Decimal Adder

→ Computers or calculators that perform arithmetic operations directly in the decimal number system represent decimal numbers in binary coded form.

→ There is a wide variety of possible decimal adder circuits, depending upon the code used to represent the decimal digits.

BCD Adder

→ Consider the arithmetic addition of two decimal digits in BCD, together with an input carry from a previous stage.

→ Since each input digit does not exceed 9, the output sum cannot be greater than $9 + 9 + 1 = 19$, the 1 in the sum being an input carry.

→ Suppose we apply two BCD digits to a four-bit binary adder. The adder will form the sum in binary and produce a result that ranges from 0 through 19.

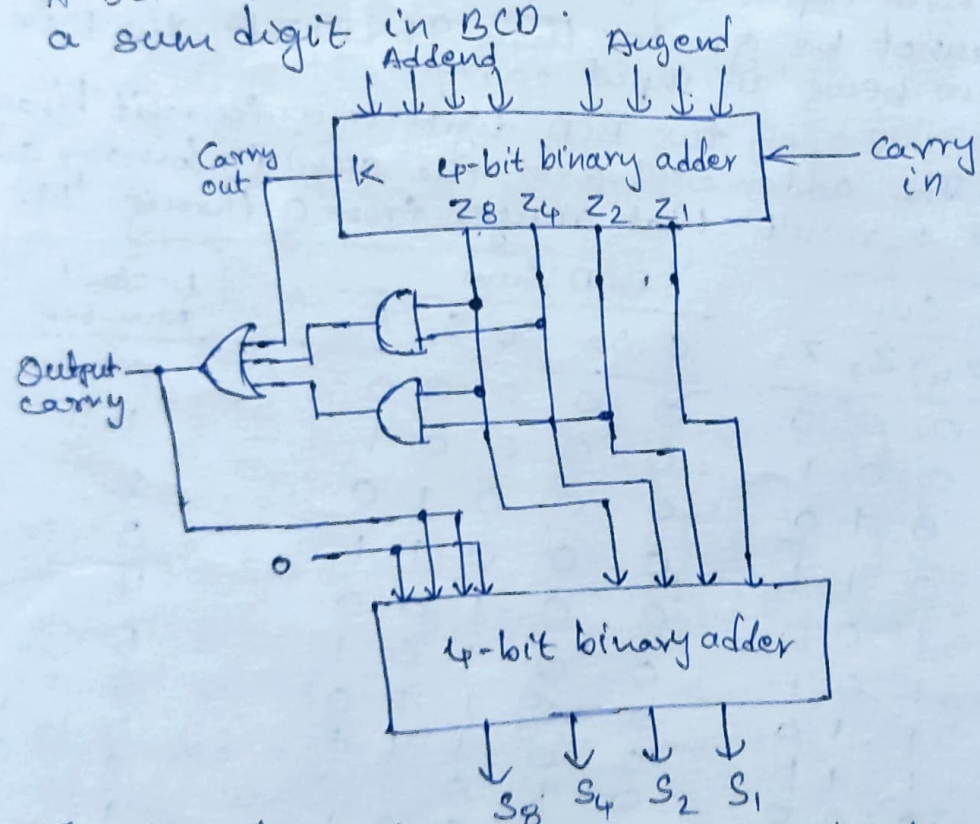| Binary Sum					BCD Sum					Decimal Number
K	Z_8	Z_4	Z_2	Z_1	C	S_8	S_4	S_2	S_1	
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	0	1	0	2
0	0	0	1	1	0	0	0	1	1	3
0	0	1	0	0	0	0	1	0	0	4
0	0	1	0	1	0	0	1	0	1	5
0	0	1	1	0	0	0	1	1	0	6
0	0	1	1	1	0	0	1	1	1	7
0	1	0	0	0	0	1	0	0	0	8
0	1	0	0	1	0	1	0	0	1	9
0	1	0	1	0	1	0	0	0	0	10
0	1	0	1	1	1	0	0	0	1	11
0	1	1	0	0	1	0	0	1	0	12
0	1	1	0	1	1	0	0	1	1	13
0	1	1	1	0	1	0	1	0	0	14
0	1	1	1	1	1	0	1	0	1	15
1	0	0	0	0	1	0	1	1	0	16
1	0	0	0	1	1	0	1	1	1	17
1	0	0	1	0	1	1	0	0	0	18
1	0	0	1	1	1	1	0	0	1	19

→ These binary numbers are labeled by symbols K, z_8, z_4, z_2 and z_1

→ K is the carry, and the subscripts under the letter z represent the weights 8, 4, 2, and 1 that can be assigned to the four bits in the BCD code.

→ When the binary sum is equal to or less than 1001, the corresponding BCD number is identical, and therefore no conversion is needed.

→ When the binary sum is greater than 1001, we obtain an invalid BCD representation. The addition of binary 6 (0110) to the binary sum converts it to the correct BCD representation and also produces an output carry as required.

→ The logic circuit that detects the necessary correction can be derived from the entries in the table.

→ The condition for a correction and an output carry can be expressed by the Boolean function

$$C = K + z_8 z_4 + z_8 z_2$$

→ A BCD adder that adds two BCD digits and produces a sum digit in BCD.

→ The two decimal digits, together with the input carry are first added in the top four-bit adder to produce the binary sum.

→ When the output carry is equal to 0, nothing is added to the binary sum.

→ When it is equal to 1, binary 0110 is added to the binary sum through the bottom four-bit adder.

→ The output carry generated from the bottom adder can be ignored, since it supplies information already available at the output carry terminal.

→ A decimal parallel adder that adds n decimal digits needs n BCD adder stages.

→ The output carry from one stage must be connected to the input carry of the next higher order stage.