

# Supplementary materials

## Mining logical circuits in fungi

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4-input-1-output logical functions discovered in experiments with mycelium bound composites.

$$\begin{aligned} &(\overline{AD}) + (\overline{CB}) + (\overline{DA}) + (\overline{AB}) + (\overline{BDC}) \\ &(\overline{AD}) + (\overline{DA}) + (\overline{BDC}) \\ &(\overline{ADC}) + (\overline{BD\overline{A}}) + (\overline{AC\overline{BD}}) \\ &(\overline{BD}) + (\overline{ABC}) + (\overline{AC\overline{B}}) \\ &(\overline{AD}) + (\overline{BD\overline{A}}) \\ &(\overline{BC}) + (\overline{BD}) + (\overline{CD}) + (\overline{AD}) + (\overline{DA}) \\ &(\overline{ABC}) + (\overline{ACD\overline{B}}) \\ &(\overline{AD\overline{B}}) + (\overline{D\overline{BC}}) + (\overline{BCD\overline{A}}) + (\overline{AB\overline{CD}}) \\ &(\overline{B\overline{D}}) + (\overline{D\overline{A}}) + (\overline{AC\overline{D}}) \\ &A + B + \overline{D} \\ &(\overline{BC}) + (\overline{BD}) + (\overline{ACD}) + (\overline{AC\overline{D}}) \\ &(\overline{AD}) + (\overline{CD\overline{A}}) \\ &(\overline{AD\overline{B}}) + (\overline{AC\overline{D}}) + (\overline{D\overline{BC}}) + (\overline{BCD\overline{A}}) \\ &(\overline{BC\overline{A}}) + (\overline{ABD\overline{C}}) + (\overline{ACD\overline{B}}) + (\overline{AB\overline{CD}}) \\ &\overline{ADC} \\ &(\overline{BC}) + (\overline{CD}) + (\overline{AD}) + (\overline{D\overline{A}}) \\ &\overline{C} + (\overline{AB}) + (\overline{B\overline{A}}) + (\overline{D\overline{A}}) \\ &(\overline{ABC}) + (\overline{AD\overline{B}}) + (\overline{BD\overline{A}}) + (\overline{CD\overline{A}}) \\ &(\overline{ABC}) + (\overline{AC\overline{D}}) \\ &(\overline{ABC\overline{D}}) + (\overline{BCD\overline{A}}) + (\overline{AB\overline{CD}}) \\ &(\overline{AC\overline{B}}) + (\overline{BD\overline{A}}) + (\overline{A\overline{BD}}) \\ &(\overline{B\overline{A}}) + (\overline{C\overline{A}}) + (\overline{D\overline{B}}) + (\overline{BC\overline{D}}) + (\overline{A\overline{BC}}) \\ &(\overline{ABD}) + (\overline{ACD}) \\ &(\overline{ABC}) + (\overline{AC\overline{B}}) + (\overline{BC\overline{D}}) + (\overline{BD\overline{C}}) + (\overline{CD\overline{B}}) \end{aligned}$$

$$\begin{aligned}
& ABD\overline{C} \\
& (\overline{AB}) + (\overline{BA}) + (\overline{DA}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{BCD}) + (\overline{BDA}) + (\overline{BDC}) + (\overline{DAC}) + \\
& (\overline{ABC}) + (\overline{BCD}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACB}) + (\overline{ACD}) + (\overline{ADB}) + (\overline{ADC}) + (\overline{BDA}) + (\overline{BDC}) + \\
& (\overline{CDA}) + (\overline{CDB}) \\
& (\overline{ABD}) + (\overline{ACD}) + (\overline{ACDB}) \\
& (\overline{BA}) + (\overline{CA}) + (\overline{DA}) + (\overline{BCD}) + (\overline{CDB}) \\
& (\overline{DA}) + (\overline{DB}) + (\overline{DC}) + (\overline{ABC}) + (\overline{ABD}) + (\overline{ACB}) + (\overline{ACD}) + (\overline{BCA}) + (\overline{BCD}) \\
& (\overline{BA}) + (\overline{BC}) + (\overline{BD}) + (\overline{ACD}) + (\overline{CAD}) + (\overline{DAC}) + (\overline{ACDB}) \\
& (\overline{ABCD}) + (\overline{DABC}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{DB}) + (\overline{DC}) \\
& (\overline{DA}) + (\overline{DC}) + (\overline{BCA}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{DBC}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{BCD}) + (\overline{BDC}) + (\overline{CDB}) + \\
& (\overline{ABC}) + (\overline{BCD}) \\
& (\overline{ABD}) + (\overline{ACB}) + (\overline{CDA}) + (\overline{DAB}) \\
& (\overline{AD}) + (\overline{BCA}) + (\overline{DABC}) \\
& (\overline{BCA}) + (\overline{BDC}) + (\overline{ACDB}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{CB}) + (\overline{DA}) + (\overline{DC}) \\
& (\overline{ADC}) + (\overline{BDA}) + (\overline{CDA}) \\
& (\overline{AC}) + (\overline{BCD}) + (\overline{BDA}) + (\overline{CDB}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{DA}) \\
& (\overline{AB}) + (\overline{CA}) + (\overline{DC}) \\
& (\overline{DA}) + (\overline{DB}) + (\overline{ABC}) + (\overline{BCA}) \\
& (\overline{ABD}) + (\overline{ACD}) \\
& (\overline{ABCD}) + (\overline{ACDB}) + (\overline{BCDA}) \\
& (\overline{BC}) + (\overline{AD}) + (\overline{DA}) + (\overline{DB}) \\
& (\overline{ACB}) + (\overline{BCA}) + (\overline{BDC}) + (\overline{ACD}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{BCDA}) \\
& (\overline{AD}) + (\overline{BCD}) + (\overline{DAB}) + (\overline{DAC}) \\
& \overline{A} + \overline{B} + (\overline{CD}) + (\overline{DC}) \\
& (\overline{BAC}) + (\overline{BAD}) + (\overline{BCD}) \\
& (\overline{ACD}) + (\overline{ACDB}) + (\overline{BCAD}) \\
& (\overline{ABC}) + (\overline{ACDB}) + (\overline{BCAD}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{ADB}) + (\overline{BCA}) + (\overline{ABCD}) \\
& (\overline{BA}) + (\overline{CAD}) + (\overline{ACDB}) \\
& (\overline{ACD}) + (\overline{ACDB})
\end{aligned}$$

$$\begin{aligned}
& (ABC\overline{C}) + (ACD\overline{B}) + (BCD\overline{A}) \\
& (AD\overline{C}) + (BD\overline{A}) \\
& \overline{A} + \overline{D} + (\overline{B}\overline{C}) + (\overline{C}\overline{B}) \\
& (D\overline{A}) + (D\overline{B}) + (D\overline{C}) + (A\overline{C}\overline{B}) + (A\overline{C}\overline{D}) + (B\overline{C}\overline{A}) + (B\overline{C}\overline{D}) \\
& (A\overline{D}) + (D\overline{A}) + (B\overline{C}\overline{A}) + (B\overline{D}\overline{C}) + (C\overline{D}\overline{B}) \\
& \overline{C} + (B\overline{D}) + (A\overline{B}) + (B\overline{A}) \\
& (B\overline{C}) + (B\overline{D}) + (C\overline{D}) + (D\overline{A}) + (A\overline{C}\overline{D}) \\
& (A\overline{D}) + (D\overline{A}) + (D\overline{C}) \\
& (A\overline{D}) + (B\overline{C}) + (C\overline{A}) + (C\overline{B}) + (D\overline{A}) \\
& (A\overline{C}) + (D\overline{C}) + (A\overline{D}\overline{B}) + (B\overline{C}\overline{D}) \\
& B + \overline{A} + \overline{D} \\
& (A\overline{C}\overline{D}) + (B\overline{D}\overline{A}) \\
& \overline{A} + \overline{B} + \overline{D} \\
& (A\overline{D}) + (B\overline{A}) + (B\overline{C}) + (C\overline{D}\overline{B}) \\
& (D\overline{A}) + (D\overline{B}) + (A\overline{B}\overline{C}) \\
& (A\overline{D}) + (B\overline{A}) + (B\overline{C}) + (B\overline{D}) + (D\overline{A}) + (\overline{A}\overline{C}) + (\overline{C}\overline{D}) + (A\overline{C}\overline{B}) + (C\overline{D}\overline{B}) \\
& (D\overline{A}) + (D\overline{C}) + (A\overline{C}\overline{B}) + (B\overline{C}\overline{A}) \\
& (A\overline{C}\overline{D}\overline{B}) + (A\overline{B}\overline{C}\overline{D}) \\
& (A\overline{B}\overline{D}\overline{C}) + (A\overline{B}\overline{C}\overline{D}) + (D\overline{A}\overline{B}\overline{C}) \\
& (A\overline{D}) + (D\overline{A}) + (D\overline{B}) + (D\overline{C}) + (\overline{B}\overline{C}) \\
& (A\overline{B}) + (A\overline{C}) + (B\overline{C}\overline{A}) + (B\overline{D}\overline{A}) + (\overline{B}\overline{C}\overline{D}) \\
& (A\overline{B}\overline{D}) + (A\overline{C}\overline{D}) \\
& (A\overline{B}) + (A\overline{C}) + (A\overline{D}) + (B\overline{C}\overline{A}) + (B\overline{C}\overline{D}) + (B\overline{D}\overline{A}) + (B\overline{D}\overline{C}) + (C\overline{D}\overline{A}) + \\
& (C\overline{D}\overline{B}) + (\overline{B}\overline{C}\overline{D}) \\
& (B\overline{D}) + (A\overline{B}\overline{C}) + (B\overline{C}\overline{A}) + (A\overline{C}\overline{D}) + (A\overline{C}\overline{D}\overline{B}) \\
& (B\overline{C}\overline{D}) + (B\overline{C}\overline{D}) + (A\overline{C}\overline{B}\overline{D}) + (A\overline{D}\overline{B}\overline{C}) \\
& (B\overline{C}\overline{A}) + (B\overline{D}\overline{C}) + (A\overline{C}\overline{D}\overline{B}) + (A\overline{B}\overline{C}\overline{D}) \\
& (A\overline{D}) + (B\overline{A}) + (B\overline{D}) + (C\overline{A}) + (C\overline{D}) + (D\overline{A}) + (A\overline{B}\overline{C}) + (D\overline{B}\overline{C}) \\
& (A\overline{B}) + (A\overline{D}\overline{C}) + (B\overline{C}\overline{A}) + (\overline{B}\overline{C}\overline{D}) \\
& (A\overline{D}) + (A\overline{C}\overline{B}) + (B\overline{C}\overline{A}) + (B\overline{D}\overline{A}) \\
& (A\overline{C}\overline{B}) + (A\overline{C}\overline{D}) + (A\overline{B}\overline{D}) + (B\overline{C}\overline{D}\overline{A}) \\
& (B\overline{D}) + (C\overline{D}) + (D\overline{A}) + (D\overline{B}\overline{C}) \\
& (B\overline{C}) + (B\overline{D}) + (C\overline{B}) + (C\overline{D}) + (D\overline{A}) + (D\overline{B}) + (D\overline{C}) \\
& (A\overline{B}) + (A\overline{D}) + (B\overline{A}) + (B\overline{D}) + (C\overline{A}) + (D\overline{A}) + (D\overline{B}) \\
& (A\overline{D}) + (A\overline{B}\overline{C}) + (A\overline{C}\overline{B}) + (B\overline{C}\overline{A}) + (\overline{B}\overline{C}\overline{D}) \\
& A + B + D + \overline{C} \\
& (A\overline{C}\overline{B}) + (B\overline{C}\overline{D}\overline{A}) \\
& (A\overline{B}\overline{C}) + (A\overline{C}\overline{B}) + (A\overline{B}\overline{D})
\end{aligned}$$

$$\begin{aligned}
& (AB) + (CD\overline{B}) + (A\overline{C}\overline{D}) + (D\overline{A}\overline{C}) \\
& (\overline{A}\overline{D}) + (BC\overline{A}) + (BD\overline{A}) + (CD\overline{B}) \\
& (AB\overline{D}) + (AC\overline{B}) + (BCD\overline{A}) \\
& (BC\overline{A}) + (CD\overline{A}) + (AB\overline{D}) + (A\overline{C}\overline{D}) \\
& (B\overline{D}) + (AB\overline{C}) + (BC\overline{A}) + (A\overline{C}\overline{D}) + (ACD\overline{B}) + (D\overline{A}\overline{B}\overline{C}) \\
& \overline{D} + (\overline{A}\overline{B}) + (\overline{A}\overline{C}) + (\overline{B}\overline{A}) + (\overline{B}\overline{C}) + (\overline{C}\overline{A}) + (\overline{C}\overline{B}) \\
& (AC\overline{B}) + (AD\overline{C}) + (BCD\overline{A}) \\
& (AB\overline{C}) + (AB\overline{D}) + (BC\overline{A}) + (BC\overline{D}) + (BD\overline{A}) + (BD\overline{C}) + (CD\overline{B}) \\
& (A\overline{C}\overline{D}) + (BCD\overline{A}) \\
& (AD\overline{B}) + (BCD\overline{A}) \\
& (AB\overline{C}) + (A\overline{C}\overline{D}) + (BC\overline{A}\overline{D}) \\
& (\overline{B}\overline{A}\overline{C}) + (\overline{C}\overline{B}\overline{D}) + (D\overline{A}\overline{B}) \\
& (\overline{A}\overline{D}) + (\overline{D}\overline{A}) + (BC\overline{A}) + (CD\overline{B}) + (\overline{A}\overline{B}\overline{C}) \\
& (\overline{A}\overline{D}) + (\overline{D}\overline{A}) + (\overline{D}\overline{C}) + (\overline{B}\overline{C}) + (BC\overline{A}) \\
& (\overline{B}\overline{A}) + (\overline{B}\overline{D}) + (\overline{A}\overline{B}\overline{C}) + (\overline{C}\overline{A}\overline{D}) + (\overline{D}\overline{B}\overline{C}) \\
& (AB\overline{C}) + (AB\overline{D}) + (A\overline{C}\overline{D}) + (ACD\overline{B}) + (BCD\overline{A}) \\
& (\overline{C}\overline{D}) + (\overline{D}\overline{B}) + (\overline{D}\overline{C}) + (AB\overline{C}) \\
& (\overline{C}\overline{B}) + (\overline{D}\overline{A}) + (\overline{B}\overline{D}) + (AB\overline{C}) \\
& (AC\overline{B}) + (A\overline{C}\overline{D}) + (BCD\overline{A}) \\
& (B\overline{D}) + (\overline{C}\overline{A}) + (\overline{C}\overline{B}) + (\overline{C}\overline{D}) + (\overline{A}\overline{D}) + (AB\overline{C}) + (AD\overline{B}) + (AD\overline{C}) \\
& (AC\overline{B}) + (A\overline{C}\overline{D}) + (BC\overline{A}\overline{D}) \\
& (ABD\overline{C}) + (ACD\overline{B}) + (\overline{A}\overline{B}\overline{C}\overline{D}) + (D\overline{A}\overline{B}\overline{C}) \\
& (\overline{A}\overline{D}) + (BCD) + (BD\overline{A}) + (\overline{C}\overline{B}\overline{D}) \\
& (\overline{A}\overline{D}) + (AB\overline{C}) + (BCD\overline{A}) \\
& (BD\overline{C}) + (\overline{A}\overline{B}\overline{D}) \\
& (\overline{A}\overline{B}) + (\overline{A}\overline{C}) + (BC\overline{A}) + (\overline{B}\overline{C}\overline{D}) \\
& (\overline{B}\overline{A}) + (\overline{B}\overline{C}) + (\overline{C}\overline{D}) + (AC\overline{B}) + (D\overline{A}\overline{C}) \\
& (ABD\overline{C}) + (ACD\overline{B}) + (BCD\overline{A}) \\
& (AB\overline{D}) + (\overline{C}\overline{B}\overline{D}) \\
& (\overline{D}\overline{A}) + (\overline{D}\overline{B}) + (\overline{D}\overline{C}) + (AB\overline{C}) + (AC\overline{B}) + (BC\overline{A}) \\
& (\overline{C}\overline{B}\overline{D}) + (\overline{A}\overline{B}\overline{C}\overline{D}) \\
& (\overline{B}\overline{C}) + (\overline{D}\overline{A}) + (\overline{D}\overline{B}) + (AB\overline{D}) + (\overline{C}\overline{A}\overline{B}) \\
& (\overline{B}\overline{C}) + (AB\overline{D}) + (AC\overline{B}) + (A\overline{C}\overline{D}) + (AD\overline{B}) + (AD\overline{C}) + (BD\overline{A}) + (CD\overline{A}) + \\
& (CD\overline{B}) + (\overline{A}\overline{C}\overline{D}) \\
& (\overline{D}\overline{A}) + (\overline{D}\overline{B}) + (\overline{D}\overline{C}) + (A\overline{C}\overline{D}) \\
& (AB\overline{C}) + (AB\overline{D}) + (CD\overline{B}) + (\overline{A}\overline{C}\overline{D}) + (D\overline{A}\overline{B}) \\
& (BD) + (AB\overline{C}) + (AC\overline{B}) + (\overline{B}\overline{C}\overline{A}) \\
& (AB) + (AC) + (\overline{A}\overline{D}) + (BC\overline{D})
\end{aligned}$$

$$\begin{aligned}
& (C\overline{D}) + (D\overline{C}) + (AB\overline{C}) + (AD\overline{B}) \\
& (C\overline{B}) + (D\overline{A}) + (\overline{AB}) + (\overline{ACD}) \\
& (AB\overline{C}) + (\overline{ACD}) + (\overline{ADC}) + (BD\overline{A}) \\
& (\overline{AB}) + (\overline{AD}) + (\overline{BA}) + (\overline{BD}) + (\overline{DA}) + (\overline{DB}) \\
& (\overline{DA}) + (\overline{DC}) + (\overline{ACB}) \\
& (\overline{AD}) + (\overline{BA}) + (\overline{BC}) + (\overline{CD}) + (\overline{ACB}) \\
& (BCD) + (\overline{ABC}) + (\overline{ACB}) \\
& (BC\overline{A}) + (\overline{ABD}) + (\overline{ACD}) \\
& (AB\overline{C}) + (\overline{ABD}) + (\overline{CDA}) + (\overline{CDB}) \\
& (\overline{ACB}) + (\overline{CBD}) + (\overline{ABCD}) \\
& (\overline{BA}) + (\overline{CA}) + (\overline{BCD}) + (\overline{CBD}) + (\overline{ADBC}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{BA}) + (\overline{BC}) + (\overline{CA}) + (\overline{CB}) + (\overline{DA}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{DB}) + (\overline{BC}) + (\overline{BCA}) \\
& (ABD) + (BCD) + (\overline{ABCD}) \\
& (ABD) + (\overline{ACD}) + (BCD) + (\overline{BCD}) \\
& (\overline{ABC\overline{D}}) + (\overline{ACD\overline{B}}) + (\overline{BCD\overline{A}}) + (\overline{ABCD}) + (\overline{DABC}) \\
& (\overline{AB\overline{C}}) + (\overline{AC\overline{B}}) + (\overline{AB\overline{D}}) + (\overline{BCD\overline{A}}) \\
& (\overline{AB\overline{C}}) + (\overline{AB\overline{D}}) + (\overline{CDB}) + (\overline{ACD}) \\
& ABCD \\
& (\overline{ACB}) + (\overline{BCA}) + (\overline{ACD}) + (\overline{BCD}) + (\overline{CAD}) \\
& (\overline{ABD\overline{C}}) + (\overline{ACD\overline{B}}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{BC}) + (\overline{BD\overline{A}}) \\
& (\overline{AC}) + (\overline{BD}) + (\overline{DB}) + (\overline{DC}) \\
& (\overline{AB}) + (\overline{BD}) \\
& (\overline{AB\overline{C}}) + (\overline{ACD}) + (\overline{ADC}) + (\overline{BD\overline{A}}) + (\overline{CDA}) \\
& (\overline{ACD}) + (\overline{ACD\overline{B}}) + (\overline{BCD\overline{A}}) \\
& ACD\overline{B} \\
& (\overline{BA}) + (\overline{CA}) + (\overline{DB}) + (\overline{ABC}) \\
& (\overline{ACB}) + (\overline{ACD}) + (\overline{BCD\overline{A}}) \\
& A + D + (\overline{BC}) + (\overline{BC}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{CD}) + (\overline{BAD}) \\
& (\overline{DA}) + (\overline{DB}) + (\overline{DC}) + (\overline{ABC}) + (\overline{ABD}) + (\overline{ACB}) + (\overline{ACD}) \\
& A + D + (\overline{BC}) \\
& (\overline{AD}) + (\overline{BA}) + (\overline{DA}) \\
& (\overline{ACD}) + (\overline{BD\overline{AC}}) \\
& (\overline{BCD}) + (\overline{BD\overline{A}}) + (\overline{BD\overline{C}}) + (\overline{CD\overline{B}}) + (\overline{ACD}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{AD}) + (\overline{BCA}) \\
& (\overline{AD}) + (\overline{CA}) + (\overline{DA}) + (\overline{DB})
\end{aligned}$$

$$\begin{aligned}
& ABD \\
& B + (AD) + (A\overline{C}) \\
& AC\overline{B}\overline{D} \\
& (ABC\overline{C}) + (AD\overline{B}) + (BC\overline{A}\overline{D}) \\
& BCDA\overline{A} \\
& (\overline{A}\overline{D}) + (AC\overline{B}) + (BC\overline{A}) + (BD\overline{C}) + (D\overline{A}\overline{C}) \\
& (\overline{B}\overline{A}\overline{C}) + (\overline{B}\overline{C}\overline{D}) + (\overline{C}\overline{A}\overline{D}) \\
& (\overline{A}\overline{D}) + (D\overline{A}\overline{B}) + (D\overline{A}\overline{C}) \\
& (A\overline{C}\overline{D}) + (ACD\overline{B}) + (BD\overline{A}\overline{C}) \\
& (\overline{A}\overline{D}) + (AC\overline{B}) + (BCDA\overline{A}) \\
& (D\overline{A}) + (D\overline{C}) + (AC\overline{B}) + (\overline{B}\overline{A}\overline{C}) \\
& A\overline{D} \\
& (AB\overline{D}) + (BCDA\overline{A}) \\
& A + (BC) + (BD) + (\overline{B}\overline{C}\overline{D}) \\
& (BDA\overline{A}) + (AD\overline{B}\overline{C}) \\
& (AC\overline{D}) + (BD\overline{C}) + (\overline{A}\overline{B}\overline{D}) \\
& (ABC\overline{D}) + (\overline{A}\overline{B}\overline{C}\overline{D}) \\
& (AC\overline{B}) + (AD\overline{C}) + (BD\overline{A}) + (CDA\overline{A}) \\
& (ABC\overline{C}) + (AB\overline{D}) + (CDA\overline{A}) + (CDB\overline{B}) + (A\overline{C}\overline{D}) \\
& (AB\overline{C}\overline{D}) + (BC\overline{A}\overline{D}) \\
& (AC\overline{B}) + (BC\overline{A}) + (BD\overline{A}) + (A\overline{C}\overline{D}) \\
& (AC) + (CD) + (\overline{A}\overline{D}) + (\overline{B}\overline{A}) + (D\overline{A}) + (\overline{A}\overline{C}) + (\overline{C}\overline{D}) \\
& (AB\overline{D}) + (A\overline{C}\overline{D}) \\
& (\overline{A}\overline{D}) + (D\overline{A}) + (CD\overline{B}) \\
& (\overline{B}\overline{A}\overline{C}) + (\overline{C}\overline{B}\overline{D}) + (D\overline{A}\overline{C}) \\
& (\overline{A}\overline{D}) + (CDA\overline{A}) + (CDB\overline{B}) + (D\overline{A}\overline{B}) \\
& (AB) + (AC) + (\overline{A}\overline{D}) + (\overline{B}\overline{D}) + (D\overline{A}\overline{B}) \\
& (\overline{A}\overline{B}) + (\overline{A}\overline{C}) + (\overline{B}\overline{D}) + (\overline{B}\overline{C}) + (BC\overline{A}) \\
& (\overline{A}\overline{D}) + (BC\overline{A}) + (D\overline{A}\overline{B}) \\
& (AB\overline{D}) + (A\overline{C}\overline{D}) + (ACD\overline{B}) + (BCDA\overline{A}) + (D\overline{A}\overline{B}\overline{C}) \\
& (ABC\overline{C}) + (AB\overline{D}) + (AC\overline{B}) + (BD\overline{A}) \\
& \overline{C} + \overline{D} + (\overline{A}\overline{B}) + (\overline{B}\overline{A}) \\
& (AB\overline{D}) + (ACD\overline{B}) + (BCDA\overline{A}) \\
& (\overline{A}\overline{B}) + (\overline{B}\overline{A}) + (\overline{B}\overline{C}) + (D\overline{A}) \\
& (ABC\overline{C}) + (AC\overline{B}) + (\overline{A}\overline{B}\overline{D}) + (BC\overline{A}\overline{D}) \\
& (\overline{B}\overline{A}) + (\overline{B}\overline{C}) + (\overline{B}\overline{D}) + (D\overline{A}) + (D\overline{B}) + (D\overline{C}) + (AC\overline{B}) + (A\overline{C}\overline{D}) \\
& (\overline{B}\overline{A}) + (\overline{C}\overline{D}) + (D\overline{A}) \\
& (\overline{A}\overline{D}) + (ABC\overline{C}) + (AC\overline{B}) + (BC\overline{D})
\end{aligned}$$

$$\begin{aligned}
& (\overline{AB}) + (\overline{AD}) + (\overline{BCD}) \\
& (\overline{BC}) + (\overline{ACD}) + (\overline{CDA}) + (\overline{CDB}) \\
& (\overline{BCDA}) + (\overline{ADBC}) \\
& (\overline{ACBD}) + (\overline{BCAD}) \\
& (\overline{AD}) + (\overline{BD}) + (\overline{BCA}) + (\overline{BCD}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{AD}) + (\overline{BCA}) + (\overline{BCD}) + (\overline{BD\overline{A}}) + (\overline{BD\overline{C}}) + (\overline{CDA}) + (\overline{CDB}) \\
& (\overline{CDB}) + (\overline{ACD}) + (\overline{DAC}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{DB}) + (\overline{BCA}) \\
& (\overline{AB}) + (\overline{ACD}) + (\overline{BCD}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{BD\overline{AC}}) + (\overline{CD\overline{AB}}) \\
& \overline{A} + (\overline{BC}) + (\overline{CB}) + (\overline{BD}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{ABCD}) \\
& (\overline{BCD}) + (\overline{ABD}) + (\overline{ACD}) + (\overline{BAD}) + (\overline{BCD}) + (\overline{CAD}) + (\overline{CBD}) + (\overline{DBC}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{BD}) + (\overline{BCA}) \\
& (\overline{ACB}) + (\overline{CDA}) + (\overline{ACD}) + (\overline{DAB}) \\
& (\overline{AC}) + (\overline{ADB}) + (\overline{BCD}) + (\overline{BDC}) \\
& (\overline{DC}) + (\overline{BC}) + (\overline{ADB}) + (\overline{BD\overline{A}}) \\
& (\overline{AB}) + (\overline{ADC}) + (\overline{BCDA}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{BCA}) + (\overline{BDC}) + (\overline{CDB}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{BD}) + (\overline{CD}) + (\overline{BCA}) \\
& (\overline{AD}) + (\overline{CBD}) + (\overline{BCDA}) \\
& \overline{C} + (\overline{AB}) + (\overline{AD}) + (\overline{BA}) + (\overline{BD}) + (\overline{DA}) + (\overline{DB}) \\
& (\overline{AD}) + (\overline{BA}) + (\overline{BC}) + (\overline{DA}) \\
& (\overline{BC}) + (\overline{DC}) + (\overline{ABD}) + (\overline{ADB}) + (\overline{BD\overline{A}}) + (\overline{CABD}) \\
& B + C + \overline{A} + \overline{D} \\
& (\overline{ABC}) + (\overline{BCA}) + (\overline{BCD}) + (\overline{ACDB}) + (\overline{BCD}) \\
& (\overline{DA}) + (\overline{ABC}) + (\overline{ABD}) \\
& A + B + C + D \\
& (\overline{AB}) + (\overline{ACD}) + (\overline{BCAD}) \\
& (\overline{ACD}) + (\overline{BD\overline{A}}) + (\overline{CDA}) \\
& (\overline{DB}) + (\overline{CDA}) + (\overline{ACD}) \\
& (\overline{AB}) + (\overline{BA}) + (\overline{BCD}) + (\overline{CDA}) \\
& \overline{A} + \overline{D} + (\overline{BC}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{ADB}) + (\overline{BCAD}) \\
& A + C + D + \overline{B} \\
& (\overline{DA}) + (\overline{DB}) + (\overline{ACD}) + (\overline{CAB}) \\
& (\overline{CD}) + (\overline{AD}) + (\overline{CB}) + (\overline{DA}) \\
& (\overline{AD}) + (\overline{BDC}) + (\overline{CDB}) + (\overline{BCD})
\end{aligned}$$

$$\begin{aligned}
& (\overline{DA}) + (\overline{DC}) + (\overline{ABC}) + (\overline{ACD}) + (\overline{BCA}) \\
& (\overline{AC}) + (\overline{BD}) + (\overline{CA}) + (\overline{DA}) + (\overline{DB}) \\
& (\overline{ABDC}) + (\overline{BCDA}) + (\overline{ACBD}) \\
& (\overline{ABC}) + (\overline{BCA}) + (\overline{BCD}) + (\overline{ACD}) + (\overline{ACDB}) \\
& (\overline{ABDC}) + (\overline{BCDA}) \\
& (\overline{BA}) + (\overline{BC}) + (\overline{ACB}) + (\overline{ABD}) \\
& (\overline{AC}) + (\overline{BD}) + (\overline{DA}) + (\overline{DB}) \\
& (\overline{AD}) + (\overline{BCDA}) \\
& (\overline{AD}) + (\overline{BA}) + (\overline{DA}) + (\overline{CDB}) \\
& (\overline{BA}) + (\overline{BC}) + (\overline{DC}) + (\overline{ACB}) + (\overline{CBD}) \\
& (\overline{ACDB}) + (\overline{ABCD}) + (\overline{BCAD}) \\
& (\overline{BA}) + (\overline{CA}) + (\overline{CDB}) \\
& (\overline{BC}) + (\overline{DA}) + (\overline{DB}) + (\overline{DC}) + (\overline{AC}) + (\overline{ABD}) + (\overline{ACB}) + (\overline{ACD}) \\
& (\overline{ABD}) + (\overline{ACD}) + (\overline{BCDA}) \\
& (\overline{ABCD}) + (\overline{ABDC}) + (\overline{ACDB}) + (\overline{BCDA}) \\
& (\overline{BA}) + (\overline{BD}) + (\overline{CA}) + (\overline{CD}) + (\overline{ADBC}) \\
& \overline{ABCD} \\
& A + B + (\overline{CD}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{BCD}) + (\overline{BDA}) + (\overline{BDC}) \\
& (\overline{BCD}) + (\overline{BCD}) + (\overline{CAD}) + (\overline{CBD}) + (\overline{DBC}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{ADB}) + (\overline{BCD}) \\
& (\overline{CBD}) + (\overline{DAB}) + (\overline{BACD}) \\
& (\overline{DA}) + (\overline{DB}) + (\overline{ABC}) + (\overline{ACB}) \\
& (\overline{ADC}) + (\overline{BCDA}) + (\overline{ACBD}) \\
& (\overline{DB}) + (\overline{DC}) + (\overline{BCA}) + (\overline{ABC}) \\
& (\overline{ACB}) + (\overline{CBD}) + (\overline{BCDA}) + (\overline{ABCD}) \\
& (\overline{BA}) + (\overline{ADB}) + (\overline{BCD}) + (\overline{CAD}) \\
& \overline{A} + \overline{B} + \overline{C} + \overline{D} \\
& (\overline{BD}) + (\overline{AB}) + (\overline{BCA}) + (\overline{BCD}) \\
& (\overline{ABDC}) + (\overline{ABCD}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{AD}) + (\overline{DA}) + (\overline{DB}) + (\overline{DC}) + (\overline{BCA}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{BDC}) + (\overline{CDB}) + (\overline{ABC}) \\
& (\overline{ACB}) + (\overline{ACD}) + (\overline{DABC}) \\
& (\overline{ABD}) + (\overline{ADB}) + (\overline{ADC}) + (\overline{BCDA}) \\
& (\overline{BC}) + (\overline{CB}) + (\overline{DA}) + (\overline{BD}) \\
& (\overline{ABCD}) + (\overline{ACBD}) + (\overline{BCAD}) \\
& (\overline{AD}) + (\overline{BD}) + (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{ABCD}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{ABD})
\end{aligned}$$

$$\begin{aligned}
& C + \overline{A} + \overline{D} \\
& (\overline{AD}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{BDC}) \\
& (\overline{AC}) + (\overline{AD}) + (\overline{CA}) + (\overline{CD}) + (\overline{DA}) + (\overline{DC}) + (\overline{AB}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACD}) \\
& (\overline{ADB}) + (\overline{ACD}) + (\overline{BDAC}) \\
& (AD) + (BC) + (BD) + (\overline{AC}) \\
& (\overline{AB}) + (\overline{BD}) + (\overline{BAC}) \\
& (\overline{DA}) + (\overline{ABC}) + (\overline{ABD}) + (\overline{ABC}) \\
& (\overline{ABC}) + (\overline{ACD}) + (\overline{ADC}) + (\overline{BDC}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{BDC}) + (\overline{BCD}) \\
& (\overline{BA}) + (\overline{BC}) + (\overline{BD}) + (\overline{DA}) + (\overline{DB}) + (\overline{DC}) + (\overline{AC}) + (\overline{ACB}) + (\overline{ACD}) \\
& (\overline{ABDC}) + (\overline{ACBD}) \\
& (\overline{AD}) + (\overline{ABC}) + (\overline{CDA}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{BCA}) \\
& (\overline{ABD}) + (\overline{ACB}) + (\overline{BDA}) + (\overline{CDB}) \\
& (BD) + (\overline{AB}) + (\overline{AC}) + (\overline{BCA}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{ABC}) \\
& \overline{B} + (\overline{AC}) + (\overline{AD}) + (\overline{CA}) + (\overline{CD}) + (\overline{DA}) + (\overline{DC}) \\
& (\overline{BCDA}) + (\overline{ACBD}) + (\overline{ADBC}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{BCDA}) \\
& (BD) + (\overline{ACD}) + (\overline{BCA}) + (\overline{ACD}) \\
& (\overline{AD}) + (\overline{DB}) + (\overline{BCD}) + (\overline{DAC}) \\
& (\overline{ACB}) + (\overline{CAD}) + (\overline{ABCD}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{AD}) + (\overline{BA}) + (\overline{BC}) + (\overline{BD}) + (\overline{CA}) + (\overline{CB}) + (\overline{CD}) + \\
& (\overline{DA}) + (\overline{DB}) + (\overline{DC}) \\
& (\overline{AD}) + (\overline{CDB}) + (\overline{DAC}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACD}) + (\overline{ACDB}) \\
& (\overline{CA}) + (\overline{DA}) + (\overline{BCD}) + (\overline{DBC}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{AD}) + (\overline{BDA}) + (\overline{BDC}) + (\overline{CDA}) + (\overline{CDB}) + (\overline{BCD}) \\
& (\overline{BCD}) + (\overline{BCD}) + (\overline{ACBD}) \\
& \overline{ACD} \\
& (\overline{BDA}) + (\overline{BDC}) + (\overline{ACDB}) + (\overline{ABC}) + (\overline{BCD}) \\
& (\overline{AD}) + (\overline{BCD}) \\
& (\overline{ACB}) + (\overline{BCA}) + (\overline{CAD}) + (\overline{ABCD}) \\
& (\overline{DA}) + (\overline{ABD}) + (\overline{ACD}) + (\overline{BCA}) \\
& (\overline{AD}) + (\overline{BCD}) + (\overline{CBD}) \\
& (\overline{ACDB}) + (\overline{BCDA})
\end{aligned}$$



$$\begin{aligned}
& (\overline{AD}) + (\overline{BD\overline{A}}) + (\overline{CD\overline{B}}) \\
& (\overline{BA}) + (\overline{BC}) + (\overline{D\overline{B}}) + (\overline{AC\overline{B}}) \\
& (\overline{AD}) + (\overline{D\overline{A}}) \\
& \overline{AD\overline{B}} \\
& (\overline{AD}) + (\overline{D\overline{A}}) + (\overline{BC}) + (\overline{BC\overline{A}}) \\
& (\overline{AB\overline{D}}) + (\overline{AC\overline{B}}) + (\overline{CD\overline{B}}) + (\overline{BD\overline{AC}}) \\
& (\overline{AD}) + (\overline{D\overline{A}}) + (\overline{BC\overline{A}}) + (\overline{BD\overline{C}}) + (\overline{ABC}) \\
& (\overline{BC\overline{A}}) + (\overline{ABD\overline{C}}) + (\overline{ACD\overline{B}}) \\
& \overline{A} + \overline{C} + \overline{D} \\
& (\overline{AB\overline{D}}) + (\overline{AC\overline{D}}) + (\overline{AD\overline{BC}}) \\
& (\overline{ABC}) + (\overline{BD\overline{C}}) + (\overline{CD\overline{A}}) + (\overline{AB\overline{D}}) \\
& (\overline{AD\overline{B}}) + (\overline{AD\overline{C}}) \\
& \overline{ABCD} \\
& (\overline{ABCD}) + (\overline{ABD\overline{C}}) + (\overline{ACD\overline{B}}) + (\overline{BCD\overline{A}}) + (\overline{BCD}) \\
& (\overline{D\overline{A}}) + (\overline{AC\overline{D}}) + (\overline{BD\overline{C}}) + (\overline{CD\overline{B}}) + (\overline{AB\overline{D}}) \\
& (\overline{AC\overline{B}}) + (\overline{ABD\overline{C}}) \\
& (\overline{AB\overline{C}}) + (\overline{AC\overline{D}}) + (\overline{ACD\overline{B}}) \\
& (\overline{AC\overline{D}}) + (\overline{BC\overline{A}}) + (\overline{BD\overline{A}}) + (\overline{CD\overline{A}}) \\
& (\overline{AC}) + (\overline{AD}) + (\overline{C\overline{A}}) + (\overline{C\overline{D}}) + (\overline{D\overline{A}}) + (\overline{D\overline{B}}) + (\overline{D\overline{C}}) \\
& (\overline{BD\overline{A}}) + (\overline{CD\overline{A}}) + (\overline{AC\overline{BD}}) + (\overline{AD\overline{BC}}) \\
& (\overline{AD}) + (\overline{B\overline{A}}) + (\overline{B\overline{C}}) + (\overline{D\overline{A}}) + (\overline{AC}) \\
& \overline{A} + \overline{B} + \overline{D} \\
& (\overline{AD}) + (\overline{C\overline{D}}) + (\overline{AC\overline{B}}) + (\overline{BC\overline{A}}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACD}) + (\overline{BCD}) + (\overline{BCD}) \\
& (\overline{AB\overline{D}}) + (\overline{AC\overline{D}}) + (\overline{ACD\overline{B}}) + (\overline{BCD\overline{A}}) \\
& (\overline{AB\overline{CD}}) + (\overline{BD\overline{AC}}) \\
& (\overline{D\overline{A}}) + (\overline{BC\overline{D}}) + (\overline{CD\overline{B}}) + (\overline{AB\overline{D}}) \\
& (\overline{CD\overline{B}}) + (\overline{AC\overline{D}}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{BC\overline{AD}}) \\
& \overline{D} + (\overline{AB}) + (\overline{B\overline{A}}) + (\overline{B\overline{C}}) \\
& (\overline{AB\overline{C}}) + (\overline{AC\overline{B}}) \\
& (\overline{AD\overline{C}}) + (\overline{BCD\overline{A}}) \\
& (\overline{ACD\overline{B}}) + (\overline{AB\overline{CD}}) \\
& (\overline{AC\overline{B}}) + (\overline{BCD\overline{A}}) + (\overline{AB\overline{CD}}) \\
& (\overline{CD\overline{B}}) + (\overline{AC\overline{D}}) + (\overline{BD\overline{AC}}) \\
& (\overline{AB\overline{D}}) + (\overline{AC\overline{B}}) + (\overline{BD\overline{A}}) \\
& \overline{C} + \overline{A} + \overline{B} + \overline{D} \\
& (\overline{AB\overline{C}}) + (\overline{AD\overline{C}}) + (\overline{BD\overline{A}}) + (\overline{CD\overline{A}})
\end{aligned}$$

$$\begin{aligned}
& \overline{A} + \overline{D} + (\overline{BC}) \\
& (AB\overline{D}) + (AC\overline{B}) + (BD\overline{C}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{DC}) + (\overline{BC}) + (BC\overline{A}) \\
& (AB\overline{C}) + (AC\overline{B}) + (AC\overline{D}) + (CD\overline{A}) + (\overline{BCD}) \\
& ABC\overline{D} \\
& (BD\overline{A}) + (CD\overline{A}) + (AD\overline{BC}) \\
& (\overline{CBD}) + (\overline{BACD}) + (\overline{DABC}) \\
& (AB\overline{D}) + (AD\overline{BC}) \\
& B + (CD) + (\overline{AD}) + (\overline{DA}) \\
& (AC\overline{D}) + (AD\overline{B}) + (AD\overline{C}) + (BCD\overline{A}) \\
& B + (AD) + (\overline{CD}) \\
& (\overline{BCD}) + (AC\overline{BD}) \\
& (AB\overline{D}) + (\overline{CBD}) + (BCD\overline{A}) \\
& (AC\overline{B}) + (ABD\overline{C}) + (BCD\overline{A}) \\
& (\overline{ABD}) + (ABD\overline{C}) \\
& (\overline{ABD}) + (ABD\overline{C}) + (BCD\overline{A}) \\
& (ABC\overline{D}) + (ACD\overline{B}) + (BCD\overline{A}) + (\overline{ABCD}) \\
& (\overline{AD}) + (\overline{BCD}) + (BD\overline{C}) + (CD\overline{B}) \\
& AB\overline{D} \\
& (\overline{AD}) + (\overline{BA}) + (\overline{CB}) + (\overline{DA}) \\
& (AB\overline{D}) + (AC\overline{B}) + (\overline{CBD}) + (BCD\overline{A}) \\
& (BC\overline{A}) + (\overline{ACD}) \\
& B + \overline{A} + \overline{C} + \overline{D} \\
& (\overline{BA}) + (\overline{CBD}) + (\overline{DAC}) \\
& (\overline{AD}) + (\overline{BA}) + (\overline{BC}) + (\overline{DA}) + (CD\overline{B}) \\
& (\overline{DA}) + (\overline{DC}) + (AC\overline{BD}) \\
& (AB\overline{D}) + (AC\overline{B}) \\
& (AC\overline{B}) + (\overline{ABD}) + (ABD\overline{C}) \\
& (AB\overline{D}) + (AC\overline{D}) + (BD\overline{C}) + (CD\overline{B}) \\
& (\overline{AC}) + (\overline{CA}) + (\overline{DA}) + (\overline{DB}) + (\overline{AB}) \\
& B + (AC) + (CD) + (\overline{AD}) + (\overline{DA}) + (\overline{AC}) + (\overline{CD}) \\
& (\overline{BC}) + (AC\overline{B}) + (BD\overline{A}) + (\overline{ABD}) \\
& (\overline{AB}) + (\overline{BD}) + (\overline{DB}) + (\overline{DC}) \\
& (BC\overline{A}) + (BD\overline{C}) + (ACD\overline{B}) + (\overline{ABCD}) \\
& (AD\overline{B}) + (BC\overline{D}) + (\overline{ACD}) + (BD\overline{AC}) \\
& (AC\overline{B}) + (AC\overline{D}) + (\overline{ABD}) \\
& (\overline{CA}) + (\overline{CB}) + (\overline{CD}) + (\overline{DA}) + (\overline{DB}) + (\overline{DC}) + (AB\overline{C}) + (AB\overline{D}) \\
& (AC) + (\overline{AD}) + (BD\overline{A}) + (\overline{BAC}) + (\overline{CBD})
\end{aligned}$$

$$\begin{aligned}
& (ABD\overline{C}) + (ACD\overline{B}) + (BCD\overline{A}) + (\overline{ABCD}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{DA}) + (\overline{BCA}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{BDA}) \\
& (\overline{ABD}) + (\overline{ADB}) + (\overline{ADC}) + (\overline{BDA}) + (\overline{BDC}) + (\overline{CDA}) + (\overline{CDB}) \\
& \overline{ACB} \\
& \overline{CBD} \\
& (CD) + (\overline{DA}) + (\overline{ABD}) + (\overline{ACD}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{CDB}) + (\overline{ABC}) \\
& (\overline{AD}) + (\overline{DA}) + (\overline{BCA}) + (\overline{CDB}) \\
& (\overline{AB}) + (\overline{AD}) + (\overline{BA}) + (\overline{BD}) + (\overline{DA}) + (\overline{DB}) + (\overline{DC}) \\
& (\overline{AD}) + (\overline{BC}) + (\overline{CA}) + (\overline{DA}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{BCA}) + (\overline{ABCD}) \\
& (\overline{AB}) + (\overline{AC}) + (\overline{BAD}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{ADB}) \\
& (\overline{AD}) + (\overline{ACB}) + (\overline{CBD}) + (\overline{BCDA}) \\
& (\overline{AB}) + (\overline{CDB}) + (\overline{ACD}) + (\overline{DAC}) \\
& (\overline{BA}) + (\overline{CA}) + (\overline{BCD}) + (\overline{ADBC}) \\
& (\overline{ABC}) + (\overline{ACB}) + (\overline{ABD}) + (\overline{BCD}) + (\overline{BCDA}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACDB}) + (\overline{BCDA}) \\
& (\overline{DA}) + (\overline{ACD}) + (\overline{BDC}) + (\overline{CDB}) + (\overline{ABD}) + (\overline{BAC}) \\
& C + (\overline{AD}) + (\overline{DA}) + (\overline{AB}) \\
& (\overline{AD}) + (\overline{BA}) + (\overline{BD}) + (\overline{DA}) + (\overline{AC}) + (\overline{CD}) + (\overline{ACB}) + (\overline{CDB}) \\
& (\overline{ACB}) + (\overline{ADC}) \\
& (\overline{CD}) + (\overline{DC}) + (\overline{ABC}) + (\overline{ADB}) + (\overline{BDA}) \\
& (\overline{AB}) + (\overline{AD}) + (\overline{BA}) + (\overline{BD}) + (\overline{DA}) + (\overline{DB}) + (\overline{AC}) \\
& (\overline{ABC}) + (\overline{ABD}) + (\overline{ACD}) + (\overline{BCAD}) \\
& (\overline{ACD}) + (\overline{BAC}) + (\overline{CAB}) + (\overline{DAB}) \\
& A + B + \overline{C} + \overline{D} \\
& (\overline{ADC}) + (\overline{BDA}) + (\overline{CDA}) + (\overline{ACBD}) \\
& (AB) + (AC) + (BC) + (BD) + (CD) + (\overline{AD}) + (\overline{DA}) + (\overline{ABC}) + (\overline{BCD}) \\
& (\overline{BA}) + (\overline{DA}) + (\overline{CBD}) \\
& (\overline{CDA}) + (\overline{ACBD}) + (\overline{ADBC})
\end{aligned}$$