DAV ELECTRONICS LTD.

E-Mobility Tester

TESTING THE FUTURE®

E-MOTOR & DC EMULATOR

ADVANCED POWER EMULATORS FOR VEHICLE ELECTRIFICATION TESTING

HIGH PERFORMANCE, ECONOMICAL, FACILITY FRIENDLY
REDEFINING THE STANDARD.

D&V ELECTRONICS

+ E-Motor Emulator - Significantly reduced infrastructure requirements
+ DC Emulator - Wide Bandwidth, to 20kHz, stimulation or emulation
+ Fully modular, high-precision expandable platforms to fit your needs

High fidelity DC power system and motor drive inverter testing is made achievable with the use of advanced power emulation. D&V Electronics combines leading edge technology and innovative design to produce superior EV/HEV motor drive inverter and DC power system test solutions. Two products, working stand alone or in combination, provide the foundation for vehicle electrification development and production testing.

From individual component testing to full vehicle systems integration testing of component compatibility, these products can interface with your proprietary test automation and data acquisition systems or D&V Electronics can provide a turnkey solution.

D&V Electronics Active Load Emulator (Motor Emulator) mimics all of the characteristics of a permanent magnet or induction motor/generator at full power in all four quadrants with no moving parts under user-controlled speed, torque & temperature conditions thereby simulating an electric drive train.

This electronic dynamometer, with facility requirements suitable for laboratory installations, offers significant advantages in test capabilities and flexibility with low acquisition and operating costs.

Our DC Emulator provides wide bandwidth, up to 20kHz, stimulation or emulation of the DC power system and components. It has the ability to sweep at full power, to frequencies that include the ripple of the emulated component, and provides for full characterization of system resonances and characteristics. Available from 30kW to 2.6MW, this DC source/sink emulates dynamic, complex bidirectional loads with best in class frequency response, deterministic streaming with <1 uS latency, bidirectional full-power slew rate of <100uS and repeatable noise/ripple generation. Ideal for testing vehicle energy systems and components, including batteries, and for HIL with real-time simulation to emulate large switching and regenerative loads to study their effect on the whole power system.

TESTING THE FUTURE®

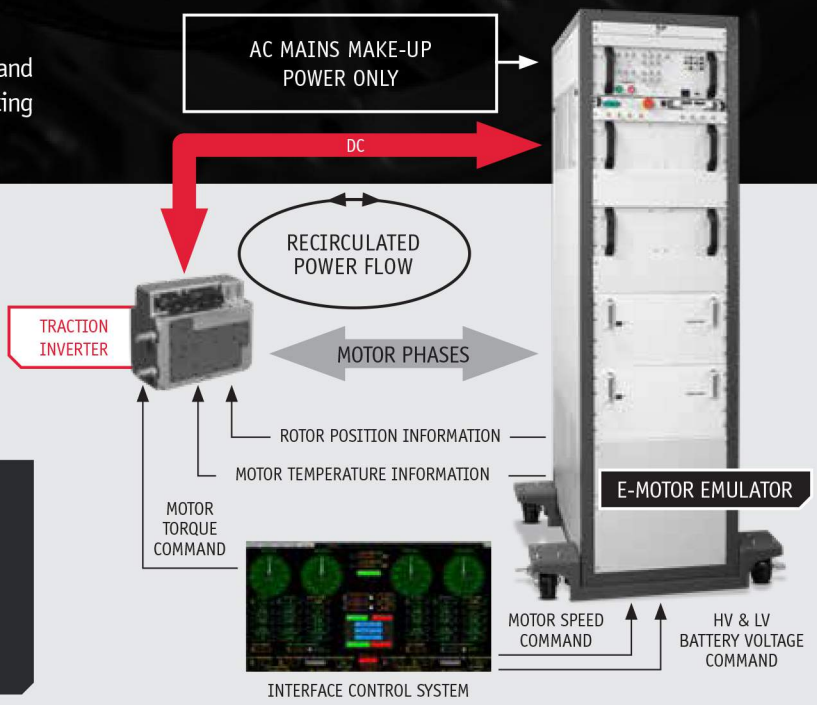
INVERTER TESTING APPLICATIONS

LOCAL POWER RECIRCULATION WITH SIGNIFICANTLY REDUCED INFRASTRUCTURE REQUIREMENTS

+ Electrical: 100A/480V service supports 250kW system, no external isolation transformer required
- Mechanical: single cabinet design with casters can be easily moved, small footprint fits multiple units around thermal chamber

CONFIGURATION 1

D&V Electronics's self-contained system emulates two motors and both the high and low voltage batteries providing high fidelity testing of the electrified power train in a single 19-inch rack.



Battery Emulator:

- ALE includes HV DC Supply and functions as battery emulator
- Controllable
- 500 VDC or 960 VDC modules
- 300 ADC Continuous per Channel | 600 ADV paralleled
- 430 ADV for 20 sec. per Channel | 860 ADC paralleled

E-MOTOR EMULATOR (ACTIVE LOAD EMULATOR)

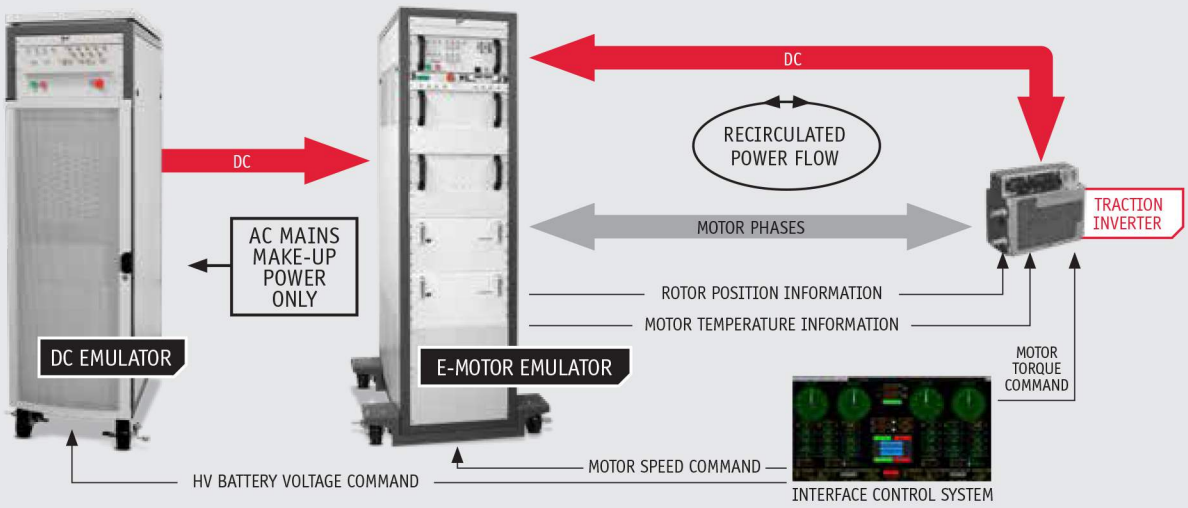
+ Permanent Magnet Motor or Induction Motor Emulation
+ Single or Dual Channel (Dual channel paralleling for 2X AC/DC current)
+ Up to 150kW per Channel; 250kW combined
+ 350A AC RMS Continuous per Channel
+ 550A AC RMS per Channel for 30 seconds

CONFIGURATION 2

Replacing the internal high voltage DC power supply with a DC Emulator provides added Battery Emulator fidelity while offering the flexibility to remove the DC Emulator and operate it as a stand alone system. This configuration continues to take advantage of the local power recirculation while expanding your testing capabilities into Batteries, Battery Chargers and Full Vehicle Systems.

Battery Emulator:

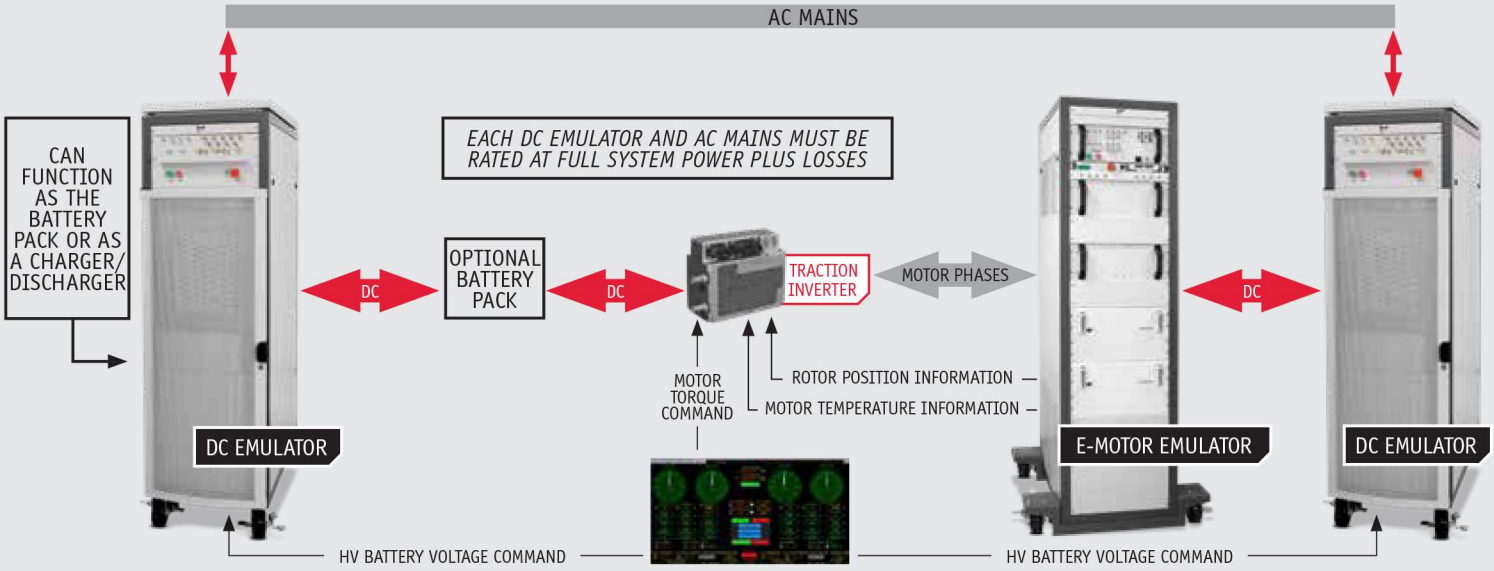
- Controllable with 20kHz Bandwidth
- 100kW; 0 to 500 VDC; ±500A
- Modular - remove and operated as stand along source (application note on next page)
- HIL operation with Fiber Optic Streaming from Real Time Simulation or Test Automation System



CONFIGURATION 3

Combining the E-Motor Emulator and DC Emulators as shown enables power recirculation through the facility AC mains for those unique test situations that require it.

While the facility requirements are significantly increased, the modularity of the DC Emulators enable you to revert back to local recirculation and its inherent advantages, while maintaining the flexibility to configure as shown or operate the DC Emulators as a standalone Battery or Battery Charger tester.



Battery Emulator & High Frequency Load Applications:

Wide bandwidth, to 20kHz, stimulation or emulation of the DC power system:

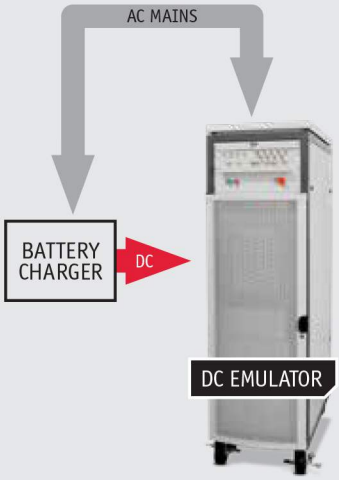
- Ideal for testing batteries and battery chargers
- Best in class frequency response, bidirectional full-power slew rate of under 100uS
- Controlled noise and ripple generation

DC EMULATOR

+ 100kW/0 to 500V/±500A
+ Master/Slave series to 1000V or parallel to 1.3MW or series parallel to 2.6MW
+ Current Transients (+500 to -500A either direction) in <100uS
+ Power Hardware in the Loop with Fiber Optic Streaming from Real Time Simulation or Stored Profiles

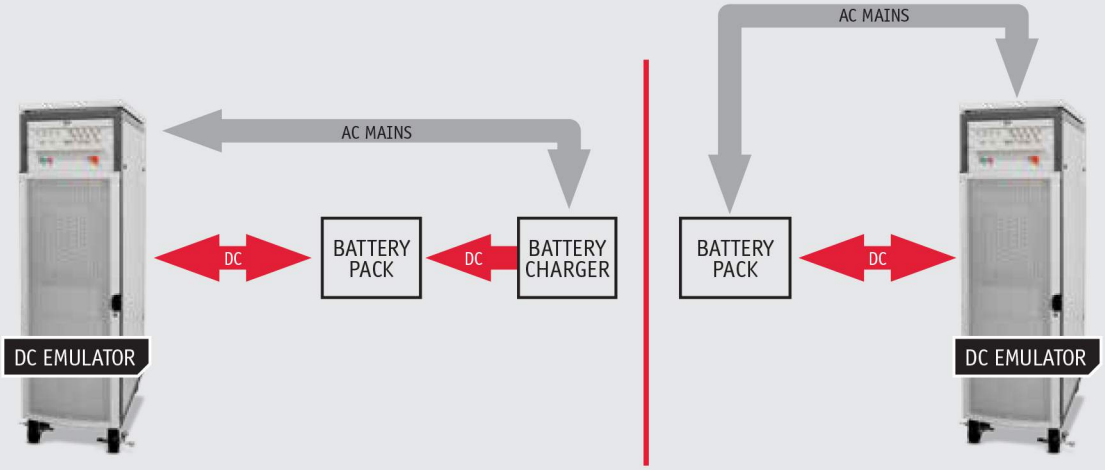
Battery Emulator for Charger Testing:

- Wideband Controlled Impedance
- Real Reactive & Nonlinear for Accurate Battery Emulation



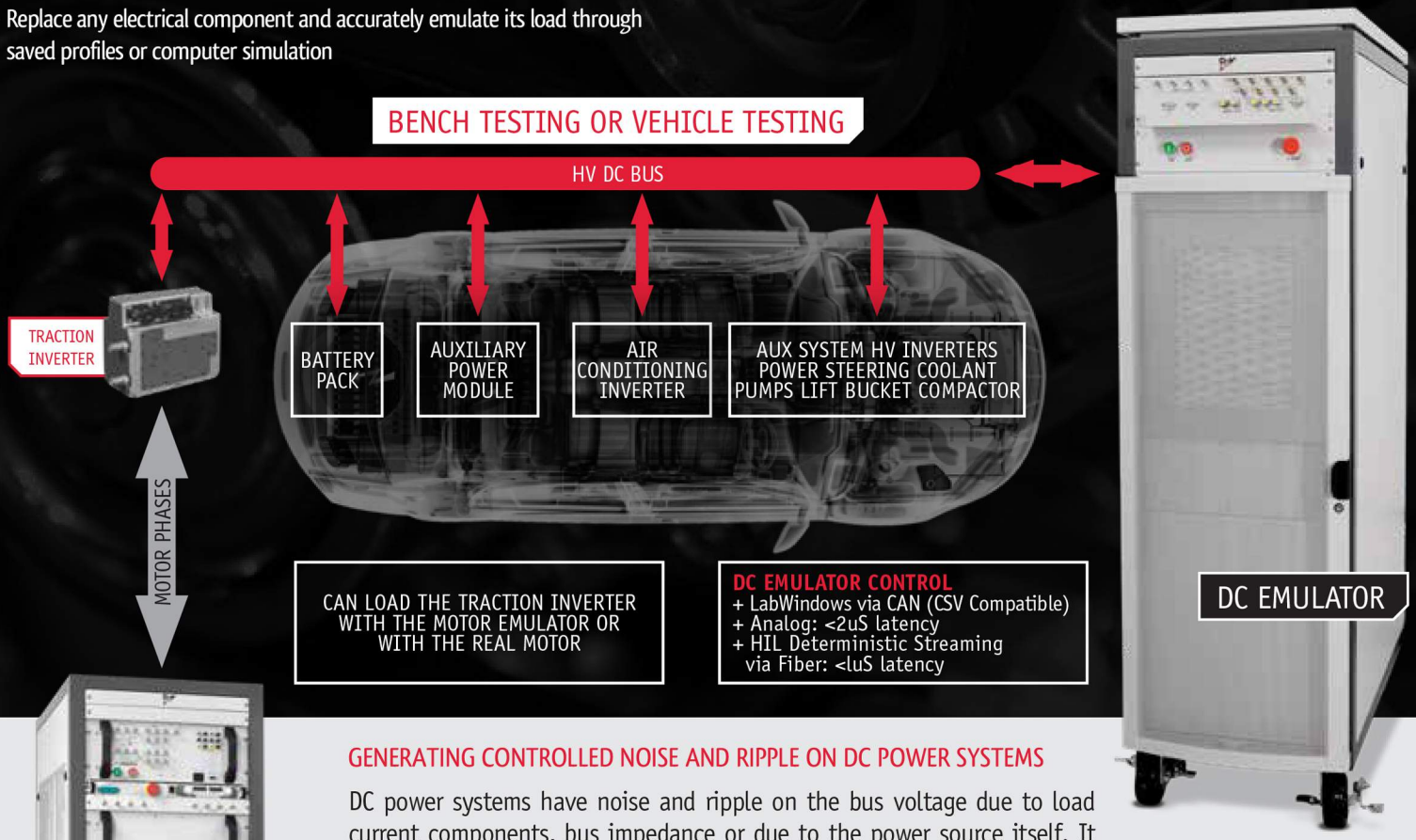
High Frequency Load:

- Generates controlled ripple up to 20kHz to emulate AC components including even the inverter switching frequencies
- Constant Power, Constant Current, Constant Resistance, Constant Voltage
- Power Slew Rate of -100% to +100% Rated Power in <100uS



FULL VEHICLE SYSTEM INTEGRATION AND COMPONENT COMPATIBILITY TESTING APPLICATION

+ Electrical Disturbance Generator at the system level that has the ability to sweep at full power to frequencies that include the ripple of the emulated component
+ Replace any electrical component and accurately emulate its load through saved profiles or computer simulation



GENERATING CONTROLLED NOISE AND RIPPLE ON DC POWER SYSTEMS

DC power systems have noise and ripple on the bus voltage due to load current components, bus impedance or due to the power source itself. It is often beneficial to be able to test for the effects of this noise and ripple on system operation. In order to do so a controlled means of generating repeatable noise and ripple is needed. The D&V Electronics DC Emulator is designed to do just that. It can be configured as a bidirectional load that can load the DC power system up to 500 volts, with DC to 20kHz current components up to +/-500A per unit (series to 1000V, parallel to +/-6500A). The output current waveform can be input via fiber from a stored table, generated by real time simulation, or fed from an analog waveform generator, all with a 2uS or less resolution.

Alternatively, to test a piece of equipment that would be placed on the DC power system and not the entire DC power system, the DC Emulator can be configured as a DC voltage supply, with the same capabilities as stated above, available to supply load currents or charge system capacitance. Voltage slew rates up to 10V/uS can be generated.

D&V Electronics' Emulators for Vehicle Electrification Testing, working standalone or in combination, provide the foundation for vehicle electrification development and production testing. From individual component testing to full vehicle systems integration testing of component compatibility, these products can interface with your proprietary test automation and data acquisition systems or D&V Electronics can provide a turnkey solution.

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E-MOBILITY TESTER

DC EMULATOR

DC Power System and Component Testing

Feature

- Highly dynamic DC load / Source for power systems
- Development and hardware loop (HIL) Testing
- Wide Bandwidth (to 20 kHz) for high power swept frequency testing for resonance identification, inject controlled noise/ripple onto DC buss, accurate reproduction of captured/simulated waveforms
- Full power slew < 100uS
- Latency – 1 uS from command to output
- Ideal for existing and future test labs
- Total 26 DCE can make series or parallel connection up to 2.6 MW

Applications

- EVs & HEVs : Battery Packs, Chargers, Converters, High Voltage DC Power Systems
- HIL for dynamic high-power source or load emulation with real-time simulation
- DC microgrid testing
- Alternative energy systems
- Aerospace DC power systems and compnents

DAV ELECTRONICS LTD.

Specifications

	MODEL 105050	MODEL 108050
Motor Emulator		
DC Power	-100kW to 100kW	
Current	± 500 ADC	
Voltage	0 to 500 VDC isolated output	0 to 800 VDC isolated output
Large Signal Bandwidth	> 20kHz Current and Voltage	
Max RMS Current Ripple	150 mA or 0.25% of set-point, whichever is greater	
Max Voltage Error	250 mA or 0.25% of set-point, whichever is greater	
Max Current Error	300 mA or 0.3% of set-point, whichever is greater	
Max Resistance Error	0.5% of set-point	
Max Power Error	50 W or 0.5% of set-point	
Load Mode	Constant Power(CP), Current(CC), Resistance(CR), Voltage(CV) (> 10A/uS)	
Source Modes	Voltage (185V/mS, limited by output capacitance)	
	Fast Voltage (> 10V/uS)	
Frequency Responsse	< ± 3 dB to > 20kHz	
Power Slew Rate	-100% to +100% Rated Power (either direction) in < 100uS	
Efficiency	> 90% at full power	
Power Factor	> 0.98	
THD	≤ 3.5%	
Isolation	Internal Galvanic with high frequency converter	

INTERFACES AND CONTROL (FONT PANEL ACCESSIBLE)	
Graphical User Interface	Labwindows ™ based with CAN interface; 10mS updates; CSV compatible profiles
Analog	± 10V; 0.5uS Sample Rate; I/O < 1uS latency
Digital	Deterministic Streaming via Fiber; 0.5uS Sample Rate; I/O < 1uS latency
Emulation Profile Storage	Size determined by host PC specifications
Operating Modes	GUI User selectable
ESTOP	Front Panel Button; Discrete output for facility tie in; Shuts down all power.
HVIL	Door swiches; Discrete output for facility tie in. HV shuts down; control enabled

FACILITY REQUIREMENTS	
Input (others available)	480VAC/150A 3-phase 4-Wire 60Hz
Input	120VAC, 1-phase, 6.5 amp (other voltages available)
Cooling **(Water or 50% WEG; non-condensing)**	6.5GPM @ 20PSI 30C max coolant
Physical Size (WxDxH inches)	23 x 42 x 75 with 6" casters
	Stack Light (add 5 ½ in.), Ships uninstalled
Weight	1000 lbs

ELECTRIC MOTOR EMULATOR

For Motor Drive Inverter Testing

Feature

- Stand alone inverter test solution
- Ideal for validation/Endurance/Production testing
  - Intergral HV&LV battery emulators
  - Configurable internal motor models with drive cycle simulation
  - P-HIL compatible with OpalRT real time simulation
- Circulates AC/DC Power between the EME and Inverter
  - Minimal facility requirements
    – power sized for make-up power only (about 25% of system rating)
  - Low operating cost
  - Supports DPWM, SVM, Sine-Triangle, etc.
- Ultimate flexibility
  - Scalable from one up to four emulators connected in parallel (up to 1.1MW)
  - Reconfigure for 3 up to 6 phase emulation

Specifications

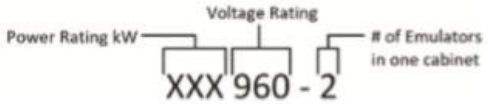
	150500-1	250500-2	275960-1	550960-2
Motor Emulator				
Quantity of Motors Emulated	1	2	1	2
Quantity of Cabinets	1	1	1	2 or 3
Max Continuous Power (kW)②	150Kw/emulator 250Kw combined		150Kw/emulator 250Kw combined	
AC Continuous Current③	350 Arms per emulator; 700Arms in parallel connection			
AC Peak Current③	550Arms for 30 sec.; 450Arms for 40 sec. (double current in parallel connection)			
Fundamental Frequency	DC to 1500Hz			
Motor Voltage	0 to 365 VAC RMS L-L		0 to 700 VAC RMS L-L④	
Motor Type	Synchromous PM or Induction, 3-phase per emulator, up to 6-phase for dual emulator connection			
Motor Rotation	Clockwise or Counter			
Torque Direction	Positive or Negative			
Motor Poles	2 to 40			
Position Sensing Emulation	Resolver or Encoder			
Resolver Lobes	2 to 24			
Resolver Offset	-2pi to 2pi radians			
Resolver Excitation	3kHz to 20kHz			
Encoder Pulses	Up to 80 pulses/revolution			
Emulated Phase Inductance	30 uH to 2000 uH			
Emulated Phase Resistance	0 to 1000 m0hm			
PWM Integrating Inductance	Used to limit UUT ripple current. 30uH to 1000uH. 960V units ship with externally configurable inductors for 105uH and 210uH, unless otherwise specified, to optimize testing of inverters from different voltage platforms.			
Temp Sensor Emulation	Three per Emulator, stator and rotor, 0 to 5V per lookup table			

	150500-1	250500-2	275960-1	550960-2
INTERNAL HV BATTERY EMULATOR				
Battery Voltage	Up to 500 VDC		Up to 960 VDC	
DC Continuous Current③	-300 to 300 ADC per emulator; -600 to 600 ADC in parallel connection			
DC Peak Current③	-430 to 430 ADC per emulator for 20 sec.; -860 to 860 ADC in parallel connection			
Battery Voltage Bandwidth	3Hz up to 20kHz (with choice of DC power supply)			
Isolated	Yes			
INTERNAL LV BATTERY EMULATOR				
UUT Control Power	8 to 30 VDC, 25A max standard. Others available			

USER INTERFACE
The EME is provided with PC based Graphical User Interface Software that can be used to control both the EME and Unit Under Test. PC to EME interface is via CAN. P-HIL compatible with OpalRT real time computer/simulation via high-speed fiber. Custom control software interfaces to the EME via standard 11-bit identifier messages at 500kbps (Communication Interface Document provided).

Notes

① Other models with Continuous Power ratings from 60kW and up are available upon request. Models defined with the following convention:



② Rated Power is based on local power circulation with a unidirectional make-up supply and nominal system losses, your actual power may vary. Bidirectional supplies can be used unidirectionally for makeup or bidirectionally to support test configurations that include an external DUT DC Source in the loop to circulate power to the facility grid - rated Power equals about 90% of DC Supply rating for grid circulation.

③ All models are rated 350Arms continuous, 550Arms peak AC and 300A continuous, 430A peak DC per emulator but may be limited to lesser values due to available makeup current. Dual emulator units can be paralleled into a single unit to double the AC and DC current, and in total 4 emulators can be paralleled to quadruple the current to 1400Arms, 1200ADC continuous.

④ The battery voltage for certain models can be configured via user interface for 500 and 960 VDC to optimize testing of inverters from different voltage platforms.

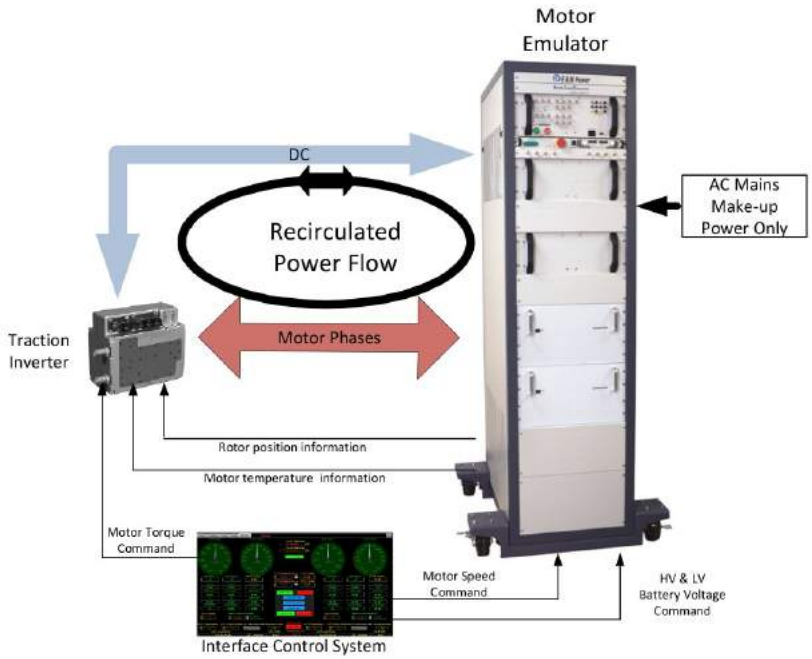
FACILITY REQUIREMENTS	
PC with CAN Interface	D&V Interface Software requires User PC with VectorCAN Compliant Hardware (VN1600 series, CANCaseXL, CANCardXL, etc.)
3Φ Service (480/380/208)	Phase current per 10kW of DC Makeup Power: Unidirectional is 18A/21A/36A; Bidirectional is 15A/18A/26A
1Φ Service (120/240)	15A
Isolation Transformer	Not required, DC make-up power supply to grid is isolated
Ambient air temperature	0 to 30C
Max UUT & EME Losses	Equal to DC make-up power supply rating
Coolant	Water (with aluminum corrosion inhibitor) or 50% WEG, 30C max, non-condensing. Multiple cabinets to be plumbed in parallel. Single cabinet from 4.5 to 6.0 GPM dependent upon power rating. Second cabinet dependent upon choice of DC power, contact D&V Electronics.
Dimensions WxDxH inches (mm)⑤	All cabinets have the same footprint of 23" x 39" (585 x 991 mm). Cabinet height varies from 75" (1900 mm) to 86" (2185 mm) depending on configuration and power rating
Weight (lbs / kg) ⑤	Approximation and will vary with choice of DC power. Emulator cabinet up to 1800 / 820, Power supply cabinet up to 1000 / 450

Notes

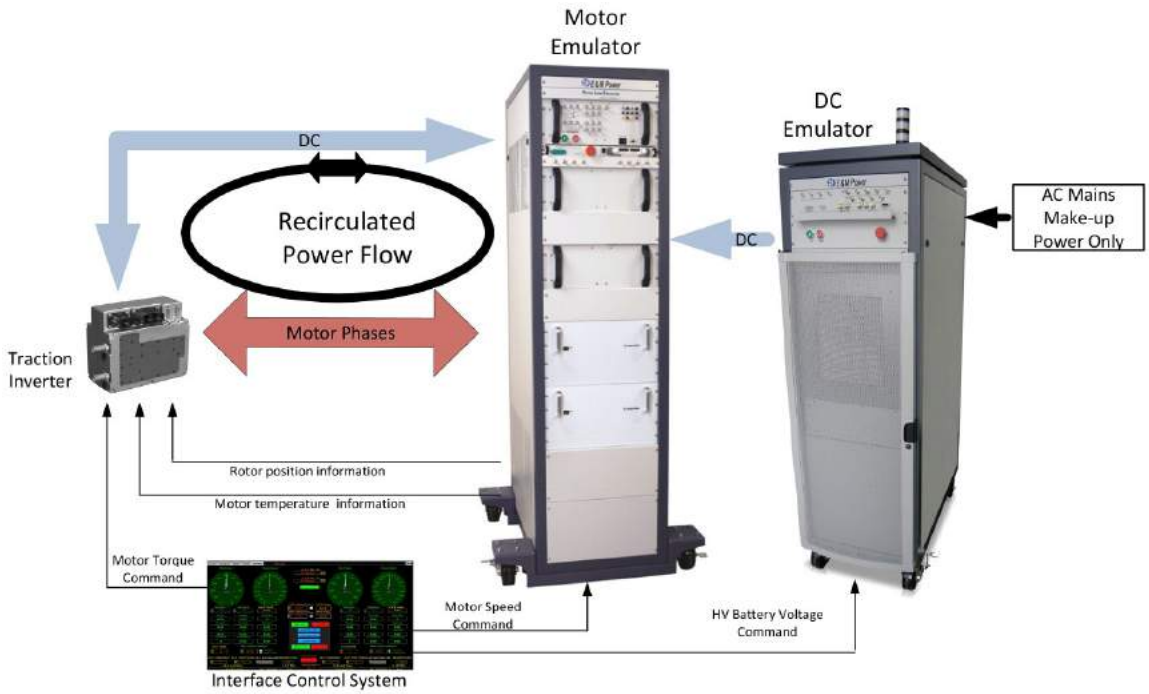
⑤ Dimensions and weights are for reference and are subject to change. Tower Light adds 6 inches and is shipped uninstalled.

Possible Application Gen3

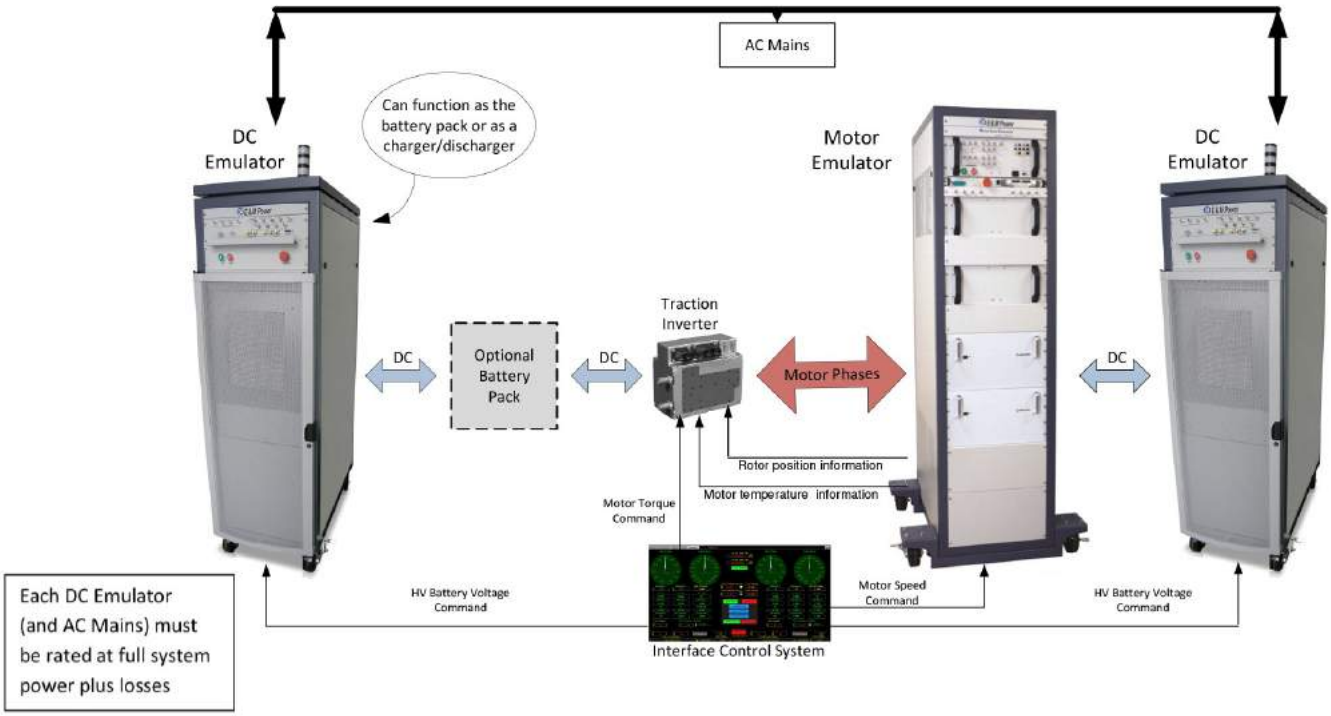
- Battery Emulator (Standard ALE has internal HV DC Supply)



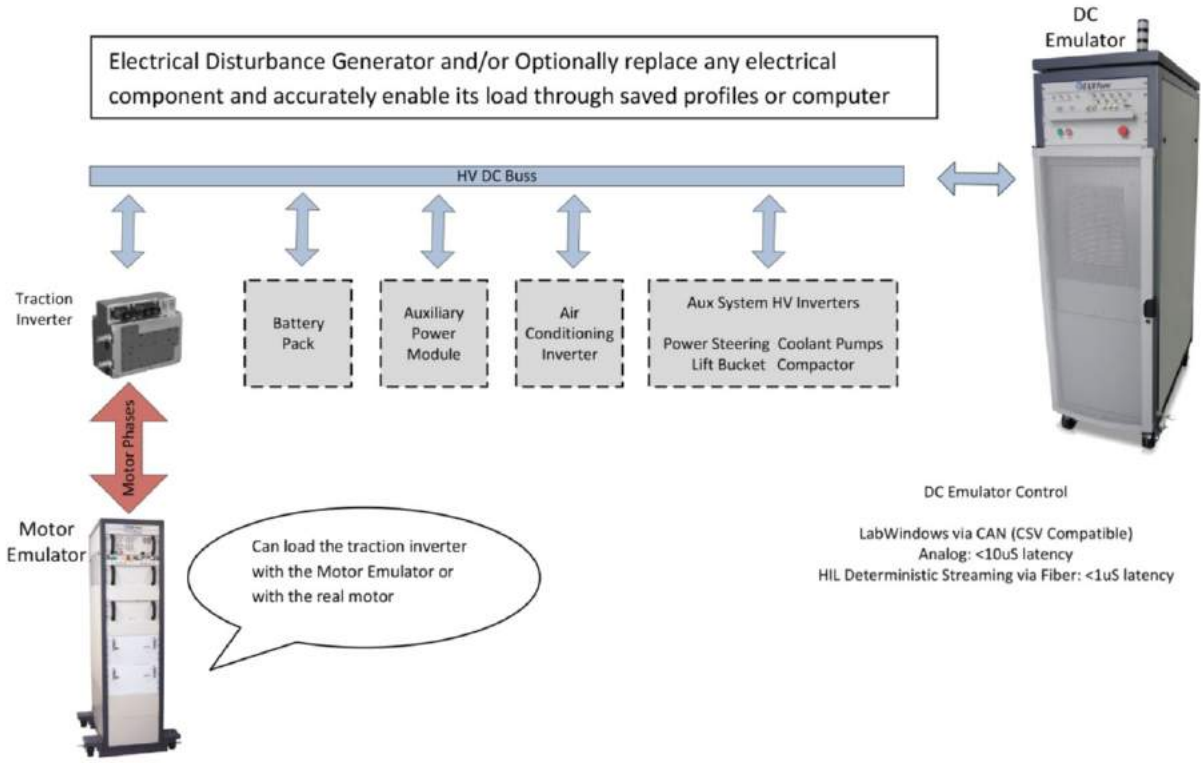
- Option to replace to internal HV DC SUPPLY with DC EMULATOR



- Power Recirculation through Mains enables the inclusion of Real Battery Pack



- Full Vehicle Systems Integration Testing of Component Compatibility



EPT SERIES

xEV E-Motor Dynamometer (Patented Dual Motor Conventional Single Motor)

Feature

- Simple-to-use and configurable user interface(GUI)
- Complete access to all measured raw data and calculated values for complete plotting flexibility via D&V's plot engine and tool set
- Testing scripts allow flexibility in creating exacting test profiles
- Traction motor speeds exceeding 25,000 RPM, torque levels to over 1300Nm, and BSG/ISG acceleration requirements up to 5000 rad/s^2

BSG SERIES

Belt Starter Generator (48V Mild Hybrid EV System Test)

Feature

- Air or water/glycol cooled
- Multiple torque measurements methods
- Variety of thermal requirements
- Highly accurate and flexible power supplies

Specifications

BSG-72	BSG-150	BSG-186	BSG-262
Measures both belt torque and direct drive torque	Two-up endurance testing with automatic belt tensioning	Performance, warranty, low volume production in one tester	High volume production tester
With or without a thermal chamber	Chamber ramp : 6°C/min	Optional belt or direct drive torque measurement	Flexible configurations for assembly lines
DUT speeds to 24,000 rpm	DUT voltage range : 8-80VDC	Load bank and starter power supply or DC-DC regen power supply	Accuracy 0.05% or better for all major parameters
DC recirculative supplt	DUT peak current : up to 500A		DUT test time approximately 20 seconds

BCT-150

Premium Battery Cell Tester

Feature

- Full automatic switching between 3 test modules
  : Cycler module, High Frequency Signal module and Coulombic Efficiency module
- Coulombic measurement reading up to 10 ppm
- 200KHz high frequency signal module
- Expandable system, up to 16 cycle modules

Technical Data

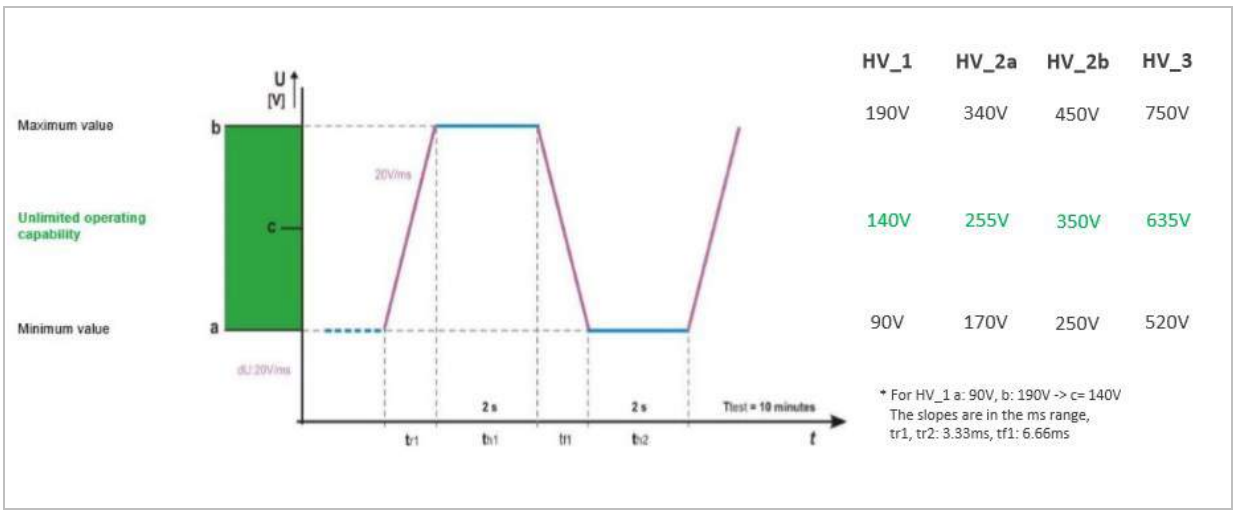
	Cycler	EIS	Columbic
Voltage Range	1 – 6 V	1 – 6 V	1 – 6 V
Max. Current	100 A	5 A	2 A
Parallel Connections	√	x	x
Voltage			
Control Resolution	3 mV	3 mV	1.8 mV
Measurement Resolution	1 mV	1 mV	1uV
Accuracy	± 0.02% FSR	± 0.02% FSR	10 ppm*

	Cycler	EIS	Columbic
AC Input Votlage	230Vac 1ø		
Software Platform	BCT - PRO		
Current			
Range	5A/25A/ 100A	5A	2A/5A
Control Resolution	2.5 mA/12.5 mA/100mA	2.5 mA	1.6 mA / 1.5 mA
Accuracy	± 0.02% FSR	± 0.02% FSR	10 ppm*
Bandwidth	-	0 ~ 50 kHz	-

Test Application for HV System

Unlimited Opeating Capability

- Requirement : See section 6.3.3.2 "Range of unlimited operating capability"
- Test type : Product validation, 3 cycles, 3 samples
- Test method : Measurement

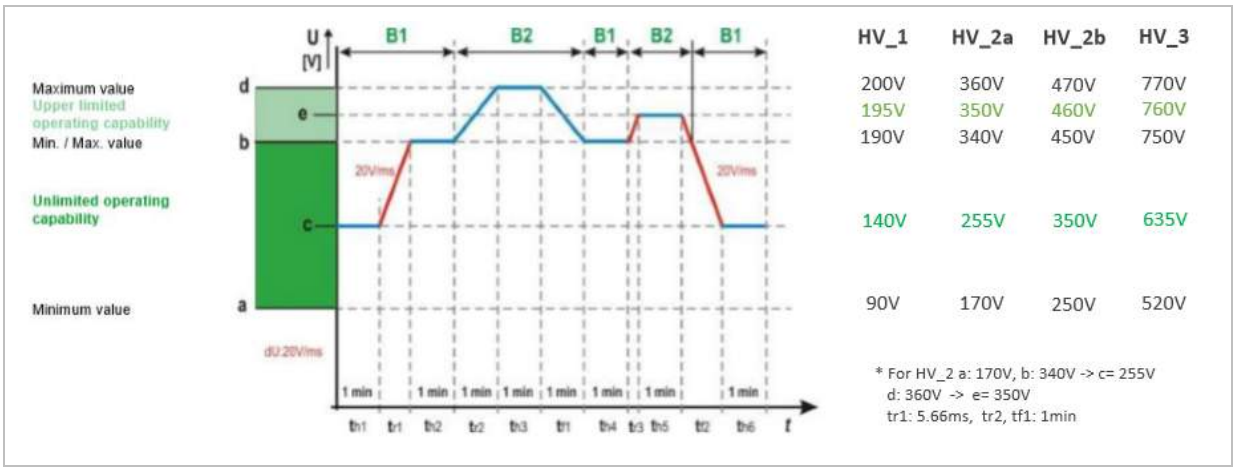


	HV_1	HV_2a	HV_2b	HV_3
	190V	340V	450V	750V
	140V	255V	350V	635V
	90V	170V	250V	520V

* For HV_1 a: 90V, b: 190V -> c= 140V
The slopes are in the ms range,
tr1, tr2: 3.33ms, tf1: 6.66ms

Upper Limited Operating

- Requirement : See section 6.3.3.3 "Range of upper limited operating capability"
- Test type : Product validation, 3 cycles, 3 samples
- Test method : Measurement

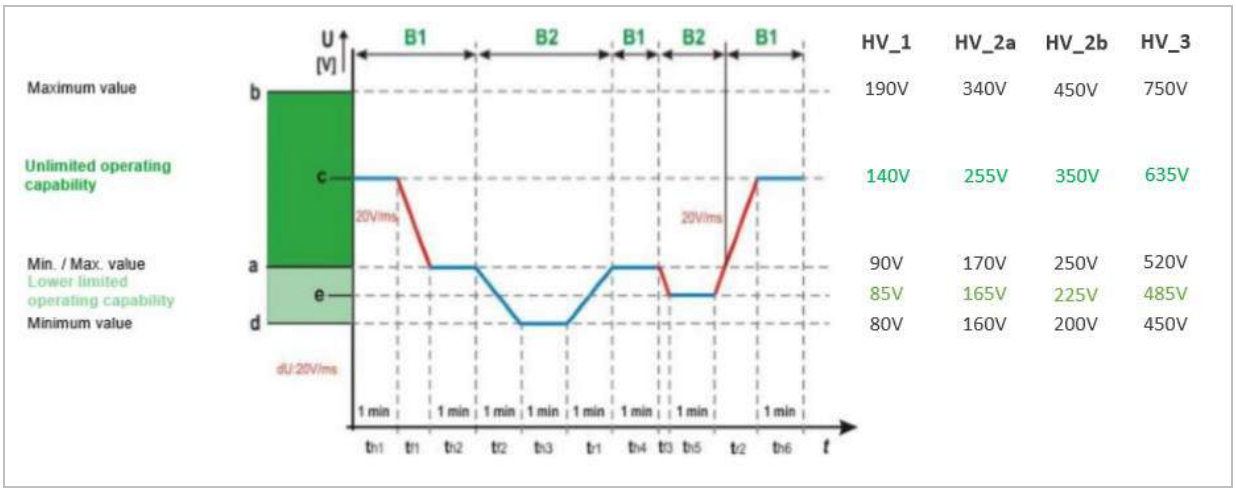


	HV_1	HV_2a	HV_2b	HV_3
	200V	360V	470V	770V
	195V	350V	460V	760V
	190V	340V	450V	750V
	140V	255V	350V	635V
	90V	170V	250V	520V

* For HV_2 a: 170V, b: 340V -> c= 255V
d: 360V -> e= 350V
tr1: 5.66ms, tr2, tf1: 1min

Lower Limited Operating Capability

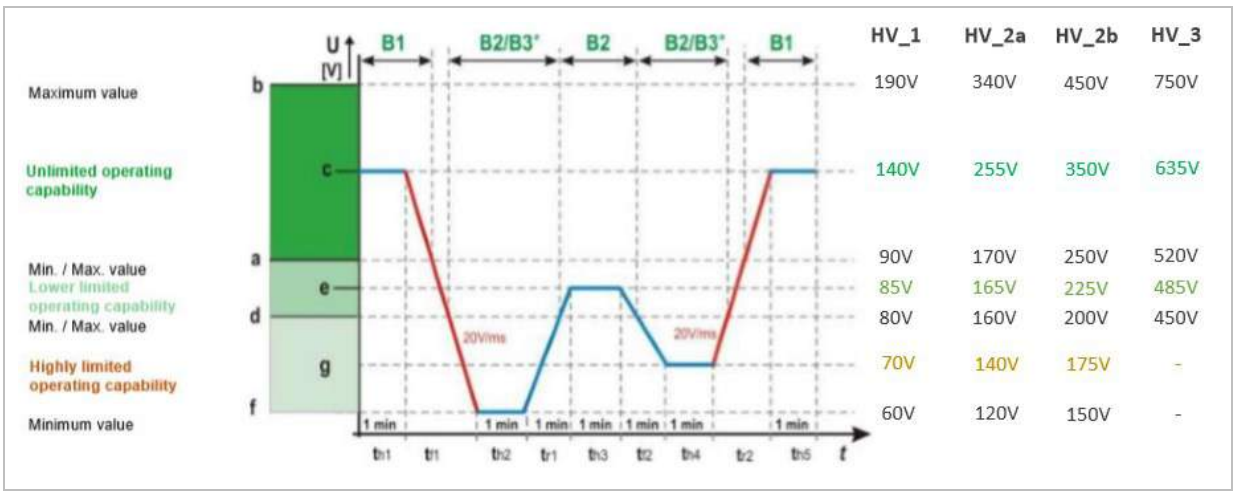
- Requirement : See section 6.3.3.4 "Range of lower limited operating capability"
- Test type : Product validation, 3 cycles, 3 samples
- Test method : Measurement



	HV_1	HV_2a	HV_2b	HV_3
Maximum value	190V	340V	450V	750V
Unlimited operating capability	140V	255V	350V	635V
Min. / Max. value	90V	170V	250V	520V
Lower limited operating capability	85V	165V	225V	485V
Minimum value	80V	160V	200V	450V

Highly Limited Operating Capability

- Requirement : See section 6.3.3.5 "Range of highly limited operating capability"
- Test type : Product validation, 3 cycles, 3 samples
- Test method : Measurement



	HV_1	HV_2a	HV_2b	HV_3
Maximum value	190V	340V	450V	750V
Unlimited operating capability	140V	255V	350V	635V
Min. / Max. value	90V	170V	250V	520V
Lower limited operating capability	85V	165V	225V	485V
Min. / Max. value	80V	160V	200V	450V
Highly limited operating capability	70V	140V	175V	-
Minimum value	60V	120V	150V	-

Voltage Dynamics

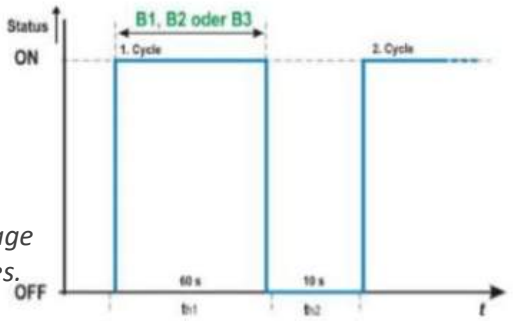
- Requirement : See section 6.3.4.2 “Voltage dynamics"
- Test type : Product validation, 10 cycles, 3 samples
- Test method : Measurement

It shall be verified that the HV operating status of the HV component in the respective operating voltage range does not change due to generated voltage dynamics (slope).

Test Generated voltage dynamics

Compliance with the maximum generated/present voltage dynamics (slope) shall be verified for all operating modes.

The test pulse in accordance with "Test pulse generated voltage
dynamics" and the specifications for voltage dynamics



* Figure 1. Test pulse generated voltage dynamics

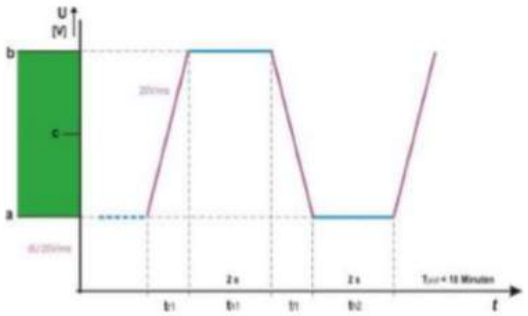
Test Generated voltage dynamics (slope) between two different steady state voltage levels (holding time > 2 s), generated by individual HV component:
Value: **+/- 15 V/ms** for HV_1, HV_2a/b and HV_3

- Requirement : See section 6.3.4.2 “Voltage dynamics"
- Test type : Product validation, 10 cycles, 3 samples
- Test method : Measurement

Present voltage dynamics

The test shall be verified in HV operating mode B1, B2, B3 Robustness with regard to the maximum present voltage dynamics (slope) shall be verified for all HV components by means of appropriate measurements. The specifications for the voltage dynamics in "Dynamic parameters" shall be used.

It shall be verified that the HV operating status of the HV component in the respective operating voltage range does not change due to present voltage dynamics (slope).



Test Generated voltage dynamics (slope) between two different steady state voltage levels (holding time > 2 s), generated by individual HV component:
Value: **+/- 20 V/ms** for HV_1, HV_2a/b and HV_3

Present Voltage Ripple

- Requirement : See section 6.3.4.3 “Voltage ripple"
- Test type : Product validation, 1 cycles, 3 samples
- Test method : Measurement

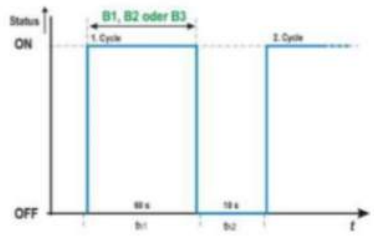
Test generated voltage ripple

For every HV component controlled by power electronics, evidence shall be provided that the generated voltage ripple in HV system operation with and without HV battery (switching equipment HV battery switched on and off) in accordance with "Dynamic parameters" is fulfilled.

The frequency response shall be documented by the supplier.

The test set-up shall be documented in detail, including line inductances, line capacitances, on-board electrical system equivalent capacitances and line resistances.

Parameter	All HV voltage operating ranges HV_1, HV_2a/2b, HV_3
Present and generated Voltage ripple with HV battery switched on	± 8 V pk



HV Component	Operating mode
DC/ DC-converter HV/LV	Boost Mode / Buck Mode
Drive system power electronics	Engine- / Generator mode
On-board charger,	HV-System (ext. el. Power supply)
Other HV component, HV battery	Load mode

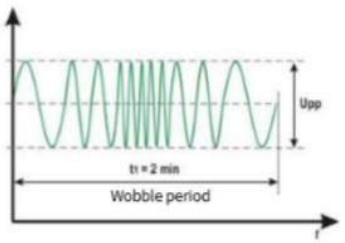
Present Voltage Dynamics

- Requirement : See section 6.3.4.3 “Voltage ripple"
- Test type : Product validation, 1 cycles, 3 samples
- Test method : Measurement

Test generated voltage ripple

For every HV component, robustness and stable operation shall be provided when there is a voltage ripple present during the operation of the HV system with and without an HV battery (switching equipment switched on/off) in accordance with Table 4 "Dynamic parameters".
The present HV voltage U without ripple is at the relevant upper limit of each HV voltage range.

Test duration : 30 min
Frequency range : 15 Hz – 20 kHz
Wobble period : 2 min
Wobble type : triangular logarithmic
UPP : 16 Vpp or 30 Vpp

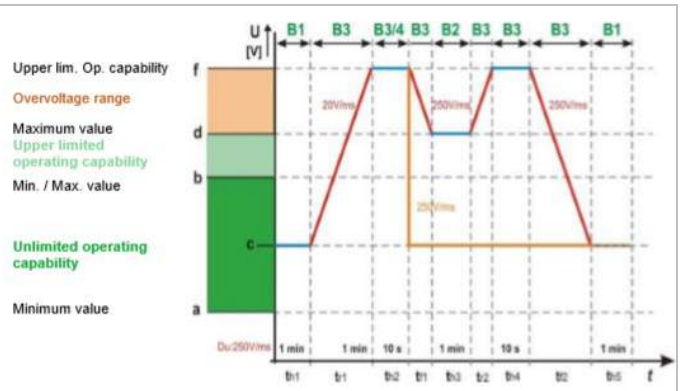


Parameter Table 4	All HV voltage ranges HV_1, HV_2a/2b, HV_3
Present and generated Voltage ripple with HV battery switched on	± 8 V pk
Present and generated Voltage ripple with HV battery switched off	± 15 V pk

Overvoltage

- Requirement : See section 6.3.5.1 "Overvoltage"
- Test type : Product validation, Cycles to be determined from the specified number of overvoltage events, 3 samples
- Test method : Measurement

It shall be verified that the required HV operating status for the range of unlimited operating capability is reestablished if the DC HV voltage exceeds the max. operating voltage and then falls again below the maximum operating voltage.



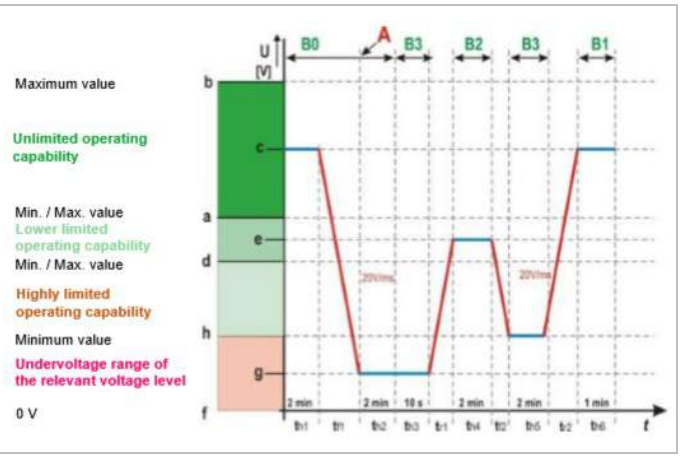
For the HV battery the voltage increase for the test pulse overvoltage shall be effected with the max. slope 20V/ms in accordance with "Dynamic parameters" up to the time when the switching equipment switches off. Then, i.e. with the switching equipment switched on, the voltage increase and decrease shall be performed with the maximum voltage dynamics with 250V/ms in accordance to "Maximum voltage dynamics".

Undervoltage

- Requirement : See section 6.3.5.2 "Undervoltage"
- Test type : Product validation, 2 cycles, 3 samples
- Test method : Measurement

Compliance with the HV operating status B3 shall be verified.

The test shall be used to verify that the maximum intended performance or the HV operating status B1 and B2 is complied with again when the DC HV voltage falls within the range of unlimited operating capability again after a deviating characteristic.

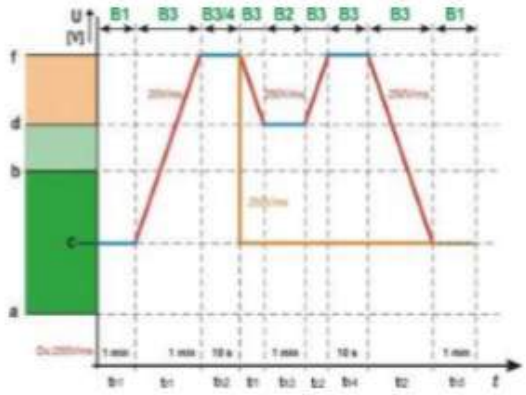


Load Dump and Voltage Limiting

- Requirement : See section 6.3.5.3 "Load dump and voltage limiting"
- Test type : Product validation, 2 cycles, 3 samples
- Test method : Measurement

a) Product validation

The test for the required behavior of an HV component during present overvoltage during load dump is covered by the „"Overvoltage „ test. No separate test is required. The test for control measures for voltage limitation during load dump shall be carried out for the HV components by the OEM. The effectiveness of the voltage limiting function shall be verified for operation at maximum load and subsequent load dump.
An appropriate test procedure shall be documented by the supplier and agreed upon with the OEM.



b) 100% standard prodction test

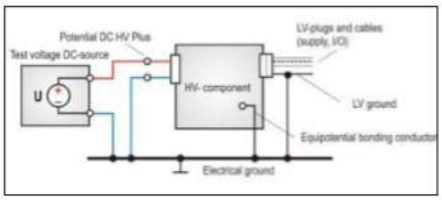
The control measures for voltage limiting during load dump shall be verified within the scope of functional tests. This test may be performed within the scope of the agreed functional test. An appropriate test procedure shall be specified by the supplier and agreed upon with the OEM.

Test Voltage Offset

- Requirement : See section 6.3.8 "Voltage offset"
- Test type : Product validation, 2 cycles, 3 samples
- Test method : Measurement

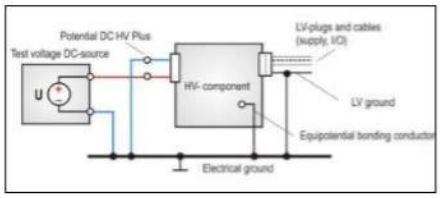
Test step 1a :

A test voltage U with the value of the upper voltage of the unlimited operating capability shall be applied between the positive DC HV potential of the HV component and the electrical ground of the test setup for a period of at least 600 s.
The negative DC HV potential of the HV component shall be connected with the electrical ground of the test setup.



Test step 1b :

A test voltage U with the value of the upper HV circuit limit voltage shall be applied between the positive DC HV potential of the HV component and the electrical ground of the test setup for a period of at least 10 s or a period agreed between the supplier and the OEM.
The negative DC HV potential of the HV component shall be connected with the electrical ground of the test setup.



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