

Understanding and Using Your moogerfooger® MF-105M MIDI MuRF®

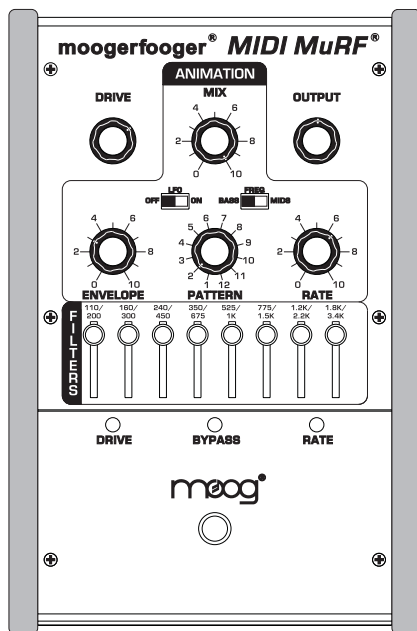


TABLE OF CONTENTS

Getting Started.....	3
Frequencies and Filters.....	5
The MIDI MuRF's Filters.....	7
Envelope Generators.....	10
Sequencers and Pattern Generation.....	10
The MIDI MuRF's Animation.....	11
The MIDI MuRF's Tap/Step Input.....	13
Audio Level Controls and Mixing.....	14
Using Both Outputs Together.....	14
Expression Pedals and Voltage Control.....	15
Using MIDI with the MIDI MuRF.....	16
Some Typical Setups.....	24
Technical Information.....	23
Appendix A - the MuRF's Patterns.....	28
Appendix B - MIDI Implementation Chart.....	32
Appendix C - Warranty Information.....	33
Appendix D - MF-105 Specifications.....	34



Welcome to the world of moogerfooger® Analog Effects Modules! Your model MF-105M MIDI MuRF is a rugged, professional-quality instrument, designed to be equally at home on stage or in the studio. Its great sound and jaw-dropping effects come from state-of-the-art analog circuitry, designed and built by the team at Moog Music in Asheville, North Carolina. The MF-105M is full of the very same analog goodness that Bob Moog designed into the original award-winning MF-105 MuRF and the MF-105B Bass MuRF.

Your MIDI MuRF is a direct descendent of the original Moog® modular synthesizers and professional rack effects. It contains two basic functions: an 8-band array of resonant filters that can be voiced for bass or mid frequency response, and a pre-programmed "Animation" module that generates sequences of envelopes that modulate the levels of the 8 filters. Several of the performance parameters are voltage-controllable, which means that you can use expression pedals, MIDI-to-CV converter, or any other source of control voltages, such as other moogerfoogers, to play your MIDI MuRF. In addition, the front panel rotary controls and switches can be controlled through the use of MIDI. The patterns of the Animation module can be synced to a MIDI Clock, and the MIDI input allows for users to customize the internal patterns. A software application that is both MIDI Controller and Pattern Editor is available at Moog Music's website: www.moogmusic.com.

While you can use it on the floor as a conventional effects box, your MIDI MuRF is much more versatile and its sound quality is higher than the single fixed-function "stomp boxes" that you may be accustomed to. You will find that your MIDI MuRF is a deep electronic musical resource and will become your creative companion as you explore its possibilities.

The following pages will first tell you how to hook up your MuRF and set the panel controls for the 'basic' setup. Next, we'll explain how the functions of your MIDI MuRF work. After that we'll go through the panel features and give you suggestions on how to use your MIDI MuRF in specific applications. At the end of this booklet you'll find technical specifications, service and warranty information, information about Moog Music and diagrams of the MIDI MuRF's Animation patterns.



GETTING STARTED

Here are some simple instructions on how to plug in and try out your MF-105M before you have read through the entire manual.

1. Unpack your MF-105M. Place it on a table while you become familiar with its controls and connections. Gently pat the wooden side pieces of your new moogerfooger to let it know that it has found its new home and that it will be well cared for.

2. Check that the power adaptor has a nominal rating of +9 volts, providing at least 300 mA (milliamperes) of current and is also rated at your country's standard power voltage (120 Volts AC for the United States and Canada; 100 Volts AC for Japan; and 220 Volts AC for most other countries). Plug the power adaptor's cord into the MF-105M's '+9V' jack. Then plug the power adaptor itself into a power voltage receptacle. ***Note the MIDI MuRF uses a power supply which is rated at 300mA output current. Using a power supply that is rated for less current may not allow the device to power up properly. Make sure to use the proper power supply.***

3. Note that the BYPASS light is on. It will light up either red or green. Red indicates that the MF-105M's effect is off-line (bypassed), while green indicates that the effect is on. Pressing the 'stomp switch' will toggle the BYPASS light between red and green. For now, leave the BYPASS light on red.

Refer to Figure 1 for steps 4, 5 and 6.

4. Connect an instrument cable from the LEFT/MONO jack to a line-level input on your amp or mixer. Turn the volume control on your amp down but not off.

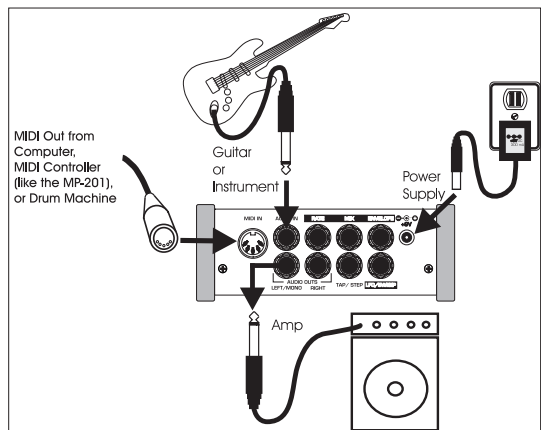
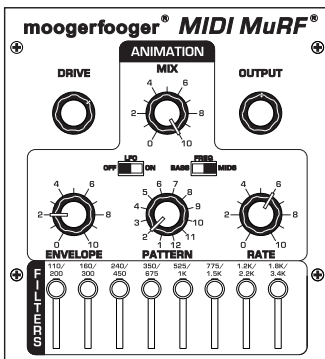


Figure 1 - Basic Connections

5. Connect a MIDI Cable from the MF-105M's MIDI In to the MIDI Out on a MIDI Controller of your choice: MIDI sequencer, Drum Machine, a MIDI foot controller like the MP-201 Multi-pedal, or a MIDI keyboard. The MIDI MURF defaults to MIDI Channel One so make sure that the MIDI controller is transmitting on MIDI Channel 1. Be sure to check out the MIDI MuRF Controller and Pattern Editor application available from www.moogmusic.com.

6. Connect an instrument cable from your signal source to the AUDIO IN jack. You can feed virtually any instrument-level or line-level signal through your MF-105M. Examples are guitar, bass, keyboard, theremin, drum machine, or Effects Send output on your mixer. Play your instrument (or turn on the signal source). Adjust the volume control on your monitor amp so that the sound level is comfortable.

7. Now set the MF-105M panel controls as follows (See Figure 2):



PATTERN	2
ENVELOPE	2
RATE	6
MIX	10
FREQ switch	MIDS
LFO switch	OFF
Filter Sliders 1-8	All the way up.

Figure 2 - Basic Settings

Press the stomp switch. The BYPASS light will now turn green. Playing your instrument, set the DRIVE control so that the DRIVE indicator lights up yellow most of the time. You will also hear the filtered signal. Adjust the OUTPUT control so the MIDI MuRF's effected signal is about the same loudness as the bypassed signal.

8. Continue to play your instrument. Low-pitched, sustaining sounds with a bright timbre will work best to learn the sound of the MIDI MuRF. Your instrument's signal is going through the MIDI MuRF's filters. Listen to how it affects the quality of your instrument's tone. You will hear the level of each of the 8 filters being turned up and down

automatically in sequence by the Animation at a tempo determined by the RATE control. Note that changing the ENVELOPE control affects the shape that turns the filters up and down. The PATTERN rotary switch selects different patterns that dictate the sequence that turns the Filters up and down automatically. The MIX control is used to blend the direct sound of your instrument with the effected sound.

8. If your MIDI controller can send MIDI Clock Messages, start sending them. The Rate LED changes color to Orange when syncing to MIDI Clock. The MIDI MuRF's Pattern should be synced to the tempo set by your MIDI controller. Try sending CC1 messages to the MIDI MuRF. This will modify the ENVELOPE control. If you have downloaded the MIDI MuRF controller software from the Moog Music website, you can control the parameters of the MIDI MuRF and program new patterns. See the program's documentation for more information.

9. In the next sections we'll explain exactly how the MIDI MuRF's Filters work and what the Animation does. For now, get a feel for the controls by experimenting with different settings.

FREQUENCIES and FILTERS

Let's start with some definitions. Please read this section carefully, as it will help you to understand the basic ideas behind the MF-105M MIDI MuRF's filters.

Sound is a vibration of the air. The speed of vibration is called the frequency. It is measured in Hertz (Hz). One Hz is one vibration per second. We hear vibrations from 20 Hz to 20,000 Hz.

Musical sounds generally have many frequency components. They're called harmonics, or overtones, or partials. They are what give a sound its characteristic tone color, or timbre. A graph showing the strength of each of a sound's harmonics is called a spectrum. A typical spectrum of a musical sound is shown in Figure 3.

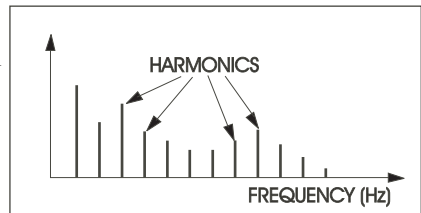


Figure 3 - Harmonic Spectrum

In general, bright sounds have lots of strong overtones, while darker, mellower sounds have fewer (and weaker) overtones.

A filter is a signal-modifying device that colors a sound by emphasizing some parts of the audio spectrum and attenuating (cutting down) other parts. In general, a filter has a quality of its own which is superimposed on the tone color of the original sound. Some types of filters (like the bass and treble controls on your sound system) have subtle, gentle effects on a sound's timbre. Other types of filters have stronger and more dramatic effects, and are frequently used as elements in the music-making and sound design process. Strong filters include phasers, flangers, and wah-type resonant filters.

A graph showing what a filter does is called the filter's frequency response. The horizontal axis is frequency. The vertical axis is the filter's gain. A gain of "1" (unity) means that, at that frequency, the output of the filter is just as strong as the input. A gain of less than unity means that the filter's output is attenuated at that frequency, while a gain of greater than unity means that the output is actually greater than the input.

Figure 4 shows examples of the frequency response characteristics of two common types of filters: (a) a lowpass filter, which passes frequencies without attenuation up to a so-called 'cutoff frequency', and attenuates the frequencies above cutoff; (b) a resonant filter, which emphasizes frequencies around the filter's 'center frequency'.

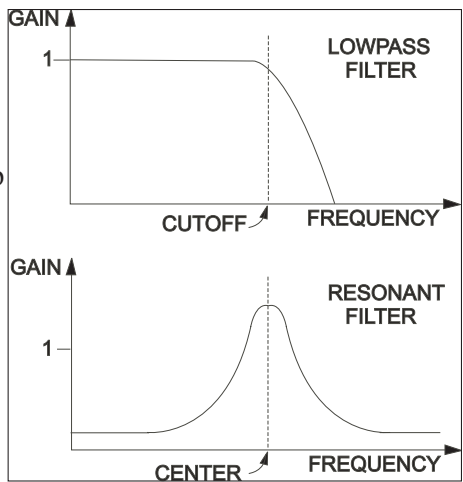


Figure 4 - Filter Frequency Response

Both of these filter types are widely used in electronic music. Each of them has its own distinct sound, a large part of which is directly related to the shape of its frequency response graph. The first type is the same as in the moogerfooger MF-101 lowpass filter, as well as the lowest filter in the MIDI MuRF's BASS voicing; the second type is in the top 7 bands of the MIDI MuRF's BASS voicing and all 8 bands of the MIDS voicing.

The MIDI MuRF's FILTERS

The MIDI MuRF contains 8 filters that can be configured for bass or mid-frequency voicing by the FREQ slide switch on the front panel.

In the BASS voicing, the lowest filter acts as a lowpass filter with a cutoff frequency of 110 Hz. This is ideal for bass players or bass sounds that need to retain the presence of all their lowest frequencies. The remaining seven filters are resonant filters with center frequencies of 160, 240, 350, 525, 775, 1200 and 1800 Hz.

In the MIDS voicing, all 8 filters act as resonant filters with center frequencies of 200, 300, 450, 675, 1000, 1500, 2200, and 3400 Hz. The MIDS voicing is very good for processing sounds with dense mid-frequency harmonics, including guitars, vocals, or synthesizer pad sounds.

Each filter has a slider that adjusts the gain of that filter. In this respect, the MuRF resembles a graphic equalizer. When a filter's slider is all the way down, the gain for that filter is zero, and the filter's output is zero. When the slider is all the way up, the filter's output is at maximum. However – the resemblance to a graphic EQ ends there. The MuRF's filters have characteristics that set them far apart from a graphic equalizer. First, they are resonant filters. They boost the signal at the center frequencies of the filters. Second, they are tuned so they don't overlap. A graphic equalizer will theoretically not color the signal at all when all the sliders are set to the same level. The MuRF's resonant filters on the other hand color the signal a great deal, adding warm analog resonances at pleasing intervals throughout the frequency spectrum.

We'll now show how the MIDI MuRF's filters affect the MF-105M's frequency response. We will always start with this 'basic' panel setup, shown in figure 5, which is:

- 1) Set each of the filters' sliders to all the way up.
- 2) With the FREQ switch in the MIDS position, switch the PATTERN to Pattern 1. When Pattern 1 is active, the Animation is turned off so you

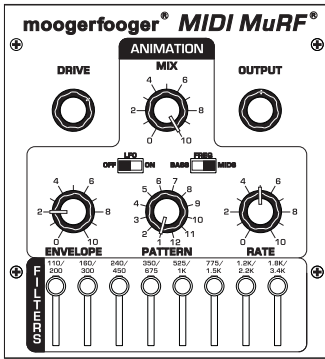


Figure 5 - Testing the Filters

can hear the effect of *just* the filters.

3) Make sure the effect is on, and MIX is at 10.

4) Connect just the "left/mono" output to your amplification. You may want to experiment with the panel controls and switches as we discuss each of the parameters.

5) Now, play a bright, sustained sound, preferably of low pitch into the MIDI MuRF - keep in mind that filter effects work by *removing* frequencies, so you must have a bright sound to hear the effect! Figure 6 shows the MF-105M's MIDS frequency response, the response that you hear when the panel controls are set up as in the basic setup. Note that there are 8 resonances – they impart warmth and color to the sound. For a moment press the bypass switch and turn the effect off. Note the change in character of the sound. Now switch the effect back on.

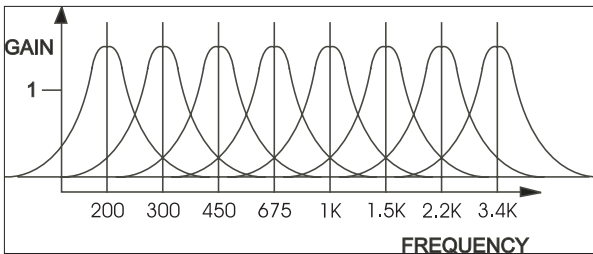


Figure 6 - MIDS Frequency Response

6) Now turn all the sliders down except the lowest one. While playing your instrument, turn each slider up one at a time, while the rest of the sliders are all the way down. Pay careful attention to the sound of each filter. When you have learned the sound of each individual filter, try various combinations, such as the bottom two and top two. At this point you will want to repeat steps 5 and 6 with the **FREQ** slide switch moved to the **BASS** voicing position. Figure 7 shows the frequency response of the 8 filters in the **BASS** voicing setting. This will familiarize you with the sounds of the two voicings. Note that even without Animation, the MIDI MuRF is a **VERY POWERFUL** filter bank with many possibilities to sculpt your tone!

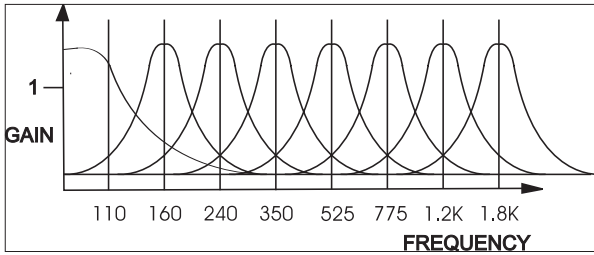


Figure 7 - BASS Frequency Response

7) The Filters' resonant frequencies can be shifted up and down by a small amount to create an effect similar to phasing. Figure 8 shows a graph that portrays the results of shifting a resonant filter's center frequency. In the MIDI MuRF this can be done two ways, depending on the position of the LFO slider switch. When the slider is in the "OFF" position, the filters' center frequencies can be shifted by an expression pedal (such as the Moog EP-2) or CV plugged into the LFO/SWEEP Jack. To hear how this works, return to the basic setup described in Figure 5. Plug a Moog EP-2 into the LFO/SWEEP control input. Then, as you play into the MIDI MuRF, rock the EP-2 back and forth. You will hear the filters' frequencies shift with the motion of the pedal.

When the LFO slide switch is in the "ON" position, a LFO (Low Frequency Oscillator) shifts the frequencies of the filters as a group up and down automatically.

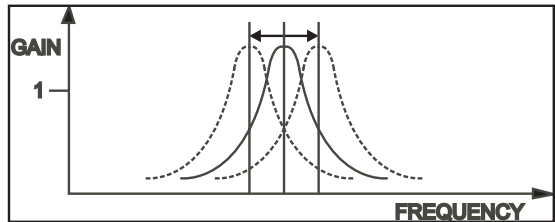


Figure 8 - Filter Frequency Shift

The LFO is a sine wave. The LFO rate is initially determined by the pattern. An expression pedal (EP-2 or equivalent) or CV connected to the LFO/SWEEP jack can modify the LFO Rate from .08 Hz to 20 Hz.

To hear the effect of the LFO on the MIDI MuRF's filters, return to the basic setup outlined in figure 5, then move the LFO slider switch to "ON". Now as you play through the MuRF, you'll hear the filters swept up and down automatically. To change the speed of the LFO, plug a Moog EP-2 expression pedal into the LFO/SWEEP Control Input. The EP-2 can now slow down or speed up the LFO.

ENVELOPE GENERATORS

Now that we have explained the MIDI MuRF's filters, let's proceed with some more definitions to explain the Animation function.

The term "Envelope" is used to describe the changes that occur to a musical sound, from its start to its end. A musical sound can have a rapid onset, like the plucking of a string or the striking of a drum. It can also have a gradual onset, like a slowly bowed violin. With the term "Envelope", the shape of the start of a sound is called the "Attack". The end of a sound can have different shapes as well – it can be abrupt, like on an organ, or it can be very gradual, fading out like a piano note held down. The shape of the end of a musical sound is called "Decay". Both Attack and Decay are time-related, and can be measured in seconds or milliseconds. Figure 9 illustrates the components of an envelope.

An "Envelope Generator" is a circuit that produces a control voltage that corresponds to the shape of a musical sound's envelope. The signal that comes out of an Envelope Generator is sent to a control, such as volume, and is used to automatically turn up and down the volume to shape the start and end of a musical sound. An Envelope Generator is started by a trigger - a signal used to start the envelope shape.

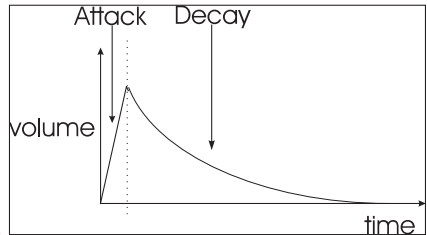


Figure 9 - Envelope

In the MIDI MuRF, there are 8 Envelope generators, one for each filter, that shape the Volume of that Filter's signal. The shapes of the Envelopes are all determined by the setting of the ENVELOPE Control. The timing and sequence of the Envelopes is determined by the PATTERN selected. To understand that, let's continue.

SEQUENCERS and PATTERN GENERATION

A Sequencer is used to generate reoccurring rhythmic patterns, often by triggering sequences of notes in synthesizers or drum machines. However sequencers can be used for purposes other than triggering notes - they can be set up to create reoccurring changes of timbre as

well. Vintage sequencers were typically designed so there were a certain number of "steps". The term "step" refers to the individual components of a pattern. For instance in a bar of music in 4/4 you have four quarter notes. If the rhythmic activity is no more complicated than quarter notes, this would correspond to four steps. In vintage analog sequencers, a sequencer typically had eight or sixteen steps available to build a pattern.

In its simplest form, as a sequencer plays back its steps, each step can be programmed to send a trigger signal, or step can be passed over like a musical rest. The trigger signals can then be used to trigger envelope generators according to the way each step is programmed - creating a rhythmically reoccurring pattern.

ANIMATION

The MIDI MuRF's Animation contains a simple 8-channel sequencer, one channel for each filter, each capable of triggering an Envelope Generator that shapes the volume of the filter. In a Pattern, each channel can be up to 64 steps long, and each channel can have a unique number of steps. The MIDI MuRF MIDI controller and Pattern Editor Application allows the user to customize most of the Patterns in the MIDI MuRF. For each step, on each channel of a pattern, the corresponding filter's envelope can be triggered, or paused. The ENVELOPE control morphs through different envelope shapes as you turn it, creating effects that are highly rhythmic in nature, or are swirling and ethereal. The RATE control sets the speed of the pattern. The patterns, selected by the PATTERN selector rotary switch in conjunction with the FREQ slider switch, have been selected to provide a useful variety of rhythmic timbral effects. There are a total of 24 patterns, arranged in two banks of 12: one bank for the BASS voicing and one for the MIDS voicing. Note that pattern 1 and 13 are fixed as having no Animation and can not be modified by the user.

An easy way to understand the Animation is to look at a simple pattern displayed on a grid. Figure 10 shows a graphic representation of pattern 2 in the MIDS setting. The columns going left to right are the steps of the pattern. The rows going from bottom to top are the

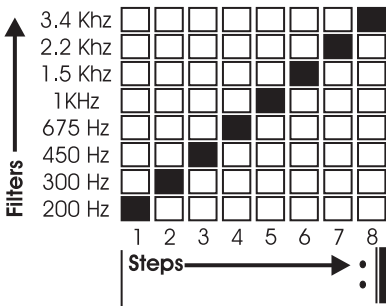


Figure 10 - MIDS Pattern 2

individual filters. *Illustrations of all the Patterns are in Appendix A, page 27.*

Return to the basic setting shown in figure 2, which features pattern 2. As you play your instrument through the MIDI MuRF, pay attention to the sound of the effect and how it corresponds to figure 10. You should hear the Animation "stair-stepping"

through the filters. Turn the RATE control up and down and notice how the pattern speeds up and slows down.

Now it's time to explore the ENVELOPE Control - one of the most powerful parts of the MIDI MuRF.

- 1) With the ENVELOPE Control set at 2, you should hear each of the filters with a sharp attack and a decay that fades out smoothly but quickly.
- 2) Turn the ENVELOPE control to 0 as you play through the MIDI MuRF. The effect sounds much choppy - the decay time has been decreased.
- 3) Now turn the ENVELOPE control up to 5. The effect now sounds smooth - the attack is the same time as the decay - like a tremolo effect.
- 4) Turn the ENVELOPE control to 6. The effect becomes swirly and the transitions from filter to filter blurred, as the Attack and Decay become so long that the effect is crossfading from one filter to the next.
- 5) Finally, turn the ENVELOPE control up to 8. The effect now sounds "backwards" as the attack time is now smooth but fast, and the decay is abrupt.

What happens as you change the ENVELOPE control is that the shape of the Envelopes controlling the gain of the filters morphs. Figure

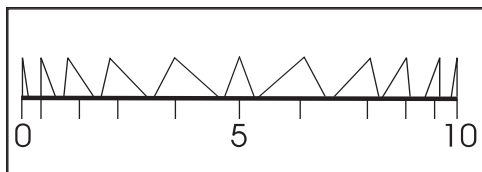


Figure 11 - Envelope shape morphing with the ENVELOPE control

11 shows the changes to the envelope times at different settings of the Envelope control. The Envelope times also change as the RATE changes. Faster Rate settings decrease the envelope times

and slower Rate settings increase the envelope times. This makes the MIDI MuRF capable of both rhythmic and smooth-changing, swirling effects. Spend some time to get to know how this control interacts with the different patterns and you will be rewarded with some very interesting sounds!

THE MuRF'S TAP/STEP INPUT

The MIDI MuRF's Animation can be synced to the tempo of the music using a Moog FS-1 footswitch plugged into the TAP/STEP input. Tapping three times activates the tap tempo feature of the MIDI MuRF. The MF-105M calculates the time in between taps and translates this into the rate for the pattern. It is important to make the time between the taps as much the same as possible to get the best results. Note that the Rate light becomes green when the rate is set by the Tap input, and returns to red if the RATE control is changed. The tempo of the Animation is twice the rate that is tapped on the footswitch. In other words, if you tap in quarter notes, the Animation will chug along in eighth notes. If you tap eighth notes, the Animation will proceed in 16th notes. A 0V off/ +5V on Gate signal may be used to set the tap tempo as well.

The "STEP" part of the TAP/STEP input refers to the fact that the jack is a TRS (Tip-Ring-Sleeve) input, and plugging the FS-1 or a gate signal in halfway to this input engages the Animation sequencer STEP function. With the tip of your FS-1 footswitch or gate signal connected to the ring of the TAP/STEP input, a press of the footswitch or a gate signal stops the automatic advancing of the current Animation pattern and the RATE LED turns green. Then, with each additional press of the footswitch or gate signal, the pattern will advance by one step. This is a very good way of coming up with your own rhythmic variations on any of the MIDI MuRF's patterns.

THE AUDIO LEVEL CONTROLS AND MIXING

The DRIVE control adjusts the signal level at the MIDI MuRF's circuit input. With this control you can set the right input level for virtually any instrument or line-level signal source. Turn this control counterclockwise for strong input signals, and clockwise for weaker sound sources.

The DRIVE light tells how strong the input signal is after being adjusted by the DRIVE control. As the signal level increases, the light goes from off, to green, to yellow, and finally to red. Very weak signals do not light up this light at all. When the light is green, the signal is below the level that results in audible distortion. When the light is yellow, some low order distortion may be audible, giving the sound a subtle warm analog quality. When the signal is strong enough to drive the light into the red, the distortion at the output becomes stronger and more distinctly audible. Watch this light when you set the DRIVE control for the desired effect. Using the distortion generated by the DRIVE control in some cases can help make the MIDI MuRF's filters sound stronger as distortion adds harmonics to the input signal.

The MIX control is used to balance the dry and effected signals when the MIDI MuRF is active. At full counter clockwise, the output signal is the dry signal, as modified by the DRIVE control. At mid-position, the balance of dry and wet signals is 50%/50%. At full clockwise position, the output signal comes from only the MIDI MuRF's filters.

The OUTPUT control adjusts the strength of the MuRF's signals that appear at the LEFT/MONO and RIGHT output jacks. Use this control to balance the MuRF's signals with the bypassed signal. Note that neither the DRIVE nor the OUTPUT controls affect the strength of the bypassed signal.

USING BOTH AUDIO OUTPUTS TOGETHER

The MIDI MuRF has two audio outputs: LEFT/MONO and RIGHT. When a cable is plugged into just the LEFT/MONO jack, the outputs of all filters are sent to that jack. If a cable is inserted into the RIGHT jack, then half of the filters are sent to the RIGHT output, and half are sent to the LEFT/MONO output. Figure 12 shows the MIDS frequency response

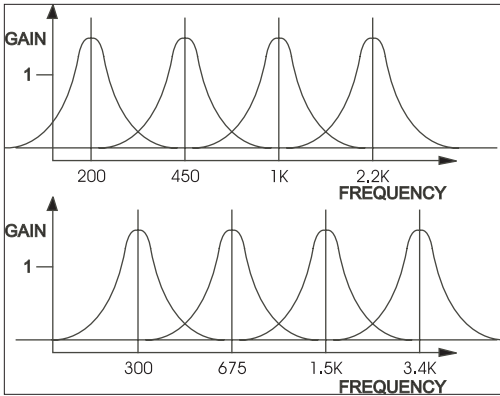


Figure 12 - Left and Right Frequency Response of MIDS filters

of the left and right outputs when both the left and right output jacks are used. Note that the odd-numbered filters are sent to the left channel, and the even-numbered filters are sent to the right channel. This allows for spreading a sound's frequencies between two speakers.

EXPRESSION PEDALS AND VOLTAGE CONTROL

You now know what each of the rotary controls does to the sound of the MF-105M. The ENVELOPE, MIX, and RATE controls have expression pedal/control inputs that duplicate their effects. In addition, the MF-105M has a LFO/SWEEP input which is used to adjust the speed of the LFO, or to sweep the frequencies of the filters if the LFO switch is OFF. This enables you to plug in up to four expression pedals to play the MF-105M with your feet as well as with your hands. The moogerfooger EP-2 Expression Pedal and MP-201 Multi-Pedal are both designed for this purpose. You can also use expression pedals with equivalent specifications. See the Technical Information section on Page 23 for more information on pedal specifications.

When you plug an expression pedal into one of the pedal inputs on your MF-105M, the pedal adds and subtracts half the range to the setting of the corresponding control. For example, let's say that you plug an expression pedal into your MF-105M's ENVELOPE input, with the ENVELOPE control set to 5. With the pedal all the way in the heel position, the Envelope shape is the same as if the ENVELOPE control was set to zero. Then, when you advance the pedal, the Envelope shape begins to morph, just as if you were turning the knob. At halfway, the pedal equals the setting of the corresponding control, and at full toe position, it is as if the control is at 10. A good rule to follow is: when you use an expression pedal, you set the corresponding knob for the middle value you want. From the middle of the pedal, advancing to toe

position increases that value, pulling back to heel position decreases the value.

The expression pedal inputs can also be used as control signal inputs. This enables you to use your MF-105M with virtually any control signal source: modular analog synthesizers, MIDI-to-CV converters, etc. You will find information on interfacing your MF-105M with external control signal sources in the Technical Information section on page 23.

USING MIDI WITH THE MIDI MuRF

Up to this point, we have described the use of the MIDI MuRF in the analog realm. The MIDI MuRF can be controlled via MIDI as well, allowing the creation of tempo-synced effects or automated effects when used with the MIDI MuRF controller software, a MIDI sequencer or a powerful MIDI controller like the MP-201 Multi-Pedal. This makes it a very powerful tool in the modern production environment. Note that the following sections assume the reader is already familiar with the basics of MIDI and the MIDI messages used to control the MIDI MuRF. It is beyond the scope of this manual to explain the basics of MIDI messages. Basic information about MIDI can be found at the website www.MIDI.org.

SETTING THE MIDI CHANNEL

The MIDI MuRF Defaults to MIDI Channel 1 for receiving Channel Mode messages (MIDI CCs, MIDI Note Ons). The MIDI Channel can be set by the user one of two ways: powering up with the LFO and FREQ switch in the left position and with the stomp switch pressed sets the MIDI channel to 1-12 corresponding to the position of the pattern rotary switch. In addition, a MIDI CC #102 with values 1-16 received on any MIDI Channel will set the MIDI channel to 1-16. When the MIDI MuRF is powered down, the last MIDI Channel assignment is remembered.

SELECTING PATTERNS WITH PROGRAM CHANGE MESSAGES

The MIDI MuRF contains 24 patterns in its memory. From the front panel, 1-12 are accessed by the PATTERN switch in the BASS voicing

setting, and 13-24 are accessed by the PATTERN switch in the MIDS voicing setting. Using MIDI Program Change Messages values 0-23 accesses the MuRF patterns 1-24. This has no impact on the position of the FREQ switch, so that using MIDI, you can use any of the 24 patterns with either voicing, overriding the front panel PATTERN and FREQ switch positions. Moving the PATTERN rotary switch or the FREQ switch restores the MIDI MuRF to the state of those front panel controls.

CONTROLLING PARAMETERS WITH MIDI CC MESSAGES

The following MIDI MuRF parameters can be controlled with MIDI CC messages:

ENVELOPE: CC1 (Mod Wheel). When the MF-105M receives a CC1 message on the MIDI channel that is assigned, the value of the CC1 message overrides the setting of the front panel ENVELOPE control and any steady voltage at the ENVELOPE control input. Moving the front panel ENVELOPE control or modifying a voltage at the ENVELOPE control input restores this parameter to its front panel state.

DRIVE: CC2 (Foot Controller). When the MF-105M receives a CC2 message on the MIDI channel that is assigned, the value of the CC2 message overrides the setting of the front panel DRIVE control. Moving the front panel DRIVE control restores this parameter to its front panel state.

LFO RATE/SWEEP: CC3. When the MF-105M receives a CC3 message on the MIDI channel that is assigned, the value of the CC3 message overrides any steady voltage present at the LFO/SWEEP input and shifts the Filters' frequencies based on the setting of the LFO ON/OFF switch. When the LFO is ON, the rate of the LFO is changed as with the LFO/SWEEP control input: .08 Hz to 20 Hz. When the LFO is OFF, CC3 Values shift the 8 filters' frequencies.

OUTPUT: CC7 (Volume). When the MF-105M receives a CC7 message on the MIDI channel that is assigned, the value of the CC7 message overrides the setting of the front panel OUTPUT control. Moving the front panel OUTPUT control restores this parameter to its front panel state.

MIX: CC8. When the MF-105M receives a CC8 message on the MIDI channel that is assigned, the value of the CC8 message overrides the setting of the front panel MIX control and any steady voltage at the MIX control input. Moving the front panel MIX control or modifying a voltage at the MIX control input restores this parameter to its front panel state.

RATE: CC9 – When the MF-105M receives a CC9 message on the MIDI channel that is assigned, the value of the CC9 message overrides the front panel RATE control and any steady voltage present at the RATE input. Note that w/no MIDI Clock messages being received, this is a continuous control the same range as the front panel control. When synced to MIDI, this CC becomes a Clock divider – with 16 possible settings. (See Clock Divider chart in the MIDI Clock section below). Moving the front panel RATE control or modifying a voltage at the RATE control input restores this parameter to its front panel state.

STACCATO MODE: CC68 OFF/ON (0-63 = OFF, 64-127 = ON). This mode changes the way envelopes behave in “Triggered Mode” (See below on p. 21 for Triggered Mode description) If this is OFF (which is the default), then the envelopes go all the way through their attack and decay no matter how briefly you hold the MIDI note. If "staccato mode" is ON, then the envelopes play all the way out if you hold down the MIDI note, but if you release the MIDI note the envelope goes immediately to zero. This is good for quick, sharp little notes or for using a sequencer to control articulation.

ENVELOPE SCALE: CC70: CC70 expands/compresses the overall duration of the envelope while keeping the same shape set by the ENVELOPE control or CC1. When NOT synced to MIDI Clock, as you adjust the Rate knob the envelope duration is automatically compressed at higher Rates and expanded at lower rates, to preserve a musical envelope response as your sequence changes speed. When Synced to MIDI Clock, the Rate knob becomes a MIDI clock divider and no longer affects the envelope scale itself. Using CC70 you can control the envelope time scale independently of the Rate control.

LFO ON/OFF: CC85; Values: 0-63=OFF; 64-127=ON. When the MF-105M receives a CC85 message on the MIDI channel that is assigned, the value of the CC85 message overrides the setting of the front panel LFO switch if it is in the range of values that is opposite the current

setting (i.e. the switch in the ON position, and the MIDI CC85 value received is 0). Moving the front panel LFO switch restores this parameter to its front panel state.

FREQ BASS/MIDS: CC86; Values 0-63=BASS; 64-127=MIDS. When the MF-105M receives a CC86 message on the MIDI channel that is assigned, the value of the CC86 message overrides the setting of the front panel FREQ switch if it is in the range of values that is opposite the current setting (i.e. the switch in the MIDS position, and the MIDI CC85 value received is 0). Note that CC86 does NOT change patterns as the front panel switch does. Moving the front panel FREQ switch restores this parameter to its front panel state including the current bank of patterns.

CC87 – Bypass On/Off. Values 0-63=Off; 64-127=ON. When the MF-105M receives a CC87 message on the MIDI channel it is assigned, the value of the CC87 message changes the bypass state and BYPASS LED if it is in the range of values that is opposite the current setting (i.e. the effect is ACTIVE, and the MIDI CC87 value received is 0). Pressing the BYPASS switch toggles the state of bypass and BYPASS LED.

Pattern Clock Sync On/Off: CC89. Values 0-63=OFF; 64-127= ON. When the MF-105M receives a CC89 message on the MIDI channel that is assigned, the value of the CC89 message enables or disables the Pattern Clock's ability to sync to incoming MIDI Clock messages. With this set to "OFF", the Pattern Clock is "free running" and its rate is set by the RATE control, or by a voltage applied to the RATE input. There is no front panel control for this feature. The default is ON. The MIDI MuRF ignores this message while actively synced to a MIDI Clock.

Pattern Reset: CC90. Any Value. A CC90 message received will instantly reset the current pattern to the beginning (step 1). This is useful for re-synchronizing the pattern to an off-beat while you are in MIDI sync.

FILTERS 1-8 LEVEL: CCs 20-27. When the MF-105M receives a CC message from CC 20 –CC27 on the MIDI channel that is assigned, the pattern clock is stopped and the CC value sets the volume of the corresponding filter up to the maximum volume set by that filter's slider. Note that the values of CC20-27 Messages do not override the positions of the sliders. Changing the Panel Rate control, Rate CV input, or receiving a MIDI Clock start or Clock Continue message restarts Pattern

clock and returns the MIDI MuRF's filters to control by the EGRs triggered by the current Pattern. If the Pattern selected has no Animation (i.e. factory default pattern 1) then upon receiving one of these CC messages, the corresponding filter level is set by that CC value, while all other filter levels are set to ON (before the sliders). If the pattern selected has Animation (i.e. factory default pattern 2) then upon receiving one of these CC messages, the corresponding filter level is set by that CC value, while all other filter levels are set to OFF (before the sliders).

MIDI Channel: CC102. Values 1-16 = MIDI Channels 1-16. When the MF-105M receives a CC102 message on ANY MIDI channel, the CC102 Value 1-16 sets the MIDI Channel accordingly. All other values are ignored.

SYNCING THE MIDI MURF WITH MIDI CLOCK MESSAGES

The MIDI MuRF detects and syncs its pattern clock to incoming MIDI System Realtime Clock messages. A MIDI Clock Start message will start the current pattern from its beginning, and a MIDI Clock Continue message starts the pattern from its last position after being stopped by a MIDI Clock Stop message. When the Pattern Clock is synced to MIDI Clock, the RATE LED turns orange, and the RATE control becomes quantized to be a MIDI Clock Divider. MIDI Clock messages are sent with 24 messages per quarter note. By counting different divisions or multiples of 24, rhythmic subdivisions can be achieved. The following are the clock divisions of RATE and LFO/SWEEP:

Four Wholes (CC values 000-006) Clock messages: 384
Three Wholes (CC values 007-012), Clock messages: 288
Two Wholes (CC Values 013-019), Clock messages: 192
Dotted Whole (CC Values 020-025), Clock messages: 144
Whole (CC Values 026-032), Clock messages: 96
Dotted ½ (CC Values 033-038), Clock messages: 72
Whole Note triplet (CC Values 39-44), Clock messages: 64
½ note (CC Values 045-051), Clock messages: 48
Dotted ¼ (CC Values 052-057), Clock messages: 36
½ note triplet (CC Values 058-064), Clock messages: 32
¼ note (CC Values 065-070), Clock messages: 24
Dotted 1/8 (CC Values 071-076), Clock messages: 18
¼ note triplet (CC Values 077-083), Clock messages: 16

1/8 note (CC Values 084-089), Clock messages: 12
Dotted 1/16 (CC Values 090-096), Clock messages: 9
1/16 note (CC Values 097-102), Clock messages: 6
Dotted 1/32 (CC Values 103-108), Clock messages: 4
1/32 note (CC Values 109-115), Clock messages: 3
Dotted 1/64 (CC Values 116-121), Clock messages: 2
1/64 note (CC Values 122-127), Clock messages: 1

A MIDI Clock Stop Message will stop the Pattern's playback until a MIDI Clock start message is received, a MIDI Clock Continue message is received or until the Front Panel RATE, FREQ, or PATTERN Controls are moved. See the section above describing the use of CC89 to enable or disable the Pattern Clock syncing to MIDI Clock.

CONTROLLING THE FILTERS WITH MIDI NOTE ON MESSAGES

Certain MIDI Note On Messages can be used to control the levels of the filters, or advance the pattern sequencer like the STEP input:

STEP MODE: Note On Value 108. When the MIDI MuRF receives a NOTE_ON Value 108 on the MIDI Channel that is assigned, the pattern clock is stopped, and the pattern is advanced to the next step in the current pattern. The pattern clock is advanced 1 cycle for each Note On Value 108 message received in this mode. Moving the RATE panel Control, changing the Rate CV input, receiving CC9, or if Pattern Clock Sync is enabled, receiving MIDI Clock start or continue message followed by clock messages restarts the Pattern Clock.

MUTE MODE: Note On Values 24, 26, 28, 29, 31, 33, 35, 36. These Notes allow the lowest C to C major scale (8 white keys) on an 88-note controller to correspond to Filters 1-8. When a Note On Message of value 24, 26, 28, 29, 31, 33, 35 or 36 is received on the MIDI Channel that is assigned, the corresponding Filter EGR is turned off for the duration of the Note On event. This allows the user to mute specific filter bands while the pattern is playing.

TRIGGERED MODE: Note On Values 48, 50, 52, 53, 55, 57, 59, 60. These notes allow the C to C major scale (8 white keys) with the highest note as Middle C to correspond to Filters 1-8. When a Note On message of value 48, 50, 52, 53, 55, 57, 59, or 60 is received on the MIDI Channel

that is assigned, the MIDI MuRF pattern clock stops running, and that filter's EGR is fired. If a Note On is held until the EGR goes through its complete attack/decay cycle, a new Note On message is required to retrigger the EGR. An EGR is retriggered from the last point in the EGR cycle if retriggered before the Decay segment reaches the end of its cycle. This is an "8-voice polyphonic" mode – so up to all 8 filters can be fired at once (in the order they are received serially). Moving the RATE panel control, changing the RATE CV input, receiving CC9, or if Pattern Clock Sync is enabled, receiving MIDI Clock start or continue message followed by clock messages restarts the Pattern Clock.

SUSTAINED MODE: Note On Values 72,74,76,77,79,81,83,84. These notes allow the C to C major scale (8 white keys) with the lowest note an octave above Middle C to correspond to Filters 1-8. When a Note On message of value 72,74,76,77,79,81,83,84 is received on the MIDI Channel that is assigned, the MIDI MuRF pattern clock stops running, and the corresponding filter is set to a level determined by the Note On Velocity. When the Note Off message is received for that same note value the filter's DAC Value is written to zero. This means you can "play" the filters in a sustained fashion with Note On messages. Moving the RATE panel control, changing the RATE CV input, receiving CC9, or if Pattern Clock Sync is enabled, receiving MIDI Clock start or continue message followed by clock messages restarts the Pattern Clock.

NOTE PRIORITY: Triggered mode and Sustained mode can be used at the same time, with the last note played taking priority for the corresponding filter.

Sustained/ Trigger Mode cannot be used at the same time as Mute Mode so if any Sustained/ Trigger Mode Note On messages are received, any Mute mode Note on values are ignored. Note that if the clock is stopped by Sustained/Trigger/Step Mode Note On values, a Mute Mode Note On does NOT restart the clock – clocks are only restarted by changing the Rate control, changing the Rate input CV, receiving CC9, or by receiving MIDI Clock start or continue message.

Sustained/ Trigger Mode cannot be used at the same time as Step Mode so if any Sustained/ Trigger Mode Note on Values are received, Note on value 108 is ignored. A Step mode note (Note On 108) received after Sustained or Trigger Mode Notes will place the MIDI MuRF back into Step mode.

Mute Mode cannot be used at the same time as Step Mode so if Note on Value 108 is received, Mute Mode Note on values are ignored.

MIDI CCs 20-27 are treated with priority over the Note On Modes to control the levels of Filters 1-8.

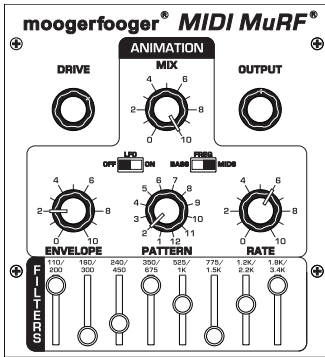
PATTERN CLOCK RESET: If the pattern clock is stopped due to a MIDI Note mode or MIDI C20-27, MIDI Note 65 (F above Middle C) will re-start the pattern animation. If the pattern clock is running, MIDI Note 65 will re-set the pattern to step 1. If the sequencer is running on Internal clock, the clock is re-synchronized to the instant you play MIDI Note 65. If the sequencer is synced to MIDI clock, MIDI Note 65 will reset the pattern to start again on the next clock step, while preserving MIDI sync.

THE MIDI MURF AND SYSTEM EXCLUSIVE

The MIDI MuRF can respond to three types of System Exclusive data: individual patterns, a complete set of 24 patterns, and firmware. The details of the MIDI MuRF System Exclusive implementation is published on the Moog website: www.moogmusic.com.

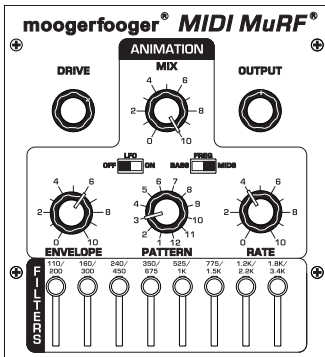
SOME TYPICAL SETUPS

UPWARD STAIRCASE WITH RHYTHMIC VARIATION



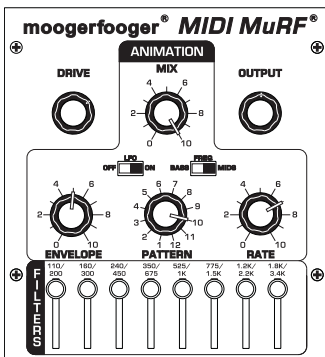
Here is a variation on the basic setting of figure 2 that shows off the ability of the MuRF to create rhythmic variations within the patterns. This is really nice with sustained chords or slowly arpeggiated playing.

SWIRLING CASCADES



This setup shows off the long envelope times of the MuRF, creating a shimmering, slowly evolving timbral landscape for your playing. This shines on chordal playing, but also gives leads an extra something that makes them stand out.

GROWING and SHRINKING TREMOLO



The Envelope control set at 5 gives a nice tremolo feel to the effect; the pattern changes gradually from one filter on to all filters on, making the timbre feel like it is growing and shrinking.

TECHNICAL INFORMATION

NOTE: The following information is intended for use by people who understand analog electronic circuitry and have enough practical experience to interconnect sophisticated electronic equipment correctly.

FIRMWARE UPDATE VIA MIDI: The MF-105M can be enabled to receive MIDI SysEx data containing the Operating Firmware for the MIDI MuRF by powering up in what is called "Bootloader Mode". This is done by setting the LFO and FREQ switch in the rightmost position and pressing the Bypass switch while the unit is powered up. The Drive and Bypass lights will blink, followed by all LEDs lighting up green. This indicates the unit is in Bootloader Mode and can be sent firmware via a MIDI connection. More information about this feature as well as tools for downloading firmware can be found on the www.moogmusic.com website.

POWER: The MF-105M works on +9 volts DC and uses a max of about 240 milliamperes of current. *Use only the power supply supplied with the MF-105M or the exact equivalent. Power sources rated with voltages in excess of +9 Volts may cause damage to the MF-105M's circuit.*

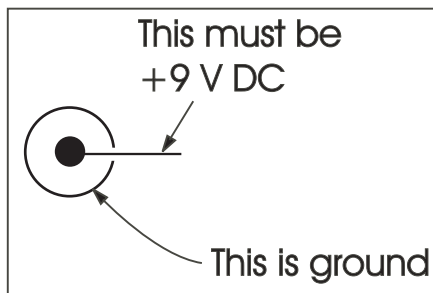


Figure 13 - Power Input Connector

PEDAL INPUTS: All pedal control input jacks are 1/4" tip-ring-sleeve (stereo) phone jacks. The sleeves are grounded and the ring terminals are supplied with +5 volts which is current-limited. The tip terminals receive the variable voltages from the pedals.

An expression pedal for use with the MF-105M should contain a 50Kohm or 100Kohm linear taper potentiometer which is connected from the sleeve to the ring terminals. The potentiometer wiper is connected to the tip

terminal. The pedal cable should be shielded, with the shield connected to the sleeve terminal. See Figure 14.

When connecting one or more pedal control input jacks to a source of external control voltage such as an analog synth or a MIDI-to-CV converter, you should use patch cords with tip-ring-sleeve phone plugs. The ring terminal on the plug should not be connected to anything, so that the MF-105M's source of +5 volts is not shorted out. See figure 15 for a diagram. If you do not plan to use any expression pedals with your MF-105M but would like to apply control voltages to one or more pedal control inputs, you can use patch cords with regular two-conductor phone plugs. These will short out the +5 volt supply to the ring contacts. This voltage is current-limited, so you won't burn anything out, but no pedal will work in any of the pedal control jacks if a tip-sleeve plug is plugged into any of the pedal jacks.

Applying a varying voltage to the tip terminal of a pedal control input jack has the same effect as turning the corresponding knob. On the MIDI MuRF, with the knobs in the mid-position, a voltage change of 0 to + 5 Volts at the tip terminal is equivalent to turning the corresponding knob through its entire range from full counterclockwise to full clockwise. You can 'program' your MF-105M performance parameters entirely from external control voltages, by turning the ENVELOPE, MIX, and RATE control knobs to mid position, and feeding 0 to +5 Volt programming

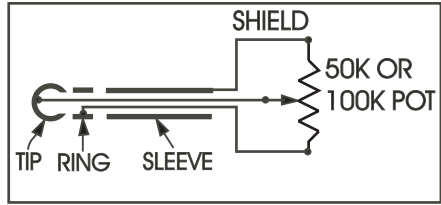


Figure 14 - EP-2 compatible wiring,

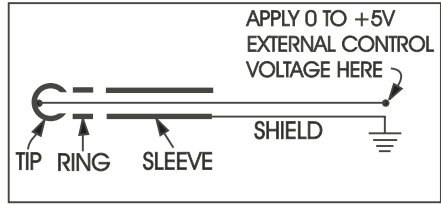


Figure 15 - wiring diagram for using external CVs with a TRS plug

voltages to the tips of the pedal control input jacks. The LFO/SWEEP jack can also receive 0 to +5 Volt programming voltages.

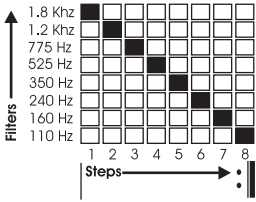
AUDIO PATH: The bypassed signal goes to the LEFT/ MONO output jack. Thus, when the MIDI MuRF is bypassed, the signal at the LEFT/ MONO output jack is the same as what your instrument is producing, and there is no signal at the right output jack. The MF-105 will not pass an audio signal unless power is applied to it.

APPENDIX A: THE MuRF's PATTERNS

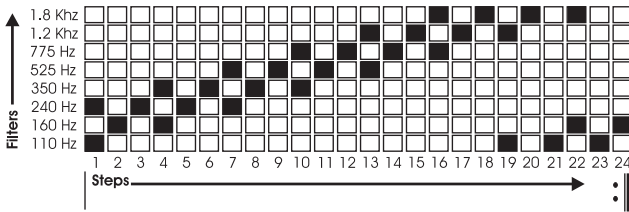
BASS FILTER VOICING

1) No Animation

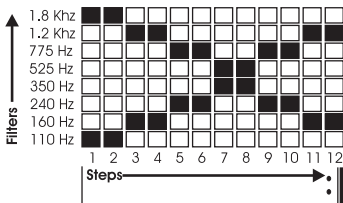
2) Downward Staircase



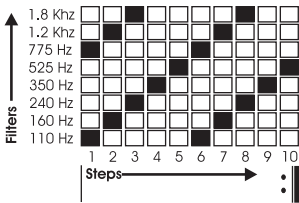
3) Upward Cascade



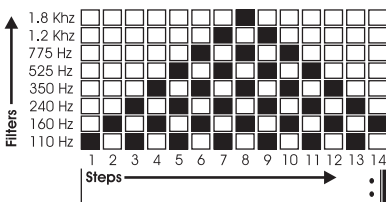
4) DoubleX



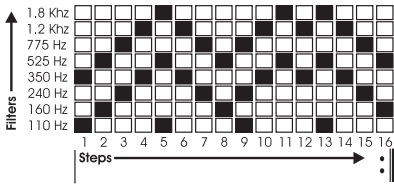
5) Perpetual Motion



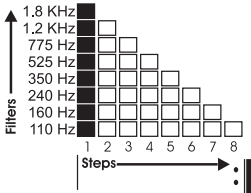
6) Stereo Pyramid



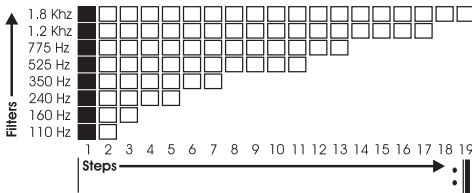
7) Double Dip



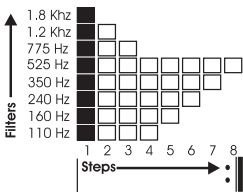
8) Inverted Rhythmicon



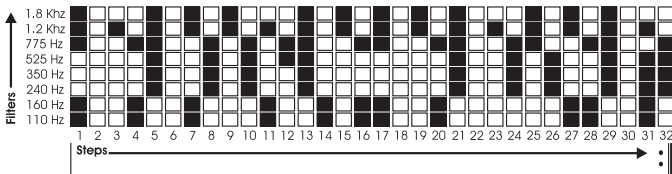
9) Prime Number Rhythmicon



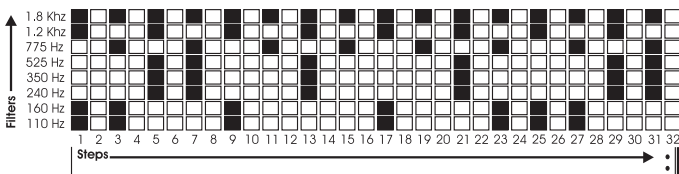
10) Folded Rhythmicon



11) Breakbeat



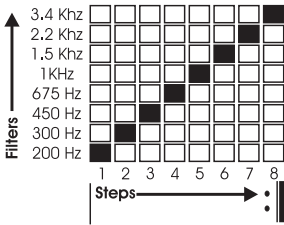
12) Big Beat



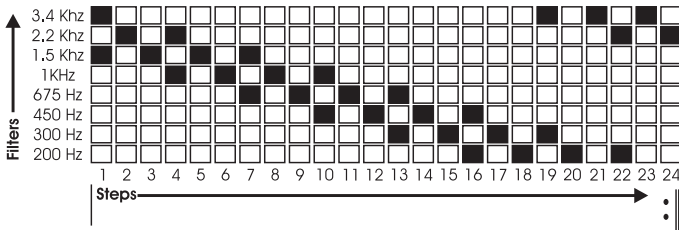
MIDS FILTER VOICING

1) No Animation

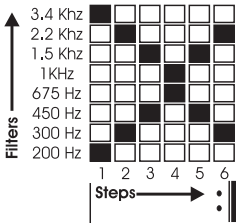
2) Upward Staircase



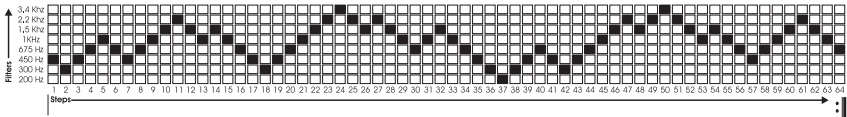
3) Downward Cascade



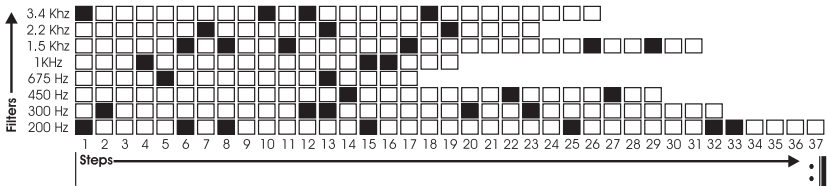
4) Criss Cross



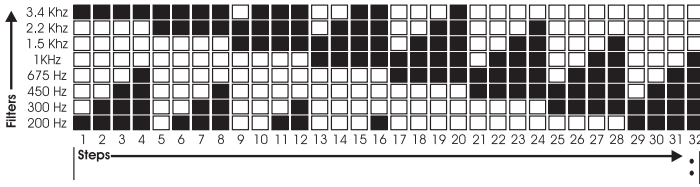
5) Brownian Motion



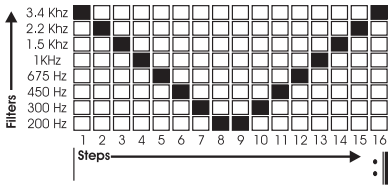
6) Random-like



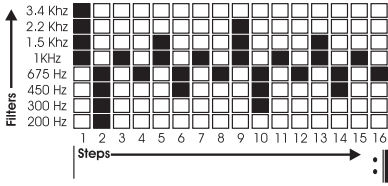
7) Downward Band Expansion



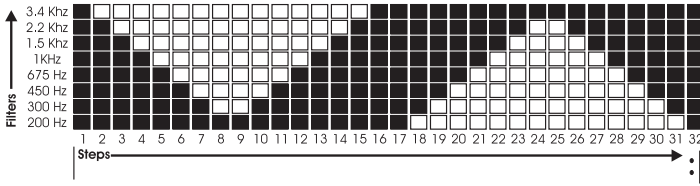
8) Down and Up



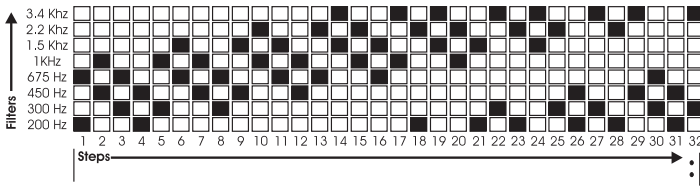
9) Pulsar



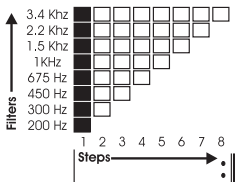
10) Growing and Shrinking Band



11) Double Cascade



12) Rhythmicon



APPENDIX B: MIDI Implementation Chart

MF-105M MIDI

MuRF MIDI Implementation Chart

Date: 08/24/09

version: 1.4

Function	Transmitted	Recognized	Remarks
Basic Channel Default Changed	X X	1 1-16	
Mode Default Messages Altered	***** ***** *****	3* ***** *****	* MIDI CC102 recognized as Mode 1 (all channels)
Note Number True voice	X	O 24,26,28,29,31,33,35, 36,48, 50,52,53,55,57, 59,60,72,74,76,77,79, 81,83,84,108*	*see page 21 of manual
Velocity Note On Note Off	X X	O X	
After Touch Key's Channel	X X	X X	
Pitch Bend	X	X	
Control Change	X	O 1,2,3,7-9,20-27, 85,86,89,102	
Program Change True Number	X	O 0-23	
System Exclusive	X	O	
System Common Song Position Song Select Tune Request	X X X	X X X	
System Real Time Clock Commands	X X	O	
Aux Messages Local On/Off All Notes Off Active Sensing System Reset	X X X X	X X X X	
Notes			

Mode 1: Omni On, Poly
Mode 3: Omni Off, Poly

Mode 2: Omni On, Mono
Mode 4: Omni Off, Mono

O: Yes
X: No

APPENDIX C: WARRANTY INFORMATION

LIMITED WARRANTY

Moog Music warrants that its products will be free from defects in materials or workmanship, and shall conform to specifications current at the time of shipment, for a period of one year from date of purchase. During the one-year period, any defective products will be repaired or replaced, at Moog Music's option, on a return-to-factory basis. This Warranty covers defects that Moog Music determines are no fault of the user.

RETURNING YOUR MF-105M FOR REPLACEMENT/REPAIR

You must obtain prior approval and an RMA number from Moog Music before returning any product to us. Wrap your MF-105M carefully and pack it with the power adaptor in its original carton. The warranty will not be honored if the product is not properly packed. Then send it to Moog Music with transportation and insurance charges paid.

A reasonable cost for service and for materials and return freight will be charged to replace materials defective through the fault of the user, or for which the one year warranty period has expired.

Transportation and insurance charges from Moog Music to your United States address, of products repaired or replaced under warranty, will be paid by Moog Music.

Appendix D: MF-105M SPECIFICATIONS

DESCRIPTION:

Analog effects module incorporating two functions: 8 – band Resonant Filter Bank and 24-Pattern Sequencer triggering Volume Envelopes for 8 Filters with CV and MIDI control.

FRONT PANEL FEATURES:

DRIVE rotary control - adjusts the gain of the audio input to the effect.

OUTPUT rotary control - balances the level of MuRF's signal when the effect is on with the bypassed signal when the effect is off.

MIX rotary control - adjusts the ratio of direct to effected signal when the effect is on.

200 Hz – 3.4 Hz slider controls - sets the gain of the 8 resonant filters.

PATTERN 12-position rotary switch - selects one of 12 animation patterns in the BASS or MIDS bank.

LFO slider switch – turns on and off the LFO that shifts all 8 filters' frequencies

FREQ slider switch – changes the voicing of all 8 filters to BASS or MID frequency range. Also changes bank of patterns.

ENVELOPE rotary control - morphs the shape of the patterns' envelopes.

RATE rotary control - adjusts the rate of the animation patterns

DRIVE, a three-color LED that shows the level of the input signal.

RATE, a LED that indicates the animation pattern rate as well as MIDI status.

BYPASS, a two-color indicator LED that tells whether the effect is active or bypassed.

ON/BYPASS, a rugged, smooth-acting 'stomp switch'.

JACK PANEL FEATURES:

AUDIO IN ¼" phone jack – accepts any instrument-level or line-level signal from –16 dBm to +4 dBm. Input impedance is one megohm.

LEFT/MONO OUT ¼" phone jack - -4 dBm nominal maximum output level; +8dBm absolute maximum output level. Output impedance is 1,000 ohms.

RIGHT OUT ¼" phone jack – 4 dBm nominal maximum output level; +8 dBm absolute maximum output level. Output impedance is 1,000 ohms.

RATE, ENV, LFO/SWEEP, MIX, all of which are TRS ¼" jacks that accept moogerfooger EP1 (or equivalent) expression pedals, or control voltages from two-circuit or three-circuit ¼" jacks.

TAP/STEP IN ¼" TRS phone jack – provides a means of syncing the tempo of the MuRF's Animation Patterns to the tempo of the music by tapping an external footswitch (Moog FS-1, or equivalent) three times. The ring connection of this jack is the STEP input which can be used to advance the steps of the current pattern by +1 with a FS-1 footpedal or Gate signal.

MIDI IN: Standard MIDI DIN input.

+9V POWER INPUT jack – accepts +9VDC unregulated 300 mA power adapter with positive center.

GENERAL SPECIFICATIONS

CASE: Black panel with hardwood sides – classic analog appearance.

DIMENSIONS: 9" x 6" x 2-1/2"

NET WEIGHT: 2 lb

SHIPPING WEIGHT: 4 lb, including power adaptor and instruction manual

POWER REQUIREMENTS: 120 volt, 5W. 220 volt power adaptor available on special order

Moog®, Moogerfooger®, and MuRF® are registered trademarks of Moog Music Inc.

©2009 Moog Music Inc.
MOOG MUSIC Inc. 2004E RIVERSIDE DRIVE ASHEVILLE, NC 28804
Phone: (828) 251-0090 Email: info@moogmusic.com
WEB SITE: www.moogmusic.com

