# Nova Engineering

# NovaRoam™ 900

# Spread Spectrum Transceiver

# User's Manual

Nova Engineering
5 Circle Freeway Drive
Cincinnati, OH 45246

513 860 3456
FAX 513 860 3535
www.nova-eng.com

© 1999 Nova Engineering, Inc. All Rights Reserved.

Nova Engineering also offers professional NovaRoam™ 900 installation at the user's discretion. This service provides the added performance benefit of generating a site survey to achieve the most reliable links possible.

Nova Engineering's custom design expertise identifies the optimum RF channels, antennas, antenna heights, operating mode, and network topology.

NOTE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at this own expense.

The NovaRoam™ 900 can be configured to operate in any of seven DSSS modes with burst data rates from 21kbps to 1.008Mbps, as shown in Table 1. This broad range of nearly 50:1 enables the user to select the best combination of throughput and range to establish a robust link. While increasing the data rate is generally desirable in order to accelerate packet transfer, this benefit comes at the expense of decreased range. Links are generally configured with the highest possible data rate consistent with reliable communications. Nova Engineering has built flexibility into the NovaRoam™ 900 through these multiple DSSS modes so that a single transceiver can close short haul links at rates exceeding 1Mbps or span distances exceeding 30km with reduced throughput. Two types of modulation are employed, binary phase shift keying (BPSK) and quadrature phase shift keying (QPSK), depending on the particular mode that has been selected. BPSK achieves better receiver sensitivity than QPSK at comparable data rates, a benefit that can be used to either improve link margin or extend the range of the NovaRoam™ 900.

The first 3 NovaRoam™ 900 modes have much narrower bandwidth than the remaining modes. While this does result in lower burst data rates, it dramatically improves the chances of avoiding interference from other systems. This is particularly useful in congested urban environments where there may be little opportunity to obtain more than 1MHz of relatively unoccupied spectrum. The NovaRoam™ 900 also includes SAW IF filters in the receiver to provide superior resistance to adjacent channel interference. The 3dB bandwidth of these filters are 2.7MHz for the narrowband modes and 9.6MHz for the wideband modes of operation.

**Table 1 NovaRoam™ 900 Modes Span Broad Range of Wireless Applications**

| Mode | Data Rate | Modulation | 3dB Bandwidth | Transmitter Power | Receiver Sensitivity | | Processing Gain |
|---|---|---|---|---|---|---|---|
| | | | | | No FEC | FEC | |
| 1 | 21kbps | BPSK | 1.2MHz | +20.4dBm | -108dBm | -109dBm | 18.0dB |
| 2 | 42 | BPSK | 1.2 | +22.8 | -105 | -106 | 14.9 |
| 3 | 101 | BPSK | 1.2 | +23.7 | -98 | -100 | 11.1 |
| 4 | 159 | BPSK | 4.3 | +27.0 | -101 | -102 | 14.9 |
| 5 | 317 | QPSK | 4.3 | +26.5 | -98 | -101 | 14.9 |
| 6 | 655 | QPSK | 4.3 | +24.1 | -93 | -97 | 11.8 |
| 7 | 1008 | QPSK | 5.8 | +25.2 | -89 | -94 | 11.1 |

The NovaRoam™ 900 operates in the 902 to 928MHz ISM band that has been authorized in accordance with §15.247 of the FCC Rules. The transceiver includes integral frequency synthesizers that can be used to tune the .5MHz grid. This enables the user to deploy the NovaRoam™ 900 at a channel in the RF spectrum that is minimally congested, thereby avoiding harmful interference. If desired, the unit can also be set up to transfer data over different channels in the forward and return links. For instance, 910MHz might be selected to send packets from unit A to unit B while 920MHz might be used to relay information from unit B to unit A. This degree of flexibility can be used to further reduce susceptibility to interferers that are physically close to NovaRoam™ 900 transceivers. The 3dB bandwidth of the NovaRoam™ 900 signal ranges from 1.2 to 5.8MHz, depending on the operating mode, as indicated in Table 1. Therefore even though the RF channel resolution is 0.5MHz, the channels need to be separated by at least the signal bandwidth when attempting to operate multiple NovaRoam™ 900 transceivers in overlapping regions.

| Table 2 | NovaRoam™ 900 Channels | |
|---|---|---|
| | Channel Frequency (MHz) | |
| Mode | Minimum | Maximum |
| 1 | 906 | 924 |
| 2 | 906 | 924 |
| 3 | 906 | 924 |
| 4 | 909 | 921 |
| 5 | 909 | 921 |
| 6 | 909 | 921 |
| 7 | 909 | 921 |

The signal bandwidth also limits the channels that may be selected since the FCC Rules prohibit the spectrum from extending beyond the 902 to 928MHz boundaries. Thus the narrower bandwidth signals may be assigned channels that are closer to these limits, as shown in Table 2. The bandpass filters at the front end of the NovaRoam™ 900 receiver also limit channel selection. Nova Engineering has deliberately selected a relatively narrow filter bandwidth in order to block interference from neighboring frequency bands such as pagers. This enables the NovaRoam™ 900 to establish robust links between sites that would otherwise be disabled by strong adjacent channel interference.

The NovaRoam™ 900 transceiver antenna port mates to one of three special types of antennas and coaxial cable assemblies. The user is cautioned against attempting to substitute antennas or cable assemblies that have not been explicitly authorized by Nova Engineering since this could result in noncompliant performance, in violation of the Part 15 Rules drafted by the FCC. This circumstance has led Nova Engineering to select a nonstandard antenna port connector, RP-TNC, to prevent improper antennas and cable assemblies from being employed. The following three configurations have been tested by Nova Engineering and approved for use with the NovaRoam™ 900 transceiver:

1. Collinear Whip: Antenex BB8965C with Antenex GMBD magnetic mount [Nova P/N 8040-0119]
2. Omni: Antenex FG9026 with 25' LMR400 cable assembly [Nova P/N 8040-0117]
3. Yagi: Antenex YB8966 with 100' LMR400 cable assembly [Nova P/N 8040-0118].

A collinear whip antenna is supplied with the purchase of each NovaRoam™ 900 transceiver. The whip attaches to a magnetic mount that includes an integral 12' coaxial cable. The whip and magnetic mount combination is supplied as a custom assembly by Nova Engineering, P/N 8040-0119, that includes an RP-TNC connector to mate directly to the NovaRoam™ 900 antenna port. Orient the antenna during installation so that it stands vertically, thereby providing an omnidirectional pattern.

The omni and Yagi antennas are selected for situations that demand extended range from the NovaRoam™ 900 transceiver. Each antenna is supplied with a special coaxial cable assembly, Nova P/N 8040-0117 or 8040-0118, that has been designed to yield FCC compliant performance from the NovaRoam™ 900. The attenuation of each cable assembly compensates for the increased gain of these antennas. Such cable assemblies can also be used to elevate the antennas on masts to further increase the NovaRoam™ 900 range. Raising the antenna is one of the most effective methods of improving marginal links. The 25' and 100' cable assemblies are specified for the omni and Yagi antenna, respectively. The longer cable assembly may also be used for the omni antenna, although this would decrease the system margin by 3dB. However, the shorter cable assembly is not authorized for the Yagi antenna since it yields radiated RF power levels in violation of the Part 15 Rules established by the FCC.

The omni antenna produces an omnidirectional pattern, as its name implies. This pattern is achieved when the antenna is oriented so that it stands vertically. The Yagi antenna produces a narrow beam along the axis of the main pole of the antenna. Consequently, the Yagi should be pointed directly toward its intended destination. The six short elements of the Yagi should be oriented vertically in order to match the polarization of other antennas in the NovaRoam™ 900 network. The Yagi is therefore used to reject strong interference that is not along the line of sight between the source and destination transceivers. The obvious disadvantage of employing a Yagi is that it cannot be used when one of the NovaRoam™ 900 units is mobile. In general, omni antennas are selected both at the master and store and forward sites of a network since they must communicate with multiple

transceivers that are dispersed throughout a region. Yagi antennas are most effective at fixed remote sites in a master/slave network that simply need to exchange packets directly with a single node in the network.

The coaxial cable assemblies that accompany each of the NovaRoam™ 900 antennas are designed to be mated to the antenna and the NovaRoam™ 900 antenna port. There is only one way to make this connection since the antenna uses a Type N connector while the NovaRoam™ 900 employs an RP-TNC. The coupling nuts should only be hand tightened. Pliers or wrenches should not be used since they might generate excessive torque, damaging the connector interface. Once the coax has been attached to the antenna, apply a layer of Vapor-Wrap™ around the joint at the antenna to prevent moisture in the outdoor environment from corroding this connection. This is accomplished by removing the paper backing from the Vapor-Wrap™ and laying it against the connector pair so that the connectors are in the center of the patch. Wrap the Vapor-Wrap™ around the connectors and cables, pushing and working the compound into all cracks. Smooth the compound onto the cable jacket. When complete, the joint should have a smooth, tapered appearance.

The antenna should be located so that there is a clear line of sight to every other NovaRoam™ 900 transceiver that it intends to communicate with directly. Obstacles such as buildings and foliage generally reduce the resulting received signal strength and thereby degrade link performance. In the case of omni and Yagi antennas, a clear line of sight can often be achieved by mounting the antenna on a mast to obtain clearance over obstructions. The NovaRoam™ 900 must be mounted within an enclosure to shield it from rain and condensing humidity, reducing its exposure to the elements. Finally, remember to point the Yagi antenna in the direction of its destination. In certain situations, minor changes in the pointing and height of the antenna can yield noticeable improvements in link margin. Therefore be prepared to make some adjustments from the initial settings if this advantage is needed. This is best achieved by performing NovaRoam™ 900 link tests at several different orientations, and noting the position that delivers the best results.

CAUTION

The NovaRoam™ 900 has been specifically designed to close the longest possible links. This goal has been accomplished in part by delivering the highest permissible RF output power to the antenna per the FCC Part 15 Rules. In August 1996, the FCC adopted RF exposure guidelines that established safety levels for various categories of wireless transceivers. Those limits are consistent with safety standards previously published by the National Council on Radiation Protection (NCRP) Report 86, §17.4.1, §17.4.1.1, §17.4.2, and §17.4.3 as well as the American National Standards Institute (ANSI) in §4.1 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz," ANSI/IEEE C95.1-1992.

The NovaRoam™ 900 complies with these FCC exposure guidelines when the following precautions are obeyed:

- Only install the exact antennas recommended in this Users Manual.
- The cable run for the selected antenna must exceed the minimum length quoted in this Users Manual.
- All persons must maintain a minimum separation of 9" (22.8cm) from any NovaRoam™ 900 antenna.

As a consequence, any person should disconnect the AC/DC input power source from the NovaRoam™ 900 whenever repositioning the antenna. The end user is responsible for taking the necessary steps to ensure that these guidelines are communicated to all persons that may come near the NovaRoam™ 900 antennas.

DSSS signals, by their very nature, produce wideband spectra in order to mitigate the effects of interference. As a consequence, these signals will tend to intermingle when multiple channels are deployed in overlapping physical regions. Nova Engineering has devised a remedy to this challenge by allowing these networks to select "sync sets" consisting of specially constructed PN sequences and frame synchronization preambles. These words have been selected to have minimum cross correlation and thereby serve as passwords to limit access to a network. A user operating within Network A cannot access channels on Network B since their passwords do not match. The NovaRoam™ 900 includes four sync sets for each of its seven operating modes. There are limitations to this strategy since even though access can be effectively denied in this way, it does not prevent interference between the competing signals. As a result, it is always best to strive to obtain the widest possible frequency separation between channels in overlapping networks.

| NovaRoam™ 900 Transceiver Specification | |
|---|---|
| **Electrical Parameters** | **Specification** |
| Waveform | Direct Sequence Spread Spectrum |
| Frequency Range | 902-928MHz ISM Band |
| Modulation Type | Differential BPSK or QPSK |
| Spread Bandwidth | 9.0MHz or 2.1MHz (User Programmable) |
| Channel Spacing | 500kHz |
| Sensitivity | -101dBm at 159kbps channel burst rate for $10^{-5}$ BER |
| Adjacent Channel Rejection | 45dB at 4.0MHz offset |
| IF Rejection | 70dB |
| Image Rejection | 70dB |
| LO Leakage | -80dBm |
| Channel Burst Data Rate | 7 Programmable Data Rates from 21kbps to 1.008Mbps |
| Processing Gain | 11.1 to 18dB (Channel Burst Data Rate Dependent) |
| Data Interface Options | 10Base-T (802.3 Ethernet) or RS-232 |
| RF Output Power | 0.5 Watt [+27.0dBm] |
| Radio Configuration | Web Browser |
| RT/TR Turn-Around | 5.0ms Typical |
| Mobile Network Size | 253 Nodes Maximum |
| **Standard Antenna Configurations** | **Specification** |
| Collinear Whip [Nova P/N 8040-0119] | +7.2dBi Gain with Magnetic Mount & 12' Teflex Cable Assembly |
| Omni [Nova P/N 8040-0117] | +8.2dBi Gain with 25' LMR400 Cable Assembly |
| Yagi [Nova P/N 8040-0118] | +11.2dBi Gain with 100' LMR400 Cable Assembly |
| **Mechanical/Environmental Parameters** | **Specification** |
| Dimensions | 4.0"x9.5"x1.5" |
| Weight | 1.9lb |
| Operating Temperature | 0°C to +60°C |
| Extended Temperature Range (optional) | -40°C to +60°C |
| Storage Temperature | -40°C to +85°C |
| Humidity | 95%, Non-Condensing (Operating and Storage) |
| **Power Consumption** | **Specification** |
| Input Power Source | +10 to +18VDC or 12VAC |
| Receive Mode | 14 Watts Typical |
| Transmit Mode | 18 Watts Typical |