JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Technische Informatik: Abgabe 4

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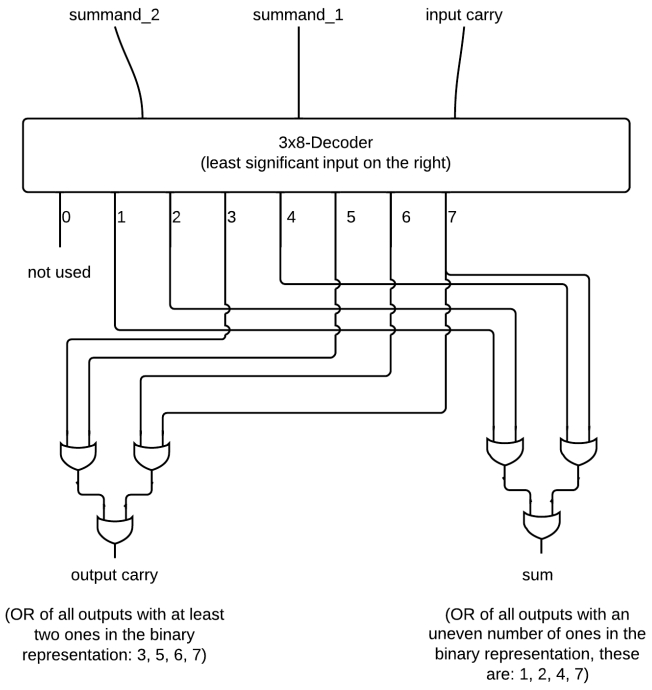
Exercise 4.1 (Full adder from decoder)



Exercise 4.2 (Subtractors)

a) Here are the tables for the two circuits we wish to implement (namely Half-Subtractor and Full-Subtractor):

minuend	subtrahend	underflow	difference
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0

If we read ms as numbers with high order bit on the left:

$$u_{out} = m_1$$
$$d = m_1 + m_2.$$

minuend	subtrahend	underflow	underflow	difference
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Again, in SOP-notation with high-order bit on the left:

$$u_{out} = m_1 + m_2 + m_3 + m_7$$
$$d = m_1 + m_2 + m_4 + m_7.$$

b) More or less compact symbolic representations of these two circuits are as follows (first component is always the resulting underflow, second is the actual difference):

$$HalfSubtractor(m, s) = (\bar{m}s, m \not\leftrightarrow s)$$
$$FullSubtractor(m, s, u) = (\bar{m} \not\leftrightarrow su, m \not\leftrightarrow s \not\leftrightarrow u)$$

c) Now we want to simplify both components (difference and undeflow) of the full subtractor using Karnaugh diagrams. We begin with the difference:

		minuend / subtrahend			
		00	01	11	10
underflow	0		1		1
	1	1		1	

It seems that this diagram is not simplifiable at all: we have to cover every one by an own 1x1 block. The simpliest expression for difference is thus:

$$d = \bar{m}\bar{s}u + \bar{m}s\bar{u} + msu + m\bar{s}\bar{u}$$

The ones for the output-underflow can be covered by three 2x1 blocks, which all intersect at 011 (we use additive color combination, light gray is supposed to be combination of red, green and blue):

		minuend / subtrahend			
		00	01	11	10
underflow	0	0	1	0	0
	1	1	1	1	0

Thus, the simplified formula for the output-underflow is:

$$u_{out} = \bar{m}u + \bar{m}s + su.$$

d)

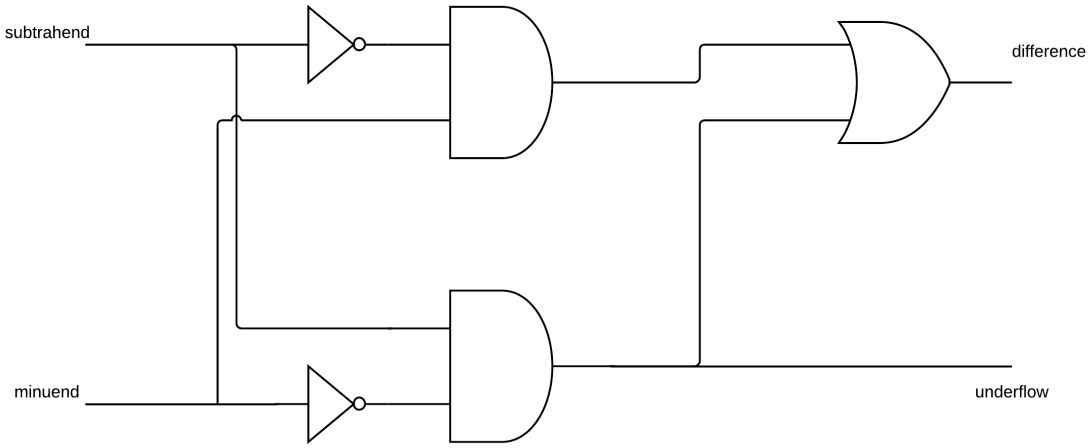


Abbildung 1: Half subtractor.

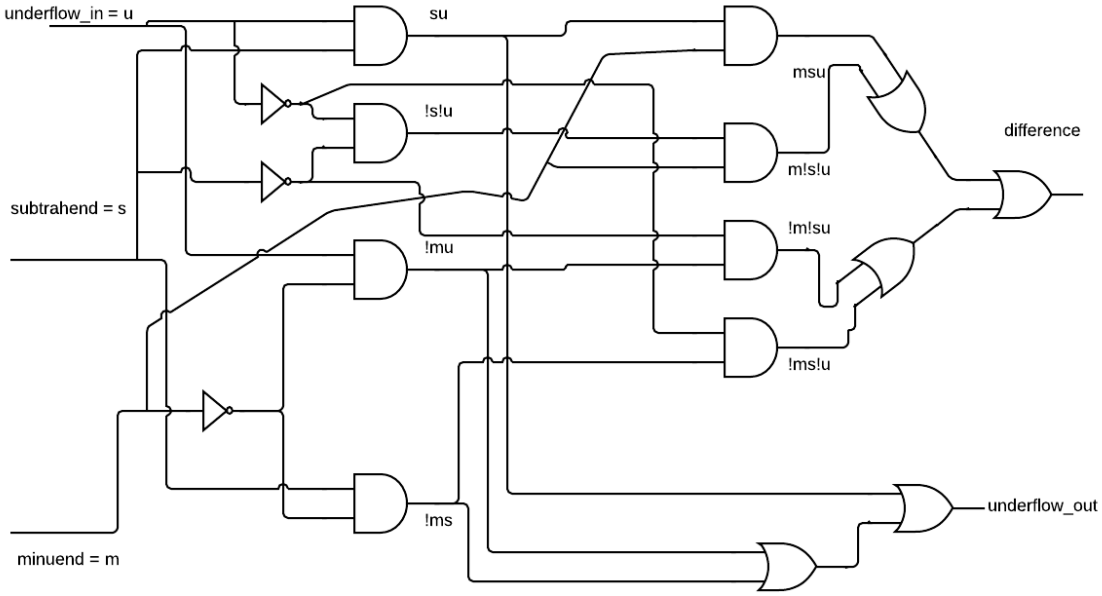


Abbildung 2: Full subtractor. We recycled as many gatters as we could for both sub-circuits. Reason: that’s the maximal complexity allowed for free LucidChart accounts...

Exercise 4.3 (TODO)

a) b)