

MINI-PAC

Integrated Switch/Joystick/Trackball/Spinner Interface

User's Guide

ULTIMARC

Ultimate Arcade Controls

www.ultimarc.com

Introducing the Mini-PAC

The Mini-PAC is a flexible, cost-effective way to integrate arcade controls (pushbuttons, joysticks, trackballs, spinners, coin door mechanics, and indicator lights) to a personal computer with a minimum of effort. It is part of a family of products offered by Ultimarc which includes the *I-PAC* and *Opti-PAC* interfaces.



The Mini-PAC shown with optional PCB mounting feet, available from Ultimarc

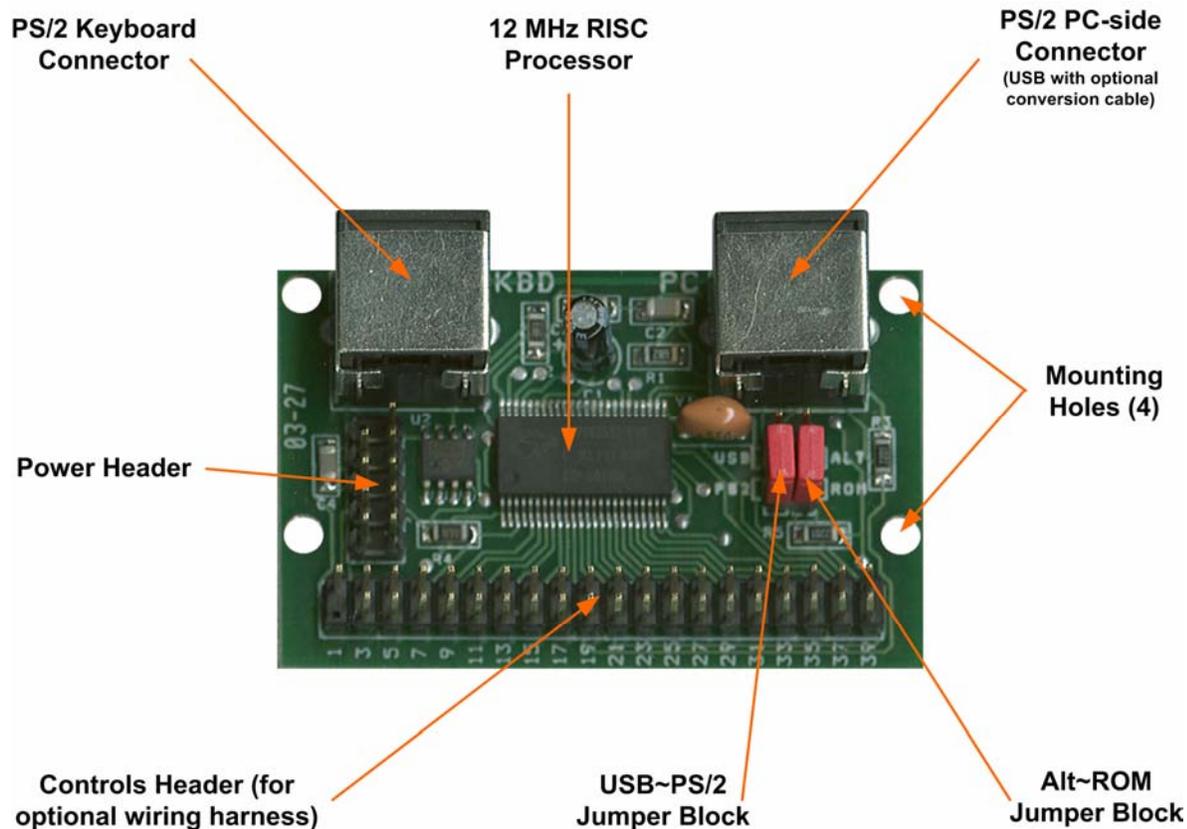
The Mini-PAC offers all of the features and programming flexibility of the *I-PAC*² in a small form factor. It also offers several options *not* found on the *I-PAC*, such as support for several optical devices and an optional wiring harness, color-coded and terminated with ‘Faston’ female spade connectors. This wiring harness comes in one of three types, two of them offering support for arcade spinners and two different types of Trackball interface. The Mini-PAC interfaces on the PC side with either a PS/2 keyboard or USB connector, and can act as a pass-through for a PC keyboard, if desired. It receives power through these connectors and requires no independent power supply. The PC/2 and USB interfaces use Windows’ (and USB-equipped Apple Macintoshes’) built-in support—no drivers are required!

The Mini-PAC uses a fast on-board 12 MHz RISC processor, and provides true arcade responsiveness without any of the “ghost keys” effects that plague “keyboard hacks.” It does not use the input ‘scanning method’ of a PC keyboard—each input is a dedicated control line.

The Mini-PAC comes with default programming perfect for a MAME machine (Multiple Arcade Machine Emulator), but can be easily re-programmed using the provided advanced interactive utilities. These utilities work on DOS, Windows, Linux, and Macintosh systems, and an unlimited number of programs can be stored and downloaded to the unit instantly, on-the-fly. Programming is retained even when the unit is powered off.

Multiple Mini-PACs may be used in parallel to increase the number of inputs, if desired.

A Tour of the Mini-PAC



The Mini-PAC Printed Circuit Board (“PCB”) consists of the following major elements:

PS/2 Keyboard Connector—if desired, a standard PC keyboard with PS/2 mini-DIN connection may be inserted into this port. The Mini-PAC will pass through keyboard data unaltered to the PC.

PS/2 PC-Side Connector—using a standard male-male PS/2 cable, this port connects the Mini-PAC to the PC’s standard PS/2 keyboard “in” connection. Alternately, a Male-PS/2-to-male-USB cable may be used to connect the unit to a USB port (see USB~PS/2 Jumper settings, below). Either cable is available as an option from Ultimarc.

Controls Header—this is a standard 40-pin IDC header, the same as those used on PC IDE hard drives. Using the optional wiring harness (or make your own), each of the 39 pins provides a wiring point for an arcade control. Pin 1 (lower left) is intentionally missing: this is a “key pin” to ensure proper orientation of the wiring harness to the header.

Power Header—optionally used to power trackballs and spinners.

USB~PS/2 Jumper Block—keep this jumper in the default position when connecting the Mini-PAC to the PC’s PS/2 keyboard port. Move the jumper to the USB position when connecting using a PS/2-to-USB cable for plugging into one of the PC’s USB port.

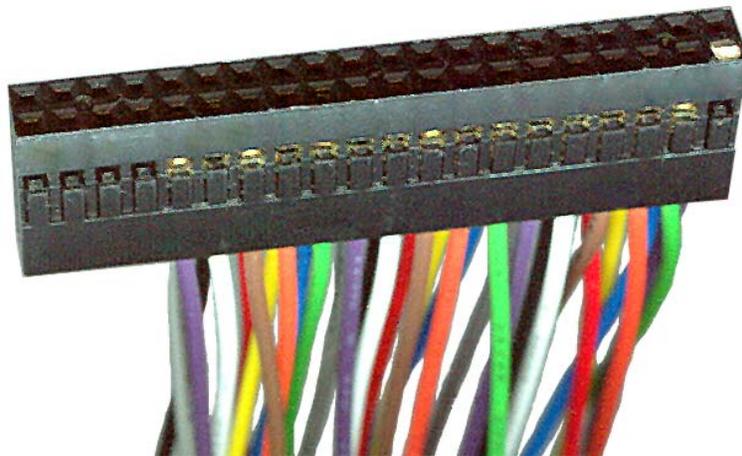
Alt~ROM Jumper Block—in the default position (ROM), this jumper accesses the Mini-PAC’s built-in programming map, which is compatible with the MAME standard (i.e., “Coin-1” is mapped to key-press “5,” “Player-1 Joystick-Up” is mapped to the keyboard’s “Up-Arrow,” etc.). By moving the jumper to the ‘alternate’ position, you may use the included programming utilities to create your own programming maps. The jumper may be moved back at any time to access the default programming again.

The Wiring Harness (Optional)

Three different pre-wired harnesses are available from Ultimarc depending upon the nature of the arcade controls which you intend to use. All three have the basic 28 micro-switch wires for connecting to arcade pushbuttons and joysticks, and all three come with a second pre-made wiring “daisy-chain” cable for connecting all of the micro-switches’ *common* terminals together. The ends of the wires that go to the controls are terminated with insulated “Faston”-style quick disconnects, as shown below (no soldering!).



(Note that three of the ‘switch’ lines may be used to control Light-Emitting Diodes , or “LEDs,” if desired; see the section on LEDs, below).



The end of the wiring harness that plugs into the Mini-PAC’s 40-pin header. Note the filled-in “key” at the pin 1 position, on the right. Shown is the “Basic” harness, as it lacks any wiring for spinners & trackballs, which would be to the left, if present.

The three wiring harness options differ only in the connections for optical devices (trackballs and spinners). The “Basic” harness has no connections for these controls; the “Opti/Happ” harness has connectors for easily attaching the harness to an Oscar Controls spinner and a Happ Controls trackball; the “Opti/Ultimarc” harness is identical to the ‘Happ’ harness except that the terminations for the trackball cater to the trackball available from Ultimarc.

Important notes about using optical devices with the Mini-PAC:

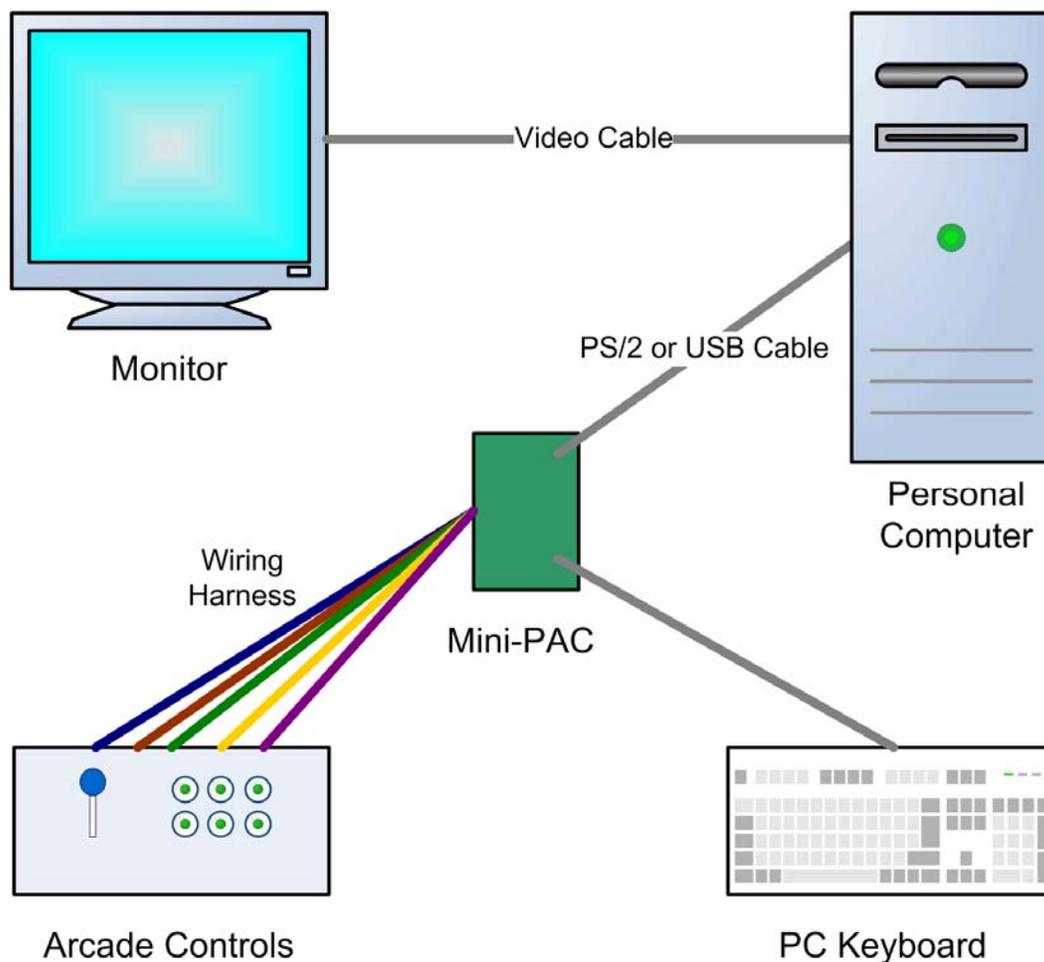
- The Mini-PAC is *not* compatible with the Suzo/Wico trackballs; and,
- Trackball/Spinner functionality only works via a USB connection, not a PS/2 PC connection .

Using the Mini-PAC in an Arcade System

In simple terms, the Mini-PAC is inserted between a PC and its keyboard (assuming that a keyboard is even needed). The wiring harness connects the Mini-PAC to the arcade controls.

In this configuration, both the arcade controls and the PC keyboard are simultaneously available. Manipulating the arcade controls sends signals to the PC which the PC “sees” as key-presses; the exact key-press associated with each arcade control is dependent upon the programming of the Mini-PAC.

While the Mini-PAC helps your PC “see” the arcade controls just as if they were another keyboard, it should be noted that it does so with much greater efficiency than a computer keyboard, which uses a [relatively] slow scanning method and has a limit to the number of simultaneous keys which may be held down at one time. The Mini-PAC does not suffer from these limitations, making it much more responsive for game play than a PC keyboard.



Note: while the above diagram shows a basic PC-based arcade system, it is one of many variations. For instance, the video setup shown is a simple connection from a PC to a PC monitor, but in an arcade cabinet, an arcade-authentic monitor may be used. In this case, the connection becomes more involved. Ultimarc makes several other products to assist in these connections, such as the ArcadeVGA video card and the Video Amplifier PCB & cable. Refer to the documentation for those products on the Ultimarc web site at <http://www.ultimarc.com> for more information.

Mini-PAC Installation Procedure

Mounting the PCB

Before making your connections, secure the PCB to your enclosure or control panel. A good mounting method is to use two of the feet from Ultimarc's *PCB Feet Kit* and fit these to the two holes nearest the harness connector. The board may need to be mounted in the centre of the arcade control panel if it is especially large to allow the wires of the harness to reach all of the controls. Wires of 320mm length will allow for approx 640mm between furthest mounted switches.

Wiring Procedure

Wiring arcade controls to the Mini-PAC using one of the Mini-PAC harnesses is not difficult. If you work through the wiring in an orderly manner you should have no problems. If you decide to make your own harness, know that the gauge of wire is not critical. Ultimarc uses 16 x 0.2 mm.

When wiring joysticks and pushbuttons, you are really running wires to the micro-switches *under* them. Joysticks and pushbuttons are simply controls that offer two different means to 'click' a micro-switch!

A switch is simply a device to complete an electrical connection, or 'circuit.' It's nothing more than a safe, convenient way of touching two wires together! So the main thing to remember about wiring a switch is that it needs two wires connected to it. In the case of wiring arcade controls, one of those wires is the 'control line' wire going to the Mini-PAC, and the other connection will be a "Common" connection. "Common" really does refer to the fact that all of your switches will be wired to a common point, which is the 'Ground' line on the main wiring harness. That's what the second daisy-chain cable is for, if you purchased an Ultimarc wiring harness set.

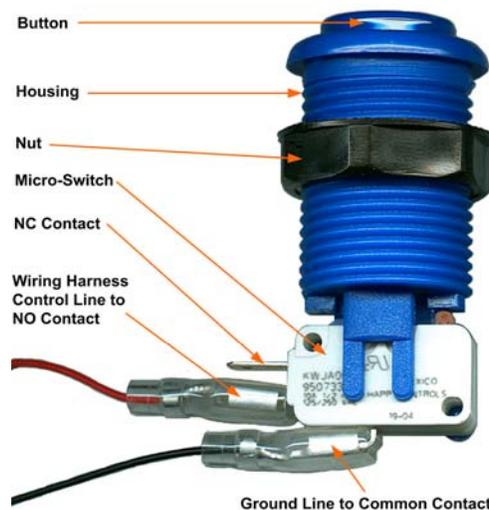
Most micro-switches have three contacts, but you will only need two of them:

Common ("Com")—the pin to a common ground, as discussed above;

Normally-Open ("NO")—the pin you will use for your control line on the wiring harness. The name refers to the fact that, until the switch is depressed, the circuit is broken or "open"; and,

Normally-Closed ("NC")—the reverse of the above, this terminal is electrically connected to the Common pin when the switch is *not* activated, and the circuit is actually *broken* when the switch is depressed. You will *not* use this pin, if it is present.

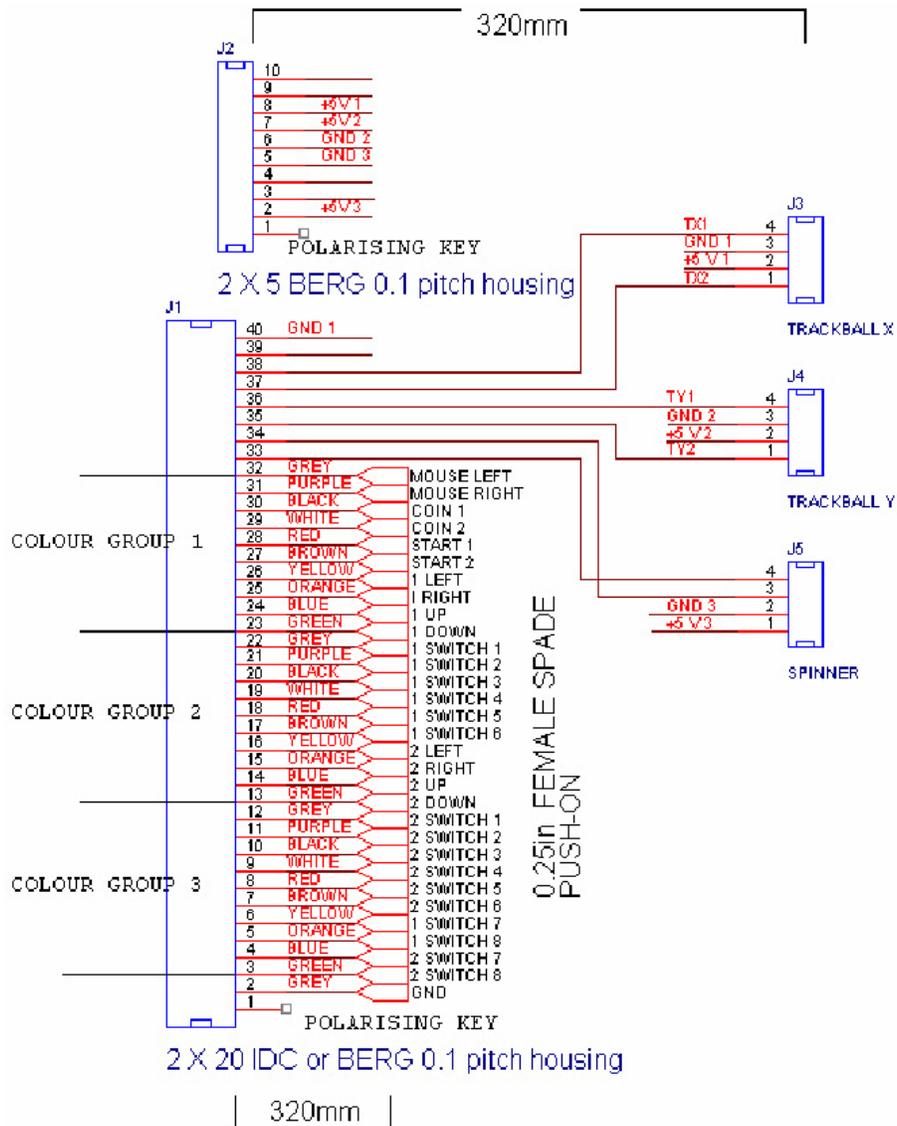
Most micro-switches label the pins (look closely), and many show a tiny schematic diagram of an arrow leading from the Common 'pole' pin to the NC pin. If your switches do not, use a continuity tester or ohmmeter to find out which pins get connected together when you push the button.



Wiring on a typical arcade pushbutton assembly

Begin making your connections by tying all of your common pins together with the daisy-chain 'ground' cable. Find the most convenient path. There are extra terminals, so if you need to 'skip' a few for longer reaches, that's fine.

Next, arrange the large connector of the wiring harness on the left as shown in the diagram, with the white polarising key (Key 1) at the bottom.



Working from the bottom of the connector, first connect the grey wire to the male connector on the ground harness.

Separate the rest of the wires into 3 groups. Start each group with the green and blue wires (bottom) and end with the purple and grey wires (top). You can tie-wrap the 3 groups close to the connector if you wish, or just lay the groups across the panel.

Now the wires from each group can be connected to the correct switches as shown on the diagram above.

If present, connect the three other plugs to the trackball and spinner as shown. Tie-Wrap all wiring for neatness.

The following color-coded table may help you when wiring your panel. Note that black text without bold-facing signifies *white* wires:

Opti-Only Group	(Connector Pin 40, Ground 1)		Pin 40
	[Not used]		Pin 39
	Trackball X TX1		Pin 38
	Trackball X Ground 1		(Power harness)
	Trackball X +5v 1		(Power harness)
	Trackball X TX2		Pin 37
	Trackball Y TY1		Pin 36
	Trackball Y Ground 2		(Power harness)
	Trackball Y +5v 2		(Power harness)
	Trackball Y TY2		Pin 35
	Spinner data		Pin 34
	Spinner data		Pin 33
	Spinner Ground 3		(Power harness)
Spinner +5v 3		(Power harness)	
Top Colour Group	Mouse Left	Grey	Pin 32
	Mouse Right	Purple	Pin 31
	Coin-P1	Black	Pin 30
	Coin-P2	White	Pin 29
	Start-P1	Red	Pin 28
	Start-P2	Brown	Pin 27
	P1 Left	Yellow	Pin 26
	P1 Right	Orange	Pin 25
	P1 Up	Blue	Pin 24
	P1 Down	Green	Pin 23
	Middle Colour Group	P1 Switch 1	Grey
P1 Switch 2		Purple	Pin 21
P1 Switch 3		Black	Pin 20
P1 Switch 4		White	Pin 19
P1 Switch 5		Red	Pin 18
P1 Switch 6		Brown	Pin 17
P2 Left		Yellow	Pin 16
P2 Right		Orange	Pin 15
P2 Up		Blue	Pin 14
P2 Down		Green	Pin 13
Bottom Colour Group		P2 Switch 1	Grey
	P2 Switch 2	Purple	Pin 11
	P2 Switch 3	Black	Pin 10
	P2 Switch 4	White	Pin 9
	P2 Switch 5	Red	Pin 8
	P2 Switch 6	Brown	Pin 7
	P1 Switch 7	Yellow	Pin 6
	P1 Switch 8	Orange	Pin 5
	P2 Switch 7	Blue	Pin 4
	P2 Switch 8	Green	Pin 3
	Ground	Grey	Pin 2
Polarizing "Key"	Pin (not used)	Pin 1	

Special Wiring Considerations

The connectors don't fit

The quick-disconnect terminals supplied with the Ultimarc wiring harnesses are for 0.25" micro-switch spade terminals. These are compatible with the pushbuttons and joysticks sold by Ultimarc. However some micro-switches, such as those supplied by Happ Controls, use narrower 0.187" spade terminals. If you find that this is the case, you can do one of three things:

- Replace the connectors with new ones of the proper size. These are commonly available in the 'electrical' sections of hardware and automotive parts stores;
- Crimp the connector gently with pliers to deform in a little and make a tighter fit. Many people have done this with no problems; or,
- Create an "adapter cable" by purchasing male 0.25" spades for one end and female 0.187" connectors for the other end.

Be sure when purchasing connectors that you buy ones appropriate for the wire gauge that you are using. They are commonly color-coded to certain ranges of wire (e.g., 12-14, 16-18, 20-22, etc.).

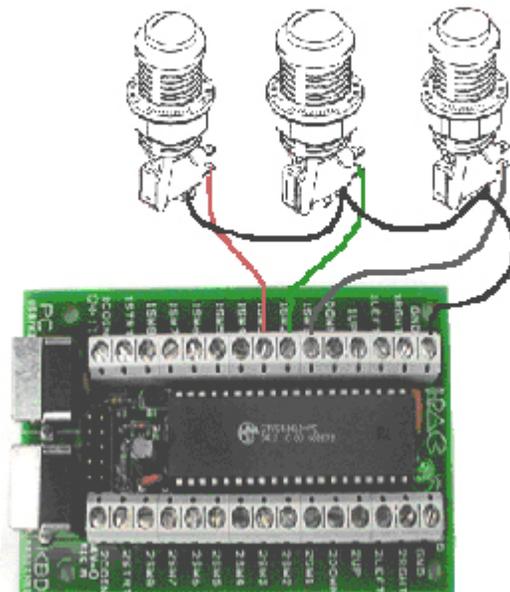
The wiring harness will not reach all controls

You can either create your own extensions (as in the adapter cable, above) or purchase a 10-pack of extenders directly from Ultimarc.

Two or more buttons have the same function

Some control panels may have duplicate functions. For instance, a joystick may be wired for Player-1 "up/down/left/right" and yet there may be pushbuttons for left and right to simulate an "Asteroids"-like layout. Or there may be a Player-1/Button-1 "Fire" button both on the panel surface and on a top-firing joystick.

This is no problem with the Mini-PAC. The duplicate micro-switches are simply wired "in parallel" with each other, each tied to a common control line of the harness. If you think of how the switch functions—activating the control line by tying it to ground—then it's easy to understand how a single control line split to two or more switches would work this way: and *one* of them completing a circuit to ground activates that control line.



The above diagram shows an I-PAC board with direct wiring to a terminal strip, but the principle is the same for a Mini-PAC. Simply tie all of your common pins together as usual, and tie the other lines from the switches to the single wire of the Mini-PAC harness that hold the common function. You can do this neatly by purchasing a small terminal strip from a hardware store's electrical department and mounting it on the underside of your control panel.

There are more arcade controls than the Mini-PAC supports

The Mini-PAC has enough connections to support a fully decked-out 2-player arcade control panel, or a modestly-equipped 4-player panel. However, in the case of a "spare-no-features" 4-player panel, more control options may be needed. No problem—two Mini-PAC units may be wired in parallel. The second board can be connected to the pass-thru connector of the first. Alternately, connect both boards to USB ports on the PC, or the first to the keyboard port and second to USB. Each board can be individually programmed with the required code set, and then the two boards can be connected together as above.

Game function LED indicators

Some classic arcade games controlled lights or other effects in the cabinet or control panel. "Asteroids," for example, would flash the 1- and 2-player Start buttons as coins were deposited. Some emulators, such as MAME, support these functions by connecting the game's signals to the LED indicator lights on a standard PC keyboard (Num Lock," "Caps Lock," and "Scroll Lock"). You need to tell MAME in its configuration that you want to do this—it is not enabled by default.

The I-PAC makes adding these indicators easy through the use of its optional LED harness, but it's possible to get the same functionality out of the Mini-PAC. The way this is done is to make three of the seldom-used player buttons bi-directional, and hooking LEDs to those control lines. These connections are:

Player 1 Button 7

Player 2 button 7

Player 1 button 8

You will need to wire 220-ohm resistors between the LEDs and a +5v supply.

These inputs can still be used for buttons even if LEDs are connected, but note that when the buttons are pressed the LEDs will light. You can wire your own LEDs to these connections.

Using LED indicators to illuminate non-illuminated buttons

A common "hack" for using the LED indicators is to illuminate the Player-1 and -2 "Start" buttons using the control lines mentioned above. Many have found that it is not difficult to mount an LED inside these pushbuttons!

To do so, squeeze the two tabs holding the button inside the housing (see the photo of the pushbutton earlier in this manual—the tabs are the two small rectangles flanking the "fork" that holds the micro-switch). With the tabs squeezed, the button can be removed from the housing. Don't lose the spring.

Making sure that the micro-switch is removed from the pushbutton, a hole can be drilled down through the bottom of the housing. An LED can be mounted in this hole (small LED 'collars' can be purchased to help secure them). With the micro-switch back in place, the two leads of the LED straddle the switch.

If you choose to perform this surgery, you will probably need to solder your wires to the leads. You may also want to use heat-shrink tubing to cover the exposed LED leads to reduce the risk of short circuits.

Please remember that dismantling, drilling, and wiring lighting into pushbuttons is most definitely "hacking" and will void any warranties of the pushbuttons. Also, Ultimarc cannot take any responsibility for such a procedure—it is simply mentioned here to let you know what many others have successfully done.

Using lamps or super-bright LEDs

Most LEDs give off a respectable amount of light considering the low voltage and current that pass through them. However, if you are mounting your LEDs behind or inside semi-opaque plastic, the illumination from a standard LED may not be enough. Some arcade aficionados prefer using 12v lighting, such as the C161 bulbs common to coin mechanisms and pinball machines, rather than LEDs.

The power coming over the bi-directional control line from the Mini-PAC is not enough to power 12v lamps. If you chose to go this route, you will need to find a way to use the control line to switch a 12v power supply. There are examples of such circuits on the Internet where the control line is used to control a transistor that acts as a switch between the lamp/LED and a 12v supply (often tapped off of a PC's power supply) but the specifics are beyond the scope of this document.

Again it must be stated that Ultimarc cannot take any responsibility for such a procedure—it is simply mentioned here to let you know what many others have successfully done.

Testing the Mini-PAC

Boot the PC into DOS or Windows and run a text program such as Notepad. If in DOS, enter COPY CON to suppress the command prompt. On a keyboard plugged into the pass-through, press CTRL-ALT-P. (press and hold each key in this order).

If the MAME/ALT jumper is set to MAME, the unit will go into test mode. If not, enter "T" in the menu to enter test mode. All pressed buttons and joysticks will be displayed on the screen. The input will be shown, followed by the code which is currently assigned, followed by the shifted code, if one is assigned. Test all buttons and joystick switches. If everything looks good, reboot to exit. Now get ready to play—your Mini-PAC is working and wired correctly!

Some notes

Keyboard Detection—A PC with a Mini-PAC properly connected to it should pass BIOS keyboard self-test with or without a normal keyboard connected. The unit is capable of being used in a closed arcade cabinet with no additional keyboard or controls and motherboard booting into an emulation menu. If an auxiliary keyboard is connected it can be used fully and even used during game-play alongside your control panel.

USB Mini-PAC with PS/2 Keyboard—In USB mode the keyboard pass-thru connector does still work, and the I-PAC translates the PS/2 keyboard protocol into USB. This is primarily for using interactive programming and test mode. It is recommended that, with Mini-PAC in USB mode, you normally connect your PS/2 or USB keyboard directly to the PC.

USB DOS Support—Most PCs support a USB keyboard in DOS mode, so the Mini-PAC in USB mode MAY work in DOS. (USB keyboard support may have to be enabled in the BIOS.) *However*, many BIOSes have poor USB support which prevents their use for gaming as the response is too slow. USB was intended for Windows use, either in a "DOS box" or a windows application.

Programming the Mini-PAC

The Mini-PAC has a built in ROM programmed with standard key codes for the MAME arcade emulator (see the following page for details). If you wish to program your own key codes, set the MAME/ALT jumper to “ALT”. In this mode the unit will not respond until it is first programmed as it is shipped with an empty EEPROM memory.

There are two methods of programming the board. The IPACUTIL utility can be downloaded from the Ultimarc web site and run from Windows 95/98/ME/DOS. (See I-PAC programming instructions for details OR you can enter the Interactive Programming and Test Mode by pressing CTRL-ALT-P on a keyboard connected to the pass through.)



The WinIPAC programming utility (refer to its documentation for use); programming utilities for Windows, Maintosh, and Unix computers are available for free download on Ultimarc’s web site.

You might also need to do some setting-up in MAME, because buttons 5 and 6 are not normally assigned by default in MAME and must be programmed (press tab in any game).

Shift-Mode

The Mini-PAC has a built-in way to add extra functionality to your arcade controls. Pressing and holding the 1-Player Start pushbutton enables shift-mode with access to the following keys (when “MAME” setting is used):

- | | | |
|----------------|---------|--|
| 2 player start | “Esc” | For exiting game and jumping back to the emulator menu |
| Joystick left | “Enter” | For running games in Windows and for MAME game config menu |
| Joystick right | “Tab” | For entering MAME config menu |
| Joystick up | “~” | For entering MAME volume/gamma menu |
| Joystick down | “P” | The MAME default pause key |
| P-1 Button-1 | “5” | For simulating coin insert. |

The above shift keys can be changed or turned off as required if the board is programmed. (MAME hint: to get past “Type OK to continue” prompt, just move joystick left then right.)

Default Programmed Key Codes

The following table shows the default “MAME” programming. The controls are color-coded to match the Mini-PAC wiring harness. Black text without boldfacing indicates a white wire in the harness.

INPUT	Key-press code sent with jumper set to “MAME”	
	<u>Normal Codes</u>	<u>‘SHIFT’ Codes (hold “P1 Start” button to Shift)</u>
P1 COIN	5	
P2 COIN	6	
P1 START	1	
P2 START	2	ESC]
P1 RIGHT	[R arrow]	Tab]
P1 LEFT	[L arrow]	[Enter]
P1 UP	[U arrow]	[~] [Tilde (adj volume, gamma, etc)]
P1 DOWN	[D arrow]	[P] (pause)
P1 SW 1	[L-ctrl]	5 (P1 Coin)
P1 SW 2	[L-alt]	
P1 SW 3	[space]	
P1 SW 4	[L-shift]	
P1 SW 5	Z	
P1 SW 6	X	
P1 SW 7	C	
P1 SW 8	V	
P2 RIGHT	G	
P2 LEFT	D	
P2 UP	R	
P2 DOWN	F	
P2 SW 1	A	
P2 SW 2	S	
P2 SW 3	Q	
P2 SW 4	W	
P2 SW 5	I	
P2 SW 6	K	
P2 SW 7	J	
P2 SW 8	L	