

# Tutorial #2 - The Blackjack Machine

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## Game Rules

- This game involves 2 players, hereafter called *Player* or *P* and *Bank* or *B*. These two players use a standard deck of poker playing cards
- *P* is on call at the beginning of the game and it can decide whether playing on his/her turn or wait for *B* to play first
- When one of the two roles decides to play, a card has to be extracted from the deck, and its value has to be added to the current score
- The initial score of each player is 0 for every new game
- The purpose of the game is to get closer enough to 21, without achieving scores greater than that number
- When *P* crosses that limit, *B* wins
- *B* tries to achieve *P*'s score, without exceeding its result. When *B* surpasses *P*'s score, *P* wins

## Behavior (1/2)

- The top level module requires 4 input signals (1 bit of parallelism), that are *Reset*, *NewGame*, *Stop* and *En*. Another 3 bits input *I* has to be employed in order to sample the playing card currently selected from the deck
- The circuit's behavior follows:
  - Whenever *Reset* is pressed, the FSM re-starts from the initial state. Display digits and led bar should be off in this phase
  - The very first time *NewGame* is pressed, the circuit becomes ready to play a new game: the 2 rightmost digits of the 7-segments display show the value "00", that is the initial score
  - It's *P*'s turn, thus input *I* is sampled whenever *En* is pressed. The random extraction ranges from 1 to 8, that are the available cards in the deck. The binary encoding is constrained to 3 bits  $\{1_{10} = 001_2, 2_{10} = 010_2 \dots 8_{10} = 000_2\}$

## Behavior (2/2)

- $P$  keeps on playing since the *Stop* button is pressed. Now it's  $B$ 's turn, and its initial score is prompted on the 2 leftmost digits of the 7-segments display ("00").  $P$ 's score keeps on being shown on the rightmost 2
- Whenever *En* is pressed, a new extraction is sampled and the card value is shown on the display and added to the previous score
- The game is over whenever:
  - $B$ 's current score is greater than  $P$ 's score, but less than or equal to 21
  - $B$ 's current score is greater than 21 and in this case  $P$  wins
  - $P$  is ranked higher than 21 in its turn, and in this case  $B$  wins
- Once the winner is determined, the relative 2 decimal separators turn on (leftmost 2 for  $B$  and rightmost 2 for  $P$ )
- The game restarts when *NewGame* is pressed

- The machine displays the current card using the led bar, encoding its number (1-8) in a binary fashion (that is a thermometric encoding). If you desire to extend the circuit in order to handle higher card numbers, you may use a pure binary encoding. In this case, the leftmost 4 leds will be used when  $B$  plays and the rightmost will be employed for  $P$ 's turns
- Please implement the circuit I/O mappings in such a way that  $\{BTN3, BTN2, BTN1, BTN0\}$  buttons are related to  $\{Reset, NewGame, Stop, En\}$  inputs and  $\{SW[7], SW[6], SW[5]\}$  switches are used in order to simulate the card extraction from the deck. If you are implementing the manual (non-random) card extractor,  $\{SW[7], SW[6], SW[5]\}$  switches will be your  $I$  signal. Otherwise, you can use them to feed the initial value of the random number generator
- The circuit should work at a frequency of about 50kHz
- Numbers on the 7-segments display should be shown using a decimal base, using the following convention  $\{1, 2, 3, \dots, 10, 11, \dots, 21\}$