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USBlinx™

User Documentation

PC / JAMMA Interface
Part Number: 990-USBlinx-UCT-02H

Version 02H
May 24, 2005

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!!! IMPORTANT NOTE !!!

This document refers to version 02H of the USBlinx interface board. 02H is the combination of PCB version B, Hub firmware version H and Trackball firmware version B. Other versions of the PCB and firmware may differ from the details presented in this document. Please refer to the correct documentation for your specific hardware (see 'Revision History' on page 16).

Legal Statement

Package Contents

- User Documentation
- Video Cable (VGA) 3ft
- USB Cable 6ft
- Reset cable (2-pin) 2ft
- USBlinx PCB
- Audio Cable (3.5mm jack) 6ft
- PS/2 Cable 3ft
- Free Gift Offer Card

Overview

The USBlinx interface card is part of UltraCade Technologies' series of JAMMA compatible interface cards. For more information and a full list of current products, please go to www.ultracade.com.

The USBlinx provides a standard JAMMA interface for simple replacement of arcade motherboards with a more reliable, configurable and upgradeable PC based systems.

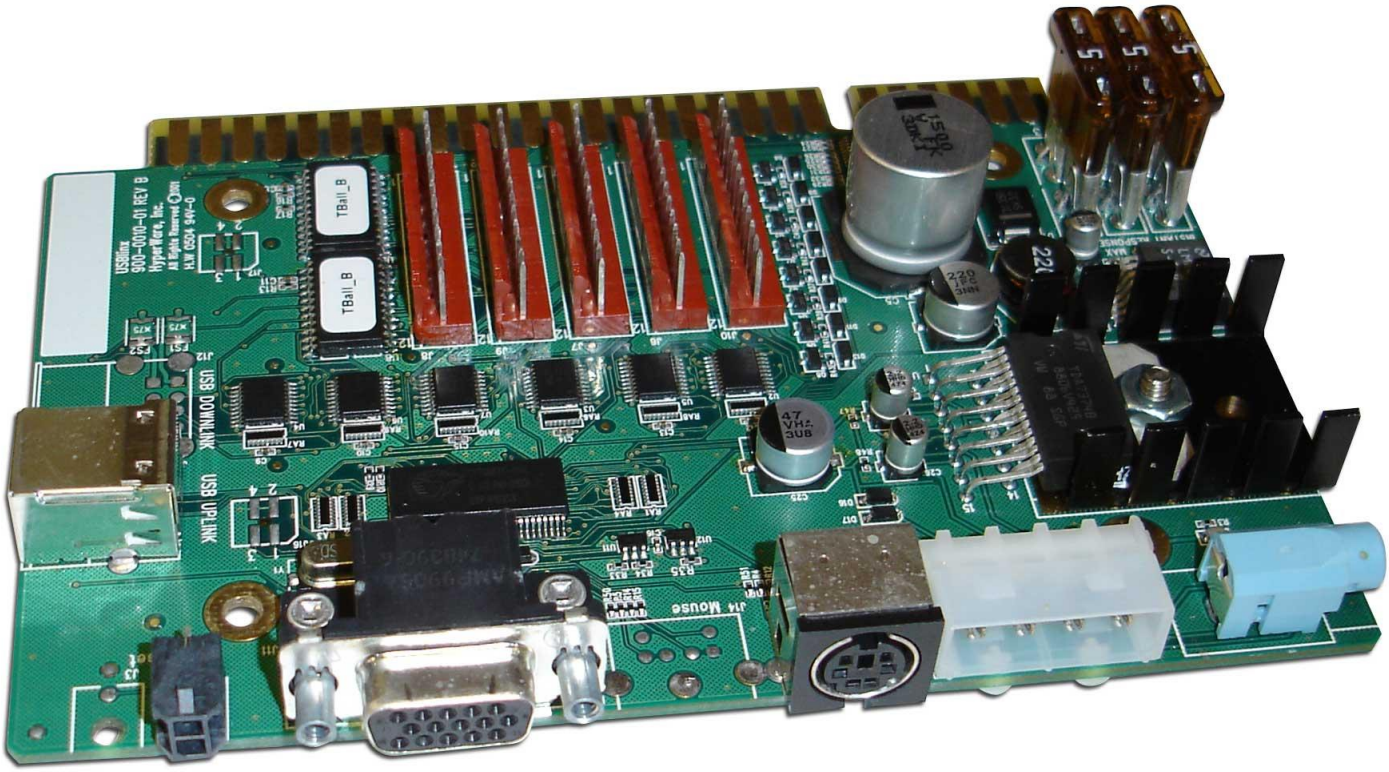
The standard JAMMA interface supports two players with four buttons each. The USBlinx can support and also enhance the standard JAMMA interface with two optional extended interfaces. The first additional predefined interface supports two players, each with six fire buttons, a trackball and a spinner. The second additional predefined interface supports four players, each with four fire buttons, and two players with a trackball and a spinner each. Custom interfaces can also be defined using the 48 inputs and 4 outputs.

The digital inputs and outputs can be transferred to and from the PC via the PS/2 or USB ports. The trackball and spinner data may only be sent via the USB port. All of the digital inputs and outputs, 2 trackballs and 2 spinners may be simultaneously connected to the USB port with no degradation in performance; no PS/2 connection is required.

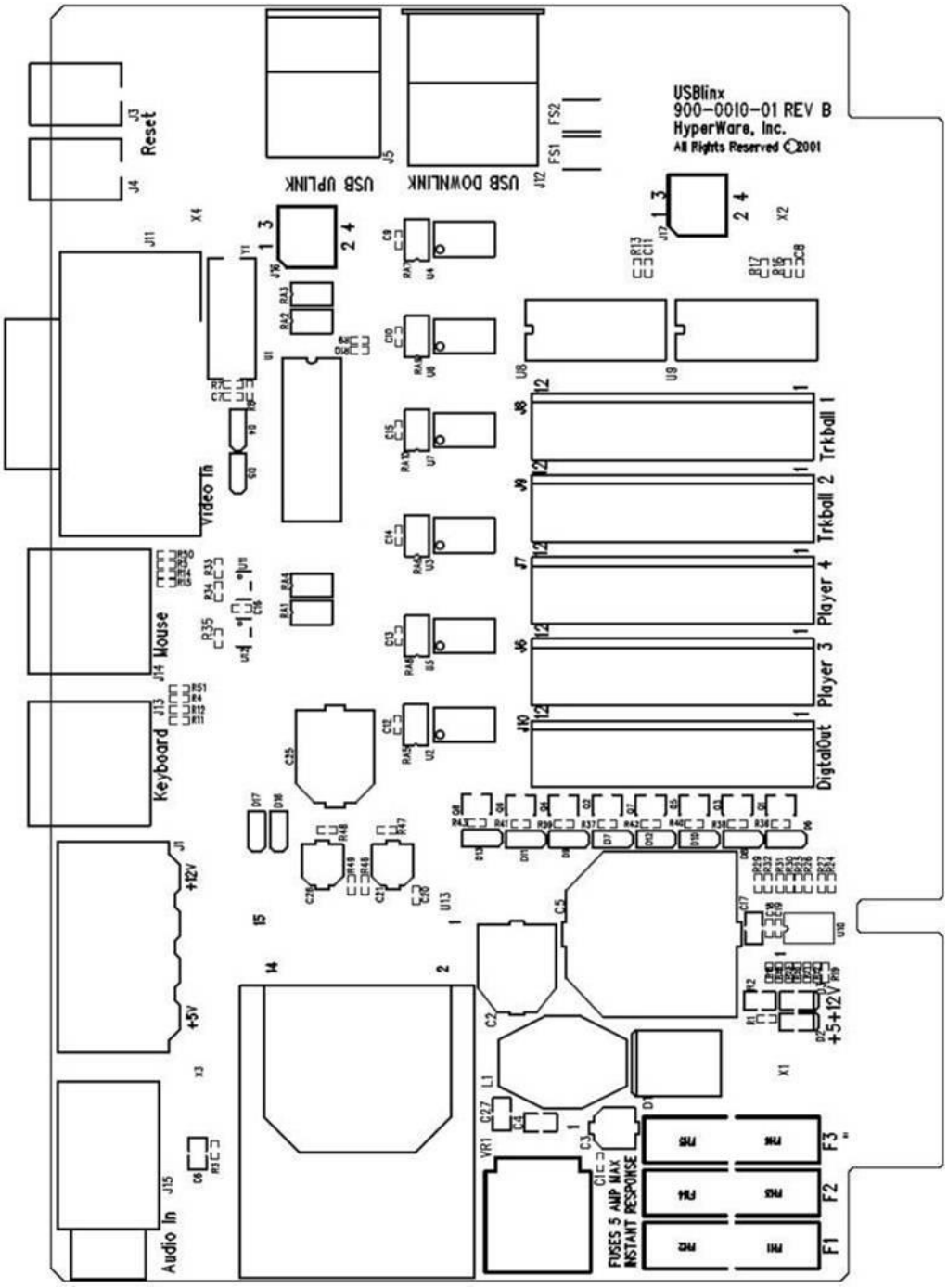
The 4 digital outputs are designed for +12v operation and include surge protection for electro-mechanical devices. Devices requiring +5v may be used; however, care is required as the surge protection will be minimal.

A watchdog circuit enables the USBlinx to detect a system crash and initiate a complete system restart. Amplifications are also provided for PC to arcade video and PC to arcade audio.

Board Image



Board Layout



Power

The USBlinx has two potential sources of power which must not be connected simultaneously. The source of power depends on the application. Some JAMMA harnesses are self-powered, while others require power to be supplied from the USBlinx. In the former case, the USBlinx is powered from the JAMMA connector and the PC HDD (hard disk drive) connector (J1) must not be connected. In the latter case, the USBlinx is powered from a standard PC HDD connector, which then powers the JAMMA harness. **NOTE: be sure the JAMMA harness is not self-powered before connecting the PC HDD power connector to the USBlinx.**

Another potential power source is the USB connector; however, no power from the USB connector is used on the USBlinx.

Irrespective of the method of connecting power, the USBlinx is protected from the power source by 5A fuses on both the +12v and +5v lines. If power is connected using the PC HDD power connector, then the USBlinx and the JAMMA harness are independently protected from the power source (J1); there are four fuses, for the +5v and the +12v lines to both the USBlinx and the JAMMA harness. If the JAMMA harness is the power source, the +5v and +12v lines each pass through 2 fuses to get to the USBlinx proper.

The USBlinx does not support the -5v JAMMA connection. If the JAMMA harness is the power source, then the -5v signal is simply unused. If the PC HDD power connector is the power source, then the -5v JAMMA connection is left unconnected, and hence not powered.

PS/2

When the PS/2 cable is connected between the USBlinx and the PC's PS/2 keyboard port, the digital inputs and outputs are sent over the PS/2 interface irrespective of the connection of a USB cable (trackball and spinner data is always sent via USB). However, it is recommended that the PS/2 cable is NOT connected when a USB connection is available. For mappings of virtual keyboard keys to digital inputs and outputs, see the sections on the Key Map, JAMMA Interface, and Additional I/O Connectors.

The USBlinx PS/2 interface is the same as a boot keyboard device. All traditional keyboards are 'boot keyboards', which means that they have a specific communication format that is supported by the PC's BIOS.

A PS/2 datum is generated whenever the state of the inputs changes. The datum is a keyboard scan code and represents the key and whether it was pressed or released. All keys, including modifier (shift, control, etc.) and special (vol+, vol-, sleep, etc.) keys generate a unique scan code when either pressed or released.

NOTE1: If used, ensure that the PS/2 cable is connected to the PC's keyboard port, which in modern PCs is colored mauve.

NOTE2: The PS/2 cable is only required when connecting to a device that does not support USB. If USB is available, connect the USBlinx through the USB cable only.

USB

When the PS/2 cable is connected between the USBlinx and the PC's PS/2 keyboard port, the digital inputs and outputs are sent over the PS/2 interface irrespective of the connection of a USB cable (trackball and spinner data is always sent via USB). However, it is recommended that the PS/2 cable is NOT connected when a USB connection is available. For mappings of virtual keyboard keys to digital inputs and outputs, see the sections on the Key Map, JAMMA Interface, and Additional I/O Connectors.

The USBlinx USB keyboard interface is the same as a boot keyboard device. All traditional keyboards are 'boot keyboards', which means that they have a specific communication format that is supported by the PC's BIOS. The trackball and spinner USB interface is only active after boot-up, and enumerate as two Windows compatible mice. However, Windows does not deal well with two pointer devices attached simultaneously!

Bringing up a USB design with the USBlinx is made simple by all three devices conforming to standard Windows compatible devices. The data from the USBlinx may therefore be obtained by simply reading from the keyboard and the two mice.

The USB communication pipes are standard and relatively simple, although the device driver may abstract away even this level of complexity. Each of the three separate devices is enumerated using two endpoints. All control commands are sent through 'Endpoint 0'. Upstream data is sent from the PC using the 'Endpoint 0' 'Set Report' command followed by the data (also on 'Endpoint 0'). The downstream data is sent from the USBlinx using an 'isochronous USB pipe on Endpoint 1'.

The USBlinx USB keyboard is required to support 48 individual inputs from the outside world (joystick, buttons, etc) and 4 outputs to the outside world (lights, coin counter, etc). However, most USB keyboards support very limited data communication.

USB keyboards receive just one byte of data to output, of which only three bits are generally used; these are for the display LEDs: Caps, Num and Scroll Lock. Despite this limitation, the standard configuration is enough for the requirements of the USBlinx outputs; see the section on Digital Outputs for more information.

The USBlinx inputs, however, do present a problem. Unlike PS/2 keyboards that send change events, USB keyboards send a list of the keys that are currently depressed; generally only up to a maximum of 6 keys. The 8 byte packet is started by 8 bits for the modifier keys (shift, control, etc), the second byte is reserved, and the final six bytes contain the six keys currently pressed. This is not enough for an arcade game where 2 or even 4 players may be simultaneously moving joysticks and buttons. The solution is to instantiate the USBlinx as a USB keyboard that supports 18 simultaneously pressed keys. Combined with the 5 modifier keys currently used in the USBlinx Key Map, this allows the USBlinx USB virtual keyboard to support 23 simultaneously depressed keys, which more than covers even extremely unlikely scenarios.

Standard USB Keyboard	Packet	Byte	USBlinx Keyboard
Modifier Keys	1	1	Modifier Keys
Reserved	1	2	Reserved
6 Keys Pressed	1	3-8	6 Keys Pressed
n/a	2	1-8	8 Keys Pressed
n/a	3	1-4	4 Keys Pressed

Digital Outputs

An application sets the USBlinx outputs by sending one byte over either the PS/2 or USB connection. If the PS/2 port is used, an output transfer is initiated and then one byte is transferred. If USB is used, the output transfer is initiated by sending the USB Set Report command (BMRequestType 21_{16} and BMRequest 09_{16}) down the control pipe (Endpoint 0) first, followed by the data packet. The first byte of the data packet is used and the rest is ignored.

The USBlinx supports 4 outputs implemented as decoupled ground enables using FET transistors. Setting an output simply enables the corresponding circuit ground; conversely, clearing the output disables the circuit ground. When connecting a device, connect the positive terminal to the relevant voltage supply, and the negative (or ground) terminal to the relevant output pin on the USBlinx. Enabling that output will enable the circuit, and therefore the device. The connections on the USBlinx output connector (J10) are shown in the table at the end of this section.

Decoupling with FETs enables the only limitation on the current draw to be from the power supply itself (the FETs have maximum ratings of 1.6 amps continuous and 10 amp pulse). In addition, a +12v surge protector is included as part of each output; this enables the safe use of +12v electro-mechanical devices. NOTE: the surge protector has a lesser effect on +5v devices.

Of the 8 outputs, only 4 are currently connected, with the remainder reserved for future expansion. The JAMMA standard defines the 4 outputs as:

- Coin counter 1 connected through component side pin 8
- Coin lock 1 connected through component side pin 9
- Coin counter 2 connected through solder side pin 8
- Coin lock 2 connected through solder side pin 9

Access to these 4 outputs is achieved through the standard keyboard method. Irrespective of whether the USBlinx is connected through PS/2 or USB port, a full byte of data is sent from the PC to the 'virtual' keyboard. Of these 8 bits the base format is that the top 5 bits are reserved, with the lower 3 bits used for the 3 keyboard LEDs (Num, Caps and Scroll lock). The PS/2 and USB standards unsurprisingly define the three outputs in differing formats.

The USBlinx uses the Num-Lock output to reset its internal watchdog circuit (see the relevant section for more information on the watchdog circuit). The 4 outputs from the USBlinx are therefore sent by the PC using the remaining 2 LED outputs in addition to the adjacent 2 reserved bits. The 8 bit byte sent from the PC to the USBlinx therefore has the format:

PS/2 output byte[7:0]	reserved	reserved	reserved	coin lock 2	coin counter 2	caps lock LED	num lock LED	scroll lock LED

USB output byte[7:0]	reserved	reserved	reserved	coin lock 2	coin counter 2	scroll lock LED	caps lock LED	num lock LED

The outputs connector on the USBlinx (J10) has the following pinout:

Pin	Usage	Virtual Keyboard	Accessed By
1	Ground	n/a	n/a
2	+12v	n/a	n/a
3	Coin Counter 1	Scroll Lock LED	Bit 0 if PS/2 Bit 2 if USB
4	Coin Lock 1	Caps Lock LED	Bit 2 if PS/2 Bit 1 if USB
5	Coin Counter 2	n/c	Bit 3
6	Coin Lock 2	n/c	Bit 4
7	Output 5	n/c	reserved
8	Output 6	n/c	reserved
9	Output 7	n/c	reserved
10	Output 8	n/c	reserved
11	+12v	n/a	n/a
12	Ground	n/a	n/a

Video

NOTE: No resolution or frequency conversion is done by the USBlinx. The only processing of the video signal is amplification on the red, green and blue signals and the combination of separate horizontal and vertical syncs into a composite sync signal. For frequency and resolution conversion, please refer to the UltraCade uVC video converter at www.ultracade.com.

The video circuit in the USBlinx is used when the target monitor is either an arcade CGA or EGA monitor. The USBlinx provides three necessary functions to convert PC signals into arcade monitor signals. Firstly, the BIOS has control of the video during the PC boot-up phase and may output incompatible signals. Secondly, the voltages of the RGB signals are different. Finally, the synchronization format may differ.

During PC boot-up, the application, and even the operating system, has no control over the video mode. The BIOS uses whatever default mode the motherboard supports. There is therefore the potential that these modern synchronization signals may damage older style arcade monitors that

do not support such fast synchronization signals. The USBlinx therefore disables the synchronization signals from propagating to the target monitor until the DDC signals enable it. DDC consists of clock (SCL) and data (SDA) lines, and is a mostly unregulated method for monitors to identify themselves by sending and receiving configuration information. The SDA line defaults to high, and the USBlinx needs to see the SDA line pulled low to enable the pass through of the video synchronization signals.

Both PC and arcade monitors use +5v synchronization signals, however, the voltage ranges are different in the red, green and blue signals. The USBlinx therefore provides a video amplifier for converting the PC's 0.7vpp RGB signals (input into the DB15 connector J11) to the arcade monitor's 5vpp signals (output through the JAMMA connector).

The type of synchronization signals used by arcade monitors can differ. All PCs produce separate horizontal and vertical synchronization signals, while some arcade monitors require just one composite signal. The USBlinx therefore combines separate synchronization signals (input into the DB15 connector) into a composite signal (output through the JAMMA connector).

Audio

Standard PC audio output is a pre-amplified signal through a 3.5mm stereo jack. A standard arcade cabinet just contains one or two 8Ω speakers, accessed through the JAMMA connector pins 10 (left) and 11 (right). The positive audio is on the component side and negative on the solder side.

The USBlinx bridges these disparate standards. A standard 3.5mm stereo jack socket is provided to connect the PC audio input. The audio is then amplified by a 2x37W audio amplifier. Finally, the amplified audio is routed to the speakers through the standard pins of the JAMMA connector.

Mono output is available by simply joining the left and right pins at the 3.5mm jack on the USBlinx. Fully amplified mono audio signals are then available at the JAMMA connector on both of the left and the right positive/negative pair.

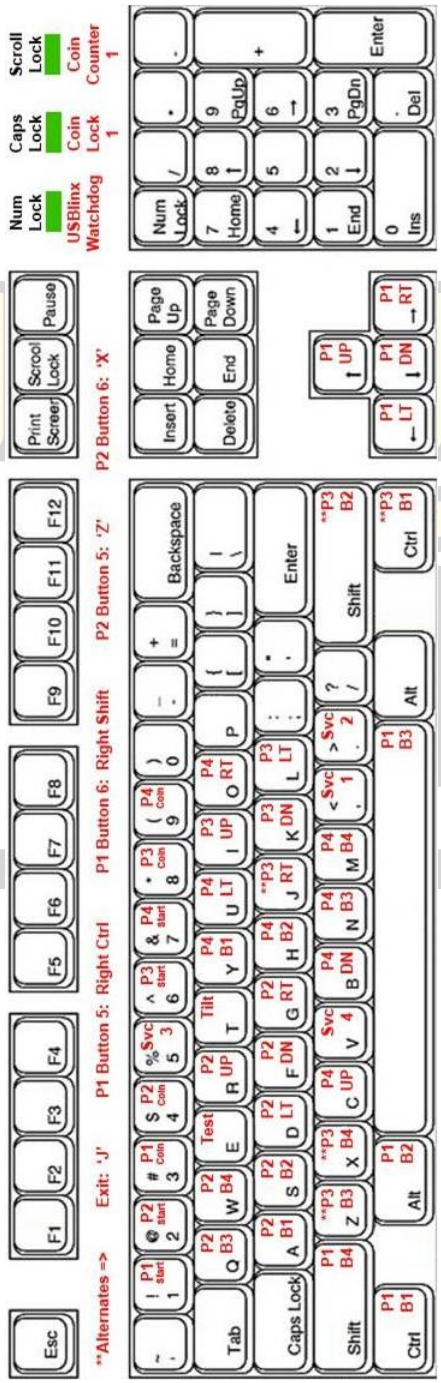
Watchdog Circuit

In the event of a PC crash, the USBlinx is designed to reboot both the PC and itself. To facilitate this, a two pin connector must be used to connect the USBlinx reset connector (J4) to the PC's reset switch (locate this by using the motherboard's documentation).

The USBlinx constantly counts up to about half a minute (the exact number is 7200_{16} milliseconds, which is 29.184 seconds). When that value is reached, the USBlinx sends a reset pulse (225 microsecond pulse) to the PC and then reboots itself. Therefore, the PC must reset the USBlinx watchdog at least every 29 seconds. The USBlinx watchdog's reset count is restarted by toggling the 'virtual' keyboard's Num-Lock LED. The Num-Lock LED bit is in different positions in the PS/2 and USB standards. In the PS/2 standard the Num-Lock LED is the middle LED bit (bit 1 in byte[7:0]). In the USB standard the Num-Lock LED is the least significant bit (bit 0 in byte[7:0]).

The USBlinx reset switch is bi-directional, such that the PC can pull the reset switch low and reboot both the USBlinx and itself, and also the USBlinx can pull the reset switch low and reboot both the PC and itself.

Key Map



JAMMA Interface

The JAMMA interface is the standard interface for arcade motherboards. To simplify the replacement of single game non-upgradeable arcade machines with PC based systems, the USBlinx allows the old motherboard to simply be unplugged and the PC plugged in. All the old controls will flow through the same JAMMA interface and be converted by the USBlinx into signals compatible with PCs (USB or PS/2).

PCB Side	Pin	Standard Usage	Usage or Virtual KB Key
Solder	1	Gnd	Gnd
Solder	2	Gnd	Gnd
Solder	3	+5v	+5v
Solder	4	+5v	+5v
Solder	5	-5v	n/c
Solder	6	+12v	+12v
Solder	7	KEY	KEY
Solder	8	coin counter 2	out byte bit 3
Solder	9	coin lock 2	out byte bit 4
Solder	10	left speaker -	audio left-
Solder	11	right speaker -	audio right-
Solder	12	green	video green
Solder	13	comp sync	video c-sync
Solder	14	service 1	'<'
Solder	15	tilt	'T'
Solder	16	p2 coin	'4'
Solder	17	p2 start	'2'
Solder	18	p2 up	'R'
Solder	19	p2 down	'F'
Solder	20	p2 left	'D'
Solder	21	p2 right	'G'
Solder	22	p2 button 1	'A'
Solder	23	p2 button 2	'S'
Solder	24	p2 button 3	'Q'
Solder	25	p2 button 4	'W'
Solder	26	service 2	'>'
Solder	27	Gnd	n/a
Solder	28	Gnd	n/a

PCB Side	Pin	Standard Usage	Usage or Virtual KB Key
Component	1	Gnd	Gnd
Component	2	Gnd	Gnd
Component	3	+5v	+5v
Component	4	+5v	+5v
Component	5	-5v	n/c
Component	6	+12v	+12v
Component	7	KEY	KEY
Component	8	coin counter 1	Scroll Lock LED
Component	9	coin lock 1	Caps Lock LED
Component	10	left speaker +	audio left+
Component	11	right speaker +	audio right+
Component	12	red	video red
Component	13	blue	video blue
Component	14	video ground	video gnd
Component	15	test 1	'E'
Component	16	p1 coin	'3'
Component	17	p1 start	'1'
Component	18	p1 up	up arrow
Component	19	p1 down	down arrow
Component	20	p1 left	left arrow
Component	21	p1 right	right arrow
Component	22	p1 button 1	left ctrl
Component	23	p1 button 2	left alt
Component	24	p1 button 3	space
Component	25	p1 button 4	left shift
Component	26	test 2	n/c
Component	27	Gnd	n/a
Component	28	Gnd	n/a

The table above shows the standard use for each of the JAMMA pins, and either the USBlinx signal or the 'virtual keystroke' the USBlinx sends to the PC as if from a standard keyboard. For example, JAMMA pin S11 is used for the audio right negative channel, which is exactly the signal sent by the USBlinx. When player 1's start button on the JAMMA C17 pin is being pressed or released, data is sent to the PC as if the keyboard number 1 key was being pressed or released. The only outputs on the JAMMA connector are the coin counters and coin locks. See the section on Digital Outputs for detailed information on their functionality.

Trackball / Spinner Interface

The USBlinx is designed to make the connection of devices as simple as possible. The USBlinx supports two trackballs and two spinners. To simplify PC connection, the data is sent in a recognized format. A standard mouse has an X-axis and a Y-axis for 2D motion, and also a Z-axis for the middle button wheel rotation. The USBlinx maps a trackball and a spinner onto a mouse by using the first two axis' to represent the trackball, and the final axis to represent the spinner. Therefore, by connecting two 'virtual mice' the data for both trackballs and both spinners is conveniently communicated.

The trackballs and spinners are connected to the USBlinx in a standard 12-pin 100mil Molex connector. There are two connectors (J8 and J9), one for each of the 'virtual mice', and both have the same format. Each axis is represented by two powered optosensors (driven both high and low). Two sensors are necessary to ascertain the direction of motion. The table below shows the usage of the pins on each of the two connectors.

Pin	Usage
1	Ground
2	+5v
3	Left Button
4	Right Button
5	Trackball X1
6	Trackball X2
7	Trackball Y1
8	Trackball Y2
9	Middle Button
10	Spinner Z1
11	Spinner Z2
12	Button 4

Additional I/O Connectors

In addition to the 'virtual mouse' connectors and the 'digital output' connector, there are two further 12-pin 100mil Molex connectors. These connectors facilitate the two extensions to the JAMMA standard. The first extension allows players 3 and 4 to be added, each with 4 fire buttons (and start, coin drop, service, etc.). The second extension allows for an 'exit' button and the two players having 6 fire buttons each (as required by the Street Fighter series).

In the two tables below, the two extensions are shown. Each table shows the usage associated with each pin of the two connectors.

Extension 1 - Four player four button		
Pin	**J6 - Player 3**	**J7 - Player 4**
1	Ground	Ground
2	Player 3 Coin	Player 4 Coin
3	Player 3 Start	Player 4 Start
4	Player 3 Up	Player 4 Up
5	Player 3 Down	Player 4 Down
6	Player 3 Left	Player 4 Left
7	Player 3 Right	Player 4 Right
8	Player 3 Btn 1	Player 4 Btn 1
9	Player 3 Btn 2	Player 4 Btn 2
10	Player 3 Btn 3	Player 4 Btn 3
11	Player 3 Btn 4	Player 4 Btn 4
12	Player 3 Service	Player 4 Service

Extension 2 - Two player six button		
Pin	**J6 - Player 3**	**J7 - Player 4**
1	Ground	n/c
2	n/c	n/c
3	n/c	n/c
4	n/c	n/c
5	n/c	n/c
6	n/c	n/c
7	Exit Button	n/c
8	Player 1 Btn 5	n/c
9	Player 1 Btn 6	n/c
10	Player 2 Btn 5	n/c
11	Player 2 Btn 6	n/c
12	n/c	n/c

PCB Connectors

This section provides the part numbers and pin assignments for the mating connectors to all of the connectors on the PCB.

PCB Ref	PCB Connector Description	Required Mate Description	Parts Required	Supplier	Part Number	Inc. in packet
J1	Power - PC HDD	Female PC HDD connector Pin1 - +12vdc Pin2 - Ground Pin3 - Ground Pin4 - +5vdc	1 x Extension 2ft OR 1 x Female housing 4 x Female terminal 4 x Wire 1 x Male housing 4 x Male terminal	UltraCade AMP AMP {any} AMP AMP	115-HDDPWR-CBL 1-480424-0 60617-1 n/a 1-480426-0 61618-1	no no no no no no
J2	JAMMA - see JAMMA Intface**	Female JAMMA**	1 x JAMMA harness	Happ	80-5100-00	no
J3	Reset switch	<removed>	n/a	n/a	n/a	no
J4	Reset switch	Female - 2-pin 118mil micro-fit Pin1 - Reset Pin2 - Ground	1 x Custom cable 2ft OR 1 x Female housing 2 x Female terminal	UltraCade Molex Molex	115-USBRST-CBL 43025-0200 43030-0010	yes no no
J5	USB uplink	USB-B plug (USB-A = PC plug)	USB A to B 6ft USB A to B 10ft USB-A extension	UltraCade UltraCade usbgear	115-USB06AB-CBL 115-USB10AB-CBL USBG-3FTE	yes no no
J6	Player 3 - see Additional I/O**	Female - 12-pin 100mil header**	1 x Female housing 12 x Female terminal	Molex Molex	22-01-2127 08-50-0108	no no
J7	Player 4 - see Additional I/O**	Female - 12-pin 100mil header**	1 x Female housing 12 x Female terminal	Molex Molex	22-01-2127 08-50-0108	no no
J8	Trackball 1 - see Trkball Interface**	Female - 12-pin 100mil header**	1 x Female housing 12 x Female terminal	Molex Molex	22-01-2127 08-50-0108	no no
J9	Trackball 2 - see Trkball Interface**	Female - 12-pin 100mil header**	1 x Female housing 12 x Female terminal	Molex Molex	22-01-2127 08-50-0108	no no
J10	Digital outputs - see Digital Outs**	Female - 12-pin 100mil header**	1 x Female housing 12 x Female terminal	Molex Molex	22-01-2127 08-50-0108	no no
J11	Video input	Male, D-Sub 15-pin Standard PC video	Std PC video 3ft Extension Cable	UltraCade Assmann	115-VGA3MM-CBL AK322-2	yes no
J12	USB downlink x 2	<removed>	n/a	n/a	n/a	no
J13	PS/2 Keyboard	Male PS/2	1 x PS/2 cable 3ft	UltraCade	115-PS2KEYB-CBL	yes
J14	PS/2 Mouse	<removed>	n/a	n/a	n/a	no
J15	Audio input	Male, stereo 3.5mm jack	1 x PC audio 6ft	UltraCade	115-AUDMINI-CBL	yes
J16	Config Jumpers	<removed>	n/a	n/a	n/a	no
J17	Config Jumpers	<removed>	n/a	n/a	n/a	no

** for pin connection details, see the relevant section (Digital Outputs, JAMMA Interface, Trackball / Spinner Interface, Additional I/O Connectors)

Revision History

- Version 02H. PCB version B. Trackball firmware version B. Hub firmware version H:
  - 05/24/2005, DT. First release of the user documentation.

Contact Information

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