

5G/4G Wideband (698-6000MHz) SMD Antennas for IoT Applications

Product Datasheet AC31700-01A, AC31700-01B

April, 2023

Rev. 3.0

Revision History

Date	Rev.	Summary of Changes
04 February 2022	0.1	First version of Preliminary Product Datasheet
01 March 2022	0.2	Reviewer edits
21 April 2022	0.3	Packaging details added
05 May 2022	0.4	GND plane size added to table 2 and table 3
14 November 2022	0.5	Evaluation kit section added, soldering profile added, efficiency plots updated
22 December 2022	1.0	PCB footprints for standalone and dual configurations updated
31 January 2023	2.0	Band support overview (section 1.4) updated Efficiency results (section 1.3 and 1.6) updated
28 April 2023	3.0	Band support overview (section 1.4) updated Efficiency results (section 1.3 and 1.6) updated Assembly recommendation for dual configuration updated (figure 11, figure 12 and figure 21) VSWR plots added

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1 Introduction

1.1 Scope and purpose

The AC31700-01A and AC31700-01B are high efficiency, 5G/4G wideband 698-6000 MHz SMD antennas designed to operate on IoT devices with small ground planes.

The antenna has been designed to support a wide variety of cellular and NB-IoT applications:

- Asset tracking
- Smart Meters
- Connected Health
- Handheld devices

The AC31700-01A antenna has the unique feature of being compatible with a low-profile booster element AC31700-01B mounted directly beneath it on the rear side of the host printed circuit board. The use of a booster element allows antenna performance to be preserved on PCB boards with reduced ground plane lengths down to 50 mm.

Table 1: Antenna configurations

Configuration	Standalone	Dual
Number of elements	1	2
Antenna elements	AC31700-01A	AC31700-01A, AC31700-01B
Ground plane lengths L	$L \geq 80\text{mm}$	$50\text{mm} \leq L \leq 80\text{mm}$

1.2 Features

- High Efficiency Wideband Antenna covering 698 to 6000 MHz
- Outstanding performance in standalone configuration on host PCBs with ground plane lengths exceeding 80mm
- Dual configuration delivers 10% efficiency boost in applications with ground plane lengths ranging from 50mm to 80mm
- Quasi-omnidirectional radiation pattern offering uniform coverage
- Low profile component implemented on rigid PCB with 3mm height for ease of integration
- Surface mount device suitable for automated assembly (SMT process). Supplied on Tape & Reel.
- RoHS and REACH Compliant

1.3 Antenna specifications

Table 2: RF specifications – standalone configuration

Parameters	AC31700-01A					
Frequency (MHz)	698 - 960	1100 - 1300	1525 - 1660	1710 - 2690	3400 - 3800	5000 - 6000
Typical Efficiency	30 – 50	30-52	32-52	51 – 66	43 – 74	50 – 67
VSWR (Return Loss)	< 4.9:1	< 5:1	< 5.2:1	< 4.0:1	< 3.8:1	< 4.5:1
GND plane size	45 x 80mm					
Input impedance	50Ω					
Radiation Pattern	Quasi- omnidirectional					
Peak Realized Gain	< 0.7dBi	<2.8dBi	< 1.1dBi	< 6.0dBi	< 5.0dBi	< 3.3dBi

Table 3: RF specifications – dual configuration

Parameters	AC31700-01A and AC31700-01B			
Frequency (MHz)	698 - 960	1480-1660	1710-2150	2500 - 2690
Typical Efficiency	31 – 35	46-88	50-89	66 – 72
VSWR (Return Loss)	< 4.5:1	< 3.5:1	< 2.7:1	< 3.4:1
GND plane size	45 x 60mm			
Input impedance	50Ω			
Radiation Pattern	Quasi- omnidirectional			
Peak Realized Gain	< 1.0dBi	< 0.5dBi	< 3.0dBi	< 5.0dBi

Notes:

- The characterization is performed with the antennas mounted on evaluation boards inside a plastic mock-up.
- The mock-up is tested in free space.
- The data presented in table 2 is obtained with a ground plane size of 45 x 80mm
- The data presented in table 3 is obtained with a ground plane size of 45 x 60mm

Table 4: Physical specifications

Parameter	AC31700-01A	AC31700-01B
Size (L x W x H) in mm	41.05 x 13.3 x 3.0 mm	41.05 x 8.2 x 3.0 mm
Material	FR4	FR4
Weight	3g	2g
Soldering Type	SMT through reflow	SMT through reflow

Notes:

- 1- For all dimensions, the ISO 2768-mK standard is followed. For the outer dimensions this means a tolerance of ± 0.1 mm is applicable

The dimensions of the AC31700-01A main antenna element and the AC31700-01B booster element are shown in Figure 1 and Figure 2, respectively.

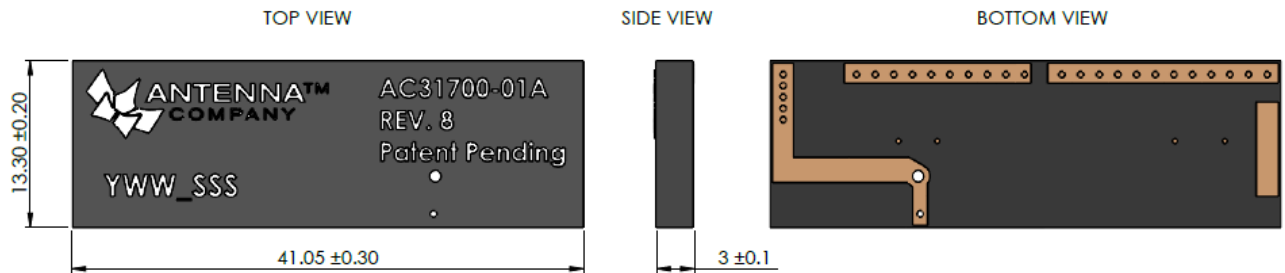


Figure 1: AC31700-01A top view and dimensions (mm)

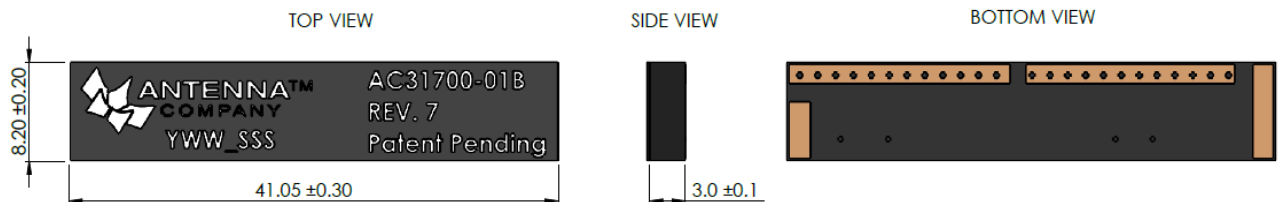


Figure 2: AC31700-01B top view and dimensions (mm)

Table 5: AC31700-01A and AC31700-01B, environmental specifications

Parameter	AC31700-01A	AC31700-01B
Operational temperature	-40°C to +85°C	-40°C to +85°C
RoHS and REACH	Yes	Yes

1.4 Overview Band Support

All LTE and GNSS bands supported by the AC31700-01A in standalone or dual configuration (with the AC31700-01B) are listed in the table below.

Table 6: AC31700-01A (with or without AC31700-01B), band support overview

FDD LTE BANDS				
LTE BAND	UPLINK (MHZ)	DOWNLINK (MHZ)	Standalone	Dual
1	1920 - 1980	2110 - 2170	✓	✓
2	1850 - 1910	1930 - 1990	✓	✓
3	1710 - 1785	1805 - 1880	✓	✓
4	1710 - 1755	2110 - 2155	✓	✓
7	2500 - 2570	2620 - 2690	✓	✓
8	880 - 915	925 - 960	✓	✓
9	1749.9 - 1784.9	1844.9 - 1879.9	✓	✓
10	1710 - 1770	2110 - 2170	✓	✓
11	1427.9 - 1452.9	1475.9 - 1500.9	N/A	✓
12	698 - 716	728 - 746	✓	✓
13	777 - 787	746 - 756	✓	✓
14	788 - 798	758 - 768	✓	✓
17	704 - 716	734 - 746	✓	✓
18	815 - 830	860 - 875	✓	✓
19	830 - 845	875 - 890	✓	✓
20	832 - 862	791 - 821	✓	✓
21	1447.9 - 1462.9	1495.5 - 1510.9	N/A	✓
22	3410 - 3500	3510 - 3600	✓	✓
23	2000 - 2020	2180 - 2200	✓	✓
24	1625.5 - 1660.5	1525 - 1559	✓	✓
25	1850 - 1915	1930 - 1995	✓	✓
26	814 - 849	859 - 894	✓	✓
27	807 - 824	852 - 869	✓	✓
28	703 - 748	758 - 803	✓	✓
29	n/a	717 - 728	✓	✓
30	2305 - 2315	2350 - 2360	✓	✓
31	452.5 - 457.5	462.5 - 467.5	N/A	N/A
32	DL CA Only	1452 - 1496	N/A	✓

TDD LTE BANDS				
LTE BAND	ALLOCATION (MHZ)	WIDTH OF BAND (MHZ)		
33	1900 - 1920	20	✓	✓
34	2010 - 2025	15	✓	✓
35	1850 - 1910	60	✓	✓
36	1930 - 1990	60	✓	✓
37	1910 - 1930	20	✓	✓
38	2570 - 2620	50	✓	✓
39	1880 - 1920	40	✓	✓
40	2300 - 2400	100	✓	✓
41	2496 - 2690	194	✓	✓
42	3400 - 3600	200	✓	✓
43	3600 - 3800	200	✓	✓
44	703 - 803	100	✓	✓
45	1447 - 1467	20	N/A	✓
46	5150 - 5925	775	✓	✓
47	5855 - 5925	70	✓	✓
48	3550 - 3700	150	✓	✓

* Covered LTE bands represent an efficiency greater than 30%

GNSS BANDS				
GNSS BAND	Center Frequency	Bandwidth	Standalone	Dual
S L1	1575.42MHz	15.345 MHz	✓	✓
GPS L2	1227.6MHz	11 MHz	✓	N/A
GPS L5	1176.45MHz	12.5MHz	✓	N/A
QZSS L5	1176.45MHz	24MHz	✓	N/A
QZSS L2C	1227.6MHz	11MHz	✓	N/A
QZSS E6/LEX	1278.75MHz	20MHz	✓	N/A
QZSS L1	1575.42MHz	12MHz	✓	✓
GLONASS I-L1	1602 MHz	6.5MHz	✓	✓
GLONASS I-L2	1246MHz	5MHz	✓	N/A
GLONASS II-L1	1575.42MHz	6.5MHz	✓	✓
GLONASS II-L1	1600.995MHz	15.365MHz	✓	✓
GLONASS II-L2	1248.06MHz	8.75MHz	✓	N/A
GLONASS II-L3	1202.025MHz	20.46MHz	✓	N/A
GLONASS II-L5	1176.45MHz	10.22MHz	✓	N/A
GALILEO-E1	1575.42MHz	12MHz	✓	✓
GALILEO-E5b	1207.14MHz	12.5MHz	✓	N/A
GALILEO-E5a	1176.45MHz	12.5MHz	✓	N/A
GALILEO-E6	1278.75MHz	20MHz	✓	N/A
COMPASS C/II/Beidou-E2	1561.098MHz	16MHz	✓	✓
COMPASS C/II/Beidou-E5	1207.14MHz	16MHz	✓	N/A
COMPASS C/II/Beidou-E6	1268.52MHz	16MHz	✓	N/A
COMPASS C/II/Beidou-B1	1561.098MHz	4.092MHz	✓	✓
COMPASS C/II/Beidou-B1-2	1589.74MHz	4.092MHz	✓	✓
COMPASS C/II/Beidou-B2	1207.14MHz	24MHz	✓	N/A
COMPASS C/II/Beidou-B3	1268.52MHz	24MHz	✓	N/A
COMPASS C/II/Beidou,B1-BOC	1575.42MHz	16.368MHz	✓	✓
COMPASS C/II/Beidou,B2-BOC	1207.14MHz	5.115MHz	✓	N/A
COMPASS C/II/Beidou,B3-BOC	1268.52MHz	35.805MHz	✓	N/A
COMPASS C/II/Beidou,L5	1176.45MHz	24MHz	✓	N/A
IRNSS-1,L5	1176.45MHz	24MHz	✓	N/A
IRNSS-1,S-Band	2492.028MHz	16.5MHz	✓	✓

* Covered GNSS bands represent an efficiency greater than 25%

Additional notes

- The band coverage summarized in above table for the standalone configuration is obtained with a ground plane size of 45 x 80mm
- The band coverage summarized in above table for the dual configuration is obtained with a ground plane size of 45 x 60mm

1.5 Radiation pattern

The typical measured radiation patterns of the AC31700-01A antenna, when operating on a 45 x 80mm host PCB, are depicted in Table 7 and has been measured along the XZ, YZ and XY planes as shown in the figure below

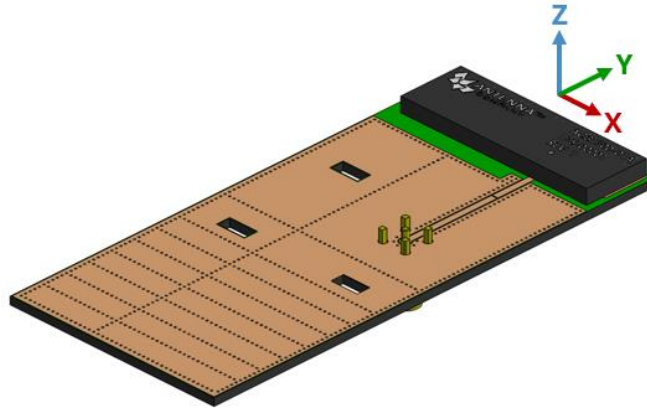


Figure 3: Illustration of radiation pattern evaluation planes

The AC31700-01A antennas can be used by itself or in a dual configuration with the booster element AC31700-01B. The radiation patterns of the dual configuration on a 45 x 60mm evaluation board are depicted in Table 8.

Table 7: Radiation patterns of AC31700-01A in standalone configuration

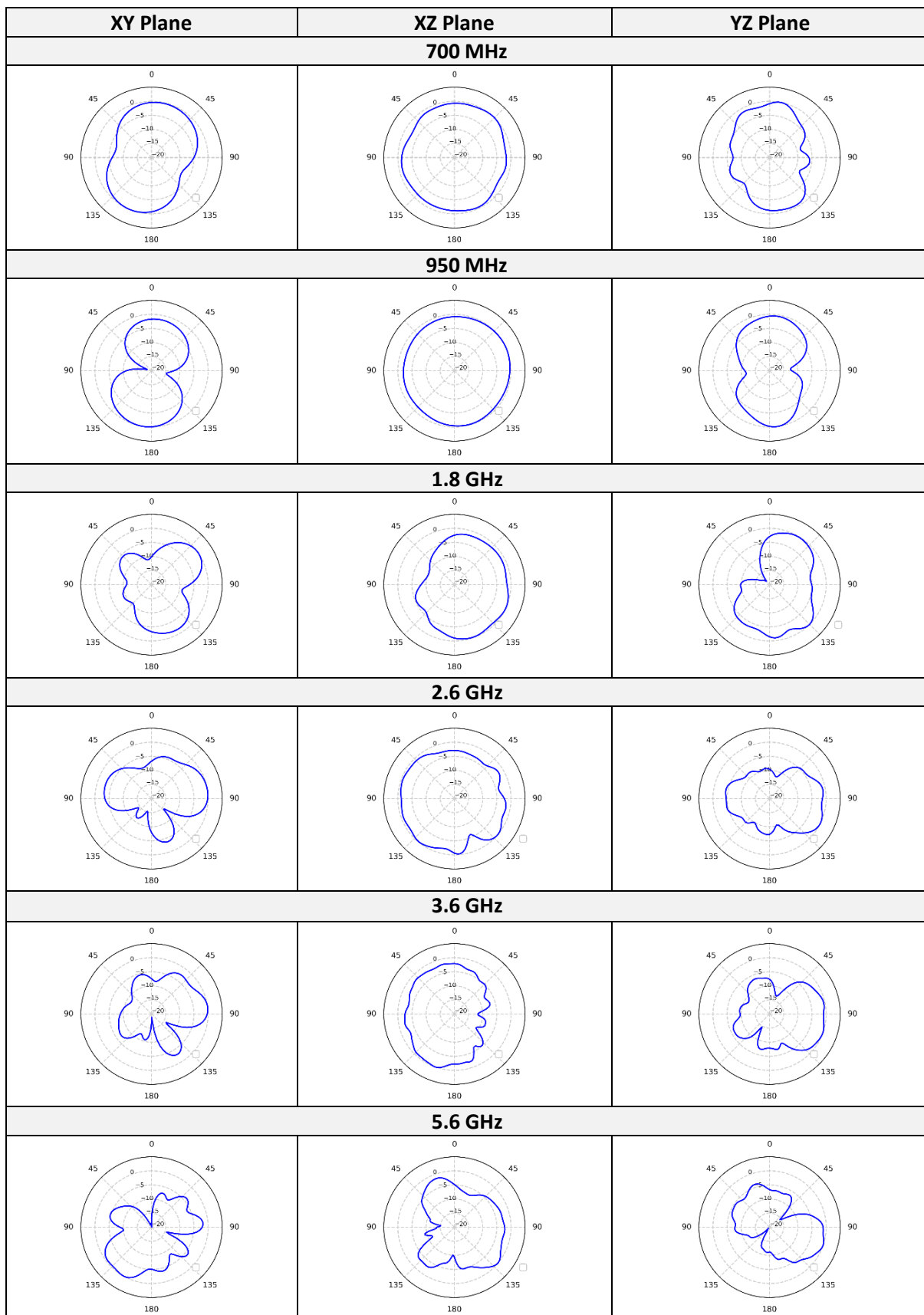
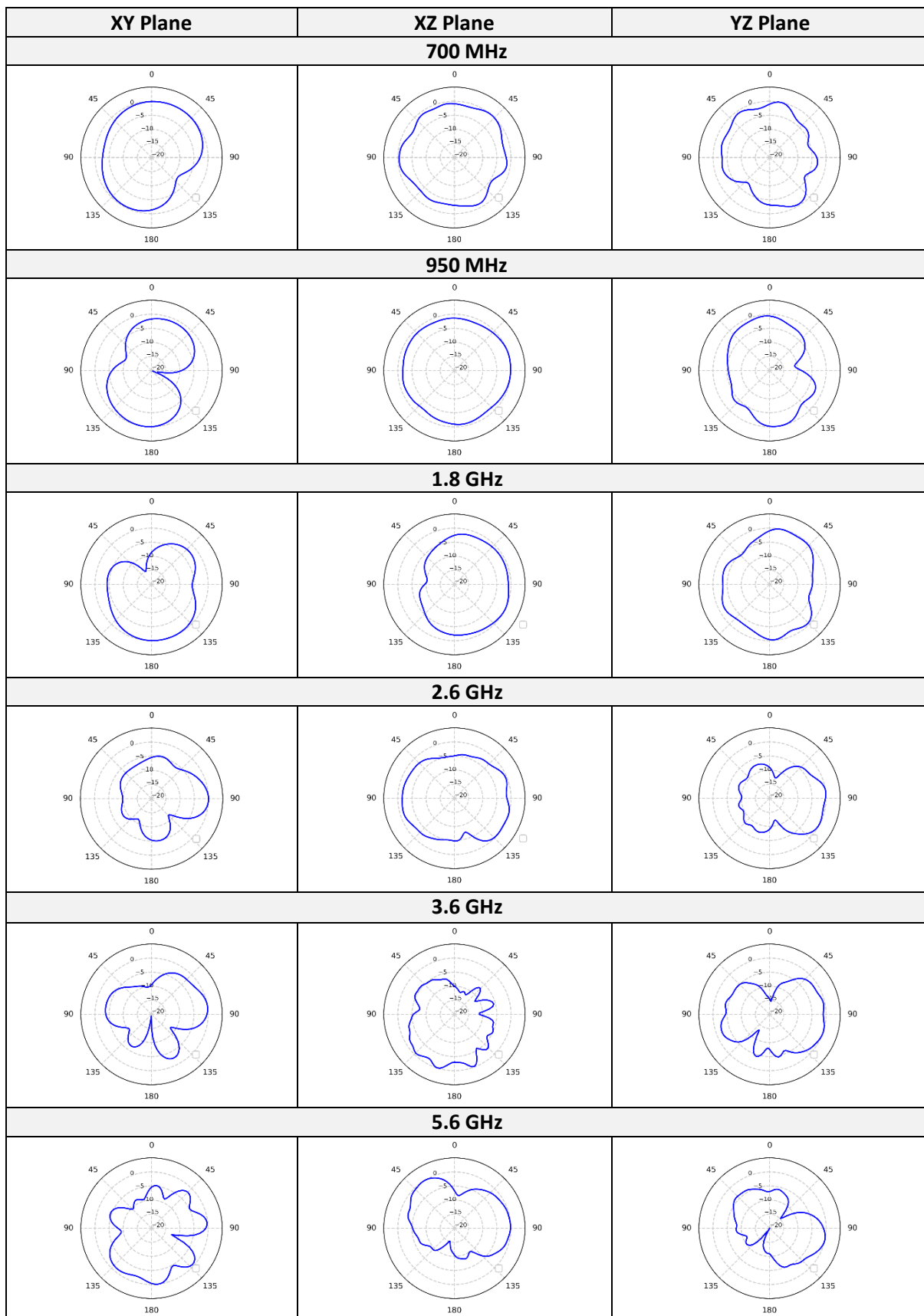


Table 8: Radiation patterns of AC31700-01A and AC31700-01B in dual configuration



1.6 Ground Plane Dependency and Antenna Efficiency

The AC31700-01A has been characterized by a wide range of test board sizes as depicted in Figure 4.

In standalone configuration, the antenna efficiency has been measured with a maximum ground plane size of 120mm and a minimum ground plane size of 60mm.

For the dual configuration with additional booster element AC31700-01B, the antenna efficiency has been measured with a maximum ground plane size of 100mm and a minimum ground plane size of 30mm.



Figure 4: Overview of test boards used to characterize the AC31700-01A antenna (with and without additional booster element AC31700-01B)

The measured VSWR and efficiency results as function of frequency are depicted in the figures below.

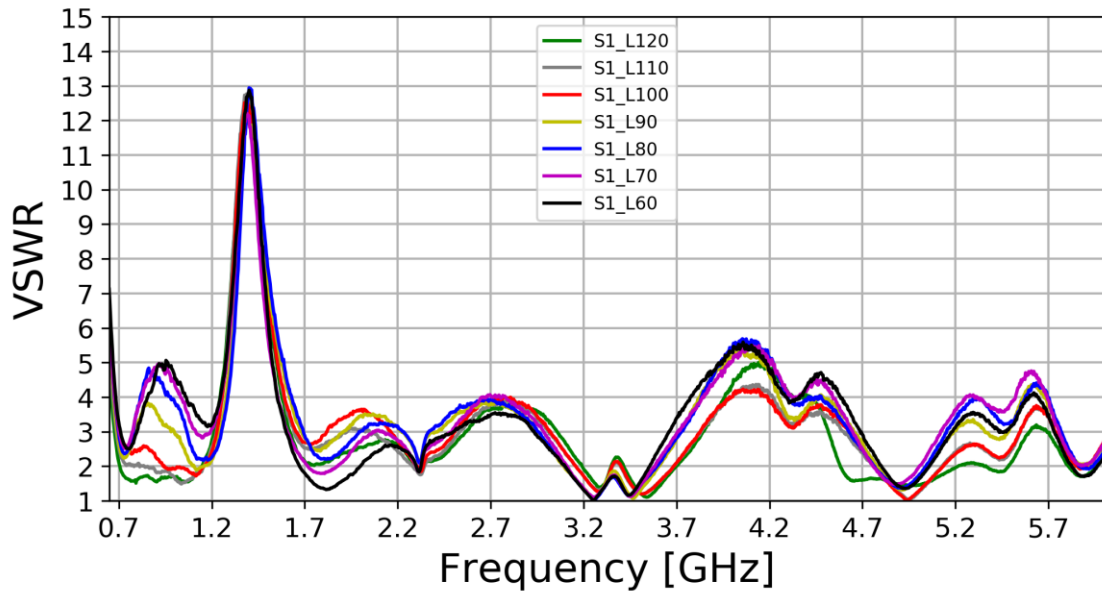


Figure 5: VSWR of AC31700-01A in standalone configuration over the frequency range [650MHz – 6GHz], for different ground plane lengths [60mm – 120mm]

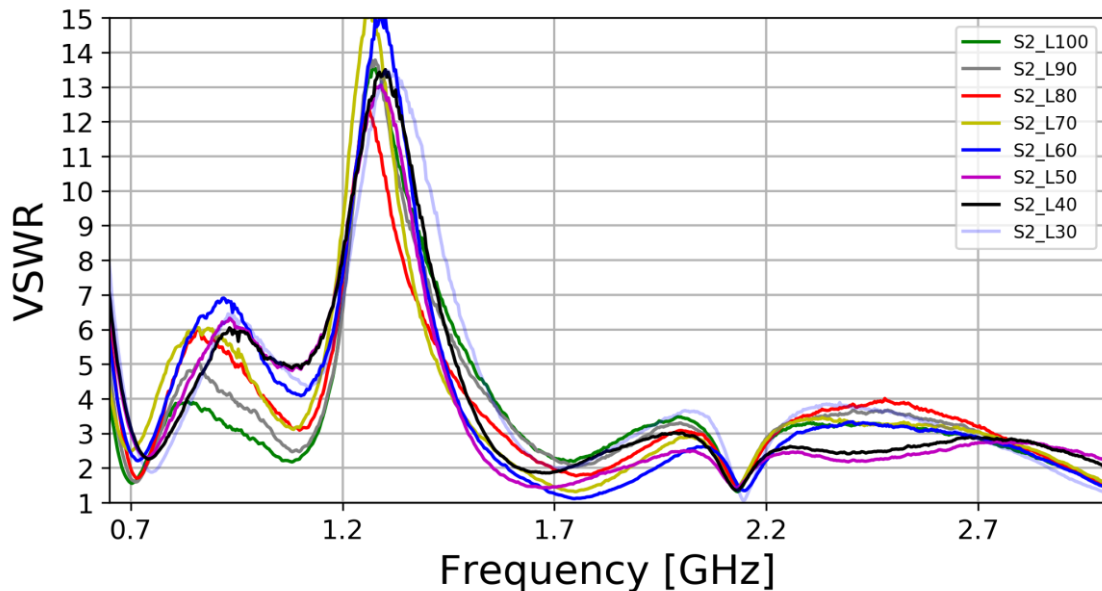


Figure 6: VSWR of AC31700-01A and AC31700-01B in dual configuration over the frequency range [650MHz – 3GHz], for different ground plane lengths [30mm – 100mm]

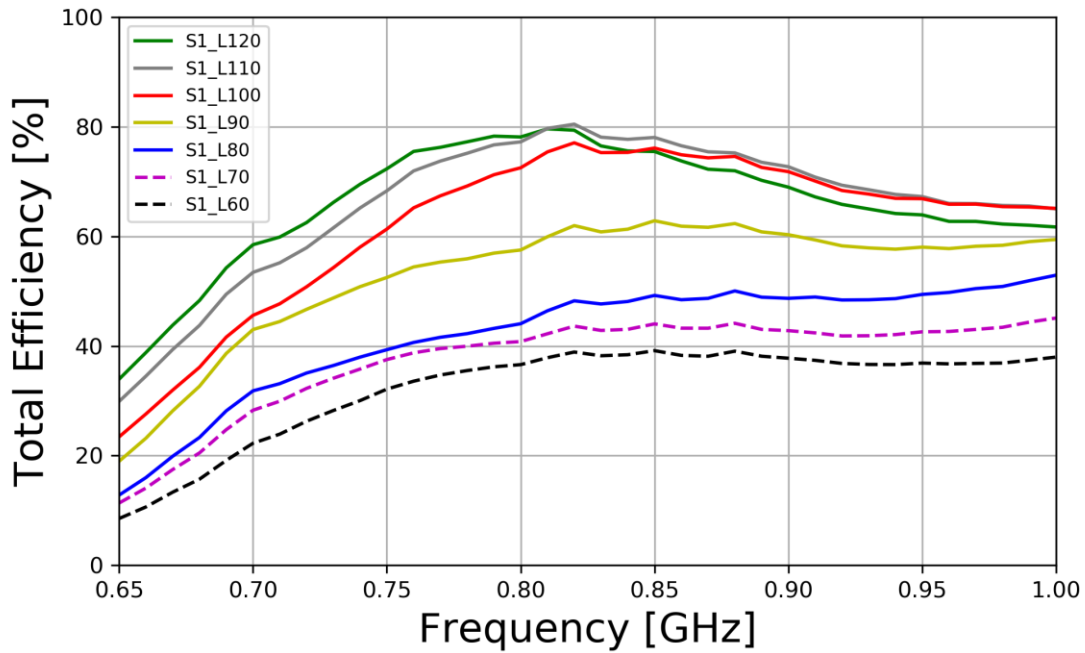


Figure 7: Efficiency of AC31700-01A in standalone configuration over the frequency range [650MHz - 1GHz], for different ground plane lengths [60mm - 120mm]

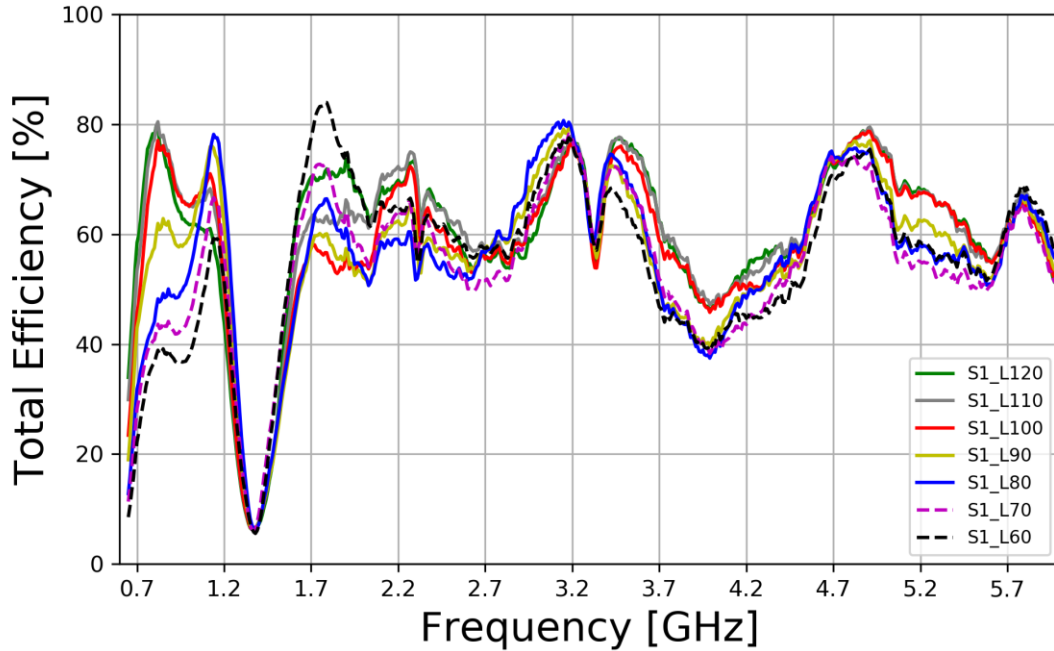


Figure 8: Efficiency of AC31700-01A in standalone configuration over the frequency range [650MHz - 6GHz], for different ground plane lengths [60mm - 120mm]

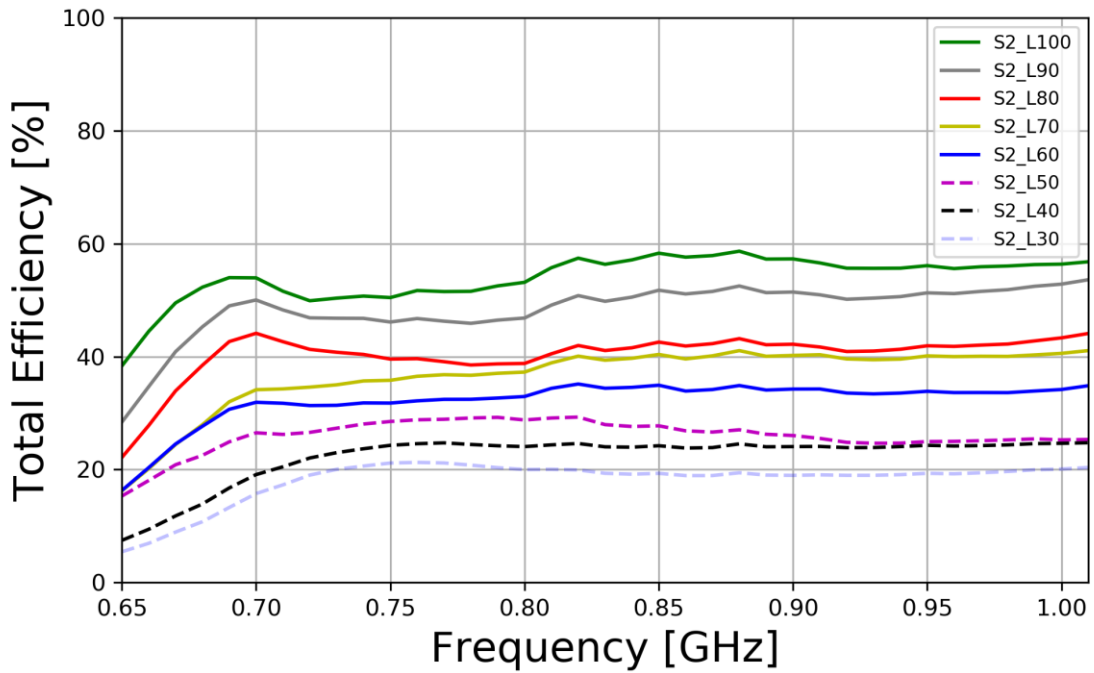


Figure 9: Efficiency of AC31700-01A and AC31700-01B in dual configuration over the frequency range [650MHz – 1GHz], for different ground plane lengths [30mm – 100mm]

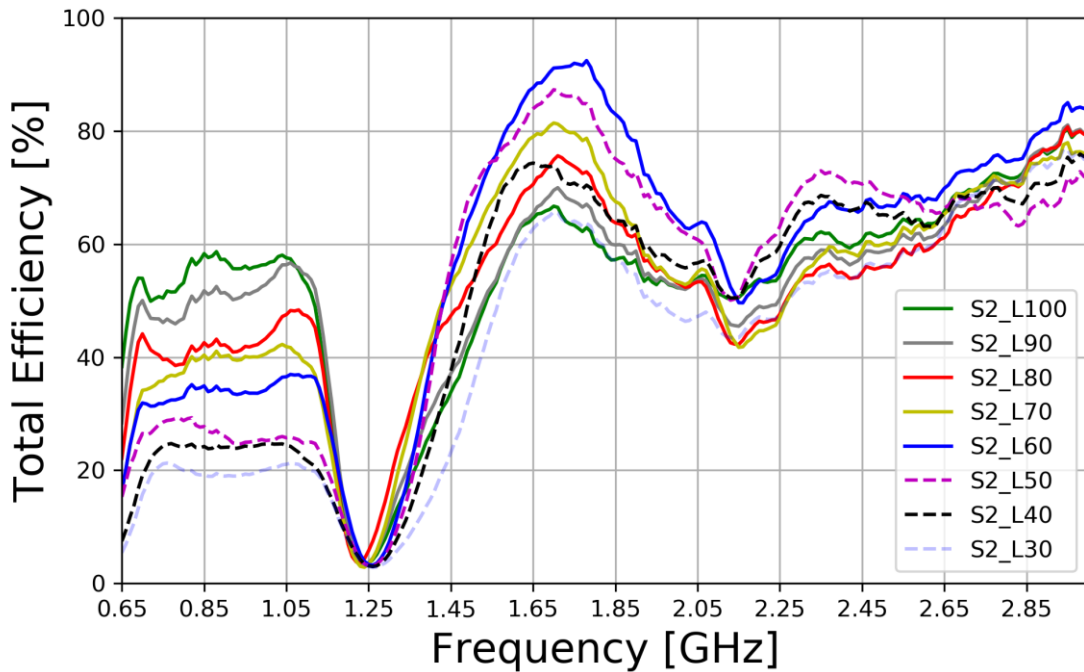


Figure 10: Efficiency of AC31700-01A and AC31700-01B in dual configuration over the frequency range [650MHz - 3GHz], for different ground plane lengths [30mm – 100mm]

2 Product Handling & Integration

2.1 Assembly Recommendation: standalone configuration

Figure 11 shows the recommended location of the AC31700-01A antenna on the host PCB.

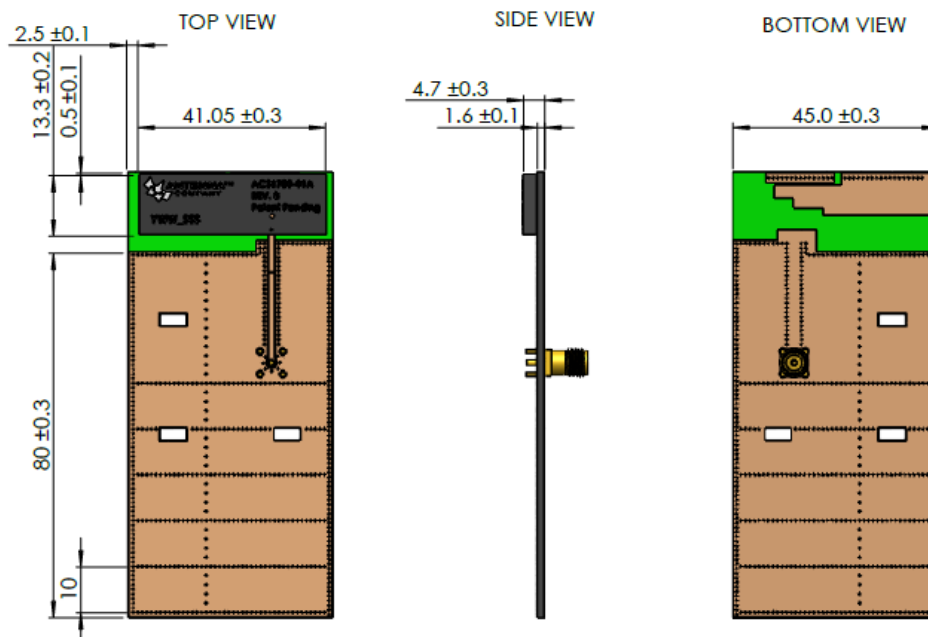


Figure 11: Illustration of the AC31700-01A integration on the top-, side- and bottom-surface of the host PCB

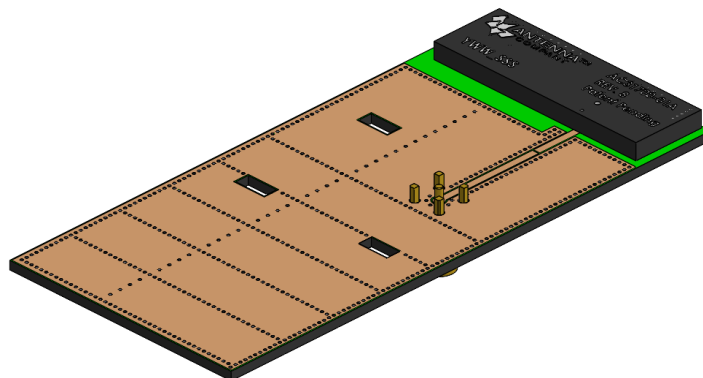


Figure 12: Isometric view of the AC31700-01A placement on the host PCB

2.2 Assembly Recommendation: dual configuration

As illustrated in the figure below, the AC31700-01A antenna can be used in combination with the AC31700-01B booster element.

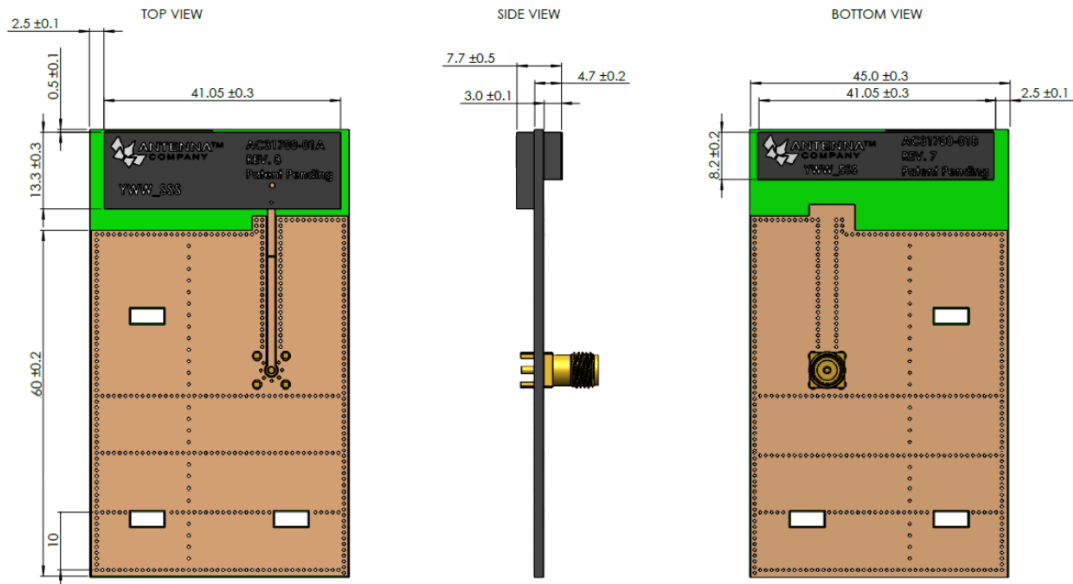


Figure 13: Illustration of the AC31700-01A integration on the top-, side- and bottom-surface of the host PCB

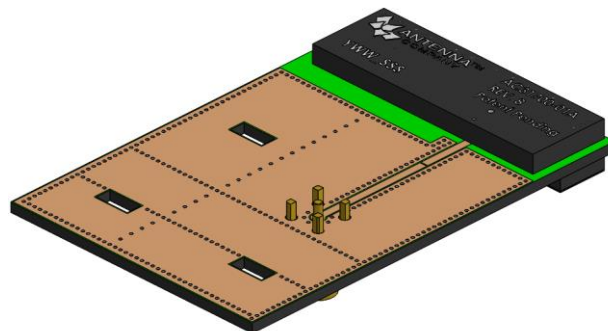


Figure 14: Isometric view of the AC31700-01A main antenna and its booster counterpart AC31700-01B placement on the host PCB

2.3 Assembly Recommendation: Reflow Profile

The recommended reflow profile is presented according to information on Figure 15 and Table 9.

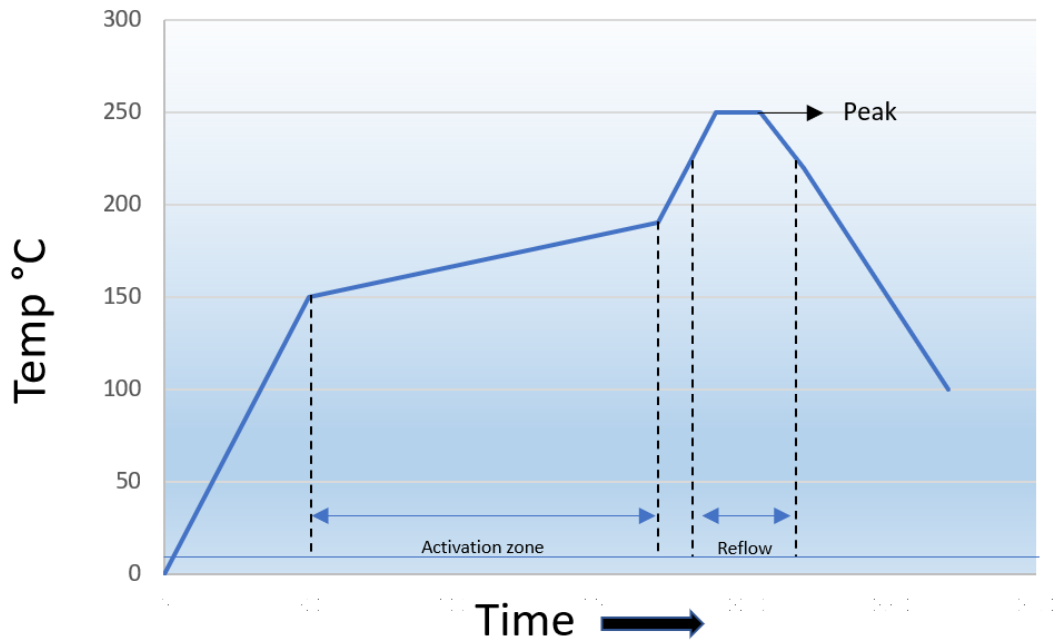


Figure 15: Suggested Reflow profile for Stand Alone and dual configuration

Table 9 - Reflow Temperature Table

		Temp Range	Time
T0 - T1	Heating Zone	0 to 150°C	Controlled 1°C~3°C/sec
T1 - T2	Activation Zone	150°C to 190°C	60s to 120s
T3 - T4	Reflow	220°C to 250°C (peak)	Above 45s
T4 - End	Cooling Zone	Cool down	Controlled~4°C/sec

2.4 Antenna Footprint

2.4.1 Standalone Configuration

The recommended PCB layout presented in this section is valid for the standalone configuration (AC31700-01A only).

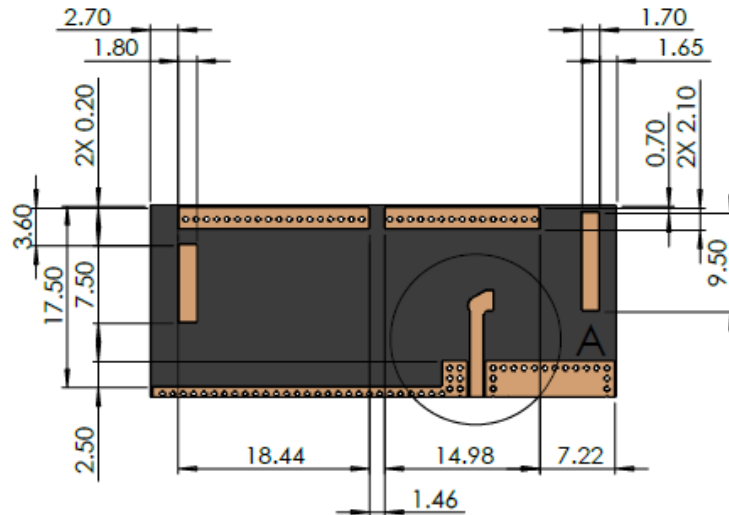


Figure 16: Footprint of the AC31700-01A on the top PCB layer. The main antenna has one feeding pad, 2 pads for mechanical fixation and 2 pads with vias to connect to the bottom PCB layer.

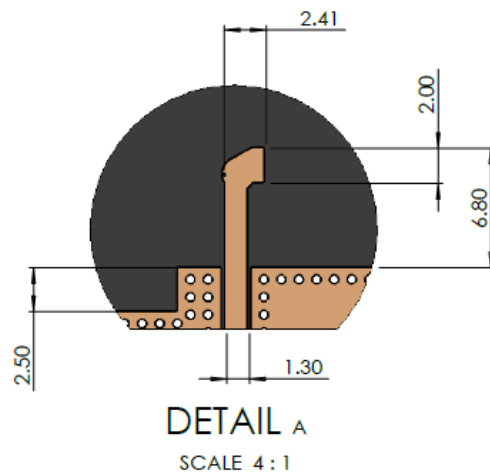


Figure 17: Close-up on the feeding pad of the AC31700-01A main antenna element.

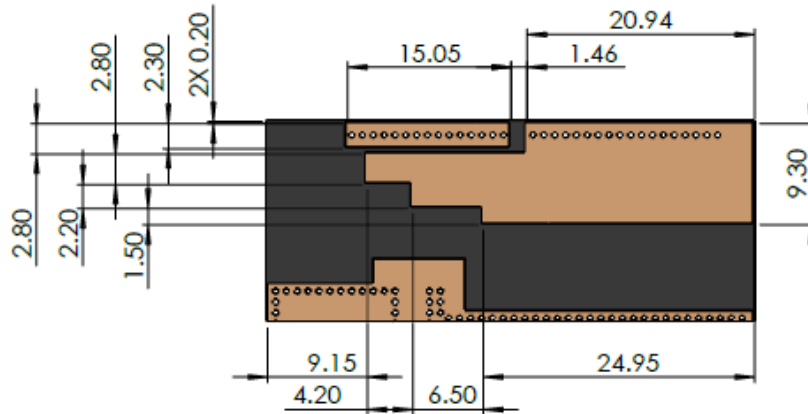


Figure 18: Footprint of the AC31700-01A on the bottom PCB layer.

Additional notes

- Any inner PCB layer should be free from ground in the antenna section, which corresponds to the black area beyond the top ground plane outline.
- Any vias in pads should be filled or tented. This would prevent solder from wicking away from the pad during reflow.
- For all dimension tolerances, standard PCB manufacturing guidelines should be followed.
- For the dual configuration reflow process, it is recommended to assemble the booster element AC31700-01B first.

2.4.2 Dual Configuration

The recommended PCB layout presented in this section is valid for the dual configuration (with additional booster element AC31700-01B).

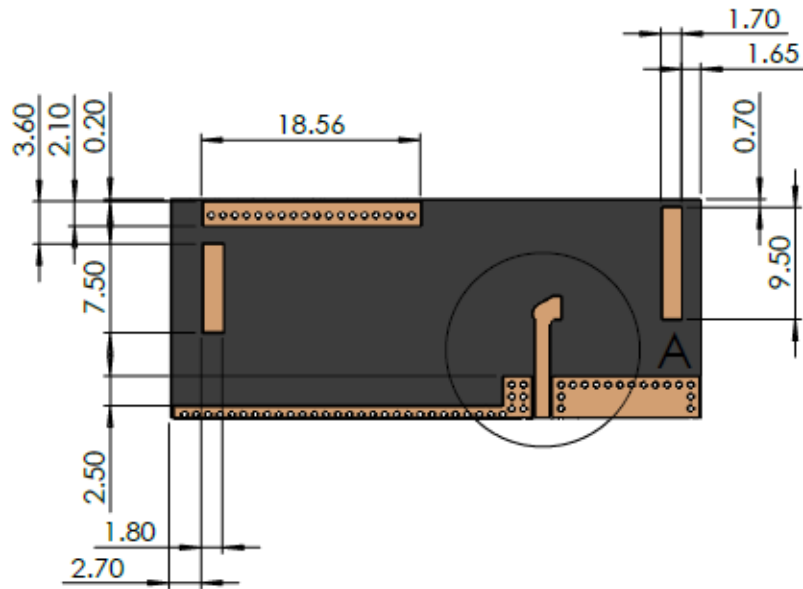


Figure 19: Footprint of the AC31700-01B on the top PCB layer. The main antenna has one feeding pad, 2 pads for mechanical fixation and 1 pad with vias to connect to the bottom PCB layer.

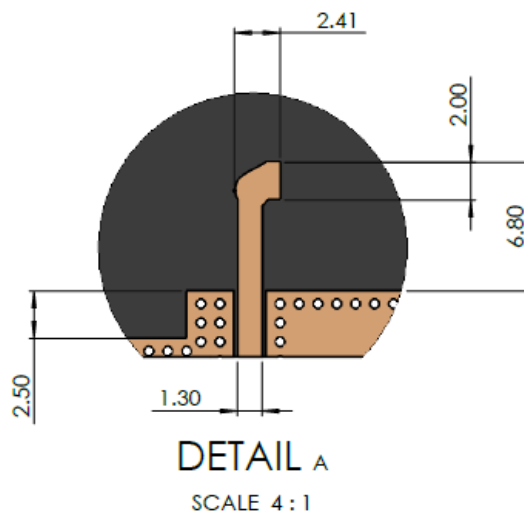


Figure 20: Close-up on the feeding pad of the AC31700-01B main antenna element.

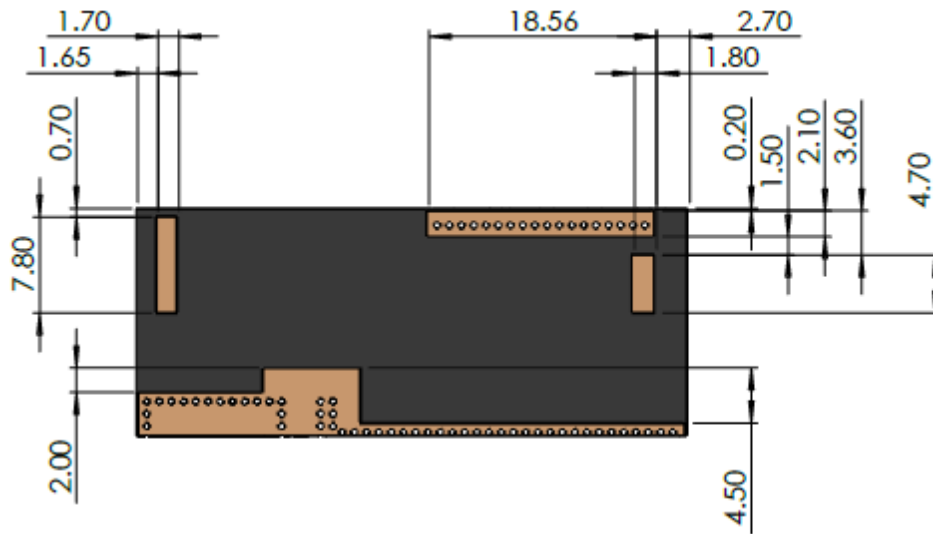


Figure 21: Footprint of the AC31700-01B on the bottom PCB layer. The booster element has one pad with vias to connect to the top PCB layer.

Additional notes

- Any inner PCB layer should be free from ground in the antenna section, which corresponds to the black area beyond the top ground plane outline.
- Any vias in pads should be filled or tented. This would prevent solder from wicking away from the pad during reflow.
- For all dimension tolerances, standard PCB manufacturing guidelines should be followed.
- For the dual configuration reflow process, it is recommended to assemble the booster element AC31700-01B first.

2.5 Evaluation Kit

The evaluation kit depicted in below figure includes a SMA female connector and can be ordered for evaluation purposes. As shown on the evaluation board, it is recommended to mount the main antenna and the booster on the shorter side of the PCBA to use the longer GND plane as antenna counterpoise and maximize performance.

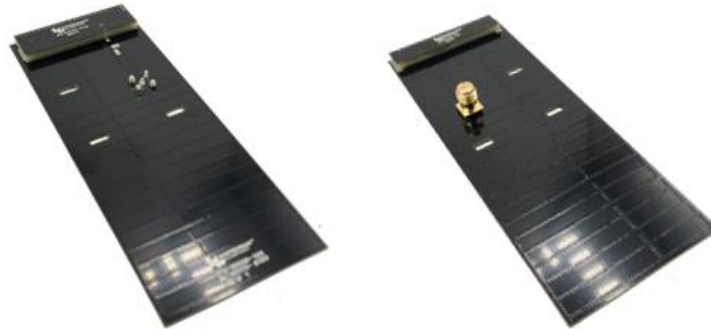


Figure 22: Top side (left) and bottom side (right) of the evaluation kit

There are four different evaluation kits as listed in the table below. The GND plane lengths are visualized in the figure below.

Table 10: Part numbers and assembly overview of the evaluation boards

Part number	GND plane length	Main antenna mounted	Booster element mounted
AC93170-A100	100mm	Yes	No
AC93170-A80	80mm	Yes	No
AC93170-B100	100mm	Yes	Yes
AC93170-B60	60mm	Yes	Yes

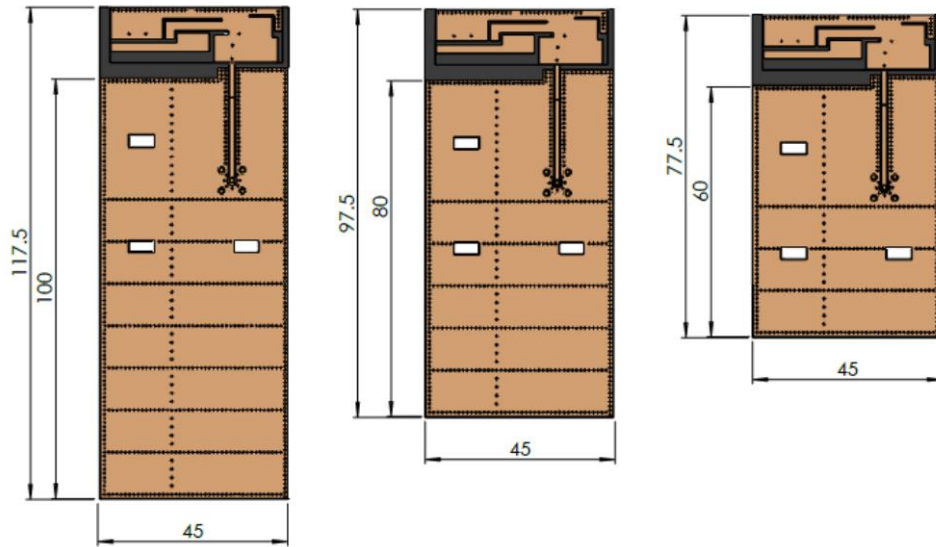


Figure 23: visuals of the GND plane lengths of the evaluation boards

2.6 Matching Network Topology

The matching network topology depicted in Figure 24 is required on the main PCB, as close as possible to the AC31700-01A main antenna (with or without booster element AC31700-01B).

The characteristic impedance of all transmission lines should be designed as 50 Ω .

The length of the transmission lines connecting the antenna to the matching circuit and the radio should be kept to as short as possible.

Any other part of the RF circuit connected to the antenna, such as power amplifiers, should also be designed with a 50 Ω impedance.

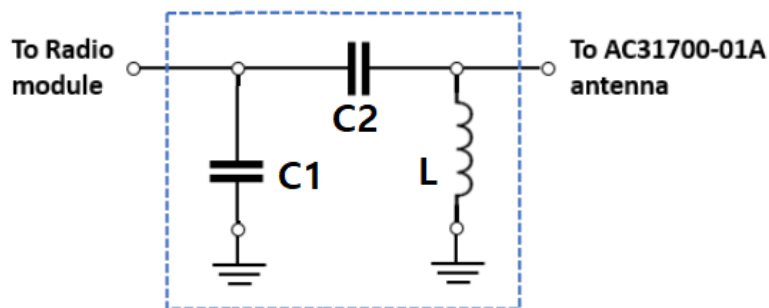


Figure 24: Required Matching Network Topology for AC31700-01 (with or without booster element AC31700-01B)

The component values and recommended types are listed in Table 11 and depend on the selected configuration (standalone or dual).

Table 11: Matching network component values

Standalone configuration: AC31700-01A		
Component	Value	Type
Capacitor (C1)	0.2pF \pm 0.1pF	GJM1555C1HR20BB01 (<i>Murata</i>)
Capacitor (C2)	4.6pF \pm 0.1pF	GJM1555C1H4R6BB01 (<i>Murata</i>)
Inductor (L)	6.8nH \pm 2%	LQG15HN6N8G02 (<i>Murata</i>)

Dual configuration: AC31700-01A and AC31700-01B		
Component	Value	Type
Capacitor (C1)	0.6pF \pm 0.1pF	GJM1555C1HR60BB01 (<i>Murata</i>)
Capacitor (C2)	4.5pF \pm 0.1pF	GJM1555C1H4R5BB01 (<i>Murata</i>)
Inductor (L)	6.8nH \pm 2%	LQG15HN6N8G02 (<i>Murata</i>)

If you need assistance, please contact sales@antennacompany.com for antenna matching network support.

2.7 Antenna Integration Guide

Below example of integration within the end-device shows the recommended clearances to metal objects around the main antenna element AC31700-01A and the booster element AC31700-01B.

The end-device illustration contains the major bulky component (e.g., a battery) along with the device outer plastic housing.

Table 12: Recommended clearances to metal objects around AC31700-01A and AC31700-01B

Clearance (mm)	D1	D2	D3	D4	D5	D6	D7	D8
Standalone Configuration	1	1	1	1	1	1	15	50
Dual Configuration	1	1	1	1	1	1	15	50

It is recommended to keep the close vicinity of the antenna and booster free from metal objects as illustrated by the blue transparent bloc in Figure 25.

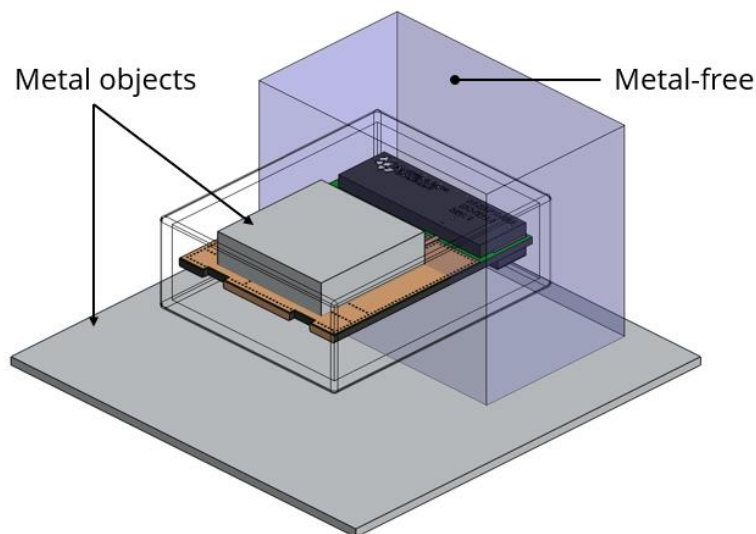


Figure 25: Illustration of the clearances around the AC31700-01A antenna element and the AC31700-01B booster element in dual configuration

The clearances D1, D2, D3, D4, D5 and D6 listed in Table 12, represents the minimum keep-out distances away from the plastic housing and are illustrated in Figure 26 and Figure 27.

The clearances D7 and D8 listed in Table 12, represents the minimum keep-out distances away from metal objects and are illustrated in Figure 26 and Figure 27.

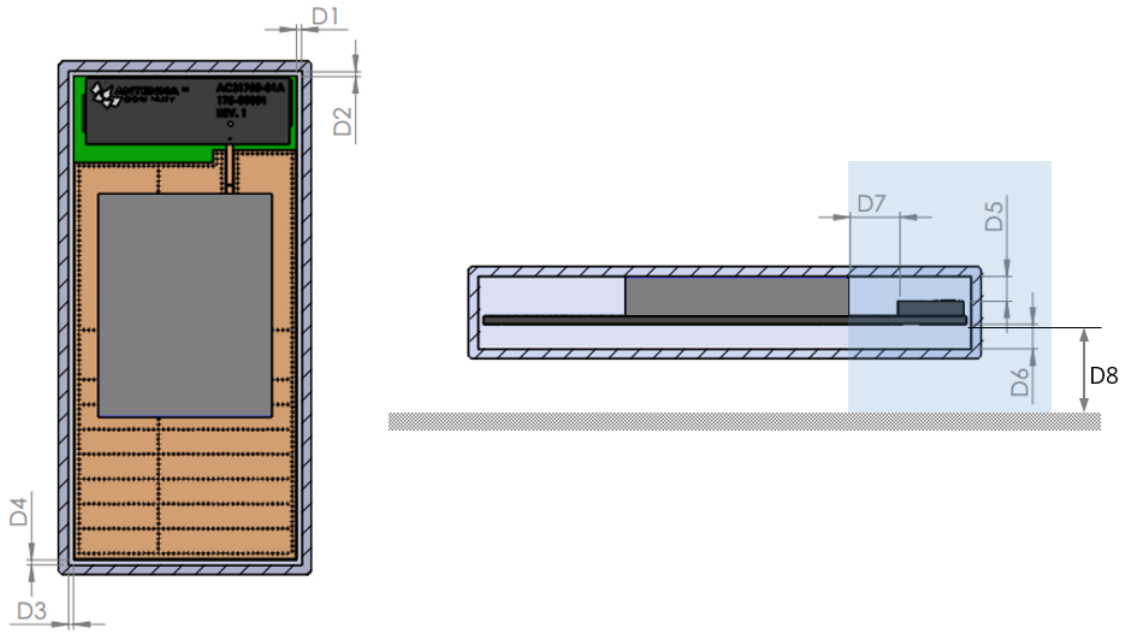


Figure 26: Illustration of the keep-out distances away from metal objects around the AC31700-01A antenna element in standalone configuration

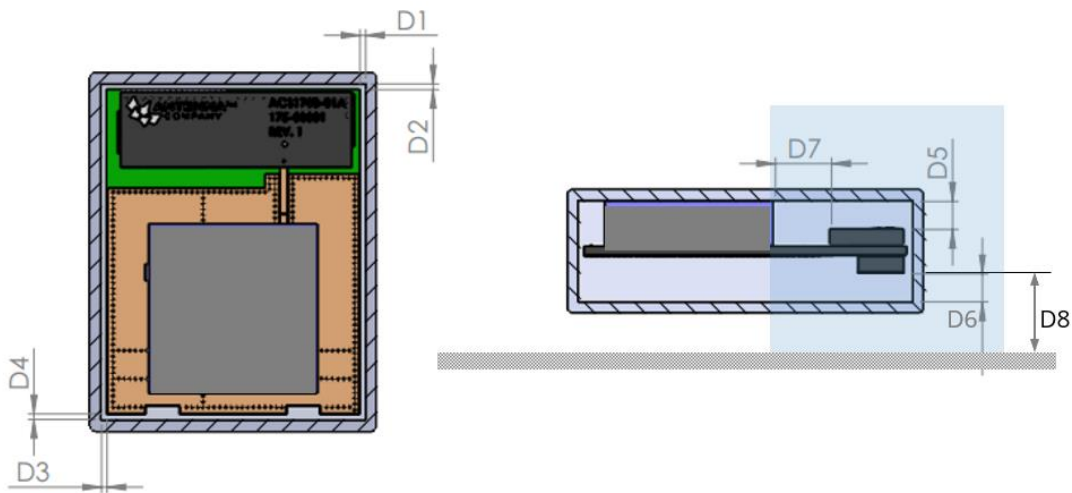


Figure 27: Illustration of the keep-out distances away from metal objects around the AC31700-01A antenna element and the AC31700-01B booster element in dual configuration

3 Product Marking & Ordering Information

3.1 Product Marking

Every antenna element contains the part number, PCB number, revision number and production date code for easy tracking, as explained in Table 13.

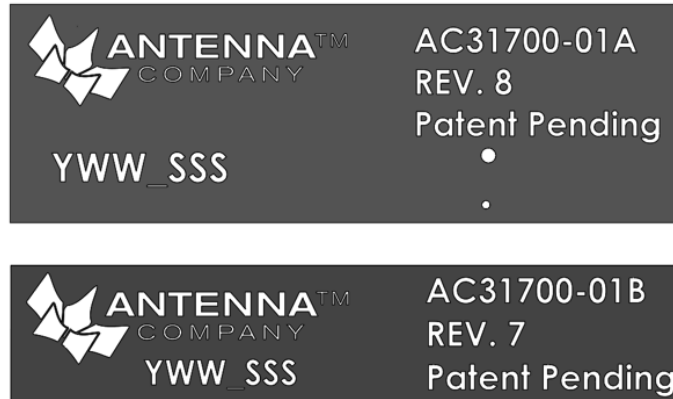


Table 13: AC31700-01A and AC31700-01B, marking specifications

Text on Antenna	Explanation
AC31700-01X	AC Type Number
REV. 1	Revision Number
YWW_SSS	Production Date and Supplier Code
Y = L	2023
Y = M	2024
Y = N	2025
WW	Manufacturing Week
SSS	Supplier Code

3.2 Packaging

The AC31700-01A main antenna and the AC31700-01B booster will be delivered in tape and reel. The packaging details are depicted in the figures below.

The number of units per reel is 800pcs for the AC31700-01A antenna and 800pcs for the AC31700-01B booster element.

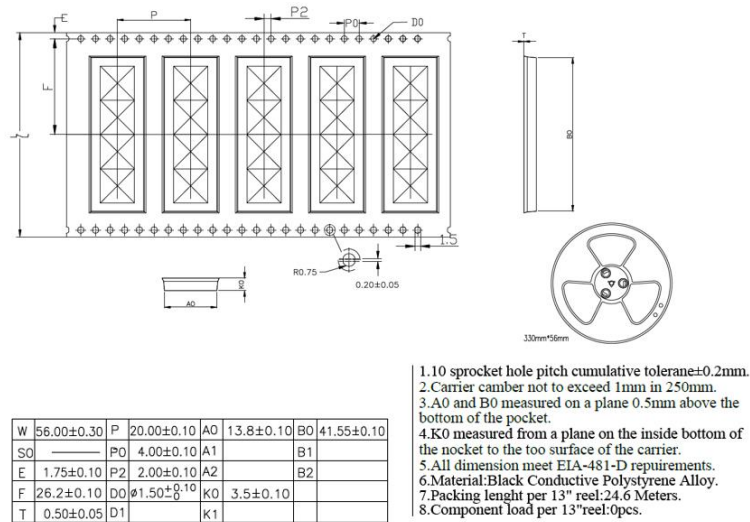


Figure 28: Tape and reel packaging details of AC31700-01A main antenna

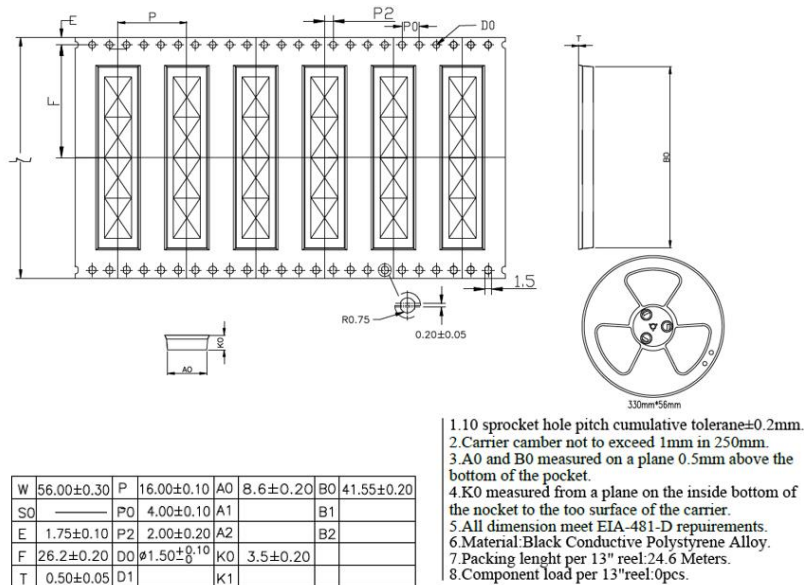


Figure 29: Tape and reel packaging details of AC31700-01B booster

3.3 Ordering Information

Orders should be placed at orders@antennacompany.com.

For purchase orders please state: part number, description, quantity, and price

Table 14: AC31700-01A, ordering information

Part number	Description	Minimum Order Quantity [pcs]	Order multiple [pcs]
AC31700-01A	5G/4G Wideband (698-6000MHz) SMT Antennas for IoT Applications	7200	800
AC31700-01B	5G/4G Wideband (698-6000MHz) SMT Booster Element for IoT Applications	7200	800
AC93170-A100	5G/4G Evaluation kit in standalone configuration with 100mm GND plane	1	1
AC93170-A80	5G/4G Evaluation kit in standalone configuration with 80mm GND plane	1	1
AC93170-B100	5G/4G Evaluation kit in dual configuration with 100mm GND plane	1	1
AC93170-B60	5G/4G Evaluation kit in dual configuration with 60mm GND plane	1	1

For sample quantities, please contact sales@antennacompany.com.

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