TruPlasma Highpulse 4002 NEW

(2000V; 1000A; 10kW; 10000Hz)

Highpulse Power Supply

USER MANUAL

Warning!

This operating manual is required for the safe operation of **TruPlasma Highpulse 4000 NEW** Power Supplies. As a result, the operating manual should be kept close to the unit at all times.

Operating Instructions for TruPlasma Highpulse Power Supply

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In the interests of providing superior equipment, TRUMPF Huettinger reserves the right to make product modifications without notifications or obligation. To the best of our knowledge the information contained in this manual is the most accurate available as of date of publishing.

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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 Highpulse generator is designed to power industrial vacuum process chambers in PVD 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 Highpulse**. "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 Highpulse** operating instruction manual and understand all of its contents.

WARNING !

Do not be careless around this equipment!

1.4. Safety standards profile

The **TruPlasma Highpulse** Power Supply was designed and constructed in compliance with the requirements outlined in the following standards and EC directives:

Standards:

- **EN 50178:** 1997 "Electronic equipment for use in power installations"
- **EN 60950-1:** 2006 "Information technology equipment – Safety – Part 1: General requirements"
- **EN 61000-6-2**: 2005 "Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments"
- **EN 61000-6-4:** 2007 "Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments"

EC directives:

- **2006/95/EC** Low Voltage Directive – Laws of Member States relating to Electrical Equipment designed for use within certain voltage limits.
- **2004/108/EC** EMC Directive – Laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336.

WARNING !

➲ 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 Highpulse system must be firmly secured and placed in a horizontal position.

Storage

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

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

2. General information

Description

The **TruPlasma Highpulse** power supply is designed for powering sputtering cathodes in PVD surface treatment technologies. It's most important features are:

- high efficiency switched-mode power conversion performance,
- up to 2000V operating output voltage,
- full output power capability at an output voltage as low as 400V,
- ultrafast arc switch-off and recovery,
- extremely low arc energy,
- wide variety of user adjustable parameters,

The **TruPlasma Highpulse** 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 Highpulse**,
- Remote: RS-232,
- Remote: Profibus,

2.1. TruPlasma Highpulse block diagram

A block diagram of the **TruPlasma Highpulse** 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,
- capacitor charging unit,
- output section,
- arc detection and arc switch-off circuitry,
- control electronics and LCD display panel (SOP).

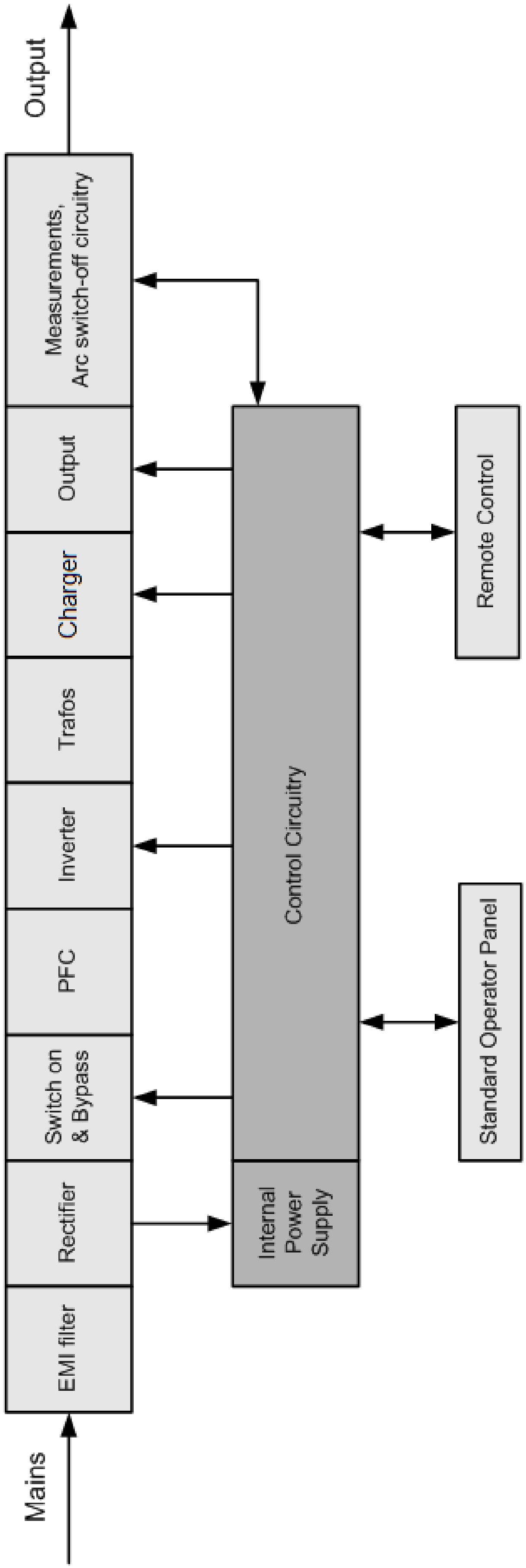


Fig.2.1. TruPlasma Highpulse block diagram

3. Electrical and mechanical specifications

3.1. Electrical and mechanical specification in tables

Electrical specification – Overall			
Mains voltage	V AC		3x400-480±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 20
Recommended fusing	A		3 x36, B-class
Efficiency	%		Approximately 85%
Warm-up delay	second		< 5

Electrical specification – Power supply section			
Nominal output values	kW\ V A µs Hz		P_n = 10 U_n = 2000 I_n = 1000 t_{IMP} = 1500 f_{PULS} = 10000 (see power characteristics Fig. 3.2.)
Control source options			Local - Standard Operator Panel Remote - RS-232 Remote - Profibus interface
Output control			P – power control U – voltage control I – current control

Mechanical Specification			
Size (Width x Height x Length)	mm		482 (19") x 356 (8U) x 683
Weight	kg		Approx. 155

Arc detection criteria			
Imax **Overcurrent detection** an arc is detected when output current exceeds Imax threshold	A		user adjustable: Imax threshold 10 … 120% In
UxI **Cross detection** an arc is detected when output current exceeds Ix threshold below Ux threshold	V A		user adjustable: Ux threshold 0 … 100% Un, Ix threshold 10 … 100% In
Maximum amount of detected and suppressed arcs per second	arc/sec		10000

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		> 3
Flow rate	l/min		> 12
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		

Cooling water parameters	
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

WARNING !

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.

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

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*).

While installing the power supply in the IP4x rack cabinet the compressed air may be supplied to the cabinet, instead of direct supplying each unit, with the flow rate of 120 l/h.

Compressed air flow rate			
Single power supply (i.e. rack cabinet IP00)	l/min		Approx. 22
Rack cabinet (at least IP40)	l/min		2

WARNING !

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

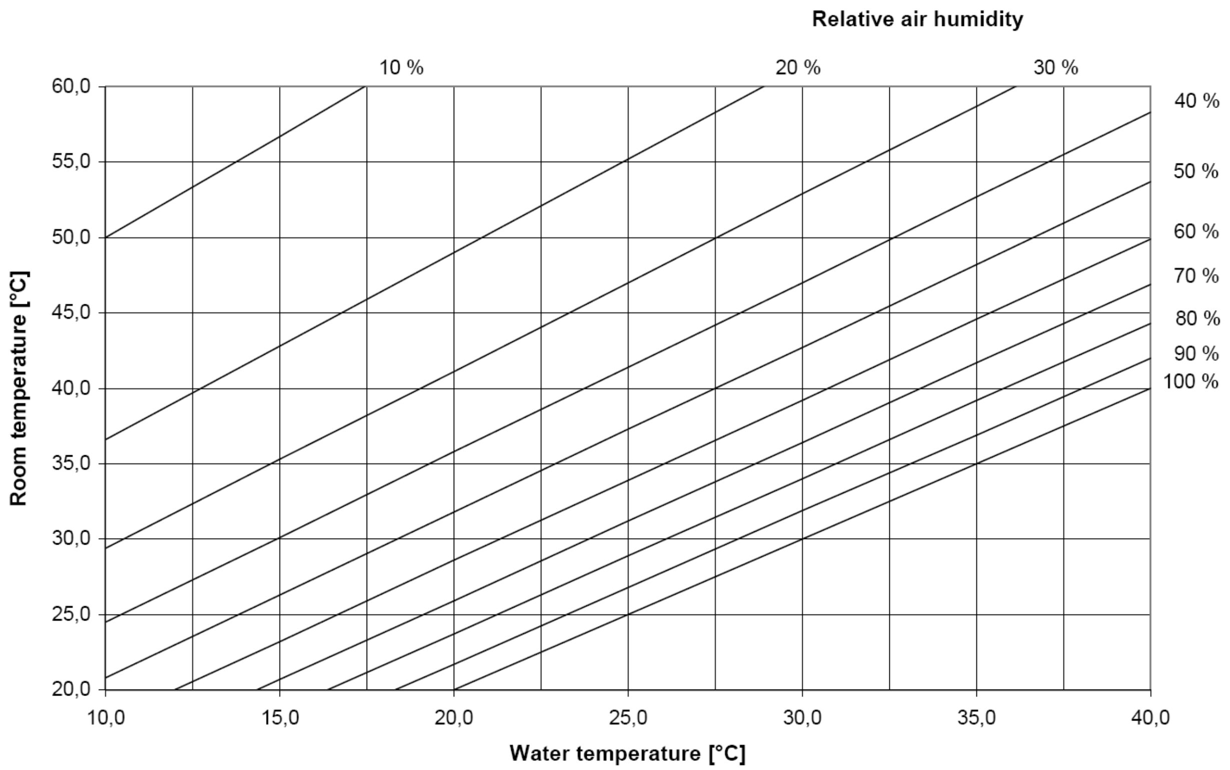


Fig. 3.1. Dew point diagram.

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

3.5. TruPlasma Highpulse power characteristics

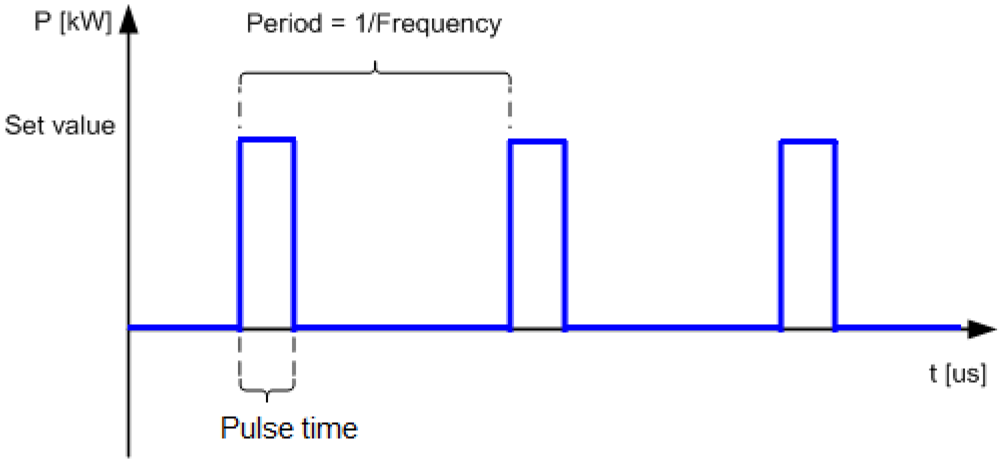


Fig. 3.2. Output characteristics of **TruPlasma Highpulse** module.

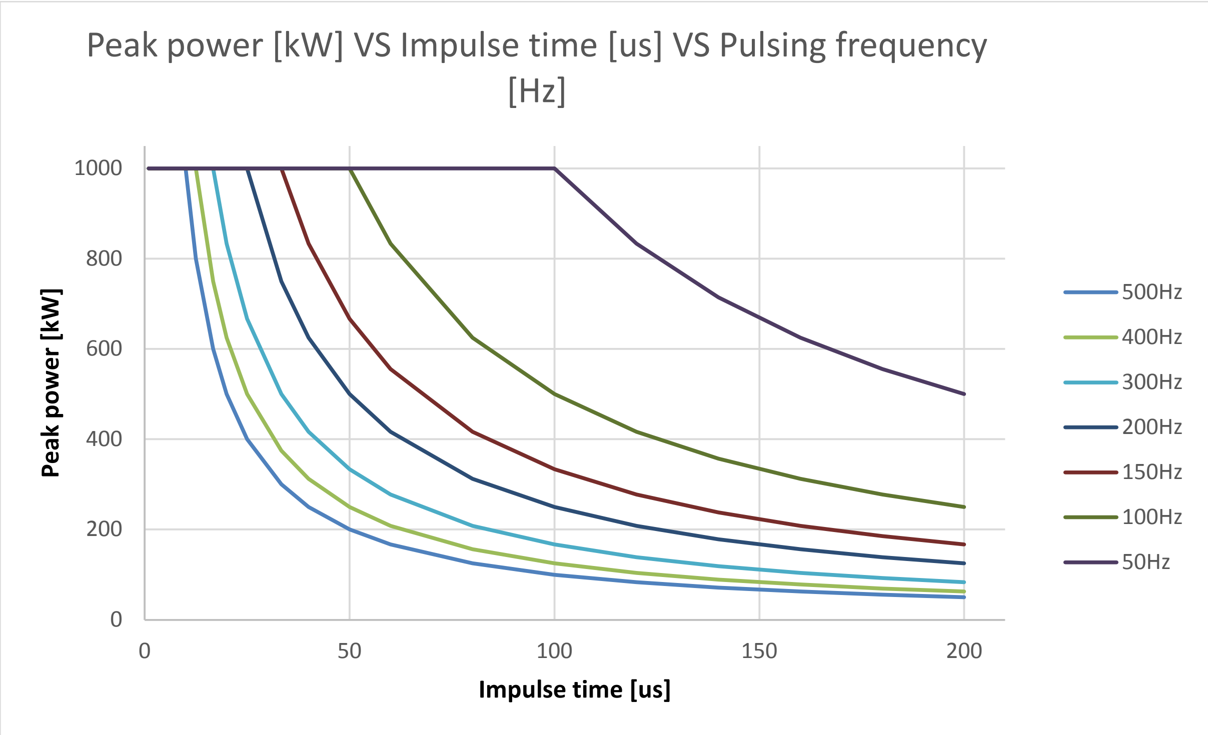


Fig. 3.3. Power characteristics of **TruPlasma Highpulse** module.

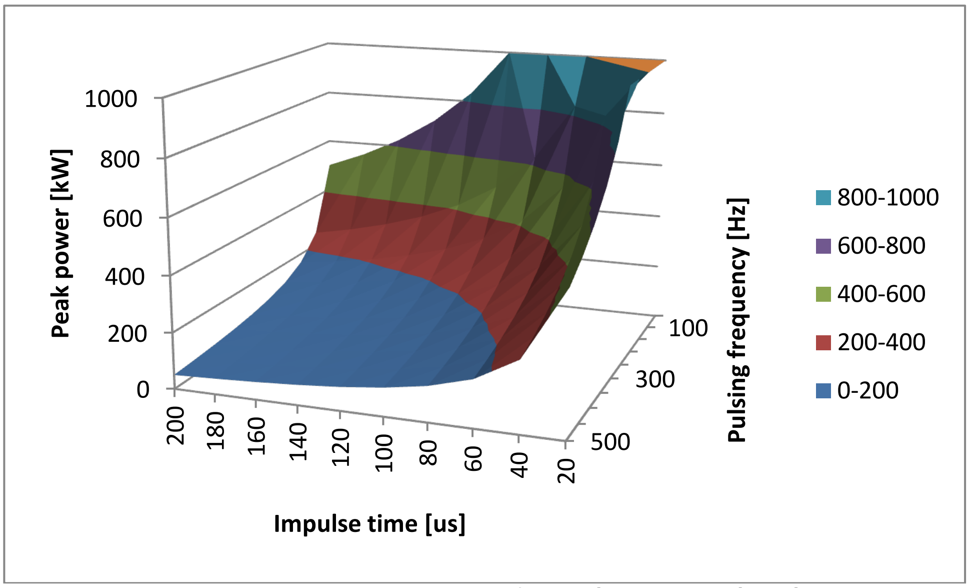


Fig. 3.4. Full power characteristics of **TruPlasma Highpulse** module.

4. Installation and connections

4.1. Installation site

Enclosure

TruPlasma Highpulse 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. 155kg 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.

Special lifting eyes (4 pieces) for lifting and moving are attached to **TruPlasma Highpulse**.

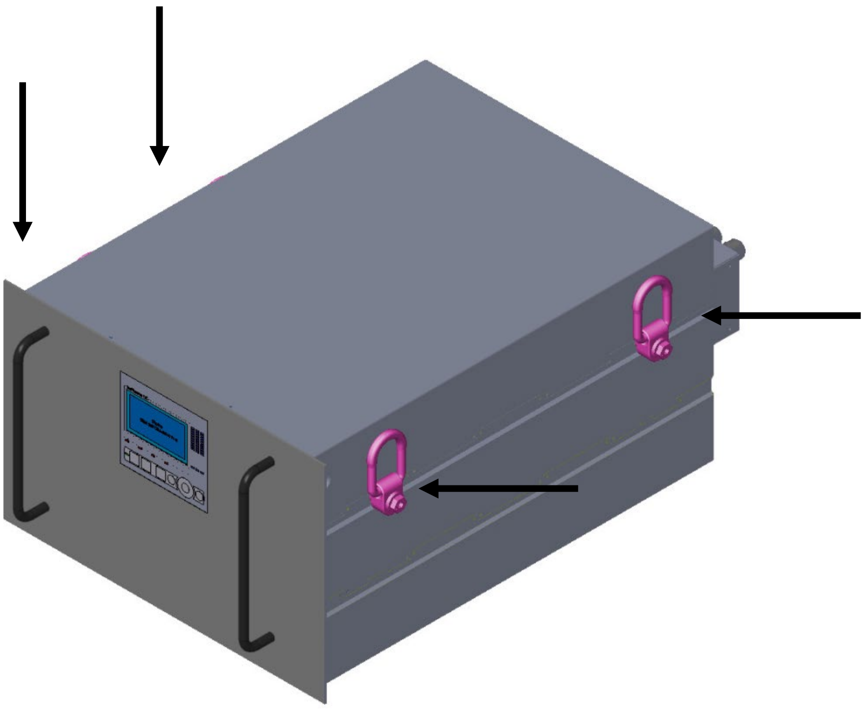


Fig. 4.1. **TruPlasma Highpulse** with lifting eyes.

HEAVY OBJECT.
May result in severe injury.
Do not lift or move without adequate equipment.
Weight 155kg.

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 36A B-class fuses will provide necessary protection.

A set of fuses has to be provided for each power supply separately, even if it works in parallel or synchronous mode.

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

4.3. Connection terminals

All connection terminals are located on rear side of **TruPlasma Highpulse**. 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.

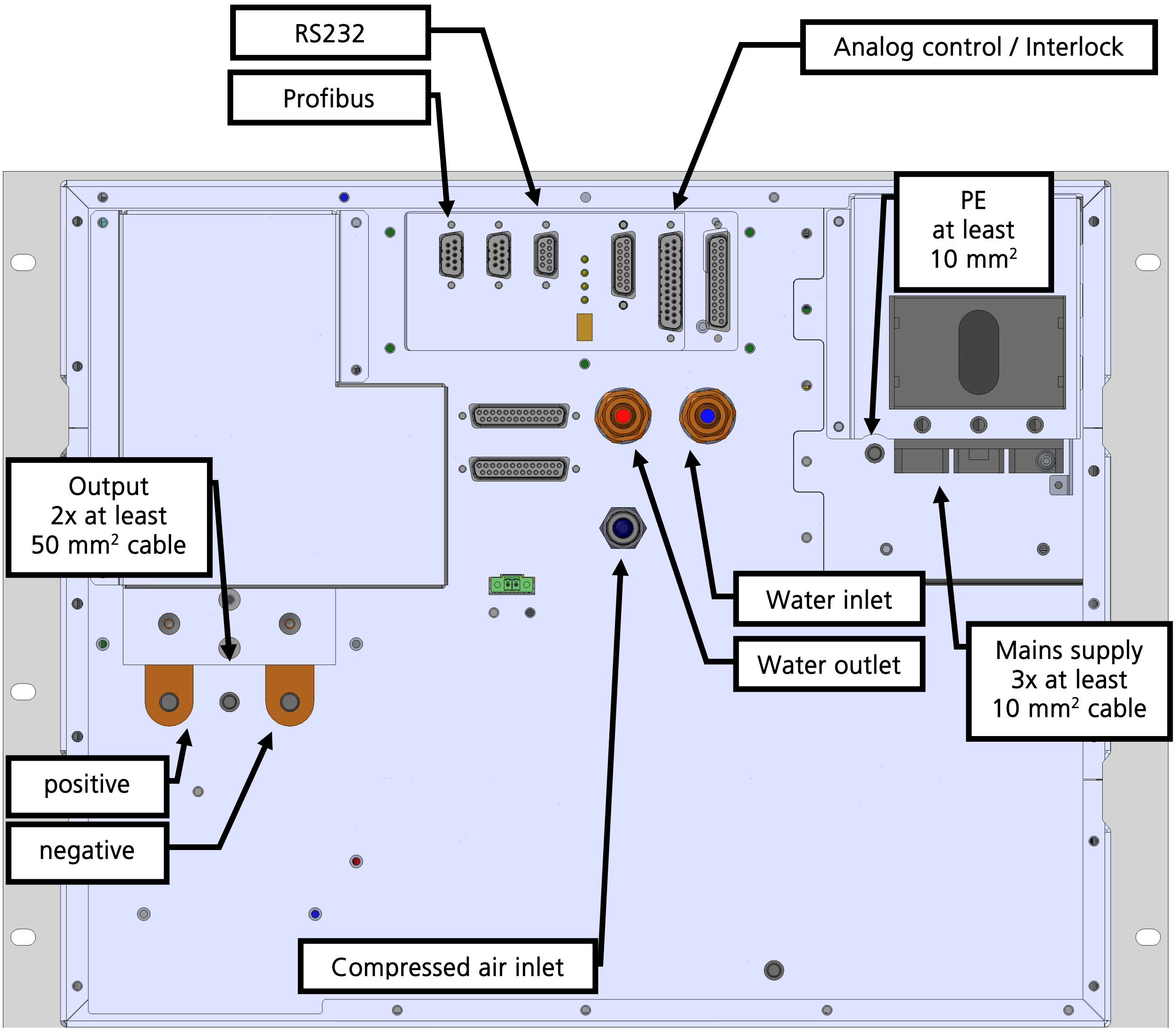


Fig. 4.2. Description of connectors and terminals on the rear panel.

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 400-480 V AC	3x min. $10mm^2$	3x ferrule
PE	Protective earth	min. 10 mm^2	M6
OUTPUT	2000V / 1000A (peak)	2x min. 50 mm^2 twisted on entire length and shielded (shield connected to ground from chamber side) high voltage (preferably 3kV) cable.	2x M8

WARNING !

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

4.5. Cooling connectors description

Terminal	Description	Hose ending
Water inlet	Stainless steel or polyurethane (PU)	ø 10 mm (quick connect adaptors are attached)
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
Profibus	communication port	see below	SUBD 9pin male
RS-485	not used in this application		n/a
RS-232	communication port	see below	SUBD 9pin female
Digital input/output	not used in this application		n/a
Scalo control			
Analog control	analog interface	see below	SUBD 25pin female
Pulse control	not used in this application		n/a
DeviceNet	not used in this application		n/a
External Bus	not used in this application		n/a

4.7. 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	RS-232 receives data
3	TxD	digital output	RS-232 transmits data
5	GND	GND	Ground, can be used for cable shield
others	-	n/c	n/c

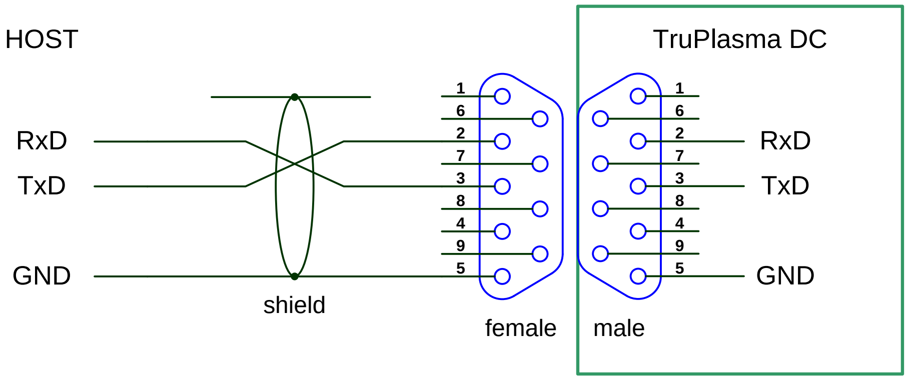


Fig. 4.3. RS-232 connection diagram.

Do NOT connect the shield with earth (PE).

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).

Default baud rate is 115200 bps.

4.8. Profibus communication terminal

Profibus 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	RxD/TxD-P	Digital I/O	Differential I/O signal
5	DGND	GND	Isolated Profibus ground
6	VP	+5V DC	Isolated Profibus supply voltage
8	RxD/TxD-N	Digital I/O	Differential I/O signal
others	-	n/c	n/c

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

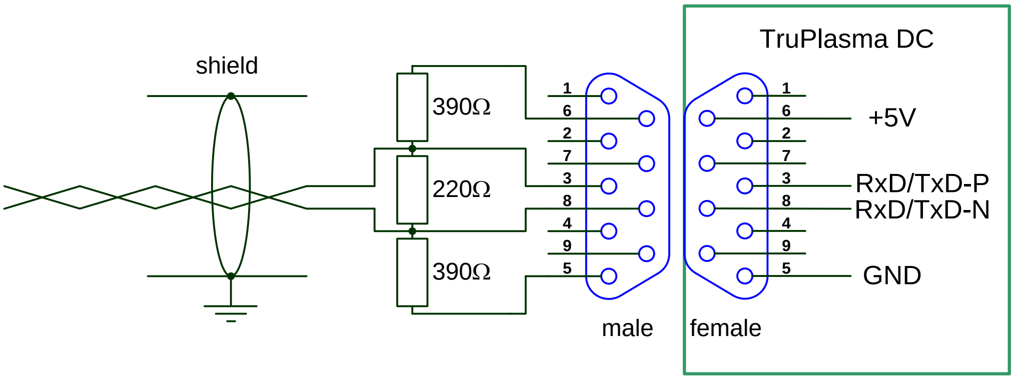


Fig. 4.5. Profibus connection diagram.

4.9. 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.

<table>
<tr><th>Pin no.</th><th>Name</th><th>Type</th><th colspan="3">Description</th></tr>
<tr><td>1</td><td>U act</td><td>Analog output</td><td colspan="3">0..10 V against GND represents 0…2000 V output voltage</td></tr>
<tr><td>2</td><td>I act</td><td>Analog output</td><td colspan="3">0..10 V against GND represents 0…1000 A output current</td></tr>
<tr><td>3</td><td>P act</td><td>Analog output</td><td colspan="3">0..10 V against GND represents 0…10 kW output power</td></tr>
<tr><td rowspan="4">14</td><td rowspan="4">Set Value</td><td rowspan="4">Analog Input Depending on the RegSel setting (pins 10 and 11) one of four control modes can be selected</td><td>RegSel0</td><td>RegSel1</td><td>Control Mode</td></tr>
<tr><td>Low</td><td>Low</td><td>Power control. 0…10V at input represents 0…10 kW power setting</td></tr>
<tr><td>Low</td><td>High</td><td>Voltage control. 0…10V at input represents 0…2000 V voltage setting</td></tr>
<tr><td>High</td><td>Low</td><td>Current control. 0…10V at input represents 0…1000 A current setting</td></tr>
<tr><td>4, 17</td><td>GND</td><td>Ground</td><td colspan="3">Reference ground for all analog signals.</td></tr>
<tr><td>5, 18</td><td>GND</td><td>Ground</td><td colspan="3">Reference ground for all digital signals.</td></tr>
<tr><td>8</td><td>Power ON</td><td>Digital Input</td><td colspan="3">Change the state from 0V to 24V in order to switch on the internal power relays and prepare unit for operation. Interlock loop must be closed and no alarm state must be present.</td></tr>
<tr><td>9</td><td>Release</td><td>Digital Input</td><td colspan="3">Connect to 24V in order to provide power to output terminals when the internal power relays are switched on (PowerON input is active).</td></tr>
<tr><td>10, 11</td><td>Reg Sel</td><td>Digital Inputs</td><td colspan="3">Control mode selector: RegSel1 (pin 10) and RegSel0 (pin11)
High = Connected to 24V; Low = Connected to GND or open. See description for pin 14 (Set Value)</td></tr>
<tr><td>12</td><td>Interlock</td><td>Digital input</td><td colspan="3">Interlock must be disabled (connected to +24V, pin 19) to enable power supply switch-ON. This is a relay-based hardware connection.</td></tr>
<tr><td>19</td><td>+24V</td><td>Supply output</td><td colspan="3">24V supply for all digital inputs.</td></tr>
<tr><td>6</td><td>Coll.</td><td>Digital output (isolated)</td><td colspan="3">All optocoupler collectors are connected to this common pin.
Max. voltage between this pin and the remaining isolated digital outputs must not exceed 30V.</td></tr>
<tr><td>21</td><td>No FaultInd.</td><td>Digital output (isolated)</td><td colspan="3">No fault indication. Voltage from pin 6 is coupled to this pin to show, that the unit is powered up and no alarms are active. Maximum pin voltage is 30V. Maximum current is 10mA.</td></tr>
<tr><td>22</td><td>PowerONind</td><td>Digital output (isolated)</td><td colspan="3">Voltage from pin 6 is coupled to this pin to show, that the unit is running. Maximum pin voltage is 30V. Maximum current is 10mA.</td></tr>
<tr><td>24</td><td>NVR</td><td>Digital output (isolated)</td><td colspan="3">Nominal Value Reached. Voltage from pin 6 is coupled to this pin to show, that the output parameter is within 5% of its set value or nominal output value . Maximum pin voltage is 30V. Maximum current is 10mA.</td></tr>
<tr><td>7</td><td>Arc Occurs</td><td>Digital output</td><td colspan="3">Voltage from pin 6 is coupled to this pin for ca. 20ms to show that an arc has occurred. These signals are not synchronized with the actual arc occurrence (50 - 500ms time shift). The number of “blinks” show the number of arcs.</td></tr>
<tr><td>13, 25</td><td>Alarm</td><td>Digital output</td><td colspan="3">Potential-free contacts are shortened when the unit is powered up and alarm state is present. Maximum load is 30V, 0.5A.</td></tr>
</table>

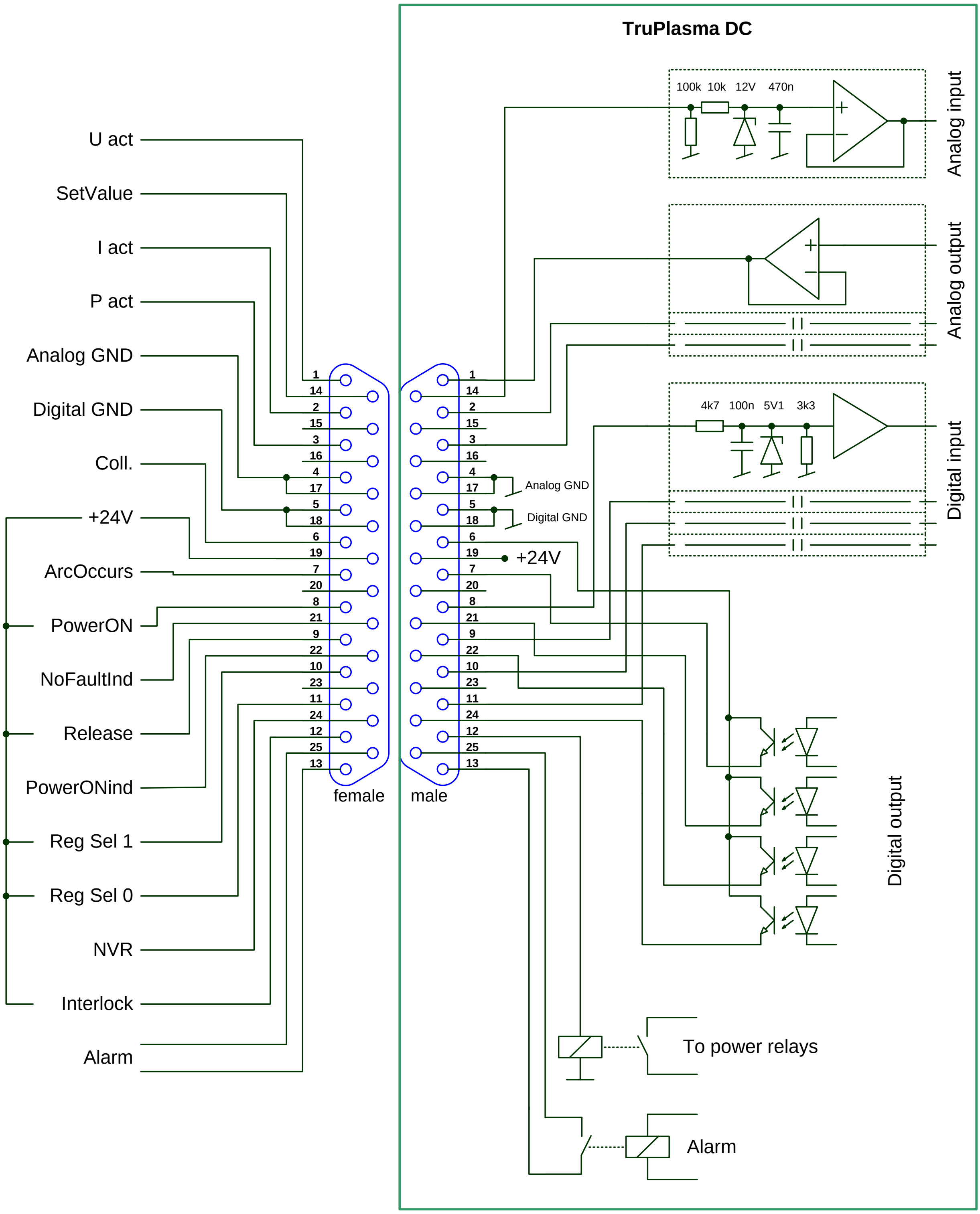
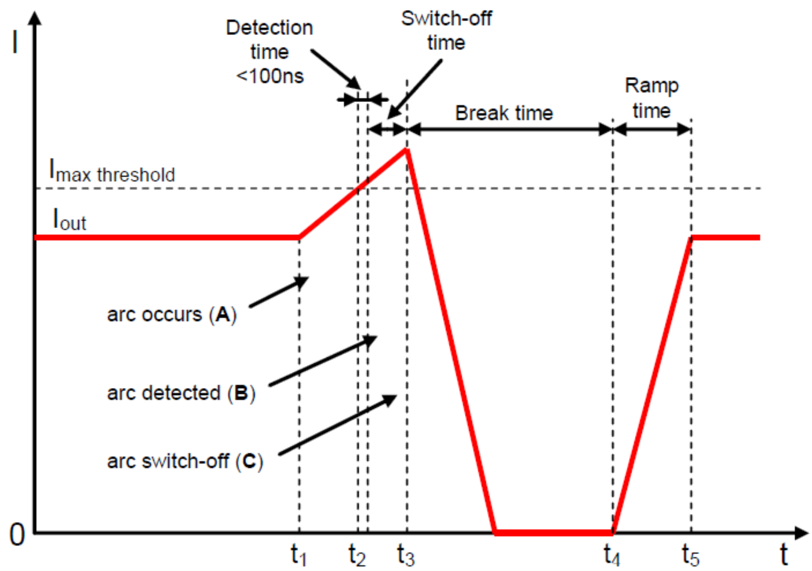


Fig. 4.7. Analog control connection and circuit diagram.

5. Arc management

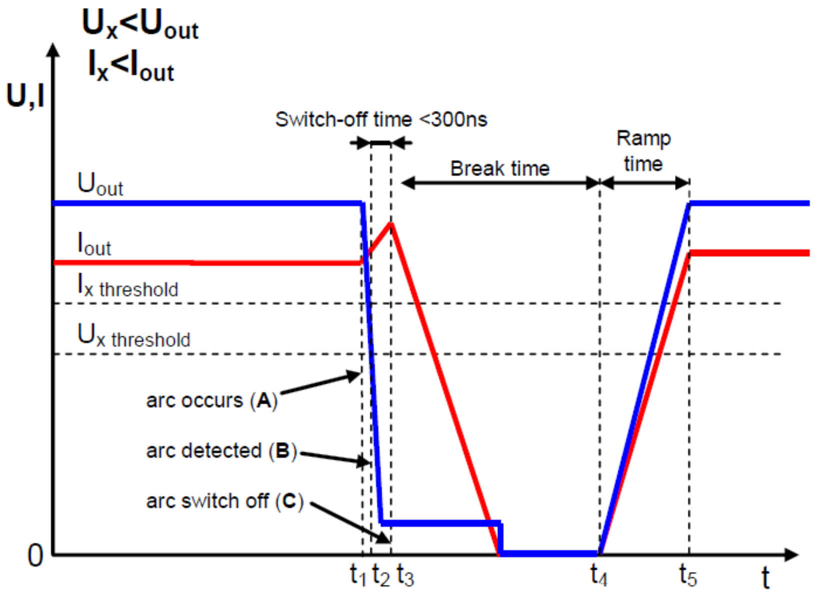
Electric arcs, observed inside vacuum chamber during all stages of surface treatment process may affect treated surface in a negative manner. In such events arcs should be suppressed as fast as possible. From an electrical point of view, arc occurrence is defined as a rapid change of impedance in chamber's electric terminals.
TruPlasma Highpulse arc detection system is equipped with two kinds of arc detection criteria:
Imax – current-based detector – reacts when output current exceeds user defined Imax threshold
UxI – voltage and current-based detector (cross-detector) – reacts when output voltage is lower than user-defined Ux threshold, while current is higher than user-defined Ix threshold
Notes:
- In TruPlasma Highpulse maximum frequency of detected and suppressed arcs can be as high as 1kHz.

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 shut-down signal is activated and output power is switched off until the time the next pulse occurs.
Imax
reacts when output current exceeds user defined Imax threshold



Imax threshold – defined by the user
Break time – not applicable for TruPlasma Highpulse
Ramp time – not applicable for TruPlasma Highpulse
UxI

reacts when output voltage is lower than user-defined Ux threshold, while current is higher than user-defined Ix threshold

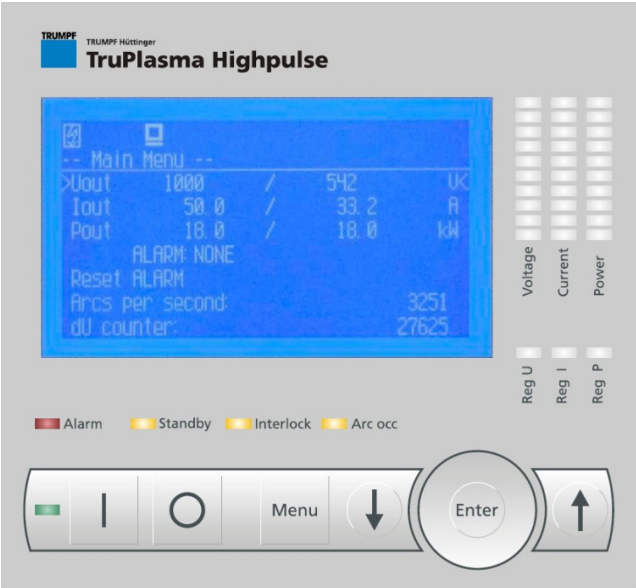


Ix threshold – defined by the user
Ux threshold – defined by the user
Break time – not applicable for TruPlasma Highpulse
Ramp time – not applicable for TruPlasma Highpulse

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. 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 peak output voltage.
Bar Graph – Current	white	Level of actual peak output current.
Bar Graph – Power	white	Level of actual peak 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.

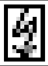
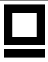
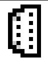
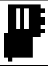
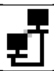
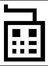
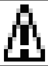
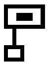
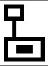
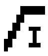
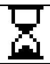
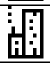
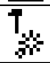
6.4. Menu structure

Display interface has graphic and text areas:

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

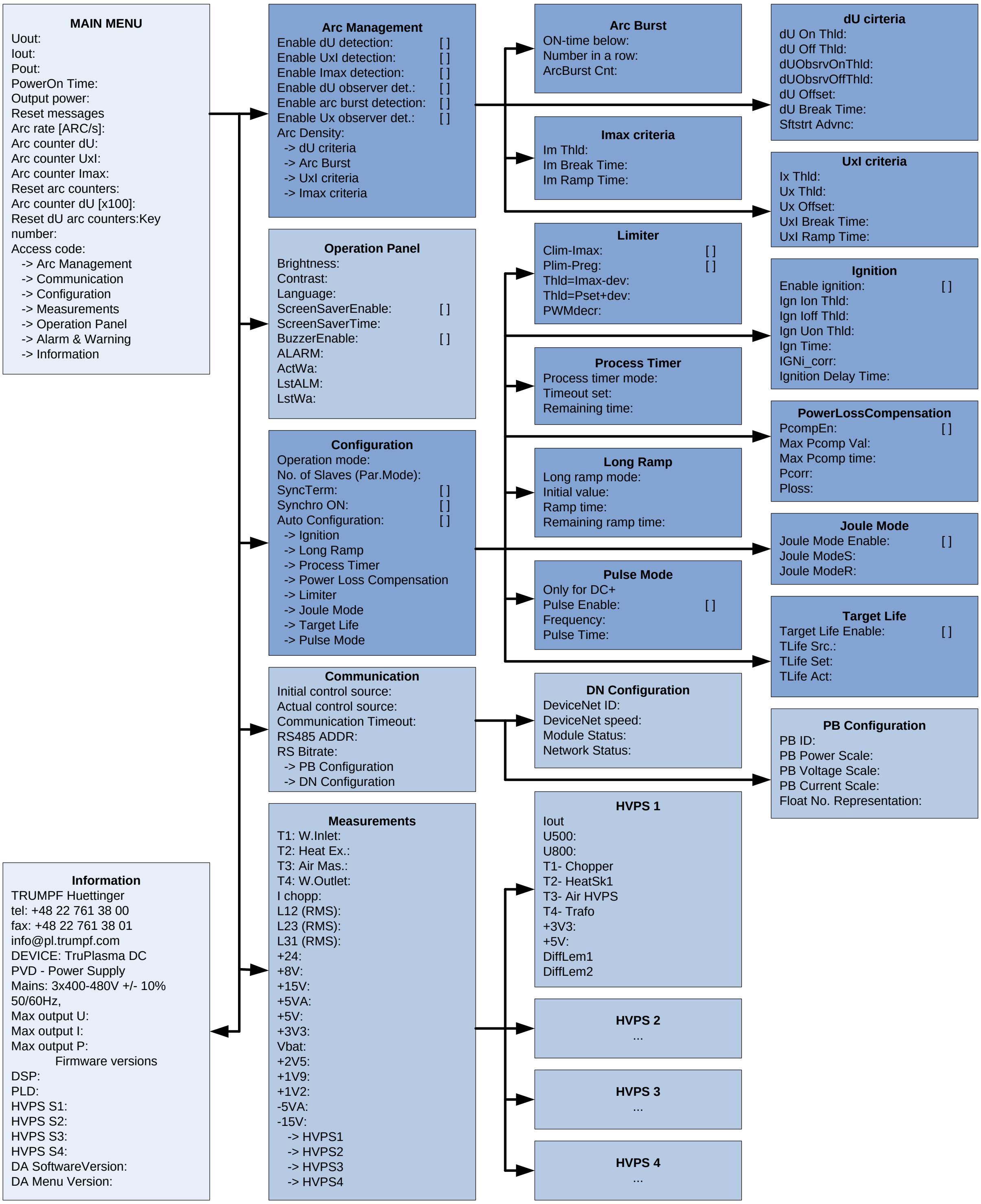
```
⚠                 ▣
Main Menu________________________________
 Pout        =   20.0     /     18.1 kW
>Uout        =    680     /      697  V<
 Iout        =   29.6     /     26.6  A
 ALARM:                      NONE
 dU counter:                       0
 UxI counter:                      0
 Imax counter:                     0
```

- 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
	OEM access mode
	STP access mode

Principle of menu navigation is use four switches (Menu, Enter, Up, Down). Menu of SOP has sub menu (three levels) structure. At the beginning of device operation the SOP display 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.7.1. Standard Operator Panel menu structure.

6.5. Description of displayed data and settings

MAIN MENU – Basic controls and readouts

Display	Modif.	Description
>Uout= 680 / 679V <	Yes	Voltage regulator setting (first number) and actual power supply's output voltage readout (second number).
>Iout= 25.0 / 24.5A <	Yes	Current regulator setting (first number) and actual power supply's output current readout (second number).
>Pout= 20.0 /16.6kW <	Yes	Power regulator setting (first number) and actual power supply's output power readout (second number).
>PowerOnTime: hh:mm.ss <	No	Time elapsed from last switching power on.
>Output power: ON <	Yes	If control mode is set to DISPLAY panel, power supply can be switched on.
> Reset messages <	Yes	Reset occurred alarms, warnings.
Arc rate [ARC/s]: 0/s	No	Arc frequency.
Arc counter UxI: 0	No	Number of arcs detected by UxI criterion, which occurred since last counter reset (max 65535).
Arc counter Imax: 0	No	Number of arcs detected by Imax criterion, which occurred since last counter reset (max 65535).
>Reset arc counters: NO<	Yes	Reset arc counters. If dU counter(x100) is full, then counter will also be reset.
>Reset dU arc counters: <	Yes	Reset dU arc x100 counter.
Key number: 123	No	Parameter for OEM access code generating.
>Access code: STD <	Yes	Entering proper access code following menus are accessable: -> Arc Management OEM -> Communication OEM -> Configuration STP -> Measurements STP -> Regulators SRV -> Operation Panel STP -> Alarm & Warning STD -> Information STD Access codes: STD – 0; STP – 1; OEM – 321.

Annotations:

- ON and OFF buttons at operator panel allow quick switching power on and off

Arc Management

Display	Modif.	Description
`>Enable UxI detection <`	Yes	Enables or disables UxI detection criterion.
`>Enable Imax detection <`	Yes	Enables or disables Imax detection criterion.
`>Enable arc burst detection <`	Yes	Enables or disables Arc Burst detector.
`>Enable Ux observer detection <`	Yes	Enables or disables Ux observer detection criterion.
`>Arc Density 2000 <`	Yes	Threshold for "TooManyArcs" alarms. If number of arcs per second is higher this threshold, Power Supply will generate alarm and switch off power on output. Alarm is activated if Arc Density parameter is different than 0. [0…8000]
`-> UxI criteria`	-	Submenus. See below.
`-> Imax criteria`	-	

Arc Management –> Imax criteria

Display	Modif.	Description
`>Im Thld: 85.5 A <`	Yes	Current threshold value for Imax detection criterion. [15…195A]

Arc Management –> UxI criteria

Display	Modif.	Description
`>Ix Thld: 13.0 A <`	Yes	Current threshold value for UxI detection criterion. [7.5… 150A]
`>Ux Thld: 259 V <`	Yes	Voltage threshold value for UxI detection criterion. [0…900V]

Communication

Display	Modif.	Description
`>Initial control source: RS232 <`	Yes	Initial control source after reboot: **DISPLAY**, **ANALOG**, **RS232**, **PROFIBUS**, **RS485** or **DeviceNet**.
`>Actual control source: RS232 <`	Yes	Control source of the power supply: **DISPLAY**, **ANALOG**, **RS232**, **PROFIBUS**, **RS485** or **DeviceNet**.
`>Communication Timeout: 3s <`	Yes	Delay time for communication lost alarm generating. [0…65s]

Display	Modif.	Description	
>RS485 ADDR= 255 <	Yes	RS485 address	[0…65535]
>RS Bitrate: 115200 <	Yes	Baud rate for RS communication	[9600, 19200, 38400, 57600, 115200]

Configuration

Display	Modif.	Description
>Ppeak Max:<	Yes	Maximum peak power
>Ignition En<	Yes	Enables or disables Ignition.
> Ign Max Time<	Yes	Maximum ignition time
> CLC En<	Yes	CLC after each pulse
> CLC Arc En<	Yes	CLC only after arc occurs

Measurements

Display	Modif.	Description
T1:W. Inlet= 24.6°C	No	Temperature of inlet water.
T2: Air Mas =24.6°C	No	Temperature of heat exchanger.
T3: Heat Ex.=24.6°C	No	Temperature of air at control PCB.
T4:W.Outlet= 24.6°C	No	Temperature of outlet water.
L12 (RMS)	No	Mains actual RMS voltage, phases 1-2.
L23 (RMS)	No	Mains actual RMS voltage, phases 2-3.
L31 (RMS)	No	Mains actual RMS voltage, phases 3-1.
+24V: 24.0 V	No	Internal power supply output voltage.
+8V: 8.0 V		Internal supply voltage.
+15V: 15.0 V		
+5V: 5.0 V		
+3V3: 3.3 V		
+Vbat: 3.3 V		
+2V5: 2.5 V		
+1V9: 1.9 V		
+1V2: 1.2 V		
-15V: -15.0 V		
-> HVPS 1 -> HVPS 2	-	Sub-menus. Readouts of measurements at internal modules.

-> HVPS 3 -> HVPS 4		

Measurements –> HVPS 1…4

Display	Modif.	Description
Iout 10.0 A	No	Output current of HVPS unit.
U500: 555 V	No	Rectified mains voltage.
U800: 800 V	No	Inverter supply voltage.
T1-Tran Chop = 24.6°C	No	Temperature of output chopper.
T2-HeatSk1 = 24.6°C	No	Temperature of heatsink.
T3-Air HVPS= 24.6°C	No	Temperature of air at control PCB.
T4-Trafo= 24.6°C	No	Temperature of main transformer.
+3V3 3.37 V	No	Internal supply voltage.
+5V 5.03 V	No	
DiffLem1 0.0 A	No	Internal sections differential current.
DiffLem2 0.0 A	No	

Operation Panel

Display	Modif.	Description
>Brightness = 90 % <	Yes	LCD screen brightness. [0…100%]
>Contrast = 50 % <	Yes	LCD screen contrast. [0…100%]
>Language = English <	Yes	Not used. Default language is English.
> Enable Screen Saver <	Yes	Enables or disables screen saver.
>Screen Saver Time: 10 min<	Yes	Screen saver delay time. [1…60min]

7. Interfaces

7.1. RS-232 transmission protocol description

TruPlasma Highpulse acts as a slave device in the communication process. It never initiates any transmissions. Computer (PC) sends a command which is executed by **TruPlasma Highpulse** and a reply is generated (see note 1). Standard commands are shown below. Additional commands can be implemented if necessary. Default baud rate is set to 115200 bps. The RS communication works in standard 8n1 (8 bits of data, non parity, 1 bit of stop).

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:
DST_H = 0xFF;
DST_L = 0xFF;
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						
$Pset_{0-3}$	Bits	CRC_H	CRC_L						

Where:

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

Bits:

0: Mains relays ON (0 → 1; slope sensitive), OFF (0)
1: Power ON (1), OFF (0)
2: Reset arc counters (0 → 1; 1 transmission is sufficient)
3: Reset Alarms
4: -
5: RS controls the **TruPlasma Highpulse** unit (1), monitoring only (0)
6: -
7: Display Control (1)

IMPORTANT: When controlling **TruPlasma Highpulse** 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 "RS :NO CTRL" 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
0x27	0xD8	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-24	25-26	27-28	29-30	31-34	35-36	37-38
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-2}$	Im_{0-1}	UxI_{0-1}	dU_{0-1}	Arc/s_{0-3}	$dUx100_{0-1}$	CRC_{0-1}

Where:

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

Bits0: Acknowledge bits.
- 0: Relays ON acknowledge (1), or OFF (0)
- 1: Power ON (1), INHIBIT (0)
- 2: Ramp active
- 3: Master Active (in parallel mode)
  or Pulse Mode ON (1) / OFF (0) (in **TruPlasma Highpulse**+)
- 4: Display control
- 5: Alarms to read.
- 6: RS232/485 control
- 7: Ready

Bits1: more acknowledge bits.
- 0: Interlock (1), no interlock (0)
- 1: OverTemp Bit: 1=Overtemp
- 2: PowerFail (1), power OK (0)
- 3: FPGA (1) OK (0)
- 4: EEprom Error (1), OK (0)
- 5: -
- 6: WarningActive (1), inactive (0).
- 7: AlarmActive (1), inactive (0).

Bits2: more acknowledge bits.
- 0: RegU ON (1), OFF (0)
- 1: RegI ON (1), OFF (0)
- 2: RegP ON (1), OFF (0)
- 3: Pcomp Active
- 4: EOJM
- 5: EOTL
- 6: EOPT
- 7: Arc occ.

Im (integer)	Arc counter (Imax criterion)	0...65535
UxI (integer)	Arc counter (UxI criterion)	0...65535
dU (integer)	Arc counter (dU criterion)	0...65535
Arc/s(float)	Arcs per second counter	
dU[x100](integer)	Arc counter (dU criterion) [x100]	0…10000

Other parameters can be accessed for reading or adjustment, through their channel numbers. Byte, integer and float values have separate channel number lists. Command strings for reading and setting these values together with channel lists are presented below.

6040 Normal run – for DC+

PC to unit:

0	1	2	3	4	5	6	7	8-11	12-15
0x1B	0xE4	DST_H	DST_L	SRC_H	SRC_L	0x60	0x40	$Uset_{0-3}$	$Iset_{0-3}$
16-19	20	21-22	23-24	25	26				
$Pset_{0-3}$	Bits	$Fset_{0-1}$	$RTset_{0-1}$	CRC_H	CRC_L				

Where:

Uset (float)	Voltage setpoint [V]	$0\ldots U_n$ V
Iset (float)	Current setpoint [A]	$0\ldots I_n$ A
Pset (float)	Power setpoint [kW]	$0\ldots P_n$ kW
Fset (uint16)	Frequency setpoint [Hz]	20…15000Hz
PTset (uint16)	Pulse Time setpoint [us]	1…100us

Bits:

0: Mains relays ON (1), OFF (0)
1: Power ON (1), OFF (0)
2: Reset arc counters (1 transmission is sufficient)
3: Reset Alarms
4: -
5: RS controls the DC unit (1), monitoring only (0)
6: Pulse ON (1), OFF (0)
7: Display Control (1)

IMPORTANT: When controlling **TruPlasma Highpulse** 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 "RS :NO CTRL" 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
0x27	0xD8	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-24	25-26	27-28	29-30	31-34	35-36	37-38
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-2}$	Im_{0-1}	UxI_{0-1}	dU_{0-1}	Arc/s_{0-3}	$dUx100_{0-1}$	CRC_{0-1}

Where:

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

Bits0: Acknowledge bits.
- 0: Relays ON acknowledge (1), or OFF (0)
- 1: Power ON (1), INHIBIT (0)
- 2: Ramp active
- 3: Master Active (in parallel mode)
  or Pulse Mode ON (1) / OFF (0) (in **TruPlasma Highpulse+**)
- 4: Display control
- 5: Alarms to read.
- 6: RS232/485 control
- 7: Ready

Bits1: more acknowledge bits.
- 0: Interlock (1), no interlock (0)
- 1: OverTemp Bit: 1=Overtemp
- 2: PowerFail (1), power OK (0)
- 3: FPGA (1) OK (0)
- 4: EEprom Error (1), OK (0)
- 5: -
- 6: WarningActive (1), inactive (0).
- 7: AlarmActive (1), inactive (0).

Bits2: more acknowledge bits.
- 0: RegU ON (1), OFF (0)
- 1: RegI ON (1), OFF (0)
- 2: RegP ON (1), OFF (0)
- 3: Pcomp Active
- 4: EOJM
- 5: EOTL
- 6: EOPT
- 7: Arc occ.

Im (integer)	Arc counter (Imax criterion)	0...65535
UxI (integer)	Arc counter (UxI criterion)	0...65535
dU (integer)	Arc counter (dU criterion)	0...65535
Arc/s(float)	Arcs per second counter	
dU[x100](integer)	Arc counter (dU criterion) [x100]	0…10000

Other parameters can be accessed for reading or adjustment, through their channel numbers. Byte, integer and float values have separate channel number lists. Command strings for reading and setting these values together with channel lists are presented below.

6101 Identification of device:

PC to TruPlasma Highpulse:

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

TruPlasma Highpulse reply:

0	1	2	3	4	5	6	7	8	9
0x20	0xDF	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x68	0x0C
10	...	29	30	31					
S_{00}	...	S_{19}	CRC_H	CRC_L					

Where: $S_{00} \div S_{19}$: device type (char[20]);

6141 Set a floating point value

PC to TruPlasma Highpulse:

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

TruPlasma Highpulse 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 TruPlasma Highpulse:

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

TruPlasma Highpulse 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

6121 Set an integer value

PC to TruPlasma Highpulse:

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

TruPlasma Highpulse 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 TruPlasma Highpulse:

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

TruPlasma Highpulse 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 TruPlasma Highpulse:

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

TruPlasma Highpulse 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 TruPlasma Highpulse:

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

TruPlasma Highpulse 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 describtion

PC to TruPlasma Highpulse:

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

TruPlasma Highpulse 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 describtion

PC to TruPlasma Highpulse:

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

TruPlasma Highpulse 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		

Channel numbers:

Byte

Chan	Text	Range	Adjustable
9	Warnings Sources Bits 1: 0="EE NoData" 1="EE CheckSum" 2="EE Write Err" 3="Arc Fmax" 4="Calbr Done" 5="UnClbtnStat" 6="T1 Warn" 7="T2 Warn"	0 … 255	NO
10	Warnings Sources Bits 2: 0="T3 Warn" 1="T4 Warn" 2="CSPC1_Warn" 3="CSPC2_Warn" 4="CSPC3_Warn" 5="CSPC4_Warn" 6="Water Flow" 7="Water Dir"	0 … 255	NO
11	Warnings Sources Bits 3: 0="CSPC1 CW" 1="CSPC2 CW" 2="CSPC3 CW" 3="CSPC4 CW" 4="DA CTW" 5="RS232 CW" 6="RS485 CW" 7="DN CW"	0 … 255	NO
12	Warnings Sources Bits 4: 0="PB CW" 1="Analog CW" 2="SynchCon W" 3="ASrc CW" 4="Slave1 W" 5="Slave2 W" 6="Slave3 W" 7="Slave4 W"	0 … 255	NO
68	Warnings Sources Bits 5: 0="EE NewMap" 1="Dev U" 2="Dev I" 3="Dev P" 4="No Plasma" 5="Pcomp" 6="CAN Warn"	0 … 63	NO
1	Alarms Sources Bits 1: 0="EE Error" 1="EE CheckSumErr" 2="FpgaConfFail" 3="CSPC1 Al" 4="CSPC2 Al" 5="CSPC3 Al" 6="CSPC4 Al"	0 … 255	NO

Chan	Text	Range	Adjustable
	7="CSPC SAR"		
2	Alarms Sources Bits 2: 0="U24 max" 1="U24 min" 2="T1 off" 3="T2 off" 4="T3 off" 5="T4 off" 6="DF Fail" 7="Phase Fail"	0 … 255	NO
3	Alarms Sources Bits 3: 0="CSPC1 CT" 1="CSPC2 CT" 2="CSPC3 CT" 3="CSPC4 CT" 4="DA CT" 5="RS232 CT" 6="RS485 CT" 7="DN CT"	0 … 255	NO
4	Alarms Sources Bits 4: 0="PB CT" 1="Analog CT" 2="SynchConn" 3="ASrc CT" 4="Slave1 Al" 5="Slave2 Al" 6="Slave3 Al" 7="Slave4 Al"	0 … 255	NO
60	Alarms Sources Bits 5: 0="I2C EE" 1="I2C Temp" 2="I2C PF" 3="I2C RTC" 4="ParBus Err" 5="CAN Err" 6="NoLoad" 7="ShortCircuit"	0 … 255	NO
61	Alarms Sources Bits 5: 0="ArcDensity" 1="PLD SW ver" 2="CLC Freq.High" 3="CLC Shorted"	0 … 15	NO
19	Initial control source, bit rate: 0: Display ini; 1: Analog ini; 2: RS232 ini; 3: Profibus ini; 4: RS485 ini; 5: DeviceNet ini; 6: EtherCAT ini;	0 … 32	YES
20	Actual control source, bit rate: 0: Display; 1: Analog; 2: RS232;	0 … 32	YES

Chan	Text	Range	Adjustable
	3: Profibus; 4: RS485; 5: DeviceNet; 6: EtherCAT ini;		
22	Pararel Operation Mode (=0 Single), bit rate: 0: Master; 1: Slave1; 2: Slave2; 3: Slave3; 4: Slave4;	0 … 16	YES
23	Long ramp modes, bit rate: 0: Power ramp (1 On/0 Off); 1: Current ramp (1 On/0 Off);	0 … 2	YES
24	ProcessTimer modes, bit rate: 0: Power On (1 On/0 Off); 1: Power regulator (1 On/0 Off);	0 … 2	YES
26	Synchro mode enable	0 … 1	YES
27	Ignition mode enable	0 … 1	YES
28	RS speed: 0: 9600 bps; 1: 19200 bps; 2: 38400 bps; 3: 57600 bps; 4: 115200 bps;	0 … 16	YES
29	Synchro Bus Termination (1 On/0 Off)	0 … 1	YES
32	Target Life enable	0 … 1	YES
33	Joule mode enable	0 … 1	YES
34	Power Compensation Enable	0 … 1	YES
35	Current and Power Limiter modes, bit rate: 0: Current Limiter On (1 On/0 Off); 1: Power Limiter On (1 On/0 Off);	0 … 2	YES
200	Arc criteria Enable/Disable, bit rate: 0: dU En (1 On/0 Off); 1: UxI (1 On/0 Off); 2: Imax (1 On/0 Off); 3: dU Obs (1 On/0 Off); 4: Arc Burst Detector (1 On/0 Off); 5: Ux Obs (1 On/0 Off);	0 … 31	YES
205	Reset arc counters (0 → 1; for 1 transmission is enough)	0 … 1	YES
206	Reset dUCnt[x100] (0 → 1)	0 … 1	YES
300	Profibus profile Type: 0: Module; 1: rsv; 2: Scalo;	0 … 4	YES
301	Float type(for Profibus) 0:Motorola, 1: Intel	0 … 1	YES
320	DeviceNet speed: 0: 125 kbps; 1: 250 kbps; 2: 500 kbps;	0 … 4	YES

Word:

Chan	Text	Range	Adjustable
	Communication:		
3	RS485 Address	0 … 65535	YES
32	Communication Timeout	0 … 65s	YES
300	Profibus ID	0 … 125	YES
301	Power Scale	0 … 65535	YES
302	Voltage Scale	0 … 65535	YES
303	Current Scale	0 … 65535	YES
320	DeviceNet ID	0 … 63	YES
	DC unit Parameters:		
12	Ignition current booster	0 … 50%	YES
20	Ignition Pulse Time	0 … 100 us	YES
33	Ignition Delay Time	0 … 10s	YES
26	Maximum Power Compensation Value	0 … 100 %	YES
28	Maximum Power Compensation Time	0 … 25 s	YES
30	Number of slave for Parallel Operation mode	0 … 4	YES
41	Long ramp time	0 … 7200s	YES
40	Long Ramp Start Value	0 … 100%	YES
44	Long ramp rest value	-	NO
42	ProcessTimer Time	0 … 36000	YES
43	ProcessTimer rest value	0 …36000	NO
11	Current clamp at set %Imax value below Imax	0 … 50%	YES
15	Power clamp at set %Pset value above Pset	0 … 50%	YES
10	The PWM power control is reduced by this % value.	0 … 50%	YES
23	CLim Cnt	-	NO
24	PLim Cnt	-	NO
8	Target Life Source select	1 … 8	YES
	Arc detection settings		
202	Time between succeeding arcs for Arc Burst detection	1 … 1000 us	YES
201	Number of arcs in row for Arc Burst detection	1 … 100	YES
216	Arc Burst detection counter	0 … 65535	NO
221	Arc Density. For volume higher than 0 activates detection of „Too many arcs“alarm	0 … 8000	YES

Float:

Chan	Text	Range	Adjustable
	Arc detection threshold settings		
200	Voltage On threshold for dU arc det. Criterion	$0.05U_n$ … $0.8U_nV$	YES
202	Voltage Off threshold for dU arc det. Criterion	0 … $0.75U_nV$	YES
203	dU Offset	30 … 200V	YES
204	Break time for dU criterion	5…1000µs	YES

Chan	Text	Range	Adjustable
222	Soft-start pre-pulse advance time for dU criterion	0 … 5 us	YES
230	Voltage On threshold for dU_observer arc det. Criterion	$0.05U_n$ … $0.8U_nV$	NO
231	Voltage Off threshold for dU_observer det. Criterion	0 … $0.75U_nV$	NO
208	Voltage threshold for UxI arc det. Criterion	0 … $0.9U_nV$	YES
207	Current threshold for UxI arc det. Criterion	$0.05I_n$ … I_nA	YES
209	Break time for UxI criterion	0.1…80ms	YES
210	Ux Offset	10 … 200V	YES
226	Ramp time for UxI criterion	0.1…100ms	YES
205	Current threshold for Imax arc det. Criterion	$0.1I_n$ … $1.3I_nA$	YES
206	Break time for Imax criterion	0.1…80ms	YES
227	Ramp time for Imax criterion	0.0…100ms	YES
	DC unit Parameters:		
22	Voltage ON threshold for Ignition mode	$0.5U_n$…U_nV	YES
20	Current ON threshold for Ignition mode	0 … $0.01I_n$ A	YES
21	Current OFF threshold_2 for Ignition mode (floating anode)	0 … $0.05I_n$ A	YES
25	Actual Power Correction value [kW]	-	NO
26	Actual Power Losses value [kW]	-	NO
51	Target Life delivered energy [kWh]	0 … 36000.0	NO
52	Target Life setpoint [kWh]	0 … 36000.0	YES
55	Joule Mode energy setpoint [kJ]	0 … 20000.0	YES
56	Joule Mode Actual Energy [kJ]	0 … 20000.0	NO
	Measurments:		
900	CMPC24 DSP version	-	NO
901	CMPC24 PLD version	-	NO
902	CSPC24 S1 version	-	NO
903	CSPC24 S2 version	-	NO
904	CSPC24 S3 version	-	NO
905	CSPC24 S4 version	-	NO
906	Display Panel version	-	NO
907	XML for DA22 version	-	NO
920	Controller supply voltage	0...32V	NO
932	Temperature T1:	0…100°C	NO
933	Temperature T2:	0…100°C	NO
934	Temperature T3:	0…100°C	NO
935	Temperature T4:	0…100°C	NO
	CSPC24 S1:		
1000	Rectified mains voltage	0...1000V	NO
1001	Rectified mains voltage after PFC	0...1000V	NO
1002	Temperature T1:	0…100°C	NO
1003	Temperature T2:	0…100°C	NO
1004	Temperature T3:	0…100°C	NO
1005	Temperature T4:	0…100°C	NO

Chan	Text	Range	Adjustable
	CSPC24 S2:		
1010	Rectified mains voltage	0...1000V	NO
1011	Rectified mains voltage after PFC	0...1000V	NO
1012	Temperature T1:	0…100°C	NO
1013	Temperature T2:	0…100°C	NO
1014	Temperature T3:	0…100°C	NO
1015	Temperature T4:	0…100°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.
4005 Bad Address
4006 Channel address not exist.
4010 Write EEPROM error.
4020 Write EEPROM disabled by slave mode (6141, 6121, 6111).
4030 Write EEPROM disabled.

7.2. Profibus transmission protocol description

Profibus is an interface that allows magnetron units to communicate with Profibus master. Magnetron power supply (DC3000) 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 (DC3000) 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

DC3000 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.

Module 1 - Control Bits

ident. 0x82,0x00,0x00,0x01

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

LSB 0: Profibus master controls DC3000 (1).
1: -
2: Mains relays ON (0 → 1), OFF (0).
3: Power ON (1), OFF (0).
4: Alarms Reset
5: Reset arc counters (0 → 1; 1 transmission is sufficient)
6: Pulsed mode (1) (for pulsed units only)
MSB 7: -

Voltage SetPoint:

Module 2 - Voltage SetPoint in integer format

ident. 0x82,0x01,0x00,0x02

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 module 21 or module 22 descriptions).

Note: Resolution depends on Uscale value.

Module 3 - Voltage SetPoint value in a floating-point format

ident. 0x82,0x03,0x00,0x03

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]

Important: If none of the above-mentioned modules are selected, then the voltage setpoint is set to a maximum (Un).

Current SetPoint:

Module 4 - Current SetPoint in integer format

ident. 0x82,0x01,0x00,0x04

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 (refer to module 21 or module 22 descriptions).

Note: Resolution depends on Iscale value.

Module 5 - Current SetPoint in a floating point-format

ident. 0x82,0x03,0x00,0x05

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]

Important: If none of the two above-mentioned modules are selected, then current setpoint is set to maximum (In).

Power Setpoint:

Module 6 - Power SetPoint in integer format

ident. 0x82,0x01,0x00,0x06

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 module 21 or module 22 descriptions).

Note: The resolution depends on Pscale value.

Module 7 - Power SetPoint in a floating point format

ident. 0x82,0x01,0x00,0x07

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

Important: If neither of the two above-mentioned modules are selected, then power setpoint is set to maximum (Pn).

Select control mode:

These two modules – will be omitted if any of previous modules (2 .. 7) are defined – select desired control mode and regulate setpoint at same time. When a certain control mode is selected, remaining setpoints are fixed to maximum. For instance, if power-control mode is selected, then current and voltage setpoints are fixed to their nominal values.

Setpoint value can be presented in both – integer or floating-point format – as in modules 2 … 7. The control mode is selected by two low significant bits from first additional byte.

Bits	RegP	RegU	RegI
2^0	0	1	0
2^1	0	0	1

Important: If any of the previous modules from 2 to 7 are chosen, Select control mode module will be omitted.

Module 8 – Select control mode; integer format setpoint

ident. 0x82,0x02,0x00,0x08

This module consists of three bytes, with control mode selected in first byte (RegSelect) and setpoint in last two bytes in integer format. Depending on selected control mode the last two bytes are scaled by user-defined Pscale, Uscale or Iscale values (see ex. in module 2, 4 and 6). Setpoints for remaining (unselected) parameters are set to their nominal values.

Module 9 – Select control mode; floating-point format setpoint

ident. 0x82,0x04,0x00,0x09

This module consists of five bytes, with control mode being selected in first byte (RegSelect) and a setpoint on last 4 bytes in floating-point format according to selected standard. Setpoints for remaining (unselected) parameters are set to their nominal values.

Settings for pulse generator:

Module 10 - Frequency Setting (for pulsed units only)

ident. 0x82,0x01,0x00,0x0A

This single word module sets frequency value.

For TruPlasmaHighPulse values in range 1 … N represent a frequency setting of 1Hz … N Hz where N is the nominal pulse frequency for this unit.

Values from beyond unit's frequency range will be limited.

Module 11 – Pulse Time Setting (for pulsed units only)

ident. 0x82,0x01,0x00,0x0B

This single byte module sets off-pulse time value in microseconds.

For TruPlasmaHighPulse values in range 10 … N represent an off-time setting of 1.0us … (N)us where(N) is the nominal off-time for this unit.

Values from beyond the unit's off-time range will be limited.

Actual output voltage:

Module 12 - Actual output voltage value in integer format

ident. 0x42,0x01,0x00,0x0C

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 voltage
Un – nominal voltage of power supply
Uscale – user defined setting – can be set via front panel by RS232 or Profibus (see module 21 or module 22 descriptions).

Note: Resolution depends on Uscale value.

Module 13 – Actual output voltage value in a floating-point format

ident. 0x42,0x03,0x00,0x0D

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:

Module 14 – Actual output current value in integer format

ident. 0x42,0x01,0x00,0x0E

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 voltage
In – nominal voltage of power supply
Iscale – user defined setting – can be set via front panel by RS232 or Profibus (see module 21 or module 22 descriptions).

Note: The resolution depends on Iscale value.

Module 15 - Actual current value in a floating-point format

ident. 0x42,0x01,0x00,0x0F

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 :

Module 16 - Actual output power in integer format

ident. 0x42,0x01,0x00,0x10

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 power
Pn – nominal power of power supply
Pscale – user defined setting – can be set via front panel by RS232 or by Profibus (see module 21 or module 22 descriptions).
Note: Resolution depends on Pscale value.

Module 17 - Actual output power value in a floating-point format

ident. 0x42,0x01,0x00,0x11

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:

Module 18 – Actual Frequency (for pulsed units only)

ident. 0x82,0x01,0x00,0x12

This single byte module shows frequency value .
For TruPlasmaHighPulse values in range 1 … N represent a frequency setting of 1Hz … N Hz where N is the nominal pulse frequency for this unit.

Module 19 – Actual pulse time (for pulsed units only)

ident. 0x82,0x01,0x00,0x13

This single byte module shows off-pulse time value in microseconds.
For TruPlasmaHighPulse values in range 10 … N represent an off-time setting of 1.0us … (N)us where(N) is the nominal off-time for this unit.

Module 20- Acknowledgement Bits

ident. 0x42,0x02,0x00,0x14

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	not used	
2	Relays ON	= 1 when power relays are switched ON inside unit
3	Power ON	= 1 when output power is enabled
4	not used	
5	Pulse Mode Ack	= 1 if unit is set to pulsed mode [1)]
6	not used	
7	Slave 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	EEprom write Fault	= 1 if the EEprom FIFO line is overloaded
5	not used	-
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	P_Lim	=1 pulse time is limited due to average power is exceeded
4	EOPT/EOJM	End Of Process Timer or End of Joule Mode[1)]
5	CLC_Pulse	=1 first stage of CLC warning is active
6	not used	
7	not used	

1) if applicable

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 and
module 22 for setting/reading in a floating-point format.

Module 21- Set/read parameter in an integer format

ident. 0xC1,0x03,0x03,0x15

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).

Module 22 - Set/read parameter in a floating-point format

ident. 0xC1,0x05,0x05,0x16

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. If both modules (21 and 22) are selected then configuration fault error can occur during communication.

List of data channels accessible through Profibus:

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: Acknowlegement Bits - Byte0	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte0		Channel available for reading only. values in floating-point format will range from 0.0 … 255.0.
	8: Acknowlegement Bits – Byte1	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte1		Channel available for reading only. values in floating-point format will range from 0.0 … 255.0.
	16: Acknowlegement Bits – Byte2	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte2		Channel available for reading only. values in floating-point format will range from 0.0 … 255.0.
2	2: Actual Power setpoint	0…P_n[kW]	0…Pscale	read only
	4: Actual Power output	0…P_n[kW]	0…Pscale	read only
	8: Nominal Power output	0…P_n[kW]	10:1	read only
3	2: Actual Voltage setpoint	0…U_n[V]	0…Uscale	read only
	4: Actual Voltage output	0…U_n[V]	0…Uscale	read only
	8: Nominal Voltage output	0…U_n[V]	10:1	read only
4	2: Actual Curent setpoint	0…I_n[A]	0…Iscale	read only
	4: Actual Current output	0…I_n[A]	0…Iscale	read only
	8: Nominal Current output	0…I_n[A]	10:1	read only
6	2: Actual Frequency	This channel represent conditions described in Module 18		read only
	3: Frequency Set point	This channel represent conditions described in Module 10		set only, if module 10 wasn't selected
7	2: Actual Pulse Time	This channel represent conditions described in Module 19		read only
	3: Pulse Time Set point	This channel represent conditions described in Module 11		set only, if module 11 wasn't selected

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	

Data group	Channel nr / description	integer value		Notes
10	2: selection of the arc detection criterion (if applicable)	Use low order bits of the low order byte represent the enabled (1) or disabled (0) states: bit0: - bit1: UxI criterion bit2: Imax criterion bit3: - bit4: - bit5: - bit6:- bit7:-		Channel available for readout only.
	3: set arc detection Criterion (if applicable)	Use low order bits of the low order byte to enable (1) or disable (0) the criterion: bit0: - bit1: UxI criterion bit2: Imax criterion bit3: - bit4: - bit5: - bit6:- bit7:-		Channel available for setting only.
12	2: Ux thld setting	0-900 V	0-900	Control settings for the UxI arc detection criterion. Channels available for readout only.
	4: Ix thld setting	$0.05I_n$ - I_n A	$0.05I_n$ –I_n *10	
	16: BreakTime setting	0.1-80.0ms	10-8000	
	32: RampTime setting	0.0-100.0ms	0-10000	
	64: Ux Offset setting	10-200 V	10-200	
	3: set Ux thld	This channel represent conditions described in Module 31 and 32 except scale. This channel scale is 1:		Control settings for the UxI arc detection criterion. Channels available for setting only. Channel 3 is set only, if modules 31 or 32 were not selected
	5: set Ix thld	This channel represent conditions described in Module 29 and 30 except scale. This channel scale is 10:1		Channel 5 is set only, if modules 29 or 30 were not selected
13	2: Im thld setting		10:1	Control settings for the Imax arc detection criterion. Channels available for readout only.
	16: BreakTime setting	0.1-80.0ms	10-8000	
	3: set Im thld	This channel represent conditions described in Module 27 and 28 except scale. This channel scale is 10:1		Control settings for the Imax arc detection criterion. Channels available for setting only. Channel 3 is set only, if modules 27 or 28 were not selected

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
21	2: dUcnt	0-65535	0-65535	Arc counters with respect to the arc detection criteria. Channels available for readout only.
	4: UxIcnt	0-65535	0-65535	
	8: Imaxcnt	0-65535	0-65535	
	16:HardArcCnt	0-65535	0-65535	
	32:uArcCnt / s.	0-10000	0-10000	
	64:dUcnt x100	0-10000	0-10000	
	128:HardArcCnt / s.	0-10000	0-10000	
22	3: Arc counter reset	Any value		Reset all arc counters, except dUcnt x100
	5: dUcnt x100 reset	Any value		Reset dUcnt x100 counter
31	2: Ign Max Time [us]	0-100	0 - 1000	readout only
	3: Ign Max Time [us]	0-100	0 - 1000	set only
38	32: Delivered Energy Thld	0-500J	1:10	readout only
	64: Real energy delivered in pulse		1:10	readout only
	33: Delivered Energy Thld	0-500J	0-5000	Set only

<table>
<tr><th>Data group</th><th>Channel nr / description</th><th colspan="2">integer value</th><th>Notes</th></tr>
<tr><td colspan="2">numbers in decimal format</td><td>range</td><td>scale</td><td></td></tr>
<tr><td rowspan="5">40</td><td>2: Temp. 1</td><td>0-100°C</td><td>0-1000</td><td rowspan="5">Internal temperature values for CMPC24
readout only</td></tr>
<tr><td>4: Temp. 2</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td>8: Temp. 3</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td>16: Temp. 4</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td>32: U24</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td rowspan="6">42, 43, 44, 45</td><td>2: Temp. 1</td><td>0-100°C</td><td>0-1000</td><td rowspan="6">Internal temperature values of Slave 1 (channel 43), Slave 2 (channel 44), Slave 3 (channel 45) and Slave 4 (channel 46);
readout only</td></tr>
<tr><td>4: Temp. 2</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td>8: Temp. 3</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td>16: Temp.4</td><td>0-100°C</td><td>0-1000</td></tr>
<tr><td>32: U500</td><td>0...1000V</td><td>0-1000</td></tr>
<tr><td>64: U800</td><td>0...1000V</td><td>0-1000</td></tr>
<tr><td rowspan="2">70</td><td>2: read Ctrl
4: read Ctrl ini</td><td colspan="2" rowspan="2">legal values:
bit 0 = Display panel
bit 1 = Analog
bit 2 = RS232
bit 3 = Profibus
bit 4 = RS485
bit 5 = Devicenet
bit 6 = EtherCAT</td><td>present control source (Ctrl)
and initial control source (Ctrl ini)
readout only</td></tr>
<tr><td>3: set Ctrl
5: set Ctrl ini</td><td>present control source (Ctrl)
and initial control source (Ctrl ini)
set only</td></tr>
<tr><td rowspan="2">72</td><td>2: read Profibus ID
4: read Float Standard
8: read Power Scale
16: read Voltage Scale
32: read Current Scale</td><td colspan="2">0-127
0: Motorola, 1: Intel
0-65535
0-65535
0-65535</td><td>readout only</td></tr>
<tr><td>3: set Profibus ID
5: set Float Standard
9: set Power Scale
17: set Voltage Scale
33: set Current Scale</td><td colspan="2">0-127
0: Motorola, 1: Intel
0-65535
0-65535
0-65535</td><td>set only</td></tr>
</table>

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
73	2: RS Address	0-65535	0-65535	readout only
	4: RS Speed	legal values: bit0="9600" bit1="19200" bit2="38400" bit3="57600" bit4="115200"		readout only
	3: RS Address	0-65535	0-65535	set only
	5: RS Speed	legal values: bit0="9600" bit1="19200" bit2="38400" bit3="57600" bit4="115200"		set only
74	2: DeviceNet ID	0-63	0-63	readout only
	4: DeviceNet Speed	legal values: bit0="125k" bit1="250k" bit2="500k"		readout only
	3: DeviceNet ID	0-63	0-63	set only
	5: DeviceNet Speed	legal values: bit0="125k" bit1="250k" bit2="500k"		set only
90	2: Errors counter	0-100	0-100	readout only
	4: Error Number	0-100	0-100	readout only
	8: Error Code	0-65535	0-65535	readout only
	16: Module ID (high word)	0-65535	0-65535	readout only
	32: Module ID (low word)	0-65535	0-65535	readout only
	64: Param (high word)	0-65535	0-65535	readout only
	128: Param (low word)	0-65535	0-65535	readout only
	5: Error Number	0-100	0-100	set only

Examples:

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

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	
0x0C	0xFF	0xFF	0xFF

Example 2

To read Break Time for cross arc detection (data group 12, channel 16):
Send:

Data group	Channels	Integer value	
0x0C	0x10	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x0C	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 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:

Module 23- Imcn

ident. 0x42,0x01,0x00,0x17

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.

Module 24- UxIc

ident. 0x42,0x01,0x00,0x18

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.

Module 25- dUcn

ident. 0x42,0x01,0x00,0x19

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.

Module 26 – Hard Arcs Counter

ident. 0x42,0x01,0x00,0x1A

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

Module 41 –uArcs Counter per second

ident. 0x42,0x01,0x00,0x29

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

Module 42 –Hard Arcs Counter per second

ident. 0x42,0x01,0x00,0x2A

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.

Current threshold for Imax arc detection criterion:

Module 27 - Current Imax threshold in an integer format

ident. 0x82,0x01,0x00,0x1B

This module consists of two bytes which represent current threshold value for Imax arc detection criterion in a 16-bit integer format. The scale for current setting is:
0 … 10000 represents a current value of 0 … In (In: nominal output current value)
Range: 0.1In – 1.3In

Module 28 - Current Imax threshold in a floating-point format

ident. 0x82,0x01,0x00,0x1C

This module consists of 4 bytes which represent current threshold value for Imax arc detection criterion in a floating-point format with respect to selected standard. This value must not exceed 1.3 In .

Current threshold for the UxI arc detection criterion:

Module 29 - Current Ix threshold in an integer format

ident. 0x82,0x01,0x00,0x1D

This module consists of two bytes which represent current threshold values for UxI arc detection criterion in a 16-bit integer format. The scaling of this setting is:
0 … 10000 represents a current value of 0 … In (In: nominal output current value)
Range: 0.1In – In (In: nominal output current value)

Module 30 - Current Ix threshold in a floating-point format

ident. 0x82,0x01,0x00,0x1E

This module consists of 4 bytes which represent current threshold value in amperes for UxI arc detection criterion in a floating-point format with respect to selected standard. This value must not exceed nominal output current of power supply - In.
Range: 0.1In – In (In: nominal output current value)

Voltage Threshold for UxI arc detection criterion:

Module 31 - Voltage Ux threshold in integer format

ident. 0x82,0x01,0x00,0x1F

This module consists of two bytes which represent a voltage threshold value for UxI arc detection criterion in a 16-bit integer format. The scaling for this setting is:
0 … 65535 represents a voltage value of 0.0V … 6553.5V
Range: 0 – Un (Un: nominal output voltage value)

Module 32 - Voltage Ux threshold in a floating-point format

ident. 0x82,0x01,0x00,0x20

This module consists of 4 bytes which represent voltage threshold value in volts for UxI arc detection criterion in a floating-point format with respect to selected standards.
Range: 0 – Un (Un: nominal output voltage value)

Internal temperature measurement

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

Module nr	ident.	Temp. sensor
33	0x42,0x01,0x00,0x21	T1
34	0x42,0x01,0x00,0x22	T2
35	0x42,0x01,0x00,0x23	T3
36	0x42,0x01,0x00,0x24	T4

The temperature scaling is:
0 .. 100°C is represented by a 0 .. 10000 integer number

Modules not used

37	0x42,0x01,0x00,0x25
38	0x42,0x01,0x00,0x26
39	0x42,0x01,0x00,0x27
40	0x42,0x01,0x00,0x28

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.

Which modules have higher priority?

In Huettinger Profibus profile main priority is created by a sequence of modules (the first selected module in the communication frame is also the first realized by the program). If for any reason, two or more of the same modules are selected, then the software will realize only the first one of them. The rest of the modules will be ignored (but they stay in the communication frame).
Another example is when a user selects two modules: module 2 and module 3. Both define a voltage setpoint (module 2 in an integer format, module 3 in a floating point format) and create a 6 byte output frame:

<table>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="4">Module 3</td></tr>
</table>

Nevertheless, only module 2 will be realized because it was first selected and is first in output frame. The second one will be ignored (but it stays in the communication frame).
Some groups modules have certain relationships which are divided into three groups:
Group 1: modules from 2 to 7 (voltage setpoint, current setpoint, power setpoint)
Group 2: modules 8 and 9 (Select control mode)
Group 3: module 21 and 22 – data group between 2 – 7, kind of channels – setpoints.

Together these groups create some kind of a priority basis.
For instance, if a prepared output frame contains modules from group 1, group 2 and group 3, modules from group 2 and specific channels from group 3 will be ignored, because modules from group 1 have higher priority. The same applies when modules from group 2 and group 3 are selected, specific channels from group 3 will be ignored, because modules from group 2 have higher priority.

Annotation - modules from group 1 have a higher priority than modules from group 2 and particular channels from group 3, and group 2 has a higher priority than particular channels from group 3.

For the user's convenience, some parts of modules (especially from group 1, group 2 and group 3) 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 = $(-1)^S * 2^{(\text{exponent} - 127)} * (1+\text{mantissa})$

Example 1: 7.5

64 dec 240 dec 0 dec 0 dec
0h F0h 00h 00h

40 F0 00 00 h = 0100 0000 1111 0000 0000 0000 0000 0000 b

Value $= (-1)^0 * 2^{(129-127)} * (1 + 2^{-1} + 2^{-2} + 2^{-3})$
$= 1 * 2^2 * (1 + 0.5 + 0.25 + 0.125)$
$= 1 * 4 * 1.875$
$= 7.5$

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 $= (-1)^0 * 2^{(136-127)} * (1 + 2^{-3} + 2^{-5} + 2^{-6})$
$= 1 * 2^9 * (1 + 0{,}125 + 0.03125 + 0{,}015625)$
$= 1 * 512 * 1{,}171875$
$= 600$

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

	104 dec	200 dec	0 dec	0 dec
	42h	C8h	00h	00h

Example: 42 C8 00 00 h = 0100 0010 1100 1000 0000 0000 0000 0000 b

$$\text{Value} = (-1)^0 * 2^{(133-127)} * (1 + 2^{-1} + 2^{-4})$$
$$= 1 * 2^6 * (1 + 0,5 + 0.0625)$$
$$= 1 * 64 * 1.5625$$
$$= 100$$

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 = $(-1)^S * 2^{(\text{exponent} - 127)} * (1+\text{mantissa})$
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, Module 8.
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	7	8	9
Modules	Module 6		Module 2		Module 4		Module 1	Module 8		
Descriptions	Power setpoint		Voltage setpoint		Current setpoint		Control Bits	Select control mode		
Values	0x15	0xF0	0x10	0xE0	0x0C	0xB2	0x0D	0x01	0x0F	0xA0

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). Last three bytes will be ignored, because module 8 belongs to group 2 in the priority basis. This group has a lower priority than group 1(modules 6, 2, 4). 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 control magnetron power supply by using only one regulator. When the following modules were selected: Module 6, Module 1, Module 16, Module 12, Module 14, Module 26, Module 20. The power was set to 12,5kW:
Integer value of power setpoint = Pscale * Pset / Pn = 10000*12.5 / 25 = 5000
The value of 5000 has a hex value of 0x1388h.
The created output frame, which Profibus master sends to the magnetron power supply, should be:

Bytes	0	1	2
Modules	Module 6		Module 1
Descriptions	Power setpoint		Control Bits
Values	0x13	0x88	0x0D

In this configuration, voltage and current are set to a nominal value automatically and only a power regulator controls the unit. Thus, it is easy to see that the output frame is much shorter than in previous examples (has only 3 bytes). In response the magnetron power supply sends 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	0x13	0x88	0x10	0x68	0x0B	0x76	0x00	0x04	0x0D	0x00	0x04

It is easy to calculate from first six bytes that:
Actual Power = integer value from module 16 * Pn / Pscale = 5000*25/10000 = 12.5kW,
Actual Voltage = integer value from module 12 * Vn / Vscale = 422*800/8000 = 422 V,
Actual Current = integer value from module 14 * In / Iscale = 2943*62.5/6250 = 29.34 A,
The remaining bytes of input frame are similar to the previous example with the exception of the last byte, which notifies that power regulator is active (0x04 = binary 00000100). In the event that a process requires two kinds of regulators, another solution should be selected.

Example 3:

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 4:

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 3: enabling of long ramp (data group 30, channel 3)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x1E	0x03	0x00	0x01

Reply received:

Data group	Channels	Integer value	
0x1E	0x03	0x00	0x01

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 5:

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 and automatically switch unit to power regulator. 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.

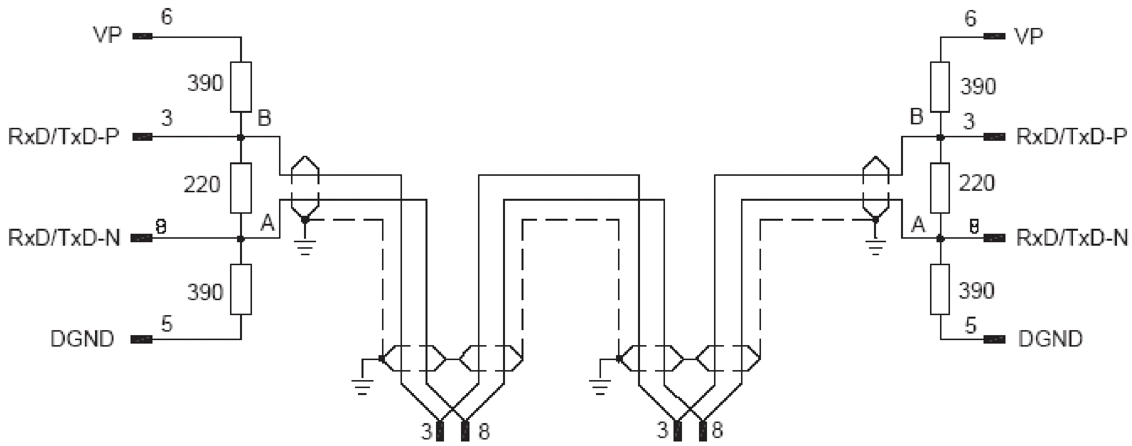
Remember – These are only several possible examples. The true combination of solutions is as endless as the user's imagination and we only attempt to provide you with the perfect tool to create your own personal profile for any specific processes.

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 TruPlasma Highpulse

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 TruPlasma Highpulse:

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. Warning and alarm messages

Error codes description.

Error Number	Description
61601	EEPROM Error
61602	Wrong checksum of data stored in EEPROM
61603	FPGA configuration failed
61604	Unexpected reset of HVPSx module
61605	Too high supply voltage (24V)
61606	Too low supply voltage (24V)
61607	Over temperature
61608	no communication with DataFlash device
61609	Mains voltage sag detected
61610	no communication with HVPS module or Main control board
61611	no communication with actual control source
61612	no communication with generator(s) in Parallel Work
61613	no communication with Actual Control Source
61614	internal communication fail
61615	Unexpected device detected on Parallel Bus
61616	U500 Voltage too low
61617	U500 Voltage too high
61618	Inverter Error
61619	U800 Voltage too low
61620	U800 Voltage too high
61621	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	PLD software version is too old
61627	CLC switching frequency too high
61628	CLC shorted
61629	Unsupported Parallel Mode configuration
61630	Global Line Active.
61631	Too low temperature of inlet water
61632	Wrong configuration
61633	U500fast high
61634	dU500/dt high
61635	U800fast high
61636	dU800/dt high
61637	Parallel Mode Malfunction
61638	Parallel connection failed
61639	User24 checksum error
61640	Unequal current in HVPS modules

Warning codes description.

Warning Number	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	Temperature warning level exceeded
61658	Cooling water flow is too low
61659	Cooling water flow wrong direction
61660	CSPC communication fail
61661	Control source communication fail
61662	communication fail with other Power supplies in parallel operation
61663	communication fail with actual control source
61664	New version of memory map in EEPROM
61665	Exceeded maximum allowable difference between set and actual values
61666	Plasma not detected
61667	PlossMax value reached. Power loss cannot be compensated properly
61668	Internal I^2C bus configuration fail
61669	Internal CAN bus configuration fail

9. Interface software

9.1. PVD Power

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

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

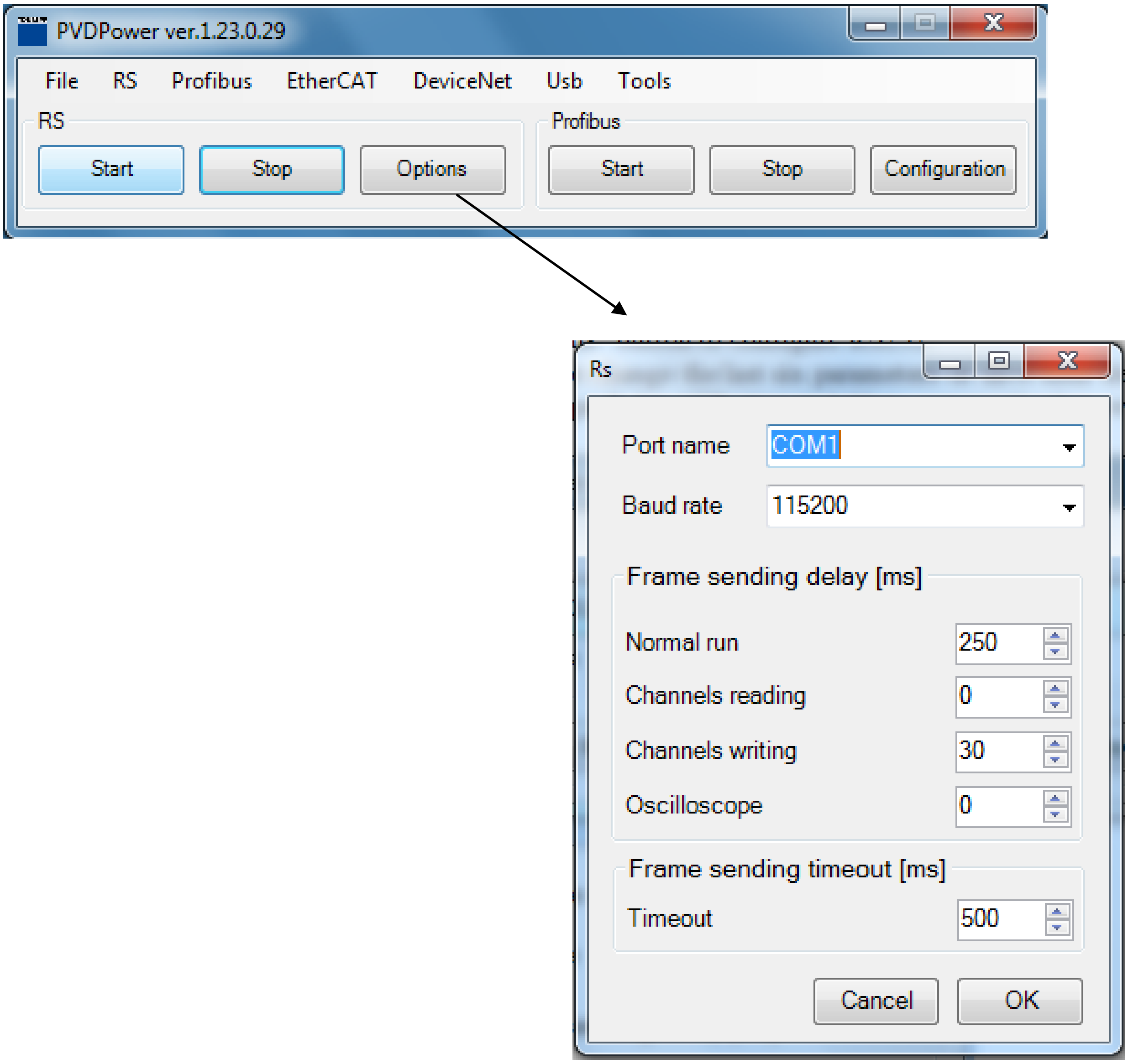
Hardware Requirements:
- o Recommended Minimum: Pentium 1 GHz or higher with 512 MB RAM or more
- o Minimum disk space:
- o x86 – 850 MB
- o x64 – 2 GB

Prerequisites:
- o Windows Installer 3.1 or later

In order to activate PVD Power software, "PVDPower_x.xx.exe" file must be running.

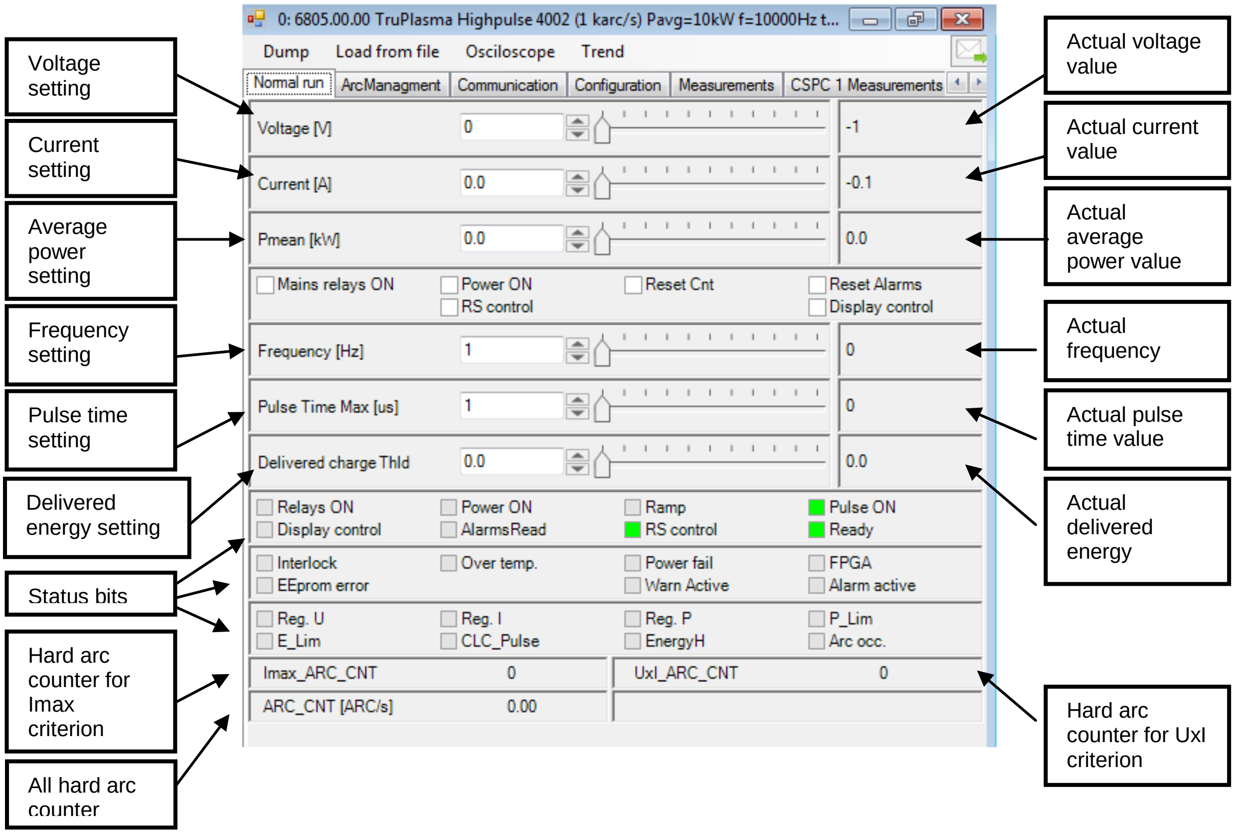
Press "options" button to configure RS232.

Please do not change the last six parameters or save their default settings. When RS232 is configured, push "start" button to initiate communication with TruPlasma Highpulse unit.

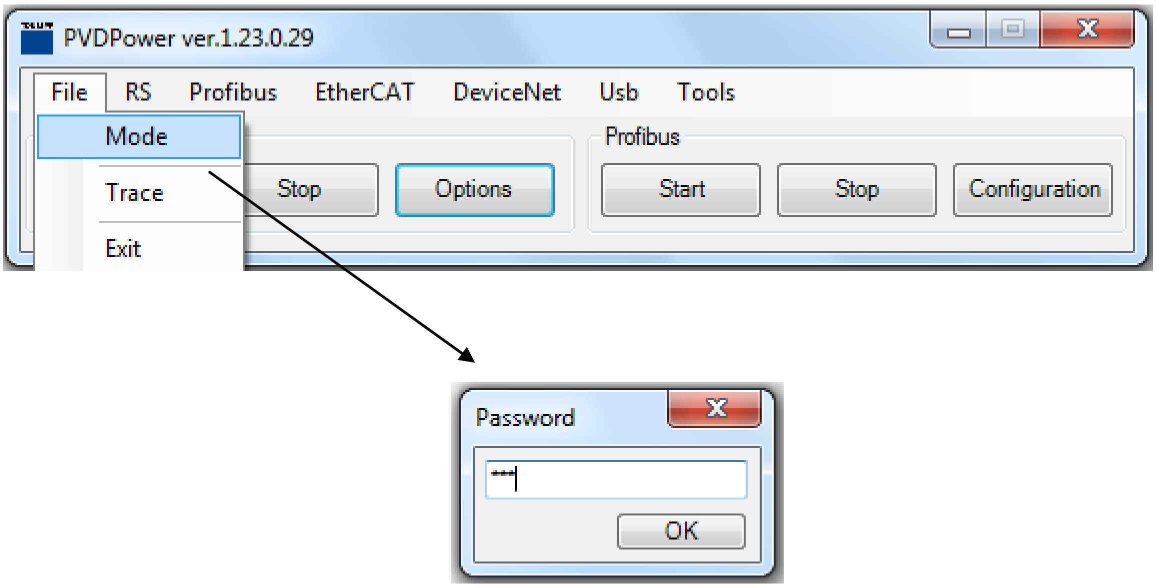


Normal Run

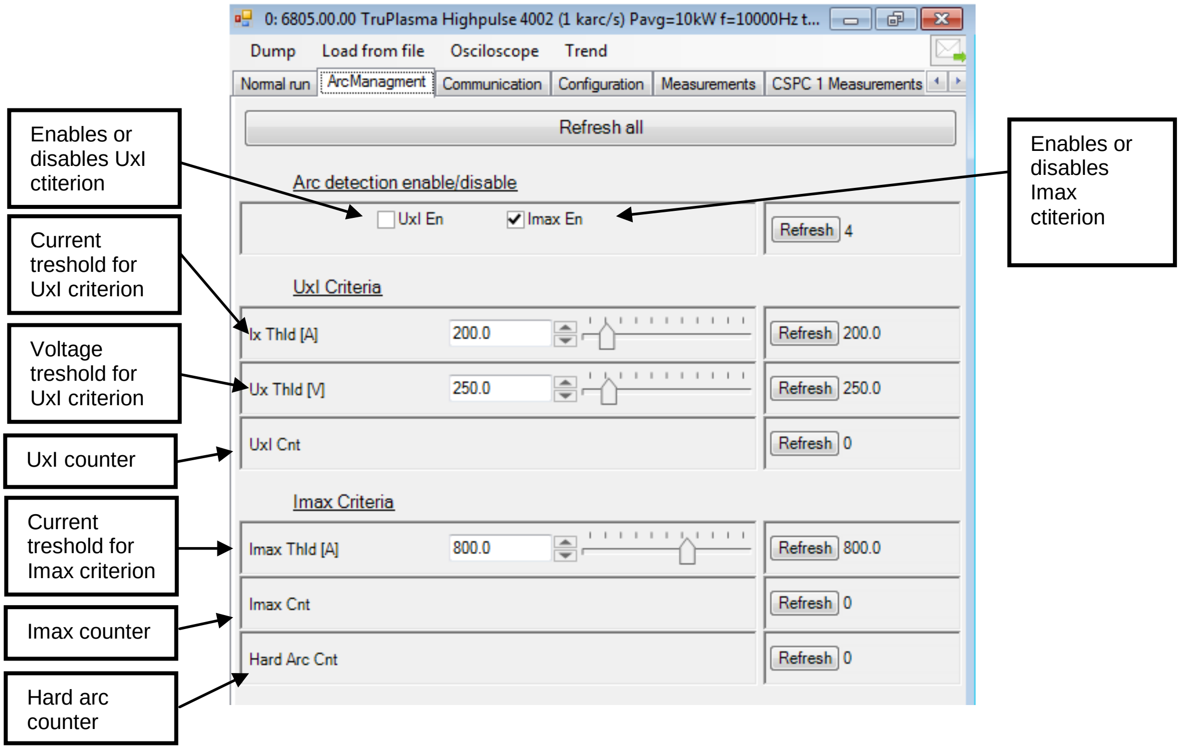
Normal run tab contains basic controls and readouts.



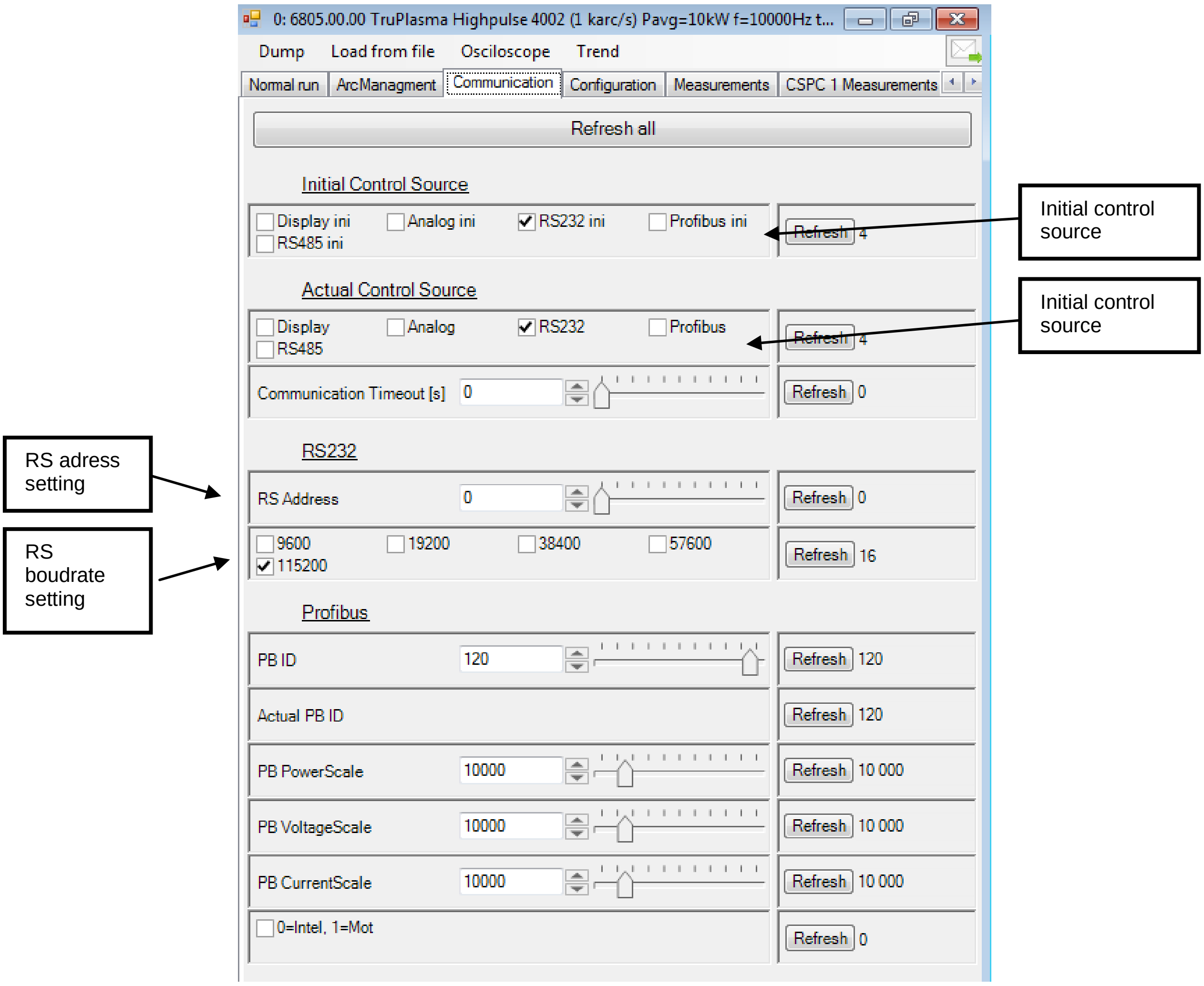
Other tabs are available after entering the password – 321.



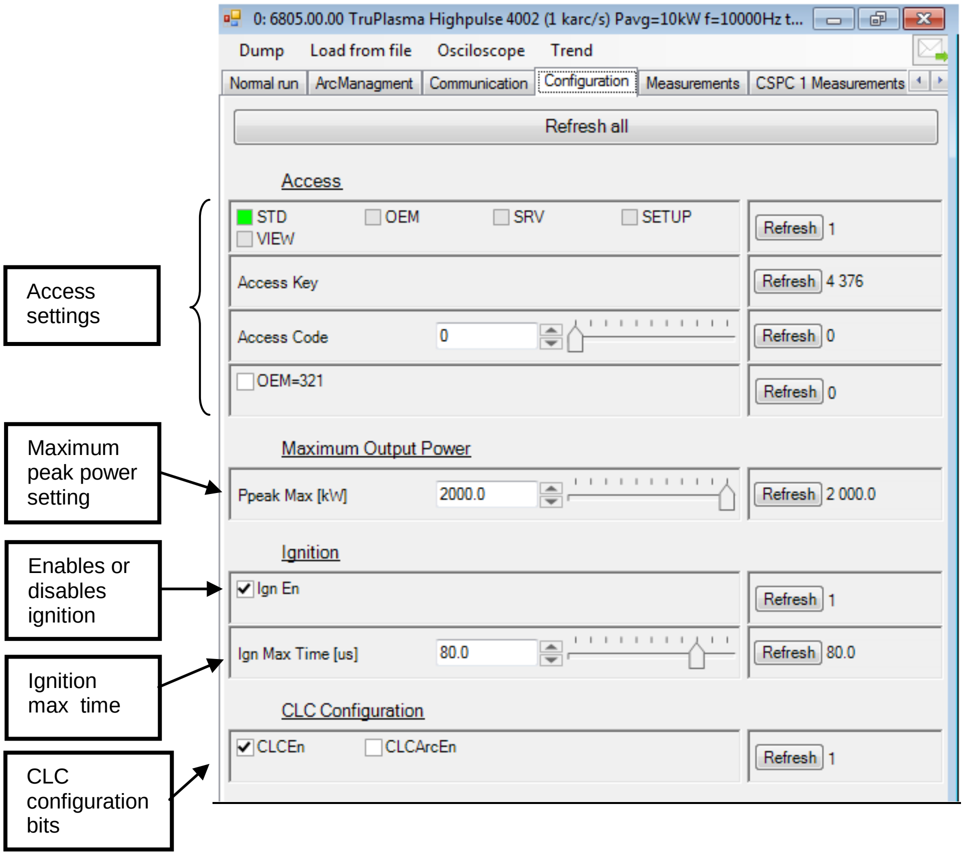
Arc Management



Communication



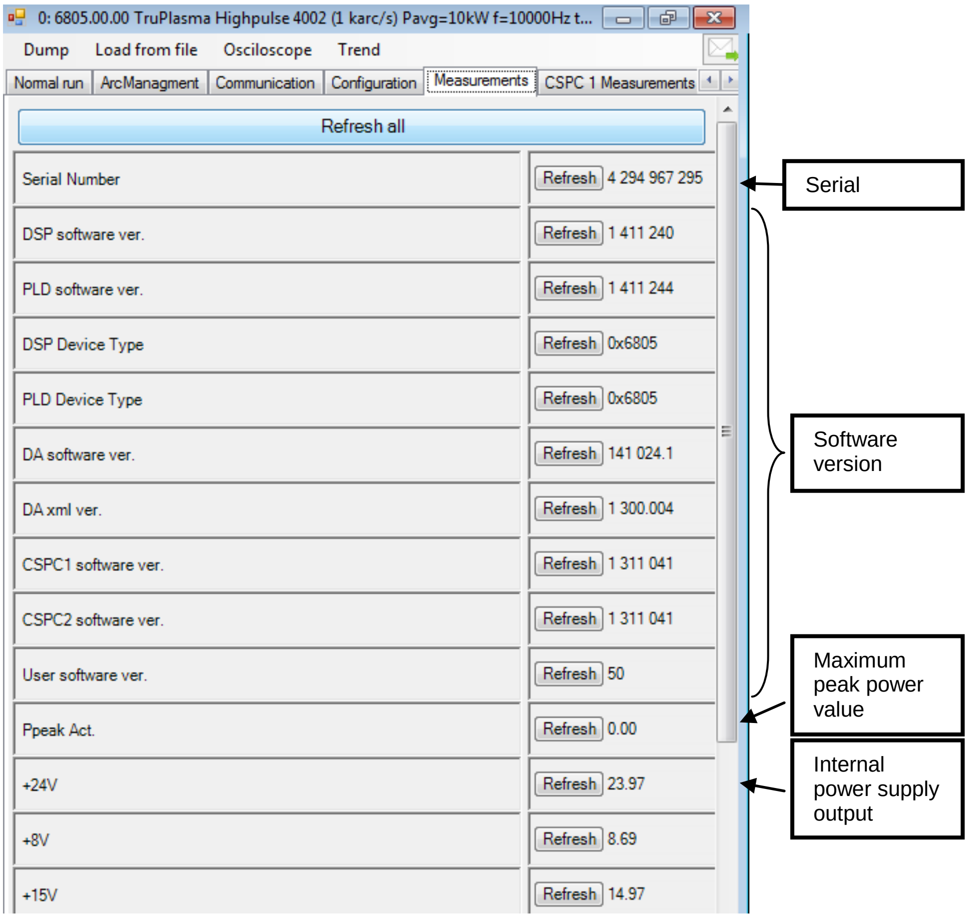
Configuration

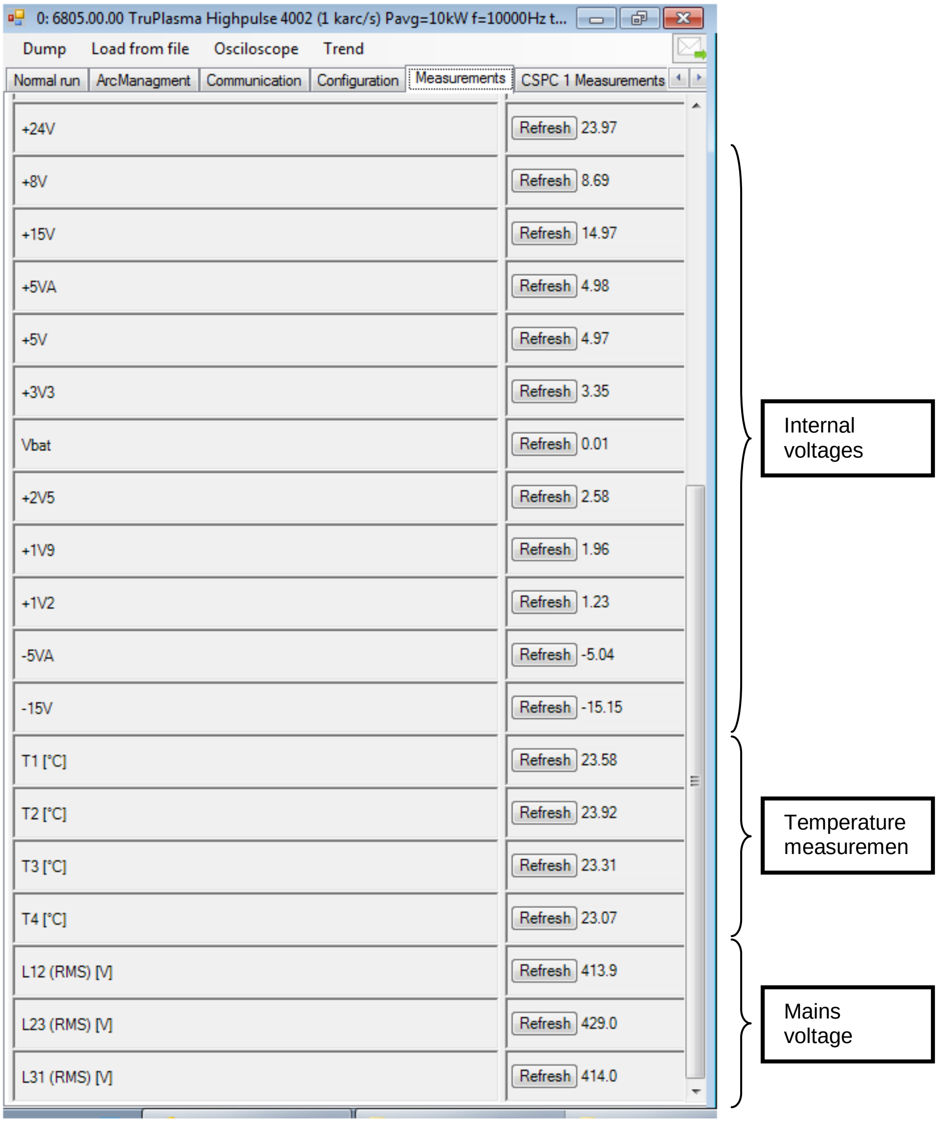


CLC Configuration

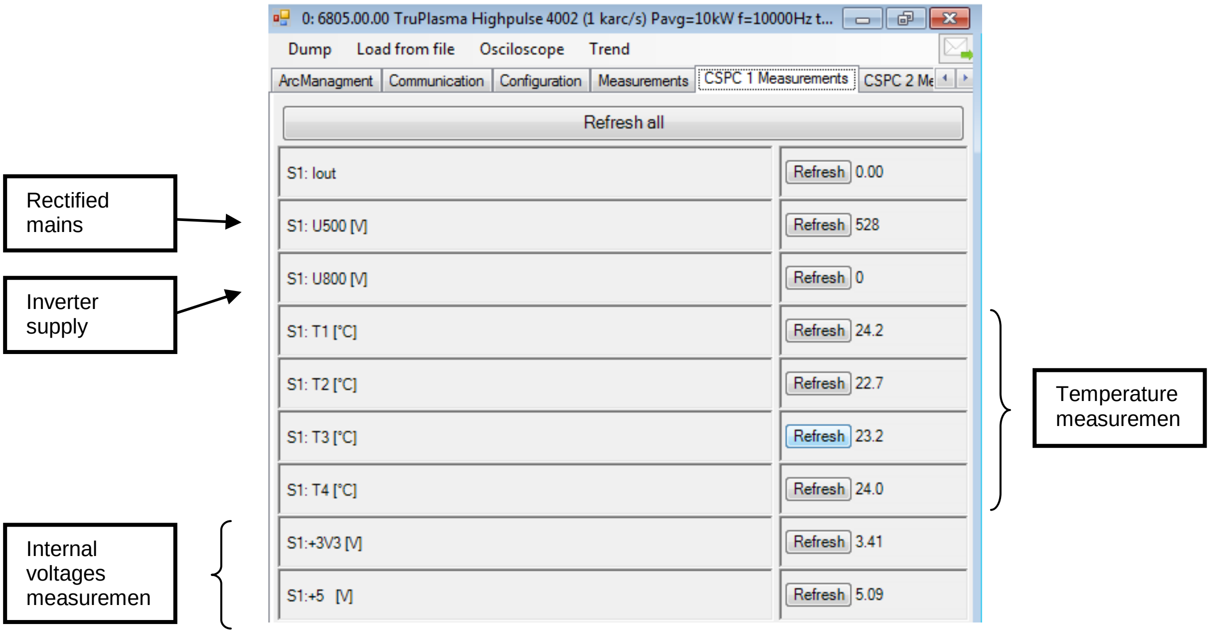
Control bits setting	Function
CLC Configuration: ☐ CLCEn ☐ CLCArcEn	CLC disabled
CLC Configuration: ☑ CLCEn ☐ CLCArcEn	CLC after each pulse
CLC Configuration: ☑ CLCEn ☑ CLCArcEn	CLC only after arc occurs
CLC Configuration: ☐ CLCEn ☑ CLCArcEn	CLC only after arc occurs

Measurements



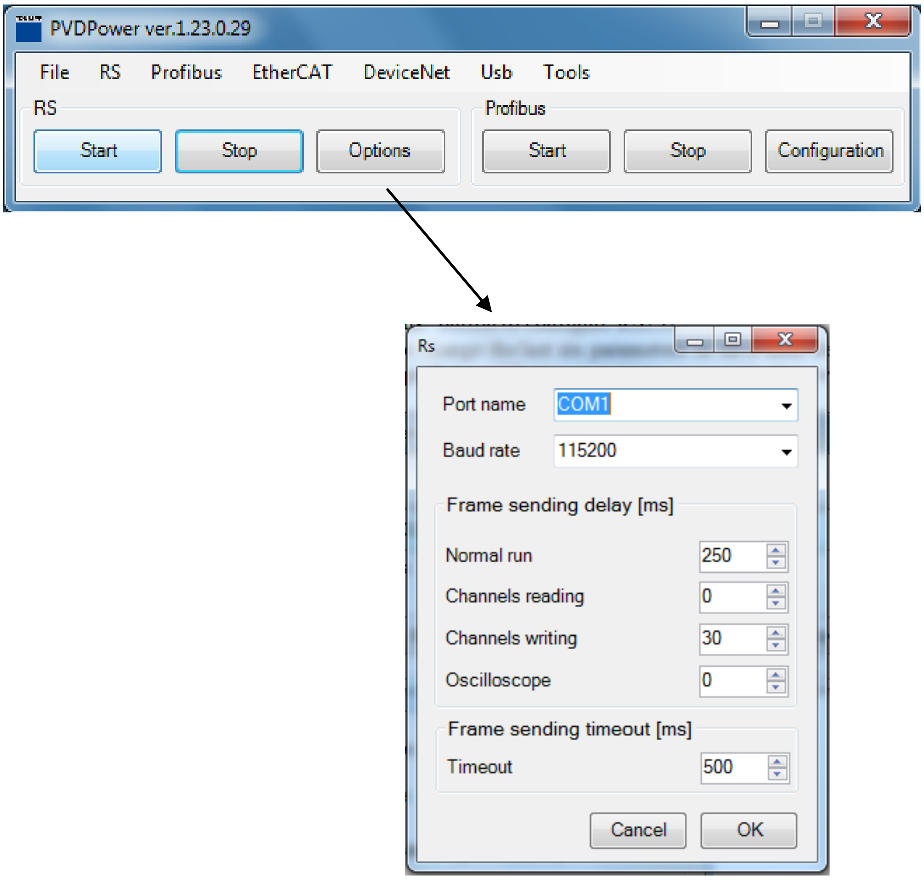

0: 6805.00.00 TruPlasma Highpulse 4002 (1 karc/s) Pavg=10kW f=10000Hz t...
Dump
Load from file
Osciloscope
Trend
Normal run
ArcManagment
Communication
Configuration
Measurements
CSPC 1 Measurements
+24V Refresh 23.97
+8V Refresh 8.69
+15V Refresh 14.97
+5VA Refresh 4.98
+5V Refresh 4.97
+3V3 Refresh 3.35
Vbat Refresh 0.01
+2V5 Refresh 2.58
+1V9 Refresh 1.96
+1V2 Refresh 1.23
-5VA Refresh -5.04
-15V Refresh -15.15
T1 [°C] Refresh 23.58
T2 [°C] Refresh 23.92
T3 [°C] Refresh 23.31
T4 [°C] Refresh 23.07
L12 (RMS) [V] Refresh 413.9
L23 (RMS) [V] Refresh 429.0
L31 (RMS) [V] Refresh 414.0
Internal voltages
Temperature measuremen
Mains voltage

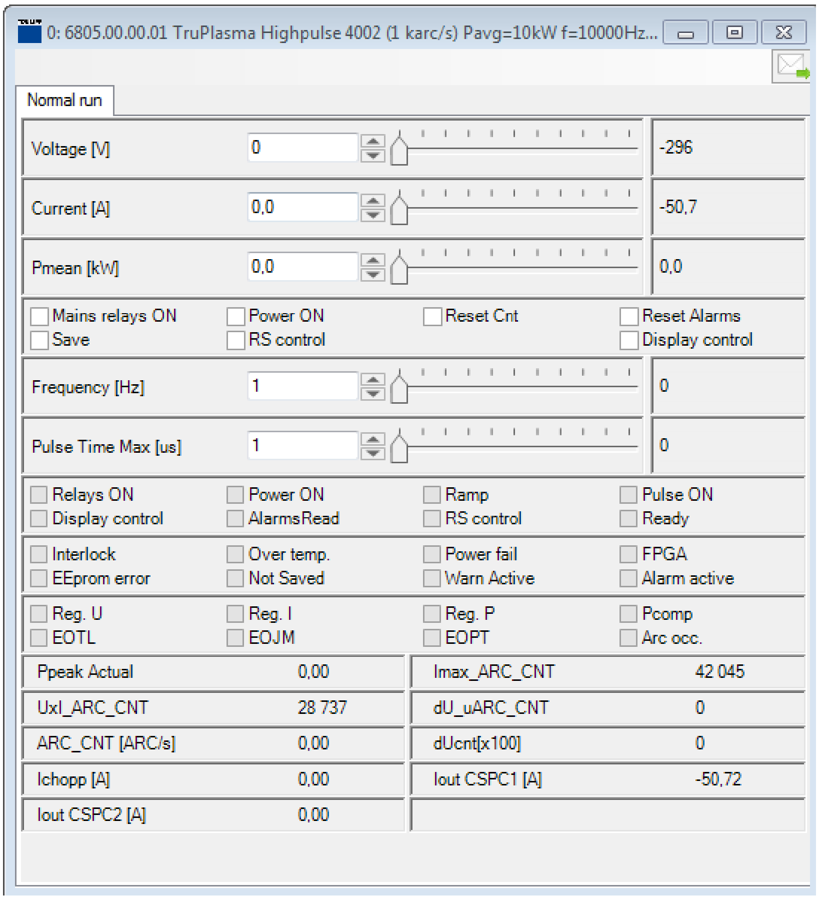
CSPC Measurements



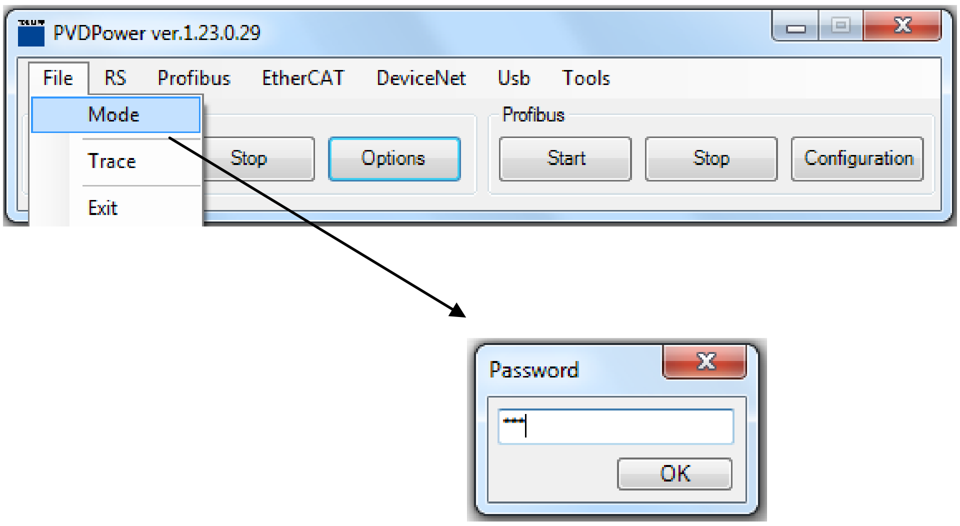
9.2. PVD Power oscilloscope

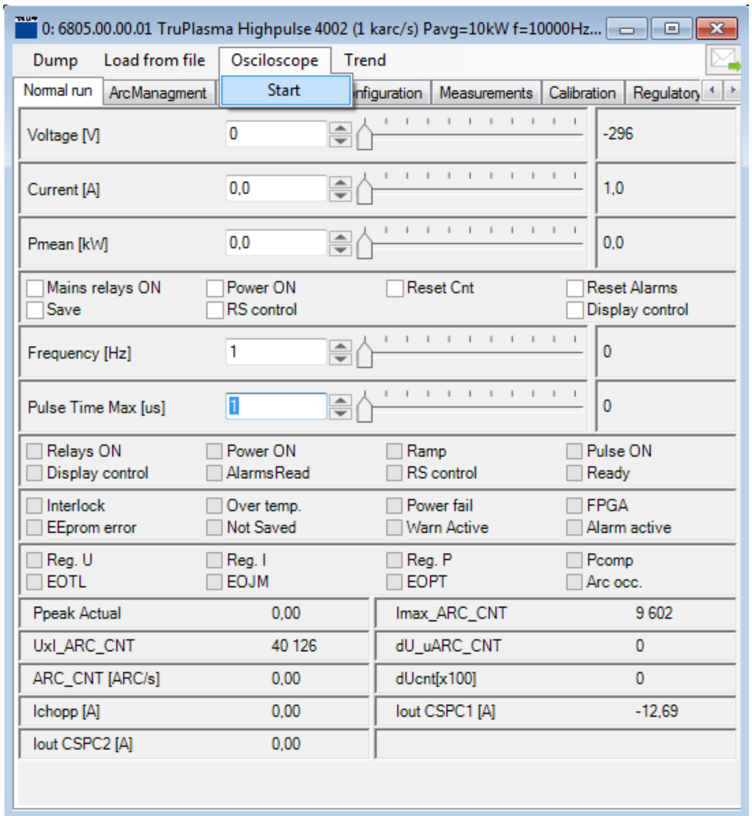
In order to run PVD Power oscilloscope, PVD Power has to be run.

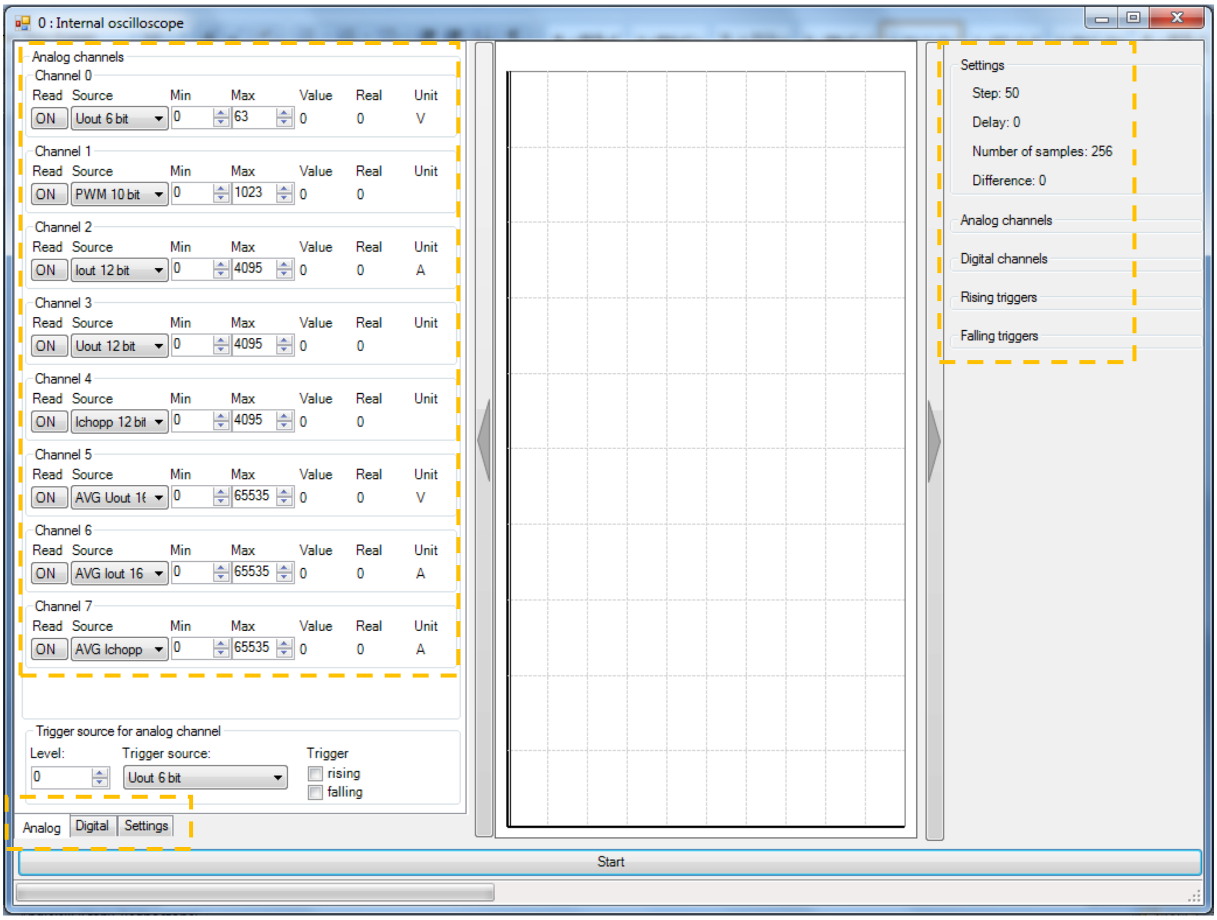




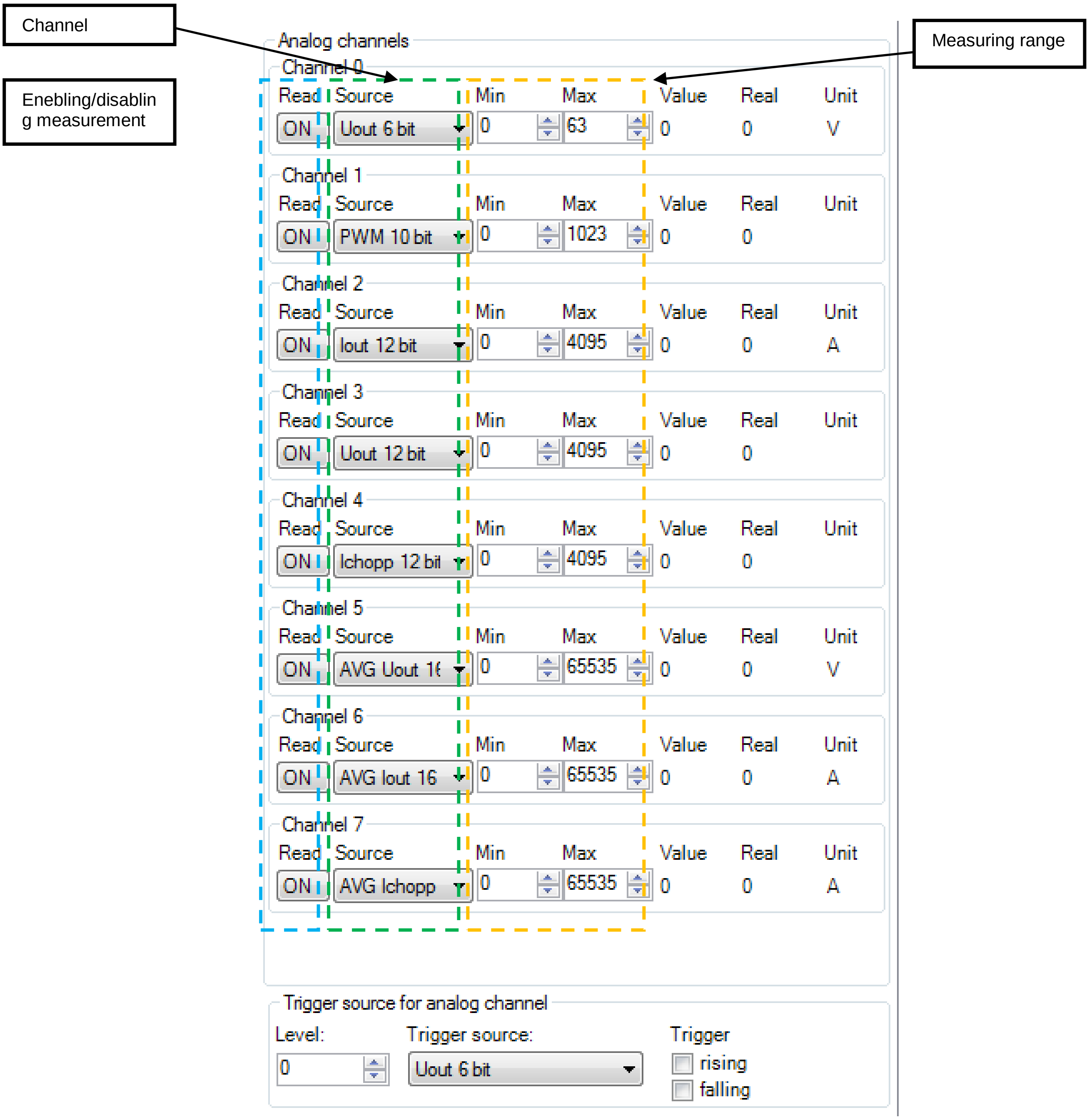
Oscilloscope is available after entering the password – 321.




0: 6805.00.00.01 TruPlasma Highpulse 4002 (1 karc/s) Pavg=10kW f=10000Hz...
Dump
Load from file
Osciloscope
Trend
Normal run
ArcManagment
Start
nfiguration
Measurements
Calibration
Regulatory
Voltage [V]
0
-296
Current [A]
0,0
1,0
Pmean [kW]
0,0
0,0
Mains relays ON
Power ON
Reset Cnt
Reset Alarms
Save
RS control
Display control
Frequency [Hz]
1
0
Pulse Time Max [us]
1
0
Relays ON
Power ON
Ramp
Pulse ON
Display control
AlarmsRead
RS control
Ready
Interlock
Over temp.
Power fail
FPGA
EEprom error
Not Saved
Warn Active
Alarm active
Reg. U
Reg. I
Reg. P
Pcomp
EOTL
EOJM
EOPT
Arc occ.
Ppeak Actual 0,00
Imax_ARC_CNT 9 602
UxI_ARC_CNT 40 126
dU_uARC_CNT 0
ARC_CNT [ARC/s] 0,00
dUcnt[x100] 0
Ichopp [A] 0,00
Iout CSPC1 [A] -12,69
Iout CSPC2 [A] 0,00


0 : Internal oscilloscope
Analog channels
Channel 0
Read Source Min Max Value Real Unit
ON Uout 6 bit 0 63 0 V
Channel 1
ON PWM 10 bit 0 1023 0 0
Channel 2
ON Iout 12 bit 0 4095 0 0 A
Channel 3
ON Uout 12 bit 0 4095 0 0
Channel 4
ON Ichopp 12 bit 0 4095 0 0
Channel 5
ON AVG Uout 16 0 65535 0 0 V
Channel 6
ON AVG Iout 16 0 65535 0 0 A
Channel 7
ON AVG Ichopp 0 65535 0 0 A
Trigger source for analog channel
Level:
Trigger source:
Trigger
0
Uout 6 bit
rising
falling
Analog
Digital
Settings
Settings
Step: 50
Delay: 0
Number of samples: 256
Difference: 0
Analog channels
Digital channels
Rising triggers
Falling triggers
Start

Analog tab contains basic controls and readouts

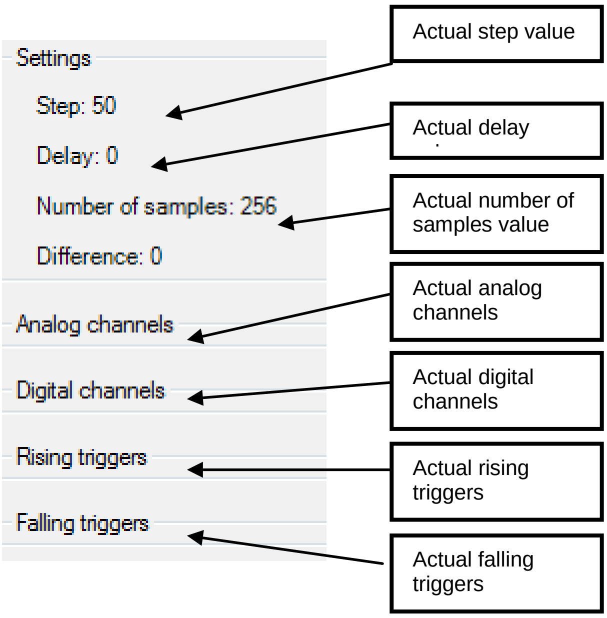


Maximum values

6 bit sources 63

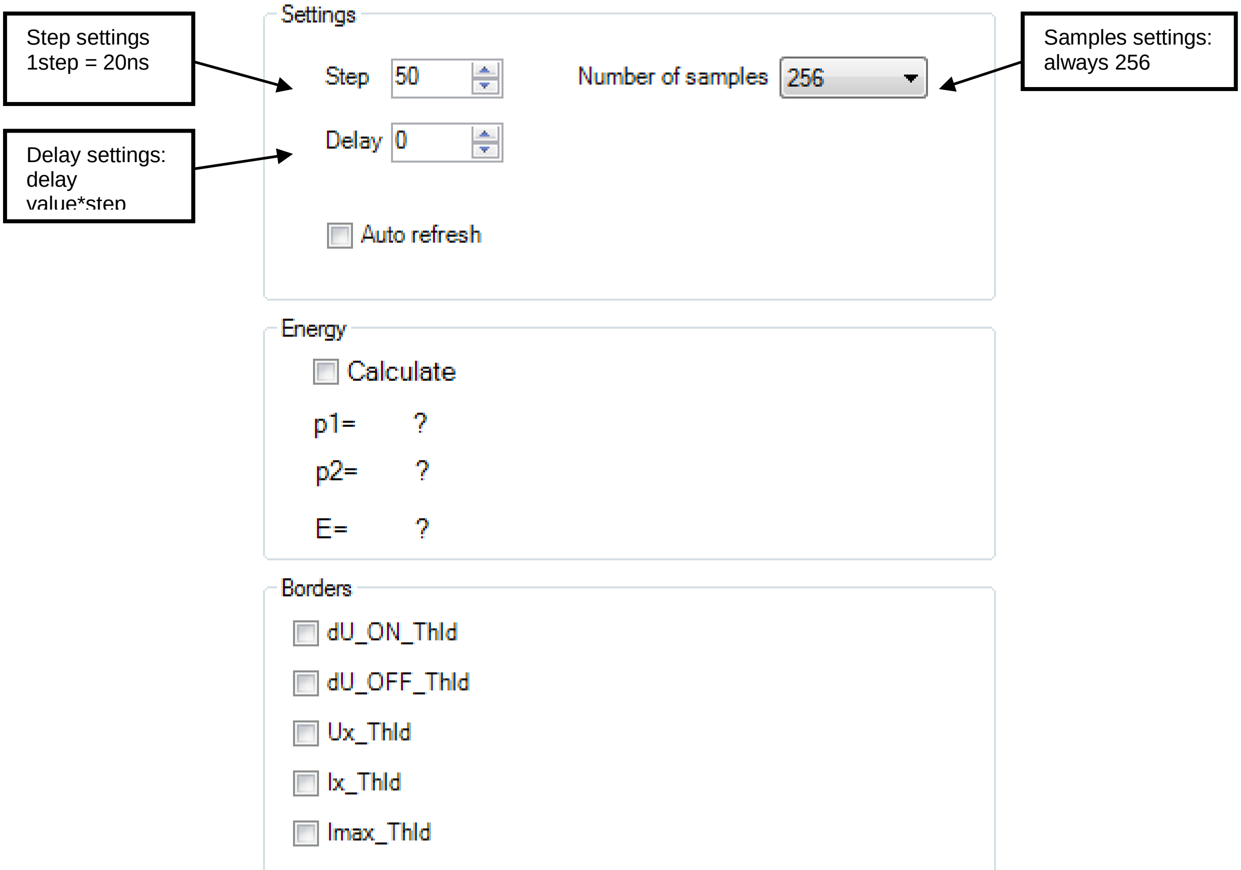
12 bit sources 4095

16 bit sources 65535


Settings
Step: 50
Delay: 0
Number of samples: 256
Difference: 0
Analog channels
Digital channels
Rising triggers
Falling triggers
Actual step value
Actual delay
Actual number of samples value
Actual analog channels
Actual digital channels
Actual rising triggers
Actual falling triggers

Digital tab contains basic controls and readouts

Settings tab contains basic controls and readouts.



Example how to set oscilloscope.

Step1.

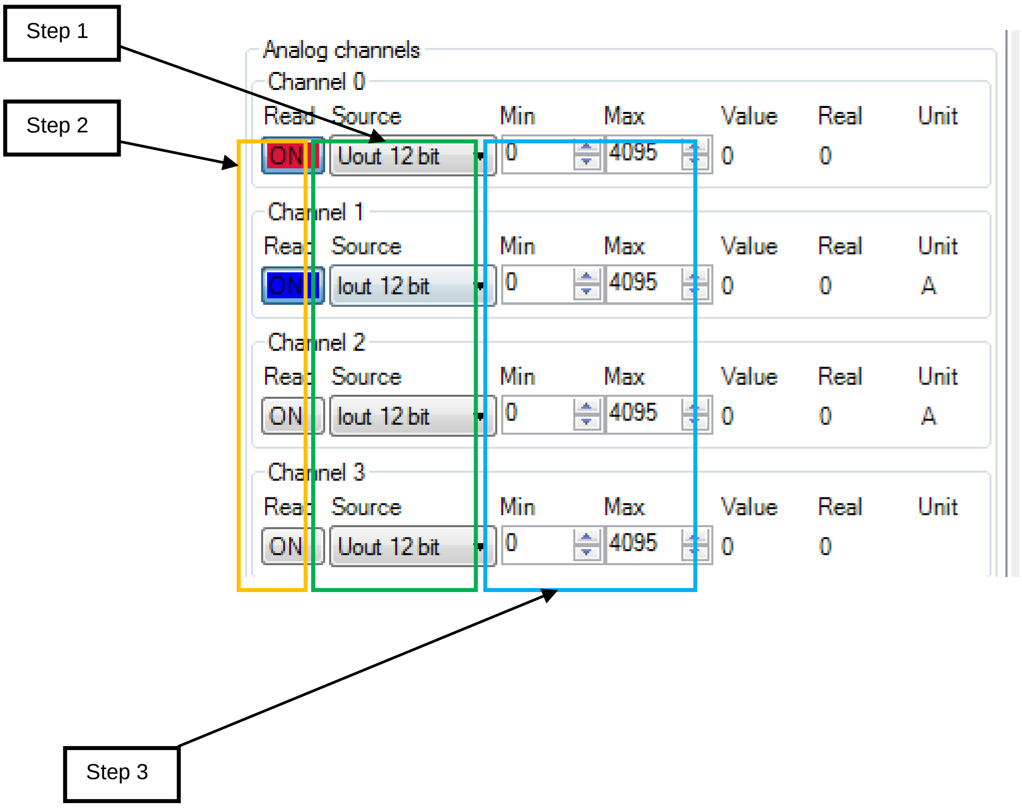
Choose source for the oscilloscope channel.

Step2.

Enable channels by clicking ON buttons. Button will change color. Corresponding curve on the oscilloscope will get the same color as ON button.

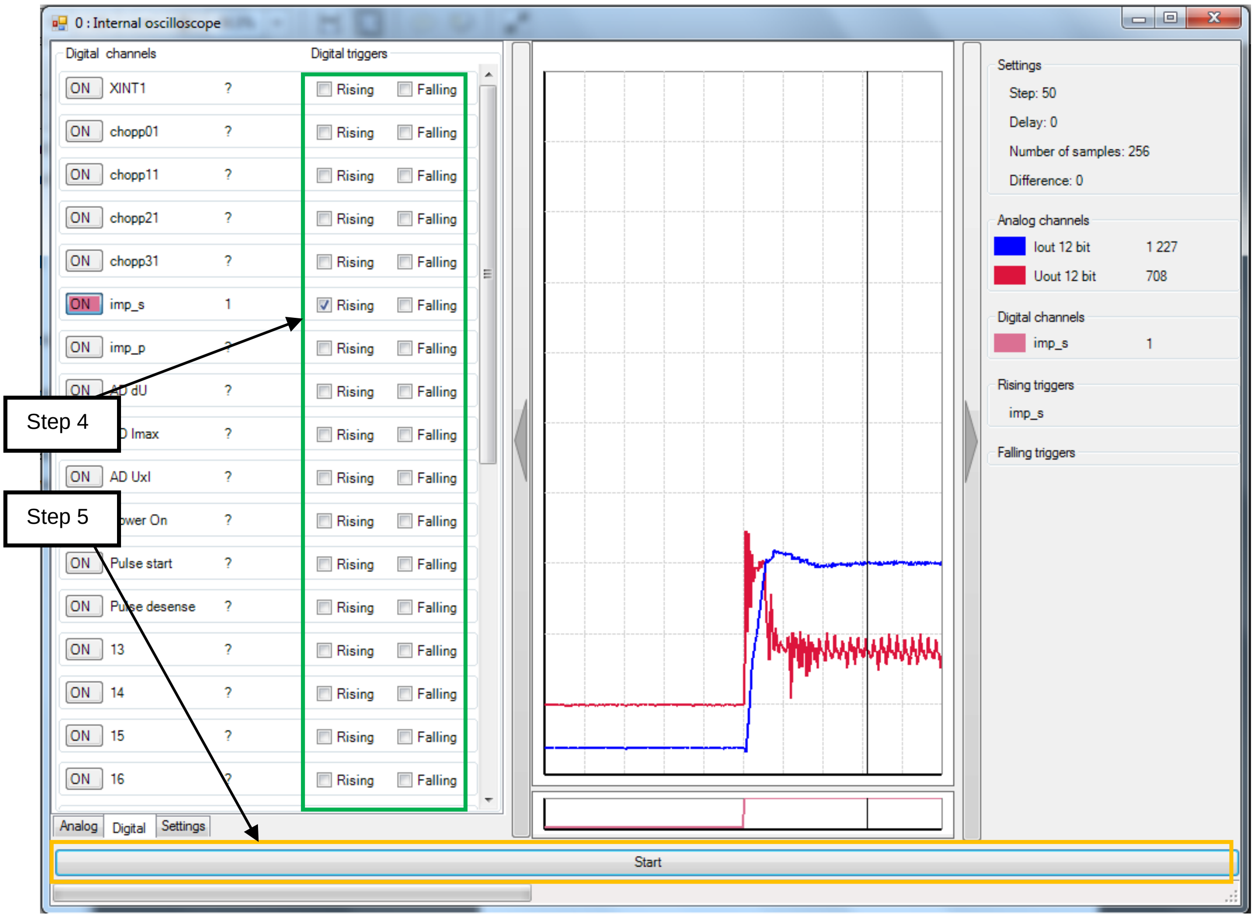
Step3.

Choose display limits. Note, that 12-bit ADC gets value in the range 0-4095, and 6-bit ADC – 0-63.



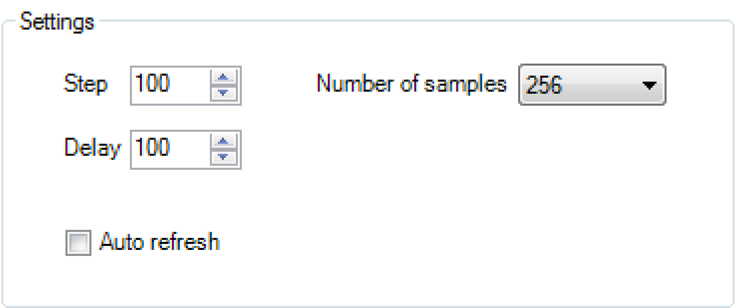
Step4. Enable the trigger.

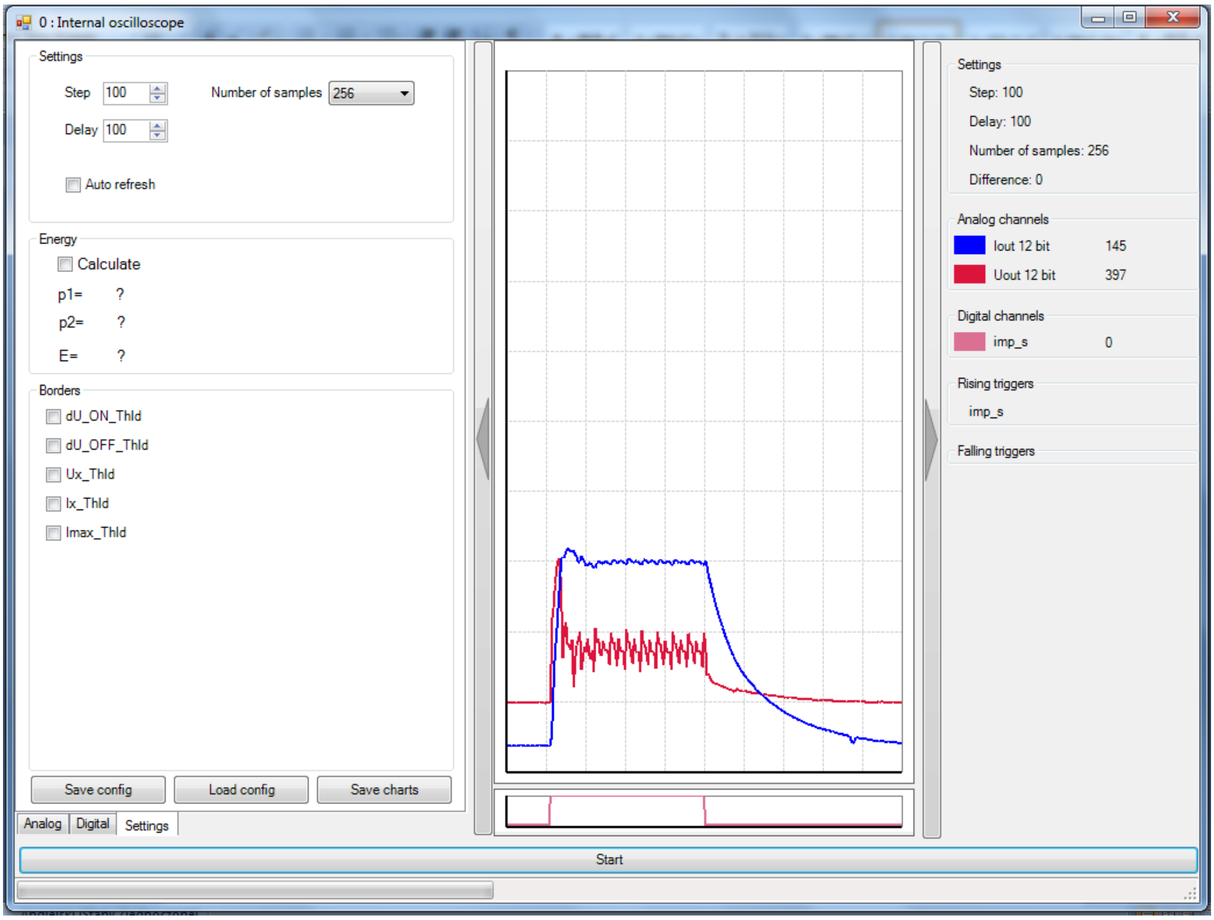
Step5. Push the Start button.



Step 7.

Change settings and push the start button again to see whole pulse.





Iout 12bit – output current

Uout 12bit – output voltage

imp_s – digital signal; equals 1 during pulse; it’s useful to trigger

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9. SOFTWARE UPDATES

This License does not guarantee the USER any rights to software updates for HUETTINGER FREEWARE or other support services.

10. USE OF DATA

HUETTINGER may collect and analyse usage and process data in order to better adapt future applications to the needs of USERS and to improve the HUETTINGER FREEWARE.

11. APPLICABLE LAW AND VENUE

The Licensing Agreement is subject to Polish law. The place of jurisdiction is the place where HUETTINGER has its registered offices. HUETTINGER reserves the right to file charges at any other permitted place of jurisdiction.

12. SEVERABILITY CLAUSE

If any provision of this Agreement should be ineffective, in whole or in part, or should it lose its legal effectiveness at a later date, this shall not affect the validity of the remaining provisions. Statutory regulations shall take the place of the ineffective provision.

10. Scope of delivery

Contents of the box:

- TruPlasma Highpulse power supply
- Dummy plug for analog control socket (interlock removal)
- Output terminals cover
- Mains terminals cover
- Quick connect water pipe adaptors (2 pieces)
- Inlet air pipe adaptor with stopper
- Lifting eyes (4 pieces)
- User Manual
- Final Quality Report
- CD (software and manual)

☞

TruPlasma Highpulse 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).