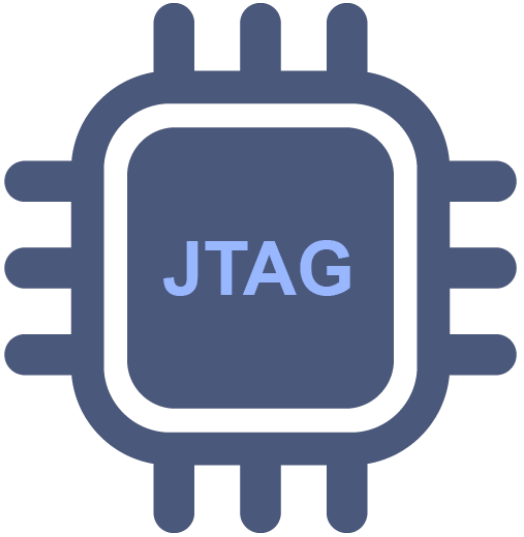
NEOCRUX SYSTEMS

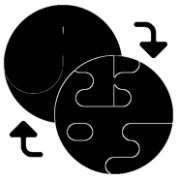
Understanding JTAG Interface in Embedded Systems

What is JTAG?

- **JTAG** = **J**oint **T**est **A**ction **G**roup, standardized as IEEE 1149.1



- Interface primarily used for:
  - Debugging embedded systems
  - In-system programming (ISP)
  - Boundary scan testing



Historical Context

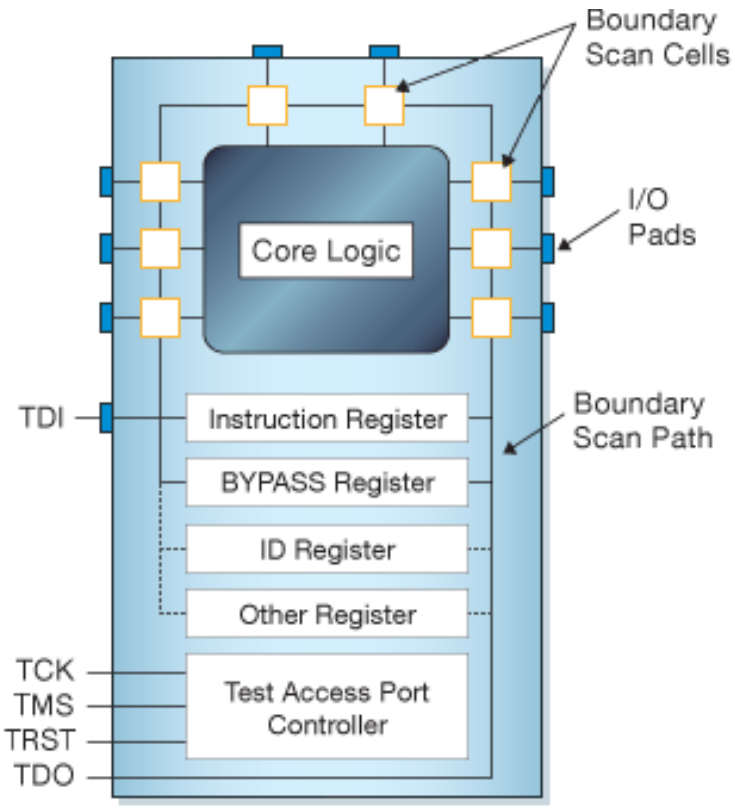
- **1985:** JTAG group formed to simplify PCB testing
- **1990**: IEEE 1149.1 standard published
- **1999**: Adopted widely by ARM, MIPS, and DSP processors
- **Present**: Standard debug method for FPGAs, SoCs, MCUs (e.g. STM32)

JTAG Pinout (ARM Example)

Signal	Description
TDI	**T**est **D**ata **I**n
TDO	**T**est **D**ata **O**ut
TCK	**T**est **C**lock
TMS	**T**est **M**ode **S**elect
TRST	Optional: **T**est **R**eset
GND	**C**ommon **G**round

JTAG Block Diagram

- TAP (Test Access Port)
- Instruction Register
- Boundary Scan Chain
- Core Debug Module
- Connections to MCU/FPGA pins



Applications of JTAG

- In-System Programming (flash MCUs, FPGAs)
- Debugging (halt/run, breakpoints, register inspection)
  - ✓Boundary Scan Testing
  - ✓Check soldering issues
  - ✓Pin-level access even without firmware
- Chain Devices Together: Debug multiple chips via shared TDI/TDO

JTAG vs SWD (Serial Wire Debug)

Feature	JTAG	SWD
Pins used	4–5	2
Speed	Slower	Faster
Debug chains	Multi-chip	Single
ARM support	Yes	Yes
Complexity	Medium	Simple

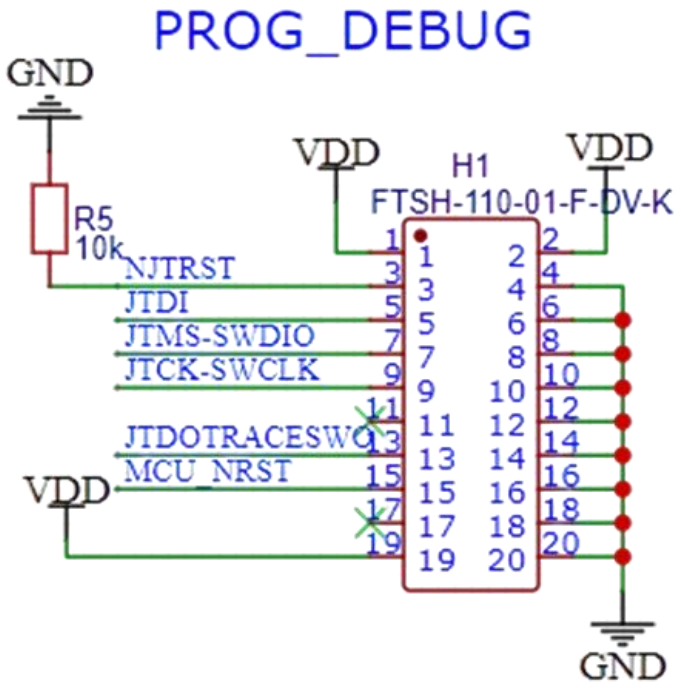
STM32F4 MCUs support both via SWJ-DP (Serial Wire JTAG Debug Port)

❑ JTAG in STM32

- ARM Cortex-M Debug Access Port (DAP):

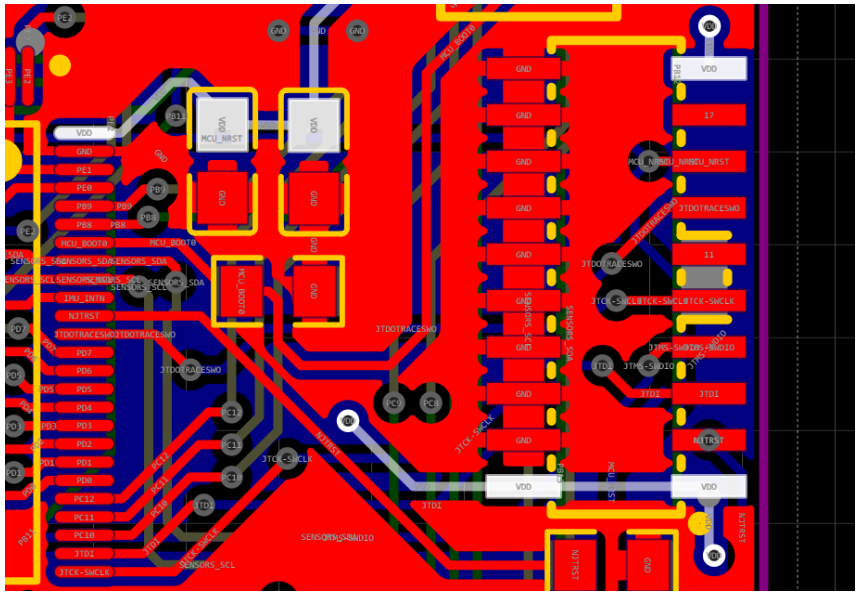
  →Supports both SWD and JTAG

  →Use ST-Link, J-Link, OpenOCD,etc…

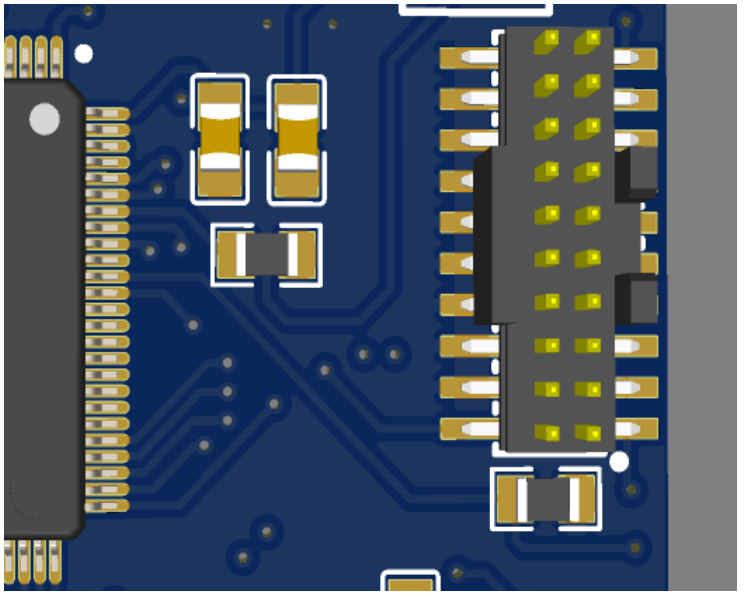


- SWJ-DP Mode: Select between JTAG/SWD via CubeMX or reset sequence

❑ JTAG in STM32 : implementation



PCB layout



3D View

Tools & Connectors

Software

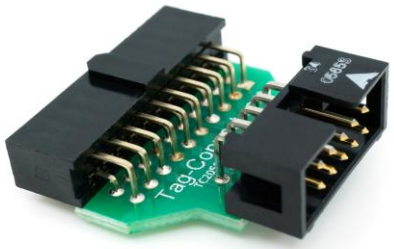
- STM32CubeIDE, OpenOCD, Keil µVision, GDB

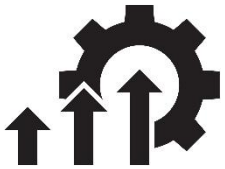
Hardware:

- ST-Link V2, SEGGER J-Link, Olimex ARM-USB-TINY

Connector Standards

- 20-pin ARM JTAG
- 10-pin Cortex Debug
- Tag-Connect (no header)





Advanced JTAG Uses

- ETM Trace Port (External trace with TPIU)
- Flash breakpoints without RAM usage
- Power debugging (current profiling via tools)
- Secure JTAG: Fuse lock, authentication-based access