

High Performance X-Bus[®] Module with 400 MHz ARM CPU



X-MAX-400

Preliminary Data Sheet (2/07)

Features

- 32 Bit X-Bus[®] CPU-Module with ARM-CPU Intel X-Scale (400 MHz incl. Thumb- and DSP functionality), can be used in a multi-processor environment
- Up to 32 MByte RAM and up to 32 MByte Flash <1>
- LCD-Color-Graphics-Interface (for DSTN and TFT)
- Resolution up to 640x480, 16 Bit Color
- Ethernet 100 BaseTx, magnetics on-board
- 3 x USB: Host, OTG (Host/Device) and Device
- 3 UARTs (serial interfaces) <3, 4, 5, 6>
- CF- resp. PCMCIA-Controller for 2 Cards <2, 6>
- MMC- resp. SD-Card Interface for 2 Cards <6>
- Audio-Interface I²S- or AC97 <6>
- I²C- and 2 x SPI-Interfaces <6>
- Interrupt- and DMA-Controller
- Watch-Dog, Manual Reset, various Timers
- 3 on-board LEDs
- Real Time Clock (bufferable by ext. battery)
- Digital Inputs and Outputs, Interrupt-capable
- JTAG-Debug-Interface
- Windows CE.NET (Vers. 4.2) and OsX incl. (in preparation)
- Dimensions only 29 x 58 x 10 mm³
- Current Consumption typ. 485mA at 100 MHz resp. 595mA at 400 MHz (V_{cc} = 3,3V)

Notes

- <1> On-board Flash can be used as Flash-File System
- <2> Ext. FPGA or CPLD required
- <3> F-UART with RS-232 levels, incl. RTS/CTS
- <4> B-UART with LVTTTL levels, incl. RTS/CTS
- <5> S-UART with LVTTTL levels, also usable as Infrared Interface up to 4 Mbit/s (SIR and FIR)
- <6> Some Interfaces cannot be used simultaneously (see below)

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Fig. 1: X-MAX-400

General Description

The CPU-Module X-MAX-400 is a complete „embedded PDA“. It provides all interfaces of modern PDAs and, in addition, some more, like e.g. Ethernet 100 BaseTx, USB-Host and USB-OTG (usable as Host or Device) and a Real Time Clock, which can be buffered by an external battery. The high speed ARM-CPU is clocked with up to 400 MHz. The very low power consumption of the module can even be lowered by changing the clock of the CPU dynamically. The architecture of the CPU equals the Intel X-Scale (PXA255). This CPU provides some extensions of the standard-ARM opcodes, especially with DSP functionality (v.5TE).

In addition, the module provides up to 32 MByte RAM and 32 MByte Flash. The Flash can be used as Flash-File System. To further reduce cost, variants of the module are provided with reduced RAM (4, 8, 16 or 32 MByte) and reduced Flash (8, 16 or 32 MByte). Some of the on-board interfaces use I/O-pins of the three 40-pin connectors which are also used by another interface. These interfaces cannot be used at the same time in the same system (see Table 2 for details). Nearly all I/O-Pins can be used as simple digital I/Os, independently of their function for special interfaces. They can be configured by software as an input or output. Those pins configured as inputs can generate an interrupt request to the CPU.

Standard Interfaces for Embedded Applications

Many of the on-board interfaces can be used in embedded applications, where the X-MAX-400 module is plugged onto a carrier board.

Some of the interface chips are to be mounted on the carrier board, e.g. the level converter. SORCUS provides different carrier boards as standard products (with 2 to 8 slots for modules), but custom specific boards are also possible with X-Bus® slots.

I/O-Levels

If no special remarks are made, all I/O-Pins provided on connectors A and C are specified as LVTTTL. The maximum voltage allowed on these pins is $V_{cc} + 0,3V$ (see technical data).

UARTs

Three UARTs are provided on the module, called: B-UART, F-UART and S-UART. All UARTs are compatible with the industry standard 16550, which is also used in PCs. All 3 UARTs provide additional functionality, like larger FIFOs, infrared operational mode and DMA (one DMA channel for receive and one for transmit). Table 1 displays the characteristics of each UART. After Power-On and after Reset, the UARTs are disabled.

Ethernet Interface

This 10/100BaseTx interface provides the magnetics on-board, which isolates it from all other interfaces of the module and also from the carrier board. The isolation does not resist high voltage because of the small distances of the traces on-board and the distances of the pins of the connectors. If higher isolation voltage is needed, a switch or hub can be used. In many applications, this is required anyway.

USB Interfaces

In total, the module provides 3 USB interfaces:

- 1) USB host incl. overcurrent detection
- 2) USB OTG incl. overcurrent detection. This interface is configured automatically as host or device, according to the opposite interface connected to it. It also can be used as an additional host interface.
- 3) USB device

These interfaces are compatible with USB spec. Rev. 2.0. (12 Mbit). The USB OTG interface also provides a voltage of 5V, which is available at a pin of one of the I/O connectors.

LCD-Graphics (for DSTN and TFT)

The controller provides a resolution of 1024 x 1024, but should not be used for more than 640 x 480 (VGA) with 16 Bit color. In addition, it provides a color palette with 256 entries at 16 Bit resolution. In monochrome mode, the number of grey scale is 256. The interface supports passive DSTN and active TFT displays, as well 1 as 2 panel displays. 4, 8 or 16 Bit per pixel can be configured. I/O-pins, that are not used for the graphics, can be used for other purposes.

I²C Interface

This interface is a two wire interface according to the standard created by Philips. It can be used as master or as slave, even in a multi master environment with 100 KB/s and 400 KB/s. It supports software general call, no 10-Bit addressing and no CBUS compatibility. Both pins of the interface (SDA and SCL) are each provided with an on-board pull up resistor.

Synchronous Serial Port (SSP)

This interfaces supports various protocols like SPI (Motorola), Microwire (NS), SSP (TI) with bitrates of 900 Hz up to 3.68 MHz. The word length is programmable from 4 to 16 Bit. Two FIFOs (16 x 16 Bit each) are available for receive and transmit. The interface is capable of generating interrupts and can also be used with DMA.

NSSP- Interface

Like the SSP interface, this NSSP interface supports various protocols, e.g. SPI (Motorola), Microwire (NS), SSP (TI) and PSP. For each direction of communication, a FIFO with 16 words is provided. The width is programmable from 4..32 Bit. Maximum speed is 13 MBps. The interface is capable of generating interrupts and can also be used with DMA.

AC97 Interface

This interface supports AC97, Rev. 2 and AC-Link and can be used to connect one or two codecs. One codec transmits digitized audio samples via AC97 to the X-MAX-400 module, where the data are stored for further processing by the CPU. In addition, digital audio data can be sent from the X-MAX-400 module via AC-Link to the codec, where the data are converted by a DA converter within the codec to analog audio data. AC97 cannot be used simultaneously with I²S.

I²S Interface

This four wire interface is used for digital audio stereo to connect a codec (see AC97 interface above). It cannot be used simultaneously with AC97. There are different variants of this interface and of the codecs to be used. Please see the literature available.

MMC (Multi-Media-Card) resp. SD Interface

This serial interface provides the signals to connect 2 MMC memory cards or 2 SD cards. For a description of the MMC system, see www.mmca.org. Two protocols are used to transfer the data, MMC standard and SPI. The maximum data rate can be up to 20 MByte/s.

PCMCIA- resp. CF-Card Interface

Two cards resp. slots are supported. The data are routed via the X-Bus[®]. Therefore, an external FPGA or CPLD is required.

The Power Supply of the Module

The module is powered via the X-Bus[®] with 3,3V. All other voltages required on the module, e.g. the 5V for USB OTG and for the RS-232 levels, are generated on

the module, as well as the voltage for the core of the CPU, which can be set by software.

The X-Bus[®] Interface

The X-Bus[®] clock is 33 MHz, but it can be switched to 100 MHz GTL+. Up to 16 interrupt inputs are available, which are transmitted as VILs (so called virtual interface lines) via the bus (see explanation of the X-Bus). For the communication with other CPU modules or with a PC via an X-Bus[®] to PCI bridge, the module provides Dual-Port-RAM resp. FIFO interface with DMA. By using burst mode, data can be transferred via the X-Bus[®] with 66 MByte/s resp. up to 200 MByte/s. The X-Bus[®] also provides the capability of multi processing without external logic required. With the interface implemented in the X-MAX-400, up to 8 CPUs can operate on the X-Bus[®] simultaneously.

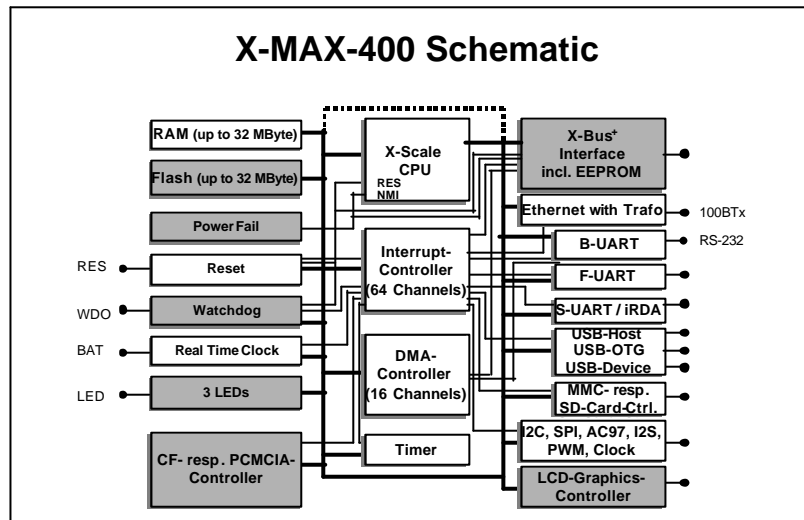


Abb. 2: Block Diagram

Table 1.: Features of the 3 on-board UARTs

Feature	F-UART	B-UART	S-UART	Note
Level of the I/O-pins	RS-232	LVTTL	LVTTL	-
Modem control signals	RTS, CTS	RTS, CTS	-	-
Hardware flow control	no	yes	no	
Bits / Character	5, 6, 7 or 8	5, 6, 7 or 8	5, 6, 7 or 8	
Parity	even, odd, no, soft	even, odd, no, soft	even, odd, no, soft	
Stop Bits	1, 1.5, 2	1, 1.5, 2	1, 1.5, 2	
Galvanic Isolation	no	no	no	-
Baudrate, max. (kbps)	230	921 (see notes)	230	@ 3k, 1nF
Baudrate (f = 14,7456 MHz)	f / 16 * D	f / 16 * D	f / 16 * D	D = 1...2 ¹⁶ -1
Infrared interface (iRDA)	SIR	SIR	SIR and FIR	FIR = 4 MB/s
Receive-FIFO (Byte)	64, can be disabled	64, can be disabled	64, can be disabled	@ FIR = 128
Transmit-FIFO (Byte)	64, can be disabled	64, can be disabled	64, can be disabled	@ FIR = 128
Interrupt	yes	yes	yes	
DMA channels (RCV and TMT)	2	2	2	-

Table 2.: Overview of the on-board interfaces and their possible simultaneous usage (for the function of the pins and their status after Reset, see Application Note AN-100).

Interface		Number of I/O-pins	Connector	Cannot be used simultaneously with (- := can be used with all other interfaces at the same time):	Additional GPIOs: used / partly / not used	Note
UART	F-UART	4+GND	A	-	0 / 0 / 0	RS-232 Level
	B-UART	4	A	Parallel Port	0 / 2 / 4	
	S-UART	2	A	iRDA	0 / 0 / 2	
Ethernet 100BTx		4	A	-	0 / 0 / 0	
USB	OTG	4	A	Parallel Port, SSP, (LED ext.)	0 / 1 / 3	
	Host	4	A	Parallel Port, Audio	0 / 4 / 4	
	Device	2	A	-	0 / 0 / 0	
iRDA	via S-UART	2	A	S-UART	0 / 0 / 2	SIR and FIR
Graphics	16 Bit	20	C	Clock outputs 1Hz, 32 KHz, 3,6 MHz, 48 MHz	0 / 0 / 20	
	2 x 8 Bit	20	C	Clock outputs 1Hz, 32 KHz, 3,6 MHz, 48 MHz	0 / 0 / 20	
	1..8 Bit	5..13	C	-	15..7 / 15..7 / 20	
Parallel Port		16	A	B-UART, USB-OTG and -Host, SSP, Audio	0 / 0 / 16	
I ² C		2	A	-	0 / 0 / 0	
SSP (Sync Serial Port)	SPI	4+1	A	Parallel Port, USB-OTG	0 / 1 / 5	
	Microwire	4	A	Parallel Port, USB-OTG	1 / 1 / 4	
	TI-SSP	4+1	A	Parallel Port, USB-OTG	0 / 1 / 5	
NSSP (Net Sync Serial Port)	SPI	4	C	-	0 / 0 / 4	
	Microwire	4	C	-	0 / 0 / 4	
	TI-SSP	4	C	-	0 / 0 / 4	
Audio	AC97	4+1	A	Parallel Port, USB-Host	0 / 1 / 5	
	I ² S	4+1	A	Parallel Port, USB-Host	0 / 1 / 5	
Memory-Card	MMC	6+1	C	-	0 / 1 / 5	
	SD	6+1	C	-	0 / 1 / 5	
IO-Card	CF	2+X-Bus	C, B	-	0 / 1 / 2	ext. Hardware
	PCMCIA	2+X-Bus	C, B	-	0 / 1 / 2	ext. Hardware
RTC: Battery (Input)		1	A	-	0 / 0 / 0	
Watch-Dog (Output)		1	A	-	0 / 0 / 0	
PWM-Output	0	1	C	-	0 / 0 / 1	for Display
	1	1	C	-	0 / 0 / 1	for Display
Takt-Output	1 Hz	1	C	Graphic 16 Bit, Graphic 2 x 8 Bit	0 / 0 / 1	
	32 KHz	1	C	Graphic 16 Bit, Graphic 2 x 8 Bit	0 / 0 / 1	
	3,6 MHz	1	C	Graphic 16 Bit, Graphic 2 x 8 Bit	0 / 0 / 1	
	48 MHz	1	C	Graphic 16 Bit, Graphic 2 x 8 Bit	0 / 0 / 1	
LEDs on-board	A red	-	-	-	0 / 0 / 0	
	B red	-	-	-	0 / 0 / 0	
	C red	-	-	-	0 / 0 / 0	
	D blue	-	-	-	0 / 0 / 0	
LED ext. (Output)		1	A	-	0 / 0 / 1	
Manual Reset (Input)		1	A	-	0 / 0 / 0	

Table 3.: Ordering Information (see also www.sorcus.com)

Module Version	Ordering Number	RAM	Flash	Operating Temperature	Status
X-MAX-400	HM-3531	32M	32M	0...70°C	in production
iX-MAX-400	HM-3740	32M	32M	-40...85°C	on request

Possible Modifications to reduce cost (minimum order 100 pcs): standard configuration = *

CPU-Speed: 400 MHz *, 200 MHz

USB interfaces in addition to USB device: 1 x OTG *, 1 x Host *

Ethernet interface: 100 Mbit inkl. Trafo *

Flash-ROM: 32 MByte *, 16 MByte, 8 MByte, 4 MByte

RAM (dyn.): 32 MByte *, 16 MByte

B-UART: RS-232 *

Operating Temperature: 0...70°C *, -40...85°C