BCD Addition

(a)
$$\begin{array}{cc} 0011 & 3 \\ +\,0100 & +\,4 \\ \hline 0111 & 7 \end{array}$$

(b)
$$\begin{array}{ccc} 0010 & 0011 & 23 \\ +\,0001 & 0101 & +\,15 \\ \hline 0011 & 1000 & 38 \end{array}$$

(c)
$$\begin{array}{ccc} 1000 & 0110 & 86 \\ +\,0001 & 0011 & +\,13 \\ \hline 1001 & 1001 & 99 \end{array}$$

(d)
$$\begin{array}{cccc} 0100 & 0101 & 0000 & 450 \\ +\,0100 & 0001 & 0111 & +\,417 \\ \hline 1000 & 0110 & 0111 & 867 \end{array}$$

Note that in each case the sum in any 4-bit column does not exceed 9, and the results are valid BCD numbers.

(a)
$$\begin{array}{ll} 1001 & \\ +\,0100 & \\ \hline 1101 & \text{Invalid BCD number } (>9) \\ +\,0110 & \text{Add 6} \\ \hline \mathbf{0001} \quad \mathbf{0011} & \text{Valid BCD number} \end{array}$$

1   3

(b)
$$\begin{array}{ll} 1001 & \\ +\,1001 & \\ \hline 1 \quad 0010 & \text{Invalid because of carry} \\ +\,0110 & \text{Add 6} \\ \hline \mathbf{0001} \quad \mathbf{1000} & \text{Valid BCD number} \end{array}$$

1   8

(c)
$$\begin{array}{ccc} 0001 & 0110 & 16 \\ +\,0001 & 0101 & +\,15 \\ \hline 0010 & 1011 & 31 \end{array}$$
Right group is invalid (>9), left group is valid.

$$+\,0110 \qquad \text{Add 6 to invalid code. Add carry, 0001, to next group.}$$

$$\mathbf{0011} \qquad \mathbf{0001} \qquad \text{Valid BCD number}$$

3   1

(d)
$$\begin{array}{ll} 0110 \quad 0111 & \\ +\,0101 \quad 0011 & \\ \hline 1011 \quad 1010 & \text{Both groups are invalid } (>9) \\ +\,0110 \quad +\,0110 & \text{Add 6 to both groups} \\ \hline \mathbf{0001} \quad \mathbf{0010} \quad \mathbf{0000} & \text{Valid BCD number} \end{array}$$

1   2   0