**K60i Wireless Communication System
User Guide**

Release 1.2
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· Increase separation between the equipment and receiver.
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1 Preface

1.1 Preface overview

Thank you for choosing the K60i system from Kwikbit. This guide introduces you to system concepts, system architecture and commonly used terms.

This preface describes:

- Audience for this guide
- Additional documentation
- Where to go for more help

1.2 About this guide

This guide provides an overview of the K60i system, its components, its network architecture, and how it is configured and a deployed.

This guide is intended for network and system administrators who must install, configure, and manage K60i distribution networks. This guide is meant to provide an overview to the system. This guide does not provide detailed information on installing or operating the system.

It is assumed readers of this guide are familiar with:

- Basic networking concepts
- Layer 2 (link layer) of OSI model
- Layer 3 (network layer) of OSI model
- Routing and switching in networks
- Radio frequency (RF) systems engineering
- Virtual local area network (VLAN) technology

1.3 Additional documentation

If you cannot find the information you need in this guide, you may want to refer to the following documents:

- K60i Physical Installation Guide
- Kwikbit Edge Controller User Manual

1.4 Additional help

Kwikbit is committed to providing our customers with high quality technical support via the following methods:

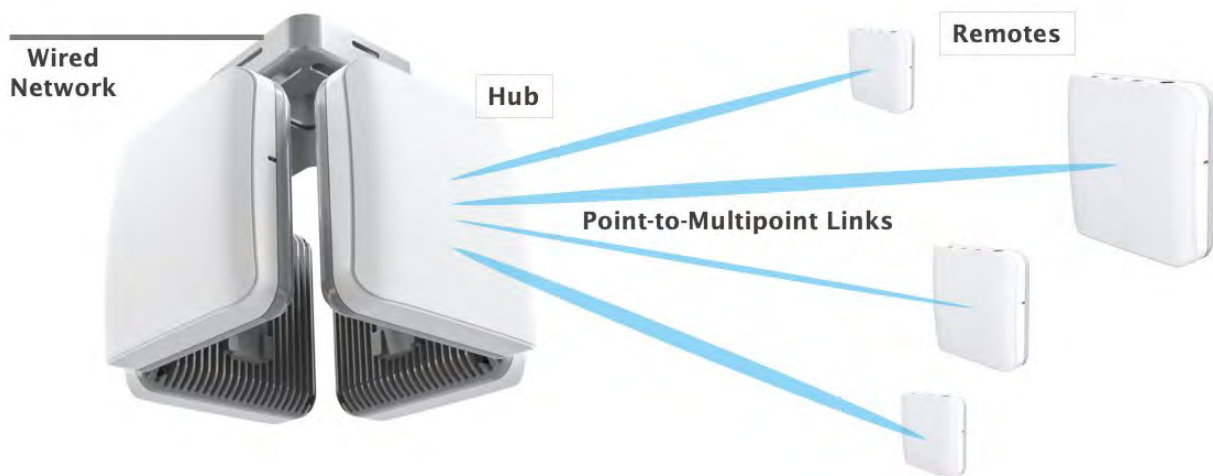|	
Web	www.kwikbit.com/support
E-mail	support@kwikbit.com
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2 Kwikbit K60i System Overview

**Figure 1: K60i System in a Point-to-Multipoint (PtMP)
Wireless Communication Application**

Kwikbit is a leader in gigabit wireless distribution solutions that intelligently adapt to challenging environments to maximize performance and reliability.

The K60i system operates in the 60 GHz unlicensed frequency band and is designed primarily for line-of-sight (LoS) operation. Non-line-of-sight (NLoS) operation is possible within short range and in the presence of reflective surfaces. By utilizing advanced beamforming techniques, the K60i system automatically adapts in Point to Multi-Point (PMP) communication configuration and is adaptable to changes in the operating environment. The beam forming capability also makes system installation simple for

non-technical staff as precise mechanical alignment, as required by previous generation 60 GHz systems, is not required.

The K60i system is designed for use in multiple applications including IoT backhaul (sensors, security cameras, etc.), optical fiber extension, and corporate and enterprise data backhaul services by providing 1 Gbps of symmetric throughput.

The K60i system operates in unlicensed Time Division Multiplexing (TDD) band 57.05 – 64.00 GHz in both Point to Point (PTP) and Point to Multi-Point (PtMP) configurations. Some of the main product characteristics are shown in Table 1.

Table 1: Main K60i Characteristics

Duplex Mode	Time Division Multiplexing (TDD)
Physical Layer / Antenna System	64 patch beamforming antenna
Operation Configuration	PtP and PtMP
Capacity	1.86 Gbps goodput aggregate
Symmetry	Dynamic downlink (DL) and uplink (UP) based on offered load
Frequency of Operation	57.05 – 64.00 GHz
Channel Bandwidth	2.16 GHz
Network Interface	3x gigabit Ethernet
Form Factor	4.25 x 4.25 x 2" with integrated antenna

The K60i system consists of the following components:

- **Hub Unit**: control communication to one or more Remote Units
- **Remote Unit**: scan for available Hub Units and connect to the Hub configured or assigned via the Edge Controller
- **Edge Controller**: Optional appliance computer that provides WebUI tools for deployment planning, commissioning, network configuration, management,

monitoring and fault isolation. Edge controller is highly recommended for networks of medium and large scale.

The K60i Hub and Remote Units are identical from a hardware perspective, only differing in software configuration. The K60i has a small form factor that can be easily and unobtrusively deployed in many different indoor environments.

3 K60i System Description

Kwikbit's K60i wireless indoor backhaul solution is designed to meet the requirements of network planners where rapid and flexible deployment, high reliability, multi-gigabit capacity and excellent latency performance are needed. Applications for the system include IoT gateway aggregation, Wi-Fi access point backhaul, video camera connectivity and other gigabit IP based applications. The system can function either as a Point-to-Point (PTP) or Point-to-Multipoint (PMP) wireless Ethernet bridge.

Some of the main characteristics of the system include:

- **Time Division Duplex (TDD):** The K60i solution features TDD access mode with variable frame length.

- **Adaptive Modulation with Link Adaptation:** The K60i system supports BPSK, QPSK and 16QAM on both the downlink and uplink path to achieve high capacity in the channel bandwidth (1.86 Gbps Ethernet layer throughput for combined downlink and uplink traffic).

- **Beamforming:** Use of the 60 GHz band allows extremely fast communication, but also presents the challenge of limited propagation. Signals in the 60 GHz band are also more susceptible to disruption from physical barriers than at lower frequencies. The K60i system includes adaptive beamforming, a technique that enables robust multi-gigabit communications at greater distances. Kwikbit's beamforming feature uses directional antennas to reduce interference and automatically focus a signal between two devices into a concentrated beam. During the beamforming process, devices establish communication and then fine-tune their antenna settings to improve the quality of directional communication until there is enough capacity for the desired data transmission.

  One key benefit of Kwikbit's beamforming is that if an obstacle blocks the line of sight between two devices, for example, if someone walks between them, the devices can quickly establish a new communications pathway. Another benefit of the K60i beamforming is that non-technical personnel can quickly and easily install the system. Precise physical alignment of the radios, as required with previous 60

GHz products, is not required with the Kwikbit system. The beamforming feature also enables the PMP communication capability of the system.

- **Power Management:** The K60i system utilizes the scheduled access mode to reduce power consumption. Devices connected with each other via a directional link schedule the periods during which they communicate and, in between those periods, they can sleep to save power. This capability allows devices to more precisely tailor their power management to their actual traffic workload, reduces potential co-channel interference and enables efficient spectrum utilization.

- **Advanced Security:** The K60i system utilizes strong security mechanisms, including Galois/Counter Mode, a highly-efficient mode of encryption that is designed to support higher communication speeds. Encryption is based on the government-grade Advanced Encryption Standard (AES) and is implemented in hardware for performance and efficiency.

- **Integrated Antennas:** The K60i units integrate a specially-designed, 64 element antenna module that enables a peak EIRP of 40 dBm with a 90º azimuthal and 40º vertical beam sweep range.

- **PMP with Dynamic Bandwidth Allocation:** The K60i system can operate in PTP or PMP configurations with up to eight Remotes. The capacity allocated to each Remote is variable according to the requirements of connected devices.

- **Compact Form Factor:** The K60i transceiver units are highly integrated, compact (107x107x50mm), and low in weight (388g), so they can be easily mounted on most ceiling structures and walls.

- **Connectivity:** K60i backhaul devices include three standard RJ45 Gigabit Ethernet ports, two of which supply PoE power to connected Wi-Fi access points, IoT gateways, surveillance cameras and other payload communication devices.

The Kwikbit K60i system provides these network management features:

- Each K60i unit incorporates a WebUI. This WebUI enables configuration, fault management, and administration of the unit, as well as provides system state and performance information.
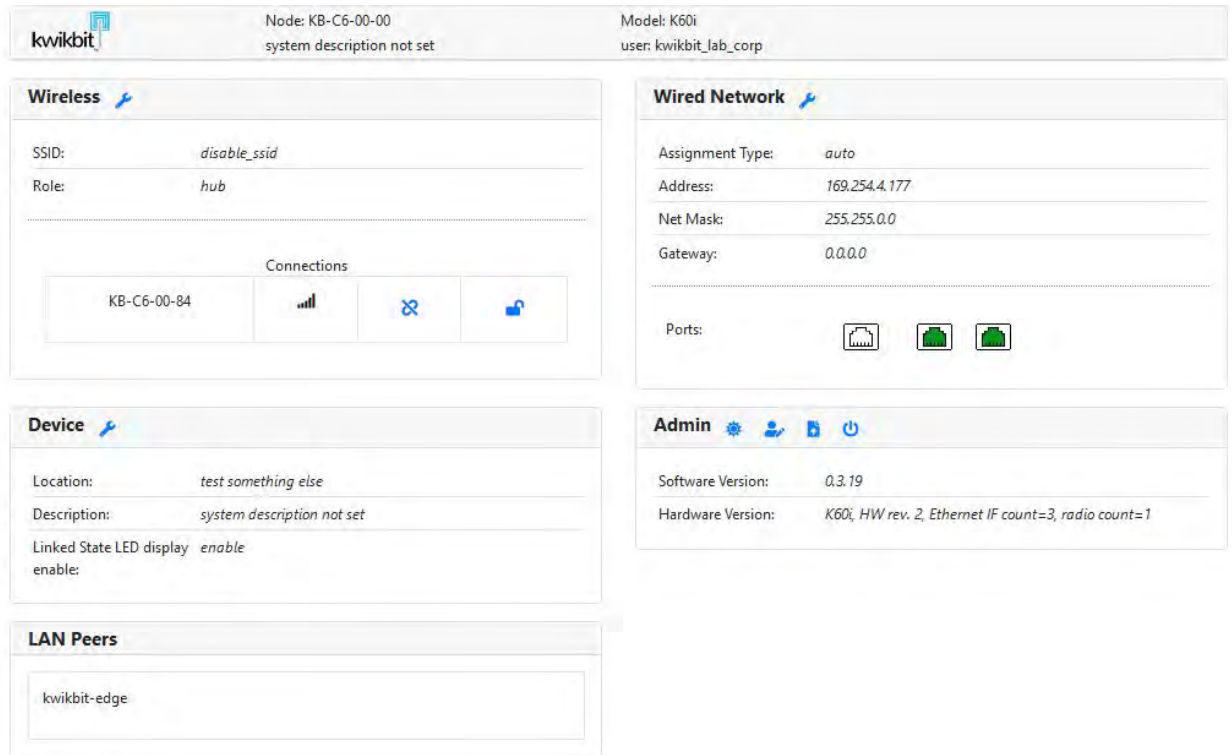
Figure 2: K60i Hub and Remote WebUI interface page

- The Kwikbit Edge Controller is a very powerful part of the Kwikbit solution. The Edge Controller connects through an Ethernet connection to the root K60i unit and enables non-technical personnel to physically install an entire network without K60i units being configured on the bench in advance. A local or remote IT resource can design, commission and manage the network using the Edge Controller's WebUI. The Edge Controller can be connected to the cloud for remote management of multiple locations.

4 Technical Specifications

4.1 System Specifications

Aggregate capacity	Up to 1.8 Gbit/sec (Layer 2/ Ethernet)
Ethernet frame type	Transparent bridging of all Ethernet types including VLAN and VLAN stacking

Latency	250 microseconds average
L2 switching	Complete Layer 2 switching with VLAN support
Security	AES 128 with automatic secure key distribution
Network Attributes	Ethernet bridge, 802.1Q, DSCP/ToS/802.1p (IPv4/v6) and 802.1ad/ QinQ tagging
Network Interfaces	3 x GigE RJ-45 (2x with PoE output)
Other Interfaces	LEDs indicators for power, link condition, signal strength, and unit location
Provisioning	Zero-touch deployment and commissioning with Edge Controller web application
Management	Web GUI and Edge Controller

4.2 Radio Specifications

Access Technology	Single carrier beamforming physical layer
Duplex	Time Division Multiplexing (TDD)
Modulation	BPSK, QPSK; 8 levels of adaptive modulation and coding schemes
Frequencies	57.05 - 64.00 GHz
Channel Bandwidth	2.16 GHz
Antenna System	64 patch beamforming antenna with 90˚ horizontal and 40˚ vertical scan range

Output power (maximum)	40 dBm EIRP
Typical Range	100 meters

4.3 Mechanical, Power and Environmental Specifications

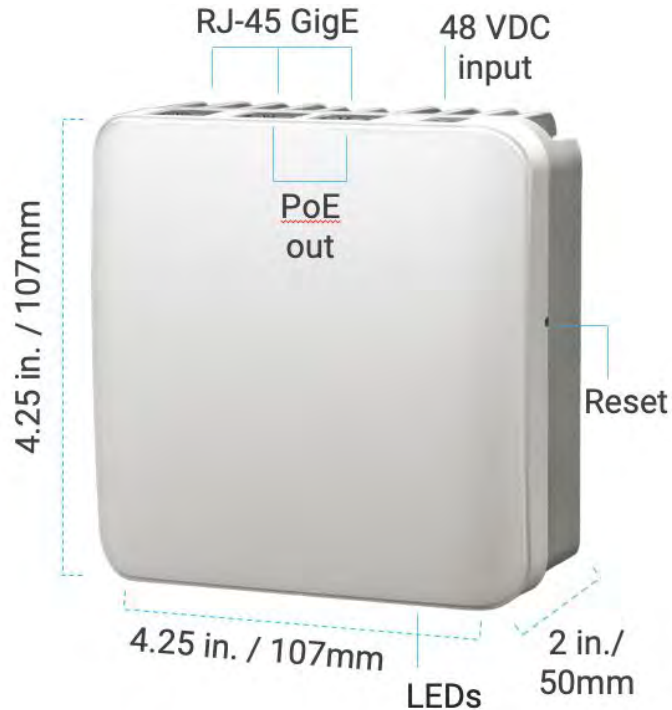| Configuration	Single-piece indoor unit with integrated antenna
Dimensions (H x W x D)	107 x 107 x 50 mm 4.25 x 4.25 x 2 inches
Weight	388g / 13.7 ounces
Power Input	12-48 VDC
Power Consumption	K60i only: 8 watts idle, 13 watts maximum K60i + PoE: 58.4 watts maximum
Power Output	PoE available on 2 ports for Vin = 48 Vdc: 802.3af (15.4 watts) on RJ45 port closest to DC input and 802.3at (30 watts) on middle RJ45
Operating temperature	0˚C to +45˚C
Humidity	Up to 95% non-condensing
UL	62368-1
ESD	IEC EN 61000-4-2
EMC	IEC EN 61000-4-3

4.4 System Enclosure

Figure 3: K60i Backhaul Unit (Hub and Remote)

The K60i enclosure is a rugged casing that can be supplied with multiple mounting bracket configuration options, including: high bay, exposed ceiling, office ceiling T-bar, and wall mount. The mounting brackets allow for a range of orientation flexibility to enable mounting in challenging locations. The ceiling bracket can accommodate up to four units. The wall bracket can accommodate one or two units. The installed units then can be interconnected for medium and large network deployments.

The mechanical enclosure for the transceiver Module has a 48 VDC power connector, three RJ45 connectors for Gigabit Ethernet network connectivity and an opening to the factory reset switch. Two of the three RJ45 port connectors provide PoE compliant power output to power devices connected to the network.

5 System Throughput

The K60i system uses time division duplexing (TDD) access mode, employing a single frequency for both transmit and receive paths. The throughput for the downlink and uplink depends on a downlink-to-uplink frame bandwidth ratio. The ratio is automatically adjusted based on the offered load in each direction, taking into account all Remotes connected to an Hub in PMP. Furthermore, the system's throughput depends on the

Modulation and Coding Rate (MCS) which varies according to link and signal conditions. The following table details Ethernet uplink and downlink combined throughput for a K60i link.

Table 8: Throughput Performance for Cyclic Prefix of 1/8

MCS Index	Modulation	NCBPS	Repetitions	Code Rate	Data Rate (Mbit/s)
1	π/2 BPSK	1	2	1/2	310
2	π/2 BPSK	1	1	1/2	620
3	π/2 BPSK	1	1	5/8	775
4	π/2 BPSK	1	1	3/4	930
5	π/2 BPSK	1	1	13/16	1007
6	π/2 QPSK	2	1	1/2	1240
7	π/2 QPSK	2	1	5/8	1550
8	π/2 QPSK	2	1	3/4	1860

6 Element and Network Management

The K60i system supports the following network management interfaces:

- K60i Web Interface (WebUI). Accessible via HTTP(S), the K60i WebUI provides an interactive visual toolset that allows an operator to modify the full configuration of the K60i system as well as view state, fault, and performance indicator.
- The Edge Controller WebUI application provides complete access to configuration, state, performance and fault information for all K60i units in a network system.

The WebUI network management interface on the K60i system is accessible via HTTP(S). Connect to the K60i system with your browser utilizing one of the following methods:

- **Local Name**: Connect a K60i transceiver unit directly to your computer by plugging an Ethernet cable into any of the K60i's three RJ45 connectors. In the URL field on your computer's browser type **https://KB-XX-XX-XX.local** where **KB-XX-XX-XX** is the Host name of the unit that appears on the sticker on the back of the unit. For

example, if the unit Host name is **KB-C5-6B-78**, then the URL address of the unit is **https://KB-C5-6B-78.local**. Your browser will display a warning stating that the connection is not secure. You may ignore the warning and proceed connecting to the unit. To avoid the warning, please go to the Kwikbit support website, download the Kwikbit security certificate, and install it on your browser.

- **Management IP Address:** An operator assigned, static, Automatic Private IP Addressing (APIPA) or Dynamic Host Configuration Protocol (DHCP) IP address can be used for remote management of the units. Both Hubs and Remotes need a management IP address. For the Hub, the management IP Address is accessible from the Ethernet side of the network, while for the Remote the management IP Address is accessible from the wireless side (i.e., from behind the Hub). All traffic to and from the management IP address can be encapsulated in an operator-configurable VLAN.

The optional Kwikbit Edge Controller's management application automatically discovers all connected K60i devices on the network and establishes a secure connection to each one utilizing a security certificate provided by Kwikbit and customized by the customer. For more information on the Kwikbit Edge Controller device and associated applications, please refer to the Kwikbit Edge Controller User Manual.

The K60i system provides the following network management functions:

1. Device configuration information and status is displayed on the WebUI page interface as shown above in Figure 2. When the mouse cursor is hovered over an Ethernet Port or wireless connections icon, detailed information is displayed. In the Wireless section, the list of wirelessly connected devices is displayed. The list of LAN connected devices is displayed in the LAN Peers section. The WebUI of a connected device is established by clicking on the device's name.
2. Configuration Management. The system configuration section covers several functional areas:
   - Device
     - o Device location
     - o Device description
   - Wired Network
     - o Device IP address assignment
       - ▪ Static address
       - ▪ DHCP – requires DHCP server
       - ▪ Automatic Zero Configuration address assignment
     - o Management VLAN
     - o Ethernet ports
       - ▪ Enable / Disable
       - ▪ PoE Enable / Disable (port 2 and 3)
   - Wireless Network

- o Device role
- o SSID
- o Airlink passcode
- o Channel frequency
- o Preferred Hub (if device configured as Remote)
3. Administration Operations:
    - Flash LEDs of the device – used to identify location of physically installed device
    - Change administration password of the device
    - Upgrade device software
    - Reboot the device

To reset the device to factory defaults:
- cycle the power
- during power-up, observe the LEDs: there should be two illuminated.
- Keep your eyes peeled on the LEDs, after about a minute, a flashing pattern will appear
- the flashing pattern signals the start of a brief window of opportunity for you to press the reset button (a round toothpick or an unfolded paper clip works good for this).
- Press the button and hold it until you see a distinctive flashing pattern
- Once this distincting flashing pattern appears, release the button
- the device is now operating at factory default settings
- The login password is "kwikbit_root"

7 Ethernet Bridge Support

Designed to seamlessly integrate into existing Ethernet backhaul or general-purpose networks, the K60i system is built for Ethernet connectivity services and provides network functionality as a standard Layer 2 (L2) Transparent Bridge (IEEE 802.1d), whereby the K60i cluster (a cluster being one Hub with its group of up to eight Remotes) is the bridge, and the Ethernet ports on the Hub and associated Remotes are the ports of the bridge.

The embedded bridge functionality performs Media Access Control (MAC) address learning (up to 4096 MAC addresses). This function allows the Hub to perform an optimal allocation of radio resources by sending traffic to the Remote behind which the destination of that traffic is located.

The K60i system allows network management traffic to be encapsulated in a dedicated management VLAN and can transport standard Ethernet frames (up to 1518 bytes).

8 Installation Planning

When planning the installation of K60i systems, refer to the Kwikbit K60i Install Guide and delegate physical install to appropriately trained professionals. When unpacking K60i backhaul units during install, be sure to do the following for each unit:

- Locate the label on the unit casing that lists the Serial Number (SN) and Host name of the unit
- Record the SN on your registration card for future reference
- Record the Host name for future reference when provisioning the system

After installation of the K60i backhaul units, perform the tasks described in Chapter 11 "System Provisioning".

9 Using the K60i Web User Interface (UI)

9.1 Requirements

The K60i embedded WebUI allows for direct configuration of both Hub and Remote units. It is a standard web application that runs directly on the K60i unit and is accessible through the default port for HTTPS (443) at URL https://<Host name of the unit>. Your browser will display a warning stating that the connection is not secure. You may ignore the warning and proceed connecting to the unit. To avoid the warning, go to the Kwikbit support website, download the Kwikbit security certificate, and install it on your browser.

The recommended browsers for the K60i WebUI are:

- Google Chrome
- Safari

Operating System (OS) support for K60i WebUI:

- Windows
- Mac OS X
- Unix
- Linux

Note: With the exception of IE9, the K60i WebUI supports the most recent web browser and OS versions.

Required basic K60i unit configuration tasks can be performed using the units WebUI; however, the Kwikbit Edge Controller can be used to quickly and efficiently plan,

commission, configure and monitor small to large K60i networks. See the K60i Edge Controller User Guide for details.

9.2 K60i Web UI Page

The K60i WebUI is a single page that provides device status as well as configuration options.

9.2.1 Logging In

Use your browser to connect to K60i device's WebUI as described above. It is not necessary to login to the system in order to view the WebUI page. You will then be prompted to login once you click on any one of the configuration tabs if you do not have a security certificate installed on your computer. The security certificate based authentication option is available when utilizing an Edge Controller to manage the network.

The default username and password is as follows:

> User Name: root
> Password: kwikbit_root

The page remains read-only if you do not login to the system and only gives general system information.

At the top of the WebUI screen, general node information including node name, node description, model number and user is displayed. There are two network sections on the page, Wireless and Wired.

The **Wireless Network** section displays the connection SSID, the unit role (Hub or Remote) and all current wireless connections. If the unit is a Hub, all currently linked Remotes will be displayed under connections. If the unit is a Remote, only one connection to a Hub can be listed. Each connection displays the connected unit name as well as graphical representation of the signal quality of the connection. By clicking on the connected device's name, a browser page of that device is opened. By hovering over the signal quality graphic, detailed signal level information is displayed. You can change SSID and unit Role configuration by clicking on the tool icon in the section banner, assuming you are an authorized user.

The **Wired Network** section displays the unit's assigned IP address and the status of the three Gigabit Ethernet ports. By hovering over the Ethernet port icons, detailed port status information is displayed. The unit's IP configuration can be changed by clicking on the tool icon in the section banner. Clicking on the Ethernet port icons allows a user to enable and disable ports as well as turn PoE output on or off for ports one and two.

The **Device** section displays and provides configuration capability for **Device Location** and **Device Description**.

The **LAN Peers** section displays the names of all K60i units that are connected to the current unit over a LAN connection. In most cases, these would be collocated units that provide additional wireless connectivity from that location.

The **Administration** section displays the software and the hardware versions of the device and includes controls to change user password, upgrade device software, flash device LEDs for device identification, and to reboot the device.

10 System Provisioning

Network planning, installation procedure and commissioning are most efficiently performed using the Kwikbit Edge Controller. In addition, the Edge Controller enables centralized network operation view and management. Please see the Kwikbit Edge Controller User Guide for detailed information.

If it is desired to provision a K60i network without the use of edge controller, the following tasks associated with preparing a K60i system must be followed:

1. Initial system setup and IP configurations
2. Setting units' roles
3. Setting SSID and airlink connectivity passcode
4. Setting communication channel frequency

10.1 Initial System Setup and IP Configurations

All new K60i units shipped from the factory are identical with a default software configuration loaded. You must connect to the management interface in order to configure the following system management parameters:

1. Connect your computer directly to the unit with an Ethernet cable. Once connected, open a browser on the computer and enter the following URL:

https://KB-XX-XX-XX.local where **KB-XX-XX-XX** is the Host name of the unit that appears on the sticker on the back of the unit. If the unit Host name is **KB-C5-6B-78**, for example, then the URL address of the unit is **https://KB-C5-6B-78.local**. Initially, the browser will display a warning stating that the connection is not secure. You may ignore the warning and proceed connecting to the unit. To avoid receiving the browser warning, please visit the Kwikbit support site, download the Kwikbit security certificate and install it on your browser.

2. After successfully opening the WebUI page, the unit's IP address can be changed by clicking on the **Wired Network** section tool icon:
   - When prompted for user name, enter root **admin** for the username and **kwikbit_root** for password.
   - Select the desired address assignment protocol. If static address is selected, enter the network mask and default gateway.
   - Click Submit and the unit will reboot with the new address assignment. Your browser will automatically reconnect and display the page.

3. Click on the Wireless section tool icon to configure wireless communication parameters:

   - Select the role of the unit. When configuring a PTP or PMP communication system, only one of the wirelessly connected devices may be configured with a Hub role. The units connecting to the Hub wirelessly must be configured as Remotes.
   - Configure SSID, airlink passcode and channel frequency (not required on remote). These parameters must match between the Hub and all wirelessly connected Remotes in order to establish wireless communication.
   - If a configured Remote can connect to multiple Hubs, you may want to set the optimal Hub in the Preferred Hub field.
   - There needs to be a Hub node configured with Network Root = enable. Alternatively, each remote needs to be configured with "Preferred Hub". Lacking both of these will result in Remote nodes periodically scanning attempting to locate the Root node.

   - Click **Submit** to save changes.

4. Click on the tool icon in the Device section to configure the **Location** at which the device will be physically installed and the description of the device. Click **Submit**.
5. In the Admin section, click on the second icon to change the management interface password.

The unit is now configured and ready to be installed.

11 Appendices
11.1 Glossary

DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DNS	Domain Name System
FTP	File Transfer Protocol
Gbps	Gigabits per second
GHz	Gigahertz
HU	Hub Unit
IEEE	Institute of Electrical and Electronics Engineers
L2	Layer 2
LAN	Local Area Network
LED	Light Emitting Diode
LoS	Line-of-Sight
MAC	Media Access Control
Mbps	Megabits per second
MCS	Modulation and Coding Scheme
MHz	Megahertz
NLoS	Non-Line-of-Sight
NMS	Network Management System
PC	Personal Computer

PtMP	Point-to-Multipoint
PtP	Point-to-Point
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
RU	Remote Unit
SSID	Service Set Identifier
TDD	Time Division Duplexing
UL	Uplink
VLAN	Virtual Local Area Network
VDC	Volts Direct Current

11.2 FCC Statement

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. 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.

11.3 FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. A minimum of 20 centimeters (11 inches) of separation between the K60i and all persons shall be maintained.