Battery Application

FEV Documentation Team

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CONTENTS

Welcome to **SCALE** Battery Documentation!

> *Essential element of new transportation area, batteries are key part of the energy transition. In constant evolution, battery testing has to be innovative and reactive!*

SCALE Battery (**S**tandard and **C**onfigurable **A**pplication for **L**aboratory **E**nvirronment) is a MORPHEE® application for battery test cells. It allows to perform test on:

- Cells,
- Module
- Pack.

Note: **SCALE** also exists for many different kind of test cell on automotive market:

- **SCALE Component** : A basic to test all your automotive components.
- **SCALE Engine** : The state of the art for all of your thermal and hybrid engine test benches. From End-Of-Line to Research & Development solution.
- **SCALE Emotor** : Adapt your test benches and working methods to new market trends. E-mobility is more than ever a reality!
- **SCALE Fuel Cell** : The new trend for power generation in modern vehicles. Tomorrow's ideas have already a SCALE solution today.
- **SCALE Epowertrain/Powertrain** : Testing the complete powertrain in its conventional, hybrid or electrical configuration is now possible.
- **SCALE Vehicle** : For Vehicle on chassis dynamometer testing

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See also:

Get more info on **MORPHEE**,

Part I

Introduction

CHAPTER

ONE

GENERAL PRESENTATION

1.1 Introduction

SCALE Battery has been developed to address all type of battery;

- Cell
- Module
- Pack

To meet the market demand, we are using the MORPHEE® multi-instance concept. This allows to start on the the same computer;

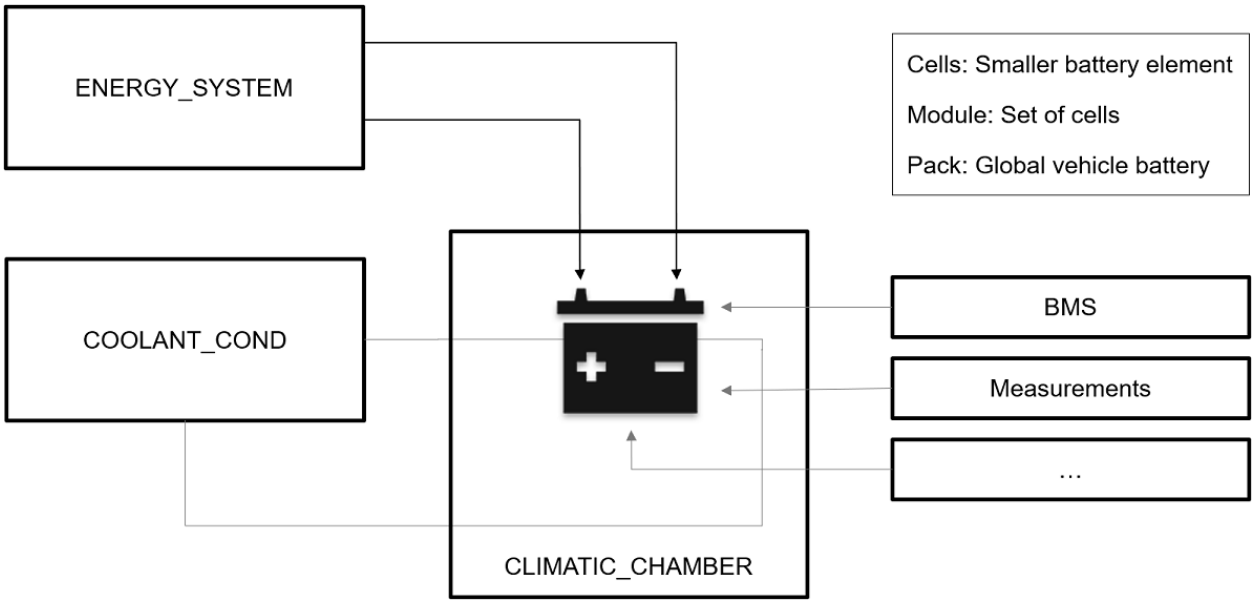
- Up to 32 cell tests in parallel
- Up to 16 Module tests in parallel
- Up to 8 Packs tests in parallel

1.2 Battery Testing principle

1.2.1 Equipements and measure

To test a battery we need to have:

- **An Energy System** >> Allow to charge and discharge the battery. Generally it also manage the re-injection on the network.
- **A climatic chamber** - *optional* >> Allow to simulate environmental conditions
- **A coolant conditionning system** - *optional* >> use to cooldown the battery in same condition as in the vehicle.
- **A BMS** (**B**attery **M**angement **S**ystem) - *optional* >> Battery control unit handling the different cells/modules/pack and different modes (charge/sleep/Drive)
- ***Additionnal acquisition*** - *optional* >> Allow to add voltage, current and temperature measurement.

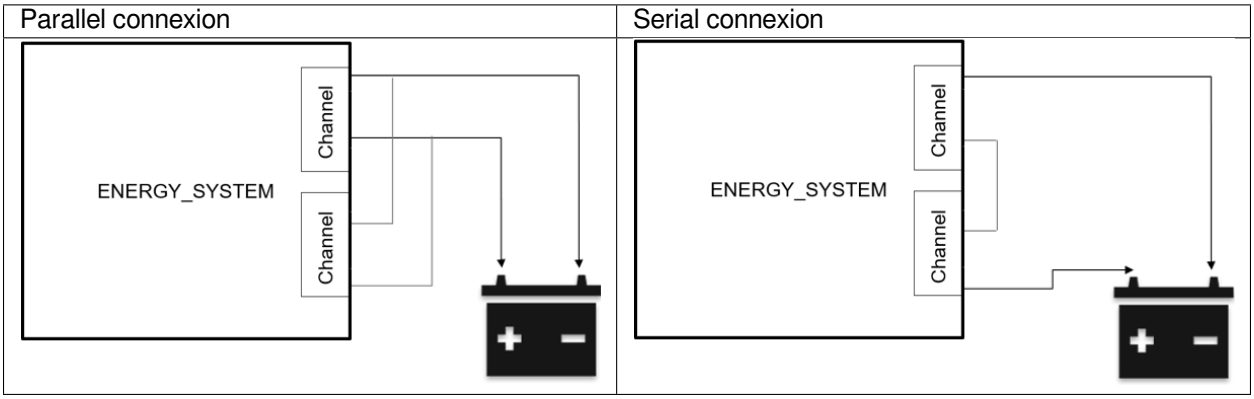


Note: Except Energy System, all others equipement can be 'Optional', depending on each application.

1.2.2 Energy system channel concept

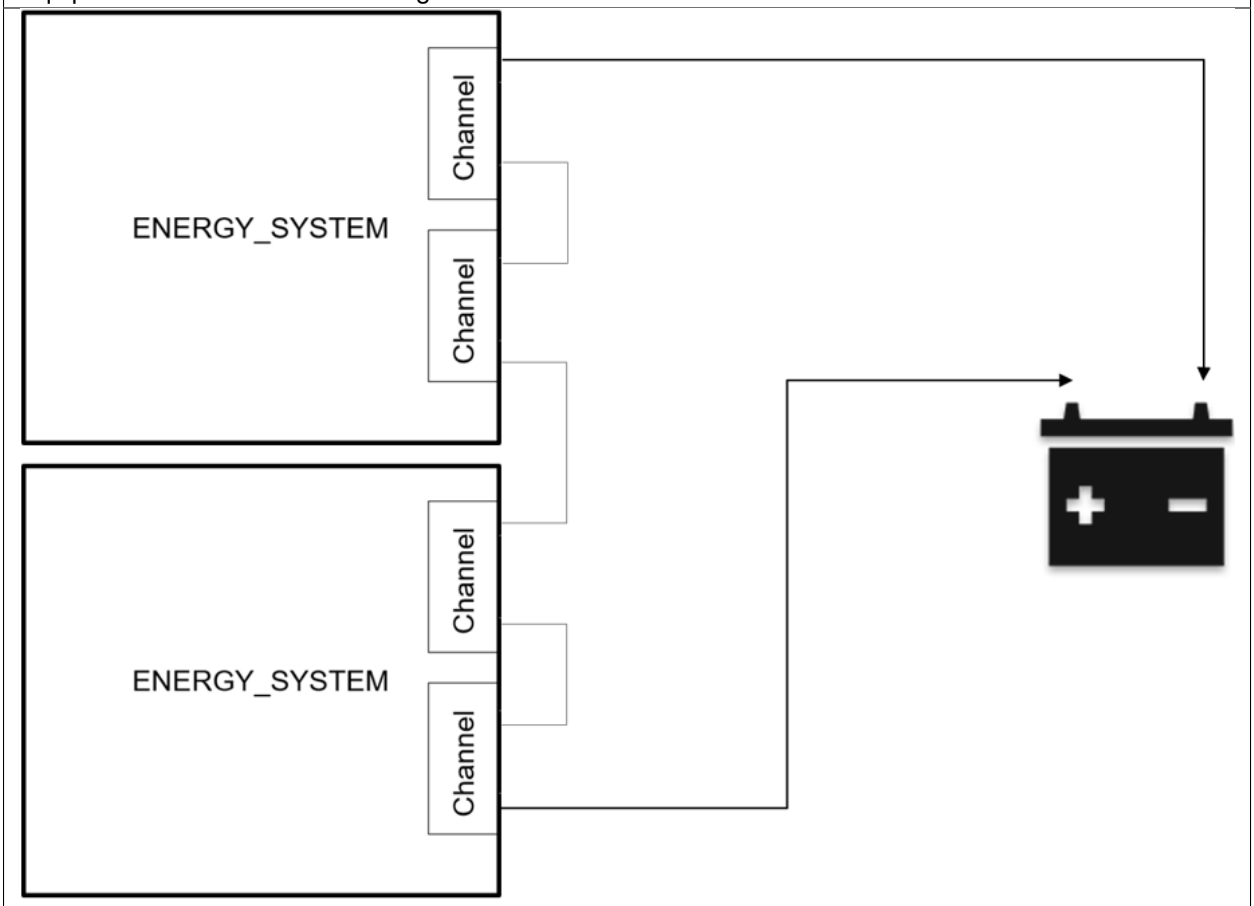
Energy System have one or several channel allowing to address one or several battery:

- If there is a need for more current, channels can we wired in parallel
- If there is a need for more voltage, channels can be wired in serial



Regarding equipement capability, it is also possible to combine Energy system cascading and channel parallelisation or serialisation.

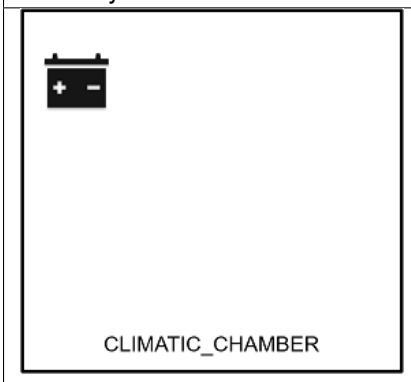
Equipement and channel cascading



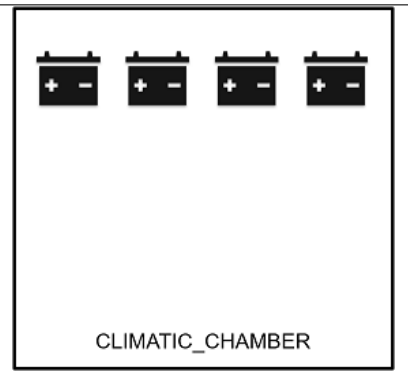
1.2.3 Modularity

Generally, in one climatic chamber there will be several battery in test. Climatic condition are identical but tests can be different!

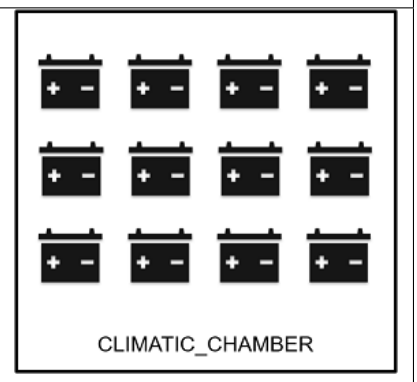
1 battery



4 batteries



12 batteries



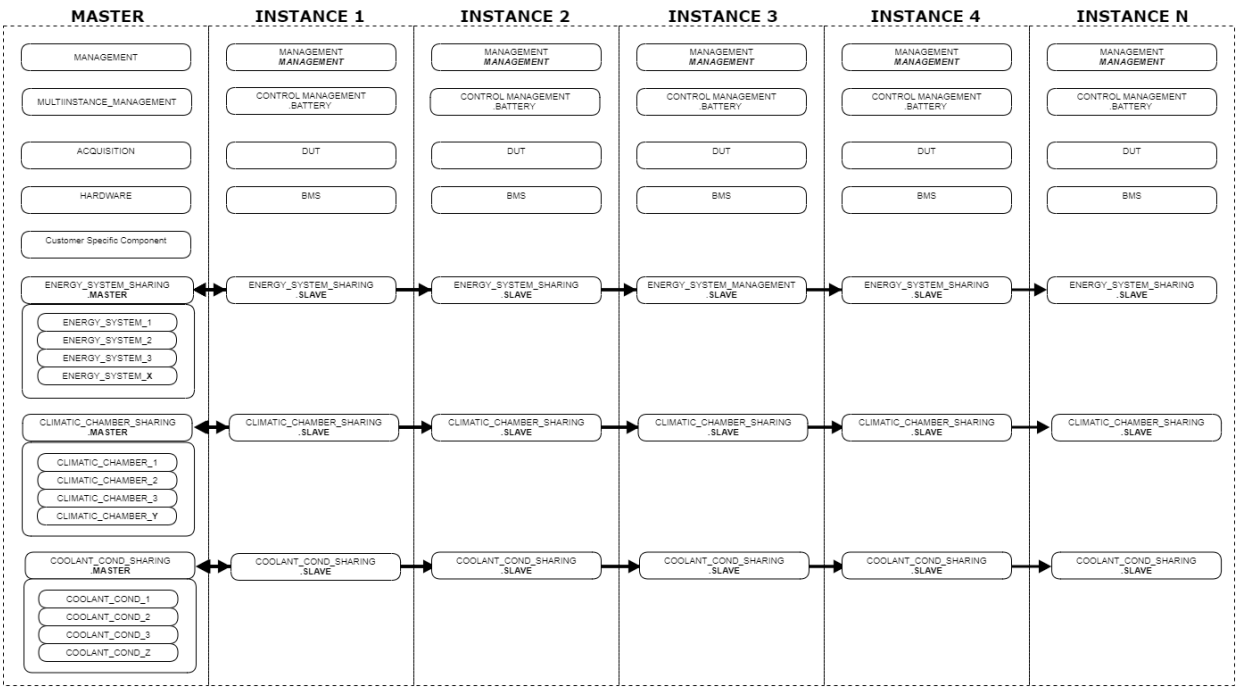
Important: The quantity of test is directly linked to the quantity of Energy System channels. For example, if globaly a system has 8 channels, we can:

- Start 8 independant test using 1 channel each
- Start 4 independant test using 2 channel each (in // or serial)
- Start 2 independant test using 4 channel each (in // or serial)

Possibility is given, in one side from the hardware, and in the other side from the software configuration.

1.3 Software architecture

Software architecture is based in one hand, on a master application managing most of the equipments (Energy, cooling, acquisition, climatic…), and on another hand several procedure executing the test(call instances). Communication between main application and procedure is developped the in *MORPHEE® multi-instance* chapter.



Objective is to keep all instances as identical as possible. Only some interfaces can change;

- BMS
- Specif devices.

A specific configuration (hardware connexion) can also be done for every instance..

1.4 Instances capability

We limit the quantities of instances to 1 master + 32 instances. But more generally, the quantities will be limited by the configuration you will select:

Ref	Description
SA-M64-MULTI-04	Possibility to start **1** Master Instance + **4** test instances
SA-M64-MULTI-08	Possibility to start **1** Master Instance + **8** test instances
SA-M64-MULTI-16	Possibility to start **1** Master Instance + **16** test instances
SA-M64-MULTI-24	Possibility to start **1** Master Instance + **24** test instances
SA-M64-MULTI-32	Possibility to start **1** Master Instance + **32** test instances

1.5 Instances limitation

Actual limitations are as follow:

Ref	Master	Instances
Up to 1 + 8 instances	1 kHz	1 kHz
Up to 1 + 16 instances	500 Hz	500 Hz
Up to 1 + 32 instances	100 Hz	100 Hz

Note: This limitations has been achieved with FEV 8 cores computer.

CHAPTER

TWO

MORPHEE® MULTI-INSTANCE

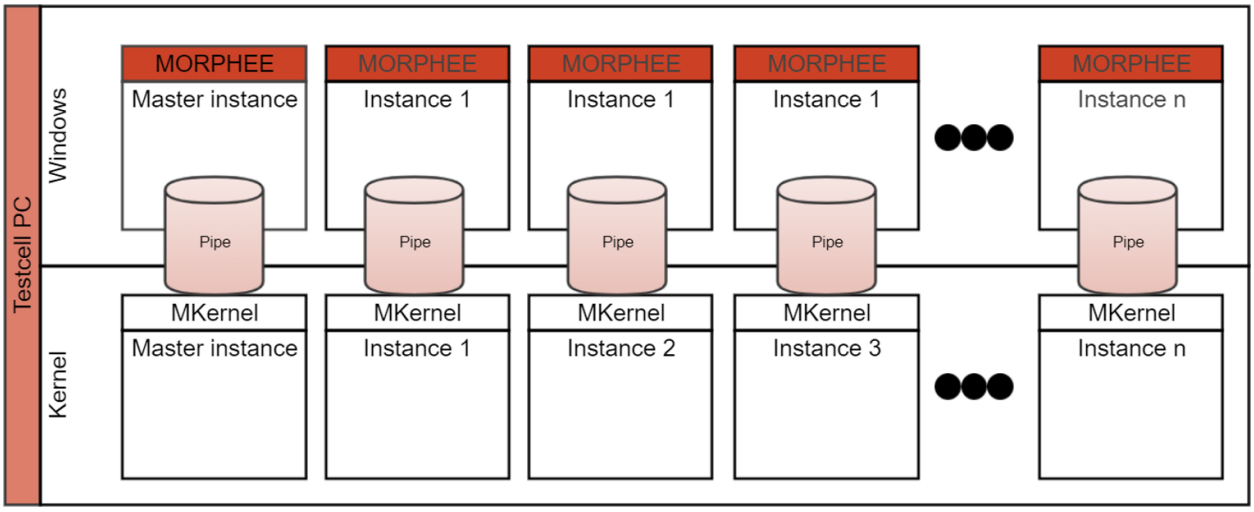
Born from our internal need to have independent application running on the same hardware architecture, **MORPHEE®** multi-instance has been developed to ensure multiple tests execution independently in terms of procedure and securities.

2.1 General concept

In order to meet the growing need for multi-UUT testing, especially in the field of battery, and after many feasibilities, **FEV** has developed a new **MORPHEE®** multi-instance concept.

Based on this, it is now possible to run several **MORPHEE®** on the same computer. The first instance is seen as the 'master instance' (or main instance). It can be used to orchestrate all the other instances, to centralize hardware, share channels and distribute events.

All others instances are completely independent and can perform test in real time using own channels, screens, alarms, methods, etc..

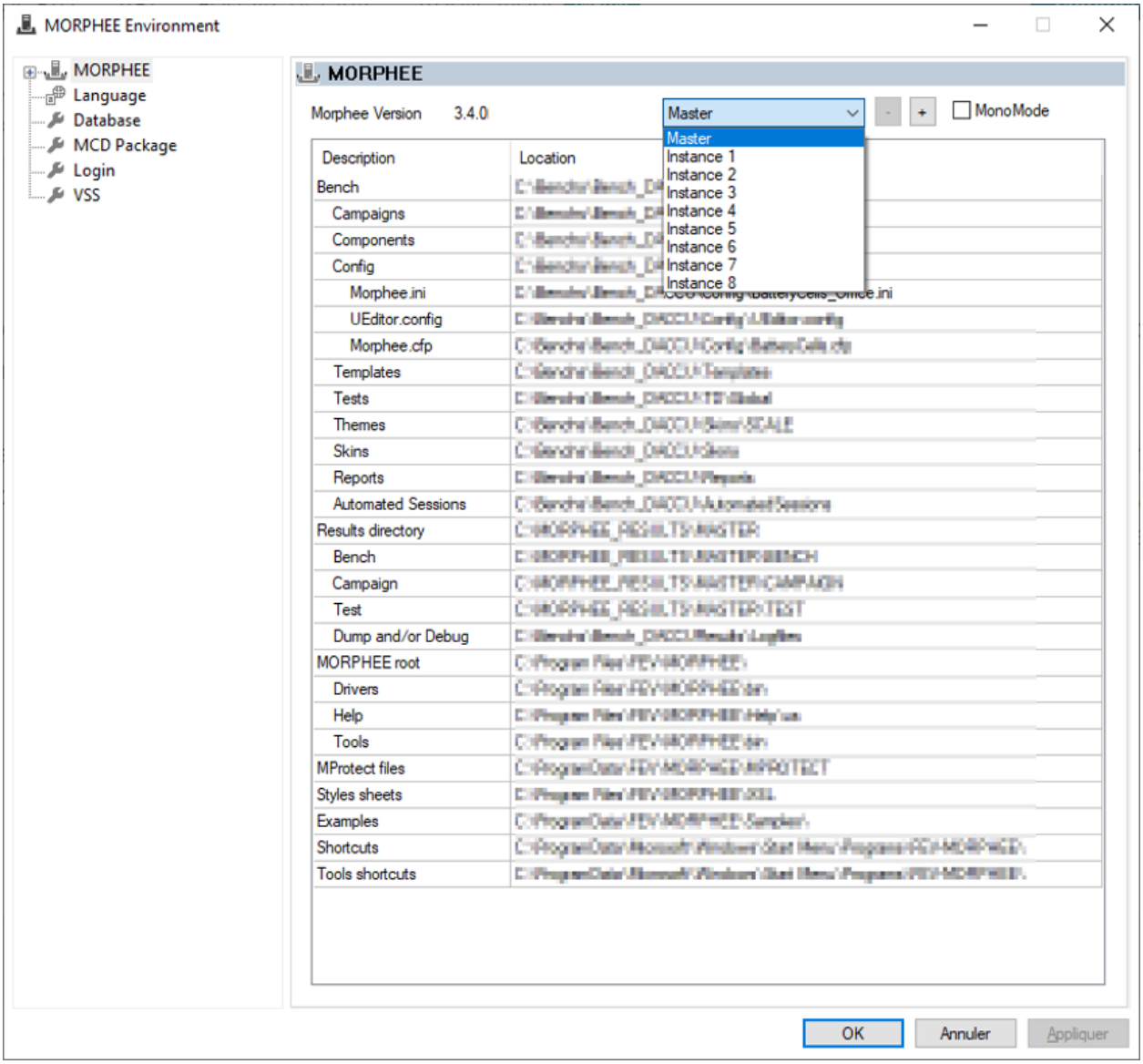


2.2 Multi-Instance activation and configuration

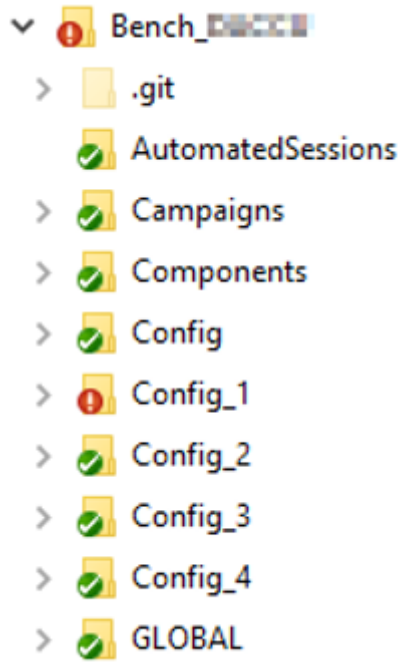
2.2.1 Activation

Activation of the multi-instance can be done quickly, as it is sufficient to specify in **MENV** (**M**ORPHEE **Env**ironment software) that an additional instance is required.

You can add as many instances as needed, and also delete them if they are not needed anymore;



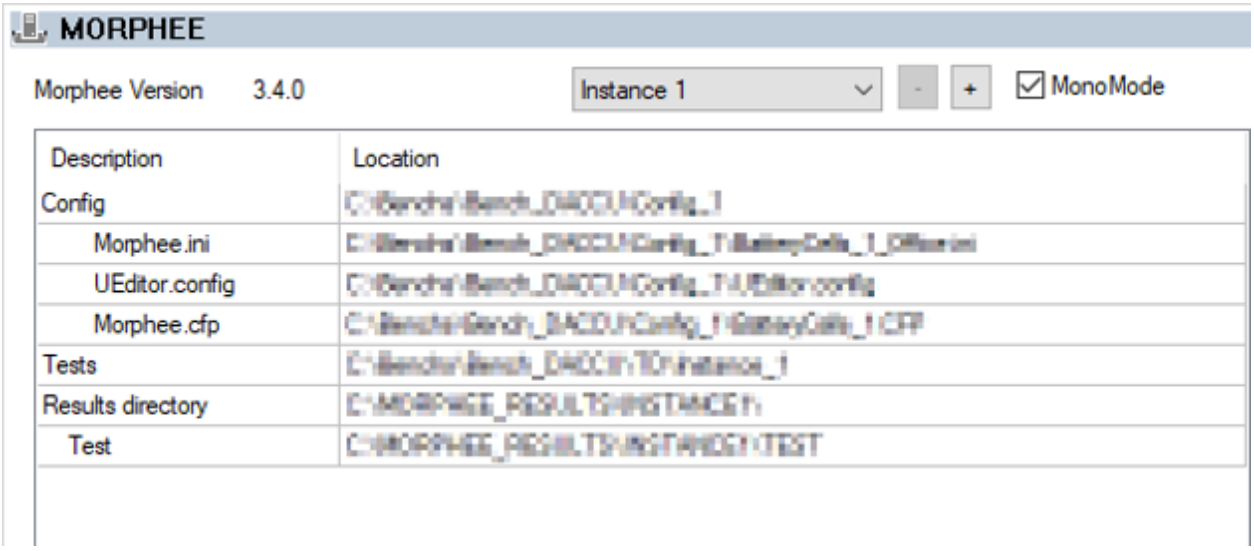
If no folders exist for multi-instance, **MENV** will create them and populate then with files from Master instance.



If folders are already existing, no actions will be performed.

2.2.2 Configuration

However, activation is not enough, as the whole system has to be configured in order to be able to run a test. Configuration of each instance is done directly from **MENV** layer;



Not all parameters have to be modified as we fixed some rules to simplify global configuration. Only:

- Initialization file (`Morphee.ini`)
- Physical Configuration file (`Morphee.cfp`)
- Editor configuration (`UEditor.config`)
- Test Path and Result directory

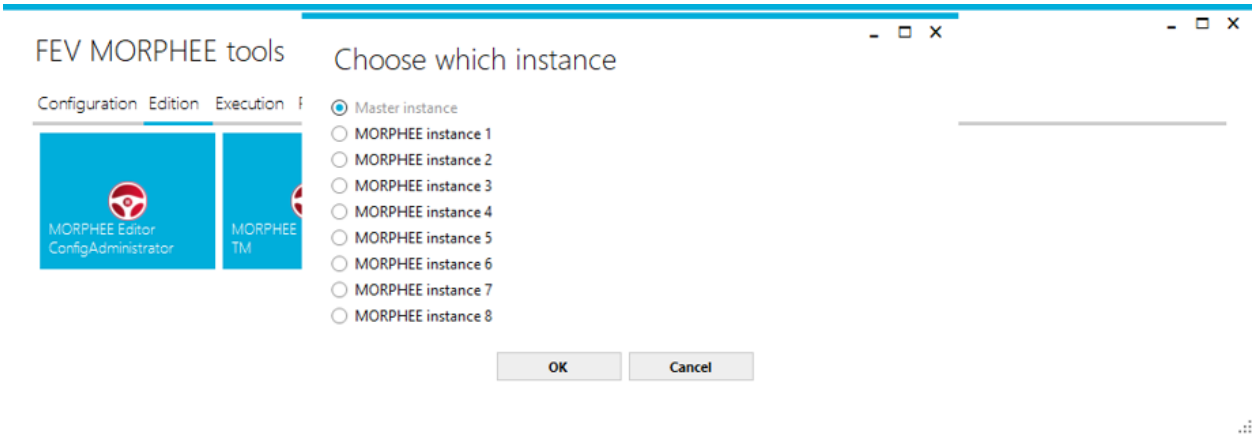
All other parameters are common to all instances, mainly:

- Components
- Templates
- Themes
- Skins
- Reports
- Automatic Session
- Binaries• …

2.3 Working with Instances

2.3.1 Editing / Starting a specific instance

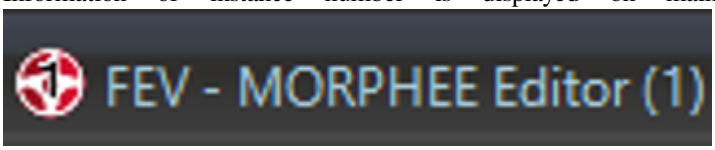
By using MToolBar, you will every time prompted to know which instance you want to use;



For;

- Starting **MORPHEE® Editor**
- Starting **MORPHEE® Executive**

Information of instance number is displayed on main Form and also in the main toolbar:

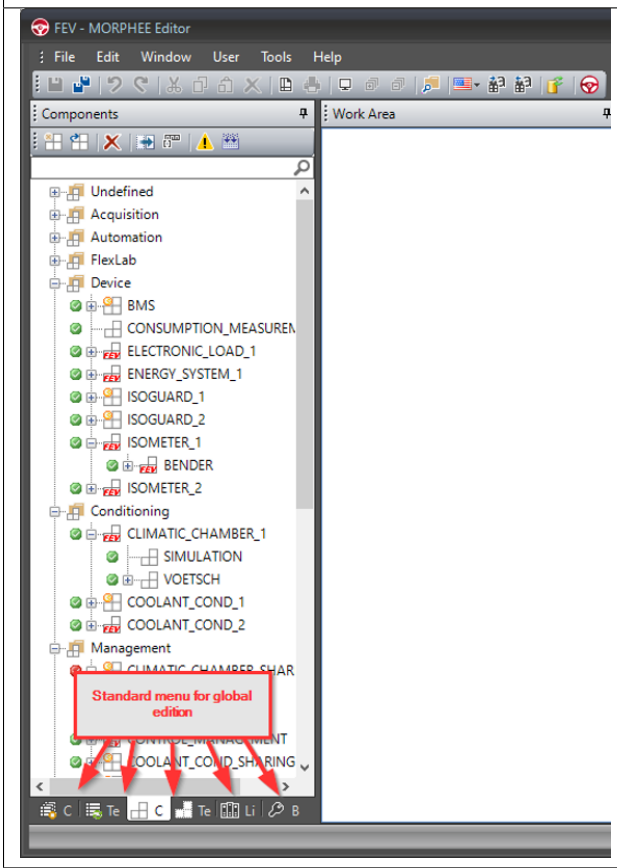
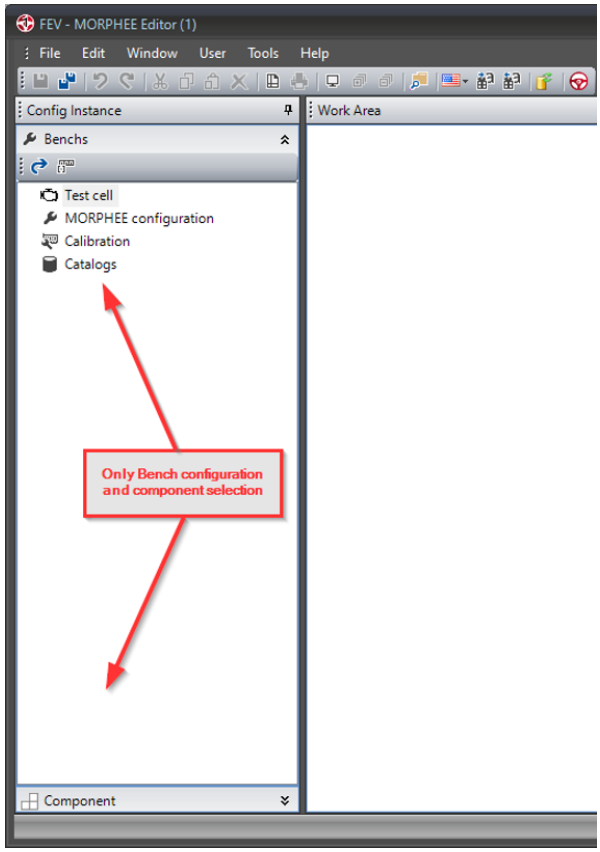


It can be very complex to work with many instances at the same time. Some basic rules can help to avoid problem link to quantity of place where modification can be done.

For example:

- Use Meditor instance, only for configuration:
  - Adding and configuring features
  - Hardware links
  - Test cell configuration

- Use Meditor master instance for all others things:
  - Master instance configuration
  - Component writing
  - Test Writing
  - Channel calibration
  - Etc…

Master Instance	Others instances
	

2.3.2 Exchanging data between instances

Each instance can be completely autonomous. Nevertheless, in most cases, it is necessary to share measurement channels, or simply status paths, between the instances. To make instance independent and use same component, following best practices could be used:

Sharing a channel from master instance to all instances

The name of the channel in master instance has to be the same in others instance. The channel type has to be `[SHARED_IN]`

Master	Instance 1	Instance 2	Instance 3	Instance N
T_AMB >> [ECat-AI008]	T_AMB >> [SHARED_IN]	T_AMB >> [SHARED_IN]	T_AMB >> [SHARED_IN]	T_AMB >> [SHARED_IN]

Sharing a channel from master to a specific instance

To keep instance generic and use the same channel name, the physical channel has to redirect the standard name from the instance.

Master	Instance 1	Instance 2	Instance 3	Instance N
T_CELL**#1** >> [ECat-AI101]	T_ CELL >> [SHARED_IN]			
T_CELL**#2** >> [ECat-AI102]		T_ CELL >> [SHARED_IN]		
T_CELL**#3** >> [ECat-AI103]			T_ CELL >> [SHARED_IN]	
T_CELL**#N** >> [ECat-AI104]				T_ CELL >> [SHARED_IN]

Getting channel from instances

To send value of channel to master, it is also possible to use the same principle, but channel type must be `[SHARED-OUT]`.

Master	Instance 1	Instance 2	Instance 3	Instance N
SP_OIL**#1** >> [ECat-AO200]	SP_OIL >> [SHARED_OUT]			
SP_OIL**#2** >> [ECat-AO201]		SP_OIL >> [SHARED_OUT]		
SP_OIL**#3** >> [ECat-AO202]			SP_OIL >> [SHARED_OUT]	
SP_OIL**#N** >> [ECat-AO203]				SP_OIL >> [SHARED_OUT]

Part II

Configuration

CHAPTER

THREE

FIRST INSTALLATION

3.1 Software Installation

Use of MORPHEE® 3.4.x

Use of last SCALE Battery version

All version and setup can be download here >> https://download.fev-software.com/DownloadPortal/pages/DownloadPortal

3.2 Licensing / Protection

Get protection codes:

- SCALE Battery
  - Management
  - Control management.BATTERY
  - MULTIINSTANCE_MANAGEMENT
  - ENERGY_SYSTEM_SHARING
  - CLIMATIC_CHAMBER_SHARING
  - COOLANT_COND_SHARING
- SCALE Devices
  - ENERGY_SYSTEM_X.***your device***
  - CLIMATIC_CHAMBER_X.***your device***
  - COOLANT_COND_X.***your device***
- Multi instance
  - Multi Instance code for 4, 8, 16 or 32 instances

If codes are missing please contact hotline@fev.com

CHAPTER

FOUR

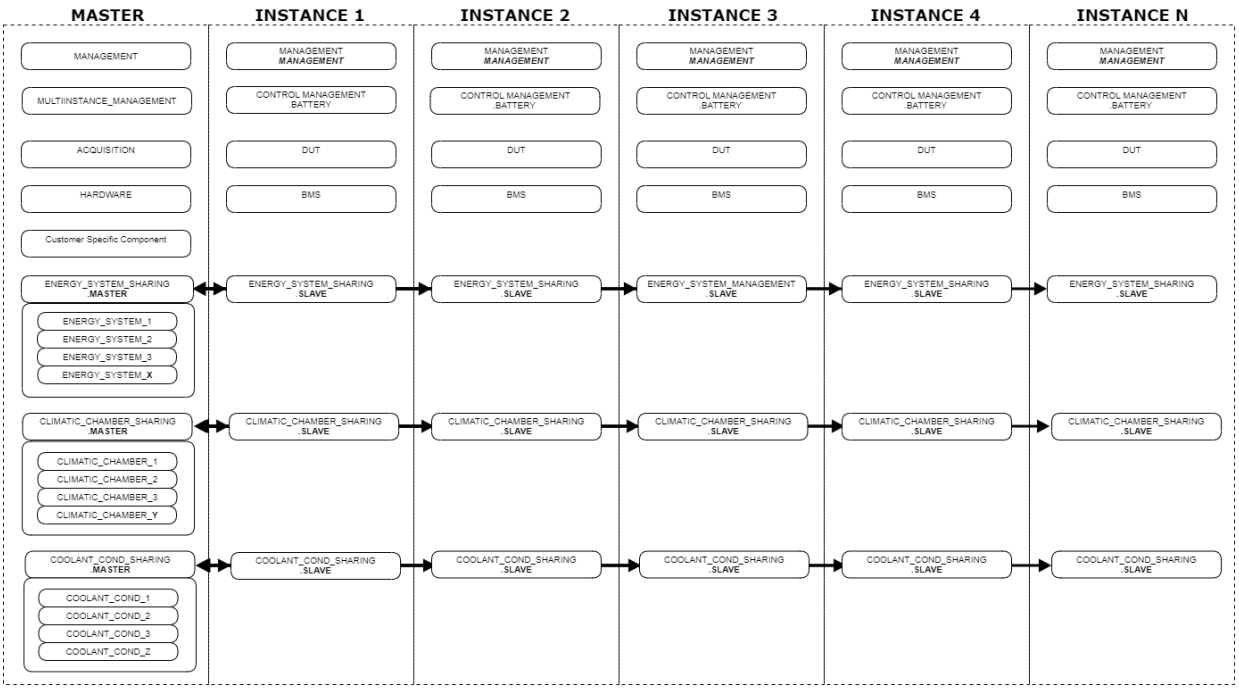
BASE CONFIGURATION

Important: This documentation will not develop the hardware and feature configuration. This has to be done previously.

Nevertheless, it will be possible to test all equipement one by one when it will be possible to start MORPHEE® master instance.

4.1 Principle

Concept of the SCALE Battery configuration is to use most of the equipement in the master instance and to give the possibility for each instance to attach to one (or more) equipement through 'Sharing' components;



The Sharing equipements take care of all present equipement of the familly;

ENERGY_SYSTEM_SHARING

- ENERGY_SYSTEM_1

- ENERGY_SYSTEM_2
- …
- ENERGY_SYSTEM_x

4.2 Component role

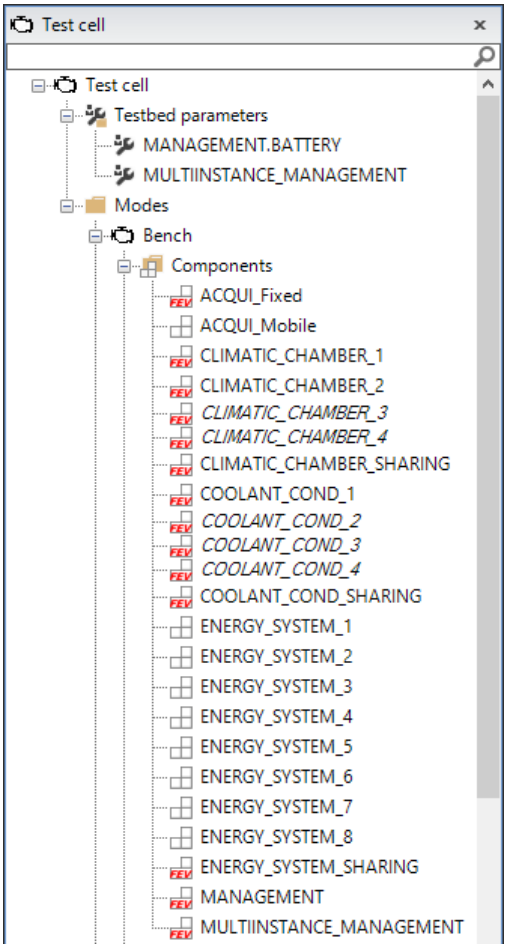
4.2.1 Definition

Component role are defined below:

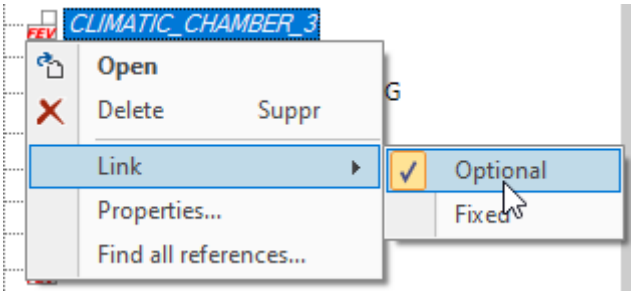
Component		Master	Inst.	Description
MANAGEMENT	*SCALE*	**X**	**X**	Global management of all SCALE and non SCALE component in the configuration. Must be in all configuration
CONTROL_MANAGEMENT.BATTERY	*SCALE*		**X**	Management of the different control mode for battery;
MEASUREMENT_MANAGEMENT.BATTERY	*SCALE*		**X**	Management of acquisition for battery;
MULTIINSTANCE_MANAGEMENT	*SCALE*	**X**		Handling of the configuration (see below) and instances
ACQUISITION		**X**	(**X**)	Component for "normed name" customer channels. This is the main place to define: Link to hardware channel Securities Calculation Acquisition plan
HARDWARE		**X**		Component to place hardware channels of the configuration. Act as a simple passive component to concentrate acquisition channels.
Customer specific component		**X**	(**X**)	All needed component for customer configuration, such as; PLC Barcode Various interface …
BMS	*SCALE*		**X**	Communication with the battery BMS, adressed either in CAN or FDX protocol. Frame given by SCALE architecture, but possibility to ADD new methods and channels if there is a need to add customer specific command (father method)
DUT	*SCALE*		**X**	DUT description. Frame given by SCALE architecture, but possibility to ADD new parameters if needed.
ENERGY_SYSTEM_SHARING	*SCALE.MASTER*		*.SLAVE*	Management of different ENERGY_SYSTEM; In link with the instance In regards to configuration
ENERGY_SYSTEM_X	*SCALE*	**X**		SCALE energy system devices
CLIMATIC_CHAMBER_SHARING	*SCALE.MASTER*		*.SLAVE*	Management of different CLIMATIC_CHAMBER; In link with the instance In regards to configuration
CLIMATIC_CHAMBER_X	*SCALE*	**X**		SCALE climatic chamber devices
COOLAND_COND_SHARING	*SCALE.MASTER*		*.SLAVE*	Management of different COOLAND_COND; In link with the instance In regards to configuration
COOLAND_COND_X	*SCALE*	**X**		SCALE coolant conditionning devices
SCADA_CLIENT_MASTER	*SCALE*	***X***		Can be used only with SCADA
SCADA_CLIENT_INSTANCE	*SCALE*		**X**	Can be used only with SCADA

4.2.2 Configuration in UEditor

Here is an example of a standard Bench configuration;

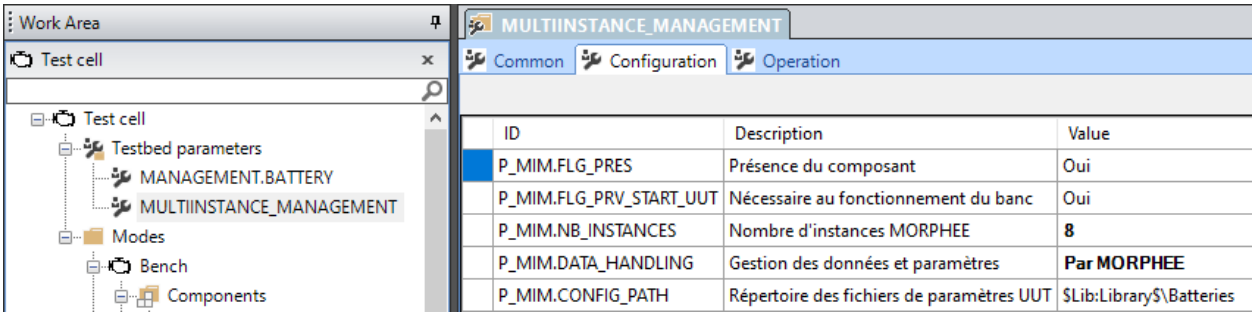


Hint: To avoid re-design of the Dashboard, it makes sense to always use all equipement in the Bench configuration and make the link 'Optional' if they are not used;



4.2.3 MultiInstance configuration

Before starting, you need also to configure the MULTIINSTANCE_MANAGEMENT component:



By default, you can configure as follow;

Parameter	Description	Value
P_MIM.NB_INSTANCES	Quantity of MORPHEE Instance	8
P_MIM.DATA_HANDLING	Management of parameters	By MORPHEE

4.2.4 Configuration without any hardware

Example of Configuration without any hardware and simulated components:

Master configuration (In Bench cfg)
MANAGEMENT
MULTIINSTANCE_MANAGEMENT
ENERGY_SYSTEM_SHARING.***MASTER***
ENERGY_SYSTEM_1.SIMU_BASIC
ENERGY_SYSTEM_2.SIMU_BASIC
ENERGY_SYSTEM_3.SIMU_BASIC
ENERGY_SYSTEM_4.SIMU_BASIC
CLIMATIC_CHAMBER_SHARING.***MASTER***
CLIMATIC_CHAMBER_1.SIMULATION
CLIMATIC_CHAMBER_2.SIMULATION
COOLANT_COND_SHARING.***MASTER***
COOLANT_COND_1.SIMULATION

Master configuration (In Bench cfg)	Instance 1 configuration (In Test cfg)	Instance n configuration (In Test cfg)
MANAGEMENT	MANAGEMENT	MANAGEMENT
MULTIIN-STANCE_MANAGEMENT	CON-TROL_MANAGEMENT.BATTERY	CON-TROL_MANAGEMENT.BATTERY
EN-ERGY_SYSTEM_SHARING.***MASTER***	EN-ERGY_SYSTEM_SHARING.***SLAVE***	EN-ERGY_SYSTEM_SHARING.***SLAVE***
EN-ERGY_SYSTEM_1.SIMU_BASIC		
EN-ERGY_SYSTEM_2.SIMU_BASIC		
EN-ERGY_SYSTEM_3.SIMU_BASIC		
EN-ERGY_SYSTEM_4.SIMU_BASIC		
CLI-MATIC_CHAMBER_SHARING.***MASTER***	CLI-MATIC_CHAMBER_SHARING.***SLAVE***	CLI-MATIC_CHAMBER_SHARING.***MASTER***
CLI-MATIC_CHAMBER_1.SIMULATION		
CLI-MATIC_CHAMBER_2.SIMULATION		
COOLANT_COND_SHARING.***MASTER***	COOLANT_COND_SHARING.***SLAVE***	COOLANT_COND_SHARING.***SLAVE***
COOLANT_COND_1.SIMULATION		

Note: All component existing in your configuration but not present in this table can be put as 'Optional'

4.2.5 Configuration with hardware

The configuration with hardware is not so different. You just have to replace 'Simulated' equipments with real one, and add your own component if needed (Acquisition, Hardware, etc…).

The table below is not exhaustive but show the configuration concept by using hardware:

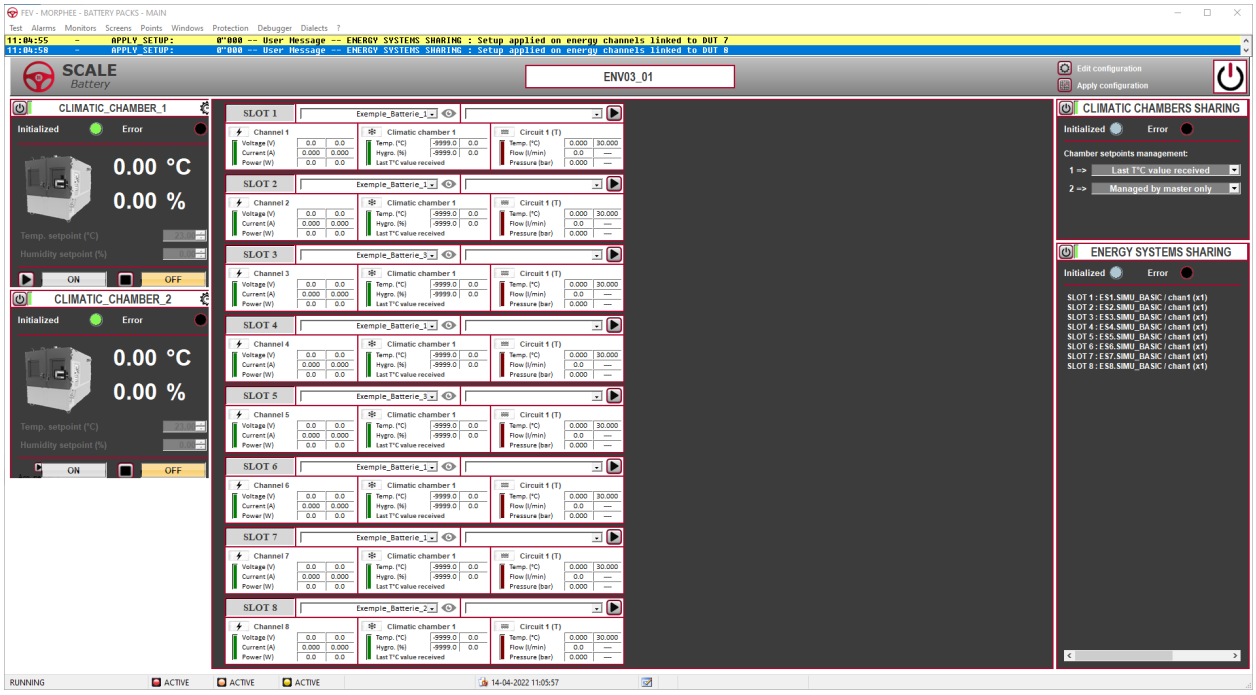
Master configuration (In Bench cfg)
MANAGEMENT
MULTIINSTANCE_MANAGEMENT
ENERGY_SYSTEM_SHARING.***MASTER***
ENERGY_SYSTEM_1.*Real device*
ENERGY_SYSTEM_2.*Real device*
ENERGY_SYSTEM_3.*Real device*
ENERGY_SYSTEM_4.*Real device*
CLIMATIC_CHAMBER_SHARING.***MASTER***
CLIMATIC_CHAMBER_1.*Real device*
CLIMATIC_CHAMBER_2.*Real device*
COOLANT_COND_SHARING.***MASTER***
COOLANT_COND_1.*Real device*

4.3 First start

Hint: We recommend, for the first start, to use the simulated components and to limit the number of instances.

When you have reach this point, you are ready to start SCALE Battery master instance.

You should see:



CHAPTER

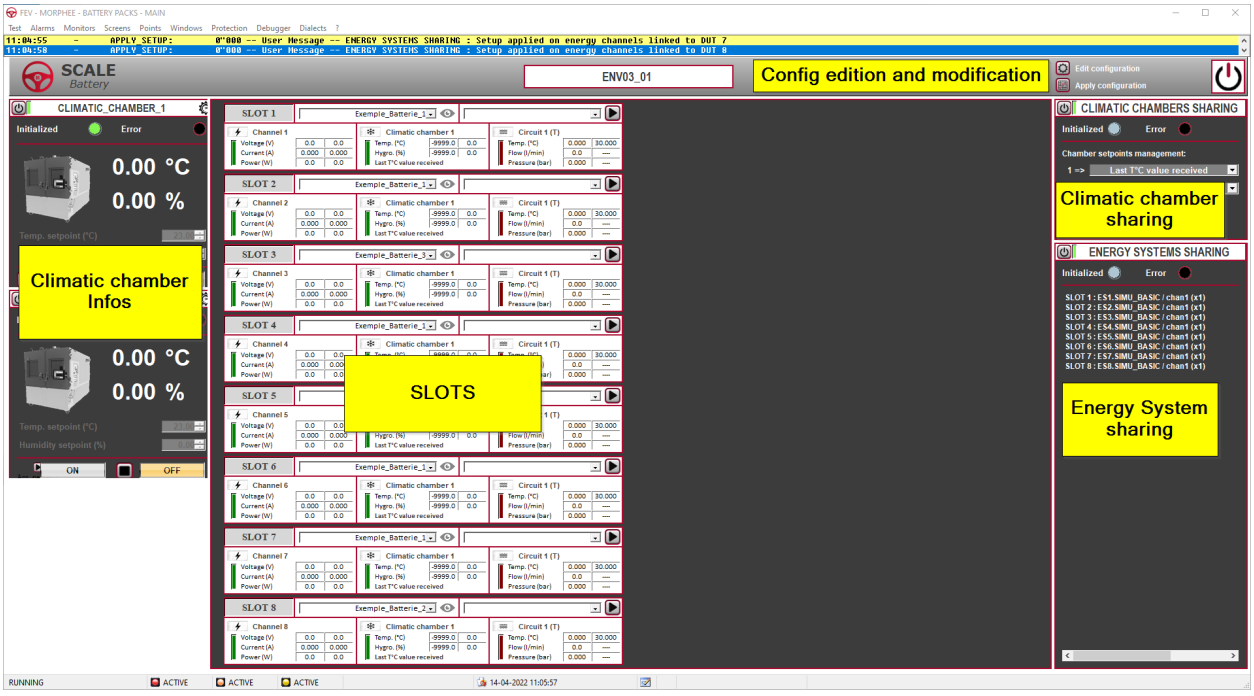
FIVE

RUNTIME CONFIGURATION

Important: If you read this section, this means you succeed to start MORPHEE main instance. If not, please go back to previous section.

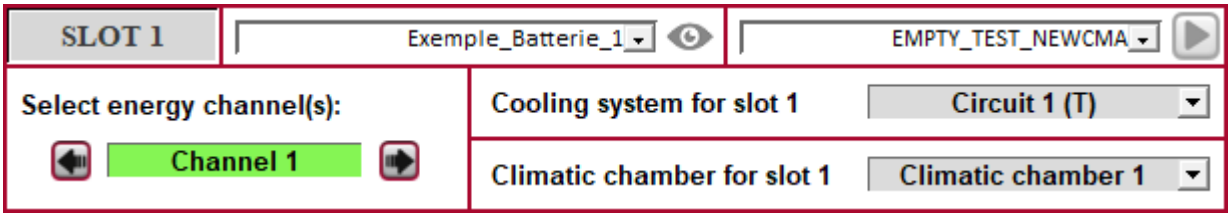
5.1 Dashboard

Main Dashboard can be modified in the Bench configuration. By default, it displays the different slots, the climatic chamber information, The climatic chamber sharing configuration and the Energy system sharing configuration.



5.1.1 Slots configuration

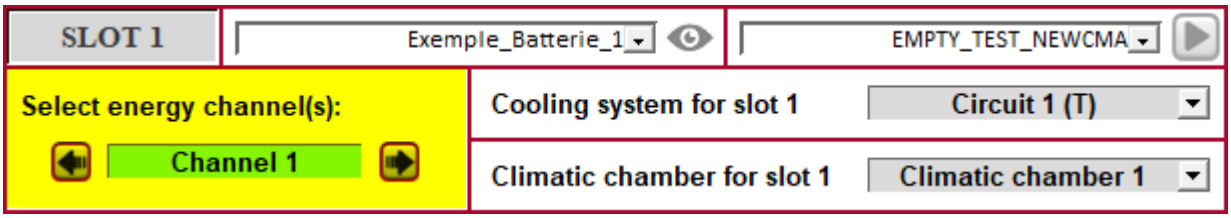
You can modify the configuration by pushing the 'Edit configuration' button.



It will display all the Slot and you will be able to modify each slot configuration.

5.1.2 Channel affectation

You can select the channels you want to affect to the Slot.



By default, each slot has its own channel;

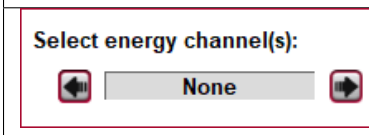
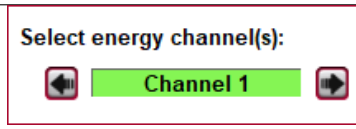
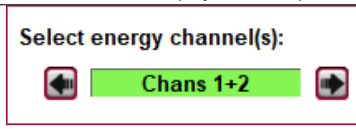
Slot	Electric Channel
Slot 1	Channel 1
Slot 2	Channel 2
Slot 3	Channel 3
Slot 4	Channel 4
Slot 5	Channel 5
…	…
Slot X	Channel X

But if ENERGY_SYSTEM Component allows it, we can use several channels for one slot;

Slot	Electric Channel
Slot 1	Channel 1 + Channel 2
Slot 2	*No more available*
Slot 3	Channel 3 + Channel 4 + Channel 5
Slot 4	*No more available*
Slot 5	*No more available*
…	…
Slot X	Channel X

etc…

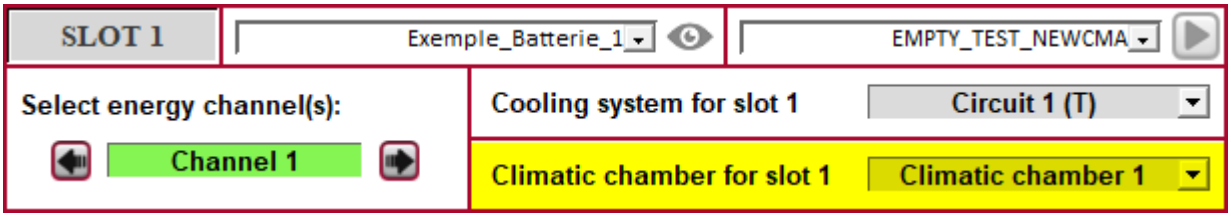
You can modify the configuration by clicking in on the right and left button:

No channel	One channel	Two channels (if possible)
		

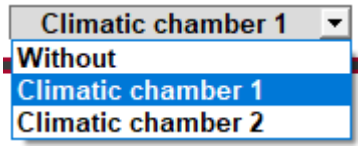
Caution: If a channel is used by a slot, it is not anymore available for the next slot.

5.1.3 Climatic chamber selection

When you have affected a channel, you can precise if the slot is in a climatic chamber, and if yes, in which one;

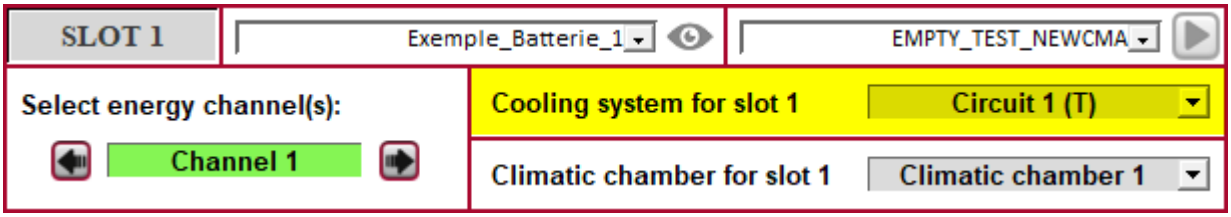


The list of Climatic chamber depends on the configuration:

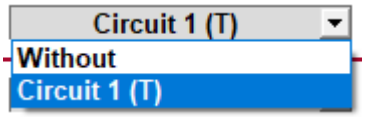


5.1.4 Cooling system selection

If battery is using a cooling system, it can also be defined here;

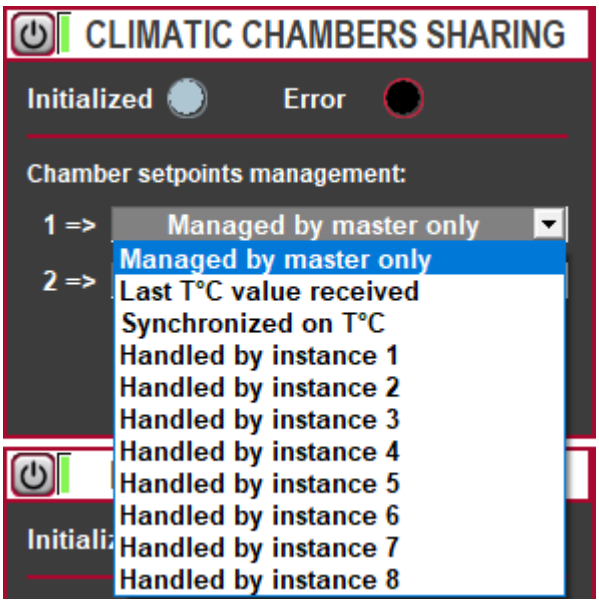


The list of Coolant conditionning circuit appears in the list:



5.2 Climatic chamber sharing

As it is possible to have several slots inside the same climatic chamber, it is necessary to describe how the system will react if different setpoint arrives in the master;

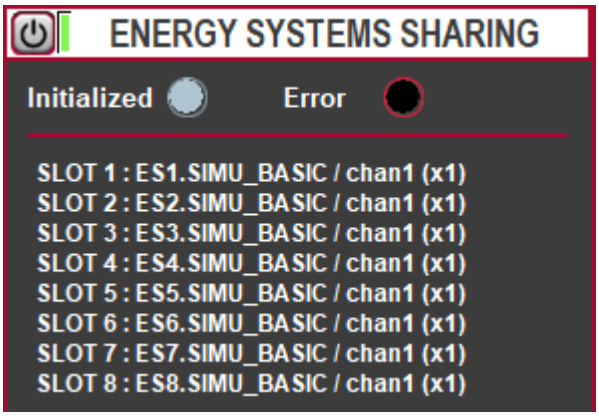


The possibilities are:

Selection	Description
Managed by master only	The temperature setpoint is managed by the master. Every test from instances, even if sending a setpoint, will not be taken into account
Last T°C value received	The last temperature received will be applied, wherever and whenever it arrives.
Synchronized on T°C	Wait that all runing instances send the same setpoint to apply it. All the test on the different instances will be on hold as long as setpoint is not applyed.
Handled by instance *X*	Only setpoint coming from Instance ***X*** will be applied.

5.3 Energy System sharing

The Energy System Sharing window will display actual configuration with available slots:



For every Energy System used in the *configuration*, it will display:

- Name of the component
- Number of channels in this component

Part III

Utilization

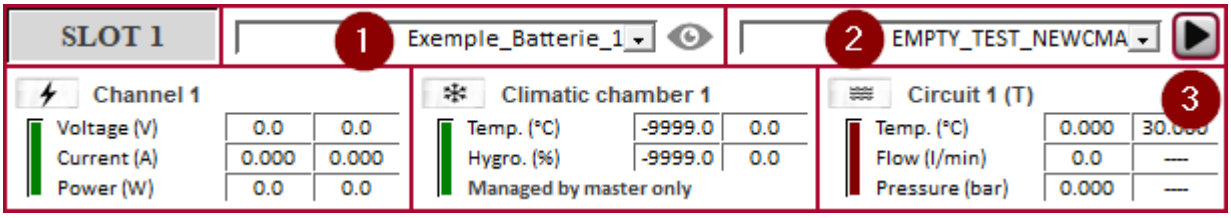
CHAPTER

SIX

STARTING AN INSTANCE

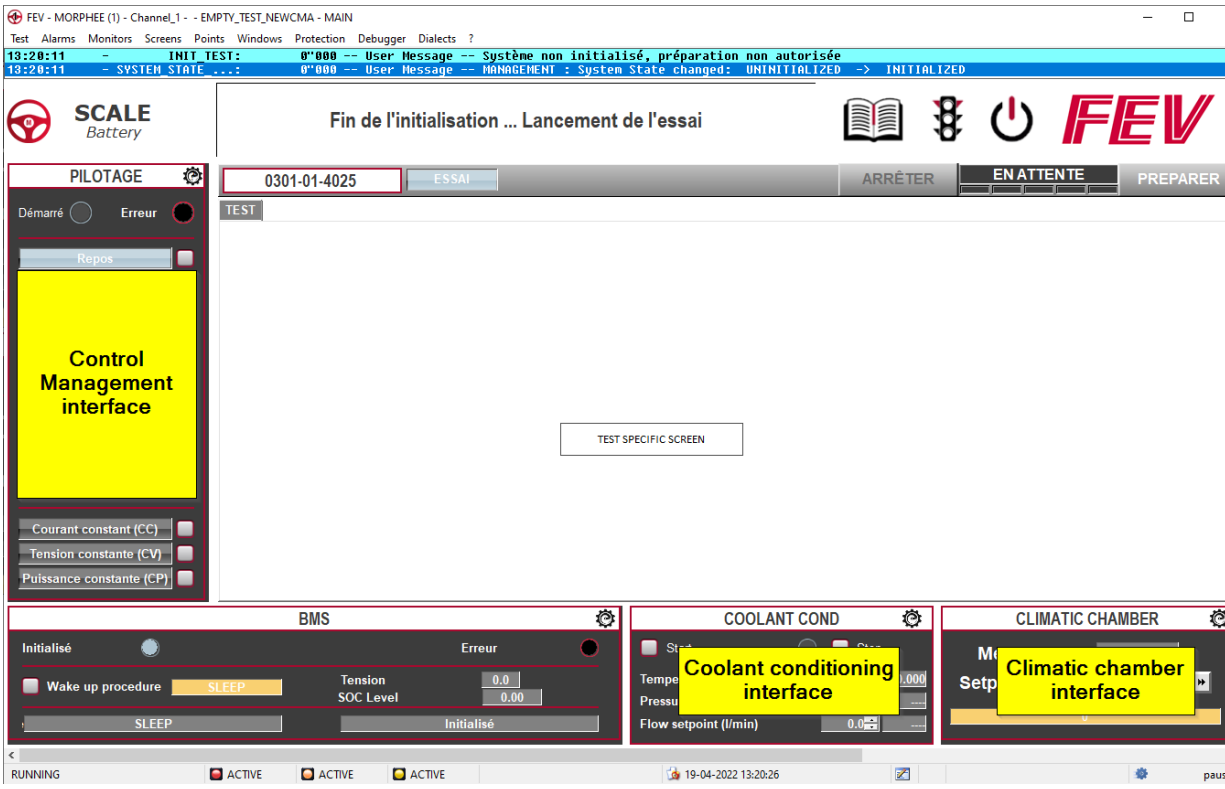
6.1 The first start

When your configuration is complete, you are ready to start your first instance. By default, you should see some battery description and at least one basic test (EMPTY_TEST_NEWCMA):



1. Select a battery definition
2. Select the test: EMPTY_TEST
3. Push the ‘PLAY BUTTON’

This should result in:



- In the top left, you should see the instance number
- On main screen:
  - The control Management interface
  - The coolant conditioning interface
  - The climatic chamber interface

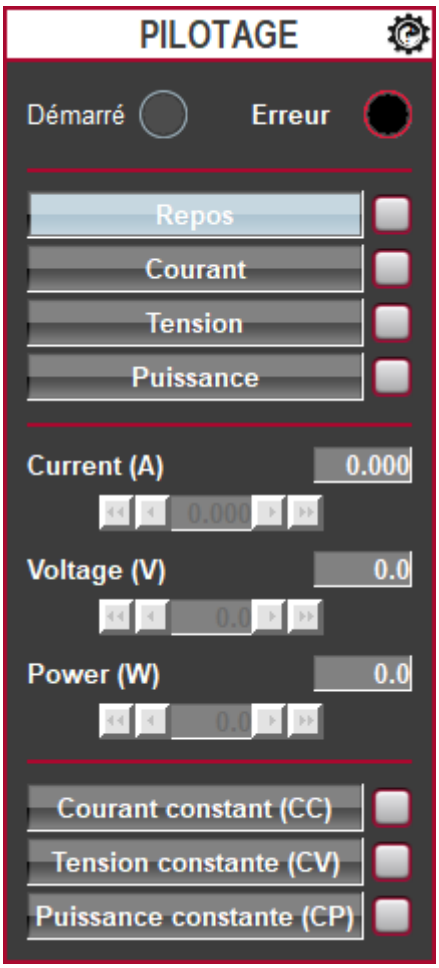
6.2 Testing the functionnalities

6.2.1 The Control Management

Once the instance started, you should **PREPARE** the different component. For this, push the **PREPARE** button on the top right.

When prepared, you are ready to send commands to the related **ENERGY_SYSTEM**

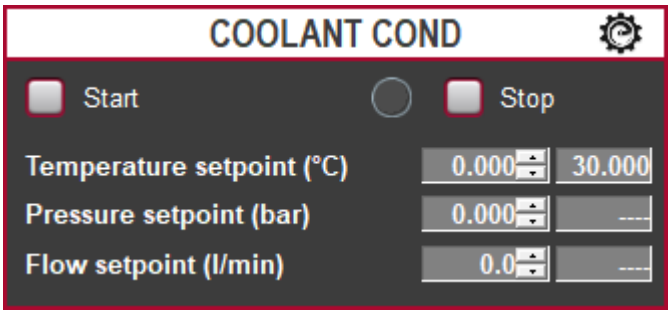
Note: Control Management



- States:
  - **Rest**: Battery is in Idle mode
  - **Current**: Battery is in Current mode
  - **Volatge**: Battery is in Voltage mode
  - **Power**: Battery is in Power mode
  - *Each button will select the related mode*
- When the mode is set:
  - Setpoint can be send through S_CMA.**f**_SET (where **f** is either I, V or P)
  - Measurement are read in R_CMA.**f**_ACT (where **f** is either I, V or P)
- Integrated function:
  - SET_CC: Integrated command to send current setpoint with voltage and duration limit.
  - SET_CV: Integrated command to send voltage setpoint with current and duration limit.
  - SET_CP: Integrated command to send power setpoint with voltage and duration limit.

6.2.2 The coolant conditioning

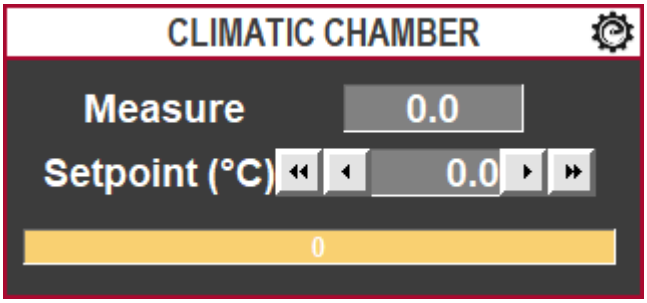
Note: Coolant conditionning



- Start the conditioning
  - When started, different setpoint are take into account
- Stop the conditioning

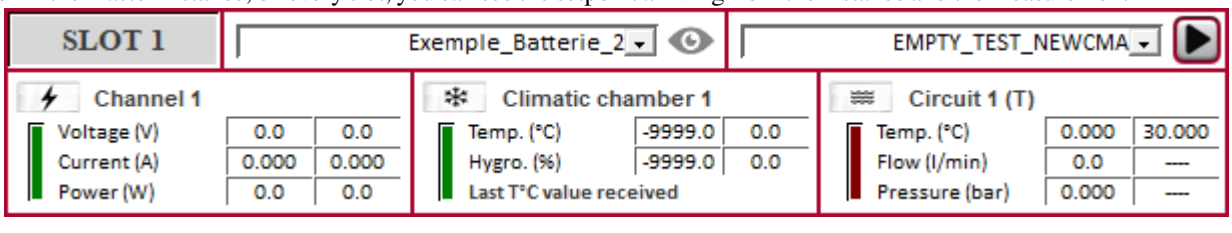
6.2.3 The climatic chamber

Note: Climatic Chamber



- Measurement
- Set point
- Status

Important: In the master instance, on every slot, you can see the setpoint arriving from the instance and the measurement going back;



CHAPTER

SEVEN

STARTING SEVERAL INSTANCES

Attention: THIS
SECTION
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UNDER
CONSTRUCTION

Part IV

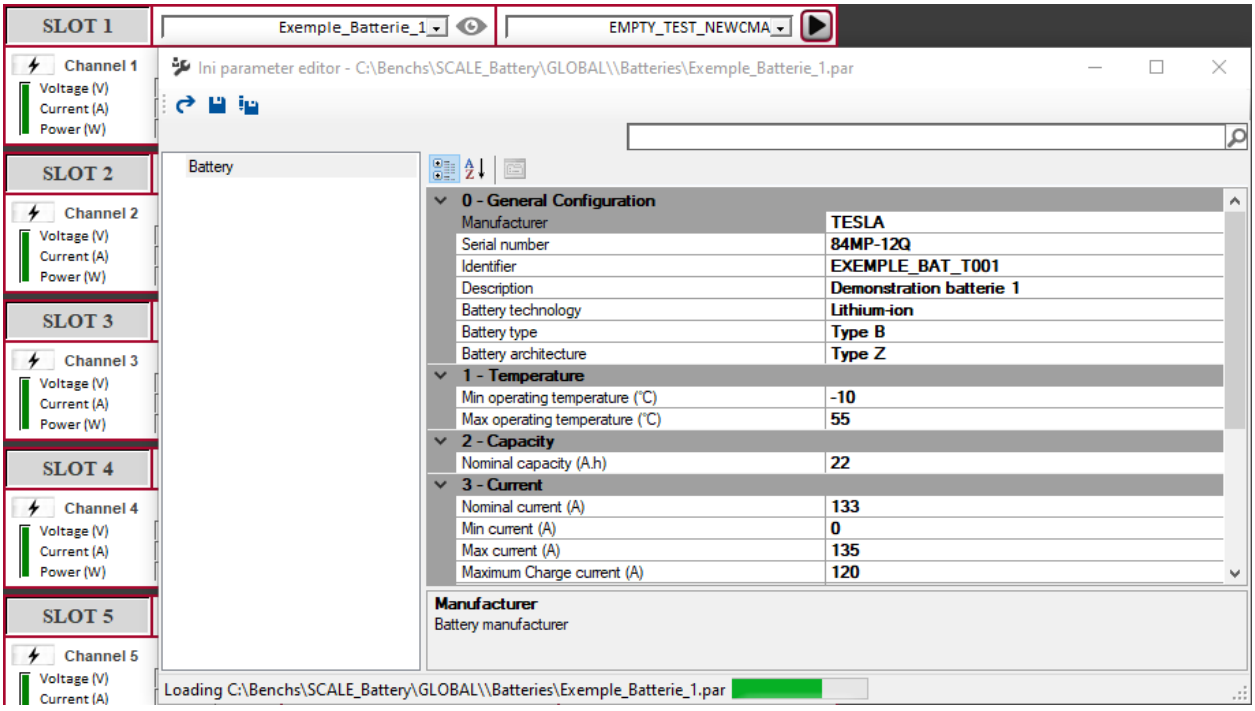
Reference Guide

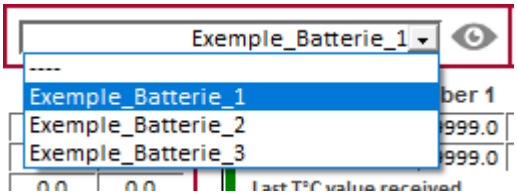
CHAPTER

EIGHT

INTERFACING THROUGH FILE

Attention: THIS SECTION IS UNDER CONSTRUCTION





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[DB]
P_DUT.MANUFACTURER=TESLA
P_DUT.SERIAL_NUMBER=84MP-12Q
P_DUT.CAPACITY_NOM=22
P_DUT.CURRENT_NOM=133
P_DUT.CURRENT_MIN=0
P_DUT.CURRENT_MAX=135
P_DUT.CURRENT_CHARGE_MAX=120
P_DUT.CURRENT_DISCHARGE_MAX=-122
P_DUT.POWER_NOM=130
P_DUT.POWER_MIN=0
P_DUT.POWER_MAX=135
P_DUT.VOLTAGE_NOM=180
P_DUT.VOLTAGE_MAX=200
P_DUT.VOLTAGE_MIN=80
P_DUT.VOLTAGE_CHARGE_MAX=175
P_DUT.VOLTAGE_DISCHARGE_MAX=100
P_DUT.TYPE=1
P_DUT.ARCHITECTURE=2
P_DUT.TECHNOLOGY=0
P_DUT.DESCRIPTION=Demonstration batterie 1
P_DUT.OPERATING_TEMP_MIN=-10
P_DUT.OPERATING_TEMP_MAX=55
P_DUT.IDENTIFIER=EXEMPLE_BAT_T001
```

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<?xml version="1.0" encoding="utf-8" ?>
<ConfigDesc>
        <Group Id="Battery">
                <Category Id="0 - General Configuration">
                        <Property Section="DB" Field="P_DUT.MANUFACTURER" Type=
↪"NotEmptyString" DisplayName="Manufacturer" Description="Battery manufacturer" />
                        <Property Section="DB" Field="P_DUT.SERIAL_NUMBER" Type=
↪"NotEmptyString" DisplayName="Serial number" Description="Battery serial number"/>
                        <Property Section="DB" Field="P_DUT.IDENTIFIER" Type=
↪"NotEmptyString" DisplayName="Identifier" Description="Unique identifier"/>
                        <Property Section="DB" Field="P_DUT.DESCRIPTION" Type="String
↪" DisplayName="Description" Description="Free description field"/>
                        <Property Section="DB" Field="P_DUT.TECHNOLOGY"  Type="Int[0,
↪3]" DisplayName="Battery technology" Description="Battery technology" DefaultValue=
↪"1">
                                <TypeConverter Localizable="false">
                                        <Value Value="0" DisplayValue="Lithium-ion" />
                                        <Value Value="1" DisplayValue="Lithium-sulphur
↪" />
                                        <Value Value="2" DisplayValue="Aluminium-air"␣
↪/>
                                </TypeConverter>
                        </Property>
                        <Property Section="DB" Field="P_DUT.TYPE"  Type="Int[0,2]"␣
↪DisplayName="Battery type" Description="Battery type (A, B or C)" DefaultValue="1">
                                <TypeConverter Localizable="false">
                                        <Value Value="0" DisplayValue="Type A" />
                                        <Value Value="1" DisplayValue="Type B" />
                                        <Value Value="2" DisplayValue="Type C" />
                                </TypeConverter>
                        </Property>
```

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```
                        <Property Section="DB" Field="P_DUT.ARCHITECTURE"  Type=
↪"Int[0,2]" DisplayName="Battery architecture" Description="Battery architecture (X,␣
↪Y or Z)" DefaultValue="0">
                                <TypeConverter Localizable="false">
                                        <Value Value="0" DisplayValue="Type X" />
                                        <Value Value="1" DisplayValue="Type Y" />
                                        <Value Value="2" DisplayValue="Type Z" />
                                </TypeConverter>
                        </Property>
                </Category>
                <Category Id="1 - Temperature">
                        <Property Section="DB" Field="P_DUT.OPERATING_TEMP_MIN" Type=
↪"Int[-100,100]" DisplayName="Min operating temperature (°C)" Description="Minimum␣
↪temperature" />
                        <Property Section="DB" Field="P_DUT.OPERATING_TEMP_MAX" Type=
↪"Int[-100,100]" DisplayName="Max operating temperature (°C)" Description="Maximum␣
↪temperature"/>
                </Category>
                <Category Id="2 - Capacity">
                        <Property Section="DB" Field="P_DUT.CAPACITY_NOM" Type="Int[0,
↪2000]" DisplayName="Nominal capacity (A.h)" Description="Battery capacity" />
                </Category>
                <Category Id="3 - Current">
                        <Property Section="DB" Field="P_DUT.CURRENT_NOM" Type="Int[0,
↪1000]" DisplayName="Nominal current (A)" Description="Battery nominal current" />
                        <Property Section="DB" Field="P_DUT.CURRENT_MIN" Type="Int[0,
↪1000]" DisplayName="Min current (A)" Description="Battery minimum current" />
                        <Property Section="DB" Field="P_DUT.CURRENT_MAX" Type="Int[0,
↪1000]" DisplayName="Max current (A)" Description="Battery maximum current" />
                        <Property Section="DB" Field="P_DUT.CURRENT_CHARGE_MAX" Type=
↪"Int[0,1000]" DisplayName="Maximum Charge current (A)" Description="Maximum charge␣
↪current" />
                        <Property Section="DB" Field="P_DUT.CURRENT_DISCHARGE_MAX"␣
↪Type="Int[-1000,0]" DisplayName="Maximum discharge current (A)" Description=
↪"Maximum discharge current" />
                </Category>
                <Category Id="4 - Voltage">
                        <Property Section="DB" Field="P_DUT.VOLTAGE_NOM" Type="Int[0,
↪1000]" DisplayName="Nominal voltage (V)" Description="Battery nominal voltage" />
                        <Property Section="DB" Field="P_DUT.VOLTAGE_MIN" Type="Int[0,
↪1000]" DisplayName="Min voltage (V)" Description="Battery minimum voltage" />
                        <Property Section="DB" Field="P_DUT.VOLTAGE_MAX" Type="Int[0,
↪1000]" DisplayName="Max voltage (V)" Description="Battery maximum voltage" />
                        <Property Section="DB" Field="P_DUT.VOLTAGE_CHARGE_MAX" Type=
↪"Int[0,1000]" DisplayName="Maximum Charge voltage (V)" Description="Maximum charge␣
↪voltage" />
                        <Property Section="DB" Field="P_DUT.VOLTAGE_DISCHARGE_MAX"␣
↪Type="Int[0,1000]" DisplayName="Maximum discharge voltage (V)" Description="Maximum␣
↪discharge voltage" />
                </Category>
                <Category Id="5 - Power">
                        <Property Section="DB" Field="P_DUT.POWER_NOM" Type="Int[0,
↪1000]" DisplayName="Nominal power (kW)" Description="Battery nominal power" />
                        <Property Section="DB" Field="P_DUT.POWER_MIN" Type="Int[0,
↪1000]" DisplayName="Min power (kW)" Description="Battery minimum power" />
                        <Property Section="DB" Field="P_DUT.POWER_MAX" Type="Int[0,
↪1000]" DisplayName="Max power (kW)" Description="Battery maximum power" />
```

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```
                </Category>
        </Group>
</ConfigDesc>
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CHAPTER

NINE

INTERFACING WITH FLEXLAB

Attention: THIS
SECTION
IS
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CONSTRUCTION

CHAPTER

TEN

COMPONENT CONFIGURATION

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CHAPTER

ELEVEN

WRITING A TEST

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