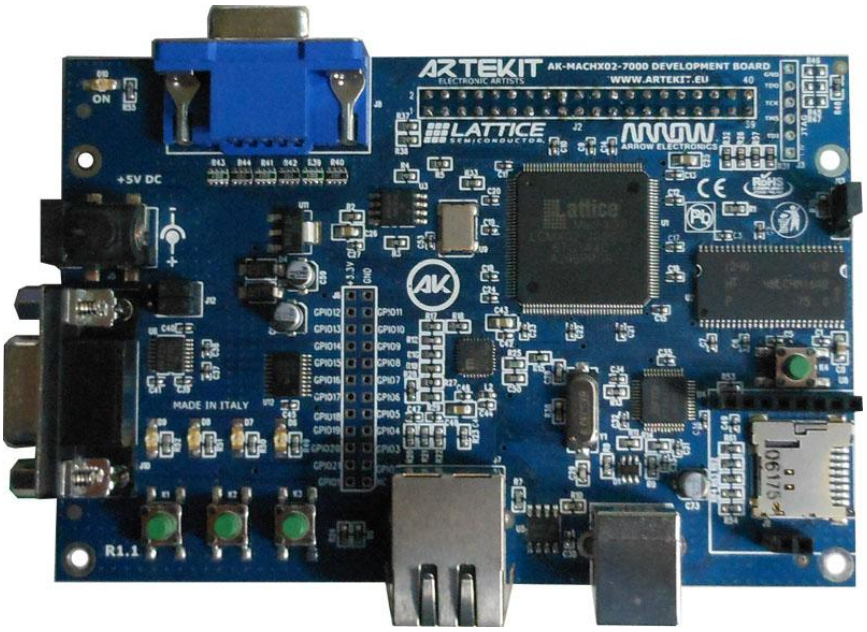
AK-MACHX02-7000 Development Board

Technical manual



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About this document

Revision history

The table below displays the revision history for the chapters in this manual.

Chapter	Date	Revision	Changes made
All	March 2013	1.0	First publication

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Specifications

General description

The AK-MACHX02-7000 development board is a full-featured hardware platform to evaluate the Lattice MachX02 PLD Line. The complete schematics of the board are provided and can be download from the Artekit website.

Main components

The AK-MACHX02-7000 Development board features the following components:

- Lattice MACHX02-7000 PLD
- 10/100 Mb Ethernet adapter with link/speed LEDs
- 32Mb (4MB) serial data flash
- 64Mb (8MB) DRAM
- 1 RS232 (TX/RX only)
- VGA output using R2R method
- 2 x expansion connector
- 4 user LED
- 4 user KEY
- Lattice JTAG programmer/debug cable on board
- 25 MHz clock oscillator
- Powered from USB cable or external 5V DC power supply

Environmental requirements

The AK-MACHX02-7000 development board must be stored between –40° C and 100° C. The recommended operating temperature is between 0° and 55° C.

The AK-MACHX02-7000 development board can be damaged without proper anti-static handling.

Handling the board

When handling the board, it is important to observe the following precaution:

Static discharge precaution — Without proper anti-static handling the board can be damaged. Therefore, take anti-static precautions while handling the board.

Electrical characteristic

The AK-MACHX02-7000 Board must be powered through USB cable or external 5V power supply.
The board consumption depends of the PLD configuration. The consumption of the PLD without any internal logic programmed is about 60mA.

Components description

The following section describes in detail the main components of the development board.

NOTE: The part numbers can change without previous notice.

BOARD

The board is composed of the following main components:

- Lattice LCMX02-7000C-6TG144C FPGA.
- Micron MT48LC4M16A2P-75 DRAM.
- ATMEL AT25DF321A-SH-T serial Data Flash.
- FTDI FT2232D as JTAG adapter.
- MICREL KSZ8041NL Ethernet MAC.
- 25 MHz oscillator as main FPGA clock.
- 74HC244 as user LED driver.
- ST2232 as RS232 driver.
- MicroSD socket.
- AK-SDS-UART socket for a easy SD File System.
- VGA connector using R2R method.
- 1 generic expansion connector.
- 1 specific expansion connector for a piggy-back board.
- 1 external 5V power connector jack.
- 1 RS232 connector with TX/RX driven.
- 1 RJ45 shielded Ethernet connector, with speed/link led.
- 1 USB B-type for JTAG and power, and for a VCP UART to the PC.
- 4 users LED.
- 4 users KEY.

Expansion connector J6

PIN NAME	PIN #	DESCRIPTION	COMMENT
	1	No connection	
GPIO2	2	X02-PIN 125 - Generic I/O	Unprotected
GPIO3	3	X02-PIN 126 - Generic I/O	Unprotected
GPIO4	4	X02-PIN 103 - Generic I/O	Unprotected
GPIO5	5	X02-PIN 43 - Generic I/O	Unprotected
GPIO6	6	X02-PIN 52 - Generic I/O	Unprotected
GPIO7	7	X02-PIN 54 - Generic I/O	Unprotected
GPIO8	8	X02-PIN 55 - Generic I/O	Unprotected
GPIO9	9	X02-PIN 4 - Generic I/O	Unprotected
GPIO10	10	X02-PIN 2 - Generic I/O	Unprotected
GPIO11	11	X02-PIN 25 - Generic I/O	Unprotected
GND	12	Board electrical ground	
GPIO1	13	X02-PIN 133 - Generic I/O	Unprotected
GPIO21	14	X02-PIN 5 - Generic I/O	Unprotected
GPIO20	15	X02-PIN 26 - Generic I/O	Unprotected
GPIO19	16	X02-PIN 27 - Generic I/O	Unprotected
GPIO18	17	X02-PIN 1 - Generic I/O	Unprotected
GPIO17	18	X02-PIN 35 - Generic I/O	Unprotected
GPIO16	19	X02-PIN 34 - Generic I/O	Unprotected
GPIO15	20	X02-PIN 33 - Generic I/O	Unprotected
GPIO14	21	X02-PIN 32 - Generic I/O	Unprotected
GPIO13	22	X02-PIN 31 - Generic I/O	Unprotected
GPIO12	23	X02-PIN 28 - Generic I/O	Unprotected
+3.3V	24	3.3V from the internal power regulator	

Expansion connector J9

NOTE: The following pin names are for the AK-TFT480X272, a TFT 480 x 272 expansion board. You can use it as a generic expansion I/O connector.

PIN NAME	PIN #	DESCRIPTION	COMMENT
TFT_PWM	1	X02-PIN 132 – PWM backlight control	Unprotected
	2	No connection	
TS_MISO	3	X02-PIN 50 – Touch screen SPI MISO	Unprotected
	4	No connection	
TS_MOSI	5	X02-PIN 49 – Touch screen SPI MOSI	Unprotected
TFT_POWER	6	X02-PIN 6 – Power ON TFT board	Unprotected
TS_CLK	7	X02-PIN 47 - Touch screen SPI CLK	Unprotected
TS_CS	8	X02-PIN 48 - Touch screen SPI nCS	Unprotected
TFT_VSYNC	9	X02-PIN 89 – TFT Vertical Sync.	Unprotected
TFT_DE	10	X02-PIN 127 – TFT Data Enable	Unprotected
TFT_CLK	11	X02-PIN 128 – TFT Dot Clock	Unprotected
TFT_HSYNC	12	X02-PIN 87 – TFT Horizontal Sync.	Unprotected
TFT_BLUE_4	13	X02-PIN 142 – TFT Blue 4. Connected also to pin 19 (1)	Unprotected
TFT_BLUE_5	14	X02-PIN 143 – TFT Blue 5. Connected also to pin 20 (1)	Unprotected
TFT_BLUE_2	15	X02-PIN 140 – TFT Blue 2	Unprotected
TFT_BLUE_3	16	X02-PIN 141 – TFT Blue 3	Unprotected

TFT_BLUE_0	17	X02-PIN 138 – TFT Blue 0	Unprotected
TFT_BLUE_1	18	X02-PIN 139 – TFT Blue 1	Unprotected
TFT_BLUE_4	19	X02-PIN 142 – TFT Blue 4. Connected also to pin 13 (1)	Unprotected
TFT_BLUE_5	20	X02-PIN 143 – TFT Blue 5. Connected also to pin 14 (1)	Unprotected
TFT_GREEN_4	21	X02-PIN 121 – TFT Green 4. Connected also to pin 27 (1)	Unprotected
TFT_GREEN_5	22	X02-PIN 122 – TFT Green 5. Connected also to pin 28 (1)	Unprotected
TFT_GREEN_2	23	X02-PIN 42 – TFT Green 2	Unprotected
TFT_GREEN_3	24	X02-PIN 120 – TFT Green 3	Unprotected
TFT_GREEN_0	25	X02-PIN 115 – TFT Green 0	Unprotected
TFT_GREEN_1	26	X02-PIN 117 – TFT Green 1	Unprotected
TFT_GREEN_4	27	X02-PIN 121 – TFT Green 4. Connected also to pin 21 (1)	Unprotected
TFT_GREEN_5	28	X02-PIN 122 – TFT Green 5. Connected also to pin 22 (1)	Unprotected
TFT_RED_4	29	X02-PIN 113 – TFT Red 4. Connected also to pin 35 (1)	Unprotected
TFT_RED_5	30	X02-PIN 114 – TFT Red 5. Connected also to pin 36 (1)	Unprotected
TFT_RED_2	31	X02-PIN 111 – TFT Red 2	Unprotected
TFT_RED_3	32	X02-PIN 112 – TFT Red 3	Unprotected
TFT_RED_0	33	X02-PIN 109 – TFT Red 0	Unprotected
TFT_RED_1	34	X02-PIN 110 – TFT Red 1	Unprotected
TFT_RED_4	35	X02-PIN 113 – TFT Red 4. Connected also to pin 29 (1)	Unprotected
TFT_RED_5	36	X02-PIN 114 – TFT Red 5. Connected also to pin 30 (1)	Unprotected
GND	37	Electrical ground	
GND	38	Electrical ground	
+5V	39	+5V from the external Power or USB cable	
+5V	40	+5V from the external Power or USB cable	

(1) The AK-TFT480X272 board supports 24 bit color, but the AK-MACHX02-7000 board uses only 18 bit color. To get full black and white colors, the least significant TFT bits for each color will be connected to the respective higher bit: (R0 to R6 and R1 to R7, G0 to G6 and G1 to G7, B0 to B6 and B1 to B7).

Jumper settings

The AK-MACHX02-7000 board has two jumper options:

- J12 switches a programmable MachX02 UART to the FTDI FT2232D second channel UART or to the external RS232 connector (J10) through a ST3232 TTL to RS232 driver.
- J13 switch is a user jumper option.

J12 UART Direction

MODE	JUMPER POSITION	COMMENTS
TO FT2232D	3 –5 and 4–6 short (Default)	Drives the MachX02 UART to the PC through USB.
TO RS232	1–3 and 2-4 short	Drives the MachX02 UART to external RS232 connector J10.

J13 User Switch

MODE	JUMPER SETTINGS
To Vss (Ground)	2–3 short, drive MachX02 pin 70 to Vss through a 100 ohm resistor
To Vcc (+3.3V)	1-2 short, drive MachX02 pin 70 to Vcc through a 100 ohm resistor

CAUTION: Do not change jumper switches while the board is powered, and do not try another jumpers combinations. The board could be permanently damaged.

VGA connector J8

The AK-MACHX02-7000 board offers a R2R VGA output using 4 bit color. The VGA uses the same TFT color pin. Please see the schematic diagram to see the details.

10/100 Mbps Ethernet MAC

The AK-MACHX02-7000 board has an Ethernet MAC U7 connected in RMII layout to the MachX02.

MachX02-PIN	MAC-PIN	SIGNAL
13	11	RMII_MDIO
14	12	RMII_MDC
15	16	RMII_RXD0
17	15	RMII_RXD1
19	18	RMII_CRSDV
20	20	RMII_RX_ER
21	24	RMII_TXD0
22	25	RMII_TXD1
23	23	RMII_TXEN
24	21	ETH_INTN

User KEYs

The AK-MACHX02-7000 board has four user keys. Remember to set the MachX02 pin using the internal MachX02 weak pull-up. All keys are active low. The user keys are connected in the following mode:

KEY	MachX02-PIN	DESCRIPTION
K1	5	Used also as GPIO21
K2	26	Used also as GPIO20
K3	27	Used also as GPIO19
K4	119	This is a special key, used also as MachX02 Programming mode. Please see the MachX02 device manual for details. This MachX02 pin has a 10K pull-up resistor. Can be used also as generic key.

User LEDs

The AK-MACHX02-7000 board has four user LEDs connected to the MachX02 using a 74HC244 (U12) as LED driver. The next table shows the used MachX02 pins. All LEDs lights in active high mode.

LED	MachX02-PIN	DESCRIPTION
D6	1	Used also as GPIO18
D7	35	Used also as GPIO17
D8	34	Used also as GPIO16
D9	33	Used also as GPIO15

MicroSD socket

The AK-MACHX02-7000 board has a MicroSD socket connected in SPI mode. All pins have a 47k pull-up resistors. The next table shows the MachX02 pins used for the MicroSD slot:

MicroSD-PIN	MachX02-PIN	DETAIL
Card Detect	41	Used also as AK-SDFS-UART AKRESET signal
CD/DATA3	39	Used also as AK-SDFS-UART AKUART_RX signal
CMD	38	Used also as AK-SDFS-UART AKUART_TX signal
CLK	103	Used also as GPIO4
DATA0	52	Used also as GPIO6

SDRAM connection

The AK-MACHX02-7000 board has a 64Mb (8MB) DRAM (4MB x 16) (U2) and is connected to the MachX02 as follow:

DRAM-PIN	MachX02-PIN	DETAIL
23	77	DRAM Address 0
24	79	DRAM Address 1
25	81	DRAM Address 2
26	82	DRAM Address 3
29	107	DRAM Address 4
30	106	DRAM Address 5
31	105	DRAM Address 6
32	104	DRAM Address 7
33	100	DRAM Address 8
34	99	DRAM Address 9
22	76	DRAM Address 10
35	98	DRAM Address 11
16	68	DRAM nWE signal
19	73	DRAM nCS signal
17	69	DRAM nCAS signal
18	63	DRAM nRAS signal
15	67	DRAM DQML signal
39	95	DRAM DQMH signal
2	61	DRAM Data I/O 0
4	60	DRAM Data I/O 1
5	59	DRAM Data I/O 2
7	58	DRAM Data I/O 3
8	57	DRAM Data I/O 4
10	56	DRAM Data I/O 5
11	62	DRAM Data I/O 6
13	65	DRAM Data I/O 7
42	94	DRAM Data I/O 8
44	93	DRAM Data I/O 9
45	92	DRAM Data I/O 10
47	91	DRAM Data I/O 11
48	86	DRAM Data I/O 12
50	83	DRAM Data I/O 13
51	84	DRAM Data I/O 14
53	85	DRAM Data I/O 15

37	97	DRAM CKE signal
38	96	DRAM CLK signal
20	74	DRAM BA0 signal
21	75	DRAM BA1 signal

Serial Data Flash

The AK-MACHX02-7000 board has a 32Mb (8MB) SPI serial data flash connected in the following way:

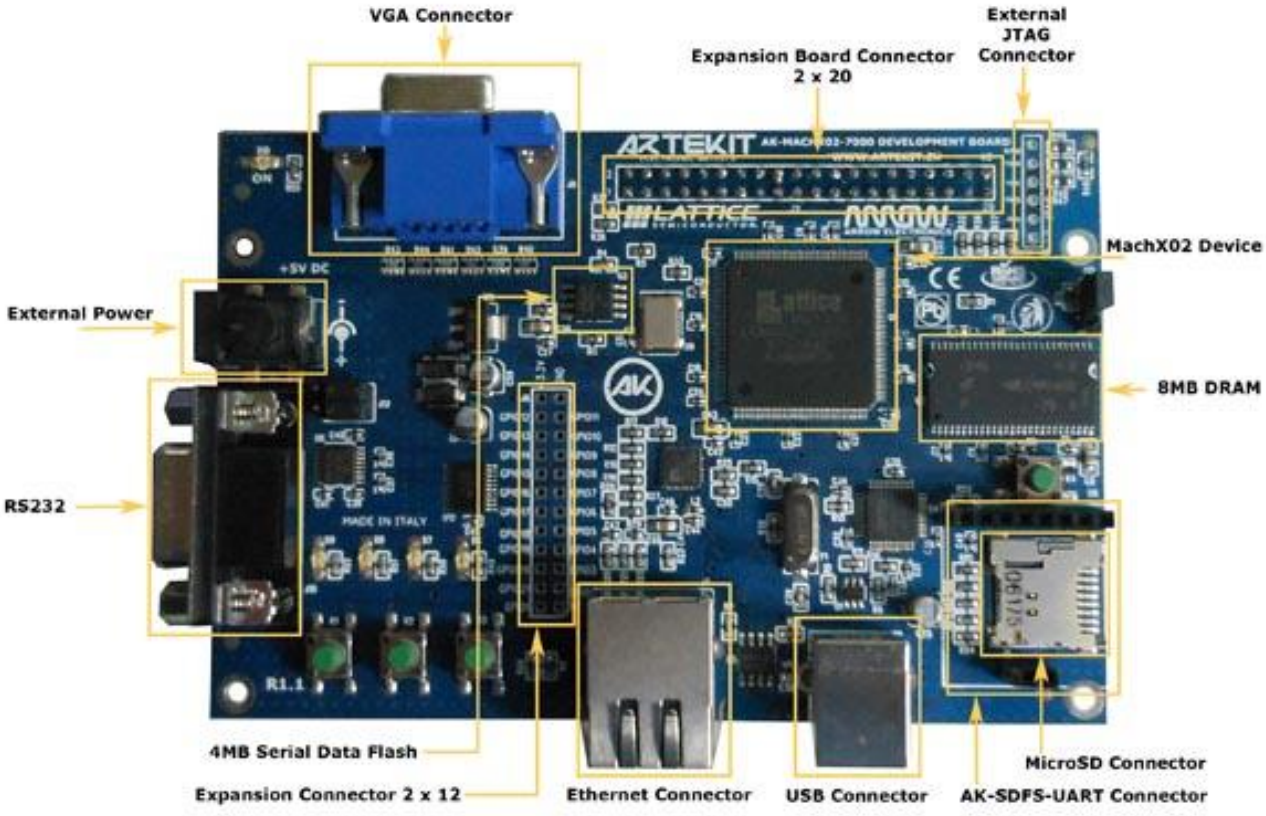
DF-PIN	MachX02-PIN	DETAIL
1	40	DF SPI nCS
2	45	DF SPI MISO
5	71	DF SPI MOSI
6	44	DF SPI CLK

AK-SDFS-UART board connector

The AK-MACHX02-7000 board has a special connector to interface an optional AK-SDFS-UART to implement an easy full FAT File System through UART. Remember that the AK-SDFS-UART and the on-board microSD slot cannot be used concurrently. The MachX02 connections are shown in the next table.

SDFS-PIN	MachX02-PIN	DETAIL
1	38	UART RX (Output from the MachX02)
2	39	UART TX (Input to the MachX02)
7	41	AK-SDFS-UART nRESET pin

Board Layout



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