

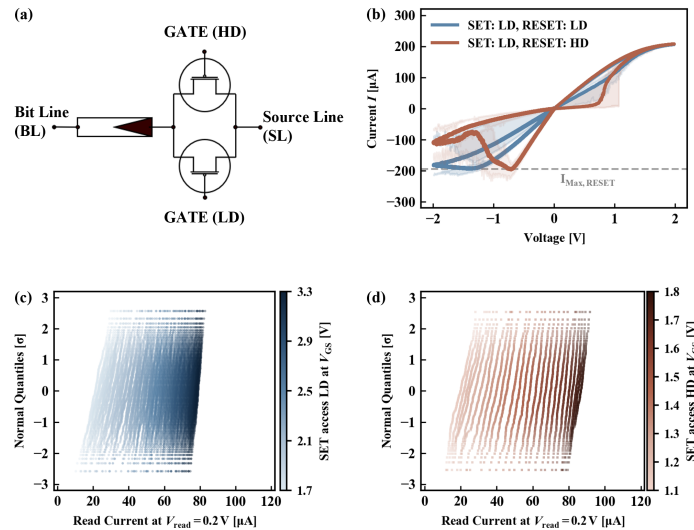
# 2T1R RRAM with Complementary Transistor Sizing for Coarse-to-Fine Conductance Tuning

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Valence change mechanism (VCM) [1] based resistive random-access memory (RRAM) is a promising candidate for in-memory computing due to its multi-state conductance tunability. In 1T1R configurations, the access transistor acts as effective current compliance and critically determines the programming capability. Previous studies have shown that in 1T1R structures, the voltage drop across the access transistor during RESET may leave insufficient voltage across the RRAM cell to achieve a full RESET into the high resistive state (HRS) [2]. In this work, we investigate the impact of transistor dimensions on RRAM programmability using a 2T1R structure integrating a low-drive (LD,  $W/L = 2$ ) and a high-drive (HD,  $W/L = 10$ ) transistor connected parallel to each other and in series with a single RRAM cell, as illustrated in Fig. 1 (a).

We demonstrate that while the LD transistor enables successful SET operation, it fails to provide sufficient current for RESET, as shown in Fig. 1 (b). By leveraging the HD transistor for RESET, reliable switching is achieved. The experimental observations are further supported by simulations using the JART VCM Rth compact model [3], which accurately reproduces the transistor-size-dependent switching behavior. Furthermore, using the incremental gate voltage verify algorithm (IGVVA) [4] for pulse programming (Fig. 1 (c),(d)), we show that the HD transistor enables coarse conductance tuning, whereas the LD transistor enables fine conductance tuning. This complementary behavior is exploited in the 2T1R architecture to achieve hierarchical weight programming, offering a promising strategy for accurate and efficient synaptic weight updates in neuromorphic and in-memory computing applications.



**Figure 1:** (a) Schematic of the 2T1R structure with a low-drive (LD,  $W/L = 2$ ) and a high-drive (HD,  $W/L = 10$ ) transistor. (b) I–V curves: LD-only RESET (blue) fails; HD-assisted RESET (red) succeeds. (c) Read current distribution after incremental pulse programming via LD transistor. (d) Read current distribution via HD transistor.

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[3] S. Son et al., IEEE Access, 13, 127280–127291, 2025.

[4] V. Milo et al., IEEE IRPS, 1–6, 2021.