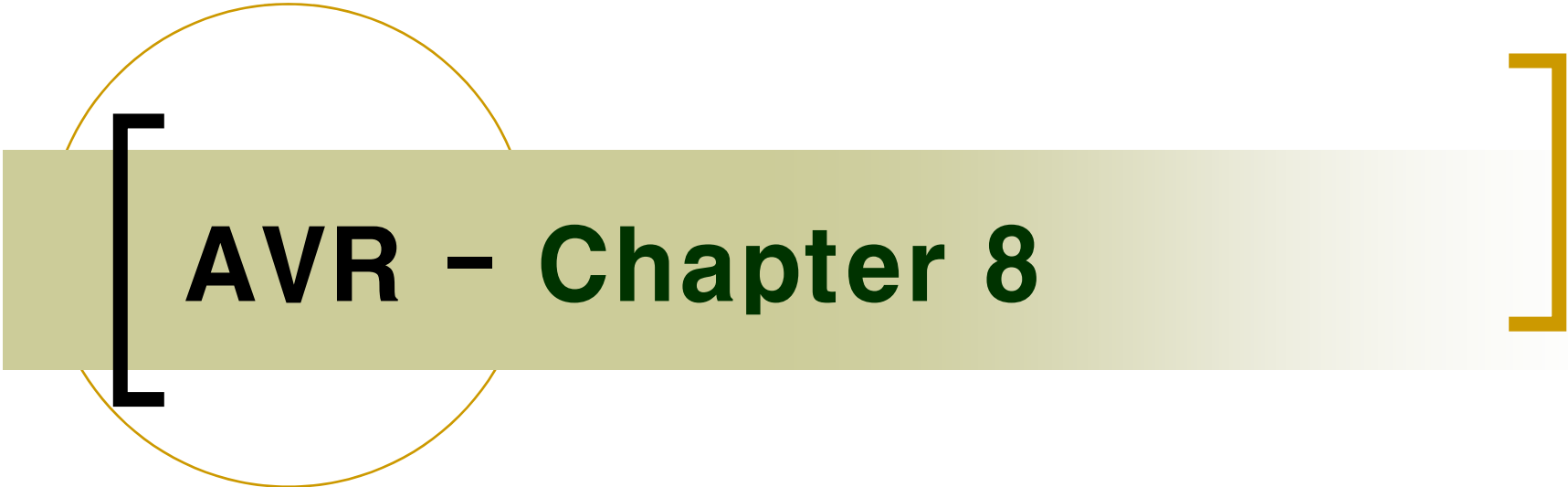




AVR - Chapter 8

류대우

(주)뉴티씨(NEWTC) 대표이사

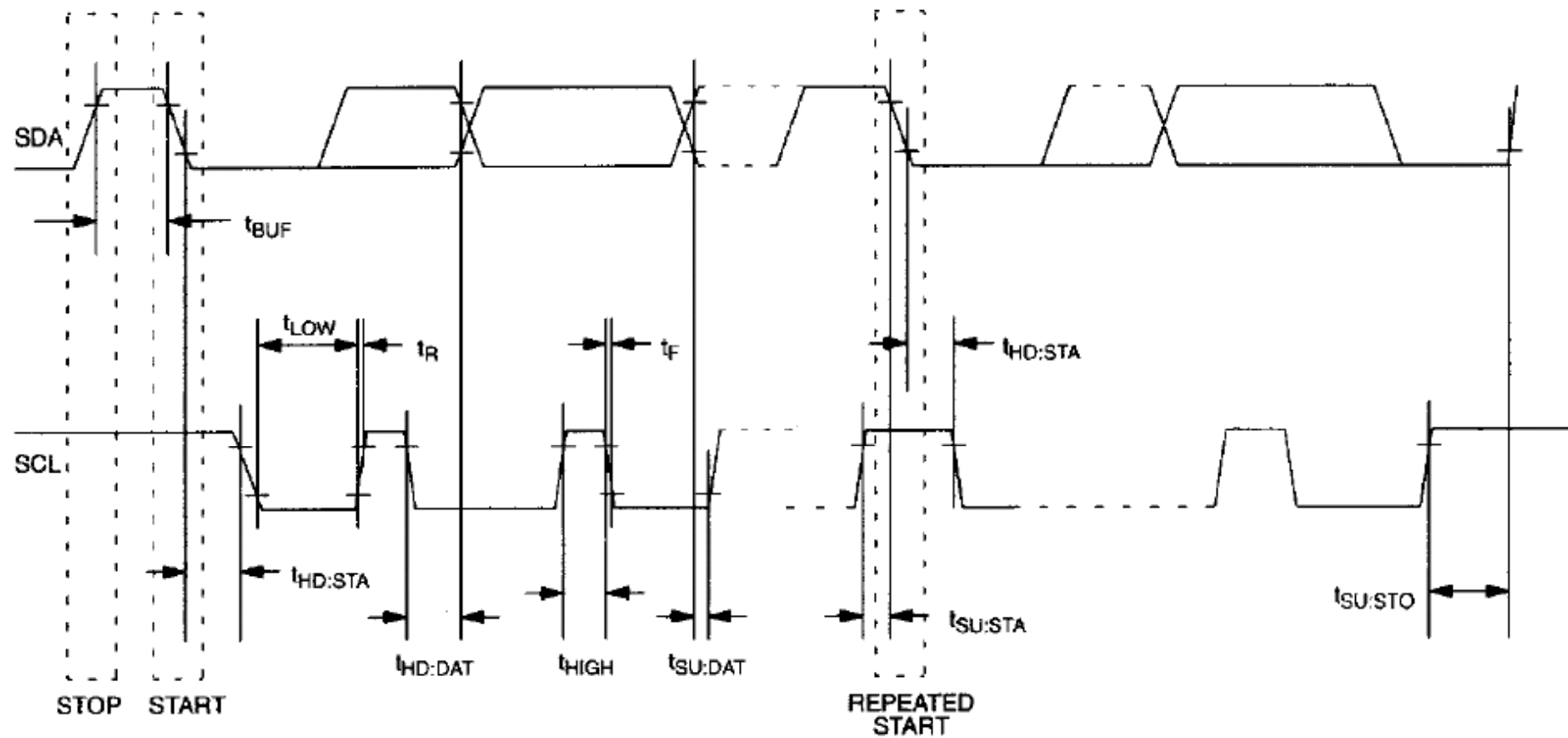
davidryu@newtc.co.kr

[I2C 실습

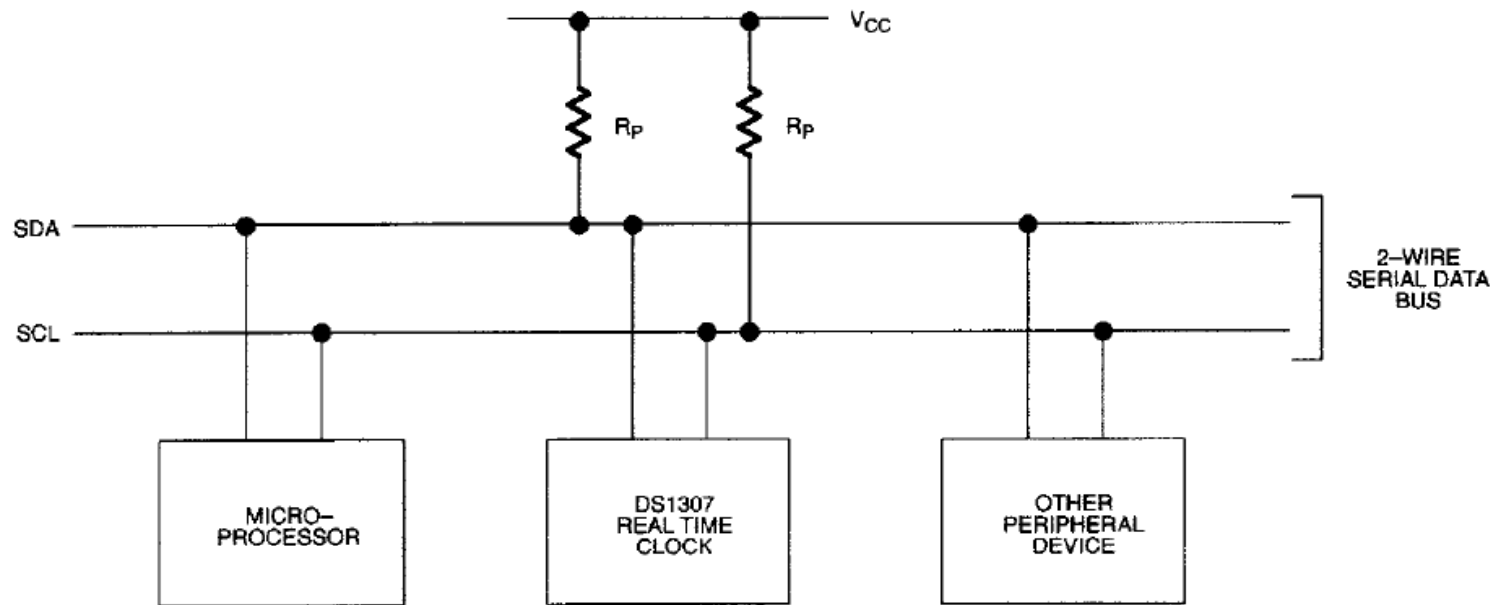
]

1. 타이밍도
2. I2C 소스 분석
3. I2C를 이용한 시계 함수 소스

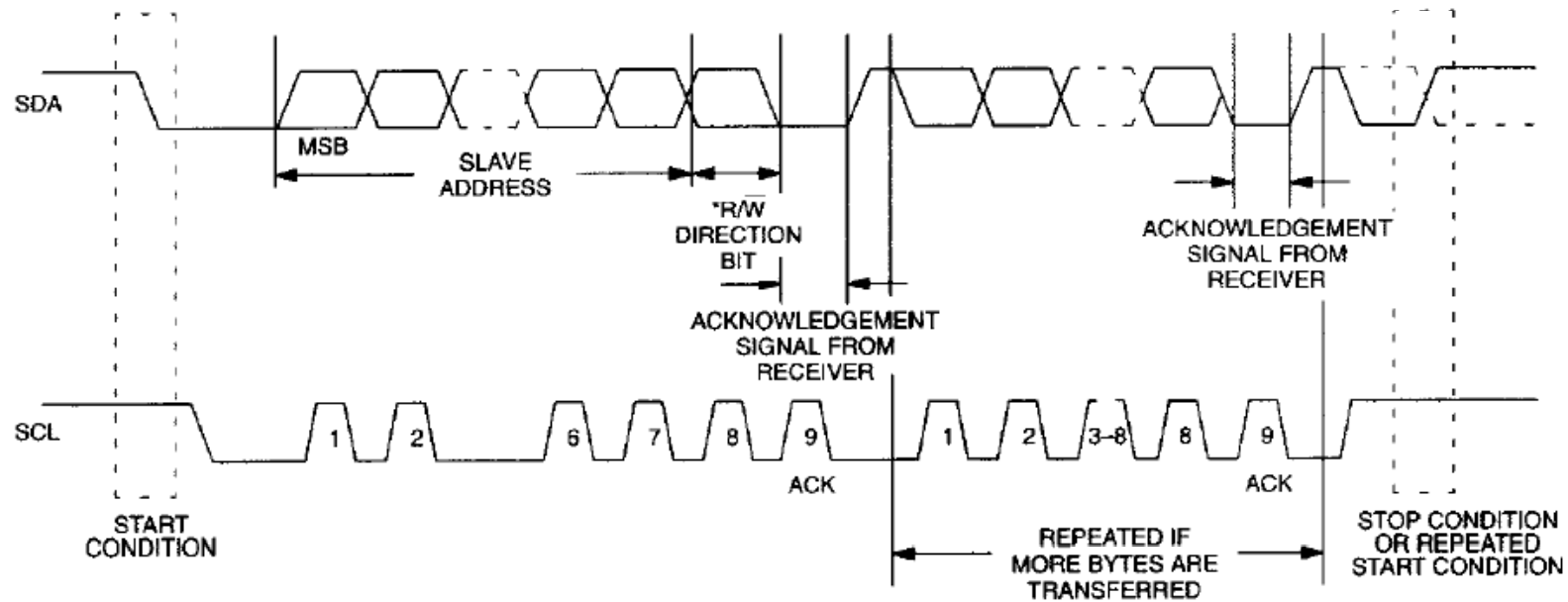
[I2C 표준 타이밍도



[TYPICAL 2-WIRE BUS CONFIGURATION]

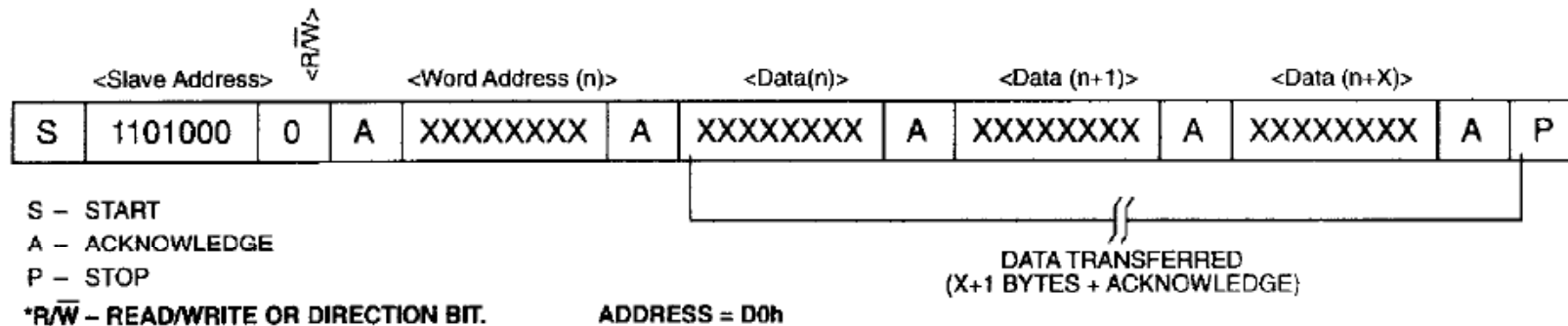


[DATA TRANSFER ON 2-WIRE SERIAL BUS]



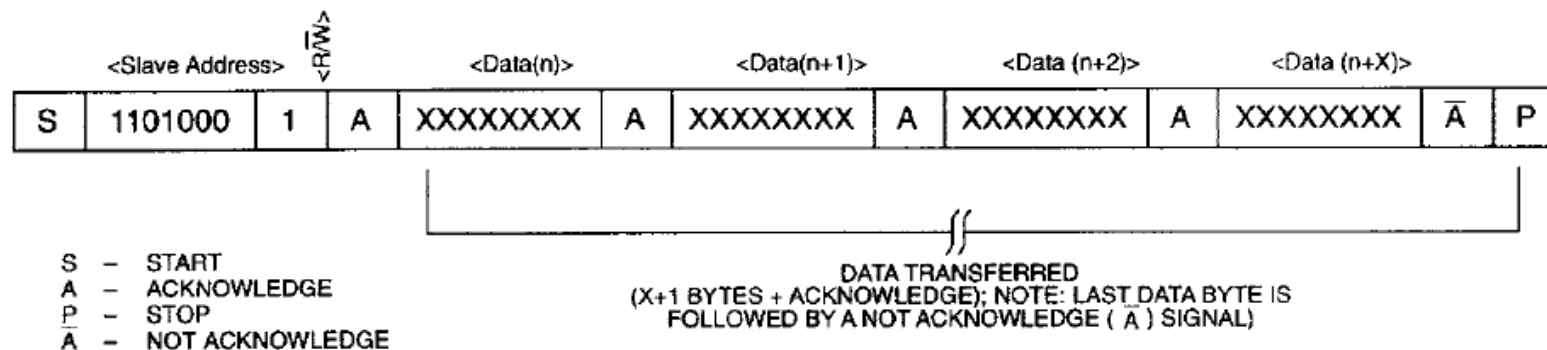
DATA WRITE

[– SLAVE RECEIVER MODE]



DATA READ

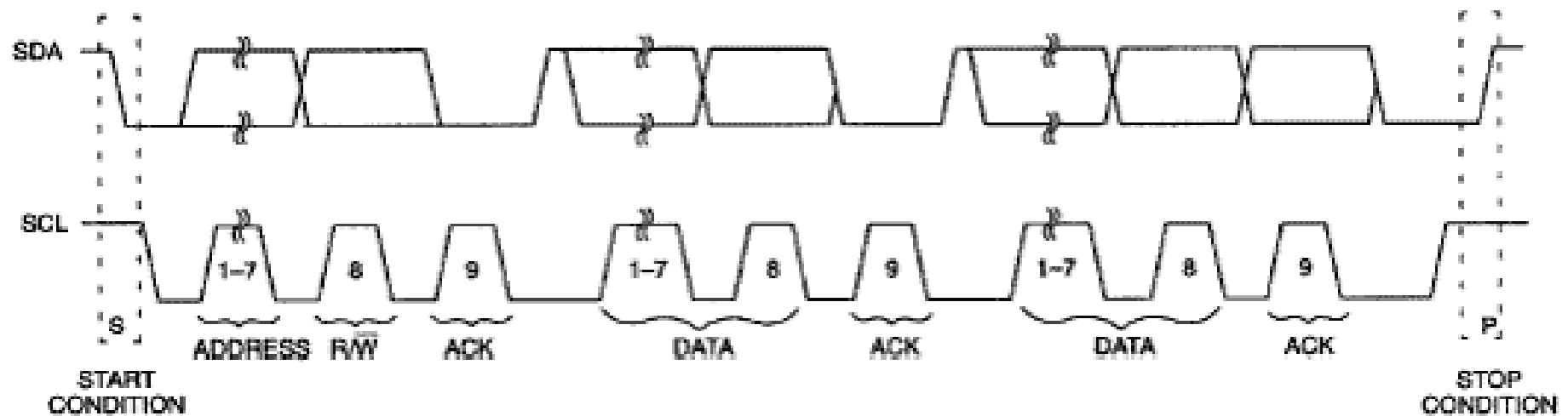
[- SLAVE TRANSMITTER MODE]



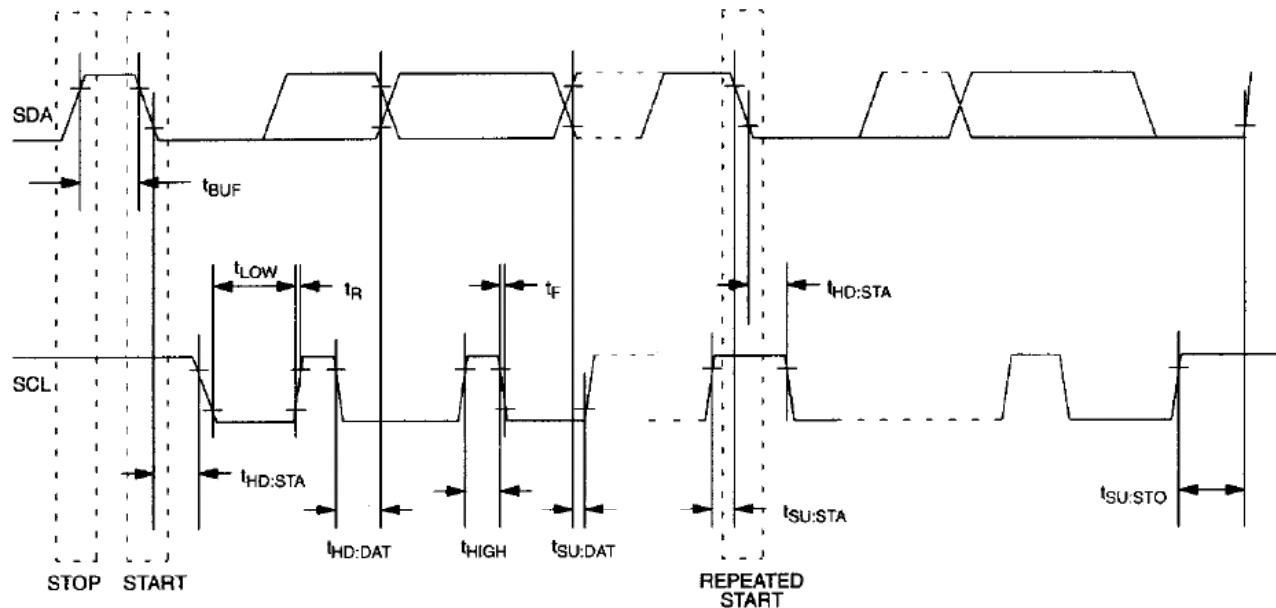
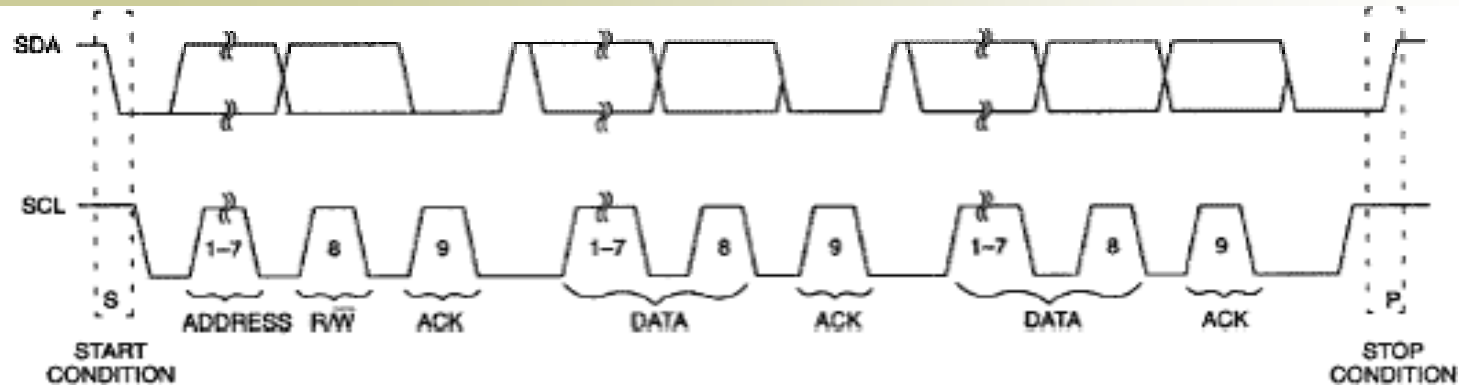
* $\bar{R/W}$ - READ/WRITE OR DIRECTION BIT

ADDRESS = D1h

[DS1307 시계의 I2C 타이밍도]

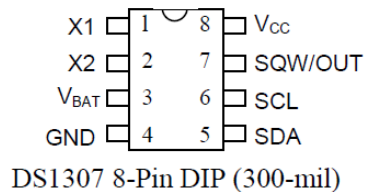


[타이밍도 한꺼번에 짚은 거]



[DS1307 IC description]

■ Pin Assignment



■ Pin Description

- VCC – Primary Power Supply
- X1, X2 – 32.768kHz Crystal Connection
- VBAT – +3V Battery Input
- GND – Ground
- SDA – Serial Data
- SCL – Serial Clock
- SQW/OUT – Square Wave/Output Driver

[Electrical parameter(DS1307)]

(Over the operating range*)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
SCL Clock Frequency	f_{SCL}	0		100	kHz	
Bus Free Time Between a STOP and START Condition	t_{BUF}	4.7			μs	
Hold Time (Repeated) START Condition	t_{HD-STA}	4.0			μs	3
LOW Period of SCL Clock	t_{LOW}	4.7			μs	
HIGH Period of SCL Clock	t_{HIGH}	4.0			μs	
Set-up Time for a Repeated START Condition	t_{SU-STA}	4.7			μs	
Data Hold Time	t_{HD-DAT}	0			μs	4,5
Data Set-up Time	t_{SU-DAT}	250			ns	
Rise Time of Both SDA and SCL Signals	t_R			1000	ns	
Fall Time of Both SDA and SCL Signals	t_F			300	ns	
Set-up Time for STOP Condition	$t_{SU-STOP}$	4.7			μs	
Capacitive Load for each Bus Line	C_B			400	pF	6
I/O Capacitance ($T_A = 25^\circ C$)	C_{IO}		10		pF	
Crystal Specified Load Capacitance ($T_A = 25^\circ C$)			12.5		pF	

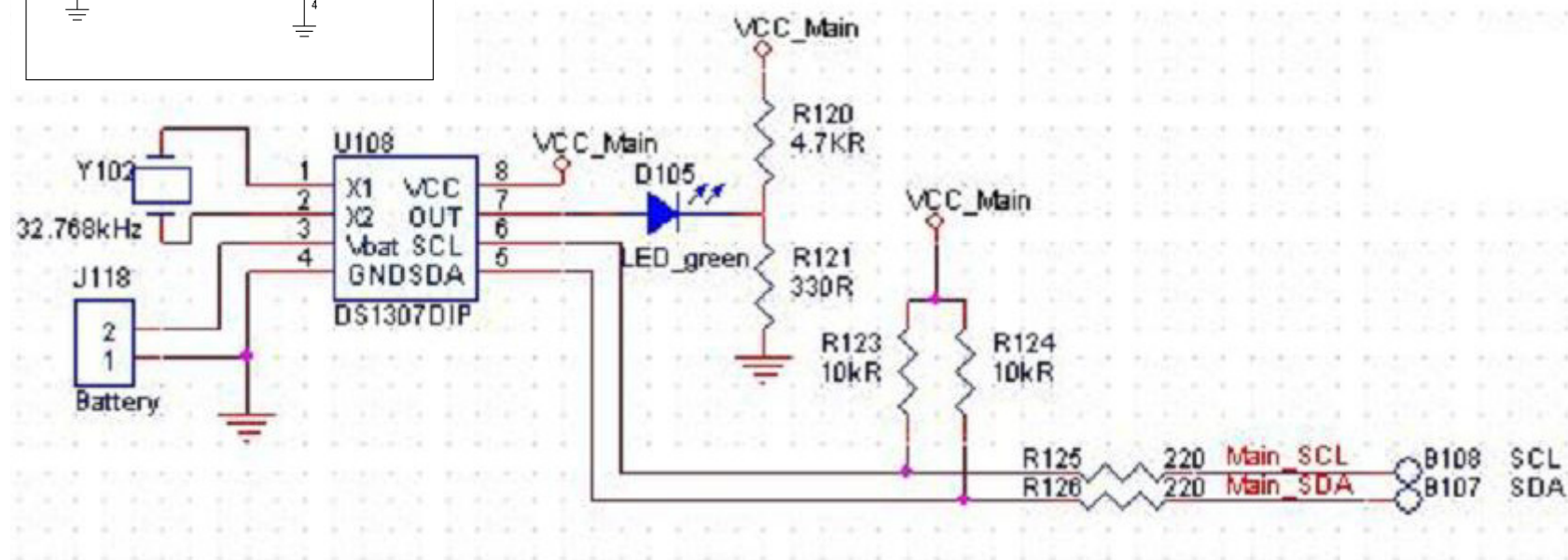
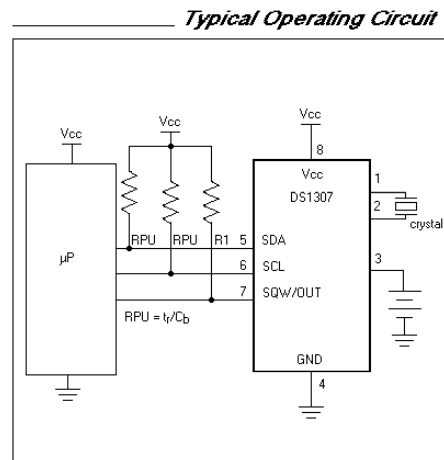
*Unless otherwise specified.

NOTES:

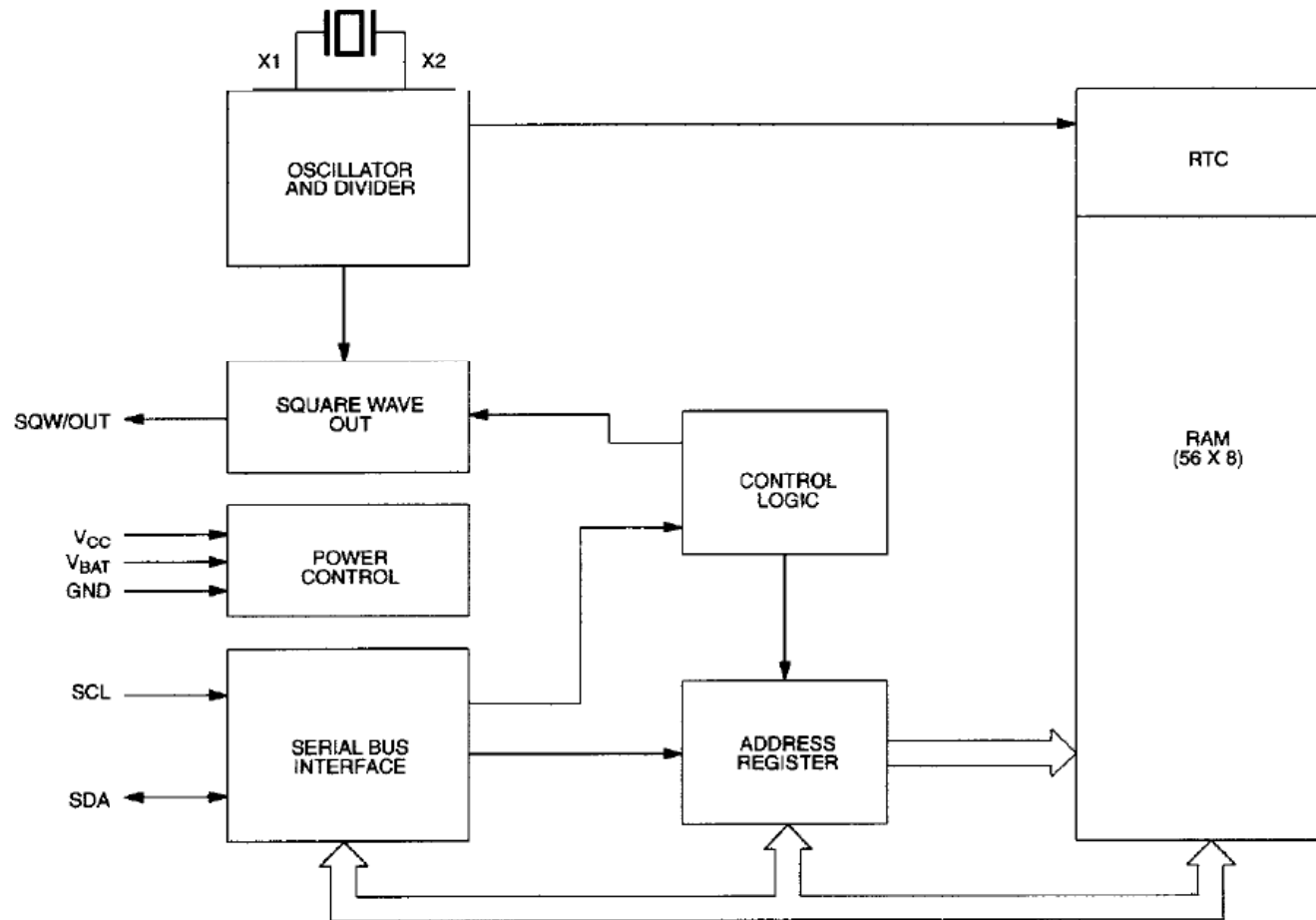
1. I_{CCS} specified with $V_{CC} = 5.0V$ and SDA, SCL = 5.0V.
2. $V_{CC} = 0V$, $V_{BAT} = 3V$.
3. After this period, the first clock pulse is generated.
4. A device must internally provide a hold time of at least 300ns for the SDA signal (referred to the V_{IHMIN} of the SCL signal) in order to bridge the undefined region of the falling edge of SCL.
5. The maximum t_{HD-DAT} has only to be met if the device does not stretch the LOW period (t_{LOW}) of the SCL signal.
6. C_B – Total capacitance of one bus line in pF.
7. I_{CCA} – SCL clocking at max frequency = 100kHz.
8. V_{PF} measured at $V_{BAT} = 3.0V$.

[Typical Circuit

]



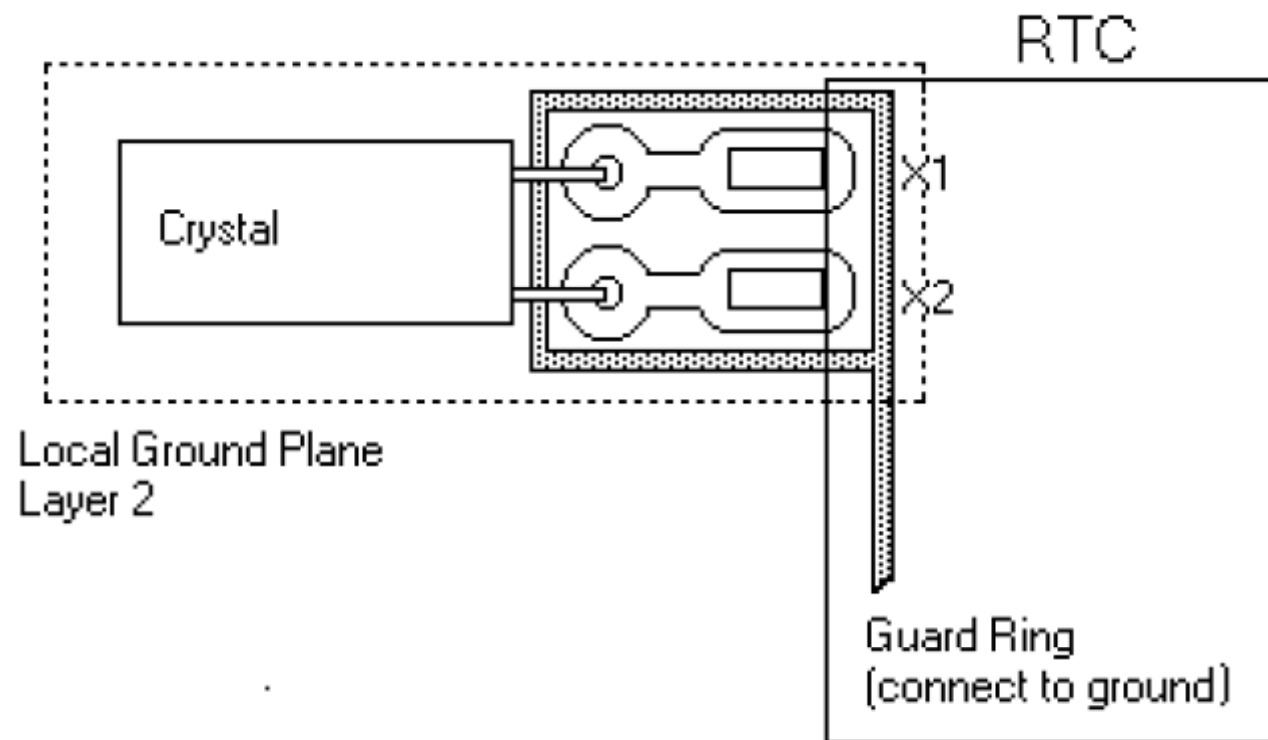
[DS1307 Block Diagram]



[SIGNAL DESCRIPTIONS]

- **VCC, GND – DC power is provided to the device on these pins. VCC is the +5V input. When 5V is applied within normal limits, the device is fully accessible and data can be written and read. When a 3V battery is connected to the device and VCC is below $1.25 \times V_{BAT}$, reads and writes are inhibited. However, the timekeeping function continues unaffected by the lower input voltage. As VCC falls below VBAT the RAM and timekeeper are switched over to the external power supply (nominal 3.0V DC) at VBAT.**
- **VBAT – Battery input for any standard 3V lithium cell or other energy source. Battery voltage must be held between 2.0V and 3.5V for proper operation. The nominal write protect trip point voltage at which access to the RTC and user RAM is denied is set by the internal circuitry as $1.25 \times V_{BAT}$ nominal. A lithium battery with 48mAh or greater will back up the DS1307 for more than 10 years in the absence of power at $25 \pm 0.5^\circ\text{C}$. UL recognized to ensure against reverse charging current when used in conjunction with a lithium battery.**
- See “Conditions of Acceptability” at <http://www.maxim-ic.com/TechSupport/QA/ntrl.htm>.
- **SCL (Serial Clock Input) – SCL is used to synchronize data movement on the serial interface.**
- **SDA (Serial Data Input/Output) – SDA is the input/output pin for the 2-wire serial interface. The SDA pin is open drain which requires an external pullup resistor.**
- **SQW/OUT (Square Wave/Output Driver) – When enabled, the SQWE bit set to 1, the SQW/OUT pin outputs one of four square wave frequencies (1Hz, 4kHz, 8kHz, 32kHz). The SQW/OUT pin is open drain and requires an external pull-up resistor. SQW/OUT will operate with either Vcc or Vbat applied.**
- **X1, X2 – Connections for a standard 32.768kHz quartz crystal. The internal oscillator circuitry is designed for operation with a crystal having a specified load capacitance (CL) of 12.5pF.**
- For more information on crystal selection and crystal layout considerations, please consult Application Note 58, “Crystal Considerations with Dallas Real-Time Clocks.” The DS1307 can also be driven by an external 32.768kHz oscillator. In this configuration, the X1 pin is connected to the external oscillator signal and the X2 pin is floated.

[RECOMMENDED LAYOUT FOR CRYSTAL]



[DS1307 ADDRESS MAP]

00H	SECONDS
	MINUTES
	HOURS
	DAY
	DATE
	MONTH
	YEAR
07H	CONTROL
08H	RAM
3FH	56 x 8

[DS1307 TIMEKEEPER REGISTERS]

	BIT7							BIT0
00H	CH	10 SECONDS			SECONDS			00-59
	0	10 MINUTES			MINUTES			00-59
	0	12 / 24	10 HR A/P	10 HR	HOURS			01-12 00-23
	0	0	0	0	0	DAY		1-7
	0	0	10 DATE		DATE			01-28/29 01-30 01-31
	0	0	0	10 MONTH	MONTH			01-12
	10 YEAR				YEAR			00-99
07H	OUT	0	0	SQWE	0	0	RS1	RS0

Setting function --> [Application Function for watch]

- **void SetYear(unsigned char year);**
- **void SetMonth(unsigned char month);**
- **void SetDate(unsigned char date);**
- **void SetDAY(unsigned char day);**
- **void SetHours(unsigned char hours);**
- **void SetMinutes(unsigned char minutes);**
- **void SetSeconds(unsigned char seconds);**
- **void SetControl(unsigned char control);**
- **void SetH12(void);**
- **void SetH24(void);**

[I2C Function (1/4)]

- **SCL(char highlow)**
 - Highlow 값에 따라서 SCL을 High low로 전환하는 함수
 - 전환 후에 4us만큼 쉬어준다.
- **SDA(char highlow)**
 - Highlow 값에 따라서 SCL을 High low로 전환하는 함수
 - 전환 후에 4us만큼 쉬어준다.
- **SDADIR(char dir)**
 - Dir 값에 의해 SDA 핀의 IN, OUT 방향을 정해준다.
- **SCLDIR()**
 - SCL 핀을 출력으로 지정한다.

[I2C Function (2/4)]

■ Init_I2C()

- I2C의 초기화 함수.
- 반드시 I2C를 최초로 하는 보드는 이함수를 실행한다.
- SDA 출력 방향을 AVR이 출력하는 것으로 함.
- SCL, SDA : High로

■ I2C_Start()

- SDA 출력 방향을 AVR이 출력하는 것으로 함
- SCL, SDA : High로
- SDA : Low로 떨어뜨림.

■ I2C_Stop()

- SDA 출력 방향을 AVR이 출력하는 것으로 함
- SCL을 High로
- SDA를 Low로
- SDA를 High로

[I2C Function (3/4)]

■ I2C_Receive_Ackn()

- 원래는 한 바이트를 보낸 후에, DS1307로부터 Ack를 받아야 정상인데, 여기서는 그냥 한 비트를 쉬면서 강제로 SDA를 Low로 떨어뜨렸다.

■ I2C_Clock()

- SCL을 High
- SCL을 Low

■ Write_I2C_Byte(unsigned char byte)

- SDA 출력을 AVR에서 출력하는 것으로 한다.
- 1.SCL을 Low로 떨어뜨린다.
- 2.최상위 비트부터 한 비트 쓴다.
- 3.SCL을 High로 올린다.
- 4.답 비트 준비
- 1,2,3,4을 8번 반복한다.
- Ackn을 체크한다.

[I2C Function (4/4)]

■ Read_I2C_Byte(void)

- SDA핀을 AVR에서 입력 받는 것으로 한다.
- 1. SCL을 High로 올린다.(I2C에서 데이터 수신 받을 때 안정적인 쪽은 클럭이 High일 때이므로)
- 2. 최상위비트부터 한 비트 받는다.
- 3. SCL을 Low로 떨어뜨린다.
- 4. 담 비트 받을 준비한다.
- 1,2,3,4를 8번 반복한다.
- Ackn을 받는다.

[Read & Write function for watch -->] Basic Function for watch

- **WatchWrite(UC Address, UC Data)**
 - I2C_Start();
 - I2C에 0xD0 쓴다.(시계 IC에 쓰는 걸 알려줌)
 - I2C에 시계 IC에 쓸 내부 주소 씀 Address
 - I2C에 시계 IC에 쓸 데이터 씀 Data
 - I2C_Stop();

- **WatchRead(UC Address)**
 - 일단, 읽을 주소를 써놓고
 - I2C_Start();
 - I2C에 0xD0 쓴다.(시계 IC에 쓰는 걸 알려줌)
 - I2C에 시계 IC에 쓸 내부 주소 씀 Address
 - I2C_Stop();
 - 주어진 주소에서 값을 읽어옴.
 - I2C_Start();
 - I2C에 0xD1 씀.
 - I2C에서 한 바이트 읽어옴.
 - I2C_Stop();

[Detail - Setting Function]

- **SetSeconds(UC seconds)**
 - 초 설정
 - 비슷한 부류로.....분,시간,일, 요일,월,년 설정
- **Seconds()**
 - 현재의 초 값을 리턴한다.
 - 비슷한 부류로.....분,시간,일, 요일,월,년 읽음
- **void SetH12(void);**
 - 12시간제로 변경
 - 유사함수 SetH24() 및 AM/PM 등 설정 함수가 있다.
- **void SetH24(void);**
- **WatchONOFF(int onoff)**
 - Onoff값에 따라 시계를 켜다 켜다 할 수있다.

[Testing function]

- **WatchWriteTest();**
 - 시계 영역에 데이터를 0~5까지 쓴다.
- **WatchReadTest();**
 - 시계 영역에서 데이터를 읽어온다.
- **RAMWriteTest();**
 - 시계의 램 영역에 데이터를 쓴다.
- **RAMReadTest();**
 - 시계의 램 영역에서 데이터를 읽어온다.

[문제

]

- AMPM 및 24H/12H 등 시간제 설정함수를 만드시오.
- BCD 코드로 표현되는 결과를 10진으로 바꿔서 사람이 읽기 편하도록 하는 코드를 삽입하시오.
- 시리얼로 시계가 구동하도록 만든 후, 알람을 완성하시오.
- 세븐 세그먼트로 시계가 구동하도록 만든 후, 알람을 완성하시오.