

Master Contract No.: \_\_\_\_\_

# Technical Specification

For

## AM050F MBB PV Cell Soldering Stringer

(The information herein is totally confidential and shall not be disclosed to any third party)

Supplier: (Signed and sealed)

Customer: (Signed and sealed)

Representative:

Representative:

Date:

Date:

(Faxed copies are valid)

## 1 Product Overview

AM050F MBB PV Cell Soldering Stringer is a fully automatic machine used to nondestructively cut the mono-Si or poly-Si cells and then solder them into a string. Normally it can work with 156-230mm (3BB-15BB) cells. The cell cut module can cut cells in half, or cut cells into three strips after upgrade. The soldering module can be upgraded for 156-230mm (full, half-cut, 1/3-cut) cells. With the use of PLC, servo, SCARA robot, industrial image processor system and other advanced automation technology, the entire process from cell feed to string outlet is fully automated.

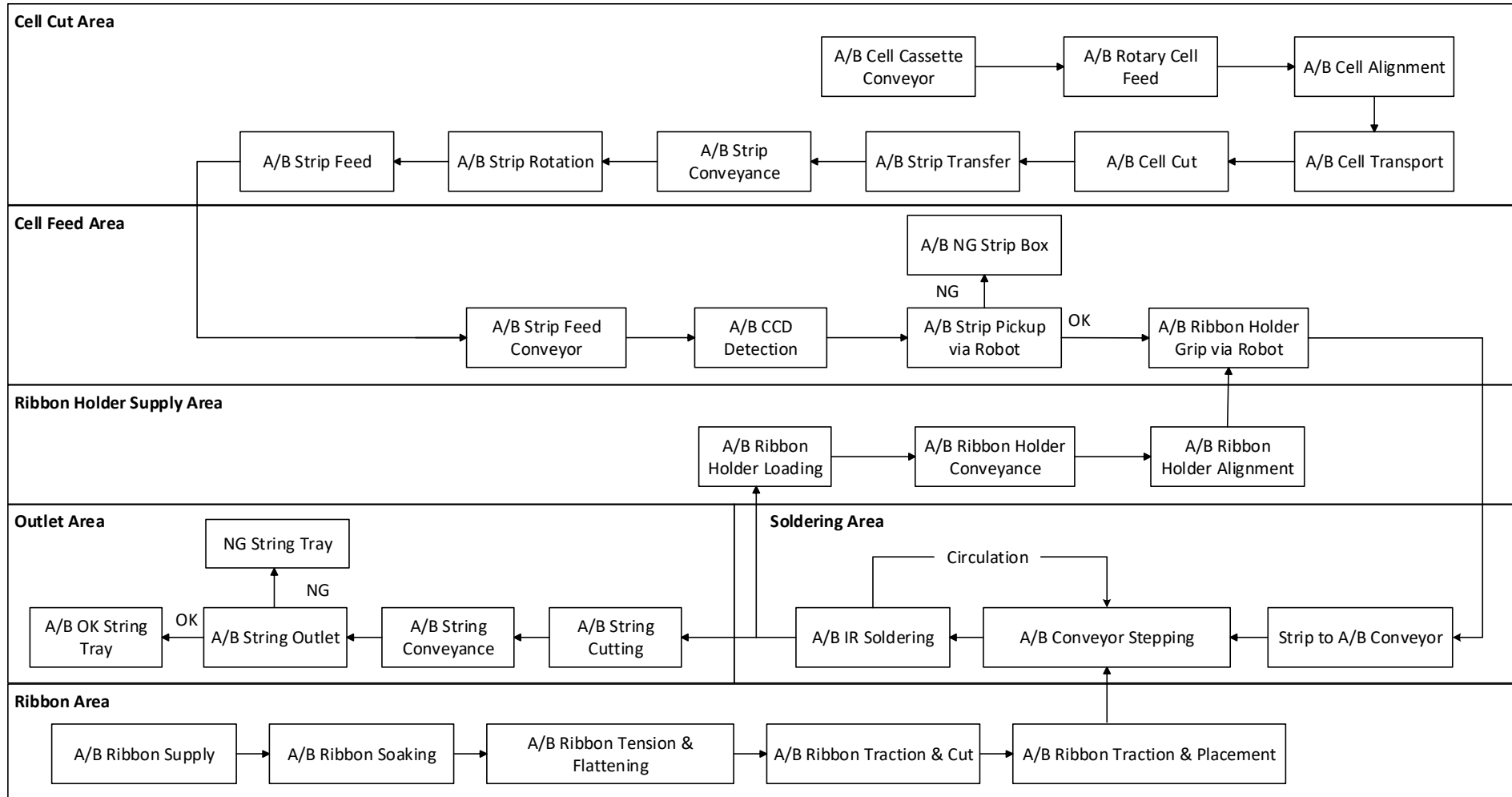
## 2 Product Info

### 2.1 Appearance

The appearance of AM050F MBB PV Cell Soldering Stringer:



## 2.2 Process flowchart



Production Process

### **3 Function**

#### **3.1 Cell Cassette Conveyor**

The cell cassette conveying system has two layers, i.e. the top full cassette conveyor and the bottom empty cassette conveyor, and each conveyor can hold three cassettes.

#### **3.2 Rotary Cell Feed**

The cell feed system consists of the Cell Raise servo, Cell Pickup servo, Rotary Cell Feed servo (with suction cups) and air knives (making sure that only one cell is picked up at a time).

When the cassette full of cells has arrived the cell pickup station, sensors will work to verify that the cell cassette is in place and cells are present in the cassette.

Upon receiving the signal from the sensor, the Cell Raise device will raise the cells in the cassette to a position for cell pickup operation.

The Cell Pickup device grabs one cell and then the Rotary Cell Feed device rotates by 180 degrees to release the cell on the cell feed conveyor.

#### **3.3 Full Cell Feed Conveyor**

The Full Cell Feed Conveyor consists of the conveyor belt itself, the rough alignment cylinder, the fine alignment servo and the CCD platform.

When the full cell has been released on the conveyor via the Rotary Cell Feed device, it is first sent forward for rough alignment. Then, when the cell is transported to the CCD platform, the fine alignment device goes up so the cam driven by a motor can make fine alignment to the cell.

Industrial cameras are used to inspect the cells for:

- 1) Defects detection: chipped edge/chipped corner/screen offset/cell rotated etc.
- 2) Find the position of cell and send the information to PLC.

#### **3.4 Cell Transport**

The Full Cell Gripper consists of a linear motor and a lift cylinder (with suction cups).

After receiving the inspection and positioning results sent from CCD, the gripper will grab the NG or OK cells to the NG tray or the cell cut platform.

#### **3.5 Cell Cut Platform**

The Cell Cut Platform, driven by a toothed belt, carries the cell on it and travels through the laser beam. The vacuum of the cut platform can be adjusted to hold cells of different size.

#### **3.6 Laser System**

The laser system consists of a grooving laser, a heating laser and a water spray device.

The grooving laser makes a groove in the head and tail surface of the aligned cell. The length of

groove is settable. Normally, it is set to a value  $\leq 3\text{mm}$ .

The heating laser heats the cell along the groove.

Immediately after laser heating, a fine spray of water comes into contact with the heating trace and the cell will split into pieces under the stress generated by the temperature gradient.

This system offers high repeatability accuracy and allows you to adjust the groove length, heating laser power, water spray flow rate, cell splitting speed etc. according to the type and thickness of cell so as to achieve satisfying cut quality.

### **3.7 Strip Transfer Gripper**

The Strip Transfer Gripper consists of a servo and lift cylinder (with suction cups).

It separates the strips to a certain distance and then grabs them to the drying conveyor. The gripper can be replaced to meet the needs of 1/2 strips or 1/3 strips pickup.

### **3.8 Strip Drying Conveyor**

The Strip Drying Conveyor consists of the servo motor, belt and drying module, which realizes the buffer and drying of strips.

When the strips go through the station, the water stain on the strip surface can be dried up. Meanwhile, the device reserves the holes for heating rods to enhance the drying effect in the later use.

### **3.9 Strip Rotate Gripper**

The Strip Rotate Gripper consists of a lift cylinder and a rotate servo.

The strips are required to be soldered together with their chamfer in the same direction, but they are not placed in this way when the cell has just been cut, thus, the Strip Rotate Gripper is used to grab one strip of each cell and turn the strip by  $180^\circ$ .

### **3.10 Strip Feed Gripper**

The Strip Feed Gripper consists of a life cylinder and transport servo.

It grabs strips on the drying conveyor and transports them to the strip feed conveyor. The release position on the feed conveyor can be adjusted according to the different cell size.

### **3.11 Flux System**

Each line of the machine (i.e. A and B line) has a set of flux soaking tray. After going through the heated flux soaking tray, the surface of the ribbon will be coated with flux.

The flux in the soaking tray is refilled by the 8L flux tank located in the cabinet. The level meter installed in the flux tank will raise an alarm when the flux level is below the lower limit, reminding the operator to add flux.

The flux tank and all the pipes and nozzles are made with anti-corrosive materials.

### 3.12 Image Processor Inspection

High precision industrial cameras are used to examine the cells for any defect.

### 3.13 SCARA robot

High-accuracy four-axis robots are used to do these:

- Grab NG cells and place them into the NG cell box.
- Grab OK cells and place them onto the conveyor. During this process, fine adjustment will be performed based on the CCD detection result so as to ensure the busbar of cell aligns with the ribbon.

The use of robot offers these advantages:

- Precise positioning: positioning precision is up to 0.01mm, which can significantly reduce soldering offset, and ensure the accuracy of the cell spacing and string straightness.
- High efficiency: fast movement contributes to high efficiency.
- Intelligent positioning: suitable for different types of cells.
- Stable and reliable: minimal maintenance is required.

### 3.14 Ribbon Feed

Ribbon feed assembly consists of 12 sets of ribbon supply motor and ribbon guide wheel set, which can be upgraded to 15 sets at most. Each ribbon supply unit can be enabled and disabled via HMI operation to fit the soldering of 3BB to 15BB cells.

The ribbon spool driven by a stepping motor directly can wind or unwind the ribbon smoothly and steadily without vibration or distortion.

The ribbon supply motor can drive a ribbon spool up to 15kg and it can work with spools made by different suppliers.

When the ribbon spool is empty, the sensor outputs a signal, and the machine will raise an alarm and then stop, prompting to replace ribbon spool. The auxiliary fixture for ribbon supply unit can help the operator change the ribbon spool quickly within 5 minutes.

### 3.15 Ribbon Stretching, Flattening and Cutting

The ribbon processing system can be used to stretch, flatten (bend, optional) and cut the ribbon. The stretching amount can be set on HMI, and the bending depth and position can be adjusted manually.

The precision-machined guide posts ensure that all ribbons are parallel to each other with correct spacing gap.

The standard stretching, flattening (bending, optional) and cutting units are suitable for 2-5BB cells; for 3-15BB cells, the switchover of guide tool is required.

### **3.16 Ribbon Traction**

The ribbon traction mechanism consists of two traction arms (inner and outer), which can work alternately to draw ribbons out and place them directly on the busbar of cell.

The servo motor and linear module used for traction arms can offer positioning accuracy of 0.01mm.

### **3.17 Assembly Conveyor in Soldering Area**

Made of Teflon, the assembly conveyor belt can resist high temperature and prevent tin adhesion.

In order to reduce the stress inside the cells caused by the temperature variation, there are several heating plates under the conveyor to preheat cells before soldering. The temperature of these plates can be set on HMI.

Driven by a servo motor, this conveyor can achieve a positioning accuracy of 0.01mm.

By using an exhaust fan to create negative pressure, the holes on the conveyor belt and heating plates can hold the cells firmly in place, preventing the offset of cell or ribbon.

The conveyor is one-side supported, easy for maintenance and replacement of belt.

### **3.18 Soldering**

The method of infrared soldering is used to heat both sides of cells at the same time and then solder the cells and the ribbons together.

The IR soldering station is controlled by a high-speed soldering controller. The soldering temperature is detected by an imported high temperature sensor. The soldering parameter can be set on HMI.

The soldering cycle is guaranteed via the use of preheated solder base. The heating of an entire piece of cell can prevent pseudo soldering or crack of cell caused by partial heating.

The soldering station is driven by a cylinder to move up and down. The soldering height is adjustable. There is no need to lift the solder station during normal work, ensuring high quality of soldering.

The service life of an infrared lamp is about 3000 hours. In normal use, it can work for about 3-5 months.

The temperature of heating plate under the conveyor in soldering position can be adjusted to fit the soldering process for different types of cells, ensuring soldering quality.

### **3.19 Outlet**

The outlet area is composed of 2 conveyor belts, 2 lower string pickup arms, 2 upper string pickup arms, 2 string traverse arms, 2 OK string tray support frames and 2 NG string tray support frames.

After the string is forwarded to the outlet area, the string pickup arms and the string traverse arm will function to send the string to one side of the machine for inspection; if the string is OK, it will

be placed on the unloading conveyor; if it is NG, it will be put in the NG string tray.

The outlet area can be set to Manual (Inspection) mode or Automatic mode. Under the Manual mode, the string will be rotated automatically for easy manual inspection.

### **3.20 Inline Optical String Inspection (Optional)**

This module is optional. Please refer to its technical specification.

### **3.21 Inline EL Inspection (Optional)**

This module is optional. Please refer to its technical specification.

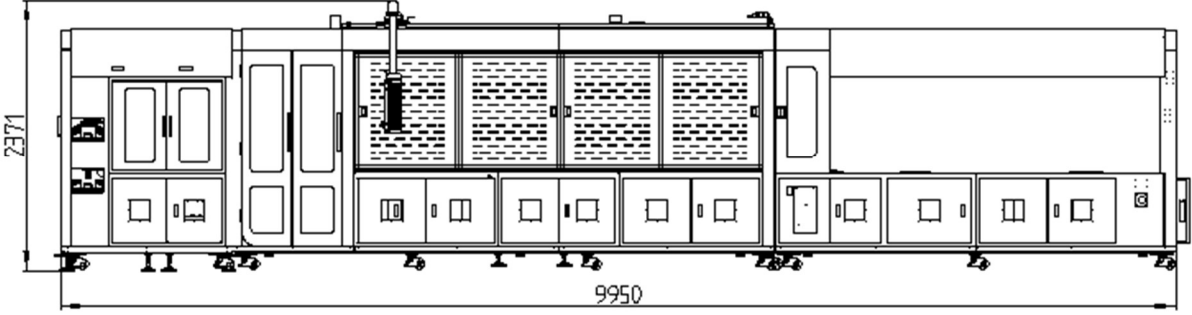


## 4 Specifications

Item		Specifications		Description
		Traditional cells	MBB cells	
Basic Information	Uptime	≥95%		(1 - unscheduled downtime/24H), unscheduled downtime refers to the time when the equipment malfunctions or is shut down unexpectedly.
	Speed	18Xmm cells: Half-cut>6800-7200 strips/hour 220mm cells: Half-cut>6800-7200 strips/hour 1/3-cut>6800-7200 strips/hour 1/4-cut>6800-7200 strips/hour		The speed depends on the solder process. If the required solder time is too long, it may affect the production speed.
	Cell Cracks	156mm to 171mm cells: Mono-Si ≤0.2%; 171mm to 230mm cells: Mono-Si ≤0.25%;		Popular Grade A cell, thickness ≥170μm Cell crack ratio = (cracked cells + micro-cracked cells)/total number of soldered cells × 100%
	Average Laser Power	50W/500W		Laser for grooving/laser for heating
	Service Life/Warranty of Laser	Warranty: 20,000 hours		
	Defect Detection	CCD		
	Overall Positioning Accuracy	Positioning deviation: ≤±0.1mm Angular deviation: ≤±0.04°		
	Flux Coating Method	Soak of ribbon		
	Soldering Method	IR soldering		
	Temp Control Accuracy	±7.5°C		The upper/lower temp limits can be set on HMI; an alarm will be raised when the temp is out of the limit.
Cell	Size	156~230mm crystalline silicon cell and its half-cut or 1/3-cut strips		Mono-Si or PERC cells with gap for cutting, excluding BSF cells.
	No. of Busbar	3BB-15BB		Tooling switchover is required for cells with different busbar number.
	Busbar distance	Busbar spacing ≥13 mm Outmost busbar to cell edge >5mm		
	Solder pad to cell edge distance	The top/bottom solder pad to cell edge >5.5mm		
	Cell Thickness	170μm~200μm		

Item	Specifications		Description	
	Traditional cells	MBB cells		
Cell String	Max String Length	1200mm		If upgraded, the length of string can be up to 2500mm.
	Head/Tail Extra Ribbon	The length of extra ribbon for the first and last string can be set separately.		
	String Straightness Deviation	±0.5mm		
	Peel Strength	The peel strength is no less than 1N/mm*busbar width.	Face-side ≥0.5N (∅0.4mm ribbon; up to one point <0.5N is allowed for each busbar on face side); Back-side: ≥1N (∅0.4mm ribbon)	Popular Grade A cell
	Cell Positioning	Based on the busbar of cell		/
	Cell Defects	Chipped corner, chipped edge, crack, screen screw/offset, 90°/180° screen rotation, etc.; defect level (like crack depth);		Can be defined on HMI
	Ribbon Offset	≤±0.3mm		Check if the centerline of ribbon coincides with the centerline of solder pad.
	Cell Spacing	Negative spacing: -1mm to -0.5mm Small spacing: 0.6mm to 1mm Normal spacing: adjustable within 1.5mm to 6mm		
	Ribbon Flattening	/	Thickness of flattened circular ribbon: 0.12~0.15mm for 0.29mm ribbon, length ≥4.8mm-6mm	Applicable when +0.5/-0.5mm spacing is selected
	Cell Spacing Accuracy	±0.3mm		Depending on the cell cut depth and the screen print accuracy.
	Start Point of Soldering	Depending on the actual need		/
	String Unloading	Offline or sent to the layup machine		/
Max Capacity of Cassette	360 strips		/	

Item		Specifications		Description
		Traditional cells	MBB cells	
Cell String	Optical String Inspection	Consistent soldering for each string and meet the visual requirements.		Optional
	EL String Inspection	Soldering defects, like pseudo soldering, micro-crack.		Optional
	Bad Soldered String	≤2%	≤2%	Popular Grade A cell, including pseudo soldering, over soldering, offset etc.
	Module Rework Ratio (Before Lamination)	≤12%	≤15%	/
Ribbon	Ribbon Specification	Traditional flat ribbon: Width: 0.8 to 3.0mm; Thickness: 0.18 to 0.32mm	Circular ribbon: Ø0.29 to Ø0.45mm, tolerance ≤±0.01 Yield strength: 70~80MPa; Tensile strength: ≥150MPa Elongation: ≥25%	Appearance: Free of any copper exposure, solder beads, dark spots, scratches, tin dross beyond the allowable tolerance, etc.; the surface of coating shall have bright metallic color and the winding of ribbon shall be smooth and even.
	Leaded or lead-free	Suitable for both		
	Ribbon Parameters	Average thickness of tin coating: ≥0.018±0.005mm Purity of copper substrate: ≥99.97% Elongation: ≥20% Tensile strength: ≥150MPa Yield strength: ≤70MPa		The thinnest place of tin coating ≥0.006mm
	Ribbon Spool	Inner diameter 16mm or 20mm, outer diameter ≤180mm, width ≤160mm	Inner diameter 16mm or 20mm, outer diameter ≤160mm, width ≤180mm	
Power Supply & Air Supply	Power Supply	Three-phase 380V, 50Hz Three-phase five-wire (L1/L2/L3/N/PE), wire size 4×16mm <sup>2</sup> +1×10mm <sup>2</sup>		
	Power	Average power: 40 kW; Peak power: 50 kW		
	Water Chiller for Laser	Cooling water: 20L; purified water; replace on a regular basis		Supplied with one set of external water chiller for laser

Item	Specifications		Description
	Traditional cells	MBB cells	
Power Supply & Air Supply	Water for Cell-split Cooling System	Deionized water	
	Air Supply	Pressure: 0.6-0.8Mpa Air consumption: ≥2400L/min Two Ø16mm air inlet hoses working at the same time	Two Ø16mm air inlet hoses must work at the same time to ensure stable pressure of machine.
	Air Supply Requirements	Air pressure: 0.6 - 0.8MPa; Ø16mm air inlet hose; Compressed air quality: Max. solid particle: 15µm (Class 3); Min. pressure dew point: +3°C (Class 4); Max. oil vapor concentration: 5mg/m <sup>3</sup> (Class 4)	
	Ventilation	The 5 vents on the top of machine are Ø102mm. Connect these vents to the facility exhaust piping with Ø104mm ducts. The exhaust duct of the blower is Ø65mm. The duct is connected to the facility exhaust system via the fifth Ø102 vent. The overall exhaust flow rate is larger than 1000m <sup>3</sup> /h. Considering the high temperature of exhaust, it is recommended to use PVC pipe for exhaust duct.	
	Installation Floor	The floor for installation shall have a loading capacity of 600kg/m <sup>2</sup> at least and be flat without any vibration. The installation space (including the space for the operator to work) shall be no less than 9950(L) × 3500(W) × 2650(H)mm. Ambient temperature: 5 - 40°C Relative humidity: 5 - 70% (non-condensing)	
Dimensional Drawing	 <p>Weight: cell cut part 4500KG, center part 6000KG, rear part 3000KG</p>		

## 5 Attached files

No.	Item	Qty	Remarks
1	Packing list	1	
2	Factory Inspection Report	1	
3	Operation Manual	1	
4	Service Repair Manual	1	
5	Maintenance Manual	1	

## 6 Main parts and components

Main parts and components are listed as follows:

No.	Name	Brand	Remarks
1	PLC	KEYENCE	
2	Servo	YASKAWA, INOVANCE	
3	Robot	STAUBLI, YASKAWA, DENSO	
4	CCD	DALSA	
5	Sensor	OMRON, PANASONIC	
6	Touch screen	ADVANTECH	
7	Terminals	WAGO, DEGSON	
8	Cable carrier	IGUS, MISUMI	
9	Bearing	NSK	
10	Linear screw module	THK, HIWIN, TBI, etc.	
11	Pneumatic parts	SMC, AirTAC, FESTO	
12	Mechanical parts	MISUMI, YIHEDA, etc.	
13	Motor	JSCC, Leadshine	
14	Laser	Top-class product	

## **7 After-sales service**

### **7.1 After-sales service and training**

- The supplier will provide training in the operation and maintenance of the machine for free at the owner's site.
- During the installation and commissioning period, the supplier will send technicians to the site of the owner to offer free technical guidance.
- The after-sales service staff of supplier will provide 24-hour phone support.

### **7.2 Quality assurance**

- The supplier will offer a one-year warranty (excluding the consumable parts) after the installation, commissioning and acceptance of the machine.
- During the warranty period, if any issue occurs due to the quality of equipment, the supplier will replace or repair the parts free of charge.
- The supplier shall offer the best price for the technical services the owner requested after the expiration of the warranty period.