



PHOTOVOLTAIC PRODUCTS

# Using UL Recognized Components in Your PV Modules

An effective way to minimize your risk of noncompliance



Polymeric materials, junction boxes, connectors and connecting cables are regarded as critical components of photovoltaic (PV) modules. Their compliance with established North American standards is crucial to obtaining UL certification for an end product. In addition to assessing the module itself, a separate investigation is required to evaluate the properties of its critical components. PV module manufacturers are able to reduce the risk of delay to market and the costs associated with endproduct certification if the critical components used in their products are already tested and certified by UL.

### UL Component Recognition program

UL has developed a comprehensive Component Recognition program covering all major components in PV modules to facilitate investigation of their use in photovoltaic product applications. Under this program, material properties are defined through established test methods. Once evaluation is complete, information on UL Recognized Components is published in UL's Online Certifications Directory from which PV module manufacturers can easily source components and materials meeting North American requirements. To provide end-product manufacturers with confidence that the UL Recognized Components they use continue to comply with applicable requirements, UL monitors the consistency of material properties over time on a global basis through our Follow-Up Services program. Inspection of production facilities and re-test of samples collected from manufacturing sites are conducted periodically.

### How PV module manufacturers can benefit from the UL Component Recognition program

- Increased level of safety in the design of the end product
- Reduced design costs
- No additional testing cost
- Reduced time to market
- Enhanced supply chain management

### Must-knows about critical components used in PV modules

#### Connecting cable

According to the Section 690.31(B) of the 2008 edition of the National Electrical Code® (NEC), PV wire and single-conductor cable Type USE-2 are allowed for use as PV module inter-connections.

	PV Wire	Type USE-2 Cable
Evaluation standard	Subject 4703	UL 854
CCN	ZKLA	TYLZ
<b>Ratings</b>		
Voltage	600, 1000 or 2000 V	600 V only
Temperature	90 ~ 150°C dry 90°C wet	90°C dry 90°C wet
<b>Construction</b>		
Conductor size	14 ~ 4/0 AWG	14 AWG ~ 2000 kcmil
Conductor material	Stranded Cu	Cu, CCA, Al
Number of conductors	Single-conductor	Single-conductor
Construction without jacket	√	√
Construction with jacket	√	√
<b>Critical Test Program</b>		
Physical properties (unaged and air oven aged)	√	√
Sunlight resistance	720 hours weatherometer	300 hours weatherometer
Crushing resistance test	X	√
Impact test	X	√
Overload test	X	√
Flexibility at low temperature	- 40°C	- 25°C
Capacitance and relative permittivity	√	√
Insulation resistance (long-term in water for 90°C wet rating)	√	√
Insulation resistance (long-term in air for 105 ~ 150°C dry rating)	√	—
Dielectric withstand test	√	√
Flame test	Vertical flame test (mandatory), VW-1 flame test (optional)	X



## Photovoltaic polymeric materials

Superstrates, substrates, encapsulants, adhesives, sealing materials and potting compounds used for fabricating PV modules or their components are categorized under photovoltaic polymeric materials. UL has set a minimum requirement for those material properties of particular importance to the safe operation of PV modules. Among these are flammability, resistance to ignition, thermal endurance and electrical properties.

	Superstrate or Substrate	Enclosure of Live Part	Support or Insulation of Live Part	Encapsulant	Adhesive Contacting Live Part
Evaluation standards	UL 94; UL 746A, B, C; Subject 5703; UL 1703				
CCN	QIHE2				
<b>Minimum Performance Criteria</b>					
Color and ID scans	√	√	√	√	√
Flammability	Flame Spread Index not exceeding 100 (ASTM E162)	5VA (UL 94)	Minimum HB (UL 94)		Minimum HB (UL 94)
Hot wire ignition (HWI)		≤ 4	HB – 1, V-2 – 2, V-1 – 2, V-0 – 3		HB – 1, V-2 – 2, V-1 – 2, V-0 – 3
High-current arc ignition (HAI)		≤ 3	HB – 1, V-2 – 2, V-1 – 2, V-0 – 3		HB – 1, V-2 – 2, V-1 – 2, V-0 – 3
Comparative tracking index (CTI)		≤ 2	≤ 2		≤ 2
Inclined plane tracking			1 hour (ASTM D2303)		
Relative temperature index (RTI)	≥ 90°C, MOT+20°C	MOT+20°C	MOT+20°C	MOT+20°C	MOT+20°C
Ultraviolet light exposure (UV)	Required if in direct contact of sunlight (UL 746C)				
Water exposure and immersion	Required if in direct contact of water (UL 746C)				

### Notes:

- 1) MOT – Measured Operating Temperature
- 2) Adhesives are evaluated per UL 746C (QOQW2) for its bond strength and the effect of environmental conditions on property retention.

## Junction box and PV connectors

Junction boxes and PV connectors are required both for PV modules and PV systems. Those for use in PV modules are evaluated mainly in accordance with the end-product standard, UL 1703, the Standard for Safety of Flat-Plate Photovoltaic Modules and Panels.

	Junction Box	PV Connector
Evaluation standards	UL 1703; UL 746C	UL 1703; UL 1977; UL 746C
CCN	QII02	
<b>Minimum Performance Criteria for Polymeric Enclosure</b>		
Outdoor use	f1 (UV and water resistant)	f1 (UV and water resistant)
Flammability	5VA	V-0
HWI	≤ 4	≤ 4
HAI	≤ 3	≤ 3
CTI	≤ 2	≤ 2
RTI	≥ 90°C	≥ 90°C
<b>Critical Test Program</b>		
	<ul style="list-style-type: none"> <li>• Leakage current test (UL 1703)</li> <li>• Dielectric voltage withstand test (UL 1703)</li> <li>• Water spray test (UL 1703)</li> <li>• Strain relief test (UL 1703)</li> <li>• Temperature test (UL 1703)</li> </ul>	<ul style="list-style-type: none"> <li>• Insulation resistance test (UL 498)</li> <li>• Mold stress relief test (UL 1977)</li> <li>• Impact test (UL 486D, UL 746C, UL 1703)</li> <li>• Low temperature impact test (UL 486D, UL 746C)</li> <li>• Temperature cycling test (UL 1703)</li> <li>• Humidity cycling test (UL 1703)</li> <li>• Water spray test (UL 1703)</li> </ul>

