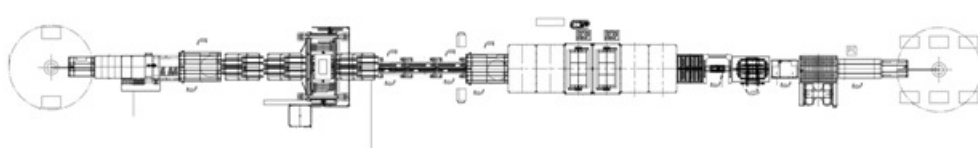


APPENDIX 1

Technical Specification

1 Overview



Solar Cell Characteristics

Cell dimensions	156 x 156 mm (6")
Cell thickness	160/180 ± 30 µm, pre-sorted
Max. bow	± 1 mm
Material	Mono- and polycrystalline, square and pseudo-square

String Characteristics

Cells per String	8 - 12 (6")
Distance between cells	2 - 10 mm
Max. length of string	2000 mm

Panel Characteristics

Glass Thickness	3.2 – 4 mm
Width	990 mm +/- 30 mm
Length	1.315 / 1640 / 1960 mm +/- 40 mm
Module dimensions	6x10 (60 cells), with automated interconnection

Line Dimensions

Length	See layout drawing
Width	See layout drawing
Working height	1.000 mm +/- 50 mm

Machine Colour

Machine	RAL 9016 traffic white
Switch Cabinet	RAL 9032 stone grey

Operation side

Operation side	Right
Transport direction	Left - Right

Power Supply

Type	3 phase/N/PE
Operation voltage	400 V AC +/- 10%
Operation frequency	50 Hz
Control voltage	24 V DC
Power consumption of line	To be determined

Pneumatics

Operation pressure	6 bar
Air consumption of complete line	To be determined

Controls

Control system	PLC Siemens S7
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Documentation and Operating Languages

Operating Manual	Italian
Machine Marking	Italian
Control System	Italian
Spare Parts List	Italian
Further Documents	Italian

Throughput of line

Calculation basis standard module (Glass – EVA – Cells – EVA – Backsheetfoil)

Working hours / day	24 h
Working days / year	365 days
Cells / string	10
Strings / module	6
Wafer power	4,2 Wp (6")
Modules per lamination	8 pcs.
Production per year	50 MW module power Depending on used EVA foil.

Parameters

Breakage rate at stringer	< 0.3%
Uptime	For more Details see Cell Specification min. 90 %

Ambient Conditions

Relative humidity	Max. 60 %
Air temperature	22°C ± 2°C
Floor loading	Min. 1.500 kg/m ² / 4.000 kg/m ² Laminator
Air temperature storage foils	22°C +/- 2°C

2 Equipment

2.1 Tabber Stringer



FUNCTION

The tabbing unit is equipped with a turntable that very precisely indexes the cells to the individual processing stations. Initially, solder ribbon for the rear side of the cells is drawn from a roll, flux is applied to it over a flux bath, then the ribbon is affixed in a frame on the turntable and finally cropped. Then the turntable is indexed to the next step in the process. Solar cells are then introduced to the machine by means of a transport carrier and separated using separation nozzles. The cells are taken by a suction gripper and placed sunny side up on the prepared solder ribbon on the turntable. A camera checks the exact orientation of the grids in relation to the ribbons. In the next process step, the solder ribbons are prepared for the front side of the solar cell. When the solder ribbons and cell are exactly positioned, the turntable indexes further to the soldering position. Here only the upper soldering ribbons are contacted. The solder is melted by means of resistance heating and the solar cell is fused with both the front and the back soldering ribbon. Finally the bus bars are cut to the correct length by a cutting unit. Thereafter, a camera checks the tabbed cells for breakage, those that are found to be undamaged are passed to a flip unit by means of a gripper system and are placed sunny side down on the stringer axis. Damaged cells are placed in a box provided for that purpose.

The tabbed cells are held exactly in position on the stringer unit, sunny side down on vacuum tables, and then soldered together using a PID controlled laser. Finally, the stringer advances the finished string to the hand-off position and transfers the string to the Layup Station for further processing.

ADVANTAGES

- Low space requirement due to compact design
- Accurate positioning of the solder ribbons
- Contact-free soldering
- Homogeneous temperature profile within the entire ribbon - bus bar connection
- Minimal thermal stress
- Maintenance-free
- Lead-free soldering

2.2 Layup Station



FUNCTION

On the Stringer unit the tabbed cells are joined together to a complete string by laser soldering. Subsequently the strings are picked up by the layup portal. For quality assurance purposes there's an optical inspection system to identify potential breakage and misalignment/orientation of the strings and to check the electrical power.

Only "Go" tested strings are transferred to the Cut-Bending station to form the joints for following interconnection. "No Go" tested strings are placed in a drawer for repair.

Afterwards the strings are placed polarity orientated on the prepared solar glass (covered with a sheet of EVA foil), as a sandwich.

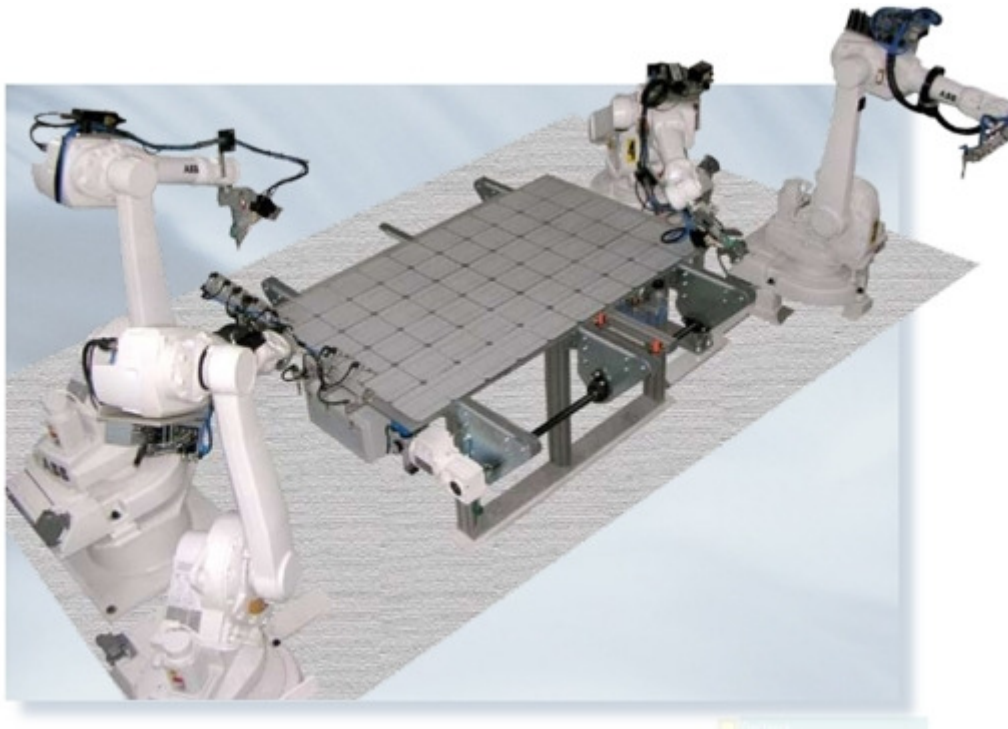
This prepared sandwich is forwarded to the lamination process.

In case of interruption of the leading or preceding machines, strings can be buffered in, which allows the stringer to keep on producing.

ADVANTAGES

- Exact positioning of strings on glass plate
- Integrated quality check of strings
- Small footprint
- High throughput
- Easy to upgrade from 30 to 60MW

2.3 Interconnection Station



FUNCTION

At the beginning of the process, the strings are laying on the EVA foil and the glass as unconnected matrix. In the Interconnection Unit the strings are connected to each other with soldering tapes. These are drawn off the reel by a optional stretching-cutting-bending-unit, stretched plane and even and cutted to length. According to the used junction boxes the soldering tapes are folded 90° and subsequently provided to the handling robot for further processing. Alternatively pre-fabricated soldering tapes are allocated from a withdrawal box. One handling and one soldering robot are each positioned at the lower and at the top end of the glass/EVA matrix, while the handling robot is serving the tapes for the soldering process to the soldering robot. The soldering process itself occurs inductive and contact-free. To obtain best soldering results, the soldering temperature is pyrometer controlled.

As the interconnection proceeds directly on the EVA foil, the handling robot inserts an additional isolation foil which can be removed after the soldering process. For a precise positioning of isolation foil and soldering tapes the matrix is being analysed by a camera system. To guarantee an exact approach of the soldering spots, camera systems are used. The operation is fully automatic; a manual intervention is not necessary. A changeover to manual operation for maintenance is possible..

ADVANTAGES

- Minimal thermal stress at maximum soldering results due to inductive soldering process
- High repeating accuracy of soldering points in comparison to manual soldering
- Gentle soldering
- Suitable for 2 and 3 bus bar cells
- Minor maintenance expenses
- Process monitoring and process data storing

2.4 Laminator



FUNCTION

The membraneless stacking laminator allows up to four solar modules with 60 cells (156 x 156mm) to be laminated simultaneously on two levels. In the 2-step process, the laminates are first stacked and buffered in the infeed system until all the positions are occupied and then transferred together to the individual levels of the prelaminating stage, where they are evacuated and heated uniformly from above and below. As soon as the necessary temperature has been reached in the laminate, the fully soldered cell matrix is embedded into the liquid encapsulation foil and pre-bonded under continuous application of heat on both sides. The pre-bonded laminates are transferred together horizontally to the subsequent level of the laminating stage, where they are laminated until they reach the required degree of crosslinking. This process can take 7 to 10 minutes, depending on the EVA foil used. The laminates are then transferred to the outfeed system for cooling.

Cooling press (3rd stage):

To achieve higher quality (higher light transmission + low warpage) the modules can be actively, quickly and controlled cooled down for immediate processing in the backend.

ADVANTAGES

- Membrane-free lamination system
- Maximum process reliability with shortest lamination time
- Oil-heated heating plates on both sides specially optimized for glass-glass modules
- Highest possible throughput with compact dimensions
- Variable module size
- Precise temperature conformity and heat input
- Monitoring system for process analysis and fast process optimization
- Minimized wear part costs

2.5 Edge Trimmer Basic



FUNCTION

Excess encapsulant and back cover film extend beyond the glass edges after lamination. This material must be removed prior to applying an edge sealant. The Edge Trimming Station allows a convenient and reliable trimming of the EVA and Backsheet foil. The module will be placed via belt conveyor to the turn table. The operator is able to rotate the fixed laminated module and lock at any turning angle. The excess encapsulant will be manually removed with a knife.

ADVANTAGES

- Low maintenance
- Ergonomically designed

2.6 Framing Press



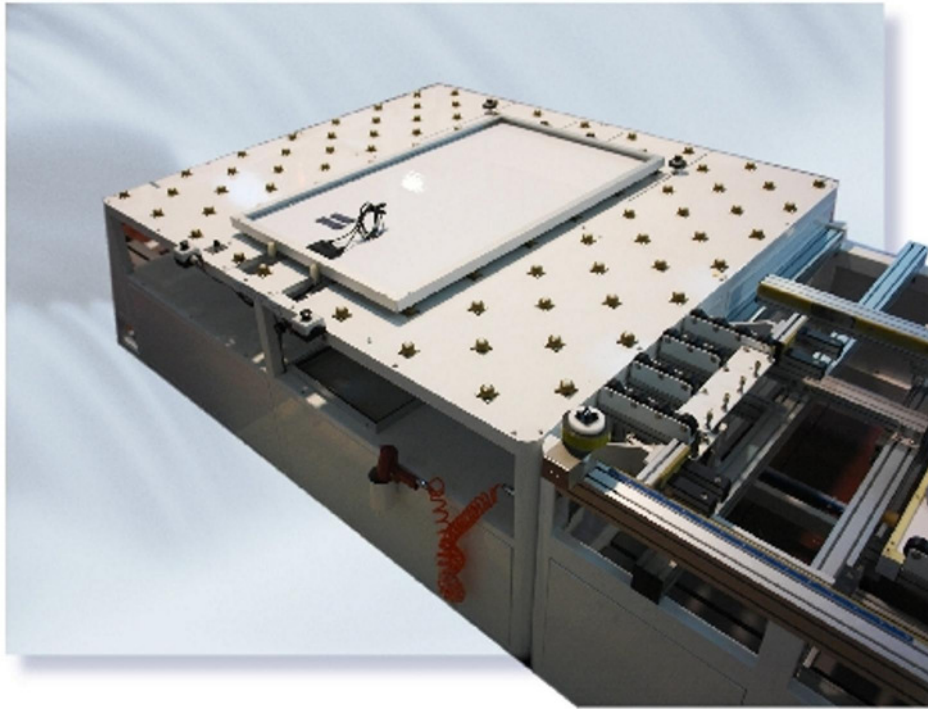
FUNCTION

Modules are transported automatically into the framing unit. The module will be centered and prepared for the framing. The Aluminum frame parts are manually positioned into the machine. Via axes systems the frame parts are pressed onto the module and automatically crimped. The Module is now protected against environmental conditions.

ADVANTAGES

- Careful handling of modules
- Precise framing
- Long term protection

2.7 Junction Box Assembler Basic



FUNCTION

A worker mounts the Junction Box on the framed module and solders or crimps the module wires to the contacts inside the box.

The station consists of a ball-table with a centering and a metering unit for the silicone adhesive.

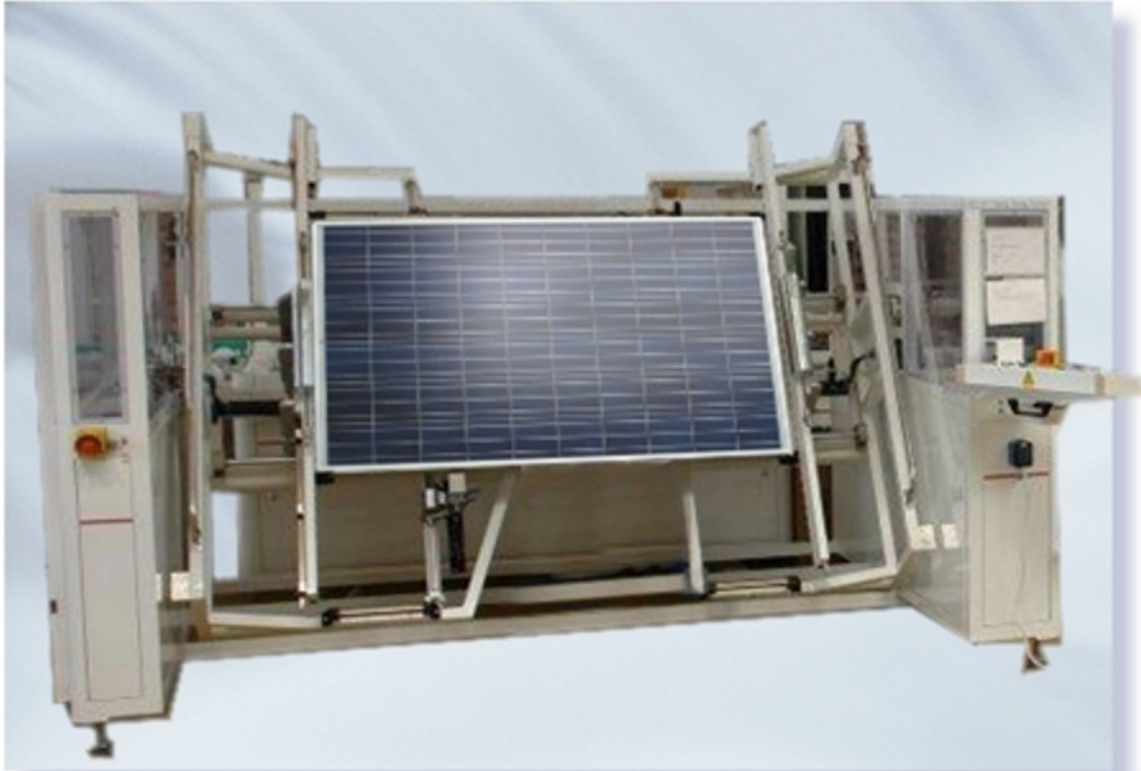
As an alternative to the dosing unit the Junction Box can also be mounted with adhesive pads.

Option: Manual Crimp unit.

ADVANTAGES

- Rotable working area
- Ergonomic

2.8 Cleaning Station



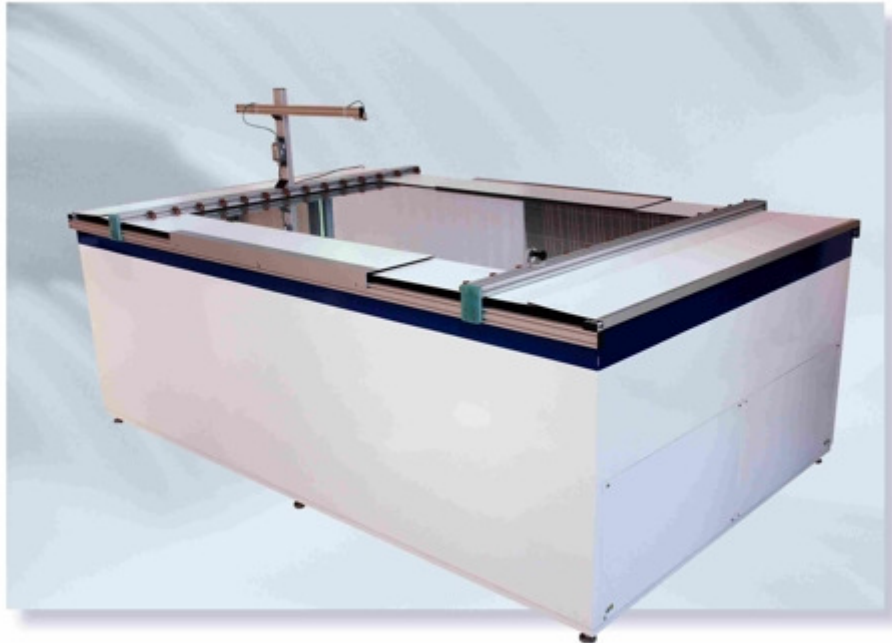
FUNCTION

In the Cleaning Station operators can handle the PV modules easily to turn them from sunny side down to sunny side up and vice versa for a manual cleaning of the glass surface, before the module will be transported into the next working station (Module Tester).

ADVANTAGES

- Ergonomic handling of PV modules
- Easy feed in/out of reference modules towards flasher for periodical referencing

2.9 Module Tester



FUNCTION

The testing system features light sources for non-uniformity and spectral distribution of irradiance and temporary flash stability that closely match the solar spectrum and fulfill the specification ASTM E-927 and IEC 60904-9.

The PV modules are placed centered (sunny side down) on the flasher. First measurement is the HiPot test (if option HiPot/Compact Tester has been chosen).

The Compact Tester checks the resistance of isolation between the cell strings inside the laminate and the metallic frame of the module. Therefore the junction box and the frame are contacted to the HiPot.

Operators can choose voltages below 3kV DC, rising and falling ramps, test time, current limiting.

Second the sun simulation test is performed. The measurement results are related to the STC (25°C, 1000W/m², AM1.5). Temperature measurement of the module temperature is integrated. Selected by software, a wide range of parameters can be stored for future analyzing including inspection images.

Based on the set limits or different module classis the classification result can be used for module sorting.

For achieving a high performance measuring calibration modules are required, for each different cell type and/or Supplier with a certified measurement.

ADVANTAGES

- Class AAA Performance (IEC 60904-9)
- Small Footprint, inline integration
- High Throughput
- Easy to operate
- Option HiPot testing

Equipment List

Turnkey Pricelist : Module-Line 50MW

STRICTLY CONFIDENTIAL				
Proposal-ID		Equipment	Qty.	
System Price Equipment Price				
PK006335-004-01		Conveyor	1	
PK006335-005-01		Conveyor	1	
PK006335-006-01		Stringer	1	
PK006335-007-01		Stringer	1	
PK006335-008-01		Layup Station	1	
PK006335-035-01		Interconnection Station	1	
PK006335-012-01		Conveyor	1	
PK006335-013-01		Conveyor	1	
PK006335-014-01		Diverter	1	
PK006335-015-01		Laminator	1	
PK006335-016-01		Diverter	1	
PK006335-017-01		Edge Trimming	1	
PK006335-018-01		Framing Unit	1	
PK006335-019-01		Junction Box Assembly	1	
PK006335-020-01		Diverter	1	
PK006335-021-01		Cleaning Station	1	
PK006335-022-01		Flasher	1	
PK006335-025-01		Modul Repair Table	1	
PK006335-027-01		Trolley	1	
PK006335-028-01		Trolley	1	
PK006335-029-01		Trolley	1	
PK006335-030-01		Software Module Line	1	
PK006335-031-01		Know-How Transfer	1	
System Price Service Package				
	Packaging			
	Freight & Transport	DDU Isso		
	Installation			
	Technology transfer			
	Project-Handling			