

SELF-RECOVERY HIGH-VOLTAGE PULSE DRIVER

TECHNICAL FIELD

[0001] The present application generally relates to the technical field of high-voltage pulse drive in electronic control, and in particular, relates to a self-recovery high-voltage pulse driver.

BACKGROUND

[0002] Time of flight mass spectrometry (TOF-MS) is a mass spectrometry which takes ionic flight times as test parameters, in which the ions enter a fieldless drift tube after being accelerated in an electric field, and fly at a constant speed to a detector, thereby realizing a process of ion flight. In particular, the ions are accelerated by the electric potential difference generated after both ends of the electric field are loaded by the high-voltage. Therefore, how to generate high-voltage pulse is one of the key technologies of implementing the time-of-flight mass spectrometry technology.

[0003] The high-voltage pulse, as one of important inputs of desorption and ionization of the time-of-flight mass spectrometer through matrix assisted laser, is applied in the high-tech world such as life sciences, microbial identification and the like. The amplitude and frequency of the high-voltage pulse may affect ionization flight times of ions. Firstly, the amplitude is large enough and can reach conditions for sample ionization, and secondly, the frequency affect detection speeds of the desorption and ionization of the time-of-flight mass spectrometer through matrix assisted laser.

[0004] There has been relevant research on pulse circuits, for example, Chinese invention patent with a publication number of CN 114660046A (an application no. of CN202210285342.7) discloses a DC pulse atmosphere glow discharge emission spectroscopy system and detection method, square pulse voltages and one synchronous TTL level signal are outputted through a DC pulse high-voltage generating unit. High-voltage pulse loading unit and traveling-wave pulse and

timing control system are configured for providing the high-voltage pulse, which solves a problem of insufficient excitation efficiency of heavy metals caused by discharge current limited of 50-70 mA in current solution cathode glow discharge technique. Chinese invention patent with a publication number of CN114597112A (an application no. of CN202210180291.1) discloses a pulse switch type ion detector device and preparation method thereof, in which high-voltage pulse loading unit and traveling-wave pulse and timing control system are configured for providing the high-voltage pulse, the timing of the high-voltage pulse is adjusted to match with the timing of an external control trigger signal. When interfering lights reaches the detector, bias voltage of the detector is intentionally reduced. When ion signal reaches the detector, the high-voltage of the detector is raised in a working state, and after operations of opening and closing doors, ion signal-to-noise ratio is improved and background interference is effectively eliminated. The adaptability of the detector under strong pulse radiation conditions is enhanced, pulse noise interference from the front-end is greatly eliminated through gating of pulse high-voltage and timing control, which only open the door for detectors within the ion arrival time period, thereby obtaining ion signals with high signal-to-noise ratio.

[0005] However, although there has been relevant research on pulse circuits, the generated high-voltage pulse amplitudes are almost within 1 KV, the amplitudes are small, the detection speeds of the desorption and ionization of the time-of-flight mass spectrometer through matrix assisted laser are affected when the flight times of ions are measured, thereby decreasing the detection accuracy. In addition, in a scheme adopting an integrated power supply, the voltage difference of the power supply is configured for directly driving, the technical solution has high cost and slow response speed. If adopting a rising-voltage scheme of transformer, the boost coil causes a large startup delay and slow response speed.

SUMMARY

[0006] An objective of the present application is to solve the technical problems in the related technology, the present application provides a self-recovery high-voltage pulse driver, which has quick response, good stability and high output voltage amplitude.

[0007] In order to achieve the above objective, a self-recovery high-voltage pulse driver according to the present application includes a high-speed pulse driving unit and a high-voltage pulse generation unit, the high-speed pulse driving unit is provided with a high-voltage switch Q, the high-voltage pulse generation unit includes a high-voltage capacitor C and a resistive network, and the high-voltage capacitor C is connected to the high-voltage switch Q, a first high-voltage HV1, a second high-voltage HV2 and a third high-voltage pulse HV3 via the resistive network. The high-speed pulse driving unit is configured to generate the third high-voltage pulse HV3 from the first high-voltage HV1 and the second high-voltage HV2 via the high-voltage switch Q and the high-voltage capacitor C, and after the high-voltage pulse is output, the third high-voltage pulse HV3 automatically recovers to the second high-voltage HV2.

[0008] In an embodiment, when the high-speed pulse driving unit has no drive inputs, an output voltage of the third high-voltage pulse HV3 is equal to a voltage of the second high-voltage HV2; when the high-speed pulse driving unit has driving pulse inputs, the output voltage of the third high-voltage pulse HV3 is equal to a difference between the voltage of the second high-voltage HV2 and the voltage of the second high-voltage HV1, and recovers to the voltage of the second high-voltage HV2 after the driving pulse disappears.

[0009] In an embodiment, the resistive network includes a resistance R1, a resistance R2, a resistance R3 and a resistance R4, a first end of the high-voltage capacitor C is connected to the high-voltage switch Q via the resistance R1, and connected to the first high-voltage HV1 via the resistance R2, and a falling speed of the high-voltage pulse output is determined by time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C, and pulse delay recovery time after high-voltage pulse output is determined by the time constants of the resistance R2, the

resistance R3 and the high-voltage capacitor C. A second end of the high-voltage capacitor C is connected to the second high-voltage HV2 via the resistance R3, and connected to the third high-voltage pulse HV3 via the resistance R4; and an output voltage power of the third high-voltage pulse HV3 is determined by a capacity of high-voltage capacitor C and a resistance value of the resistance R4.

[0010] In an embodiment, the resistance R1, the resistance R2, the resistance R3 and the resistance R4 are power resistances, a resistance value of the resistance R3 is greater than a resistance value of the resistance R2, and a resistance value of the resistance R2 is greater than a resistance value of the resistance R4 or R1.

[0011] In an embodiment, the high-speed pulse driving unit also includes a high-speed level driving circuit U, an input end of the high-speed level driving circuit U is connected to an input low-voltage control signal, and an output end is connected to a gate-level of the high-voltage switch Q, the input low-voltage control signal is connected to the gate-level of the high-voltage switch Q through the high-speed level driving circuit U.

[0012] In an embodiment, the high-speed level driving circuit U preferably includes but is not limit to an isolation driving point circuit for transformer coupling, isolation power supply coupling and optoelectronic isolation coupling, an alternative circuit is directly driven, and the isolation driving point circuit for transformer coupling, isolation power supply coupling and optoelectronic isolation coupling are in one-to-one correspondence with the gate-levels of the high-voltage switch Q.

[0013] In an embodiment, the input low-voltage control signal is TTL or CMOS signal.

[0014] In an embodiment, the high-voltage switch Q is adopted as high-voltage field-effect transistor, high-voltage transistor or insulated gate bipolar transistor, and a withstand voltage value of the high-voltage switch Q is not lower than the first high-voltage HV1.

[0015] In an embodiment, the high-voltage switch Q is in a mode of single cascade or multiple cascades, the withstand voltage value of the high-voltage switch Q in a mode of single cascade or

multiple cascades is not lower than the first high-voltage HV1.

[0016] In an embodiment, the withstand voltage value of the high-voltage capacitor C is not lower than the second high-voltage HV2.

[0017] In an embodiment, the first high-voltage HV1 and the second high-voltage HV2 are co-phase grounded high-voltage power sources.

[0018] In an embodiment, an input end of the high-voltage switch Q is connected to a zener diode D, which prevents high-voltage switch Q from inputting overvoltage.

[0019] The present application has the following beneficial effects: the self-recovery high-voltage pulse driver of the present application includes two inputs of high-voltage power sources and one high-voltage output, besides the two inputs of high-voltage power sources, the high-speed pulse driving unit is configured to generate the third high-voltage pulse HV3 from the first high-voltage HV1 and the second high-voltage HV2, which automatically recover to the first high-voltage after the high-voltage pulse is outputted. Changing inner components of the high-voltage pulse driver can configure a recovery time and falling time of the high-voltage pulse, and have short period and high frequency. Changing inner components of the high-voltage pulse driver can configure the amplitude of the high-voltage pulse output, an upper limit value of the configured amplitude of the high-voltage pulse output is far greater than the upper limit value of the amplitude of the high-voltage pulse output reached in the current related technology.

[0020] Recovery time of the present application is configured based on time constants of resistance and capacitance, which has a fast response speed, enhances response time of the whole system, promotes a deep development of mass spectrometry technology, has high output voltage amplitude, thereby facilitating the expansion of the system. In addition, the pulse delay recovery time is determined by the time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C through a full hardware approach of the high-voltage pulse driver. The falling speed of the high-voltage pulse output is determined by time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C, so that the high-voltage pulse generator has a fast

response speed. Changing capacity/withstand voltage of the high-voltage capacitor C and resistance value/withstand voltage of the resistance R4 adjusts the high-voltage output, which can stably and flexibly realize the high-voltage output, and achieve high and ultra-high output voltage, thereby achieving the high-voltage pulse output.

[0021] The features and beneficial effects are illustrated in detail below in combination with embodiments and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 is a schematic diagram of a self-recovery high-voltage pulse driver according to the present application;

FIG. 2 is a schematic diagram of a driving signal and a HV3 voltage output waveform; and

FIG. 3 is a schematic diagram of a high-speed level driving circuit.

DETAILED DESCRIPTION

[0023] Referring to FIG.1, a self-recovery high-voltage pulse driver of the present application includes a first high-voltage HV1, a second high-voltage HV2, a third high-voltage pulse HV3, a resistive network, and a high-voltage capacitor C, in which the first high-voltage HV1 and the second high-voltage HV2 are high-voltage inputs, and the third high-voltage pulse HV3 is high-voltage output. In this embodiment, the self-recovery high-voltage pulse driver includes a high-speed pulse driving unit and a high-voltage pulse generation unit, the high-speed pulse driving unit is provided with a high-voltage switch Q, the high-voltage pulse generation unit includes a high-voltage capacitor C and a resistive network, and the high-voltage capacitor C is connected to the high-voltage switch Q, a first high-voltage HV1, a second high-voltage HV2 and a third high-voltage pulse HV3 via the resistive network. The high-speed pulse driving unit is configured to generate the third high-voltage pulse HV3 from the first high-voltage HV1 and the second high-voltage HV2 via the high-voltage switch Q and the high-voltage capacitor C, and the third high-

voltage pulse HV3 automatically recovers to the second high-voltage HV2 after the high-voltage pulse is outputted. Specifically, when the high-speed pulse driving unit has no drive inputs, an output voltage of the third high-voltage pulse HV3 is equal to a voltage of the second high-voltage HV2; when the high-speed pulse driving unit drives pulse inputs, the output voltage of the third high-voltage pulse HV3 is instantaneous equal to a difference between the voltage of the second high-voltage HV2 and the voltage of the second high-voltage HV1, and recovers to the voltage of the second high-voltage HV2 after a delay, that is, the output end HV3 has a voltage of (HV2, HV2-HV1), thereby enabling the self-recovery high-voltage pulse output function.

[0024] Resistance-capacitance (RC) charging and discharging circuit is conducted level control to a reset pin of microcontroller, so as to reach an expected reset time. The implementation of RC charging and discharging circuit is divided into two processes: the first process is a charging process, when the switch is closed, the capacitance is charged by the power supply via the resistance. Due to the lack of charge at both ends of the capacitance at the beginning of charging, the initial voltage is 0. As the capacitance is continuously charged, the voltages at both ends of the capacitance are quickly increased, and the voltages at both ends of the resistance are continuously decreased. When the electrical voltages at two ends of the capacitance reach the power supply voltage, the charging process is end. The second process is a discharging process, the capacitance is discharged via the resistance, since the voltages at both ends of the capacitance are the power supply voltage, the capacitance is discharged quickly. As the capacitance is continuously discharged, the voltages at both ends of the resistance are quickly decreased to 0, the discharging process is end, thereby realizing high and low changes of the level. Therefore, it is feasible to achieve pulse high-voltage through RC charging and discharging principle in the high-voltage circuits.

[0025] Combining with the RC charging and discharging principle, the implementation of high-voltage pulse driving circuit includes: three high-voltages of HV1, HV2 and HV3, the resistances R1, R2, R3 and R4 and the high-voltage capacitor C, in particular, HV1 and HV2 are the high-

voltage input ends, the HV3 is the high-voltage output end. When there is no driving pulse input, the output voltage of the HV3 is the voltage after series connection of the HV2 and the resistances R3 and R4 and the high-voltage capacitor C, which is equal to the voltage of HV2. When inputting the driving pulse, the third high-voltage pulse HV3 is instantaneous equal to a difference between the voltage of the second high-voltage HV2 and the voltage of the second high-voltage HV1, and recovers to the voltage of the second high-voltage HV2 after a delay, that is, the output end HV3 has a voltage of $(HV2, HV2-HV1)$, thereby enabling the self-recovery high-voltage pulse output function.

[0026] The resistive network includes a resistance R1, a resistance R2, a resistance R3 and a resistance R4, a first end of the high-voltage capacitor C is connected to the high-voltage switch Q via the resistance R1, and connected to the first high-voltage HV1 via the resistance R2, and a falling speed of the high-voltage pulse output is determined by time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C, and pulse delay recovery time after high-voltage pulse output is determined by the time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C. A second end of the high-voltage capacitor C is connected to the second high-voltage HV2 via the resistance R3, and connected to the third high-voltage pulse HV3 via the resistance R4; and an output voltage power of the third high-voltage pulse HV3 is determined via a capacity of high-voltage capacitor C and a resistance of the resistance R4. Specifically, the resistance R1, the resistance R2, the resistance R3 and the resistance R4 are power resistors, a resistance value of the resistance R3 is greater than a resistance value of the resistance R2, and a resistance value of the resistance R2 is greater than a resistance value of the resistance R4 or R1.

[0027] The high-speed pulse driving unit also includes a high-speed level driving circuit U (Gate Driver MCP1416T-E/OT), the high-speed level driving circuit includes but is not limit to transformer network, isolated power network, or gate driver, an input end of the high-speed level driving circuit U is connected to an input low-voltage, and an output end is connected to the high-

voltage switch Q, and the input low-voltage is connected to the high-voltage switch Q through the high-speed level driving circuit U. Specifically, the input low-voltage is TTL or CMOS signal. An input end of the high-voltage switch Q is connected to but not limit to a zener diode D, which prevents high-voltage switch Q from inputting overvoltage.

[0028] A withstand voltage value of the high-voltage capacitor C is not lower than the second high-voltage HV2, which prevents the failure of high-voltage capacitor C due to breakdown. The high-voltage switch Q is adopted as high-voltage field-effect transistor, high-voltage transistor or insulated gate bipolar transistor, and a withstand voltage value of the high-voltage switch Q is not lower than the first high-voltage HV1, which prevents the failure of high-voltage capacitor C due to breakdown.

[0029] The first high-voltage HV1 and the second high-voltage HV2 are co-phase grounded high-voltage power sources. The first high-voltage HV1 and the second high-voltage HV2 are high-voltage inputs, and the third high-voltage pulse HV3 is high-voltage output. A voltage level of the first high-voltage HV1 includes but is not limit to 1kV, 2kV, 3kV, 4kV, 6kV, 8kV, 9kV and 10kV, and a voltage level of the second high-voltage HV2 includes but is not limit to 5kV, 10kV, 15kV, 20kV, 25kV, 30kV and 50kV.

[0030] Referring to FIG.1, the high-voltage switch Q is a high-voltage transistor or a field-effect transistor; I/P1 is high-speed pulse input signals, VCC is a power supply that shares ground with the high-voltage switch Q; the high-speed level driving circuit U includes an isolation driving point circuit for transformer coupling, isolation power supply coupling and optoelectronic isolation coupling; a withstand voltage value of the high-voltage capacitor C is not lower than the second high-voltage HV2; the resistive network includes a resistance R1, a resistance R2, a resistance R3 and a resistance R4; the pulse delay recovery time is determined by the time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C; a falling speed of the high-voltage pulse output is determined by time constants of the resistance R2, the resistance R3 and the high-voltage capacitor C; an output voltage power of the third high-voltage pulse HV3

is determined by a capacity of high-voltage capacitor C and a resistance value of the resistance R4; and DC is power supply.

[0031] Referring to FIG. 2, after turning on the power supply and starting to work, when I/P1 is low level and the high-voltage switch Q is not open, the third high-voltage pulse HV3 remains a stable voltage. When I/P1 changes from low level to high level, the high-voltage switch Q is open, a discharging circuit is open, the voltage of the third high-voltage pulse HV3 is fallen. When I/P1 changes from high level to low level, the high-voltage switch Q is close, the discharging circuit is close, a charging circuit is open, so that the voltage of the third high-voltage pulse HV3 is risen.

[0032] In particular, the recovery time $t = \ln \left(\frac{V_1 - V_0}{V_1 - V_T} \right) * R * C_0$;

discharging time $t = \ln \left(\frac{V_1}{V_T} \right) * R' * C_0$;

R is the series resistance of charging circuit, equal to R2+R3, R' is the series resistance of the discharging circuit, equal to R3+R1, C₀ is the high-voltage capacitor C, V₁ is the full charge voltage, V₀ is the initial voltage of the capacitor, and V_T is the voltage value on the resistance at time t.

[0033] In particular, the amplitude of the third high-voltage pulse HV3 is HV3=HV2-HV1.

[0034] I/P1 frequency decides the frequency of the third high-voltage pulse HV3, and rising and falling edges are decided by R2, R3, C and R3, C, R1.

[0035] Embodiment 1

When HV1=10Kv, HV2=50Kv, R1=100K, R2=100K, R3=20M, C=2000pf, then HV3=HV2-HV1=40Kv.

[0036] V0=15Kv, VT=39.6Kv, V1=40Kv

rising edge time is:

$$t = \ln \left(\frac{V_1 - V_0}{V_1 - V_T} \right) * R * C_0 = \ln \left(\frac{40 - 15}{40 - 39.6} \right) * (20.1 * 10^6) * 2000 * 10^{-9} = 0.166s.$$

[0037] Falling edge time is:

$$t = \ln \left(\frac{V_1}{V_T} \right) * R' * C_0 = \ln \left(\frac{40}{39.6} \right) * 20.1 * 10^6 * 2000 * 10^{-9} = 0.004s.$$

[0038] Embodiment 2

When HV1=5Kv, HV2=40Kv, R1=1K, R2=1K, R3=200K, C=2000pf, then HV3=HV2-HV1=35Kv.

[0039] $V_0=20Kv$, $V_T=34.6Kv$, $V_1=35Kv$

rising edge time is:

$$t = \ln \left(\frac{V_1 - V_0}{V_1 - V_T} \right) * R * C_0 = \ln \left(\frac{35 - 20}{35 - 34.6} \right) * (201 * 10^3) * 2000 * 10^{-9} = 0.0015s.$$

[0040] Falling edge time is:

$$t = \ln \left(\frac{V_1}{V_T} \right) * R' * C_0 = \ln \left(\frac{35}{34.6} \right) * 201 * 10^3 * 2000 * 10^{-9} = 0.00000404s.$$

[0041] Embodiment 3

When HV1=15Kv, HV2=40Kv, R1=10K, R2=10K, R3=200K, C=1000pf, then HV3=HV2-HV1=35Kv.

[0042] $V_0=20Kv$, $V_T=34.6Kv$, $V_1=35Kv$

rising edge time is:

$$t = \ln \left(\frac{V_1 - V_0}{V_1 - V_T} \right) * R * C_0 = \ln \left(\frac{35 - 20}{35 - 34.6} \right) * (210 * 10^3) * 2000 * 10^{-9} = 0.0007s.$$

[0043] Falling edge time is:

$$t = \ln \left(\frac{V_1}{V_T} \right) * R' * C_0 = \ln \left(\frac{35}{34.6} \right) * 210 * 10^3 * 2000 * 10^{-9} = 0.00000211s.$$

[0044] Referring to FIG.3, the self-recovery high-voltage pulse driver of the present application includes a high-speed level driving circuit, in which U1 is a gate driver, L1 and L2 are isolation transformers, U2 is a photocoupler, VCC is a power supply that shares ground with a high-voltage switch Q, VCC2 is an isolation power supply, which does not share ground with the high-voltage switch Q, VCC1 can choose a power supply that shares ground or not with the high-voltage switch Q, and I/P1 is a high-speed pulse input signal. When the input low-voltage is TTL or CMOS signal, output of the high-speed level driving circuit is high-speed level, and the high-voltage switch Q is open.

[0045] Embodiment 4

Referring to FIG.3, I/P1 is a high-speed pulse input signal, the gate driver U1 includes but is not limit to MC33151DR2G, the isolation transformers L1 and L2 include but are not limit to EE16 transformer single or a plurality of coils, the photocoupler includes but is not limit to HCPL2530, and the isolation power supplies VCC1 and VCC2 are isolation power supply modules, which include but are not limit to F0503S-2W. The connection methods of the high-voltage switch Q include but are not limited to single or series connection.

[0046] Embodiment 5

The gate driver U1 includes but is not limit to TF2190M-TAH, the isolation transformers L1 and L2 include but are not limit to EE25 transformer single or a plurality of coils, the photocoupler includes but is not limit to APV1122, and the isolation power supplies VCC1 and VCC2 are isolation power supply modules, which include but are not limit to RS1-03S05H. The connection methods of the high-voltage switch Q include but are not limited to single or series connection.

[0047] The above are the preferred embodiments of the present application, which are not intended to limit the protection scope of the present application. Therefore, all equivalent changes made according to the structure, shape and principle of the present application should be covered within the protection scope of the present application.

CLAIMS

1. A self-recovery high-voltage pulse driver, characterized by comprising: a high-speed pulse driving unit and a high-voltage pulse generation unit, wherein the high-speed pulse driving unit is provided with a high-voltage switch Q; the high-voltage pulse generation unit comprises a high-voltage capacitor C and a resistive network; the high-voltage capacitor C is connected to the high-voltage switch Q, a first high-voltage HV1, a second high-voltage HV2 and a third high-voltage pulse HV3 via the resistive network; the high-speed pulse driving unit is configured to generate the third high-voltage pulse HV3 from the first high-voltage HV1 and the second high-voltage HV2 via the high-voltage switch Q and the high-voltage capacitor C; and after the high-voltage pulse is output, the third high-voltage pulse HV3 automatically recovers to the second high-voltage HV2.

2. The self-recovery high-voltage pulse driver according to claim 1, characterized in that, when there is no driving input to the high-speed pulse driving unit, an output voltage of the third high-voltage pulse HV3 is equal to a voltage of the second high-voltage HV2; when a driving pulse is input to the high-speed pulse driving unit, the output voltage of the third high-voltage pulse HV3 is equal to a difference between the voltage of the second high-voltage HV2 and a voltage of the first high-voltage HV1, and after the driving pulse disappears, the output voltage of the third high-voltage pulse HV3 recovers to the voltage of the second high-voltage HV2.

3. The self-recovery high-voltage pulse driver according to claim 1, characterized in that, the resistive network comprises a resistance R1, a resistance R2, a resistance R3 and a resistance R4, wherein, a first end of the high-voltage capacitor C is connected to the high-voltage switch Q via the resistance R1, and connected to the first high-voltage HV1 via the resistance R2; and a second end of the high-voltage capacitor C is connected to the second high-voltage HV2 via the resistance R3, and connected to the third high-voltage pulse HV3 via the resistance R4.

4. The self-recovery high-voltage pulse driver according to claim 3, characterized in that, the resistance R1, the resistance R2, the resistance R3 and the resistance R4 are power resistances, a resistance value of the resistance R3 is greater than a resistance value of the resistance R2, and a resistance value of the resistance R2 is greater than a resistance value of the resistance R4 and/or the resistance R1.

5. The self-recovery high-voltage pulse driver according to claim 1, characterized in that, the high-speed pulse driving unit further comprises a high-speed level driving circuit U, wherein, an input end of the high-speed level driving circuit U is connected to an input low-voltage control signal, and an output end of the high-speed level driving circuit U is connected to gate-levels of the high-voltage switch Q, and the input low-voltage control signal is connected to the gate-levels of the high-voltage switch Q through the high-speed level driving circuit U.

6. The self-recovery high-voltage pulse driver according to claim 5, characterized in that, the high-speed level driving circuit U comprises isolation driving point circuits respectively for transformer coupling, isolation power supply coupling and optoelectronic isolation coupling, and the isolation driving point circuits respectively for transformer coupling, isolation power supply coupling and optoelectronic isolation coupling are in one-to-one correspondence with the gate-levels of the high-voltage switch Q.

7. The self-recovery high-voltage pulse driver according to claim 5, characterized in that, the input low-voltage control signal is a TTL or CMOS signal.

8. The self-recovery high-voltage pulse driver according to claim 1, characterized in that, the high-voltage switch Q is one of a high-voltage field-effect transistor, a high-voltage transistor and an insulated gate bipolar transistor, and a withstand voltage value of the high-voltage switch Q is not lower than the first high-voltage HV1.

9. The self-recovery high-voltage pulse driver according to any one of claims 5-8, characterized in that, the high-voltage switch Q is in a mode of single cascade or multiple cascades, and the withstand voltage value of the high-voltage switch Q in a mode of single cascade or

multiple cascades is not lower than the first high-voltage HV1.

10. The self-recovery high-voltage pulse driver according to claim 1, characterized in that, the withstand voltage value of the high-voltage capacitor C is not lower than the second high-voltage HV2.

11. The self-recovery high-voltage pulse driver according to claim 1, characterized in that, the first high-voltage HV1 and the second high-voltage HV2 are co-phase grounded high-voltage power sources.