Vubiq HaulPass Fiber

API-driven Radio Front End (RFE)

Moving the network stack outside of the radio, the HaulPass Fiber seamlessly integrates into the most complex networks and positions the control where network operators want it – at the network application or as an extension of a nearby switch. This transformational approach to millimeter wave point-to-point connectivity drastically reduces the bill of materials, eases production costs, and results in the industry's most compact outdoor radio.

As the industry's first software-defined networking (SDN) millimeter wave radio, HaulPass Fiber is truly "wireless fiber." Simply plug the API-driven radio into an existing network and instantly extend the fiber wirelessly. The provided development environment allows operators to create custom commands directly to the radio via any switch, router or network controller. This dramatically simplifies integration in nearly every network topology and allows the freedom to customize, configure and monitor high-capacity wireless links. The included integrated LTE modem provides an alternate, easy-to-use method for out-of-band management and monitoring.

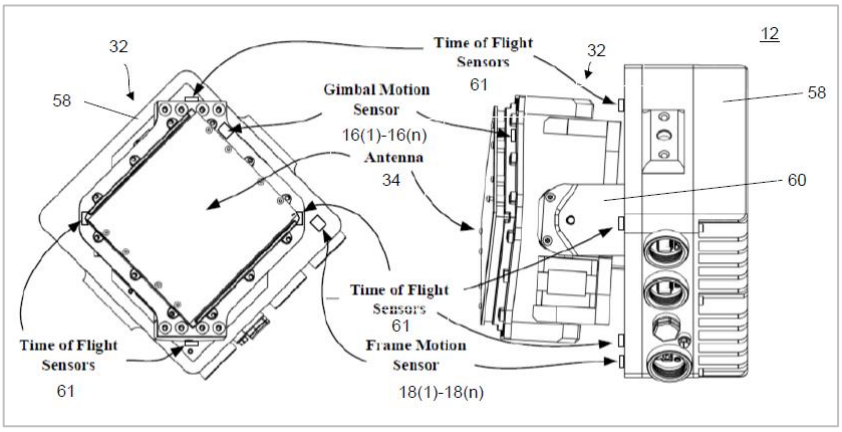
HaulPass Fiber is enclosed in a ruggedized outdoor enclosure

The frequency division duplex (FDD) radio solves the many problems associated with integrating wireless connectivity into fiber networks: the difficulty of integrating the Ethernet switch/router contained in existing radios, issues of high latency, and the costly and time-consuming process of manually aligning the radio links.

Vubiq Intelligent Articulating Antenna (IAA): Vubiq Networks is currently integrating its patented, AI-driven articulating antenna into the HaulPass Fiber radio. The new IAA feature will address the most critical challenges for narrow beam millimeter wave point-to-point communications, namely automatic antenna alignment at installation, and importantly, maintaining that precise alignment over long distances despite the effects of pole sway and thermal effects. Today, maintaining millimeter wave antenna alignment requires substantial time and precise mounting to align antennas. If alignment accuracy is not initially obtained, and not dynamically maintained during operation, the loss in data carrying ability can be substantial.

Rather than having to move the whole radio system for alignment as is necessary today, the company's innovative IAA approach controls the movement of only the high-gain antenna element. Using machine learning algorithms, geolocation, and sensor fusion technologies, the alignment and compensation control system leverages modern AI techniques in response to physical changes in the

millimeter wave radio support structure. With ±20° antenna yaw and pitch alignment range, installation time and required skills are significantly reduced. Beam alignment is maintained to fractional-degree precision in milliseconds.



Vubiq Networks' IAA features advanced AI-driven algorithms and geolocation technology

The antenna adjustments are controlled through the use of inertial sensors and position indicators to compensate for the sway of the pole, thermal changes in the antenna mounting system, or other physical fluctuations that can cause misalignment. Since only the antenna element is being moved within the antenna system, the movements are much more precise, the cost of the system much less expensive, and the response time for maintaining alignment much faster.

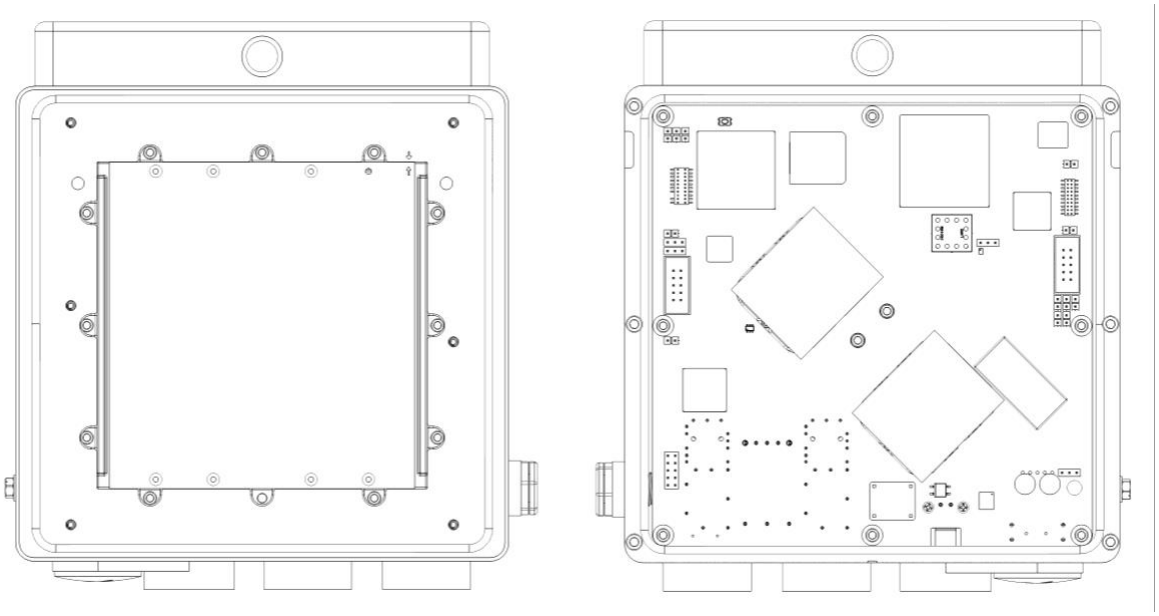
API-driven Management: Due to the nature of wireless link technology, millimeter-wave radios are typically closed, black-box network elements. Vubiq Networks' API-driven management approach is a step towards true open, SDN design. By moving the network stack outside of the radio, the HaulPass Fiber radio integrates control of the radio at either the network controller or as an extension of a nearby switch – while allowing efficient re-use of existing network switches.

The included software development kit (SDK) supports an environment allowing operators to create custom commands directly to the HaulPass Fiber radio via any switch, router or network controller. This approach simplifies integration in nearly every network topology and allows the freedom to customize, configure and monitor wireless fiber extensions.

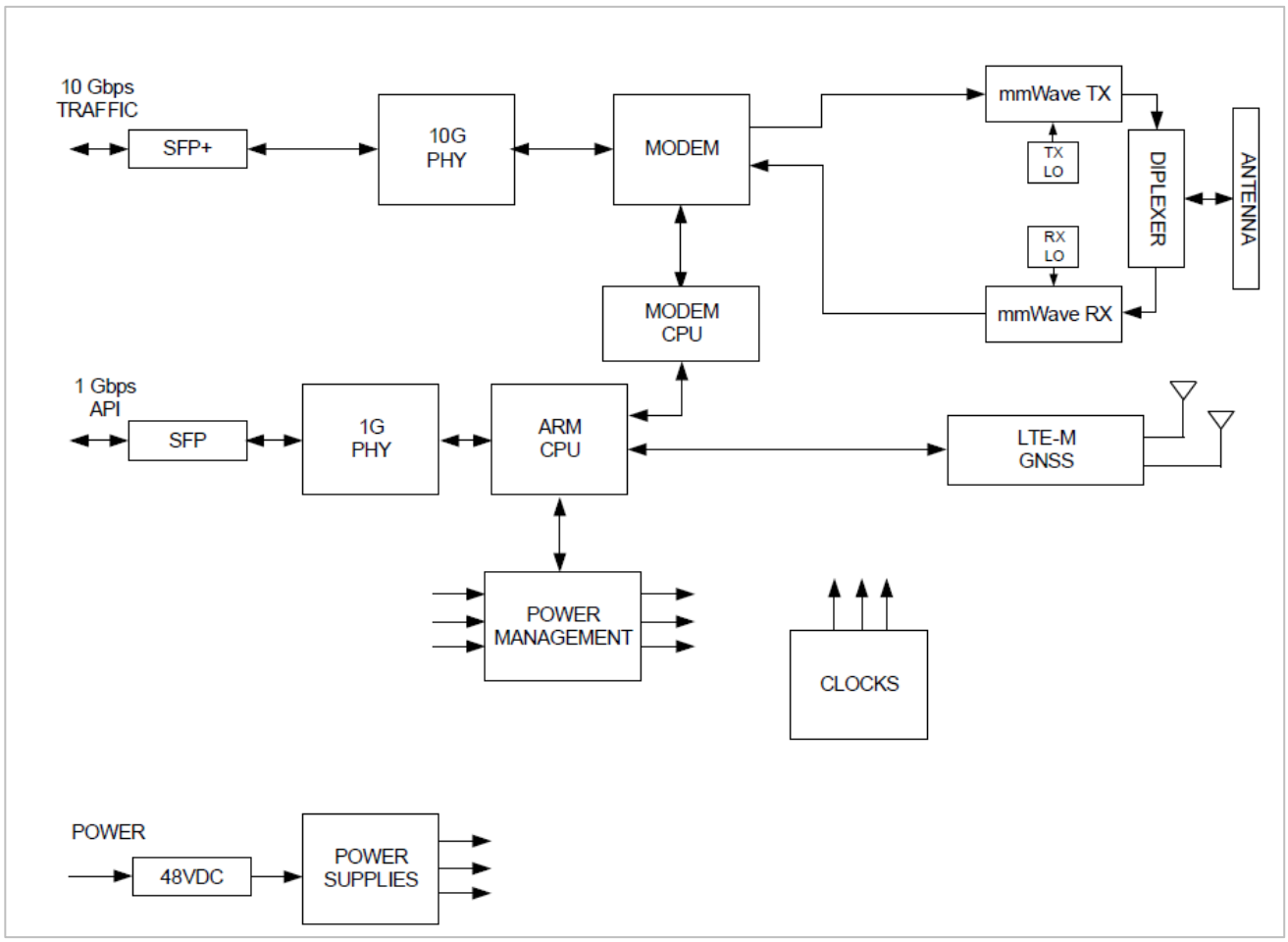
Product Specifications

Operating Frequencies	• E-Band lightly licensed (71-76 GHz; 81-86 GHz) programmable
Channel Bandwidth	• 100 MHz to 2 GHz (baud rate, coding, and modulation programmable)
Modulation	• BPSK, QPSK, 8PSK, 16QAM, 32QAM, 64QAM, 128QAM
Throughput	• 1.4 Gbps to 10 Gbps range dependent, adaptive (hitless)
Transmit Power	• 20 dBm maximum; programmable
Receive Noise Figure	• 5 dB typical
Antenna Gain	• Internal 38 dBi, 30cm parabola 44 dBi, 60cm parabola 50 dBi

Antenna Beamwidth	• Internal 1.8°, 30cm 0.9°, 60cm 0.5°
FEC	• LDPC
Overall Link Latency	• < 6.5 µs, link distance dependent
Network Topologies	• Ring, daisy chain, mesh
Software Features	• Modern API and SDK for direct network integration • Enhanced Intelligent Automatic Gain Control (AGC) • Hitless Adaptive Coding, Modulation, Baud rate (ACMB) • Mean squared error (MSE) / Signal to Noise Ratio (SNR) based ACMB
Radio Management	• Out of band, via 1 GigE management port or integrated LTE mode
Throughput and Link Ranges	• Up to 10 Gbps at distances up to 10 km, spectrum and weather dependent • ACMB assures high link availability, maintaining throughput even in heavy rain
Power Requirements	• 48 VDC, 35 Watts
Weight	• 2.6kg (5.7lbs)
Dimensions	• 17.0cm x 17.5cm x 9.5cm (6.7” x 6.9” x 3.7”)
Operating Temperature	• -40°C to +55°C (-40°F to +130°F)



HaulPass Fiber is industry’s most compact outdoor radio (6.7” x 6.9” x 3.7”)



HaulPass Fiber schematic diagram

Making Millimeter Wave Ubiquitous

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