

Carry Lookahead Adder

Carry Lookahead Addition (CLA) is a fast binary addition technique that reduces propa gation delay by computing carry bits in parallel rather than sequentially. Unlike a ripple carry adder, which propagates carry bit by bit, a CLA adder generates carry signals using the concepts of generate (G) and propagate (P) functions, defined as

$$G_i = A_i B_i,\ P_i = A_i \oplus B_i$$

The carry output at each stage is determined using precomputed expressions

such as $C_{i+1} = G_i + P_i C_i$

enabling faster addition. This parallel carry computation significantly improves speed, making CLA adders crucial in high-speed arithmetic circuits like ALUs and DSP proces sors.

Example: 8-bit Binary Addition Using Carry Lookahead Method

$$A = 11011011_2 = 219_{10}$$
$$B = 10101101_2 = 173_{10}$$

Step 1: Compute Generate (G) and Propagate (P) Bits

For each bit-pair (A_i, B_i), the Generate and Propagate signals are defined as:

$$G_i = A_i \cdot B_i \text{ (Carry Generate)}$$
$$P_i = A_i \oplus B_i \text{ (Carry Propagate)}$$

Bit Position	A_i	B_i	$G_i = A_i \cdot B_i$	$P_i = A_i \oplus B_i$
0	1	1	1	0
1	1	0	0	1
2	0	1	0	1
3	1	1	1	0
4	1	0	0	1
5	0	1	0	1
6	1	0	0	1
7	1	1	1	0

Table 1: Generate and Propagate Bits

Step 2: Compute Carry Bits

Using Carry Lookahead logic:

$$
\begin{aligned}
C_0 &= 0 \text{ (Initial Carry)} \\
C_1 &= G_0 + (P_0 \cdot C_0) = 1 + (0 \cdot 0) = 1 \\
C_2 &= G_1 + (P_1 \cdot C_1) = 0 + (1 \cdot 1) = 1 \\
C_3 &= G_2 + (P_2 \cdot C_2) = 0 + (1 \cdot 1) = 1 \\
C_4 &= G_3 + (P_3 \cdot C_3) = 1 + (0 \cdot 1) = 1 \\
C_5 &= G_4 + (P_4 \cdot C_4) = 0 + (1 \cdot 1) = 1 \\
C_6 &= G_5 + (P_5 \cdot C_5) = 0 + (1 \cdot 1) = 1 \\
C_7 &= G_6 + (P_6 \cdot C_6) = 0 + (1 \cdot 1) = 1 \\
C_8 &= G_7 + (P_7 \cdot C_7) = 1 + (0 \cdot 1) = 1
\end{aligned}
$$

Step 3: Compute Sum Bits

The sum bits are computed as:

$$S_i = P_i \oplus C_i$$

Bit Position	P_i	C_i	$S_i = P_i \oplus C_i$
0	0	0	0
1	1	1	0
2	1	1	0
3	0	1	1
4	1	1	0
5	1	1	0
6	1	1	0
7	0	1	1
C_{cout}	C_8	1	

Table 2: Final Sum Computation

Final Result

$$\text{Final Sum} = 110001000_2 = 392_{10}$$
$$\text{Carry Out} = C_8 = 1$$

Thus, the final result of 219 + 173 in binary is:

$$11011011_2 + 10101101_2 = 110001000_2$$