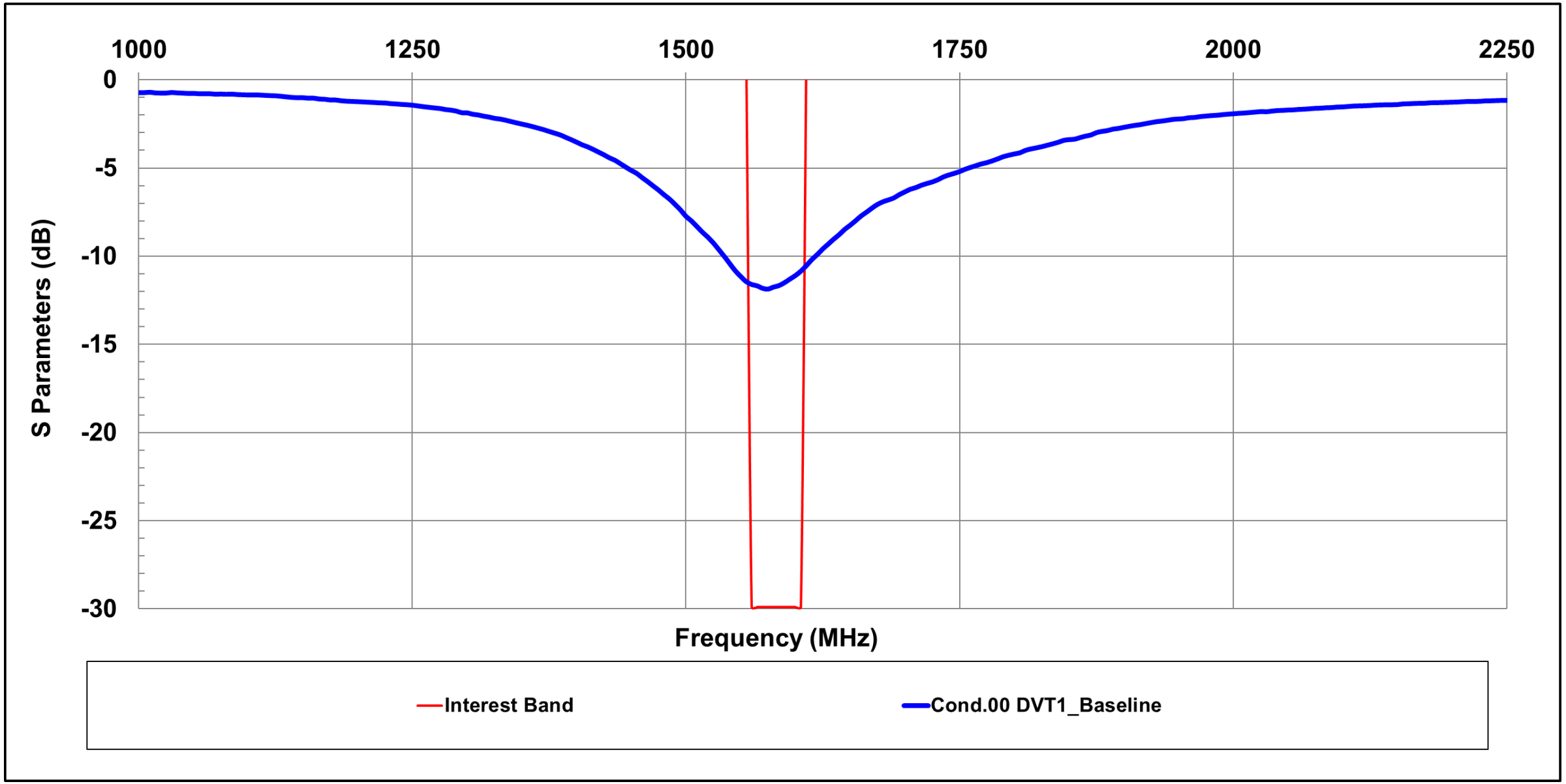


Conditions	Cond.01			
Date	2022/10/13			
Report Rev.	Rev04			
Antenna (Rev.)	WIFI Aux/Core1			
Project Stage	DVT1			
Detail	*Fine tune. *S-1nH *PIFA type			
Chamber	Auden GTS2800			
MHz	Spec	MHz	Avg. Gain(dB)	Peak. Gain(dBi)
2402	-3.0	2402	-3.2	0.3
2442	-3.0	2442	-3.2	0.2
2484	-3.0	2484	-3.7	-0.1
5150	-3.0	5150	-6.0	-1.1
5250	-3.0	5250	-5.1	0.2
5350	-3.0	5350	-4.1	1.2
5470	-3.0	5470	-4.0	1.9
5725	-3.0	5725	-4.3	2.9
5785	-3.0	5785	-4.8	2.2
5875	-3.0	5875	-5.1	1.8

Outline

- Platform and Fixture Introduction
- Pictures of Antenna pattern
- Antenna Solution and Performance
  - LTE Main
  - LTE Aux
  - WIFI Main/Aux
  - GPS Ant.
- Conclusion

GPS Antenna


1000
1250
1500
1750
2000
2250
0
-5
-10
-15
-20
-25
-30
S Parameters (dB)
Frequency (MHz)
Interest Band
Cond.00 DVT1_Baseline

GPS Antenna

Conditions		Cond.00		
Date		2022/10/13		
Report Rev.		Rev04		
Antenna (Rev.)		GPS		
Project Stage		DVT1		
Detail		*Baseline. *Factory sample. *PIFA type.		
Chamber		Auden GTS 2800		
MHz	Spec	MHz	Avg. Gain(dB)	Peak. Gain(dBi)
Total Eff.				
1560	-3.0	1560	-3.2	1.1
1585	-3.0	1585	-3.4	0.6
1610	-3.0	1610	-3.3	0.2
UHS Eff.				
1560	-6.0	1560	-6.9	
1585	-6.0	1585	-6.9	
1610	-6.0	1610	-6.4	