Improving Mobile Signal Reception Strength using Network Booster

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Abstract— One of the largest complaints mobile users create has poor signal. Not having the ability to form a decision, missing calls and having slow web speeds is usually terribly frustrating. For businesses, not having the ability to receive calls will mean revenue loss and upset customers. The major objective of the mobile signal booster is to enhance the reach of the signal to remote areas such as regions with thick walls, hilly terrains, black spots, dead zones etc. The function of the mobile phone signal booster is to take an existing cell signal, typically found outside your home, office, amplify the signal and then broadcast it to an area which has weak or no signal. A mobile phone signal booster system consists of an external antenna, a signal boosting amplifier unit and an internal antenna, with cables connecting all of the components. This research paper includes specifications of existing signal booster systems, comparative study with home-made antenna and Minimal Implementation of work in Real time environment.

Keywords: External Antenna, Signal Booster System, Internal Antenna, Repeater, Dead Zone

I. INTRODUCTION

The Signal Booster Circuit basically helps the service provider to rectify the poor signal service. It can be operated according to the user's convenience and requirement. This signal booster is economical as all the components used are of low cost and hence total cost has been integrated. It is user-friendly and eco-friendly. These are similar to the cellular broadcast towers used by the network providers for broadcasting, but are much smaller in size and are recommended to use for a particular building only. Modern signal booster system amplifiers rebroadcast cellular signals inside our home or building. Signal Booster System can also be called as a Signal Repeater. Repeater could be a networking device that, as the name suggests, repeats the signal or increases the reach of the existing wireless network. Very often, it happens that a tool needs to be connected to associate degree existing wireless network, but it is away in a remote place in the house or a building, where the signal strength is too low or reachable. A signal booster system is used in such cases to boost the signal strength or simply repeat the signal so that the said mobile unit comes under the coverage area. The systems typically use associate degree external transmitting aerial to gather the simplest cellular signal that is then transmitted to associate degree electronic equipment unit that amplifies the signal, and retransmits it locally, providing significantly improved signal strength.

II. PRE REQUISITE

A. *Dead Zone:*

A mobile signal (or reception) is that the signal strength (measured in dBm) received by the mobile phone from the cellular network (on the down link). Depending on varied factors, like proximity to a tower, obstructions like buildings or trees, etc., the signal strength can vary. Most mobile devices use a collection of bars of accelerating height to show the approximate strength of the received signal to the transportable user. Areas where mobile phones cannot transmit to a nearby mobile site, base station, or repeaters are known as dead zones. In these areas, the mobile phone is said to be in a state of outage. Dead zones area unit typically areas wherever transportable service isn't accessible as a result of the signal between the phone and mobile website antennas is blocked or severely reduced, usually by hilly terrain, dense foliage, or physical distance.

A number of things will produce dead zones, which can exist even in locations during which a wireless carrier offers coverage, because of limitations in cellular specification (the locations of antennas), restricted network density, interference with different mobile sites, and topography.

Since cell phones have faith in radio waves, that travel through the air and area unit simply attenuated (particularly at higher frequencies), mobile phones could also be unreliable sometimes.

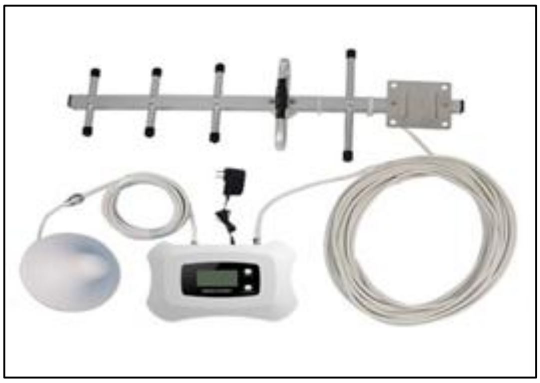
Like different radio transmissions, transportable calls may be interrupted by giant buildings, terrain, trees, or different objects between the phone and therefore the nearest base station.

B. *Antenna:*

The following antennas are most suitable for mobile communication: Directional and Omni-directional GSM antennas will be either directional or omnidirectional. Omni-directional antennas, also known as helical antennas, can receive signals from any direction. Directional antennas usually have more gain, that is, more sensitivity to signal, than omnidirectional antennas. Directional antennas accomplish this greater sensitivity because they are able to focus their energy patterns onto a smaller area than omni-directional antennas. However, to receive signal, directional antennas must be pointed in the specific direction from which the signal is emanating.

III. EXISTING SIGNAL BOOSTER SYSTEMS

A. *ATNJ AS-D2 Mobile Signal Booster System*



Brand Name: ATNJModel
Number: AS-D2
Frequency Band: DCS LTE 1800mhz
Uplink Frequency Range: 1710-1785mhz
Downlink Frequency Range: 1805-1880mhz
Gain: 70dB
Output Power: 17-23dBm
Improve: Voice + 2G 4G
Internet Coverage: 250 sqm without barriers
Accessories: inside/outside Antenna, 15m cable
Cost: US$93 approx.

B. Lintratek KW20L-DCS Mobile Signal Booster System

Brand Name: Lintratek
Model Number: KW20L-DCS
Uplink Frequency Range:1710-1785Mhz;
Downlink Frequency Range:1805-1880Mhz
Gain: 70dB
Output Power: 20dBm
Power supply: AC: 100~240V 50/60Hz; DC: 12V
Coverage: 200-500 sqm without barriers
Accessories: Yagi antenna ceiling antenna and 15M cable
Cost: US$92 approx.

C. JinRui Mobile Signal Booster System

Brand Name: JinRui
Model Number: JR-LCD-GD27coverage area:500sqm
Gain: 70dB
Output Power: 27dbm
Frequency Range Uplink: 890~915/1920-1980MHz
Frequency Range Down Link: 935~960 /2110-2170 MHz
Power Supply: AC110V~240V,50/60Hz; DC:12V/2A
Cost: US$133 approx.

IV. METHODOLOGY

The aim is to increase the strength of signal by manually designing different mobile booster system along with home-made antenna and analyze the performance to improve the signal strength for better transmission.
To overcome drawbacks of existing technology such as:

A. The High Cost of Booster System Available in the Market:

The booster systems available in the market cost very high in dollars and are easily available in foreign countries.
This adds to the value of travel or shipping the merchandise to the user destination.

B. The Reduced Mobile Network Signal Strength:

This aims at increasing the amount of access points however in spite of those there are some hot spots or locations wherever the range is not available as a result of that we have a tendency to receive weaker signal strength.

The objective is to use home-made mobile booster system. Home-made cost effective system provides us with improved signal strength. To achieve this, we need to study the various parameters of booster system available in the market, and increase the signal strength thereby improving the performance of our system. The work can be done on Real-Time basis by testing the performance of booster system in the campus at locations where the signal strength is weak.

V. SPECIFICATION OF MOBILE BOOSTER SYSTEM

It consists of three parts which are mentioned below:
1) Indoor Antenna
2) Outdoor Antenna
3) Mobile Booster Circuit

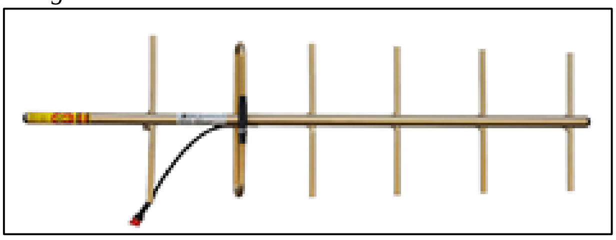
A. Indoor Antenna

1) Monopole Antenna:

Monopole antenna consist of a small pole placed upon a planar piece of metal or a series of wires radiated out from the pole. Monopole antenna are omni-directional in nature and have equal gain in all directions so that we can use it in indoor environment.

B. Outdoor Antenna

1) Yagi Uda Antenna



A Yagi antenna is a directional antenna consisting of a driven element such as dipole or folded dipole and additional parasitic elements, typically a reflector and one or more directors. It radiates in only one direction and is most commonly used in point-to-point communications.

A Yagi antenna is used for communications in a medium range of three to five miles between two points. It can also be used as a bridge antenna to connect clients to an access point. This term is also known as a Yagi-Uda array or patch antenna.

2) Designing Yagi Uda Antenna

There are no simple formulas for designing Yagi–Uda antennas due to the complex relationships between physical parameters such as element length and spacing, element diameter, performance characteristics- gain and input impedance.

However using the above kinds of iterative analysis one can calculate the performance of a given a set of parameters and adjust them to optimize the gain (perhaps subject to some constraints). Since with an n element Yagi–Uda antenna, there are $2n - 1$ parameters to adjust (the element lengths and relative spacing). This iterative analysis method is not a straightforward. The mutual impedances plotted above only apply to $\lambda/2$ length elements, so these might need to be recomputed to get good accuracy.

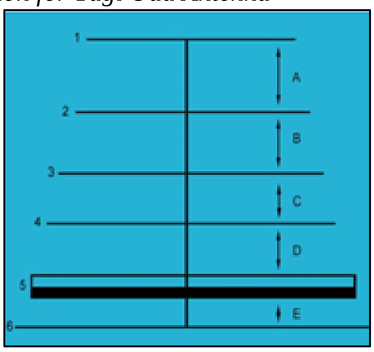
The current distribution along a real antenna element is only approximately given by the usual assumption of a classical standing wave, requiring a solution of Hallen's integral equation taking into account the other conductors. Such a complete exact analysis considering all of the interactions mentioned is rather overwhelming, and approximations are inevitable on the path to finding a usable antenna.

Consequently, these antennas are often empirical designs using an element of trial and error, often starting with an existing design modified according to one's hunch. The result might be checked by direct measurement or by computer simulation.

A well-known reference employed in the latter approach is a report published by the National Bureau of Standards (NBS) (now the National Institute of Standards and Technology (NIST)) that provides six basic designs derived from measurements conducted at 400 MHz and procedures for adapting these designs to other frequencies. These designs, and those derived from them, are sometimes referred to as "NBS yagis."

By adjusting the distance between the adjacent directors it is possible to reduce the back lobe of the radiation pattern.

3) Calculation for Yagi Uda Antenna



In our case we have built 2G 900Mhz antenna. For this calculation are as below (all lengths are in meters):

Required frequency = 900Mhz

a) Length of Director 1:
120 / frequency
120/900 = 0.1333 Meters
Interval A between 1st Director & 2nd Director:
60 / frequency
60/900 = 0.0666 Meters

b) Length of Director 2:
125 / frequency
125/900 = 0.1388 Meters
Interval B between 2nd Director & 3rd Director:
45 / frequency
45/900 = 0.05 Meters

c) Length of Director 3:
130 / frequency
130/900 = 0.1444 Meters
Interval C between 3rd Director & 4th Director:
30 / frequency
30/900 = 0.0333 Meters

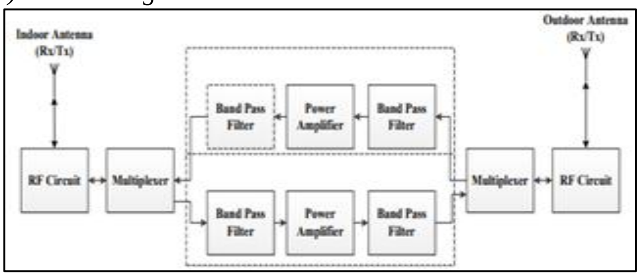
d) Length of Director 4:
138 / frequency
138/900 = 0.1533 Meters
Interval D between 4th Director & Folded Dipole:
30 / frequency
30/900 = 0.0333 Meters

e) Length of Dipôle:
143 / frequency
143/900 = 0.1588 Meters
Interval E between Folded Dipole & Reflector:
48 / frequency
48/900 = 0.0533 Meters

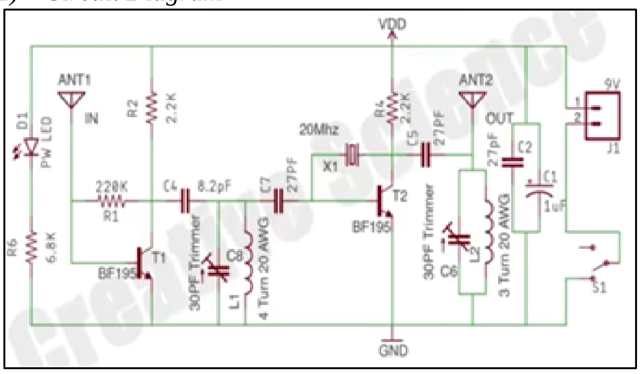
f) Length of Reflector:
150 / frequency
150/900 = 0.1666 Meters

C. Mobile Booster Circuit

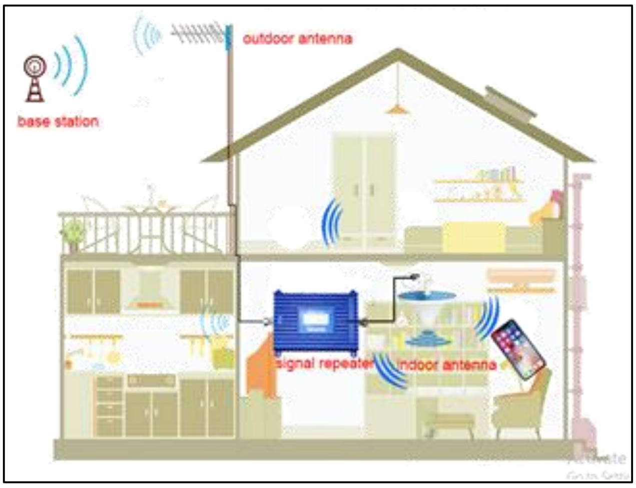
1) Block Diagram



2) Circuit Diagram



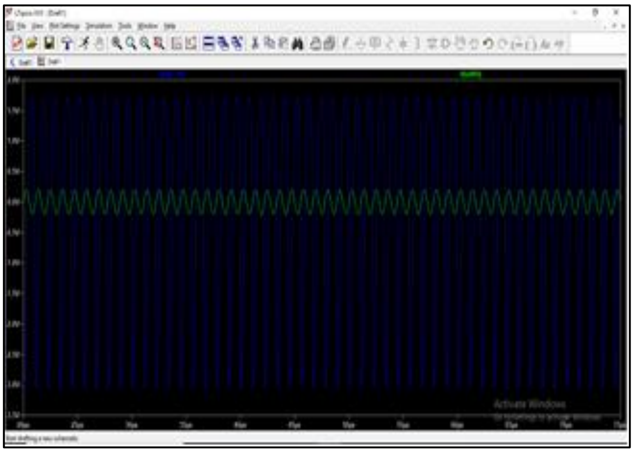
VI. IMPLEMENTATION



The major advantage of this booster system is that it enhances the applicability of mobile phones. Although mobile phones have got greater reach in today's world, the lack of mobile phone signal still remains its major short coming. This signal booster circuit will be useful in overcoming this demerit. In times of disasters, the cell phone signals become very weak. This system would enable communication even in times of crisis.

The Mobile Signal Booster System includes an antenna, an amplifier, and a coaxial cable that connects them. The antenna is placed either outside your building or on a window and then you can string the coaxial cable to the most convenient spot to place the amplifier. Some cell repeaters include an additional indoor antenna, but many of them integrate that into the amplifier.

The antenna grabs a range of supported frequencies and then retransmits them with a stronger signal from the amplifier. When you make a call or use data when within the cell repeater's range, the indoor antenna picks up the signal from your mobile phone and transmits it through the outdoor antenna.



VII. RESULTS AND DISCUSSION

The aim is to increase the strength of signal by manually designing different mobile booster system along with home-made antenna and analyze the performance to improve the signal strength for better transmission and to overcome drawbacks of existing technology.

We have analyzed from our observations that signal may be increased in low coverage areas with the assistance of those boosters.

We have observed the amplifications of Mobile Signal when booster is ON and OFF.
Hence, practically also proved the importance of repeater in enhancing the signal.

Finally, we conclude by saying that repeaters can improve the signal strength in low signal coverage areas to such an extent that everyone can receive signals without having any disturbances.

VIII. SIMULATION OUTPUT

For Network Booster Circuit:
Input Voltage: 2V
Output Voltage: 10V

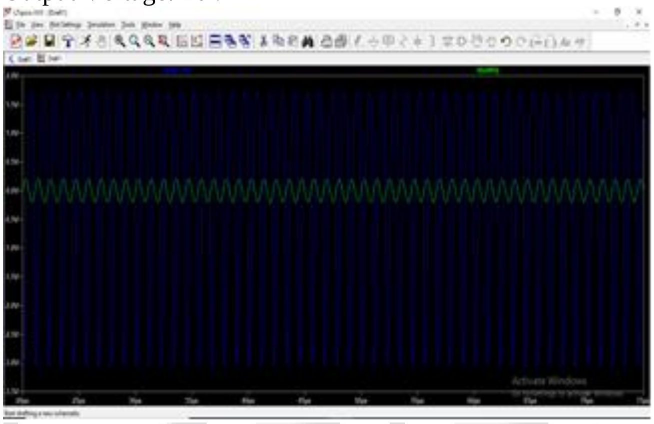


Fig: Simulation output on LT Spice software for Booster Circuit

For Yagi Uda Antenna (Outdoor Antenna):
Required Input Power: Less than -10db
Obtained Input Power:

1. -14.79db for 832.455569MHz
2. -11.58db for 863.07226MHz
3. -12.21db for 898.65332MHz (900MHz Approx.)
4. -12.50db for 934.54550MHz

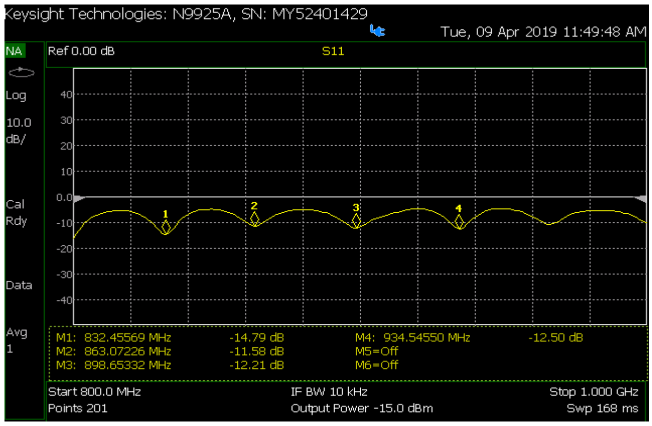


Fig: Simulation result – Yagi Uda Antenna (Log Chart obtained on Network Analyzer)

Obtained Input Impedance:

1. 45.37Ω + j16.60Ω for 832.455569MHz
2. 77.91Ω + j19.68Ω for 863.07226MHz
3. 35.85Ω + j15.28Ω for 898.65332MHz (900MHz Approx.)
4. 32.68Ω + j8.75Ω for 934.54550MHz

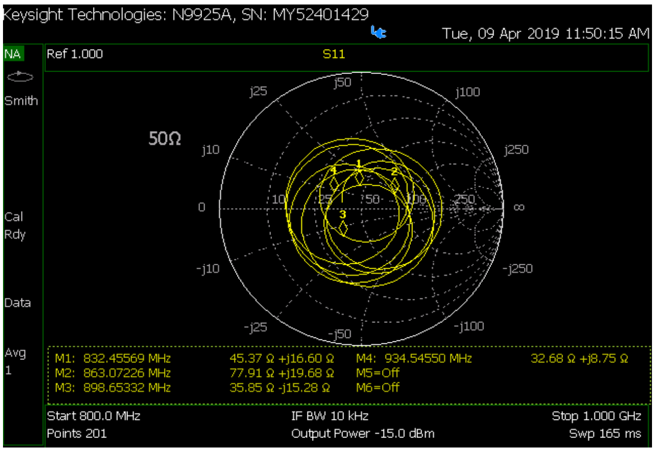


Fig: Simulation result – Yagi Uda Antenna
(Smith Chart obtained on Network Analyzer)

Required VSWR: Approximately 1 or Less than 1

Obtained VSWR:

1. 1.445 for 832.455569MHz
2. 1.722 for 863.07226MHz
3. 1.644 for 898.65332MHz (900MHz Approx.)
4. 1.627 for 934.54550MHz

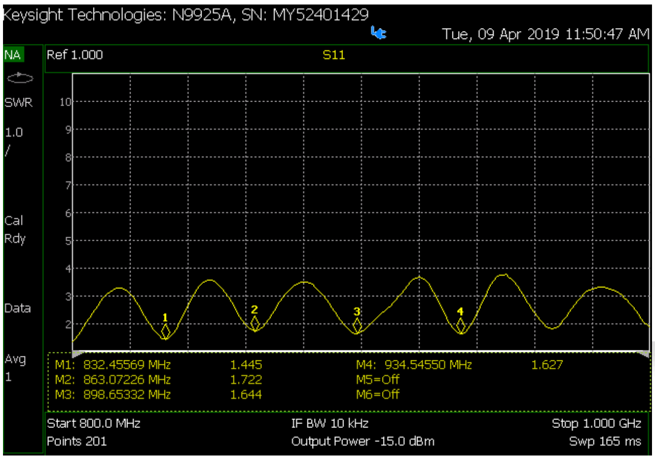


Fig: Simulation result – Yagi Uda Antenna
(VSWR obtained on Network Analyzer)

For Monopole Antenna (Indoor Antenna):

Required Input Power: Less than -10db

Obtained Input Power:

1. -37.87db for 893.65608MHz
2. -22.30db for 900.13766MHz

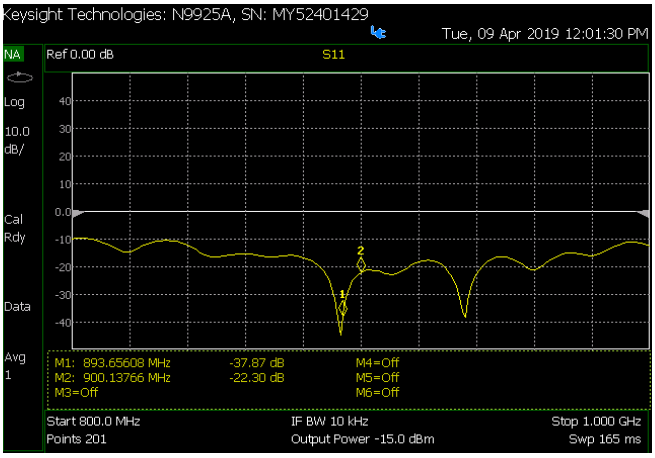


Fig: Simulation result – Monopole Antenna
(Log Chart obtained on Network Analyzer)

Obtained Input Impedance:

1. 49.98Ω + j1.50Ω for 893.65608MHz
2. 57.23Ω + j4.68Ω for 900.13766MHz

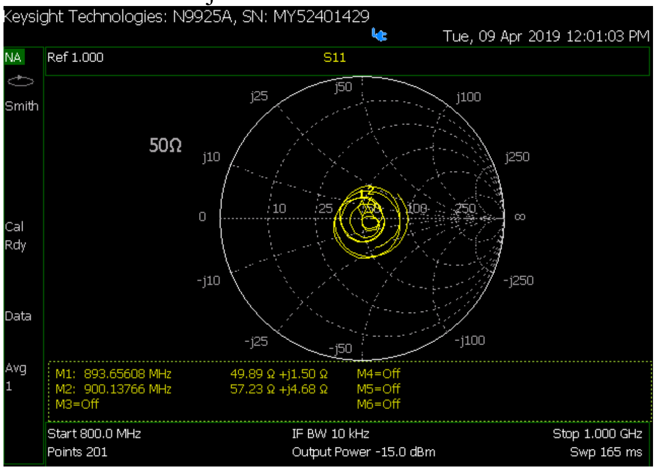


Fig: Simulation result – Monopole Antenna
(Smith Chart obtained on Network Analyzer)

Required VSWR: Approximately 1 or Less than 1

Obtained VSWR:

1. 1.033 for 893.65608MHz
2. 1.175 for 900.13766MHz

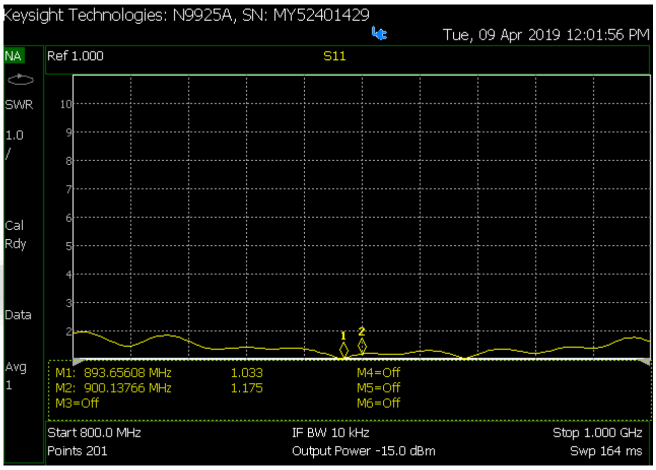


Fig: Simulation result – Monopole Antenna
(VSWR obtained on Network Analyzer)

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