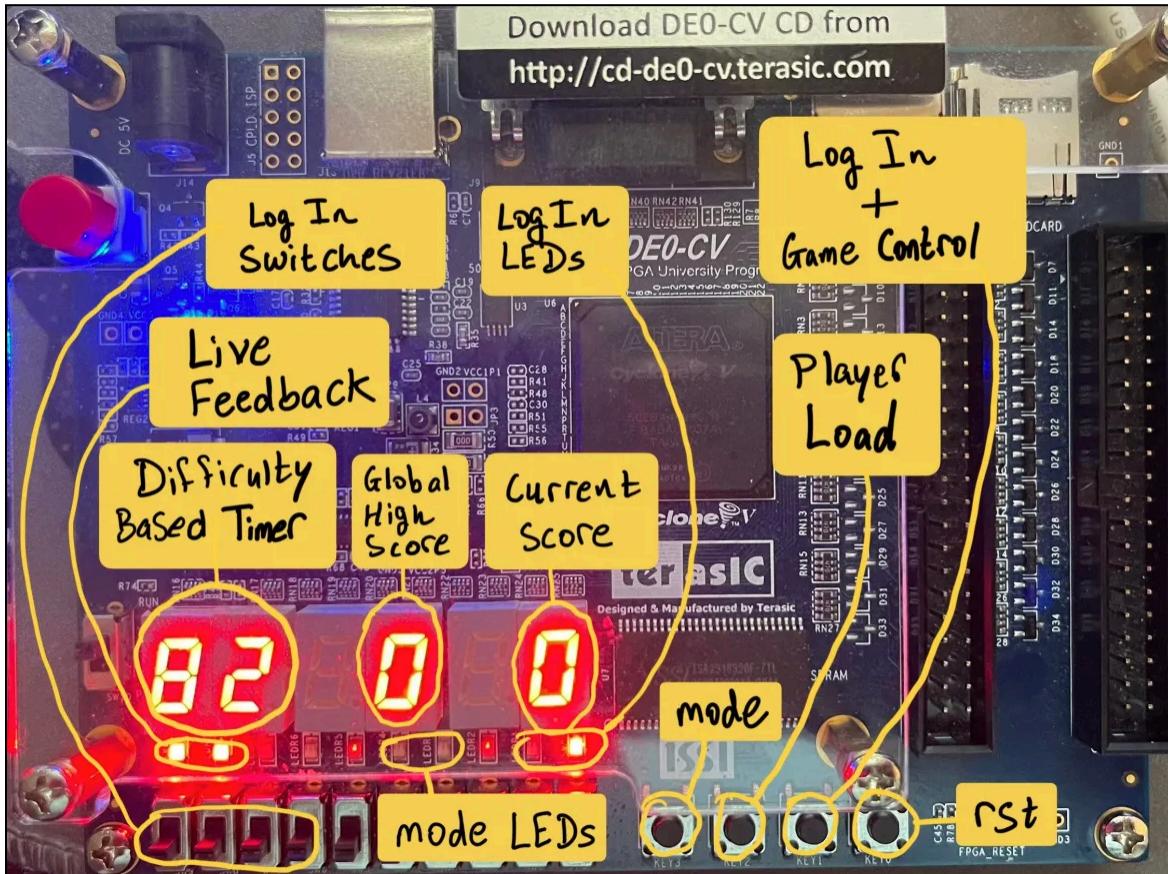


User Manual: CodeBreaker: Morse Code Training Game on FPGA Board

1. System Description

The Morse Code Training Game is a fully integrated real-time learning and evaluation system implemented on the DE0-CV FPGA board using Verilog. It is designed to train users in Morse code recognition and entry through timed gameplay. The system incorporates secure multi-user authentication, VGA-based interface rendering, per-letter decoding, and match verification against stored words in memory. Each user logs in with a predefined ID and password before accessing the game. During the session, the user is shown a 5-letter word and must enter each letter in Morse code using physical buttons. The system validates each entry, provides live feedback via LEDs and VGA, and tracks the total score and high score for each session. This project reinforces concepts in FSM design, symbol encoding, timed input processing, and hardware-software interfacing.

Below is a picture of the DE0-CV FPGA board with the designated components marked for the game:



2. Board Overview

Designated Components and Features:

- **Reset Button:** Resets the system and returns to the login screen.
 - **Toggle Switches:** Used to input 4-digit ID and password values.
 - **Input Button (PassBtn):** Confirms each digit entry for ID and password.
 - **Dot and Dash Buttons:** Used during gameplay to enter Morse symbols.
 - **Load Button (Symbol Load):** Confirms each Morse symbol input.
 - **LED Indicators (5):** Show correctness of ID/password digits and per-letter match feedback.
 - **Seven-Segment Display:** Shows countdown timer during gameplay.
 - **VGA Output:** Displays system prompts, current word, user-decoded letters, and score.
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3. System Operation

A. Login and Authentication

1. **Initialize the System:** Press the reset button to begin.
2. **Enter User ID:**
 - Use the toggle switches to set each 4-bit digit.
 - Press the PassBtn to confirm each of the four digits sequentially.
3. **Enter Password:**
 - After ID is accepted, repeat the process for four-digit password entry.
4. **Access Granted:**
 - Upon successful verification, the LED indicators show digit-level correctness.
 - VGA display transitions to the game interface.

B. Gameplay Sequence

1. **Game Start:**
 - A 5-letter word is selected from ROM_WORDS and shown on the VGA screen.
 2. **Enter Morse Code:**
 - Use the dot and dash buttons to input symbols.
 - Press the load button after each symbol. Each letter is composed of four entries.
 - After four inputs, the system decodes the sequence and shows the ASCII character.
 3. **Validation:**
 - The decoded letter is checked against the current letter in the word.
 - LED indicators show per-letter correctness.
 - Upon matching all five letters, a point is awarded.
 4. **Timer:**
 - A 2-minute timer counts down using the OneSecTimer and digitTimer modules.
 - The session ends when time runs out or the user logs out.
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4. Scoring and Feedback

- **Points:** One point is awarded for each correctly matched 5-letter word.
 - **High Score:** The system automatically updates the high score if the user achieves a new best.
 - **Visual Output:**
 - **LEDs** indicate real-time input correctness.
 - **VGA Display** shows system state, current word, user input, and scores.
 - **Seven-Segment Display** shows the countdown timer in minutes and seconds.
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5. System Reset and Logout

- **Timeout:** After 2 minutes, the game ends automatically.
 - **Logout:** Holding the logout button for 3 seconds during the game ends the session early and returns to the login screen.
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6. Educational Objectives

This project demonstrates secure authentication, sequential input capture, Morse code translation, and real-time game logic. It integrates FSM design, LFSR-based timers, ROM memory interfacing, VGA display control, and synchronized user feedback—providing a practical, hands-on application of digital design on an FPGA platform.