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# Investigation of Inversion, Accumulation and Junctionless mode Bulk Germanium FinFETs

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**Abstract**—The characteristic performance of n-type and p-type inversion (IM) mode, accumulation (AC) mode and junctionless (JL) mode, bulk Germanium FinFET device with 3-nm gate length ( $L_G$ ) are demonstrated by using 3-D quantum transport device simulation. The simulated bulk Ge FinFET device exhibits favorable short channel characteristics, including drain-induced barrier lowering ( $DIBL < 10 \text{ mV/V}$ ), sub threshold slope ( $SS \sim 64 \text{ mV/dec.}$ ). Electron density distributions in ON-state and OFF-state also show that the simulated devices have large  $I_{ON}/I_{OFF}$  ratios. Homogenous source/drain doping is maintained and only the channel doping is varied among different operating modes. Also, a constant threshold voltage  $|V_{TH}| \sim 0.31 \text{ V}$  is maintained. Moreover, the calculated quantum capacitance ( $C_Q$ ) values of the Ge nanowire emphasizes the importance of quantum confinement effects (QCE) on the performance of the ultra-scaled devices.

**Keywords**— Germanium, junctionless, FinFETs, 3D TCAD simulation, quantum confinement effects.

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