High Performance Fiber-to-the-Home Networks
Fiber-to-the-Home: The Ultimate Solution

An all-fiber network up to the subscriber is the ultimate solution for broadband connectivity because it provides virtual unlimited bandwidth and enables simultaneous delivery of multiple services. It plays the key role in next generation access networks. Realized in a point-to-point architecture fiber shows its advantages for broadband bidirectional services such as data and telephony. Regarding the RF Video Overlay in point-to-multipoint architecture is the answer for a technological mature, cost efficient and reliable solution, with the plus of a high subscriber acceptance. Based on this philosophy - point-to-point optical Ethernet and RF Video Overlay - BKtel has developed a comprehensive product portfolio. Next to the optical transmitters, optical amplifiers and passive optical components such as splitters and WDM filters for RF Video Overlay BKtel offers a series of customer premises equipment units. The equipment is designed with a future save system concept and a unified management. Interoperability with all major metro access switches present in the market, demonstrated in several projects, show seamless integration in hybrid FTTH systems. Complete management solution including autoprovisioning and remote firmware upgrade is available.

Off-load the IP traffic

The advantages for the network operator are evident. The IP traffic is not blocked by TV content reducing the complexity and the capacity needed. He can choose out of a wide variety of different business models from traditional cable TV to simple community antenna sharing. Needless to say that there is no change for the subscribers’ TV experience; it remains as simple as always.

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RF Video Overlay: Multiple Options for TV-Services

All CPES from BKtel are prepared for RF Video Overlay. The subscriber is not restricted to receive TV services in analog PAL or NTSC on his TV set but - by simply using common Set Top Boxes - also digital TV is available. The kind of signals transmitted by the RF Video Overlay can come from a whole range of different sources. The classical approach is the transmission of cable television (CATV) consisting of analog and digital cable TV (DVB-C, DVB-C2). But also terrestrial digital TV (DVB-T, DVB-T2) and satellite TV (DVB-S, DVB-S2) can be provided. Moreover digital terrestrial or cable TV in combination with satellite TV services can be offered simultaneously even as an Open Access video system with two different video service providers. The output signals of RF Video Overlay solutions are inherently compatible with standard TV or today's HD TV sets, assuming that it is equipped with an appropriate tuner or uses an external Set Top Box. The attached table shows the enormous DVB data rate capacity of the different RF Video Overlay options. The RF Video Overlay system offers between 3 and 7 Gbit/s capacity of video broadcast transmission equal to hundreds of TV programs.

<table>
<thead>
<tr>
<th>RF Video Overlay solution</th>
<th>No. of CATV TV channels</th>
<th>No. of QAM256 channels (DVB-C)</th>
<th>No. of QAM64 channels (DVB-T)</th>
<th>No. of 8-PSK channels (DVB-S)</th>
<th>DVB total data rate (Gbit/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATV</td>
<td>35</td>
<td>59</td>
<td>-</td>
<td>-</td>
<td>3.04</td>
</tr>
<tr>
<td>DVB-C</td>
<td>-</td>
<td>-</td>
<td>94</td>
<td>-</td>
<td>4.85</td>
</tr>
<tr>
<td>DVB-T</td>
<td>-</td>
<td>-</td>
<td>94</td>
<td>-</td>
<td>2.98</td>
</tr>
<tr>
<td>CATV + 1xDVB-S(52)</td>
<td>35</td>
<td>59</td>
<td>-</td>
<td>25</td>
<td>5.54</td>
</tr>
<tr>
<td>DVB-C + 1xDVB-S(52)</td>
<td>-</td>
<td>-</td>
<td>94</td>
<td>-</td>
<td>7.35</td>
</tr>
<tr>
<td>DVB-T + 1xDVB-S(52)</td>
<td>-</td>
<td>-</td>
<td>94</td>
<td>-</td>
<td>5.48</td>
</tr>
</tbody>
</table>

Notes:

- CATV: average number of TV channels
- AM-TV: Transmission usually with 36 FM radio channels
- DVB-C: QAM64 and 31.688 Mbit/s in 8 MHz and 7/8 FEC rate
- DVB-C: QAM64 with 6.8 MHz and 188/204 FEC rate
- DVB-S: 35.560 kbit/s with 8-PSK and 36.15 Mbit/s, 9/10 RS or 1/2 RS and 188/204 85% FEC or 188/204 8% FEC.
FTTH Network Architectures

Optical Ethernet and RF Video Overlay:
Two Broadband Connections to your Customer

Optical access networks based on point-to-point Ethernet offer a standardized environment with equipment available from several vendors. Since a well known technology is used these networks are easy to plan and manage. Scalability is excellent and data rates can be adapted to the requirements of the individual customer, Fast Ethernet (100 Mbit/s) up to 1 Gigabit Ethernet (1 Gbit/s) are technically feasible. Broadcast video connectivity over optical fiber based on standards set by the cable-TV industry provides a bandwidth equivalent to several Gbit/s. Analog TV, digital TV (DVB-C) and even satellite TV (DVB-S + DVB-S2).

The following figure illustrates the set up of a modern FTTH network with its key elements: The POP (the Point of Presence, which can be installed in a building or an outdoor cabinet containing active and passive equipment) and the fiber optic feeder and drop cables. In case of point to point FTTH each subscriber has a dedicated fiber connection from the POP to his premises. At the POP service providers have access to the FTTH network in order to launch their services.

In this case the two services are multiplexed on 3 different optical wavelengths: 1550 nm for RF Video Overlay and 1490 nm/1310 nm for the bidirectional data connection.

Ethernet Point-to-Point Topology (EPTP):
Two-Fiber-Solution

Fig. 1. The two-fiber solution for point-to-point FTTH networks: A separate fiber for data/telephony and TV-video.

Ethernet Point-to-Point Topology (EPTP):
One-Fiber-Solution

Fig. 2. The one-fiber solution decreases the required fiber deployment by a factor of two, so that installation costs decrease dramatically. Port-density in the POP stays the same so that only half of the POPs are needed.

PON and RF Video Overlay

Also point-to-multipoint FTTH networks such as GPON and EPON can integrate RF Video Overlay.

The RF Video Overlay can be realized in point-to-multipoint architectures such as GPON or EPON. BKtel offers a complete range of active equipment to support this application.
Customer Premises Equipment

Modern and Functional
The XON1200 is the newest member of BKtel’s XON CPE family. It addresses the main challenges currently existing in the FTTH industry: Small footprint, low power consumption and reduced equipment and operational cost, especially in the installation and maintenance process. Acting as a basic unmanaged media converter or as a full managed CPE device, the XON1200 fits to all FTTH network concepts. Including OAM and SNMP it is possible supervise efficiently the fiber link and the status of the CPE device.

Smart System Concept: True End Customer Self Installation
The XON1200 housing allows a self installation and a self connection of the CPE by the untrained end customer. Thanks to the well-designed sliding mechanism the XON1200 can easily be inserted in the passive fiber termination unit XON30.W. Furthermore the XON30.W offers a sophisticated fiber management, which allows a flexible usage in any cases of fiber termination or purposes of installation. With enough space for a gas blocker, optical couplers and standard splice holders, the XON30.W eases installation and fits into all FTTH application scenarios. The installation kit XON30.WMP allows an easy upgrade of existing XON10.W fiber terminations to install the XON30.W.

Available Units
- XON1200.SC (One- or Two-Fiber-Solution available)
- XON1200.C
- XON1200.C-WDM
- XON1200.L

Key Features
Management Options
- Unmanaged basic media converter
- Full IP managed switch with auto-configuration and remote firmware update possibility

Gigabit Ethernet Media Converter
- Multi-Rate WAN Interface, 1000Base-BX10 and 100Base-BX10
- 1 x 1000 Base-T LAN Interface
- IPv6 Support
- Virtual LAN (VLAN)
- Quality of Service / Class of Service
- Bandwidth Control
- SNMP Agent
- Remote Diagnostics
- IEEE802.3ah OAM
- Ultra low noise cable TV Receiver
- Link loss carry forward (LLCF)
- Link layer discovery protocol (LLDP)

Green Ethernet
- Link-On Cable Length Power Saving
- LED ECO Mode

General Technical Data
- Size: 48 x 150 x 150 mm (XON30.W)
- Weight: < 500g (XON1200.SC)
- Power Supply: 6V DC
- Power Consumption: < 3.5W (XON1200.SC)

RF Video Overlay

Optical Transmission
A key component of an RF Video Overlay system is the optical transmitter converting the electrical TV signal into an optical modulated signal. The optical wavelength is generally chosen in the range of 1550 nm because optical amplifiers with high performance are available for this wavelength.

External Modulated Transmitter
- 1550 nm high performance Optical BC (broadcast) Transmitter for FTTH networks
- Bandwidth ES10XL (CATV): 47 ... 1006 MHz
  ES28XL (CATV + SAT): 47 ... 870 MHz CATV
  950-2800 SAT-TV
- Long distance > 100 km
- SBS threshold adjustment
  ES10XL (CATV): up to +19 dBm for 65 km fiber
  ES28XL (CATV + SAT): up to +15 dBm for 40 km fiber
- Automatic Gain Control (AGC)
- Up to 2 x 13 dBm optical output power

ES10XL / ES28XL

Direct Modulated, Amplified Optical Transmitter for CATV and SAT IF Transmission
- RF Video Overlay with 1550 nm wavelength in FTTH networks providing very high optical budget (GPON compatible)
- Bandwidth 2.6 GHz, 5 ... 870 MHz
  950 ... 2605 MHz
- Optical output power
  8 (16) x 20 dBm ± 0.5 dB
- Up to 10 km distance
- NEC inside
- Redundant powering

Fx-AOTnn200
**Optical Amplification**

The optical amplifier, the second key component, is required in order to recover the optical signal level after transmission over long fiber distances (inline amplifier, EDFA) or in order to boost its level for the final distribution (YEDFA) to a large number of end users.

- Optical amplification of CATV and SAT-IF signals in FTTH networks, 1540 nm - 1560 nm
- Adjustable output power
- Constant Output Power Mode and Constant Gain Mode
- SBS detection

### Optical Amplifier (EDFA)

- **Fx-OVnxxx**
  - Amplification of CATV and SAT-IF signals in FTTH networks, 1540 nm - 1560 nm
  - Pre- and Booster Amplifier in one 19" device
  - Usable in combination with external modulated Optical Transmitter (Fx-ES10, Fx-ES26)
  - Adjustable output power
  - Constant Output Power Mode and Constant Gain Mode

### Very High Power Optical Amplifier (YEDFA)

- **Fx-OV16xxx**
  - RF Video Relay in FTTH networks, used as Booster Amplifier on the last mile
  - Amplification of CATV and SAT-IF signals in FTTH networks, 1545 nm - 1565 nm
  - Pre- and Booster Amplifier in one 19" device
  - Usable in combination with external modulated Optical Transmitter (Fx-ES10, Fx-ES26)
  - Adjustable output power
  - Constant Output Power Mode and Constant Gain Mode

#### Available Versions

- **Fx-OV32165**
  - 16 x 14.5 dBm (SC/APC or LC/APC) in 1 RU*
  - 16 x 16.5 dBm (SC/APC or LC/APC) in 1 RU*
  - 32 x 16.5 dBm (SC/APC or LC/APC) in 1 RU*
  - 16 x 20 dBm (LC/APC) in 1 RU*
  - 8 x 20 dBm (LC/APC) in 1 RU*
  - 64 x 16 dBm (LC/APC) in 2 RU*

### Very High Power Optical Amplifier + Integrated 1310 & 1490 & 1610 / 1550 nm WDM Array

- **Fx-OVnnxxx-IP**
  - RF Video Overlay in PON-systems
  - Up to 32 PON-ports can be connected

#### Available Versions

- 8 x 17.5 dBm (SC/APC or LC/APC) + 8 WDM in 1 RU*
- 8 x 20 dBm (SC/APC or LC/APC) + 8 WDM in 1 RU*
- 16 x 16.5 dBm (SC/APC or LC/APC) + 16 WDM in 2 RU*
- 16 x 19 dBm (SC/APC or LC/APC) + 16 WDM in 2 RU*
- 18 x 20 dBm (SC/APC) + 18 WDM in 2 RU*

### Very High Power Optical Amplifier with Integrated Optical Input Switch

- **OVSxEnnxxx-IP**
  - RF Video Overlay in PON systems
  - Up to 64 ON-ports can be connected

#### Amplification of 1550 nm optical signals on single mode fibers in FTTH Video overlay and CATV networks

- Input redundancy switch (nominal and redundant optical input)
- Cladding-pumped ErYb-doped fiber amplifier technology
- 1310 & 1490/1550nm WDM coupler at each output for multiplexing of bidirectional IP traffic
- Optical preamplifier (EDFA) included
- Output power 19.0 dBm
- 32 or 64 output ports (internal optical splitter)
- Broad optical wavelength range (1545 ... 1563 nm)
- Constant output power control
- Supervision of the optical input level, optical output level and pump laser current

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* RU = Rack Unit
Passive Optical Power Splitting on an RF only System

The third key component is represented by passive optical splitters and optical wavelength division multiplexers (WDM). The components are required for splitting optical power in order to supply adequate optical signal level to the end user or to combine or separate the different optical wavelengths on a fiber optic link.

Outdoor Optical Amplifier (YEDFA)
- Outdoor application
- SNMP management via Ethernet
- 48 VDC redundant power supply
- LC / APC connectors

Available Versions:
- 40 x 13.5 dBm (LC/APC) in 2 RU*
- 20 x 13.5 dBm (LC/APC) in 2 RU*
- 32 x 16.5 dBm (LC/APC) in 2 RU*
- 16 x 16.5 dBm (LC/APC) in 2 RU*
- 8 x 16.5 dBm (LC/APC) in 2 RU*

Optical Splitter
- RF Video Overlay in FTTH networks
- Up to 64 output ports available in 1 or 2 RU
- Optical connector: SC/APC or LC/APC
- Insertion loss < 19.7 dB
- Uniformity < 1.6 dB
- Wavelength range: 1260 -1650 nm

Optical MDU Amplifier
- Optical booster amplifier for in- or intra-building extension of FTTH RF video or CATV broadcast networks
- Compact, low cost, high-performance EDFA
- 4 output ports, 14.5 dBm optical power each
- Constant Output Power Mode
- RF monitor port
- 1x SC/APC in, 4xSC/APC out
- Solid metal housing with fiber management unit, wall mountable
- Designed for installation in multiple dwelling units (MDU)

16 x 1310 & 1490 & 1610 / 1550 nm WDM Array in 19” Housing
- 16 x 1310 & 1490 & 1610 / 1550 nm WDM
- 16 SC/APC RF Video In
- 16 SC/PC GPON/GEPON In/Out
- 16 LC/APC combined RF Video + GPON/GEPON In/Out
- Insertion loss RF Video: <1.0 dB
- Insertion loss GPON/GEPON: <0.6 dB
- 1 RU
- Also available with 8 WDMs
RF Video Overlay

**Optical Splitter + Integrated WDM Array**

- IP and RF Video Overlay in FTTH networks over one fiber: 1310 & 1490 & 1610 nm IP / 1550 nm RF Video
- 1 input port RF Video
- 1 RU

**Available Versions:**
- **FOV016-PLC-IP**
  - 16 In/Out ports IP (MPO APC)
  - 16 combined RF Video and IP In/Out ports (SC/APC)
  - Insertion loss < 1.5 dB
  - Uniformity < 1.9 dB
- **FOV032-PLC-IP**
  - 32 In/Out ports IP (MPO APC)
  - 32 combined RF Video and IP In/Out ports (SC/APC)
  - Insertion loss < 1.8 dB
  - Uniformity < 1.9 dB
- **FOV064-PLC-IP**
  - 64 In/Out ports IP (MPO APC)
  - 64 combined RF Video and IP In/Out ports (LC APC)
  - Insertion loss < 20.7 dB
  - Uniformity < 2 dB

* RU = Rack Unit

Network Management

For monitoring, control and configuration of the active equipment a Network Element Controller (NEC-E) integrated in optical transmitters or optical amplifiers is available. The NEC-E is equipped with an embedded Web-Server, accessible by standardized security procedures via an Ethernet interface from any Web-Browser. The remote SNMP interface allows controlling and monitoring of all active components and provides the interface to a higher level Umbrella Management System, such as the BKtel CABLEwatch EMS.
To complete a FTTH network BKtel offers the Device Auto Configuration System (DACS). DACS is a software solution that automates the remote configuration process of all CPEs in FTTH networks without any customer hardware assignment. Based on DHCP Option 82 DACS allocates the subscribed services and provides each connected CPE device with the corresponding configuration parameters. The software system is especially designed for the operation with BKtel’s XON product family.

Provisioning of Network Termination Units

Features
- Access port based configuration via DHCP Option 82
- Remote configuration of all parameters
- Automatic firmware management for each device type
- TFTP/DHCP management included
- Fully automated device configuration

BKtel Provisioning:
- IP address assignment (DHCP)
- Switch configuration (e.g. VLANs)
- VoIP configuration
- Firmware upgrade
- Default configuration upgrade

Remote Diagnostics of CPE:
- Optical Transceiver parameters
- Physical Port Status
- Voice Status
- Direct Link Detection
- Optical Input Power of the CATV receiver

Our Company
BKtel was founded 1997 as a result of a management buy-out from Alcatel Cable and has currently a workforce of approx. 100 employees worldwide. The company is based in two locations in Germany, the headquarters in Hueckelhoven-Baal, near Düsseldorf and a second office in Konneweisheim, near Stuttgart. Further international offices were founded in China and Japan for the growing Asian market. The company develops and manufactures products in the field of interactive FTTH-, Video Overlay-, RFoG- and HFC-networks for high performance data, telephone and cable TV services. The active and passive components are designed and manufactured in company-own facilities. The high quality products as well as the comprehensive support in designing optical networks make BKtel to one of the leading international suppliers in the FTTH and HFC market.

Our Products
BKtel develops FTTH, Video Overlay, RFoG and HFC broadband networks and related network management. The product portfolio includes a wide range of products starting from optical transmitters, optical amplifiers, optical receivers, optical return channel systems, customer premises equipment up to DWDM technology for upstream and downstream applications. The own manufacturing facilities guarantee a high quality standard (ISO 9001 certified). Furthermore the company offers a complete range of services such as planning, installation and training.
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Connecting the World at the Speed of Light