VII-8 A MULTIKILOWATT X BAND NANOSECOND SOURCE

H. Goldie

Westinghouse

We have recently investigated several possible methods of generating nanosecond pulses of relatively large amplitude. By employing a 25-kilowatt magnetron X-band pulser, a four-port circulator, and two thyratron waveguide switches, we have generated a 19-kilowatt ouput pulse (see figure 1) the half-power pulsewidth of which is 10 nanoseconds. The risetimes and falltimes are 2 and 4 nanoseconds, respectively. The width at −10, −13, −20, and −23 dB down from the peak value is 12.5, 15, 20, and 22 nanoseconds, respectively.

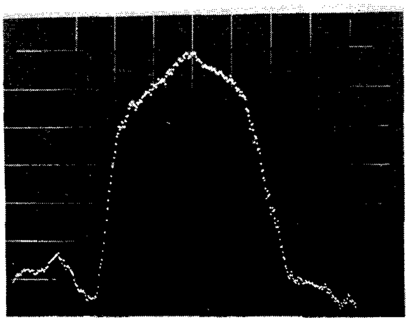
Increasing the peak power level to 50 kW resulted in a narrower pulse (~7 nanoseconds) with a risetime of 1.5 nanoseconds. Though the experiment was limited by the maximum power output of the laboratory magnetron, theory indicates even shorter pulses with steeper skirts at higher power levels (~1/4 megawatt in X-band).

The principle of operation is based on the time lag inherent in initiating an RF-induced avalanche-type gas breakdown. This time lag is the sum of the statistical plus formative time periods. The statistical lag can be eliminated by creating a plasma with a selected density and whose onset time is coincident with the RF wavefront. Then, for constant RF power, the breakdown time is a function only of the formative time lag, and the pulse edge rate-of-rise is dependent only on the characteristics of the gas; i.e., the type of atom or molecule and its density.

No tuned circuits are used; hence, the bandwidth is limited only by the frequency sensitivity of the circulator.

Pulse-shaping experiments using the voltage-controlled mode of switch actuation at 50 kilowatts and 9 gigahertz have resulted in transorming a 2.2-μsec magnetron generated pulse into an output pulse whose width could instantaneously be varied from 30 to 2000 nanoseconds. The risetime and falltime of the pulse are 12 to 14 nanoseconds; jitter was less than 2.0 nanoseconds. The output pulse was approximately 42 kW; it is also possible to assign a certain width to each individual high power pulse. Alternate antenna pulse switching was also demonstrated in which, from a train of 50-kW pulses, certain individual pulses were directed from the main antenna to an auxiliary antenna.

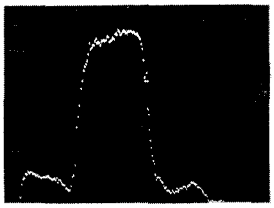
The circuitry to effect trigger delays are simple to achieve sincethe actuating pulses for the switches are low energy trigger pulses of 80-volt amplitude. The peak power limitations were not investigated; however, the short pulse mode of operation is limited only by external waveguide breakdown, whereas, the variable pulsewidth and antenna-switching modes are limited by internal switch self-breakdown (~200 kW, depending on RF duty cycles).



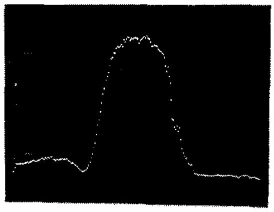
6557A-PF-1

1A. 10 Nanosecond - 19 Kilowatt Output Pulse
Vertical Scale = 3 Kilowatts/cm
Time Scale = 2.5 Nanoseconds/cm
HP185 Sampling Oscilloscope With
Delay Line. Internally Synchronized

The risetime and falltime are 2 and 4 nanoseconds. The width at -10, -13, -20, and -23 dB down from the peak value is 12.5, 15, 20, and 22 nanoseconds, respectively.



1B. 10-nanosecond, 70-kilowatt X-band pulse
Time scale = 4 nanoseconds/CM
Risetime = 1-1/2 nanoseconds, falltime = 2 nanoseconds.



1C. 6-nanosecond, 45-kilowatt X-band pulse
Time scale = 2 nanoseconds/CM
Risetime = 1 nanosecond, falltime = 2 nanoseconds.

Oscillograms taken with HP 185 sampling oscilloscope with delay line. Synch pulse derived from detected envelope of magnetron output pulse before shaping.