CRS
INDUSTRIAL POWER EQUIPMENT

QUASAR PP & PPR RECTIFIERS

Quasar is a line of switch-mode rectifiers for surface treatment processes, electro-winning and water treatment, that adopts pulse width modulation (PWM) technique for the controlling of current amplitude.

Electrical Features

> High speed IGBT technology
> Modular power platform and multi-tower interconnection
> Microprocessor controlled
> Up to 40% power saving versus Silicon Controlled Rectifier (SCR)
> Power factor > 0.95 at rated load
> Low frequency low output current ripple
> High precision voltage and current regulation (1000 steps)
> Fast response time and high stability to load variation (~1ms)

Operation Modes

> Manual
> Automatic (Via PC or PLC)
> CRS remote control

Available Interfaces

> Included:
- CRS-ASCII
- Modbus-RTU

> Optional with additional board:
- Profibus-DP
- DeviceNet
- Modbus/TCP
- Profinet
- EthernetIP

Hardware Features

> 15 to 190cm height
> 45 x 45cm max. base size
> Light weight
> Main switch and operator control panel in the front
> All input/output connections in the back for easy access

Software Features

> Simple output parameters and waveform programming from the operator panel (current, voltage, cycle time and ramp time)
> Customized software available
> Software available in different languages
> A/h and A/min meters for precise thickness and dosing pumps control
> Only one software for DC / DCR / PP slow / PPR slow rectfiers (one specific software for PP fast / PPR fast rectifiers)

— 2 Years Warranty —

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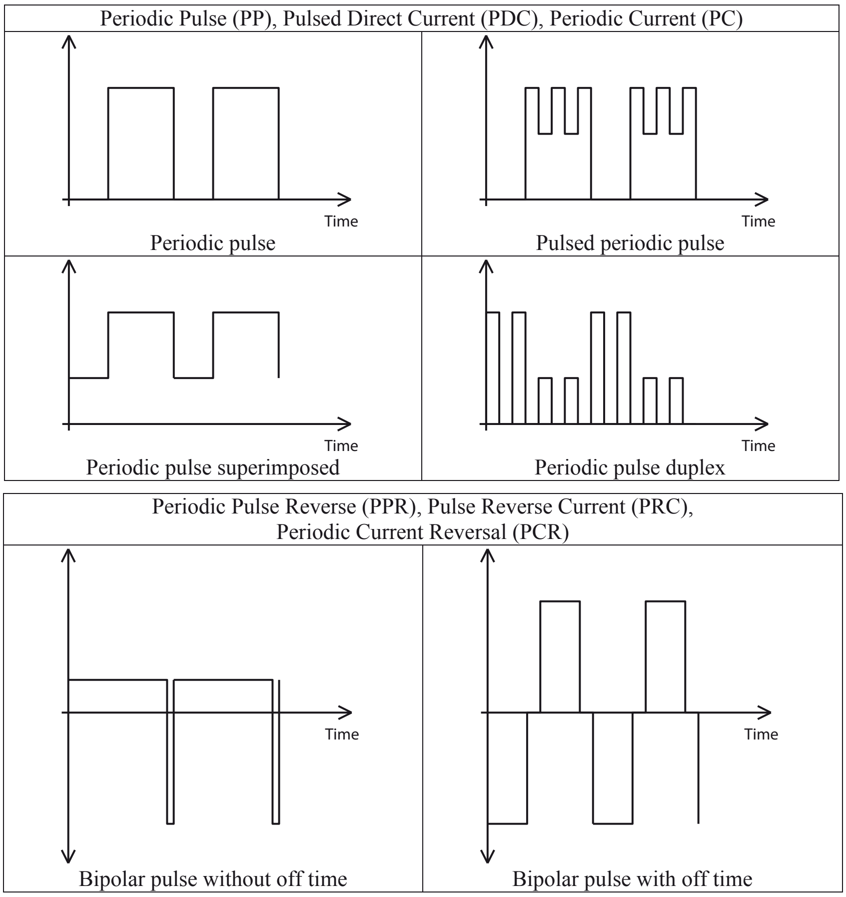
Pulse Plating & Pulse Plating Reverse rectifiers are designed to handle forward and reverse pulsed output current with the possibility to create, via software, special mixed waveforms. These rectifiers are able to generate very fast and complex current and voltage patterns. Using these pulse patterns in combination with appropriate chemical products, remarkable improvements are obtained.

SQUARE WAVEFORMS

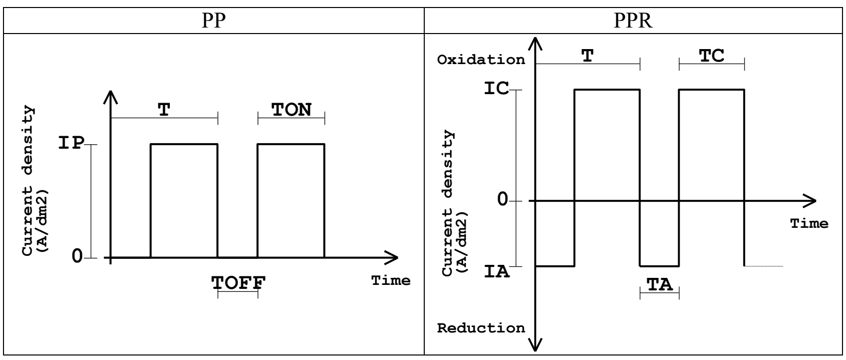
Introduction

Pulse Electro Deposition (PED) is widely used to improve the electrochemical process. The potential or current is alternated swiftly between different values with the aim to lower the effect of a charged layer forming around the cathode. In PCB manufacturing the combined use of additives and reverse current pulses, improves the uniform distribution of metal on sharp edges. The application are varied: PCB, anodizing, micro-plating, etc. Applications of PED are object of research, and many other uses of this technology may yet be discovered. Generally speaking, there are no limits to pulsed applications. While are not specialized on the chemistry of plating we can propose power supply solutions that best fit your applications.



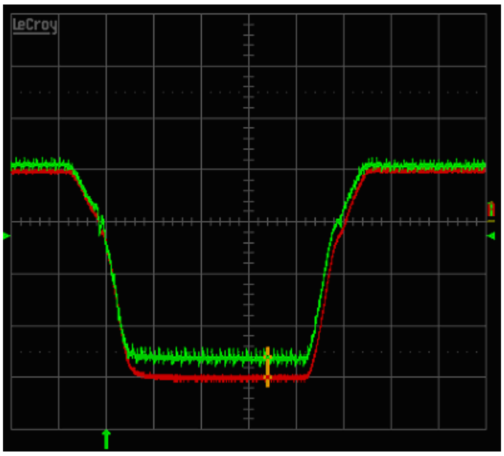
Timing

The key element of the pulsed machines is the timing of the required pattern. The chemistry requires a right angle wave shape that is drawn by lines at right angles.



But the current can't increase (or fall) in null time. It needs time to charge inductive and capacitive component of power supply and output cables.

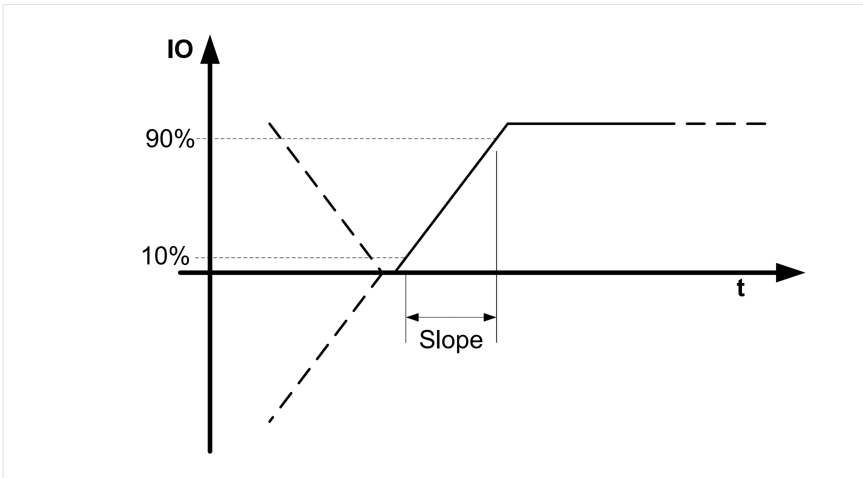
With the aim of stabilizing the output waveform that could occur for the changing of characteristics of Tank and cables, we have introduced "controlled" changes in the current, instead to brutally varying the output. The following is an oscilloscope recording of a pulse of current (red) and voltage (green) over a test Tank



200µs/div

Slope

The changing of current has a rate of growth that can be measured. The Slope is the time needed to increase the current from 10% to 90% of final maximum current.



The CRS software produces a controlled Slope in output current to avoid oscillation, overshoot, undershoot or deviation of chosen pattern. In order to simplify choosing, and to introduce a standardization, CRS has divided the Slope time in three values:

FAST (Slope: 0.09 ms) - Impulses as narrow as 1ms that require great care in output line and stable components in the module. It is used by the PCB manufacturer. To avoid output wave distortions, the design of output line, that connects power supply to tank, must be done by a qualified installer. The design of a pulsed power supply starts by filling in the spreadsheet provided by CRS.

SLOW (Slope: 0.8 ms) - Impulses as narrow as 3ms. No particular care is necessary; we advise only for a summary check of inductance for very long line (greater than 10m). It is often used by anodizers. We encourage using the SLOW Slope instead of FAST, whenever the application permits impulse wider than 3ms. We can drive two towers with the same output waveform, on the condition that the outputs must not be interconnected together.

DC (Slope: 100 ms) - for these slow machines (1000ms), we can realize large installations, with many towers connected together (up and over 1MW). The cabling must keep in account only for the dissipation requirement.

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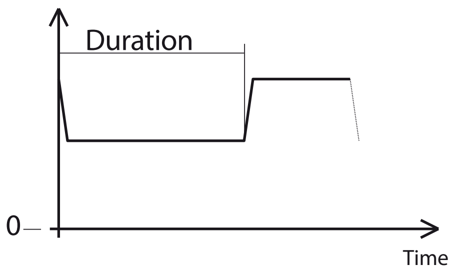
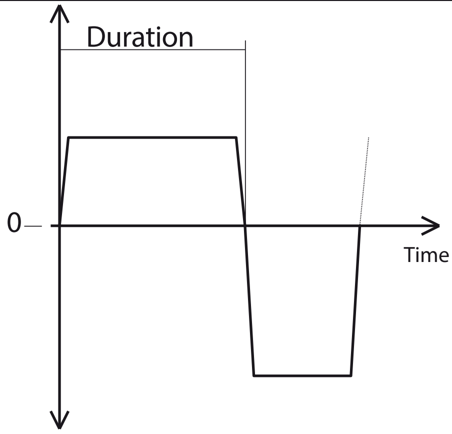
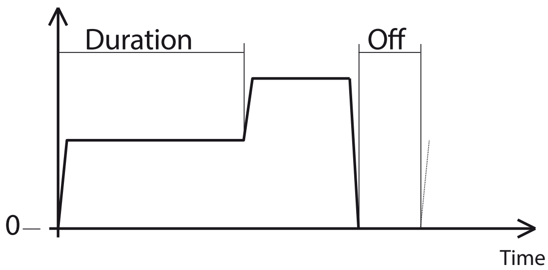
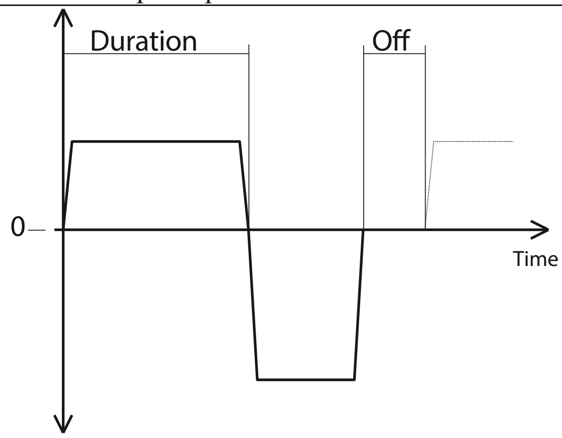
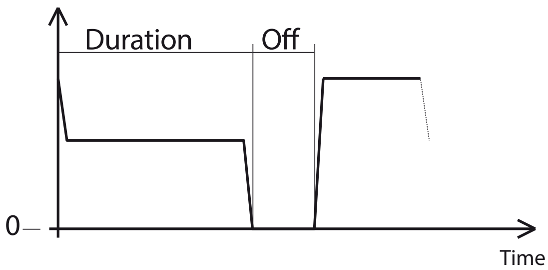
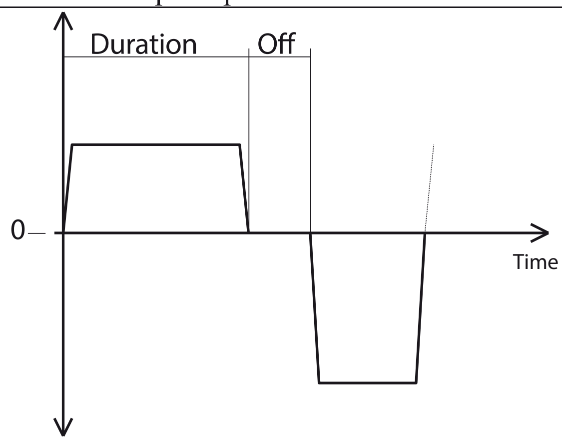
Duration

The other fundamental element is the time of one pulse. The Duration is the total time of a pulse both in pulsed or pulse reverse machines. The optional Off time is the time of output null.

PP	PPR
 Unipolar pulse without off time	 Bipolar pulse without off time
 Unipolar pulse with off time	 Bipolar pulse with off time
 Unipolar pulse with off time; singularity before off	 Bipolar pulse with off time; no change before off

Duration is the time the time that completes one single pulse or the zero to zero time.

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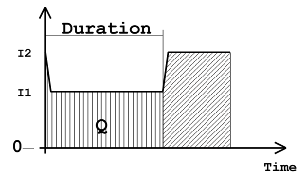
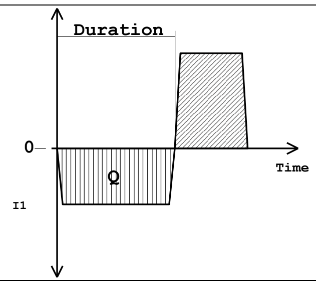
Charge

Due to the Slope, the total charge moved during one pulse is less due to many factors: power supply speed, line length, and inductance in electrodes. By specifying the Slope all these phenomena are keep under control, because the wave shape is controlled. Also the rms current is more stable because the wave shape overshoot and undershoot, are less severe. This is useful in electrochemical to replicate the design parameters of a bath with less adjustments.

	PP	PPR
		
FAST	$Q = I1 * Duration + (I2 - I1) * 5.6 * 10^{-5}$	$Q = I1 * (Duration - 1.1 * 10^{-4})$
SLOW	$Q = I1 * Duration + (I2 - I1) * 5 * 10^{-4}$	$Q = I1 * (Duration - 1.10^{-3})$
DC	$Q = I1 * Duration + (I2 - I1) * 6.3 * 10^{-2}$	$Q = I1 * (Duration - 1.3.10^{-1})$

E.g. in a FAST PPR machine that deliver 1ms pulse, the total charge is 11% less than the theoretical expected, in SLOW a 3ms pulse has 33% less charge.

Types of rectifiers

We divide machines in six categories:

	Slope [ms]	Min Duration [ms]	Min Off [ms]	PWR Design
PP FAST **PPR FAST**	0,09	1	0,1	CUSTOM (Custom design of the module and special care in output cable setup)
PP SLOW **PPR SLOW**	0,8	3	1	STANDARD
DC **DCR**	100	1000	1000	STANDARD

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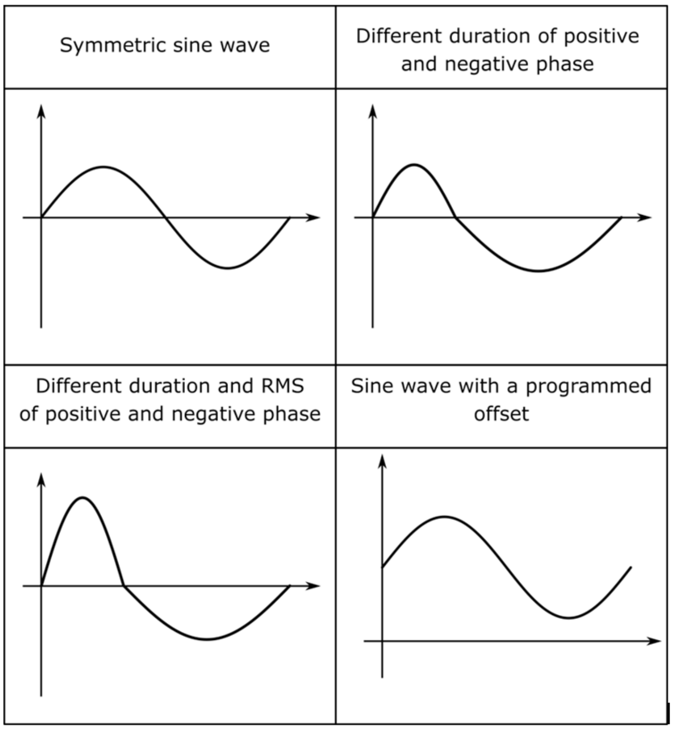
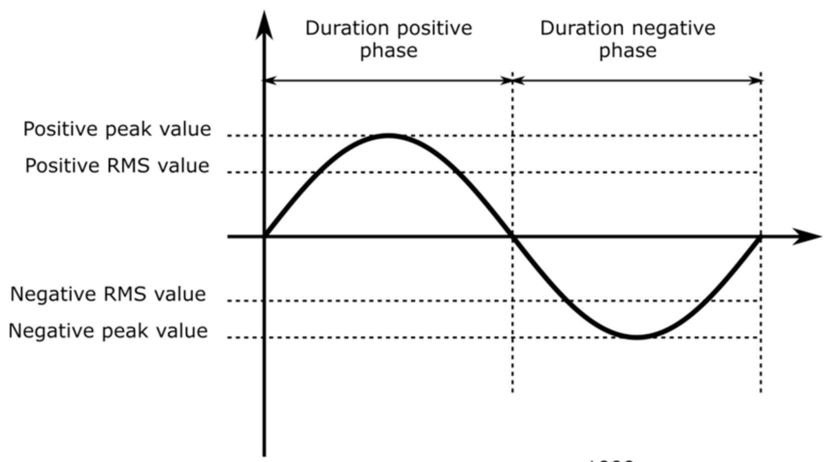
SINE WAVES

Introduction

The pulsed rectifiers can be used to generate sine waves. Sine waves are usually required for coloring applications.
The generated sine wave can be asymmetrical, with different durations and RMS values for the positive and the negative half. Asymmetric sine waves can be used to optimize the coloring process, reducing the process time, especially if compared with transformer based rectifiers, where the duration and RMS of the two halves of the sine wave must have the same values.
An offset can also be programmed, to generate sine waves that lay in in the positive or in the negative half of the plane.



Parameters that define a sinusoidal waveform



$$\text{Frequency (Hz)} = \frac{1000}{\text{(Duration positive phase (ms) + Duration negative phase (ms))}}$$

$$\text{Peak Value} = \text{RMS value} \times \sqrt{2}$$

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Features

- Sine wave frequency: 25Hz to 100Hz
- Duration of the positive phase: 5ms to 20ms
- Duration of the negative phase: 5ms to 20ms
- Max RMS value: (rectifier output voltage/current) / sqrt(2). The positive and the negative halves of the sine wave can be programmed with different RMS values. The peak value of a sine wave, given the RMS, can be calculated as: RMS * sqrt(2). The peak value cannot exceed the rectifier output voltage or current.
- Programmable offset available to generate sine waves that lay in the positive or in the negative half of the plane. When an offset is programmed, the rectifier can only operate in direct or reverse mode (the sine wave cannot cross the zero axis).

Multi-tower configuration

- To increase the output power for PP/PPR slow rectifiers, up to 15 towers can be paralleled. See chapter "Multi-tower Interconnection" of TECHNICAL DOCUMENTATION book.
- PP/PPR fast rectifiers are synchronized for the applications where different areas need different running processes.

Technical Specifications

ELECTRICAL SPECIFICATIONS

<table>
<tr><th></th><th></th><th></th><th>Q100 model</th><th>Q300 model</th><th>Q500 / Q500B model</th></tr>
<tr><td rowspan="15">Output</td><td rowspan="2">Average power</td><td>PP</td><td>Up to 8kW</td><td>Up to 32kW</td><td>Up to 110kW per tower</td></tr>
<tr><td>PPR</td><td>Up to 4kW</td><td>Up to 20kW</td><td>Up to 100kW per tower</td></tr>
<tr><td rowspan="2">Voltage</td><td>PP</td><td>5 - 160VDC</td><td>5-450VDC</td><td>5-450VDC</td></tr>
<tr><td>PPR</td><td colspan="3">5-50VDC</td></tr>
<tr><td colspan="2">Max. pulsed current</td><td colspan="3">Up to 3 times the max DC current value depending on the pattern required</td></tr>
<tr><td colspan="2">Operation Mode</td><td colspan="3">Current control or Voltage Control</td></tr>
<tr><td colspan="2">Resolution</td><td colspan="3">Iout≤ 25A - Min. step: 0.01A - Display resolution: 2 decimal digits
25A< Iout ≤ 250A - Min. step: 0.1A - Display resolution: 1 decimal digits
250A< Iout ≤ 600A - Min. step: 0.2A - Display resolution: 1 decimal digits
600A< Iout ≤ 2000A - Min. step: 1A - Display resolution: No decimal digits
2000A< Iout ≤ 5000A - Min. step: 2A - Display resolution: No decimal digits
Iout > 5000A - Min. step: 5A - Display resolution: No decimal digits</td></tr>
<tr><td colspan="2">Accuracy</td><td colspan="3">1% on full scale</td></tr>
<tr><td colspan="2">Current regulation range</td><td colspan="3">2 - 100% of max current (CTRD05)</td></tr>
<tr><td colspan="2">Voltage regulation range</td><td colspan="3">5 - 100% of max voltage (CTRD05)</td></tr>
<tr><td colspan="2">Low frequency current ripple (RMS)</td><td colspan="3"><2.0% of rated output current in current operation mode
(<1.0% on request for Vout≤160V)</td></tr>
<tr><td colspan="2">Efficiency</td><td colspan="3">89% (typ.) @ rated load / 92% (for ≥ 160VDC) @ rated load</td></tr>
<tr><td colspan="2">Pole to be connected to ground</td><td colspan="3">Vout<200V : Positive - Vout≥200V : Positive or Negative</td></tr>
<tr><td rowspan="6">Main Supply</td><td colspan="2">Line voltage</td><td colspan="3">3 x 208VAC ± 10% or 3 x 230VAC ± 10% or 3 x 400VAC ± 10% or
3 x 440VAC ± 10% or 3 x 480VAC ± 10% or 3 x 575VAC ± 10% (max primary current 110A)</td></tr>
<tr><td colspan="2">Frequency</td><td colspan="3">50 - 60Hz</td></tr>
<tr><td colspan="2">Neutral</td><td colspan="3">NOT USED</td></tr>
<tr><td colspan="2">Power factor</td><td colspan="3">> 0,95 @ rated load</td></tr>
<tr><td colspan="2">Primary current in max DC</td><td>Max 20A</td><td>Max 55A</td><td>Max 230A per tower</td></tr>
<tr><td colspan="2">Earth leakage current</td><td colspan="3">See EMC filter input specifications</td></tr>
</table>

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GENERAL SPECIFICATIONS

		Q100 model	Q300 model	Q500 / Q500B model
Technology		Switching mode PWM, Full Bridge IGBT inverter		
Cooling Systems		Air		
		Water		
Operation Conditions	Location	Indoor use only		
	Ambient temperature	0 - 40°C (up to 50°C with 15% derating -air cooled- / 10% derating -water cooled-)		
	Relative humidity	15 - 85% not condensing		
	Filter obstruction - air cooled	15% max		
	Water input temp. - water cooled	19 - 28°C		
	Altitude	<= 2000m		
Degree of Protection	Air cooled	IP31	IP21 (on request IP54 or NEMA12)	IP32
	Water cooled	IP43	-	IP42 (on request IP54 or IP65)
Enclosure color		RAL 3004	RAL 5010	RAL 3004
Conformity of EU Directives		2006/95/EC - Low Voltage Directive		
		2004/108/EC - Electromagnetic Compatibility		

SOFTWARE AND SERIAL INTERFACE

Communication Protocols

CRS-ASCII	Included	RS232 point-to-point and RS485 network
Modbus-RTU	Included	RS232 point-to-point and RS485 network
Profibus-DP	Optional with additional board	Profibus-DP network
DeviceNet	Optional with additional board	CAN bus network
Modbus/TCP	Optional with additional board	Ethernet
Profinet	Optional with additional board	Ethernet
EthernetIP	Optional with additional board	Ethernet

Communication Ports

- RS232
- RS485

All the above protocols are managed by only one software for DC / DCR / PP slow / PPR slow rectifiers.
One specific software is required for PP fast / PPR fast rectifiers.

PROTECTION

Surge

According to directive	EN 61000-4-5

2kV between each input phase and PE. 1kV across each input phase combination.

Phase Loss

Type	Hardware	Software
Programmed limit	Half cycle	Adjustable via configuration parameter

Output Short Circuit

> Programmable limit from 1 to 100% of max. I_{out}
> Detection time: 1ms

Thermal Protection

> With PTC on each module

FULL LOAD HARMONICS DISTORTION

Harmonic	Freq. (Hz)	Absorbed Current Distortions
3	150	-
5	250	< 22.5%
7	350	< 12.5%
9	450	-
11	550	< 11.0%
13	650	< 7.6%
17	850	< 8.0%
19	950	< 4.8%
THD		**MAX 30%**

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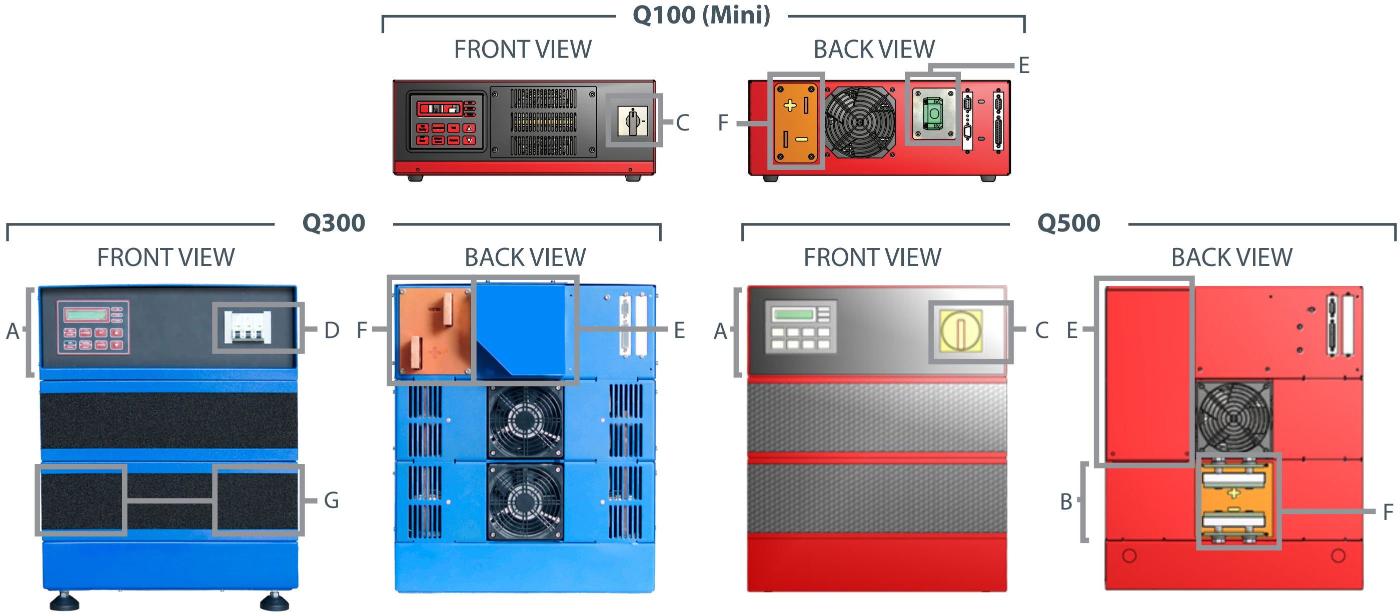
Hardware Differences of Quasar Models



- > A. HEADER - only on Q300 & Q500/Q500B
- > B. INTERMEDIATE COOLING UNIT - only on Q500/Q500B
- > C. MAIN I/O SWITCH - only on Q100 & Q500/Q500B
- > D. CIRCUIT BREAKER - only on Q300
- > E. AC INPUT UNIT - Type, size and location vary per model
- > F. OUTPUT CONNECTIONS - Type and location vary per model
- > G. ADDITIONAL FANS ON EACH MODULE - only on Q300 model

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