

Offline - 3

1 bit full Subtractor

Given

P	minuend
Q	Subtrahend
R	previous borrow
D	Difference
B	Output borrow

truth table

P	Q	R	D	B
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

K-map for minimal SOP form of

D:

P \ QR	00	01	11	10
0	0 m_0	1 m_1	0 m_3	1 m_2
1	1 m_4	0 m_5	1 m_7	0 m_6

Annotations from the K-map:

- Group m_1, m_2 (top row, columns 01 and 10) is labeled $P'QR$.
- Group m_2, m_3 (top row, columns 10 and 11) is labeled $P'Q'R$.
- Group m_4, m_5 (bottom row, columns 00 and 01) is labeled $PQ'R$.
- Group m_5, m_7 (bottom row, columns 01 and 11) is labeled PD .

$$\begin{aligned}
 \therefore D &= PQR + P'Q'R + P'QR' + PQ'R \\
 &= R(PQ + P'Q') + R'(P'Q + PQ') \\
 &= R \cdot \overline{P \oplus Q} + R' \cdot \overline{P \oplus Q} \\
 &= \overline{P \oplus Q} \oplus R
 \end{aligned}$$

$\left(\begin{aligned} A \oplus B &= \overline{A}B + A\overline{B} \\ \overline{A \oplus B} &= \overline{\overline{A}B + A\overline{B}} \end{aligned} \right)$

Logical Expression for B

$$\begin{aligned}
 B &= P'Q'R + P'QR' + P'QR + PQR \\
 &= P'Q'R + PQR + P'QR' + PQR \\
 &= R(P'Q' + P.Q) + P'Q(R' + R) \\
 &= R(\overline{P \oplus Q}) + P'Q
 \end{aligned}$$



