# **Freeway Exercise**

#### Solutions for OEMs, FreeStudio Thermostat exercise





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**Function Description** 

**Goal:** Describe thermostat flow chart









Programming

Goal:

- Familiarizing with programming environment
- Creating Thermostat Function Block



# **Creating New project**





# **Creating New project**



| No name - Eliwell Free Studio App | Ecation - [Welcome]  |   |     |
|-----------------------------------|--|---|-----|
| File Edit View Project On-        | line Debug Window Tools Options Help   |   | - 1 |
| 8 G G P P P & P M I               | N & N & L D P P P P P P P P P  |   |     |
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| 些国,可能利,自知力。                       | 业/ [高级指定] [2] [2]  |   |     |
| dinitions                         | 9 × 59 Welcome   |   |     |
| ₩ Definitions /                   | Wolcome to Ethwell Free Studio - Application     Image: |   |     |
| utsut.                            |  | # X Library                             |     |
| •), Build / Find in project ), [  | Debug /  | • [ • ]. Operator and standard blocks / |     |

#### **Creating New project**

|   | 0.0           |
|---|---------------|
|   | 2 / x         |
|   |               |
|   |               |
|   |               |
|   |               |
| Opput         # x         Linuxy           Preprocessing module TARGET completed,         #LABS         #DV         In/UN         IN/UN         IN/UN         IN/UN   |               |
| Preprocessing module TARGET completed.  | 9 ×           |
| Preprocessing module MAIN completed,<br>Preprocessing basic completed,<br>0 wernings, 0 errors.<br>Packer Bide Bide Bite Bise Bite Bite Bite Bite Bite Bite Bite Bit  |               |
| Al M. Operator and standard blocks / Terrativersibles \ Terrative |               |
| Rady FDIT MODE  | NOT CONNECTED |



#### **Programming environment**





# **Programming Languages**



The FREE STUDIO platform is compatible with all 5 standard programming languages (IEC 61131-3).



5 programming languages, 2 text-based and 3 graphics-based:

- ST, Structured Text, language text
- FBD, Functional Block Diagram language graphical
- LD, Ladder language graphical
- IL, Instruction List language text
- SFC, Sequential Function Chart language graphical



# Associating a program to a task



- For a program to run, it must be associated to a task.
- There are various types of tasks:
- BOOT Task runs once only at system start-up.
- Init. Task runs each time the application is downloaded and after **BOOT**.
- Timed. Task runs at regular intervals which can be set by the developer.

The default setting is 100ms.



- •Background. Task runs with low priority after the Timed tasks (between the end of one Timed task and the start of the next), it can be interrupted in case of long execution or executed more than 1 time in case short execution.
- Note Each new project has the main program associated to the background task (the main program can still be eliminated and/or associated to other tasks).
- To activate a task, go to the task you want, right-click and select Add program

#### Tasks



- BOOT Task runs once only at system start-up.
- Init. Task runs each time the application is downloaded and after BOOT.
- **Timed.** Task runs at regular intervals which can be set by the developer. The default setting is 100ms.
- •Background. Task runs with low priority after the Timed tasks (between the end of one Timed task and the start of the next).



#### Assigning program to the task





#### View FBD toolbar





## New function block creation





- 1. Right Click
- 2. New function block
- **3. Select the language**
- 4. Assign a name
- 5. Double click on the Hysteresis to open the editor related to the selected language.

Note: Try to create function if the block does not require static RAM, it will optimize the RAM usage

| New function blo | ck    |      |        | ×     |
|------------------|-------|------|--------|-------|
| Canguage         | © FBD | © LD | ● ST   | © SFC |
| Name<br>Hysteres | is    |      |        |       |
|                  | Ok    |      | Cancel |       |

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#### Insert record

Window Tools Developer Help

1

2



x

# Inside Hystersis FBD



| Local variables |            |     |                 |      |       |            |           |                  |  |
|-----------------|------------|-----|-----------------|------|-------|------------|-----------|------------------|--|
|                 | Class      | Pin | Name            | Туре | Array | Init value | Attribute | Description      |  |
| 1               | VAR_INPUT  | 0   | Temperature     | INT  | No    |            |           | Analogue Input 1 |  |
| 2               | VAR_INPUT  | 1   | Setpoint        | INT  | No    |            |           | Set point        |  |
| 3               | VAR_INPUT  | 2   | Differentiation | INT  | No    |            |           | Δ                |  |
| 4               | VAR_OUTPUT | 0   | Alarm           | BOOL | No    |            |           | Probe Alarm      |  |
| 5               | VAR_OUTPUT | 1   | Output          | BOOL | No    |            |           | Actuator         |  |

| 0001<br>0002<br>0003<br>0004 | <pre>(* Hystersis FBD *) if Temperature &gt;= Setpoint + Differ Output := TRUE;</pre> | rentiation then                 | Compile resu<br>as FBD used | ılt i<br>in | s va<br>the | lid as soo<br>program |
|------------------------------|---|---------------------------------|-----------------------------|-------------|-------------|-----------------------|
| 0005                         | end_if;   |                                 |                             |             |             |                       |
| 0006                         | if Temperature < Setpoint then  | Output                          |                             |             |             |                       |
| 0008                         | Output := FALSE;  | Free code space:                | 2F1E0h                      | (           | 188         | KByte)                |
| 0010<br>0011<br>0012         | (* Probe disconnection detector )   | Data space:<br>Free data space: | 8C0h<br>8ABh                | (<br>(      | 2<br>2      | KByte)<br>KByte)      |
| 0013                         | if Temperature = -32768 then  |                                 |                             |             |             |                       |
| 0014<br>0015<br>0016         | Alarm := TRUE;<br>else Alarm := FALSE;<br>end_if;                                     | O warnings, O ern               | rors.                       |             |             |                       |
| 0017<br>0018                 |   | ▲ ► Build Find in pro           | ject ) Debug ) Resource     | es /        |             | _                     |

## FBD in Background





# Set password for written FB



| Ap PLC - Eliwell Free Studio Application - C:\Electrical\Solution Archite   | Ap M171 exercise - Eliwell Free Studio Applicatio  | n - C:\Electrica                |
|---|--|---------------------------------|
| File Edit View Project On-line Debug Scheme Variab  | File Edit View Project On-line Deb   | ug Scheme                       |
|   | - i 💁 🔁 🕞 トロス 🏝 🛍 🖓 🖓  | 🖨 🖪 🗖                           |
| 「     「     「     」     「     」     「     」     「     」      」     」     」     」     」     」      」     」     」      」     』     』     』     』     』     』     』      』     』     』     』     』     』      』     』     』     』     』     』     』     』     』     』     』     』      』     』     』 | [], , * <\ : : : : : : : : : : : : : : : : : :   |                                 |
| Project        Project     Project  | Project # ×  | Resources                       |
| PLC Project Local variables   | B-@ M171 exercise Project  | Local variables                 |
| Programs     Name     Name  | 🕀 🦲 Programs   | Eocur vonuores                  |
| Hysteresis 1 Input_Temp   | Function blocks  | 1 Hysters                       |
| Functions   Global variab   Global shared   Tasks     Duplicate function block properties   Duplicate function block   Delete function block   Delete function block to library     Copy (name)   Crypt   Decrypt     Decrypt     Build Find  | Edit source<br>View Function block proper<br>Edit Function block proper<br>Edit Function block propert<br>Duplicate function block<br>Delete function block<br>Export function block to lib<br>Copy (name)<br>Crypt<br>Decrypt | rties<br>ties<br>rary<br>Ctrl+C |
| Get password Password: Confirm password: OK Cancel Unical Training   April 2014   Ai  | Get password  Password:  Confirm password: Confirm password: Cancel  | You o<br>to yo<br>inside        |

You can prevent access to your written codes inside of FBD by cript.

#### FBD toolbar...





- **1.** Connection
- 2. Watch
- 3. New block
- 4. Variable
- 5. Constant
- 6. Return
- 7. Jump
- 8. Comment
- 9. Increase number of pins
- **10. Decrease number of pins**
- 11. Display enable I/O pins
- **12. FBD properties**
- 13. View source

#### 11. The output will not update if En=False





#### **Cross Reference**





# Compile/Build

Compile

| Output   | ዋ ×                     |
|--|-------------------------|
|  | A                       |
| Preparing for PLC application download done.<br>Downloading file C:\Users\SESA94552\Thermostat New\Thermo<br>Booting PLC application done. | stat New.cod completed. |
| O warnings, O errors.  |                         |
|  | E                       |
| < III  | - F                     |
| LIN Build & Find in project & Debug & Resources /  |                         |
|  |                         |
| lutput   | <del>т</del> ×          |
| Generating program THERMOSTAT  | *                       |
| Generating program DISPLAYALARMLED   |                         |
| Generating program APPLICATIONMENU   |                         |
| Generating unresolved  |                         |
| ADDILEG.<br>THEDMOSTAT(19EB·HVSTEDSIS 00) - error 20008· ST =\ Invel   | id access to variable   |
| <u>metalosini (1915.misteksis_00)</u> elitel 60000. SI -> 11041  | in access to variable   |
| 0 warnings, 1 errors, Double click   | on the error to         |
|  |                         |
| refer to the er  | ror source              |
|  |                         |
| I. Build (Findiansia) Debug Descures (   |                         |

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# Chapter 3

#### Resources

#### Goal:

Defining the resources:

- Assigning physical Input/output
- EEPROM parameters
- Status variables
- Menu definition and navigation



# Physical I/O Mapping (Base Unit)...



|                          |    |      |                     |      |                      | Local I/O Mapping         |
|--------------------------|----|------|---------------------|------|----------------------|---------------------------|
| esources $+ \wedge$      | #  | Name | Variable            | Туре |                      | Description               |
|                          | 1  | AIL1 | Ambient_temperature | INT  | AIL1 analogue input  |                           |
| Madhua abiasta           | 2  | AILZ |                     | INT  | AILZ analogue input  |                           |
|                          | 3  | AIL3 |                     | INT  | AIL3 analogue input  |                           |
|                          | 4  | AIL4 | 141                 | INT  | AIL4 analogue input  |                           |
| Status variables         | 5  | AIL5 | •                   | INT  | AIL5 analogue input  |                           |
|                          | 6  | DIL1 |                     | BOOL | DIL1 digital input   |                           |
| Menu Pra                 | 7  | DIL2 |                     | BOOL | DIL2 digital input   |                           |
| Menu set                 | 8  | DIL3 |                     | BOOL | DIL3 digital input   | 2 I/O Manning definition: |
| E I/O Mapping 2          | 9  | DIL4 |                     | BOOL | DIL4 digital input   | 2. Vo mapping demittion.  |
|                          | 10 | DIL5 |                     | BOOL | DIL5 digital input   |                           |
| Extended                 | 11 | DIL6 |                     | BOOL | DIL6 digital input   | Local: Base I/O           |
| Remote 13                | 12 | DOL1 | Otput_Heating       | BOOL | DOL1 digital output  | Extend: Expansion         |
| Alarms                   | 13 | DOL2 | Alarm               | BOOL | DOL2 digital output  |                           |
| Help                     | 14 | DOL3 |                     | BOOL | DOL3 digital output  | Remote: Keyboard          |
|                          | 15 | DOL4 |                     | BOOL | DOL4 digital output  |                           |
|                          | 16 | DOL5 |                     | BOOL | DOL5 digital output  |                           |
| Project 🗠 Defini 🖽 Resou | 17 | DOL6 |                     | BOOL | DOL6 digital output  |                           |
|                          | 18 | AOL1 |                     | INT  | AOL1 analogue output |                           |
|                          | 19 | AOL2 |                     | INT  | AOL2 analogue output |                           |
| •                        | 20 | AOL3 |                     | INT  | AOL3 analogue output |                           |
|                          | 21 | AOL4 |                     | INT  | AOL4 analogue output |                           |
| Resources                | 22 | AOL5 |                     | INT  | AOL5 analogue output |                           |
|                          | 23 | TCL1 |                     | INT  | TCL1 analogue output |                           |

- 3. Local
- 4. Name variables

# ...Physical I/O Mapping (Base Unit)...



| Ap Thermostat Exercise rev.1 - Eliwell Free Studio Application - C:\Electrical\Solution Architect\Eliwell\Exercise\Thermostat Exercise\Restore\Thermostat Exercise |                                   |              |                                    |              |                      |                               |  |  |  |  |
|--|-----------------------------------|--------------|------------------------------------|--------------|----------------------|-------------------------------|--|--|--|--|
| 🔚 File Edit View Project On-line Debu  | ug V                              | Vindow Tools | Developer Help                     |              |                      |                               |  |  |  |  |
|  | <b>9</b>                          | 🕾 🖪 🖾        | a 🔊 🎘 🛜 🛱 🗊 🔳                      |              | ▶ !□ • ∞ お           | 동명 년 ] 법 타 타 [ 근 근 ] 道 @      |  |  |  |  |
|  |                                   | P 📬 🗄 🕂 ++   | 0          /   0   0   0  () () () | 5 (P (P (B ) | 🎬 🛗 🏥 😫 🗐 🗉          | = 昴♪♪彡/  쁆 陥 陥 昏  🗟 🖻 😂 窓     |  |  |  |  |
| Project 7 × Resources 7 Thermostat 💫 Global variables  |                                   |              |                                    |              |                      |                               |  |  |  |  |
| 🖃 🗃 Thermostat Exercise rev.1 Project 🦵  | Thermostat Exercise rev.1 Project |              |                                    |              |                      |                               |  |  |  |  |
| 🖶 💼 Programs   |                                   |              |                                    |              |                      | FreeSmart Local I/O Mapping   |  |  |  |  |
| 🖶 🚞 Function blocks  |                                   |              |                                    |              |                      | - · · ·                       |  |  |  |  |
| Eunctions  | #                                 | Name         | Variable                           | Туре         |                      | Description                   |  |  |  |  |
| 🗄 🛄 Global variables 🛛 📩 📘   | 1                                 | AIL1         | Ambient_temperature                | INT          | AIL1 analogue input  |                               |  |  |  |  |
| Global shared  | 2                                 | AIL2         |                                    | INT          | AIL2 analogue input  |                               |  |  |  |  |
|  | 3                                 | AIL3         |                                    | INT          | AIL3 analogue input  |                               |  |  |  |  |
| Appings  | 4                                 | AIL4         |                                    | INT          | AIL4 analogue input  |                               |  |  |  |  |
|  | 5                                 | AIL5         |                                    | INT          | AIL5 analogue input  | After saving the project, all |  |  |  |  |
|  | 6                                 | DIL1         |                                    | BOOL         | DIL1 digital input   | the defined recourses will    |  |  |  |  |
|  | 7                                 | DIL2         |                                    | BOOL         | DIL2 digital input   | the defined resources will    |  |  |  |  |
|  | 8                                 | DIL3         |                                    | BOOL         | DIL3 digital input   | be available under Global     |  |  |  |  |
|  | 9                                 | DIL4         |                                    | BOOL         | DIL4 digital input   | shared folder:                |  |  |  |  |
|  | 10                                | DIL5         |                                    | BOOL         | DIL5 digital input   |                               |  |  |  |  |
|  | 11                                | DIL6         |                                    | BOOL         | DIL6 digital input   | Mappings in case of I/O       |  |  |  |  |
|  | 12                                | DOL1         | Otput_Cooling                      | BOOL         | DOL1 digital output  |                               |  |  |  |  |
|  | 13                                | DOL2         | Alarm                              | BOOL         | DOL2 digital output  |                               |  |  |  |  |
|  | 14                                | DOL3         |                                    | BOOL         | DOL3 digital output  |                               |  |  |  |  |
|  | 15                                | DOL4         |                                    | BOOL         | DOL4 digital output  |                               |  |  |  |  |
|  | 16                                | DOL5         |                                    | BOOL         | DOL5 digital output  |                               |  |  |  |  |
|  | 17                                | DOL6         |                                    | BOOL         | DOL6 digital output  |                               |  |  |  |  |
| l l  | 18                                | AOL1         |                                    | INT          | AOL1 analogue output | t                             |  |  |  |  |
| l l  | 19                                | AOL2         |                                    | INT          | AOL2 analogue output | t                             |  |  |  |  |
|  | 20                                | AOL3         |                                    | INT          | AOL3 analogue output | t                             |  |  |  |  |
| F  | 21                                | AOL4         |                                    | INT          | AOL4 analogue output | t                             |  |  |  |  |
| F  | 22                                | AOL5         |                                    | INT          | AOL5 analogue output | -<br>t                        |  |  |  |  |
|  | 23                                | TCL1         |                                    | INT          | TCL1 analogue output | t                             |  |  |  |  |

# ...Physical I/O Mapping (Expansion)



## How to configure I/O types, range?



| Image: Continue to the contin the continue to the continue to the continue to the continue to | Image: Second continuation         Image: Second continuation         Build Configuration           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application to cate           Image: Second continuation         Image: Second continuation         Export application           Image: Second continuation         Image: Second continuation         Export application | alog<br>(小) 田樹(逾勤(小)) =<br>hysteresis         | 한한하노 <b>않성영역</b> (명명):<br>1866년년년(1991):<br>1966년년년(1991): | 2月11日日本 (1991日) (199100) (1991 |  |
|---|--|---|--|---|--|
| FreeSmart<br>FreeSmart<br>Status variables<br>Status variables<br>Status variables<br>Status variables<br>Status variables<br>Status variables<br>BIOS Parameters<br>BIOS Parameters<br>Menu Prg<br>Setting Menu<br>Setting Menu<br>Setting Menu<br>Setting Menu<br>Setting Menu<br>Setting Menu<br>Setting Menu<br>Help<br>Help  | Display<br>Fundamental<br>state display: Redisent Temperator<br>F1<br>F5<br>I<br>F5<br>I<br>F3<br>eliL/eli   | F2<br>F2<br>Esc<br>I<br>Prg<br>I<br>Set<br>F4 | FreeSmart Configuratio                                     | Drowse Export   |  |

#### 1. Menu Developer ► Open with free studio device

Note: BIOS parameters are also available on the installation manual

# Check FS Device parameters description...



| Project                    | 1       | 7 ×  |           |         |           |       |       |  |
|----------------------------|---------|------|-----------|---------|-----------|-------|-------|--|
| 🗊 Thermosta exercise rev.2 |         |      |           |         |           |       |       |  |
| E-FreeSmart                |         | _    |           |         |           |       |       |  |
| BIOS parameters            |         |      |           |         |           |       | Local |  |
| in Marameters              | Address | Name | Value     | Um      | Default   | Min   | Max   | Description                              |
|                            | 53304   | CL00 | 2=NTC     | num     | 2=NTC     | 0     | 8     | AIL1 analogue input type                 |
|                            | 53305   | CL01 | 2=NTC     | num     | 2=NTC     | 0     | 8     | AIL2 analogue input type                 |
| Pamoto                     | 53306   | CL02 | 2=NTC     | num     | 2=NTC     | 0     | 7     | AIL3 analogue input type                 |
|                            | 53307   | CL03 | 2=NTC     | num     | 2=NTC     | 0     | 7     | AIL4 analogue input type                 |
|                            | 53308   | CL04 | 2=NTC     | num     | 2=NTC     | 0     | 8     | AIL5 analogue input type                 |
|                            | 15649   | CL10 | 500       | °C/Bar  | 500       | -9999 | 9999  | AIL3 analogue input full scale value     |
| Extended                   | 15655   | CL11 | 0         | °C/Bar  | 0         | -9999 | 9999  | AIL3 analogue input start of scale value |
| Remote                     | 15650   | CL12 | 500       | °C/Bar  | 500       | -9999 | 9999  | AIL4 analogue input full scale value     |
| Protection Password        | 15656   | CL13 | 0         | °C/Bar  | 0         | -9999 | 9999  | AIL4 analogue input start of scale value |
| Application                | 53334   | CL20 | 0         | °C      | 0         | -120  | 120   | AIL1 analogue input differential         |
| Empes                      | 53335   | CL21 | 0         | °C      | 0         | -120  | 120   | AIL2 analogue input differential         |
|                            | 53336   | CL22 | 0         | °C/Bar  | 0         | -120  | 120   | AIL3 analogue input differential         |
|                            | 53337   | CL23 | 0         | °C/Bar  | 0         | -120  | 120   | AIL4 analogue input differential         |
|                            | 53338   | CL24 | 0         | °C      | 0         | -120  | 120   | AIL5 analogue input differential         |
|                            | 53344   | CL60 | 0=0-20mA  | num     | 0=0-20mA  | 0     | 2     | AOL5 analogue output type                |
|                            | 53346   | CL70 | 0=Disable | num     | 0=Disable | 0     | 2     | Enable TCL1 analogue output              |
|                            | 53347   | CL71 | 0=Disable | num     | 0=Disable | 0     | 2     | Enable AOL1 analogue output              |
|                            | 53348   | CL72 | 1=Enable  | num     | 1=Enable  | 0     | 2     | Enable AOL2 analogue output              |
|                            | 53349   | CL73 | 27        | Deg     | 27        | 0     | 90    | Phase shift TCL1 analogue output         |
|                            | 53350   | CL74 | 27        | Deg     | 27        | 0     | 90    | Phase shift AOL1 analogue output         |
|                            | 53351   | CL75 | 27        | Deg     | 27        | 0     | 90    | Phase shift AOL2 analogue output         |
|                            | 53352   | CL76 | 10        | 69 µsec | 10        | 5     | 40    | TCL1 analogue output pulse length        |
|                            | 53353   | CL77 | 10        | 69 µsec | 10        | 5     | 40    | AOL1 analogue output pulse length        |
|                            | 53354   | CL78 | 10        | 69 µsec | 10        | 5     | 40    | AOL2 analogue output pulse length        |

# ...and define the Application BIOS Default



## **EEPROM** parameters





|   | Add 📃   | Remove          | Recalc        |               |                  |               |     |     |       |        |      |        | 5              |             |      |
|---|---------|-----------------|---------------|---------------|------------------|---------------|-----|-----|-------|--------|------|--------|----------------|-------------|------|
| # | Address | Name            | Display label | Device type   | Application type | Default value | Min | Max | Scale | Offset | Unit | Format | AccessLevel    | Description | Note |
| 1 | 16384   | Setpoint        | SetP          | Signed 16-bit | INT              | 180           | 150 | 300 | 1     | 0      | °C   | XXX.Y  | Always visible |             |      |
| 2 | 16385   | Differentiation | Diff          | Signed 16-bit | INT              | 20            | 5   | 50  | 1     | 0      | °C   | XXX.Y  | Always visible |             |      |

# **EEPROM Properties**

|  |         |                 |               |               |                  |               | FreeSmart EEPROM Parameters |     |       |        |      |        |                |             |  |
|--|---------|-----------------|---------------|---------------|------------------|---------------|-----------------------------|-----|-------|--------|------|--------|----------------|-------------|--|
| -  | Add 🚦   | Remove          | Recalc        |               |                  |               |                             |     |       |        | 2    |        | 4              |             |  |
| #  | Address | Tvame           | Display label | Device type   | Application type | Default value | Min                         | Max | Scale | Offset | Unit | Format | AccessLevel    | Description |  |
| 1  | 16384   | Setpoint        | SetP          | Signed 16-bit | INT              | 180           | 150                         | 300 | 1     | 0      | °C   | XXX.Y  | Always visible |             |  |
| 2  | 16385   | Differentiation | Diff          | Signed 16-bit | INT              | 20            | 5                           | 50  | 1     | 0      | C    | XXX.Y  | Always visible |             |  |
| <ul> <li>Mesrage from webpage</li> <li>Image: State of the sta</li></ul> |         |                 |               |               |                  |               |                             |     |       |        |      |        |                |             |  |

#### Ар

#### **Status Variables**



34



#### Alarms





# Fundamental state display configuration




### Menu Program – Add Folder



- 1. Menu Prg.
- 2. Add Menu
- 3. New Menu, name it (Cfg)
- 4. 7 segment preview

### Menu Set – Add Folder





- 1. Menu Set, Right Click Add Menu
- 2. New Menu, name it (Setting Menu)
- 3. 7 segments preview

### Add/Remove elements to folder





### Add/Remove elements by drag & drop



| Resources          | <b>ч</b> × | F   | eeSmart 'Cfg' Menu  |
|--------------------|------------|---|---------------------|
| Configuration      |            | er e e e e e e e e e e e e e e e e e e    |                     |
| 🚊 🚛 FreeSmart      |            |   |                     |
| 🗄 📲 Modbus objects |            | # Name Description                        |                     |
| EEPROM Parameters  |            | 1 Setpoint                                |                     |
| Status variables   |            | 2 Differentiation                         |                     |
| - 🕅 Enums          |            |   |                     |
| BIOS Parameters    | Drog       |   |                     |
| - Menu Prg         | Drag       | J & Drop                                  |                     |
| Cfg                |            |   |                     |
| Menu set           |            |   |                     |
| R Setting Menu     |            | FreeSmart                                 | 'Setting Menu' Menu |
|                    |            | La |                     |
| Alarms             |            | Display label: Add Add Remove Down        |                     |
| A Help             |            | # Name Description                        |                     |
| - Tich             |            | 1 Setpoint                                |                     |
|                    |            | 2 Differentiation                         |                     |
|                    |            | 3 Ambient_Temperator                      |                     |

|   |                       |                 |               |               |                  | FreeSmar      | t EEPROM Param | ieters |       |        |        |                |
|---|-----------------------|-----------------|---------------|---------------|------------------|---------------|----------------|--------|-------|--------|--------|----------------|
|   | Add 🔚 Remove 📓 Recalc |                 |               |               |                  |               |                |        |       |        |        |                |
| # | Address               | Name            | Display label | Device type   | Application type | Default value | Min            | Max    | Scale | Offset | Format | AccessLevel    |
| 1 | 16384                 | Setpoint        | SetP          | Signed 16-bit | INT              | 180           | 150            | 300    | 1     | 0      | XXX.Y  | Always visible |
| 2 | 16385                 | Differentiation | Diff          | Signed 16-bit | INT              | 20            | 5              | 50     | 1     | 0      | XXX.Y  | Always visible |

### Menu Program – How to Access





### Menu Set – How to Access





### Menu architecture









## Using physical I/O





## System LED setting

2



LED reference for the developer

#### <del></del> <del>x</del> Resources 🗃 Configuration EreeSmart Modbus objects EEPROM Parameters Status variables 🔊 Enums BIOS Parameters 🖮 🖳 Menu Prg -- 🗈 Cfg - Menu set Setting Menu I/O Mapping 🗄 Local Extended 📑 Remote Alarms 🥭 Help



The IEC developer can turn on (either steady or blinking) and off the whole range of local display LEDs, by properly setting the array SYSLED.

| LED number | Symbol or icon | Description    | Off          | On (steady)  | On (blinking) |
|------------|----------------|----------------|--------------|--------------|---------------|
| 0          | :              | Colon          | SYSLED[0]=0  | SYSLED[0]=1  | SYSLED[0]=2   |
| 1          | %R.H.          | %RH            | SYSLED[1]=0  | SYSLED[1]=1  | SYSLED[1]=2   |
| 2          | *              | Defrost        | SYSLED[2]=0  | SYSLED[2]=1  | SYSLED[2]=2   |
| 3          | Bar            | Bar            | SYSLED[3]=0  | SYSLED[3]=1  | SYSLED[3]=2   |
| 4          | Ċ              | Stand-by       | SYSLED[4]=0  | SYSLED[4]=1  | SYSLED[4]=2   |
| 5          | °C             | °C             | SYSLED[5]=0  | SYSLED[5]=1  | SYSLED[5]=2   |
| 6          | 桊              | Cooling        | SYSLED[6]=0  | SYSLED[6]=1  | SYSLED[6]=2   |
| 7          | $\odot$        | Clock (RTC)    | SYSLED[7]=0  | SYSLED[7]=1  | SYSLED[7]=2   |
| 8          | 業              | Heating        | SYSLED[8]=0  | SYSLED[8]=1  | SYSLED[8]=2   |
| 9          | -              | User-defined 1 | SYSLED[9]=0  | SYSLED[9]=1  | SYSLED[9]=2   |
| 10         | -              | User-defined 2 | SYSLED[10]=0 | SYSLED[10]=1 | SYSLED[10]=2  |
| 11         | •              | User-defined 3 | SYSLED[11]=0 | SYSLED[11]=1 | SYSLED[11]=2  |
| 12         | •              | User-defined 4 | SYSLED[12]=0 | SYSLED[12]=1 | SYSLED[12]=2  |
| 13         | •              | User-defined 5 | SYSLED[13]=0 | SYSLED[13]=1 | SYSLED[13]=2  |
| 14         | -              | User-defined 6 | SYSLED[14]=0 | SYSLED[14]=1 | SYSLED[14]=2  |
| 15         | -              | User-defined 7 | SYSLED[15]=0 | SYSLED[15]=1 | SYSLED[15]=2  |
| 16         | $\wedge$       | Alarm          | SYSLED[16]=0 | SYSLED[16]=1 | SYSLED[16]=2  |
| 17         | ABC            | Menu           | SYSLED[17]=0 | SYSLED[17]=1 | SYSLED[17]=2  |
| 18         | Ô              | Economy        | SYSLED[18]=0 | SYSLED[18]=1 | SYSLED[18]=2  |

Some of the LEDs - for example, LED number 0, 1, 3, 5, and 7 (in green) - cannot be used by the IEC developer when BIOS menu is active.

## System local LED assigning









### Connecting dedicated LED's to the FBD





### Valorize Fundamental State Display



### Compile/Build



|  | •]  = 🎧 🖓 🖋 🖋 🎼 🌆 🛍 🔂 🔜  |
|--|--|
| Compile  |  |
| Output   | <b>д</b> х   |
| Preparing for PLC appli<br>Downloading file C:\Use<br>Booting PLC application<br>O warnings, O errors.                                     | cation download done.<br>ers\SESA94552\Thermostat New\Thermostat New.cod completed.<br>done.       |
|  | nong <u>Antesources</u>  |
| Generating program THE<br>Generating program DIS<br>Generating program APP<br>Generating unresolved<br>aborted.<br>THERMOSTAT(1\$FB:HYSTER | AMOSTAT<br>PLAYALARMLED<br>LICATIONMENU<br>SIS_00) - error G0008: ST => Invalid access to variable |
| O warnings, 1 errors.  | Double click on  |

Debug

Image: Image

Resources

-

the error to refer to

the error source

# Chapter 4

Simulation/Debugging – Part 1

### Goal:

Debugging created FB by different off-line simulation tools such as Watch or Oscilloscope



### Off line simulation mode







The state of communication is shown in a small box next to the right border of the **Status bar.** 

If you have not yet attempted to connect to the target, the state of communication is set to **Not connected.** 

### NOT CONNECTED

- When you try to connect to the target device, the state of communication becomes one of the following:
- -Error: the communication cannot be established. You should check both the physical link and the communication settings.

### ERROR

-Connected: the communication has been established





- Next to the communication status there is another small box which gives information about the status of the application currently executing on the target device.
- When the connection status is Connected, the application status takes on one of the following values.
- -No code: no application is executing on the target device.

### NO CODE

--Diff. code: the application currently executing on the target device is not the same as the one currently open in the IDE; moreover, no debug information consistent with the running application is available: thus, the values shown in the watch window or in the oscilloscope are not reliable and the debug mode cannot be activated.





--Diff. code, Symbols OK: the application currently executing on the target device is not the same as the one currently open in the IDE; however, some debug information consistent with the running application is available (for example, because that application has been previously downloaded to the target device from the same PC): the values shown in the watch window or in the oscilloscope are reliable, but the debug mode still cannot be activated.

### DIFF. CODE (SYM)

-Source OK: the application currently executing on the target device is the same as the one currently open in the IDE: the debug mode can be activated.

### SOURCE OK

### Assigning local variable to the FBD





## Debug mode/Changing values





## Watch configuration



| ſ        | Name<br>Hysteresis 00 | Type<br>Hysteresis | Address<br>Auto | Array | Init value | Attribute |    |           |    | independant  |
|----------|-----------------------|--------------------|-----------------|-------|------------|-----------|----|-----------|----|--------------|
| 2        | Input_Temp            | INT                | Auto            | No    |            |           | 11 |           |    | ive debug in |
|          |                       |                    |                 |       |            |           |    | Drag & Dr | on |              |
| Vat<br>P | ch<br>🍽   🕨 🖥 🚮       | ۶                  |                 |       |            |           |    |           | op |              |
| Sym      | nbol                  | Valu               | іе Ту           | pe    | Location   |           |    |           |    |              |
| B        | HYSTERESIS_00         | -                  | H.              |       | @BACKGRO   | UND       |    |           |    |              |
| -        | - TEMPERATURE         | 250                | IN              | Т     | @BACKGRO   | UND       |    |           |    |              |
| -        | - SETPOINT            | 180                | IN              | Т     | @BACKGRO   | UND       |    |           |    |              |
| -        | - DIFFERENTIATIO      | ON 20              | IN              | Т     | @BACKGRO   | UND       |    |           |    |              |
| -        | ALARM                 | FALS               | SE BO           | DOL   | @BACKGRO   | UND       |    |           |    |              |
|          |                       | TRU                | E BO            | OOL   | @BACKGRO   | UND       |    |           |    |              |

### Watch/ drag & drop







|   | Watch        |       |      |                        |  |  |  |  |
|---|--------------|-------|------|------------------------|--|--|--|--|
|   |              |       |      |                        |  |  |  |  |
| ~ | Symbol       | Value | Туре | Location               |  |  |  |  |
| 4 | - INPUT_TEMP | 0     | INT  | @BACKGROUND:THERMOSTAT |  |  |  |  |

## Watch Configuration/ST language



| 0001       (* Hystersis FBD *         0002       if Temperature >=         0003       if Temperature >=         0004       Output := TRUH         0005       end_if;         0006       Output := FALS         0008       Output := FALS         0009       end_if; | *)<br>Setpoint +<br>I;<br>Setpoint the<br>SE; | Differenti<br>en   | <ul> <li>ation then</li> <li>2</li> <li>1. Select the variale</li> <li>2. Double click</li> <li>3. Drag &amp; drop it directly to the watch properties</li> </ul>   |
|---|---|--|---|
| 0010         (* Probe disconned           0012         if Temperature = -           0013         if Temperature = -           0014         Alarm := TRUE           0015         else Alarm :=           0016         end_if;           0017         0018            | tion detec<br>32768 then<br>FALSE;            | 0001<br>0002<br>0003<br>0004<br>0005<br>0006<br>0007<br>0006<br>0007<br>0008<br>0009<br>0010<br>0011<br>0012<br>0013<br>0014<br>0015<br>0014 | <pre>(* Hystersis FBD *) if Temperature &gt;= Setpoint + Differentiation then     Output := TRUE; end_if; if Temperature &lt; Setpoint then     Output := FALSE; end_if; if Temperature = -32768 then Alarm := TRUE; else Alarm := FALSE; end_if;</pre> |
| Watch   |   |  |   |
| 🖉 🚳 🕨 🖪 🖬 😫 🗡   |   |  |   |
| Symbol  | Value   | Туре   | Location  |
| — HYSTERESIS_00.TEMPERATURE   | 0   | INT  | @BACKGROUND:THERMOSTAT  |

### Oscilloscope



View ► Tool windows ► Async graphic windows ► 👼

|  | 5 | 1 🗊   📰 |
|--|---|---------|
|--|---|---------|



## Assigning variable to the oscilloscope



## Assigning variable to the oscilloscope









When you add a variable to the Oscilloscope, data acquisition begins immediately.

However, you can suspend the acquisition by clicking on **Pause acquisition.** The curve freezes (while the process of data acquisition is still running in background), until you click on **Restart acquisition.** 

In order to stop the acquisition you may click on Stop acquisition.

In this case, when you click on **Restart acquisition, the evolution of the** value of the variable is plotted from scratch.

### Oscilloscope tools/ Vertical split





- 1.Selected track's vertical show all
- 2. Horizental show all
- 3. Show all values
- 4. When you are watching the evolution of two or more variables, you may want to split the respective tracks.
- 5. The tool highlights the single values detected during data acquisition.
- You can click on the same item again, in order to go back to the default view mode.
- 6. The Oscilloscope includes two measure bars, which can be exploited to take some measures on the chart.









When you open the Oscilloscope, Application applies a default scale to the axes. However, if you want to set a different scale, you may follow this procedure:

1) Open the graph properties 2) Set the scale of the horizontal axis & sampling polling rate 3) Specify a distinct scale for the vertical axis.

4) Confirm your settings.

| cilloscope settings  |                |             | ? >     |           |
|----------------------|----------------|-------------|---------|-----------|
| Show grid 🛛 🕅        | Sample polling | grate 20    | ms      | Real rate |
| Show time bar 🛛 📝    | Horizontal sca | le 5000     | ms/di∨  | 20.00     |
| Show tracks list 🛛 📝 | Buffer size    | 40000       | samples |           |
|                      |                | Fracks list |         | 3         |
| Name                 | Unit           | Value/div   | Offset  | Hide      |
| @BACKGROUND:TH       | ERMC           | 1           | 0       |           |
| @BACKGROUND:TH       | ERMC           | 1           | U       |           |
| @BACKGROUND:TH       | ERMC           | 1           | 0       |           |
| @BACKGROUND:TH       | ERMC           | 1           | 0       |           |
| @BACKGROUND:TH       | ERMC           | 1           | 0       |           |
|                      |                |             |         |           |
|                      |                |             |         |           |
|                      |                |             |         | _ ا       |
|                      |                |             |         |           |
|                      | (              | Cancel      | Apply   | ОК        |

### Oscilloscope/export



Oscilloscope **Ψ**× 🛅 🖻 | 🕀 | 🛠 🎗 🖃 | 🛠 🎗 🗊 | 🔳 🕨 💽 🖆 🎒 Ap Save As - 22 - G 🕸 📂 🗔 -Deskto Save in: 1. Save icon 23 2. Name & format defining Recent Places Libraries Aidin Network Desktop Aliyarzade. -OSC: simple plain-text file, containing Desktop time and value of each sample 1400 Launch free -OSCX: XML file, that includes more Libraries Studio complete information **Available formats** Computer 2 3. Open it via Excel (OSCX) (îi Network Oscilloscope XML files (\*.OSCX) Themostat OSCX Save File name: Oscilloscope files (\*.OSC) Save as type Osciloscope XML files (".OSCX) Cancel All files (\*.\*)

|    | А           | В                     | C                                |                        | D   | E           | F           | G       | Н                      |          | J           |
|----|-------------|-----------------------|----------------------------------|------------------------|-----|-------------|-------------|---------|------------------------|----------|-------------|
| 1  | hscale 🛛 💌  | triggerpos 🛛 🔽        | name                             | 💽 ur                   | m 💌 | vscale 💿 💌  | offset 🛛 🔽  | color 💽 | note 💌                 | sample 💌 | time 🔽      |
| 2  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870186   |
| 3  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870205.9 |
| 4  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870226.2 |
| 5  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870246.1 |
| 6  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870266.2 |
| 7  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870286.2 |
| 8  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE | $\int^{}$              | ٦   | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870306.1 |
| 9  | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE | $\mathbf{S}\mathbf{B}$ |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870326   |
| 10 | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870346.1 |
| 11 | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870366   |
| 12 | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870386.2 |
| 13 | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870406.1 |
| 14 | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870426.2 |
| 15 | 55536.85563 | 1.79769313486232E+308 | @BACKGROUND:THERMOSTAT.NTC_PROBE |                        |     | 25323.57143 | 111271.0714 | 65535   | @BACKGROUND:THERMOSTAT | 0        | 232870445.9 |

# Chapter 5

**Simulation and Debugging – Part 2** 

### Goal:

On-Line simulation mode, testing of:

- Physical I/O
- 7 segment display



## Off line simulation mode





### **Simulation tools**





Active code execution
 Show I/O panels
 Show HMI window

| Digital Inputs |  |
|----------------|--|
|                |  |
|                |  |
| DIL3           |  |
| DIL4           |  |
| DIL5           |  |
| DIL6           |  |
|                |  |

| Π | Analogue Inputs |            | × |
|---|-----------------|------------|---|
|   | I AIL1          |            | 0 |
|   | AIL2            |            | 0 |
|   | AIL3            | — <u> </u> | 0 |
|   | II AIL4         |            | 0 |
|   | AIL5            |            | 0 |
|   |                 |            |   |



| Digital Outputs | Analogue Outputs | 8 |
|-----------------|------------------|---|
| 🗉 DOL1 🖉        |                  |   |
| 🔲 DOL2 🥥        | AOL2 0           |   |
| 🗉 DOL3 🥥        | AOL3 0           |   |
| 🗉 DOL4 🥥        | AOL4 0           |   |
| 🗉 DOL5 🥥        | AOL5 0           |   |
| 🔳 DOL6 🥥        |                  |   |
|                 |                  |   |
|                 |                  |   |

### **Open Free Studio Device from Application**



|   | 18189<br>18189  | Build Configuration<br>Export application to catalog | 리미터 (미호퍼)에 = 타타라<br>(에) (開始) (해) (해) (해) (해) (해) (해) (해) (해) (해) (해 | 「「舞藝後聞」回回「い姓」を有多単しののママ国の   |  |
|---|---|--|---|--|--|
| Resources       # ×         Configuration       FreeSmart         Image: Status variables       Image: Status variables         Image: Status variables       < | Display       Fundamental<br>state display:       F1       F2   Data export<br>Select XSLT export filter: |  | Hysteresis Fr F2 Data export Select XSLT export filter:             | PeeSmart Configuration  Execution time Set execution time: Execution time (ms): 100  Browse Export |  |
|   | I<br>F5<br>F3   | ① ② ③ ④ ⑤ ⑥ ⑦<br>eli⊾~ell                            | 1. Deve   | eloper ► Open with Free Studio Device  |  |

### Free Studio Device (Simulation Target)



| Thermostat Exercise rev.1.CFN - Eliwell Free Stu  | dio Device   |             |                             | • ×        |
|---|--|-------------|-----------------------------|------------|
| File Edit View Parameters Recipes Option  | is Help  |             |                             | _          |
| 🗋 🥔 🗐 🕄 🖓 🛄   R W 🗗 Lj  |  |             |                             |            |
| Project # 1   |  | Catalog     |                             | <b>a</b> 3 |
| Thermostat Exercise rev.1   | FreeSmart 412 Configuration  | Device name | Version Maxversi Descriptio | an         |
| Internostat Exercise rev1     I | General         Name:       FreeSmart         Me version:       412.15         Communication       Settings         Address:       127.0.0.1         Obsable communication       Obsable communication         Part:       TCPSP-5000         Baud rate:       Obsable communication         F1       TCPSP-5000         Part:       TCPSP-5000         Baud rate:       Disable communication         Status:       NOT CONNECTED         F1       Free         F2       Esc         I       Prg         I       Status:         NOT CONNECTED       Free ware version: |             |                             | •          |
| nnect to the tar<br>te: Free Studio   | get ► Connected feedback Device does not download the code in Simulation or cotting EEPROM parameters and check Status   | n, it       |                             | 3          |

С

N
### Read / Write Values



| Address | Name            | Value | Um | Default | Min   | Max   | Description |
|---------|-----------------|-------|----|---------|-------|-------|-------------|
| 6384    | Setpoint        | 180.0 | °C | 180.0   | 150.0 | 300.0 |             |
| 6385    | Differentiation | 20.0  | °C | 20.0    | 5.0   | 50.0  |             |

# **Menu Navigation**







# **Menu Navigation**







# Setting the setpoint





# Setting the differentiation













Out of range message Only can disply: - 99.9.....999.9 Free Studio Device does not write default values

# Testing program/applying values



Setpoint=26.0, Differentiation=10.0 & Ambient\_Tempereature =37.0
 ⇒ DOL1= ON & ☆ = ON

- Setpoint=26.0, Differentiation=10.0 & Ambient\_Tempereature =25.0
   ⇒ DOL1= OFF & ☆ = OFF
- Setpoint=26.0, Differentiation=10.0 & 26.0<Ambient\_Tempereature<36.0</li>
   ⇒ DOL1= ON & ☆ = ON
- Ambient\_Tempereature =-32768
   > DOL1= OFF , 🔅 = OFF & DOL2= ON (probe disconnection alarm= ON)



- Application is the programming starting point.
- Device is used to download the overall compiled project and it is the only tool able to write EEPROM parameters.
- From Application it will always be possible to open Device directly without having to launch the program using the FREE Studio icon.





**Connection to Smart** 

**Goal:** DMI interface driver installation and connect to the target





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# DMI interface setup WIN 7



• As soon as the DM interface is connected, the Windows 7 operating system recognizes the newly connected hardware. The steps to be followed are described below.

**Note: Connection procedure:** 

Connection: first USB then TTL

**Disconnection:** first TTL then USB

1.Once the hardware is connected, the message shown in the figure will appear:



Click on the message to start the Guided installation procedure Or you can manualy find it at:

Control Panel > All Control Panel Items > System

### Device manager ► other devices ►

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# Update driver software



2. The screen shown below will appear: select the second option to identify the driver

| + | Search automatically for updated driver software<br>Windows will search your computer and the Internet for the latest driver software<br>for your device, unless you've disabled this feature in your device installation<br>settings. |
|---|--|
| • | Browse my computer for driver software<br>Locate and install driver software manually.   |
|   |  |

3. In the next screen, select the installation path for the FREE Studio program. Unless changed during installation, the path will be as shown in the next figure.

# Update driver software



# 4. Once you have selected the correct path, the screen shown below will appear: select **Install this driver software anyway**

|  | Windows Security  |
|--|---|
| G I Update Driver Software - AVR USB CDC DEMO  | Windows can't verify the publisher of this driver software  |
| Browse for driver software on your computer<br>Search for driver software in this location:  | Don't install this driver software<br>You should check your manufacturer's website for updated driver software<br>for your device.  |
| <ul> <li>Computer → Windows (C:) → Program Files (x86) → Eliwell → free Studio</li> <li>Browse</li> <li>Include subfolders</li> </ul>  | <ul> <li>Install this driver software anyway</li> <li>Only install driver software obtained from your manufacturer's website or disc. Unsigned software from other sources may harm your computer or steal information.</li> <li>See details</li> </ul> |
| Let me pick from a list of device drivers on my computer<br>This list will show installed driver software compatible with the device, and all driver<br>software in the same category as the device. |   |
| Next Cancel  |   |

# Update driver software



5. The screen shown below will appear, indicating that the action has been performed.



6. On completion of the process, the screen shown below will appear, then close.



# **DMI** Test via FS Device



To check correct installation of the driver and the port to which the hardware has been allocated, check the Windows screens shown below:



# **Connection to Smart**



To download the IEC applications of **Studio from the personal computer to the Smart target device**,



# Note: in "Direct", Smart must not be connected to earth

- it can switch on Smart without external power supply

# **Connection to Smart**

### Smart

### **Preliminary operations**

In order to download the application correctly:

- 1. connect the DMI hardware interface to the PC.
- 2. Make sure that the driver is installed

### Press **Settings**

The COM port must previously have been read/set in "Peripherals Management" (see Reading the DMI interface COM port) to be recognized. If there are errors, refer to the paragraph "DMI interface connection error".

the COM settings must be set on all of the workspaces: Application, Device and User Interface



| -General      |         |          |
|---------------|---------|----------|
| Name: Fro     | eeSmart |          |
| File version: | 412.15  |          |
| - Communicat  | ion     |          |
| Protocol:     | EwDMI   | Settings |
| Address:      | 1       |          |
| Port:         | COM:5   |          |
| Baud rate:    | 38400   |          |
|               |         |          |





# **Protocol Configuration**



- For Smart select EWDMI or Modbus\*. If the protocol is not activated press the Activate button
- The value selected for the COM port will be saved and will reappear each time the program is accessed, until it is changed.
- The properties are visible and can be edited from the panel Communication
   > Settings > Properties\*\*

| DMI Configuration v10.0.28.0 | 2       |
|------------------------------|---------|
| Protocol settings ——         |         |
| Port                         | COM13 💌 |
| Baudrate                     | 38400 💌 |
| Frame settings               | E,8,1   |
| Protocol settings            |         |
| Address                      | 1       |
| Timeout                      | 1000    |
| ОК                           | Cancel  |

\* in the case of Modbus for /S models only with maximum speed 19200 baud. TTL not for use. NOT POSSIBLE TO UPDate the BIOS.
\*\* obviously, the protocol must be activated beforehand

Address:1, Baud rate: 9600 E,8,1 (CF30=1, CF31=3, CF32=1)



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Error opening serial port

If the "Error opening serial port" message appears, proceed as follows:

1.Check that the COM port setting in the program is the same as one read in the COM port reading by the DMI interface.

2. Check if Com Server is opened when you try to connect to Evolution. If not disconnect TTL cable, USB port and reconnect first USB and then TTL.



3. Repeat the DMI Detection function.



# Parameters needed for correct connection between the **Smart target and Free Studio.**

| parameter     | description   | values   | default                                      | visibility  | notes  |  |  |  |
|---------------|---|--|--|---|--|--|--|--|
| CF30          | Modbus protocol controller<br>address                               | 1255   | 1  | 3   |  |  |  |  |
| CF31**        | Modbus protocol baud rate   | 0,1,2 = not used<br>3 = 9600 baud<br>4 = 19200 baud<br>5 = 38400 baud<br>6 = 57600 baud<br>7 = 115200 baud | 3  | 3   | Check that the set<br>values correspond to<br>those defined by the<br>panel<br><b>Communication &gt;</b> |  |  |  |
| CF32          | Modbus protocol controller<br>parity                                | 1= EVEN<br>2 = NONE<br>3 = ODD   | 1  | 3   | Settings > Properties  |  |  |  |
| *COM1 = TTL / | *COM1 = TTL / RS485 (/S models only): cannot be used simultaneously |  |  |   |  |  |  |  |
| **CF31        |   |  | 5=38400 baud<br>6=57600 baud<br>7=115200 bau | d (RS485: not support<br>d (RS485: non suppor<br>ud (RS485: non suppo | ed)<br>ted)<br>orted)  |  |  |  |



Smart parameters in the CF folder manages the connection between the target and Studio If the target is "empty", i.e. there is no IEC application on the device, Smart will display the message FrEE, otherwise fundamental state is displayed (Press F5 to switch to FrEE menu)



To view the parameter menu, press the Esc and Set keys at the same time. This will open the PAr menu.



The parameters menu PAr contains all controller folders. Press the set key to view folders.



The first folder shown is the CF configuration folder. Press the set key to view the folder parameters.



The first parameter shown is CF30. To view the value of the parameter press the set key.



Use the UP and DOWN keys to change the value if necessary. To confirm the value press the set key. To exit press Esc



Use the UP and DOWN keys to scroll the other parameters and repeat the procedure to view the values and if necessary - edit them.

### Customize Smart Baud Rate by FS Device





#### **Only After Connection has been estabilished:**

1. Project ► BIOS parameters ► All parameters ► Configuration 2. CF31 editing ► 38400 bits/Sec.

Protocol parameters are loaded at power up, remember to switch off controller after changing them.

|         | configuration |            |     |           |     |       |                                     |  |
|---------|---------------|------------|-----|-----------|-----|-------|-------------------------------------|--|
| Address | Name          | Value      | Um  | Default   | Min | Max   | Description                         |  |
| 53265   | CF01          | 1          | num | 1         | 0   | 1     | Select COM1 protocol                |  |
| 53272   | CF20          | 0          | num | 0         | 0   | 14    | Eliwell protocol controller address |  |
| 53273   | CF21          | 0          | num | 0         | 0   | 14    | Eliwell protocol controller family  |  |
| 53274   | CF30          | 1          | num | 1         | 1   | 255   | Modbus protocol controller address  |  |
| 53275   | CF31          | 5=38400 💌  | num | 3=9600    | 0   | 7     | Modbus baud rate protocol           |  |
| 53276   | CF32          | 1=2400 🔺   | num | 1=Even    | 1   | 3     | Modbus parity protocol              |  |
| 15639   | CF60          | 2=4800     | num | 0         | 0   | 999   | Customer code 1                     |  |
| 15640   | CF61          | 4=19200 =  | num | 0         | 0   | 999   | Customer code 2                     |  |
| 53456   | CF50          | 5=38400    | num | 1=Present | 0   | 1     | RTC present                         |  |
| 15715   | Ui26          | 6=57600    | 4ms | 350       | 0   | 999   | Key hold time to enable function    |  |
| 15744   | Ui27          | 7=115200 * | num | 1         | 0   | 255   | Installation engineer password      |  |
| 15745   | Ui28          | 2          | num | 2         | 0   | 255   | Manufacturer password               |  |
| 15636   | Par_POLI      | 1026       | num | 0         | 0   | 65535 | Polycarbonate code                  |  |

#### Configuration

## Free Studio Device - Main icons



| File Edit View Parameters Recipes Options   |   |          |  |
|---|---|----------|--|
| Project R W 1 40<br>Project X X<br>Thermostat Exercise rev.1<br>FreeSmatt<br>FreeSmatt<br>Configuration<br>- Configuration<br>- Configuration<br>- Configuration<br>- Configuration<br>- Configuration<br>- Configuration<br>- Configuration  | General          General         Name:       FreeSmart         File version:       412.15                     | FreeSma  | <ol> <li>Continuous read/write by toggle auto<br/>refresh mode. As soon as value changes,<br/>it will automatically aligne with the target.</li> <li>Select all variables</li> <li>Read all device parameters</li> </ol> |
| Contraction     Contraction | Communication       Protocol:     EwDMI       Address:     1       Port:     COM:13       Baud rate:     9600 | Settings | <ul> <li>4. Write all device parameter</li> <li>5. Download all (PLC &amp; parameter)</li> <li>6. It is possible to check the firmware version via information.</li> </ul>   |
| Recipes   | F1 $F5$ $F3$ $F1$ $F1$ $F1$ $F3$ $F3$ $F1$ $F3$ $F3$ $F3$   | free F2  | Information<br>Status: CONNECTED 6   |

## Free Studio Device - Colors





|         |      |       |    | Local   |     |     |                      |
|---------|------|-------|----|---------|-----|-----|----------------------|
| Address | Name | Value | Um | Default | Min | Мах |                      |
| 8336    | AIL1 | 0.0   |    | 0.0     |     |     | AIL1 analogue input  |
| 8337    | AIL2 | 0.0   |    | 0.0     |     |     | AIL2 analogue input  |
| 8338    | AIL3 | 0.0   |    | 0.0     |     |     | AIL3 analogue input  |
| 8339    | AIL4 | 0.0   |    | 0.0     |     |     | AIL4 analogue input  |
| 8340    | AIL5 | 0.0   |    | 0.0     |     |     | AIL5 analogue input  |
| 8192    | DIL1 | False |    | False   |     |     | DIL1 digital input   |
| 8193    | DIL2 | False |    | False   |     |     | DIL2 digital input   |
| 8194    | DIL3 | False |    | False   |     |     | DIL3 digital input   |
| 8195    | DIL4 | False |    | False   |     |     | DIL4 digital input   |
| 8196    | DIL5 | False |    | False   |     |     | DIL5 digital input   |
| 8197    | DIL6 | False |    | False   |     |     | DIL6 digital input   |
| 8528    | DOL1 | False |    | False   |     |     | DOL1 digital output  |
| 8529    | DOL2 | False |    | False   |     |     | DOL2 digital output  |
| 8530    | DOL3 | False |    | False   |     |     | DOL3 digital output  |
| 8531    | DOL4 | False |    | False   |     |     | DOL4 digital output  |
| 8532    | DOL5 | False |    | False   |     |     | DOL5 digital output  |
| 8533    | DOL6 | False |    | False   |     |     | DOL6 digital output  |
| 8448    | AOL1 | 0.0   |    | 0.0     |     |     | AOL1 analogue output |
| 8449    | AOL2 | 0.0   |    | 0.0     |     |     | AOL2 analogue output |
| 8450    | AOL3 | 0.0   |    | 0.0     |     |     | AOL3 analogue output |
| 8451    | AOL4 | 0.0   |    | 0.0     |     |     | AOL4 analogue output |
| 8452    | AOL5 | 0.0   |    | 0.0     |     |     | AOL5 analogue output |
| 8453    | TCL1 | 0.0   |    | 0.0     |     |     | TCL1 analogue output |

soon as you change them. Color meanings: **Red**: not aligned with the target Grey: read only data **Blue:** value is different from default **Green**: data is not visible in the target **Black**: aligned with the target (if auto referesh is enabled)

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# Connect to the target and Download All



| Thermostat Exercise rev. Structure<br>File Edit View Parameters uper Options  | C Ⅲ   R ₩ ()Ĵ 4()   [].   | <b>7 9 8</b>            | EWDevice                         |                        |
|---|---|-------------------------|----------------------------------|------------------------|
| Project 7 ×<br>Thermostat Exercise rev.1<br>FreeSmart<br>H BIOS parameters<br>H BIOS parameters<br>Configuration<br>Local | General<br>Name: FreeSmart  | nfiguration             | Are you sure you wa              | nt to download ALL ?   |
| Extended     Remote     I/O Values     Local     Extended     Protection Password     Application                         | File version:     412.15       Communication  | EWDevice                | 2                                | K Cancel               |
| Cfg<br>Cfg<br>Setting Menu<br>Recipes   | Baudrate: 38400   | Stotusi<br>Firmvare ver | Download parameters default valu | ies into 'FreeSmart' ? |
| <ol> <li>Download All</li> <li>Write the default<br/>parameter values</li> </ol>  | $ \begin{array}{c} I \\ F_{5} \\ I \\ F_{7} $ | 43                      | 0                                | Cancel                 |
| 4. DMI Blink:<br>Communicating  | -Firmware management<br>BIOS download<br>Create firmware file   |                         | 4                                |                        |

# Editing value





# Oscilloscope





# Oscilloscope





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# Oscilloscope



# Debug on-line/Watch





| Otput_Heating       Symbol       Value       Type       Location         Debug windows   | ŤÂ |
|--|----|
| Debug windows       Int global         Watch       Int global         Oscilloscope       Int global         Image: Alarm of the second seco | _  |
| Watch       Oscilloscope       OUTPUT_HEATING       TRUE       BOOL       global         - ALARM       FALSE       BOOL       global         - SETPOINT       18       INT       @BACKGROUND:THERMOSTAT         - DIFFERENTIATION       2       INT       @BACKGROUND:THERMOSTAT   |    |
| Oscilloscope FALSE BOOL global<br>- SETPOINT 18 INT @BACKGROUND:THERMOSTAT<br>- DIFFERENTIATION 2 INT @BACKGROUND:THERMOSTAT   |    |
| - SETPOINT         18         INT         @BACKGROUND:THERMOSTAT           - DIFFERENTIATION         2         INT         @BACKGROUND:THERMOSTAT  |    |
| - DIFFERENTIATION 2 INT @BACKGROUND:THERMOSTAT   |    |
|  |    |
|  |    |
|  |    |
|  |    |

# Chapter 7

**Target conversion and code import** 

**Goal:** Reuse of existing code and libraries



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# Convert project from Smart to Evolution



| File     Edit     View     Project       Image: Configuration     Image: Configuration     Image: Configuration       Image: FreeSmart     Image: Configuration       Image: FreeSmart     Image: Configuration                      | On-line     Debug     Window     Tools     Developer       w object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object     Image: State object     Image: State object     Image: State object     Image: State object       Index object<   | Help<br>副圖論用品語目目的 中 与話話常習言<br>[小(() (> (> (> (> (> (> (> (> (> (> (> (> (>              | <ol> <li>1. Project ► Select target</li> <li>2. Free evolution EVD*</li> <li>3. Change</li> <li>4. Save the project</li> </ol>                                |
|--|---|---|---|
| EEPROM NO Obj     Status va     Enums     Enums     BIOS Par     BIOS Par     BIOS Par     Menu Prg     Cfg     Menu set     Setting N     Et Local     Et Local     Et Extended     BE Remote     Alarms     Alarms     Ref     Opt | ect Browser<br>mple F7<br>comple all<br>nerate redistributable source module<br>port object from library<br>tort object from library<br>rary manager<br>fresh all libraries<br>cros<br>ect target<br>fresh current target<br>bons<br>(1 ② ③ ④   | Sele<br>F2<br>F2<br>F2<br>F<br>F<br>F<br>F<br>F<br>F<br>F<br>F<br>F<br>F<br>F<br>F<br>F | Available Targets  FreeEvolution EVC 477.18  FreeEvolution EVC 423.18 FreeEvolution EVP 489.11 FreeSmart 412.15 FreeSmart Modbus Master 542.1  Cancel  Change |
| By target co<br>to reuse   | F3 elicell<br>Execution time<br>Set execution time:<br>Execution time (ms): 100<br>Execution time (ms): 100 | F4  | Eliwell Free Studio Application   |

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# Converted project from Smart to Evolution



- 0 × 📅 Thermosta exercise rev.2 - Eliwell Free Studio Application - CAElectrical/Solution Architect/Eliwell/Exercise/Thermostat Exercise/rev.2/Thermosta exercise rev File Edit View Project On-line Debug Window Tools Developer Help - # 3 X 5 Resources \* Watch Project ⇒ I Thermosta exercise rev 2 Proje 四形 \*\* 劉劉圖 \* Programs FreeEvolution Configuration Symbol Value Type Location Thermostat Function blocks Hystoresis Eurotions 2 -11111 1111111 🖶 🧮 Global variables. Automatic variables 22222 Conversion between Evolution to Smart is Mapped variables Constants Retain variables not fully supported (all resources are Global shared d- Alarms deleted). TempProbeError - Meppings INTC\_Probe M Output Heating br Alarm - Parameters \*\*\*\*\* ...... C Setpoint -111111 ........... Differentiation - Veriables Ambient\_Temperator Oscilloscope Tosks -Execution time 日回用[\$\$\$E]\$\$日|■■ ■ ■ @ @ @ - Timed Background Set execution time: -12 Execution time (ms): - Boot - O Init -Data export-Select XSLT export filter: Browse Export Library # X Track Lim. Min value Max value Curvelue w/div Red cursor Output MABS 7 NOT >> SHR Preprocessing module TARGET completed. 28hCOSH IN LN Preprocessing module MAIN completed. KIACOB €DV MaLOG. LOR: WISN. Preprocessing Global shared completed. + ADD = E0 < LT SPOW. MISINH Preprocessing Menu completed. 7 ADR e DP MMAX 10 R HI SIZEC Preprocessing basic completed, 8 AND FLOOR **MMN** CHART SORT ZIASIN & GE \$MOD WROL - SUB O warnings, O errors. **KIATAN** > GT ET MOVE MROR ZITAN be TANH KATAN2 HM JMP XMUL CPIS | PICEL € LE NMAX SEL SEL + TO B VICOS. RUMT # NE < SHL TO D Project /wo Definity... (Billesour... / + ) Build (Find in project ) Dabug ) Resources + + Operator and standard blocks ( Target variables | Target blocks ) basic ; EDIT MODE NOT CONNECTED

Ready

# Import Objects from library (or Project)



| Roject  |                         | New object<br>Copy Object<br>Paste object<br>Duplicate object                                      | ,        | ]D4 @ 1월 1월 부 등 등 등 1월  |
|---|-------------------------|--|----------|---|
| Programs  | er<br>X                 | Delete object<br>PLC Object properties<br>Object Browser   | At+Enter | FreeEvolution Configuration   |
| Function bli<br>Functions<br>Global vari<br>Global sha<br>Global sh | 19<br>19                | Compile<br>Recompile all<br>Generate redistributable source module                                 | F7       | Image: Set execution time         Image: Set execution time |
|   | d<br>grc : 10<br>ain 40 | Import object from library<br>Export object to library<br>Library manager<br>Refresh all libraries | ,        | Data export Select XSLT export filter:  |
|   |                         | Select target<br>Refresh current target<br>Options   |          | Both directions, upgrade & downgrade are possible, from: Smart ► Evolution  |

It allows also to import programs, FB, functions from other projects regardless the related target.

# Import Objects from Project...



х

3

Name B Hys

< III.

Select all

mport objects

Cancel

Enable merge meth

| Look in:       | 🐌 Thermostat       | exercise rev.0                | - 🕝 🌶 📂 🖽         |             | <ul> <li>Objects filter</li> </ul> |                    |
|----------------|--------------------|-------------------------------|-------------------|-------------|------------------------------------|--------------------|
| (Ca            | Name               | *                             | Date modified     | Туре        | <u>▼</u> Programs                  | Ope <u>r</u> ators |
| Percent Discor | Ap thermosta       | t exercise rev.0.ppjs         | 09/05/2014 1:35 P | M PPJS File | Function Blocks                    |                    |
| Necent Places  |                    |                               |                   |             | ✓ <u>F</u> unctions                | Standard function  |
|                |                    | 12                            |                   |             | ✓ariables                          | Local variables    |
| Desktop        |                    | •                             |                   |             | <u> </u>                           | Basic types        |
| Libraries      |                    |                               |                   |             | Check <u>a</u> ll                  | Check <u>n</u> one |
|                |                    |                               |                   |             | Other filters                      |                    |
|                |                    |                               |                   |             | Name *                             |                    |
| Computer       |                    |                               |                   |             |                                    |                    |
|                |                    |                               |                   |             | Location All                       |                    |
| Network        | •                  | III                           |                   | •           | Library                            |                    |
|                | File <u>n</u> ame: | thermostat exercise rev.0.p   | pjs 🔻             | Open        | Varstyne All                       |                    |
| 11             | Files of type:     | Single file PLC project files | (* poie) -        | Cancel      |                                    |                    |

- 1. Select \*.ppjs file type
- 2. Select desired project (Smart )
- 3. Select desired program & FBD
- 4. Import Objects

ь

Select none

# ...Assign to Task (in case of program)





# Assigning imported program to the task



|  |                    |                | Project<br>⊡  | Ψ×  |
|--|--------------------|----------------|---|---|
| Objects filter                               |                    | Name           | Programs  | _   |
| ✓ Programs                                   | Ope <u>r</u> ators | °P main        | Intermostat   | _   |
| Function <u>B</u> locks                      |                    | 🛯 🖻 Thermostat | Eurotion blocks   | _   |
| <u> </u>                                     | Standard functions |                | Global variables  | _   |
|  | Local variables    |                |   | _   |
| □ <u>U</u> ser types                         | Basic types        |                | ⊡∰ Tasks  | _   |
|  |                    |                | C Timed   |   |
| Check <u>a</u> ll                            | Check <u>n</u> one |                | Background  |   |
|  |                    |                | Thermostat  |   |
| ther filters                                 |                    |                | - to Boot   | _   |
| Name *                                       | ОК                 |                | init  | _   |
|  |                    |                |   |   |
| Location All                                 | •                  |                | 1. Select the desired   | program                                   |
| Location All<br>Library All                  | •                  |                | 1. Select the desired<br>name ► OK  | program                                   |
| Location All<br>Library All<br>Vars type All | •                  |                | <ol> <li>Select the desired<br/>name ► OK</li> <li>The ? Disapeares in</li> </ol>   | program<br>n prgram                       |
| Location All<br>Library All<br>Vars type All | •                  |                | <ol> <li>Select the desired<br/>name ► OK</li> <li>The ? Disapeares in</li> <li>It will assign to to open</li> </ol>                      | program<br>n prgram<br>lesired            |
| Location All<br>Library All<br>Vars type All | •                  | < <u> </u>     | <ol> <li>Select the desired<br/>name ► OK</li> <li>The ? Disapeares in</li> <li>It will assign to to c<br/>task (delete non-re</li> </ol> | program<br>n prgram<br>lesired<br>equired |
## Link libraries...



## ...Link Libraries



| Pr | oject library list |   | X          |
|----|--------------------|---|------------|
|    | Name               | Link                                      | Add        |
|    | basic              | c:\program files (x86)\eliwell\free studi |            |
|    | PIDregulators_v1   | C:\Electrical\Solution Architect\HVAC     | Remove     |
|    | -                  |   | Remove all |
|    |                    |   | UnLink     |
|    |                    |   | ReLink     |
|    |                    |   | Close      |



## Save a project as:

File ► save a project as :

\* Create a folder for the project before saving

| Ap Save As  |                             |                            |                                |         | *       | x              |
|---|-----------------------------|----------------------------|--------------------------------|---------|---------|----------------|
| App Save As<br>Save in:<br>Recent Places<br>Desktop<br>Libraries<br>Computer<br>Network | Desktop<br>Libraries        | Aidin<br>Aliyarzade        | Computer                       | Retwork | Desktop |                |
|   | File name:<br>Save as type: | Themostat<br>Single-file P | Exercise<br>LC project files ( | *.ppjs) | ▼<br>▼  | Save<br>Cancel |









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## Thanks

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