GENERAL RULES

- ***FM BROADBAND ANTENNAS***
  (Dipole, Yagi, Panel, Circular),
- ***VHF-UHF-SHF ANTENNAS***
  (Corner, Yagi, Parabols from 200 Mhz to 2,5 Ghz),
- ***FM STAR TYPE COMBINERS***
- ***FM DOUBLE BRIDGE COMBINERS***
- ***COAXIAL CAVITIES AND NOTCH***
- ***POWER SPLITTERS***
- ***HYBRID COUPLERS***
- ***DIRECTIONAL COUPLERS***
- ***CABLES, CONNECTORS AND ADAPTERS***
- ***INSTALLATION ACCESSORIES***

WARRANTY

Label Italy Srl warrants each new product manufactured to be free from defects in material and workmanship and agrees to remedy any such defect, or to furnish a new part, in exchange for any part of any unit which under normal installation, use, and service discloses such defect within 1 year from the date of purchase by original owner. This warranty does not extend to any of our products which have been subjected to misuse neglect, accident, incorrect wiring, improper installation or to use in violation of instruction furnished by us. Nor does it extend to units which have been repaired or altered outside of our factory nor to accessories used therewith not of our own manufacture. Label Italy reserves the right to make any changes deemed necessary or desirable without advance notice incurring any obligation to make like changes in units previously manufactured or sold. This warranty does not cover transportation or installation cost that may be incurred. Label Italy’s sole liability is the remedy of any defect for 1 year. Label Italy is not responsible for personal injury or property damage resulting from improper or careless installation or usage not intended by the manufacturer. No person is authorized to assume for us any other liability in connection with the sale of our product. You must furnish model code, serial number, date, place and proof of purchase. Such as a copy of the sales receipt to establish warranty. Your letter should include all pertinent details along with part or item serial number involved. Do not return anything until requested to do so.

WARNING

When energized by an RF transmitter, this antenna system will present a high intensity R.F. field.
Care should be taken not to touch the antenna system when energized unless performing touch test under factory supervision. It is not advisable to remain near the antenna for extended periods of time while the antenna system is energized. All the maintenance or repairs should be done with the transmitter switched off . If the antenna is not pressurized, condensation can occur inside the antenna harness resulting in possible failure of the antenna.

LIGHTNINGS - ORIGINS AND PROTECTION CRITERIA

The violent and timely atmospheric perturbations, in which electrical phenomena are involved, such a lighting strokes, have an important influence on the choice of the site in which the transmitting station will be created. In the low part of the clouds, there is an important quantity of negative loads, while in the upper part there is the same quantity of positive loads. When the ionization of the surrounding air reaches some critical values in the low part of the cloud, a discharge towards the earth is developed, and determines an elevating counter-discharge that will intercept the descending discharge. The ground draining of the electrical loads enable the passage of a current pulse that goes from a value of a few KA to several thousands of KA with an intense electrical field that reaches 300.000 Volt/m: such a passage represents the visible part of the lightning stroke, which can be one Km long if the discharge happens between the cloud and the earth. On very high structures, especially if they are situated in dominating positions such as radio and television transmitting installations, during the storm perturbations some over-tensions that create real elevating discharges can be observed.
One must keep in mind that during the discharge phenomenon there can be some clouds which are electrically loaded and which have not already found their discharge channel ; these positions consist of materials that are good electric conductors and that because of its nature the lightning stroke chooses the way that presents the lowest electrical resistance.
One realizes the importance and delicateness of the problem and the resolution of the lightning themselves. The lightings phenomenon depends much on probability, and as a consequence, one can never have the absolute and guaranteed certainty to be protected. One should not protect all the positions without any discrimination, but protect the positions that could be touched more easily in reason of the geographical characteristics of the terrain.

The most important and preferred criteria that must be followed for the protection of the radio electrical stations are normally the following:

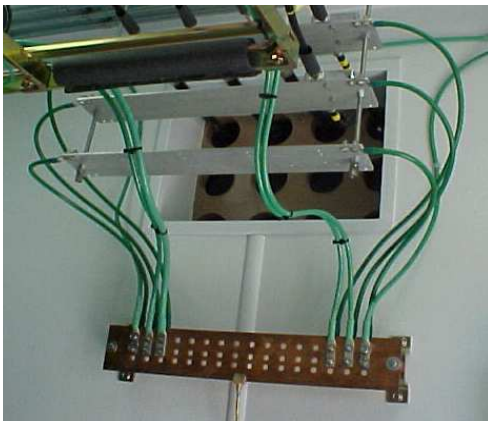
1) Creation of a valid grounding system for the whole site, this system must have a low resistance value of discharge dispersion.

2) Shielding of all the electrical and radio electrical circuits after the supply transformation.

3) Superposition of opportune voltage limiters in the connection points between the screened and non-screened circuits including the isolation of such circuits.

The antenna tower, the equipment room, but also the transformation box must be connected to the same grounding system.

Such system must be designed and built in such way that it guarantees the major and uniform equipotentiality between the different parts. Moreover, the resistance value of discharge dispersion must be low enough. As far as material is concerned, one can use both copper or zinc-plated steel under the form of cords or plaits but copper is more resistant to corrosion. In order to avoid more risk, one can install some isolation transformers in the supply network. One must pay particular attention to the dispersor, which is directly connected to the antenna tower which is encharged of dispersing almost all the lightning current to the ground. The dispersor can be either vertical (pickets) or horizontal (rings or nets), depending on the resistivity of the terrain.



Finally, it will be necessary to link the metallic fence to the general grounding system, while the distance between such fence and the dispersors of the system shall not exceed 5 meters. One should remember that in order to have a more efficient shielding, the screens of the cables and the metallic sheaths must be grounded at both ends. All the grounding connections must have a short and rectilinear path and have multiple interconnections.

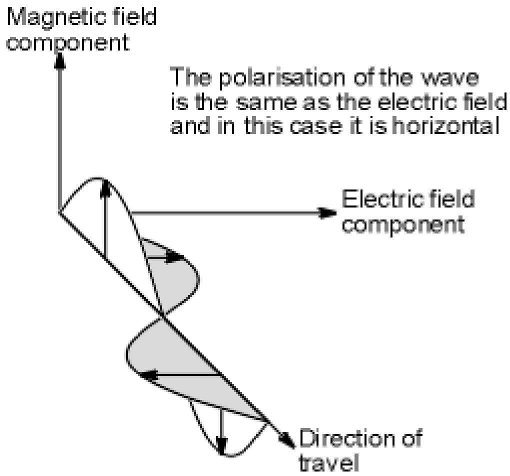
To conclude, the lightning stroke generally touches the antenna tower that carries the radiating antennas.

In order to avoid serious damages it is necessary that the antennas are situated with large margin, within the protection cone of the tower. Otherwise it is indispensable to install metallic rods that pick-up the discharges to the top of the tower connected to it with a good electrical contact.

POLARISATION

The Polarisation is an important factor for RF antennas and radio communications in general. Both RF antennas and electromagnetic waves are said to have a polarization. For the electromagnetic wave the polarization is effectively the plane in which the electric wave vibrates. This is important when looking at antennas because they are sensitive to polarisation and generally only receive or transmit a signal with a particular polarization. For most antennas it is very easy to determine the polarization. It is simply in the same plane as the elements of the antenna. So a vertical antenna (i.e. one with vertical elements) will receive vertically polarised signals best and similarly a horizontal antenna will receive horizontally polarised signals.

LABEL ITALY SRL - Via S. Allende, 59 – 41122 MODENA
TEL: 059/362993 FAX: 059/376056
P.IVA 02578750362 Capitale Sociale 32.500 Euro
web -www.labelitaly.com e-mail - info@labelitaly.com



An electromagnetic wave

It is important to match the polarization of the RF antenna to that of the incoming signal. In this way the maximum signal is obtained. If the RF antenna polarization does not match that of the signal there is a corresponding decrease in the level of the signal. It is reduced by a factor of cosine of the angle between the polarisation of the RF antenna and the signal. Accordingly the polarisation of the antennas located in free space is very important, and obviously they should be in exactly the same plane to provide the optimum signal. If they were at right angles to one another (i.e. cross-polarised) then in theory no signal would be received. For terrestrial radio communications applications it is found that once a signal has been transmitted then its polarisation will remain broadly the same. However reflections from objects in the path can change the polarisation. As the received signal is the sum of the direct signal plus a number of reflected signals the overall polarisation of the signal can change slightly although it remains broadly the same.

POLARISATION CATEGORIES

Vertical and horizontal are the simplest forms of antenna polarization and they both fall into a category known as linear polarisation. However it is also possible to use circular polarisation.
Circular polarisation can be seen to be either right or left handed dependent upon the direction of rotation as seen from the transmitter. Another form of polarisation is known as elliptical polarisation. It occurs when there is a mix of linear and circular polarisation. However it is possible for linearly polarised antennas to receive circularly polarised signals and vice versa. The strength will be equal whether the linearly polarised antenna is mounted vertically, horizontally or in any other plane but directed towards the arriving signal.
There will be some degradation because the signal level will be 3 dB less than if a circularly polarised antenna of the same sense was used. The same situation exists when a circularly polarised antenna receives a linearly polarised signal.

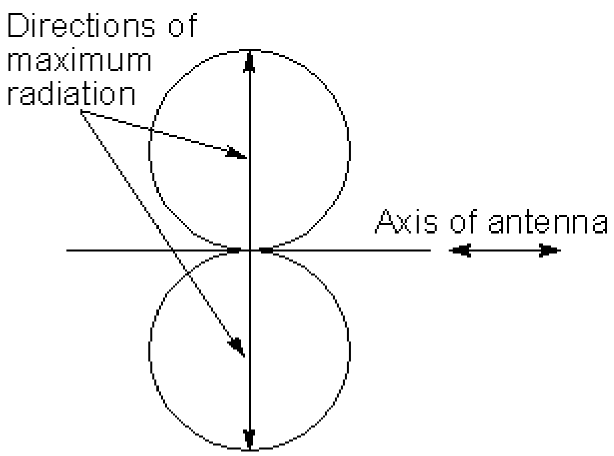
APPLICATIONS OF ANTENNA POLARISATION

Different types of polarisation are used in different applications to enable their advantages to be used. Linear polarization is by far the most widely used for most radio communications applications. Vertical polarisation is often used for mobile radio communications. This is because many vertically polarized antenna designs have an omni-directional radiation pattern and it means that the antennas do not have to be re-orientated as positions as always happens for mobile radio communications as the vehicle moves. For other radio communications applications the polarisation is often determined by the RF antenna considerations. Some large multi-element antenna arrays can be mounted in a horizontal plane more easily than in the vertical plane. This is because the RF antenna elements are at right angles to the vertical tower of pole on which they are mounted and therefore by using an antenna with horizontal elements there is less physical and electrical interference between the two. This determines the standard polarisation in many cases.

In some applications there are performance differences between horizontal and vertical polarization. For example medium wave broadcast stations generally use vertical polarisation because ground wave propagation over the earth is considerably better using vertical polarization, whereas horizontal polarization shows a marginal improvement for long distance communications using the ionosphere. Circular polarisation is sometimes used for satellite radio communications as there are some advantages in terms of propagation and in overcoming the fading caused if the satellite is changing its orientation.

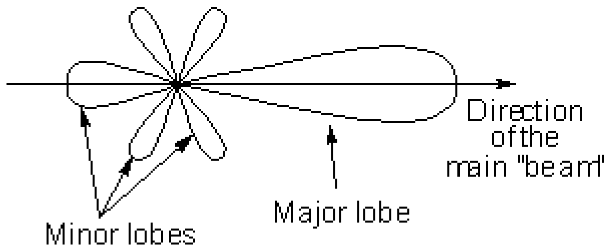
DIRECTIVITY

the aerials do not radiate equally in all directions. It is found that any realizable RF antenna design will radiate more in some directions than others. The actual pattern is dependent upon the type of antenna design, its size, the environment and a variety of other factors. This directional pattern can be used to ensure that the power radiated is focused in the desired directions. It is normal to refer to the directional patterns and gain in terms of the transmitted signal. It is often easier to visualize the RF antenna is terms of its radiated power, however the antenna performs in an exactly equivalent manner for reception, having identical figures and specifications. In order to visualize the way in which an antenna radiates a diagram known as a polar diagram is used. This is normally a two dimensional plot around an antenna showing the intensity of the radiation at each point for a particular plane. Normally the scale that is used is logarithmic so that the differences can be conveniently seen on the plot. Although the radiation pattern of the antenna varies in three dimensions, it is normal to make a plot in a particular plane, normally either horizontal or vertical as these are the two that are most used, and it simplifies the measurements and presentation. An example for a simple horizontal polarization dipole antenna is shown below.



Polar diagram of a half wave dipole in free space

Antenna designs are often categorized by the type of polar diagram they exhibit. For example an omni-directional antenna design is one which radiates equally (or approximately equally) in all directions in the plane of interest. An antenna design that radiates equally in all directions in all planes is called an isotropic antenna. As already mentioned it is not possible to produce one of these in reality, but it is useful as a theoretical reference for some measurements. Other RF antennas exhibit highly directional patterns and these may be utilized in a number of applications. The Yagi antenna is an example of a directive antenna and possibly it is most widely used for many applications.



Polar diagram for a yagi antenna

RF ANTENNA BEAM WIDTH

There are a number of key features that can be seen from this polar diagram. The first is that there is a main beam or lobe and a number of minor lobes. It is often useful to define the beam-width of an RF antenna. This is taken to be angle between the two points where the power falls to half its maximum level, and as a result it is sometimes called the half power beam-width.

ANTENNA GAIN

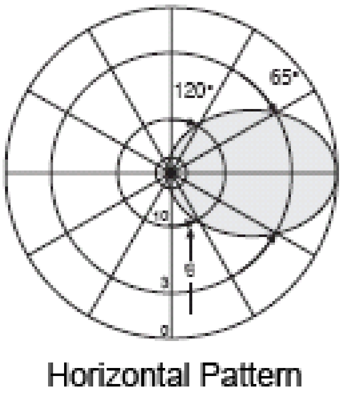
An RF antenna radiates a given amount of power. This is the power dissipated in the radiation resistance of the RF antenna. An isotropic radiator will distribute this power equally in all directions. For an antenna with a directional pattern, less power will be radiated in some directions and more in others. The fact that more power is radiated in given directions implies that it can be considered to have a gain. The gain can be defined as a ratio of the signal transmitted in the "maximum" direction to that of a standard or reference antenna. This may sometimes be called the "forward gain". The figure that is obtained is then normally expressed in decibels (dB). In theory the standard antenna could be almost anything but two types are generally used. The most common type is a simple dipole as it is easily available and it is the basis of many other types of antenna. In this case the gain is often expressed as dBd i.e. gain expressed in decibels over a dipole. However a dipole does not radiated equally in all directions in all planes and so an isotropic source is sometimes used. In this case the gain may be specified in dBi i.e. gain in decibels over an isotropic source. The main drawback with using an isotropic source (antenna dBi) as a reference is that it is not possible to realize them in practice and so that figures using it can only be theoretical. However it is possible to relate the two gains as a dipole has a gain of 2.1 dB over an isotropic source i.e. 2.1 dBi. In other words, figures expressed as gain over an isotropic source will be 2.1 dB higher than those relative to a dipole. When choosing an antenna and looking at the gain specifications, be sure to check whether the gain is relative to a dipole or an isotropic source, i.e. the antenna dBi figure of the antenna dBd figure. Apart from the forward gain of an antenna another parameter which is important is the front to back ratio. This is expressed in decibels and as the name implies it is the ratio of the maximum signal in the forward direction to the signal in the opposite direction. This figure is normally expressed in decibels. It is found that the design of an antenna can be adjusted to give either maximum forward gain of the optimum front to back ratio as the two do not normally coincide exactly. For most VHF and UHF operation the design is normally optimized for the optimum forward gain as this gives the maximum radiated signal in the required direction.
All our antennas have gain in “dBd”

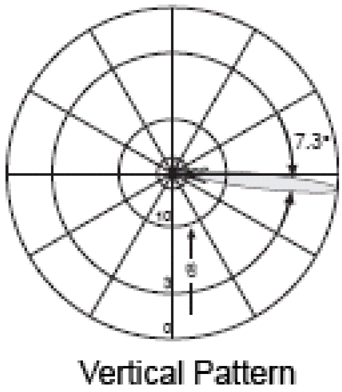
RF ANTENNA GAIN / BEAM WIDTH BALANCE

It may appear that maximizing the gain of an antenna will optimize its performance in a system. This may not always be the case. By the very nature of gain and beam width, increasing the gain will result in a reduction in the beam width. This will make setting the direction of the antenna more critical. This may be quite acceptable in many applications but not in others. This balance should be considered when designing and setting up a radio link.

BEAM TILT

is used in radio to aim the main lobe of the vertical plane radiation pattern of an antenna below (or above) the horizontal plane. The simplest way is mechanical beam tilt where the antenna is physically mounted in such a manner as to lower the angle of the signal on one side. However this also raises it on the other side making it useful in only very limited situations.





Horizontal and vertical radiation patterns, the latter with a pronounced downward beam tilt
More common is electrical beam tilt, where the phasing between antenna elements is tweaked to make the signal go down (usually) in all directions. This is extremely useful when the antenna is at a very high point and the edge of the signal is likely to miss the target entirely.

Electrical tilting, front and back lobes tilt in same direction : for example an electrical downtilt will make both front lobe and back lobe tilt down. This is the property used in the above example where the signal is pointed down in all directions. On the contrary the mechanical downtilting will make the front lobe tilt down and the back lobe tilt up. In almost all practical cases antennas are only tilted down . Occasionally the mechanical and electrical tilt will be used together for odd situations in order to create greater beam tilt in one direction than the other, mainly to accommodate unusual terrain. Along with “null fill” beam tilt is the essential parameter controlling the focus of radio communications and together they can create almost infinite combinations of 3-D radiation patterns for any situation.

NULL FILL

is used in radio antenna systems which are located on mountains or tall towers to prevent too much of the signal from overshooting the nearest part of intended coverage area. Phasing is used between antenna elements to take power away from the main lobe and electrically direct more of it at a more downward angle in the vertical plane. This requires a phased array. Changing the relative power supplied to each element also changes the radiation pattern. Often both methods are used in combination.

SUGGESTED GUYED MAST SECTION

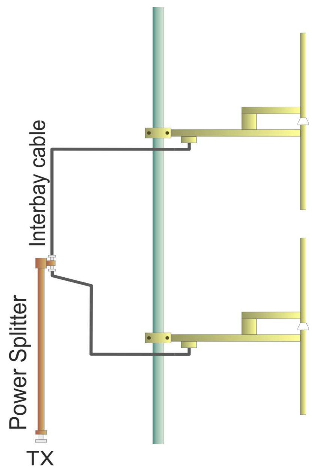
Is suggested install FM Dipole Antennas over guyed masts because the section higher than 110mm can be increase the SWR value and modify the radiation pattern.

DISTANCE ESTIMATION BETWEEN FM ANTENNA BAYS

Wave Lenght $= \lambda = 300 : f(MHz)$
Distance between antenna bays (all antenna types) = d
d (suggested) = $\lambda \times 0.85$

EXAMPLES

88MHz ⋗ $\lambda = 300 : 88 = 3.41$ mt ⋗ d = 3.41 x 0.85 = 2.9 mt
98MHz ⋗ $\lambda = 300 : 98 = 3.06$ mt ⋗ d = 3.06 x 0.85 = 2.6 mt
108MHz ⋗ $\lambda = 300 : 108 = 2.78$ mt ⋗ d = 2.78 x 0.85 = 2.36 mt
Distance d suggested for mid band 2.6mt



RETURN LOSS - VSWR

When designing or building an electronic circuit using radio frequency elements the return loss is of great importance as are the voltage standing wave ratio, and reflection coefficient for the signal. This can be of great importance when using or designing RF equipment. While it is often necessary to calculate the VSWR or return loss when undertaking RF design or maintaining or using RF equipment it can sometimes be useful to convert between return loss, VSWR and voltage reflection coefficient.

Return Loss (dB) is defined as a ratio of the incoming signal to the same reflected signal as it enters a component. The Return Loss (RL) may also be explained as the difference between the power of a transmitted signal and the power of the signal reflections caused by variations in link and channel impedance. A return loss plot indicates how well the link and channel's impedance matches its rated impedance over a range of frequencies. High return loss values mean a close impedance match, which results in greater differentiation between the powers of transmitted and reflected signals.

Table showing the conversion between dbm, Voltage and Power.

dB	Power (times)	Voltage (Times)
0,0	1,00	1,00
1,0	1,26	1,12
2,0	1,58	1,26
3,0	2,00	1,41
4,0	2,51	1,58
5,0	3,16	1,78
6,0	3,98	2,00
7,0	5,01	2,24
8,0	6,31	2,51
9,0	7,94	2,82
10,0	10,00	3,16
11,0	12,59	3,55
12,0	15,85	3,98
13,0	19,95	4,47
14,0	25,12	5,01
15,0	31,62	5,62
16,0	39,81	6,31
17,0	50,12	7,08
18,0	63,10	7,94
19,0	79,43	8,91
20,0	100,00	10,00
21,0	125,89	11,22
22,0	158,49	12,59
23,0	199,53	14,13
24,0	251,19	15,85
25,0	316,23	17,78
26,0	398,11	19,95
27,0	501,19	22,39
28,0	630,96	25,12
29,0	794,33	28,18
30,0	1000,00	31,62

Table showing the conversion between VSWR and return loss.

VSWR	RL dB	VSWR	RL dB	VSWR	RL dB	VSWR	RL dB
1,01	-46,06	1,21	-20,44	1,41	-15,38	1,61	-12,63
1,02	-40,09	1,22	-20,08	1,42	-15,21	1,62	-12,52
1,03	-36,61	1,23	-19,73	1,43	-15,04	1,63	-12,41
1,04	-34,15	1,24	-19,40	1,44	-14,88	1,64	-12,31
1,05	-32,26	1,25	-19,08	1,45	-14,72	1,65	-12,21
1,06	-30,71	1,26	-18,78	1,46	-14,56	1,66	-12,11
1,07	-29,42	1,27	-18,49	1,47	-14,41	1,67	-12,01
1,08	-28,30	1,28	-18,22	1,48	-14,26	1,68	-11,91
1,09	-27,32	1,29	-17,95	1,49	-14,12	1,69	-11,82
1,10	**-26,44**	**1,30**	**-17,69**	**1,50**	**-13,98**	**1,70**	**-11,73**
1,11	-25,66	1,31	-17,45	1,51	-13,84	1,71	-11,63
1,12	-24,94	1,32	-17,21	1,52	-13,71	1,72	-11,54
1,13	-24,29	1,33	-16,98	1,53	-13,58	1,73	-11,46
1,14	-23,69	1,34	-16,75	1,54	-13,45	1,74	-11,37
1,15	-23,13	1,35	-16,54	1,55	-13,32	1,75	-11,29
1,16	-22,61	1,36	-16,33	1,56	-13,20	1,76	-11,20
1,17	-22,12	1,37	-16,13	1,57	-13,08	1,77	-11,12
1,18	-21,66	1,38	-15,94	1,58	-12,96	1,78	-11,04
1,19	-21,23	1,39	-15,75	1,59	-12,85	1,79	-10,96
1,20	**-20,83**	**1,40**	**-15,56**	**1,60**	**-12,74**	**1,80**	**-10,88**

Some criteria for evaluating antennas

Typical cases of doubt:

• high reflected power,
• a high VSWR,
• a bad adaptation,
• It seems that the antenna absorbs abnormally power from the transmitter

To properly diagnose these apparent failures we have to find out if the cause is the same product just purchased or poor installation of the same. The following F.A.Q. can help determine if the product qualifies as defective by the manufacturer's warranty. Assuming that all connections are clean, dry and tight; also that all the test equipments are in good condition and calibrated:

What VSWR you have measured?
Most of FM antennas have a match of 1.2:1 or 1.4:1 across a specified bandwidth. Performance at a Voltage Standing Wave Ratio greater than 1.5:1 may be unsatisfactory. Performance at a Return Loss of less than -15 dB may be unsatisfactory.

What test equipment did you use?
Check to see that it has been properly calibrated and that any connector adaptors are of good quality. Poorly matched adaptors can invalidate the results.

Wattmeter/Power Meter?
These devices are inexpensive and therefore more common but can be inaccurate, particularly if more than one RF carrier is present. Technicians who use them tell you how many Watts of power is reflected back to the transmitter but often do not know the actual mismatch. The forward power measurement is required to calculate the VSWR or Return Loss number. This can be necessary because some transmitters have an output stage protection circuit which reduces power under highly VSWR conditions.

Network Analyzer/Spectrum Analyzer with Tracking Generator?
These devices do not rely upon the site's transmitter as a signal source. They can produce more accurate and meaningful results but do not control the antenna to full power where arcing or flashover would occur.

Did you perform the measurement directly at the antenna's connector?
The technician may have chosen not to perform this test because it requires climbing the tower. This procedure should be done to eliminate jumper cable effects. These cables could be defective and cause the problem or absorbing the reflection which masks the problem.

What is your operational frequency?
Check to see if the antenna was ordered for the correct frequency. Several methods can be used to determine an antenna's frequency. If the technician has swept the response of the antenna he will know the frequency of best match. That should be its designed frequency. The technician may also measure the physical length so that we may compare it to a cut chart. This is a crude method. If the antenna is of relatively new and the model number is known, the factory may still have the production test data sheet which will identify its frequency by Serial Number.

Did you measure the antenna free and clear of metal objects?
A mounting too close to the tower can detune an antenna. The required spacing between the antenna and any other metal object decreases as the operational frequency increases.

What is the DC continuity measurement using an ohmmeter?
Some antennas have direct ground lightning protection. These normally measure as a DC short between the connector's inner and outer conductor but will be the proper 50 Ohm RF impedance . See lightning notes in the catalog specs to determine if this antenna model should measure as an open or a short.

Did you have the opportunity to substitute an identical antenna?
If the second antenna measures OK under the same mounting conditions, thefirst antenna is probably defective. If the second one yields the same bad result, the problem is unlikely to be the antenna. Perhaps the transmitter is not operating on the expected frequency.

When was the antenna installed?
It could either be new and defective or could have worked well for some time before failing. It is a good practice for technicians to test products on receipt before transporting them to the job site. Manufacturer's warranties cover only manufacturing defects, not damage from an improper installation. An example would be mounting a standard antenna upside-down. This would put the drain hole at the top where it could collect water and cause the product to fail over time

Are the antenna drain holes open?
They are placed at the bottom of the antenna for draining internal moisture. Periodic inspection of these openings is the responsibility of the owner. They must remain clear of debris to preclude corrosion from internal condensation. Such damage can drastically affect performance and is not covered by warranty.

Is the antenna intermittent?
It is a good idea to shake the antenna during the above tests to ensure there are no mechanical intermittents. Poor connections may lead to RF intermodulation products. Water entering the antenna may lead to electrical intermittents which subside when the antenna dries out.

Notes
Match is only one indicator of antenna quality. VSWR tells us how well the product's impedance matches to (absorbs) a transmitters signal and is easy to measure in the field. Unfortunately VSWR does not reveal an antenna's efficiency (how well it radiates the signal).
This measurement (an antenna's radiation pattern) is more difficult to perform in the field. We may presume that match bandwidth and pattern bandwidth are equal, but this may not always be true. Usually, substitution with an identical unit of known quality is the method of choice when a defective product is suspected. The typical VSWR for a good antenna is 1.2:1. Although some site engineers can declare the need for an even lower value. For example at 1.5:1 the 4.0% of the power is reflected back, creating a 0.18 dB loss. At 1.3:1 only the 1.7% is reflected resulting in 0.07 dB loss. The performance improvement is only 0.11 dB. It is a good idea to document performance upon installation. This is usually done by choosing a remote site and measuring the signal level received from the transmitter. Periodic measurements at that same location will reveal the amount of any degradation so corrective action may be taken.