ALB-250 Series - 5 GHz band

Carrier-class 802.16 broadband wireless solution

PRODUCT OVERVIEW

Albentia Systems introduces the ALB-250 series, the new family of high performance OFDM broadband wireless backhauling and bridging solution compliant with the IEEE 802.16-2004 standard (WiMAX) designed for use in the 5GHz unlicensed bands with aggregated capacity up to 34.4 Mbps.

ALB-250 belongs to the ALB-200 family of IP-oriented point-to-point solution based on the IEEE 802.16-2004 OFDM standard. ALB-250 series can also be used in Point-Multipoint networks thanks to the compatibility with the ALB-400 Point-Multipoint backhauling system

An ALB-250 point-to-point long distance link is able to provide an unprecedented net throughput thanks to the combination of an advanced frame-based contention-free Medium Access Control layer and a robust and high performance hardware platform.

Unprecedented Spectral-Efficiency

The use of a frame-based contention-free MAC layer maximizes the net spectral efficiency by avoiding packet collisions and unused idle time. This highly efficient use of the spectrum allows more robust modulation schemes with lower Signal-to-Noise ratio requirements, providing outstanding net throughput in log distance links.

The physical layer is able to provide a maximum over-the-air rate of 37.7 Mbps. Thanks to the high efficiency of the ALB-250 MAC, this gross capacity can be translated into 34.4 Mbps of aggregated Ethernet available throughput.

Advanced layer-2 scheduler and QoS mechanisms

ALB-250 equipment incorporates an advanced layer-2 scheduler which allows prioritization and physical layer resource allocation for multiple differentiated service flows.

Capacity for critical services like professional video transmission can be guaranteed in combination with general purpose Ethernet data.

SYSTEM DESCRIPTION

A complete point-to-point link comprises a pair of ALB-250 units, acting as master and slave units. Each station includes a weatherproof outdoor unit with optional 23dBi integrated directional antenna, and an indoor unit for interfacing with the system. The indoor and outdoor units are connected through standard cat5 Ethernet cable.

System integration and service provisioning is supported by a powerful and intuitive management system based on SNMP, web, command line interface and an innovative XML-RPC based remote configuration system.

The solution incorporates powerful mechanisms to guarantee a secure and reliable communication, including authentication, Automatic Repeat Request (ARQ), 3DES encryption and robust adaptive modulation and error-correcting mechanisms.

APPLICATIONS

- **Carrier-class point to point radio links**
- **Professional backhaul solution**
- **Point-point and Point-Multipoint solution**
- **Radio links for LAN bridging**
- **Professional video transmission systems**

PRODUCT HIGHLIGHTS

Carrier-class IP oriented solution

IEEE 802.16-2004 (WiMAX) standard compliance

Adaptive OFDM modulation for superior performance in **NLOS** scenarios

Point to Point applications

Compatibility with ALB-400 Base Station for **Point-Multipoint** networks

Frame-based contention-free highly efficient MAC layer

Advanced **layer-2 scheduling** mechanisms

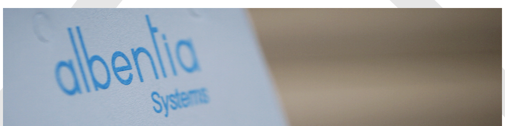
Service differentiated **QoS** control for multi-user/multi-service, **VoIP** and **Video** applications

License-exempt 5GHz band

Net throughput up to **34.4Mbps**

Automatic Transmit Power Control (ATPC) allows for optimal network deployment, tight frequency reuse, and interference avoidance

Ease of **System Integration** and remote **Service Provisioning**



albentia systems s.a. - C/ Margarita Salas, 22 - Parque Tecnológico Leganés
28918 Madrid (SPAIN) Tel: +34 91 440 0565 - Fax: +34 91 440 0569 - www.albentia.com

FUNCTIONAL DESCRIPTION

Contention-free framed transmission for superior spectral efficiency

ALB-250 equipment is a connection-oriented point-point wireless system which incorporates a high performance OFDM physical layer and a highly efficient contention-free MAC layer able to guarantee an outstanding net capacity to several independent data connections. This is achieved by means of a framed transmission protocol where time slots are allocated to each connection, so end-to-end QoS parameters (net capacity, latency and jitter) can be guaranteed for each connection even in time-varying wireless physical channels.

As indicated in the IEEE 802.16-2004 standard, transmission is implemented in frames with a defined length, all frames with the same number of symbols or time slots. ALB-250 systems use TDD duplexing to transmit uplink and downlink data, so that each frame is divided in two subframes, the downlink subframe and the uplink subframe. The slots in each subframe are further allocated to a specific connection or *service flow*. Service flows are independent logical channels used to transmit data with specific QoS needs. The required capacity in bits per second can be guaranteed to each service flow.

The allocation of the frame slots is described by the master station in the frame map at the beginning of each frame. The Slave unit simply follows the instructions from the master unit and transmits only during the symbols allocated to the uplink.

This well defined frame structure with continuous use of the spectrum and absence of contention slots is the way ALB-250 is able to guarantee outstanding layer-2 net capacity, which can go well beyond 80% of the physical layer gross capacity.

ALB-250 allows capacity allocation to service flows based on a min/max criterion. Critical services like VoIP or video transmission can be transmitted by service flows with granted capacity, while Ethernet traffic can be transmitted on a separate service flow without any guarantee of capacity (best effort). In case the physical channel is degraded with the consequent capacity reduction, the scheduler in the master station makes the proper slot allocation in order to guarantee the required capacity to critical services with minimum granted capacity.

Advanced Physical Layer Control

ALB-250 allows control of the most relevant physical transmission parameters. This control may be used to establish the right balance between capacity and several specific performance parameters like latency, sensitivity, achievable link distance, immunity against multipath and Bit Error Rate. The following link configuration parameters are available in ALB-250 equipment:

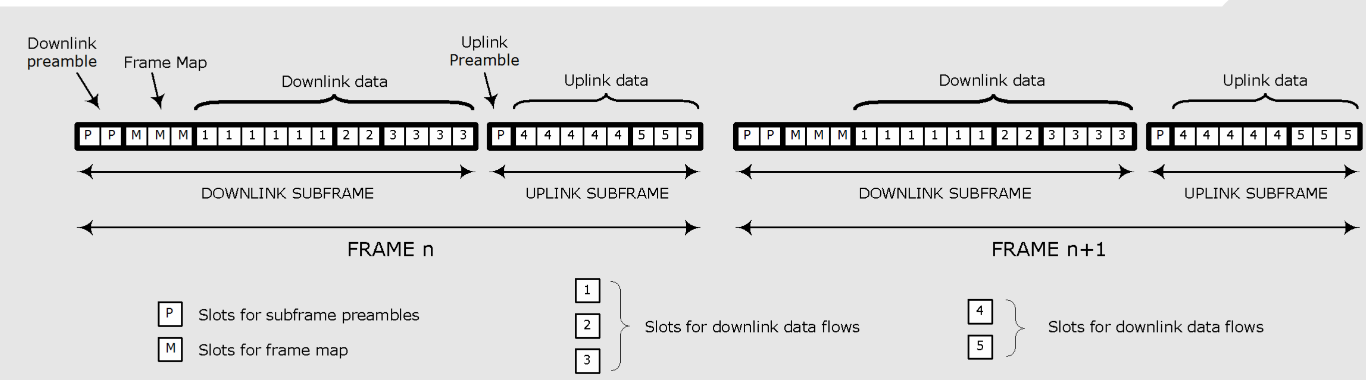
- **Frame duration** for latency control: Available frame duration times range from 2.5 ms to 20 ms. Short frames help to reduce the round-trip latency of the system, and long frames maximize the capacity of the link due to the smaller relative overhead.

- **Bandwidth** for capacity and sensitivity control: Signal bandwidth can be selected to be 1.75, 3.5, 7 or 10 MHz. Achievable link capacity is 3 bps/Hz (30Mbps for 10MHz bandwidth). Large bandwidth maximizes capacity, while smaller bandwidths increase link budget due to the improvement in sensitivity.

- **OFDM cyclic prefix control** for multipath immunity: The cyclic prefix size can be programmed to be 1/4, 1/8, 1/16 or 1/32 of the OFDM symbol time. Symbol times are 22.4, 32, 64 and 128 microseconds for 10MHz, 7MHz, 3.5MHz and 1.75MHz bandwidth respectively. Short cyclic prefix maximize link capacity, while long cyclic prefix increase the robustness against multipath propagation.

- **Uplink/Downlink subframe sizing**: Most point-point applications require symmetric capacity in the uplink and downlink channels, with equal length of the uplink and downlink subframes. ALB-250 also offers the possibility of programming the desired downlink/uplink time ratio, from 3:1 to 1:3.

- **Modulation format**: The modulation used in the downlink and uplink subframes is automatically selected according to the physical channel conditions in order to maximize capacity while maintaining a very low bit error rate. ALB-250 allows manual control of the modulation schemes. This feature, combined with the selectable ARQ algorithm allows capacity maximization by balancing a higher bit error rate with retransmissions.



Example frame structure: The previous figure illustrates an example with 60% of the frame allocated to downlink data and 40% to uplink data. In this example the downlink subframe has been distributed among three different data flows, while the uplink subframe slots have been divided into two independent data flows. The downlink subframe includes the frame map which described how the frame slots have been allocated to each data flow. Each subframe starts with a preamble used for synchronization, equalization and gain control purposes.

Built-in Layer-2 Traffic Shaper

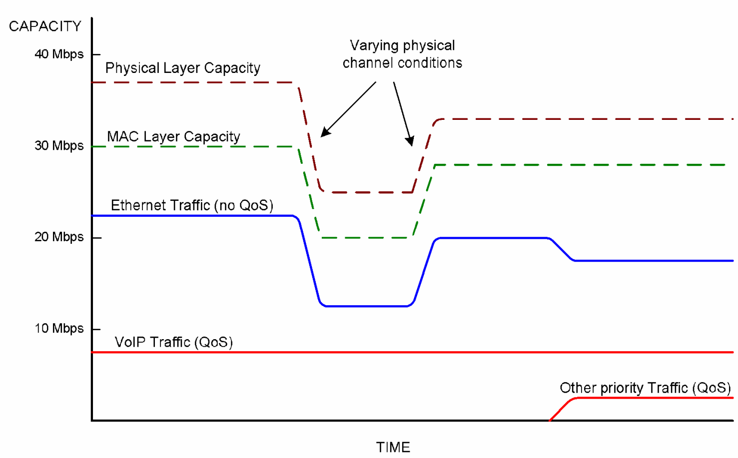
Traffic shaping is necessary when several services with different capacity and QoS requirements share the same physical channel. Wireless communication systems introduce complexities that may severely affect the accomplishment of QoS objectives, like limited bandwidth, transmission errors, and time-varying channel conditions and capacity. Traffic shaping is therefore absolutely necessary in wireless systems if critical services like VoIP and video transmission are to be combined with Ethernet data in the same radio link.

Traditional traffic shaping techniques in point-point wireless links are implemented at the IP level (layer-3). These techniques allow service differentiation and prioritization, but at the layer 3 level there is no information about the physical layer instantaneous capacity, so it is only possible to implement relative capacity allocation, where capacity is distributed proportionally to each service's capacity needs. These techniques fail to maintain minimum capacity for critical services in time-varying channel conditions (see example capacity plot)

ALB-250 equipment implements advanced layer-2 traffic shaping techniques by assigning physical channel slots according to the capacity requirements of each service flow. Layer-2 techniques have absolute knowledge of the physical layer instantaneous capacity, so services can not only be differentiated and prioritized, but physical resources can also be allocated based on the QoS requirements. These techniques are able to maintain constant capacity for critical services even in time-varying channel conditions.

ALB-250 equipment is able to handle up to six differentiated service flows, three in the uplink subframe and three in the downlink subframe. Capacity is allocated to each service flow based on a Minimum/ Maximum traffic criterion.

Automatic Repeat Request (ARQ) can also be enabled on a per service flow basis to guarantee error-free transmission, or disabled for loss-tolerant applications in order to guarantee the minimum jitter.



HOW LAYER-2 TRAFFIC SHAPING WORKS

Layer-2 traffic shaping is performed at the MAC level, where there is absolute knowledge of the physical layer available capacity.

While traditional Layer-3 traffic shaping (IP level) is only able to distribute the total available capacity among the different services based on certain **relative** capacity ratios, Layer-2 traffic shaping is also able to distribute the known available instantaneous capacity based on the **absolute** capacity needs of each service

As illustrated in the figure above, layer-2 traffic shaping is able to instantaneously adapt the net capacity allocated to each type of service to the physical channel conditions, so that the necessary capacity can be guaranteed for high-priority

Cost-savings with ALB-250

ALB-250 helps to reduce the total radio link cost thanks to the highly efficient MAC layer, which implies important savings in antennas, and built-in traffic shaper, avoiding the need of external and less efficient equipment.

The deterministic contention-free highly efficient MAC layer of ALB-250 equipment can provide a net capacity above 90% of the maximum physical layer gross capacity. In contrast, MAC layer efficiency in 802.11 based equipment rarely goes beyond 25%. This implies that, for a given required net capacity, ALB-250 demands less gross capacity to the physical layer, so more robust modulation schemes with lower SNR requirements can be used. This turns into a higher link budget and allows antenna gain reduction, with the associated cost saving.

The layer-2 built-in traffic shaper avoids the need for external expensive traffic shaping equipment, achieving better performance due to the knowledge of the instantaneous physical layer status and capacity.

System Specifications

Radio parameters

Frequency Band	5470-5725 MHz (ETSI) or 5725-5875 MHz (FCC). See ordering options.
Modulation	OFDM IEEE 802.16-2004 - 256 subcarriers, cyclic prefix 1/4,. 1/8, 1/16 or 1/32
Supported channel bandwidth	1.75, 3.5, 7 and 10 MHz
Adaptive modulation	BPSK, QPSK, 16QAM and 64QAM
FEC code rate	1/2, 2/3 and 3/4 concatenated Reed-Solomon and Viterbi
Maximum output power	+24 dBm
Transmit power control	> 40 dB
Duplexing method	TDD (Time Division Duplexing)
Uplink/Downlink allocation	Programmable from 4:1 to 1:4
Dynamic Frequency Selection	Yes
Antenna	23 dBi integrated antenna or N-type 50 ohms connector for external antenna

	Modulation	**Sensitivity (1.75 MHz)**	**Sensitivity (10 MHz)**
RF parameters	BPSK-1/2	-99.5 dBm	-92 dBm
	QPSK-1/2	-96.5 dBm	-89 dBm
	QPSK-3/4	-94 dBm	-86.5 dBm
	16QAM-1/2	-91 dBm	-83.5 dBm
	16QAM-3/4	-87.5 dBm	-80 dBm
	64QAM-2/3	-83.5 dBm	-76 dBm
	64QAM-3/4	-81.5 dBm	-74 dBm

Data traffic and Throughput

Maximum over-the-air data rate	37.7 Mbps (64QAM-3/4, 10 MHz BW)
Ethernet aggregated throughput	34.4 Mbps (64QAM-3/4, 10 MHz BW)
MAC efficiency	Aggregated Ethernet throughput is up to 91% of over-the-air rate
ARQ support	Yes. Selectable per service flow
Encryption	AES and 3DES

Quality of Service (QoS)

QoS control		Layer-2 QoS. Min/Max granted capacity per service flow
Service differentiation	Layer-2	MAC source/destination address, EtherType, VLAN tag
	Layer-3	DSCP ToS, IP source/destination address and subnet, Protocol type
	Layer-4	TCP, UDP source/destination port range
Differentiated service flows		Unlimited

Management and Provisioning

Management local interfaces	Web, Command-Line Interface
Management remote interfaces	SNMP, XML-RPC

Network functionality

Layer-2 Network functionality	Bridging (IEEE 802.1), VLAN (IEEE 802.1q)
Layer-3 Network functionality	Static/Dynamic routing, NAT, DHCP server/client
Networking modes	Bridge mode, IP routing
Data interface	10/100 Base-T Ethernet RJ45

Physical, Mechanical and Electrical

Size		395 x 265 x 95 mm
Outdoor Unit Weight		3.2 kg
Power Supply	Basic	802.3af compliant (PoE)
	Optional	12 or 48 Volts (separate connector for solar panel supply)
Power Consumption		<18 Watts (full traffic conditions)

Standards Compliance

Radio	ETSI EN 301 893, ETSI EN 302 502
Environmental	ETSI EN 300 019-1-4 C4.1E (ODU), ETSI EN 300 019-1-3 C3.2 (IDU)

Link budget calculation and achievable link distance/throughput - Examples

Modulation	BPSK-1/2	QPSK-1/2	QPSK-3/4	16QAM-1/2	16QAM-3/4	64QAM-2/3	64QAM-3/4
Ethernet throughput [Mbps]	3,8	7,6	11,4	15,2	22,9	30,5	34,4
Link budget [dB] (integrated antennas)	162,0	159,0	156,5	152,5	148,0	143,0	140,0
Margin @ 5 km [dB] (integrated antennas)	40,6	37,6	35,1	31,1	26,6	21,6	18,6
Margin @ 10 km [dB] (integrated antennas)	34,6	31,6	29,1	25,1	20,6	15,6	12,6
Margin @ 20 km [dB] (external 28 dBi antennas)	38,6	35,6	33,1	29,1	24,6	19,6	16,6
Margin @ 50 km [dB] (external 28 dBi antennas)	30,6	27,6	25,1	21,1	16,6	11,6	8,6

Note: The decision on whether the fade margin is sufficient for the required availability of the link is the engineer's responsibility.
Note: Link loss calculated based on Friis formula at 5.6 GHz (127 dB for 10 km, 141 dB for 50 km)
Note: The previous table assumes maximum transmit power. Some countries have established e.i.r.p limitations that must be obeyed

ORDERING INFORMATION

ALB256A	ALB200 for the ETSI 5470-5725 MHz band, integrated antenna
ALB258A	ALB200 for the FCC 5725-5875 MHz band, integrates antenna
ALB256E	ALB200 for the ETSI 5470-5725 MHz band, N-type connector for external antenna
ALB258E	ALB200 for the ETSI 5725-5875 MHz band, N-type connector for external antenna
ALB-IDU	Optional rack-mount professional indoor unit

albentia Systems

albentia systems s.a.
C/ Margarita Salas, 22 - 28918 Leganés - Madrid (SPAIN)
Tel: +34 91 440 0213
Fax: +34 91 440 0569
E-mail: sales@albentia.com

www.albentia.com