

AURIX™, TriCore™, XC2000, XE166,  
XC800 Families

DAP Connector

AP24003

Application Note

V1.4, 2014-05

Microcontrollers

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## Revision History

### DAP

#### Revision History: V1.4 2014-05

Previous Version(s): V1.0, V1.1, V1.2, V1.3

Page	Subjects (major changes since last revision)
<a href="#">12</a>	FM modulation of DAP clock recommended for high-speed DAP
<a href="#">13</a>	<a href="#">Table 6-1</a> added with DAP connector pinning for AURIX™

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## Table of Contents

	<b>Revision History</b> .....	<b>4</b>
	<b>Table of Contents</b> .....	<b>5</b>
<b>1</b>	<b>About this document</b> .....	<b>6</b>
1.1	Scope and purpose .....	6
1.2	Intended audience .....	6
1.3	Related documentation .....	6
<b>2</b>	<b>DAP Physical Connector</b> .....	<b>7</b>
<b>3</b>	<b>Pin Description</b> .....	<b>8</b>
<b>4</b>	<b>User Pins</b> .....	<b>9</b>
<b>5</b>	<b>DAP/SPD Enabling</b> .....	<b>10</b>
5.1	DAP Enabling .....	10
5.2	SPD Enabling .....	10
5.3	SPD or DAP Enabling .....	11
<b>6</b>	<b>Target System Integration</b> .....	<b>12</b>
6.1	High Speed DAP .....	12
6.2	AURIX™ / TriCore™ Family .....	13
6.3	XC2000 / XE166 Families .....	14
6.4	XC800 Family .....	14

## 1 About this document

### 1.1 Scope and purpose

Infineon's DAP (Device Access Port) is a two-wire tool access port for microcontrollers and similar devices. It allows robust high speed connections over a long cable for automotive applications.

SPD (Single Pin DAP) is a single wire DAP variant for low pin count devices.

This document describes the connector, it's pins, how to enable DAP, and some guidelines on integration.

### 1.2 Intended audience

This document is intended for PCB designers and tool vendors.

### 1.3 Related documentation

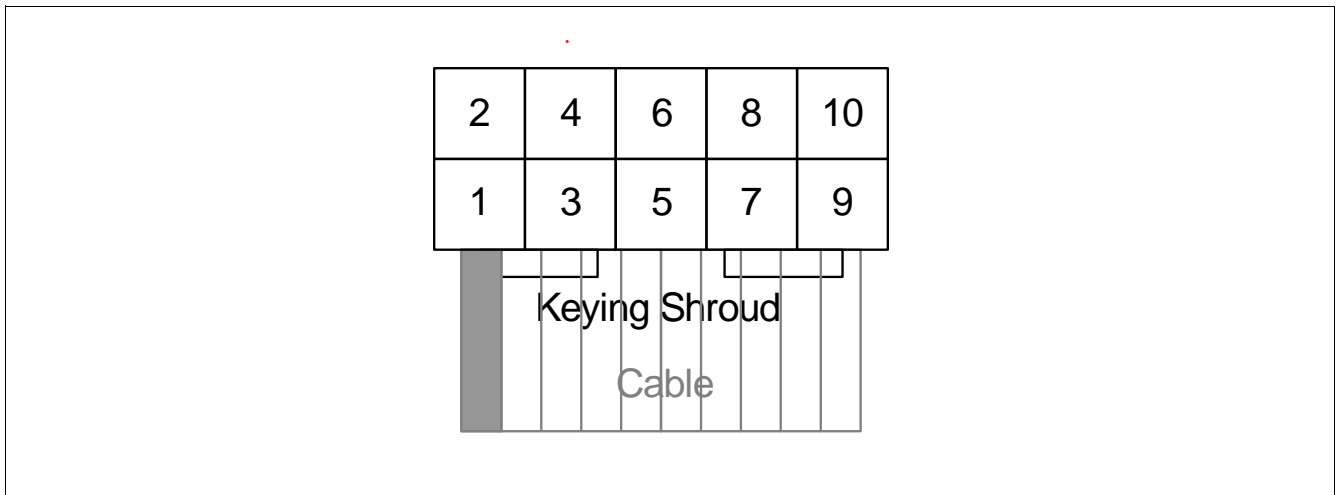
For more detailed informations about DAP/SPD please refer to the DAP/SPD section in the target device documentation.

- Samtec FTSH series documentation ([www.samtec.com](http://www.samtec.com))
- DAS Product Brief ([www.infineon.com/DAS](http://www.infineon.com/DAS))

## 2 DAP Physical Connector

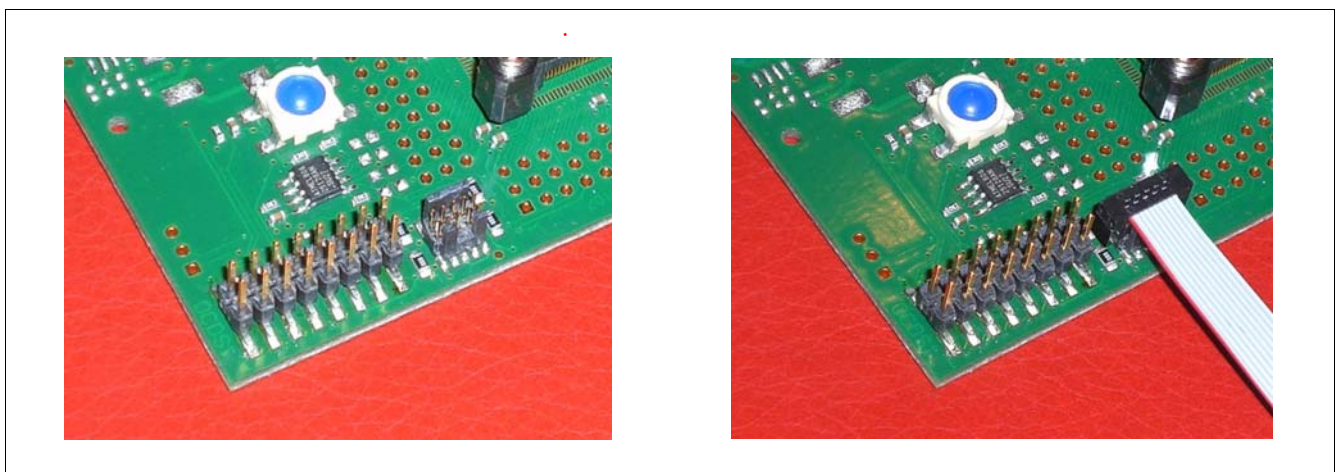
On the target board the standard connector is a 0.05 inch double row, 10 pin micro terminal with keying shroud. There are many varieties of these, such as the Samtec FTSH-105-01-L-DV-K for example. It is offered as a standard dual row header 1.27 mm x 1.27 mm with 0.4 mm square pins.

The figure below shows the DAP pinout top-view of the connector on the target board. The keying shroud is on the side with the uneven pin indexes. For mechanical protection of the connector pins it is recommended that this side is closer to the edge of the target board.



**Figure 2-1 DAP Connector**

The figure on the left, below, shows a DAP connector mounted as recommended at the edge of the PCB. The keying shroud enforces the right polarity and provides mechanical protection of the connector pins. To the left of the DAP connector is the much larger OCDS L1 connector (AP24001), with 0.1 inch pitch.



**Figure 2-2 DAP Connector next to OCDS L1 Connector**

In the picture on the right, the DAP cable is plugged in. Please note that the cable plug (width approximately 10.5mm) is much wider than the DAP connector (width approximately 6.5mm) on the board. This means that for about 2.5 mm either side of the DAP connector, there can not be parts which are higher than 2 mm.

### 3 Pin Description

Note that 'Direction' in the following table is from the target system point of view.

**Table 3-1 DAPPins**

Pin	Name	Direction	Description
1	VREF	O	Supply voltage from the target system. The voltage has to be strong enough to supply the target side of the level shifters within the tool hardware up to about 20 Mhz DAP operating frequency. The required supply current is in the range of 5 mA, mainly caused by signal switching. It can be reduced by lowering frequency and capacitance. Beyond 20 MHz the tool hardware has to supply the level shifter from another source and use this pin just as a voltage reference.
2	DAP1	IO	DAP: Data pin.
	SPD	IO	SPD: Data pin.
	UART	IO	Single-wire UART. Serial communication interface (e.g. used for Bootstrap Loader BSL).
3	GND		Recommended pin for signal return of DAP1 for high frequency impedance matching.
4	DAP0	I	DAP: Clock.
	SUP	I	SPD: Optional user pin value for feedback into the target system. Otherwise reserved.
5	GND		Recommended pin for signal return of DAP0 for high frequency impedance matching.
6	DAP2	IO	DAP: Optional second data pin.
	USER0	IO/O	Generic signal that can be used for non specified functions.
7	KEY (GND in cable)		If the recommended connector with keying shroud is not used, this pin provides another option to enforce polarization. In that instance this pin is removed from the target connector and the associated jack in the cable connector closed with a plastic pin for example.
8	DAP3	IO	DAP: Optional third data pin.
	USER1	IO/I	Generic signal that can be used for non-specified functions.
	(DAPEN)	I	Optional indicator that the tool is connected. This can be used to enable the DAP interface of the device.
9	GND		Supply ground.
10	RESET	IO	Target reset signal. Open drain active low signal. May be used bi-directionally to drive or sense the target reset signal. Usually driven by the tool to reset the target system. The target system is responsible for providing a pull-up to VREF on this signal to establish a logic one. The resistor shall not have a value less than 1 kOhms.



## 4 User Pins

Support of user pins (USER0, USER1) is optional for a given tool. Please refer to the specific tool documentation about the availability of this feature and its control.

If supported by the tool, these pins can be used to conveniently control target system specific features, such as selecting microcontroller boot options. Both signals can be bi-directional, depending on the tool hardware.

If only a subset of pin directions is supported, the rule is that USER0 is Out (optional In) and USER1 is In (optional Out).

**Table 4-1 USER, DAP2, DAPEN Pin behavior**

Pin	Name	Direction	Default	Description
6	USER0	IO/O	O	Generic signal that can be used for non specified functions. From a DAS Client it can be accessed as user signal 0.
	DAP2	IO	O	DAP2 data signal
8	USER1	IO/I	I H	Generic signal that can be used for non specified functions. From a DAS Client it can be accessed as user signal 1.
	DAP3	IO	I H	DAP3 data signal.
	DAPEN	I	I H	Some target devices have an explicit pin to enable DAP only when a tool is connected. This pin will have a weak pull down on the target system/chip side. Only when the tool hardware drives it high, DAP will be enabled. Note that depending on the target device this pin is evaluated at the de-activation of the reset (positive edge on $\overline{\text{RESET}}$ pin).

## 5 DAP/SPD Enabling

There are three options for DAP/SPD enabling:

1. Always enabled.
2. Enabled with DAPEN pin.
3. Enabled with DAP1/SPD value (H) at  $\overline{\text{RESET}}$  de-activation.

The first option includes the case that the DAP/SPD interface is enabled with a setting in the Flash config sector evaluated during device startup. Specific devices can support one or several of these options to be flexible to the needs of different systems, so a tool has to support all options.

### 5.1 DAP Enabling

The tool and device behavior is summarized in the following table:

**Table 5-1 DAP Enabling with DAP1 or DAPEN**

Pin	Name	Tool Behavior	Device Behavior
2	DAP1	Automatically pulled high (4.7-10 kOhms) when $\overline{\text{RESET}}$ is activated, and for 5 ms afterwards, since the sample point for the DAP1 value can be delayed depending on the device type.	The DAP1 pin value is latched at reset de-activation: L: DAP stays disabled H: DAP is enabled
8	USER1 DAPEN	In the initial tool hardware state this signal is driven high (VREF). It is under the responsibility and control of the user to change the pin state depending on the target system.	Will enable DAP if High at $\overline{\text{RESET}}$ release. Depending on the device type, it has to stay static High during operation.

#### Provisions for Tool 'Hot Attach'

If the device has a dedicated DAP interface which is always enabled, the hot attach of a tool is possible without restrictions. If not, the conditions for DAP1 or DAPEN ([Table 5-1](#)) have to also be satisfied when no tool is connected.

For DAPEN this is easily achieved for instance with a pull-up resistor, or with hard-wiring.

However, for devices where the enabling is controlled with DAP1, some circuitry is required, since the pull-up or driving of DAP1 needs to be disabled when the tool operates the DAP protocol. The condition for this disabling can be the level of the DAPEN pin at the tool connector, which is driven High when the tool is connected.

### 5.2 SPD Enabling

SPD is enabled by applying a High value to the SPD pin of the device at  $\overline{\text{RESET}}$  de-activation. This means the tool behavior, described in [Table 5-1](#) for DAP1, is applied to the SPD pin as well.

### 5.3 SPD or DAP Enabling

SPD has a reduced performance compared to DAP, so some devices will support SPD and DAP. To distinguish between SPD and DAP within the device, the encoding listed in [Table 5-2](#) is used. The values in the first two columns are the levels seen by the device at  $\overline{\text{RESET}}$  release.

**Table 5-2 SPD/DAP Enabling with DAP0/1**

DAP0	DAP1	Device Behavior
H	H	DAP mode will be enabled.
L	H	SPD mode will be enabled.
H	L	Reserved (e.g. JTAG will be enabled).
L	L	DAP and SPD disabled.

#### SPD Only Option

On the target board the availability of the SPD or DAP mode is configured with the connection between the DAP0 pin of the device and the DAP0 pin of the connector. When they are not connected it means that the tool is using SPD mode and the DAP0 pin is fully available for the application.

*Note: For such a target system, where only SPD is used, the circuitry on the target board for the user pin with the alternate DAP0 functionality has to make sure that this pin is not pulled or driven High during RESET de-activation.*

## 6 Target System Integration

### 6.1 High Speed DAP

AURIX™ TriCore™ devices support DAP frequencies up to 160 MHz over the full automotive temperature range. The DAP connector and the associated flat ribbon cable are suited for this frequency with acceptable EMC behavior, if the following points are considered.

#### Recommendations for PCB Design

- Very short direct connection between DAP connector and device pins
- Solid GND plane or GND traces below or beside all DAP signals
- Further connections to DAP signals need to be removable (e.g. 0R bridges) for high speed operation
- Keep trace length of DAP1 and DAP2 equal

#### Termination Recommendations for Longer Signal Paths

- Use serial termination method on both ends for DAP1/DAP2 signals since they are bi-directional
- DAP0 can be terminated only at source (depending on the properties of the DAP0 driver)
- All terminations must match the line impedance (50 ohms recommended)
- Total trace length on board of less than 10 cm (the parasitic load of cable has to be considered as well)

#### FM Modulated DAP0 Clock

A frequency modulation (FM) of the clock drastically reduces the emissions of the DAP interface. For instance a 1.25 % FM modulation will reduce the emissions by 3 to 20 dB below 1 GHz.

#### Further Information

- Application Note AP24026 EMC Design Guidelines for Microcontroller Board Layout
- TC2xx PCB and High Speed Serial Interface Design Guideline Application Note

## 6.2 AURIX™ / TriCore™ Family

**Table 6-1 DAP Connections on the Target Board for AURIX™**

Pin	Name	Device Pin	Remark
2	DAP1	DAP1	
4	DAP0	DAP0	
6	DAP2	DAP2/TGI3/TGO3	DAP or trigger pin (or user functionality) on P21.7
8	DAP3	DAP3/TGI2/TGO2	DAP or trigger pin (or user functionality) on P21.6
	(DAPEN)	$\overline{\text{TRST}}$	DAP will only be enabled if TRST is high during $\overline{\text{PORST}}$ de-activation. The recommendation is not to use this connector pin for this purpose since this can also be statically ensured in the board.
10	$\overline{\text{RESET}}$	$\overline{\text{PORST}}$	

**Table 6-2 DAP Connections on the Target Board for TriCore™**

Pin	Name	Device Pin	Remark
2	DAP1	DAP1	
4	DAP0	DAP0	
6	DAP2	DAP2	
	USER0	user defined	If DAP2 is not needed, this pin can be connected to a user defined signal. AURIX™ devices for instance have DAP and trigger functionality overlaid to the same device pin (P21.7 DAP2/TGI3/TGO3).
8	DAPEN	$\overline{\text{TRST}}$	DAP will only be enabled if the tool is connected and drives this pin high during $\overline{\text{PORST}}$ de-activation.
	USER1	user defined	If DAP enabling is controlled elsewhere, this pin can be connected with a user defined signal.
10	$\overline{\text{RESET}}$	$\overline{\text{PORST}}$	



### 6.3 XC2000 / XE166 Families

**Table 6-3 DAP, SPD and UART Connections on the Target Board for XC2000/XE166**

Pin	Name	Device Pin	Remark
2	DAP1	DAP1	
	SPD	SPD/UART	SPD and/or single-wire UART for Bootstrap Loader (BSL)
4	DAP0	DAP0	
6	USER0	user defined	Can be connected with a user defined signal.
8	DAPEN	$\overline{\text{TRST}}$	DAP will only be enabled if the tool is connected and drives this pin high during $\overline{\text{PORST}}$ de-activation.
	USER1	user defined	If DAP enabling is controlled elsewhere, this pin can be connected to a user defined signal.
10	$\overline{\text{RESET}}$	$\overline{\text{PORST}}$	

### 6.4 XC800 Family

For XC800 devices the DAP, SPD and single-wire UART port availability differs across products.

**Table 6-4 DAP, SPD and UART Connections on the Target Board for XC800**

Pin	Name	Device Pin	Remark
2	SPD	SPD/UART	SPD and/or single-wire UART for Bootstrap Loader (BSL)
	DAP1	DAP1	If XC800 device supports 2-pin DAP.
4	DAP0	DAP0	
6	USER0	user defined	Can be connected with user defined signals.
8	USER1	user defined	
10	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$	Can be used to control the power supply if the XC800 device has no $\overline{\text{RESET}}$ pin.

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