

## Introduction

Congratulations on your purchase of the M-Audio ProKeys 88sx, the complete all-purpose digital piano with additional MIDI control. We strongly recommend that you read through this manual to learn about proper installation, operation and advanced functionality before using this product.

### What's in the Box

Besides the product itself, the ProKeys 88sx package will include the following items:

- Software CD (drivers and applications)
- 5-foot USB cable
- Printed user manual
- Power supply (12V DC)
- Sustain pedal

If any of these items are missing, please contact the retail outlet where you purchased this product.

### ProKeys 88sx Overview

The ProKeys 88sx is an 88-note digital piano with MIDI controller features.

The ProKeys 88sx offers seven high-quality sounds and can be used in standalone mode with headphones or external amplification.

You can also connect an external MIDI sound module or MIDI synthesizer/keyboard to the MIDI ports on the back, or even connect a computer via the built in USB interface. The ProKeys 88sx makes it easy to control and play virtual instruments as well as traditional hardware sound modules whether you are composing, recording or playing live.

### About This Manual

The ProKeys 88sx can function as a stand-alone digital piano, or a MIDI controller if used in conjunction with your computer or sound module.

Part 1 of this manual will detail the functions of the ProKeys 88sx as a standalone digital piano. In part 2 we will present the MIDI controller features of the ProKeys 88sx. Finally, part 3 takes a look at the ProKeys 88sx as a master controller for your home MIDI studio.

You may decide to use the ProKeys 88sx as a Digital Piano only. In this case, there is no need to consult parts 2 or 3, unless you are curious about the unit's advanced functionality.

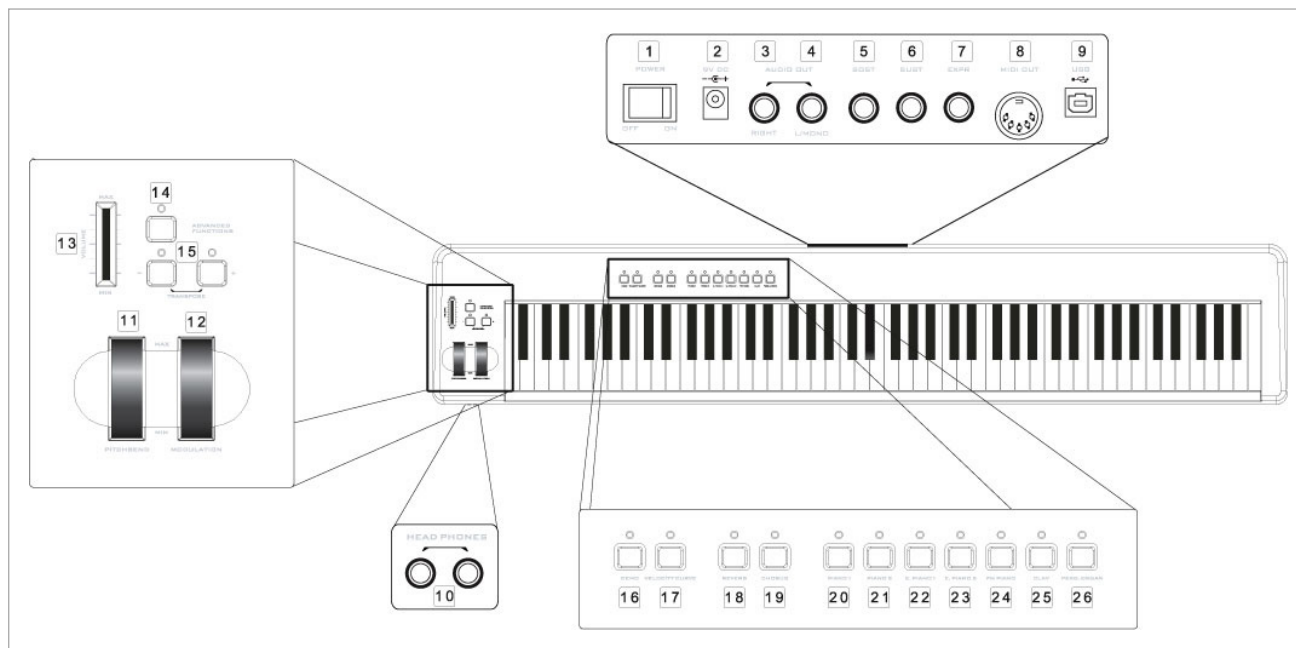
### Terminology

Before we begin, please take a moment to familiarize yourself with some terminology that we will use throughout this manual.

- **Performance Mode** - When you first turn on your ProKeys 88sx, it will be in Performance mode. In Performance mode, the keys of your ProKeys 88sx are used for generating musical notes.
- **Edit Mode** - Edit mode describes the state after the Advanced Functions button has been pressed, in which you can adjust parameters. In Edit mode, the keys of your ProKeys 88sx are used for data entry and selecting various functions. Please consult Appendix B for a diagram that maps out these functions.
- **Instrument** - The ProKeys 88sx comes with 7 built-in instruments including Piano 1 and 2, Electric Piano 1 and 2, FM Electric Piano, Clav, and Perc Organ. Different instruments are selected by pressing one of the 7 instrument select buttons.

### Controls and Connectors Diagram

The controls and connectors are referred to by name. The following illustration identifies the name and location of each control or connector on your ProKeys 88sx.



- |   |  |
|---|--|
| 1: Power switch – Page 6.                           | 12: Modulation wheel – Page 8 and 14.                              |
| 2: DC power supply socket – Page 6.                 | 13: Volume Slider – Page 8 and 15.                                 |
| 3: Audio Out jack (right channel) – Page 7.         | 14: Advanced Functions button – referenced throughout this manual. |
| 4: Audio Out jack (left channel, or mono) – Page 7. | 15: Transpose buttons – Page 9 and 13.                             |
| 5: Sustain pedal jack – Pages 8 and 16.             | 16: Demo button – Page 7   |
| 6: Sostenuto pedal jack – Page 8 and 16.            | 17: Velocity curve – Page 8  |
| 7: Expression pedal jack – Page 8 and 16.           | 18: Reverb Effect button – Page 8                                  |
| 8: MIDI Out port – Pages 10 and 12.                 | 19: Chorus Effect button – Page 8                                  |
| 9: USB 1.1 port – Page 11.                          | 20-26: Instrument buttons – Page 7 and 13.                         |
| 10: 2 headphone sockets – Page 7.                   |  |
| 11: Pitch bend wheel – Pages 8 and 14.              |  |

### Function Keys in Edit Mode

When you press the Advanced Functions button, the ProKeys 88sx enters Edit Mode. In Edit mode, keys C1 to C5 of the ProKeys 88sx are used for data entry. Please also consult Appendix B on page 22 for an illustration of how the functions are mapped across the keys. The functions are listed below and a page reference is also given to tell you where you should look in the manual to see what each function is used for.

#### White Keys

- C1 .....Cancel ..... Page 15
- D1 to E3 .....Channel Select ..... Page 12
- F3 .....Default ..... Page 15
- G3 to B4 .....Data Entry ..... Page 15
- C5 .....Enter ..... Page 15

#### Black Keys

- C#1 .....Data = Octave ..... Page 9, 13
- D#1 .....Data = Transpose ..... Page 9, 13
- F#1 .....Data = Program. .... Page 12
- G#1 .....Data = Bank LSB ..... Page 12
- A#1 .....Data = Bank MSB ..... Page 12
- C#2 .....Data = Channel. .... Page 12

#### Black Keys (continued)

- D#2 .....Data = Tuning ..... Page 9
- F#2 .....Panic ..... Page 16
- G#2 .....MIDI Out from USB. .... Page 17
- A#2 .....Local Off. .... Page 12
- C#3 .....Octave + ..... Page 9, 13
- D#3 .....Octave - ..... Page 9, 13
- F#3 .....Wheel Assign. .... Page 15
- G#3 .....Pedal Assign ..... Page 15
- A#3 .....Slider Assign ..... Page 15
- C#4 .....Transpose + ..... Page 9, 13
- D#4 .....Transpose - ..... Page 9, 13
- F#4 .....Program. .... Page 12
- G#4 .....Bank LSB ..... Page 12
- A#4 .....Bank MSB. .... Page 12

### Powering Up Your ProKeys 88sx

The ProKeys 88sx can only be powered using the included PSU with the correct power specifications.

Should you require a different power supply, the specifications are:

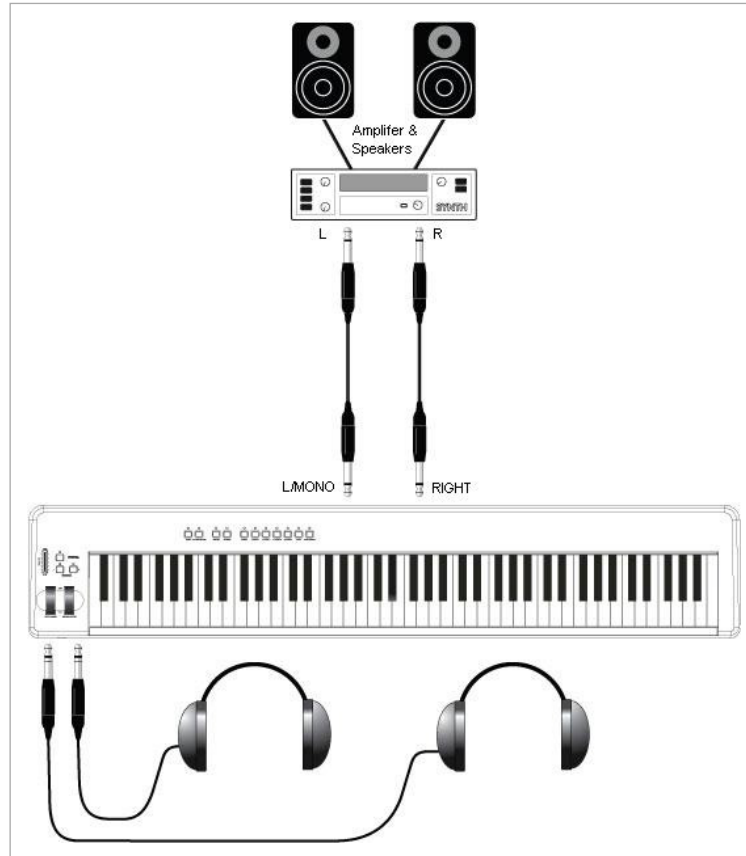
- 12V DC
- Center positive
- 1000mA

## Part 1: ProKeys 88sx as a Digital Piano

### 1.0 Introduction

In Part 1, we will look at how to use the ProKeys 88sx as a standalone digital piano.

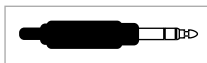
### 1.1 Setup



The ProKeys 88sx should be connected to a mixer or amplifier which in turn should be connected to a pair of speakers.

The Audio Out jacks on the ProKeys 88sx take 2 standard 1/4" jack plugs. Such instrument cables are available in most professional audio retailers.

**Mono Operation** – If a jack is plugged into the left audio output only, a mono mix of the audio from the ProKeys 88sx will be heard.



There are also 2 headphone sockets on the front of the ProKeys 88sx, underneath the Pitch Bend and Modulation wheels. These jacks will accept a 1/4" jack plug as used on many standard headphone sets.

### 1.2 Instrument Buttons

Each instrument button will call up the associated sound. The Instruments available to you are:

- Piano 1 – Classical Grand Piano
- Piano 2 – Bright Piano
- E. Piano 1 – Rhodes™
- E. Piano 2 – Wurlitzer™
- Clav – Clavinet™
- FM Piano – DX7™
- Percussive Organ – B3™

### 1.3 Demo

The Demo button allows you to hear what the ProKeys 88sx is really capable of. When you press the Demo button, the LEDs above each of the instrument buttons will flash. If you then press an instrument button, you will hear a demo of that instrument. To exit out of this Demo mode, press the Demo button again. The LED above the Demo button will turn off, and Performance mode will resume.

## 1.4 Velocity Curve

The ProKeys 88sx has four different velocity curve settings. The velocity curves define the response of the keyboard to how hard or soft you strike a key. You should experiment with each to find which curve best suits your playing style. To cycle through the various velocity curves, keep pressing the Velocity Curve button.

One of the four curves gives a fixed velocity of 100 regardless of how hard or soft you strike a key. When this curve is selected, the velocity curve is effectively OFF. The LED above the Velocity Curve button will turn off to reflect this.

## 1.5 Volume Slider

The Volume slider will control the output level of your ProKeys 88sx.

## 1.6 Sustain Pedal

If you connect a foot switch pedal to the Sustain Pedal socket, you will be able to control the decay of the sound just like a sustain pedal does on a real piano. A sustain pedal affects all notes played while the pedal is being held down.

## 1.7 Sostenuto Pedal

If you connect a foot switch pedal to the Sostenuto Pedal socket, this pedal performs the same function as on a real piano. The sostenuto pedal affects only those notes held down at the time the pedal is depressed.

## 1.8 Expression pedal

A continuous controller-type pedal can be connected to the Expression Pedal socket. This pedal can be used to control the volume level of the ProKeys 88sx. Controlling the volume with your foot allows you to keep both hands on the keyboard at all times.

## 1.9 Pitch Bend Wheel

The Pitch Bend wheel allows you to bend the pitch of your instrument. The Pitch Bend will raise or lower the pitch of your instrument by two semi-tones. For example, if you play a C and push the Pitch Bend wheel all the way forward, the note you hear will be D. If you pull it all the way back towards you, you will hear Bb.

## 1.10 Modulation Wheel

Some of the instruments have Tremolo and Vibrato effects associated with them. The Modulation wheel will control the depth of these effects. So, if you set the wheel at the bottom, the Tremolo/Vibrato effect will be off. If you then move the modulation wheel upwards, the Tremolo/Vibrato effect will become more and more prominent.

The following table defines the effect that the Modulation wheel controls for each of the seven instruments:

Instrument	Effect
Piano 1	None
Piano 2	None
E. Piano 1	Tremolo
E. Piano 2	Tremolo
Clav	None
FM Piano	Tremolo
Perc. Organ	Vibrato

## 1.11 Digital Effects

There are two digital effect buttons – Reverb and Chorus. Reverb will add ambience, as if you are playing your instrument in a large hall or church. Reverb can be used to add warmth to the sound of your instrument.

Chorus is an effect that sounds much like two of the same instruments being layered together and slightly detuned one from the other. It can be used to fatten up the sound of your instrument. In some cases, Chorus can make your instrument sound like a different instrument altogether. For example, adding a lot of Chorus to Piano 1 or Piano 2 will add a “honky-tonk” effect to the piano sound.

Each of the digital effects has four levels of depth – Reverb (off, small, medium and large) and Chorus (off, narrow, medium and wide). Pressing the Reverb or Chorus button repeatedly will select the depth of the corresponding effect. The depths increase in ascending order.

When the effect is set to off, the LED above the relevant button remains off. Pressing the effect button will then turn the effect on, with a small depth. Pressing the button again will increase the depth from a “small” or “narrow” amount, to a “medium” amount, and pressing it again will increase the depth further. The LED will remain on. Finally, pressing the button a third time will set the effect back to off and switch off the LED.

## 1.12 Transpose Buttons

The Transpose buttons can be used to change the pitch of the instrument. Some players like to play in a particular key like C or F, for example. Transpose lets you change the pitch of your instrument and continue to play in the key that is most comfortable for you. It is possible to transpose up or down by as much as 12 semitones. This means if you press the transpose + or – button 12 times, the tone will sound exactly one octave higher or lower.

The Transpose buttons each have an associated LED. When the ProKeys 88sx is not transposed, both LED's will be off. If you set the transpose to a negative value, the LED above the Transpose - button will light up, but the LED above the Transpose + button will remain off. If you set the transpose to a positive value, the + LED will light up.

Pressing both Transpose buttons at the same time will set the transpose back to zero, and both LEDs will switch off.

### 1.12.1 Octave

It is also possible to set the Transpose buttons so as to shift a whole octave “on the fly”. This is achieved as follows:

- Press Advanced Functions.
- Press key C#1.

It is possible to change the keyboard's pitch by a maximum of one octave down or two octaves up. Pressing both Transpose buttons together will set the octave shift back to zero and both LEDs will turn off.

In order to switch the Transpose buttons back to controlling Transpose:

- Press Advanced Functions.
- Press key D#1.

If you just want to make a quick octave adjustment, and do not wish to alter the assignment of your Transpose buttons, this is achieved using the Octave + and Octave – function keys when in Edit mode.

- Press Advanced Functions.
- Press key C#3 to decrease the pitch, or D#3 to increase it.

### 1.12.2 Master Tuning

The Transpose buttons can also be assigned to control the master tuning. To set this up:

- Press Advanced Functions.
- Press key D#2.

You can now use the Transpose + and - keys to alter the master tuning of the keyboard by up to 100 “cents” (100 cents = 1 semitone) in either direction. Pressing both Transpose buttons together will shift the tuning back to zero.

In order to switch the Transpose buttons back to default:

- Press Advanced Functions.
- Press key D#1.

**Note:** If you have assigned the Transpose buttons to a function other than transpose, it is still possible to transpose your ProKeys 88sx, using the Transpose + and Transpose – function keys in Edit mode:

- Press Advanced Functions.
- Press key C#4 to decrease the pitch, or D#4 to increase it.

## 1.13 Resetting the Keyboard

On power up, the keyboard is in its default state of Performance mode, with all effects set to off, and the tuning, transpose and octave shifts set to zero. Any edits made of the types that are defined in part 1 of this manual will not be saved across power cycles since the keyboard resets each time you power up.

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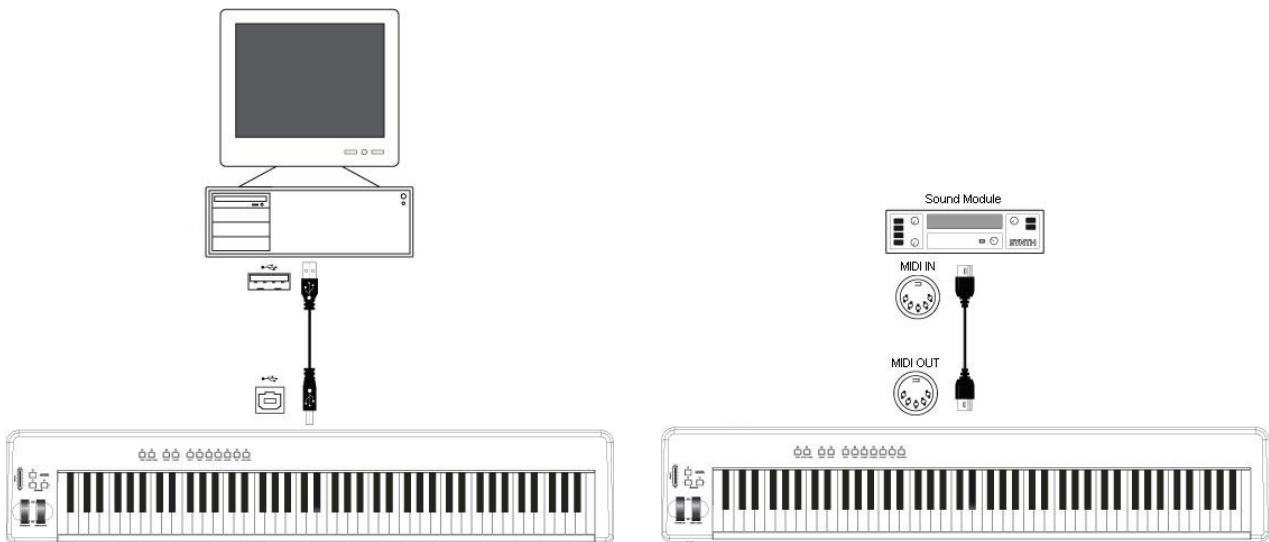
## Part 2: The ProKeys 88sx as a MIDI Controller

### 2.0 Introduction

The USB MIDI capabilities of the ProKeys 88sx make it a very useful controller for software-based virtual instruments and synthesizers. Part 2 takes an in-depth look at the ProKeys 88sx as a USB MIDI controller for use with MIDI applications on a computer, or as a MIDI controller for sound modules.

Programming the various MIDI parameters that the ProKeys 88sx offers is achieved in Edit mode. To engage Edit mode, press the Advanced Functions button. Please refer to the illustration in Appendix B for a full outline of the function keys in Edit mode.

### 2.1 Setup



If you only intend to use your ProKeys 88sx to control a sound module or synthesizer through the MIDI out port, there is no need to read the following three sections and you should skip to section 2.4. If you intend to connect your ProKeys 88sx to a computer, please be sure you read sections 2.2 and 2.3 first.

### 2.2 Minimum System Requirements

If you are using your ProKeys 88sx with a computer, the following minimum system requirements apply:

#### Windows XP

- Pentium II 350MHz
- 128MB RAM
- native USB 1.1 port

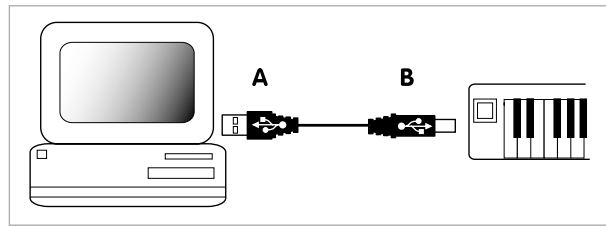
#### Mac OS X 10.2.8 or higher

- G3 450MHz
- 128MB RAM
- native USB 1.1 port

These are the requirements your computer must have to work with your keyboard. However, please check your software application(s) for any additional minimum system requirements.

## Before You Connect your ProKeys 88sx...

**Important:** Do not connect the USB to a computer until instructed to do so in the installation instructions that follow.



Your computer must have a USB port. The wide flat end of the included USB cable (A) connects to the USB port at the back or on the side of your computer. Plug the square end of the cable (B) into the back of the keyboard.

The ProKeys 88sx cannot use the USB cable to provide the keyboard with its power. You must power your ProKeys 88sx using the included power supply. If you wish to use an alternative power supply, make sure to choose one that meets the required specifications given on page 6.

## 2.3 Driver Installation Procedure

### 2.3.1 Basic Installation

Because it is a class-compliant device, installing the ProKeys 88sx on your Windows XP or Mac OS X computer is simple and straightforward:

- Use the supplied USB cable to connect the ProKeys 88sx to a USB port on your computer, connect and plug-in the power supply, and you'll be ready to go! You can do this while the computer is on or off, and no driver installation is necessary.

### 2.3.2 Installing the Windows Multi-Client Driver

While class-compliance offers easy setup and connection of the ProKeys 88sx, the Windows class driver allows only one MIDI application, or program, to use the ProKeys 88sx at any given time. For many users, this is perfectly acceptable, as they will only be using the ProKeys 88sx to communicate with their host MIDI/audio application.

However, if you use multiple applications at once, including applications "ReWired" together (such as Ableton Live™ as a host and Propellerhead Reason™ as a slave), you'll need to install the Windows ProKeys 88sx MIDI driver so that both the host and the ReWired application can be simultaneously controlled from the ProKeys 88sx.

**PLEASE NOTE:** DO NOT connect your ProKeys 88sx to your computer until the appropriate driver files have been copied to your computer.

1. Insert the Stage Piano Series CD-ROM into your computer's CD-ROM drive.
2. The computer will automatically display the interactive menu. If your computer fails to launch the menu, manually start the menu by clicking on Start > My Computer > Stage Piano Series > autorun.exe.
3. Follow the onscreen directions to choose your product. Once you select your product, click "Install" to begin copying files.
4. Follow the driver installer's on-screen instructions.
5. At various points in this installation process, you may be notified that the driver being installed is not "digitally signed." Click "Continue Anyway" to proceed with the installation.
6. Click "Finish" once the installer is complete.
7. Connect your ProKeys 88sx to an available USB port and switch it on.
8. Windows will identify the new MIDI device and will display a "Found New Hardware Wizard." If you have Service Pack 2 installed on your computer, you will be asked if you'd like to search the Internet for a driver. Please select "No, not this time" and press "Next."
9. Choose "Install software automatically (recommended)" and click "Next."
10. Once the wizard is completed, click "Finish." You will see a message pop up that says "Your new hardware is installed and ready to use."

### 2.3.3 Using the ProKeys 88sx with Your Software

When installed, the ProKeys 88sx will appear in the computer as a simple MIDI device with one input port and two output ports. You should select the ProKeys 88sx input port as the MIDI input device in your audio application. The application will then be able to read any of the data transmitted by you from the ProKeys 88sx.

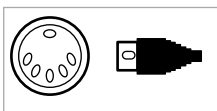
To trigger the internal sounds of your ProKeys 88sx using MIDI data from your sequencer, you should select the first ProKeys 88sx MIDI output that you see in your sequencer's MIDI output devices.

To stream data directly to the external MIDI Out port of your ProKeys 88sx, you should select the second ProKeys 88sx MIDI output that you see in your sequencer's MIDI output devices.

The port names are defined in the table below. Note that the MIDI ports will appear with different names depending on whether you are using Mac or PC, and whether you've installed the Windows multi-client driver or not:

	Input Port	Output to Internal Sounds	Output to MIDI OUT port
<b>Mac OS X</b>	USB ProKeys 88sx	USB ProKeys 88sx port 1	USB ProKeys 88sx port 2
<b>Windows Class Driver</b>	USB Audio Device	USB Audio Device (1)	USB Audio Device (2)
<b>Windows Multi-Client Driver</b>	USB ProKeys 88sx In	USB ProKeys 88sx Out (1)	USB ProKeys 88sx Out (2)

## 2.4 MIDI Connections



The MIDI Out jack allows connection of a standard 5-pin DIN-type MIDI plug. Such cables are available from most professional audio retailers.

The MIDI Out jack can be used to connect your ProKeys 88sx to a sequencer or an external synthesizer, allowing the ProKeys 88sx to trigger the various sounds of the synth or tone module.

## 2.5 Local Mode

You may find it useful to turn Local mode off when using the ProKeys 88sx as a MIDI controller. When Local mode is turned off, the keyboard of your ProKeys 88sx will not control the internal sounds. However, it will continue to send and receive MIDI data to and from both the USB MIDI port (if you are connecting your ProKeys 88sx to a computer) and MIDI output port (when connecting to a MIDI interface or external MIDI device).

Setting Local mode to off does not mean that the internal sounds of your ProKeys 88sx are completely disabled. The internal sounds will continue to respond to incoming MIDI messages from the USB port.

By default Local mode is on. Note that this will be the case each time you turn your ProKeys 88sx on. To turn Local mode off:

- Press the Advanced Functions button
- Press the Local Off function key, key A#2 (see Appendix B).
- Performance mode will resume. However, playing the keyboard will no longer trigger the internal sounds.
- To turn Local mode back on, repeat the three steps outlined above.

## 2.6 MIDI Channel

The ProKeys 88sx' default MIDI channel is set to "1." However, you are able to transmit on any channel from 1 to 16. The ProKeys 88sx will only transmit on one channel at a time and cannot transmit on multiple channels simultaneously. If you are using a computer, often the MIDI software will be receiving on all channels. However, with external MIDI synthesizers, sound modules and some virtual instruments, you will need to match the transmit channel of your ProKeys 88sx with the receiving channel of your MIDI device in order for things to work properly.

To change the transmit channel of your ProKeys 88sx:

- Press the Advanced Functions Button
- Press one of the white Channel keys, which run from D1 to E3. These are labelled as CH1 to CH16 in Appendix B.

Alternatively you can set the + and – buttons to control the MIDI transmit channel:

- Press the Advanced Functions button
- Press the DATA = CHANNEL key, C#2 (see Appendix B).
- Performance mode will resume.
- You can now use the Transpose + and - buttons to change between different channels.

Controlling Percussion Sounds – Setting the transmit channel of your ProKeys 88sx to channel 10 will allow you to control percussion sounds on your external GM, GS, or XG module or synthesizer.

Turning Velocity Off - You may prefer not to use velocity sensitivity when playing drums or percussion programs, especially if you are playing sounds from original sound-generating devices that cannot respond to velocity information changes. Turn velocity off by pressing the Velocity Curve button until the LED above it turns off.

## 2.7 Program, Bank LSB, and Bank MSB Messages

Program messages (commonly referred to as program changes) are used to select different instrument sounds in a MIDI device. Program messages cover a range of 128 instruments. These instruments are accessed by sending program numbers 0 to 127.

Some MIDI devices have more than 128 instruments. If this is the case, the instruments tend to be separated into banks. You can send bank MSB and bank LSB messages from the ProKeys 88sx to access these different banks. Please consult the user manual of your MIDI device to see the bank numbers and program numbers that map to the different instruments that are available to you.

### To Send a Program Change:

- Press the Advanced Functions button.
- Press the Program function key, F#4 (see Appendix B).
- Use the white data entry keys, F3 to B4 to enter the number of the program change you want to send.
- Press C5 to accept the value and return to Performance Mode.

### Alternatively,

- Press the Advanced Functions button.
- Press the 'DATA = PROGRAM' key, F#1 (see Appendix B).
- Performance mode will resume.
- You can now use the Transpose + and - buttons to change between different Programs.

**To Send a Bank Change:**

- Press the Advanced Functions button.
- Press either the Bank LSB or Bank MSB function key, keys G#4 and A#4 respectively.
- Use the white data entry keys, F3 to B4 to enter the number of the Bank LSB or MSB message you want to send.
- Press C5 to accept the value and return to Performance mode.

**Alternatively,**

- Press the Advanced Functions button.
- Press either the 'DATA = BANK LSB or DATA = BANK MSB' key, keys G#1 and A#1 respectively.
- Performance mode will resume.
- You can now use the Transpose + and - buttons to change between different Banks.

## 2.8 The Instrument Buttons

The instrument buttons can also be used to send Program changes out on the current transmit channel of your ProKeys 88sx. The Program changes that these buttons send are listed in the table below. The Program change message will be accompanied by a Bank LSB and MSB message with a value of zero. These are also the Program messages you will need to send from your computer or sequencer to the ProKeys 88sx, in order to play the programs from an external source.

Program	Instrument
00	Piano 1
01	Piano 2
04	E. Piano 1
02	E. Piano 2
05	FM Piano
07	Clav
17	Perc. Organ

## 2.9 Transpose Buttons

The Transpose buttons can be used to change the pitch of the instrument. Some players like to play in a particular key like C or F, for example. Transpose lets you change the pitch of your instrument and continue to play in the key that is most comfortable for you. It is possible to transpose up or down by as much as 12 semitones. This means if you press the Transpose + or - button 12 times, the tone will sound exactly one octave higher or lower.

The Transpose buttons each have an associated LED. When the ProKeys 88sx is not transposed, both LEDs will be off. If you set the transpose to a negative value, the LED above the Transpose - button will light up, but the LED above the Transpose + button will remain off. If you set the transpose to a positive value, the + LED will light up.

Pressing both Transpose buttons at the same time will set the transpose back to zero, and both LEDs will switch off.

**Note:** If you have assigned the Transpose buttons to a function other than transpose, it is still possible to transpose your ProKeys 88sx, using the Transpose + and Transpose - function keys in Edit mode:

- Press Advanced Functions.
- Press key C#4 to decrease the pitch, or D#4 to increase it.

### 2.9.1 Octave

It is also possible to set the Transpose buttons so as to shift a whole octave "on the fly." This is achieved as follows:

- Press Advanced Functions.
- Press key C#1.

It is possible to change the keyboard's pitch by a maximum of one octave down or two octaves up. Pressing both Transpose buttons together will set the octave shift back to zero and both LEDs will turn off.

In order to switch the Transpose buttons back to controlling Transpose:

- Press Advanced Functions.
- Press key D#1.

If you just want to make a quick octave adjustment, and do not wish to alter the assignment of your Transpose buttons, this is achieved using the Octave + and Octave - function keys when in Edit mode.

- Press Advanced Functions.
- Press key C#3 to decrease the pitch, or D#3 to increase it.

## 2.10 Pitch Bend Wheel

The Pitch Bend wheel allows you to bend the pitch of your instrument. The range of frequencies that the pitch bend wheel will achieve depends on the default Pitch Bend Range setting of your sound module, or virtual instrument. However, in many cases, by default the pitch bend will increase or decrease the pitch by two semi-tones. For example, if you play a C and push the Pitch Bend wheel right to the top, the note you hear will be D. If you pull it all the way back towards you, you will hear Bb.

It is possible to alter the range of the Pitch Bend wheel to allow even larger pitch shifts. This is explained in detail on page 16.

## 2.11 MIDI Controller Messages

There are 128 MIDI controller messages that are used for controlling the MIDI-adjustable parameters on your MIDI device. Examples of these controllable parameters include volume, pan, expression, reverb, chorus and portamento.

There are three controls (Slider, Modulation Wheel, Expression Pedal) on your ProKeys 88sx that can send any of the 128 MIDI controller messages to control such parameters. Please note that in order for these effects to work, the MIDI device you are sending them to must be able to receive these messages!

The controls that are able to send MIDI controller messages are the volume slider, the modulation wheel and the expression pedal. By default, these controls are assigned to send master volume, modulation, and expression messages, respectively. However, you can assign them to send different MIDI controller messages, by changing the number that is assigned to the control. These numbers are defined in Appendix C.

For example, you may want to set the Modulation wheel to control a reverb amount. This would be achieved by changing the control number of the Modulation wheel assignment to 91.

Examples of other popular effects are listed in the table below. Please consult Appendix C for the full list.

Effect	Control Number
Modulation	1
Volume	7
Pan	10
Expression	11
Reverb depth	91
Chorus depth	93

### 2.11.1 Extra Controller Messages

You may have noticed that although we have said there are 128 MIDI controller messages, Appendix C shows 132. This is because messages 128 – 131 are not “standard” MIDI controller messages, but are useful messages that we have added to the controller list. They are more complicated messages, but you can assign them to your controls in exactly the same way as any other MIDI controller message.

The extra messages are supported by GS, XG and GM2 devices. The use of each message is given in the table below:

Controller Number	MIDI Message	Use
128	Pitch Bend Sensitivity	Alters the range of a pitch bend message
129	Master Tune (coarse)	Adjusts the tuning of your sound module or synthesizer in large steps
130	Master Tune (fine)	Adjusts the tuning of your sound module or synthesizer in small steps
131	Channel Aftertouch	Adds a vibrato effect

### 2.11.2 Data Entry

Some of the Advanced Functions require data entry. When in Edit mode, you can use keys F3 to B4 for data entry. Pressing ENTER will select the data value you have entered and your ProKeys 88sx will return to Performance mode. Alternatively you can press CANCEL, which will return your ProKeys 88sx to Performance mode and ignore any entries you may have made.

The following tables define Advanced Functions that require data entry, and the range of the data you can enter:

Key	Advanced Function	Data Range
F#2	Wheel Assign	0-131
G#2	Pedal Assign	0-131
A#2	Slider Assign	0-131
F#3	Program	0-127
G#3	Bank LSB	0-127
A#3	Bank MSB	0-127

If you enter a value that is out of range for the Advanced Function you have selected to edit, the last two digits you entered will be used as the assigned value if you press Enter to confirm. For example, if you are editing the Wheel Assign value and you enter 135, the value 35 will be accepted if you then press enter.

#### Default

The Default key (F3) is a data entry key that sets the parameter you are editing back to its default value, which is the value that the parameter has at power up. The default key also has the effect of immediately returning the ProKeys 88sx back to Performance mode.

### 2.11.3 Enter Keys

The Enter key is located at the end of the data entry keys, key C5. When the Enter key is pressed, Performance mode resumes. Any parameter selected for editing will be updated with any valid data values entered on the data entry keys. If Enter is pressed without having entered a data value, the parameter remains unchanged.

### 2.11.4 Cancel

Key C1 is the Cancel key. Pressing the Cancel key in Edit mode will exit Edit mode. Performance mode resumes. If any data entry was currently underway, the value entered is ignored.

### 2.11.5 Slider Assign

To assign the Volume slider to a different MIDI Controller message:

- Press the Advanced Functions button.
- Press the Slider Assign function key, key A#3 (see Appendix B).
- Use the white data entry keys, F2 to A3 to enter the number of the Bank LSB or MSB message you want to send.
- Press C5 to accept the value and return to Performance Mode.

The Volume slider can be assigned a controller number from 0 to 131. Please see appendix C for more detail.

**Note:** pressing the Default key during data entry will cause the slider to become assigned to Master Volume.

### 2.11.6 Pedal Assign

To assign the Expression pedal to a different MIDI Controller message:

- Press the Advanced Functions button.
- Press the Pedal Assign function key, key G#3 (see Appendix B).
- Use the white data entry keys, F3 to B4 to enter the number of the controller you wish to assign to the pedal (see appendix C).
- Press C5 to accept the value and return to Performance mode.

The Expression pedal can be assigned a controller number from 0 to 131. Please see appendix C for more detail.

**Note:** pressing the Default key during data entry will cause the pedal to become assigned to Expression (controller 11).

### 2.11.7 Wheel Assign

To assign the Modulation wheel to a different MIDI Controller message:

- Press the Advanced Functions button.
- Press the Modulation wheel function key, key F#3 (see Appendix B).
- Use the white data entry keys, F3 to B4 to enter the number of the controller you wish to assign to the wheel (see appendix C).
- Press C5 to accept the value and return to Performance Mode.

The Modulation wheel can be assigned a controller number from 0 to 131. Please see appendix C for more detail.

**Note:** pressing the 'default key' during data entry will cause the wheel to become assigned to Modulation (controller 11).

### **2.11.8 Sustain Pedal**

If you connect a foot-switch pedal to the Sustain Pedal input, the pedal will send controller 64 on/off messages to your sound module, synthesizer or virtual instrument. The Sustain Pedal when held affects all notes being played until the pedal is released.

### **2.11.9 Sostenuto Pedal**

If you connect a foot-switch pedal to the Sostenuto Pedal input, the pedal will send controller 66 on/off messages to your sound module, synthesizer or virtual instrument. The Sostenuto Pedal affects all notes held down when the pedal is engaged until the pedal is released.

### **2.11.10 Pitch Bend Range**

The range of frequencies that your pitch bend can control can be altered, so long as the Pitch Bend Range message is supported by your sound module or virtual instrument.

To change the range of the pitch bend, you need to assign either the slider, expression pedal or modulation wheel to controller 128 (see appendix C).

Taking the Modulation wheel as an example, the process is as follows:

- Press the Advanced Functions button.
- Press the Wheel assign function key, key F#3 (see Appendix B).
- Press white data entry keys, A3, B3 then A4 to enter the number '128'.
- Press C5 to accept the value and return to Performance mode.
- The Modulation wheel will now vary the range of the pitch shift obtainable from the Pitch Bend wheel.

## **2.12 Panic**

---

Sometimes you may find that the sound on your sound module or virtual instrument does not seem correct. Or, you may find that notes get "stuck" while on and will sound continuously. This may be because your sound module or synth did not properly receive a NOTE OFF message for some reason. There may also be some controller settings that are altering the sound in a way you do not like. You can reset all controllers, and turn off all notes from the ProKeys 88sx, as follows:

- Press the Advanced Functions button.
- Press the Panic key, key F#2 (see Appendix B).
- Performance mode will resume, and the message will be sent on the currently assigned MIDI channel.

Pressing this function key will send the 'reset all controllers' and the 'all notes off' MIDI messages.

## Part 3: Using Your ProKeys 88sx within a MIDI Studio

### 3.0 Introduction

The final part of this user manual takes a look at some advanced uses of your ProKeys 88sx. In this section, we explain how to use the ProKeys 88sx as a master controller for your entire home MIDI studio.

### 3.1 MIDI Out From USB Function

MIDI Out from USB can be used to switch the source of the MIDI data seen at the MIDI Out port of your ProKeys 88sx.

At power up, MIDI Out from USB mode is off. This means that as you play your ProKeys 88sx, MIDI data will be generated at the MIDI Out port.

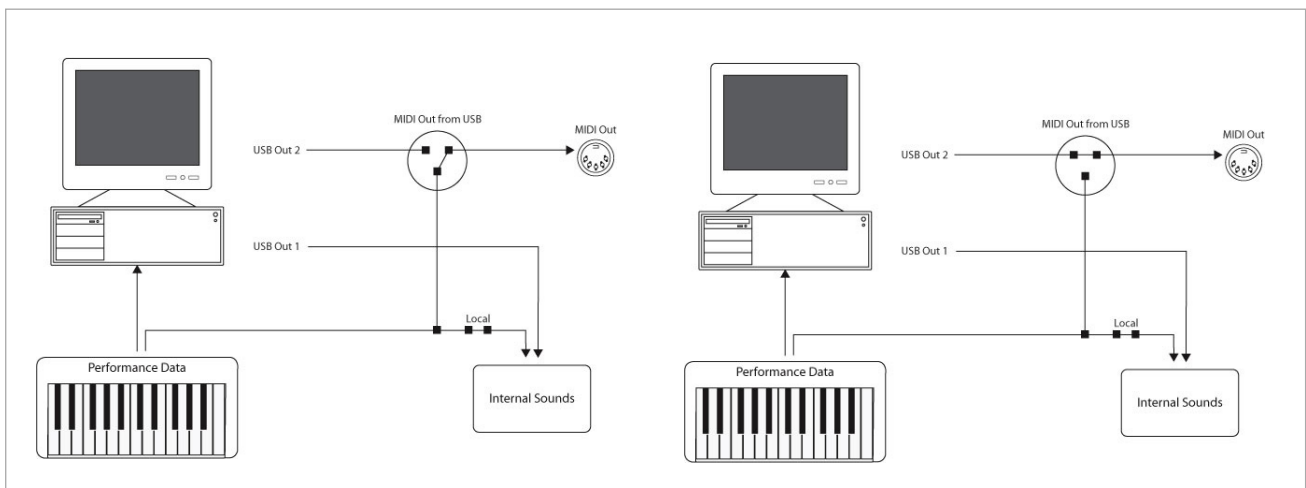
If you turn MIDI Out From USB mode on, playing your ProKeys 88sx will no longer generate data at the MIDI Out port. The data is instead streamed from the computer. So, as long as you have selected the second output port as the MIDI output device in your computer's sequencer, this is the data that will be seen at the MIDI Out port.

For example, if you want to control a sound module from your ProKeys 88sx, you should turn MIDI Out from USB off. If you want the sound module to play data from your computer however, then you should turn MIDI Out from USB on and ensure that the second output port for your ProKeys 88sx is selected as the computer's MIDI output device.

The following diagrams clarify the routing of MIDI data when MIDI out from USB mode is both off and when it is on:

*MIDI Out from USB mode is off:*

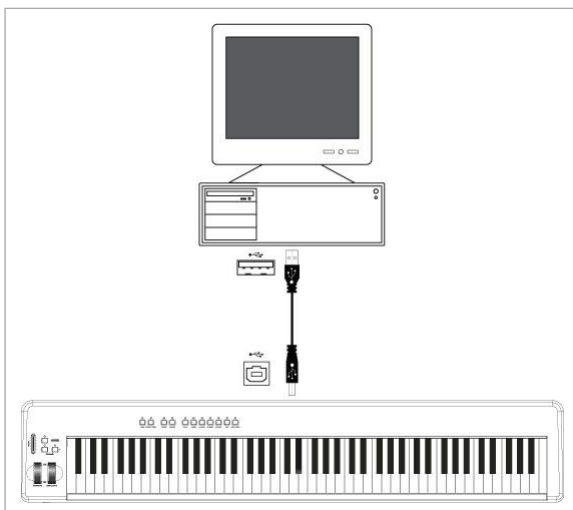
*MIDI Out from USB mode is on:*



To turn MIDI out from USB mode on:

- Press the Advanced Functions Button.
- Press the MIDI Out from USB function key, G#2 (see Appendix B).
- Performance Mode will resume. However, data generated from the keyboard and controls of your ProKeys 88sx will no longer trigger the internal sounds.
- To turn MIDI Out from USB mode back off, repeat the three steps outlined above.

### 3.2 Recording your Performance on a Sequencer



A sequencer is able to record, store and edit MIDI data. Although hardware sequencers also exist, here we are going to focus on software sequencers. Examples of popular software sequencers are Pro Tools™, Cubase™ and Logic™, although there are many varied sequencing applications available for your computer.

In order to use the ProKeys 88sx with your sequencer, you need to set up the sequencer so that the ProKeys 88sx is recognized as the sequencer's MIDI input device.

The first of the two available output devices for your ProKeys 88sx should be selected as your sequencer's output device. The method of setting up the MIDI devices varies between different sequencers. Please consult your sequencer's user manual for more information on how this is achieved. Section 2.3.3, "Using the ProKeys 88sx With Your Software" details how the ProKeys 88sx will appear in the device preferences window of your sequencer.

It is recommended that when recording your performance in a MIDI sequencer, you should turn Local mode off (see page 11) and select MIDI Thru on your sequencer to allow the incoming MIDI data going to your sequencer to be

passed back out to your ProKeys 88sx and thereby allow you to monitor your sounds when recording (consult your sequencer manual for more information).

With the ProKeys 88sx set to communicate with the sequencer in this manner, data will go into the sequencer, and straight back out of the sequencer to trigger the internal sounds of the ProKeys 88sx, when you play the keyboard.

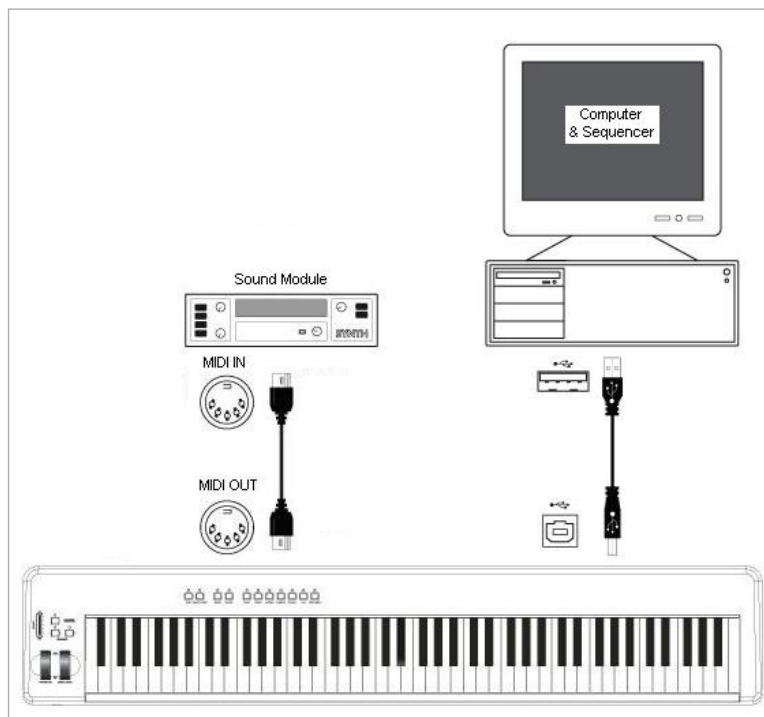
You can therefore record and edit your performance on your sequencer.

### 3.2.1 Percussion Sounds and Unsupported Programs

Please note that if your ProKeys 88sx receives any data on channel 10 from your sequencer, this data has no effect on the internal sounds. (Channel 10 is commonly used for MIDI drums.)

Similarly, if you are sending Program changes from your sequencer, please note that program changes that are not listed in the table on page 13 will not trigger any of the internal sounds. In order to create arrangements with more sounds than just the seven available sounds of your ProKeys 88sx, you should use either a software synthesizer on your computer, or an external sound module. Using an external sound module to achieve additional sounds is explained in the next section.

## 3.3 Controlling a Sound Module from the Computer



By turning on MIDI Out from USB mode (see page 17), the data coming in from the computer will go directly out of the MIDI Out port and trigger the sounds in the external sound module. This means that your ProKeys 88sx is effectively acting as a USB to MIDI interface. In order to channel MIDI data from the computer to the MIDI Out port, you should set the MIDI Output device on your computer to be the second ProKeys 88sx output.

Alternatively, you may want to merge the MIDI data from your ProKeys 88sx with the data from the computer. This would allow you to play and record to a sequencer, and play back the entire performance on a sound module connected to the MIDI Out port of your ProKeys 88sx. To do this:

- Ensure MIDI Out from USB mode is on ((see page 17).
- Turn Local mode off.
- Ensure the ProKeys 88sx is selected as the MIDI Input device in your sequencer.

### And Finally...

If you are still having trouble with any of the features on the ProKeys 88sx, please consult the following troubleshooting guide, which answers some frequently asked questions. If you are still not able to find the answer you are looking for, please feel free to contact M-Audio technical support for further assistance. Support details are given on page 20.

## Troubleshooting

The ProKeys 88sx has been designed to give you high performance and professional quality audio. It has been tested under a wide range of systems and operating conditions. However, there are a virtually limitless number of operating scenarios, any of which may affect your system's performance. Though this section cannot cover all possible issues you may encounter, we would like to offer you some suggestions for dealing with common problems.

If you are connecting to a computer, we recommend that you avoid connecting too many devices to your computer at the same time. The more devices you have connected to the computer, the greater the load on the computer's CPU. Although it is possible in theory to chain multiple USB devices together, doing so may degrade your system's performance.

*If you are experiencing clipping or distortion:*

- Turn the volume slider down. You may be overloading the input of the audio device you have connected the ProKeys 88sx to.
- If you are recording the audio from your ProKeys 88sx on a computer, the distortion may be due to the audio settings of your computer's sound card. This can be corrected by either increasing the audio buffer size used by your soundcard, or trimming its input gain levels. Refer to the user manual for your computer sound card for more information.

*My ProKeys 88sx suddenly stopped working after having performed well since installation on a computer.*

- Switch off the unit and leave it off for 10 seconds. Then restart your computer, power up your ProKeys 88sx and try again. If the problem persists, you may have to reinstall the drivers for the unit. The latest drivers are available at <http://www.m-audio.com>.

*I have plugged in a Sustain pedal to my ProKeys 88sx, but it works backwards.*

- The polarity of the Sustain pedal is calculated by the ProKeys 88sx when it is powered up. On power up, the Sustain pedal is assumed to be in the off position. So, if you want the Sustain pedal to be off when it is not depressed, make sure not to press the pedal when you power up. To reverse the pedal polarity, just press and hold the pedal when you power up. Note: this will have to be done each time you power up the ProKeys 88sx.

*I have connected the ProKeys 88sx to my computer. When I press a key, there is a delay before I hear any sound.*

- This delay is known as latency. Latency with MIDI signals is caused at the computer and is not coming from the ProKeys 88sx. This may be due to the CPU load of the soft-synth you are using. MIDI data is simply control data. MIDI data is read by the soft-synth; the soft-synth then completes a large number of complex calculations in order to produce the sound you hear and all this processing activity takes time. If you already have adjusted the appropriate parameters relating to latency on your sound card, try re-installing the latest drivers for the sound card, or try reducing the buffer sizes of the sound card. If you are using a host application, check its buffer size settings as most applications allow for user adjustment to improve timing.
- If you feel that you may need to upgrade your sound card, please visit <http://www.m-audio.com>.

## Warranty

### Warranty Terms

M-Audio warrants products to be free from defects in materials and workmanship, under normal use and provided that the product is owned by the original, registered user. Visit [www.m-audio.com/warranty](http://www.m-audio.com/warranty) for terms and limitations applying to your specific product.

### Warranty Registration

Thank you for registering your new M-Audio product. Doing so immediately both entitles you to full warranty coverage and helps M-Audio develop and manufacture the finest quality products available. Register online at [www.m-audio.com/register](http://www.m-audio.com/register) to receive FREE product updates and for the chance to win FREE M-Audio gear

## Contact

If you have any questions, comments or suggestions about this or any M-Audio product, we invite you to contact us by using the following information:

<p><b>M-AUDIO U.S. -</b> 5795 Martin Road, Irwindale, CA 91706-6211, U.S.A.</p> <p><b>Sales Information:</b> ..... (626) 633-9050  <b>Sales (fax):</b> ..... (626) 633-9070  <b>Sales Information (email):</b> ..... info@m-audio.com  <b>Tech Support (phone):</b> ..... (626) 633-9055  <b>Tech Support (email):</b> ..... techsupt@m-audio.com  <b>Tech Support (fax):</b> ..... (626) 633-9060  <b>Internet Home Page:</b> ..... http://www.m-audio.com</p>	<p><b>M-AUDIO Deutschland (Germany) -</b> Kuhallmand 34, D-74613 Ohringen, Germany</p> <p><b>Sales Information:</b> ..... +49 (0)7941 987000  <b>Sales Information (email):</b> ..... info@m-audio.de  <b>Technical Support:</b> ..... +49 (0)7941 9870030  <b>Technical Support (email):</b> ..... support@m-audio.de  <b>Technical Support (fax):</b> ..... +49 (0)7941 98 70070  <b>Internet Home Page:</b> ..... http://www.m-audio.de</p>
<p><b>M-AUDIO U.K. -</b> Floor 6, Gresham House, 53 Clarendon Road, Wafford, WD17 1LA, United Kingdom</p> <p><b>Sales Information (phone):</b> ..... 44 (0) 1923 204010  <b>Sales Information (fax):</b> ..... 44 (0) 1923 204039  <b>Sales Information (email):</b> ..... info@maudio.co.uk  <b>Technical Support (PC):</b> ..... 44 (0) 1309 671301  <b>Technical Support (Mac):</b> ..... 44 (0) 1765 650072  <b>Technical Support (email):</b> ..... support@maudio.co.uk  <b>Internet Home Page:</b> ..... http://www.maudio.co.uk</p>	<p><b>M-AUDIO Canada -</b> 1400 St-Jean Baptiste Ave. #150, Quebec City, Quebec G2E 5 B7, Canada</p> <p><b>Technical Support (e-mail):</b> ..... techcanada@m-audio.com  <b>Technical Support (PC):</b> ..... (418) 872-0444  <b>Technical Support (Mac):</b> ..... 1-800-638-2120  <b>Technical Support (fax):</b> ..... (418) 872-0034  <b>Sales (e-mail):</b> ..... infocanada@m-audio.com  <b>Sales (phone):</b> ..... (866) 872-0444  <b>Sales (fax):</b> ..... (514) 396-7102  <b>Internet Home Page</b> ..... http://www.m-audio.ca</p>
<p><b>M-AUDIO France -</b> Floor 6, Gresham House, 53 Clarendon Road, Wafford, WD17 1LA, United Kingdom</p> <p><b>Assistance Technique (aucune questions reliées aux ventes)</b>  courriel (assistance PC): ..... support@m-audio-france.com  courriel (assistance Mac): ..... mac@m-audio-france.com  téléphone (assistance PC): ..... 0820 000 731 (0,12 Euros par minute)  téléphone (assistance Mac): ..... 0820 391 191 (0,12 Euros par minute)  télécopieur/fax: ..... 01 72 72 90 52</p> <p><b>Ventes (aucun appels d'assistance technique)</b>  téléphone: ..... 0810 001 105 (Numero Azur)  courriel: ..... info@m-audio-france.com  télécopieur/fax: ..... 01 72 72 90 52</p>	<p><b>M-AUDIO Japan -</b> (株式会社エムオーディオジャパン) 460-0002 愛知県名古屋市中区丸の内 2-18-10</p> <p>テクニカルサポート : ..... 052-218-0859  <b>テクニカルサポート</b>  (Macintosh): ..... mac-support@m-audio.co.jp  <b>テクニカルサポート</b>  (Windows): ..... win-support@m-audio.co.jp  <b>Fax:</b> ..... 052-218-0875  <b>ホームページ:</b> ..... http://www.m-audio.co.jp</p>

## Technical Info

**Caution:** Electro Static Discharge, Electrical Fast Transient and Conducted RF interference may cause the unit malfunctioning. In such case, unplug the unit and plug it in again to restore normal operation.

**Note:** Your M-Audio ProKeys 88sx has been tested to comply with FCC Standards FOR HOME OR OFFICE USE. Modifications not authorized by the manufacturer may void users authority to operate this device.

**Note:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

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## Appendices

### Appendix A

#### MIDI Implementation Chart for the ProKeys 88

Function		Transmitted	Received	Remarks
Basic Channel	:Default :Changed	1 1-16	All except 10	
Mode	:Default :Messages :Altered	----- X *****	X	
Note Number	:True Voice	0-127 *****	0	
Velocity	:Note ON :Note OFF	0 X	0	
After Touch	:Keys :Ch's	X 0	X	
Pitch Bend		0	0	
Control Change	0-119	0	0	
Channel Mode	120-127	0	0	
Program Change	:True Number	0-127 *****	only those on page 13.	
System Exclusive		GM2 Reverb, Chorus Type. Master Volume.	GM2 Reverb, Chorus Type. Master Volume. Master Tuning.	
Song Position Common	:Song Select	X X	X	
System Exclusive	:Clock :Commands	X X	X	
Aux Messages	:Local ON/OFF :All Notes OFF :Active Sense :Reset	0 X X X	X	
Notes:		0 = YES	X = NO	



## Appendix C

### Standard MIDI Controller Numbers

00	Bank Select	61	Controller 61
01	Modulation	62	Controller 62
02	Breath Control	63	Controller 63
03	Controller 3	64	Sustain Pedal
04	Foot Control	65	Portamento
05	Porta Time	66	Sostenuto
06	Data Entry	67	Soft Pedal
07	Channel Volume	68	Legato Pedal
08	Balance	69	Hold 2
09	Controller 9	70	Sound Variation
10	Pan	71	Resonance
11	Expression	72	Release Time
12	Effects Controller 1	73	Attack Time
13	Effects Controller 2	74	Cut-off Frequency
14	Controller 14	75	Controller 75
15	Controller 15	76	Controller 76
16	Gen Purpose 1	77	Controller 77
17	Gen Purpose 2	78	Controller 78
18	Gen Purpose 3	79	Controller 79
19	Gen Purpose 4	80	Gen Purpose 5
20	Controller 20	81	Gen Purpose 6
21	Controller 21	82	Gen Purpose 7
22	Controller 22	83	Gen Purpose 8
23	Controller 23	84	Portamento Control
24	Controller 24	85	Controller 85
25	Controller 25	86	Controller 86
26	Controller 26	87	Controller 87
27	Controller 27	88	Controller 88
28	Controller 28	89	Controller 89
29	Controller 29	90	Controller 90
30	Controller 30	91	Reverb Depth
31	Controller 31	92	Tremolo Depth
32	Bank Select LSB	93	Chorus Depth
33	Modulation LSB	94	Celeste (De-tune)
34	Breath Control LSB	95	Phaser Depth
35	Controller 35	96	Data Increment
36	Foot Control LSB	97	Data Decrement
37	Porta Time LSB	98	Non-Reg Param LSB
38	Data Entry LSB	99	Non-Reg Param MSB
39	Channel Volume LSB	100	Reg Param LSB
40	Balance LSB	101	Reg Param MSB
41	Controller 41	102	Controller 102
42	Pan LSB	103	Controller 103
43	Expression LSB	104	Controller 104
44	Controller 44	105	Controller 105
45	Controller 45	106	Controller 106
46	Controller 46	107	Controller 107
47	Controller 47	108	Controller 108
48	Gen Purpose 1 LSB	109	Controller 109
49	Gen Purpose 2 LSB	110	Controller 110
50	Gen Purpose 3 LSB	111	Controller 111
51	Gen Purpose 4 LSB	112	Controller 112
52	Controller 52	113	Controller 113
53	Controller 53	114	Controller 114
54	Controller 54	115	Controller 115
55	Controller 55	116	Controller 116
56	Controller 56	117	Controller 117
57	Controller 57	118	Controller 118
58	Controller 58	119	Controller 119
59	Controller 59		
60	Controller 60		

### Channel Mode Messages

120	All Sound Off
121	Reset all Controllers
122	Local Control
123	All Notes Off
124	Omni Off
125	Omni On
126	Mono On (Poly Off)
127	Poly On (Mono Off)

### Extra RPN Messages

128	Pitch Bend sensitivity
129	Fine Tune
130	Coarse Tune
131	Channel Pressure

## Appendix D

### GM Program Numbers in Bank 0

Piano	Bass	Reed	Synth Effects
0 Acoustic Grand Piano	32 Acoustic Bass	64 Soprano Sax	96 SFX Rain
1 Bright Acoustic Piano	33 Electric Fingered Bass	65 Alto Sax	97 SFX Soundtrack
2 Electric grand Piano	34 Electric Picked Bass	66 Tenor Sax	98 SFX Crystal
3 Honky Tonk Piano	35 Fretless Bass	67 Baritone Sax	99 SFX Atmosphere
4 Electric Piano 1	36 Slap Bass 1	68 Oboe	100 SFX Brightness
5 Electric Piano 2	37 Slap Bass 2	69 English Horn	101 SFX Goblins
6 Harpsichord	38 Syn Bass 1	70 Bassoon	102 SFX Echoes
7 Clavinet	39 Syn Bass 2	71 Clarinet	103 SFX Sci-Fi
Chromatic Percussion	Strings/Orchestra	Pipe	Ethnic
8 Celesta	40 Violin	72 Piccolo	104 Sitar
9 Glockenspiel	41 Viola	73 Flute	105 Banjo
10 Music Box	42 Cello	74 Recorder	106 Shamisen
11 Vibraphone	43 Contrabass	75 Pan Flute	107 Koto
12 Marimba	44 Tremolo Strings	76 Bottle Blow	108 Kalimba
13 Xylophone	45 Pizzicato Strings	77 Shakuhachi	109 Bag Pipe
14 Tubular Bells	46 Orchestral Harp	78 Whistle	110 Fiddle
15 Dulcimer	47 Timpani	79 Ocarina	111 Shanai
Organ	Ensemble	Synth Lead	Percussive
16 Drawbar Organ	48 String Ensemble 1	80 Syn Square Wave	112 Tinkle Bell
17 Percussive Organ	49 String Ensemble 2 (Slow)	81 Syn Sawtooth Wave	113 Agogo
18 Rock Organ	50 Syn Strings 1	82 Syn Calliope	114 Steel Drums
19 Church Organ	51 Syn Strings 2	83 Syn Chiff	115 Woodblock
20 Reed Organ	52 Choir Aahs	84 Syn Charang	116 Taiko Drum
21 Accordion	53 Voice Oohs	85 Syn Voice	117 Melodic Tom
22 Harmonica	54 Syn Choir	86 Syn Fifths Sawtooth Wave	118 Syn Drum
23 Tango Accordion	55 Orchestral Hit	87 Syn Brass & Lead	119 Reverse Cymbal
Guitar	Brass	Synth Pad	Sound Effects
24 Nylon Acoustic	56 Trumpet	88 New Age Syn Pad	120 Guitar Fret Noise
25 Steel Acoustic	57 Trombone	89 Warm Syn Pad	121 Breath Noise
26 Jazz Electric	58 Tuba	90 Polysynth Syn Pad	122 Seashore
27 Clean Electric	59 Muted Trumpet	91 Choir Syn Pad	123 Bird Tweet
28 Muted Electric	60 French Horn	92 Bowed Syn Pad	124 Telephone Ring
29 Overdrive	61 Brass Section	93 Metal Syn Pad	125 Helicopter
30 Distorted	61 Syn Brass 1	94 Halo Syn Pad	126 Applause
31 Harmonics	62 Syn Brass 2	95 Sweep Syn Pad	127 Gun Shot

## Appendix E

### Audio Specifications

#### General

- Sample Rate . . . . . 48kHz

#### Line Outputs

- Frequency response: . . . . . 20Hz-20kHz, +/-0.3dB
- SNR: . . . . . -102dB @ 48kHz (a-weighted)
- Dynamic Range: . . . . . 102dB @ 48kHz (a-weighted)
- THD+N: . . . . . 0.0065% (-83.7dB) @ -1dBFS, 1kHz
- Maximum Output: . . . . . +15dBu (4.4Vrms) unbalanced at 0dBFS.
- Output Impedance: . . . . . 150 Ohms, unbalanced
- Crosstalk: . . . . . <-110dB, channel-to-channel

#### Headphone Outputs

Both Headphone Outputs should meet or exceed the following audio specifications, even when used simultaneously.

- Max Output: . . . . . +4.6dBu (1.3Vrms) @ 32 Ohms
- Output Impedance: . . . . . 75 Ohms
- Working Range: . . . . . 32 Ohms to 600 Ohms
- Crosstalk: . . . . . <-70dB, channel-to-channel