Spider IIIAR Reader

Installation Instructions

FCC Certification

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- ✓ Reorient or relocate the receiving antenna.
- ✓ Increase the separation between the equipment and receiver.
- ✓ Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- ✓ Consult the dealer or an experienced radio/TV technician for help.

Introduction

When placing the reader in a permanent position, several factors need to be considered that contribute to choosing the reader's position.

- ✓ RF visibility
- ✓ Tag density
- ✓ Range configuration
- ✓ Access to Power
- ✓ Access to LAN communication
- ✓ Communication bandwidth
- ✓ Environmental conditions.
- ✓ Serviceability.

RF Visibility

RF Visibility refers to the reader's ability to "see" the tags in its reporting area. The best condition is to have an RF line-of-sight between the reader and all tags. In most cases the Spider IIIAR's RF line-of-sight is equivalent to a visual line-of-sight. However, there are some materials that are transparent to RF but not to light. The spider reader can read tags through a typical wall such as found in an office environment. Some walls are more transparent than others. Metal wall studs, typically grounded to the electrical system ground, absorb the tags signal. However, because there is space between studs, some signal does get through. Different walls have different RF transparencies. Because some walls are more RF transparent than others, they need to be tested to determine their RF transparency.

Example: a wall composed of wood studs and gypsum wallboard is more transparent than a wall with steel studs and gypsum wallboard.

Metal objects reflect or absorb RF signals; they are not transparent to RF.

Example: If a tag is placed next to a metal filing cabinet, the RF signal from the tag is reflected off the filing cabinet's metal and is seen best from the same side of the cabinet on which the tag is located. The tag can be seen from the other side of the cabinet due to the RF signal multi-pathing (reflecting off of several metal surfaces). A multipath signal is usually weaker than a direct path signal.

Example: if a tag is placed inside a metal filing cabinet, the signal from the tag is reflected off the metal of the interior of the filing cabinet several times and most of the signal is eventually absorbed inside the cabinet. The tag can be seen from outside the cabinet due to multi-pathing of the RF signal that leaks out of the drawer openings of the cabinet. That tag's signal that leaks out will be considerably weaker than if the signal were seen directly.

Earth ground or a grounded metal structure actually absorbs the tag's signal. If you place the tag or the reader on the ground, there is a very good chance you will not see the tag's ID because the earth ground absorbs the tag's signal.

Multi-story buildings generally have grounded rebar in the floor structure of each level. The grounded rebar in the floor can be as RF absorbing as earth ground. Since the roof of one room is the floor of the room above, mounting a spider reader on or near the roof may be the same as setting it on the ground; you may not see the tag's ID because the grounded rebar absorbs the tag's signal. Different floors have different transparencies to RF. When planning reader placements, because some floors are more RF transparent than others, they need to be tested to determine their RF transparency.

To minimize RF interference, maintain a four to six foot separation between the Spider Reader antennas and potential RF radiators such as computers, monitors, printers, wireless network access points and electronic office equipment. The local "radio noise environment" can limit the reader's effective range. Grounded and reflective metallic structures around the reader's antennas and/or tags affects the system's performance.

The best location for placing a reader is line of sight to the most number of tags to be being covered by this reader.

Tag Density

The Spider IIIAR reader can handle a limited number of tags at the same time. The optimum number of tags varies with the chirp rate of the tag, the distance between the reader and the tags, the antennas on the reader, and the range setting on the reader. For example, the reader can efficiently handle about 500 seven-second tags at a normal distribution at the same time. If the tag chirp rate goes to one second, the same reader can handle about 70 tags at the same time. If the chirp rate goes to 14 seconds, the same reader can handle about 1000 tags at the same time.

If there are more tags in the area of a reader than can normally be handled, the range setting of the reader can be reduced to limit the number of visible tags to a manageable quantity. In a highly mobile tag population, transient densities need to be calculated to assure that a reader is not forced past its capacity limits when a large number of tags transit its area.

The antenna on the reader determines the maximum read range of the reader and thereby its coverage area. The type of antenna selected for the reader can be used to control the number of tags visible to the reader.

Range Selection

The Spider IIIAR reader has the online ability to set the range of the receiver. Reader Range is adjustable in eight incremental steps. Range eight is the maximum gain of the receiver while range 1, the lowest gain, covers the minimum range.

Using the range control feature of the reader, the reader can be restricted to see tags only in its immediate area instead of a larger area that contains more tags than it can handle at one time. By setting the read range to something less than maximum range, the reader can be restricted to a coverage area that fits the requirements of the system.

Using the input from two or more readers, the end user application can perform a location search by comparing the ranges the same tag is seen by two or more readers. The tag is located where the ranges of the readers overlap. Concentrator LI has a feature that automatically scans specified ranges on a reader and sends the resultant tag information to the database.

Power Wiring to the Reader

The reader's power adaptor requires a 120 VAC power source, about 1 Amp service. The reader is supplied with a transformer with a standard North American three prong 120 VAC plug. This transformer supplies 18 VAC to the Spider IIIAR reader. Using the cable supplied with the power transformer, the power outlet can be located as far as fifteen feet from the reader's location.

The reader has the ability to accept a DC power input such as a battery. This makes the reader a candidate for a totally wireless installation. The reader can be powered from a battery with a solar cell recharger, while the reader communicates to the network by wireless Ethernet.

Reader AC input voltage	10 to 18 VAC
Optional Reader DC input voltage	10 to 24 VDC

Wired Ethernet Connection

When the reader is used as a wired Ethernet interface, the Ethernet cable needs to be run to the reader and terminated with an RJ-45 connector. The wired Ethernet connection can operate up to a ten-megabit bandwidth. This cable needs to be run separately from the power wiring to prevent electrical noise from being induced into the Ethernet communication lines.

Wireless Ethernet Connection

When the reader is used as a wireless Ethernet interface, no Ethernet cable needs to be run to the reader. The wireless LAN card is installed in the reader and it becomes the communication link to the database. Using IEEE 802.11b communication protocol, the reader talks to an Access Point as its link to the system database. The wireless LAN supported by RF Code is a 3com Nomadic wireless client bridge that uses Lucent's 2.4 MHz Direct Sequence Spread Spectrum (DSSS) network. The wireless Ethernet connection can operate up to a two-megabit bandwidth. Using this method of connection reduces the wiring required to operate the communications between the reader and the database.

The wireless data link needs to be planned and / or tested to assure every Spider IIIAR reader has a reliable connection to an access point on the

Ethernet network. The 802.11b protocol will automatically connect the reader to the access point with the most reliable connection. If the access point is on the fringe of the connection capability to the reader, it may be necessary to relocate or add another reader to obtain the coverage or add an access point to stabilize the connection.

Readers can be connected to the same network using either wired or wireless Ethernet.

Caution: do not attempt to operate the wired and wireless connections on the same reader at the same time.

Bandwidth

When planning the system, it is necessary to calculate the system's data throughput to determine the capacity requirements of the network. Data throughput is both the information generated by the readers plus the overhead traffic required to maintain the network.

Bandwidth calculations also provide visibility for processor capacity and / or network infrastructure requirements.

Environmental Conditions

The Spider IIIAR Reader enclosure is designed to meet the requirements of NEMA 12 indoor installation standards.

Operating Temperature	-20 + 60° C
Storage Temperature	-40 + 75° C
Operating humidity	<95% Non-condensing at 50° C
Storage humidity	<98% Non-condensing at 50° C

If the reader needs to be installed outdoors in diverse weather conditions, the Spider IIIAR reader can be placed inside a NEMA 4 enclosure, available from RF Code, that will protect it from the weather. Although the NEMA 4 enclosure protects the reader from the weather, it does not improve the temperature and humidity ratings shown above.

Service

The Spider IIIAR has no user serviceable components inside the reader. If the reader should develop an operational problem, it automatically power cycles itself off and back on which restarts the reader in its basic power up standby mode. The system software application must recognize that the reader can restart itself and needs to be able to automatically configure and bring the reader back online. Information, if any, in the reader at the time of the power cycle will be lost. If a reader should fail completely and cannot be restarted, replacing the reader is the recommended remedy.

Physical Mounting

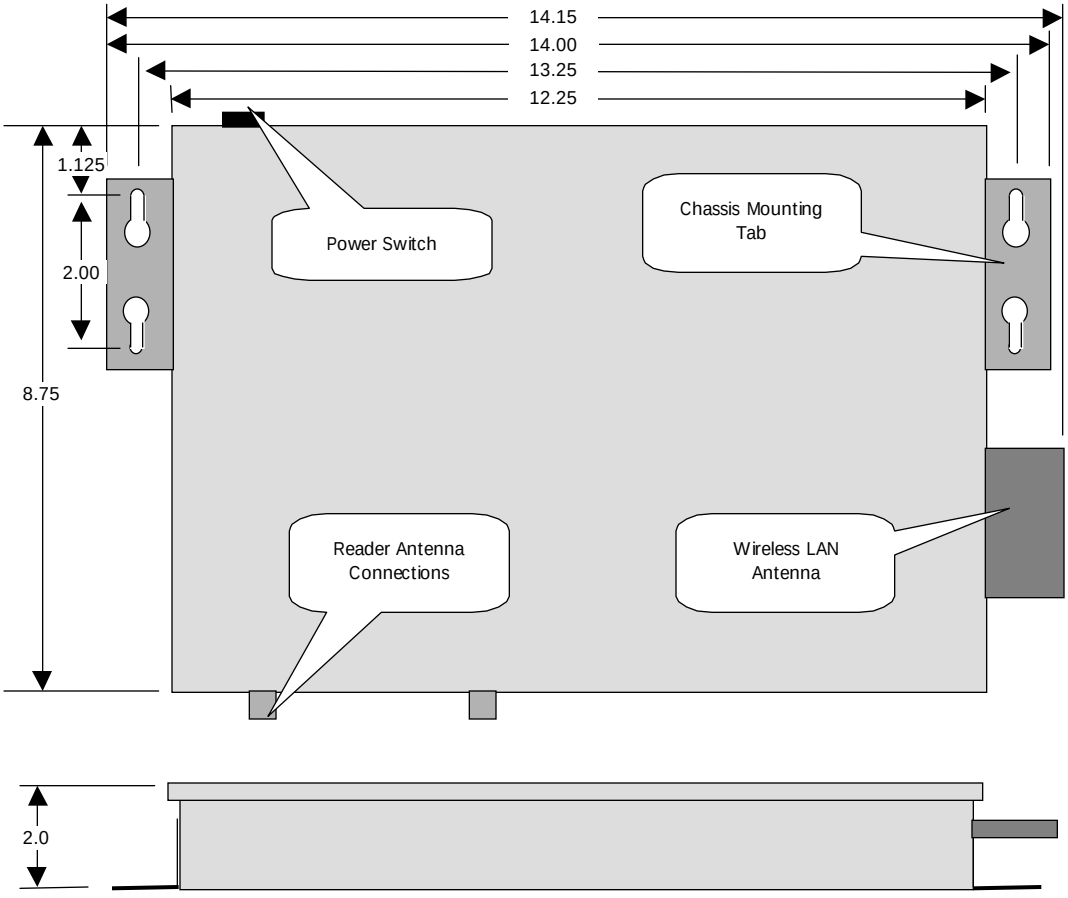
As a general rule, the higher the reader antenna is positioned above the ground or floor, the better the reader's detection range. The reader's antennas should be mounted as high as *reasonably* possible to get the best RF visibility over the coverage area. However, mounting the antennas on the ceiling that is also the floor of the story above may be harmful because the antennas are located near a "grounded floor". In this case, the floor (RF absorbing ground) is now above the reader instead of below the reader. It may be necessary to experiment to find the optimum mounting position for placing the reader / reader's antennas.

The reader can be mounted in one place with the reader antennas mounted nearby. Low loss SMA coaxial extension cables may be used to extend the antennas from the reader chassis.

If the reader antennas are mounted separately from the reader chassis, the reader mounting may still be determined by the communication requirements of the network. If the network is using wireless communication, the readers need to be mounted so they are visible to the wireless access point(s) required to make the connection. If the readers are connected by wired Ethernet, there are no RF restrictions on where the reader chassis is mounted.

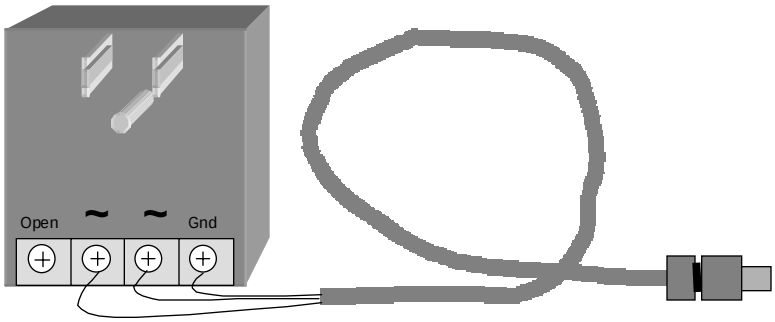
The Spider IIIAR Reader chassis has mounting tabs as shown below. The mounting slots accommodate up to a size 8 screw.

Dimensions are in inches.

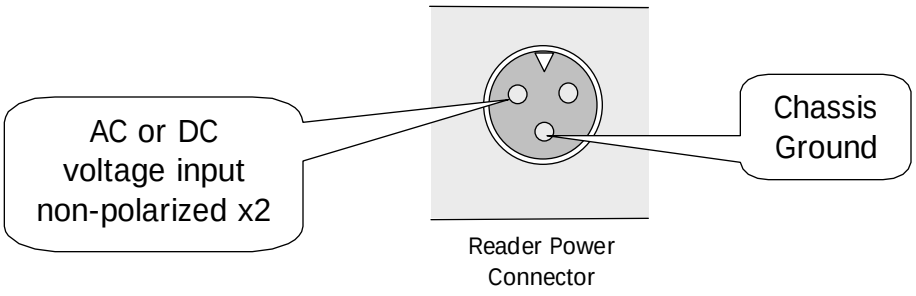


Power Source

The reader is normally powered from a wall transformer that plugs into a 120 VAC power outlet. The transformer delivers 18 VAC to the reader through a 15 feet cable and a circular three-conductor plug. Two of the conductors are the power source (18VAC) and the other conductor is earth ground from the ground pin of the wall socket



If available and/or needed, the reader may be powered by low voltage AC or DC power. This may be advantageous if there is other power sources available such a UPS or battery. The reader can operate with 10 to 18 VAC input or 10 to 24 VDC input. The power input pins are non-polarized and can be connected using either polarity DC. DC power may be useful if the reader is mounted in a remote location using a battery for power with a solar cell recharger to the battery.



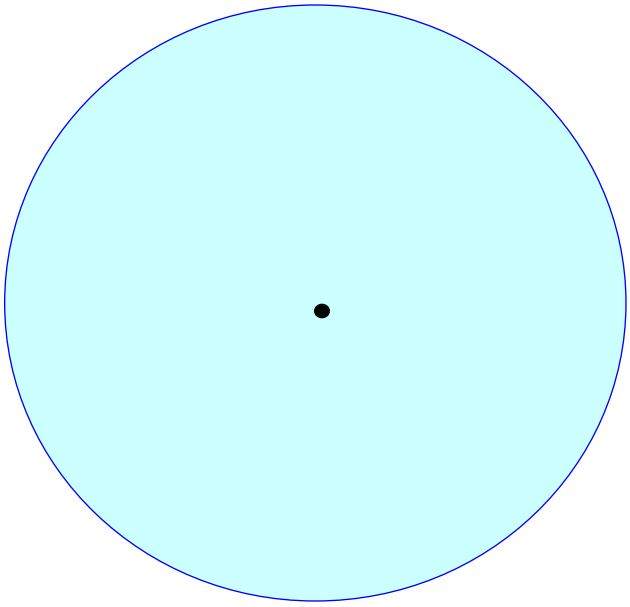
Antennas

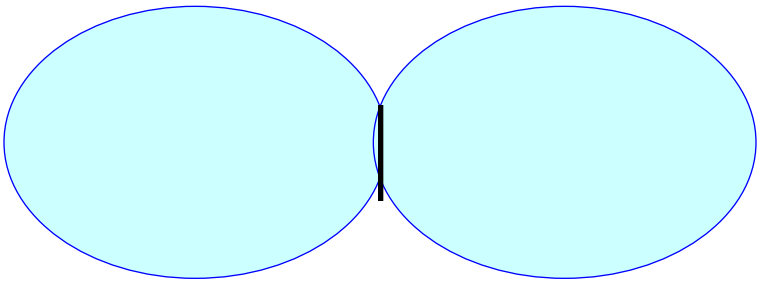
The type and placement of the antenna determines the maximum range of the reader. The antenna coverage patterns shown for relative illustration purposes and not intended as definitive design parameters. The antenna ranges specified are considered best case under optimum conditions.

¼ Wave Helical

The maximum range of the helical ¼ wave antenna is about 150 feet.

Top view, ¼ wave antenna coverage pattern. The view is looking down on the tip of the antenna with a circular coverage pattern.





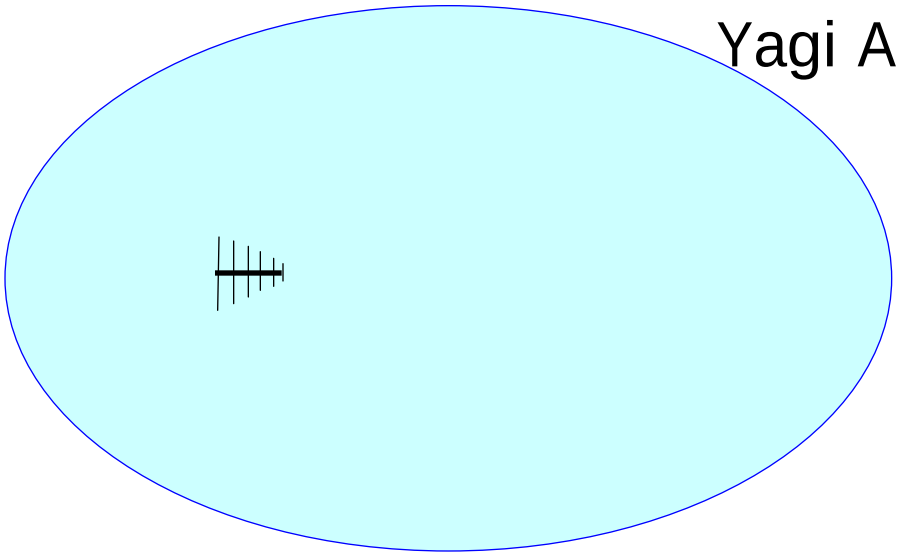
Side view, ¼ wave antenna coverage pattern. The view is looking at the side of the antenna. Coverage is a donut shape with less coverage above and below the antenna than on the sides of the antenna.

¼ Wave Whip

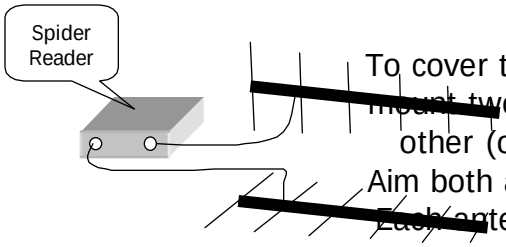
The maximum range of the ¼ wave Whip antenna is about 200 feet.

The coverage pattern is the same as the 1/4 wave antenna shown on the previous page.

Yagi Antenna

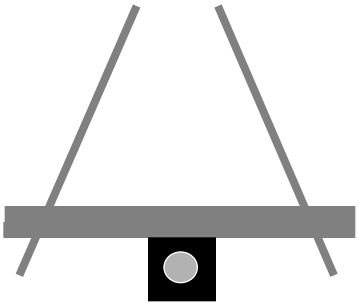


Yagi antennas cover an elongated (up to 1000 feet) pattern. Mount the antenna high above surrounding obstructions with a clear line-of-sight view of the target area. Aim the antenna at the center of the target

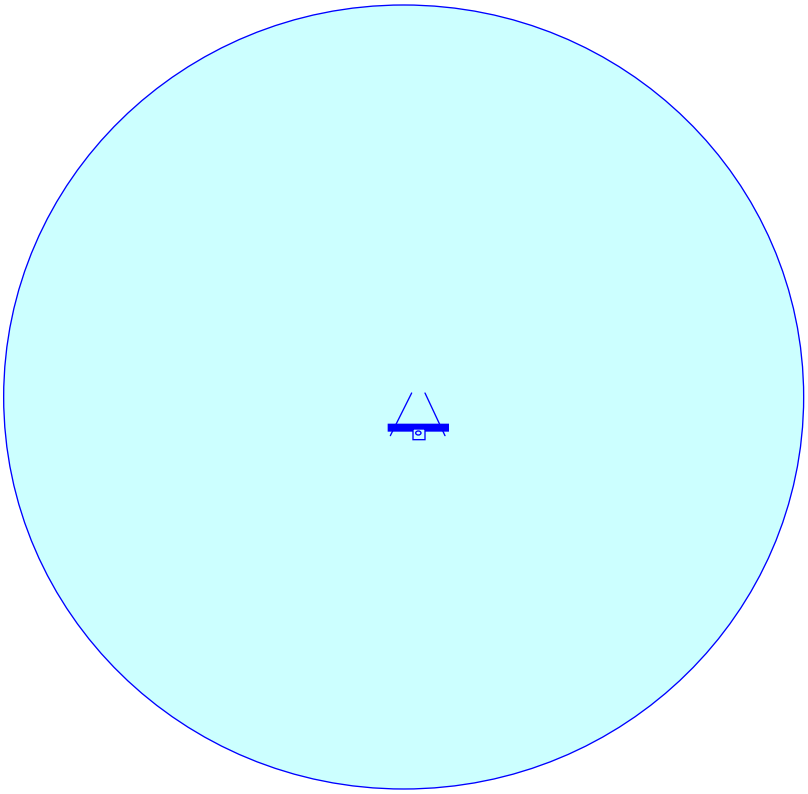


To cover the various orientations of the tag, mount two antennas at right angles to each other (one vertical and one horizontal). Aim both antennas at the same target area. Each antenna is connected to one antenna connector on the Spider Reader.

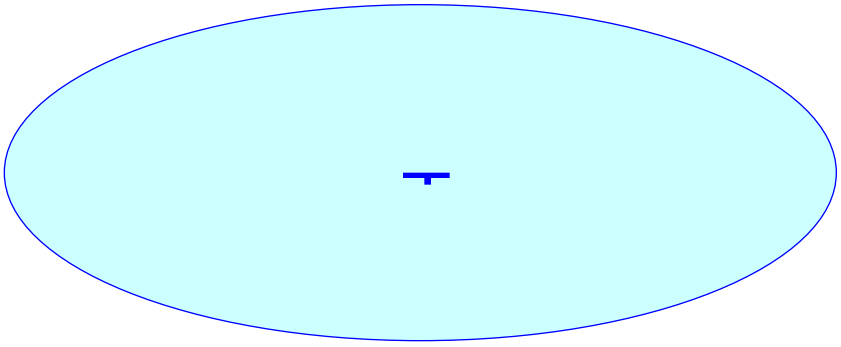
Omni Angle Antenna



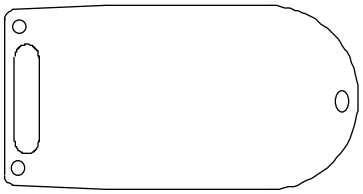
Top view, Omni Angle antenna coverage pattern. The antenna is mounted horizontally. The coverage is circular, up to 400 feet line-of-sight all directions.



Side view, Omni Angle antenna coverage pattern. The coverage is elliptical with less coverage above and below the antenna than to the sides of the antenna.



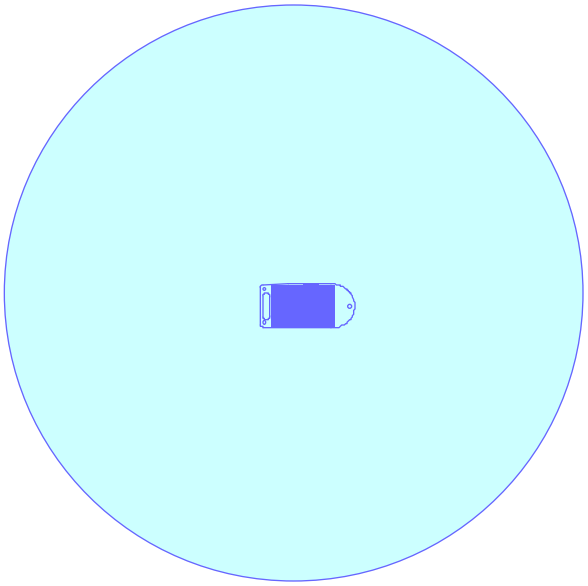
Spider Tags



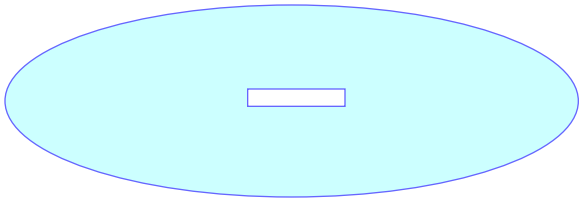
The spider tag is a miniature radio that periodically transmits an identity code. The transmission frequency is 303.825 MHz at an extremely low power. The identity coding plan permits about four billion identities in each family group code. There are several thousand group codes available.

The tag derives its power from a battery included in the tag. Because of the low power transmission, the tags battery life is three to five years depending on the environmental extremes to which it is exposed. The basic tag can be opened and the battery replaced if needed. The Spider tag is FCC certified for use as a low power transmitter.

The tag's transmission pattern is circular when viewed from above. A Spider reader can see a tag from any direction as long as the tag and the reader's antennas are oriented in the same plane. During installation, try to maintain a common orientation for all tags used in the installation.



The transmission distance in the other plane of the tag is considerably shorter than the transmission distance of the primary plane.



From a practical standpoint, having all the tags in the same orientation in an installation probably is not possible. For this reason, the Spider reader needs its antennas positioned to receive tag transmissions from any orientation. The two antennas on the reader need to have a receive orientation of 90 degrees to each other.

The tag's read distance is severely limited when the tag is close to the ground because the ground absorbs the tag's transmission. Place the tag as far above the ground as possible.

When deploying Spider Tags, ***avoid*** placing tags on top of each other in such a manner that there is a mutual inductance between the tags. Mutual inductance detunes the transmission frequency of the tag which makes it invisible to the Spider Reader. After it's installed, each tag must have a minimum of ½ inch distance between it and any adjacent tag.

Radio frequency energy is absorbed by water; that's what makes your microwave oven work. The Spider Tag transmits a radio frequency identity and its transmission is also absorbed by water. Tagging people presents a particular problem because people are made up of mostly water. When a tag is attached to a person, the body to varying degrees absorbs radiated energy. Absorbed energy is not available for detection by the reader.

A thinner portion of the body, such as the wrist, is a preferable place to position a tag. The chest area is also preferable because there is a "thin wall" of flesh in front and back with lungs full of air in between. Although the foot may be a good place to hang a tag on a person, the foot's close proximity to the ground is bad because the ground absorbs as much or more energy than the body.

When tagging people it's necessary to test the effective range of the tag and place the readers in appropriate places to compensate for the reduced transmission range.

The tag can be attached to a metallic or non-metallic assets. When attaching to a non-metallic asset, it is simply attached in the most efficient way. A non-metallic surface permits the tag's transmission to be radiated in all directions including through the asset.

When attaching the tag to a metallic asset, the tag must be held away from the metal a minimum of ¼ inch. A longer distance is better. When properly held away from the metal, the transmission pattern is
Example; if there is documentation attached to the asset in a plastic carrier (zip lock bag) the tag can be wrapped in bubble wrap and dropped in the carrier bag along with the documentation.