TruPlasma Bipolar Series 4000 G2.1 PECVD

Power Supply

USER MANUAL

Warning!
This operating manual is required for the safe operation of **TruPlasma Bipolar Series 4000 G2.1 PECVD** Power Supplies. As a result, the operating manual should be kept close to the unit at all times.

Operating Instructions

for TruPlasma Bipolar Series 4000 G2.1 PECVD Power Supply

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To ensure years of dependable service, TRUMPF Huettinger products are thoroughly tested and found to be among the most reliable and highest quality systems available.

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Returning Units for Repair

Before returning any product for adjustment or repairs please call **TRUMPF Huettinger Services** to discuss the problem with a service engineer representative. Be prepared to give the serial number of the unit and reason for return. This consultation call will help the Customer Service Department to determine if the unit needs to be returned. Such technical consultations are always available free of charge.

Table of contents

1. Safety Information

1.1. Important information

TruPlasma Bipolar Series 4000 G2.1 PECVD generator is designed to power industrial vacuum process chambers in PECVD surface treatment technologies. Any other uses or any uses beyond these mentioned above are considered to be improper. TRUMPF Huettinger Company shall not be held liable for any losses or damages resulting in any improper usage.

Correct usage also includes:

- Full compliance with all instructions from operating manual.
- Full adherence to inspection and maintenance intervals.

Safe operating procedures and proper equipment usage are the sole responsibilities of the system's user.

1.2. Explanation of symbols and notes

Failure to comply with these precautions may cause physical injury or result in damage of equipment.

Failure to comply with these warnings may result in death, serious physical injury or damaged equipment.

Failure to comply with this information can affect the generator's performance.

Useful notices and tips regarding proper handling, operation and maintenance.

1.3. Personnel

Only qualified personnel should work with the **TruPlasma Bipolar Series 4000 G2.1 PECVD.** "Qualified" is defined as personnel who are familiar with the safe installation procedures, maintenance and operation.

All of the personnel working with this equipment must take appropriate precautions to protect themselves against the possibility of electrical shocks or fatal injuries. They must be familiar with the entire **TruPlasma Bipolar Series 4000 G2.1 PECVD** operating instruction manual and understand all of its contents.

Do not be careless around this equipment!

1.4. Safety standards profile

Power unit is intended to use in an industrial environment.

There may be potential difficulties in ensuring electromagnetic compatibility in other environment, due to conducted as well as radiated disturbances.

The **TruPlasma Bipolar Series 4000 G2.1 PECVD** Power Supply was designed and constructed in compliance with the requirements outlined in the following standards and EC directives:

Standards:

- **EN 61010-1:** 2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements.
- **EN 61000-6-2:** 2005/AC:2005 " Electromagnetic compatibility (EMC). Part 6-2: Generic standards –Immunity for industrial environments.
- **EN 55011:** 2009/A1:2010 Class A and Group 2; Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement.

EC directives:

- **2014/35/EC** Low Voltage Directive of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.
- **2014/30/EC** EMC Directive of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility.

➲ **Check external fuse value and grounding circuit before switching mains on.**

➲ **Never unscrew or remove rear terminals covers before switching mains off..**

1.5. Transportation and storage

Transportation

TruPlasma Bipolar Series 4000 G2.1 PECVD system must be firmly secured and placed in a horizontal position.

Very heavy! Lifting the power supply requires more than one person (weights are differentiated according to the output power)

Storage

Storage environments should be dry, free of aggressive vapours and not exposed to temperatures from beyond the 1K4 class range – EN 50178 (i.e.: -25, +55ºC). See table 'Environment'.

Before storage and transportation remove all cooling water residues from the generator by carefully blowing compressed air through the lines.

Usage of drain plug (screw) in the valve, located on the bottom side is required in order to remove all cooling water from radiator.

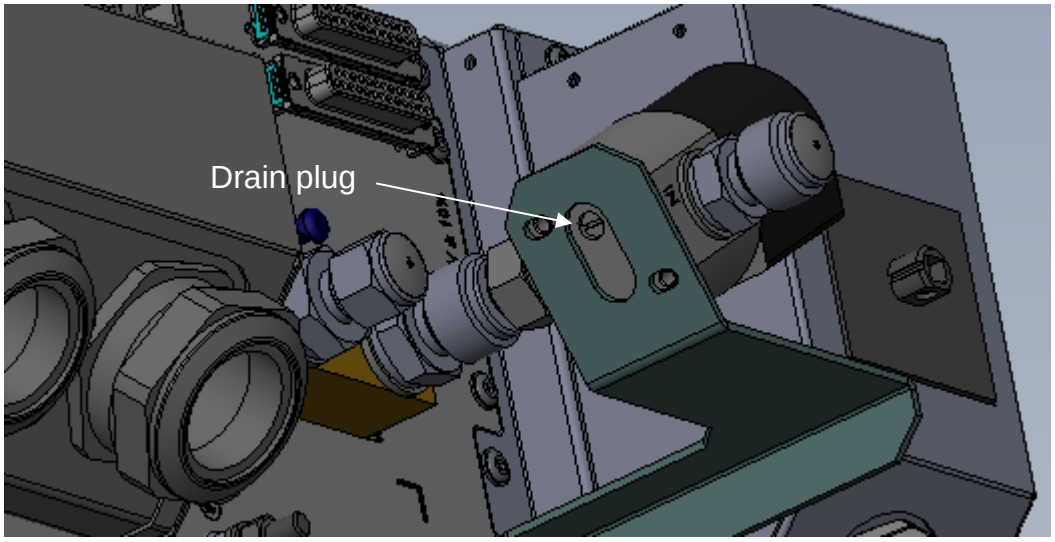


Fig. 1.1. Drain plug location

2. General information

Description

The **TruPlasma Bipolar Series 4000 G2.1 PECVD** power supply is designed for plasma-assisted film deposition PECVD and dual cathode sputtering processes, where reliability and performance are critical. Its most important features are:

- high efficiency switched-mode power conversion performance,
- up to 600V operating output voltage,
- full output power capability at an output voltage as low as 320V,
- ultrafast arc switch-off and recovery,
- extremely low arc energy,
- wide variety of user adjustable parameters,
- two switchable outputs

The **TruPlasma Bipolar Series 4000 G2.1 PECVD** power supply is assembled in one industrial steel enclosure ready to insert into a 19'' rack power system. All cable ends and electric terminals for user connections are located at the rear of the module.

Microprocessor

Power supply is microprocessor-controlled. All control-signal connections are digitally and opto-isolated providing high resistance against electromagnetic disturbances.

Interfaces

A multi-control system gives user a possibility of selecting from a variety of control sources.

Depending on configuration, there are available:

- Local: Standard Operator Panel located on the front panel of the **TruPlasma Bipolar**,
- Remote: RS-232,
- Remote: RS-485,
- Remote: Analog interface.
- Remote: Profibus

2.1. TruPlasma Bipolar Series 4000 G2.1 PECVD block diagram

A block diagram of the **TruPlasma Bipolar Series 4000 G2.1 PECVD** is shown below it consists of the following functional blocks:

- input EMI filter to reduce electromagnetic interferences delivered to mains,
- three-phase rectifier,
- circuit providing a soft switch-on,
- power factor correction circuit,
- MOSfet switch-mode DC/DC power converter,
- output sections,
- arc detection and arc switch-off circuitry,
- control electronics

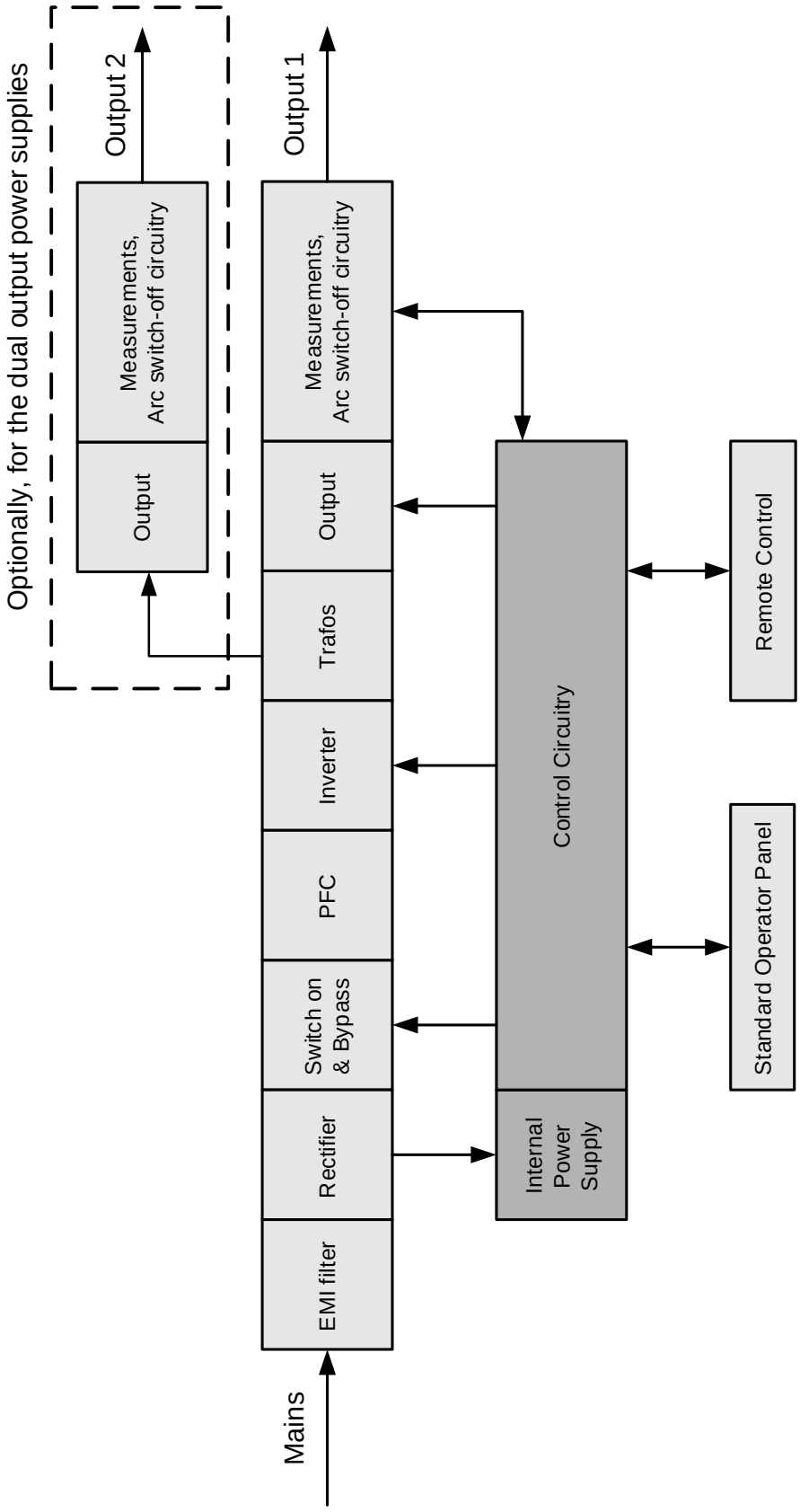


Fig.2.1. TruPlasma Bipolar Series 4000 G2.1 PECVD

3. Electrical and mechanical specifications

3.1. Electrical and mechanical specification in tables

Electrical specification – Overall			
Mains voltage	**V AC**		3x380-480±10% **+PE** It is recommended to maintain a power quality according to EN 61000-2-4 (class 3).
Mains frequency	**Hz**		50/60 (range: 47 to 63)
Maximum mains input current	**A**		3 x 48
Recommended fusing	**A**		3 x 63, B-class
Efficiency	**%**		Approximately 91%
Warm-up delay	**second**		< 5

Electrical specification – Power supply section					
Nominal output values (each output)			2x15 kW	2x20 kW	30 kW
	$P_{n\ mean}$		**15 kW (Blink)**	**20 kW (Blink)**	**30 kW (Blink)**
	$U_{n\ RMS}$		**600 V**	**600 V**	**600 V**
	$I_{n\ RMS}$		**43 A (Blink)**	**50 A (Blink)**	**75 A (Blink)**
Output frequency	**kHz**		5-50		
Control source options			Local - Standard Operator Panel located on the front panel Remote - RS-232 Remote - RS-485 Remote - Analog interface Remote - Profibus		
Output control			P – power control U – voltage control I – current control		

Mechanical Specification			
Size (Width x Height x Length)	**mm**		482 **(19")** x 178 **(4HU)** x 700
Weight	**kg**		Approx. 60

Arc detection criteria			
Imax **Overcurrent detection** an arc is detected when output current exceeds threshold value	**A** **%**		user adjustable: Imax Threshold 4,9 … 1,3 In Imax offset 0 … 100
Dynamic U x I Cross detection reacts when output voltage drops while output current rises	**A** **V**		user adjustable: Ix 4,9 … 1,3 In Ux 0 … 800
dU **Dynamic voltage change (microarc)** an arc is detected when output voltage immediately drops by the set value.	**%**		user adjustable: dU Thld 0 … 100
Usag **Voltage-based detector**	**%**		user adjustable: Uout Sag Factor 10 … 50
Breaktime and Ramp time	**µs** **ms** **µs**		Hard arc break time 10 … 2000 Hard arc Ramp Time 0 … 2 Micro arc break time 10 … 1000
Arc Burst	**us** **us**		BreakTime: 25 … 10000 Number in row: 1 … 100 On-Time Below 1 … 1000
Maximum amount of detected and suppressed arcs per second	**arc/sec**		20000

3.2. Environmental specification

Environmental Specification			
Ambient operating temperature	**°C** **°F**		+5 … +45 (Class 3K3, EN 50178) +41…+113
Storage temperature	**°C** **°F**		-25 … +55 (Class 1K4, EN 50178) -13 … +131
Relative humidity	**%** **g/m³**		5...85 Non-condensing 1…25 (Class 3K3, EN 50178)
Air pressure	**kPa** **mbar**		86-106 (Class 3K3, EN 50178) 860-1060 (max altitude: approximately 2000m above sea level)
Degree of Pollution			2 (see chapter 4.1. Installation site: contamination)

3.3. Cooling water specification

Cooling water parameters			
Temperature	**°C**		+20 to +35 The temperature must be higher than dew point.
Pressure	**bar**		< 7
Differential pressure input to output	**bar**		> 2
Flow rate	**l/min**		> 8
Flow rate in standby mode	**l/min**		1 … 2
Conductivity	**µS/cm**		50 … 600
Protection class IP			IP40

Total Hardness	Max Ph-Value
8 °dH	7.8
6 °dH	8.1
4 °dH	8.3

Description	Limit Value
Aggressive carbonic acid	must not be detected
Ammonia	must not be detected
Nitrite	< 1 mg/l
Iron	< 0.3 mg/l
Manganese	< 0.05 mg/l
Sulfate	< 250 mg/l
Chloride	< 250 mg/l
COD (chemical oxygen demand)	< 40 mg/l
Microbiologic growth: - number of colonies - sulfate reducing agents	 < 1000/ml must not be detected

Min. 1l/min of cooling water is required in standby mode.
If the minimal water flow for standby mode cannot be provided, mains must be switched off.

3.4. Compressed air specification

To avoid problems with humidity condensation it is recommended to connect the compressed air to the dedicated terminal in the power supply. It is especially important when generator operates in tropical areas with high humidity.
The condensed water could lead to internal short circuits and finally to damage of the power supply.

The table with air quality parameters with references to ISO 8573-1/2010 standard below:

Compressed air parameters				Quality class according to ISO 8573-1
Pressure	**bar**		0.1 … 0.2	
Pressure dew point	**°C**		max. +3 (see the next page for dew point diagram)	4
Oil content	**mg/m³**		< 0.1	2
Dust-free			Acc. to Tab. 2 ISO 8573-1/2001	2

Compressed air connector is placed on the rear side of the generator (see chapter *4.3. Connection terminals* and chapter *4.5. Cooling terminals descriptions*).

To prevent water condensation, connect compressed air 60 minutes before usage.

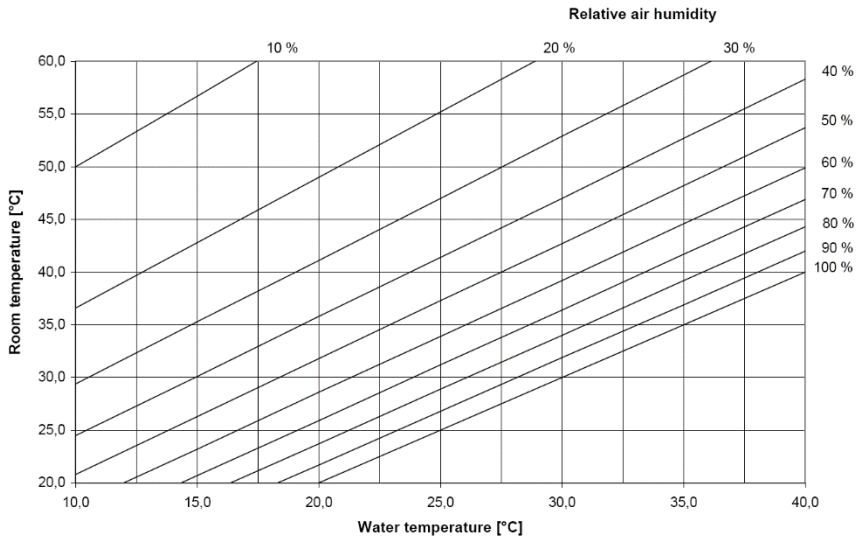


Fig. 3.1. Dew point diagram.

The dew point diagram has been created with an assumed air pressure of 1013 mbar.

3.5. TruPlasma Bipolar Series 4000 G2.1 PECVD power characteristic

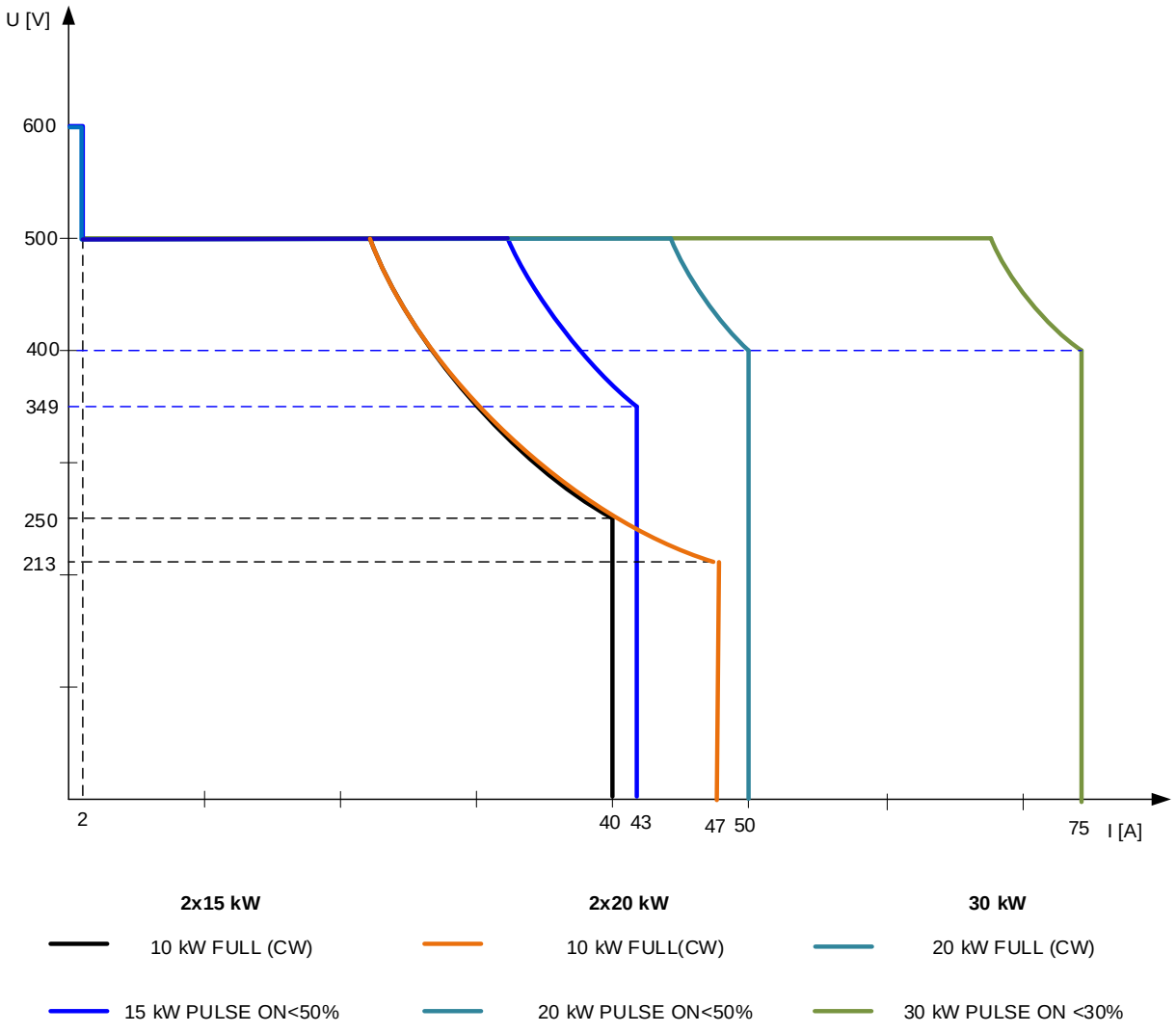


Fig. 3.2. Power characteristic of **TruPlasma Bipolar Series 4000 G2.1 PECVD**

3.6. Description of continuous working modes

Power supply can work in continuous mode on one of the outputs. In that case the current and power maximum values are shown below:

Output parameters						
		Ton/(Ton+Toff) > 50 % (for 30 kW 30%)		Ton/(Ton+Toff) < 50 % (for 30 kW 30%)	
2x15 kW	**A** **kW**	I max P max	**40** **10**	I max P max	**43** **15**
2x20 kW	**A** **kW**	I max P max	**47** **10**	I max P max	**50** **20**
30 kW	**A** **kW**	I max P max	**50** **20**	I max P max	**75** **30**

FULL MODE

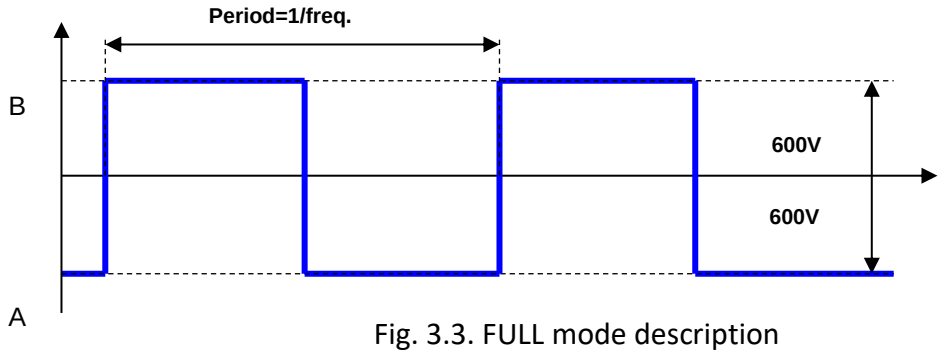


Fig. 3.3. FULL mode description

Parameter	Description	Range
Frequency	$\boldsymbol{Frequency = \frac{1}{Period}}$	5 kHz – 50 kHz
Duty	$\boldsymbol{Duty = \frac{Pulse\ A}{Pulse\ A + Pulse\ B}}$	1 % - 99 %

Frequency of released power pulses (polarization A and B) can be changed with power on in range from 5 kHz to 50 kHz with 0,1 kHz step
Duty cycle for A and B polarization can be set from 1% to 99%.
Power supply controls and measures mean power, RMS current and RMS voltage on the output.

Outputs cannot be grounded!

BIPULSE MODE

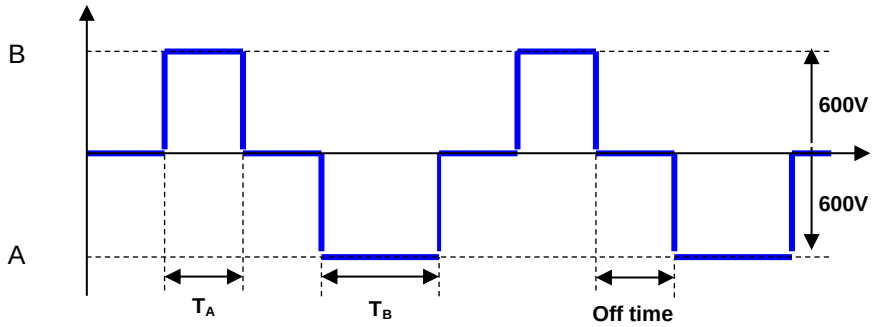


Fig. 3.4. BiPulse mode description

Parameter	Description	Range
Frequency	$\boldsymbol{Frequency = \frac{1}{Period}}$	5 kHz – 50 kHz
Duty	$\boldsymbol{Duty = \frac{Pulse\ A}{Pulse\ A + Pulse\ B}}$	1 % - 99 %
Off time	-	1 % - 20 %

Frequency of released power pulses (polarization A and B) can be changed with power on in range from 5 kHz to 50 kHz with 0,1 kHz step
Duty cycle for A and B polarization can be set from 1 % to 99 %.
Power supply controls and measures mean power, RMS current and RMS voltage on the output.

Outputs cannot be grounded!

TRAPEZ MODE

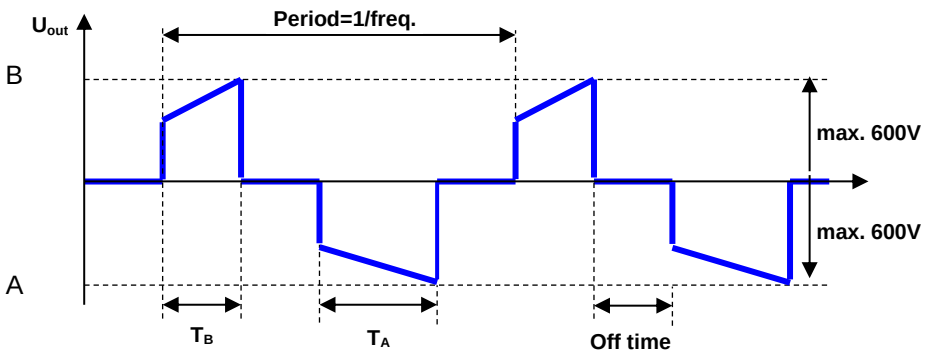


Fig. 3.5. TRAPEZ mode description

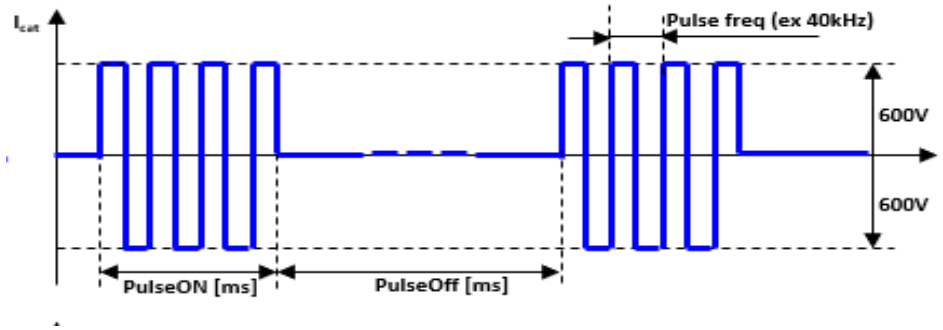
Parameter	Description	Range
Frequency	$\boldsymbol{Frequency = \frac{1}{Period}}$	5 kHz – 50 kHz
Duty	$\boldsymbol{Duty = \frac{Pulse\ A}{Pulse\ A + Pulse\ B}}$	1 % - 99 %
Off time	-	1 % - 20 %

Frequency of released power pulses (polarization A and B) can be changed with power on in range from 5 kHz to 50 kHz with 0,1 kHz step and duty cycle for pulses can be set from 1 % to 99 %. Accretion speed is dependent on the off time value.
Power supply controls and measures mean power, RMS current and RMS voltage on the output.

Outputs cannot be grounded!

3.7. Blink mode

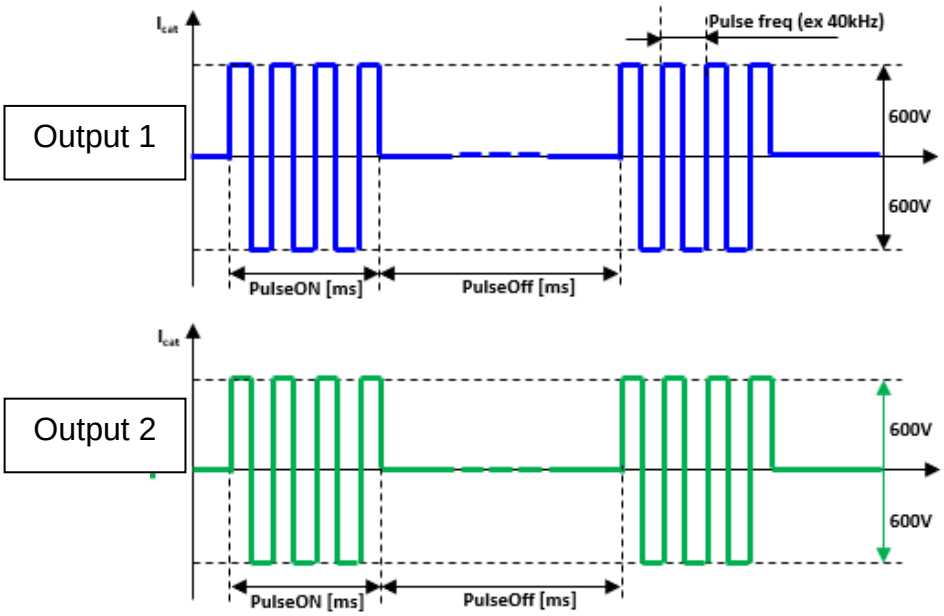
Power supply can work in blink mode on one output.



Dual output units

Power supply can work in blink mode on both outputs at the same time. In case of dual output working mode both outputs can work in the same time while not exceeding 30 kW combined. Otherwise pulse on must be shifted:

$$P\ out1 + P\ out2 \leq 30\ kW$$



$$P\ out1 + P\ out2 > 30\ kW$$

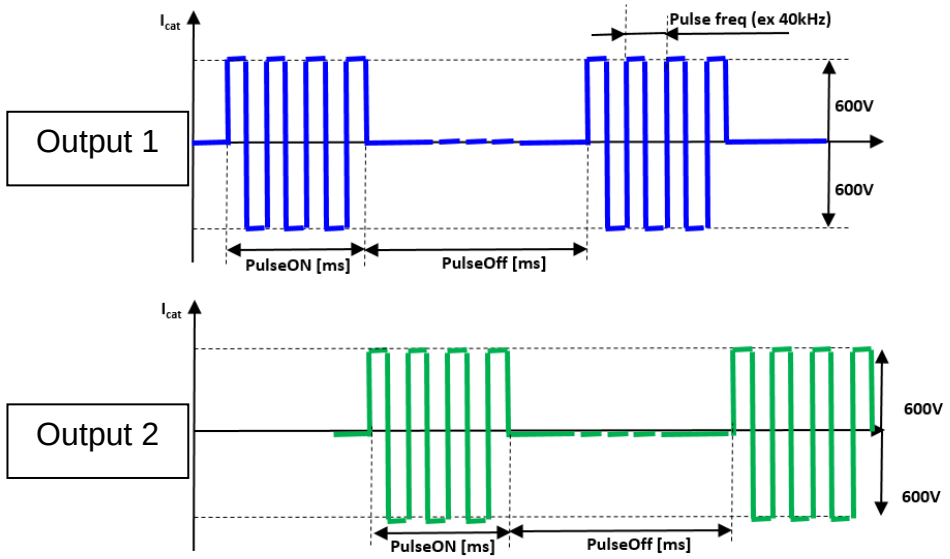


Fig. 3.6. Dual output blink mode

When two output's power exceeds 24 kW the following conditions must be met:
PulseOn_Out1 [ms]*n + PulseOff_Out1 [ms]*(n-1)+2 us (time necessary to switch outputs) <=PulseOff_Out2 [ms]
PulseOn_Out2 [ms]*n + PulseOff_Out2[ms] + 2 us <= PulseOff_Out1 [ms]
Blink_Out1 [ms] = Blink_Out2 [ms] *n or Blink_Out2 [ms] = Blink_Out1 [ms] *n

Where:
T_SWITCH – time of minimum break between switching outputs.
Blink_Out1= PulseOn_Out1 + PulseOff_Out1
Blink_Out2= PulseOn_Out2 + PulseOff_Out2

If any of the conditions is not met the "Blink wrong Configuration" bit will be active.

The maximum current and power parameters are the same as in the continuous mode.

Blink mode parameters			
Blink on	ms		1 … 500
Blink off	ms		1 … 500

4. Installation and connections

4.1. Installation site

Enclosure

TruPlasma Bipolar Series 4000 G2.1 PECVD power supply is built in a standard 19" enclosure and is designed to fit into a standard 19", 800mm deep, rack cabinet. Weight of device is approx. 45kg and mechanical construction of cabinet should be strong enough to support it. Temperature inside cabinet should not exceed 45°C measured at front panel of module.

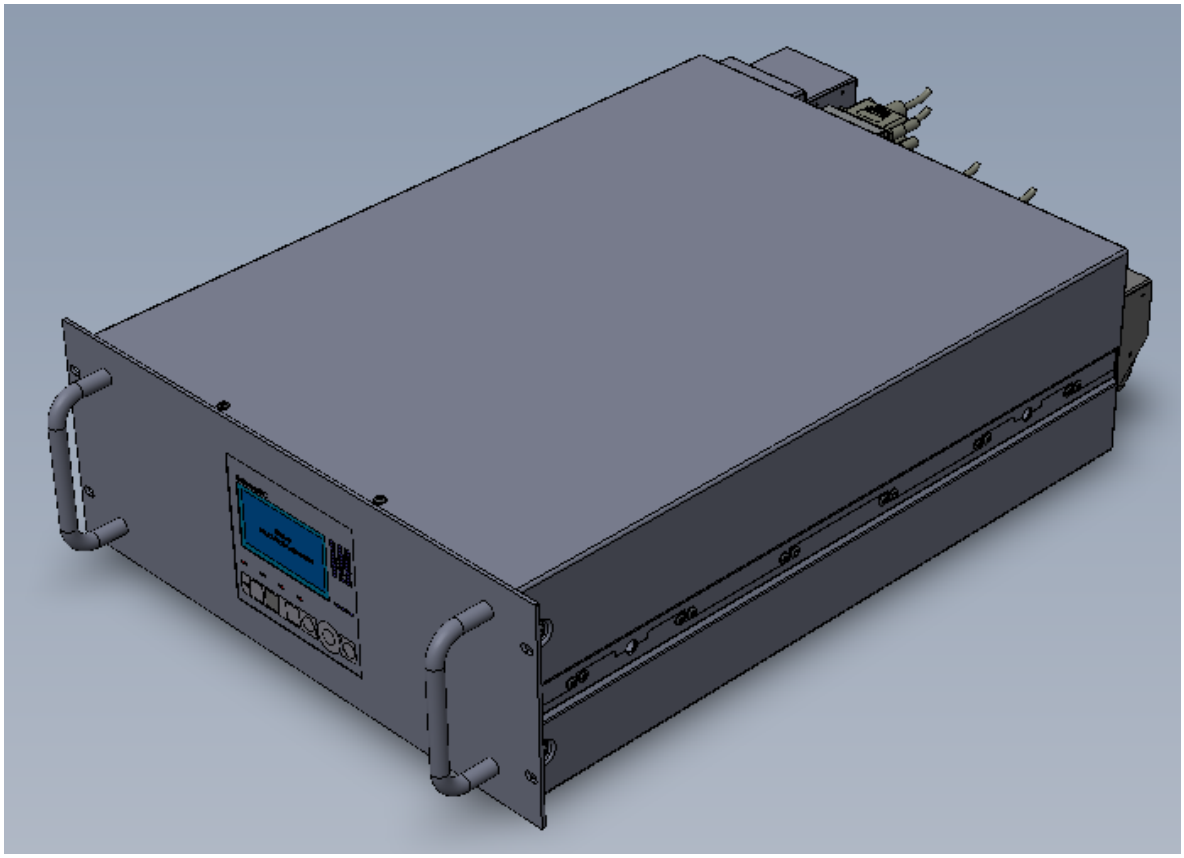


Fig. 4.1. TruPlasma Bipolar Series 4000 G2.1 PECVD.

HEAVY OBJECT.
May result in severe injury.
Do not lift or move without adequate equipment.
Weight 60 kg.

Contamination

Cooling air should be kept free from corrosive vapors and any particles that could become conductive after exposure to moisture.

Unpacking

Inspect the devices packaging for damage and compare its contents carefully with delivery documents**.**

4.2. Fusing

External mains fuses are highly recommended with respect to EN61010-1 standard. A set of three-phase 63A B-class fuses will provide necessary protection.

A set of fuses has to be provided for each power supply separately.

Usage of circuit breakers with the same tripping characteristic and rated current instead of fuses is also possible.

All terminal connection operations have to be made when power supply is not powered with mains and (if applicable) external 24V.

4.3. Connection terminals

All connection terminals are located on rear side of **TruPlasma Bipolar Series 4000 G2.1 PECVD**. Output terminals should be covered by cap delivered with the device. Sufficient space for cables should be provided (at least ½U) between modules installed together inside one cabinet.

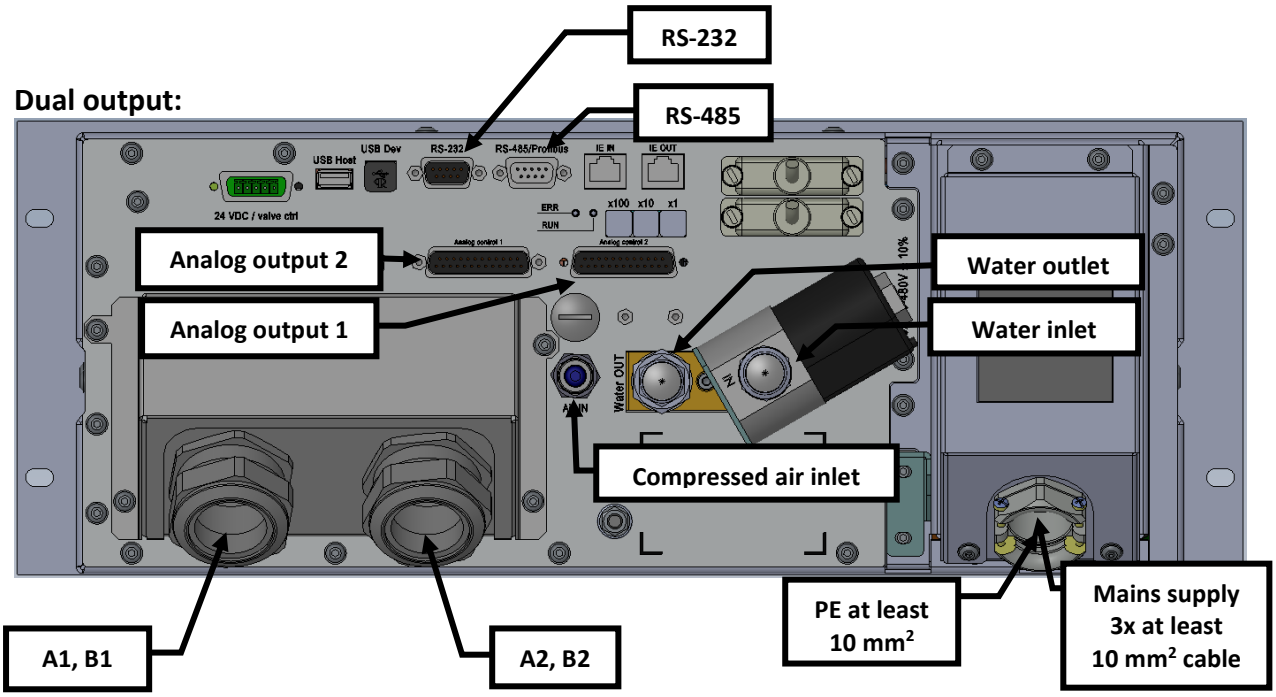


Fig. 4.2. Description of connectors and terminals on the rear panel on the example of dual output power supply.

Check inlet and outlet water connection. Changing water flow direction will cause power supply's malfunction!

To prevent water condensation, connect compressed air 60 minutes before usage.

4.4. Power terminals description

Terminal	Description	Cable	Cable endings
MAINS	3 x 380-480±10% V AC	3x min. 10 mm^2	3x ferrule
PE	Protective earth	min. 10 mm^2	M6
OUTPUT 1	600V / Inom	2x min. 16 mm^2 Copper twisted on entire length and shielded cable is recommended. Shielded output cables connected to power supply via EMC cable gland with tight and full 360-degree metal-to-metal contact of screen connection. Use dedicated cable (TRUMPF Huettinger cable type DC15).	2x M8
OUTPUT 2 (only in dual output)	600V / Inom	2x min. 16 mm^2 Copper twisted on entire length and shielded cable is recommended. Shielded output cables connected to power supply via EMC cable gland with tight and full 360-degree metal-to-metal contact of screen connection. Use dedicated cable (TRUMPF Huettinger cable type DC15).	2x M8

Do NOT turn on unit's power until the power supply is properly grounded!

Properly and firmly made connections and installation of Power Supply are necessary to fulfill safety and EMC standards.

4.5. Cooling connectors description

Terminal	Description	Hose ending
Water inlet	Stainless steel or polyurethane (PU)	ø 10 mm (G3.8 inch threaded holes)
Water outlet		
Compressed air inlet	Polyurethane (PU)	ø 8 mm (quick connect adaptor with $^1/_8$" external thread and stopper are attached)

4.6. Communication terminals description

Terminal	Description	Connection	Cable endings
RS-232	communication port	see below	SUBD 9pin female
RS-485	communication port	see below	SUBD 9pin male
Analog	communication port	see below	SUBD 25pin female
Others	not used in this application		n/a

4.7. Other connectors description

Terminal	Description	Cable endings
24V IN	External 24 V supply	MSTB 2,5/ 2-ST-5,08
Water valve control	Control of the water valve	MSTB 2,5/ 2-ST-5,08

4.8. RS-232 communication terminal

RS-232 port is located on the rear side of device and uses a 9-pin male SUBD connector. Table below provides description of pins.

Pin no.	Name	Type	Description
2	**RxD**	digital input	RS232 receives data
3	**TxD**	digital output	RS232 transmits data
5	**GND**	GND	Ground, can be used for cable shield
others	-	n/c	n/c

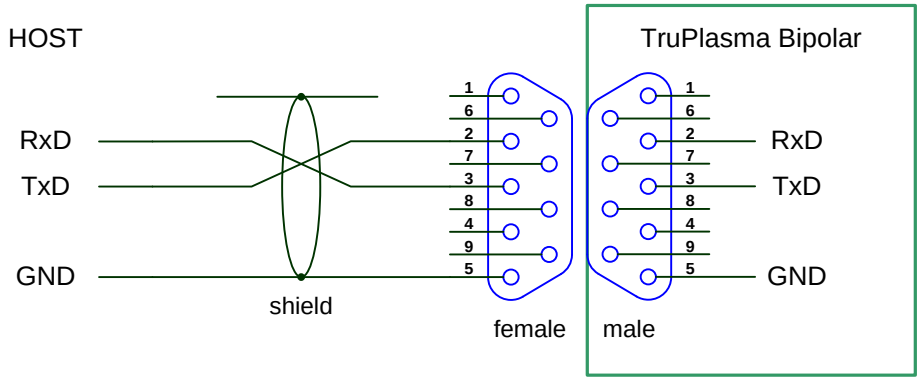


Fig. 4.3. RS-232 connection diagram.

WARNING !

Do NOT connect the shield with earth (PE).

WARNING !

Do not forget about the shield otherwise it will result in error occurrence

RS-232 communication baud rate can be set from the range: 9600, 19200, 38400, 57600 and 115200 bps, and it works in standard 8n1 (8 bits of data, non-parity, 1 bit of stop).
In order to get errorless communication, cable length shouldn't be longer than 3 m.

Default baud rate is 115200 bps.

4.9. RS-485 communication terminal

RS-485 port is located on the rear side of device and uses a 9-pin female SUBD connector. Table below provides description of pins.

Pin no.	Name	Type	Description
3	**A**	RxD/TxD-P	Differential I/O signal
5	**GND**	GND	Isolated RS-485 ground
6	**VP**	+5V DC	Isolated RS-485 supply voltage
8	**B**	RxD/TxD-N	Differential I/O signal
others	-	n/c	n/c

Termination resistors are necessary only at both ends of the cable.

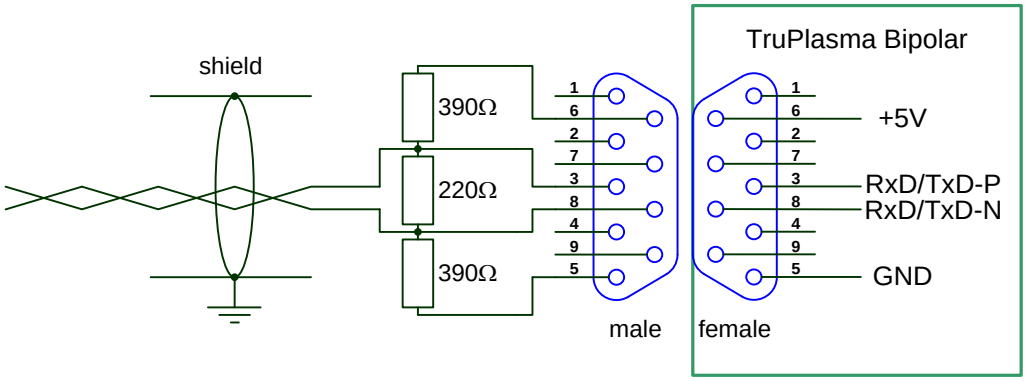


Fig. 4.4. RS-485 – 2 wire connection diagram.

4.10. Analog control terminal

Analog control connector is located on the rear side of device and uses a 25-pin male SUBD connector. Table below provides description of pins.

Pin no.	Name	Type	Description
1	**Uact**	Analog output	**0..10 V** against GND represents **0…600 V** output voltage
2	**Iact**	Analog output	**0..10 V** against GND represents **0…In** output current
3	**Pact**	Analog output	**0..10 V** against GND represents **0…Pn** output power
14	**Pset**	Analog Input	**0..10 V** at input represents **0…Pn** power setting
4	**GND**	Ground	Reference ground for all analog signals
5	**GND**	Ground	Reference ground for all digital signals
8	**PowerON**	Digital Input	Connect to 24V in order to switch the power ON
9	**Release**	Digital Input	Connect to 24V in order to INHIBIT output power pulses. When signal is high the power is on, when low the power is off
12	**Interlock**	Digital input	Interlock must be disabled (connected to +24V, pin 19) to enable power supply switch-ON. This is a relay-based hardware connection.
19	**+24V**	Supply output	24V supply for all digital inputs.
6	**Coll.**	Digital output (isolated)	All optocoupler collectors are connected to this common pin. **Max. voltage between this pin and the remaining isolated digital outputs must not exceed 30V.**
21	**Ready**	Digital output (isolated)	Ready acknowledge
22	**Alarm**	Digital output (isolated)	Alarm feedback signal
7	**Release confirmation**	Digital output (isolated)	Output pulse wave feedback signal

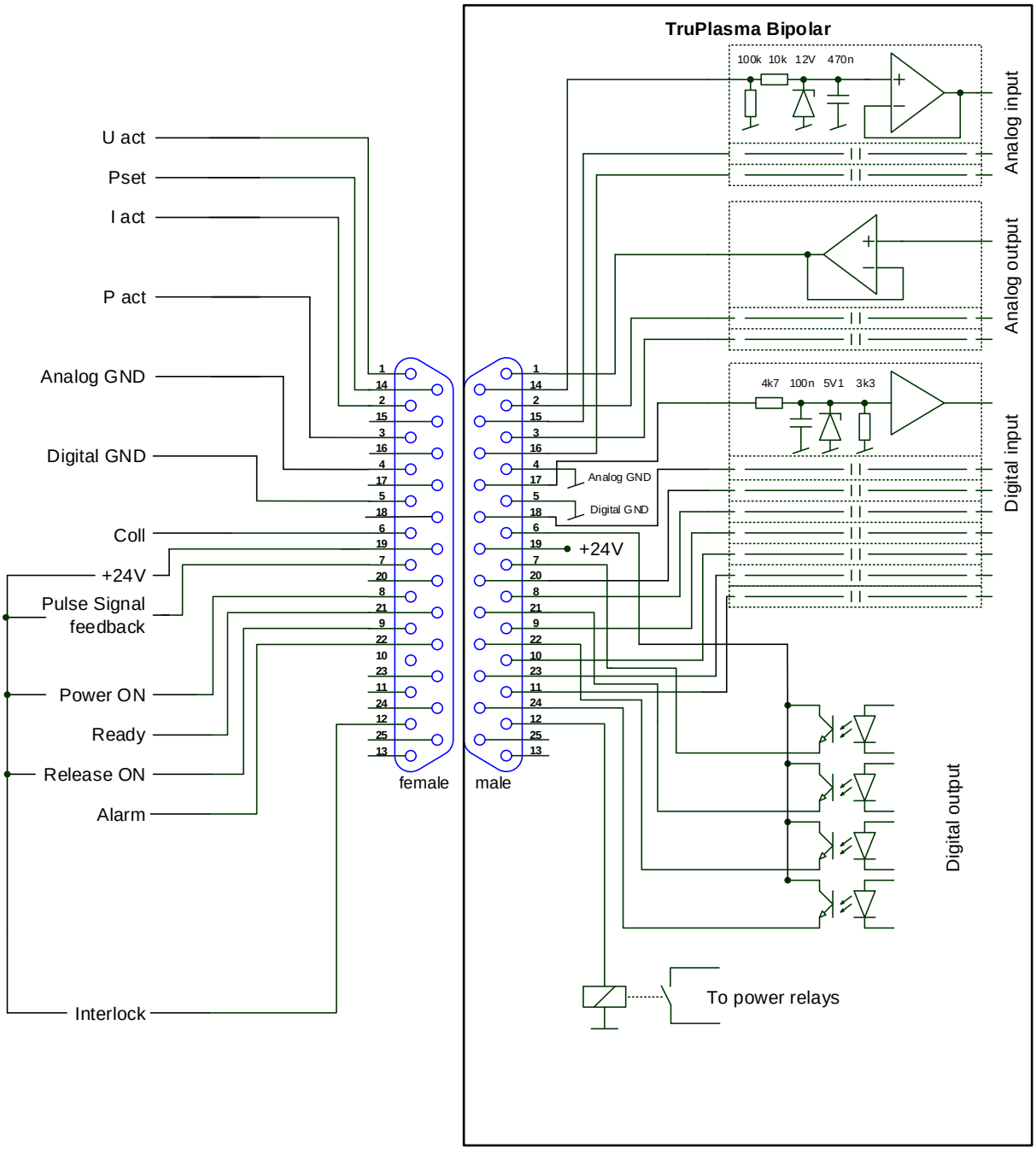
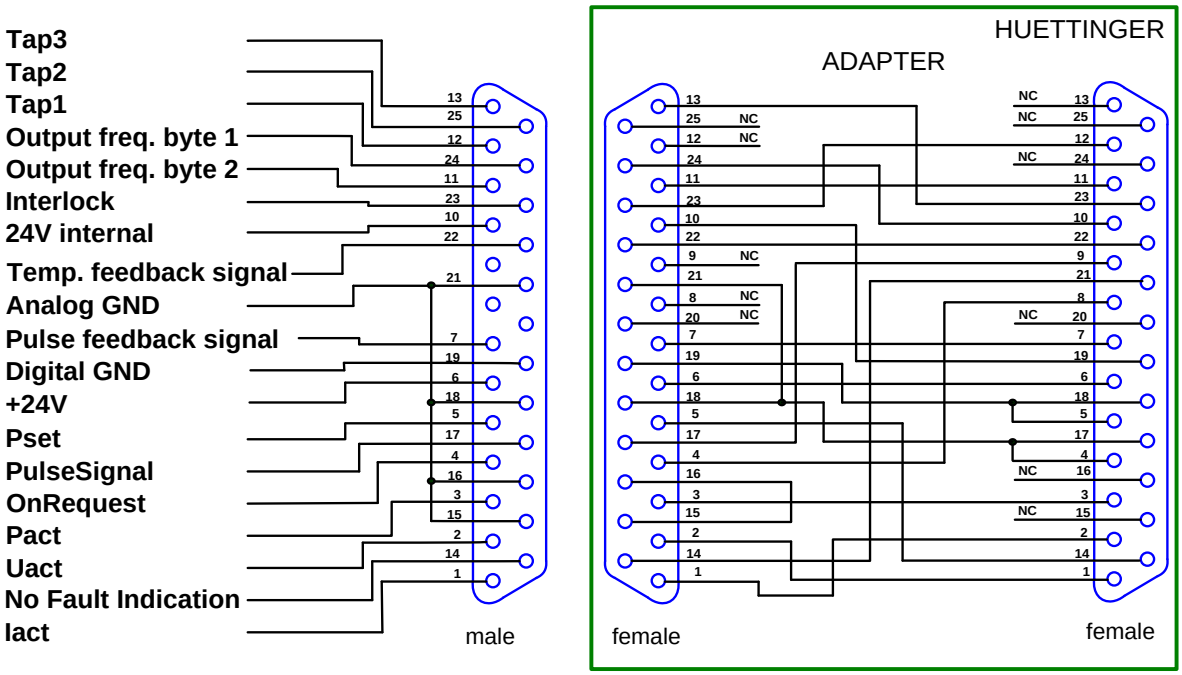


Fig. 4.5. Analog control connection and circuit diagram.



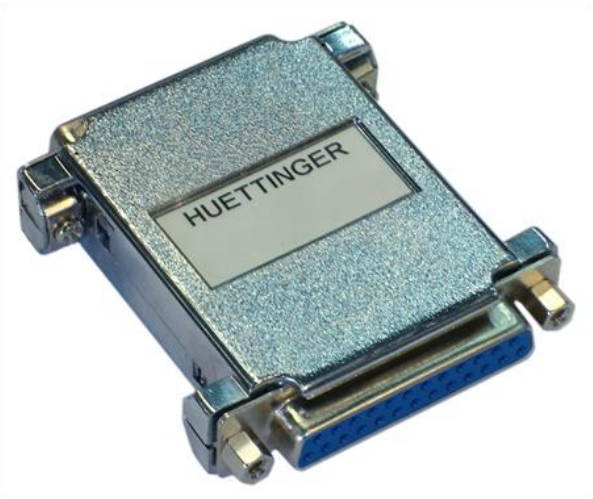
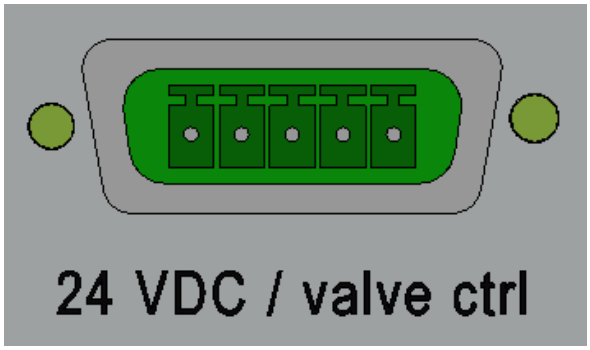


Fig. 4.6. Analog control adapter (additional equipment, not required for operation).

4.11. Valve control

Valve ctrl. terminal is located on the rear side of device and uses 5-pin connector.



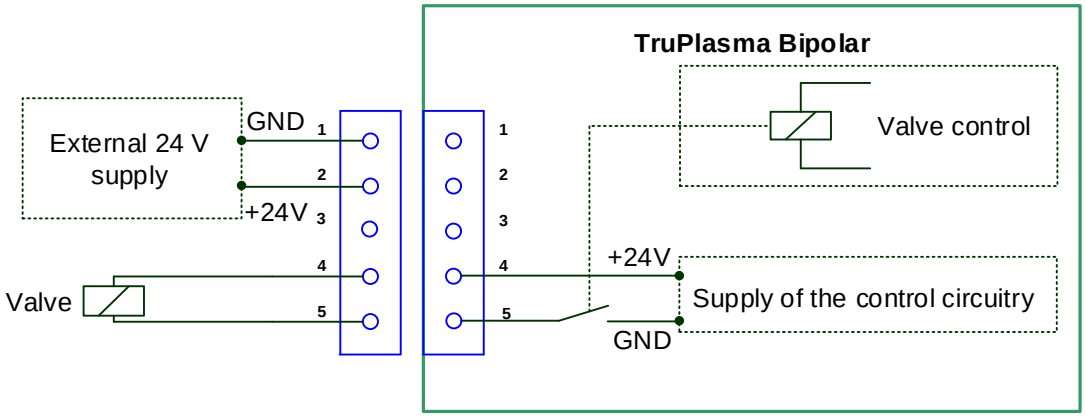


Fig. 4.8. Valve control circuitry diagram.

Valve control terminals are connected to relay with normally open contacts.

Relay closes (valve opens) when:

- temperature measurement T3 exceeds 38°C
- output power or current is at least 20% of the nominal value
- any temperature warning is active.

Relay opens (valve closes) when:

- temperature measurement T3 drops below 35°C
- output power or current is less than 20% of the nominal value for at least 30s
- no temperature warning is active for at least 30s.

In case a valve control circuitry is not equipped with freewheeling diode, an external one must be provided.

5. Arc management

Electric arcs, observed inside vacuum chamber during all stages of surface treatment process may affect treated surface in a negative manner. In such events arcs should be suppressed as fast as possible. From an electrical point of view, arc occurrence is defined as a rapid change of impedance in chamber's electric terminals.

TruPlasma Bipolar Series 4000 G2.1 PECVD arc detection system is equipped with four kinds of arc detection criteria:

Imax – current-based detector – reacts when output current exceeds user defined Imax threshold. The threshold can be set as a fixed value (Imax Thld [A]) or as a percentage of set output current (Imax Offset [%]). If Imax Offset is set to "0" then threshold is defined as a set value by Imax Thld. Otherwise threshold is defined as a relative value of Iset by Imax Offset parameter.

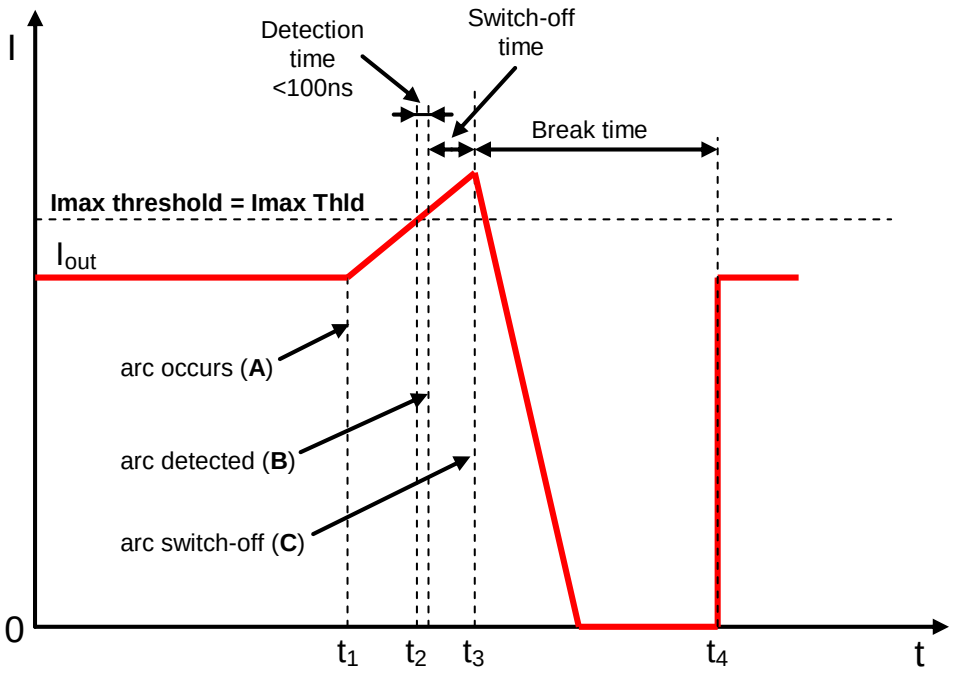


Fig. 5.1. I_{max} criterion arc detection example - **Imax Offset [%] = 0**.

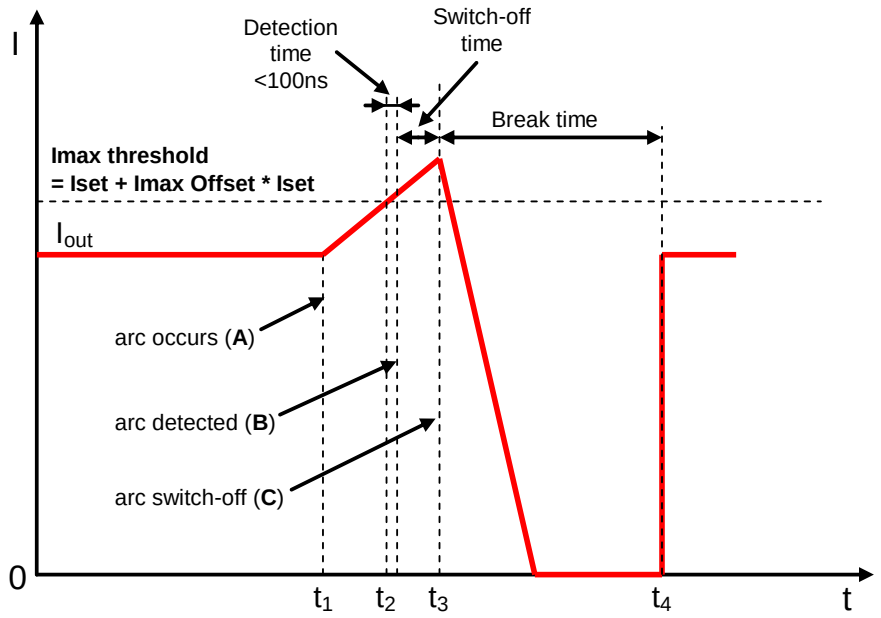


Fig. 5.2. I_{max} criterion arc detection example - **Imax Offset [%] ≠ 0**.

UxI – voltage and current-based detector (cross-detector) – reacts when output voltage is lower than user-defined Ux_Thld while output current is higher than user-defined Ix_Thld

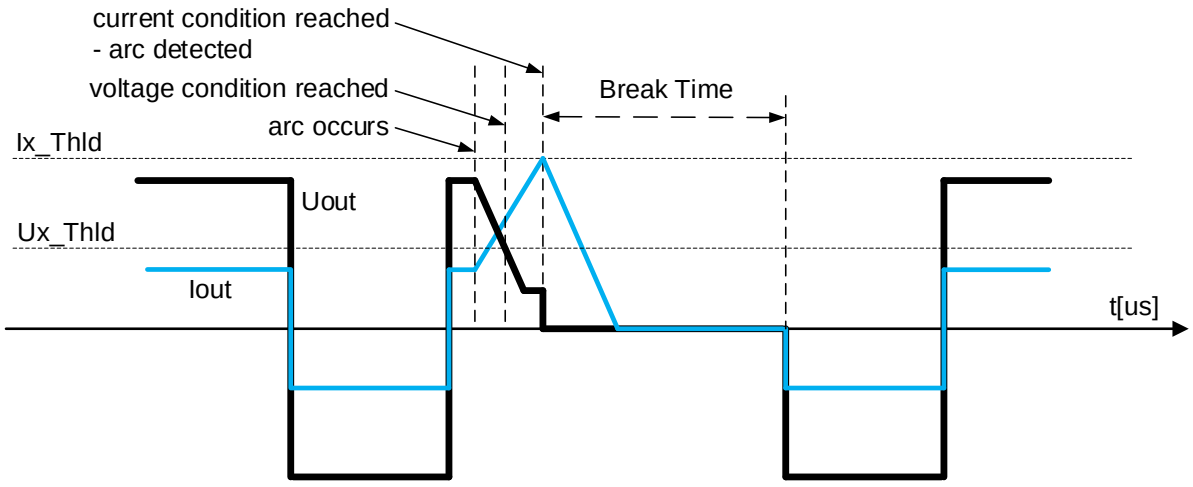


Fig. 5.3. **UxI** (cross detection) criterion arc detection example.

dU – voltage-based detector (microarc) – the generator remembers the shape of output voltage waveform from the last pulse. It compares momentarily output voltage value with corresponding value from the last pulse reduced by dU Thld %. If the present value is lower an arc is detected.

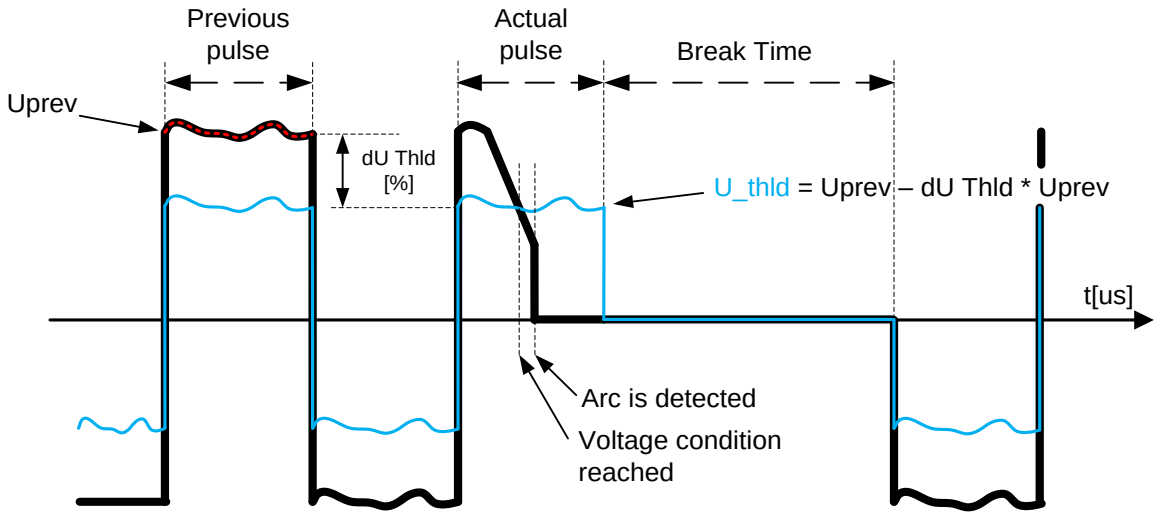


Fig. 5.4. **dU** (dynamic voltage change) criterion arc detection example.

Usag – Voltage-based detector – it compares RMS output voltage value of present pulse with RMS output voltage value of previous pulse reduced by Uout thld %. If present value is lower the sag is detected.

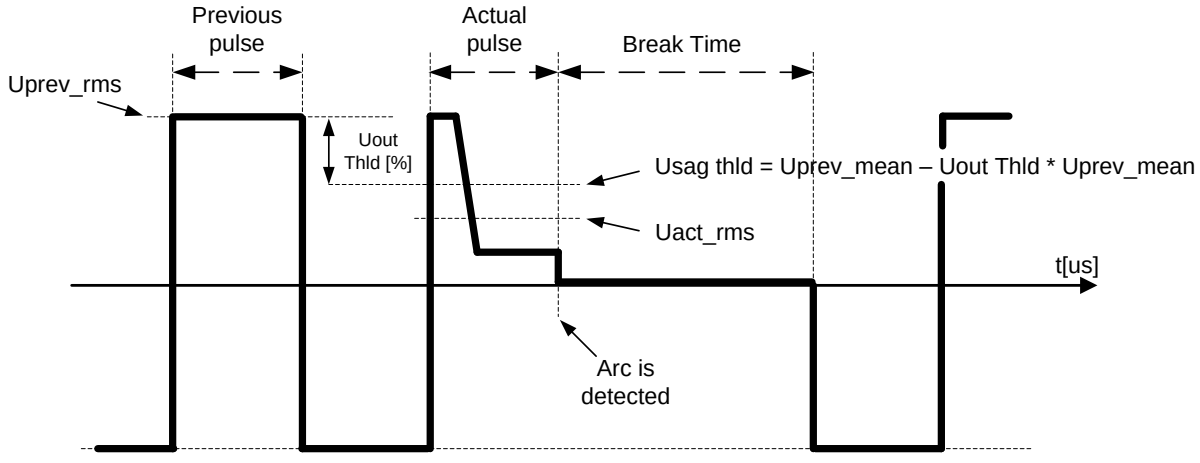


Fig. 5.5. **Usag** detection example.

Notes:

- In **TruPlasma Bipolar Series 4000 G2.1 PECVD** maximum frequency of detected and suppressed arcs can be as high as 20000Hz. This is valid only when cable length between power supply and load is no longer than 10 meters, otherwise frequency is limited to lower values (overheating protection).

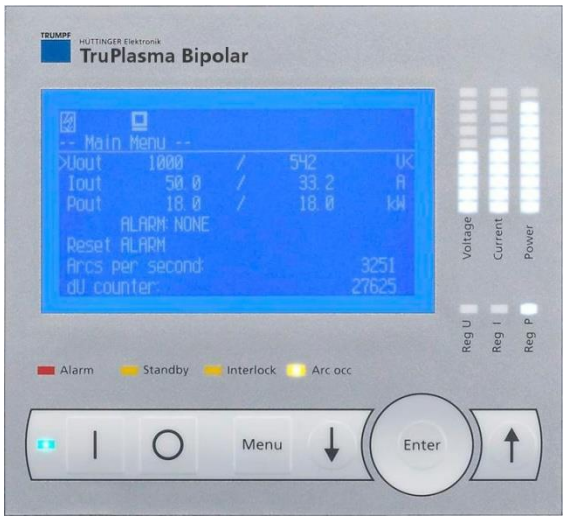
Number of detected arcs is displayed by the front panel display or can be read from communication interface with respect to the criteria which detects an arc.
Once an arc has been detected the output power is switched off. At the same moment, a time control procedure and **break time** counter are initiated.

After break time output power returns to its previous setting value. **Break time** parameter can be set through RS232 or RS485

6. Standard Operator Panel (SOP)

6.1. LED description

To increase interactive between customer and device, the Standard Operator Panel has the LED indicators. Even if user is remote from Power Supply, he can check most important process indicators and quickly respond. SOP has two kinds of LED indicators. First group are single LEDs which are corresponding to most important process events, for example: alarm, turn on, arc occur, etc. Second group are bar graphs which indicates levels for most important parameters, for example: actual voltage, actual power, etc. In case of the dual output unit the parameters and the settings concern only one output, there is a possibility in main menu to choose which one. Following table shows LED indicators used in SOP:



Function name	Color	Description
Standby	Yellow	Power supply is powered, but not yet switched-on.
ON	Green	Power supply is running.
Interlock	Yellow	Interlock or door-closed detection circuits are open.
Arc occ	Yellow	Blinks after an arc is detected.
Alarm	Red	Blinks when critical conditions occur. Audible signal/beep is also activated.
Reg U	White	Indicates that voltage regulator is currently active.
Reg I	White	Indicates that current regulator is currently active.
Reg P	White	Indicates that power regulator is currently active.
Bar Graph – Voltage	White	Level of actual output voltage.
Bar Graph – Current	White	Level of actual output current.
Bar Graph – Power	White	Level of actual output power.

6.2. Buzzer

To inform about warning or error events, the Standard Operator Panel has the buzzer. Beep signal is linked to Alarm LED signal. Buzzer became active when warning or alarm state occurs. It remains active until the user presses any button or resets alarms.

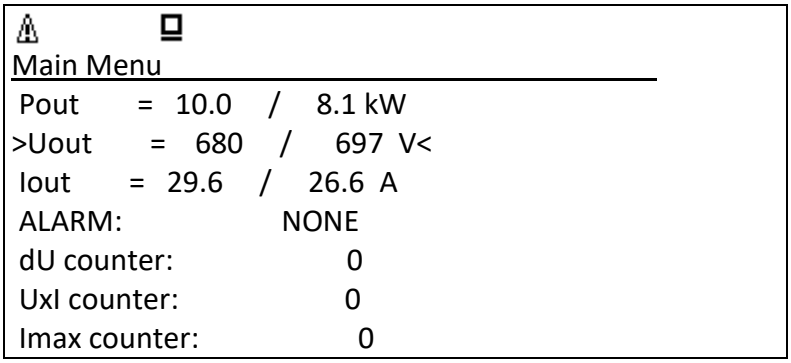
6.3. Screen saver

Standard Operator Panel has screen saver option which duration time is adjustable in menu. The user can either enable or disable screen saver by menu. The principle of screen saver is turn off the display backlight when is not any activity for some time in the device navigation.

6.4. Menu structure

Display interface has graphic and text areas:

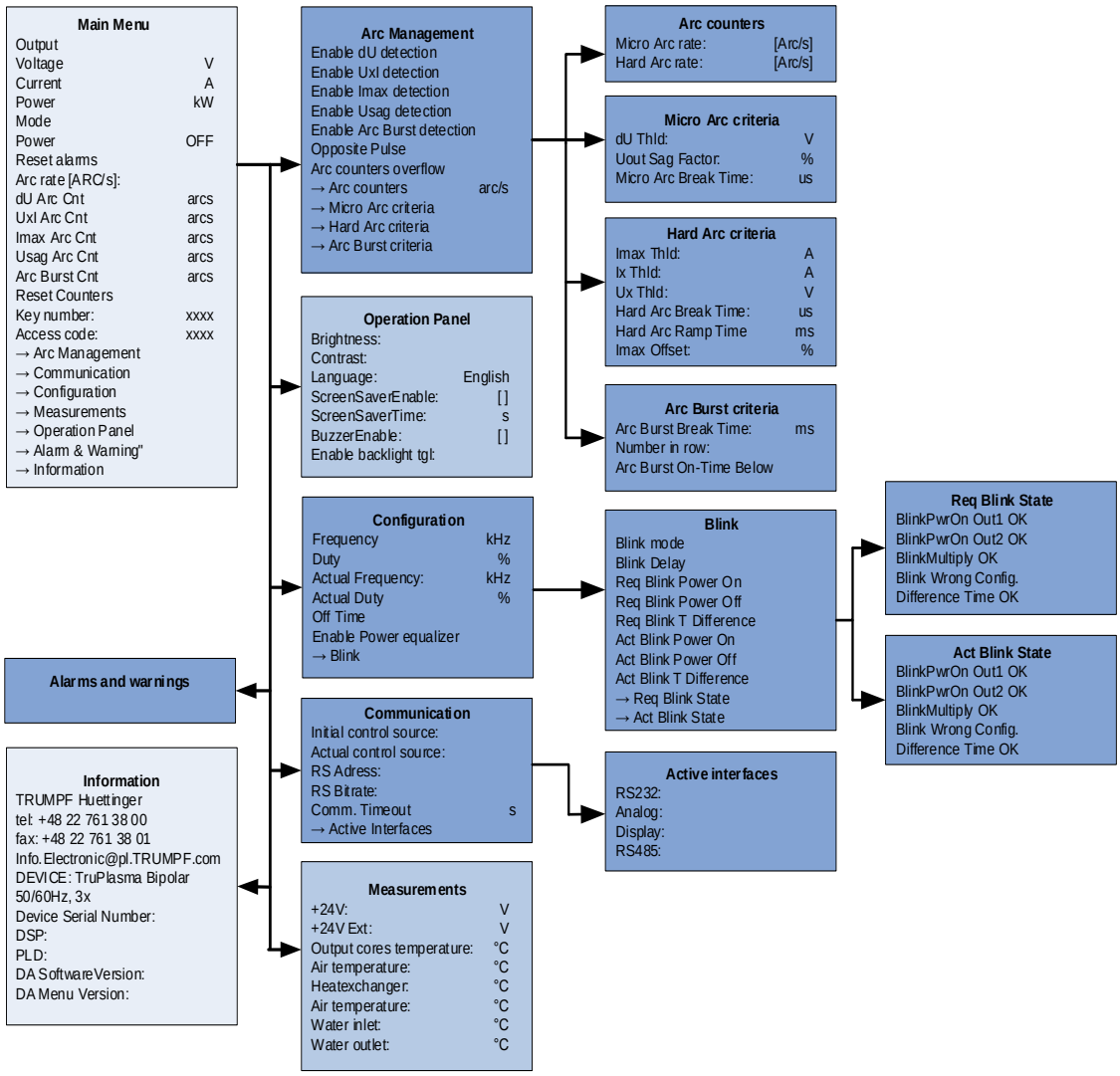
- Text area consists of six text lines at twenty characters showing the process parameters (see below).



- Graphic area consists of pictograms (see below). Those are small figures placed on the top of display. They are responsible for indicating the most important events for the process, for example: power on, warning or fault, etc.

Pictogram	Description
	Output power released
	Display control
	RS-232/485 control
	Profibus control
	DeviceNet control
	EtherCAT control
	Analog control
	Warning
	Alarm
	Unit works as a Master in parallel operation mode
	Unit works as a Slave in parallel operation mode
	NVR – Nearest Value Reached
	Power long ramp
	Current long ramp
	Output timer active
	End of output timer
	Ready
	Wait, not ready
	Setpoint limited
	OEM access mode
	STP access mode

Principle of menu navigation is use four pushbuttons (Menu, Enter, Up, Down). Menu of SOP has sub menu (three levels) structure. At the beginning of device operation SOP displays main page. The user can either choose parameters or sub menu on page by pressing Up or Down button and select it by Enter button. Each press Menu button brings user to upper level of menu structure.
ON and OFF buttons allow quick switching power on and off.



Access level:	STD	STP	OEM
Access code:	0	1	321

Fig.6.1. Standard Operator Panel menu structure.

6.5. Description of displayed data and settings

MAIN MENU – Basic controls and readouts

Display	Modif.	Description
Output	Yes	Number of output in the dual output case
Voltage	Yes	Voltage regulator setting (first number) and actual power supply's output voltage readout (second number).
Current	Yes	Current regulator setting (first number) and actual power supply's output current readout (second number).
Power	Yes	Power regulator setting (first number) and actual power supply's output power readout (second number).
Mode	Yes	Power supply working mode
Power	No	If control mode is set to DISPLAY panel, power supply can be switched on
Reset alarms	Yes	Reset occurred alarms, warnings.
Arc rate [Arc/s]	No	Arc frequency.
dU Arc Cnt	No	Number of arcs detected by dU criterion, which occurred since last counter reset (max 65535).
UxI Arc Cnt	No	Number of arcs detected by UxI criterion, which occurred since last counter reset (max 65535).
Imax Arc Cnt	No	Number of arcs detected by Imax criterion, which occurred since last counter reset (max 65535).
Usag Arc Cnt	No	Number of arcs detected by Usag criterion, which occurred since last counter reset (max 65535).
Arc Burst Cnt	No	Number of arcs detected by Arc Burst criterion, which occurred since last counter reset (max 65535).
Reset Counters	Yes	Reset arc counters. If dU counter(x100) is full, then counter will also be reset.
Key number: 123	No	Parameter for OEM access code generating (if necessary).
>Access code: STD <	Yes	Entering proper access code following menus are accessible: -> Arc Management OEM -> Communication OEM -> Configuration OEM -> Measurements STP, OEM -> Operation Panel STP, OEM -> Information STD, STP, OEM Access codes: STD – 0; STP – 1; OEM – 321.

Arc Management

Display	Modif.	Description
Enable dU detection	Yes	Enables or disables dU detection criterion.
Enable UxI detection	Yes	Enables or disables UxI detection criterion.
Enable Imax detection	Yes	Enables or disables Imax detection criterion.
Enable Usag detection	Yes	Enables or disables Usag detection criterion.
Enable ArcBurst detection	Yes	Enables or disables ArcBurst detection criterion.
Opposite pulse	Yes	When opposite pulse is on, after the break time the power starts from opposite pulse
Arc counters overflow	Yes	Resets the arc counter when it reaches max value
-> Arc counters		Submenus. See below.
->Micro arc criteria		Submenus. See below.
->Hard arc criteria		Submenus. See below.
->Arc burst criteria		Submenus. See below.

Arc Management –> **Arc counters**

Display	Modif.	Description
Micro Arc rate [ARC/s]	No	Number of micro arcs per second
Hard Arc rate [ARC/s]	No	Number of hard arcs per second

Arc Management –> **Micro arc criteria**

Display	Modif.	Description
dU Thld	Yes	Threshold value for dU criterion
Uout Sag Factor	Yes	Percentage value for Usag criterion
Micro Arc Break Time	Yes	Break time for micro arcs: dU and Usag

Arc Management –> **Hard arc criteria**

Display	Modif.	Description
Imax Thld	Yes	Threshold value for Imax criterion
Ix Thld	Yes	Current threshold value for UxI criterion
Ux Thld	Yes	Voltage threshold value for UxI criterion
Hard Arc Break Time	Yes	Break time for hard arcs: Imax and UxI
Hard Arc Ramp Time	Yes	Ramp time for hard arcs: Imax and UxI
Imax Offset	Yes	Offset for autoimax criterion

Arc Management –> **Arc burst criteria**

Display	Modif.	Description
Arc Burst Break Time	Yes	Break time for arc burst criterion
Number in row	Yes	Number of arcs to be detected for the arc burst criterion
Arc Burst On-Time Below	Yes	Amount of time for the arcs to be detected for the arc burst criterion

Communication

Display	Modif.	Description
Initial control source: RS232	Yes	Initial control source after reboot: **DISPLAY**, **ANALOG**, **RS232**, **EtherCAT**, **RS485**.
Actual control source: RS232	Yes	Control source of the power supply: **DISPLAY**, **ANALOG**, **RS232**, **EtherCAT**, **RS485**.
RS Adress= 255	Yes	RS address **[0…65535]**
RS Bitrate: 115200	Yes	Baud rate for RS communication **[9600, 19200, 38400, 57600, 115200]**
Comm. Timeout	Yes	Delay time for communication lost alarm generating **[0…65s]**
Active Interfaces		Possibility to choose from below: ➔ RS232 ➔ Analog ➔ Display ➔ RS485

Configuration

Display	Modif.	Description
Frequency	Yes	Frequency settings for bipolar mode **[5…50 kHz]**
Duty	Yes	Duty settings for bipolar mode **[1…99 %]**
Actual Frequency	No	Actual set frequency
Actual Duty	No	Actual set duty
Off Time	Yes	Off time for Bipulse and Trapeze modes **[0…20%]**
Enable Power Equalizer	Yes	Enables or disables power equalizer
Blink		Submenus. See below.

Configuration –> **Blink**

Display	Modif.	Description
Blink Mode	Yes	Enables or disables blink mode
Blink Delay	Yes	Blink delay settings
Req Blink Power On	Yes	Requested by user power on time
Req Blink Power Off	Yes	Requested by user power off time
Req Blink T Difference	Yes	Actual time difference between blinks
Act Blink Power On	No	Actual power on time
Act Blink Power Off	No	Actual power off time
Act Blink T Difference	No	Actual time difference between blinks
Req Blink State		Current blink settings
Act Blink State		Current blink settings

Measurements

Display	Modif.	Description
+24V:	No	Internal power supply output voltage.
+24V Ext:	No	Internal PCB voltage
Output cores temperature	No	Temperature of output cores
Air temperature	No	Temperature of air at control PCB.
Heatexchanger	No	Temperature of heat exchanger.
Air temperature	No	Temperature of air at control PCB.
Water inlet	No	Temperature of inlet water.
Water outlet	No	Temperature of outlet water.

Operation Panel

Display	Modif.	Description
Brightness	Yes	LCD screen brightness. **[0…100%]**
Contrast	Yes	LCD screen contrast. **[0…100%]**
Language	Yes	Not used. Default language is English.
ScreenSaverEnable	Yes	Enables or disables screen saver.
Screen Saver Time:	Yes	Screen saver delay time. **[1…60min]**
BuzzerEnable	Yes	Enables or disables buzzer.
Enable Backlight toggle	Yes	Enable or disables backlight toggle

7. Digital interfaces

7.1. RS232/RS485 transmission protocol description

MP acts as a slave device in the communication process. It never initiates any transmissions. Computer (PC) sends a command which is executed by MP and a reply is generated (see note 1). Standard commands are shown below. Additional commands can be implemented if necessary. Baud rate can be chosen by byte channel no. 28. Default value is 115200 bps. The RS communication works in standard 8n1 (8 bits of data, non parity, 1 bit of stop, LSB first).

Frame general description

Command:

0	1	2	3	4	5	6	7	...	
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	CMD_H	CMD_L	…	
							...	LEN-2	LEN-1
							...	CRC_H	CRC_L

Reply:

0	1	2	3	4	5	6	7	8	9
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
...							…	LEN-2	LEN-1
…							…	CRC_H	CRC_L

Where: LEN, ~LEN: length and inverted length (byte, byte);

DST_H, DST_L: receiver number (word); - default value for RS232 is:

Output 1:

DST_H = 0x00;

DST_L = 0x01;

Output 2:

DST_H = 0x00;

DST_L = 0x02;

SRC_H, SRC_L: sender number (word); - default value for RS232 is:

SRC_H = 0x00;

SRC_L = 0x00;

CMD_H, CMD_L: command code (word);

CRC_H, CRC_L: checksum (word); - all bytes sum (without LEN and ~LEN);

ACK_H, ACK_L: reply code (word);

ACK == 0x4000 => OK.

ACK != 0x4000 => fault

6040 Normal run

PC to unit:

0	1	2	3	4	5	6	7	8-11	12-15
0x17	0xE8	DST_H	DST_L	SRC_H	SRC_L	0x60	0x40	$Uset_{0-3}$	$Iset_{0-3}$
16-19	20	21	22						
$Pset_{0-3}$	Ctrl Bits	CRC_H	CRC_L						

Where:

Uset (float)	Voltage set point [V]	0…U_n V
Iset (float)	Current set point [A]	0…I_n A
Pset (float)	Power set point [kW]	0…P_n kW

Ctrl Bits:

0: Mains relays ON (1), OFF (0) (edge sensitive 0⟶1), OFF (0)
1: Power ON (1), OFF (0) (edge sensitive 0⟶1), OFF (0)
2: Reset arc counters (1 transmission is sufficient)
3: RS controls the generator unit (edge sensitive 0⟶1)
4: -
5: -
6: -
7: Reset Alarms

IMPORTANT: When controlling Bipolar unit digitally, (by way of RS232) a command must be sent at least once every 3 seconds to keep power supply running. If, for any reason, transmission fails – an alarm "ActSourceFail " (code 61613) will appear after 4-5 seconds and power supply will be switched off.

unit reply to PC

0	1	2	3	4	5	6	7	8	9
0x2A	0xD5	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-25	26-27	28-29	30-31	32-33	34-35	36-39
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-3}$	$Imax_{0-1}$	UxI_{0-1}	dU_{0-1}	$Usag_{0-1}$	$ArcBurst_{0-1}$	Arc/s_{0-3}
40	41								
CRC_H	CRC_L								

Where:

Uact (float)	Output mean voltage [V]	0...U_n V
Iact (float)	Output peak current [A]	0...I_n A
Pact (float)	Output mean power [kW]	0...P_n kW

Bits0: Acknowledge bits.
- 0: Relays ON acknowledge (1), or OFF (0)
- 1: Power ON (1), INHIBIT (0)
- 2: Ready
- 3: RS232/485 control
- 4: -
- 5: MessageRead (1)
- 6: -
- 7: PlasmaBit ON (1), OFF (0)

Bits1: more acknowledge bits.
- 0: -
- 1: -
- 2: -
- 3: -
- 4: Full
- 5: BiPulse
- 6: Trapez
- 7: -

Bits2: more acknowledge bits.
- 0: Interlock (1), no interlock (0)
- 1: -
- 2: -
- 3: FPGA OK (1), error(0)
- 4: Power Off Sequence
- 5: -
- 6: Warning Active (1), inactive (0).
- 7: Alarm Active (1), inactive (0).

Bits3: more acknowledge bits.
- 0: RegU ON (1), OFF (0)
- 1: RegI ON (1), OFF (0)
- 2: RegP ON (1), OFF (0)
- 3: -
- 4: Blink Internal
- 5: Blink External
- 6: -
- 7: Arc occ.

Imax (integer)	Arc counter (Imax criterion)	0...65535
UxI (integer)	Arc counter (UxI criterion)	0...65535
dU (integer)	Arc counter (dU criterion)	0...65535
Usag (integer)	Arc counter (Usag criterion)	0...65535
Arc Burst	Arc counter (Arc Burst criterion)	0...65535
Arc/s(float)	Arcs per second counter	

6141 Set a floating point value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x10	0xEF	DST_H	DST_L	SRC_H	SRC_L	0x61	0x41	CHN_H	CHN_L
10	11	12	13	14	15				
VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L				

Where:

CHN (int)	Channel number
Val (float)	Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x41
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int)	Channel number

6142 Read a floating point value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x42	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int)	Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x12	0xED	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x42
10	11	12	13	14	15	16	17		
CHN_H	CHN_L	VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L		

Where:

CHN (int)	Channel number
Val (float)	Value to be set

6151 Set an double integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x10	0xEF	DST_H	DST_L	SRC_H	SRC_L	0x61	0x51	CHN_H	CHN_L
10	11	12	13	14	15				
VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L				

Where:

CHN (int) Channel number
Val (int) Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x51
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number

6152 Read an double integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x52	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x12	0xED	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x52
10	11	12	13	14	15	16	17		
CHN_H	CHN_L	VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L		

Where:

CHN (int) Channel number
Val (float) Value to be set

6121 Set an integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	0x61	0x21	CHN_H	CHN_L
10	11	12	13						
VAL_H	VAL_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number
Val (int) Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x21
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number

6122 Read an integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x22	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x10	0xEF	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x22
10	11	12	13	14	15				
CHN_H	CHN_L	VAL_H	VAL_L	CRC_H	CRC_L				

Where:

CHN (int) Channel number
Val (float) Value to be set

6111 Set a byte value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0D	0xF2	DST_H	DST_L	SRC_H	SRC_L	0x61	0x11	CHN_H	CHN_L
10	11	12							
VAL	CRC_H	CRC_L							

Where:

CHN (int) Channel number
Val (int) Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x11
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number

6112 Read a byte value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x12	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0F	0xF0	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x12
10	11	12	13	14					
CHN_H	CHN_L	VAL	CRC_H	CRC_L					

6301 Read alarm code and description

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0A	0xF5	DST_H	DST_L	SRC_H	SRC_L	0x63	0x01	CRC_H	CRC_L

Unit reply:

0	1	2	3	4	5	6	7	8	9
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x63	0x01
10	11	12 to n-2				n-1	n		
$CODE_H$	$CODE_L$	Description				CRC_H	CRC_L		

6302 Read again last alarm code and description

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0A	0xF5	DST_H	DST_L	SRC_H	SRC_L	0x63	0x02	CRC_H	CRC_L

Unit reply:

0	1	2	3	4	5	6	7	8	9
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x63	0x02
10	11	12 to n-2				n-1	n		
$CODE_H$	$CODE_L$	Description				CRC_H	CRC_L		

6101 Identification of device:

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0A	0xF5	DST_H	DST_L	SRC_H	SRC_L	0x61	0x01	CRC_H	CRC_L

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x19	0xE6	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x77	0x01
10	...	22	23	24					
S_{00}	...	S_{12}	CRC_H	CRC_L					

Where: $S_{00} \div S_{12}$: device type (char[13]);

Channel numbers:

Byte:

Channel	Description	Range	Adjustable ?
20	Ctrl Src Act 0: RS232 1: Analog 3: Display 4: RS485 7: USB	1 ... 255	YES
19	Ctrl Src Ini 0: RS232 1: Analog 3: Display 4: RS485 7: USB	1 ... 255	YES
18	Active Interfaces 0: RS232 1: Analog 3: Display 4: RS485 7: USB	1 ... 255	YES
803	Power Equ Bits 0: Enable	0 ... 1	YES
202	Arc Cnt Overflow 0: Arc Cnt Ovfl	0 ... 1	YES
33	Bipulse Mode 2: Full 3: BiPulse 4: Trapez	4 ... 16	YES
265	Number in row	1 ... 100	YES
261	Imax Offset [%]	0 ... 100	YES
252	Uout Sag Factor [%]	10 ... 50	YES
604	Req Blink Stat 0: BlinkPwrOn Out1 OK 1: BlinkPwrOn Out2 OK 2: BlinkMultiply OK 3: Blink Wrong Config.	-	NO
200	Arc Enable Bits 0: dU En 1: UxI En 2: Imax En 3: Usag En 4: Arc Burst En	0 ... 31	YES
650	Off Time [%]	1 ... 20	YES
28	RS Speed 0: 9600 1: 19200 2: 38400 3: 57600 4: 115200	1 ... 255	YES

602	Blink Cfg 0: Internal Blink 1: External Blink	0 ... 2	YES
605	Act Blink Stat 0: BlinkPwrOn Out1 OK 1: BlinkPwrOn Out2 OK 2: BlinkMultiply OK 3: Blink Wrong Config.	-	NO
209	Arc Config Bits 0: Opposite Pulse	0 ... 1	YES

Word:

Channel	Description	Range	Adjustable ?
276	Arc Burst On-Time Below [us]	1 ... 1000	YES
13	This Module RS Address	-	NO
5	Communication Timeout [s]	0 ... 65	YES
275	Arc Burst Break Time [us]	25 ... 10000	YES
3	Base RS Address	1 ... 65535	YES

DWord:

Channel	Description	Range	Adjustable ?
100	Serial Number	-	NO
900	DSP SW ver.	-	NO
901	FPGA SW ver.	-	NO

Float:

Channel	Description	Range	Adjustable ?
938	T2 CC 1 [°C]	-	NO
937	T1 CC 1 [°C]	-	NO
936	T0 CC 1 [°C]	-	NO
234	Hard Arc Rate [arc/s]	-	NO
208	Ux Thld [V]	0 ... 800	YES
233	uRate [arc/s]	-	NO
920	CMPC Supply [V]	-	NO
256	dU Thld [%]	0 ... 100	YES
251	Micro Arc BT [us]	10 ... 1000	YES
207	Ix Thld [A]	$0.1I_n$ ... $1.0I_n$	YES
205	Imax Thld [A]	$0.1I_n$ ... $1.3I_n$	YES
600	Blink Power On Act [ms]	-	NO
921	+24V Ext. [V]	-	NO
51130	Frequency [kHz]	5 ... 50	YES
51141	Duty [%]	-	NO
932	T0 [°C]	-	NO
51131	Duty [%]	1 ... 99	YES

237	Hard Arc Ramp Time [ms]	0 ... 2	YES
51140	Frequency [kHz]	-	NO
617	Req Blink Power Off [ms]	1 ... 500	YES
939	T3 CC 1 [°C]	-	NO
250	Hard Arc BT [us]	10 ... 2000	YES
616	Req Blink Power On [ms]	1 ... 500	YES
601	Blink Power Off Act [ms]	-	NO
602	Blink Delay [ms]	0 ... 4	YES
933	T1 [°C]	-	NO

Acknowledge and failure codes (HEX format)

4000 Transmission OK and command executed.
4001 Transmission length error. Byte1 is not a cancellation of Byte0.
4002 Check sum error. The two byte checksum is not equal to sum of bytes no. 2 … (n-2).
4004 Unknown Command.
4006 Channel address not exist.
4010 Write EEPROM error.
4020 Write EEPROM disabled by slave mode (6141, 6121, 6111).
4030 Write EEPROM disabled.
4031 Written value is above upper limit.
4032 Written value is below lower limit.

7.2 Profibus transmission protocol description

Profibus is an interface that allows Bipolar units to communicate with Profibus master. Bipolar power supply (Bipolar4000) acts as a slave device in the communication process. It never initiates transmission. Profibus master sends commands coded in modules, which are executed by power supply, and a reply is generated. Convenient and flexible construction of Profibus profile allows user to construct all communication (length of input and output buffer) via Profibus by using only one module or several modules. It is only limited by the imagination and innovation of customer. Recognized modules are presented below, but new functional modules can be implemented for special orders.

Baud Rate for communication between Profibus master and Profibus slave
Profibus slave (Bipolar4000) has an auto–baudrate feature which adjusts automatically to rate of Profibus master system during start-up. Baud rates are accessible in a range from 9.6 kbits to 12 Mbits.

Setting Profibus ID

ID number is set via front panel console (if available) or through RS232 or Profibus. Software activates ID number once after reset, therefore, if ID number has been changed unit must be restarted (powered-off completely and powered-on again).

Profibus module construction

BIPOLAR4000 uses transmission modules, which have different byte length. Module sequences and their quantities can be different (choice of modules and length of frame depends only on user) in conditions when there are no more than 20 modules and the quantity of maximum input and output bytes does not exceed 80. It is always possible to increase this limitation by special order.
All integer (2 bytes) values are listed with the most significant byte (MSB) coming first. Floating-point values can be represented in both: INTEL and MOTOROLA standards. The standard of floating-point values is set via front panel console, by RS232 or Profibus (ref. to module 21 or module 22 descriptions). Additional modules can be implemented if necessary. All modules (except modules 21 and 22) are available from channel level of module 21 (as an integer value) and module 22 (as a floating point number). All types of modules are presented below.

Control Bits:
First Output: Module 1 ident. 0x82,0x00,0x00,0x01
Second Output: Module 65 ident. 0x82,0x00,0x00,0x41

This module is represented by one byte which includes 8 control bits:

LSB 0: Profibus master controls unit (rising edge 0→1), release ctrl (0).
1: -
2: Mains relays ON (1)(edge sensitive 0→1), OFF (0).
3: Power ON (1) (edge sensitive 0→1), OFF (0).
4: Alarms Reset (edge sensitive 0→1)
5: Reset arc counters (edge sensitive 0→1)
6: -
MSB 7: -

Voltage SetPoint:

Voltage SetPoint in integer format:
First Output: Module 2 ident. 0x82,0x01,0x00,0x02
Second Output: Module 66 ident. 0x82,0x01,0x00,0x42

This module consists of two bytes, which represent voltage setpoint value in a 16-bit integer format. The full voltage range of power supply:

0 … Un [V]

is represented by a

0 … Uscale integer value

integer value = Uscale * Uset / Un
where:
Uset – voltage setpoint
Un – nominal voltage of power supply
Uscale – user defined setting – can be set via front panel, by RS232 or Profibus (ref. to description of module 21, 22 for first output, or module 85, 86 for second output).

Note: Resolution depends on Uscale value.
If module is not selected Voltage SetPoint value is set to previous value (ex. value which was set by Modules 8, 9, 21 or 22).

Voltage SetPoint value in a floating-point format:
First Output: Module 3 ident. 0x82,0x03,0x00,0x03
Second Output: Module 67 ident. 0x82,0x03,0x00,0x43

This module consists of 4 bytes which represent voltage setpoint value in a floating-point format with respect to a selected standard. This value must not exceed nominal output voltage of power supply - Un [V].

Note: If module is not selected Voltage SetPoint value is set to previous value (ex. value which was set by Modules 8, 9, 21 or 22).

Current SetPoint:

Current SetPoint in integer format:

First Output:	**Module 4**	ident. 0x82,0x01,0x00,0x04
Second Output:	**Module 68**	ident. 0x82,0x01,0x00,0x44

This module consists of two bytes which represent current setpoint value in a 16-bit integer format.
Full current range of power supply
0 … In [A]
is represented by a
0 … Iscale integer value
integer value = Iscale * Iset / In
where:
Iset – current setpoint
In – nominal current of power supply
Iscale – user defined setting – can be set via Front Panel, RS232 or Profibus (ref. to description of module 21, 22 for first output, or module 85, 86 for second output).

Note: Resolution depends on Iscale value.
If module is not selected Current SetPoint value is set to previous value (ex. value which was set by Modules 8, 9, 21 or 22).

Current SetPoint in a floating point-format:

First Output:	**Module 5**	ident. 0x82,0x03,0x00,0x05
Second Output:	**Module 69**	ident. 0x82,0x03,0x00,0x45

This module consists of 4 bytes which represent the current setpoint value in a floating-point format with respect to selected standard. This value must not exceed nominal output current of power supply - In.[A]

Note: If module is not selected Current SetPoint value is set to previous value (ex. value which was set by Modules 8, 9, 21 or 22).

Power Setpoint:

Power SetPoint in integer format:

First Output:	**Module 6**	ident. 0x82,0x01,0x00,0x06
Second Output:	**Module 70**	ident. 0x82,0x01,0x00,0x46

This module consists of two bytes which represent power setpoint value in a 16-bit integer format.
The full power range of power supply
0 … Pn [kW]

is represented by a

0 … Pscale integer value

integer value = Pscale * Pset / Pn

where:

Pset – power setpoint

Pn – nominal power of power supply

Pscale – user defined setting – can be set via front panel, through RS232 or Profibus (ref. to description of module 21, 22 for first output, or module 85, 86 for second output).

Note: The resolution depends on Pscale value.

If module is not selected Power SetPoint value is set to previous value (ex. value which was set by Modules 8, 9, 21 or 22).

Power SetPoint in a floating point format:

First Output:	**Module 7**	ident. 0x82,0x01,0x00,0x07
Second Output:	**Module 71**	ident. 0x82,0x01,0x00,0x47

This module consists of 4 bytes, which represent power setpoint value (P_mean) in a floating-point format with respect to selected standard. This value must not exceed nominal output power of the power supply - Pn [kW].

Note: If module is not selected Power SetPoint value is set to previous value (ex. value which was set by Modules 8, 9, 21 or 22).

Actual output voltage:

Actual output voltage value in integer format:

First Output:	**Module 12**	ident. 0x42,0x01,0x00,0x0C
Second Output:	**Module 76**	ident. 0x42,0x01,0x00,0x4C

This module consists of two bytes and shows actual output voltage value in 16-bit integer format.

Full voltage range of power supply

0 … Un [V]

is represented by a

0 … Uscale integer value

integer value = Uscale * Uact / Un

where:

Uact – actual output mean voltage

Un – nominal mean voltage

Uscale – user defined setting – can be set via front panel by RS232 or Profibus (see description of module 21, 22 for first output, or module 85, 86 for second output).

Note: Resolution depends on Uscale value.

Actual output voltage value in a floating-point format:

First Output:	**Module 13**	ident. 0x42,0x03,0x00,0x0D
Second Output:	**Module 77**	ident. 0x42,0x03,0x00,0x4D

This module consists of 4 bytes which represent actual output voltage value in a floating-point format with respect to selected standards.

Actual output current:

Actual output current value in integer format:

First Output:	**Module 14**	ident. 0x42,0x01,0x00,0x0E
Second Output:	**Module 78**	ident. 0x42,0x01,0x00,0x4E

This module consists of two bytes and displays actual output current value in 16-bit integer format.
Full current range of power supply
0 … In [A]
is represented by a
0 … Iscale integer value

integer value = Iscale * Iact / In
where:
Iact – actual output peak current
In – nominal peak current
Iscale – user defined setting – can be set via front panel by RS232 or Profibus
(see description of module 21, 22 for first output, or module 85, 86 for second output).

Note: The resolution depends on Iscale value.

Actual current value in a floating-point format:

First Output:	**Module 15**	ident. 0x42,0x01,0x00,0x0F
Second Output:	**Module 79**	ident. 0x42,0x01,0x00,0x4F

This module consists of 4 bytes which represent actual output current value in a floating-point format with respect to selected standard.

Actual output power :

Actual output power in integer format:

First Output:	**Module 16**	ident. 0x42,0x01,0x00,0x10
Second Output:	**Module 80**	ident. 0x42,0x01,0x00,0x50

This module consists of two bytes which represent actual output power value in a 16-bit integer format.

The full power range of power supply
0 … Pn [kW]
is represented by a
0 … Pscale integer value

integer value = Pscale * Pact / Pn
where:
Pact – output mean power
Pn – nominal mean power
Pscale – user defined setting – can be set via front panel by RS232 or by Profibus
(see description of module 21, 22 for first output, or module 85, 86 for second output).
Note: Resolution depends on Pscale value.

Actual output power value in a floating-point format:

First Output:	**Module 17**	ident. 0x42,0x01,0x00,0x11
Second Output:	**Module 81**	ident. 0x42,0x01,0x00,0x51

This module consists of 4 bytes which represent actual output power value in a floating-point format with respect to a selected standard.

Actual pulse generator settings:

Actual Frequency:

First Output:	**Module 18**	ident. 0x82,0x00,0x00,0x12
Second Output:	**Module 82**	ident. 0x82,0x00,0x00,0x52

This module consists of two bytes (big endian) which represent actual Frequency value in kHz with 10:1 scale.
Values 50 … 500 represent a frequency setting of 5kHz…50kHz.

Actual pulse time/duty time:

First Output:	**Module 19**	ident. 0x82,0x00,0x00,0x13
Second Output:	**Module 83**	ident. 0x82,0x00,0x00,0x53

This module consists of two bytes (big endian) which represent Duty value in % with 10:1 scale.
Values 1…999 represent a Duty setting of 0.1…99.9%.

Acknowledgement Bits:

First Output: **Module 20** ident. 0x42,0x02,0x00,0x14
Second Output: **Module 84** ident. 0x42,0x02,0x00,0x54

This module consists of 3 bytes which present basic binary status data. These bytes are described below.

Bit	name	description
Byte 0		
0	Profibus Ctrl Ack	= 1 when the unit is controlled by Profibus commands = 0 when the unit is controlled from other sources
1	-	-
2	Relays ON	= 1 when power relays are switched ON inside unit
3	Power ON	= 1 when output power is enabled
4	Toggle Bit	Bit toggled with frequency equal 1Hz
5	Bipolar Mode Ack	= 1 if unit is set to Full, Bipulse or Trapez mode
6	-	-
7	Ready	= 1 is Power Supply is ready to turn on
Byte 1		
0	Interlock Ack	= 1 when interlock loop is open
1	Over Temp	= 1 when unit overheats
2	Power Fault	= 1 when mains voltage is too low or one phase is missing
3	FPGA Fault	= 1 if FPGA unit fails
4	-	-
5	-	-
6	Warning active	= 1 if any warning state is active
7	Alarm Active	= 1 if any alarm state is active
Byte 2		
0	RegU Ack	These 3 bits display output parameter (voltage, current or power), which is actually limited by controller. E.g. bit0=1; bit2=0 at no load conditions even if power control mode is selected.
1	RegI Ack	
2	RegP Ack	
3	-	-
4	-	-
5	-	
6	-	-
7	-	-

General set / read modules:

All remaining settings and readouts can be accessed through two types of input / output modules:
module 21 for setting/reading in an integer format (first output)
module 22 for setting/reading in a floating-point format (first output)

module 85 for setting/reading in an integer format (first output)
module 86 for setting/reading in a floating-point format (first output)

Module 21 or 22 may appear in configuration only once and they cannot be present together. The same restriction is for modules 85 and 86.
If more than one module 21/85 or module 22/86 or both will appear in configuration, special flag Configuration Fault will be rised. The same restriction is for modules 85 and 86.

Set/read parameter in an integer format:

First Output:	**Module 21**	ident. 0xC1,0x03,0x03,0x15
Second Output:	**Module 85**	ident. 0xC1,0x03,0x03,0x55

Output bytes

1	2	3	4
Data group	Channel	Integer value	
Out_Byte 0	Out_Byte 1	Out_Byte 2	Out_Byte 3

Input bytes

1	2	3	4
Data group	Channel	Integer value	
In_Byte 0	In_Byte 1	In_Byte 2	In_Byte 3

First byte Out/In_Byte0 defines data group number (see table below). Second byte (Out/In_Byte1) represents channel number which is assigned to a parameter. One channel is dedicated for reading and another for the setting of a parameter. The last 2 bytes show actual (In_Byte2 and In_Byte3) or set (Out_Byte2 and Out_Byte3) value of parameter.
Setting and readout should be set or interpreted with respect to range and scale specified in table below. For instance, setting value of 250V to dUOFF parameter (data group=11, channel=5) requires a value of 2500 to be placed in Out_Byte2 and Out_Byte3 (Out_Byte2=0x09; Out_Byte3=0xC4).

Set/read parameter in a floating-point format:

First Output: Module 22 ident. 0xC1,0x05,0x05,0x16

Second Output: Module 86 ident. 0xC1,0x05,0x05,0x56

Output bytes

1	2	3	4	5	6
Data group	Channels	Floating-point value			
Out_Byte 0	Out_Byte 1	Out_Byte 2	Out_Byte 3	Out_Byte 4	Out_Byte 5

Input bytes

1	2	3	4	5	6
Data group	Channels	Floating-point value			
In_Byte 0	In_Byte 1	In_Byte 2	In_Byte 3	In_Byte 4	In_Byte 5

First byte (Out/In_Byte0) defines data group number (see table below). Second byte (Out/In_Byte1) represents channel number which is assigned to parameter. One channel is dedicated for reading and another for setting parameters. Last 4 bytes show actual (In_Byte2 - In_Byte5) or set (Out_Byte2 - Out_Byte5) value of parameters in floating-point format with respect to selected standard.

Important:

1. **Only specified channel numbers can be used to access data.**
2. **In some instances it takes up to 50ms for a newly set variable to be updated in power supply's control system. Reading such variable at this time may result in display of previous value.**
3. **All values can be accessed in an integer or floating-point format. Binary values for floating point format will be shown as 0.0 (for low) or 1.0 (for high).**
4. **It is impossible to work with module 21 and 22 or 85 and 86 simultaneously. If both are selected then configuration fault error will be notified.**

List of data channels accessible through Profibus (see next page):

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
1	2: Control Bits	The 8 bits represent conditions described in Module 1 – Controls Bits		Channel available for reading only. values in floating-point format range from 0.0 … 255.0.
	4: Acknowledgement Bits - Byte0	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte0		
	8: Acknowledgement Bits – Byte1	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte1		
	16: Acknowledgement Bits – Byte2	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte2		
	32: Work Mode	bit 0: - bit 1: - bit 2: - bit 3: - bit 4: Full bit 5: BiPulse bit 6: BiPulseTrapez		
	3: Bits	The 8 bits represent conditions described in Module 1 – Controls Bits		Channel available for setting only. values in floating-point format will range from 0.0 … 255.0.
	33: Work Mode	Bit 0: - bit 1: - bit 2: - bit 3: - bit 4: Full bit 5: BiPulse bit 6: BiPulseTrapez		
2	2: Actual Power setpoint	0…P_n[kW]	0…Pscale	read only
	4: Actual Power output	0…P_n[kW]	0…Pscale	
	8: Nominal Power output	0…P_n[kW]	0…Pscale	
	16: Actual average output power – Pulse A	0…P_n[kW]	0…Pscale	
	32: Actual average output power – Pulse B	0…P_n[kW]	0…Pscale	
	3: Power Setpoint	0…P_n[kW]	0…Pscale	set only, if module 6,7,8,9 wasn't selected
3	2: Actual Voltage setpoint	0…U_n[V]	0…Uscale	read only
	4: Actual Voltage output	0…U_n[V]	0…Uscale	
	8: Nominal Voltage output	0…U_n[V]	0…Uscale	
	3: Voltage Setpoint	0…U_n[V]	0…Uscale	set only, if module 2,3,8,9 wasn't selected

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
4	2: Actual Current setpoint	0…I_n[A]	0…Iscale	read only
	4: Actual Current output	0…I_n[A]	0…Iscale	
	8: Nominal Current output	0…I_n[A]	0…Iscale	
	3: Current Setpoint	0…I_n[A]	0…Iscale	set only, if module 4,5,8,9 wasn't selected
6	2: Frequency set point	5…50[kHz]	1:10	read only
	4: Actual Frequency	5…50[kHz]	1:10	
	3: Frequency set point	5…50[kHz]	1:10	set only
7	2: Duty set point	1…99[%]	1:1	read only
	4: Actual Duty	1…99.9[%]	1:10	read only This channel represent conditions described in Module 19/83
	3: Duty set point	1…99[%]	1:1	set only
10	2: selection of the arc detection criterion	5 low order bits of the low order byte represent the enabled (1) or disabled (0) states: bit 0: dU criterion bit 1: UxI criterion bit 2: Imax criterion bit 3: Usag enable bit 4: ArcBurst enable		read only values in floating-point format will be in the range of 0.0 … 31.0
	3: set arc detection Criterion	use low order bits of the low order byte to enable (1) or disable (0) the criterion: bit 0: dU criterion bit 1: UxI criterion bit 2: Imax criterion bit 3: Usag enable bit 4: ArcBurst enable		set only
11	2: dU Threshold	1 … 100[%]	1:1	read only
	4: uArc Break Time	10 ... 1000[us]	1:1	
	8: Uout Sag Factor	10 ... 50[%]	1:1	
	3: dU Threshold	1 … 100[%]	1:1	set only
	5: uArc Break Time	10 ... 1000[us]	1:1	
	9: Uout Sag Factor	10 ... 50[%]	1:1	
12	2: Ux Threshold	0 … 800[V]	1:10	read only
	4: Ix Threshold	0.1I_n … I_n [A]	(0.1 … 1)Iscale	
	3: Ux Threshold	0 … 800[V]	1:10	set only
	5: Ix Threshold	0.1I_n … I_n [A]	(0.1 … 1)Iscale	
13	2: Imax Threshold	0.1I_n … 1.3I_n [A]	(0.1 … 1.3)Iscale	read only
	4: Imax Offset	0 …100[%]	1:1	
	16: Hard Arc Break Time	10 … 2000[us]	1:1	
	32: Hard Arc Ramp Time	0 … 2[us]	1:10	
	3: Imax Threshold	0.1I_n … 1.3I_n A	(0.1 … 1.3)Iscale	set only
	5: Imax Offset	0 …100%	1:1	
	17: Hard Arc Break Time	10 … 2000[us]	1:1	
	33: Hard Arc Ramp Time	0 … 2[us]	1:10	

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
15	2: Arc Config Bits	bit 0: opposite pulse		read only
	4: Arc Counters Overflow	bit 0: arc counters overflow		
	3: Opposite Pulse	bit 0: opposite pulse		set only
	5: Arc Counter Overflow	bit 0: arc counters overflow		
21	2: dU Counter	0 … 65535	1:1	read only Arc counters with respect to the arc detection criteria.
	4: UxI Counter	0 … 65535	1:1	
	8: Usag Counter	0 … 65535	1:1	
	16:Imax Counter	0 … 65535	1:1	
	32:uArc Rate	0 … 10000[/sec]	1:1	
	64:Hard Arc Rate	0 … 10000[/sec]	1:1	
	128:Arc Burst Counter	0 … 10000[/sec]	1:1	
22	3: Arc counters reset	Any value		set only Reset all arc counters, except dUcnt x100
25	2: Blink Mode	bit 0: Internal Blink bit 1: External Blink		read only
	4: Requested Blink On Time	1 … 500[ms]	1:10	
	8: Requested Blink Off Time	1 … 500[ms]	1:10	
	16: Actual Blink On Time	1 … 500[ms]	1:10	
	32: Actual Blink Off Time	1 … 500[ms]	1:10	
	64: Blink Delay	0 … 4[ms]	1:1000	
	3: Blink Mode	bit0: Internal Blink bit1: External Blink		set only
	5: Requested Blink On Time	1 … 500[ms]	1:10	
	9: Requested Blink Off Time	1 … 500[ms]	1:10	
	65: Blink Delay	0 … 4[ms]	1:1000	
26	2: Requested Blink Status	Bit 0: BlinkPwrOn Out1 OK bit 1: BlinkPwrOn Out2 OK bit 2: BlinkMultiply OK bit 3: Blink Wrong Config.		read only
	4: Actual Blink Status	bit 0: BlinkPwrOn Out1 OK bit 1: BlinkPwrOn Out2 OK bit 2: BlinkMultiply OK bit 3: Blink Wrong Config.		
40	2: Output Cores temperature	0 … 100[°C]	1:10	read only
	4: Air temperature	0 … 100[°C]	1:10	
	8: Heatexchanger temperature	0 … 100[°C]	1:10	
	16: Air temperature	0 … 100[°C]	1:10	
	32: Water inlet	0 … 100[°C]	1:10	
	64: Water outlet	0 … 100[°C]	1:10	
48	2: Off Time	1 … 20[%]	1:1	read only
	3: Off Time	1 … 20[%]	1:1	set only
49	2: Power Equalizer Config	bit 0: Power Equalizer Enabler		read only

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
	3: Power Equalizer Config	bit 0: Power Equalizer Enabler		set only
50	2: Parallel Mode	bit 2: Internal Parallel Enabler		read only
	3: Parallel Mode	bit 2: Internal Parallel Enabler		set only
70	2: Actual Control Source 4: Initial Control Source 8: Control Source Active Interfaces	bit 0: RS232 bit 1: Analog bit 3: Display panel bit 4: RS485 bit 5: Profibus		read only
	3: Actual Control Source 5: Initial Control Source 9: Control Source Active Interfaces	bit 0: RS232 bit 1: Analog bit 3: Display panel bit 4: RS485 bit 5: Profibus		set only (if applicable)
72	2: Profibus ID	0 … 127	1:1	read only
	4: Float Standard	0: Motorola, 1: Intel		
	8: Power Scale	0 … 65535	1:1	
	16: Voltage Scale	0 … 65535	1:1	
	32: Current Scale	0 … 65535	1:1	
	3: Profibus ID	0 … 127	1:1	set only
	5: Float Standard	0: Motorola, 1: Intel		
	9: Power Scale	0 … 65535	1:1	
	17: Voltage Scale	0 … 65535	1:1	
	33: Current Scale	0 … 65535	1:1	
73	2: RS Address	0 … 65535	1:1	read only
	4: RS Speed	bit 0: 9600 bit 1: 19200 bit 2: 38400 bit 3: 57600 bit 4: 115200		
	3: RS Address	0 … 65535	1:1	set only
	5: RS Speed	bit 0: 9600 bit 1: 19200 bit 2: 38400 bit 3: 57600 bit 4: 115200		
90	2: Errors Counter	0 … 100	1:1	read only
	4: Error Number	0 … 100	1:1	
	8: Error Code	0 … 65535	1:1	
	16: Module ID (high word)	0 … 65535	1:1	
	32: Module ID (low word)	0 … 65535	1:1	
	64: Param (high word)	0 … 65535	1:1	
	128: Param (low word)	0 … 65535	1:1	
	5: Error Number	0 … 100	1:1	set only

Examples:

First three examples are based on module 21/85 and the last example is based on module 22/86.

Example 1

To set a new value of Ux threshold = 220V, the data group 12 and channel 3 are used.
Send:

Data group	Channels	Integer value	
0x0C	0x03	0x08	0xAC

Integer value=0x08AC (HEX) = 2200 (in integer format)
If value was entered properly then unit will send back a confirmation:

Data group	Channels	Integer value	
0x0C	0x03	0x08	0xAC

If a non-existing channel was selected or a value is out of range then unit will reply with:

Data group	Channels	Integer value	
0x8C	0x03	N/a	N/a

Example 2

To read Break Time for cross arc detection (data group 13, channel 16):
Send:

Data group	Channels	Integer value	
0x0D	0x10	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x0D	0x10	0x07	0xD0

Integer value=0x07D0 (HEX) = 2000 (dec)
As a result, Break Time for cross arc detection is 20ms.

Example 3

In order to read Rectified mains voltage U500 (data group 42, channel 32) :
Send:

Data group	Channels	Integer value	
0x2A	0x20	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x2A	0x20	0x15	0x90

Integer value=0x1590 (HEX) = 5520 (dec)
As a result rectified mains voltage is 552V.

Example 4

To enable dU and UxI and disable Imax arc detection criteria (in floating-point format, Intel standard)
Send:

Data group	Channels	Float value			
0x0A	0x03	0x40	0x40	0x00	0x00

Reply received:

Data group	Channels	Float value			
0x0A	0x03	0x40	0x40	0x00	0x00

Float value=3.0 (HEX) = 0x40400000, binary = 00000011

Arcs Counters:

Imcn:

First Output:	**Module 23**	ident. 0x42,0x01,0x00,0x17
Second Output:	**Module 87**	ident. 0x42,0x01,0x00,0x57

Imcn - Arc counter (Imax criterion). This module consists of two bytes which represent actual value of arc counter for Imax in a 16-bit integer. Range of arc counter is: 0 - 65535.

UxIc:

First Output:	**Module 24**	ident. 0x42,0x01,0x00,0x18
Second Output:	**Module 88**	ident. 0x42,0x01,0x00,0x58

UxIc - Arc counter (UxI criterion). This module consists of two bytes which represent actual value of arc counter for UxI in a 16-bit integer. Range of arc counter is: 0 - 65535.

dUcn:

First Output:	**Module 25**	ident. 0x42,0x01,0x00,0x19
Second Output:	**Module 89**	ident. 0x42,0x01,0x00,0x59

dUcn - Arc counter (dU criterion) – spark counter. This module consists of two bytes which represent actual value of arc counter for dU in a 16-bit integer. The range of arc counter is: 0 - 10000.

Hard Arcs Counter:

First Output:	**Module 26**	ident. 0x42,0x01,0x00,0x1A
Second Output:	**Module 90**	ident. 0x42,0x01,0x00,0x5A

This module consists of two bytes which represent actual value of hard arc counter (ArcImax+ArcUxI). The range of ARC counter is: 0 - 10000.

uArcs Counter per second:

First Output:	**Module 41**	ident. 0x42,0x01,0x00,0x29
Second Output:	**Module 105**	ident. 0x42,0x01,0x00,0x69

This module consists of two bytes which represent actual value of micro arc (dU +Usag criterion) counter per second. The range of arc counter is: 0 - 10000.

Hard Arcs Counter per second:

First Output:	**Module 42**	ident. 0x42,0x01,0x00,0x2A
Second Output:	**Module 106**	ident. 0x42,0x01,0x00,0x6A

This module consists of two bytes which represent actual value of hard arcs (UxI and Imax criteria) counter per second. The range of hard arcs counter is: 0 - 10000.

Internal temperature measurement

Eight temperature sensors measure temperatures inside power supply. Temperature values can be accessed by the following Profibus modules:

Module nr first output	ident.	Module nr second output	ident.	Temp. sensor
33	0x42,0x01,0x00,0x21	97	0x42,0x01,0x00,0x61	T1
34	0x42,0x01,0x00,0x22	98	0x42,0x01,0x00,0x62	T2
35	0x42,0x01,0x00,0x23	99	0x42,0x01,0x00,0x63	T5
36	0x42,0x01,0x00,0x24	100	0x42,0x01,0x00,0x64	T6
37	0x42,0x01,0x00,0x25	101	0x42,0x01,0x00,0x65	T7
38	0x42,0x01,0x00,0x26	102	0x42,0x01,0x00,0x66	T8

The temperature scaling is:
0 .. 100°C is represented by a 0 .. 1000 integer number

Modules not used

37	0x42,0x01,0x00,0x27
38	0x42,0x01,0x00,0x28
103	0x42,0x01,0x00,0x67
104	0x42,0x01,0x00,0x68

How can we create an ideal Profibus communication?

Configuration of communication largely depends on the type of process, target and some additional factors. Modular construction in the Huettinger Profibus profile creates an easy method, which adapts to required processes and allows fast and flexible communication frame between magnetron power supply and control system (for example PLC). Remember that the module sequence and their quantity can be different provided there are no more than 20 modules and that a maximum input or output of bytes quantity does not exceed 80 bytes. In some cases there is a possibility of increasing the maximum amount of modules or bytes. The following examples demonstrate how to configure module(s) to personal demands.

How to organize the modules in own configuration?

In Huettinger Profibus profile configuration is very flexible. If for any reason, more than one of the same output modules are selected, then master receive Configuration Fault flag in diagnosis response. Input modules has not got above limitation.

Annotation – if configuration will choose a module which have access to specific value, an access to that value through module 21/22 will be disabled. Because of asynchronous nature of module 21/22 this safety mechanism is necessary.

For the user's convenience, some parts of modules are defined in two formats: integer and floating point. For the integer format an additional parameter is necessary to scale an integer to real value. This parameter is referred to as an "integer scale".

How to use an integer scale?

In order to precisely set or read values in such a current, voltage and power in an integer format, it is necessary to establish the proper value of three parameters in the integer scale. These parameters are: power scale (for power), current scale (for current) and voltage scale (for voltage). These parameters are all available on display panel (menu "CONTROL CFG"), RS232 protocol (word channel no.: 66, 67, 68) or Profibus (module 20 or 21, data group 72). The values of these parameters define nominal value of current (in case of current scale), power (in case of power scale) and voltage (in case of voltage scale). Example: Nominal power (Pn) for DC3025 is 25kW, nominal voltage (Vn) is 800V and nominal current (In) is 62.5A. If two decimal places are required to set and read power or current, and one decimal place is required to set and read voltage, the value of the integer scale should be set in the following manner:

Power scale = 2500, voltage scale = 8000, current scale – 6250.
Another example is when DC3025 has on output of the following values:
Actual voltage = 432, actual current = 32,5A, actual power = 14,04kW.
Actual values can be transformed in a simple way into an integer value as shown below:Integer value of power = Pscale * Pact / Pn = 2500 * 14.04 / 25 = 1404
Integer value of voltage = Vscale * Vset / Vn =8000 * 432 / 800 = 4320
Integer value of current = Iscale * Iset / In = 6250 * 32.5 / 62.5 = 3250

The integer format has one disadvantage – a constant decimal point – because of this accuracy is sometimes lost. One solution for this problem is to use a floating point number.

How to use a floating point?

A floating point number is a 32-bit value (4 bytes), which can describe each value, both integer and fraction. Floating point number is divided into 3 parts: sign, exponent and mantissa. Below are some examples of how to use floating-point numbers.

byte 0		byte 1		byte 2	byte3
bit7	bit 6 bit 0	bit7	bit6 bit0	bit7 bit0	bit7 bit0
S	2^7 2^6 2^5 2^4 2^3 2^2 2^1	2^0	2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6} 2^{-7}	2^{-8} 2^{-9} 2^{-10} 2^{-11} 2^{-12} 2^{-13} 2^{-14} 2^{-15}	2^{-16} 2^{-17} 2^{-18} 2^{-19} 2^{-20} 2^{-21} 2^{-22} 2^{-23}
sign	exponent		mantissa	mantissa	mantissa

Formula: Value = (-1)S * 2(exponent –127) * (1+mantissa)

Example 1: 7.5

64 dec 240 dec 0 dec 0 dec
40h F0h 00h 00h
40 F0 00 00 h = 0100 0000 1111 0000 0000 0000 0000 0000 b

Value = (-1)0 * 2(129-127) * (1 + 2-1 + 2-2 + 2-3)
= 1 * 22 * (1 + 0.5 + 0.25 + 0.125)
= 1 * 4 * 1.875
= 7.5

Example 2: 600.0

68 dec 22 dec 0 dec 0 dec
44h 16h 00h 00h
44 16 00 00 h = 0100 0100 0001 0110 0000 0000 0000 0000 b

Value = (-1)0 * 2(136-127) * (1 + 2-3 + 2-5 + 2-6)
= 1 * 29* (1 + 0,125 + 0.03125 + 0,015625)
= 1 * 512 * 1,171875
= 600

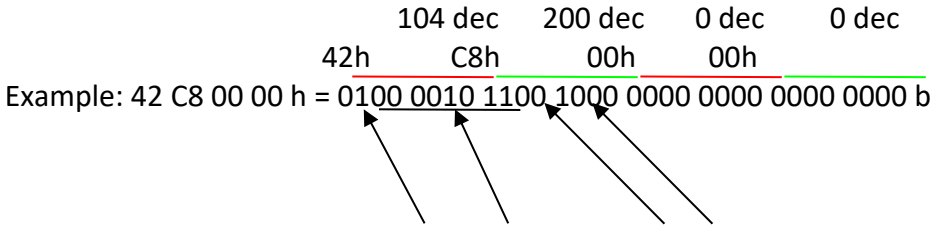
Example 3: 10.0

65 dec 32 dec 0 dec 0 dec
41h 20h 00h 00h
41 20 00 00 h = 0100 0001 0010 0000 0000 0000 0000 0000 b

Value = (-1)0 * 2(130-127) * (1 + 2-2)

= 1 * 23* (1 + 0,25)
= 1 * 8 * 1,25
= 10

Example 4: 100.0



Value = $(-1)^0$ * 2(133-127) * (1 + 2-1+ 2-4)
= 1 * 26* (1 + 0, 5+0.0625)
= 1 * 64 * 1. 5625
= 100

For more details please refer to: **http://babbage.cs.qc.edu/courses/cs341/IEEE-754.html**
To present a floating point number, two standards are available: Motorola and Intel.

What is the difference between the Motorola and Intel format?

The difference between these two standards is simply merely in an adequate sequence of bytes. An example of floating point format and both standards are presented below:

byte 0		byte 1		byte 2	byte3
bit7	bit 6 bit0	bit7	bit6 bit0	bit7 bit0	bit7 bit0
S	2^7 2^6 2^5 2^4 2^3 2^2 2^1	2^0	2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6} 2^{-7}	2^{-8} 2^{-9} 2^{-10} 2^{-11} 2^{-12} 2^{-13} 2^{-14} 2^{-15}	2^{-16} 2^{-17} 2^{-18} 2^{-19} 2^{-20} 2^{-21} 2^{-22} 2^{-23}
sign	exponent		mantissa	mantissa	mantissa

Where value = $(-1)^S$ * 2(exponent –127) * (1+mantissa)
Intel format of floating point numbers (for example like those used in Texas Instruments or Intel processors) send a less significant byte (LSB) before the most significant byte (MSB):

byte 0	byte 1	byte 2	byte3

Motorola format of floating point format (for example used in Philips or Motorola processors) send the most significant byte (MSB) before least significant byte (LSB):

byte 3	byte 2	byte 1	byte 0

Annotation– there are no other differences between Motorola and Intel standards other than a sequence of bytes. Accuracy and principles of operation for both formats are always the same.

Examples

The following examples show how to configure modules and how to use all the information which is presented below. All examples are based on the DC3025 device where nominal voltage (Un) is 800V, nominal current (In) is 62,5A and nominal power (Pn) is 25kW. Other parameters are set at following values: power scale (Pscale) is 10000, voltage scale (Vscale) is 8000 and current scale (Iscale) is 6250.

Example 1:

This example shows how to switch on the power in the output and set the voltage to 432V, current to 32.5A and power to 14.04kW in the simplest of configurations. The following modules are selected: Module 6, Module 2, Module 4, Module 1, Module 16, Module 12, Module 14, Module 26, Module 20.

Integer value of power setpoint = Pscale * Pset / Pn = 10000*14.04 / 25 = 5616
The value of 5616 has a hex value of 0x15F0h.
Integer value of voltage setpoint = Vscale * Vset / Vn =8000 * 432 / 800 = 4320
The value of 4320 has a hex value of 0x10E0h.
Integer value of current setpoint = Iscale * Iset / In = 6250 * 32.5 / 62,5 = 3250
The value of 3250 has a hex value of 0x0CB2h
The created output frame which Profibus master sends to DC3025 should be:

Bytes	0	1	2	3	4	5	6
Modules	Module 6		Module 2		Module 4		Module 1
Descriptions	Power setpoint		Voltage setpoint		Current setpoint		Control Bits
Values	0x15	0xF0	0x10	0xE0	0x0C	0xB2	0x0D

First six bytes represent setpoints. The next byte, according to the description of module 1, sends the bits which take control of the unit and switch on the relays and power (0x0D = binary 00001101). After this directive, unit switch off relays and set the voltage regulator to 400V.

Anotation: Setpoint requests for voltage, current and power will be ignored, but not until the Profibus master takes control of the DC3025.
Magnetron power supply responds by sending the following input frame:

Bytes	0	1	2	3	4	5	6	7	8	9	10
Modules	Module 16		Module 12		Module 14		Module 26		Module 20		
Descriptions	Actual power		Actual Voltage		Actual current		Hard arc counter		Acknowledge Bits		
Values	0x10	0x00	0x0F	0xA0	0x0A	0x00	0x00	0x04	0x0D	0x00	0x01

It is easy to calculate from first six bytes that:
Actual power = integer value from module 16 * Pn / Pscale = 4096*25/10000 = 10,24kW,
Actual Voltage = integer value from module 12 * Vn / Vscale = 4000*800/8000 = 400 V,
Actual power = integer value from module 14 * In / Iscale = 2560*62.5/6250 = 25.6 A,
Next two bytes show that there were four hard arcs (module 26). Last three bytes belongs to module 20 – Acknowledge bits, which inform (according to the descriptions of this module)

Profibus master take the control on magnetron power supply and switch on relays and power (first byte, 0x0D = binary 00001101), and unit works on Voltage regulator (third byte). This type of configuration (if module 8 is avoided) is the most basic for controlling magnetron power supply, because it allows setting and reading actual power, current or voltage. Additionally, module 1 admits to switching on the relays and power, module 26 and 20 show status of the unit.
However, in a process only one regulator is needed, as the configuration of Profibus should be different which is depicted in the next example.

Example 2:
This example shows how to use module 9 (select control mode). This kind of module allows selecting the desired control mode and setting the setpoint at the same time. In this example the following modules were selected: Module 1, Module 9, Module 16, Module 12, Module 14, Module 20. The output frame which Profibus master sends to the magnetron power supply should be:

Bytes	0	1	2	3	4	5
Modules	Module 1	Module 9				
Descriptions	Control Bits	Select control mode – floating point format				
Values	0x0D	0x01	0x41	0xCC	0x8F	0x5C

The last four bytes describe a value of 25.57 in a floating-point format in Intel standard (corresponding with the descriptions above). The first byte in module 9 (and second byte in output frame) switch over unit to work in current regulator. Due to this, remaining setpoints (power and voltage) are set to their nominal values. Module 1 (first in output frame) assumes control of the unit and switches on the power and relays. In response, magnetron power supply sends following input frame:

Bytes	0	1	2	3	4	5	6	7	8
Modules	Module 16		Module 12		Module 14		Module 20		
Descriptions	Actual power		Actual Voltage		Actual current		Acknowledge Bits		
Values	0x0C	0xF0	0x0C	0xA8	0x09	0xFD	0x0D	0x00	0x02

It is easy to calculate from first six bytes that:
Actual power = integer value from module 16 * Pn / Pscale = 3312*25/10000 = 8.28kW,
Actual voltage = integer value from module 12 * Vn / Vscale = 3240*800/8000 = 324 V,
Actual current = integer value from module 14 * In / Iscale = 2557*62.5/6250 = 25.57 A,
This time the input frame is without a Hard Arc counter (and by this is two bytes shorter). Last byte (module 20) informs us that a current regulator is active (0x02 = binary 00000010).

Example 3:
This example shows how to use module 21 (set/read parameter in integer format) in order to create a faster interface with least amount of input and output bytes. For module 21, the

upload packet sent from Profibus master to magnetron power supply contains the following information:

1	2	3	4
Data group	Channels	Integer value	
Out_Byte 0	Out_Byte 1	Out_Byte 2	Out_Byte 3

And the input bytes are:

1	2	3	4
Data group	Channels	Integer value	
In_Byte 0	In_Byte 1	In_Byte 2	In_Byte 3

According to the description of module 21 and module 22 (shown previously), an example of interface (outlined in steps) demonstrates how to control unit by using only one module.
Step 1: Taking control of the unit (data group 1, channel 3)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x01

Reply received:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x01

Step 2: selection of power regulator and assignment of 5kW of power (data group 2, channel 3)
Calculation for power setpoint:
Integer value of power setpoint = Pscale * Pset / Pn = 10000*5.0 / 25 = 2000
The value of 2000 has a hex value of 0x07D0h.
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x08	0x03	0x07	0xD0

Reply received:

Data group	Channels	Integer value	
0x08	0x03	0x07	0xD0

Step 4: enabling dU and Imax criterions, disabling UxI criterion (data group 10, channel 3)

Last byte switches on dU and Imax criteria (for arc detection) and switches off UxI criterion. (0x05 = binary 00000101).
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x0A	0x03	0x00	0x05

Reply received:

Data group	Channels	Integer value	
0x0A	0x03	0x00	0x05

Step 5: set the dUoff parameters to 100V(data group 11, channel 3)

Last byte sets dUoff parameters to 100V. The value of 100 has a hex value of 0x0064h.
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x0B	0x03	0x00	0x64

Reply received:

Data group	Channels	Integer value	
0x0B	0x03	0x00	0x64

Step 6: Switch on Power (data group 1, channel 3)

Last byte switches on relays and power. (0x0D = binary 00001101).
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x0D

Reply received:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x0D

Step 7: Readout of actual power (data group 2, channel 4)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x02	0x04	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x02	0x04	0x11	0xD0

Last two bytes contain information about actual power (The value of 0x11D0 in hex has a decimal value of 4560). It is easy to calculate that:
Actual power = integer value from module 16 * Pn / Pscale = 4560*25/10000 = 11.4 kW,

Step 8: Readout of actual current (data group 4, channel 4)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x04	0x04	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x04	0x04	0x06	0x22

Last two bytes contain information about actual power (value of 0x0622 in hex has a decimal value of 1570). It is easy to calculate that:
Actual power = integer value from module 16 * Pn / Pscale = 1570*62.5/6250 = 15.7 A,
Step 9: Readout of acknowledgement bits0 (data group 1, channel 4)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x01	0x04	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x01	0x04	0x00	0x0D

Last byte informs us that relay and power is switched on (0x0D = binary 00001101).

We can observe that all parameters can be changed by using this one module.
An additional advantage of this configuration, is the handshake quality – in first two bytes of input frame an echo of last command is sent back. On account of this the PLC receives confirmation that command was accepted. Since a response to the request is generated automatically, (sometimes even 1 ms later) the entire communication process works exceptionally fast. If orders are sent one by one, then entire process can be achieved at an incredible speed. Only Profibus baud rate and number of slaves in field can limit this.

Example 4:
Last example shows how to use module 21 (set/read parameter in integer format) with other modules. The following modules were selected in this example: Module 6, Module 29, Module 21, Module 12, Module 14, Module 20. The output frame which Profibus master sends to the magnetron power supply is:

Bytes	0	1	2	3	4	5	6	7
Modules	Module 6		Module 29		Module 21			
Descriptions	Power setpoint		Current Ix threshold		Set/read parameter in integer format			

First two bytes set power. Next two bytes allow to control the level of current threshold for UxI arc detection criterion. The control bits are available via module 21 (last four bytes in input frame). Other parameters are also accessible in this module if necessary. In response, magnetron power supply sends out the following input frame:

Bytes	0	1	2	3	4	5	8	9	10	11	12
Modules	Module 12		Module 14		Module 20			Module 21			
Descriptions	Actual Voltage		Actual current		Acknowledge Bits			Set/read parameter in integer format			

First four bytes show actual value of voltage and current (in an integer format). They can be used to calculate actual power (this is why the module of actual power is omitted). The next three bytes represent Acknowledge bits, which show status of magnetron power supply. Last four bytes belong to module 21. This example shows how different modules can replace other modules and maintain their usability as well as flexibility.

Remember – These are only several possible examples. The true combination of solutions is as endless as the user's imagination and we only attempt to provide you with the perfect tool to create your own personal profile for any specific processes.

Profibus safety

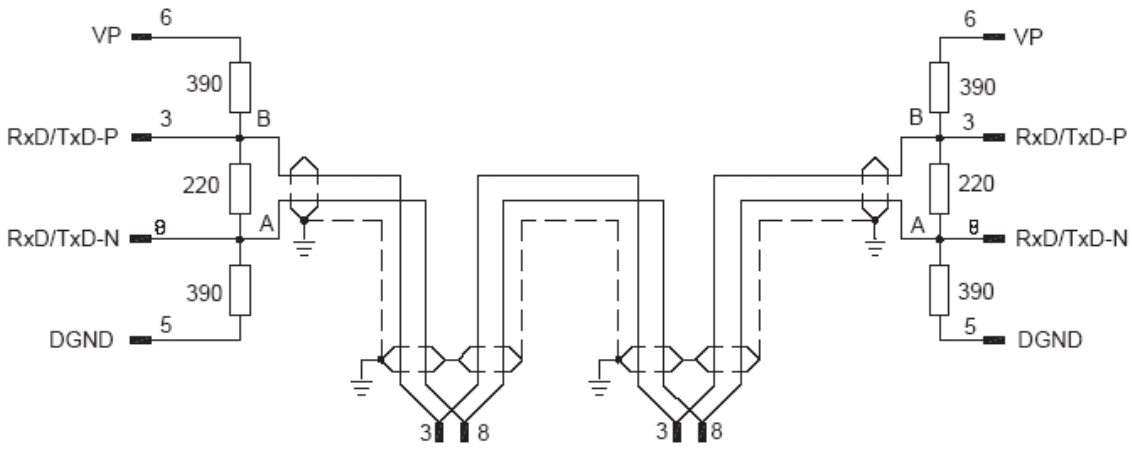
In the event that Profibus slave loses connection with master or when the master stops communicating, the power supply turns off its output power and waits until communication is restored or until another control source is selected.

Physical layer and configuration of Bipolar4000

In order to connect the power supply with the Profibus, an isolated RS-485 interface (according to EN 50170) is required. Please make certain that termination resistors are affixed at both ends of the cable. If special Profibus connectors are being used, the resistors found inside the connector must be switched on. The cable shield should be firmly connected to ground in every device. Make sure that there is no potential difference between grounds in devices.

GSD files

GSD (Electronic data sheet of a device) files contain and describe the functions and character of the Profibus device. In order to use this unit in a PROFIBUS system, it needs to have a specific GSD file that is compatible with the unit.
Please be advised to only use the GSD file, which comes delivered with your power supply.



Specification for Profibus slave Bipolar4000:

Configuration data: in accordance with GSD file (AC0A31.gsd)
Technology: ASIC
Physical separation fieldbus side: Standard
Baud rate for RS485: Automatic detection up to 12 Mbaud
Sync: Supported
Freeze: Supported
Primitive fieldbus ID: 120
Dipswitch: Supported

8. Interface software

8.1. PVD Power requirements

Attached CD includes PVD Power control software.

Note: PVD Power requires .NET Framework version 4.0.
Microsoft .NET Framework Version 4.0 Redistributable Package (x86) is available at Microsoft Download Center:
http://www.microsoft.com/en-us/download/details.aspx?id=17718

System requirements

Supported operating systems:
- Windows XP SP3
- Windows Server 2003 SP2
- Windows Vista SP1 or later
- Windows Server 2008 (not supported on Server Core Role)
- Windows 7
- Windows Server 2008 R2 (not supported on Server Core Role)
- Windows 7 SP1
- Windows Server 2008 R2 SP1

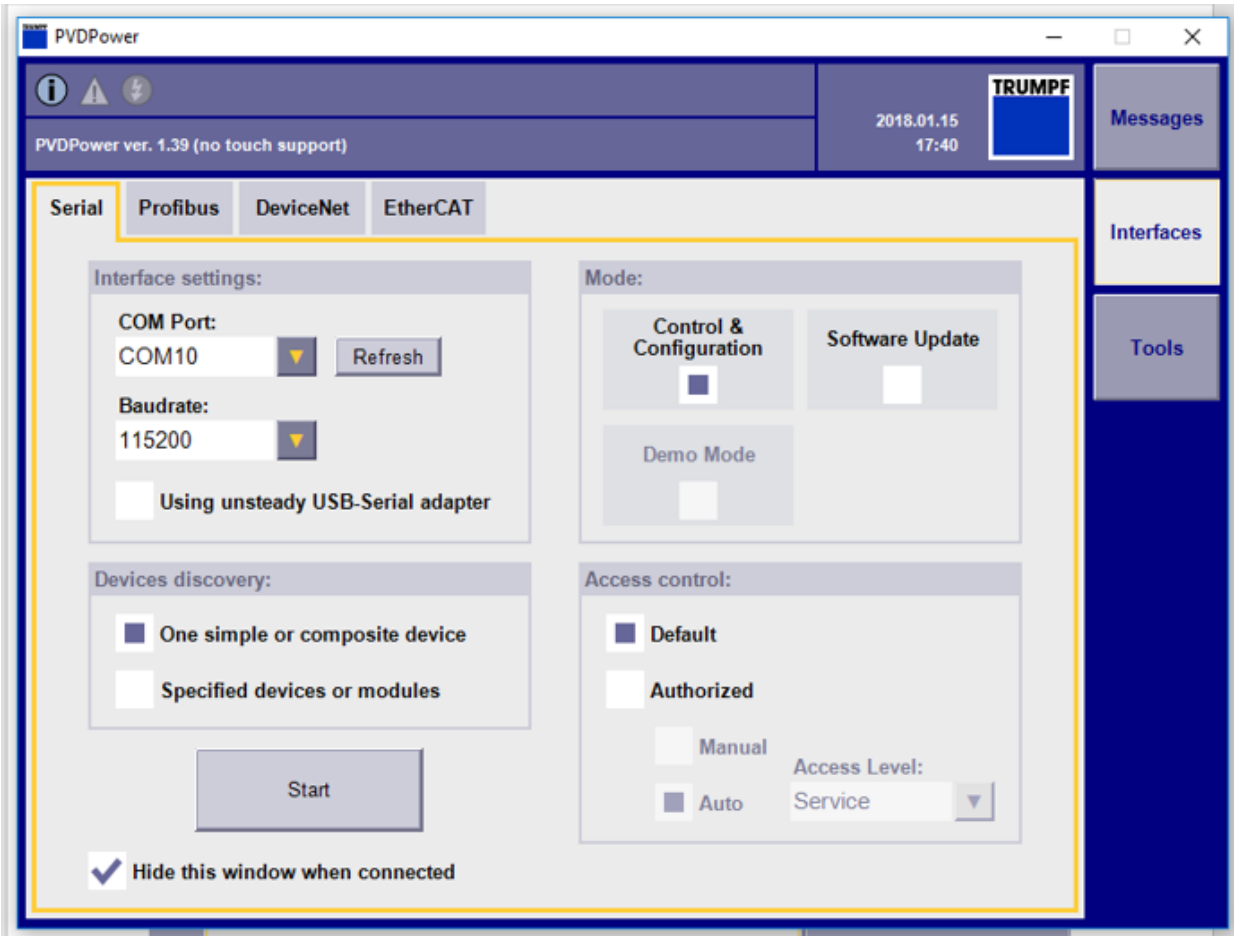
Supported Architectures:
- x86
- x64
- ia64 (some features are not supported on ia64 for example, WPF)

Hardware Requirements:
- Recommended Minimum: Pentium 1 GHz or higher with 512 MB RAM or more
- Minimum disk space:
- x86 – 850 MB
- x64 – 2 GB

Prerequisites:
- Windows Installer 3.1 or later

8.2. PVD Power Operation

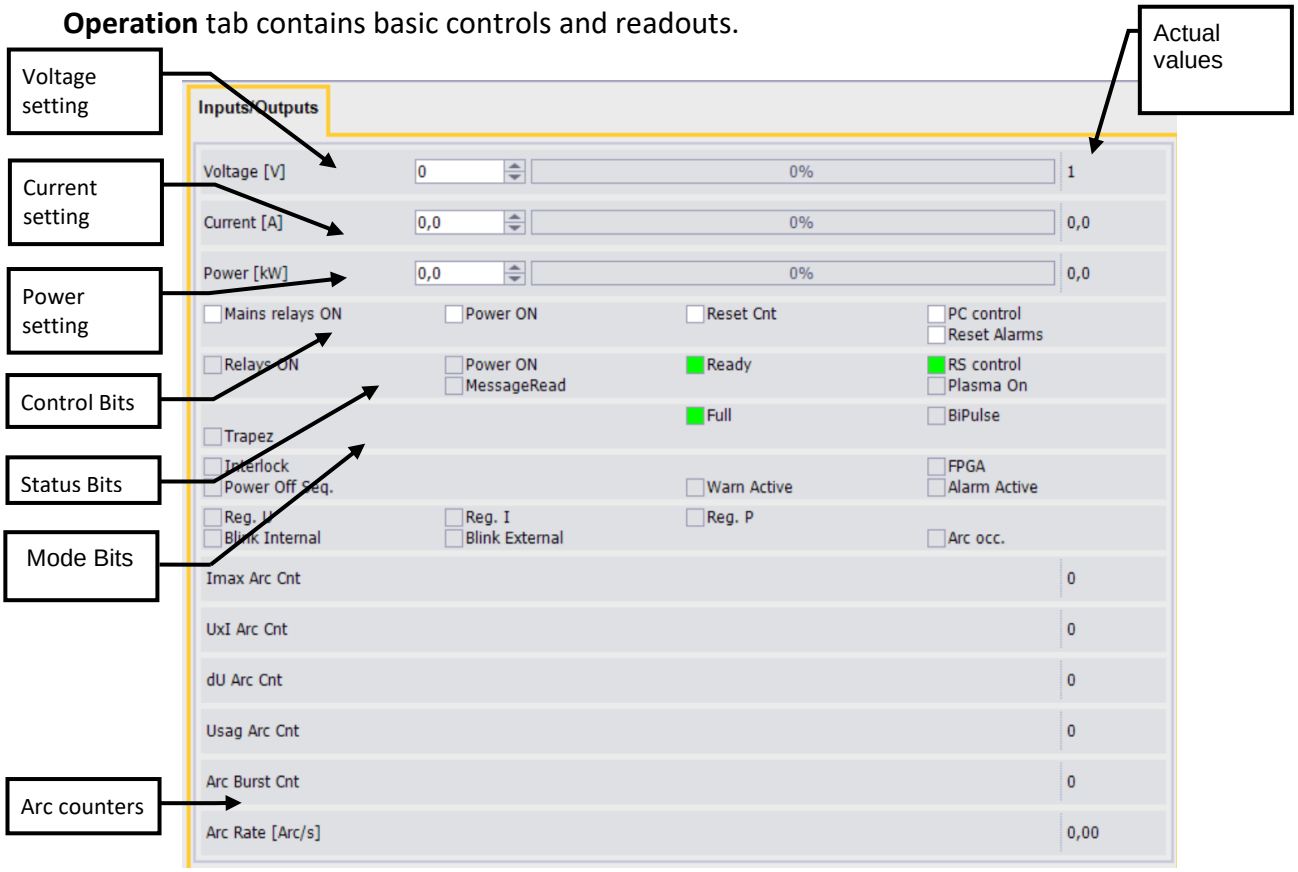
In order to activate PVD Power software, “PVDPower_x.xx.exe” file must be running. Check the correct COM port and baudrate to avoid error messages.
When RS232 is configured, press “Start” button to initiate communication with **TruPlasma Bipolar** unit.



In case of errors or alarms appearance search for solutions in the error list and alarm causes

Operation

Operation tab contains basic controls and readouts.



Booting the power supplies process:

If the Alarm Active Bit is on, find out what possible errors may have occurred and check the Reset Alarms bit in Control Bits section.

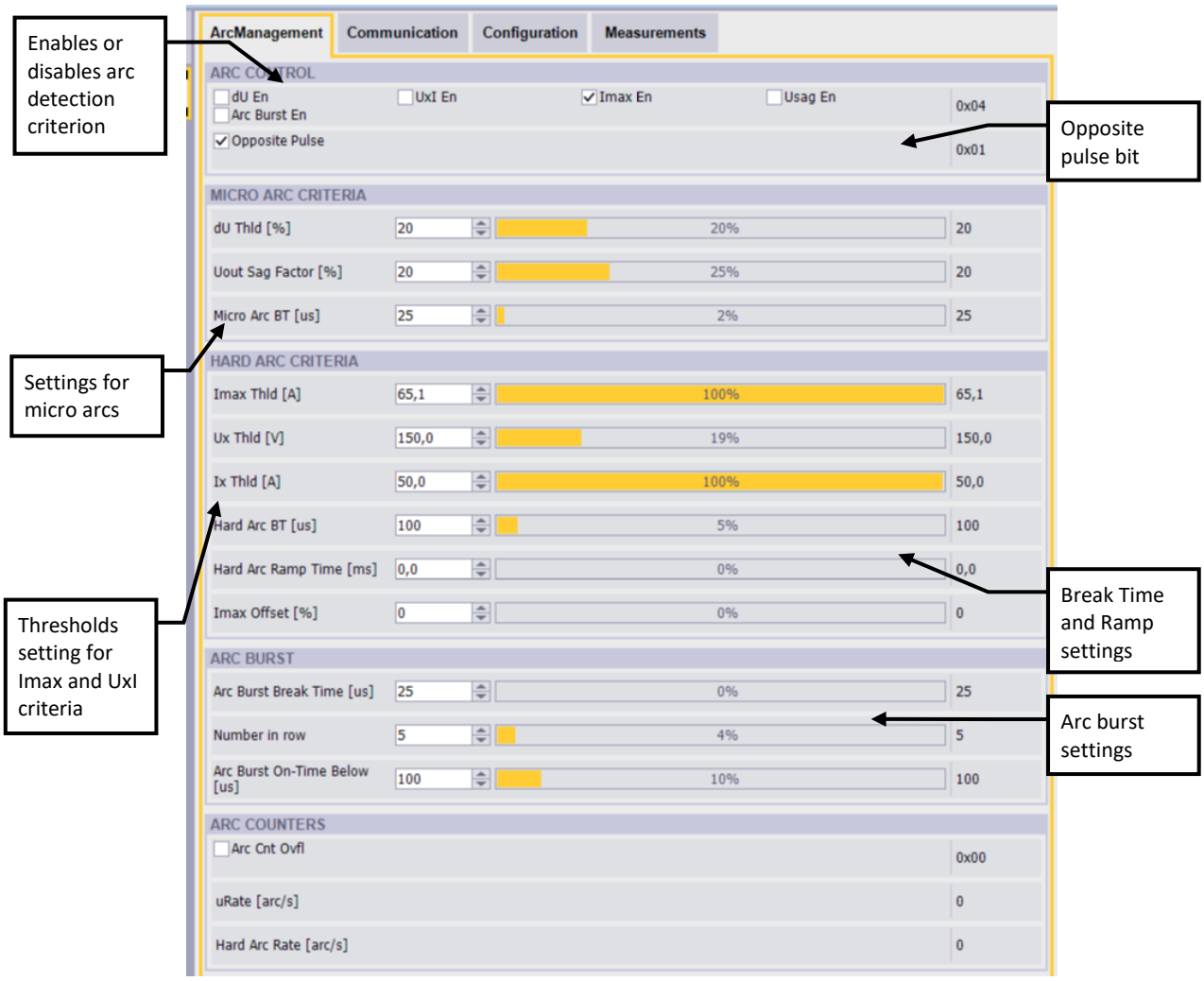
If the Interlock Bit is on, check all possible interlock causes (fig.4.2.)

Set the Voltage, Current and Power on the chosen levels

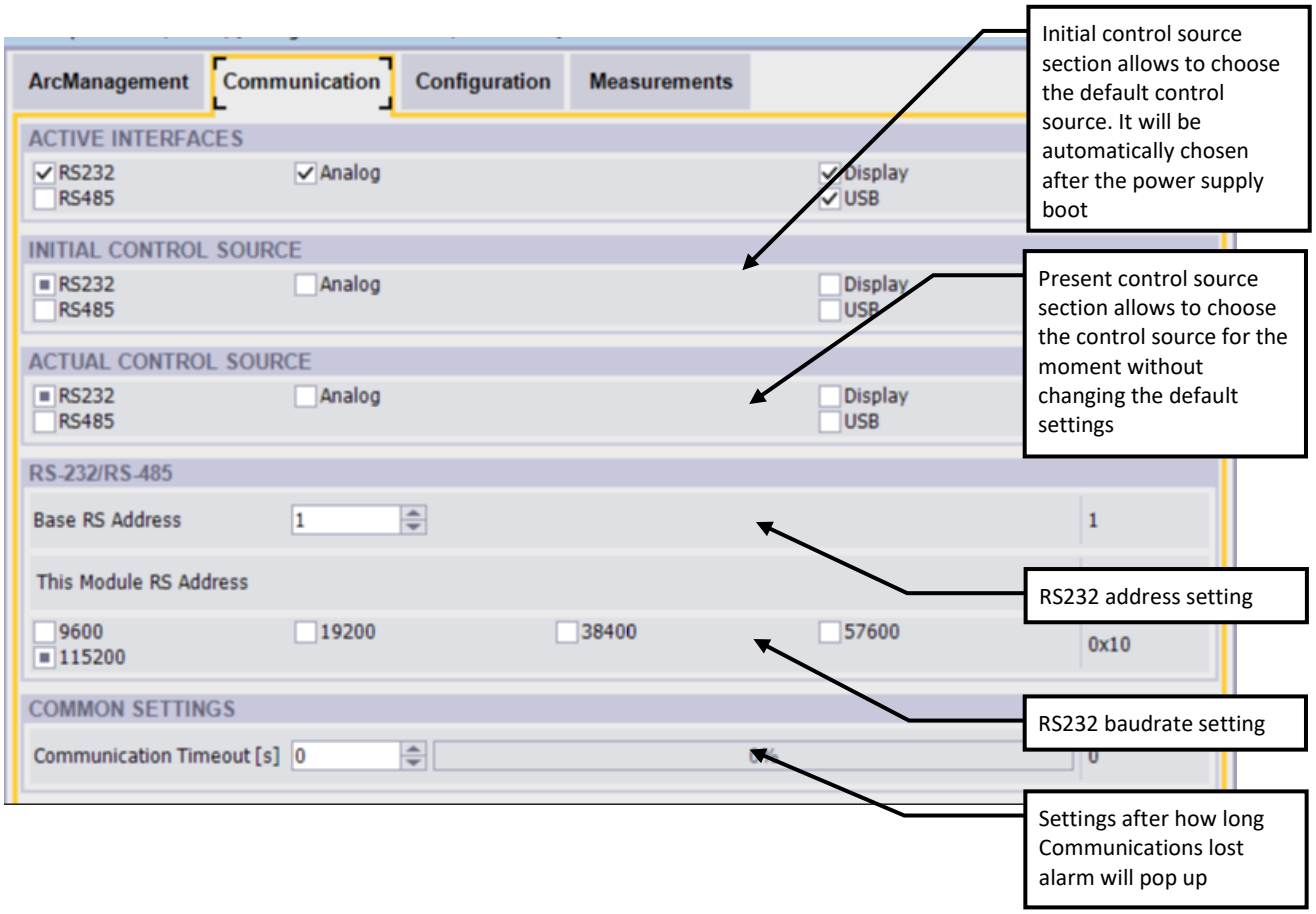
Choose the desired work mode in the Mode Bits section

Check the Mains relays ON (wait for the “Relays ON” bit to turn green) and then Power ON Bit in Control Bits section.

Arc Management



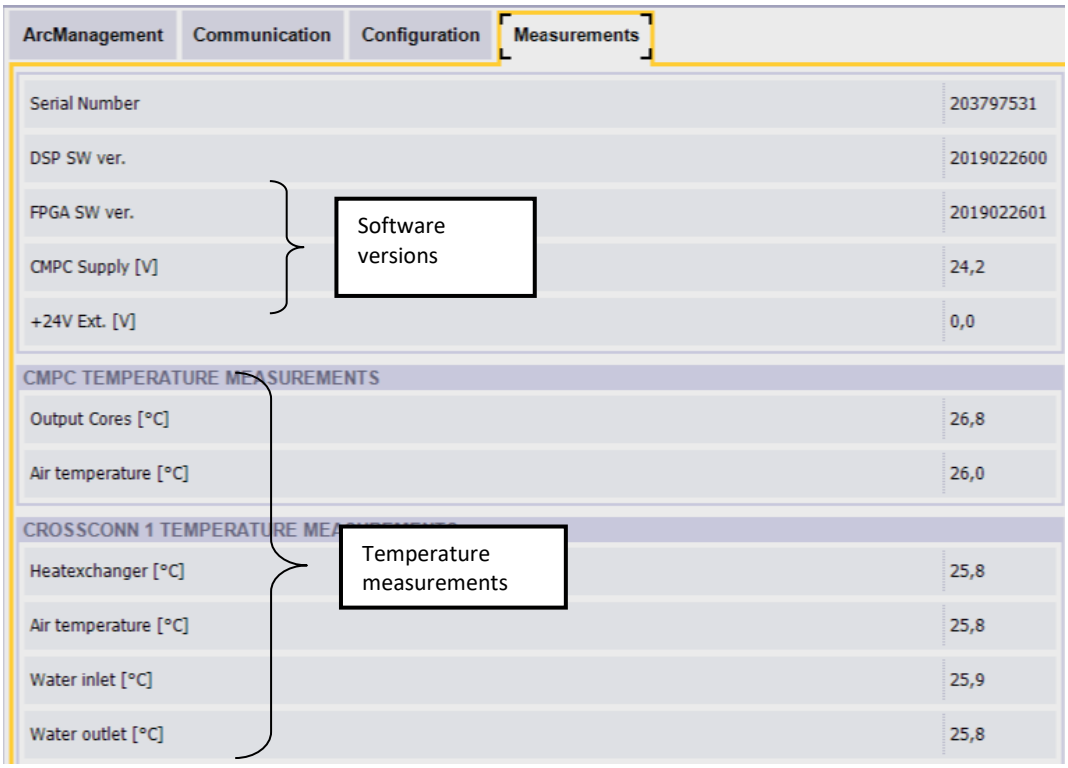
Communication



In order to permanently change the control source remember to check the correct box in the initial control source section

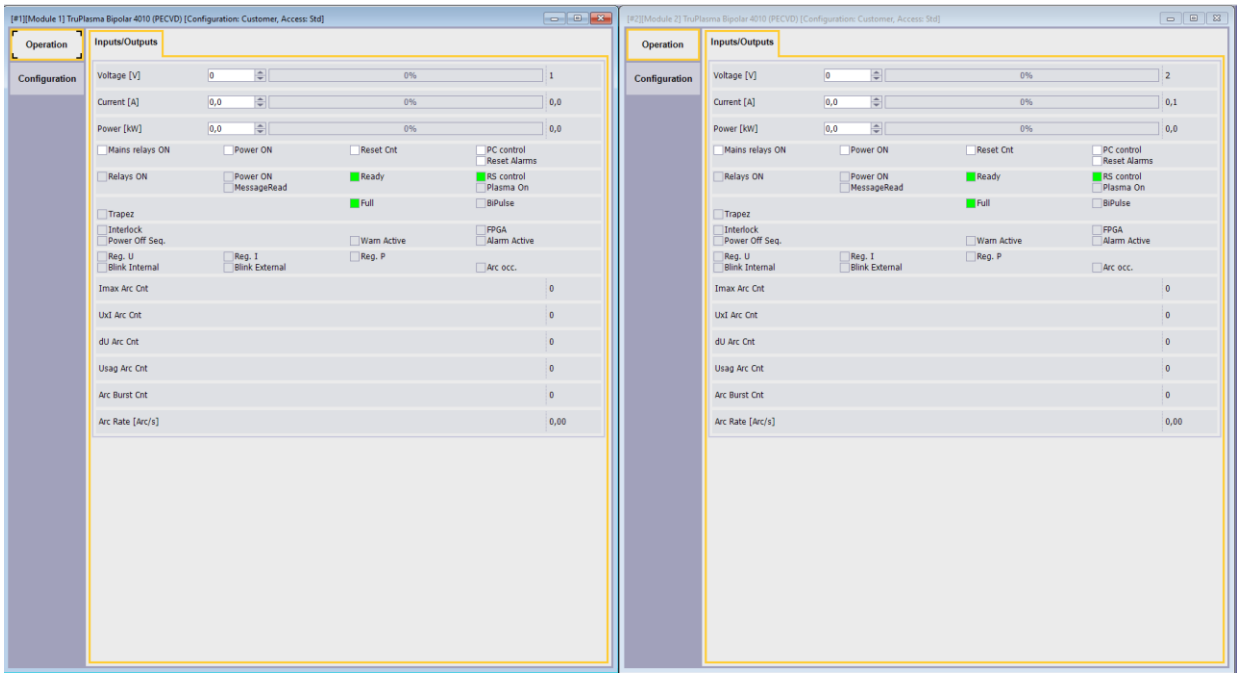
Configuration

Measurements



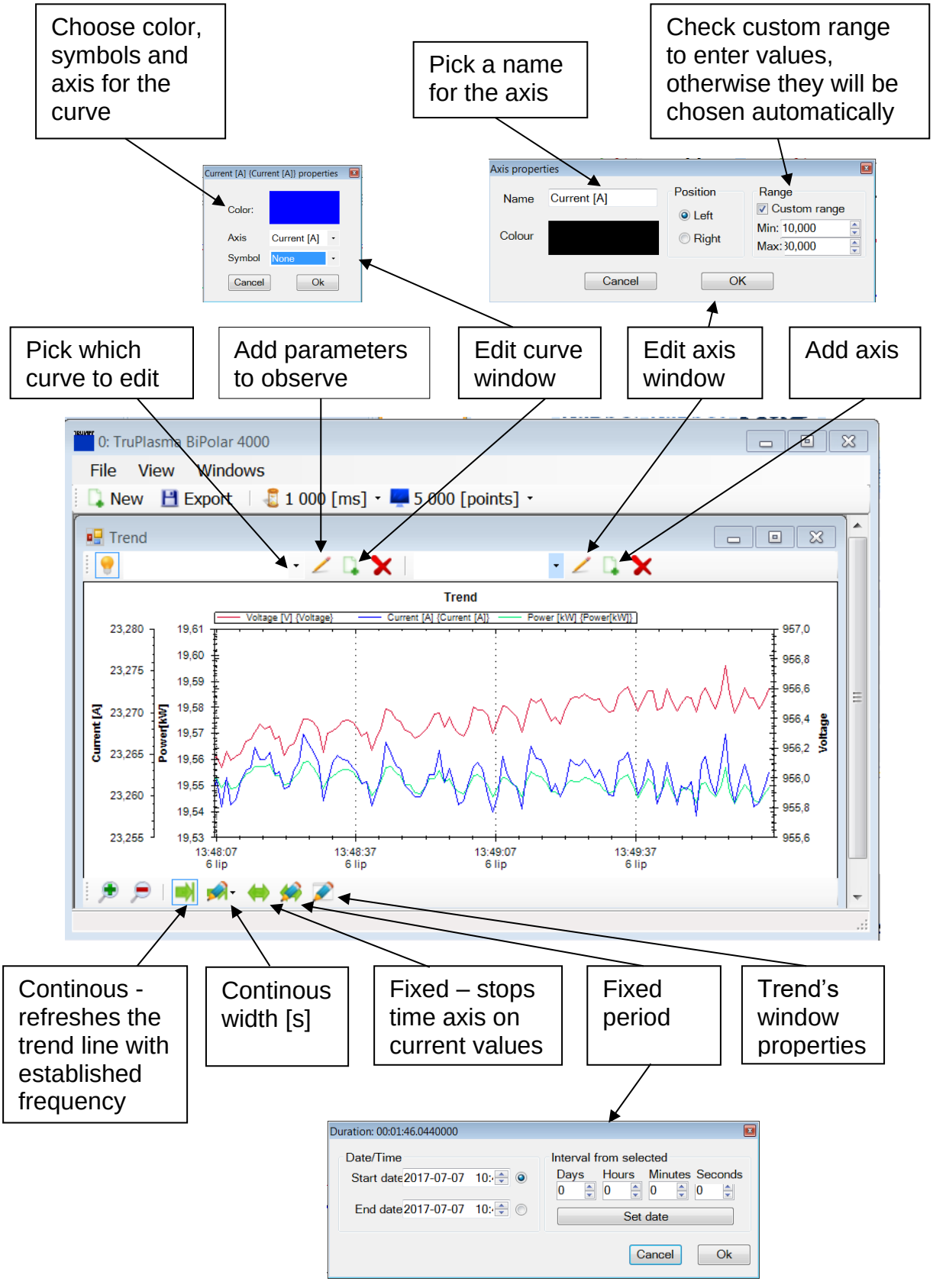
Dual output operation

Dual output independent operation can be controlled by two different windows in the PVD Power software.

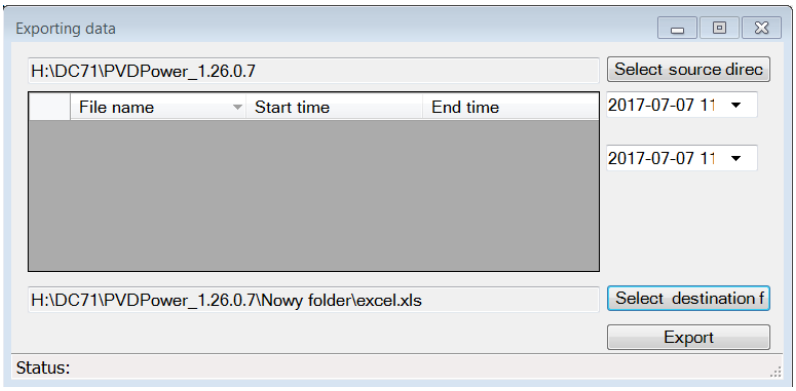


Trend function

In order to see the power supply's trend line go to tools->trend and click on new.



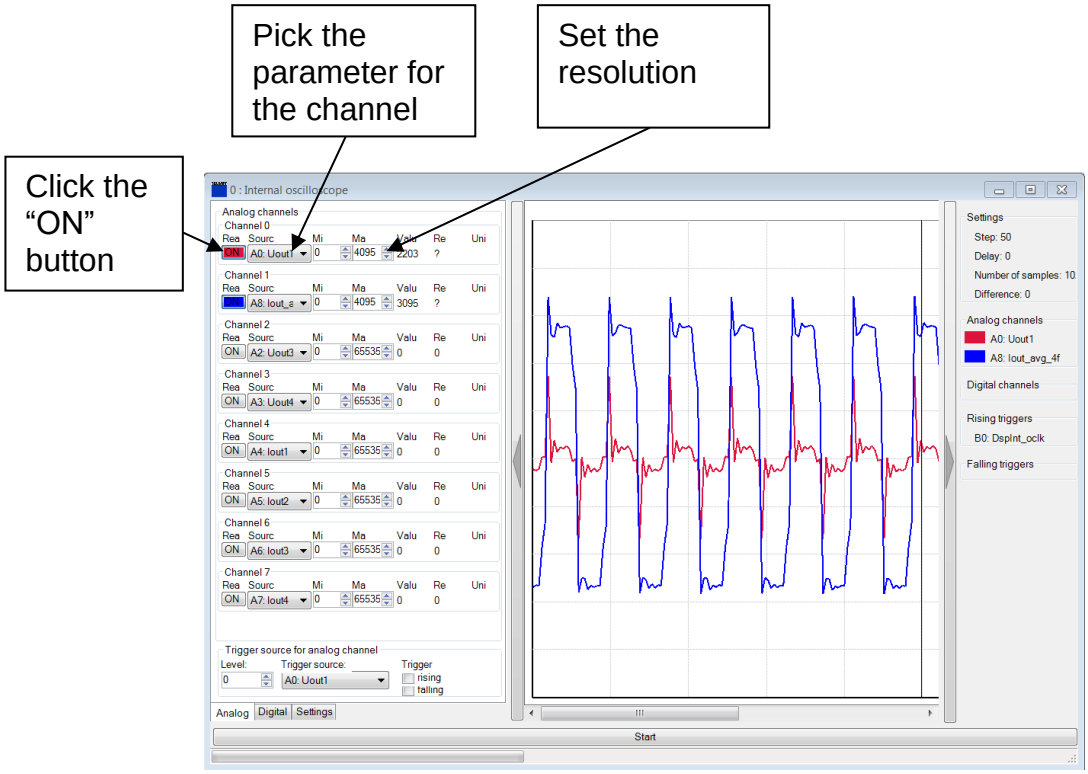
Trend line data export



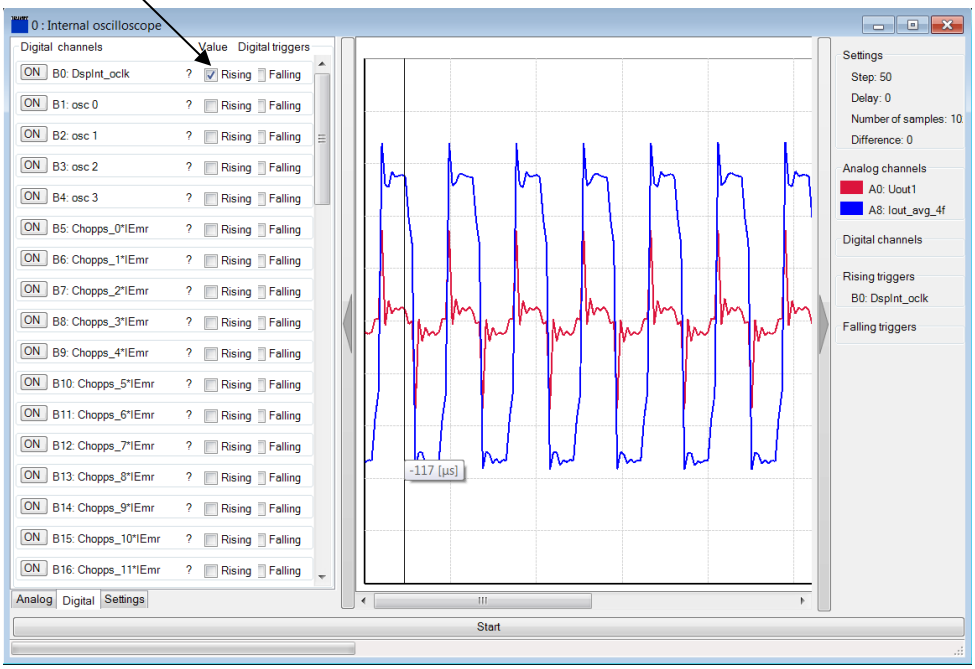
1. Select the source folder
2. Select the beginning and ending date
3. Select the destination folder

Internal Oscilloscope

PVDPower contains an 8-channel oscilloscope. It is available after choosing tools -> oscilloscope from the menu.

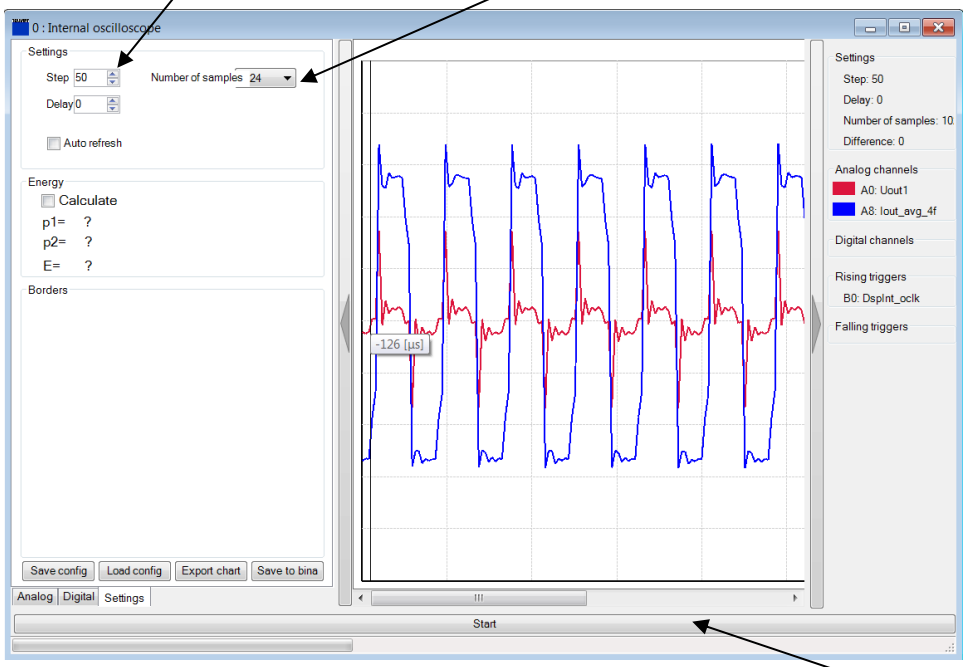


Turn on the digital signals, to trigger the analog ones



Set the step value – one step indicates 20 ns. Example: with the step parameter set on 50 acquisition will occur every 1 µs

Set the number of displayed samples



Press start

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9. Warning and alarm messages

Error codes description.

Error Number	SNr-Param	Description
61601	-	EEPROM error
61602	-	Wrong checksum of data stored in EEPROM
61603	-	FPGA configuration failed
61605	supply voltage (24V) * 100	Too high supply voltage (24V)
61606	supply voltage (24V) * 100	Too low supply voltage (24V)
61607	Sensor ID=xe6 + temperature value Tx*100	Too high temperature on sensor x
61608	-	no communication with DataFlash device
61609	kind of sag	Mains voltage sag detected
61613	2	no RS232 communication available anymore
	7	no communication with EtherCAT interface
	ID of interface, which is in use	no communication with Actual Control Source
61614	1	no communication with EEPROM device
	2	no communication with Temperature measurement module
	3	no communication with Mains measurement module
	4	no communication with RTC device
	5	no communication with Currents measurement module
61616	U500 voltage * 100	U500 Voltage too low
61617	U500 voltage * 100	U500 Voltage too high
61618	-	Inverter Error
61619	U800 voltage * 100	U800 Voltage too low
61620	U800 voltage * 100	U800 Voltage too high
61621	U800 voltage * 100	Too high U800 voltage during Power On sequence
61622	-	CAN configuration error
61623	-	No Load
61624	-	Short Circuit
61625	-	Arc Density exceeded the limit
61626	Minimum, required PLD SW version	PLD software version is too old
61627	Freq [Hz]	CLC switching frequency too high
61631	temperature value *100	Too low temperature of inlet water
61632	kind of wrong configuration	Wrong configuration
61633	U500 voltage * 100	U500fast high
61634	-	dU500/dt high
61635	U800 voltage * 100	U800fast high
61636	-	dU800/dt high
61642	-	Power fail IemrRate
61646	U500 voltage * 100	U500 fast low
61647	U800 voltage * 100	U800 fast low
61649	-	Chopper fail
61690	-	Device type mismatch
61691	-	FPGA regulator mismatch
61692	Freq [Hz]	Blink switching frequency too high
61694	-	PFC emergency error
61695	-	Reverse overcurrent

Error Number	SNr-Param	Description
61706	U800 voltage * 100	U800 shorted
61707	U800 voltage * 100	U800 is not increasing
61709	-	Output emergency error
61710	-	Fans off too long
61712	-	FPGA clock configuration error
61713	-	Internal error
61714	-	Test version. Internal use only
61716	-	No serial (0) or SAP (1) number
61724	-	Too high EEPROM usage

Warning codes description.

Warning Number	SNr-Param	Description
61651	-	No data In memory banks – default restored
61652	-	Checksum error in memory bank
61653	-	EEPROM write error
61654	-	Arc Density exceeded the limit
61655	-	Recalibration done
61656	-	Unauthorized recalibration attempt
61657	Sensor ID=xe6 + temperature value Tx*100	Temperature warning level exceeded Tx
61658	-	Cooling water flow is too low
61659	-	Cooling water flow wrong direction
61661	2,7	No communication with the Actual control source
61663	ID of interface, which is in use	communication fail with actual control source
61664	-	New version of memory map in EEPROM
61665	1	Exceeded maximum allowable difference between voltage set and actual values [mV]
	2	Exceeded maximum allowable difference between current set and actual values [mA]
	3	Exceeded maximum allowable difference between power set and actual values [W]
61666	-	Plasma not detected
61667	-	PlossMax value reached. Power loss cannot be compensated properly
61669	-	Internal CAN bus configuration fail
61670	temperature value *100	Low temperature of inlet water
61697	-	Blink input pulse too short
61698	-	Blink input pulse too long
61701	-	PWM PT too long
61702	-	PWM recipe not saved
61711	-	Test version. Internal use only
61723	-	High EEPROM usage

10. Scope of delivery

Contents of the box:

- TruPlasma Bipolar Series 4000 G2.1 PECVD power supply
- Dummy plug (interlock removal) – two in case of dual output unit
- Output terminals cover
- Mains terminals cover
- Inlet air pipe adaptor with stopper
- Quick start guide
- Certificate of conformity
- Lifting handles (4 pcs. per package)
- USB flash drive (software and manual)

TruPlasma Bipolar Series 4000 G2.1 PECVD power supply is delivered in ready-to-use condition.
Device is designed to operate correctly when all connections and installation procedures are followed in accordance with user manual. Default settings should assure proper behavior of device in the most commonly used system configurations.

Nevertheless, it would be useful to learn as much as possible about maintenance and operation principles before proceeding with startup. A full understanding of these system operating principles will help user to obtain the most useful information from controller's display as well as understand behavior of the entire power supply. Introducing any changes to device's settings requires full knowledge of system (and also the password).

Version	Reason of change
03	Change of the rear panel and the valve control terminal description