A Binary-Coded Decimal (BCD) adder is a digital circuit specifically designed to add decimal numbers represented in BCD code. Unlike a binary adder that simply adds bit by bit, a BCD adder needs to handle potential overflows that arise due to the nature of BCD encoding.

Here’s a detailed explanation:

BCD Code:

BCD code represents each decimal digit (0-9) using a 4-bit binary pattern. This makes it easier for humans to interpret and interface with digital circuits. However, it comes at the cost of potential redundancy and overflow issues.

For example, the decimal number 15 in BCD is represented as 0001 0101. While this clearly shows the digits 1 and 5, it’s technically a larger value (21) in binary. This is where the BCD adder’s special handling comes in.

BCD Adder Circuit:

BCD Adder Explained in Detail with Book References
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BCD Adder Circuit:

A BCD adder typically consists of multiple cascaded stages, each handling one decimal digit position. Each stage usually comprises:

- Full Adder: This performs the basic binary addition of two 4-bit BCD digits.
- Overflow Detector: This circuit checks for an output exceeding 9 (1001 in binary) in the full adder's sum.
- Correction Logic: If an overflow is detected, this logic adds 6 (0110 in binary) to the sum, effectively carrying over the "excess" 1 to the next digit position.

Operation:

1. Two BCD numbers are applied as inputs to the cascaded stages.
2. Each stage performs binary addition using the full adder.
3. The overflow detector checks for a sum exceeding 9.
4. If overflow occurs, the correction logic adds 6 to the sum, resulting in a valid BCD representation of the decimal result.
5. The corrected sum and any potential carry are propagated to the next stage.

Benefits of BCD Adders:

- Human-friendly: BCD representation simplifies debugging and interfacing with humans.
- Decimal accuracy: Ensures correct decimal results without rounding errors.
- Modular design: Cascaded stages allow for easy scaling to handle larger numbers.

Diagram:

BCD Adder Circuit Diagram

References:

- Digital Design by Morris Mano (5th Edition)
- Computer Organization and Design by David A. Patterson and John L. Hennessy (5th Edition)
- Fundamentals of Digital Logic with Verilog Design by Stephen Brown and Zvonko Vranesic (4th Edition)

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