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Embedded Computer Systems

Video ClientX User's Manual
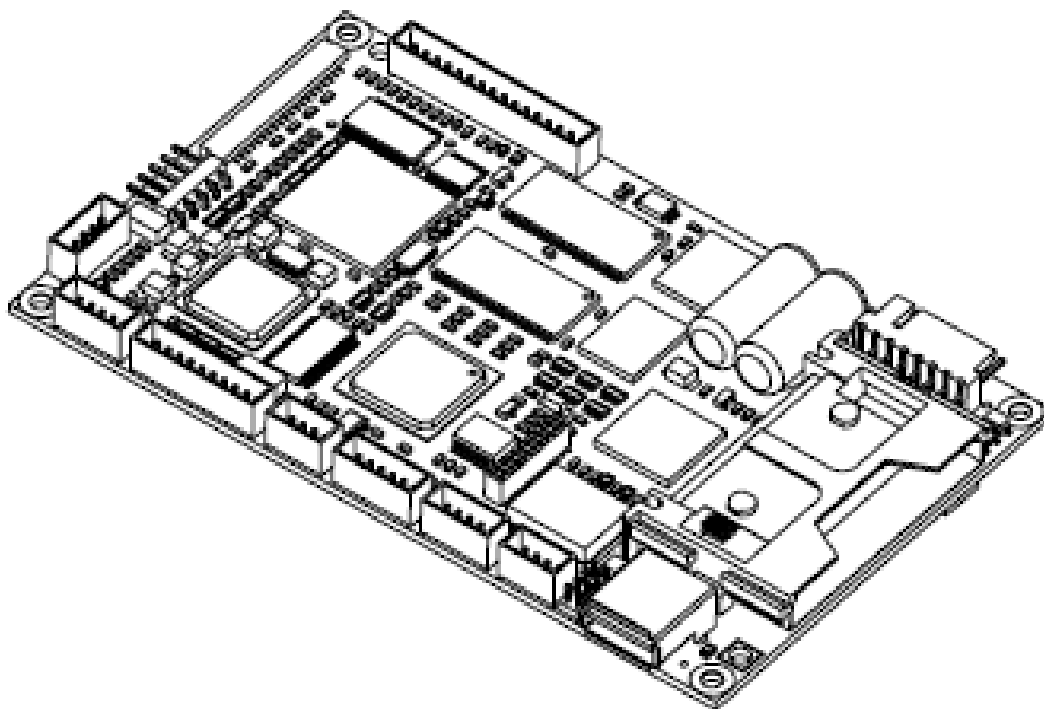
Applied Data Systems

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About the Cover Image

The cover image shows a fully populated revision 2 Video ClientX.

Printing this Manual

This manual has been designed for printing on both sides of a 8.5x11 inch paper, but can be printed single-sided as well. It has also been optimized for use in electronic form with active cross-reference links for quick access to information.

Revision History

The following list summarizes the changes that have been made between released revisions of the manual.

REV	DESCRIPTION	BY
1	Draft release	2/24/06 ak

Table of Contents

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1   Introduction

1.1   *Overview*

The Video ClientX is a full-featured single board computer using the PXA255 XScale RISC microprocessor. The Video ClientX is designed to meet the needs of embedded and graphical systems developers.

This manual applies to the most current revision of the Video ClientX listed in Chapter 7, the Revision History.

1.2   *Features*

The follow are the key features of the Video ClientX:

1.2.1   Processor

- PXA255 32-bit XScale
- Clock 400 MHz, typical
- Voltage and frequency scaling

1.2.2   Power Supply

- 5 V and 3.3 V for main power

1.2.3   Memory

- 16, 32, 64 or 128 MiB[1] synchronous DRAM
- 32 or 64 [2] MiB flash RAM
- CompactFlash[3] (CF), Type I and II, 3.3 and 5 V

1.2.4   Communications

- USB 1.1 Host port (low 1.5 Mbit/s and full 12 Mbit/s speeds)
- USB 1.1 Function port, full speed (e.g. to connect to PC)
- Serial Ports
    Serial 1: EIA/TIA-232 (5-wire)
    Serial 2: 3.3V logic (5-wire)
    Serial 3: EIA/TIA-232 (9-wire))
- 10/100BT Ethernet
- CompactFlash socket

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[1] MiB is the IEC abbreviation for mebibyte = 2^{20} byte = 1 048 576 byte. The kibi and mebi abbreviations are based on the 1998 IEC standard for binary multiples. For further reading, see the US NIST web site, http://physics.nist.gov/cuu/Units/binary.html

[2] The Video ClientX supports synchronous and asynchronous flash. The 64 MiB flash option is available only in synchronous flash.

[3] CompactFlash is a trademark of the CompactFlash Association, http://www.compactflash.org/.

1.2.5 User Interface and Display

- SM501 graphics accelerator
- SA7118 for four channels of analog video input
- ogic-level flat panel interface
- Four-wire analog-resistive touch panel interface (five-wire factory option)

1.2.6 Discrete I/O

- Two [tbd] general-purpose digital I/Os

1.2.7 Audio Interface

- Connector for off-board AC '97 codec

1.3   *Block Diagram [tbd]*

The following diagram illustrates the system organization of the Video ClientX. Arrows indicate direction of control and not necessarily signal flow.

[tbd]

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ADS document # 110117-10011, draft

2   Getting Started

2.1   Development Systems

Video ClientX boards are shipped as development systems designed to get the developer up and running quickly.

To use the system, simply plug power supply into the mini DIN-8 receptacle on the system.

If the screen does not display anything after five to ten seconds, check the *Frequently Asked Questions*, below. Most operating systems cold boot within twenty seconds.

2.1.1   System Components

A typical development system is shown at right (system at right illustrates a BitsyX development system). It consists of the following components:

- Video ClientX single-board computer
- Flat panel display and cable
- Backlight inverter and cable
- Touch screen and cable
- 120/240 VAC power adapter
- Plexiglas mounting
- Developer's Cable Kit including
    - Serial Port DB9 adapter (ADS cable #610111-80001)
    - DB9F/F null modem cable
- Operating system of your choice
- User's Guide (this document and operating system guide)

Please make sure you have received ***all*** the components before you begin your development.

2.2   Frequently Asked Questions

The following are some of the most commonly asked questions for development systems:

Q: When I plug in power, my screen is white and nothing comes up on it.

A: Check the connector seating. The flat panel connector may have come loose in shipping. Press it firmly into the panel and reapply power to your system.

Q: When I plug in power, the LED doesn't turn on.

A: Your system may still be booting. The LED is software controlled and is not necessarily turned on at boot.

Q: Do I have to turn off the system before I insert a CompactFlash card?

A: No. The Video ClientX supports hot-swapping of CompactFlash cards. Consult the operating system documentation for details.

Q: Do I need to observe any ESD precautions when working with the system?

A: Yes. Where possible, work on a grounded anti-static mat. At a minimum, touch an electrically grounded object before handling the board or touching any components on the board.

Q: What do I need to start developing my application for the system?

A: You will need a flash ATA card (16 MiB or larger, 32 MiB recommended) and the cables supplied with your system to interface your development station to the system. For further direction, consult the ADS guide for the installed operating system.

Q: Who can I call if I need help developing my application?

A: ADS provides technical support to get your development system running. For customers who establish a business relationship with ADS, we provide support to develop applications and drivers.

Q: Is there online support?

A: Yes. Information about the Video ClientX hardware and software is available on the ADS support site at http://www.applieddata.net/support. See section 2.4 for further details.

Q: Can I upgrade the version of the operating system?

A: Yes. ADS provides regular operating system updates on its developers' web site. For operating systems not maintained by ADS, contact the operating system vendor.

Q: I would like to interface to a different display panel. How can I do this?

A: ADS may have already interfaced to the panel you are interested in. Consult ADS for availability.

2.3 *Organization of this Manual*

The manual organizes information in five key sections:

Introduction	Provides an overview of the functionality and organization of the Video ClientX, as well as how to use this manual.
Hardware Reference	Describes the configuration settings and pinouts for all connectors and jumpers on the Video ClientX.
Feature Reference	Gives details about the various subsystems of the Video ClientX.
Power Management	Provides key information about power management, tips for system integration and electrical and mechanical interface specifications.
Specifications	Electrical and mechanical interface specifications.

To locate the information you need, try the following:

1. Browse the *Table of Contents.* Section titles include connector designators and their function.

2. Follow cross-references between sections.

3. View and search this manual in PDF format

2.4   *Errata, Addenda and Further Information*

Errata and addenda to this manual are posted on the ADS support forums along with the latest release of the manual. Consult the support forums any time you need further information or feel information in this manual is in error. You may access the forums from the ADS support site,

http://www.applieddata.net/support

In addition to manuals, the support forums include downloads, troubleshooting guides, operating system updates and answers to hundreds of questions about developing applications for ADS products. You may also post questions you have about ADS products on the forums.

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3 Hardware Reference

This section gives an overview of the hardware features of the Video ClientX. This overview includes a description of the switches, jumper settings, connectors and connector pinouts.

3.1 Identifying Connectors

The section describes how to locate connectors on the board and how to determine how each header is numbered.

3.1.1 Locating Connectors

The following diagram illustrates the location of key components on the Video ClientX. For example, the USB socket is located in square C5 and the CompactFlash socket spans A5 to C5. Component listings in this chapter refer to this diagram.

This diagram shows the Video ClientX with the all standard features installed (6.1.4).
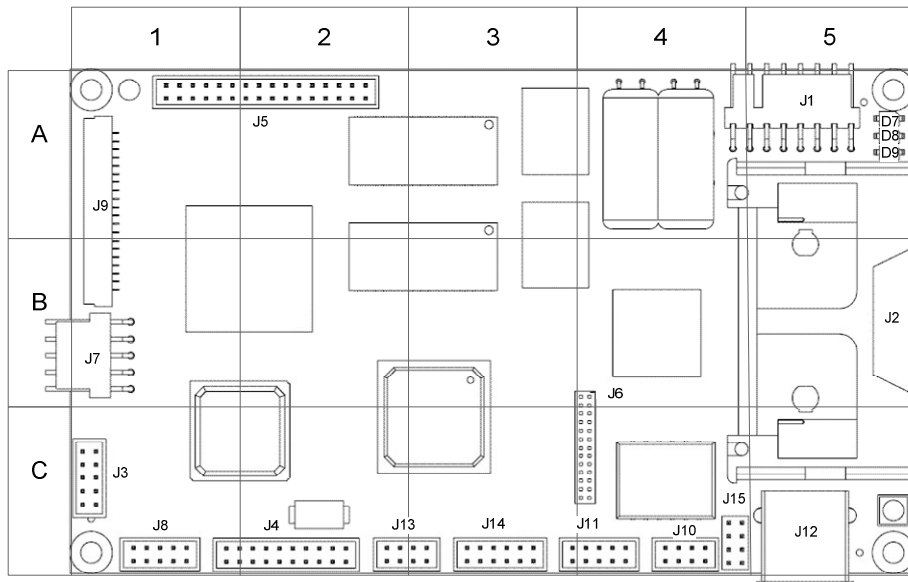
3.1.2 Determining Pin Numbers

The pins of headers and connectors on ADS products are numbered sequentially. Double-row headers place even pins on one side and odd pins on the other. The diagram at right indicates how pins are numbered, as seen from the component side[4] of the board.
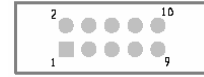
To locate pin 1 of a connector or jumper, try the following:

1. Look for a visible number or marking on the board that indicates connector pin numbering. A notch or dot usually indicates pin 1.

2. Look at the underside of the board. The square pad is pin 1.

3. Download the mechanical drawing of the Video ClientX from the ADS Support site (section 2.4). The square or indicated pad on each connector is pin 1.

3.2 Switches, Controls and Indicators

This section describes various switches, controls and indicators on the Video ClientX board. The location indicated for each item refers to the grid diagram of the Video ClientX in section 3.1.1.

3.2.1 LED Indicators

The Video ClientX has several onboard light-emitting diodes (LEDs) to indicate system operation. Some are software-controllable, while others indicate the status of specific functions.

Software-Controllable LEDs

Location on board: A5

Three LEDs are controlled by the CPU (section 4.1.5) and are used to indicate boot and operating system status. These LEDs can often be used by applications to indicate operational status.

Signal Name	Designator	Color
LEDOUT0	D9	Green
LEDOUT1	D8	Amber
LEDOUT2	D7	Red

The LEDs are driven by the same buffers as the display driver data lines, so will be off when the display buffers are disabled.

3.3 Jumper Settings

The Video ClientX controls options programmatically and with board stuffing options. The Video ClientX does not have any user-selectable jumpers.

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[4] The "component side" of the Video ClientX is the one on which the Compact Flash slot is installed. As a factory option, some through-hole connectors may be installed on the "bottom side" of the Video ClientX.

3.4 *Signal Headers*

The following tables describe the electrical signals available on the connectors of the Video ClientX. Each section provides relevant details about the connector including part numbers, mating connectors, signal descriptions and references to related chapters.

The location indicated for each item refers to the grid diagram of the Video ClientX in section 3.1.1 For details about how to determine pin numbers of a header, see section 3.1. For precision measurements of the location of the connectors on the Video ClientX, refer to section 6.1.1.

Legend:

n/c	Not connected
GND	Video ClientX ground plane
(0)	Reference section for signals

Signal Types

I	signal is an input to the system
O	signal is an output from the system
IO	signal may be input or output
P	power and ground
A	analog signal
OCI	open-collector/open-drain input
OC	open-collector/open-drain output

3.4.1 J1: Input Power Connector

Board Connector: 1x8 Molex #7478, 0.1 inch spacing

Location on board: A5

This header supplies power to the Video ClientX. +5V_IN and +3.3V_IN are the main power supply inputs. See section 5.2.1 for an overview of how the Video ClientX power supply is structured.

Pin	Name	Type	Description
1	*+5V_IN*	*PI*	*5V input power*
2	*GND_IN*	*P*	*ground*
3			
4	*+3.3V_IN*	*PI*	*3.3V input power*
5			
6	*POWERON*	*O*	*Output for power supply management*
7	*ON_OFF*	*OCI*	*System wakeup input (CPLD)*
8	*Vsupercap*	*PI*	*Input for external supercapacitors*

3.4.2 J2: CompactFlash Socket

Location on board: A5-C5

The CompactFlash socket can be used to connect memory and networking cards to the Video ClientX. The socket accepts Type I and Type II-sized CompactFlash cards.

3.4.3 J3: Analog Video Inputs

Board Connector: 2x5 2 mm, Hirose DF11-10DP-2DSA

Location on board: C1

The analog inputs can be configured to accep composite analog video, S-VHX (Y/C) or component (RGB analog video. This header supplies five of the analog input channels of the SAA7118.

Pin	Name	Pin	Type	Description
1	*GND*		*P*	
3	*GND*		*P*	
5	*GND*		*P*	*ground*
7	*GND*		*P*	
9	*GND*		*P*	
	AN_INPUT1	*2*	*AI*	
	AN_INPUT2	*4*	*AI*	
	AN_INPUT3	*6*	*AI*	*Analog Video inputs*
	AN_INPUT4	*8*	*AI*	
	AN_INPUT5	*10*	*AI*	

3.4.4 J4: Zoomed Video Port

Board Connector: 2x10 2 mm, Hirose DF11-20DP-2DSA

Location on board: C1-C2

This header accepts Zoomed Video data input using standard supported by the SM501. Data inputs 8-15 may be grounded for 8 bpp incoming data streams.

Pin	Name	Pin	Type	Description
1	*VPDATA0*		*I*	
3	*VPDATA1*		*I*	
5	*VPDATA2*		*I*	
7	*VPDATA3*		*I*	
9	*VPDATA4*		*I*	*Data 0-7*
11	*VPDATA5*		*I*	
13	*VPDATA6*		*I*	
15	*VPDATA7*		*I*	
	VPDATA8	*2*	*I*	
	VPDATA9	*4*	*I*	
	VPDATA10	*6*	*I*	
	VPDATA11	*8*	*I*	*Data 8-15*
	VPDATA12	*10*	*I*	*or*
	VPDATA13	*12*	*I*	*ground*
	VPDATA14	*14*	*I*	
	VPDATA15	*16*	*I*	
17	*VP_VSYNC*		*I*	*Vertical sync*
	VP_HSYNC	*18*	*I*	*Horizontal sync*
19	*GND*		*P*	*ground*
	VP_CLK	*20*	*I*	*clock*

3.4.5 J5: LCD Display

Board Connector: 2x16 header, 2 mm spacing, Hirose DF11-32DP-2DSA

Location on board: A1-A2

The following table describes the signals on the LCD interface connector. Signal names shown are for TFT active matrix color LCDs at 16 bpp (bit-per-pixel). For other color depths and LCD technologies, consult the table in section 4.5.3. Signals from the XScale are buffered and EMI filtered before reaching this header. See section 4.5 for further details about displays.

Pin	PXA255 Signal Name	Pin	Color Active TFT Display at 16bpp	
			ADS Signal Name	Description
1	L_PCLK		PNL_PIXCLK	Pixel Clock
		2	PNL_GND2	ground
3	L_FCLK		PNL_VSYNC	Vertical Sync.
	L_LCLK	4	PNL_HSYNC	Horizontal Sync.
		6	PNL_GND2	ground
5	L_DD15		PNL_RED0	Red data
	L_DD11	8	PNL_RED1	
7	L_DD12		PNL_RED2	
	L_DD13	10	PNL_RED3	
9	L_DD14		PNL_RED4	
	L_DD15	12	PNL_RED5	
11			PNL_GND1	ground
	L_DD5	14	PNL_GREEN0	Green data
13	L_DD6		PNL_GREEN1	
	L_DD7	16	PNL_GREEN2	
15	L_DD8		PNL_GREEN3	
	L_DD9	18	PNL_GREEN4	
17	L_DD10		PNL_GREEN5	
		20	PNL_GND2	ground
19	L_DD4		PNL_BLUE0	Blue data
	L_DD0	22	PNL_BLUE1	
21	L_DD1		PNL_BLUE2	
	L_DD2	24	PNL_BLUE3	
23	L_DD3		PNL_BLUE4	
	L_DD4	26	PNL_BLUE5	
25			PNL_GND1	ground
27			PNL_PWR	Panel power: 5 or 3.3 V
	L_BIAS	28	PNL_LBIAS	Data enable
29			PNL_RL	Horizontal Mode Select
		30	PNL_PWR	Panel power: 5 or 3.3 V
31			PNL_ENA	Panel Enable
		32	PNL_UD	Vertical Mode Select

3.4.6 J6: Serial 1, USB Function, Power and Factory Programming

Board Connector: 2x13 receptacle, 2 mm spacing

Location on board: B4-C4

This header provides some of the most common signals used to communicate with and control the Video ClientX.

The JTAG signals are intended only for factory use to program the boot flash and onboard logic and are not otherwise supported.

In the table below, pins are grouped by function.

Pin	Name	Type	Description
1	*TXD1*	*O*	
2	*RXD1*	*I*	*Serial 1 (EIA-232)*
3	*RTS1*	*O*	
4	*CTS1*	*I*	
5	*VCC*	*PO*	*5 V*
6	*VDDX*	*PO*	*3.3 V*
7	*/RqOnOff*	*OCI*	*Wakeup signal*
8	*/Reset_In*	*OCI*	*Reset input*
9	*TCLK*	*I*	
10	*TMS*	*I*	
11	*TDO*	*O*	*JTAG*
12	*TDI*	*I*	
13	*FL_STS*	*O*	
14	*CPLD_PEN*	*I*	*pull high for JTAG programming*
15	*USB_VCC*	*I*	
16	*USB_UDC+*	*IO*	*USB Function Port (4.2.3)*
17	*USB_UDC-*	*IO*	
18	*SW0*	*OCI*	*DIP switch inputs to CPLD*
19	*SW1*	*OCI*	
20	*GND*	*P*	*ground*
21	*TDI_7118*	*I*	*JTAG, SAA7118*
22	*TDO_7118*	*O*	
23	*GND*	*P*	
24	*GND*	*P*	*ground*
25	*GND*	*P*	
26	*GND*	*P*	

3.4.7 J7: Touch Panel

Board Connector: 1x4 or 1x5 header, 0.100 inch spacing, Molex 22-23-2051(5-pin)

Location on board: B1

Pin	Name	Type	Description		
			4-wire	*5-wire*	
1	*TSMX*	*AIO*	*left*	*LL*	
2	*TSPX*	*AIO*	*right*	*UL*	
3	*WIPER*	*AI*	*n/a*	*WIPER*	*Touch screen*
4	*TSMY*	*AIO*	*top*	*LR*	
5	*TSPY*	*AIO*	*bottom*	*UR*	

3.4.8   J8: RGB Output

Board Connector: 2x5 header, 2 mm spacing, Hirose DF11-10DP-2DSA

Location on board: C1

This header provides signals from the SM501 graphics controller to drive an RGB CRT display. These signals are typically wired to a DB-15 socket for connection to standard "VGA" displays.

Pin	Name	Pin	Type	Description
1	*VGA_RED*		*O*	
3	*VGA_GREEN*		*O*	
5	*VGA_BLUE*		*O*	*RGB Output Signals*
7	*VGA_HSYNC*		*O*	
9	*VGA_VSYNC*		*O*	
	GND	*2*	*P*	
	GND	*4*	*P*	
	GND	*6*	*P*	*ground*
	GND	*8*	*P*	
	GND	*10*	*P*	

3.4.9   J9: LCD Signals: LVDS

Board Connector: 20-pin header, 1.25 mm spacing, JAE FI-S20P-HF

Location on board: A1-B1

This header supplies the LCD signals in LVDS format. This header was designed to interface with the NEC NL10276BC20-04 LCD display.

The LCD signals on each differential pair are listed in the table below (data is clocked out MSB first but is listed LSB first below). Production stuffing options set the voltage that is presented on the scan direction and 18_24 signals. Additional details about LVDS are listed in section 4.5.3.

Pin	Name	Type	Description
1	*TXIN3-*	*O*	*LVDS Data 3 [tbd]*
2	*TXIN3+*	*O*	
3	*SCAN_DIR*	*O*	*Selects scan direction*
4	*18_24*	*O*	*Selects 18 or 24 bpp mode*
5	*GND*	*P*	*ground*
6	*CKOUT+*	*O*	*LVDS Clock (PCLK)*
7	*CKOUT-*	*O*	
8	*GND*	*P*	*ground*
9	*TXIN2+*	*O*	*LVDS Data 2*
10	*TXIN2-*	*O*	*(B1, B2, B3, B4, HSYNC, VSYNC, DE)*
11	*GND*	*P*	*ground*
12	*TXIN1+*	*O*	*LVDS Data 1*
13	*TXIN1-*	*O*	*(G1, G2, G3, G4, G5 B4, B0)*
14	*GND*	*P*	*ground*
15	*TXIN0+*	*O*	*LVDS Data 0*
16	*TXIN0-*	*O*	*(R4, R0, R1, R2, R3, R4,G0)*
17	*GND*	*P*	*ground*
18			
19	*PNL_PWR*	*PO*	*Display power*
20			

3.4.10 J10: Ethernet

Board Connector: 2x4 header, 2 mm spacing, Hirose DF11-8DP-2DSA

Location on board: C4

This header provides the signals for connecting to Ethernet magnetics and an RJ-45 socket. See section 4.2.4 for interface details.

Pin	Name	Pin	Type	Description
1	ETH_TX+		O	Transmit
3	ETH_TX-		O	
5	ETH_RX+		I	Receive
7	ETH_RX-		I	
	ETH_LED1A	2	O	LED1 anode (+)
	ETH_LED1K	4	I	LED1 cathode (-)
	ETH_LED2A	6	O	LED2 anode (+)
	ETH_LEDK	8	I	LED2 cathode (-)

3.4.11 J11: Serial 3

Board Connector: 2x5 header, 2 mm spacing, Hirose DF11-10DP-2DSA

Location on board: C3-C4

Pin	Name	Type	Description
1	DCD3	I	Data Carrier Detect
2	DSR3	I	Data Set Ready
3	RXD3	I	Receive data
4	RTS3	O	Ready To Send (or RTR Ready to Receive)
5	TXD3	O	Transmit data
6	CTS3	I	Clear To Send
7	DTR3	O	Data Terminal Ready
8	RIB3	I	Ring Indicator
9	GND_COM3	P	Serial 3 ground
10	n/c	-	

3.4.12 J12: USB Host Port

Board connector: USB Type A, Amp 787616-1

Location on board: C5

Connector J1 provides the signals for USB host connectivity. USB mice, keyboards and other USB function devices may be plugged in.

Pin	Name	Type	Description
1	USB_M_VCC	PO	Power output
2	USB_M_UDC-	IO	USB host +
3	USB_M_UDC+	IO	USB host -
4	GND	P	ground

3.4.13   J13: Digital LCD Expansion

Board Connector: 2x4 header, 2 mm spacing, Hirose DF11-8DP-2DSA

Location on board: C2-C3

The VPDATA pins can be used to support 24 bpp LCD displays.

Pin	Name	Type		Description
1	*VPDATA8*	*O*	*19*	
2	*VPDATA9*	*O*	*20*	
3	*VPDATA10*	*O*	*21*	*SM501 Digital LCD Outputs*
4	*VPDATA11*	*O*	*22*	
5	*VPDATA12*	*O*	*23*	
6	*VPDATA13*	*O*	*24*	
7	*GND*	*P*		*ground*
8	*GND*	*P*		

3.4.14   J14: I^{2}C, PWMs, GPIOs

Board Connector: 2x6 header, 2 mm spacing, Hirose DF11-12DP-2DSA

Location on board: C3

This header supplies signals from the PXA255, SM501 and CPLD.

Pin	Name	Type	Description
1	*PWM0*	*O*	*PXA255 PWM output 0*
2	*PWM1*	*O*	*PXA255 PWM output 1*
3	*TXD2*	*O*	*Serial 2 (logic-level)*
4	*RXD2*	*I*	*or digital I/O*
5	*GND*	*P*	*ground*
6	*GND*	*P*	
7	*I2C_SDA*	*IO*	*PXA 255 I^{2}C bus*
8	*I2C_SCL*	*IO*	
9	*GC_SCL*	*IO*	*SM501 I^{2}C bus*
10	*GC_SDA*	*IO*	
11	*CPLD_GPI00*	*IO*	*CPLD Digital IO 0*
12	*CPLD_GPI01*	*IO*	*CPLD Digital IO 1*

3.4.15   J15: I^{2}S for External Codec

Board Connector: 2x4 unshrouded header, 2 mm spacing

Location on board: C4

The I^{2}S signals can be used to connect to an off-board audio codec.

Pin	Name	Type	Description
1	*VCC*	*PO*	*5 V*
2	*VDDX*	*PO*	*3.3 V*
3	*I2S_BITCLK*	*O*	
4	*/I2S_RESET*	*O*	
5	*I2S_SD_IN*	*I*	*I^{2}S*
6	*I2S_SD_SYNC*	*O*	
7	*I2S_SD_OUT*	*O*	
8	*GND*	*P*	*ground*

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4   Feature Reference

This chapter provides details about the architecture and many features of the Video ClientX, and how they can fit together to create a system that meets your application needs.

4.1   *System Architecture*

4.1.1   Boot Code

The Video ClientX uses the first block of onboard flash to store the boot code. At the factory, boot code is loaded using the JTAG interface. Most ADS Video ClientX boot loaders are field-upgradeable using a flash card on the CompactFlash port.

4.1.2   Synchronous DRAM

One bank of synchronous DRAM (SDRAM) can be populated for a system total of 16, 32, 64 or 128 MiB of RAM. The data bus width is 32 bit.

The memory clock speed is one half the CPU core clock speed. Typical memory bus operation is at 99.5 MHz.

The self-refreshed RAM consumes most of the system sleep current. Sleep current increases in direct proportion to the amount of RAM installed.

4.1.3   Non-Volatile Memory

There are several ways to store data on the Video ClientX that will survive a power failure. Some devices can only be accessed through operating system drivers, and not all are available for application data storage.

Flash Memory

Flash memory is the primary site for non-volatile data storage. The Video ClientX includes a bank of flash memory for non-volatile data storage. The board supports 8, 16 or 32 MiB of installed flash. The data bus width is 32 bit.

ADS systems store the operating system, applications and system configuration settings in the onboard flash. Most operating systems configure a portion of the flash as a flash disk, which acts like a hard disk drive.

CompactFlash Cards

CF cards provide removable storage in a wide variety of capacities. These cards can be cost-effective means to expand system storage capacity for applications that provide access to the CF slot.

4.1.4 Interrupts [tbd]

The Video ClientX includes several sources for external interrupts. The following table summarizes the external interrupt sources and the devices to which they are connected.

[tbd]

Your operating system may not include drivers for all interrupt sources.

4.1.5 PXA255 GPIO Cross-Reference

The following table describes how the Video ClientX utilizes the XScale GPIO lines (*GPn*). They are offered for reference purposes only. Most operating systems make this information transparent to developers.

[tbd]

---

[5] Important! The PXA255 has restrictive constraints concerning timing of successive interrupts. While you may configure one or more XScale GPIOs as interrupt sources, it's possible to create a condition under which interrupts in rapid succession can cause the processor to lock up.

4.2 Data Communications

The Video ClientX has several built-in channels for communication with peripheral and peer devices. These include EIA/TIA-232, -logic-level serial; USB host and function USB ports and I^2C.

4.2.1 Serial Ports

The Video ClientX has seven serial ports: three from the XScale processor and four from a quad UART. The serial ports can be configured as follows:

Port	# signals	Headers	Standard
1	5	J6	EIA/TIA-232
2	3	J14	3.3 V logic
3	9	J11	EIA/TIA-232

XScale UART

The XScale processor supplies three standard serial ports. The "Bluetooth UART" is Serial 1 on the Video ClientX; the "IrDA UART" is Video ClientX Serial 2; and the "Full-featured" UART" is Video ClientX Serial 3.

Ports that are configured for 3.3 V logic operation connect directly to the XScale and should be treated electrically as GPIOs. See section 6.2.11 for GPIO electrical specifications and 6.2.7 for serial port specifications.

4.2.2 SSP/SPI Port

The Video ClientX has a number of internal SSP/SPI buses. The following table describes how the buses are used on standard production Video ClientX systems:

SSP Bus	Use on Video ClientX
PXA255 SSP	Touch panel controller
PXA255 NSSP	not used
SM501 SSP0	not used

4.2.3 USB

The Video ClientX includes signals for USB 1.1 Host and Function ports. The USB Host (downstream) signals are controlled by the SM501; the USB Function signals are on header are connected to the PXA255.

To create a USB connection, you must wire a standard USB socket as described in the following sections. For each type of connector, pin numbering is as follows:

Pin	USB signal
1	USB_PWR
2	USB -
3	USB +
4	GND

USB Host Port

The Video ClientX USB Host port allows you to connect one USB device to the Video ClientX. USB mouse and keyboard are the most common client devices, but you can connect any USB function device that has USB drivers installed on the Video ClientX.

The Video ClientX includes Type A USB connector J12 for the host signals. The mating face of such a socket is shown at left. To connect more than one USB client device to the Video ClientX, use a USB hub.

The USB protocol allows client devices to negotiate the power they need from 100 mA to 500 mA in 100 mA increments. The Video ClientX supplies 5 V power through the USB_PWR pin. Make sure to account for power used through USB in your Video ClientX power budget (section 5.3.1). Electrical specifications are in section 6.2.8.

USB Function Port

The Video ClientX includes a USB Function (or "Client") port. This interface allows the Video ClientX to appear as a client device to USB Host devices such as desktop and laptop computers.

The USB Function signals are available on connector J6. Connect these signals to a USB client Type B socket (mating face shown at left). The USB standard also permits directly wiring the USB signals to the host or to a host connector (e.g. like a USB mouse).

The Video ClientX supports the full USB connection speed (12 Mbit/s). It indicates this to the host device with a 1.5 kΩ pull-up on the USB+ signal.

USB_VCC is power supplied from the host computer. Since the Video ClientX is self-powered (not powered by the USB host), USB_VCC is not needed as a power input. However, USB_VCC tells the Video ClientX when a USB cable is connected, so include it when connecting the USB signals to the Video ClientX.

The Video ClientX includes the capability to simulate a Function port cable disconnection. This feature can be used to force the host to re-enumerate the Video ClientX (e.g. after wakeup).

4.2.4   Ethernet

The Video ClientX includes a 10/100 BT Ethernet controller with signals on header J10 for connection to an off-board socket.

Ethernet details and electrical specifications are listed in section 6.2.10.

4.2.5   I²C Bus Master

I²C (Inter-IC) Bus is a multi-master, "two-wire" synchronous serial bus developed by Philips for communications between integrated circuits (ICs). The bus master addresses devices using the data line and provides a synchronous clock for reading and writing devices. Client devices respond only when queried by the master device. Philips has developed many I²C devices, but other organizations (e.g. Maxim) have adopted I²C as a convenient means for addressing peripherals in a system.

I²C on the Video ClientX

Applications can use the XScale I²C bus to to communicate with external peripherals.

The following diagram illustrates the I²C architecture on Video ClientX. Parts are shown populated as they are found on standard production systems.
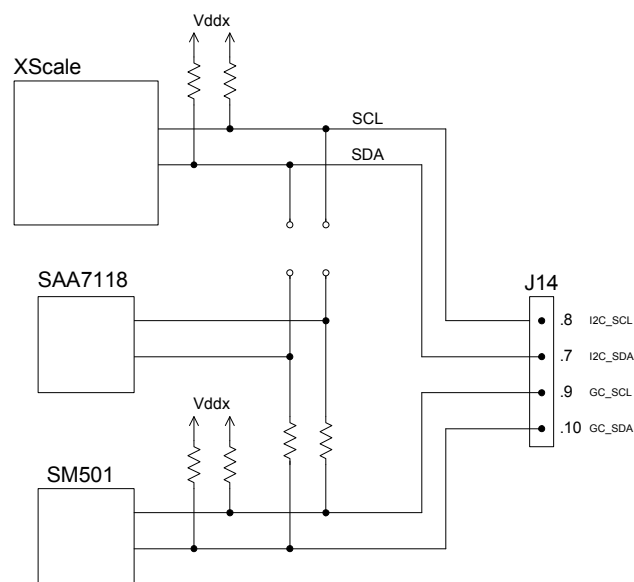
XScale I²C

The XScale typically controls all I²C peripherals on the Video ClientX. Its I²C signals are routed to header J8 via low-impedance resistors. Specifications are listed in section 6.2.14.

SM501 I²C

As a factory option for volume production, the SM501 I²C controller could be used to control off-board peripherals. Contact ADS Sales if your application requires this feature.

I²C Device Addresses

The following are the bus addresses of the I²C devices included on standard Video ClientX systems:

> 0x40   SAA7118

Select I²C devices with addresses that will not conflict with the onboard devices. Onboard devices are typically controlled by operating system drivers and should not be addressed directly.

4.3 *Discrete IOs*

This section summarizes the discrete signals on the Video ClientX that can be used for measurement or control.

4.3.1 Digital IOs [tbd]

4.3.2 Analog Inputs

The Video ClientX does not support any standard analog inputs. A/D devices may be added with external I2C devices.

4.3.3 Analog Outputs (PWM)

The Video ClientX has two PWM outputs. These can be used to control LCD backlighting levels and other pseudo-analog inputs (section 4.5.3).

4.4 *Touch Panel*

The Video ClientX supports four and five-wire analog resistive touch panels. Five-wire panels are a factory option. Connect the touch panel to the inputs on connector J7. The touch panel controller can wake the system from sleep (section 5.2.3) Electrical details are listed in section 6.2.5.

4.5 *Display Controller*

Standard production Video ClientX systems use the Silicon Motion SM501 graphics accelerator, but the Video ClientX can be factory configured to use the XScale display controller. This section describes both controllers and the Video ClientX subsystems they use in common.

4.5.1 The XScale Display Controller

The XScale controller uses system memory for the display frame buffer. It can drive VGA (640x480) and SVGA (800x600) displays easily. Larger displays will work with the XScale, with some constraints imposed by the controller architecture. The ADS Support Forums provide details about the design tradeoffs that are required to support larger displays.[6]

Key features of the XScale controller include

- Frame buffer is in system DRAM
- Dual 16 x 8-byte display data FIFOs

See section 6.1.4 for additional implications of depopulating the SM501 display controller.

4.5.2 The SM501 Display Controller

The Silicon Motion SM501 graphics accelerator has its own internal frame buffer, which reduces the load on the system bus for displays with larger dimensions and higher refresh rates. The controller also features graphics acceleration and support for a variety of display types.

Features of the controller include:

- Internal frame buffer RAM
- 2D display engine (accelerator)
- Digital LCD or analog VGA outputs
- Hardware display rotation)
- Dual and Virtual display support
- Hardware cursor (mouse)
- USB Host
- General-purpose digital I/Os

Additional factory options include:

- TV input (NTSC/PAL, Composite/S-Video) using external Zoomed Video Port converter

Standard production systems make use of the basic features of the display controller. Contact ADS Sales if your application requires use of the advanced or factory option features of this controller. Electrical specifications for the controller are listed in section 6.2.8.

4.5.4 Using Analog Displays

The Video ClientX SM501 display controller supports VGA output with the signals on header J8.

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[6] At the time of writing, posted at http://www.applieddata.net/forums/topic.asp?topic_id=580

[7] Intel. PXA255 Processor: Developer's Manual. Order number 278693-001, March 2003. pp. 7-20 to 7-22.

[8] Double pixel data (DPD) mode = 1

4.5.5 Developing Display Drivers

ADS provides display timings for supported displays on request. For displays not yet supported, ADS has a panel configuration service to creates panel timings and cable drawings. Contact ADS Sales for further details.

4.6 *EMI/RFI and ESD Protection*

The Video ClientX board incorporates a number of standard features that protect it from electrostatic discharge (ESD) and suppress electromagnetic and radio-frequency interference (EMI/RFI). Transient voltage suppressors, EMI fences, filters on I/O lines and termination of high-frequency signals are included standard on all systems. For details, see electrical specifications for subsystems of interest.

4.6.1 Agency Certifications

Many products using ADS single-board computers have successfully completed FCC and CE emissions testing as a part of their design cycle. Because ADS supplies only the single-board computer and not fully integrated systems, ADS cannot provide meaningful system-level emissions test results.

The crystal frequencies (section 6.2.12) and electrical specifications listed in Chapter 6 may provide helpful information for agency certifications.

4.6.2 Protecting the Power Supply Inputs

It is the responsibility of the designer or integrator to provide surge protection on the input power lines. This is especially important if the power supply wires will be subject to EMI/RFI or ESD.

5   Power and Power Management

Power management is especially critical in portable and handheld applications where battery power is at a premium. The Video ClientX includes advanced power management features, including the low power XScale CPU and partitioned power distribution. The Video ClientX can also operate as a conventional single-board computer, taking advantage of the inherently low power consumption of the system.

This chapter describes the architecture of the Video ClientX power supply, factors affecting power consumption and reference designs to get you started. For information about how much power the Video ClientX consumes, consult the electrical specifications in section 6.2.3.

5.1   Power Management Modes

Most handheld and portable systems available today never really turn "off." They make use of power management algorithms that cycle the electronics into "standby" and "sleep" modes, but never fully remove power from the full system.

This section describes the various power management modes of the XScale processor and how the Video ClientX makes use of them.

5.1.1   XScale Power Management Modes

The XScale PXA255 processor supports four operational modes: Turbo, Run, Idle, and Sleep.

- Sleep mode uses the least amount of electrical power. The processor core is powered off and only a few processor peripherals (I/Os and interrupt control) remain active. The transition back to Run mode may take a few hundred milliseconds, as clocks must stabilize and hardware that was powered off must be reinitialized.

- Idle mode reduces power consumption by pausing the processor core clock. Processor peripherals remain enabled. This mode is used for brief periods of inactivity and offers a quick transition back to Run mode.

- Run mode is the typical mode used when applications are running. It offers the best MIPS/mW (performance vs. power) performance when running applications from RAM.

- Turbo mode runs the processor core at up to three times the Run mode speed. Since external memory fetches are still performed at the memory bus frequency, Turbo mode is best used when running the application entirely from cache.

5.1.2   Power Management on the Video ClientX

The Video ClientX can actively be configured to be in XScale Run, Turbo or Sleep modes. Idle mode is controlled by the operating system or application and is typically transparent to the application.

In Turbo, Run and Idle modes, the power supplies are in their standard, full-power state and applications run normally on the system. Specific subsystems may be selectively disabled to conserve power during these states. The operating system is responsible for adjusting the core voltage (Vddi) for optimal power consumption in each mode.

In Sleep mode, sometimes called "Suspend" mode, the processor puts the SDRAM in a low-power, self-refresh mode, the processor core shuts off, most peripheral sub-systems are shut down and the power supplies drop into low-power states or turn off entirely. In this state, the Video ClientX consumes very little power, most of which is dedicated to the maintenance of the RAM (see section 6.2.3 for specifications). The system can be "awakened" and returned to the Run state by initiating a system wakeup using one of the methods described in section 5.2.2.

5.1.3 Video ClientX Rapid Load Shedding

The standard Video ClientX includes a feature that significantly reduces power consumption when it detects a power failure condition. This feature turns off the display controller, reducing power consumption to increase the time the supercaps can supply power to the system.

5.2 Architectural Overview and Power Management Features

This section provides an overview of the architecture of the Video ClientX power supply and a description of the various features of the Video ClientX power management systems.

5.2.1 Power Supply Architecture

The Video ClientX power supply is organized as shown in the following diagram.

[diagram tbd]

Specifications for the Video ClientX power supply are listed in section 6.2.2.System Sleep

This section describes several methods for putting the system into Sleep mode. Section 5.2.3 describes how to return the system to its operating state.

RQOnOff Input

Operating systems and applications can configure the /RQONOFF signal to put the system to sleep. In conjunction with the wakeup function (section 5.2.3, below), the RQONOFF input can be used as an "on/off" button for some systems. Electrical specifications are listed in section 6.2.1.

Software Control

Applications can put the system to sleep programmatically. Operating systems may also put the system to sleep if the system has not been used for a certain amount of time or for other reasons. In remote, battery-powered applications, software Sleep can be used in conjunction with the Timed Wakeup feature (section 5.2.3) for minimum power consumption.

5.2.3 System Wakeup

This section describes several mechanisms for waking an Video ClientX system that has been placed in Sleep mode (section 5.2.2). The system will resume operation in Run mode unless the power supply voltage is lower than Vsleep (section 6.2.1). If the input voltage is too low, the system will not wake under any circumstances. This protects the RAM from getting corrupted by an undervoltage condition.

RQOnOff Input

Shorting the /RQONOFF signal (section 5.2.2 above) to ground will wake the system. The signal is connected to the system controller. Electrical specifications are listed in section 6.2.6.

Timed Wakeup

The XScale can wake up at a predetermined time. This feature is controlled by software.

5.2.5 Power Supply Efficiency

The Video ClientX power supply achieves high efficiency through several means. First, it utilizes high-efficiency switching regulators. These regulators use conventional step-down switchers under operating load conditions, but are configured by the system for linear and "burst" mode[9]

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[9] "Burst mode" in this context is a registered trademark of Linear Technology Corporation

operation during low-load conditions that occur during system sleep. Additionally, there is only one level of cascaded regulation, reducing the losses that multiply through each stage.

5.3   *Designing for Optimal Power Management*

Designing a system for optimal power management requires careful attention to many details. This section provides some guidelines and tips for best power management.

5.3.1   Create a Power Budget for Peripherals

Embedded system designers using the Video ClientX should have a clear understanding of how power usage will be allocated in the system they design. Designers should create a power budget that takes into account the types of devices that are expected to be used with the Video ClientX.

The following lists detail some of the typical external loads that can be placed the Video ClientX power supplies. Baseline power consumption of the Video ClientX is listed in section 6.2.3.

3.3 V Loads

Typical external loads on the 3.3 V power supply include the following:

- Display
- Personality Board
- CompactFlash cards

5 V Loads

5 V loads come from both onboard and external devices. Typical loads include the following:

External:
- Display
- USB devices

Onboard:
- Processor core power supply (Vddi)
  Multiply by 115% to account for power supply efficiency

Loads on Main Supply

Assume 85% efficiency for external loads that cascade through the 5 V supply. Consider these loads when creating your power budget.

5.3.2 Power Loads During Sleep

When designing systems for minimal power consumption during Sleep mode, make sure to consider DC losses to external connections. The following are a few of the ways your system may "leak" when asleep:

- CompactFlash cards
  Cards in place when the system is asleep can drain power through the Card Detect and Voltage Sense lines. Assume that all four lines ground the Video ClientX CF pull-ups (section 6.2.13) while the card is inserted.

- Digital I/Os
  Review digital I/O connections for potential voltage differences from external connections when the Video ClientX is asleep.

- USB
  Depending on how USB devices are powered and how the operating system handles USB, USB devices may draw power during Sleep.

6   System Specifications

6.1   *Mechanical Specifications*

The Video ClientX is 3.0 inches by 5.0 inches in size. This section describes the component dimensions and mounting of the board. Detailed drawings are available on the support forums (section 2.4), and 3D models are available from ADS in electronic format for production customers.

6.1.1   Mechanical Drawing

The following mechanical drawing specifies the dimensions of the Video ClientX, as well as locations of key components on the board. All dimensions are in inches. This image is an excerpt from the full mechanical drawings, ADS document number 630117-10002.
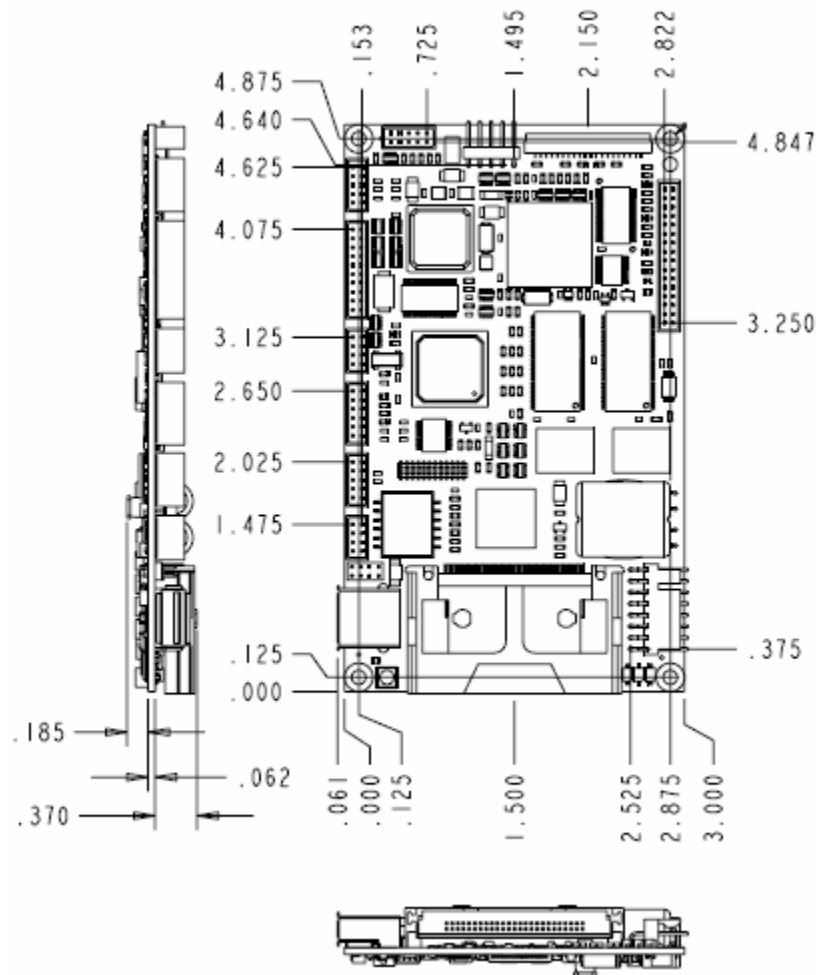
6.1.2   Mounting Holes

Four holes are provided, one on each corner, for mounting. The diameter of the holes is 0.125-in for use with #4 screws. Mounting holes are plated through and connected to the Video ClientX ground plane through EMI-filtering inductors.

For reliable ground connections, use locking washers (star or split) when securing a Video ClientX in an enclosure. Make sure that washers do not extend beyond the limits of the pads provided.

6.1.3   Clearances

The Video ClientX has a low profile. It can fit in an enclosure with inside dimensions as thin as 0.717 inch (18.2 mm). Key clearances are as follows:

- Highest component: 0.370 inch (9.4 mm), top
  0.185 inch (4.7 mm), bottom
- Board thickness: 0.062 inch (1.57 mm)
- Clearance over top and bottom: 0.05 inch (1.3 mm), each

Note: Selection of connectors and wiring harnesses will determine height of final assembly.

6.1.4   Production Options

The Video ClientX has a number of production options detailed throughout this manual. This section describes options that most significantly affect the mechanical design of the board. These options are generally available only for volume production orders.

Display Settings

The primary factory option for the Video ClientX is display settings. Signal levels for PNL_RL, PNL_UD, 18_24 and others are set with factory installed shunts on the board.

6.2 *Electrical Specifications*

This section provides electrical specifications for the Video ClientX.

6.2.1 Reset, Sleep, Wakeup, Temperature

Absolute Maximum Ratings

Reset Input (RESET_IN)............................ 3.6 V (note 1)

Symbol	Parameter	Min	Typ.	Max	Units
Temperature					
Trun	operating temperature	-40		+85	°C

Notes:

1. The reset controller can support operating voltages up to 10 VDC. However, such high voltages on Vddx through the pull-up resistor may damage the system.
2. Short /Reset_In to GND to reset system

6.2.2   Power Supply

The Video ClientX is powered from external 5 V and 3.3 VDC supplies and generates additional voltages for onboard logic. The 5 V and 3.3 V supplies are available on the Video ClientX output connectors and are limited to the current draws specified below. [TBD]

6.2.3   Power Consumption

The following table lists power consumption for the Video ClientX with varying activity levels.

Power consumption varies based on peripheral connections, components populated on the system and the LCD panel connected. Input voltage, temperature and the level of processor activity affect power consumption to a lesser extent.

LCD displays and backlights add significantly to the total power consumption of a system. ADS development systems include the Sharp LQ64D343 5V TFT VGA display, which draws about one watt, and the Xentek LS520 backlight inverter, which draws about six watts at full intensity.

Symbol	Parameter	Min	Typ.	Max	Units
P sleep	Sleep mode power				mW
P idle	Idle mode power (note 8)		[TBD]		W
P run	Run mode power (note 9)			3	W

Notes: Power consumption was measured on a fully populated 64 MiB Video ClientX with no peripheral connections under the following conditions:

8.   System running only the Windows CE desktop (predominantly in Idle mode; <5% CPU utilization)

9.   Full (95-100%) processor utilization in Run mode achieved by using Ethernet heavily and running multiple instances of a graphical application under Windows CE.

6.2.4   Display

LCD display panels have a wide range of voltage and data requirements. See section 4.5 for further details.

Standard production Video ClientXs use the SM501 graphics accelerator. See section 6.2.8 for SM501 specifications.

Symbol	Parameter	Min	Typ.	Max	Units
LCD (4.5.3)					
V pnl	LCD voltage (note 10)	3.3		5.0	V
P pnl_pwr	LCD power (note 11)			2	W
V pnl_data	LCD data voltage (note 12)	3.3	3.3	5.0	V

Notes:

10. The display voltage is selected programmatically.

11. Total power available depends on system power budget.

6.2.5 Touch Panel Controller

The Video ClientX uses touch panel controllers from Burr Brown. It uses the ADS7846 to support four-wire analog-resistive touch panels and the ADS7845 to support five-wire panels. The system is factory-configured for use with four-wire panels. All touch-panel signals are ESD and RF protected. The touch panel controller is powered during sleep mode and can generate an interrupt to wake the system.

Symbol	Parameter	Min	Typ.	Max	Units
Vdd	Supply voltage		Vddx		V
	A/D sample resolution		12		bit

6.2.6 System Controller

A Xilinx XCR3256XL CPLD on the Video ClientX provides system logic for chip selects, power management, interrupt decoding, clock generation, CompactFlash logic and other system control functions. It is programmed at the factory using the JTAG interface (3.4.6).

Absolute Maximum Ratings

Input voltage, digital I/O pins................. -0.5 to 5.5 V [tbd]

Output current, continuous,
digital I/O pins .... -100 to 100 mA [tbd]

Symbol	Parameter	Min	Typ.	Max	Units
Vdd	Supply voltage		3.3		V
Digital Outputs					
Vol	[tbd]	0		0.4	V
Voh		2.4			V
Digital Inputs					
Vil	[tbd]	0		0.8	V
Vih		2.0		3.5	V

6.2.7 Serial Ports

The Video ClientX supports several serial ports as described in section 4.2.1.

Serial ports 1 through 3 are controlled by the XScale processor. Serial ports A through D are controlled by an Exar ST16C554 or compatible quad UART.

EIA-232 signals are generated using charge pump devices (e.g. Sipex SP3232 and SP3243).

Symbol	Parameter	Min	Typ.	Max	Units
	Logic voltage, serial ports		3.3		V

6.2.8 Silicon Motion SM501

The Silicon Motion SM501 is a graphics controller that includes support for USB Host functions.

Symbol	Parameter	Min	Typ.	Max	Units
Digital I/Os (J8, 3.4.13; 4.3.1; note 17)					
Voh	High-level output voltage				V
Vol	Low-level output voltage		[tbd]		V
I gc_io	Sink/Source current				mA

Notes:

17. These digital I/Os are available only if the SM501 display controller is installed.

6.2.9　USB

The Video ClientX supports USB operation as described in section 4.2.3. See section 6.2.11 (PXA255) for USB function port specifications and section 6.2.8 (SM501) for USB host specifications.

6.2.10　Ethernet

The Video ClientX uses an SMSC LAN91C111 10/100 BT Ethernet controller with Pulse H1112 magnetics. The MAC (Media Access Control) address is stored in a serial EPROM connected to the controller.

6.2.11   PXA255 Processor

The XScale PXA255 core can change system voltage Vddi (6.2.2) dynamically to achieve lower power consumption at high clock rates. It uses voltage Vddx to power its interface I/Os. The EIOn digital I/Os include series resistance and ESD protection.

Serial ports configured for 3.3 V logic operation run directly to the processor (section 4.2.1). These lines should be treated as digital I/Os and protected for over-current and over-voltage accordingly.

Absolute Maximum Ratings

Input voltage, digital I/O pins....................................3.6 V

Symbol	Parameter	Min	Typ.	Max	Units
Digital Outputs					
Vol			0		V_{ddx}
Voh			1.0		V_{ddx}
Io		-2		2	mA
Digital Inputs					
Vil				0.2	V_{ddx}
Vih		0.8			V_{ddx}

6.2.12   Crystal Frequencies

Agencies certifying the Video ClientX for compliance for radio-frequency emissions typically need to know the frequencies of onboard oscillators. The following table lists the frequencies of all crystals on the Video ClientX.

Crystal	Device	Typ.	Units
X1	XScale core	3.6864	MHz
X2	XScale RTC	32.768	kHz
X3	SA7118	24.576	MHz
X4	SM501 display controller	24.000	MHz
X5	Ethernet	25.000	MHz

6.2.13 CompactFlash Controller

Video ClientX CompactFlash control logic is managed by a Xilinx XCR3032XL CPLD with firmware developed by ADS. The signals run through buffers before going to the CompactFlash socket.

Absolute Maximum Ratings

Input voltage, port I/O pins.......................................6.5 V

Symbol	Parameter	Min	Typ.	Max	Units
V_{ddx}	CF buffer power		3.3		V
$V_{ccCardA,B}$	CF supply voltage (note 18)	3.3	5.0	5.0	V
I 3.3V	3.3 V socket power			2	W
I 5V	5 V socket power			2	W
Rp	Card detect (1 & 2) and voltage sense (VS1 & 2) pull-ups (note 19)		100		kΩ
	Card detect and voltage sense pull-up voltage		3.3		V
Digital Outputs					
Vol				0.2	V
Voh		3.1			V
Digital Inputs					
Vil	Vddx=3.3 V			0.8	V
Vih	Vddx=3.3 V	2.0		5.5	V

Notes:

18. The CompactFlash port supply voltage is selected programmatically.
19. Each card inserted in a CompactFlash slot can drain up to 0.4 mW when the system is in Sleep mode ($4 * (Vddx^2/Rp)$).

6.2.14 I²C Bus Master

The I²C buses on the Video ClientX are driven by the PXA255 and the SM501 and are configured as described in section 4.2.5.

Symbol	Parameter	Min	Typ.	Max	Units
Rbus	pull-up on SDA, SCL		1.82		kΩ
Vbus			3.3		V
PXA255					
	bus clock (note 20)	100		400	kHz
	buffer size			1	byte

Notes:

20. The PXA255 supports "standard" and "fast" I²C speeds of 100 and 400 kHz.

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7 Board Revision History

7.1   Identifying the board revision

The product revision number of the Video ClientX is etched on the underside of the printed circuit board. That number is 170117-1000x, where "x" is the board revision.

7.2   Revision History

The following is an overview of the revisions of the Video ClientX circuit board.

7.2.1   Revision 2

Initial release.

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