Warranty
This product is fully factory tested and warranted against manufacturing defects for a period of 1 year. As the circumstances under which this product is installed cannot be controlled, failure of the product due to installation problems cannot be warranted. This includes misuse, miswiring, and operation under conditions beyond the design range of the product. No guarantees are expressed or implied as to the suitability of the product for its intended use by the purchaser. No guarantees can be made as to the communications range or performance of this product in the presence of radio or other electromagnetic interference. It is possible that interference can cause undesired operation including loss of control of speed, direction etc. Damage to purchaser’s equipment due to loss of control is not warranted or covered by NCE.

For warranty or non-warranty issues send the product (plus payment, if required) to:

NCE Warranty Center
82 East Main St.
Webster, NY 14580

Spare Parts:
Spare parts for your RB02 or RPT1 may be ordered from the list below. $4 US will be added to your order for US priority mail and packaging. Check or credit card will be accepted.

<table>
<thead>
<tr>
<th>Description</th>
<th>Price (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProCab bottom w/ battery door</td>
<td>$10.00</td>
</tr>
<tr>
<td>Procab top</td>
<td>$10.00</td>
</tr>
<tr>
<td>Rubber keypad for ProCab</td>
<td>$9.00</td>
</tr>
<tr>
<td>ProCab battery clip set w/wires</td>
<td>$3.00</td>
</tr>
<tr>
<td>Antenna 1/2 Wave</td>
<td>$16.00</td>
</tr>
<tr>
<td>Pro Cab screws (set of 9)</td>
<td>$2.00</td>
</tr>
<tr>
<td>Cab04/05 rear cover w/battery door</td>
<td>$7.00</td>
</tr>
<tr>
<td>Cab04/05 screws (set of 4)</td>
<td>$2.00</td>
</tr>
<tr>
<td>Cab04/05 battery holder</td>
<td>$1.50</td>
</tr>
<tr>
<td>Rubber keypad for Cab04/05</td>
<td>$9.00</td>
</tr>
</tbody>
</table>

Address all parts orders to:

NCE Spare Parts
82 East Main St.
Webster, NY 14580

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**Last revised: 8 June 2005

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RB02/RPT1

Wireless base station and Repeater Manual

Version 1.0

Operate your cabs without plugging in

Features:
- Second Generation two way wireless for DCC
- Handles up to 48 wireless cabs.
- Use up to 30 repeaters with one base station
- Two way communication with the cab
- All features of your Cabs are available without plugging in
- Just plug it in - no soldering!
- Cabs automatically switch over to bus power when plugged in

No guarantees are made by NCE or authorized NCE dealers as to the suitability of this product for its intended use. As with all radio products, communication integrity in the presence of interference cannot be guaranteed.

This book, schematics, drawings and artwork copyright 2005
NCE Corporation    Webster, NY 14580
If you have received the RB02 as part of a complete NCE DCC system:
Setup and run the system without the wireless connected following the Quick Start guide in
your system manual. When you have confidence that all is working properly at that level then
proceed with connection of the radio.

About the NCE Second generation wireless:
The RB02 and RPT1 are NCE’s second generation two-way radio system for NCE wireless
throttle operation. The RB02 (Radio Base station) is designed to work with NCE wireless
cabs to eliminate the need for tethered operation. Only one RB02 may be connected to your
DCC system. In many cases the RB02 alone is sufficient to cover most layouts.

If you need to cover more area than the RB02 alone can provide you may add up to 30 RPT1
(RoPeaTers). Repeaters are slave radio transmitter/receivers that work under the control of
the RB02. The RB02 has two expansion ports (PORT A and PORT B). You may plug a
repeater into either port or both ports. The RB02 can directly handle 2 repeaters. Each
repeater has two expansion ports (also labeled PORT A and PORT B). These ports are also
designed to accept repeaters. You may daisy chain repeaters up to 4 levels “deep” in each
chain. Addition of repeaters is discussed in more detail later in this manual.

If you have purchased repeaters along with your RB02 we suggest starting with just the RB02
Hookup and Quick Start below. As you gain familiarity with the radio operation then proceed
to add the repeaters.

RB02 hookup diagram

RB02 Hookup:
1- Thread the included antenna to the mating connector on top of the RB02.
2- Connect the included 6 wire cable from the “Bus” connector on the RB02 to a convenient
   Cab Bus connection on your layout (a UTP panel is shown as the connection point
   above).

Quick Start for radio operation:
1- Make sure the DCC system is on.
2- Make sure your wireless equipped cab is setup in the proper address range (wireless
   ProCabs use addresses 2-17, wireless small crafts use addresses 19-49).
3- Make sure your wireless cab has fresh, correctly installed batteries and the antenna is
   attached
4- On the ProCab press EMERGENCY STOP (HORN on small cabs) until the cab powers
   up. If you have trouble turning on the ProCab try pushing ENTER at the same time as
   EMERGENCY STOP. The LCD on the ProCab will then briefly display the cab version
   number and cab address just as when plugging it in to the cab bus. Then it will display
   the software version and Layout ID of the radio in the cab. With smaller cabs the “Data
   Entry” LED on the front of the cab will briefly light.
5- If all is working properly you should see a steady ‘heartbeat’ pulsing of the red light on top
   of the cab. This light flashes every time the cab responds to a probe from the radio base
   station. On the ProCab your normal operating screens should be displayed on the LCD.
   On smaller cabs the red LED on the front of the cab should briefly light when a key is
   pressed.
6- Enjoy your wireless operation

See the “Tips” section later in this manual for more radio operating tips.

Tips for operation:
When you press a button on a Cab hold it down for about a second. You don’t have to press
harder than normal but pressing slightly longer results in better performance.

We recommend having several conventional cab plug-in panels (UTP or DIN) located around
the layout where you can plug in the cab in case the battery goes dead or conditions such as
interference cause loss of control via radio. We usually hang 2 or 3 short cab cables about 2
feet long from a small number of these panels to facilitate plugging in if an operator experiences
problems.

You may find it more expedient to plug in the cab while doing extensive programming or
system setup. When performing complex tasks that require many messages to be displayed
on the ProCab, communications between the cab and command station may take longer than
expected thus slowing down your operations.

The LED on the cab flashes every time it sends a cab status update to the base station.
You can use this flashing to map out the dead spots in the layout room. The cab is
communicating best when the LED has a steady flicker. Move about the room noting where
the spots where the flashing stops or becomes erratic. Then move the base station to a
different location until you get good reception at the most important operating spots.

The cab may not operate when you get within 2 feet (600mm) of the base station (other cabs
will still operate normally). The LED on the cab will flicker but the will not seem to
communicate with the base station. This is due to overloading of the base station radio
receiver. In this situation we have found that covering the antenna with your hand will attenuate
the signal enough for reliable communication. Due to the extreme low power of the cab
radios we’ve had to make the radio receivers in the base station very sensitive. This can
result in the receiver being overloaded when a cab is too close.

Cabs will work much better with the antenna vertical rather than pointing the antenna at the
base station.

Priority is placed on commands getting from the cab to the base station or repeater. As you
approach the maximum range of the cab, updates to the LCD display from the base will lag
behind the commands sent to the base. If the base station is not able to complete sending
display updates it will try to re-send them 16 times before giving up. The RB02 Local RX LED
will flash brightly when it is trying to send display update information. If the cab becomes
sluggish when operating at long range allow several seconds for the display to catch up.

FCC statement:
This device has been tested to comply with Part 15 of the FCC rules.

Operation is subject to the following conditions (1) this device may not cause harmful
interference and (2) this device must accept any interference received, including interference
that may cause undesired operation.

The RB02, RPT1 wireless base station and repeater are RF products and may only be used
in countries in which the units have been Type Approved or Certified for sale and operation.
These units are certified for sale and operation only in the United States, Canada and
Australia. Use of these products in countries where they are not certified may result in
interference to other critical radio services and legal penalties. Importation and operation in
other countries is subject to the laws of those countries. NCE can not and will not ship radio
equipped products to those countries.
Specifications:
Supply voltage - 12 volts DC nominal. 8 volts minimum, 16 volts DC maximum
Supply current - RB02: 70mA maximum, RPT1: 35mA maximum
Cab Bus protocol - NCE Cab Bus, same as RB01
RF Radio Modulation - 10kps Manchester encoded, OOK, 16 bit preamble. Same as RB01
RF Output Power - 450 uW maximum, 350uW typical

Maximum length cable to RPT1 - 40 feet, #26 AWG

Connections:

RB02 Cab Bus connections:
1- Not connected (white wire)
2- DC cab bus supply common (black wire)
3- RS-485 A lead (red wire)
4- RS-485 B lead (green wire)
5- +12 volt DC cab bus supply (yellow wire)
6- Not connected (blue wire)

RPT1 Bus connections:
1- TX/RX input (blue wire)
2- DC cab bus supply common (black wire)
3- RS-485 A lead (red wire)
4- RS-485 B lead (green wire)
5- +12 volt supply into RPT1 (yellow wire)
6- Preamble Good output (white wire)

PORT A & PORT B Bus connections (all units):
1- TX/RX output (white wire)
2- DC cab bus supply common (black wire)
3- RS-485 A lead (red wire)
4- RS-485 B lead (green wire)
5- +12 volt supply into RPT1 (yellow wire)
6- Preamble Good input (blue wire)

Layout ID
The layout ID of all cabs and the RB02 must match for cab to be able to communicate successfully with the base station. All NCE wireless products come with the ID set to 0.

Setting the layout ID:
1- Unplug the RB02 from the Cab Bus. Do not turn off system power.
2- Plug a ProCab into the PORT A connector of the RB02 using any standard Cab Bus cable.
   If the repeater cable is already plugged into this expansion port temporarily remove it.
3- Restore the Cab Bus connection to the RB02.
4- Type the desired Layout ID number (factory default) then press ENTER.
5- Unplug the ProCab from PORT A to enable radio operation of the RB02. The radio will not operate until the cab is unplugged.
6- Restore the repeater connection to PORT A if it was removed.

Wireless communications:
The transmitter power of the RB02 and RPT1 is .00035 Watts. By contrast your cell phone can put out 3 Watts or roughly 10,000 times the power. We are continuously about the operating distance of the wireless cab. There are many factors governing the useful range of wireless products. The RB02/RPT1 operates in the ISM (Industrial, Scientific and Medical) radio band at 916.5 Megahertz (MHz). Many cordless phones, wireless computer networks, home automation systems, and wireless security devices also operate in this portion of the radio band and all contribute to radio interference. Radio waves are like one big telephone 'party line' where everyone is talking at once. A device using these radio waves must attempt to sort out what 'voices' are relevant to its operation and which ones are noise. If there is too much noise it can't do this successfully and will operate poorly or not at all.

Indoor radio propagation is an issue for special consideration. The human body readily absorbs radio energy in the frequency band used by the cab radios. Placement of the base station and repeaters can mitigate blocking of the radio signal due to human body absorption. In most indoor situations 'dead spots' can be found where reception is very difficult. These can occur even if there appears to be a direct line of sight between the transmitter and receiver. These dead spots, or 'nulls', are the result of multiple radio transmission paths between two points each caused by reflections off metal objects such as steel beams, screen wire, concrete rebar, metal door and window frames, ceiling tile frames, model railroad track, etc. Nulls occur where the path lengths differ by an odd ½ wavelength (about 6 inches at 900 MHz). Deep nulls are usually very localized and can be avoided by moving slightly, usually only a few inches. We suggest adding one or more RPT1 repeaters if you experience severe null areas on your layout.

Installation of the RB02:
Just plug it in to the NCE cab bus (read "RB02 Hookup" on previous page).

Radio power planning:
If you are planning to add repeaters make sure the Cab Bus jack you are using can provide ample DC power for the RB02 and any repeaters. The RB02 needs 60mA (about 1/2 the power of a standard ProCab) and each RPT1 requires 35mA (about 1/3 the power of a ProCab) of DC power.

Example: An RB02 plus 5 RPT1 repeaters will draw the DC power equivalent of 2 ProCabs. In this case if the current cab bus can handle two ProCabs plugged in at the point where you want to connect the RB02 then you should be OK.

For installations involving more than 10 repeaters a UTP panel can be used to add power for the repeaters. Contact the factory of specific directions on using the UTP to add radio DC power.

RB02 Location:
We've found good operation can be achieved by placing the unit at about shoulder level. We've also had success with placing the RB02 (or RPT1) upside down on the ceiling of the layout room (7-10 feet high). This gets the antenna above the main body mass of operators in the layout room so less of the radio signal will be blocked by humans. See the diagram below for how the radio signal propagates from the antenna.

The pattern is a 'Torus' (donut) shape
Frequently asked questions
(courtesy of Mark Gurris)

1) Will the RB02 and RPT1 work with older NCE, System One or Ramtraxx systems?
   Yes.

2) Do I need the latest EPROM update to my system?
   No. The radio should be compatible with any command station software dated 1/12/95 or later.

3) Is a termination plug needed on unused PORT A and PORT B sockets?
   No. You can leave unused sockets alone without any concern.

4) What are the limits in configuration or arrangement of the RB02/RPT1 radio system?
   There are 3 limits:
   A) The maximum depth of a repeater daisy chain. 5 levels with the RB02 as level 1.
   B) The maximum number of repeaters. Thirty repeaters plus 1 RB02 base station.
   C) The maximum power available for radio daisy chain network is sufficient.

5) What happens if you exceed 5 levels or repeaters?
   Reliable operation is not guaranteed.

6) Can I use 'standard' Cab Bus cables with the RPT1 repeaters?
   Yes as long as they are pin-to-pin 6 wire cables. A 40 foot cable is supplied with each RPT1, the RB02 comes with a 7 foot cable.

7) Do I need to modify any of my 1st generation radio cables to work with the 2nd generation RB02/RPT1?
   No. Assuming the cab already has a radio it should work with no changes.

8) Is there any difference between PORT A and PORT B?
   In operation there is no difference. PORT A on the RB02 is used to change the layout ID but that doesn't affect radio operation or installation.

9) What do the LEDs mean?
   RPT1:
   The LOCAL RX will light if the repeater is receiving a valid command on its internal radio receiver, PORT A or PORT B.
   The PORT A or PORT B lights up when a valid command is coming in on that port.
   RB02:
   The LOCAL RX LED has a steady faint 'heartbeat' pulse to indicate it is sending out status probes to cabo. It will flash brighter when trying to send an update for the LCD of a ProCab. It will try 16 times to send an update before giving up.
   The PORT A or PORT B lights up when a valid command is coming in on that port.

10) What happens if I accidentally plug an RPT1 into the Cab Bus or connect PORT A/B to the expansion port of another repeater or RB02?
    Not much. It won't work and will probably shut down the Cab Bus while it is plugged in but there will be no damage.

11) Can I use multiple RB02s plugged in to the Cab Bus?
    No. Just like the old RB01 you can only use one.

12) Is the RB01 still available?
    No. It has been replaced by the RB02.

13) Can I replace the long 1/2 Wave antennas on my cabs with shorter antennas?
    Keep the long antenna on the base or repeater but you can try shorter antennas on the cabo. One antenna we have used is Digikei's part number: ANT-918-CW-RH. (1-800-DIGIKEY - www.digikey.com). This is a loaded 1/4 wave whip (about 2 inches long) that we have used around the shop with some success. The range is somewhat reduced compared to the 1/2 wave whip supplied by NCE but with sufficient receiver coverage it works very well.