BSS AUDIO Ltd
London England Telex 265612 EDGE G

USING THE DPR-502 MIDI NOISE GATE

Introduction

If you know noise gates, then you know the DPR–502 by **BSS Audio**. It has all the capabilities of conventional stereo noise gates, and some extra features that you probably hadn't imagined you needed — but once you have used them, you won't want to live without.

Features like Audio Attack, which analyses the input signal to determine the best attack time, and ADE™ — Auto Dynamic Enhancement — which preserves the "punch" that can sometimes be lost in the gating process.

In addition to logical, responsive controls and rewarding audio performance, there is MIDI too. A sound source triggering the gate can also trigger MIDI Note-on and Note-off messages. Not only that, but source dynamics are preserved in the form of MIDI Key Velocity. This is the gate that thinks like a MIDI processor.

To find out about some of the common uses of a MIDI noise gate — and some of the uncommon ones too — read on. Let these notes be the starting point for YOUR creative ideas . . .

TABLE OF CONTENTS

Essential Controls

Threshold

This controls the level at which the gate will open. Any sound louder than the threshold level will trigger the gate. For any sound quieter than the threshold level, the gate will remain closed. Basically, the lower the threshold, the more you will hear. It's best to start with the threshold very low (fully anticlockwise), then increase it until the gate just starts to cut out some of the sound you want. Back off a little and you're there.

You can see when the gate triggers, as well as hear it, by the triangular GATE OPEN LED below the KEY LEVEL bargraph meter. These displays show the level of the signal in relation to the threshold.

The average level is shown by the bar display, with separately illuminated LED showing peaks. When the peak level passes the centre LED, the envelope sequence is initiated. When the gate is open, the triangular LED lights up. This means that the relationship between signal level and gate open/closed status can be seen at a glance.

Envelope

The ATTACK, HOLD and RELEASE controls determine the ENVELOPE of the gate, or how it responds dynamically once it has been triggered. Usually, if the sound you're working on has a fast attack, then you will set the gate to fast attack too. If your sound dies away quickly, then you will set the gate to die away (release) quickly too. The object is to have the sound you are trying to capture cover up the unwanted noises all the time the gate is open. The Attack and Release controls are there to "help it along".

HOLD sets the time the gate will remain open, regardless of signal level, before the release phase starts. Hold can be set to 100 milliseconds or thereabouts for many purposes. It can also be used to achieve special effects, some of which will be described later.

Range

RANGE refers to the amount of attenuation the gate provides when it is closed. This can be from 0dB to 70dB. The studio engineer will usually keep this on 70dB, but the live engineer will find moderate settings useful too.

In an orchestra pit full of "real" instruments, there is sometimes unwanted chatter going on during rests. Gating to the full 70dB sounds unnatural, but a more modest setting of perhaps 10 to 20dB can make a world of difference to the amount of extraneous noise, without the gating effect being audible.

Key filter

The KEY FILTER and WIDTH controls are used so that the triggering circuits of the gate can "tune in" on a range of frequencies. The momentary KEY LISTEN switch allows you to hear temporarily the signal which is triggering the gate, through the normal output connector. In this way, the effect the Key Filter and Width controls have upon the trigger signal can be assessed.

Check

This momentary button forces the gate to open, regardless of signal level and threshold setting, for checking signal paths. This will be especially useful to the live engineer during his pre-start checks. The Check function also outputs MIDI data to test any triggers that may be set up. More about this later.

Key source

Normally, the signal being gates will act as its own trigger. By switching to EXT, an external signal can act as the trigger source.

Mode

For normal use, this is set to GATE. DUCKing reverses the operation of the gate, so that a signal passes through unhindered when it is BELOW the threshold, and is attenuated when it rises above it. See the section on ducking (page 13) for applications.

Link

This makes the two channels trigger simultaneously, with the settings on channel 1 controlling the parameters of both. See the section on linking channels (page 13).

Analogue applications

Background noise

One of the main functions of a noise gate is to cut out unwanted background noise. It's often the case that you have to take the rough with the smooth, in the recording studio or out on the road. Just when you have got a good sound from the guitar, you notice that hiss and crackle from the amp is coming through the monitors, or PA, too. The idea of the noise gate is to shut out the amplifier noise when the guitarist isn't playing.

To put it simply, when the guitarist plays the gate opens and the sound get through. The guitar will be loud enough to mask the unwanted noise from the amp. When the guitarist takes a few bars rest, the gate closes up so that the noise is shut out. This set-up isn't just for the guitar, it can be used for any mike or instrument which is suffering from extraneous noise.

Listening to a gated sound like this on its own, it can seem a little unnatural. But if you listen to the improvement it makes to the mix, then you will be hooking up the noise gate almost every time! Let's see how you would set up the gate in a situation like this:

— DIAGRAM 1

You will be seeing a lot more of this diagram, so it needs a little explanation. The operation of the rotary controls is obvious, but in the case of the pushbutton switches, where a switch is shown coloured in BLACK then the switch should be pushed in. If it is left open in the diagram, then the switch should be left out.

For clarity, the console is sometimes left off the diagram, but it should be remembered that the **DPR–502** is designed to work with line level sources only. When you need to gate a microphone, some form of mike pre-amp is required. This can be a separate unit, or the **DPR–502** can be patched into the console's channel insert points.

These settings are suggestions for starting points. Set the **DPR–502** as in the diagram, then fine tune to your own requirements. For instance, you may need to increase the Hold or Release settings to preserve the low level decay of sustained notes or chords.

Vocals

As you are aware, singers don't come with a level control built in. Even the most controlled vocalist can vary in level by 10dB or more. What do you do about it? Patch in a compressor of course.

The problem with this is you end up with "compressor noise". It's not that you bought an inexpensive compressor and it's making all that noise itself. The fact is that when you compress, you're bringing the level of the signal down. This makes any background noise, from air conditioning or simply a noisy mike, more apparent.

Fortunately, you have a noise gate to deal with the situation.

— DIAGRAM 2

It's worth bearing in mind, in the studio, that it can be quite difficult to gate a vocalist as the vocals are going down onto tape. It can be tricky to get exactly the right settings, and vocals are usually tricky enough. Communication between producer and singer is strained if the gate cuts out what the singer is saying between takes. Also, some vocalists will hum quietly into the mike (they shouldn't, but they do!) before their entry to make sure they're getting the right note. If you have gated the feed to their cans then they may come in off-key.

Drums

One of the difficult tasks for the engineer, live or studio, is miking a drum kit. Without noise gates, it is virtually impossible to get a good result, because of the interaction between the various mikes on the kit. The tom tom mikes are picking up spill from the snare and vice versa. The answer is to gate the mike on each drum by patching a **DPR–502** into the console insert points, which will make sure that the mike is only "live" when the drum is being played. The PA engineer will also appreciate the fact that gating the mikes on the kit will cut out spill coming in from the backline amplification.

If you are not in the fortunate situation of having enough **DPR–502** units to gate every mike, then it may be sufficient to gate just the tom toms. The reasoning behind this is that the snare sound is usually more important. If the snare miking is optimised, then spill from the snare getting into the tom tom mikes will degrade the overall results. Gating the toms gets rid of the spill.

Sometimes a gate will open in response to the sound from another drum, rather than the one intended. The Key Filter and Width controls can be used to tune in on the frequencies of each drum so that gate does not open at the wrong time. Use of these controls is explained in "Side chain" page 10.

Tape noise

— DIAGRAM 3

Even if you gated every track as it went down onto multitrack tape, then you will still have the problem of tape noise when you mix.

If you are fortunate enough to have twelve stereo noise gates, then there will be no difficulty deciding how to allocate them. If you only have one or two stereo units, then it's a simple matter to pick out the tracks which cause the most noise nuisance — usually those that are the loudest or most heavily EQ'd. The benefits of gating just

the two noisiest tracks can be considerable.

Sometimes the noisiest components of a mix might be the digital effects units you are using. Gating these can improve the overall noise floor.

Auto attack

The **DPR–502** has two unique features which provide welcome assistance to the engineer, Auto Attack and ADE™.

With Auto Attack selected, the 3DPR–502 will set the optimum attack time for the signal source all by itself.

Usually, the engineer will want to be in control of the gate's attack, but if the source signal isn't consistent in its dynamic or harmonic content, constant readjustment may be necessary. For instance, a keyboard player may be changing his patch during a song. One patch might be a "plucked" sound, another may be a slow string effect. Auto Attack frees the engineer from having to worry about this.

For the technically minded, Auto Attack works by analysing and adjusting for the high frequency content of the sound source. Usually this is an excellent guide to the attack time required.

By the way, if you are using this function, the normal rotary Attack control will not operate.

ADE™

ADE™ — Auto Dynamic Enhancement — is a unique effect that overcomes the problem of losing the leading edge transients that contribute significantly to the individual character of musical sounds.

Usually, a good noise gate can react fast enough to let even the fastest transient signals through. Subjectively though, some of the "punch" of the sound can appear to have been lost. The ADE™ feature can either restore that lost "punch" by subtle dynamic shaping, or it can go further and be used as an effect in its own right.

ADE™ is best used on percussive sounds. The rear mounted switch selects the "strength" of the effect, approximately 3–4dB dynamic boost for the lower (IN) setting and 6–7dB for the higher setting (OUT).

NB: As ADE™ operates by boosting the leading edge transient, it is important to ensure that this does not cause clipping in the console. If the console is being driven hard before ADE™ is selected, then switching in ADE™ will punch the console over the top and cause distortion. The solution is to reduce the level going into the **DPR–502** by adjusting the input gain control of the mixing console channel.

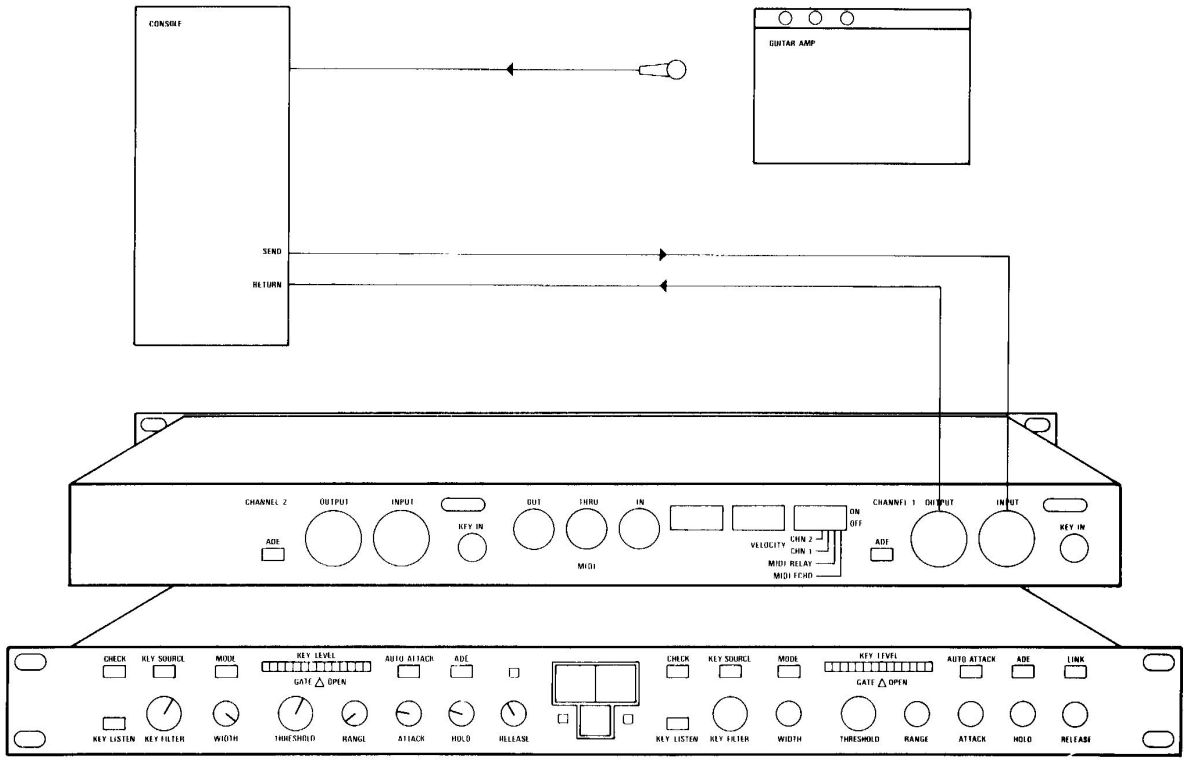

DIAGRAM 1

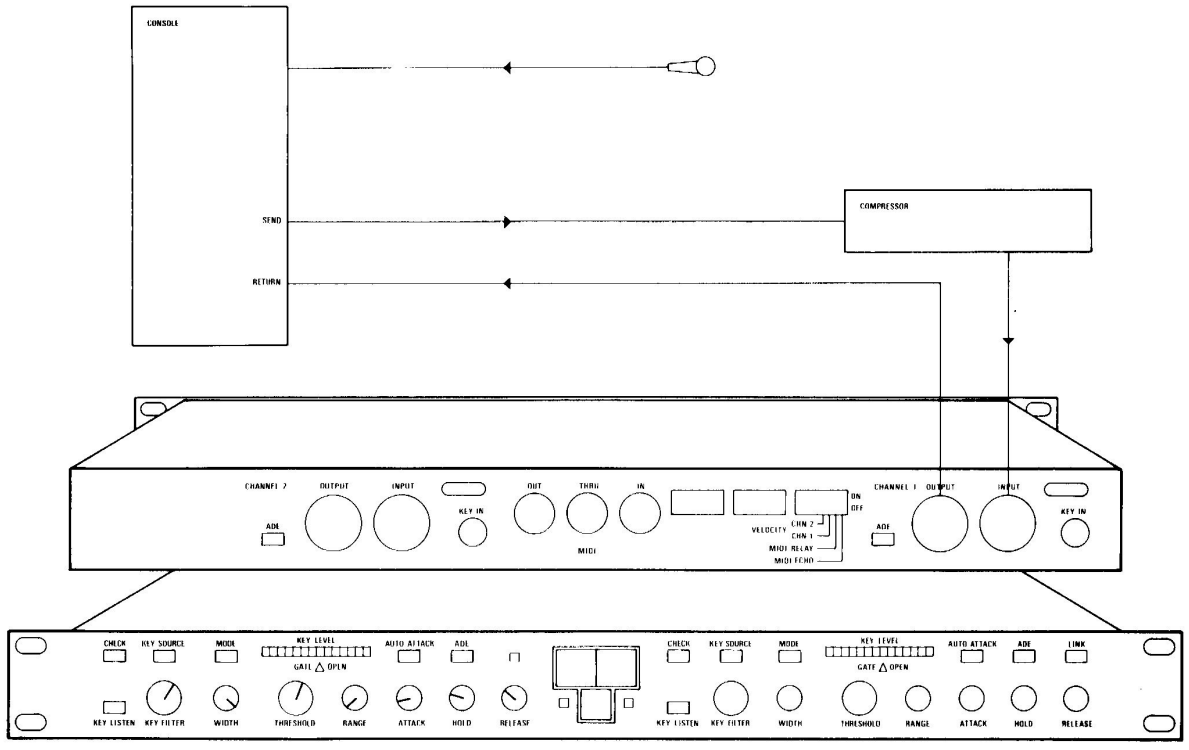

DIAGRAM 2

Advanced analogue techniques

Gated reverb

Many digital reverb units have "gated reverb" programs. It's becoming so common that you could easily forget how the effect was originally created — using natural echo and a noise gate.

Taking the easy way out by using a preset reverb program may be OK for many situations, but using the natural studio ambience, or an echo plate perhaps (remember those?), will give you results that you could NEVER achieve the "quick way".

——DIAGRAM 4

Notice that the external KEY IN is used to trigger the gate. Normally, the sound source acts as its own key but there is no reason why that should always be so. In this case, the close mike is used as the key signal so that there is a good reliable trigger on every hit. Keying from a reverb signal is more tricky, although you may want to try it.

The envelope settings determine the "shape" of the reverb sustains for a period of time before the release stage of the envelope comes into play and shuts the reverb off. It's usual to adjust the Hold so that the reverb matches in with the tempo of the song.

In practice, you might be applying gated reverb to the whole kit. In this case, there is a choice of which drum you use as the key. You might want it so that any drum will trigger the gate, so you would take the key signal from an auxiliary send on the console, and turn up the aux on each drum channel. Alternatively, it's sometimes nice to have only certain drums triggering the reverb. You could have it so that when the drummer plays just snare, bass drum and hihat, there is no reverb, but when he plays the toms it comes belting in.

This technique could also be used to create drum samples so that you can have natural reverb actually on your samples and you don't have to add the artificial kind during the mix.

Envelope shaping

Going a stage further with the external Key In function, it is possible to control the dynamics of one sound source from another. For instance, a sustained synth from a hihat:

——DIAGRAM 5

If you want to have synth chords playing in 16th notes in time with the track it's pretty hard to play, unless you sequence it. Easier than sequencing, and with greater versatility, is the trick of using the hihat as a key. The drummer will be able to play in 16ths with no trouble, and all the keyboard player has to do is to hold down the chord — and remember to change it each bar. Set the Attack, Hold and Release to get the dynamics of the synth as you want. Experiment too with the ADE™ settings.

It's not necessary to do this with a sustained chord, you could easily add a tremolo effect to a guitar part with this technique. Just turn the Range to a lower setting. The advantage is that the remolo can be in time with the track — or in any rhythm you want.

Another use of envelope shaping is so-called 'reverse reverb'. Do you have this setting on your digital reverb unit? Guess where it originally came from!

——DIAGRAM 6

You can see the trigger comes from the sound source, rather than the reverb signal. This time, a digital reverb unit, rather than natural echo, is used. But even if it does have a reverse reverb preset, it probably won't sound half as good as doing it this way.

The "reverse" effect comes from the slow attack setting which makes the reverb build up initially. In this example, the reverb comes to an abrupt finish, because the release is set very fast. It could be fast, medium or slow, as you want. Don't forget to experiment with the Hold control.

Of course, neither of these is REAL reverse reverb. You can only do that by turning the tape over and recording backwards.

Instrument sync

Do you ever find it annoying when the bass guitarist and drummer are not playing EXACTLY in time? The difference between being "almost there" and being spot-on is a big difference. It depends on the nature of the music, but very often this technique can be a great help:

——DIAGRAM 7

Suppose that the drummer is playing one steady beat per bar on his bass drum. If the bass player doesn't get his note exactly in time, it makes the whole performance sound sloppy. By keying the bass guitar channel from the bass drum, the guitar CANNOT sound until the drum does. You have to hear this to appreciate the difference it can make. The hold and release times are set so that the gate closes just before the end of the bar, so that it's ready to sync up the bass to the next drum beat. After the first beat of the bar, the bassist can play what he likes. You don't even have to tell him what you're doing. In fact, DON'T tell him what you're doing, but add some ADE™ as well and watch him smile as how tight and punchy he's playing.

It is not unlikely that fifty per cent of the time the bass player is coming in a fraction too late, and there is nothing even the **DPR–502** can do

Stereo linking

—— DIAGRAM 13

Sometimes it's necessary to gate a stereo program. A common example is using a stereo chorus unit to enhance an otherwise uninteresting sound. The nature of the chorus effect means that unwanted noise is often produced which needs gating, but the two channels will vary in level independently. If the two channels of the gate are allowed to trigger separately the result will not be pleasant to listen to. It's better to have both working together, but merely setting the controls identically for each channel will not achieve this.

The LINK button on channel 2 is the solution. The side chains for BOTH channels are added together so that the entire unit is under one control signal. More than that, channel 1 now acts as the MASTER for both channels. The controls on channel 2 are inoperative.

Ducking

How you ever admired the radio DJ's skill in pulling down the faders on the music every time he speaks? Well actually, you're admiring the skill of a noise gate such as the **DPR–502** operating in DUCKING level, the level of the program source is REDUCED.

—— DIAGRAM 14

In this case, when the DJ speaks into the mike, the music from the record deck is reduced in level by around 10dB, automatically.

This technique isn't just used by radio stations. You could subgroup backing tracks and pass them through the **DPR–502**, using the lead vocal as the key input. When there is no vocal, the backing track gets through at peak level. When the singer comes in, the track ducks down in level to make way.

Combination reverb

—— DIAGRAM 15

This is another use of ducking. But here, one channel of the unit is set to GATE, the other to DUCK. When the signal is below the threshold — which is the same on both channels — the ducking channel sends it to one reverb unit. When the signal exceeds the threshold, the gating channel sends it to another.

In this way, COMPLETELY different effects — perhaps other than reverb — can be set up to come into play at different signal levels. And why stop at two?

This one is better on sustained sounds rather than drums as it is impossible to duck seventy decibels instantaneously. Experiment with the attack control on the ducking channel.

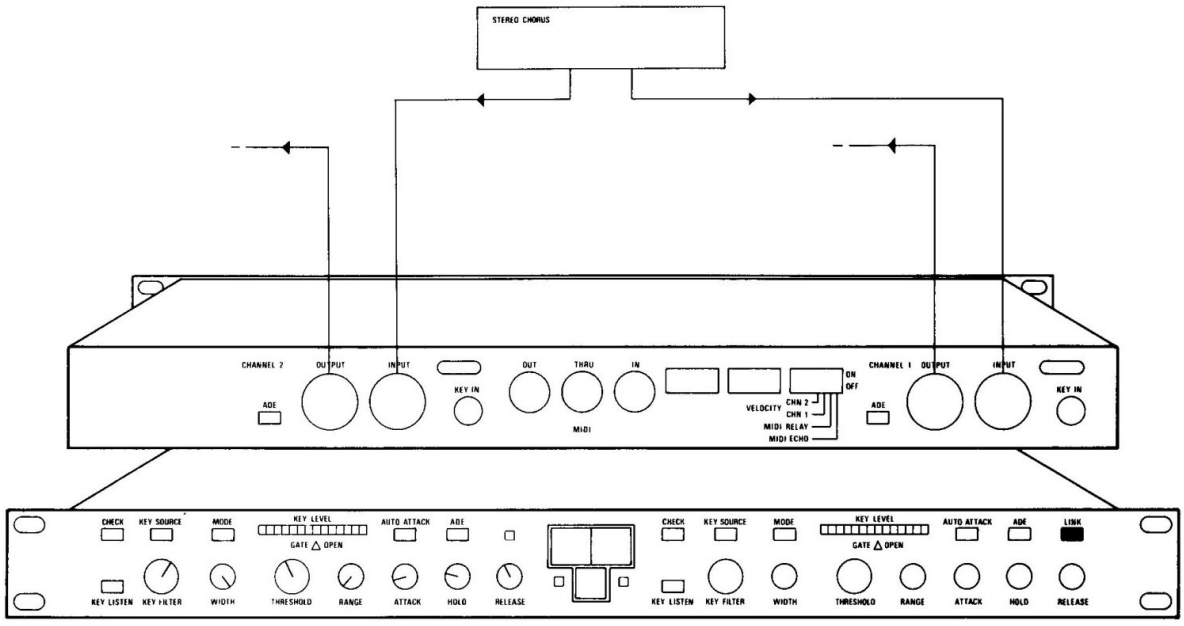

DIAGRAM 13

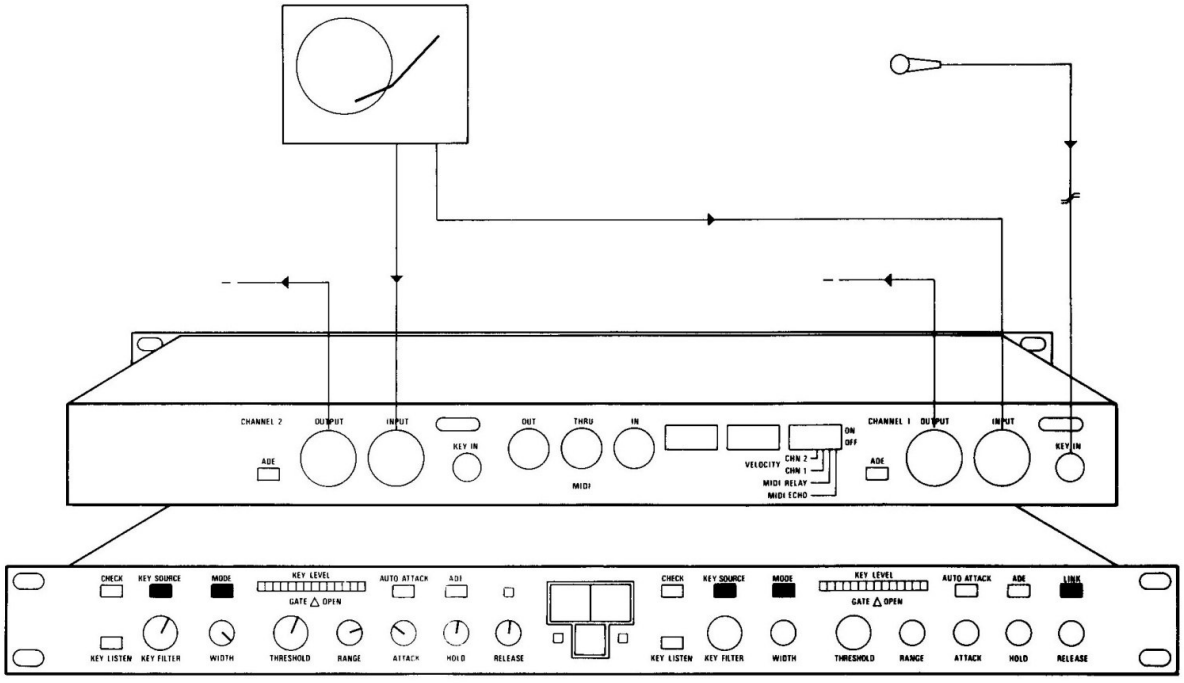

DIAGRAM 14

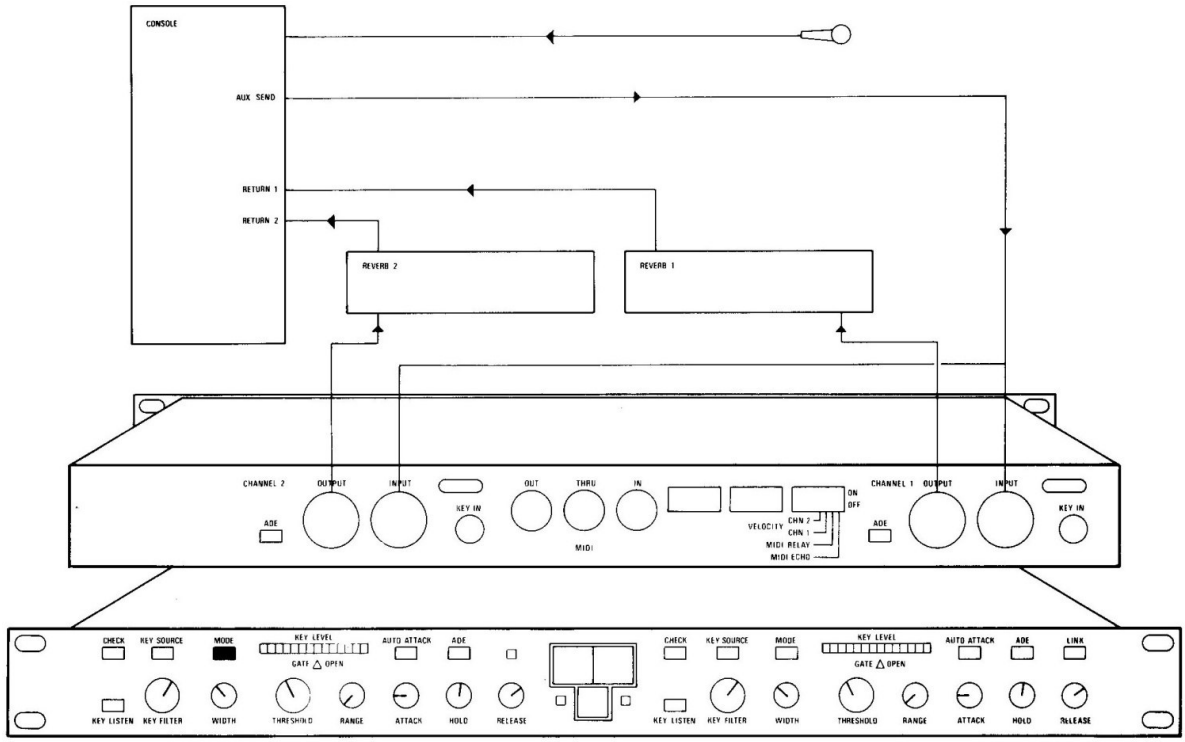

DIAGRAM 15

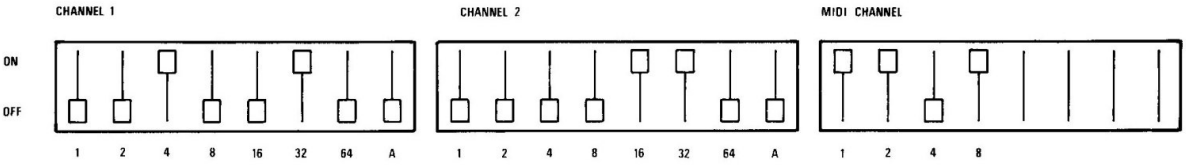

DIAGRAM 16

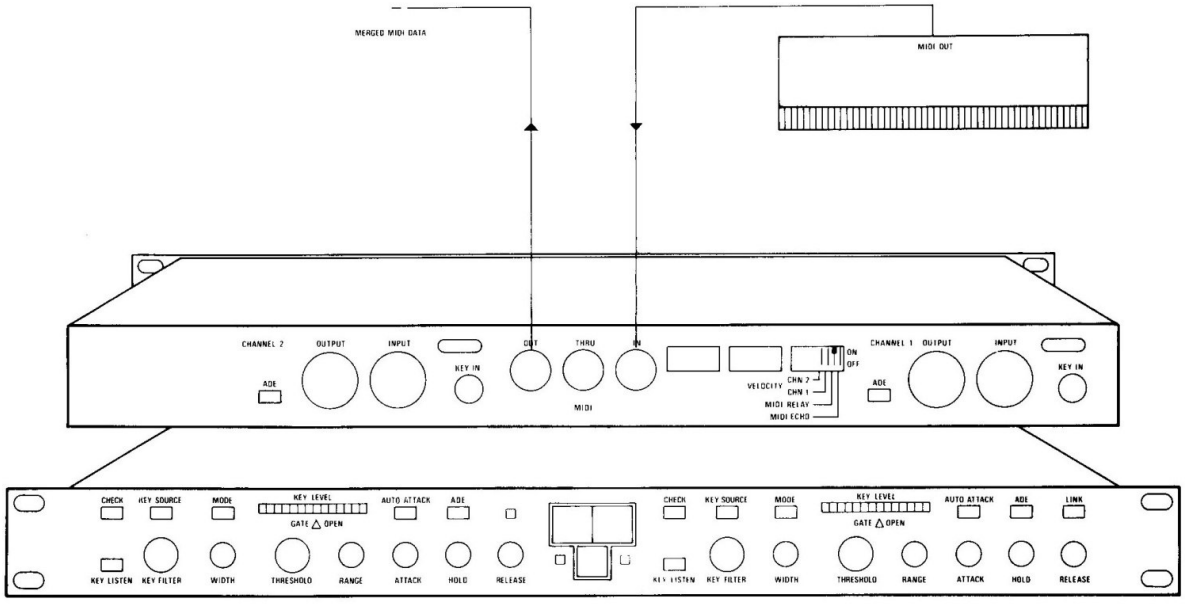

DIAGRAM 17

MIDI

As well as fulfilling all the functions of a conventional noise gate, the **DPR–502** has MIDI capability too. As you know, MIDI is a data buss which can transmit messages from the keyboard on one synthesiser to the tone generating circuitry of another.

Like a synthesiser, the **DPR–502** has the normal MIDI connections — In, OUT and THRU, which work in the same way as on any other MIDI unit:

IN; the unit acts upon incoming data.

OUT; output for data generated by the unit.

THRU; a copy of the incoming data, for output without modification.

Instead of making sounds of its own, the gating function of the **DPR–502** can be controlled by a MIDI keyboard, or it can send MIDI messages to trigger other equipment.

When a note is played on a MIDI keyboard, a Note-on message is transmitted. This contains the MIDI channel (1 to 16), Note number (corresponding to the key played) and Velocity (how hard the key was hit).

In the case of the **DPR–502**, when the gate opens, a MIDI Note-on message is transmitted. When it closes, a Note-off message is sent. The MIDI Note Number can be set independently for each channel of the **DPR–502**. The MIDI Channel is set simultaneously for both channels.

In addition, the **DPR–502** can send MIDI Velocity messages corresponding to the level of the signal that triggers the gate.

——DIAGRAM 16

Here, the unit is set to receive and transmit on MIDI channel 12. Channel 1 of the **DPR–502** is set to transmit note C1, channel 2 of the **DPR–502** is set to transmit C2.

The following table will explain more fully. A switch that is in the UP position (marked '*') is ON. DOWN (marked '–') is OFF:

Note	Note number	Switch positions
C1	36	– – * – – * – –
D1	38	– * * – – * – –
E1	40	– – – * – * – –
F1	41	* – – * – * – –
G1	43	* * – * – * – –
A1	45	* – * * – * – –
B1	47	* * * * – * – –
C2	48	– – – – * * – –
D2	50	– * – – * * – –
E2	52	– – * – * * – –
F2	53	* – * – * * – –
G2	55	* * * – * * – –
A2	57	* – – * * * – –
B2	59	* * – * * * – –
C3	60	– – * * * * – –
D3	62	– * * * * * – –
E3	64	– – – – – – * –
F3	65	* – – – – – * –
G3	67	* * – – – – * –
A3	69	* – * – – – * –
B3	71	* * * – – – * –
C4	72	– – – * – – * –
D4	74	– * – * – – * –
E4	76	– – * * – – * –
F4	77	* – * * – – * –
G4	79	* * * * – – * –
A4	81	* * – – * – * –
C5	84	– – * – * – * –
D5	86	– * * – * – * –
E5	88	– – – * * – * –
F5	89	* – – * * – * –
G5	91	* * – * * – * –
A5	93	* – * * * – * –
B5	95	* * * * * – * –
C6	96	– – – – – * * –

When the 'A' switch is ON, the **DPR–502** will respond to MIDI Note-on messages regardless of the note number.

MIDI channel	Switch positions
1	– – – –
2	* – – –
3	– * – –
4	* * – –
5	– – * –
6	* – * –
7	– * * –
8	* * * –
9	– – – *
10	* – – *
11	– * – *
12	* * – *
13	– – * *
14	* – * *
15	– * * *
16	* * * *

As well as transmit, the **DPR–502** can receive MIDI too. A Note-on message of the appropriate MIDI channel and Note Number will open the gate. A Note-off message will close it. Whenever MIDI data is being transmitted or is being acted upon, the MIDI ACTIVE LED on the front panel will light. This is a VERY useful check of what's happening MIDI-wise.

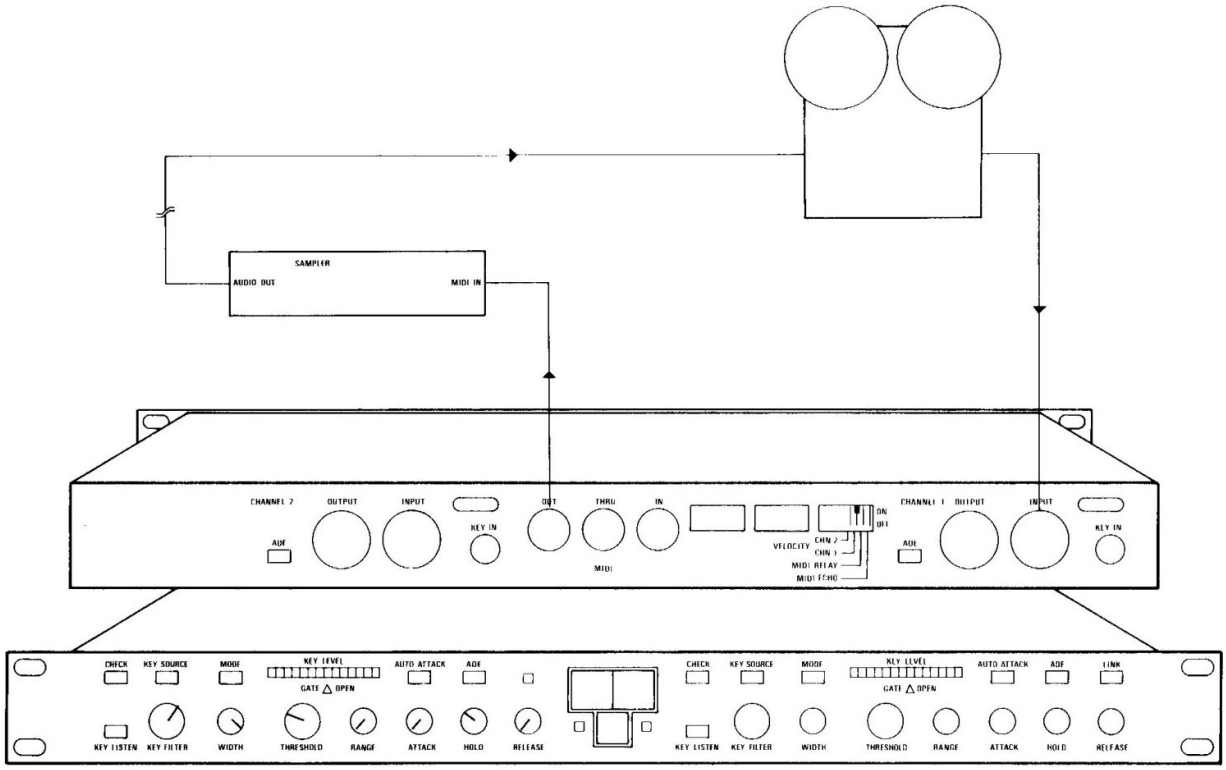

DIAGRAM 18

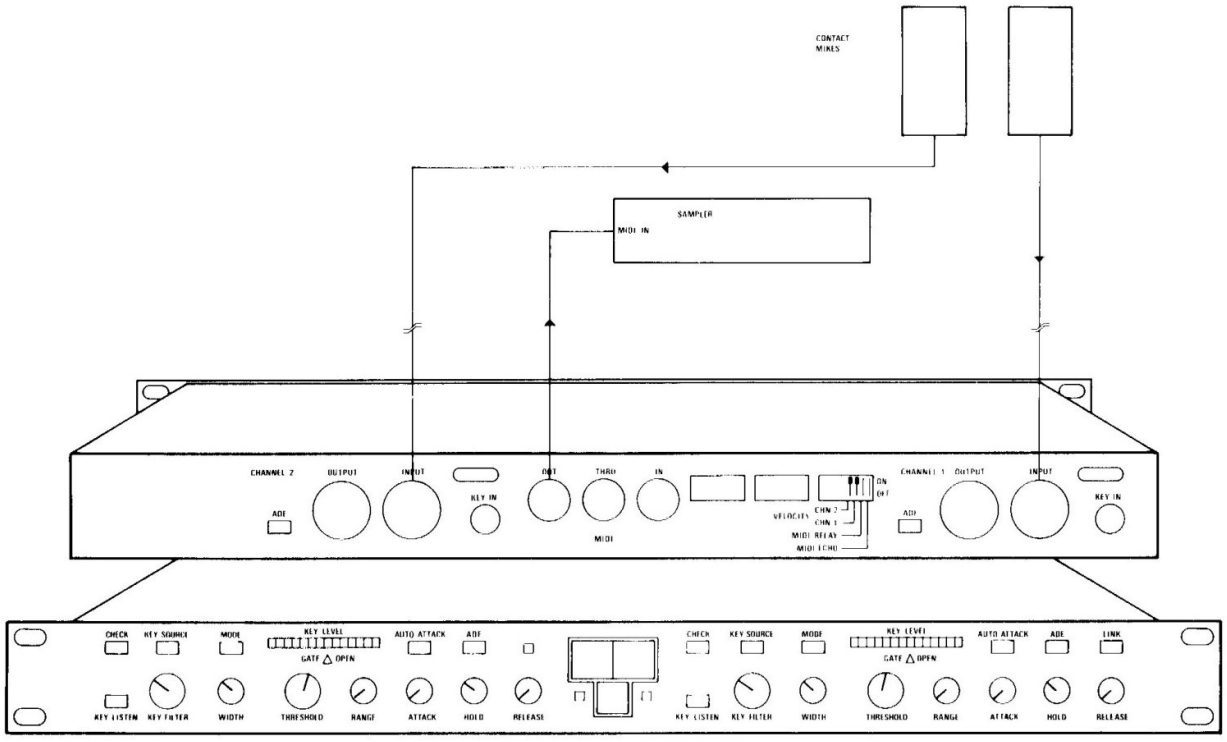

DIAGRAM 19

MIDI Relay

When MIDI RELAY is ON, any MIDI data present at the MIDI IN connector is passed on to the MIDI OUT, together with any data generated by the **DPR–502** itself. This would be a typical set up:

—— DIAGRAM 17

MIDI Echo

If MIDI ECHO is on, when the **DPR–502** receives a MIDI Note-on message and the gate opens, it will transmit a similar Note-on message as if the gate had opened under normal audio control. Similarly for Note-off.

The Note-on message is transmitted when the gate opens, regardless of the attack time set. The Hold control is used to delay the Note-off message, if desired, stretching the duration of the note.

MIDI trigger

—— DIAGRAM 18

The most common use of this would be to replace a drum sound on tape with a more suitable sample. A weak snare can be replaced by a 'beefed-up' hit, for example. Many samples do not have audio trigger facilities, and some that do are not quick enough to keep the beat.

The **DPR–502** can be used to turn an audio pulse into a MIDI Note-on and Note-off message. As in the diagram, feed the drum track to be replaced to the **DPR–502**, and have a sampler provide the alternative sound.

Two things to bear in mind: It's easier if you keep the MIDI note numbers on the **DPR–502** constant, and make adjustments on the sampler to get the right sound at the right pitch. Also, with the MIDI velocity function on the **DPR–502** switched ON, as in the diagram, changes in loudness in the original track will be passed through to the sampler, retaining the original dynamics and hence the 'feel' of the performance.

To set up the **DPR–502** for the best MIDI Velocity response, remember that a signal which just exceeds the threshold level and opens the gate will give a MIDI Velocity of 10. A signal which reaches peak level on the Key Level bargraph will give the maximum MIDI Velocity value of 127.

Another possibility is to use a mixed stereo track as a trigger and add extra percussion in tempo. For this you need to use the Key Filter and Width controls, and possibly an extra graphic equaliser in the side chain. With these frequency controls it is possible to pick out a rhythmic sound from the mix and emphasise it with a sample. You'll be surprised how easy this is to do.

Knee slapping

——DIAGRAM 19

How do you trigger samples? On a MIDI keyboard? On MIDI drum pads? MIDI drum pads may be OK if you are a drummer, but the keyboard does not lend itself to 'instinctive' drumming.

It may look bit odd, but if you tape contact mikes to your thighs, you can slap away in time to the music and trigger MIDI samples in the process. You could tape the mikes to anything that is convenient and get the same result.

Vocal Trigger

——DIAGRAM 20

This is perhaps more fun than practical, but it could point the way to other ideas.

Here, one channel is set, using the Key Filter and Width controls, to respond to low frequencies. The other channel is set to respond to high frequencies. Get one channel to trigger a bass drum and the other to trigger a snare. By making appropriate vocal noises of high and low pitches, you'll soon be 'singing' a drum track!

Legato/staccato

——DIAGRAM 21

Playing smoothly from one note to the next keeps the signal above the noise gate's threshold, and no MIDI messages are sent. Separate the notes slightly and each note will initiate a MIDI Note-on.

It's a nice effect to have an 'attack' sound in the sampler and mix it in with the synth sound. Play smoothly and the attack remains silent, play staccato and it's there.

MIDI reverb

There are digital reverb units available which use MIDI Velocity to control parameters such as reverberation depth, or wet/dry mix. Since the **DPR–502** can turn real life dynamics into MIDI Velocity messages, this could be a fruitful area for experiment. There are also MIDI signal processors which change one type of MIDI message into another. The MIDI Note-on and Velocity output of the **DPR–502** could be converted into Program Change messages, for example.

What you can do depends on the MIDI equipment you have available. One possibility is:

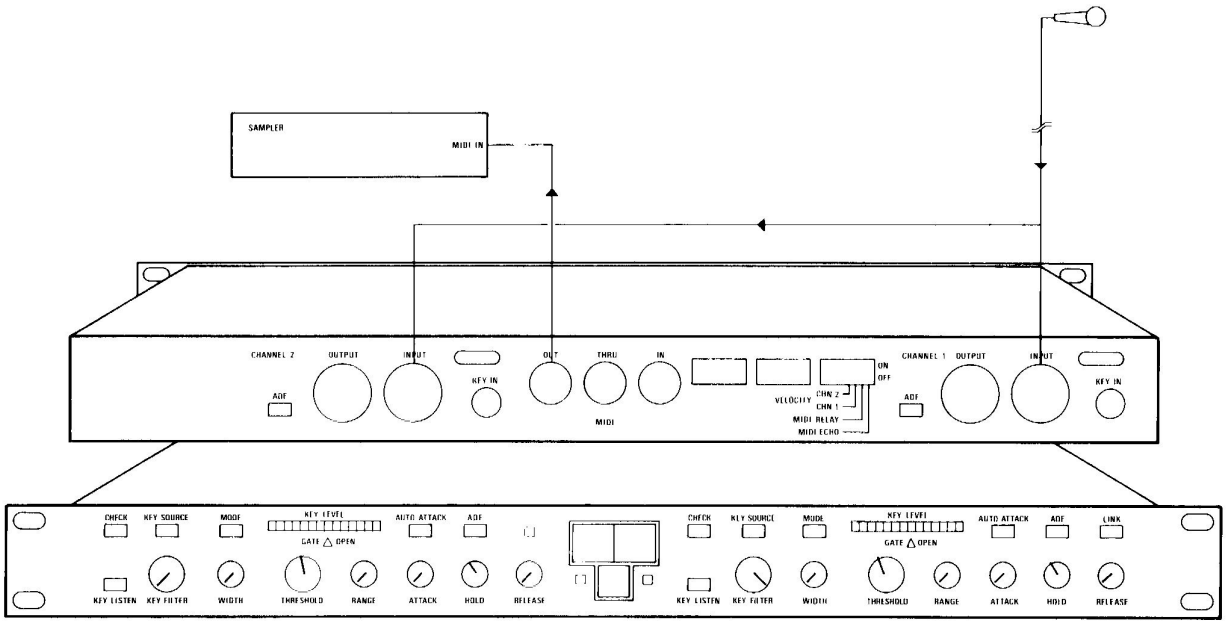

DIAGRAM 20

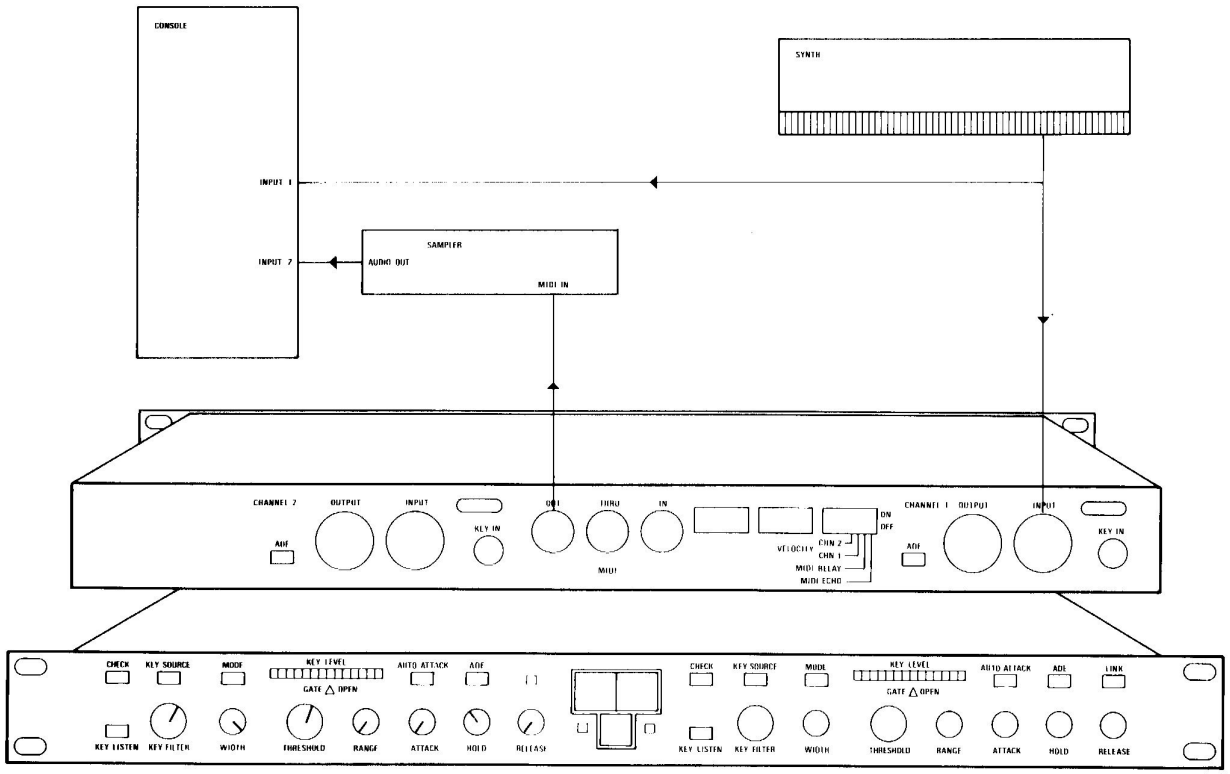

DIAGRAM 21

MIDI echoes

——DIAGRAM 22

A percussive signal is sent to a digital delay, with a little feedback or regeneration, to produce a series of echoes which die away.

By feeding this to the **DPR–502** with MIDI velocity set to ON, a series of MIDI Note-on messages can be created, with Velocity values which start high, then decrease steadily.

Feed this to your MIDI processor or effects unit and see what happens!

MIDI fade

—— DIAGRAM 23

Automated stereo fade-in and fade-out can be performed with the **DPR–502**. The stereo signal is passed through the gate, and triggered by a Note-on message from the MIDI keyboard. When the Note-on is received, the signal fades up. When the note is released, it fades down again. The fade times are determined by the attack and release settings. The Key Source switch is set to EXT so that the signal source doesn't act as its own trigger. (Setting the Threshold control fully clockwise with the Key Source switch set to INT gives the same result — or you can experiment with the threshold level to have a combination of conventional and MIDI-controlled triggering).

As an alternative to MIDI fades, this set-up can be used as a keyboard controlled pan. Feed the same signal to both channels and take the outputs to separate inputs on the console. You can have it so that C1, say, pans the signal left, C2 pans it right.

Instead of panning, you could have different EQ's set up, so that you could change EQ, in rhythm, from the MIDI keyboard, or from a sequencer.

Drum track into sequencer

It's not unusual to have a drummer record a drum track into a sequencer on MIDI drum pads. But these will not feel like a proper kit and the drummer may not give his best performance. What we need is a way to convert drums into MIDI.

How about recording the drum track onto multitrack tape, then use the **DPR–502** to copy each track individually into a sequencer? You would need to change the MIDI Note Number for every drum or cymbal. Timecode on the multitrack tape would be handy too.

Use the sequenced track to play samples, or sample the actual kit used to record the track. This way, you get all the benefits of real drums, with the creative scope that sequencing can offer.

More . . .?

The **DPR–502** MIDI noise gate may be simple to use, but it contains a whole world of possibilities, from the most basic noise gate functions to highly creative applications that are not available in other units.

As you use the **DPR–502** you will appreciate its quality of construction, its accuracy and the intuitive feel of the controls. What is more, you will start to find new applications for the **DPR–502**. When you come up with something interesting, let us know and we'll share it with other engineers in future updates to this manual. They will share their applications with you too.

The sample applications here have probably just scratched the surface. Now it's your turn. . . .

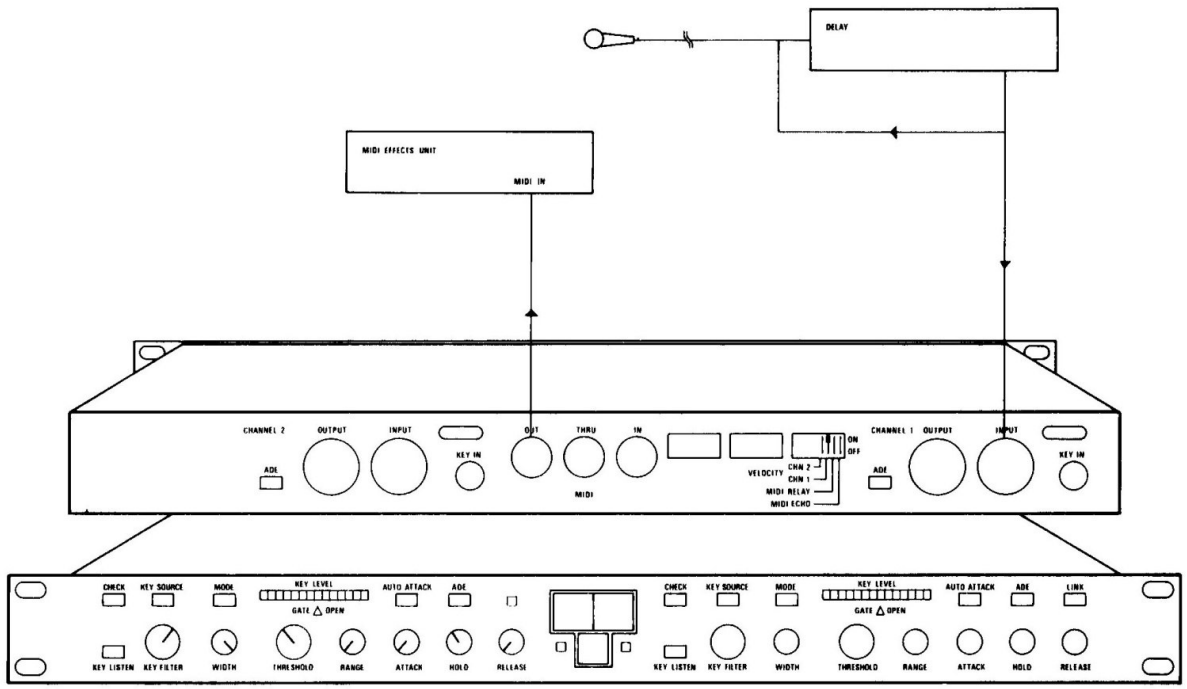

DIAGRAM 22

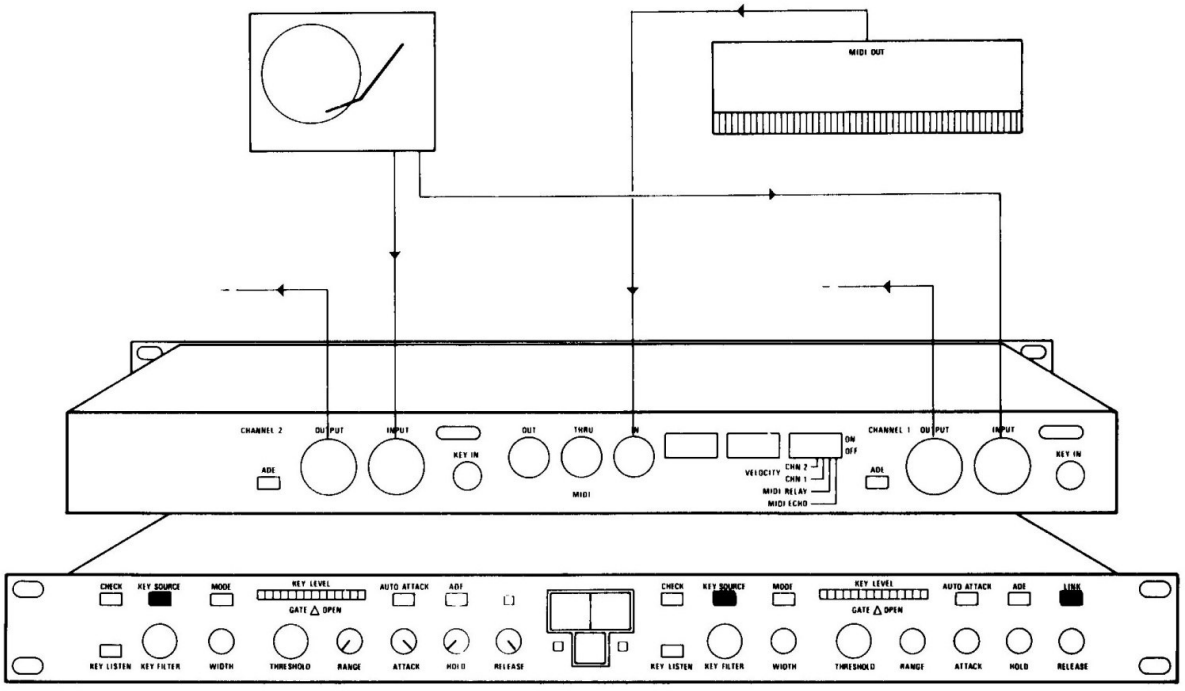

DIAGRAM 23