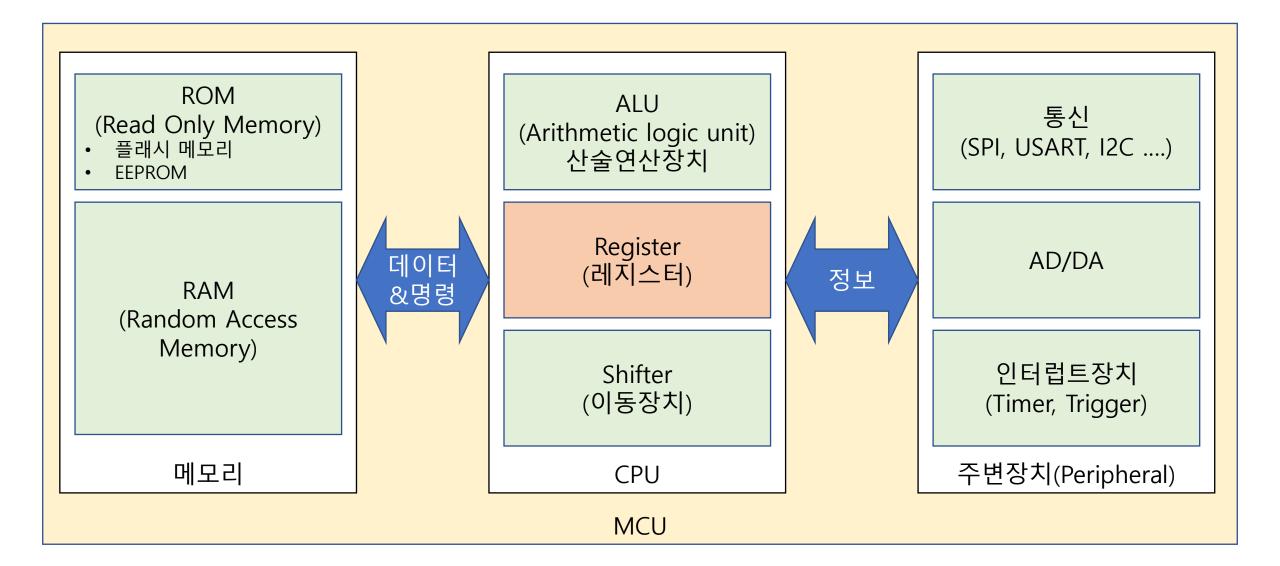
레지스터와 포트의 이해 그리고 C언어

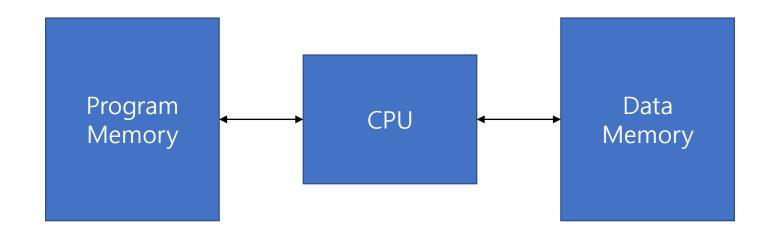
마이크로프로세서 종합 설계. 3주차.



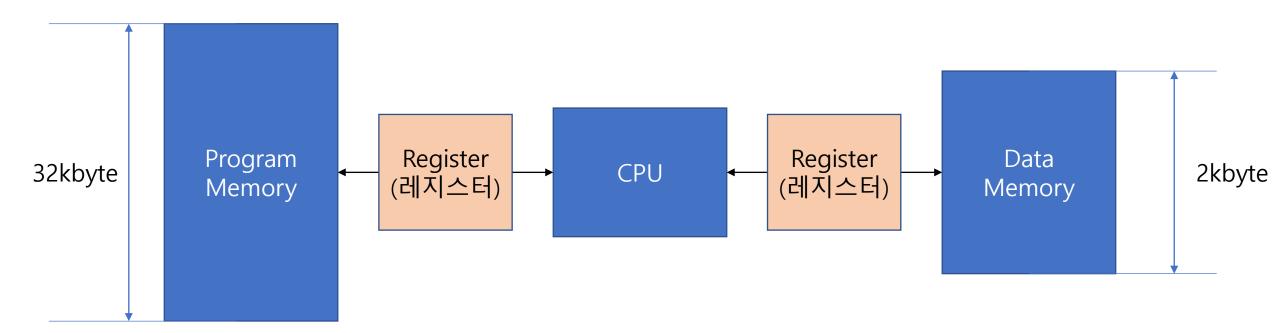
마이크로프로세서의 기본 구성



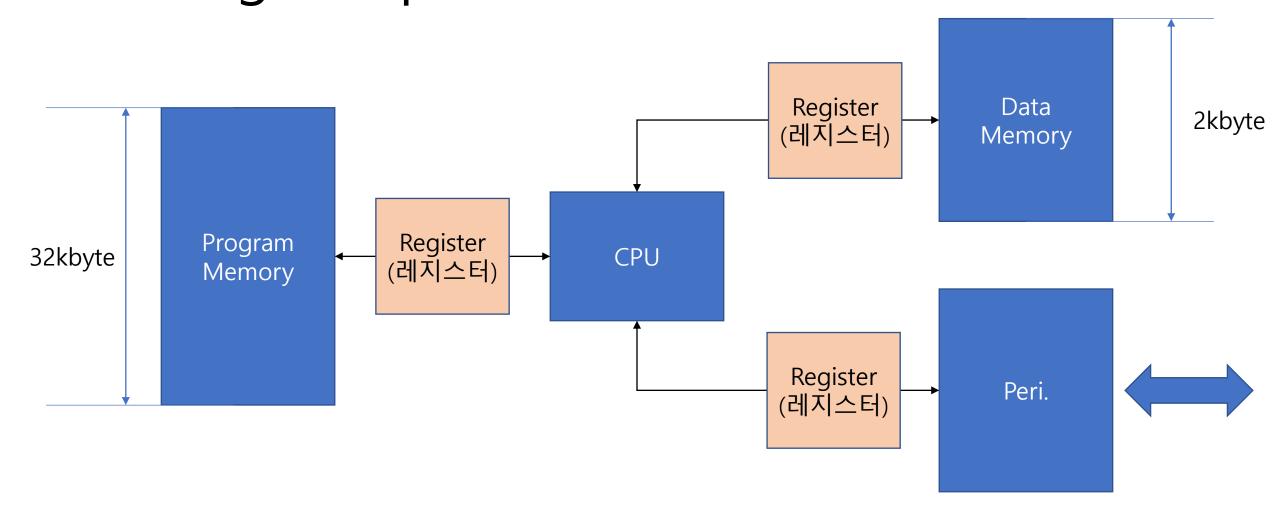
하버드 구조(Harvard architecture)



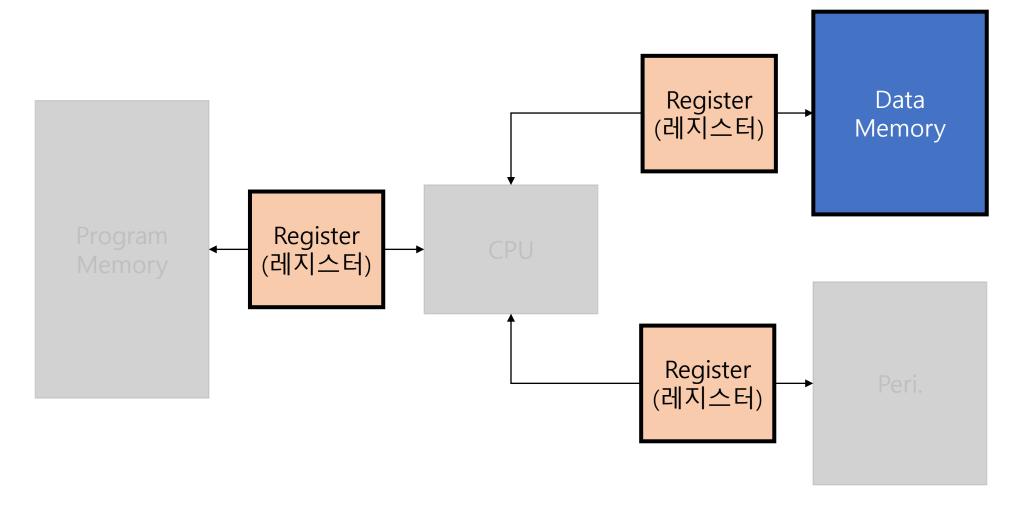
Atmega328p의 메모리



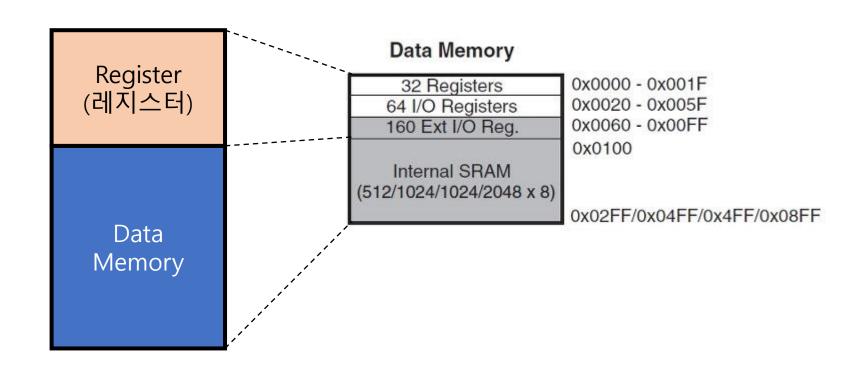
Atmega328p의 메모리 & 외부장치



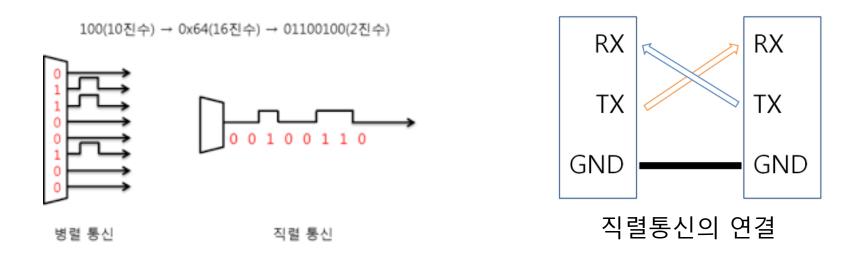
Atmega328p의 메모리맵

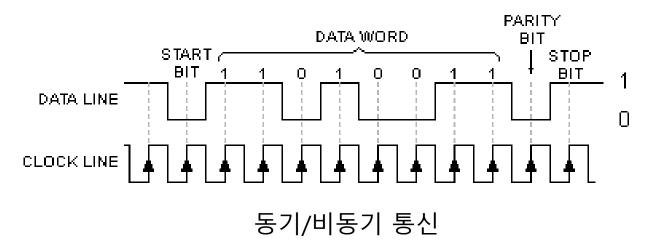


Atmega328p의 메모리맵



마이크로프로세서와 C언어 - 시리얼통신





마이크로프로세서와 C언어 - 시리얼통신

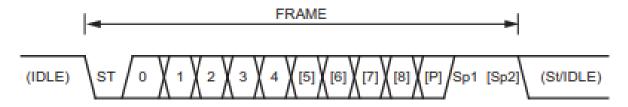
• 비동기식 시리얼 통신

- UART 통신을 이용하기 위해서는 크게 다음의 두 가지 항목을 사전에 정의해줘야 한다.
 - 통신속도: Baud rate
 - Baud rate 의 단위는 bps(bits per second) : 1초당 전송하는 bit 수
 - 표준 bps: 1200, 2400, 4800, **9600**, 19200, 38400, 57600, 115200
 - 프레임사이즈 : Size of each frame field
 - 일반적으로
 - Data bit는 1
 - Bytes site = 8 bits 사이즈로 설정
 - Stop bit는 1 bit
 - Parity bit는 0 bit로 설정
 - 통신을 사용하는 환경에 따라 미리 약속하여 사용

마이크로프로세서와 C언어 - 시리얼통신

• 시리얼통신 데이터 포멧

Figure 19-4. Frame Formats



- St Start bit, always low.
- (n) Data bits (0 to 8).
- P Parity bit. Can be odd or even.
- Sp Stop bit, always high.
- IDLE No transfers on the communication line (RxDn or TxDn). An IDLE line must be high.

참고:데이타시트 https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P_Datasheet.pdf 147p

마이크로프로세서와 C언어 - ASCII

Dec	Нх	Oct Cha	r	Dec	Нх	Oct	Char	Dec	Hx	Oct	Char	Dec	Нх	Oct	Char	9	8 -9		
0	0 0	000 NUL	(null)	32	20	040	Space	64	40	100	0	10000000		140	200	128 Ç	161 i	193 4	225 B
1			(start of heading)	33	21	041		65	41	101	A			141	a	129 ü	162 ó	194 -	
2			(start of text)	34	22	042	rr	66	42	102	В			142		130 é	163 ú	195	227 π
3			(end of text)	35	23	043	#	67	43	103	C			143		131 â	164 ñ	196 -	228 Σ
4			(end of transmission)	36	24	044	8	68	44	104	D	V/25/1996		144		132 ä	165 N	197 +	229 o
5			(enquiry)	37	25	045	*	69	45	105	E	1-00 PG 0 PK 100		145	e	133 à	166	198 =	230 ш
6			(acknowledge)	38	26	046	6.	70	46	106	F	CONTRACTOR OF THE PARTY OF THE		146	f	134 å	167°	199	231 τ
7		007 BEL		39	27	047	I.	71	47	107	G	MINNO COL		147	a	135 ¢	168 /.	200 4	232 4
8		010 BS	(backspace)	40	28	050	(72	48	110	H	1/25/2		150	h	136 ê	169_	201 [233 @
9			(horizontal tab)	41	29	051)	73	49	111	I	5075 Tr (TS)		151	i	137 ë	170 -	202 #	
10		012 LF	(NL line feed, new line)	42	2A	052	*	74	4A	112	J			152	7	138 è	171 1/2	203 #	235 8
11		013 VT	(vertical tab)		2B	053	+	75	4B	113	K	MISSION PROCESS		153	k	139 ï	172 1/4		000
12)14 FF	(NP form feed, new page)	44	20	054	,	76	4C	114	L	V/2"		154		140 î 141 î	173 j 174 «	205 = 206 #	238 €
13		015 CR	(carriage return)	45	2D	055	-	77	4D	115	M	Property Control		155	m	141 1 142 Å	175 »	207 1	239
14		016 80	(shift out)	46	2E	056		78	4E	116	N	V200 100 120		156	n	143 Å	176	208 1	240 ≡
15		017 SI	(shift in)	47	2F	057	1	79	4F	117	0	125-000 200		157	0	144 É	177	209 =	
			(data link escape)	48	30	060	0	80	50	120	P	50500000		160		145 æ	178	210 -	0.40
			(device control 1)	49	31	061	1	JA SOLICE		121	Q	100.100.001.100		161	q	146 Æ		211	243 ≤
		22 DC2	(device control 2)	50	32	062	2	82	52	122	R			162		147 ô	180 -	212	
			(device control 3)	51	33	063	3	83	53	123	S			163	3	148 ö	181 =	213 =	245
			(device control 4)	52	34	064	4	67,100,000		124	T	C 20 C 10 C 10 C		164		149 ò	182 #	214	246 ÷
			(negative acknowledge)	53	35	065	5	85	55	125	U	10.00000		165	u	150 û	183 m	215 #	247 ≈
			(synchronous idle)	54	36	066	6	1.55 5 5 5 5 5 5 5		126	V	F 20 C 20		166	V	151 ù	184 7	216 +	248 °
			(end of trans. block)	55	37	067	7	300000		127	W	on Contract		167	W	152	185	217	0.0000000000000000000000000000000000000
24	18 0	30 CAN	(cancel)			070		G15 A 3200		130	X	9472793995		170		153 Ö	186	218	250
		031 EM	(end of medium)	57	39	071	9	0000000		131	Y	50000 FO 495		171	Y	154 Ü	187	219	251 V 252
26	1A 0	32 SUB	(substitute)	58	ЗА	072	:	90		132	Z	DOMESTIC OF THE PARTY OF THE PA		172	Z	156 €	188	220	253 2
27	1B 0	33 ESC	(escape)	59	3B	073	;	91		133	[1715 F11 01 UP		173	1	157 ¥	189 4	221 222	254
		34 FS	(file separator)	60	30	074	<	46555		134	1	W/2 277 2 26		174	5	158	190 4	223	255
		35 GS	(group separator)	61	3D	075	=	00000000		135]	125			}	159 f	191	224 a	200
		36 RS	(record separator)	62	3E	076	>	450000		136	٨			176	DEL		192	227 00	
		37 US	(unit separator)	63	3F	077	2	95	5F	137	-	127	7F	177	DEL				

마이크로프로세서와 C언어 - ASCII

Dec	65 41 101 A	97 61 141 a Det Char	Dec Hx Oct Char Dec Hx Oct Char	
n	66 42 102 B	TOUR TO A PROPERTY OF THE PARTY	64 10 100 8 96 60 140 108 C 161 f 193 ± 225 B	
1	67 43 103 C	99 63 143 C 40 Space	65 41 101 A 97 61 141 a 129 u 162 6 194 - 226 T	0 40
2	68 44 104 D	100 64 144 d	66 42 102 B 98 62 142 b 180 e 163 ú 195 - 227 π	0x48
3	69 45 105 E	101 65 145 e 43 #	67 43 103 C 99 63 143 C 181 a 164 a 196 - 228 Σ 68 44 104 D 100 64 144 d 12 a 165 N 197 + 229 σ	UX 1 0
4	70 46 106 F	102 66 146 £ 44 8	69 45 105 E 101 65 145 e 13 à 166 198 = 230 µ	
6	71 47 107 G	103 67 147 9 46 6	70 46 106 F 102 66 146 f 184 a 167 ° 199 - 231 t	
7	72 48 110 H	104 68 150 h	71 47 107 G 103 67 147 G 185 c 168 x 200 L 232 D	0 6
8		105 69 151 i	72 48 110 H 104 68 150 h 186 ê 169 201 F 233 ® 173 49 111 I 105 69 151 1 187 ê 170 - 202 4 234 \(\Omega\)	0x65
9	CONTRACTOR	106 6A 152 J 51 1	73 49 111 I 105 69 151 1 187 6 170 - 202 2 234 23 74 4A 112 J 106 6A 152 J 188 6 171 4 203 - 235 8	
10	74 4A 112 J	107 6B 153 k	75 4B 113 K 107 6B 153 k 189 i 172 ¼ 204 = 236 ∞	
11	75 4B 113 K		76 4C 114 L 108 6C 154 1 110 1 173 205 = 237 0	
13	76 4C 114 L	100 00 134 -	77 4D 115 M 109 6D 155 m 141 i 174 « 206 # 238 8	\sim
14	77 4D 115 M	109 6D 155 1 56 .	78 4E 116 N 110 6E 136 11 13 Å 176 208 1 240 =	0x6C
15	78 4E 116 N	110 6E 156 n	00 50 120 P 112 70 160 P 14 E 177 209 T 241 E	UNUC
16	79 4F 117 0	111 6F 157 0 60 0	01 51 101 0 113 71 161 0 145 8 178 210 T 242 4	
18	80 50 120 P	112 70 160 P	82 52 122 R 114 72 162 E 17 8 180 212 244 f	
19	81 51 121 Q	113 71 161 q 63 3	83 53 123 \$ 115 73 163 \$ 148 6 181 = 213 = 245 J	0.70
20 .	82 52 122 R	114 72 162 r 64 4	84 54 124 T 116 74 164 t 149 à 182 214 m 246 ÷ 185 55 125 U 117 75 165 u 150 û 183 m 215 + 247 ≈	0x6C
21 .	83 53 123 S	115 73 163 5 65 5	85 55 125 V 117 75 165 V 150 û 183 T 215 # 247 2 86 56 126 V 118 76 166 V 151 û 184 7 216 # 248 °	UNUC
22 .		116 74 164 t 67 7	87 57 127 W 119 77 167 W 152 185 217 249	
24	84 54 124 T	117 75 165 u 170 8	88 58 130 X 120 78 170 X 153 Ö 186 218 - 250 -	
25 .	85 55 125 U	110 76 166 1	89 59 131 Y 121 79 171 Y 154 Ü 187 219 251 V	0
26 .	86 56 126 V	110 10 100	90 3A 132 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0x6F
27 .	87 57 127 W	119 77 167 W 73 :	92 50 134 \ 124 70 174 158 190 222] 254	
28 .	88 58 130 X	120 /8 1/0 4	93 5D 135] 125 7D 175 } 159 f 191 7 223 255	
30	89 59 131 Y	121 79 171 Y	94 5E 136 A 126 7E 176 A 100 8 192 L 224 00	
21	00 51 100 7	122 74 172 Z	95 5F 137 127 7F 177 DEL	

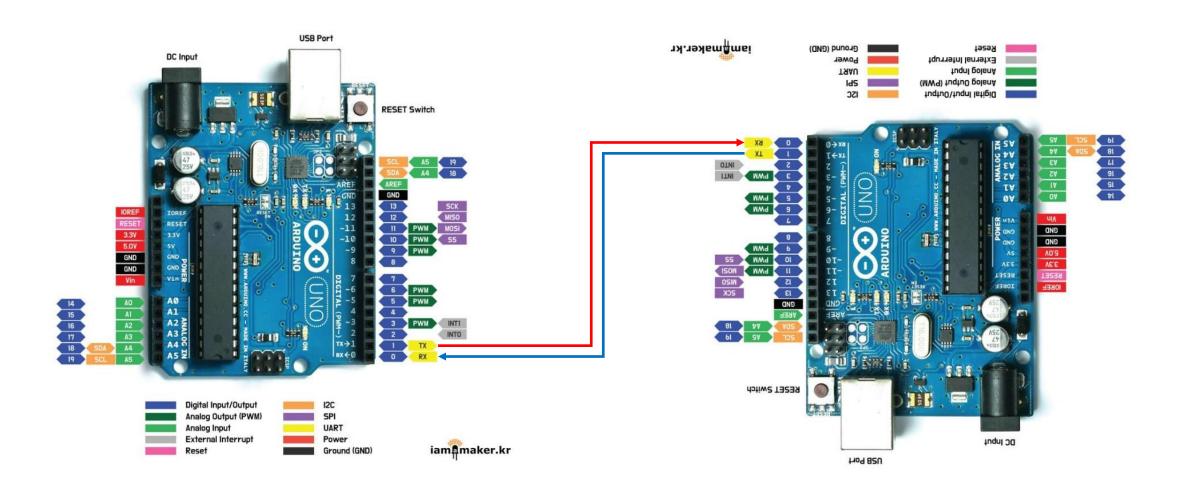
아두이노를 이용한 시리얼통신 실험

```
int incomingByte = 0; // for incoming serial data
void setup()
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop()
 // send data only when you receive data:
 if (Serial.available()) {
   // read the incoming byte:
   incomingByte = Serial.read();
   // say what you got:
   Serial.print("I received: ");
   Serial.println(incomingByte, DEC);
```

아두이노를 이용한 시리얼통신 실험

```
• 예제3
                       void setup()
                        Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
                       void loop()
                          Serial.print(char(0x48));
                          Serial.print(char(0x65));
                          Serial.print(char(0x6c));
                          Serial.print(char(0x6c));
                          Serial.print(char(0x6f));
                          delay(1000);
```

아두이노를 이용한 시리얼통신 실험



마이크로프로세서와 C언어 - 변수

```
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop()
 char c = 'a';
 int i = 10;
 unsigned int j = -10;
 float f = 1.24;
 double d = 1.234;
   Serial.print("char mem size= ");
   Serial.print(sizeof(c)) ;
   Serial.println(" byte") ;
delay(1000);
```

마이크로프로세서와 C언어 - 조건문 if

```
int incomingByte = 0; // for incoming serial data
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 if (Serial.available()) {
                                                                 비교연산자
   // read the incoming byte:
                                                                 1. ==
   incomingByte = Serial.read();
                                                                 2. !=
                                                                 3. >
   if( incomingByte == 'a' ) {
                                                                 4. >=
      // say what you got:
                                                                 5. <
    Serial.print("I received: ");
                                                                 6. <=
    Serial.println(incomingByte, DEC);
```

마이크로프로세서와 C언어 – if~else

```
int incomingByte = 0; // for incoming serial data
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 // send data only when you receive data:
 if (Serial.available())
   // read the incoming byte:
   incomingByte = Serial.read();
   if( incomingByte == 'a' )
      // say what you got:
    Serial.print("I received: ");
     Serial.println(incomingByte, DEC);
   else
       // say what you got:
    Serial.print("Not A");
```

마이크로프로세서와 C언어 - switch~case

```
int incomingByte = 0; // for incoming serial data
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 // send data only when you receive data:
 if (Serial.available())
   // read the incoming byte:
   incomingByte = Serial.read();
   switch(incomingByte)
   case 'a' :
    Serial.println("input a");
    break;
   case 'b':
    Serial.println("input b");
    break;
   case 'c':
    Serial.println("input c");
    break;
   case 'd':
    Serial.println("input d");
    break;
   default:
    Serial.println(incomingByte, DEC);
    break;
```

마이크로프로세서와 C언어 - 함수

void function1(void)
{
 Serial.println("function test");
}

void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
}

void loop() {
 function1();
}

마이크로프로세서와 C언어 - 함수

```
void function2(char c)
 Serial.print(c);
 Serial.print("Decimal Value = ");
 Serial.println(c, DEC);
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 function2('k');
```

마이크로프로세서와 C언어 - 함수

```
int function_add(int a, int b)
  int c = a+b;
  return c;
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 int result = function_add(1, 4);
 Serial.print("result = ");
 Serial.println(result) ;
```

- while 문
- do~while 문
- for 문

```
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 int condition = 1;
 unsigned int count = 0;
 while(condition)
   Serial.print("count = ");
   Serial.println(count) ;
   count++;
   if( count > 100 ) condition = 0;
```

```
void setup() {
 Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
void loop() {
 int condition = 1;
 unsigned int count = 0;
 do
   Serial.print("count = ");
   Serial.println(count) ;
   count++;
   if( count > 100 ) condition = 0;
 }while(condition);
```

```
void setup() {
    Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
}

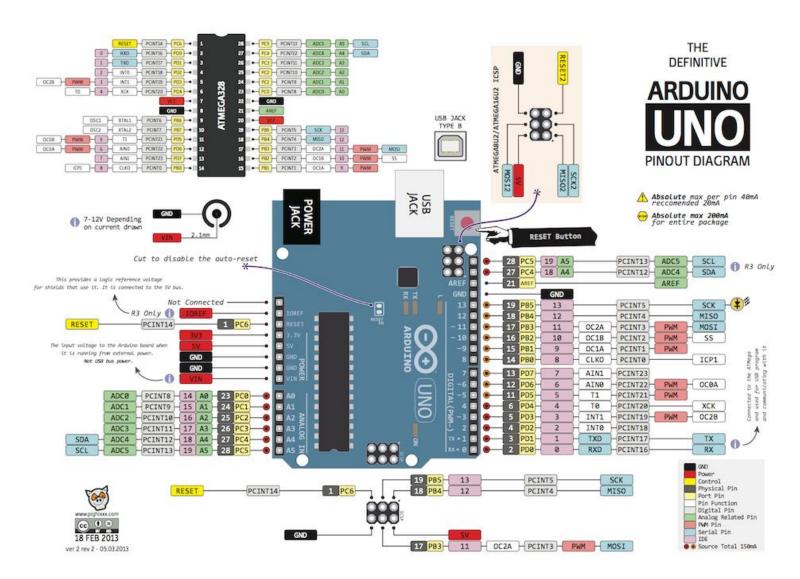
void loop() {
    int i = 0;
    for( i = 0; i<100; i++)
    {
        Serial.print("i = ");
        Serial.println(i);
    }
}</pre>
```

• 퀴즈 : for 문을 이용하여 1부터 100까지 더한 결과를 얻는 기능을 프로그래밍 하시오

• Hint : 예제13과 예제10번을 참고

IO 포트

Port



IO 포트 관련 레지스터

Port

13.4.2 PORTB - The Port B Data Register

Bit	7	6	5	4	3	2	1	0	_
0x05 (0x25)	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	PORTB
Read/Write	R/W	•							
Initial Value	0	0	0	0	0	0	0	0	

13.4.3 DDRB - The Port B Data Direction Register

Bit	7	6	5	4	3	2	1	0	_
0x04 (0x24)	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	DDRB
Read/Write	R/W	•							
Initial Value	0	0	0	0	0	0	0	0	

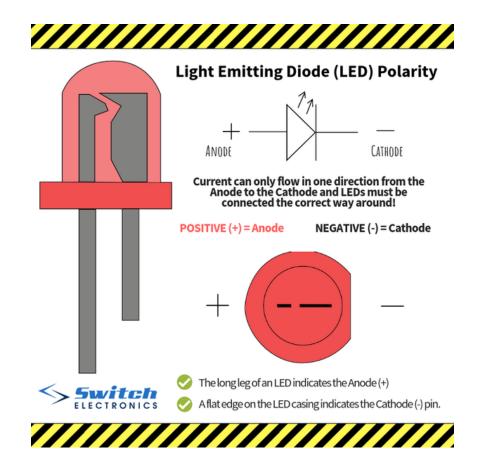
13.4.4 PINB - The Port B Input Pins Address

Bit	7	6	5	4	3	2	1	0	
0x03 (0x23)	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	PINB
Read/Write	R	R	R	R	R	R	R	R	•
Initial Value	N/A								

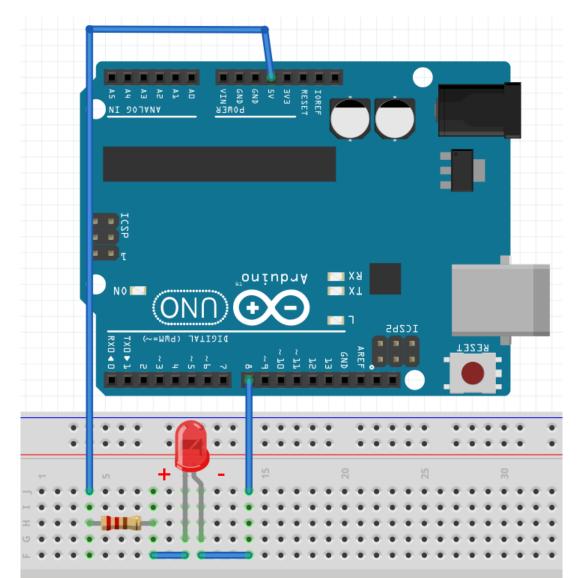
IO 포트 테스트

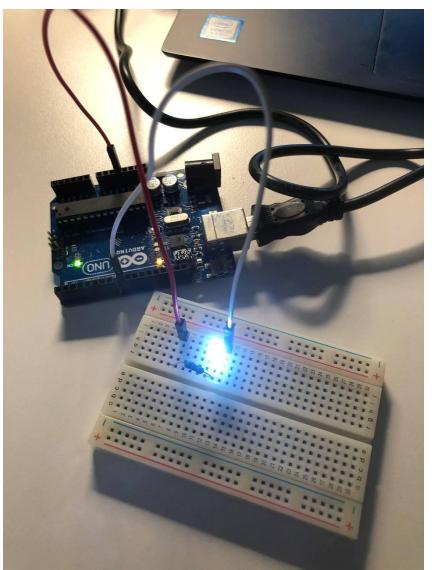
• LED를 이용한 포트 Output 테스트





IO 포트 테스트





IO 포트 테스트

```
void setup() {
 // put your setup code here, to run once:
 DDRB = B00000001;
 PORTB = B00000000;
void loop() {
 // put your main code here, to run repeatedly:
 PORTB = B00000001;
 delay(1000);
 PORTB = B00000000;
 delay(1000);
```

수고하셨습니다.

다음주에 만나요.