IMPLEMENTING 32-BIT WALLACE MULTIPLIER

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REQUIRED CIRCUIT:

64-BIT CARRY LOOKAHEAD ADDER
64-BIT FULL ADDER
64-BIT AND GATE GENERATOR

FILES USED:

- **WALLACE MULTIPLIER:**
  - 32wallace.v(MAIN FILE)
  - 32wallace_tb.v (TEST-BENCH FILE)
  - 32wallace.vcd(GTK_WAVE FILE)

- **64-BIT CARRY LOOKAHEAD ADDER:**
  - 2kpg.v
  - kpg.v
  - ppc1.v
  - adder64alt.v

- **64-BIT FULL ADDER**
  - fullAdder.v
  - fourBitAdder.v
  - 16BitAdder.v
  - 32BitAdder.v
  - 64BitAdder.v
  - 3fa.v
  - 3fam.v

- **64-BIT AND GATE GENERATOR**
  - ppg.v

IMPLEMENTING 64-BIT CARRY LOOKAHEAD ADDER:
PROCEDURE:

- "Adder64alt.v" IS THE MAIN FILE WHICH ESTABLISHES THE FUNCTIONALITY OF CARRY LOOK AHEAD ADDER.
- RECURSIVE DOUBLING ALGORITHM IS USED TO GENERATE CARRY PARALLELY
- "kpg.v" GENERATES THE 8-BIT STRINGS/CARRY IN THE FORM "k", "p" and "g WHICH STANDS FOR KILL,PROPAGATE AND GENERATE.

- “Kpg.v” DEPENDS ON CIRCUIT “2kpg.v” WHICH GENERATES 1-BIT CARRY STRINGS IN THE SAME FORM AS ABOVE
- “ppc1.v” USES RECURSIVE DOUBLING ALGORITHM TO DIVIDE 64 STRINGS OF CARRY STRINGS INTO TWO GROUPS AT EACH LEVEL.THERE ARE LOG(64) LEVELS/PIPELINE
- I.E 6 LEVELS

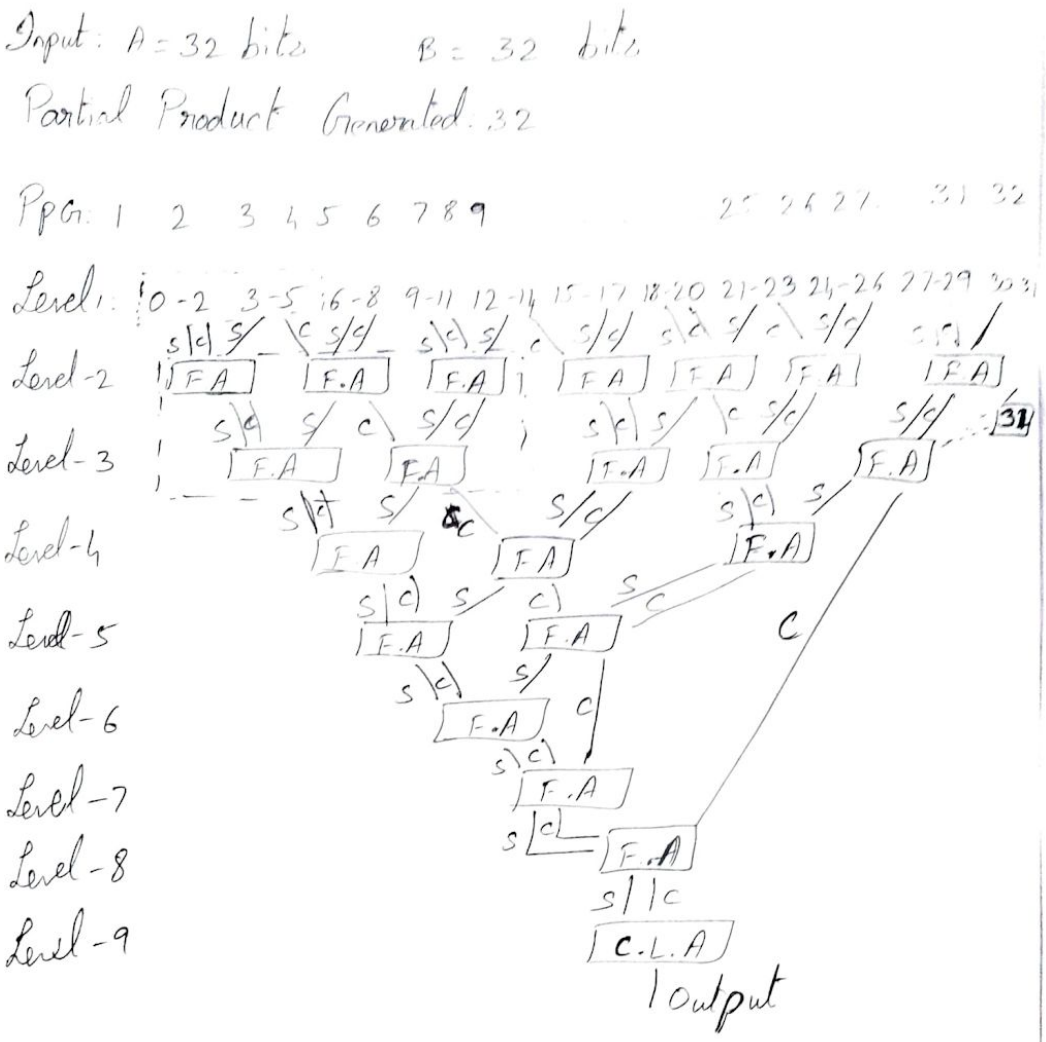
NOTATION:
K= A NOR B(TRUE WHEN BOTH ARE 0)
P=A XOR B(TRUE WHEN EITHER ONE OF THEM IS 1)
G=A AND B(TRUE WHEN BOTH ARE 1)

IMPLEMENTING 64-BIT FULL ADDER:
PROCEDURE:

- “64BitAdder.v” IS THE MAIN FILE.BOTTOM-UP-APPROACH IS USED TO CONSTRUCT THE ADDER
- FIRST 1 BIT FULL ADDER IS CONSTRUCTED FIRST AND THEN FOUR BIT FULL ADDER IS CONSTRUCTED AND GOES ALL THE WAY TO 64 BIT ADDER
- HIERARCHY :1 BIT->4-BIT->16-BIT->32-BIT->64-BIT
- HERE THE FULL ADDER HAS A MODIFIED PURPOSE ,IT GENERATES SUM AND CARRY BITS SEPERATELY.
- FOR EXAMPLE 4-BIT FULL ADDER GENERATES 4-BIT SUM AND 4-BIT CARRY OUTPUT BASED ON THE LOGIC :
  - SUM =A XOR B XOR CARRY _IN
  - CARRY=(A.B) + (B.C) + (C.A)

IMPLEMENTING WALLACE MULTIPLIER:
PROCEDURE:
HIERARCHY LEVEL/PIPELINE LEVEL:
CONNECTIONS ARE MADE ACCORDING TO LEVEL WISE.REFER THE TREE.INPUTS ARE THE PARTIAL PRODUCTS AND THE OUTPUT IS THE MULTIPLIED RESULT
CIRCUIT DEPTH : 9
PARTIAL PRODUCTS GENERATED: 32
OUTPUT_BIT_LENGTH:MAX 63

LEVEL-TREE:



At Level-1 ( ) the dotted box is generated using 3fa.v which takes 3 partial products as input and "Sum" and "Carry" as Output (two bit width)
At Level-2 through 8, the box (sample at Level-2) takes ~~three~~ five Sum and four Carry products as input and two Sum and two Carry as Output

OUTPUT:

TESTBENCH:

```
(base) sharan@OMEN:~/Desktop/course/vlsi_lab/exp5$ iverilog 32wallace_tb.v
(base) sharan@OMEN:~/Desktop/course/vlsi_lab/exp5$ ./a.out
VCD info: dumpfile 32wallace.vcd opened for output.
                   0 Input bts:Multiplier=5.419827e+07 and Multiplicand =3.866623e+06;
                               Output:
                               In Exponential form:Result=2.095643e+14
                               Decimal form=     209564281208833

                   5 Input bts:Multiplier=1.900000e+01 and Multiplicand =1.500000e+01;
                               Output:
                               In Exponential form:Result=2.850000e+02
                               Decimal form=                285

                  10 Input bts:Multiplier=9.943000e+06 and Multiplicand =3.302367e+06;
                               Output:
                               In Exponential form:Result=3.283544e+13
                               Decimal form=      32835435081000

                  20 Input bts:Multiplier=4.294967e+09 and Multiplicand =4.282057e+09;
                               Output:
                               In Exponential form:Result=1.839129e+19
                               Decimal form=18391292651155357894

                  25 Input bts:Multiplier=2.598300e+04 and Multiplicand =6.419870e+05;
                               Output:
                               In Exponential form:Result=1.668075e+10
                               Decimal form=         16680748221

                  35 Input bts:Multiplier=2.882400e+09 and Multiplicand =2.882208e+09;
                               Output:
                               In Exponential form:Result=8.307676e+18
                               Decimal form= 8307675765591249094
```

GTKWAVE FORM: