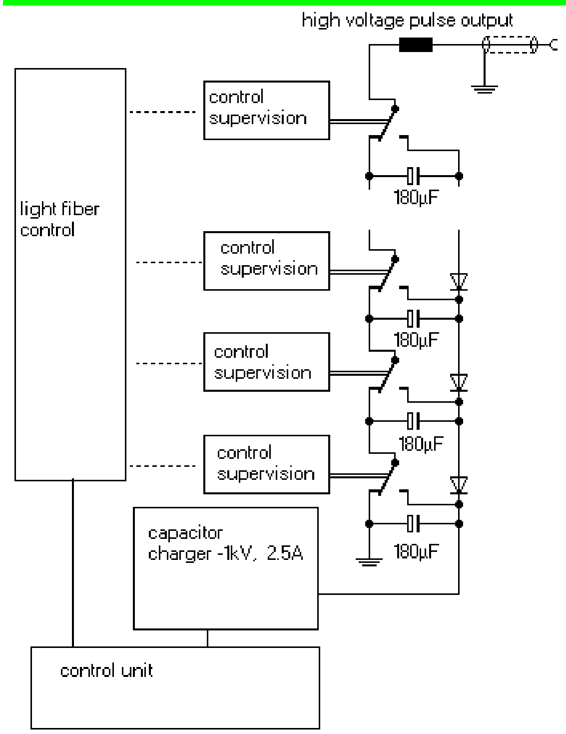
RUP6-12CL

Improved pulse generator for high power and resistive as well as capacitive loads

- True square wave pulse with active switching off
- Arbitrary pulse width
- rise time adjustable in the ranges 0.7...7µs and 5...50µs
- frequency up to 3 kHz
- voltage up to -12 kV
- pulse current up to 100 A
- average power up to 2.5 kW
- short circuit proof

The RUP6-12CL is an universal solid state pulse generator with an output voltage up to -12kV, which also may be constructed for other maximum voltages in the range 1 ... -40 kV, bipolar versions are also available.
The version „CL“ is developed from the standard version and stands for ability to handle also higher capacitive loads. So it can handle high pulse currents, the ability not only to source but also to sink such high currents, and a large range for adjusting the rise and fall time. Together with an inductor in the output this decreases switching losses and allows to handle a large range of capacitive loads with comparatively high frequencies.
Prominent features of the RUP6 in general are high pulse current, very high efficiency, scalability of the voltage and ultra fast switching off in case of arcs.
The RUP6 consists of numbers of 1 kV pulse modules which are charged in parallel and are switched in series during pulse. Power supply and modulator are integrated within this principle.

Technical data



Principal scheme RUP6-12CL

Current and Voltage

- maximum output pulse voltage -12 kV
- maximum output power 2.5 kW, decreasing with duty cycle. Pout=Pmax *(1 - frequency * (pulse width + 150µs))
- Output impedance around 7 Ohm, corresponding to 0.6 Ohm per module. In series to this is an inductor of 25µH, corresponding to 2µH per module. The output inductor can be exchanged to values of 50µH and 100µH. The output inductor can also be removed so that only the residual inductance of about 10µH remains; but this is not recommended if heavy arcing is expected.
- Internal pulse capacity around 15µF, corresponding to 180 µF per module.
- Maximum peak current 100 A. This applies to sourcing as well as sinking. Overcurrent (>100...120 A) for more than 350ns activates short circuit switch off. The inherent peak short circuit current (at maximum voltage) is around 160A. An Arc (sudden short circuit within a pulse) will initiate current limiting within 80 ns and switch off after 700ns.

GBS ELEKTRONIK GmbH

- Maximum average current around 200 mA.
- Maximum RMS current in the output 6A. Exceeding this will inhibit triggering and therefore reduce frequency.

Wave Form and Frequency

- Trapezoidal pulse with variable pulse width, frequency and rise time.
- Rise time adjustable in the range 0.7 ... 7µs and in a second range from 5 µs to 50µs.
- The ratio of fall time to rise time can also be adjusted the range 1:1 to 1:3, so that the fall time is always longer or equal to rise time.
- Overshoot correction adjustment.
- Adjustable pulse width 1 µs - 100 µs, using external control signal also longer. Principally the internal pulse capacitor should not discharge more than 10% of the maximum rated voltage (1kV in this case). Without load, pulse width up to 2 seconds is possible.
- Duty cycle can be chosen nearly arbitrarily, it has only to be noted that the maximum possible output power will linearly decrease with increasing duty cycle. The reason for that is that the internal power supply is off during pulse and up to 150µs after pulse.
- Maximum frequency 3 kHz.
- With large capacitive loads, rise time may have to be increased for not to exceed the peak current of 100A, and frequency may have to be reduced to avoid exceeding the maximum RMS current rating.

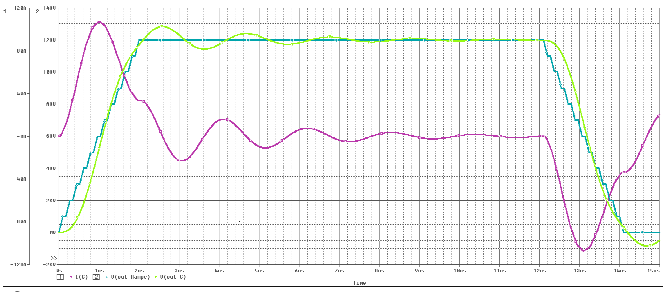
Example for RMS calculation:

A load of C=11nF shall be charged to U=10kV within t=1.3µs. The current needed for this is Ip=CU/t=85A, which is within the specification. If this shall be done with a repetition rate of 2 kHz, and a fall time as short as the rise time, the RMS output current of this calculates as $I_{RMS} = \sqrt{I_p^2 \times 2 \times t \times f}$ =6.1A.

So this at the very limit of possible RMS current. For long term operation, it may be recommended to reduce voltage or frequency, or increase rise and/or fall time a little bit.

Overshoot:

In the case of a capacitive load, combined with the inherent output inductance and an arbitrary rise time, there will be significant overshoot.
However, if no losses are assumed and the ramp time fits to multiples of the ringing frequency, there will be no overshoot.
In the more realistic case of a damped circuit, it can be shown that at least one ramp time can be found where overshoot is <8%.
By creating a bend in the ramp with the above mentioned overshoot correction adjustment, even this small overshoot can be cancelled out to zero.



Output signal (green output voltage, blue ramp voltage, red current) calculated for a 10.9nF load, 10µH residual inductance and 7.2 Ohm residual inductance. The rise time can be always adjusted such that the overshoot stays <8%, even without correction.

Mechanical, included items

- 19" rack, 780 * 550 * 1100 mm (20HE)
- grid supply 230 V.
- Control of voltage, pulse width, frequency, rise time and rise time ratio by potentiometers on the front. Pulse control may also be done by external TTL signal at the control input at the front.
- monitor outputs for voltage and current.
- Meters for internal power supply voltage and current as well as RMS output current.
- documentation

Safety

- external interlock
- a fast short circuit detection protects the pulse modules from damage by short circuit or arcing in the load.
- short circuit currents are inherently limited to 160 A.
- The pulse generator is compatible to regulations about electromagnetic compatibility (EMC).

12.04.13 Dr. Jörg Brutscher

GBS Elektronik GmbH
Bautzner Landstraße 22
01454 Großerkmannsdorf
Germany

Tel.: 0049 (0)351 21 70 07 - 0
Fax.: 0049 (0)351 21 70 07 - 21
E-Mail: kontakt@gbs-elektronik.de
Website: www.gbs-elektronik.de