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Assignment no: 1

Title : Code Converter

Aim : Design and implementation of 4-bit Code convertors.

i) BCD to Excess – 3 Code

IC's Used:

IC 7404(Hex INV), 7432 (OR-gate), 7408 (AND-gate), 7486 (Ex-or gate)

Theory:

There is a wide variety of binary codes used in digital systems. Some of these codes are binary-coded -decimal (BCD), Excess-3, Gray, octal, hexadecimal, etc. Often it is required to convert from one code to another. For example the input to a digital system may be in natural BCD and output may be 7-segment LEDs. The digital system used may be capable of processing the data in straight binary format. Therefore, the data has to be converted from one type of code to another type for different purpose. The various code converters can be designed using gates.

1. **BCD Code:**

Binary Coded Decimal (BCD) is used to represent each of decimal digits (0 to 9) with a 4-bit binary code. For example $(23)_{10}$ is represented by 0010 0011 using BCD code rather than$(10111)_2$ This code is also known as 8-4-2-1 code as 8421 indicates the binary weights of four bits(2^3, 2^2, 2^1, 2^0). It is easy to convert between BCD code numbers and the familiar decimal numbers. It is the main advantage of this code. With four bits, sixteen numbers (0000 to 1111) can be represented, but in

BCD code only 10 of these are used. The six code combinations (1010 to 1111) are not used and are invalid.

Applications : Some early computers processed BCD numbers. Arithmetic operations can be performed using this code. Input to a digital system may be in natural BCD and output may be 7-segment LEDs.

It is observed that more number of bits are required to code a decimal number using BCD code than using the straight binary code. However in spite of this disadvantage it is very convenient and useful code for input and output operations in digital systems.

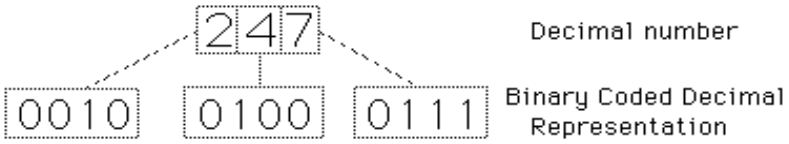


Fig. 3 BCD Coded Decimal Representation

2. EXCESS-3 Code:

Excess-3, also called XS3, is a non-weighted code used to express decimal numbers. It can be used for the representation of multi-digit decimal numbers as can BCD.The code for each decimal number is obtained by adding decimal 3 and then converting it to a 4-bit binary number. For e.g. decimal 2 is coded as 0010 + 0011 = 0101 in Excess-3 code.

This is self-complementing code which means 1's complement of the coded number yields 9's complement of the number itself. Self-complementing property of this helps considerably in performing subtraction operation in digital systems, so this code is used for certain arithmetic operations.

BCD To Excess – 3 Code Conversion:

Convert BCD 2 i. e. 0010 to Excess – 3 code
For converting 4 bit BCD code to Excess – 3, add 0011 i. e. decimal 3 to the respective code using rules of binary addition.

0010 + 0011 = 0101 – Excess – 3 code for BCD 2

Excess – 3 Code To BCD Conversion: The 4 bit Excess-3 coded digit can be converted into BCD code by subtracting decimal value 3 i.e. 0011 from 4 bit Excess-3 digit.

e.g. Convert 4-bit Excess-3 value 0101 to equivalent BCD code.

0101-0011= 0010- BCD for 2

A. BCD To Excess-3 Code Conversion: Truth Table:

INPUT (BCD CODE)				**OUTPUT (EXCESS-3 CODE)**			
B_3	**B_2**	**B_1**	**B_0**	**E_3**	**E_2**	**E_1**	**E_0**
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	x	x	x	x
1	0	1	1	x	x	x	x
1	1	0	0	x	x	x	x
1	1	0	1	x	x	x	x
1	1	1	0	x	x	x	x

1	1	1	1	x	x	x	x

2) K-Map For Reduced Boolean Expressions Of Each Output:

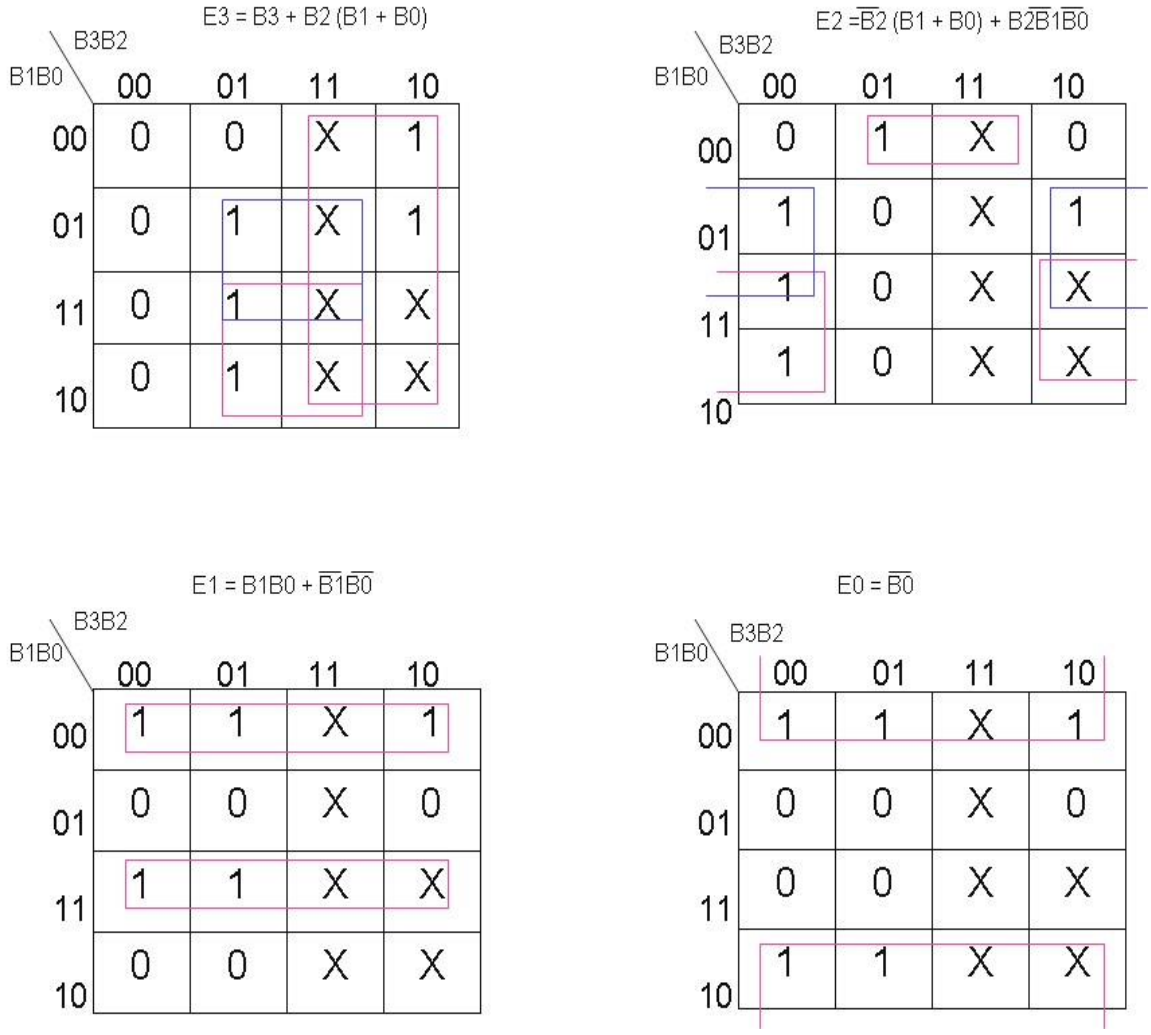


Fig. 8 K-Map For Reduced Boolean Expressions Of Each Output (Excess-3 Code)

3) Circuit Diagram:

BCD TO EXCESS-3 CONVERTER

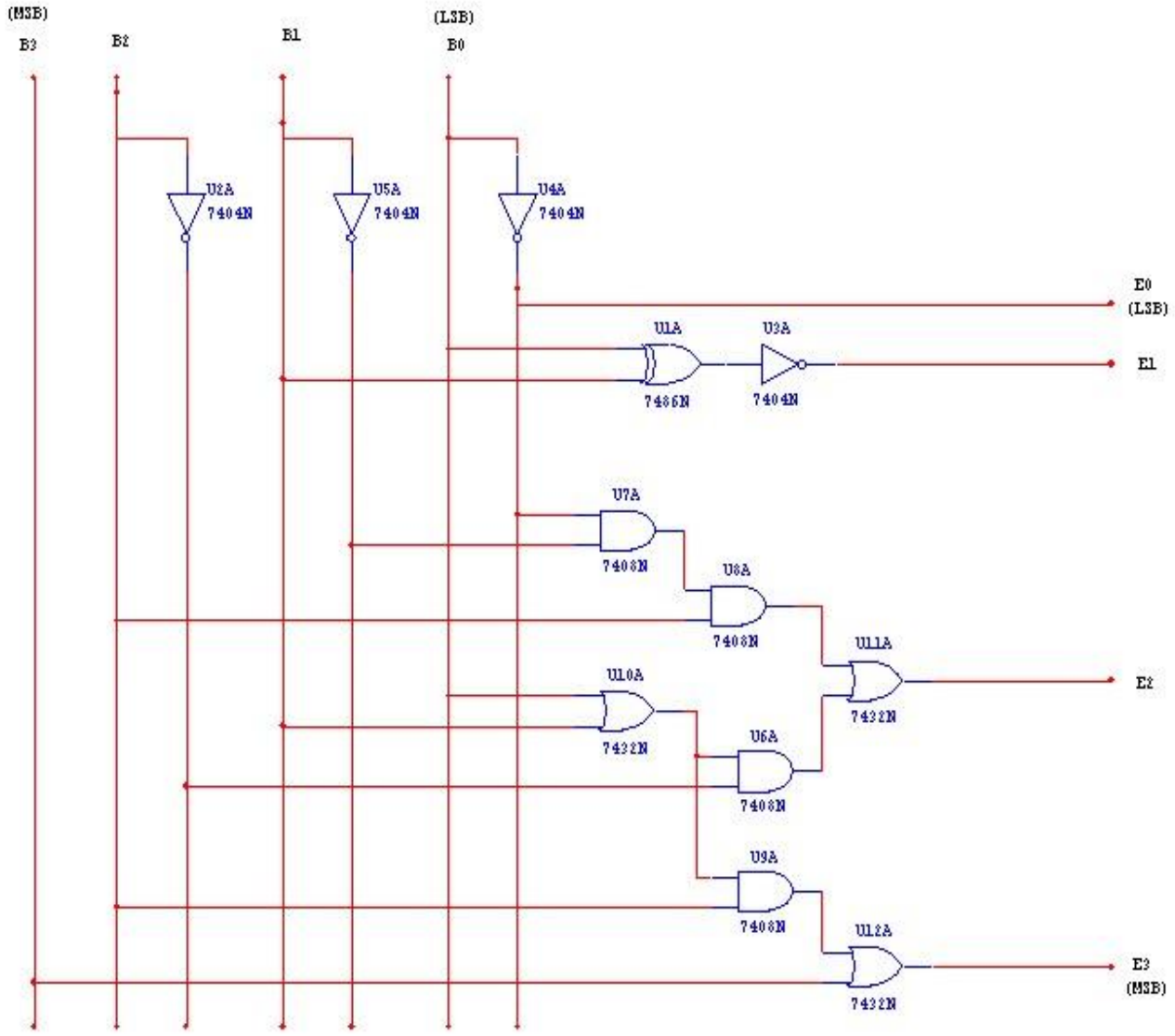


Fig.9 Logic Diagram for BCD to Excess-3 Code Conversion

4) Hardware Requirements Table:

GATE	Quantity	IC	Quantity
XOR	1	7486	1
NOT	4	7404	1
AND	4	7408	1
OR	3	7432	1

Table 5 Hardware Requirement Table

Test the circuit for all possible combinations of input and output codes.

Conclusion:

Thus, we studied different codes and their conversions including applications.

The truth tables have been verified using IC 7486, 7432, 7408, and 7404.

FAQ's with answers:

Q.1) What is the need of code converters?

→There is a wide variety of binary codes used in digital systems. Often it is required to convert from one code to another. For example the input to a digital system may be in natural BCD and output may be 7-segment LEDs. The digital system used may be capable of processing the data in straight binary format. Therefore, the data has to be converted from one type of code to another type for different purpose. Q.2) What is Gray code?

→It is a modified binary code in which a decimal number is represented in binary form in such a way that each Gray- Code number differs from the preceding and the succeeding number by a

single bit.(e.g. for decimal number 5 the equivalent Gray code is 0111 and for 6 it is 0101. These two codes differ by only one bit position i. e. third from the left.) It is non weighted code. Q.3) What is the significance of Gray code?

→Important feature of Gray code is it exhibits only a single bit change from one code word to the next in sequence. Whereas by using binary code there is a possibility of change of all bits if we move from one number to other in sequence (e.g. binary code for 7 is 0111 and for 8 it is 1000). Therefore it is more useful to use Gray code in some applications than binary code. Q.4) What are applications of Gray code?

→1. Important feature of Gray code is it exhibits only a single bit change from one code word to the next in sequence. This property is important in many applications such as Shaft encoders where error susceptibility increases with number of bit changes between adjacent numbers in sequence.

2. It is sometimes convenient to use the Gray code to represent the digital data converted from the analog data (Outputs of ADC).

3. Gray codes are used in angle-measuring devices in preference to straight forward binary encoding.

4. Gray codes are widely used in K-map

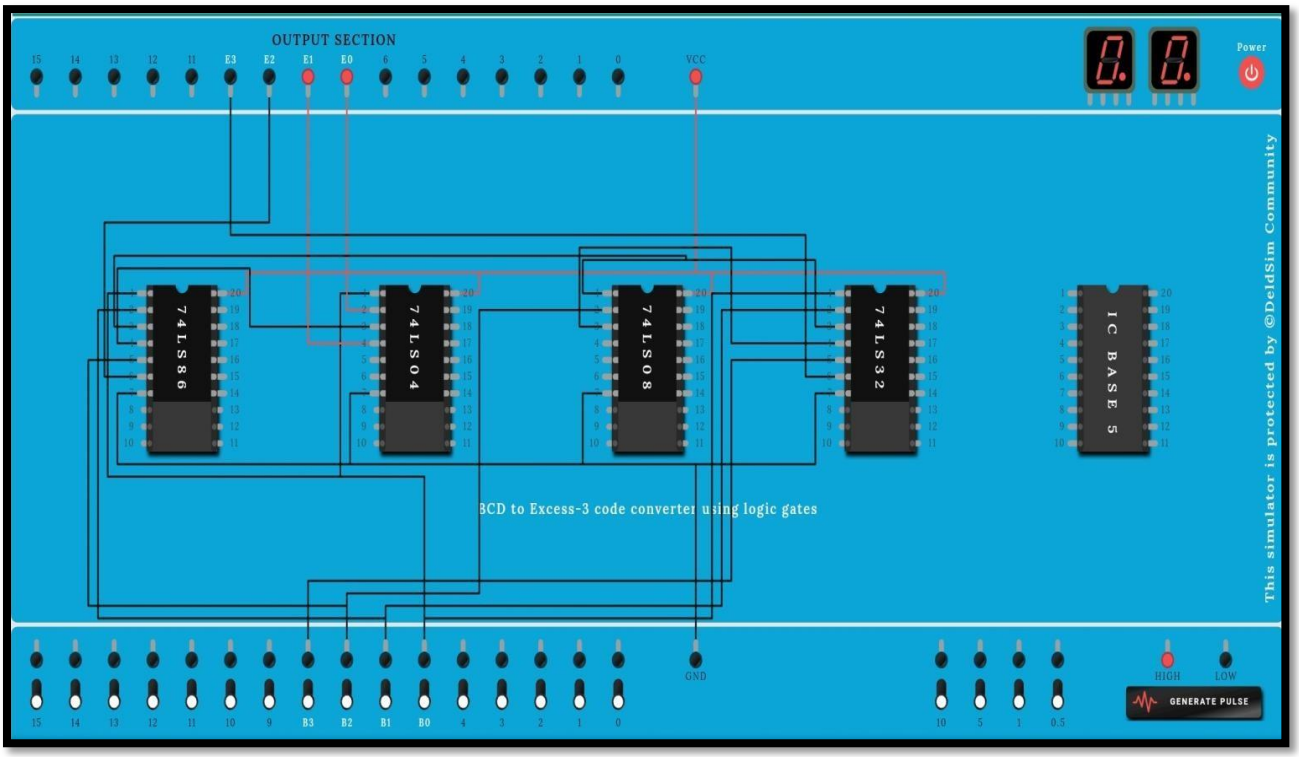
Q.5) What are weighted codes and non-weighted codes?

→ In weighted codes each digit position of number represents a specific weight. The codes 8421, 2421, and 5211 are weighted codes. Non weighted codes are not assigned with any weight to each digit position i.e. each digit position within the number is not assigned a fixed value. Gray code, Excess-3 code are non-weighted code.

Q.6) Why is Excess-3 code called as self-complementing code?

→Excess-3 code is called self-complementing code because 9's complement of a coded number can be obtained by just complementing each bit. Q.7) What is invalid BCD?

→With four bits, sixteen numbers (0000 to 1111) can be represented, but in BCD code only 10 of these are used as decimal numbers have only 10 digits fro 0 to 9. The six code combinations (1010 to 1111) are not used and are invalid.


OUTPUT SECTION
15 14 13 12 11 E3 E2 E1 E0 6 5 4 3 2 1 0 VCC
Power
74LS86
74LS04
74LS08
74LS32
IC BASE 5
BCD to Excess-3 code converter using logic gates
This simulator is protected by ©DeldSim Community
15 14 13 12 11 10 9 B3 B2 B1 B0 4 3 2 1 0
GND
10 5 1 0.5
HIGH LOW
GENERATE PULSE