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StoreX Series
User Manual V1.05E
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User Manual

for

StoreX

Robotic Storage

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1 THE STOREX-40 FAMILY

1.1 StoreX Instruments

The StoreX 40 Series is the first compact Climate Storage with integrated Handling that covers the whole range of climate in laboratory applications. The StoreX Series not only covers a wide temperature range it also offers storage and processes from ultra-dry to extreme humidity. A variety of gas option is available.

All StoreX units have the same compact dimensions. StoreX have a user front door which allows comfortable and easy access for manual operation. The internal Glass Door allows visual inspection of the content and operation of the system without disturbing the internal climate. Removable cassettes make the use of the StoreX even simpler and more efficient. Cassettes are available for all common plate types.

The modular mechanical design in combination with extremely simple commands ease the integration of the StoreX into any environment. A growing number of accessories is available for the StoreX Series.

The combination of environmentally controlled **Stor**age and Automatic Plate **Ex**change Capability make StoreX the **Rex** (Latin: king) of storage in laboratory applications.

1.2 The StoreX Handler

Inside the StoreX climate chamber there is a handling system that allows random transport of plates. Plates can be moved internally as well as transferred to an form the environment. Access times are short and the internal climate is kept stable even at short time periods between accesses.
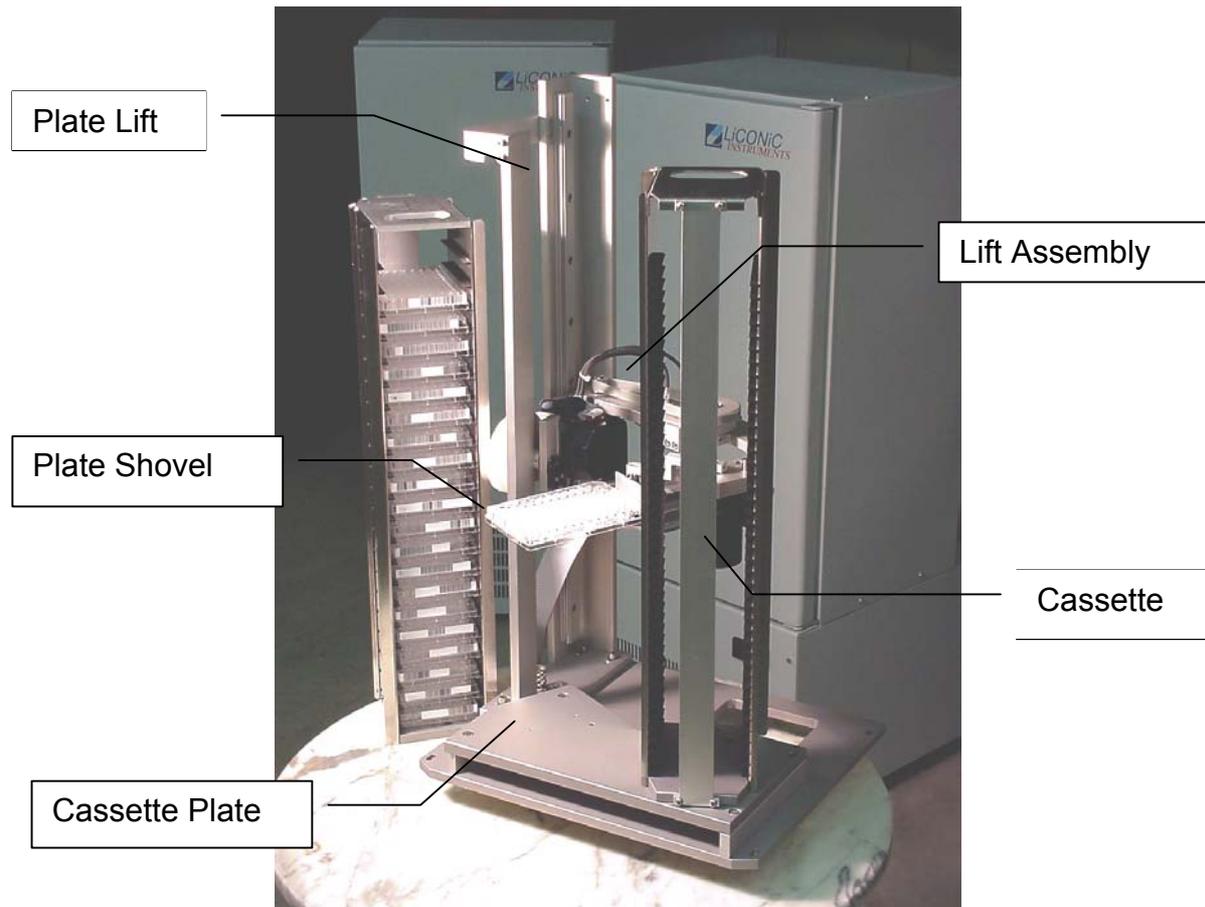
A Handler (4) is used for vertical transport as well as loading and unloading of goods. The Handler consists of a Vertical Positioning Drive (40) , a Turn Drive (42) and a Shovel Drive (43). The Handler has a number of vertical positions which is determined by the number of cassette levels and the loading or unloading level.

A stepper motor is used for vertical positioning of the Handler. All vertical positions are defined by a z-Initiator (15) and the software z-Offset (DM20). The level height is determined by the number of steps of height. The actual travel path to a certain cassette level calculated by multiplying the level (DM5) by the pitch (DM21) and then adding the z-Offset (DM20). The z-positions of the Transfer Station are stored in Data Memories (DM22, DM24).

The Handler is not only used for vertical transport of the goods, it is also used to pick and place plates in the cassettes and to get from or put plates on the Transfer Station.

The pick- / place- and get- / put action are vertical movements at extended shovel. Beware the difference in vertical travel for pick- / place movement (DM21), get movement (DM26) and put movement (DM28).

The Turn Drive is used to face the Shovel towards the Transfer Station or towards the desired cassette. The Turn Drive may be positioned at three turn positions. The position at left cassette id stored in Data Memory DM80, the turn position at the right position in Data Memory DM81 and the turn position at the Transfer Station is stored in Data Memory DM82.

The radial Shovel motion is a between two hardstops. Power and speed of this drive is controlled by the hardware of the controller card. Speed and force can be adjusted by authorized service personnel.

The correct sequence of motions is monitored by initiators, by detecting the end-positions of motions. Initiators are foreseen for Shovel-In (11) and Shovel-Out Position (12) and Turn Save Range (13).

For save operation also Gate-Open and Gate-Close Position are detected. The Gate may only be closed when the Turn Save Range initiator is active indicating the Handler being turned in.

There are two different types of Transfer Stations. Beside the common load-unloading stations, in which the good is taken by or put on the Transfer Station, there is a shuttle station. The shuttle station hands the goods over by the handler-shovel directly. Therefor the handling-shovel hands the goods to the next system by the radial- and swap-drive stretched out.

1.3 STX Climate Options

1.3.1 StoreX-40 IC

(Incubator System)

1.3.2 StoreX-40 HC

(Wet Cooling System)

1.3.3 Stroex-40 DC

(Dry Cooling System)

1.4 STX Configurations

1.4.1 Table Top

1.4.2 Copper Climate Chamber

2 ACCESSOIRES

2.1 STX Cassettes

The StoreX can handle almost every plate currently available in the market. For optimum performance Liconic offers a variety of cassettes. Beside the standard size cassettes customized sizes are available on request.

The table below lists the standard size cassettes. These sizes are stock items.

Cassette	Levels	Pitch	
MTP (Micro Titer Plate)	22	23	Standard Plate
Deepwell	9	50	
NTP (Nano Titer Plate)	42	11	Evotec NTP
	18	28	
1536 Plate	25	17	

2.2 STX Transferstations

2.2.1 Standard Transferstation

A variety of transfer stations are available. The transfer station is accessed by the StoreX handler as well as by any external robot. StoreX transfer stations will allow most grippers access to the plate. All StoreX transfer stations are equipped with alignment pins that will realign plates in both horizontal directions. The alignment is works for the StroeX handling as well as for any external robotic transportation system.

The transfer station can easy be adjusted. The transfer plate can be adjusted horizontally and vertically. Rotation of the transfer plate can also be adjusted.

The presence of a plate on the transfer station can be checked through the plate sensor. The plate sensor status can be requested through the handling communication port.
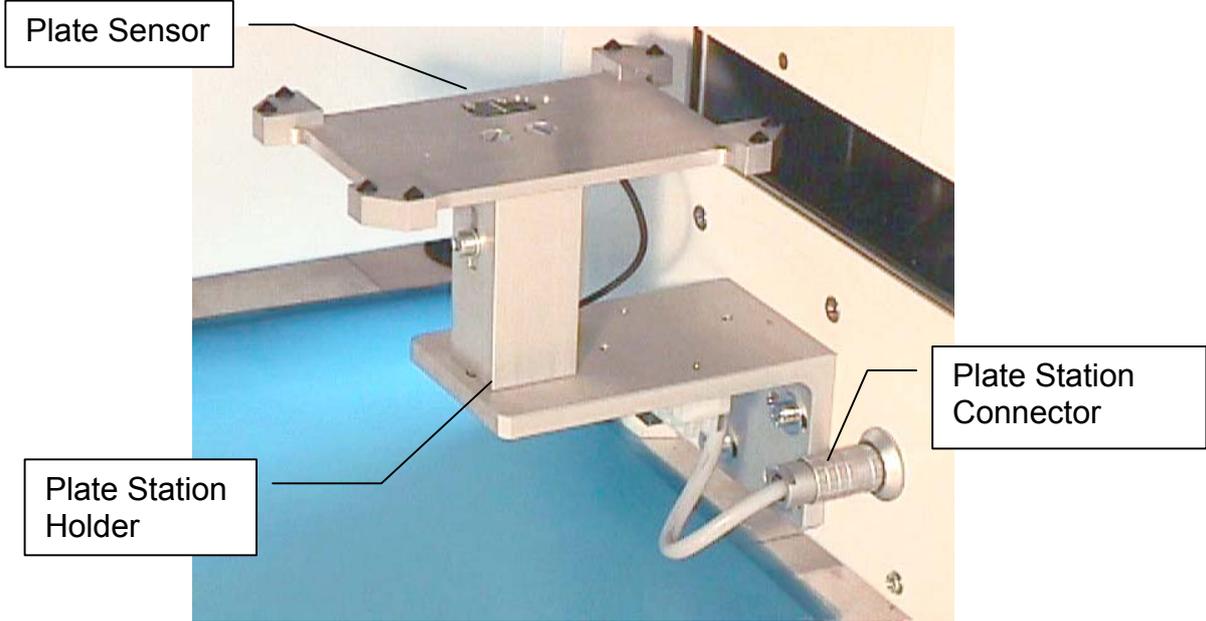
2.2.2 Turn Station

The StroeX handler transports plates along their longer axis. Many systems require the plate to be presented rotated by 90 degree. The Turn Station will rotate each plate before and after the access by the StoreX handler.

Plate Rotation Drive
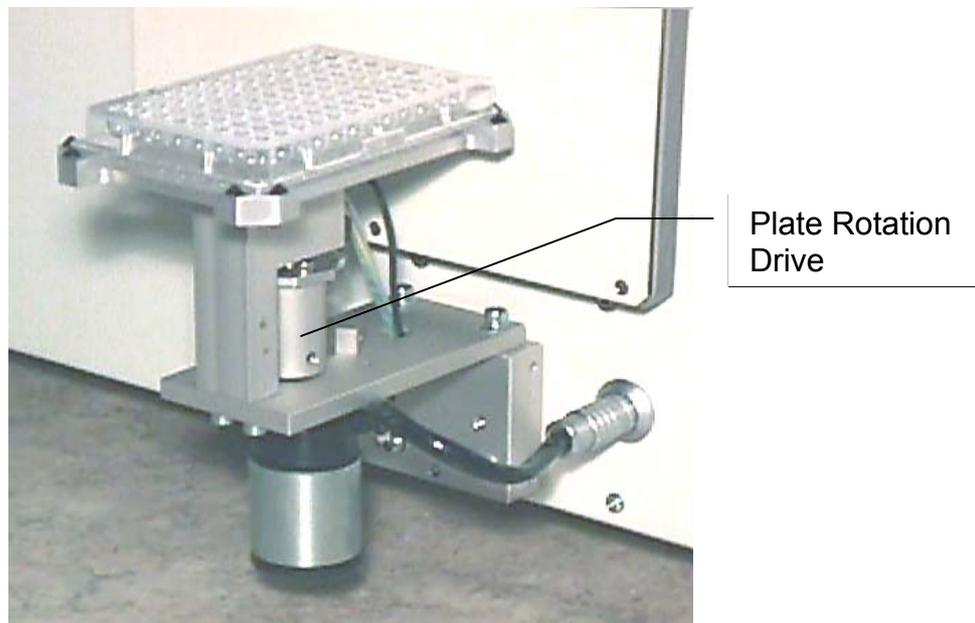
Rotation controlled by the StoreX system. No additional external software is required.

2.2.3 Swap Station

The Swap station has two transfer plates mounted on a rotation (swap-) drive. The swap drive rotated the two transfer plates by 180 degree. The swap station acts as a plate buffer as well as a plate extension shuttle. The distance of the actual transfer position is increased by 145 mm.

The swap station is controlled by the user system. The swap station is accessed through the handling communication port. The StoreX system will monitor possible conflicts with the StroeX handler and the Swap Station.

The swap station has two plate sensors integrated. Both sensor status con be requested individually.

Swap Drive
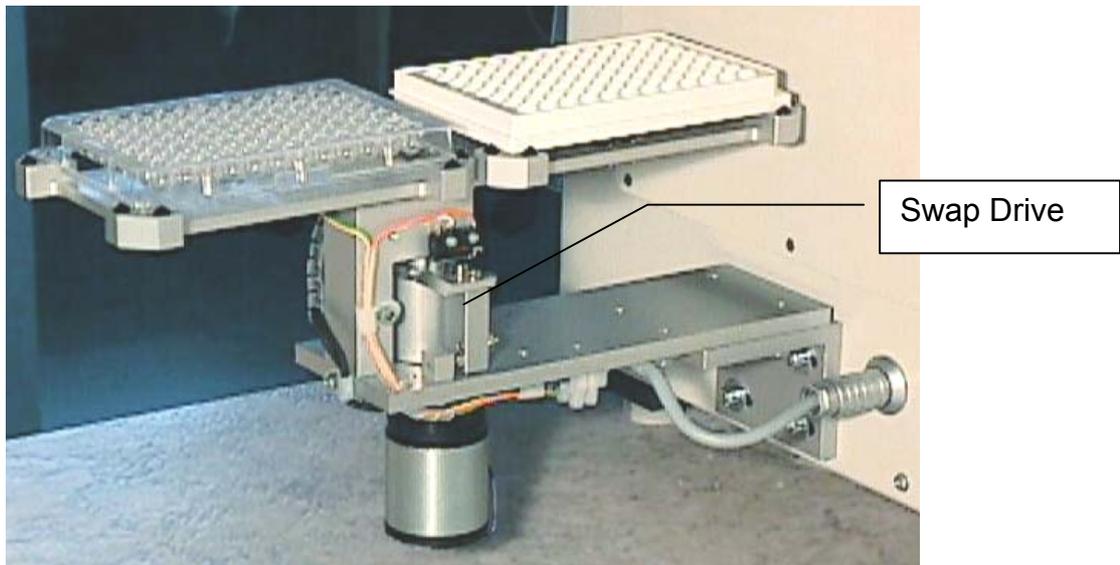
2.3 Shuttle Station

When the distance of transfer location to the StoreX is not sufficient, it may be extended by the Shuttle Station. The Shuttle Station has a linearly displaceable Transfer Plate. The travel path of the Transfer Plate is approximately 170 mm.

Shuttle Drive
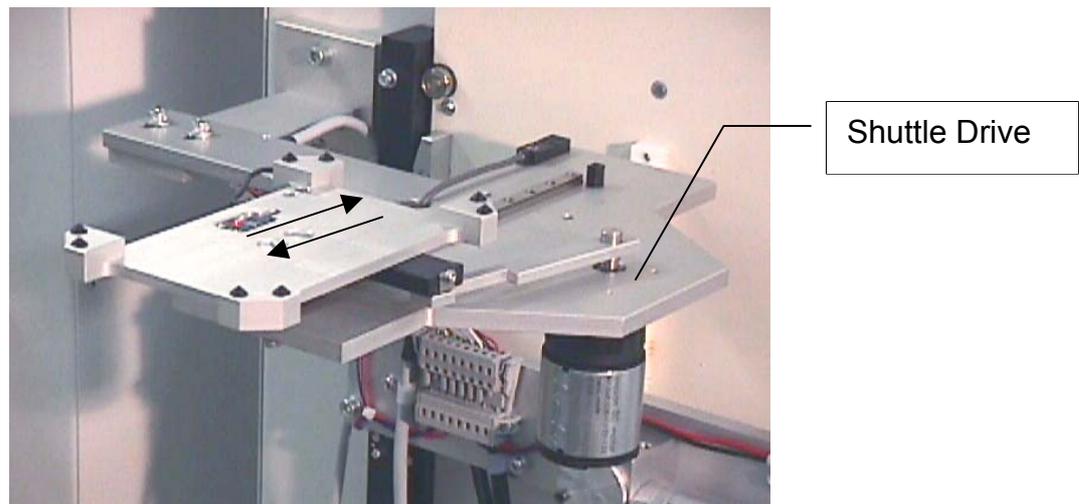
The movement of the Shuttle Station are controlled by the StoreX system. Each time a plates is accessed by the StoreX handling the Transfer Plate is shifted toward the StoreX unit. After the access by the StoreX the Plate Shuttle is extended towards the external system.

2.3.1 MTP (Standard) Transfer Plate

There are Transfer Plates available for applications where the transfer position is mechanically attached to the external system. Transfer Plates have alignment features. Transfer Plates are manufactured in aluminum with anodized surface finish.

Alignment Pins
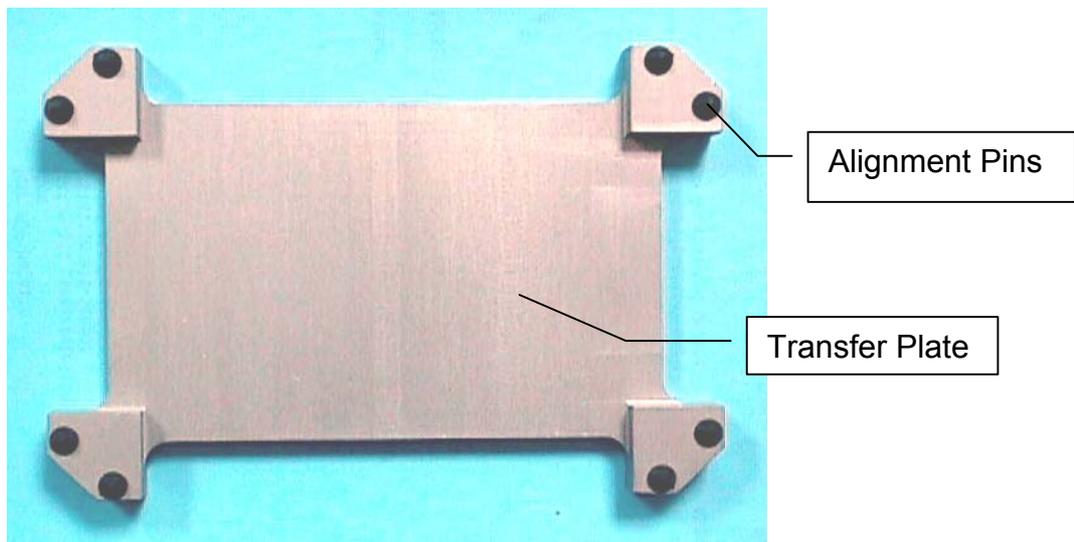
Transfer Plate

2.3.2 NTP (Nano Titer Plate) Transfer Plate

Transfer Plate for NTP (Nano Titer Plates) and other very high density plates.

Attachment Bores
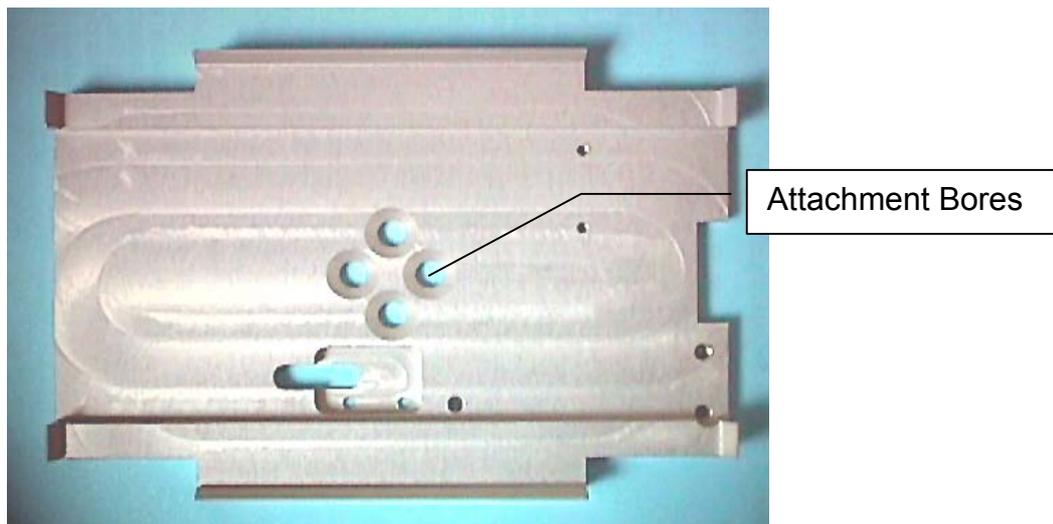
This Transfer Plate is best suited for very high alignment accuracy and for very light plates. This Transfer Plate can be equipped with Active Alignment for even higher alignment needs.

2.3.3 Transfer Plate Sensor

A very sensitive optical sensor can be integrated in the StoreX Transfer Stations. The Transfer Plate Sensor will detect all commonly used plates. Transparent, opaque, white or black plates are detected. The miniaturized design of the sensor helps to keep the Transfer Station flat. The Transfer Plate Sensor is connected to the StoreX system. The sensor status can be requested through the handling communication port.

Transfer Station Plate Sensor
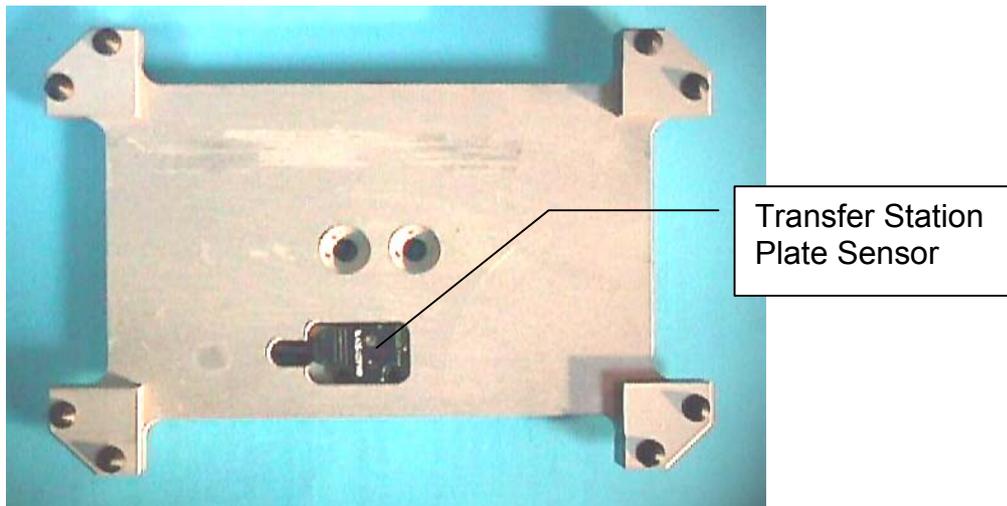
2.3.4 Active Plate Alignment

For applications with extremely high alignment accuracy there is an Active Plate Alignment available. The Active Plate Alignment is attached to the Transfer Plate. Every time a plate is accessed by the external system, the Active Plate Alignment is selected. The alignment takes approximately one second. The alignment accuracy is better than 0.1 mm.

The Active Plate Alignment is controlled by the external system. The access is performed through the handler communication port.

2.4 Bar Code Reader

2.5 Gas Options

2.5.1 RH-Option

2.5.2 CO2 Option

2.5.3 O2 Option

2.5.4 Nitrogen Option

2.6 UHS (Ultra High Speed) Option

Applications with very short access times. The access speed of the UHS handler is almost doubled compared to standard High Speed handlers.

2.7 Scheduler

A independent Scheduler traces the location and duration of presence in the climate chamber. The Scheduler is timed by the StoreX internal clock. Two operation modes can be selected.

The Trace Mode monitors the time of presence of each plate at the time of the unloading of the plate. The actual time can be read by the external system through the handler communication port.

The Alarm Mode indicates plates that remained the specified time in the climate chamber to the external system. The remain time of each plate can be set by time of loading the plate.

2.8 Customized Color

Standard coating of the StroeX is RAL 7035

3 TRANSPORT AND INSTALLATION

For transportation of the StoreX unit remove cassettes form climate chamber and secure the lift assembly in its turn-in position. Always use the original StoreX box for transportation. Do not lift the unit at the front door or at the Gate-Assembly. Use fork-lift for dislocating the instrument.

CAUTION !
- The StoreX unit weights up to 100kg (200 lbs.). Use adequate equipment for transportation and/or displacement of the instrument.
- Transport unit in upright position with cassettes removed form the climate chamber.
- Do not use front door or Gate as handles.

When installing the instrument follow the described steps in the given order below.

3.1 Unpacking the Instrument

- Unpacking of the instrument is best done by two person
- Remove fasten straps and open the cardboard box on the upper side
- Open top cover of cardboard box

Cardboard box

- Remove Cassettes and Foam Top

- Lift the cardboard box over the instrument
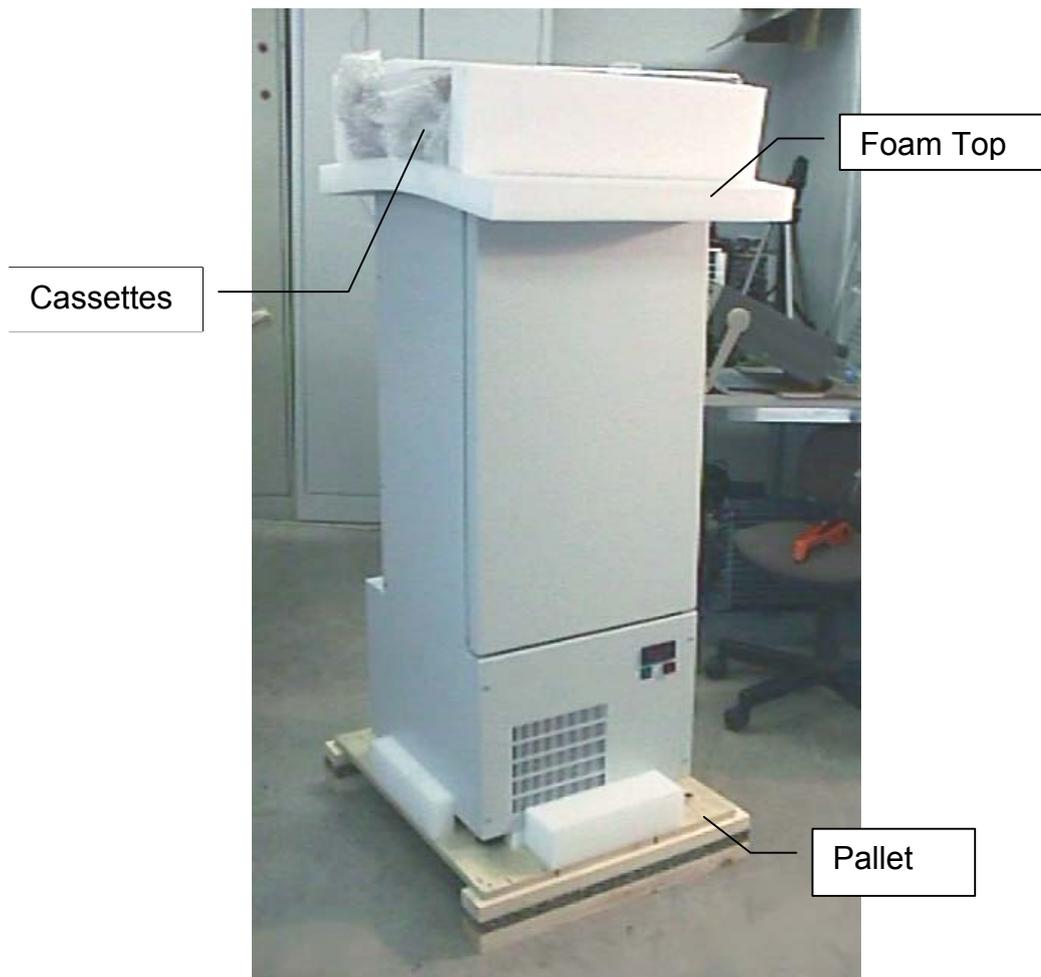
- Lift the StoreX from the pallet base and carefully place it to the floor
- Open the front door and remove the secure-wrapping from the lift assembly
- Remove the Secure Tape and the Secure Wrapping which secure the Handler in its home position

Secure Tape

Secure Wrapping
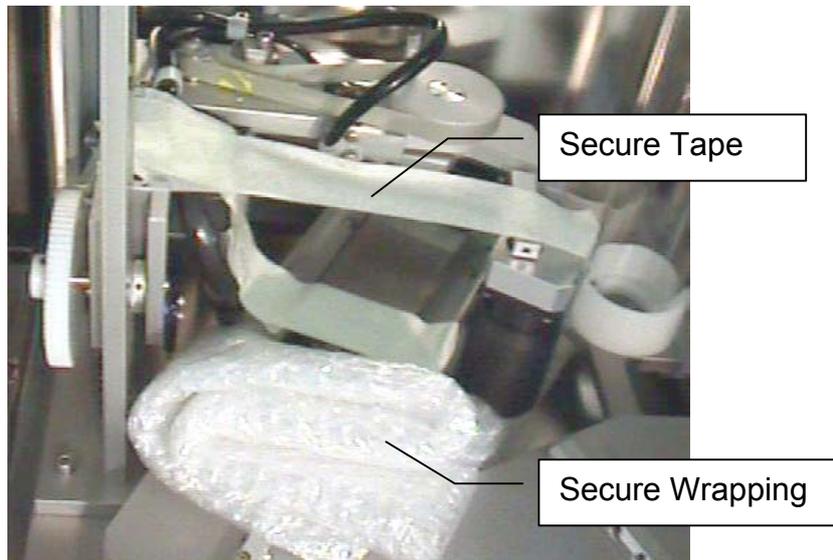
3.2 Installation of the Instrument

The instrument has to stand firmly on a flat and horizontal surface. Make sure that there is no mechanical interference between the gate and any other equipment.

Adjust the four feet in their height until the instrument is horizontal and the desired height. Use metric spanner size 12 for adjustment and size 17 to secure. Clockwise turns of the Adjustment Screw will increase the height of the instrument.

Lockscrew

Adjustment
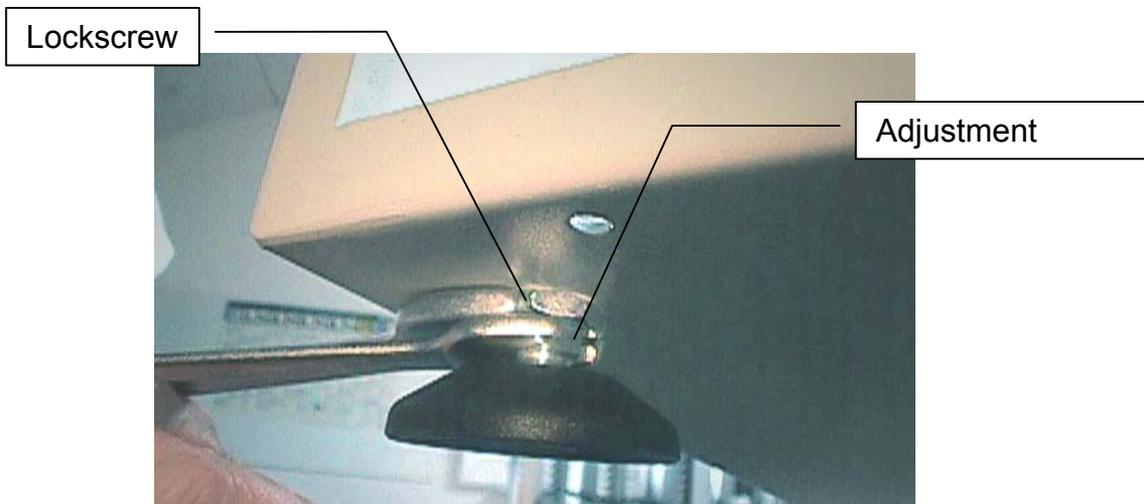
Check that each foot has contact with the ground and the instruments weight is evenly distributed over all feet. Allow sufficient room between surface and ground floor. Check rear side of the instrument for free Gate movement.

For optimum room usage you may stack several StoreX units. Allow approximately 10..20 mm clearance between units. The minimum clearance to the ground should be greater than 30 mm. StoreX Cooling unit have their air inlet in the bottom surface. Therefor the StoreX unit should only be operated in clean environment. Consult maintenance guide for cleaning instruction.

The air outlet is located at the front panel. The front panel must not be blocked by any obstacle. Allow free air circulation.

Allow ~10mm clearance between units

Front Door

Front Panel

Ventilation Slits

Allow min. 30mm clearance to ground
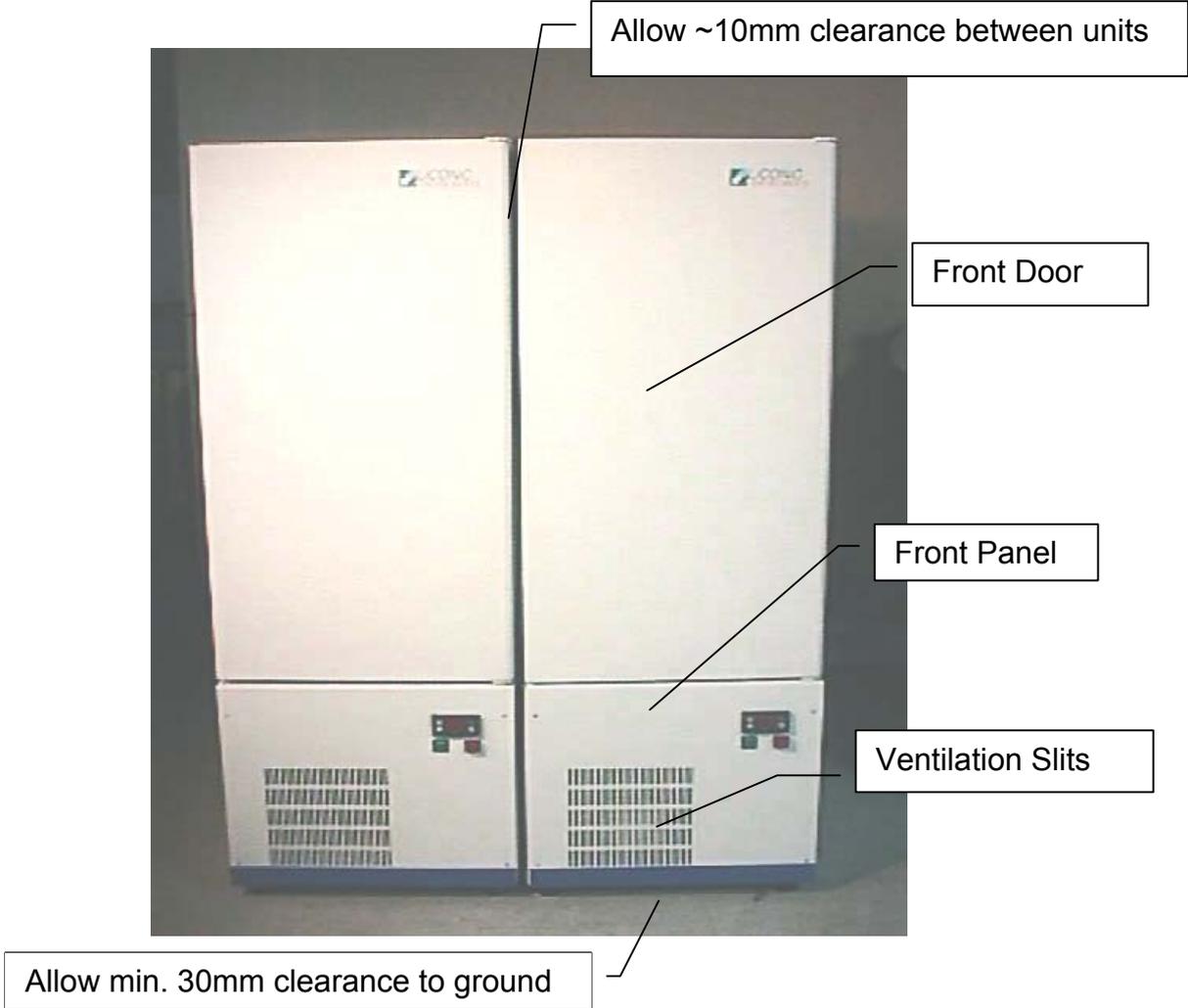
For instruments with cooling option do not operate instrument immediately after transportation. Leave instrument turned off for at least 12 hours.

The picture below shows another possibility of arranging StoreX units. This example depicts the combination of two Stand Alone units and one Table Top unit. This arrangement allows maximum usage of valuable laboratory space. For easy integration and short access paths the Gate of Table Top units is located near the bottom of the unit while the Gate of Stand Alone units are located near the top of the instrument.

StoreX Table Top

StoreX Stand Alone

A rear view of the instrument with some important measurements is given in the chapter "Transfer Station Adjustment ".

CAUTION !
- Never cover ventilation slits of the instrument
- Allow minimum clearance between instrument and ground of 30mm
- Instruments with cooling option must settle power-off at least 12 hours
- Operate instrument in clean and dry environment only
- Consult Cleaning Instructions

3.3 Transfer Station Position

For adjustment of the transfer position use the utility software delivered with the StoreX unit. Start the program „STXFER.EXE" on the STX Utility Diskette and follow the step-by-step procedure given by the program. Note that the adjustment of the transfer position requires good skill in mechanics. Improper action may harm and/or damage the instrument. If needed call Liconic Customer Service for assistance.
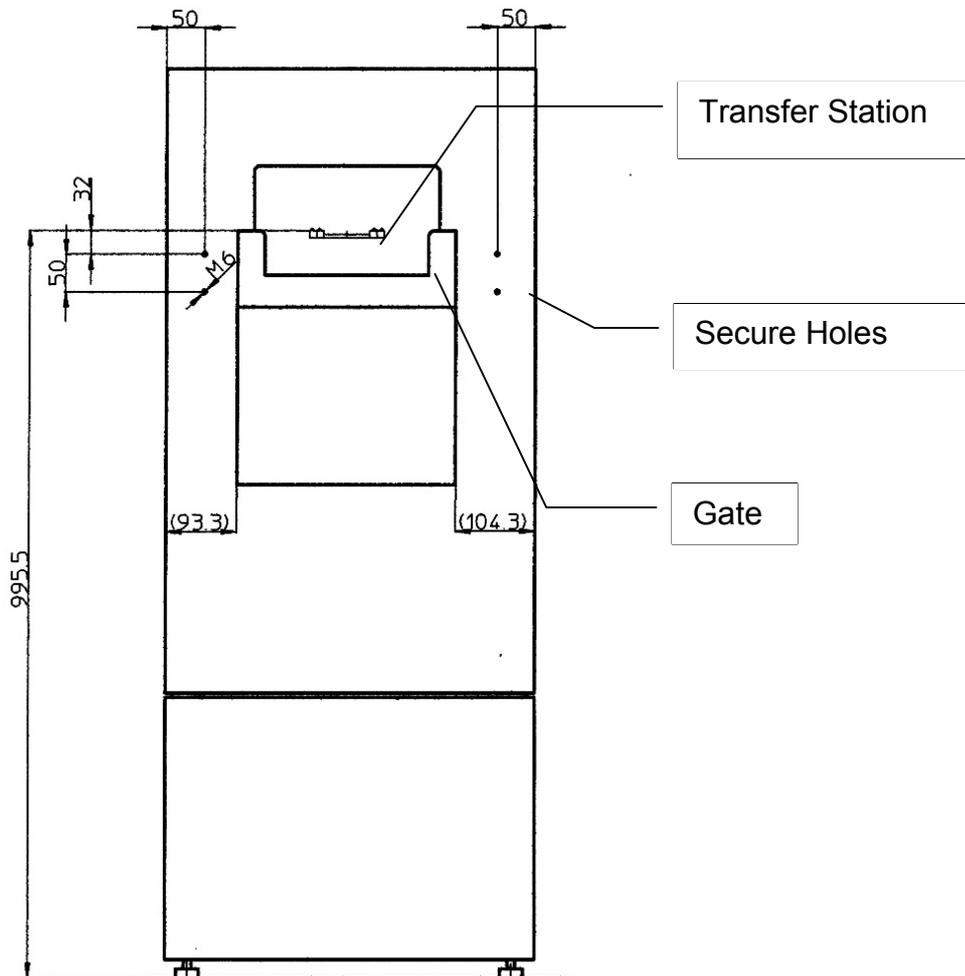
Ansicht "A"

CAUTION !
• There is potential risk of injury by the Gate. Make sure that the Gate cannot be accessed by the operator during operation
• When setting up the instrument, be sure to leave enough room on the rear side for gate movement
•

Operate the instrument in dry and clean environment only. Note that external climate situations may influence the performance of the instrument.

3.4 Installation and Removal of StoreX Handling

The StoreX Handling can be removed from the climate chamber for cleaning and servicing purpose. The removal / installation procedure includes

- Removing Cassettes from Climate Chamber
- Securing Lift
- Removing three handling attachment screws
- Removing Handling Plug at inner side of Climate Chamber
- Removing of two temperature sensors at the rear side if the Lift Tower
- Carefully removing handling form Climate Chamber

For re-installation of the handling follow the steps above in reversed order.

Beware, after removing the handling form the Climate Chamber, the Handling has to be re-aligned. Great care must be taken that all moving parts move freely and no cable and other moving part of the Lift Assembly will interfere with any obstacle. Note that above procedure requires good skill in mechanics. Improper operation may harm and/or damage the instrument. Please call Liconic Customer Service for additional information or customer training.

CAUTION !
- Though the entire StoreX handling can be removed for cleaning and servicing it is recommended to call service for assistance.

3.5 Electrical Connections

The electrical connection are located on the rear side of the instrument. Power and communication connector are on the same panel. The Transfer Station connector feeds and controls the Transfer Station Option. The StoreX unit automatically detects the presence of a motorized Transfer Station through this connector. The Gas Connector connects to optional gas supply such as CO_2, Oxygen or Nitrogen. Beware of maximum gas pressures of 6 bar.
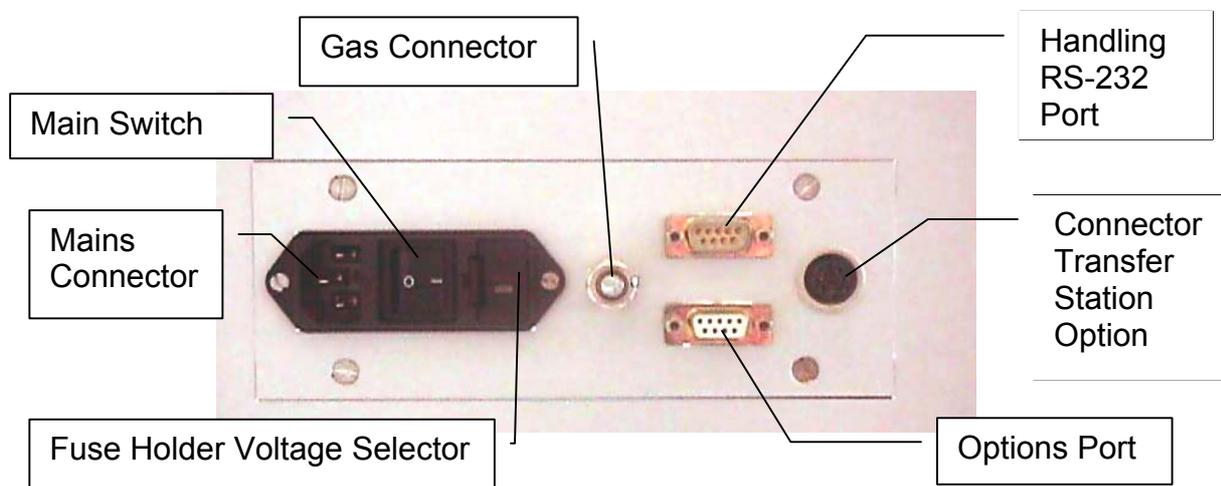
Prior connecting the instrument to the mains power check instrument for proper voltage setting and fuses for specified value. The voltage selector is located at the rear side of the instrument.

Fuse Holder / Voltage Selector

Backplane
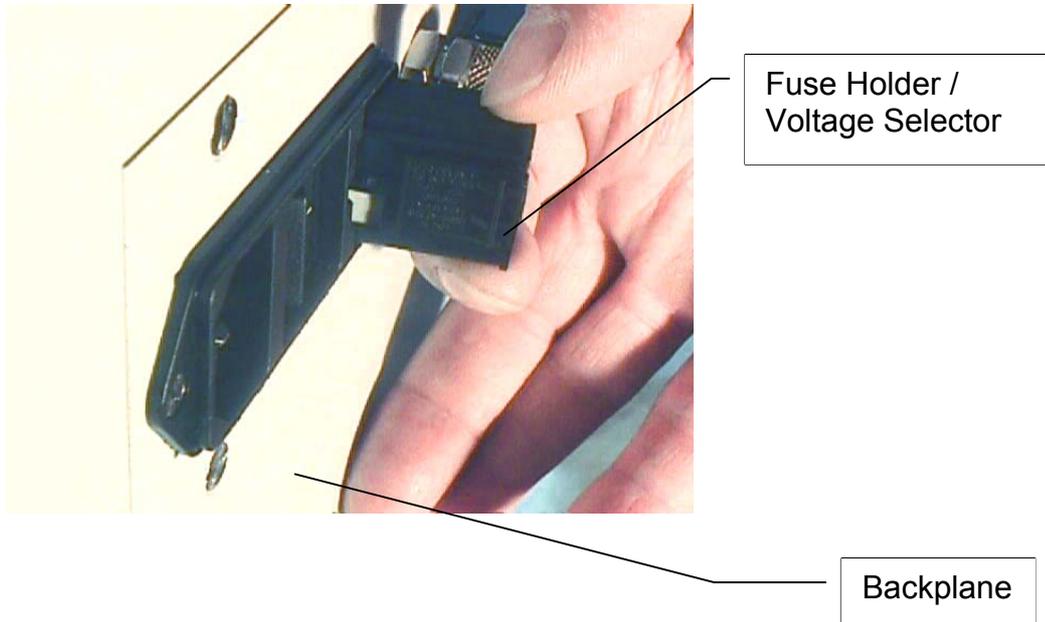
The voltage setting is displayed in a small window in the fuse holder.

CAUTION !
- Beware of high voltage inside the instrument.
- Emergency stop functions have to be implemented by the integrator and his global safety concepts.
- Do not open covers with mains connected. Disconnect mains cable prior any service and/or maintenance work.
- Wrong voltage settings will permanently destroy the instrument.
- Instruments with integrated cooling option must be operated at the specified mains frequency only.

3.6 Communication Connections

For communication there is a serial communication port (9pin Sub-D male, crossed RX, TX) which is located on the rear side of the incubator. The RTS and DSR, respectively DCD and DTR are connected internally (null modem).

The StroeX can be operated with any PC or Laptop or other system having a RS-232 port option. Terminal programs are available for most systems. A demo software that includes a terminal option is shipped with each instrument. It is recommended to use this software to get familiar with the command set of the StoreX system.

External Serial Connector Cable AT-Link
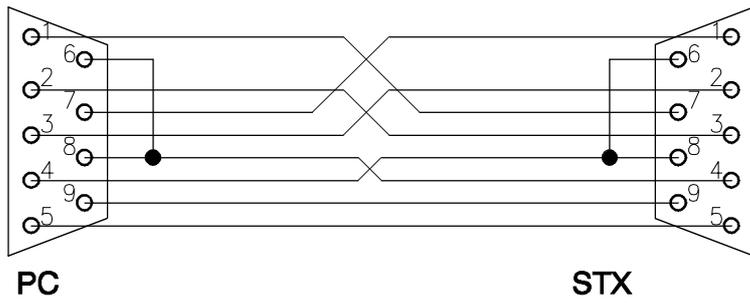
PC   STX

External Serial Connector Cable Null-Modem

PC   STX

External Serial Connector Cable Null-Modem

STX   PC
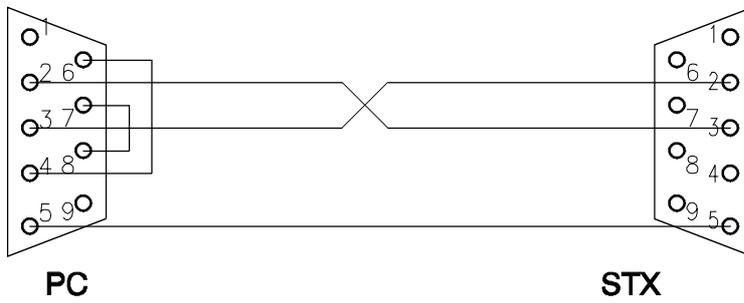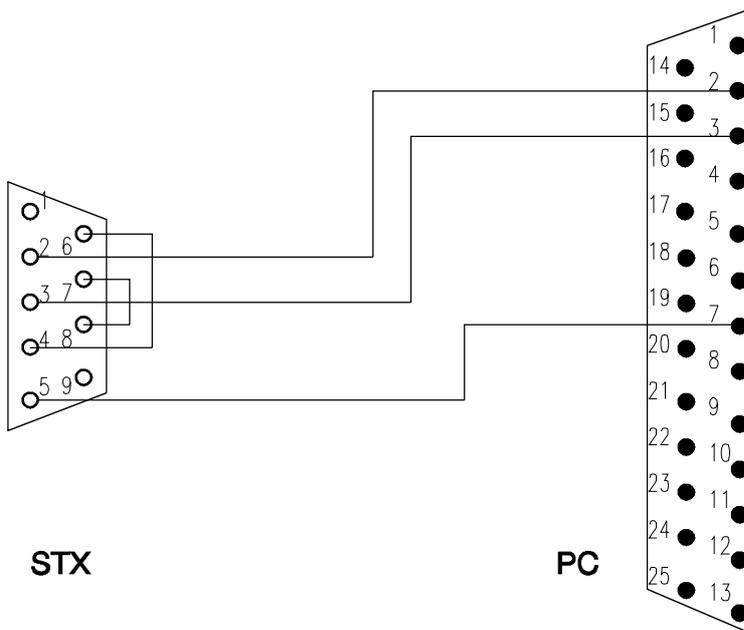
Internal RS-232 Connector Cable
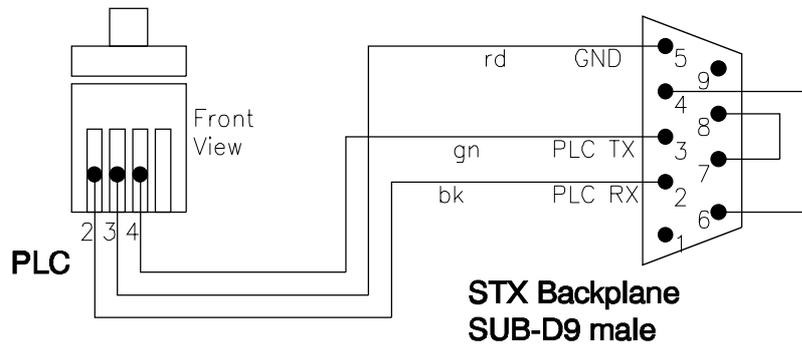
Handshake-lines are short-circuit internally.

4 MANUAL OPERATION

4.1 Front Door

The Front Door may be opened at the left side of the instrument. A Magnetic Sealing keeps the Front Door closed. The Front Door should be kept closed all times. When access is necessary, the Front Door should be opened for a short time only.

In order to avoid condensation an allow even temperature distribution inside the instrument, the Front Door is heated. Note that extended times at opened Front Door will also influence its temperature.
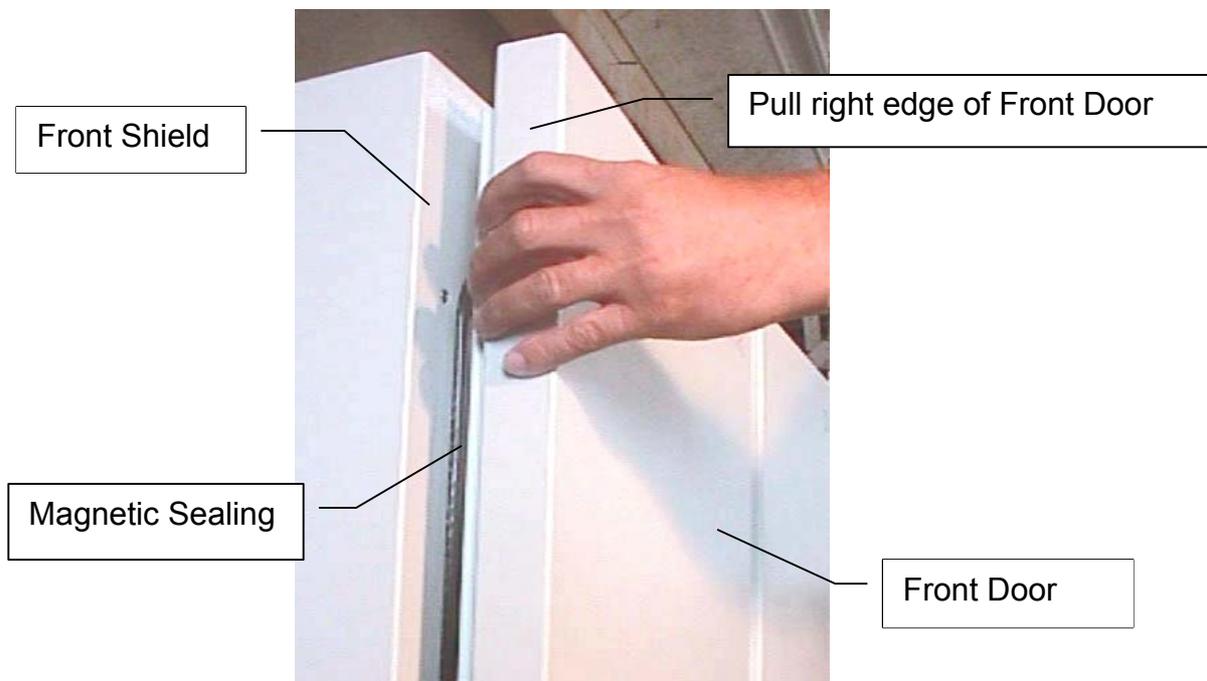
The Front Door is opened by pulling the left edge of the Front Door. The Front Door may be opened by an angle of almost 180 degree when standing alone. When placed next to another StoreX unit the Front Door may be opened by approximately 100 degree.

Regularly inspect sealing performance of the Front Door. The Magnetic Sealing must keep the Front Door firmly closed over its hole surface. When the Front Door is tilted against the Front Shield it must be re-aligned by authorized service. Note that gaps between Magnetic Sealing and Front Shield will cause undesired air exchange and therefore condensation and degrade temperature distribution.

CAUTION !
- Use right edge of Front Door to open Front Door
- Keep Front Door closed at times of no access

- Make Front Door Access as short as possible
- Magnetic Sealing of Front Door must firmly close Front Door
- Keep Magnetic Sealing clean

4.2 Glass Door

Behind the Front Door there is the Glass Door. The Glass Door allows inspection of the stored goods and observation of the function of the Handling while keeping the climate stable.

The Glass Door may be opened at its left side. Keep the Glass Door closed at all times. When access is necessary, the Glass Door should be opened as shortly as possible. A Glass Door Access will dramatically influence climate inside the instrument. Mainly humidity and CO2 is extremely sensitive to these accesses.

The Glass Door is sealed by the Inner Sealing. The Inner Sealing completely isolates the Climate inside the Climate Chamber form the ambient climate. Gas exchange between Climate Chamber and the exterior is almost eliminated.

Inner Sealing

Glass Door Lock
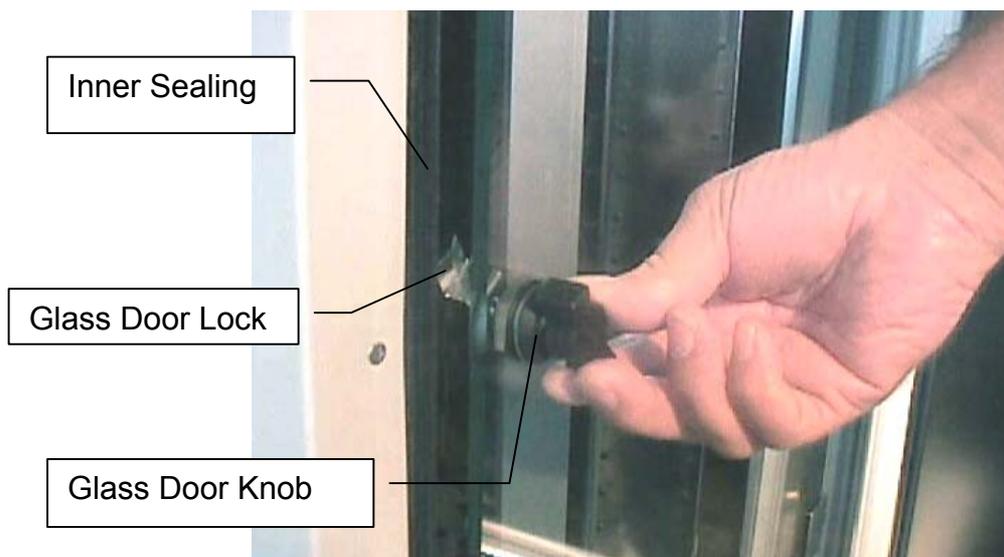
Glass Door Knob

When a Glass Door Access exceeds a certain time an alarm will occur. This alarm will also prevent the Glass Door being left open unintended. The alarm may be stopped. The alarm is re-trigged by closing the Glass Door.

CAUTION !
- Rotate Glass Door Knob clockwise to open Glass Door
- Keep Glass Door closed all time during critical processes. Opening the Glass Door will dramatically change climate in Climate Chamber and destroy substances
- Make Front Door Access as short as possible
- Regularly inspect Glass Door Sealing
- Glass Door Lock must firmly close the Glass Door

- Keep Inner Sealing clean

4.3 Cassettes

Cassettes allow simple and comfortable loading and unloading of storage goods. Further cassette allow preparation outside the climate chamber. Once prepared the goods can be quickly transferred into the climate chamber inside the StoreX unit.

The cassettes are open at their front side. On the back side there is the cassette back. The plates are loaded from the front side.
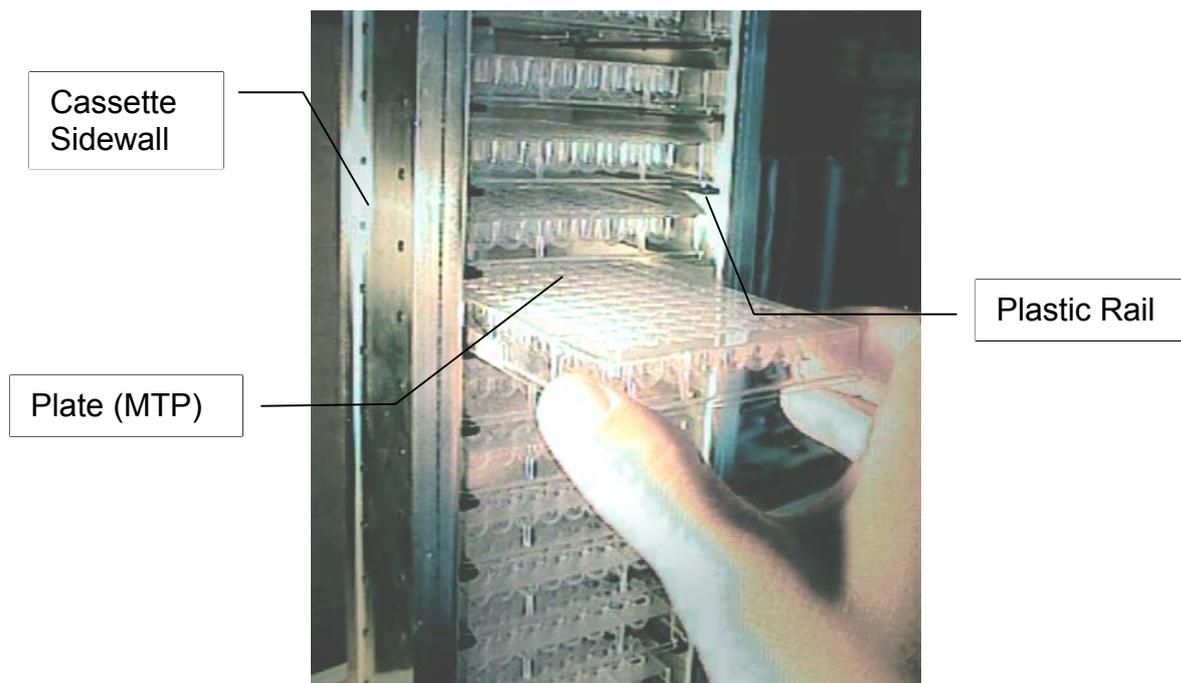
To put a plate in the cassette center the plate to the desired level and slide the plate towards the back of the cassette. Slightly lift the front of the plate to avoid excessive wear of the retaining nozzles at the front end of the rails. When all plates are loaded make sure that all plates are pushed towards the back of the cassette. Make sure that all plates are pushed to the back of the cassette. Plates that jut out the front side of the cassette may cause collision with the handler and may result damage to the handler.

Cassette must be treated with great care. Cassettes are aligned within 1mm when leaving the factory. Miss-aligned, tilted or bent cassettes are frequent cause for handling failures. Miss-aligned cassettes must be returned for re-alignment. Special care must be taken when cassettes are filled with full plate load.

The cassette plate must be kept clean. Particles may cause the cassette to be tilted. Do not place cassettes on the floor for they mey pick-up particles. Always store cassettes inside the climate chamber or on clean surfaces.

Use cassette handle for transport. When lifting the cassette at its handle it will slightly tilt backward in order to prevent plates from shifting to the front.

Cassette Handle
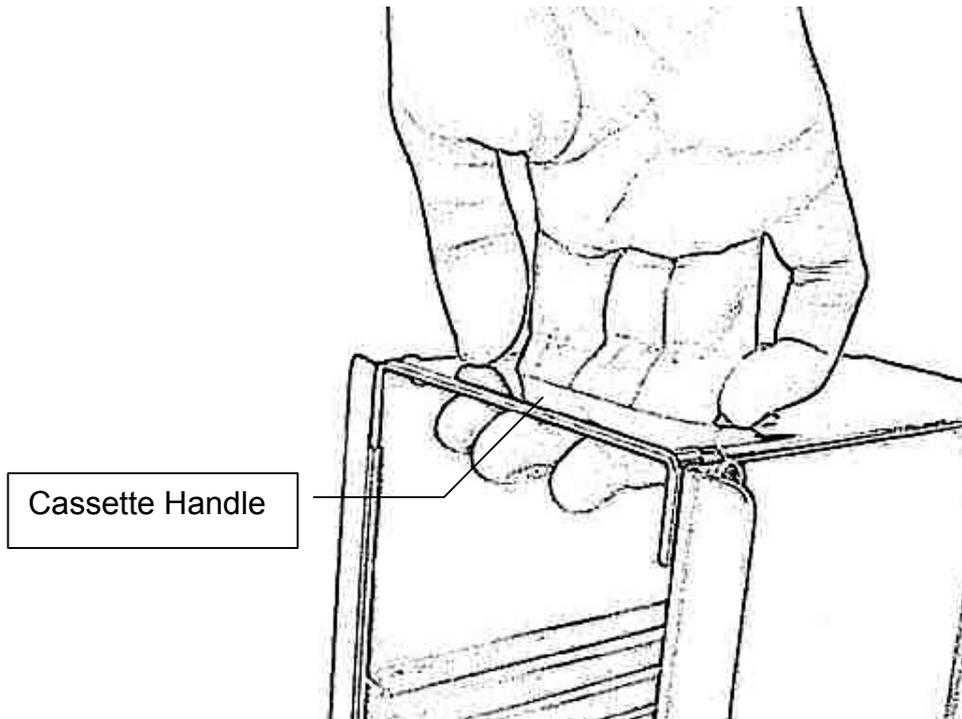
Never apply force to the cassettes. Do not drop cassettes. Mechanical shock will miss-align the cassette. Never lift cassette at its side walls for this may bent the side walls of the cassette. Bent side walls will cause the plates to block when being loaded and/or unloaded.

Cassette Side Wall
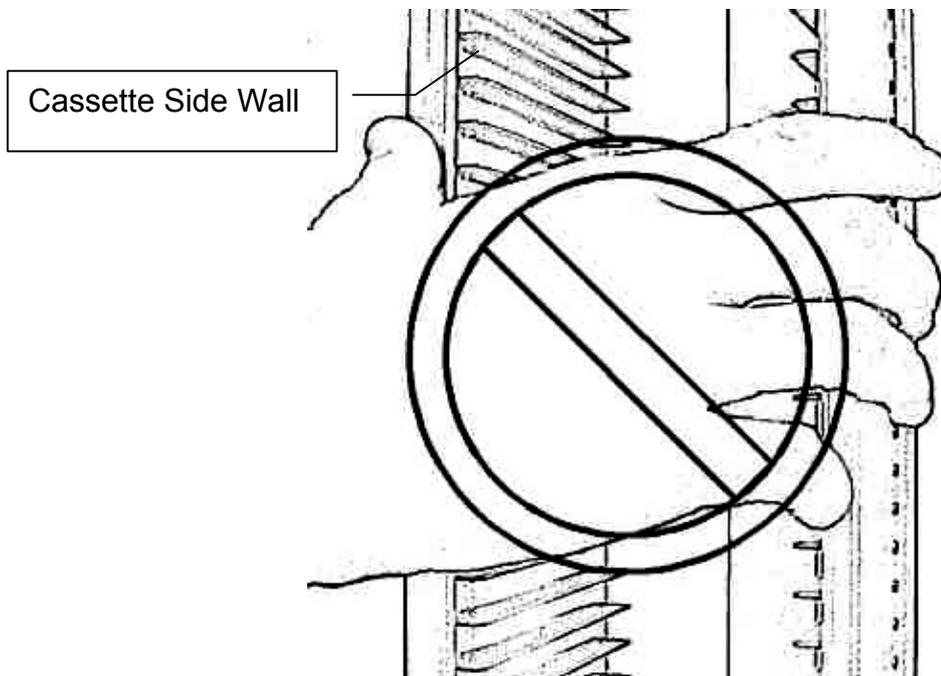
In the rear event of a blockage of the extended shovel in the cassette, special care must be taken when removing a cassette. In this case gently push the shovel backwards until the shovel can move freely then remove cassette.

Cassette Handle

Cassette

Cassette Back
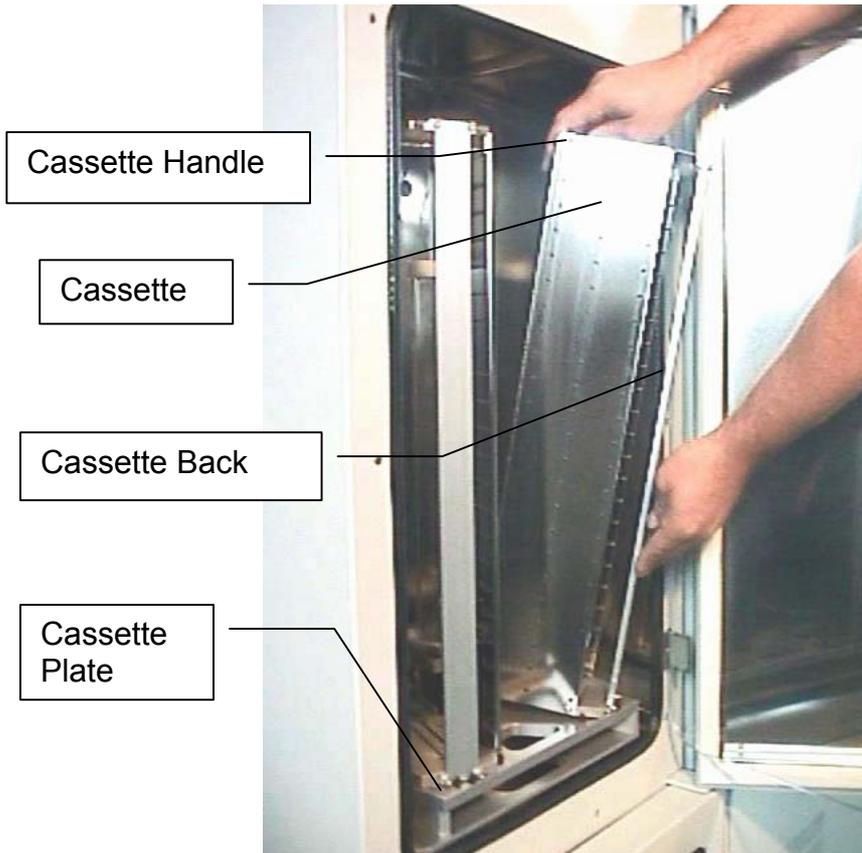
Cassette Plate

The cassettes are secured by alignment rails to the cassette plate. The cassettes may slightly be tilted backwards (towards the front opening) for removal. In order to load a cassette align the back of then cassette base plate to the centering pins located on the cassette plate. Push the cassette forward until it stands vertically. The cassette should now firmly stand on the cassette plate. There should be no play present.

Centering Pins

Cassette Base Plate

Cassette Plate

Cassette Alignment Rail
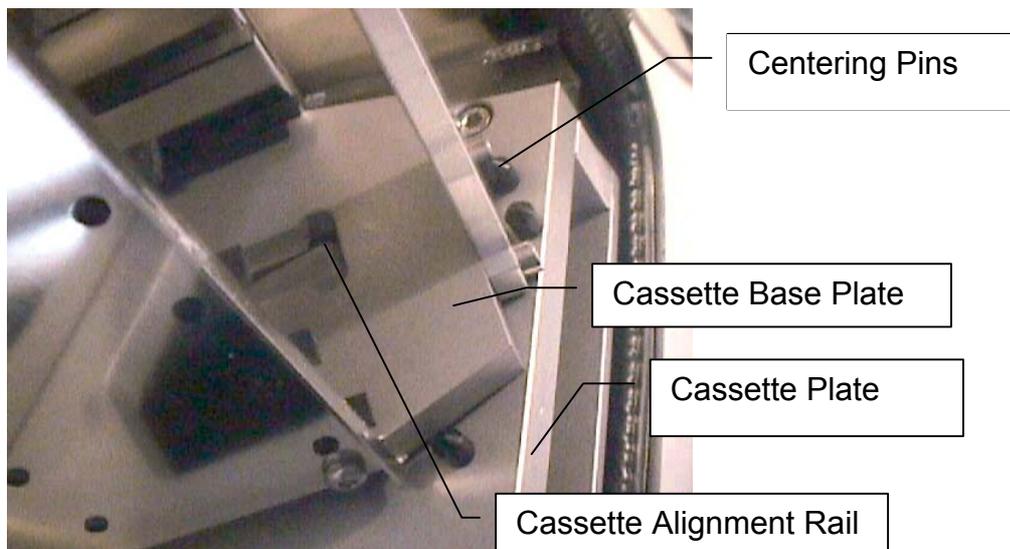
To remove cassette slightly pull the cassette handle backward in order to tilt the cassette. Lift the cassette until it becomes lose from the cassette alignment rail. Use both hands for this operation. Never use force.

CAUTION !
- Make sure that ALL plates are pushed to the back of the cassette. Plates jut out the front side of the cassette may cause collision with the handler shovel.
- Lift cassette at the cassette handle only
- Do not drop cassettes. Miss-aligned cassettes can cause handling errors
- Do not autoclave cassettes. Use disinfecting solution for sterilization.
- Keep cassette plate clean. Particles may tilt cassettes

4.4 The Robot Gate

The Robot Gate is located at the rear side if the instrument. Through the Robot Gate the storage good is transported by the Handler. The Robot Gate is sealed like the Front Door. Because of frequent accesses through the Gate special care must be taken on the sealing performance of the Gate.

The Gate may make spontaneous movements. External commands, manual interaction and internal protection time-out functions may cause the Gate to close. Special care must be taken that the Gate cannot be accessed during operation.

The Gate movement is speed- and force controlled. However, the high demands on the sealing capability of the Gate require certain minimum forces. The Gate can cause painful interactions.

Never put hands into Gate opening when instrument is active..

4.5 Incubation Liquid

Di water , HC, IC not HC
2l capacity do not overfill
beware water front panel
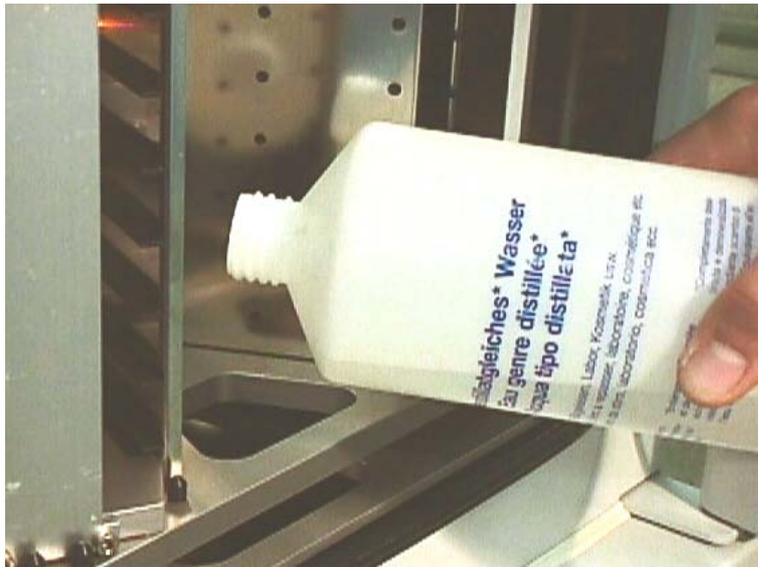
Level-indicator
Poor over front cover

4.6 Power-On System

The power of the instrument is activated by the incubator main switch. The instrument is turned on by pressing the power switch located at the front side of the instrument. After power-on the climate portion of the instrument is activated automatically. An alarm will occur. If the green light of the Power Switch does not turn on, check the Main Switch at the back side of the instrument.

Themperature Display

Start Switch

Power Switch
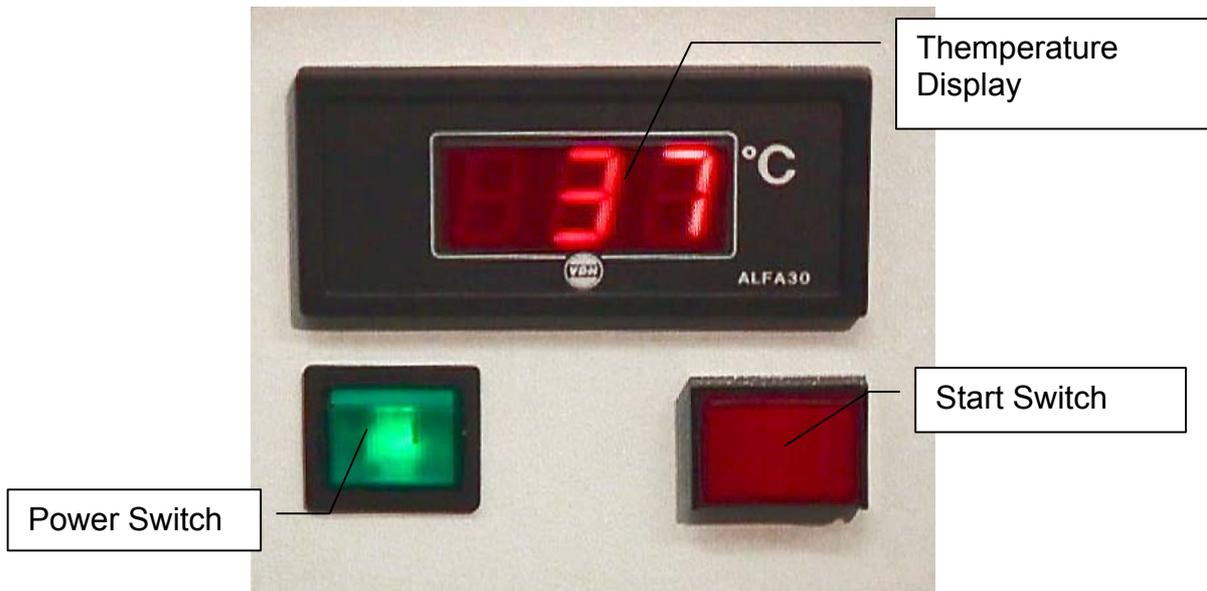
This alarm indicates that the handling is not activated. In order to activate the handling, the red Start Switch has to be pressed. The Start Switch will cause the handling to initialize. Note that the Gate - if opened- is also closed after pressing the Start Switch.

Pressing the Start Switch is equal to sneding an external Activate Command through the Communication Port.

It is normal that some condensation occurs during warm-up. This condensation will disappear once the internal climate is stabilized. The settling time may take several hours.

The temperature inside the Climate Chamber is displayed on the Temperature Display. The Temperature Display may not be used to set Temperature. The Operating Temperature can only be set through the Communication Port.

4.7 Alarm System

Reset, Start, unauthorized access, Handler blockage
Close Gate
Alarm Sound Gate, Front Door, Not Init, Access Collition, Handler Blockage

4.8 Temperature Settings

Prior Startup of the instrument, the temperature of the instrument has to be set. Do not set temperature higher than 45C. Higher temperatures may damage the handling drives. For incubator temperature adjustment procedure consult the remote communication chapter of this manual.

WARNING!
• Avoid incubator temperatures above 45C.
• Adjust temperature prior first startup.

The manual access is limited to the positioning of the carrousel. The Robot Gate cannot be activated manually.

WARNING
• Remote Accesses have priority over manual accesses.
• The integrator has to make sure that no remote access is initiated during a manual access (Always check Ready Bit prior sending command)

For manual positioning rotate the Positioning Key located in the front panel of the incubator to a position 1..9. In order to accept a manual positioning, the key-switch next to the positioning switch has to be put in its right position.

WARNING
• The Gate cannot be opened manually. Do not apply force to Gate.

4.9 Defrost

5 REMOTE OPERATION

5.1 RS 232 Configuration

- ASCII data format
- Full duplex
- PC: Delimiter CR (Chr 13h)
- PLC: Delimiter CR,LF (Chr 13h,10h)
- 9600 Baud
- 8 Data bits
- 1 Stop bit
- Parity even

The example program shows how the comport is initialized under MS-DOS. For details refer to the MS-DOS manuals.

```
FUNCTION STX_InitCom(pN:INTEGER):INTEGER;
  VAR n:INTEGER;
  BEGIN
    n:=ModeCom(pN,9600,'E',8,1);
    STX_InitCom:=n
  END;
```

5.2 Command Transmission Procedure

5.2.1 Break Signal

The controller serial port is reset by sending a 'Brake Signal'. The specification of the Brake Signal is given below.
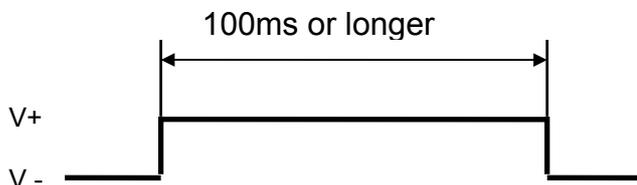
In most cases the Brake Signal can be omitted. The example program shows how a Brake Signal can be implemented under MS-DOS. The example program consists of two procedures where the inner procedure "LCR_Brake" is called by the outer procedure ("STX_ComReset"). Note that this program will directly address the comport chip. There may be operating systems that will not allow the chip being addressed directly.

```
PROCEDURE STX_ComReset(pN:INTEGER);
  PROCEDURE LCR_Brake(rAdr,tme:INTEGER);
    BEGIN
      Port[rAdr]:=Port[rAdr] OR $40; Delay(tme); {Bit6=Brake }
      Port[rAdr]:=Port[rAdr] AND $BF; Delay(2);
    END;
  BEGIN
    CASE pN OF
      1: LCR_Brake($3FB,500);
      2: LCR_Brake($2FB,500);
    END
  END;
```

5.2.2 Command Syntax

For communication only a few commands are required. A command is an ASCII-string
which is sent to the controller. Response is an ASCII string sent by the controller. Note
that each command is prompted by a Response string.

A command consists of command segments. The first command segment defines the
intention of the command. Command segments are separated by Space (ASCII 20h).
Response Segments are separated by comma (ASCII 1Ch). The table below gives a
list of abbreviations used later on.

Command Segment	Mnemonics
Communication Request	CR
Communication Quit	CQ
Communication Clear	CC
Communication Finished	CF
Set	ST
Reset	RS
Read	RD
Write	WR
Write Set	WS
Data Memory	DM
Timer	T
Space ASCII 20h	*sp*
Line Feed ASCII 0Ah	*lf*
Carriage Return ASCII 0Dh	*cr*

The following example program shows how a string sent to the StoreX controller can
be generated and sent. The "STX_SendStr" will allow a string "s" to be sent through
port "pN". The result of the function may be used for error handling. Note that the
string "s" does not require any delimiter. The delimiter is added inside the function. The
"auxStrAut" may be any low level or DOS procedure that supports the transmission
through the comport.

```
FUNCTION STX_SendStr(pN:INTEGER; s:STRING):INTEGER;
  VAR ss:STRING;
  BEGIN
    STX_SendStr:=0;
    ss:=Concat(s,cr);
    auxStrOut(pN,ss)
  END;
```

Since every command is prompted by the StoreX it makes sense to introduce a procedure that handles this send-receive sequence. A possible solution is given below.

```
FUNCTION STX_ReadBackStr(pN:INTEGER; s:STRING):STRING;
  CONST tries=2;
  VAR i,n,m,err:INTEGER; w:WORD; s0,s1:STRING; c,kp:CHAR;
  BEGIN
    IF NOT(kbdEsc) THEN
      BEGIN
        EmptyAux(pN);
        i:=-1;
        s0:=s;
        m:=Pos('-',s0);
        IF m>0 THEN
          BEGIN
            Delete(s0,m,1);
            s1:=Copy(s0,m,Length(s0));
            Val(s1,n,err);
            Delete(s0,m,Length(s0));
            w:=-n; Str(w,s1); s0:=s0+s1
          END;
        REPEAT
          Inc(i);
          EmptyAux(pN); auxStrOut(pN,s0+cr);
          IF i>3 THEN DelayMs(100);
          auxStrIn(pN,s1,5,lf);
          Delete(s1,PRED(Length(s1)),2)
        UNTIL (s1[1]<>'E') OR (i>tries) OR KbdEsc;
        STX_ReadBackStr:=s1;
      END
    ELSE
      STX_ReadBackStr:=''
  END;
```

5.2.3 Open / Close Communication

Prior communication with the controller, the communication has to be opened. Before the communication is opened, the controller accepts only the Open Communication Command (CR). For better safety, it is recommended to close communication (CQ) when no communication is required for a longer period of time.

	Command	Response
Open Communication	CR *cr*	CC *cr lf*

Send Commands (see below)		
Close Communication	CQ *cr*	CF *cr lf*

The two example programs show how to open and close communication to the StoreX.

```
FUNCTION STX_OpenCom(pN:INTEGER):STRING;
  BEGIN
    STX_OpenCom:=STX_ReadBackStr(pN,'CR')
  END;
```

Time out functions and communication error can be trapped at this level.

```
FUNCTION STX_CloseCom(pN:INTEGER):STRING;
  BEGIN
    STX_CloseCom:=STX_ReadBackStr(pN,'CQ')
  END;
```

These examples show how simple communication becomes when using the "STX_ReadBack" procedure. The following example explain how often used sequences are programmed. The 'Set-'procedure sets an internal relay (or flag). The value of the flag becomes '1'. The 'Reset-'procedure resets an internal relay (or flag) . The calue of the flag becomes '0'. Flags can be set, reset or read.

```
FUNCTION STX_Set(pN,rel:INTEGER):STRING;
  VAR sR:STRING;
  BEGIN
    Str(rel,sR);
    STX_Set:=STX_ReadBackStr(pN,'ST '+sR)
  END;

FUNCTION KV_Reset(pN,rel:INTEGER):STRING;
  VAR sR:STRING;
  BEGIN
    Str(rel,sR);
    STX_Reset:=STX_ReadBackStr(pN,'RS '+sR)
  END;

FUNCTION STX_Read(pN,rel:INTEGER):STRING;
  VAR sR:STRING;
  BEGIN
    Str(rel,sR);
    STX_Read:=STX_ReadBackStr(pN,'RD '+ sR)
  END;
```

The Set and Reset will return an 'OK'-response if operation is successful. The Read-procedure will return a '0' or '1'.

Datamemories are 16 bit oriented. They can be read or written. The following examples show how to use the datamemories.

```
FUNCTION STX_ReadDataMemory(pN,nbr:INTEGER):STRING;
```

```
   VAR sR:STRING;
   BEGIN
     Str(nbr,sR);
     STX_ReadDataMemory:=STX_ReadBackStr(pN,'RD DM'+ sR)
   END;

FUNCTION STX_WriteDataMemory(pN,nbr:INTEGER; valu:WORD):STRING;
   VAR sR,sV:STRING;
   BEGIN
     Str(nbr,sR); Str(valu,sV);
     STX_ReadDataMemory:=STX_ReadBackStr(pN,'WR DM'+ sR + ' ' + sV)
   END;
```

Not that the Response on above Write procedure is always 'OK'. The Read procedure will return a five-character-string.

5.2.4 Controller Error Messages

The following Error Codes are sent by the PLC. These error codes indicate system-errors and are not the same as the Instrument own error-messages (refer to "Handling Error Messages")

Error	Comment	Response
Relay Error	Undefined timer, counter, data memory, check if requested unit is valid	E0 *cr lf*
Command Error	Invalid Command, check if communication is opened by CR, check command sent to controller, check for interrupts during string transmission	E1 *cr lf*
Program Error	Firmware lost, reprogram controller	E2 *cr lf*
Hardware Error	Controller hardware error, turn controller ON/OFF, controller is faulty and has to be replaced	E3 *cr lf*
Write Protected Error	Unauthorized Access	E4 *cr lf*
Base Unit Error	Unauthorized Access	E5 *cr lf*

5.2.5 System Status

The Handling responds on Ready-Polling ("x") is '0' (handling not ready to accept commands) or '1' (handling ready, command may be sent). In its idle status the handling sets the Ready Bit to '1'.

	Command	Response
Read Ready-Bit	RD *sp* 1915 *cr*	x *cr lf*

When polling the ready Bit after sending a command, wait at least 200ms before requesting the Ready Status. We recommend to wait 100ms – 200ms between polling sequences.

Ready Polling
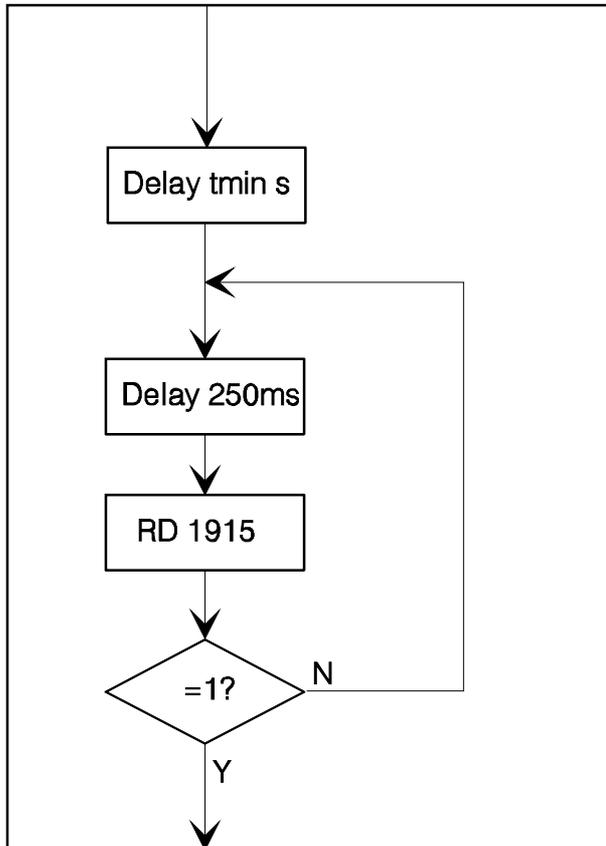
A sample program will explain the polling sequence in detail. Note that monitoring a flag change either form '0' to '1' or form '1' to '0' may also me advisable.

```
PROCEDURE STX_WaitReady(portNbr:INTEGER);
  BEGIN
    DelayMs(300);
    WHILE (STX_Read(portNbr,1915)='0') AND NOT(KeyPressed) DO
      DelayMs(200)
  END;
```

NOTE !
• Commands may only be sent when Ready Bit equal '1' (RD 1915 -> '1').
• Allow >200ms delay between any command and the first Ready Bit request.
• Use 100ms..200ms delay between requests.

5.3 Commands

5.3.1 Basic Commands

	Command	Response
Reset	**ST** *sp* **1900** *cr*	**OK** *cr lf*

Read Ready Flag	**RD *sp* 1915 *cr***	**x *cr lf***
Read Error Flag	RD *sp* 1814 *cr*	x *cr lf*
Read Plate-Ready Flag	RD *sp* 1914 *cr*	x *cr lf*
Activate Handling System	**ST *sp* 1801 *cr***	**OK *cr lf***
Deactivate Handling System	RS *sp* 1801 *cr*	OK *cr lf*
Read Status Handling System	RD *sp* 1801 *cr*	x *cr lf*
Set cassette slot position m (0..m)	**WR *sp* DM0 *sp* m *cr***	**OK *cr lf***
Set Handler level position n (1..n)	**WR *sp* DM5 *sp* n *cr***	**OK *cr lf***
Set Handler Cassette Pitch	WR *sp* DM23 *sp* p *cr*	OK *cr lf*
Open gate	ST *sp* 1901 *cr*	OK *cr lf*
1) Close gate	ST *sp* 1902 *cr*	OK *cr lf*
2) Continue Access (on Handshake Mode)		
Terminate Access	ST *sp* 1903 *cr*	OK *cr lf*
Load plate to m,n*)	**ST *sp* 1904 *cr***	**OK *cr lf***
Unload plate from m,n*)	**ST *sp* 1905 *cr***	**OK *cr lf***
Set plate to x-fer station m,n*)	ST *sp* 1906 *cr*	OK *cr lf*
Get plate from x-fer station m,n*)	ST *sp* 1907 *cr*	OK *cr lf*
Pick plate form cassette, level m,n*)	ST *sp* 1908 *cr*	OK *cr lf*
Place plate to cassette, level m,n*)	ST *sp* 1909 *cr*	OK *cr lf*
Position z-Lift for BCR reading m,n*)	ST *sp* 1910 *cr*	OK *cr lf*
Activate Shovel Transfer Sensor (70º C HT Version)	ST *sp* 1911 *cr*	OK *cr lf*
Rotate Swap Station 180 degr.	ST *sp* 1912 *cr*	OK *cr lf*
Rotate Swap Station back to home position	RS *sp* 1912 *cr*	OK *cr lf*
Read Shovel Plate Sensor	RD *sp* 1812 *cr*	x *cr lf*
Read Transfer Station Plate Sensor	RD *sp* 1813 *cr*	x *cr lf*
Read 2nd Transfer Station Sensor	RD *sp* 1807 *cr*	x *cr lf*
Read Swap Station position	RD *sp* 1912 *cr*	x *cr lf*
Read Actual Temperature (1/10º Celcius)	**RD DM982 *cr***	**ttttt *cr lf***
Read Set Temperature value (1/10º C; e.g. 370 = 37.0º Celcius)	RD DM890 *cr*	sssss *cr lf*
Set operation temperature (1/10º C)	**WR DM890 *sp* ttttt *cr***	**OK *cr lf***
Read Actual Humidity (1/10% RH)	**RD DM983 *cr***	**ttttt *cr lf***
Read Set Temperature value (1/10% RH; e.g. 900 = 90.0% RH)	RD DM893 *cr*	sssss *cr lf*
Set operation temperature (1/10% RH)	**WR DM893 *sp* ttttt *cr***	**OK *cr lf***
Read Actual CO2 concentration (1/100% CO2 Vol.)	**RD DM984 *cr***	**ttttt *cr lf***
Read Set CO2 value (1/10º C; e.g. 370 = 37.0º Celcius)	RD DM894 *cr*	sssss *cr lf*
Set operation CO2 concentration (1/100% CO2 Vol.)	**WR DM894 *sp* ttttt *cr***	**OK *cr lf***

Reponse 'x' expect '0' or '1'.
t = actual value (Word=16Bit)

s = set value (Word=16Bit)

The cassette slot is selected by sending m=1..2. The handler is positioned towards the specified slot. Note that cassette levels are numbered starting at the bottom level upwards. Bottom level is 1.

The Activate Handler-Command initializes the handling. Use the Activate Handler Command after cold-start or after sending a Reset Command. The Activate Handler Command should not be used as 'on-off' function.

Functions marked with *) can only be used with selected cassette slot. The value of number of cassettes is stored in DM29. The value of number of levels is stored in DM25. When using the Position z-Lift for BCR reading command the ST 1910 command has to send once only. Once set, the handler is positioned by simply writing the carrousel and level position into DM0 and DM5.

The Activate Plate Sensor command is used in HT-units only. In HT units the Shovel Plate Sensor is deactivated by default. Prior reading the sensor status it has to be turned on by sending the Activate Plate Sensor command (ST 1911). This command will turn the sensor on for ~2 seconds. The sensor can be read during this period of time. After turning the sensor on wait approximately 0.1 seconds before reading the sensor with the RD 1812 command.

The Error-Flag is set when the handling cannot finish a movement within time. Check the Error-Flag by sending "RD 1814" when the Ready-Bit does not become '1'.

The Plate Ready flag (1815) is set when the system has cleared the plate from the Transfer Station on executing a Load command or when a plate is placed on the Transfer Station during an UnLoad command. This Plate Ready flag allows increased access speeds. The read Plate Ready (RD 1815) returns '1' until the read Ready flag (RD 1915) is set to '1'.

5.3.2 Examples of Usage of Basic Commands

The following example strings show the usage of the basic commands. To Initialize the system after a cold-start or a reset you may send:

Command	Response	Comment
ST *sp* 1801 *cr*	OK *cr lf*	Initialize Command

Prior sending a initialization command you may request the system status by reading the Ready Flag:

Command	Response	Comment
RD *sp* 1915 *cr*	'1' *cr lf*	System Ready
RD *sp* 1915 *cr*	'0' *cr lf*	System Busy

To load a plate from the Transfer Station to level 10 in the cassette at slot 2. The command to be sent is:

Command	Response	Comment
WR *sp* DM0 *sp* 2 *cr*	OK *cr lf*	Position rotation at slot 2
WR *sp* DM5 *sp* 10 *cr*	OK *cr lf*	Select level 10 in cassette
ST *sp* 1904 *cr*	OK *cr lf*	Load Command to start Load process

To unload a plate form level 22 in the cassette at slot 1 and place it on the Transfer Station to the command strings to be sent are:

Command	Response	Comment
WR *sp* DM0 *sp* 1 *cr*	OK *cr lf*	Position rotation at slot 1
WR *sp* DM5 *sp* 22 *cr*	OK *cr lf*	Select level 22 in cassette
ST *sp* 1905 *cr*	OK *cr lf*	Unload Command to start Load process

If you simply want to remove a plate from the shovel by placing it to the transfer station you may send:

Command	Response	Comment
WR *sp* DM0 *sp* 1 *cr*	OK *cr lf*	Position rotation at any position; must be defined
WR *sp* DM5 *sp* 1 *cr*	OK *cr lf*	Select any level
ST *sp* 1906 *cr*	OK *cr lf*	Start execution of setting plate from the shovel to the Transfer Station

Remember that Slot Position and Level Position must also be set at the "ST 1906" and " ST 1907" command.

In order to transport one plate from level 15 of cassette 2 to level 17 of the same cassette 2 the following sequence has to be sent:

Command	Response	Comment
WR *sp* DM0 *sp* 2 *cr*	OK *cr lf*	Position rotation at slot 1
WR *sp* DM5 *sp* 17 *cr*	OK *cr lf*	Pick plate from level 17 of cassette 2
ST *sp* 1908 *cr*	OK *cr lf*	Start execution of Pick plate from level 17 of cassette on the Shovel
RD *sp* 1915 *cr*	'0' *cr lf*	System busy executing command
RD *sp* 1915 *cr*	'0' *cr lf*	System Ready for next command
WR *sp* DM5 *sp* 15 *cr*	OK *cr lf*	Select level 15
ST *sp* 1909 *cr*	OK *cr lf*	Place command to place plate form shovel to the cassette

Please note that the slot position value in DM0 and / or the level information in DM5 remains in the Data Memories after completion of command. Therefore in above example the "WR DM0 1" needs not to be sent again.

5.3.3 Extended Commands

	Command	Response
Read Error Flag (default =0)	RD *sp* 1814 *cr*	x *cr lf*

Read Auto-End-Access Flag (default =1)	RD *sp* 1600 *cr*	x *cr lf*
Set Auto-End-Access Flag (default =1)	ST *sp* 1600 *cr*	x *cr lf*
Reset Auto-End-Access Flag (default =1)	RS *sp* 1600 *cr*	x *cr lf*
Read Actual Slot Position n (0..2)	RD *sp* DM1 *cr*	nnnnn *cr lf*
Read Handler z-Offset (default = 600)	RD DM20 *cr*	ddddd *cr lf*
Read Handler dz Pick- & Place-Movement in Cassette (default = 500)	RD DM21 *cr*	ddddd *cr lf*
Read Handler In-Transfer z-Position (default ~42'000)	RD DM22 *cr*	ddddd *cr lf*
Read Handler z-Pitch (default =1925)	RD DM23 *cr*	ddddd *cr lf*
Read Handler Out-Transfer z-Position[1]	RD DM24 *cr*	ddddd *cr lf*
Read Max. Number of Levels (default = 22)	RD DM25 *cr*	ddddd *cr lf*
Read Handler dz Pick- & Place-Movement at Transfer Station (default = 800)	RD DM26 *cr*	ddddd *cr lf*
Internally used (default = 9999)	RD DM27 *cr*	ddddd *cr lf*
Read Handler dz Pick- & Place-Movement at Out-Transfer Station (default = 800)[2]	RD DM28 *cr*	ddddd *cr lf*
Read Max. Number of Cassettes (default = 2)	RD DM29 *cr*	
Read BCR z-Lift Read Position offset (default ~200)	RD DM62 *cr*	ddddd *cr lf*
Read Handler Left Cassette position (default ~70)	RD DM80 *cr*	ddddd *cr lf*
Read Handler Right Cassette position (default ~940)	RD DM81 *cr*	ddddd *cr lf*
Read Handler Transfer Station position (default ~3500)	RD DM82 *cr*	ddddd *cr lf*
Set Handler z-Offset	WR DM20 *sp* d *cr*	OK *cr lf*
Set Handler dz Pick- & Palce-Movement	WR DM21 *sp* d *cr*	OK *cr lf*
Set Handler In-Transfer z-Position	WR DM22 *sp* d *cr*	OK *cr lf*
Set Handler z-Pitch	WR DM23 *sp* d *cr*	OK *cr lf*
Set Handler Out-Transfer z-Position[3]	WR DM24 *sp* d *cr*	OK *cr lf*
Set Handler dz Pick- & Place-Movement at Transfer Station	WR DM26 *sp* d *cr*	OK *cr lf*
Set Handler dz Pick- & Place Movement at Out-Transfer z-Position[4]	WR DM28 *sp* d *cr*	OK *cr lf*
Set BCR z-Lift Read Position offset	WR DM62 *sp* d *cr*	OK *cr lf*
Set Handler Left Cassette position	WR DM80 *sp* d *cr*	OK *cr lf*
Set Handler Right Cassette position	WR DM81 *sp* d *cr*	OK *cr lf*

---

[1]Handler: DM24 = DM22
[2] Handler: DM26=DM28
[3]StoreX: DM24 = DM22
[4]StoreX: DM26 = DM28

	Command	Response
Set Handler Transfer Station position	WR DM82 *sp* d *cr*	OK *cr lf*

d = data (Word=16Bit)
x = 0,1 (Word=16Bit)
t = actual value (Word=16Bit)
s = set value (Word=16Bit)

5.3.4 Short Access Commands

The following commands allow extremely short and simple command sequences. When using short commands the plates are numbered from 1 to the maximum plate capacity. The maximum plate capacity is the value in DM25 (number of levels) multiplied with the value in DM29 (number of cassettes). The way the plates are numbered can be selected. By default the plates are numbered beginning at the lowest level of cassette 1 to the top level of cassette 1, continuing at the lowest level of cassette 2 ending at the top level of cassette 2 (Vertical Mode). The optional numbering starts at the lowest level of cassette 1, lowest level of cassette 2, second level of cassette 1, second level of cassette 2, third level of cassette 1 etc. (Horizontal Mode).

	Command	Response
Load plate n	WR *sp* DM10 *sp* n *cr*	OK *cr lf*
UnLoad plate n	WR *sp* DM10 *sp* -n *cr*	OK *cr lf*
UnLoad plate n (unsigned alternative)	WR *sp* DM15 *sp* n *cr*	OK *cr lf*
Select Vertical Numbering Mode (default)	ST *sp* 1604 *cr*	OK *cr lf*
Select Horizontal Numbering Mode	RS *sp* 1604 *cr*	OK *cr lf*

One Short Access Command can be sent while the prior access is being executed. This second command is stacked and executed after termination of the first command.

5.4 Handling Status / Error Messages

Error Commands are used when the handling detects an internal error (e.g. when loading a plate to an occupied location). In case of error the Error Flag (1814) is set from '0' to '1'. The exact cause of an error can be found in the data memory 200 (DM200). For each type of error an error code is set in DM200. The list below shows the meaning of the error code.

Errors are read by reading the content of DM200. On a time-out, first the Error Flag is read (RD 1814). Then DM200 is read in order to find the cause of error. An error is reset by sending the Reset Command (ST 1900).

Errors DM200=1xx are Load Plate Errors, errors DM200=2xx are Unload Plate Errors.

	Command	Response
Read Error Flag (default =0)	RD *sp* 1814 *cr*	x *cr lf*
Read Error Code	RD *sp* DM200 *cr*	x *cr lf*

The following tables will list the StoreX status messages.

Error	Description	Code
General Handling Error	Handling action could not be performed in time.	00001 *cr lf*
Gate Open Error	Gate could not reach upper position or Gate did not reach upper position in time	00007 *cr lf*
Gate Close Error	Gate could not reach lower position or Gate did not reach lower position in time	00008 *cr lf*
General Lift Positioning Error	Handler-Lift could not reach desired level position or does not move	00009 *cr lf*
User Access Error	Unauthorized user access in combination with manual rotation of carrousel	00010 *cr lf*
Cassette Slot Error	Cassette slot cannot be reached	00011 *cr lf*
Remote Access Level Error	Undefined cassette level has been requested	00012 *cr lf*
Plate Transfer Detection Error	Unload operation while plate is on transfer station	00013 *cr lf*
Lift Initialization Error	Lift could not be initialized	00014 *cr lf*
Plate on Shovel Detection	Trying to load a plate, when a plate is already on the shovel	00015 *cr lf*
No Plate on Shovel Detection	Trying to remove or place plate with no plate on the shovel	00016 *cr lf*
No recovery	Recovery was not possible	00017 *cr lf*

Error	Description	Code
Load Plate Cassette Positioning Error	Carousel could not reach desired radial position during Load Plate procedure or Lift could not reach transfer level during Load Plate procedure.	00100 *cr lf*
Load Plate Handler Transfer Turn out Error	Handler could not reach outer turn position at transfer level during Load Plate procedure.	00101 *cr lf*
Load Plate Shovel Transfer Outer Error	Shovel could not reach outer position at transfer level during Load Plate procedure.	00102 *cr lf*
Load Plate Lift Transfer Error	Lift did not reach upper pick position at transfer level during Load Plate procedure.	00103 *cr lf*
Load Plate Shovel Transfer Inner Error	Shovel could not reach inner position at transfer level during Load Plate procedure.	00104 *cr lf*
Load Plate Handler Transfer Turn in Error	Handler could not reach inner turn position at transfer level during Load Plate procedure.	00105 *cr lf*
Load Plate Lift Cassette	Lift could not reach desired cassette	00106 *cr lf*

Travel Error	level during Load Plate procedure.	
Load Plate Shovel Cassette Front Error	Shovel could not reach front position on cassette access during Plate Load procedure.	00107 *cr lf*
Load Plate Lift Cassette Place Error	Lift could not reach cassette place level during Load Plate procedure.	00108 *cr lf*
Load Plate Shovel Cassette Inner Error	Shovel could not reach inner position at cassette plate placement during Load Plate procedure.	00109 *cr lf*
Load Plate Lift Travel Back Error	Lift could not reach zero level during Load Plate procedure.	00110 *cr lf*
Load Plate Lift Init Error	Lift could not be initialized after Load Plate procedure.	00111 *cr lf*

Error	Description	Code
Unload Plate Lift Cassette Travel Error	Carousel could not reach desired radial position during Unload Plate procedure or Lift could not reach desired cassette level during Unload Plate procedure.	00200 *cr lf*
Unload Plate Shovel Cassette Front Error	Shovel could not reach front position on cassette access during Plate Unload procedure.	00201 *cr lf*
Unload Plate Lift Cassette Load Error	Lift could not reach cassette pick level during Unload Plate procedure.	00202 *cr lf*
Unload Plate Shovel Cassette Inner Error	Shovel could not reach inner position at cassette plate pick during Unload Plate procedure.	00203 *cr lf*
Unload Plate Lift Transfer Positioning Error	Lift could not reach transfer level during Unload Plate procedure.	00204 *cr lf*
Unload Plate Handler Transfer Turn out Error	Handler could not reach outer turn position at transfer level during Unload Plate procedure.	00205 *cr lf*
Unload Plate Shovel Transfer Outer Error	Shovel could not reach outer position at transfer level during Unload Plate procedure.	00206 *cr lf*
Unload Plate Lift Transfer Place Error	Lift did not reach lower place position at transfer level during Unload Plate procedure.	00207 *cr lf*
Unload Plate Shovel Transfer Inner Error	Shovel could not reach inner position at transfer level during Unload Plate procedure.	00208 *cr lf*
Unload Plate Handler Transfer Turn in Error	Handler could not reach inner turn position at transfer level during Unload Plate procedure.	00209 *cr lf*
Unload Plate Lift Travel Back Error	Lift could not reach Zero position during Unload Plate procedure.	00210 *cr lf*
Unload Plate Lift Init Error	Lift could not be initialized after Unload Plate procedure.	00211 *cr lf*

Error	Description	Code
Plate Remove Errors (1906)	Errors as above but in conjunction with Remove Plate Command	003xx *cr lf*
BarCode Read Errors (1910)	Errors as above but in conjunction with BCR Command	004xx *cr lf*
Plate Place Errors (1909)	Errors as above but in conjunction with Place Plate Command	005xx *cr lf*
Plate Set Errors (1907)	Errors as above but in conjunction with Set Plate Command	006xx *cr lf*
Plate Get Errors (1908)	Errors as above but in conjunction with Get Plate Command	007xx *cr lf*

d = data (Word=16Bit)
x = 0,1 (Word=16Bit)

The following example will show how the ready Polling can be combined with the continuos system status request. The program below will display details of the handling actions of the StoreX handler. In combination with a data base detailed status reports can be output real-time to the operator all time.

```
PROCEDURE STX_WaitReadyTrace(portNbr:INTEGER);
  VAR c:CHAR; x,y,err:INTEGER; n:WORD;
  BEGIN
    WRITE(' ');
    x:=WhereX; y:=WhereY;
    DelayMs(300);
    WHILE (STX_Read(prtNbr,1915)='0') AND NOT(KeyPressed) DO
      BEGIN
        DelayMs(100);
        GotoXY(x,y);
        Val(STX_ReadDataMemory(portNbr,200,n,err); WRITE(n:3)
      END
  END;
```

5.5 Program Examples

Cold Start with Positioning

```
        ┌─────────────┐
        │    start    │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   CR->CC    │      open communication
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   Ready     │
        │   Polling   │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   ST 1801   │      activate/initialize
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   Ready     │
        │   Polling   │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │  WR DM0 m   │      carrousel stop position
        └─────────────┘      m=1 .. 9
               │
               ▼
        ┌─────────────┐
        │   Ready     │
        │   Polling   │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │     end     │
        └─────────────┘
```
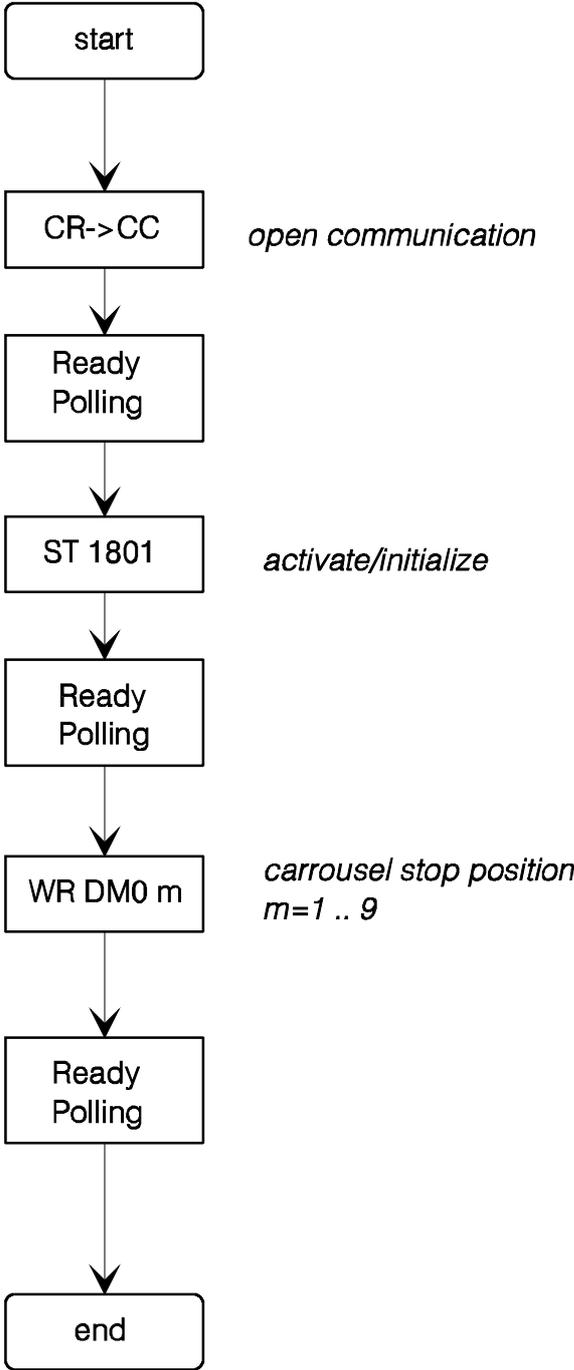
Load Access to Slot m Level n

```
        ┌─────────────┐
        │    start     │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   Ready     │
        │   Polling   │
        └─────────────┘
               │
               ▼
        ┌─────────────┐        position carrousel to slot m
        │  WR DM0 m   │        m=1..9
        └─────────────┘
               │
               ▼
        ┌─────────────┐        select level n
        │  WR DM5 n   │        n=1..21
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │  ST 1904    │        Load command
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   Ready     │
        │   Polling   │
        └─────────────┘
               │
               ▼
        ┌─────────────┐        continu access
        │  ST 1902    │        at x-fer position
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │   Ready     │
        │   Polling   │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │    end       │
        └─────────────┘
```
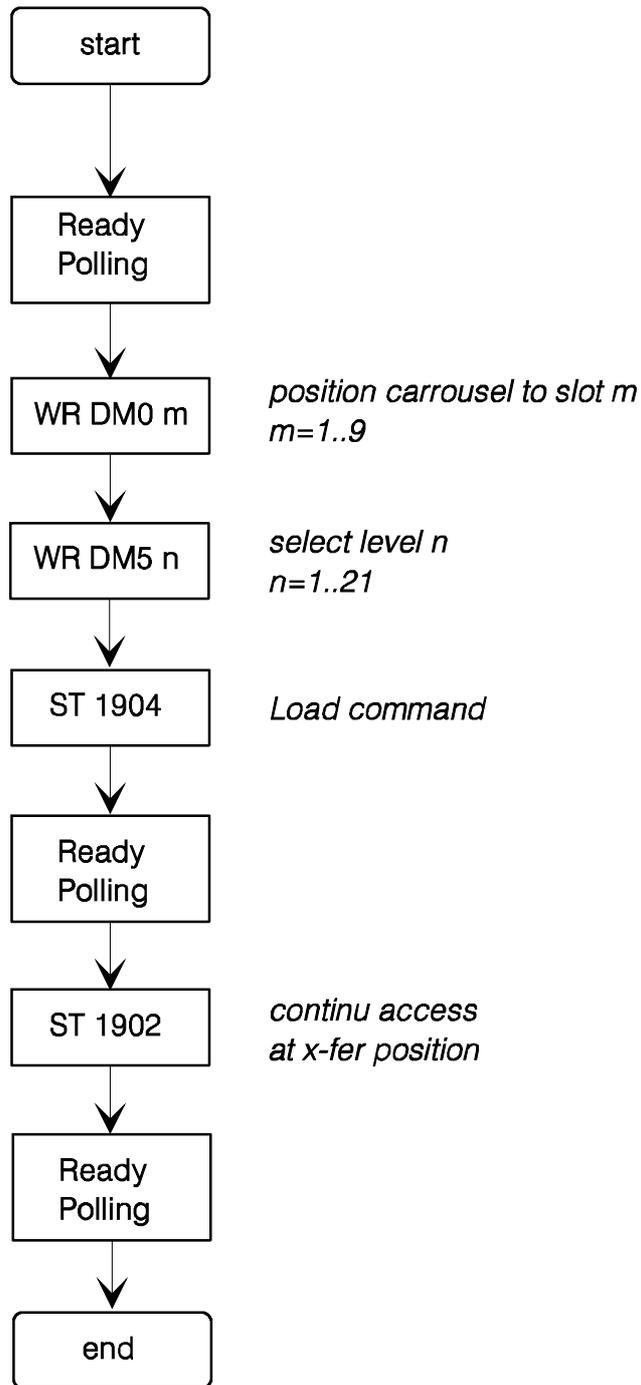
Unload Access from Slot m Level n

```
        ┌─────────┐
        │  start  │
        └─────────┘
             │
             ▼
        ┌─────────┐
        │  Ready  │
        │ Polling │
        └─────────┘
             │
             ▼
        ┌─────────┐        position carrousel to slot m
        │ WR DM0 m│        m=1..9
        └─────────┘
             │
             ▼
        ┌─────────┐        select level n
        │ WR DM5 n│        n=1..21
        └─────────┘
             │
             ▼
        ┌─────────┐
        │ ST 1905 │        Unload command
        └─────────┘
             │
             ▼
        ┌─────────┐
        │  Ready  │
        │ Polling │
        └─────────┘
             │
             ▼
        ┌─────────┐        continu access
        │ ST 1902 │        at x-fer position
        └─────────┘
             │
             ▼
        ┌─────────┐
        │  Ready  │
        │ Polling │
        └─────────┘
             │
             ▼
        ┌─────────┐
        │   end   │
        └─────────┘
```
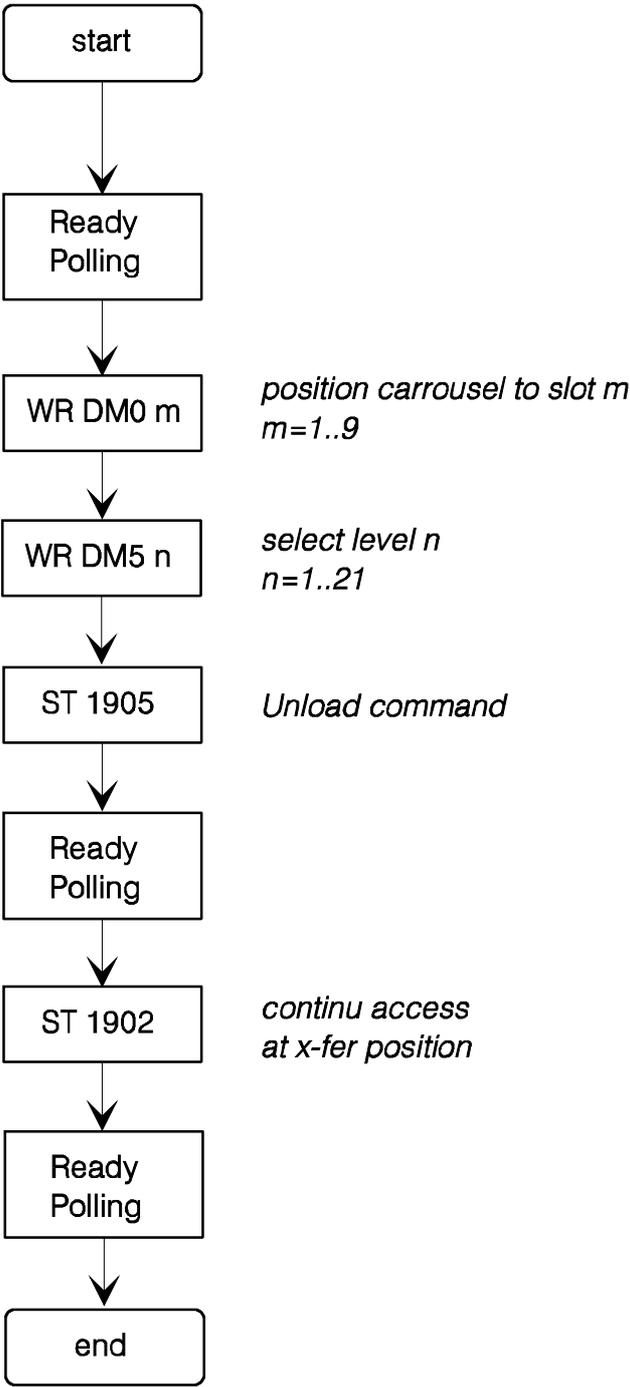
A universally usable procedure which can be used for most StoreX commands is given below. Use this procedure after initializing the instrument only.

```
PROCEDURE STX_DoPlate(pN,slot,level:INTEGER; command:STRING);
  BEGIN
    IF NOT(KeyPressed) THEN
      BEGIN
        STX_WaitReady(pN);
        STX_WriteDataMemory(pN,0,slot);
        STX_WriteDataMemory(pN,5,level);
        STX_Set(pN,command);
        STX_WaitReadyTrace(portNbr)
      END;
  END;
```

```
        STX_WaitReady(pN);
        STX_WriteDataMemory(pN,0,slot);
        STX_WriteDataMemory(pN,5,level);
```

6 UTILITY SOFTWARE

```
LiCONiC R&D                                         01-06-96
C.G.Malin                                           09:04:01

         HBI-UserSoft    *   V 0.04, 25.05.96
_____
Heraeus AG                                         HBI 2001-3
UserName                                              S-Nbr


         Direct Commands                    1
         Monitor Flags                      2
         Macros                             3
         Teach Positioning Times            4
         Random Positioning                 5
         Random Access Cycles               6
         Random Fast Access                 7
         Quit                               0

_____
         Enter [0..7]                       _
```

6.1.1 Direct Commands

Direct entering of commands (ASCII-Characters) and sending to the Handling Controller. The commands can be entered as capital letters or
Prompt entries by Return.

Enter direct commands to KV-PLC, press q to quit

_

6.1.2 Monitor Flags

```
P0          0000    Rot.EN      0500
Pn          0001    GateEN      0501
GtClse      0002    GateEN      0502
GtOpen      0003    Rot.Dir     0503
            0004    GtTmOut     0504
F.Door      0005    AccsLED     0505
SW 2E0      0006
SW 2E1      0007
SW 2E2      0008
SW 2E3      0009


Acs.        1100
Key Valid
InPos
Ready       1915


RotPos. DM01    Accs.  DM00    AccV.  DM02
SetSpd. DM91    aSlpe. DM92    bSlpe. DM93    intvl. DM94

_
```

Status Flag of the Handling Controller. The status message "0" means inactive, the status message "1" means active.

Code	Status Flag	Comment
P0	0000	0-initiator of carousel
Pn	0001	Position-initiator of carousel
GtClse	0002	Gate closed switch
GtOpen	0003	Gate opened switch
KeySw	0004	Key switch
Gn LED	0005	Green LED
SW 2E0	0006	Manual positioning switch bit0
SW 2E1	0007	Manual positioning switch bit1
SW 2E2	0008	Manual positioning switch bit2
SW 2E3	0009	Manual positioning switch bit3
Acs.	1100	Carousel access (remote or manual)
Key Valid		Manual positioning switch valid
Ready	1915	Ready-Bit
Rot.Pos.	DM1	Actual carrousel position
Access.	DM0	Carousel set position
AccV.	DM2	Access accepted

6.1.3 Macros

Sending of complete, preprogrammed command sequences.

```
Function             Command          Key

Rot. Position        WR DM0 x         1..9
Enable Rotation      WR DM0 0           0
Gate Open            ST 1901            O
Gate Close           ST 1902            C
End Access           ST 1903            E
Shaker ON            ST 1907            S
Shaker OFF           RS 1907            F
CarAct ON            ST 1801            A
CarAct OFF           RS 1801            D
Command Reset        ST 1900            R

Quit                 --               esc
Ready [1915]

Please Select ->      _
```

Code	Comment
0	No access, carrousel rotation enabled
1..9	Position carousel
O	Gate open (only when carousel is positioned)
C	Gate closed
R	Reset Handling Controller
Q	Exit macro menu
Accs.	Carousel access (remote or manual)
Ready	Ready-Bit

6.1.4 Teach Positioning Times

Program to measure positioning times of the carrousel.

The program starts positioning automatically. As a result a table containing the measured positioning times is presented.

6.1.5 Random Positioning

Program for positioning the carousel randomly without gate movements.

After entering the access intervals the program continuously simulates accesses at random positions until the "q-Key" is pressed. As a result a table containing statistical data is presented.

If an error of positioning time larger then 0.4 seconds compared with the calibrated positioning time is observed a positioning error is assumed and monitored.

6.1.6 Random Access Cycles

Program for positioning the carousel randomly including gate movements.

After entering the access intervals the program continuously simulates accesses at random positions until the "q-Key" is pressed. As a result a table containing statistical data is presented.

If an error of positioning time larger then 0.4 seconds compared with the calibrated positioning time is observed a positioning error is assumed and monitored.

6.1.7 Random Fast Access

Program for positioning the carousel randomly including combined positioning-gate movements commands.

After entering the access intervals the program continuously simulates accesses at random positions until the "q-Key" is pressed. As a result a table containing statistical data is presented.

If an error of positioning time larger then 0.4 seconds compared with the calibrated positioning time is observed a positioning error is assumed and monitored.

7 TROUBLESOOTING

The following list shows the possible errors of StoreX handler which can be removed by a customer. If the steps below doesn't give you the success, you need, please contact an authorized service personnel.

CAUTION!

- Never touch electrical connectors as long the Handler is in connection with the external net or one or more covers are removed.

- If there is some work with the lift assembly or inside the climate chamber always disconnect mains.

Error	Cause	Action
Instrument does not power-up, green light of the Power Switch is off	Main Switch at the rear side of the instrument is turned off	Turn Main Switch on
	Fuse burned	Replace Fuse(s)
Handler doesn't react on external commands	Some fault in the electrical connectors/cables	Check handling RS232/V24 plug respectively 9pol. cable of PC to Null-Modem
	No communication to Null-Modem	Built respectively control the communication with single orders.
	Internal error	Call service personnel
Handler doesn't react at all	No connection	Control Voltage setting and ON/OFF switch
	Fuse damage	Control fuse and in case of damage replace it (2AT)
	Error in electrical connection between Null-Modem and external net	Control connection respectively 25pol. exterial connector cable null modem
	Belt is displaced	Control belt for damage and put it into right position again
	Internal error	Call service personnel

8 MAINTAINANCE

Handler 4 are only for use in clean and dustfree environment (laboratory use). Dust can hurt the open rotating parts. In case the instrument is in a dusty unclean atmosphere for a longer distance of time, remove the dust and clean the instrument very carefully before installation of the instrument. Caution ! There are some parts which need some new grease.

The handler 4 is constructed for no maintenance and with the exception of the periodly control of the tension of the belt, they don't need any regular service.

The lift assembly takes a minimum of regular maintenance and controlworks. The period of maintenance dependence on the number of movements . The maintenance means the control of the lubrication of the gears, the control of **mark of oil-filling** in the lift assembly and the control of play in the gear.

		Check		Maint.		Replace	
		Mo.	Mov.	Mo.	Mov.	Mo.	Mov.
Lift assembly	• Lubrication film over the entire length of the lift rails • Free of particles • Must not indicate wear • Remove old lubrication film • Apply new lubrication film • Play of the vertical lift guidance means exchange of the parts	2	20000	6	50000	--	--
Shovel Guidance	• Control max. play in height-play and side-play • Lubrication film over the entire length of the linear-guidance • Free of particles • Remove old lubrication film • Renew lubrication film • Too much play in the linear guidance means exchange of the parts	2	20000	6	50000	--	--
Turn Drive Belt	• Check for wear • Check belt teeth for cracks • Check belt metal core for free metal parts	2	20000	6	50000	12	--
Climate Chamber Cleaning	•						
Condenser Cleaning	•						
Defrost	•						
Front Door Sealing	• Control the wear of the	2	--	6	--	12	--

	belt • The edge of the belt may not indicate wear • The fabric of the belt is not visible • Tighten the belt						
Gate Sealing	•						
Front Panel Sealing	•						
Glass Door Sealing	• Control the wear of the belt • The edge of the belt may not indicate wear • The fabric of the belt is not visible	2	--	6	--	12	--

For lubrication of the radial-lead there is a lubrication-hole in the front side of the **Laufwagen**. Put lubrication in the lubrication-hole until it floods the sealing on the side.
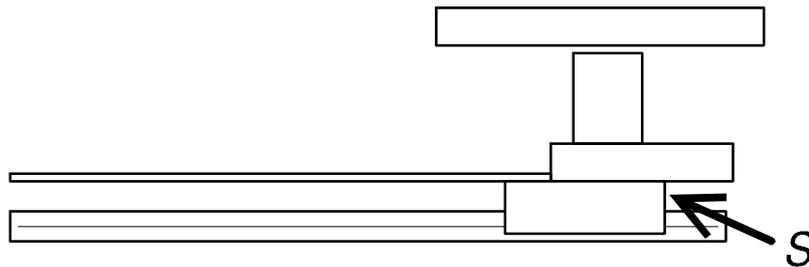
For the Lift assembly lubricate at A, B as sown below. Make sure that lubrication will cover the entire length of the linear-guidance. Use recommend acid-free grease only. For the gears special lubrication products are needed. Lubricate C,D,E as shown below. Lubrication **thoothbar** F and gears G.
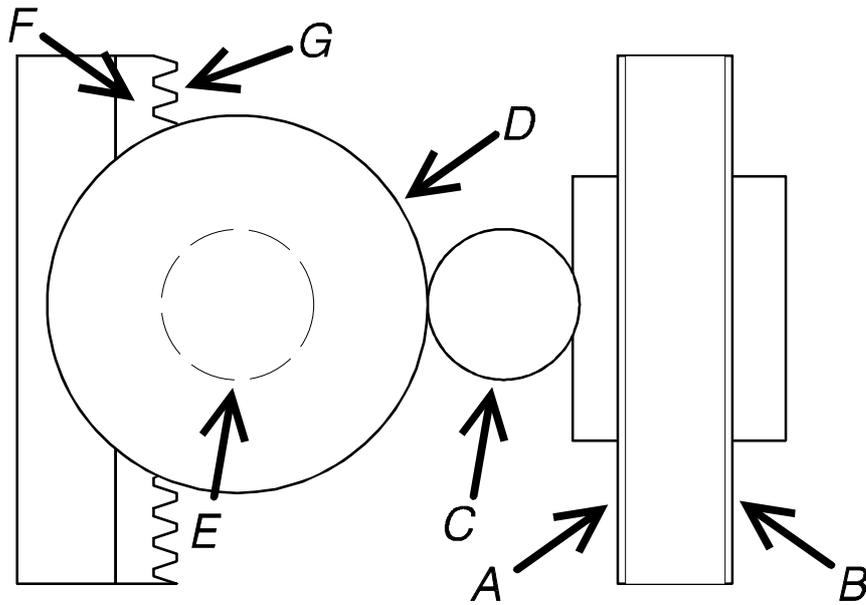
8.1 Cleaning

If there are some parts which are contaminated , you can clean them easily with regular disinfecting-cleaner. Always remove old lubrication on external parts and replace it with new lubrication film.

8.2 Tension

For the correct tension of the Turn Drive belt

9 TECHNICAL DATA

9.1 Mechanics

- Slots (Standard config.)   2 MTP-Positions, max. load 5 kg
- Levels   22, usable height / level 17mm
- Lift drive   Stepper Motor, bipolar, micro-stepping mode
- Shovel drive   DC-Motor
- Gate   Linear movement, heated
-
- Noise   <52dBA / 1m
- RAL Color

9.2 Electronics

- Mains   115 / 230VAC, 50/60Hz   (STX-IC)
- Power-Supply Handling   24V=, max. Power Consumption 70W,
                               Communication via RS-232
                               2=Controller RX, 3=Controller TX, 5=GND
                               7,8 and 4,6 shortended
- Gateheater   24VDC

9.3 Pneumatics

- Optional Gas Pressure   2.6 bar
-

9.4 Dimensions

STOREX