Fields of Application

Laser Diode Markets

Laser Diode

Consumer Products

Recommended Models
- LT020 series
- LT022 series
- LT023 series

(See page 19)
- CD players
- Video disc players
- CD-I
- CD-V
- CD-ROM
- CD-IV

Office Automation Equipment

Recommended Models
- LT030 series
- LT028 series
- LT021 series
- LT026 series
- LT027 series
- LT017 series
- LT025 series

(See page 21)
- Laser printers
- Facsimiles
- Laser copiers
- Bar code readers
- Laser pens
- POS terminals
- Laser printing plate engraving

Communication Equipment

Recommended Models
- LT023 series
- LT010 series
- LT015 series
- LT090 series
- LT011 series

(See page 22)
- Fiber optic communications
- Atmospheric communications
- Satellite communications

Information Processing Equipment

Recommended Models
- LT030 series
- LT021 series
- LT024 series
- LT026 series
- LT027 series
- LT015 series
- LT025 series

(See page 19 and 20)
- Optical disk memories
- Optical floppy disks
- Optical memory cards

Medical Apparatus

Recommended Models
- LT015 series
- LT090 series

- Laser treatment equipment
- Biochemical analyzers

Measurement, Analysis and Control Instruments

Recommended Models
- LT030 series
- LT023 series
- LT010 series
- LT017 series
- LT090 series
- LT011 series

(See page 23)
- Laser scanners
- Optical micrometers
- Laser gyroscopes
- Velocity meters
- Infinitesimal displacement meters
- Photoelectric switches
- Range finders
- Interferometers
- Electrical measurement instruments
- Strain gauges
- Rotary encoders
- YAG laser pumping

Optical Disk Memories

An optical disk memory is a recording medium for storing Information in the form of pits on the surface of the disk The information is read or written by a laser beam focused to a spot diameter of 1 –2 μm on the disk surface.
Optical disk systems can be categorized into read-only types, such as CD and video disc players, and read/write types for use as computer memory.

CD Players

Fig. 19-2 shows the optical system of a typical CD player The beam emitted by a laser diode is collimated, transmitted through a polarized beam splitter and quarter-wave plate, and focused onto the disc surface. The disc surface has concentric rings of pits, each pit representing one bit of data (Fig. 19-3). When the laser beam irradiates a pit, the light is diffused and only a small portion is reflected back through the focusing lens. In the absence of a pit, a large percentage of the beam is reflected back through the focusing lens. Digital data is recorded as the presence and absences of pits, and maybe detected by measuring the amount of light reflected back through the optical system
After being recollimated by the objective lens, the reflected beam is again transmitted through the quarter-wave plate, resulting in a total polarization rotation of 90° relative to the original beam The beam is then directed by the polarized beam splitter to a four-quadrant photodetector which converts the optical signal to an electrical signal The four-quadrant photodetector produces the digital output signal as well as control signals for focusing and tracking the laser beam. The combination of the polarized beam splitter and the quarter-wave plate prevents the reflected beam from returning to the laser diode, thus reducing the feedback induced noise
The CD player operates in a non-contact fashion, eliminating disc wear and the effects of dust The CD player, in conjunction with the pulse code modulation (PCM) technique, provides extremely high quality sound reproduction. The compact disc system requires a laser diode with a high signal-to-noise ratio. Sharp's LT022 series is ideal for this application.

Video Disc Players

On compact discs, the information is stored on the disc in the form of digital signals composed of combinations of O and 1, but in the case of video discs, the lengths of the pits on the disc surface are used as analog quantities to generate corresponding signals Therfore, video disc players require a much better noise characteristic than compact disc players. Sharp's LT023 series satisfies this requirement and is ideal for video disc players

Fig. 19-1 Types of Optical Disk Memory

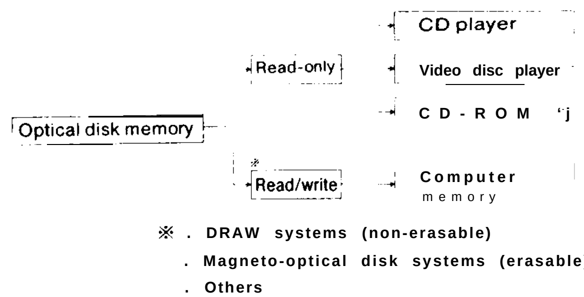


Fig. 19-2 Optical System of CD Player

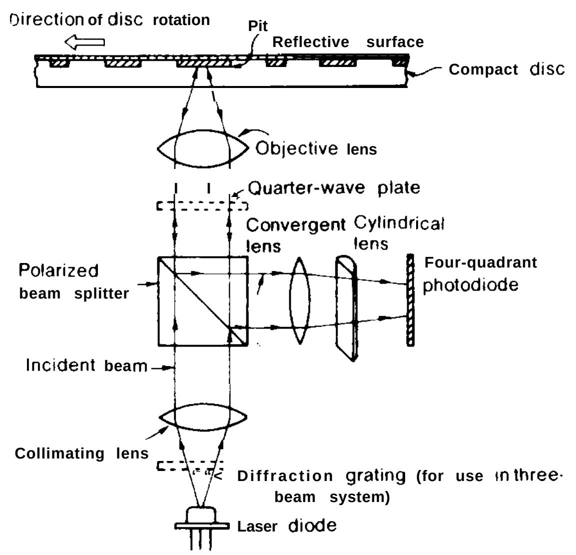


Fig. 19-3 Pit Arrangement on Disc Surface

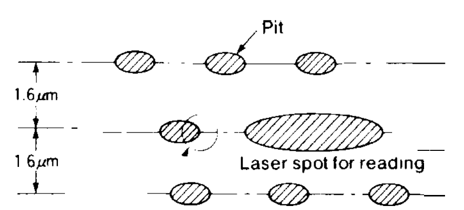
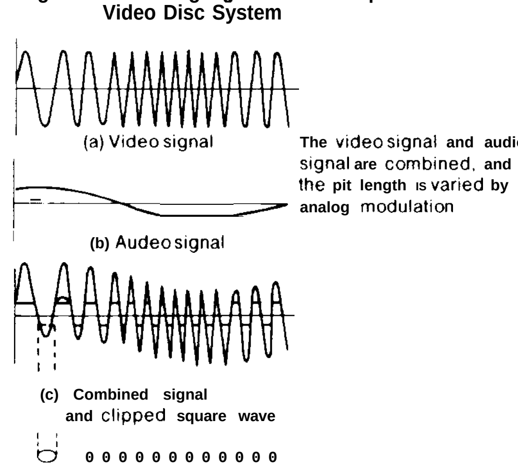


Fig. 19-4 Recording Signals snd Pit Equivalents in the Video Disc System



Magneto-optical Disk Systems

The family of erasable optical disk memory includes those that use a thermo-magnetic effect and those that use a phase change effect to record data. Here we will describe a thermo-magneto-optical disk system. An example of the type of optical pick-up assembly used in these systems is shown in Fig. 20-1 The disk is coated with a magnetic film which permits magnetic.recording in the direction perpendicular to the disk surface. Initially, the entire surface of the disk is magnetically oriented in the same direction (up), as shown in Fig. 20-2a, A magnetic field pointing down is then applied and a laser beam is focused on the disk surface (Fig. 20-2 b), resulting in a local rise in the temperature of the magnetic film. When the temperature rises above the Curie point, the area of the focused beam becomes magnetized in the direction of the externally applied magnetic field, that Is, in the direction opposite to its original magnetic orientation. By switching the laser beam on and off according to the digital signal to be recorded, the signal is recorded in the form of magnetic orientations on the disk. The recording density is dependent on the diameter of the laser spot, and since the spot can be as small as 1 ‘micrometer in diameter, high density recording is possible. A 130 millimeter diameter disk has a capacity of 500 megabytes, or the equivalent of 500 floppy disks.

To read the data from the disk, an magneto-optical effect (Kerr effect or Faraday effect) is used in which the polarization of linearly polarized light is rotated when it is reflected from a magnetized surface, The direction of this polarization rotation depends on the direction of the magnetization of the reflecting surface. The recorded data is read by detecting the direction of the polarization of the reflected light. In Fig. 20-1, the section with the polarized beam splitter is used to read the data from the disk.

Magneto-optical disk and other erasable optical disk systems reguire a laser diode with an optical power output of 20 to 40 milliwatts. Sharp’s LTO1 5 series and LT025 series, with a maximum power output of 40 milliwatts, LT024 AD/ED with a maximum power output of 35 milliwatts, and LT024 MD/ MF/PD with a maximum power output of 30 milliwatts, are ideal for this application.

Fig. 20-1 Optical System of Magneto-optical Disk System

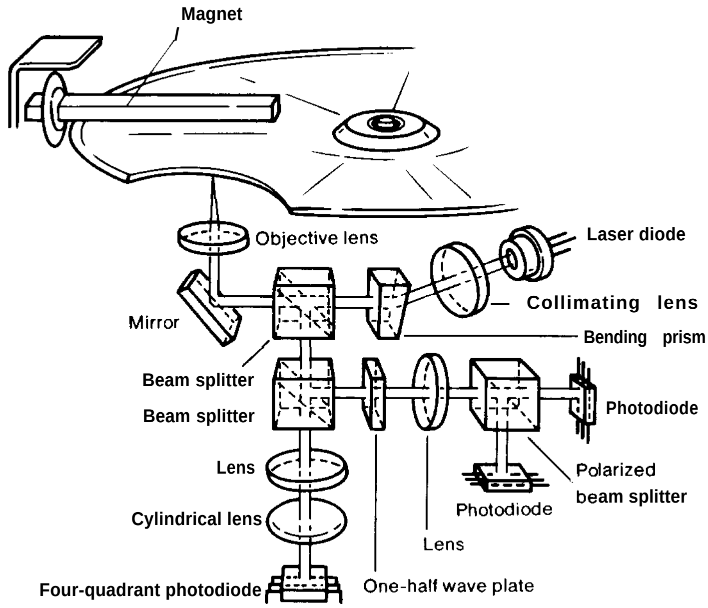
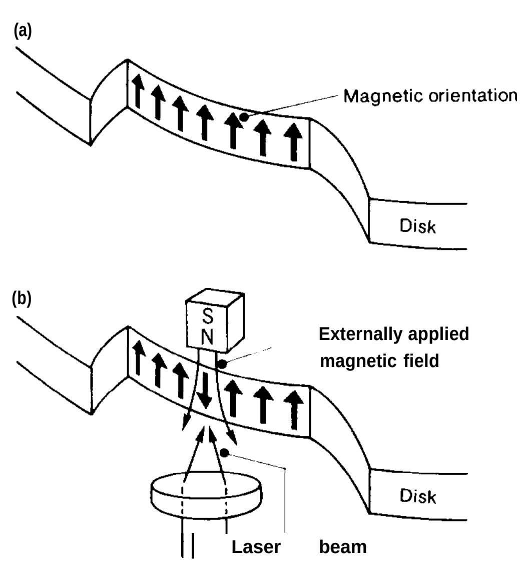


Fig. 20-2 Recording Principle



Laser Printers

Laser printers have recently received wide Interest in the ever expanding office automation market because of their high speed and high quality printing capability. Helium-neon and helium-cadmium gas lasers were first used as ligh sources, but in recent years a number of printers using laser diodes have come onto the market. The use of a laser diode has the following advantages.

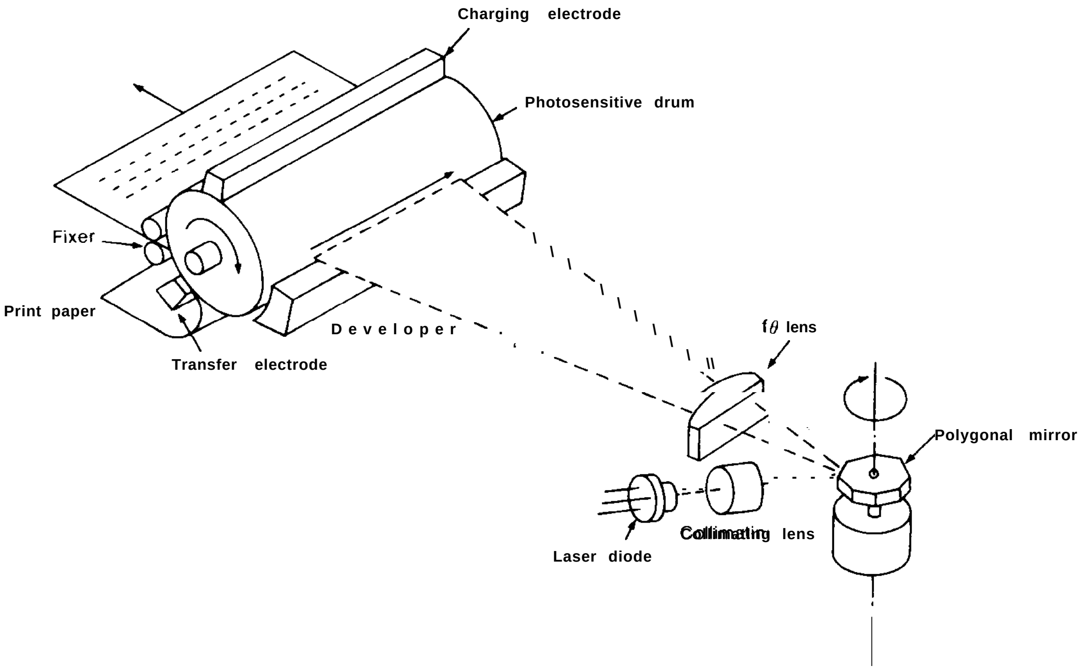
1) It is compact and lighweight

2) It permits direct modulation, thus simplifying the optical system and reducing costs.

3) It requires less power.

Fig. 21-1 shows a laser printer mechanism using a laser diode.

Fig. 21-1 Laser Printer System



The laser printer uses electrophotographic technology originally developed for use in copy machines, The laser beam is directly modulated with the information to be printed and the modulated beam is scanned horizontally by a rotating polygonal mirror.

The beam is projected onto a photosensitive drum which rotates at a constant speed, and the information is recorded as an electrostatic latent image on the drum surface.

The printing process is as follows. First, the drum surface is uniformly charged by the charging electrode, When the modulated laser beam is projected onto the drum, the resistance of the irradiated points is reduced. Discharge of the initial electric charge in the irradiated areas creates an electrostatic latent image on the drum surface, The developer applies charged toner, usually a black resin powder, to the discharged areas of the drum surface In this way, the latent image is converted into a toner image. The transfer electrode applies an electric field from behind the print paper causing the toner image to be transferred from the drum to the paper Finally, the fixer applies heat and pressure to the paper to firmly adhere the toner image. The above operation proceed continuously to complete the print.

The photosensitive coating on the printer drum may be an organic photoconductor, selenium (Se), or amorphous silicon (a-Si). Since the sensitivity nf these materials significantly diminished at longer wavelengths, it is desirable to use a laser with the shortest possible wavelength. Sharp has developed three laser diodes for use in high speed laser printers: the LT030 series with a wavelength of 750 nm and a maximum power output of 5mW and the LT021 series with a wavelength of 780nm and a maximum power output of 15mW. For medium speed laser printers, Sharp developed the LT027 series with a wavelength of 780nm and maximum power output of 10mW, and for general purpose laser printers LT026 series and LT028 series with a wavelength of 780nm and maximum power output of 5mW, and the LTO17MD with a wavelength of 81 Onm and a maximum power output of 50mW.

Fiber Optic Communications

. Features of Fiber Optic Communications

Communications utilizing fiber optics has become very popular in recent years and is now being used for such varied applications as undersea cables and consumer products. Fiber optic cables have the following advantages over conventional wire cables

(1) Large ammounts of information can be transmitted at high speeds. Thin fiber optic cables with a core diameter of 200 μm can transmit signals at a frequency of a magnitude 10 times higher than conventional electrical wires such as coax cables.
In fact, soon a high speed transmission rate of 1.6 Gb/s will be possible in the public communications field. Furthermore, research is being expanded to utilize the coherency of laser light to its fullest extent which should make high speed data transmission of 20 Tb/s possible.

(2) Optical fibers are neither affected by noise nor generate noise Since light is the transmission medium fiber optic communications are not affected by electromagnetic noise from outside the fiber. For this reason, fiber optic cables can be laid next to electrical cables used in factories, automobiles, and other environment which exhibit high noise characteristics.
Furthermore, since transmitted signals do not “leak” outside the cable, optical transmissions produce no electromagnetic interference (EM I), which has been the object of stricter regulations.

● Light Sources for Fiber Optic Communication

Both light emitting diodes (LED’s) and laser diodes are used as light sources for fiber optic data transmissions. Laser diodes however exhibit the following advantages as compared to LED’s.

(1) High-speed response (cutoff frequency of 1 GHz or more)

(2) The spectral width of the emitted light is narrow and therefore there are no band restrictions due to the wavelength dispersion characteristics of the fiber optic cable.

(3) Since the optical power output and directionality are greater, higher intensity light can be coupled into the fiber optic cable.
Fig. 22-1 shows an example of the wavelength loss characteristic of a fiber optic cable. Due to these characteristic, long distance transmissions require that long wavelength light sources be used. At present for long distance transmission a band of 1.3 μm or 1,55 μm are being used.
Although on the other hand there is a large transmission loss for short wavelength sources of 900 nm and less, there is a big advantage of being able to use inexpensive silicon pin photodiodes. There fore these wavelengths are used for short to medium range transmissions of several kilometers where line losses are not a problem. This is especially true for 780 nm band laser diodes, which are currently being mass produced for CD players and video disc players. These laser diodes are highly reliable making them well suited for short distance communications

Fig. 22-1 Transmission Characteristic of Optical Fibers

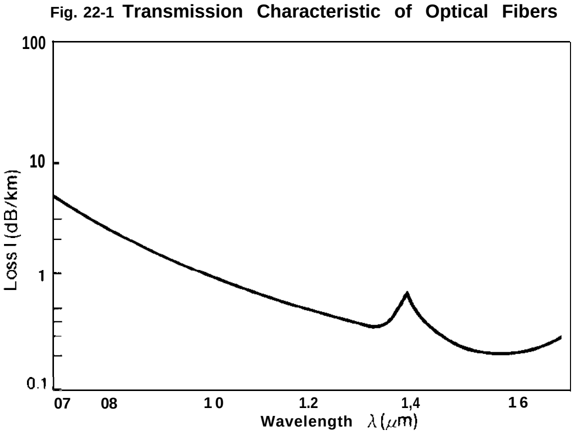
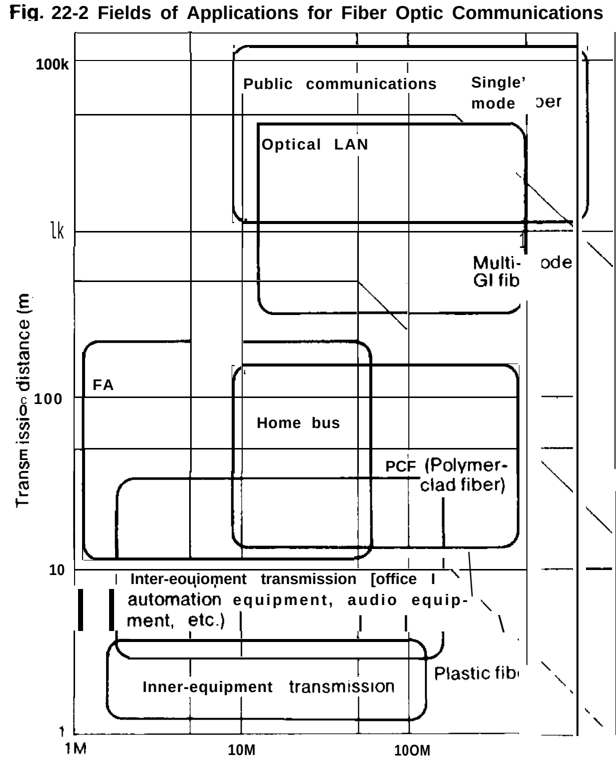


Fig. 22-2 Fields of Applications for Fiber Optic Communications



In addition to the three items described before, these laser diodes also have the following fourth advantage:
(4) Laser diodes have high optical feedback noise Immunity even when reflected light from optical connectors is present.

. Fields of Applications

Fig 22-2 illustrates the wide range of fields in which fiber optic communications are used.

. Recommended Models

We recommend the low noise LT022 and LT023 series. For environments where reliability at high temperatures is required, we recommend LT022HC/HS/WD/WS and LT023HC/HS/WS. For wavelength multiplexed communications, we have produced a series of wavelengths at 30nm Intervals for improved signal isolation. For transmissions directly propagated through air we recommend the LTO15MD or other high power laser diodes.

Table 23-1

Model No.	Max. Optical Power Output	Wavelength (TYP)
LT030 series	5mW	750nm
LT022 series		780nm
LT023 series		
LTO1 O series		81 Onm
LTO11 series		840nm

YAG Laser Pumping

Yittrium aluminum garnet (YAG) doped with Nd^{3+} ions is well known as a representative solid laser crystal material. Conventionally, flash tubes containing Kr, Xe or other inert gases were used as pumping sources for YAG lasers However, since these flash tubes emit white light, efficiency is low (1 % or less), and service life is short As a result, laser diodes have become widely used as pumping sources for YAG lasers.
As illustrated in Fig. 23-1 YAG crystals doped with Nd^{3+} 'ions have a strong absorption between 800nm and 820nm. This band of wavelengths corresponds closely to the wavelength at which GaAlAs laser diodes produce their maximum power output. Therefore when YAG lasers are pumped using GaAlAs laser diodes, the effective efficiency is greatly increased (more than 10%) and longer service lifetimes are possible.
Fig. 23-2 shows a YAG optical system using laser diodes. This system uses a method called "end-pumping" in which excitation is carried out in the direction opposite to the direction of travel of the laser beam. Reflective mirrors Ml and M2, which makeup the YAG laser oscillator, are placed perpendicular to the direction of the laser beam Mirror Ml is a dichromatic mirror which allows the wavelength of the laser diode (about 81 Onm) to pass through while acting as a perfect reflector for the YAG wavelength (1 .06μm). Mirror M2 is a reflecting mirror semitransparent to the wavelength 1.06μm. and is thereby able to draw out the laser beam in the direction opposite to the pumping source.
This kind of YAG laser pumping by laser diodes has gained much attention as an Innovative new way to build compact, efficient, and long lasting lasers with extremely stable wavelengths. The YAG laser is presently being used in a wide variety of processing applications, and is expected to be used in various new fields in the near future,

. Recommended Models

We recommend the LTO1 7MD with a maximum optical power output of 50mW and a wavelength of 81 0nm.

Fig. 23-1 Nd³ ; YAG Absa tion Spectrum

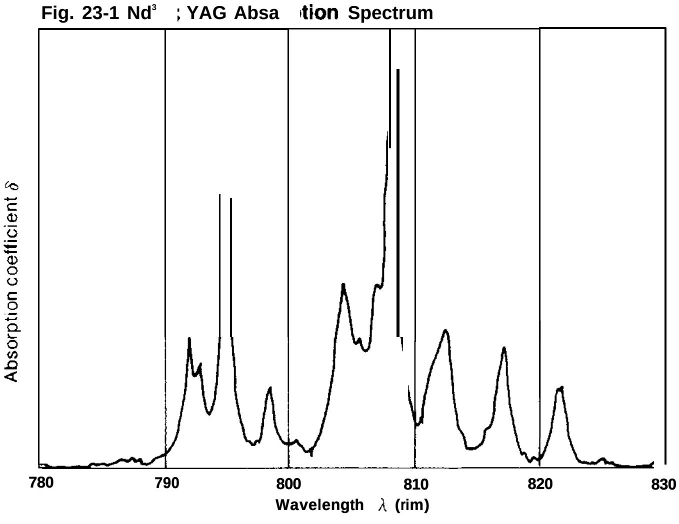


Fig. 23-2 Laser diode pumped YAG laser