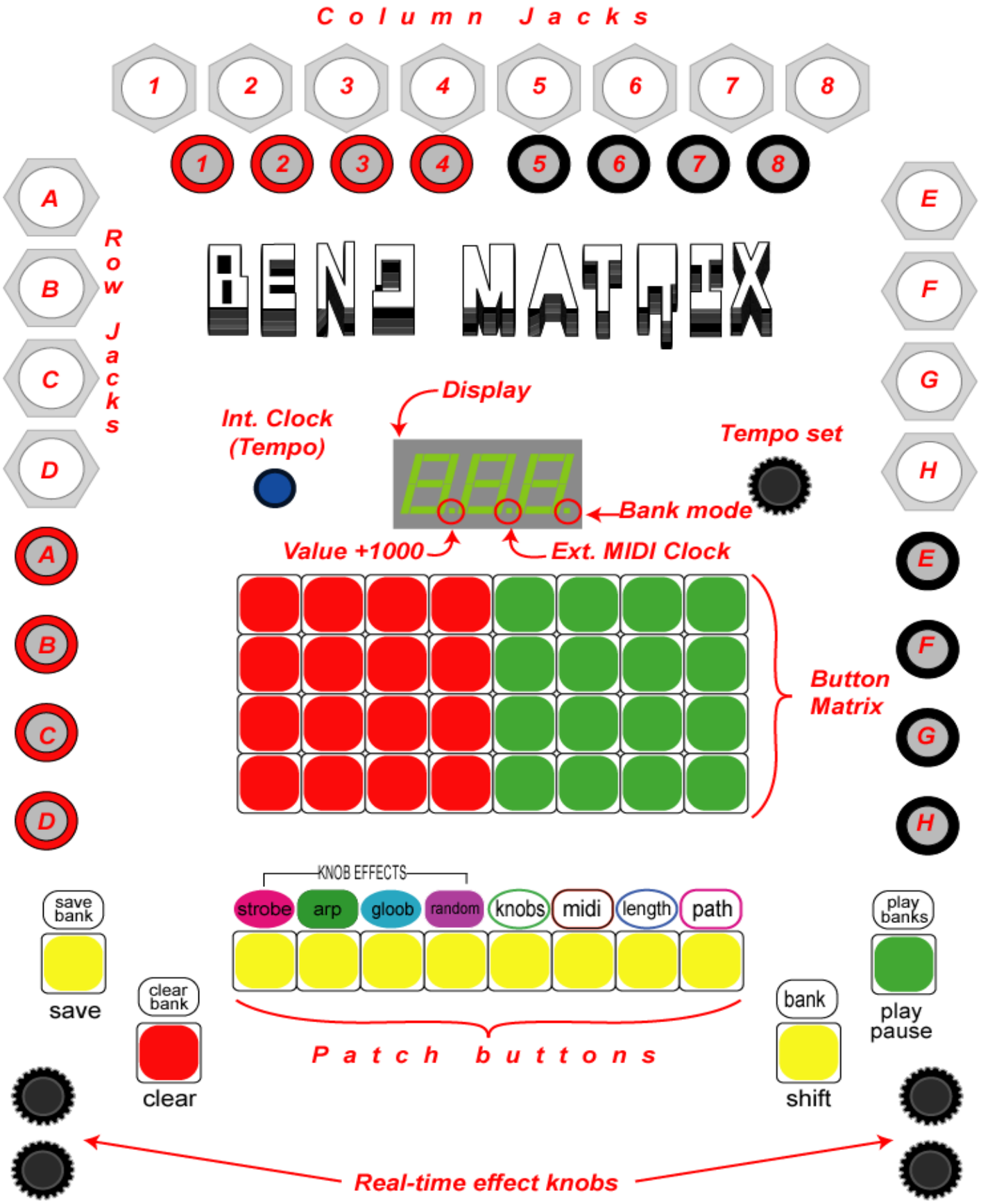
Column Jacks
1
2
3
4
5
6
7
8
A
B
C
D
E
F
G
H
Row Jacks
BEND MATRIX
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Tempo set
Bank mode
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Bend Matrix User Manual

v2.3.2

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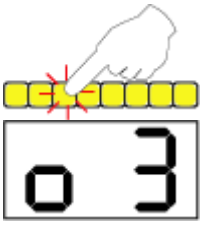
INTRODUCTION

Button Matrix

- The Bend Matrix has 4 rows of 8 buttons, totaling 32 buttons in the ***BUTTON MATRIX***
- Each button represents a switch between a "column" jack (columns 1-8) and a "row" jack (rows A/B/C/D in normal mode, and also rows E/F/G/H in dual mode). See the panel layout diagram for jack locations.
- When a switch is activated, a signal can flow between the corresponding row and column jacks. The signal can be audio, video, digital data, control voltage, etc. *Normally, the signal can flow in either direction, although your Bend Matrix may optionally be wired with buffers to only allow the signal to flow in one direction.*
- For example, pressing the third button from the left on the second row (diagram at left) will connect Column 3 Jack with Row B Jack. A signal can now flow between whatever you have plugged into Column 3 and Row B.
- When you press a button, it will light up. The button will stay lit and the switch will be activated until you press it again *Note: in Momentary Mode, the button will only stay on as long as your finger is holding it down..*
- Pressing buttons on the button matrix will not effect what's stored in memory unless you save it. You can undo your changes by re-loading the current patch (see below)

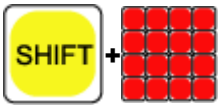
PATCHES AND BANKS

Load Patch



- The patches are access by the yellow ***PATCH BUTTONS***.
- There are 8 patches per bank, each patch stores button matrix state into memory.
- Press a yellow ***PATCH BUTTON*** to load a patch. The patch number is shown on the display (for example, the picture on the left indicates patch #3)
- When you press a ***PATCH BUTTON***, the stored patch will be loaded into the button matrix
- The current patch is indicated by a yellow patch button being lit up. You can press the current ***PATCH BUTTON*** to re-load it and undo any changes you've made on the button matrix.

Load Bank



- There are 16 banks, each bank stores 8 patches in a sequence.
- In ***PLAY*** or ***PAUSE*** mode, the current bank # is displayed. The picture on the left means “Bank 1”.
- You can also see what bank you're in by holding down ***SHIFT***: the current bank will flash on the button matrix.
- The red matrix buttons are the bank buttons. The top row is banks numbers 1-4, the next row is 5-8, etc. (total of 16 banks)
- To change to another bank, hold down ***SHIFT*** and press a bank button: the display will indicate which bank you selected and the button matrix will immediately be loaded with a patch from the new bank.

Clear patch

- Press ***CLEAR*** to clear the current button matrix. This will not erase the current patch in memory: you can undo a clear by pressing the current ***PATCH BUTTON.***
- Note: Holding down ***CLEAR*** and pressing a button on the matrix will add that button to the CLEAR LAYER (see the Layers chapter)

Clear bank

- Press ***SHIFT***+***CLEAR*** to clear all 8 patches in the current bank.

Save patch

- Press ***SAVE*** to save the current button matrix to a patch
- The 8 ***PATCH BUTTONS*** will flash, with the current patch flashing rapidly
- Press a ***PATCH BUTTON*** to save to that patch number.
- To cancel, press ***CLEAR***
- *Hint*: press ***SAVE*** twice in a row to save to the current patch and step the sequencer ahead. You can quickly program an entire bank this way: make the first patch, hit ***SAVE*** twice, make the second patch, hit ***SAVE*** twice, make the third patch, hit ***SAVE*** twice, etc..
- Note: saving a patch does not store it into long-term memory. The patch will be saved as long as the power is on. In order to have it saved after you turn the Bend Matrix off, you must save a whole bank (see "Save Bank" below).

Save Bank

- Hold ***SHIFT*** and press ***SAVE*** to save the current bank
- The 16 ***BANK BUTTONS*** will flash on the button matrix, with the current bank flashing rapidly
- Press a flashing ***BANK BUTTON*** to save into that bank. The bank will be stored in long-term memory even after the Bend Matrix is turned off. The display should briefly flicker to indicate long-term memory is being written to.
- Press ***CLEAR*** to cancel.
- Saving a bank will also save the Length settings (see below).

SEQUENCER

Play mode

- Press ***PLAY*** : the 8 patches in the current bank will be played in sequence and repeated.
- The method of playback and repeating can be changed with the Path and Length features (see below)
- The ***PLAY*** button will be lit up continuously, the ***TEMPO*** light will flash, and the display will animate while continuing to show the current Bank # (e.g. Bank #5)
- Press ***PLAY*** again to pause.
- In Play mode, you can press and hold a ***PATCH BUTTON*** to force the Bend Matrix to hold at that patch. As soon as you release the ***PATCH BUTTON***, it will continue playing from that patch. In this way you can play different patches like a keyboard, and the Bend Matrix will fill when you're not playing.
- You also can change banks while playing. Simply hold ***SHIFT*** and press a red ***BANK BUTTON***.

Play bank

- Press ***SHIFT*** + ***PLAY*** to play multiple banks. By default, banks 1 through 16 will be played, and then repeated.
- The direction of playback and range of banks to repeat can be changed with the Path and Length features (see below)
- The right-most dot on the display indicates Play Bank Mode
- The current bank number will continue to be shown on the display and will be updated as new banks are loaded
- Press ***SHIFT*** + ***PLAY*** again to return to Play mode

Tempo/BPM

- Turn the ***TEMPO*** rotary knob to change the current BPM by +/-50
- Hold down ***SHIFT*** while turning ***TEMPO*** to change the BPM by +/-5 (fine tuning)
- Hold down ***SHIFT*** for two seconds to display the current BPM
- Each patch represents one beat (e.g. 120 BPM means 120 patches will be played in 1 minute, or 2 patches per second)
- The minimum BPM is 2 (or 30 seconds per patch)
- The maximum is 1995 (about 30 microseconds per patch)
- The left-most dot on the display indicates +1000 (e.g. the bottom picture means “1500 BPM”

Set Length

- To set the beginning and ending patches or banks for playback, hold ***SHIFT*** and press ***LENGTH***
- The 8 patch buttons and the 16 bank buttons will flash and the display will say "BEG" (for beginning)
- At this point, you can choose between setting the ***patch*** length or ***bank*** length:
    - To set the beginning/ending ***patches*** for the playback: Press a yellow Patch Button to set the beginning patch. The display will change to "END" and you can press another yellow Patch Button to set the ending patch.
    - To set the beginning/ending ***bank*** for bank playback: Press a Bank Button to set the beginning bank. The display will change to "END" and you can press another Bank Button to send the ending bank.
    - To cancel, press the red ***CLEAR*** button.
- For example, if you want playback to repeat patches 3 through 6, press ***SHIFT+LENGTH*** and then press the 3rd ***PATCH BUTTON,*** and then press the 6th ***PATCH BUTTON***.
- Or, for example, if you want playback to repeat banks 2 through 14, press ***SHIFT+LENGTH***, and then press Bank 2 and then Bank 14.
- Note: The patch and bank length settings are stored in long-term memory.

Set Path

- Press ***SHIFT***+***PATH*** to set the "path" or repeat mode. The display will indicate the current mode:
  - Fwd (default mode): repeats the sequence *forwards* (counting up).
  - rEv: repeats the sequence in *reverse* (counting down)
  - onE: plays the sequence forwards *once*, and then stops
  - rAn: plays *random* patches. In Play Bank Mode, random banks are also selected
- Keep pressing ***SHIFT***+***PATH*** until the display shows the mode you want.
- The selected path will always work within the bounds set by Length. For instance, if you set the Patch Length to be from patch 5 to 7, and Bank Length to be from banks 9 to 12, and Path to be Reverse, the Bend Matrix will play:
  - Bank 12, Patch 7, then
  - Bank 12, Patch 6, then
  - Bank 12, Patch 5, then
  - Bank 11, Patch 7, then
  - Bank 11, Patch 6,
  - ...etc. until it reaches
  - Bank 9, Patch 5, and then repeats starting at
  - Bank 12, Patch ...

EFFECTS

- You can apply real-time analog-controlled effects to the current button matrix using the knobs.
- The effects are typically laid over the current patch or playback. This allows you to let a repeating or random sequence run while you modulate effects in a separate layer. At any time, the layers can be "flattened" and the current button matrix (consisting of a loaded patch plus effects) can be saved into a patch.
- You can select one of four effects: Strobe, Arp, Gloob, or Random.
- Each of the four effects has four modes numbered 1/2/3/4.
- Each of the four knobs modifies the effect for *one section* of the button matrix.
- To select an effect, hold ***SHIFT*** and press the appropriate yellow ***KNOB EFFECT*** button. The display will indicate the first letter of the current effect (S/A/G/R), and current effect mode (1/2/3/4)
- To cycle through the effect modes, press ***SHIFT+KNOB EFFECT*** button again.
- The way the button matrix is sectioned up is set by the Knob Layout Mode (see below). In this way, the effect can be applied in different ways to different parts of the button matrix.
- **To turn the effects off**, press ***SHIFT+KNOB EFFECT*** (any effect) to cycle through the effect modes until the display shows three dashes.

Strobe effect

- Strobe effect flickers, or strobes, the current patch. It only is active in play mode (or play banks mode). In pause mode, the knobs have no effect.
- When a knob is at zero, its corresponding button matrix section is "off" (nothing is lit up)
- As the knob is turned up from zero to mid-way, the current patch will flicker or strobe "on" when the sequencer loads a new patch. The duration of the strobe will become longer and longer as the knob is turned up.
- When the knob is at mid-way, the patch will behave normally (full strobing, or no flicker).
- As the knob is turned up from mid-way to full, the patch will strobe between two patches that depend on the effect mode. The duration of the strobe will become longer and longer as the knob is turned up.
    - Effect mode 1: Start at the current patch, flicker to an overlay of the current patch and next patch
    - Effect mode 2: Start at an overlay of the current patch and next patch, flicker to the current patch
    - Effect mode 3: Start at the current patch, flicker to the next patch
    - Effect mode 4: Start at the next patch, flicker to an overlay of the current patch and next patch.
- Strobe effect mode 1 and 2 can be used as a sort of mixer, with each knob being a sort of "level" control. When the knob is turned down , the section is off. As the knob is turned up, the patch becomes more and more present (analogous to "louder"), until mid-way when the current patch is fully present and then starts to "bleedthrough" to the next patch. This is especially useful with 4 audio inputs and 8 speaker outputs on "row" Knob Layout Mode: each knob controls the "level" of each instrument.

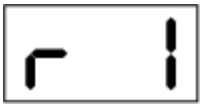
Gloob effect

- Gloob effect pushes bits and blocks around the button matrix as the knobs are turned. The bits and blocks are overlayed on top of the current patch.
    - Effect mode 1: A single button is lit up, and moves around the knob's section.
    - Effect mode 2: The knob's section is filled up with bits in a digital counting fashion (0000, 0001, 0010, 0011, 0100, 0101, ...)
    - Effect mode 3: A block moves into the section from the left (or top) until it completely overlays the section, and then exits to the right (or bottom).
    - Effect mode 4: The knob's section is filled up with bits in a digital counting fashion, and this is XOR'ed with the current patch. This can be used to "punch out" bits in a patch
- Gloob is a useful effect for moving sounds or connections around manually. The knobs can be turned in real-time until an interesting patch results, and then it can be saved. This can be repeated to fill up a bank with patches.

Arp effect

- Arp is an arpeggiation effect. Arp will light up, one at a time, the buttons in the current patch.
- For instance, if a patch has three buttons lit up, numbers 2,4, and 5, then Arp will first light just button 2, then just button 4, then just button 5... In this way a "chord" can be defined within a single patch and Arp will play individual "notes" of the chord.
- The knobs set the speed and direction of arpeggiation.
    - At center, the effect is held or frozen at the first "note".
    - When the knob is to the right of center, the arpeggiation goes upwards.
    - When the knob is to the left of center, it goes downwards.
    - As the knob is turned up or down, the arpeggiation plays slowly when it's closer to center and faster at the extremes (up to 64 times the current tempo BPM).
- The effect modes change the way the arpeggiation happens:
    - Effect mode 1: repeat the arpeggiation indefinitely
    - Effect mode 2: play the arpeggiation once, then go blank
    - Effect mode 3: play the arpeggiation once, then hold on the last "note"
    - Effect mode 4: play random "notes" in the arpeggiation. The knob still controls the speed, but has no effect on direction.
- An interesting feature of the Arp Effect is that each section of the button matrix can change at different rates relative to each other, while the overall rate will always be dependent on the tempo BPM (even when the sequencer is not playing).

Random effect

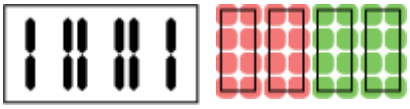


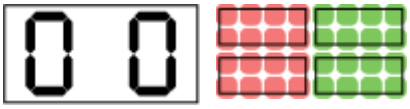
- Random mode turns random bits on and off within the current patch.
- The speed at which bits are flipped is determined by the knobs: from 0 (no effect) to 64 times the current tempo/LED.
- The effect modes determine the number of bits that are flipped at a time:
    - Effect mode 1: one bits flipped at a time
    - Effect mode 2: two bits flipped at a time
    - Effect mode 3: three bits flipped at a time
    - Effect mode 4: four bits flipped at a time

Knob Layout

- The Knob Layout Mode chooses how the 32 buttons are split into 4 sections, one for each knob. To cycle through the knob modes, press Shift+Knobs until the display indicates the mode you want:

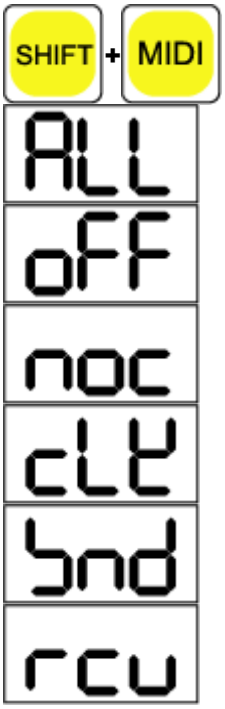
Row mode (default):  4 rows of 8

Column mode:  4 double columns

Corner mode:  4 corners

MIDI

MIDI mode



- The button matrix is linked to MIDI notes. You can enable or disable the sending and/or receiving of MIDI messages by pressing ***SHIFT***+***MIDI*** to cycle through six modes:
  - ALL: MIDI is sent and received
  - OFF: no MIDI messages are sent or received
  - NOC: (“NO Clock”) MIDI is sent and received, except for MIDI CLOCK messages
  - CLK: (“Clock”) Only MIDI CLOCK messages are sent and received
  - SND: MIDI is only sent
  - RCV: MIDI is only received

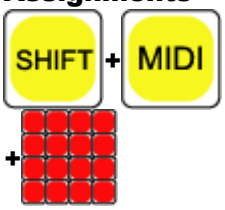
- **Sending MIDI**:
  - Note commands: Each button on the matrix is mapped to a MIDI note, so by pressing buttons (or by playing patches), you can use the Bend Matrix as a MIDI controller, like a keyboard.
  - CC command: Turning the analog knobs will output a CC command.
- **Receiving MIDI**:
  - Note commands: Playing a MIDI keyboard into the Bend Matrix will turn buttons on the matrix on and off.
  - CC Commands: These are mapped to the analog knobs. When a CC command is received, the knob's actual state is overridden until it's turned again.

- The MIDI mode is stored in long-term memory.

MIDI Clock

- **Clock input:** The Bend Matrix will automatically sync to MIDI clock messages in play mode. In pause mode, MIDI clock messages have no effect. The Bend Matrix's own internal clock will be merged with the external clock source, therefore to normally sync the Bend Matrix to another clock source, set the Bend Matrix's tempo *slower* than the external clock source. To get interesting poly-rhythmic swagger effects, set the Bend Matrix's tempo faster than the external clock source.
- **Clock output**: The Bend Matrix also sends MIDI clock messages 24 times per beat. This can be used to slave another device to the same tempo as the Bend Matrix

MIDI Assignments



- Each button can be assigned to a MIDI note, and each knob can be assigned to a MIDI CC number. These assignments can be changed on the fly by going into MIDI Assign Mode.

- **MIDI Assign Mode:**
  - To enter MIDI Assign Mode, press and hold ***SHIFT+MIDI***, and while still holding ***SHIFT***, press a button on the matrix. The display will briefly say "not" (MIDI Note).
    - The button you pressed will flash on the matrix, and the current MIDI Note value assigned to that button will show on the display.
  - Spin the rotary knob to change the current MIDI Note value (0-127)
    - Or, input a MIDI Note and the display will instantly jump to the note it heard. This is useful if you don't know the note numbers, but you want a particular key/feature on your external controller to trigger a particular button on the Bend Matrix.
  - When you find the MIDI Note number you want, you can press another matrix button to start assigning it.

  - At any time, you can turn a knob to assign the knobs' CC numbers. The display will briefly say "CC" to indicate that you are now assigning MIDI CC numbers. To go back to assigning MIDI Note numbers to matrix buttons, just press any matrix button and the display will say "not" again.
  - Assigning MIDI CC numbers to knobs is done in the same way as with matrix buttons: Turn a knob to select it, then spin the rotary (or input a CC command) to find the MIDI CC number you want, then turn the next knob to select it, find your MIDI CC number, turn the next knob, etc...

  - *Note: If you have the photocell mod, flip the photocells OFF before assigning MIDI. Changes in ambient light/shadows on a photocell could cause MIDI Assign Mode to jump to assigning its CC number.*

- **Saving MIDI Assignments**
  - When you're done assigning MIDI values, press ***SAVE*** to store your changes into long-term memory. Or, if you just want to use your new values for this session only, press ***CLEAR*** and the old MIDI assignment values will go back into effect after you power-down the Bend Matrix.
  - Whether you ***SAVE*** or ***CLEAR*** your changes, it's important to note that while you are assigning MIDI values, your changes go into effect immediately, even as you scroll through various values-- this is very useful if you are performing and want to use live re-patching as an effect. For example, if you are running a sequencer or drum machine into the Bend Matrix's MIDI input, the most recent MIDI Note/CC message that comes in will be assigned to the currently flashing button/knob...
  - The Bend Matrix sequencer will run in the background even while you assign MIDI values. The button matrix display, however, will not show you what the sequencer is doing.

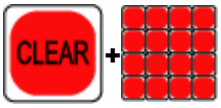
LAYERS

The Bend Matrix's button matrix uses the concept of layers, and an understanding of this concept is important for advanced use.
There are five layers:

- MIDI layer (set by MIDI input)
- Effect layer (set by real-time effects)
- Clear layer (set with ***CLEAR+BUTTON***, see below)
- Save layer (set with ***SAVE+BUTTON***, see below)
- Button layer (set by pressing buttons on the matrix, and recalling stored patches)

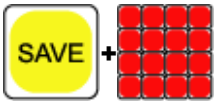
These five layers are combined, and the resulting matrix is used to set the switches between row and column jacks. The result is alsp displayed on the button matrix's LEDs.
The method of combining these layers is to first turn on the sum of the MIDI, Effect, and Save layers, and then turn off every button on the Clear layer. Finally, the Button layer is added in. Keeping the button layer at the end insures that a performing musician can always press a button and have it light up, no matter the state of the other layers.

Clear Layer



- Hold down CLEAR and press one or more buttons on the matrix. Continue to hold down CLEAR and you will notice these buttons flashing dimly. This indicates they are on the Clear Layer.
- Holding down CLEAR and pressing a button on the Clear Layer a second time will take that button off the Clear Layer. The button will no longer flash dimly when you hold down CLEAR.
- Any buttons on the Clear Layer will never light up, unless you press them.
- The Clear Layer is useful if you need to insure certain buttons will not light up, for instance a button that plays a loud sample or resets the power on a circuit-bent device. No matter what patches are played, MIDI notes are received, or effects are run, the Clear Layer buttons will not light up. The only way to light one up is to press it manually.

Save Layer



- Hold down SAVE and press one or more buttons on the matrix. Continue to hold down SAVE and you will notice these buttons flashing brightly. This indicates they are on the Save Layer.
- Holding down SAVE and pressing a button on the Save Layer a second time will take that button off the Save Layer. The button will no longer flash brightly when you hold down SAVE.
- If you put a button on the Save Layer, and it's already on the Clear Layer, it will be taken off the Clear Layer.
- Any buttons on the Save Layer will always stay lit.
- The Save Layer is useful if you need to insure certain buttons stay lit no matter what MIDI, patches or effects are playing. For instance if a button represents a repeating bass-line, you may want to keep it active while you improvise with the other buttons, and not have to worry about accidentally turning the bass-line off.

ADVANCED FEATURES

4x8 / Dual 4x4

+POWER

- The Bend Matrix has two major modes: 4x8 (default) or Dual 4x4.
- To change between modes, hold ***SHIFT*** when turning the power on. The display will indicate 4-4 or 4-8 to show what mode we're in.
- 4x8 mode is the default mode: the button matrix acts a single grid
    - There's 4 row jacks (A/B/C/D) and 8 column jacks (1-8).
    - Each row can connect to each column.
    - Row jacks E/F/G/H aren't used.
- In Dual 4x4 mode the Bend Matrix functions as two separate 4x4 matrices:
    - The Red matrix connects Row Jacks A/B/C/D and Column Jacks 1/2/3/4.
    - The Green matrix connects Row Jacks E/F/G/H and Column Jacks 5/6/7/8.
    - This is a useful mode for using a single Bend Matrix to control two separate signal paths: for instance one side routes audio signals and the other side controls circuit bending points (or video, etc..)
    - Dual 4x4 mode is also useful for re-ordering up to 6 effect pedals in a serial chain. See the sample patch diagrams.

Momentary mode (optional)

- Normally pressing a button on the button matrix will enable that switch until you press the button again. This is non-momentary (or latching) mode.
- Flip the tap/latch switch down to enter Momentary mode. In this mode a button on the matrix will be active only as long as you hold the button down. As soon as you release the button, it will go off again. This is useful for playing the Bend Matrix like a keyboard
- Note: playing a blank bank is the same as being in momentary mode.

Photocells (optional)

- This mod adds a four photocells, one for each analog knob.
- Each knob/photocell combo has a switch to select whether the knob or the photocell is enabled.
- Waving your hand over the photocells will cause the effect parameters to change: total darkness is the same as the knob all the way down, and bright light is the same as the knob turned all the way up.
- MIDI CC data is sent, just like with the analog knobs. This allows for the Bend Matrix to be a gestural MIDI controller.

Trigger Inputs (optional)

- This mod adds three trigger input jacks: Play/Pause, Step Forward, and Step Backwards
- The jacks accept a trigger pulse of about 1V, e.g. a loud audio signal, or a CV Gate/Trigger pulse.

BOOTLOADER

+POWER

- The bootloader is an advanced feature of the Bend Matrix, that allows you to upgrade or change the firmware program.
- The latest firmware and bootloader instructions are available from this page:
    - http://www.commonsound.com/kits/doku.php?id=commonsound:bendmatrixcode
- You will need a computer with MIDI IN and MIDI OUT jacks, Sysex software (MIDI-OX or an OSX equivalent), two MIDI cables.
- Follow the instructions on commonsound.com, which involve downloading a firmware file, and using MIDI-OX to transfer it to the Bend Matrix over the MIDI cables.

SPECIFICATIONS:

- Dimensions: 10” x 12” x 3” (25cm x 30cm x 7cm)
- Weight: 3.2 lb (1.4 kg)
- Power supply: 9VDC, negative center 2.1mm barrel plug, 500mA or greater
- Signal switching
  - On-state resistance: 60-120ohms typical
  - Off-state feedthrough: -95dB typical (Vin = 2Vp-p 1 kHz sine-wave over 1kohm load)
  - Frequency range: 0Hz (DC) to 45MHz
- MIDI:
  - Send/Receive Channel: 1
  - Receive:
    - MIDI CLOCK (24 clocks cause a patch change)
    - MIDI NOTE ON
    - MIDI NOTE OFF (or NOTE ON with velocity 0)
    - MIDI CC (default: 20, 21, 22, 23)
  - Send:
    - MIDI CLOCK (24 times per patch change)
    - MIDI NOTE ON
    - MIDI NOTE OFF
- Long-term memory (EEPROM)
  - Total size: 1MB
  - Bank/patch storage: 512B
  - Bank/patch “length” storage: 32B
  - Globals (MIDI, optional): 5B
  - Reserved: 475B
  - Maximum writes per bank: 100,000 (typical)
- Components
  - Illuminated tactile buttons (44)
  - Three-digit seven-segment LED display
  - Rotary encoder
  - Analog potentiometers (4)
  - Blue LED
  - 1/4” jacks (16) typical
  - Banana jacks (16) typical
  - 1/8” jacks (16) optional to replace 1/4” or banana jacks
  - RCA jacks (16) optional to replace 1/4” or banana jacks
  - Power plug, 2.1mm barrel
  - MIDI jack, standard 5-pin female DIN (2 typical)
  - 2mm aluminum top panel