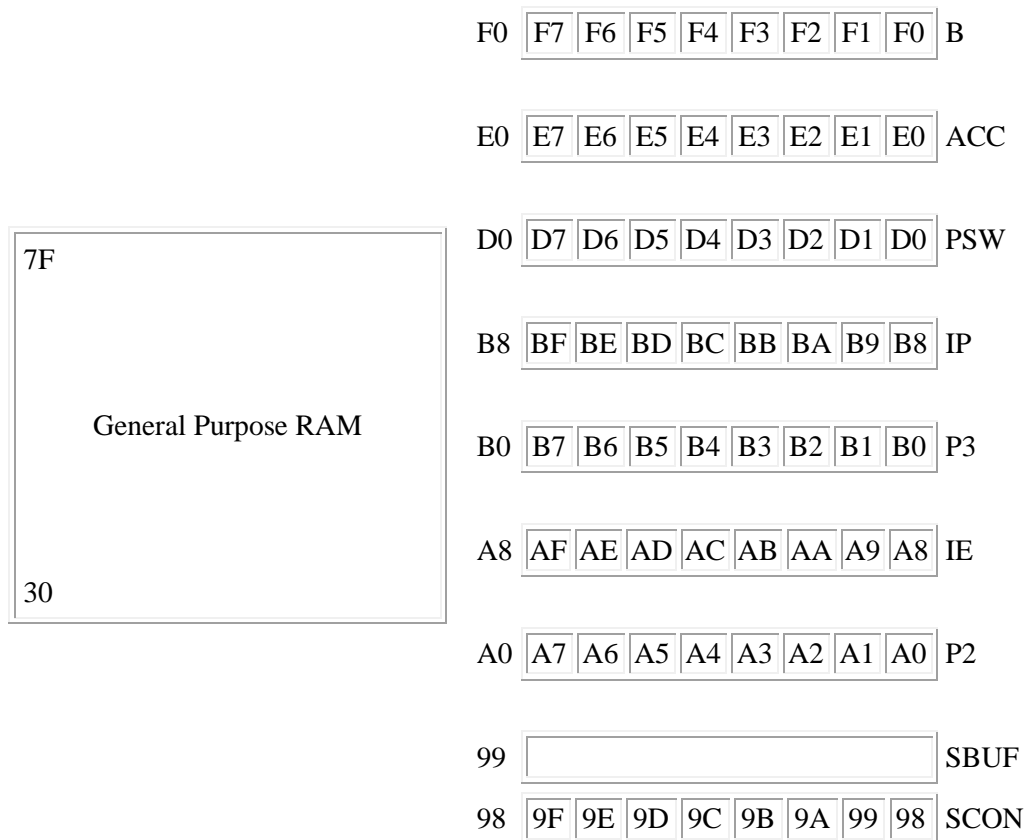## 8051 Memory Organization

Internal ROM

The 8051 has 4K (4096 locations) of on-chip ROM. This is used for storing the system program. $2^{12} = 4096$, therefore the internal ROM address bus is 12 bits wide and internal ROM locations go from 000H to FFFH.

Internal RAM

There are 256 bytes of internal RAM on the 8051. $2^8 = 256$, therefore the internal RAM address bus is 8 bits wide and internal RAM locations go from 00H to FFH.

The first 128 locations (00H to 7FH) of internal RAM are used by the programmer for storing data while the second 128 locations (80H to FFH) are the Special Function Registers (SFRs) which we will deal with later.

The diagram below is a summary of the 8051 on-chip RAM.

F0	F7	F6	F5	F4	F3	F2	F1	F0	B

E0	E7	E6	E5	E4	E3	E2	E1	E0	ACC

D0	D7	D6	D5	D4	D3	D2	D1	D0	PSW

B8	BF	BE	BD	BC	BB	BA	B9	B8	IP

B0	B7	B6	B5	B4	B3	B2	B1	B0	P3

A8	AF	AE	AD	AC	AB	AA	A9	A8	IE

A0	A7	A6	A5	A4	A3	A2	A1	A0	P2

99	SBUF

98	9F	9E	9D	9C	9B	9A	99	98	SCON

7F

General Purpose RAM

30

RAM

2F	7F	7E	7D	7C	7B	7A	79	78
2E	77	76	75	74	73	72	71	70
2D	6F	6E	6D	6C	6B	6A	69	68
2C	67	66	65	64	63	62	61	60
2B	5F	5E	5D	5C	5B	5A	59	58
2A	57	56	55	54	53	52	51	50
28	4F	4E	4D	4C	4B	4A	49	48
28	47	46	45	44	43	42	41	40
27	3F	3E	3D	3C	3B	3A	39	38
26	37	36	35	34	33	32	31	30
25	2F	2E	2D	2C	2B	2A	29	28
24	27	26	25	24	23	22	21	20
23	1F	1E	1D	1C	1B	1A	19	18
22	17	16	15	14	13	12	11	10
21	0F	0E	0D	0C	0B	0A	09	08
20	07	06	05	04	03	02	01	00

1F	
	Register Bank 3
18	
17	
	Register Bank 2
10	
0F	
	Register Bank 1
08	
07	
	Default Register Bank (Bank 0)
00	

RAM

SPECIAL FUNCTION REGISTERS

90	97	96	95	94	93	92	91	90	P1
8D									TH1
8C									TH0
8B									TL1
8A									TL0
89									TMOD
88	8F	8E	8D	8C	8B	8A	89	88	TCON
87									PCON
83									DPH
82									DPL
81									SP
80	87	86	85	84	83	82	81	80	P0

SPECIAL FUNCTION REGISTERS

Register Banks

There are four register banks from 00H to 1FH. On power-up, registers R0 to R7 are located at 00H to 07H. However, this can be changed so that the register set points to any of the other three banks (if you change to Bank 2, for example, R0 to R7 is now located at 10H to 17H).

Bit-addressable Locations

The 8051 contains 210 bit-addressable locations of which 128 are at locations 20H to 2FH while the rest are in the SFRs. Each of the 128 bits from 20H to 2FH have a unique number (address) attached to them, as shown in the table above. The 8051 instruction set allows you to set or reset any single bit in this section of RAM.

With the general purpose RAM from 30H to 7FH and the register banks from 00H to 1FH, you may only read or write a full byte (8 bits) at these locations. However, with bit-addressable RAM (20H to 2FH) you can read or write any single bit in this region by using the unique address for that bit. We will later see that this is a very powerful feature.

Special Function Registers (SFRs)

Locations 80H to FFH contain the special function registers. As you can see from the diagram above, not all locations are used by the 8051 (eleven locations are blank). These extra locations are used by other family members (8052, etc.) for the extra features these microcontrollers possess.

Also note that not all SFRs are bit-addressable. Those that are have a unique address for each bit.

We will deal with each of the SFRs as we progress through the course, but for the moment you should take note of the accumulator (ACC) at address E0H and the four port registers at addresses 80H for P0, 90h for P1, A0 for P2 and B0 for P3.