Large cell

USER MANUAL

Model number	Description
M05W-144-0063	ESS module 144V 63F basic
M35W-144-0063	ESS module 144V 63F with CMS (Capacitor Management System)
M05W-144-P063	ESS module 144V 63F with Power cells basic
M35W-144-P063	ESS module 144V 63F with CMS (Capacitor Management System) and Power cells

Revision history:

Document version	Change description	Date
1	Original document	21-05-05
2	Addition of CAN bus protocol	23-10-12

Contents

1 Introduction

The purpose of this user manual is to provide a functional description and installation information of the SECH 144V module used in grid energy storage applications.

The Energy Storage System module (ESS module) form SECH is self-contained power storage device comprised of individual SECH ultracapacitors connected in series.
The module integrated cell voltage balancing management system (CMS) and as well temperature measurement. The values of these measurements can be retrieved by CAN communication. The module includes also 1 digital output for a status signal.

Multiple modules may be connected in series to obtain higher operating voltages, in parallel to provide additional energy storage, or a combination of series/parallel arrangements for higher voltages and energy.

2 Module features

SECH 144V ESS module is fully functional energy storage systems addressing energy and power requirements for Grid Energy Storage applications. The module has been designed in a way to be integrated into 19” racks. With a height of 4U, the module can be stacked into the rack leaving a space of about 2cm between the module for a cooling channel.
The 48 cells are connected in series with strong laser weld. The laminated busbars provide very high insulation level with a good thermal conductivity. The module is intentionally open with a protection rate IP00, eliminating all unnecessary housing interfering the thermal dissipation.

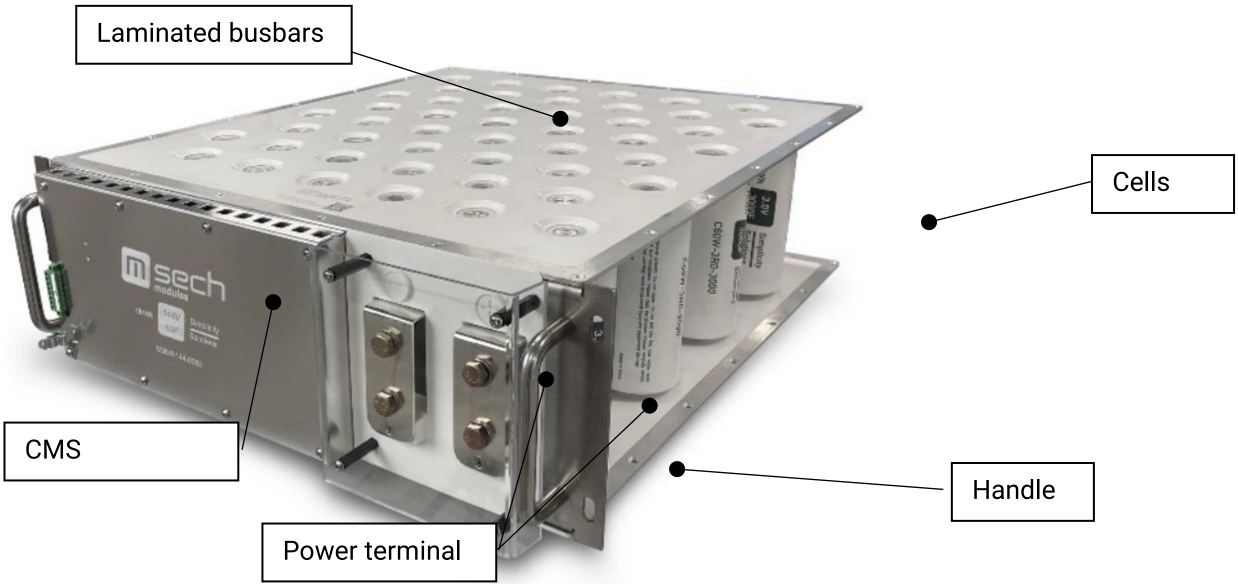


Figure 1: SECH ESS module features

2.1 Front panel

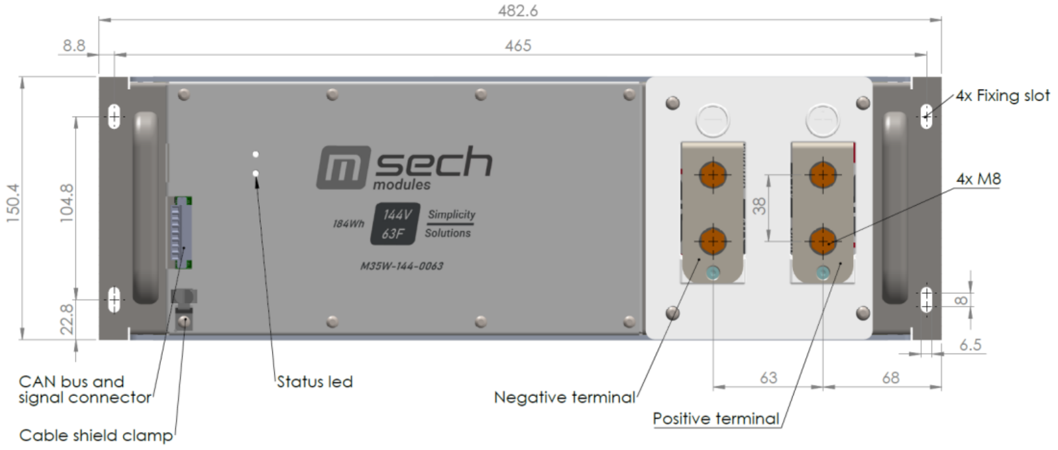


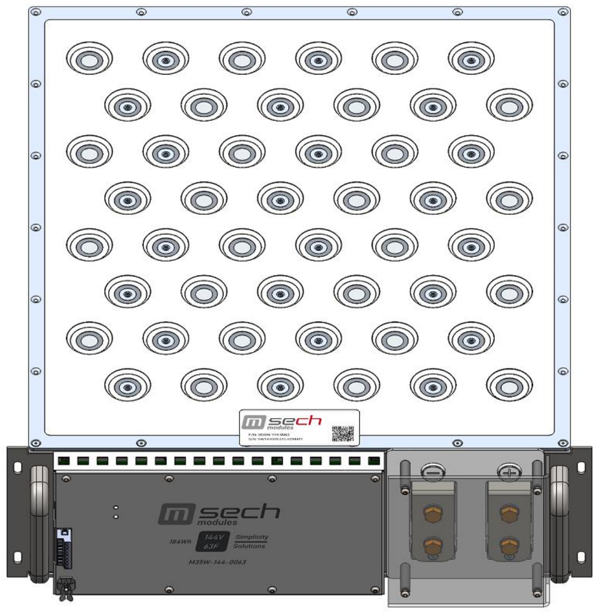
Figure 2 Front panel

The front panel offer all necessary connections for the power and the signals. Intentionally, the power connections are on one side when the signals are on the other side. This eases the wiring for the user and avoid cross of power and signal cables/busbars.

WARNING
The power connectors are not protected against touch and are rated IP00. It is the responsibility of the user to comply with the local rules and regulations.

2.2 Supercapacitors connection

The 48 cells are connected in series with pure aluminum connectors strongly welded around the post of the cells. There is a total of 96 welds.



WARNING
The welded connections are intentionally not protected against touch and are rated IP00. It is the responsibility of the user to comply with the local rules and regulations.

3 Installation

3.1 Safety notice

!! PLEASE TAKE ALL NECESSARY PRECAUTIONS WHEN HANDLING THE MODULE.

Ultracapacitor modules are electrical energy storage devices that may contain more than enough electrical energy to cause serious bodily injury or even death when improperly operated or when proper safety precautions are not taken.

Visit www.sechsa.com and download the appropriate datasheet for your module.

The modules are shipped in carton box packaging.

3.2 Unboxing

Step 1: Cut the cardboard box open with precaution in order to not touch the module itself.

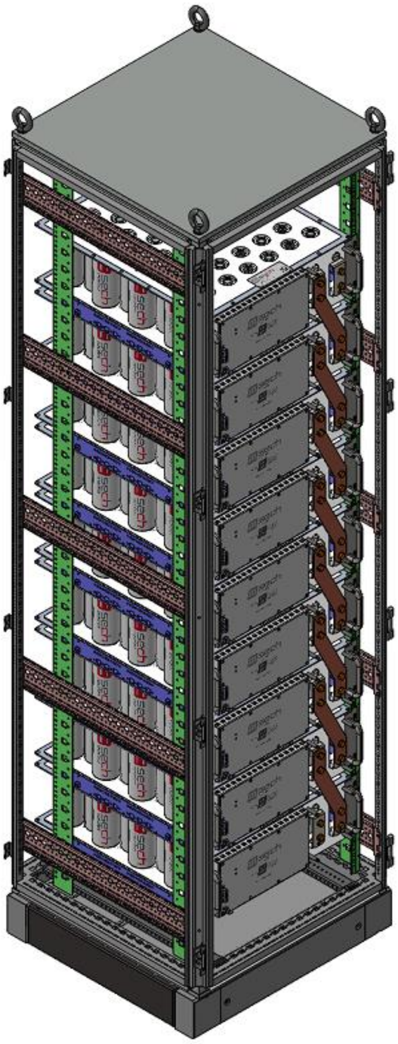
Step 2: Remove protection from around the module

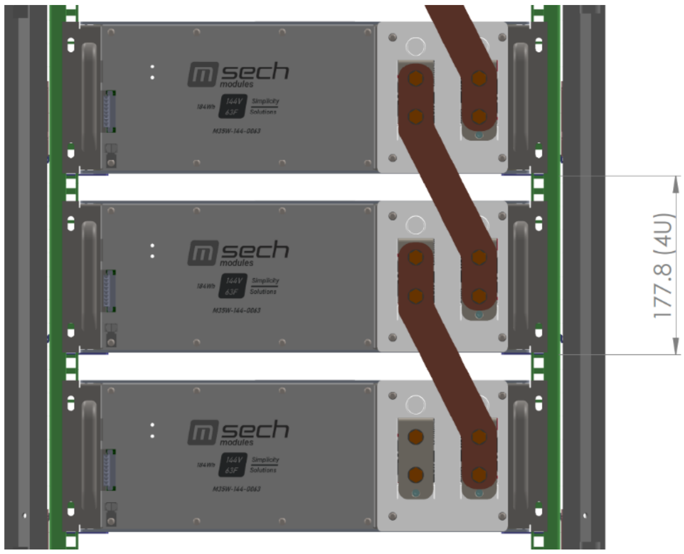
Step 3: Lift the module out of the cardboard box.

The module is 32kg and must be carried by 2 persons. Do not attend to lift it on your own as it might results in injuries.

3.3 Mounting

The ESS module is designed to fit into 19” rack. The height of 4U is advised to create an air-cooling channel between the modules and also the necessary electrical insulation distance.





2 sliders per modules according rack manufacturer instruction and 4 cage nuts will be used to fix the modules. The distance between 2 sliders sets must be 4U (177.8mm). The rack as well as the sliders and the other mechanical support must be dimensioned to hold the weight of the modules.

3.4 Power connection

The power terminals are located on the front of the module. They are designed with a large flat area to ensure a good electrical connection and minimize the contact resistance. They are made of copper and are tin coated to prevent oxidation.

WARNING

The power terminals as well as the module are not touch proof. The Ingres Protection grade is 00 (IP00). It is the responsibility of the user to install all necessary protection to insure the conformity to the local rules and regulation.

If there is no shorting wire present, measure the terminal-to-terminal voltage on the module to ensure worker safety.

The final user must make sure that standard precaution with high power equipment is taken during the power line connection.

There is multiple way to connect the ESS modules. Copper busbars 3mm thick and 35mm wide (105mm^2) should be preferred.

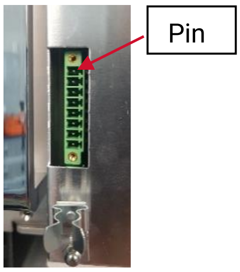
The copper busbars are secured with 2 screws M8. The torque should be 14Nm. Safety washers should be used to prevent any unlocking.

3.5 Communication line

Prepare the communication X1 cables according to the following instruction and to the configuration of your system.

3.5.1 Pinout

Pin	Signal	Description
1	+24V	+24V Control voltage IO (for error-output)
2	Error-output	Open-collector, low = error, high = ok
3	0V GNDIO[1]	GNC for +24V control voltage IO
4	CAN GNC[1]	CAN GND
5	CAN Low	CAN LOW
6	CAN High	CAN High
7	+24V	+24 Control voltage (for module electronic)
8	0V[1]	GND for 24V Control voltage



[1] do not connect pin 3,4 and 8, max. voltage allowed between pins 3, 4, 8 and PE = 42V

3.5.2 24V

The can communication must be powered with 24V. See the datasheet for details.
The wires cross-section must be sufficient to carry the total communication current of all connected modules (~200mA per module).

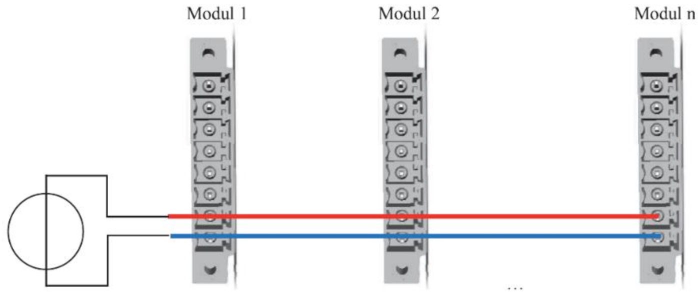


Figure 3: X1 connector 24V connection

3.5.3 CAN

For the CAN, the linear form of connection is recommended. A 120Ω resistor between CAN-L and CAN-H at both ends of the line is necessary to close the data bus.

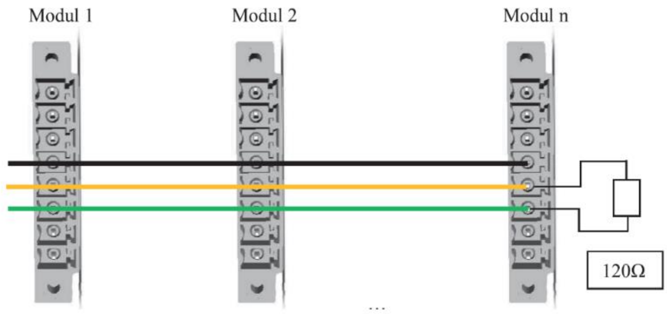


Figure 4: X1 connector CAN connection

3.5.4 Error output

Each CMS has an open-collector error output. "Low" means error, "high" means no error. Several boards can be connected with a pull-up resistor (2.4kΩ....4kΩ; max. 10mA) to a OR connection. For example, an LED can be used to indicate a summery fault error.

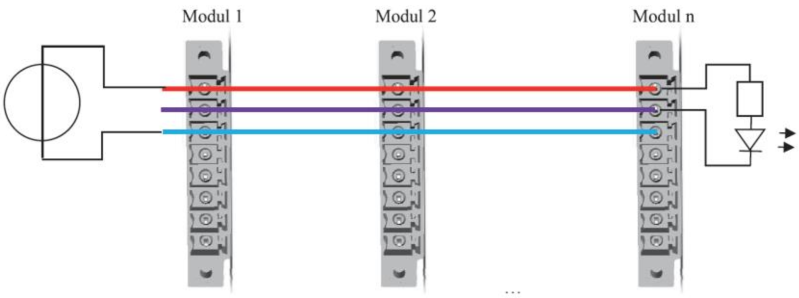


Figure 5: X1 connector Error connection

3.5.5 Signal Cable Shielding

There is the possibility for the user to use the signal cable shield clamp. See pictures below an example of use.

Note that the 24V is not connected in the above pictures.

4 Module Monitoring and Balancing

4.1 Overview

ESS modules M35W-144-0063 and M35W-144-P063 are equipped with an electronic board, called CMS (Capacitor Management System) whose functions are:

- Balancing
- Monitoring
- Diagnostic
- Communication

In order to simplify the integration of multiple modules in a complex system, SECH proposes the use of a Module Control Unit (MCU) as an option. The MCU communicates with the ESS modules via CAN (ModulCAN[1]), acquires the data of the individual modules and evaluates them. It provides system information to a higher-level controller via CAN (ControlCAN[2]), which can also be used for diagnostics, but as well for commissioning and parameterization.

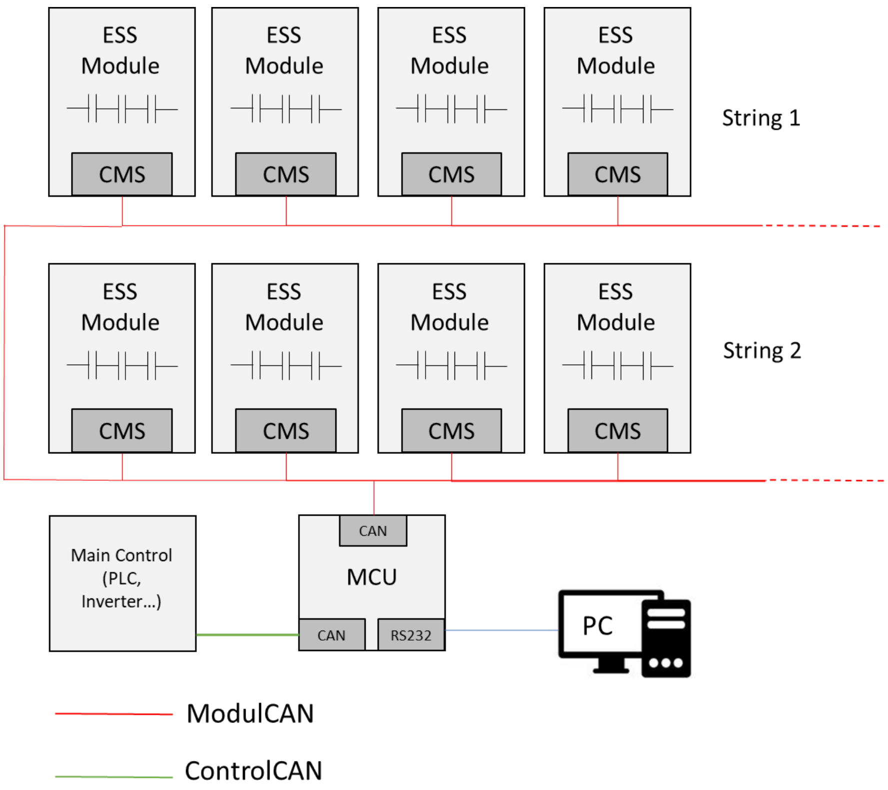


Figure 6: System overview

[1] See 4.3 ModuleCAN
[2] See document MCU TwinCAN - ControlCAN_Ver1.pdf for details

4.2 Capacitor Management System (CMS)

4.2.1 Overview

From a module voltage of 22V, the CMS becomes active even without an external 24V supply. The CMS is then powered from the supercapacitors. This guarantees the monitoring of the cell voltages and temperature already from this voltage. Any events are logged by the module. An external supply is required to retrieve the data via CAN. The following basic measures are recorded:

- Total voltage of the module
- Voltage of each cell[3]
- Cell temperature at 4 measuring points

4.2.2 Monitoring

The individual cell voltage is evaluated both in absolute terms and in relation to each other. The average, maximum and minimum voltage values of the cells are determined. The sum of the cell voltages is as well compared with the module measured total voltage. The maximum and minimum temperature are also determined. These values, as well as derived status information, are provided through the ModulCAN.

The CMS reports warnings or errors if:

- One or more cells exceed the parameterized maximum voltage value. The warning and error thresholds can be adjusted.
- The difference between the lowest and highest cell voltage exceeds a permissible limit. The warning and error thresholds can be adjusted.
- The difference between the sum of the cell voltages and the measured module voltage is too large. This is interpreted as a malfunction of the measurement system, e.g. failure of a single cell voltage measurement. The permissible difference can be adjusted.
- The total voltage exceeds the set maximum values. The warning and error thresholds can be adjusted.
- The peak value of the temperature sensors exceeds the set maximum value. The warning and error thresholds can be adjusted.

Furthermore, there is a self-monitoring of the module, which monitors the execution behavior and the integrity of the parameter memory. Faults are reported as system errors.

4.2.3 Balancing

Several ways to balance cell voltage are used. Passive balancing affects the cells at any time, regardless of the state of the module or the power supply of the assembly. This is realized with a resistance (130Ω) connected in parallel to each cell.
An active balancing is realized by allowing additional resistors to be switched on to each cell depending on its state, thereby increasing the balancing current (=discharge current) on this cell. Active balancing depends on a number of conditions:

1. Regardless of module voltage or cell stress distribution, a cell that exceeds a maximum value is balanced. This value is adjustable and depends on the cell type.
2. From a module voltage of 100V (or other adjustable value), the balancing logic evaluates additionally the voltage distribution of the cells. The difference of each cell to the average voltage is calculated and for cells that have a too high positive deviation, the active balancing is activated. The threshold value for the deviation is adjustable.
3. condition 1) and 2) are continuously checked for each cell until no condition is met or until the maximum number of simultaneously balanced cells[4] is reached. In addition, restriction due to the symmetry resistors layout is observed in order to better distribute the power dissipation.

[3] Independent of external 24V supply, the measurement of cell voltages is only possible from a module voltage of >30V. This value is technical, but can be changed via parameters for testing purposes
[4] Adjustable, but not currently part of the parameters

The active balancing can therefore be activated for 2 reasons:

- Active balancing type 1 (see Figure 8: active balancing type 1): Exceeding the maximum value of a cell voltage. The portion marked in red is unloaded by the balancing.
- Active balancing type 2 (see Figure 7): Exceeding the maximum difference to the average value of cell stresses. The low cell does not respond.

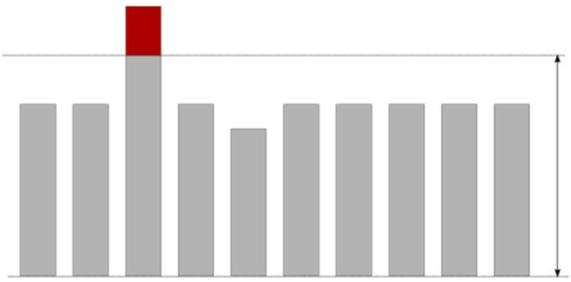


Figure 8: active balancing type 1

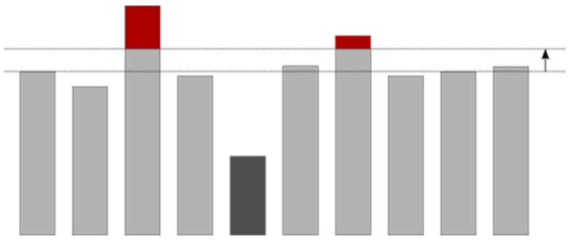


Figure 7: Active balancing type 2

4.2.4 Services

In addition to the monitoring and balancing, the CMS also contains a number of service functions:

- **System Parameters for adapting functionality to different module or cell types.**
- **Event Logger that saves module's warnings, errors, and messages.**
- **Firmware update**
- **Communication module to provide collected data via CAN, fibre optic or service interface. Depending on the type of communication, different data are available, e.g. the Event Logger can be read out via the service interface.**

4.2.5 Communication parameters

Parameter	Default value	Description
CAN Send Auto	not activated	By default, the module sends data only on request.
CAN Send Cycle	500 ms	Cycle in which the module sends data if automatic sending of data is configured.
CAN Baudrate	500 kbit/s	CAN Baudrate on the ModuleCAN
CAN ID Offset	0	Offset for the CAN identifiers. Usable when collision with other participants in the ModuleCAN
CAN ID 29Bit active	not activated	By default, the module uses 11Bit Identifier

4.2.6 Monitoring parameters

Parameter	Default value	Description
Module Voltage Warning Threshold	143.0 V	Limits from which warnings or errors are reported by the module.
Module Voltage Error Threshold	148.0 V	
Cell Voltage Warning Threshold	3.0 V	
Cell Voltage Error Threshold	3.1 V	
Cell voltage delta Warning Threshold	300 mV	
Cell voltage delta Error Threshold	600 mV	
Temperature Warning Threshold	60 °C	
Temperature Error Threshold	65 °C	
Max Measurement Plausibility Deviation	1.8 V	Maximum permissible deviation between sum of cell voltages and measured module voltage
Minimum Voltage for Cell voltage Measurement activation	30 V	Only from this module voltage is measurement of the cell voltages possible.

4.2.7 Balancing parameters

Parameter	Default value	Description
Maximum Cell Voltage Value	3V	Maximum value that a cell can support before balancing becomes active.
Maximum Deviation to Average	150mV	Maximum value that a cell can deviate from the voltage average before active balancing is activated. The cell voltage must be higher than the average.
Hysteresis	10mV	Hysteresis for switching on/off the balancing
Minimum voltage activation	100V	minimum voltage of the module before balancing is authorized.

4.2.8 Identification

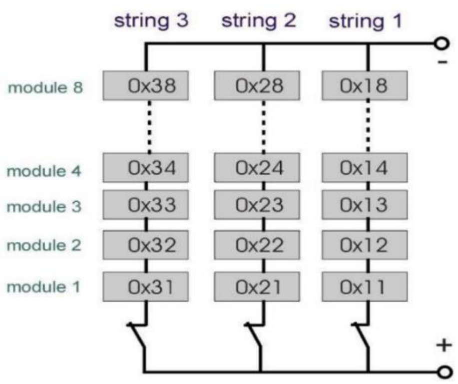
Each module has a personal ID with which it can be used for data queries or assignment of measurement data and
errors which can be identified. These module IDs must be uniquely and clearly assigned within a energy storage or CAN segment.

An ID is one byte in size and encodes both the string to which the module belongs (High Nibble) as well as the number of the module in the string (Low Nibble). Since a 0 should not occur, a maximum of 15 strings can be addressed, whereby each string can contain and be addressed by up to 15 modules.

Example:

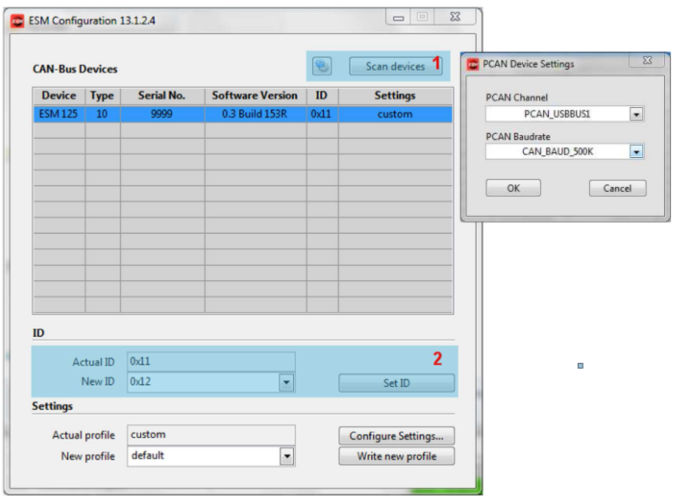
The first string has the IDs 0x11, 0x12, 0x13... 0x18, the third string the IDs 0x31, 0x32, 0x33...0x38 where only as many IDs are assigned like a string of modules contains.

In this example and case, the number of strings = 3 and the total number of modules = 24.



4.2.9 ID and Profile Setting

The "ESM Configuration" tool is used to parameterize the ESS module. The modules must be supplied with 24V and must be addressable via CAN. The configuration is recommended after the wiring to the desired ESS, as then the classification of serial numbers to the strings can be fixed.



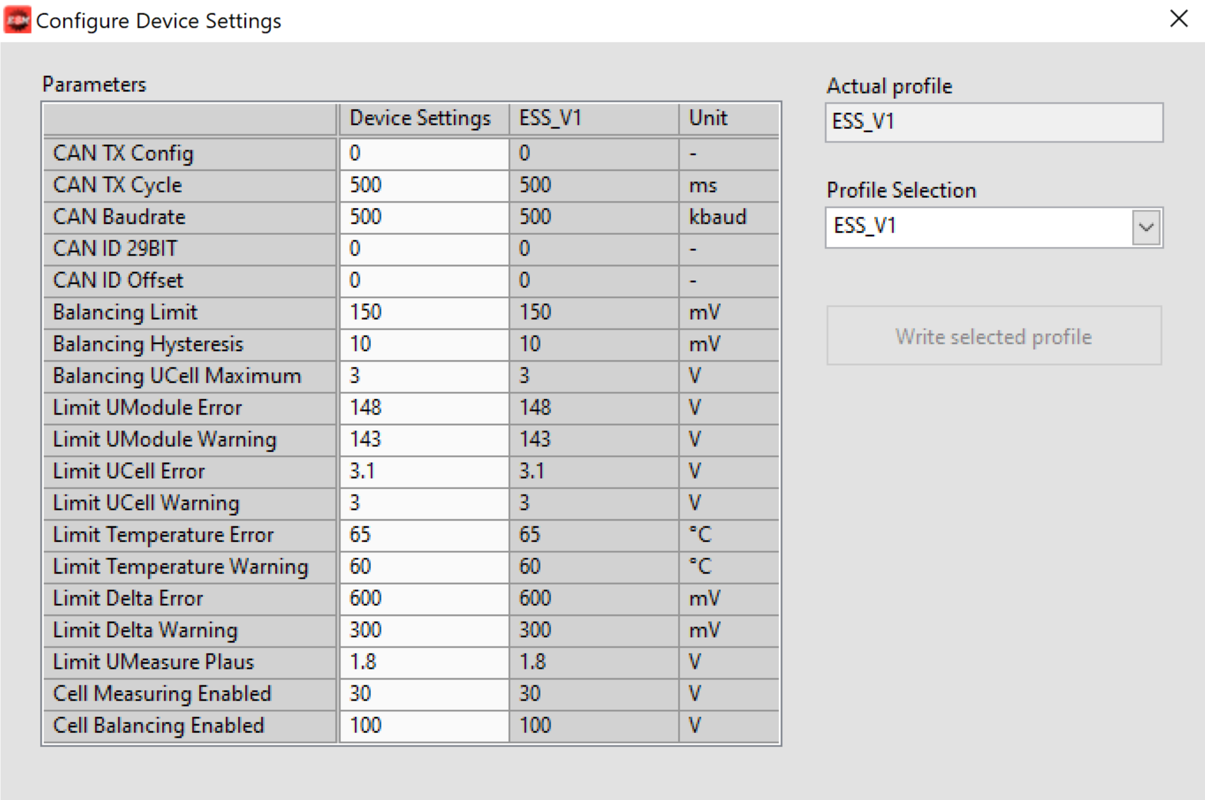
If the tool is started for the first time, you can use the gear symbol to open the dialog "PCAN Device Settings" and specify the baud rate and the adapter used. This is only necessary if several PCAN-USB adapters are connected to the PC. These settings will be retained with a restart of the program.

In step 1, the CAN bus is scanned for existing modules. The found modules are displayed in the table below. This shows the module type (Device, Type), serial number and software version of the module and how it is configured (ID, Settings).

In step 2, the module ID and parameters of the module can now be changed. By clicking in a table line, the respective module is selected on the basis of the serial number. Then the desired ID can be selected via the dropdown field "New ID" and set via the button "Set ID". The tool then automatically performs a new scan and the table will be updated.

Since all modules have the ID 0x00 in the default state, not all information is displayed during the first scan. Only after a valid ID has been assigned all data be retrieved from the module or parameters can be changed.

The other module parameters can be set by selecting a parameter profile or individually via the "Configure Settings" button (see picture below) The Settings column shows the name of the parameter profile in the first case and the entry "custom" in the second case. In most cases, the settings can be left at the default values ("default" profile). Profiles can be adjusted simply via a text editor.



	Device Settings	ESS_V1	Unit
CAN TX Config	0	0	-
CAN TX Cycle	500	500	ms
CAN Baudrate	500	500	kbaud
CAN ID 29BIT	0	0	-
CAN ID Offset	0	0	-
Balancing Limit	150	150	mV
Balancing Hysteresis	10	10	mV
Balancing UCell Maximum	3	3	V
Limit UModule Error	148	148	V
Limit UModule Warning	143	143	V
Limit UCell Error	3.1	3.1	V
Limit UCell Warning	3	3	V
Limit Temperature Error	65	65	°C
Limit Temperature Warning	60	60	°C
Limit Delta Error	600	600	mV
Limit Delta Warning	300	300	mV
Limit UMeasure Plaus	1.8	1.8	V
Cell Measuring Enabled	30	30	V
Cell Balancing Enabled	100	100	V

4.3 ModuleCAN

The ModuleCAN connects all modules and allows data to be queried by a master that controls and evaluates communication. Functions in the ModuleCAN are:

- Recognition of all connected modules (scan)
- Query of measured values and status of each module (monitoring)
- Configuration modules (GetID, Restart, ...)

CAN specification:

- CAN Standard 2.0A (B)
- Length of the used identifier: 11 Bit (29 Bit)
- Baud rate: 500 kbaud (default)

4.3.1 CAN identifier

The identifier is formed from a protocol number and a configurable module ID. The module ID consists of a string number and a string related module number. The protocol number determines the type of message (content) and the module ID is used for unique addressing and assignment of a module.

10	9	8	7	6	5	4	3	2	1	0
Protocol number			String number				Module number			
1..7			1..15				1..15			

Module ID

Table 4-1: CAN Identifier structure for module CAN

The convention is the following:
CAN-IDdec = (Protocolnumber * 256) + (Stringnumber * 16) + Modulnumber
CAN-IDhex = $\text{Protocolnumber}_{hex}\text{Stringnumber}_{hex}\text{Modulnumber}_{hex}$

4.3.2 Broadcasts

The service protocols allow broadcasts to all modules (module ID = 0x00) or to all modules of only one string (module number = 0). The module or string number 0 is therefore reserved and cannot be assigned. Broadcasts have higher priority than direct addressing.

Example: Protocol number = 4 (0x4), String number. = 2 (0x2), Module number. = 10 (0xA)
CAN IDhex = 0x42A
CAN-IDhex = 0x420 (Broadcast to modules in string 2)
CAN-IDhex = 0x400 (Broadcast to all modules)

The modules respond to broadcast requests with a delay that depends on the module ID and the broadcast type. The **base delay** is **2ms** and is multiplied by the module ID or module number.

Example: Module ID 0x2A (module number 10 in string 2)
Broadcast Every2ms * Module-IDDec = 84ms
Broadcast String 2ms * Module No = 20ms

4.3.3 Protocol Overview

A distinction is made between process data (data logs) and service data (service logs). The latter allow you to send commands to the module, for example, to query the software version or trigger a restart. All U/INT16 or U/INT32 data types are sent with the least significant byte first. Empty data bytes of a CAN-Msg are unused. The value is arbitrary, but for the sake of clarity it should be described as 0.

	ProtNr	Description of the protocol	Direction	CAN-Msg
Process data	0	Data request	Rx	1
	1	Data 1: Module State	Tx	1
	2	Data 2: Cell State	Tx	1
	3	Data 3: State detail	Tx	1
	4	Data 4: Cell voltages	Tx	16
	5	Reserved	-	-
Service data	6	Service request (command)	Rx	1
	7	Service response	Tx	1

Table 4-2: Protocols in the Module CAN

4.3.4 Process data

Module data is requested via the protocol Data Request (Table 4-3). Depending on the content of the request, the corresponding data protocols are sent once or cyclically. The request has only 4 data bytes (DLC = 4).

ProtNr: 0		Data Request	
Byte	Type	Element	Description
0..1	WORD	TxConfig	Bit 0: Accept content of the request as AutoTx Bit 1: Send data 1: Status module Bit 2: Send data 2: Status cells Bit 3: Send data 3: Status detail Bit 4: Send data 4: Cell voltages
2..3	UINT16	TxCycle	TxCycle 1 inc = 10ms, Min. 50ms, Max. 10s, 0=AutoTx Off

Table 4-3: Protocol Data Request

4.3.5 Module data

There are 4 response protocols defined. The protocol Status Module (Table 4-4) provides the essential data and the status of the module.
If a warning or an error is reported, the log enables status details (Table 4-4) an identification of the cause. More than one error or warning may be active at the same time.
The Status Cells protocol (Table 4-6) is used to evaluate the cell voltage distribution. For analysis or monitoring purposes, the values of all cell voltages can be retrieved via the Cell Voltages (Table 4-11) log.

ProtNr: 1		**Data 1: Module Status**		
Byte	Type	Element	Description	Standardization
0..1	WORD	ModuleState	General module status	Definition in Table 4-5
2..3	UINT16	UModule	Module voltage [V]	1inc = 100mV
4	INT8	TCellMax	Highest cell temperature [°C]	1inc = 1K 0 = 0°C
5	INT8	TCellMin	Lowest cell temperature [°C]	
6	UINT8	ErrorCode	Code for last occurred error	
7	UINT8	LiveCount	0..255..0, incremented at each transfer	

Table 4-4: Protocol Data 1: Status Module

The LiveCount is used to monitor the module function. If it is incremented with each transmission, the module works and sends current data.

BitNr	Name	Description
ModuleState.0	ACTIVE_CELL_MEAS	Cell measurement is activated (Module voltage > LevelMeasOn)
ModuleState.1	ACTIVE_CELL_SYMM	Cell balancing is active (cells are out of tolerance)
ModuleState.2	ACTIVE_WARNING	At least one warning is set
ModuleState.3	ACTIVE_ERROR	At least one error is set

Table 4-5: Module State bits definition

ProtNr: 2		**Data 2: Cells Status**		
Byte	Type	Element	Description	Normalization
0..1	UINT16	UCellMax	Maximum cell voltage[V]	1inc = 5V / 2^{14}
2..3	UINT16	UCellMin	Minimum cell voltage[V]	
4..5	UINT16	UCellMean	Average cell voltage [V]	
6	UINT8	UCellMaxNr	Cell with maximum voltage	
7	UINT8	UCellMinNr	Cell with minimum voltage	

Table 4-6: Protocol Data 2: Cells State

ProtNr: 3		Data 3: State details	
Byte	Type	Element	Description
0..1	WORD	-	Reserved
2..3	WORD	Warning	Module warnings => Definition in Table 4-8
4..5	WORD	Error	Module error => Definition in Table 4-9
6..7	WORD	ErrorSys	System electronic error => Definition in Table 4-10

Table 4-7: Protocol Data 3: State details

BitNr	Name	Description
Warning.0	WARN_VOLT_MODULES	Module voltage via warning threshold
Warning.1	WARN_VOLT_CELL	Maximum cell voltage above warning threshold
Warning.2	WARN_TEMP_CELL	Maximum cell temperature above warning threshold
Warning.3	WARN_DELTA	Deviation max. cell to min. cell above warning threshold
…	…	…
Warning.7	CELL_CALIBRATION	Incorrect cell calibration or raw values mode

Table 4-8: Module Warning bits definition

BitNr	Name	Description
Error.0	ERR_VOLT_MODULES	Module voltage above error threshold
Error.1	ERR_VOLT_CELL	Maximum cell voltage above error threshold
Error.2	ERR_TEMP_CELL	Maximum cell temperature above error threshold
Error.3	ERR_DELTA	Deviation max. cell to min. cell above error threshold
Error.6	ERR_VOLT_PLAUS	Measurement voltage (cells or module) not plausible
Error.8	ERR_ID_BLOCK	No serial number and/or PCB number assigned

Table 4-9: Module error bits definition

BitNr	Name	Description
ErrorSys.0	ERR_SYS_WDT_INT	Internal watchdog has triggered
ErrorSys.1	ERR_SYS_WDT_EXT	External watchdog has triggered
ErrorSys.10	ERR_SYS_PAR_INIT	Initialization error Parameter
ErrorSys.11	ERR_SYS_PAR_EVAL	Initialization error Copy EEPROM data
ErrorSys.12	ERR_SYS_PAR_CRC	Checksum error EEPROM data
ErrorSys.13	ERR_SYS_EEPROM	Access error EEPROM

Table 4-10: System error bits definition

ProtNr: 4		**Data 4: Cells voltage**		
Byte	Type	Element	Description	Normalization
0	UINT8	MsgNr	0..15 MsgNr 0 = CellNr 1.. 3 etc... until MsgNr 15 = CellNr 46..48	
1	UINT8	Norm	Always 1 (=> 5V / 2^{14})	
2..3	UINT16	UCellData[1]	Cell voltage [V]	1inc = 5V / 2^{14}
4..5	UINT16	UCellData[2]		
6..7	UINT16	UCellData[3]		

Table 4-11: Protocol data 4: Cell voltages

When the cell voltage protocol is requested, the module responds with 16 messages that can be distinguished by the element MsgNr. Each message contains 3 cell voltage values in ascending order.

4.3.6 Service data

Service data is exchanged via two service protocols (request and response). The service protocols can be used for commands (type 0xA). The module does not respond to service requests as long as an old service request is still active. Corresponding CAN messages are rejected without response.

ProtNr: 6/7		Service request / answer	
Byte	Type	Element	Description
0	UINT8	Type	Type Service protocol 0xA (0x8A): Command protocol (error message)
1	UINT8	Code	Command code (CmdCode) (Table 4-14)
2	UINT8	Data	Service specific options/data
3	UINT8	Data	Service specific options/data
4	UINT8	Data	Service specific options/data
5	UINT8	Data	Service specific options/data
6	UINT8	Data	Service specific options/data
7	UINT8	ErrCode	Error Code (Table 4-13)

Table 4-12: Structure of the service protocols

Errors are indicated by the service type 0x8A (bit 7 in the Type element is set) and specified by an error code (ErrCode) on byte 7 of the response message.
Data bytes 2..6 are zero in this case.

ErrCode	Designation	Description
0x6	RC_WRONG_SIZE	Value has wrong size
0x7	RC_VALUE_HIGH	Value too high
0x8	RC_VALUE_LOW	Value too small
0x9	RC_READ_ONLY	Write attempt on ReadOnly
0xB	RC_PERM_DENIED	No access authorization
0xE	RC_WRONG_STATE_WRITE	Writing not allowed in the current state
0xF	RC_INVALID_DATA	Invalid data (e.g. invalid service type)
0x20	RC_CMD_NOT_EXIST	Command unknown (CmdCode does not exist)

Table 4-13: Definition of error codes for service logs

4.3.7 Command Protocol

The command protocol is used to request identification data and to send simple control commands. The command code (CmdCode) determines the type of the command. Modules with the ID 0x00 only respond to the *GetID* command.

CmdCode	Command	Description	Broadcast
Operation			
0x1	GetID (polling)	Query identification (ModuleID, Serial No.)	Yes
0x20	GetVersion	Query software version	Yes
0x21	Restart module	e.g. after changing baud rate, module-ID	Yes

Table 4-14: Command codes of the module

In Table 4-15 to Table 4-17 are the command-specific assignments of the data bytes 2 to 7 are given. Byte 0 always corresponds to the service type 0xA and byte 1 to the respective command code. Data bytes without content are 0. Data without specified scaling must be interpreted as pure decimal value/hex value.

Cmd 0x1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Answer	UINT16	UINT32				
	ModuleID	SerialNr (serial number module)				

Table 4-15: Command GetID

Cmd 0x20	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Answer	UINT8	UINT8	UINT16		CHAR	UINT8
	SwHigh	SwLow	SwBuildNr		SwVariant	Type Modules

Table 4-16: Command GetVersion

The element *SwVariant* can take the values R (Release) and D (Debug).

Cmd 0x21	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Request	UINT8					
	RestartMode					

Table 4-17: Restart module command

If RestartMode = 0x01, the module starts the bootloader after the reset, otherwise a normal reset of the module is executed. If the command is given as a broadcast, a normal reset is always performed.

4.4 MCU (option)

The MCU (Master Control Unit) can be purchased optionally to supervise the ESS modules installed. The MCU is scanning the ModulCAN for existing modules and based on the IDs it receives, will recognize the string configuration of the system automatically. The MCU can currently be configured to monitor up to 32 modules on one CAN segment.

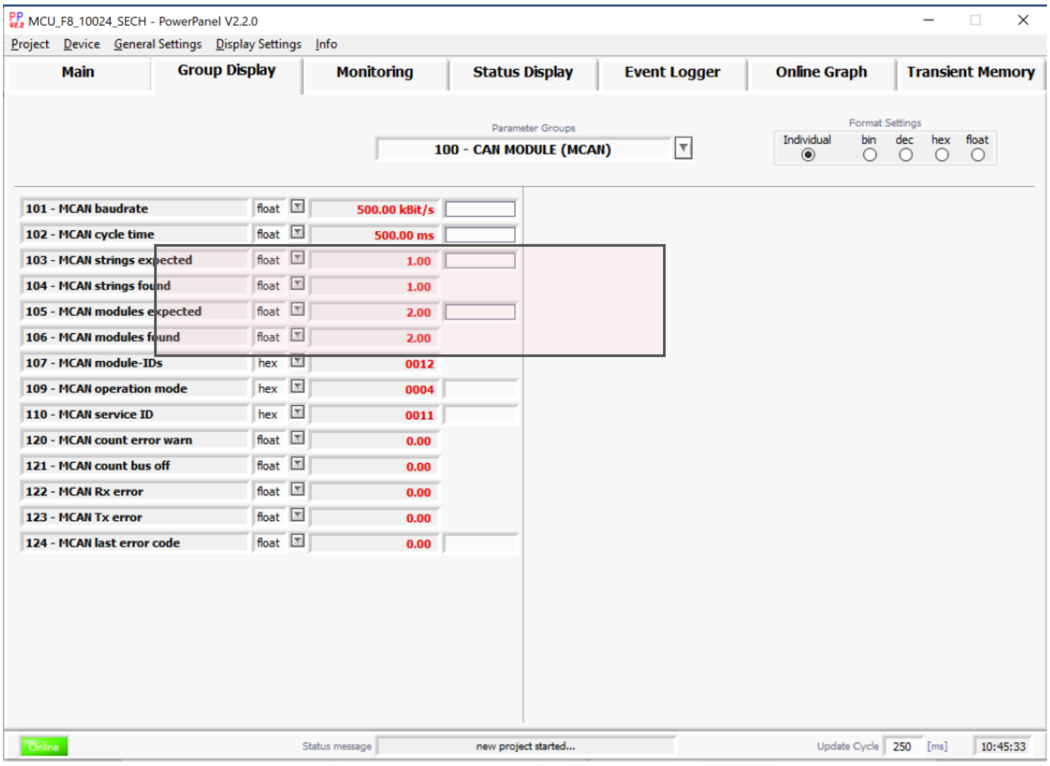
Both the modules and the MCU must be configured properly when setting up an energy storage device. As a rule, only the number of modules and the distribution among individual strings are specified, so that the measurement data is correctly assigned and monitored during operation.

4.4.1 System configuration

The number of modules and strings which the energy storage system contains must be set on the MCU. This serves on the one hand to verify after the initial scan whether all modules are 'visible' and on the other hand to classify the data of the modules into strings and e.g. to calculate string voltages.

The configuration is done by the program "PowerPanel". The connection to MCU is established via the serial interface with a baud rate of 38.4 kbaud. These settings can be made in the menu "General Settings -> COM Interface".

The connection to the MCU is established via item in the menu "Project -> New". The program loads the parameter list of the MCU. The relevant settings can be found in parameter group 100 - CAN MODULE (MCAN). The parameters of a group can be clearly displayed via the tab "Group Display". In the following picture the parameters which need to be changed are marked:



The number of strings need to be entered in parameter #103. In parameter #105 the total number of all modules (in all strings) is set. The new setting must then be permanently saved via the menu item "Device -> Configuration" by pressing the button "Save current values to EEPROM".

After a restart of the MCU it is an automatically scan for modules performed. The number of modules found is displayed in parameter #104 and #106. If these values deviate from the parameterized values, the MCU will indicate this by showing an error message.

4.4.2 System monitoring

Once this setting done, The PowerPanel can be used to monitor the complete system. Via the menu "Project => Open", the project “MCU_ESS_SECH_0.prj” can be selected. The interface (see Figure 9) proposed is totally adaptable to customer needs.[5]

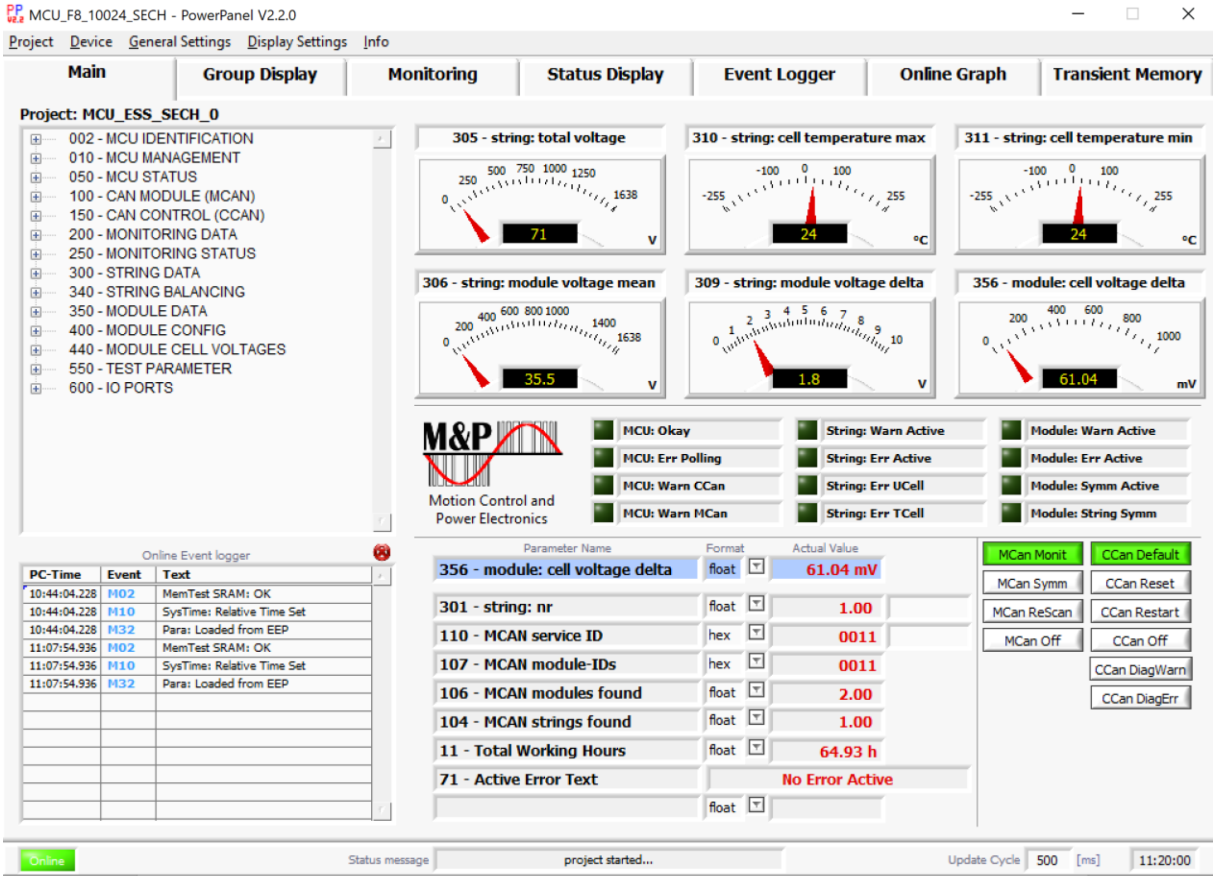


Figure 9: PowerPanel ESS module interface

4.5 Communication parameter

On the MCU, the behavior of the moduleCAN (MCAN) and the ControlCAN (CCAN) must be set.

Parameter	Default value	Description
MCAN Baudrate	500 kbit/s	Baudrate on the moduleCAN
MCAN Send Cycle	500 ms	cycle in which the MCU retrieves data from the modules. Depending on the number of modules, a shorter interval is possible.
MCAN String quantity	3	Expected number of electrical strings. The value is compared to the strings actually identified.
MCAN Module quantity	12	Expected total number of modules in the system. The MCU compares this value with the number of modules actually found.
CCAN Baudrate	500 kbit/s	Baudrate on the ControlCAN
CCAN Send Cycle	500 ms	Cycle with which the MCU sends data to the higher-level controller.
CCAN Device-ID	0x9	When using multiple MCUs in one system, the device ID of each MCU is used to form unique identifiers on the CAN.

[5] See document PowerPanel_Manual_engV0.3.pdf via the menu “Info”

5 Operation

The module should only be operated within specified voltage and temperature ratings specified on the datasheet. Determine whether current limiting is necessary based on the current ratings of attached components. Observe polarity indicated on module. Do not reverse polarity.
Please refers to datasheets at our website: www.sechsa.com , for product specifications.

6 Safety

DANGER	
HIGH VOLTAGE HAZARD 	**Never touch the positive (+) or negative (–) terminals as the module can be charged and cause fatal electrical shocks. Always verify that the module is fully discharged before manipulating the module. Refer to the instructions in section 6.1 below for the manual discharge procedure.**

- Do not operate unit above the specified voltage.
- Do not operate unit above the specified temperature rating.
- Do not touch terminals with conductors while the module is charged. Serious burns, shock, or material fusing may occur.
- Protect surrounding electrical components from incidental contact.
- Provide sufficient electrical isolation when working above 50 VDC.
- Prior to installation in or removal from the system, fully discharge the module to guarantee the safety of all personnel.

WARNING	
	**A fully discharged module may "bounce back" if it is stored without a shorting wire connected to the positive (+) and negative (–) terminals. This bounce back can be as much as 15V and could cause dangerous electrical shocks, especially in multi-module strings.**

6.1 Discharge procedure

To discharge an individual module:

a. Using a voltmeter, measure the voltage between the positive (+) and negative (–) terminals.
b. If the voltage is above 2V, a power resistor (not supplied with the module) may be connected between the terminals to discharge the module. Proper care needs to be taken in the design and construction of such a resistor. The discharge time, current, power and temperature will depend on the resistor value and the amount of energy to be discharged.

NOTE	
	Customers may also use a DC electronic load tool to support the safe/controlled discharge of individual modules prior to service

c. If the voltage is under 2V, connect a shorting wire between the positive (+) and negative (–) terminals.
d. The module is now safe for handling. However, leave the shorting wire connected at all times until you are installing the module and connecting power cables to the terminals.

7 Maintenance

Prior to removal from the system, cable removal, or any other handling ensure that the energy storage module is completely discharged in a safe manner. The stored energy and the voltage levels may be lethal if mishandling occurs. Maintenance should only be conducted by trained personnel on discharged modules (see the “Discharge procedure” section 6.1 above).

7.1 Routine maintenance

WARNING	
	**Do not use high-pressure sprays or immersion to clean the module. Keep water away from the cell management system cover and power terminals (see the “Module ” section on page 3 for details).**

Cleaning	
Use a damp cloth to clean the exterior of the module and remove dirt and grime.	As needed
Use a calibrated torque wrench to check mounting fasteners for proper torque.	
Inspect housing for signs of internal damage.	
Check mounting fasteners for proper torque	

8 Storage

The discharged module can be stored in the original package in a dry place. Discharge a used module prior to stock or shipment. After you discharge the module, connect a shorting wire between the positive (+) and negative (–) terminals to maintain a short circuit.
For more information about discharging a module, see the “Discharge procedure” section.

9 Disposal

Do not dispose of module in trash. Dispose of according to local regulations.

10 Specification

SECH refers to datasheets at our website: www.sechsa.com , for product specifications of each product.