

# Millennia

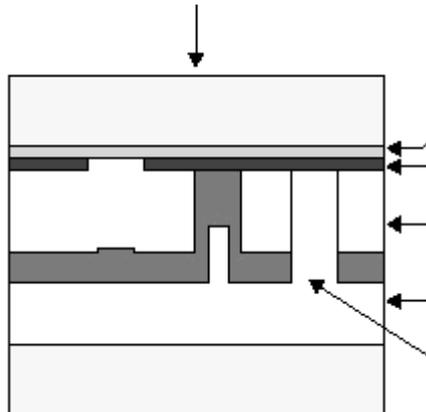
Millennia modules use hundreds of times less silicon and substantially less energy to manufacture than conventional PV modules, making them an ideal choice where resource use and environmental impact are important considerations. Millennia modules are available in two voltage categories: the MV series, designed for moderate- to high-voltage arrays; and the LV series, designed primarily for systems using 12-volt batteries or for other applications requiring a multiple of the nominal 12-volt increment. These modules and laminates can realize a cost savings of up to 25% over traditional products. MV products are particularly applicable to residential, commercial, and industrial utility-interactive arrays;

and direct-coupled (batteryless) water pumping systems. LV products are applicable to all traditional remote PV installations, particularly basic power systems for homes in developing nations. With their even coloration and precise laser scribing, Millennia products are especially suited to architectural applications and other applications where appearance is important. They are available in two standard configurations: • Framed with clear-anodized (standard) or bronze anodized (optional) extruded aluminum framing and

a high-volume junction box;  
 • Equipped with the Integra™ framing/mounting/ wiring system (MV models only) for low-cost, fast installation and direct roof-mounting. For OEM applications, they may also be special-ordered as frameless laminates. **Rated Power Guaranteed** Millennia photovoltaics are conservatively rated, taking into account the attenuation which occurs during the first several months of a thin film product's solar exposure. They are guaranteed to deliver at least their rated minimum power when purchased and 80% of their rated minimum power 20 years after purchase. (Rated minimum power is the lower margin of the module's power [ $P_{max}$ ] tolerance window.) Contact bp solar Marketing for full terms of this limited warranty. **bp solar's Millennia™ photovoltaic modules use advanced tandem-junction thin-film technology to transform light energy into electricity. bp solar is a pioneer in thin-film technology, which creates solar cells by depositing semiconductor alloys in thin layers on glass. A major development in both efficiency and stability, the tandem-junction structure stacks two solar cells vertically, with each cell tuned for optimum conversion of different segments of the spectrum.**

*Top: Integra™ framing showing channel and wiring. Bottom: Universal framing. MST-43MV with Integra™ framing. The Natural Source for Electricity™ bp solar's Millennia modules require less energy to manufacture than conventional PV products, giving a much faster energy payback (typically less than one year) and a larger lifetime*

contribution of green energy. **Photovoltaic Modules**



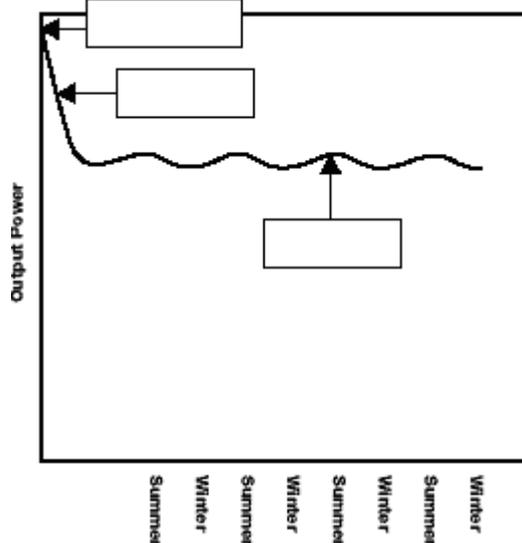
When first deployed, Millennia modules generate as much as 18% above their rated power. In some applications, this initial power bonus must be considered when sizing power system components such as wiring, inverters and switchgear. **Savings in High-Voltage Systems** Because MV modules are designed specifically for medium- and high-voltage arrays, they can provide savings beyond their competitive pricetags. A 200-volt array, for example, needs only three MV modules in series instead of the twelve needed with traditional modules, greatly reducing interconnection time and materials. Additional savings may be realized because, in most applications, a Millennia module doesn't require the protection of bypass diodes in a high-voltage array. Its microstructural uniformity and large-area electrical connections give it the ability to withstand reverse voltages that destroy some other modules. Also,

Millennia modules operate on a broader power curve than most modules, facilitating module power matching and ensuring maximum power from the array. **Laser-Scribed Monolithic Structure** Millennia modules are made in bp solar's new automated thin film manufacturing facility. A patented laser-scribing procedure forms the individual solar cells, with all intercell electrical connections (shown below) internal to the module. This monolithic structure is innately reliable, and is unique among large power-producing photovoltaics. The conductive oxide layer is applied by a proprietary process which yields excellent film uniformity, improves optical coupling and enhances module efficiency. The combination of laser processing and ultra-uniform textured tin oxide film produces a module which is both attractive and efficient. The laser's precision means cell divisions can be very thin, maximizing the glass surface area devoted to power production. **Attractive and Uniform** Millennia modules are extremely attractive, with a slate-colored surface well-suited to many architectural applications. Because they are more uniform in appearance than most PV modules—particularly round-cell modules—they integrate easily into architecture. They complement many standard building materials and can be provided with color matching for critical applications. **Proven Reliability and Materials** Millennia modules pass the test requirements of ANSI Z97.1 and CEC 701(IEC 1646), which include tests measuring the effects of extended solar exposure, application of reverse voltage, robustness of terminations, hail impact, and annealing. The tests include:

- 200 cycles between -40°C and 85°C;
- 1000 hours exposure to 85°C at 85% relative humidity;
- 10 cycles between -40°C and 85°C at 85% relative humidity;
- dry and wet current leakage (before and after above tests). Millennia materials reflect bp solar's 25 years of experience with PV systems installed in virtually every climate on Earth. Laminates comprise two 3mm sheets of glass with EVA (ethylene vinyl acetate) encapsulation providing a weatherproof seal. Universal module frames are corrosion-resistant anodized extruded aluminum—strong, attractive framing compatible with bp solar mounting hardware and a broad range of other mounting structures. **Safety Approved** For over twenty years, bp solar has manufactured PV modules not just to its own rigorous specifications, but to demanding specifications of various U.S. and international agencies and laboratories. Millennia approvals and certifications include:

- listing by Underwriter's Laboratories for electrical and fire safety (Class B fire rating);
- in the Universal-frame configuration, approval by Factory Mutual Research for application in NEC Class 1, Division 2, Groups A, B, C & D hazardous locations;
- in a special configuration, certification by TUV Rheinland as Class II equipment.

• Compliance with the requirements IEEE 1262 and IEC 1646. Silicon  
Dioxide Tin Oxide Glass Light Glass EVA a-Si/a-SiGe  
Tandem Intercell  
Scribe Back  
Contact



**Integra-Framed Modules** Millennia MV modules are available with bp solar's patent-pending Integra™ framing/mounting/wiring system, which facilitates quick, low-cost installation

on most support structures and on sloped surfaces such as roofs. These modules include integral plug-together electrical connectors which enable array electrical connection without tools. Once assembled, the connectors are concealed in channels in the bronze-anodized frame, providing smooth, uncluttered appearance yet easy access for troubleshooting. For U.S. NEC-compliant installation, additional components are required, and are available in the UL-listed installation kit. **Electrical Characteristics** Like a crystalline module, a Millennia module's peak

power and short-circuit current are approximately proportional to irradiance. However, projecting Millennia's on-site performance is more complex than projecting crystalline performance, since it depends not only on instantaneous illumination and temperature, but on duration of deployment and insolation/thermal history during deployment. The module's unique performance factors include initial output attenuation on exposure to sunlight, and response to temperature change. **Initial Output Attenuation** Like all amorphous silicon photovoltaics, a Millennia

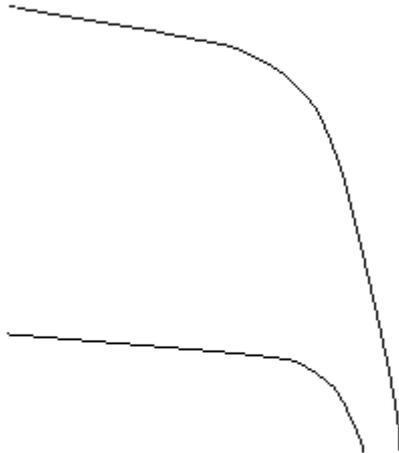
product's power output decreases during the first few months of solar exposure. This attenuation, shown conceptually above, is recognized in Millennia's rated electrical characteristics. Initial power may be as much as 18% higher than rated; voltage, 12% higher; and current, 6% higher. This initial power bonus must be considered when

designing the power system. **Effects of Temperature** In the short term, temperature changes affect Millennia output similarly to the output of a crystalline module: as module temperature increases, current increases and voltage decreases, with a slight reduction in peak power. However, extended exposure to elevated temperature causes an annealing effect which partially counters attenuation. As a result, in long-term operation under typical conditions, Millennia peak power does not vary more than 10%

due to temperature changes, with efficiency increasing in warm seasons. **Rated Electrical Characteristics<sup>(1)</sup>** MST-43MV MST-43LV Maximum power ( $P_{max}$ ) 43W  $P_{max}$  tolerance  $\pm 10\%$  Voltage at  $P_{max}$  72V 16.5V Current at  $P_{max}$  0.6A 2.6A Open-circuit voltage ( $V_{oc}$ ) 98V 22.7V Short-circuit current ( $I_{sc}$ ) 0.8A 3.3A Design Max  $V_{oc}$ <sup>(2)</sup> 117V 27V Nominal voltage 48V 12V Minimum blocking diode 3A 6A Maximum system voltage 600V Series fuse rating 20A<sup>(3)</sup> Notes (1) Performance ratings are based on measurements made at Standard Test Conditions (STC), which are illumination of 1 kW/m<sup>2</sup>

(1 sun) with a spectral distribution of AM 1.5 and cell temperature of 25°C. All performance parameters  $\pm 10\%$ . Contact bp solar for

additional performance information. (2) For maximum system voltage design calculations. (3) 15A for modules with Integra framing and connectors. Initial Power Attenuation Annealing **Typical Output over Time**





Current (A) Current (A)

4 3.5 3 2.5 2 1.5 1 0.5 0 Voltage (V) 0 5 10 15 20 25 **MST-43LV I-V Curves** 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0 Voltage (V) 0 20 40 60  
 80 100 120 **MST-43MV I-V Curves** **Curve Conditions:** All curves at cell temperature of 25°C and spectral distribution of AM 1.5;  
 Upper curves at 1 kW/m<sup>2</sup> illumination;  
 lower curves at 250 W/m<sup>2</sup> illumination. *MST-43LV with Universal framing.* **Mechanical Characteristics** Dimensions in inches [mm]  
 Overall tolerances ±1/8" [3mm] **Universal-Framed Module**  
**Weight: 34.8 pounds (15.8 kg)**

**Dimensions: see drawing Integra-Framed Module**

**Weight: 32 pounds (14.5 kg)**

**Dimensions: see drawing Unframed Laminate (Special Order)**

**Weight: 28.5 pounds (12.9 kg)**

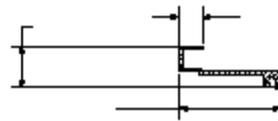
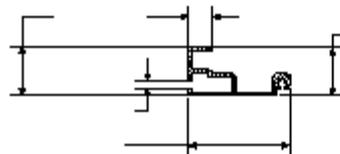
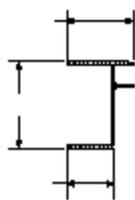
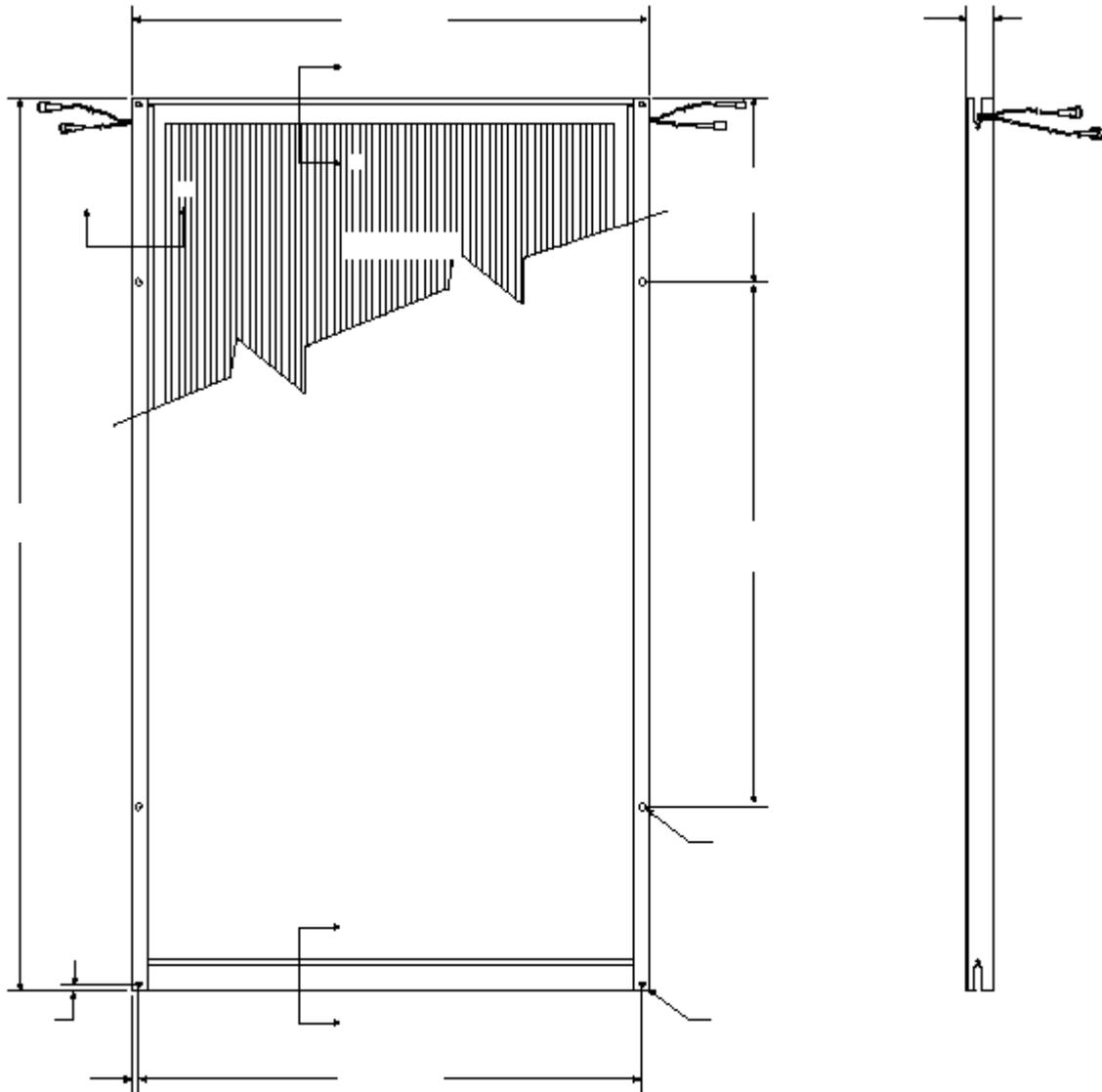
**Dimensions:**

**25.88 [657] wide**

**48 [1219] long**

**0.26±.025 [6.6] thick**





Back View 28.38 [721] Ref. 0.38 [9.6] Dia.  
 mtg. holes 4 plcs. Ground clip  
 mtg. slots

4 plcs. 27.06 [687] C C 0.34 [8.6] 0.38 [9.7] 48.38 [1229] A A B B 27.74 [705] 10.00 [254] Ref. 1.50 [38]

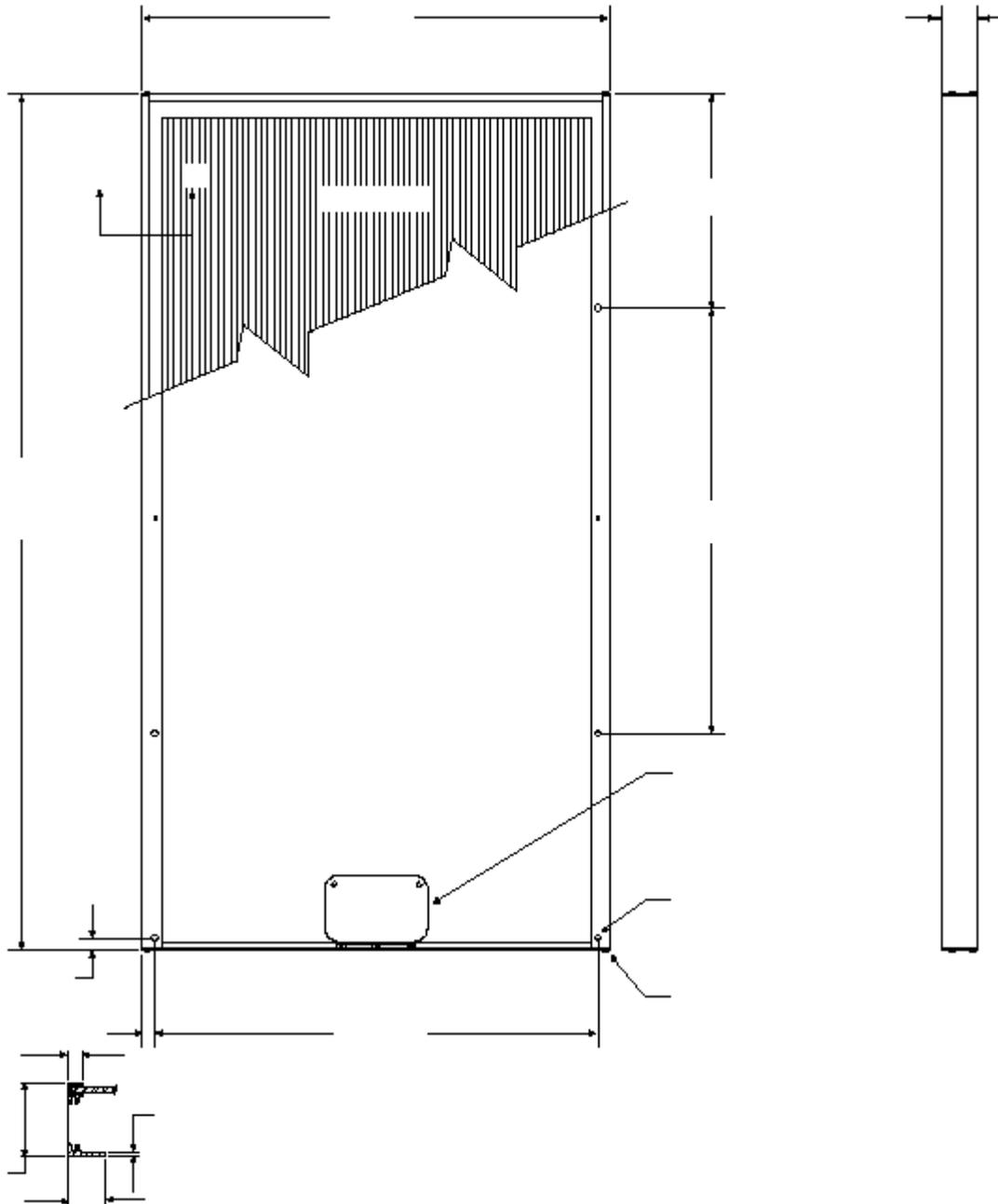
Section C-C

End frame without wire trough 0.72 [18.4] 0.41 [10.3] 1.74 [44.2] Section B-B

End frame with wire trough 0.12 [3.0] 1.74 [44.2] 0.83 [21.1] 0.41 [10.3] 0.83 [21.1] 1.16 [29.4] 1.50 [38.1] 0.81 [20.6] MST-43 with

Integra Frame Front View Section A-A Side View **Dimensions** Dimensions in brackets are in millimeters. Unbracketed dimensions are in inches.

Overall tolerances  $\pm 1/8"$  (3mm)



26.24 [666] X 12.13 [308] Ref. 24.00 [610] Ref. Junction box 0.38 [9.6] Dia.  
 mtg. holes 8 plcs.

8 plcs. 0.10 [2.5] Max  
 screw head

projection [10 Plcs.] 1.97 [50] 24.87 [632] 0.69 [17.4] 0.69 [17.5] 48.38 [1229]

[Does not include screw head projection] 1.97 [50] MST-43 with Universal Frame Side View Back View X Front View 0.44 [11.2]  
 0.09 [2.3] 1.06 [26.9] 1.98 [50] Section X-X