

7100 Series Battery Cell Testing



7100 Series Test System that Saves Space





MODULAR CELL TEST SYSTEM

HIGH LEVEL OF INTEGRATION AND FLEXIBILITY

Key Features:

- › Modular Design
- › Regenerative Power Supply 95% Overall Efficiency
- › Built-In Cybersecurity
- › Built-In Remote Access Control
- › Built-In Battery Simulation
- › Built-In Self-Calibration
- › Built-in Extra IO per channel (Optional)
- › Built-in Graphical User Interface (GUI) Automated
- › Parallelization (available on demand) Software
- › Defined Power Supply
- › Automated Dynamic Test Profiles. Oscilloscope (Optional)
- › Function For Data Analytics

7100 Types:

	Type 1	Type 2	Type 3	Type 4
Parameter	Coin Cell	Low	Med	High
Voltage Range	10VDC	10VDC	10VDC	10VDC
Current Range	20mA	10A	150A	300A
Power per Channel	200mW	100W	1500W	2000W
Channels per Device	128	64	8	8
Channels per Cabinet	1024	512	64	64
				

Type 3

Single Channel – 150A

8x	4x	2x	900A	1x
150A	300A	600A	300A	1200A
150A CH#1	300A CH#1	600A CH#1	900A CH#1	1200A CH#1
150A CH#2				
150A CH#3	300A CH#2			
150A CH#4				
150A CH#5	300A CH#3	600A CH#2	300A CH#1	
150A CH#6				
150A CH#7	300A CH#4	300A CH#2		
150A CH#8				

Type 4

Single Channel – 300A

8x	4x	2x	1800A	1x
300A	600A	1200A	600A	2400A
300A CH#1	600A CH#1	1200A CH#1	1800A CH#1	2400A CH#1
300A CH#2				
300A CH#3	600A CH#2			
300A CH#4				
300A CH#5	600A CH#3	1200A CH#2	600A CH#1	
300A CH#6				
300A CH#7	600A CH#4	600A CH#2		
300A CH#8				

7100 Series System Three Product Versions: Basic, Standard and Premium

Description	Basic	Standard	Premium
Max. Voltage per channel	10V	10V	10V
Min. Output Voltage	850mV	650mV	250mV
Voltage accuracy (@ 6V)	0.05%	0.03%	0.01%
Current accuracy (@ 10A)	0.05%	0.03%	0.01%
Voltage Resolution	150µV	150µV	150µV
Current Resolution (300 Aversion)	4.5mA	4.5mA	4.5mA
EtherCAT	Yes	Yes	Yes
EtherNet	Yes	Yes	Yes
Self-tests per channel	Yes	Yes	Yes
Cards parallelization	Yes*	Yes*	Yes*
CC,CV, CP modes	Yes	Yes	Yes
Auxiliary voltage measurement	Yes	Yes	Yes
Dynamic profiles mode	-	Yes	Yes
Analog IN	Yes	Yes	Yes
Analog OUT	Yes	Yes	Yes
Thermocouple	1 ch	1 ch	1 ch
Thermistor(4 wires)	-	2 ch	4 ch
RS485	-	Yes	Yes
Relay (30 Vdc / 2A)	-	-	2 ch
GUI	-	Yes	Yes
Remote access	-	Yes	Yes
Snapshot/Oscilloscope per channel	-	-	Yes
Cyber Security package	-	-	Yes
Self-calibration per channel	Yes	Yes	Yes

* only with same type of cards

Basic

- › Covers all cycling testing scenarios.
- › High voltage and current accuracy .
- › Minimum output voltage lower than one volt.
- › EtherCAT and EtherNET.

Standard

All Basic features plus:

- › Voltage and current accuracy improved to 0.03%.
- › Minimum output voltage lower reduced to 650mV.
- › Automatized dynamic testprofiles.
- › RS485 interface.
- › Graphical User Interface (GUI).

Premium

All Standards features plus:

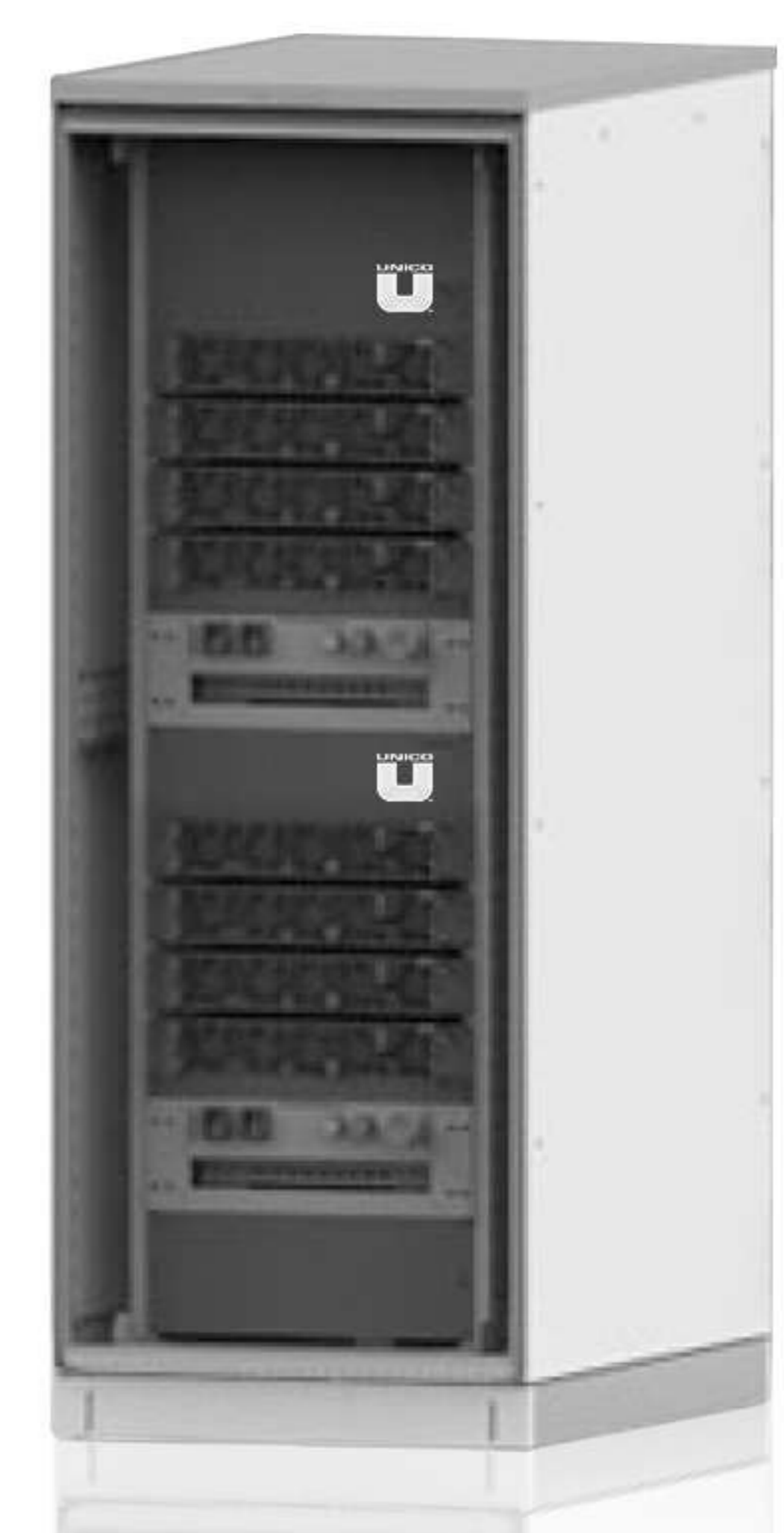
- › Voltage and current accuracy improved to 0.01%.
- › Minimum output voltage lower reduced to 250mV.
- › Snapshot (Oscilloscope feature) per channel included.
- › Built in self calibration, increasing the lifetime of the accuracy.
- › Cybersecurity



7100 device chassis



7100 Half Rack Cabinet



7100 Full Rack Cabinet

7100 Series Battery System Specification



Static Performance		20mA	10A	150A	300A
AC Grid Voltage in V		3 phase - 400 - 480Vrms - 50/60Hz			
Number of channels per cabinet	Large Cabinet	1024	512	64	64
	Small Cabinet	512	256	32	32
Parallel mode per number of channels		128	64	8	8
Serial mode		Up to 600V		Up to 80V	
Operation modes		CC, CV, CP, CR			
Max. power		200 mA	125W	1500W	2000W
Current	Range	20 mA	10A	150A	300A
Voltage	Range	10 V	10V	10V	10V
Efficiency		95%			
Measurement		Basic	Standard	Premium	
Current	Resolution	0.00038% range			
	Accuracy	0.05% range	0.03% of range	0.01% of range	
Voltage	Resolution	0.00038% range			
	Accuracy	0.05% range	0.03% of range	0.01% of range	
Waveform Measurement ¹					
Waveform Bandwidth		1 MHz			
Measurement		Voltage & Current			
Digitizing Rate Range		10K - 1 MSample/Sec			
Default Digitizing Rate		100 K/Sample/Sec			
Memory		64 K Sample			
Dynamic Performance					
Current rise/fall Time		< 0.8 ms (10 - 90% step)			
Time from minus to maximum current		< 1 ms			
Ripple		≤ 25 mV			
Built-in Interfaces Specifications					
Network		EtherCAT		Ethernet	
Sampling Rate		1kHz		Up to 100kHz	
Built-in IO per Channel		Basic	Standard	Premium	
Voltage sense		Yes	Yes	Yes	
Analog IN		Yes	Yes	Yes	
Analog OUT		Yes	Yes	Yes	
Thermocouple		1 ch	1 ch	1ch	
Thermistors		-	2ch	4ch	
RS485 (Full Duplex)		-	Yes	Yes	
Relay Driver (30 Vdc/2A)		-	-	2ch	
Safety					
Isolation AC Input		3.8 kV AC Input to chassis / 3.8 kV AC to DC Output			
Isolation UUT Input		600 V UUT to chassis 3.8 kV UUT to chassis 3.8 kV UUT to chassis			
Safety Interlocks		Emergency stop, external user input			
Internal Protection		Over- Current (OC) Under-Voltage (UV) Over-Voltage (OV) Over-Power (OP) Over-temperature			
Programmable Safety Limits		Over- Current (OC) Under-Voltage (UV) Over-Voltage (OV) Over-Power (OP)			
Internal Watchdog Timer		Continuously control and monitoring			
Mechanical Specifications					
Cabinet Size (WxDxH)	Large Cabinet	32 x 48 x 87" / 2200 x 800 x 1200 mm			
	Small Cabinet	32 x 48 x 55" 1400 x 800 x 1200 mm			
Cabinet Weight		3086lbs/1400kg per full cabinet 1763lbs/800 kg per full cabinet			
Cooling method		Forced Airflow			
Operating noise		< 60dB			
Color		Light Grey (RAL7035)			

¹ Waveform Measurement is only included in the Premium Version.

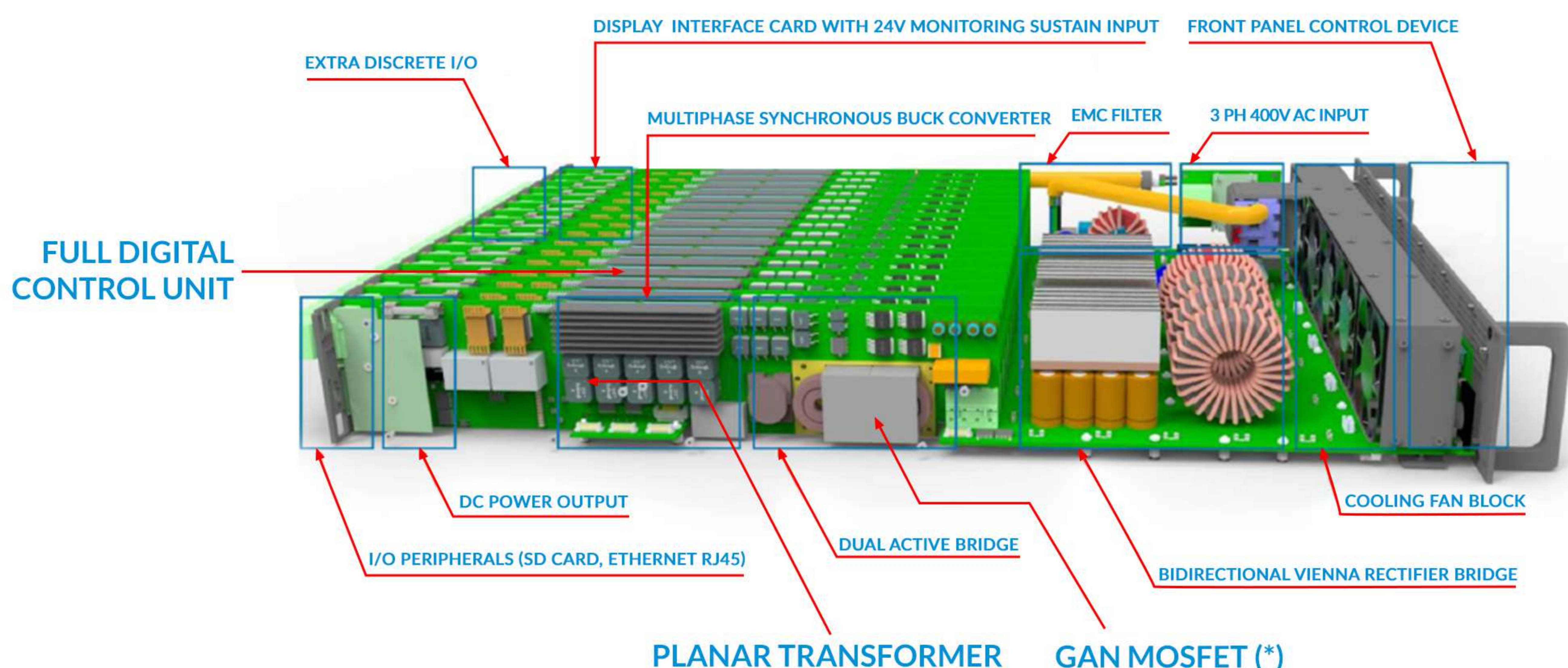


7100 Series Test System that Saves Space

MODULAR CELL TEST SYSTEM

HIGH LEVEL OF INTEGRATION AND FLEXIBILITY

- › 19" rack mount chassis – 2HU – 30 kg
- › 4 types of Battery Cell tester devices
- › High Power Density - up to 18 kW in 2HU
- › Capability to test up to 64 battery cells simultaneously per device (Type 2 - Multichannel)
- › Parallelization and serialization of channels are possible.
- › High efficiency 95 % (with forced-air cooling system)
- › High accuracy on voltage and current measurement up to 0.01% (Premium Version)
- › Timing Control Resolution – 1 μ s
- › Native EtherCat and Ethernet communication.
- › Remote control capability
- › High level of integration due to the digital control
- › Integrated DAQ with embedded GUI per channel
- › Snapshot and analytics application – Digital Oscilloscope with Bandwidth 1Msps (Premium Version)
- › Constant monitoring of the outputs with embedded oscilloscope (Premium Version)
- › 4 additional temperature measurements (Premium Version)
- › Bidirectional – 2 Quadrants Switched Power Supply (configurable power source and sink)
- › All channels are galvanic isolated
- › Double Isolation Protection 4kV
- › Cyber Security Key Switch (Premium Version)



7100 Series Advantages

Modular Cell Test System

Battery capacity measurement and automatic shutdown on end of charge/discharge

- › An automated test script that can be run from the device “Test Console” is in implementation to control the BCE and thereby determine the battery capacity.
- › During charge/discharge operation the BCE controller shall cyclically acquire battery current and voltage and record these acquisitions with a time stamp.
- › The BCE controller shall display to the script log file the actual acquired measurement values.
- › Accuracy of end-of-charge voltage level detection shall be <100mV.
- › Accuracy of voltage measurements shall be <100mV.
- › Accuracy of current measurements shall be <100mA.
- › The BCE shall acquire and monitor the battery voltage and autonomously terminate the charge/discharge process upon reaching the configured/programmed end-of-charge voltage level, the discharge voltage level respectively. The termination function shall include automatic switch off the power supply, electronic load respectively, and isolate the battery.
- › The battery voltage shall be independently monitored in case of BCE failure.
- › The additional memory consumption for cached data and the data-pool on the device shall be compatible with the memory available on the embedded Linux controller.

	Output State	Meas. BCE Voltage [V]	Meas. BCE Current [A]	Meas. BAT Voltage [V]	Meas. BAT Temp. [°C]	FLP State	SLP State	Mode	Prog. Eoc [V]	Prog. Isc [A]	Prog. Isink [A]
Ch. 1	OFF	0	0	0	0	00 0	00000 000	CHARGE	0	0	0
Ch. 2	OFF	0	0	0	0	00 0	00000 000	CHARGE	0	0	0
Ch. 3	OFF	0	0	0	0	00 0	00000 000	CHARGE	0	0	0
Ch. 4	OFF	0	0	0	0	00 0	00000 000	CHARGE	0	0	0
Ch. 5	OFF	0	0	0	0	00 0	00000 000	CHARGE	0	0	0

	SLP OVP: Row [V]	SLP OCP: Row [A]	SLP R.OCP: Row [A]	SLP OVP: Filter 1 [V]	Delay OVP: Filter 1 [µs]	SLP OCP: Filter 1 [A]	SLP R.OCP: Filter 1 [A]	Delay OCP: Filter 1 [µs]	SLP OVP: Filter 2 [V]	Delay OVP: Filter 2 [µs]	SLP OCP: Filter 2 [A]	SLP R.OCP: Filter 2 [A]	Delay OCP: Filter 2 [µs]	FLP OVP [V]	FLP OCP [A]	FLP R.OCP [A]	BAT OVP [V]	BAT VVP [V]	BAT OT [°C]
Ch. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

7100 Series Advantages Modular Cell Test System

Self-Calibration Capability

Self-Calibration

› Calibration procedure

Voltage calibration - is enabled by opening series FET of voltage divider and enabling voltage input of ADC over SSR switch. Only proper combination of binary switches is allowed by control FPGA IP. Then DAB is started to open loop and set point $\geq 120V$, MPB open loop is started to several set points. ADC readings are averaged over 100ms* period by HW IP and stored by ESW. This is done 3 times for each set point. Once this is done, by linear interpolation calibration data are calculated.

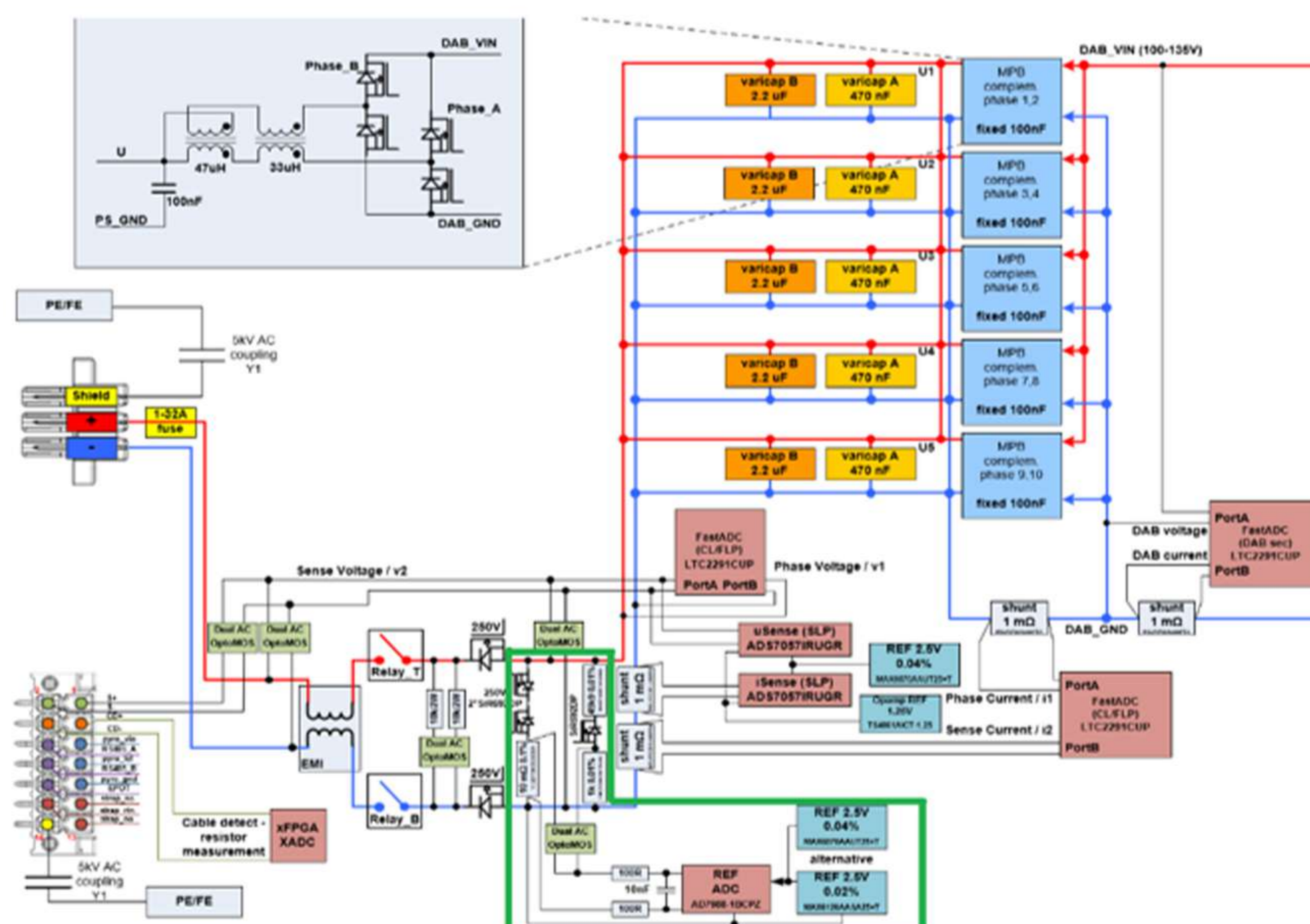
Current calibration - is enabled by opening series back-to-back FETs of shunt resistor and enabling current input of ADC over SSR switch. Also here only proper combination of binary switches is allowed by control FPGA IP. Then DAB is started to open loop and set point $\geq 120V$, MPB open loop is started and calculate MPB voltage to represent desired current set points. ADC readings are averaged over 100ms period by HW IP and stored by ESW. This is done 3 times for each set point. Once this is done, by linear interpolation calibration data are calculated.

*100ms average period is selected to cover both 50 and 60Hz mains on Voltage and Current periods.

› New calibration set can be then

- › applied to given run time (valid until reboot)
- › stored to Flash of device board config (will be present also after reboot)
- › used to verify existing calibration set (self-test)

› MPB power stage with highlighted (green shape) autocalibration circuit



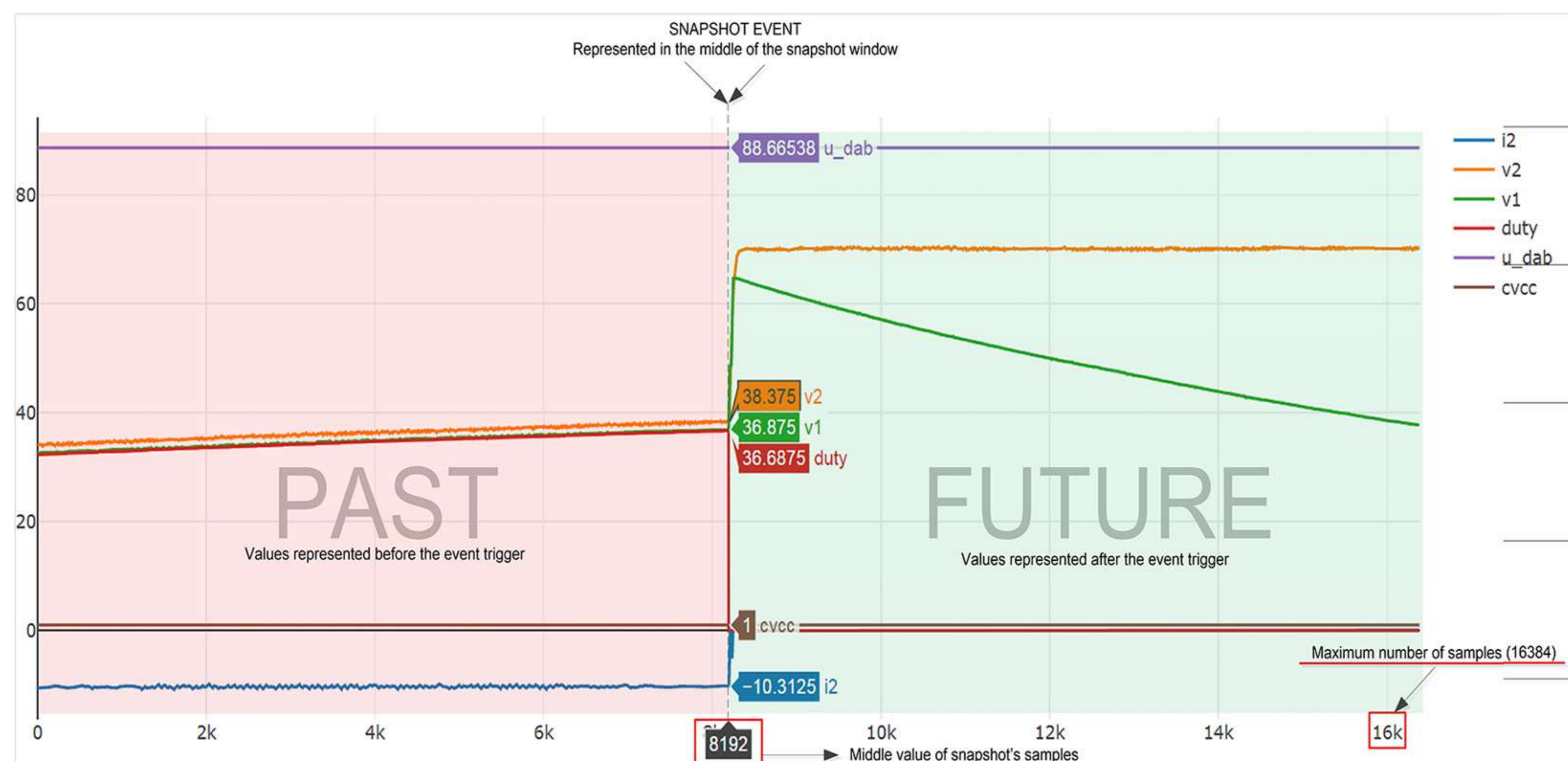
7100 Series Premium Version Advantages Modular Cell Test System

INTERNAL OSCILLOSCOPE

SNAPSHOT AND DATA ANALYTICS APPLICATION

- ✓ Snapshot for data analytics
- ✓ Event recorded before and after the event
- ✓ Remote or local treatment
- ✓ Signal recording is running all the time
- ✓ Web GUI and export files

Snapshot is a software method that offers the possibility to configure, catch, transfer, store, display and analyze the waveform of external and internal signals.



7100 Series Premium Version Advantages

MODULAR CELL TEST SYSTEM

HIGH LEVEL OF INTEGRATION AND FLEXIBILITY

4 additional temperature measurements

- NTC-Resistor based
- All channels galvanic isolated
- Programable safety event

High Accuracy voltage measurement (sense)

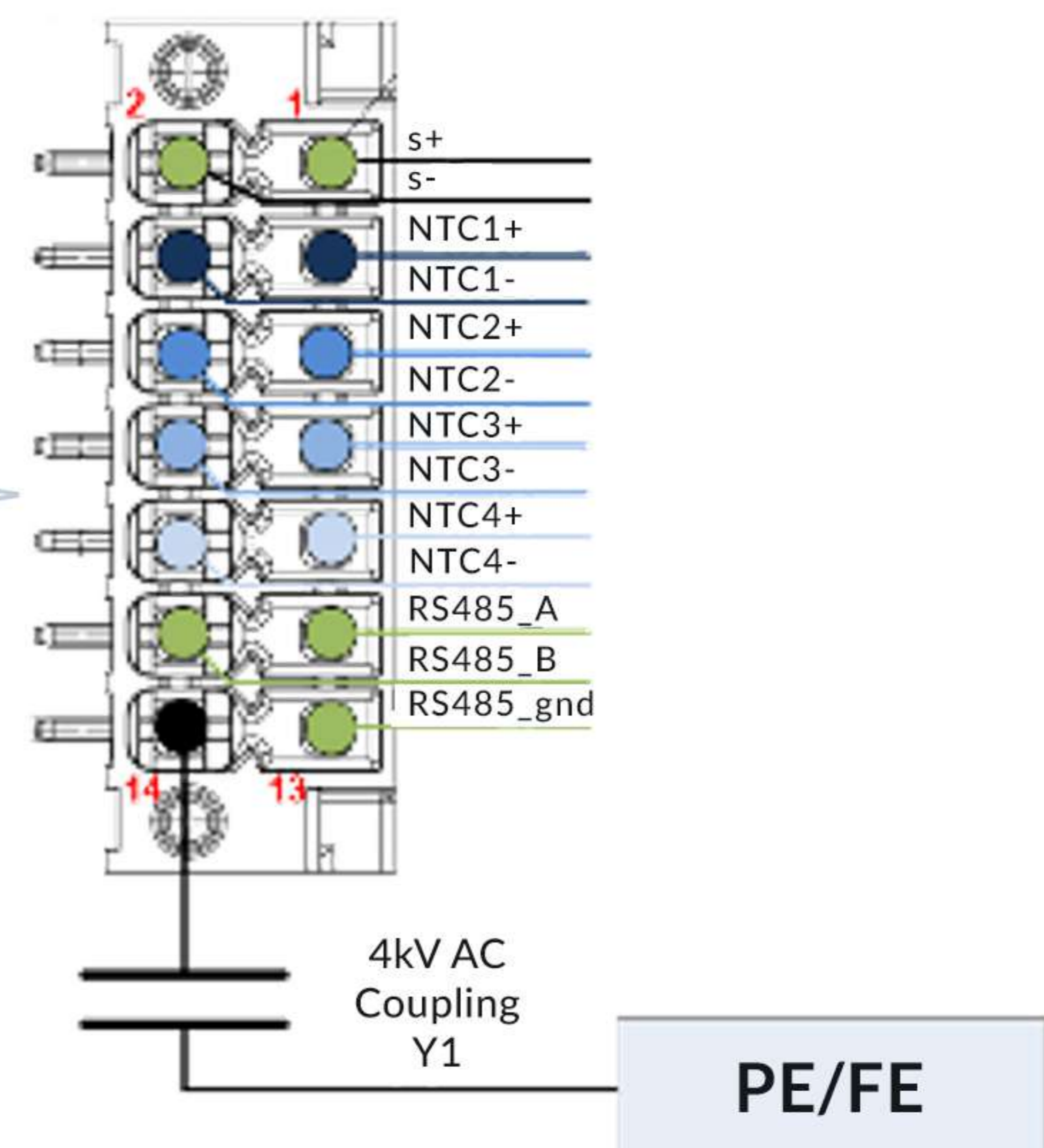
- Target 0.01% at full scale
- Update rate: 1kHz
- Self-calibration

High Accuracy current measurement (sense)

- Target 0.01% at full scale, minimum target is 0.03%
- Update rate: 1kHz
- Self-calibration

Redundant voltage measurement

- Internal voltage measurement
- Unconnected device
- Losses on wires



Virtual Integrated BMS (for Cells)

External (additional) BMS not required

Battery Management System

	Output			Voc [V]		Isc [A]		Vmp [V]		Imp [A]		FLP/OVP [V]		FLP/OCF [A]	
	New	Active	Trans.	New	Active	New	Active	New	Active	New	Active	New	Active	New	Active
Ch. 1	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 2	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 3	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 4	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 5	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 6	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 7	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 8	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 9	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2
Ch. 10	OFF	OFF	inactive	10	10	0.6	0.6	9	9	0.5	0.5	95	95	6	6.2

	Strap (Grp) 1		Strap (Grp) 2		Strap (Grp) 3		Strap 4	
	New	Active	New	Active	New	Active	New	Active
PCDU	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
OBC	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
BCDR	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE

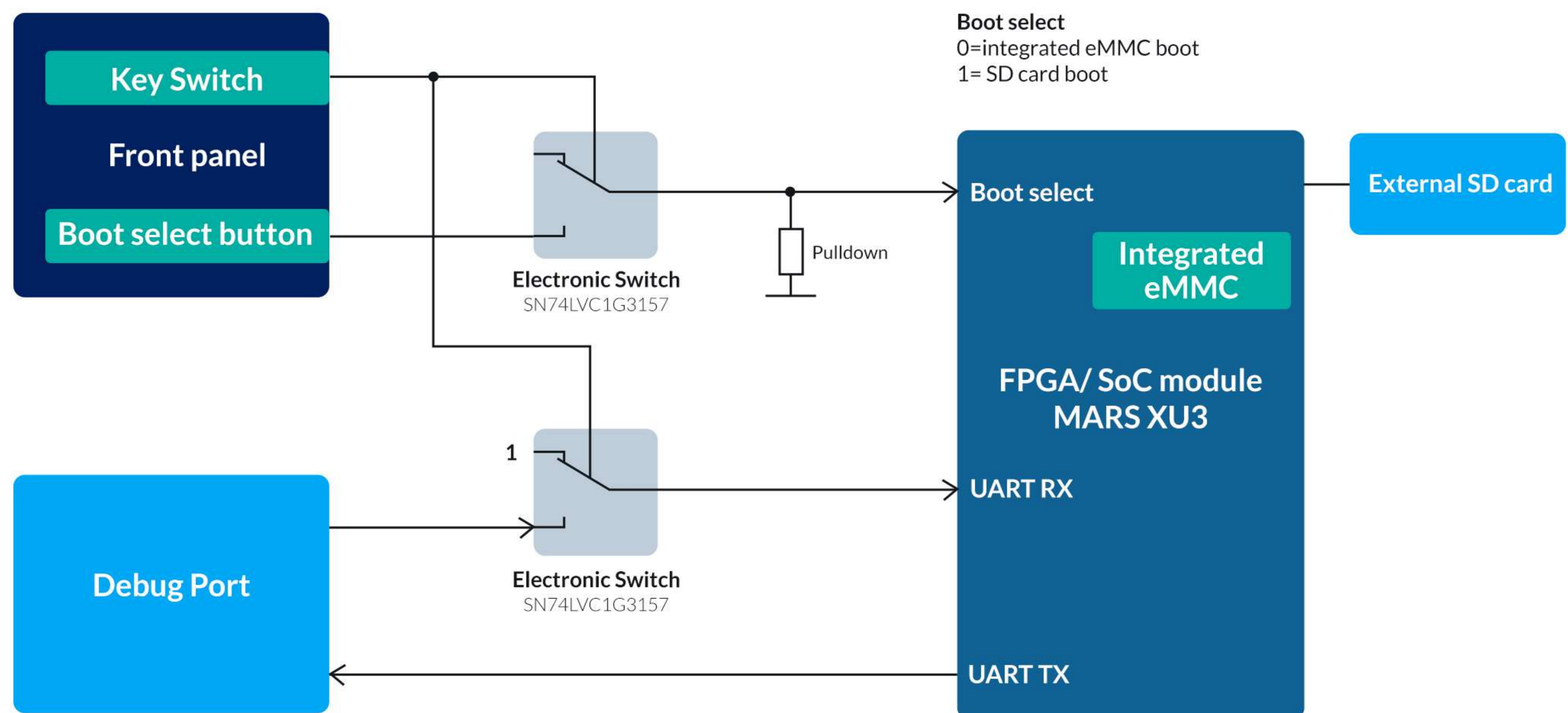
Clean Save Load Ch.1 -> ALL As Default Apply

7100 Series Premium Version Advantages Modular Cell Test System

Cyber Security Compliance

Cyber Security (compliance with the security Standard)

- › Key switch to protect unauthorized access to boot console and the SD card booting
- › Key on the front panel of USAS to enable/disable these features.



Change my nick name	Release control	Request control		
#	Auth name	Nick name	IP	Last activity
1	???	Andreas	10.50.143.252	3:00

SAFETY Event					
Disc Usage	OK	File Check-Sum	OK	NTP Status	OK
RAID Status	OK	IPMI Status	OK	Maser Status	OK
				Lantime Status	OK

SECURITY Event					
Account Changes	0	Failed Authentications	0	Login Sessions	0
		Anomaly Events	0	Clamscan Status	OK

7100 Series Advantages

Modular Cell Test System

Benefits for the user



Power density that reduces required overall footprint to half of traditional cyclers



Improve engineering productivity



Confidently test today's technologies AND tomorrow's innovations



Decrease capital & operating expenses (CAPEX/OPEX)



Eliminate user errors & ensure repeatable testing

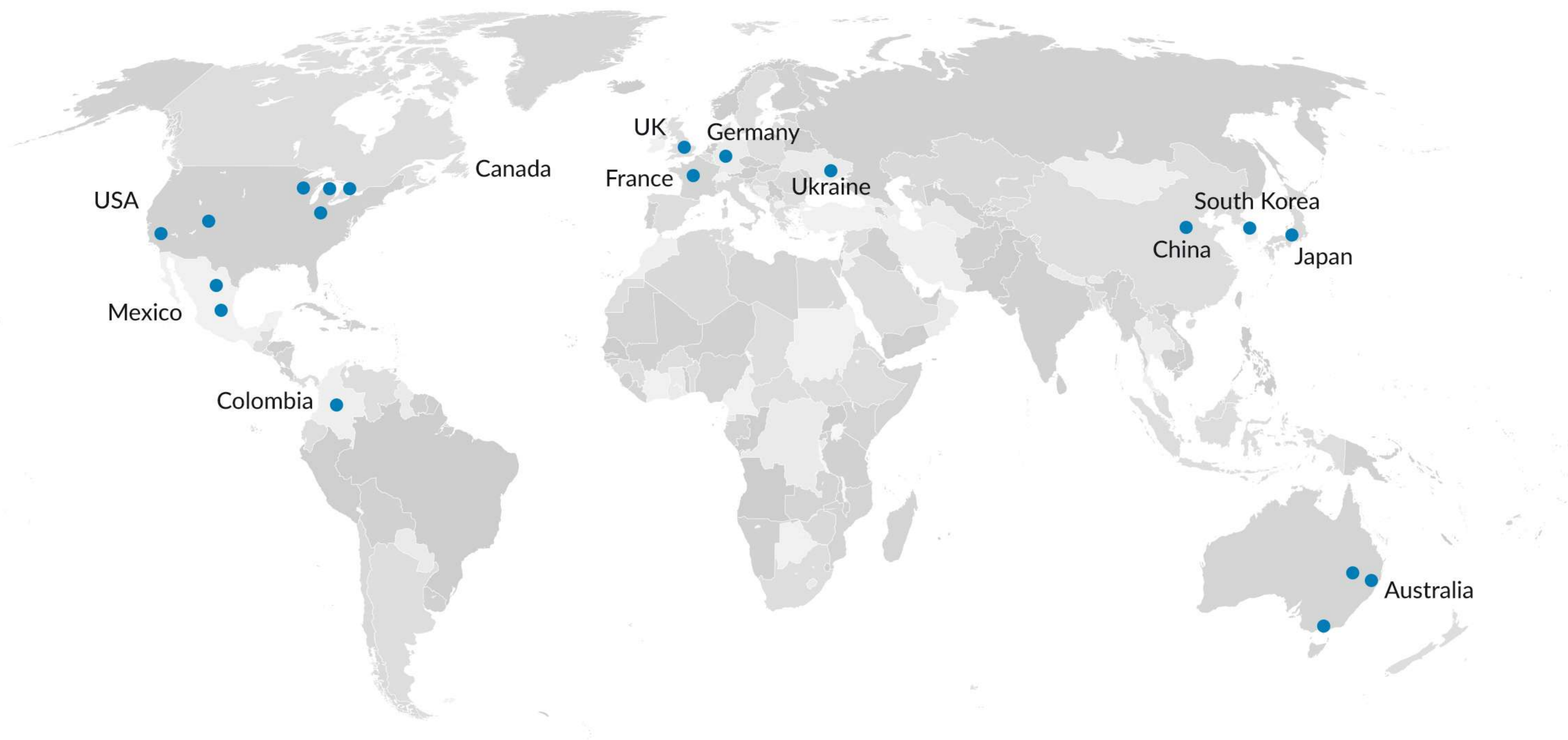


Improve safety & reduce risk



Benefits for the user, having a 95% efficiency - Battery cell tester

7100 Series Model Configurator											
Series	Output Voltage	Output Amp	Output kW	Channels	Input Voltage	Coolant	Communication	Feedback	Options	Cabinet Size	
7100	- 0010 -	-	- 18 -	-	- 2 -	- A -	- ETE -	- 000 -	-	-	
Battery Test	Output Voltage	Output Amp	Power (kW)	#Channel	Input Voltage	Coolant	Communication	Feedback	Options	Cabinet Size	
7100=Cell Cycler	0010	000(0.020)	0018	0001	2=380-480VAC	A=Air	Cell Level		000=None	H=Half(14 HP)	
		0010		0002			ETE=Ethernet & Ethercat	000=None	PDU-Cell Level	F=Full(28HP)	
		0150		0003					UPS=1.8kW		
		0300		0004							
				...1024							



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