# Supplementary Data for

## Effect of an ultrathin Fe interlayer on the growth of MnGa and spin-orbit-torque induced magnetization switching

### §1 Experimental conditions of current-induced magnetization switching for a MnGa(2)/Fe(0.6) bilayer and a MnGa(2) single layer

After the magnetization direction was aligned by applying an out-of-plane magnetic field of $\mu_0 H_z$ = –0.5 T or 0.5 T, a current pulse $I_P$ with a duration of 100 μs was applied to the channel (+$x$ direction) while varying the amplitude from –10 mA to 10 mA. For deterministic switching, an in-plane magnetic field $\mu_0 H_x = \pm 10$ mT was applied along the $x$-axis. $R_{yx}$ was measured with a sensing current $I$ of 100 μA after application of each $I_P$.

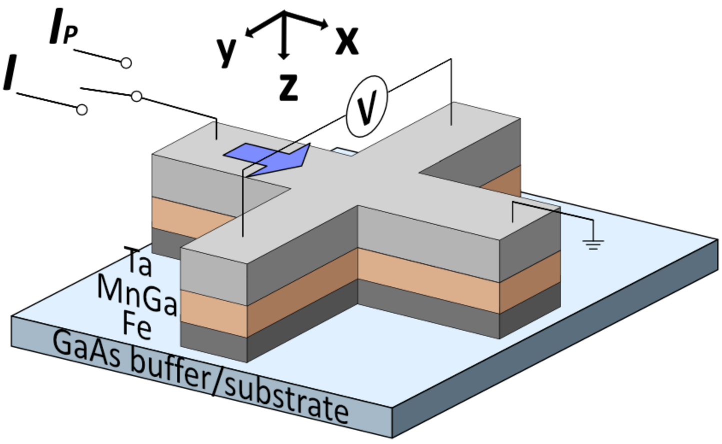


Fig. S1.Measurement configuration for SOT-induced switching.

### §2 Measurement of effective magnetic field originating SOT acting on the magnetization of domain walls

Since the coercive field is much smaller than $H_k$ in both MnGa/Fe bilayer and MnGa single layer [see Figs. 3(a), (b)], the DWs were introduced during the magnetization reversal. Following the method proposed by C. Pai et al. [31], we measured the modulation of coercive field by the Slonczewski-like SOT assisted DW motion. The effective magnetic field originating from the Slonczewski-like SOT is given by $H_{\mathrm{eff}}\, \mathbf{m} \times \mathbf{y}$, where **m** is the unit vector along the magnetization, and **y** is the unit vector along the y-axis. Thus, when the $x$-component of magnetization is induced in the DWs by the application of $H_x$, an effective magnetic field along z-axis is exerted on magnetization in the DWs, and it induces a shift in the out-of-plane hysteresis loop by an amount $H_{\mathrm{eff}}$. The measurements were carried out in a cryostat kept at 250 K to reduce effects of Joule heating arising from the applied DC current.

**§3 Effect of Rashba and Dresselhaus spin orbit interactions at Fe/GaAs interface on SOT efficiency**

Chen et al. observed a sizable spin-orbit field (SOF) originated from Rashba and Dresselhaus spin orbit interactions at the epitaxial Fe/GaAs interface [33]. The magnitude of SOF is maximized (minimized) when the current direction is along [110] ([1-10]). If such SOF is produced in the Fe/GaAs interface, the SOT-induced effective field should have certain current direction dependence. Figure S2 shows $\mu_0 H_{\mathrm{eff}}$ as a function of $\mu_0 H_{\mathrm{x}}$ for a MnGa/Fe bilayer. The black squares (red triangles) in the figure indicate $\mu_0 H_{\mathrm{eff}}$ when the current and $H_{\mathrm{x}}$ directions are along [110] ([1-10]). No significant difference was observed, indicating that we have no direct evidence for the presence of such SOFs in our devices.

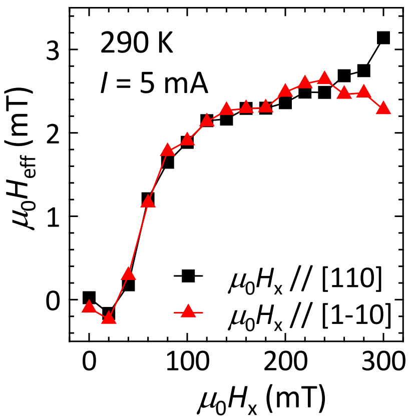


Fig. S2. $\mu_0 H_{\mathrm{eff}}$ at $I$ = 5 mA as a function of $\mu_0 H_x$ for a MnGa/Fe bilayer with different current direction.