

*Proof.* If  $U = e^{ia}S(b)R(c)S(d)$ , choosing the matrices

$$\begin{aligned} C &= S(b)R(c/2), & B &= R(-c/2)S(-(d+b)/2), \\ A &= S((d-b)/2), & E &= \text{diag}(1, e^{ia}), \end{aligned}$$

yields the desired result. Indeed, we have  $CBA = \mathbf{1}$ . Therefore, the circuit on the right hand side yields on input of  $|00\rangle$  and  $|01\rangle$  the same result as  $\Lambda_{0;1}(U)$ . Using  $X^2 = \mathbf{1}$ , we obtain for  $CXBXA$  the expression

$$CXBXA = \underbrace{S(b)R(c/2)}_C X \underbrace{R(-c/2)XXS(-(d+b)/2)}_B X \underbrace{S((d-b)/2)}_A,$$