TFS 500
HMI Operating Instruction
v 1.2
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2. Document History

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.12.2005</td>
<td>PRa</td>
<td>V1.0 First version</td>
</tr>
<tr>
<td>04.05.2006</td>
<td>PRa</td>
<td>V1.1 Changes for Mikkeli TFS500</td>
</tr>
<tr>
<td>08.11.2007</td>
<td>PRa</td>
<td>V1.2 Minor changes</td>
</tr>
</tbody>
</table>
3. General

TFS 500 control system is based on:

- PC user interface (PC or HMI=Human Machine Interface), which is implemented using InTouch-software. Operator can control and monitor operation of TFS 500 by using PC.
- Siemens S7-300 PLC (PLC), which takes care of measuring encoders (temperature etc. process values) and controlling actuators (valves etc.).

PC screen is divided into 3 parts; Window upper, Window center and Window lower part.

Window upper part consist of Beneq-logo, machine state lamps and text indication, Login/Logout-buttons with logged user information, Date/Time-fields and name of the selected function (above CONTROL).

Machine states are (TEXT INDICATION):

- Solid white
  - Idle state (IDLE).
- Solid green
  - Batch running (RUN).
- Blinking green
  - Machine starting up (STARTUP)
- Blinking yellow
  - Machine in maintenance, pressurize, evacuate or shutdown state (MAINTENANCE, PRESSURIZE, VACUUMIZE, SHUTDOWN).
- Red
  - Major or Fatal alarm active or emergency stop pressed (MAJOR, FATAL, EMERGENCY).

By pressing Login-button in the Window upper part, a popup window above appears on the screen.

Some functions are password protected e.g. Configuration-function. Before accessing password protected functions, valid username and password has to be entered by using Login-button. There are usernames and password for 3 levels (1-operator, 2-maintenance and 3-Beneq). If user has not
logged in, then it’s not possible to select that function and button text is gray and box around the button won’t come up. After using password protected function, original user level (0-none) can be returned by selecting Logout-button.

Window center part changes according to selected function.

Window lower part consist of function-buttons, where all functions can be selected. After selecting Window center part changes. If there are any alarms, Alarm-button is red (like above).

PC is operated by using keyboard and mouse. Only left-click is possible. If there is anything on the screen, which can be changed e.g. buttons or input field, then box comes up around that object.

All set values are shown in black colour and actual values in blue colour.

All popup windows can be closed by pressing Close-button shown above.

NOTE!!! If there is communication error between PC and PLC, then communication error alarm appears. It is indicated in the Window upper part too. When there is communication error, then TFS 500 cannot be run until problem is solved. Then cable from PC to PLC should be checked that it is connected properly. Sometimes it requires PC reboot to get rid out of the problem.
4. Control function

This is main function, which is most of the time on the screen during operation.

Temperature and pressure trends are represented on the screen. Trends can be configured and zoomed. Name (above Temperature and Pressure) beside buttons can be changed, if required.

Recipe can be selected. After selection it can be compiled and downloaded into the PLC.

Most important set and actual values (chamber, chiller and hot source temperatures, chamber pressure and mass flow controller flows) are shown. Set values can be changed, too.

Chamber and hot source heating can be turned on and off. Chamber and hot source heating have Preheating-button, where preheating preset value can be selected into use.

General information of recipe is shown on the screen. Batch can be started and stopped. There are buttons for pressurizing and vacuumizing chamber, starting and stopping batch and acknowledging.
emergency stop. Set and actual value of loop counters of repeat loops can be shown on the screen, too.

Trends can be configured by clicking trend in question and assigning tags (temperature, pressure and flow actual value) to pens.

There is a scooter (time at x-axis), which can be moved. Thus trend values can be seen on the Pens popup window.
Trend values can be zoomed vertically by scrolling vertical bars beside trend Y-axis. There is one bar for high limit and one for low limit. Y-axis scale can be changed for next pen by clicking Y-axis.

Buttons for trends:
- Panel: Panel for zooming and scrolling trends is shown in a popup window.
- Pens: Selected pens and their values are shown in a popup window.
- Save: Pen settings (user settings) can be saved for further use.
- Load: Saved pen settings (user settings) can be returned back.
- Default: Pen default values can be loaded.
- Update: Automatic update can be turned on and off.

Panel for temperature trend

Panel for zooming and scrolling trends is shown on the screen by pressing Panel-button. Following buttons are available:

Changing start time of trend by selected time step. In this case start time is changing by +- 1 minute.

Changing end time of trend by selected time step. In this case end time is changing by +- 1 minute.

X-axis (time) can be zoomed in by 50% and out by 100% (time scale half or double).

Time scale selections for operation of other buttons. When in red color that time scale has been selected for use. Time scale value for button in the middle (above 1 minutes) can be changed by pressing it and entering new value.
Changing start and end time of trend by selected time step. In this case whole trend is moving by +-1 minute.

Changing current time to end time of trend. Start time won’t change.

Selected pens and their values can be seen by pressing Pens-button.

Currently selected pens can be saved by pressing Save-button. They can be returned back by pressing Load-button.

Default settings can be returned back by pressing Default-button. Default values are:
- Start time = Last batch start time.
- End time = Current time.
- Max scale = 100% (Temperature 600 C, Pressure 1200 mbar, Flow=3500 sccm).
- Min scale = 0 % (Temperature 0 C, Pressure 0 mbar, Flow=0 sccm).

Trend update can be started and stopped by pressing Update-button. Green text indicates that update is on. This feature helps to observe values by using scooter, because otherwise every time trend is updated the scooter will go to end of the trend (last value).

Note! When changing PC date and time in autumn (when turning one clock hour backwards), trend data for one hour is overlapping. Daylight saving feature is not done automatically by PC.
Loop counters can be followed on the screen in above window. Set values can be changed, if required to speed up or slow down the process, too.
5. Recipe function

This is function, where recipes can be edited, compiled and downloaded.

Available recipes are shown in Recipe - combo box. By clicking required recipe it will be shown below (large white area).

Recipe can be edited. Copy and Paste functions are available, too.. Recipe is saved using Save recipe-button.

Recipe is compiled and downloaded into the PLC by pressing Recipe compile and download – button.

During downloading Recipe compile and download –button’s colour changes to green. Number of items and current item are shown. Downloading can be stopped by pressing Stop compile and download –button.
Note! If downloading is stopped before it is ready, then there is no valid recipe in the PLC.
Note! If there are troubles downloading a recipe to the PLC, then there will be red indication text just below selected recipe name. Then it has to be downloaded again until it’s successful.
6. Archive function

This is function, where data of previous batches can be seen.

Batch data is fetched from archive by entering Batch number and pressing Search-button. If it’s not found, there will be “NOT FOUND”-text below the Search-button.

Operation with trends is like in Control-function.

Used recipe is shown below, too.

Batch data can be printed out by pressing Print-button.
Then batch report including batch number, start and end time and used recipe is shown in Notepad. By using File/Print (or Ctrl+P) it can be printed to Windows printer. Hardcopy of the screen including temperature, pressure and flow trends is printed out, too.
7. Configuration function (requires maintenance password)

Configuration menu

This is a function, where machine configurations can be changed. Required sub functions can be selected on this screen:

- Analog input value scaling
- Analog output value scaling
- PID parameters
- Valve controls
- Routine handling
- Recipe handling
- Miscellaneous

There are some special functions, which can be controlled here, too:

- Maintenance mode can be started and stopped.
- Shutdown-routine can be started.
- Startup-routine can be started.
- Machine can be forced to IDLE-state.
- Vacuum pump can be turned on/off.
- User interface (InTouch) can be closed.
Analog input value scaling

This is a function, where analog input configurations can be changed.

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Actual Value</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction chamber temperature control T1AC-H1 [°C]</td>
<td>23.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaction chamber temperature monitoring T1A-R1 [°C]</td>
<td>23.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot source 1 container temperature T1AC-H1 [°C]</td>
<td>97.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot source 2 container temperature T1AC-H2 [°C]</td>
<td>138.4</td>
<td></td>
<td></td>
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<tr>
<td>Spore TC type K T1A-G1 [°C]</td>
<td>600.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spore TC type K T1A-G2 [°C]</td>
<td>600.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spore TC type K T1A-G3 [°C]</td>
<td>600.0</td>
<td></td>
<td></td>
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<tr>
<td>Operation door heater temperature T1AC-V1H [°C]</td>
<td>23.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black wall heater temperature T1AC-V2H [°C]</td>
<td>23.1</td>
<td></td>
<td></td>
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<tr>
<td>Chamber cylinder #1 heater temperature T1AC-V3H [°C]</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber cylinder #2 heater temperature T1AC-V4H [°C]</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber cylinder #3 heater temperature T1AC-V5H [°C]</td>
<td>23.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber cylinder #4 heater temperature T1AC-V6H [°C]</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot source 1.1 body heater temperature T1AC-H1H [°C]</td>
<td>92.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot source 1.2 neck heater temperature T1AC-H2H [°C]</td>
<td>92.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot source 2.1 body heater temperature T1AC-H3H [°C]</td>
<td>127.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot source 2.2 neck heater temperature T1AC-H4H [°C]</td>
<td>140.6</td>
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<tr>
<td>Vessel wall temperature T1A-V1 [°C]</td>
<td>23.7</td>
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<td></td>
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<tr>
<td>Spore TC type K T1A-S5 [°C]</td>
<td>600.0</td>
<td></td>
<td></td>
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<tr>
<td>Chamber pressure PIA-V1 [mbar]</td>
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<td>6.0</td>
<td>1000.0</td>
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<tr>
<td>Feeding pressure A PIA-FA [mbar]</td>
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<td>0.0</td>
<td>100.0</td>
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<tr>
<td>Reactor pressure PIA-P1 [mbar]</td>
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<td>0.0</td>
<td>100.0</td>
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<tr>
<td>Feeding pressure B PIA-FB [mbar]</td>
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<tr>
<td>Flow measuring MFC-A [sccm]</td>
<td>102.4</td>
<td>0.0</td>
<td>6000.0</td>
</tr>
<tr>
<td>Flow measuring MFC-B [sccm]</td>
<td>104.2</td>
<td>0.0</td>
<td>6000.0</td>
</tr>
<tr>
<td>Flow measuring MFC-C [sccm]</td>
<td>104.2</td>
<td>0.0</td>
<td>6000.0</td>
</tr>
<tr>
<td>Chiller temperature T1AC-I [°C]</td>
<td>20.0</td>
<td>16.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Spore monitoring TIA-S6 25mA</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Spore monitoring TIA-S7 25mA</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Spore 0-10V TIA-08</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Spore 0-10V TIA-S9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Analog output value scaling

<table>
<thead>
<tr>
<th>Analog Output Value Scaling</th>
<th>Set Value</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>3001: Chiller temperature TAC-LS [°C]</td>
<td>20.0</td>
<td>10.0</td>
<td>50.0</td>
</tr>
<tr>
<td>3002: Flow control MFC-AS [sccm]</td>
<td>600.0</td>
<td>0.0</td>
<td>6000.0</td>
</tr>
<tr>
<td>3003: Flow control MFC-VS [sccm]</td>
<td>600.0</td>
<td>0.0</td>
<td>6000.0</td>
</tr>
<tr>
<td>2007: Spare 4-20mA TAC-S1S</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2008: Spare 4-20mA TAC-S2S</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2009: Spare 0-10V TAC-S3S</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2010: Spare 0-10V TAC-S4S</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

This is a function, where analog output configurations can be changed.
# PID parameters

## PID PARAMETERS FOR CHAMBER

<table>
<thead>
<tr>
<th>PID</th>
<th>Operation door</th>
<th>Kick-off factor</th>
<th>Chamber resistor factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID 1</td>
<td></td>
<td>1.000</td>
<td>1.050</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PID</th>
<th>Back wall</th>
<th>Kick-off step factor</th>
<th>I-term</th>
<th>D-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID 2</td>
<td></td>
<td>0.35%</td>
<td>0.0</td>
<td>0.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PID</th>
<th>Cylinder #1</th>
<th>PID PARAMETERS FOR HOT SOURCES</th>
<th>Neck gradient [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID 3</td>
<td></td>
<td>180.0</td>
<td>97.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PID</th>
<th>Cylinder #2</th>
<th>Neck gradient [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID 4</td>
<td></td>
<td>91.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PID</th>
<th>Cylinder #3</th>
<th>Neck gradient [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID 5</td>
<td></td>
<td>91.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PID</th>
<th>Cylinder #4</th>
<th>Neck gradient [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID 6</td>
<td></td>
<td>91.0</td>
</tr>
</tbody>
</table>

This is function, where PID parameters can be changed.
Valve controls

This is a function, where valves can be controlled manually in the Maintenance-state.

Most important set values can be changed (chamber temperature etc.) and actual values are shown, too.
Routine handling

This is function, where routines can be downloaded into the PLC.

Available routines are shown in Routine - combo box. There are separate routines for Startup-, Shutdown-, Major-, Fatal-, Emergency-, Pressurize- and Vacuumize-routines. By clicking required routine it will be shown below (large white area).

Routine is compiled and downloaded into the PLC by pressing Routine compile and download – button.

During downloading Routine compile and download –button’s colour changes to green. Number of items and current item are shown. Downloading can be stopped by pressing Stop compile and download –button.
Note! If downloading is stopped before downloading is ready, then there is no valid routine in the PLC.

Note! If there are troubles downloading a routine to the PLC, then there will be red indication text just below selected routine name. Then it has to be downloaded again until it’s successful.
Recipe handling

Recipe handling is a function where user recipes are copied into the PC. After that they can be seen in the Recipe-function.

User recipe has to be named as “New Recipe.txt” and has to reside in C:\Project\Recipe\User Recipe –directory, before it can be taken into use. First line in user recipe has to be “* Recipe RECIPENAME”, where RECIPENAME is the name of the new recipe.

By clicking User recipe –combo box, it will be shown below.

By clicking Move-button User recipe is copied into C:\Project\Recipe\Recipe –directory. If recipe with same name already exists, it will be replaced. File extension of the recipes are .txt.

By clicking Current recipes, all existing recipes are shown in Current recipes -combo box.

Current recipe can be deleted by selecting it in Current recipes -combo box and by pressing Delete-button.
This is a function, where other miscellaneous parameters can be changed.
8. Alarm

All alarms are shown in this function including date, time and alarm comment.

Alarm can be acknowledged by pressing ALARM ACK-button.

Alarm colours:
- Red - Alarm active, not yet acknowledged.
- Blue - Alarm disappeared, not yet acknowledged.
- Black - Alarm active, acknowledged.

After alarm has been acknowledged and it’s not active anymore, it disappears from the screen.
9. Screen saver

This is function, which comes up on the screen after inactivity timeout. It can be called on the screen by Screen saver-button, too.
10. **Print screen**

Hardcopy of the screen can be taken by Print Screen –button.