

4.2 SPECIAL FUNCTION REGISTERS (SFRs)

8051 MICROCONTROLLER SPECIAL FUNCTION REGISTERS

SFR registers exist in the address range of 80h through FFh. Each SFR has an address (80h through FFh) and a name. The following Table 4.2.1 provides a the 8051's SFRs, their names and their address. Although the address range of 80H through FFH offers 128 possible addresses, there are only 21 SFRs in a standard 8051.

Symbol	Name	Address
ACC*	Accumulator	0E0H
B*	B register	0F0H
PSW*	Program status word	0D0H
SP	Stack pointer	81H
DPTR	Data pointer 2 bytes	
DPL	Low byte	82H
DPH	High byte	83H
P0*	Port 0	80H
P1*	Port 1	90H
P2*	Port 2	0A0H
P3*	Port 3	0B0H
IP*	Interrupt priority control	0B8H
IE*	Interrupt enable control	0A8H
TMOD	Timer/counter mode control	89H
TCON*	Timer/counter control	88H
T2CON*	Timer/counter 2 control	0C8H
T2MOD	Timer/counter mode control	0C9H
TH0	Timer/counter 0 high byte	8CH
TL0	Timer/counter 0 low byte	8AH
TH1	Timer/counter 1 high byte	8DH
TL1	Timer/counter 1 low byte	8BH
TH2	Timer/counter 2 high byte	0CDH
TL2	Timer/counter 2 low byte	0CCH
RCAP2H	T/C 2 capture register high byte	0CBH
RCAP2L	T/C 2 capture register low byte	0CAH
SCON*	Serial control	98H
SBUF	Serial data buffer	99H
PCON	Power control	87H

* Bit-addressable

Table 4.2.1 8051 Special Function Registers (SFRs) Addresses

[Source: "The 8051 Microcontroller and Embedded Systems: Using Assembly and C" by Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay]

The 21 Special Function Registers of 8051 Microcontroller are categorized in to seven groups. They are:

- ***Math or CPU Registers:*** A and B
- ***Status Register:*** PSW (Program Status Word)
- ***Pointer Registers:*** DPTR (Data Pointer - DPL, DPH) and SP (Stack Pointer)
- ***I/O Port Latches:*** P0 (Port 0), P1 (Port 1), P2 (Port 2) and P3 (Port3)
- ***Peripheral Control Registers:*** PCON, SCON, TCON, TMOD, IE and IP
- ***Peripheral Data Registers:*** TL0, TH0, TL1, TH1 and SBUF

CPU OR MATH REGISTERS

A OR ACCUMULATOR (ACC)

The Accumulator or Register A is the most important and most used 8051 Microcontroller SFRs. The Register A is located at the address E0H in the SFR memory space. The Accumulator is used to hold the data for almost all the ALU Operations.

B (REGISTER B)

The B Register is used along with the ACC in Multiplication and Division operations. These two operations are performed on data that are stored only in Registers A and B. During Multiplication Operation, one of the operand (multiplier or multiplicand) is stored in B Register and also the higher byte of the result.

In case of Division Operation, the B Register holds the divisor and also the remainder of the result. It can also be used as a General Purpose Register for normal operations and is often used as an Auxiliary Register by Programmers to store temporary results. Register B is located at the address F0H of the SFR Address Space.

PROGRAM STATUS WORD (PSW)

The PSW or Program Status Word Register is also called as Flag Register and is one of the important SFRs. The PSW Register consists of Flag Bits, which help the programmer in checking the condition of the result and also make decisions

POINTER REGISTERS

DATA POINTER (DPTR - DPL AND DPH)

The Data Pointer is a 16-bit Register and is physically the combination of DPL (Data Pointer Low) and DPH (Data Pointer High) SFRs. The Data Pointer can be used as a single 16-bit register (as DPTR) or two 8-bit registers (as DPL and DPH).

DPTR doesn't have a physical Memory Address but the DPL (Lower Byte of DPTR) and DPH (Higher Byte of DPTR) have separate addresses in the SFR Memory Space. DPL = 82H and DPH = 83H. The DPTR Register is used by the programmer addressing external memory (Program - ROM or Data - RAM).

SP or Stack Pointer points out to the top of the Stack and it indicates the next data to be accessed. Stack Pointer can be accessed using PUSH, POP, and CALL and RET Instructions. The Stack Pointer is an 8-bit register and upon reset, the Stack Pointer is initialized with 07H.

I/O Port Registers (P0, P1, P2 and P3)

The 8051 Microcontroller has four Ports which can be used as Input and/or Output. These four ports are P0, P1, P2 and P3. Each Port has a corresponding register with the same name (the Port Registers are also P0, P1, P2 and P3). The addresses of the Port Registers are as follows: P0 - 80H, P1 - 90H, P2 - A0H and P3 - B0H.

PCON (Power Control)

The PCON or Power Control register, as the name suggests, is used to control the 8051 Microcontroller's Power Modes and is located at 87H of the SFR Memory Space. Using two bits in the PCON Register, the microcontroller can be set to Idle Mode or Power down Mode.

SCON (Serial Control)

The Serial Control or SCON SFR is used to control the 8051 Microcontroller's Serial Port. It is located at an address of 98H. Using SCON, we can control the Operation Modes of the Serial Port, Baud Rate of the Serial Port and Send or Receive Data using the Serial Port.

Byte address	Bit address	
FF		
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	-- -- -- BC BB BA B9 B8	IP
B0	B7 B6 B5 B4 B3 B2 B1 B0	P3
A8	AF -- -- AC AB AA A9 A8	IE
A0	A7 A6 A5 A4 A3 A2 A1 A0	P2
99	not bit-addressable	SBUF
98	9F 9E 9D 9C 9B 9A 99 98	SCON
90	97 96 95 94 93 92 91 90	P1
8D	not bit-addressable	TH1
8C	not bit-addressable	TH0
8B	not bit-addressable	TL1
8A	not bit-addressable	TL0
89	not bit-addressable	TMOD
88	8F 8E 8D 8C 8B 8A 89 88	TCON
87	not bit-addressable	PCON
83	not bit-addressable	DPH
82	not bit-addressable	DPL
81	not bit-addressable	SP
80	87 86 85 84 83 82 81 80	P0

Special Function Registers

Figure 4.2.1 8051 SFR RAM Address (Byte and Bit)

[Source: "The 8051 Microcontroller and Embedded Systems: Using Assembly and C" by Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay]

TCON (Timer Control)

Timer Control or TCON Register is used to start or stop the Timers of 8051 Microcontroller. It also contains bits to indicate if the Timers has overflowed. The TCON SFR also consists of Interrupt related bits.

TMOD (Timer Mode)

The TMOD or Timer Mode register or SFR is used to set the Operating Modes of the Timers T0 and T1. The lower four bits are used to configure Timer0 and the higher four bits are used to configure Timer1.

IE (Interrupt Enable)

The IE or Interrupt Enable Register is used to enable or disable individual interrupts. If a bit is SET, the corresponding interrupt is enabled and if the bit is cleared, the interrupt is disabled. The Bit7 of the IE register i.e. EA bit is used to enable or disable all the interrupts

IP (Interrupt Priority)

The IP or Interrupt Priority Register is used to set the priority of the interrupt as High or Low. If a bit is CLEARED, the corresponding interrupt is assigned low priority and if the bit is SET, the interrupt is assigned high priority.