HE4 4G Broadband Head-End

5-Band Distributed Antenna System Head-End

User Manual

Table of Contents

Revision History

Rev. 1	Initial manual
Rev. 2	Updated AWS and Band 17 UL power levels
Rev. 3	Added remote access section
Rev 4	Added FCC ID for EV-DO modem

Safety & Certification Notice

"Only qualified personnel should handle DAS equipment. Any person involved in installation or service of this equipment should understand and follow these safety guidelines."

Use this unit only for the purpose specified by the manufacturer. Do not modify or fit any spare parts that are not sold or recommended by the manufacturer.

This amplifier system is designed to operate from single-phase 120VAC power and should always be operated with both the neutral and ground wires properly connected.

Do not install or make adjustments to this unit during an electrical storm.

This equipment will generate radio signals and could continuously emit RF energy. Avoid prolonged exposure to the antennas and maintain a 12 inch clearance from the antenna while the system is operating.

Power for this equipment shall be supplied through wiring installed in a normal building. If powered directly from the mains distribution system, it shall be used additional protection, such as overvoltage protection device.

Only manufacturers recommended antennas, cables, and passive devices shall be used with this equipment.

Opening the chassis will void the warranty.

Always power off the unit prior to performing any work.

To meet FCC Part 27.50 compliance, the installation height of the donor antenna for an AWS band (1700/2100 MHz) operation is limited to 10 meters above ground.

WARNING. This is **NOT a CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an **FCC LICENSE** or express consent of an FCC Licensee to operate this device. Unauthorized use may result in significant forfeiture penalties, including penalties of $100,000 for each continuing violation.

FCC Information

FCC ID: 2AEQJ-HE4-001

WARNING. This is **NOT a CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an **FCC LICENSE** or express consent of an FCC Licensee to operate this device. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of $100,000 for each continuing violation.

Warning: Changes or modifications to this device not expressly approved by the manufacturer could void the user's authority to operate the equipment.

You MUST operate this device with approved antennas and cables as specified by the manufacturer. Antennas MUST be installed at least 30 cm (12 inches) from any person.

Industry Canada Regulations

IC ID:

This Class B digital apparatus meets all requirements of the Canadian Interference Causing Equipment Regulations. Operation is subject to the following two 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 term "IC" before the radio certification number only signifies that Industry Canada technical specifications were met.

RF Exposure: The manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output 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.

Cet appareillage numérique de la classe [B] répond à toutes les exigences de l'interférence canadienne causant des règlements d'équipement. L'opération est sujette aux deux conditions suivantes: (1) ce diapositives peut ne pas causer l'interférence nocive, et (2) ce dispositif doit accepter n'importe quelle interférence reçue y compris l'interférence qui peut causer l'opération peu désirée.

Le fabricant nominale de la puissance de sortie de ce matériel est simple transporteur. Pour les situations lorsque plusieurs signaux porteurs sont présents, l'évaluation devrait être réduite de 3.5 dB, en particulier lorsque le signal de sortie est réémise et peut provoquer des interférences adjacentes à la bande utilisateurs. Ce pouvoir est de la réduction par le biais de la sortie d'alimentation ou la réduction de gain et non par un atténuateur à la sortie du dispositif.

Please note: This unit has been approved for use in Canada under RSS 131, however, consent for the use of this device to improve mobile communications coverage, must be obtained through your mobile network provider, prior to placing the unit in operation. Please refer to the Industry Canada document CPC 2-1-05, Section 6.1 available or viewable at:
http://www.ic.gc.ca/epic/site/smt-gst.nsf/en/sf08942e.html

Distributed Antenna System Overview

Cellular signals from outdoor cell towers may not provide clear and consistent coverage inside buildings, consequently wireless operators and building owners use distributed antenna systems (DAS) to broadcast cell signals throughout their facilities.

In-building weak signals are produced by a variety of reasons, including LEED construction, base station position, building position, construction material, in-building content, etc. Within a building the cell signals can be strong near the external walls and become non-existent as the signals try to propagate within the building. Typical in-building signal loss can be seen in Table 1.

Substance	Cellular 800/900 MHz	PCS / AWS 1700/2100 MHz
Drywall	2dB	3dB
Plywood	1dB	3dB
Cubicle (each)	1dB	2dB
Glass (no shielding)	2dB	3dB
Low-e Glass	15dB	19dB
Concrete	18dB	22dB
Lead	45dB	52dB

Table 1: Typical Signal Loss in Buildings

Signal loss is a key term used in the cellular industry. For each 3dB of loss in signal strength, this represents the ability to make a call or not. The range of operable cell signals can extend from very strong -50dB signals—when a subscriber is standing next to a cell tower—to very weak signals of -95dB or weaker. At -95dB, a call may get through at times, but the subscriber will be frustrated by the number of dropped calls and overall poor call quality. Also data applications are much more vulnerable to weak signals, causing constant retransmissions and resulting in reduced data rates.

In-building DAS can eliminate problems associated with signal proliferation, coverage, and capacity for voice and data applications. In-building systems work by distributing cell signals throughout an interior space: the signal is typically brought to the building using roof-mounted donor antennas or with a base station (BTS) installed in the telecommunications equipment room. The donor antennas or BTS is then connected to the DAS using cabling. The DAS network of antennas is placed strategically throughout the building to provide voice and data services.

Product Description

Intelligent Distributed Amplifier System (IDAS) is a distributed network of active coverage nodes controlled by an intelligent head-end called the HE4. The head-end simultaneously supports 2G, 3G, & 4G communication services from multiple carriers. The product is connected to donor antennas that are normally roof mounted to capture the strongest mobile broadband signals available. The signals are transmitted from the donor antennas into the head-end where the signals are filtered, balanced to correct near and far tower signals, amplified, and transmitted to each of the coverage nodes within the building. Each coverage node is a linear and ultra-low noise amplifier that supports voice, texting, and demanding data centric applications providing a very scalable in-building network. The major features include supporting all major networks simultaneously, high speed data, programmable signaling, and alarm triggers for all degraded network conditions.

The HE4 is a fully programmable device that can adjust uplink and downlink signaling as well as providing feedback on donor antenna positioning. During idle mode or in a state where no uplink signal is present, the uplink gain on the HE4 is lower than the maximum gain to reduce electronic noise output. When an uplink signal is present, the output power is adjusted accordingly as needed for power level control required for a variety of communication protocols. The product works in conjunction with a network of coverage nodes and associated donor antennas.

Automatic Shutdown

The detected power levels are monitored by a microcontroller in the HE4. The microcontroller limits the maximum output power to keep the amplifiers linear without interfering with the network power control. The HE4 will also detect low-level self-oscillation and corrects it in real-time. During installation the HE4 alerts the user with LED outputs to adjust the position of the antennas if the unit is self-oscillating to clear the issue. If the microcontroller cannot correct the self-oscillation it will shut the unit down to protect the network and notify the user with LED outputs on the unit.

To resolve oscillation, increase the antenna separation between in-building antennas or provide improved isolation from the outside donor antennas and the in-building antennas. This isolation should be in the order of 70 dB and is usually obtained by mounting the outside antenna away from the edges of the roof. The use of window mounts or other non-rooftop mountings should be avoided.

Remote Access

The HE4 has a microcontroller that interfaces to a cellular modem (FCC ID: RI7DE910-DUAL) that supports remote data access. The modem is continuously checking for an incoming connection, and if found it will complete the connection and open up a data path to the unit. This allows for a remote program to monitor the HE4 activity, make any necessary adjustments, or shut down the HE4 if needed.

The internal contained cellular modem (FCC ID: RI7DE910-DUAL) is a dual band device supporting 800/1900MHZ frequency bands as well as CDMA 1xRTT and CDMA 1xEV-DO Rev. A Air Interfaces.

Authorized Equipment

The HE4 has been tested using the antennas and cable.

Part Number	Description
WOA-N11	In-building broadband ceiling mount antenna
WDA-N21	In-building broadband directional wall mount antenna
WDA-N03	Wideband directional donor antenna
CC10-001	10 ft. antenna cable

Warning: do not use any antennas, cables, and /or coupling devices not authorized by the manufacturer.

Product Specifications

The product works in conjunction with the head-end as well as surrounding coverage nodes, and is responsible for delivering optimal cellular communications to the target coverage area. The HE4 supports the following:

PCS Band 2:

System gain: uplink = 70dB; downlink = 70dB
Downlink: 1.93-1.99GHz, Uplink: 1.85-1.91GHz

AWS Band 4:

System gain: uplink = 70dB; downlink = 70dB
Downlink: 2.11-2.155GHz, Uplink: 1.71-1.755GHz

Cellular Band 5:

System gain: uplink = 70dB; downlink = 70dB
Downlink: 869-894MHz, Uplink: 824-849MHz

LTE Band 13:

System gain: uplink = 70dB; downlink = 70dB
Downlink: 746-757MHz, Uplink: 776-787MHz

LTE Band 17:

System gain: uplink = 70dB; downlink = 70dB
Downlink: 734-746MHz, Uplink: 704-716MHz

General Product:

Industrial enclosure
Input power = 6.0 VDC
Dimensions 10” x 8.25” x 2”

Electrical Specifications

PCS Band 2		
Test Parameter	**Condition (GHz)**	**Specification**
Uplink Operating frequency		1.85 to 1.91 GHz
Downlink Operating frequency		1.93 to 1.99 GHz
Uplink maximum amplifier gain	Peak Gain over 1.85 to 1.91	70 dB typical
Downlink maximum amplifier gain	Peak Gain over 1.93 to 1.99	70 dB typical
Uplink minimum amplifier gain	Peak Gain over 1.85 to 1.91	40 dB
Downlink minimum amplifier gain	Peak Gain over 1.93 to 1.99	40 dB
Maximum Ripple in BW	1.85 to 1.91 1.93 to 1.99	10 dB typical 10 dB typical
Uplink Noise Figure	Max. Gain Min. Gain	5.0 dB typical 15 dB typical
Downlink Noise Figure	Max. Gain Min. Gain	5 dB typical 15 dB typical
Uplink IP3	Max. Pout	35 dBm minimum
Downlink IP3	Max. Pout	23 dBm minimum
Amplifier Signal Delay	1.85 to 1.91 1.93 to 1.99	200 nsec max 150 nsec max
Uplink Input Signal Range	1.85 to 1.91	-60dBm to –12dBm
Downlink Input Signal Range	1.93 to 1.99	-100 dBm to –34 dBm
UL RF Composite Output Power -GSM	1.85 to 1.91	+23 dBm max
DL RF Composite Output Power -GSM	1.93 to 1.99	+15 dBm max

AWS Band 4		
Test Parameter	**Condition (GHz)**	**Specification**
Uplink Operating frequency		1.71 to 1.755 GHz
Downlink Operating frequency		2.11 to 2.155 GHz
Uplink maximum amplifier gain	Peak Gain over 1.71 to 1.755	70 dB typical
Downlink maximum amplifier gain	Peak Gain over 2.11 to 2.155	70 dB typical
Uplink minimum amplifier gain	Peak Gain over 1.71 to 1.755	40 dB
Downlink minimum amplifier gain	Peak Gain over 1.93 to 1.99	40 dB
Maximum Ripple in BW	1.71 to 1.755 2.11 to 2.155	8.0 dB typical 8.0 dB typical
Uplink Noise Figure	Max. Gain Min. Gain	5.0 dB typical 15 dB typical
Downlink Noise Figure	Max. Gain Min. Gain	5 dB typical 15 dB typical
Uplink IP3	Max. Pout	35 dBm minimum
Downlink IP3	Max. Pout	23 dBm minimum
Amplifier Signal Delay	1.71 to 1.755 2.11 to 2.155	200 nsec max 150 nsec max
Uplink Input Signal Range	1.71 to 1.755	-60 dBm to –12 dBm
Downlink Input Signal Range	2.11 to 2.155	-100 dBm to –34 dBm
UL RF Composite Output Power -GSM	1.71 to 1.755	+18 dBm max
DL RF Composite Output Power -GSM	2.11 to 2.155	+15 dBm max

Cellular Band 5		
Test Parameter	**Condition (GHz)**	**Specification**
Uplink Operating frequency		824 to 849 MHz
Downlink Operating frequency		869 to 894 MHz
Uplink maximum amplifier gain Downlink maximum amplifier gain	Peak Gain over 824 to 849 Peak Gain over 869 to 894	70 dB typical 70 dB typical
Uplink minimum amplifier gain Downlink minimum amplifier gain	Peak Gain over 824 to 849 Peak Gain over 869 to 894	40 dB 40 dB
Maximum ripple in BW	824 to 849 869 to 894	4 dB typical 4 dB typical
Uplink Noise Figure	Max. Gain Min. Gain	5.0 dB typical 15 dB typical
Downlink Noise Figure	Max. Gain Min. Gain	5 dB typical 15 dB typical
Uplink IP3	Max. Pout	39 dBm
Downlink IP3	Max. Pout	18 dBm
Amplifier Signal Delay	824 to 849 824 to 849	100 nsec max 100 nsec max
Uplink Input Signal Range	824 to 849	-55 dBm to –4 dBm
Downlink Input Signal Range	869 to 894	-100 dBm to –34 dBm
UL RF Output Power - GSM	824 to 849	+23 dBm max
DL RF Output Power -GSM	869 to 894	+15 dBm max

LTE Band 13		
Test Parameter	**Condition (MHz)**	**Specification**
Uplink Operating frequency		776 to 787 MHz
Downlink Operating frequency		746 to 757 MHz
Uplink maximum amplifier gain Downlink maximum amplifier gain	Peak Gain over 776 to 787 Peak Gain over 746 to 757	70 dB typical 70 dB typical
Uplink minimum amplifier gain	Peak Gain over 776 to 787	40 dB
Downlink minimum amplifier gain	Peak Gain over 746 to 757	40 dB
Maximum ripple in BW	776 to 787 746 to 757	4 dB typical 4 dB typical
Uplink Noise Figure	Max. Gain Min. Gain	5.0 dB typical 15 dB typical
Downlink Noise Figure	Max. Gain Min. Gain	5 dB typical 15 dB typical
Uplink IP3	Max. Pout	39 dBm
Downlink IP3	Max. Pout	18 dBm
Amplifier Signal Delay	776 to 787 746 to 757	100 nsec max 100 nsec max
Uplink Input Signal Range	776 to 787	-55 dBm to –4 dBm
Downlink Input Signal Range	746 to 757	-100 dBm to –34 dBm
UL RF Output Power - GSM	776 to 787	+23 dBm max
DL RF Output Power -GSM	746 to 757	+15 dBm max

LTE Band 17		
Test Parameter	**Condition (MHz)**	**Specification**
Uplink Operating frequency		704 to 716 MHz
Downlink Operating frequency		734 to 746 MHz
Uplink maximum amplifier gain	Peak Gain over 704 to 716	70 dB typical
Downlink maximum amplifier gain	Peak Gain over 734 to 746	70 dB typical
Uplink minimum amplifier gain	Peak Gain over 704 to 716	40 dB
Downlink minimum amplifier gain	Peak Gain over 734 to 746	40 dB
Maximum ripple in BW	704 to 716 734 to 746	4 dB typical 4 dB typical
Uplink Noise Figure	Max. Gain Min. Gain	5.0 dB typical 15 dB typical
Downlink Noise Figure	Max. Gain Min. Gain	5 dB typical 15 dB typical
Uplink IP3	Max. Pout	39 dBm
Downlink IP3	Max. Pout	18 dBm
Amplifier Signal Delay	704 to 716 734 to 746	100 nsec max 100 nsec max
Uplink Input Signal Range	704 to 716	-55 dBm to –4 dBm
Downlink Input Signal Range	734 to 746	-100 dBm to –34 dBm
UL RF Composite Output Power - GSM	704 to 716	+18 dBm max
DL RF Composite Output Power -GSM	734 to 746	+15 dBm max

Pre-installation Survey

A pre-installation survey should be performed prior to commitment to installation. Measurement of Received Signal Strength Indication (RSSI) should be recorded throughout the building in all areas where mobile broadband coverage is desired. RSSI levels around the exterior of the building as well as on the rooftop or as close to the point where the exterior antenna will be installed should also be recorded. RSSI readings at the position where the outside antenna will be installed should be greater than –90 dBm. Successful installations may be made with lower readings and engineering support will be required.

The exact location of the proposed outside antenna should be measured with a GPS unit and the coordinates of the cell sites closest to the building in which the system is being installed should be obtained. With these coordinates the distance and bearing to each of the local cell sites can be computed and made available to the installation team. The first choice should be the closest site unless there is blockage in the form of buildings or terrain between the building and this cell site. If blockage exists an alternate site may be available.

If GPS coordinates are not available there is an alternative method of locating the dominant site: connect a handset via SMA female to N male adapter to the directional donor antenna. Rotate the antenna until maximum RSSI readings are obtained and secure it. The location of the HE4 head-end should allow access to the donor antennas as well as the associated components of the system. The location of the CP4 coverage nodes and the interior antennas should be determined through the use of

floor plans of the building in which the system is to be installed. It is important to locate the CP4 as close as possible to the antenna to keep the coax runs as short as possible. A maximum length of 150 feet is suggested from the riser tap to the CP4 although longer runs might be accommodated. This assumes that a coax with loss at 1900 MHz of approximately 8.0 dB per 100 feet is used. The coax used should be a nominal RG-11 type with a flame retardant rating except when installed in space where moving air (heating and/or cooling) exists. In which case the coax must be "plenum" rated. Of primary concern is the isolation between the outside antenna and the inside antennas.

Physical Installation

You must obtain express consent of an FCC Licensee prior to the installation of an industrial signal booster. A contact list of each licensee is provided in this manual.

The coaxial cable discussed above should be pulled from the rooftop location to the space designated for the HE4 installation. To meet FCC Part 27.50 compliance, the installation height of the donor antenna for an AWS band (1700/2100 MHz) operation is limited to 10 meters above ground. Additional coax should be pulled from the HE4 head-end to where power splitters are located and thus to the position designated for each CP4 and associated antennas. Usually this is accomplished by using existing cableways and running the cable above suspended ceilings. In many cases the Omni-directional antennas can be located above the suspended ceilings however, when this is not possible, alternatives such as ceiling or wall mounted antennas may be used.

When mounting the HE4, 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. The HE4 provides the following visual diagnostics using the two LED lights.

Top LED power status 

	Power feed is good.
	Power level is low. Need to check connections.
	Power level is not adequate. Check power source as well as connections.

Bottom LED RF status 

	Donor antenna RF signal is good.
	RF signal level is low. Need to check connections, cable, and donor antenna position.
	RF signal level is not adequate. Check RF donor source, cable, and connections.
	Not connected to in-building network when blinking red LED. Check all in-building connections, cable, and components.

Contact Information

To consult with a Whoop Wireless directly please call us at (888) 983-7381 or email at info@whoopwireless.com.

Licensee Contact Information

For further information, visit
http://wireless2.fcc.gov/UlsApp/UlsSearch/searchLicense.jsp

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