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B—1—5 Integrated GaAs E-FET/Tunnel Diode Inverter and Memory Cell

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The passive resistor and constant current transistor loads used in state-of-the-art GaAs inverter circuits[1] do not simultaneously satisfy the conflicting requirements of short turn-on time and of low steady state power dissipation when the inverter is turned off. Both requirements can be satisfied by using a tunnel diode load. The tunnel diode provides a high resistance during the inverter's low level output, and a low resistance during the transition to its high level output. Moreover, the transistor-tunnel diode combination can also function as a memory element by suitable choice of the transistor gate voltage such that the transistor characteristic intersects the tunnel diode load line at two stable operating points. The normally off enhancement mode gallium arsenide field effect transistor and the gallium arsenide tunnel diode can be operated at supply voltages less than 1 volt without need for level shifting. The tunnel diode integrated with the n^+-drain region of the transistor provides an extremely compact integrated high speed device structure.

An analysis of transistor response to large signal switching and of the turn-on and turn-off times of the integrated transistor/tunnel diode circuit will be presented. It will be shown that the tunnel diode speed (peak current to capacitance ratio) is the key parameter which governs the circuit response.

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1. "Gallium Arsenide Spawns Speed" by R. Van Tuyl and C. Liechti, IEEE Spectrum, March (1977), pp. 41-47.