Karnatak Law Society’s

GOGTE INSTITUTE OF TECHNOLOGY

Udyambag Belagavi -590008

Karnataka, India.



A Course Project Report on

**Micro Controller 8051 – Architecture and Salient features**

Submitted for the requirements of 3rd semester B.E. in CSE

for **“Computer Organization”**

**Submitted by**

|  |  |
| --- | --- |
| **NAME** | **USN** |
| **Shradha Mallikarjun Patil** | **2GI20CS144** |
| **Srushti B Mudennavar** | **2GI20CS158** |
| **Vinit Gunaki** | **2GI20CS181** |
| **Yash Herekar** | **2GI20CS184** |
|  |  |

**Under the guidance of**

**Prof. Ravi U. Kalkundri**

**Assistant Professor, Department of Computer Science**

Karnatak Law Society’s

GOGTE INSTITUTE OF TECHNOLOGY

Udyambag Belagavi -590008

Karnataka, India.

Department of CSE

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**Certificate**

This is to certify that the Course seminar work titled **“Micro Controller 8051 – Architecture and Salient features” for** **“Computer Organization** (18CS33)**”** carried out by Students: SHRADHA MALLIKARJUN PATIL (2GI20CS144), SRUSHTI B MUDENNAVAR (2GI20CS158), VINIT GUNAKI(2GI20CS181), YASH HEREKAR(2GI20CS184) have submitted in partial fulfilment of the requirements for 3rd semester B.E. in COMPUTER SCIENCE AND ENGINEERING, Visvesvaraya Technological University, Belagavi. It is certified that all corrections/suggestions indicated have been incorporated in the report. The course seminar report has been approved as it satisfies the academic requirements prescribed for the said degree.

Date:01-02-2022 Signature of Guide

Place: Belagavi Prof. Ravi U Kalkundri

Asst. Professor, Dept. of CSE

KLS Gogte Institute of Technology,

Belagavi.

MARKS ALLOCATION:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Batch No.:** | | | | | |
| 1. | Seminar Title: **Micro Controller 8051 – Architecture and Salient features** | Marks Range | **USN** | | | |
| **2GI18CS144** | **2GI18CS158** | **2GI18CS181** | **2GI18CS184** |
| 2. | Abstract (PO2) | 0-2 |  |  |  |  |
| 3. | Application of the topic to the course (PO2) | 0-3 |  |  |  |  |
| 4. | Literature survey and its findings (PO2) | 0-4 |  |  |  |  |
| 5. | Methodology, Results and Conclusion  (PO1, PO3, PO4) | 0-6 |  |  |  |  |
| 6. | Report and Oral presentation skill (PO9, PO10) | 0-5 |  |  |  |  |
|  | Total | 20 |  |  |  |  |

**\* 20 marks is converted to 10 marks for CGPA calculation**

**1.Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**2.Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.

**3.Design/Development of solutions:**Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**4.Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**5.Modern tool usage:**Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**6.The engineer and society:**Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**7.Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need

for sustainable development.

**8.Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**9.Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

**10.Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**11. Project management and finance:** Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**12. Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

**Signature of Staff**

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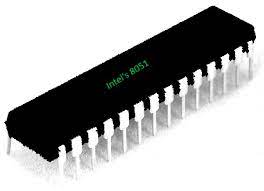
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**INTRODUCTION:**

A microcontroller (MCU for *microcontroller unit*) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit (IC) chip. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals.

The Intel MCS-51 is a single chip microcontroller (MCU) series developed by Intel in 1980.  Its foundation is based on Harvard architecture and this microcontroller was developed principally for bringing it to be used in **Embedded Systems.**

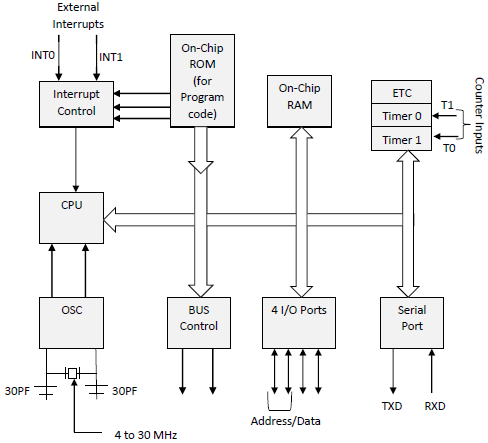
It is an 8-bit microcontroller which means data bus is of 8-bits. Therefore, it can process 8-bits at a time. It is used in wide variety of embedded systems like robotics, remote controls, automotive industry, telecom applications, power tools etc.

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**8051 ARCHITECTURE:**

The 8051 microcontroller is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.

In the following diagram, the system bus connects all the support devices to the CPU. The system bus consists of an 8-bit data bus, a 16-bit address bus and bus control signals. All other devices like program memory, ports, data memory, serial interface, interrupt control, timers, and the CPU are all interfaced together through the system bus.



Basic components present internally inside 8051 Microcontroller architecture are:

**CPU (Central Processing Unit)**: CPU act as a mind of any processing machine. It synchronizes and manages all processes that are carried out in microcontroller. User has no power to control the functioning of CPU. It interprets the program stored in ROM and carries out from storage and then performs it projected duty. CPU manage the different types of registers available in 8051 microcontrollers.

**Interrupts**: Interrupts is a sub-routine call that given by the microcontroller when some other program with high priority is request for acquiring the system buses the and interrupts occur in current running program.

Interrupts provide a method to postpone or delay the current process, performs a sub-routine task and then restart the standard program again.

**Memory**: For operation Micro-controller requires a program. This program guides the microcontroller to perform the specific tasks. This program installed in microcontroller requires some on chip memory for the storage of the program.

Microcontroller also requires memory for storage of data and operands for the short duration. In microcontroller 8051 there is code or program memory of 4 KB that is it has 4 KB ROM and it also comprise of data memory (RAM) of 128 bytes.

**Bus:** Bus is a group of wires which uses as a communication canal or acts as means of data transfer. The different bus configuration includes 8, 16 or more cables. Therefore, a bus can bear 8 bits, 16 bits all together.

**Types of buses in 8051 Microcontroller:**

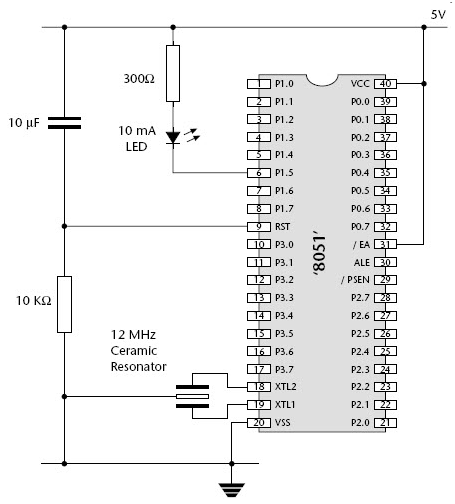
* **Address Bus**: 8051 microcontrollers is consisting of 16 bit address bus. It is generally be used for transferring the data from Central Processing Unit to Memory.
* **Data bus**: 8051 microcontroller is consisting of 8 bits data bus. It is generally be used for transferring the data from one peripherals position to other peripherals.

**Oscillator**: As the microcontroller is digital circuit therefore it needs timer for their operation. To perform timer operation inside microcontroller it required externally connected or on-chip oscillator. Microcontroller is used inside an embedded system for managing the function of devices. Therefore, 8051 uses the two 16-bit counters and timers. For the operation of this timers and counters the oscillator is used inside microcontroller.

**8051 PIN CONFIGURATION:**

The 8051 microcontrollers consist of 40 pins which are dedicated to several functions such as I/O, address, RD, WR, data and interrupts.  A total of 32 pins are set away into four Ports such as P0, P1, P2 and P3. Where, each port contains 8 pins.

* **Pins 1 to 8** − These pins are known as Port 1. This port doesn’t serve any other functions. It is internally pulled up, bi-directional I/O port.
* **Pin 9** − It is a RESET pin, which is used to reset the microcontroller to its initial values.
* **Pins 10 to 17** − These pins are known as Port 3. This port serves some functions like interrupts, timer input, control signals, serial communication signals RxD and TxD, etc.
* **Pins 18 & 19** − These pins are used for interfacing an external crystal to get the system clock.
* **Pin 20** − This pin provides the power supply to the circuit.
* **Pins 21 to 28** − These pins are known as Port 2. It serves as I/O port. Higher order address bus signals are also multiplexed using this port.
* **Pin 29** − This is PSEN pin which stands for Program Store Enable. It is used to read a signal from the external program memory.
* **Pin 30** − This is EA pin which stands for External Access input. It is used to enable/disable the external memory interfacing.
* **Pin 31** − This is ALE pin which stands for Address Latch Enable. It is used to demultiplex the address-data signal of port.



* **Pins 32 to 39** − These pins are known as Port 0. It serves as I/O port. Lower order address and data bus signals are multiplexed using this port.
* **Pin 40** − This pin is used to provide power supply to the circuit.

**INPUT OUTPUT PORTS:**

8051 microcontrollers have 4 I/O ports each of 8-bit, which can be configured as input or output. Hence, total 32 input/output pins allow the microcontroller to be connected with the peripheral devices.

* **Pin configuration**, i.e., the pin can be configured as 1 for input and 0 for output as per the logic state.
  + **Input/Output (I/O) pin** − All the circuits within the microcontroller must be connected to one of its pins except P0 port because it does not have pull-up resistors built-in.
  + **Input pin** − Logic 1 is applied to a bit of the P register. The output FE transistor is turned off and the other pin remains connected to the power supply voltage over a pull-up resistor of high resistance.
* **Port 0** − The P0 (zero) port is characterized by two functions −
  + When the external memory is used then the lower address byte (addresses A0A7) is applied on it, else all bits of this port are configured as input/output.
  + When P0 port is configured as an output then other ports consisting of pins with built-in pull-up resistor connected by its end to 5V power supply, the pins of this port have this resistor left out.

### Input Configuration

If any pin of this port is configured as an input, then it acts as if it “floats”, i.e. the input has unlimited input resistance and in-determined potential.

### Output Configuration

When the pin is configured as an output, then it acts as an “open drain”. By applying logic 0 to a port bit, the appropriate pin will be connected to ground (0V), and applying logic 1, the external output will keep on “floating”.

In order to apply logic 1 (5V) on this output pin, it is necessary to build an external pullup resistor.

### Port 1 P1 is a true I/O port as it doesn’t have any alternative functions as in P0, but this port can be configured as general I/O only. It has a built-in pull-up resistor and is completely compatible with TTL circuits.

### Port 2 P2 is similar to P0 when the external memory is used. Pins of this port occupy addresses intended for the external memory chip. This port can be used for higher address byte with addresses A8-A15. When no memory is added then this port can be used as a general input/output port similar to Port 1.

### Port 3 In this port, functions are similar to other ports except that the logic 1 must be applied to appropriate bit of the P3 register.

## **Pins Current Limitations**

* When pins are configured as an output (i.e., logic 0), then the single port pins can receive a current of 10mA.
* When these pins are configured as inputs (i.e., logic 1), then built-in pull-up resistors provide very weak current, but can activate up to 4 TTL inputs of LS series.
* If all 8 bits of a port are active, then the total current must be limited to 15mA (port P0: 26mA).
* If all ports (32 bits) are active, then the total maximum current must be limited to 71mA

**8051 INTERRUPTS:**

Interrupts are the events that temporarily suspend the main program, pass the control to the external sources and execute their task. It then passes the control to the main program where it had left off.

8051 has 5 interrupt signals, i.e. INT0, TFO, INT1, TF1, RI/TI. Each interrupt can be enabled or disabled by setting bits of the IE register and the whole interrupt system can be disabled by clearing the EA bit of the same register.

## **IE (Interrupt Enable) Register**

This register is responsible for enabling and disabling the interrupt. EA register is set to one for enabling interrupts and set to 0 for disabling the interrupts. Its bit sequence and their meanings are shown in the following figure.

IE Register

|  |  |  |
| --- | --- | --- |
| EA | IE.7 | It disables all interrupts. When EA = 0 no interrupt will be acknowledged and EA = 1 enables the interrupt individually. |
| - | IE.6 | Reserved for future use. |
| - | IE.5 | Reserved for future use. |
| ES | IE.4 | Enables/disables serial port interrupt. |
| ET1 | IE.3 | Enables/disables timer1 overflow interrupt. |
| EX1 | IE.2 | Enables/disables external interrupt1. |
| ET0 | IE.1 | Enables/disables timer0 overflow interrupt. |
| EX0 | IE.0 | Enables/disables external interrupt0. |

## **IP (Interrupt Priority) Register**

We can change the priority levels of the interrupts by changing the corresponding bit in the Interrupt Priority (IP) register as shown in the following figure.

* A low priority interrupt can only be interrupted by the high priority interrupt, but not interrupted by another low priority interrupt.
* If two interrupts of different priority levels are received simultaneously, the request of higher priority level is served.
* If the requests of the same priority levels are received simultaneously, then the internal polling sequence determines which request is to be serviced.

IP Register

|  |  |  |
| --- | --- | --- |
| - | IP.6 | Reserved for future use. |
| - | IP.5 | Reserved for future use. |
| PS | IP.4 | It defines the serial port interrupt priority level. |
| PT1 | IP.3 | It defines the timer interrupt of 1 priority. |
| PX1 | IP.2 | It defines the external interrupt priority level. |
| PT0 | IP.1 | It defines the timer0 interrupt priority level. |
| PX0 | IP.0 | It defines the external interrupt of 0 priority level. |

## **TCON Register**

TCON register specifies the type of external interrupt to the microcontroller

**SALIENT FEATURES:**

* **On-chip RAM**: Random access memory of 128 byte is used for data storage in 8051. RAM as a non-volatile memory consists of register banks, stacks for temporary data storage and some special function registers.
* **On-chip ROM**: 8051 consists of 4KB ROM for program storage. ROM as a volatile memory helps in permanent data storage.
* **Timers and Counters**: Timer helps in providing delay between the events. In 8051, there are two timer pins T0, T1. If these pins are used in the counter mode, we can count the external pulses. In T0, it is possible to store 16 bit data. This is done by storing the lower 8 bit in TL0 and the upper 8 bit in TH0. Similarly, we can store 16 bit data in T1 also. TMOD and TCON helps in the timer operation.
* **Serial Port**: In order, to perform the serial communication, TXD and RXD pins are used. TXD pin is used for transmitting the serial data and the RXD pin is used for the transmission of the data. SCON register is used to control the operation of the serial communication.
* **Input and Output Ports**: P0, P1. P2. P3 form the four ports of 8051 microcontroller. Each of the port is 8 bit wide. Port **P0** is used as a Lower Order Address bus. Port **P2** can be used as I/O port and higher order bus A8 to A15. Port **P3** can be used as I/O pin and each pin of port 3 has special functions.
* **Oscillator** – This is used to provide clock to the 8051 microcontrollers. The crystal frequency can vary from 4MHz to 30MHz.
* **Interrupts** - Interrupts are requests which are used to handle special events or routines known as Interrupt Service Routines. INT0 and INT1 are the basic interrupt pins used in 8051.
* **Arithmetic Logic Unit** - This unit is used for arithmetic calculations.
* **Accumulator** (A register) – This register is used for arithmetic operations.
* **B register** – This is an 8bit register that is bit addressable and is used for two instructions only like MUL AB and DIV AB.
* **Program Counter** – is a 16 bit register that helps to access address from 0000H to FFFFH. Program Counter is used to address the next instruction to be executed from the ROM.
* **Flag Bits and PSW register** – The flag bits are used to indicate the arithmetic condition of the ACC. Program Status Word (PSW) is the flag resister in 8051. This register consists of four flags like Carry, Auxiliary Carry Flag, Register Select 1, Register Select 0, Parity Flag, Overflow flag.

1. Parity Flag (P) – If the accumulator registers consists of odd number of 1’s, then the parity flag will be set to 1. While, if the accumulator register consists of even number of 0’s, then the parity flag will be 0.
2. Carry Flag (CY) – This flag is set when there is a carry out from the D7 bit.
3. Auxiliary Carry (AC) – If there is a carry out after addition or subtraction operation from D4 bit, then the AC is set. Otherwise, AC is cleared.
4. Overflow Flag (OV) – This flag is set when the result of the signed operation is very big.
5. Register Select (RS1 and RS0) – They are used to change the bank registers.

**CONCLUSION:**

The 8051-microcontroller architecture provides many functions (central processing unit (CPU), random-access memory (RAM), read-only memory (ROM), input/output (I/O) ports, serial port, interrupt control, timers) in one package. The 8051 microcontrollers have made a significant improvement in digital systems with low time required for performing operation. They’re highly economical due to their higher integration. They can easily interface with additional RAM, ROM and I/O ports.

**REFERENCES:**

8051-microcontroller Wikipedia

The 8051 Microcontroller and Embedded Systems by Mazidi

https://www.tutorialspoint.com/microprocessor/microcontrollers\_8051\_architecture.htm

https://microcontrollergarden.blogspot.com/2015/10/some-salient-features-of-8051.html?m=1