



## **EH-5500FD**

# **Product Description**

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## Document Information

Revision	Date	Author	Revision notes
1	6 October 2016	SH	Initial Release

## Intended Audience

- Solution architects and network planning staff
- Telecom backhaul engineers
- Wireless ISP, business connectivity and wireless networks pre-sale engineers

Terminology used in this document assumes audience familiarity with millimeter wave radio communication and networking technologies.

Comments and suggestions are welcome to: [info@siklu.com](mailto:info@siklu.com).

## 1. Introduction

This Product Description documents details the special features of the EH-5500FD product, in reference to EtherHaul™ family generic characteristics which are reviewed in a companion document, the EtherHaul™ System Description (reference [1]), also available on Siklu's partners' portal. Radio performance, Mechanical and Power information, for example are listed in this document, while the generic behavior of the family are explained in the companion document (example: Management concepts). The 2 documents can be reviewed in the order suitable to the reader.

The EtherHaul™-5500FD (EH-5500FD) radio delivers carrier-grade wireless point-to-point Gigabit Ethernet services utilizing the 70 GHz lightly-licensed E-band spectrum. The solution is designed for a range of applications providing connectivity between aggregation sites, up to demanding services to MDU and businesses. The EH-5500FD on one hand meets the stringent requirements of service providers while on the other hand allows easy installation by non-Telco professional staff.

The EH-5500FD is based on Siklu's revolutionary integrated-silicon technology, which results in a highly reliable, zero footprint, and low-cost radio.

The EH-5500FD offers multi Gigabit throughput, enhanced adaptive bandwidth, coding & modulation for maximum spectral efficiency, and services availability. It supports advanced OAM&PM tools and ring protection optimized high-availability connectivity. It supports complex network topologies, such as daisy chain, ring, and mesh. All in a very small and light outdoor package that is optimized for zero footprint installations and designed to overcome pole sway, twist and/or tilt. The EH-5500FD is fast, simple and inexpensive to deploy.

EH-5500FD includes the following features:

- Field proven technology
- Reduced TCO and fast ROI
- All-outdoor zero footprint
  - Small and light
  - Quick and easy to install
- Optimized for variety of deployments, from street level to roof-top
  - Works on poles, buildings facades (walls), traffic lights and more
  - Designed to overcome sway, twist and/or tilt
- Spectral efficient
  - Wide range of frequencies

- FDD modulation with seamless delay and jitter
- Adaptive bandwidth coding and modulation for high availability

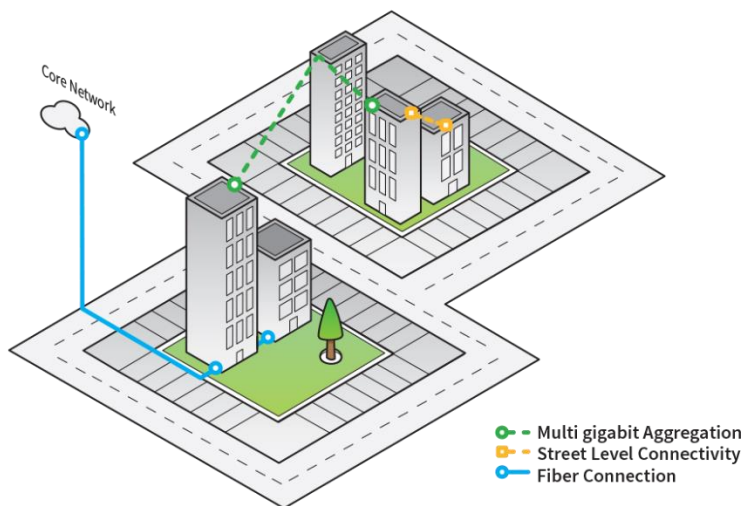


Figure 1 - MDU / Business Services

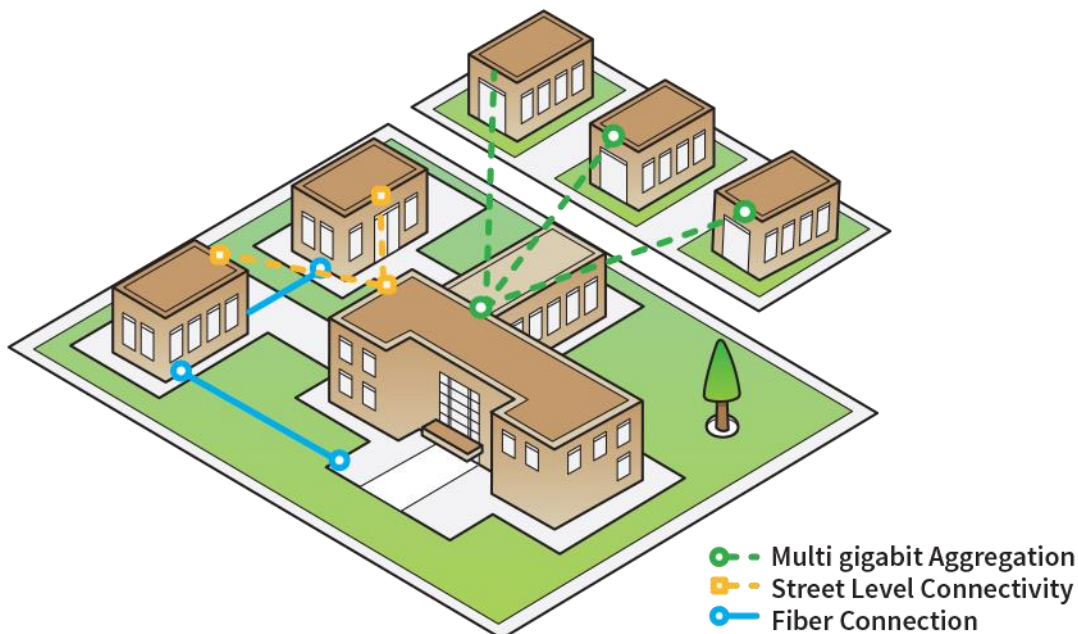


Figure 2 - Campus Connectivity

Easily integrated into service-provider networks, out-of-the-box up & running capable. Highly-scalable, the EtherHaul™ products are software-upgradable to support future capabilities as networks evolve.

The EtherHaul™ products features advanced adaptive modulation, bandwidth and coding - allowing operators to maintain, prioritize, and verify QoS in all weather

conditions, while achieving maximum (up to 99.999%) link availability for prioritized services such as voice, control protocols or SyncE.



Figure 3 - EH-5500FD installed

Offering easy and low cost all-outdoor installation and a small form factor, the EtherHaul™ products are also environmentally-friendly - boasting a small system and antenna footprint with especially low power consumption.

The EtherHaul™ systems are High-capacity Gigabit Ethernet backhaul at the lowest TCO in the industry. EtherHaul™ enables service providers to profitably and reliably provide data intensive services. Provided by Siklu, the pioneer in silicon based mm-waves backhaul systems, EtherHaul™ systems are the perfect choice for future proof investment.

## 2. EtherHaul™-5500FD System Overview

### 2.1 Functional Blocks

The EtherHaul™-5500FD is all-outdoor units comprised of the following functional blocks:

- RFIC: Siklu's integrated Silicon Germanium (SiGe) transceiver operating at 71-76 GHz and 81-86 GHz.
- Modem/Baseband ASIC: Siklu's modem/baseband ASIC includes the modem, and the FEC engines.
- Interfaces: The network interface consists of one SFP+ cage for traffic and 1 integrated 100/1000 Ethernet port for management.
- Host processor (integrated with the network processor): the general purpose host processor controls the system, and the antenna alignment system.
- Antenna: Siklu's self-designed, innovative antenna.

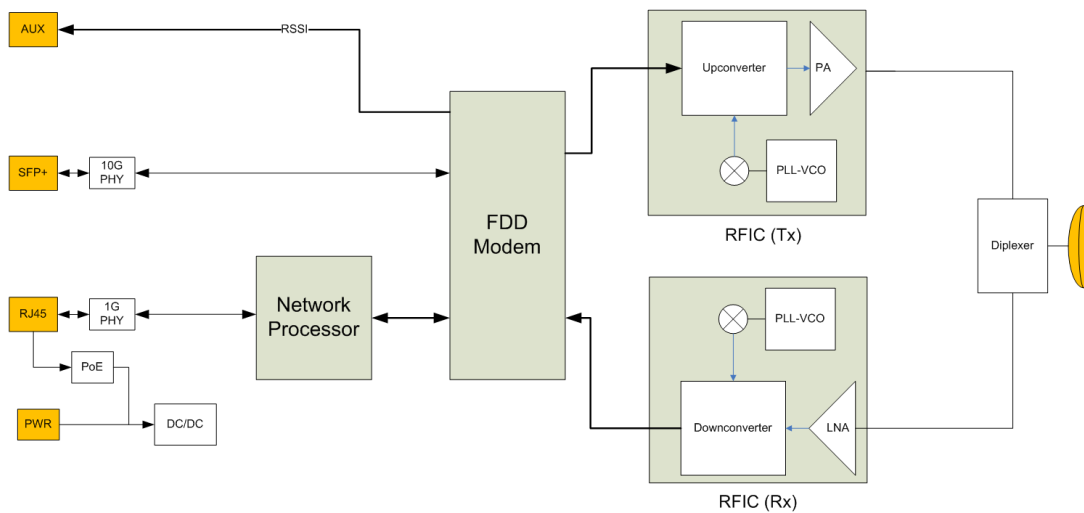


Figure 4 - EtherHaul™-5500FD functional block diagram

## 2.2 EH-5500FD General Specifications

Technology and frequency	FDD, 71-76GHz, 81-86 GHz
Modulation	BPSK/QPSK/QAM16/QAM32
Adaptive modulation	Hitless adaptive bandwidth, coding and modulation, boosting system gain by 25dB
Over-the-air throughput	Up to 5,000Mbps full duplex
Interfaces	1x SFP+ 10Gbps line-rate 5Gbps throughput for traffic and 1xGbE copper port for management
Antenna options	0.5ft - 38dBi, 1ft - 48dBi, 2ft - 50dBi (size / gain)
Power options	Direct input 36÷57VDC (flexible polarity) or PoE-In (803.at+) 45W
Network topologies	Ring, daisy-chain and mesh
Management	Out-of-band local management and over-the-air remote management, Web GUI (one click management of local & remote units), embedded CLI, SNMPv2/3, Zero-touch turn-up, TACACS+, RADIUS
Environmental	Operating temperature: -45° ÷ +50°C Ingress protection rating: IP67
Regulatory	ETSI EN 302 217-2-2, USA FCC 47 CFR Part 101 :2009, UK IR 2078 & IR 2000, CE marked, EMC, safety UL60950
Dimensions	ODU + 0.5ft antenna: 9.17x 8.11x 5.55" (23.3x20.6x14.1cm) ODU + 1ft antenna (Dia. x Depth): 12.2x4.3" (31cm13cm) ODU + 2ft antenna (Dia. x Depth): 25.6x15.35" (65x37cm)
Weight	ODU + 0.5ft antenna: 9.2lbs. (4.2kg) ODU + 1ft. antenna: 9.9lbs. (4.5kg) ODU + 2ft. antenna: 24.3lbs (11kg)

Table 1 : Features list



## 3. EtherHaul™-5500FD product specifications

### 3.1 Frequency band, channels and modulation schemes

#### 3.1.1 Frequency band

The EtherHaul™-5500FD operates in the 71-76 GHz & 81-86GHz E-band frequency spectrum. The supported center frequencies<sup>1</sup> are: 71,750 / 81,750, 73,000 / 83,000 and 74,250 / 84,250 MHz.

#### 3.1.2 Channel sizes

The EtherHaul™-5500FD support channel sizes of 1250 MHz.

#### 3.1.3 Modulation

The system implements adaptive modulation scheme which includes adaptation of the following system parameters:

- Modulation: 32 QAM, 16 QAM, QPSK and BPSK (2 levels)
- Channel bandwidth: full bandwidth to 1/4 bandwidth

Mode	Modulation
0	QAM 32
1	QAM 16
2	QPSK
3	BPSK
4	BPSK

Table 2: EH-5500FD modulation table

#### 3.1.4 Standard compliance

The EH-5500FD complies with both ETSI spectrum channel arrangement and FCC requirements:

- ETSI EN 302 217-2-2
- USA FCC Part 101:2009

<sup>1</sup> available in some countries, radio regulations dependent.

### 3.1.5 Benefits

The RF parameters are configured using the management software resulting in a minimum service interruption and doesn't require any manual calibration. This enables rapid, easy and flexible frequency planning and additional cost savings on the occupied spectrum.

The high performance design of radio and modem makes possible using spectral efficient modulations like QAM16 and QAM32 to achieve high capacity on the one hand, and to provide a robust connection using strong error correction codes and increased sensitivity, on the other hand.

3 operating frequencies<sup>2</sup> allow dense mmWave deployments, and more importantly, superior link performance as some channels are located in better spectrum, where the Oxygen Effect is not as dominant in the link attenuation.

## 3.2 Radio Specifications

### 3.2.1 Transmit power, receiver sensitivity, channel capacity

Channel (MHz)	Modulation	Occupied BW (MHz)	Pout (dBm)	Receiver Threshold (dBm @ BER=10 <sup>-6</sup> )	L1 Capacity - full duplex (Mbps)
5000	QAM32	1250	16	-55.5	5000
	QAM16	1250	16	-58.5	3980
	QPSK1	1250	18	-64	2135
	BPSK2	625	18	-70	530
	BPSK1	312.5	18	-75	210

Table 3: EH-5500FD radio parameters

#### 3.2.1.1 Benefits

The high performance design of radio and modem enables spectral efficient modulations like QAM16 and QAM32 to achieve high capacity on the one hand, and to provide a robust connectivity using strong error correction codes and increased sensitivity on the other hand.

<sup>2</sup> available in some countries, radio regulations dependent.

### 3.2.2 Transmit power control

The nominal transmit power may be controlled to allow deployment of short distance links. The transmit power may be set in range between +18 dBm (default) to 0 dBm.

When commissioning a link the maximum RSSI should not exceed -35 dBm. If the maximum RSSI is exceeded, the transmit power needs to be reduced until reaching the maximum allowed RSSI.

### 3.3 Antenna

The EtherHaul™-5500FD is equipped with a Siklu Universal Antenna Port (UAP), which allows mounting a variety of Siklu provided antennas, from a compact 0.5ft with 38dBi gain (not approved in FCC) to 1ft or 2ft with 43 dBi or 50 dBi respectively. The antennas are directional antennas and designed for street level or roof-top installation scenarios and optimized to cope with poles sway and vibration. The form-factor of the 0.5ft antenna is designed as a perfect flow of the ODU itself, yielding a zero-footprint very compact form factor.

Type	0.5ft	1ft	2ft
Gain (typical)	38 dBi	43 dBi	50 dBi
3 dB Beam width	2°	0.9°	0.5°
Radiation Pattern Envelope	ETSI: EN 302 217-4-2 V1.5.1 Class 2 FCC: N/A (not permitted)	ETSI: EN 302 217-4-2 V1.5.1 Class 2 FCC: 47CFR101	ETSI: EN 302 217-4-2 V1.5.1 Class 3 FCC: 47CFR101

Table 4- antenna specifications

#### 3.3.1 Standard compliance

ETSI EN 302 217-4-2 V1.5.1

FCC: 47CFR101

### 3.3.2 Benefits

- The 0.5ft antenna results a zero foot print outdoor solution, durable wind load, and easy installation and alignment
- Direct-Mount capability and installation kits extend links physical durability for enhanced performance at tough weather conditions.

### 3.4 Ethernet interfaces

The EH-5500FD includes 1x SFP+ cage for traffic up to 5Gbps full-duplex with a line rate of 10Gbps, and 1x 100/1000 base-T Ethernet port for management traffic only.

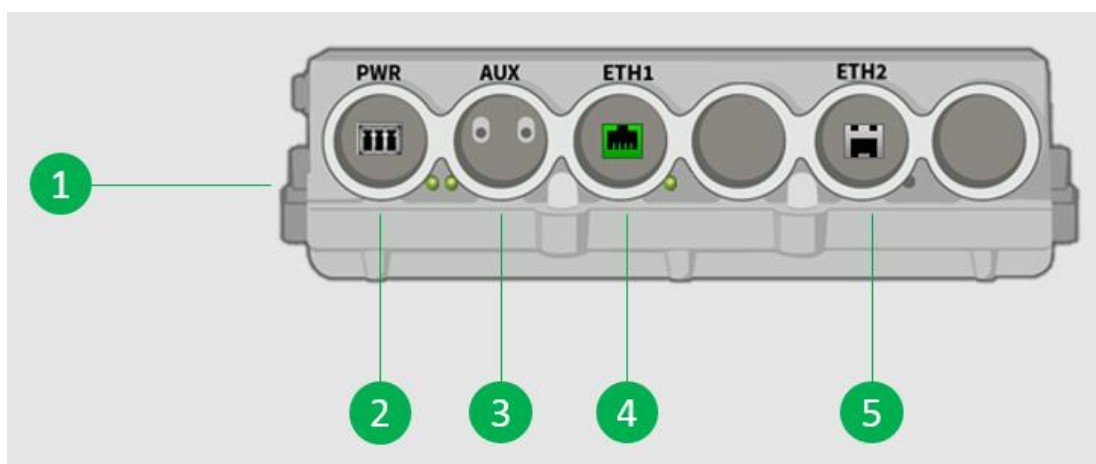


Figure 5 - EtherHaul™-5500FD interfaces

- (1) Ground
- (2) DC Power
- (3) Aux
- (4) ETH1, 100/1,000 Base T for management and PoE-In
- (5) ETH2, SFP+ cage for 10Gbps transceiver

### 3.4.1 Ingress protection

An EtherHaul™ product use standard 10Gbps (SFP+ cage) or GE (RJ-45) connectors and does not require any proprietary sealing solution. Ingress protection is assured by mean of the All Weather Shell illustrated in Figure 6:

- Connector outlet (1)
- Rubber gasket (2)
- Cable inlet (3) with cable securing holder, designed for standard tie-wrap strips.

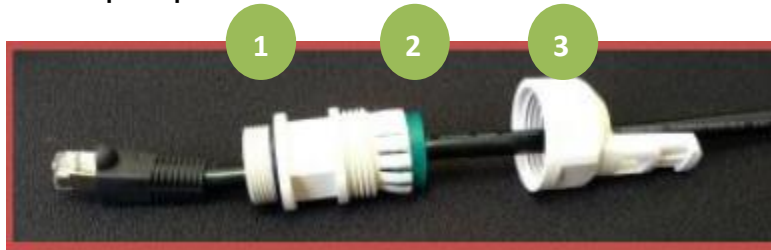


Figure 6 - EtherHaul™ connector weather shell assembly

### 3.4.2 Standard compliance

	ETH1	ETH2
Connector standard	RJ-45 100 Base-T/1000 Base-TX (Auto-sensing or fixed)	SFP+ cage MSA SFP+
Max Segment Length	Up to 100 meters with Cat5e cable	Up to 300m with MMF Up to 10Km with SMF

Table 5: 100/1000 Base-T(X)

### 3.4.3 Benefits

- SFP+ sockets are ideal to match the optical interface to the distance required at a hub or chain site. It enables connecting to switches or routers, located close or far, with standard interfaces and protocols.
- An EtherHaul™ product use standard 10Gbps (SFP+ cage) or GE (RJ-45) connectors and does not require any proprietary cables.

### 3.5 System capacity

The EH-5500FD products features up to 5 Gbps, full-duplex capacity, as detailed in 3.2.1.

### 3.5.1 Benefits

High capacity allows operators to:

- Provide wireless closure to ring topologies.
- Implement a backup network connectivity for important end-users
- Deliver multiple services, all with max capacity at same location.

### 3.6 Adaptive modulation

The EH-5500FD implements hitless/errorless adaptive bandwidth, coding and modulation adjustment to optimize the over-the-air transmission and prevent weather-related fading from causing traffic on the link to be disrupted. The EtherHaul™ products can gain up to 25 dB in link budget by dynamically adapting: Modulation, FEC coding rates and channel bandwidth.

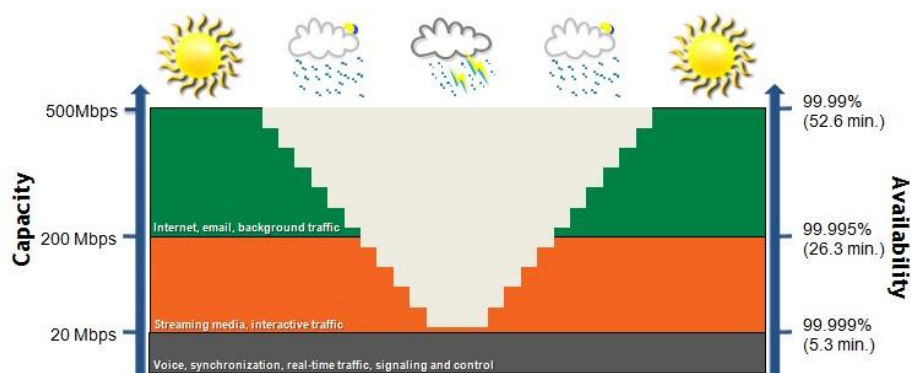


Figure 7 - Hitless Adaptive Bandwidth, Coding and Modulation

#### 3.6.1 Benefits

- Adaptive bandwidth, coding and modulation ensures maximum capacity most of the time with guaranteed high priority services all the time.
- The adaptive algorithm ensures zero down time to enable a constant flow of critical services allowing carriers to meet their service commitments for enhanced user experience.

### 3.7 Full-duplex throughput

The EtherHaul™-5500FD operates in Frequency Division Duplexing (FDD) mode, allowing symmetric traffic mode, up to full 5Gbps capacity in both directions.

### 3.7.1 Benefits

- Frequency division multiplexing simplifies network design and traffic engineering.

## 3.8 Alignment

The EH-5500FD must be aligned on both local and remote unit. The coarse alignment is performed initially on each ODU, followed by fine alignment. Accurate alignment of the ODU is essential for achieving the strongest possible receive signal.

In order to perform antenna alignment, the ODU must be in Alignment Mode, either using CLI/Web or by just plugging the probes of the voltmeter into a dedicated alignment connector.

Dividing the DVM millivolt output by 10 will provide the actual receive signal strength calculation (RSSI). For example, a DVM millivolt reading of 450 mV is equivalent to -45 dBm.

### 3.8.1 Benefits

- Simple and reliable antenna alignment process (no computer connection is needed)
- Simple RSSI indication conversion
- The alignment is done using standard tools with the EH-5500FD mounting kit

## 3.9 Power

### 3.9.1 Input Power

The EH-5500FD has the following power input:

- Direct 48V DC nominal (36÷57VDC)
- PoE++ (IEEE 802.3at+) over port ETH1
- power draw of 45W in both cases

#### 3.9.1.1 Benefits

Thanks to the efficient system design and high integration, the EH-5500FD:

- Reduces the power consumption and accordingly the associated energy costs.
- Simplifies the installation scenario with backup, enabling dual power input to the ODU.

## 4. Networking features

The single traffic port of the EH-5500FD allows delivers minimal delay, 5  $\mu$ sec (typical, max 10  $\mu$ sec).

The EH-5500FD features a simple and efficient flow control procedure, to signal to the neighbor switch / router about its own inability to deliver the ingress traffic to the other ODU. Whenever the ODU ingress buffers are full, it will transmit back 802.3 Ethernet "pause" frames.

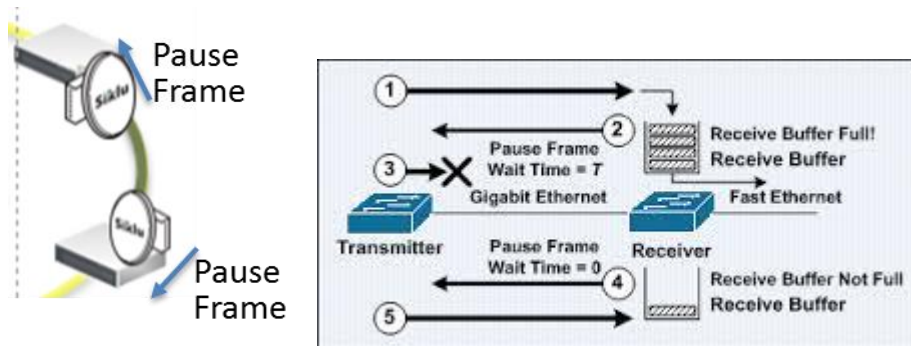


Figure 8: Ethernet Pause frames

## 5. Management concept

The following management concepts and more are reviewed in the companion document "EtherHaul™ System Description": Web GUI, CLI, SNMP, FTP, and User Access & Rights Management.

### 5.1 Management connections

The EH-5500FD can be managed locally via ETH1, out-of-band, as shown in Figure 1Figure 9.

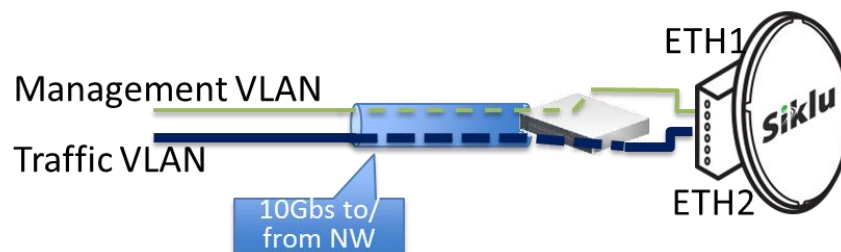


Figure 9: Management connections to EH-5500FD



If the management terminal is not connected directly to ETH1, then the management connection from the network must be separated out-band at the switch nearest to the EH-5500FD, and bridged to ETH1. After the out-of-band connectivity is in place, management of the EH-5500FD will follow the same generic concepts for management of the ODU as discussed in “EtherHaul™ System Description”: Web GUI, CLI, SNMP, FTP, and User Access & Rights Management.

As far as managing the remote ODU, on the other side of the link from the ODU above, then standard remote management functions are available, for example the Web GUI dual pane will show the near ODU and the remote over 1 screen.

## 6. Security

The following security aspects and more are reviewed in the companion document “EtherHaul™ System Description”: physical security, management security and secure interfaces to 3<sup>rd</sup> party managers.

## 7. Logging and auditing features

The logging and auditing capabilities of the EtherHaul™-5500FD are discussed in the companion document “EtherHaul™ System Description”.

## 8. Diagnostic tools

The diagnostic tools of the EtherHaul™-5500FD are reviewed in the companion document “EtherHaul™ System Description”.

## 9. EtherHaul™ Deployment Topologies

The topologies supported by the EtherHaul™-5500FD are explained in the companion document “EtherHaul™ System Description”.

## 10. List of supported standards by EtherHaul

The list of standards and recommendations supported by EtherHaul™ 5500FD:

- Antennas: ETSI EN 302 217-4 Class2
- Frequency Regulations:
  - ETSI EN 302 217-2-2
  - USA FCC 47 CFR part 101:2009

Management (reference also to Security)

- IEEE 802.1ab - Link Layer Discovery Protocol (LLDP)
- RFC 1157 SNMPv2/3
- RFC 2131 - Dynamic Host Configuration Protocol
- RFC2819 – RMON Remote Network MONitoring

Security

- IETF TACACS+
- RADIUS
- RFC 2246 - Transport Layer Security (TLS) protocol
- RFC 2818 – HTTPS, HTTP over TLS
- RFC 4251 - the IETF extension of the Secure Shell protocol (SSH) version 2.0
- RFC 913 SFTP, SFTP, TFTP
- RFC2616 - Hypertext Transfer Protocol (HTTP)

Networking

- IEEE 802.3ab / Ethernet 1000BASE-T

Environmental, Power

- CE: CE Marked
- EMC: EN 301 489-4 ;FCC 47 CFR part 15
- IEEE 802.3at+ PoE power(ed) device (model dependent)
- Ingress Protection Rating: IP67
- MSA SFP INF-8074 Small Form Factor Pluggable
- Operation: EN 300 019-1-4 Class 4.1E
- Safety: UL 60950
- Storage: EN 300 019-1-1 Class 1.2
- Transportation: EN 300 019-1-2 Class 2.2

## 11. References

[1] Siklu' EtherHaul™ System Description, Release 1.0, 2016

## About Siklu

Siklu delivers Gigabit capacity millimeter wave wireless backhaul solutions operating in the 60, 70 and 80 GHz bands. Ideal for dense, capacity-hungry urban security networks, the ultra-high capacity wireless links can be easily and discreetly installed on the very same street fixtures as the security cameras. The most deployed mmW radios in the world, thousands of units are delivering carrier grade performance in varying weather conditions around the world.

