High Current Banks With Rail Spark Gaps

Specifications of ¼ modules

- Rail spark gap
- Four capacitors, each 2.85 μF 60 kV
- Two capacitors are connected in parallel to form an assembly
- Two assemblies are connected in series, see Figure 1
- Dual polarity DC power supply is needed
- Charging voltage varies from 20 to 50 kV
- Maximum stored energy in the system is 14 kJ
- For short-circuited condition 1/4 period is 0.7 μs
- For short-circuited condition, maximum current is .6 MA
- 10 V pulse is required to trigger the system
- 200-300 kV Mini-Marx generator activates the rail spark gap

Applications

- Study of plasma focus, Z and Θ-pinches, and imploding liners.
- Research in RF/HPM generation.

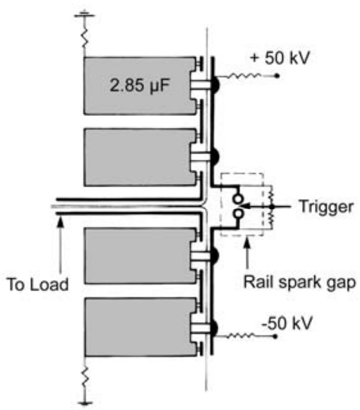

Figure 1. Schematic of ¼ module

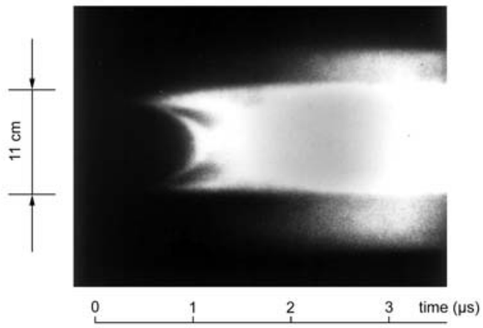

Figure 2. Streak record of the imploding liner placed in Θ geometry using ¼ module.

Figure 3. Photograph of ¼ module in action. 250 kV pulse from the Mini-Marx generator triggers the ¼ module

Figure 4. Photograph of module obtained by connecting four ¼ modules in parallel

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Experimental conditions

- ¼ module is charged to ± 35 kV producing 70 kV pulse.
- Stored energy in the ¼ module is 6.9 kJ.
- MCG-like structure is used as the load of the ¼ module.
- When the MCG like structure is short-circuited, the current waveform shown in Fig. 6, trace A is obtained.
- When the MCG like structure is present, the current waveform given in Fig. 6, trace B is obtained.
- 3 GHz bandwidth oscilloscope is used to record the data.
- B dot probe is employed as the current dot probe. It consists of 4 turns tightly wound helix of 1 mm in diameter. The helix is then attached to a miniature (solid) coaxial line of 50 Ω.
- Probe is able to record the frequency from 70 MHz to 3 GHz as it is indicated in Fig. 6. This figure is the FFT of the current dot waveform given in Fig. 8, trace B
- E field probe is used to measure the RF and HPM radiations. The probe is placed 80 cm away from the MCG-like structure.

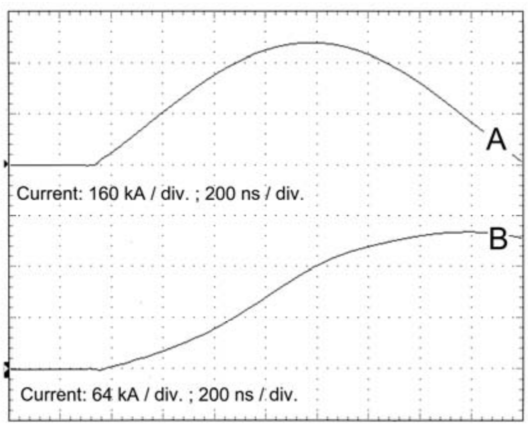

Figure 5. Current waveforms: A is the current when the load is short-circuited and B is the trace when the load is present.

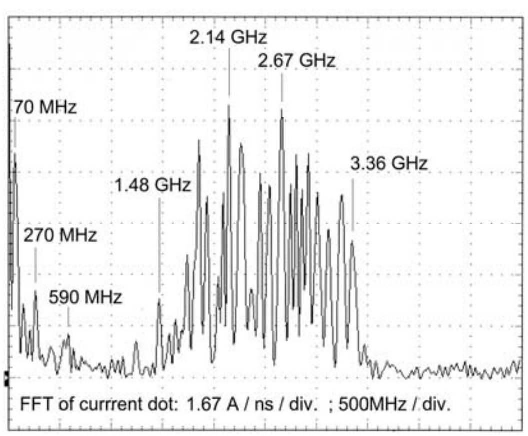

Figure 6. This figure indicates the frequency response of the current dot probe.

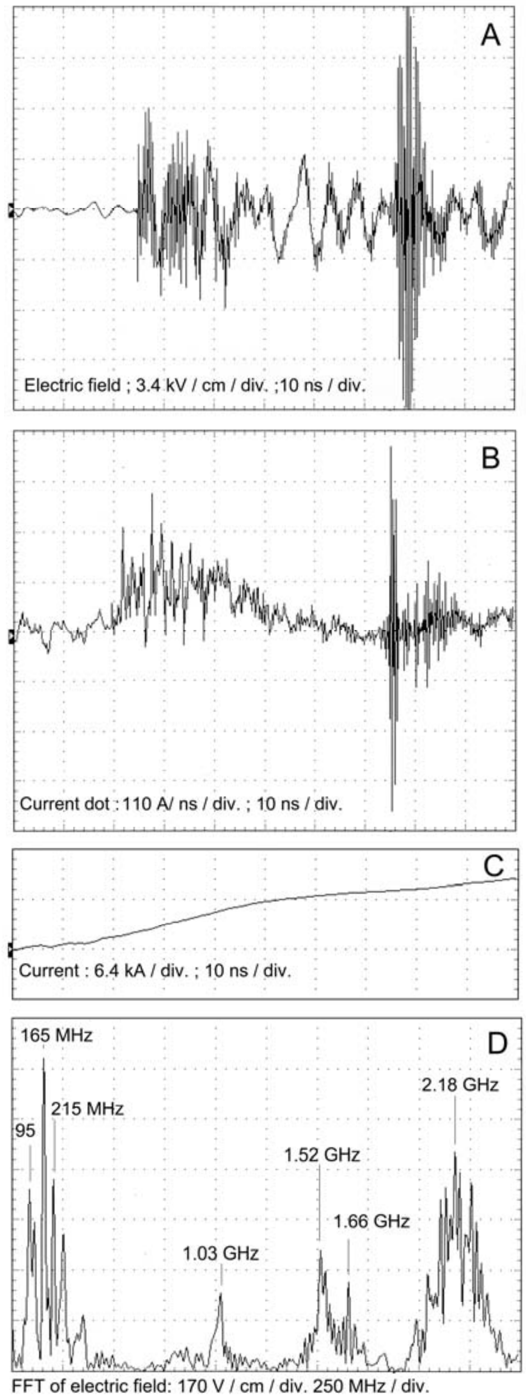

Figure 7. Experimental data obtained with 10 ns / div. time scale. A is the electric field, B the current dot, and C is the current obtained by integrating the trace C. D is the FFT of trace A.

Commencing at 12.5 ns in trace A the RF/HPM emissions are due to the joint action of the rail spark gap and the Mini-Marx generator. The main HPM signal in trace A corresponds to the action of the MCG-like structure

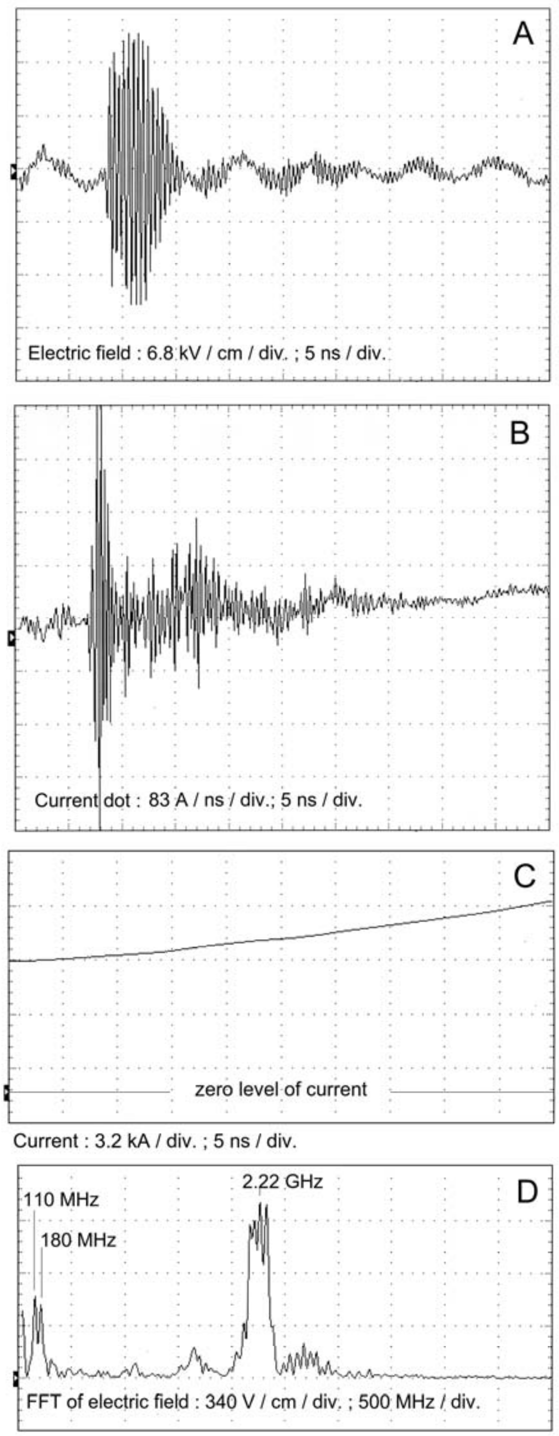

Figure 8. Conditions as in Fig. 7, except that the data are observed with 5 ns /div. time scale. Oscilloscope is set to record the main HPM pulse shown also in Fig. 7.

The oscilloscope used is of the limited bandwidth, the current measurement, (trace C) is only tentative. If 20 GHz oscilloscope would have been used, it is possible; that HPM emission recorded around 2 GHz (trace D) will have also high frequency components.

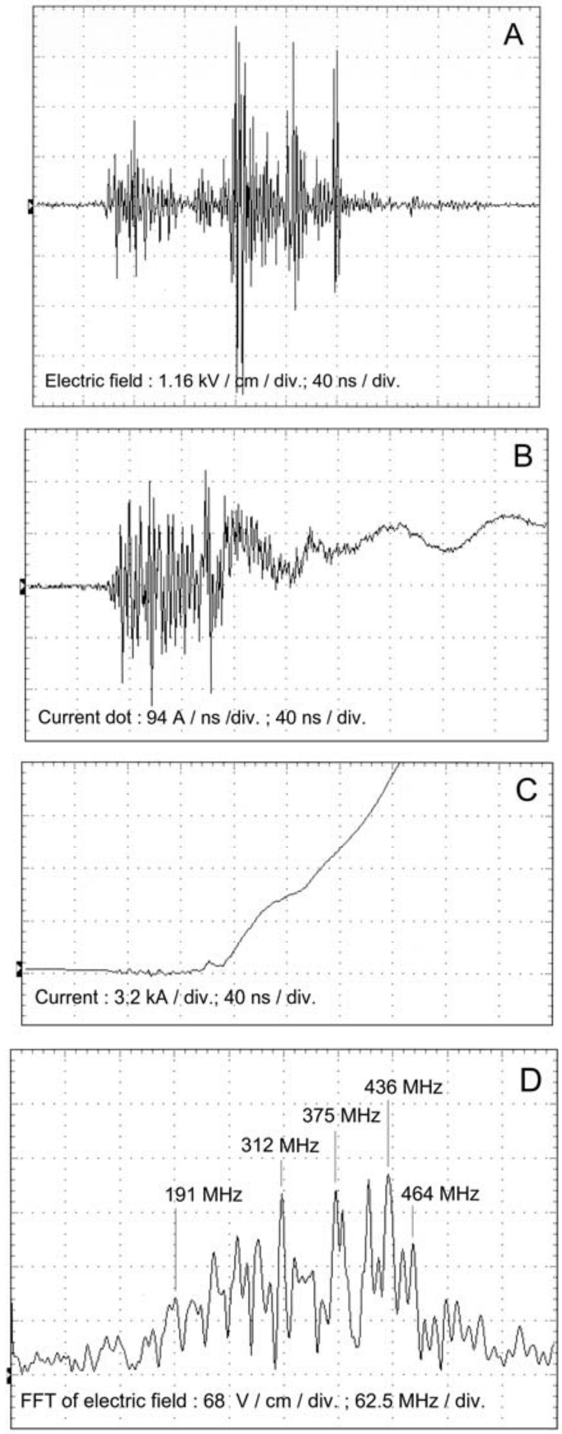

Figure 9. Conditions as in Fig. 7, except that the data are observed with slow 40 ns /div. time scale.

Three HPM pulses are shown in trace A. Because of the slow time scale, trace B fails to observe the three current dot peaks that corresponds to the three HPM peaks. In trace D the frequencies are mainly due to the action of both, the Mini-Marx generator and the rail spark gap.