



Lösung 1

$$1. y = c \wedge (a \nrightarrow b) \wedge \bar{d} = c(\bar{a}b \vee a\bar{b})\bar{d} = c\bar{a}b\bar{d} \vee cab\bar{d}$$

$$\begin{aligned} \text{NAND: } y &= \overline{\overline{c\bar{a}b\bar{d}} \vee \overline{cab\bar{d}}} = \overline{\overline{c\bar{a}b\bar{d}} \wedge \overline{cab\bar{d}}} \\ &= \text{NAND}_2(\text{NAND}_4(c, \bar{a}, b, \bar{d}), \text{NAND}_4(c, a, \bar{b}, \bar{d})) \end{aligned}$$

$$\begin{aligned} \text{NOR: } \bar{y} &= \overline{\overline{c\bar{a}b\bar{d}} \vee \overline{cab\bar{d}}} = \overline{\overline{c\bar{a}b\bar{d}} \wedge \overline{cab\bar{d}}} \\ &= \text{NOR}_2(\text{NOR}_4(\bar{c}, a, \bar{b}, d), \text{NOR}_4(\bar{c}, \bar{a}, b, d)) \\ y &= \bar{y} \vee \bar{y} \quad \text{oder: } y = \text{NOR}_2(\bar{y}, \bar{y}) \end{aligned}$$

$$2. y = (c \leftrightarrow b) \bar{a} = \overline{(cb \vee \bar{c}\bar{b})} \wedge a = \overline{cba \vee \bar{c}\bar{b}a} = (\bar{c} \vee \bar{b} \vee \bar{a})(c \vee b \vee \bar{a})$$

$$\begin{aligned} \text{NAND: } \bar{y} &= \overline{\overline{cba \vee \bar{c}\bar{b}a}} = \overline{\overline{cba} \wedge \overline{\bar{c}\bar{b}a}} \\ &= \text{NAND}_2(\text{NAND}_3(c, b, a), \text{NAND}_3(\bar{c}, \bar{b}, a)) \\ y &= \bar{y} \wedge \bar{y} \quad \text{oder: } y = \text{NAND}_2(\bar{y}, \bar{y}) \end{aligned}$$

$$\begin{aligned} \text{NOR: } y &= \overline{\overline{(\bar{c} \vee \bar{b} \vee \bar{a})(c \vee b \vee \bar{a})}} = \overline{\overline{(\bar{c} \vee \bar{b} \vee \bar{a})} \vee \overline{(c \vee b \vee \bar{a})}} \\ &= \text{NOR}_2(\text{NOR}_3(\bar{c}, \bar{b}, \bar{a}), \text{NOR}_3(c, b, \bar{a})) \end{aligned}$$

$$\begin{aligned} 3. y &= (a \vee \bar{b} \wedge (b \vee \bar{c})) \wedge (\bar{a} \vee \bar{c}) = (a \vee \bar{b}b \vee \bar{b}\bar{c})(\bar{a} \vee \bar{c}) = (a \vee \bar{b}\bar{c})(\bar{a} \vee \bar{c}) \\ &= a\bar{a} \vee a\bar{c} \vee \bar{b}\bar{c}\bar{a} \vee \bar{b}\bar{c}\bar{c} = a\bar{c} \vee \bar{c}\bar{b}\bar{a} \vee \bar{b}\bar{c} = a\bar{c} \vee \bar{b}\bar{c} \end{aligned}$$

$$\begin{aligned} \text{NAND: } y &= \overline{\overline{a\bar{c} \vee \bar{b}\bar{c}\bar{a} \vee \bar{b}\bar{c}}} = \overline{\overline{a\bar{c}} \wedge \overline{\bar{b}\bar{c}}} \\ &= \text{NAND}_2(\text{NAND}_2(a, \bar{c}), \text{NAND}_2(\bar{b}, \bar{c})) \end{aligned}$$

$$\text{NOR: } \bar{y} = \overline{\overline{a\bar{c} \vee \bar{b}\bar{c}}} = \overline{\overline{a\bar{c}} \wedge \overline{\bar{b}\bar{c}}}$$

$$= \text{NOR}_2(\text{NOR}_2(\bar{a}, c), \text{NOR}_2(b, c))$$

$$y = \bar{y} \vee \bar{y} \quad \text{oder:} \quad y = \text{NOR}_2(\bar{y}, \bar{y})$$

4. $y = \bar{b}\bar{a} \vee cba \vee edc$

$$\begin{aligned} \text{NAND: } y &= \overline{\overline{b\bar{a} \vee cba \vee edc}} = \overline{\overline{b\bar{a}} \wedge \overline{cba} \wedge \overline{edc}} \\ &= \text{NAND}_3\left(\text{NAND}_2(\bar{b}, \bar{a}), \text{NAND}_3(c, b, a), \text{NAND}_3(e, d, c)\right) \end{aligned}$$

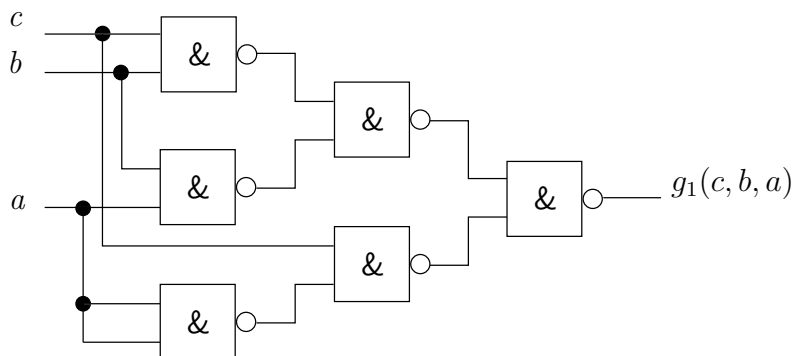
$$\begin{aligned} \text{NOR: } \quad \bar{y} &= \overline{\bar{b}\bar{a} \vee cba \vee edc} = \overline{\bar{b}\bar{a}} \vee \overline{cba} \vee \overline{edc} \\ &= \text{NOR}_3(\text{NOR}_2(b, a), \text{NOR}_3(\bar{c}, \bar{b}, \bar{a}), \text{NOR}_3(\bar{e}, \bar{d}, \bar{c})) \\ y &= \bar{y} \vee \bar{y} \quad \text{oder: } y = \text{NOR}_2(\bar{y}, \bar{y}) \end{aligned}$$

Lösung 2

1. Realisierung von $g_1(c, b, a)$ mit NAND-Gattern mit zwei Eingängen ($\bar{\wedge}$ -Operator):

$$\begin{aligned}
 g_1(c, b, a) &= \left((\bar{c} \vee \bar{b}) \wedge (\bar{b} \vee \bar{a}) \right) \vee (c \wedge \bar{a}) \\
 &= \overline{\overline{((\bar{c} \vee \bar{b}) \wedge (\bar{b} \vee \bar{a})) \vee (c \wedge \bar{a})}} \\
 &= \left((\bar{c} \vee \bar{b}) \overline{\wedge} (\bar{b} \vee \bar{a}) \right) \overline{\wedge} (c \overline{\wedge} \bar{a}) \\
 &= \left((c \overline{\wedge} b) \overline{\wedge} (b \overline{\wedge} a) \right) \overline{\wedge} (c \overline{\wedge} \bar{a}) \quad (\bar{a} = a \overline{\wedge} a)
 \end{aligned}$$

Schaltbild:

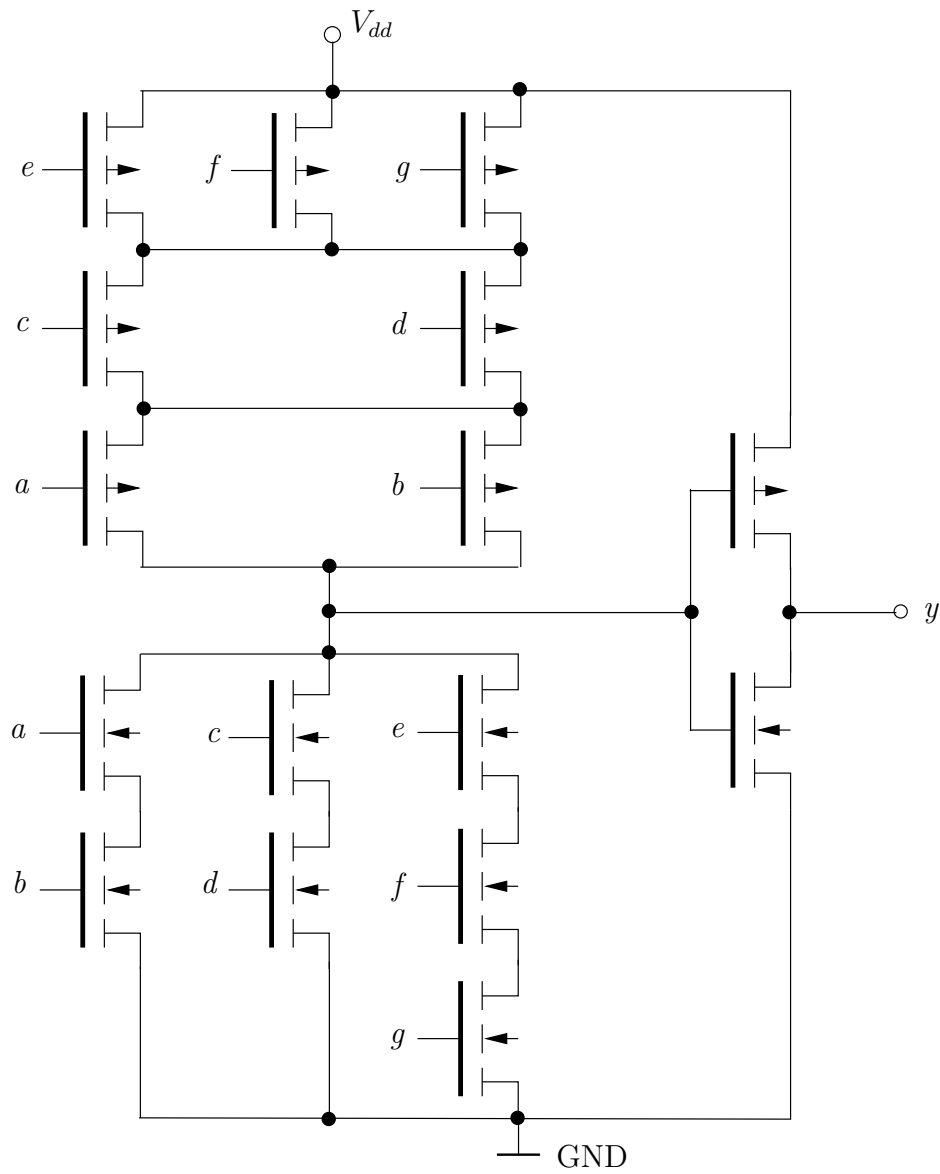


2. Realisierung von $g_2(c, b, a)$ mit NOR-Gattern mit zwei Eingängen ($\overline{\vee}$ -Operator):

$$g_2(x_1, x_2, x_3) = \overline{x_1 \vee x_2 \vee x_3} = \overline{(x_1 \overline{\vee} x_2)} \overline{\vee} x_3$$

Lösung 4

1. CMOS-Schaltnetz:

2. Schaltfunktion: $z = \overline{ad \vee bd \vee aef \vee bef \vee ced \vee cf}$