

# Voice Programming on the Yamaha Reface DX

## Part 1: Introduction

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## 1 Introduction

In 2015, Yamaha released a series of four mini-keyboards based on earlier Yamaha sound-generation technology; one of these was the Reface DX, which is derived from the classic Yamaha DX7. The Reface DX is a great synthesizer - it has a powerful, fully programmable, seven octave FM (Frequency Modulation) tone generator attached to a solidly built, velocity sensitive keyboard, and it is quite affordable.

The primary point of this (and later) articles is to explain how to modify or create sounds on the Reface DX (which I will refer to as “RDX” for brevity). FM synthesis was developed by John Chowning of Stanford University and was first commercially available (at least in mass production) with the release of the Yamaha DX7 synthesizer in 1983. The sounds of the DX7 were extremely popular, but manipulating or creating voices was complicated. However, good documentation was available that described how to do it (e.g., Howard Massey’s 1986 book, *The Complete DX7*), as well as a book that explained the theoretical basis of FM, using the DX7 as an experimental platform (*FM Theory and Applications*, by Chowning and Bristow).

For the RDX, there is extensive online material that addresses these topics (see the **Resources** section), but it is spread over multiple sites, and there does not appear to be any coherent printable standalone material on the subject. This series of articles is intended to provide a thorough introduction to sound manipulation on the RDX, describing FM foundations in detail using the RDX as an experimental platform. The articles are intended for people who are not familiar with FM synthesis (or synthesizers at all), as well as providing

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Many thanks to Martin Tarenskeen for the amazing *Reface DX Legacy Project* (<http://refacedx.martintarenskeen.nl>), and for his consistently helpful answers to email questions about the Reface DX and FM programming. Thanks also to Margaret Loomis for her insightful comments on style, grammar, and punctuation.

some useful information for people who are familiar with other FM instruments, but not with the RDX itself. If you're new to FM and you encounter some technical gibberish that you don't understand (particularly in the footnotes), just skip over it and move on to the actual voice examples and manipulations.

This is not an academic article so I am not using inline references, but any publication mentioned in these articles will be described in the **Resources** section (Appendix B). Many of the resources are available online, and I've tried to include clickable PDF links. The **Resources** section also lists a number of online sites for learning about voice programming on the RDX.

This first article will give an overview of the RDX, and also describe some of the reasons that FM synthesis is interesting. It will then provide a short summary of some important front panel functions, followed by an introduction to modifying some (non-FM) voice characteristics of the RDX.

The plan for subsequent articles is as follows:

- Part 2 will provide an introduction to Frequency Modulation sound synthesis (operators, carriers, modulators, algorithms, etc.), as well as a guided tour of the presets, with examples of some of the programmable characteristics and some useful modifications. It will also provide an introduction to the process of voice analysis/dissection - analysis of existing voices is, and has always been, one of the best ways to learn FM synthesis.
- Part 3 will go into more detail on some of the RDX presets and describe how to experiment with existing voices. It will also describe the educational (really!) and potentially fun (really!) process of entering a voice from the RDX front panel (just like in the olde DX7 days).
- Part 4 will build up a voice from scratch (i.e., from VOICE INIT). It will start with a basic electric organ sound using additive sine waves (simple, but fun and useful) and then expand it some to use the FM capabilities of Frequency Modulation (including Feedback). It will also provide examples of other RDX organ voices available from the internet.
- Part 5 will provide some exercises on the fundamentals of FM that can be done on the RDX, largely based on the DX7 "X"-amples in Chowning and Bristow's book, *FM Theory and Applications*. This may not be immediately useful for voice programming purposes, but it is important if you really want to understand FM synthesis. This should equip you to follow all of the Chowning and Bristow examples using an RDX, should you like that kind of technical stuff.

This introductory article is **not** intended as a substitute for the *Reface Owner's Manual*. I will assume that:

1. You have access to (and have at least skimmed) the owner's manual (see the **Resources** section if not).
2. You have a basic understanding of how the front panel touch controller interface works, and how it relates to the LCD display (see pages 16-18 of the owner's manual).
3. You know how to call up the 32 voices stored in Voice memory (four banks, eight voices per bank) (see page 20 of the owner's manual).

## 2 FM Synthesis

Why should anyone care about a 40-year-old digital synthesis technology when you can use a sophisticated sampling device? Why should you be interested in an FM 4-operator, 3-octave mini-keyboard that can only play eight notes at a time, when you can have an 88-key, 8-operator Yamaha Montage that has 128 note polyphony and 82 FM algorithms?

1. The RDX is much more portable (and much cheaper).
2. The RDX is a powerful FM tone generator that can create some really great sounds, even with just four FM operators.<sup>1</sup> The RDX cannot layer voices like the TX81Z and V50, but various enhancements (including the two built-in Effects units) help compensate for some of its limitations.<sup>2</sup>
3. Synthesis is intellectually intriguing. Rather than starting with a complex digital recording of a sound and modifying it, sounds are created from scratch, using sine waves as the starting wave form. Analog synths did this with envelopes and filters; FM synths did this by modulating one sine wave (the “carrier”) with another sine wave (the “modulator”).<sup>3</sup> One of the initial motivations for FM (in the early 1970s) was the replication of acoustic instrument sounds using computers. In particular, one important characteristic of acoustic sounds, particularly the initial attack, is the change over time (slowly or rapidly) of a rich and complex frequency spectrum (the timbre), and the modulation approach of FM is very good for this. A second strong point of FM is the ability to precisely control many aspects of the sound (not just volume) with key press velocity.

FM is one of the better synthesis methods for emulating acoustic instruments (and certainly the most available), and it is also very flexible for creating completely new sounds. It’s not simple and straightforward, but it’s quite easy to experiment with on a decent FM synthesizer like the RDX.

4. Although the RDX may look like a toy, it is a powerful, standalone, fully programmable FM synthesizer. It has great sound, decent built-in speakers, and can run on AA batteries. It can also be used as a small velocity-sensitive MIDI controller for an external tone generator (I sometimes use it with my microtunable TX81Z), or, if the 3-octave keyboard is too limited for you, the RDX can be used as a seven octave tone

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<sup>1</sup>FM operators will be covered in detail in Part 2; for now, just think of it as a programmable sine wave generator. The four operators can be combined in various ways; this is the “Algorithm” diagram you see when you select a voice. See “FM Tone Generator” on page 18 of the owner’s manual.

<sup>2</sup>Some of the FM enhancements on the RDX are the ability to apply two types of feedback (sawtooth and square wave) to **each** of the four operators, new 4-op algorithms, the ability to use Pitch LFO and Pitch EG on any subset of the four operators, and eight-parameter envelopes (like the DX7, rather than the simpler five-parameter ADSR envelopes on most Yamaha 4-op synths). Some significant differences (not necessarily improvements) of the RDX from other Yamaha FM instruments are a different Level Scaling breakpoint, and the way feedback is processed with respect to the operator output level and envelope.

<sup>3</sup>This is conceptually similar to FM radio, but it uses audio-range frequencies for both carriers and modulators. The modulation can create very rich harmonic output, with the resulting sound dependent on both the frequency and the amplitude of the modulating signal. The amplitude of the modulating wave is controlled by a programmed envelope, which allows precise dynamic control of timbre over time.

generator for an external MIDI controller. The auxiliary jack allows you to plug in an external music device and play along using the RDX built-in speakers.

Pretty good for \$300 (in the US).

The RDX is fully programmable from the buttons and controls on the front panel, and that is the approach I will take in this article. However, you may prefer to do graphical voice editing from a MIDI-connected computer. Two options for this are the editor on Yamaha's *Soundmondo* website, and the CTRLR panel available at the *Reface DX Legacy Project* web site (see **Resources**).

### 3 Voice Sources

Although this series of articles will focus on the RDX presets, it is worth knowing about two online sites that provide thousands of free RDX voices: Yamaha's *Soundmondo* website and the *Reface DX Legacy Project* website (see the **Resources** section for further details and the actual web links). There are lots of great voices available on both sites, although in both cases it can be a bit of a chore to search through the large number of voices to find ones that you really like. You will also have to figure out a way to download them to your RDX from your particular home setup (using MIDI, over USB or MIDI cables). There are too many variations to cover here – I personally use “amidi” on Linux to download SYSX files, but that probably won't work for you.

*Soundmondo* has thousands of user-programmed Reface DX voices available for download, either using a MIDI-enabled Google Chrome browser, or by using a smartphone application. I do not run the required Google Chrome nor do I have the required smartphone, so I haven't been able to directly use *Soundmondo* for anything useful. As a result, I don't know much about the site, so you're on your own. However, the voices are specifically targeted for the Reface DX, so they will often make full use of the RDX capabilities. Some of the voices are excellent.

The *Reface DX Legacy Project* (henceforth RDLP) is an open-source project that provides RDX translations of factory presets and other voices from older 4-op FM synthesizers such as the Yamaha V50 and TX81Z (the tone generator of the RDX is significantly different from the earlier models, so the translation is non-trivial). All of the RDLP voices are supplied in both MIDI and SYSEX formats, as well as a TXT file format that lists the parameters for each voice. This gives you the option of entering them from the front panel, which is slightly tedious but educational (this was a fairly standard approach for the DX7 back in the 1980s, when you could buy books of printed patches and then enter them by hand).

### 4 General Interface

Before starting on aspects of sound generation, I will review some of the basic functionality of the RDX. This is not a substitute for the owner's manual, but I want to emphasize and clarify some features that are important for voice programming.

## 4.1 Voice Storage and Memory

The RDX has writeable voice storage for four banks of eight voices, accessed by the front panel VOICE SELECT/EDIT buttons (unfortunately, you can only cycle through the banks in ascending order). These 32 locations are shipped with the factory presets, but you can overwrite them with downloaded or customized voices; the voice memory is retained over power off. The RDX is sometimes criticized for only having 32 voices, however, this overlooks the fact that the 32 factory presets are stored in ROM and can be recalled individually at any time without affecting any stored voices (this is done using VOICE RECALL, which is described below).

Editing a voice (or recalling a preset using VOICE RECALL, or downloading a voice over MIDI) loads the voice into a transient edit buffer; this edit buffer is **not** saved over power off. If you want to save your changes, use the STORE button (the RDX doesn't require turning off a "Memory Protect" mode like most earlier Yamaha devices). This means that working with a voice will not affect voice memory; however, it also means that if you change to a different voice you will lose your edit. (If you accidentally do this, you can sometimes get your edit back by doing an EDIT RECALL; see page 22 of the owner's manual.)

## 4.2 Slider Control

One convenient (though sometimes glitchy) aspect of the RDX is the four parallel touch slider controls (see pages 16-18 of the owner's manual). These controllers help make front-panel editing simpler than on earlier FM instruments, and they also can be used as real-time controls during performance, substituting for the missing modulation wheel (most of the controlled parameters have an immediate effect on the currently playing voice).

However, one significant downside is that moving one touch slider can often affect one of the adjoining sliders, so watch carefully! Similarly, even if you're not editing a voice, accidentally brushing the touch panel can sometimes cause an unintended change to a voice. Setting Frequency can be a bit of a pain, and if you're used to device touch screens, you'll probably find yourself occasionally sliding your finger on the LCD display and wondering why it's not working.

## 4.3 FUNCTION button

The FUNCTION button provides access to a variety of different configuration capabilities (see pages 21-22 of the owner's manual; the TUNE screen is described on pages 13-14 of the *Supplementary Manual*). Unlike the other Reface instruments, the RDX allows you to configure various aspects of the instrument (e.g., device parameters such as master tune and speaker on/off) from a menu interface.<sup>4</sup> The values are persistent (that is, saved over power off). No explicit STORE is required to save values, although you do need to switch out of FUNCTION mode before powering off (e.g., push the BANK button).

There are five labeled screens accessed from the FUNCTION button; they can be cycled through in one direction only. After a power on, an initial press of the FUNCTION button

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<sup>4</sup>The RDX device parameters are M.TUNE (Master Tune, up or down about a quarter step in intervals of .2 HZ), M.TP (Master Transpose, up or down one octave in intervals of a half-step), four MIDI parameters (TR CH, RV CH, LOCAL, and CONTROL; see page 21 of the owner's manual), AUTO P.OFF and SP (described later), and SUSTAIN and CONTRAST (see page 22 of the owner's manual).

will place you on the VOICE screen, which allows configuring four voice-specific parameters that are stored with the voice. One parameter accessed from the FUNCTION:VOICE page is Voice Transpose (TP), which changes the pitch of the voice up or down as much as two octaves, in half-step intervals. This can be very useful with FM, as voices can vary drastically in differ in different registers, and you may prefer a preset in a different pitch range. (You can even use TP as a real-time control: play a note, and use the control to play a melody!) The pitch bend parameter (PB) sets the range controlled by the pitch bend lever for this voice (up to two octaves, including the option of reversing the direction so that pulling the PB lever towards you raises the pitch). The other two parameters relate to monophonic voices; these will be described later.

The next three screens (TUNE, MIDI, and SYSTEM) control the persistent device parameters mentioned above. Two very useful ones are SYSTEM:SP, which controls whether or not the RDX on-board speaker will be active, and SYSTEM:AUTO P.OFF, which controls whether the RDX will automatically power off after 30 minutes of non-use (this is valuable if you're running on batteries, less important if not).

One more press of the FUNCTION button gets you to the JOB screen, which contains two important commands for these articles: VOICE INIT and VOICE RECALL. VOICE INIT creates a simple voice in the edit buffer that consists of a single sine wave, with an organ-like square envelope; the Effects are disabled (set to THRU). To execute this (try it!), go to the JOBS screen, press VOICE INIT, and then press YES when you are asked, "Are you sure?" Now press a key on the keyboard; you will hear a sine wave that is matched to the intended key pitch. If you press the BANK button, you will see that the voice name in the transient edit buffer is "INIT VOICE".

VOICE RECALL allows you to retrieve any of the factory presets into the (transient) edit buffer (and then STORE it in any location if you wish to do so). However, you need to know the location (bank and voice number) of the preset you're interested in, and this information, surprisingly, is not listed anywhere in the Yamaha documentation (nor is it available on the RDX itself). A list is provided in Appendix A.

So: to recall a preset, set the Bank/Voice to the preset you want (e.g., Bank 1, Voice 4 for LegendEP), go to the FUNCTION:JOB screen, press VOICE RECAL, and confirm with YES. If you play a key, you will hear the designated preset, and if you press the BANK button, you will see that the voice name in the edit buffer is now "LegendEP". If you change to another voice without doing a STORE first, the preset will disappear. (My own approach is to to leave Bank 4, Voice 8 available to STORE a preset that has been recalled.)

## 4.4 STORE button

I was planning to skip the STORE button in this article (it's described on page 23 of the owner's manual), but I recently discovered that STORE provides a way to do a close equivalent to the (very useful) EDIT/COMPARE function on earlier Yamaha FM synths.

The STORE button stores the contents of the current edit buffer (including FM, EFFECT, and FUNCTION:VOICE parameters) into one of the 32 persistent voice memory locations. After pressing STORE, you can choose a location by either using the slider, or by pressing the BANK and NUMBER buttons. You can alter the name before storing, and can use the CHECK button to retrieve the name of the voice you're about to overwrite to make sure you're Doing the Right Thing. Finally, press the STORE touch

button, and confirm with YES.

But wait: it turns out that the CHECK button can be toggled to a speaker icon. This allows you to compare the original stored voice with your edited version **with a single keystroke** (like the EDIT/COMPARE button of most other Yamaha FM synths).

To do this, I'll assume that you are editing a voice that was stored in a voice memory location, and you have done some edits that you want to compare with the original.

1. Press the **\*physical\*** STORE button. Playing the keyboard will play your edited voice.
2. Press the CHECK touch button; the display will change to a speaker icon. Playing the keyboard will now play the original stored voice.
3. You can use the CHECK button to toggle back and forth between the CHECK display and the speaker icon to switch between your edited version and the stored version.
4. Press the **\*physical\*** STORE button again to go back to editing (or you could actually choose to STORE the voice if you want).

## 4.5 Miscellaneous

The RDX is velocity sensitive, but it does not have aftertouch, and it doesn't even have a modulation wheel (though the control sliders provide a similar capability). The RDX (along with the other Reface keyboards) has a front panel OCTAVE switch that can shift the keyboard up or down one or two octaves; this affects the pitch of built-in sound generation and MIDI output, but does not affect the pitch if the RDX is being controlled by an external tone generator.

The only external non-MIDI controller that can be directly plugged into the RDX is a sustain pedal (no volume pedal, and no trendy-in-the-80s breath controller). However, control of the RDX can be done using an external MIDI controller (e.g., a Yamaha MFC10 foot pedal). You'll probably need to use the information provided in the *Reface Data List*.

## 5 Reface DX Sound Components, Voice Editing, and Factory Presets

OK, now that we've covered the basic logistics of the Reface DX, it's time to dig into the sound generation capabilities - the fun part! Virtually every aspect of the sounds generated by the RDX can be manipulated/programmed by the user. However, it is non-trivial: the total number of parameters (numbers) to define a voice is about 115, so understanding it will take time. This introduction will only describe a subset of these parameters, but you can experiment with anything you want. Editing on the RDX is risk-free since it takes place in a transient edit buffer (as long as you don't push STORE). If you're pushing editing buttons and have gotten confused and aren't sure what state your RDX is in, pressing the BANK button will usually get you back to the top level without affecting your changes. Alternatively, just turn your RDX off and then back on. You will be in play mode, with Bank 1, Voice 1 active (but your most recent edit changes will be lost).

This first article will cover two components of RDX voice programming: the EFFECTS button, and the VOICE components accessed from the FUNCTION button. The FM components of RDX voice programming will be covered in later articles, although the next subsection will provide a very brief overview for those who want to experiment with it.

To demonstrate the voice programming capabilities of the RDX, these articles will often make use of the 32 factory preset voices. These are the voices that were stored in memory when you first opened the box, and that are permanently available in ROM. Many users are not particularly fond of the RDX presets. Some of them are musically useful, but a number of them are primarily sound effects, and even among the 32 presets there's a certain amount of repetition. However, the presets on a synthesizer are often intended as examples of its capabilities (so they are educationally useful), and, critically, these are voices that every RDX user has immediate access to.

For simplicity, I'll assume your RDX has voices stored as they were when you first took it out of the box, with the presets as listed in Appendix A (that is, it is in the equivalent of a FACTORY RESET state). If your RDX already has alternate stored voices you want to keep, that's fine - you can use VOICE RECALL to temporarily recall individual factory presets without affecting your stored voices.

My reference style for a preset will be, for example, "P3.1" for Bank 3, Voice 1 (WoodEP).

## 5.1 Frequency Modulation Overview

This section will give a brief summary of the FM (Frequency Modulation) aspects of RDX voice generation. This will be terse and technical; the material will be covered in more gentle detail in later articles. You can (and perhaps should) skip this section if you want to; it is not necessary for the rest of this Introduction.

The FM sounds for the RDX are constructed from four operators, where an operator is a fundamental Yamaha FM component consisting of an oscillator (a sine wave with a programmable frequency (FREQ) and output level (LEVEL)), an output envelope (EG: Envelope Generator, with four RATEs and four LEVELs for each operator), and a number of other programmable components (accessed from the OP1-OP4 buttons). Each operator can be used as either an FM "carrier" or "modulator"; this is controlled by the "algorithm" (ALGO), which determines how the four operators are connected to each other (this is the diagram that shows up when you select a voice). Programmable aspects of a voice that are generated by the FM component include: (1) timbre (largely determined by the frequency and output levels of the operators), (2) changes over time in the sound quality, including loudness, tone quality, response to initial key press (the attack), and response to key release (all largely determined by the envelopes), (3) operator level response to key press velocity (VEL. S), and (4) a low-frequency oscillator (LFO) that can produce slow or fast cyclic changes in pitch, timbre, or volume.

Some important FM aspects of a voice can be manipulated by the four FM buttons on the front panel. These control operator frequency (FREQ), operator feedback (FB: this allows an operator to modulate itself in two different possible ways, either tending towards generating a square waveform or a sawtooth waveform, depending on the value), and operator output level (LEVEL), as well as the algorithm (ALGO). The first three buttons allow control of all four operators on one screen, and can be used either for editing, or as real-time controls during performance. More detailed FM programming can be accessed by pushing the EDIT



button, which repurposes most of the BANK/VOICE buttons; EDIT mode is documented in the *Reface DX Reference Manual*.

As mentioned earlier, if you get confused while editing, just push the BANK button to get back to the top level.

## 6 FUNCTION:VOICE Parameters

The VOICE page accessed from the FUNCTION button provides four voice parameters that are stored along with the other voice data. In addition to the transpose and pitch bend parameters described earlier, two additional parameters configure the behavior of monophonic voices. Although restricting yourself to a monophonic voice may initially seem pointless (why reduce the capabilities of the RDX so that you can only play one note at a time?), it actually has some interesting capabilities for melodic expression. I will use P1.5 (DynaLead) as the working voice throughout this section. (Five other factory presets also use MONO; see Appendix A.)

One simple capability that is probably familiar to synthesizer players, but less so to organ or piano players, is the monophonic drone effect. This is something that would be difficult or impossible to do if you actually had to finger it. It's hard to explain, so just try it: select P1.5, press a key and hold it down, then press a second key and release it. Hold one key down, then press a bunch of other keys rapidly and see what happens.

Somewhat more interesting is the way in which MONO voices respond to staccato and legato fingering - that is, whether each note is fingered separately, or whether the second key is pressed while the first note is still playing. Many RDX voices have a strong attack triggered by a keypress, and also a complex development over time; this is a result of the programmed FM envelope of the voice. With a MONO voice, if you engage in legato fingering (that is, pressing down a second key before the first is released), the second key press will **not** retrigger the envelope, but will just continue with the envelope of the first key. Again, this is hard to explain, but fairly obvious when you try it, so select P1.5 and compare staccato and legato fingering. Some of the "sound effect" type voices, such as P1.2 (WobbleBass) and P2.2 (ModemLead), will be even more dramatic if you compare quick staccato fingering with legato fingering.

Finally, monophonic voices (only) also allow doing glissando (a smooth pitch glide between successive notes) by setting the portamento value (PORTA) to non-zero. The presets do not provide a good example of this, so select P1.5 (DynaLead), and then go to the FUNCTION:VOICE page and set PORTA to 50. Now press one key, then a second key; the note will slide between them. A PORTA value of 0 means no glissando, a low value (say, 5) is a very rapid glide, and a PORTA value of 127 takes about 12 seconds to glide across three octaves. Experiment with the value.

The MONO-FULL mode used in P1.5 will **always** glide between successive notes if PORTA is non-zero, regardless of how the notes are fingered. Try changing to MONO-LGATO; in this mode, a glide will only occur with overlapped legato fingering, otherwise the notes will be separated. This allows you to control when a glissando will occur by your choice of fingering.

Depending on the characteristics of the voice (which are under your control), these MONO characteristics can allow you to play interesting variations of a melody based solely on the nature of the staccato/legato fingering; it can also substitute for pitch bend lever use in some

circumstances. Try these modifications with a voice that you like.

## 7 Effects

The digital effects on the RDX are not FM synthesis per se, but they are very important to the overall sound of the RDX. The effects settings are stored individually with each voice. The general impression I've gotten online is that the RDX effects are decent, even good, but that they don't match high-end studio effects units; they also have limited control, as each effect has only two adjustable parameters. However, the effects can help compensate for the 4-op limitation of the RDX.

In addition to their importance for sound creation, the effects are important to understanding FM on the RDX, because it will be important to turn them **\*off\*** in order to isolate the FM capabilities. This section will cover the RDX effects in moderate detail, using the presets as examples of their use, but the effects will be ignored (turned off) in later articles.

NOTE: I'm not the best person to be writing about effects, as I have very little experience with electronic effects at all. However, the effects are an important part of the RDX sounds, and they are not well described, so hopefully this combination of personal observations and web research will be useful (the effects documentation for the Reface CP in the User's Manual (pages 27-29) may or may not have some applicability here). If you notice any errors, or have any suggestions about how to make this more useful, please let me know!

### 7.1 Logistics

The RDX has two independent inline effects units; the effects choices and the parameter values are stored independently with each voice. You can use both effects units with a voice, or just one, or turn them off entirely. The effects are accessed by (surprise!) the EFFECT button. Pushing it after a power on will put you on the programming page for the EFFECT 1 unit; a second press of the EFFECT button puts you in EFFECT 2 (these will be abbreviated as EFF1 and EFF2). Using the left-hand touch control, each effect unit can either be disabled (set to THRU), or can be set to one of seven effects: Distortion (DIST), Touch Wah (T.WAH), Chorus (CHO), Flanger (FLA), Phaser (PHA), Delay (DLY), or Reverb (REV). Unfortunately, the effects can only be cycled through in one direction, in the order listed above, so multiple key presses are required to turn an effect on and off. (Note that even if the parameters for an effect are set to zero, it may still affect the sound.)

Each effect unit has two configurable parameters ranging from 0 to 127. The parameter names vary across the different effects (these will be listed below), but the actual numeric values are shared within an effects unit - that is, DRIVE=59, TONE=20 for Distortion will display as DEPTH=59, RATE=20 if you change to Chorus. The effects can be made fairly extreme when set to 127, or very subtle when set close to 0. It is possible for a voice to use two different instances of the same effect type, with different parameter settings.

One good way to get familiar with the effects is to listen to how an RDX voice sounds with one or both effects removed. Pick a voice you're interested in (or that uses an effect that you want to understand), press the EFFECT button, and set one or both effects to THRU. To experiment with the parameters, it is best to just change just one at a time. So, for instance, to look at CHORUS, set DEPTH to an obviously noticeable level (say, 64

or higher), then set the RATE value to various settings between 0 and 127 and see how it affects the sound. The parameter settings can change the effect drastically; experiment with low values (0-40), high values (100-127), and in-between values. If you want to do a back-and-forth comparison, use the approach described above in the STORE button section. (Another approach to playing with RDX effects is to use INIT VOICE, and then apply effects to it. It's actually possible to come up with useable voices this way, particularly if you add a bit of feedback and velocity sensitivity.)

Manipulating the effect parameter values has an immediate effect on the sound that is currently playing. This can be useful for experimentation, and also for real-time performance control.

The following sections provide brief discussions of each of the RDX effects, with examples using the presets. The order does not match the user interface sequence listed above. The three modulation effects (Chorus, Flanger, and Phaser) are grouped at the end.

## 7.2 Reverb

Reverb (REV) is an effect that mimics a natural environment with some echo (reverberation). Reverb has two parameters: TIME, which controls how long the reverb lasts (higher value = longer), and DEPTH, which controls ... well, try it for yourself. Unlike many other Yamaha devices, RDX Reverb has only these two numeric parameters, and there is no option for room or reverb type such as "Hall", "Stage", "Tunnel", or "Plate".<sup>5</sup> Reverb is used in 15 of the presets. A moderate amount of Reverb is used in presets such as P3.8 (FMBrass) and P3.6 (Marimba). Larger amounts are used with P4.3 (AlTiPad) and P1.5 (DynaLead); the latter voice combines Reverb with Delay. A 60s electric organ voice like P3.7 (CheezOrgan) sounds somewhat lifeless without Reverb; try raising both DEPTH and TIME to 127 to get even more Cheezy.

## 7.3 Delay

Delay (DLY) repeats the note(s) you've played, with a controllable time delay. The DEPTH parameter controls the number of repeats (higher = more), while TIME controls the time from the keypress until the first repetition starts (higher value = longer).

If the parameters are set to low-to-moderate values, the DELAY will add some reverb-like richness; P4.5 (WarmPad) and P2.2 (ModemLead) are examples. At high settings, DELAY can repeat for a very long time, although the volume decreases slowly (a hard keypress, with a parameter setting of DEPTH=127, TIME=127 is still audible after 8 minutes). This can be fun to fool around with (you can layer your playing), and is probably useful for ambient-style sounds.

P3.5 (AmbiPluck) is a good starting point for playing with high DELAY values. Play a few notes and notice the delay. Then go to EFF2, increase the DEPTH parameter to 110 or so, and then play a few keys. The result is vaguely reminiscent of some minimalist or ambient musics. If you want to stop the sound before it stops itself (highly likely), switch EFF2 from DLY to REV.

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<sup>5</sup>Someone experienced with digital reverb might be able to create a mapping between the two. I am not that person.

Now, while the notes are still playing, slide the TIME control up or down...whoa, it makes weird noises! Play some more notes, and the weird noises feed into the delay. Hit more keys, and continue playing with the TIME slider. You can now pretend to be an avant-garde electronic musician!

Finally, for more fun, switch EFF1 to DLY as well, and set the DEPTH to 110 or so. Set the TIME so that it's different than EFF2. Press a few keys, and, optionally, play with the TIME slider.

## 7.4 Touch Wah

Touch Wah (T. WAH) is an attack effect. Like a MONO envelope, it is only triggered by the first note of a legato fingered key sequence. The SENS parameter controls how sensitive the WAH effect is to keystroke velocity (this appears to apply only if the FM portion of the voice is velocity sensitive); the REZ parameter controls the resonance.

Touch Wah is an interesting effect, but it isn't used in any of the presets. One modification that works for me uses P1.5 (DynaLead). Set EFF1 to Touch Wah, set both parameters to 127, and change FUNCTION:VOICE from MONO to POLY as well. To me, this results in an interesting useable voice.

## 7.5 Distortion

Distortion (DIST) is an effect historically derived from overdriving an analog tube amplifier. The two parameters are DRIVE and TONE.

Distortion usually sounds ugly to me, particularly at high parameter settings. However, it can add significant volume, which can sometimes be useful if you're using the built-in speakers (this is largely based on the DRIVE parameter). P2.6 (BleepClv) is one example where Distortion is critical to the volume level; it is also important to the tone. P2.8 (BuzzSiren) and P4.8 (Chopper) are sound-effect type voices where Distortion is the source of the volume level.

## 7.6 Chorus, Flanger, Phaser

The remaining three effects are Chorus (CHO), Flanger (FLA), and Phaser (or Phase Shifter: PHA). They have a number of similarities (e.g., they all use the same two parameters), and they are sometimes grouped together as "modulation effects". In all three effects, a portion of the sound signal is modified (often by a low-frequency oscillator), and is then mixed back into the original signal (often with a delay). The end result is a form of cyclic pulsing sound which can be subtle or extreme depending on the parameters used. In some cases it can be used to (roughly) mimic the sound of a rotating Leslie speaker.

The DEPTH parameter controls the amount of the signal that is sent off for modification, while RATE controls the speed of the LFO (which affects the speed of the pulsing of the resulting sound). The RATE parameter covers a wide range; a low RATE of zero will cause a slow cycling rate ranging from a few to many seconds, depending on which of the three effects is being used. A high rate of 127 will cause a rapid cycle which will effectively create a tonal change on the sound.

Of the three effects, Chorus tends to be the most subtle, causing a shimmering effect, while Flanger can be fairly extreme. Phaser falls in the middle.<sup>6</sup>

Chorus (CHO) is a low-key delay/modulation effect used in 17 of the 32 presets. Some examples are P1.3 (MotionPad), P1.4 (LegendEP) and P2.7 (FeelIt). It is an important component of bell-like voices such as P1.7 (TublarBell) and P4.6 (FutureBell).

As noted, Flanger (FLA) is the most extreme of the three modulation effects; it uses shorter delay times than Chorus. Two preset examples using Flanger are P1.1 (DigiChord) and P3.2 (UniLead).

Phaser (PHA) is only used in two of the presets, P2.1 (BeginSweep) and P4.1 (SolPhase), and in both cases it's combined with Chorus. As a small modification, I think P1.1 (DigiChord) sounds good with FLA changed to PHA, and raised up an octave.

Note that if a voice uses a very slow RATE with these effects, it can seem as if random variation is happening on the note onset (this might be either useful or annoying to you). This is because the underlying time cycle is not triggered by the key stroke. Try this experiment: Select P1.1 (Digichord), and for Flanger (EFF1), set DEPTH to around 100 and RATE to around 30. Hit a single key repeatedly and slowly, and listen to the different attack over time. The same phenomenon occurs with Phaser, but it's more obvious if you raise DEPTH to 127. It's hard to hear with Chorus.

## 7.7 Other

OK, that's pretty much the last that we'll talk about effects. For the rest of the series of articles, we'll usually turn them off to look at FM synthesis. But the effects can be very useful. For example, many of the *Reface DX Legacy Project* voices that were translated from early 4-op FM devices, such as the Yamaha DX100 or TX81Z, do not make significant use of effects because effects did not exist on the original device, or existed in very limited form. So you can use effects to enhance the RDLP voices a bit, or to change them drastically. My own suspicion is that a skilled RDX voice architect might craft an FM voice specifically to make use of some of the available effects (the Manny Fernandez articles (see **Resources**) may address this).

Just for curiosity, I looked at the SoundMondo RDX voices to see which effects were used. Out of approximately 6,000 non-duplicated voices, each potentially using two effects, the most used effects were Reverb (about 3,200 voices), Chorus (2,800 voices), and Delay (1,650 voices). Distortion was used in 960 voices, Phaser in 490, Flanger in 460, and Touch Wah in 180 voices.

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<sup>6</sup>Note that the voice generated by the FM portion of the RDX can be shimmering before effects are added. This is usually implemented by using slightly mismatched operator frequencies (FREQ), by using DETUNE, or by use of the pitch or amplitude controls associated with the LFO (Low Frequency Oscillator). However, the shimmering added by Chorus is the main motivation for my earlier comment about the effects helping to compensate for the lack of operators. P1.7 (TublarBell) strikes me as an example.

## 8 What Next?

The RDX is a very powerful tone generator, which means that an article of this length can only be a starting point. I plan to write more articles, as described in the Introduction, but here are some things to play with in the meantime.

1. Search through the thousands of RDX voices available at *Soundmondo* and the *Reface DX Legacy Project*. You will almost certainly find some voices you like better than the presets. Pick some voices you like and play with them. *Soundmondo* voices will make much heavier use of the RDX effects and the new FM features than the RDLP voices will. You'll probably want to use STORE.

If you can't download the voices for some reason, you can use an RDLP TXT file and enter the voice from the RDX front panel; this process will be described in a later article. With practice, it only takes a few minutes (and it's educational!).

2. Experiment more with modifying voices (presets or otherwise). Although I haven't gone into FM in any detail, that doesn't mean you can't fool around with it.
3. Check out other materials in the **Resources** below. Many of them assume that you already have a fair amount of familiarity with FM and the RDX, but there may be some things that will be useful to you. Citations specific to the DX7 (e.g., the 1986 books by Massey, and by Chowning and Bristow) will need to have details modified for the RDX (e.g, six operator vs four operator), but the general approach and information about FM is still useful.

## 9 Appendix A: Reface DX Factory Preset List

In order to retrieve an individual preset from ROM using VOICE RECALL, you need to know where it was stored in the original memory bank layout. Somewhat surprisingly, Yamaha doesn't seem to document this **anywhere** nor is it accessible from the RDX itself. Shrink this list to about 65% and tape it on the left or right panel of your RDX. ("M" indicates a monophonic voice).

- 1.1, DigiChord
- 1.2, WobbleBass(M)
- 1.3, MotionPad
- 1.4, LegendEP
- 1.5, DynaLead(M)
- 1.6, DarkBass
- 1.7, TublarBell
- 1.8, D'n'Beats
- 2.1, BeginSweep(M)
- 2.2, MoDemLead(M)
- 2.3, BeepBass(M)
- 2.4, BitTune
- 2.5, TinPerc
- 2.6, BleepClv
- 2.7, FeelIt
- 2.8, BuzzSiren
- 3.1, WoodEP
- 3.2, UniLead(M)
- 3.3, AttackBass
- 3.4, CloudPad
- 3.5, AmbiPluck
- 3.6, Marimba
- 3.7, CheezOrgan
- 3.8, FMBrass
- 4.1, SolPhase
- 4.2, FlyingKode
- 4.3, AlTiPad
- 4.4, StarPad
- 4.5, WarmPad
- 4.6, FutureBell
- 4.7, GlassHarp
- 4.8, Chopper

## 10 Appendix B: Resources

1. *Reface Owner's Manual*

You should have gotten one of these when you bought your RDX, but just in case it wasn't included with the one you found in a dumpster, here's the online version:

[https://usa.yamaha.com/files/download/other\\_assets/6/438816/reface\\_en\\_om\\_b0.pdf](https://usa.yamaha.com/files/download/other_assets/6/438816/reface_en_om_b0.pdf)

2. *Reface Version 1.30 Supplementary Manual*

This describe some features from the 1.30 firmware update for each of the Reface instruments; these are not in the owner's manual. For the RDX, the two changes are Master Tune and Master Transpose.

[https://usa.yamaha.com/files/download/other\\_assets/0/960060/v130\\_Manual\\_en.pdf](https://usa.yamaha.com/files/download/other_assets/0/960060/v130_Manual_en.pdf)

3. *Reface DX Reference Manual*

Yamaha's documentation that covers the EDIT mode features:

[https://uk.yamaha.com/files/download/other\\_assets/7/438827/reface\\_en\\_rm\\_a0.pdf](https://uk.yamaha.com/files/download/other_assets/7/438827/reface_en_rm_a0.pdf)

4. *Reface Data List*

This contains details about MIDI System Exclusive data format, controller numbers, etc. This is important if you want to control the Reface using an external MIDI controller.

[https://usa.yamaha.com/files/download/other\\_assets/7/794817/reface\\_en\\_dl\\_b0.pdf](https://usa.yamaha.com/files/download/other_assets/7/794817/reface_en_dl_b0.pdf)

5. *Soundmondo*

Yamaha's web site for sharing and editing voices for the Reface DX and other Yamaha instruments.

<https://soundmondo.yamahasynt.com>

6. *Reface DX Legacy Project*

This project/website is a great source for RDX voices that are translations of voices from earlier 4-op FM tone generators (Yamaha TX81Z, V50, DX100, and many others). All voices are provided in SYX, MID, and TXT formats; the open-source Python program that does the translation is also available. (Note that the voice translation is difficult, and it varies significantly across instruments. Some of the translations are excellent, while some are less than excellent. However, the project is constantly being improved). If you find the site useful, please consider making a donation to support the website and its continuing improvements (it is a very complex project):

<http://refacedx.martintarenskeen.nl>

7. *YouTube*

There appear to be hundreds of YouTube videos about the Reface DX. As an example, I learned some useful things from the following "Moessieurs" video about Reface DX effects (in French, with English subtitles).

<https://www.youtube.com/watch?v=HO0IBSWWyEc>



8. *Yamaha's Online Resources*

The following site is the Yamaha entry point for articles and videos about the Reface series:

<https://www.yamahasynth.com/reface>

Of particular interest are seven articles by Manny Fernandez about programming the Reface DX. They require some FM background, as well as access to videos and other resources on *Soundmondo*, but they're very detailed. Here are current links to them:

<https://www.yamahasynth.com/learn/synth-programming/basics-of-fm-synthesis>

<https://www.yamahasynth.com/learn/synth-programming/basics-of-fm-synthesis-lesson-2>

<https://www.yamahasynth.com/learn/synth-programming/basics-of-fm-synthesis-lesson-3>

<https://www.yamahasynth.com/learn/synth-programming/basics-of-fm-synthesis-lesson-4-new>

<https://www.yamahasynth.com/learn/synth-programming/basics-of-fm-synthesis-lesson-5-new>

<https://www.yamahasynth.com/learn/synthprogramming/mannys-modulation-manifesto-lead-sounds>

<https://www.yamahasynth.com/learn/synth-programming/mannys-modulation-manifesto-wrapping-up-advanced-tips-tricks-fm-quirks>

FM basics are covered at:

<https://www.yamahasynth.com/learn/synth-programming/fm-101-article-series>

9. *The Synthesis of Complex Audio Spectra by Means of Frequency Modulation*

John Chowning. 1973. Journal of the Audio Engineering Society.

This highly technical article is the first description of FM synthesis, preceding the release of the DX7 by 10 years. It was reprinted in *Foundations of Computer Music* (see below), and is also available online at:

[https://ccrma.stanford.edu/sites/default/files/user/jc/fm\\_synthesispaper-2.pdf](https://ccrma.stanford.edu/sites/default/files/user/jc/fm_synthesispaper-2.pdf)

10. *FM Theory and Applications: By Musicians for Musicians*

John Chowning and David Bristow. 1986. Yamaha Music Foundation.

This book is somewhat mathematically oriented, but it is a very good theoretical introduction to FM that uses the DX7 as an experimental platform.

I do not know the copyright status of the following link, but the book is currently available online at:

[http://www.burnkit2600.com/manuals/fm\\_theory\\_and\\_applications.pdf](http://www.burnkit2600.com/manuals/fm_theory_and_applications.pdf)

11. *Foundations of Computer Music*

Curtis Roads and John Strawn. 1985. MIT Press.

Not for most people, but pretty cool if you're interested in FM as a (somewhat mathematical) research topic. This volume contains Chowning's original 1973 article (see above), as well as five other 1970s technical articles on FM (and a number of articles on separate topics). You will need to be familiar with FM to understand these at all, but they can be interesting even if you can't follow the math (I can't). You should be able to replicate and extend most of these results with a Reface DX.

12. *The Complete DX7*

Howard Massey. 1986. Amsco Publications.

This is a very thorough and useful (but sometimes verbose) introduction to programming the original DX7, and can be useful for learning FM. It is out of print, and not worth the current \$200 price on Amazon and Ebay.

I do not know the copyright status of the following link, but the book is currently available online at:

**<http://yates.ca/dx7/The Complete DX7/The Complete DX7.pdf>**