MTE Energy Systems & Services

E-Mobility Testing

Calibration of Electricity Meters applied in Electric Vehicle Supply Equipment (EVSE)

While climate change rose to the top of many governments' agendas and consumers attitudes have evolved, adoption of electric vehicles (EVs) is becoming a worldwide trend.

The combined annual sales of battery electric vehicles and plug-in hybrid electric vehicles tipped over the two-million-vehicle mark for the first time in 2019, while EVs staked their claim on a 2.5% share of all new car sales. US car manufacturer "Ford" announced that from 2030 they intend to sell only EVs in Europe while OEM "GM" goes even further supplying solely EVs by 2035.

The further development and implementation speed may vary between different regional markets while the long-term outlook for EVs remains strong triggered by factors such as consumer sentiment, policy and regulation, car manufacturers' strategy and the role of corporate companies.

It's expected that the global EV market grows by a CAGR of 29% over the next ten years: Total EV sales growing from 2.5 million in 2020 to 11.2 million in 2025, then reaching 31.1 million by 2030. By then EVs would secure approximately 32% of the total market share for new car sales.[1)]

The income from taxes on gasoline and diesel for road maintenance will decrease in future as the proportion of EVs increases. It is therefore likely that taxes will also be raised per kWh of electrical energy loaded to the EV. This will require the use of certified AC and DC electricity meters in Electric Vehicle Supply Equipment (EVSE), widely known as "charging stations", as this is for example already the case in Germany.

[1)] Source: Deloitte Insights: Electric vehicles. Setting a course for 2030 (2020).

Therefore, the correct registration and billing of the charged electrical energy to the customer is becoming even more important while also a regular calibration of the EVSE on-site will be mandatory as this is the common case at fuel pumps.

Having a dense network of EVSE is one of the most important factors enabling the successful spread of EVs. While the availability of EVSEs is growing steadily, the reliability, efficiency and accuracy is often not yet addressed. Since the conformity with calibration law is also valid for EVSE, this must be checked periodically.

To maximize the opportunities presented by the growing demand for EVs and EVSEs infrastructure, utilities, meter manufacturers and meter service providers allover the world should examine the priorities they have and ask themselves key questions such as:

- How can we plan and build up an efficient and reliable EVSE infrastructure?
- What are the electricity meters being used in EVSE and how can we test its accuracy and correct registration?
- How can we make sure to provide a secure and reliable charging infrastructure while the consumer is being charged for the accurate amount of consumption?

Addressing such questions and challenges, MTE came up with different solutions along e-mobility testing for customers such as utilities, meter manufacturers and meter service providers.

(1) Calibration of built-in AC electricity meters on-site

For customers such as utilities, meter service providers or operators of EVSE, MTE developed the **eMOB I-32.3 AC test adapter** which enables three-phase precision AC current measurement up to 32 A and three phase AC voltage measurement at the outlet of an AC charging station. This set up allows the precise measurement of the energy charged to the accumulator of the EV considering also the voltage drop between the built-in electricity meter and the outlet of the charging station, where the power is available for the customer. In combination with the **PWS 2.3 genX Portable Working Standard** from MTE, the eMOB I-32.3 AC can be connected to any EVSE to retrieve all relevant performance data, thus realizing a test system of accuracy class 0.1 and making it possible to test the installed energy meter and determine the existing power loss.

Advantages

- Portable working standard accuracy class 0.1
- Easy and fast connection between EVSE and EV
- Operation with rechargeable battery (option) connected to 12 VDC input, if auxiliary supply connection is missing
- Charging current three-phase up to 32 A (up to 22 kW power)
- User-friendly functions such as integrated operation manual
- Large 7" touch screen color display and web server for remote display of graphical user interface and remote control of the unit

Application example

The adapter is used to test the energy measurement accuracy of the EVSE by comparison of the energy measured by the built-in AC electricity meter with the energy measured by the Portable Working Standard PWS 2.3 genX with an eMOB I-32.3 AC test adapter at the output of the charging station.

This can be done by a so-called register test or error measurement as shown in the example below.

The eMOB I-32.3 AC test adapter is first connected to the PWS 2.3 genX and then connected to the EVSE and the EV.

Register test

First a charging process at the EVSE is initialized but not started yet. Then a register test at the PWS2.3 genX is initialized by entering the start energy reading, either zero for charged energy or the actual energy register reading of a built-in electricity meter shown on the display or in an App or through a window in the EVSE.

Then the energy measurement is started at the PWS2.3 genX. Now the charging of the EV at the EVSE is started and the amount of charged energy is observed and should reach at least 200 units of the last indicated digit before the charging is stopped at the EVSE. The energy measurement is then stopped at the PWS2.3 genX and the charged energy or energy register reading indicated is entered as end reading and the error of the EVSE energy measurement unit compared to the PWS2.3 genX + eMOB I-32.3 AC adapter is calculated and indicated.

Error measurement

If the EVSE has a built-in AC electricity meter equipped with a test output, which generates LED pulses or electrical pulses proportional to the power, an error measurement can be performed as shown in the example. The charging of the EV must be started at the EVSE and running during the whole test.

One pulse represents a defined energy quantity, e.g. 1 Wh. In the example shown this test LED of the AC electricity meter is visible through a window in the charging station.

A scanning head connected to the PWS 2.3 genX is mounted over this window and adjusted to detect the LED pulses, which then are counted by the PWS 2.3 genX.

The energy registered by the AC electricity meter, based on the counted LED pulses, is later compared with the reference energy measured by the PWS 2.3 genX + eMOB I-32.3 AC test adapter and the error of the energy measurement of the EVSE is calculated and indicated.

With our universal test software CALegration, running on a tablet or portable PC, a predefined test procedure can be used to guide the operator through the different test steps, like data entry, register test, error measurement, no load test etc., including the evaluation of the results and the generation of a test report.

(2) Calibration of built-in DC electricity meters on-site

In general, the principle and application are the same as applied at AC electricity meters. For this set-up, MTE developed another test adapter **eMOB I-200.1 DC** with CCS Type 2 inlet (IEC 62196-3) and DC charging cable with CCS plug.

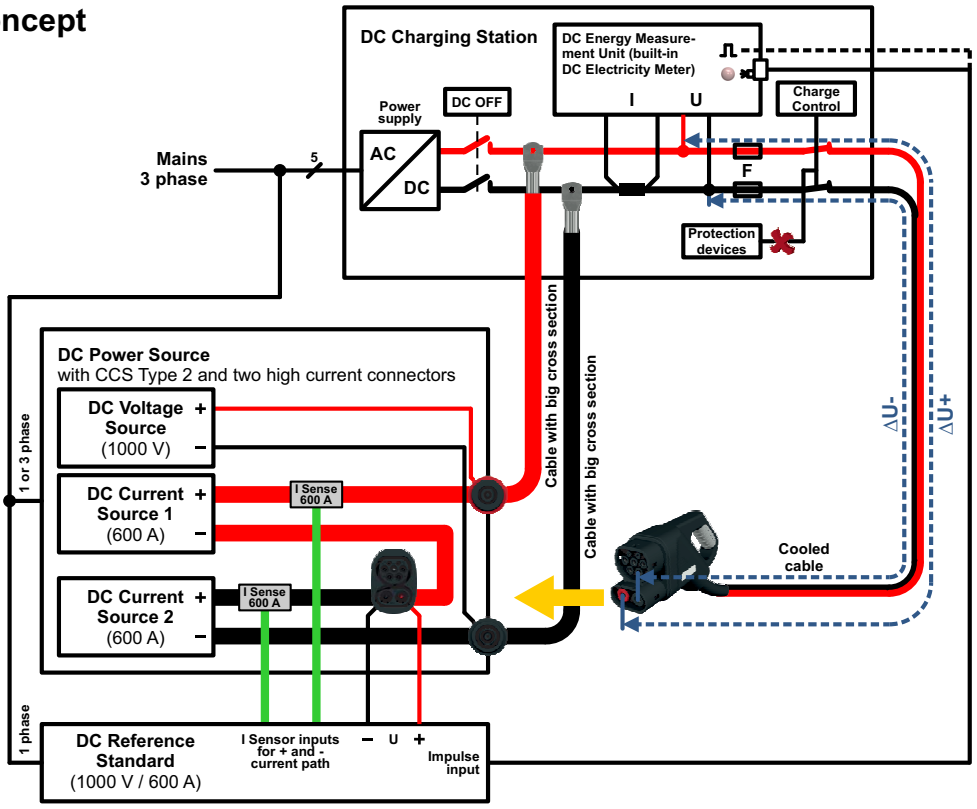
In combination with a reference standard, such as the new PWS 3.3 genX, the setting can measure single-phase DC voltage up to 1000 V, DC current up to 200 A and resulting DC power/energy.

Advantages

- Portable working standard accuracy class 0.05
- Easy and fast connection between EVSE and EV
- Battery operation (option), if auxiliary supply connection is missing
- Field testing of EVSE up to 1000 VDC | 200 ADC (up to 200 kW power)
- User-friendly functions such as integrated operation manual
- Large 9" touch screen color display and web server for remote display of graphical user interface and remote control of the unit

(3) Calibration of built-in DC electricity meter on-site with simulated load (under development)

Solution concept



A DC voltage source (up to 1000 V) and two DC current sources (up to 600 A) are used to simulate a variable DC load (up to 600 kW) and to simulate the losses between the inside measurement unit and the end of the charging cable (voltage drop ΔU).

The voltage source and the current source used for the DC- path with the current measurement element simulate the DC power for the Energy Measurement Unit inside the EVSE, which must be separated from the inside DC power source (DC OFF) for this test (phantom load principle).

The second current source is used to simulate the same voltage drop ΔU on the second current path (DC+), as this would be the case with a real load with the same current.

A DC reference standard measures the DC voltage at the CCS Type 2 car inlet integrated in the test equipment and the DC current in the DC- path with the current measurement element and registers the DC energy as transferred to the EV to perform register tests and, if a pulse output (optical or electrical) is available, to perform error measurements also.

This allows to calibrate the built-in DC Energy Measurement Unit or DC electricity meter on-site at different load points as in the laboratory.

This test principle requires access to the EVSE (operation of mains circuit breaker, possibility to separate the DC power source from the measurement unit, possibility to connect voltage and current sources on DC+, DC- paths before the measurement unit, connection to mains to supply the test equipment).

Further it must be possible to deactivate protection devices or charge control processes, which lead to an opening of the output switches during the tests.

Advantage: This test configuration allows the simulation of high DC power values up to 600 kW on-site with less weight of the test equipment compared to other solutions with adjustable real loads or regenerative electronic loads.

Calibration of AC and DC electricity meters in the laboratory

MTE has a broad experience in the field of testing different electricity meters and hundreds of customized high precision meter test systems to its credit.

Based on its comprehensive product range and the modular system components MTE may cover all kind of standard requirements from the metering industry as well as upcoming adaptations in the course of EVSE and its components or specific AC and DC electricity meters.

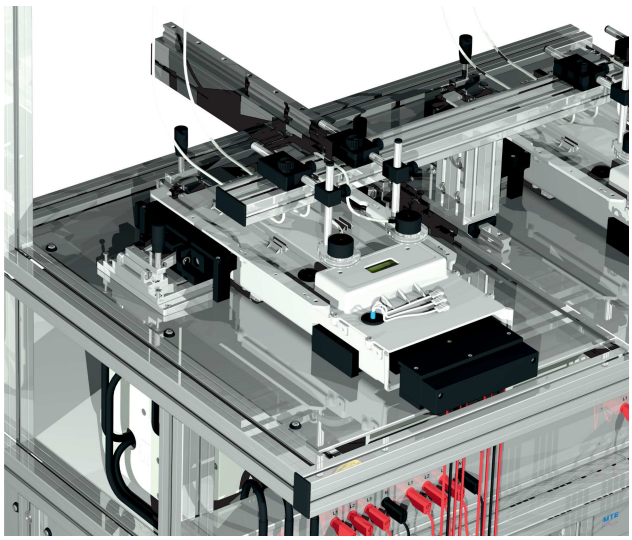
The modular approach provides flexibility and enables MTE to select the optimal customer orientated solution for each single- or three-phase meter test system the customer requires to meet the changing needs in the metering world. It's the customer who chooses the degree of automation, the integration of various test modules and steps or the number of measuring positions and throughput of meters.

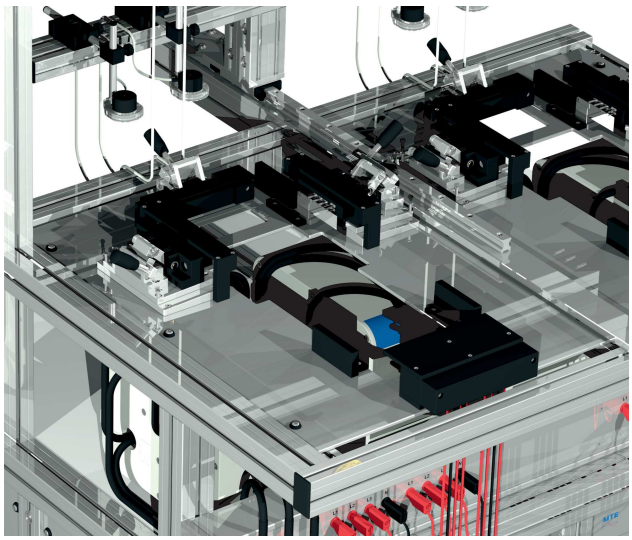
All key components of a test system are coming from the same and MTE's own single source.

Project example

Test bench for calibration of 10 (5 DUT with 2 each) three-phase AC electricity meters AC reference standard and power source, three-phase:

- Voltage range: 30 V … 300 V phase-neutral (optional: 480 V, 600 V)
- Current range: 1 mA … 120 A (optional: 200 A)



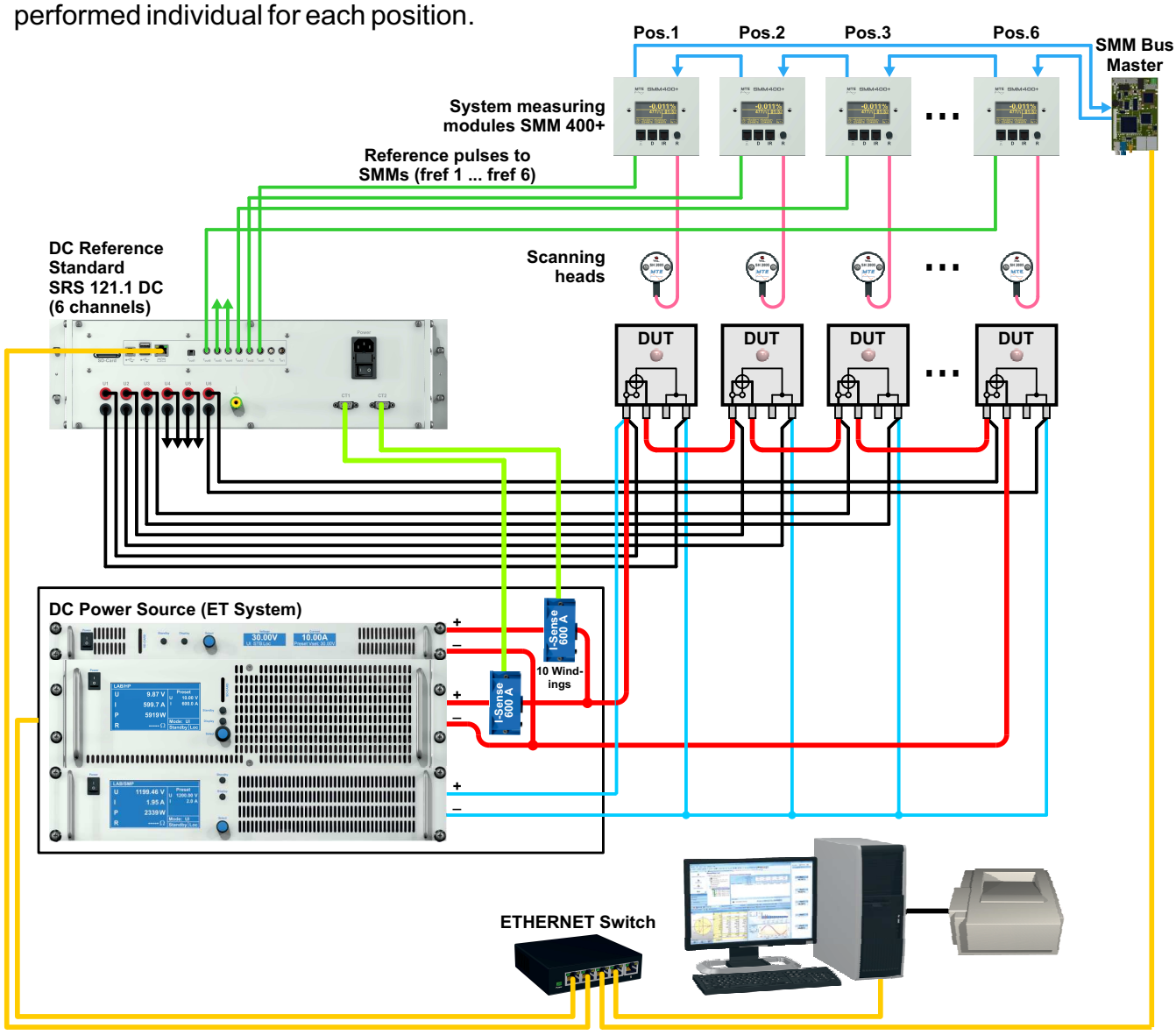


1 to 6 Position Test System for DC Electricity Meters or DC Energy Measuring Units of EVSEs with U and I path connected

- Voltage range: 100 V … 1000 V
- Current range: 5 A … 600 A
- DC reference standard class 0.05 / 0.1 (6 channels)

If 2 or more DC electricity meters with closed link (voltage and current path connected) are tested and the test voltage is connected to the current at position 1, the following positions will see a lower test voltage, reduced by the voltage drop on the current path between the meters, which varies with the current amplitude.

To overcome this problem with variable test voltages influencing the accuracy of the calibration, a DC reference standard with 6 U channels is used to measure the exact test voltage at 1 up to 6 test positions individually. Together with the common current sensors these leads to 6 DC power reference channels with 6 pulse outputs fref 1 … fref 6 connected to 1 up to 6 error evaluation modules SMM 400+. These are used for error measurements, if the DUTs are equipped with optical or electrical pulse outputs. Should no pulse outputs be available, register tests can be performed individual for each position.



The DC Meter Calibration System is designed to test single-phase DC electricity meters with open and closed I-P links. It is fully electronic, using only solid state electronic components and is controlled by a PC via the integrated ethernet interfaces.

The system is equipped with following components:

- DC Power source with one DC voltage amplifer and two DC current amplifiers
- DC reference standard SRS 121.1 DC
- Control unit STE 10

DC Power Sources

Fully static single-phase DC sources for the generation of voltage and current for the meters under test. The power sources works independently from the supply network.

Voltage amplifier

- Voltage range: 0 ... 1200 VDC | 2400 W
- Accuracy: ≤± 0.2 %
- Stability: ≤± 0.05 %

Current amplifiers

- Current range: 0 ... 80 ADC | 1200 W
  0 ... 600 ADC | 10000 W
- Accuracy: ≤± 0.2 %
- Stability: ≤± 0.05 %

DC Reference Standard

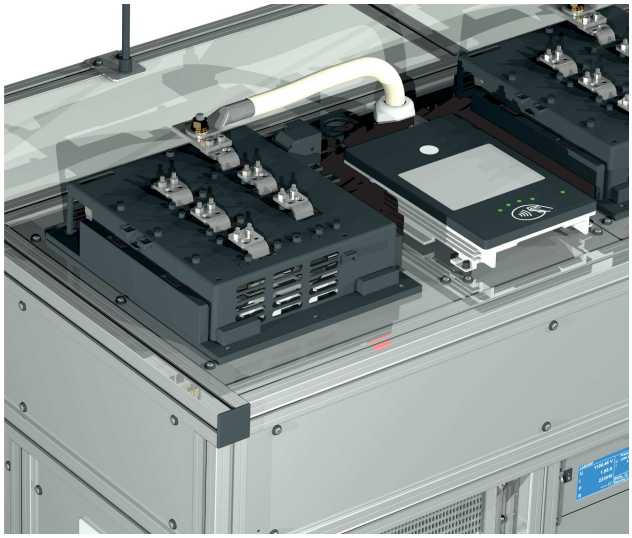
The SRS 121.1 DC is a 6-channel single-phase reference standard for DC power / energy class 0.04 for verification of 1 up to 6 DC Meters or DC Energy Measuring Units of EVSE (Electric Vehicle Supply Equipment) at the same time.

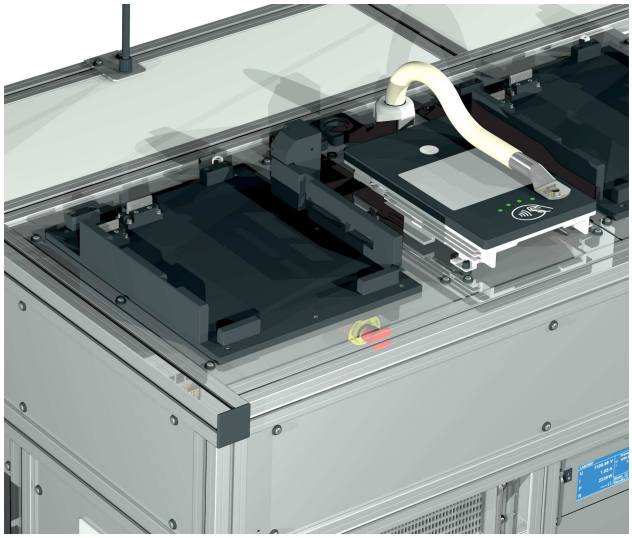
- Voltage range: 0.5 ... 1000 VDC
  (1500 VDC on demand)
- Current range: 0.1 ... 600 ADC
- Accuracy: ≤± 0.04 %

Project example

Test bench for calibration of 5 single-phase DC electricity meters DC reference standard and power source, single-phase:

- Voltage range: 100 V … 1000 V
- Current range: 5 A … 600 A





EMH Energie-Messtechnik GmbH receives DAkkS accreditation for DC Power / Energy measurements

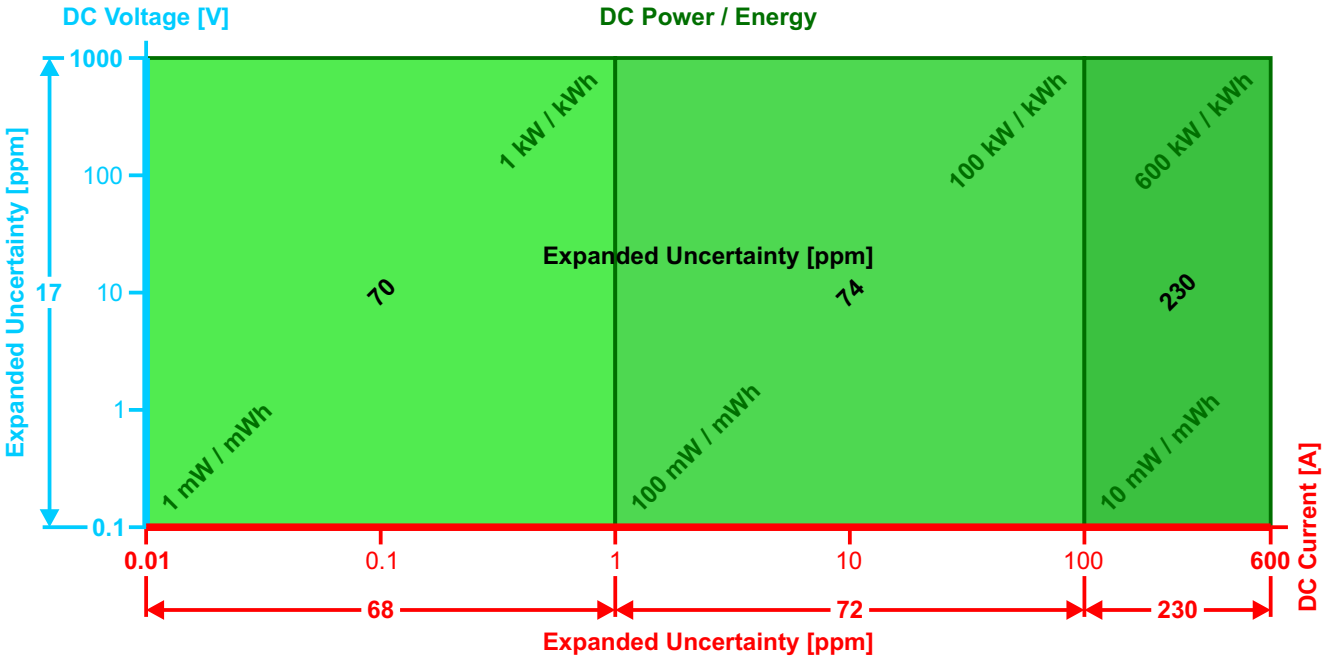
The EMH DAkkS Calibration Laboratory got as one of the first among the calibration laboratories in Germany the DAkkS Accreditation for DC Power / Energy measurements uo to 600 kW / 600 kWh.

Scope of Accreditation

- DC Voltage: 100 mV ... 1000 V
- DC Current: 10 mA ... 600 A
- DC Power: 1 mW ... 600 kW
- DC Energy: 1 mWh ... 600 kWh

Thus, EMH's accreditation to ISO/IEC 17025 guarantees the consistent and high quality of calibration services for MTE Meter Test Equipment and its customers in the field of portable and stationary DC test systems.

EMH Energie-Messtechnik GmbH DAkkS ISO/IEC 17025 accreditation Calibration and Measurement Capabilities for DC Measurements [ppm]



The following MTE leaflets are available:

Overviews:	Company Portrait / Portable Test Equipment / Stationary Meter Test Systems Automatic Test Systems / Transformer Monitoring / E-Mobility Testing
Comparator:	K2008
Portable Reference Standards:	PRS 600.3 / CALPORT 300
Portable Working Standards:	PWS 3.3 / PWS 2.3 *genX*
Portable Standards:	CheckMeter 2.3 *genX* / CheckMeter 2.1
Portable Test Systems:	PTS 400.3 PLUS / PTS 3.3 *genX* / PTS 2.3 *genX* / PTS 2.3 *genX* CheckSystem 2.3 / CheckSystem 2.1 / CheckSystem 2.1 S
Portable Power Sources:	PPS 400.3 / PPS 3.3 *genX* / CheckSource 2.3
Software:	CAL*egration*®

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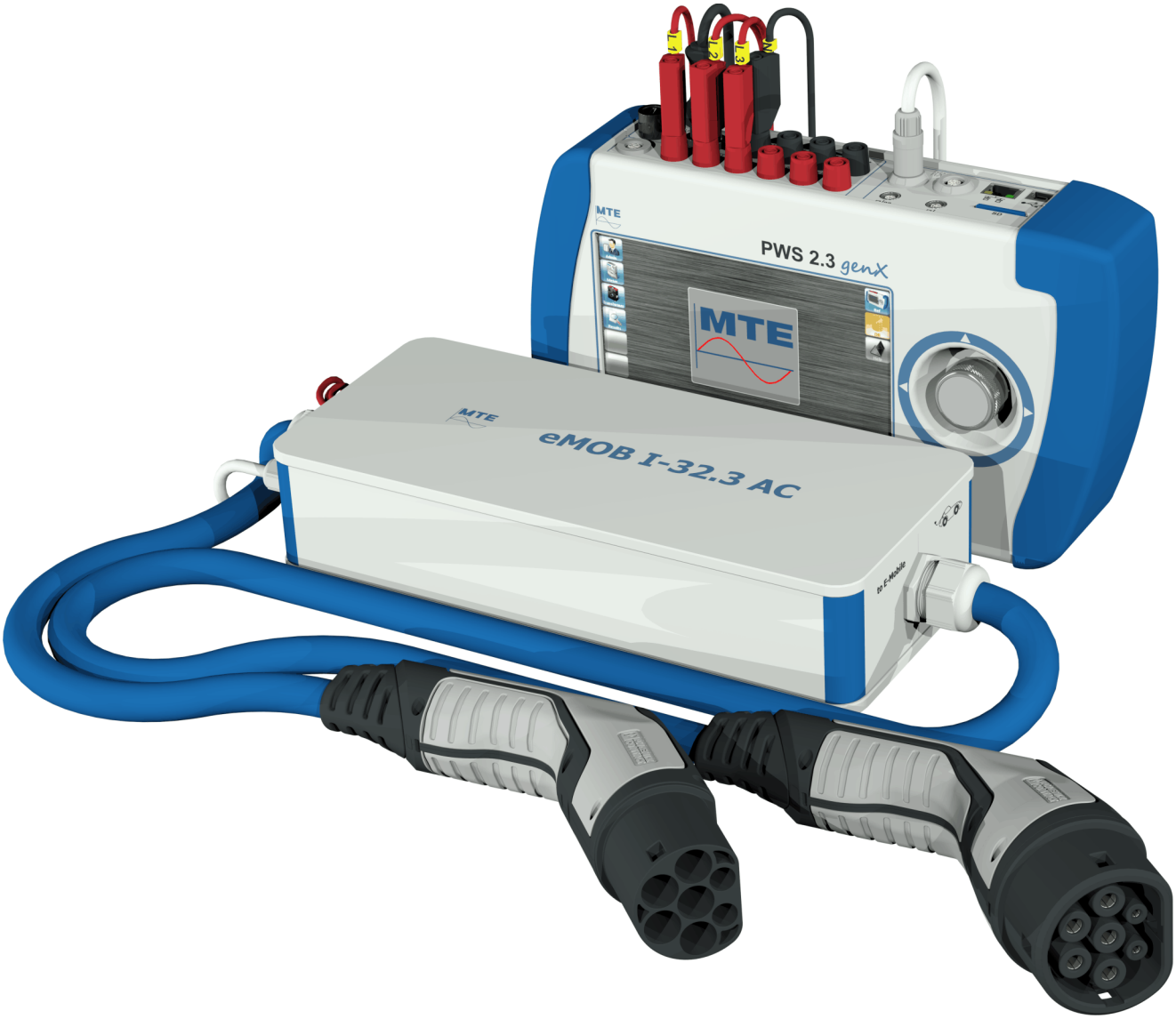
Test it!

MTE Energy Systems & Services

eMOB I-32.3 AC

Test Adapter for E-Mobility Charging Stations



The new eMOB I-32.3 AC test adapter enables in combination with the PWS 2.3 genX portable working standard a comprehensive on-site test of AC charging stations for electric vehicles.

This is prerequisite for precise billing of the en-ergy charged in the accumulator of the electric vehicle considering the voltage drop between the built-in electricity meter and the outlet of the charging station.

The eMOB I-32.3 AC is equipped with charging connectors acc. EN 62196 type 2 (“Mennekes plug”).

Advantages

- Portable working standard accuracy class 0.1
- Easy and fast connection between charging station and vehicle
- Charging current three-phase up to 32 A (up to 22 kW power)
- User-friendly functions such as integrated operation manual
- Large 7" touch screen colour display and web server for remote display of graphical user interface and remote control of the unit

Technical data eMOB I-32.3 AC

General

Power supply:	18 VDC available from the universal CT inputs of PWS 2.3 genX
Power consumption:	max. 10W
Housing	Hard Plastic
Dimensions:	L 305 x W 135 x H 70 mm
Weight:	ca. 4.5 kg
Operation temperature:	-10 °C ... +50 °C
Storage temperature:	-20 °C ... +60 °C
Relative humidity:	≤ 85% at Ta ≤ 21°C
	≤ 95% at Ta ≤ 25°C, 30 days / year spread
Connection:	EN 62196 Type 2 („Mennekes plug“)

Safety

CE certified

Isolation protection:	IEC 61010-1:2011-07
Measurement Category:	300V CAT III
Degree of protection:	IP-42

Measurement range

Measuring Quantity	Range	Phase
Current ranges	1 mA … 32 A	I1, I2, I3
Internal ranges	Range	Output value [V]
	1 mA … 32 mA	0.15 V … 1.5 V AC
	32 mA … 320 mA	0.15 V … 1.5 V AC
	320 mA … 3.2 A	0.15 V … 1.5 V AC
	3.2 A … 32 A	0.15 V … 1.5 V AC

Technical data PWS 2.3genX + eMOB I-32.3 AC

Measurement Accuracy

Voltage / Current		≤ ± E [%] [1 2 4]
Measuring quantity	Range	**Cl. 0.1**
Voltage (U1, U2, U3, N)	46 V … 300 V	0.1
Current direct (I1, I2, I3)	6 mA … 32 A	0.1
	1 mA … 6 mA	0.1

Power / Energy Voltage: 46 V… 300 V (U - N)		≤ ± E [%] [1 2 3]
Measuring quantity / Input I	Range	**Cl. 0.1**
Active (P), Reactive (Q), Apparent (S)		
Current direct (I1, I2, I3)	6 mA … 32 A	0.1
	1 mA … 6 mA	0.1
Drift / year at Power / Energy (PQS) (I direct)		0.02

		≤ ± TC [%/°C] [3]
Temperature coefficient (TC):	Range	**Cl. 0.1**
	0° C ... +40°C	0.005
	-10° C ... +50°C	0.008

Frequency / Phase angle		≤ ± E
Measuring quantity	Range	**Cl. 0.1**
Frequency (f)	40 Hz … 70 Hz	0.01 Hz
Phase angle (φ)	0.00 °… 359.99°	0.1 °

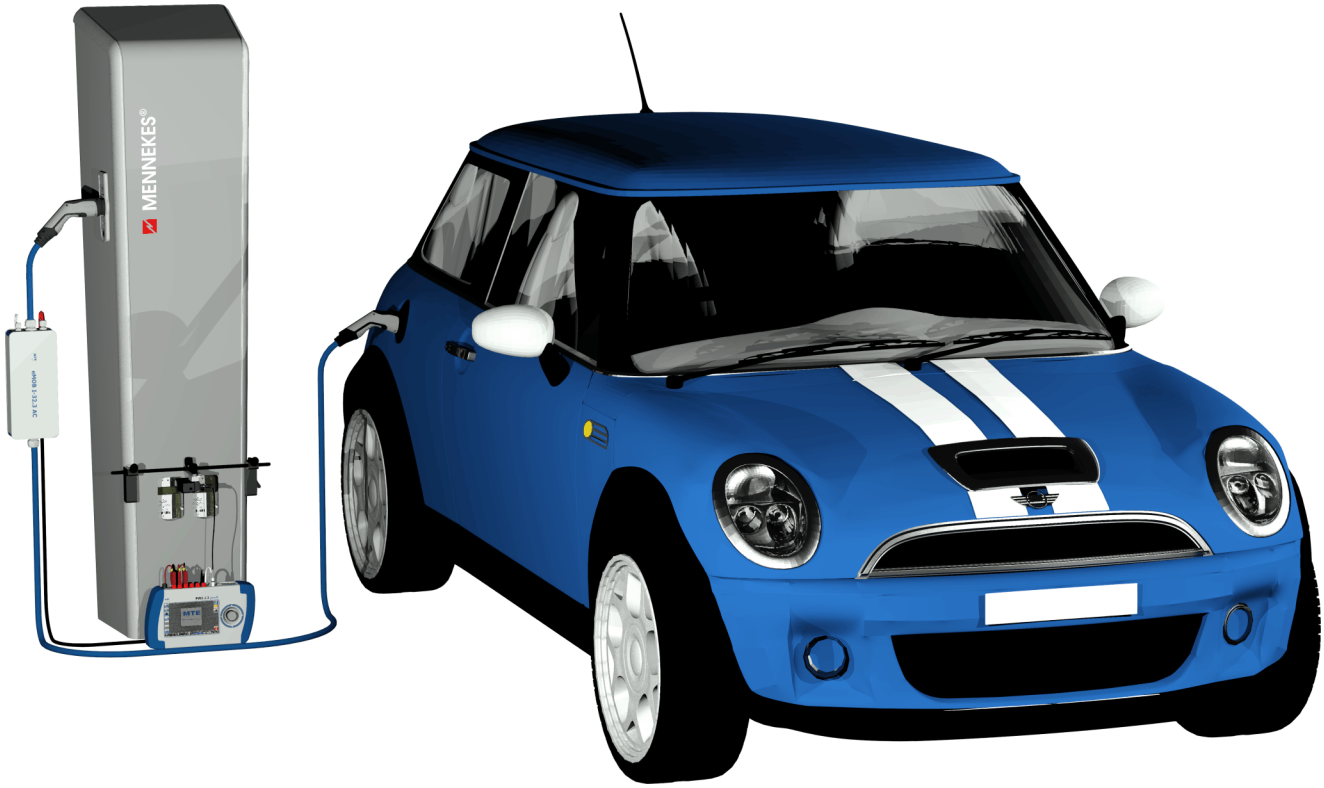
Notes

[1] x.x : Related to the measuring value
x.x : Related to the measuring range final value (full scale, FS),
E(M) = FS/M * x.x (e.g. 0.1 at FS =6 mA, E(2mA) = 6/2 * 0.1 = 0.3 %)

[2] Fundamental frequency in the range 45 … 66 Hz

[3] S: x.x, P,Q: x.x / PF (related to apparent power), 3- and 4-wire networks

Application



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MTE Energy Systems & Services

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PWS 2.3 genX

Three-phase Portable Working Standard for Testing Electricity Meters and Instrument Transformers

The PWS 2.3 genX Portable Working Standard is a three-phase portable electronic meter test unit of accuracy class 0.1%, used for testing single and three-phase electricity meters on site. The PWS 2.3 genX allows checking of all meter installation parameters and associated circuits.

The unit can be used either with a direct connection in the range of 1 mA ... 12 A, or by using a set of 3 active 120 A error compensated UCT clamp-on CT's (included in the standard accessories set) in the range 10 mA …120 A. It is therefore possible to easily and accurately measure both CT and direct connected meters.

The unit can be powered either from the measuring circuit or from an auxiliary single-phase supply.

Advantages

- Large 7" (800 x 480 pixels) TFT touch screen colour display with graphical user interface
- Data transfer and communication via USB (Type B), ETHERNET or WLAN
- Built in web server for remote display of graphical user interface and remote control of the unit
- Data storage on removable SD memory card
- Independent sets of UCT clamp-on CTs allow service, calibration or later purchase of UCT clamp-on CTs without factory return of the device.

Measurement Inputs

- 3 voltage inputs U1, U2, U3
- 3 direct current inputs I1, I2, I3
- 2 UCT clamp-on CT current inputs for I1, I2, I3

Functions

- Meter testing of pulse outputs (LED/disc mark/S0) and registers of active, reactive, apparent 1- or 3-phase, 3- or 4-wire energy meters with 2 pulse inputs (1 configurable as pulse output).
- Measurement of electrical parameters (UI φ, PQS, f, PF) including vector diagram, harmonic analysis and wave form display.
- Instrument transformer testing (CT/PT burden, CT/PT ratio)

Options

- Software CALegration
- Set of 3 UCT 10.3 clamp-on CT 10A
- Set of 3 UCT120.3 clamp-on CT 120A (active error compensated)
- Set of 3 UCT 1000.3 clamp-on CT 1000A
- Set of 3 UCT LEM.3 flexible current probes FLEX 3000 (30/300/3000A)
- UCT AMP-LiteWire 3-phase adapter set for AmpLiteWire
- Primary current sensor AmpLiteWire 2000 A
- UCT VOLT-LiteWire 3-phase adapter set for VoltLiteWire
- Primary voltage sensor VoltLiteWire 40 kV

Technical Data PWS 2.3 *gen X*

General

Auxiliary supply:	Power may be taken from the auxiliary supply or the measuring circuit at: 46 VAC_{min} … 300 VAC_{max}, 47 Hz ... 63 Hz 65 VDC_{min} … 423 VDC_{max} Protection: up to 440 VAC_{max}
External 12 V DC supply:	10 VDC_{min} … 14.4 VDC_{max}
Frequency range:	47 Hz ... 63 Hz
Power consumption:	max. 15W / 30 VA
Housing:	Hard Plastic
Dimensions:	W 308 x H 173 x D 70 mm
Weight:	approx. 1.5 kg
Operation temperature:	-10 °C ... +50 °C
Storage temperature:	-20 °C ... +60 °C
Relative humidity:	≤ 85% at Ta ≤ 21°C
	≤ 95% at Ta ≤ 25°C, 30 days / year spread

Safety

CE certified

Isolation protection:	IEC 61010-1:2010
Measurement Category:	300V CAT III
Degree of protection:	IP-40

Measurement Range

Measuring Quantity	Range	Input / Sensor
Voltage (phase - neutral)	0 V … 300 V	U1, U2, U3
	20 mV … 3 V	U1 (Burden)
Current	1 mA … 12 A	I1, I2, I3
	1 mA … 10 A	UCT 10.3
	10 mA … 120 A	UCT 120.3
	100 mA …1000 A	UCT 1000.3
	3 A …3000 A	FLEX 3000
Primary current	30 A …2000 A	AmpLiteWire 2000A
Primary voltage	500 V … 40 kV	VoltLiteWire 40kV

Measurement Accuracy

Voltage / Current		≤ ± E [%] [1 2 4]
Measuring Quantity	Range	**Cl. 0.1**
Voltage (U1, U2, U3, N)	46 V … 300 V	0.1
	5 V … 25 V	0.1
Current direct (I1, I2, I3)	10 mA … 12 A	0.1
	1 mA … 10 mA	0.1
Current CT 10A **UCT 10.3**	30 mA … 10 A	0.2
	1 mA … 30 mA	1.0
Current CT 120A **UCT 120.3**	100 mA … 120 A	0.2
	10 mA … 100 mA	1.0
Current CT 1000A **UCT 1000.3**	10 A …1000 A	0.2
	1 A … 10 A	1.0
Current FLEX 3000 **UCT LEM.3**	300 A …3000 A 30 A … 300 A 3 A … 30 A	0.1 + E_M
Burden Voltage (U1, N)	100 mV … 5 V	0.5
	20 mV … 100 mV	0.5
Current AmpLiteWire 2000A	300 A …2000 A	0.1 + E_M
	30 A … 300 A	0.1 + E_M
Voltage VoltLiteWire 40kV	6 kV … 40 kV	0.1 + E_M
	500 V … 6 kV	0.1 + E_M

Power / Energy Voltage: 46 V… 300 V (U - N)		≤ ± E [%] [1 2 3]
Measuring quantity / Input I	Range	**Cl. 0.1**
Active (P), Apparent (S) Power / Energy		
Direct (I1, I2, I3)	10 mA … 12 A	0.1
	1 mA … 10 mA	0.1
Current CT 120A UCT 120.3	100 mA … 120 A	0.2
Curr. CT 1000A UCT 1000.3	10 A …1000 A	0.2
Reactive (Q) Power / Energy		
Direct (I1, I2, I3)	10 mA … 12 A	0.2
	1 mA … 10 mA	0.2
Current CT 120A UCT 120.3	100 mA … 120 A	0.4
Curr. CT 1000A UCT 1000.3	10 A …1000 A	0.4
Drift / year at Power / Energy (PQS) (I direct)		0.03

		≤ ± TC [%/°C] [3]
Temperature coefficient (TC):	Range	**Cl. 0.1**
	0° C ... +40°C	0.005
	-10° C ... +50°C	0.008

CT Burden		≤ ± E [%] [1 2]
I (current direct I1)	U (U1 - N)	**Cl. 0.1**
10 mA … 12 A	100 mV … 3 V	0.6
10 mA … 12 A	20 mV … 100 mV	0.1 + 0.5

PT Burden		≤ ± E [%] [1 2]
I (Current direct I1)	U (U1 - N)	**Cl. 0.1**
10 mA … 12 A	46 V … 300 V	0.2
1 mA … 10 mA	46 V … 300 V	0.1 + 0.1

CT Ratio		≤ ± E [%] / Δφ [°] [1 2 4 5]
IP - Input / Range	IS (I1, I2, I3)	**Cl. 0.1**
Current CT 120A UCT 120.3		
100 mA … 120 A	10 mA … 12 A	0.3 / 0.3
100 mA … 120 A	1 mA … 10 mA	1.0 / -
Current CT 1000A UCT 1000.3		
10 A …1000 A	10 mA … 12 A	0.3 / 0.3
1 A … 10 A	10 mA … 12 A	1.0 / -
FLEX 3000 UCT LEM.3		
300 A …3000 A 30 A … 300 A 3 A … 30 A	10 mA … 12 A	0.2 + E_M / -
AmpLiteWire 2000A		
300 A …2000 A	10 mA … 12 A	0.2 + E_M / -
30 A … 300 A	10 mA … 12 A	0.1+0.1+E_M/ -

Frequency / Phase Angle / Power Factor		≤ ± E
Measuring Quantity	Range	**Cl. 0.1**
Frequency (f)	40 Hz … 70 Hz	0.01 Hz
Phase Angle (φ)	0.00 °… 359.99°	0.1 °
Power Factor (PF)	-1.000 …+1.000	0.002

Notes

[1] x.x :Related to the measuring value
x.x :Related to the measuring range final value (full scale, FS),
E(M) = FS/M * x.x (e.g. 0.1 at FS =10 mA, E(2mA) = 10/2 * 0.1 = 0.5 %)

[2] Fundamental frequency in the range 45 … 66 Hz

[3] S: x.x, P,Q: x.x / PF (related to apparent power), 3- and 4-wire networks

[4] E_M: Accuracy specified by manufacturer of clamp-on CT or sensor

[5] E[%]: Accuracy of ratio Ei, Et; Δφ[°]: Phase shift of phase displacement φp, φs.

Pulse Input / output

Input 1 can be configured as output

Input level:	4 … 12 VDC (24 VDC)			
Input frequency:	max. 200 kHz			
Supply:	12 VDC (I < 60 mA)			
Output level:	5V			
Pulse length:	≥ 10µs			
Meter constant: Active, Reactive, Apparent	C = C_0 / (In * Un) C_0= 36'000'000 [imp/Wh(varh,VAh)] The meter constant depends on the highest selected internal ranges In, Un. The direct voltage input has only one range: Un = 300 V. The actual constant CPZ_1 with unit [imp/Ws (vars, VAs)] is indicated on the display at frequency output.			
	Internal current ranges In [A]			
Direct I1, I2, I3	0.012	0.12	1.2	12
Current CT 120A UCT 120.3	0.12	1.2	12	120
Current CT 1000A UCT 1000.3	1	10	100	1000
FLEX 3000	-	30	300	3000
	Example: Un = 300V, In = 12 A C = 10'000 [imp/Wh(varh,VAh)]			
Output frequency:	CPZ_1 = C / 3'600 [imp/Ws(vars, VAs)] f_0 = CPZ_1 * PΣ(QΣ, SΣ) f_{max} = CPZ_1 * **3** * Un * In = 2.77778 imp/Ws * **3** * 300V * 12A = 30'000 [imp/s] Factor **3** for 3-phase system			

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MTE Energy Systems & Services

eMOB I-200.1 DC

Test Adapter for E-Mobility Charging Stations

The new eMOB I-200.1 DC test adapter enables in combination with the PWS 3.3 genX Portable Working Standard a comprehensive on-site test of DC charging stations for electric vehicles.

This is prerequisite for precise billing of the energy charged into the accumulator of the electric vehicle considering the voltage drop between the built-in electricity meter and the outlet of the charging station.

The eMOB I-200.1 DC test adapter is equipped with a CCS Type 2 inlet (IEC 62196-3) to plug-in and lock the cable of the charging station and on the other side with a charging cable with CCS plug for the Electric Vehicle.

Advantages

- Calibration of the DC energy measuring unit(s) inside the charging station with a reference equipment of accuracy class 0.1
- Easy and fast connection between charging station and vehicle
- Charging voltage up to 1000 VDC measured
- Charging current up to 200 ADC measured (up to 200 kW DC power at 1000 VDC)
- User-friendly functions such as integrated operation manual
- Large 9" touch screen colour display and web server for remote display of graphical user interface and remote control of the unit

Technical Data eMOB I-200.1 DC

General

Power supply:	Power may be taken from the CT-Inputs of the Metering device: U = ± 18 VDC U = 3.3V DC
Power consumption:	max. 18 W
Housing:	Hard Plastic
Dimensions:	L 390 x W 180 x H 230 mm
Weight:	7.45 kg
Operation temperature:	-10 °C ... +50 °C
Storage temperature:	-20 °C ... +60 °C
Relative humidity:	≤ 85% at Ta ≤ 21°C
	≤ 95% at Ta ≤ 25°C, 30 days / year spread
Connection:	CCS Type 2 inlet and cable with CCS plug (IEC 62196-3)

Safety

CE certified

Isolation protection:	IEC 61010-1:2020-03
Measurement Category:	1000V CAT III
Degree of protection:	IP-42

Measurement Range

Measuring Quantity	Range	Phase
DC Current	1 A… 200 A	I1
Internal ranges	Range	Output value [V]
	1 A … 1.5 A	0.2V … 2.5V DC
	1.5 A … 3 A	0.2V … 2.5V DC
	3 A … 6 A	0.2V … 2.5V DC
	6 A … 12 A	0.2V … 2.5V DC
	12 A … 25A	0.2V … 2.5V DC
	25 A … 50 A	0.2V … 2.5V DC
	50 A … 100 A	0.2V … 2.5V DC
	100 A … 200 A	0.2V … 2.5V DC

Technical Data PWS 3.3 genX + eMOB I-200.1 DC

Measurement Accuracy

Voltage / Current		≤ ± E [%] [1]
Measuring Quantity	Range	**Cl. 0.1**
DC Voltage (U1-N)	40 V …1000 V	0.05
	10 V … 40 V	0.05
DC Current direct (I1)	2 A … 200 A	0.1
	1 A … 2 A	0.1

DC Power / Energy DC Voltage: 40 V … 1000 V		≤ ± E [%] [1]
Measuring quantity / Input I	Range	**Cl. 0.1**
DC current direct (I1)	2 A … 200 A	0.1
	1 A … 2 A	0.1
Drift / year at Power / Energy (I direct)		0.02

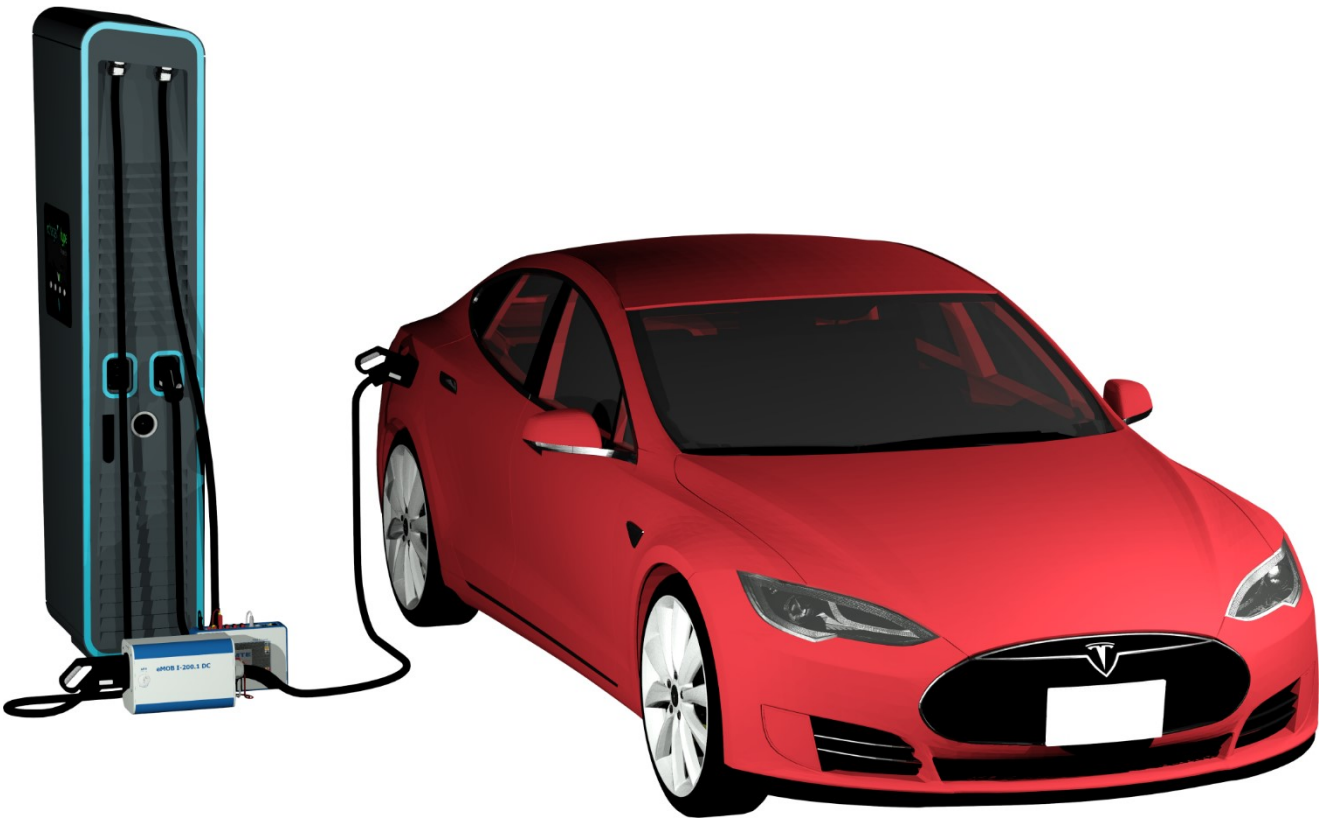
	Internal voltage ranges Un [V]			
DC Voltage (U1-N)	125	250	500	1000

		≤ ± TC [%/°C]
	Range	**Cl. 0.1**
Temperature	0°C ... +40°C	0.005
coefficient (TC)	-10°C … +50°C	0.008

Notes

[1] x.x :Related to the measuring value
x.x :Related to the measuring range final value (full scale, FS),
E(M) = FS/M * x.x
(e.g. 0.05 at FS = 125 V, E(25) = 125/25 * 0.05 = 0.25 %)

Application



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MTE Energy Systems & Services

MTE Services Elk. Ener. San. Tic. A.Ş.

PWS 3.3 genX

Three-phase Portable Working Standard and Power Quality Analyzer

The PWS 3.3 genX is a combination of a Portable Working Standard of class 0.05 % and an IEC 61000-4-30 Class A compatible Power Quality Analyzer with 4 voltage (U1, U2, U3, UN, UPE) and 4 current channels (direct: I1, I2, I3 and via clamp-on CT: IN / IPE Neutral current / Protection Earth current).

The modular concept of the PWS 3.3 genX allows the extension of the direct current measurement range from 12A up to 120A and the adding of a battery pack keeps the device running in the event of interruptions in the supply voltage during Power Quality recording or when supply from measuring voltage or mains is not possible.

NEW FUNCTIONS

The PWS 3.3 genX enables as first MTE reference standard

- **Calibration of DC meters or DC energy measurement units** up to 1000 VDC / 200 ADC applied in EVSE Electric Vehicle Supply Equipment with CCS Type 2 connector (IEC 62196-3).
- **Calibration of digital meters, non-conventional CTs / PTs and merging units** with SV Sampled Values interface (IEC 61850-9-2 LE) in digital substations.

Advantages

- Large 9” (800 x 480 pixels) TFT touch screen colour display with graphical user interface
- Integrated operation manual
- Built in web server for remote display of graphical user interface and remote control of the unit
- Data transfer and communication via USB (Type B), ETHERNET or WLAN
- Data storage on removable SD memory card
- Two USB (type A) connectors for connection of peripherals like mouse, keyboard, optical readout head OKK to communicate with the meter
- Time synchronisation via GPS (option) and 1 PPS Pulse Per Second / IRIG-B signal

WORKING STANDARD - Functions

- Meter testing of pulse outputs (LED/disc mark/S0) and registers of active, reactive, apparent 1- or 3-phase 3- or 4-wire energy meters with 2 pulse inputs (1 configurable as pulse output).
- Measurement of electrical parameters (UIφ, PQS, f, PF) including vector diagram, harmonic analysis and wave form display.
- Instrument transformer testing (CT/PT burden, CT/PT ratio)

POWER QUALITY ANALYZER – Functions

- Dips / Swells / Interruptions
- Harmonics / Interharmonics / Signal voltages
- Unbalance
- Flicker
- RVC Rapid Voltage Changes
- Transients

Options

- Software CALegration
- UCT 10.3 set of 3 clamp-on CT’s 10 A
- UCT 120.3 set of 3 clamp-on CT’s 120 A
- UCT 1000.3 set of 3 clamp-on CT’s 1000 A
- UCT LEM.3 set of 3 flexible current probes FLEX 3000 (30/300/3000A)
- UCT 120.1 clamp-on CT 120A for IN/IPE
- UCT AMP-LiteWire 3-phase adapter set for AmpLiteWire + primary high voltage current sensor AmpLiteWire 2000 A
- UCT VOLT-LiteWire 3-phase adapter set for VoltLiteWire + primary voltage sensor VoltLiteWire 40 kV

Adapters for EVSE Electric Vehicle Supply Equipment test

- eMOB I-32.3 AC (600 V / 32 A) to test AC charging
- eMOB I-200.1 DC (1000 VDC / 200 ADC) to test DC charging

Portable Working Standard PWS 3.3 *genX*

Auxiliary power supply:	46 … 300 VAC, 47 … 63 Hz (65 … 423 VDC) Protection: up to 440 VAC
Power consumption:	max. 20 VA (+ 10 VA + 20 VA (charging)) PWS 3.3 genX (+ I.3 120A + Battery module)
Safety / Protection:	IEC 61010-1:2010 (CE certified) / IP-40
Measurement Category:	300V CAT IV, 600V CAT III
Operation temperature:	-10 °C ... +50 °C (Storage: -20 °C ... +60 °C)
Relative humidity:	≤ 85% at Ta ≤ 21°C
	≤ 95% at Ta ≤ 25°C, 30 days / year spread

Measurement Ranges

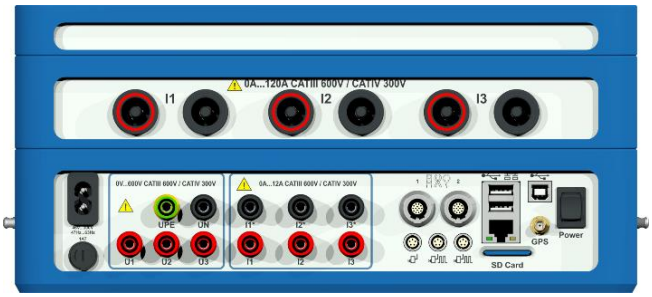
Measuring Quantity	Range	Input / Sensor
Voltage (phase - neutral)	5 V … 600 V 10 mV … 5 V 10 VDC …1000 VDC	U1, U2, U3, UPE U1, U2, U3 (Burden) U1
Current	1 mA … 12 A	12 A (I1, I2, I3)
	10 mA … 120 A	I.3 120 A (I1, I2, I3)
	1 mA … 10 A	UCT 10.3
	10 mA … 120 A	UCT 120.3
	100 mA …1000 A	UCT 1000.3
	10 mA … 120 A	UCT 120.1 (IPE / IN)
	3 A …3000 A	FLEX 3000
	1 mA … 32 A	eMOB I-32.3 AC
	1 ADC… 200 ADC	eMOB I-200.1 DC (I1)
Primary current	30 A …2000 A	AmpLiteWire 2000A
Primary voltage	500 V … 40 kV	VoltLiteWire 40kV

Accuracy Class Power / Energy Measurement

Class	Input / Sensor
0.05	current direct 12 A / current direct 120 A
0.1	eMOB I-32.3 AC adapter / eMOB I-200.1 DC adapter
0.2	Clamp-on CT's UCT 10.3 / UCT 120.3 / UCT 1000.3

3 MODULES FOR VARIOUS APPLICATIONS

Module (Hard Plastic)	Dimensions [mm]	Weight [kg]
PWS 3.3 *genX*	W 320 x H 210 x D 66	approx. 2.5
I.3 120A	W 320 x H 210 x D 56	approx. 1.5
Battery	W 320 x H 210 x D 29	approx. 1.0



Portable Working Standard PWS 3.3 *genX* - 12A

Best for meter test, CT / PT burden and ratio test and installation check in installations with instrument transformers.

NEW FUNCTIONS AND APPLICATIONS

- **Field Testing of EVSE Electric Vehicle Supply Equipment**
  Calibration of AC or DC electricity meters or energy measurement units built into the charging stations for EV Electric Vehicles with connector Type 2 / CCS Type 2 (IEC 62196-2/3).
  - **PWS 3.3 genX + eMOB I-32.3 AC adapter** with **Type 2** connector to test 3 phase AC energy accuracy up to 3 x 32 A
  - **PWS 3.3 genX + eMOB I-200.1 DC adapter** with **CCS Type 2** connector to test DC energy accuracy up to 1000 VDC, 200 ADC

- **Field Testing of Digital Meters, non-conventional CTs / PTs and Merging Units** (under development)
  - ETHERNET interface for IEC 61850-9-2-LE Sampled Values
  - Time synchronisation: GPS and 1 PPS Pulse Per Second / IRIG-B

Portable Working Standard PWS 3.3 *genX* - 120A

Best for use in the laboratory in combination with a power source or in the field to test direct connected meters up to 120A.

PWS 3.3 *genX* - 12A with Battery module

Best for Power Quality Analysis or EVSE testing to keep the device running if auxiliary supply from measuring voltage or socket is interrupted or not available.

- Battery 12V, 4000 mAh (20 x NiMH 1.2V type AA) for operation up to 4h
- Power Quality Analysis IEC 61000-4-30 Class A (0.1 %), IEC 62586-2 with 4 voltage and 4 current channels (under development)

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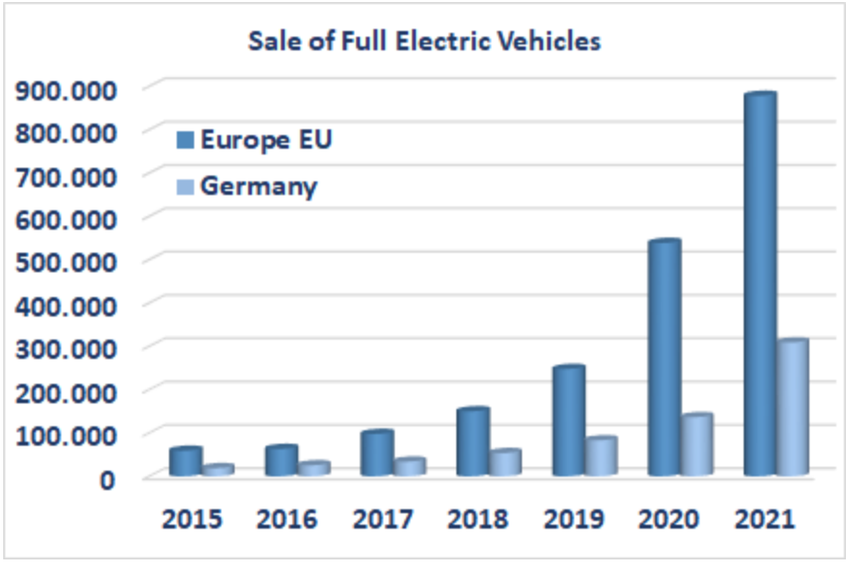
MTE Energy Systems & Services

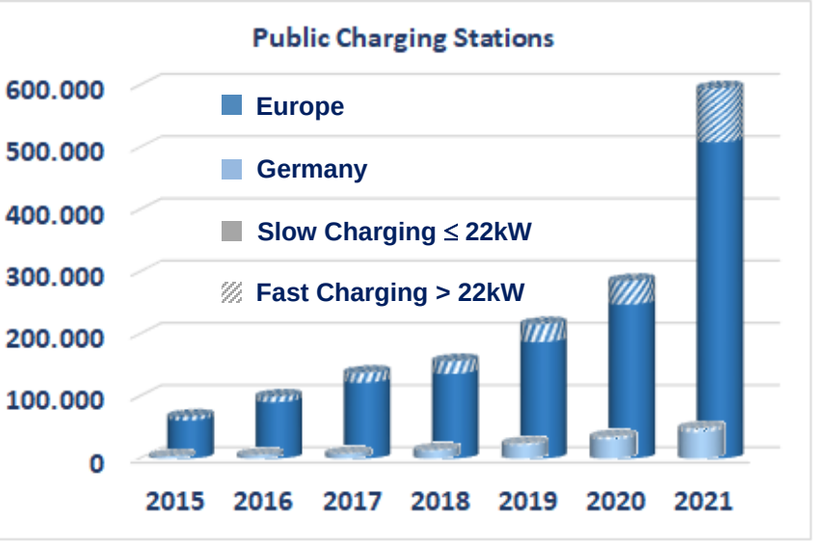
MTE's Solutions for E-Mobility Testing and Calibration of DC Energy Meters

e-Mobility Testing

Background

- Drivers/Trends
  - Major increase of renewable energy share of gross electricity consumption by 2030
  - Reduction of greenhouse gas emissions and primary energy consumption (oil, coal, gas, etc.) by 50%
  - Changeover of inner city and passenger transportation to e-mobility

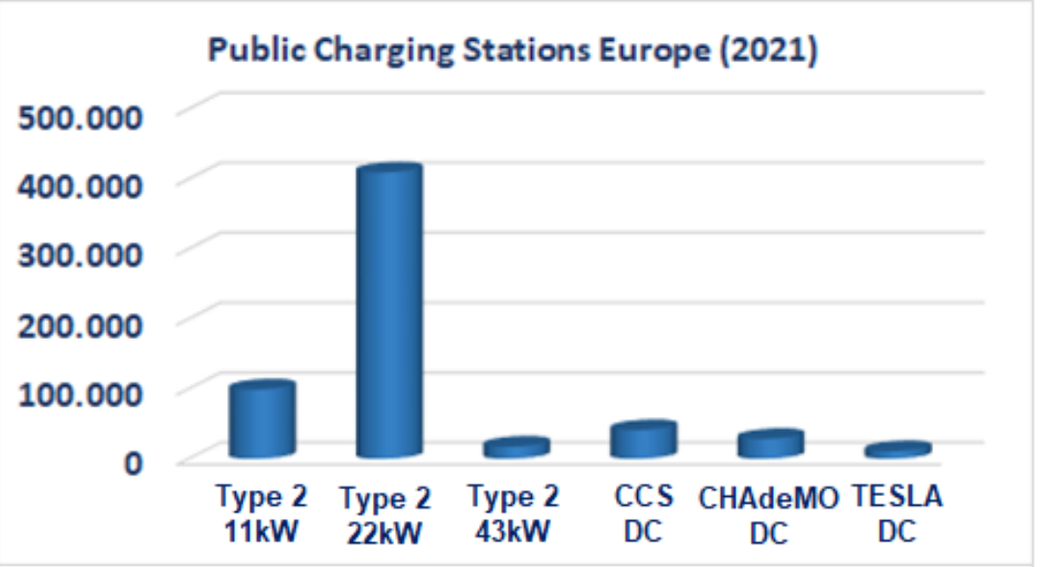




e-Mobility Testing

Background

- AC ⇔ DC Charging
  - wide majority of electric vehicle fleet and e-charging stations based on AC charging
  - DC Charging Advantages
    - fast charging due to external AC/DC conversion
    - loading voltages/currents up to 1.500VDC/600ADC (up to 900kW)



AC/DC Charging Station

Dimensions: 0,5m (L) x 0,8m (D) x 1,9m (H)
Weight: approx. 400kg
Costs: up to 50k€

AC Charging Station

Dimensions: 0,4m (L) x 0,3m (D) x 1,3m (H)
Weight: approx. 70kg
Costs: up to 5-10k€

e-Mobility Testing

Background

- Charging Connectors
  - Europe/Germany
    - AC Charging
      - EN 62196 Type 2 / “Mennekes Plug”
      - typically 400V (11kW/22kW/43kW)
      - 230/380V AC x 32A AC = 22kW
    - DC Charging / CCS/Combo 2
      - typically 50-350kW (up to 500kW)
      - max. 1.000V DC | 500A DC
  - Asia-Pacific/Japan
    - DC Charging
      - CHAdeMO / ISO/IEC 61851-23/-24
      - typically 50kW (up to 100-400kW)
      - 500V DC | up to 125A DC

eMOB I-32.3 AC & PWS 2.3 genX

Field Testing of E-Mobility Charging Stations

- Application
  - Calibration of energy measurement accuracy of EVSE (electrical vehicle supply equipment)
  - Impulse comparison method using scanning head or impulse cable
  - Register test incl. communication with back-end system of charge point operator

AC Charging

EN 62196 Type 2 / “Mennekes Plug”

eMOB I-32.3 AC & PWS 2.3 genX

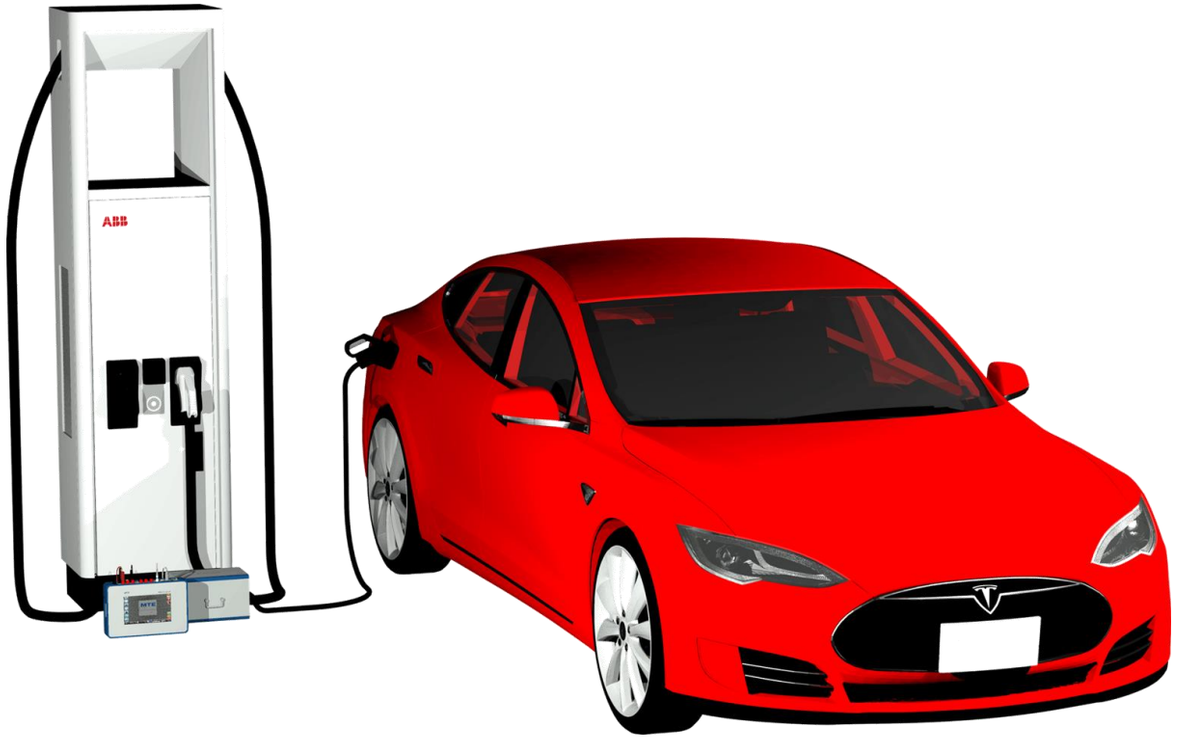
Field Testing of E-Mobility Charging Stations

- Advantages
  - Portable working standards PWS 2.3 genX with
    accuracy class 0.1%
  - Easy and fast connection between EVSE electrical vehicle supply equipment) and EV (electric vehicle) or alternative load (typically fan heater)
  - Charging current three-phase up to 32A (22kW)
  - Large 7” touch-screen colour display and web-server for remote display of graphical user interface and remote control of the unit
  - Calibration using pulse comparison method or register test

eMOB I-200.1 DC & PWS 3.3 genX

Field Testing of E-Mobility Charging Stations

- Application
  - Same measurement principle as for testing of AC EVSE (electrical vehicle supply equipment)
  - Impulse comparison method using scanning head or impulse cable



DC Charging

EN 62196-3 / CCS/Combo 2 Plug

eMOB I-200.1 DC & PWS 3.3 genX

Field Testing of E-Mobility Charging Stations

- Advantages
  - New Portable working standards PWS 3.3 genX with accuracy class 0.05%
  - Testing of EVSE up to 1.000VDC | 200A (160kW)
  - Power quality analysis acc.
    IEC 61000-4-30 /
    IEC 62856 Cl. A
  - Field testing of digital meters, non-conventional CTs/PTs and merging units based on IEC 61850-9-2 LE interface with 1pps signal
  - Large 9” touch-screen colour display and webserver for remote display of graphical user interface and remote control of the unit
  - optional battery pack

eMOB I-200.1 DC & PWS 3.3 genX

Field Testing of E-Mobility Charging Stations

- Procedure
  - Connection of eMOB I-200.1 DC & PWS 3.3 genX between electrical vehicle and charging station
  - Start of energy measurement on PWS 3.3 genX firmware
  - Charging of electrical vehicle (ideally for min. 20 x resolution of it's energy counter
  - Introduction of energy measurement of charging station into PWS 3.3 genX firmware
  - Error calculation by PWS 2.3 genX firmware

eMOB I-200.1 DC & PWS 3.3 *genX*

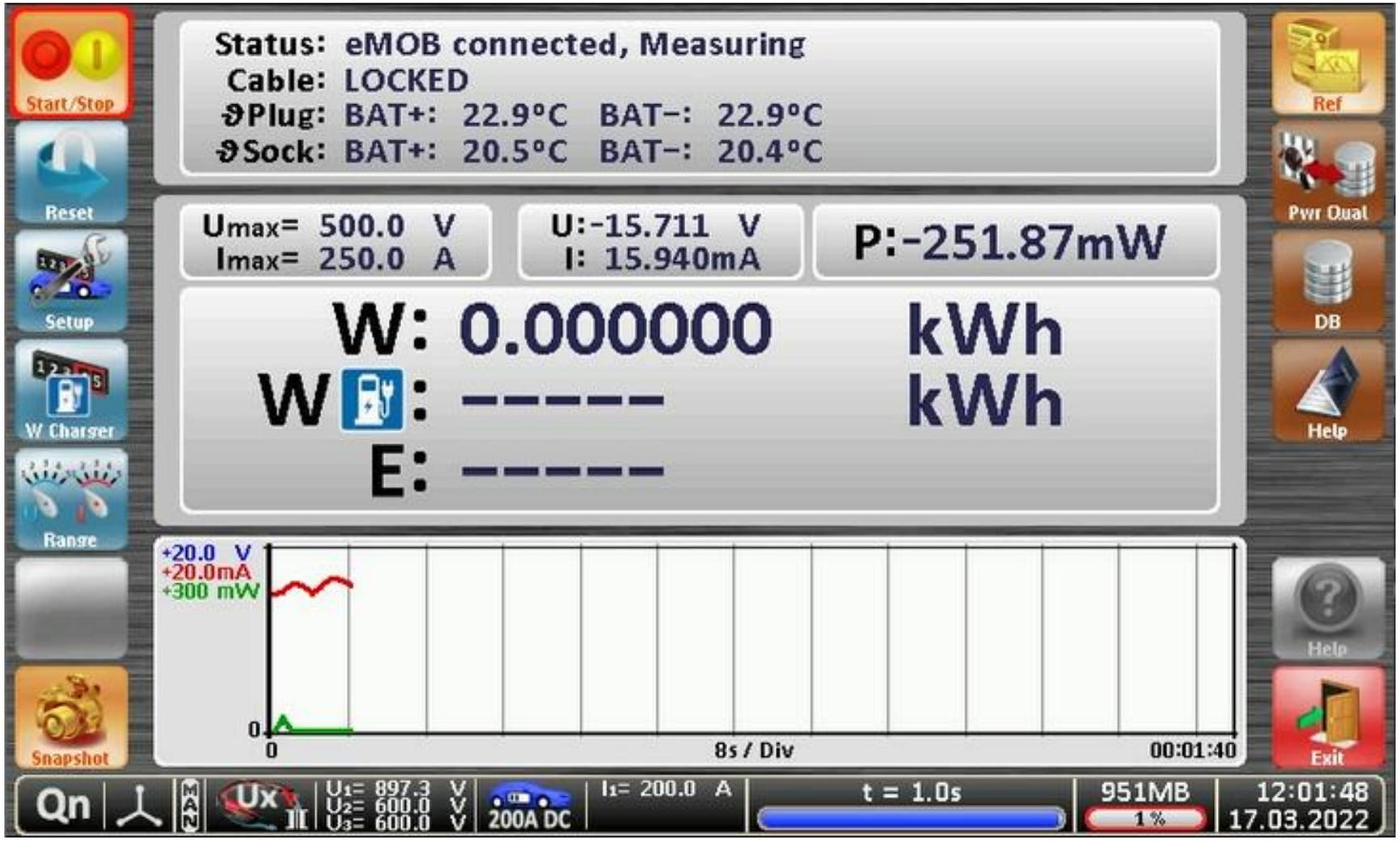
Field Testing of E-Mobility Charging Stations

- Procedure
  - Connection of eMOB I-200.1 DC & PWS 3.3 *genX* between electrical vehicle and charging station

eMOB I-200.1 DC & PWS 3.3 *genX*

Field Testing of E-Mobility Charging Stations

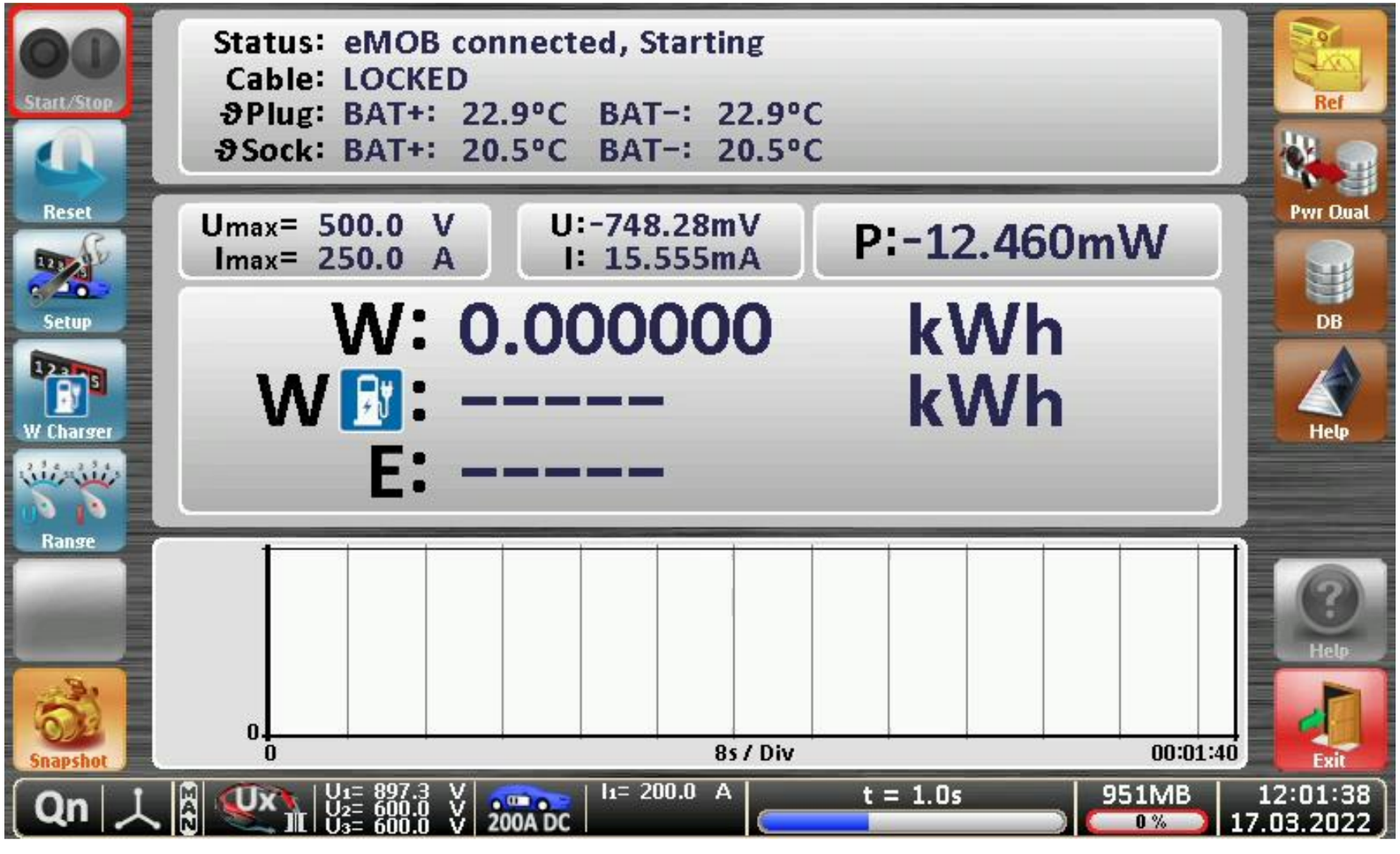
- Procedure
  - Start of energy measurement on PWS 3.3 *genX* firmware



eMOB I-200.1 DC & PWS 3.3 genX

Field Testing of E-Mobility Charging Stations

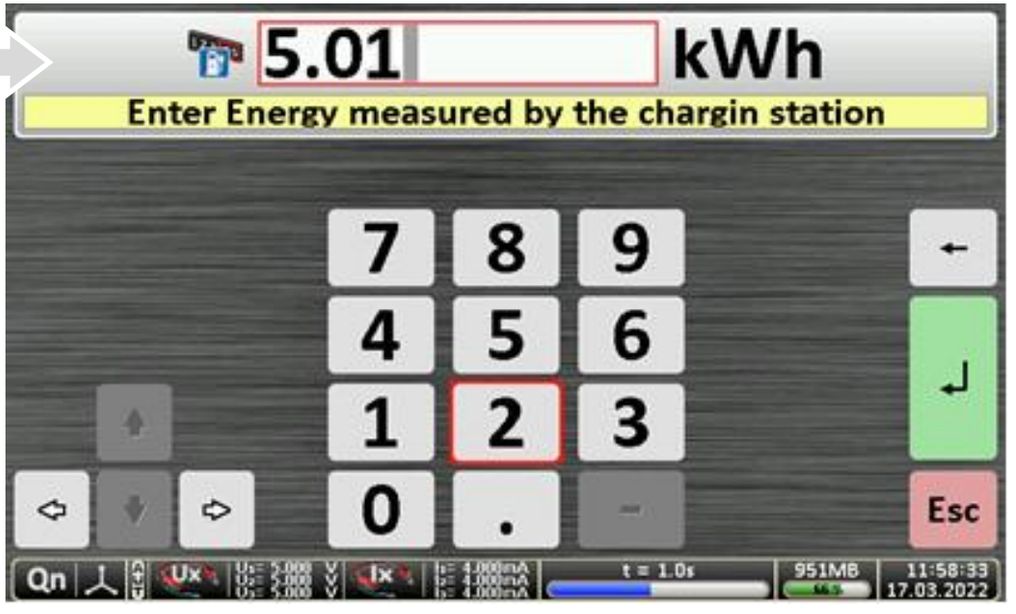
- Procedure
  - Charging of electrical vehicle



eMOB I-200.1 DC & PWS 3.3 *genX*

Field Testing of E-Mobility Charging Stations

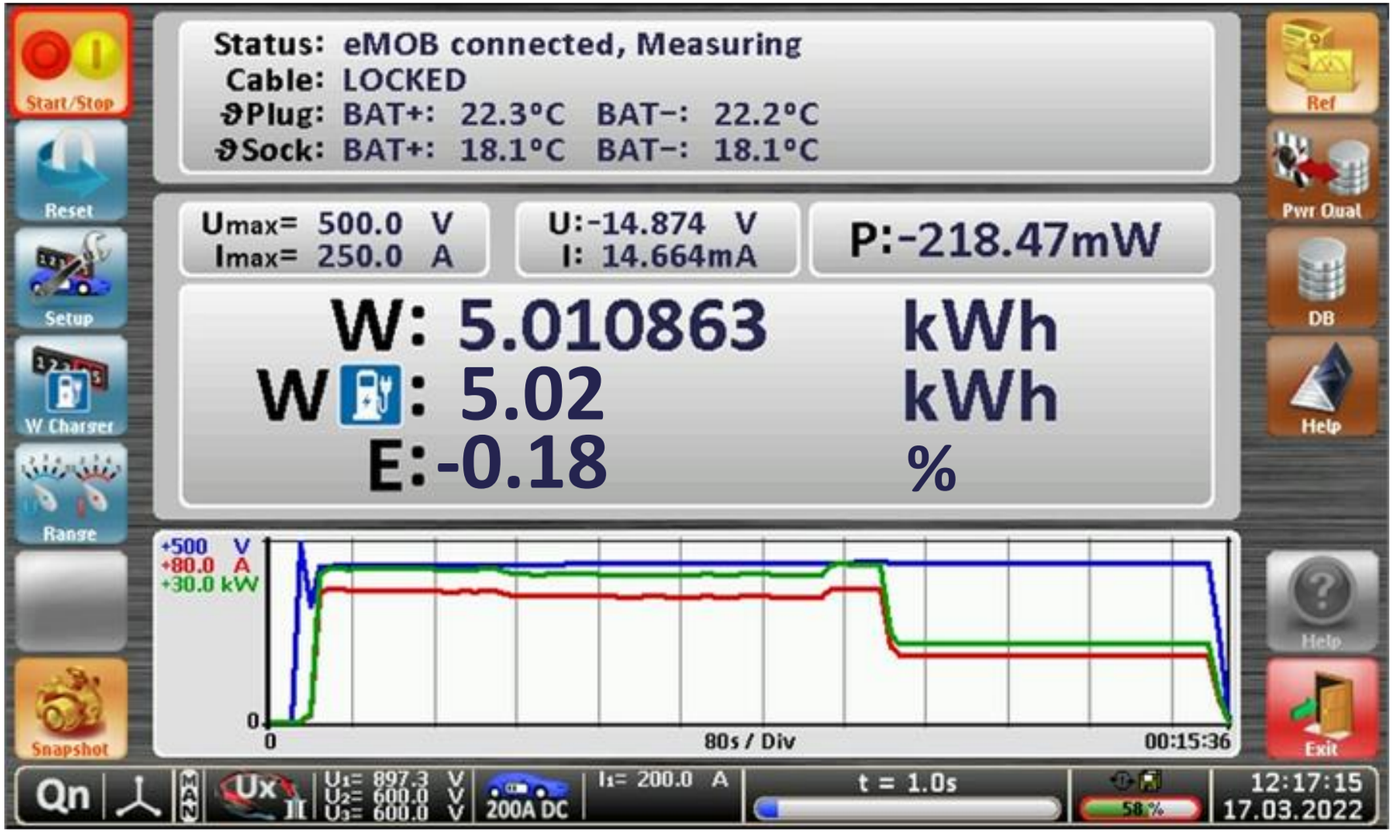
- Procedure
  - Introduction of energy measurement of charging station into PWS 3.3 *genX*



eMOB I-200.1 DC & PWS 3.3 *genX*

Field Testing of E-Mobility Charging Stations

- Procedure
  - Error calculation by PWS 3.3 *genX* firmware

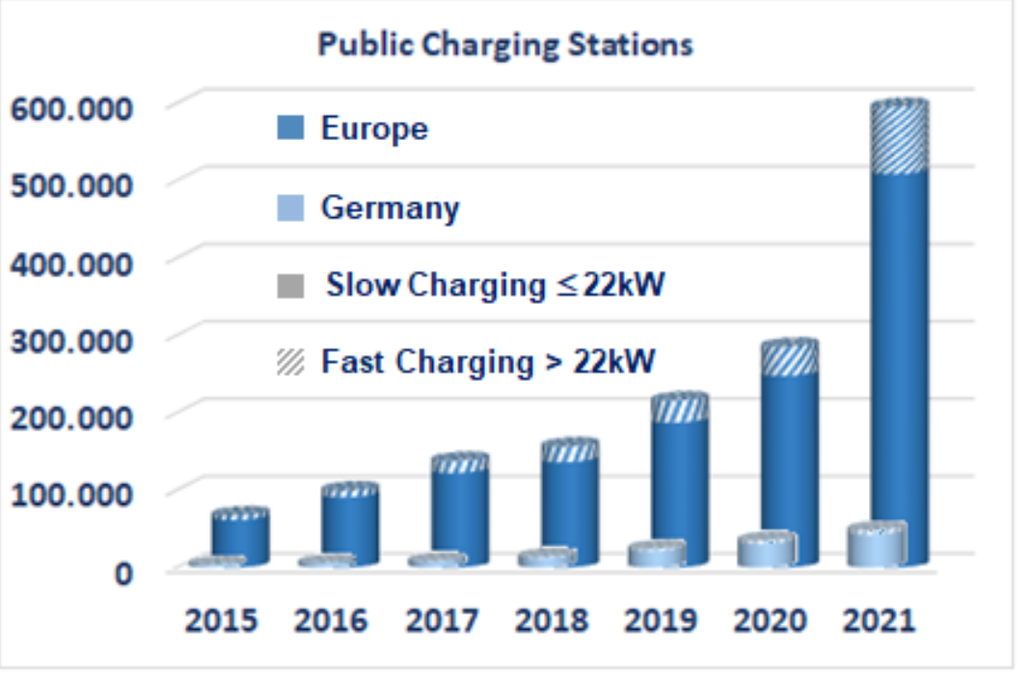


DC Meter Calibration Systems

Laboratory/Production Testing of DC Energy Meters

Background

- Applications
  - DC fast charging stations
  - CCS 1.0 max. 80kW (< 500VDC | < 200A)
  - CCS 2.0 max. 350kW (200-1.000VDC | < 500A)
  - annual increase of approx. 10%/year until 2024 (i.e. 300 nos. in Germany and 6.500 nos. in Europe)
- Standards
  - IEC 62053-41 (Ed.1 FDIS 03-2021)
    - up to 1.500V DC
    - up to 500A DC
    - Accuracy Classes 0,5 and 1



DC Meter Calibration Systems

Laboratory/Production Testing of DC Energy Meters

SRS 121.1 DC Reference Standard

- Product Overview
  - Setup
    - 6-Channel U_{ADC} PCB
    - 2-Channel I_{ADC} PCB
    - 2 Current Sensor LEM IT 605-S ULTRASTAB
    - Power Supply / No Display
  - Specification

Measuring Quantity	Measuring Range	Measurement Uncertainty
Voltage	100V – 1.000V < 100V	≤ ± 0,04% * ≤ ± 0,04% **
Current	5A – 600A < 5A	≤ ± 0,04% * ≤ ± 0,06% **
Power/Energy	100V – 1.000V | 5A – 600A < 100V | <5A	≤ ± 0,04% * ≤ ± 0,06% **

  - CAT III 1.000V
  - CAT II 1.500V available on demand

SRS 121.1 DC Frontside

SRS 121.1 DC Backside

DC Meter Calibration Systems

Laboratory/Production Testing of DC Energy Meters

DC Meter Calibration System

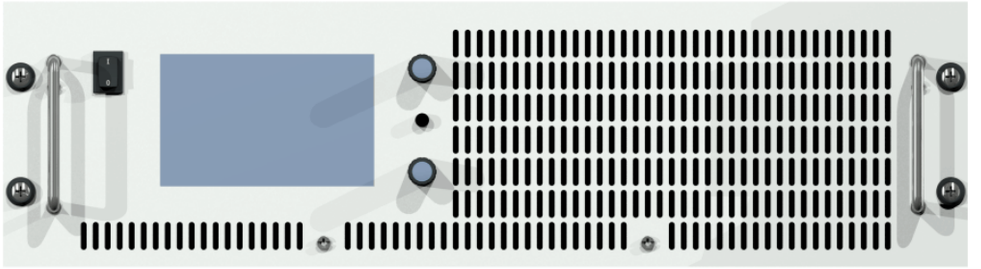
- DC Power Sources
  - Models
    - Voltage Source 1.200V DC 2.4kW
    - Current Source
      750A DC 10.0kW
      80A DC 1.0kW
  - Specification

Range	Stability	Accuracy
Voltage 0 – 1.200V DC	≤ ± 0,05%	≤ ± 0,2% *
Current 0 – 80A DC	≤ ± 0,05%	≤ ± 0,5% *
0 – 600A DC	≤ ± 0,05%	≤ ± 0,2% *

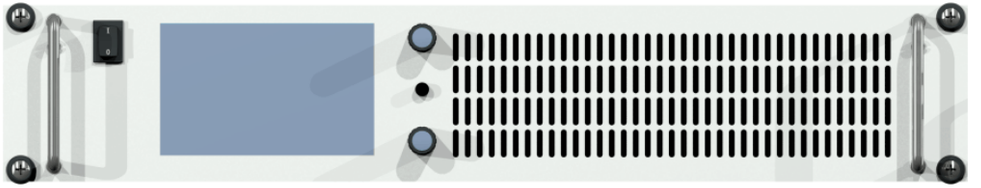
* of the range final value

I-Source 80 A / 15 V / 1200 W

I-Source 750 A / 15 V / 10000 W



U-Source 1200 V / 2 A / 2400 W

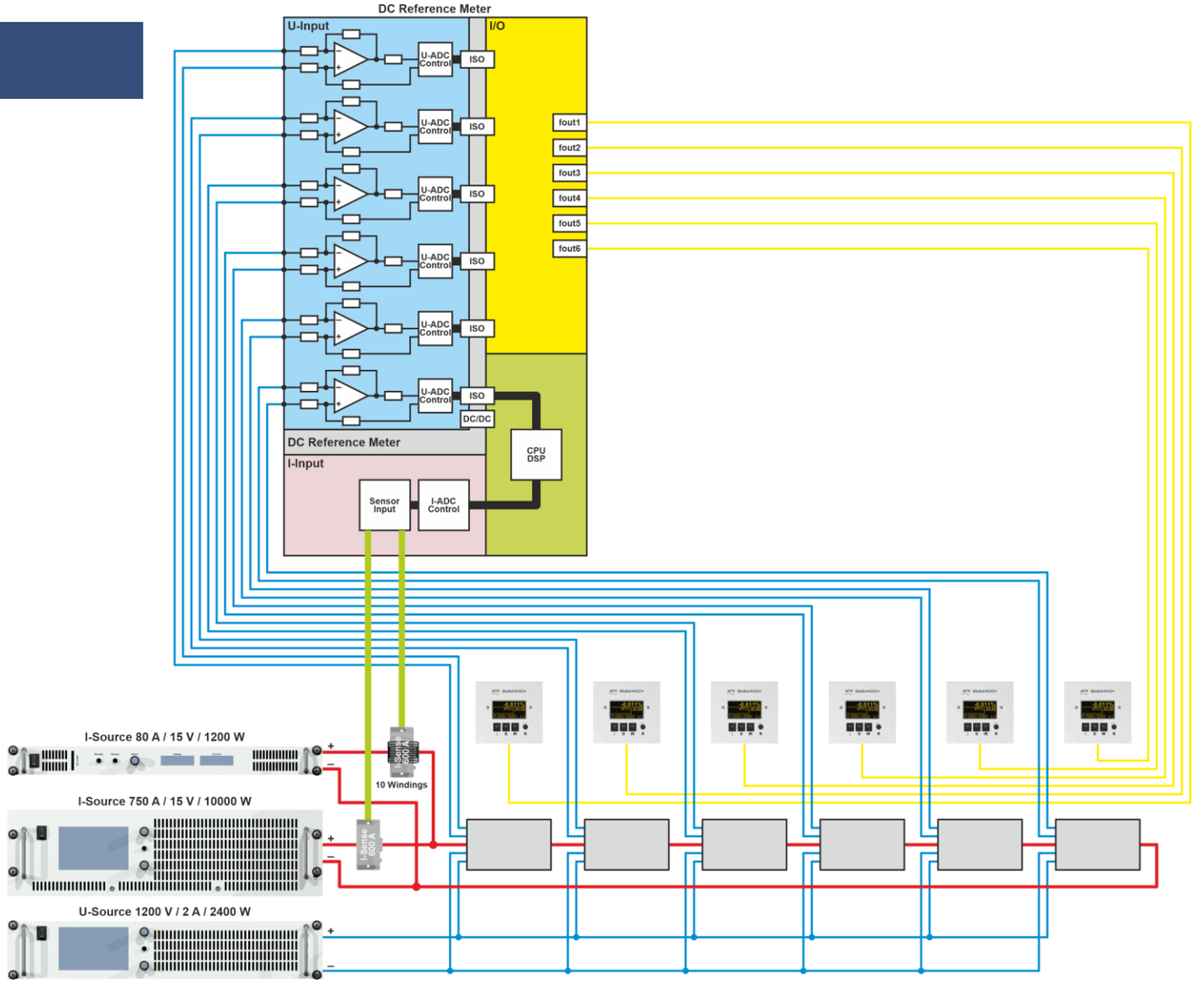


DC Meter Calibration Systems

Laboratory/Production Testing of DC Energy Meters

Solution

- System Setup

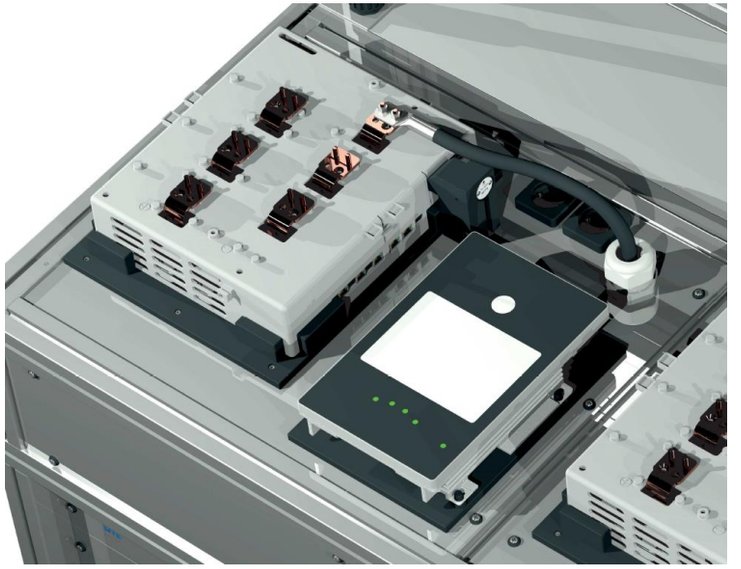


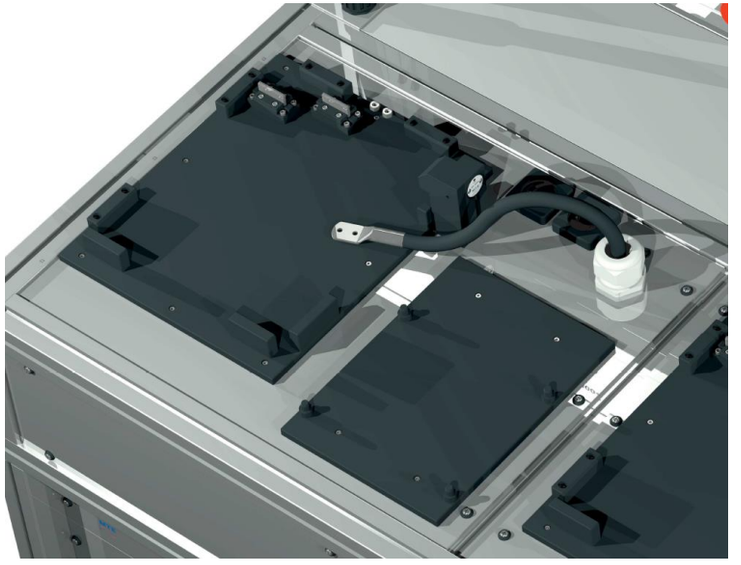
DC Meter Calibration Systems

Laboratory/Production Testing of DC Energy Meters

Project Example

- Contacting Solution
  - Models
  - Contacting resistances at 375/500A DC extremely critical
  - Current In
    DC Clip Mount
  - Current Out
    Cable Lug
    (double screwed)





ISO 17025 Calibration Laboratory

Scope Expansion for DC Measuring Quantities

Voltage | Current | Power | Energy

- Support of the product strategy to develop portable and stationary test equipment for DC energy meters and DC EVSE
- USP and competence increase
- Investment during 2021: approx. 250k€

ISO 17025 Calibration Laboratory

Scope Expansion for DC Measuring Quantities

Voltage | Current | Power | Energy

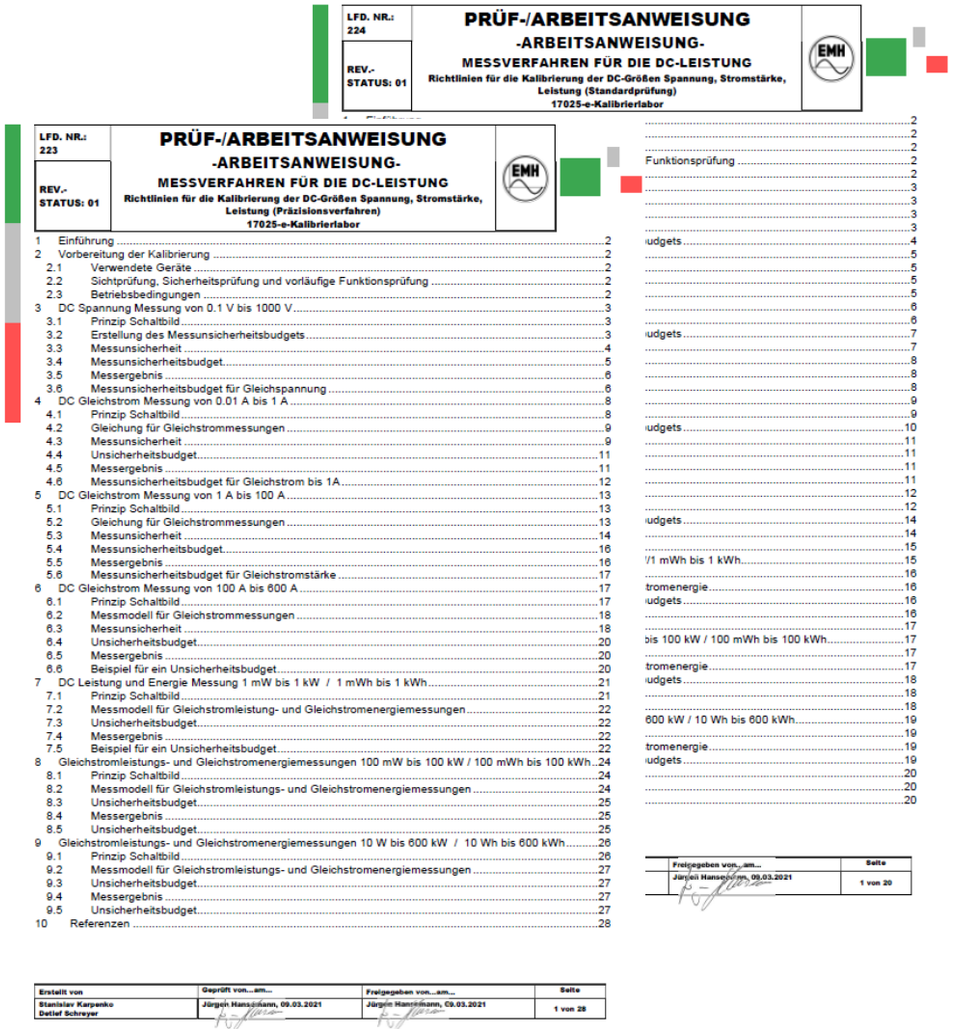
- Equipment
  - FLUKE Calibrator 5522A
  - FLUKE Transconductance Amplifier 52120A
  - FLUKE 8.5 digit digital multimeter 8558A (2 nos.)
  - Precision Current Amplifier DELTA Elektronik 400A SM15-400 (2 nos.)
  - Zero Flux Current Transformer DANISENSE DS 400ID
  - FLUKE Precision Shunts A40B (100mA | 1A | 10A | 100A)

ISO 17025 Calibration Laboratory

Scope Expansion for DC Measuring Quantities

Planning

- Development Calibration Procedures/ Measurement Uncertainty
  - PA/AA 223
    High Precision Calibration
    Power/Energy **229ppm**
  - PA/AA 224
    Standard Calibration
    Power/Energy **301ppm**
- DAkkS request for scope expansion: May 2021
- DAkkS accredation audit:
  Nov. 2021 (Administration)
  Jan. 2022 (Technical)



LFD. NR.: 224
REV.-STATUS: 01

PRÜF-/ARBEITSANWEISUNG
-ARBEITSANWEISUNG-
MESSVERFAHREN FÜR DIE DC-LEISTUNG
Richtlinien für die Kalibrierung der DC-Größen Spannung, Stromstärke, Leistung (Standardprüfung)
17025-e-Kalibrierlabor

LFD. NR.: 223
REV.-STATUS: 01

PRÜF-/ARBEITSANWEISUNG
-ARBEITSANWEISUNG-
MESSVERFAHREN FÜR DIE DC-LEISTUNG
Richtlinien für die Kalibrierung der DC-Größen Spannung, Stromstärke, Leistung (Präzisionsverfahren)
17025-e-Kalibrierlabor

Erstellt von	Geprüft von...am...	Freigegeben von...am...	Seite
Stanislav Karpenko Detlef Schreyer	Jürgen Hansemann, 09.03.2021	Jürgen Hansemann, 09.03.2021	1 von 28

Freigegeben von...am...	Seite
Jürgen Hansemann, 09.03.2021	1 von 20

ISO 17025 Calibration Laboratory

Scope Expansion for DC Measuring Quantities

Accreditation

- officialized on 02 Aug. 2022
- as per end of Aug. 2022 it seems that no other German DAkkS ISO 17025 calibration laboratory is accredited for DC electric power/energy up to 600kWh:

DAkkS Deutsche Akkreditierungsstelle

Annex to the accreditation certificate D-K-12011-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
DC electric power and electric energy	1 mW to 1 kW 1 mWh to 1 kWh	100 mV to 1000 V 10 mA to 1 A	$70 \cdot 10^{-6}$	Comparison with digital multimeter FLUKE 8588A and current transformer Danisense DS400ID with transducer Danisense DSSIU-4-1U
	100 mW to 100 kW 100 mWh to 100 kWh	100 mV to 1000 V > 1 A to 100 A	$74 \cdot 10^{-6}$	
	10 W to 600 kW 10 Wh to 600 kWh	100 mV to 1000 V > 100 A to 600 A	$0{,}23 \cdot 10^{-3}$	

DAkkS Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV
Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition

Accreditation

The Deutsche Akkreditierungsstelle GmbH attests that the calibration laboratory

EMH Energie-Messtechnik GmbH
Vor dem Hassel 2, 21438 Brackel

is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out calibrations in the following fields:

Electrical Quantities
DC and Low Frequency Quantities
- **DC voltage**
- **DC current**
- **AC voltage**
- **AC current**
- **Electric energy**
- **Electric power**
- **Current ratio**

The accreditation certificate shall only apply in connection with the notice of accreditation of 02.08.2022 with the accreditation number D-K-12011-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 3 pages.

Registration number of the certificate: **D-K -12011-01-00**

Berlin, 02.08.2022 — Dr. Florian Witt, Head of Technical Unit — Translation issued: 02.08.2022, Technical Unit

The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH. https://www.dakks.de/en/content/accredited-bodies-dakks

This document is a translation. The definitive version is the original German accreditation certificate.

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MTE Energy Systems & Services

SRS 121.1 DC

6-channel System Reference Standard for DC power/energy (Class 0.04)

The SRS 121.1 DC is a 6-channel single-phase reference standard for DC power/energy class 0.04 for verification of 1 up to 6 DC Meters or DC Energy Measuring Units of EVSE (Electric Vehicle Supply Equipment) at the same time.

The voltage is measured with 6 independent channels U1 to U6. The current is measured common for all channels with two external Zero Flux Precision Current Transducers connected to the two Current Transducer inputs CT1, CT2.

The DC energy measurement with 6 channels (voltage Ux multiplied with current I) allows to calibrate up to 6 DUTs with closed test link (voltage and current path connected) at the same time.

The operation and processing of the measured values of this device without display is carried out using special operation commands from a personal computer.

Advantages

- 6 wide range voltage inputs 0.5 … 1000 VDC (1500 VDC on demand)
- Wide range current input 0.1 … 600 ADC (CT2: 0.1 … 60 ADC, CT1: 1 … 600 ADC)
- Data transfer and communication via USB (Type B), ETHERNET or WLAN
- Data storage on removable SD memory card
- Two USB (Type A) connectors for future extensions

Functions

- DC energy measurement parallel with 6 channels with 6 programmable pulse outputs (fout1 electrical and optical)
- DC Reference Standard for integration in a DC Test Systems with up to 6 positions, each equipped with a SMM400 error evaluation module.
- Integrated error calculator with 2 pulse inputs

Options

- Software CALegration

Technical Data SRS 121.1 DC

General

Auxiliary power supply:	88 VACmin ... 264 VACmax / 47 … 63 Hz 125 VDCmin ... 373 VDCmax
Power consumption:	max. 45 VA
Housing:	19" plug-in unit, 3 HE
Dimensions:	W 483 x D 133 x H 326 mm
Operation temperature:	-10 °C ... +50 °C (operating range) +10 °C ... +40 °C (specified range)
Storage temperature:	-20 °C ... +60 °C
Relative humidity:	≤ 85% at Ta ≤ 21°C
	≤ 95% at Ta ≤ 25°C, 30 days / year spread

Safety

CE certified

Isolation protection:	IEC 61010-1:2010
Measurement Category:	1000 VDC CAT III (1500 VDC CAT II [3])
Degree of protection:	IP-20

Measurement Ranges

Measuring Quantity	Range	Input
DC Voltage	0.5 V ...1000 V (1500 V) [3]	U1 … U6
DC Current 60A / 600A	0.1 A … 60 A	CT2
	1 A … 600 A	CT1

Measurement Accuracy

Voltage / Current		≤ ± E [%] [1 2]
Measuring Quantity	Range	**Class 0.04**
DC Voltage	100 V …1000 V (1500 V) [3]	0.04
	0.5 V … 100 V	0.04
DC Current	5 A … 600 A	0.04
	0.1 A … 5 A	0.06

DC Power / Energy Voltage: 100 V… 1000 (1500) V		≤ ± E [%] [1 2]
Measuring Quantity / Input I	Range	**Class 0.04**
DC Current CT1, CT2	5 A … 600 A	0.04
	0.1 … 5 A	0.06
DC Power / Energy Voltage:	0.5 V … 100 V	
Measuring Quantity / Input I	Range	
DC Current CT1, CT2	5 A … 600 A	0.04 (Un)
	0.1 … 5 A	0.06 + 0.04 (Un)

Notes

[1] x.x :Related to the measuring value
x.x :Related to the internal measuring range final value (full scale, FS), Un, In in the U, I range left or Un at x.x (Un) in the U range indicated above
E(M) = FS/M * x.x (e.g. 5 A, 0.06: FS = 8 A, E(5) = 8 / 5 * 0.06 = 0.096 %)

[2] at temperature + 23 °C ± 2 °C

[3] 1500 V version on demand

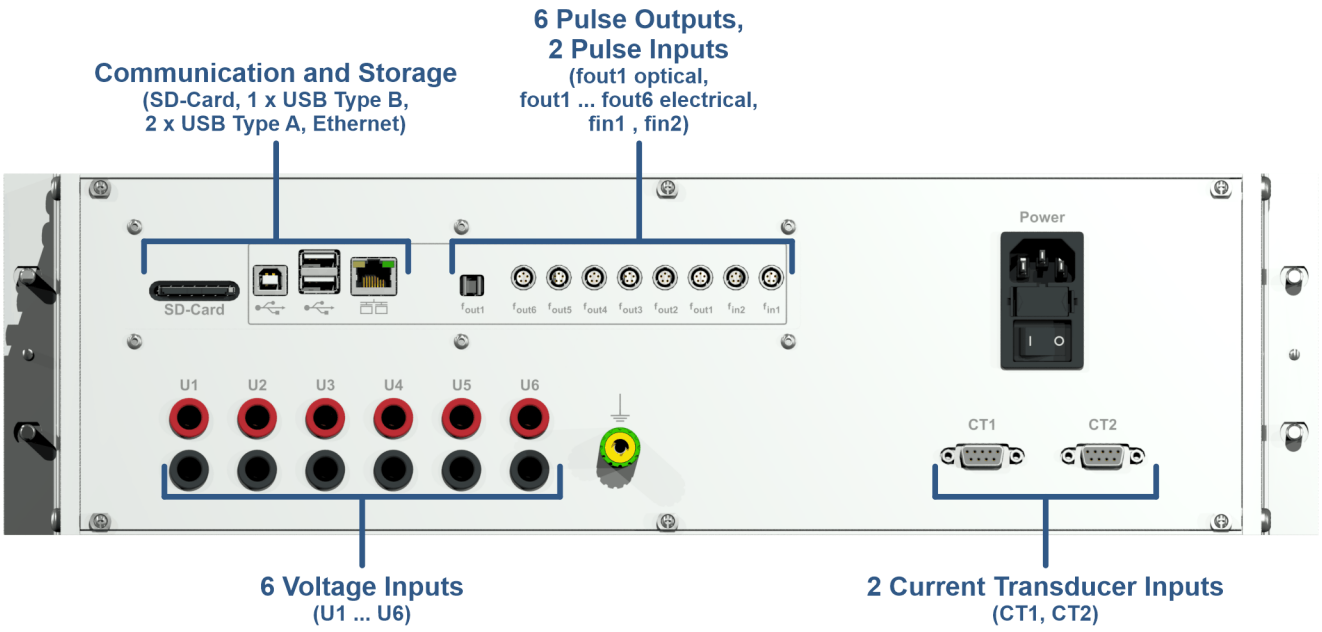
Pulse inputs 1 … 2

Level:	5 … 24 VDC
Frequency:	max. 200 kHz
Supply:	12 VDC (I < 60 mA)

Pulse outputs 1 … 6

Pulse output 1 parallel electrical and optical (fiber optic connection)

Level:	5 VDC				
Frequency:	max. 60 kHz				
Pulse length:	≥ 8µs				
Supply:	12 VDC (I < 60 mA)				
Meter constant: DC energy	$C = C_0 / (In * Un)$ C_0= 216'000'000 [imp/Wh] The meter constant depends on the highest selected internal ranges In, Un.				
	Internal current ranges In [A]				
DC Current CT2	0.5	1	2	4	8
	15	30	60		
DC Current CT1	5	10	20	40	80
	150	300	600		
	Internal voltage ranges Un [V]				
DC Voltage U1 … U6	8	15	30	60	120
	250	500	1000	(2000)	
	Example: Un = 500 V, In = 300 A C = 1'440 [imp/Wh]				
Output frequency:	CPZ_1 = C / 3'600 [imp/Ws] f_0 = CPZ_1 * P f_{max} = CPZ_1 * Un * In = 0.4 imp/Ws * 500V * 300A = 60'000 [imp/s]				



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EMH Calibration Laboratory – Scope Extension for DC measurements

We are glad to announce, that the

Calibration Laboratory for Electrical Quantities (D-K-12011-01-00) of our partner company EMH Energie-Messtechnik GmbH, was accredited according to general requirements of international standard ISO/IEC 17025 by the national accreditation body of the Federal Republic of Germany (DAkkS) for DC measurements.

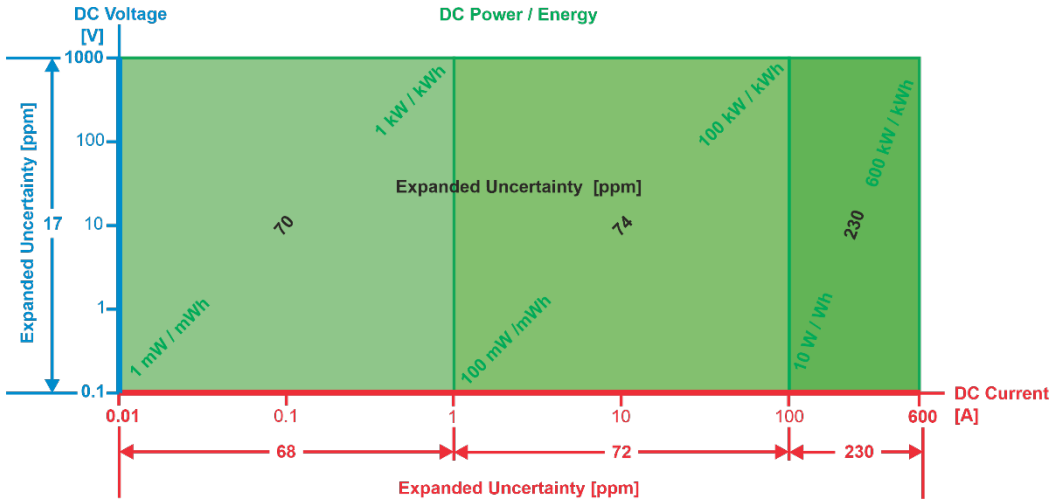
EMH Calibration Laboratory got as one of the **first** among the calibration laboratories in Germany the DAkkS Accreditation for **DC Power/Energy measurements** up to **600 kW / 600 kWh**.

Scope of Accreditation:

- **DC Voltage** 100 mV … 1000 V
- **DC Current** 10 mA … 600 A
- **DC Power / Energy** 1 mW … 600 kW / 1 mWh … 600 kWh

New DC laboratory equipment

Calibration and Measurement Capabilities for DC Measurements [ppm]



Calibration and Measurement Capabilities for DC measurements

Regarding DAkkS database of accredited bodies - Annex to the accreditation certificate D-K-12011-01-00 (link)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement
DC voltage	100 mV to 1000 V		$17 * 10^{-6}$
DC current	10 mA to 1 A		$68 * 10^{-6}$
	> 1 A to 100 A		$72 * 10^{-6}$
	> 100 A to 600 A		$0.23 * 10^{-3}$
DC electric power and electric energy	1 mW to 1 kW 1 mWh to 1 kWh	100 mV to 1000 V 10 mA to 1 A	$70 * 10^{-6}$
	100 mW to 100 kW 100 mWh to 100 kWh	100 mV to 1000 V > 1 A to 100 A	$74 * 10^{-6}$
	10 W to 600 kW 10 Wh to 600 kWh	100 mV to 1000 V > 100 A to 600 A	$0.23 * 10^{-3}$

This allows calibration certificates which are provided by EMH Calibration Laboratory to be recognised worldwide and to perform traceable calibration service for our new portable and stationary DC test equipment used for the calibration of DC meters and DC measuring units inside EVSE Electric Vehicle Supply Equipment applied for charging of EV Electric Vehicles.

Portable Working Standard PWS3.3 genX + eMOB I-200.1 DC adapter
used for calibration of DC energy measurement (class 0.1) of EVSE on site up to 1000 V, 200 A, 200 kW

Stationary Reference Standard SRS121.1 DC
used as 6 channel class 0.04 reference standard in stationary DC meter test equipment up to 1000 V, 600 A, 600 kW.

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MTE Energy Systems & Services

MTE Forum 2022

Workshop Testing of E-Mobility Charging Stations

MTE Meter test Equipment AG

Metrological Control of EVSE

Meter testing on-site with

Three-phase Portable Working Standard PWS 3.3 *genX* (0.05 %)

with test adapter **eMOB I-200.1 DC**
1000 VDC, 200 ADC (200 kW DC) **(0.1 %)**

with test adapter **eMOB I-32.3 AC**
3 x 230 V, 32 A (22kW) **(0.1 %)**

AC and DC meter testing in the laboratory with

Phantom load test benches for meter calibration

Single-phase DC

- Voltage range: 100 V ... 1000 V
- Current range: 5 A ... 600 A
- Accuracy class: 0.04

MTE Meter test Equipment AG

Metrological Control of EVSE

Standards for DC meters

IEC 62053-41

EN 50470-4 (Draft)

Guide for EVSE

OIML G 22 Guide for EVSE Electric Vehicle Supply Equipment (EVSE)

- Metrological and technical requirements
- Metrological control and performance test

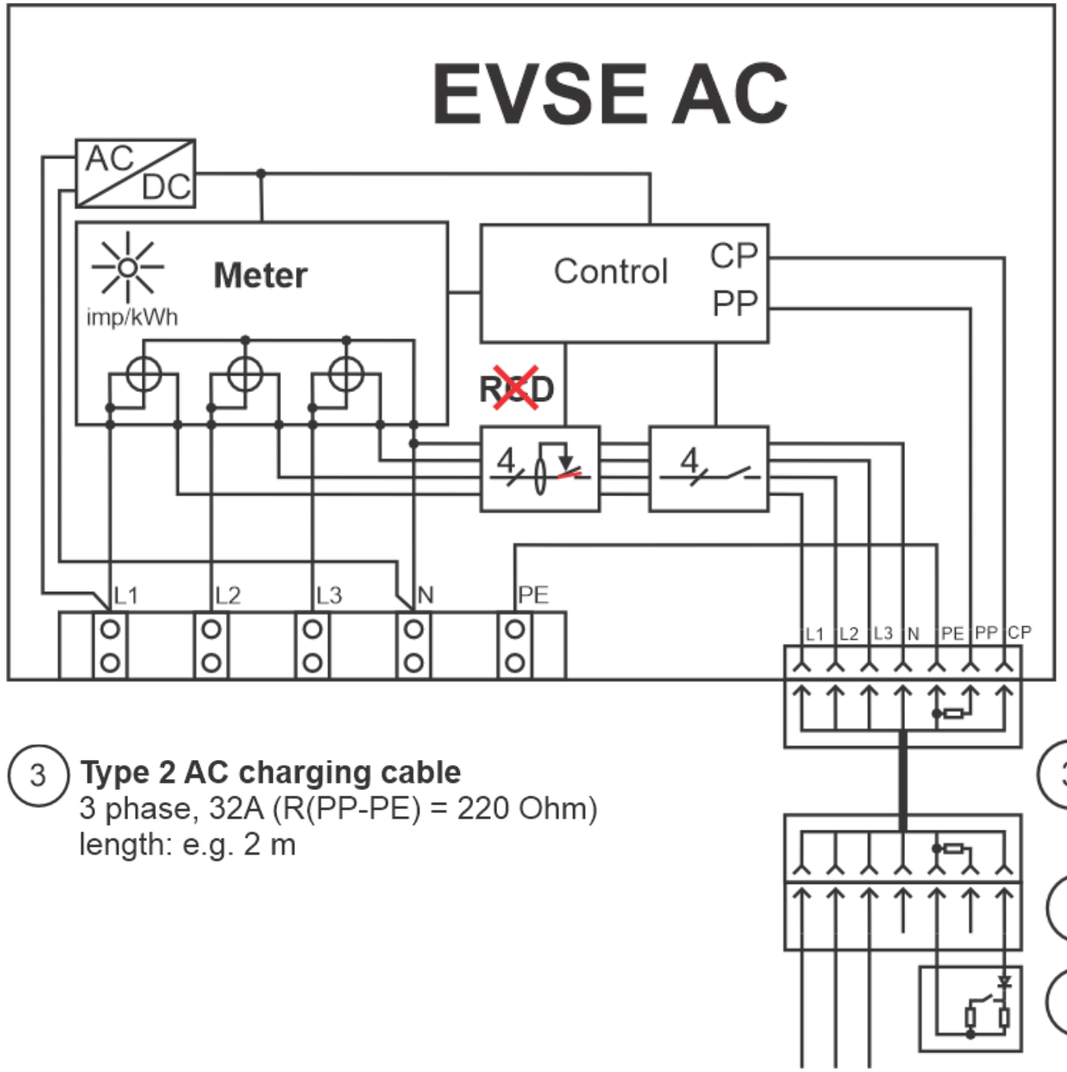
Regional regulations, working groups

Local regulations in Germany, Spain

Working group LegalEVcharge, NordCharge in Europe

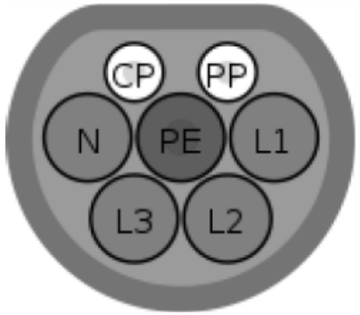
MTE Meter test Equipment AG

EVSE Electric Vehicle Supply Equipment AC with outlet type 2

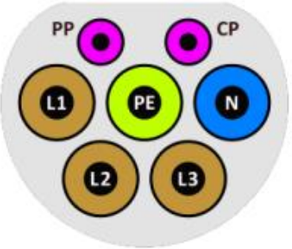


3 **Type 2 AC charging cable**
3 phase, 32A (R(PP-PE) = 220 Ohm)
length: e.g. 2 m

EVSE outlet
Type 2 female (IEC 62196)

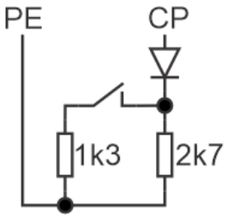


1 **AC EV car inlet**
Type 2 male (IEC 62196)

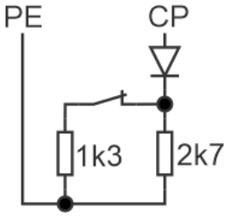


2 **EV Simulation**
CP Control Pilot (1 kHz, +-12V)

EV connected
(CP: + 9V / -12V)



EV ready to charge
(CP: + 6V / -12V)



MTE Meter test Equipment AG

Metrological Control of EVSE - Traceability

EMH Energie-Messtechnik GmbH receives DAkkS accreditation for DC Power/Energy measurements

The EMH Calibration Laboratory got as one of the first among the calibration laboratories in Germany the DAkkS Accreditation for DC Power/Energy measurements up to 600 kW / 600 kWh

MTE Meter test Equipment AG

Metrological Control of EVSE - Traceability

EMH Energie-Messtechnik GmbH receives DAkkS accreditation for DC Power/Energy measurements

Scope of Accreditation

DC Voltage	100 mV	…	1000 V
DC Current	10 mA	…	600 A
DC Power	1 mW	…	600 kW
DC Energy	1 mWh	…	600 kWh

MTE Meter test Equipment AG

Metrological Control of EVSE - Traceability

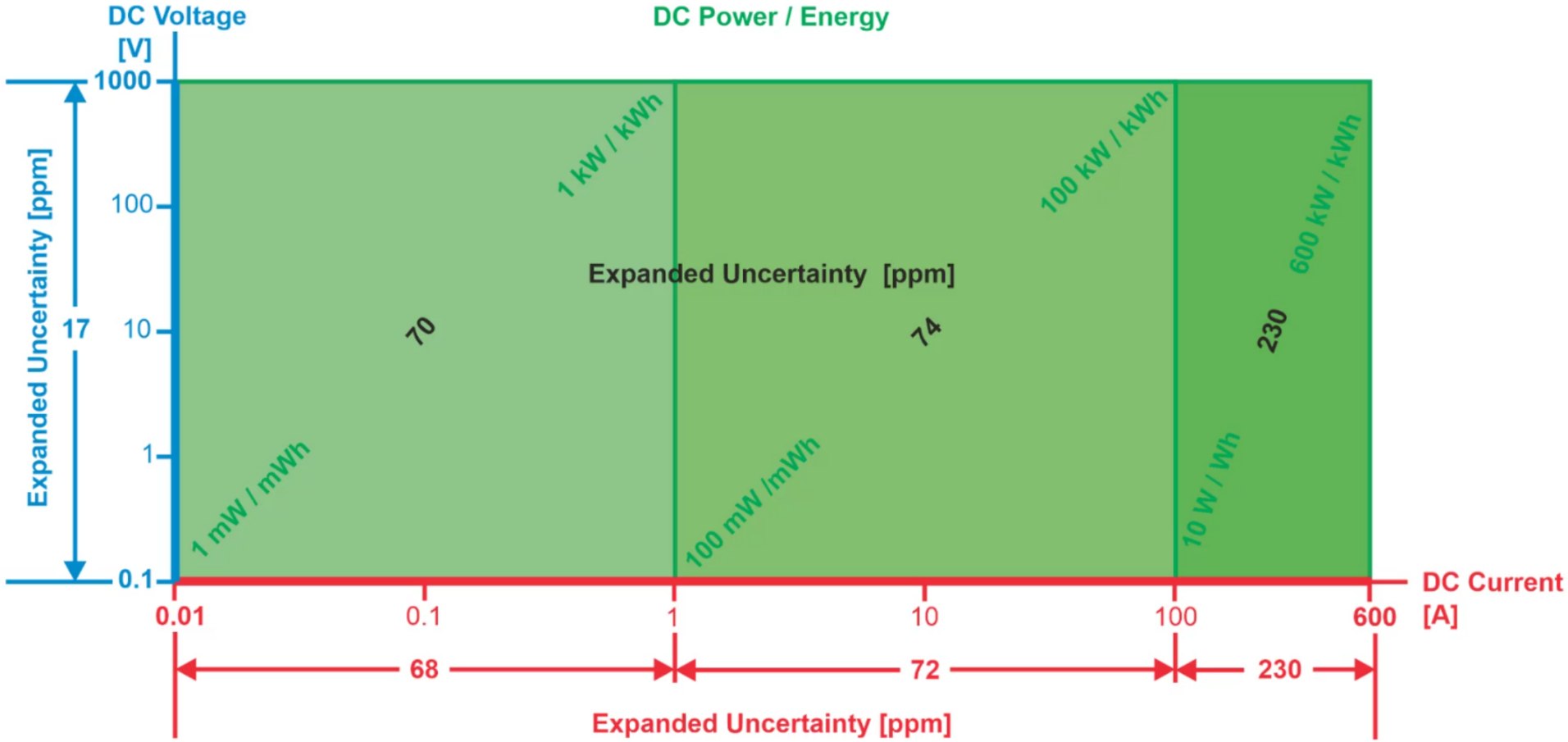
EMH Energie-Messtechnik GmbH receives DAkkS accreditation for DC Power/Energy measurements

Thus, EMH's accreditation to ISO/IEC 17025 guarantees the consistent and high quality of calibration services for MTE Meter Test Equipment and its customers in the field of portable and stationary DC test systems.

MTE Meter test Equipment AG

Metrological Control of EVSE - Traceability

EMH Energie-Messtechnik GmbH DAkkS ISO/IEC 17025 accreditation Calibration and Measurement Capabilities for DC Measurements [ppm]



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