United States Patent Application Publication	20250260916
Kind Code	A1
Publication Date	August 14, 2025
Inventor(s)	BOWLER; David et al.

MULTI-RATE AND MULTI-MODULATION ONT AND OLT

Abstract

An optical network unit may include a light sensitive unit suitable for receiving NRZ and/or PAM signals effectively. The optical network unit may include a laser transmission unit for providing NRZ and/or PAM signals effectively.

Inventors: **BOWLER; David (Stow, MA), PRATT; Bruce C. (Bedford, NH), CHAMBERLAIN; John Charles (Hickory, NC), GRONVALL; Erik J. (Bloomington, MN)**

Applicant: **ARRIS Enterprises LLC** (Horsham, PA)

Family ID: **86330891**

Assignee: **ARRIS Enterprises LLC (Horsham, PA)**

Appl. No.: **19/169997**

Filed: **April 03, 2025**

Related U.S. Application Data

parent US continuation 18294107 20240131 parent-grant-document US 12294818 US continuation PCT/US2023/018545 20230413 child US 19169997
us-provisional-application US 63338407 20220504

Publication Classification

Int. Cl.: **H04Q11/00** (20060101); **H04B10/60** (20130101)

U.S. Cl.:

CPC **H04Q11/0067** (20130101); **H04B10/60** (20130101);

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a 371 National Stage patent application claiming priority to PCT International Patent Application No. PCT/US23/18545, which claims the benefit of U.S. Provisional Patent Application Ser. No. 63/338,407 filed May 4, 2022.

BACKGROUND
[0002] The subject matter of this application relates to optical network components.
[0003] Many telecommunications networks include Passive Optical Networks (“PONs”). In PONs, generally most to all components which require power (“active components”), e.g., repeaters, relays, memory chips, processors, between the Central Office exchange and termination points at the customer premises are eliminated, and passive optical components are put into the network to guide traffic based on splitting the power of optical wavelengths to endpoints along the way. The passive splitters or couplers are devices working to pass or restrict light, and as such, have no power or processing requirements thereby lowering overall maintenance costs for the service provider.
[0004] FIG. **1** shows a typical PON **100** for an optical access architecture. The PON **100** includes an optical line terminator (“OLT”) **110** located at a Central Office (“CO”) and a set of optical network units (“ONU”) **120**, or optical network terminals, located at the customer premise. Each of the ONUs **120** is connected to the OLT **110** through feeder fiber **130**, e.g., an outside fiber plant, optical power splitter **140**, and individual distribution fibers **150**. The feeder fiber **130** may transmit optical signals at 125 Megabits per second (“Mbps”), 155 Mbps, 622 Mbps, 1.25 Gigabits per second (“Gbps”), 2.5 Gbps, 10 Gbps, or 50 Gbps, or otherwise, in accordance with standards used for various access platforms. Various access platforms, including various transmission formats, and communication and control protocols, e.g., Ethernet based PON (“EPON”), Broadband PON (“BPON”), Gigabit PON (“GPON”), and ATM based PON (“APON”), have been developed to deliver information, e.g., data, voice, and video, from the Central Office to each of the customer premises.
[0005] Access platforms, e.g., EPON, BPON, or GPON, use light having a wavelength of 1.49 microns (“um”), or otherwise, to transmit information in downstream **160** direction and light having the wavelength of 1.31 um, or otherwise, to transmit information in upstream **170** direction between the Central Office and the customer premises. The OLT **110** contains a high power distributed feedback (“DFB”) laser to produce the light at 1.49 um in downstream **160** direction, which is shared by a plurality, e.g., 16, 32, or more of ONUs **120**.
[0006] For example, BPON (ITU-T G.983 (01/2005) “Broadband optical access systems based on Passive Optical Networks (PON)”, incorporated by reference herein) operates at generally 155/622/1200 Mbps downstream and 155/622/1200/2500 Mbps upstream, with laser wavelength of 1490 downstream and laser wavelength of 1310 nm upstream. BPON transmits downstream in a broadcast manner and upstream in a time division multiple access manner.
[0007] For example, GPON (ITU-T G.984.1 (03/2008) “Gigabit-capable passive optical networks (GPON): General characteristics”, incorporated by reference herein) operates at generally 155 Mbps/622 Mbps/1.2 Gbps/2.5 Gbps downstream and 1.244 Gb/s upstream, with laser wavelength of 1490 nm downstream and laser wavelength of 1310 nm upstream. GPON transmits downstream in a broadcast manner and upstream in a time division multiple access manner.
[0008] The OLT **110** may service the plurality of ONUs **120** through the use of one or more optical power splitters **140** and access platform PON protocols to control the sending and transmission of signal across the shared access facility. Data may be transmitted downstream **160** from OLT **110** to each of ONU **120**, and each ONU **120** processes the data destined to it by matching the address at

the access protocol transmission unit header. Upstream **170** data from each of the ONUs **120** to the OLT **110** is transmitted according to access control mechanisms and protocols in the OLT **110**, which include a time division multiplexing scheme, in which dedicated transmission time slots are granted to each individual ONU **120**, to avoid data collision. As such, transport of information between the Central Office and customer premises depends on the type of the access platform used by the Central Office and customer premises. Further, each OLT **110** at the Central Office requires its own feeder fiber **130** to provide data transmission to and from the plurality of ONUs **120**. In addition, a timing algorithm may be used in existing access platforms, which limits the distance between the OLT **110** and the ONU **120**.
[0009] In this manner, depending on the particular architecture implemented, the OLT and/or the ONUs are configured to include the appropriate lasers together with the appropriate modulation scheme, and appropriate optical sensors.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0010] For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:
[0011] FIG. **1** illustrates an optical access architecture.
[0012] FIG. **2** illustrates a 10G-PON network implementation.
[0013] FIG. **3** illustrates a 25G-PON network implementation.
[0014] FIG. **4** illustrates a 50G-PON network implementation.
[0015] FIG. **5** illustrates two stages of an OLT and/or ONU.
[0016] FIG. **6** illustrates three stages and a FPGA of an OLT and/or ONU.
[0017] FIG. **7** illustrates a limiting amplifier output.
[0018] FIG. **8** illustrates another embodiment of a OLT and/or ONU.
[0019] FIG. **9** illustrates a laser and a laser driver.
[0020] FIG. **10** illustrates a power output of a laser.
[0021] FIG. **11** illustrates a laser and a pair of laser drivers.
[0022] FIG. **12** illustrates another power output of a laser.
DETAILED DESCRIPTION
[0023] Referring to FIG. **2**, one network implementation may include 10G-PON, where the OLT is configured to send and receive 10G-PON signals, and each ONU is configured to send and receive 10G-PON signals. For 10G-PON the data is transmitted as a binary code of 1's and 0's based upon a non-return to zero (NRZ) signaling, where ones are represented by one significant condition (normally a higher value) while zeros are represented by some other significant condition, usually a lower value, with no other neutral or rest condition.
[0024] Referring to FIG. **3**, one network implementation may include 25G-PON, where the OLT is configured to send and receive 25G-PON signals, and each ONU is configured to send and receive 25G-PON signals. For 25G-PON the data is transmitted as a binary code of 1's and 0's based upon a PAM4 signaling, where the message information is encoded in the amplitude of a series of signal pulses. PAM4 uses four signal levels for transmission, such that within each clock period, where two bits of logic information can be transmitted (i.e., 0,0; 0,1; 1,0; and 1,1). Therefore, under the same rate, the bit rate of a PAM4 signal is twice that of a NRZ signal.
[0025] Referring to FIG. **4**, one network implementation may include 50G-PON, where the OLT is configured to send and receive 50G-PON signals, and each ONU is configured to send and receive 50G-PON signals. For 505G-PON the data is transmitted as a binary code of 1's and 0's based upon a PAM8 signaling, where the message information is encoded in the amplitude of a series of signal pulses. PAM8 uses eight signal levels for transmission, such that within each clock period, where

four bits of logic information can be transmitted (i.e., 0,0,0,0; 0,0,0,1; . . . , 1,1,1,0; 1,1,1,1). Therefore, under the same rate, the bit rate of a PAM8 signal is twice that of a PAM4 signal. Other pulse amplitude modulation signaling may be used.

[0026] It is noted that with each of the different modulation schemes, the timing between bits may stay the same while the throughput of the data is different. Also, the timing between the bits may be changed, if desired. Also, the signal to noise ratio for each of the modulation schemes is different.

[0027] In many environments it is desirable to deploy a network architecture that includes 10G-PON, at the OLT and the ONU, because it provides sufficient data throughput at a lower complexity and expense than 25G-PON and/or 50G-PON. Over time as the customers consume increasing amounts of data, it may be desirable to upgrade from 10G-PON to 25G-PON, which traditionally requires changing out the OLT and the ONUs at each customer's premise, which is burdensome for the customer and burdensome for the service provider. Over time as the customers consume increasing amounts of data, it may be desirable to upgrade from 25G-PON to 50G-PON, which traditionally requires changing out the OLT and the ONUs at each customer's premise, which is burdensome for the customer and burdensome for the service provider. As it may be observed, it is burdensome to change out the OLT and/or the ONUs of the network over time, which often involves a service technician arranging to change out the ONUs one at time at each customer's premises. Also, PAM8 signaling is more sensitive to noise than PAM4, which in turn is more sensitive to noise than NRZ. Higher order PAM signaling may likewise be used.

[0028] After further consideration, it was determined it would be desirable to include a set of optics within the OLT and/or ONUs where the laser (e.g., light source), the photo diode (e.g., light detector), and its associated optics (e.g., lens) may be reused in a manner that enables the OLT and/or the ONUs to be upgraded based upon controlling software (e.g., firmware) from 10G-PON to 25G-PON and/or 50G-PON, or from 25G-PON to 50G-PON. In this manner, the customer ONU may be upgraded with improved data capacity without the need to replace the customer premise equipment. In this manner, the OLT may be upgraded with improved data capacity without the need to replace the equipment. By way of example, the same optical receiver may be used for the different configurations, such as a positive-intrinsic-negative diode or an avalanche photodiode. In this manner, the same interconnection to the optical fibers may be used for the different configurations. By way of example, the same laser transmitter may be used for the different configurations, such as an indium gallium arsenide based laser.

[0029] Referring to FIG. **5**, the ONU (or OLT) may include a first stage that receives the optical signal from the fiber, such as using a diode. The diode receives the optical signal and in response provides a current output. The ONU may include a second stage that receives the current output from the diode and in response provides a voltage output, such as using a transimpedance amplifier typically implemented using one or more operational amplifiers and/or a current mirror. Accordingly, the two stages of the ONU converts the received optical signal to a corresponding voltage level. The same may be applied to the OLT, as desired. The first and second stages may be combined within a single stage, as desired.

[0030] Referring to FIG. **6**, the voltage level from stage **2** tends to be a relatively small signal that should be amplified by a third stage so that it may be more readily processed by a digital processor, such as a field programmable gate array or an application specific integrated circuit. Upon further review, it was determined that signals that are NRZ tend to be generally rectangular and/or sinusoidal in nature to indicate the binary levels, while signals that are PAM4 and/or PAM8 tend to be multi-level in nature to indicate the different values. A switch **600** may be included, such as one that is controllable by software, to provide the output of stage **2** to a different amplification stage based upon the type of signals that are being amplified. For the NRZ signals, the switch **600** sends the voltage signals to a limiting amplifier **610**. Referring also to FIG. **7**, the limiting amplifier **610** generally allows signals below a level to pass mostly unaffected while attenuating the signals above the level, or also or alternatively, the limiting amplifier **610** generally allows signals above a level to pass mostly unaffected while attenuating the signals below the level, or otherwise those signals in the middle band to pass. In general, the limiting amplifier tends to pass the middle region of the signals while attenuating the upper and/or lower signals. As described, a limiting amplifier has extremely variable and non-linear gain, and this gain may be a function of the amplitude of the input signal. Typically, low amplitude signals see a lot of gain, which increases signal edge rate and “squares up” the signal. Typically, large amplitude signals see effectively way less gain because the limiting amplifier has a maximum high output level and a maximum low output level that it can achieve. For the PAM4 and/or PAM8 signals, the switch **600** sends the voltage signals to a linear amplifier **620** (or substantially linear or non-linear, and more generally a non-limiting amplifier). In general, a linear amplifier maintains the eye pattern of the PAM4 and/or PAM8 signals unlike a limiting amplifier, and a limiting amplifier accentuates the transitions between 0 and 1 of the NRZ signals unlike a linear amplifier.

[0031] The output of the limiting amplifier **610** or the linear amplifier **620** is provided to a digital processor **630**, such as a field programmable gate array or an application specific integrated circuit, for receiving the input signal, decoding the signal levels, and processing the resulting data. The processor **630** may include a de-serializer **640** that receives the serialized 0's and 1's and forms a set of bytes or otherwise which are parallel in nature. The processor **630** may include an analog-to-digital converter **650** that receives each of the amplitudes of the different levels, converts the level to an associated digital signal, and forms a set of bytes or otherwise which are parallel in nature. Accordingly, when the input signal is switched by the switch **600** between a NRZ signals and a PAM4 and/or PAM8 signal, the FPGA **630** is likewise switched between the de-serializer **640** and the analog to digital converter **650**, so that the appropriate signals are processed.

[0032] Referring to FIG. **8**, in another embodiment, the output of stage 2 may be processed by a preamplifier **800** (e.g., linear or non-linear) the output of which is provided to a FPGA **810**. The FPGA **810** may include a switch **820** which selectively provides the pre-amplified signals to either a de-serializer **830** or an analog-to-digital converter **840**, in a manner akin to FIG. **6**.

[0033] In another embodiment, a preamplifier may be included together with an analog to digital converter that is used for both the NRZ and the PAM4 and/or PAM8 signaling. In this case, the sensitivity may tend to be lower than desired for the NRZ. Depending on the particular implementation, a link budget that is available for the Optical Distribution Network (ODN) loss, which includes fiber and passive splitting losses, may be sufficient to support lower sensitivity for the NRZ while also supporting the PAM4 and/or PAM8.

[0034] The FPGA may include digital processing, that includes a clock recovery, as desired. Further, the OLT may include the same type of configuration as the ONU, described above.

[0035] Referring to FIG. **9**, the OLT and/or the ONU may include a laser **900** together with a laser driver **910** that modulate an optical signal **920** that is transmitted through the optical fiber **930**. Referring also to FIG. **10**, the laser **900** is operated based upon being provided a current input **1000** which includes a corresponding optical power output **1010** from the laser **900**. The response curve of the laser **900** is typically relatively flat until a knee **1020** is reached, corresponding to a bias current level **1030**. With a bias current being applied at the bias current level **1030** the output of the laser remains zero or substantially zero. A modulation current **1040** may be selectively provided in addition to the bias current level **1030**. With a selected modulation current **1040** being provided a desired power output **1010** may be selected. In this manner, with the bias current “on” and the modulation current “on”, a high-power output **1010** is achieve normally referred to as a binary “1”. In this manner, with the bias current “on” and the modulation current “off”, a lower power output **1010** is achieve normally referred to as a binary “0”. Also, with the bias current “off” and the modulation current “off”, a lower power output **1010** is achieve normally referred to as a binary “0”, though for stable operation often the bias current remains on while optical modulation is occurring.

[0036] Referring again to FIG. **9**, the laser driver **910** may include a bias current driver **940** that selectively provides a bias current **942** to the laser **900**. The bias current driver **940** may be selectively enabled by one or more control signals **944** from the FPGA **950**. The laser driver **910** may include a modulation current driver **960** that selectively provides a modulation current **962** to the laser **900**. The modulation current driver **940** may be selectively enabled by one or more control signals **964** from the FPGA **950**. Based upon the selective enabling of the bias current driver **940** and the modulation current driver **960**, a suitable current level may be provided to the laser **900** to modulate the optical signal **920** in a manner to provide a NRZ signal. By way of example, the laser driver **910** may be suitable for 10G-PON.

[0037] To provide a multi-level signal, such as one suitable for PAM4 and/or PAM8 signaling, the modulation current driver could be designed to be suitable for providing multiple levels of output. However, including a multi-level current driver tends to require relatively complicated electronics, with the current driver being tuned to provide relatively accurate signal at a plurality of different levels, which is more prone to error than providing a more binary set of outputs.

[0038] Referring to FIG. **11**, the OLT and/or the ONU may include a laser **1100** together with a laser driver A **1110** that modulate an optical signal A **1120** that is transmitted through the optical fiber **1130**. The laser driver A **1110** may include a bias current driver A **1140** that selectively provides a bias current A **1142** to the laser **1100**. The bias current driver A **1140** may be selectively enabled by one or more control signals A **1144** from the FPGA **1150**. The laser driver A **1110** may include a modulation current driver A **1160** that selectively provides a modulation current A **1162** to the laser **1100**. The modulation current driver A **1140** may be selectively enabled by one or more control signals A **1164** from the FPGA **1150**. Based upon the selective enabling of the bias current driver A **1140** and the modulation current driver A **1160**, a suitable current level may be provided to the laser **1100** to modulate the optical signal **1120** in a manner to provide a NRZ signal. By way of example, the laser driver A **1110** may be suitable for 10G-PON.

[0039] The OLT and/or the ONU may include the laser **1100** together with a laser driver B **1112** that modulate the optical signal **1120** that is transmitted through the optical fiber **1130**. The laser driver B **1112** may include a bias current driver B **1170** that selectively provides a bias current B **1172** to the laser **1100**. The bias current driver B **1170** may be selectively enabled by one or more control signals B **1174** from the FPGA **1150**. The laser driver B **1112** may include a modulation current driver B **1180** that selectively provides a modulation current B **1182** to the laser **1100**. The modulation current driver B **1180** may be selectively enabled by one or more control signals B **1184** from the FPGA **1150**. Based upon the selective enabling of the bias current driver B **1170** and the modulation current driver B **1180**, a suitable current level may be provided to the laser **1100** to modulate the optical signal **1120** in a manner to provide a NRZ signal. By way of example, the laser driver B **1112** may be suitable for 10G-PON.

[0040] The FPGA may selectively use either the laser driver A **1110** or the laser driver B **1112** to provide 10G-PON optical signals, with a backup laser driver in the event one of the laser drivers become non-operational. In addition, by the selective use of the laser driver A **1110** in combination with the laser driver B **1112**, a set of four different currents may be provided to the laser **1110**.

[0041] Referring also to FIG. **12**, the four different currents that may be selectively provided to the laser **1110** include, (1) the bias current A **1142**; (2) the modulation current A **1162**; (3) the bias current B **1172**; and (4) the modulation current B **1182**. Various combination of the four different currents levels may be selectively provided to the laser **1110**, such as for example, to provide four different output levels from the laser **1110** which in turn provide four different power levels for the optical signal **1120**, [0042] 0,0 optical signal level: [0043] the bias current A **1142** “on”, [0044] the modulation current A **1162** “off”, [0045] (3) the bias current B **1172** “off”, [0046] (4) the modulation current B **1182** “off”. [0047] 0.1 optical signal level: [0048] the bias current A **1142** “on”, [0049] the modulation current A **1162** “on”, [0050] (3) the bias current B **1172** “off”, [0051] (4) the modulation current B **1182** “off”. [0052] 1,0 optical signal level: [0053] the bias current A **1142** “on”, [0054] the modulation current A **1162** “on”, [0055] (3) the bias current B **1172** “on”,

[0056] (4) the modulation current B **1182** “off”. [0057] 1,1 optical signal level: [0058] the bias current A **1142** “on”, [0059] the modulation current A **1162** “on”, [0060] (3) the bias current B **1172** “on”, [0061] (4) the modulation current B **1182** “on”.
[0062] The values of the respective modulation and bias currents are selected so that they provided the desired power output from the laser. For example, the bias current A may be different than the bias current B. For example, the modulation current A may be different than the modulation current B. For example, the bias current A may be different than the modulation current B. For example, the bias current B may be different than the modulation current A. For example, each of the currents may be different than any of the others. Moreover, the selection of the current levels is preferably based upon optical power output profile of the laser, which is especially suitable for a non-linear profile. Additional laser drivers may be included for additional levels of PAM modulation. For example, with three laser drivers PAM8 modulation may be achieved.
[0063] Moreover, each functional block or various features in each of the aforementioned embodiments may be implemented or executed by a circuitry, which is typically an integrated circuit or a plurality of integrated circuits. The circuitry designed to execute the functions described in the present specification may comprise a general-purpose processor, a digital signal processor (DSP), an application specific or general application integrated circuit (ASIC), a field programmable gate array (FPGA), or other programmable logic devices, discrete gates or transistor logic, or a discrete hardware component, or a combination thereof. The general-purpose processor may be a microprocessor, or alternatively, the processor may be a conventional processor, a controller, a microcontroller or a state machine. The general-purpose processor or each circuit described above may be configured by a digital circuit or may be configured by an analogue circuit. Further, when a technology of making into an integrated circuit superseding integrated circuits at the present time appears due to advancement of a semiconductor technology, the integrated circuit by this technology is also able to be used.
[0064] It will be appreciated that the invention is not restricted to the particular embodiment that has been described, and that variations may be made therein without departing from the scope of the invention as defined in the appended claims, as interpreted in accordance with principles of prevailing law, including the doctrine of equivalents or any other principle that enlarges the enforceable scope of a claim beyond its literal scope. Unless the context indicates otherwise, a reference in a claim to the number of instances of an element, be it a reference to one instance or more than one instance, requires at least the stated number of instances of the element but is not intended to exclude from the scope of the claim a structure or method having more instances of that element than stated. The word “comprise” or a derivative thereof, when used in a claim, is used in a nonexclusive sense that is not intended to exclude the presence of other elements or steps in a claimed structure or method.

Claims

1-15. (canceled)
16. An optical network unit for an optical network comprising: (a) a light sensitive diode suitable to sense light from said optical network and provide a first output in response thereto; (b) a transimpedance amplifier that receives said first output and provides a second output in response thereto; (c) a switch selectively providing said second output to a first amplifier or a second amplifier; (d) said first amplifier receiving said second output and amplifying said second output based upon a limiting amplifier to provide a limited amplified output; (e) said second amplifier receiving said second output and amplifying said second output based upon a non-limiting amplifier to provide a non-limited amplified output; (f) a processor selectively receiving either of said limited amplified output and said non-limited amplified output for subsequent processing.
17. The optical network unit of claim 16 wherein said light sensitive diode includes at least one of a

positive-intrinsic-negative diode and an avalanche photodiode.
18. The optical network unit of claim 16 wherein said switch is controllable by software.
19. The optical network unit of claim 16 wherein said non-limiting amplifier is a substantially linear amplifier.
20. The optical network unit of claim 16 wherein said switch provides NRZ based second output to said first amplifier.
21. The optical network unit of claim 16 wherein said switch provides PAM based second output to said second amplifier.
22. An optical network unit for an optical network comprising: (a) a conversion module that receives an optical signal from said optical network and in response thereto provides a voltage output; (b) a switch selectively providing said voltage output to a first amplifier or a second amplifier; (c) said first amplifier receiving said voltage output and amplifying said voltage output based upon a limiting amplifier to provide a limited amplified output; (d) said second amplifier receiving said voltage output and amplifying said voltage output based upon a non-limiting amplifier to provide a non-limited amplified output; (e) a processor selectively receiving either of said limited amplified output and said non-limited amplified output for subsequent processing.
23. An optical network unit for an optical network comprising: (a) said optical network unit including a laser providing an optical output at a selected frequency; (b) a first laser driver that includes a first bias current source interconnected with said laser to provide a first bias current thereto and a first modulation current source interconnected with said laser to provide a first modulation current thereto; (c) a second laser driver that includes a second bias current source interconnected with said laser to provide a second bias current thereto and a second modulation current source interconnected with said laser to provide a second modulation current thereto; (d) said laser driver controller configured in a first configuration to selectively cause to be provided at least one of said first bias current and said first modulation current to said laser by selection of at least one of said first bias current source and said first modulation current source thereby providing two different current levels to said laser, without selecting said second bias current source nor said second modulation current source of said second laser driver; (e) said laser driver controller configured in a second configuration to selectively cause to be provided at least one of said first bias current, said first modulation current, said second bias current, and said second modulation current to said laser by selection of at least one of said first bias current source, said first modulation current source, said second bias current source, and said second modulation current source thereby providing four different current levels to said laser.
24. The optical network unit of claim 23 wherein said first laser driver is capable of providing said first bias current and said first modulation current to said laser in a manner to provide 10G-PON signals based upon NRZ.
25. The optical network unit of claim 23 wherein said second laser driver is capable of providing said second bias current and said second modulation current to said laser in a manner to provide 10G-PON signals based upon NRZ.
26. The optical network unit of claim 23 wherein the combination of said first laser driver and said second laser driver are capable of providing current to said laser in a manner to provide 25G-PON signals based upon PAM4.
27. The optical network unit of claim 23 wherein the combination of said first laser driver and said second laser driver are capable of providing current to said laser in a manner to provide 50G-PON signals based upon PAM8.
28. The optical network unit of claim 23 wherein the combination of said first laser driver and said second laser driver are capable of providing current to said laser in a manner to provide G-PON signals based upon PAM.
29. An optical network unit for an optical network comprising: (a) a light sensitive element suitable to sense light from said optical network and provide a first output in response thereto; (b) a

transimpedance element that receives said first output and provides a second output in response thereto; (c) a control s selectively providing said second output to a first amplifier or a second amplifier; (d) said first amplifier receiving said second output and amplifying said second output based upon a limiting amplifier to provide a limited amplified output; (e) said second amplifier receiving said second output and amplifying said second output based upon a non-limiting amplifier to provide a non-limited amplified output; (f) a processor selectively receiving either of said limited amplified output and said non-limited amplified output for subsequent processing.

30. The optical network unit of claim 16 wherein said optical network is a passive optical network.

31. The optical network unit of claim 22 wherein said optical network is a passive optical network.

32. The optical network unit of claim 23 wherein said optical network is a passive optical network.

33. The optical network unit of claim 19 wherein said optical network is a passive optical network.