RTC (Real Time Clock) – DS3234

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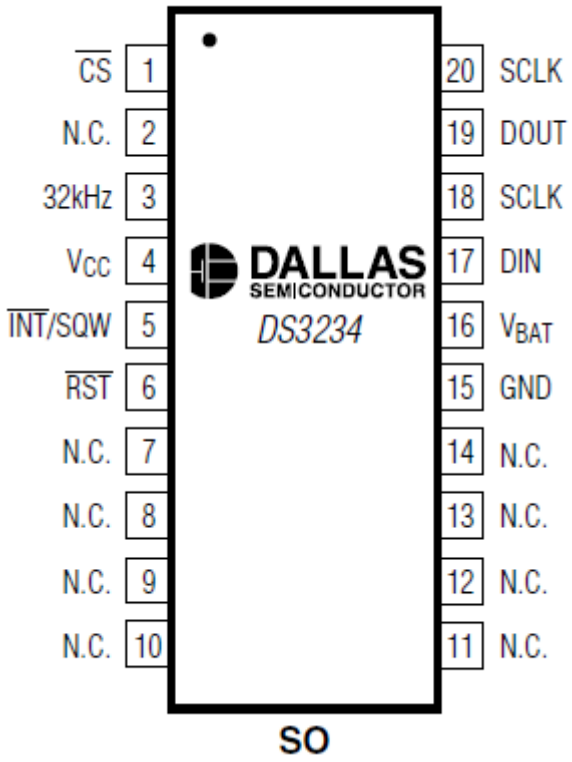
1. 실시간 시계 (RTC : Real Time Clock)

- 수정발진자, 카운터 회로(기준 주파수를 적절히 분주), 배터리 백업회로의 3가지를 가지고 있어서 항상 실시간으로 현재의 시간 정보를 알 수 있는 소자

2. DS3234 IC 내부구조

- 내부에 수정발진자, 카운터 회로, 배터리 백업용 SRAM을 가지고 있고, 외부에 배터리 백업 회로를 추가해주어야 함.



PIN	NAME	FUNCTION
1	$\overline{CS}$	Active-Low Chip Select Input. Used to select or deselect the device.
2, 7–14	N.C.	No Connection. Not connected internally. Must be connected to ground.
3	32kHz	32kHz Push-Pull Output. If disabled with either EN32kHz = 0 or BB32kHz = 0, the state of the 32kHz pin will be low.
4	V_{CC}	DC Power Pin for Primary Power Supply. This pin should be decoupled using a 0.1µF to 1.0µF capacitor.
5	$\overline{INT}$/SQW	Active-Low Interrupt or Square-Wave Output. This open-drain pin requires an external pullup resistor. It can be left open if not used. This multifunction pin is determined by the state of the INTCN bit in the Control Register (0Eh). When INTCN is set to logic 0, this pin outputs a square wave and its frequency is determined by RS2 and RS1 bits. When INTCN is set to logic 1, then a match between the timekeeping registers and either of the alarm registers activates the $\overline{INT}$/SQW pin (if the alarm is enabled). Because the INTCN bit is set to logic 1 when power is first applied, the pin defaults to an interrupt output with alarms disabled. The pullup voltage can be up to 5.5V, regardless of the voltage on V_{CC}. If not used, this pin can be left unconnected.
6	$\overline{RST}$	Active-Low Reset. This pin is an open-drain input/output. It indicates the status of V_{CC} relative to the V_{PF} specification. As V_{CC} falls below V_{PF}, the $\overline{RST}$ pin is driven low. When V_{CC} exceeds V_{PF}, for t_{RST}, the $\overline{RST}$ pin is driven high impedance. The active-low, open-drain output is combined with a debounced pushbutton input function. This pin can be activated by a pushbutton reset request. It has an internal 50k_ nominal value pullup resistor to V_{CC}. No external pullup resistors should be connected. On first power-up, or if the crystal oscillator is disabled, t_{RST} is bypassed and $\overline{RST}$ immediately goes high.
15	GND	Ground
16	V_{BAT}	Backup Power-Supply Input. If V_{BAT} is not used, connect to ground. Diodes placed in series between the V_{BAT} pin and the battery can cause improper operation. UL recognized to ensure against reverse charging when used with a lithium battery. Go to www.maxim-ic.com/qa/info/ul.
17	DIN	SPI Data Input. Used to shift address and data into the device.
18, 20	SCLK	SPI Clock Input. Used to control timing of data into and out of the device. Either clock polarity can be used. The clock polarity is determined by the device based on the state of SCLK when $\overline{CS}$ goes low. Pins 18 and 20 are electrically connected together internally.
19	DOUT	SPI Data Output. Data is output on this pin when the device is in read mode; CMOS push-pull driver.

2-1. 어드레스 맵

READ 와 WRITE 시
전송하는 주소의 7번째 비트가 다름

ADDRESS READ/WRITE		MSB BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	LSB BIT 0	FUNCTION	RANGE
00h	80h	0	10 Seconds			Seconds				Seconds	00–59
01h	81h	0	10 Minutes			Minutes				Minutes	00–59
02h	82h	0	12/$\overline{24}$	$\overline{AM}$/PM 20 hr	10 hr	Hour				Hours	1-12 +$\overline{AM}$ /PM 00-23
03h	83h	0	0	0	0	0	Day			Day	1-7
04h	84h	0	0	10 Date		Date				Date	01-31
05h	85h	Century	0	0	10 Mo	Month				Month/ Century	01-12 + Century
06h	86h	10 Year				Year				Year	00-99
07h	87h	A1M1	10 Seconds			Seconds				Alarm 1 Seconds	00-59
08h	88h	A1M2	10 Minutes			Minutes				Alarm 1 Minutes	00-59
09h	89h	A1M3	12/$\overline{24}$	$\overline{AM}$/PM 20 hr	10 hr	Hour				Alarm 1 Hours	1-12 +$\overline{AM}$ /PM 00-23
0Ah	8Ah	A1M4	DY/$\overline{DT}$	0 10 Date		Day Date				Alarm 1 Day Alarm 1 Date	1-7 01-31
0Bh	8Bh	A2M2	10 Minutes			Minutes				Alarm 2 Minutes	00-59
0Ch	8Ch	A2M3	12/$\overline{24}$	$\overline{AM}$/PM 20 hr	10 hr	Hour				Alarm 2 Hours	1-12 +$\overline{AM}$ /PM 00-23
0Dh	8Dh	A2M4	DY/$\overline{DT}$	0 10 Date		Day Date				Alarm 2 Day Alarm 2 Date	1-7 01-31
0Eh	8Eh	$\overline{EOSC}$	BBSQW	CONV	RS2	RS1	INTCN	A2IE	A1IE	Control	—
0Fh	8Fh	OSF	BB32kHz	CRATE1	CRATE0	EN32kHz	BSY	A2F	A1F	Control/ Status	—
10h	90h	SIGN	DATA	DATA	DATA	DATA	DATA	DATA	DATA	Crystal Aging Offset	—
11h	91h	SIGN	DATA	DATA	DATA	DATA	DATA	DATA	DATA	Temp MSB	Read Only
12h	92h	DATA	DATA	0	0	0	0	0	0	Temp LSB	Read Only
13h	93h	0	0	0	0	0	0	0	BB_TD	Disable Temp Conversions	—
14h–17h	94h–97h	—	—	—	—	—	—	—	—	Reserved	—
18h	98h	A7	A6	A5	A4	A3	A2	A1	A0	SRAM Address	—
19h	99h	D7	D6	D5	D4	D3	D2	D1	D0	SRAM Data	—

2-2. SPI I/F 타이밍 다이어그램

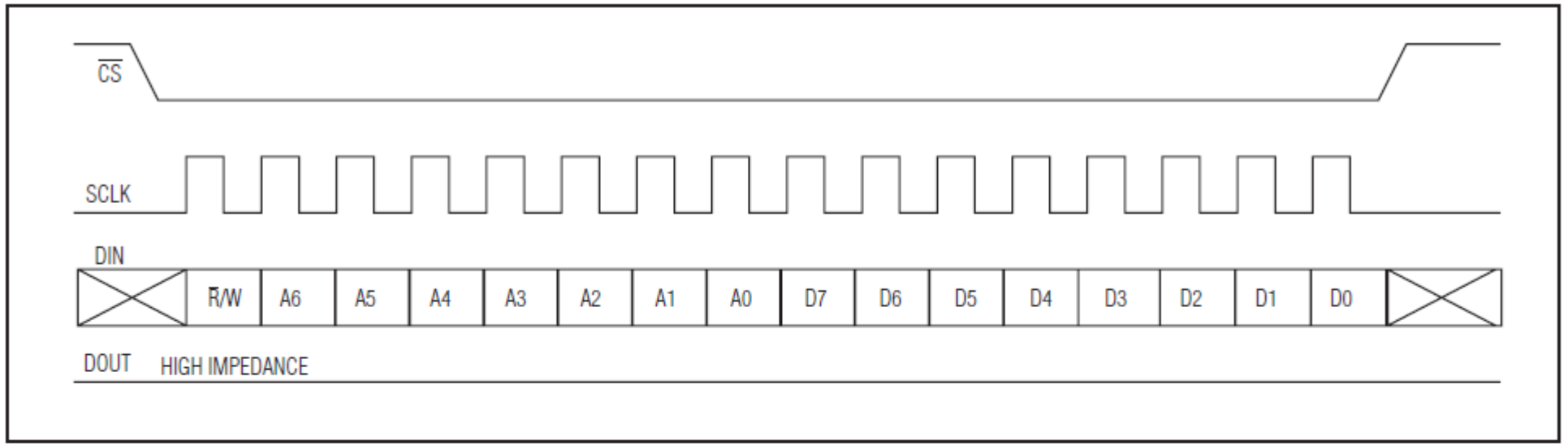


Figure 3. SPI Single-Byte Write

- WRITE동작
주소와 데이터를 합쳐서
DIN핀으로 16bit를 전송.

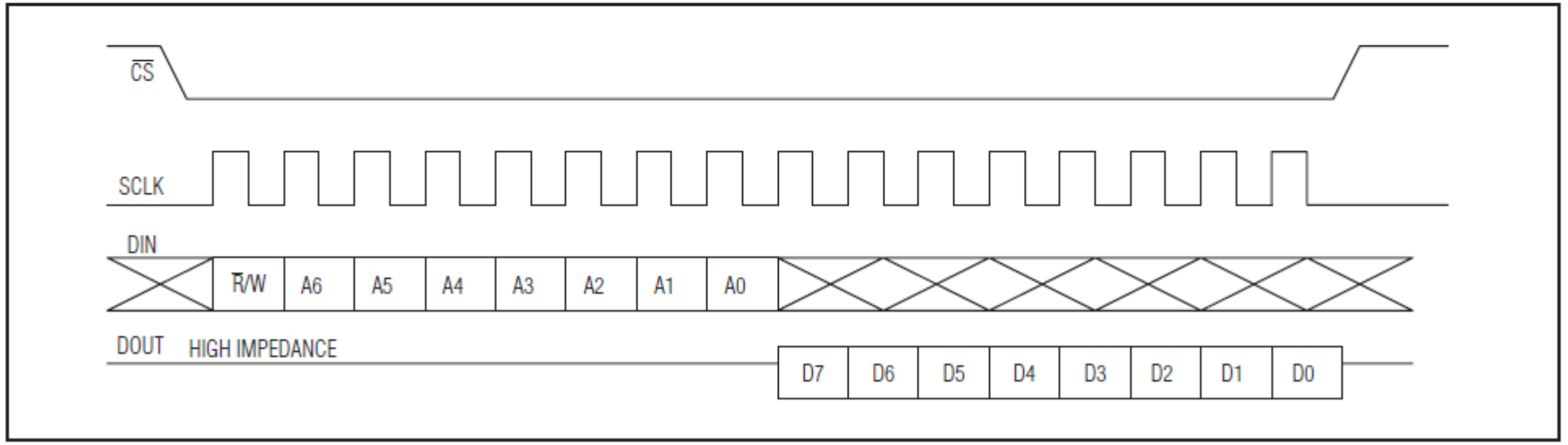


Figure 4. SPI Single-Byte Read

- READ 동작
주소를 먼저 DIN핀으로 WRITE 하면,
데이터가 DOUT 핀으로 출력됨.

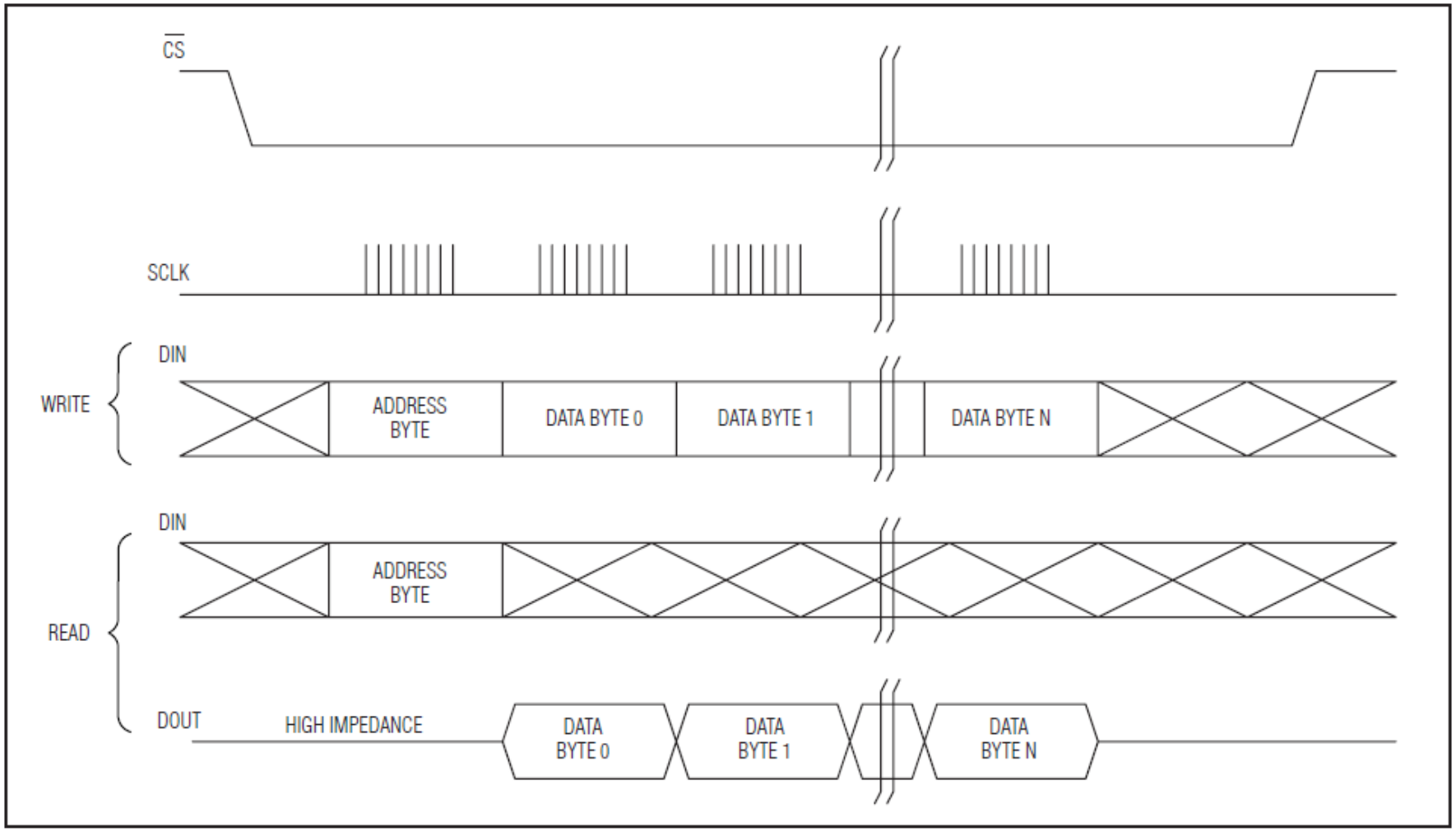
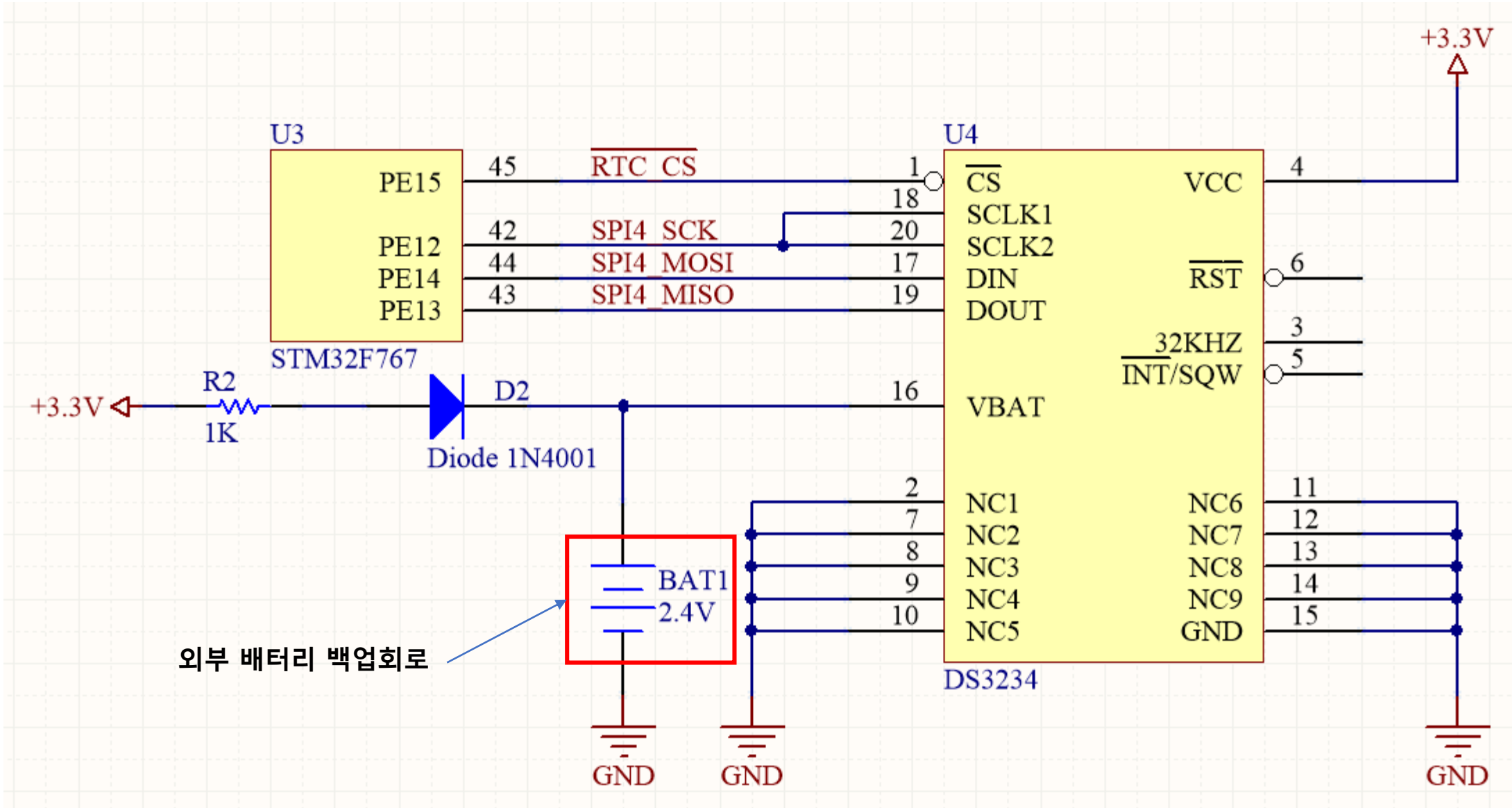


Figure 5. SPI Multiple-Byte Burst Transfer

* 멀티 바이트 전송
WRITE : 1byte의 주소를 write 하면,
자동으로 주소 번지가 증가하고 DIN
핀으로 데이터를 계속 write하기만 하면 된다.

READ : 1byte의 주소를 write 하면,
자동으로 주소 번지가 증가하고, DOUT
핀으로 데이터를 계속 read하면 된다.

3. 회로도


+3.3V
U3
PE15
PE12
PE14
PE13
45
42
44
43
RTC_CS
SPI4_SCK
SPI4_MOSI
SPI4_MISO
STM32F767
U4
1
18
20
17
19
16
CS
SCLK1
SCLK2
DIN
DOUT
VBAT
VCC
RST
32KHZ
INT/SQW
4
6
3
5
2
7
8
9
10
NC1
NC2
NC3
NC4
NC5
11
12
13
14
15
NC6
NC7
NC8
NC9
GND
DS3234
+3.3V
R2
1K
D2
Diode 1N4001
BAT1
2.4V
외부 배터리 백업회로
GND
GND
GND

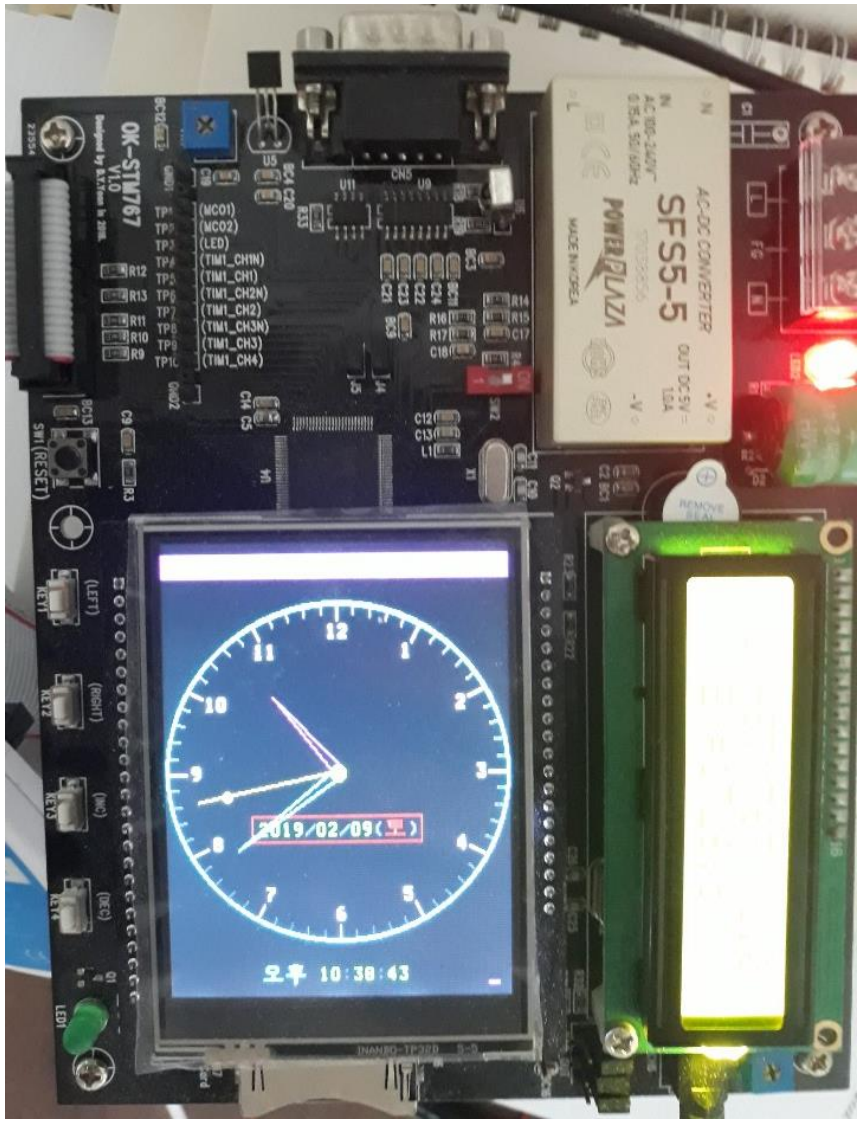
4. DS3234 제어 관련 함수

```
DS3234_initialize(void) /* DS3234 초기 설정 */
{
  unsigned char SEC, MIN, HOUR, WEEK, DATA, MON, YEAR;
  RCC->AHB1ENR |= 0x00000010;
  RCC->APB2ENR |= 0x00002000;

  GPIOE->MODER &= 0x00FFFFFF;
  GPIOE->MODER |= 0x6A000000; // PE14=SPI4_MOSI, PE13=SPI_MISO, PE12=SPI4_SCK, PE15=CS(RTC)
  GPIOE->AFR[1] &= 0xF000FFFF;
  GPIOE->AFR[1] |= 0x05550000; // PE12,13,14 를 부수적인 기능 AF5(SPI) 로 설정
  GPIOE->ODR |= 0x00008000;

  SPI4->CR1 = 0x0365;
  SPI4->CR2 = 0x0F00;

  SEC = DS3234_read(0x00);
  MIN = DS3234_read(0x01);
  HOUR = DS3234_read(0x02);
  WEEK = DS3234_read(0x03);
  DATE = DS3234_read(0x04);
  MON = DS3234_read(0x05);
  YEAR = DS3234_read(0x06);

  if((SEC > 0x59) || (MIN > 0x59) || (HOUR < 0x40) || (WEEK > 0x07) || (DATE > 0x31) || (MON > 0x12) || (YEAR > 0x99))
  {
    DS3234_write(0x00, 0x00);
    DS3234_write(0x01, 0x00);
    DS3234_write(0x02, 0x12 + 0x40);
    DS3234_write(0x03, 0x01);
    DS3234_write(0x04, 0x01);
    DS3234_write(0x05, 0x01);
    DS3234_write(0x06, 0x17);
    DS3234_write(0x0E, 0x00);
    DS3234_write(0x0F, 0x00);
  }
}
```

```
unsigned char DS3234_read(U16 address)
{
  unsigned short word;

  word = SPI4->DR;
  GPIOE->BSRR = 0x80000000;
  SPI4->DR = address << 8;  // READ 동작의 타이밍도에서 DIN8~15 부분이 주소 데이터로 인식됨.
  while((SPI4->SR & 0x0003) != 0x0003); // 데이터가 전송완료될 때까지 대기
  word = SPI4->DR;
  GPIOE->BSRR = 0x00008000;

  return word & 0x00FF;
}
```

```
 void DS3234_write(U16 address, U08 value)
 {
   unsigned short word;

   word = SPI4->DR;
   GPIOE->BSRR = 0x80000000;
   SPI4->DR = ((0x80 + address) << 8) + value;  // WRITE 시에는 주소와 데이터를 한꺼번에 전송함.
   while((SPI4->SR & 0x0003) != 0x0003);
   word |= SPI4->DR;
   GPIOE->BSRR = 0x00008000;
 }
```

5. 결과 화면



TFT-LCD 모듈에 표시하는 아날로그 시계