

Application Bulletin AB-2 *High Voltage Testing Standards Overview*

High voltage testing for equipment or components is based on the probable or expected transients that can, or may, occur for a given working voltage. These are quoted in standards such as IEC664 or DIN VDE0109. The standards summarized in this Bulletin are UL1950, UL1577, UL 3101-1 (IEC1010-1 or IEC61010-2001), and VDE0884.

Type Tests

Type tests employed to determine if the product is suitable for the working voltage quoted and are considered destructive. The equipment or components tested in this manner are generally not recommended for sale.

- UL1950 Makes no distinction between Type testing and production testing, but allows a one-second test for production, without making recognition of possible damage caused by Type testing.

- UL1577 Makes no distinction either. But requires testing at 120% of rated voltage for shorter durations in production testing.

- UL3101-1 Recognizes that damage may be caused by Type testing, and recommends that equipment, or components, used for Type testing should not be subject to further Type testing once they have left the manufacturer.

- VDE0884 Recognizes that Type tests are “not non-destructive.”

Production Tests

Production tests are shortened tests to verify that the manufactured items meet the working voltages of the relevant standards, and are defined by each standard:

- UL1950 One second at 100% of dielectric withstand test for rated working voltage.
- UL1577 One second at 120% of dielectric withstand test for rated working voltage
- UL3101-1 Two seconds at 100% of dielectric withstand test for rated working voltage.
- VDE0884 One second at 160% of working voltage. No more than 5 pC partial discharge allowed.

UL1950, UL1577, and UL3101-1 are only concerned with breakdown. They emphasize that breakdown must not occur but “corona effects and similar phenomena are disregarded.”

Table 1 shows the test voltages for different working voltages, and also the creepage and clearance distances. The table is taken from UL3101-1, which corresponds to IEC1010-1 and IEC61010-2001.

		Pollution Degree II									
		Installation Category (Overvoltage Category) II									
		Working Voltage (RMS or DC) up to V	Clearance (mm)	Creepage Distance (mm)					Test Voltage (V)		
				In Equipment			On Printed Wiring Board		Peak Impulse 1.2/50µs	RMS 50/60Hz 1 min.	DC or 50/60Hz peak 1 min.
Material Group				Not Coated CTI>175	Coated CTI>100						
I CTI>600	II CTI>400	III CTI>100									
50	0.2	1.2	1.7	2.4	0.4	0.12	850	510	720		
100	0.4	1.4	2	2.8	0.4	0.4	1,360	740	1,050		
150	1.6	1.6	2.2	3.2	1.6	1.6	2,550	1,400	1,950		
300	3.3	3.3	4.2	6	3.3	3.3	4,250	2,300	3,250		
600	6.5	6.5	8.5	12	6.5	6.5	6,800	3,700	5,250		
1000	11.5	11.5	14	20	11.5	11.5	10,200	5,550	7,850		
1500	16	16	21	30			13,600	7,400	10,450		
2000	21	22	28	40			17,000	9,300	13,150		
2500	26	28	36	50			20,400	11,100	15,700		

Table 1. Double Insulation or Reinforced Insulation.

Linear interpolation of values for clearance and creepage is allowed, but interpolation of test voltage is not allowed.

Partial Discharge Testing (VDE0884*)

Type Testing

$U_{INITIAL}$ (the barrier dielectric withstand voltage) is determined by the service class and working voltage. For example, for 300V_{RMS} working voltage and Class III, $U_{INITIAL} = 4000 V_{peak}$ (see Table 2).

$U_{INITIAL}$ is determined from the desired working voltage (U_{IORM}) and the Service Class of operation (see Table 2). U_e is the partial discharge extinguish voltage, and should not be less than $1.2 \times U_{IORM}$.

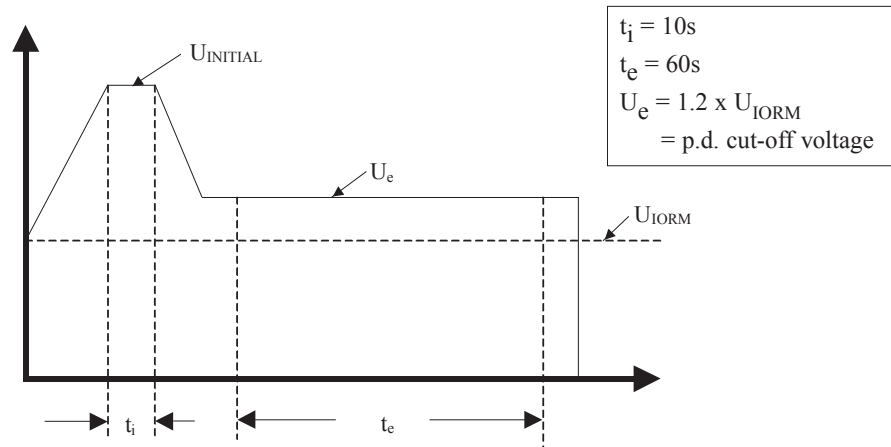


Fig.1 Type Testing and Random Testing (Destructive Test)

The Type testing and Random sample testing is conducted as shown in Fig. 1. The voltage is ramped at 100 V/s from a value below the partial discharge cut-off point to $U_{INITIAL}$ and maintained for 10 seconds. Partial discharge is allowed to occur at this voltage, but not breakdown. The voltage is then decreased at 100 V/s after 10 seconds to the voltage at which partial discharge ceases, which is U_e . U_e must be greater than or equal to $1.2 \times U_{IORM}$. Values of at least 5 pC are specified as criteria for the presence of partial discharge. For example, if the desired working voltage is 300 V_{RMS} and Service Class 3 is specified, partial discharge must have ceased at $300 \times 1.2 = 360 V$ (U_e) for this working voltage to be acceptable. If not, the working voltage must be lowered.

Routine or Production Testing (VDE0884)

For Routine, or Production, testing the time for monitoring for partial discharge may be reduced to one second. The test voltage U_{pr} is now raised to $1.6 \times U_{IORM}$. The partial discharge test criteria is that the device should exhibit less than five discharges, each less than 5 pC in magnitude, in a time of one second. Routine testing is deemed non-destructive.

U_{IORM} RMS	Insulation Test Voltage for Service Class-- $U_{INITIAL}=AC_{peak}$			
	I	II	III	IV
50	330	500	800	1,500
100	500	800	1,500	2,500
150	800	1,500	2,500	4,000
300	1,500	2,500	4,000	6,000
600	2,500	4,000	6,000	8,000
1,000	4,000	6,000	8,000	12,000

Table 2. Insulation Test Voltages (adapted from DIN VDE 0109)

*To date, NVE has not applied for VDE0884 approval for IsoLoop Isolators.

Conclusions

For most products, including IsoLoop Isolators, the maximum working voltage is determined from the appropriate standard by the package creepage and clearance distances. If approved by a standard, the testing requirements of that standard are mandatory unless a waiver, or alternative method, is approved in writing.

As stated earlier, only VDE0884 stipulates testing by partial discharge. The other standards are concerned only with breakdown, not corona phenomenon or flashover. To date NVE has not applied for VDE0884 approval. The requirements of VDE0884 are supplied only for information purposes since it is an often-quoted approval for optocouplers.

Table 3 shows the comparative production test times for each standard for the working voltages given. The service class, or insulation category, must be considered before the final table can be constructed. This table is based on the most likely categories for the IsoLoop Isolators, and is only intended to show the relative testing parameters.

Standard	Qualified or Working Voltage	Test Voltage	Production Test Time	Pass Criterion
UL1577	2500 V _{RMS} (1min)	3000 V _{RMS}	1 s	No breakdown
IEC61010-2001	400 V _{RMS}	3700 V _{RMS}	2 s	No breakdown
VDE0884	300 V _{RMS}	679 V _{peak}	1 s	<5 pC

Table 3. Comparative Requirements of Standards