

RUP6-10CL_{r5}

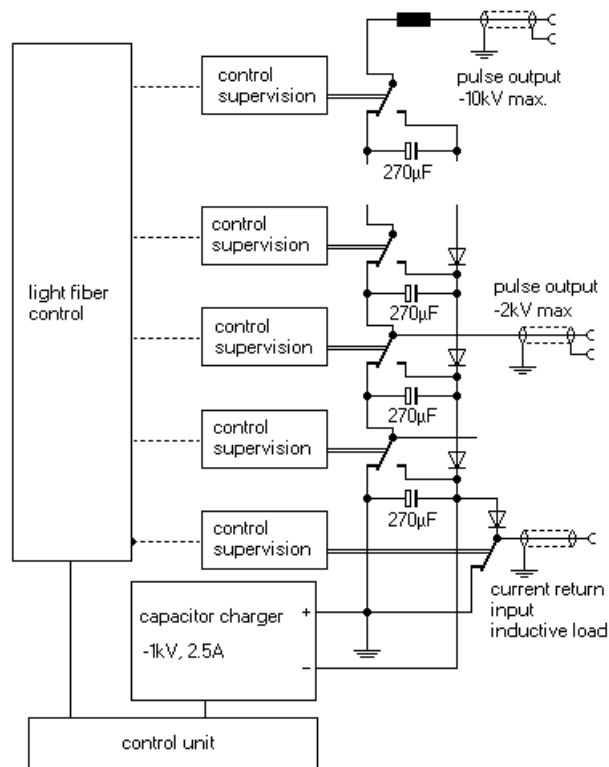
High voltage pulse generator for capacitive and inductive loads

- True square wave pulses with active switching off
- Rise-/fall time adjustable to adapt to capacitive loads
- separate current return input for inductive loads
- frequency up to 2 kHz
- voltage up to -10 kV
- pulse current up to 200 A
- average power up to 2.4kW
- short circuit proof

The RUP6 series is a universal solid state high voltage pulse generator, which can be built for the voltage range of -1 kV to -35kV. Prominent properties are high pulse current, very high efficiency, scalability of voltage and fast arc switch off. 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. As synchronous switching of the modules is not necessary with this principle, stepwise switching can be used to make rise and fall times adjustable.

The version CL incorporates in contrast to the standard version current enhanced modules, which can handle up to 200 A, and not only forward, but also reverse during switching off. Combined with the adjustable rise and fall time it makes an excellent choice for capacitive loads.

The current return input, to be used with inductive loads, will effect that at the end of the pulse the inductive energy will be fed back to the pulse generator and therefore the current will decay quite fast. An application for this pulse generator are insulation tests on transformers and motors. The pulse generator allows to test the insulation between windings, between windings and housing, but also between beginning and end of a winding.



Current and voltage

- Maximum output pulse voltage -10 kV
- Maximum effective power 2.4 kW, corresponding to 1000V, 2.4 A of the internal power supply. Will decrease with increasing duty cycle according to the formula $P_{out} = P_{max} \cdot (1 - \text{frequency} \cdot (\text{pulse width} + 130\mu s))$
- output impedance <4 Ohm, corresponding to <0.4 Ohm per pulse module. In series to this is an inductor of 20µH, which can be increased to 40µH or 80µH by changing connections.
- Internal pulse capacity 27µF, corresponding to 270µF per module.
- Maximum peak current 200 A. This is the limit for voltage rise and plateau (sourcing) as well als for voltage fall (sinking).
- Maximum effective current (RMS) 10A.

However, with currents above 100A with capacitive loads there will be a disproportionate rise in switching

losses. If the generator is operated with maximum frequency at the same time, it may happen that already below 10A_{RMS} the temperature limit at the modules will be exceeded and the pulse generator will switch off after some time.

Current surveillance

The pulse generator is short circuit proof and usable for insulation life tests until breakdown. Overcurrents (e.g. due to sparkover) will not cause damage to the generator. Overcurrents are detected very fast and reliable and will be switched off:

- If the adjustable peak current limit (0..200A) is exceeded for more than 1µs, it will activate short circuit shut down. Within 200 ns the current will be limited, after 1.5µs the pulse will be ended and at the same time, primary power supply and HV is switched off.
- Also if the primary power supply current limit (0-2.5A, adjustable) is exceeded it will cause shutdown.

- Likewise also exceeding the RMS current limit of 10A causes switching off.
- If the current reaches 90% of the limits for peak current, RMS current or power supply current, it will be indicated by a corresponding LED.
- Also an error on a pulse module (overcurrent, overtemperature, missing supply) will be detected, indicated and will shutdown the pulse generator.

Waveform and frequency

- Trapezoidal pulse with variable pulse width, frequency and rise time.
- Rise time adjustable in two ranges from 0.3 ... 3µs and 2 µs ... 20µs.
- Pulse width adjustable in the range 1 µs ... 100 µs; with the external control input also longer pulses are possible. Without load, pulse width can be extended theoretically until around 2 seconds.
- Frequency adjustable in the range 0 ... 2 kHz, with external control up to 3 kHz possible.
- Duty cycle can be chosen nearly arbitrarily, just that the average will decrease with increasing duty cycle. The reason for that is that the internal power supply will not work during a pulse and up to 130 µs after it.

If large capacitive loads are connected, the rise time has to be reduced in order not to exceed the maximum peak current of 200A. Further it may be necessary to reduce also the frequency to stay within the RMS current limit.

Operation with inductive load

If an inductive load is connected to a RUP6, the pulse current will have a triangular shape. It will rise very fast during pulse on and decay rather slowly after the end of the pulse.

To speed up the current decay, it is recommended to connect the load not between HV out and ground (cable shield), but between HV out and current return input. With this, the inductor sees a reverse voltage up to 1000V after the end of the pulse, and the remaining energy stored within the inductor is fed back to the capacitors of the pulse generator. Current fall time is then limited to 10 times the current rise time.

Operation with 2 kV output

If voltages < 2kV are needed for testing, the 2kV output can be used, resulting in a more stable operation. It is directly connected to the output of the 2nd pulse module.

- Rise time can be adjusted only very crude, as switching is in 2 steps only.
- With inductive load and current return input used, the current decay time is limited to double the rise time.
- The accuracy of the output voltage is limited by the power supply hysteresis (<=10V). With the 2 kV output used, the accuracy is around 20 V, with the 10 kV output used the accuracy is about 100V.

Mechanical, included items

- 19" rack, 550 * 780 * 1100 mm (20HE)
- Supply voltage 230-240 V.
- 10-turn potentiometers for adjustment of voltage, pulse width, frequency, rise time, peak current limit and power supply current limit.
- LEDs indicating that 90% of the current limits for peak current, power supply current, or RMS current are exceeded.
- Analog control input (0-5V) to generate arbitrary shaped pulse signals.
- TTL-synchronisation output (BNC)
- Switch for selecting the rise time range.
- Switch for selecting external or internal voltage control.
- High voltage outputs for -10 kV, -2kV, and current return input: All realized as B120 receptacle, 2*3m output cable with corresponding plugs are included. Further included is a spare plug.
- Connection for external grounding stick; delivers 230VAC with „HV on“.
- 2 monitor outputs for voltage (1:1000 resp. 1:200 for the 2 kV output)
- current monitor output (50mV/A).
- Display for internal power supply voltage (0-1000V, 3½-digit), internal power supply current (0-3A, analog) and RMS output current (0-10A, analog).
- Resettable operation hour counter for “HV on”.
- external interlock.
- Analog control interface Sub-D25 plug: May be used to switch remotely the generator on and off, with analog signals in the range 0-10V it is possible to control voltage, pulse width, frequency and rise time. Further there are monitor outputs for internal power supply voltage, internal power supply current, RMS output current and the TTL synchronisation signal.
- 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 270 A.
- The pulse generator is compatible to regulations about electromagnetic compatibility (EMC).

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