FAST PULSE SOURCE FOR FIELD EMISSION APPLICATIONS

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ABSTRACT

Field emission cathodes are used in various applications, e.g. vacuum gauges and X-ray sources. The issue by driving them with direct current is the quick degradation of the emission current depending on the local pressure, due to the ion bombardment [1]. Baptist et. al. showed in their work that pulsed operation allows the cathode to work at higher local pressures or leads to an increased lifetime at low pressures [2]. In order to pulse the electron source with short rising and falling edges an electrical circuit with a floating node was developed (Fig. 1).

The system is designed that a minimum of external devices are necessary. The logical side needs a DC power supply (5V) and a reference voltage (0 to 5V). On the load side a high voltage supply (up to 1kV) can be connected. This voltage is limited by the output-stage MOSFETs. Finally, the circuit provides one contact for the electron source, which should be pulsed.

The logical power input is supplied by a DC power source (VLOGIC) which drives the two-channel logic-inverter (INV), the primary side of the gate-driver (GDRIVE) and also the two DCDC-converters (DCDC_HIGH, DCDC_LOW). The INV takes care of the incoming reference voltage (VREF) and solves the issue of synchronized input signals at the GDRIVE inputs (INA, INB). The INV speeds up the incoming VREF signal down to 9ns (10%-90%). The GDRIVE uses the levels at INA and INB to switch the output-channels OUTA and OUTB, which are powered by the two DCDC-converters. That supply voltages (12.5V) are connected to the corresponding output-channel power-pins (VDDA, VSSA, VDDB, VSSB). These leads to edge times (10%-90%) of 13ns at the LS gate (Fig. 2). Furthermore, DCDC_HIGH and DCDC_LOW preventing the feedback of the switching signals to the logic side. The output-stage is realized by two n-type MOSFETs (HS, LS), which driving the floating node (FN). Due to the connection of VSSA to FN, which leads to a floating of the entire HS channel, we could use the same FETs as switching elements. These lead to uniform switching speeds. In addition, the trim-resistor (RADJUST) allows the adjustment of the rise and fall times of the cathode voltage.

Detailed signal characteristics and field emission measurements of pulsed silicon electron sources will be presented on the conference.

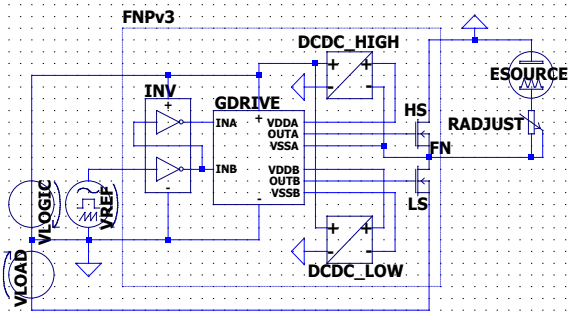

Figure 1. Simplified circuit diagram of the floating node system for an electron source, which should be pulsed, with all power sources and logical parts.

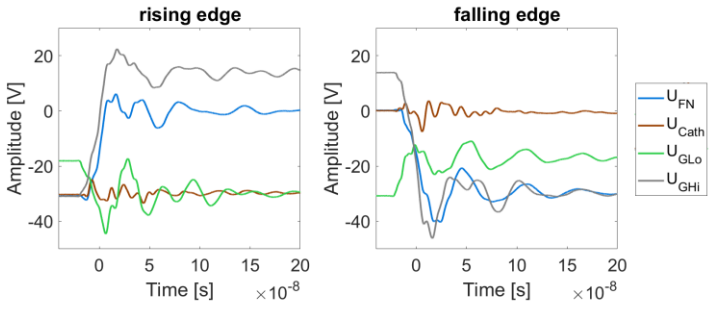

Figure 2. Signals for the rising (left) and falling (right) edge of the time-domain signal characteristics for the voltages of the floating node (U_{FN}), cathode (U_{Cath}) and for the gates of low- and high side driver (U_{GLo}, U_{GHi}).

References

[1] W. I. Karain, L. V. Knight, David. D. Allred, and A. Reyes-Mena, Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films, vol. 12, no. 4, pp. 2581–2585

[2] R. Baptist, Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures, vol. 14, no. 3, p. 2119