

DM48

DIGITAL CHROMATIC HARMONICA

USER MANUAL

Firmware version 1.40
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Contents

Important general notes	3
Introduction	4
Overview of the DM48	4
Important notes on MIDI and wind instruments	4
Software settings and functions	6
Quick start guide	6
Changing and restoring default settings	6
Adjustable parameters	6
Sensitivity	7
Response	7
Trigger level	7
Bend trig level	7
Bend sens.....	7
Bend direction	7
Modltn trig lvl	8
Modltn sens.....	8
Mono/poly	8
Octave transp	8
Key transp	8
Slider interval.....	8
Slider delay.....	8
2nd slider intv.....	8
3rd slider intv	9
2nd/3rd slider	9
Tuning.....	9
Tuning editor	9
MIDI CC no.....	10
MIDI velocity	10
MIDI channel.....	10
MIDI program.....	10
MIDI ctrl keys.....	10
Double notes.....	11
Gain skew	11
Display.....	11
Global preset.....	11
Firmware version check	11
Setup examples and guidelines	12
GarageBand or Logic	12
Reason and Acoustic Electro Waves	12
Multichannel setup with ThumbJam	13
Multichannel setup in Reason	13
Yamaha VL70-m and other hardware synthesizers	14
Untethered playing using a smartphone	14
Lid removal and breathing resistance adjustment	16

Important general notes

Please read these notes carefully before using the DM48 chromatic harmonica MIDI controller.

- The DM48 is designed to be played in the same pressure range as a fine acoustic chromatic harmonica. When properly setup, it should respond swiftly to gentle blowing force. While the pressure sensors are rated to handle pressures beyond what can be experienced during normal play, in no way must they be exposed to unnatural excessive air pressure, such as pressurized air from compressors or “canned air” containers.
- Do not expose the slider button to unnecessary force.
- Similar to a normal chromatic harmonica, the DM48 should be handled with care and not be exposed to falls or strong forces. Store and transport it in its protective case. Be careful not to scratch the protective black anodized surface on mouthpiece.
- The mouthpiece can be cleaned using a damp cloth. We recommend cleaning it before first use. Cotton swabs can be used for cleaning inside the channels. The mouthpiece can be detached using a screwdriver, although this is generally not needed or recommended. When reattaching the mouthpiece, do not over-tighten the screws. Pull it just enough to ensure it sits airtight against the chassis (test this by blocking each hole with a finger on the back of the instrument).
- The 3D printing process gives the lid and chassis a slightly rough surface, which can be difficult to clean. Clean hands are thus recommended to maintain a nice look. Early instruments had white lids, and these can be removed for cleaning (see *Lid removal and breathing resistance adjustment* below) using soap and water or in a dishwasher. Ensure the lid is completely dry before reattaching it.
- Make sure the USB cable is properly connected (a distinct “click” should be felt when connecting the mini-USB connector). Do not expose the USB connector to mechanical forces. A hole in the chassis at the backside of the instrument allows the USB cable to be secured using a cable tie (supplied) for safer live playing.

Introduction

Overview of the DM48

The DM48 is a MIDI controller without sound synthesis. From the point-of-view of a music production application or synthesizer, it behaves like a MIDI controller keyboard. However, rather than having keys, it makes use of twelve pressure sensors to present the user with a chromatic harmonica-like control interface. Similar to a MIDI controller keyboard, knowledge of MIDI, synthesizers, and computer-based sound synthesis/production is useful to make good use of it.

A single USB cable supplies both communication (using the so called “class-compliant USB MIDI” standard) and power. The supplied USB cable allows the DM48 to be connected to a Mac or PC, and using a suitable converter such as the Apple Lightning to USB adapter, it can also be connected to portable devices such as iPads/iPhones. A suitable software or hardware synthesizer is needed for sound synthesis, and examples and affordable suggestions are given below (see *Setup examples and guidelines*). A smartphone cannot only be used for sound synthesis, but also to route the MIDI data further over Wi-Fi to enable untethered playing (see *Untethered playing using a smartphone*).

Important notes on MIDI and wind instruments

Even if you are familiar with MIDI - and even MIDI wind instruments - we recommend reading the following notes. There are two main types of MIDI messages: note on/off events and “Controller Change” (CC) events. A MIDI controller keyboard can work well using only the former, which is enough to trigger notes at different velocities (depending on the force applied to the key) and stop notes when keys are released. While a MIDI wind controller also sends note on/off messages, rather than relying on velocity values it makes use of MIDI CC events to modulate the intensity/volume of the sound. Such messages are transmitted continuously at a high rate also *after* a note has been triggered. This allows the intensity of the sound to be modulated during the full duration of the note, as the player changes the applied air pressure. “Pitch bend” messages are transmitted in a similar manner.

By default, the DM48 is set to monophonic mode (see *Mono/poly* below), meaning that no more than one note is ever triggered at a time. Most users will find that this gives good playability for “chromatic-style” tunes. In polyphonic mode, when multiple notes can be triggered simultaneously, there are some additional considerations. An important property of the MIDI standard is that MIDI CC and pitch bend messages affect *all* triggered notes on a given MIDI channel. For a MIDI saxophone this is not a limitation, since the instrument is monophonic. In the case of a MIDI harmonica, this means that notes in a chord will be played at the same intensity, and that bending affects all triggered notes equally. While “clean playing” is always desirable on a chromatic harmonica, it may therefore be more important on the

DM48. If neighboring holes are triggered by mistake, these will be played at the same intensity as the target note (there is also more advice in the *Quick start guide* below).

The limitation described above applies when the DM48 is set to *Polyphonic* mode and transmits all data on a single MIDI channel (1 by default). The issue can be overcome by instead using multichannel mode (see *MIDI channel* below). In this configuration, each hole transmits MIDI data on a separate MIDI channel (1-12). With proper downstream setup, the holes can then be modulated completely independently of each other, as on an acoustic harmonica. This is not complicated in principle, but does require a more complex setup on the receiving end. Some synthesizers (see *Multichannel setup with ThumbJam* below) will work immediately with the DM48 in multichannel mode, while others require a more complicated configuration, typically involving multiple instances of a synthesizer on multiple tracks where each one is set to only receive on a single MIDI channel (see *Multichannel setup in Reason* below). “Reduced” multichannel configurations are also possible, such that for example four channels are used (the twelve holes will in this case transmit on channels 1-2-3-4-1-2-3-4-1-2-3-4 or 2-3-4-5-2-3-4-5-2-3-4-5). This reduces the number of required synths/tracks.

With C solo tuning (and many other tunings) and using polyphonic mode, it is possible to trigger two identical notes (typically “C”) simultaneously – something that cannot be achieved with a keyboard. Many synths will handle this correctly and will play double notes, including standard wind instruments in GarageBand or Logic. However, some, including most monophonic synths, are not prepared for this. When two notes are triggered and one of them is released, this may cause the second one to go silent, too. By default, the DM48 is therefore set to block double triggering of the same note. This is controlled by *Double notes* parameter (see below). However, when using a synthesizer that correctly handles double notes, or when using a multichannel configuration, it is appropriate to turn off this filter to allow double note triggering.

Software settings and functions

Quick start guide

By connecting the USB cable, the DM48 should immediately become selectable as an input MIDI device in your favorite music software without any special drivers. The default settings on the DM48 give a good starting point and few changes should be needed for an initial setup. Parameters will return to default as soon as you turn it off and on again, so there is no need to be afraid to explore different settings.

The most important parameter that may need to be changed is *MIDI CC no.*, which determines what MIDI CC number is used to transmit breath pressure data to the receiving synthesizer. This parameter defaults to 11 (Expression), which works for many standard instruments, for example in Logic or GarageBand. However, some synths may instead expect 2 (Breath Controller) or a specialized message called *Channel pressure* (also called aftertouch), which is also supported by the DM48.

Sensitivity determines the pressure sensor gain. Less force is required during playing when this parameter is increased, but this will also make it easier to saturate the intensity of the sound, resulting in loss of expressiveness/dynamics. Many times it is rather the playback volume on your amplifier that needs to be increased – always try that first. *Trigger level* determines the amount of pressure required to trigger a note. Lowering it makes the DM48 more responsive, but also increases the risk of triggering a note by mistake. *Asstd poly* (assisted polyphonic mode) makes it easier to play clean solo tunes by actively suppressing triggering of neighboring holes, while still allowing chords. This feature is accessible from the *Mono/poly* menu page, as is also monophonic mode (default), which is usually preferable if only single notes are to be played. Many sounds are more interesting outside of the default note range – try *Octave transp* to shift down an octave or two.

Changing and restoring default settings

Once you have found settings that you like, you can make these your new defaults such that they will be loaded every time you power up the controller. Go to the *Global preset* menu page and hold down the round button for two seconds. Select one of twelve possible “slots” and press the round button. A confirmation message will be shown.

The DM48 can be restored to factory default settings by holding down all three menu buttons during power-up. Release when a confirmatory message is seen on the display. Note that custom tunings will still be maintained. A full restore, including tunings, will be achieved if the three buttons are kept pressed even longer, until a confirmation about restored tunings is shown.

Adjustable parameters

This section lists all parameters on the DM48, each one accessible through

a separate menu page on the screen.

Sensitivity

Controls dynamics and volume depending on how hard and soft you play. Specifically, this is the sensitivity/gain for controller (MIDI CC) messages that determine sound volume/intensity. Controller messages are sent at a high rate, such that the volume/intensity can be modulated post triggering a note based on the applied pressure. When set to a lower (less sensitive) setting, more pressure needs to be applied to reach maximum sound intensity. If set too high, the instrument becomes less dynamic as maximum intensity is quickly reached.

Response

Response curve for volume/intensity MIDI CC messages. A non-linear curve that reaches higher intensities sooner may provide a more harmonica-like feel/response. However, it should be noted that this also depends on the characteristics of the downstream synthesizer. *Sensitivity* (above) may need to be reduced to compensate for a more aggressive response curve.

Trigger level

Pressure threshold for triggering MIDI “note on” messages. Lower values makes the instrument more sensitive, but increases involuntary triggering of neighboring holes.

Bend trig level

The DM48 provides a pressure-activated bending feature: by blowing harder than a certain threshold value, bending occurs through transmission of MIDI pitch bend messages. This parameter determines how hard you have to blow/draw before bending kicks in. Increase it if involuntary bending happens.

Bend sens

Once you reach the bending threshold (see above), this parameter determines how aggressively the instrument will bend. Bending is pressure controlled in a continuous way, and this is simply the “gain”. Negative values mean that bends will happen in the downward direction (as on a regular harmonica), will positive values will result in upward bending. When values are close to zero, more pressure is required for bending. Set it to *off* to disable bending.

Bend direction

When this menu page is activated (by pressing the round button), the left arrow key is transformed into a real-time control button that allows bending direction to be switched while playing. In contrast to the other menu pages, this is thus not a parameter. Although undocumented in the menu graphics, the right arrow will act as an extra slider button (see *3rd slider intv* below) when this mode is active.

Modltn trig lvl

The DM48 can send “modulation” MIDI CC messages (controller 1), which on most synths will result in a vibrato effect. This parameter determines how hard you need to blow/draw before modulation is activated.

Modltn sens

Once you reach the modulation trigger threshold (see above), this parameter determines how aggressively the instrument will increase the modulation intensity. When values are close to zero, more pressure is required. Set it to *off* to disable modulation.

Mono/poly

When this parameter is set to *Monophonic*, only a single note is triggered at a time, and the hole with the highest pressure will determine what note is to be played. This is often the mode of choice. When set to *Polyphonic*, multiple holes/notes can be played simultaneously. In this mode and when using a standard single MIDI channel setup (the default), the DM48 is more sensitive to mis-triggering of neighbor holes compared to an acoustic harmonica. This is due to a limitation in the MIDI standard (see *Important notes on MIDI and wind instruments* above). Continue stepping through the options and *Asstd poly* (assisted polyphonic mode) will appear on the screen. This feature attempts to aid in playing clean solo tunes by suppressing triggering neighbor holes, once a note has been triggered. The strength of this effect can be adjusted gradually from 1 to 10.

Octave transp

Transposition in whole octave steps.

Key transp

Transposition in semitone steps. Also shows the current key, based on the assumption that the tuning has been entered in the key of C.

Slider interval

When pressing the slider, all notes will be transposed by this many semitones. With the default tuning (*Solo*), this transposition is already built into the tuning scheme, so it should therefore normally be set to 0. With Richter tuning, for example, this setting allows the slider to be used for instant transposition: a setting of +5 would make it possible to shift from C to F at any time.

Slider delay

Introduces a time delay when releasing the main slider button. For players not yet adapted to the short stroke-length of the DM48 slider, this parameter may help in compensating for the quicker response time compared to a mechanical slider.

2nd slider intv

On the DM48, it is possible to use to use the arrow keys as a extra slider buttons (see *2nd/3rd slider* below). This setting determines the interval, in

semitones, by which the second slider (left arrow) will shift the current tuning.

3rd slider intv

On the DM48, it is possible to use the arrow keys as a extra slider buttons (see *2nd/3rd slider* below). This setting determines the interval, in semitones, by which the third slider (right arrow) will shift the current tuning.

2nd/3rd slider

When this menu page is activated (by pressing the round button), the left and right arrows are transformed into real-time control buttons that acts as extra sliders (see above). In contrast to the other menu pages, this is thus not a parameter.

A shortcut key combination is available to quickly reach this page as well as *Global preset*: press the two rightmost buttons simultaneously and keep holding to toggle between the two pages.

Tuning

Shows the current tuning scheme. Ten “slots” are available, all of them customizable using the tuning editor (see below). By default, the two first slots are called *Solo* (standard chromatic tuning) and *Richter* (typical tuning for diatonic/blues harmonicas), but all of them can be edited. By holding down the round button for two seconds, this page will also allow the current tuning to be saved to one of the available slots. After a slot is selected, the name of this slot can be edited. The arrows are used to change the character at the cursor, and the round and slider buttons are used to move to the next and previous character, respectively.

Tuning editor

Use this to modify the current tuning. Simply use the arrows to select hole, blow/draw and slider position, and press the round button to edit the selected note. Select *Quit* to step out of the editor by using the arrows. All changes are effective immediately and can be played without saving anything, while still editing. By stepping past the last hole, a screen will appear with options for transposing the current tuning up or down.

Additionally, functions for exporting and importing tunings is available on this screen: *Send tuning* will send the current tuning as MIDI notes, to be recorded and saved for example as a MIDI file that can be shared with others. After selecting *Receive tuning*, the DM48 is ready to receive a tuning which will replace the current one. Simply choose *DM48* as your output MIDI device in your sequencer and then play back a previously recorded tuning. Remember to save (see *Tuning* above) it if you want to keep it permanently in your DM48.

Navigation in the tuning editor is “circular” – step past the last option on the last page to return to the first page.

MIDI CC no.

This is a critical parameter that determines what type of MIDI CC message is used to modulate sound intensity. By default this parameter is set to 11 (Expression), and many synthesizers will respond to this controller message and adjust the volume/intensity accordingly. However, some synths instead expect it to be set to 2 (Breath). A last resort is to use 7 (Volume). This is usually not desirable, as this can also affect the volume of added effects such as reverb, but it is still better than no volume modulation. On this screen, you can also set the DM48 to transmit *Channel pressure* messages (also called aftertouch) rather than MIDI CC, which is expected by some synthesizers.

MIDI velocity

A static velocity value transmitted with all “note on” messages. The most important means for modulating sound intensity on a wind instrument is MIDI CC messages (see above).

MIDI channel

Channel used for sending MIDI messages (normally 1). This setting also allows the DM48 to be set to multichannel mode. In this configuration, the holes will transmit MIDI data on different channels. The number of channels can be selected, with for example *Multich. 1-12* indicating that twelve separate channels will be used, one for each hole. *Multich. 1-4* indicates that four channels will be used, such that the holes will transmit MIDI data on channels 1-2-3-4-1-2-3-4-1-2-3-4. “Base 2” multichannel ranges are also available, for example *Multich. 2-5* or *Multich. 2-13*, which can be useful together with synthesizers that support the MPE (MIDI Polyphonic Expression) standard, as channel 1 is then not to be used for note triggering. Note that *Double notes* (see below) should typically be set to *Allow* in multichannel mode. This allows, for example, double C notes to be played when using Solo tuning.

MIDI program

Can be used to remotely select patch (sound) on the downstream synthesizer. Note that not all synths will respond to MIDI program change messages.

MIDI ctrl keys

When this feature is activated, the slider button will transmit MIDI data when pressed (MIDI CC 24 will toggle from 0 to 127). Similarly, when any of the real-time control modes are active (*Bend direction* or *2nd/3rd slider*, see above), the left and right arrow keys will send MIDI messages (22 and 23, respectively). Setting any of the slider intervals to zero allows the corresponding button to be used purely as a MIDI controller. This feature allows more flexibility in controlling downstream MIDI devices, for example by assigning these controller numbers to specific parameters in your music production software.

Double notes

Many tuning schemes allow double simultaneous triggering of the same note (e.g. C in Solo tuning), but not all synthesizers can handle this on a single MIDI channel (see *Important notes on MIDI and wind instruments* above). This setting controls whether double triggering of the same note is allowed (*Allow*) or blocked (*Block*). This parameter has no relevance in *Monophonic* mode (see *Mono/poly* above).

Gain skew

By opening the DM48, it is possible to adjust the breathing resistance such that lower holes have less resistance, similar to an acoustic harmonica (see *Lid removal and breathing resistance adjustment* below). This will however reduce the pressure in the lower chambers (or vice versa should the resistance be increased on higher notes). This parameter makes it possible to compensate for the effect, by applying a higher gain to lower notes and vice versa. Should normally be in the neutral position as indicated by a horizontal line.

Display

Allows the display to be set to automatically dim or turn off after 4 seconds of inactivity.

Global preset

The DM48 provides ten “slots” for storing global settings. By holding down the round button for two seconds, this page will also allow the current settings to be saved to one of the available slots. Note that the first slot (*Default*) is always loaded at startup. Stored settings are recalled immediately when selected on this menu page, and corresponding tunings will also be loaded. Additionally, MIDI program change messages will be sent in cases when loading a preset causes this parameter to change. After a slot is selected, the name of this slot can be edited. The arrows are used to change the character at the cursor, and the round and slider buttons are used to move to the next and previous character, respectively.

A shortcut key combination is available to quickly reach this page as well as *2nd/3rd slider*: press the two rightmost buttons simultaneously and keep holding to toggle between the two pages.

Firmware version check

By holding down the slider during power-up, the version of the currently installed firmware as well as the electronic serial number of your DM48 will be shown on the screen.

Setup examples and guidelines

The DM48 does not synthesize sounds and is thus not a musical instrument, but rather an instrument controller. The synthesizer to which it is connected is therefore a critical part of the setup. This section contains a few examples and step-by-step guides to complete setups, including affordable software synthesizers that are suitable for a wind controller like the DM48.

GarageBand or Logic

The DM48 will likely become usable as an input device directly after connecting it – if not check the settings in *Preferences, Audio/MIDI*. Some of the sampled wind instruments in Garageband or Logic on MacOS are decent, and there are plenty of synthesizers and patches that can be adapted to work with a wind controller. GarageBand on iOS works too, but offers a less impressive selection of instruments. GarageBand instruments expect *MIDI CC no.* on the DM48 to be set to 11 (Expression). They can also correctly handle double triggering of the same note, meaning that *Double notes* should preferably be set to *Allow* (see *General notes in MIDI and wind instruments* above).

Remember that there is no “decay”, as on a piano tone, on blown instruments – the tone can be kept alive as long as there is still air in the lungs. When adapting non-wind instrument patches for playing with the DM48, try thus to change the “decay” parameter that is available on most software synthesizers. The Sculpture modeling synth, included in Logic, is good for wind instruments. To enable polyphonic playing (chords), increase the polyphony parameter on the upper part of the Sculpture panel.

Reason and Acoustic Electro Waves

EWI Reason Sounds provides an excellent set of software synthesizers for wind controllers in the form of plugins (refills) for Reason, including one called Acoustic Electro Waves. We found these to be excellent together with the DM48, on both MacOS and Windows machines. Together with Reason in demo mode (song loading disabled, but otherwise full functionality at no cost) it is a bargain at \$13. These instruments expect *MIDI CC no.* on the DM48 to be set to 2 (Breath). They do *not* correctly handle double triggering of the same note, meaning that *Double notes* should be set to *Block* (see *General notes in MIDI and wind instruments* above).

1. Download the full version of Reason at <https://www.propellerheads.se/download/>
2. Connect the DM48 if disconnected.
3. Set *Midi CC no.* to 2 on the DM48.
4. Follow Reason installation instructions closely and start Reason. Select *Demo mode*.
5. When asked about attached control surfaces, select *Manufacturer: Other, Model: MIDI Keyboard (No controls), In Port: DM48*. For audio

output, the default settings should work fine.

6. Purchase and download the Acoustic Electric Waves synth plugin at <http://www.ewireasonsounds.com/reason-refills.html>
7. In Reason, there is a *Browser* window to the left. Navigate to the Acoustic Electro Waves file you just downloaded. Clicking it should give you a selection of patches ending in “.cmb”. Double-click one of these to add it to the rack.

Multichannel setup with ThumbJam

The ThumbJam app is a nice low-budget option for getting started on iOS devices (iPhone/iPad) and it works immediately with the DM48 without any additional settings. Even better, it will respond correctly to multichannel data right from the start. You only need to activate this on the DM48 by setting *MIDI channel* to *Multich. 1-12* and *Mono/poly* to *Polyphonic*. You can also set *Double notes* to *Allow* (see *General notes on MIDI and wind instruments* above), to allow triggering of double identical notes (e.g. adjacent C notes in solo tuning).

Multichannel setup in Reason

For multichannel mode (see *MIDI channel* and *General notes on MIDI and wind instruments* above) to work correctly, the downstream synthesizer(s) should be setup to receive MIDI data on several separate MIDI channels. In some cases, such as ThumbJam (see above), this is easy, but many times it requires some more advanced MIDI skills and knowledge, and there is no universal fix as the solution will be specific to your downstream synthesizer setup. We provide one example here on how to achieve this in Reason, using four synths. In theory, twelve synths/channels is optimal, as this will make the holes completely independent of each other, similar to an acoustic harmonica. However, this may put a lot of load on the computer, in addition to being more time consuming to set up.

1. Set *Mono/poly* to *Polyphonic* and *MIDI channel* on the DM48 to *Multich. 1-4*. The holes will now transmit data on four different MIDI channels.
2. For best playability, also set *Double notes* to *Allow* (see *General notes on MIDI and wind instruments* above).
3. In Reason, go to *Preferences, Control surfaces* and remove the single control surface (input device) that is probably installed already (the DM48). Go to *Sync* and set *Bus A* to *DM48*.
4. Add four synthesizers to the rack by dragging from the browser window. Note that these should be wind-controller-adapted synths such as Acoustic *Electro Waves* (see above).
5. On the top rack unit (*Hardware interface*), click *Advanced MIDI*. Assign *Channel 1* to the first synth (if using Acoustic Electro Waves, pick the first *Combinator > In* in the list). Assign *Channel 2* to the next synth,

etc.

Note that changing patch now involves changing it on four separate synthesizers in the rack.

Yamaha VL70-m and other hardware synthesizers

Due to the DM48 being a class-compliant USB MIDI device, it cannot directly control a hardware synthesizer with a typical 5-pin MIDI connector. However, most music production software can be used to route the DM48 MIDI signals to an external synthesizer. A USB MIDI interface will be required, but these are available at low cost. Additionally, using a so called “USB host to MIDI” device, manufactured for example by Kenton (MIDI USB Host MkII) or Mode Machines (Cerebel USB), it is possible to eliminate the PC altogether. We have tested the DM48 together with the Kenton device and the acclaimed Yamaha VL70-m hardware modeling synthesizer, which sounds great, but one should keep in mind that this is a monophonic synth and chords are thus not possible. *MIDI CC no* needs to be set to 2 (Breath Controller) for the VL70-m and many other hardware modeling synthesizers. *Monophonic* mode (see *Mono/poly* above) may be preferable. If *Polyphonic* mode is used, some degree of *Asstd poly* is recommended (see *Mono/poly* above). In this case, the VL70-m will not correctly handle double triggering of the same note, meaning that *Double notes* should be set to *Block* (see *General notes in MIDI and wind instruments* above).

Untethered playing using a smartphone

Although the DM48 is supplied with a long USB cable to enable live performances, there is a simple way to become even more mobile. Built into Apple’s ecosystem is support for network MIDI, which means you can connect the DM48 to an iOS device (iPhone or iPad) using the Apple Lightning-to-USB adapter, and then route the MIDI signals over Wi-Fi to other devices. As a bonus, the iOS device acts as a mobile power source for the DM48. Windows-based machines should also be able to receive these signals if the correct driver is installed (see <https://www.tobias-erichsen.de/software/rtpmidi.html>). The approach described here is thus not a feature of the DM48 *per se*, but it becomes very useful with a small handheld instrument.

We used an iOS app called MIDIflow to control Reason running on MacOS from a DM48 connected to an iPhone with excellent results. The setup is relatively easy.

1. On your Mac, create a computer-to-computer network (click network icon in top status bar and select *Create network...*). Join this network on your iOS device.
2. In MIDIflow, select *DM48* as input device (top + icon) and *Network Session 1* as destination device (bottom + icon).
3. On the Mac, start Audio MIDI Setup (use Spotlight search to find this application), click *Window, Show MIDI window* and click *Network*.

Add a new session (+) and tick the box for this session. In the *Directory* list, choose your iOS device and click *Connect*. There should now be a MIDI device called *Network Session 1* available to any of your music applications in MacOS. This device behaves just like a locally connected DM48.

Lid removal and breathing resistance adjustment

The breathing resistance can be adjusted individually for each hole by means of 12 screws inside the DM48. By adjusting these screws, one can mimic the uneven resistance pattern encountered on a regular harmonica (less resistance on the lower holes). Changing the breathing resistance will also influence the pressure in the chambers. Thus, lessening the resistance will make it possible to blow or draw more strongly without saturating the sensors. Conversely, the instrument can be made very sensitive by tightening the screws, to allow pressure to build up more easily. The *Gain skew* setting (see above) can be used to compensate for the loss of signal that would result from opening up screws on lower-numbered holes or tightening high-numbered holes.

By default, all holes have been calibrated for equal response, and in most cases there should be no need to alter the screw settings. Breathing resistance adjustment is an advanced feature that requires opening up the instrument:

1. Remove the two bottom screws using a T8 torx driver.
2. Slide the lid backwards away from the mouthpiece, using some light force. If necessary, a screwdriver or similar may be inserted in between the mouthpiece and the lid to help gently wiggle it backwards a few mm. All maneuvers should be done with great care to avoid damaging any of the parts and components.
3. Having slid it away ~5 mm from the mouthpiece, lift up the lid at the front end (facing the mouthpiece), tilt it backwards a little bit, and slide it backward away from the instrument. Do this very gently to ensure that components come free from the lid.
4. The individual holes are adjusted using a 2 mm hex key, included with your DM48. Coincidentally, a T8 torx driver also works well.
5. Reverse the procedure above when replacing the lid. Do not over-tighten the screws as to not damage the plastic chassis.