

MELEC`s PULSE BOOK

basic drawings and applications

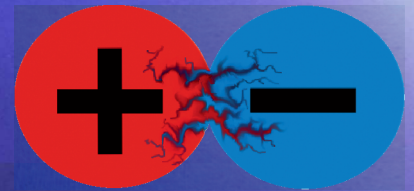
first EDITION

DC Pulse Power Controller for synchronized applications:

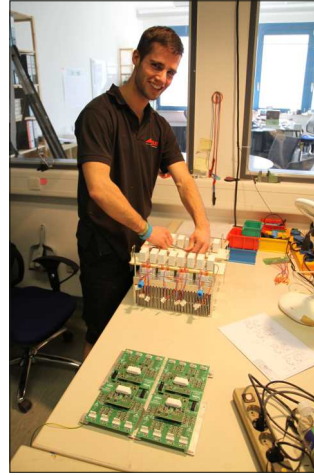
- HiPIMS
- Mid Frequency
- Pulsed Bias

Superimposed Processes:

- HiPIMS + DC
- HiPIMS + MF
- HiPIMS + MF + Pulsed Bias



Company



Located in south Germany MELEC is producing and developing DC Pulse Controller for plasma applications since 1998. With the experience of over 15 years in power electronics and thin-film technology MELEC became standard in R&D and industry applications.

MELEC products are utilized for the generation of highly-ionized plasma discharges, called HiPIMS. Our generators are the costumers tool to meet their high requirements of pulsed plasma applications, well adapted for the future because of their high flexibility and stability. The integrated Free Pulse Pattern Generator (FPPG) makes it possible to develop, adjust and stabilize wide ranges of innovative processes.

On basis of our international patent right registrations the MELEC cooperated in a large number of publications of well-known institutes and universities.

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MELEC`s Know How Fits Customers Needs

Consuting

MELEC provides with his products a high performance pulse power plasma consulting for Research and industrial applications worldwide.

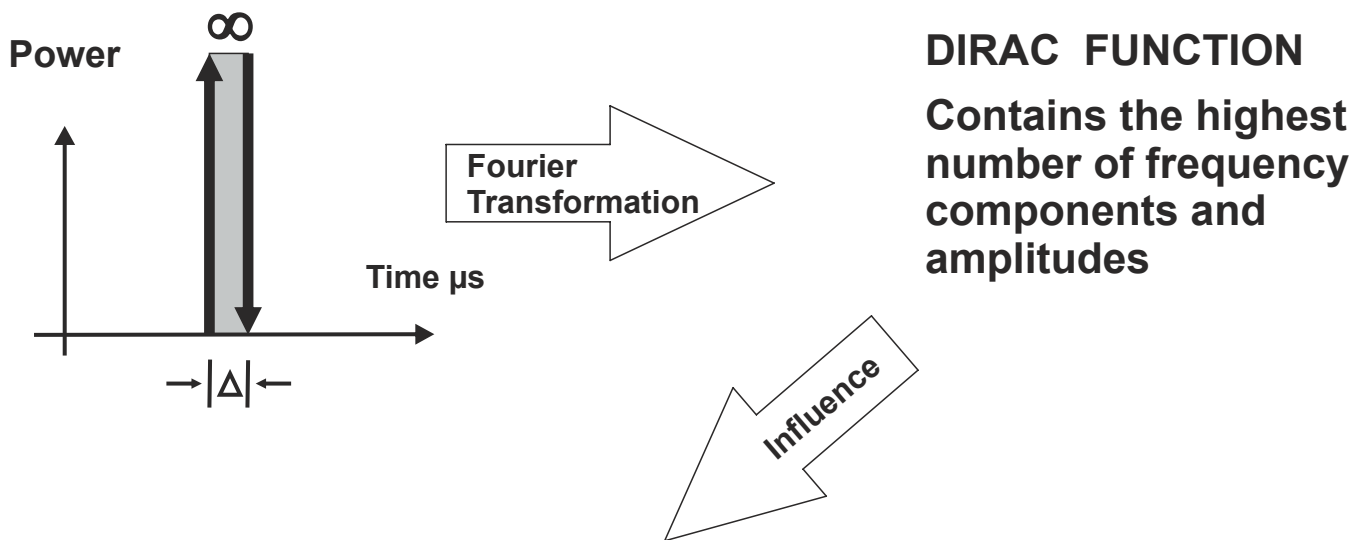
Our Mission

MELEC`s SIPP – TECHNOLOGY (Super Impose Pulse Power - TECHNOLOGY) using HiPIMS (High – Power Impulse Magnetron Sputtering) combined with DC, Mid-frequency or rf – 13,56 MHz (BIAS) opens a new latitudes / horizons in the pulse plasma technology. The development of MELEC`s pulse power controller is focused and going straight ahead forward in such kind of technology to create new additional features and advantages.

Our Quality Aspiration

MELEC is a synonymous for quality with a high level of conditions at ourselves. Our goal is for our customer to be the business base on their technical requirements of pulse plasma application to provide solutions with our advantage of SIPP -Technology. We work out solutions and implement them together with the workforce. This ensures that the solutions are readily accepted and sustainable.

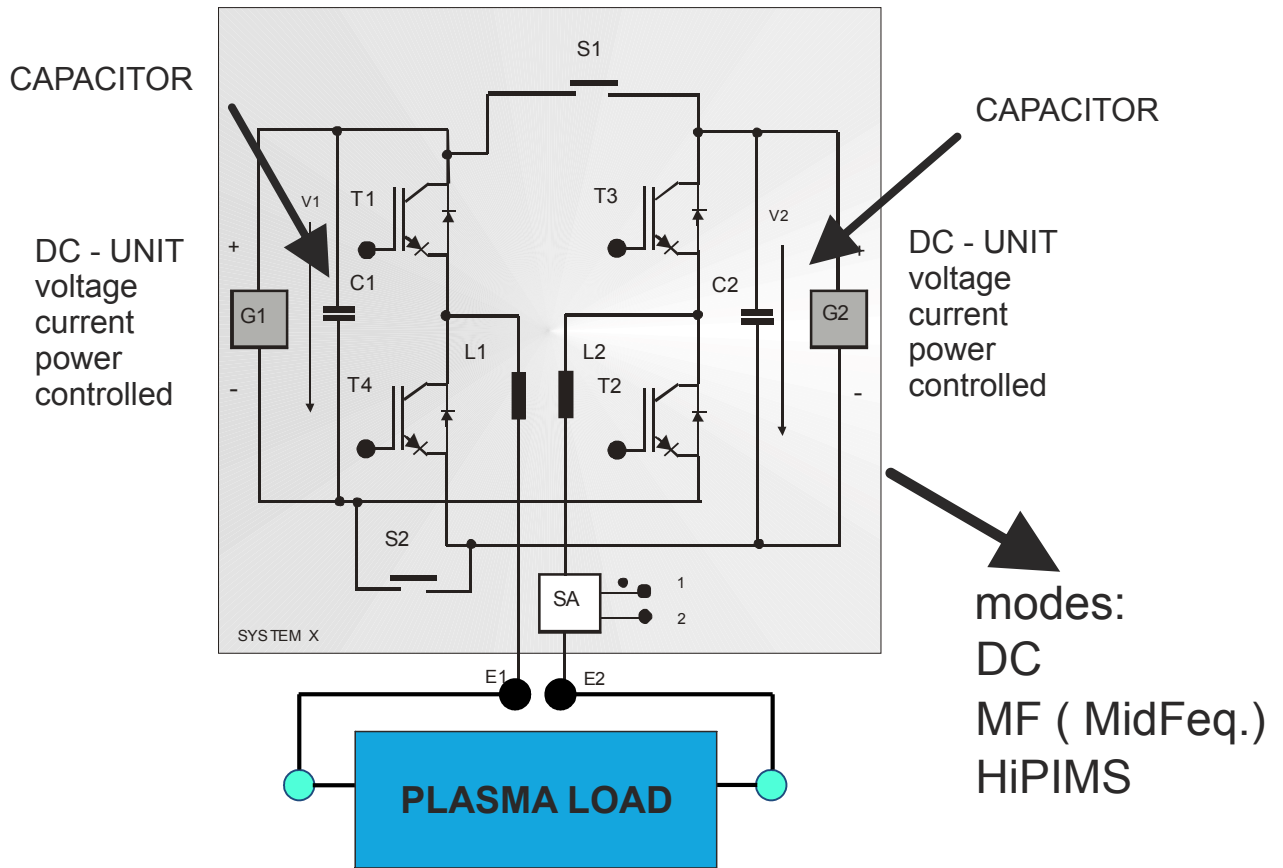
Our Philosophy About High Pulse Power Plasmatriement



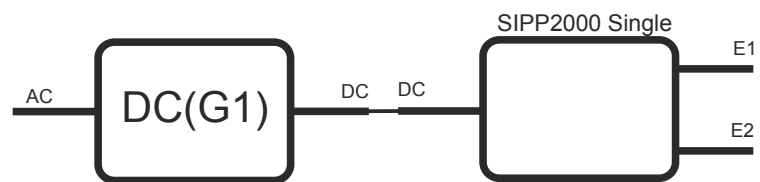
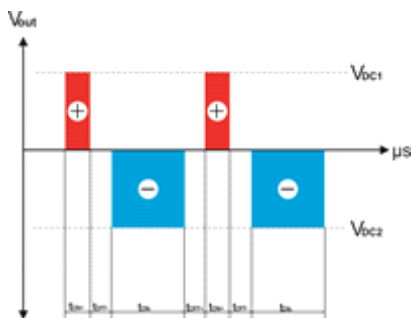
THIN FILM PROPERTIES

Advantages

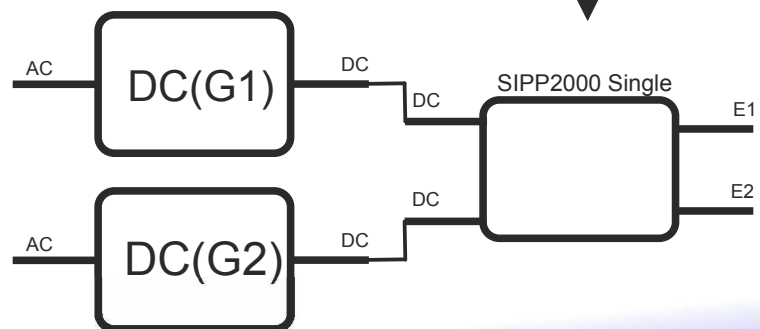
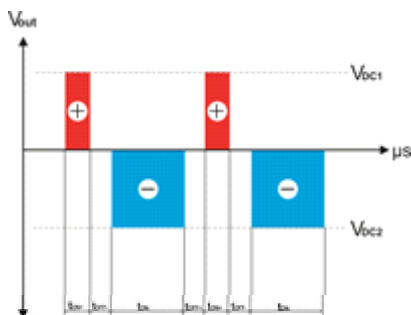
Symmetric / Asymmetric bipolar pulse pattern



SYMMETRIC: S1/S2 closed - G1 only



ASYMMETRIC : S1/S2 open- G1/G2



Single or Dual Magnetron applications

Applicable using CO – SPUTTERING (different target materials)

DC , unipolar ; bipolar pulse pattern

Interactively freely adjustable pulse pattern duration (pos. and /or negative pulses)

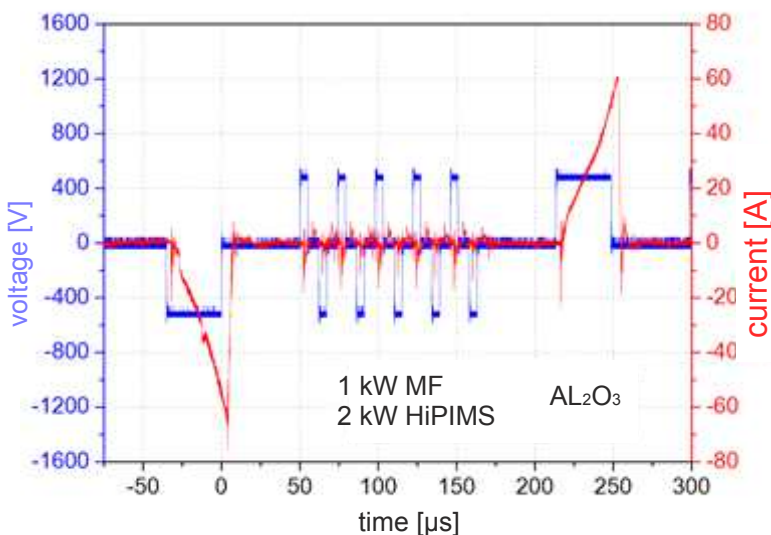
MELEC's: SIPP – Technology

Highest deposition rate using HiPIMS combined with DC or

Mid-Frequency so called **SIPP** – Technology **S**uper **I**mposed **P**ulse **P**ower Technology. Open new latitudes /horizons in the plasma technology.

Reducing of ARCING using pulse package mode instead of pure HiPIMS – mode only.

Avoidance and prevention of poisoning using HiPIMS – BP combined with Mid-Frequency-BP



Superimposed HiPIMS (BP) and MF (BP)

Separation of Metal – and Gas – Ions:

Synchronization or phase shifted of pulsed BIAS voltage in relation to the HiPIMS Pulses – large power applications are ready for use to separate Metal- and Gas-Ions.

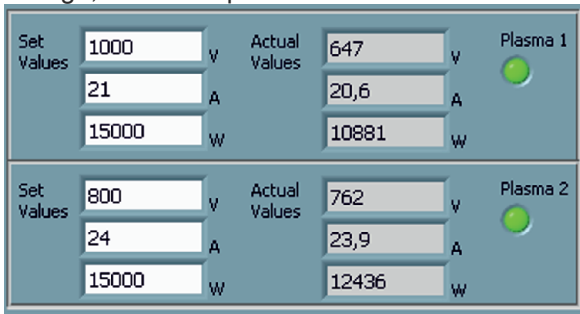
Synchronization or phase shifted of pulsed rf- 13,56 MHz voltage in relation to the HiPIMS Pulse – first test done with several 100Watts on a LAB –PVD coater – still under development.

Closed loop control

External pulse pattern INPUT on each channel of the MELEC pulse power unit using for a closed loop control is possible. For example using an external OES-System, etc. ...

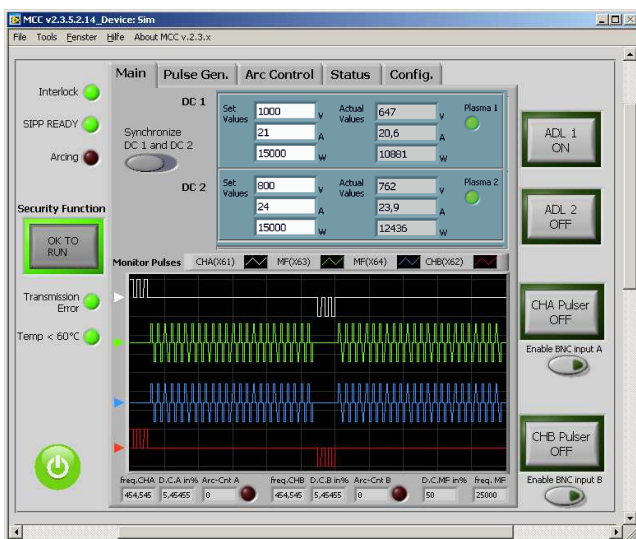
Software Modules of SIPP2000_USB Version using LabVIEW

DC 1, DC 2 controlled by setting values of voltage, current or power



Features of software:

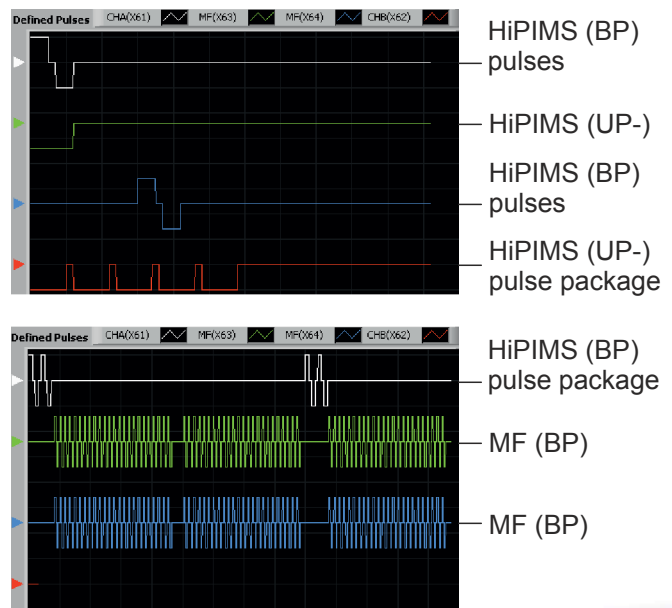
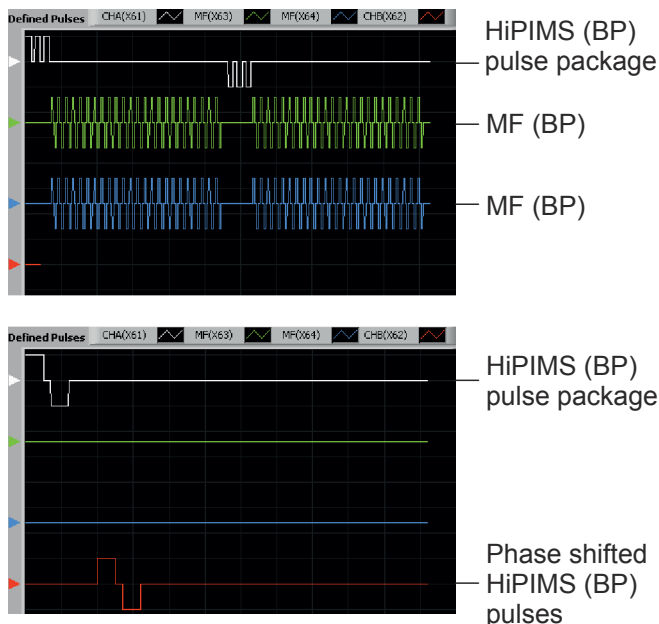
- Full control of HiPIMS Pulse Unit
 - Interactively configurable Pulse Waveform
 - Saving and Loading of Pulse Waveforms
 - Freely adjustable ARC Management
 - Monitoring of all status signals
- Synchronized Pulse Generation output for external triggering of additional MF unit
- Full control of ADL GmbH DC-Units or alternatively PNCL DUAL® DC-Units
 - Symmetric ON-OFF of two DC-Units
 - Set Point for voltage, current and power
 - Reading of DC-Unit working parameters
- Industrial security functions
 - Control software runs on Windows XP or higher versions



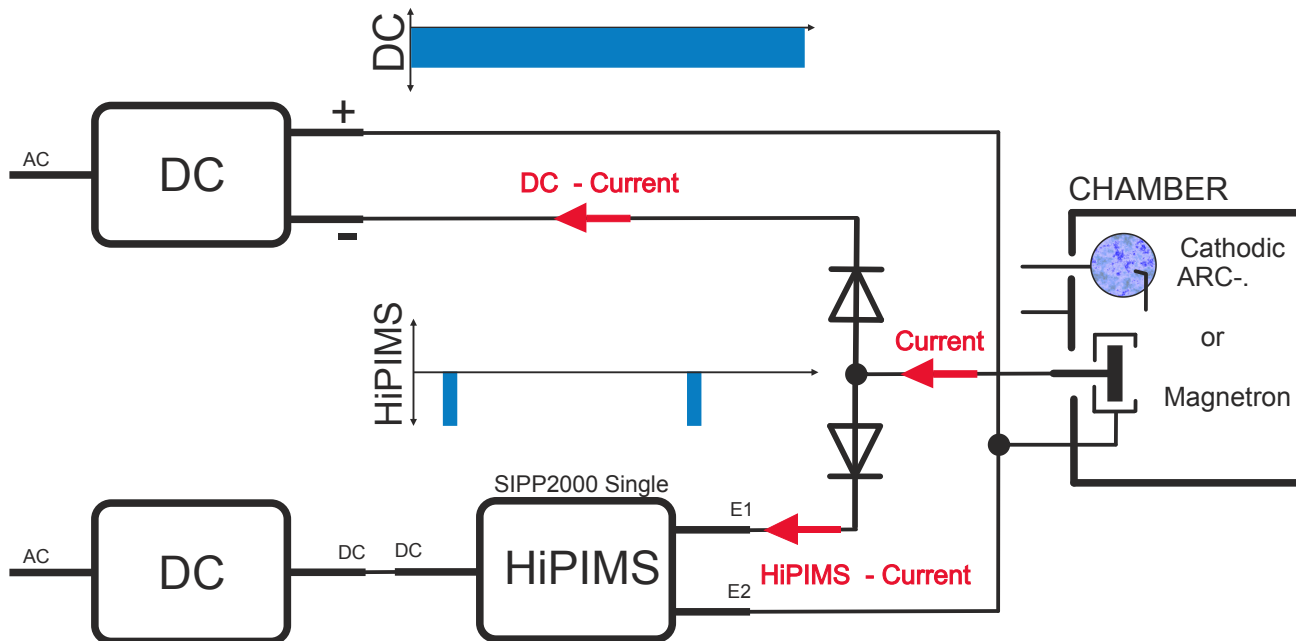
- DC 1 ON/OFF
- DC 2 ON/OFF
- Pulse Channel A ON/OFF
- Enable external pulse pattern Channel A
- Pulse Channel B ON/OFF
- Enable external pulse pattern Channel B



Example:



Superimposed DC / HiPIMS (UP) using Single Magnetron and Cathodic ARC

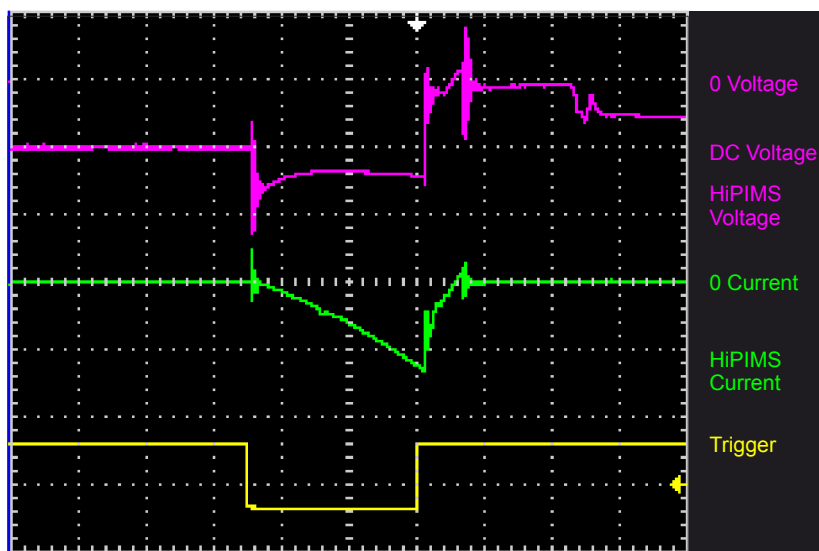


EXAMPLE OF APPLICATIONS:

- Large area coating on glasses
- Retrofit of existing inline coating systems
- applicable using single magnetron or cathodic ARC - deposition

ADVANTAGES:

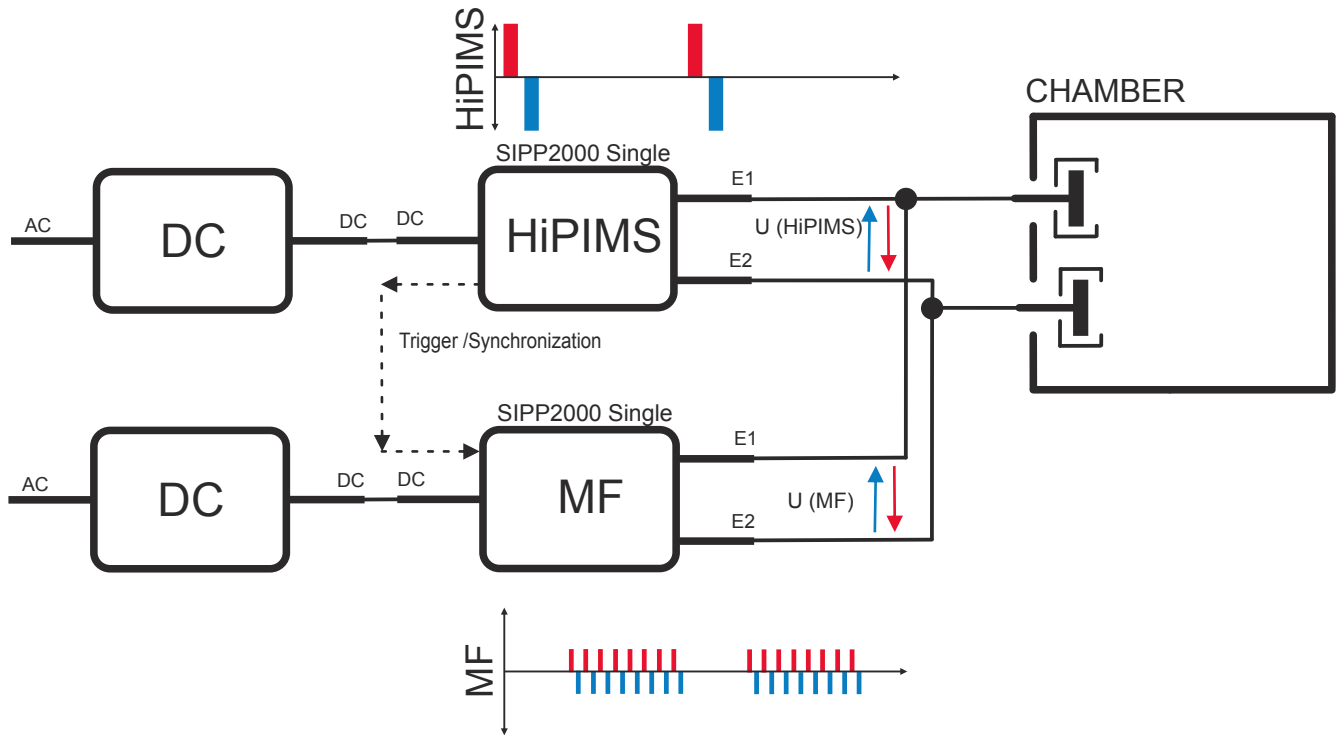
- Superimposed DC/HiPIMS(UP) with high depositions rate
- Smoother and denser films compare to DC sputtering
- low cost of retrofit
- easy control of single pulse or pulse packages



HiPIMS and DC

Patent Pending

Superimposed HiPIMS / MidFreq. (MF- BP)

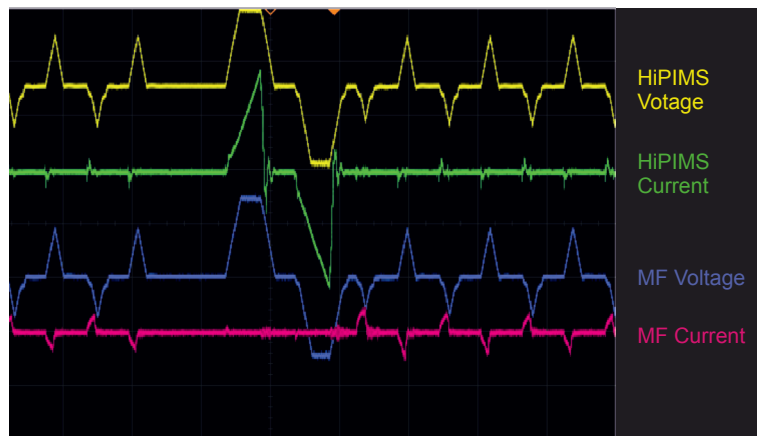


EXAMPLE OF APPLICATIONS:

- Large area coating on glasses

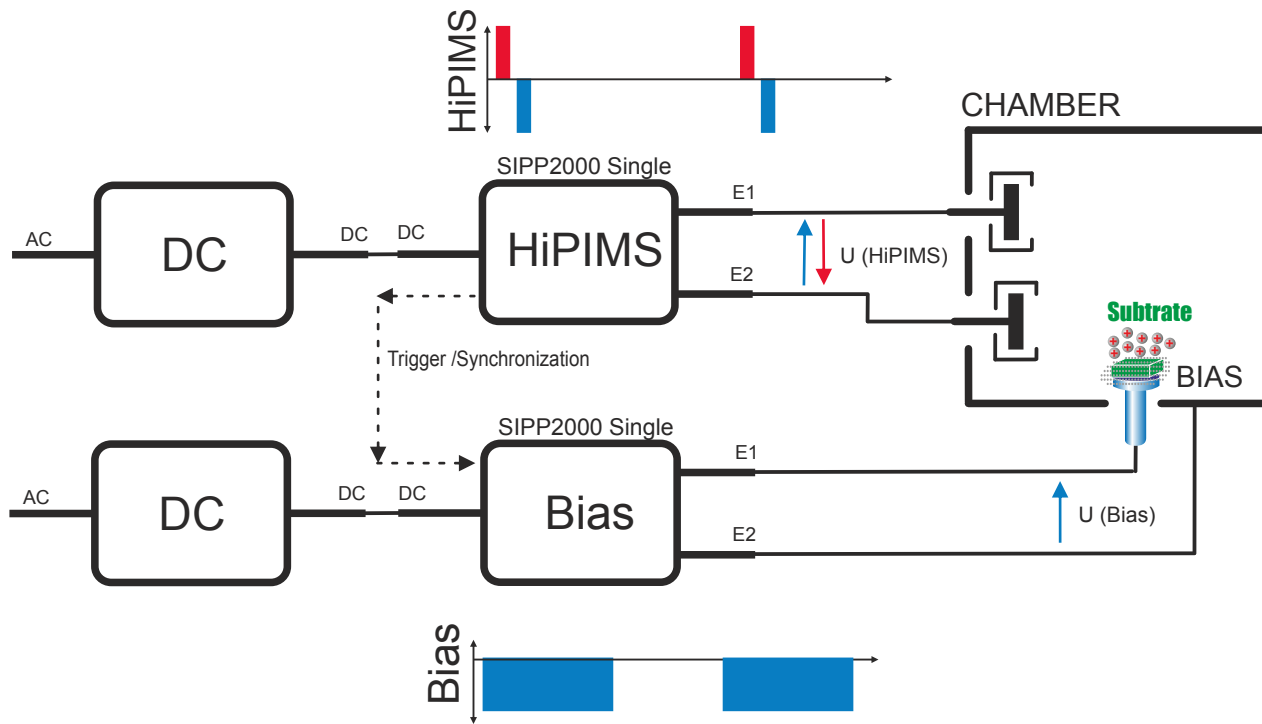
ADVANTAGES:

- Superimposed HiPIMS(UP)/Mid Frequency (MF-BP) with high depositions rate
- New process latitude
- Stable coating process
- Preventing of arcing and poisoning by control of Mid Frequency (BP)



Patent Pending

HiPIMS and MidFreq. (MF- UP) synchronized BIAS using conductive substrate



EXAMPLE OF APPLICATIONS:

- Hard and decorative coating using synchronized MF(UP) BIAS.
- synchronized or phase shifted to HiPIMS pulses

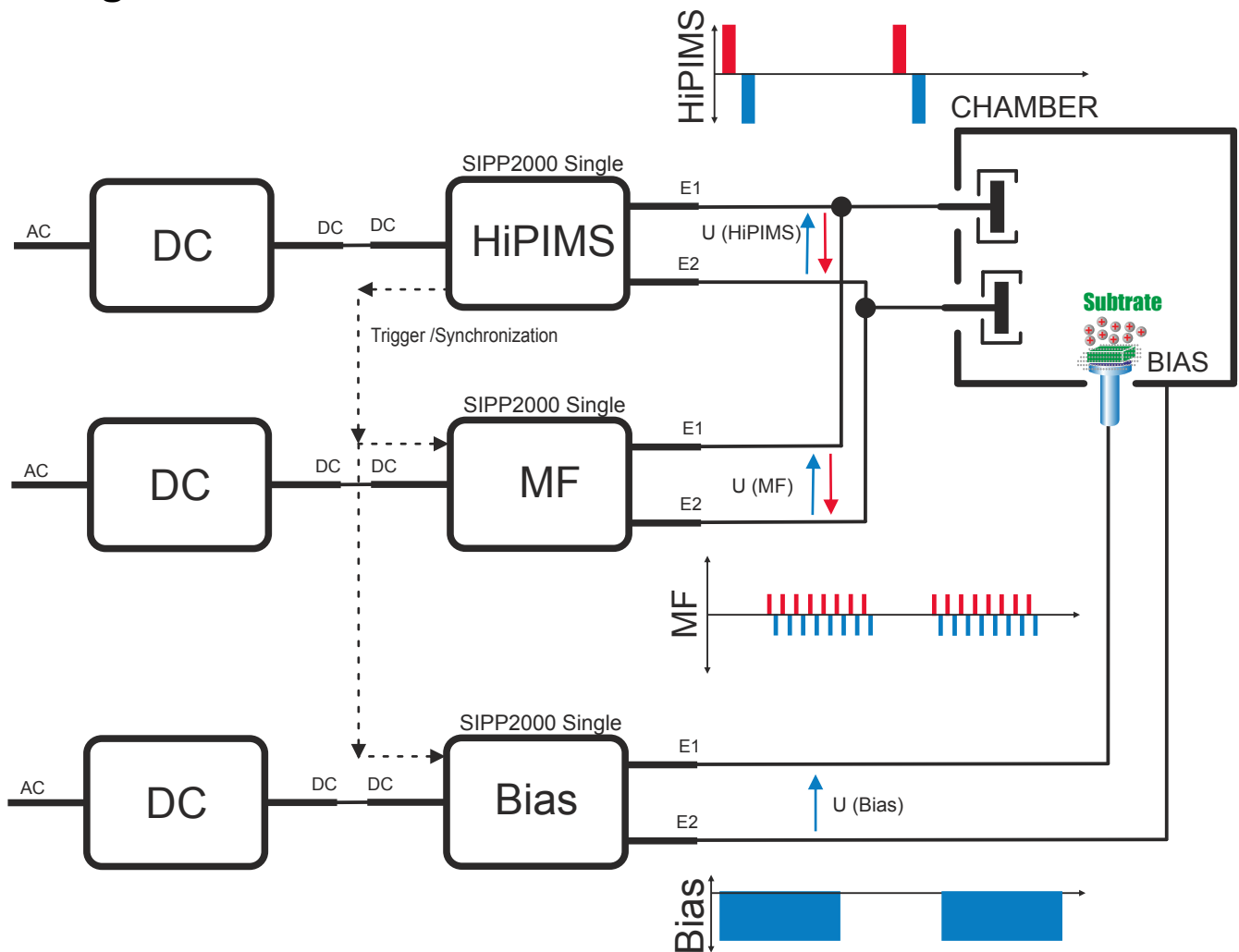
ADVANTAGES:

- Single- or Dual-Magnetron system application using conductive substrate allowed a variation and high performance of thin film structure deposition



Patent Pending

Superimposed HiPIMS (BP) / MidFreq. (MF- BP) and MidFreq.(MF- UP) synchronized pulsed BIAS using conductive substrate

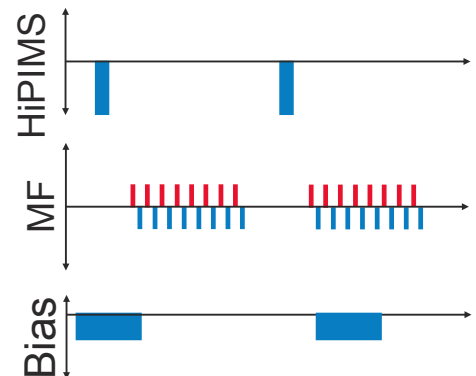


EXAMPLE OF APPLICATIONS:

- Hard and decorative coating using synchronized MF(UP) BIAS.
- synchronized pulsed BIAS or phase shifted to HiPIMS pulses

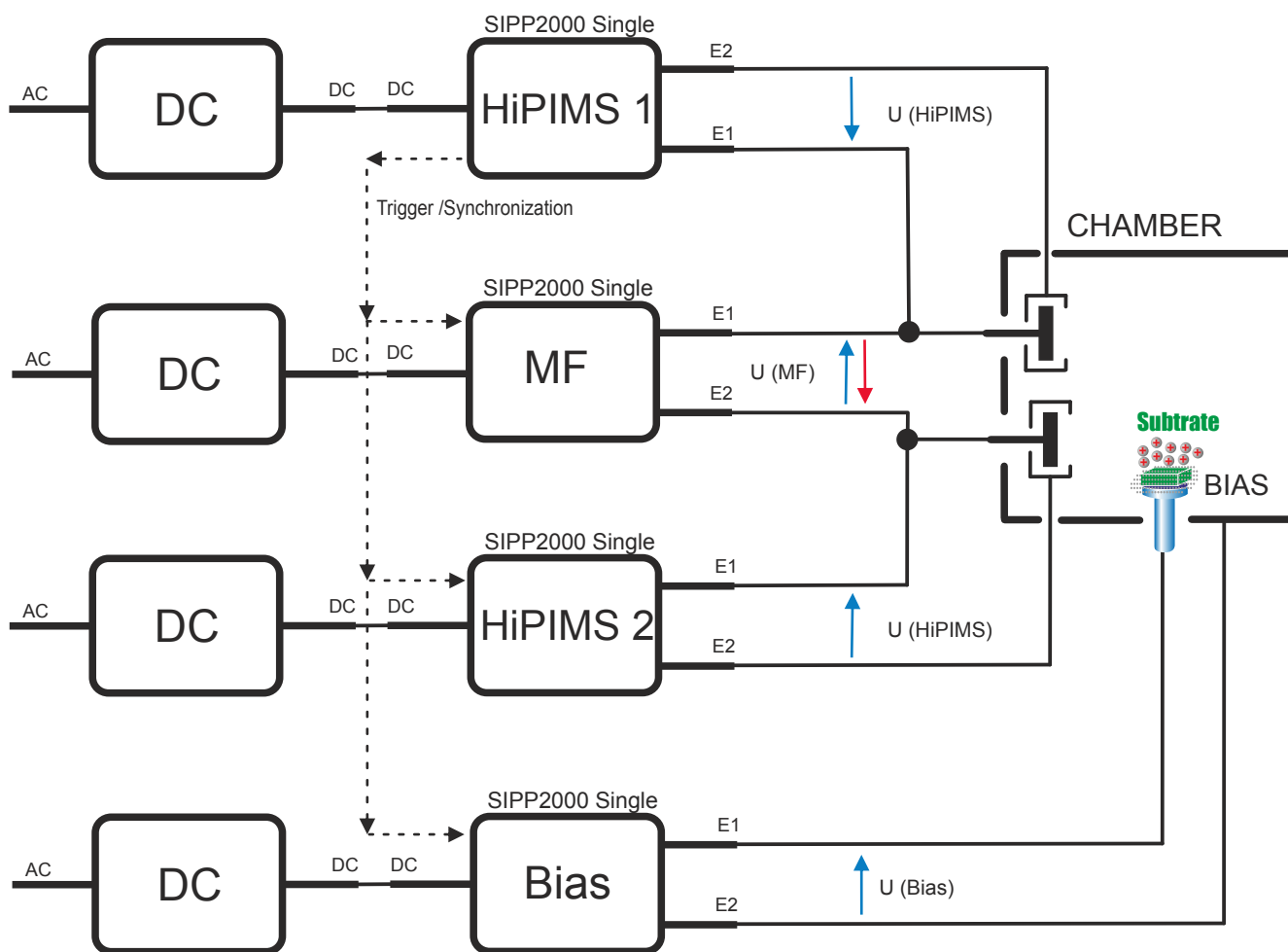
ADVANTAGES:

- Single- or Dual-Magnetron system application using conductive substrate allowed a variation and high performance of thin film structure deposition
- Superimposed HiPIMS(UP)/Mid Frequency (MF-BP) with high depositions rate
- New process latitude
- Stable coating process
- Preventing of arcing and poisoning by control of Mid Frequency (BP)



Patent Pending

Superimposed HiPIMS (UP) / MidFreq. (MF - BP) and MidFreq. (MF- UP) synchronized BIAS using conductive substrate

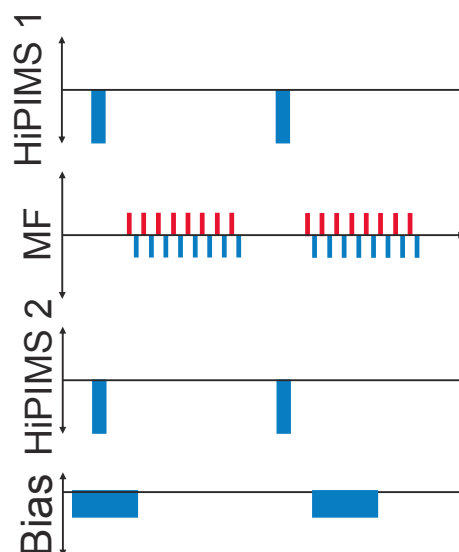


EXAMPLE OF APPLICATIONS:

- Hard and decorative coating using synchronized MF(UP) BIAS.
- synchronized pulsed BIAS or phase shifted to HiPIMS pulses

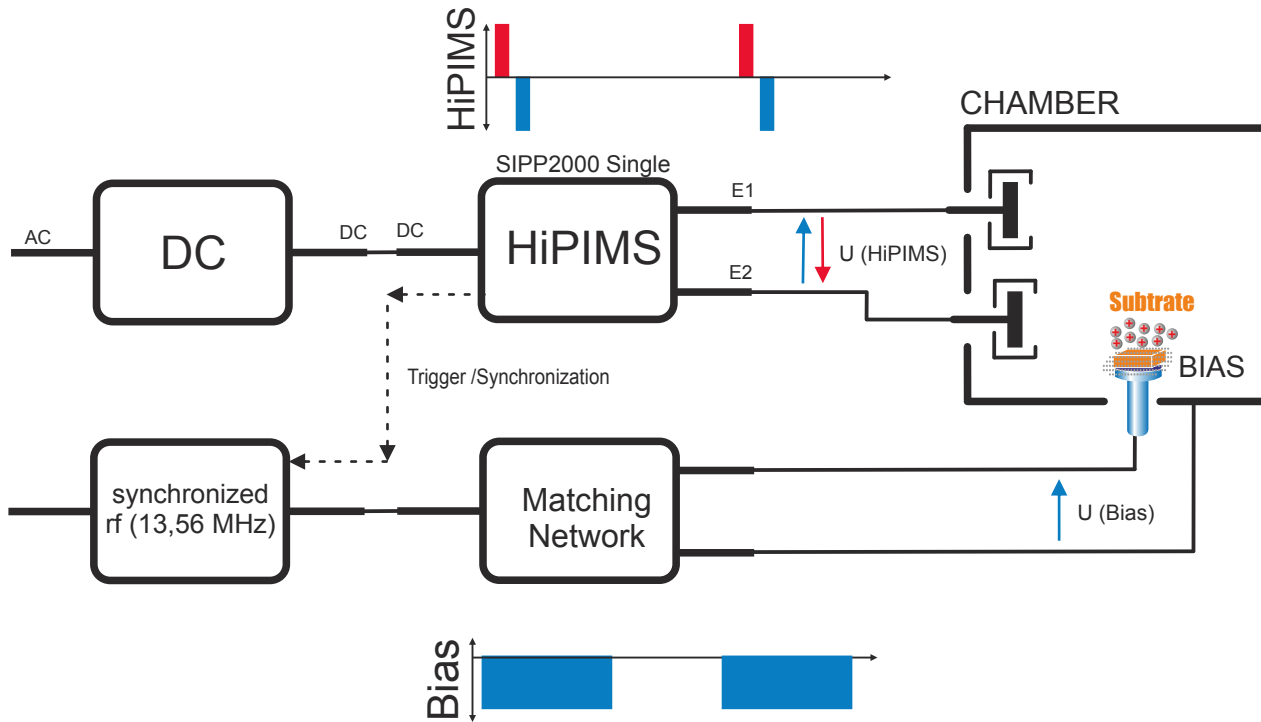
ADVANTAGES:

- Dual-Magnetron system application using conductive substrate allowed a variation and high performance of thin film structure deposition
- Superimposed HiPIMS(UP)/Mid Frequency (MF-BP) with high depositions rate
- New process latitude
- Stable coating process
- Preventing of arcing and poisoning by control of Mid Frequency (BP)



Patent Pending

HiPIMS (BP) and synchronized rf (13,56 MHz) BIAS using nonconductive substrate



EXAMPLE OF APPLICATIONS:

- CO-sputtering with dual magnetron system of two different target materials (Al, Cr) using Argon and N combined with synchronized rf (13,56 MHz) BIAS using nonconductive substrate
- HiPIMS pulse waveforms full synchronized with rf (13,56MHz) BIAS pulse
- HiPIMS waveform phase shifted with rf (13,56MHz) BIAS pulse

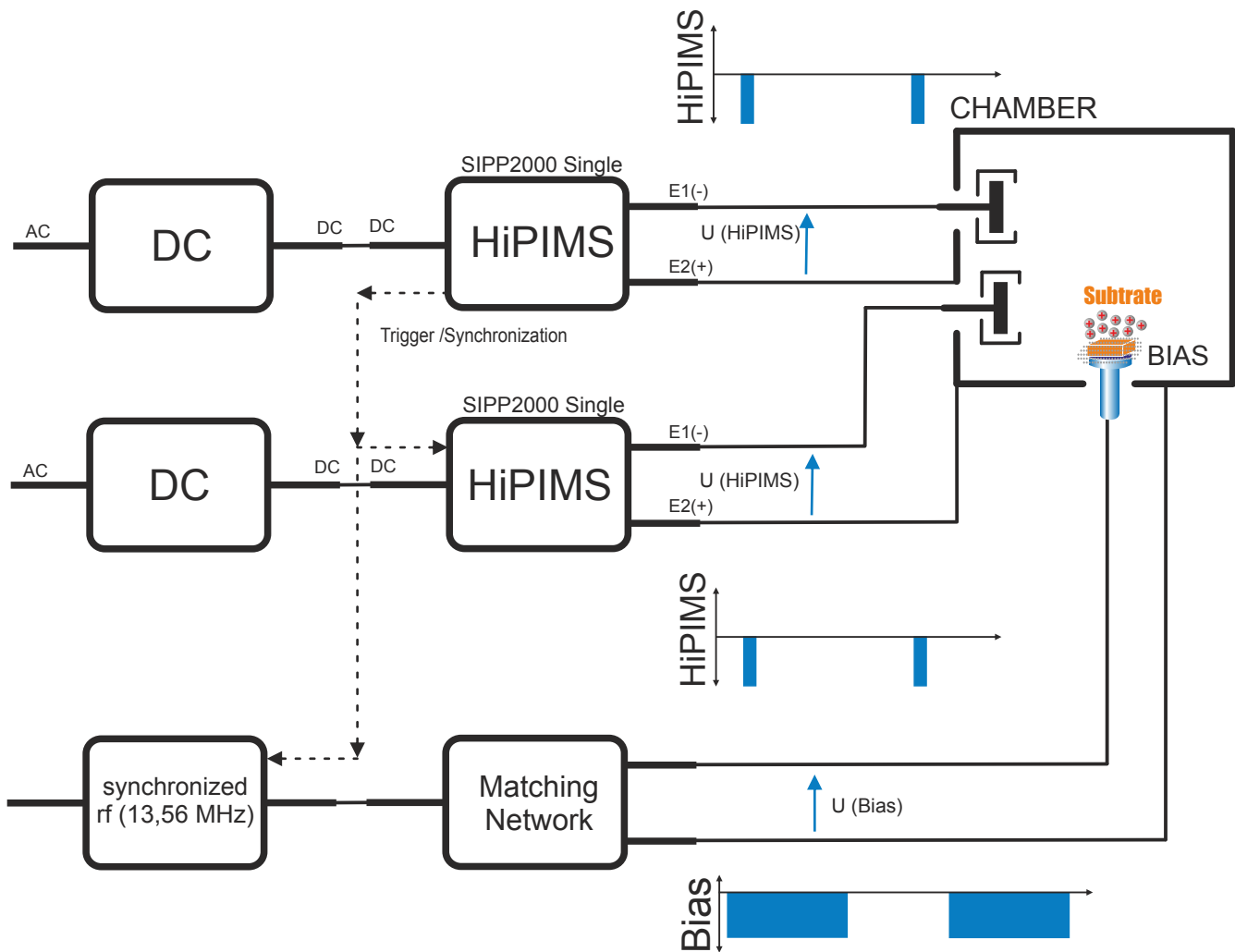
ADVANTAGES:

- New process latitude
- Stable coating process
- Preventing of arcing and poisoning by control of HiPIMS (BP) using pulse package of Al deposition and single pulse of Cr



Patent Pending

Superimposed HiPIMS (UP) and synchronized rf-BIAS (13,56 MHz) using nonconducting substrate



EXAMPLE OF APPLICATIONS:

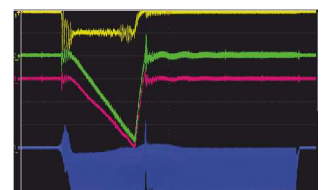
- CO-sputtering with two dual magnetron system of two different target materials (Al, Cr) using Argon and N combined with synchronized rf (13,56 MHz) BIAS using nonconductive substrate
- HiPIMS pulse waveforms full synchronized with rf (13,56MHz) BIAS pulse
- HiPIMS waveform phase shifts with rf (13,56MHz) BIAS pulse

ADVANTAGES:

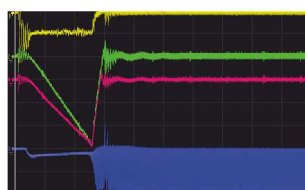
- New process latitude
- Stable coating process
- Preventing of arcing and poisoning by control of HiPIMS (BP) using pulse package AI



HiPIMS without BIAS



HiPIMS unit synchronized rf BIAS



HiPIMS unit pulse shifted synchronized rf BIAS

Patent Pending

SIPP2000 Single Version PLASMA DC PULSE POWER CONTROLLER



Features:

- Full control of MF Pulse Unit configured for 1 CH or 2 CH functionality
- Interactively configurable Pulse Waveform
- Saving and Loading of Pulse Waveforms
- Freely adjustable ARC Management
- Monitoring of all status signals
- Synchronized Pulse Generation output for external triggering of additional MF unit
- Full control of ADL GmbH DC-Units or alternatively PNCL DUAL® DC-Units
- Set Point for voltage, current and power
- Industrial security functions

SIPP2000USB-HiPIMS

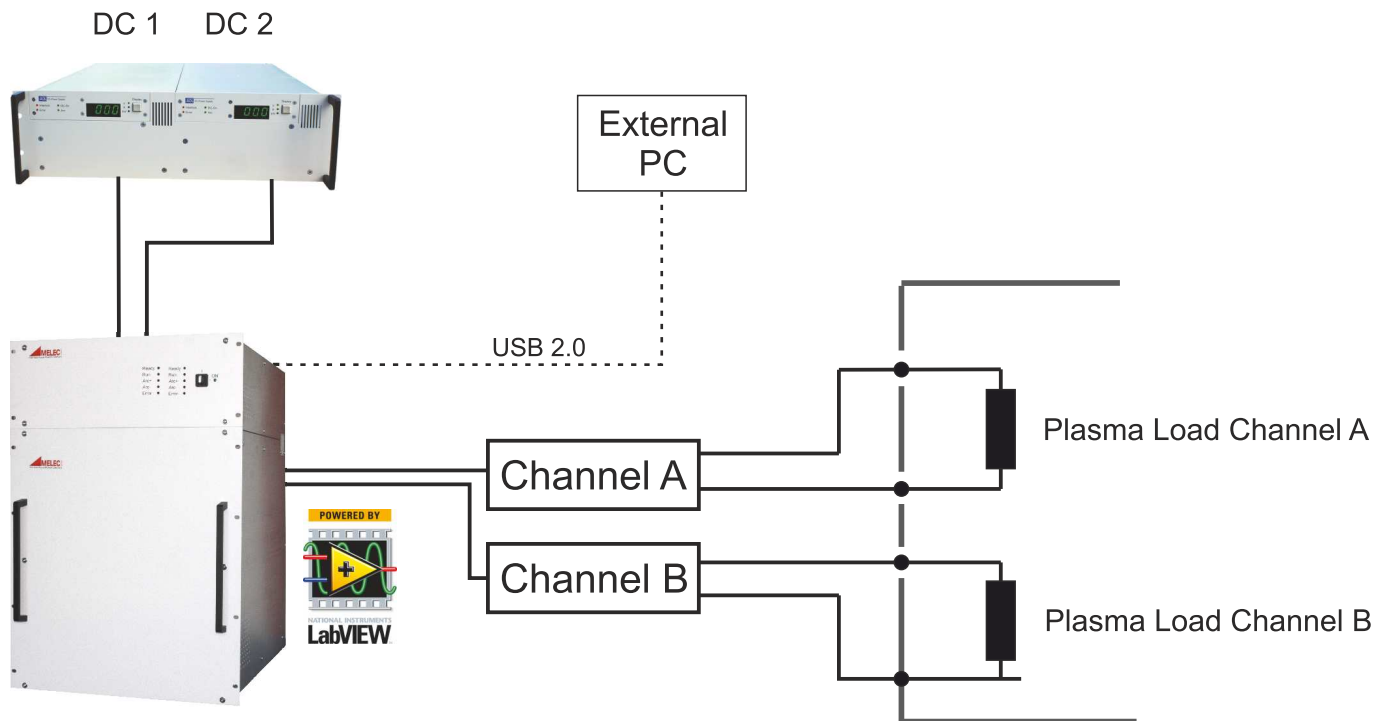
HiPIMS/HPPMS SIPP2000USB_...	...10_1000_S 10 kW	...20_1000_S 2x 10 kW = 20 kW	...30_1000_S 2x 15 kW = 30 kW or 1x 30 kW
Pulse Output Power	1000 kW (peak)		
Pulse Output Voltage	+/- 1000 V max.		
Pulse Output Current	+/- 1000 A max.		
Pulse Time Conditions	UP+ ; UP- ; BP		
ON-TIMES +/-	Ton ^{+/-} ≥ 20 μs		
OFF-TIMES +/-	Toff ^{+/-} ≥ 20 μs		
HiPIMS / HPPMS Frequency Conditions	Σ (Ton ^{+/-} and Toff ^{+/-}) ≥ 500 μs (2 kHz)		
MF (optional) ON-TIMES +/-	Ton ^{+/-} ≥ 5 μs		
MF (optional) OFF-TIMES +/-	Toff ^{+/-} ≥ 5 μs		
MF (optional) Frequency Conditions	Σ (Ton ^{+/-} and Toff ^{+/-}) ≥ 20 μs Current Pulse Peak ≤ +/-100 A (50 kHz)		

SIPP2000USB-MF

MidFrequency SIPP2000USB_...	...10_1000_S 10 kW	...20_1000_S 2x 10 kW = 20 kW	...30_1000_S 2x 15 kW = 30 kW or 1x 30 kW
Pulse Output Power	1000 kW (peak)		
Pulse Output Voltage	+/- 1000 V max.		
Pulse Output Current	+/- 500 A max.		
Pulse Time Conditions	UP+ ; UP- ; BP		
ON-TIMES +/-	Ton ^{+/-} ≥ 5 μs		
OFF-TIMES +/-	Toff ^{+/-} ≥ 5 μs		
MidFrequency Conditions	Σ (Ton ^{+/-} and Toff ^{+/-}) ≥ 20 μs Current Pulse Peak ≤ +/-100 A (50 kHz)		

Patent Pending

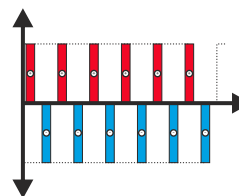
SIPP2000 Dual Version PLASMA DC PULSE POWER CONTROLLER



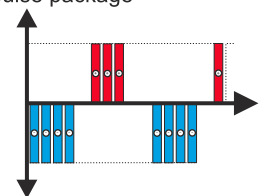
Features:

- Full control of two separated channels for HiPIMS, MF or Bias
- Synchronization of HiPIMS, Bias and MF
- Separated Arc Management for both channels
- Control of 2 DC units (2 x ADL GX or PNCL Dual)
- All parameters can be controlled over software
- Free adjustable pulse pattern generator (FPPG)

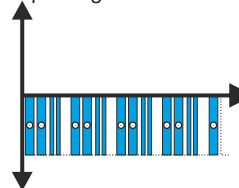
Bipolar HiPIMS/HPPMS



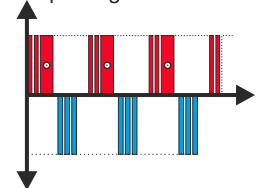
Unipolar HiPIMS/HPPMS pulse package



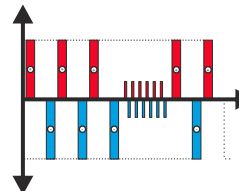
Unipolar HiPIMS/HPPMS pulse package



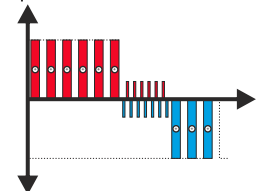
Bipolar HiPIMS/HPPMS pulse packages



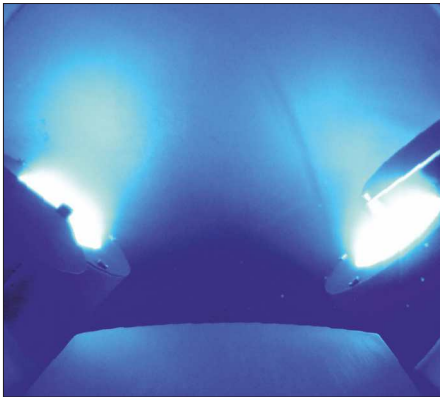
Superimposed bipolar HiPIMS/HPPMS and MF



Superimposed unipolar HiPIMS/HPPMS and MF



Patent Pending

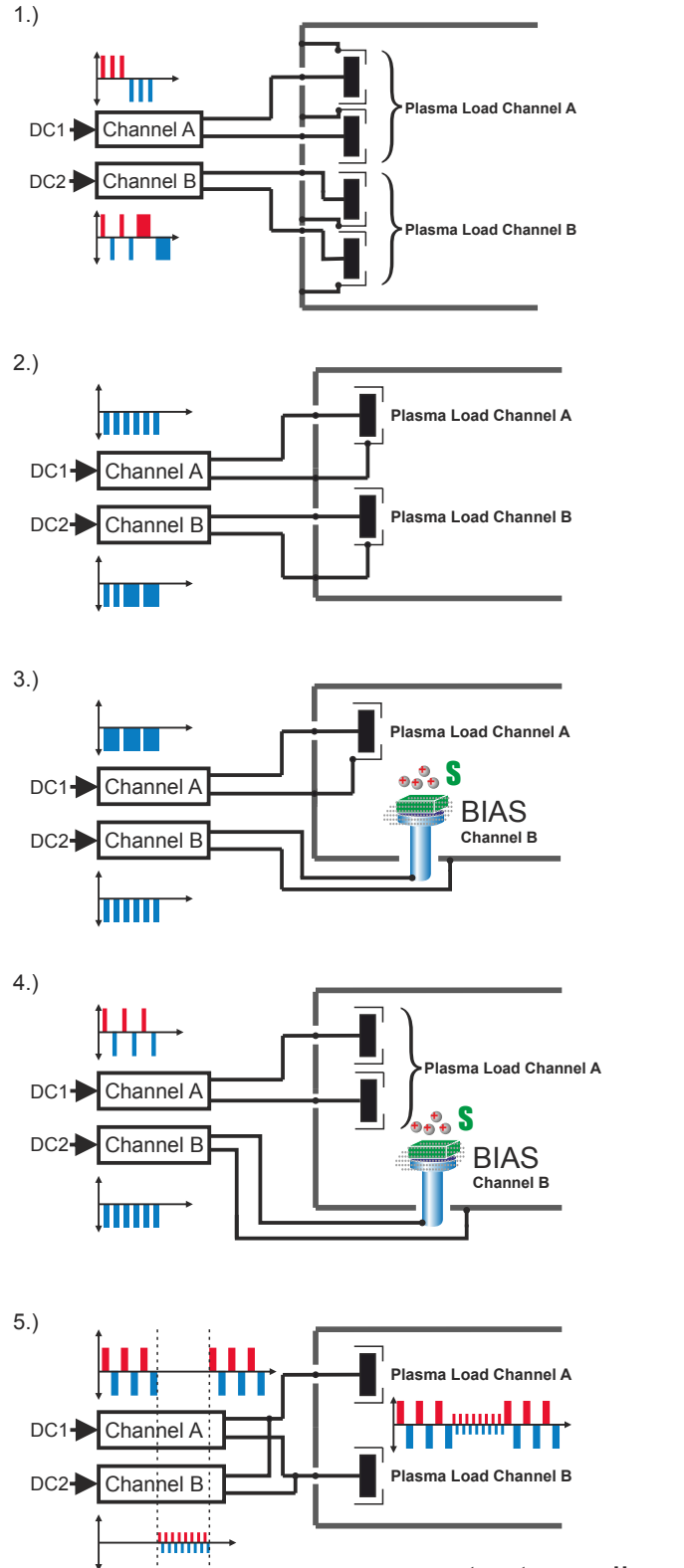


Source: Helmholtz-Zentrum
Dresden-Rossendorf
Germany

SIPP2000 DUAL

1x HiPIMS/HPPMS and 1x MF or 2x HiPIMS/HPPMS or 2x Mid Frequency(MF)	CHANNEL A 5 kW	CHANNEL B 5 kW
Pulse Output Power (peak Power)	500 kW	500 kW
Pulse Output Voltage	+/- 1000 V (max.)	+/- 1000 V (max.)
Pulse Output Current	+/- 500 A (max.)	+/- 500 A (max.)
Pulse Time Conditions	UP+ ; UP- ; BP	UP+ ; UP- ; BP
HiPIMS/HPPMS ON-TIMES +/-	$T_{on}^{+/-} \geq 20 \mu s$	$T_{on}^{+/-} \geq 20 \mu s$
HiPIMS/HPPMS OFF-TIMES +/-	$T_{off}^{+/-} \geq 20 \mu s$	$T_{off}^{+/-} \geq 20 \mu s$
HiPIMS/HPPMS Frequency Conditions	$\Sigma (T_{on}^{+/-} \text{ and } T_{off}^{+/-}) \geq 500 \mu s$ Current Pulse Peak $\leq \pm 500 A$ (2 kHz)	
MF ON-TIMES +/-	$T_{on}^{+/-} \geq 5 \mu s$	$T_{on}^{+/-} \geq 5 \mu s$
MF OFF-TIMES +/-	$T_{off}^{+/-} \geq 5 \mu s$	$T_{off}^{+/-} \geq 5 \mu s$
MF Frequency Conditions	$\Sigma (T_{on}^{+/-} \text{ and } T_{off}^{+/-}) \geq 20 \mu s$ Current Pulse Peak $\leq \pm 100 A$ (50 kHz)	

Applications...



patent pending

DC Power Supply GS- and GX-Models ADL GmbH



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Type	DC Output		
ADL GmbH GS Class			
GS15/1000	1000V	2,4 A	1,5 kW
GS15/1000	1000V	2,8 A	2,0 kW
GS15/1000	1000V	4,2 A	3,0 kW
ADL GmbH GX Class			
GX50/1000	1000V	10,0 A	5,0 kW
GX80/1000	1000V	16,0 A	8,0 kW
GX1000/1000	1000V	20,0 A	10,0 kW
GX150/1000	1000V	30,0 A	15,0 kW

DC Power Supply HX- Models ADL GmbH



Copyright ADL GmbH-2014

Type			
HX 150/1000	15 kW	1000 V	25 A
HX 200/1000	20 kW	1000 V	35 A
HX 250/1001	25 kW	1000 V	40 A
HX 300/1001	30 kW	1000 V	50 A

MELEC - Measurement System



Measurement System	
MS-500-S	2 Channels (1 x 500 A, 1 x 1000 V)
MS-500-S-TB	2 Channels (1 x 500 A, 1 x 1000 V, 1x housing for Transducer Model)
MS-500-D	4 Channels (2 x 500 A, 2 x 1000 V)
MS-500-D-TB	4 Channels (2 x 500 A, 2 x 1000 V, 2x housing for Transducer Model)
MS-1000-S	2 Channels (1 x 1000 A, 1 x 1000 V)
MS-1000-S-TB	2 Channels (1 x 1000 A, 1 x 1000 V, 1x housing for Transducer Model)
MS-1000-D	4 Channels (2 x 1000 A, 2 x 1000 V)
MS-1000-D-TB	4 Channels (1 x 500 A, 1 x 1000 V, 2x housing for Transducer Model)



System Rack



Source: Materias Chemistry, RWTH / University Aachen, Prof. Jochen M. Schneier



Cabinet System Dual Channel Puls Unit set with 4-Channel Measurement System

System Racks can be configured to mount...

- SIPP2000 units
- DC Units
- Measurement applications
- IPC
- etc.

Additional components for superimposition applications, such as high power - high speed diodes for DC-Superimposition can be optionally added into the System Rack.

ADVANTAGES:

- Ready to use
- All Components mounted

Futher Applications:

- Plasma CVD
- Plasma Nitriding
- Atmospheric Plasma
- Plasma Oxidation

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