安特微智能通讯(深圳)有限公司
Ante Intelligent Communications (Shenzhen) Co., Ltd.

Model6 R & D Design Tracking Report

- This report is a detailed process and summary to better support collaborative customers.
- The ideas and methods for the RF performance of all products in this report are custom-d
- Do not disseminate this research and development report to third parties without the per

Report Versior	Reporting Time	Main matters of this report	Customer Conclusions
V1	20231130	Passive Test	

Test system and equipment (5*5*5 TEM24 multi-probe test system, Agilent5071 series network analyzer

Attachment: Description and introduction of antenna design and development process

Phase 1	Antenna performance pre-assessment	According to the characteristics of different projects, suggest the most appropriate evaluation methods for customers, including simulation review, drawing file review, hand board review, etc. Antenna review, as a very important part of antenna research and development, is introduced in the early stage of the project, which is of great significance to the performance and realizability of the antenna in the later stage.
Phase 2	Passive performance test of antenna	As a device for energy conversion and transmission, its essence is a passive device, and the parameters that characterize its own performance are passive parameters. In the non-debugging stage, the main debugging antenna itself transmission parameters and radiation parameters, the test parameters of concern are mainly impedance, return loss, efficiency and gain.
Phase 3	Antenna active performance test	In the case that the antenna confirms the passive parameters OK, the final use effect also needs to be put into the product for performance confirmation. At this stage, what needs to be debugged is the overall performance of the entire system. The main parameters of concern are power and sensitivity, which are the most intuitive active parameters to quantify the antenna's transmitting and receiving capabilities.
Phase 4	Wireless User Experience Test	For all wireless electronic products, the user experience is the ultimate goal we need to achieve, which is also the user's personal experience. Therefore, all our early research and development are actually in service for the final stage.

Explanation of Common Antenna Parameters in R & D Report

Category (Measuring	Antenna parameters	Interpretation	
Antenna Passive Parameters (network analyzer)	Standing wave ratio (VSWR)	The voltage standing wave ratio refers to the ratio of the standing wave antinode voltage to the node voltage amplitude, also known as the standing wave coefficient and the standing wave ratio. When the standing wave ratio is equal to 1, it means that the impedance of the feed line and the antenna is completely matched. At this time, all high-frequency energy is radiated by the antenna without energy reflection loss; when the standing wave ratio is infinite, it means total reflection and no energy is radiated.	VSWR≤3
	Return loss	Return loss is the ratio of the reflected wave power of the transmission line port to the incident wave power, expressed in logarithmic form, the unit is dB, generally negative, and its absolute value can be called reflection loss.	∣RL∣≥6dB
	Impedance Chart (SMITH CHART)	The Smith chart (Impedance Chart) is the 1 tool to effectively select and calculate the matching impedance in high frequency and UHF circuit design.	The better the antenna operating band is closer to the 50 ohm point
	Antenna efficiency (Effeciency)	Antenna efficiency refers to the ratio of the power radiated by the antenna (that is, the power of the effective conversion electromagnetic wave part) to the active power input to the antenna.	Non-metal environment: Effeciency ≥ 35% Metal environment: Effeciency ≥ 20%
	Antenna gain (Gain)	Antenna gain refers to the ratio of the power density of the signal generated by the actual antenna and the ideal radiating element at the same point in space under the condition that the input power is equal. It quantitatively describes the degree to which an antenna concentrates the input power, the key parameter is the micro-maximum gain, and the average gain of the antenna is the efficiency.	Depending on the operating frequency band and product characteristics and different
	Antenna pattern (radiation pattern)	Antenna pattern refers to the pattern of the relative field strength (normalized mode value) of the radiation field changing with the direction at a certain distance from the antenna, which is usually represented by two mutually perpendicular plane patterns in the maximum radiation direction of the antenna.	According to the actual use of the experience of different needs and different

Active motherboard conduction parameters (comprehensive tester + shielding box)	Transmit power TX Power (motherboard conduction)	The transmission power of the main board is the source of the electromagnetic wave radiated from the antenna to the space, and it is a quantitative parameter to measure the transmission ability of the RF chip. Conductive testing is also called point testing or closed-loop testing. There is usually a specific position on the motherboard as a calibration port, which is closer to the antenna. It should be noted that if the calibration port is far away from the antenna, the power eventually conducted to the antenna input port may differ greatly from the calibration port measurement value.	CSM850/900:≥ 32.5dBm DCS/PCS:≥29dBm DCMA/TD-SCDMA:≥23dBm WCDMA/LTE:≥22.5dBm WIFI and BT vary according to the specific system and rate
	Receive sensitivity RX Sensitivity (motherboard conduction)	The main board conduction receiving sensitivity is the limit state of the antenna receiving electromagnetic wave, and it is a quantitative parameter to measure the radio frequency chip in the case of no external interference and no transmission loss. If the conduction sensitivity is low, then the receiving sensitivity of the whole machine OTA will definitely not be high, and other precautions are the same as the conduction transmission power.	GSM/CDMA/TD/WCDMA:≤-109dBm LTE:≤-96dBm@10MHz
active antenna parameters	Total antenna radiated power (TRP)	The total radiated power of the antenna refers to the power value of the whole machine in each typical direction of 360 ° collected by using the standard antenna probe in the 3D microwave anechoic chamber. Through near-field to far-field and spherical integration, the total radiated power of the project in each direction in space is finally calculated, which is ideally closely related to the antenna efficiency.	According to different product forms and customer requirements
	Antenna Total Receive Sensitivity (TIS)	Similar to TRP,TIS also refers to the use of dark room standard antenna probes to collect the receiving sensitivity of the whole machine in each typical direction of 360 ° in a 3D microwave dark room. Through near-field to far-field and spherical integration, the total receiving sensitivity of the project in each direction in space is finally calculated, which is also positively correlated with efficiency under the condition of project approval.	According to different product forms and customer requirements
Analysis of common antenna problems			
auxiliary method		Method Interpretation	

External Antenna Experiment	There are two main features of the external antenna. 1 is that it is not bound by space and can be defaulted to an antenna with very high efficiency (through efficiency ≥ 60%). The 2 is far away from the motherboard and far away from each interference device, and the interference will be much smaller than that of the built-in antenna. Therefore, the external antenna experiment, according to its two characteristics, can effectively verify the two aspects of the problem, the 1 is in the case of high antenna efficiency, the whole machine OTA transmission power can reach a theoretical calculation value of the normal state; the 2 is far away from the motherboard, the receiving sensitivity will be subject to greater interference. The external antenna experiment is the 1 limit verification idea, which can quickly lock the problem direction and is more practical.
Environmental treatment experiment	The experimental purpose of environmental treatment is divided into two categories. The 1 is to improve the antenna radiation model, which is mainly used to improve the efficiency of the antenna or optimize the directional diagram, and finally improve the overall power and sensitivity parameters. The 2 is to reduce the radiation interference of other components as much as possible by shielding interference sources and connecting them in parallel, which can mainly improve the receiving sensitivity of the whole OTA.
matching circuit experiment	As a microwave device, the antenna also has input and output ports. For the transmitting process (the receiving process is exactly the opposite), the most important parameter of the input port is the impedance parameter, and by debugging and optimizing the impedance of the antenna, in the case of matching the impedance of the input signal, the loss of the input end can be effectively reduced, thereby improving the efficiency of the antenna transmission energy.
limit state simulation	The main purpose of this experiment is to simulate the use of extreme antenna debugging schemes, modification of routing areas and antenna materials, etc. under the current project environment, to improve antenna performance as much as possible, and to test a state that the performance can reach, so as to judge the next working direction, which can be regarded as a mass production feasibility version of the external antenna experiment.
Human Head and Hand Simulation Experiment	As the use of some products is inseparable from the human body, such as the grip of human hands, the proximity of human heads, etc., for such products, we will comprehensively consider the actual use of the scene, increase the simulation test of human hands and human heads, in order to more truly judge the performance of the product in the user experience.

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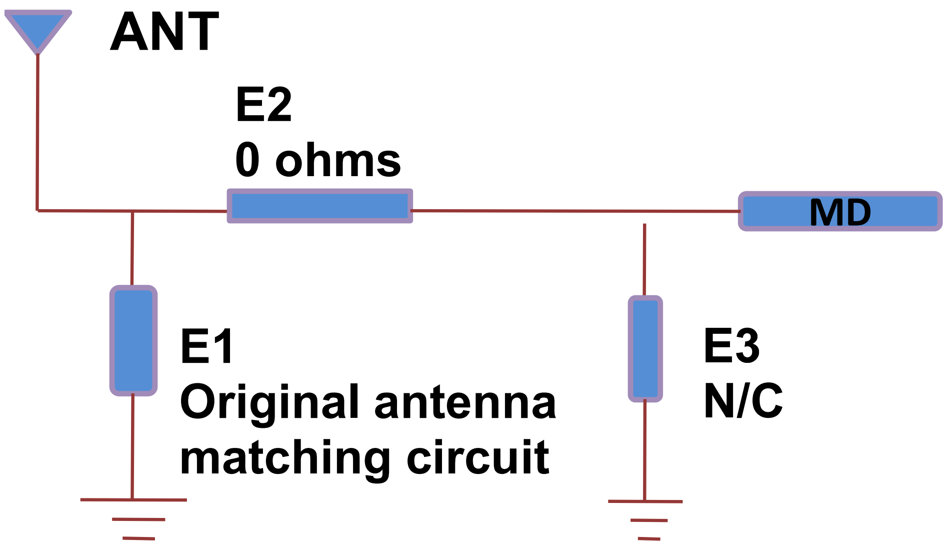
Model6European version antenna development reportV1

Item Description: telephone
This debugging customer requirements:4G
Highlights of this report:
Conclusion of this debugging:

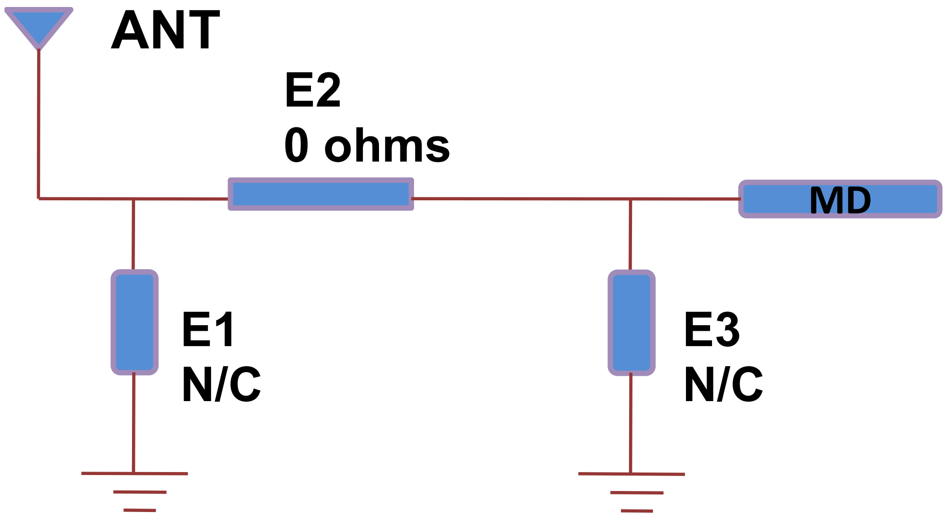
Antenna matching circuit modification schematic

MAIN



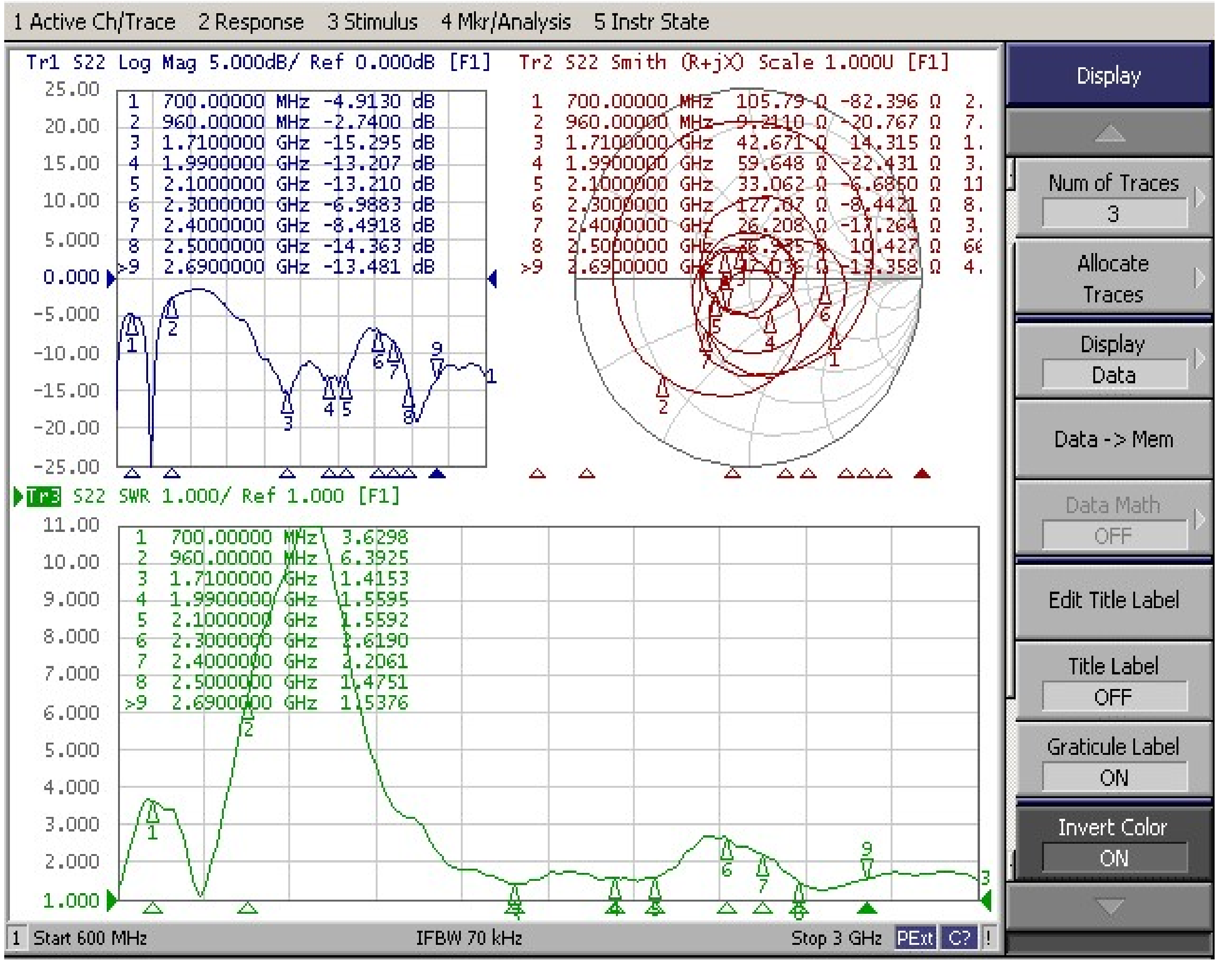
MAIN(Primary antenna matching)	
E1-(0201)	original antenna matching circuit
E2-(0201)	0 ohms
E3-(0201)	N/C

WIFI



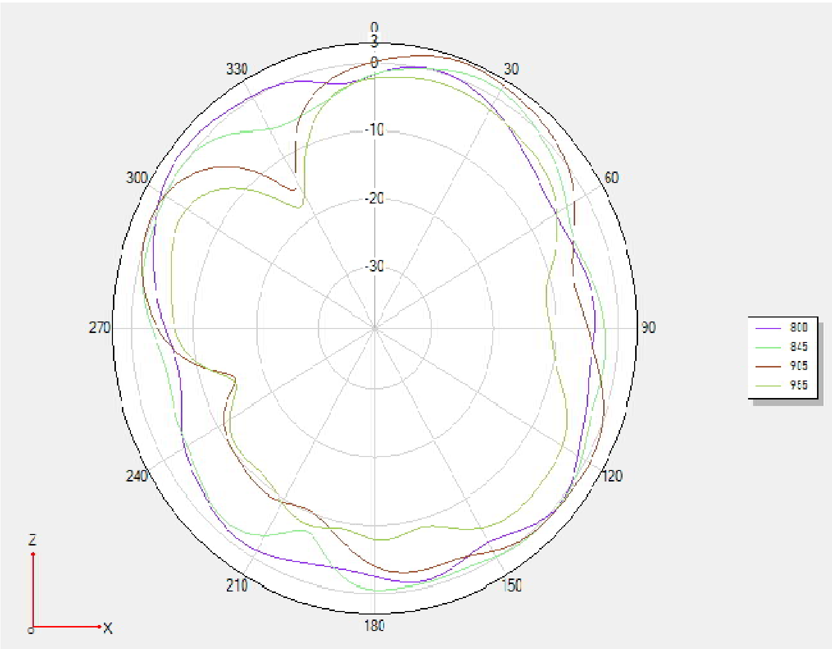
DIV(Primary antenna matching)	
E1-(0201)	N/C
E2-(0201)	0 ohms
E3-(0201)	N/C

Antenna passive test data (free space) return loss(Return Loss)

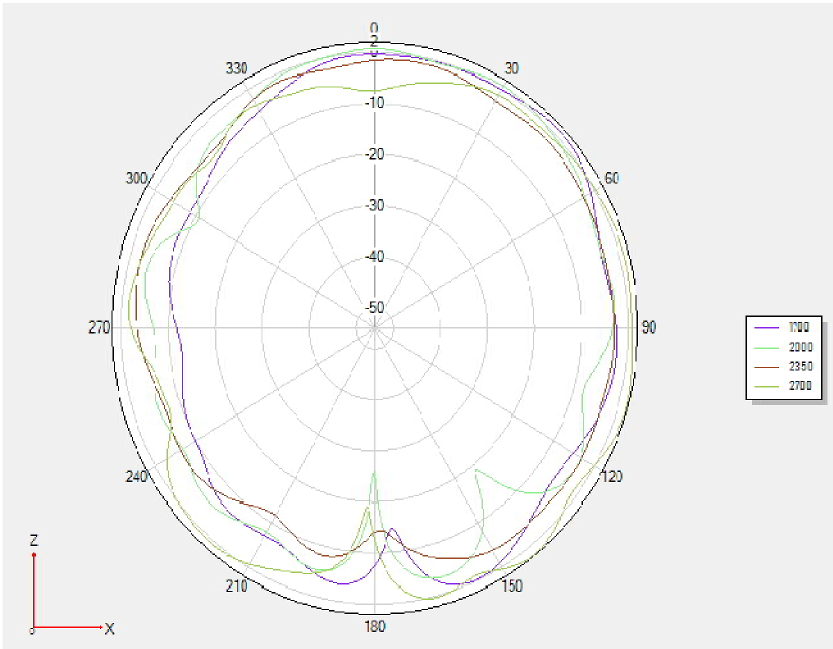


2Ddirectional diagram

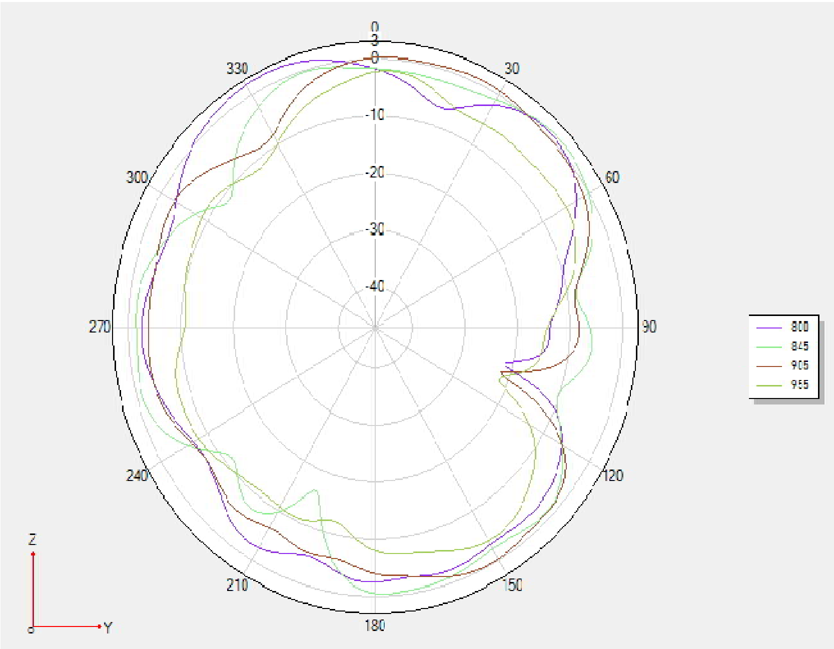
824-960NHZ

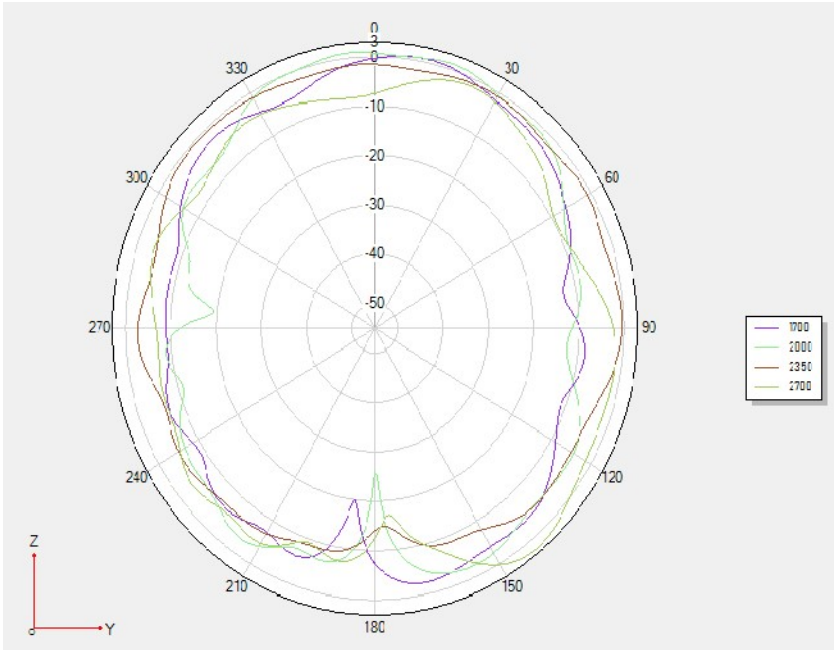


1710-2700MHZ

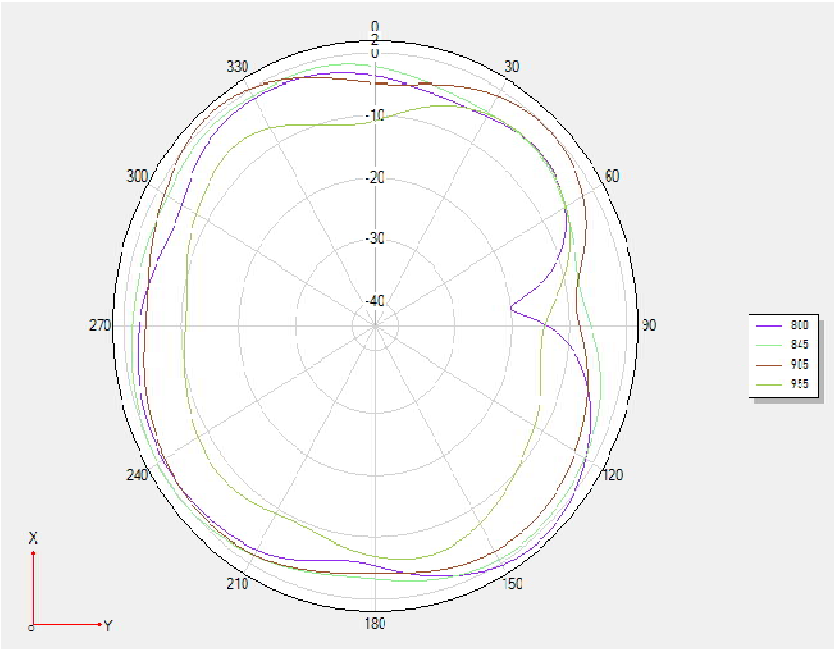


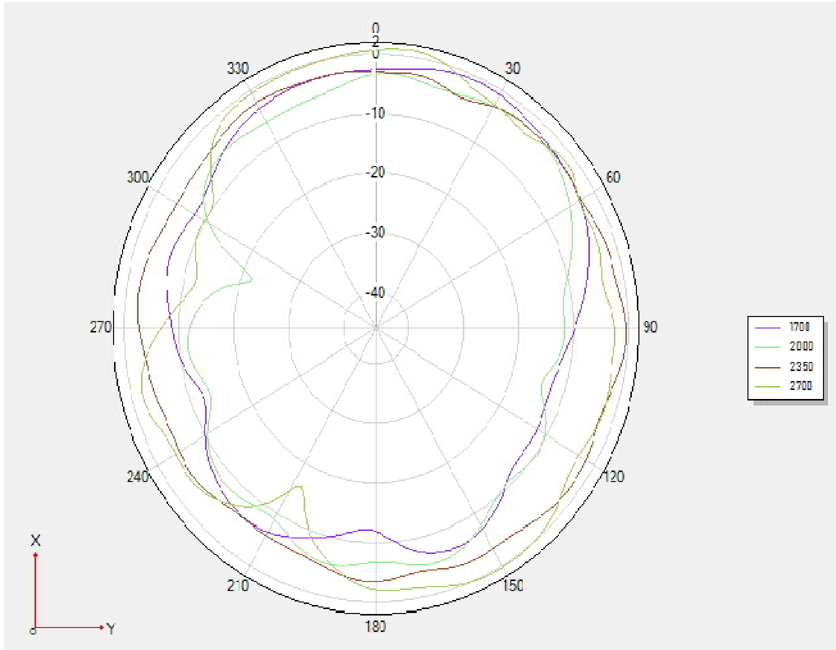
Phi 0 2D Figure





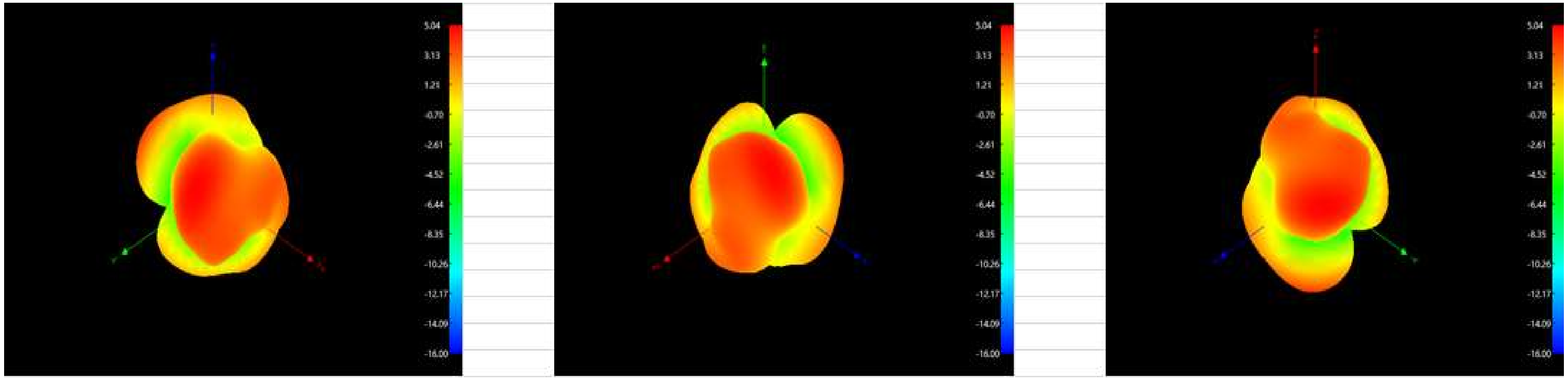
Phi 90 2D Figure



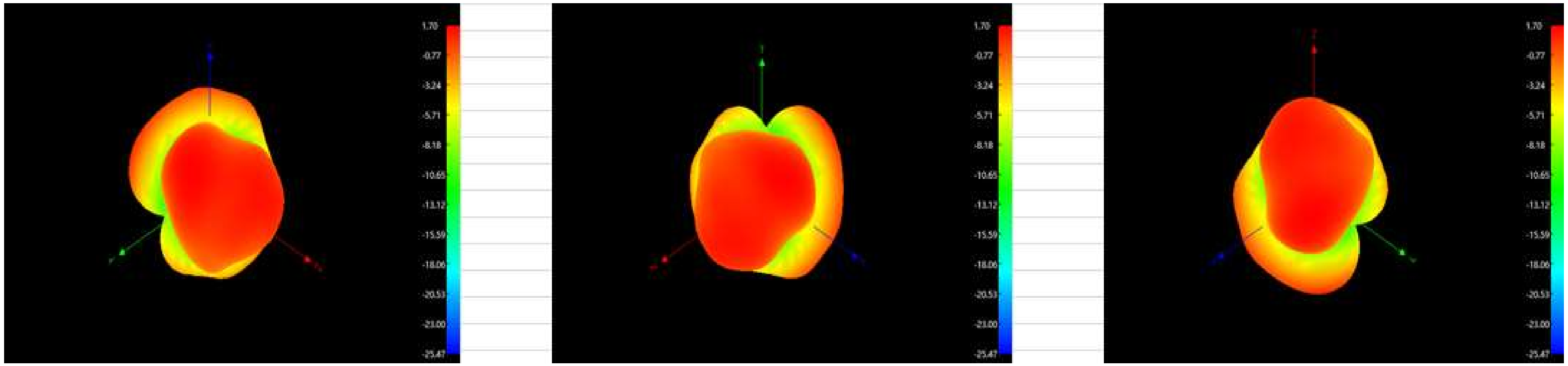


Theta 90 2D Figure

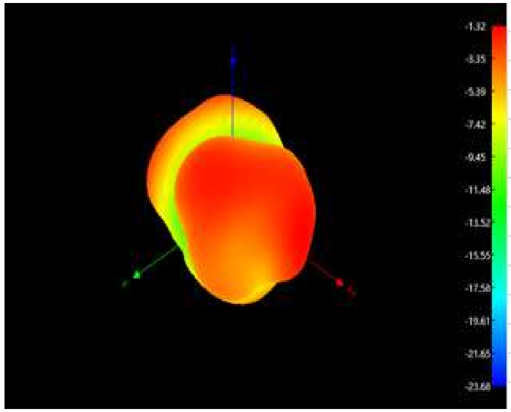
3D pattern

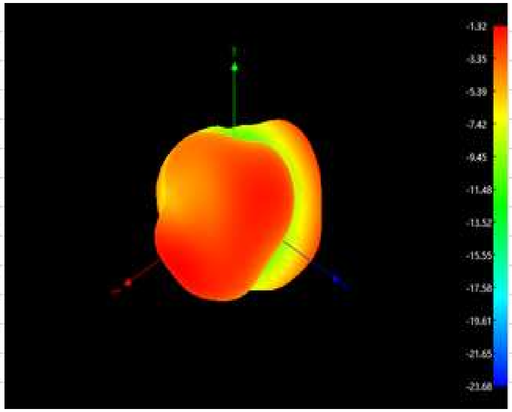


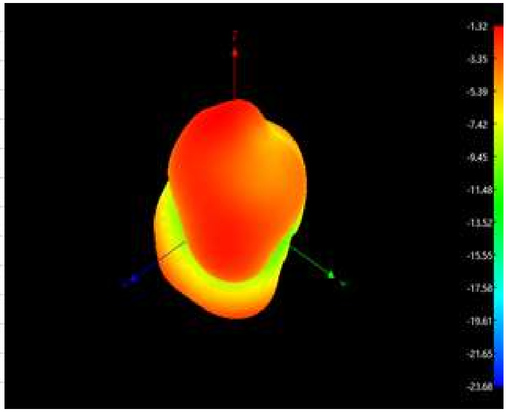
824MHZ



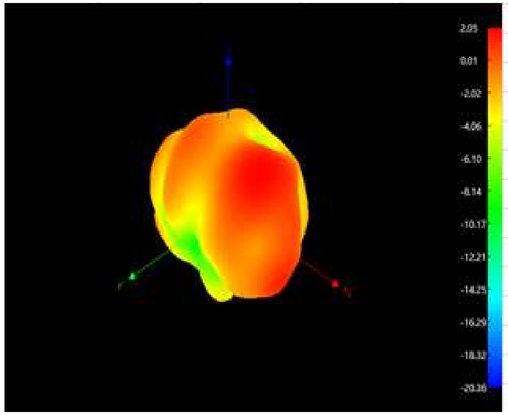
900MHZ

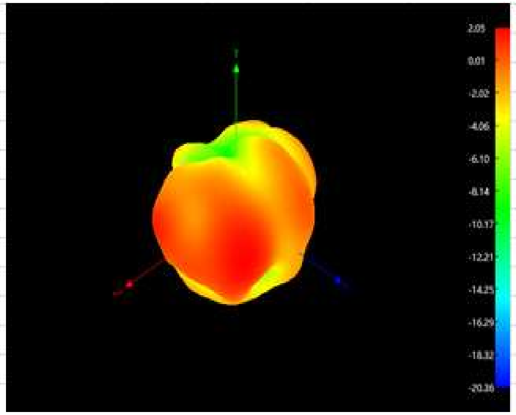


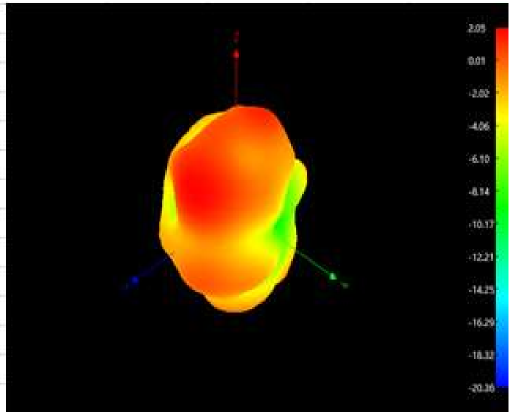




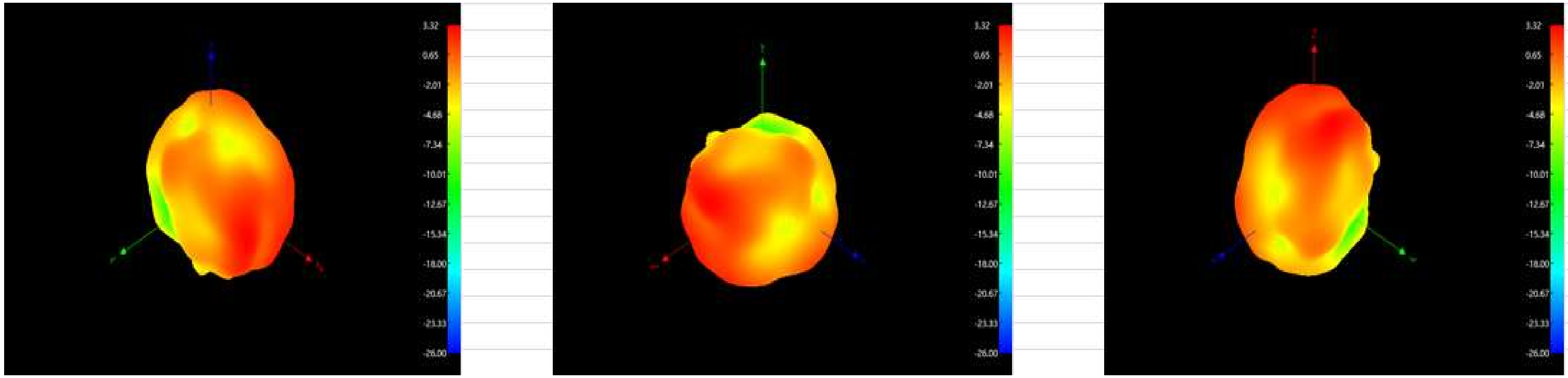
960MHZ



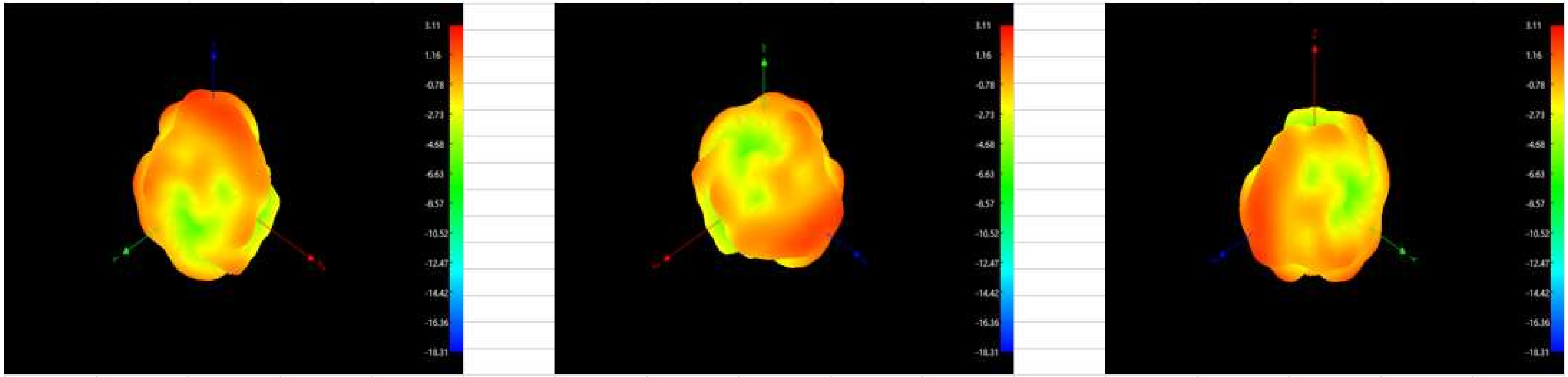




1710MHZ



2100MHZ



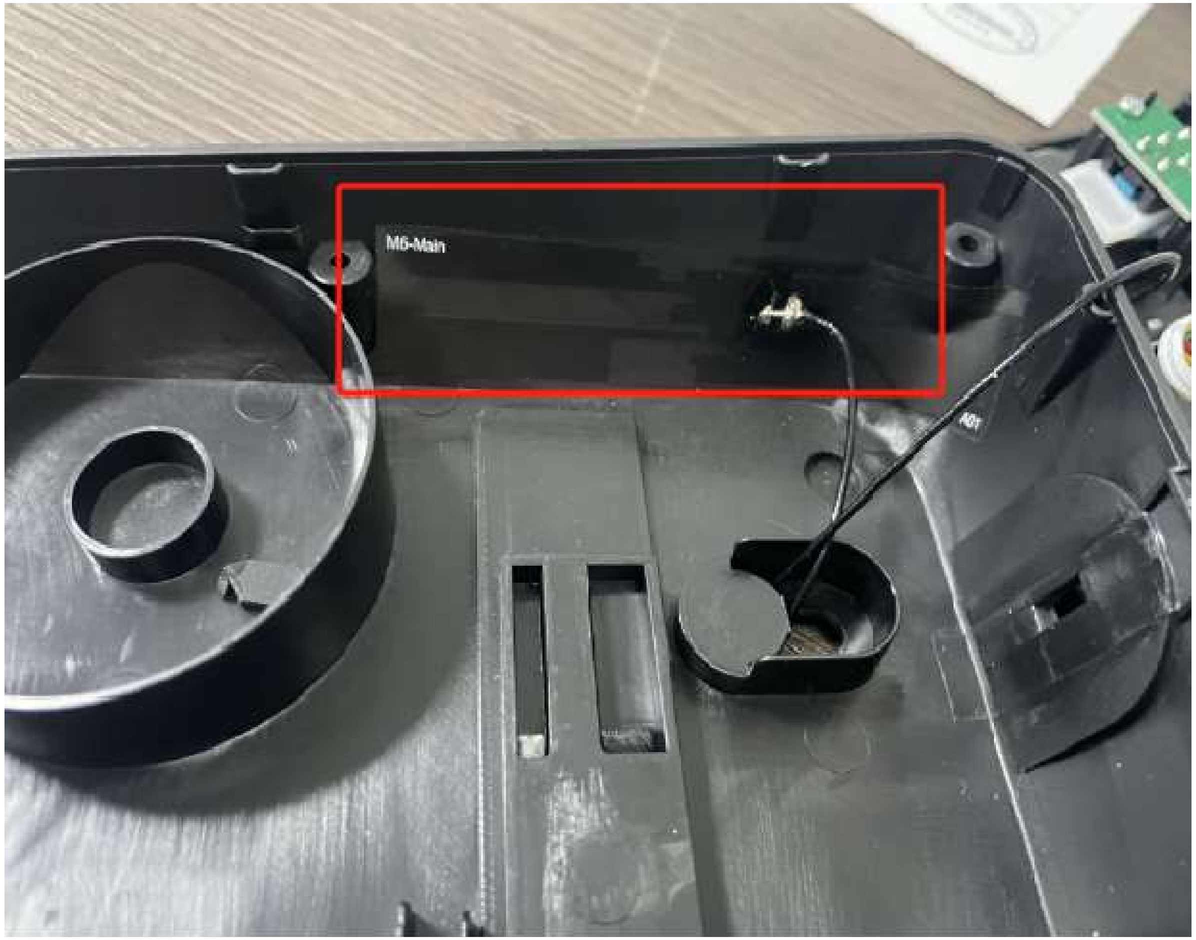
2700MHZ

efficiency gain

700-960MHz			
Frequency/MHz	ficiency /	Efficiency / %	Gain
780	-2.92	51.05	1.72
800	-3.78	41.88	1.7
820	-3.33	46.45	1.95
840	-2.94	50.82	2.67
860	-3.61	43.55	1.56
880	-3.11	48.87	1.74
900	-3.53	44.36	0.76
920	-3.93	40.46	0.39
940	-3.92	40.55	-0.17
960	-4.69	33.96	-1.25

1700-2700MHz			
Frequency/MHz	ficiency /	Efficiency / %	Gain
1700	-3.93	40.46	2.01
1800	-3.36	46.13	2.72
1900	-2.79	52.6	2.5
2000	-2.64	54.45	2.07
2100	-3.56	44.06	2.17
2200	-2.82	52.24	2.17
2300	-3.55	44.16	2.77
2400	-3.18	48.08	2.71
2500	-3.2	47.86	2.78
2600	-2.49	56.36	2.57
2700	-2.83	52.12	2.7

Antenna location diagram



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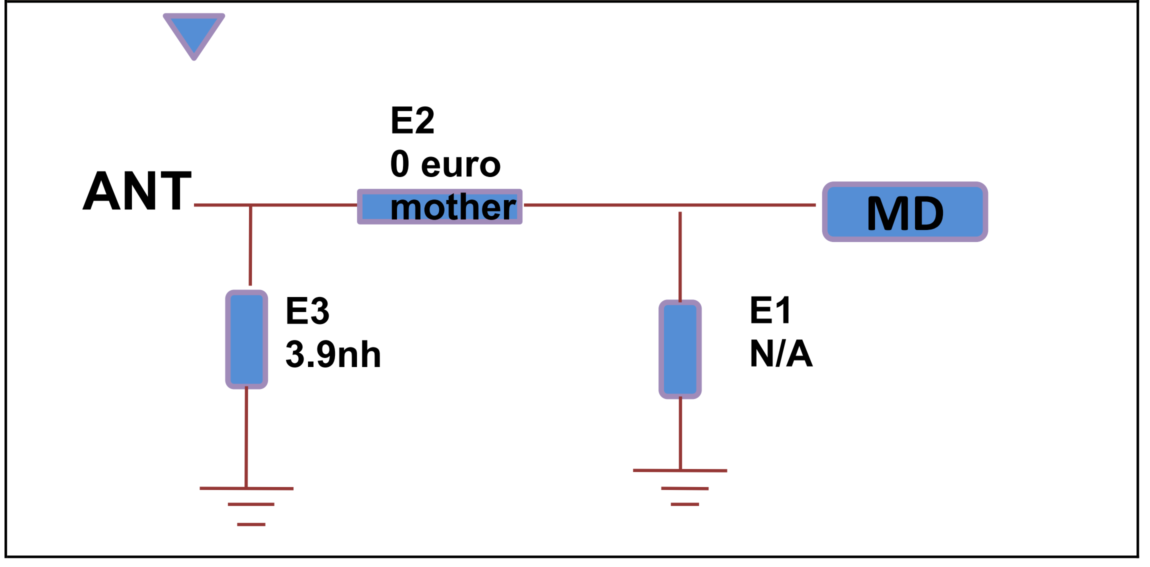
Model6 Antenna Development Report V2

Project Description:
Customer requirements for this debugging: debugging passive
This report focuses on:
The debugging conclusion:

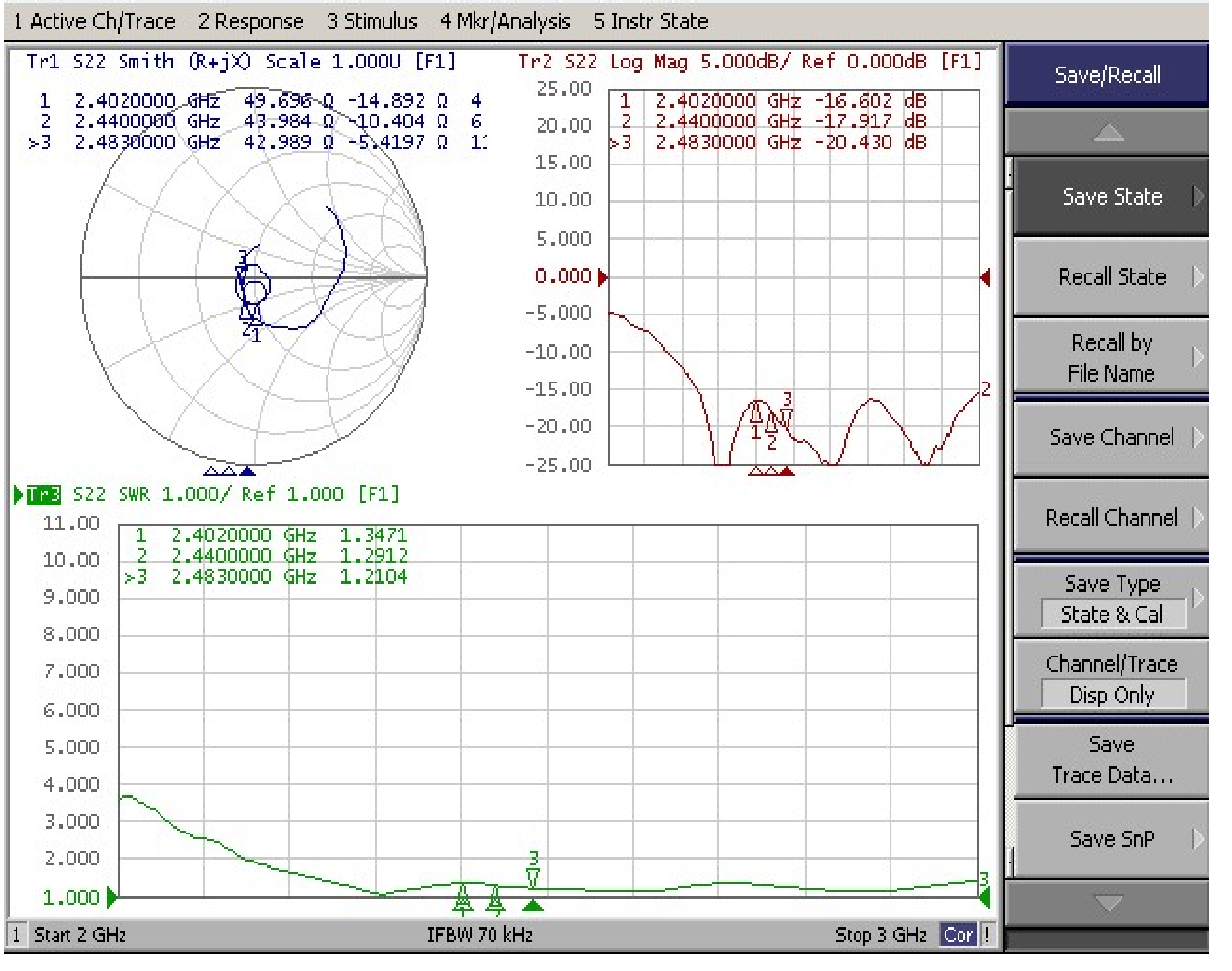
Modification Schematic of Antenna Matching Circuit

WIFI



E1-(0201)	N/A
E2-(0201)	0 euro mother
E3-(0201)	3.9nh

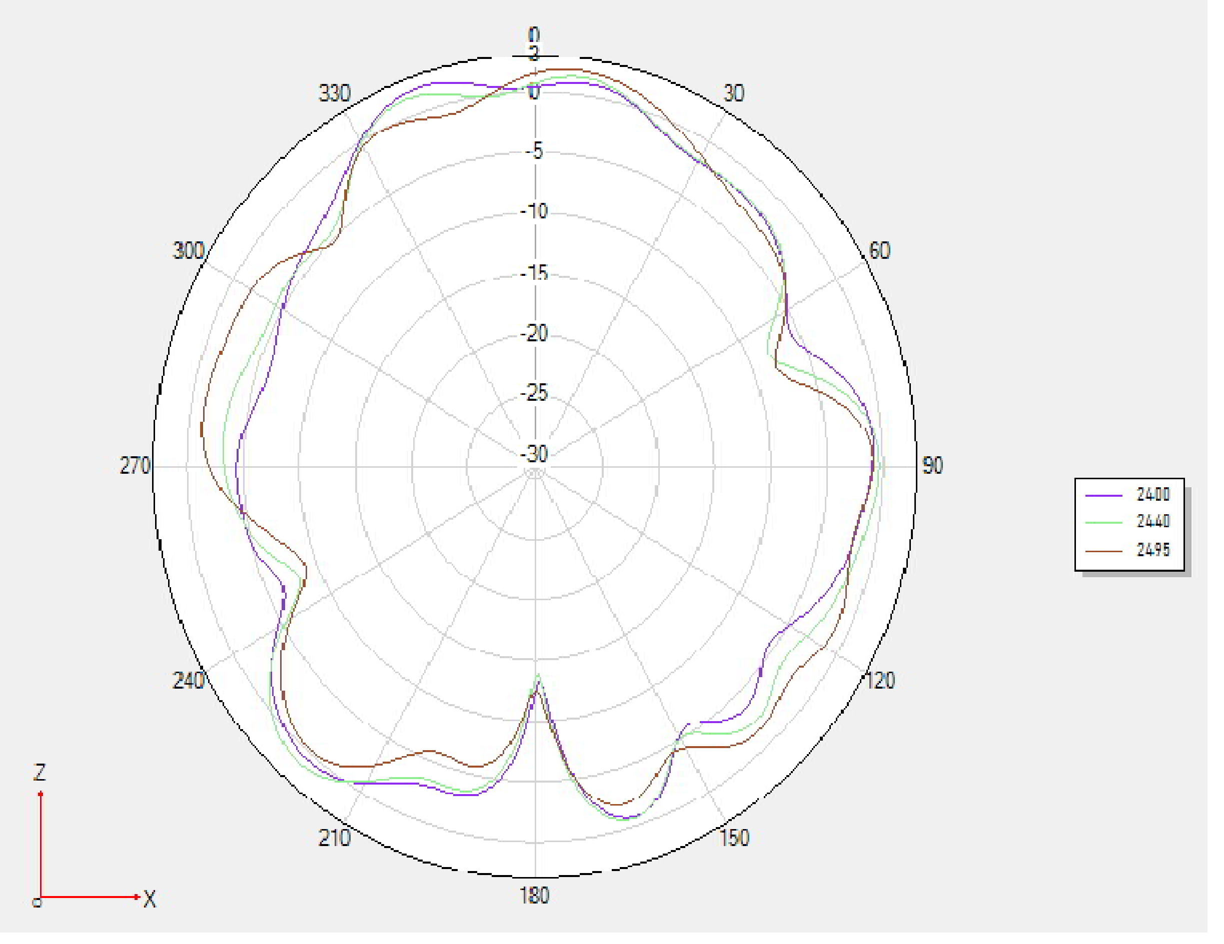
Antenna Passive Test Data (Free Space) Return Loss



Antenna efficiency test (free space)

BT			
Frequency / MHz	Efficiency / dB	Efficiency / %	Gain
2400	-1.9	64.57	2.4
2410	-1.79	66.22	2.18
2430	-2	63.1	2.57
2450	-1.92	64.27	2.64
2460	-1.82	65.77	2.45
2470	-2.04	62.52	2.38
2480	-2	63.1	2.3
2490	-2.11	61.52	2.7

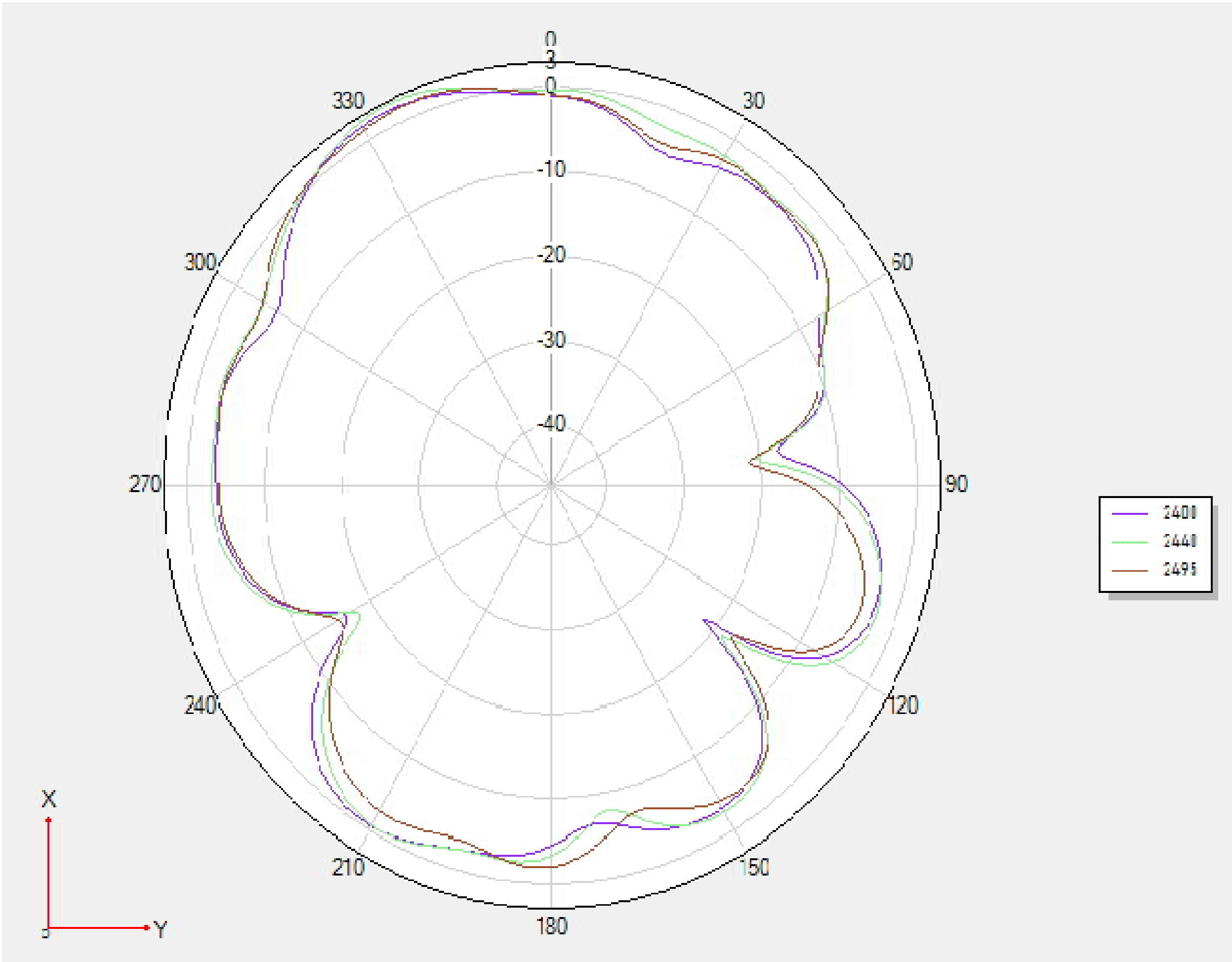
2D pattern



0
5
0
-5
-10
-15
-20
-25
-30
30
60
90
120
150
180
210
240
270
300
330
2400
2440
2495
Z
X

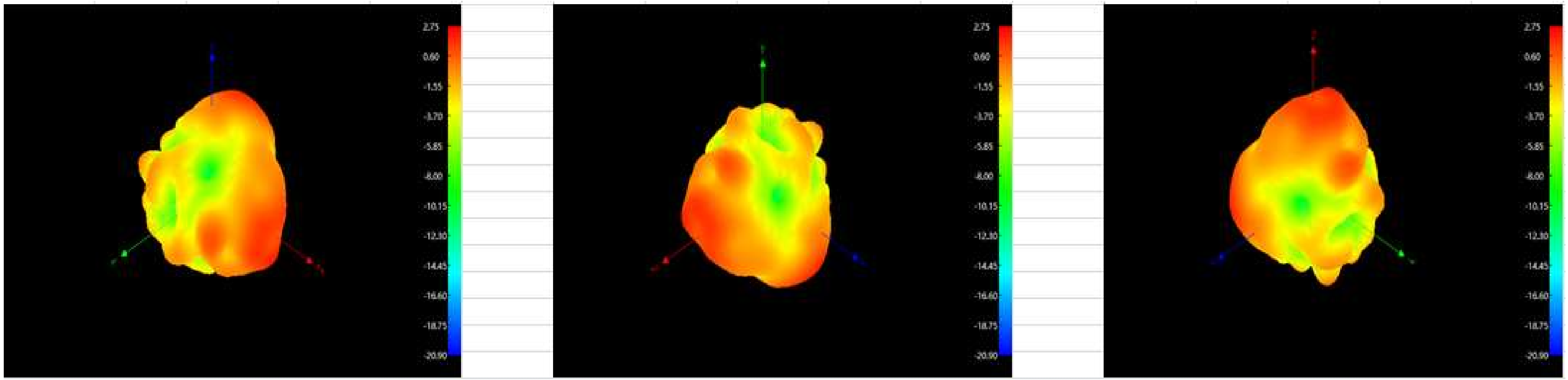
Phi 0 2D Figure

Phi 90 2D Figure

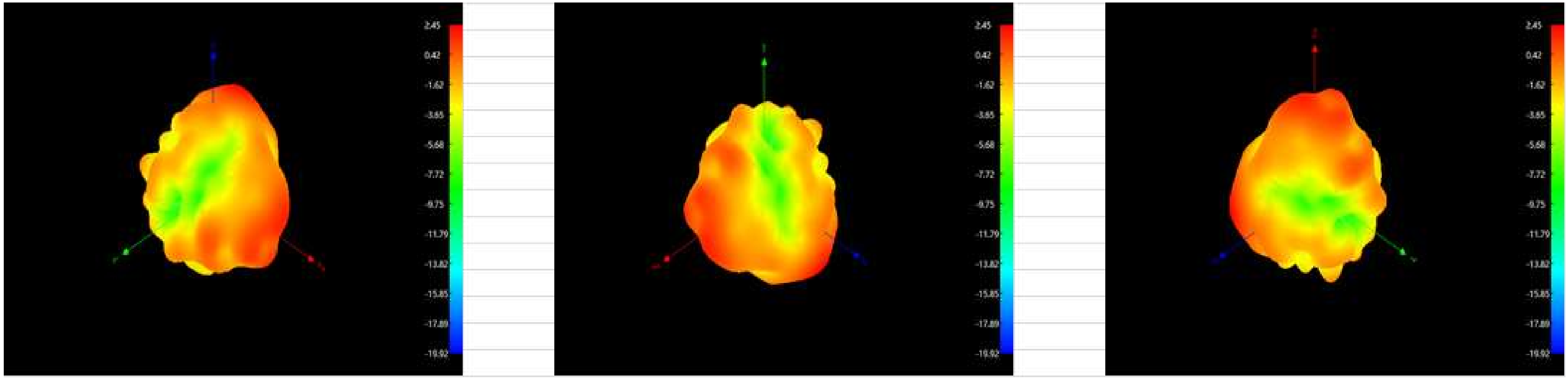


Theta 90 2D Figure

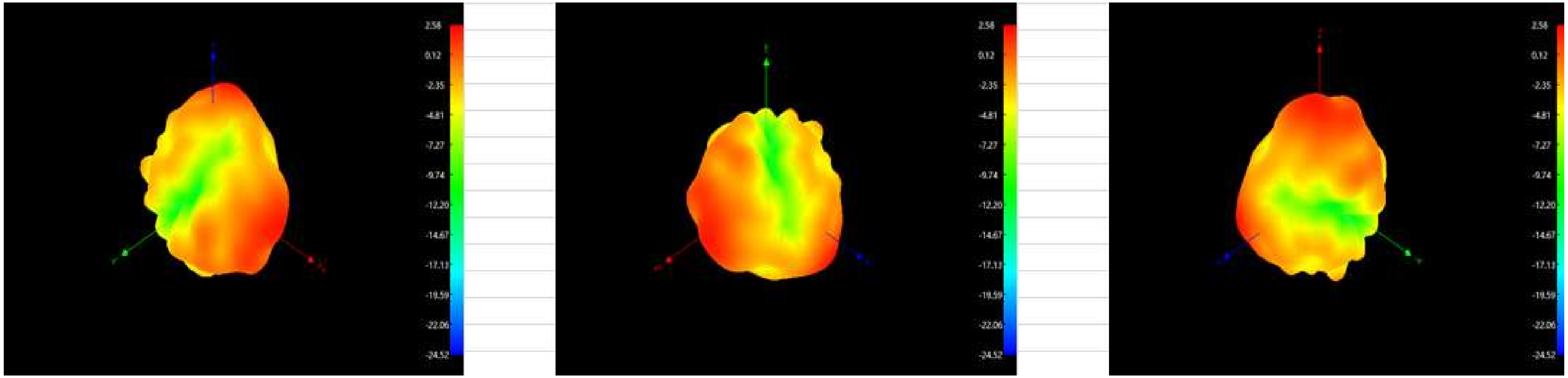
3D pattern



2400MHz

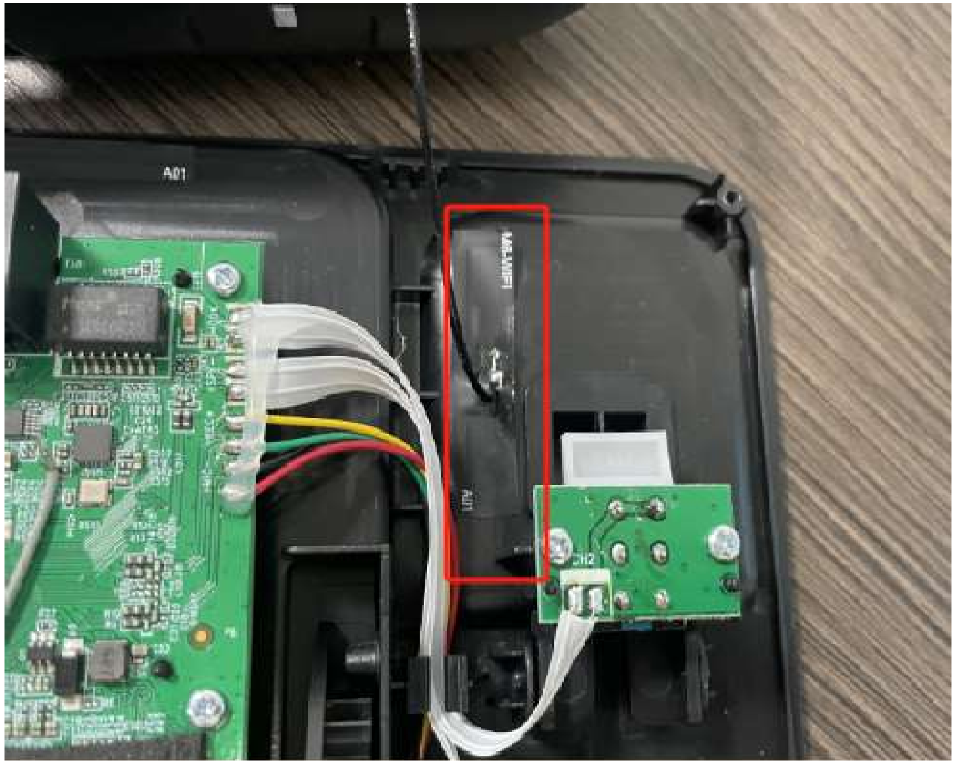

2.45
0.42
-1.62
-3.65
-5.68
-7.72
-9.75
-11.79
-13.82
-15.85
-17.89
-19.92

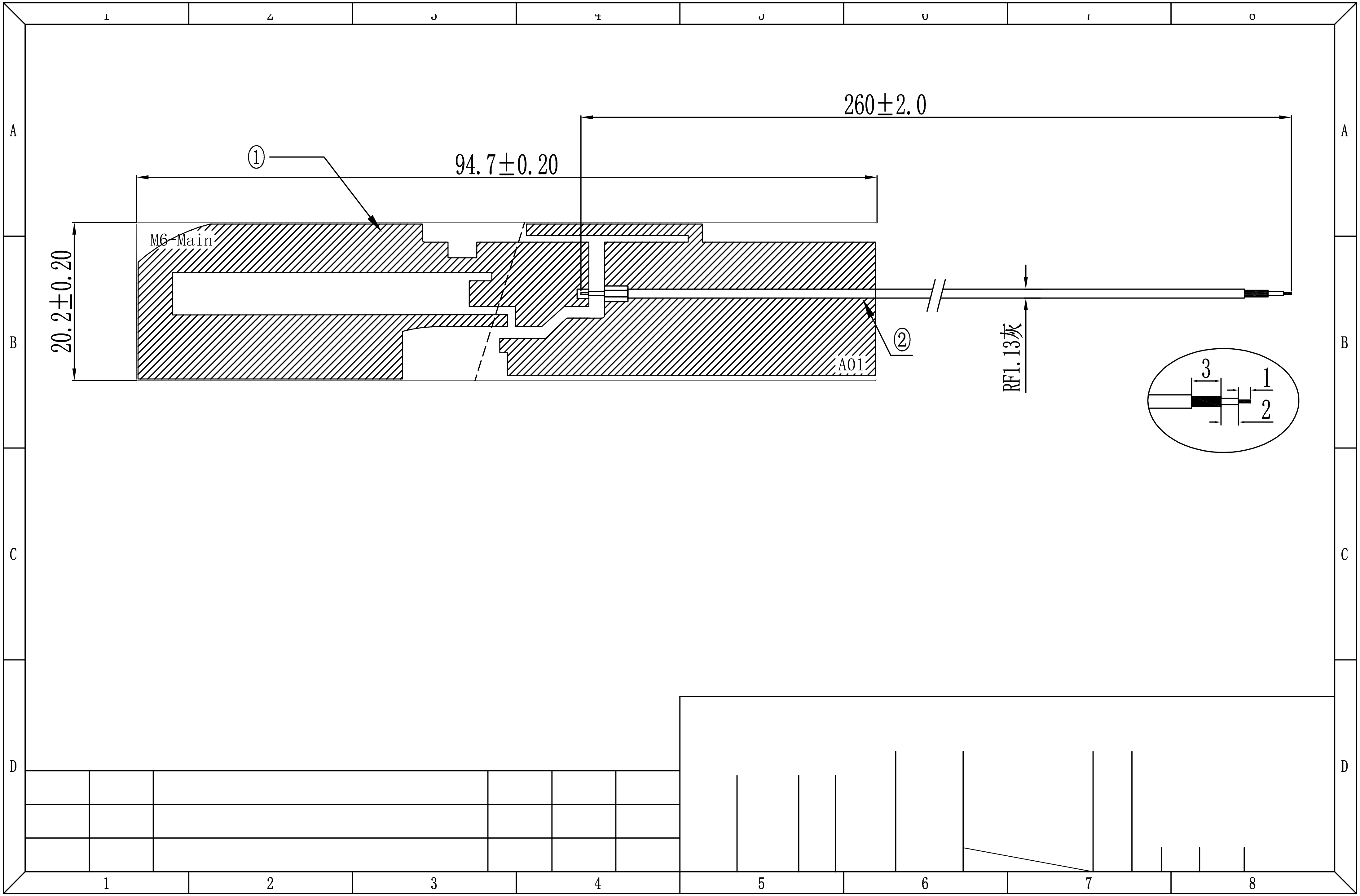
2450MHz


2.58
0.12
-2.35
-4.81
-7.27
-9.74
-12.20
-14.67
-17.13
-19.59
-22.06
-24.52

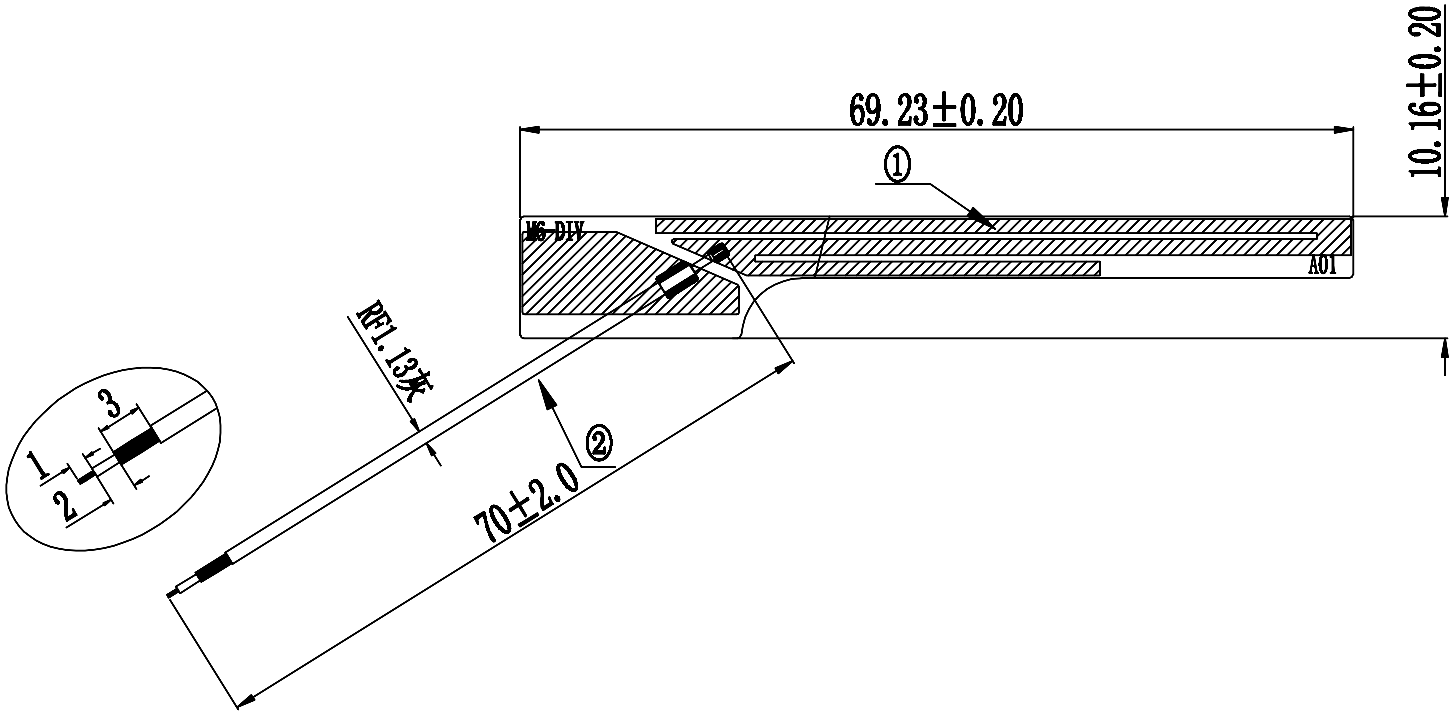
2485MHz

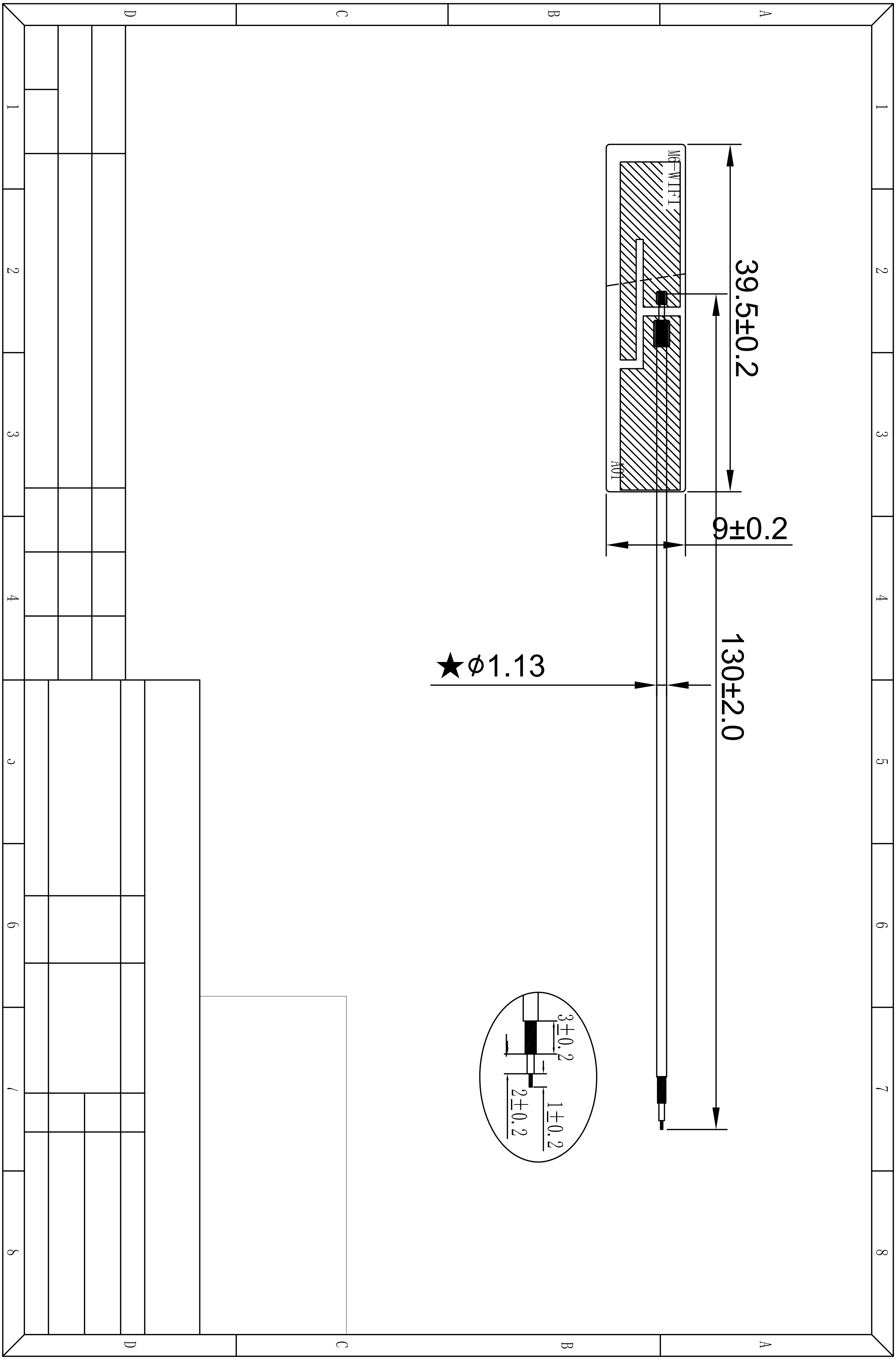
Antenna location map



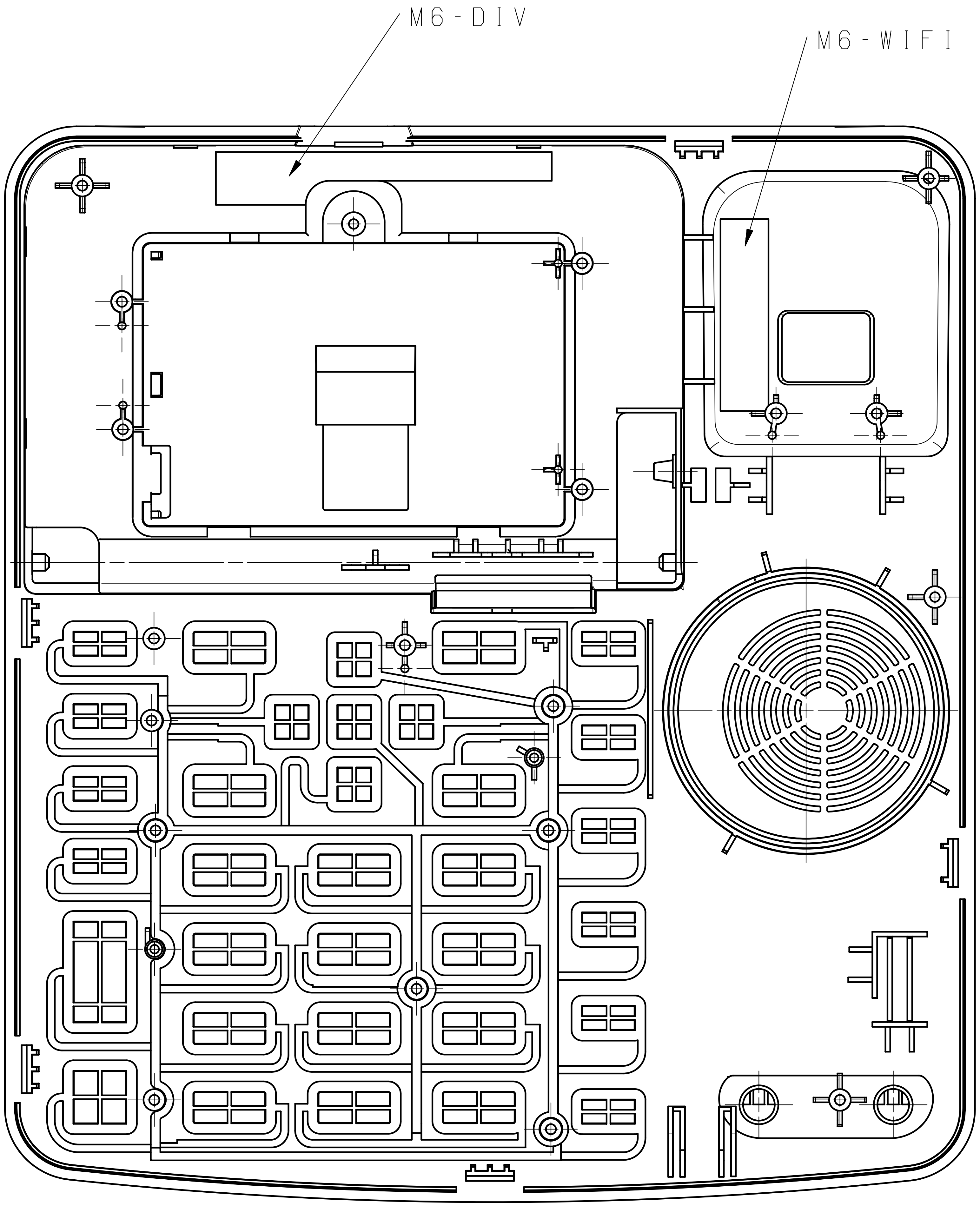


260±2.0
①
94.7±0.20
20.2±0.20
M6-Main
A01
②
RF1.13灰
3
1
2

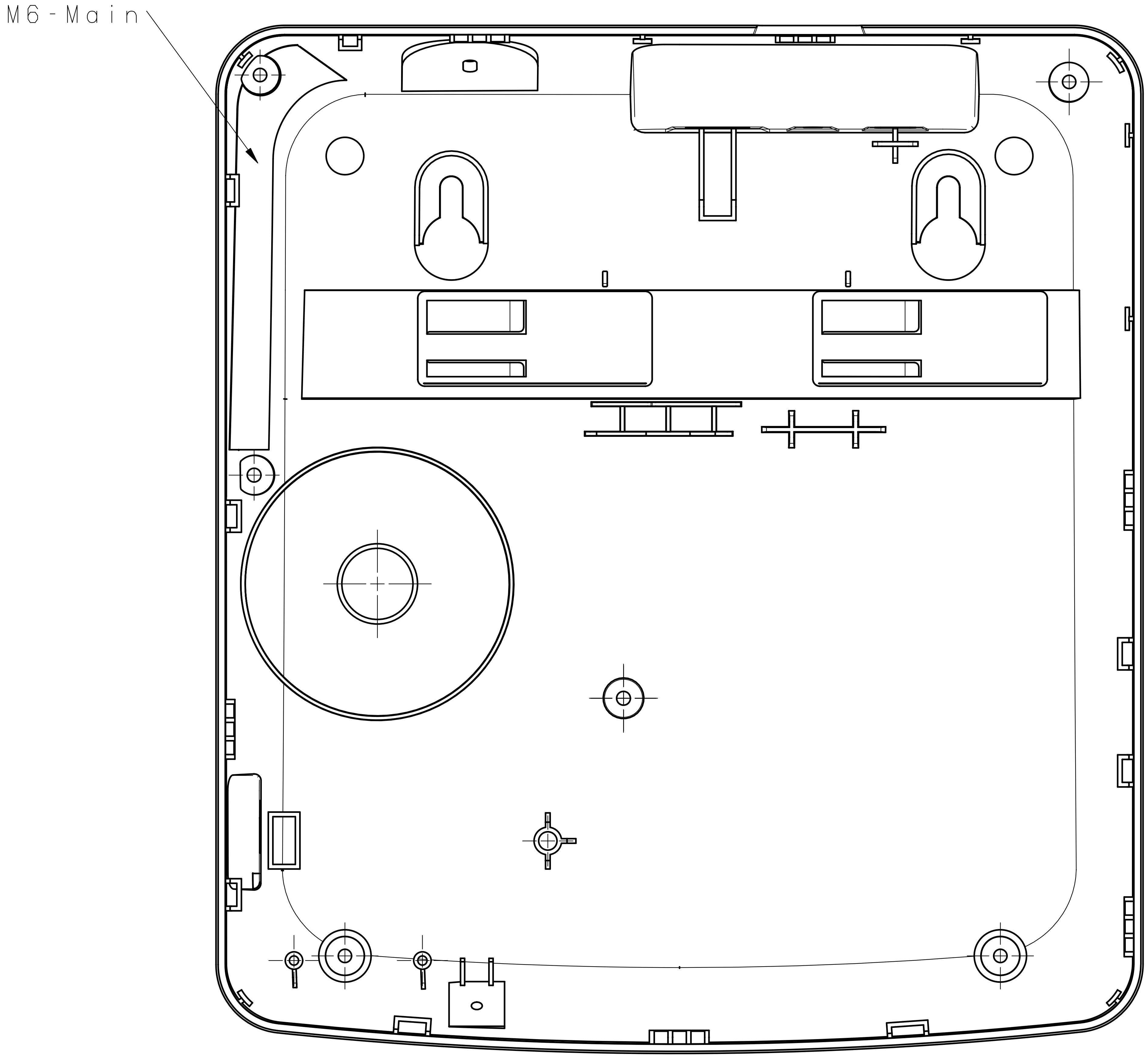

69.23±0.20
10.16±0.20
①
MG-DIV
A01
RF1.13
3
1
2
70±2.0
②

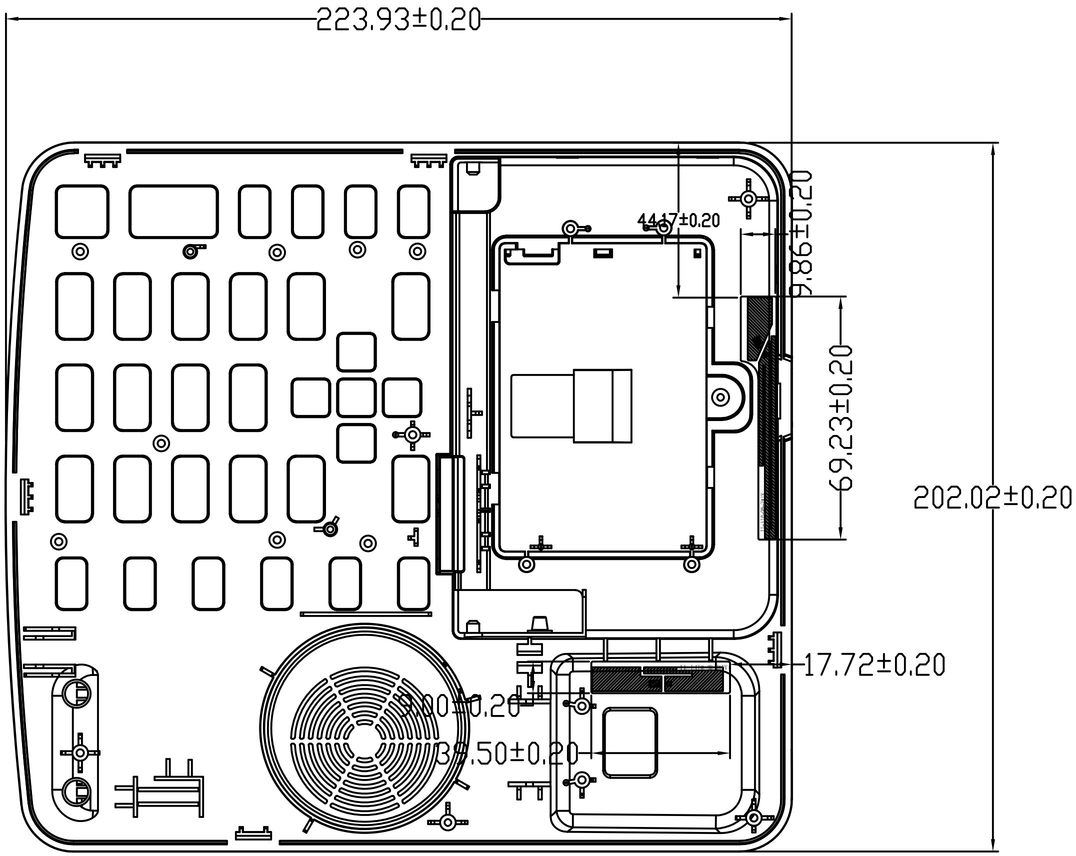


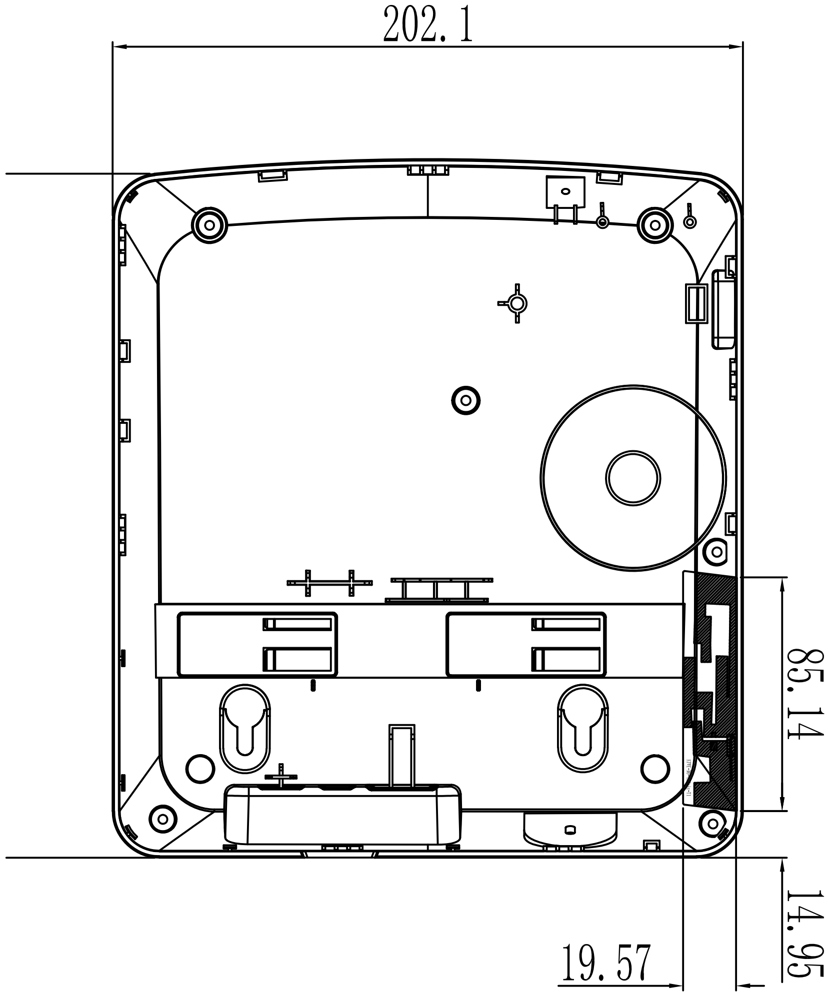
M6-WIFI
A01
39.5±0.2
9±0.2
★ϕ1.13
130±2.0
3±0.2
2±0.2
1±0.2



M6-DIV
M6-WIFI


M6-Main


223.93±0.20
44.17±0.20
9.86±0.20
69.23±0.20
202.02±0.20
17.72±0.20
9.00±0.20
32.50±0.20


202.1
85.14
14.95
19.57