# REAL WORLD INTERFACES

# User Manual for the Devil Fish MIDI In system V1.0.4

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(There are separate manuals for the V1.0.0 to V1.0.3 MIDI In systems and for the MIDI In and Out system.)

***Contents***

## 0 - Quickstart and default behaviour

The ***Devil Fish*** modified TB-303 can be fitted with a MIDI In system or a MIDI In and Out system. Here are the most important things you need to know about the MIDI In system versions 1.0.4 and above:

- It receives MIDI if you plug a MIDI lead into the Sync Socket.
- It receives Note and Filter Frequency messages on Channel 1. (This is the default – the system can receive in any channel 1 to 16, with this and other user-controllable settings being stored in non-volatile memory.) Middle C is the C on the left of the TB-303 keyboard in Pattern Write mode. (There are non-volatile user settings for transposition.)
- Note On events with velocities 1 to 63 will be played without Accent and those with velocities 64 to 127 will be played with Accent ON.
- The ***Devil Fish*** modified TB-303 is a monophonic instrument. If two or more notes are active from MIDI In, it will play the pitch of the most recent of these notes. As this and other notes are turned off, the pitch revert to the most recently turned on of the currently playing notes, for up to a maximum of 10 notes being on at once.
- If one or more MIDI In notes is still active when a new one is played, the new note will be played with Slide ON.
- Control Change 1 messages (Mod Wheel) control the Filter Frequency, with an approximately 5 octave range. This "control" adds to, rather than overrides, all the other internal signals and the Cutoff pot, which also affect the Filter Frequency.
- The rest of the manual describes other functions such as controlling Slide and Accent with MIDI Control Changes, changing the receive channel, setting a transposition value etc.
- The machine receives MIDI Sync messages: Start, Continue, Stop and Timing Clock. If your master sequencer or drum machine outputs these, (most will do so by default) then when you drive the ***Devil Fish*** from the master device's MIDI Out, the TB-303's Internal sequencer will start, run in time and stop in sync with the master device. When the master device is not playing a song, it will typically output MIDI Timing Clock messages at whatever tempo it is set to run at. These will enable the TB-303's Internal Sequencer to flash its LEDs in whatever mode it is in: Pattern or Track Write or Play.

Please see the Engineering Change Order section of the Devil Fish site for problems in Devil Fishes which can be fixed by a technician or worked around by some other methods.

# 1 - Overall description

This MIDI In system is an additional modification I can install in a ***Devil Fish*** modified TB-303. It is not available as kit for someone else to install. I usually install it as part of the ***Devil Fish*** mods, where I have provision for it on the Version 4.0 and later printed circuits. It is also possible for me to install this system on Version 2.x or 3.x ***Devil Fish*** modified TB-303s – by replacing the two original Devil Fish circuit boards with two new ones.

This is a MIDI In system, with no Out or Thru. The existing DIN socket is used for MIDI In – but it can still be used for Sync when not used for MIDI In. The system uses the TB-303's internal Digital to Analogue Converter (DAC), so the control voltages and therefore oscillator pitches are identical to those produced by the internal sequencer.

User Definable Parameters are altered via the **BACK** and **TAP** buttons, with status indicated by a new Blue LED, which shines through the same 'e' in the Devil Fish logo as the Red Gate LED. The values of the user definable parameters are stored in non-volatile memory, which does not depend on the TB-303's C-cell batteries. So these settings remain after the machine has been turned off and on.

The system receives Note Commands and some Control Change Commands on a single, user definable, MIDI channel. It also receives MIDI Sync: Start, Clock, Stop and Continue. The system ignores all other MIDI messages. Brief descriptions of the system's capabilities are as follows:

## Notes

The full 4 octave range of the TB-303's internal sequencer is received – with the C on the left of the TB-303 keyboard in Pattern Write mode (2 Volts) corresponding to MIDI Middle C (note number 60). In addition, 3 additional semitones below and above this range are also received, although the accuracy of the TB-303's VCO may not be ideal at these voltages. The lowest MIDI note number received is 45 (A1 = 0.75 volts = 3 semitones below the internal sequencer's lowest C) and the highest is 100 (E6 = 5.333 volts = 4 semitones above the internal sequencer's highest C when the pattern is transposed upwards by 12 semitones).

A transposition of +/- 24 semitones can be applied to the MIDI note numbers before the notes are played within the above range. There is no pitch bend facility.

## Accent

Accent is turned on according to the note's Velocity being above a threshold. The threshold is a user definable choice of one of four preset values.

## Slide

Slide can be turned on for "tied notes" – where one note starts before the last one is released. Slide can also be turned on via MIDI Control Change (AKA "MIDI Controller") 65 (Portamento) or by a user definable Control Change number which also drives Sustain (Gate). Sliding – slewing of the DAC voltage slowly from the previous pitch to the new pitch – is a separate function from keeping the Gate on between what would otherwise be two separate Gate pulses for two separate notes.

### *Gate (Sustain)*

In addition to normal Gate operation from the received MIDI notes, Controller 64 (Sustain or Hold) can be used to independently turn on the TB-303's Synthesizer Gate. Another user definable MIDI Controller can also turn on Gate and/or Slide.

### *Filter Frequency*

A user definable Controller can be used to drive the Filter Frequency, over a range of about 5 octaves, in a similar manner to the Devil Fish Filter CV In Socket. This MIDI control of Filter Frequency adds to, rather than replaces or overrides, the control exerted by the Filter CV In socket and all the other internal signals which affect Filter Frequency.

### *Synchronisation*

The system receives MIDI Sync (Start, Continue, Clock and Stop) to drive the TB-303's internal sequencer. With a suitable lead, such as the Sync Lead (see sync-lead/ page on the Devil Fish website) the MIDI In system can also produce DIN Sync for external devices in response to these received Sync messages.

Below is a guide to using the "Front Panel" for setting various parameters and a detailed discussion of all the features and parameters.

### *Firmware updates via installing a new microcontroller chip*

The MIDI In microcontroller (PIC16F870 for V1.0.4) is a 28 pin DIP device which can be replaced with a new one containing later versions of the firmware, to fix any bugs and to implement new features. This involves completely dismantling the TB-303 / Devil Fish and reassembling it – so this should only be undertaken by an experienced technician. The microcontroller is small and easy to send in the post.

### *The Sync / MIDI In socket is not an ordinary MIDI In socket*

**The Sync / MIDI socket of the Devil Fish with MIDI In is not an ordinary MIDI In socket. The two outside pins carry Run/Stop and Clock. This means that devices such as the Evolution 225C (and no-doubt other keyboards from this company: www.evolution.co.uk ) should not be plugged into the Devil Fish, except with a lead which does not connect to the outside pins.** (The Evolution 225C has +5 volts and a 5 volt MIDI signal on the outside pins so that it can be powered by a special lead which plugs into a PC sound card's joystick connector. Please use a special lead, or an ordinary lead with the outside pins broken off, between such a keyboard and the Devil Fish. Another approach is to plug the keyboard into some other MIDI device and use the Thru of that device to drive the Devil Fish.)

## 2 - The "Front Panel"

The MIDI In and Out system uses a very minimal *Front Panel* – the user-interface by which user definable parameters can be changed and by which several other functions can be activated:

The **BACK button** and the **TAP button** are the two *Input* elements.

A **Blue LED** mounted so it shines through the 'e' of the ***Devil Fish*** logo is the sole *Display* element.

The TB-303's CPU sees the **BACK** and **TAP** buttons too, so pressing them for the purposes of controlling the MIDI In system may also affect what the TB-303's CPU does. **BACK** and TAP have little or no effect when playing patterns in Pattern Play or Pattern Write modes, except that when the internal sequencer is stopped in Pattern Play mode, pressing **TAP** will cause it to play a high C note which lasts until the **TAP** button is pressed again or until some other action occurs. When writing patterns, **BACK** and **TAP** (NEXT) directly affect the writing operation, so it is best not to try to control the MIDI In system while writing patterns. **Note: This minimal "Front Panel" system will drive you bananas if you don't read the following section clearly!** Please pay close attention to these instructions regarding Pressing, Holding and Releasing these two switches. The order and timing of these actions is crucial.

### Initialising the Parameters

The Microcontroller at the heart of the MIDI In system uses non-volatile memory, which is completely independent of the memory of the TB-303 and which does not rely on any batteries. If, for some reason, you want to initialise the values of the parameters to the defaults listed in the table on page 15 (include receiving MIDI Notes and Controllers on Channel 1, and receiving MIDI Sync), **turn the machine on whilst holding both BACK and TAP**. The Blue LED will flash **triple flash – triple flash – triple flash**. Release the **BACK** and **TAP** buttons during or after these flashes and the machine will be ready for ordinary operation.

### Firmware version display

To display the version of firmware programmed into the MIDI In and Out system's microcontroller, **turn the machine on whilst holding the BACK button but not the TAP button**. The Blue LED will continually cycle through a pattern of varying brightness. **Release the BACK button once the Blue LED turns on.** A long moderate brightness period is followed by three dim periods, within which 0, 1 or more bright flashes may be inserted. The number of flashes indicates the software version. Version 1.0.4 is indicated by one flash in the first dim period, no flashes in the second dim period and four flashes in the third. In this mode, the microcontroller is not receiving MIDI or driving the TB-303 hardware. To restore normal operation, turn the machine off and on again.

### MIDI Notes and Control Changes are received by default at power on

In V1.0.0 to V1.0.3 I intended that the state of whether the Devil Fish receives MIDI Notes and Control Changes would be retained in non-volatile memory. Due to a bug, it wasn't – reception would always be on at power up. No-one complained about this and I decided to retain this behaviour in V1.0.4. (In the MIDI In and Out system, I have made it a setting which *is* stored in non-volatile memory.)

## *Blue LED MIDI activity display and how to disable it*

The Blue LED which shines through the Red Gate LED in the 'e' of the Devil Fish logo has five functions:

1. Acknowledging the Initialise all Parameters command, as described above.

2. Displaying the firmware version. as described above.

3. Indicating the status of "Front Panel" operations – the pressing and releasing of the **BACK** and **TAP** buttons.

4. Indicating successfully received MIDI In messages with brief flashes, as described in the section below *The Blue LED*. This function is normally on, except for when "Front Panel" operation is in progress.

The Blue LED circuit may cause very slight interference with the audio output. Its operation for function 5 above can be disabled, by **turning the machine on with the TAP button pressed, and the BACK button not pressed**.

## *Turning on and off the reception of MIDI Notes and Control Changes*

This is a single setting, which is not stored in non-volatile memory. So whatever change you make will not be retained after the machine is turned off and on. At power on, the reception will be turned on.

Before following either of the procedures below, make sure that the machine is not in the middle of the "Altering the value of a parameter" operation, as described on page 7. If the machine is in this state, press and hold both **BACK** and **TAP** buttons for a few seconds, until there is either a series of double flashes (a normal exit from editing a parameter) or a continual series of flashes at about 6 Hz (an exit before a parameter has been selected for editing).

**Turn ON reception of MIDI notes and controllers**

**Hold down the TAP button.**

**Press and release the BACK button within a second or so.**
While both buttons are pressed, the Blue LED will flash rapidly. After the Back button is released the Blue LED will stay ON for 0.8 seconds and will then turn OFF.

**Release the TAP button.**

After reception is turned on, the MIDI In system will not take control of the TB-303's DAC until a Note On is received on the correct MIDI channel, within the currently valid range of note numbers. This control will still be maintained after no more MIDI events are received, even if the MIDI lead is removed from the Sync/MIDI socket.

The MIDI In system will begin to drive the Filter Frequency only after a Control Change for this is received. Slide and Gate (Sustain) can be driven by several types of MIDI In Control Change messages, as well as after a Note On event has been received.

In order to return control of the DAC etc. to the TB-303's internal sequencer so the MIDI In system no longer drives Gate, Slide, Accent or Filter Frequency, use the following procedure:

**Turn OFF reception of MIDI notes and controllers**

**Hold down the BACK button.**

**Press and release the TAP button within a second or so.**

While both buttons are pressed, the Blue LED will flash rapidly. After the Tap button is released the Blue LED will stay ON for 0.2 seconds and will then turn OFF.

**Release the BACK button.**

The control of the reception of MIDI Sync is separate – see Parameter 7 in the table and descriptions below, pages 10 and 23 respectively.

## *Altering the value of a parameter*

There are 8 parameters, numbered 0 to 7, which can have their values changed with the following procedure. The details of these parameters are listed in the User Definable Parameters table on page 10. Please be aware that pressing the Tap button in Pattern Play mode can cause the Internal Sequencer to play a sustained C4 note, as described in Section 7 - The Pesky C4 Note in Pattern Play mode (page 27).

The MIDI In system continues to receive MIDI and play notes etc. whilst parameters are having their values altered – the effects, if any, of the new value take place immediately. The final step writes the altered value into non-volatile memory. If this final step is not done, the changed setting will remain until the machine is turned off and will be replaced by the previously stored setting when the machine is turned on.

**Entering Parameter Select mode**

**Press and Hold both BACK and TAP buttons, for as long as it takes for the Blue LED to stop flashing, which will be about 4 seconds.**

While the two switches are both pressed, the Blue LED will flash repeatedly very quickly. After about 4 seconds, the flashing will stop and the Blue LED will turn ON continually.

It doesn't matter whether you press **BACK** or **TAP** first, or how long after pressing the first switch you press the second.

**Release both switches.**

The Blue LED will turn OFF.

(If you release either switch before the Blue LED turns on continually, then the MIDI In system will not enter Parameter Select mode. The system will resume normal operation once both switches have been released.)

**Selecting which parameter to alter**

If you want to alter the first parameter – MIDI Receive Channel – then there is nothing to do at this stage, since this is the first parameter. For other parameters further down the User Definable Parameters table (page 10): the Parameter number is how many times the **BACK** button should be pressed:

> **Press and Release the BACK button the number of times indicated in the table. For instance, for Parameter 7, press and release the BACK button 7 times.**
>
> The Blue LED will flash briefly each time the **BACK** button is released.

Once you have done this the appropriate number of times – including, for Parameter 0 as just mentioned, not pressing the **BACK** button at all – perform the next step which tells the MIDI In and Out system which Parameter you will be altering the value of:

> **Press and Release the TAP button.**
>
> The Blue LED will flash once.

(If, before performing the above step, you decide not to change the value of a Parameter, press and hold both **BACK** and **TAP** for about 3 seconds. During this time, the LED will not light, but at the end of the time, it will flash with a distinctive sequence of double flashes. These double-flashes indicate that your command to exit has been accepted. Release the buttons and the MIDI In and Out system will resume normal operation.)

**Altering the selected parameter's value**

The parameter you selected is now ready to be incremented (made one higher than it currently is) with the **BACK** button or decremented (made one lower) with the **TAP** button.

\+ Increment the parameter: **Press and Release the BACK button.**

– Decrement the parameter: **Press and Release the TAP button.**

> The Blue LED will flash briefly once for either of the above actions except when the parameter has reached its minimum or maximum value.

Each parameter has a minimum and maximum value. If you Decrement when it is at its minimum, or Increment when it is at its maximum, the value will not change and the Blue LED will flash for a longer time. If you changed the value of the parameter to a new state, then the Blue LED will flash for a short time.

There is no display of the Parameter's current value, but you can find the value by stepping it down with **TAP** until it reaches is minimum, which is visible by a longer flash of the Blue LED when you try to reduce it further from this value. For instance, if the original value was 3 and the minimum value is 0, then it will take three presses of the **TAP** button to change the value to 0, each of which will generate a normal flash. A fourth press of the **TAP** button will attempt to reduce the value from its minimum, and this will be indicated by a long flash. In this example, with a minimum value of 0, a

double-flash on the fourth press of the **TAP** button shows that the original value was 3, so pressing the **BACK** button 3 times will restore the original value.

Similarly, to determine the current value, you can step up to the maximum value with the **BACK** button, until there is a longer flash of the Blue LED, indicating that the previous press of the **BACK** button had taken the value to its maximum.

Changing the value of a parameter has immediate effects on the MIDI In system. Furthermore, changes to the values of some parameters cause specific actions, such as clearing received notes, Accent, Slide etc. if the MIDI receive channel is changed. These are explained in the detailed information below on each of the parameters.

**The changed value of the parameter will not be written into non-volatile memory unless the next step is performed.**

If you wish to abandon whatever change you just made to the parameter, turn the machine off. Turning it on will restore the value to whatever was stored in non-volatile memory.

**Saving to non-volatile memory and returning to normal operation**

Whether or not you have altered the value of a parameter in the step above, to return to normal operation, you must perform the following procedure – which also writes the new value (or the original value, if unchanged) to non-volatile memory.

> **Press and hold both the BACK and TAP buttons until the Blue LED flashes with a distinctive double flash pattern. This will involve holding both buttons for about 3 seconds.**

When you have pressed and held them for long enough, the Blue LED will flash with a distinctive double-flash pattern. This is the signal to:

> **Release both buttons.**

after which the Blue LED will turn OFF and the MIDI In system's "Front Panel" will be in normal operation mode.

## 3 - User Definable Parameters

Turning on and off the reception of Notes and Control Changes is described on pages 6 and 7. The other parameters are accessed and altered by the procedure described immediately above – Altering the Value of a parameter, on pages 7, 8 and 9.

The following table lists all the User Definable Parameters by their names, range of values, default value and a short description of their function. Each parameter is discussed in greater detail in Section 5 below. Page numbers for these explanations are in blue in the left column.

| **Name of parameter** More details on page xx | **Parameter number** = number of presses of the BACK button to select this parameter before pressing TAP | **Range & (default)** | **Function** Red bold = default |
|---|---|---|---|
| **MIDI Receive Channel** 18 | **0** (None – just press **TAP**.) | 1 – 16 (**1**) | Selects which channel will be used for receiving Note and Controller messages. |
| **Transpose Enable** 20 | **1** | 0 – 2 (**0**) | **0 = No transposition.**<br>**1** = Transpose Up.<br>**2** = Transpose Down. |
| **Transpose Amount** 20 | **2** | 0 – 24 (**12**) | Number of semitones to transpose the MIDI Note number up or down before playing it on the TB-303. |
| **Filter Frequency Controller** 21 | **3** | 0 – 19 (**1**) | **0** = Disabled.<br>**1 = Mod wheel.**<br>**2** to **19** = this controller number. |
| **Slide on Tied Notes** 22 | **4** | 0 – 1 (**1**) | **0** = Disabled.<br>**1 = Turn on Slide when a new note is started before the previous one ends.** |
| **Sustain-Slide Controller** 23 | **5** | 0 – 19 (**0**) | **0 = Disabled.**<br>**1** = Mod wheel.<br>**2** to **19** = this controller number. |
| **Accent Velocity Threshold** 23 | **6** | 0 – 3 (**0**) | The value which Note On Velocity must equal or exceed in order that Accent will be turned on:<br>**0 = 65*** ;<br>**1** = 80;<br>**2** = 100;<br>**3** = 120<br>* 64 for V1.0.0 to V1.0.3. |
| **Receive MIDI Sync** 24 | **7** | 0 – 1 (**1**) | **0** = No reception of MIDI Sync.<br>**1 = Receive MIDI Sync.** |

## 4 - Interaction between the MIDI In system and the TB-303 / Devil Fish

A full understanding of the various parameters and features requires a good understanding of the three elements of hardware – the basic TB-303, the Devil Fish enhancements to it and how the MIDI In system interfaces to these.

### The standard TB-303

The standard TB-303 can be divided into two sections: Internal Sequencer and Synthesizer.

The **Internal Sequencer section** comprises:

- The CPU chip (a 4 bit NEC microcontroller).
- Battery backed-up memory – three 1024 x 4 bit static RAM chips.
- Push-button switches, rotary switches and LEDs.
- The Sync section:
  - Run/Stop button and flip-flop.
  - Tempo pot and oscillator.
  - Sync socket .

The CPU chip contains firmware which makes it respond to all the above and so perform the functions of the Internal Sequencer. This involves reading and writing data from and too the memory and controlling the Synthesizer section with the following signals:

A 6 bit DAC (Digital to Analogue Converter) which provides a voltage between 1.0 and 5.0 volts, in 1/12 volt steps. This voltage is made available at the CV Out socket. (Its range is 1 to 64 steps of 1/12 volt each, but below 1 volt and above 5 volts it is not necessarily accurate and the VCO tracking of these voltages is less accurate than in the 1.0 to 5.0 volt range.

A Gate signal which is high when a note is ON. This is available at the Gate Out socket as an approximately +6 volt signal.

An internal Slide signal which controls the slewing of the CV (to the Synthesizer's VCO and the CV Out socket) so that it takes a fraction of a second to slew from the voltage of the previous note to the voltage of the new note, as produced by the 6 bit DAC.

An internal Accent signal which alters the way the Synthesizer works. (See the Devil Fish User Manual for more information on Slide and Accent.)

The TB-303's **Sync section** consists of two front-panel circuits – a Tempo Clock oscillator and a Run/Stop switch, flip-flop and LED – and a special 5 pin DIN socket. This socket uses the middle pin (2) for ground (as does MIDI) and the two outside pins (1 and 3) for the Run/Stop and Clock signals, respectively. (Pin 4 is also an input for the TAP function and Pin 5 for some undocumented function. These are not normally used in any Sync arrangement, and these functions are removed when the MIDI In system is installed.)

Normally, with nothing plugged into the Sync socket, a two-part switch in the socket connects the local Run/Stop signal (generated by the Run/Stop switch and its associated flip-flop) to pin 1 – and the Clock signal, from the Tempo oscillator to pin 3. These are both +5 volt signals. 0 volts on the Run/Stop pin means that the TB-303's Internal

Sequencer, will not play a pattern or track, but is ready to play or write a pattern or track according to the MODE switch. +5 volts or more (up to + 15 volts) on the Run/Stop pin tells the TB-303's Internal Sequencer to "Run": play a pattern or the patterns in a track, according to the pulses which arrive on the Clock pin. The positive (rising) edge of these pulses (again typically +5 volts, but perhaps as high as +15 volts), on the Clock pin tells the Internal Sequencer that this is the start of a 1/24th of a quarter note.

The Clock circuit is normally a free-running square-wave oscillator – but it is reset and made to restart with a slight delay every time the Run/Stop button is pressed so as to turn Run/Stop on. This is to ensure that the Run/Stop signal goes high, at the start of playing a pattern or pattern of a track, when the Clock signal is low – and that there be a defined time delay before the next rising edge of the Clock signal. This delay is musically unimportant, but is vital to allow the TB-303's CPU to recognise this first Clock cycle, rather than miss it while the CPU is responding to the rising edge of the Run/Stop signal.

If a plug is inserted into the Sync socket, without activating the switch, pins 1 and 3 function as outputs for the Run/Stop and Clock signals respectively. This can be done by partially inserting the plug, or by removing its shell (or part of the shell) so it doesn't press against the white rod inside the top of the Sync socket. This is not a standard part of TB-303 functionality, but it can be useful. (For further discussion, see Section 6 below.)

If a plug is inserted normally into the Sync socket, this activates the two-pole normally closed switch at the back of the socket, which disconnects the local Run/Stop and Clock circuits from the socket's pins 1 and 3. The idea is that the lead which has been plugged in will drive these pins. The voltage levels for receiving Run/Stop and Clock are not critical – low should be 0 to maybe 1 volts and high should be between 3 and 15 volts.

So in normal operation, whether an external Sync source is plugged into the TB-303, or whether nothing is plugged in and the local circuits drive pins 1 and 3, these pins have a valid Run/Stop signal and a valid Clock signal. The CPU sees these signals and uses them to drive most of its operations. Without a regular Clock signal, the CPU will not play any notes, flash any LEDs or respond normally to front panel button activity.

The Sync system is a two-signal *input* to the TB-303's CPU. The TB-303's CPU does not drive the Sync socket. In a TB-303 without this MIDI In system, only an external cable, or the internal Run/Stop and Clock circuits drive the socket and therefore these two inputs to the CPU.

(A common fault in TB-303s is that there are one or more broken solder joints at the Sync socket and its associated switch. This can prevent the CPU receiving the Run/Stop signal and/or the Clock signal. Without a Clock signal, the CPU will not flash the front panel LED lights or respond to buttons being pressed. Without the Run/Stop signal, the CPU will not play a pattern or track.)

The **Run/Stop LED** is also driven by the Sync socket – if pin 1 is above about 0.5 volts the LED will be On, but only if the power supply to the TB-303's CPU is at the correct voltage. If the power supply voltage is low, such as due to running from flat batteries, or using an inadequate external power supply, then this LED will be dim or off.

Normal note-playing activity in the TB-303, when playing or writing patterns or tracks, involves:

- The CPU latching a 6 bit number into the DAC.
- The CPU selecting whether or not the Slide circuit causes a slow slew in how the new DAC voltage drives the VCO and CV Out socket.
- The CPU turning the Accent signal on or off.
- The CPU driving the Gate signal to the Synthesizer and Gate Out socket.

The standard TB-303 has no inputs for CV (to drive the VCO), Gate, Accent, Slide or Filter frequency.

The Devil Fish Modifications add a number of inputs and new sources of control for CV, Gate, Accent, Slide and Filter CV. The Devil Fish mods also add an Accent Out socket – a +6 volt signal which can be used to drive other equipment, such as one or more other Devil Fishes. Here are descriptions of the four signals as they are handled in the Devil Fish without MIDI In, and in the Devil Fish **with MIDI In**. The MIDI In details are in **bold blue text**.

### *Devil Fish CV In*

The TB-303 CPU drives the 6 bit DAC, which has in internal impedance of 100k ohms. In the TB-303, this is connected directly to a the Slide circuit, which can cause a slow slew when the voltage changes, via a 0.22uF capacitor. In the Devil Fish, the DAC drives a *normally closed* terminal of the Devil Fish's CV In socket. When nothing is plugged into this socket, the DAC signal goes to the Slide circuit, via an over-voltage protection circuit (3.3k ohms) and the new Slide pot (0 to 500k ohms). When an external CV is plugged into this socket (probably with a much lower impedance than 100k ohms, meaning that it drives the socket in a more robust fashion than the relatively weak 100k ohm impedance of the DAC) the voltage from the DAC is ignored and input voltage goes via the over-voltage protection circuit and the Slide circuit, slewing according to the value of the Slide pot (+ 3.3k ohms + the impedance of the input signal) whenever the Slide signal is on.

The output of the Slide circuit goes to the VCO, the Filter Tracking pot and the TB-303's CV Out socket.

**The MIDI In system is the same as the above, except that the PIC microcontroller in the MIDI In system can take control of the DAC from the TB-303's CPU. When this happens, if the TB-303 CPU drives the DAC as part of playing a note, the DAC voltage will be controlled solely by the MIDI In system's microcontroller.**

Plugging a lead into the CV In socket will mean that the VCO, Filter Tracking pot and CV Out socket are driven by whatever signal is on that lead. This means the output of the DAC, and therefore the pitches received from MIDI IN, will be ignored.

Note there is a potential problem with some Devil Fishes: an occasional intermittent poor connection in the CV In socket's *normally closed* function means that the VCO pitch drifts, remains static, or is way out of tune. The solution is to insert a plug a few times into the socket, so the contacts get some movement. This is discussed more fully in the Devil Fish User Manual in the section regarding reliability.

### *Devil Fish Gate*

There are three signals which can turn on the Gate – for the Synthesizer Gate, the Gate Out socket and the Red Gate LED in the 'e' of "Devil".

1. The TB-303 CPU's Gate signal.

2. The Devil Fish's Gate In socket.

3. In Devil Fish versions 2.1D (2003-11-11) and later, a voltage above about 4.0 volts on the Slide In socket will also turn on the Gate.

These are ORed – any one, any two or all three of them being active will turn on Gate.

**The MIDI In system can drive the Gate in a similar way – an OR arrangement of the above three signals with its own Gate signal. The MIDI In system cannot turn off the Gate if it is turned on by any of the above.**

If the TB-303's CPU was turning the Gate on continually, the MIDI In system would not be able to make it go on and off. If the MIDI signal contains no Sync (Start, Clock etc.) this is unlikely to occur, because plugging a lead into the Sync socket will open the switches and disconnect the TB-303's internal Run/Stop signal from pin 1, and therefore from the Run/Stop input of the CPU. This will cause the TB-303's CPU to deactivate its Gate signal. However, if the MIDI lead was only partially inserted, or was modified so as not to activate the switch, then the TB-303's CPU could be driving Gate whilst the MIDI In system is trying to turn Gate on and off. This *might* be musically useful, but is more likely to be troublesome. (For further discussion, see Section 6 below.)

With an ordinary MIDI lead, properly inserted, there could be a situation in which the TB-303's CPU is activating Gate at the same time as the MIDI In system is trying to play notes by activating the Gate. This occurs when these three conditions are true:

1. The MIDI In system is configured to receive MIDI Sync, which is the default arrangement.

2. The MIDI signal includes Clock bytes and at least one Start or Continue byte, which causes the MIDI In system to turn on Run/Stop (pin 1 of the Sync socket, and as an input to the TB-303's CPU) and to provide Clock pulses (on pin 3, and also to the CPU).

3. The TB-303 is currently set up to play a pattern, or track, such that the pattern it plays contains some notes.

In the typical situation with an external MIDI sequencer which puts out Sync bytes, there are two ways of avoiding this problem of the TB-303 CPU driving the Gate when you really want to be controlling the Synthesizer entirely from MIDI. Either of these approaches will solve the problem:

1. Disable the reception of MIDI Sync (Parameter 7 in the *User Definable Parameters* section above.) or:

2. Make sure the TB-303 is in Pattern Play (or Write) mode on a blank pattern.

### *Devil Fish Slide*

There are two signals which can turn on the Slide circuit. (This is *not* the same as turning on the Gate to tie two otherwise separate periods of Gate on into a single period. The TB-303's CPU, when playing two notes with Slide, does this, leaving the Gate on as it changes the DAC voltage, whilst turning on the Slide signal to cause the resulting voltage to the VCO to slew slowly.)

1. The TB-303 CPU's Slide signal.

2. The Slide signal which results from the Devil Fish Slide input socket having more than about 2.3 volts applied to it.

**The MIDI In system can override the TB-303 CPU's Slide signal and the Devil Fish Slide input socket.**

**When the MIDI In system is driving the DAC, it doesn't matter whether the TB-303 CPU or the Slide input socket is driving the Slide – the MIDI In system will control Slide irrespective of these. This overriding begins with the first note played by the MIDI in system in response to MIDI In. The override is not activated simply by the MIDI In system being ready to receive notes. A note must be received first. Once this happens, the MIDI In system will control Slide, according to Tied Note Slide and the Slide-Sustain Controller – until the reception of notes is turned off by holding down the BACK button and pressing and releasing the TAP button.**

### *Devil Fish Accent*

There are three signals which can turn on the Accent to the Synthesizer, which also turns on the Devil Fish's Accent Out socket.

1. The TB-303 CPU's Accent signal. (This could be stuck On if the CPU's sequencer function is stopped in the middle of a pattern with an accented note, or perhaps if it is ready to play a pattern which starts with an accented note.)

2. The Accent signal which results from the Devil Fish Slide input socket having more than about 2.3 volts applied to it.

3. The Accent Button being pressed.

**The MIDI In system overrides the TB-303 CPU's Accent signal. When it is driving the DAC (as described in more detail in the paragraph in blue immediately above), it doesn't matter what the TB-303's sequencer is doing. The MIDI In system's Accent signal is ORed with the signals from the Accent In socket and the Accent button to produce the final Accent signal for the Synthesizer and the Accent Out socket.**

### *MIDI In Sync system*

The MIDI In system cannot sense whether anything is plugged into the Sync socket to open the switches which disconnect the TB-303's internal Run/Stop and Tempo Clock circuits from pins 1 and 3 of the socket respectively. Nor can it sense the state of these pins to know if an external signal, such as by a special lead carrying both MIDI and Sync, is driving the pins. So the MIDI In system cannot sense whether the TB-303's CPU is playing a pattern, driving Gate, Accent etc.

However, the MIDI In system can drive positive voltages (about + 5 volts) onto the pins 1 and 3 (Run/Stop and Clock respectively) of the Sync socket. This means it will drive the TB-303's CPU and any external lead which may connect these pins to other devices. Assuming no external signal is driving these pins, and assuming that a normal lead has been inserted far enough to activate the switch which disconnects the internal Run/Stop and Clock circuits, then the MIDI In system is free to drive the pins according to the bytes it receives from MIDI, if the parameter 7 (Receive MIDI Sync) is set to 1, On, which it is by default.

However, if there is some other source of Run/Stop or Clock, such as due to the Sync socket switch not being properly pressed (meaning it does not disconnect both the Run/Stop and Clock drive signals from the TB-303's internal Temp oscillator and Run/Stop flip-flop), or some other signals being applied to the pins, then the MIDI In system will not be able to reliably drive these pins.

The drive for each pin is +5 volts, via a diode and 1k resistor. This should protect the MIDI In microcontroller from shorts or externally applied positive voltages, but be sure not to apply negative voltages, or any static electricity spikes, to these pins.

## 5 - Details of features and User Definable Parameters

Here is a complete description of the operation of the MIDI In system. Please refer to the table on page 10 which lists the User Definable Parameters.

### Monophonic reception of multiple notes

The Devil Fish modified TB-303 is a monophonic synthesiser, but MIDI is a polyphonic interface. There are several ways a monophonic device, such as a MIDI-to-CV converter, might be designed to choose which single pitch to play when multiple note-on and note-off events are received. Common approaches include high-note or low-note priority, where the highest or lowest note of the currently active notes is the one which drives the monophonic synthesiser.

The Devil Fish MIDI In system uses a *most recent note* priority system, with a ten-deep internal stack of the most recently turned on notes, which are used if the currently played note is turned off. This means that up to ten notes can be active at once, and as they are released, the MIDI In system will back-track through the list of currently active notes, selecting the most recently started, when more recently started notes are released.

### The Blue LED

The MIDI In system has a Blue LED, mounted to shine on the Red LED in the '***e***' of the ***Devil Fish*** logo. This is a conventional Blue LED, which is brighter – and somewhat more "aqua" – LED than the Blue LEDs which can be installed in the TB-303 front panel. The new Blue LED may not be clearly visible in very bright lighting, such as sunlight, but should be clearly visible in most other circumstances.

If the machine is turned on with the **BACK** button pressed, the LED will light in a continuing sequence of pulses, showing the three digit version of the MIDI In and Out system's firmware. (This is described on page 5.)

The primary purpose of the Blue LED is both to indicate various states of the "Front Panel" system and to indicate the successful reception of a MIDI In Note or Control Change message. The signal which drives the Blue LED may cause slight interference with the Audio Out signal, so for critical recording purposes involving MIDI In Note and Controller messages, it may be best to turn this off as described in the next paragraph.

When no front panel operations are in progress, the LED indicates successfully received MIDI messages, unless this **Blue ED reporting of MIDI In activity is turned off** by turning the machine on with the **TAP** button pressed and the **BACK** button not pressed. When the Blue LED is enabled (when the machine is turned on without holding Back or Tap), there are three types of flash for three types of message. The first two types are only received if Reception of MIDI Notes and Control Changes is enabled (page 6).

- **Bright 16 ms flash.** One or more Note On or Note Off messages have been received. The LED will not flash if the message is for a different channel to the one currently being received, or if it is for a MIDI note number which is outside the range the MIDI In system can play, given the current Transposition (Parameters 1 and 2) settings. If a Note On message is received for a MIDI note number which is already on, then the second message will be ignored by the interface and will not generate a flash of the LED.

- **Dim 160ms flash.** One or more Control Changes have been successfully received of three types. These can only occur if Reception of MIDI Notes and Control Changes is enabled.
    - Filter Frequency Control Change (Parameter 3).
    - Sustain-Slide Control Change (Parameter 4).
    - Standard MIDI Control Change functions:
        - Controller 64 for Sustain.
        - Controller 65 (Portamento) for Slide.
        - Controller 120 and 123 All Notes Off.

Since one flash can be terminated and replaced by another, and since one message can arrive within a millisecond of the previous one, only 1ms of the flash due to the first message will be visible – and this is too short to perceive in the presence of a different type of flash which takes its place. For instance, a Control Change message followed by a Note On or Off message will cause a short bright flash, while these two messages received in the reverse order will cause a longer dim flash.

### *MIDI Receive Channel (parameter 0)*

Changing this parameter turns off a number of things which may be on:

1. Any note being played. This also clears the 10 deep stack of notes which is used to convert polyphonic notes into monophonic notes.
2. The MIDI In system's control of the control voltage DAC.
3. The MIDI In system's control of Filter Frequency.
4. The MIDI In's drive of Slide, Accent and Gate.

Notes and Control Changes are immediately received on the new channel, which may lead to notes being played and other effects, such as Slide or Accent. The flashing of the Blue LED for Notes and Control Change commands is turned off during the parameter change process – so if you are fishing for the right MIDI channel, it is probably best to do this by listening for notes (or looking at the Red Gate LED), since it takes quite a few seconds to exit from the parameter change process in order to see the Blue LED activity which indicates successful MIDI reception.

As with all the parameters, be sure to exit the change process by holding down both **BACK** and **TAP** buttons, in order to save the new setting to non-volatile memory, and to return the system to ordinary operation.

Here is an example of changing the MIDI Channel to 5, assuming it was previously set at the default of 1.

**a – Enter Parameter Select mode:**

**Press and Hold both BACK and TAP buttons, for as long as it takes for the Blue LED to stop flashing, which will be about 4 seconds.**

While the two switches are both pressed, the Blue LED will flash repeatedly very quickly. After about 4 seconds, the flashing will stop and the Blue LED will turn ON continually.

**Release both switches.**

The Blue LED will turn OFF.

**b – Select Parameter 0 (Base MIDI Receive Channel) to edit:**

Since this is Parameter 0, there's no need to press the **BACK** button.

**Press and Release the TAP button.**

The Blue LED will flash once.

**c – Alter the value from 1 to 5:**

\+ + + + **Press and Release the BACK button 4 times.**

The Blue LED will flash briefly once for each of the above actions except when the parameter has reached its maximum value.

If you are unsure of the MIDI Receive Channel number when you start this procedure, you can decrement it to its minimum value of 1 by pressing and releasing the **TAP** button until the Blue LED flashes for a longer time, which indicates you have reached the minimum value for this Parameter, which in this case is 1. Then you can press and release the **BACK** button 4 times, to increment the value to 5.

**d – Write the new value to Non Volatile Memory so it will be retained, even after the machine is turned off and on again:**

**Press and hold both the BACK and TAP buttons until the Blue LED flashes with a distinctive double flash pattern. This will involve holding both buttons for about 3 seconds.**

When you have pressed and held them for long enough, the Blue LED will flash with a distinctive double-flash pattern. This is the signal to:

**Release both buttons.**

after which the Blue LED will turn OFF and the MIDI In system's "Front Panel" will return to normal operation.

### *Transposition (parameters 1 and 2)*

These two parameters affect MIDI In reception of incoming notes, enabling received Note On and Off events to play a pitch in the Devil Fish which is different from that of the incoming MIDI Note. The range of transposition is -24 to +24 semitones = +/- 2 octaves.

As with changing the MIDI Receive Channel, changing these parameters ends any currently playing notes, disengages the drive of the Filter Frequency, and ends any drive of Slide, Accent and Gate.

Without transposition, the range of MIDI Notes which are received is:

| MIDI Note number | MIDI Note name | DAC voltage | Relation to TB-303 sequencer<br>Pale yellow means VCO tuning and CV Out voltage may be inaccurate. |
|---|---|---|---|
| 45 | A1 | 0.750 V | 3 semitones below normal TB-303 range. |
| 46 | A#1 | 0.833 V | 2 semitones below normal TB-303 range. |
| 47 | B1 | 0.916 V | 1 semitone below normal TB-303 range. |
| 48 | C2 | 1.000 V | Lowest C on TB-303 sequencer: Left C of the TB-303 keyboard, when Pattern Write Transpose Down is active. |
| 60 | C3 | 2.000 V | Left C of TB-303 keyboard with no transposition. (Middle C.) |
| 72 | C4 | 3.000 V | Right C of TB-303 keyboard with no transposition. |
| 84 | C5 | 4.000 V | Highest C of a pattern without transposition: Right C of the TB-303 keyboard when Pattern Write Transpose UP is active. |
| 96 | C6 | 5.000 V | Highest C of a pattern with 12 semitone transposition: The pattern itself contains a C5 and in Pattern Play mode, or Track mode, the entire pattern has been transposed up 12 semitones. |
| 97 | C#6 | 5.083 V | 1 Semitones above normal range. |
| 98 | D6 | 5.166 V | 2 Semitones above normal range. |
| 99 | D#6 | 5.250 V | 3 Semitones above normal range. |
| 100 | E6 | 5.333 V | 4 Semitones above normal range. |

A transpose value of, for instance, +3 can be achieved with Parameter 1 set to “1” and Parameter 2 set to “3”. This would cause a MIDI Note number 57 (A2) to play the C3 note on the TB-303 / Devil Fish.

### *Filter Frequency Controller (parameter 3)*

When this parameter is set to 0, there will be no reception of Control Changes to drive the Filter Frequency.

A MIDI Control Change message consists of three bytes containing three numbers:

- The MIDI Channel number 1 to 16.
- The Controller number, 0 to 127.
- The value for this Control Change, in the range 0 to 127.

For instance, if a keyboard is transmitting on channel 3, and its Mod Wheel is moved to the forward position, the resulting MIDI Out message consists of three bytes:

**10110010** Status byte for Control Change on Channel 3, encoded as 2 in a range 0 to 15 for Channels 1 to 16, with binary 0010 = decimal 02.

**00000001** First data byte: Controller 1 = Mod Wheel.

**01111111** Second data byte: Value = 127.

When this parameter is set to a value in the range 1 to 19, and a Control Change for this MIDI Controller number is received on the currently selected channel (parameter 0) then the MIDI In system will begin to drive the Filter Frequency.

When this parameter is set to a value in the range 1 to 19, and a Control Change for this MIDI Controller number is received on the currently selected channel (parameter 0) then the MIDI In system will begin to drive the Filter Frequency.

The default setting is 1, which means the MIDI In system will receive Mod Wheel Control Change messages and use the values in these messages to control the Filter Frequency.

There is an approximately 5 octave range between controller values 0 and 127. A value of about 83 will not alter the filter frequency. Values above this will increase the filter frequency and values below will decrease it. This is equivalent to applying a 0 to 5 volt signal to the Filter CV socket, where 3.3 volts has no effect on the filter frequency.

This MIDI control of Filter Frequency does not override the other sources of control – it adds or subtracts from the sum of the signals generated by:

- The Cutoff Pot.
- The Main Envelope Generator via the Env Mod Pot.
- On accented notes, the Main Envelope Generator via the Accent Sweep Circuit (three modes controlled by the Sweep Speed switch), if the Sweep-Resonance switch is in positions 1 or 2.
- The AC coupled (only rapid changes, not the overall DC voltage) output of the VCA (which incorporates the Muffler) via the Filter FM Pot.
- The CV (from the internal sequencer or from the external CV input) via the Filter Tracking Pot. (Linear.)
- AC-coupled signal from the Audio Filter FM input (tip of old headphone socket). (Linear as well.)
- DC coupled signal from the Filter CV Input. (Exponential: about 1 volt / octave.)

The Filter Frequency will no longer be driven by the MIDI In system when any one of the following occurs:

1. Note and Filter Frequency reception is turned off by holding **BACK** and pressing and releasing **TAP**. (See page 6)
2. Parameter 0 – Receive Channel – is changed.
3. Either of the Transpose parameters (1 and 2) are changed.
4. The Filter Frequency Controller parameter (3) is changed.

Points 2, 3 and 4 only cause a transitory disabling of the Filter Frequency drive. As long as the MIDI In system is ready to receive Notes and Filter Frequency Control Changes (that is, point 1 has not been done – or if it has been, it is turned on again by holding **TAP** and pressing and releasing **BACK** – see page 6), if the MIDI In system receives a Control Change message on the correct controller number (parameter 3) and MIDI Channel (parameter 0) then it will again turn on the Filter Frequency control.

The MIDI In system can receive Control Changes on controller numbers 1 to 19.

For reference, here is how this range of Control Change controller numbers is commonly used. *These are just the names of functions of other synthesizers which may transmit various controller numbers. These functions have nothing to do with the Devil Fish MIDI In system.* Those marked with * are common.

| Controller number | | Function |
|---|---|---|
| 1 | * | Modulation Wheel |
| 2 | | Breath Controller |
| 3 | | |
| 4 | | Foot Controller |
| 5 | | Portamento Time |
| 6 | * | Data Entry Slider |
| 7 | * | Volume |
| 8 | | |
| 9 | | |
| 10 | | Pan |
| 11 | | Expression |
| 12 | | Effect Control 1 |
| 13 | | Effect Control 2 |
| 14 | | |
| 15 | | |
| 16 | | General Purpose Slider 1 |
| 17 | | General Purpose Slider 2 |
| 18 | | General Purpose Slider 3 |
| 19 | | General Purpose Slider 4 |

### *Slide on Tied Notes (parameter 4)*

When this parameter is set to 1, which is the default, Slide will be turned on when a second note is played while one is already active. When it is set to 0, this will not happen – the CV to the VCO (and the CV Out socket) will change immediately to the new note's voltage. Changing this parameter to 0 will end any Slide which is on at that time due to tied notes.

### *Sustain-Slide Controller (parameter 5)*

When set to 0 (the default), this feature is disabled. When set to 1 to 19, and a Control Change message for this controller number is received on the currently selected channel (parameter 0) then the value of this message will drive Slide and/or Sustain (Gate On, even if there is no note currently playing). However this will only occur *after* at least one Note On has been received so that the MIDI In system has taken control of the TB-303's DAC. (The Blue LED will show a longer dim flash for each reception of this controller, but only when a note is played will the Gate and Slide be turned on.)

The intention is that a sequencer, or more likely a live player, will manipulate a controller number (such as 6 via a Data Entry Slider of a keyboard) to select Slide and/or Sustain. The effect of the controller values are:

| Controller value | Sustain (Gate) | Slide |
|---|---|---|
| 0 – 31 | | |
| 32 – 63 | | On |
| 64 – 95 | On | |
| 96 – 127 | On | On |

Please see the Gate and Slide sections of Section 4 above (pages 14 and 15) for details of how these signals are ORed with other signals to create the final Gate and Slide signal to the synthesiser.

### *Accent Velocity Threshold (parameter 6)*

This parameter selects which of four thresholds will be used to decide whether a new Note On event will activate the Accent signal to the synthesiser. For instance, if this parameter is set to 0 (default) then any Note On with a velocity of 65 or above will activate the Accent signal. Instruments which output a Note On event without variable velocity typically use 64 for each note's velocity.

| Parameter 6 value | Threshold equal to or above which Note On Velocity will activate Accent |
|---|---|
| 0 | 65 For MIDI In V1.0.0 to V1.0.3 this was 64. |
| 1 | 80 |
| 2 | 100 |
| 3 | 120 |

* For V1.0.0 to V1.0.3 this was 64.

Changing this value has no effect on any Note which is currently playing.

### *Receive MIDI Sync (parameter 7)*

The MIDI In reception of Sync is controlled according to the two possible values of Parameter 7:

| Parameter 7 value | Receive Sync from MIDI In | Unplug timer |
|---|---|---|
| 0 | Off | |
| **Default: 1** | **ON** | Enabled |

Changing this parameter's value from 1 to 0 resets any currently active Run/Stop and Clock which the MIDI In system is driving to the Sync socket and TB-303 CPU.

The "Turn Off reception of MIDI Notes and Control Changes" command (page 6: holding **BACK** and pressing and releasing **TAP**) *does not* affect the reception of MIDI Sync. So it is possible to receive MIDI Sync, have the Internal Sequencer playing in time with a master device which is putting out Sync and possibly notes and Control Changes, including the Filter Frequency Controller (Parameter 3) and to alternate between:

- Enabling reception of MIDI Notes and Control Changes (with these notes controlling the TB-303's DAC (which provides the Pitch voltage to the CV In socket where, if nothing is plugged in, it is routed to the Synthesizer) and:
- Disabling this, so the DAC is then controlled by the Internal Sequencer.

A potential problem with receiving MIDI Sync, is if a Start byte has been received (which causes the MIDI In system to turn on Run/Stop drive to the Sync Socket and therefore the Internal Sequencer) and if, as is usual, Clock bytes are being received (and likewise used to create Clock pulses for the Sync Socket and Internal Sequencer) the MIDI In lead is unplugged from whatever is driving it, and/or from the Sync Socket.

Without special provisions, the MIDI In system would keep driving the Run/Stop high, but would not be generating Clock pulses (to the Sync Socket, and so the Internal Sequencer). Some MIDI slave devices such as the Cyclone Analogic TT-303 Bass Bot cope with this loss of Clock bytes by turning off their Run/Stop state.

In order to halt the MIDI In system's drive of Run/Stop if there are no incoming Clock bytes, there is an **Unplug Timer** in the MIDI In firmware, which turns off this drive after 1.5 seconds elapse with no incoming Clock bytes.

Note: With a conventional MIDI lead plugged into the Sync Socket, it is not possible to simultaneously receive MIDI Sync and receive DIN Sync. However, if a special cable is used (including the Sync Cable, with one of its three normally output DIN Sync connectors being driven with DIN Sync) then it is possible that both the MIDI In system and the external source of DIN Sync will be driving the Sync Socket's Run/Stop and Clock pins – and therefore driving the Internal CPU. The outcome of this would depend on many factors and I will not attempt to discuss this usage of the system. For more details on such arrangements, please see the section below "Advanced use of the Sync-MIDI-In socket: MIDI In whilst still using the internal Tempo Clock and Run/Stop".

# 6 - Advanced use of the Sync-MIDI-In socket

## Isolation of MIDI Pin 2

The TB-303's Sync socket uses Pin 2 (centre) for ground, via a 22 ohm resistor. In most MIDI devices, this pin of the MIDI In socket is not connected to anything. It is always connected to ground on MIDI Out sockets for the purpose of grounding the shield of the cable.

The MIDI data lines (Pins 4 and 5 – on either side of the centre pin) drive the MIDI In device via an opto-isolator, to avoid problems with ground loops, which can cause background hum etc. (An opto-isolator consists of a Light Emitting Diode driving a phototransistor in an on-off manner. The serial data bits of MIDI are conveyed by light, rather than by electrical current or any form of direct electrical connection.)

This standard MIDI arrangement of having Pin 2 being a non-connection means there is no electrical connection between the MIDI Out device and the MIDI In device, other than the current flowing between pins 4 and 5 through the LED of the opto-isolator. This is not a direct electrical connection between the sending and receiving machines, so the MIDI cable connection cannot cause any ground noise problems.

With the TB-303 / Devil Fish with MIDI In, there will be no such electrical isolation between devices due to the 22 ohm resistor between pin 2 of the Sync/MIDI In socket and ground, so there could be some electrical noise, particularly if the driving device is a personal computer, which are notorious for generating electrical noise. A workaround is to use a special lead with the centre pin cut off, or disconnected, at the TB-303 / Devil Fish end. Any potential ground loop problems are likely to be less serious than if Pin 2 was directly connected to the TB-303 / Devil Fish ground. The 22 ohm resistor (which is part of the original TB-303 circuitry) is low enough to connect the TB-303 / Devil Fish ground to the ground of an external Sync source, if there was no other form of connection between these two grounds. However, the 22 ohms is high enough that it is likely to have not such a strong ill effect in the event of a “ground loop” or other such ground noise problem. (The subject of ground noise problems is extensive and difficult to comprehensively describe.)

## MIDI In whilst still using the internal Tempo Clock and Run/Stop

If a MIDI lead's plug was modified so as to cut away the metal of the shell where the locating ridge is (the top of the shell when it is plugged into the TB-303 / Devil Fish) then MIDI information can be sent to the MIDI In system without activating the Sync socket switch which disconnects the internal Tempo Clock oscillator (controlled by the Tempo knob) and the internal Run/Stop flip-flop (controlled by the Run/Stop button).

This would enable MIDI control of Note, Gate, Slide, Accent and Filter Frequency via MIDI while the TB-303's internal sequencer is operating from its internal Tempo Clock oscillator. It would also be possible to play notes – but this would take control of the TB-303's DAC away from the TB-303's CPU. Then, only the TB-303 CPU's Gate output would affect the synthesiser, since the MIDI In system takes full control over Accent and Slide.

It would also be possible to receive MIDI Sync in this mode, but the results are likely to be confusing. The final Run/Stop (to the Sync socket and the TB-303's CPU) would be the TB-303's Run/Stop ORed with the Run/Stop output of the MIDI In system. Likewise, the final Clock would be an OR of the internal Tempo Clock and whatever Clock pulses were generated by the MIDI In system in response to MIDI Clock commands. In principle, there might be some use for such an arrangement – but it would result in erratic timing for the TB-303's internal sequencer.

One potential use might be to use Start and Stop – without any Clock commands, which most sequencers would normally generate – via MIDI purely to start and stop the TB-303's internal sequencer, with its tempo being controlled manually with the Tempo knob.

### *Receiving MIDI Sync and driving external devices*

With an external box, or a special lead, it is possible to achieve the following:

1. A separate MIDI In socket, which connects only pins 4 and 5 to the TB-303 / Devil Fish's Sync/MIDI socket. This solves any ground noise problems created by the noise on the ground of the MIDI Out device.

2. One or more sockets or 5 pin DIN plugs which take the pins 1, 2 and 3 (Run/Stop, Ground and Clock) signals from the Sync socket to one or more other devices.

   Since one Sync output device can drive practically any number of Sync input devices – a dozen or a hundred, it depends on their input impedance – and since there is no need for electrical shielding of these cables, or concern about their length (tens or hundreds of metres should be fine), a suitable box with sockets, or flying leads, could be created to extend the usefulness of the MIDI In system.

We can supply such a lead. Please see the **sync-lead/** page at the Devil Fish website.

## 7 - The Pesky C4 Note in Pattern Play mode

There is a pesky **combination of circumstances** which may cause trouble with an unwanted sustaining C4 note for the Devil Fish synthesiser and any slave devices running from its CV and Gate outputs.

When the TB-303's Internal sequencer is in Pattern Play mode and one of these two combinations occur:

A - The Internal Sequencer is Running (the TB-303's Run/Stop LED – labelled "RUN BATTERY" is On – due to local Run/Stop and Tempo, DIN Sync In or MIDI Sync Receive) and the Tap button is pressed for any reason, such as any of the Devil Fish MIDI In system Front Panel operations, including reducing the MIDI Receive Channel by 1, AND the Internal Sequencer is subsequently put into a Stop state, or:

B - The Internal Sequencer is not Running and the Tap button is pressed for any reason.

Two potentially annoying things will occur:

1 - The Internal Sequencer will play and hold a note C above Middle C = 2.0 volts = C4 = MIDI Note number 72. (The pitch of this note is not affected by using the Pitch button and one of the keys to transpose the pattern.) This note will remain on until the Internal Sequencer starts playing again, in this setting of the Mode Switch (Pattern Play) or in one of the other three: Track Write, Track Play or Pattern Write. Simply changing the Mode Switch does not turn off the note.

2 - Any slave devices running from the Devil Fish's Gate output will receive a Gate On signal and so play this Pesky C4 note.

**One workaround** is to use Pattern Write Mode when changing the MIDI Receive channel or doing some other Front Panel operations. However, Pattern Write Mode does not allow two valuable features of having the Internal Sequencer playing in Pattern Play mode:

1. The ability to transpose by pressing the Transpose button and one of the keys.

2. The ability to change the Pattern being played, including selecting multiple patterns with keys 1-2; 2-3; 3-4; 1-2-3; 2-3-4; 5-6; 6-7; 7-8; 5-6-7 and 6-7-8.

The problem behaviour is built into the TB-303's Internal Sequencer.

**A second workaround** is to use Pattern Play mode of the Internal Sequencer and accept that the Internal Sequencer's C4 note on the Devil Fish synthesizer, via CV and Gate Out and **via the Devil Fish's MIDI Out system** will occur – but use a quick Start and Stop action on the Devil Fish's Run/Stop button, or on whatever master sequencer the Devil Fish is synched to, in order to stop the Pesky C4 note and, necessarily, play the first note of the current pattern for a fraction of a second.

## 8 - Firmware version history

- **1.0.0** 2004-12-09 First version, only one machine still has this.

- **1.0.1** 2004-12-22 Fixed a bug which was discovered in V1.0.0 in the saving of a changed parameter value to Non Volatile Memory.

- **1.0.2** 2005-02-16 Fixed potential problems when machine is turned off then on again quickly. Previous versions did not have the PIC Brown Out Detector enabled and sometimes the PIC would wake up in a strange state. On some occasions, the MIDI Receive Channel parameter was corrupted to be 255. (Most easily fixed by going Up one, to 256 = 0, which is MIDI Channel 1.) Turned on the Brown Out Detector which stopped these problems as far as I can observe, and moved the parameters up in EEPROM so they do not use location 00, which may be more likely to be corrupted than other locations.

- **1.0.3** 2008-01-01 Added a function to the "Turn Off reception of MIDI notes and controllers" command, which stops receiving MIDI In Sync and resets the Run/Stop and Clock drive to the TB-303's Sync Socket and so to its Internal Sequencer and front panel LED. The last Devil Fish to use this version was modified in February 2013.

- **1.0.4** 2013-12-23. Fixed bugs and changed capabilities with respect to V1.0.3:

    - Changed the threshold voltage for the 0 setting of parameter 6 (Accent Velocity Threshold) from 64 to 65. V1.0.3 would play an Accented note for a MIDI In note with velocity 64 and above. However 64 is the usual velocity to for notes which come from a non-velocity sensitive instrument.

    - Fixed the 1 semitone offset bug. The pitch played is now exactly that of the MIDI In note message, according to the Transpose parameters. The highest voltage output is now 5.333 volts, for MIDI Note Number 100 (E6).

    - Removed the facility mentioned on page 8 of the MIDI In 1.0.3 manual, introduced in V1.0.3, for turning off Sync reception with the "Turn Off MIDI reception of Notes and Controllers". I introduced this to solve a problem which may occur if the MIDI In lead is unplugged while the Devil Fish MIDI In system is running from MIDI Sync: this state would persist, preventing the Internal Sequencer (and the drive to Sync Socket) from being controlled by the Run/Stop button, until either Sync reception was turned off (parameter 7, page 11) or the machine was turned off and on again. This facility works as intended – providing an easy way to turn of a no-longer wanted Run state. However, this facility had the potentially unwanted effect that it was no longer possible to alternate the control of the DAC and therefore the Devil Fish synthesizer between the Internal Sequencer playing from MIDI Sync and the notes being received on MIDI In, since turning off MIDI In reception would also turn off the Run state. In versions 1.0.4 and later I removed this feature. For V1.0.0, V1.0.1 and V1.0.2 and for V1.0.4, if the Run/Stop LED remains on after the MIDI In lead has been removed, the easiest way to restore normal operation is to turn the machine off and on again.

    - Machines I work on to install 1.0.4 or later versions will have a hardware change which resets the Internal Sequencer's Accent flip-flop at power on.

## 9 - Document history

- 2004-12-22 Added *Firmware version history* section, covering up to Version 1.0.1.
- 2004-12-24 Updated material on Slide. MIDI In overrides both TB-303 CPU's Slide and the Devil Fish Slide input, not just the TB-303 CPU's. Added material on how this override begins and ends.
- 2005-02-10 Minor improvements and added details of the new MIDI and three-output Sync lead.
- 2005-02-16 Updated for Version 1.0.2. Added note about Evolution keyboards having 5 volts and a MIDI signal on the outside pins.
- 2007-11-27 Added link to Sync Lead page.
- 2008-01-01 Added documentation of version 1.0.3 firmware.
- 2010-01-02 Converted to PDF format.
- 2013-03-02 Added notes about the behaviour of the Blue LED when pressing buttons. Slightly rewrote some button pressing instructions.
- 2013-07-06 Corrected instructions on how to display the firmware version number.
- 2013-08-10 Forked the manual into three documents: for the V1.0.0 to 1.0.3 MIDI In systems, for the 1.0.4 MIDI In system and for the 2.1.0 MIDI In and Out system.
- 2013-08-19 to 2013-09-23 Improvements thanks to proofreading and suggestions by Lincoln Webber.
- 2013-10-23 to 2013-11-03 Expanded the list of differences between V1.0.4 and previous versions and added note that this manual doesn't yet cover these changes. On 2013-11-03 I added the section on the Pesky C4 note.
- 2014-01-26. Minor improvements to the text.
- 2014-09-26. Fixed ommision of TAP button press in step b of example of changing the MIDI In Channel from 1 to 5. Other minor improvements to the text.