

GLOW WIRE TESTING AND EVALUATION OVERVIEW: **IMPROVING SAFETY IN HOME APPLIANCES**



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The majority of fires worldwide — about 60 percent — are domestic, and most fire casualties occur in homes, according to a recent study by the Austrian Standards Institute. These facts make safety and fire prevention essential in the home appliance industry. The International Electrotechnical Commission (IEC) has developed a method to evaluate the potential effects of an overloaded circuit or overheated component in a home appliance. One threat of an overloaded circuit includes a potential household fire.

The IEC has established specific safety standards in IEC 60335-1 for appliances that are often run while unattended. Electrical connectors in these applications must pass glow wire testing to be compliant with the standard where specified. This is especially significant because, as the smart appliance market continues to grow, many of these appliances are designed to operate with enhanced autonomy.

About Glow Wire Testing

Glow wire testing evaluates the tendency of a connector's plastic material to resist reaching ignition when wires are overloaded — and, if ignited, its ability to self-extinguish without propagating to other areas or components within the appliance. Both raw materials, in the form of test specimens or plaques, and end connector products can undergo glow wire testing.



Examples of end products subject to glow wire testing include these unattended appliances that are set in place and operate on their own:

- Washing machines
- Dryers
- Dishwashers
- Ranges and Ovens
- Microwave ovens
- Cooking fans and hoods
- Refrigerators
- Freezers
- Water heaters
- Air conditioners

Connectors used within appliances identified as unattended with a current of less than 0.2A, or within appliances categorized as attended, are subject to less stringent testing methods. Examples of attended appliances include:

- Vacuum cleaners
- Food processors
- Irons
- Toasters
- Coffee machines
- Hair dryers

Classification of attended versus unattended appliances drives the applicable level of component testing per IEC 60335-1.

IEC Standards for Improved Safety: Glow Wire Testing Types

Since 2001, many countries have adopted these IEC standards to decrease the risk of household fires. The glow wire tests for end products and materials governed by IEC 60695-2-11 to 13 are typically required in Europe, and increasingly in Asia and the Americas. As more appliance platforms are developed to be global in nature, additional design requirements to support these IEC standards are often included.

The International Standard EN 60335-1 6th edition “Household and similar electrical appliances - Safety - Part 1” contains safety requirements noted within Section 30, “Resistance against fire and heat.” This section refers to the glow wire tests described within IEC 60695-2-10 to 13, which include the following:

- IEC 60695-2-10 Glow wire Apparatus and common test procedure
- IEC 60695-2-11 Glow Wire Flammability Test for End Products (GWEPT)
- IEC 60695-2-12 Glow Wire Flammability Test for raw material specimens (GWFI)
- IEC 60695-2-13 Glow Wire Ignitability Test (GWIT) for raw material specimens

Note that GWEPT pertains to testing on a finished end product, for example a connector, as it will be used in the end application. In contrast, GWFI and GWIT refer to tests performed on a raw material that will be used as part of the overall appliance design.

Glow Wire Test Procedures and Pass Criteria for Unattended Appliances

For parts in unattended appliances with currents greater than 0.2A, the requirements within IEC 60335-1, Section 30.2.3 are summarized below and fully detailed within this specification.

Level of Testing	Specification	Test	Test Procedure	Pass Criteria
1	IEC 60695-2-12	GWFI	850°C minimum	Material sample \geq 850°C
OR				
1	IEC 60695-2-11	Flammability test for end products (GWEPT)	850°C glow wire applied for 30 seconds, observation for 30 seconds following	If no ignition – pass If ignition – pass if: <ul style="list-style-type: none"> • Flames or glowing combustion extinguish within 30 seconds after heat element removed, and • Layer underneath the test specimen does not ignite
Result				Pass Level 1 – Move to Level 2
2	IEC 60695-2-13	GWIT	775°C minimum	Material sample \geq 775°C
AND				
2	IEC 60695-2-11	Flammability test for end products (GWEPT)	750°C glow wire applied for 30 seconds, observation for 30 seconds following	If no ignition – pass If ignition, pass if: <ul style="list-style-type: none"> • No flames during the test persist beyond 2 seconds after the heat element removed, and • Layer underneath the test specimen does not ignite
Result				Pass IEC 60335-1 flammability requirements

If flames persist longer than 2 seconds during GWEPT at 750°C:

Item	Pass Criteria
Verify whether surrounding components* near the connector within the appliance have a flame classification of V1 or V0 according to IEC 60695-11-10	If yes, Pass IEC 60335-1 flammability requirements
Alternative Test	
Perform needle flame test per IEC 60695-11-5 on surrounding components*	If pass needle flame test, pass IEC 60335-1 flammability requirements

* Surrounding Components - address components that are within an envelope 20.00mm diameter by 50.00 mm tall cylinder above the connector in the appliance

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Note that appliance companies establish their own requirements concerning specific testing results criteria for GWIT, GWFI and GWEPT that meet and could exceed the IEC 60335-1 specification. For example, some require GWEPT to be completed and passed in all cases beyond successful GWIT and GWFI. Specific to GWIT and GWFI, often resin suppliers perform these tests on the resin plaques and may publish the results within the UL yellow card.

Manufacturers of connectors, appliances and resin can perform glow wire tests within their own test labs and/or through outside lab resources. Certain agencies perform testing for final approval and certification of a given connector part or family. Additionally, resin suppliers typically test and qualify ratings for GWIT/GWFI.

Molex [performs end-product testing](#) per IEC-60695-2-11 GWEPT testing methodology and runs the procedure twice. The test sample (for example, a connector housing with contacts loaded as for use in the application) is fastened to a secure position with tissue paper beneath it. An element (or glow wire) is first heated to 750 °C, then pressed onto a test sample for 30 seconds. If the sample ignites, the duration of the flame, its height and any drips from the melted test sample are recorded. The test is repeated at 850 °C with a new test sample (housing with contacts). The test results are then compared to the GWEPT criteria specified in the above table.



Glow Wire Testing Apparatus Used to Evaluate Different Resins

Specific Areas of Note

Performance of Materials Across Glow Wire Testing Categories

Materials may perform differently across the different testing types. For example, if a resin material sample passes GWIT/GWFI, it may not always pass in the end product testing/GWEPT. This could be due to air gaps, sample orientation and/or thickness of the affected walls adding fuel to the combustion. A raw material plaque test is not governed by the same conditions of additional fuel (oxygen) during testing of the connector, as it is a solid piece of the material not influenced by design of the end connector product.

Availability of Low-Halogen or Halogen-Free Glow Wire Resin

A limited range of resins are currently available, but new resins are in development. Based on evolving requirements and further testing and evaluation, it is still necessary to determine which of these resins are suitable for home appliance applications. Industry factors and environmental initiatives in various regions may drive potential use of low-halogen and halogen-free solutions.

UL 94V2 and UL 94V0 Products for Glow Wire

Molex offers various products to support both UL 94V2 and 94V0 resins. These widely used tests rank plastics according to a few factors: their ability to ward off ignition, remain consistent at high temperatures and whether they produce flammable drippings. UL 94V2 rating requires that burning stops within 30 seconds on a vertical part and permits drops of flammable plastic, while UL94V0 requires burning to stop within 10 seconds and requires that plastic drips not be in flames. OEM interest is mostly in new platforms requiring UL 94V0 with glow wire.



Meeting a Growing Need

Today's home appliances are becoming increasingly advanced and autonomous. As technological innovations and customer demands for more features grow in tandem, safety will be a continued focus among appliance manufacturers. These factors contribute to the need for glow wire-compliant components in most appliances in the home.

Molex offers a wide and growing range of glow wire-compliant connectors that meet all safety and environmental requirements mandated by the home appliance industry within IEC 60335-1. Many of these connectors also provide advanced features and a variety of options to meet rapidly evolving design needs, while optimizing consumer safety.

The Molex Advantage

As built-in electronics in manufactured products grow — accompanied by a maze of regulations affecting their composition and design — it helps to consult with experts from the start.

Molex designs with glow wire testing in mind and can provide critical early involvement with design engineers to ensure that the products not only meet standards, but provide the highest possible levels of safety, reliability and efficiency. When building a brand-new product or modifying existing models, Molex can help incorporate the next-generation of electrical and electronic connectors and user-interface capabilities that customers are seeking.

To learn more, please see our [glow wire products](#).

Glossary

Attended – Refers to Attended Appliances where a person is present with the appliance during normal operation. Opposite of Unattended.

GWEPT – Glow Wire End Product Test, performed on the end product per IEC 60695-2-11.

GWFI – Glow Wire Flammability Index, property associated with raw material used in the end product. GWFI is the highest temperature at which the material does not ignite or self-extinguishes for flames or glowing combustion present within 30 seconds after removal of the heated element per IEC 60695-2-12.

GWIT – Glow Wire Ignition Temperature, property associated with raw material used in the end product. GWIT is the temperature which is 25°C (30°C for 900°C and 930°C) higher than the maximum test temperature at which three test specimens at the relevant thickness withstand the test criteria of no ignition or the entire flame event is not longer than 5 seconds and the test specimen is not totally consumed per IEC 60695-2-13.

IEC – International Electrotechnical Commission. IEC is a non-profit, non-governmental international standards organization that prepares and publishes International Standards for all electrical, electronic and related technologies. <http://www.iec.ch/>

Needle Flame Test – Test used to simulate the effect of small flames. A 12.00mm high flame held at a 45° angle is applied to the base of a test specimen for a specified period of time per IEC 60695-11-5.

Unattended – Refers to Unattended Appliance where a person is not present with the appliance during normal operation. Opposite of Attended.

UL – Underwriters Laboratories, global independent safety science company offering expertise across five key strategic businesses: Product Safety, Environment, Life & Health, Verification Services and Knowledge Services.