



## **VMXP-6453**

**DM&P Vortex86MX+ 800MHz**

**PC/104 CPU Module**

**With**

**3S/4USB/VGA/LCD/LVDS/AUDIO/LAN/GPIO/CF/PWMx16**

**512MB or 1GB DDR2 Onboard**

**User's Manual**

**(Revision 1.1A)**

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# Chapter 1

## Introduction

### 1.1 Packing List

Product Name	Package
SOM304MX-6453	<ul style="list-style-type: none"><li>● RS232 cable x 3</li><li>● PRINT cable x1</li><li>● USB cable x2 (USB port x 4)</li><li>● VGA cable x 1</li><li>● NET 4x2 (2.0) cable x 1</li><li>● GPIO cable x 1</li><li>● Audio cable x 2</li><li>● PS/2 Mouse cable x 1</li><li>● PS/2 Keyboard cable x 1</li><li>● Screw Kit x 1</li></ul>
SOM304MP-VP	<ul style="list-style-type: none"><li>● SOM304MP-VP CPU Module x1</li></ul>

## 1.3 Product Description

The VMXP-6453, low-power consumption x86 embedded controller is designed to meet PC/104 Form Factor, and integrated with the following features.

- 800 MHz Vortex86MX+ SoC
  - Either VGA or TFT/ LVDS LCD support
  - 512MB / 1GB DDR2 system memory
  - Enhanced IDE (UltraDMA-100/66/33)
  - 10/100Mbps Ethernet
  - USB 2.0 (host) x4
  - Up to 3serial ports
  - Parallel port
  - 16-bit GPIOs
  - HD Audio
  - SST NAND Flash Onboard (Opt.)
  - 2 watchdog timer
  - PWM 16~24 channels
  - AMI BIOS
  - Single voltage +5V DC
  - Support extended operating temperature range of -20°C to +70°C
- The VMXP-6453 PC/104 embedded controller is designed with backward compatibility in mind, to provide migration path for projects facing end-of-life challenges with their existing x86 based PC/104 controller. The VMXP-6453 controller is designed to support legacy software to help extend existing product life cycle without heavy re-engineering.
- VMXP-6453 is suitable for broad range of data-acquisition, Industrial automation, Process control, Automotive controller, AVL, Intelligent Vehicle management device, Medical device, Human machine interface, Robotics, Machinery control and any application that requires small footprint, low-power and low-cost hardware.

# 1.4 Specifications

## ■ SOM304MP-6453

Features	SOM304MP-6453
Connectors	<ul style="list-style-type: none"> <li>● 2.00 mm Ø 44-pin box header for LCD x 1</li> <li>● 2.00 mm Ø 26-pin box header for Printer x1</li> <li>● 2.00 mm Ø 20-pin box header for 16-bit GPIO x1</li> <li>● 2.00 mm Ø 16-pin header for LVDS x 1</li> <li>● 2.00 mm Ø 10-pin box header for VGA x1</li> <li>● 2.00 mm Ø 10-pin box header for USB x2</li> <li>● 2.00 mm Ø 10-pin box header for RS-232 x3</li> <li>● 2.00 mm Ø 8-pin header for Ethernet x 1</li> <li>● 2.54 mm Ø 5-pin box header for Keyboard x1</li> <li>● 2.54 mm Ø 5-pin box header for Mouse x1</li> <li>● 2.54 mm Ø 2-pin header for Reset x1</li> <li>● 1.27mm Ø 76-pin header for Signal x4</li> <li>● 1.25 mm Ø 4-pin Wafer for Line-out/MIC-in x2</li> <li>● Type I/II Compact Flash Slot x1</li> </ul>
Power Requirement	Single Voltage +5V @ 200mA
Dimension	90 X 96mm (3.54 x 3.77 inches)
Weight	125g
Operating Temperature	0°C ~+60°C -20°C ~+70°C (Optional)

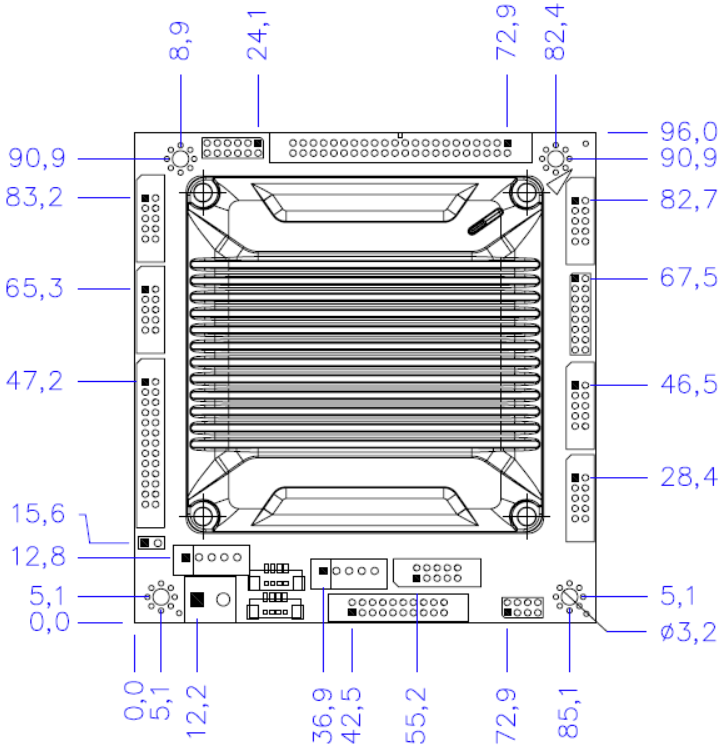
## ■ SOM304MP-VP

Features	SOM304MP-VP
CPU	DM&P SoC CPU Vortex86MX+- 800MHz Real Time Clock with Lithium Battery Backup
Cache	L1:16K I-Cache, 16K D-Cache, L2 Cache 256KB
BIOS	AMI BIOS
Bus Interface	PCI bus standard compliant LPC Bus & SPI Bus
System Memory	512MB/1GB DDR2 Onboard
Watchdog Timer	Software programmable from 30.5 us to 512 seconds x2 sets(Watchdog 1 fully compatible with M6117D)
VGA	Integrated 2D VGA chip VGA and TFT Flat Panel Interface Support (Either VGA or LCD) Share system memory 16MB/32MB, Mono, DSTN, STN, TFT Flat Panel interface support & resolution up to 1280x1024, 16M colors
LAN	Integrated 10/100M Ethernet
AUDIO	ALC 262 (HD Audio)
I/O Interface	<ul style="list-style-type: none"> <li>● Enhanced IDE port (UltraDMA-100/66/33) x1</li> <li>● RS-232 port x3</li> <li>● USB port (Ver2.0) x4</li> <li>● Parallel poet x1</li> <li>● 16-bit GPIO port x2</li> <li>● 10/100Mbps Ethernet port x1</li> </ul>
Flash Disk Support	<ul style="list-style-type: none"> <li>● Onboard SST Flash Disk (512MB/1GB/2GB/4GB are Optional)</li> <li>● MSTI EmbedDisk Module (16MB and above)</li> <li>● 44-pin IDE to Micro SD (optional)</li> </ul>
PWM	16~24 channels
Power Requirement	Single Voltage +5V @ 700mA (with 2GB NAND Flash)
Dimension	70 (L) x70 (W) x10.5 (H) mm (with cover)
Weight	25g
Operating Temperature	0°C ~+60°C -20°C ~+70°C (Optional)

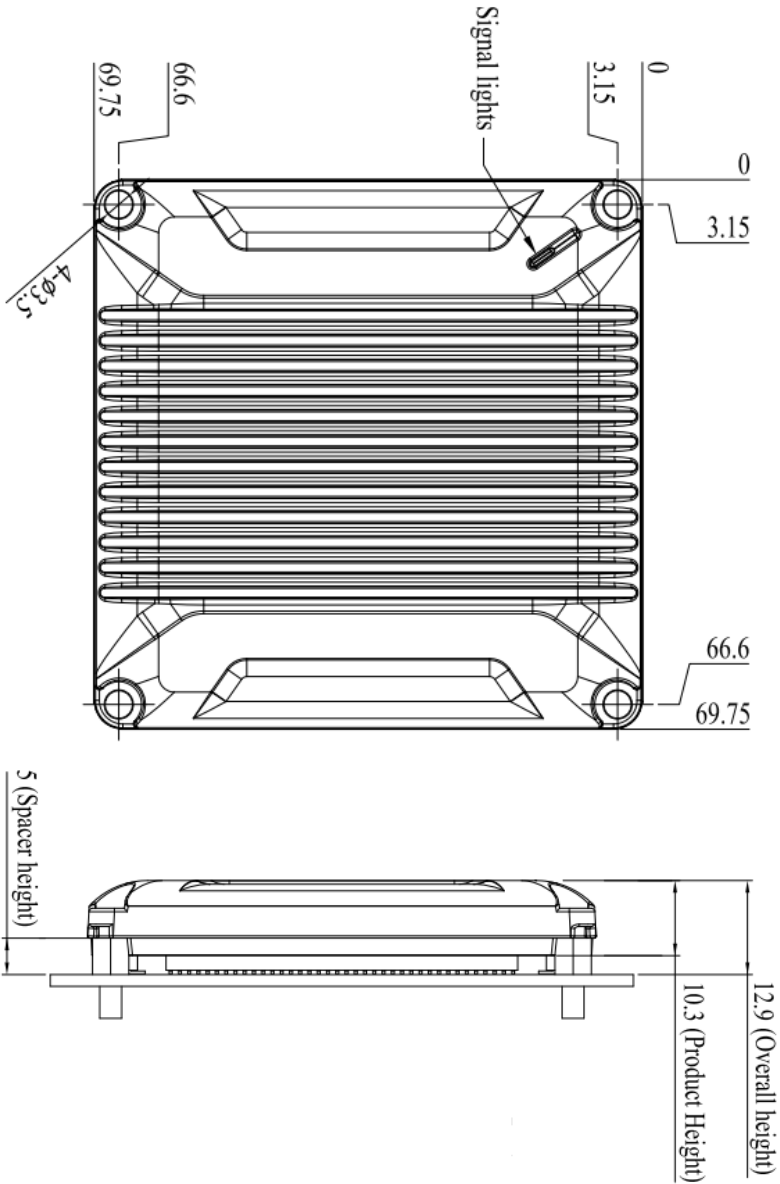


# 1.5 Board Dimension

## ■ SOM304MP-6453



■ SOM304MP-VP

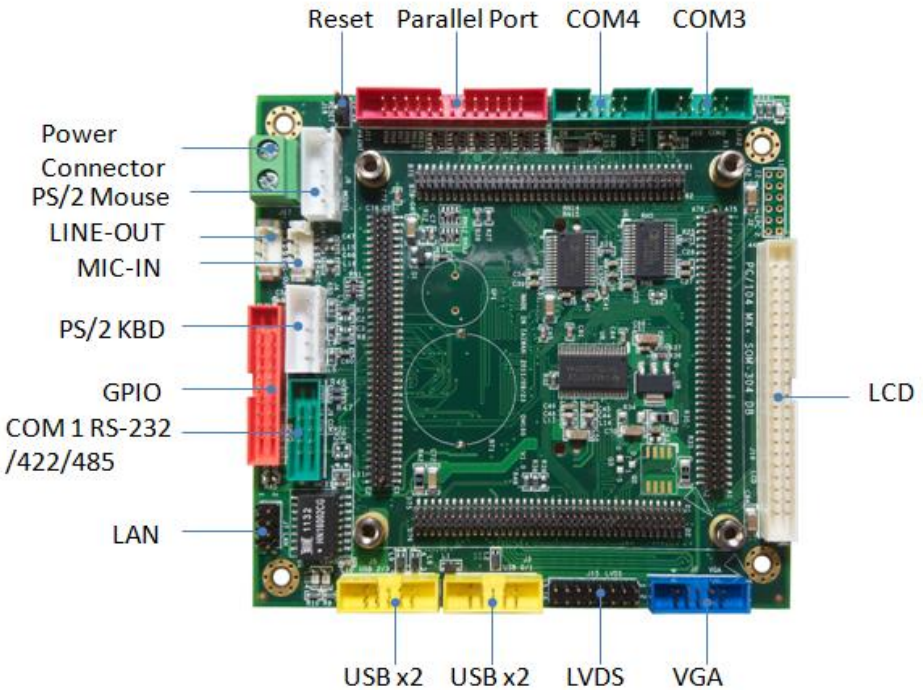




# Chapter 2

## Installation

### 2.1 Board Outline



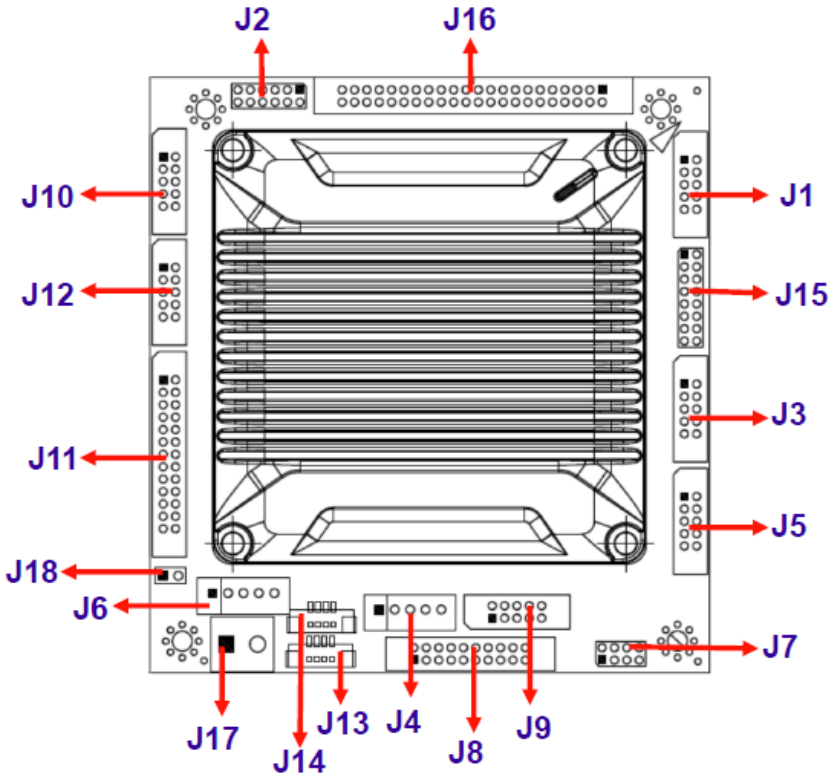
(Note1: COM1 RS232/422/485 is selected by BIOS setting)

(Note2: LPC Bus is optional)

(Note3: Onboard SST Flash Disk: 512MB/1GB/2GB/4GB are Optional)

## 2.2 Connectors & Jumpers Location

### Connectors



(Note1: J2 is optional)

## 2.3 Connectors & Jumpers Summary

Summary Table

Nbr	Description	Type of Connections	Pin nbrs.
J1	VGA	Box Header, 2,0Ø ,5x2	10-pin
J2	LPC (Optional)	Pin Header, 2,0 6x2	12-pin
J3	USB 0,1	Box Header,2,0Ø , 5x2	10-pin
J4	PS/2 Keyboard	Box Header, 2,54Ø,1x5	5-pin
J5	USB 2,3	Box Header,2,0Ø , 5x2	10-pin
J6	PS/2 Mouse	Box Header, 2,54Ø,1x5	5-pin
J7	LAN	Pin Header, 2,0Ø , 4x2	8-pin
J8	GPIO ( Port 0 / 1 /PWMx16)	Box Header, 2,0Ø ,10x2	20-pin
J9	COM1(RS232/422/485)	Box Header, 2,0Ø 5x2	10-pin
J10	COM3 (Optional :TTL)	Box Header, 2,0Ø 5x2	10-pin
J11	PRINT	Box Header, 2,0Ø , 13x2	26-pin
J12	COM4 (Optional :TTL)	Box Header, 2,0Ø 5x2	10-pin
J13	LINE-OUT	Wafer, 1,25Ø , 4x1	4-pin
J14	MIC-IN	Wafer, 1,25Ø , 4x1	4-pin
J15	LVDS	Pin Header, 2,0Ø 8x2	16-pin
J16	LCD Connector	Box Header,2,0Ø ,22x2	44-pin
J17	Power Connector	Terminal Block 5.0Ø,2x1	2-pin
J18	Reset	Pin Header, 2,54Ø,1x2	2-pin
CF1	Compact Flash	Type I/II CF Connector	50-pin
PWR-LED	Power Active LED (Red)	LED-SMD	
IDE-LED	IDE Active LED (Green )	LED-SMD	
LED 3	LAN Link/Active LED (Green)	LED-SMD	
LED 4	LAN Duplex LED ( Yellow )	LED-SMD	

## 2.4 Pin Assignments & Jumper Settings

### J1: VGA

Pin #	Signal Name	Pin #	Signal Name
1	R OUT	2	GND
3	G OUT	4	GND
5	B OUT	6	GND
7	HSYNC	8	GND
9	VSYNC	10	GND

### J2: LPC (Optional)

Pin #	Signal Name	Pin #	Signal Name
1	CLK24MOUT	2	LAD0
3	LFRAME-	4	LAD1
5	GND	6	LAD2
7	LDRQ-	8	LAD3
9	SERIRQ	10	VCC
11	PCIRST-	12	PCICLK1

### J3: USB 0, 1

Pin #	Signal Name	Pin #	Signal Name
1	VCC	2	VCC
3	LUSB0D1-	4	LUSB0D0-
5	LUSB0D1+	6	LUSB0D0+
7	GND	8	GND
9	GGND	10	GGND

### J4: PS/2 Keyboard

Pin #	Signal Name	Pin #	Signal Name
1	KBCLK	2	KBDAT
3	NC	4	GND
5	VCC		

## J5: USB 2, 3

Pin #	Signal Name	Pin #	Signal Name
1	VCC	2	VCC
3	LUSBD3-	4	LUSBD2-
5	LUSBD3+	6	LUSBD2+
7	GND	8	GND
9	GGND	10	GGND

## J6: PS/2 Mouse

Pin #	Signal Name	Pin #	Signal Name
1	MSCLK	2	MSDATA
3	NC	4	GND
5	VCC		

## J7: LAN

Pin #	Signal Name	Pin #	Signal Name
1	ATX+	2	ATX-
3	ARX+	4	LED0
5	LED0+	6	ARX-
7	LED1+	8	LED1

## J8: GPIO (Port 0 / 1/ PWMx16)

Pin #	Signal Name	Pin #	Signal Name
1	GND	2	VCC
3	GP00	4	GP10
5	GP01	6	GP11
7	GP02	8	GP12
9	GP03	10	GP13
11	GP04	12	GP14
13	GP05	14	GP15
15	GP06	16	GP16
17	GP07	18	GP17
19	VCC	20	GND



## J9: COM1 RS232 / 422 / 485 (Optional: TTL / PWMx8)

Pin #	Signal Name	Pin #	Signal Name
1	DCD2/ 422TX- / RS485-	2	RXD1 / 422TX+ / RS485+
3	TXD1 / 422RX+	4	DTR1 / 422RX-
5	GND	6	DSR1
7	RTS1	8	CTS1
9	RI1	10	NC

## J10: COM 3 (Optional: TTL)

Pin #	Signal Name	Pin #	Signal Name
1	DCD3	2	RXD3
3	TXD3	4	DTR3
5	GND	6	DSR3
7	RTS3	8	CTS3
9	RI3	10	NC

## J11: PRINT

Pin #	Signal Name	Pin #	Signal Name
1	STB-	14	AFD-
2	PD0	15	ERR-
3	PD1	16	INIT-
4	PD2	17	SLIN-
5	PD3	18	GND
6	PD4	19	GND
7	PD5	20	GND
8	PD6	21	GND
9	PD7	22	GND
10	ACK-	23	GND
11	BUSY	24	GND
12	PE	25	GND
13	SLCT	26	NC

## J12: COM4 (Optional: TTL)

Pin #	Signal Name	Pin #	Signal Name
1	DCD4	2	RXD4
3	TXD4	4	DTR4
5	GND	6	DSR4
7	RTS4	8	CTS4
9	RI4	10	NC

## J13: LINE OUT

Pin #	Signal Name
1	LOUT_R
2	GND
3	GND
4	LOUT_L

## J14: MIC-IN

Pin #	Signal Name
1	MIC_IN_R
2	GND
3	GND
4	MIC_IN_L

## J15: LVDS (Support LVDS 18bits)

Pin #	Signal Name	Pin #	Signal Name
1	VCC3 (+3.3V)	2	VCC3 (+3.3V)
3	GND	4	GND
5	RxIN0+	6	RxIN0-
7	RxIN1-	8	GND
9	GND	10	RxIN1+
11	RxIN2+	12	RxIN2-
13	CKIN-	14	GND
15	GND	16	CKIN+

## J16: LCD (DVO) Connector

Pin #	Signal Name	Pin #	Signal Name
1	+3.3V	2	+3.3V
3	LG2	4	LG3
5	LG4	6	LG5
7	NC	8	NC
9	LR0	10	LR1
11	LR2	12	LR3
13	LR4	14	LR5
15	GND	16	NC
17	NC	18	NC
19	NC	20	GND
21	NC	22	NC
23	LB0	24	LB1
25	LB2	26	LB3
27	LB4	28	LB5
29	NC	30	NC
31	LG0	32	LG1
33	GND	34	GND
35	NC	36	LCLK
37	NC	38	LDE
39	NC	40	LHSYNC
41	NC	42	LVSYNC
43	LBACKL	44	LVDDEN

[\(Please refer to Appendix A, for TFT Flat Panel Data Output\)](#)

## J17: Power Connector (Terminal Block 5.0mm)

Pin #	Signal Name
1	+5V
2	GND

## J18: RESET

Pin #	Signal Name	Pin #	Signal Name
1	RST_SW	2	GND

## 2.5 System Mapping

### System Mapping

#### Memory Mapping

Address	Description	Usage
00000000 - 0009FFFF	System RAM	*
000A0000 - 000AFFFF	EGA/VGA Video Memory	*
000B0000 - 000B7FFF	MDA RAM, Hercules graphics display RAM	*
000B8000 - 000BFFFF	CGA display RAM	*
000C0000 - 000C7FFF	EGA/VGA BIOS ROM	*
000C8000 - 000CFFFF	Boot ROM enable	
000CC000 - 000CFFFF	Console Redirection enable	
000D0000 - 000D7FFF	Expansion ROM space	
000D8000 - 000DBFFF	SPI FLASH Emulation Floppy A Enable	
000DC000 - 000DFFFF	Expansion ROM Space	
000E0000 - 000EFFFF	USB Legacy SCSI ROM space	
000F0000 - 000FFFFF	Motherboard BIOS	*
FEBD9000 - FEBD9FFF	Standard OpenHCD USB Host Controller	*
FEBDA000 - FEBBAFFF	Standard OpenHCD USB Host Controller	*
FEFBB400 - FEFBB4FF	On board Ethernet Adapter	*
FEFBB800 - FEFBB8FF	Standard Enhanced PCI to USB Host Controller	*
FEFBBC00 - FEFBBCFF	Standard Enhanced PCI to USB Host Controller	*

#### I/O Mapping

I/O Address	Owner	Usage
0000h - 000Fh	DMA 8237-1	*
0010h - 0017h	COM 9	

0020h - 0021h	PIC 8259-1	*
0022h - 0023h	Indirect Access Registers (6117D configuration port)	*
002Eh - 002Fh	Forward to LPC BUS	
0040h - 0043h	Timer Counter 8254	*
0048h - 004Bh	PWM counter 8254	*
004Eh - 004Fh	Forward to LPC BUS	
0060h	Keyboard / Mouse data port	*
0061h	Port B + NMI control port	*
0062h - 0063h	8051 download 4k address counter	*
0064h	Keyboard/ Mouse status/ command port	*
0065h	WatchDog0 reload counter	*
0066h	8051 download 8bit data port	*
0067h	WatchDog1 reload counter	*
0068h - 006Dh	WatchDog1 control counter	*
0070h - 0071h	CMOS RAM port	*
0072h - 0075h	MTBF control register	*
0078h - 007Ch	GPIO port 0,1,2,3,4 default setup	*
0080h - 008Fh	DMA page register	*
0092h	System control register	*
0098h - 009Ch	GPIO direction control	*
00A0h - 00A1h	PIC 8259-2	*
00C0h - 00DFh	DMA 8237-2	*
00E0h - 00EFh	DOS 4G Page access	*
0170h - 0177h	IDE1 (IRQ 15)	
01F0h - 01F7h	IDE0 (IRQ 14)	*
0220h - 0227h	COM8 Forward to LPC BUS	

0228h – 022Fh	COM7 Forward to LPC BUS	
0238h – 023Fh	COM6 Forward to LPC BUS	
0278h – 027Fh	Printer port (IRQ7, DMA 0)	*
02E8h – 02EFh	COM4 (IRQ 11)	*
02F8h – 02EFh	COM2 (IRQ3)	*
0338h – 033Fh	COM5 Forward to LPC BUS	
0376h	IDE1 ATAPI device control write only register	*
03E8h – 03EFh	COM3 (IRQ 10)	*
03F0h – 03F7h	Floppy Disk (IRQ6, DMA2)	
03F6h	IDE0 ATAPI device control write only register	*
03F8h – 03FFh	COM1 (IRQ 4)	*
0480h – 048Fh	DMA High page register	*
0490h – 0499h	Instruction counter register	*
04D0h – 04D1h	8259 Edge / level control register	*
0CF8h – 0CFh	PCI configuration port	*
DE00h – DEFFh	On board LAN	*
FC00h – FC05h	SPI Flash BIOS control register	*
FC08h – FC0Dh	External SPI BUS control register	*

IRQ Mapping		
IRQ#	Description	Usage
IRQ0	System Timer	*
IRQ1	Keyboard Controller	*
IRQ2	Cascade for IRQ8 – 15	

IRQ3	Serial Port 2	
IRQ4	Serial Port 1	*
IRQ5	USB	*
IRQ6	USB	*
IRQ7	Printer Port	*
IRQ8	Real Time Clock	*
IRQ9	USB/ Ethernet 10/100M LAN	*
IRQ10	Serial Port 3	
IRQ11	Serial Port 4	
IRQ12	Mouse	*
IRQ13	Math Coprocessor	*
IRQ14	Hard Disk Controller#1	*
IRQ15	Hard Disk Controller#2	*

DMA Mapping		
DMA#	Description	Usage
DMA0		
DMA1		
DMA2	Floppy Disk Controller	
DMA3		
DMA4		
DMA5		
DMA6		
DMA7		

## 2.6 Watchdog Timer

There are two watchdog timers in Vortex86SX/DX/MX+ CPU. One is compatible with M6117D watchdog timer and the other is new. The M6117D compatible watchdog timer is called WDT0 and new one is called WDT1.

We also provide DOS, Linux and WinCE example for your reference. For more technical support, please visit: <http://www.dmp.com.tw/tech> or download the PDF file:

<http://www.dmp.com.tw/tech/vortex86dx/>



## 2.7 GPIO (General Purpose Input / Output)

40 GPIO pins are provided by the Vortex86SX/DX/MX+ for general usage in the system. All GPIO pins are independent and can be configured as inputs or outputs, with or without pull-up/pull-down resistors.

We also offer DOS, Linux and WinCE example for your reference. For more technical support, please visit: <http://www.dmp.com.tw/tech> or download the PDF file:

<http://www.dmp.com.tw/tech/vortex86dx/>

## 2.8 PWM (Pulse-width modulation)

Pulse-width modulation (PWM) of a signal or power source involves the modulation of its duty cycle, to either convey information over a communications channel or control the amount of power sent to a load.

The popular applications of pulse width modulation are in speed control of electric motors, volume control of Class D audio amplifiers or brightness control of light sources and many other power electronics applications.

The Vortex86DX /Vortex86MX+ SoC integrated 32 channels of PWM interface enabling the Automation, robotic industry to a New Age x86 SoC platform and we also offer the sample code of PWM which will guide the engineer to control the PWM functionality smoothly.

For more inquire of this sample code that please contact our sales team or mail to:

[som@icop.com.tw](mailto:som@icop.com.tw)

# Chapter 3

## Driver Installation

### VGA

The Vortex86MX+ processor is integrated RDC Display chip which is an ultra-low powered graphics chipset with total power consumption at around 1-1.5 W. It is capable in providing VGA display output up to 1600x1200. With DVO interface, developers could easily connect flat Panel to support TFT and LVDS output.

### LAN

The Vortex86MX+ processor also integrated 10/100Mbps Ethernet controller that supports both 10/100BASE-T and allows direct connection to your 10/100Mbps Ethernet based Local Area Network for full interaction with local servers, wide area networks such as the Internet.

The controller supports: Half / Full-Duplex Ethernet function to double channel bandwidth, auto media detection.

### AUDIO

The ALC262 series are 4-Channel High Definition Audio Codecs with UAA (Universal Audio Architecture) featuring two 24-bit stereo DACs and three 20-bit stereo ADCs, they are designed for high performance multimedia desktop and laptop systems. The ALC262 series incorporates proprietary converter technology to achieve over 100dB Signal-to-Noise ratio playback quality; easily meeting PC2001 requirements and also bringing PC sound quality closer to consumer electronic devices.

### Operating system support

The Vortex86MX+-6453 PC/104 CPU board supports Embedded software: Free DOS, DOS 6.22, Windows CE 6.0, Windows XP Professional, Windows Embedded standard (XPE) and Windows 2000 (SP4).

Vortex86MX+-6453 also supports most of the popular Linux distributions, for more detail information, please visit DMP official website: <http://www.dmp.com.tw/tech/vortex86mx/>

## Appendix

### A. TFT Flat Panel Data Output

Vortex86 SX/DX Pin Name	TFT LCD 18 / 24 Bits	
1	VCC3 (3.3V)	VDD
2	VCC3 (3.3V)	VDD
3	LG2	G2
4	LG3	G3
5	LG4	G4
6	LG5	G5
7	NC	/
8	NC	/
9	LR0	R0
10	LR1	R1
11	LR2	R2
12	LR3	R3
13	LR4	R4
14	LR5	R5
15	GND	VSS
16	NC	/
17	NC	/
18	NC	/
19	NC	/
20	GND	VSS
21	NC	/
22	NC	/
23	LB0	B0
24	LB1	B1
25	LB2	B2
26	LB3	B3
27	LB4	B4
28	LB5	B5
29	NC	/
30	NC	/
31	LG0	G0
32	LG1	G1
33	GND	VSS
34	GND	VSS
35	NC	/
36	LCLK	XCLK
37	NC	/
38	LDE	DEN
39	NC	/
40	LHSYNC	HSYNC
41	NC	/
42	LVSYNC	VSYNC
43	LBACKL	/
44	LVDDEN	VDDEN





## D. Flat Panel Wiring and Lighting

### ■ Hardware

Before you connect the TFT LCD Flat Panel with Vortex86MX+-6453, please make sure that the input Voltage of LCD is +3.3V or Not

### ■ BIOS

Please contact or e-mail our regional sales to get the special BIOS for the any TFT LCD Flat Panels.

### ■ Wiring LCD Cable

Please refer to [Page 12, 13 \(J15: LCD & J16: LVDS connector\)](#) and [Page22~25](#). Or for more LCD lighting and integration service, please contact our regional sales or mail to [som@icop.com.tw](mailto:som@icop.com.tw), if you have any questions.

## E. TCP/IP library for DOS real mode

DSock is a TCP/IP library for DOS real mode, which is used by RSIP. It provides simple C functions for programmer to write Internet applications. ICOP also provide Internet examples using DSock: BOOTP/DHCP, FTP server, SMTP client/server, HTTP server, TELNET server, Talk client/server, etc.

DSock provides a lot of example source code. Programmer can add Internet functions to their project easily and save development time. With a utility "MakeROM", programmer also can make a ROM image to fit their application, those examples can be seen in the following Application systems: Mity-Mite Serial Server, Web Camera Tiny Server and RSIP Serial Server.

DSock is free for All ICOP products using M6117D/Vortex86/Vortex86SX/Vortex86DX/Vortex86MX+ CPU and ICOP also provide the business version of DSock for those customers who are using other x86 CPUs. If you would like to use DSock or business version of DSock, Please mail to [info@icop.com.tw](mailto:info@icop.com.tw) or contact your regional sales.

Please download the trial DSock software and Utilities from our website:  
<http://www.dmp.com.tw/tech/dmp-lib/dsock/>



## F. BIOS Default setting

If the system cannot be booted after BIOS changes are made, Please follow below procedures in order to restore the CMOS as default setting.

- Press “End” Key, when the power on



- Press <Del> to enter the AMI BIOS setup
- Press “F9” to Load Optimized Defaults
- Press “F10” to Save configuration changes and exit setup

## Warranty

This product is warranted to be in good working order for a period of one year from the date of purchase. Should this product fail to be in good working order at any time during this period, we will, at our option, replace or repair it at no additional charge except as set forth in the following terms. This warranty does not apply to products damaged by misuse, modifications, accident or disaster. Vendor assumes no liability for any damages, lost profits, lost savings or any other incidental or consequential damage resulting from the use, misuse of, originality to use this product. Vendor will not be liable for any claim made by any other related party. Return authorization must be obtained from the vendor before returned merchandise will be accepted. Authorization can be obtained by calling or faxing the vendor and requesting a Return Merchandise Authorization (RMA) number. Returned goods should always be accompanied by a clear problem description.