RESEARCH WORK-7

In System Programming(ISP):

In-System Programming (ISP) is a method of updating the firmware or software of an embedded system without removing the device from its circuit board or system. Instead of replacing the entire device, ISP allows for the modification or replacement of the firmware using an external interface, such as a JTAG(Joint Test Action Group) or SWD (Serial Wire Debug) interface.

To use ISP, the device must have an interface that supports in-system programming. This interface can be a dedicated port or pins on the device's microcontroller, or it may be integrated with the JTAG or SWD interface. The interface allows for communication with the device's microcontroller, enabling the firmware to be updated or replaced.

In Circuit Serial Programming(ICSP):

ICSP (In-Circuit Serial Programming) is a programming technique commonly used in embedded systems for programming microcontrollers in circuit without removing them from the circuit board. ICSP allows for the programming or updating of the firmware or software of a microcontroller-based system by connecting a programming device to specific pins on the microcontroller.

ICSP typically uses a 3- or 5-wire interface that includes a Clock (CLK) signal, a Data Input (DI) signal, a Data Output (DO) signal, and optionally, a Reset (RST) signal and/or a Vcc supply.The programming device communicates with the microcontroller through these pins, sending programming commands and data to the microcontroller's memory.

Differences between ICSP and ISP:

ICSP (In-Circuit Serial Programming) and ISP (In-System Programming) are both programming techniques used in embedded systems for programming microcontrollers. The main difference between ICSP and ISP lies in the way they connect to the microcontroller.

ICSP requires a dedicated connection to the microcontroller's programming pins. This connection is typically made using a programming header or connector that is designed to fit into a specific location on the circuit board. The programming device communicates with the microcontroller through these pins, sending programming commands and data to the microcontroller's memory. ICSP is typically used when the microcontroller cannot be removed from the circuit board or is difficult to access.

MISO	1	○ ○	2	+VCC
SCK	3	○ ○	4	MOSI
RST	5	○ ○	6	GND

ICSP
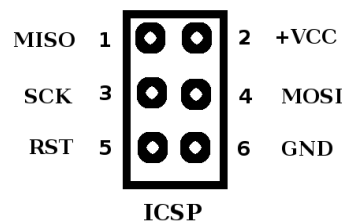
ISP uses a dedicated interface, such as a JTAG (Joint Test Action Group) or SWD (Serial Wire Debug) interface, to connect to the microcontroller. This interface allows for communication with the microcontroller, enabling the firmware to be updated or replaced. ISP is typically used when the microcontroller can be easily accessed and removed from the system, or when higher speed programming interface is require.
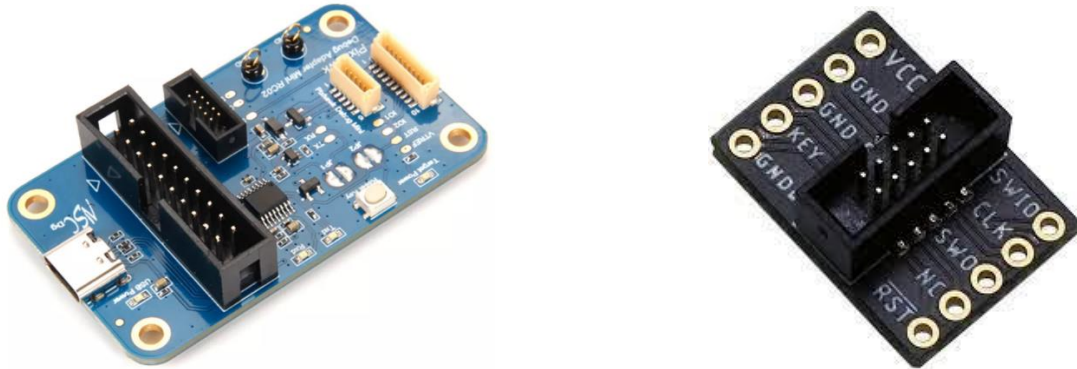
Working of ICSP and ISP:

ICSP:

➢ The microcontroller's programming pins are connected to a programming device, such as a programmer or debugger, using a programming header or connector.
➢ The programming device sends programming commands and data to the microcontroller's memory through the programming pins.

ISP:

➢ The programming device connects to the microcontroller's dedicated programming interface, such as JTAG or SWD, using a programming cable or connector.
➢ The programming device sends programming commands and data to the microcontroller's memory through the programming interface.

In both cases, the programming process involves sending new programming data to the microcontroller's memory, verifying the programming, and resetting the system. However, the method of connecting to the microcontroller and sending the programming data differs between ISP and ICSP.

Importance of ICSP and ISP in Embedded System:

➢ Allows for firmware updates: ICSP and ISP enable developers to update the firmware or software of a microcontroller-based system without removing the microcontroller from the circuit board or the system from the field. This is particularly useful in situations where the system cannot be easily accessed, such as in remote locations.
➢ Enables faster testing and development: With ICSP and ISP, developers can quickly test and debug their code by programming the microcontroller directly in the circuit board. This can save significant time and effort compared to having to remove the microcontroller from the circuit board for programming.

➢ Facilitates efficient production processes: ICSP and ISP enable automated programming of microcontrollers during the manufacturing process, which can significantly increase production efficiency and reduce costs.
➢ Supports a wide range of microcontrollers: Many microcontroller manufacturers support ICSP and ISP, which allows developers to use these techniques with a wide range of microcontrollers.
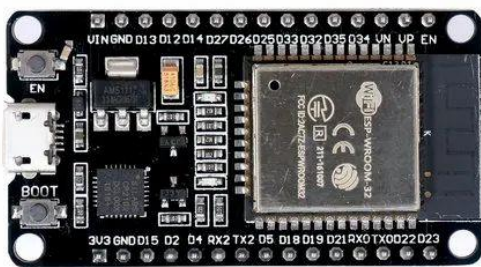
Most popular ICSP used boards:
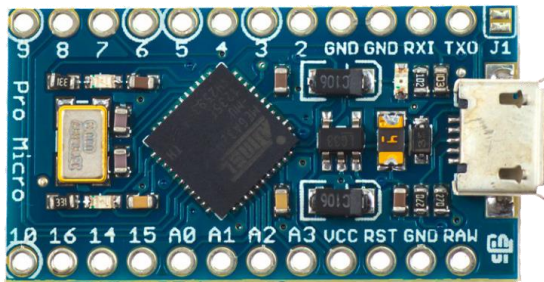
ProMicro development board (SparkFun Electronics)

Based on the ATmega32U4 microcontroller.
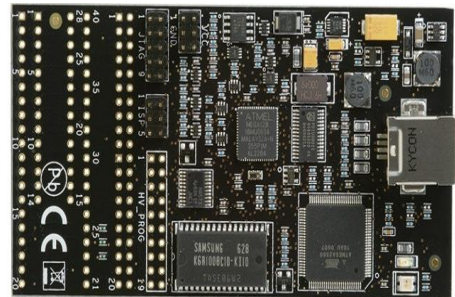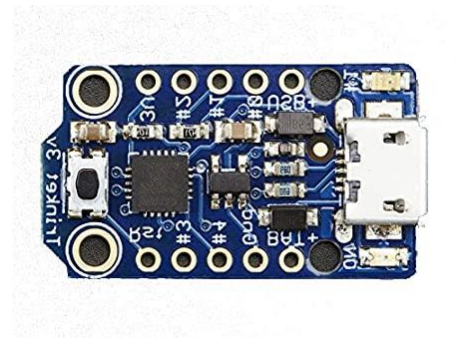

AVR Dragon programming and debugging

Tool(Microchip Technology)

NodeMCU development board

Based on the ESP8266 Wi-Fi module

Helps users to prototype IoT products easily.

Adafruit Trinket is an Arduino-compatible

microcontroller board.

Most popular ISP used Programmers:

Atmel SAM-ICE is a powerful emulator and programmer

for Atmel ARM-based microcontrollers.

AVR ISP MkII is an in-system programmer
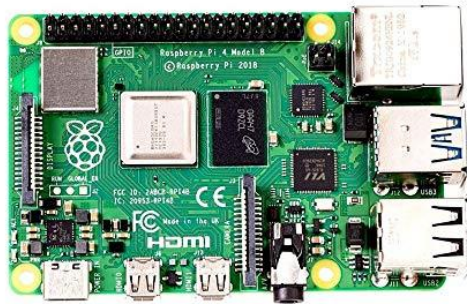
for AVR microcontrollers

Microchip ICD3 is a debugger and programmer for

Microchip's PIC microcontrollers.

ST-LINK is a programmer/debugger for

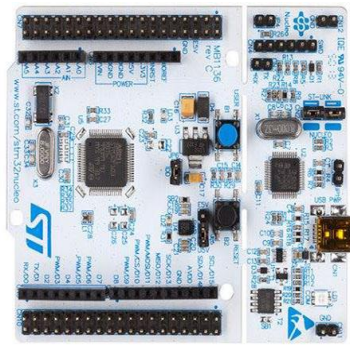ST Microelectronics' ARM-based microcontrollers

Most popular ISP and ICSP used boards:

Raspberry pi

Arduino UNO

STM32Nucelo

Teensy 4.0

Beagle Bone Green

Real Time Applications of ISP and ICSP Protocols:

➢ **Electronics:** In the field of electronics, these protocols are used for programming microcontrollers and other embedded devices. They are used in various applications such as home automation, industrial automation, robotics, and many more.

➢ **Automotive:** In the automotive industry, these protocols are used for programming engine control modules, airbag modules, and other electronic control units. They are also used for updating the firmware of the infotainment systems in modern cars.

➢ **Aerospace:** In the aerospace industry, these protocols are used for programming the flight control systems of aircraft, satellites, and rockets. They are also used for updating the firmware of various onboard systems.

➢ **Medical:** In the medical field, these protocols are used for programming medical devices such as pacemakers, insulin pumps, and other implantable devices. They are also used for updating the firmware of various medical devices.

➢ **IoT:** In the field of IoT (Internet of Things), these protocols are used for programming various devices such as smart sensors, smart home devices, and other connected devices. They are also used for updating the firmware of various IoT devices.