

Loadstation Reference Manual

Tempress[®] Systems, Inc.
Loadstation manual
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1. Introduction

1.1 Scope of the manual

The contents of this manual and drawings are to provide the necessary instructions and information for installing, adjustment, operating and maintenance of the loadstation. Before starting up, installing, operating and/or maintaining the loadstation this manual must have been read first.

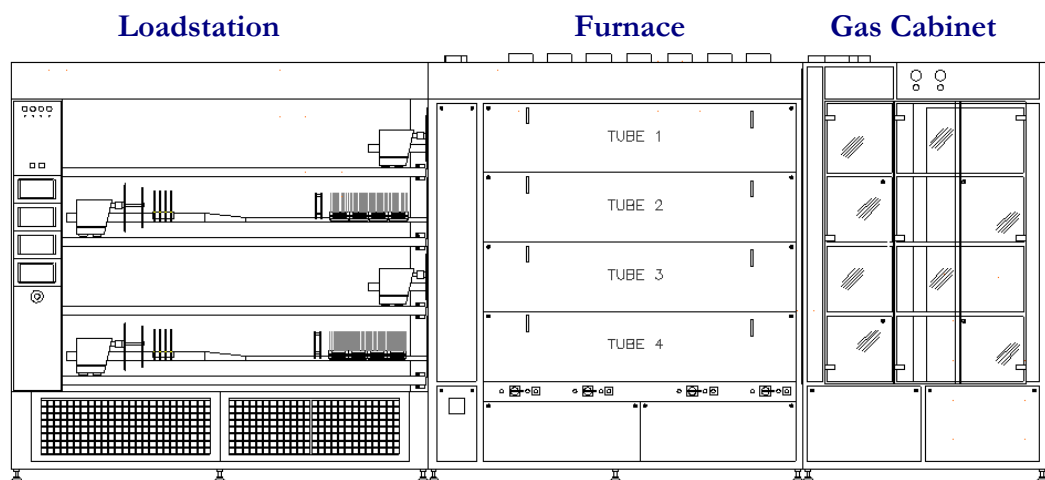


Figure 1-1 Example of a diffusion furnace system

1.2 Diffusion System

The system is designed to perform Diffusion/Atmospheric and Low Pressure Chemical Vapor Deposition (LPCVD) processing on wafers from 75 mm up to 300 mm, and may be installed in a cleanroom environment.

Major components of this system are:

- Furnace System
- **Loadstation**
- Cross flow box (Horizontal or Vertical Flow Loadstation)
- Gas Cabinet
- Control system

1.3 Loadstation

Boatloaders move the loaded cantilever assemblies contactless into the furnace process tube. The Class 10 in-line load station provides horizontal or vertical, laminar airflow over the cantilever area where the loaded boats are placed prior to insertion into the furnace.

Concealed boatloader assemblies are mounted within shelves attached to the loadstation. Cantilever assemblies mounted to the boatloaders are designed to accept the same environmental conditions as the wafer-loaded quartz boats they hold during the process run.

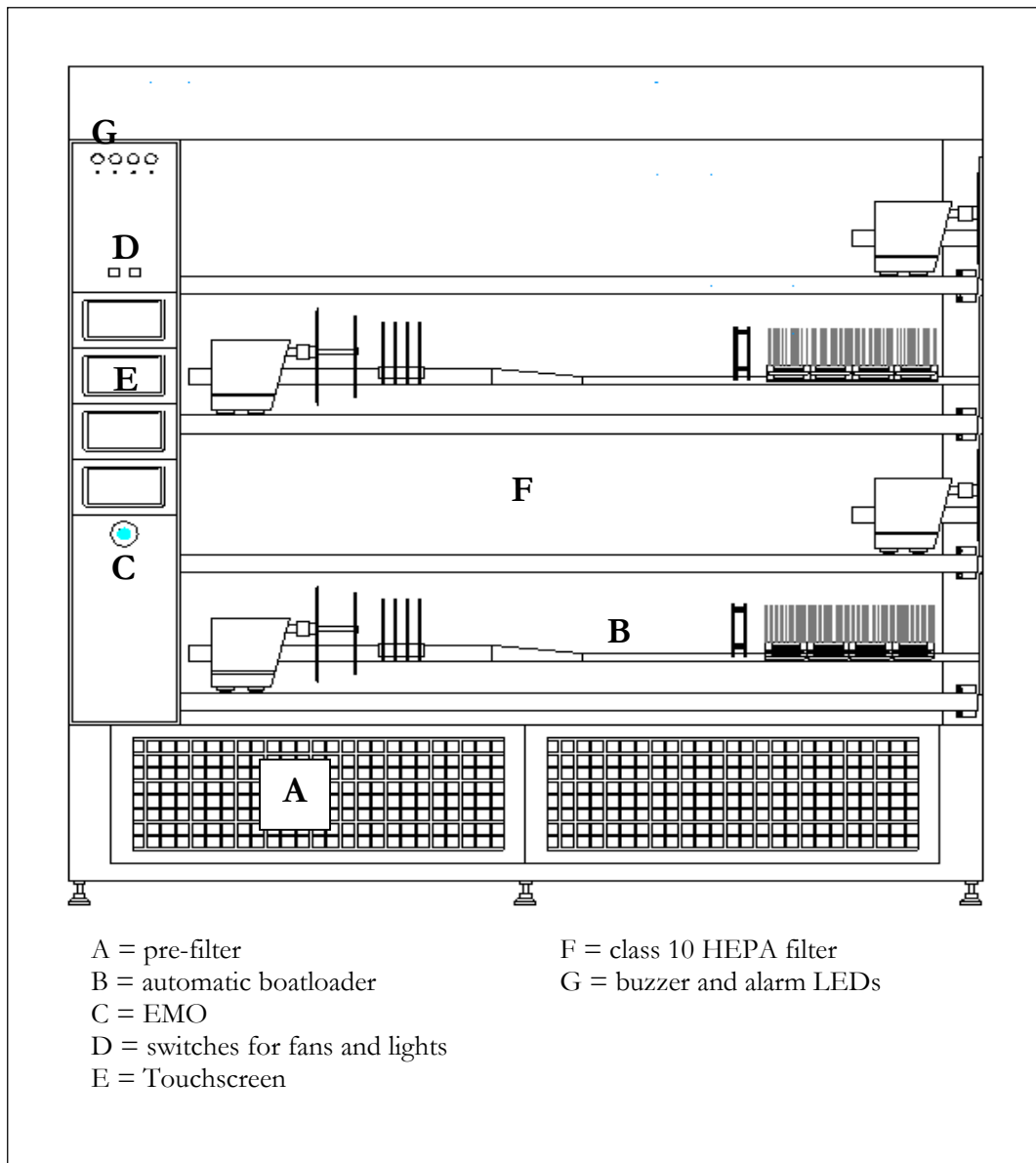


Figure 1-2 Example of a loadstation

A class 10 laminar flow load station is designed to mate with a furnace. It accepts 4 boatloaders with cantilever head assemblies, driving motors and associated power supplies, which are located in the base of the load station and on individual shelves, one for each tube level. It is designed for use with fully automated wafer loading.

The framing of the Ultra Pure Air (ULPA) filtration system allows permanent clamping of filter frame to a closed-cell neoprene gasket, ensuring system integrity. The work surface, perforated filter screen, and tube-level shelves are all made from polished stainless steel.

The load station exceeds the cleanroom requirement of Federal Standard 209, class 10. The final filter provides 99,997 percent efficient filtration of particles 0.3 microns or larger.

Pyrex diffuser glass panels enclose 2 white fluorescent lamps, located in the top of the load station (in horizontal and vertical load stations) and in each shelf (in horizontal load stations). They are replaceable from the front of the unit.

The loadstation has an illuminated on/off switch for the fans and for the light.

The load station of a 4-stack furnace contains the following components:

- Atmospheric cantilever loading systems and/or LPCVD cantilever loading systems, with a paddle or twin rod system.
- Airtight flowbox.
- Pre-filter and blower system in the base of load station, for horizontal flow. The blower speed is controlled by an adjustable auto-transformer.
- Downflow system above operator area (optional).
- Protection screen in front of the filters.

1.4 Boatloader

The boatloaders are automatic and provide vibration-free loading of up to 300 mm wafers in a class 10 or better environment.

The boatloaders are controlled by the Digital Process Controller (DPC).

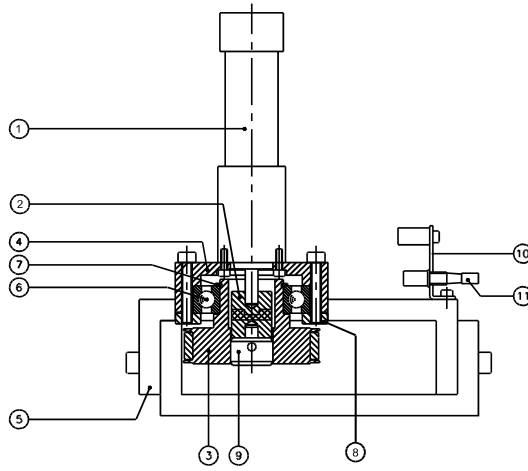
The assembly is driven by a servo motor to provide smooth, vibration-free movement over the full speed range. With power off or in manual mode, the carriage assembly may be moved by hand. The speed of the boatloaders is incrementally controllable throughout its range of motion. In addition, the boatloader speed is ramped up and down as it begins and ends its motion (soft start).

The servo motor is controlled by a servo driver unit, suitable for all kinds of boatloading. By using a precision roller-way, the vibration is minimized. This construction is moved by a belt, which is made of special non-elastic material. See Figure 1-3.

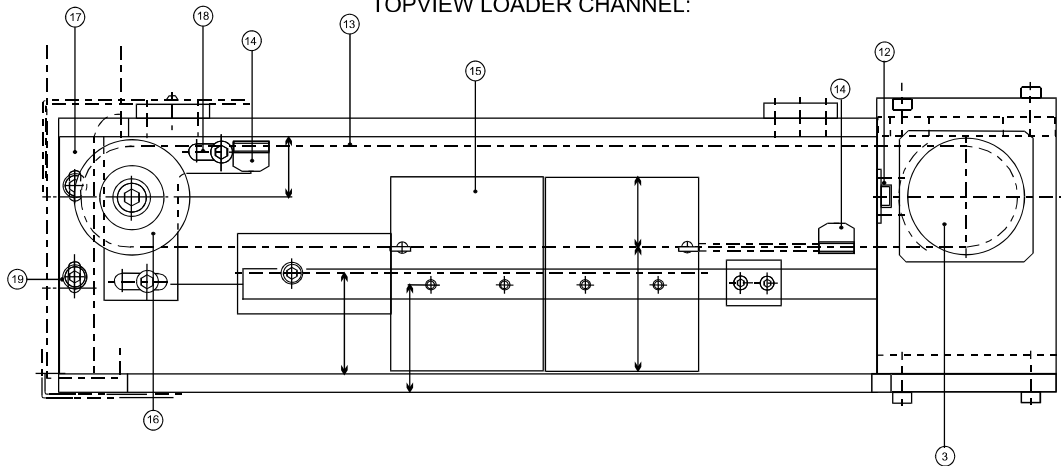
Furthermore the boatloader contains the following components:

- Polished stainless steel shelves.
- Left and right limit switches.
- Automatic zero position detection circuit.
- System jammed detection.
- Reference detector for '0' detection.

MOTOR SIDEVIEW:



TOPVIEW LOADER CHANNEL:



CROSSSECTION OF THE CARRIER:

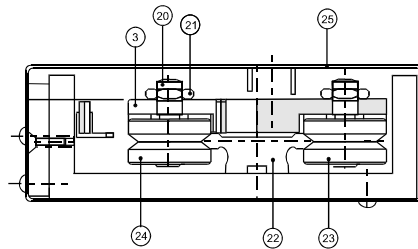


Figure 1-3 Loader for a horizontal flow loadstation

Motorside view:

1. Loadermotor
2. Coupling
3. Pulley servodrive
4. Connection flange motor
5. Bracket servo-motor loader
6. Bearing
7. Circlip
8. Clamp flange motor
9. Extension shaft
10. Bracket auto/man switch
11. Switch tumbler auto/man

Top view Loader Channel:

12. Optical sensor
13. Timing belt
14. Actuator optical switch
15. Rollertable
16. Endpulley
17. Adjustable mounting plate endpulley
18. Clampscrew
19. Side alignment screws

Crosssection of the Loader:

20. Horizontal alignment screws
21. Locking screw
22. Slide way
23. Journal assembly excentric (adjustable)
24. Journal assembly centric
25. Coverplate loaderchannel

1.5 Diffusion Cantilever Assembly

Mounted on a boatloader system, the cantilever head assembly is the interface between the wafer boat (carrier) and the boat moving system.

1.5.1 Cantilever

The cantilevers are x-, y- and z-axis adjustable and have the option of using:

- Silicon carbide paddle system.
- Silicon carbide twin rod system.
- Quartz or Silicon Carbide Endplate for Tube closing.

Silicon carbide is more chemical resistant, capable of withstanding higher temperatures and more rigid than quartz. SiC is also more expensive than quartz.

The cantilever head additionally contains door closure systems. These door closures depend on the type of furnace (atmospheric or LPCVD) and are designed to close the tube front (a quartz tube closure plate or a silicon carbide closure plate), as well as the scavenger (scavenger door closure).

The following figure shows a “Doorclosure for an atmospheric diffusion system with paddle”.

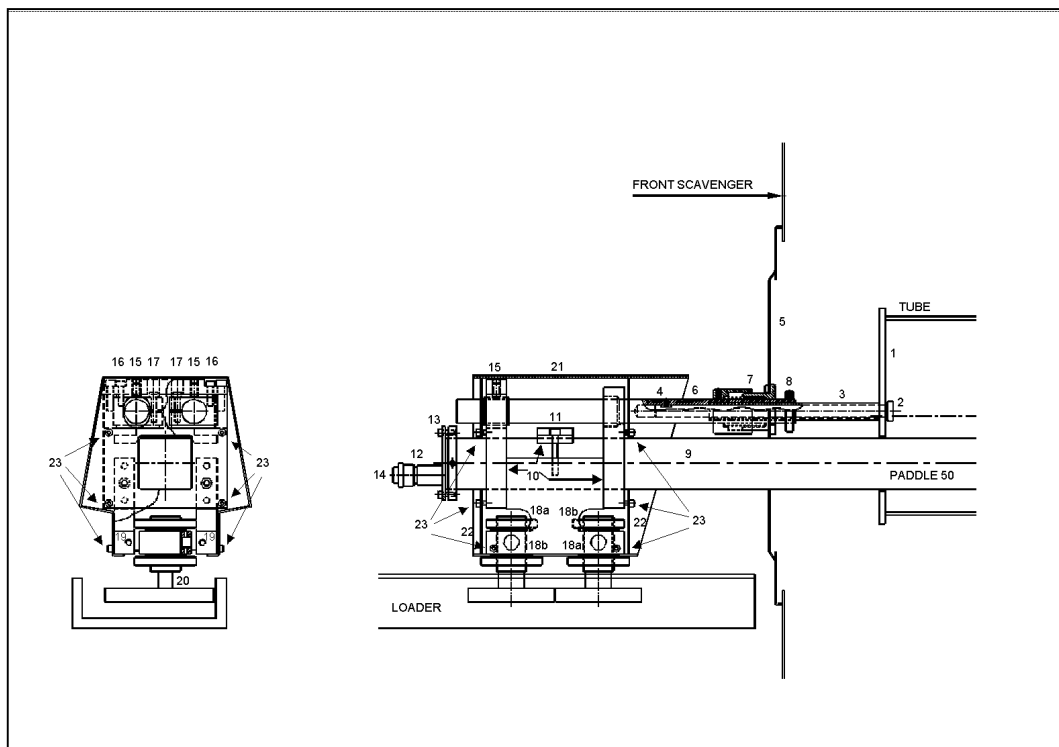


Figure 1-4 Doorclosure diffusion with paddle

1. Quartz Door (1x)
2. Quartz Suspension Rod (2x)
3. Quartz Suspension Rod Cover (2x)
4. Hexagon socket Setscrew and Mounting Block Quartz Suspension Rod (4x)
5. Steel Scavenger Door (1x)
6. Steel Suspension Rod Scavenger Door (2x)
7. Spring Compression Steel Door (2x)
8. Scavenger Door End Stop (2x)
9. Paddle (1x)
10. Paddle Clamp Doorclosure (1x)
11. Paddle Clamp Bolt (2x)
12. UltraTorr for profiling Thermocouples (optional 1x)
13. Gasket (optional 1x)
14. Stop (optional 1x)
15. Height Adjust Screw Quartz Door and Scavenger Door (2x)
16. Locking Screw Height Adjustment Quartz Door and Scavenger Door (2x)
17. Clamping Screw and Length Adjustment Quartz Door and Scavenger Door (2x)
18. Hexagon Nut for Height Adjustment (a) and Locking (b) of Cantilever System (4x)
19. Locking Screw Side Alignment Cantilever System (2x)
20. Distance Bolt connected on Loader (2x)
21. Head Assembly Steel Cover (1x)
22. Head Assembly Steel Front and End Plate (2x)
23. Head Assembly Steel Cover Screws (12x)

1.5.2 Soft Contact loader

The Soft Contact Loader is an electronically controlled mechanism for transporting wafer carriers into the process tube. The tube loader moves the wafer carriers into and out of the process tube. A variety of loading devices can be mounted on the *basic* loader, each appropriate to the type of process being run in the tube.

The tube loader movement is controlled by the DPC, which interfaces with:

- the servo drive control unit (to provide movement);
- the tube loader encoders (which provide position information);
- the operator (to receive commands and report status).

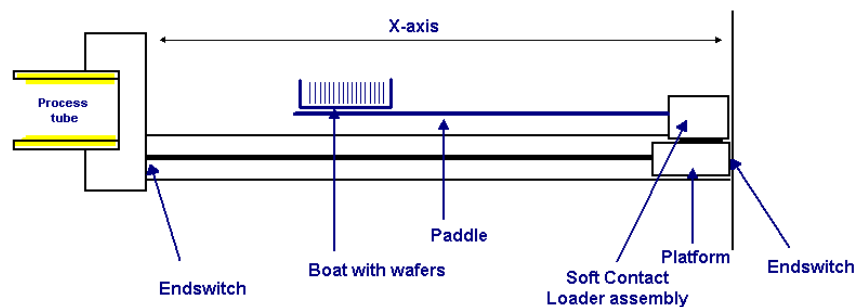


Figure 1-5 Soft Contact Loader

The soft contact loader (SCL) lay-down the wafer carriers on the bottom of the tube. Subsequently, the paddle is removed and the tube is completely sealed. The stabilization time is reduced because less material needs to be heated (no paddle).

This loader includes the soft contact loader platform and mechanism (this is in addition to the frame with covered track, the carriage and the basic loader mechanism).

The platform mechanism houses a motor to raise or lower the platform with the paddle and a motor that tilts the platform to compensate for the weight of the wafer carriers at the end of the paddle. This loader can be used for diffusion and LPCVD systems.

See Appendix A for the complete description concerning the Soft Contact Loader.

1.6 Fans

1.6.1 Introduction

The fans provide horizontal laminar airflow through a HEPA filter. In this way a cleanroom compatible load area is supplied. Note that the room behind the filter always must be leak free. The air-velocity must be between 0.45 m/sec and 0.5 m/sec. This must be checked weekly. With a Variac transformer the rotation speed of the fans can be adjusted. See chapter 4 for adjustment details.

1.6.2 Assembly prescriptions

The impellers should be checked for the running direction out of true before usage.

Electrical connection

The fanswitch on the loadstation start the fans. Before starting up the system the following needs to be noted:

- The motor of the fan is protected against excess temperature.
- The rotation direction must be checked. It is marked with an arrow on the fan.

Maintenance

The fan motor is provided with self greasing bearings. Depending on exhaust of air, the impeller must be checked on contamination. If there is a lot of contamination, this can influence the air capacity and the balance and requires cleaning of the impellers. See chapter 4 for maintenance instructions.

2. Installation

2.1 Introduction

Unpacking, installation and inspection procedures are detailed in the following paragraphs.

When the load station is moved in transit and during final placement at the customer's facility, care should be exercised at all times.



NOTE

Transport of the system should be in an upright position at all times!!

2.2 Unpacking

- Before the load station is unpacked a visual inspection of packing materials should be made. If there is evidence of damage during transit the carrier should be contacted so that an inspector can be present to verify any damage before the loadstation is unpacked
- If there is any visible damage Amtech/Tempres Systems should be notified verbally and/or in writing within 24 hours.
- A fork-lift with a capacity of at least 1500kg must be available to move/carry the load station in its right place.
- Check off all boxes one by one.
- Unpack the boxes one by one.
- Check the contents of the boxes against the collo list.
- If any damage is visible, then Amtech/Tempres Systems should be notified verbally and/or in writing within 24 hours.



NOTE

Do not dispose any of the packing materials or boxes.

- Release and remove equipment wrappings.



NOTE

Lift or pull the wrappings away from all stainless steel surfaces. Do not drag packing materials across the equipment surfaces. This could cause damage.

- Depending on the type of packing materials a final dedusting must be done before the loadstation is put into its position. The system has been pre-cleaned before leaving the Tempress Systems factory.

2.3 Placing the loadstation

Items, described in this paragraph, are the customer's responsibility.

- The loadstation can be placed after the furnace is in position.
- Locate the loadstation in its final position.
- Place a spirit level on top of the loadstation.
- Level and align the load station with respect to the furnace using the adjustable feet.



NOTE

The boatloader must be aligned at the same time as the furnace heating element.

- Install all facilities as indicated on the outline drawing and verify that they comply to the labeling.
- Do not switch on any of the services that have been connected, this may only be done in the presence of a qualified engineer from Amtech/Tempress Systems, except when written permission is gained from Amtech/Tempress Systems.
- Final alignment and facility functionality will be checked by the Amtech/Tempress-engineer.



NOTE

Do not yet remove the polythane wrapping the hepa-filters.

2.4 Boatloaders

2.4.1 Inline Cantilever loader

- Move the boatloader/cantilever mounting plates for all the tube levels to the end of the loadstation (furthest from the furnace).
- Mount the diffusion or LPCVD cantilever heads on the cantilever mounting plate (See Figure 1-5 Soft Contact Loader).
- Insert the paddles or twin rods into the cantilever head (See paragraph

Mounting a Paddle 4.1.2).

- Adjust the cantilever heads to move freely in and out of the process tube as described in paragraph.

2.4.2 Soft Contact Loader

See 2.4.1 Inline Cantilever loader.

2.4.3 Pre-Filter and Blower System

In case of a sepArate filter and blower system, notice the following:

- The weather strip between loadstation and filter/blower needs to be placed first. Then place filter and blower system on top of the loadstation.

In case of sepArate filter and blower system, or placed in the base of the loadstation:

- Check if all fans are working.
- Check the rotation direction of the fans.
- Adjustment of the rotation speed of the fans.
- For the vertical flow system, one LED has to be green. For the horizontal flow system the air velocity must be between 0.45 m/sec and 0.5 m/sec.

2.5 Inspection

- Check for any parts that may have loosened or become free during transit (especially the electrical connections), and check all Components for damage.
- Check if the fans and lights switches are "OFF".
- Check if the cabling is proper connected.



NOTE

High voltage may cause serious injury or may be fatal. It is essential that all safety guidelines are followed when working with high voltage equipment

3.Start-up

3.1 Introduction

After the load station is installed and leveled correctly the start-up can begin.

The Digital Process Controller (DPC) is used to control the boatloader (boatfused alarm and high/low limit alarm). **For more information, see the DPC Technical Manual.**

3.2 Start-up

First the start up procedure of the furnace, as described in the Diffusion Furnace Instruction and Maintenance Manual”, Chapter 4.0 START-UP must have been completed. When this is finished the start-up procedure of the load station and the boatloader can be done.

3.2.1 Load Station

- Remove the polythene wrappings from the HEPA filters. This must be done very carefully to prevent damage to the filter elements.
- Check if the flat cables are connected properly and in the right place (they have to be connected in stack-order).
- Check if the electrical wires and voltage are connected correctly with the furnace. So, if the switch of tube 1 is turned on, loader 1 (upper loader) will begin to operate.



NOTE

Align the boatloaders before applying power. Failure to do so may result in equipment damage.

- Use the fan switch and the light switch to start the fans and the lights.

3.2.2 Boatloaders

Inline loader

- Put the "MANUAL/AUTO" switch near the shelves in "AUTO".
- Turn on the power for the DPC.
- Check if the boatloader is working correctly via the DPC.

3.2.2.1 Soft contact loader

See Appendix A for the complete description concerning the Soft Contact Loader.

4. Maintenance

4.1 Introduction

This chapter describes the maintenance procedures for the loadstation. A preventive maintenance schedule with an overview of routine, daily, monthly and yearly maintenance of the loadstation is included at the end of this chapter.



NOTE

When working with silicon carbide and/or quartz, always wear gloves to protect them against grease of all kinds. Also put them on a safe and very clean place, to protect them against dust and other environmental factors which may cause any damage to the material



NOTE

The numbers, mentioned in the following paragraphs refer to the numbers of paragraph 1.5.1 and Figure 1-4 on page 1-1.

4.1.1 Mounting and adjustment procedures

1. Mounting a paddle and quartz door
2. Unmounting a paddle
3. Unmounting a quartz door
4. Adjusting a door to the paddle
5. Adjusting the paddle to process tube

4.1.2 Mounting a Paddle

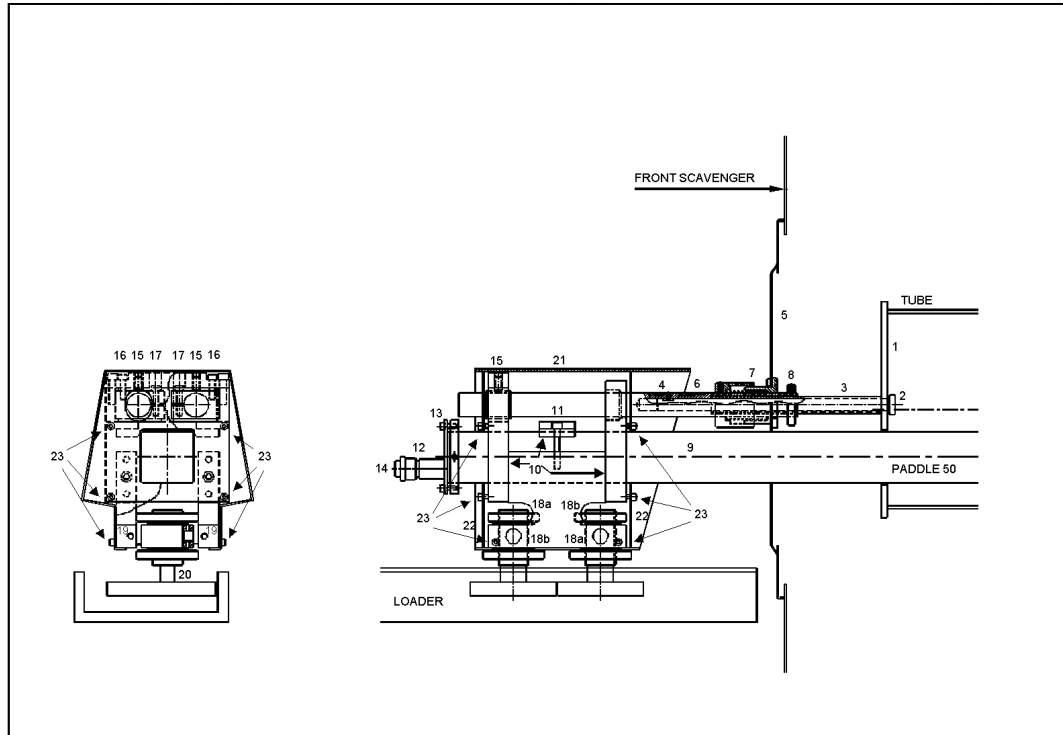


Figure 4-1 Doorclosure diffusion with paddle

- | | |
|--|---|
| 1. Quartz Door (1x) | 16. Locking Screw Height Adjustment Quartz Door and Scavenger Door (2x) |
| 2. Quartz Suspension Rod (2x) | 17. Clamping Screw and Length Adjustment Quartz Door and Scavenger Door (2x) |
| 3. Quartz Suspension Rod Cover (2x) | 18. Hexagon Nut for Height Adjustment (a) and Locking (b) of Cantilever System (4x) |
| 4. Hexagon socket Setscrew and Mounting Block Quartz Suspension Rod (4x) | 19. Locking Screw Side Alignment Cantilever System (2x) |
| 5. Steel Scavenger Door (1x) | 20. Distance Bolt connected on Loader (2x) |
| 6. Steel Suspension Rod Scavenger Door (2x) | 21. Head Assembly Steel Cover (1x) |
| 7. Spring Compression Steel Door (2x) | 22. Head Assembly Steel Front and End Plate (2x) |
| 8. Scavenger Door End Stop (2x) | |
| 9. Paddle (1x) | |
| 10. Paddle Clamp Doorclosure (1x) | |
| 11. Paddle Clamp Bolt (2x) | |
| 12. UltraTorr for profiling Thermocouples (optional 1x) | |
| 13. Gasket (optional 1x) | |
| 14. Stop (optional 1x) | |
| 15. Height Adjust Screw Quartz Door and Scavenger Door (2x) | |

- Head Assembly Steel Cover Screws (12x) Move the entire cantilever system to BOAT OUT position.
- Put the loader in MANUAL operation mode.



NOTE

The head assembly steel front and end plate are secured with 4 screws (23) each and are retained from the head assembly body by washers that may fall out.

- Remove the head assembly steel cover (21) and head assembly steel endplate (22)

Remove the remaining head assembly steel cover screws (23) and loosen the head assembly steel front plate (22)



NOTE

The paddle end must be supported to prevent the paddle from falling.



NOTE

Use clean support material to prevent contamination.

- Slide the spring compression steel door (7) and the steel scavenger door (5) over the steel suspension rod scavenger door (6).
- Carefully slide the quartz door (0) over the paddle neck
- Slide the paddle through the steel scavenger door (5) under the paddle clamp bolt (11) until the paddle sticks approximately 20 mm out of the backside of the head assembly.
- Place the paddle clamp plate on top of the paddle while holding the paddle horizontally.

2 paddle clamp bolt (11) maximum 4Nm (no lubricant allowed)

- start with 1 and 2 until fingertight while keeping the paddle horizontal
- Use a torque wrench to tighten the paddle clamp bolt
- Start with 1 and 2 to 0.5Nm
- Repeat this to 1Nm and finish off to 4Nm

4 paddle clamp bolt (11) maximum 3Nm (no lubricant allowed)

- Start with 1 and 4 until fingertight while keeping the paddle horizontal then do 2 and 3 fingertight
- Use a torque wrench to tighten the paddle clamp bolt
- Start with 1 and 4 to 0.5Nm

- Then do 2 and 3 to 0.5Nm
- Repeat this to 1Nm and finish off to 2Nm

6 paddle clamp bolt (11) maximum 2Nm (no lubricant allowed)

- start with 3,4 until fingertight while keeping the paddle horizontal
- then do 1,6 fingertight
- then do 2,5 fingertight
- Use a torque wrench to tighten the paddle clamp bolt
- Start with 3,4 to 0.5Nm
- Then do 1,6 to 0.5Nm
- Then do 2,5 to 0.5Nm
- Repeat this to 1Nm and finish off to 3Nm
- Slide the quartz suspension rod (2) through the quartz door (0) and place the quartz suspension rod cover (3) over the quartz suspension rod
- Place the quartz suspension rod spring into the steel suspension rod (6) and slide the quartz suspension rod in as well.
- Make sure to place the flat side of the quartz suspension rod (2) upwards.
- **CAREFULLY** tighten the hexagon socket setscrew and mounting block (4) until the quartz suspension rod (2) is fixed securely and the quartz door (0) is hanging on the quartz suspension rods (2).

4.1.3 Disassembling a Paddle



NOTE

Care must be taken not to put any force on the quartz endplate while moving the paddle through. the quartz endplate is mounted on quartz suspension rods that break easily.

- Remove the ultratorr (11) and the gasket (13).
- Unscrew the paddle clamp bolt (11) **while supporting the paddle**.
- Remove the paddle (9) through the steel scavenger door (4) and the quartz door (0) **very gently** in the direction of the tube until it can be completely removed from the loadstation.
- Store the paddle in a secure place for cleaning or replacement.
- Put the new or cleaned paddle back using the reversed order as described above. Screw the paddle clamp nuts tight and place the ultratorr with gasket.

4.1.4 Disassemble a quartz (SiC) door

- Make sure the paddle has been removed according to paragraph 4.1.3
- Remove the hex socket setscrews and mounting block (4) on the suspension rod.
- Remove the quartz suspension rod (2), the quartz suspension rod cover (3) and the quartz door (0).



NOTE

Be careful not to let the quartz suspension rod slide out of the door.

- Clean or replace the quartz endplate.
- After cleaning or replacement, put everything back in reverse order as described above.

4.1.5 Door Adjustment

4.1.5.1 Cantilevers

- The quartz and steel door must be adjusted to allow free movement of the paddle through those doors and prevent the formation of particles.
- Unlock the suspension rod locking screws (16).
- Adjust the quartz door (0) and the steel scavenger door (4) height in respect of the paddle using the height adjustment screws (15). Make sure both do not touch the paddle anywhere.
- Lock the suspension rod locking screws (16).

4.1.6 Adjustment of paddle to the process tube

The cantilever head assembly must be aligned to:

- 1) fit the process wafers inside the tube
- 2) seal the process tube from the scavenger exhaust
- 3) seal the scavenger box from the cleanroom

Requirements:

Full load of wafers

Flow baffle

Heat barriers

C-type key

Summary:

- Place flow baffle on the end of the paddle
- Adjust the cantilever head assembly using the C-type key on the hexagonal nuts (18a) for height and parallelism and (18b) for locking.
- Start with the flow baffle just inside the tube and adjust until top, left and right spacing between the edge of the flow baffle and the process tube is equal and the paddle is parallel to the loader channel
- **Manually** move the loader **Slowly** in and out of the tube, making sure no contact is made between flow baffle and tube.

The cantilever head assembly and paddle are now configured for daily use. Proceed to the loader calibration procedure to finalize the loader setup.

4.1.7 Calibration of the servo drive unit

This paragraph describes the calibration procedure of the servo drive unit in Tempress loader systems.

4.1.7.1 For Cantilever

Preparation requirements:

Remove the loader channel cover to allow access to the belt and activator flags. Make sure the tube is at standby temperature and a full load of wafers is available.

Calibration procedure:

1. Make sure the servo drive unit is configured for the correct loadstation-furnace configuration (right-handed (RH) or left-handed (LH)). In this document RH means the furnace is right of the loadstation when one is positioned as if one would load wafers. Check that the first jumper from the connector side is *removed*. Make sure to turn off the power supply before removing any connectors from the servo drive unit (see note)

See drawings:

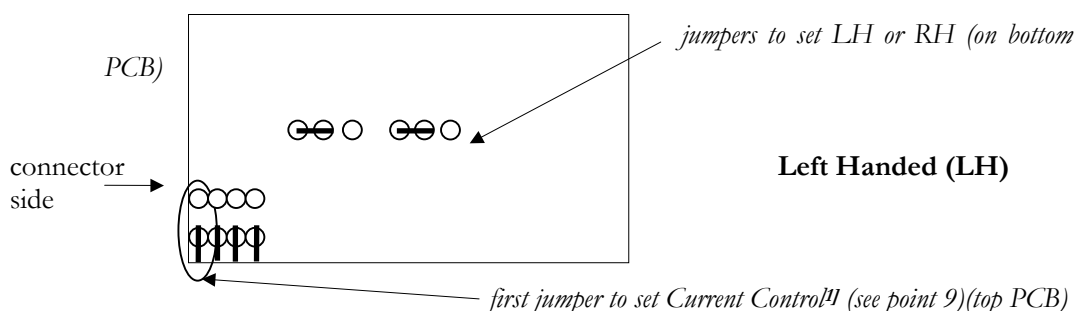


Figure 4-2 Loadstation Furnace Configuration



Figure 4-3 Loadstation-Furnace Configuration

2. Manually put the loader in *boat-out* position (the activator needs to be inside the optocoupler). The boat position read-out should be 10 mm. Mark the cantilever head assembly position.
3. Manually put the loader in *boat-in* position, making sure a 2-5 mm gap is left between the quartz (or SiC) door and the process tube (the activator needs to be inside the optocoupler, adjust the activator position if necessary). Mark the cantilever head assembly position again and determine the loader travel distance.
4. In the Certification Mode, program the loader travel distance as determined in point 3. Use a starting point of 10 mm.
5. In Recipe Mode, make a quick recipe for boat-in/boat-out (1 line should be sufficient)
6. Start this recipe to *boat out*, check if the starting point of 10 mm is reached
7. Start this recipe to *boat in*, boatloader will travel to boat-in position. The position shown on the touch-screen will be different from the calculated travel distance but this will change to the value set in point 4 in a few seconds when the boat in position is reached (the activator should be inside the optocoupler, readjust if required)
8. The servo drive unit will calculate the traveled distance and the corresponding speed. This speed will now agree with the programmed speed

9. Set *boat-out* using the recipe, then turn of the power to the servo driver. Set the first jumper on the connector side as shown below.

To insure the door is firmly closed during operation the servo driver is equipped with a current control feature. This feature is activated by setting the first jumper on the connector side. It needs the 2-5 mm offset to measure the nominal drive current and multiplies this by a factor to calculate the maximum drive current. It is necessary for the calibration to be done with full load and at loading conditions

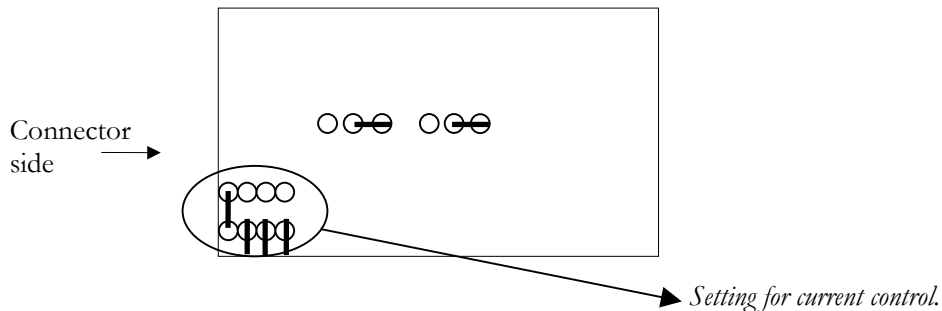


Figure 4-4 Current Control Configuration

10. Put the loader in *boat-in* position using the recipe, this allows the Current Control configuration feature to determine the force needed to keep the door closed. After that, put the loader in *boat-out* position.
11. Check boat-in and boat-out operation using the recipe. No *boat fused* alarms should be generated.

Note: If this calibration does not work even after several tries, the servo drive unit memory can be reset by removing the jumper next to the battery for about 10 min.

Note: Make sure the power supply is removed or switched off during removal/installation of the servo drive unit. Failure to do so will result in a damaged servo motor (disconnect the power lead to the power supply (upon reassembly a spark will occur))



NOTE

If this calibration does not work even after several tries, the servo drive unit memory can be reset by removing the jumper next to the battery for about 10 min.



NOTE

Make sure the furnace power is switched off during removal/installation of the servo drive unit. Failure to do so will result in a damaged servo motor.

(Remove 24V outlet from loader power supply (upon reassembly a spark will occur) or make a switch to cut it off)

4.2 Cleaning procedure for silicon carbide

To prevent the potential of accidental breakage, the components should not be subjected to high temperatures immediately after wet cleaning.

Components should be allowed to dry at room temperature for 12 hours or longer. After room temperature drying, it is preferred to insert components at 300^o- 400^o C for 1 -2 hours, then use normal 300^oC/hr ramp-up cycle.

Initial Room Temperature Clean

- Use Normal quartz cleaning procedure including HF and/or NH₄OH solutions. Dilute HF Solutions should have an equal amount of HCL, eg: HF:HCL:H₂O = 1:1:4.
- Do not use concentrated HF and HNO₃ combined.
- Rinse in DI water and N₂.

Initial high temperature clean:

- Heat to 50^o C higher than intended process temperature or higher if practical. **Cleaning Temperatures:** cleaning/time:, 1100^oC/48 Hr - 1200^oC/16 Hr - 1300^oC/8 Hr.
- **Paddles and wafer boats:** insert at 500^o C to 800^o C and ramp up.
- TLC - Run dry O₂ at 4 liters/min. N₂ carrier gas at 300 ml/min through bubbler at 30^o C for time indicated.

--OR--

- HCL - Run dry O₂ at 4 liters/min. and HCL at 250 ml/min. for time indicated.
- Oxidize after TLC of HCL for 30 minutes with dry O₂ at 4 liters/min.

Removal of CVD Glasses, Dopants or Oxide:

- Etch in diluted HF at room temperature as long as needed. 10:1 H₂O:HF will remove the following Å per minute at 25^o C: Thermal Oxide, 300; CVD Oxide, 1800; CVD Oxide with 10%P, 7000; Thermal Oxide with P precp, 36,000.
- After Removal a new HCL/TLC cleaning and oxidation is required (Eight hours at 50^o C above operating temperature).

Removal of Si₃N₄:

- Etch in concentrated HF at room temperature as long as needed.
- Expect about 50 Å/minute removal rate.
- There is little danger of attacking the component.

Removal of Polysilicon:

- Conservative:
Etch in 50 parts HNO₃, 1 part HF and 20 parts DI water. Expect about 90 Å/minute removal rate.
- Aggressive:
Proportion of HF may be increased for faster removal, but is essential to avoid exposure of the bare component to this solution. Once Si is removed, subsurface Si will quickly be etched out of the component making it porous and weak. The best approach is to leave a slight layer of surface polysilicon.



NOTE

Paddle handles must be protected i.e. with a Teflon® sleeve, during etching.

4.3 Cleaning Procedure for Quartz ware

The procedure described below applies to almost all LPCVD processes, such as Poly, Nitride and Oxides.

Cleaning Procedure for a Quartz tube:

- Use HF-HNO₃ and DI water solution for the Process tubes.
- Concentrations 1 part HF, 1 part HNO₃ and 5 parts DI water. These ratios may vary.
- Etch the tube till the deposited layer has almost or completely disappeared.
- Check with litmus paper for neutral Ph.
- Rinse with 1 PA and blow it dry with N₂.



NOTE

These cleaning procedures only apply for customers who do not have an automatic tube cleaning station. In case of an automatic cleaning station, follow the instructions applicable for such a unit.

4.4 Maintenance of the fans

Before checking, cleaning and/or eventually disassembling of the fan, turn off power.

- Uncouple the cable from the connection box.
- Disassemble the impeller by disassembling the suction cone with assemble cross from the house by loosening the fastening bolts.

- After taking away of the suction cone you have to take away the motor/impeller very carefully from its rubber-suspension and take it out of the house.
- In case of cleaning you have to note the following:
 - Do not detach the motor from the impeller
 - Seal condensation openings in such a way, that during cleaning the moisture cannot make contact with the motor.
 - Keep the balance weights always at their place, so be careful and prevent to pull loose the balance weights during cleaning.
 - When using water/moisture entrance of water into the motor via the axis must be avoided to prevent damage.
 - The vanes must be cleaned perfect, otherwise imbalance might occur.

Reassemble in the reverse order a cleaning of the impellers. After reassembly the motor has to do a test run for several minutes. Check the following items:

- The right rotating direction of the impeller
- The fan must rotate almost or complete without vibration
- The current intensity may not exceed the nominal current.
- Seals, which are fitted before the cleaning, must be removed.

Adjustment of the Variac

The Variac transformer connected to the fans regulates their rotation speed. The air-velocity must be 0.45 – 0.5 m/sec at 10cm from the filter outlet surface. The airflow should be checked with an air flow meter.

4.5 Replacement of the hepa filter

Depending on the cleanroom conditions, the filters may be replaced once a year. Replacement is necessary if the air-velocity is below 0,45 m/sec and the Variac transformer is set above 80%. . Before replacing any filters make sure that the fan power is turned off.

- Loosen the bolts, which connect the filter on the frontside to the sub frame behind the filter.
- Remove the subframe
- Remove the filter
- Place the new filter
- Tighten the filter against the frame of the loadstation. Take care that there are no leaks, which can influence the maximum pressure construction.

4.6 Preventive maintenance

Routine checks:

- Check on particles, especially inside loader channel
- Check for proper closure of doors
-

Weekly Maintenance:

- Clean doorclosure (e.g. driptrays in case of POCl_3 , flange connections in case of siliconnitride)
-

Monthly Maintenance:

- Check air-velocity. This must be between 0.45 m/sec and 0.5 m/sec measured at 10 cm from the laminar flow filter. If necessary increase fanspeed. Replace filters if the fan speed exceeds 80% of maximum scale.
- Check the fans for cleanliness
- Check running parts of the boat-loader for smooth operation
-
-

Half yearly Maintenance:

Check and replace pre-filters

.....

Yearly Maintenance:

Check and replace laminar flow filters

.....

5. Trouble shooting

PROBLEM:	POSSIBLE CAUSE AND SOLUTION(S):
<ul style="list-style-type: none"> • Boat loader does not operate 	<ul style="list-style-type: none"> • Check if “MANUAL/AUTO” switch is put on “AUTO”. • Powercheck
<ul style="list-style-type: none"> • LED of the fan has turned red 	<ul style="list-style-type: none"> • Filters are stopped.
<ul style="list-style-type: none"> • Loader alarm: <ul style="list-style-type: none"> • Out of limits • Boat fused 	<ul style="list-style-type: none"> • Loader has moved too far • • Too heavy loaded • Contamination on rail system • Out of alignment • Something is blocking the loader

Appendix A

1. Soft Contact Loader

1.1.1 Introduction

The Tempress Back mounted Tube Loader is an electronically controlled mechanism for transporting wafer carriers into the process tube. The tube loader moves the wafer carriers into and out of the process tube. A variety of loading devices can be mounted on the *basic* loader, each appropriate to the type of process being run in the tube.

The tube loader movement is controlled by the Tempress DPC, which interfaces with:

- the servo drive control unit (to provide movement);
- the tube loader encoders (which provide position information);
- the operator (to receive commands and report status).

1.1.2 Servo drive control unit



Figure 5 Servo drive control unit

The Servo Drive Control Unit (SDCU) (Figure 5 Servo drive control unit) containing the

1. Manual/Auto switch
2. Digital I/O unit
3. Motor drive unit for Tilt and Door
4. Motor drive unit for Loader and Height
5. CPU unit
6. Power supply
7. Connection (J11) for the Manual control panel
8. Servo driver interface board

is located in the load station. The CPU (5) is programmed for the control of the servomotors that provide the movement of the paddle. It is self regulating and for proper functioning the CPU (5) only needs to be adjusted on number “1” with the rotary switch (5a). The rotary switch can be adjusted in the range of 0-8, but for soft contact loading, only the “1” and “0” position will be used.



Figure 6 CPU unit (detail)

1.1.3 Basic Loader

The Tempress back mounted basic loader consists of a track with a platform that moves on a horizontal axis between its home position and the process tube (end position). The track is housed in a frame, which runs along the full length of the loading frame.

Encoders are mounted on top of the servomotors and send position and speed information to the CPU of the SDCU. End-switches at each side-end of the track serve as position reference and prevent the tube loader from moving further than mechanically possible.

On the loader platform, a soft contact loader assembly can be mounted.

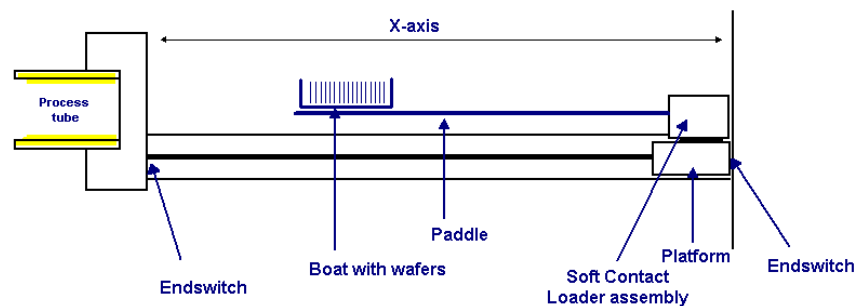


Figure 12 Soft Contact Loader assembly

1.1.4 Soft Contact Loader (Loading device)

The soft contact loader (SCL) sets-down the wafer carriers on the bottom of the tube. Subsequently, the paddle is removed and the tube is completely sealed. The stabilization time is reduced because less material needs to be heated (no paddle).

This loader includes the soft contact loader platform and mechanism (this is in addition to the frame with covered track, the carriage and the basic loader mechanism).

The platform mechanism houses a motor to raise or lower the platform with the paddle and a motor that tilts the platform to compensate for the weight of the wafer carriers at the end of the paddle.

This loader can be used for diffusion and LPCVD systems.

1.1.4.1 Manual Control Panel



Figure 8 Manual Control Panel

The Manual Control Panel (MCP) is a service tool, separate from the system, for the adjustment of setpoint positions. It allows the service engineer to check or teach-in setpoints for paddle movement.

The manual control panel, shown in Figure 8, contains 4 switches (for motor selection, setpoint selection and movement), 1 (red) pushbutton (for defining setpoint) and two red LED (for indication). User instructions about the MCP will be given in section 1.3.

It can exclusively be used for manual control of the servo-motors to check or teach-in setpoints.

1.1.4.2 Axes of movement

The basic loader moves horizontally along the X-axis. The soft contact mechanism is attached to the basic loader, which gives two more axis of movement. The lift (Z-axis) provides the vertical movement of the paddle and the tilt (phi-axis) corrects bending of the paddle due to the wafer load. These axes are shown in Figure 9.

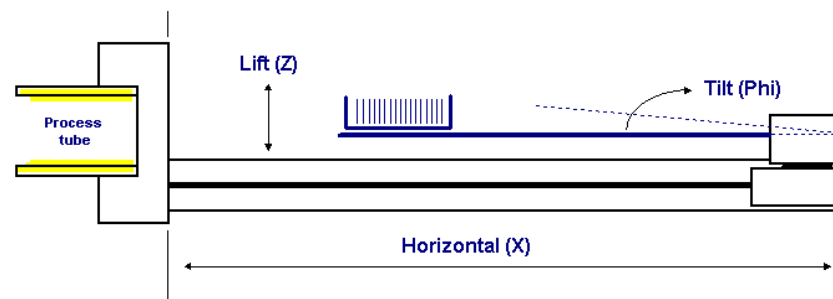


Figure 9 Axes of movement

The Z-axis and the phi-axis are equipped with end switches to prevent movement beyond the allowed range.

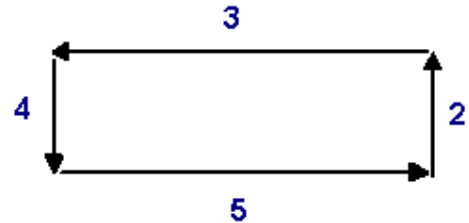
1.1.4.3 Head assembly movement

The head assembly is controlled by the three motor drive mechanisms. Via the DPC that gives a boat command (position, speed and up/down) to the CPU, the sequence will be executed.

The *load sequence* is given below:

Load sequence:

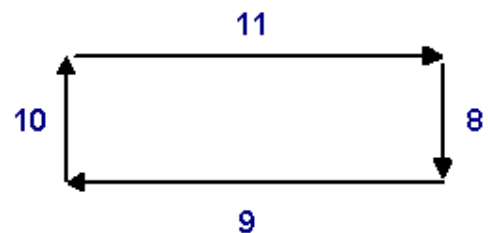
1. Open door
2. Lift (Z) and tilt (Phi)
3. Boat in (X)
4. Lower (Z) and tilt horizontally (Phi)
5. Boat out, leaving wafer carriers in the tube (X)
6. Close door



The *unload sequence* is given below:

Unload sequence:

7. Open door
8. Boat in (X)
9. Pick up boat (lift, Z) and tilt (Phi)
10. Boat out (X)
11. Lower (Z) and tilt horizontally (Phi)
12. Close door



Interlocks prevent opening or closing of automatic load door when the loader is not in its end position and activating the end switch.

Additionally it is not possible to move the boat in as long as the automatic load door to the furnace is closed.

1.2 DPC interfaces

1.2.1 DPC paddle control

1.2.1.1 Reference position

Any position specification makes reference to the HOME position of the tube loader. The HOME position is defined as follows:

- X-axis: HOME is at the end of the track at a point furthest from the process tube. Defined with the optocoupler endswitch.
- Z-axis: HOME is the point where the tilt plate is just at the down-endswitch activation point. Down position is defined with an optocoupler, the Up position with a micro-switch.
- Phi-axis: HOME is the point where the tilt is in the Up position. The Up position is defined with an optocoupler, the Down position with a micro-switch.

1.2.1.2 Paddle speed

The Z-axis and phi-axis speeds are fixed and no acceleration/deceleration can be specified. DPC on-board timers control speed and acceleration/deceleration.

Paddle speed can be set by speed parameters of the Boat command in the DPC (10-1000 mm/min) as part of the process recipe. (See DPC / Touchscreen manual.)

1.2.1.3 End switch safety mechanism

Opto-couplers or micro-switches at each end of each mechanical axis are mounted. These end switches provides a built-in safety mechanism for the tube loader.

The sensors are used to define HOME and END position of all motor activities. The motor will automatically stop if the end switch is activated.

End switches for position definition of the basic loader (horizontal movement) are mounted in the frame at the start and end of the track.

End switched for the maximum height range.

1.2.2 Safeties

Self-controlling electrical power limitation to prevent mechanical damage. In case the required electrical power exceeds the nominal power by more than 40% the motor will stop and an alarm will be generated.

1.2.3 Door open close control

If the loader is in its HOME position ($x=10\text{mm}$) the door will close automatically. In case a boat command, other than 10 mm is given, the door automatically opens before the loader X-movement will start. The loader can only move into the tube if the door is in the OPEN (HOME) sensor.

The door can only OPEN/CLOSE if the loader is in its home position.

1.3 Operating the loader (SCL)

1.3.1 Manual control of the tube loader

For manual control and setpoint calibration of the soft contact loader the MCP, needs to be connected with the 10 pin connector to position 'J11' on the interconnection board for soft contact loading, see Appendix B. The Auto/Manual switch located in the load station, see Figure 5 for an example, must be in "manual" mode. A red LED indicator (L2) on the MCP with the text 'Manual' must be 'On'.

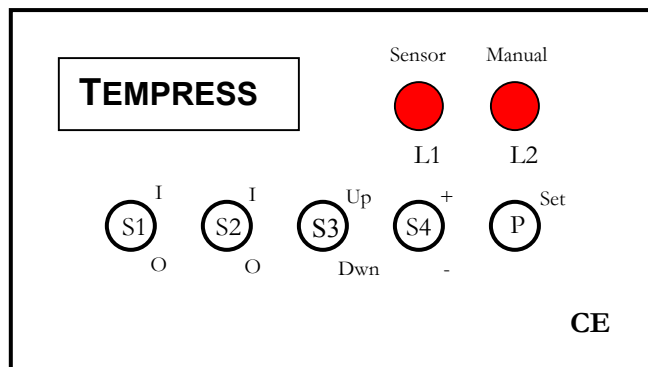


Figure 10 Schematic Manual control panel

If the Auto/Manual switch is set in Manual mode, all boat commands and alarm messages are discarded immediately.

The Manual Control Panel allows separate control of all loader motors. It contains 4 switches (S1-S4), 1 pushbutton (P) and 2 red LEDs (L1, L2).

There function is as follows:

S1-S2 Motor selection switches

	S1	S2
Motor 0 (Loader)	0	0
Motor 1 (Height)	0	I
Motor 2 (Tilt)	I	0
Motor 3 (Door)	I	I

S3 Up/Down Setpoint selection

S4 Motor movement Up/Down

P Motor position setpoint malfunction storage

L1 Motor in sensor according to the direction of S4. In case L1 is blinking, the approach speed was too high and the sensor position is incorrect.

L2 Manual mode. This LED is on if the Manual Control Panel is connected to the system and switched over to manual mode.

Teach-in Sensor positions

Normally the (Z) and (Tilt) position are equal with the matching end switches. Only in case an intervening value is desirable a setpoint can be taught in with the use of the manual control panel.

To teach-in sensor positions see following procedure:

Select the correct servo-motor (for example height) with S1 and S2.

Press S4 in Down-direction until L1 is ON. If L1 is blinking instead of ON, the motor reached the sensor to fast and cannot be record. It needs to be pulled back by S4 in Up-direction carefully, until the sensor is OFF.

Press S4 in Down-direction again until L1 is ON.

Press S4 in Up direction to go to the opposite end switch. Hold S4 until L1 starts blinking. After the sensor is ON instead of blinking, the sensor position is stored in the memory of the Servo drive unit.

Teach-in UP/DOWN position

Move to the particular Down position.

Switch S3 over to SP_DWN (Setpoint Down)

Press P to save the Down position.

Move to the particular Up position

Switch S3 over to SP_UP (Setpoint Up)

Press P to save the Up position

Teach-in Tilt Position

Repeat above-mentioned UP/DOWN procedure.

The horizontal movement (X) as well as the Door movement does not need to be taught-in.

1.3.2 Reset Memory

In case the CPU internal memory must be reset and all information about reference and taught-in positions must be removed, the following procedure should be carried out:

- 1) Remove power from the SCDU by disconnecting the power supply (Item 6 fig 1)
- 2) Adjust the rotary switch (5a) on SCDU to “0” position
- 3) Re-connect power to SCDU for approximately 20 seconds
- 4) Remove power from the SCDU by disconnecting the power supply (Item 6 fig 1)
- 5) Adjust the rotary switch (5a) on SCDU to “1” position
- 6) Re-connect power to SCDU.


NOTE

After this reset procedure, all taught-in positions are deleted. After reset, on receiving the first boat command, the unit will self calibrate to the location of the end sensors for Z, Phi and door axes.

It is then necessary to manually re-teach the desired set points.

1.3.3 Alarms/Errors

The operator panel alarm sounds upon detection of any control or mechanical alarm and continues to sound until the fault condition is removed or acknowledged.

If one of the servomotors is broken or not working properly, a BOAT FUSED alarm occurs.

1.3.4 DPC commands

The Oscillation speed command in the Boat instruction of the Tempres DPC process recipes has been used for (obsolete) wheel paddles in combination with stepmotors. It allowed for a 12mm span of movement with oscillation speeds of 0, 10, 20, ..., 90, 100 mm/min.

Currently, servomotors are used and the Oscillation Speed is not sent to the servo driver, and therefore it is not used at all for standard Tempres inline loaders.

For the Soft Contact Loader, also known as Soft Lander, an extra dimension is required to allow movement up and down, and tilting of the paddle.

In the DPC software a modification of the Oscillation Speed instructions allows the use of Soft Lander boat loaders.

The setting Osc. 0 (zero) is equal to movement down and tilting horizontal (tilting active).

The setting Osc. 10 (or 20, 30, .., 90, 100) is equal to movement up and tilting up (tilting home).

1.3.5 Usage

To safely load a batch of wafers in the tube the following order of boat instructions are required:

1) boat out, up and tilted	Boat 10 mm with 300mm/min and osc. Speed 10 mm/min
2) load wafers	
3) boat in, up and tilted	Boat 2000¹ mm with 300mm/min and osc. Speed 10 mm/min
4) boat in, down and tilted horizontally	Boat 2000¹ mm with 300mm/min and osc. Speed 0 mm/min

¹ Depends on actual loadstation length

5) boat out, down and tilted horizontally	Boat 10 mm with 300mm/min and osc. Speed 0 mm/min
---	---

To unload a batch of wafers the revers procedure should be used:

1) boat in, down and tilted horizontally	Boat 2000 ¹ mm with 300mm/min and osc. Speed 0 mm/min
2) boat in, up and tilted	Boat 2000 ¹ mm with 300mm/min and osc. Speed 10 mm/min
3) boat out, up and tilted	Boat 10 mm with 300mm/min and osc. Speed 10 mm/min
4) unload wafers	

1.3.6 Installation and maintenance

Adjustment of the soft contact loader requires the use of a spirit level. The following procedure should be used:

- boat out to 10 mm with 300mm/min and oscillation speed 0: boat out, down and horizontal
- set the boat manual, move the paddle just before the tube
- read the boat position
- set boat to automatic, program the boat to the position determined above, e.g. boat to 600 mm with 300 mm/min and oscillation speed 0: boat to 600mm, down and horizontal
- set boat back to manual
- adjust with 3 bolts the height of the paddle and make the paddle level



NOTE

Leave sufficient space below the paddle not to touch the profile thermocouple.



NOTE

Use an (approximate) load while adjusting.

- Set boat to automatic
- Set the boat oscillation speed to 10 mm/min: boat (still) to 600 mm, up and tilted
- Check the height of the paddle with load



NOTE

The load should not touch the tube at any time

- 3 sensors determine the loader up/down and tilt position, only the up sensor activator can be adjusted.

If adjustment of the up sensor is necessary:

- Set the boat oscillation speed to 0 mm/min: boat (still) to 600 mm, down and horizontal
- Adjust up sensor activator
- Set the boat oscillation speed to 10 mm/min: boat (still) to 600 mm, up and tilted
- Check position at the top of the tube
- Set boat manual and CAREFULLY move the boat in and out the tube

Repeat until load can freely move out without touching the tube.

The softlander has an additional learning feature which allows the up and tilt position to be positioned in between the hardware sensor activators. This requires the use of a *manual control panel* which is included.

1.3.7 Position and adjustment of the end-switches

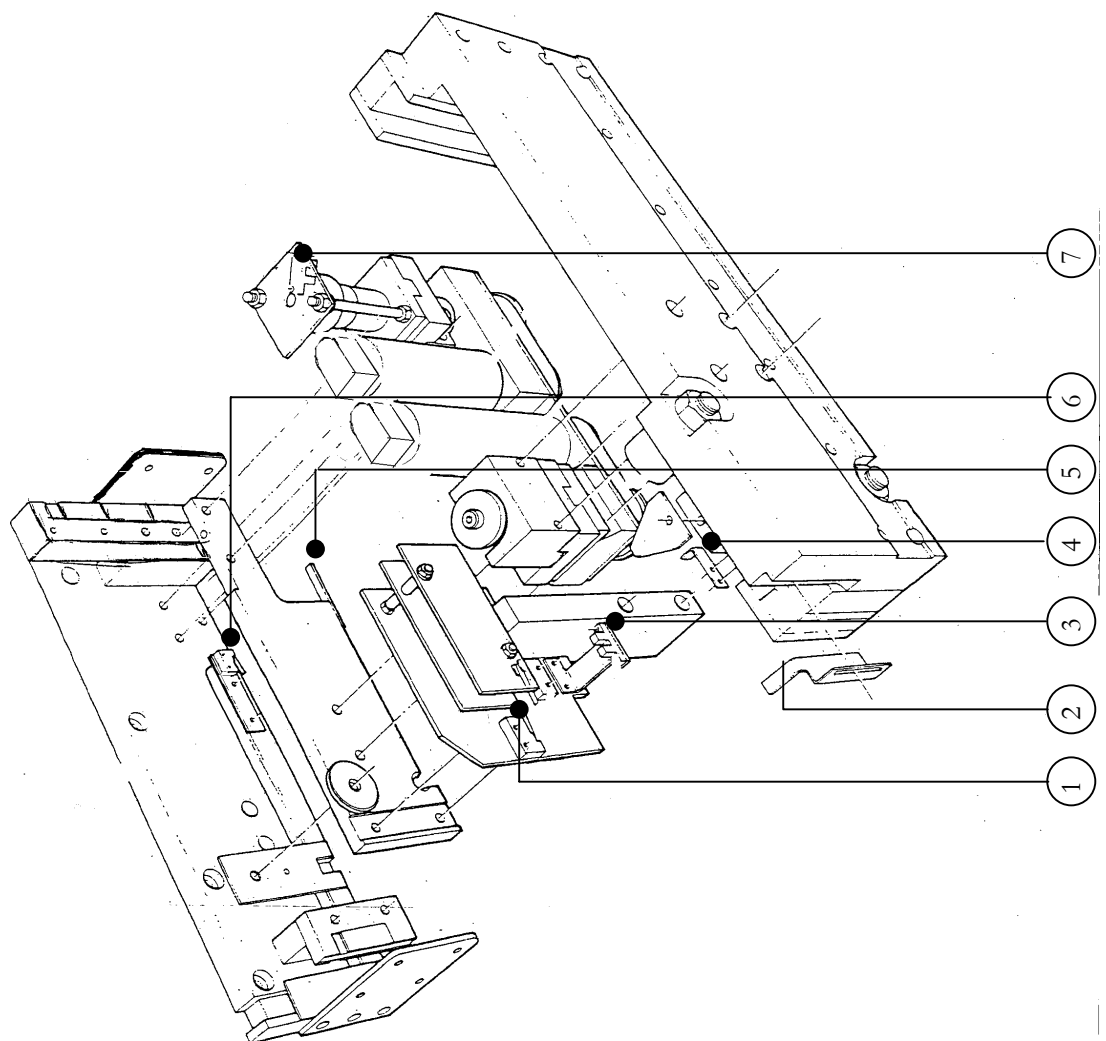


Figure 11 Loading device (SCL)

<i>NR.</i>	<i>Description</i>	<i>Motion</i>
1	End switch Height up	Height Up
2	Activator Height up end switch	
3	Optocoupler Height down	Height Dwn
4	Activator Height down optocoupler	
5	Acitvator Tilt down micro-switch	Tilt Dwn
6	Micro switch Tilt down	
7	Opto coupler with activator for Tilt up	Tilt Up

Table 1 Switch indication

The end-switches defines the Home and End position of each paddle movement, see section (1.2.1.1 Reference position). In case the adjustment of the paddle position is not optimal (anymore), it is possible to redefine the hardware end-switch position.

Note: For adjustment of the paddle position, full paddle loading is required.

For optimal loading and unloading, the paddle needs to be horizontal and free of any contact with the tube. There are two process positions:

- Boat in, horizontal paddle with the tilt in its HOME position and activating (**nr. 1**).
- Drop wafers/Boat out; the tilt activates (**nr. 6**) and the height in its HOME position.

To realise these two positions calibrate the Tilt Up/Dwn and the Height Up/Dwn position. See table Table 1 Switch indication, for the correct end-switch:

Tilt Dwn: In case that the tilt is too much in the drop wafers/boat out situation and the paddle contacts the tube or paddle thermocouple, reset the flag that activates micro-switch (**nr. 6**) (Figure 11 Loading device (SCL)).

Tilt Up: Because of the weight of the wafers and boats the paddle needs a correction to get horizontal. If this in not correct, reset the opto-coupler (**nr.7**). Lowering the switch will raise the end of the paddle tip.

Height Up: In the highest position, the micro switch (**nr. 1**) will be activated. Wafers needs to be free of contact with the tube. The flag that activates the opto-coupler can be reset, to adjust new height setpoint.

Height Dwn: In the lowest position the opto-coupler (**nr. 3**) will be activated. The flag that activates the optocoupler can be reset, to adjust new height setpoint.

2.TROUBLE SHOOTING

FAULT	ACTION	SOLUTION
<p>Loader does not respond to command input.</p>	<p>Check FPD for alarm indicating that manual/auto switch is in manual position</p> <p>Check FPD for alarm indicating that activation switch is in the de-activate position.</p> <p>Check that power supply to SCDU is O.K. by ensuring LEDES on SCDU are lighting</p> <p>Check status of motors using the FPD “servo status display” screen. If one axis is not in the correct position for a new boat command, system will not operate.</p>	<p>Switch to automatic and reset command.</p> <p>Switch to activate position and reset command.</p> <p>Fault find power loss.</p> <p>Determine fault with motor, sensor or axis.</p>

Appendix B

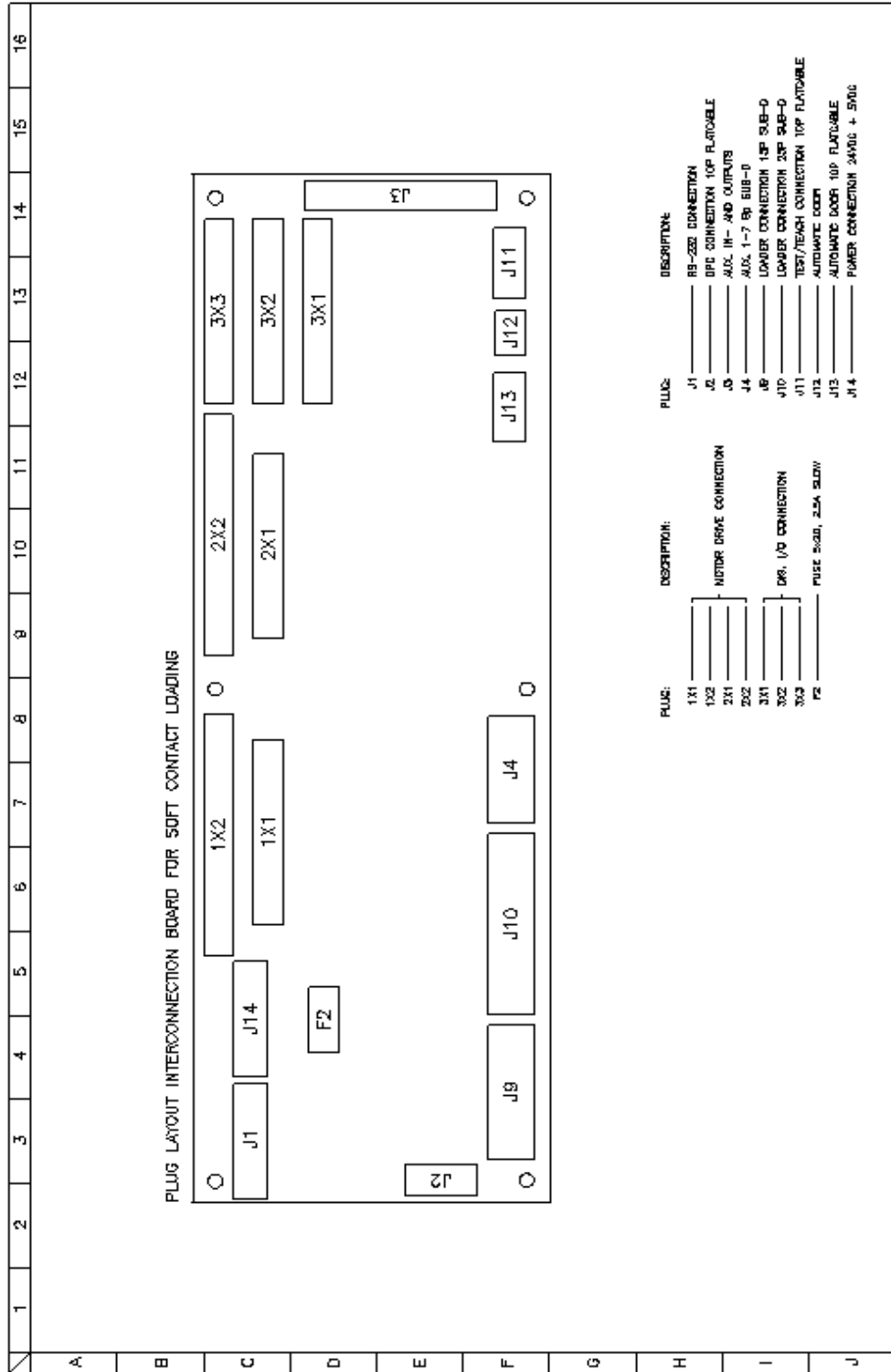


Figure 12 Interconnection board for soft contact loading