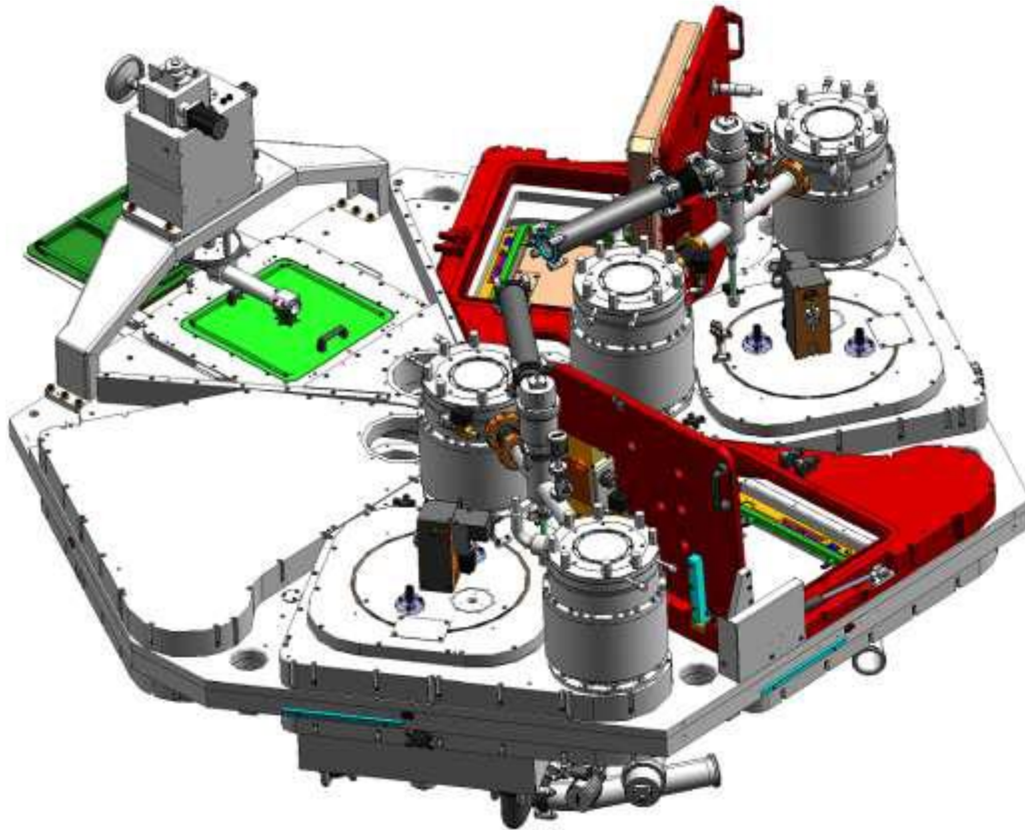
TECHNICAL SPECIFICATION

Process Module
The SINGULAR is equipped with two IR-heating stations and two individual customized PECVD process stations. A support frame is receiving the aluminum made main vacuum chamber. The different process stations are mounted on the main vacuum chamber. A transfer handling is exchanging the substrates carriers from the loading/unloading module into the load lock of the process module. The process gas dosing is controlled by high precision mass flow controllers for each process chamber independently. The vacuum is controlled by high efficient turbo pumps, suitable for the applied process. All vacuum components, vacuum gauges and vacuum safety switches are included.
The substrate carries are hold inside the vacuum chamber. Substrates are passing through the process module in a sequence of different stations.
The sequence is:
Load lock
PS1 – IR heating station
PS2 – PECVD coating top down for intrinsic a-Si (“clean chamber”)

PS3 – IR heating station
PS4 – PECVD coating top down for dopted a-Si, SiOx, SiNx (“dirty chamber”)
Empty
Load lock



Process Module SINGULAR : Two IR-heating station and two ICP-PECVD process stations with high efficiency H-turbo pumps, dry fore-vacuum pump (main process pump)

Process Module
The process module is equipped with two IR heating stations and two ICP-PECVD process stations. The typical order of processing is PS1-IR Heating, PS2-PECVD Station, PS3-IR Heating, PS4 PECVD Station. The empty station is prepared for an eventual later upgrade of an additional process station.
The systems consists of a vacuum chamber base plate fixed to the support frame, a rotary system for the turntable mounted in the center, a load lock, each process station and a gas system for nine process gases.

Vacuum System
The main vacuum chamber and the process stations are evacuated by turbo molecular pumps and one fore-vacuum pump:
Two Turbo molecular pumps type STP 1003C or equivalent for the main chamber
- pumping speed 1000 l/s (N2)
- with exhaust, vacuum safety switch, etc.

Two turbo molecular pumps STP XH2603 or equivalent for each deposition station
- pumping speed 2600 l/s (N2)

- with exhaust, vacuum safety switch, etc.

One dry fore-vacuum pump type iHX 1220H or equivalent

- pumping speed 1200 m³/h (N_2)
- with exhaust, vacuum safety switch, etc.
- Distance between dry pump and Singular has to be specified, but will be

about 5m.

The vacuum measuring system of each unit consists of:
One ionization vacuum gauge type HPG400-SP, range: >$2x10^{-6}$ mbar
One capacitive vacuum sensor CDG025,
range: 10 Torr mounted at the fore vacuum dry pump
One capacitive vacuum sensor CDG025,
range: 10 Torr mounted at the main chamber
One pressure switch type Baratron 51A12MGA2BA010 fixed at 10 mbar absolute pressure
One pressure switch type Baratron 51A11MGA2BA0,5 fixed at 0,5 mbar absolute pressure
One 1000 mbar vacuum switch type VSA100A

2.9.2 Load Lock

The load lock is evacuated by a dry fore-vacuum pump consisting of:
one dry fore-vacuum pump type iGX 100L or equivalent

- pumping speed 100 m³/h (N_2)
- with exhaust, vacuum safety switch, etc

The vacuum measuring system consists of:
Pirani Standard Gauge PCG 500, range: 1000 mbar to 10^{-3} mbar
One pressure switch type Baratron 51A11MGA2BA0,5 fixed at 0,5 mbar absolute pressure
One 1000 mbar vacuum switch type VSA1000A

IR - Heating Station

The heating station is installed in the next position to the load lock and .
The main components are:
Infrared heating array consisting of near infrared tungsten wire quartz bulbs.
The heating array is mounted on the chamber lid of the heating station and can be swiveled 90° upwards for easy maintenance access.
The maximum infra red power density is of up to 120 kW/m^2. This allows heating ramps of up to 70 K/s on wafers (depending on the wafer type).
Water cooled nickel plated copper shields protect the carrier and the surrounding from being overheated.
Pyrometer IN 510-N

PECVD - process station

The Process stations are arranged between the heating station and the load lock. The maximum number of process stations is four. The process stations are integrated into the main vacuum chamber. During process each station is separated from the main chamber by a mechanical sealing mechanism which opens during the wafer transport. Each station can run independent processes, which allows the deposition of highly flexible layers and layer stacks.
The main components are:
One inductively coupled plasma source (ICP source) normally mounted on the bottom (sunny side down deposition)
Water cooled RF generator 13.56 MHz
Water cooled matching network
Water cooled process lid
Gas shower for the precursor gas (e.g. Silane)

Gas shower for the reactive gas (e.g. Ammonia)
Pyrometer IN 510-N to control substrate temperature before/after processing between each Station

The SINGULAR has two customized process stations.

PS 2 – PECVD ("clean chamber")
ICP plasma source mounted on bottom, coating bottom up
Mass flow controllers and needle valves, integrated in station gas box (exhaust)
Silane SiH_4 1500 sccm, purity 5.0
Hydrogen H_2 3000 sccm, purity 5.0
Ar 3000 sccm, purity 5.0
NF_3 3000 sccm, purity 4.0
Nitrogen N_2 (purging & washing of gas pipes) needle valve, purity 6.0

PS 4 – PECVD ("dirty chamber")
ICP plasma source mounted on bottom, coating bottom up
Mass flow controllers and needle valves, integrated in station gas box (exhaust)
Silane SiH_4 1500 sccm, purity 5.0
Hydrogen H_2 3000 sccm, purity 5.0
Ammonia NH_3 3000 sccm, purity 5.0
NF_3 3000 sccm, purity 4.0
H_2 for n-doping (PH3) 1500 sccm, (0.5% PH_3 in H2)
H_2 for p-doping (TMB) 1500 sccm, (0.5% TMB in H2)
N_2O 3000 sccm, purity 4.0
N_2 3000 sccm, purity 6.0
Nitrogen N_2 (purging & washing of gas pipes) needle valve, purity 6.0

Clean Room
The loading / unloading module of the SINGULAR is covered by class 100 compatible clean room.

Power Distribution and Control System
All electrical power distribution- and control cabinets are an integral part of the machine frame.

Power distribution
The power distribution cabinet +E1 include the main contactor, circuit breakers and components to produce the auxiliary voltages like 230 VAC or DC 24 V.
The cabinet is located below the input and output conveyors.

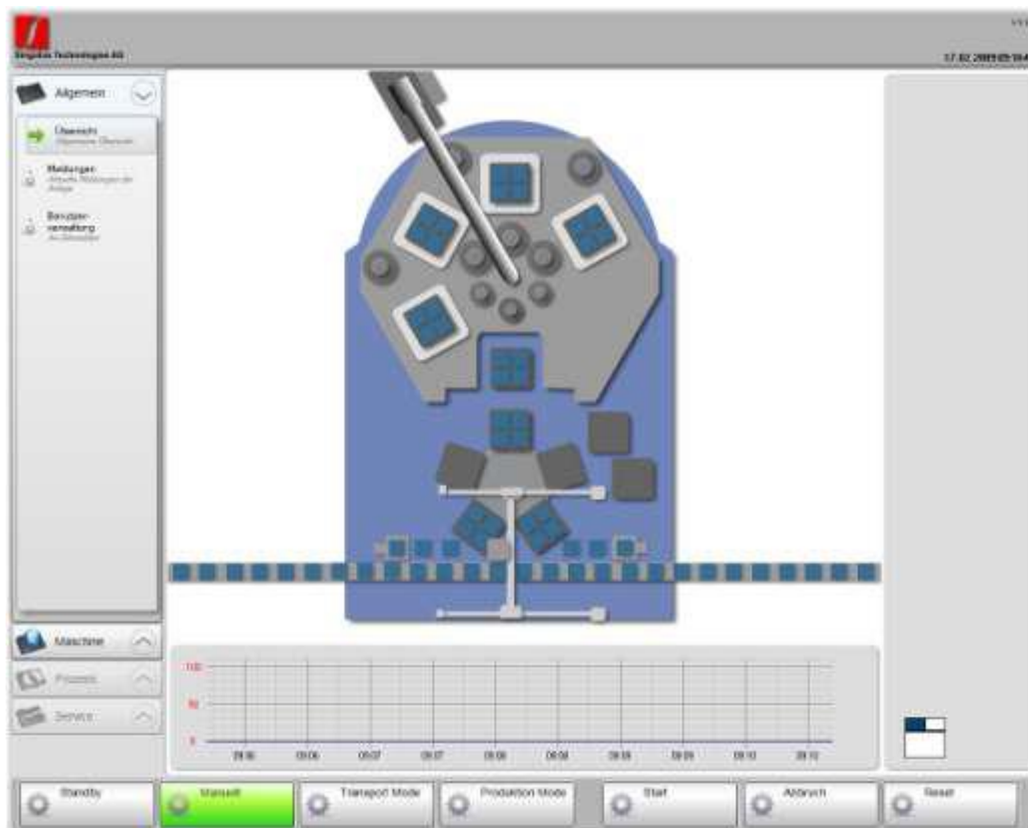
Servo drives
All drive applications are realized with Mitsubishi Servo Drives Type J3.

All motors have an absolute value encoder and are controlled by one central motion controller, which is located in the central industrial PC.
The servo amplifiers are in the cabinet +E2, which is located above the conveyors.
The amplifiers are connected to the motion controller via optical fiber cables (SSCNET).

Control Concept
The complete machine, including loading and unloading device, is controlled via one central Industrial PC (+E4).
All safety interlocks are carried out by an additional safety PLC.
The analog and digital I/O modules are connected to the central PC via Profibus or Profinet.
One 19” touch screen displays allowing a convenient operation of the SINGULAR.

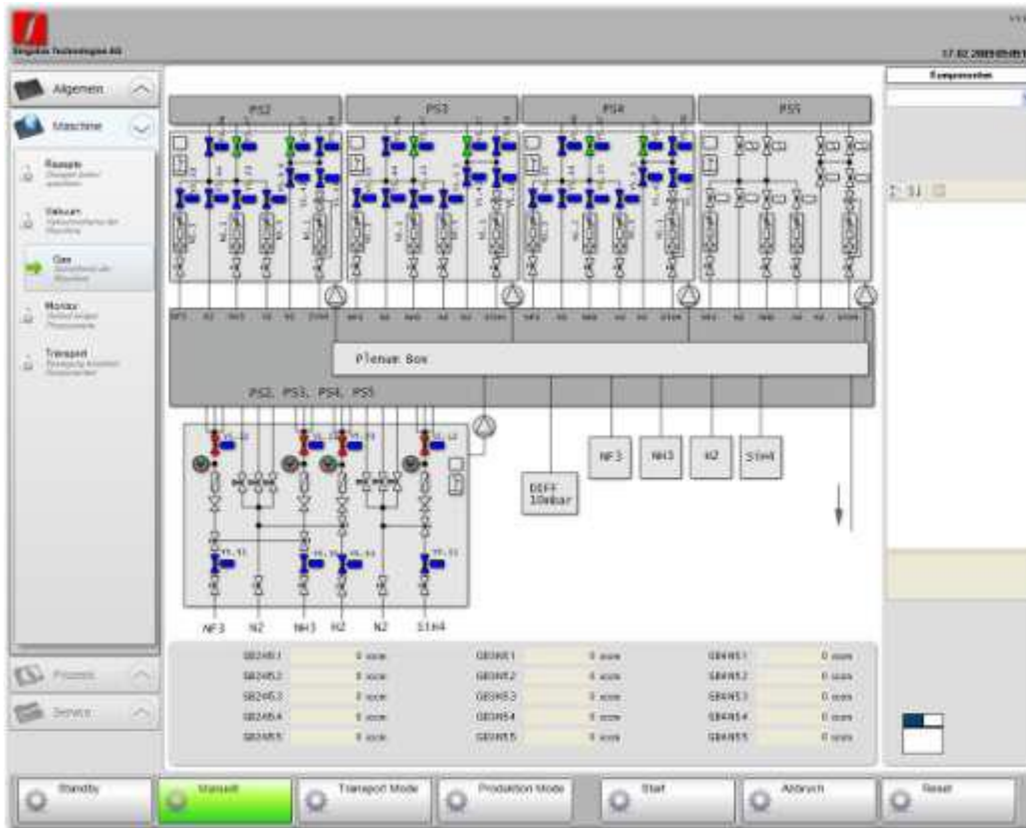
Software
Operating System: Windows XP
PLC Controller Soft PLC Win AC TRX 2008 (RTX Real Time Kernel)
Human Interface Microsoft.NET framework Visiwin.NET (Inosoft)

Human Interface / Visualization



The visualization software permits operating the SINGULAR in manual or automatic mode with access to all necessary machine parameters and data to process all wafers characteristic that are specified there.

The software uses the complete display area of one 19” TFT touch-screen, is logically programmed and shows a convincingly organized structure.
Password management is defined in a four level access from normal production runs to process development.
Additional feature: Recipe controlled wafer processing
For the recipe controlled wafer processing, single or multiple wafers will be automatically processed in a predefined way (script) with individual predefined recipes. This recipes can be cleaning or coating recipes.



DESIGN AND PRODUCTION DATA

Design

The design of the SINGULAR is shown in a separate diagram. The substrate transport height is 1.100 mm +/- 20 mm.

Dimensions and weight of the machine

Length approx. 6,100 mm
Width approx. 5,000 mm
Height approx. 2,600 mm
Weight process module approx. 5,500 kg

Weight loading/unloading module approx. 1,850 kg

Total weight: approx. 7,350 kg

Load on one machine foot: approx. 10,000 N
Number of feet: 6
Load per mm^2: approx. 0,57 N

Floor and walls
The machine has to be placed on a floor with sufficient load-bearing capacity.
With floors of pre-stressed concrete, all machine parts must stand on one single slab.
The floor surface must be flat; the cover should be resistant against solvents used in the machine.
Leveling pads should adhere well.
Floor, wall and ceiling should be antistatic and must not be a source for particles.

Environmental conditions:
Room class: class 100.000
Ambient temperature: max. 25°C
min. 20°C ± 3°C
Atmospheric
ambient air humidity range: 35 – 55 % RH
Dew point: ≤ 10°C
Power losses to the environment: 15 KW

Electric Data:
Power Quality
Only shielded equipment may be connected to the same branch as the machines. No peaks are permitted in the ground conductor either.
Power drops must be avoided.
No equipment generating and emitting strong noise fields (e.g. arc welding, high frequency heating) may be placed near the machines.
Mains connection: 3 Φ / N/ PE / AC 400 V 10%
Frequency: 50…60 Hz
Protection class: IP44
Connected power: 100 kVA
Power consumption: 60 kW
Power consumption Stand-by: 23 kW
Protection current: 3 x 200 A (protection fuse)
Network connections: Profibus DP
Ethernet
Standards: CE Conform, SEMI S2 compliant

Media supplies

Water
Standard cooling water: open circuit
Max. inlet temperature: 25°C
Min. inlet temperature: 18°C
Outlet temperature: max. 35°C
Max. pressure: 4.5 to 6 bar
Min. required pressure difference 3 bar
Water usage: ~ 90 l/min – 5.4 m^3/h
Hardness: ≤ 3 dH
pH range: 7 – 9
Particle size: ≤ 200 µm
Particle concentration: ≤ 10 parts/cm^3
Cl content: ≤ 20 mg/l
CO_2 content: ≤ 15 mg/l
Conductibility: ≤ 200 µs/cm at 25°C
Inlet connection: G 1 1/2 " OD
Outlet connection: G 1 1/2 " OD
Remark: Power losses to the water: ~ 54 KW
3.7.2 Compressed Air
Compressed air: oil and water free
(dry compressor recommended)
Temperature: 20°C
Pressure: 6 bar
Max. required pressure difference: 4 bar
Max. consumption for the coating module: ~ 1.2 m^3/h
Particle size: ≤ 5 µm
Particle concentration: ≤ 5 mg/m^3
Dew point: -20°C
Inlet connection: G 1/4" ID

Process Gasses
The following process gasses are connected to the SINGULAR VMB with exhaust
Silane SiH_4
Ammonia NH_3
Nitrogen trifluoride NF_3
Nitrous oxide N_2O
Hydrogen H_2
Hydrogen for n-doping (PH_3)
Hydrogen for p-doping (TMB)
Argon Ar
Nitrogen N_2
Additional gasses for processing are needed:
Nitrogen N2 (purging of pumps, venting) needle valve, purity 5.0
Nitrogen N2 (purging & washing of gas pipes) needle valve, purity 6.0
Typical process gas flows during coating and cleaning period
This cannot be specified, because it is depending very much on individual process. It is important for the correct function of the system that the gas supply system can deliver sufficient amounts of each process gas, without significant pressure drop.
Typical N_2 gas flow during coating & cleaning period
Flushing gas N_2 purity 5.0
(purging of pumps, venting): ~ 3.5 m^3/h

Exhausts
Exhausts to scrubber/washer
This depends very much on individual process and cannot be specified exactly. The exhaust system, the scrubber/washer need to able to process maximum possible gas flows (all MFC's open).
Connection process pump exhaust to scrubber/washer
DN 40 KF, exhaust 10 mbar under atmosphere monitored on SINGULAR system.
Exhaust to atmosphere
Gas Toolbox + 3 x MFC-Boxes approx. 60 m^3/h by 1 mbar
under atmosphere
Connection: Exhaust OD 100 mm

Process pump housing 100 m^3/h evacuated by 1 mbar
under atmosphere
Connection: exhaust process pump housing OD 100 mm
Load lock pump exhaust 1 mbar under atmosphere
Connection: exhaust of load lock pump DN 25 KF