1. Quality & RD Capabilities

2. Honey M

3. Trinasmart
Overview of Quality Tests

Over 30 in-house tests

- **Environmental Reliability Testing**
  Extreme environmental testing ensures reliability and performance in the most unforgiving environments
  - Wet Leakage Test
  - Damp Heat Test
  - Mechanical load Test
  - Highly Accelerated Stress Test
  - Humidity Freeze Test
  - Outdoor Exposure Test
  - UV Preconditioning Test
  - Impact Testing
  - Corrosive Atmosphere Test
  - Hot-spot Endurance Test
  - Insulation Test (Dry & Wet)
  - Thermal Cycling Test

- **Component Testing**
  Testing of module components maximizes electrical output and minimizes module degradation
  - Bypass Diode Test
  - Measurement of NOCT
  - Electrical Component Testing
  - Flash Testing
  - Micro-crack Testing
  - Q. C. throughout Manufacturing Process
  - Materials & components testing
  - Measurement of NOCT

- **Long-term Strategic Partnerships** to perform in-house certification testing

- **Trina Solar**
  Smart Energy Together
Innovation Excellence

Trina Solar is the first PV firm to receive the Client Test Data Program (CTDP) Certification

- Trina Solar laboratories can independently test for and issue UL recognized data
- Affirms testing staff, standards and capabilities are of the highest caliber in the PV industry

Capabilities: Product certification, material reliability testing, highly accelerated aging test, a comprehensive range of test material evaluation, and other research
1. Quality & RD Capabilities

2. Honey M

3. Trinasmart
Honey Technology

• World Record for Multi-Crystalline Modules
  – 274 Wp in September 2011
  – 284.7 Wp in May 2012
  – 324.4 Wp in May 2014
  – All confirmed by TUV Rheinland

• Highly Developed Technology
  – Enhanced Structure and lower Reflection
  – Smaller Fingers and Busbars
  – Better Performance under Low-Light-Conditions
  – Improved High Temperature Performance
  – Selektive Emitter
  – Backside Passivation
  – High transparent EVA
  – Highly reflecting Backsheet
Honey M – DC05A.05

Innovative Honey M Technology

16.4% Module efficiency

Available from 260W to 265W

Outstanding Performance under Low-Light-Conditions

Attractive Appearance:
- Black Frame
- Dark Cells
- Black Backsheet

Perfect for Homes and commercial systems

Excellent Wind- and Snowload (2400/5400pa)
Honey M – DC05A.8

DC05A.08

Innovative Honey M Technology

17.1% Module efficiency

Available from 265W to 275W

Outstanding Performance under Low-Light-Conditions

Attractive Appearance:
- Black Frame
- Dark Cells

Perfect for Homes and commercial systems

Excellent Wind- and Snowload (2400/5400pa)
Honey M – Excellent spectral response

Solar Panels Efficiencies

<table>
<thead>
<tr>
<th>TSM-260DC05A</th>
<th>TSM-265DC05A</th>
<th>TSM-270DC05A</th>
<th>TSM-275DC05A</th>
<th>TSM-280DC05A</th>
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<tbody>
<tr>
<td>17.2%</td>
<td>17.1%</td>
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<tr>
<td>16.8%</td>
<td>16.7%</td>
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<tr>
<td>15.8%</td>
<td>15.8%</td>
<td>15.8%</td>
<td>15.9%</td>
<td></td>
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</table>

Solar Panels Efficacies

IQE [%]

wavelength [nm]

Trina Solar
Smart Energy Together

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1. Quality & RD Capabilities
2. Honey M
3. Trinasmart
How Trinasmart Works

Trinasmart modules communicate wirelessly through the gateway to the MMU, allowing users to monitor and optimize system performance in real time.
Trinasmart System Components

- PCB integrated in the J-Box
- Maximizes the Module performance
- Receives it’s “setting” from MMU via GW
- Gives Module performance back to GW for Monitoring purposes

- Gateway sends “setting” to each Module
- Forwards information from Modules to MMU
- Each Gateway can handle up to 120 Trinasmart Panels
- 15m of eye-sight wireless range
- Mounted on module or racking

- Sets Modules operating points
- Sends information to GW
- Can handle up to 360 Modules
- Connects to max. 6 GWs
- Connected via Ethernet to Internet for monitoring function
- Has to be connected to Inverter via cable
- What happens with shade?

**WITHOUT**

\[
\sum_{1}^{3} P = 420W
\]

<table>
<thead>
<tr>
<th></th>
<th>30.4V</th>
<th>140W</th>
<th>4.6A</th>
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</thead>
</table>

**WITH**

\[
\sum_{1}^{3} P = 610W
\]

<table>
<thead>
<tr>
<th></th>
<th>30.4V</th>
<th>240W</th>
<th>7.89A</th>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>28V</th>
<th>140W</th>
<th>4.6A</th>
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</table>

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<th>240W</th>
<th>7.89A</th>
</tr>
</thead>
</table>

Shading

3.29A
| **Safe installation** | No potentially dangerous voltages present before system commissioning  
|                       | No Sparks, No Electrical risk |
| **Module level arc fault detection and switch off** | |
| **Module-level disconnect for maintenance and emergency response** | Automatically when the electricity supply is switched off  
| | Or manually via the PV Safe button or remotely via the web |
| **Low-voltage shutoff mode** | Austria and France require it, Germany in 2014. |
More efficient O&M

Monitor panel-level data in real time reports & analytics

Diagnose problems remotely
Diagnose problems accurately

Maintain up time & reduce O&M costs

Installer Benefits
- Show performance of all installations in one consolidated web page (no development time/expense required)
- Potential for new business stream to provide proactive maintenance

End-Customer Benefits
- Automated monthly reports show system performance
- Comfort that someone can identify any system issues remotely
Trinasmart Maximizes the Energy Harvest

**Traditional System**

- Module output is limited by the lowest string amperage
- One underperforming module can bring down an entire string

**Causes of mismatch**

**Shading**
- Shaded modules pull down others

**Output variance**
- In each power bin, a +0W module will pull down a +5W module

**Degradation variance**
- Faster degrading modules pull down others as they age

---

**Trinasmart DC**

- Allows each module to operate independently
- The more mismatch in a system the more extra energy delivered relative to a traditional array

---

**Mismatch drags down a string**

Canyon High School, 2/22/13
Shade Affects 38 modules more than 50%

**Trinasmart corrects mismatch**

Canyon High School, 2/09/13
Shade Affects 9 modules more than 50%
Advantages

• Strings up to 30 % longer, lower resistive losses
• Reduction in BOS (Combiners, Fuses, Cables, etc.)
• Reduced workmanship
• More efficient Inverters

Voltage Limit

• Set in the factory to 33.4V $V_{OC}$
• Temperature Independant

Trinasmart – Reduced BOS cost due to SmartCurve

Trinasmart I-V Curve

$V_{T5} = 33.4V$
Smart Curve Changes the Electrical Spec of Modules

**Max Voltage**
- Programmed at factory
- Not temperature dependent

**Certification**
- UL1741, EN62109-1
- TUV, CSA spec approved
- Compliant with IEC and NEC

**Benefits**
- 30% longer strings
- 30% lower I²R losses
- Fewer BOS components
- More efficient inverters

**Trinasmart IV Curve**

**String Length**

<table>
<thead>
<tr>
<th>String Power (W)</th>
<th>TSM-270 DC05A</th>
<th>TSM-270 DC05A.082</th>
<th>TSM-265 DC05A</th>
<th>TSM-265 DC05A.082</th>
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<tbody>
<tr>
<td>1000V Strings</td>
<td>23</td>
<td>29</td>
<td>23</td>
<td>29</td>
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<tr>
<td>850V Strings</td>
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<tr>
<td>800V Strings</td>
<td>23</td>
<td>24</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>String Power (W)</td>
<td>6.480</td>
<td>6.750</td>
<td>6625</td>
<td>6.890</td>
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</tbody>
</table>

**Electrical Specifications**

<table>
<thead>
<tr>
<th></th>
<th>TSM-270 DC05A</th>
<th>TSM-270 DC05A.082</th>
<th>TSM-265 DC05A</th>
<th>TSM-265 DC05A.082</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{mpp} (V)</td>
<td>30.8</td>
<td>30.6</td>
<td>30.6</td>
<td>30.6</td>
</tr>
<tr>
<td>V_{mpp,T=-10°C} (V)</td>
<td>34.2</td>
<td>33.4</td>
<td>34.1</td>
<td>33.4</td>
</tr>
<tr>
<td>V_{oc} (V)</td>
<td>38.6</td>
<td>33.4</td>
<td>38.5</td>
<td>33.4</td>
</tr>
<tr>
<td>V_{oc,T=-10°C} (V)</td>
<td>42.8</td>
<td>33.4</td>
<td>42.6</td>
<td>33.4</td>
</tr>
<tr>
<td>Module Power (W)</td>
<td>270</td>
<td>270</td>
<td>265</td>
<td>265</td>
</tr>
</tbody>
</table>

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The Integrated Trinasmart Solution

Optimization factory installed and calibrated

- Safe & Easy to install
- Time, labor and shipping savings
- Low possibility for error

Trinasmart is Compatible with ALL inverters worldwide
Over 1,200 inverter types operating successfully in the field with Trinasmart equipment
The Benefits of TrinaSmart DC

**The Safest Solar**
- Panel-level disconnect to remotely deactivate module power
- Arc and over-temperature detection, fire and safety hazard mitigation

**More Efficient O&M**
- Panel-level monitoring to pinpoint problems
- Detailed real-time alerts and analytics

**Highest Power Density**
- Install more modules on any roof, even in partially shaded areas
- Uneven string length enables design flexibility

**Maximized Energy Harvest**
- Impedance matching technology eliminates mismatch loses
- More power from each module class

**Lower BOS Cost**
- 30% lower max open circuit voltage, 30% longer strings
- Fewer combiner boxes, fuses and copper wiring required

**Fully Integrated**
- Compatible with any inverter
- No additional boxes to mount to a module
Thank you