

## Hamming Code Generator Using 45 nm CMOS

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### Abstract

This paper gives details of an extended binary Hamming code generator for generation of code word using 45 nm CMOS. It is required that these codes maintain a minimum Hamming distance of three. For the present application, a suitable (7,4) extended Hamming code generator is designed for 4 data bits, which generates a corresponding 7 bit codeword for each data word. The design implemented in Microwind 3.1 software is detailed here along with showing the Hamming distance between the generated codes. Code which allows one bit error detection & correction each called hamming code.

### I. INTRODUCTION

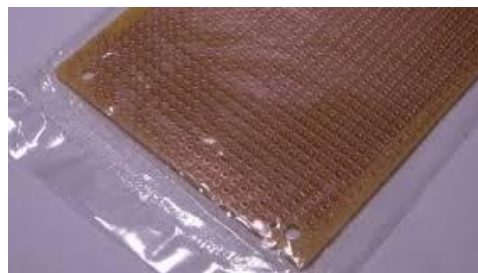
Hamming code generator is a device that can detect an error in any communication system like telecommunication, mobile communication, data communication wireless communication etc. For preventing the occurrence of an error introduced due to noise generated by any external & internal sources. The hamming code generator detects up to a minimum of two errors and can correct a single error in a given communication system because the minimum hamming distance of hamming code is three. Hamming (7, 4) is a linear error-correcting code that encodes 4 bits of data into 7 bits by adding 3 parity bits. The Hamming code adds three additional check bits to every four data bits of the message. Hamming's (7, 4) can correct any single-bit error, or detect all single-bit and two-bit errors.

### II. HARDWARE USED

- Four PCB
- Five XOR gate IC (7486)
- Two NOT gate IC (7404)
- Four SPDT switches
- Banana socket connector
- LED'S
- Connection wire
- 1 K $\Omega$  resistance
- 5 V power supply

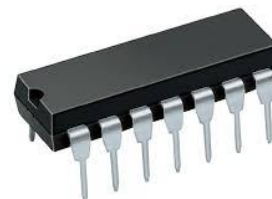
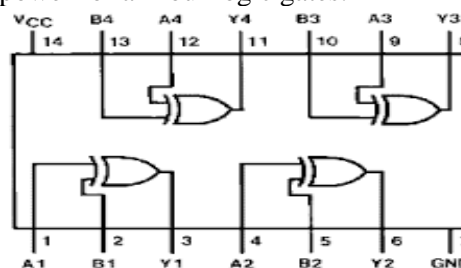
### III. COMPONENT DETAIL

PCB:- A **printed circuit board (PCB)** mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCBs can be *single sided* (one copper layer), *double sided* (two copper layers) or *multi-layer*.



#### XOR IC 7486:-

The 7486 IC package contains four independent positive logic XOR GATES. Pins 14 and 7 provide power for all four logic gates.

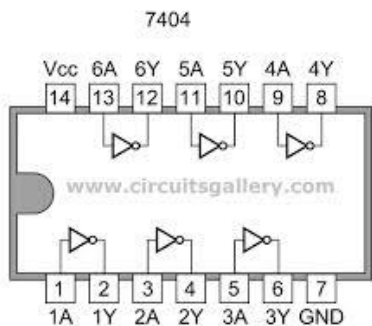


#### NOT IC 7404:-

Not gate (inverter) the output is true when the input is not true, the output is

The inverse of the input :  $Q = \text{NOT } A$ .

A NOT gate can only have one input. A not gate is also called an inverter.



Resistance:- 1KΩ



Power Supply:-



Image for reference only

SPDT Switch:-

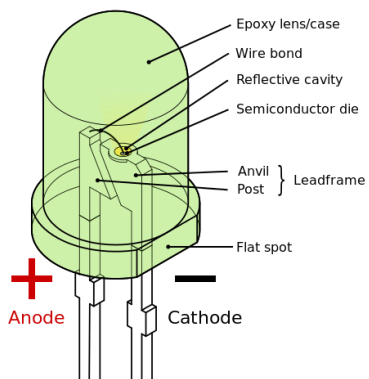


Banana Socket Connectors:-



acumenlabware.com

LED:-



#### IV. CIRCUIT EXPLANATION

- Encoder section  
 Traditional Hamming codes are (7,4) codes, encoding four bits of data into seven bit blocks (a Hamming code word). The extra three bits are parity bits. Each of the three parity bits is parity for three of the four data bits, and no two parity bits are for the same three data bits. All of the parity bits are even parity.
- Error Generating Section  
 In the error generating section we have introduced the error at pin no.M5 of encoding section through the Not gate IC-7404, the input of M5 from encoder is pin no.1 of IC-7404 and the output at pin no. 2 is connected to the LED.
- Decoding Section  
 In a word without errors decoding a Hamming code word would be very easy. Just Throw out the parity bits. The encoding example produced a 7 bit code word. Its parity bits are 101 and its data bits are 1010. If you receive a 1011010, just decode it as 1010. But what happens if you receive a code word with an error and one or more of the parity bits are wrong?

Connection Wires:-



- Error Correcting Section

In the error correcting section, the parity bits P1 ,P2 and P4 indicates the error produced at which transmitted bit, as we have introduced an error at M5 so P1 P2 P4

will indicate the sequence 101, here 101 means 5 in decimal, so there is an error at 5<sup>th</sup> bit introduced at encoder. So as to correct the introduced error we can replace the present bit with its complement as for '0' it would be replaced by '1' and hence the error can be terminated in this way.

### V. SIMULATION RESULTS

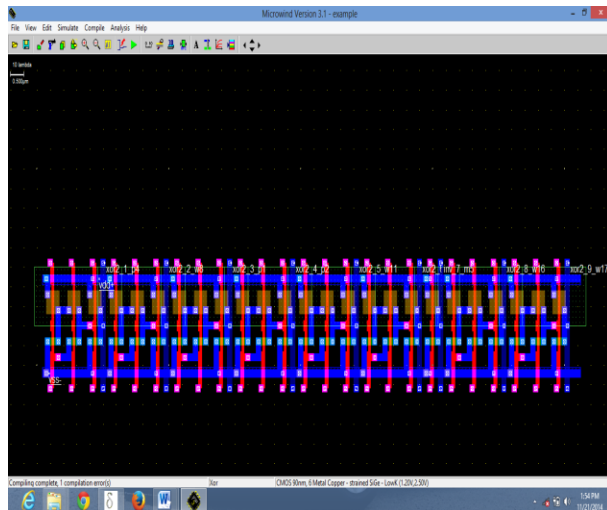


Figure (c) Hamming code generator layout

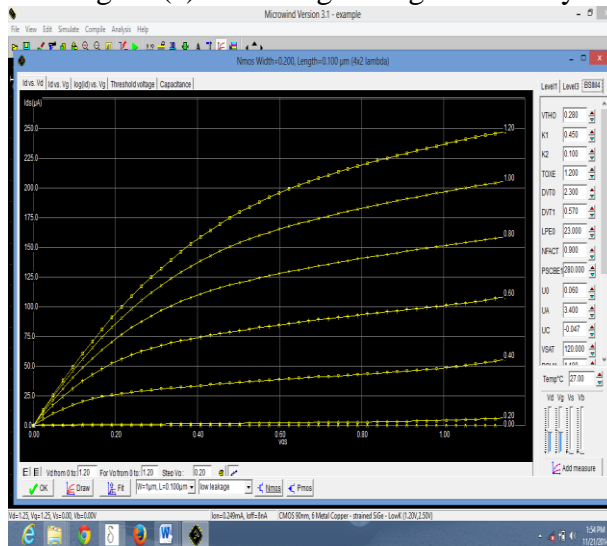


Figure (d) Hamming code generator V-I output curve

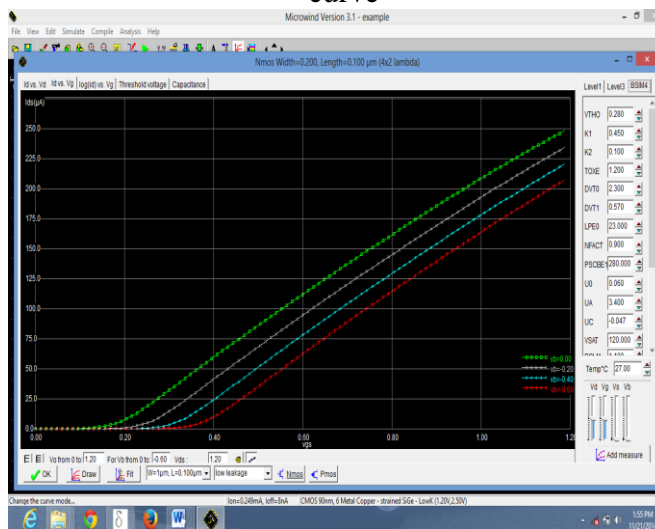


Figure (e) Hamming code generator V-I transfer curve

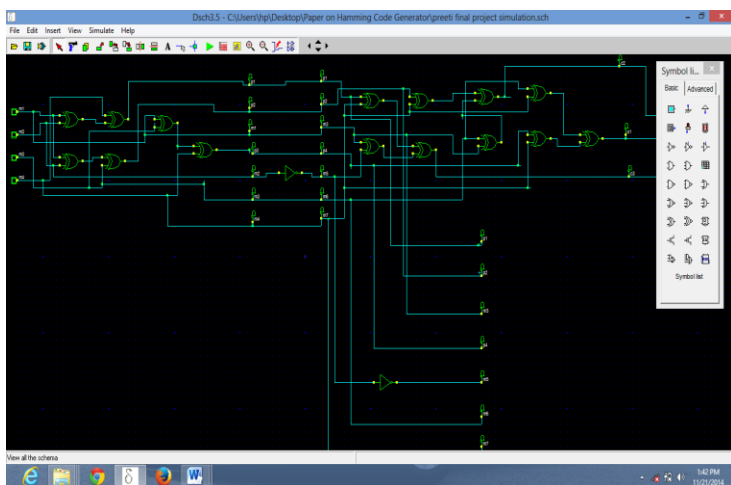


Figure (a) Hamming code generator circuit

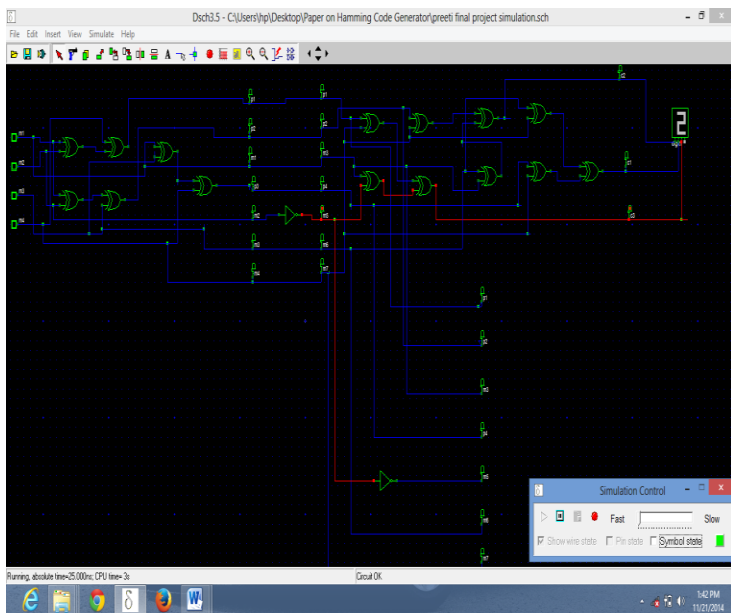


Figure (b) Hamming code generator simulation

## VI. CONCLUSION

45 nm CMOS is used for less area and low power consumption. Hamming code generator has been designed and implemented:

- (i) Hamming code generator is used to detect into 2 errors and correct one error.
- (ii) Encoder using XOR gate IC is used for generating 7-bit code word.
- (iii) Decoder using XOR gate IC is used for error detection purpose.
- (iv) In error correcting section NOT gate IC is used to correct the defaulted bit at the appropriate bit position.

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