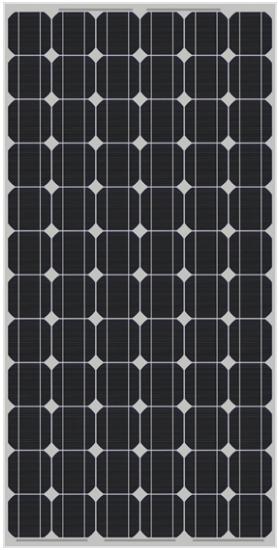
Subject: Solar Cell Tabbing and Bussing	Product: Sigma-5	Doc#: AO.MCD.10.016
Title: Solar Cell Tabbing and Bussing		

Solar Cell Tabbing and Bussing

Application Overview



Tabbing and bussing are two applications that link individual solar cells together to form a solar module (or solar panel). These applications also provide a method to transfer power from the solar cells to a power output, the junction box. Solar cell interconnect occurs when individual solar cells are joined together with tabbing ribbon (also called stringing ribbon), forming a cluster of solar cells. This is frequently referred to as cell tabbing (or stringing). The tabbing ribbon carries the solar cell's current to a larger ribbon, the bus ribbon, which then carries power from the cell clusters to the module's junction box for final output.

Application Challenges:

- Precise positioning of the tabbing and bus ribbons on the solar cells.
- Repeatability to assure maximum efficiency.
- Simple programming for faster machine commissioning.
- Interoperability with EtherCAT network.

Yaskawa Products:

Product	Feature	Benefit
Sigma-5	SGDV Sigma-5 Servo amplifier frequency response of 1.6kHz	Faster settling times allow for higher performance of the servo system.
	20-bit absolute encoder standard on all Sigma-5 servomotors	Precise positioning and repeatability requirements can be met without increased cost to the user
	SGDV with EtherCAT option card	Interoperability with existing standards.
MotionWorks IEC Software	IEC61131-3 Global Standard Programming Environment	Reduced learning curve. User libraries of pre-defined functions are easily incorporated into new projects, saving time and speeding the build cycle.
MP2000iec Controllers	Multi-Axis Control	Up to 16 axes controlled with one controller.

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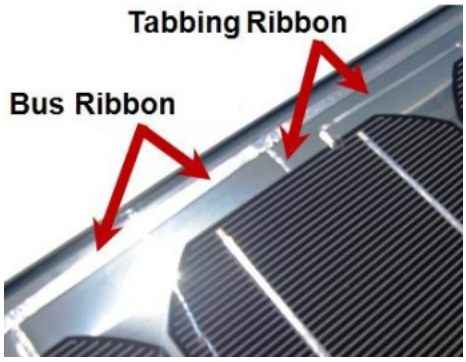
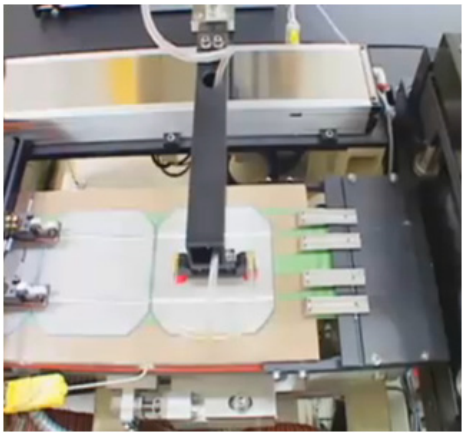
Application Details:

The top layer of a solar cell is a Transparent Conductive Oxide (TCO) to which solder will not adhere. Therefore, a paste is applied to the TCO to provide a solderable surface for the tabbing and bus ribbons to be applied. Tabbing ribbon and bus ribbon are both made from solder-coated oxygen-free high conductivity (OFHC) copper. The solder protects the surface of the copper from oxidation and provides a layer of solder to form the solder joint. The main difference is the width of the ribbon. Tabbing ribbon is typically about 2 mm wide, while bus ribbon is about 5 mm wide.



Tabbing and Bus Ribbons

Tabbing ribbons are commonly applied as parallel strips that weave from the top of one cell to the bottom of the next to connect the positive and negative sides of the cells in series. The ribbon is soldered onto the paste that was applied to the TCO. The tabbing application creates a cluster of solar cells. Once all of the cells have been strung together with tabbing ribbons, they are then placed onto a substrate, typically glass. Then the thicker bus ribbon is soldered so that it connects to the tabbing ribbon of each solar cell cluster. The tabbing ribbon collects electric current within its cluster of solar cells and delivers it to the bus ribbon. The bus ribbon then conducts the cumulative electric power from all of the solar cell clusters to a junction box for final output. Imagine tabbing ribbon as a road that travels across the solar cell. The bus ribbons serve as the highways to connect and tie them together. Bus ribbon is larger in cross-section because it has more electrical power to carry.



Tabbing ribbon applied to solar cells

Material handling and XYZ positioning are used throughout the tabbing and bussing processes. Sigma-5 amplifiers perform with a 1.6 kHz frequency response. With one parameter auto-tuning, they are capable of reducing settling times to under 4ms. This allows for higher cycle times. All Sigma-5 servomotors feature a standard 20-bit absolute encoder. This provides greater positional precision and enhances repeatability, both keys for tabbing and bussing applications.

MP2000iec controllers with up to 16 axes of control can easily accommodate these material handling and positioning applications. MotionWorks IEC Software features a variety of pre-programmed functions that are easily incorporated into new projects, speeding up development time for the controller.