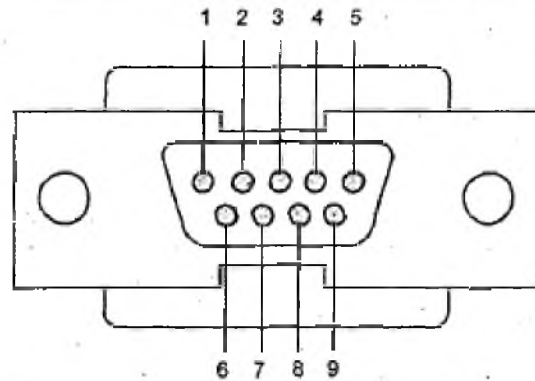


8051 SERIAL PORT PROGRAMMING**8051 Connection to RS232**

RS-232 is a standard communication port for connecting the computers and then-peripheral devices to enable the serial data exchange.



Pin	Description
1	Data Carrier Detect (DCD)
2	Received Data (RxD)
3	Transmitted Data (TxD)
4	Data Terminal Ready (DTR)
5	Signal ground (GND)
6	Data Set Ready (DSR)
7	Request To Send (RTS)
8	Clear To Send (CTS)
9	Ring Indicator (RI)

(1) RxD and TxD Pins

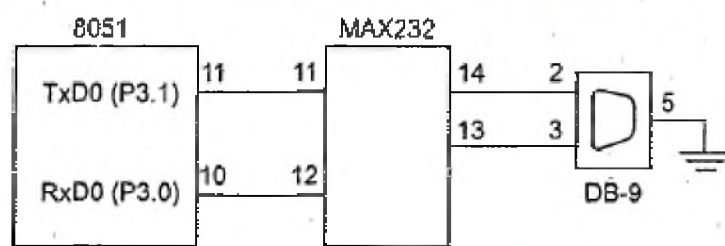
8051 has two pins that are used specifically for transferring and receiving data serially. These two pins are called TxD and RxD and are part of the port f 3 group (P3.0 and P3.1).

Pin 11 of the 8051 (P3.1) is assigned to TxD and pin 10 (P3.0) is designated as RxD. These pins are TTL compatible; therefore, they require a line driver to make them RS232 compatible.

(2) MAX 232

The RS232 standard is not TTL compatible, therefore, it requires a line driver (voltage converter) such as the MAX232 chip to convert RS232 voltage levels to TTL levels, and vice versa.'

The RS232's signals to TTL voltage levels will be acceptable at the 8051's TxD and RxD pins.



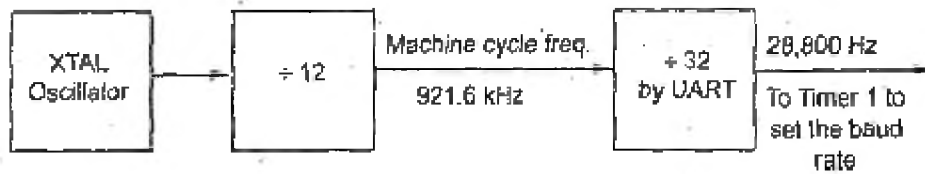
Baud Rate in 8051

To allow the data transfer between the PC and 8051 system without any error, we must make sure that the baud rate of the 8051 system matches the baud rate of the PC's COM port.

The 8051 transfers and receives data serially at many different baud rates. The baud rate in the 8051 is programmable which is done with the help of Timer 1.

The 8051 divides the crystal frequency by 12 in order to get the machine cycle frequency. In the case of XTAL = 11.0592 MHz, the machine cycle frequency is 921.6 kHz ($11.0592 \text{ MHz} / 12 = 921.6 \text{ kHz}$).

The 8051's serial communication UART circuitry divides the machine cycle frequency of 921.6 kHz by 32 once more before it is used by Timer 1 to set the baud rate. Therefore, 921.6 kHz is divided by 32 gives 28,800 Hz.



When Timer 1 is used to set the baud rate it must be programmed in mode 2, that is 8-bit, auto-reload. To get baud rates compatible with the PC, we must load TH1 > with the values shown in Table.

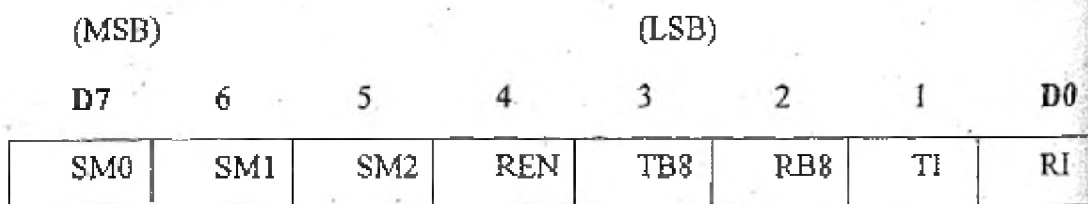
Baud Rate	TH1(Decimal)	TH1(Hex)
9600	- 3	FD
4800	- 6	FA
2400	- 12	F4
1200	- 24	E8

SBUF Register

SBUF is a 8-bit register used solely for the purpose of serial communication. For a byte data to be transferred via the TxD line, it must be placed in the SBUF register. Similarly, SBUF holds the byte of data when it is received by 8051 RxD line.

SCON (Serial Control) Register

The SCON register is a 8-bit register which is used to program the start bit, stop bit, and data bits of the data framing. Fig 3.29 describes various bits of the SCON register.



Symbol	Position	Name and significance
SM0	SCON.7	Serial port Mode control bit 0 which is set/cleared by the software.
SM1	SCON.6	Serial port Mode control bit 1 which is set/cleared by the software.
SM2	SCON.5	Serial port Mode control bit 2 which is used for multiprocessor communication.
REN	SCON.4	Receiver Enable control bit. Set/cleared by the software to enable/disable the serial data reception.
TB8	SCON.3	Transmit Bit 8. Not widely used.
RB8	SCON.2	Receive Bit 8. Not widely used.
TI	SCON.1	Transmit Interrupt flag. Set by HW and cleared by SW.
RI	SCON.0	Receive Interrupt flag. Set by HW and cleared by SW.

(i) SMO, SMI:

SMO and SMI are D7 and D6 of the SCON register, respectively. These two bits determine the framing of data by specifying the number of bits per character, and the start and stop bits.

In the SCON register, when serial mode 1 is chosen, the data framing is 8 bits, 1 stop bit, and 1 start bit which makes it compatible with the COM port of IBM/compatible PCs.

In serial mode 1, it allows the baud rate to be variable and is set by Timer 1 of the 8051.

(ii) SM2

SM2 is the D5 bit of the SCON register and this bit enables the multiprocessing capability of 8051.

(iii) REN (Receive Enable)

It is D4 bit of the SCON register which is also referred to as SCON.4 since SCON is a bit-addressable register.

(i) When REN bit is high (REN = 1), it allows the 8051 to receive data on the RxD pin of the 8051.

(ii) When REN bit is low (REN = 0), the receiver is disabled.

REN = 1 or REN = 0 can be achieved by the instructions “SETB SCON.4” and “CLR SCON. 4”, respectively.

These instructions use the bit-addressable features of register SCON. This bit; can be used to block any serial data reception.

(iv) TB8 (Transfer Bit 8)

TB8 is bit D3 of SCON which is used for both the serial modes 2 and 3.

(v) RB8 (Receive Bit 8)

RB8 is bit D2 of the SCON register. In serial mode 1, this bits get a copy of the stop bit when a 8-bit data is received.

(vi) TI (Transmit Interrupt)

TI is bit D1 of the SCON register. When 8051 finishes the transfer of 8-N: character:

It raises TI flag to indicate that it is ready to transfer an another byte.

TI bit is raised at the beginning of the stop bit.

(vii) RI (Receive Interrupt)

RI is the D0 bit of the SCON register. After 8051 receives data serially via RxD:

Programming the 8085 to Transfer Data Serially:

The following steps are used to program the 8051 in order to transfer the character bytes serially:

(i) TMOD register is loaded with the value 20H which indicates the use of timer 1 in mode 2 (8-bit auto-reload) to set the baud rate.

- (ii) The TH 1 is loaded with one of the values to set the baud rate for serial data transfer.
- (iii) The SCON register is loaded with the value 50H which indicates serial mode 1, where a 8- bit data is framed with start and stop bits.
- (iv) TRI is set to 1 to start Timer 1.
- (v) TI is cleared by “CLR TI” instruction.
- (vi) The character byte to be transferred serially is written into SBUF register.
- (vii) The TI flag bit is monitored with the use of instruction “JNB TI, xx” which indicates whether the character has been transferred completely.
- (viii) To transfer the next byte, go to Step 5.

Programming the 8051 to Receive Data Serially:

The following steps are used to program the 8051 to receive character bytes serially:

- (i) TMOD register is loaded with the value 20H, which indicates the use of timer 1 in mode 2 (8-bit auto-reload) to set baud rate.
- (ii) TH 1 is loaded to set baud rate.
- (iii) The SCON register is loaded with the value 50H, which indicates serial mode 1, where a 8- bit data is framed with start and stop bits and receive enable is turned on.
- (iv) TRI is set to 1 to start Timer 1.
- (v) RI is cleared by “CLR RI” instruction.
- (vi) The RI flag bit is monitored with the use of instruction “JNB RI, xx” if an entire character has been received .
- (vii) When RI is raised, SBUF has the byte and its contents are moved into place.
- (viii) To receive the next character, go to step 5.