APPLICATION NOTE

Switching & Protection for Deposition Equipment in Semiconductor Applications

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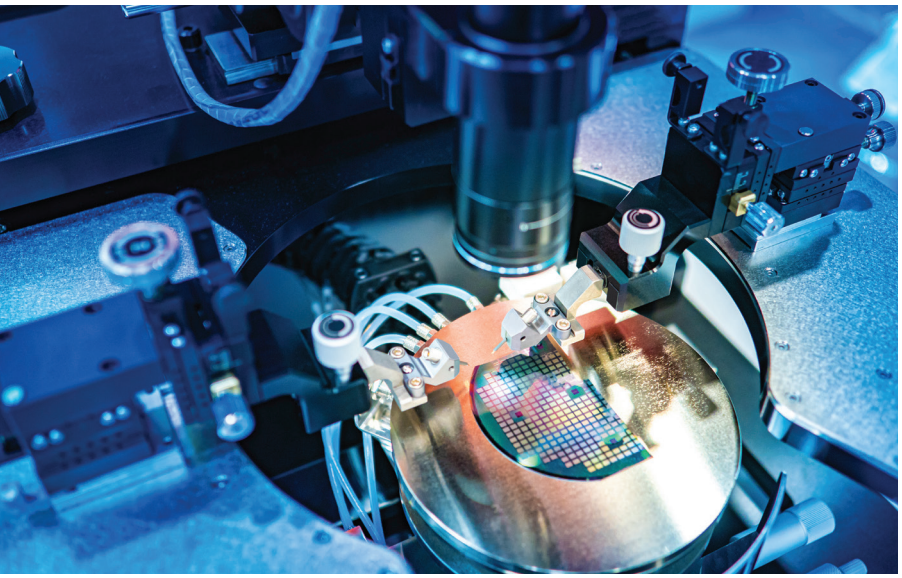


Are you searching for Switching and Protection solutions to protect circuits in semiconductor fabrication machinery?
You can easily find the best solution to fit into your fab tools and quickly configure your installation thanks to our Application Bundles based on concrete examples.

What is a Vapor Deposition Reactor?
Semiconductor manufacturing is complex and includes multiple steps. One of these is deposition, an essential process during which metals, semiconductors and even organic materials are vaporized, then deposited in thin films or coatings to provide the required functionality. Physical vapor deposition (PVD) and chemical vapor deposition (CVD) reactors are closely controlled systems comprising valves, heating elements, chamber, vacuum pump and controls. By modulating the temperature, pressure and gas flow rate, the desired layers are deposited on wafers, which form the foundation of all semiconductor devices.

Why you need Switching & Protection solutions
Each reactor requires fine process control and lots of power. Heating elements control chamber or wafer temperature and may be resistive or inductive, but either way, they require significant current and related overcurrent protection. A vacuum pump is used to create the correct atmospheric pressure for the specific reaction inside the chamber. The pump is, at its core, a motor circuit and should be protected as such, with control, short circuit and overload protection. Finally, a disconnecting means provides safety and isolation for users and the personnel who service the equipment.

Main benefits

Smarter protection
Improve the performance of your system while reducing OPEX by using our advanced switching and protection components.

Speed up your projects
Accelerate product development using our reference designs and bill-of-materials to ensure comprehensive protection.

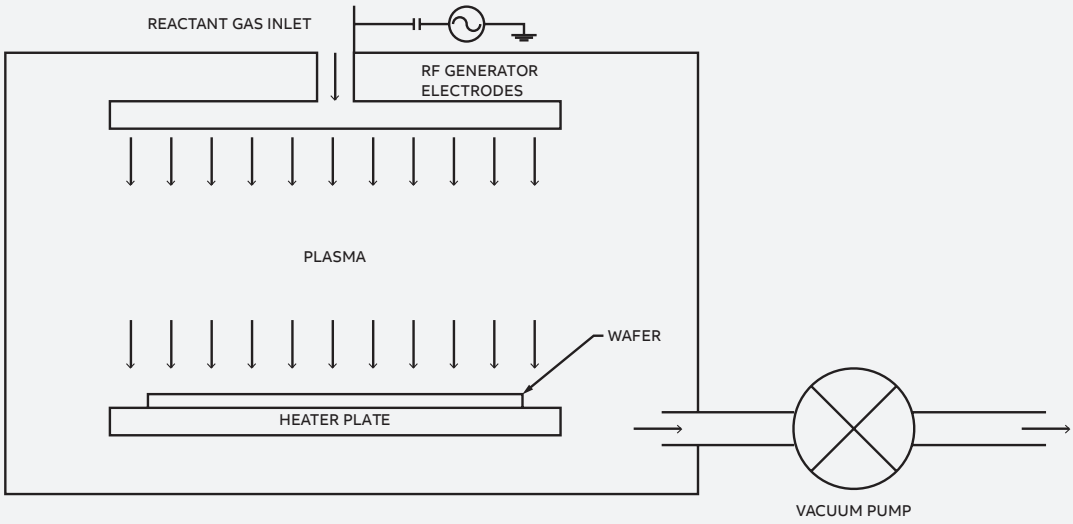
Safety
Avoid the risk of downtime and damage to sensitive electrical equipment by using a complete range of Surge Protection Devices (SPDs) to protect your entire electrical system from lightning and transient overvoltages associated with poor power quality and switching.

Smarter metering and monitoring
Maximize process yield and system uptime with the full line of ABB control, measurement and monitoring devices for both power and control circuits.

Vapor Deposition Reactor

Overview

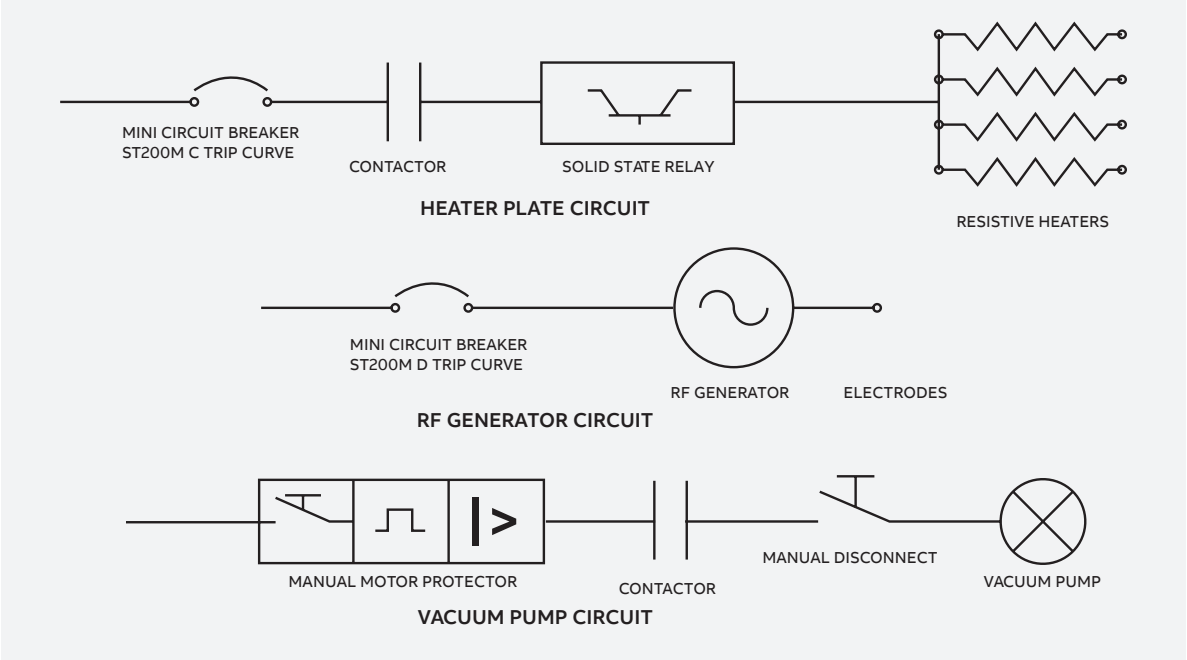
- There are countless variations of the deposition process, but Physical Vapor Deposition (PVD) and Chemical Vapor Deposition (CVD) dominate.
- Physical vapor deposition occurs by sputtering or evaporating the material directly onto the substrate, whereas chemical vapor deposition is obtained by chemical reactions between the gas and substrate. CVD may be dramatically accelerated in the presence of a plasma, or ionized gas, as in the so-called plasma-enhanced CVD (PECVD).
- The reactors are designed to control parameters such as film thickness, crystal structure, surface morphology and film composition.
- Deposition is a vital step in the creation of semiconductors of any size or process node (e.g. 3nm, 5nm, 7nm).



- Gas is introduced via the **inlet/s**, which is/are managed by a mass-flow controller.
- Optionally, a plasma (an ionized gas) is generated by placing the gas between the high voltage electrodes of an **RF generator circuit**. The plasma creates an electrical affinity of the gas to the target material. The generator consists of conductors, an inductor or transformer, switching controller and DC blocking capacitor.
- Heat is provided to the media via the **walls** of the chamber (hot-walled CVD), or it is heated directly by a supporting **plate heater** (cold-walled). The media is typically heated in the range of 400°C - 1000°C.
- Various control circuits throttle the temperature, pressure and flow rate of the reactor, and provide supervisory support of the process.
- A **vacuum pump** ensures the required pressure (vacuum) and ejects the waste gases to the subfab (supporting plant infrastructure).
- The human-machine interface **(HMI)** includes a display and user interface, as well as various **annunciators** (pilot lights and light towers), **buttons** (pushbutton and E-stops) and **switches** (e.g.: keyed selector switches).

Vapor Deposition Reactor

Fundamentals, main components & functionalities



Main Components	Functional Description
Main Power Circuit (not shown)	
Tmax XT molded-case circuit breaker w/ Ekip Touch intelligent trip unit	Main Power Distribution w/ [optional] power, current, energy measurement
OVR series surge protective device	Transient overvoltage protection
Wafer Heater Plate (<1 kW/circuit)	
ST200M C-curve supplementary protector (miniature circuit breaker)	Supplemental overcurrent protection
AF series contactor	Isolating contactor
Plasma RF Generator (<2.5 kW)	
ST200M D-curve supplementary protector (miniature circuit breaker)	Disconnecting and overcurrent protection for RF circuit
Vacuum Pump Circuit (<5 hp)	
MS132 series manual motor protector	Isolation, overload and short circuit protection
Contactor	Remote isolation and control
MS132 series manual motor protector w/ enclosure, or EOT-series enclosed motor disconnect	Disconnect means and isolation for vacuum pump circuit

Primary Functional Requirements

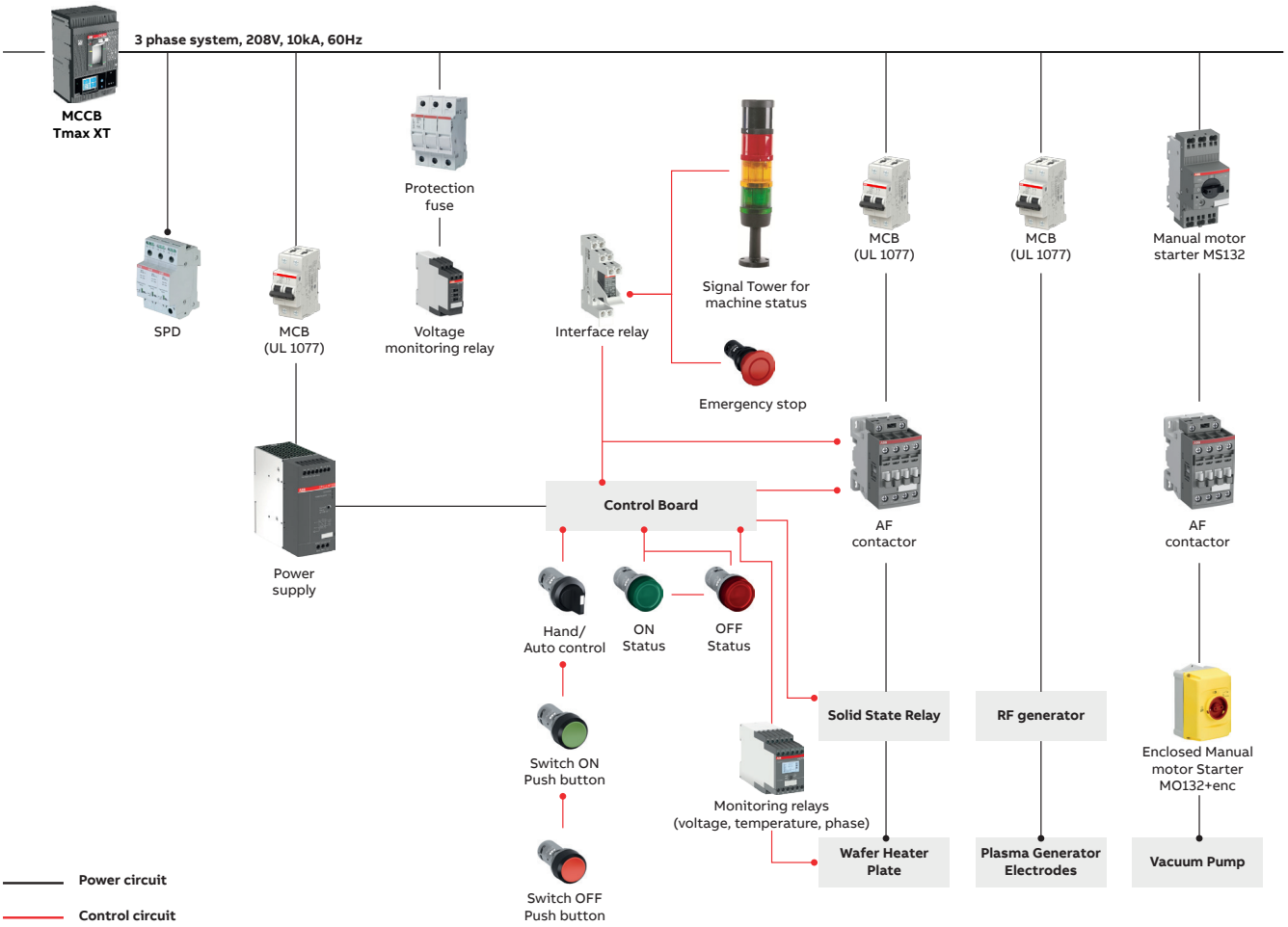
- Switching and overcurrent protection for the primary power source
- Protection against transient overvoltage conditions using a surge protective device
- Switching, control and overcurrent protection for:
  - heater circuits
  - plasma RF generator
  - Vacuum pump circuit

Secondary Optional Requirements

- Monitoring: where an outage or degradation to the performance of the equipment may adversely affect the process yield
  - Voltage, current or temperature monitoring
  - Communication: to communicate parameters to centralized monitoring system
- Remotely-operated: need for remote control
- Controls and signalling for all fab tool users (pre-dominantly pilot devices)
- Machine safety for users and service personnel

Switching and Protection solutions for Vapor Deposition Equipment

Discover our Switching & Protection solutions for straightforward deposition tool configuration considering PECVD architecture.



Specifications of electrical quantities

Field Descriptor	Rating	Units
Main Power Supply		
System rated power [kW]	6	kW
AC Main Supply Voltage	208	V
AC Main OCPD Rating (In)	30	A
Short Circuit Current Rating	10	kA
Heater Circuit		
Total Heater Circuit Power	1	kW
Heater Circuit Voltage Rating	120	V
Heater Circuit OCPD Rating (In)	10	A
RF Generator Circuit		
RF Generator Circuit Power	1	kW
RF Generator Voltage Rating	120	V
RF Generator Circuit OCPD Rating (In)	10	A
Vacuum Pump Circuit		
Vacuum Pump UL Horsepower Rating	5	hp
Vacuum Pump Voltage Rating	208	V (3-phase)
Control Circuit		
Control Circuit Power Rating	0.24	kW
Control Circuit Voltage Rating	24	V DC
Control Circuit Current Rating	10	A

Bill of Materials

Power Circuit Components

Location	Part Number	Description	US product code	Quantity
Main supply	1SDX036849R1	XT2N 125 E.HI-T LSI 040 3p UL	XT2NU3040TFF000XXX	1
Main supply	1SDA074637R1	XT1N 125 TMF 30-500 3P F F UL/CSA *	XT1NU3030AFF000XXX	0
Main supply	2CTB802346R2100	OVR SPD 3P+N 40KA 175V P TS 3RD ED	OVR T2 3N 40-150 P TS U	1
Main supply	2CSM299932R1801	E90 CLASS CC FH 3P 30A	E93/30CC	1
Main supply	1SVR730885R1300	CM-MPS.11S THREE-PHASE MON.	CM-MPS.11S	1
Heater circuit	2CDS272334R0104	MCB ST200M 2P C 10A UL1077	ST202M-C10	1
Heater circuit	1SBL136001R3010	AF09Z, 3P, 1NO0NC, 24VDC	AF09Z-30-10-30	1
Heater circuit	1SVR750740R0110	CM-TCN.011S TEMP MON RLY LCD+NFC	CM-TCN.011S	1
RF generator	2CDS272334R0101	MCB ST200M 2P D 10A UL1077	ST202M-D10	1
Vacuum pump circuit	1SAM350000R1013	3P MMP 16.0-20.0A RANGE	MS132-20	1
Vacuum pump circuit	1SAM360000R1013	3P MMP 16.0-20.0A RANGE MAG ONLY	MS132-20	1
Vacuum pump circuit	1SAM201911R1011	ENCLOSURE, RED/YE, IP65, 3X LOCKAB	IB132-Y	1
Vacuum pump circuit	1SBL176001R3010	AF16Z, 3P, 1NO0NC, 24VDC	AF16Z-30-10-30	1

* use as basic, low-cost alternative

Control Circuit Components

Location	Part Number	Description	US product code	Quantity
Control circuit	2CDS271334R0034	MCB ST200M 1P C 3A UL1077	ST201M-C3	1
Control circuit	1SVR360663R1001	CP-C.1 24/10.0 POWER SUPPLY	CP-C.1 24/10.0	1
Control circuit	1SFA619403R5022	PILOT LIGHT CL2 GREEN 24V AC/DC	CL2-502G	1
Control circuit	1SFA619403R5021	PILOT LIGHT CL2 RED 24V AC/DC	CL2-502R	1
Control circuit	1SFA619200R1076	SELECTR 2 POS. MAINT. BLACK 1NO+1NC	C2SS1-10B-11	1
Control circuit	1SFA619100R1072	COMPACT FLUSH PB MOM. GREEN 1NO+1NC	CP1-10G-11	1
Control circuit	1SFA619100R1071	COMPACT FLUSH PB MOM. RED, 1NO+1NC	CP1-10R-11	1
Control circuit	1SVR405622R1100	CR-U024DC3L PLUGGABLE RELAY	CR-U024DC3L	1
Control circuit	1SVR405660R0000	CR-U3S SOCKET	CR-U3S	1
Control circuit	1SFA619550R1071	40MM TW-REL RED, 1 NO & 1 NC	CE4T-10R-11	1
Control circuit	1SFA616070R3051	PERMANENT LIGHT RED LED 24VAC/DC	KL70-305R	1
Control circuit	1SFA616070R3052	PERMANENT LIGHT GREEN LED 24VAC/DC	KL70-305G	1
Control circuit	1SFA616070R3053	BEACON, LIGHT ELEMENT,YELLOW	KL70-305Y	1
Control circuit	1SFA616075R1002	STACKLIGHT,TERM ELE,BRKT-BASE	KT70-1002	1
Control circuit	1SFA616077R1031	STACKLIGHT,MTG BRACKET,1 SIDE	KA70-1031	1

APPLICATION FINDER

We've made it simpler for you to set up your project!
Click here to find the reference architecture that best fits your needs and download the Bill of Materials.

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