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The Least Stand-By Power System Using a 1x7 All-Optical Switch

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1. Introduction

According to the explosive popularization of the internet, the infrastructure for a broadband optical network becomes very important. The most serious problem, however, for a broadband network is large energy consumption of the infrastructure. For example, over 1% of generated energy is consumed in Japan, and in the near future it will become over 10 %. An energy-saving measure, therefore, is energetically promoted in all of Japan including the government, industry and universities. Namely, an effort to save energy in homes is important, because about 50 million families are living in Japan. With the spread of "fibre to the home (FTTH)", in the future, several services such as high definition television (HDTV), will use the Internet, which will become a larger energy consumer in homes. Equipment for FTTH, which include electrical-switched devices, such as HUBs and Routers, are on stand-by for communication. If the energy consumption in every home decreased by 10%, it will bring about surprising energy savings.

An optically gated optical switch without any electric parts is composed of several lenses and a dye-dissolved high-boiling-point solvent, where the absorbance of the dye for the signal light is lower than 0.1 and for the gating light is over 3. The most versatile advantage of this system is easy selection of the wavelengths for both the gating light and the signal light. The signal light, which is transparent to the dye-solution, is refracted by a temporally formed microscopic thermal-lens (region with lower refractive index) that is locally heated around a focal point by the irradiation of the gating light (Tanaka et al., 2007; Tanaka et al., 2010, Ueno et al., 2003, Ueno et al., 2007, Tanaka et al., 2010).

Here, we have developed a local telecommunications system for FTTH using an optically gated optical switch composed of only optical parts. This system is suitable for a local-area network within a home. An optical-fibre line from a telephone office is directly connected to a 1x7 optically gated optical switch (Fig. 1). A terminal unit (optical interface; Opt-I/F) of the present system connected directly between a 1x7 optically gated optical switch (all-optical switch) and a PC, TV, IP-phone and so on, plays the role of a controller of 1x7 optically gated optical switch for the light-path switching of a PC, and so on. This unit sends a command to another terminal unit for negotiation among the terminal units using a 980 nm line. All terminal units connected to a 1x7 optically gated optical switch via a reflection-type optical star coupler in a 980 nm line can establish completely independently collision-free communication among the terminal units.

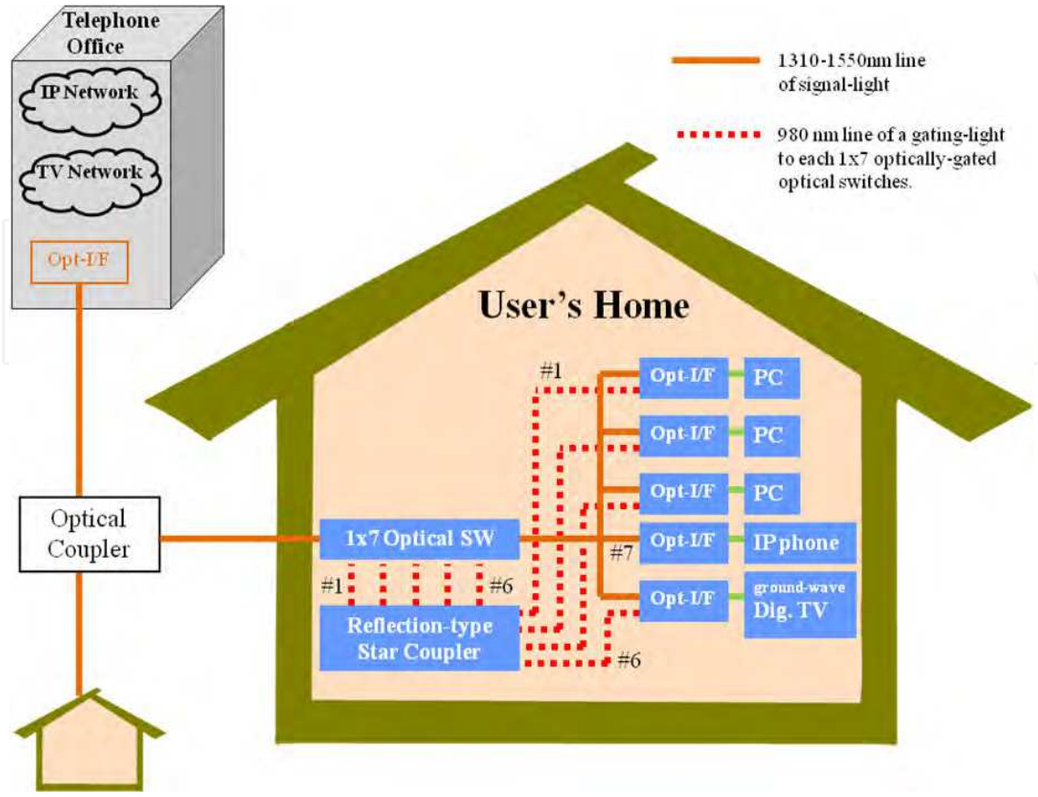


Fig. 1. Block diagram of the present system. The solid line is the optical fibre for data communication (wavelength of 1310-1550 nm), and the dashed line is the optical fibre for the control of a 1x7 all-optical switch (wavelength of 980 nm). The 1x7 optically gated optical switch (1x7 all-optical switch) is connected directly to the optical interface (Opt-I/F).

2. Current system

The current system concerning the least stand-by power by using a 1x7 all-optical switch is composed of a 1x7 optically-gated optical switch, 7 optical interfaces for each user terminal and a reflection-type star coupler (Fig. 1). The key equipment of the least stand-by power system is both a control system and an optically-gated optical switch, which is controlled directly by each user terminal ordering to occupy the circuit by selecting the 1x7 optically-gated optical switch. To avoid collisions among the user terminals, a control system is employed.

2.1 1x7 all-optical switch

The most advanced feature of an optically gated optical switch without any electrical parts is an easy selection of both the gating light and the signal light by selecting a suitable dye for a transparent wavelength region as the signal light and a large absorption wavelength region as the gating light. This switch is composed of four important optical components. The 1st component involves two-types of 7-bundled optical-fibres, both for incidence and collecting. The incidence optical fibre is composed of a central optical fibre for the signal light and six outer optical fibres for the gating

light. All of the collecting optical fibre is for the signal light (details of these fibres are explained in section 2.1.3). The 2nd is a dye cell made of quartz filled with a high-boiling-point solvent and a dissolved dye for the absorbing gating light. The medium for operating an optical switch is perfectly dehumidified and deoxygenated, which brings long-life operation, even under light-irradiation (details of preparation are explained in section 2.1.2). The 3rd is a prism of a hexagonal truncated pyramid, located between a collecting lens for the dye-cell and a collimating lens for the collecting fibre. This prism brings a higher coupling efficiency to the collecting fibre. The 4th are lenses focusing both the signal light and the gating light from an incidence optical fibre to a dye-cell. Another two pairs of lenses collect signal light from the dye-cell, and focuses it to the collecting optical fibre.

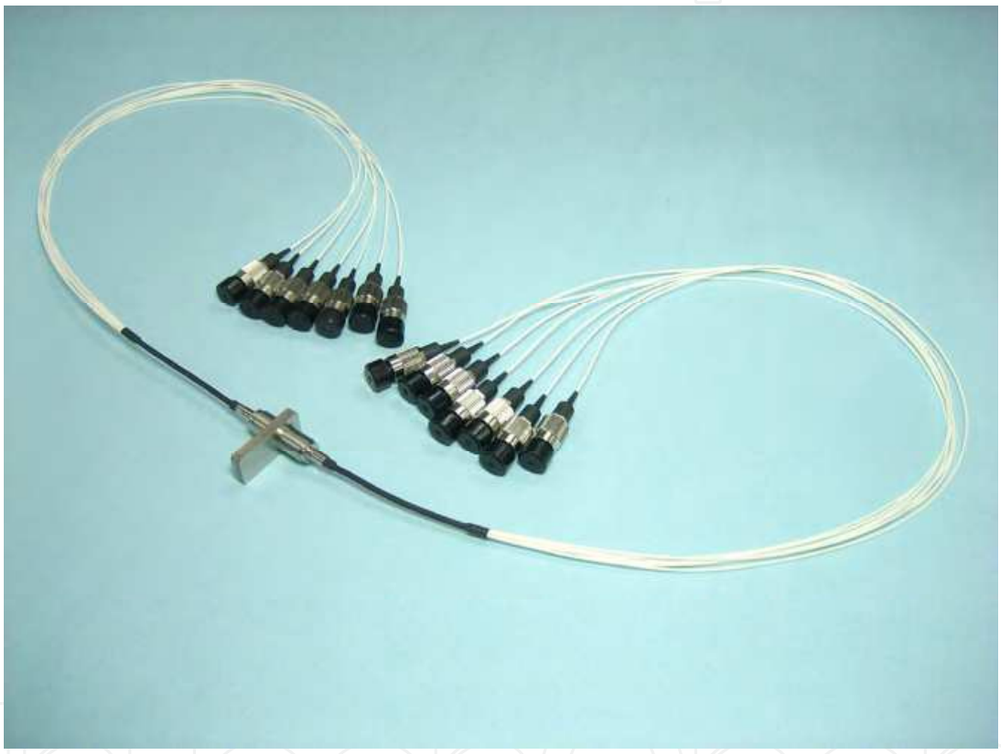


Fig. 2. An external view of 1x7 optically-gated optical switch.

The typical performance of the present 1x7 optically gated optical switch is summerized in Table 1. Both the insertion loss and the crosstalk are the mean value of the 7 exit ports.

Parameters	Specifications
Wavelength	1310-1490 nm
Gating light	980 nm
Insertion loss	6.5 dB min.
Crosstalk	34 dB min.
Dimension	95×30×12mm

Table 1. Typical performance of a 1x7 optically gated optical switch using different axis configurations under a gating light power of 20~35 mW.

2.1.1 Principle of an optically gated optical switch

We have developed two types of optically gated optical switches: coaxial configuration of the signal and gating light (Tanaka et al., 2007, Ueno et al., 2007), and a different axis configuration of the signal and gating light (Ueno et al., 2010). The former having a coaxial configuration can operate under a lower gating power, because the signal light is refracted at a region just heated by the gating light. This configuration possesses, however, a lower coupling efficiency to a collecting optical fibre because of ring-shaped refracted light. The later configuration of the different axis type is the currently adopted where the 1x7 optically gated optical switch (shown in Fig. 2) possesses large advantages. The basic operation of a different axis type switch is explained using a 1x2 optical switch (Fig. 3).

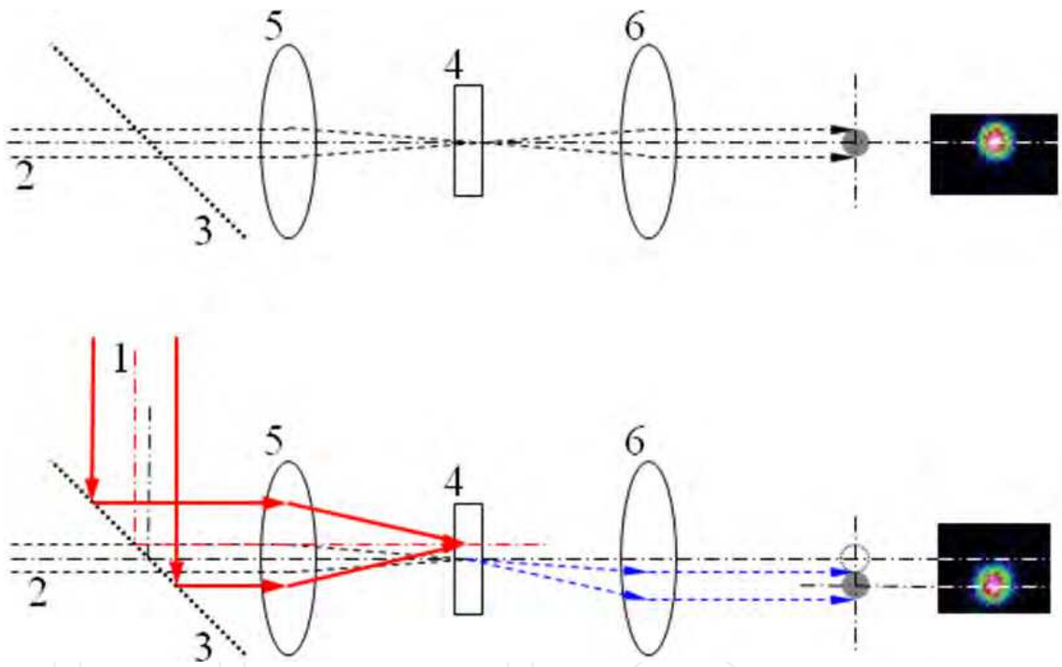


Fig. 3. Basic operation of a different axis configuration. Gating light (1) is mixed with the signal light (2) using a dichromatic mirror (3), and is introduced into a dye cell (thermal-lens forming element)(4) via a focusing non-spherical lens (5). The gating light and the signal light have different axis configurations. The switched light is collimated by a lens (6). In the case with gating light, the switched light is projected to a shifted position.

The reason why both the signal light and the gating light simultaneously pass through a dye-cell is due to the dichromatic property of the dye solution. An organic dye, generally, exhibits a relatively sharp absorption spectrum. An organic dye of "YKR3080", for example, exhibits both large absorption around a wavelength of 1000 nm and small absorption longer than 1200 nm, as shown in Fig. 4. This dichromatic property of an organic dye allows easy selection of both the signal and gating wavelength of light for present in the optically gated optical switch.

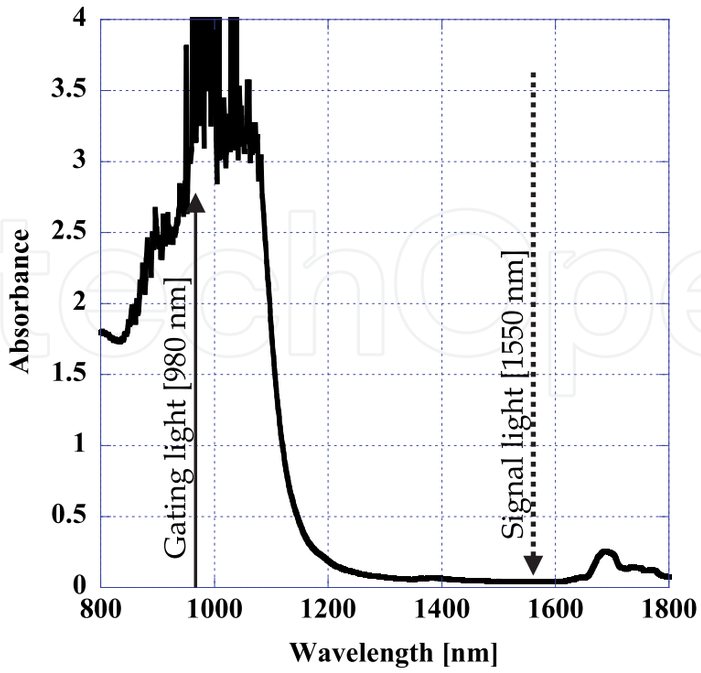


Fig. 4. Absorption spectrum of 0.2 wt%-YKR3080/solvent "S" in a 0.5 mm quartz cell for a 980 nm gating. The wavelength of the signal light is 1310-1550 nm.

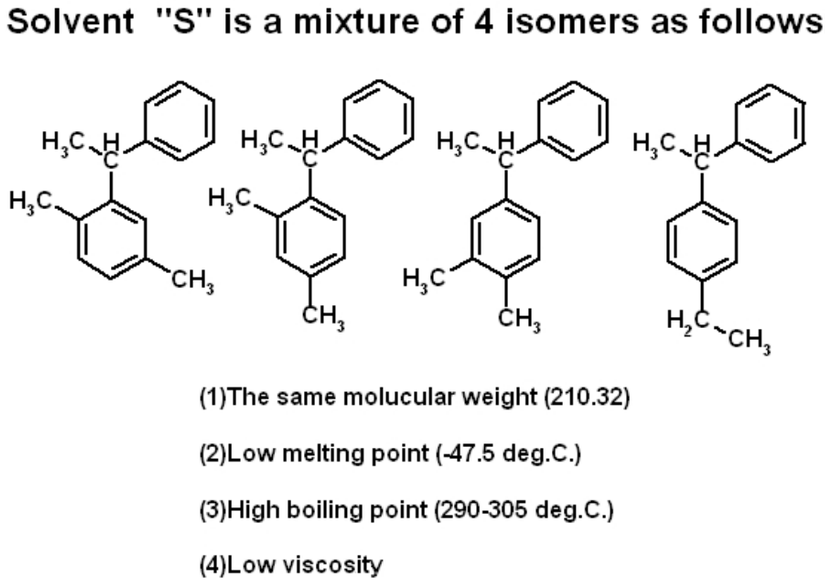


Fig. 5. Solvent "S" is composed of 4 kinds of structural isomers with the same molecular weight: 1-Phenyl-1-(2,5-xylyl)ethane, 1-Phenyl-1-(2,4-xylyl)ethane, 1-Phenyl-1-(3,4-xylyl)ethane and 1-Phenyl-1-(4-ethylphenyl)ethane.

Another important component of the dye solution is the solvent. Here, solvent "S" is employed for a medium to form a thermal lens in the dye cell. When the gating light is

focused into a dye solution, molecules of YKR3080 absorb energy of the irradiated light, which causes an increase in the temperature of the dye by thermal relaxation of the excited state. The transferred energy from the dye-molecule to solvent "S" (Fig. 5) around the focal point of the gating light forms a high-temperature region around the focal point of the gating light. As a relation between the refractive index (n) of solvent "S" and the temperature (T; deg.) is expressed as Equation (1); the refractive index of solvent "S" at the heated region become lower than the surrounding region (Hiraga et al., 2008).

$$n = 1.5742 - 0.00048259\ T \quad (1)$$

This is the reason the signal light is refracted at around the focal point of the gating light. It is difficult to determine the exact shape of the region at a lower refractive index, because the dye solution has large absorbance at around 3 and the "Beer-Lambert law". We suppose the shape to be a triangular pyramid as shown in Fig. 6. We are now trying to measure the local temperature using the Raman-scattering method (Hiraga et al., 2010). In the case of different-axis configuration, the axis of the gating light (1) to be at about 40 μm parallel translation from the signal light (2) as shown in Fig. 6.

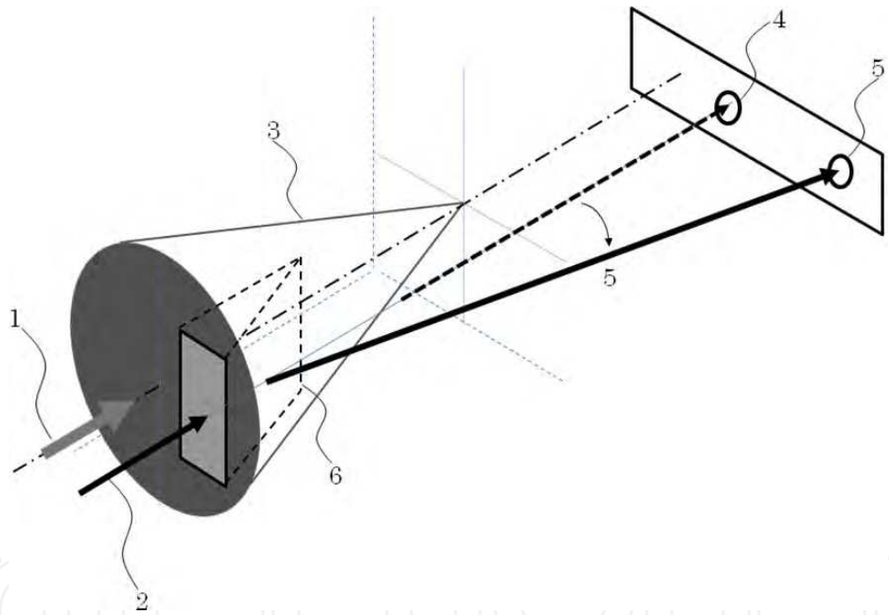


Fig. 6. Refraction of the signal light by an optical gating under different axis configurations of the gating light with the signal light: 1, gating light; 2, signal light; 3, thermal lens; 4, non-refracted light without gating light; 5, refracted light with gating light; 6, imaginary wedge-shaped thermal lens.

Fig. 7 shows a schematic drawing of the optics of the 1x7 optically gated optical switch. It is composed of 6 kinds of optical parts. The incidence 7-bundled optical fibre (1) is employed for both the signal light and the gating light, where the centre-to-centre distance of the core is 40 μm. The collecting 7-bundled optical fibre (6) is employed for only signal light, where centre-to-centre distance of the core is 250 μm. A prism of a hexagonal truncated pyramid (4) set up between the focusing lens (5) and the collecting lens (6) is employed for enhancing the coupling efficiency to a collecting 7-bundled optical fibre (6).

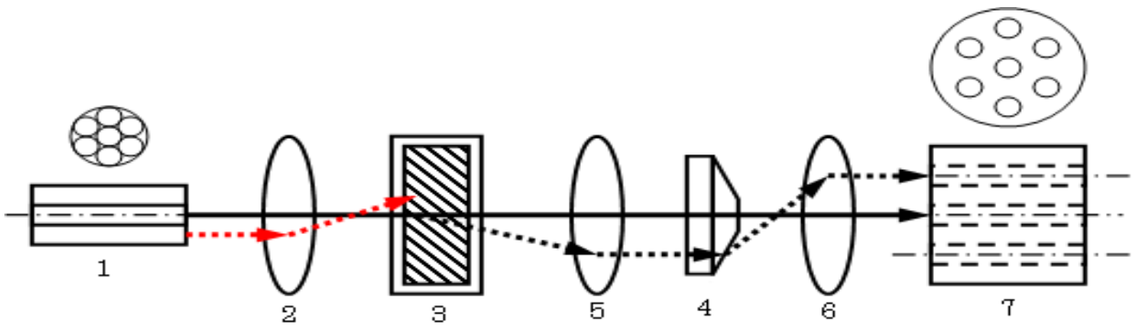


Fig. 7. Schematic drawing of the optics of the 1x7 optically gated optical switch: 1, incidence 7-bundled optical fibre; 2, focusing lens; 3, dye solution; 4, prism of hexagonal truncated pyramid; 5, focusing lens; 6, collecting 7-bundled optical fibre.

2.1.2 A dye-cell as one of the most important parts

The most important residual component for degradation of the dye solution in a quartz cell is both oxygen and water. Therefore, a dye-cell made of a quartz capillary is prepared in a vacuum glove box. First, a solvent "S" is dried using a molecular sieve for several hours. Second, a freeze-pump-thaw treatment of a dye-dissolved solution is employed several tens of times in a vacuum glove box. Next, a quartz capillary of outer diameter of 1 mm, inner diameter of 0.5 mm and 25 mm length is sealed at one end after being dried in a vacuum groove box. A dye of YKR3080 dissolved in a solvent "S" with a high concentration near saturation is charged into the capillary by a micro-syringe. Another end of the capillary is sealed temporally by glue in the vacuum glove box. At the outside of the glove box, another end of the capillary is sealed by melting quartz using a micro burner (Fig. 8).



Fig. 8. Micro cell made of a quartz capillary: outer diameter of 1 mm, inner diameter of 0.5 mm and 25 mm length. Both the purification and sealing processes are performed in an ultra-pure vacuum glove box.

2.1.3 A 7-bundled optical fiber

Two types of a 7-bundled optical fibre are developed: one is for incidence and the other is for collecting. The incidence optical fibre is composed of a centre fibre for the signal light and 6-outer fibres for the irradiating gating-light to a dye cell. The diameter of the clad of a single mode optical fibre for optical communication is reduced from 125 μm to 40 μm, so as to reduce the centre-to-centre distance of the core to 40 μm in a 7-bundled optical fibre as

shown in Fig. 9(a); 7 optical fibres are assembled as the closest packing configuration in a sleeve of inner diameter 120 μm.

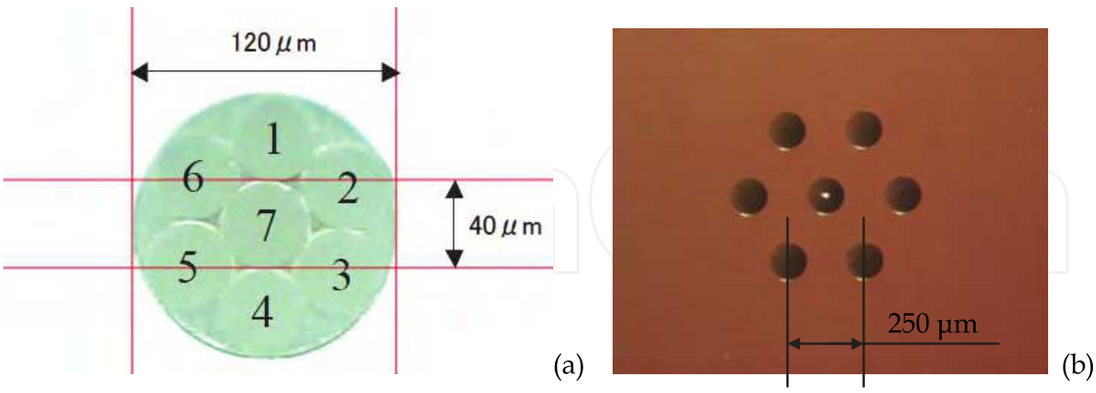


Fig. 9. Incidence (a) and collecting (b) 7-bundled optical fibre composed of a single-mode optical fibre (core diameter of about 10μm). Centre fibre of (b) is lightened.

The collecting optical fibre is composed of 7 optical fibres for the collecting signal light, where the centre-to-centre distance of the core is 250 μm; 7 optical fibres with a clad diameter of 125 μm are independently set up in a ferrule with 7 holes, as shown in Fig. 9(b).

2.1.4 A prism of hexagonal truncated pyramid for improving the throughput to the receiving optical fiber

A 3 mm diametre prism of the hexagonal truncated pyramid set up between the focusing lenses is employed for enhancing the coupling efficiency to a collecting 7-bundled optical fibre (Fig. 10). This prism brings rectangular incidence of refracted light from a dye-cell to a collecting optical fibre. The non-refracted signal light, i.e., in the case without the gating light, passes through a flat area of the centre top in the prism. The refracted signal light, in the case with gating light, passes through the side slope in the prism (one of the 6-polished surfaces).

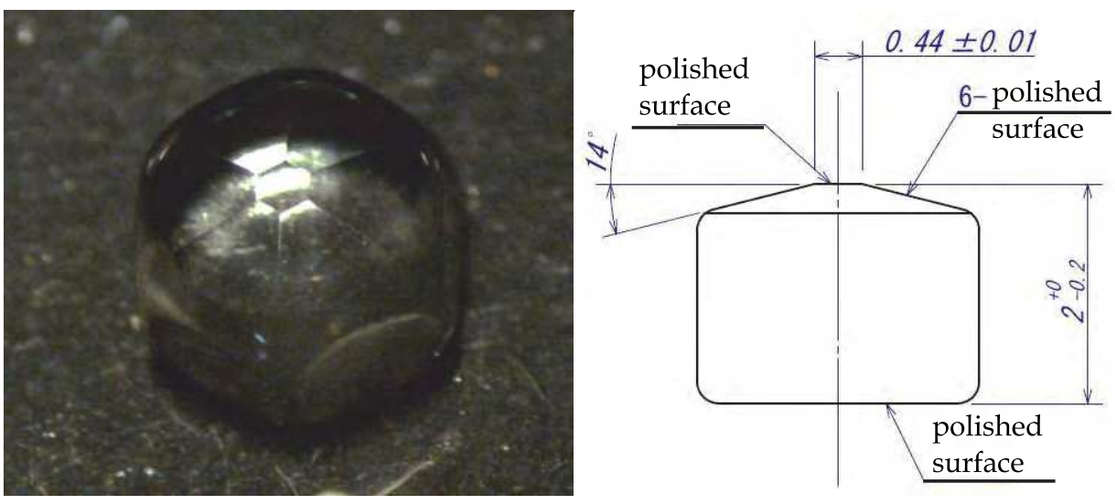


Fig. 10. Prism of a hexagonal truncated pyramid made by a glass-mould pressing method.

2.2 The least stand-by power system

The optical-fibre line from a telephone office is directly connected to a 1x7 optically gated optical switch (Fig. 1). A terminal unit (optical interface; Opt-I/F) of the present system is connected directly between a 1x7 optically-gated optical switch and a PC, TV, IP-phone and so on. It serves as a controller of the 1x7 optically gated optical switch for light-path switching of the PC and so on. This unit sends a command to another terminal unit for negotiation among the terminal units using a line having a wavelength of 980 nm. All terminal units connected to a 1x7 optically gated optical switch via a reflection-type optical star coupler in the 980 nm line can establish completely independent collision-free communication among these terminal units.

Several functions of optical LAN of the present system connected to a telephone office are as follows (Fig. 11). The Ethernet of the electrical and optical performance is Tx of 1550 nm and Rx of 1310 nm, Filtering of data communication involves 1000 base-T, 100 base-T and serial communication, Communication of the control system for data communication, and The Measurement of energy consumption for each port.

Several functions of optical LAN of the present system connected to a PC, TV, IP-phone and so on are as follows. The Ethernet of the electrical and optical performance is Tx of 1310 nm and Rx of 1550 nm, Filtering of data communication involves 1000 base-T, 100 base-T and serial communication, Communication of the control system for data communication, The Measurement of energy consumption for each port, and Gating-light of 980 nm for controlling a 1x7 all-optical switch. Function of a reflection-type optical star coupler in 980 nm line is delivery of gating-light to each 1x7 optically-gated optical switches.

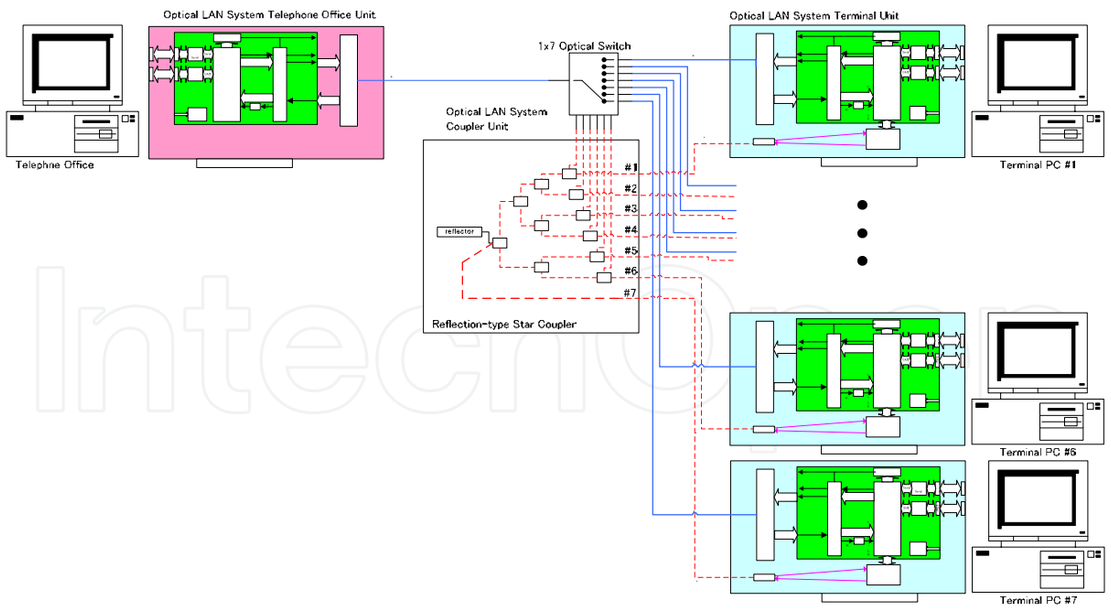


Fig. 11. Overview of the present system for demonstration. Left upper is a unit for establishing an IP Network、a TV network, and so on in a home network. Top middle is "Reflection-type Star Coupler" with the 1x7 optically-gated optical switch. Right blocks are 7 downstream units from the 1x7 optical switch located in a user's home.

An “Optical LAN System as a Telephone Office Unit” and a “Telephone Office PC” (left upper in Fig. 11) are a virtual unit for establishing an IP Network、TV network, and so on in the home network; 7 downstream units from a 1x7 optical switch are settled in a user’s home. An “Optical LAN System Coupler Unit” (top middle in Fig. 11) consists of a “Reflection-type Star Coupler”, which carries both communication among each “Terminal PC” and control of the 1x7 optical switch distributing gating light of 980 nm in a user’s home. Each “Terminal PC” communicates with each other using gating light of 980 nm via the “Optical LAN System Terminal Unit”. When one “Terminal PC” is ready to communicate using the circuit (a connected circuit is free from exclusiveness), an order is sent to select the 1x7 optically-gated optical switch using 980 nm light. Then, the circuit between the “Optical LAN System as a Telephone Office Unit” and the “Terminal PC” are occupied and begin to communicate. Using the present system, the idling “Terminal PC” is to shut down, which allows the least stand-by power system.

2.2.1 Setup of the system

The functional block of the present system in a user’s home, and categorised into three groups as shown in Fig. 12. The 1st is a continuously power supplied unit, such as a telephone, where a relatively slow transmission speed is allowed (blue block in Fig. 12). The 2nd is medium transmission-speed terminals, indicated as yellow, where both e-mail and network surveying is mainly used. The 3rd is high transmission-speed terminals, indicated as pink, where a dynamic (or moving) image is mainly used. The “Optical LAN System Telephone Office Unit” with a low speed I/F, which is always powered by the least energy takes part in controlling these three units. The other unit of both “Middle Speed I/F” and “High Speed I/F” is always stand-by, and working when communication is needed.

2.2.2 Operation of the present system

The initial state of the present system is through connection from the “Optical LAN System Telephone Office Unit” (left upper) to the “Optical LAN System Terminal Unit” (low speed I/F : blue block at right lower; continuously power supplied). Without any gating light in a 1x7 optically-gated optical switch, the optical path is automatically selected from an incidence port to a central port of the collecting optical fibre (exit side). The central port of the exit side in a 1x7 optically gated optical switch is connected to an “Optical LAN System Terminal Unit” (blue block at right lower; continuously power supplied). At this time, it is able to occupy a circuit using 980 nm light delivery from an “Optical LAN System Terminal Unit” to the other “Optical LAN System Terminal Unit” via an “Optical LAN System Coupler Unit”. By means of these negotiations, an order for occupying the circuit from each “Optical LAN System Terminal Unit” will be arranged by the “Optical LAN System Terminal Unit” (low speed I/F: blue block at right lower; continuously power supplied).

An “Optical LAN System Terminal Unit#1”(right upper one) output gating light from a 980 nm LD in the “Optical LAN System Terminal Unit#1” is used to occupy a circuit for communication. An “Optical LAN System Coupler Unit“ delivers gating light of 980 nm from the “Optical LAN System Terminal Unit#1“ to both a “1x7 Optical Switch“ and an “Optical LAN System Terminal Unit“ (low speed unit), which establish communiation of the “Optical LAN System Terminal Unit“. After finishing communication (data transfer)

against for “Optical LAN System Telephone Office Unit”, the “Optical LAN System Terminal Unit#1” broadcast to the “Optical LAN System Terminal Unit” end of communication using 980 nm light, releases the occupied circuit. By these procedures, the connection of the circuit becomes the initial state shown in Fig. 12. By the alternative action described above, each “Optical LAN System Terminal Unit”(#1~#6) can communicate alternatively to the “Optical LAN System Telephone Office Unit”.

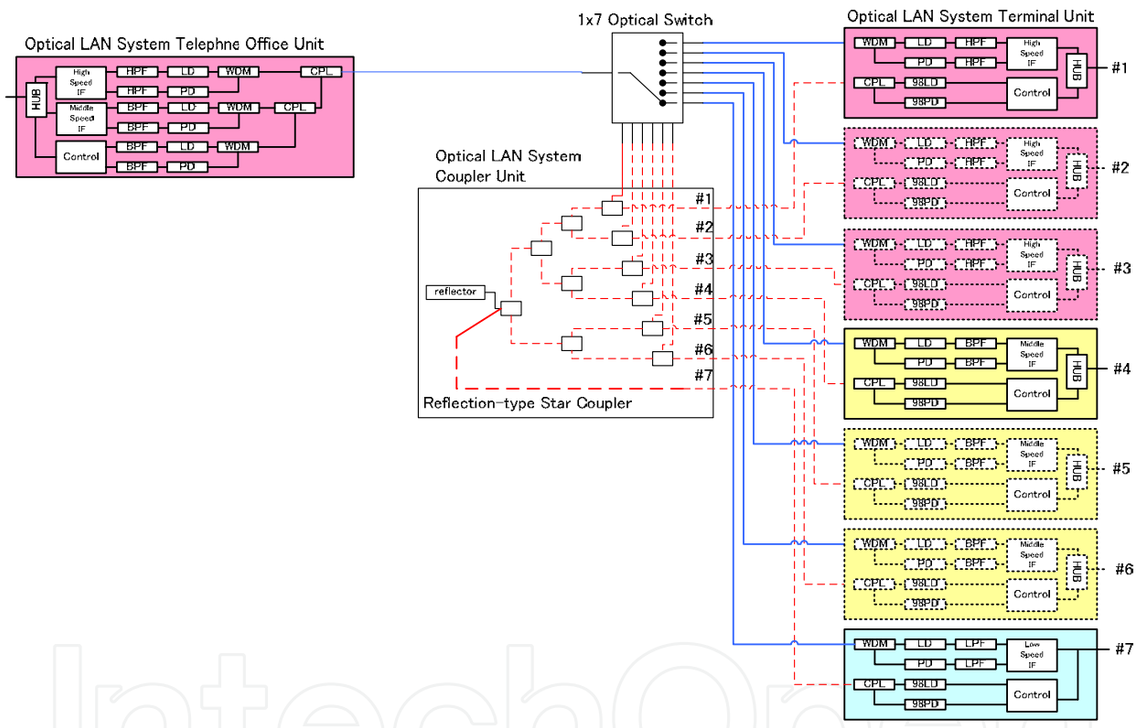


Fig. 12. Full system of the innovative least stand-by power equipment. The blue block at the right lower indicates a unit continuously supplied with power (low speed I/F). Three pink blocks at the right upper (high-speed I/F) and three yellow blocks at the right middle (middle-speed I/F) indicate users. The white block at the centre indicates a reflection-type star-coupler. The white block at the upper centre indicates an optically-gated optical switch. The pink block at the left upper indicates a unit in a telephone office.

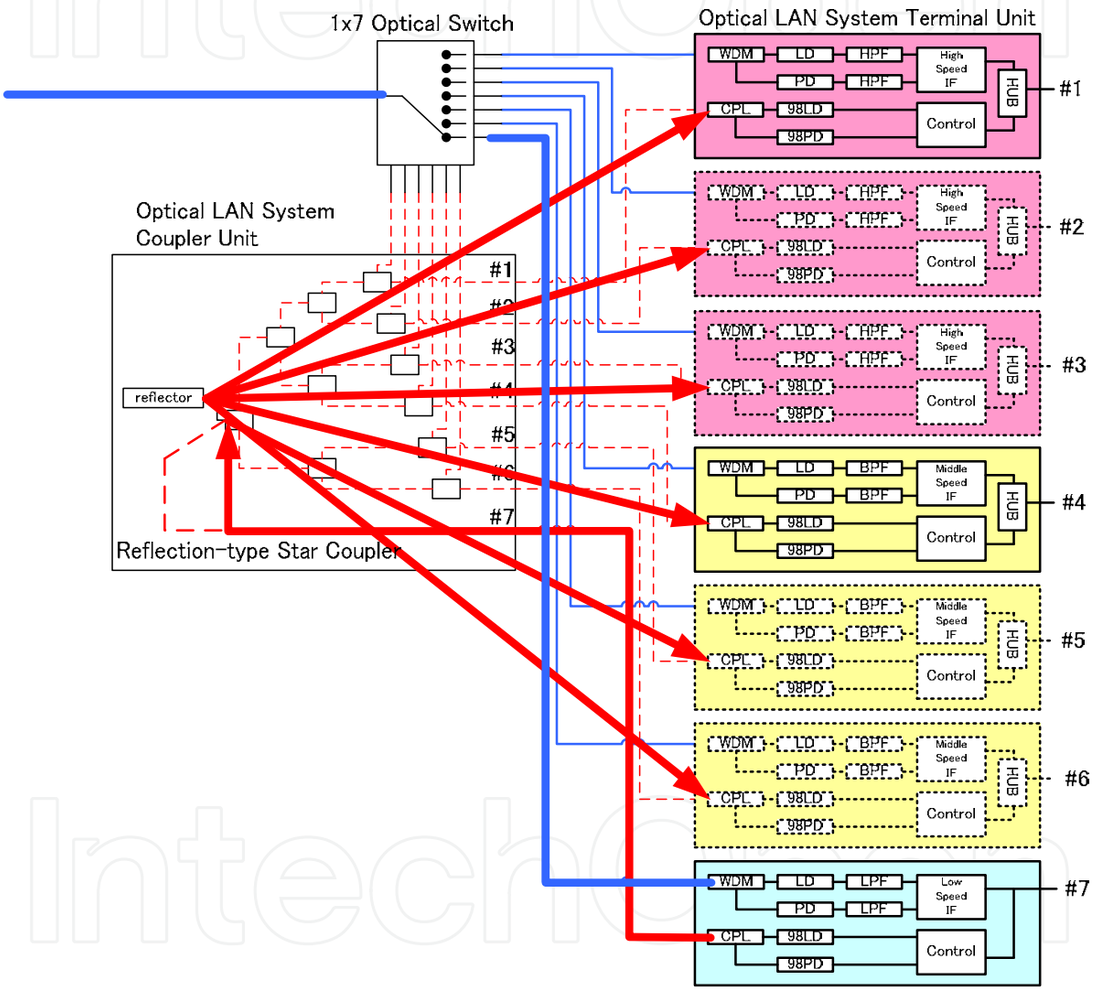


Fig. 13. First step of communication among an "Optical LAN System Terminal Unit" using 980 nm light.

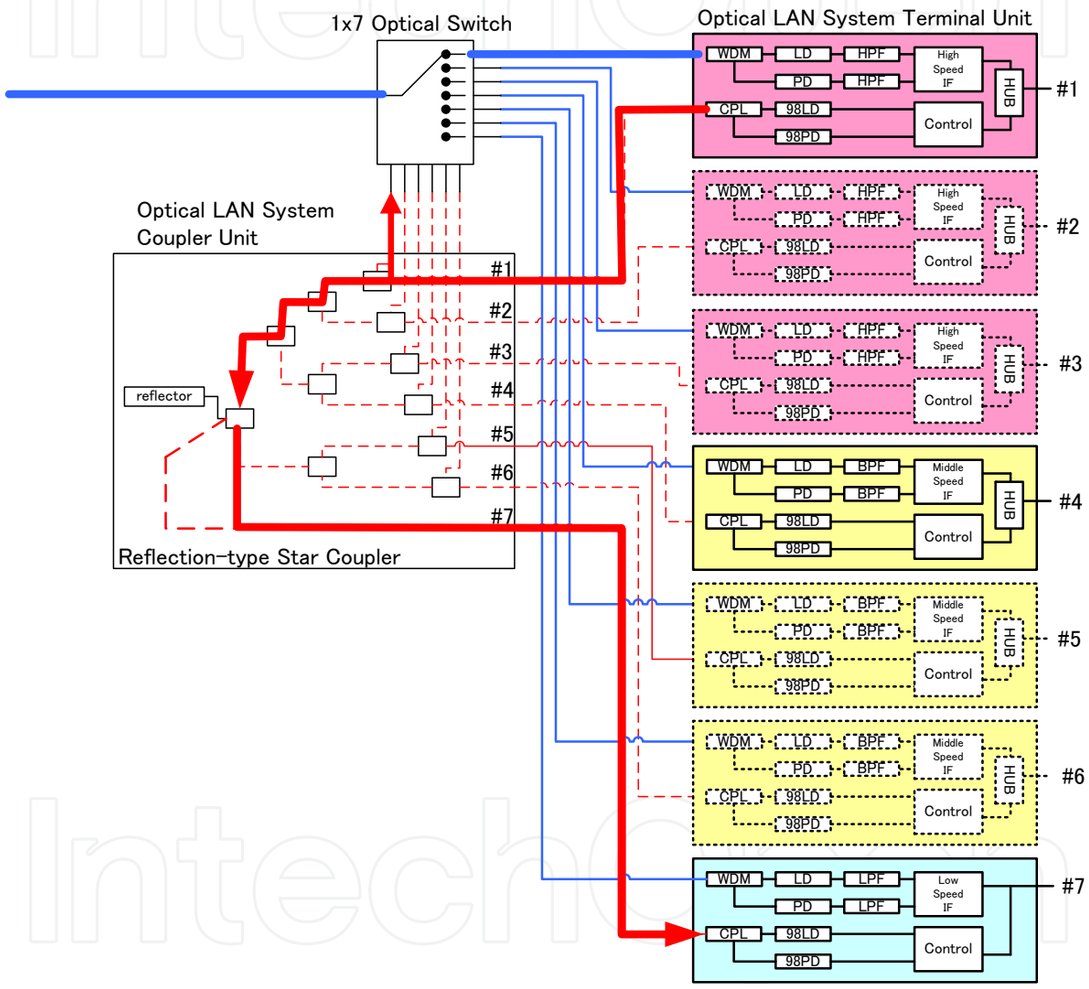


Fig. 14. Operation of communication between one "Optical LAN System Terminal Unit" and an "Optical LAN System Telephone Office Unit" using 980 nm light.

In Fig. 15, an external view of "The least stand-by power system using a 1x7 optically-gated optical switch" currently being developed is shown. The specifications of both the OLT (Optical Line Terminal) and the ONU (Optical Network Unit) are summarized in Table 2 and Table 3, respectively.

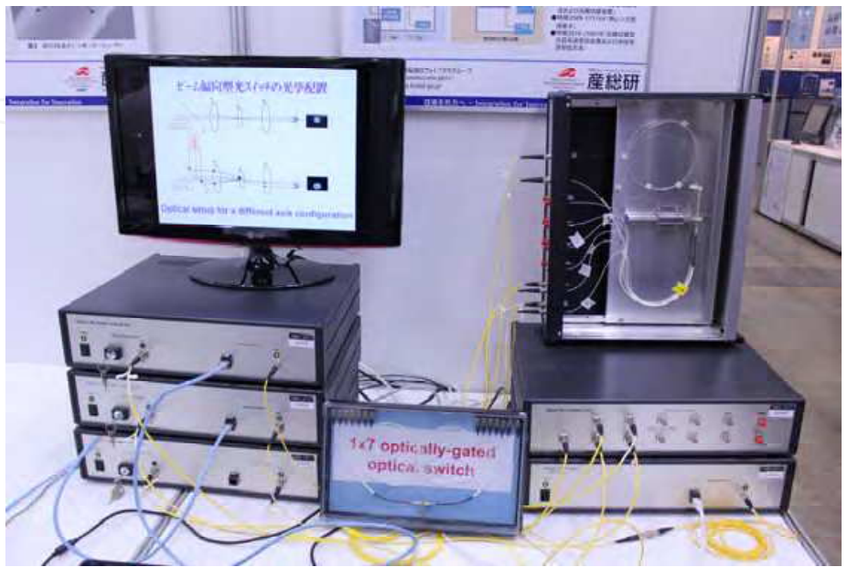


Fig. 15. External view of "The least stand-by power system using a 1x7 all-optical switch".

E/O Unit		
Electrical Interface	OLT Tx+/-	1250Mbps DATA_IN LVPECL SMA NRZ
Optical Interface	Wavelength	1310-1490 nm
	Output Power	≧+3.5dBm@Enable≦-39dBm@Disable
	Extinction Ratio	≧9dB
O/E Unit		
Electrical Interface	OLT RX+/-	1250Mbps DATA_OUT LVPECL SMA NRZ
Optical Interface	Wavelength	1310-1490 nm
	Min. Input Power	≦-30.0dBm
	Max. Input Power	≧-8.0dBm
	LOS Detection	≧-45.0dBm(Detection)≦-30.0dBm(Release)
Function		
Display	LED	Power Supply, LD, LOS
Switch	SW	Power Supply, LD
Lock	Key	LD Source
Others		
Controll Interface	USB	Rev. 2.0 full speed USB-B
	Controll Item	LD ON/OFF LOS Monitor
Power Supply	-	DC 5V, 0.8 W
Size	-	W210mm × D350mm × H99mm
Weight	-	2.5 kg

Table 2. Specifications of OLT (Optical Line Terminal) Optical Interface Unit.

E/O Unit		
Electrical Interface	ONU Tx+/-	1250Mbps DATA_IN LVPECL SMA NRZ
	Burst Enable	LVTTL High-Z Active-High
Optical Interface	Wavelength	1310-1490 nm
	Output Power	≧-0.5dBm@Enable≦-45dBm@Disable
	Extinction Ratio	≧9dB
O/E Unit		
Electrical Interface	ONU RX+/-	1250Mbps DATA_OUT LVPECL SMA NRZ
Optical Interface	Wavelength	1310-1490 nm
	Min. Input Power	≦-26.0dBm
	Max. Input Power	≧-3.0dBm
	LOS Detection	≧-44.0dBm(Detection)≦-26.0dBm(Release)
Function		
Display	LED	Power Supply, LD, LOS
Switch	SW	Power Supply, LD
Lock	Key	LD Source
Others		
Controll Interface	USB	Rev. 2.0 full speed USB-B
	Controll Item	LD ON/OFF LOS Monitor
Power Supply	-	DC 5V, 0.8 W
Size	-	W210mm × D350mm × H99mm
Weight	-	2.5 kg

Table 3. Specifications of ONU (Optical Network Unit) Optical Interface Unit.

3. Conclusion

A versatile optically gated optical switch using an organic dye is suitable for light-path switching in optical communication at various wavelengths of the signal light. The feature of utilizing a thermal-lens effect generated in a thin layer of a dye solution is possible to cover a wide range of wavelengths by varying the types of pigment. An organic dye for absorbing the gating light combined with a high-boiling solvent for forming a thermal lens is properly selected by choosing the wavelengths of both the gating light and the signal light. The formed thermal-lens in a dye solution is very small, which brings about high-speed switch of around 1 msec.

An epoch-making 1x7 optically-gated optical switch has been developed using both a 7-bundled optical fibre with a centre-core distance of 40 μm and a prism of a hexagonal truncated pyramid. Around 0.6 of the coupling efficiency of incidence light to a 7-bundled optical fibre and smaller than 40 dB of crosstalk for both incidence light have been achieved. Using the 1x7 optically-gated optical switch, we have developed a least stand-by power system as well. This system is located in a home, and is composed of the 1x7 optically gated optical switch and a reflection-type optical star coupler, which directly connects between an optical coupler from a telephone office and a PC, TV, IP-phone, etc. Using this system, the least stand-by power in the home will be achieved.

4. Acknowledgment

This work is a joint study of Norio Tanaka and Shigeru Takarada of Dainichiseika Color & Chemicals Mfg. Co., Ltd., Noriyasu Siga and Kazuya Ohta of Trimatiz, Ltd., Hirofumi Watanabe, Toshimasa Tamura and Keiji Negi of Inter Energy Co., Ltd. and Masaki Kubo of HIMEJI RIKA CO., LTD.. This study is supported by NEDO.

5. References

Hiraga, T.; Ueno, I.; Nagaeda, H.; Shiga, N.; Watanabe, H.; Futaki, S. & Tanaka, N. (2008). Development of an Optically gated Optical Switch using an Organic Dye - Applied to Local Telecommunication Technology. *Proceedings of SPIE*, Vol. 6891, No. 68910G, PP. 1-15.

Hiraga, T.; Ueno, I.;Siga, N.; Watanabe, H.;Futaki, S.; Kubo, M.; Takarada, S.;Tanaka, N. (2011). Switching mechanism of an optically-gated optical switch using an organic dye. *Proc. of SPIE,* Vol. 7935, No. 79350Y, pp. 1-12.

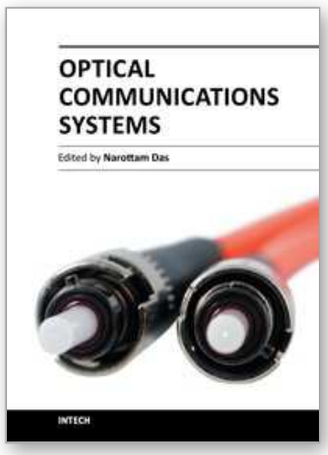
Tanaka, N.; Ueno, I.; Hiraga, T.; Tanigaki, N.; Mizokuro, T.; Yamamoto, N. & Mochizuki, H. (2007). Optically controlled optical-path-switching apparatus, and method of switching optical paths. *US patent*; 7,301,686.

Tanaka, N.; Ueno, I.; Hiraga, T.; Tanigaki, N.; Mizokuro, T.; Yamamoto, N. & Mochizuki, H. (2010). Optically controlled optical-path-switching-type data distribution appratus and distribution method. *US patent*; 7,792,398B2.

Ueno, I.; Tsujita, K.; Chen, G.; Tanaka, N.; Takarada, S.; Yanagimoto, H.; Moriwaki, D.; Mito, A.; Hiraga, T. & Moriya, T. (2003). Coaxial Configuration of the Gating and Signal Light for a Switching Device of a Dye-Dissolved Polymer Film. *Jpn. J. Appl. Phys.*, Vol. 42, No. 3, pp. 1272-1276.

Ueno, I.; Hiraga, T.; Mizokuro, T.; Yamamoto, N.; Mochizuki, H. & Tanaka, N. (2007). Optical path switching device and method. *US patent*; 7,215,491.

Ueno, I.; Tanigaki, N.; Yamamoto, N.; Mizokuro, T.; Hiraga, T.; Tanaka, N.; Nagaeda, H. & Shiga, N. (2010). Optical deflection method and optical deflection apparatus. *US patent*; 7,826,696B2.



Optical Communications Systems
Edited by Dr. Narottam Das

ISBN 978-953-51-0170-3
Hard cover, 262 pages
Publisher InTech
Published online 07, March, 2012
Published in print edition March, 2012

Optical communications systems are very important for all types of telecommunications and networks. They consists of a transmitter that encodes a message into an optical signal, a channel that carries the signal to its destination, and a receiver that reproduces the message from the received optical signal.This book presents up to date results on communication systems, along with the explanations of their relevance, from leading researchers in this field. Its chapters cover general concepts of optical and wireless optical communication systems, optical amplifiers and networks, optical multiplexing and demultiplexing for optical communication systems, and network traffic engineering. Recently, wavelength conversion and other enhanced signal processing functions are also considered in depth for optical communications systems. The researcher has also concentrated on wavelength conversion, switching, demultiplexing in the time domain and other enhanced functions for optical communications systems. This book is targeted at research, development and design engineers from the teams in manufacturing industry; academia and telecommunications service operators/ providers.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Takashi Hiraga and Ichiro Ueno (2012). The Least Stand-By Power System Using a 1x7 All-Optical Switch, Optical Communications Systems, Dr. Narottam Das (Ed.), ISBN: 978-953-51-0170-3, InTech, Available from: http://www.intechopen.com/books/optical-communications-systems/the-least-stand-by-power-system-using-a-1x7-all-optical-switch

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