SPECIFICATIONS

A.1 OPERATING SPECIFICATIONS

The following are the operating specifications for the HEATPULSE 4100 system.

- **Wafer handling:** automatic, serial processing using standard cassettes.
- **Throughput:** Process dependent, approximately 80 wafers per hour (in a null cycle) without flat finder.
- **Wafer sizes:** 4", 5", and 6" standard; 3" optional.
- **Ramp up rate:** Programmable, 10°C to 200°C per second.
- **Steady-state duration:** 1-600 seconds per step.
- **Ramp-down rate:** Programmable, 10°C to 250°C per second. Ramp-down rate is temperature-and-radiation-dependent and the maximum is 150°C per second.
- **Recommended steady-state temperature range:** 400 - 1300°C.
- **ERP temperature accuracy:** ±3.5°C (typical) to ±7.0°C (maximum), when calibrated against an instrumented thermocouple wafer (ITC).
- **Temperature repeatability:** ± 3°C or better at 1150°C wafer-to-wafer. (Repetition specifications are based on a 100-wafer set.)
- **Temperature uniformity:** ± 5°C across a 6" (150 mm) wafer at 1150°C. (This is a one-sigma deviation from 100 angstrom oxide-uniformity.) For a titanium-silicidation process, no more than 1.5% increase to uniformity during the first anneal at 650°C to 700°C.

A.2 PHYSICAL DIMENSIONS

- **Width** 40 in. (102 cm)
- **Depth** 42 in. (107 cm)
- **Height** 82 in. (208 cm)
- **Weight** 1500 lb (680 kg)
- **Shipping weight** 1800 lb (816 kg)

A.3 UTILITY REQUIREMENTS

Utility requirements include:

- **Power**

  Standard: 200, 208, 220, 240 VAC; 50 or 60 Hz; 70 A maximum; three-phase plus neutral plus ground

  Optional: 200, 208 VAC; 40 A maximum; three-phase plus ground

  380, 415 VAC; 50 Hz; 40 A; three-phase plus neutral and ground

- **Water Type**

  Pre-filtered with conventional particulate filter **(No DI Water);** Closed-loop recirculator highly recommended

A.4 FACILITY CONNECTIONS

The following table is a summary of the facility connections for the HEATPULSE 4100 system:

Table A-1. *Facility Connections*

UTILITY	SERVICE SIZE	CONN. TYPE
CDA or Utility N2	1/2" 1/4"	Swagelok Swagelok
Cooling-Water Supply **Cooling-Water Return**	5/8" 5/8"	Swagelok Swagelok
Gas-Box Exhaust	4" OD	Duct
Cooling Exhaust **Scavenger-Hood Exhaust** **Containment Exhaust (Optional)** **OR** **Exhaust-Manifold Outlet**	2" OD 2" OD 2" OD 3" OD	Duct Duct Duct Duct
Process-Gas Exhaust (Scrubber)	3/8"	VCR, Male
Process-Gas Supply	1/4"	VCR, Female
Oven-Recirculator Water Supply **Oven-Recirculator Water Return**	5/8" 5/8"	Swagelok Swagelok

A.5 UTILITY SPECIFICATIONS

The following table is a summary of the utility specifications for the HEATPULSE 4100 system:

Table A-2. *Utility Specifications*

UTILITY	FLOW RATE			PRESSURE		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
CDA or Utility N2 (Cooling)	8 SCFM	10 SCFM	15 SCFM	30 PSIG	60 PSIG	100 PSIG
CDA or Utility N2 (Valve Act.)	<1 SCFM	<1 SCFM	<1 SCFM	70 PSIG	80 PSIG	100 PSIG
Cooling-Water Supply	1.6 GPM	2 GPM	2.5 GPM	30 PSIG	40 PSIG	100 PSIG
Cooling-Water Return	1.6 GPM	2 GPM	2.5 GPM	20 PSIG	30 PSIG	40 PSIG
Gas-Box Exhaust	0 SCFM	150 SCFM	>200 SCFM	.5" H_2O	.75" H_2O	--------
Cooling Exhaust	8 SCFM	10 SCFM	15 SCFM	.5" H_2O	.75" H_2O	--------
Scavenger-Hood Exhaust	20 SCFM	25 SCFM	30 SCFM	.5" H_2O	.75" H_2O	--------
Containment Exhaust (Optional)	0 SCFM	0 SCFM	2 SCFM	.5" H_2O	.75" H_2O	--------
OR						
Exhaust-Manifold Outlet	28 SCFM	35 SCFM	45 SCFM	.5" H_2O	.75" H_2O	--------
Process-Gas Exhaust (Scrubber)	10 SLPM	10 SLPM	10 SLPM	.5" H_2O	.75" H_2O	2.5" H_2O
Process-Gas Supply	10 SLPM	10 SLPM	10 SLPM	30 PSI	60 PSI	100 PSI
Oven-Recirculator Water Supply	3 GPM	5 GPM	7 GPM	30 PSI	40 PSI	60 PSI
Oven-Recirculator Water Return	3 GPM	5 GPM	7 GPM	10 PSI	20 PSI	40 PSI

SYSTEM INTRODUCTION

1.1 OVERVIEW

The 4100 HEATPULSE system is a single-wafer, cassette-to-cassette rapid thermal-processor, capable of processing in inert or corrosive ambients. The system is built for the production environment. It is housed in a compact, through-the-wall frame (which can also be installed stand-alone, if desired)

4100 system components include:

- Heating chamber, containing two high-intensity tungsten-halogen lamp arrays
- System controller
- Quartz isolation-tube
- Robot
- Gas-control electronics
- ULPA filtration-system

The 4100 contains a subsystem for each of the following:

- Electronics (including a dedicated microprocessor)
- Mass-flow-controlled gas handling
- Cooling
- ULPA filtration
- Mechanical assemblies
- Extended Range Pyrometer (ERP)

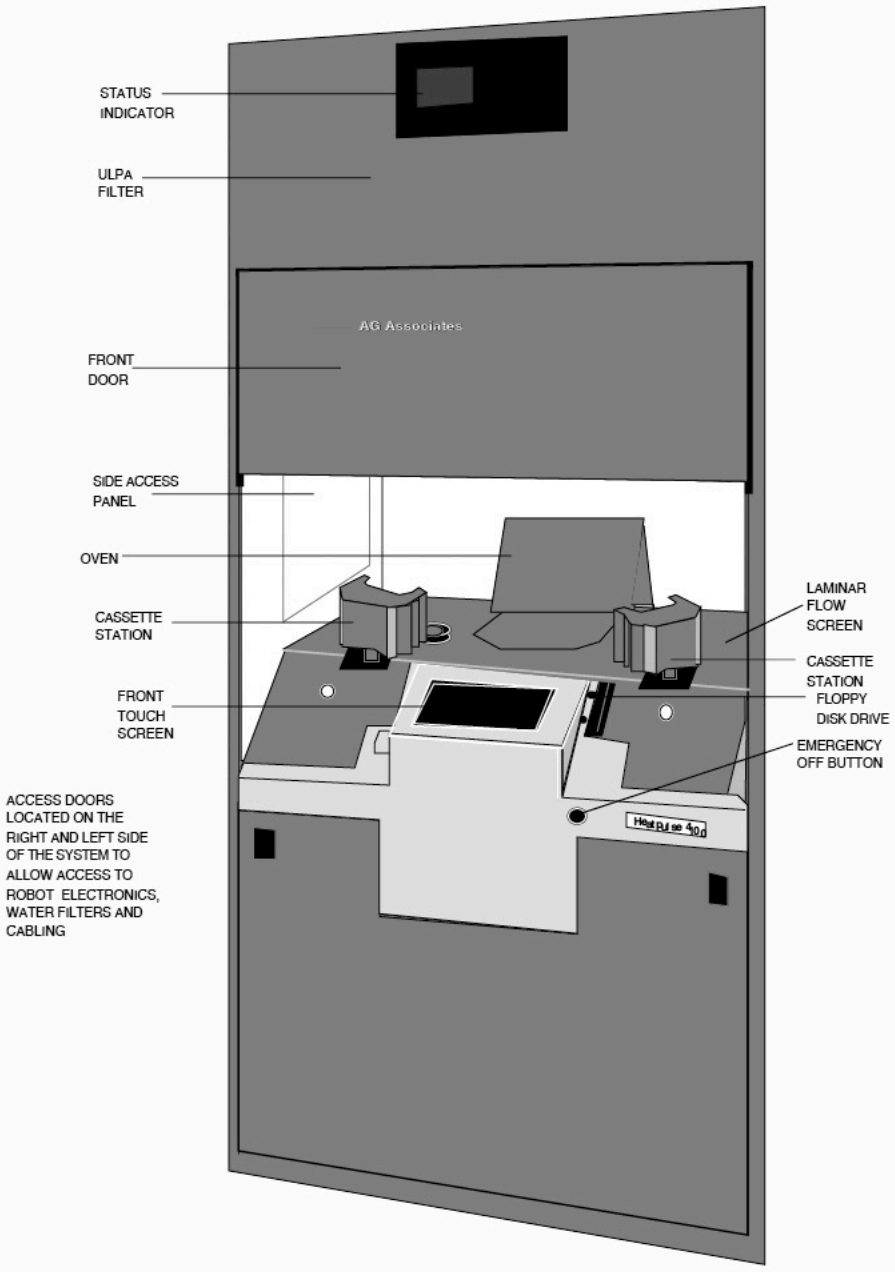
Software programs, called recipes, specify the details for each process. The system includes a 3-1/2-inch floppy disk-drive for process recipe storage.

A three-axis industrial robot automates processing by transporting wafers into and out of the heating chamber. It uses closed-loop feedback for precise motion-control and accurate positioning.

To provide cold-wall processing, water is circulated through the heating-chamber walls. The quartz isolation-tube is cooled with nitrogen or compressed air.

FEATURES

The HEATPULSE 4100 system contains many capabilities which provide significant advantages over conventional batch processing in the production of VLSI circuits. Clean-room integrity, precise temperature control and measurement, software flexibility, and the physical structure of the system (designed for the production environment) are among these advantages.



4100 HEATPULSE System Features

Contaminant-Free Processing

The HEATPULSE 4100 system is designed with the clean-room environment in mind. The following are the key features which make this HEATPULSE system contaminant-free:

- A stainless-steel laminar flow-processing floor and an ULPA filter are located in the processing area to reduce the number of particles in the environment. The walls of the processing area are also stainless steel.
- Designed to prevent particles from circulating around the wafer-handling area which allows the front-panel door to remain open during processing.
- Easy service-access is available from the rear and side panels.
- Through-the-wall installation maintains clean-room integrity.
- Belts and pulleys (a large source of particle contamination) do not exist in the 4100 wafer-handling area.
- Test results have shown added particles of ≤ 0.01 particles per cm^2 per wafer.

Heating, Cooling, and Temperature Measurement

The following list contains the key features of 4100 heating, cooling, and temperature measurement:

- High-intensity visible radiation heats wafers for short periods of 1 to 600 seconds at precisely-controlled temperatures in the 200°C-to-1300°C range.
- Tungsten-halogen lamps and cold-heating chamber walls respectively allow fast wafer heating and cooling rates.
- The system delivers time and temperature profiles tailored to suit specific process requirements.
- Pyrometer or thermocouple sensing offers precise closed-loop temperature control.
- Cooling gas flows through the heating chamber and around the isolation tube.
- Extended Range Pyrometer (ERP) subsystem accurately measures wafer temperatures from 400° C to 1200° C.

Software

The HEATPULSE 4100 system features simple touch-screen operation that is easy to learn. Additional software features are listed below.

- Screen menus allow a process cycle to be easily defined and executed.
- Status reports are continually displayed on the screen as the system operates.
- A self-diagnostic routine is active whenever the system is on and terminates the cycle in progress if an abnormal condition is detected.
- Access codes provide security for the system recipe-programming and diagnostic-functions.
- Recipes and process procedures are highly flexible.
- Screen menus are simple and easy to use.
- Touch-screen menus eliminate the need for a keyboard or special commands.
- Manual mode is available to allow engineers and service personnel to activate individual subassemblies and functions.
- Discrete diagnostic-routines, using a separate Diagnostic mode, are available.
- Thermal-processing cycles may be customized for unique processing-requirements.
- Custom recipes created by Process Engineers may be saved on floppy diskette and executed by Production Line Operators.
- System parameters and robot alignment parameters are saved in EEPROM on the RMS Board.

Service Access

The 4100 system has been built for fast servicing in the production environment which provides a low mean time to repair (MTTR). The features listed below reflect this purpose:

- An optional touch-screen is available at the rear of the system that is enabled through a key-control switch.
- The system is specifically designed for easy access and maintenance.
- A front-access window closes to prevent clean-room contamination during maintenance for through-the-wall installation.

Wafer Handling, Control, and Accuracy 4100 system features include the following:

- Consistent wafer-to-wafer process cycle repeatability
- The robotic transport of wafers in excess of 80 wafers per hour (in a null cycle without flatfinder)
- As an option, both the send and receive cassette bases swivel to accommodate loading and unloading by a clean-room robot in a fully robotic environment.

Safety

The 4100 system was designed with safety in mind. Safety features include:

- Software and hardware interlocks to prevent hazardous gas-combinations
- Emergency shut-off switches in both the front and rear of the system
- Error messages and alarm signals to convey system status

Cost Savings

The 4100 offers two features which result in considerable cost savings when compared to conventional batch-processing. Thus, it requires:

- Low-energy use
- Few employees for operation and maintenance

OPTIONS

The following options can be added to the 4100 HEATPULSE system at any time:

- **Non-Contact Wafer Aligner** — Finds the flat edge or notch of a wafer prior to loading it into the heating chamber. No contact is made with the edge of the wafer; contact is on the backside of the wafer only.
- **Susceptor Autoloader** — Provides the capability to process wafers in a susceptor. Wafers are automatically loaded into a susceptor for processing and unloaded at the end of the process cycle. This application is ideal for processing GaAs wafers.
- **E-SECS** — Protocol messages which facilitate the remote control of the HEATPULSE 4100 from a host computer system. Option includes communication processor with 12K ROM and 16K RAM. Option supports common SECS II communications protocol required to operate the HEATPULSE 4100.
- **Slip Free** — Hardware and software that dramatically reduces slip for high-temperature processing. Option includes either the flatfinder or non-contact wafer aligner.
- **Dual-Color Pyrometer** — The Dual-Color Pyrometer (DCP) measures the wafer temperature at two different wavelengths. Using the emissivity correction software, the system can compensate for variations in emissivity from one wafer to another.

APPLICATIONS

The HEATPULSE 4100 system is a versatile tool that can be useful for many applications, such as (but not limited to):

- Silicon-dielectric growth
- Implant annealing
- Glass reflow
- Silicides formation and annealing
- Nitridation of metals
- Contact alloying
- Oxygen-donor annihilation