17 Behaviour of the ballast at end of lamp life

17.1 End of lamp life effects

At the end of lamp life the ballast shall behave in such a way that no overheating of lamp cap(s occurs at any voltage between 90% and 110% of the rated supply voltage.

For the test simulating end of lamp life effects, three tests are described:

a) asymmetric pulse test (described in 17.2);

b) asymmetric power dissipation test (described in 17.3);

c) open filament test (described in 17.4).

Any of the three tests may be used to qualify electronic ballasts. The ballast manufacturer shall determine which of the three tests will be used to test a given ballast based on the design of that particular ballast circuit. The chosen test method shall be indicated in the ballast manufacturer's literature.

NOTE Checking ballasts against their capability to cope with the partial rectifying effect is recommended by IEC 61195, Annex E, and IEC 61199, Annex H.

Lamps used in the ballast test circuits shall be new lamps seasoned for 100 h.

17.2 Asymmetric pulse test

The ballast shall have adequate protection to prevent lamp cap overheating at the end of the lamp life cycle. Compliance is checked by the following test.

The following values of maximum cathode power P_{max} apply:

- for 13 mm (T4) lamps, P_{max} = 5,0 W;
- for 16 mm (T5) lamps, P_{max} = 7,5 W.

(Other diameters are under study.)

Test procedure

Refer to the schematic diagram in Figure 3.

If only one connection per electrode is available at the ballast and/or lamp, T1 shall be removed and then the ballast shall be connected to J2 and the lamp to J4. The ballast manufacturer should be asked which of the output terminals has to be connected to J4 and, in case two output terminals per electrode exist, whether they can be short-circuited or be bridged with a resistor.

(1) Close switches S1 and S4, and set switch S2 to position A.

(2) Turn on the ballast under test and allow lamp(s) to warm up for 5 min.

(3) Close S3, open S1, and wait for 15 s. Open S4 and wait for 15 s.

(4) Measure the sum of the average power dissipated in the power resistors, R1A to R1C and R2A and R2B, and the Zener diodes, D5 to D8.

NOTE The power should be measured as the average value of the product of the voltage between terminals J5 and J6 times the current flowing from J8 to J7. The voltage should be measured with a differential voltage probe, and the current should be measured with a dc current probe. A digital oscilloscope can be used for the multiplication and averaging functions. If the ballast operates in a cycling mode, the averaging interval should be set to cover an integer number of cycles. (Each cycle is typically greater than 1 s.) The sampling rate and number of samples included in the calculations should be sufficient to avoid aliasing errors.

The power dissipation shall be below P_{max}.

If the power dissipation is greater than P_{max}, the ballast has failed and the test is discontinued.

(5) Close S1 and S4.

(6) Set S2 to position B.

(7) Repeat steps (2), (3) and (4).

The ballast shall pass both position "A" and position "B" tests.

(8) For multi-lamp ballasts, repeat steps (1) to (7) for each lamp position.

A multi-lamp ballast shall pass the tests for each lamp position.

(9) For ballasts that operate multiple lamp types (e.g 26W, 32W, 42W), each lamp type specified shall be tested. Repeat steps (1) to (8) for each lamp type.

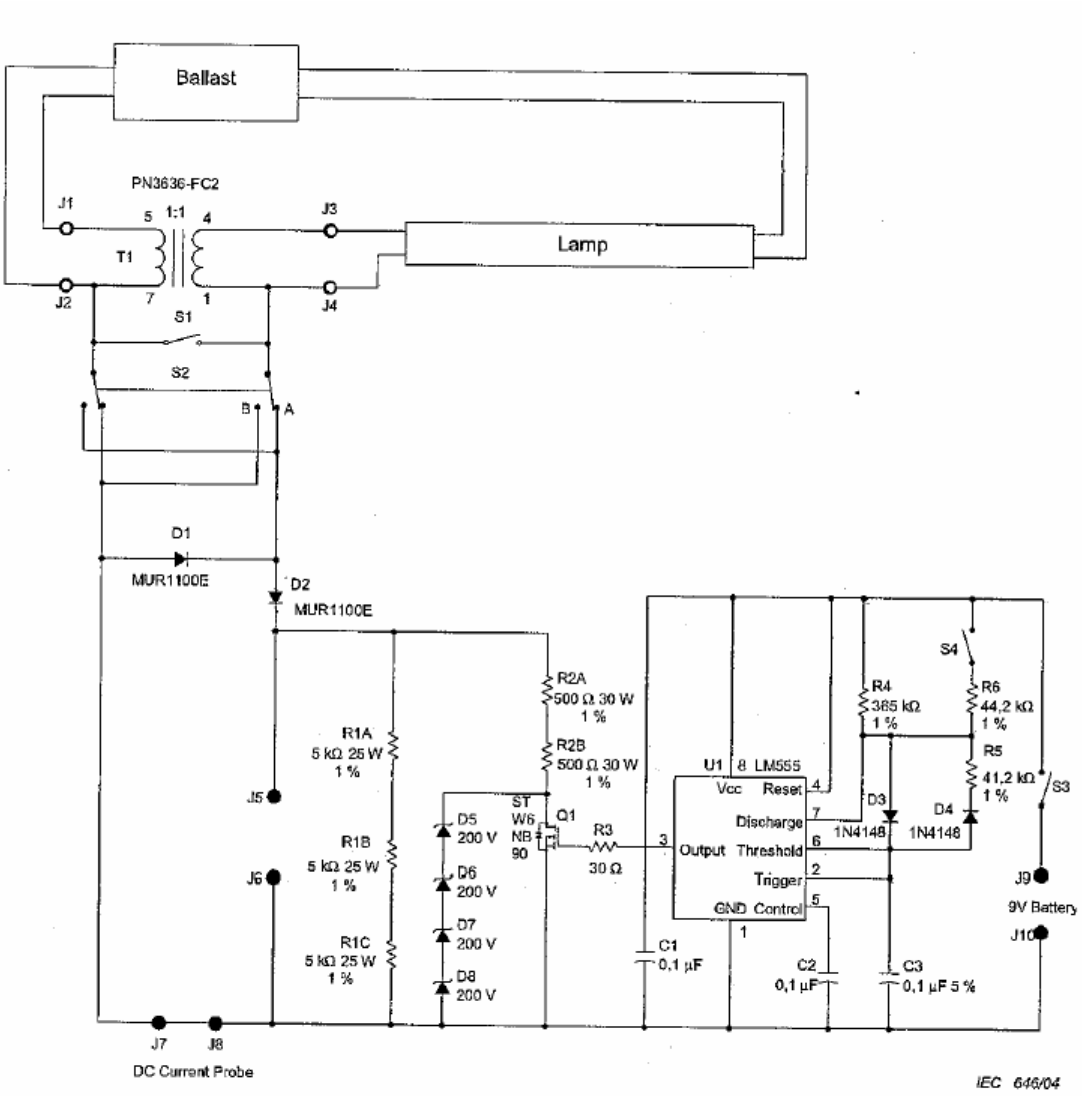


Figure 3 – Asymmetric pulse test circuit

NOTE FET Q1 should be on for 3 ms and off for 3 ms when S4 is closed, and on for 27 ms and off for 3 ms when S4 is open.

A list of material and transformer specifications is given in Annex K. Any other transformer components with the same functionality are permitted.

17.3 Asymmetric power test

The ballast shall have adequate protection to prevent lamp cap overheating at the end of the lamp life cycle. Compliance is checked by the following test.

The following values of maximum cathode power P_{max} apply:

- for 13 mm (T4) lamps, P_{max} = 5,0 W;
- for 16 mm (T5) lamps, P_{max} = 7,5 W.

(Other diameters are under study.)

Test procedure

Refer to the schematic diagram in Figure 4.

(1) Set switch S1 to position A.

(2) Set resistance of resistor R1 to 0 (zero) Ω.

(3) Start lamp(s) by turning on power to ballast under test and allow lamp(s) to warm up for 5 min.

(4) Increase the resistance of R1 rapidly, (within 15 s) until the power dissipated by resistor R1 equals the test wattage value of 10 W for a T4 lamp or 15 W for a T5 lamp. If the ballast limits the power in R1 to a value less than the test wattage, set R1 at the value which produces the maximum wattage. If the ballast switches off before reaching the test wattage, continue with (5). If the ballast does not switch off and limits the power in R1 to a value less than the test wattage, set R1 at the value which produces the maximum wattage.

(5) If the test wattage value was reached in step (4), wait for an additional 15 s. If the test wattage value was not reached in step (4), wait for an additional 30 s. Measure the power in R1.

The power dissipation in resistor R1 shall be below or equal to P_{max}. If the power dissipation in resistor R1 is greater than P_{max}, The ballast has failed and the test is discontinued.

(6) Turn off power to ballast. Set switch S1 to position B.

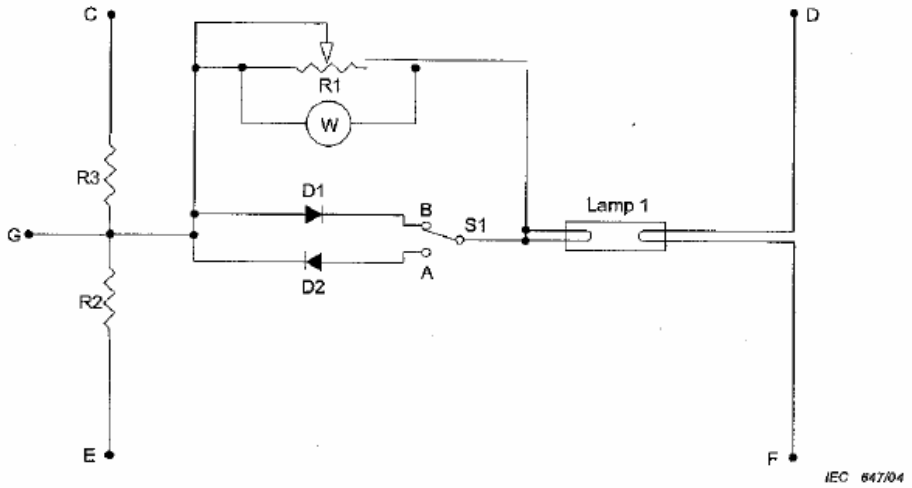
(7) Repeat test procedure steps (3) to (5) above.

The ballast shall pass both position "A" and position "B" tests.

(8) For multi-lamp ballasts, repeat test procedure steps (1) to (7) for each lamp position.

A multi-lamp ballast shall pass the tests for each lamp position.

(9) For ballasts that operate multiple lamp types (e.g. 26W, 32W, 42W) each lamp type specified shall be tested. Repeat steps (1) to (8) for each lamp type.



NOTE 1 R2 = R3 = x Ω (this resistance is ½ resistance of hot cathode – refer to lamp data sheet).

NOTE 2 C, D, E and F represent cathode connections for the ballast.

NOTE 3 For instant start ballasts, connection G is connected to one and the combined D and F are connected to the other terminal.

Figure 4 – Asymmetric power detection circuit

17.4 Open filament test

17.4.1 Selection

The ballast shall have adequate protection to prevent lamp cap overheating at the end of the lamp life cycle under open filament conditions. Compliance is checked by either test procedure A or B as determined by the value of I_{max} below.

During the test the following values of maximum lamp current I_{max} apply:

- for 13 mm (T4) lamps, I_{max} = 1 mA;
- for 16 mm (T5) lamps, I_{max} = 1,5 mA.

(Other diameters are under study.)

If these current values are exceeded, test procedure B shall be applied; otherwise test procedure A shall be applied.

17.4.2 Measurements to be carried out prior to test procedure A

Determine the r.m.s. currents, $I_{LL}(1)$, $I_{LH}(1)$, $I_{LL}(2)$, $I_{LH}(2)$, at the ECG output terminals, by using a current probe and mark the terminals respectively, where:

$I_{LL}(1)$ is the lower of the r.m.s. currents through lead-in wire of electrode 1.

$I_{LH}(1)$ is the higher of the r.m.s. currents through lead-in wire of electrode 1.

$I_{LL}(2)$ is the lower of the r.m.s. currents through lead-in wire of electrode 2.

$I_{LH}(2)$ is the higher of the r.m.s. currents through lead-in wire of electrode 2.

Connect the circuit according to Figure 5a.

17.4.3 Test procedure A

Refer to schematic diagram in Figure 5a.

(1) Set S to position 1.

(2) Turn on the ballast under test and allow lamp(s) to warm up for 5 min.

(3) Set S to position 2 and wait for 30 s.

(4) Measure the r.m.s. current value of I_{lamp} with the current probe near to the lamp end. If I_{lamp} is pulsing, the r.m.s. value shall be computed over one complete pulse cycle including the off time.

The lamp discharge current I_{lamp} shall not be greater than I_{max}.

If the lamp discharge current is greater than I_{max}, the ballast has failed and the test is discontinued.

Refer to Figure 5b.

(5) Set S to position 1.

(6) Turn on the ballast under test and allow lamp(s) to warm up for 5 min.

(7) Set S to position 2 and wait for 30 s.

(8) Measure the r.m.s. current value of I_{lamp} with the current probe near to the lamp end. If I_{lamp} is pulsing, the r.m.s. value shall be computed over one complete pulse cycle including the off time.

The lamp discharge current I_{lamp} shall not be greater than I_{max}.

(9) For multi-lamp ballasts, repeat test procedure steps 1 to 8 for each lamp position.

A multi-lamp ballast shall pass the tests for each lamp position to pass the end-of-lamp-life test.

(10) For ballasts that operate multiple lamp types (e.g. 26W, 32W, 42W), each lamp type specified shall be tested. Repeat steps (1) to (9) for each lamp type.

17.4.4 Test procedure B

Connect the lamp as shown in Figures 5a and 5b with the measurement arrangement according to Figure 5c. If the ballast has an isolation transformer, connect the 1 MΩ resistor to the corresponding terminal defined in 17.4.2.

(1) Set S to position 1.

(2) Turn on the ballast under test and allow lamp(s) to warm up for 5 min.

(3) Set S to position 2 wait for 30 s.

Measure the r.m.s. voltage value with the differential probe placed as indicated in Figure 5c. If the voltage is pulsing, the r.m.s. value shall be computed over one complete pulse cycle including the off time.

(4) The voltage shall not be greater than 25 % of the rated lamp voltage. If the voltage is greater than 25 %, discontinue the test.

Refer to Figure 5b.

(5) Repeat test procedure steps (1) to (4) above.

(6) For multi-lamp ballasts, repeat test procedure steps (1) to (5) for each lamp position.

A multi-lamp ballast shall pass the test for each lamp position to pass the end-of-lamp life test.

(7) For ballasts which operate multiple lamp types (e.g. 26W, 32W, 42W), each lamp type specified shall be tested.

Repeat steps (1) to (6) for each lamp type. A multiple lamp ballast shall pass the test for each lamp type.

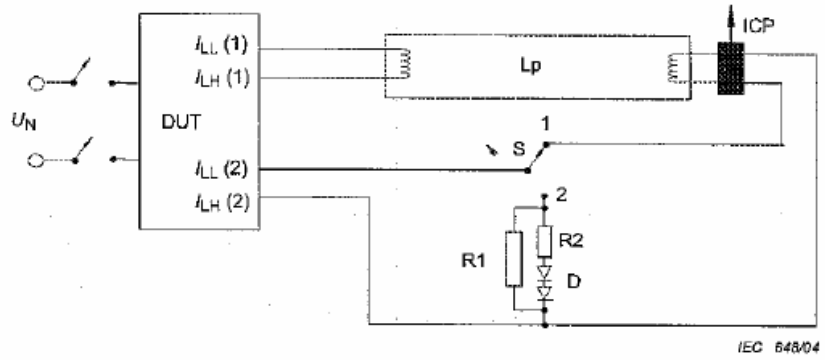


Figure 5a – Open filament test circuit; electrode (1) check

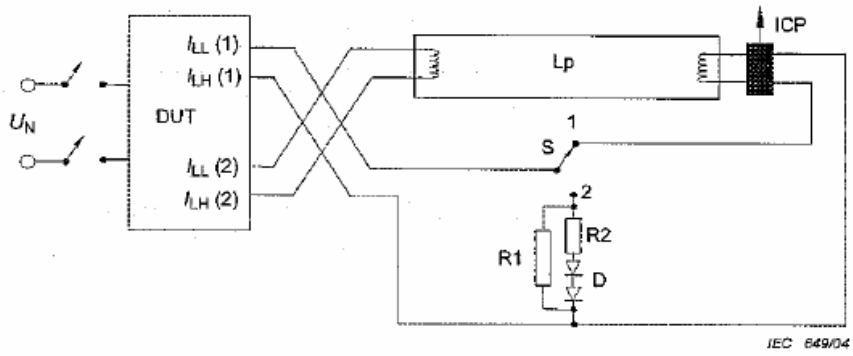
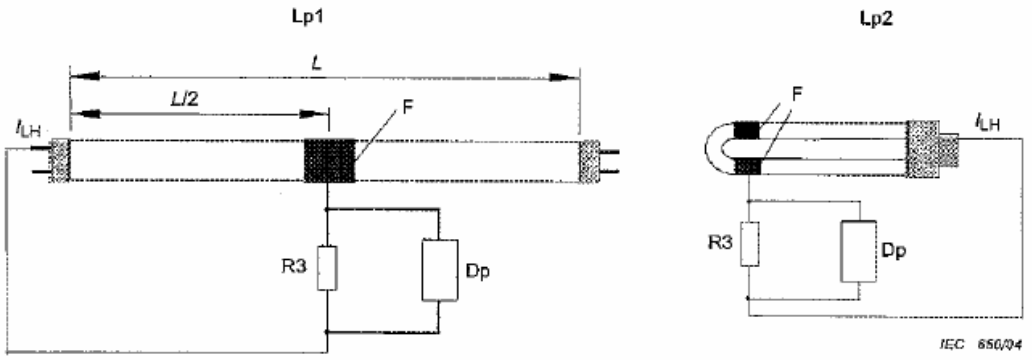


Figure 5b – Open filament test circuit; electrode (2) check



NOTE Use terminal I_{LH}(2) of Figure 5a or I_{LH}(1) of Figure 5b.

Figure 5c – Detection of lamp current

Key to Figures 5a, 5b and 5c

Lp = lamp

Lp1 = straight lamp; copper foil width 4 cm

Lp2 = bended lamp (single capped and circular); copper foil width: twice 2 cm; foils connected

U_N = supply

F = copper foil, width 4 cm and 2 cm × 2 cm

ICP = I_{lamp} current probe

R1 = 10 kΩ

R2 = 22 Ω, 7 W

R3 = 1 MΩ

D = fast diodes

DUT = device (ballast) under test

Dp = differential probe < 10 pF

Figure 5 – Open filament test circuits