Docsis over PON
D-PON
Proposal for two-way HDTV+Ethernet In 3000 Subscribers' FTTH Community

1.0 Project Overview

This proposal gives the solution for the Cable MSO to offer HDTV+Ethernet services to about 3000 FTTH subscriber in the community of less than 10Km fiber distance to the headend office. Each subscriber will have 60ch QAM channel HDTV contents and 50Mbps broadband capability. RFoG micronode, CMTS and CWDM are main technologies in this proposal.

2.0 Key Points

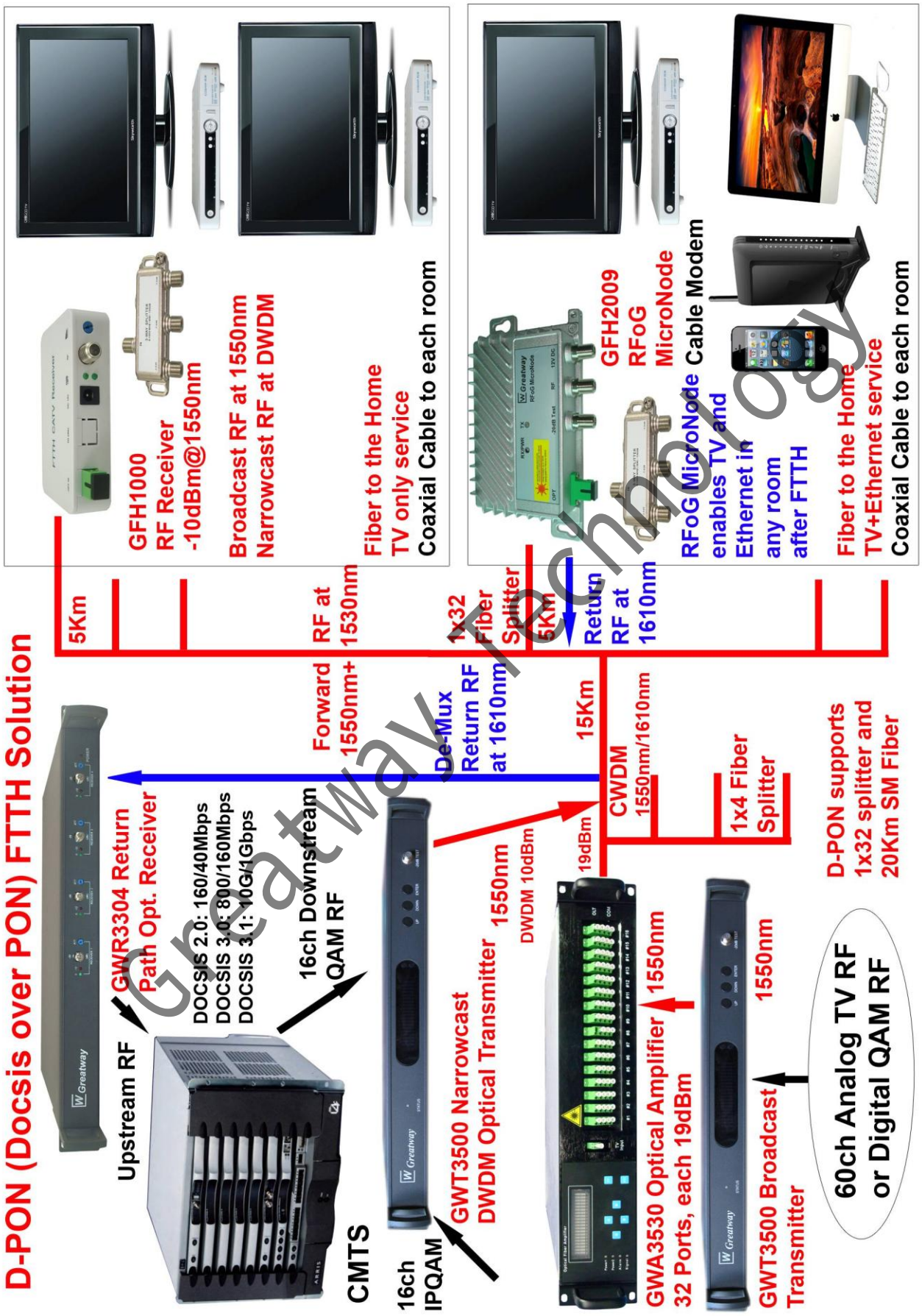
SCTE announced RF over Glass (RFoG) standard SCTE-174-2010 few years ago, defining the return path burst mode which allows only one cable modem sending reverse data over fiber cable to CMTS when all cable modems are set at TDMA mode. With RFoG, Cable MSO can extend CMTS/Cable Modem service from HFC network to Fiber to the home (FTTH) network. This is the so-called DOCSIS over Passive Optical Network (D-PON). D-PON supports 1x32 optical splitter at 20Km fiber distance or 1x64 optical splitter at 10Km fiber distance.

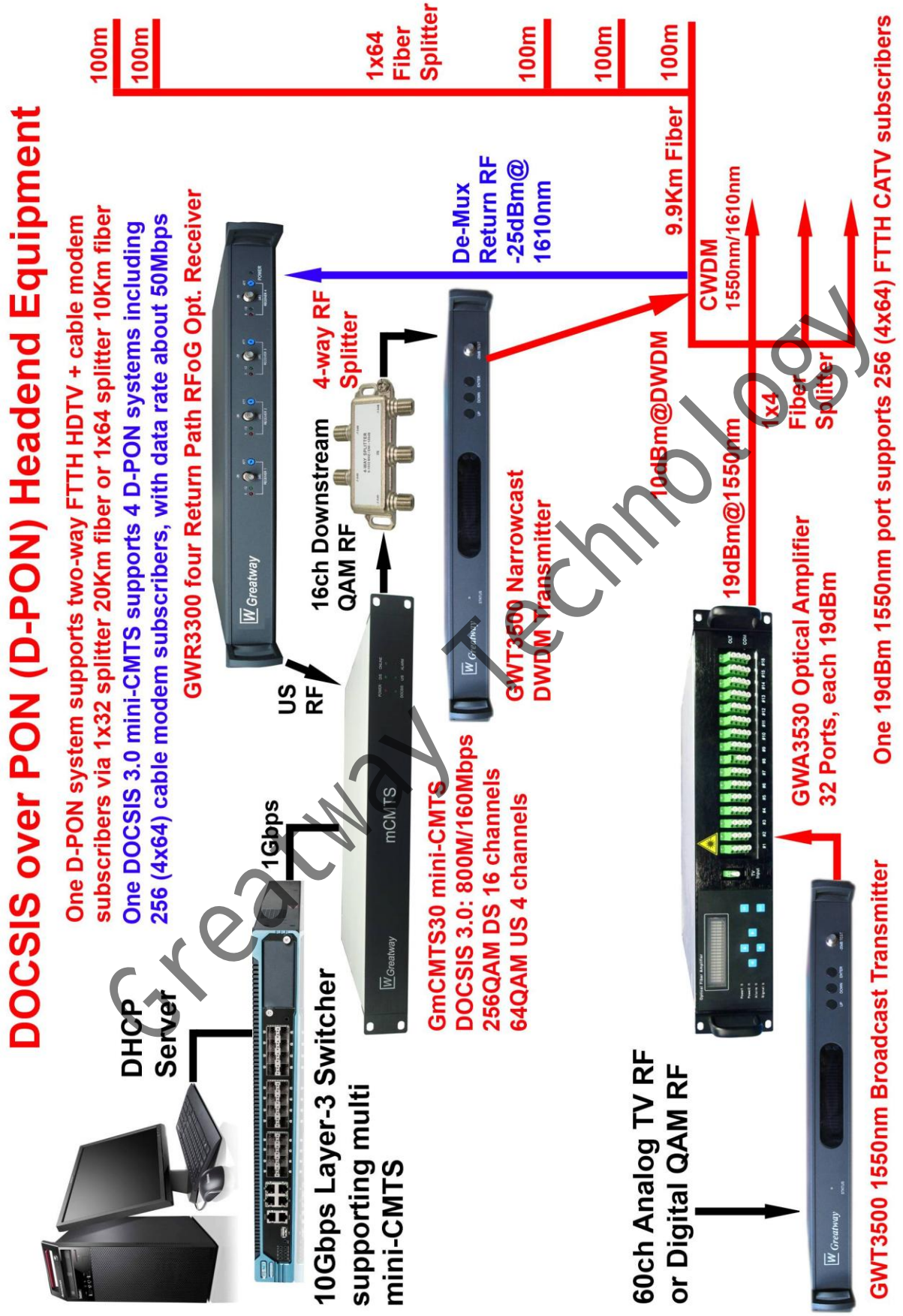
We also introduced Docsis 3.0 mini-CMTS based on C-DOCSIS standard. GmCMTS30 has 16ch downstreaming channels and 4 upstreaming channels, which supports docsis 2.0 and docsis 3.0 cable modems. At 256QAM, 16 DS channels may have shared 800Mbps bandwidth, which means to 256 cable modem subscribers, the pure Ethernet speed can be about 50Mbps.

In the system of Docsis 3.1 or Docsis 4.0 which requests more return path channel bonding at lower CATV bandwidth, optical beat interference (OBI) is a more challenging factor in PON system. With built-in uncooled CWDM return path laser at selected optical window, GFH2009 RFoG Micronode realizes OBI free demand at an economical budget, having the advantages of broadcasting hundreds of HD TVs and shared 10Gbps Ethernet data.

With the perfect combination of mini-CMTS and D-PON, Cable MSO can offer competitive HDTV and High Speed internet services at affordable cost. With fiber to the home, all system maintenances and upgrade become much easier.

See D-PON proposal network drawing and D-PON headend equipment connection drawing followed.





3.0 Bill of Materials (BoM)

Part A: Ethernet Mangaement		
Part Number	Description	Qty
	DHCP Server	1
	10Gbps layer-3 Routing Switcher, more than 12 Gigabit ethernet port	1
GmCMTS30	Docsis 3.0 layer-2 mini-CMTS, 16ch DS and 4ch US, 19" 1RU	12
Part B: CMTS US and DS headend transmission equipment		
GWT3500-10D	1550nm DWDM 1218MHz narrowcast transmitter module, AGC, 10dBm, SC/APC	48
GWR3304	Quad independent RFoG return parth optical receivers in 19" 1RU, SC/APC	12
	4-way RF Splitter, 1 for GWT3500 optical Tx, 1 for local monitoring, 2 for future application	12
Part C: Broadcast TV transmission fiber optics		Quantity
GWT3500-10-SA	1000MHz 1550nm Emcore DFB laser Transmitter, VFD, 10mW, 19" 1RU, SC/APC	1
GWA3530-31-12-SA	31dBm Optical Amplifier in 19" 2RU, 12 Outputs, Each 19dBm, SC/APC	1
MPFS-4-P-SA	1x4 Optical Splitter in 100x80x10mm box, SC/APC, 1 meter pigtail	12
MPFS-64-P-SA	1x64 Optical Splitter module,1 in and 64 out, 1 meter pigtail with SC/APC connector	48
SA-SA-SS-5M	SC/APC-SC/APC SM Simplex Jumper, 5 meter, connecting splitter and ODF fiber cable	1000
Part D: Fbier to the Home (FTTH) one-way and two-way equipment		Quantity
GFH1000	1000MHz FTTH CATV Receiver, 18dBmV@-8dBm, AGC: -10dBm~-2dBm, SC/APC, 12V DC	
GFH2009-10-31-2	1000MHz RFoG micronode,20dBmV@-8dBm, 1310nm return,65/85MHz, SC/APC, 12V DC	3000
Part E: Home electronics		Quantity
	STB for TV only	
	HDTV STB with cable modem and Wi-Fi	3000

4.0 Datasheet Attachments

4.1 GWT3500 Broadcast 1550nm transmitter
4.2 GWA3530 Erbium Doped Fiber Amplifier
4.3 GmCMTS mini-CMTS
4.4 GWR3304 Quad Return Path receiver for RFoG
4.5 GFH1000 one-way CATV receiver
4.6 GFH2009 RFoG Micronode

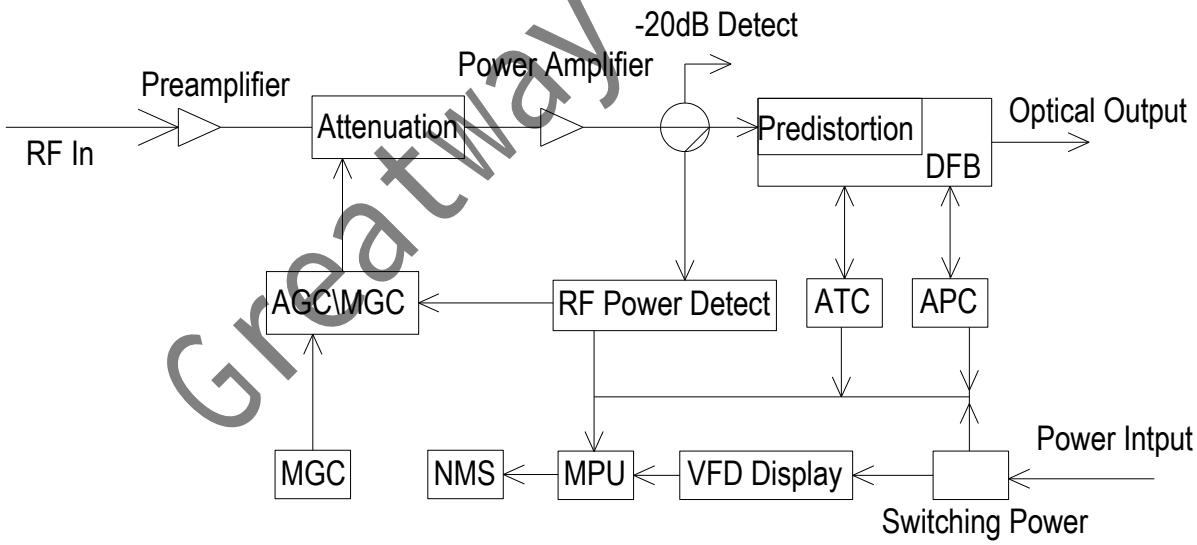
GWT3500 1550nm DWDM DFB Transmitter

GWT3500 is a direct modulation 1550nm DFB transmitter for analog TV, digital TV and CMTS signals local fiber dense distribution and QAM TV Signal long-distance fiber transmission. The transmitter utilizes high linearity DFB laser, RF power digital automatic process technique, along with RF pre-distortion circuit developed by Greatway Technology. The built-in microprocessor monitors the transmitter working status and automatically ensures the optimistic performance. GWT3500 is ideal for analog TV fiber distribution within 20Km and QAM TV signal long distance transmission within 100Km.

Features

- Low noise high linearity Ortel-Emcore cooled DFB laser
- GaAs Technology up to 862/1000MHz
- RF power digital automatic process technology control the laser driving RF power level automatically according to RF signal level and channels, ensuring the best C/N, CTB and CSO
- Excellent pre-distortion technology improves CTB, CSO and C/N
- Built-in microprocessor accurately monitors laser output power and temperature.
- Front panel VFD displays the status parameters and function message
- SNMP network management optional

Block Diagram



Specifications

Item	Unit	Parameter
Optical Power	mW	10
Optical Link Path Loss	dB	11
Optical Wavelength	nm	1550±10
Type of Laser		14pin cooled DFB laser in butterfly package with isolator
Optical modulation mode		Direct Modulation
Optical connector Type		SC/APC or FC/APC
Frequency Range	MHz	47~862 (1000MHz Optional)
RF Input Level	dBmV	15~25
Flatness In Band	dB	±0.75
RF Input Impedance	Ω	75
Input Reflection Loss	dB	≥16 (47~862)MHz
C/CTB	dB	≥65
C/CSO	dB	≥59
C/N	dB	≥51
AGC Control Range	dB	0~15
MGC Control Range	dB	0~15
Power Voltage	V	AC 100V~240V （50/60 Hz）
Power Consumption	W	15
Operation Temperature	℃	0~50
Store Temperature	℃	-40~85
Relative Humidity	%	Max 95% no condensation
Dimension	mm	483 (L) ×381 (W) ×44 (H)
Weight	Kg	5

Test condition：Input 59 channels PAL-D signal to the optical transmitter and measure the standard optical receiver C/CTB, C/CSO and C/N in conditions of -1dBm optical input (10km fiber + optical attenuator) and 36 dBmV RF output.

Ordering Information:

GWT3500-AB-CD-EF-G Forward Path Transmitter

AB: Optical output power in mW, 10mW only
CD: Optical connector, FC_FC/APC, SC_SC/APC
EF: None for 862MHz, 1000 for 1GHz bandwidth
G: None for RS-232 interface, N for SNMP interface

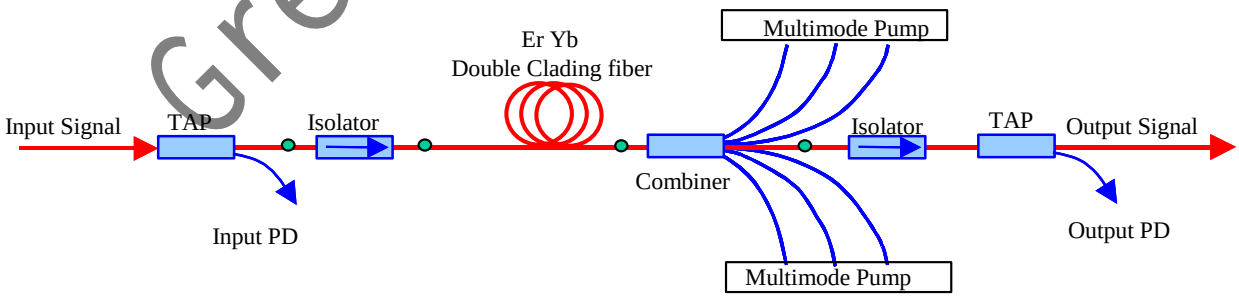
GWA3530 Series 1550nm Fiber Amplifier

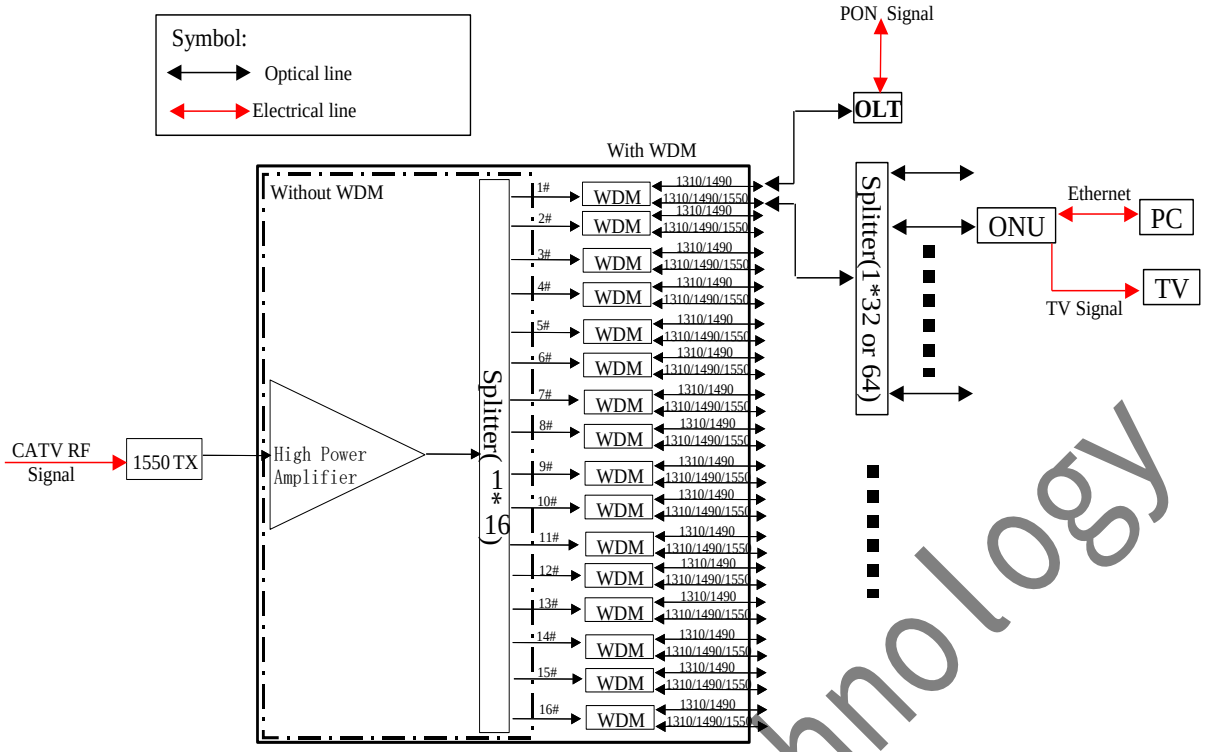
With up to 35dBm 1550nm output, GWA3530 series Er-Yb Doped Fiber Amplifiers are important 1550nm relay transmission equipments for High performance supertrunking links, High power distribution networks, Fiber Deep architectures and FTTx networks. GWA3530 Fiber Amplifier is designed to meet the most demanding noise performance requirements of CATV and FTTx applications. GWA3530 fiber amplifier provides optical isolation on the input and output of the gain block for stable, low noise operation. The input and output optical signal power levels are detected for monitoring and control. The input optical signal is amplified with active gain control for a constant output power level, or with active output power control for constant gain mode. GWA3530 series optical amplifiers also provide monitoring functions and associated alarms for all vital characteristics. The optical output of the GWA3530 series optical amplifiers can be split into up to 32 ports by an optional internal splitter.

Features

- High adjustable output power: maximum 35dBm
- Fiber output supporting multi-ports: 20dBm×N or 17dBm×N
- Low NF: Typical <5.5dB @+5dBm input
- Extremely low CSO distortion: < -70dBc
- Dual CPU dealing with amplifier local controller and remote communication
- High stability and reliability: MTBF ≥150000 hours
- Dual Hot-swappable 110V AC or -48V DC Power supplies
- Ethernet, RS485 and RS232 network interfaces
- Supporting Telnet and SNMP network management
- Intelligent temperature control system: Employ special temperature control chip, radiating and power consumption can be reduced 30%
- Built-in 1310nm,1490nm,1550nm WDM(Optional)
- RoHS Complied
- Bellcore GR-1312-CORE Complied

Block and Application Diagram





EPON System Diagram

Specifications

Optical Parameter

Parameter	Symbol	Min	Typ	Max	Unit
Wavelength	λc	1540	1550	1565	nm
Saturated Output Power	Po	13	33	35	dBm
Input Power	Pi	-3		+10	dBm
Gain	G			30	dB
Noise Figure*	NF			6	dB
Output Power Stability	ΔPo		±0.05	±0.2	dB
Input Isolator	ISOi	30			dB
Output Isolator	ISOo	30			dB
Input Pump Leakage	PumpLin			-35	dB
Output Pump Leakage	PumpLout			-45	dB

Return Loss	RL			-45	dB
Polarization Dependent Gain	PDG			0.3	dB
Polarization Mode Dispersion	PMD			0.5	ps

* Tested at +5dBm optical input

Power Supply

Power Supply: AC: 90V~265V (50/60 Hz) or -48V DC

Power Consumption: ≤50W

Environment

Parameter	Symbol	Min	Typ	Max	Unit
Operating Temperature	Tw	-5		60	℃
Storage Temperature	Ts	-40		80	℃
Humidity		10		85	%

Physical Parameters

Weight: ≤20Kg

Dimensions (mm): 483 ×416×88 (19” 2RU)

Ordering Information

GWA3530-AB-C-D-E-F High Power Fiber Optical Amplifier in 19” 2RU

AB (Output Power): 30_30dBm, 33_33dBm, 35_35dBm

C (Output Ports): 01_1 port, 02_2 ports, 04_4 ports, 08_8 ports, 16_16 ports, 20_20 ports

D (Connector): FA_FC/APC SA_SC/APC

E (Power Supply): Default _single 220V AC, 48_single -48V DC,

AA_Two AC power supplies, DD_Two DC Power supplies;

AD_AC and DC power supplies

F (1310nm/1490nm/1550nm WDM at each fiber output port): Default_None, W_WDM

Mini CMTS

Greatway Technology's GmCMTS30 is a cost-effective indoor Mini CMTS with layer-2 switching capability in 19" 1RU chassis. Working with layer-3 switcher via RJ-45 port or SFP module, GmCMTS30 can deliver total 16 downstream channels of 800Mbps and 4 upstream channels of 160Mbps high-speed internet bandwidth. The GmCMTS30 can support up to 500 pcs DOCSIS2.0 or 400 pcs DOCSIS 3.0 Cable Modems online.

Features:

- Robust 19" 1RU chassis with built-in heat sink for long reliability
- Easy to use Mini CMTS with layer-2 switching capability
- Compatible with standard layer-3 switcher via RJ-45 port or SFP
- Supporting both DOCSIS2.0 and DOCSIS3.0 Cable Modem
- 4 upstream channels with bandwidth to 160Mbps
- 16 downstream channels with bandwidth to 800Mbps
  - including 8 IPQAM channels that can be configured for VoD services
- Real-time Web management software for easy configuration and monitoring, supporting SNMP

Specifications:

Downstream Specification	
QAM standard	Annex A, B, C
QAM modulation	64QAM, 256QAM
Uni-Channel speed	36M@64QAM; 51M@256QAM
Downstream channels	16
Downstream maxi-speed	800Mbps
Downstream Frequency	87MHz ~1000MHz
Bandwidth	6MHz
Output RF Level	46dBmV (8 channels)
	41dBmV (16 channels)
RF Output adjusted step	0.5dB
Post-balance MER	42dB
External noise	<-20dBm
Upstream Channel Specification	
Upstream channels	4
Upstream modulation	QFSK, 16QAM, 64QAM
Uni-channel speed	0.32Mbps~40Mbps
Upstream highest rate	160Mbps
Upstream frequency range	5MHz~65MHz
Input level range	-13dBmV~+23dBmV
RF output specification	
RF IN interface	F connector, 75Ohm
RF IN mount	1 RFin

RF OUT interface	F connector, 75Ohm
RF OUT quantity	1 RFout
Data port specification	
Net port speed	10/100/1000Mbps
Net port type	1 RJ45 port and 1 SFP module port
Full speed support	Support
Management specification	
RS232 serial	Support
Command line (CLI)	Support
Telnet or SSH	Support
SNMPv1, v2, v3	Support
DOCSIS MIBs	Support
Other functions	
Maximum CM amount	511
Dynamic load balance	Support
DHCP delay	Option 82, Option 60
QoS	Support
VLAN process	Support
Environment specification	
Temperature	-25 Deg C~75Deg C
Humidity	10% - 90%
Power Supply	90 - 240V AC 50/60Hz
Power Consumption	<26W
Dimension (mm)	483×381×44

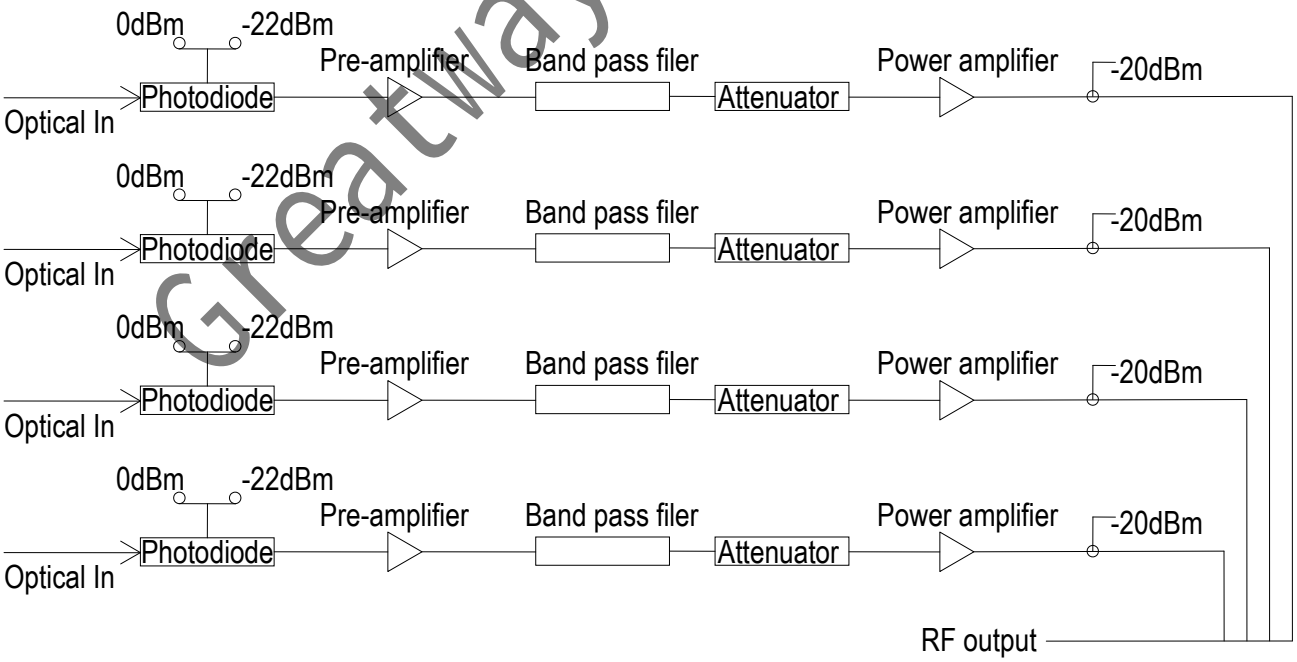
GWR3300 Return Path Optical Receiver

GWR3300 rack mount return path receiver is designed for the indoor CATV return signal receiving. In the 19" 1RU rack, there are maximum 4 independent return path optical receivers. With high performance photodiode and hybrid amplifier, GWR3300 offers a clean return path band for Cable Modem up-streaming signals. Optical power indicator and RF test port on the front panel can indicate receiver's status.

Features

- 1000~1650nm optical wavelength for regular and OBI free RFoG return signal
- 19" 1U standard rack mount
- Low noise, high linearity photodiode
- 5- 200 MHz RF Bandwidth
- Band pass filter depressing the up-streaming noise
- Output adjustment and -20dB RF test available on front panel
- -28dBm receiving sensitivity for RFoG return signal

Block Diagram



Specifications:

Items	Unit	Parameters
Optical Wavelength	nm	1000 ~ 1650
Input Optical Power	dBm	-28 ~ +2
Recommended Optical Input	dBm	-25 ~ -5
Optical Return Loss	dB	>45
Optical Fiber Connector		FC/APC or SC/APC
Noise Power Ratio	dB	≥ 15 (for DFB laser return path transmitter)
		≥ 10 (for FP laser return path transmitter)
Frequency range	MHz	5~200
Flatness in band	dB	±0.75
RF Output Level	dBmV	>20dBmV@-22dBm optical input, 0dB MGC
MGC Control Range	dB	0~20
RF Return Loss	dB	≥16 (5~200 MHz)
Output Impedance	Ω	75
LED in Front Panel		Green@0~-28dBm optical input Green+Red@>0dBm optical input OFF@<-28dBm optical input
Working Temperature	℃	0~+50
Power consumption	W	20
Power Supply	V	100~240 (50/60Hz)
Dimensions	mm	480×325×44
Weight	Kg	8

Ordering Information

GWR3300-A-BC 19” 1U Optical Return Path Receiver

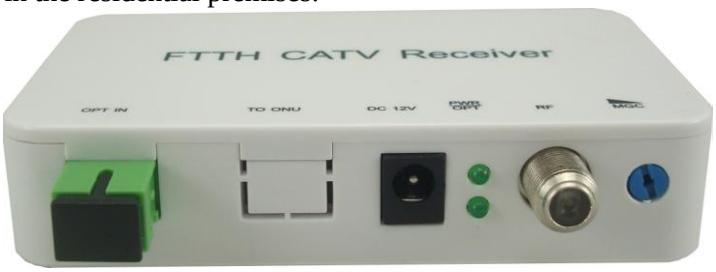
A: Number of independent optical return path receiver, from 1 to 4

BC: FC for FC/APC connector

SC for SC/APC connector

GFH1000 FTTH Optical Receiver

GFH1000 is designed to receive FTTH 1310nm/1550nm analog TV or QAM RF optical signal from Passive Optical Network (PON). With built-in low-noise amplifier and AGC circuit, GFH1000 outputs high quality CATV RF for TVs in the residential premises.



Feature:

- Compact plastic flame retarding housing
- High Linearity Photodiode for CATV RF
- 45~1000MHz (downstream) RF Output (45~1218MHz optional)
- Optical AGC range: -10dBm ~ 0dBm
- Optional MGC range: 0~15dB
- DC Power and optical input LED indicator
- 12V DC power adapter

Specifications

Item	Parameter
Input CATV Optical Wavelength	1260nm~1650 nm 1550nm~1560nm only on Request
Working Optical Power	-8dBm ~ +2dBm (Analog TV RF) -15dBm ~ +2dBm (DVB-C QAM RF)
Optical AGC Range	-10dBm ~ 0dBm
Optical Connector	SC/APC
Optical Return Loss	45 dB
RF Bandwidth	45 ~ 1000 MHz (1218MHz optional)
RF Connector	American F
RF Output Impedance	75Ω
RF Output Level	>76dBμV@-8dBm (No MGC)
MGC Range	0~15dB (Optional)
RF Flatness	±1.0dB (45~1000MHz)
RF Return Loss	>14 dB
CNR	>46 dBc @ -6dBm (Analog TV RF)
CSO	<-63 dBc @77ch NTSC (Analog TV RF)
CTB	<-63 dBc @77ch NTSC (Analog TV RF)
MER	>34 dB @ -12dBm (BER: <1.0E-9)
Power LED	Green when DC power is ON
Optical Input LED	Red (<-15dBm) Green (-15dBm~+2dBm)
Environment	
Power Supply	12 V 0.5A (UL or CE approved)
Power Consumption	<2W (not including power adapter)
Working Temperature	-10 ~ +50℃
Board Dimension (L*W*H)	106mm×62mm×25mm
Weight (without power adapter)	200g

Ordering Information

GFH1000 FTTH CATV Optical Receiver

GFH1000 optical receiver test results in MER

Optical Rx Input	Output RF Level	MER(dB)
+2dBm	79dBμV	38.8
+1dBm	79dBμV	38.8
+0dBm	78dBμV	38.8
-1dBm	78dBμV	38.8
-2dBm	78dBμV	38.7
-3dBm	78dBμV	38.6
-4dBm	78dBμV	38.6
-5dBm	78dBμV	38.5
-6dBm	78dBμV	38.5
-7dBm	78dBμV	38.5
-8dBm	78dBμV	38.4
-9dBm	78dBμV	38.2
-10dBm	77dBμV	38.1
-11dBm	75dBμV	37.8
-12dBm	73dBμV	37.7
-13dBm	71dBμV	37.5
-14dBm	69dBμV	37.3
-15dBm	67dBμV	37.1
-16dBm	65dBμV	35.9
-17dBm	63dBμV	34.8
-18dBm	62dBμV	33.5

Test condition: 80ch DVB-C, 64QAM, Transmitter OMI 4.0%

GFH2009 RFoG MicroNode

GFH2009 RFoG MicroNode is designed to receive 1550nm broadcasting RF or IP HD video from Passive Optical Network (PON) and send upstream cable modem signals at 1610nm or other CWDM wavelength. GFH2009 supports the return RF signal burst mode transmission, allowing one cable modem to communicate with CMTS at the time section of TDMA. GFH2009 outputs bi-directional interactive RF services. GFH2009 is designed to support DOCSIS2.0, DOCSIS3.0 and DOCSIS3.1.

Features:

- Compact Aluminum Housing
- 1002/1218MHz forward path RF bandwidth
- 17dBmV RF output for FTTH
- ALC effective at -7dBm~+1dBm optical input
- 5~42MHz/85MHz/204MHz return RF bandwidth
- Reverse RF over 1310nm or 1610nm DFB laser working at burst mode
- Cost effective CWDM return path laser option for OBI free
- LED display forward and return optical working status
- 6KV Surge Protection
- 12V DC power at RF port

Specifications

Item	Parameter
Forward Path Receiver	
Forward RF Optical Wavelength	1540~1560 nm
Working Optical Input Power	-7dBm ~ +2dBm
Fiber Input Connector	SC/APC
Optical Return Loss	50 dB
RF Bandwidth	54MHz/102MHz/258MHz ~ 1218MHz
RF Connector	American F
RF Output Impedance	75Ω
ALC Effective Range	Optical Input: -7dBm~+1dBm
ALC Stability	± 1 dB
RF Output Level	17dBmV@-6dBm

RF Flatness	±1 dB
RF Return Loss	>16 dB
CNR (@-6dBm)	>46 dB
CSO (@+1dBm)	<-60 dBc @77ch NTSC
CTB (@+1dBm)	<-60 dBc @77ch NTSC
Return Path Transmitter	
Return Path Laser Wavelength	1610nm, 1310nm or CWDM
Optical Output Power	3±1 dBm
Return Path Laser off power	<-30dBm
Return Laser Rise/Fall Time	1μs (SCTE-174-2010)
Return RF Bandwidth	5~42MHz/85MHz/204MHz
Return RF Level	12dBmV~50dBmV
Laser Turn On RF Level	>12dBmV
Environment	
Working Temperature	-40 ~ +60℃
Storage Temperature	-40 ~ +85℃
Power Supply	12V~18V DC Power Adapter with F connector
Power Consumption	< 5.0W
Dimension (L*W*H)	165mm×85mm×38mm
Weight	0.5Kg

12V DC powering at RF port

Ordering Information

GFH2009X-A-B-C-D Fiber to the Home RFoG MicroNode
X (Forward RF output level): none_17dBmV, M_30dBmV, H_36dBmV
A (Forward Path RF Bandwidth): 10_1002MHz, 12_1218MHz
B (Return Path Laser Wavelength): 61_1610nm, 31_1310nm, 35_1350nm, 37_1370nm, 39_1390nm, 41_1410nm, 43_1430nm, 45_1450nm, 47_1470nm, 49_1490nm
C (RF Frequency Duplexer): 1_42/54MHz, 2_65/85MHz, 3_85/105MHz, 4_204/258MHz
D (ONU Loop Port): None_No ONU port, W_Including 1310nm/1490nm WDM for ONU