

# High Frequency Ceramic Solutions

Application Note: AN090

6/16/2020

G.Kuo/M.Carmona

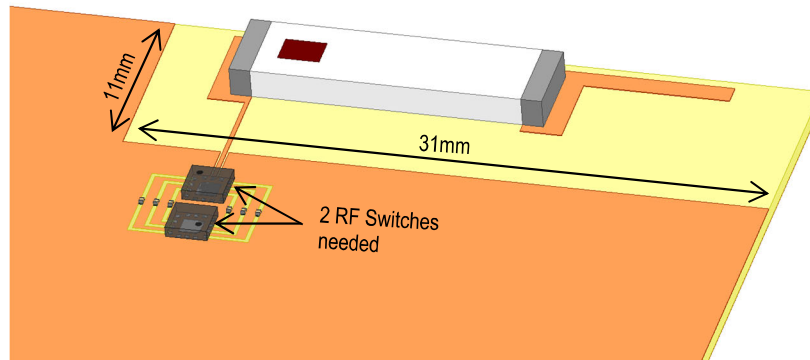
## Johanson Technology's 7-band, single Antenna Solution for: Cellular LTE NB IoT/CAT M1, Sub GHz, GPS/GNSS, and 2.4GHz

### Abstract

As the demand for a compact, all-encompassing solution for IoT connectivity continues to grow, we've developed a multi-band flexible solution using one antenna (p/n 0830AT54A2200). This antenna can resonate at multiple frequencies. For it to achieve high efficiency and bandwidth, it requires antenna matching networks to cover Cellular/SubGHz/GPS-GNSS/2.4GHz bands.

All characterizations and gains we measured on a small, 51x51mm PCB (including the antenna clearance)

Below is a representation of the total antenna effective area and 2 switches required for this solution:



### Introduction

In an effort to create a small-footprint antenna solution for cellular LTE, NB-IoT, geo location GPS/GNSS, and 2.4GHz frequency spectrums, Johanson Technology has created a single antenna matching solution to cover all relative frequency bands. In addition to simplifying device bill-of-materials, costs can be reduced by re-using the same flexible solution in various applications.

By combining Johanson's 0830AT54A2200 antenna with 2 channel switches, the designer has the ability to cycle through all usable channels mentioned above.

Based on the number of channels required, we recommend the use of 2 (two), SP6T switches to cover the entire cellular spectrum as well as GPS/GLONASS and 2.4GHz Bluetooth or WiFi. In our example, the Qorvo RFSW6062 switch is used. The Hexawave HWS556 is a substitute performance-wise, but it is not interchangeable. You can find a link to more information on the final page.

Antenna Datasheet: <https://www.johansontechnology.com/datasheets/0830AT54A2200/0830AT54A2200.pdf>

Qorvo RFSW6062 Switch: <https://www.qorvo.com/products/p/RFSW6062>

Hexawave HWS556 Switch: [http://www.hw.com.tw/PDF/Switch/HWS556\\_V2.pdf](http://www.hw.com.tw/PDF/Switch/HWS556_V2.pdf)



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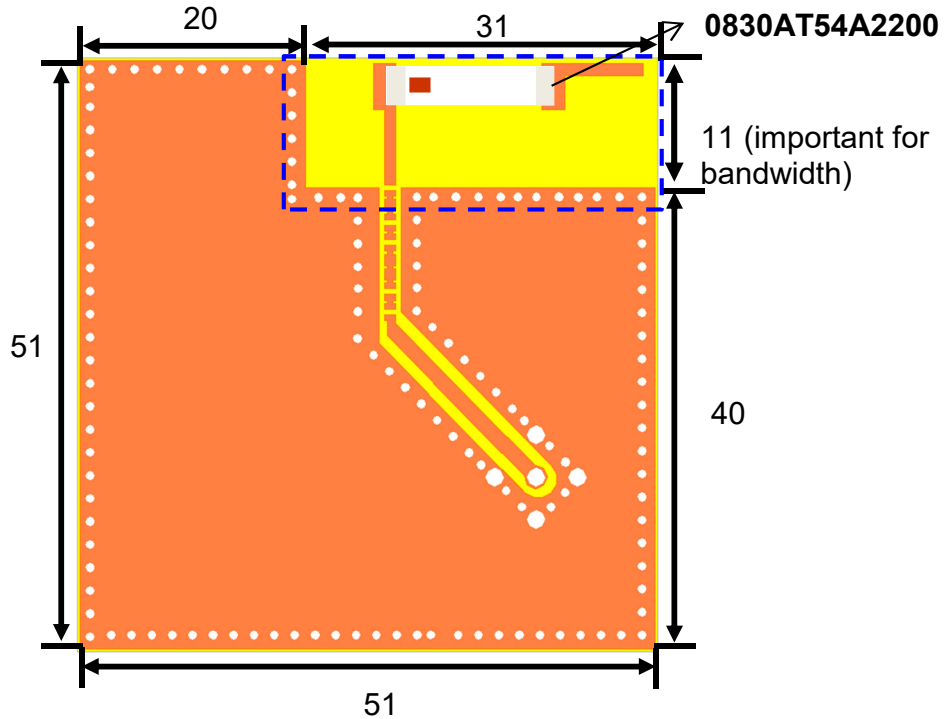
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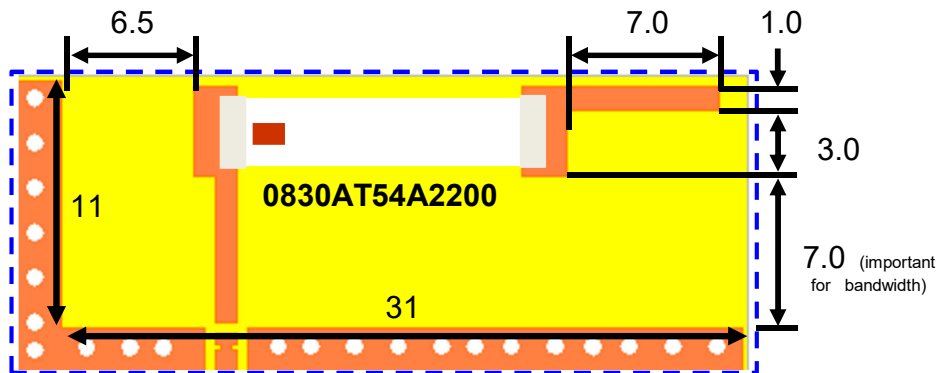
**Johanson Technology's 7-band, single Antenna Solution for:  
Cellular LTE NB IoT/CAT M1, Sub GHz, GPS/GNSS, and 2.4GHz**

## PCB size and Recommended Antenna Keep-out Area

All units in: mm



All units in: mm



Units in mm

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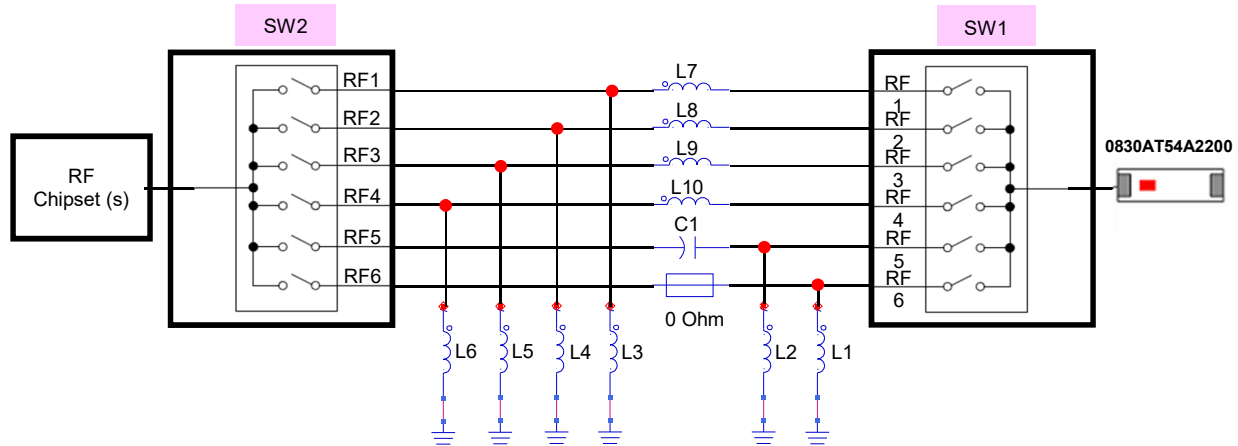
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## Matching Network Topologies with Switches



## Qorvo RFSW6062 Switch

<https://www.qorvo.com/products/p/RFSW6062>

## Frequency Channels and Matching Values

| Channel | Frequency (MHz)         | L1   | L2    | L3   | L4   | L5    | L6    | L7   | L8   | L9   | L10  | C1    |
|---------|-------------------------|------|-------|------|------|-------|-------|------|------|------|------|-------|
| 1       | 700 - 750               |      |       | 11nH |      |       |       | 30nH |      |      |      |       |
| 2       | 750 - 800               |      |       |      | 10nH |       |       |      | 27nH |      |      |       |
| 3       | 791 - 894               |      |       |      |      | 8.2nH |       |      |      | 22nH |      |       |
| 4       | 880 - 960               |      |       |      |      |       | 6.9nH |      |      |      | 18nH |       |
| 5       | 1574 - 1577*            |      | 3.0nH |      |      |       |       |      |      |      |      | 0.9pF |
| 6       | 1710 - 2200 2400 - 2480 | 24nH |       |      |      |       |       |      |      |      |      |       |

\*Channel 5 may be tuned for GLONASS operation (1598-1609MHz)

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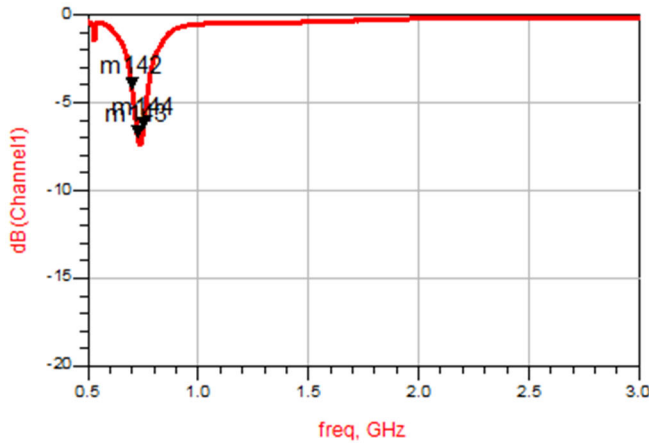
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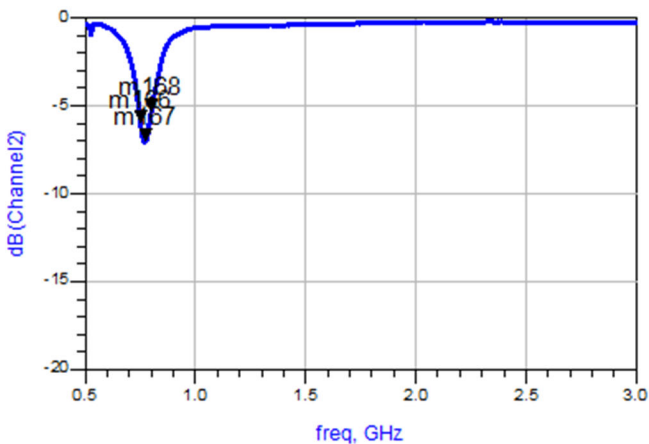
### Measured Return Loss By Channel



m 142  
freq=700.0MHz  
dB(Channel1)=-4.271

m 143  
freq=725.0MHz  
dB(Channel1)=-6.988

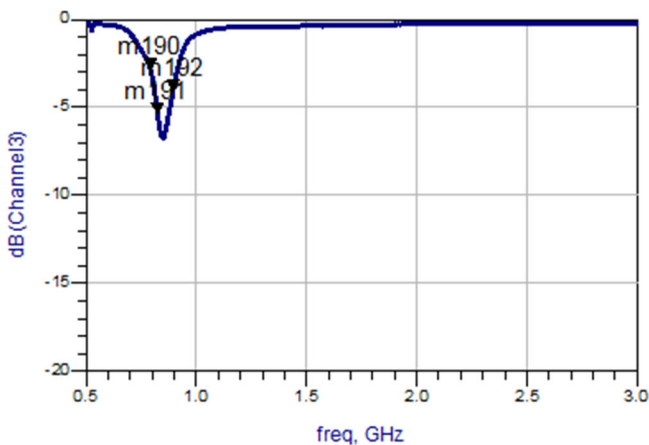
m 144  
freq=750.0MHz  
dB(Channel1)=-6.549



m 166  
freq=750.0MHz  
dB(Channel2)=-5.978

m 167  
freq=775.0MHz  
dB(Channel2)=-7.008

m 168  
freq=800.0MHz  
dB(Channel2)=-5.271



m 190  
freq=791.0MHz  
dB(Channel3)=-2.851

m 191  
freq=824.0MHz  
dB(Channel3)=-5.380

m 192  
freq=894.0MHz  
dB(Channel3)=-4.076



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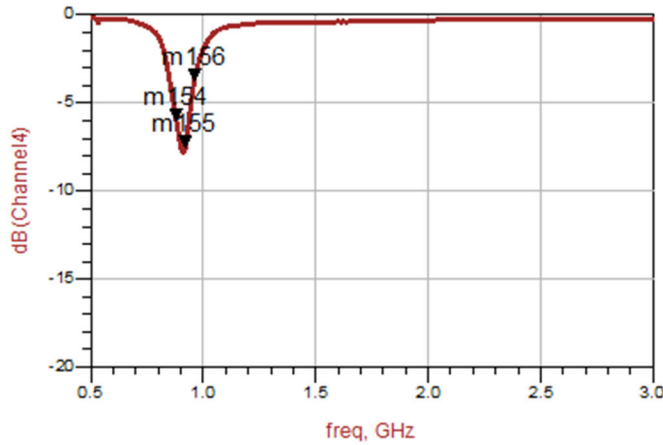
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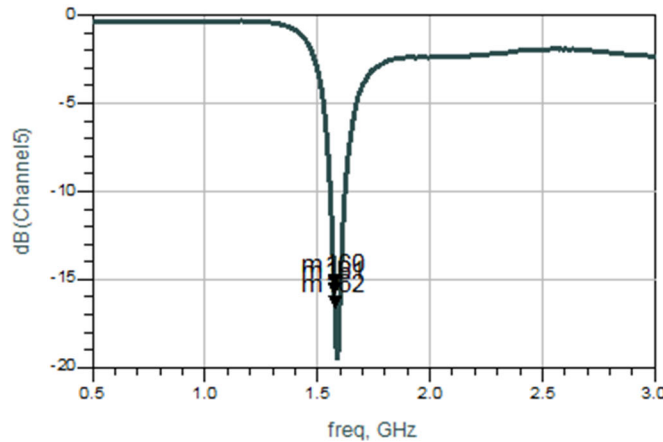
### Measured Return Loss By Channel



m154  
freq=880.0MHz  
dB(Channel4)=-6.017

m155  
freq=920.0MHz  
dB(Channel4)=-7.489

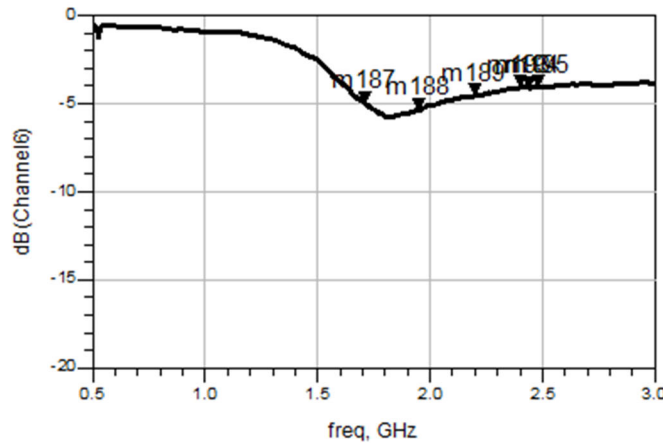
m156  
freq=960.0MHz  
dB(Channel4)=-3.710



m160  
freq=1.574GHz  
dB(Channel5)=-15.448

m161  
freq=1.575GHz  
dB(Channel5)=-15.850

m162  
freq=1.577GHz  
dB(Channel5)=-16.610



m187  
freq=1.710GHz  
dB(Channel6)=-4.969

m188  
freq=1.950GHz  
dB(Channel6)=-5.403

m189  
freq=2.000GHz  
dB(Channel6)=-4.578

m193  
freq=2.400GHz  
dB(Channel6)=-4.106

m194  
freq=2.440GHz  
dB(Channel6)=-4.121

m195  
freq=2.480GHz  
dB(Channel6)=-4.091



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## 0830AT54A2200 Radiated Efficiency on 51x51mm board

| Frequency (MHz) | Channel setting |  | Efficiency of 0830AT54A2200 (%) | Insertion loss of two SP6T Switch | Efficiency of 0830AT54A2200 with two SP6T Switch (%) |
|-----------------|-----------------|--|---------------------------------|-----------------------------------|--|
| 700             | RF1             |  | 23                              | 0.9 typ.                          | 18.7   |
| 750             |                 |  | 21                              |                                   | 17.1   |
| 800             | RF2             |  | 21                              |                                   | 17.1   |
| 791             |                 |  | 23                              |                                   | 18.7   |
| 824             | RF3             |  | 22                              |                                   | 17.9   |
| 894             | RF3             |  | 12                              |                                   | 9.8  |
| 880             | RF4             |  | 22                              |                                   | 17.9   |
| 920             |                 |  | 16                              |                                   | 13.0   |
| 960             |                 |  | 14                              |                                   | 11.4   |
| 1574            | RF5             |  | 43                              |                                   | 1.0 typ.   |
| 1575            | RF5             |  | 43                              | 34.2                              |  |
| 1577            | RF5             |  | 42                              | 33.4                              |  |
| 1710            | RF6             |  | 44                              | 1.1 typ.                          | 35.0   |
| 1955            |                 |  | 69                              |                                   | 54.8   |
| 2200            |                 |  | 59                              |                                   | 45.8   |
| 2400            |                 |  | 54                              |                                   | 42.0   |
| 2440            |                 |  | 55                              |                                   | 42.7   |
| 2480            |                 |  | 49                              |                                   | 38.0   |

Performance based on example PCB with dimensions 51mm x 51mm

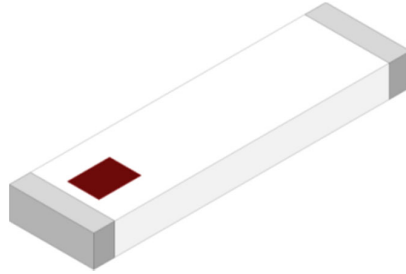
# High Frequency Ceramic Solutions

**LTE Multi-Band Ceramic Antenna, SMD. Ideal for Cellular, IoT, CAT M1, and NB (Narrow Band) Applications** P/N: 0830AT54A2200

Detail Specification: 6/16/2020

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| General Specifications  |  |                  |
|---|--|------------------|
| Part Number   | 0830AT54A2200                                      |                  |
| Operating Frequencies   | Tuning Version 1                                   | Tuning Version 2 |
| Frequency (MHz)   | 700 - 800  | 824 - 960        |
|   | 1700 - 2100  | 1710 - 2690      |
|   | <b>Antenna-Switch Solution*</b>                    |                  |
|   | 700 - 960, GPS/GLONASS, 1710 - 2200, 2400 - 2480   |                  |
| Return Loss (dB)  | 3.5 min.   | 4.5 min.         |
| Peak Gain <small>measured on EB1/2</small>                        | 2.0 typ. (dBi)                                     | 2.0 typ. (dBi)   |
| Average Gain <small>measured on EB1/2</small>                     | -1.6 typ. (dBi)                                    | -1.0 typ. (dBi)  |
| Power Capacity (W)  | 3 max. (CW)  |                  |
| Quantity/Reel   | 500  |                  |
| Operating Temperature   | -40°C to +85°C (may be expanded, ask us how)       |                  |
| Storage Conditions for unused product on T&R and max shelf period | +5 to +35 °C<br>Humidity 45 - 75%RH<br>18 mos. max |                  |



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\* All frequencies can be achieved in a combined antenna and switch solution. More information can be found in our [Application Note 80](#).

| Part Number Explanation |  |          |  |                            |
|-------------------------|--|----------|--|----------------------------|
| P/N Suffix              | Packing Style                                  | Bulk     | Suffix = S                                     | e.g. 0830AT54A2200S        |
|                         |  | T & R    | Suffix = E                                     | e.g. 0830AT54A2200E        |
|                         |  | 100% Tin | Suffix = None                                  | e.g. 0830AT54A2200(E or S) |
| Evaluation Boards       | Tuning Version 1: 0830AT54A2200-EB1SMA (large) |          | Tuning Version 2: 0830AT54A2200-EB2SMA (large) |                            |
|                         | Tuning Version 1: 0830AT54A2200-EB3SMA (small) |          | Tuning Version 2: 0830AT54A2200-EB4SMA (small) |                            |

| Mechanical Dimensions |               |             |
|-----------------------|---------------|-------------|
|                       | In            | mm          |
| L                     | 0.591 ± 0.008 | 15.00 ± 0.2 |
| W                     | 0.157 ± 0.008 | 4.00 ± 0.2  |
| T                     | 0.059 ± 0.008 | 1.50 ± 0.2  |
| a                     | 0.039 ± 0.012 | 1.00 ± 0.3  |

Side View

Top View

Bottom View

| Terminal Configuration |          |
|------------------------|----------|
| No.                    | Function |
| 1                      | FEED     |
| 2                      | NC       |

Pin 2 must be soldered onto the PCB for mechanical stability

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Detail Specification: 6/16/2020

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## Mounting Style, Small: Tuning versions 1 and 2

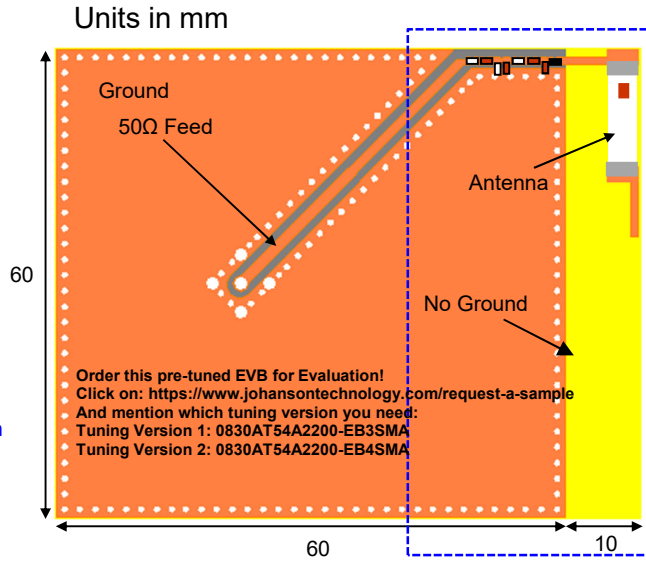
**Orderable p/ns**  
**Tuning Version 1: 0830AT54A2200-EB3SMA (small)**  
**Tuning Version 2: 0830AT54A2200-EB4SMA (small)**

EB3SMA and EB4SMA are evaluation boards which overall size is reduced to demonstrate that this antenna can operate at reduced form factors. Go to page for the larger form factor sizes/examples

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 Contact us by clicking on the link below:

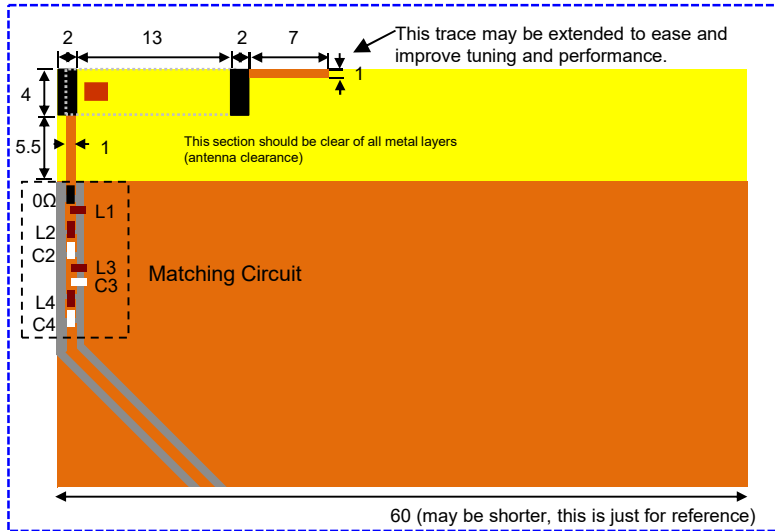
<https://www.johansontechnology.com/ask-a-question>

These are the layout recommendations for both tuning versions 1 and 2



Units in mm

It is recommended that the designer leave available slots for the topology of the network to the right. These particular antenna matching values are used when antenna is mounted on Johanson's evaluation board. The matching values on client's PCB will be different, just leave them empty until final assembly, then tune.



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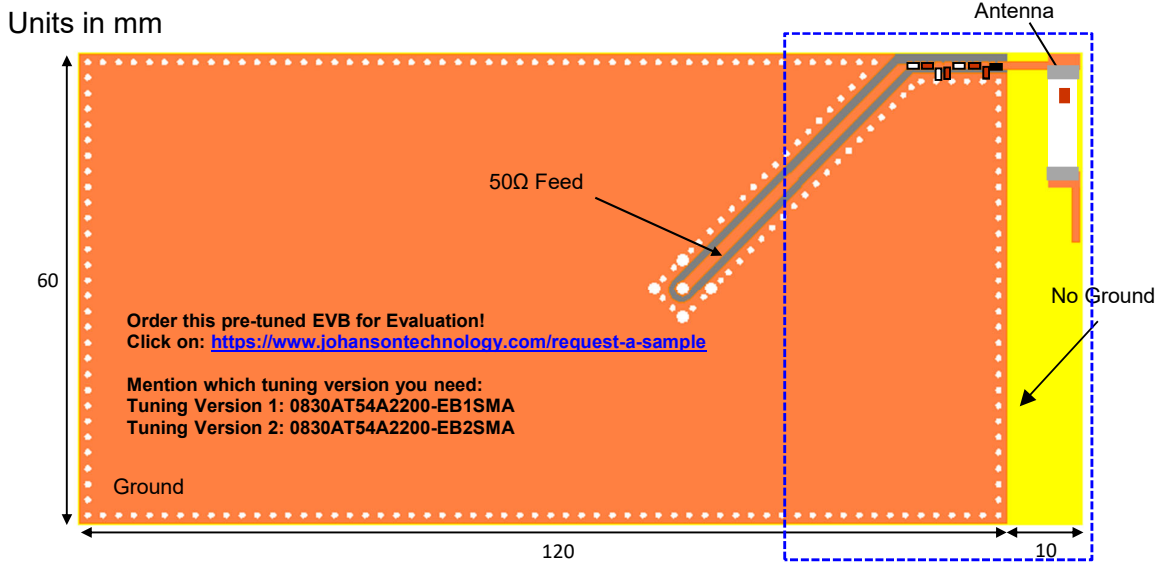
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**LTE Multi-Band Ceramic Antenna, SMD. Ideal for Cellular, IoT, CAT M1, and NB (Narrow Band) Applications** P/N: 0830AT54A2200

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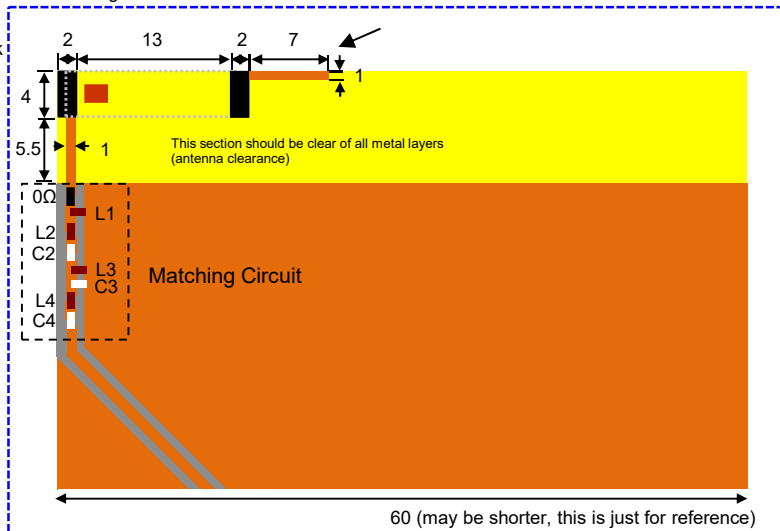
## Mounting Style, Standard: Tuning versions 1 and 2



Units in mm

It is recommended that the designer leave available slots for the topology of the network to the right. These particular antenna matching values are used when antenna is mounted on Johanson's evaluation board. The matching values on client's PCB will be different, just leave them empty until final assembly, then tune.

These are the layout recommendations for both tuning versions 1 and 2



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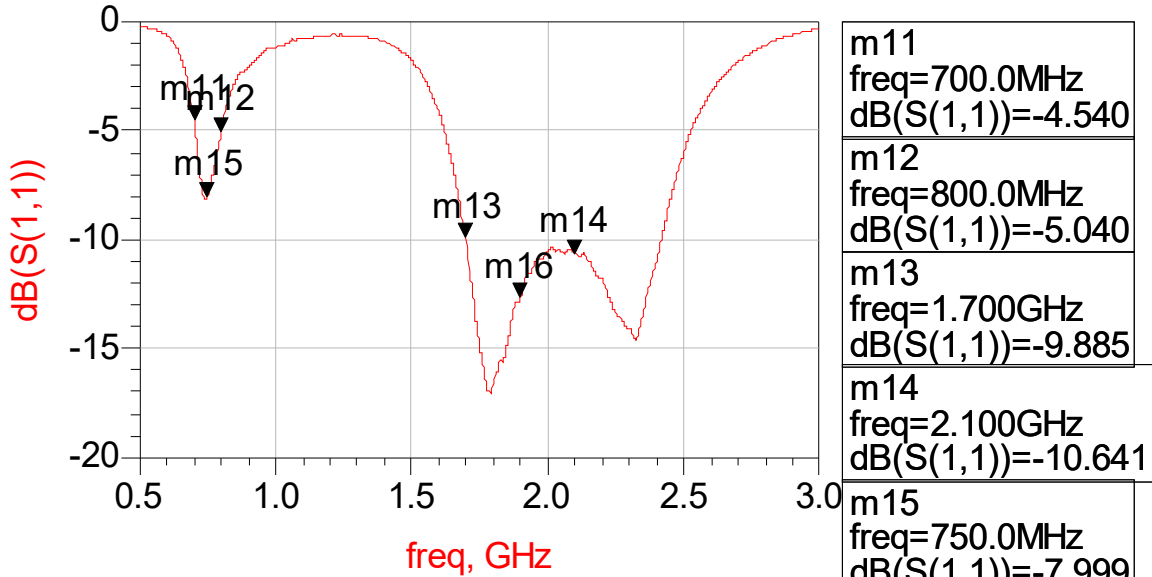
LTE Multi-Band Ceramic Antenna, SMD. Ideal for Cellular, IoT, CAT M1, and NB (Narrow Band) Applications

Detail Specification: 6/16/2020

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## Typical Electrical Characteristics (T=25°C) Tuning Version 1

### Tuning Version 1: Evaluation Board p/n: 0830AT54A2200-EB1SMA



To order a pre-tuned 50Ω EVB with a female SMA connector for "Tuning Version 1" click here: <https://www.johansontechnology.com/request-a-sample>  
Reference p/n: 0830AT54A2200-EB1SMA

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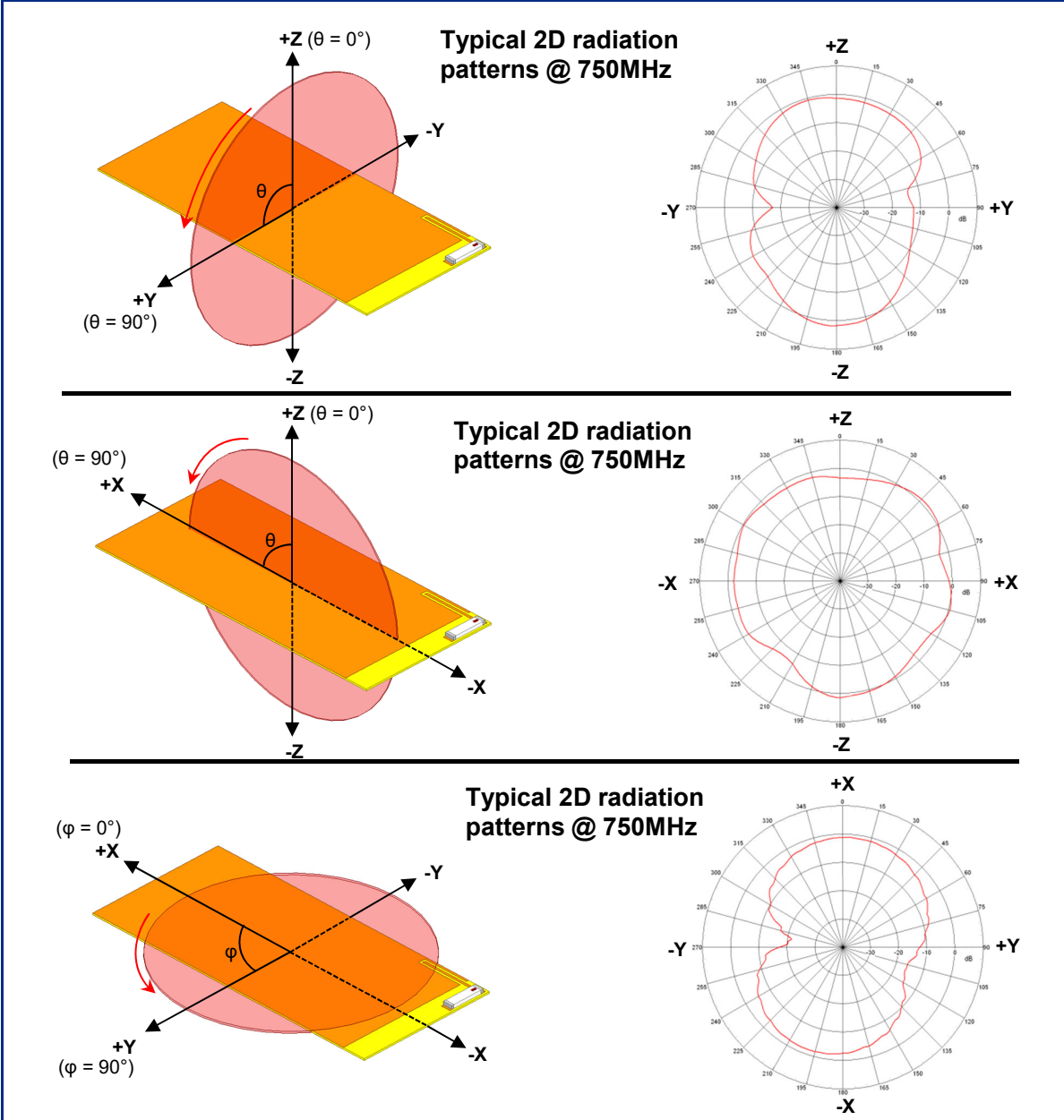
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## Tuning Version 1: Radiation pattern and gain for P/N 0830AT54A2200-EB1SMA (Low Band)



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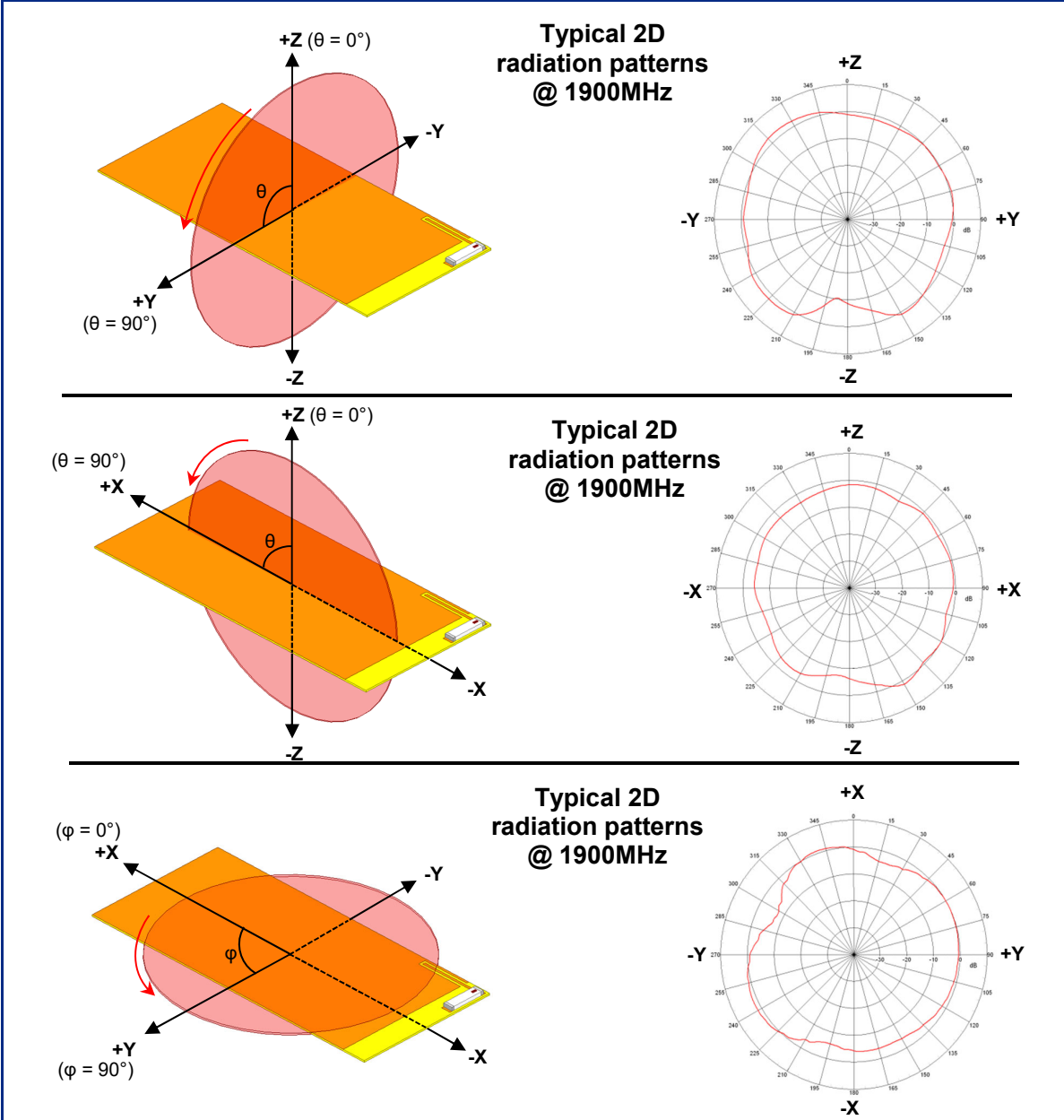
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## Tuning Version 1: Radiation pattern and gain for P/N 0830AT54A2200-EB1SMA (High Band)



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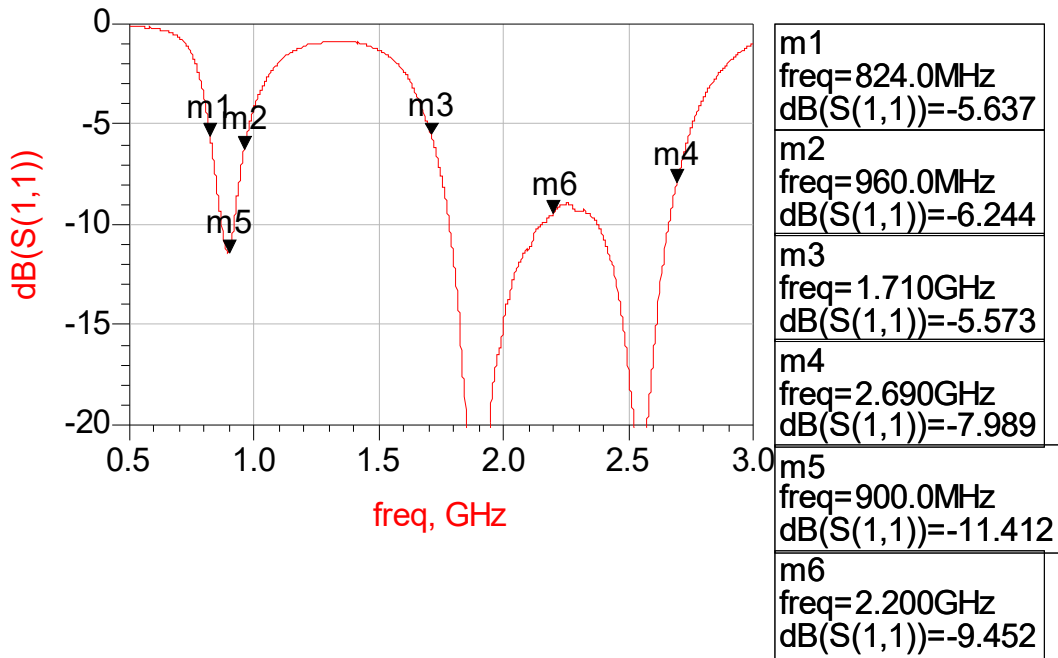
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## Typical Electrical Characteristics (T=25°C) Tuning Version 2

### Tuning Version 2: Evaluation Board p/n: 0830AT54A2200-EB2SMA



To order a pre-tuned 50Ω EVB with a female SMA connector for "Tuning Version 2" click here: <https://www.johansontechnology.com/request-a-sample>  
Reference p/n: 0830AT54A2200-EB2SMA

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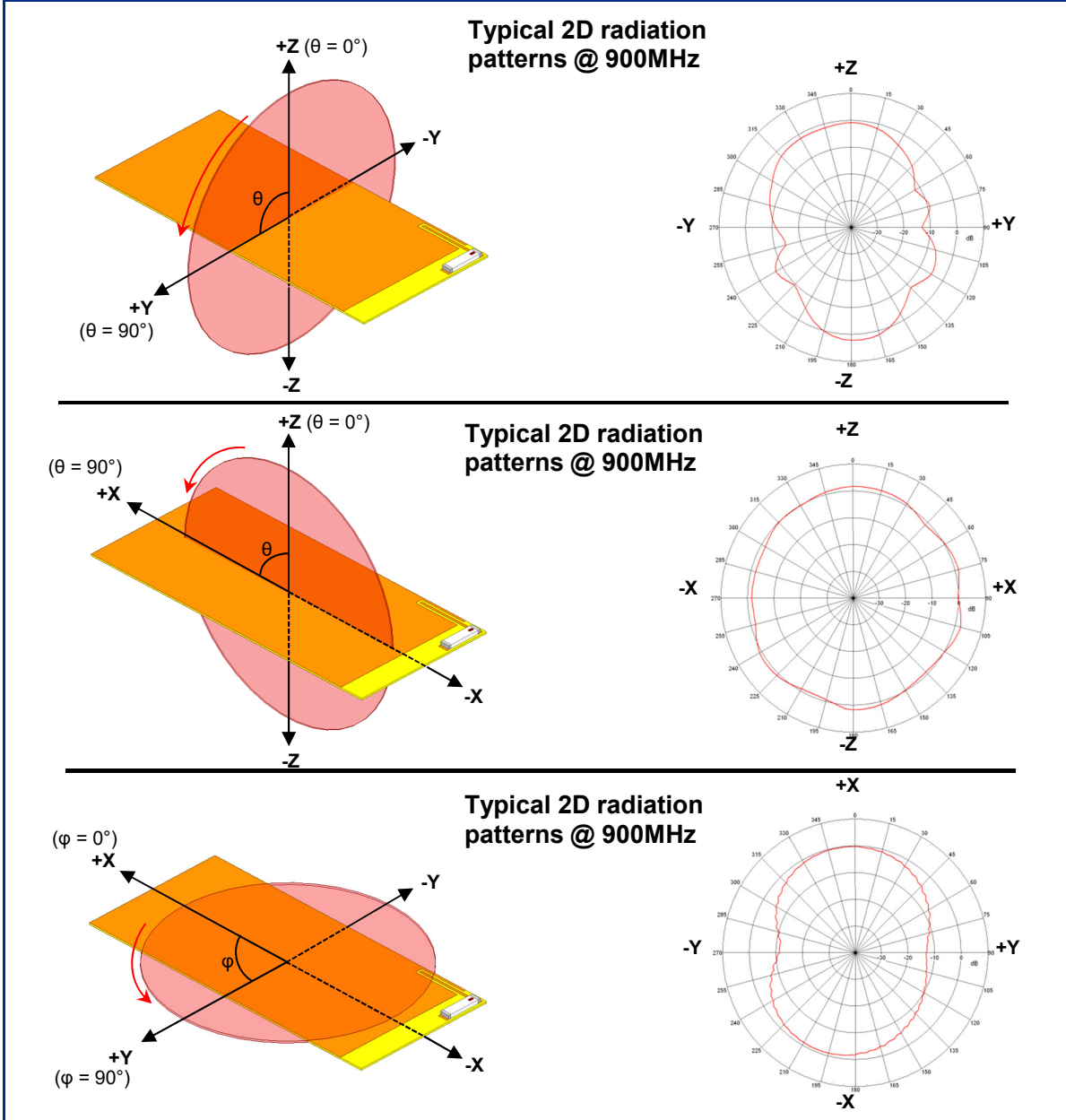
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## Tuning Version 2: Radiation pattern and gain for P/N 0830AT54A2200-EB2SMA (Low Band)



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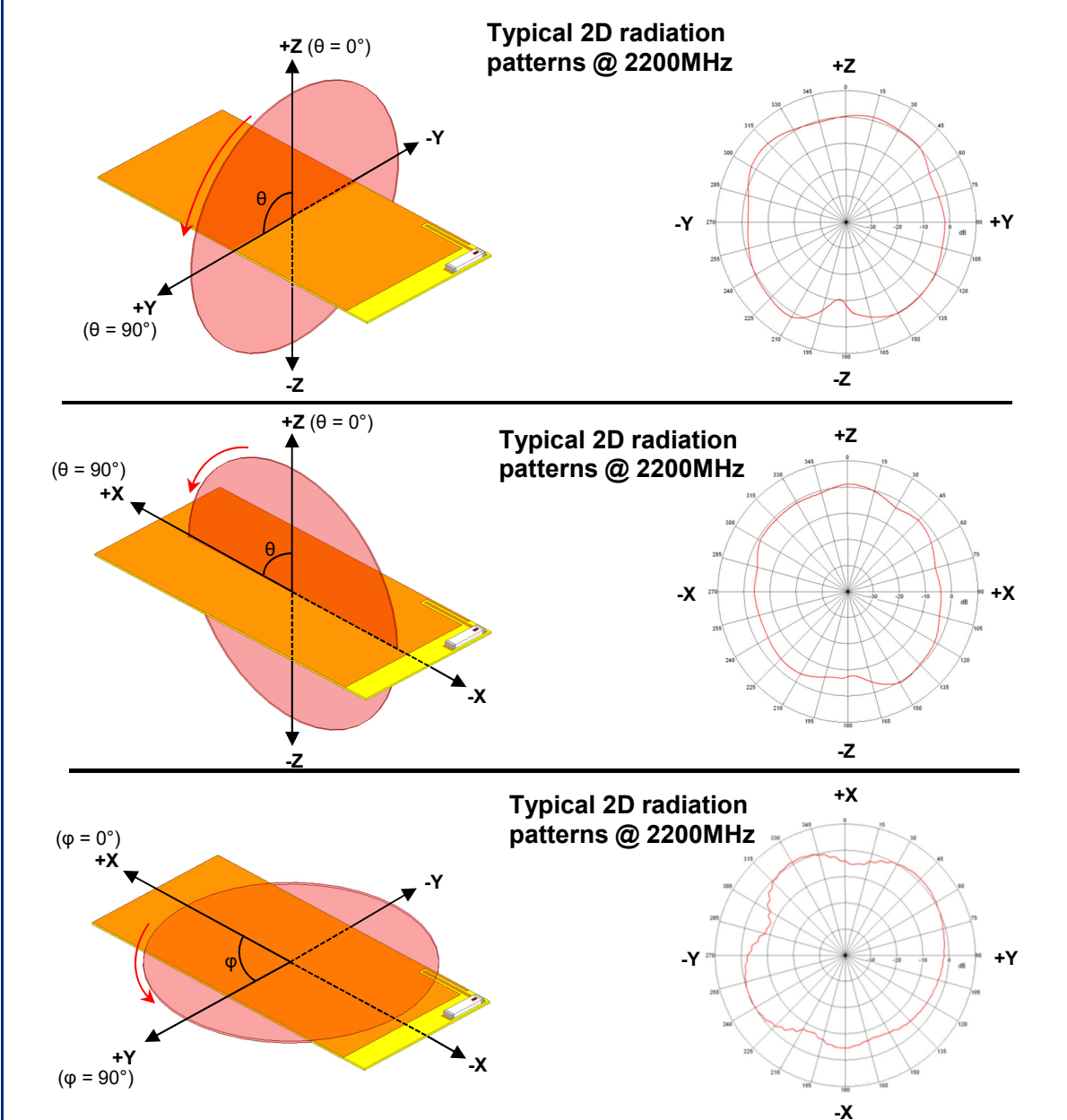
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## Tuning Version 2: Radiation pattern and gain for P/N 0830AT54A2200-EB2SMA (High Band)



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## Antenna switch application note

<https://www.johansontechnology.com/downloads/app-notes/jti-an090.pdf>

## Antenna tuning, optimization, and validation services:

<https://www.johansontechnology.com/ipc-antenna-services>

## For more antennas and to download measured S-parameters, go to:

<https://www.johansontechnology.com/antennas>

## Soldering Information

<https://www.johansontechnology.com/ipcsoldering-profile>

## MSL Info

<https://www.johansontechnology.com/msl-rating>

## Packaging information

<https://www.johansontechnology.com/tape-reel-packaging>

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## RoHS Compliance

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## Qorvo RFSW6062 Switch

<https://www.qorvo.com/products/p/RFSW6062>

## Hexawave HWS556 Switch

[http://www.hw.com.tw/PDF/Switch/HWS556\\_V2.pdf](http://www.hw.com.tw/PDF/Switch/HWS556_V2.pdf)

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