Introduction to SWD multi-drop for STM32 with ST-LINK

Introduction

The Serial Wire Debug (SWD) is an Arm® communication interface between a debugging tool and a target device based on an Arm® Cortex®-M processor.

The first version of the protocol (v1) only allows a point-to-point communication through a two-wire connection between the host and the device to debug. This was the first version implemented in STM32 microcontrollers.

A second version of the protocol (v2) enables the connection of multiple devices in parallel on the same SWD lines as shown in Figure 1. This feature is called SWD multi-drop. It comes with several constraints, which are exposed in this document.

Figure 1. SWD multi-drop connection to multiple targets

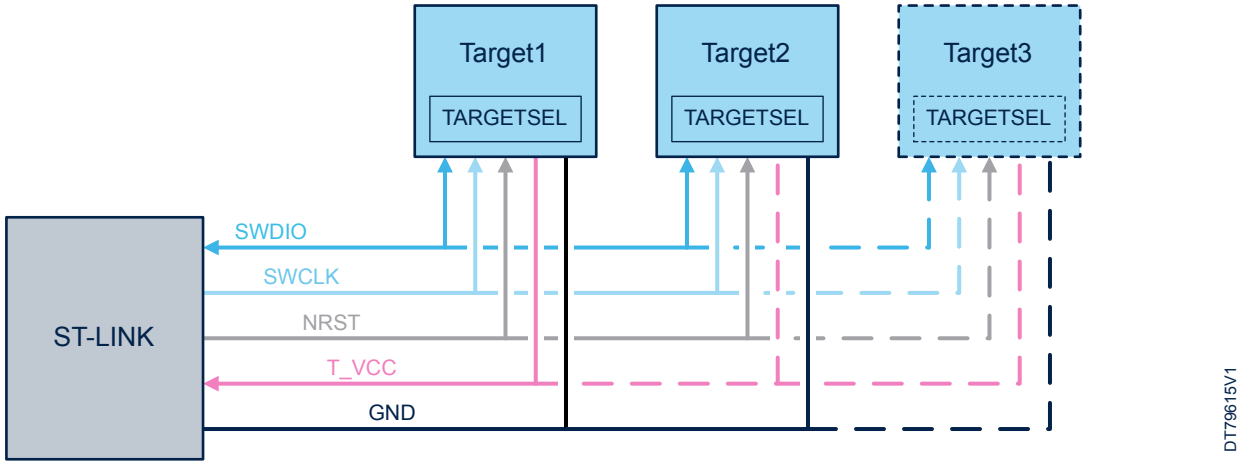

Table 1 lists the ST-LINK tools that support SWD multi-drop.

Table 1. Applicable products

Reference	Products
Development tools	ST-LINK/V2
	STLINK-V3MINIE
	STLINK-V3MODS
	STLINK-V3PWR
	STLINK-V3SET

See Section 1 for examples of compatible target devices.

1 Compatible targets

SWD multi-drop is available on the STM32 targets that support SWD protocol v2. Compatible STM32 targets can be identified through their DP_DPIDR register (bits [15..12]), which is detailed in their reference manual.

In an SWD multi-drop configuration, the connection sequence uses a 32-bit value to select a single target to connect to. This value is read from a target pseudo-register called TARGETSEL. The target is selected if and only if the two following conditions are met:

- TARGETSEL[27..0] matches DP_TARGETIDR[27..0]. This bitfield is further called targetID in the document. Its value typically includes the STM32 DEV_ID.
- TARGETSEL[31..28] matches DP_DLPIDR[31..28]. This bitfield is further called instanceID in the document. Its value is typically 0 for compatible STM32 targets.

To find the values of DP_TARGETIDR[27..0] and DP_DLPIDR[31..28], use any of the two following solutions:

- Consult the corresponding STM32 reference manual (preferred solution).
- Dynamically read in a point-to-point context from a tool allowing such low-level accesses.

Table 2 gives a non-exhaustive list of TARGETSEL values with corresponding STM32 microcontrollers.

Table 2. TARGETSEL values for STM32 MCUs implementing SWD protocol v2

TARGETSEL	STM32 MCU references
0x04500041	STM32H742xx, STM32H743xx, STM32H750xx, STM32H753xx
0x04510041	STM32F76xxx, STM32F77xxx
0x04520041	STM32F72xxx, STM32F73xxx
0x04540041	STM32U375xx, STM32U385xx
0x04550041	STM32U535xx, STM32U545xx
0x04590041	STM32U031xx
0x04740041	STM32H503xx
0x04760041	STM32U5Fxxx, STM32U5Gxxx
0x04780041	STM32H523xx, STM32H533xx
0x04800041	STM32H7A3xx, STM32H7B0xx, STM32H7B3xx
0x04810041	STM32U59xxx, STM32U5Axxx
0x04820041	STM32U575xx, STM32U585xx
0x04830041	STM32H72xxx, STM32H73xxx
0x04840041	STM32H562xx, STM32H563xx, STM32H573xx
0x04850041	STM32H7Rxxx, STM32H7Sxxx
0x04860041	STM32N657xx
0x04890041	STM32U073xx, STM32U083xx
0x04920041	STM32WBA5xxx
0x04950041	STM32WB5MMx
0x04960041	STM32WB35xx
0x04970041	STM32WL5xxx
0x04B00041	STM32WBA6xxx

The STM32 32-bit microcontrollers implementing SWD protocol v2 are based on the Arm® Cortex®-M processor.

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2 Compatible tools

2.1 ST-LINK boards and firmware

SWD multi-drop is available with the following ST-LINK standalone probes provided their firmware versions are recent enough (see Table 3):

- ST-LINK/V2, including the ST-LINK/V2-ISOL variant
- STLINK-V3SET
- STLINK-V3MINIE
- STLINK-V3MODS
- STLINK-V3PWR

SWD multi-drop can also be used with STM32 boards providing a DEBUG_OUT connector from their embedded ST-LINK/V2-1, STLINK-V2EC, STLINK-V3E, or STLINK-V3EC (see Table 3 for the minimum firmware versions).

Table 3. Minimum ST-LINK firmware version for SWD multi-drop

ST-LINK	Minimum firmware version
Standalone ST-LINK/V2	V2J45S7
Standalone ST-LINK/V2-ISOL	V2J45S7
Standalone STLINK-V3SET	V3J15M6B5S1
Standalone STLINK-V3MINIE	V3J15M6
Standalone STLINK-V3MODS	V3J15M6B5S1
Standalone STLINK-V3PWR	V4J5B1P5
Board with embedded ST-LINK/V2-1	V2J45M30
Board with embedded STLINK-V2EC	V2J45M30
Board with embedded STLINK-V3E	V3J15M6
Board with embedded STLINK-V3EC	V3J15M6

The ST-LINK firmware can be updated either from some toolchains, or with the STSW-LINK007 software tool available from the *www.st.com* website.

2.2 Host toolchains

The Keil® MDK-ARM third-party toolchain and STMicroelectronics' STM32CubeProgrammer (STM32CubeProg) support SWD multi-drop through ST-LINK. Table 4 gives the minimum versions for SWD multi-drop support through ST-LINK.

Table 4. Toolchains minimum versions for SWD multi-drop support with ST-LINK

Company	Toolchain	Minimum version	Website
Arm® Keil®(1)	MDK-ARM	5.40	www.keil.com(2)
STMicroelectronics	STM32CubeProgrammer (STM32CubeProg)	2.21.0	*www.st.com*

1. *Keil is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.*
2. *This URL belongs to a third-party. It is active at document publication. However, STMicroelectronics shall not be liable for any change, move, or inactivation of the URL or the referenced material.*

3 General constraints of SWD multi-drop

3.1 Electrical constraints

Power supply and ground

When connecting multiple targets together in an SWD multi-drop configuration, all targets must work at the same voltage level and share the same GND reference.

When connecting multiple boards via ST-LINK, users must be careful with power supplies interconnection through the T_VCC signal on the STDC14 connector (pin 3). As a safety precaution, connect only one T_VCC signal to the ST-LINK after verifying that all other boards can communicate correctly at the corresponding voltage level.

SWDIO pin

Conflicts might occur on the SWDIO pin depending on the usage context.

ST-LINK operates in open-drain mode, which minimizes the electrical impact of protocol errors. However, users must avoid situations where multiple targets drive the line simultaneously, such as when connecting in point-to-point mode instead of using the SWD multi-drop mode. Proper implementation of the SWD multi-drop protocol prevents such conflicts.

3.2 Constraints on usage

In its v2 version, SWD remains a protocol that enables a single communication flow between a host and a target. The SWD protocol v2 implements a method to select a single target among multiple ones simultaneously connected to the same SWD lines. The consequences are listed below.

Single-target debug session

A debug session can be performed on only one target at a time, even in SWD multi-drop mode. It is not possible to open multiple simultaneous debug sessions on different targets that share the same SWD lines. When starting a new session, the user must select the target to connect to from all the targets present on the lines.

No point-to-point mode with multiple devices

The user must not attempt to connect in point-to-point mode on systems that provide multiple devices sharing the same SWD lines. Although these devices implement the SWD protocol v2, they still respond to the protocol v1 entry sequence. As a result, such a connection attempt causes a conflict on the SWDIO line.

It is important to avoid situations where an illusory working state is reached, where one device drives the line while other devices enter a protocol error state. Such scenarios must be prevented due to the conflicts required to reach this state. Additionally, it is unpredictable which device gains control of the line.

Connection order with ST-LINK in shared mode

When using ST-LINK in shared mode, the first application that opens a connection with a target defines the connection mode. All subsequent applications attempting to connect must use the same mode and select the same target; otherwise, their connections fail.

No automatic target detection

It is not possible to automatically detect at the protocol level which targets are connected in SWD multi-drop mode. To overcome this limitation, the tools can implement a connection loop that iterates on known existing TARGETSEL values to identify the values that receive a response.

3.3 Constraints on target

To prevent conflicts on SWD lines, especially in the upstream direction, only a single target must communicate with the host at any time. This requirement imposes the constraints listed below.

No target implementing the SWD protocol v1

It is not possible to insert a target implementing the SWD protocol v1 on the SWD lines. This target does not correctly interpret the SWD multi-drop sequence that selects another target. Consequently, it might unexpectedly drive the SWDIO line and cause a conflict.

No simultaneous targets with the same TARGETSEL

It is not possible to insert multiple targets that cannot be uniquely selected by the SWD multi-drop selection sequence. This requires all devices on the lines to have distinct TARGETSEL values. On current STM32 devices, modifying the instanceID (defaulted to 0) is not supported. Therefore, only devices with different targetID values can be parallelized in SWD.

Revision history

Table 5. **Document revision history**

Date	Revision	Changes
06-Nov-2025	1	Initial release.

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