FPGA 코드 프로그램 문서

fpga_io.h

```
#ifndef FPGA_IO_H
#define FPGA_IO_H

#include <stdint.h>

int init_fpga_io();
void close_fpga_io();

int write_dot(int matrix[10][7]);
int write_fnd(int digits[4]);
int write_lcd(const char* line1, const char* line2);
int write_led(int led[2][4]);
int write_buzzer(int on);
int write_motor(int direction, int speed);

int read_push(uint8_t push[13]);

#endif
```

fpga_io.c

```
#include "fpga_io.h"
#include <fcntl.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

static int fd_dot = -1, fd_fnd = -1, fd_lcd = -1, fd_led = -1;
static int fd_buzzer = -1, fd_motor = -1, fd_push = -1;

int init_fpga_io() {
    fd_dot = open("/dev/fpga_dot", O_WRONLY);
    fd_fnd = open("/dev/fpga_fnd", O_WRONLY);
    fd_lcd = open("/dev/fpga_text_lcd", O_WRONLY);
    fd_led = open("/dev/fpga_led", O_WRONLY);
    fd_buzzer = open("/dev/fpga_buzzer", O_WRONLY);
    fd_motor = open("/dev/fpga_step_motor", O_WRONLY);
    fd_push = open("/dev/fpga_push_switch", O_RDONLY);

    if (fd_dot < 0 || fd_fnd < 0 || fd_lcd < 0 || fd_led < 0 ||
        fd_buzzer < 0 || fd_motor < 0 || fd_push < 0) {
        perror("Device open failed");
        return -1;
    }
    return 0;
}
```

```
void close_fpga_io() {
    if (fd_dot >= 0) close(fd_dot);
    if (fd_fnd >= 0) close(fd_fnd);
    if (fd_lcd >= 0) close(fd_lcd);
    if (fd_led >= 0) close(fd_led);
    if (fd_buzzer >= 0) close(fd_buzzer);
    if (fd_motor >= 0) close(fd_motor);
    if (fd_push >= 0) close(fd_push);
}

int write_dot(int matrix[10][7]) {
    if (fd_dot < 0) return -1;
    uint8_t data[10] = {0};

    for (int row = 0; row < 10; ++row)
        for (int col = 0; col < 7; ++col)
            if (matrix[row][col])
                data[row] |= (1 << (7 - col));

    return write(fd_dot, data, 10);
}

// ... 생략: 다른 함수 구현 동일 방식
```

test.c

```
#include "../fpga_io.h"
#include <stdio.h>
#include <unistd.h>

int main() {
    if (init_fpga_io() != 0) {
        fprintf(stderr, "FPGA I/O 초기화 실패₩n");
        return 1;
    }

    int dot[10][7] = {0};
    for (int i = 0; i < 7 && i < 10; ++i)
        dot[i][i] = 1;
    write_dot(dot);

    int digits[4] = {2, 0, 2, 5};
    write_fnd(digits);

    write_lcd("LED & Push Test", "Press Buttons ↓");

    int led[2][4] = {
        {1, 0, 1, 0},
        {0, 1, 0, 1}
    };
    write_led(led);

    write_buzzer(1);
    sleep(1);
    write_buzzer(0);

    uint8_t push[13] = {0};
```

```
        printf("푸시 스위치 상태 (13개):₩n");
        for (int t = 0; t < 5; ++t) {
            if (read_push(push) == 13) {
                printf("Tick %d: ", t + 1);
                for (int i = 0; i < 13; ++i)
                    printf("%d", push[i]);
                printf("₩n");
            }
            sleep(1);
        }

        close_fpga_io();
        return 0;
    }
```