Optocouplers for Safe Electrical Isolation to DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending (Appnote 48)

Because of their high reliability and long life, optocouplers are used in applications requiring safe electrical isolation of two circuits, such as in switched-mode power supplies (SMPS). Optocouplers have to comply with the relevant VDE standards and/or international standards like IEC when used for protecting systems against electrical damage.

Currently the tendency is to incorporate international standards (e.g. IEC) into the German VDE regulations. On the other hand, the goal is to make a national VDE standard (such as one that has proved to increase safety) into an internationally recognized IEC standard. For example, a new VDE standard, DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending, has just been introduced in Germany and also is being reviewed in various international standardization committees.

German VDE standards are divided into three main groups:

- Basic VDE standards, such as VDE 0110 which describes air and creepage path requirements in general
- VDE standards governing components, such as the recently expired VDE 0883 standard for optocouplers
- VDE standards governing systems and equipment, such as VDE 0805/0806 for office machines and EDP systems

Optocouplers used in a switched mode power supply of a computer have to satisfy the requirements of VDE 0883 and VDE 0805/0806.

Thickness of solid insulation between conducting parts, the isolation test voltage and the air and creepage paths are crucial in applications requiring reliable electrical isolation. Depending on the sensitivity of the application, different values are given in the VDE standards.

For example, an electrical control cabinet will probably be opened and operated infrequently and only by skilled staff. However, it's not unusual for a cup of coffee to be spilled accidentally over the keyboard of an electric typewriter. Thus the requirements to be met in the two cases are very different.

The latest findings in high-voltage technology have questioned two parameters thickness of solid insulation and isolation test voltage. Dielectric strength does increase with the thickness of the insulating material, but only when the insulating material is homogeneous and free of impurities or air-pockets. A high-quality thin insulation can be better than a thick layer with impurities or air-bubbles. The trend is clearly towards reducing insulation thickness (about 0.3 to 0.5 mm) for more economical manufacturing and technologically advanced optocoupler functions.

To test the breakdown strength, isolation test voltage normally lasts 60 seconds in qualification tests and up to one second in 100 % inspection (depending on the particular VDE standard). However, no determination is made whether any partial discharge occurs in the insulation material during testing. This requires measurement equipment of extreme sensitivity and has been introduced on the market only recently.

Studies in high-voltage technology have shown that a single partial discharge will probably not be extinguished at low voltages and that permanent partial discharge may degrade and damage the insulating material. So that even under normal operating conditions partial discharge may occur when operating voltage is applied. A high-voltage breakdown is likely to occur after a certain time of operation.

The new standard for optocouplers, DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending, used for safe electrical isolation addresses the two drawbacks mentioned earlier. Suitable dielectric strength is now determined by the presence of partial discharges at a defined test voltage. Partial discharges occur with impurities or air-bubbles in the insulating material or insufficient thickness of solid insulation.

The conventional breakdown test (isolation test voltage) may risk causing initial damage to the optocoupler which is not detectable. This test has been replaced in DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending by the partial discharge test which detects any partial discharge. The absence of partial discharge during the test reliably proves the isolation capability without any undesirable initial damage to the insulation material.

Partial discharge measurement method per VDE 0884

Two measurement methods, as described in DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending, have proved to be reliable and suitable for optocouplers.

- Measurement method A—a destructive test to qualify optocouplers and for sample testing in manufacture.
- Measurement method B—a non-destructive test of every component (100 % inspection).
- Figures 1 and 2 show two typical voltage time curves (AC voltage peak-to-peak values) for Vishay optocoupler testing per DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending.

A destructive test for the qualification of optocouplers and sample testing in manufacture. This time-test voltage diagram can be used with SFH601 and CNY17 couplers.

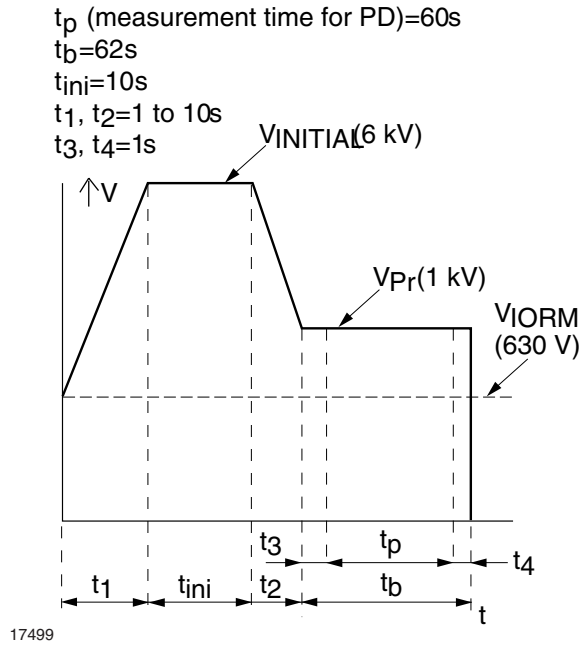

Figure 1. Measurement method A of DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending

A non-destructive test of every component (100 % inspection).

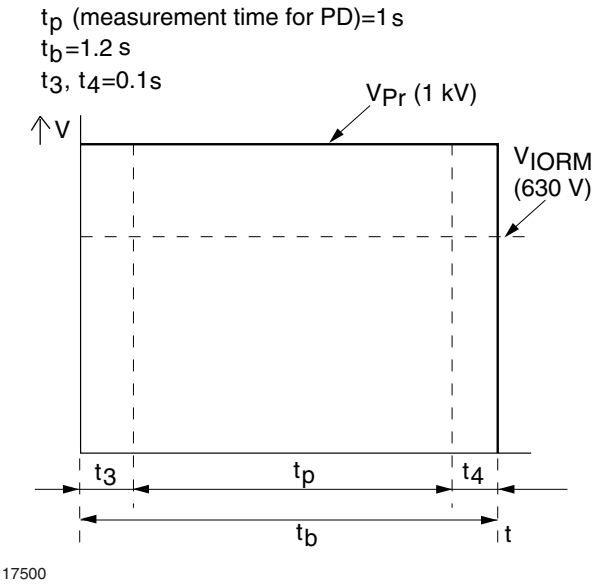

Figure 2. Measurement method B

More DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending test criteria for safe electrical isolation by optocouplers

In addition to the partial discharge test, DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending has further requirements to improve optocoupler reliability. For example, data on reliability limits such as limit current, temperature, and/or power dissipation must be given for every approved and qualified component. Figure 3 shows the reliability limit values for SFH601 and CNY17 optocouplers.

Limit values are generally higher than the maximum ratings. They indicate whether and if additional components are required in the circuit to ensure safe electrical isolation in case of failure in the surrounding circuitry.

In the qualification test (destructive test) the optocoupler is exposed to numerous tests in rough environments such as humidity cycles or temperature shocks. The optocouplers are then stressed to the limit values for 72 hours. Finally, they are tested partial discharge. Absence of partial discharge (PD) currently means a value below 5 picocoulombs.

Importance of DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending standard for the future

Optocouplers used in applications for safe electrical isolation are tested for freedom from partial discharge to give improved reliability and useful information on the long term stability of insulating materials. DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending is only a first step in this direction. Partial discharge measurements probably will become applicable to transformers, capacitors, and other components. VDE 0883 is no longer the standard since December 1988. However, until the end of 1991 approvals to VDE 0883 were accepted in the marketplace.

From 1992 optocouplers must have DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending approval. New designs of PC boards or systems using optocouplers which have to fulfil the requirements of safe electrical isolation, must use only optocouplers with DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending approval.

Vishay already offers the SFH601 and CNY17 optocouplers with DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending approval under option 1. Other types, especially DIP-4 series, have been approved and are available.

For every optocoupler type approved to DIN EN 60747-5-2 (VDE0884)/ DIN EN 60747-5-5 pending, reliability limit values such as limit temperature, current and power dissipation must be given.

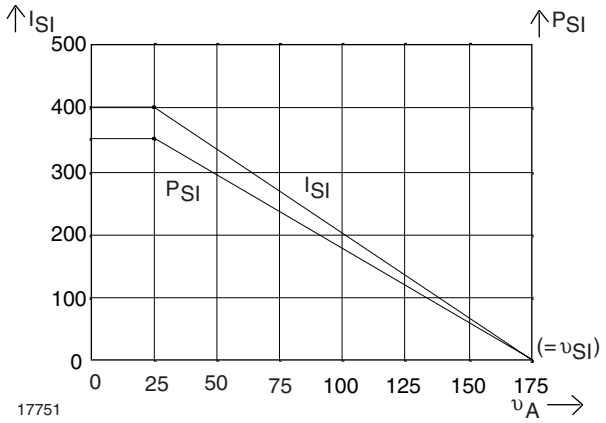

Figure 3. Dependency of reliability maximum ratings on ambient temperature for SFH601, CNY174