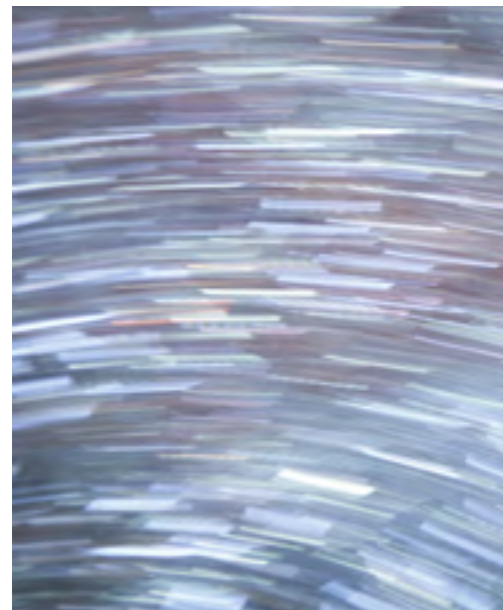


Multi-Tabbing

PV WIRE



Solar Technologies



Ulbrich Solar Technologies Inc. (UST) is a world leader in PV Ribbon products used to interconnect and transmit current for crystalline silicon and thin film solar cells. For decades, UST has supplied the Solar Industry with tinned flat copper ribbon while continuously identifying emerging PV Ribbon technologies and engineering innovative solutions to increase the electrical output and performance of solar modules.

Ulbrich Solar Technologies Inc. (UST) has always been a reliable development partner for the Photovoltaic Industry. The dedication to continuous innovation and product development ensures leading edge technologies are available to various customers and partners in the Solar Industry.

The solar cell is arguably the most critical component of a solar module. The evolution to high-performance solar cells has drastically improved the power performance of PV modules making it possible to achieve module outputs > 300 watts. These new developments have resulted in the consistent achievement of new solar cell performance records.



Ulbrich Solar Technologies Inc. (UST) recognized this change in c-Si cells and adapted the Multi Bus-bar technology to strengthen its position as the innovative leader of PV Ribbon products. In addition to the standard flat PV Ribbon and our Light Capturing Ribbon (LCR), Ulbrich Solar Technologies Inc. is able to supply a full portfolio of PV Ribbon products for today's diverse module designs.

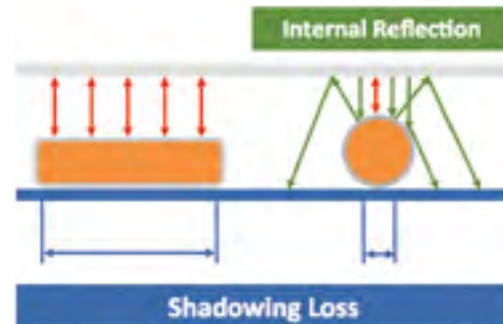
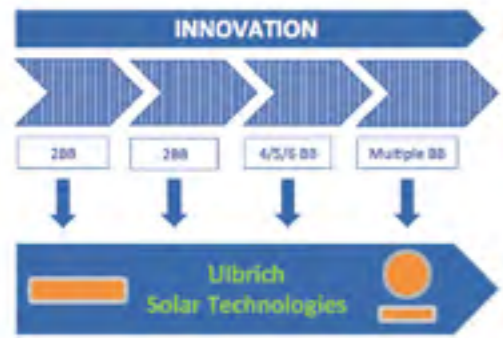
Multi-Tabbing PV Wire is the newest development for the multiple Bus-bar technology. Over the years, UST has leveraged experiences in product development, manufacturing and marketing competences to engineer a solder coated copper round wire for cell interconnection.

Ulbrich's Multi-Tabbing PV Wire offers the same high quality and product performance standards you are familiar with from all our other products we supply to the PV Industry.

Multi-Tabbing PV Wire is available in all common copper grades including high-purity oxygen-free copper. There are no limitations regarding the available dimension you need to build the best performance modules.

We have developed a solder coating process to achieve concentric coating layers to guarantee consistent soldering results in the stringing process. The options of solder materials have been expanded to include bismuth and indium alloys, in addition to our standard SnPb alloys.

| Multi-Tabbing PV Wire Specification | |
|--|---|
| Base material | CDA 110 / ETP-1 CDA 101 / CDA 102 / OF-1 copper |
| Dimension | Ø 0.200 - 0.500 ± 0.005 [mm] |
| Coating alloy | Sn60Pb40 |
| | Sn100 |
| | Bi58Sn42 |
| Coating thickness | Sn62Pb36Ag2 |
| | Sn96.5Ag3.0Cu0.5 |
| Mechanical Properties | 2.0 – 5.0 [µm] |
| | 10.0 – 20.0 [µm] |
| | $R_m < 270$ [N/mm ²] $R_{p0.2} < 100-160$ [N/mm ²] $A > 20$ [%] |
| Spool | 10S |
| | H20 |
| | K125 |
| Customized specifications available upon request | |



Innovative solar cell concepts require adaptive Bus-bar technologies that promise efficiency gains, lower series resistance, less shadowing and the reduction of silver consumption.

Two and three Bus-bar technologies have dominated the Solar Industry for a long time, however advanced and more powerful generations of solar cells require new designs and a higher number of Bus-bars to carry the extra current. Today's technology includes four, five, six or even more Bus-bars.

One of the new innovations in PV module design and solar cell technology has replaced the traditional use of copper flat wire with a tinned copper round wire.

The small dimension of the round wire allows a narrower Bus-bar width on the solar cell reducing the shadowing loss with traditional rectangular ribbon, while maintaining optimal power gains for the best output results.

The natural curved shape of the round wire's surface makes it possible to reduce the shadowing loss by internal light reflection.

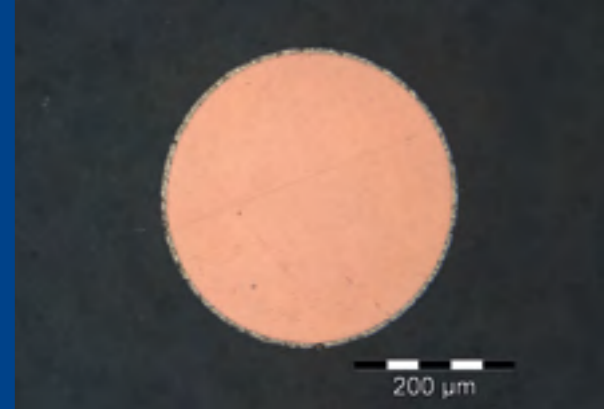
Multiple Bus-bar solar technology will make significant contributions to present and future PV module performance achievements.

Optimized mechanical properties of the Multi-Tabbing PV Wire improve the thermo-mechanical stress situation caused by the different thermal expansion coefficients of the copper wire and silicon solar cell.

Standard and custom PV Ribbon spools can be offered to fit current pay-off systems of the stringer equipment.

In summary Multi-Tabbing PV Wire is,

- Concentric solder coated round wire for high efficiency solar cell modules
- Available in lead or lead free solder materials including special low melting temperature materials
- Engineered to your unique dimension, surface coating and physical property requirements
- Manufactured with state of the art processes to ensure consistent product properties
- Precision wound and packaged for safe transportation and stringer processing
- Flexible concerning cell bond options regardless of the heat source
- Manufactured according to ISO certified processes





Solar Technologies

Ulbrich Solar Technologies, Inc.

Corporate Headquarters

692 Plant Road
Westminster, SC 29693 USA
Tel: +1 (864) 647-6-87
E-mail: solar@ulbrich.com

UST South Carolina

692 Plant Road, P.O. Box 619
Westminster, SC 29693 USA
Tel: +1 (864) 647-6087
Fax: +1 (864) 647-0482
E-mail: flatwire@ulbrich.com

UST Oregon

22975 NW Evergreen Parkway, Ste 404
Hillsboro, OR 97124 USA
Tel: +1 (503) 597-6880
E-mail: solar@ulbrich.com

Ulbrich of Austria GmbH

Industriestrasse 1
A-7052 Müllendorf, Austria
Tel: +43-676-729-4230
E-mail: Austria@ulbrich.com