



# 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 can not be guaranteed.

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NCE Corporation Webster, NY 14580

**If you have received the RB02 as part of a complete NCE DCC system:**

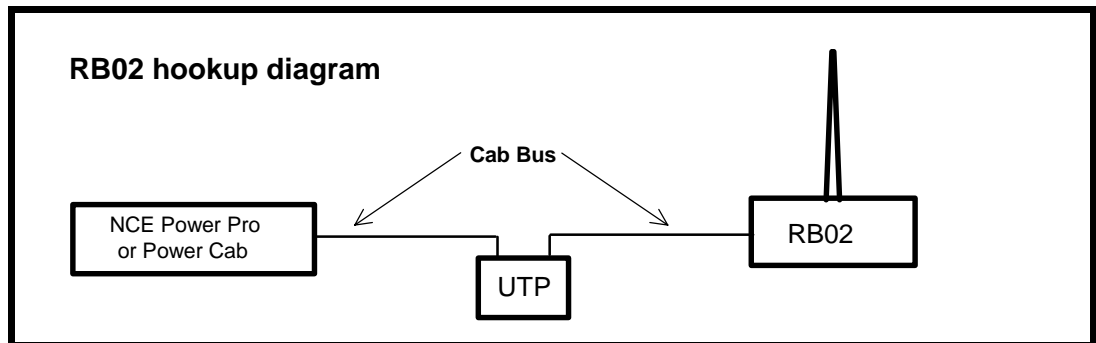
Setup and run the system without the wireless connected following the Quick Start guide in your system manual. When you have confidence that all is working properly at that level then proceed with connection of the radio.

**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 (RePeaTers). 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:**

- 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 cabs 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.

**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 asked 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 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 1/2 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:**

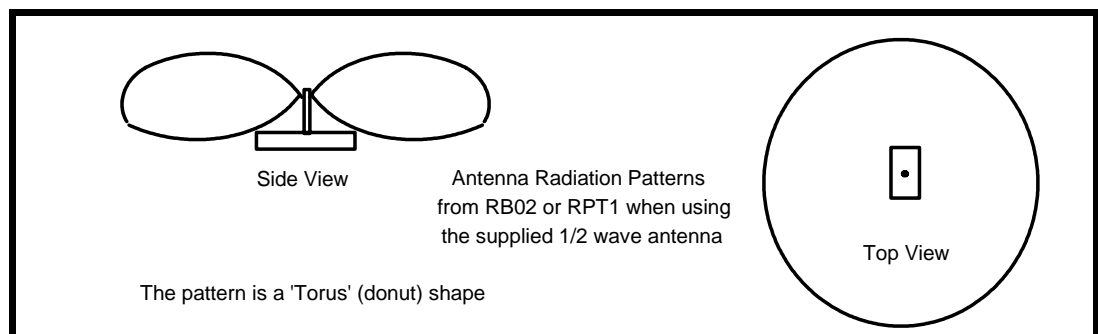
If you are planning to add repeaters make sure the Cab Bus jack you are using can provide ample DC power for the RB02 and any repeaters. The RB02 needs 60mA (about 1/2 the power of a standard ProCab) and each RPT1 requires 35mA (about 1/3 the power of a ProCab) of DC power.

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.



### **Operation of the RB02:**

Operation is automatic when connected to the NCE cab bus. There are no adjustments or other installation required.

### **Description of RB02 LED activity:**

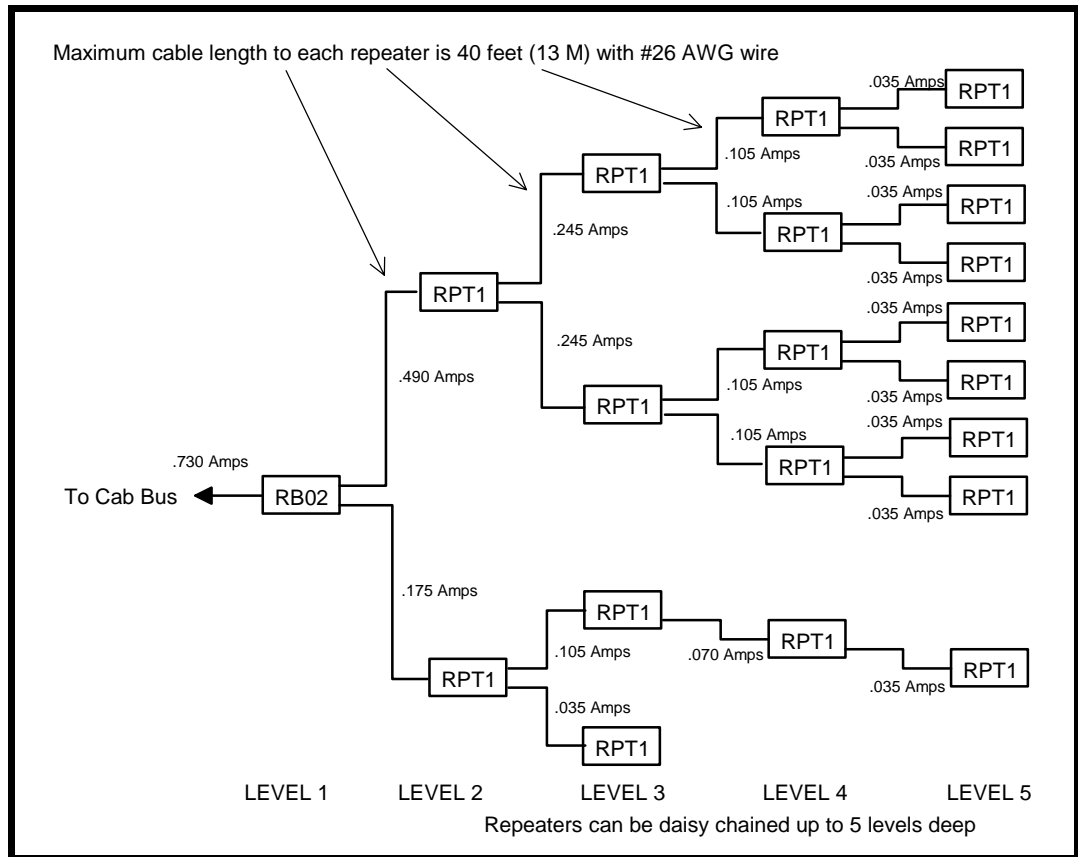
The "Local RX" LED on RB02 will flicker weakly every time it communicates with a wireless cab. A regular low intensity 'heartbeat' of this LED indicates it is receiving status updates from cabs. The messages are very short so the intensity of the flash is low. The flashing will intensify when the RB02 is attempting to send updates to ProCab LCD displays. These message are longer (2-8 times longer) compared to cab status updates so they result in 2-8 times brighter flashes of the LED.

The PORT A or PORT B LEDs up when a valid command is coming in on that port from a repeater. If you have no repeaters then these LEDs will be inactive.

### **Wiring topology of repeaters:**

Only one RB02 base station is allowed per system and it is the only radio box that can connect to the Cab Bus. The RB02 is the top of a tree (base) from which all expansion starts. The input jack labeled "BUS" connects to the Cab Bus. The RB02 base station also has two expansion ports called "PORT A" and "PORT B". RPT1 repeaters can connect to these expansion ports on the RB02. A 6 wire cable (a 40 foot long cable is supplied with each repeater) connect the "BUS" connector of a repeater to one of the expansion ports of the RB02. In this way two repeaters can be connected directly to the RB02 and separated by up to 40 feet from the RB02. Each repeater also has two expansion ports (PORT A and PORT B) that can be connected to more repeaters forming a "binary tree" that expands out from the RB02 in a 1->2->4->8->16 manner. See the illustration below

In the diagram the upper branch from the RB02 is fully populated with repeaters while the lower branch is sparsely populated (a much more likely configuration on most layouts). Note the power calculations in small print on the drawing.



## Frequently asked questions (courtesy of Mark Gurries)

- 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) Total number of repeaters. Thirty repeaters plus 1 RB02 base station
  - B) The maximum depth of a repeater daisy chain. 5 levels with the RB02 as level 1.
  - 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 cabs 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 cabs. 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 cabs. One antenna we have used is Digikey part number ANT-916-CW-RH. (1-800-DIGIKEY - [www.digikey.com](http://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 repeater coverage it works very well.

## 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 - 10kpbs Manchester encoded, OOK, 16 bit preamble. Same as RB01

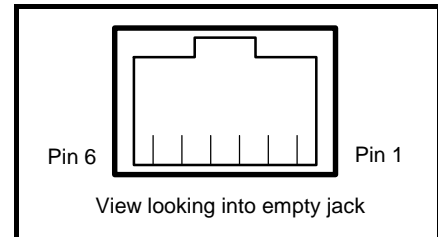
RF Output Power - 450 uW maximum, 350uW typical

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 a 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.

**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 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've 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.

**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 can not be controlled, failure of the product due to installation problems can not 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  
899 Ridge Road  
Webster, New York 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.

Description	Price (US \$)
ProCab bottom w/ battery door	\$10.00
Procab top	\$10.00
Rubber keypad for ProCab	\$8.00
ProCab battery clip set w/wires	\$3.00
Antenna 1/2 Wave	\$16.00
Pro Cab screws (set of 9)	\$2.00
Cab04/05 rear cover w/battery door	\$7.00
Cab04/05 screws (set of 4)	\$2.00
Cab04/05 battery holder	\$1.50
Rubber keypad for Cab04/05	\$8.00

Address all parts orders to :

NCE Spare Parts  
899 Ridge Road  
Webster, NY 14580

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