JAYBEAM Wireless™
730 21st St Dr, SE - Hickory, NC 28602 Phone: (828) 324-6971 Fax: (828) 327-6027

Basestation Antenna - VSWR Test Procedure

What is VSWR?

Voltage Standing Wave Ratio (VSWR) is the ratio of the maximum voltage to the minimum voltage in the standing wave on a transmission line. Standing waves are the result of reflected RF energy. As the VSWR approaches 1.00:1, the reflections on the line approach zero and maximum power may be transmitted.

Reflections occur any place where the impedance of the transmission line changes. Inside a typical basestation antenna, the impedance of the line is changed at many places in order to distribute the RF energy across the aperture. Antenna engineers design matching sections inside the antenna to minimize the overall impedance change (and associated reflections) relative to a 50 ohm reference. Measuring the VSWR of the antenna indicates the how closely the antenna is matched to 50 ohms impedance and indicates the magnitude of the reflected energy.

How is VSWR measured?

The VSWR of basestation antennas is measured using a device called a network analyzer. The network analyzer is a meter that injects signals into the antenna across a wide frequency band and measures the magnitude of the reflected signals. Calibration standards are used to "calibrate" or "zero" the network analyzer at the end of a test cable. This point becomes the "reference plane" to which the impedance of the antenna under test is compared.

Finding a proper location to test basestation antennas:

When measuring VSWR, a small amount of RF energy is transmitted by the network analyzer and radiated from the antenna under test. Any external objects (particularly metal objects) in the field of view of the antenna will reflect that energy back into the antenna. This reflected signal will add to or subtract from the internal reflections of the antenna as a function of wavelength, causing ripple to be seen in the VSWR measurement. The magnitude of this ripple can be large enough to make a "good" antenna appear "bad."

When basestation antennas are tested at the factory, the antenna is placed in front of a wall of RF absorbing material. The RF absorber dissipates the radiated energy from the antenna and prevents reflections outside of the antenna from bouncing back into the measurement. This allows an accurate, repeatable measure of the antenna's VSWR and closely simulates the free-space environment the antenna will see in the field.

Since RF absorbing walls are not generally available in the field, care must be taken to minimize external reflections when measuring the antenna. The best test location is one that allows a clear, unobstructed view of the sky over a wide horizontal area. Since most basestation antennas have a wide beam in the azimuth direction, care must be given to minimize obstructions ± 60° on either side of the antenna. Testing the antenna while it is installed on a tower will typically provide good results. If the antenna is being tested on the ground, candidate test locations are fields, empty lots, rooftops or loading docks.

Other considerations:

1) Never test basestation antennas inside a building (unless you have a wall of RF absorber!)
2) Do not point the antenna at the ground.
3) Avoid parked cars, fences and buildings within the field of view of the antenna.
4) Do not put any part of your body in front of the antenna while performing a test. Arms and legs in front of the antenna will cause large reflections!

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Visually inspect all test equipment:

Before beginning a VSWR test, verify that the network analyzer has been calibrated within the previous 12 months.

Determine which test cables, connector adapters and calibration pieces will be required to perform the test. The connector at the end of the test cable must be the same type but opposite sex as the antenna being tested. Connector adapters may be added to the test cable to obtain the required connector type and sex.

The connectors on the calibration pieces (open, short & load) must be the same type and same sex as the connector on the antenna being tested. Connector adapters should not be used on the calibration pieces. Adding connector adapters to the calibration pieces will result in insertion phase errors and will effect the accuracy of the measurement.

Visually inspect all RF connectors on the test cables, adapters and calibration pieces to be used during calibration and test. Make sure there is no trash or metal flakes inside any connector. Clean the connectors, if necessary, using a lent-free cotton or foam swab with isopropyl alcohol. Allow all residual alcohol to evaporate before testing. Verify that the connector pins and sockets are not bent or damaged. (This is a common problem on Type-N connectors.) Verify the connector threads are not damaged. Carefully repair or replace any damaged components found.

Visually inspect the entire length of the test cable assembly for kinks, wear or other signs of physical damage. Look closely at the region where the connectors attach to the cable. This region of the cable assembly can become damaged easily due to repeated cable bending. If damage is found, repair or replace the test cable.

Attach the test cable and any required connector adapters to the network analyzer. Make sure all connections are tight to prevent loosening during the test.

Visually inspect the antenna:
Visually inspect the antenna connector for signs of damage. Verify that the connector pin or socket is not bent or damaged. Verify that the connector threads are not damaged. If damage is found, contact the antenna manufacture for a repair estimate.

Visually inspect the antenna connector to make sure it is clean and dry. If any trash or metal flakes are found, clean the connector using a lent-free cotton or foam swab with isopropyl alcohol. Allow all residual alcohol to evaporate before testing. If water is found inside the connector, dry the connector completely before testing (water inside the connector is the most common reason for high VSWR measurements in the field.)

If the antenna has been previously installed at a site, remove all weatherproofing tar from the connector's external threads prior to testing.

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Calibrate the Network Analyzer:

Calibrate the network analyzer + test cable according to the manufacturer's recommended procedure.

Note: The calibration pieces (open, short & load) must have the same type and same sex connectors as the antenna being tested. Do not use connector adapters on the calibration pieces!

Verify that the calibration is good. Re-attach the load used during calibration to the end of the test cable and observe the VSWR vs. frequency. The plot should be smooth across the frequency band and should have a maximum VSWR value no greater than 1.02:1.

If excessive noise is seen in the measurement, flex each connector and cable joint independently looking for loose or intermittent connections. If necessary, tighten, repair or replace intermittent components and recalibrate.

Re-check the calibration periodically between measurements (hourly if testing outdoors) to insure the calibration remains good. The quality of the calibration will degrade over time due to thermal drift in the network analyzer.

Test the antenna:

Attach the calibrated reference plane (test cable) directly to the antenna under test. Make sure the connection is tight. Observe the maximum VSWR in the frequency range of interest on the network analyzer. Compare the value measured to the antenna manufacturer's specification for that antenna to determine if the antenna is "good" or "bad."

Note: Ensure the defined Frequency range is in accordance with the antenna specifications (PCS: 1850 – 1990 MHz, Cellular: 824-896 MHz or 806-896 MHz). Setting the frequency range beyond the antenna specification range can yield erroneous VSWR readings!

Do not measure the antenna VSWR through a feed line and/or jumper cable! Measuring the antenna + feed line and/or jumper cable will provide a measure of the cascaded mismatch of the various transmission line components. The VSWR measured in this manner is not an accurate measure of the antenna mismatch by itself. To determine whether or not the antenna is functioning correctly, the reference plane of the network analyzer must be connected directly to the antenna under test. (See reference paper on cascaded VSWR measurements.)

For additional information, contact JAYBEAM Wireless Customer Service at:

Phone: 828-324-6971 ext. 302
Fax: 1-828-327-6027