Supplement Information

Ultralow-crosstalk, microsecond-response resonant SAW multidimensional force sensor for robotic arm integration

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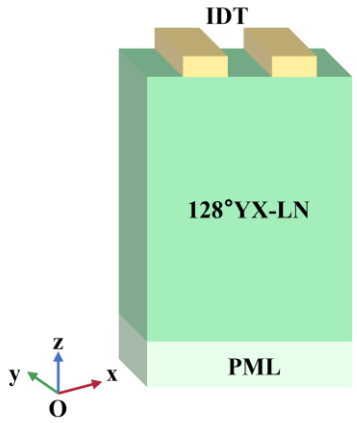

Figure S1 Simulating periodic units

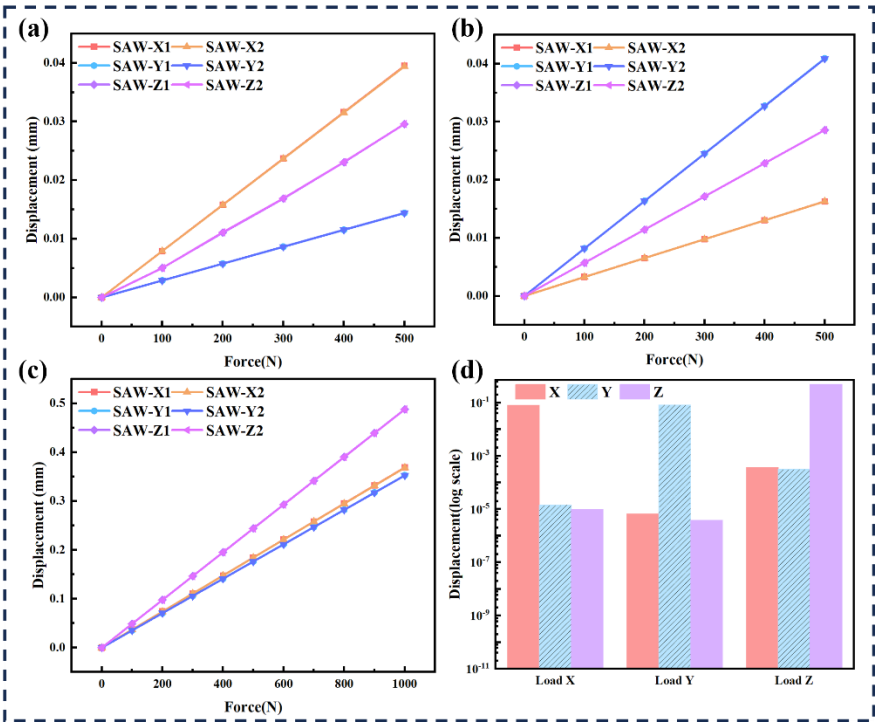

Figure S2 FEM-derived stress distributions for each SAW device under X/Y/Z loading (a)X (b) Y (c) Z (d) the displacement magnitudes across X, Y, and Z directions after differential/average processing (logarithmic scale)

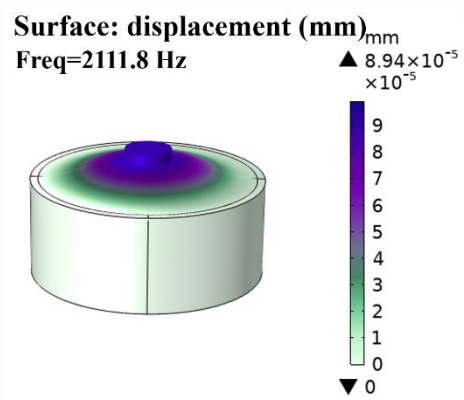

Figure S3 The first-order natural frequency

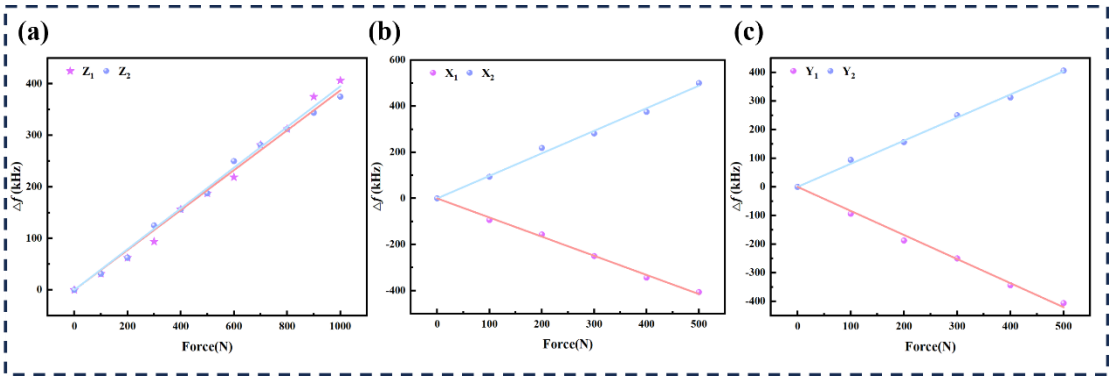

Figure S4 Output frequency change curve (a) Z-axis (b) X-axis (c) Y-axis

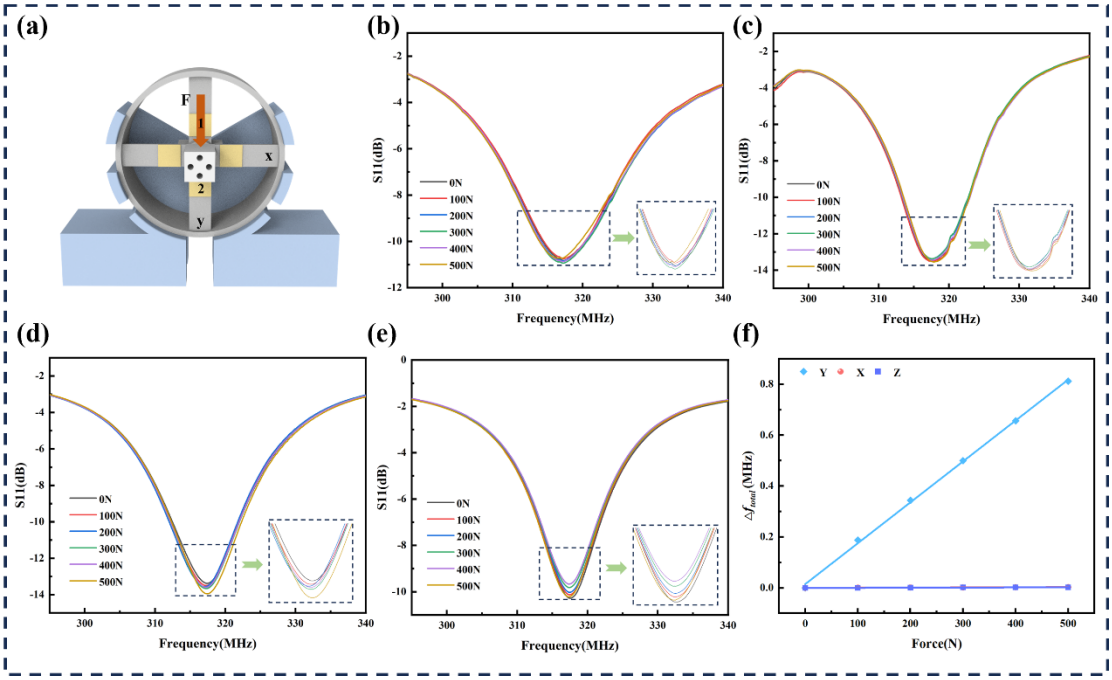

Figure S5 Performance of the SAWMFS (a) Sensor orientation for Y-axis loading; S_{11} curves at different forces (b) Y_1 (c) Y_2 (d) X_1 (e) Z_1 (f) Output frequency change fitting curve

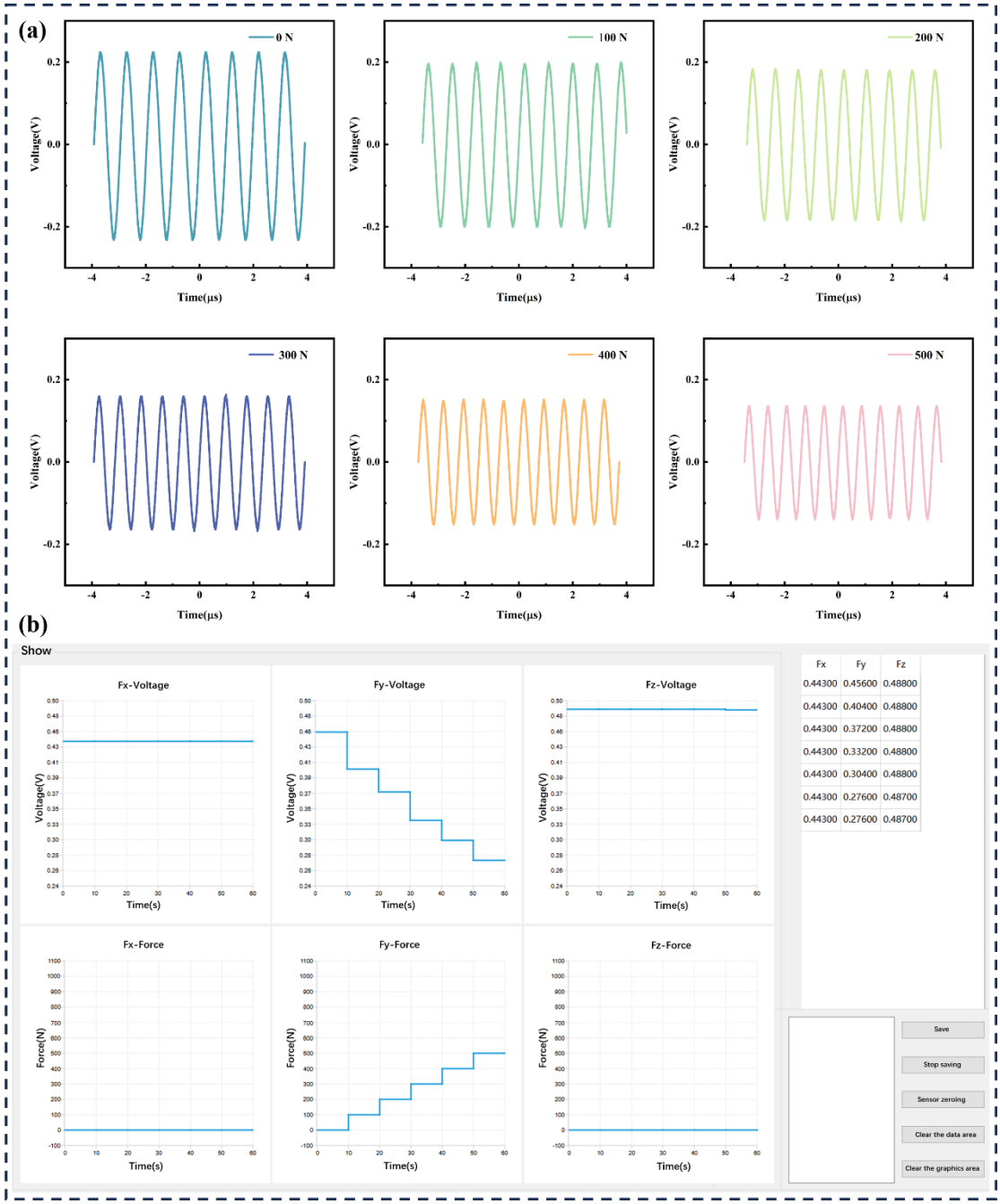

Figure S6 Performance of the SAWMFS (a) SAW-Y_2 voltage waveform e (b) Interface display

Fy

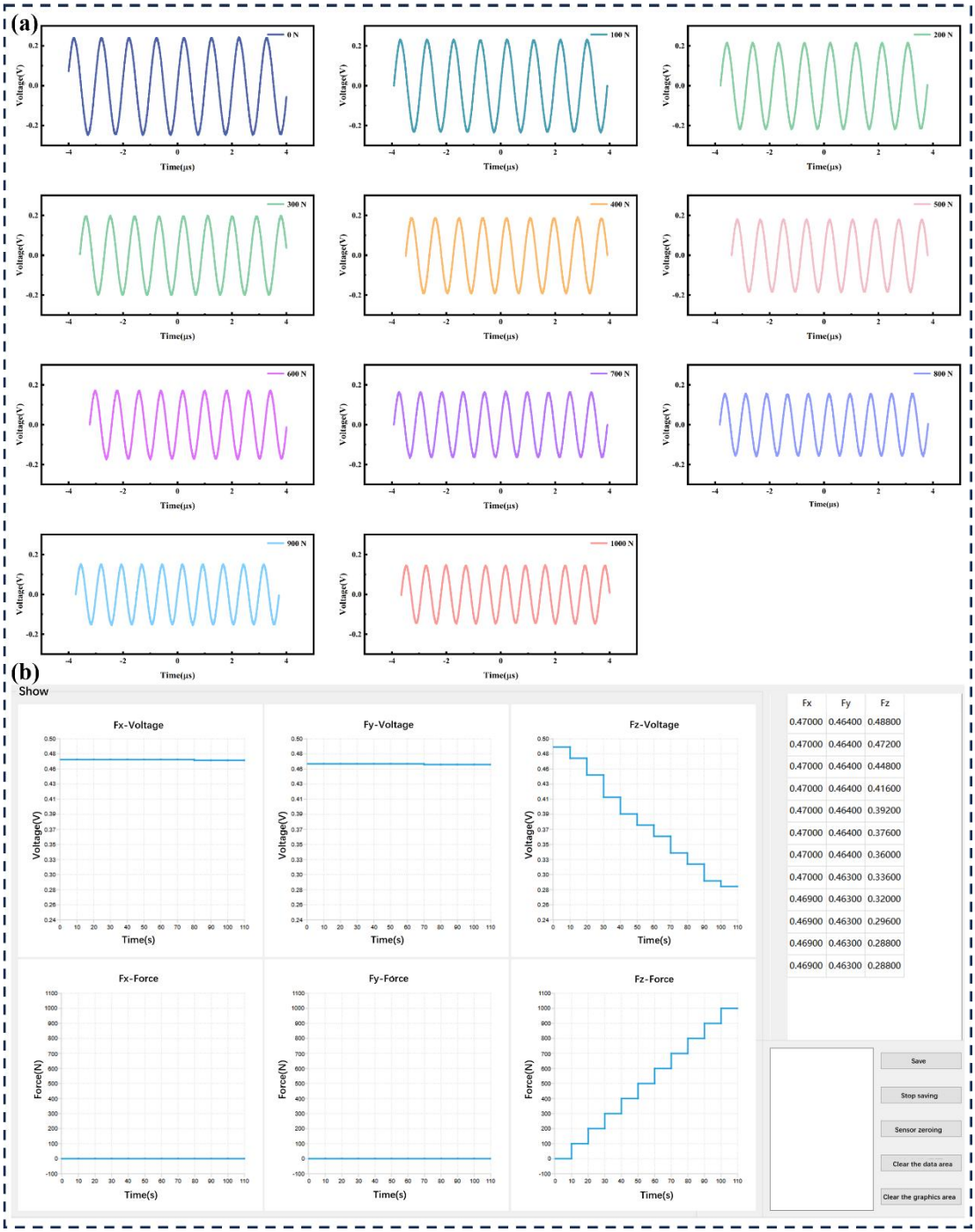

Figure S7 Performance of the SAWMFS (a) SAW-Z_2 voltage waveform e (b) Interface display Fz

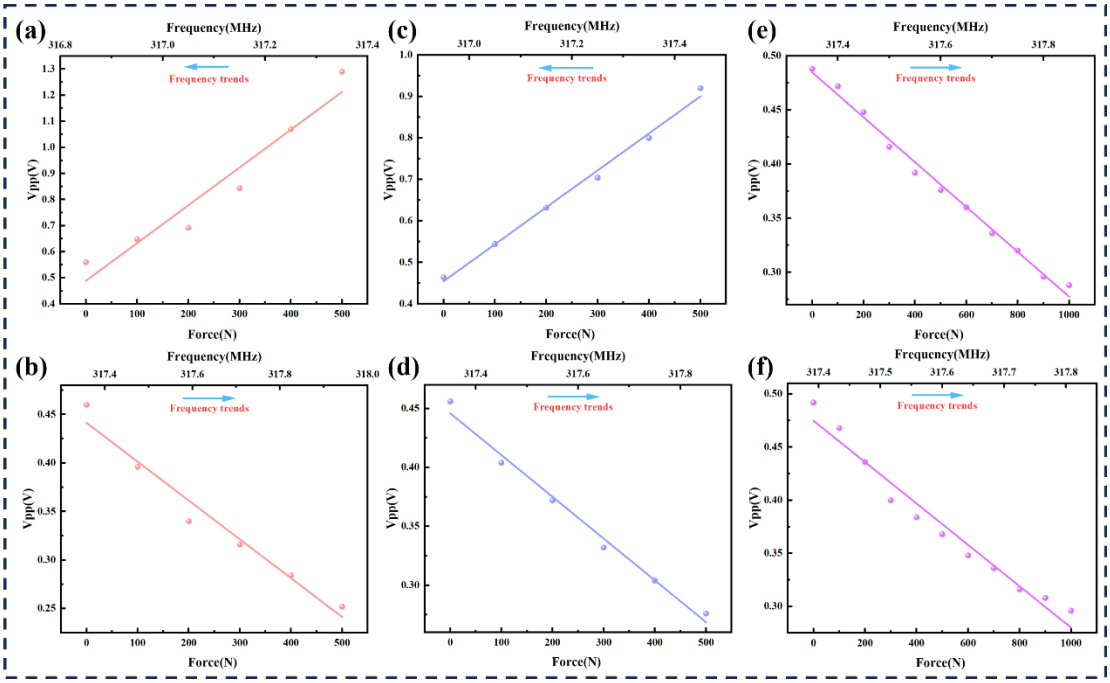

Figure S8 V_{pp}–pressure/frequency fitting curve (a) SAW-X_1 (b) SAW-X_2 (c) SAW-Y_1 (d) SAW-Y_2 (e) SAW-Z_1 (f) SAW-Z_2