LIGHT EMITTING DIODE(LED)

Alightemittingdiode(LED)isknowntobeoneofthebestoptoelectronicdevicesout of the lot. The device iscapable of emitting a fairly narrow bandwidth of visibleor invisible light when its internal diode junction attains a forward electric current orvoltage.

The visible lights that an LED emits are usually orange, red, yellow, or green.The invisible light includes the infrared light. The biggest advantage of this device isits high power to light conversionefficiency.Thatis,theefficiency isalmost50timesgreaterthanasimpletungsten lamp.

The response time of the LED is also known to be very fast in the range of 0.1microsecondswhencomparedwith100millisecondsforatungstenlamp.Duetotheseadvantages, the device wide applications as visual indicators and as dancing lightdisplays.

We know that a P-N junction can connect the absorbed light energy into itsproportional electric current. The same process is reversed here. That is, the P-Njunctionemitslightwhenenergyisappliedonit.Thisphenomenonisgenerallycalledelectroluminance,whichcanbedefinedastheemissionoflightfromasemi-conductorundertheinfluenceofan electricfield.

The charge carriers recombine in a forward P-N junction as the electrons crossfromtheN-regionandrecombinewiththeholesexistingintheP-region.Freeelectronsareintheconductionbandofenergylevels,whileholesareinthevalenceenergyband.

Thus the energy level of the holes will be lesser than the energy levels of theelectrons. Some partof theenergy mustbe dissipated in order torecombine theelectrons andtheholes.Thisenergyis emittedin theformofheat and light.

Theelectronsdissipateenergyintheformofheatforsiliconandgermaniumdiodes.ButinGallium-Arsenide-phosphorous(GaP)andGallium-phosphorous(GaP)semiconductors,theelectronsdissipateenergybyemittingphotons.Ifthesemiconductoristranslucent,thejunctionbecomesthesourceoflightasitisemitted, thus becoming a light emitting diode (LED). But when the junction is reverse biasedno light will be produced by the LED, and, on the contrary the device may also getdamaged.

All the semiconductorslisted abovecan be used.AnN-typeepitaxial layerisgrown up onasubstrate,andtheP-regionisproducedbydiffusion.TheP-regionthatincludes the recombination of charge carriers is shown is the top. Thus the P-regionbecomes the device surface. In order to allow more surface area for the light to beemittedthemetalanodeconnectionsaremadeattheouteredges ofthеP-layer.

Forthelighttobereflectedasmuchaspossibletowardsthesurfaceofthedevice,agold film is applied to the surface bottom. This setting also enables to provide acathodeconnection.There-absorptionproblemisfixedbyincludingdomedlensesforthedevice.Allthewiresintheelectroniccircuitsofthedeviceisprotectedbyencasingthedevice.

The light emitted by athe device depends on the type of semiconductor materialused. Infrared light is produced by using Gallium Arsenide (GaAs) as semiconductor.Red or yellowlight is produced by using Gallium -Arsenide-Phosphorus (GaAsP) assemiconductor.

LEDCircuitSymbol

The circuit symbol of LED consists of two arrow marks which indicate theradiationemittedbythe diode.

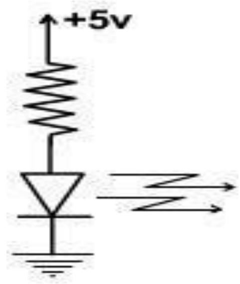

Figure: 1.6.1 SymbolofLED

[Source: "Electronic devices and circuits" by"Balbir Kumar, Shail.B.Jain, and Page: 145]

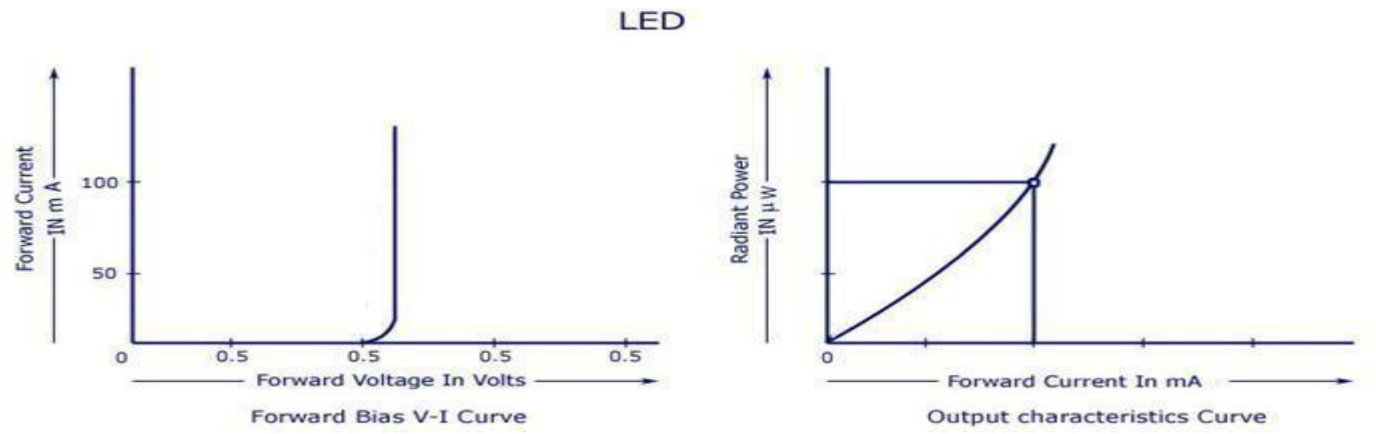

Figure: 1.6.2LEDcharacteristicscurve

[Source: "Electronic devices and circuits" by"Balbir Kumar, Shail.B.Jain, and Page: 145]

The forward bias Voltage-Current (V-I) curve and the output characteristicscurve is shown in the figure above. The V-I curve is practically applicable in burglaralarms. Forward bias of approximately 1 volt is needed to give significant forwardcurrent. The second figure is used to represent a radiant power-forward current curve.Theoutputpowerproducedisverysmallandthustheefficiencyinelectrical-to-radiantenergyconversionisveryless.

ThecommerciallyusedLED‘shaveatypicalvoltagedropbetween1.5Voltto

2.5Voltorcurrentbetween10to50milliamperes.TheexactvoltagedropdependsontheLEDcurrent,colour,tolerance,andsoon.

LEDasanIndicator

The circuit shown below is one of the main applications of LED. The circuit is designed by wiring it in inverse parallel with a normal diode, to prevent the device from being reverse biased. The value of the series resistance should be half, relative to that o f a DC circuit.

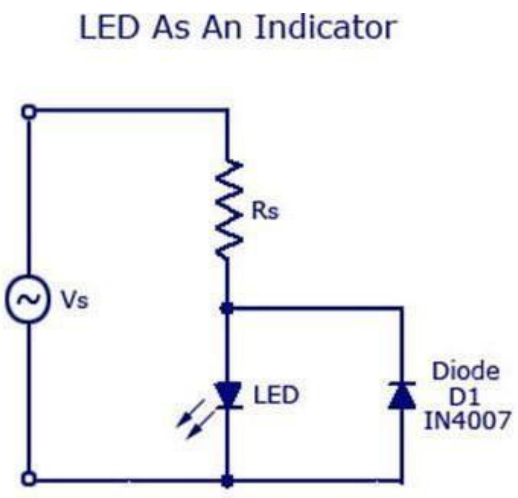

Figure: 1.6.3LEDasanindicator

[Source: "Electronic devices and circuits" by"Balbir Kumar, Shail.B.Jain, and Page: 147]

LEDS displays are made to display numbers from segments. One such design isthe seven- segment display as shown below. Any desired numerals from 0-9 can bedisplayedbypassingcurrentthroughthecorrectsegments.Toconnectsuchsegmentacommon anode or common cathodecathodeconfigurationcanbeused.Boththeconnectionsareshownbelow.TheLED's are switchedON andOFF by usingtransistors.

- **AdvantagesofLED's**
  - Verylowvoltageandcurrent areenoughtodrivetheLED.
  - Voltagerange–1 to2 volts.
  - Current–5to20mill amperes.
  - Totalpoweroutputwillbelessthan150millwatts.
  - Theresponsetimeisveryless–onlyabout10nanoseconds.
  - Thedevicedoes not need anyheatingandwarmup time.
  - Miniatureinsizeandhencelightweight.
  - Havearuggedconstructionandhencecanwithstandshockandvibrations.
  - AnLEDhasalifespanofmorethan20years.

- **DisadvantagesofLED**

- Aslightexcessinvoltageorcurrent candamagethedevice.
- Thedeviceisknowntohaveamuchwiderbandwidthcomparedtothelaser.
- Thetemperaturedependsontheradiantoutputpowerandwavelength

Laserdiode

Alaserdiode,orLD,isanelectricallypumpedsemiconductorlaserinwhichtheactive laser medium is formed by a p-n junction of a semiconductor diode similar tothat foundinalight-emittingdiode.

Thelaserdiodeisthemostcommontypeoflaserproducedwithawiderangeofuses that include, but are not limited to, fiber optic communications, barcode readers,laser pointers, CD/DVD/Blu-ray Disc reading and recording, laser printing,laserscanningand increasinglydirectionallightingsources.

AlaserdiodeiselectricallyaP-i-ndiode.Theactiveregionofthelaserdiodeisintheintrinsic(I)region,andthecarriers,electronsandholes,arepumpedintoitfromtheNandPregionsrespectively.

While initial diode laser research was conducted on simple P-N diodes, all modernlasers use the double-hetero structure implementation, where the carriers and thephotons are confined in order to maximize their chances for recombination and lightgeneration.Thelaserdiodeepitaxialstructureisgrownusingoneofthecrystalgrowthtechniques, usuallystarting from an N doped substrate, and growing the .Idopedactive layer, followedbythePdopedcladding,andacontactlayer.Theactivelayermostoftenconsistsofquantumwells,

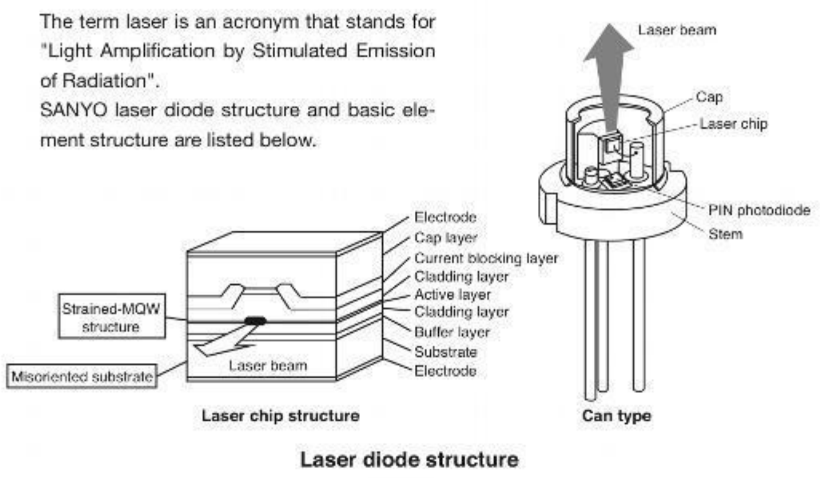

Figure: 1.6.4 Laser Diode

[Source: "Electronic devices and circuits" by"Balbir Kumar, Shail.B.Jain, and Page: 151]

LaserdiodeL/Icharacteristic

One of the most commonly used and important laser diode specifications orcharacteristics is the L/I curve. It plots the drive current supplied against the lightoutput.

Thislaserdiodespecificationisusedtodeterminethecurrentrequiredtoobtaina particular level of light output at a given current. It can also be seen that the lightoutput isalsoverydependentuponthetemperature.

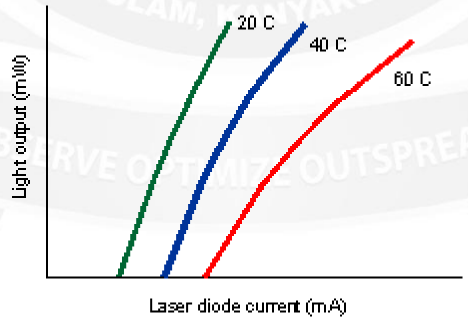

Figure: 1.6.5 LaserdiodeL/ICharacteristic

[Source: "Electronic devices and circuits" by"Balbir Kumar, Shail.B.Jain, and Page: 146]

From this characteristic, it can be seen that there is a threshold current belowwhich the laser action does not take place. The laser diode should be operated clear ofthis point to ensure reliable operation over the full operating temperature range as thethreshold current rises with increasing temperature. It is typically found that the laserthresholdcurrent rises exponentiallywithtemperature.

LaserDiodeSpecifications&Characteristics

A summary or overview of laser diode specifications, parameters and characteristics used in defining laser diode performance for datasheets.

In this section

- Laser diode technology
- Laser diode types
- Structure & materials
- Theory & operation
- Specs & characteristics
- Lifetime, failure & reliability

- Other diodes

When using a laser diode it is essential to know its performance characteristics. Accordingly laser diode specifications are required when designing equipment using laser diodes or for maintenance using near equivalents.

Like any electronics components, many of the specifications are relativelygeneric,butotherparameterswilltendtobemorefocusedontheparticularcomponent.Th is is trueforlaserdiodespecificationsandcharacteristics.

Thereareanumberoflaserdiodespecifications,orlaserdiodecharacteristicsthatarekeytotheovera llperformanceandthesearеoutlined.