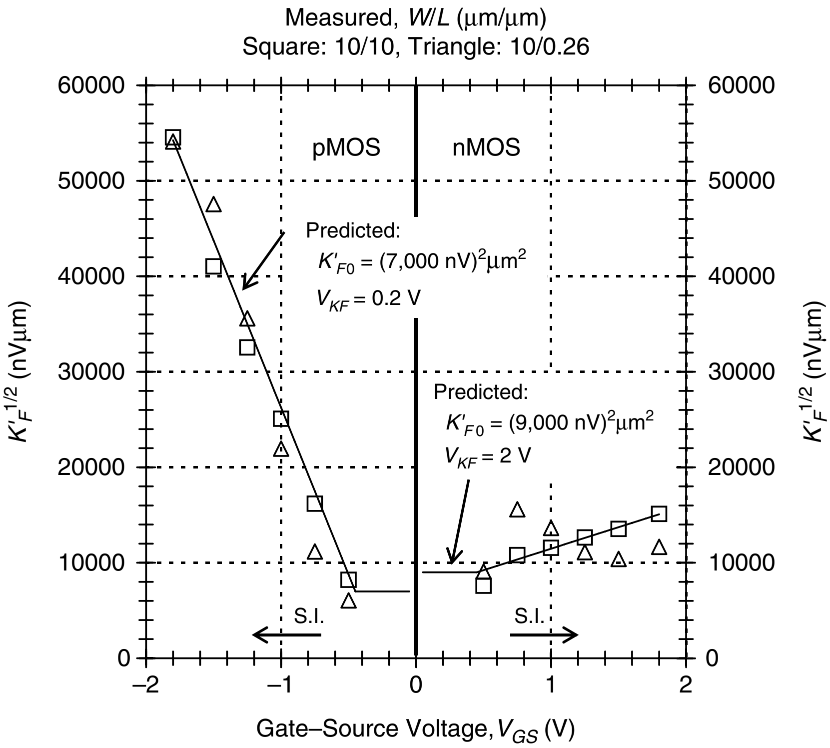

Figure 3.64 Measured and predicted flicker noise for a 0.18 μm CMOS process from data in [76] with noise presented as the square root of the hand calculation, flicker-noise factor, $K_F'^{1/2}$. Gate-referred flicker-noise voltage density, $S_{VG}^{1/2}$, in units of $\mathrm{nV/Hz^{1/2}}$, is found by multiplying the data shown by $1/(WLf^{AF})^{1/2}$, where W and L are MOS width and length in μm, f is the frequency in Hz, and AF is the flicker-noise PSD slope. nMOS devices show modest flicker-noise increase with inversion level, while pMOS devices show significant increase. Flicker noise is comparable for nMOS and pMOS devices for operation below the onset of strong inversion

significant inversion-level ($V_{EFF} = V_{GS} - V_T$) dependency for pMOS devices and only a slight or modest dependency for nMOS devices. For pMOS devices, $K_F'^{1/2}$ increases from 7000 to 56000 nV · μm as V_{GS} ranges from near or below 0.5 V to the process maximum of 1.8 V. This corresponds to a gate-referred flicker-noise voltage density, $S_{VG}^{1/2}$, at 1 Hz for a gate area of 1 μm^2 that increases from 7000 to 56000 $\mathrm{nV/Hz^{1/2}}$, a factor-of-eight increase in noise density or factor-of-64 increase in noise PSD. For nMOS devices, $K_F'^{1/2}$ increases from 9000 to 14000 nV · μm, which corresponds to a 56 % increase in noise density or 142 % increase in noise PSD. The noise increases are modestly different than values reported for [76] in Table 3.33 because the noise is fitted across different channel lengths.

As observed in Figure 3.64, $K_F'^{1/2}$ and the associated gate-referred flicker-noise voltage density increase linearly with V_{GS} or $V_{EFF} = V_{GS} - V_T$ for operation in moderate and strong inversion. This corresponds to an increase in K_F' and the associated noise PSD with $(V_{EFF} = V_{GS} - V_T)^2$ as predicted by the unified or carrier density, correlated mobility fluctuation model described in Section 3.10.3.3. This model was used for the development of Equation 3.123 (summarized in Table 3.31) used for the $K_F'^{1/2}$ prediction shown in the figure. In contrast, the Hooge, carrier mobility fluctuation model described in Section 3.10.3.2 predicts a noise PSD increase linearly with $V_{EFF} = V_{GS} - V_T$, while the McWhorter, carrier density fluctuation model described in Section 3.10.3.1 predicts constant noise PSD in its original form having a fixed value of K_F'. The significant increase in flicker noise for pMOS devices is well predicted using $V_{KF} = 0.2$ V, while the modest flicker-noise increase for nMOS devices is well predicted using a factor-of-10 higher value of $V_{KF} = 2$ V.

While Figure 3.64 shows a significant increase in gate-referred flicker-noise for pMOS devices, the increase is much less if operation is constrained between weak inversion and the onset of strong