Terminal Potential Stabilizers

For the precise regulation of the high voltage terminal of single ended or tandem particle accelerators, NEC manufactures three models of Terminal Potential Stabilizer (TPS) systems. These systems use two simultaneous control elements, together with two feedback systems, to maintain a consistent terminal voltage.

Operation

Depending on the mode of operation, the TPS accepts signals from either a Generating Voltmeter (GVM) or energy analysis slits, and then sends the signals to a vacuum triode. The vacuum triode controls the resistance to ground of a set of corona needles that face the high voltage terminal. As the signal varies, resistance to ground varies. This resistance variance controls the rate of charge transferred from the terminal to the corona needles. In turn, the voltage of the terminal is precisely controlled if adequate charging current is provided.

The TPS also incorporates a signal from Capacitive Pickoff (CPO) plates. The CPO ripple signal is combined with either the GVM or Slit control error signal to form a composite proportional (V) plus derivative (dV/dT) corona probe control signal allowing higher closed loop gains and better regulation.

Modes

The TPS has three standard operating modes. These include GVM mode, SLIT mode, and AUTO mode. The feedback from CPO plates is incorporated in all three modes.

GVM Mode

In GVM mode, the TPS system accepts signals from a Generating Voltmeter. The GVM signal is amplified and rectified by the GVM amplifier located near the GVM at the pressure vessel. This signal is conditioned to drive the signal through the cables to the TPS. Within the TPS chassis, the signal, which also drives a front panel display showing terminal potential, is compared with the desired terminal voltage (TV) to form the error signal (GVM - TV). GVM - TV is then combined with the CPO signal, conditioned to establish proper gain and phase margins, and is subsequently applied to the grid of the vacuum triode.

SLIT Mode

In SLIT mode each of the two energy analyzed slit current signals are logarithmically amplified, sent to the TPS chassis, and combined to form Log (HE) - Log (LE). The subtraction of logarithms, forming a slit error signal, is dependent on relative transverse beam displacement but independent of beam current. This difference in signal is proportional to the ratio of the currents rather than the total current intercepted by the slits. The slit error signal is combined with the CPO signal, conditioned to establish proper gain and phase margins, and then applied to the vacuum triode.

AUTO Mode

AUTO mode is the internal selection of either GVM or SLIT mode. SLIT mode is selected if the terminal voltage is within 50 kV of the desired terminal reference voltage, and if there is a minimum current on one slit. If these conditions are not met, then GVM mode is selected.

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LINER Mode

This mode is only an available option on the TPS-7.0. LINER mode allows for fast terminal ripple correction and can be switched on for normal operation or may be turned off for comparison. Liner control uses the CPO signal as a corrective input and is active for both GVM and SLIT control modes.

Options

Housings are available in four sizes depending on the number of signal processing boards to be included. The smallest housing (size 1) contains the unit power supply and space for one signal processing board. A size 2 housing also contains the unit power supply with space for two signal processing boards. A size 3 housing contains the unit power supply with space for four signal processing boards. The largest size (size 4) has space available for eight signal processing boards. The power supply is contained in a separate size 4 housing.

In addition to the capabilities of the TPS-6.0 the TPS-7.0 also incorporates the use of a capacitively driven liner control system for AC terminal voltage stabilization. The bandwidth of the corona probe control system is limited by column parameters to about 1 Hz. To correct for terminal ripple at higher frequencies, a cylindrical shell is installed close to the tank wall facing the terminal. The liner is driven using a ±10 kV high voltage amplifier whose input signal is derived from the CPO signal. The liner can typically change the terminal voltage by up to 25% of the amplifier voltage for frequencies up to 100 Hz. In the TPS-7.0 control system, both the corona probe and the liner regulate terminal voltage at the same time. To allow for optimum performance, several internal user settable parameters are included to adjust the gains of the feedback elements and the bandwidths of the control elements.

All three models have a dynamic corona current control range of 0-200 μA. However, an option is available to increase this range to 500 μA, which is useful when the beam current injected exceeds 100 μA. Please contact NEC for more information regarding this option.

Additional Features

All of the TPS models are capable of manually controlling and monitoring the position of a motor-positioned corona probe assembly using an analog position command.

The TPS is capable of preventing the accelerator terminal from reaching a set overvoltage condition. All three models are also able to detect an undervoltage condition in a similar fashion, which is useful when operating an unattended accelerator for long periods.

Accessories

NEC TPS systems integrate with GVMs, energy control slits, and CPOs. These components and related amplifiers are also available from NEC upon request.

Terminal Potential Stabilizer (front view)

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Summary

	Model 5.5	Model 6.0	Model 7.0
GVM, SLIT, AUTO modes	X	X	X
CPO feedback for fast error correction and improved DC error	X	X	X
Overvoltage / undervoltage protection *Only overvoltage protection	X*	X	X
Probe current linearly proportioned to error signal	X	X	X
Remote probe position control	X	X	
Slit log amps for nA to 100 µA	X	X	X
Front panel displays of terminal potential, slit currents, grid voltage, probe current / position	X	X	X
Analog output available for data logging	X		
Stability ±0.01% *With liner correction on Pelletron systems : ±0.02% stability	X	X	X*
Local or remote control of terminal potential, probe current, probe position, mode, overvoltage and all control system tuning parameters		X	X
Remote corona probe position control via analog position command		X	X
LINER signal			X
CPO output monitor signals available for scope display	X	X	X

Contact NEC

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