Software Requirement Analysis

for AAA System

Project Team

Team 3

Date

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Table of Contents

1   Introduction

1.1   Purpose

Digital watch System에서 사용할 수 있는 SW를 구현하기 위한 요구사항을 명세한 문서이다.

1.2   Scope

1.2.1 개발팀

3팀

1.2.2 제한사항

HW (손목시계)와 연동까지 고려하지 않고, SW로만 구동할 수 있도록 한다

1.2.3 제품의 활용도

개발이 완료된 후 실제 손목시계의 SW를 개발하기 위한 프로토타입으로 삼을 수 있다.

1.2.4 개발환경

IDE: Eclipse, Text editor Compiler: GCC (MinGW, Cygwin)

1.3   Definition, acronyms, and abbreviations

SW: Software

HW: Hardware

buzzing : Boolean type으로 Buzzer가 울리고 있는지를 나타냄

Button_data : Character Type으로 입력된 버튼 값을 저장함

backlight_Time : Integer Type으로 Backlight가 켜진 시간을 나타냄

LIGHT_STATE : Boolean type으로 Backlight가 켜져 있는지를 나타냄

alarm_indicator_data : Boolean type으로 Alarm Indicator가 켜져 있는지를 나타냄

LAP_TIME_STATE : Boolean type으로 Lap Time이 화면에 출력되고 있는지를 나타냄

sm_data : Integer type으로 Time Setting Mode 일 때 1, Alarm Time Setting Mode 일 때 2, 둘 다 아닐 때 0이다.

time_pointer : Interger Type으로 Time Setting Mode에서 가리키고 있는 시간 단위를 나타낸다. 값이 0일 때 초, 1일 때 분, 2일 때 시, 3일 때 일, 4일 때 월, 5일 때 연도를 가리키고 있음을 의미한다.

alarm_time_pointer : Integer Type으로 Alarm Setting Mode에서 가리키고 있는 시간 단위를 나타낸다. 값이 0일 때 시, ㅇ

1.4 Reference

IEEE Std. 830-1998

1.5 Overview

2 Overall Description

2.1 Product Perspective

대상 제품은 실제 손목시계에 사용될 수 있는 제품이 될 수 있다. HW(버튼) 에 의한 동작을 처리하고, 처리한 결과는 HW (화면) 에 출력한다. 실제 HW에 의한 동작은 SW 및 console화면으로 처리하여 기능의 동작 유무를 확인하도록 한다. 시계 HW는 4 개의 버튼과 LCD 화면을 가진 것으로 한다.

2.2 Product functions

2.2.1 Date-Time

화면에 일자와 시간을 표시한다.
오후 시간 표시는 24시로 표현한다.

2.2.2 Stopwatch

시간의 경과를 알려주고, 특정 순간의 시간을 알려준다.
1/100 초 단위로 측정이 가능하다.
Lap time 기록이 가능하다.

2.2.3 Backlight

출력하는 문자의 색깔을 노란색으로 표시한다.

2.2.4 Alarm

alarm이 설정되면 alarm indicator가 켜진다.

정해 놓은 시간에 소리(beep 음)로 알려준다.

알람은 5 초간 울린다. 알람이 울릴 때 a, b, c, d 중 아무 버튼을
누르면 소리가 꺼진다.

2.3 User characteristics

2.4 Constraints

날짜의 표기법은 '월-일' 이다.

초기 시간은 2019년 01월 01일 00시 00분 00초이다.

2019-1-1 부터 2099년까지 표시가 가능하다. 알람
을 설정할 때 시, 분은 반드시 설정해야 한다.

2.5 Assumptions and dependencies

버튼입력은 키보드 입력으로 대신한다. 버튼이 여러 개 입
력되었을 때 우선순위는 D>C>B>A 이다. 시간을 수정할
때 선택된 부분이 깜박이는 표현은 숫자 밑에 밑줄을 표시
하는 것으로 대체한다.

Backlight는 실제 시계의 경우 LED를 켜는 것으로 구현되어야 하지만 출력되는 문자의
색을 바꾸는 것으로 대체한다.

알람 음은 PC의 Beep로 대체한다.

3   Structured Analysis

3.1   System Context Diagram

3.1.1   System Context Diagram

System Context Diagram
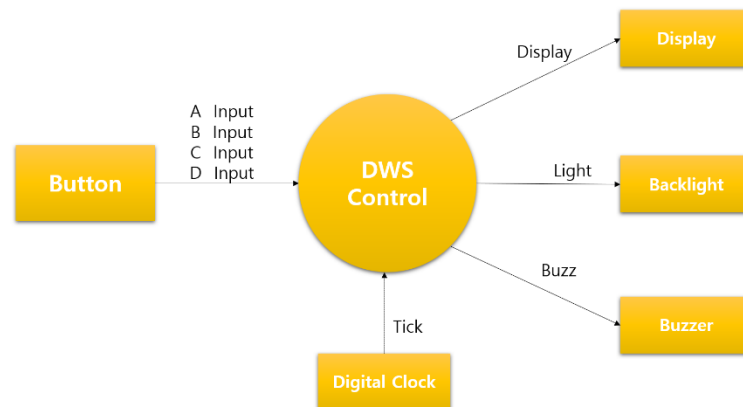
3.1.2 Event List

Event	Description
A input	If Button A is pushed, transfer character data "A" to DWS Control.
B input	If Button B is pushed, transfer character data "B" to DWS Control.
C input	If Button C is pushed, transfer character data "C" to DWS Control.
D input	If Button D is pushed, transfer character data "D" to DWS Control.
Display	Display time or menu of each mode.
Light	Turn on the light on display.
Buzz	Sound "Beep".
Tick	Trigger each Millisecond.

3.2   Data Flow Diagram

3.2.1 DFD level 0

3.2.1.1 DFD

DFD Level 0
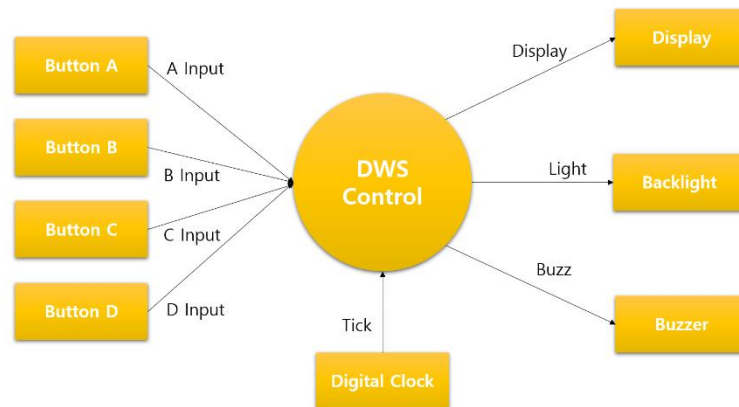
3.2.1.2   Process Specification

3.2.1.2.1   Process 1

Reference No	0
Name	DWS Control
Input	A Input, B Input, C Input, D Input , Tick
Output	Display , Light, Buzz
Process Description	DWS Control gets inputs of A,B,C,D and sends commands to Backlight, Buzzer and Display

3.2.1.3   Data Dictionary

Data	Description	Format/Type
A Input	Button A Input from user	Analogue Value, Interrupt
B Input	Button B Input from user	Analogue Value, Interrupt
C Input	Button C Input from user	Analogue Value, Interrupt
D Input	Button D Input from user	Analogue Value, Interrupt
Display	Display Watch Screen	Day of week /Month/Date/Hour/Minute/Second/Alarm Indicator/Mode Indicator
Light	Turn the Backlight on	Boolean
Buzz	Buzz the buzzer	Boolean

3.2.2 DFD Level 1

3.2.2.1 DFD

DFD Level 1
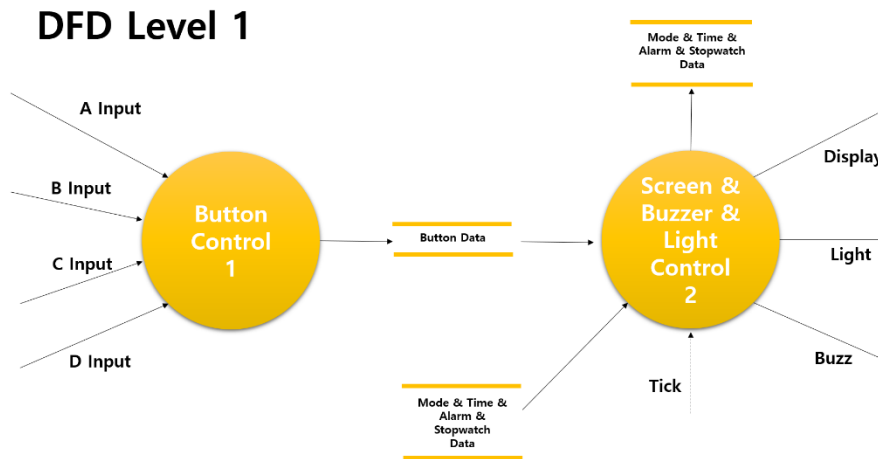
3.2.2.2 Process Specification

3.2.2.2.1 Process #1

Reference no	1
Name	Button Control
Input	A Button Input, B Button Input, C Button Input, D Button Input
Output	Button Data
Process Description	"Button Control" process reads analog value from the Button sensors by interrupt, converts it into digital character value, and assigns it into output variable "Button Data"

3.2.2.2.2 Process #2

Reference No	2
Name	Screen & Buzzer & Light Control
Input	Button, Time, Mode, Alarm Data
Output	Display, Light, Buzz

3.2.2.2.3 Data Dictionary

Data	Description	Format/type
A Input	Button A Input from user	Analogue Value, Interrupt
B Input	Button B Input from user	Analogue Value, Interrupt
C Input	Button C Input from user	Analogue Value, Interrupt
D Input	Button D Input from user	Analogue Value, Interrupt
Button Data	Data of pushed button. If button A is pushed, set Button_data as character data "A". If button B is pushed, set Button_data as character data "B". If button C is pushed, set Button_data as character data "C". If button D is pushed, set Button_data as character data "D". If any button isn't pushed, set Button_data as NULL	Character
Time Data	Data of current time. (int t_second, int t_minute, int t_hour, int t_date, int t_month, int t_year, int t_day) Each data is data of current time. t_second means second value of current time, and its range is 1 to 59. t_minute means minute value of current time, and its range is 1 to 59. t_hour means hour value of current time, and its range is 0 to 23. t_date means date value of current time, and its range is 1 to 31. t_month means	Struct of integers

	month value of current time, and its range is 1 to 12. t_year means year value of current time, and its range is 2019 to 2099. t_day means day value of current time,(like Monday, Sunday...) and its range is 0 to 6. *Initial value t_year : 2019 t_month : 1 t_date : 1 t_day : 1(cause 2019 1/1 is Tuesday) t_hour : 0 t_minute : 0 t_second : 0 Data of Time Setting value. (ts_second, ts_minute, ts_hour, ts_date, ts_month, ts_year, ts_day) :When the mode changes to time setting mode, get the data of current time(t_second, t_minute...) and set the value of time setting data as it. (Ex) ts_second=t_second, t_minute=ts_minute, t_hour=ts_hour ....) The initial value of ts data. ts_year : 2019 ts_month : 1 ts_date : 1 ts_day : 1 ts_hour : 0 ts_minute : 0 ts_second : 0	
Mode	Mode data of each modes.	Struct of integers

Data	This includes 'int sm_data','int time_pointer','int alarm_time_pointer','bool LAP_TIME_STATE','bool LIGHT_STATE', 'alarm_indicator _data'.	
	'sm _data' indicates that the mode now is Setting mode. If the mode now is "Time Setting Mode". Set the sm_data as 1. If the mode now is "Alarm Setting Mode", set the sm_data as 2. If the mode now is "Time Setting Mode" nor "Alarm Setting Mode" set the sm_data as 0. The initial value is 0.	
	'time_pointer' indicates that which data in time data will be changed like second,minute,hour.... For example, in the time setting mode, if time_pointer is 0, that means the value that selected now is second. When the time_pointer is 1 it means the value that selected now is minute. When the time_pointer is 2 it means the value that selected now is hour.	
	When the time_pointer is 3 it means the value that selected now is date.	
	When the time_pointer is 4 it means the value that selected now is month.	
	When the time_pointer is 5 it means the value that selected	

	now is year. 'Alarm_time_pointer' indicates that which data in alarm data will be changed. For example, in the Alarm setting mode, if alarm_time_pointer is 0, that means the value that selected now is minute. When the alarm_time_pointer is 1 it means the value that selected now is hour. 'LAP_TIME_STATE' indicates that the laptime is shown on the display now or not. If the value is 0 it means that laptime is not visible on the display, if the value is 1, it is visible. 'LIGHT_STATE' indicates that LIGHT_STATE. If the value is 0 it means light turns off now. If the value is 1, it means light turns on now. 'Alarm_indicator_data' indicates that the alarm indicator is visible on the display or not. It's also means that the alarm is on or off. If alarm is available now, the data of 'alarm_indicator_data' is set by 1 and visible on display. If alarm is unavailable now, the data of 'alarm_indicator_data' is set by 0, and not visible on display.	
Alarm Data	Data of Alarm's Month/Day/Hour/Minute, buzzing, buzzing_time(How	Struct(Integer/Boolean)

	long the buzzer buzzed) *Value range Month : 1-12 Day : 1-31 Hour : 0-23 Minute : 0-59 *Initial value Month : 1 Day : 1 Hour : 0 Minute : 0 Buzzing : false Buzzing_time : 0	
Stopwatch Time	Data of Stopwatch's minute/second/centisecond(These are the values measured by the stopwatch) and Lap time. Time is measured in centiseconds. * Value range(Integer) Centisecond : 0-99 Second : 0-59 Minute : 0-99 Lap time centisecond : 0-99 Lap time second : 0-59 Lap time minute : 0-99	Struct(integer)
Display	Display Watch Screen	Day of week /Month/Date/Hour/Minute/Second /Alarm Indicator/Mode Indicator
Light	Value of LIGHT_STATE	Boolean
Buzz	Value of buzzing	Boolean

3.2.3 DFD Level 2

3.2.3.1 DFD

DFD Level 2
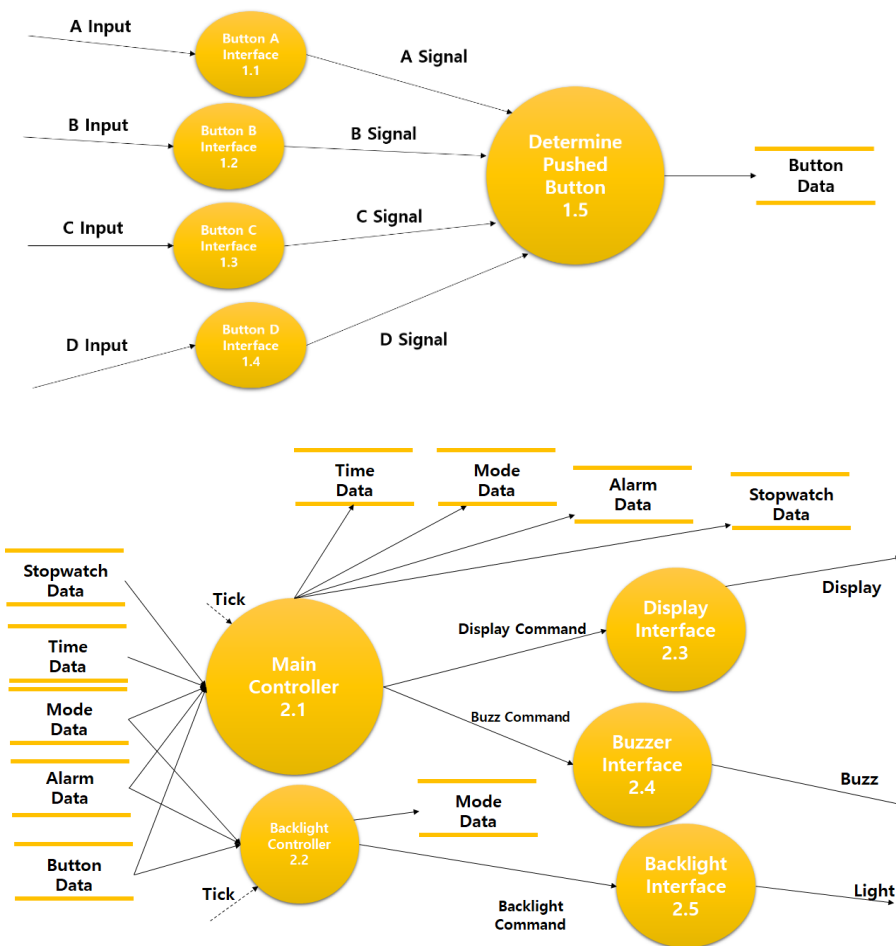
3.2.3.2 Process Specification

3.2.3.2.1 Process 1.1

Reference No	1.1
Name	Button A Interface
Input	A Input
Output	A Signal
Process Description	"A Input", process read analog value by interrupt, converts into a digital value and assigns it into output variable "A Signal".

3.2.3.2.2 Process 1.2

Reference No	1.2
Name	Button B Interface
Input	B Input
Output	B Signal
Process Description	"B Input", process read analog value by interrupt, converts into a digital value and assigns it into output variable "B Signal".

3.2.3.2.3 Process 1.3

Reference No	1.3
Name	Button C Interface
Input	C Input
Output	C Signal
Process Description	"C Input", process read analog value by interrupt, converts into a digital value and assigns it into output variable "C Signal".

3.2.3.2.4 Process 1.4

Reference No	1.4
Name	Button D Interface
Input	D Input
Output	D Signal
Process Description	"D Input", process read analog value by interrupt, converts into a digital value and assigns it into output variable "D Signal".

3.2.3.2.5 Process 1.5

Reference No	1.5
Name	Determine Pushed Button
Input	A Signal, B Signal, C Signal, D Signal
Output	Button Data
Process Description	"Determine Pushed Button" process reads button signals and determine which button was pressed, then stores Button_Data. If multiple buttons were pressed, D>C>B>A has higher priority. if)A==true -> Button_Data='A' Else if)B==true -> Button_Data ='B' Else if)C==true -> Button_Data ='C' Else if)D==true -> Button_Data ='D')

3.2.3.2.6 Process 2.1

Reference No	2.1
Name	Main Controller
Input	Button Data, Time Data, Mode Data, Alarm Data, Stopwatch Data, Tick
Output	Mode Data, Time Data, Stopwatch Data, Display Command, Buzz Command
Process Description	"Main Control" process reads Data of Button, Time, Mode, and Alarm and determine "Display Command", "Buzz Command", "Light Command" and transfer them to their interfaces and renew Button, Time, Mode, and Alarm Data.

3.2.3.2.7 Process 2.2

Reference No	2.2
Name	Backlight Controller
Input	Button Data, Alarm Data, Mode Data, Tick
Output	Mode Data, Backlight Command
Process Description	"Backlight Control" process reads Data of Button, Alarm, Mode, and determine "Backlight Command" and transfer

3.2.3.2.8 Process 2.3

Reference No	2.3
Name	Display Interface
Input	Display Command
Output	Display
Process Description	"Display Interface" process gets "Display Command " and display on the watch display followed by its command.

3.2.3.2.9 Process 2.4

Reference No	2.4
Name	Buzzer Interface
Input	Buzz Command
Output	Buzz
Process Description	"Buzz Interface" process gets "Buzz Command " and make beep sound followed by its command

3.2.3.2.10 Process 2.5

Reference No	2.5
Name	BackLight Interface
Input	Light Command
Output	Light
Process Description	."BackLight Interface" process gets "Backlight Command " and turn light on the display followed by its command.

3.2.3.2.11 Data Dictionary

Data	Description	Format/type
A Input	Button A Input from user	Analogue Value, Interrupt
B Input	Button B Input from user	Analogue Value, Interrupt
C Input	Button C Input from user	Analogue Value, Interrupt
D Input	Button D Input from user	Analogue Value, Interrupt
A Signal	Character value 'A' from Button A Interface	Character
B Signal	Character value 'B' from Button B Interface	Character
C Signal	Character value 'C' from	Character

	Button C Interface	
D Signal	Character value 'D' from Button D Interface	Character
Button Data	Data of pushed button. If button A is pushed, set Button_data as character data "A". If button B is pushed, set Button_data as character data "B". If button C is pushed, set Button_data as character data "C". If button D is pushed, set Button_data as character data "D". If any button isn't pushed, set Button_data as NULL	Character
Time Data	Data of current time. (int t_second, int t_minute, int t_hour, int t_date, int t_month, int t_year, int t_day) Each data is data of current time. t_second means second value of current time, and its range is 1 to 59. t_minute means minute value of current time, and its range is 1 to 59. t_hour means hour value of current time, and its range is 0 to 23. t_date means date value of current time, and its range is 1 to 31. t_month means month value of current time, and its range is 1 to 12. t_year means year value of current time, and its range is 2019 to 2099. t_day means	Struct of integers

	day value of current time,(like Monday, Sunday...) and its range is 0 to 6. *Initial value t_year : 2019 t_month : 1 t_date : 1 t_day : 1(cause 2019 1/1 is Tuesday) t_hour : 0 t_minute : 0 t_second : 0 Data of Time Setting value. (ts_second, ts_minute, ts_hour, ts_date, ts_month, ts_year, ts_day) :When the mode changes to time setting mode, get the data of current time(t_second, t_minute...) and set the value of time setting data as it. (Ex) ts_second=t_second, t_minute=ts_minute, t_hour=ts_hour ....) The initial value of ts data. ts_year : 2019 ts_month : 1 ts_date : 1 ts_day : 1 ts_hour : 0 ts_minute : 0 ts_second : 0	
Mode Data	Mode data of each modes. This includes 'int sm_data','int time_pointer','int alarm_time_pointer','bool	Struct of integers

	LAP_TIME_STATE','bool LIGHT_STATE','Alarm_indicator_data'. 'sm _data' indicates that the mode now is Setting mode. If the mode now is "Time Setting Mode". Set the sm_data as 1. If the mode now is "Alarm Setting Mode", set the sm_data as 2. If the mode now is "Time Setting Mode" nor "Alarm Setting Mode" set the sm_data as 0. The initial value is 0. 'time_pointer' indicates that which data in time data will be changed like second,minute,hour.... For example, in the time setting mode, if time_pointer is 0, that means the value that selected now is t_second. When the time_pointer is 1 it means the value that selected now is t_minute. When the time_pointer is 2 it means the value that selected now is t_hour. When the time_pointer is 3 it means the value that selected now is t_date. When the time_pointer is 4 it means the value that selected now is t_month. When the time_pointer is 5 it means the value that selected now is t_year. 'Alarm_time_pointer'	

	indicates that which data in alarm data will be changed. For example, in the Alarm setting mode, if alarm_time_pointer is 0, that means the value that selected now is minute. When the alarm_time_pointer is 1 it means the value that selected now is hour. 'LAP_TIME_STATE' indicates that the laptime is shown on the display now or not. If the value is 0 it means that laptime is not visible on the display, if the value is 1, it is visible. 'light_state' indicates that LIGHT_STATE. If the value is 0 it means light turns off now. If the value is 1, it means light turns on now. 'Alarm_indicator_data' indicates that the alarm indicator is visible on the display or not. It's also means that the alarm is on or off. If alarm is available now, the data of 'alarm_indicator_data' is set as 1 and visible on display. If alarm is unavailable now, the data of 'alarm_indicator_data' is set as 0, and not visible on display.	
Alarm	Data of Alarm's	Struct(Integer/Boolean)

Data	Hour/Minute, buzzing, buzzing_time(How long the buzzer buzzed) *Value range Hour : 0-23 Minute : 0-59 *Initial value Hour : 0 Minute : 0 Buzzing : false Buzzing_time : 0	
Stopwat ch Data	Data of Stopwatch's minute/second/centisecond(These are the values measured by the stopwatch) and Lap time. Time is measured in centiseconds. * Value range(Integer) Centisecond : 0-99 Second : 0-59 Minute : 0-99 Lap time centisecond : 0-99 Lap time second : 0-59 Lap time minute : 0-99	Struct(integer)
Display	Display Watch Screen	Signal
Display Comma nd	Data which is going to transfer to display	Day of week /Month/Date/Hour/Minute/Seco nd/Alarm Indicator/Mode Indicator
Light	Turn the backlight on	Signal
Backligh t Comma nd	Value of LIGHT_STATE	Boolean
Buzz	Ring the alarm	Signal

Buzz Command	Value of buzzing	Boolean

3.2.4 DFD Level 3

3.2.4.1 DFD
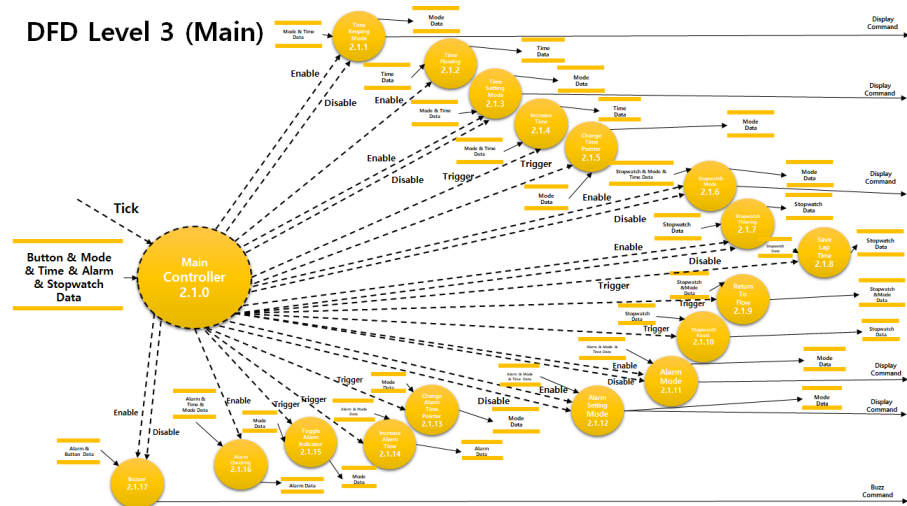
DFD Level 3 (Main)

DFD Level 3 (Backlight)
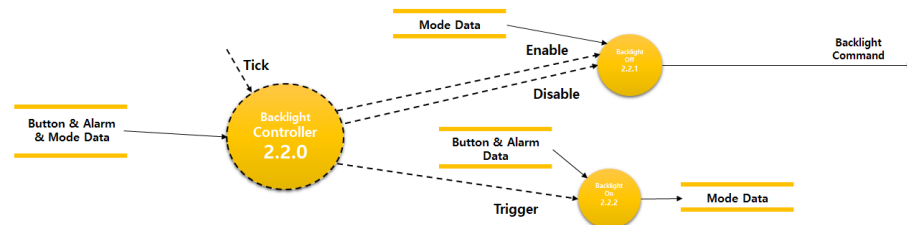
3.2.4.2 Process Specification

3.2.4.2.1 Process 2.1.0

Reference No	2.1.0
Name	Main Controller
Input	Button & Mode & Time & Alarm & Stopwatch Data
Output	Enable, Disable, Trigger
Process Description	This gets data, and send commands to components.

3.2.4.2.2 Process 2.1.1

Reference No	2.1.1
Name	Time Keeping Mode
Input	Mode & Time data
Output	Mode data, display command
Process Description	This display time now. This gets 't_second', 't_minute', 't_hour', 't_day','t_date','t_month','t_year' and display it. And this gets 'alarm_indicator_data' in Mode data. If the value of 'alarm_indicator_data' is 1, alarm indicator will be displayed. If the value of 'alarm_indicator_data' is 0, alarm indicator is not going to visible.

3.2.4.2.3 Process 2.1.2

Reference No	2.1.2
Name	Time Flowing
Input	Time data
Output	Time data
Process Description	This process increase the time data that means the flow of time. This increase the value of 't_second' in Time data by each second and if the value of 't_second' is 59, set it as 0. And increase the value of 't_minute' in Time data by 1. If the value of 't_minute' is 59 now, set it as 0, and increase the value of 't_hour' in Time data by 1. If the value of 't_hour' is 23 now, set it as 0 and increase the value of 't_date' and 't_day' by 1, but if the value of 't_day' is 6 now set it as 0. If the value of 't_month' is one in 1,3,5,7,8,10,12 and the value of 't_date' is 31 now, set 't_date' as 0 and

	increase the value of 't_month' by 1. If the value of 't_month' is one in 2,4,6,9,11 and the value of 't_date' is 30 now, set 't_date' as 0 and increase the value of 't_month' by 1. If the value of 't_month' is 12 now, set 't_month' as 1, and increase the value of 't_year' by 1.

<div align="center">3.2.4.2.4 Process 2.1.3</div>

Reference No	2.1.3
Name	Time Setting
Input	Mode Data, Time data, Enable, Disable
Output	Mode data, Display Command
Process Description	Set the value of 'sm_data' in Mode data as 1. Display the time setting data in Time data and flicker it by time_pointer in Mode data.

3.2.4.2.5 Process 2.1.4

Reference No	2.1.4
Name	Increase Time
Input	Mode Data, Time Data, Trigger
Output	Time Data
Process Description	This process increases the value of time data by the value of time_pointer in Mode data. If the value of time_pointer is 0 now, and there is trigger command, increase the value of 'ts_second' by 1. If the value of time_pointer is 1 now, and there is trigger command, increase the value of 'ts_minute' by 1. If the value of time_pointer is 2 now, and there is trigger command, increase the value of 'ts_hour' by 1. If the value of time_pointer is 3 now, and there is trigger command, increase the value of 'ts_date' by 1. If the value of time_pointer is 4 now, and there is trigger command, increase the value of 'ts_month' by 1. If the value of time_pointer is 5 now, and there is trigger command, increase the value of 'ts_year' by 1. And if the value of 'ts_second' is 59, set it as 0, and increase the value of 'ts_minute' in Time data by 1. If the value of 'ts_minute' is 59 now, set it as 0, and increase the value of 'ts_hour' in Time data by 1. If the value of 'ts_hour' is 23 now, set it as 0 and increase the value of 'ts_date' and

	'ts_day' by 1, but if the value of 'ts_day' is 6 now set it as 0. If the value of 'ts_month' is one in 1,3,5,7,8,10,12 and the value of 'ts_date' is 31 now, set 'ts_date' as 0 and increase the value of 'ts_month' by 1. If the value of 'ts_month' is one in 2,4,6,9,11 and the value of 'ts_date' is 30 now, set 'ts_date' as 0 and increase the value of 'ts_month' by 1. If the value of 'ts_month' is 12 now, set 'ts_month' as 1, and increase the value of 'ts_year' by 1.

3.2.4.2.6 Process 2.1.5

Reference No	2.1.5
Name	Change Time Pointer
Input	Mode data, Trigger
Output	Mode data
Process Description	Increase the value of time_pointer in Mode data by 1. If value of it is 5 when there is trigger command. Set it as 0.

3.2.4.2.7 Process 2.1.6

Reference No	2.1.6
Name	Stopwatch Mode
Input	Enable, Disable, Stopwatch Data, Mode Data, Time Data
Output	Mode data, Display Command
Process Description	This process get stopwatch data and display it. If the value of 'LAP_TIME_STATE' is 1, display Laptime data int Stopwatch Data(laptime centisecond, laptime second, laptime minute) And this gets 'alarm_indicator_data' in Mode data. If the value of 'alarm_indicator_data' is 1, alarm indicator will be displayed.

3.2.4.2.8 Process 2.1.7

Reference No	2.1.7
Name	Stop Watch Flowing
Input	Enable, Stopwatch Data
Output	Stopwatch Data
Process Description	It keeps track of stopwatch time flow. This process increase the Stopwatch data. This increase the value of 'centisecond' in Stopwatch data by each second and if the value of 'centisecond' is 99, set it as 0. And increase the value of 'second' in Stopwatch data by 1. If the value of 'second' is 59 now, set it as 0, and increase the value of 'minute' in Stopwatch data by 1.

3.2.4.2.9 Process 2.1.8

Reference No	2.1.8
Name	Save Lap Time
Input	Stopwatch Data, Mode Data, Trigger
Output	Stopwatch Data, Mode Data
Process Description	Saves current stopwatch elapsed time as lap time in stopwatch data. Set the value of LAP_TIME_STATE in Mode data as 1. Each centisecond, second, minute in Stopwatch Data is set as laptime centisecond, laptime second and laptime minute.

3.2.4.2.10 Process 2.1.9

Reference No	2.1.9
Name	Return to flow
Input	Mode Data, Trigger
Output	Mode Data
Process Description	Changes screen from lap time display to stopwatch time display. Set the value of LAP_TIME_STATE in Mode data as 0.

3.2.4.2.11 Process 2.1.10

Reference No	2.1.10
Name	Stopwatch Reset
Input	Stopwatch Data
Output	Stopwatch Data
Process Description	Resets stopwatch time to 0 Set centisecond, second, minute in Stopwatch Data as 0.

3.2.4.2.12 Process 2.1.11

Reference No	2.1.11
Name	Alarm Mode
Input	Enable, Disable , Alarm Data, Mode Data, Time Data
Output	Mode Data, Display Command
Process Description	This gets the 't_date','t_month' in Time data and 'Hour','Minute' in Alarm Data and display them. And this gets 'alarm_indicator_data' in Mode data. If the value of 'alarm_indicator_data' is 1, alarm indicator will be displayed.

3.2.4.2.13 Process 2.1.12

Reference No	2.1.12
Name	Alarm Setting Mode
Input	Enable, Disable, Alarm & Mode & Time Data
Output	Mode data, Display Command
Process Description	Set the value of 'sm_data' in Mode data as 2. Display 't_date', and 't_month' in Time Data. Display the Alarm Data and flicker it by alarm_time_pointer in Mode data. If value of it is 1, flicker the hour section, else flicker the minute section.

3.2.4.2.14 Process 2.1.13

Reference No	2.1.13
Name	Change Alarm Time Pointer
Input	Mode Data, Trigger
Output	Mode Data
Process Description	Increase the value of alarm_time_pointer in Mode data by 1. If value of it is 1, when there is trigger command. Set it as 0.

3.2.4.2.15 Process 2.1.14

Reference No	2.1.14
Name	Increase Alarm Time
Input	Alarm & Mode Data, Trigger
Output	Alarm Data
Process Description	This process increases the value of Alarm data by the value of alarm_time_pointer in Mode data. If the value of alarm_time_pointer is 1 now, and there is trigger command, increase the value of 'Hour' in Alarm Data by 1. If the value of alarm_time_pointer is 0 now, and there is trigger command, increase the value of 'Minute' by 1. When the value of alarm_time_pointer is 1, and there is trigger command, if the value of 'Hour' is 23, set it as 0.

3.2.4.2.16 Process 2.1.15

Reference No	2.1.15
Name	Toggle Alarm Indicator
Input	Mode Data, Trigger
Output	Mode Data
Process Description	Change the value of 'alarm_indicator' in Mode data. If it is 0 now, set it as 1. If it is 1 now, set it as 0. 1 means "True" that alarm is on now. 0 means "False" that alarm is off now.

3.2.4.2.17 Process 2.1.16

Reference No	2.1.16
Name	Alarm Checking
Input	Enable, Alarm & Time & Mode Data

Output	Alarm Data
Process Description	This process check the alarm time all the time. If the value of 'alarm_indicator' in Alarm Data is 1 now, and sm_data is 1 or 2(Time Setting Mode or Alarm Time Setting Mode), and the value of 't_second' is 0 now, and if the value of 'minute', 'hour' in Alarm Data, and 't_minute', 't_hour' are same, change the value of 'buzzing' in Alarm Data. (if buzzing is 0, change it to 1. If buzzing is 1, change it to 1.)

3.2.4.2.18 Process 2.1.17

Reference No	2.1.17
Name	Buzzer
Input	Enable, Disable, Alarm Data, Button Data
Output	Buzz Command
Process Description	If Buzzer is enabled and when "buzzing" has true value, Buzzer sends the buzz command(Ring the alarm), and then increase "buzzing_time"'s value by one per second. and If "buzzing_time"'s value reach 5, or user presses button before 5, sends buzz command(stop the buzz) and set "buzzing" to false.

3.2.4.2.19 Process 2.2.0

Reference No	2.2.0
Name	Backlight Controller
Input	Button Data, Alarm Data, Mode Data
Output	Mode Data, Backlight Command
Process Description	It controls the data involved in the Backlight.

3.2.4.2.20 Process 2.2.1

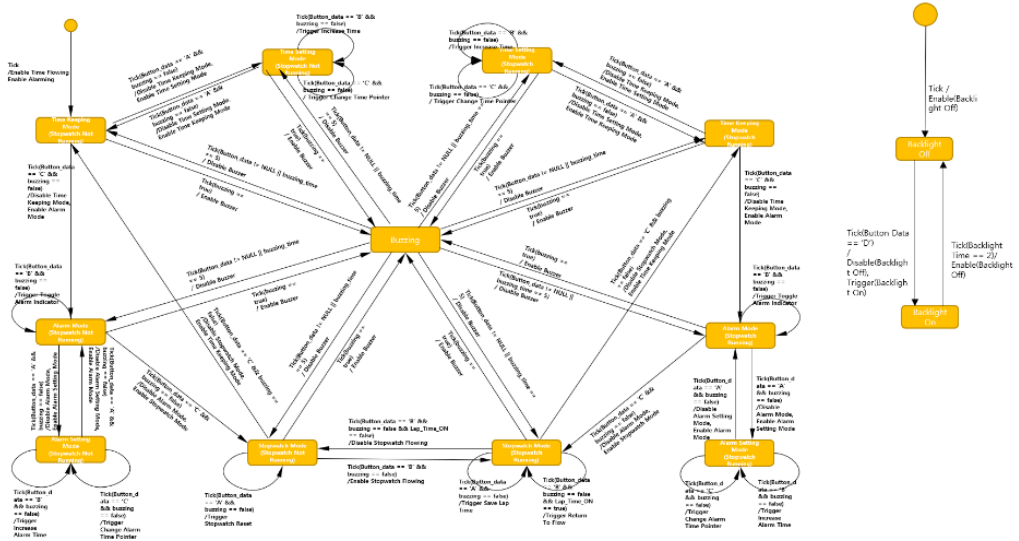| Reference No	2.2.1
Name	Backlight Off
Input	Enable, Disable, Mode Data
Output	Backlight Command

Process Description	If "Backlight Off"' process Enabled, sends Backlight command to keep backlight off. When "LIGHT_STATE" has true value and "buzzing" has false value, It will be Disabled, If "LIGHT_STATE" is false, it will be enabled.

3.2.4.2.21 Process 2.2.2

Reference No	2.2.2
Name	Backlight On
Input	Mode Data, Trigger
Output	Mode Data
Process Description	"Backlight On" process changes Mode Data's "LIGHT_STATE" to true value when Alaram Data's "buzzing" has false value. and Increase "backlight_time" value by one per second. After 2 seconds, "LIGHT_STATE" is set to false

3.2.4.3 State Transition Diagram (*Name of Controller*)

DFD Level 4 (Display Controller / Backlight Controller)

3.2.5 Overall DFD

Overall DFD