$$\log P(y|s_k) =$$
$$\frac{-1}{2(1-\rho^2)}\left\{\frac{\left(\Re(y)-\mu_{k,\text{real}}\right)^2}{\sigma_{k,\text{real}}^2}+\frac{\left(\Im(y)-\mu_{k,\text{imag}}\right)^2}{\sigma_{k,\text{imag}}^2}\right.$$
$$-2\rho_k\left(\frac{\Re(y)-\mu_{k,\text{real}}}{\sigma_{k,\text{real}}}\right)\left(\frac{\Im(y)-\mu_{k,\text{imag}}}{\sigma_{k,\text{imag}}}\right)$$
$$\left.-\log\left(2\pi\sqrt{1-\rho^2}\sigma_{k,\text{real}}\sigma_{k,\text{imag}}\right)\right\}$$