

Team **ARCSix**

Lec02 (Embedded Hardware Outline)

- ***Embedded Systems***

- Concept of Real Time*

- Microprocessor v/s Microcontroller*

- AVR Microcontrollers*

- ***Hardware Essentials***

- Component Selection*

- Component Testing*

- Reading Datasheets*

- Reading Documentation*

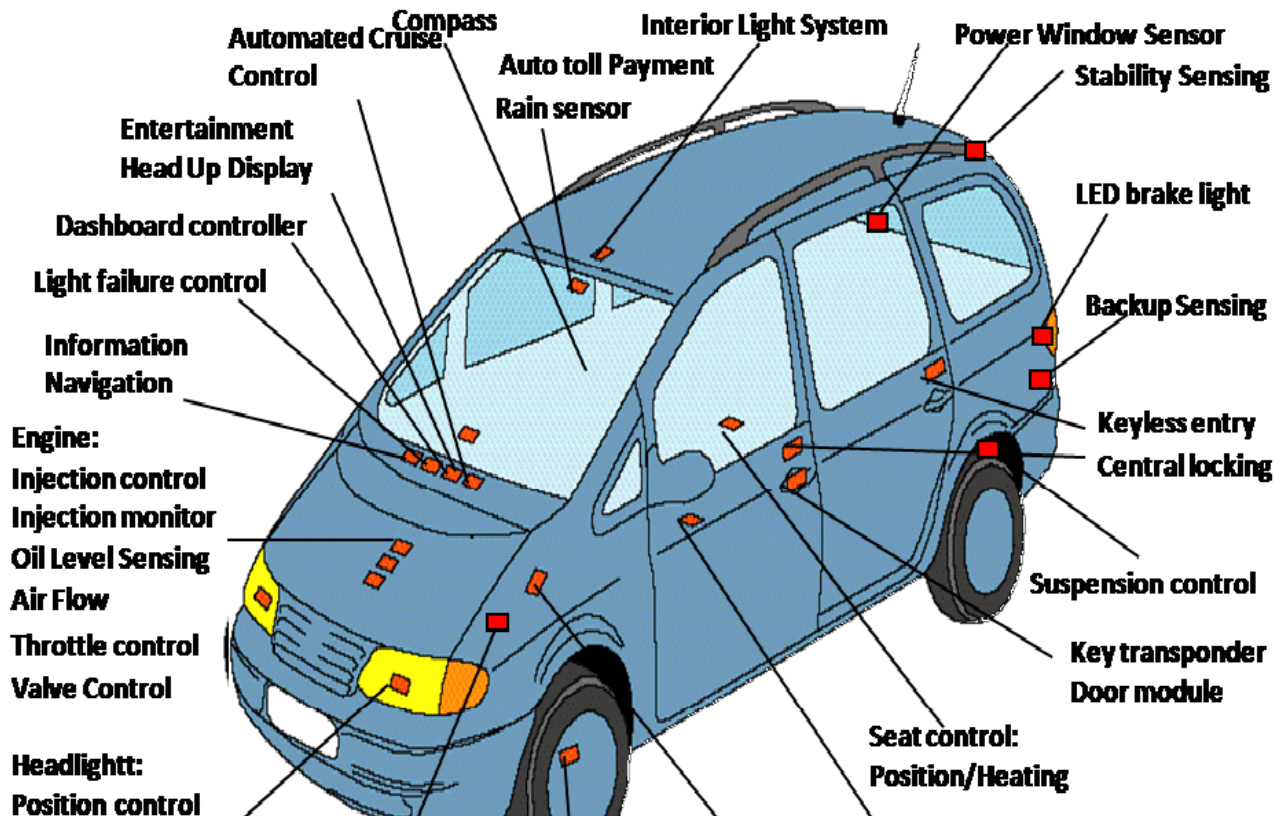
- Writing Documentation*

Embedded Systems

Embedded Systems

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints.

Automobile Control System



Real Time ... But How?

- **Measuring “Real Time”**

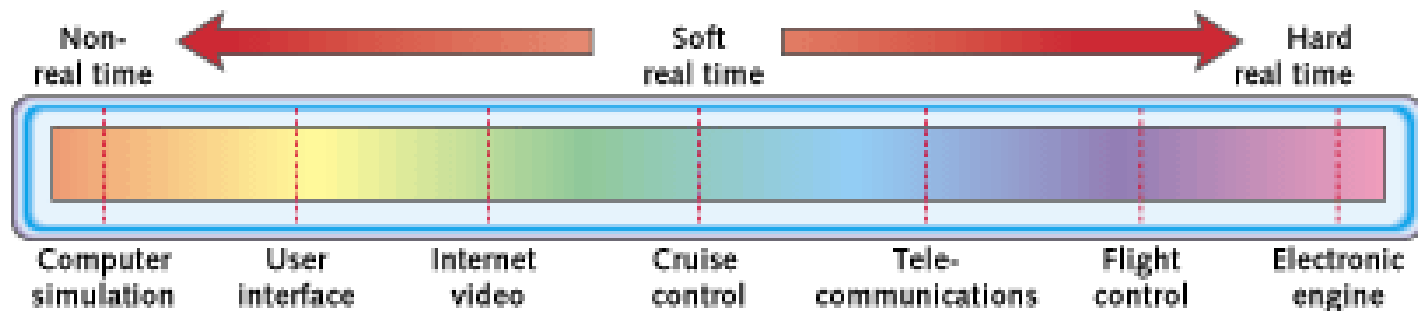
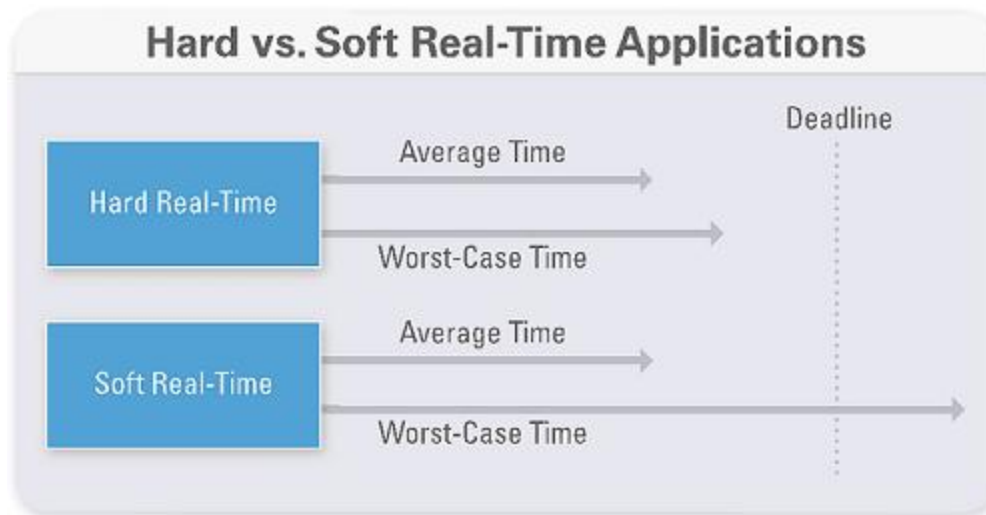
*Defining it in terms of **determinism** ... What’s that?*

*A **deterministic system** is a system in which no randomness is involved in the development of future states of the system.*

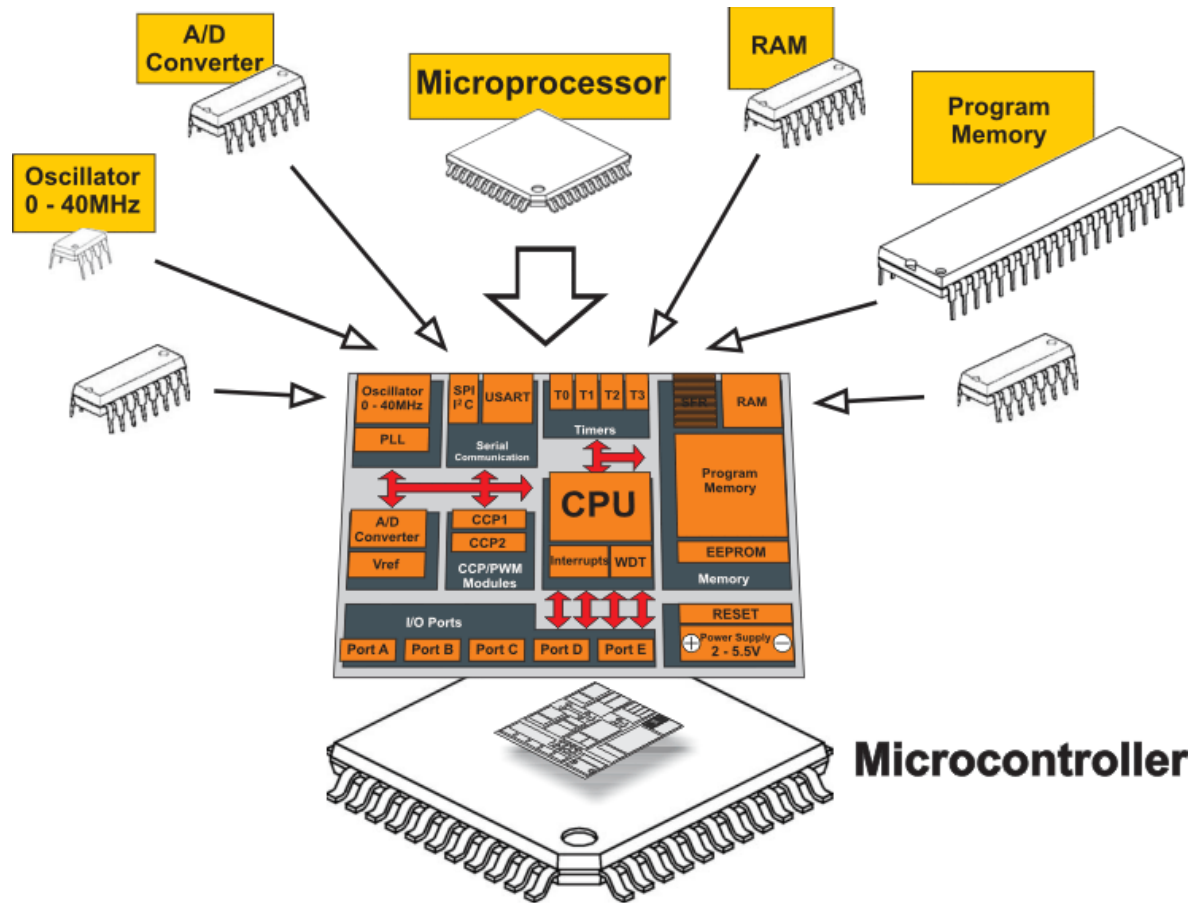
*A **deterministic model** will thus always produce the same output from a given starting condition or initial state.*

That is, a **Real Time System** guarantees that a given set of operations will be **performed in a specified duration of time**, and is **reproducible** (giving the same results each time).

- **But then, the real world is cruel. So ...**
We define our priorities – Soft & Hard



Microprocessor v/s Microcontroller



Need a more thorough difference? Look [Here](#)

AVR Microcontrollers



AVR is a family of **8-bit/RISC/single-chip** μ c.
Their system architecture is [**Modified-Harvard**](#).

The modified Harvard architecture is a variation of the Harvard computer architecture that allows the **contents of the instruction memory to be accessed as if it were data.*

[Outline](#)

[Get Started](#)

[Quick Reference](#)

Hardware Essentials

Component Selection

Factors to bear in mind

1. Must meet minimum requirements
2. Must have low hardware/software complexity
3. Must have low hardware/software dependencies
4. Availability of good documentation & sample-usage applications
5. Pricing & Availability
6. Power Considerations – How much power will it consume? How long will it last?

GSM / GPRS + GNSS Modules

Module	Technology	Dimensions	Normal Temperature
SIM968	Quad-Band GSM/GPRS+GNSS	30 x 30 x 3.0mm	-40°C to +85°C
SIM808	Quad-Band GSM/GPRS+GPS+BT 3.0	24.0 x 24.0 x 2.6mm	-40°C to +85°C
SIM868	Quad-Band GSM/GPRS+GNSS	17.6 x 15.7 x 2.3mm	-40°C to +85°C

LTE Modules

Module	Technology	Dimensions	Normal Temperature
SIM7100E	TDD-LTE/FDD-LTE/WCDMA/GSM/GNSS	30 X 30 X 2.9 mm	-40°C to +85°C
SIM7500E	LTE-FDD/GSM	24 X 27 X 2.75 mm	-40°C to +85°C
SIM7500A	LTE-FDD/HSPA	24 X 27 X 2.75 mm	-40°C to +85°C
SIM7600C	LTE-TDD/LTE-FDD/HSPA+ /TD-SCDMA	30 X 30 X 2.9 mm	-40°C to +85°C

Selecting a module for GSM/GPRS + GPS Application

SIM900

GSM / GPRS



SIMCom presents an ultra compact and reliable wireless module-SIM900. This is a complete Quad-band GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core, allowing you to benefit from small dimensions and cost-effective solutions.

Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in your M2M applications, especially for slim and compact demands of design.

NB! SIM900 is EOL now. Limited quantity available. Please consider to use SIM800x series modules.

Downloads

SIM900

General features

- Quad-Band 850/900/1800/1900 MHz
- GPRS multi-slot class 10/8
- GPRS mobile station class B
- Compliant to GSM phase 2/2+
 - Class 4 (2 W @850/ 900 MHz)
 - Class 1 (1 W @ 1800/1900MHz)
- SAIC (Single Antenna Interference Cancellation) support
- Dimensions: 24 x 24 x 3 mm
- Weight: 3.4g
- Control via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands)
- SIM application toolkit
- Supply voltage range : 3.2 ... 4.8V
- Low power consumption: 1.0mA (sleep mode&BS-PA-MFRMS=9)
- Operation temperature: -40°C to +85 °C

Specifications for Fax

- Group 3, class 1

Specifications for GPRS Data

- GPRS class 10: max. 85.6 kbps (downlink)
- PBCCCH support
- Coding schemes CS 1, 2, 3, 4
- PPP-stack

Specifications for CSD Data

- USSD
- Non transparent mode

Specifications for SMS via GSM/GPRS

- Point to point MO and MT
- SMS cell broadcast
- Text and PDU mode

Software features

- 0710 MUX protocol
- Embedded TCP/UDP protocol
- FTP/HTTP

Special firmware

- Embedded AT
- FOTA
- MMS

Specifications for Voice

- Tricodex
 - Half rate (HR)
 - Full rate (FR)
 - Enhanced Full rate (EFR)
- AMR
 - Half rate (HR)
 - Full rate (FR)
- Hands-free operation (Echo suppression)

Interfaces

- Interface to external SIM 3V/ 1.8V
- Analog audio interface
- RTC backup
- SPI interface (option)
- Serial interface
- Antenna pad
- I2C
- GPIO
- PWM
- ADC

Compatibility

- AT cellular command interface

Certifications:

- CE
- FCC
- GCF
- PTCRB
- IC
- ICASA
- ROHS
- REACH
- NCC
- Anatel
- A-TICK
- ATEX

Carrier Approvals

- Rogers
- Oranges
- AT&T
- Vodafone
- Deuts Telecom
- Telia Sonera
- TIM
- GMA

Selecting a module for GSM/GPRS + GPS Application

SIM808

GSM / GPRS + GNSS



SIM808 module is a complete Quad-Band GSM/GPRS module which combines GPS technology for satellite navigation.

Downloads

SIM808

The compact design which integrated GPRS and GPS in a SMT package will significantly save both time and costs for customers to develop GPS enabled applications. Featuring an industry-standard interface and GPS function, it allows variable assets to be tracked seamlessly at any location and anytime with signal coverage.

Application Notes

General features

- Quad-band 850/900/1800/1900MHz
- GPRS multi-slot class 12/10
- GPRS mobile station class B
- Compliant to GSM phase 2/2+
 - Class 4 (2 W @ 850/900MHz)
 - Class 1 (1 W @ 1800/1900MHz)
- Bluetooth: compliant with 3.0+EDR
- FM: 76~109MHz worldwide bands with 50KHz tuning step
- Dimensions: 24.0*24.0*2.6mm
- Weight: 3.30g
- Control via AT commands (3GPP TS 27.007, 27.005 and SIMCOM enhanced AT Commands)
- Supply voltage range 3.4 ~ 4.4V
- Low power consumption
- Operation temperature:-40°C ~85°C

Specifications for GPRS Data

- GPRS class 12: max. 85.6 kbps (downlink/uplink)
- PBCCCH support
- Coding schemes CS 1, 2, 3, 4
- PPP-stack
- CSD up to 14.4 kbps
- USSD

Specifications for SMS via GSM/GPRS

- Point to point MO and MT
- SMS cell broadcast
- Text and PDU mode

Software features

- 0710 MUX protocol
- Embedded TCP/UDP protocol
- FTP/HTTP
- MMS
- POP3/SMTP
- DTMF
- Jamming Detection
- Audio Record
- SSL
- Bluetooth 3.0 (optional)
- TTS CN(optional)
- Embedded AT (optional)

Specification for GPS

- Receiver type
 - 22 tracking /66 acquisition -channel
 - GPS L1 C/A code
- Sensitivity
 - Tracking: -165 dBm
 - Cold starts : -147 dBm
- Time-To-First-Fix
 - Cold starts: 30s (typ.)
 - Hot starts: 1s (typ.)
 - Warm starts: 28s (typ.)
- Accuracy
 - Horizontal position : <2.5m CEP

Interfaces

- 68 SMT pads including:
 - Analog audio interface
 - PCM interface (optional)
 - SPI interface (optional)
 - RTC backup
 - Serial interface
 - USB interface
 - Interface to external SIM 3V/1.8V
- Keypad interface
- GPIO
- ADC
- GSM Antenna pad
- GPS Antenna pad
- Bluetooth Antenna pad

Compatibility

- AT cellular command interface

Certifications

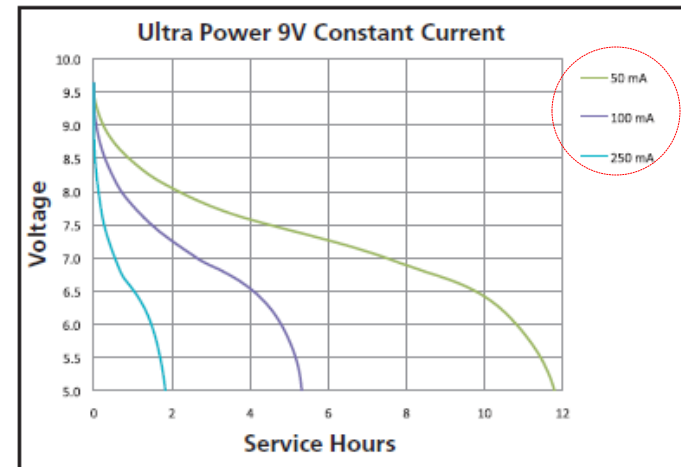
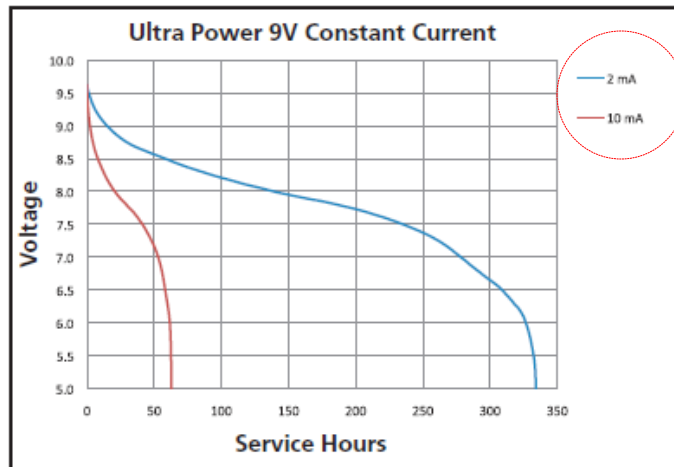
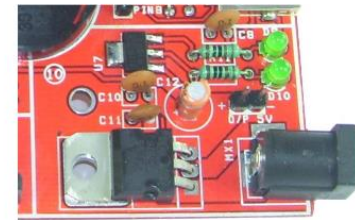
- CE
- A-TICK
- TA
- CCC

Component Testing

Factors to bear in mind

1. Provide the min. I/P voltage(s) as specified in user-guide
2. Check for voltage drain (of 9V battery) using DMM
3. Make use of status LEDs – concept of BIOS
4. Check for V_{CC} , GND issues
5. Run firmware code

Power to the board via 9V DC Main Adapter



Run-times for 9V Duracell battery

Reading Datasheets

Factors to bear in mind

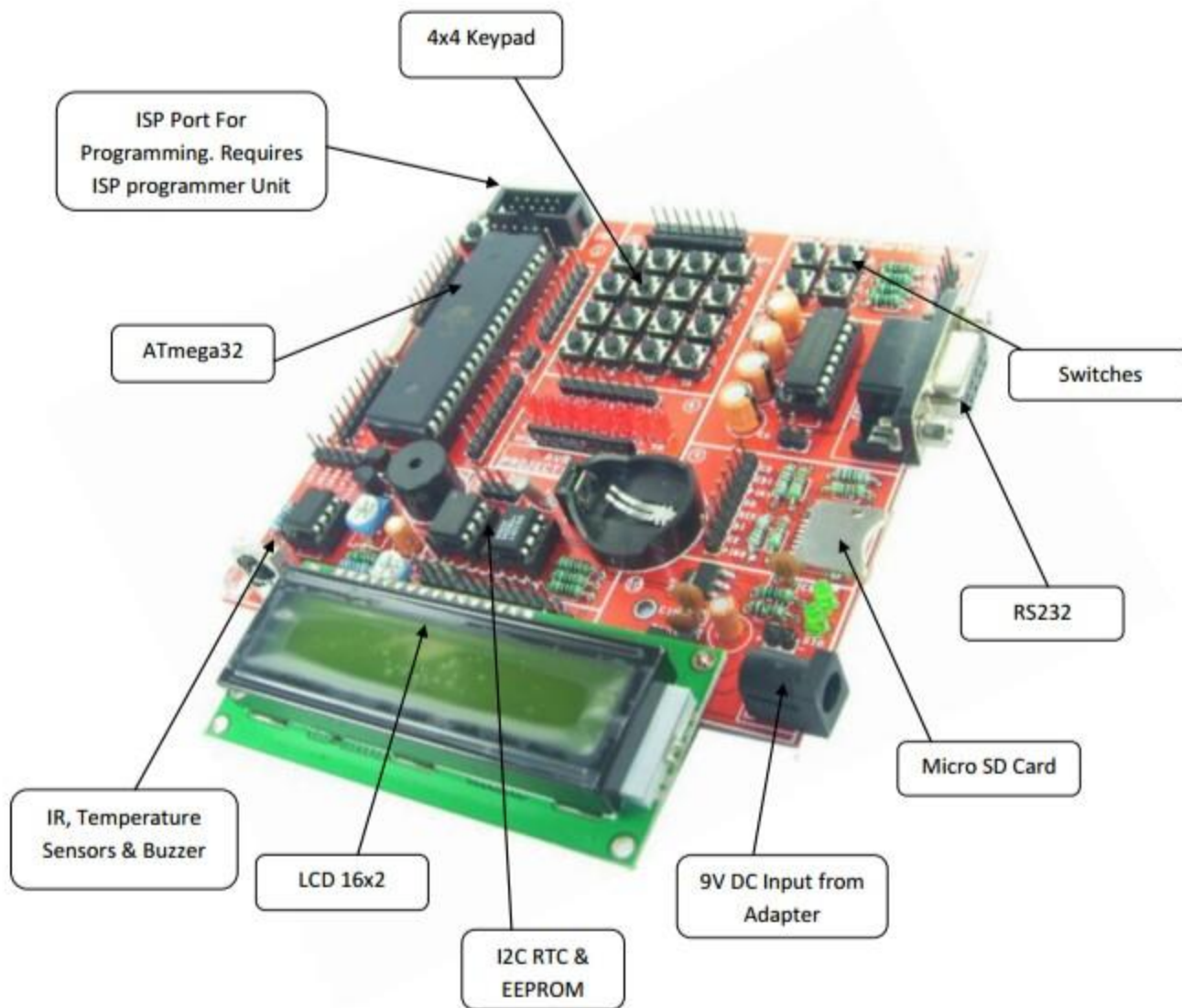
1. Pinout & Available Packages – DIP/QFP
2. Block Diagram
3. Identify GPIO
4. Identify options to programme, debug & simulate O/P
5. Look for operating voltages – I/P & O/P (Use [Linear Voltage Regulators](#))
6. Look for Application Notes
7. Look for Troubleshooting Notes

[ATmega32A](#)

Reading Documentation

Factors to bear in mind

1. Start with datasheet, make notes
2. Look for documentation on compatible hardware/software
3. Search the internet for existing projects:
 - Youtube – Video tutorials
 - Github – Source Code
 - Hackster – Projects/Ideas
 - Hackaday - Projects/Ideas



AVR Trainer-Kit

Writing Documentation

Sections to include

1. Abstract
2. Block Diagram
3. Functional/Flow Diagram
4. Algorithm Implementation – Flowchart/Steps
5. Use-Case – UML Diagrams
6. Description
7. References

