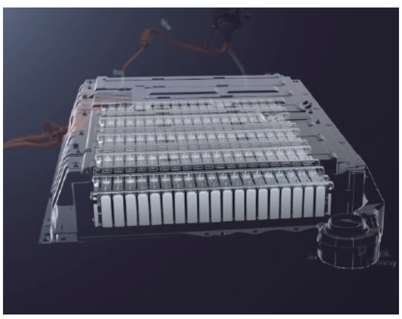
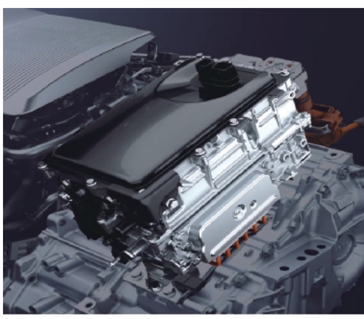
HY-LV123SU Series

New Energy Automobile High Voltage Ripple Test Power Supply

Hangyu Power System (Shanghai) Co., Ltd.





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HY-LV123SU Series New Energy Automobile High Voltage Ripple Test Power Supply

High voltage systems are becoming increasingly widespread in the application of new energy vehicles, including hybrid, plug-in hybrid, pure electric, etc.The safety of high-voltage components operating on high voltage systems has received considerable attention and importance. Therefore, the testing regulation LV123 was born, defining the standard requirements and testing methods for the electrical performance characteristics and safety testing of high-voltage components.

HY-LV123SU series new energy vehicle testing high-voltage ripple power supply, suitable for LV123, VW80303, VW80300, ISO21498-2 and other new energy vehicle testing standards, convenient operation, efficient assistance in high-voltage component ripple superposition testing, ensuring long-term stable operation of the high-voltage system.

Product Features

- Applicable standards：LV123、VW80303、VW80300、ISO21498-2
- Output voltage: 0-1500V
- Output current:0-1000A
- DC output power single machine maximum 500kW (Can achieve higher power through parallel operation)
- Support multiple power supplies for parallel operation
- The maximum ripple frequency can reach 10Hz～150kHz

Application Field

- HV battery system
- Inverter
- DC/DC converter HV
- On-board charger
- Electrical air conditioning compressor
- Electrical transmission oil pump

Electrical Characteristic Testing Project

1、VW80300、VW80303、LV123 Test Content

Electrical HV test	Test Type	Details Page
EHV-01 Performance test within the regular HV operating voltage range	Voltage variation	P45
EHV-02 Operation within the HV overvoltage range	Voltage variation	P46
EHV-03 Operation within the HV undervoltage range	Voltage variation	P47
EHV-05 Generated HV voltage dynamics	Launch test	P49
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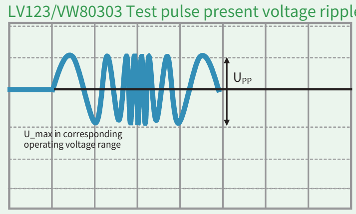
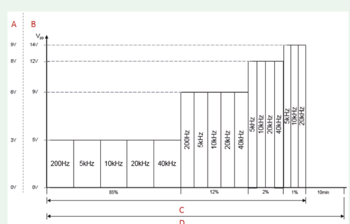
EHV-09 System HV voltage ripple	DC ripple	P53
EHV-10 System load dump	Voltage variation	P55
EHV-11 HV voltage offset	Voltage variation	P56
EHV-12 HV overcurrent	Current variation	P57
EHV-13 HV service life (addenda)	Life cycle testing	P58
EHV-14 On/off durability testing for HV components	Periodic test	P61
EHV-15 Functionality of HV interlock, maintenance connector, and crash signaling	Functional testing	P62

LV123/VW80303 Test pulse present voltage ripple



VW 80300 Cycle description with frequency distribution



HY-LV123SU Series Product Model Selection And Selection Purchase

Product Selection Notice

Product series	Output voltage	Output current	Output broadband
HY-LV123SU	300	500	100k

Selection Example:
Product model: HY-LV123SU 300-500-100k
output voltage 0-300V, Output current 0-500A,
Purchase frequency 100kHz

* All technical indicators can only be guaranteed when the equipment runs continuously for more than 30 minutes at the specified operating temperature.

Standard Communication Interface

- RS-485
- RS-232

Optional Communication Interface

- LAN : Ethernet communicationinterface
- CAN : CAN communication interface
- GPIB : GPIB communication interface
- IA : Analog quantity programming and monitoring interface (isolated type)

HY-LV123SU Series Product Selection And Parameters

This series of products optional power supply output wide band: 10Hz-150kHz
If there is no model in the selection table that meets your needs, you can propose it separately for special customization.

Output Power 2.5kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-8.4	300V	8.4A	2.5kW
HY-LV123SU 400-6.3	400V	6.3A	2.5kW
HY-LV123SU 500-5	500V	5A	2.5kW
HY-LV123SU 600-4.2	600V	4.2A	2.5kW

Models	Output voltage	Output current	Output power
HY-LV123SU 750-3.4	750V	3.4A	2.5kW
HY-LV123SU 800-3.2	800V	3.2A	2.5kW
HY-LV123SU 1000-2.5	1000V	2.5A	2.5kW
HY-LV123SU 1500-1.7	1500V	1.7A	2.5kW

Output Power 5kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-16.7	300V	16.7A	5kW
HY-LV123SU 400-12.5	400V	12.5A	5kW
HY-LV123SU 500-10	500V	10A	5kW
HY-LV123SU 600-8.4	600V	8.4A	5kW
HY-LV123SU 750-6.7	750V	6.7A	5kW
HY-LV123SU 800-6.3	800V	6.3A	5kW
HY-LV123SU 1000-5	1000V	5A	5kW
HY-LV123SU 1500-3.4	1500V	3.4A	5kW

Output Power 10kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-33.4	300V	33.4A	10kW
HY-LV123SU 400-25	400V	25A	10kW
HY-LV123SU 500-20	500V	20A	10kW
HY-LV123SU 600-16.7	600V	16.7A	10kW
HY-LV123SU 750-13.4	750V	13.4A	10kW
HY-LV123SU 800-12.5	800V	12.5A	10kW
HY-LV123SU 1000-10	1000V	10A	10kW
HY-LV123SU 1500-6.7	1500V	6.7A	10kW

HY-LV123SU Series Product Model Selection And Selection Purchase

Output Power 20kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-67	300V	67A	20kW
HY-LV123SU 400-50	400V	50A	20kW
HY-LV123SU 500-40	500V	40A	20kW
HY-LV123SU 600-34	600V	34A	20kW
HY-LV123SU 750-27	750V	27A	20kW
HY-LV123SU 800-25	800V	25A	20kW
HY-LV123SU 1000-20	1000V	20A	20kW
HY-LV123SU 1500-13.5	1500V	13.5A	20kW

Output Power 30kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-100	300V	100A	30kW
HY-LV123SU 400-75	400V	75A	30kW
HY-LV123SU 500-60	500V	60A	30kW
HY-LV123SU 600-50	600V	50A	30kW
HY-LV123SU 750-40	750V	40A	30kW
HY-LV123SU 800-38	800V	38A	30kW
HY-LV123SU 1000-30	1000V	30A	30kW
HY-LV123SU 1500-20	1500V	20A	30kW

Output Power 40kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-134	300V	134A	40kW
HY-LV123SU 400-100	400V	100A	40kW
HY-LV123SU 500-80	500V	80A	40kW
HY-LV123SU 600-67	600V	67A	40kW
HY-LV123SU 750-54	750V	54A	40kW
HY-LV123SU 800-50	800V	50A	40kW
HY-LV123SU 1000-40	1000V	40A	40kW
HY-LV123SU 1500-27	1500V	27A	40kW

Output Power 50kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-167	300V	167A	50kW
HY-LV123SU 400-125	400V	125A	50kW
HY-LV123SU 500-100	500V	100A	50kW
HY-LV123SU 600-84	600V	84A	50kW
HY-LV123SU 750-67	750V	67A	50kW
HY-LV123SU 800-63	800V	63A	50kW
HY-LV123SU 1000-50	1000V	50A	50kW
HY-LV123SU 1500-33.5	1500V	33.5A	50kW

Output Power 60kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-200	300V	200A	60kW
HY-LV123SU 400-150	400V	150A	60kW
HY-LV123SU 500-120	500V	120A	60kW
HY-LV123SU 600-100	600V	100A	60kW
HY-LV123SU 750-80	750V	80A	60kW
HY-LV123SU 800-75	800V	75A	60kW
HY-LV123SU 1000-60	1000V	60A	60kW
HY-LV123SU 1500-40	1500V	40A	60kW

Output Power 75kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-250	300V	250A	75kW
HY-LV123SU 400-188	400V	188A	75kW
HY-LV123SU 500-150	500V	150A	75kW
HY-LV123SU 600-125	600V	125A	75kW
HY-LV123SU 750-100	750V	100A	75kW
HY-LV123SU 800-94	800V	94A	75kW
HY-LV123SU 1000-75	1000V	75A	75kW
HY-LV123SU 1500-50	1500V	50A	75kW

Output Power 100kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-334	300V	334A	100kW
HY-LV123SU 400-250	400V	250A	100kW
HY-LV123SU 500-200	500V	200A	100kW
HY-LV123SU 600-167	600V	167A	100kW
HY-LV123SU 750-134	750V	134A	100kW
HY-LV123SU 800-125	800V	125A	100kW
HY-LV123SU 1000-100	1000V	100A	100kW
HY-LV123SU 1500-67	1500V	67A	100kW

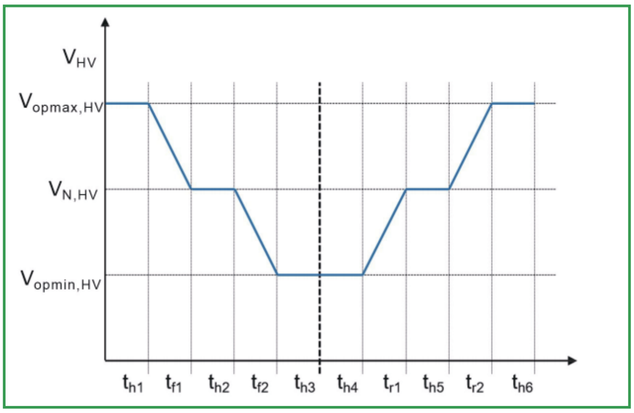
Output Power 150kW Series Power Supply Model Selection

Models	Output voltage	Output current	Output power
HY-LV123SU 300-500	300V	500A	150kW
HY-LV123SU 400-375	400V	375A	150kW
HY-LV123SU 500-300	500V	300A	150kW
HY-LV123SU 600-250	600V	250A	150kW
HY-LV123SU 750-200	750V	200A	150kW
HY-LV123SU 800-188	800V	188A	150kW
HY-LV123SU 1000-150	1000V	150A	150kW
HY-LV123SU 1500-100	1500V	100A	150kW

1.1、EHV-01 Performance test within the regular HV operating voltage range

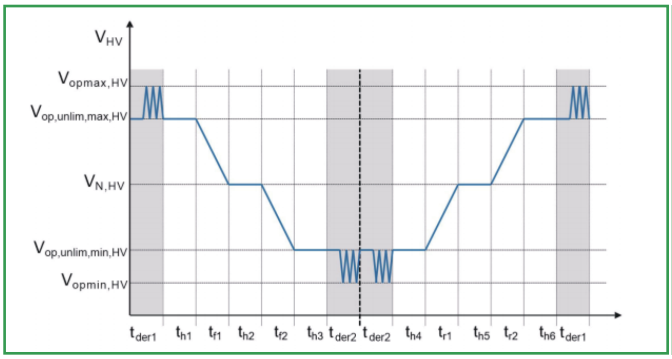
Purpose:Within the regular HV operating voltage range, functional state A and the maximum specified power must be verified under various operating parameters.This test validates the performance of the component in the regular operating voltage range from $V_{opmin, HV}$ to $V_{opmax, HV}$.

Test：It includes two sub-tests:
– EHV-01a for components that do not require any voltage-dependent derating in the regular operating voltage range as per the Component Performance Specification；
–EHV-01b for components that perform voltage-dependent derating in the regular operatingvoltage range as per the Component Performance Specification.

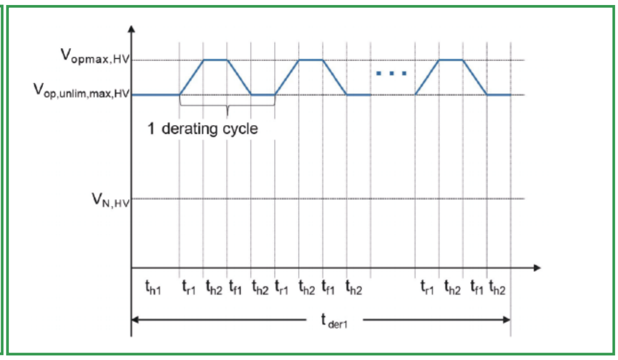


EHV-01a HV voltage curve within the regular HV operating voltage range

Test parameters for EHV-01a Operation within the regular HV operating voltage range	
DUT operating mode	$Operation_{max}$
LV voltages	V_{op}
Internal resistance of HV source	$R_{i,HV}$ = 0mΩ
t_{h1}	As per Component Performance Specification, but at least 5 min
t_{f1}	As per Component Performance Specification, but at least 5 min
t_{h2}	As per Component Performance Specification, but at least 5 min
t_{f2}	As per Component Performance Specification, but at least 5 min
t_{h3}	As per Component Performance Specification, but at least 5 min
t_{h4}	As per Component Performance Specification, but at least 5 min
t_{r1}	As per Component Performance Specification, but at least 5 min
t_{h5}	As per Component Performance Specification, but at least 5 min
t_{r2}	As per Component Performance Specification, but at least 5 min
t_{h6}	As per Component Performance Specification, but at least 5 min
Temperatures	T_{max} with $T_{cool,max}$, T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$
Number of cycles	1 per temperature
Number of DUTs	6
Test case 1	
HV components	Voltage curve as per figure EHV-01a
Test case 2	
HV energy storage devices (closed contactors)	The power specified in the Component Performance Specification must be generated by a corresponding charging and discharge current. Times as per Component Performance Specification



EHV-01b HV voltage curve in the regular HV operating voltage range with voltage-dependent derating



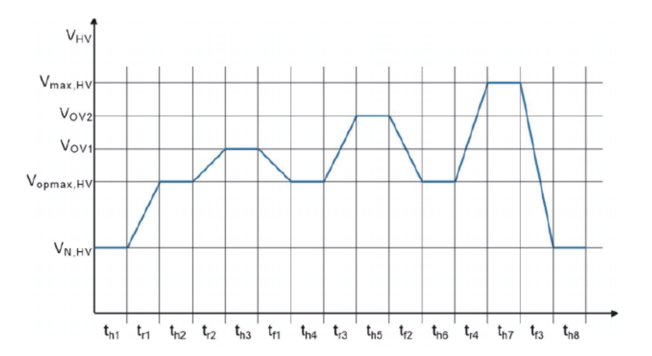
EHV-01b HV voltage curve in upper derating range

Test parameters for EHV-01b Operation within the regular HVoperating voltage range	
DUT operating mode	Operation_{max}
LV voltages	V_{op}
Internal resistance of high voltage power supply	$R_{i,HV}$ = 0mΩ
t_{edr1}	As per Component Performance Specification, but at least 5 min
t_{h1}	As per Component Performance Specification, but at least 5 min
t_{f1}	As per Component Performance Specification, but at least 5 min
t_{h2}	As per Component Performance Specification, but at least 5 min
t_{f2}	As per Component Performance Specification, but at least 5 min
t_{h3}	As per Component Performance Specification, but at least 5 min
t_{der2}	As per Component Performance Specification, but at least 5 min
t_{h4}	As per Component Performance Specification, but at least 5 min
t_{r1}	As per Component Performance Specification, but at least 5 min
t_{h5}	As per Component Performance Specification, but at least 5 min
t_{r2}	As per Component Performance Specification, but at least 5 min
t_{h6}	As per Component Performance Specification, but at least 5 min
Temperatures	T_{max} with $T_{cool,max}$' , T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$'
Number of cycles	1 per temperature
Number of DUTs	6

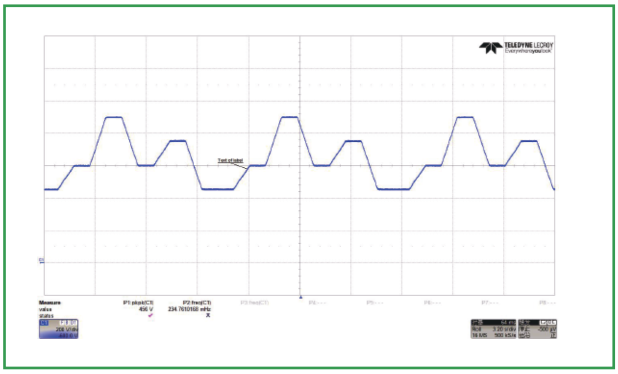
EHV-01b Test parameters within the lower and upper derating ranges	
DUT operating mode	Operation_{max}
$V_{op,unlim,max,HV}$	Upper voltage threshold at which the component operates without voltage-independent derating
$V_{op,unlim,min,HV}$	Upper voltage threshold at which the component operates without voltage-independent derating
t_{edr1}, t_{edr2}	As per Component Performance Specification, but at least 5 min
t_{h1}	60 s, variable up to 80 s, if necessary (dependent on t_{der1} or t_{der2})
t_{r1}	5s
t_{h2}	5s
t_{f1}	5s
Derating cycle of upper derating range	$t_{r1} + t_{h2} + t_{f1} + t_{h2}$ = 20 s
Derating cycle of lower derating range	$t_{f1} + t_{h2} + t_{r1} + t_{h2}$ = 20 s

1.2、EHV-02 Operation within the HV overvoltage range

Within the HV overvoltage range, the specified functional state and the specified power must beverified under various operating parameters.
After the voltage returns to the regular HV operating voltage range, functional state A and the maximum specified power must be fulfilled again.



EHV-02 HV voltage curve in HV overvoltage range

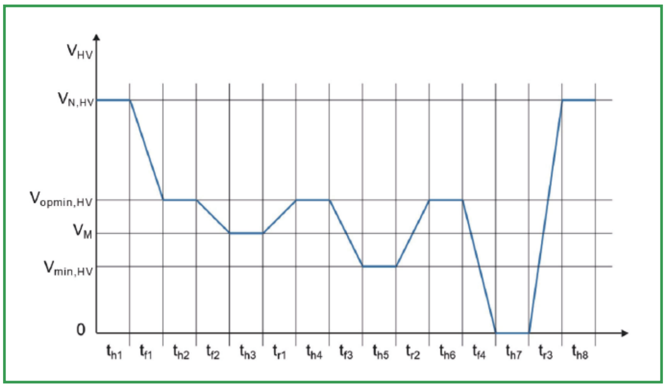


Actual measurement chart

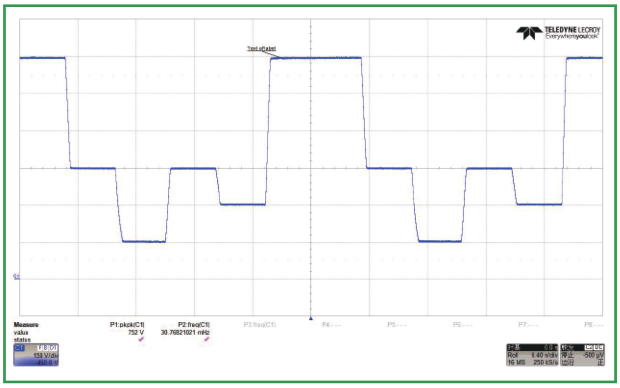
Test parameters for EHV-02 Operation within the HV overvoltage range	
DUT operating mode	$Operation_{min}$ and $Operation_{max}$
LV voltages	V_{op}
Internal resistance of HV source	$R_{i,HV}$ = 0mΩ
V_{ov1}	Below the overvoltage detection threshold
V_{ov2}	Above the overvoltage detection threshold and below the switchoff threshold
t_{h1}	Hold time until having reached a constant temperature throughout, but at least 5 min
t_{r1}	1min
t_{h2}	1min
t_{r2}	1min
t_{h3}	1min
t_{f1}	1min
t_{h4}	1min
t_{r3}	1min
t_{h5}	1min
t_{f2}	1min
t_{h6}	1min
t_{r4}	1min
t_{h7}	1min
t_{f3}	1min
t_{h8}	1min
Temperatures	T_{max} with $T_{cool,max}$ ，T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$
Number of cycles	3
Number of DUTs	6

1.3、EHV-03 Operation within the HV undervoltage range

Within the HV undervoltage range, the specified functional state and the specified power must beverified under various operating parameters.After the voltage returns to the regular HV operat-ing voltage range, functional state A and the maximumspecified power must be fulfilled again.



EHV-03 HV voltage curve in HV undervoltage range

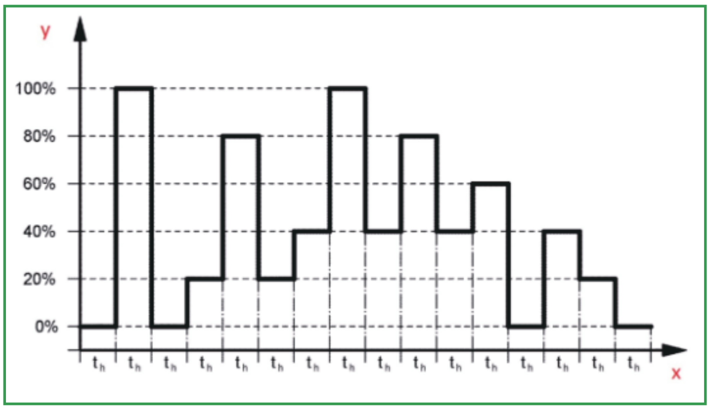


Actual measurement chart

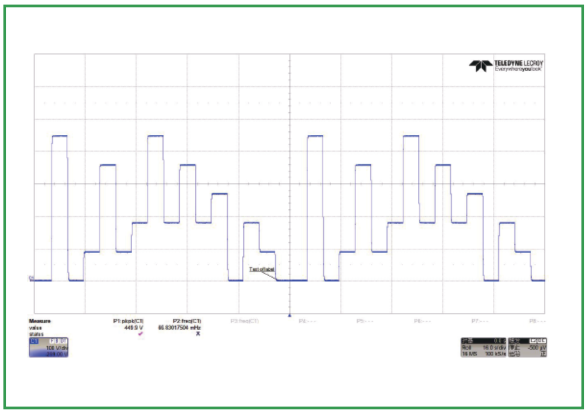
Test parameters for EHV-03 Operation within the HV undervoltage range	
DUT operating mode	$Operation_{min}$ and $Operation_{max}$
LV voltages	V_{op}
Internal resistance of HV source	$R_{i,HV}$ = 0mΩ
V_m	$V_m = V_{opmin,HV} - (V_{opmin,HV} - V_{min,HV}) / 2$
t_{h1}	Hold time until having reached a constant temperature throughout, but at least 5 min
t_{f1}	1min
t_{h2}	1min
t_{f2}	1min
t_{h3}	1min
t_{r1}	1min
t_{h4}	1min
t_{f3}	1min
t_{h5}	1min
t_{r2}	1min
t_{h6}	1min
t_{f4}	1min
t_{h7}	1min
t_{r3}	1min
t_{h8}	1min
Temperatures	T_{max} with $T_{cool,max}$，T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$
Number of cycles	3
Number of DUTs	6

1.4、EHV-05 Generated HV voltage dynamics

The purpose of the test is to verify that the HV voltage dynamics (rate of change) generated by the component fall within the specified limits and that the HV functional state does not change during the power jumps that are part of the test.



EHV-05 Control signal for power cycle – Example



Actual measurement chart

Test parameters for EHV-05 Generated HV voltage dynamics	
DUT operating mode	$Operation_{min}$ and $Operation_{max}$
HV voltages	V_{opmin}、$V_{N.HV}$、$V_{opmax.HV}$
LV voltages	V_{op}
Internal resistance of HV source	$R_{i.HV}$ as per table 1
Control signal	$S_{P.HV}$=0% - operating mode $Operation_{min}$ $S_{P.HV}$=100% - operating mode $Operation_{max}$
Hold time	th≥5s but at least as long as required for the DUT's power and functionality to reach a steady state and for all measured values to be recorded
Limit for HV voltage rate of change	450-VDC vehicle electrical system：($\Delta V_{HV}/\Delta t$) ≥ 15 V/ms 900-VDC vehicle electrical system：($\Delta V_{HV}/\Delta t$) ≥ 30 V/ms or as per Component Performance Specification
Temperatures	T_{max} with $T_{cool,max}$' ，T_{RT} with T_{cool}，T_{mix} with $T_{cool,mix}$'
Number of cycles	3
Number of DUTs	6

Internal resistance as a function of temperature	
T_{min}	$R_{i,HV}$ = 200 mΩ
T_{RT}	$R_{i,HV}$ = 100 mΩ
T_{max}	$R_{i,HV}$ = 50 mΩ

1.5、EHV-06 System HV voltage dynamics

The robustness of HV components when subjected to the maximum HV voltage dynamics in the HV system (HV voltage rate of change) must be verified.

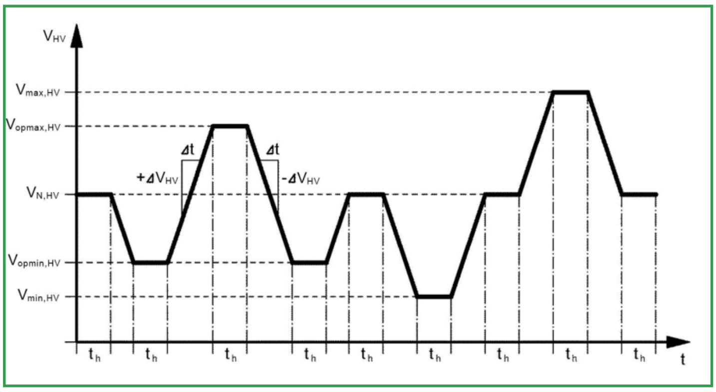
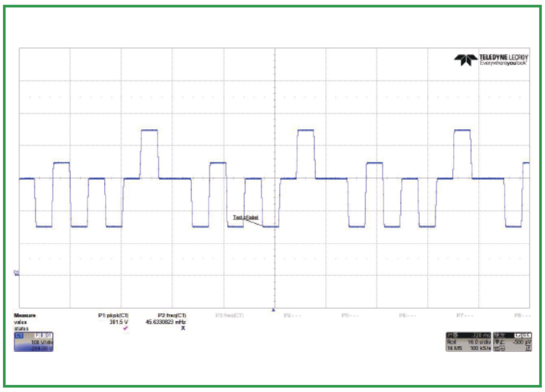


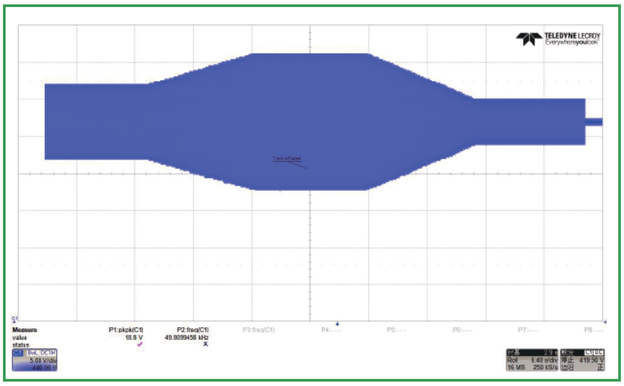
Figure 25 –System HV voltage dynamics – Example



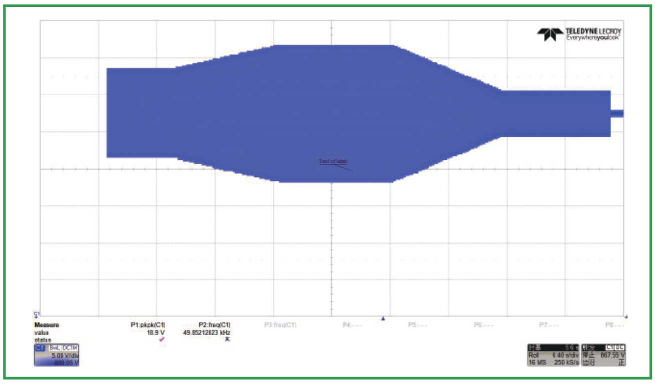
Actual measurement chart

Test parameters for EHV-06 System HV voltage dynamics	
DUT operating mode	$Operation_{max}$
HV voltages	As per figure 25
LV voltages	V_{op}
Internal resistance of HV source	$R_{i,HV}$ = 0mΩ
Hold time	th≥5s but at least as long as required for the DUT's power and functionality to reach a steady state and for all measured values to be recorded
HV voltage rate of change	450-VDC vehicle electrical system：($\Delta V_{HV}/\Delta t$) ≥ 20 V/ms 900-VDC vehicle electrical system：($\Delta V_{HV}/\Delta t$) ≥ 40 V/ms or as per Component Performance Specification
Temperatures	T_{max} with $T_{cool,max}$' ，T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$'
Number of cycles	3
Number of DUTs	6

1.6 EHV-08 Generated HV voltage ripple



450-VDC vehicle electrical system



900-VDC vehicle electrical system

Purpose

- The purpose of this test is to verify that the generated HV voltage ripple of an HV component falls within the specified limits and that its HV functional state will not change as a result of this selfgenerated HV ripple.

Test

- The ripple contents superimposed on the DC HV supply voltage and the DC HV supply current must be tested.
- Test setup type 2 in section 4.9.2 must be used.
- All measurement signals must be fed to a spectrum analyzer, data logger, or oscilloscope with afast Fourier transform (FFT) function and must be evaluated.
- In order to take different circuit topologies and power classes into account, this test must be evaluated in the time domain and in the frequency domain. The component must meet all of the require ments individually.
- Before the test, the worst-case scenario out of the possible operating and load scenarios must be determined for each HV operating voltage. The test must then be carried out using this scenario.
- Worst-case scenarios include, for example:
  – Voltage ripple caused by hunting oscillation at low load, e.g., at 5% to 10% of the rated load
  – Voltage ripple when fast control algorithms are activated, e.g., in order to damp jerking caused by mechanical vibrations in the powertrain
  – Voltage ripple at maximum acceleration from stop or from a low speed
  – Low-temperature operation of a duty cycle/PWM-controlled heater
- The test must be carried out at the following HV component power levels:
  – The worst-case scenario determined previously
  – Idling with powertrains at 5% to 10% of the rated speed
  – 25%
  – 50%
  – 75%
  – 100%
- For each measurement run, a spectral amplitude distribution of the HV voltage and current ripples must be generated in the form of a diagram. In this diagram, the maximum amplitude and at least the following 10 maxima, with the corresponding frequency and amplitude, must be marked as characteristic frequencies. These characteristic frequencies must be listed in a table that also specifies all relevant parameters.
- If operation without an HV energy storage device is intended for the DUT, the entire test must additionally be run for this operating case, with the parameters adjusted accordingly.

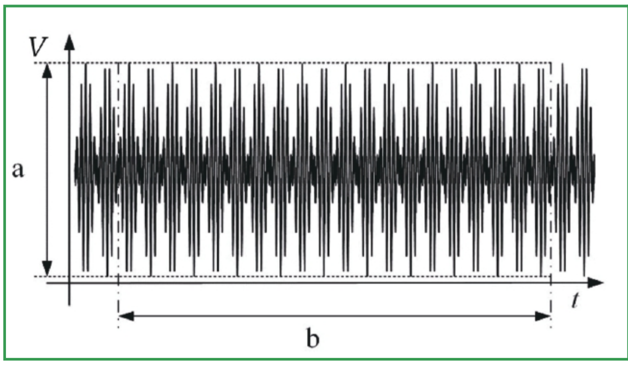


Figure 27 – Example of the measured voltage (VHV) in the time domain

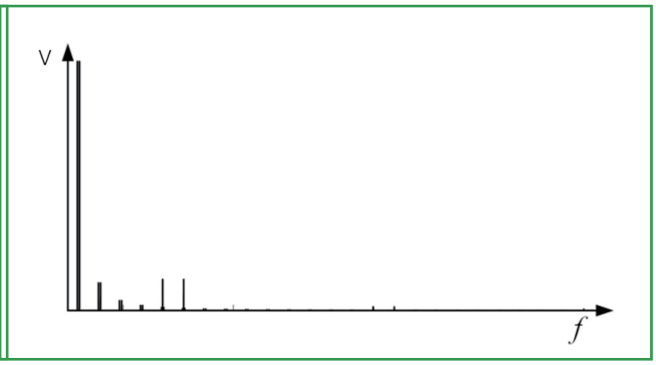


Figure 28 – Example of the measured voltage (VHV) in the frequency domain

Table 31 – Test parameters for EHV-08 Generated HV voltage ripple

DUT operating mode	Operation$_{min}$ and Operation$_{max}$	
HV voltages	$V_{opmin,HV}$, $V_{N.HV}$, $V_{opmax.HV}$	
LV voltages	V_{op}	
Internal resistance of HV source	$R_{i.HV}$ = 100mΩ	
Measuring frequency range f	10Hz~150kHz	
Maximum voltage ripple up to and including the constant power output specified in the Component Performance Specification in the time domain, unless otherwise specified in the Component Performance Specification	450-VDC vehicle electrical system：16Vpp 900-VDC vehicle electrical system：16Vpp	
Short-term, maximum voltage ripple in the time domain above the constant power output (static and dynamic), unless otherwise specified in the Component Performance Specification.The permissible duration must be derived from the peak load scenarios.	450-VDC vehicle electrical system：32Vpp 900-VDC vehicle electrical system：32Vpp	
In the frequency domain, unless otherwise specified in the Component Performance Specification	450-VDC vehicle electrical system	10Hz~2kHz 10Vpp 2kHz~5kHz 10Vpp~19Vpp(frequency log scale) 5kHz~40kHz 19Vpp 40kHz~50kHz 19Vpp~6Vpp(frequency log scale) >50kHz 6Vpp
	900-VDC vehicle electrical system	10Hz~2kHz 12Vpp 2kHz~5kHz 12Vpp~19Vpp(frequency log scale) 5kHz~40kHz 19Vpp 40kHz~50kHz 19Vpp~6Vpp(frequency log scale) >50kHz 6Vpp
Maximum voltage ripple without HV energy storage device	The test must be carried out in generator mode with CS = 700 µF with the same maximum voltage ripple values.	
Temperatures	T_{max} with $T_{cool,max}$' , T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$'	
Number of cycles	3	
Number of DUTs	3	

1.7、EHV-09 System HV voltage ripple

Purpose

- The robustness of HV components when subjected to the HV voltage ripple produced in the HV system must be verified.
- NOTE 4:The test results flow into the System Performance Specification as feedback.

Test

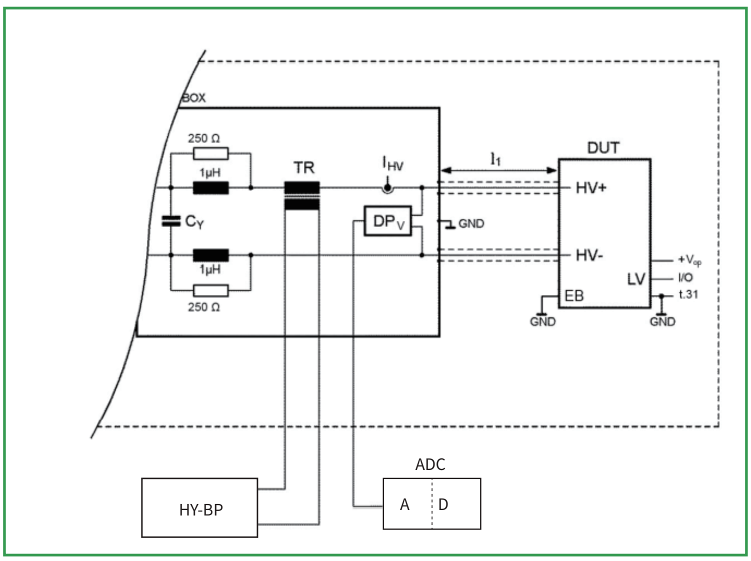
- An alternating voltage with a variable amplitude and frequency is superimposed on the DUT's DC HV supply voltage.
- Test setup type 2 in section 4.9.2 must be used and expanded as per the diagram in figure 29.
- An oscilloscope must be used to monitor the injected alternating voltage. The test parameters are specified in table 32.
- If the DUT is powered from the HV vehicle electrical system via a DC-DC converter, the curve for the system ripple must be agreed upon between the purchaser and the contractor on a project-specific basis.

Test case 1

- In test case 1, the amplitude of the ripple voltage on the DUT must be set to the values specified in table 32 and readjusted, if necessary.
- During the test, it is necessary to look out for resonance phenomena between the test setup and the DUT. All peaks and sags in the ripple content of the HV voltage and HV current in the DUT must be documented together with the corresponding frequency.

Test case 2

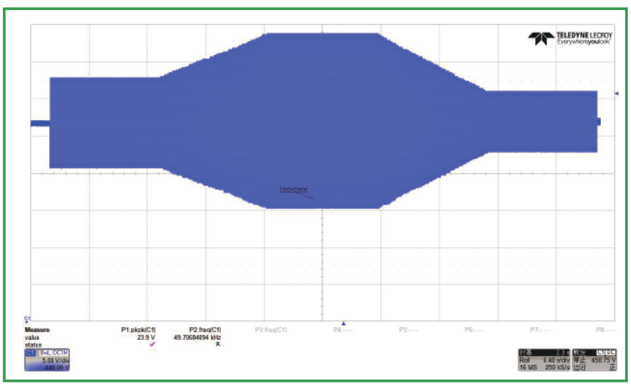
- In test case 2, the amplitude of the ripple voltage on the DUT must be set to the value specified in table 32 at 1 kHz. After this, the required frequency range must be run through without any change to the injected amplitude. During this process, the amplifier is only used to correct the amplitude frequency response of the transformer used for coupling purposes.
- During the test, it is necessary to look out for resonance phenomena between the test setup and the DUT. All peaks and sags in the ripple content of the HV voltage in the DUT must be document-ed together with the corresponding frequency.
- NOTE 5:If test case 1 showed that there is a resonance point at 1 kHz, the amplitude must be set at a frequency between 500 Hz and 1 kHz at which there is no resonance point.



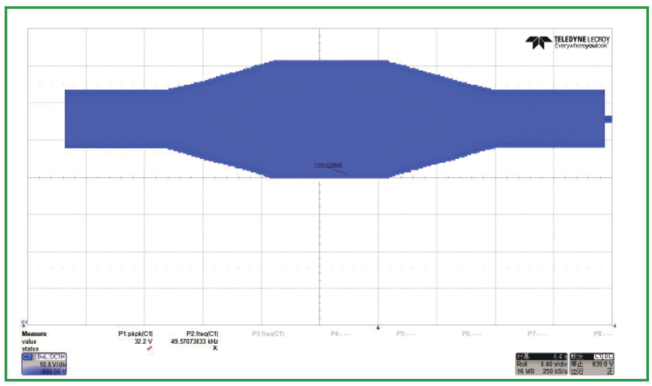
DPv :Differential probe for HV voltage measurement
ADC :Oscilloscope
TR :Coupler
HY-BPSU :Automotive Electronics Test High Speed Power Supply

Table 32 – Test parameters for EHV-09 System HV voltage ripple

DUT operating mode		$Operation_{min}$ and $Operation_{max}$
HV voltages	Test case 1	V_{opmin}, $V_{N.HV}$, $V_{opmax.HV}$
	Test case 2	$V_{N .HV}$
LV voltages		V_{op}
Internal resistance of HV source		$R_{i.HV}$=100mΩ
Power limiting		AC current limiting:The applied current must be limited to a maximum of 100 A, unless otherwise defined in the Component Performance Specification.
Voltage waveform		Sinusoidal
Increment		10Hz (80Hz~1kHz) 100Hz (1kHz~10kHz) 1kHz (10kHz~150kHz)
Test duration per frequency increment		> 2s- but at least as long as required for all measured values to be recorded
Test case 1 Voltage ripple	450-VDC vehicle electrical system	80Hz~1kHz 12V_{pp} 1kHz~5kHz 12V_{pp}~24V_{pp}(frequency log scale) 5kHz~40kHz 24V_{pp} 40kHz~50kHz 24V_{pp}~8V_{pp}(frequency log scale) >50kHz 8V_{pp}
	900-VDC vehicle electrical system	80Hz~1kHz 15V_{pp} 1kHz~5kHz 15V_{pp}~32V_{pp}(frequency log scale) 5kHz~40kHz 32V_{pp} 40kHz~50kHz 32V_{pp}~15V_{pp}(frequency log scale) >50kHz 15V_{pp}
Test case 1 Resonance test		Voltage ripple amplitude :4 Vpp at 1 kHz Frequency range :80 Hz to 150 kHz
Temperatures	Test case 1	T_{max} with $T_{cool,max}$' , T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$'
	Test case 2	T_{RT} with T_{cool}
Number of cycles		3
Number of DUTs	Test case 1	3
	Test case 2	1



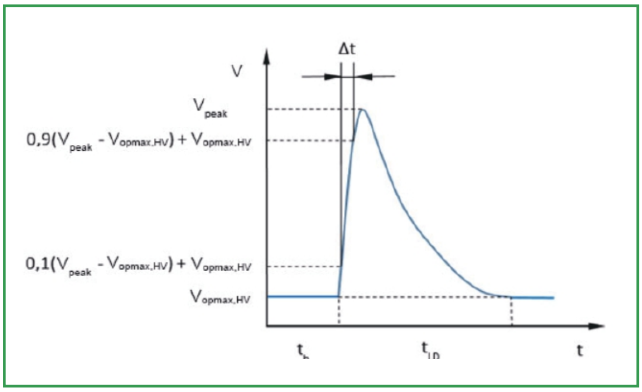
450-VDC vehicle electrical system



900-VDC vehicle electrical system

1.8、EHV-10 System load dump(Need to select the configuration throw load)

Purpose:The robustness of HV components and of the electronics in HV energy storage devices when subjected to the HV voltage dynamics produced in the HV system in the event of a load dump must be verified.



Load dump up to HV voltage before failure

Test:

Test setup type 1 in section 4.9.1 must be used.

The DUT must be subjected to the load dump pulse in figure 30.

During load dump pulse duration tLD, at least voltage Vpeak must be reached. The pulse is allowed to reach the initial value after tLD at the earliest.

Before testing begins, a reference measurement of the test setup must be performed and documented.

For this purpose, a dummy load with Rload = 2 Ω must be used.

The test parameters are specified in table 33.

Figure 30 – HV voltage curve for EHV-10 Load dump all the way to HV voltage before failure

Table 33 – Test parameters for EHV-10 Load dump all the way to HV voltage before failure

DUT operating mode	$Operation_{max}$
HV voltages	As per figure 30
LV voltage	V_{op}
Hold time before load dump pulse	t_h>10s– but at least as long as necessary for the DUT to operate stably and to have reached a constant temperature throughout
Load dump pulse duration	t_{LD} = 10 ms
ΔV_{HV}	0.8 (Vpeak - Vopmax,HV) + Vopmax,HV),see figure 30
HV rate of change $\Delta V_{HV} / \Delta t$	250 V/ms
Load dump peak voltage	$V_{peak} = V_{DUT,BF}$
Temperatures	T_{max} with $T_{cool,max}$’ ，T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$‘
Number of cycles	3
Number of DUTs	3

System load dump with high rate of change

Test(Need to select the configuration throw load) :

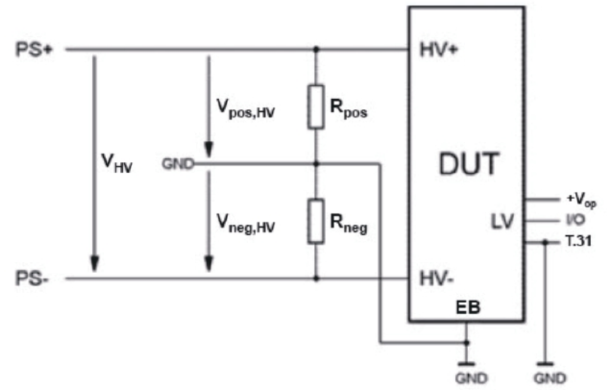
Test setup type 1 in section 4.9.1 must be used.The DUT must be subjected to the load dump pulse in figure 30. During the load dump pulse duration, at least voltage V_{peak} must be reached.

The test parameters are specified in table 34.

Table 34 – Test parameters for EHV-10 Load dump with rapid rate of change

DUT operating mode	$Operation_{max}$
HV voltages	As per figure 30
LV voltage	V_{op}
Hold time before load dump pulse	t_h>10s– but at least as long as necessary for the DUT to operate stably and to have reached a constant temperature throughout
HV rate of change $\Delta V_{HV} / \Delta t$	3000 V/ms
Load dump peak voltage	$V_{peak} = V_{N,HV}$ + 20 V, but $\leqslant V_{DUT,BF}$
Temperatures	T_{RT} with T_{cool}
Number of cycles	3
Number of DUTs	3

1.9、EHV-11 HV voltage offset



PS+ : Positive connection of the HV voltage source
PS- : Negative connection of the HV voltage source
Rpos : Discharge or load resistor
Rneg : Discharge or load resistor
EB : Connection for equipotential bonding
Vpos,HV : Voltage between PS+ and GND
Vneg,HV : Voltage between GND and PS-

Figure 31 – Basic test setup for EHV-11 HV voltage offset

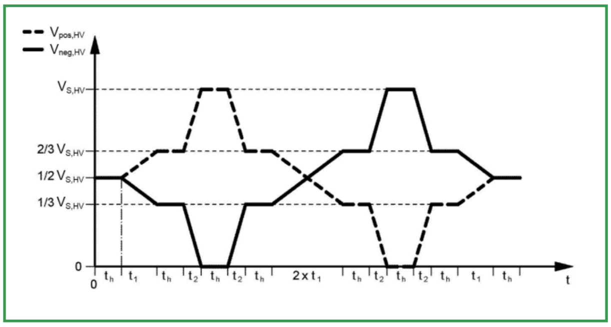


Figure 32 – HV voltage curve for test step 1 of the HV voltage offset test

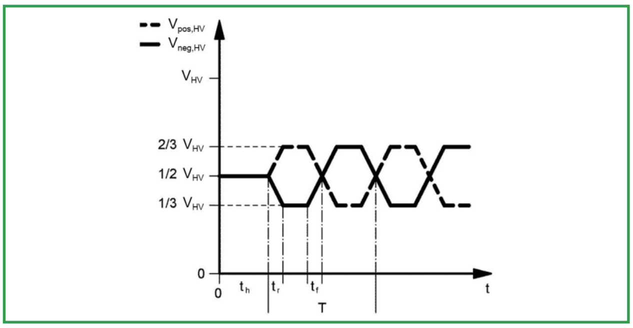


Figure 33 – HV voltage curve for test step 2 of the HV voltage offset test

Table 35 – Test parameters for EHV-11 HV voltage offset	
DUT operating mode	$Operation_{max}$
HV voltages	$V_{opmin,HV}$, $V_{N,HV}$, and $V_{opmax,HV}$
LV voltages	V_{op}
Temperatures	T_{max} with $T_{cool,max}$’ ，T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$‘
Resistors	Unless otherwise defined in the Component Performance Specification, the following applies:Total resistance（Rpos+Rneg）≤100 kΩ
Number of cycles	3
Number of DUTs	3
Test step 1	
Hold time	T_h = 120 s
Transition period	T_1 = 60 s ，T_2 ≤ 20 s
Test step 2	
Hold time	T_h = 120 s
Period duration	T = 100 ms , 20 ms, 10 ms
Rise time	T_r = 1 ms ... 1/4 T
Fall time	T_f = 1 ms ... 1/4 T
Cycle duration	5 min per period duration

1.10、EHV-12 HV overcurrent

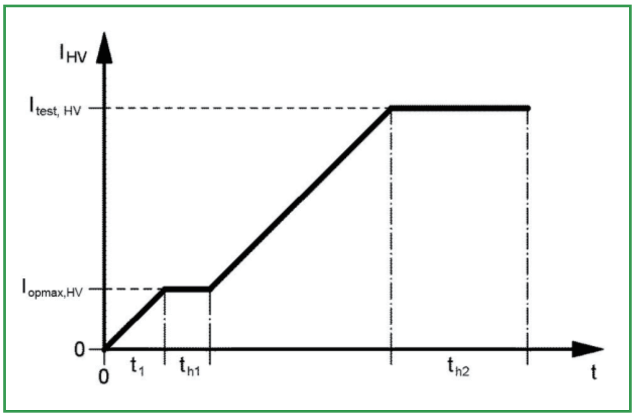


Figure 34 – HV current curve for the overcurrent test for HV energy storage devices

Purpose：The robust behavior of the HV overcurrent protection must be verified.The overcurrent strength of electromagnetic swi-tches, contacts, electronic outputs, and supply connections in ba-ckfeed-capable HV components must be tested. Higher currents than in the normal load case (e.g., maximum stalling current of a motor) must also be considered.

Table 36 – Test parameters for EHV-12 HV overcurrent	
DUT operating mode	$Operation_{max}$
HV voltages	$V_{opmax,HV}$
LV voltages	V_{op}
Maximum load current	$I_{test,HV} = 3 \times I_{opmax,HV}$
T_1	20 s
T_{h1}	10 s
T_{h2}	15 min
Temperatures	T_{max} with $T_{cool,max}$
Number of cycles	2
Number of DUTs	3

In a second test step, the DUT must be switched "on", "off", and then back "on" once at Itest,HV under load.

1.11 EHV-13 HV service life (additional)

Purpose

- As a result of existing HV voltage ripples and HV voltage dynamics, HV components are subject to a load that has an influence on the required service life.
- This test uses accelerated loading on the components that represents the load during the entire vehicle service life.

Test

- In addition to test L-02 "High-temperature durability service life test" in VW 80000, the following applies: Test setup type 2 in section 4.9.2 must be used and expanded as per diagram figure 29.
- 1 cycle = computed total test time / 50
- The test must be carried out as per the parameters in table 37.
- In each cycle, the HV voltage ripple to which the DUT must be subjected must be set as per table 38.
- For each HV voltage ripple, the frequencies must be distributed evenly as per figure 35.

Table 37 – Test parameters for EHV-13 HV service life (additional)

DUT operating mode	Operation$_{max}$
$V_{S.HV}$ HV voltages	$V_{N.HV}+V_{VPP.HV}$
HV voltages	V_{op}
Internal resistance of HV source	100mΩ
Voltage waveform	Sinusoidal
Number of cycles	50

Proportion	450-VDC power system	9000-VDC power system	Frequencies
85%	$3V_{pp}$	$5V_{pp}$	200Hz/5kHz/10kHz/20kHz/40kHz
12%	$6V_{pp}$	$9V_{pp}$	200Hz/5kHz/10kHz/20kHz/40kHz
2%	$8V_{pp}$	$12V_{pp}$	5kHz/10kHz/20kHz/40kHz
1%	$9V_{pp}$	$14V_{pp}$	5kHz/10kHz/20kHz

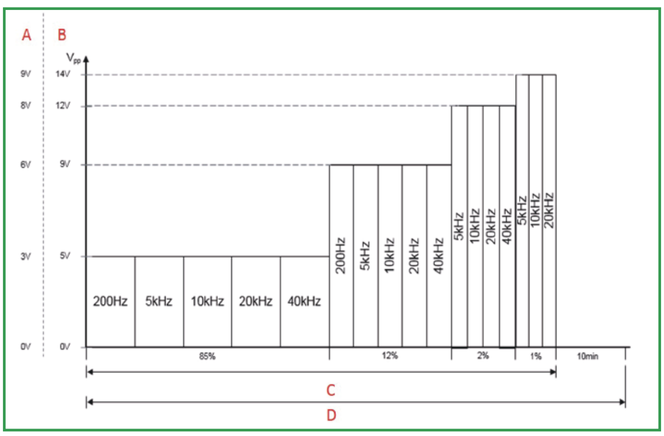


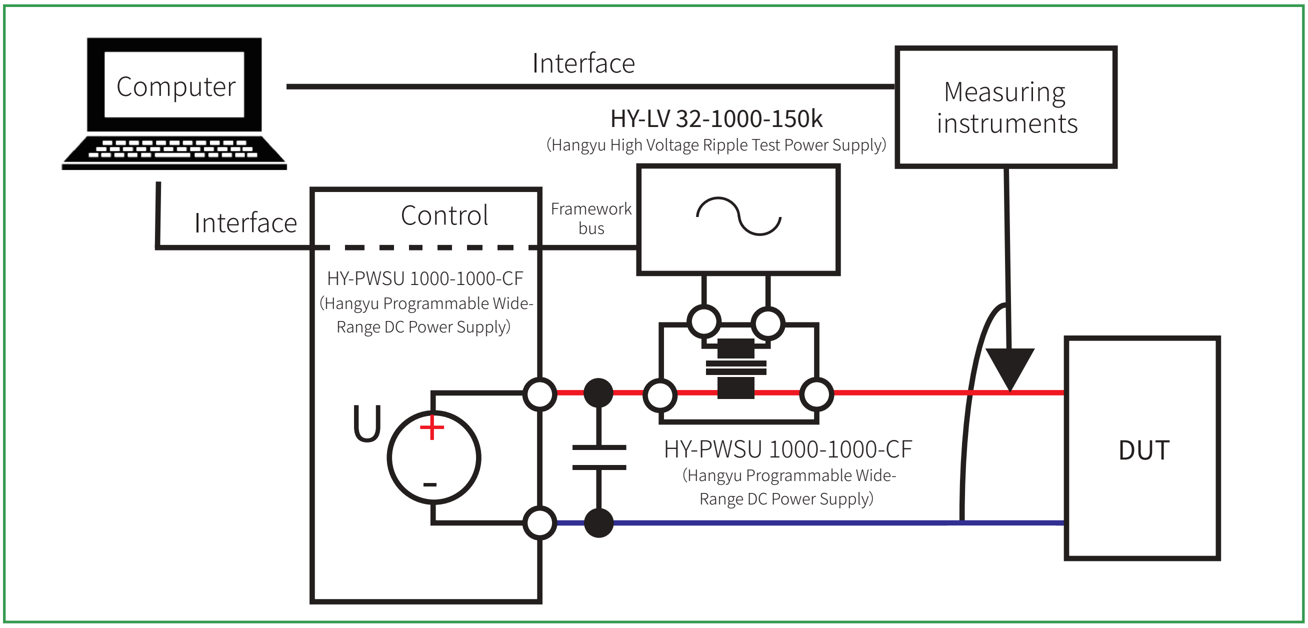
Figure 35 – Cycle description with frequency distribution

A 450-V DC vehicle electrical system

B 900-VDC vehicle electrical system

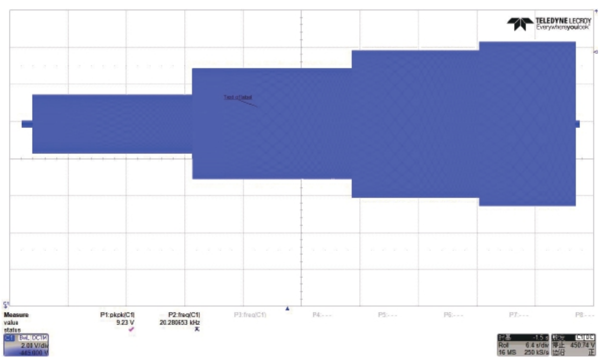
C 1/50 (-10 min) of total test duration (Arrhenius model)

D 1 cycle

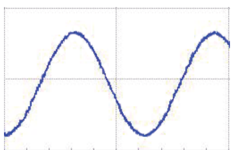


Implementation testing schematic diagram

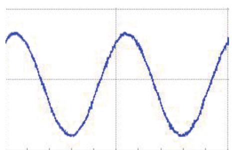
VW 80000, L-02 “High temperature durability service life test” requirements apply



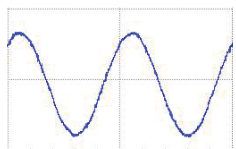
DC450V Envelope line



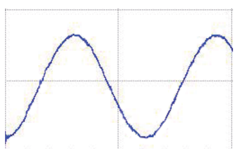
VPP 3V 5kHz



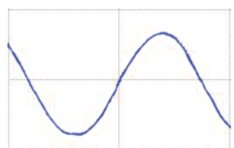
VPP 3V 10kHz



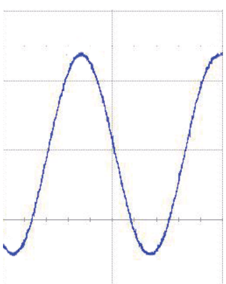
VPP 3V 20kHz



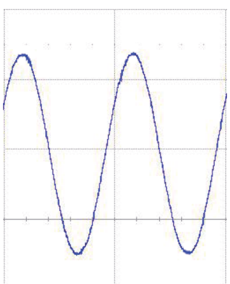
VPP 3V 40kHz



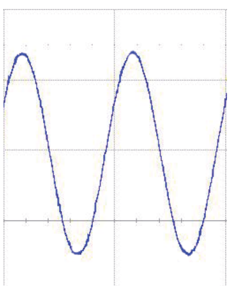
VPP 3V 200Hz



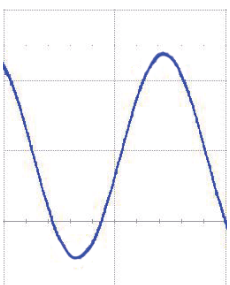
VPP 6V 5kHz



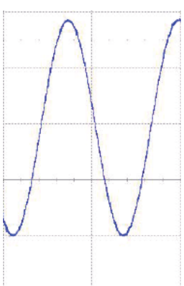
VPP 6V 20kHz



VPP 6V 10kHz

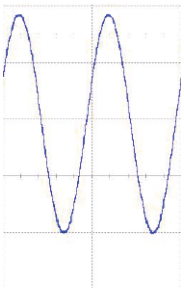


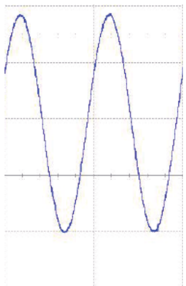
Vpp 6V 200Hz

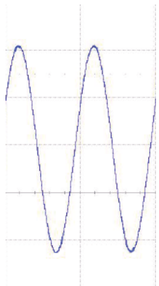


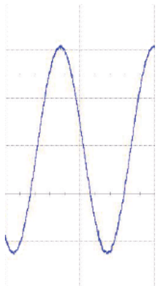
VPP 8V 5kHz

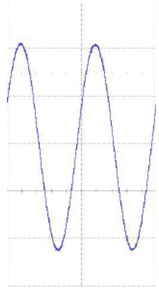
VPP 8V 200Hz

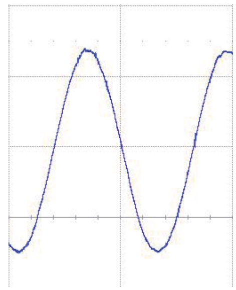

VPP 8V 10kHz

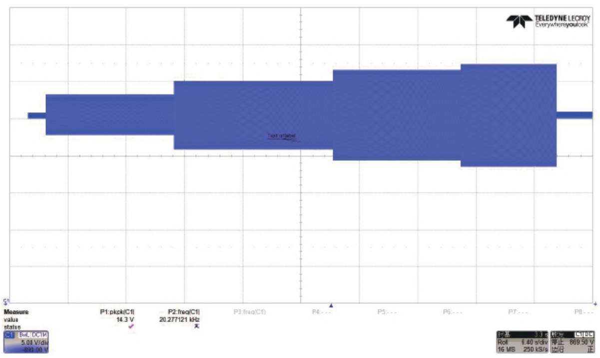

VPP 8V 20kHz


VPP 9V 20kHz

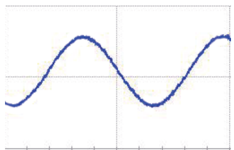

VPP 9V 5kHz

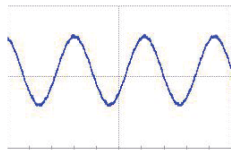

VPP 9V 10kHz

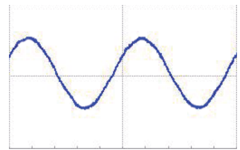

Vpp6V 40kHz

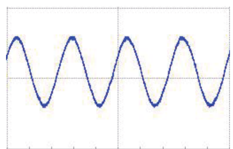


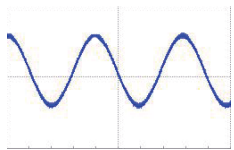
DC900V Envelope line

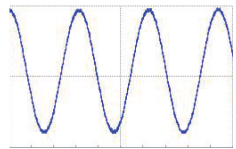

VPP 5V 5kHz

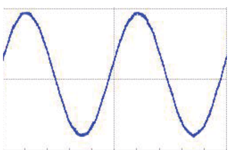

VPP 5V 10kHz

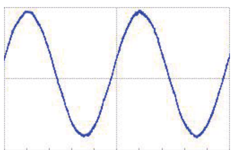

VPP 5V 20kHz

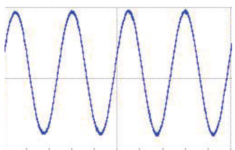

VPP 5V 40kHz

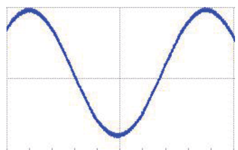

VPP 5V 200Hz

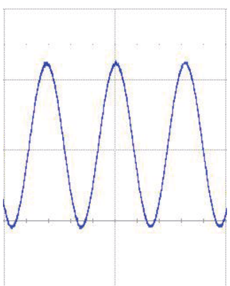

VPP 9V 5kHz

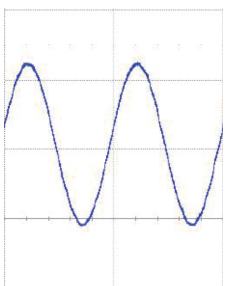

VPP 9V 10kHz

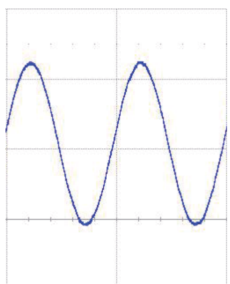

VPP 9V 20kHz


VPP 9V 40kHz


VPP 9V 200Hz


VPP 12V 5kHz


VPP 12V 10kHz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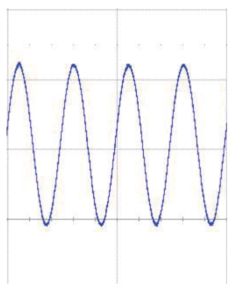
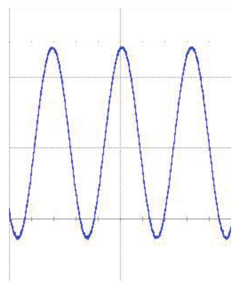
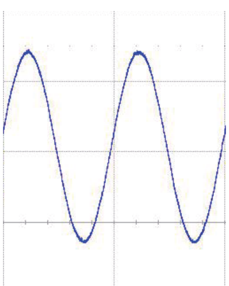
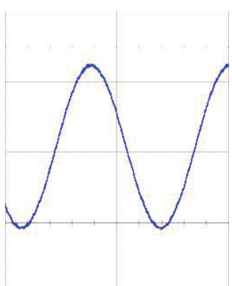
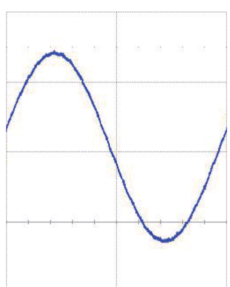
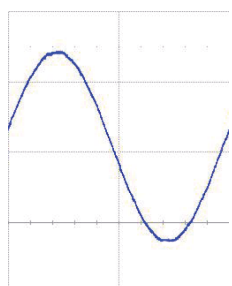

VPP 12V 40kHz


VPP 14V 5kHz


VPP 14V 20kHz


VPP 12V 5kHz


VPP 14V 5kHz


VPP 14V 10kHz

1.12、EHV-14 On/off durability testing for HV components

Purpose	■ The purpose of this test is to verify the reliable initialization, startup, and shutdown of the component at all voltage levels. As a result of pre-charging, HV components are subject to a load that has an influence on the required service life.
Test	■ This test must be performed as described in VW 80000.It deviates from VW 80000 as follows: The voltages $V_{opmin,HV}$, $V_{N,HV}$, and $V_{opmax,HV}$ must be distributed in equal parts to the cycles of the test as defined in VW 80000.

VW80000 Test parameters for E-24a ON/OFF durability testing		
Number of cycles	54 000 in driving operating mode Additionally 46 000, e.g., for charging, preconditioning	
Activation	e.g., t.15, t.87, t.15 via network	
Distribution of cycles	70% at T_{RT} 20% at T_{max} 10% at T_{min} At each temperature level: 33% at $V_{opmin.HV}$ 34% at $V_{N.HV}$ 33% at $V_{opmax.HV}$	
VW80000 Test parameters for E-24b - T.30 cycle		
Number of cycles	100	
Activation	T.30, t.30c - if available	
Distribution of cycles	70% at T_{RT} 20% at T_{max} 10% at T_{min} At each temperature level: 33% at $V_{opmin.HV}$ 34% at $V_{N.HV}$ 33% at $V_{opmax.HV}$	30s Duration while t.30 is present

At the start of a cycle, the component is fully live and the t.30 voltage supply is switched off.

1.13、EHV-15 Functionality of HV interlock, maintenance connector, and crash signaling

Purpose
- The functionality of the HV-specific LV signals and LV signal chains must be tested as part of the electrical tests in VW80000.

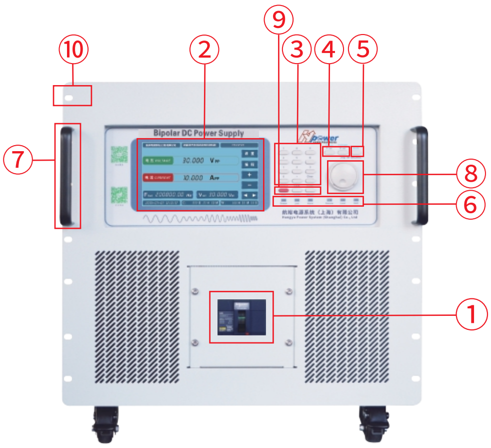
Test
- The correct functionality and signal integrity of signal generators for an interlock loop (HV interlock) and for the maintenance connector must be verified during all the electrical tests in VW 80000.

Table 39 – Additional parameters for LV signal loops

DUT operating mode	$Operation_{max}$ at LV level
HV voltages	$V_{N,HV}$
LV voltages	V_{op}
Minimum loop resistance	As per Component Performance Specification
Maximum loop resistance	As per Component Performance Specification
Maximum loop capacity to GND	As per Component Performance Specification
Switching thresholds	As per Component Performance Specification
Discontinuity time	⩾ 2 s
Short circuit time	⩾ 2 s
Response times	As per Component Performance Specification
Permissible measurement tolerances	As per Component Performance Specification
Temperatures	T_{max} with $T_{cool,max}$’ ，T_{RT} with T_{cool}, T_{mix} with $T_{cool,mix}$‘
Number of cycles	3
Number of DUTs	6

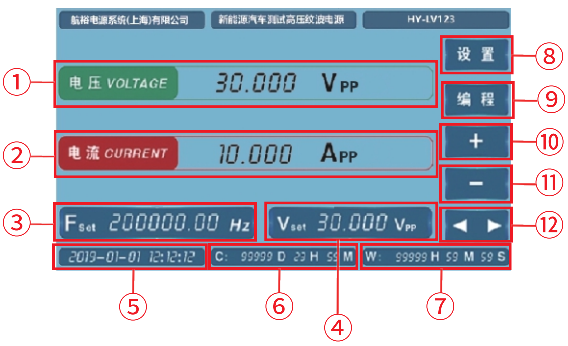
HY-LV123SU Series Display And Control Panel

Control Panel



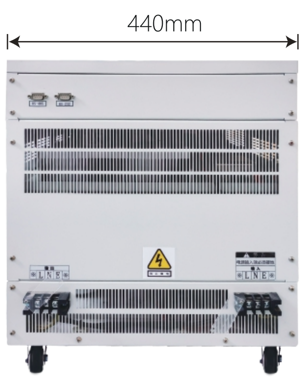
① Power input circuit breaker
② 7-inch LCD display window display: voltage setting value，Voltage and current measurement values, function settings menu
③ Function buttons: used for required numerical input and parameter settings
④ Voltage/current setting key
⑤ Shift function reuse key
⑥ Status indicator light
⑦ Chassis handle
⑧ Multi-stage adjustment knob, the inner circle adjusts one word at a time, and the outer circle is divided into ± 8 adjustable segments
⑨ Lock、Enter、Esc、Local、Reset/Alarm、Output ON/OFF
⑩ 19 inch standard rack mounting holes

Display Screen



① Voltage measurement value display
② Current measurement value display
③ Frequency setting value display
④ Voltage setting value display
⑤ Current time display
⑥ Accumulated working time display
⑦ Current working hours
⑧ Set menu button for setting system parameters
⑨ Programming button, used to set parameters during programming
⑩ When editing the voltage and current values, quickly increase them. For example, when the voltage is 2V, pressing "+" can increase it to3、4、5……
⑪ When editing voltage and current values, quickly reduce them. For example, when the voltage is 10V, press "-" to decrease it to9、 8、7……
⑫ When modifying the set value, you can click the arrow keys to select the number that needs to be modified

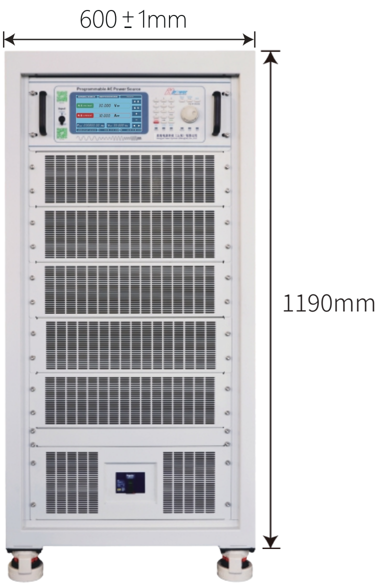
10U 440(W)*600(D)*445(H)mm

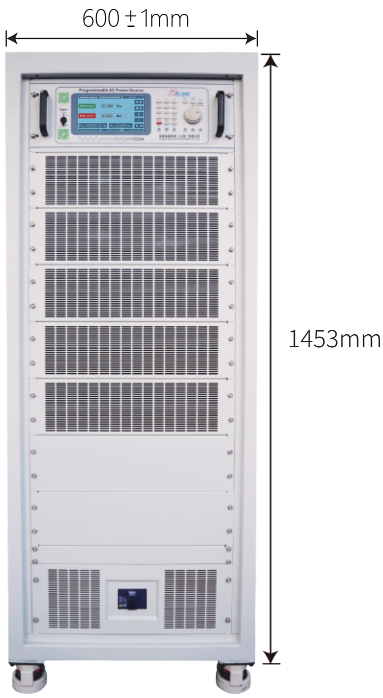


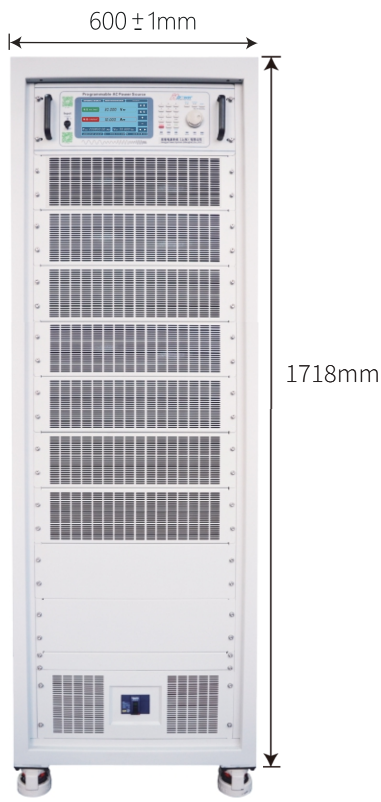
HY-LV123SU Series Appearance & Size

18U 600(W)*800(D)*920(H)mm

24U 600(W)*800(D)*1190(H)mm
30U 600(W)*800(D)*1453(H)mm
36U 600(W)*800(D)*1718(H)mm







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Hangyu Power Supply Automotive Electronic Test Solution Manual, Version 05.24, May 2025

All technical data and instructions are based on the actual product
If there is any change, Hangyu Power has the final interpretation right

Authorized distributor：