General Description

BASIC FUNCTION

In an electrical circuit, an optocoupler ensures total electric isolation, including potential isolation, as in the case of a transformer, for instance

In practice, this means that the control circuit is located on one side of the optocoupler, i.e., the emitter side, while the load circuit is located on the other side, i.e., the detector side. Both circuits are electrically isolated by the optocoupler. Signals from the control circuit are transmitted optically to the load circuit. In most cases, this optical transmission is realized with light beams whose wavelengths span the red to infrared range, depending on the requirements applicable to the optocoupler. The bandwidth of the signal to be transmitted ranges from a dc voltage signal to frequencies in the MHz band. An optocoupler is comparable to a transformer or relay. Besides having smaller dimensions in most cases, the advantages of optocouplers are: shorter switching times, no contact bounce, no interference caused by arcs, wear the circuitry[1]. Optocouplers are suitable for circuits used in microelectronics, data processing and telecommunication systems. Optocouplers are used to an increasing extent as safety tested components, e. g., in switch mode power supplies.

Note

1. See Applications Notes for additional information.

DESIGN

An optocoupler has to fulfill 5 essential requirements:

- Good isolation
- High current transfer ratio (CTR)
- Low degradation
- No interference by field strength influences

These factors are essentially dependent on the design, the materials used and the corresponding chips used for the emitter/detector.

Vishay has succeeded in achieving a design with optimized isolation behavior and good transfer characteristics. The basic function of an optocoupler is to isolate the input from the output by means of an insulation material.

The thickness-through-insulation of at least 4 mm provided by Vishay provides better safety and protection against electrical shock (see Figure 1 and 2). Vishay builds in additional reliability in these devices to protect the coupler system against ambient light and dust.

The mechanical clearance between the emitter and detector is at least 4 mm and is thus mechanically stable even under thermal overloads, i.e., the possibility of a short circuit caused by material short circuit is minimized. This is important for optocouplers which must meet strict safety requirements (VDE/UL specifications), see DIN EN 60747-5-2 (VDE 0884)/DIN EN 60747-5-5 pending facts and information. As a result, Vishay couplers have a very low coupling capacitance of 0.2 pF. Couplers with conventional designs have higher coupling capacitance values by a factor of 1.3 to 2. Attention must be paid to the coupling capacitance in digital circuits in which steep pulse edges are produced which superimpose themselves on the control signal. With a low coupling capacitance, the transmission capabilities of these interference spikes are effectively suppressed between the input and output. This capability of suppressing dynamic interferences is commonly known as "common-mode rejection"[1].

Note

1. See Applications Notes for additional information.

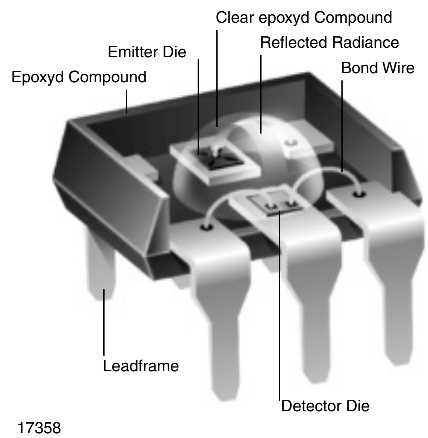

Fig. 1 - Coplanar Construction Principle

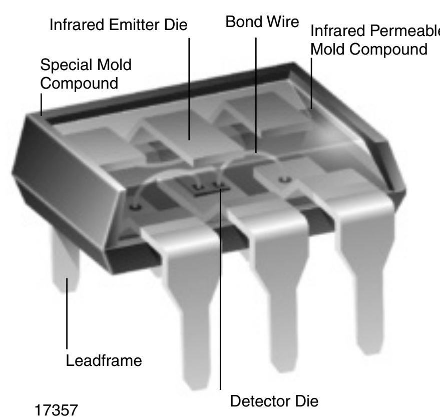

Fig. 2 - Face to Face Construction Principle

The degradation of an optocoupler, i.e., impairment of its CTR over a finite period, depends on:

1. the emitter element due to its decreasing radiation power while
2. the degradation of an optocoupler over time results primarily from the emitter chip

A decrease in the radiation power can be primarily ascribed to thermal stress caused by an external, high ambient temperature and/or high a forward current. In practice, optocouplers are operated with forward current of 1 to 30 mA through the emitting diode. In this range, degradation at an average temperature of 40 °C is less than 5 % after 1000 h. In general, an optocoupler's life time is a period of 100000 h, i.e, the CTR should not have dropped below 50 % of its value at 0 h during this time (see figure 4).

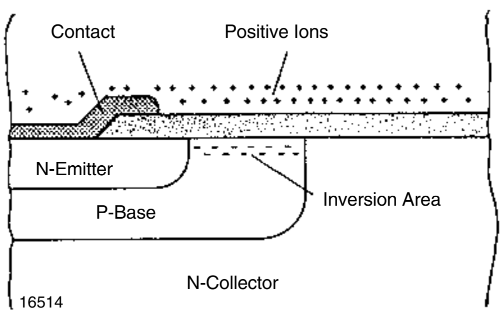

Fig. 3 - Function of Parasitic Field Effect Transistor as a Result of Failure (Latch-up) in the Phototransistor of Couplers

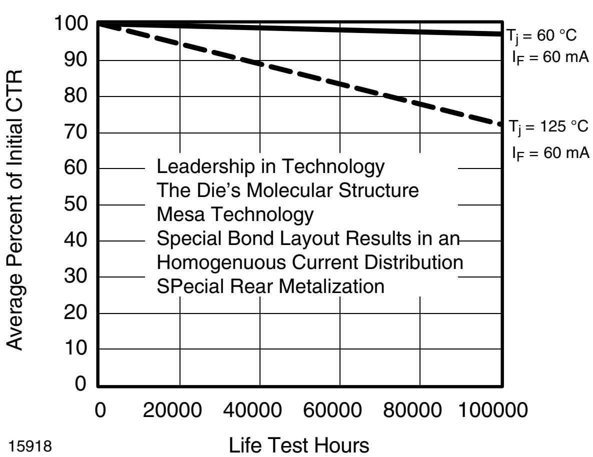

Fig. 4 - Degradation under Typical Operating Conditions

TECHNICAL DESCRIPTION – ASSEMBLY

Emitter

Emitters are manufactured using the most modern Liquid Phase Epitaxy (LPE) process. By using this technology, the number of undesirable flaws in the crystal is reduced. This results in a higher quantum efficiency and thus higher radiation power. Distortions in the crystal are prevented by using mesa technology which leads to lower degradation. A further advantage of the mesa technology is that each individual chip can be tested optically and electrically even on the wafer.

Detector

Vishay detectors have been developed so that they match to the emitter. They have low capacitance values, high photosensitivity and are designed for an extremely low saturation voltage. Silicon nitride passivation protects the surface against possible impurities.

Assembly

The components are fitted onto lead frames by fully automatic equipment using conductive epoxy or eutectic adhesive. Contacts are established automatically with digital pattern recognition using the well-proven thermosonic technique. In addition to optical and mechanical check mechanical checks, all couplers are measured at a temperature of 100 °C on short/open test equipment.