

Cellular Specialties, Inc.

Model 150 Miniature In-Building Amplifier

Operation and Users Manual

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1. Product Description

Background

The performance of a cell phone can be easily degraded when in enclosed structures where signals from a local cell site are not sufficient for reliable phone operation. The Model 150 In-Building Amplifier (Mini-IBA) was developed to enhance wireless network performance within these enclosed structures. Specifically, the Model 150 is intended to cover relatively small areas such as home offices, workshops, offices etc.

Functional Description

The Model 150 amplifier boosts the wireless network's performance by providing amplification of both transmit and receive signals. The unit receives the portable phone's signal through an inside antenna, amplifies it and then sends it to an outside antenna. This signal is referred to as the "Uplink". The amplifier also receives signals from the Cell Site base station through the outside antenna. This signal is amplified and re-radiated to the portable phone and is referred to as the "Downlink". It is necessary that sufficient signal be available at the outside antenna.

The outside antenna is usually a directional type such as a "Yagi", however an Omni-directional antenna may be used when the structure is located in close proximity to one or more cell sites. Inside antennas are usually Omni-directional although other types, such as low profile wall or ceiling mount, may be used for special installations.

As shown in Figure 1, there are four stages of gain in the Downlink and four stages in the Uplink for maximum gain of 50 dB in each link. The maximum linear output power is 125 milliwatts for the Uplink and 80 milliwatts for the Downlink. These levels are factory set and are maintained by an internal Automatic Gain Control (AGC) circuit.

Four LED indicators on the unit indicate:

- Green "**Power**" LED indicates that power is applied and the unit is operating.
- Yellow "**AGC**" LED indicates that the gain of the Uplink and/or Downlink is being reduced to maintain the maximum power

output, which prevents spurious radio-frequency emissions from the amplifier.

- Yellow “**Isolation**” LED indicates that the microcontroller in the unit has sensed instability due to insufficient isolation between the inside antenna and the outside antenna, and has reduced the gain of the amplifier. This is done to prevent oscillation, which can interfere with the handsets in the covered area and/or the wireless service provider’s base station. This “degraded mode” will be maintained until the amplifier power is disconnected and reconnected. The outside antenna should be placed as far as practical from the internal antenna, and should not be pointed toward the inside antenna.
- Red “**Shutdown**” LED indicates that the gain of the unit has been reduced to minimum to prevent very strong input signals from overloading the amplifier. The amplifier will attempt to recover from this condition, initially at fifteen intervals and then at four-minute intervals.

Circuit Description

Uplink Amplifier

The uplink amplifier circuit consists of four stages of gain. Each gain stage is a monolithic integrated circuit (MMIC) mounted to a printed circuit board (PCB). The signal received by the inside antenna is directed to the 1st MMIC stage by a frequency diplexer, which separates the uplink frequency band (1850 - 1910 MHz) from the downlink frequency band (1930 - 1990 MHz). This signal is amplified by three additional MMIC stages and filtered by a ceramic bandpass filter, then directed to an identical diplexer at the output of the fourth stage. A variable attenuator is provided to implement Automatic Gain Control (AGC) in the Model 150, and is controlled by the Control circuit (described below). All stages are biased for linear operation. The overall gain from the inside antenna terminal to the outside antenna terminal is nominally 50 dB. Each diplexer / filter combination provides more than 65 dB of rejection between the uplink amplifier chain and the downlink.

Downlink Amplifier

The downlink circuit is identical in operation to the uplink, providing four stages of MMIC amplification. The major differences are the downlink frequency (1930 – 1990 MHz.) and signal flow in the opposite direction.

Controller

Operation of the Model 150 amplifier is monitored and controlled by a microcontroller. The primary functions of the microcontroller are: maintain linear operation by controlling the gain of the unit to prevent spurious radio-frequency emissions; shut down the amplifier in the event of a severe overload condition which exceeds the range of the AGC circuit; and to detect and reduce the amplifier's gain to prevent instability of the unit in the event that the isolation between the outside antenna and the inside antenna is insufficient.

Power Supply

All of the MMIC amplification stages, in both the uplink and downlink, operate from a single supply voltage of +5 Vdc. All internal dc circuits are filtered and de-coupled from the RF circuits. A high-efficiency 115 Volt AC to 5 Volt DC “Wall” supply is provided with the unit. The current requirement at 5 Volts DC is less than 1.2 Amperes.

2. General Specifications

All specifications stated as typical unless otherwise noted. Cellular Specialties, Inc. reserves the right to change these specifications at any time without prior notice.

	<u>Downlink</u>	<u>Uplink</u>
Frequency Band	1930 – 1990 MHz	1850 – 1910 MHz
Linear Gain (dB)	50	50
Typical Power Out (max) Linear * **	+19 dBm (80 mW)	+21 dBm (125 mW)
Noise Figure	6 dB	6 dB
Propagation Delay	< 150 nsec.	< 150 nsec.
Passband Ripple (max)	4 dB pk-pk	4 dB pk-pk
Connectors	Type N female	
Power Requirements	+5 Vdc, 1.2 A	
Temperature	-40° F to +122° C; -40° C to +50° C	
Dimensions	6.1 x 3 x 1 inch; 15.4 x 7.6 x 2.5 cm.	
Weight (amplifier only)	1.2 lb.; 0.55 kg.	
Indicator LEDs	Power, AGC, Isolation, Shutdown	
Regulatory Approvals	FCCID: NVRBA15X-01 IC: 4307A-BA15X19	

NOTES

- * The manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating must be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device.
- ** *Maximum total output power without exceeding the FCC allowable emissions of -13 dBm.*

3. Inspection and Installation

Inspection

Inspect the equipment as soon as possible after purchase. If any part of the equipment has been damaged in transit, report the damage to the transportation company and also to the company where purchased.

Contents

The unit package contains the following:

Model 150 Amplifier
Power Transformer, 110 volt to 5 volt
User Manual

Installation

Note:

The Installer should refer to the **Safety Precautions**, in the following section, for proper antenna selection and installation

The installation of the Model 150 is relatively simple. If possible, measurements of the Received Signal Strength Indicator (RSSI) should be recorded as close as possible to the proposed outside antenna location. Optimum performance will be obtained with RSSI readings greater than -85 dBm.

With the exact location of the outside antenna and the coordinates of the cell sites closest to the building in which the unit is being installed, the distance and bearings to each of the local cells can be determined. The first choice would be the closest site unless there is blockage in the form of buildings or terrain. If blockage exists, an alternate site may be available.

If coordinates are not available, measure the signal strength at the outside antenna output by connecting a phone to the outside antenna and slowly rotating the antenna until a maximum reading is obtained. NEVER CONNECT A PHONE DIRECTLY TO THE AMPLIFIER.

The amplifier and inside antenna should be centrally located, keeping coaxial cable runs to a minimum. A maximum length of 100 feet of low loss cable is recommended. The actual coax used should be RG-8 type or better

with a flame retardant rating as a minimum. If the coax is run through an area where heating and/or cooling air is channeled, a plenum rated coax must be used. When mounting the amplifier, take care to avoid areas of high heat or extreme cold. In general, do not place the unit on or near the top of high ceilings, by heaters or in cold storage areas.

During installation, care must be taken to provide the adequate isolation between inside and outside antennas. It is good practice to install the antennas where that there are metal and/or concrete building obstructions between the antennas, such as concrete floors, elevator shafts, restroom areas, chimneys, etc. The outside antenna should never be pointed in the direction of any inside antenna unless significant metal/concrete obstructions or significant height difference exists between the antennas.

Isolation must be at least 60 dB to prevent re-generative feedback in the system. Feedback of this nature could cause the amplifier to emit a continuous signal at maximum amplitude. The Model 150 amplifier's controller will detect inadequate isolation and will reduce the gain of the amplifier to prevent oscillation (the yellow "Isolation" indicator indicates this condition). Though the amplifier will continue to operate, its performance is reduced and the inadequate isolation condition should be corrected.

If the yellow "Isolation" LED is on, re-orient the outside and / or inside antennas to minimize signals between the antennas and reset the amplifier by disconnecting and reconnecting the power supply at the amplifier. The gain of the amplifier will remain in a reduced state until adequate isolation is achieved and it is reset.

There are no installation or user adjustments or tuning on this unit.

Safety Precautions

CAUTION



For INDOOR use, an Omni-Directional Antenna with a maximum gain of 8 dBi is authorized for use with this unit.

Inside antennas must be positioned to observe minimum separation of 20 cm. (~ 8 in.) from all users and bystanders. For the protection of personnel working in the vicinity of inside (downlink) antennas, the following guidelines for minimum distances between the human body and the antenna must be observed.

The installation of an INDOOR antenna must be such that, under normal conditions, all personnel cannot come within 20 cm. (~ 8.0 in.) from any inside antenna. Exceeding this minimum separation will ensure that the employee or bystander does not receive RF-exposure beyond the Maximum Permissible Exposure according to section 1.1310 i.e. limits for General Population/Uncontrolled Exposure.



For OUTDOOR use, a Directional Antenna up to a maximum gain of 14 dBi is authorized for use with this unit. The Outside antenna must be positioned to observe minimum separation of 120 cm. (~ 4 ft.) from all users and bystanders. For the protection of personnel working in the vicinity of outside (uplink) antennas, the following guidelines for minimum distances between the human body and the antenna must be observed.

The installation of an OUTDOOR antenna must be such that, under normal conditions, all personnel cannot come within 120 cm. (~ 4 ft.) from the outside antenna. In all installations, the antenna should never be mounted such that the main beam is directed toward an area where workers or bystanders may be present. Exceeding this minimum separation will ensure that the worker or bystander does not receive RF-exposure beyond the Maximum Permissible Exposure according to section 1.1310 i.e. limits for General Population/Uncontrolled Exposure.