$$J_2 = |u_{i\alpha_ref}(k+1) - u_{i\alpha}(k+1)| + |u_{i\beta_ref}(k+1) - u_{i\beta}(k+1)|;$$

$$J_3 = |U_{dc_ref} - U_{dc}(k+1)| + |i_{L_ref} - i_L(k+1)|;$$

$$J_4 = |U_{dc_ref} - U_{dc}(k+1)| + |i_{L_ref} - i_L(k+1)| + \lambda_2 |U_{c1}(k+1) - U_{c2}(k+1)|;$$

$u_{r\alpha}(k+1)$ is a projection of alternating current voltage $u_r(k+1)$ output by a T-type three-level rectifier on an α-axis at sampling time $k+1$, and $u_{r\alpha_ref}(k+1)$ is a projection of a reference value $u_{r_ref}(k+1)$ of the alternating current voltage output by the T-type three-level rectifier on the α-axis; $u_{r\beta}(k+1)$ is a projection of the alternating current voltage $u_r(k+1)$ output by the T-type three-level rectifier on a β-axis at the sampling time $k+1$, and $u_{r\beta_ref}(k+1)$ is a projection of the reference value $u_{r_ref}(k+1)$ of the alternating current voltage output by the T-type three-level rectifier on the β-axis at the sampling time $k+1$; $U_{c1}(k+1)$ and $U_{c2}(k+1)$ represent voltage values of direct current side capacitors C_1 and C_2 of the T-type three-level rectifier at the sampling time $k+1$ respectively, $u_{i\alpha}(k+1)$ is a projection of alternating current voltage $u_i(k+1)$ output by a T-type three-level inverter on the α-axis at the sampling time $k+1$, $u_{i\alpha_ref}(k+1)$ is a projection of a reference value $u_{i_ref}(k+1)$ of the alternating current voltage output by the T-type three-level inverter on the α-axis at the sampling time $k+1$, $u_{i\beta}(k+1)$ is a projection of alternating current voltage $u_i(k+1)$~~the reference value $u_{i_ref}(k+1)$ of the alternating current voltage~~ output by the T-type three-level inverter on the β-axis at the sampling time $k+1$, $u_{i\beta_ref}(k+1)$ is a projection of the reference value $u_{i_ref}(k+1)$ of the alternating current voltage output by the T-type three-level inverter on the β-axis, λ_1 is a control weight of the T-type three-level rectifier, and λ_2 is a control weight of a three-level three-phase direct current converter; i_{L_ref} is an inductance current value of the T-type three-level three-phase direct current converter; U_{dc_ref} is an instruction value of direct current side voltage of the T-type three-level rectifier, and $U_{dc}(k+1)$ is a value of direct current side capacitor voltage at the time $k+1$; and

selecting an output quantity of each switch tube when the optimization function is minimum (1 represents on of the switch tube, and 0 represents off of the switch tube), and controlling on-off of the switch tube of the T-type three-level rectifier, the switch tube of the T-type three-level inverter, and the switch tube of the three-level three-phase

Claims

1. An electrical state quantity prediction method for an uninterruptible power supply system, comprising:

a calculation formula for a predicted value $i_g(k+1)$ of alternating current output by a T-type three-level rectifier of the UPS system is:

$$i_{\mathrm{g}}(k+1)=(1-\frac{R_{\mathrm{s}}T_{\mathrm{s}}}{L_{\mathrm{s}}})i_{\mathrm{g}}(k)+\frac{T_{\mathrm{s}}}{L_{\mathrm{s}}}[u(k)-u_g(k)];$$

a calculation formula for a reference value $u_{\mathrm{r_ref}}(k)$ of alternating current voltage output by the T-type three-level rectifier of the UPS system is:

$$u_{\mathrm{r_ref}}(k)=\frac{L_{\mathrm{s}}}{T_{\mathrm{s}}}i_{\mathrm{rg_ref}}(k)+(R_{\mathrm{s}}-\frac{L_{\mathrm{s}}}{T_{\mathrm{s}}})i_{\mathrm{g}}(k)+u_{\mathrm{g}}(k);$$

a calculation formula for a reference value $u_{\mathrm{i_ref}}(k)$ of alternating current voltage output by a T-type three-level inverter of the UPS system is:

$$u_{\mathrm{i_ref}}(\mathrm{k})=u_{\mathrm{n}}(k);$$

a calculation formula for a predicted value $u(k+1)$ of alternating current voltage of the UPS system is:

$$u(k+1)=u(k)e^{j\omega T_s};$$

a calculation formula for a predicted value $U_{\mathrm{cn}}(k+1)$ of a voltage stabilization capacitor on a direct current side of the UPS system is:

$$U_{\mathrm{cn}}(k+1)=U_{\mathrm{cn}}(k)+\frac{T_s}{C_n}i_{\mathrm{Cn}}(k);$$

a calculation formula for a predicted value $i_{\mathrm{L}}(k+1)$ of inductance current of a three-level three-phase direct current converter of the UPS system is:

$$i_{\mathrm{L}}(k+1)=\frac{T_s}{L}[U_{\mathrm{ES}}-(T_1\,||\,T_3)U_{\mathrm{C1}}(k)-(T_2\,||\,T_4)U_{\mathrm{C2}}(k)]+i_{\mathrm{L}}(k);$$

wherein $u(k)$ is alternating current voltage output by the T-type three-level rectifier, L_{s} is a value of filter inductance output by the T-type three-level rectifier, T_{s} is sampling interval time, R_{S} is resistance of an output line of the UPS system, $i_{\mathrm{g}}(k)$ is grid side current at sampling time k, and $u_{\mathrm{g}}(k)$ is grid voltage at the sampling time k; $u_{\mathrm{r_ref}}(k)$ is instruction voltage output by an alternating current side of the T-type three-level

rectifier at the sampling time k, and $i_{rg_ref}(k)$ is an instruction value of grid side current at the sampling time k; $u_n(k)$ is a sampling value of rated load voltage at the sampling time k; ω is an angular frequency of a grid; $U_{cn}(k+1)$ is a voltage value of a direct current side capacitor C_n of the T-type three-level rectifier at sampling time $k+1$, $U_{cn}(k)$ is a voltage value of C_n at the sampling time k, and $i_{cn}(k)$ is a value of current flowing through C_n at the sampling time k; U_{ES} is voltage of an energy storage battery, L is an inductance value of the three-level three-phase direct current converter of the UPS system, T_1-T_4 are output states of a switch tube of the three-level three-phase direct current converter, and $i_L(k)$ is an inductance current value of the three-level bidirectional direct current converter at the time k; n=1, 2; and || represents a logical OR operation.

2. An electrical state quantity prediction system for an uninterruptible power supply system, comprising a processor and a memory, wherein the processor is used to execute a computer program stored in the memory; and the computer program is configured to execute the steps of the electrical state quantity prediction method according to claim 1.

3. A control method for an uninterruptible power supply system, comprising:

when the UPS system works in a UPS power supply mode, if a SOC of a battery≥ 0.8, constructing an optimization function $Q=J_1+J_2$;

when the UPS system works in the UPS power supply mode, if the SOC of the battery < 0.8, constructing an optimization function $Q=J_1+J_2+J_3$;

when the UPS system works in a battery power supply mode, or when the UPS system works in a battery feed mode, if the SOC of the battery > 0.2, constructing an optimization function $Q=J_2+J_4$;

wherein,

$$J_1=|u_{r\alpha_ref}(k+1)-u_{r\alpha}(k+1)|+|u_{r\beta_ref}(k+1)-u_{r\beta}(k+1)|+\lambda_1|U_{c1}(k+1)-U_{c2}(k+1)|;$$

$$J_2=|u_{i\alpha_ref}(k+1)-u_{i\alpha}(k+1)|+|u_{i\beta_ref}(k+1)-u_{i\beta}(k+1)|;$$

$$J_3=|U_{dc_ref}-U_{dc}(k+1)|+|i_{L_ref}-i_L(k+1)|;$$

$$J_4=|U_{dc_ref}-U_{dc}(k+1)|+|i_{L_ref}-i_L(k+1)|+\lambda_2|U_{c1}(k+1)-U_{c2}(k+1)|;$$

$u_{r\alpha}(k+1)$ is a projection of alternating current voltage $u_r(k+1)$ output by a T-type

three-level rectifier on an α-axis at sampling time k+1, and $u_{r\alpha_ref}(k+1)$ is a projection of a reference value $u_{r_ref}(k+1)$ of the alternating current voltage output by the T-type three-level rectifier on the α-axis; $u_{r\beta}(k+1)$ is a projection of the alternating current voltage $u_r(k+1)$ output by the T-type three-level rectifier on a β-axis at the sampling time k+1, and $u_{r\beta_ref}(k+1)$ is a projection of the reference value $u_{r_ref}(k+1)$ of the alternating current voltage output by the T-type three-level rectifier on the β-axis; $U_{c1}(k+1)$ and $U_{c2}(k+1)$ represent voltage values of direct current side capacitors C_1 and C_2 of the T-type three-level rectifier at the sampling time k+1 respectively, $u_{i\alpha}(k+1)$ is a projection of alternating current voltage $u_i(k+1)$ output by a T-type three-level inverter on the α-axis at the sampling time k+1, $u_{i\alpha_ref}(k+1)$ is a projection of a reference value $u_{i_ref}(k+1)$ of the alternating current voltage output by the T-type three-level inverter on the α-axis at the sampling time k+1, $u_{i\beta}(k+1)$ is a projection of alternating current voltage $u_i(k+1)$~~the reference value $u_{i_ref}(k+1)$ of the alternating current voltage~~ output by the T-type three-level inverter on the β-axis at the sampling time k+1, $u_{i\beta_ref}(k+1)$ is a projection of the reference value $u_{i_ref}(k+1)$ of the alternating current voltage output by the T-type three-level inverter on the β-axis, λ_1 is a control weight of the T-type three-level rectifier, and λ_2 is a control weight of a three-level three-phase direct current converter; i_{L_ref} is an inductance current value of the T-type three-level three-phase direct current converter; U_{dc_ref} is an instruction value of direct current side voltage of the T-type three-level rectifier, and $U_{dc}(k+1)$ is a value of direct current side capacitor voltage at the time k+1; and

selecting an output quantity of each switch tube when the optimization function is minimum, wherein the output quantity 1 represents on of the switch tube, and the output quantity 0 represents off of the switch tube; and controlling on-off of the switch tube of the T-type three-level rectifier, the switch tube of the T-type three-level inverter, and the switch tube of the three-level three-phase direct current converter according to the output quantity of the corresponding switch tube;

wherein $u_{r_ref}(k+1)$ and $u_{i_ref}(k+1)$ are calculated by the electrical state quantity prediction method according to claim 1, or calculated by using the electrical state quantity prediction system according to claim 2.

4. The control method for an uninterruptible power supply system, wherein $\lambda_1+\lambda_2=1$.

5. A control system for an uninterruptible power supply system, comprising a processor and a memory, wherein the processor is used to execute a computer program stored in the memory; and the computer program is configured to execute the steps of the control method according to claim 3 or 4.