

Debug Port Design Guidelines

This document provides information on designing debug ports for different processor types, either by providing links to the processor vendor's recommendations, or by detailed descriptions if recommendations are not available from the vendors.

N.B. The lists of mandatory signal/pin connections are those required by our μ Master Test and Debug Solutions – other uses of the debug ports may need additional connections.

In the case on-screen viewing, click the following links to locate your processor type:

[AMD®](#)

[ARM®](#)

[Freescale™/IBM PowerPC™ - COP](#)

[Freescale™ PowerPC™ - BDM](#)

[Freescale™ ColdFire® / 68K](#)

[IBM® PowerPC™ 4xx cores](#)

[Intel® Pentium® processor family](#)

[Intel® XScale™ Microarchitecture](#)

[TI OMAP™](#)

[Other CPUs](#)

[Contact details for more information](#)

Introduction

Traditionally, low-level microprocessor code was debugged using an emulator. An emulator is an instrument that replaces a socketed processor, and provides the developer with the debug functions to download code, set breakpoints, single step code, and so on.

As processor speed increased, it became impossible to design emulators of this type, so CPU vendors began to embed the debug functions on the processor die. Typically, these functions are accessible via the JTAG port, but in some cases proprietary interface pins are used (e.g. Freescale™ BDM).

CPU vendors use different naming conventions for their debug interfaces, but throughout this document, the term debug port is frequently used as a generic term.

A debug port is typically an on-board connector or series of test points that link to a set of test/debug pins on the processor package. If JTAG is used, it consists of the 5 JTAG signals and 0-3 other signals. The number of additional signals required depends on the processor type.

Intel® Pentium® processors (μ Master 3010)

Processors relevant to this section:

- Intel® Pentium® processors
- Intel® Pentium® MMX processors (293-pin PPGA/SPGA)

Design guidelines for debug ports:

- Chapter 6 from our Getting Started Guide:

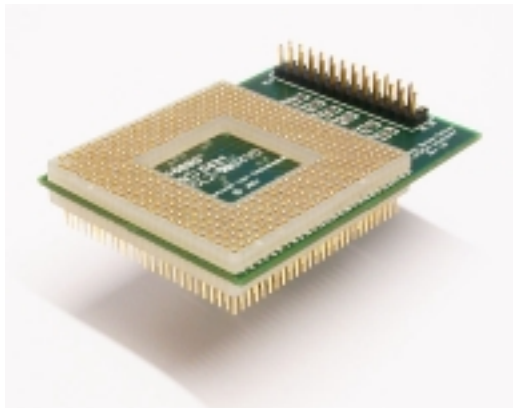
<http://www.intertesttech.com/download/dft3000.pdf>

- “Pentium® Processor Family Developer’s Manual 1997 - Volume 1” (product no. 241428 – first part of 3 Volume set that has product no. 241563). Order from Intel®

If your board has a 20-pin or 30-pin male debug header (only 20 pins used), which is designed following the above specification, then you can plug directly into this.

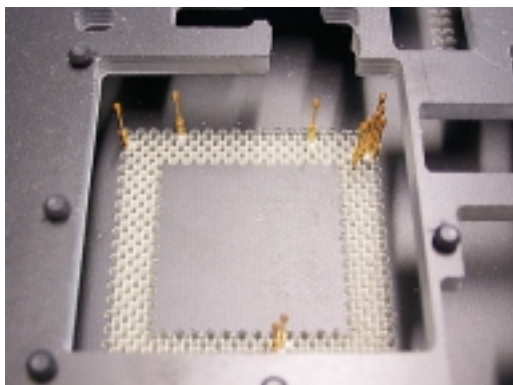
If your board does not have a header, but has a socketed processor, you can use one of our interposer products. An interposer is a break-out PCB that sits between the processor and the socket. An interposer example is shown in illustration 1. See our website for details of interposer types:

http://www.intertesttech.com/ate/products_interposers.htm



1. Intel® Pentium® M processor interposer

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.



2. Simple fixture to access debug port lines

Although, the Pentium debug port specification defines a 20- or 30-pin connector, the pins required for the operation of µMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
3	RESET
4	GND
6	Vcc
7	R/S#
11	PRDY

12	TDI
13	TDO
14	TMS
16	TCK
18	TRST

Intel® Pentium® Pro™, Pentium® II/III & Celeron® processors (µMaster 3020)

Processors relevant to this section:

- Intel® Pentium® Pro™ Processor
- Intel® Pentium® II/III Processor (Slot 1)
- Intel® Pentium® II/III Xeon™ Processor (Slot 2)
- Intel® Pentium® II Processor MMC-1 & MMC-2
- Intel® Pentium® III Processor 1.5V FC-PGA (Coppermine – 370 pin)
- Intel® Pentium® III Processor 1.25V FC-PGA (Tualatin – 370 pin)
- Mobile Intel® Pentium® III Processor-M (478 pin)
- Intel® Celeron® Processor 2.5V PPGA (370 pin)
- Intel® Celeron® Processor 1.5V FC-PGA (370 pin)
- Mobile Intel® Celeron® Processor (478 pin)

Design guidelines for debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft3000.pdf>

- For processors with 2.5V TAP - “P6 Family of Processors Hardware Developer’s Manual 1998” (product no. 244001-001). Search for “244001” on the Intel® website if the link below doesn’t return the document:

<http://www.intel.com/design/pentiumii/manuals/24400101.pdf>

- For processors with 1.5V TAP - “Low Voltage Intel® Pentium® III Processor 512K and Ultra Low Voltage Intel® Celeron® Processor/815E Chipset Platform” (product no. 273676-004). See section on “Debug Port Changes”. Search for “273676” on the Intel® website if the link below doesn’t return the document:

<http://www.intel.com/design/pentiumiii/designgd/27367604.pdf>

If your board has a 30-pin debug header, which is designed following the above specification, then you can plug directly into this. The header for 2.5V TAP is male, whereas the header for 1.5V TAP is female with mirrored pin-outs. We supply an adapter to connect to the female header (illustration 3).



3. Female to male 30-pin debug port adapter

If your board does not have a header, but has a socketed processor, you can use one of our interposer products. An interposer is a break-out PCB that sits between the processor and the socket. An interposer example is shown in illustration 1. See our website for details of interposer types:

http://www.intertesttech.com/ate/products_interposers.htm

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although, the debug port specification defines a 30-pin connector, the pins required for the operation of μ Master Test and Debug solutions are:

Debug Port Pin No.	Signal
1	RESET#
2	GND
5	TCK
7	TMS
8	TDI
9	POWERON
10	TDO
12	TRST
16	PREQ0#
18	PRDY0#

Intel® Pentium® 4, Pentium® 4 Processor-M, Xeon™, Pentium® M (Centrino™), and Celeron® processors (μ Master 3040)

Processors relevant to this section:

- Intel® Pentium® 4 processor FC-PGA (423 pin)
- Intel® Pentium® 4 processor μ FC-PGA (478 pin)
- Mobile Intel® Pentium® 4 Processor-M (478 pin)
- Intel® Pentium® M processor - Centrino™ (478 pin)
- Intel® Celeron® processors based on the above cores
- Intel® Xeon™ processor INT- μ PGA (603 pin)
- Intel® Xeon™ processor FC- μ PGA2 (604 pin)

Design guidelines for debug ports:

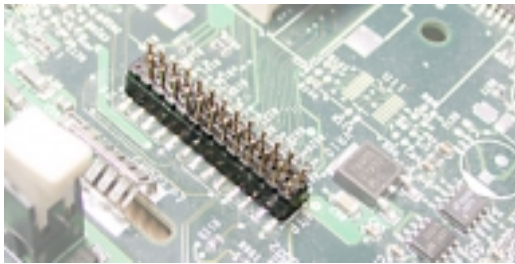
- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft3000.pdf>

- “ITP700 Debug Port Design Guide” (product no. 249679-014). Search for “249679” on the Intel® website if the link below doesn’t return the document:

<http://www.intel.com/design/xeon/guides/24967914.pdf>

If your board has a 26-pin male debug header (ITP700), which is designed following the above specification, then you can use this.



4. 26-pin male debug port header (ITP700)

If your board has a 60-pin male debug header (XDP), then you can use this by inserting an ITP700 – XDP adapter supplied by us.



5. 60-pin male debug port header (XDP)

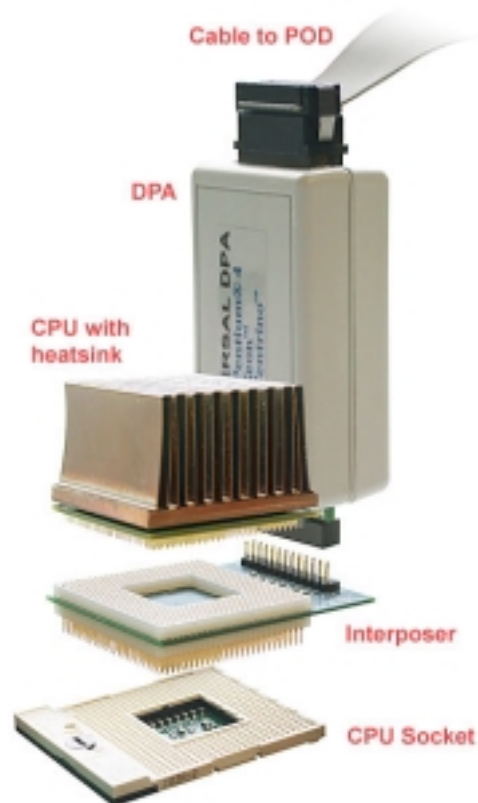


6. ITP700 (26 pin) – XDP (60 pin) adapter

An Intel®-specified Debug Port Adapter, supplied by us, has to be plugged into the debug port header (a DPA is shown in illustration 7 – this would plug directly into the header, rather than into an interposer as shown).

If your board does not have a header, but has a socketed processor, you can use one of our interposer products. An interposer is a breakout PCB that sits between the processor and the socket. A DPA is required to condition signals – this is plugged into the interposer, as shown in illustration 7. See our website for details of interposer types:

http://www.intertesttech.com/ate/products_interposers.htm



7. Interposer and Debug Port Adapter (DPA)

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access

to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although, the debug port specification defines a 26-pin connector (or 60 pin in the case of XDP), the pins required for the operation of μ Master Test and Debug solutions are:

Debug Port Pin No.	Signal
1	GND
2	TCK1*
6	DBR#
9	BPM[3]#
10	TDI
11	BPM[4]#
12	TMS
13	BPM[5]#
14	TRST#
15	RESET#
16	TCK
22	PWR
23	BPM5DR#
24	TDO

* TCK1 on pin 2 is only required when using a DPA for XDP connection (not for ITP700 connection). This second clock signal is also only needed on multiprocessor platforms.

FreeScale™/IBM® PowerPC™ - COP (μ Master 4031)

Processors relevant to this section:

- Freescale™ PowerPC™ 740/745/750/755
- Freescale™ PowerPC™ 603e (200-300 MHz)
- Freescale™ PowerPC™ 7400/7410/7450/7455/7457, etc.
- Freescale™ PowerPC™ 8240
- IBM® PowerPC™ 750 DD2/DD3

- IBM® PowerPC™ 750 FX DD1/DD2
- This list may be incomplete – see our website for the latest status:

http://www.intertesttech.com/ate/products_4030.htm

The PowerPC™ Common On-Chip Processor (COP) debug port uses the processor's JTAG bus and some additional signals.

Design guidelines for COP debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- See the reference manual for your specific processor, e.g. "MPC5200 Hardware Specifications". Search for "MPC5200" on the Freescale™ website if the link below doesn't return the document:

http://www.freescale.com/files/microcontroller/doc/data_sheet/MPC5200.pdf

If your board has a debug header, which is designed following the above specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although the PowerPC™ COP debug port specification defines a 16-pin connector, the pins required for the operation of μ Master Test and Debug solutions are:

Debug Port Pin No.	Signal
1	TDO
3	TDI
4	TRST
6	VDD

7	TCK
9	TMS
12	GND
13	HRST

FreeScale™ PowerPC™ processors – BDM (μMaster 4033, 4133, 4034)

Processors relevant to this section:

- Freescale™ PowerPC™ 5xx Family
- Freescale™ PowerPC™ 8xx Family

The PowerPC™ Background Debug Mode (BDM) debug port uses a proprietary 3-pin bus with additional signals.

Design guidelines for PowerPC™ BDM debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- See the reference manual for your specific processor, e.g. Application Note AN2387/D, titled “MPC8xx Using BDM and JTAG”. Search for “AN2387” on the Freescale™ website if the link below doesn’t return the document:

http://www.freescale.com/files/netcomm/doc/app_note/AN2387.pdf

If your board has a 10-pin BDM debug header, which is designed following the above specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although the PowerPC™ BDM debug port specification defines a 10-pin connector, the

pins required for the operation of μMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
1	VFLS0
3	GND
4	DSCLK
6	VFLS1
7	HRESET
8	DSDI
9	VDD
10	DSDO

FreeScale™ ColdFire®/683xx processors (μMaster 4041, 4042)

Processors relevant to this section:

- Freescale™ ColdFire® processor families, including: MCF548x, MCF547x, MCF540x, MCF530x, MCF528x, MCF527x, MCF524x, MCF523x, MCF521x, MCF520x
- Freescale 683xx family, including: MC68331, MC68332, MC68336, MC68340, MC68360, MC68F375, MC68376

These processors use a BDM-type debug port, which uses a proprietary 3-pin bus with additional signals.

Design guidelines for ColdFire®/68K BDM debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- See the reference manual for your specific processor, e.g. “MCF5271 Reference Manual”. Search for

“MCF5271RM” on the Freescale™ website if the link below doesn’t return the document:

http://www.freescale.com/files/32bit/doc/ref_manual/MCF5271RM.pdf

If your board has a 26-pin ColdFire® BDM debug header, which is designed following the above specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although the ColdFire® BDM debug port specification defines a 26-pin Berg connector, the pins required for the operation of μMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
2	BKPT
3	GND
4	DSCLK
7	RESET
8	DSI
9	Pad-Voltage
10	DSO
12	PST3
13	PST2
14	PST1
15	PST0
24	PSTCLK

Intel® XScale™ Microarchitecture (μMaster 4050)

Processors relevant to this section:

- Intel® 80200/80200T Processors
- Intel® PCA processors (PXA2xx Applications Processors)
- Intel® IXP Network Processors (IXP2xxx, IXP12xx, IXP425, IXP225, IXP220, etc)
- Intel® IOP I/O Processors based on XScale™ cores (IOP310, IOP315, IOP321, IOP331, etc)
- Intel® IXC1100 Control Plane Processor
- This list may be incomplete – see our website for the latest status:

http://www.intertesttech.com/ate/products_4030.htm

The XScale™ debug port uses the processor’s JTAG bus, and some additional signals.

Design guidelines for XScale™ debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- These debug ports comply with ARM® Multi-ICE guidelines. The following User Manual contains a section that describes the debug port:

http://www.arm.com/pdfs/DUI0048F_MICE2_2.pdf

If the above link doesn’t return the document, look in the documentation page on the ARM® website:

http://www.arm.com/documentation/Trace_Debug/index.html

- See the reference manual for your specific processor, e.g. “Intel® IQ80321 I/O Processor Evaluation Platform”. Search for “273521” on the

Intel® website if the link below doesn't return the document:

<http://www.intel.com/design/iio/manuals/27352108.pdf>

If your board has a 20-pin debug header, which is designed following the above specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although, the XScale™ debug port specification defines a 20-pin connector, the pins required for the operation of μMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
1	VTref
3	nTRST
4	GND
5	TDI
7	TMS
9	TCK
13	TDO
15	nSRST

ARM® 7/9 processors and cores (μMaster 4071)

Processors relevant to this section:

- ARM® 7 processors
- ARM® 9 processors
- Any processor based on ARM®7/9 cores, such as the following:
- Cirrus Logic® EP9xxx Embedded Processors
- Conexant® ARM®-based networking SoC's

- Freescale™ MAC7100 family (Automotive)
- OKI Semiconductor ARM®-based MCU's
- STMicroelectronics ARM®-based MCU's
- Texas Instruments™ TI OMAP™ processors with single ARM® cores

The ARM® debug port uses the processor's JTAG bus, and some additional signals. Design guidelines for ARM® debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- ARM® Multi-ICE guidelines. The following User Manual contains a section that describes the debug port:

http://www.arm.com/pdfs/DUI0048F_MICE2_2.pdf

If the above link doesn't return the document, look in the documentation page on the ARM® website:

http://www.arm.com/documentation/Trace_Debug/index.html

If your board has a 20-pin debug header that is designed following the above specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although, the ARM® debug port specification defines a 20-pin connector, the pins required for the operation of μMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
1	VTref

3	nTRST
4	GND
5	TDI
7	TMS
9	TCK
13	TDO
15	nSRST

TI OMAP™ Dual ARM® Core processors (µMaster 4072)

Processors relevant to this section:

- TI OMAP™ 8xx and 7xx Modem and Applications processors
- Please follow guidelines in the ARM® 7/9 section for TI OMAP™ processors with single ARM® cores

The TI OMAP™ debug port uses the processor’s JTAG bus, and some additional signals.

Design guidelines for TI OMAP™ debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

If your board has a debug header, you may be able to plug directly into this, after having established the pin-out arrangement and availability of mandatory signals.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Debug port specifications are application-specific. However, the pins required for the

operation of µMaster Test and Debug solutions are:

Signal
TDI
TDO
TMS
TCK
TRST
MPU_RST (Warm reset)
PWR_ON_RST (Cold reset)
GND
Power sense line

AMD® processors (µMaster 4010)

Processors relevant to this section:

- AMD® Athlon™
- AMD® Duron™
- AMD® Opteron™
- AMD® Sempron™
- AMD® Athlon™ 64

The AMD® Hardware Debug Tool (HDT) debug port uses the processor’s JTAG bus, and some additional signals.

Design guidelines for AMD® HDT debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- Obtain the reference manual for your specific processor from AMD®

<http://www.amd.com>

If your board has a 16-pin debug header, which is designed following the above

specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although, the AMD® HDT debug port specification defines a 16-pin connector, the pins required for the operation of µMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
1	VCC_CORE
2	TCK
4	TMS
8	TDI
10	TRST#
11	GND
12	TDO
13	DBREQ#
14	DBRDY
15	RESET#

The fact that the HDT doesn't include a system reset means that an external reset connection will be required by µMaster.

IBM® PowerPC™ 4xx Cores

Processors relevant to this section:

- IBM® PowerPC™ 405xx family of embedded cores
- IBM® PowerPC™ 440xx family of embedded cores

The IBM® 4xx 16-pin debug port uses the processor's JTAG bus, and some additional signals.

Design guidelines for these debug ports:

- Chapter 6 from our Getting Started Guide:

<http://www.intertesttech.com/download/dft4000.pdf>

- Obtain manual from IBM®, e.g. "PowerPC 405 Processor Core User Guide" (publication no. SA14-2764-00). Search for "ppc405fx_um" on the IBM® website if the link below doesn't return the document:

[http://www-306.ibm.com/chips/techlib/techlib.nsf/techdocs/D060DB54BD4DC4F2872569D2004A30D6/\\$file/ppc405fx_um.pdf](http://www-306.ibm.com/chips/techlib/techlib.nsf/techdocs/D060DB54BD4DC4F2872569D2004A30D6/$file/ppc405fx_um.pdf)

If your board has a 16-pin debug header, which is designed following the above specification, then you can plug directly into this.

If your processor is soldered, and your board does not have a debug header, then you will have to construct a simple test jig to get access to the appropriate test points (illustration 2). Contact us if you require assistance with this.

Although, the IBM® debug port specification defines a 16-pin connector, the pins required for the operation of µMaster Test and Debug solutions are:

Debug Port Pin No.	Signal
1	TDO
3	TDI
4	TRST
6	Power Sense
7	TCK
9	TMS
16	GND

I can't see my CPU Type...

The range of supported CPUs is constantly increasing, so if you cannot see your CPU type here, check our website for the latest status:

http://www.intertesttech.com/ate/products_hd5.htm

or contact one of our Sales Reps. for further information:

http://www.intertesttech.com/ate/company_locations.htm

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