Code Compliance Research Report
CCRR-0580

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DIVISION: 07 – THERMAL AND MOISTURE PROTECTION
Section: 07 31 00 - Roof Shingles and Shakes

REPORT HOLDER:
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REPORT SUBJECT:
Timberline Solar BIPV Roofing System, Model TLS-2

1.0 SCOPE OF EVALUATION

1.1 This Research Report addresses compliance with the following Codes:

- 2024, 2021, 2018, and 2015 *International Building Code®* (IBC)
- 2024, 2021, 2018, and 2015 *International Residential Code®* (IRC)
- 2023 and 2020 *Florida Building Code* (including High Velocity Hurricane Zones (HVHZ) (see Section 9)
- 2023, 2020, 2017, and 2014 *National Electrical Code* (NEC), NFPA 70

NOTE: This report references the most recent Code editions cited. Section numbers in earlier editions may differ.

1.2 The Timberline Solar TLS-2 BIPV Roofing System has been evaluated for the following properties (see Table 1):

- Material properties
- Electrical Certification
- Fire classification
- Wind resistance
- Impact resistance
- Photovoltaic hazard control

1.3 The Timberline Solar BIPV Roofing System has been evaluated for the following uses (see Table 1):

- Use as building-integrated photovoltaic shingles in accordance with IBC Section 1507.16 and IRC Section R905.15.
- Use where a Class A, B or C Fire Classification in accordance with IBC Section 1505 and IRC Section R902.1 is required.
- Use where a listed PV hazard control system or listed rapid shutdown PV array is required in accordance with NEC Article 690.12(B)(2) (1).

2.0 STATEMENT OF COMPLIANCE

The GAF Energy LLC Timberline Solar TLS-2 BIPV Roofing System complies with the Codes listed in Section 1.1, for the properties stated in Section 1.2, and uses stated in Section 1.3, when installed as described in this report, including the Conditions of Use stated in Section 6.0.

3.0 DESCRIPTION

3.1 Timberline Solar TLS-2 BIPV Modules: The TLS-2 BIPV modules are BIPV shingles complying with IBC Section 1507.16 and IRC Section R905.15. Panel dimensions are shown in Figure 1.

3.2 Asphalt Shingles: The BIPV roofing system may be used in conjunction with asphalt shingles complying with the Code. Installation requirements for the shingles are identified in Section 5.2.

The BIPV roofing may be used in conjunction with GAF Timberline® Solar HD or Timberline® Solar HDZ asphalt shingles. The shingles are listed by UL for compliance with UL 790 (Class A fire classification), ICC-ES AC438, ASTM D3161 (Class F) and ASTM D7158 (Class H). See UL Listing TFWZ.R21.

3.3 Underlayment: Underlayment must comply with IBC Section 1507.1.1 or IRC Section R905.1.1.

3.4 System Components: Components for installation are provided by GAF Energy LLC and include the components shown in Figure 2.

4.0 PERFORMANCE CHARACTERISTICS

4.1 Material Standards: The Timberline Solar TLS-2 BIPV modules are listed by Intertek as complying with UL 7103 and UL 61730-1 and 61730-2 in accordance with IBC Section 1507.16.6 and IRC Section R905.15.4.

4.2 Wind Resistance: When installed in accordance with this report, the TLS-2 BIPV Roofing System has a Class F classification when tested in accordance with ASTM D3161 and complies with the requirements of TAS 107.

4.3 Wind-driven Rain: When installed in accordance with this report, the Timberline Solar BIPV Roofing System has demonstrated compliance with TAS 100.

4.4 Roof Classification: When installed in accordance with this report, the TLS-2 BIPV Roofing System has demonstrated a Class A fire classification when tested in accordance with ASTM E108 (UL 790).

4.5 Impact Resistance: The TLS-2 BIPV modules have demonstrated a Class 4 rating when tested in accordance with UL 2218. Note, this is supplemental information; the building Codes do not require impact resistance for roofing installed at slopes greater than 2:12.

4.6 Photovoltaic Hazard Control: The Timberline Solar BIPV Roofing System, in combination with the Delta Electronics components described below, are listed by Intertek for compliance with UL 3741, Photovoltaic Hazard Control, in accordance with NEC Article 690.12(B)(2)(1). The system is used where a rapid shutdown PV array is required.

The system is used with the following components:
Midnite Solar Rapid Shutdown System
Delta Electronics Rapid Shutdown System
Delta Electronics M series inverters, or Shenzhen Growatt New Energy Co. MIN-series inverters, or Ginlong Technologies Co. Solis-series inverters.

5.0 INSTALLATION

5.1 General: The Timberline Solar TLS-2 BIPV Roofing System must be installed in accordance with the manufacturer's published installation instructions, the applicable Code, and this Research Report. A copy of the manufacturer's instructions must be available on the jobsite during installation.

5.2 Application: The Timberline Solar modules must be installed over an underlayment complying with IBC Section 1507.1.1 or IRC Section R905.1.1. on minimum 15/32-inch plywood or 7/16-inch OSB roof decks. Minimum slope is 2:12; maximum slope is not limited. Application of the underlayment must be in accordance with IBC Section 1507.16.3 and IRC Section R905.15.3.

Asphalt shingles used in conjunction with the BIPV roofing system must be shown, to the satisfaction of the building official, to meet the applicable requirements of IBC Section 1504 and IRC Section R905.2. The shingles must additionally be classified as Class F in accordance with IBC Table 1504.2 and IRC Table R905.2.4.1 and must have Class A fire classification in accordance with IBC Section 1505 and IRC Section R902. A minimum of one course of shingles must be installed at eaves and ridges.

GAF Timberline® Solar HD or Timberline® Solar HDZ asphalt shingles must be installed with the manufacturer's installation instructions. The shingles are sized to provide the same reveal as the Timberline Solar modules.

The Timberline Solar TLS-2 modules must be nailed to the roof deck using six evenly spaced nails in the designated nailing zone. Nails must be 10-12 gauge, barbed, deformed, or smooth shank roofing nails with heads 3/8 in. to 7/16 in. diameter, and must comply with ASTM F1667. Fasteners must be long enough to penetrate at least 3/4 in. into wood decks or through plywood or OSB sheathing. The release liner on the module adhesive must be removed prior to installation completion. When adjacent to asphalt shingles, the GAF Energy Step Flap must be installed 2 inches above the reveal line and must be fastened with two nails.

Penetrations in the roof deck may occur only in the sections of the roof covering where the asphalt shingles are located. Penetrations must be flashed in accordance with applicable Code requirements.

6.0 CONDITIONS OF USE

6.1 Installation must comply with this Research Report, the manufacturer's published installation instructions, and the applicable Code. In the event of a conflict, this report governs.

6.2 The Timberline Solar TLS-2 BIPV Roofing System is manufactured under a quality control program with inspections by Intertek Testing Services NA, Inc.

7.0 SUPPORTING EVIDENCE

7.1 Reports of tests in accordance with UL 7103, UL 61730 (1 & 2), ASTM E108, UL 790, ASTM D3161, TAS 100, TAS 107, UL 2218 and UL 1703 Section 30 and UL 3741.

7.2 Intertek Listing Report "GAF Energy LLC – Timberline Solar TLS-2 BIPV Roof System" on the Intertek Directory of Building Products.

7.3 Intertek Listing Report "GAF Energy LLC – Timberline Solar TLS-2 Roof Impact" on the Intertek Directory of Building Products.

7.4 Intertek Listing Report "Photovoltaic Module Safety Qualification Part 1 Requirements for Construction" and "Photovoltaic Module Safety Qualification Part 2" on the Intertek Directory of Listed Products.

8.0 IDENTIFICATION

The GAF Energy LLC Timberline Solar TLS-2 BIPV modules are identified with the manufacturer's name, the product name, a label indicating listing to UL 7103 and UL 61730 (1 & 2), the Intertek Mark as shown below, the Intertek Control Number and the Code Compliance Research Report number (CCRR-0580). Packaging labels shall also include reference to TAS 107 and ASTM D3161, Class F.

9.0 OTHER CODES

9.1 Florida Building Code: The Timberline Solar TLS-2 BIPV Roofing System, described in Sections 2.0 through 7.0 of this Research Report, complies with the 2023 and 2020 *Florida Building Code – Building and Florida Building Code – Residential*, including High-velocity Hurricane Zones (HVHZ).

Intertek is an approved evaluation entity and quality assurance entity pursuant to Florida Statute 553.842 – *Product Evaluation and Approval*.

9.2 National Electric Code: Timberline Solar, in combination with the Delta Electronics components and components that are listed under the user manual revision of Rev 2.1 has been evaluated as a system to the requirements in ANSI/CAN UL 3741 Photovoltaic Hazard Control.

When installed in accordance with manufacturer's installation instructions and this report, this system meets the requirements of Article 690.12 of the National Electrical Code for 2014, 2017, 2020, and 2023.

The terms to describe this function vary slightly in each Code cycle.

2014: *"Rapid Shutdown"* (RSD) Conductors leaving the array must drop to 30V or less within 10 seconds of rapid shutdown initiation. Equipment must be listed, but standards are not specified. *2014 NEC 690.12(2)* and *(5)*

2017: *"PV Rapid Shutdown Array"* (PVRSA) A listed assembly or system designed to *"reduce but not eliminate risk of electric shock hazard within a damaged PV array during fire-fighting procedures." 2017 NEC 690.12(B)(2)(1)*

2020: *"PV Hazard Control System"* (PVHCS) Equipment or multiple pieces of equipment listed to UL 3741 *"to reduce the risk of electric shock hazard within a damaged PV array for fire fighters." 2020 NEC 690.12(B)(2)(1)*

2023: *"PV Hazard Control System"* (PVHCS) Equipment or multiple pieces of equipment listed to UL 3741 "to reduce the risk of electric shock hazard within a damaged PV array for firefighters." 2023 NEC 690.12(B) (2)(1)

Refer to each Code cycle of the NEC for more detail.

See Table 2 for the approved list of PVHCS components (sub-assemblies not included).

10.0 CODE COMPLIANCE RESEARCH REPORT USE

10.1 Approval of building products and/or materials can only be granted by a building official having legal authority in the specific jurisdiction where approval is sought.

10.2 Code Compliance Research Reports shall not be used in any manner that implies an endorsement of the product by Intertek.

10.3 Reference to the https://bpdirectory.intertek.com is recommended to ascertain the current version and status of this report.

TABLE 1 – PROPERTIES EVALUATED

PROPERTY	APPLICABLE CODE SECTIONS[1]			
	2024 IBC	2024 IRC	2023 FBC - Building	2023 FBC - Residential
Material properties	1507.16.6	R905.15.4	1507.17.6	R905.17.5
Fire classification	1505.8	R902.3	1505.8 1516	R902
Wind resistance	1507.16.8	R905.16.6	1507.17.8 1518.11	R905.16.7
Wind-driven rain	NA	NA	1523.6.5	R4402
Impact resistance	UL 7103	UL 7103	UL 1703	UL 1703
Components	1506	R902	1506 1517	R902

[1]Section numbers in earlier editions of the Code may differ.

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TABLE 2 – PV HAZARD CONTROL SYSTEM (PVHCS) COMPONENTS (sub-assemblies not included)

Component & Function	Manufacturer	Model No.	Certification Standards	Years of Compliance to NEC 690.12[2]
Rapid Shutdown System	MidNite Solar	MNSSR-600S MNSSR-600S-SS	UL 1741 PVRSE	2014, 2017, 2020, 2023
Rapid Shutdown System	Enphase Energy Inc.	IQ8AC-72-M-US IQ8P-3P-72-E-US IQ8HC-72-M-US	UL 1741 PVRSE	2014, 2017, 2020, 2023
Rapid Shutdown System	Tesla	MCI-2	UL 1741 PVRSE	2014, 2017, 2020, 2023
Energy storage system, inverter	Tesla	1707000-xx-y	UL 1741, Photovoltaic Rapid Shutdown System	2014, 2017, 2020, 2023
PV rapid shutdown system (power optimizer)	Solar Edge Technologies Ltd.	S500B U650	UL 1741, Photovoltaic Rapid Shutdown System	2014, 2017, 2020, 2023
Rapid Shutdown System (Smart RSS)	Delta Electronics	GPI00010105	UL 1741 PVRSE	2014, 2017, 2020, 2023
Inverters	Delta Electronics	M4- TL-US M5-TL-US M6-TL-US M8-TL-US M10-TL-US	UL 1741	2014, 2017, 2020, 2023
	Growatt	MIN3000TL-XH-US MIN3800TL-XH-US MIN5000TL-XH-US MIN6000TL-XH-US MIN7600TL-XH-US MIN8200TL-XH-US MIN3090TL-XH-US MIN10000TL-XH-US MIN11400TL-XH-US	UL 1741	2014, 2017, 2020, 2023
	Solis	Solis-1P3.6K-4G-US Solis-1P5K-4G-US Solis-1P6K-4G-US Solis-1P7K-4G-US Solis-1P7.6K-4G-US Solis-1P8K-4G-US Solis-1P9K-4G-US Solis-1P10K-4G-US	UL 1741	2014, 2017, 2020, 2023
	Tesla	1538000-45-X	UL 1741 & UL 3741	2014, 2017, 2020, 2023

TABLE 2 – PV HAZARD CONTROL SYSTEM (PVHCS) COMPONENTS (sub-assemblies not included), *continued*

Component & Function	Manufacturer	Model No.	Certification Standards	Years of Compliance to NEC 690.12[2]
Inverters	Solar Edge Technologies Ltd.	SE3000H-US SE3800H-US SE5000H-US SE5700H-US SE6000H-US SE7600H-US SE10000H-US SE11400H-US	UL 1741	2014, 2017, 2020, 2023
PV Shingle Module (Solar Shingle)	GAF Energy	TLS-2 [1]	UL 61730 & UL 7103	2014, 2017, 2020, 2023
Wire Cover	GAF Energy	294000922 [1]	Tested in end-product within UL 3741 & UL 7103	2014, 2017, 2020, 2023
Top Flashing Assembly	GAF Energy	294000959[1]	Tested in end-product within UL 3741 & UL 7103	2014, 2017, 2020, 2023
Transition Box	GAF Energy	TB-2[1]	UL 1741 and tested in end-product to UL 3741 and UL 7103	2014, 2017, 2020, 2023
Pass Through Device	GAF Energy	PTD-2 [1]	UL 1741 and tested in end-product to UL 3741 and UL 7103	2014, 2017, 2020, 2023
Jumper Module	GAF Energy	TLS-2J[1] TLS-2 AJM [1]	UL 61730 & UL 7103	2014, 2017, 2020, 2023

[1] Evaluated as part of the listed PV Hazard Control System.
[2] See Section 9.2 for applicable Code sections related to specific Code years.

TABLE 2 (CONT.)

INSTALLATION REQUIREMENTS	
Max System Voltage	**600 VDC**
Max Array Internal Voltage After Actuation	600 VDC (cold weather V_{OC})
RSS Voltage Output after Actuation	≤30 VDC
Voltage Bleed-Down Interval	≤30 secs.
Max Series-Connected Solar Shingles per (1) RSS	48
OTHER INSTALLATION INSTRUCTIONS RECOMMENDED BY GAF	
INSTALLATION MANUAL REVISION Applicable for Integrated Rooftop Solar for Composition Shingle Steep Sloped Roofs, Installed Using "Timberline Solar Roofing System by GAF Energy LLC, Rev 2.1"	
1. RSS shall be secured inside the Transition Box using provided fasteners.	
2. One RSS must be connected to each series string (48 solar shingles max) or separate mounting plane subarray string. MCI and RSS may be installed on subarrays smaller than 48 series- connected solar shingles. For the most current specifications, instructions and limitations on the use of Delta Electronics components, please refer to their website at https://www.deltaww.com/en-US/ index	
4. Verification that each MCI or RSS is installed with 48 or fewer modules shall be documented for inspection by as-built string diagrams and/or voltage measurement logs. Voltage output per string not to exceed 600 VDC.	
5. The Delta RSS has a metal enclosure and shall be bonded to the EGC using the lay-in lug and M4 bolt provided, or by equivalent means approved in the NEC.	
6. A designated PV system disconnect shall serve as the RSD/PVRSA/PVHCS initiator and shall be sized, installed, and labeled in accordance with NEC requirements. The specific part shall be identified on the as-built system drawings. The inverters evaluated with this system are equipped with an integrated disconnect.	

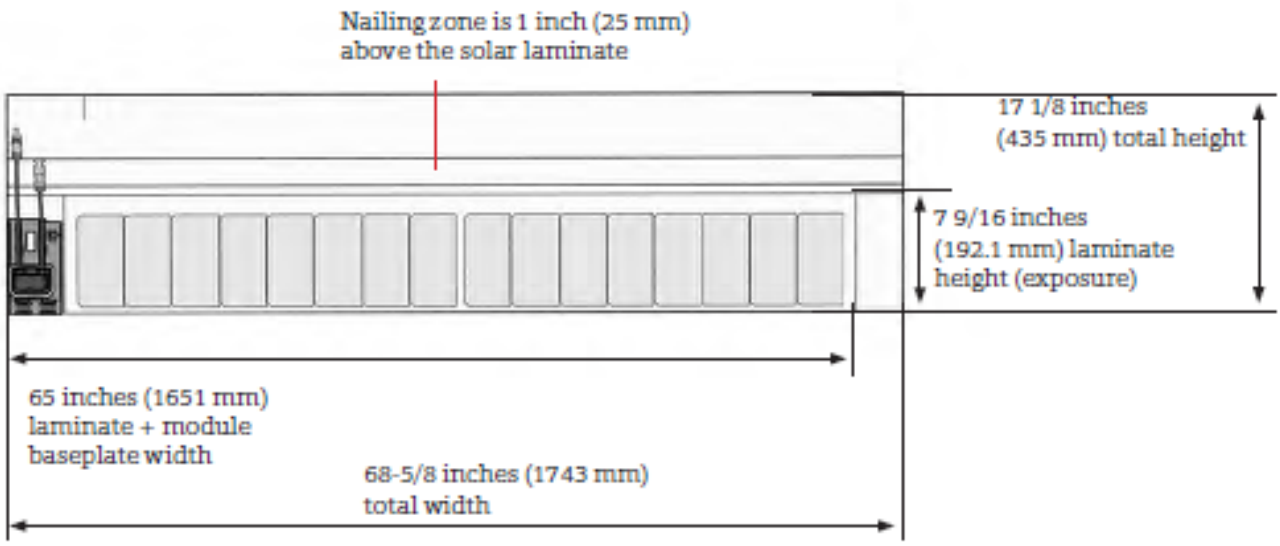
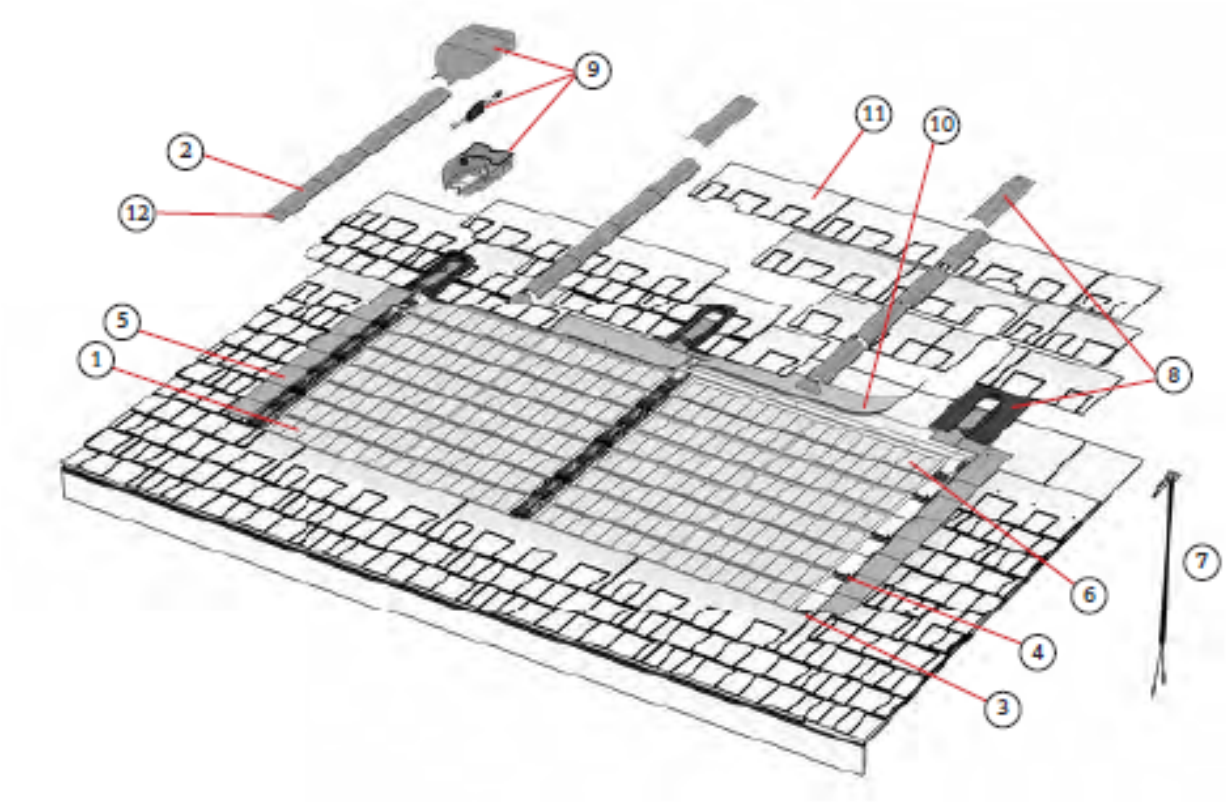


Figure 1 – Module Dimensions



1. Energy Shingle
2. Wire cover
3. Cover hook
4. Floating bracket
5. Step flap
6. Jumper module (JM)
7. Option 1: Pass-thru device for in-attic wiring
8. Top flashing
9. Option 2: Transition box for wiring on the exterior of the home
10. GAF QuickStart® Peel and Stick starter roll
11. Asphalt shingles
12. Bottom cap

Figure 2 – System Components